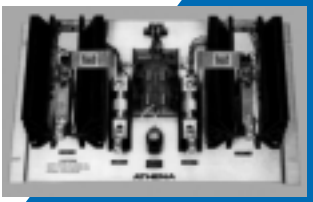
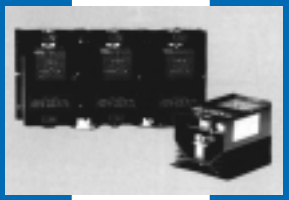
SCR Power Controllers





ATHENA

Operating Instructions

SCR POWER CONTROLLERS
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OPERATING INSTRUCTIONS

Series 19 and 39 SCR Power Controllers
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Section 1. General Description

Introduction

Athena's 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., an Athena temperature controller. For most processes, the combination of an Athena 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 no. tag) 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 suppression
Load:	Resistive, 1- or 3-phase - 3-wire wye or delta

All specifications subject to change.

Section 2. Firing Modes

Zero-Crossing Control.

A zero-crossing switched (zero-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. Athena's 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 half 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.

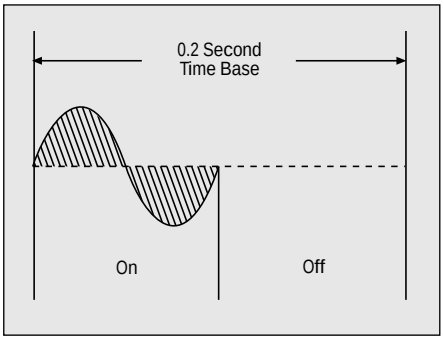


Figure 1. Time-proportioned, zero-cross burst.

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 triggered, 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.

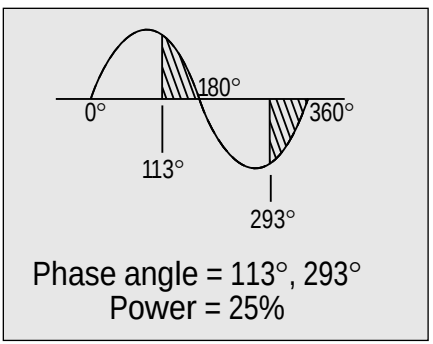


Figure 2. Phase-angle changes and their effect on output power.

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) Athena's 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

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

$$\frac{.4 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{50^{\circ}\text{C} - \text{Ambient}^{\circ}\text{C}} = \text{Min. Exposed Sq. Ft.}$$

Formula for forced air cooling

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

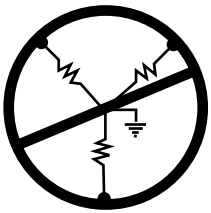
$$\frac{3.8 \times \text{AMPS} \times \#\text{ of Controlled Legs}}{122^{\circ}\text{F} - \text{Ambient}^{\circ}\text{F}} = \text{Min. CFM}$$

Figure 3. Calculations for determining cooling requirements.

3.2 Wiring

The wiring components of Athena's SCR power controllers consist 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 and 93), it is not necessary to connect the phases to any particular terminal. Because these controllers are phase-to-phase controllers, either Wye or Delta connected loads may be used.

CAUTION

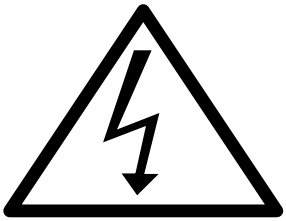


On Wye connected loads, do not connect the center terminal to the line or to the ground.

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.

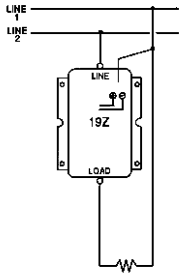


Figure 4a. Wiring scheme for Series 19Z.

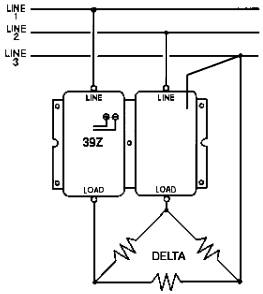


Figure 4b. Wiring scheme for Series 39Z.

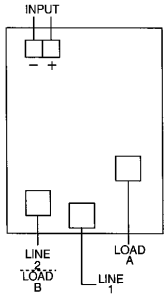


Figure 4c. Wiring scheme for Series 91Z (35, 60, 80 and 100 A).

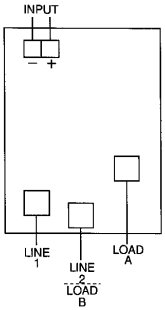


Figure 4d. Wiring scheme for Series 91Z (150 & 200 A).

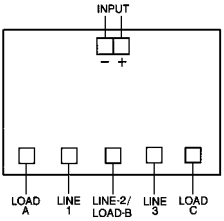


Figure 4e. Wiring scheme for Series 93Z (35, 60, 80, and 100 A).

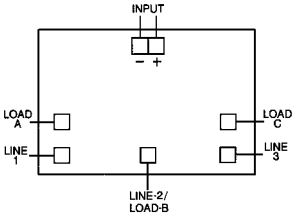


Figure 4f. Wiring scheme for Series 93Z (150 and 200 A).

3.22 Phase-Angle

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

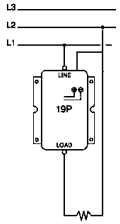


Figure 5a. Wiring scheme for Series 19P.

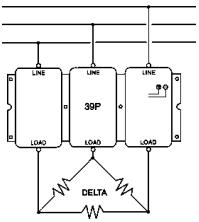


Figure 5b. Wiring scheme for Series 39P.

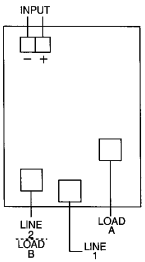


Figure 5c. Wiring scheme for Series 91P. (35, 60, 80, and 100 A).

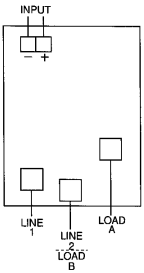


Figure 5d. Wiring scheme for Series 91P (150 and 200 A).

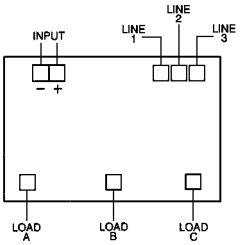


Figure 5e. Wiring scheme for Series 93P (35, 60, 80, and 100 A).

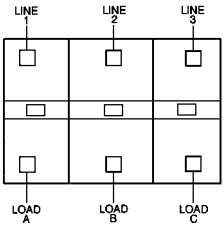


Figure 5f. Wiring scheme for Series 93P (150 & 200 A).

3.23 Fuses and Safety Warnings

Only I^2T 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. (I^2T fuses are supplied standard with the Series 91 and 93, and are available as an option with the Series 19 and 39.)

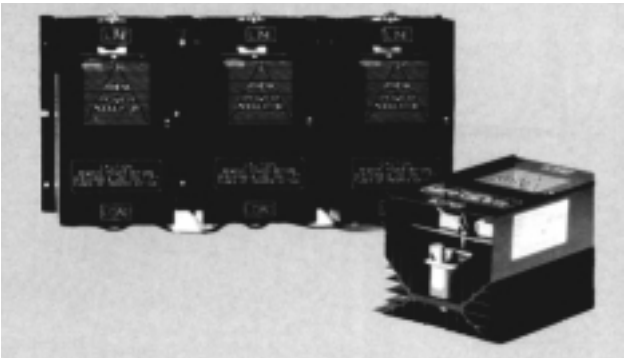
IMPORTANT SAFETY WARNINGS - READ BEFORE OPERATING CONTROLLER.


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, they have a leakage current in the OFF state on the order of 10 mA 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 separate, thermally protected safety contactor is strongly recommended.

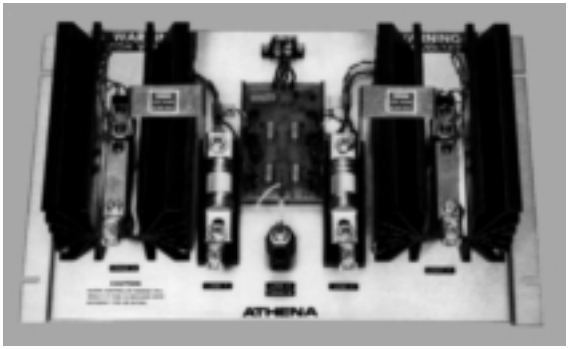
Section 4. Operation



4.1 Series 19Z/39Z/91Z/93Z

The Athena Series 19Z, 39Z, 91Z, and 93Z 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 an Athena 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/91P/93P

The Athena Series 19P, 39P, 91P, and 93P 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 an Athena temperature controller.

The "P" Suffix designates the controller as operating in the Phase-Angle firing mode. Providing full proportional control, the SCRs are turned ON during each 1/2 cycle at a point (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 output 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.

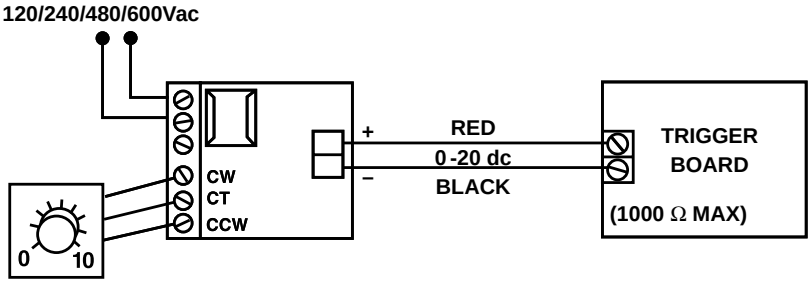


Figure 6. Wiring diagram for manual control (Option module M required).

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 CCW wires.

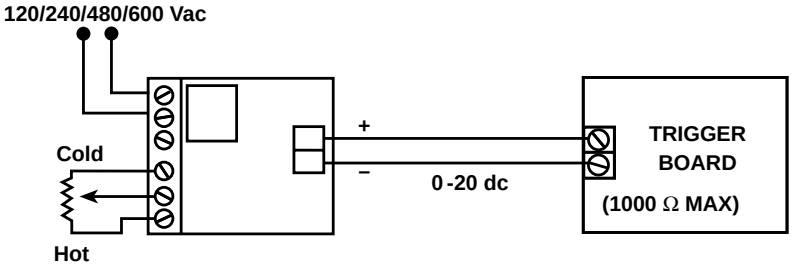
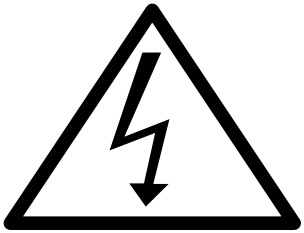


Figure 7. Wiring diagram for thermostatic control (Option H required).

4.7 Maintenance

Athena's 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. If the problem persists, contact your Athena representative or call 1-800-782-6776.

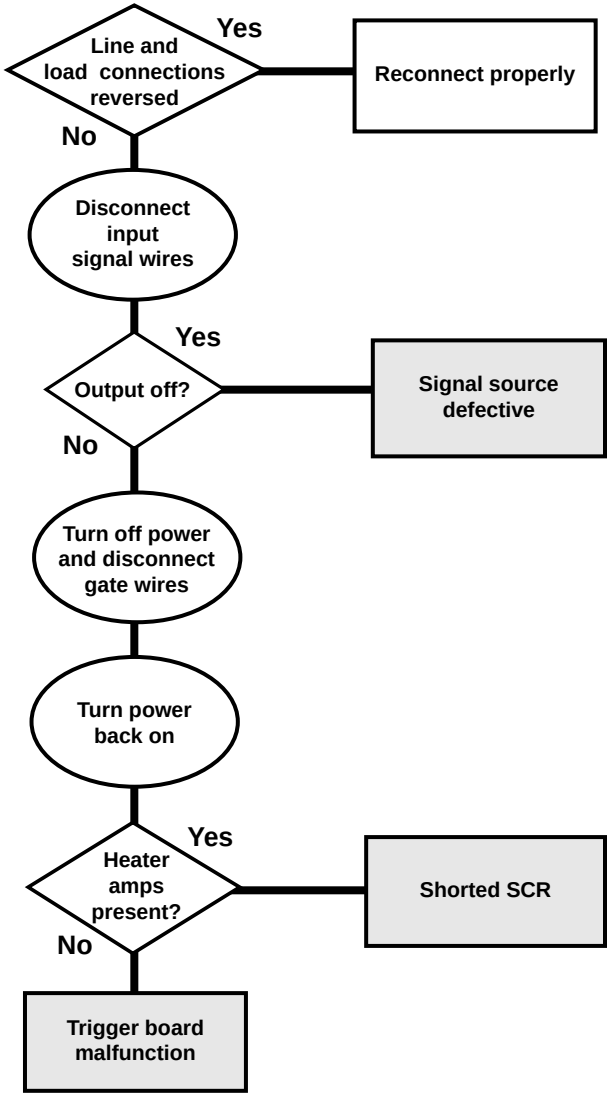
Symptom: *No heat or reduced heat output.*

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

Models 91 and 93

Symptom: *Heaters will not turn off*



Models 19 and 39

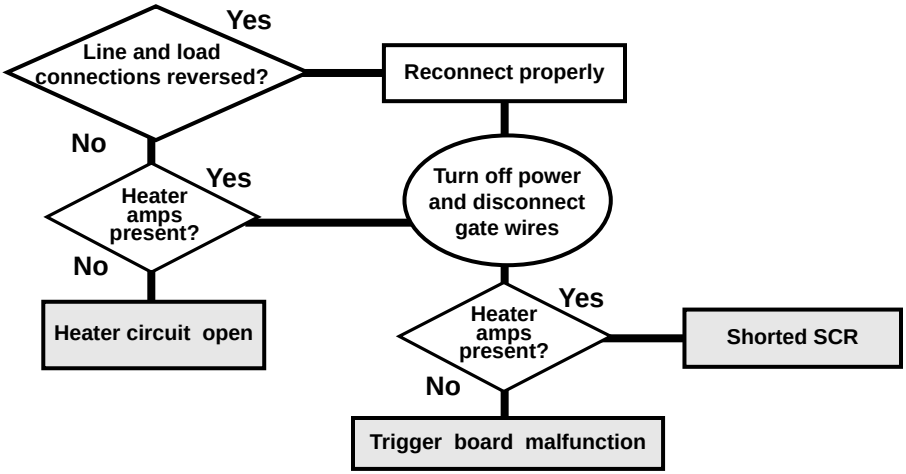
Input Signal Problems: In normal operation, the green LED will illuminate if an input signal of proper polarity is present. Its brightness indicates signal level.

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 for 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. Replacement of SCR

5.1 Procedures. ***35, 60, 80, and 100 A Controllers.***

1. Disconnect leads on SCR module. Remove mounting bolts.
2. Insert new SCR module, using heat sink compound between surface of module and heat sink. Tighten bolts securely (20-30 lb-in), and reconnect wires to SCR.

Higher-Power Controllers.

1. Remove two nuts holding mounting clamp in center of heat sink. DO NOT remove top clamp from heat sink. Move top heat sink aside and remove SCR, noting whether the flange is up or down.

2. Spread heat sink compound on both sides of the new SCR and place it in the center of the lower heat sink with the flange in the same direction as the original SCR. Place the top heat sink onto the SCR, making sure that the centering pin from the clamp assembly falls into the locating hole in the SCR. Then, push the stud bar up through the holes in the heat sinks and the clamp. Spin the hex nuts down on the clamp studs until finger-tight. Using a socket wrench, tighten each nut alternately one-half turn until the bottom side of the clamp is even with the appropriate notch on the pressure gauge (1000 lb for SCR module part numbers C350 and C380).

3. If the SCR is supplied with two trigger signal wires, unplug the original wires from the trigger board and replace with those from the new SCR, observing the same color coding. If the SCR has no trigger wires, remove the wires from the original SCR and connect them to the new SCR.

Section 6. Parts Lists

Series 19/39

		Fuses
24040/12040	A050F040	210A015U01
24060/12060	A050F060	210A012U01
24080/12080	A050URG080	210A014U01
48040	A070F040	
48060	A057F060	210A004U01
48080	FWP80	210A002U01

SCR Module (19P, 19Z, 39Z)	SCR Module (39P)
IRKT 57-10	IRKH 72-10
IRKT 57-10	IRKH 72-10
IRKT 92-10	IRKH 92-10
IRKT 57-10	IRKH 72-10
IRKT 57-10	IRKH 72-10
IRKT 92-10	IRKH 92-10

Series 91/93

Model No. (Prefix = 120, 240, 480, or 575 V) (Suffix = 35, 60, 80, 100, 150, or 200 A)	Fuses
12035	A70P35
12060	A70P60
24035	A70P35
24060	A70P60
24080	A70P80
24100	A70P100
24150	A70P150
24200	A70P200
48035	A70P35
48060	A70P60
48080	A70P80
48100	A70P100
48150	A70P150
48200	A70P200
57035	A70P35
57060	A70P60
57080	A70P80
57100	A70P100
57150	A70P150
57200	A70P200

SCR Module (91P, 91Z, 93Z)	SCR Module (93P)
CD431060	CD421060
CD431060	CD421060
CD431060	CD421060
CD431060	CD421060
CD431090	CD421090
CD431090	CD421090
C350D	A390D*
C380D	A390D*
CD431060	CD421060
CD431060	CD421060
CD431090	CD421090
CD431090	CD421090
C350N	A390N*
C380N	A390N*
CD431060	CD421060
CD431060	CD421060
CD431090	CD421090
CD431090	CD421090
C350P	A390P*
C380P	A390P*

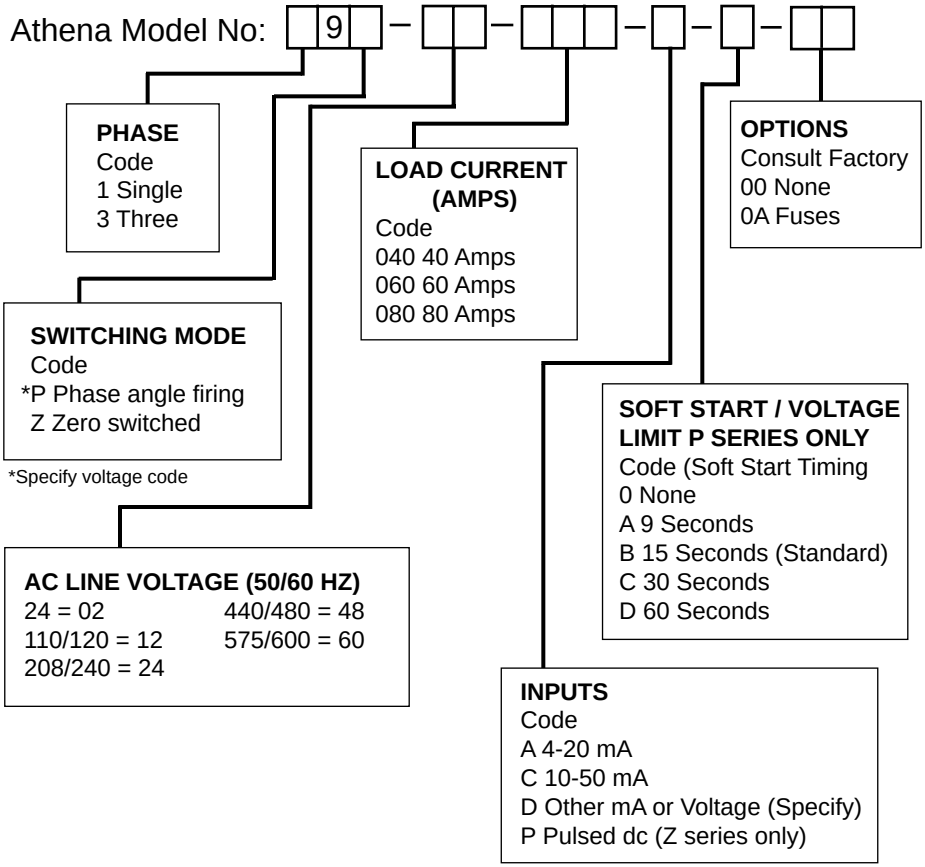
*Rectifier; 1 SCR also used on each leg. SCR listed under 93Z.

Printed Circuit Board Assemblies

Model	120V	240V	480V	575V/600
19P	785A126U02-120	785A126U02-240	785A126U02-480	785A126U02-575
19P SS & VL	785A126U01-120	785A126U01-240	785A126U01-480	785A126U01-575
19Z	785A122U01-120	785A122U01-240	785A122U01-480	785A122U01-575
39P	785A124U01-120	785A124U01-240	785A124U01-480	785A124U01-575
39P SS & VL	785A125U01-120	785A125U01-240	785A125U01-480	785A125U01-575
39Z	785A122U03-120	785A122U03-240	785A122U03-480	785A122U03-575
91P	785A094U01	785A094U02	785A094U03	785A094U04
91Z	785A174U02-120	785A174U02-240	785A174U02-480	785A174U02-575
93P	785A095U01	785A095U01	785A095U02	785A095U03
93Z	785A174U01-120	785A174U01-240	785A174U01-480	785A174U01-575
91ZR	785A097U06	785A097U07	785A097U08	—
93ZR	785A097U04	785A097U03	785A097U02	—
Voltage Limit & Soft Start	785A092U01-120	785A092U01-240	785A092U01-480	785A092U01-575
Voltage Limit Only	785A092U02-120	785A092U02-240	785A092U02-480	785A092U02-575
Manual	785A091U01-120	785A091U01-240	785A091U01-480	785A091U01-575

Section 7. Model Identification

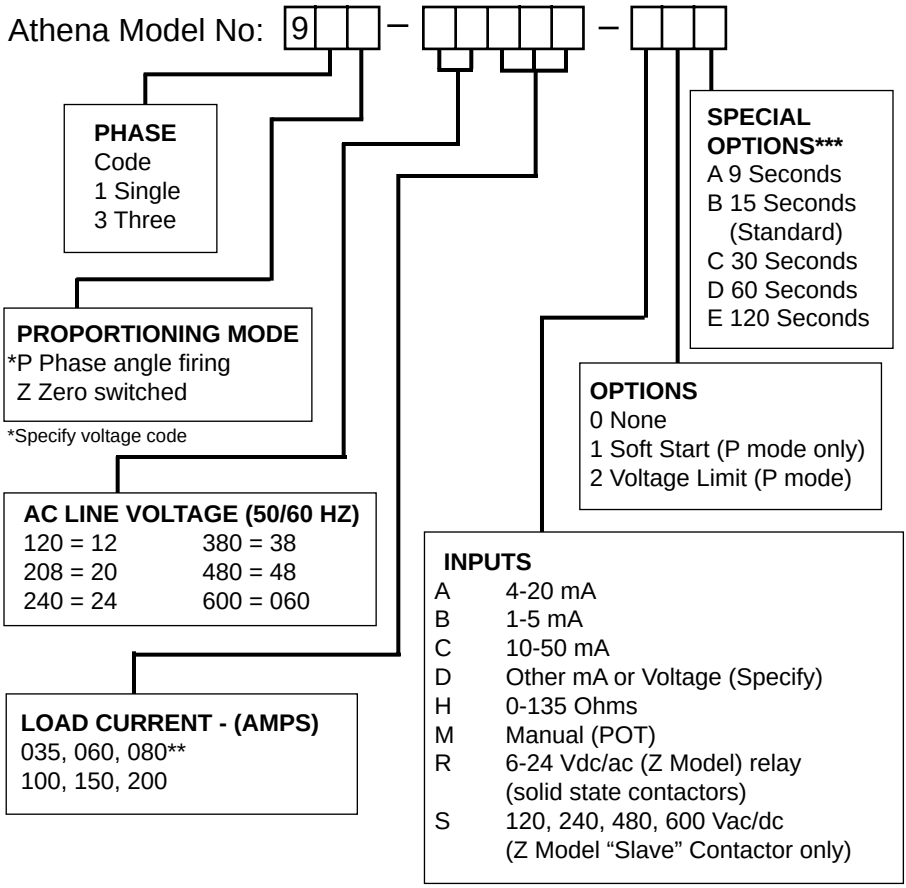
Ordering Codes: Series 19/39



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)

Odering Codes: Series 91/93



** Not available on 3 Phase, Phase Angle Units (93P)
*** Soft Start Timing Available on Phase Angle Only (91P & 93P)

Ordering Example:
91Z = 24030 — AO = Series 90 Power Controller **9**, rated single-phase **1** zero -voltage proportioning mode **Z** 240 Vac line voltage **24**, 30 A load current **030** 4 to 20 mA input **A**, with no option **0**

Section 8. 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".

Series 91/93

91P & 91Z		93Z		93P	
Output Current (amps)	Dimensions H x W x D (in)	Output Current (amps)	Dimensions H x W x D (in)	Output Current (amps)	Dimensions H x W x D (in)
35	12 1/4 x 10 1/4 x 4	35	8 3/4 x 19 x 4	35	14 x 19 x 4
60	12 1/4 x 10 1/4 x 4	60	8 3/4 x 19 x 4	60	14 x 19 x 4
75	12 1/4 x 10 1/4 x 6	75	12 1/4 x 19 x 6	100	17 1/2 x 19 x 6
100	12 1/4 x 10 1/4 x 6	100	12 1/4 x 19 x 6	150	19 1/4 x 24 x 10
150	17 x13 x 10	150	17 1/2 x 19 x 10	200	19 1/4 x 24 x 10
200	17 x13 x 10	200	17 1/2 x 19 x 10		

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- Portable controller and mainframe systems
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