QPAC

User's Manual

Modular SCR Power Control

WATLOW

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Use The Manual

How to Use the Manual

First…

This manual will make your job easier. Reading it and applying the information is a good way to become familiar with the QPAC. An overview:

Starting Out

Introduction, Chapter 1, Page 4.

Install/Wire

Installation and Wiring, Chapter 2, Page 6.

Operation

Operation, Chapter 3, Page 25.

Appendix

Troubleshooting, Page 28
Specifications
Warranty

Notes

NOTE:
Details of a "Note" appear here, in the narrow box on the outside of each page.

A bold text **"NOTE"** marks a short message in the margin to alert you to an important detail.

Safety Information

This user's manual also has **boldface** safety information notes to protect both you and your equipment. Please be attentive to them. Here are explanations:

CAUTION:
Details of a "Caution" appear here, in the narrow box on the outside of each page.

The CAUTION symbol (exclamation point) in the wide text column alerts you to a "**CAUTION**," a safety or functional hazard which could affect your *equipment* or its performance. A full explanation is in the narrow column on the outside of the page.

WARNING:
Details of a "Warning" appear here, in the narrow box on the outside of each page.

The WARNING symbol (lightning bolt) in the wide text column alerts you to a **"WARNING**," a safety hazard which could affect you and the equipment. A full explanation is in the narrow column on the outside of the page.

Your Feedback

We welcome comments or suggestions on this manual, please contact: Technical Writer, Watlow Winona, 1241 Bundy Blvd, P.O. Box 5580, Winona, MN 55987-5580. Phone: 507-454-5300; Fax: 507-452-4507.

Technical Assistance

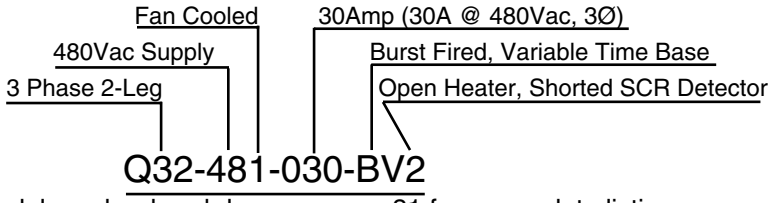
If you encounter a problem with your Watlow controller, review your configuration information to verify that your selections are consistent with your application: inputs, outputs, alarms, limits, etc. If the problem persists, you can get technical assistance from your local Watlow representative (see back cover), by e-mailing your questions to wintechsupport@watlow.com or by dialing +1 (507) 494-5656 between 7 a.m. and 5 p.m., Central Standard Time (CST). Ask for for an Applications Engineer. Please have the following information available when calling:

- Complete model number
- All configuration information
- User's Manual
- Serial Number

The model, part number, and serial numbers can be found on the label on the outside of the case.

How to Read the QPAC Model Number

The QPAC model number provides phase, supply voltage, amperage, and control type information, in that order. For example:



Refer to the model number breakdown on page 31 for a complete listing.

Table of Contents

Chapter 1

Starting Out With The QPAC,
Modular SCR Power Control

Figure 1 -
The QPAC-01
SCR Power Control

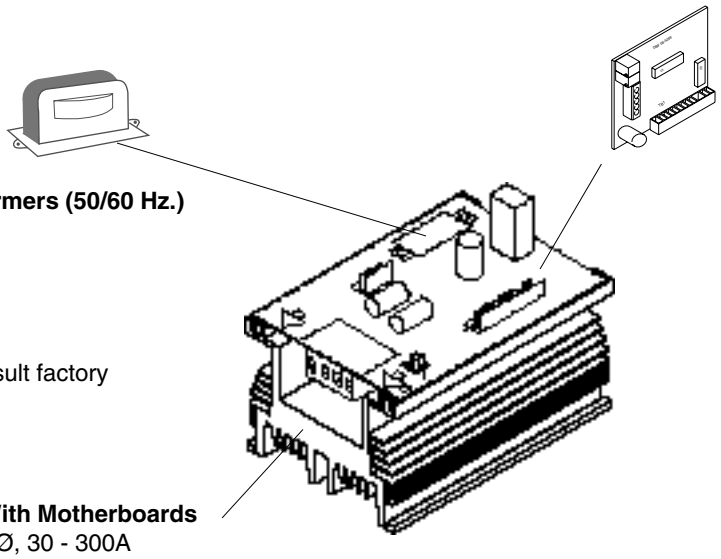
General Description

The QPAC Power Controls are a family of solid state controls used for electric heating applications. A solid state power control provides output power that is proportional to the input command signal from a temperature control. This proportional output power helps to produce a closely controlled heater temperature, which saves energy and prolongs heater life by holding heater elements at a nearly constant temperature.

The QPAC has a modular construction with plug-in features for flexibility. The three modules of the QPAC are the Power Base, Transformer, and Control

Control Cards
- Solid state contactor, AC input, CA
- Solid state contactor, DC input, CD
- Burst firing (zero cross) fixed time base, BF
- Burst firing (zero cross) variable time base, BV
- Phase angle control, AF *
- Phase angle control with current limiting, AL *

* Note: For 1Ø and 3Ø, 3 wire controls only; not for 3Ø, 2 leg controls.



Plug-in transformers (50/60 Hz.)
- 120Vac
- 208/240Vac
- 380Vac
- 415Vac
- 480Vac
- 575Vac, consult factory

Power Bases With Motherboards
- QPAC-01: 1Ø, 30 - 300A
- QPAC-32: 3Ø, 2 leg, 30 - 300A
- QPAC-33: 3Ø, 3 wire, 30 - 300A

Figure 2 - QPAC Modularity Overview

Card. See Figure 2. Power Bases are avaliable in 30 to 300A ratings with UL508 and C-UL listing and 400-1,000 amps non-agency approved in single phase, three phase-two leg and three phase-three wire configurations. A Transformer plugged into the Power Base allows the QPAC to operate on any voltage from 120 to 480Vac fan. 575Vac consult factory. The plug-in Control Card sets the QPAC's firing mode. Control Cards are available in solid state contactor, burst firing (zero cross), or phase angle firing with a wide variety of options. This modular approach, using a standard Power Base with plug-in Transformers and Control Cards, allows power control users, distributors and OEMs to maintain minimum inventories while still providing rapid service.

The different QPACs provide the types of power control needed for different power sources and loads. The QPAC-01 is designed for all single phase power sources and loads. The QPAC-32 is for three phase zero cross applications such as resistance heating elements, balanced or unbalanced. The QPAC-33 is best suited for balanced three phase, phase angle applications requiring soft start or current limiting, or with inductive loads.

Steps To Put Your Power Control To Work

To put your QPAC to work, we suggest the following steps:

- Read the User's Manual.
- Plan your installation and wiring.
- Mount the QPAC.
- Wire your QPAC to the system.
- Start the system and, if applicable, adjust the bias and gain on the QPAC.
- That's all there is to it!

Chapter 2

How to Install and Wire the QPAC

System Planning

This chapter tells you how to install the QPAC. All mounting and wiring information is right here. Watlow power controls are thoroughly tested before leaving the factory, so the QPAC is ready to install when you receive it.

This chapter is divided into three sections which describe the three steps you need to do to install the QPAC—mounting, power wiring and control card wiring. The first section lists the mounting information for each of the three types of QPACs, which, depending on amperage, use one of five case styles. The second section describes the power and load wiring of the QPACs and semiconductor fuses, if required. The last section describes the input signal wiring to the QPAC Control Card.

Before you begin working, read through this chapter to gain an understanding of the entire installation. Consider the installation carefully. Plan the power, load, and input signal wiring before mounting the QPAC. Also refer to any noise guidelines in the temperature control documentation before proceeding.

Mounting the QPAC

WARNING:
To avoid potential electric shock and other hazards, all mounting and wiring for the QPAC must conform to the National Electric Code (NEC) and other locally applicable codes.

The physical size and mounting dimensions of the QPACs are different for different current ratings. Find the "Case Style" photo on the next pages which match your QPAC. The table and figure accompanying each case style will give you corresponding physical dimensions and mounting footprint. The table also indicates if the units are equipped with fans and externally-mounted fuses. External fuse mounting templates also accompany the case style drawings. All QPACs must be mounted vertically, power connections on top, for proper cooling. Use the wiring data table below for wire sizes and bending radii.

Table 1 - QPAC Wiring Data

Current (Amps)	Semiconductor Fuse Rating (Amps)	Minimum Recommended Wire Size	Bending Radius inches	Bending Radius (mm)	Lugs Accept # Wire	QPAC Model Number	Fuse Mounting
30	2ea, 20	10	N/A		18 to 4	Q01	Onboard
	2ea, 40					Q32	External
	3ea, 40					Q33	External
50	2ea, 30	8	1.5	(38)	18 to 4	Q01	Onboard
	2ea, 70					Q32	External
	3ea, 70					Q33	External
75	100	4	2	(51)	8 to 0	All	External
100	125	1	3	(76)	8 to 0	All	External
150	200	3/0	4	(102)	4 to 3/0	All	Onboard
200	250	250 MCM	4.5	(114)	6 to 350 MCM	All	Onboard
300	400	500 MCM	8	(203)	4 to 500 MCM	All	Onboard

Case Style A

Figure 3 -
QPAC Case Style A

Case Style A Dimensions									
Model	**Amps**	**Height (H)**		**Width**		**Depth**		**Fans**	**Fuses**
		in	**(mm)**	**in**	**(mm)**	**in**	**(mm)**		
QPAC-01	30	7	178	See		6.5	165	None	Two, Onboard
QPAC-01	50	9	229	Below		6.5	165	None	Two, Onboard

Table 2 -
QPAC Case Style A
Overall Dimensions

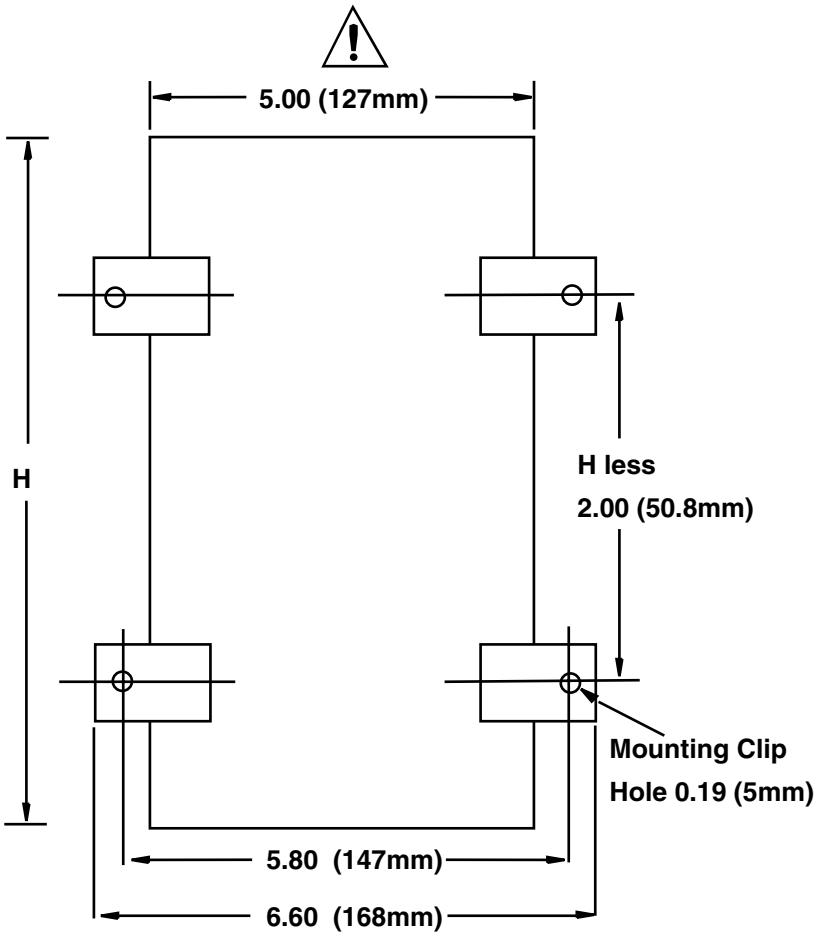


Figure 4 -
QPAC Case Style A
Mounting Footprint

CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.

Case Style B

Figure 5 -
QPAC Case Style B

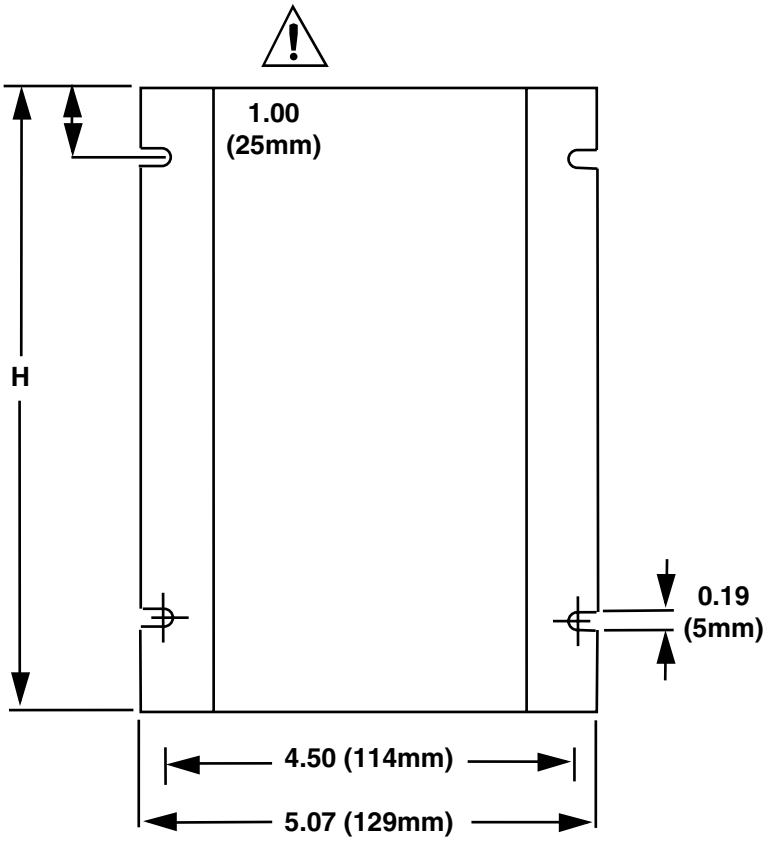
Table 3 -
QPAC Case Style B
Overall Dimensions

Case Style B Dimensions										
Model	**Amps**	**Height (H)**		**Width**		**Depth**		**Fans**	**Fuses**	**Holder (max.)**	
		in	**(mm)**	**in**	**(mm)**	**in**	**(mm)**			**in**	**(mm)**
QPAC-32	30	10.5	267	5	127	8.5	208	One	Two, External*	5.69	145
QPAC-01	75	10.5	267	5	127	8.5	208	One	One, External**	4.90	124
QPAC-01	100	10.5	267	5	127	8.5	208	One	One, External**	4.90	124
QPAC-32	50	10.5	267	5	127	8.5	165	One	Two, External*	5.69	145
QPAC-32	75	14.5	368	5	127	8.5	229	One	Two, External**	4.90	124
QPAC-32	100	14.5	368	5	127	8.5	208	One	Two, External**	4.90	124

* Note: See external fuse mounting drawing, Figure 7, Page 9.
**Note: See external fuse mounting drawing, Figure 8, Page 10.

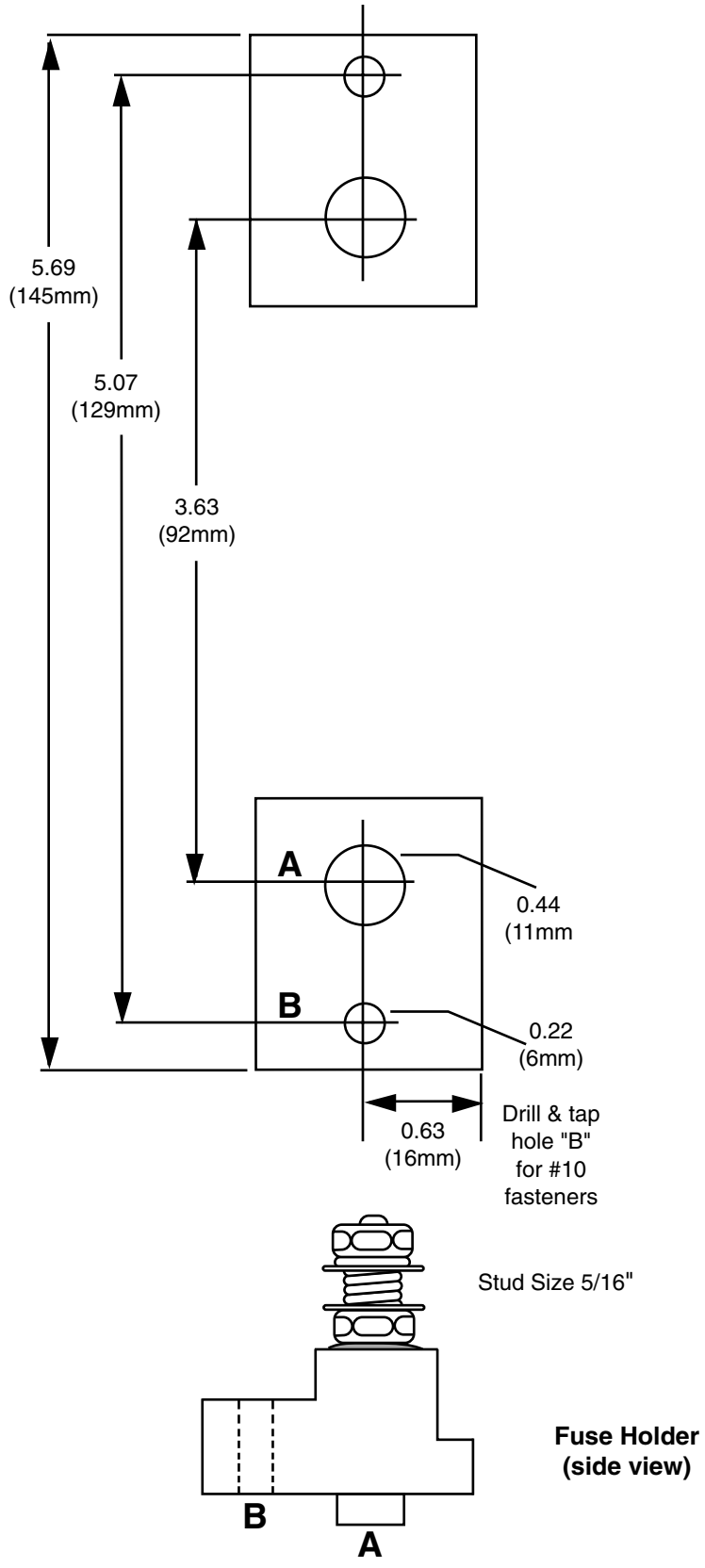
Figure 6 -
QPAC Case Style B
Mounting Footprint

CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.



Fuse Template

Use the next two pages as templates for mounting your fuse holder kit. Choose the size that matches your kit and carefully punch out the template along the perforation.



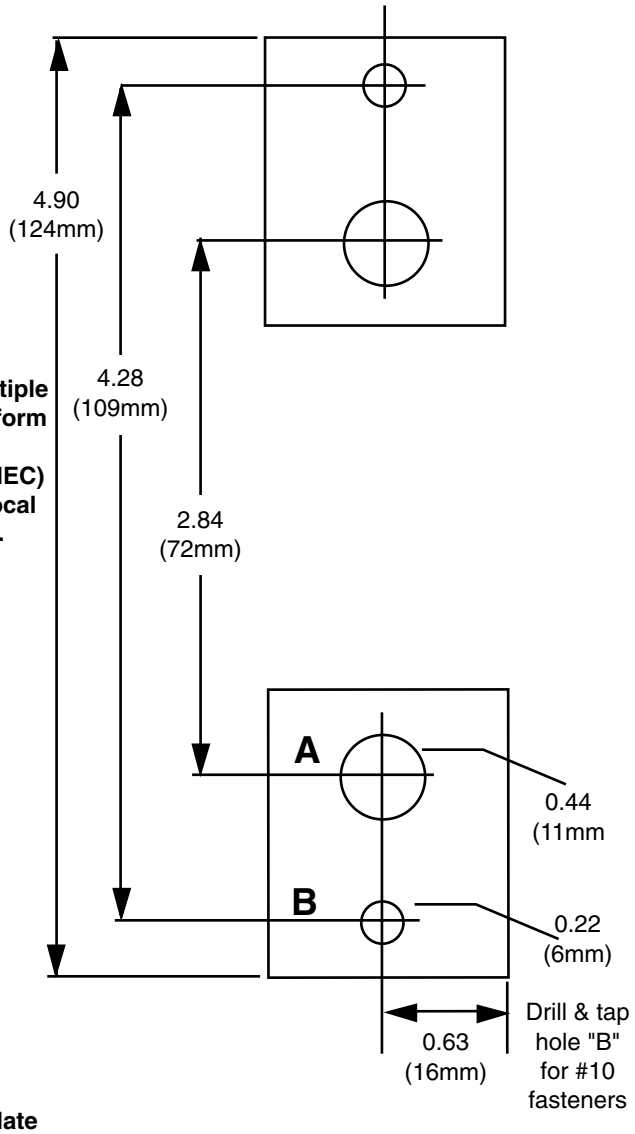
Fuse Holder (side view)

CAUTION:
Spacing for multiple fuses must conform to the National Electric Code (NEC) and any other local electrical codes.

Figure 7 -
Fuse Holder Kit Mounting Template for:
QPAC-32, 30 & 50A (2 Fuse Kits)
QPAC-33, 30 & 50A (3 Fuse Kits)

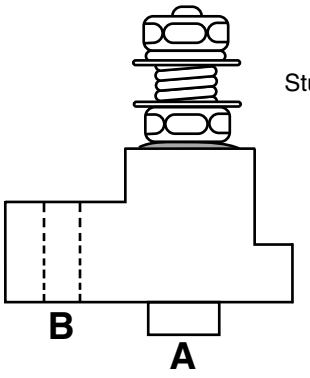
Fuse Template

Use this page as a template for mounting your fuse holder kit. Choose the size that matches your kit and carefully punch out the template along the perforation.



CAUTION:
Spacing for multiple fuses must conform to the National Electric Code (NEC) and any other local electrical codes.

Figure 8 -
Fuse Holder Kit Mounting Template for:
QPAC-01, 75 & 100A
(1 Fuse Kit)
QPAC-32, 75 & 100A
(2 Fuse Kits)
QPAC-33, 75 & 100A
(3 Fuse Kits)



Fuse Holder (side view)

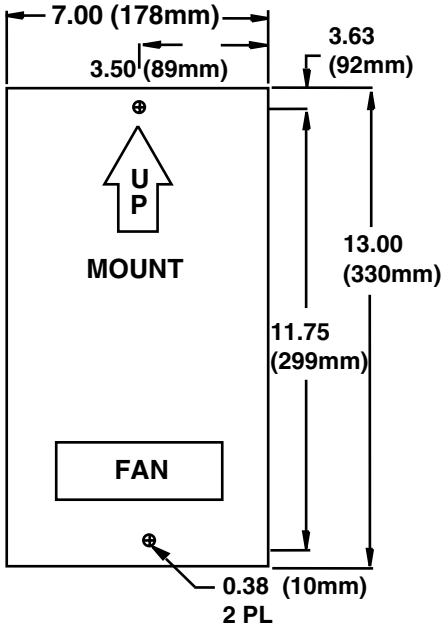
Figure 9 -
QPAC Case Style C

Case Style C Dimensions									
Model	**Amps**	**Height**		**Width**		**Depth**		**Fans**	**Fuses**
		in	**(mm)**	**in**	**(mm)**	**in**	**(mm)**		
QPAC-01	150	13	330	6.9	175	10.25	260	One	On Heat Sink
QPAC-01	200	13	330	6.9	175	10.25	260	One	On Heat Sink
QPAC-01	300	13	330	6.9	175	10.25	260	One	On Heat Sink
QPAC-32	150	13	330	14.0	348	10.25	260	Two	On Heat Sink
QPAC-32	200	13	330	14.0	348	10.25	260	Two	On Heat Sink
QPAC-32	300	13	330	14.0	348	10.25	260	Two	On Heat Sink
QPAC-33	150	13	330	21.0	533	10.25	260	Three	On Heat Sink
QPAC-33	200	13	330	21.0	533	10.25	260	Three	On Heat Sink
QPAC-33	300	13	330	21.0	533	10.25	260	Three	On Heat Sink

Note: On 575 V~(ac) applications, the fuses are mounted external to the QPAC.

Table 4 -
QPAC Case Style C
Overall Dimensions

CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.

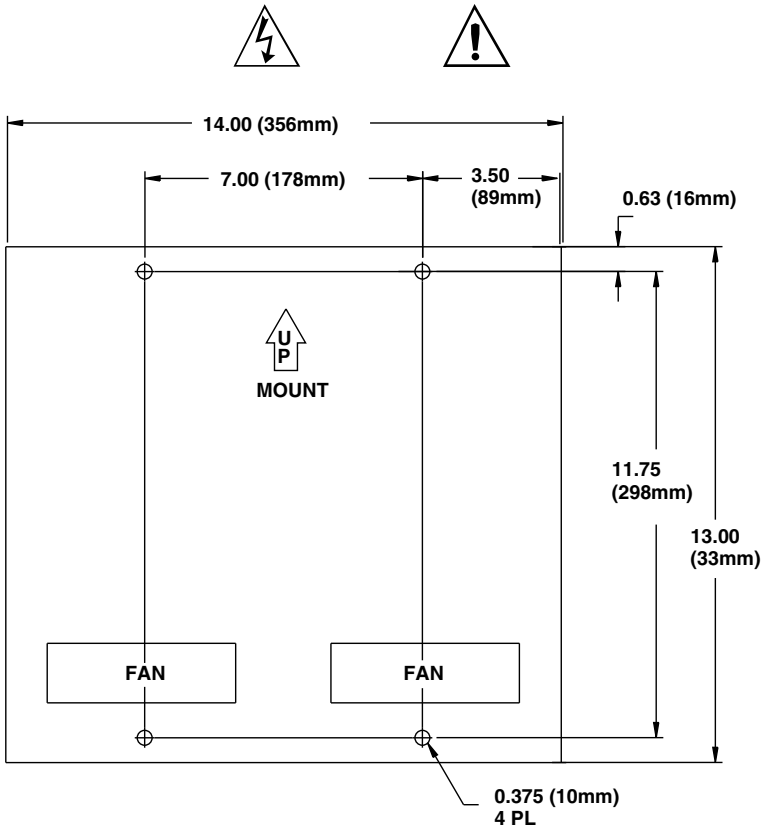


WARNING:
Style C heatsinks are electrically HOT.

Figure 10 -
QPAC Case Style C, QPAC-01, 150, 200, 300A Single Phase Mounting Footprint

Case Style C

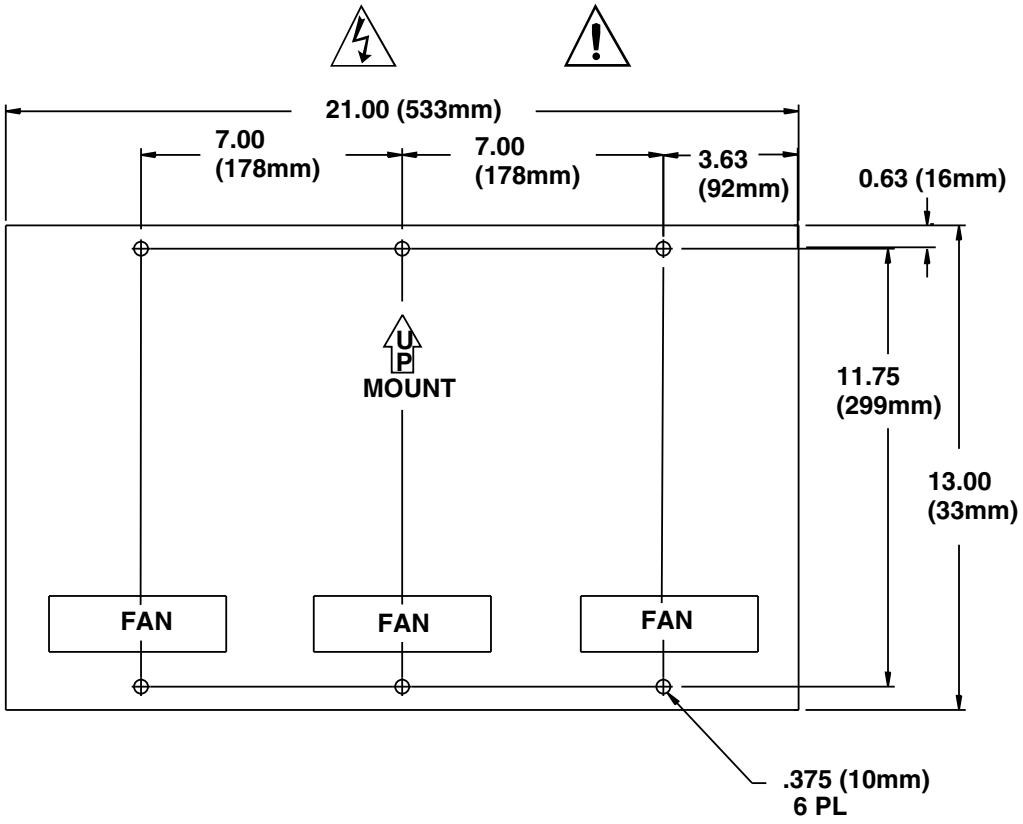
Figure 11 - QPAC Case Style C, Q32, 150, 200, 300A, Three Phase-2 Leg Mounting Footprint



CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.

WARNING:
Style C heatsinks are electrically HOT.

Figure 12 - QPAC Case Style C, Q33, 150, 200, 300A, Three Phase-3 Wire Mounting Footprint



NOTE:
See separate Addendum page for Case Style E.

Figure 13 - QPAC Case Style F

Case Style F Dimensions											
Model	**Amps**	**Height**		**Width**		**Depth**		**Fans**	**Fuses**	**Holder (max)**	
		in	**(mm)**	**in**	**(mm)**	**in**	**(mm)**			**in**	**(mm)**
QPAC-33	30	12.5	318	10.2	259	8.5	229	Two	Three, External*	5.69	145
QPAC-33	50	12.5	318	10.2	259	8.5	229	Two	Three, External*	5.69	145
QPAC-33	75	12.5	318	10.2	259	8.5	229	Two	Three, External**	4.90	124
QPAC-33	100	12.5	318	10.2	259	8.5	229	Two	Three, External**	4.90	124
*Note: See external fuse mounting drawing, Figure 7, Page 9.											
** Note: See external fuse mounting drawing, Figure 8, Page 10.											

Table 5 - QPAC Case Style F Overall Dimensions

CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.

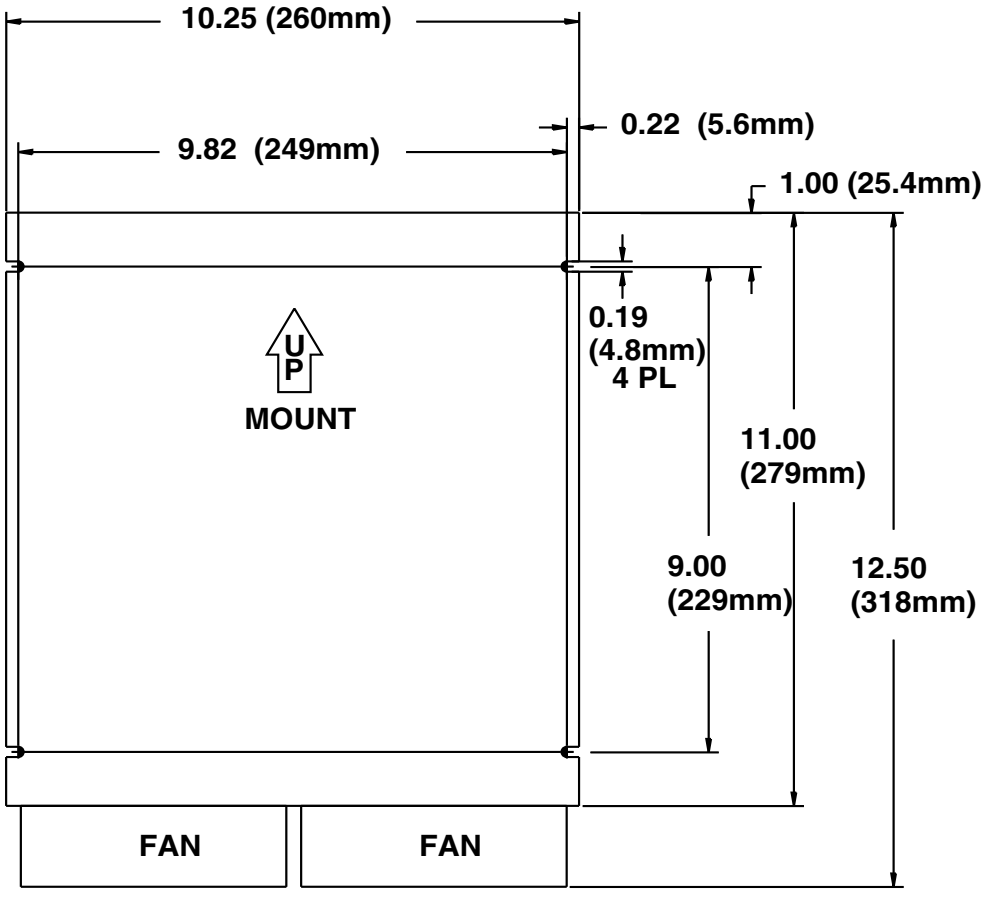


Figure 14 - QPAC Case Style F 30, 50, 75, 100A Mounting Footprint

CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

WARNING:
To avoid potential electric shock and other hazards, all mounting and wiring for the QPAC must conform to the National Electric Code (NEC) and other locally applicable codes.

QPAC-01 Power and Load Wiring

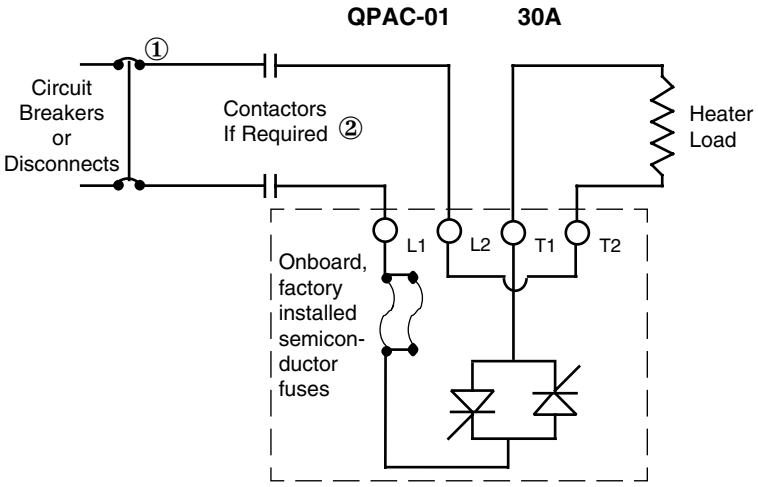


Figure 15 - QPAC-01 Wiring for 30A Units

① NOTE:
On 120Vac or 277Vac, L2 is neutral and cannot be broken.

② NOTE:
A contactor is required if a high limit control is used.

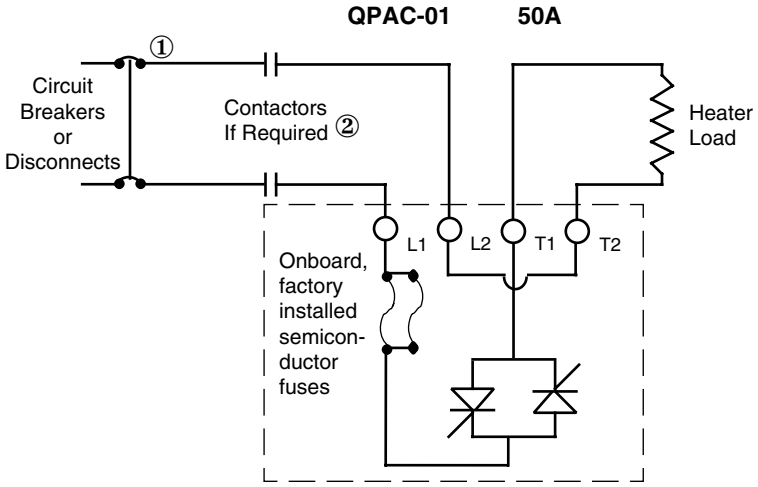


Figure 16 - QPAC-01 Wiring for 50A Units

CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

QPAC-01 75-100A

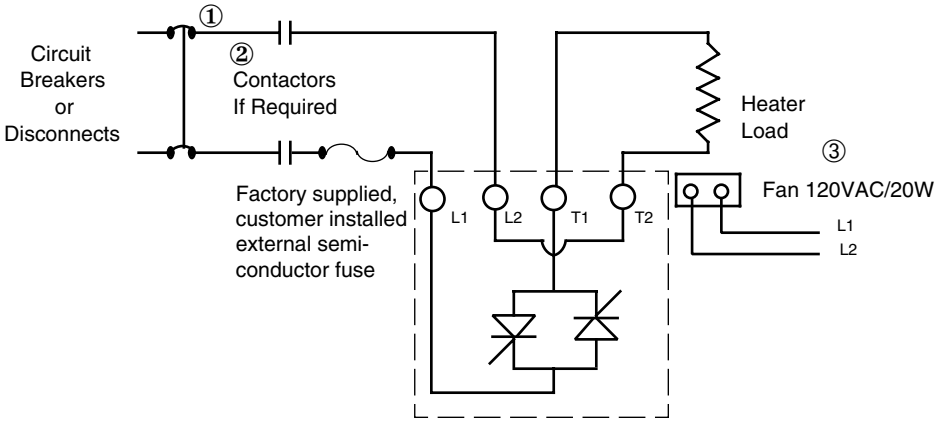


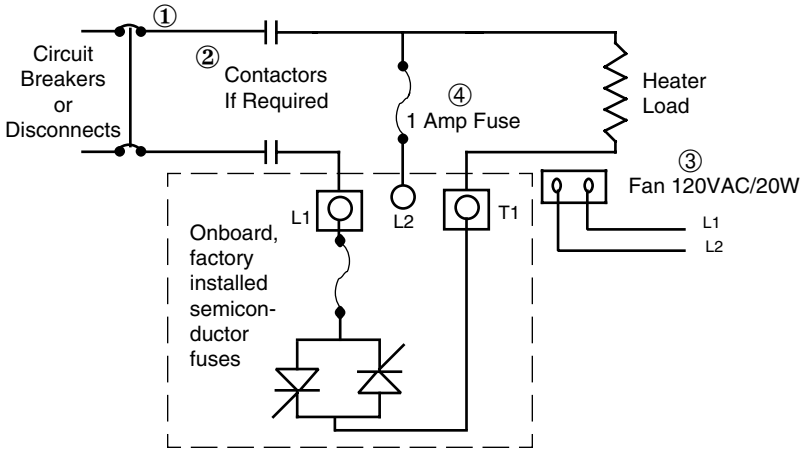
Figure 17 - QPAC-01 Wiring for 75-100A Units

① NOTE:
On 120Vac or 277Vac, L2 is neutral and cannot be broken

② NOTE:
A contactor is required if a high limit control is used.

③ NOTE:
A separate disconnect is required for the fan(s) if used.

QPAC-01 150 - 1000A



④ NOTE
Use 14 - 16 gauge wire for control power only

Figure 18 - QPAC-01 Wiring for 150 - 1000A Units

Wire QPAC-32

CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

QPAC-32 Power and Load Wiring

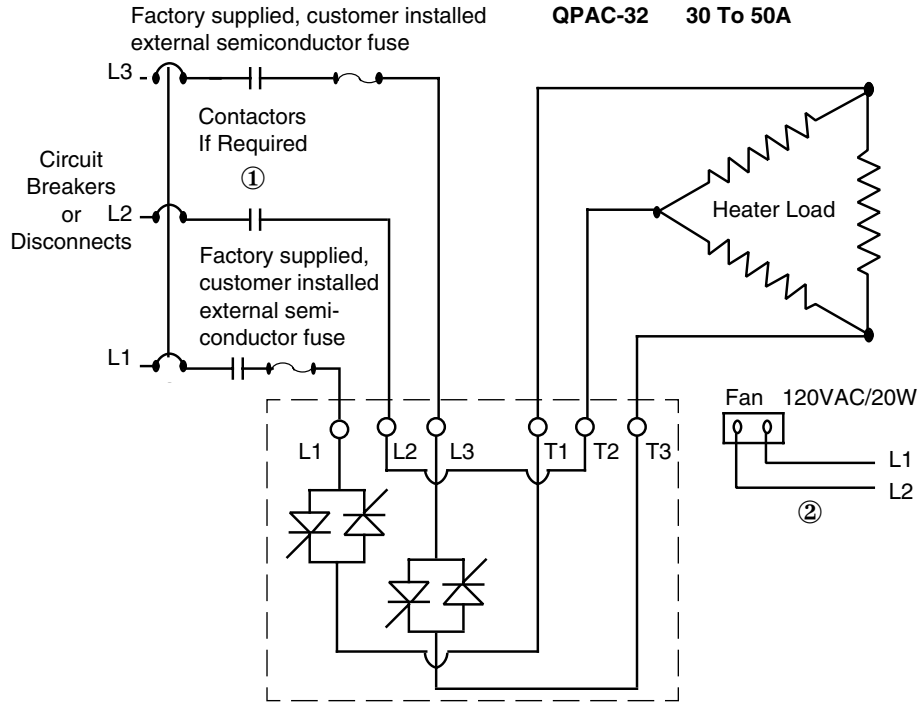


Figure 19 - QPAC-32 Wiring for 30 - 50A Units

① NOTE:
A contactor is required if a high limit control is used.

② NOTE:
A separate disconnect is required for the fan(s) if used.

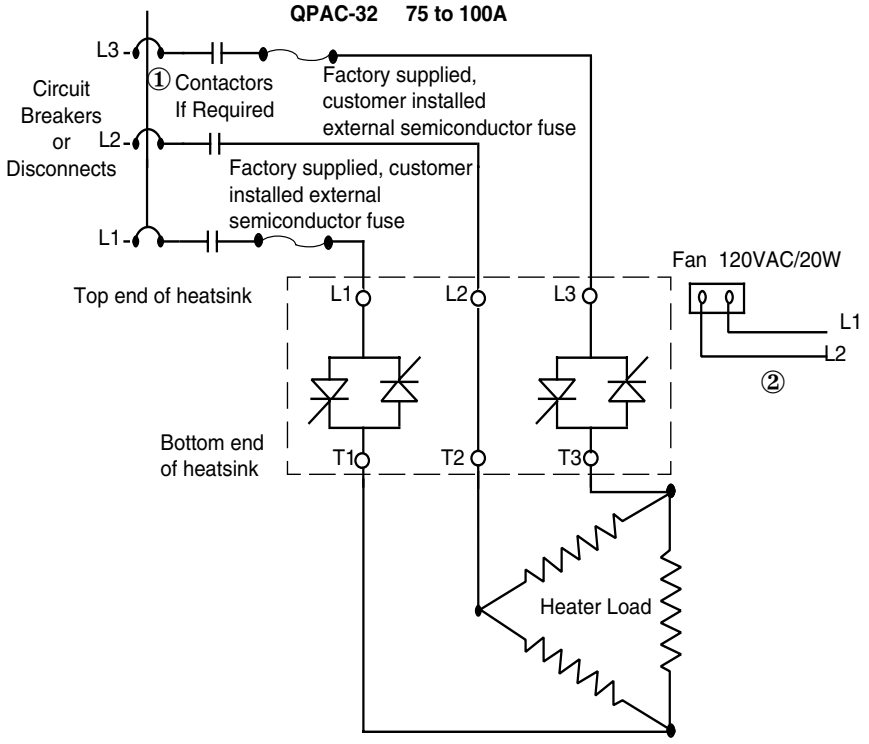


Figure 20 - QPAC-32 Wiring for 75-100A Units

CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

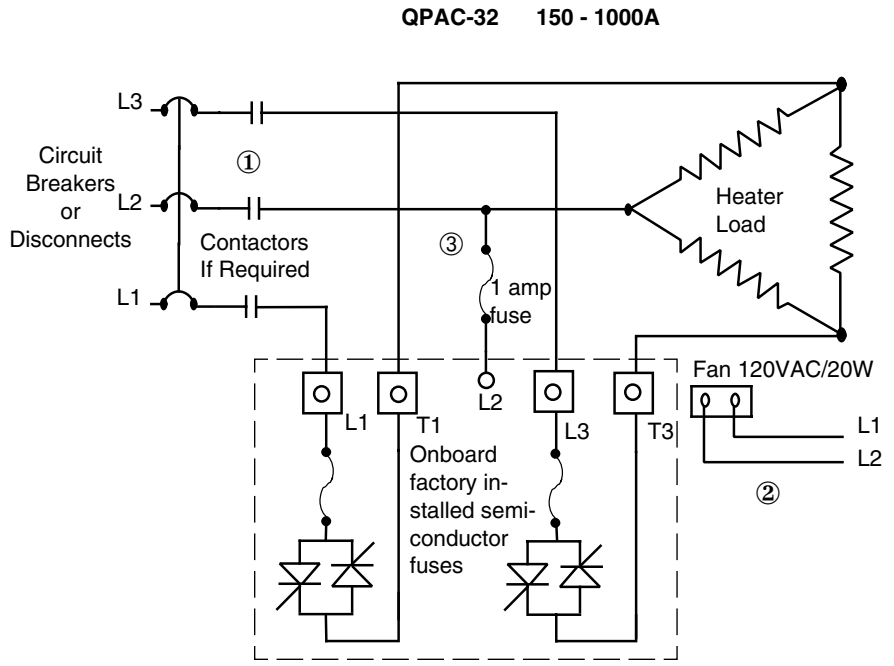


Figure 21 - QPAC-32 Wiring for 150 - 1000A Units

① NOTE
A contactor is required if a high limit control is used.

② NOTE:
A separate disconnect is required for the fan(s) if used.

③ NOTE:
Use 14 - 16 gauge wire for control power only.

QPAC-33 Power and Load Wiring

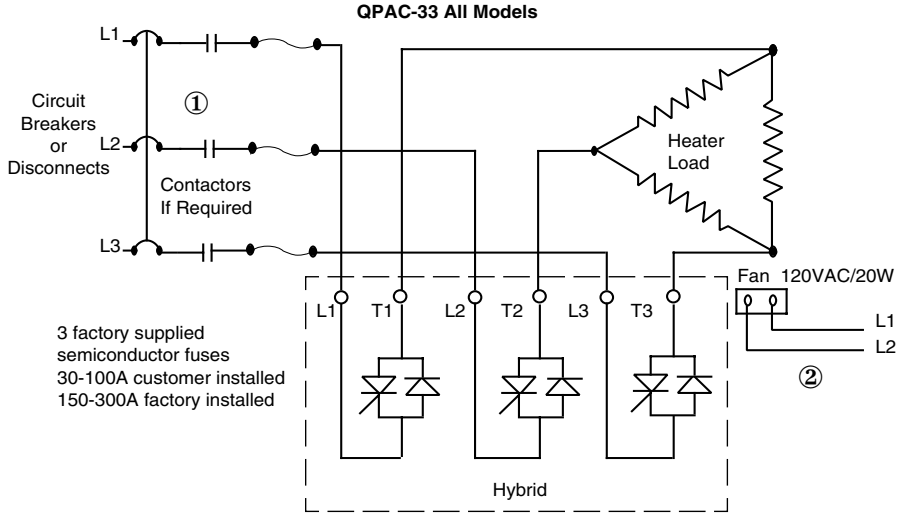


Figure 22 - QPAC-33 Wiring All Units

Input Signal Wiring

When wiring the input signal do not run any signal wires alongside or in the same conduit with the A.C. power or load wires. Signal input should be provided by shielded, two conductor wire. Shield should be grounded at the temperature control end only. Wrap the power control end with electrical tape. The following figures show the wiring configuration for the input signal to the QPAC Control Cards.

CA Control Card

The 120Vac input (24 volts input optional) signal lines for the CA (ac Input, Solid State Contactor) Control Card are connected to Pins 1 and 3 of the input signal connector. A 120Vac input signal turns the power control ON. The turn OFF voltage for the power control is 0Vac.

CAUTION:
Built-in noise reduction circuitry on the CA card requires an external load resistor (1000Ω, 25watt, typical) across the input when operating from a triac source, to prevent false triggering. Failure to apply this resistor could result in damage to product and equipment, or injury to personnel.

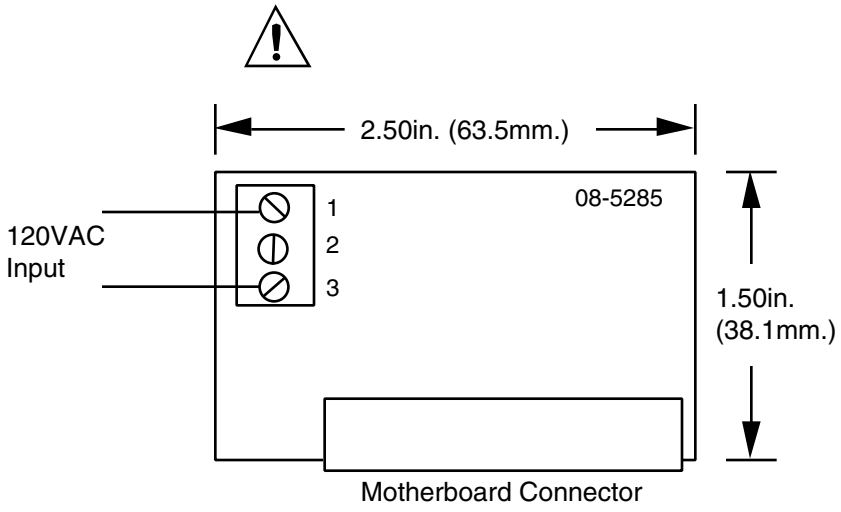


Figure 23 - CA Card Wiring SS Contactor, 120VAC Input

CD Control Card DC Input

For DC input, the input signal is wired into Pin 2 (+) and Pin 3 (-) of the input signal connector. An input signal of 3-30VDC turns the QPAC power control ON. 0-1VDC turns the power control OFF.

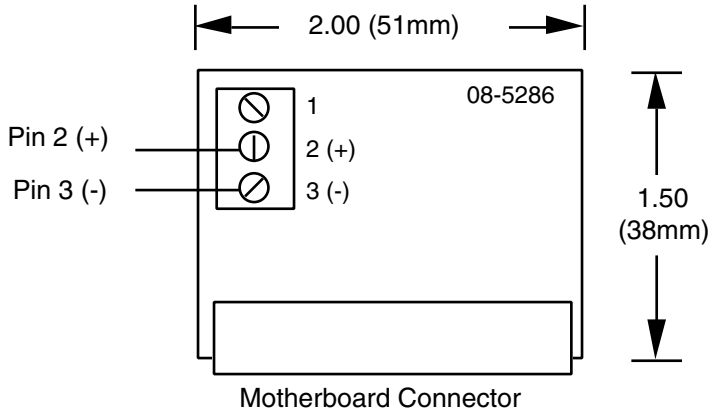


Figure 24 - CD Control Card, Solid State Contactor, 3-30Vdc Input

CD Control Card Contact Closure Input

For a contact closure input to the CD Control Card, the contact is wired to pins 1 and 2 (+) of the input signal connector. A closed contactor input turns the QPAC ON and an open contact turns the QPAC OFF. The input impedance is 10KΩ minimum.

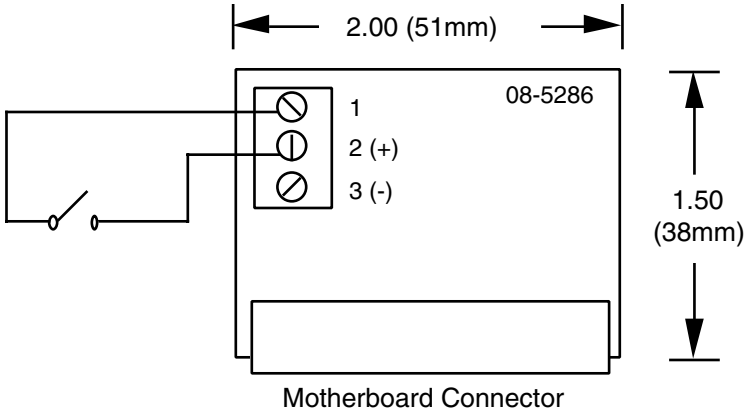


Figure 25 - CD Control Card, Solid State Contactor, Contact Closure Input

Process Input - AF, AL, BF and BV Control Cards

The QPAC AF, AL, BF and BV Control Cards are defined as follows:
AF - Phase Angle Control
AL - Phase Angle Control with Current Limit
BF - Burst Firing (Zero Cross), Fixed Time Base
BV - Burst Firing (Zero Cross), Variable Time Base
All four of these cards can be wired for a manual potentiometer input or an input from a temperature control. The following paragraphs give the connections for both configurations including an Auto/Manual configuration where the input can be switched between manual and temperature control input.

AF, AL, BF and BV Potentiometer Input

For potentiometer input, wire a 1KΩ potentiometer to the "POT", "+" and "-" connections of the control card. The wiper of the potentiometer should be connected to the "+" connection. The control card must be converted to a voltage input by replacing a jumper. See Page 25.

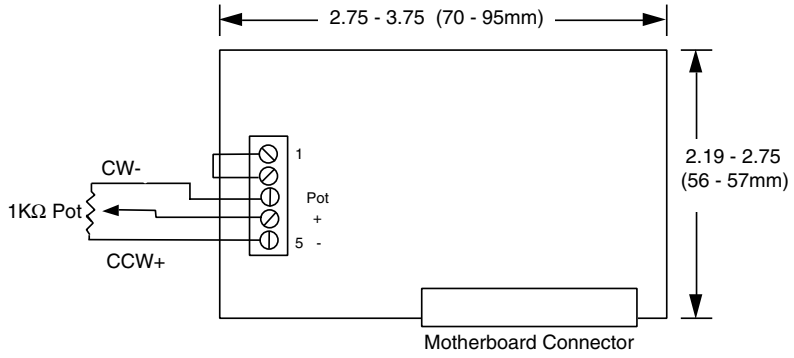


Figure 26- AF, AL, BF, BV Potentiometer Input

AF, AL, BF and BV DC Input Connections

The temperature control output to the Control Cards is wired to the "+" and "-" input terminals of the control card. These cards will accept a 0 to 12VDC, or 0 to 25mA input signal. They are factory calibrated for 4 to 20mA. If using a voltage or current range other than this, see Chapter 3, Bias & Gain Adjustments. The control card can be converted to a voltage input by removing a resistor or replacing a jumper. See Page 25.

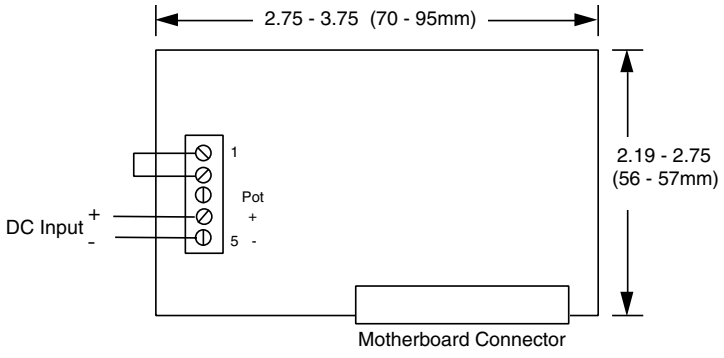


Figure 27 - AF, AL, BF and BV DC Input

AF, AL, BF and BV Auto/Manual Input

The AF, AL, BF and BV Control Cards can be wired to make it possible to select an input from either a temperature control or a manual input potentiometer. A switch is used to select between the input from a 1KΩ potentiometer or a 4-20mA temperature control. The control card must be converted to voltage input by removing the appropriate resistor or replacing a jumper. See Page 25. A 250Ω resistor must be placed in parallel with the temperature control input, so that the temperature control signal will be a 1-5 volt input.

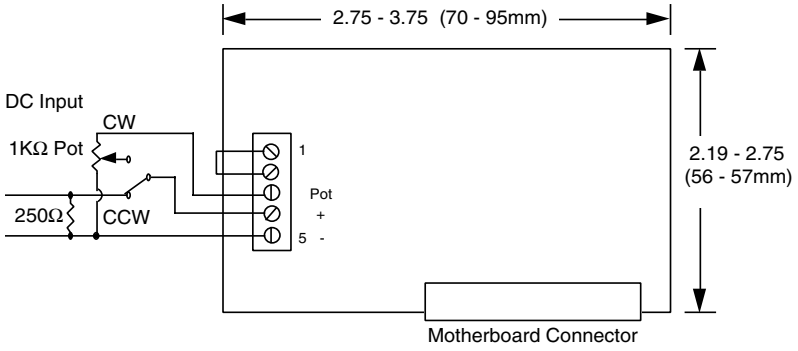


Figure 28 - AF, AL, BF and BV Auto/Manual Input

Interlock

Opening the interlock connection between Pins 1 and 2 of the input signal connector will interrupt the input signal to the control card. Do not use the interlock for limit or safety functions. Do not open the AF or AL Control Card interlock, terminals 1 & 2, when "soft start" is desirable.

Soft Start

Some heater elements change resistance with temperature. Certain types such as tungsten, change resistance very fast (tungsten increases resistance over 16 times from cold to hot). By slowly increasing the voltage to the heater, the heater element is warmed to full resistance by the time full voltage is applied, thus reducing excessive surge currents. Soft start time on the QPAC is about 6 seconds from power-up. If the QPAC is forced into emergency shut down (ESD) the QPAC will re-start soft. *Soft start is only available on phase angle models.*

AL Control Card Current Transformer Connections

The AL Control Card is wired to a transformer from the load line of the QPAC. The transformer is wired into Pins 1 and 2 of Connector TB3 of the AL card. The following table and figures show the transformer connections for different load configurations and currents.

Current Transformer (Part Number)	Description		Interstage Transformer
16-0246*	20A : 20mA	Current Transformer	Not Used
16-0246*	30A : 30mA	Current Transformer	Not Used
16-0246*	40A : 40mA	Current Transformer	Not Used
16-0246*	50A : 50mA	Current Transformer	Not Used
16-0008	**75A : 5A	Current Transformer	16-0176
16-0044	100A : 5A	Current Transformer	16-0176
16-0072	125A : 5A	Current Transformer	16-0176
16-0008	150A : 5A	Current Transformer	16-0176
16-0045	200A : 5A	Current Transformer	16-0176
16-0073	300A : 5A	Current Transformer	16-0176
Not Used	5A : 20mA	Interstage Transformer	16-0176

Table 6 - AL Control Card, Current Transformer Selection

Note: *With Wire Leads.
**Use two wire passes through current transformer #16-0008 for 75A applications.

AL Control Card Current Transformers, cont'd.

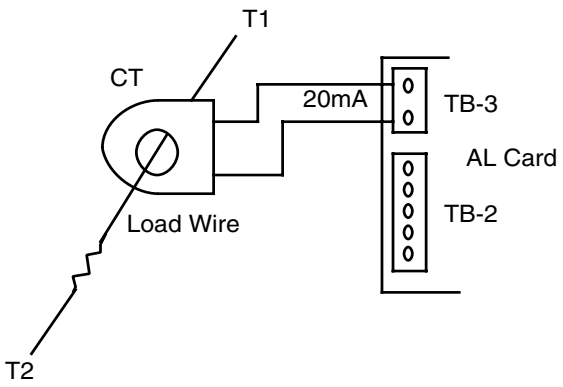


Figure 29 - Current Transformer (C.T.) Connections, One C.T. 50 Amps Or Less, 1Ø

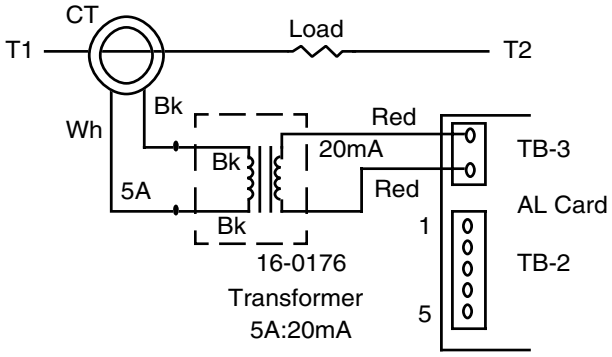


Figure 30 - Example Current Transformer (C.T.) Connections One C.T., 75 Amps and Above, 1Ø

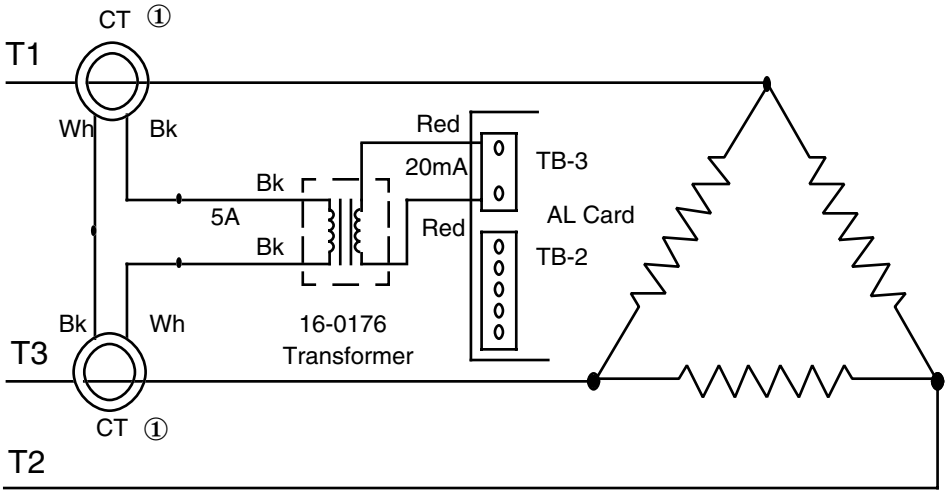


Figure 31 - Example Current Transformer Connections, Two C.T.'s for Two LegSensing, 75 Amps and Above

① NOTE:
Both load leads must pass through the C.T.'s in the same direction.

Single and Three Phase DH Option
Open Heater or Shorted SCR Detector

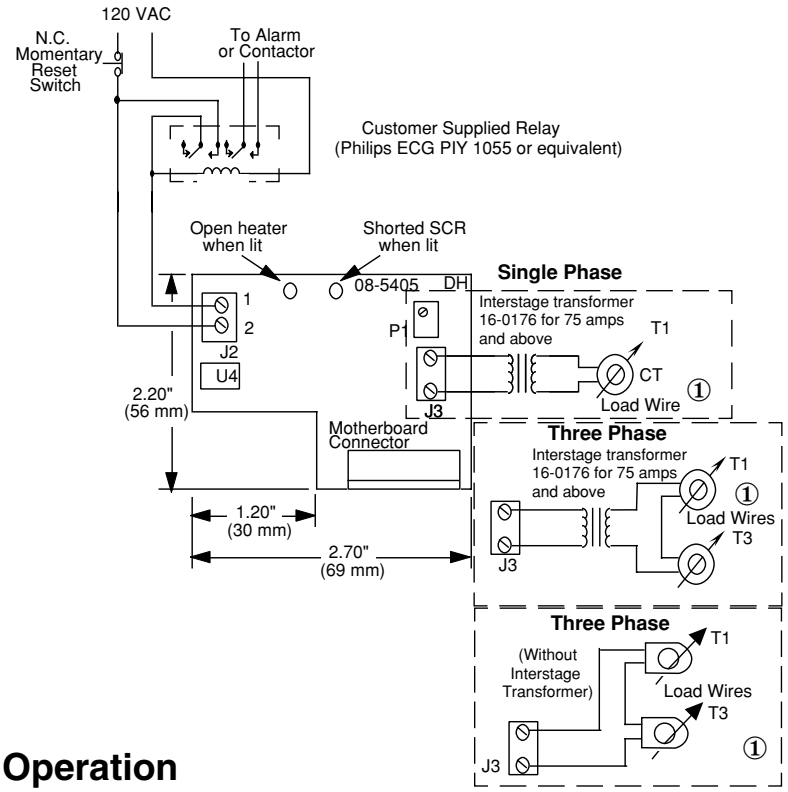


Figure 32 Single and Three Phase Wiring

① NOTE:
Interstage transformers (16-0176) required for units 75 amps and above.

CAUTION:
The shorted SCR detector feature will not work with the manual control input;

Operation

The DH card uses a CT to monitor the load current and also detects when a firing pulse is sent to the SCR's. The load current must be set by the pot on the DH board (P1). If there is load current and no pulses to turn on the SCR's, the "Shorted SCR" LED will be lit. The opto triac (U4) closes 3 or 4 seconds later and energizes an external alarm relay. If part of the load opens (20% or more), and there are SCR pulses, the "Open Htr" LED is lit and 3 to 4 seconds later, the alarm relay energizes.

This board only operates with the zero cross firing cards. For three phase, the CT's go in T1 and T3 lines.

Setup Procedure

1. With the DH card installed and the temperature control wired to the SCR power control, set the temperature control output to "full on" (20mA for 4-20mA output, or 5 volts for 0 to 5 volt output).
2. Adjust P1 until the open heater light on the DH card is full on. No intermittent cycling.
3. Slowly adjust P1 until the open heater light just turns full off. No intermittent cycling.

If you are getting false alarms, adjustment is probably set too sensitive and should be readjusted towards the off condition of the open heater light.

A shorted SCR will energize the shorted SCR light.

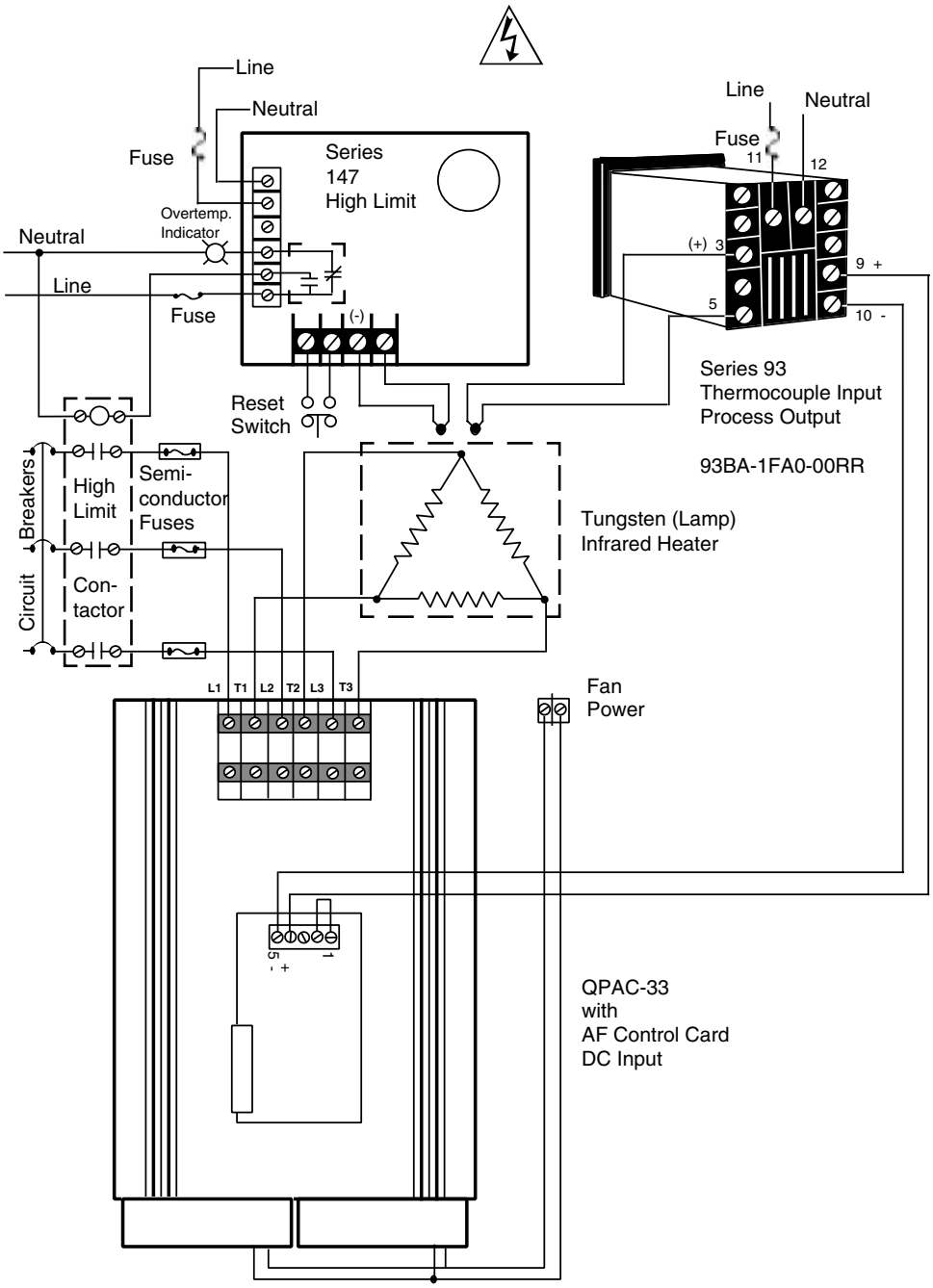
Table 7- Load Wire Passes Thru Current Transformer

Load Current	Number of Passes of Load Wire Thru Current Transformer
2 to 3 Amps	5
3 to 4 Amps	4
4 to 5 Amps	3
5 to 10 Amps	2
10 to 40 Amps	1

QPAC System Wiring Example

Figure 33 - QPAC System Wiring Example

WARNING: Follow National Electric Code safety practices and other locally applicable codes to avoid potential electric shock when wiring this unit to a power source, and to electrical sensors or peripheral devices. Failure to do so could result in serious injury or death.



Overtemperature cutout. The most common failure mode of an SCR is in the shorted state. If this happens, the temperature control can no longer control the SCR and a run-away condition exists. An independent high limit control must be used that will sense unsafe temperature and disengage the circuit breaker via undervoltage trip or a mechanical contactor as shown above.

How to Operate the QPAC

Setup Adjustments

After the QPAC is installed and wired it may need a few minor adjustments. The three phase power controls require that proper phase rotation exists. QPACs that use the BF, BV, AF or AL Control Cards may need minor bias and gain calibrations. QPACs that use the AL Phase Angle Current Limit Control Card will need current limit calibration. Refer to the following paragraphs.

Phase Rotation Adjustment for Q32 and Q33

Three phase QPAC SCR controllers require the correct phase sequence of the attached line voltage. To check for proper phase sequence of the QPAC-32 power control, measure the voltage from T1 to T2, T2 to T3 and T3 to T1 with the power control turned full ON. If any of the measurements of output voltage are not equal (within 10%), exchange any two of the power input lines (L1 and L2) to the QPAC.

To check for proper phase sequence of the QPAC-33 power control, apply power to the QPAC and observe the LED indicators in the upper left hand corner of the Power Base motherboard. If the phase rotation LED is not illuminated, exchange any two incoming power lines (L1 and L2).

Bias And Gain Adjustments for AF, AL, BF, BV

Bias and gain can be adjusted to interface with the output of most standard temperature controls with a proportional output. Bias and gain is factory set for an input control signal of 4-20mA but can be adjusted over a range of 0-12VDC or 0-25mA to match the output of a specific temperature control. Input impedance for 4-20mA input is 250Ω. The input impedance can be changed to 5KΩ to accept a voltage by performing the following procedure for each card.

Voltage Input Conversions

AF (08-5288): For 5KΩ input, move J2 jumper, located on the lower left of the AF card next to the TB-2 connector, Terminal 5. See Figure 34.

AL (08-5411): For 5KΩ input, replace the J2 jumper to the 5V position, located on the lower left of the AL card to the 5V position. See Figure 37.

BF (08-5289): For 5KΩ input, remove resistor R3, located on the lower left of the QBF card next to the TB-2 connector, Terminal 5. See Figure 35.

BV (08-5342): For 5KΩ input, remove the external resistor attached to the J3 connector plug. See Figure 36.

Adjustment Procedure:

We recommended that bias and gain adjustment be performed using a dummy load. In some applications, a dummy load may be required if the controlled load can not be turned full ON. A dummy load can be easily made by connecting 150 watt lamps in series to match the operating voltage of the QPAC. Use the following steps to make adjustments.

Bias & Gain

1. Connect a volt meter across the load or dummy load of the QPAC. Connect a volt meter across, or milliamp meter in series with, the input signal from the temperature controller. **NOTE:** AL card should be calibrated with a dummy load on the QPAC
2. Apply power to the system.
3. Set the output signal of the temperature controller to zero or its minimum output. The QPAC input is factory calibrated for full off at 4.2 mA. Adjust the bias potentiometer slowly CCW (counterclockwise) until the QPAC output just comes ON. Then turn CW (clockwise) until the output is just full OFF as observed on the output volt meter. See the following figures for the location of the bias and gain potentiometer on the Control Cards.
   NOTE: The QBV card does not include a bias adjustment. A bias and gain adjustment card can be added to the QBV card in the field. Order Watlow part number 08-7210. Follow this calibration procedure when using the bias and gain card.

4a. **AF & BF:** Adjust the output of the temperature controller to full ON (5VDC, 20mA, etc.). Adjust the gain potentiometer **CW** until the QPAC output is just full ON. The QPAC is factory calibrated to be full on at 19.8 mA.

4b. **BV & AL:** Adjust the output of the temperature controller to full ON (5VDC, 20mA, etc.). Adjust the gain potentiometer **CCW** until the QPAC output is just full ON. The QPAC is factory calibrated to be full on at 19.8 mA.

5. When adjusting the bias and gain of the current limiting (AL) control card, ensure that the current limiting is turned OFF. With the output of the temperature control full ON, adjust the current limit potentiometer until the QPAC output is full ON.
6. Repeat steps 3 and 4 until the QPAC turns full ON with a full ON signal from the temperature control, and full OFF with the minimum input signal from the temperature control. Steps 3 and 4 may need to be repeated a few times (an adjustment made on one of the potentiometers affects the adjustment of the other potentiometer).
7. Remove power, disconnect the meters, and reconnect the controlled load to the QPAC if required.

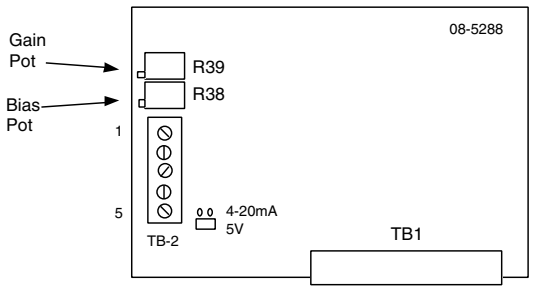


Figure 34 - AF (Rev. H) Control Card

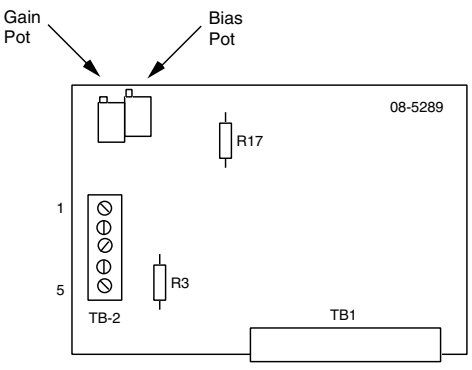


Figure 35 - BF (Rev. D) Control Card

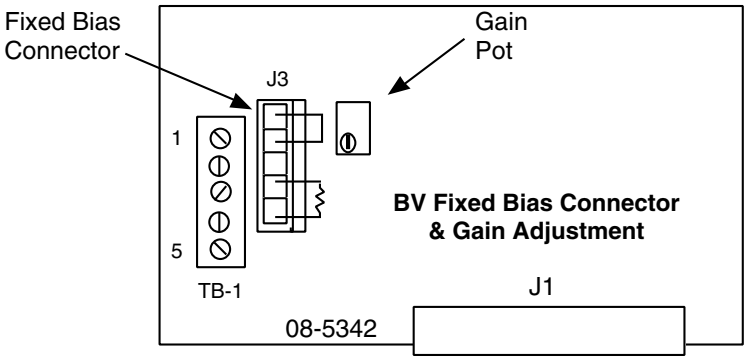


Figure 36 - BV (Rev. B) Control Card

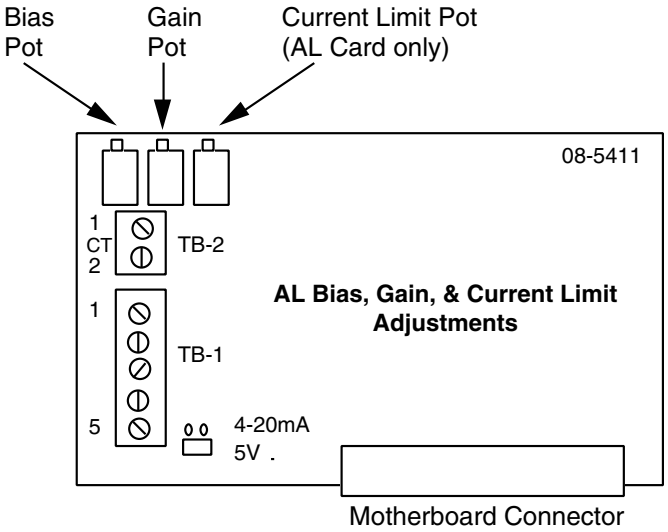


Figure 37 - AL (Rev. B) Control Card

NOTE: The AL Current Limit must be disabled (pot fully clockwise - CW) before bias and gain can be adjusted.

Current Limit Adjustments

The AL Control Card is a phase angle control with the capability to limit the maximum current to the load. A potentiometer on the AL adjusts the current limit setting. See Figure 37. Use the following steps to adjust the current limit on initial setup. The purpose of the procedure is to bring the power to the load up slowly so that the maximum current to the load is not exceeded before the current limit is adjusted.

Note: A short overcurrent through the load may occur, as the AL Card circuitry detects the higher current, if the input signal from the temperature control is abruptly increased.

1. Attach a clamp-on ammeter to the load line.
2. Adjust the AL card current limit potentiometer fully counterclockwise (for minimum current flow).
3. Turn the temperature control ON and adjust the input signal to the control card for zero percent power.
4. Turn the power to the QPAC ON.
5. Gradually increase the input signal.
6. Adjust the current limit potentiometer clockwise until current to the load is measureable.
7. Gradually increase the input signal to 100% power, then adjust the current limit potentiometer to obtain the desired maximum current to the load.

QPAC Troubleshooting

A technician can isolate a system problem by first checking if the load is good, and the line voltage and temperature signals are present and correct. If the above is true, then the power control may be the problem. This problem may be with the QPAC's control card, transformer or power base. Use Table 8 to assist with troubleshooting.

Table 8-
QPAC Troubleshooting Guide

Symptom	Probable Cause	Corrective Action
No output	Fuses blown	Check and replace fuses
	Incorrect input wiring	See “Input Wiring,” p. 18-23.
	Incorrect input signal	Check temp. control output.
	Input signal reversed	See “Input Wiring,” p. 18-23.
	Input signal not adjusted	See “Bias and Gain Adjustment" p. 25-26.
	Wrong or missing control card	See “Input Wiring,” p. 18-23.
	Transformer wiring	Check transformer connections.
	Missing load wiring	See “Power and Load Wiring,” p. 14-17. The SCR(s) will not function without a load.
Heatsink temperature exceeded 187°F (86°C)	Clogged or non-operational fan	Check fan, power, and clean if necessary. Check for shorted thermostat, replace fan or thermostat as necessary. #27-0005 thermostat is normally open and closes on temperature rise.
Transformer hot	Incorrect transformer	Check product & transformer labels.
Uncontrolled output full ON	Bad control card, or bias and gain out of adjustment	Unplug control card, try again. Readjust bias & gain.
	Bad transformer	Unplug transformer wire and try again.
	Bad power base	If full ON or half ON output present with no control card and no transformer, power base is bad, replace.
Unbalanced output (QPAC-32 & QPAC-33)	Incorrect phase rotation	See "Phase Rotation Adjust.," p. 25.

QPAC-33 Diagnostics

The QPAC-33 has four LEDs for diagnostic indication. During normal operation, all four LEDs will be illuminated.

- **Power ON** Yellow LED is ON when power is applied to the control.
- **Phase Loss** Yellow LED is ON when all three phases of line voltage are present. LED will be OFF if one phase is low or lost.
- **Phase Rotation** Yellow LED is ON when correct voltage phase exists, even when load is not wired. LED will be OFF when two phases are rotated, and when one phase is missing.
- **Phase Lock Loop** Yellow LED is ON when phase lock loop circuit is synchronized. LED can go OFF from noisy power line or if the phase synchronizing circuitry fails. Check power quality, then repair or replace power base.

QPAC Specifications—(1293)

Operation

- Modular control base with plug-in card and transformer
- **Plug-in control cards**
  Solid state contactor, ~(ac) or ⎓(dc) input
  Burst fire control, fixed or variable time base
  Phase angle fire control
  Phase angle control with soft start and current limiting
- **Plug-in transformers (50/60Hz)**
  - 120, 208, 240, 277, 380, 415, 480, 575V~(ac) operation[1]

Power bases

- Single phase (Q01), 1 pair of SCRs
- Three phase (Q32), 2 leg control, 2 pair SCRs. Resistive load only, burst firing only.
- Three phase (Q33), 3 pair hybrid SCRs/diodes. Recommended for phase angle only with balanced load.
- 30 through 1000 amps per switched leg.

Agency Approvals

- UL 873 to 300 amps, File #E43684, formerly #E67609
- UL 508 and C-UL Listed to 300 amps, File #E73741
- No agency approvals beyond 300 amps.

Control Card Inputs

(CA) Solid state contactor, ac input

- 120V~(ac) @ 30mA minimum
- ~(ac) signal input sources (i.e., triacs or mechanical relay outputs with noise suppression) require customer supplied resistors across the power controller ~(ac) command signal input terminals to prevent false firing.
  24V~(ac) input, 200Ω/10 watts typical;
  120V~(ac) input, 1kΩ/25 watts typical;
  240V~(ac) input, two 1kΩ/25 watts in series typical

(CD) Solid state contactor, dc input

- ON, 4-10V⎓(dc) @ 0.5mA; OFF, 0.5V⎓(dc)
- Built-in noise reduction network

(BF) Burst firing control fixed time base

- Process input factory set @ 4-20mA ⎓(dc)
- Input impedance 250Ω (clip resistor for 5kΩ voltage input), or manual control input
- Time base 4 seconds (clip resistor for 1 sec)

(BV) Burst firing control, variable time base

- Process input factory set @ 4-20mA ⎓(dc)
- Input impedance 250Ω (clip resistor for 5kΩ voltage input), or manual control input

(AF) Phase angle control

- Process input factory set @ 4-20mA ⎓(dc)
- Input impedance 250Ω (clip resistor for 5kΩ voltage input), or manual control input
- Soft start approximately 6 seconds upon power-up, 1 second upon set point change

(AL) Phase angle control with current limit

- Process input factory set @ 4-20mA ⎓(dc)
- Input impedance 250Ω (clip resistor for 5kΩ voltage input), or manual control input
- Soft start approximately 6 seconds upon power-up, 1 second upon set point change
- Current transformer included
- 120V~(ac) through 575V~(ac)[1]
- 1 or 3 pole only

Specifications

Line Voltage/Power
- 50/60 Hz ~(ac) line frequency, Q32 and Q33 calibration line frequency dependent
- Voltage: ±10%, 120, 208, 240, 277, 380, 415, 480, 575V~(ac)[1]

Line Voltage Compensation
- 10%Δ in line, 2%Δ in load in the 30% to 70% power region (AF, AL and BV)

Power Dissipation (Watts)
- 1.5 watts/amps per controlled leg

Isolation
- Command signal to load 1250V~(ac) minimum

Linearity
- 2%, 30% to 70% power region (All units except CA & CD)

Off-State Leakage Current
- 20mA @ 480V~(ac)

SCR Protection
- Semiconductor fuses provided dv/dt 200V/µsec minimum
- MOV[2] and RC snubber network standard
- (Q32) 3rd leg fuse kit may be used, but not required, with 3-phase, 2 leg models

Mounting
- Heat sink fins must be mounted in vertical orientation

Operating Environment
- 32 to 122°F (0 to 50°C)
- 0 to 90% RH, non-condensing

Storage Temperature
- -40 to 185°F (-40 to 85°C)

Options
- Manual Control Kit for process input cards (1k potentiometer) #08-5362
- 240V~(ac) cooling fans in place of 120V~(ac) cooling fans

Weight
- lbs (kg)

	Phase		
Amps	**1ø/Q01**	**3ø,2 leg/Q32**	**3ø,3 wire/Q33**
30	6 (2.7)	8 (3.6)	20 (9.1)
50	6 (2.7)	8 (3.6)	20 (9.1)
75	10 (4.5)	15 (6.8)	50 (22.7)
100	10 (4.5)	15 (6.8)	50 (22.7)
150	15 (6.8)	36 (16.3)	50 (22.7)
200	15 (6.8)	36 (16.3)	50 (22.7)
300	15 (6.8)	36 (16.3)	50 (22.7)

*See addendum for 400-1000 amp models

NOTES:

1 Q33 models operating on 575 V~(ac) are not UL or C-UL listed.

2 MOV comes only on Q33 (3-phase, 3 leg).

3 All cooling fans rated @ 20 watts each, must be wired by customer.

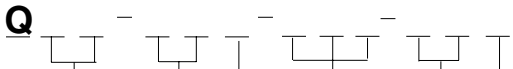
4 The open heater/shorted SCR detector is for burst fire operation only.

5 Included one current transformer for 1-phase and two current transformers for 3-phase. Models 75 amps and above require one interstage transformer.

Model No.

Model Number Information — (1294)

To order, complete the code number to the right with the information below:



QPAC = Modular power controller; phase angle, burst, or solid state contactor with fuse(s) and holder(s) included.

Phase
01 = Single phase
32 = 3-phase, 2 leg (optional 3rd leg fuse kit extra.)
33 = 3-phase, 3 leg

Operating and Output Voltage
12 = 120V~(ac)
20 = 208V~(ac)
24 = 240V~(ac)
27 = 277V~(ac)
38 = 380V~(ac)
41 = 415V~(ac)
48 = 480V~(ac)
57 = 575V[1]~(ac)

Cooling Fan Voltage[3]
Customer to supply wiring and hook-up.
0 = No fan; all 1-phase 30 and 50 amp models only
1 = 120V~(ac); required on all 3-phase models
2 = 240V~(ac); required on all 3-phase models

Output Current (Amps)
030 = 30 amps
050 = 50 amps
075 = 75 amps
100 = 100 amps
150 = 150 amps
200 = 200 amps
300 = 300 amps
400 = 400 amps
500 = 500 amps
600 = 600 amps
800 = 800 amps
01K = 1000 amps

Input Control Card
CA = Solid state ~(ac) input (08-5285) contactor
CD = Solid state ⎓(dc) input (08-5286) contactor
BF = Burst fired, fixed time base (08-5289) 4-20mA
BV = Burst fired, variable time base (08-5342) 4-20mA
AF = Phase angle fired, not available on Q32 (08-5288) 4-20mA
AL = Phase angle fired w/current limit, not available on Q32 (08-5411); 4-20mA
includes one current transformer. Add second CT for 3-phase, 3 leg.
AL models 75 amps and above require one interstage transformer.

Open Heater/Shorted SCR Detector[4,5]
0 = None
1 = Single phase operation
2 = Three phase operation

Accessories

08-5362	=	Manual Control Kit			
*16-0246	=	20A	:	20mA	Current Transformer
*16-0246	=	30A	:	30mA	Current Transformer
*16-0246	=	40A	:	40mA	Current Transformer
*16-0246	=	50A	:	50mA	Current Transformer
16-0071	=	30A	:	5A	Current Transformer
16-0042	=	50A	:	5A	Current Transformer
** 16-0008	=	75A	:	5A	Current Transformer
16-0044	=	100A	:	5A	Current Transformer
16-0072	=	125A	:	5A	Current Transformer
16-0008	=	150A	:	5A	Current Transformer
16-0045	=	200A	:	5A	Current Transformer
16-0073	=	300A	:	5A	Current Transformer
16-0069	=	600A	:	5A	Current Transformer
16-0176	=	5A	:	20mA	Interstage Transformer

*With wire leads

** Use two wire passes through current transformer #16-0008 for 75A application.

Warranty

The QPAC is warranted to be free of defects in material and workmanship for 36 months after delivery to the first purchaser for use, providing that the units have not been misapplied. Since Watlow has no control over their use, and sometimes misuse, we cannot guarantee against failure. Watlow's obligations hereunder, at Watlow's option, are limited to replacement, repair or refund of purchase price, and parts which upon examination prove to be defective within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

Returns

1. Call Watlow Customer Service, (507) 454-5300, for a Return Material Authorization (RMA) number before returning any item for repair. We need this information:
   - Ship to address
   - Bill to address
   - Contact name
   - Phone number
   - Method of return shipment
   - Your P.O. number
   - Detailed description of the problem
   - Any special instructions
   - Name and phone number of person returning the product.

2. Prior approval and an RMA number, from the Customer Service Department, is needed when returning any unused product for credit. Make sure the RMA number is on the outside of the carton, and on all paperwork returned. Ship on a Freight Prepaid basis.
3. After we receive your return, we will examine it and try to verify the reason for returning it.
4. In cases of manufacturing defect, we will enter a repair order, replacement order or issue credit for material returned.
5. To return products that are not defective, goods must be be in new condition, in the original boxes and they must be returned within 120 days of receipt. A 20 percent restocking charge is applied for all returned stock controls and accessories.
6. If the unit is unrepairable, it will be returned to you with a letter of explanation.
7. Watlow reserves the right to charge for no trouble found (NTF) returns.

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Watlow QPAC Modular SCR Power Control User's Manual
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