

QPAC

User's Guide



Modular SCR
Power Control
150 to 1,000A



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How to Use this Manual

NOTE:

Details of a "Note" appear here, on the left side of each page.



CAUTION:

Details of a "Caution" appear here, on the left side of each page.



WARNING:


Details of a "Warning" appear here, on the left side of each page.


Notes

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

Safety Information

This user's guide also has boldface safety information notes to protect both you and your equipment. Please be attentive to them.

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 left side of the 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 left side 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. The QPAC User's Guide is copyrighted by Watlow Winona, Inc. © August 2010 with all rights reserved.

Technical Assistance

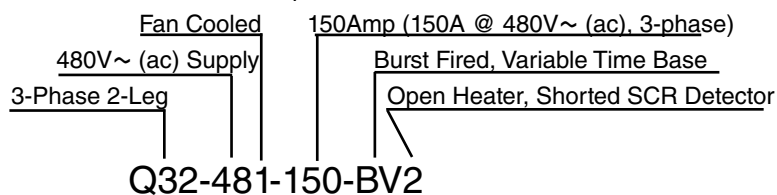
If you encounter a problem with your Watlow controller, review your configuration information to verify that your selections are consistent with your application: inputs, outputs, alarms, limits, etc. If the problem persists, you can get technical assistance from your local Watlow representative (see 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 an Applications Engineer. Please have the following information available when calling:

- Complete model number
- All configuration information
- User's Guide
- 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 in the Model Number Information chart in the Appendix for a complete listing.

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Chapter 1

Starting Out With The QPAC Power Control

*The Q32
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 Card. See the QPAC Modularity Overview below. Power Bases are available in 150 to 1,000A ratings with UL508 listed and cULus in single-phase, three-phase two-leg and three-phase three-leg configurations. A Transformer plugged into the Power Base allows the QPAC to operate

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-leg controls only; not for 3Ø, 3-leg controls.

Plug-in transformers (50/60 Hz.)

- 120V~ (ac)
- 208/240V~ (ac)
- 380V~ (ac)
- 415V~ (ac)
- 480V~ (ac)
- 575V~ (ac)



Power Bases With Motherboards

- QPAC-01: 1Ø, 150 to 1,000A
- QPAC-32: 3Ø, 2-leg, 150 to 1,000A
- QPAC-33: 3Ø, 3-leg, 150 to 1,000A

on any voltage from 120 to 575V~ (ac). 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 Guide.
- 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 that describe the three steps to installing 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 two 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.



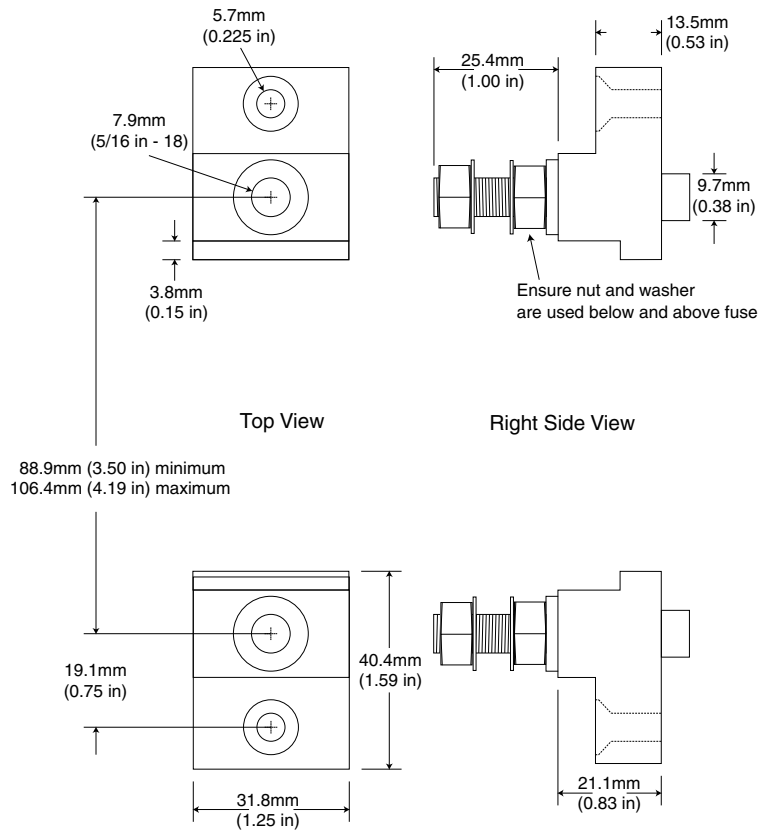
WARNING:
To avoid potential electric shock and other hazards, all mounting and wiring for the QPAC must conform to the National Electric Code (NEC) and other locally applicable codes.

Mounting the QPAC

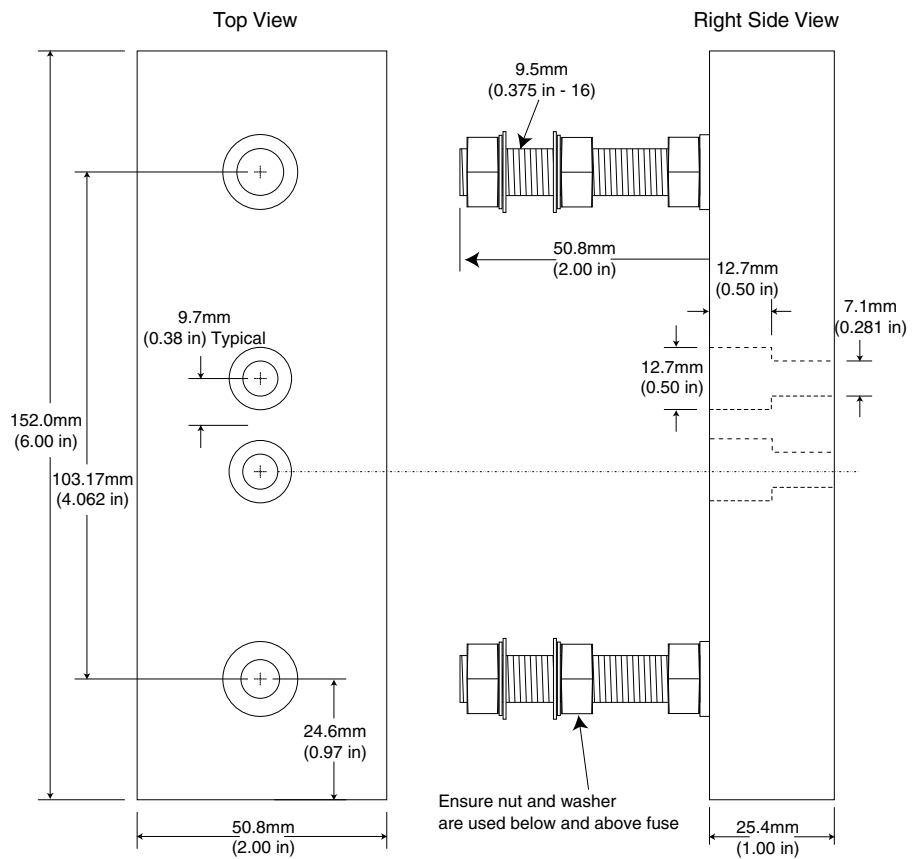
The physical size and mounting dimensions of the QPACs are different for different current ratings. Find the "Case Style" photo on the next pages that match your QPAC. The table and figure accompanying each case style will give you corresponding physical dimensions and mounting footprint. The table also indicates if the units are equipped with fans and externally-mounted fuses. 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.

Mounting

Template for Fuse Holders
with QPAC 150A, 575V.



Template for Fuse Holders
with QPAC 200 and 300A,
575V.



Case Style C Mounting

QPAC Case Style C.



QPAC Case Style C
Overall Dimensions.

Model	Amps	Height	Width	Depth	Fans	Fuses
QPAC-01	150	330mm (13 in)	175mm (6.9 in)	260mm (10.25 in)	1	on heat sink
QPAC-01	200	330mm (13 in)	175mm (6.9 in)	260mm (10.25 in)	1	on heat sink
QPAC-01	300	330mm (13 in)	175mm (6.9 in)	260mm (10.25 in)	1	on heat sink
QPAC-32	150	330mm (13 in)	348mm (14.0 in)	260mm (10.25 in)	2	on heat sink
QPAC-32	200	330mm (13 in)	348mm (14.0 in)	260mm (10.25 in)	2	on heat sink
QPAC-32	300	330mm (13 in)	348mm (14.0 in)	260mm (10.25 in)	2	on heat sink
QPAC-33	150	330mm (13 in)	533mm (21.0 in)	260mm (10.25 in)	3	on heat sink
QPAC-33	200	330mm (13 in)	533mm (21.0 in)	260mm (10.25 in)	3	on heat sink
QPAC-33	300	330mm (13 in)	533mm (21.0 in)	260mm (10.25 in)	3	on heat sink



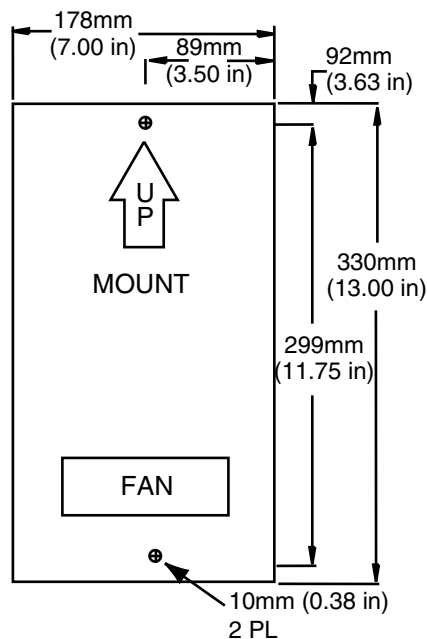
CAUTION:
Mount the QPAC vertically
(height dimension vertical)
for proper cooling. Failure
to do so could result in
power control malfunction.

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



WARNING: Shock Hazard
Heatsinks are electrically
Live.

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



Case Style C Mounting

QPAC Case
Style C, Q32,
150, 200, 300A,
3-Phase, 2-Leg
Mounting Footprint.

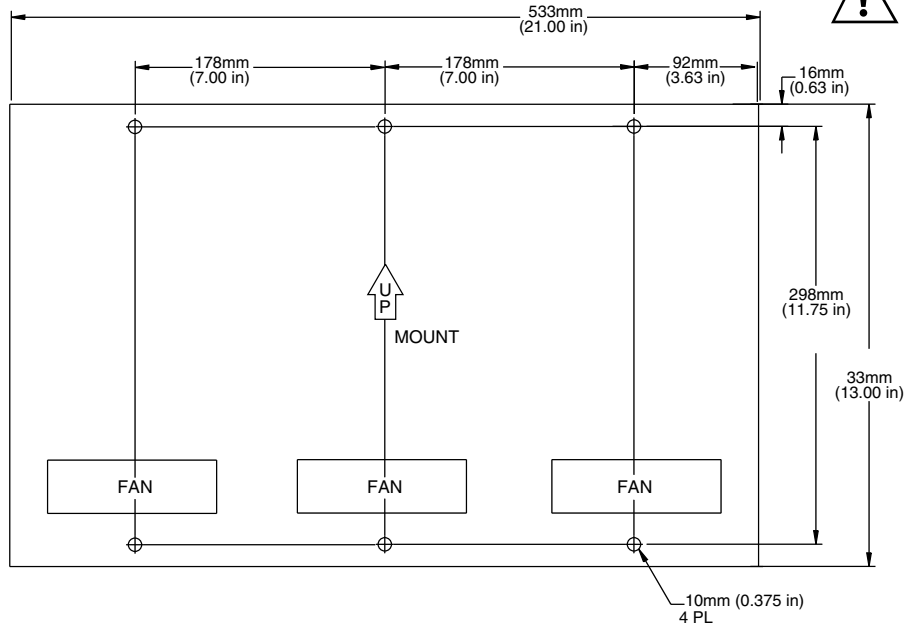
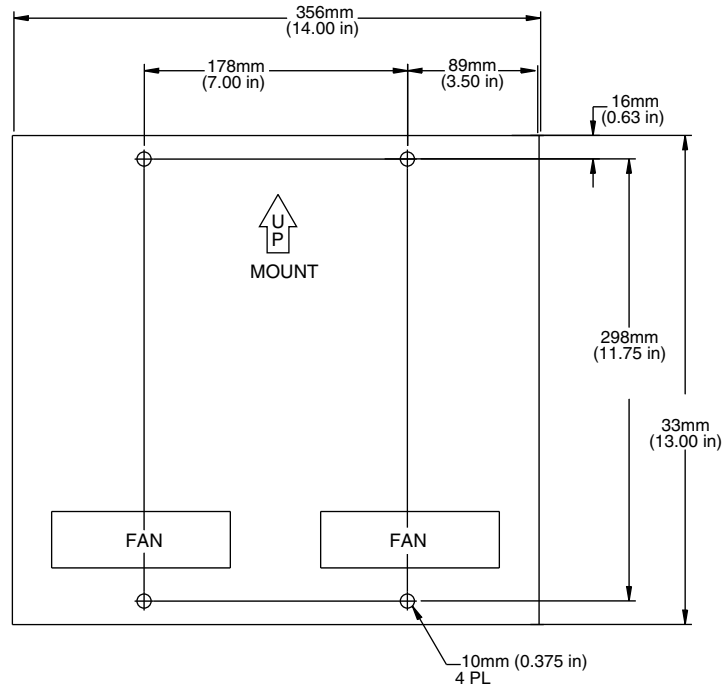


CAUTION:
Mount the QPAC verti-
cally (height dimension
vertical) for proper
cooling. Failure to do
so could result in power
control malfunction.



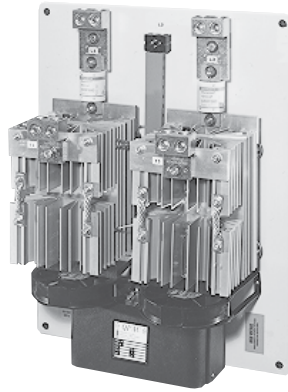
WARNING: Shock Hazard
Heatsinks are electrically
Live.

QPAC Case Style C,
Q33, 150, 200, 300A,
3-Phase, 3-Leg Mounting
Footprint.



Case Style E Mounting

QPAC Case Style E.



Model	Amps	Height	Width	Depth	Fans	Fuses
QPAC-01	400 to 600	685mm (27 in)	430mm (17 in)	300mm (11.7 in)	1	1 on-board
QPAC-01	800 to 1,000	685mm (27 in)	430mm (17 in)	340mm (13.3 in)	1	1 on-board
QPAC-32	400 to 600	685mm (27 in)	535mm (21 in)	300mm (11.7 in)	2	2 on-board
QPAC-32	800 to 1,000	840mm (33 in)	535mm (21 in)	340mm (13.3 in)	2	2 on-board
QPAC-33	400 to 600	840mm (33 in)	685mm (27 in)	300mm (11.7 in)	3	3 on-board
QPAC-33	800 to 1,000	840mm (33 in)	685mm (27 in)	340mm (13.3 in)	3	3 on-board

QPAC Case Style E
Overall Dimensions.

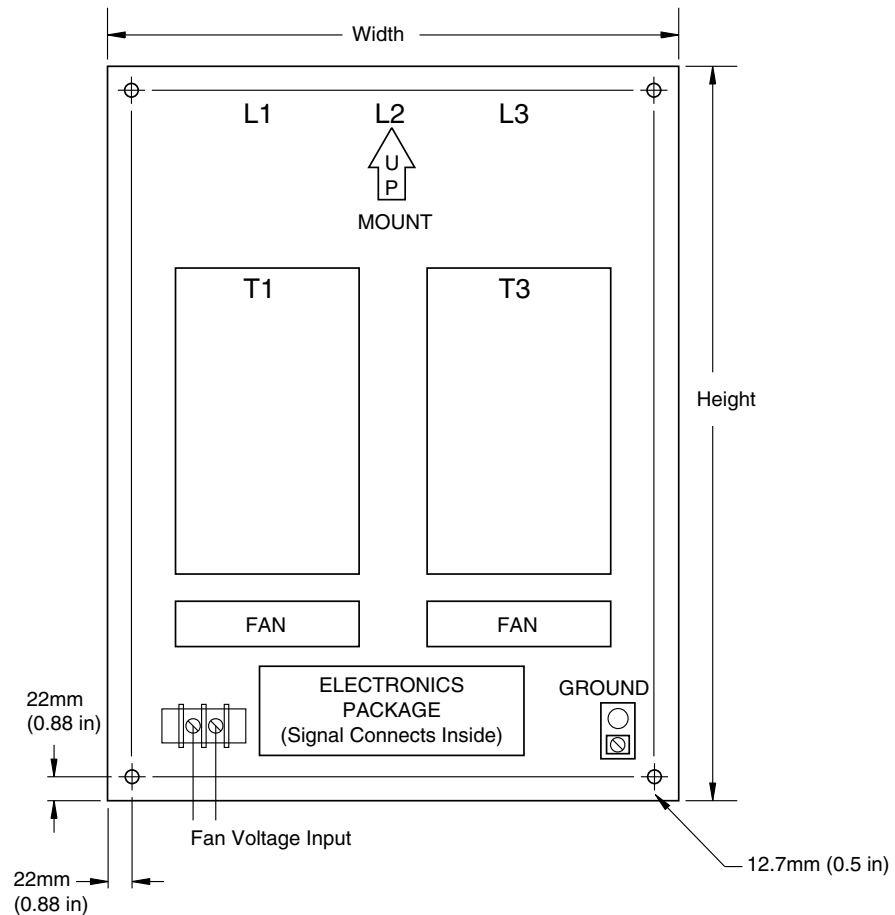


CAUTION:
Mount the QPAC vertically (height dimension vertical) for proper cooling. Failure to do so could result in power control malfunction.



WARNING: Shock Hazard
Heatsinks are electrically Live.

QPAC Case Style E
Mounting Footprint.



Wiring

QPAC Wiring Data.

Load Current (amps)	Semiconductor Fuse Rating (amps.)	Minimum Recommended Wire Size	Bending Radius	Wire Sized that Lugs Accept	Fuse Mounting	Lug Torque	Internal Allen Wrench
150	200	3/0	102mm (4 in)	4 to 3/0	*onboard	240 in/lb	3/16 in
200	250	250 MCM	114 mm (4.5 in)	6 to 350 MCM	*onboard	375 in/lb	3/8 in
300	400	500 MCM	203 mm (8 in)	4 to 500 MCM	*onboard	375 in/lb	3/8 in
400	500	Dual 350 MCM	380mm (15 in)	2 to 600 MCM	onboard	500 in/lb	1/2 in
500	600	Dual 350 MCM	380mm (15 in)	2 to 600 MCM	onboard	500 in/lb	1/2 in
600	800	Dual 500 MCM	380mm (15 in)	2 to 600 MCM	onboard	500 in/lb	1/2 in
800	1,000	Quad 250 MCM	380mm (15 in)	2 to 600 MCM	onboard	375 in/lb	3/8 in
1,000	1,250	Quad 350 MCM	380mm (15 in)	2 to 600 MCM	onboard	375 in/lb	3/8 in

*The fuses are external in Style C power controls over 575V~ (ac).

Output Wiring



WARNING: Shock Hazard
Heatsinks are electrically Live.



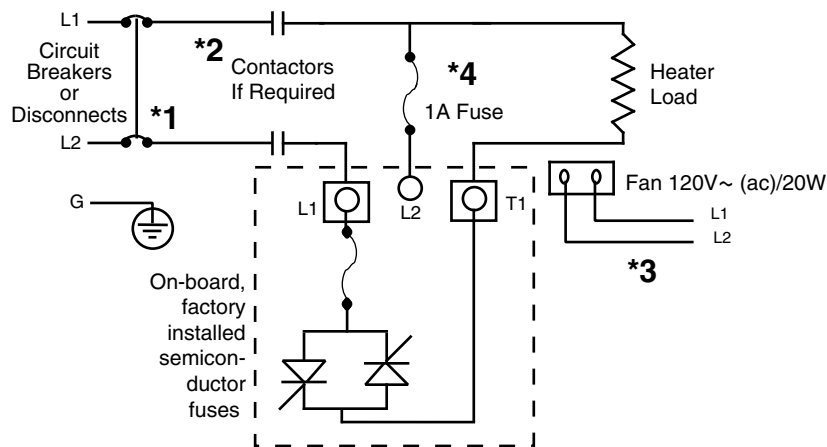
CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

NOTE:
A circuit breaker is required in addition to the semiconductor fuses. All semiconductor fuses are mounted on board the QPAC models 400 to 1,000. Where third-leg fusing is selected, additional space is required.

NOTE:
QPAC models Q01, Q32 and Q33 up to 300A and 575V~ (ac) are agency listed. QPAC models Q01 and Q32 up to 1,000A and 480V~ (ac) are agency listed. Q33 400 to 1,000A are not agency listed.



WARNING:
To avoid damage to property and equipment, and/or injury or loss of life, use National Electric Code (NEC) standard wiring practices to install and operate the QPAC. Failure to do so could result in damage and/or injury or death.



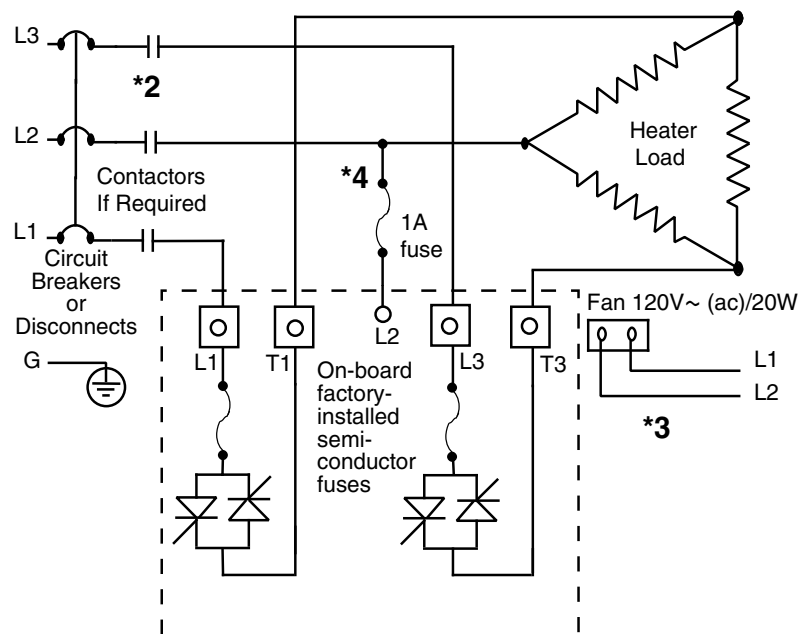
QPAC-01 Output Wiring
for 150 to 1,000A Units.

***1 NOTE:** On 120V~ (ac) or 277V~ (ac), 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.

***4 NOTE:** Use 14- to 16-gauge wire for control power only.



QPAC-32 Output Wiring
for 150 to 1,000A Units.

Output Wiring

QPAC-33 Power and Load Wiring for all Units.



WARNING: Shock Hazard
Heatsinks are electrically Live.



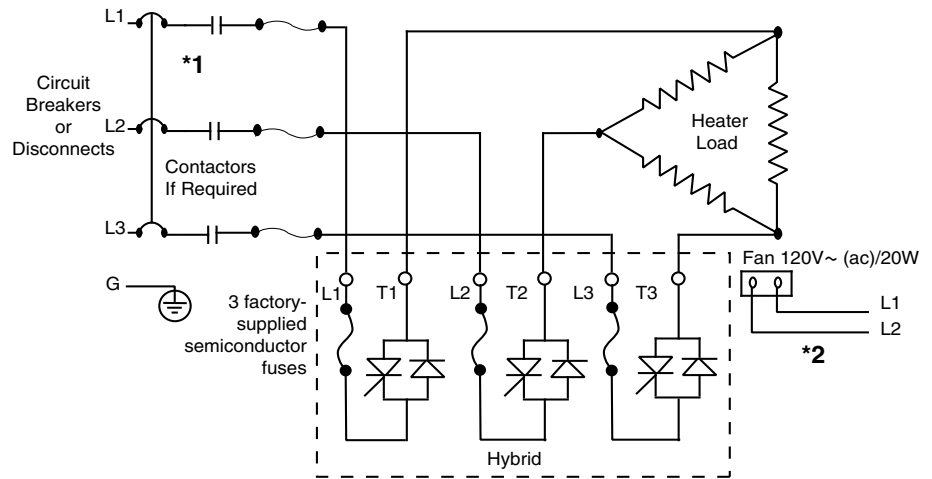
CAUTION:
Check terminals for tightness before applying power and then recheck terminals after one day of operation. Loose connections can damage the SCR.

NOTE:
A circuit breaker is required in addition to the semiconductor fuses. All semiconductor fuses are mounted on-board the QPAC models 400 to 1,000. Where third-leg fusing is selected, additional space is required.

NOTE:
QPAC models Q01, Q32 and Q33 up to 300A and 575V~ (ac) are agency listed. QPAC models Q01 and Q32 up to 1,000A and 480V~ (ac) are agency listed. Q33 400 to 1,000A are not agency listed.



WARNING:
To avoid damage to property and equipment, and/or injury or loss of life, use National Electric Code (NEC) standard wiring practices to install and operate the QPAC. Failure to do so could result in damage and/or injury or death.



***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.

Input Wiring



CAUTION:
Built-in noise reduction circuitry on the CA card requires an external load resistor (1000Ω, 25W, 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.

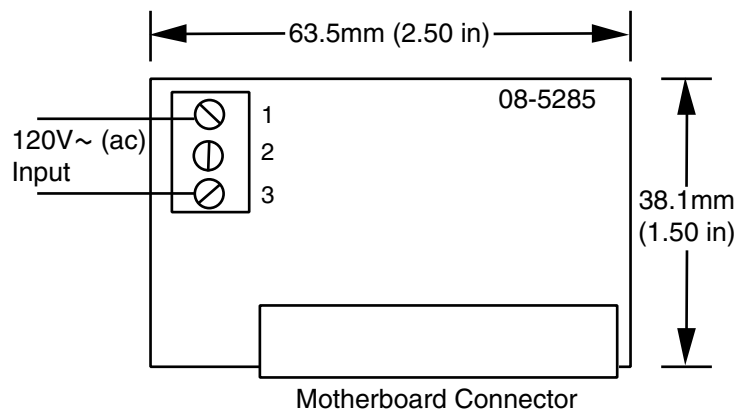
*CA Card Wiring SS
Contactor, 120V~ (ac)
Input.*

Input Signal Wiring

When wiring the input signal do not run any signal wires alongside or in the same conduit with the ac power or load wires. Signal input should be provided by a 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.

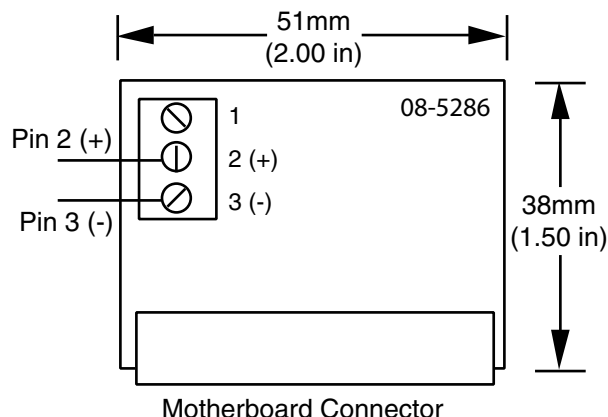
CA Control Card — AC Input Contactor

The 120V~ (ac) 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 120V~ (ac) input signal turns the power control on. The turn off voltage for the power control is 0V~ (ac).



CD Control Card — DC Input Contactor

For dc input, the input signal is wired into pin 2 (+) and pin 3 (-) of the input signal connector. An input signal of 3 to 30V_{DC} (dc) turns the QPAC power control on. 0 to 1V_{DC} (dc) turns the power control off.



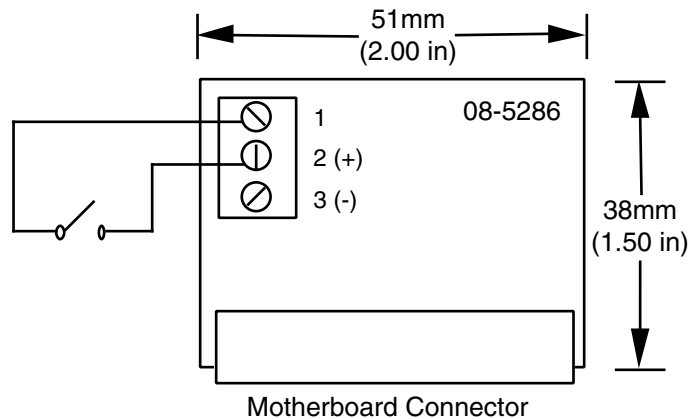
*CD Control Card, Solid-
State Contactor, 3 to
30V_{DC} (dc) Input.*

Input Wiring

CD Control Card — Contact Closure Input Contactor

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 10K Ω minimum.

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:

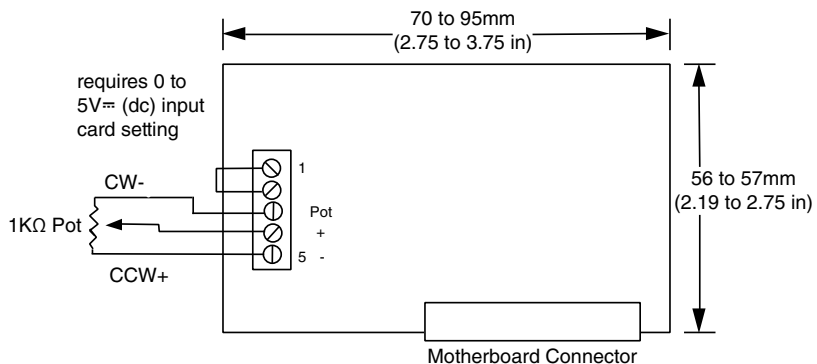
- AF - Phase Angle Control
- AL - Phase Angle Control with Current Limit
- BF - Burst Firing (Zero Cross), Fixed Time Base
- BV - Burst Firing (Zero Cross), Variable Time Base

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 1K Ω 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 "Bias and Gain Adjustments," Chapter 3.

AF, AL, BF, BV Potentiometer Input.

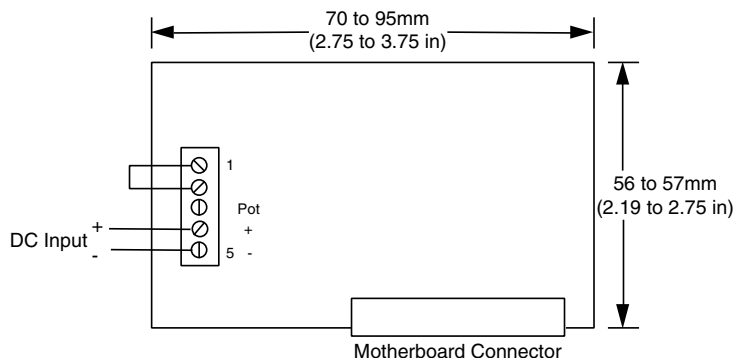


Input Wiring

AF, AL, BF and BV dc Input.

AF, AL, BF and BV DC Input Connections

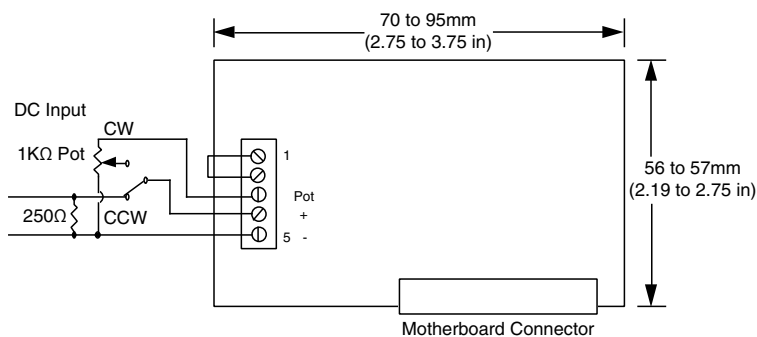
The temperature control output to the Control Cards is wired to the "+" and "-" input terminals of the control card. These cards will accept a 0 to 12V_{DC} (dc), or 0 to 25mA input signal. They are factory calibrated for 4 to 20mA. If using a voltage or current range other than this, follow bias and gain adjustment instructions in Chapter 3. The control card can be converted to a voltage input by removing a resistor or moving a jumper. Follow voltage input conversion instructions in Chapter 3.



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 1K Ω potentiometer or a 4 to 20mA temperature control. The control card must be converted to voltage input by removing the appropriate resistor or replacing a jumper. See "Voltage Input Conversions," Chapter 3. A 250 Ω resistor must be placed in parallel with the temperature control input, so that the temperature control signal will be a 1 to 5V_{DC} (dc) input.

AF, AL, BF and BV Auto/Manual Input.



Interlock

(Available on the AF, AL, BF and BV input card options.)

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 and 2, when "soft start" is desirable.

Soft Start

(Available on the Phase Angle input cards AF and AL only.)

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 restart soft. Soft start is only available on phase angle models.

AL Control Card Current Transformer Connections

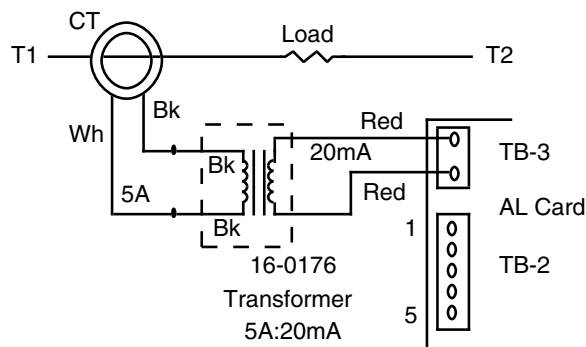
Phase Angle Current Limit Option

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
Not Used	5A : 20mA Interstage 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
0004-0286-0400	400A : 5A Current Transformer	16-0176
0004-0286-0500	500A : 5A Current Transformer	16-0176
0004-0286-0600	600A : 6A Current Transformer	16-0176
0004-0287-0800	800A : 5A Current Transformer	16-0176
0004-0288-1000	1,000A : 5A Current Transformer	16-0176

AL Control Card, Current Transformer Selection.

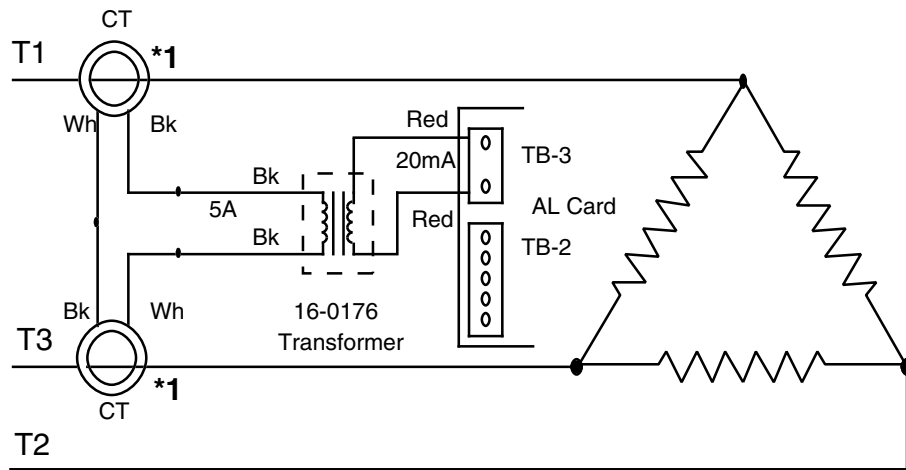
Example of Current Transformer (CT) Connections One CT, 150 Amps and Above, 1Ø.



Input Wiring

Example of Current Transformer Connection to the AL (current limit) Card.

***1 NOTE:** Both load leads must pass through the CTs in the same direction.

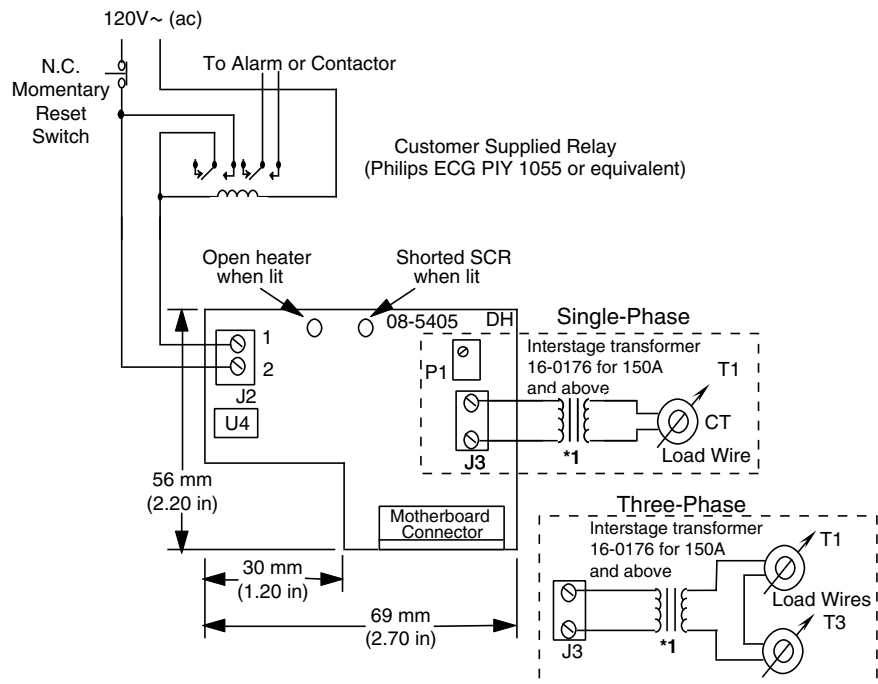


Single- and Three-Phase
DH Option Open Heater or
Shorted SCR Detector.

***1 NOTE: Interstage transformers (16-0176) are required for all units 150A and above.**



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



DH Card Operation — Heater Diagnostics

The DH card uses a CT to monitor the load current and also detects when a firing pulse is sent to the SCRs. 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 SCRs, the "Shorted SCR" indicator light 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" indicator light 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 CTs 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 to 20mA output, or 5V for 0 to 5V 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.

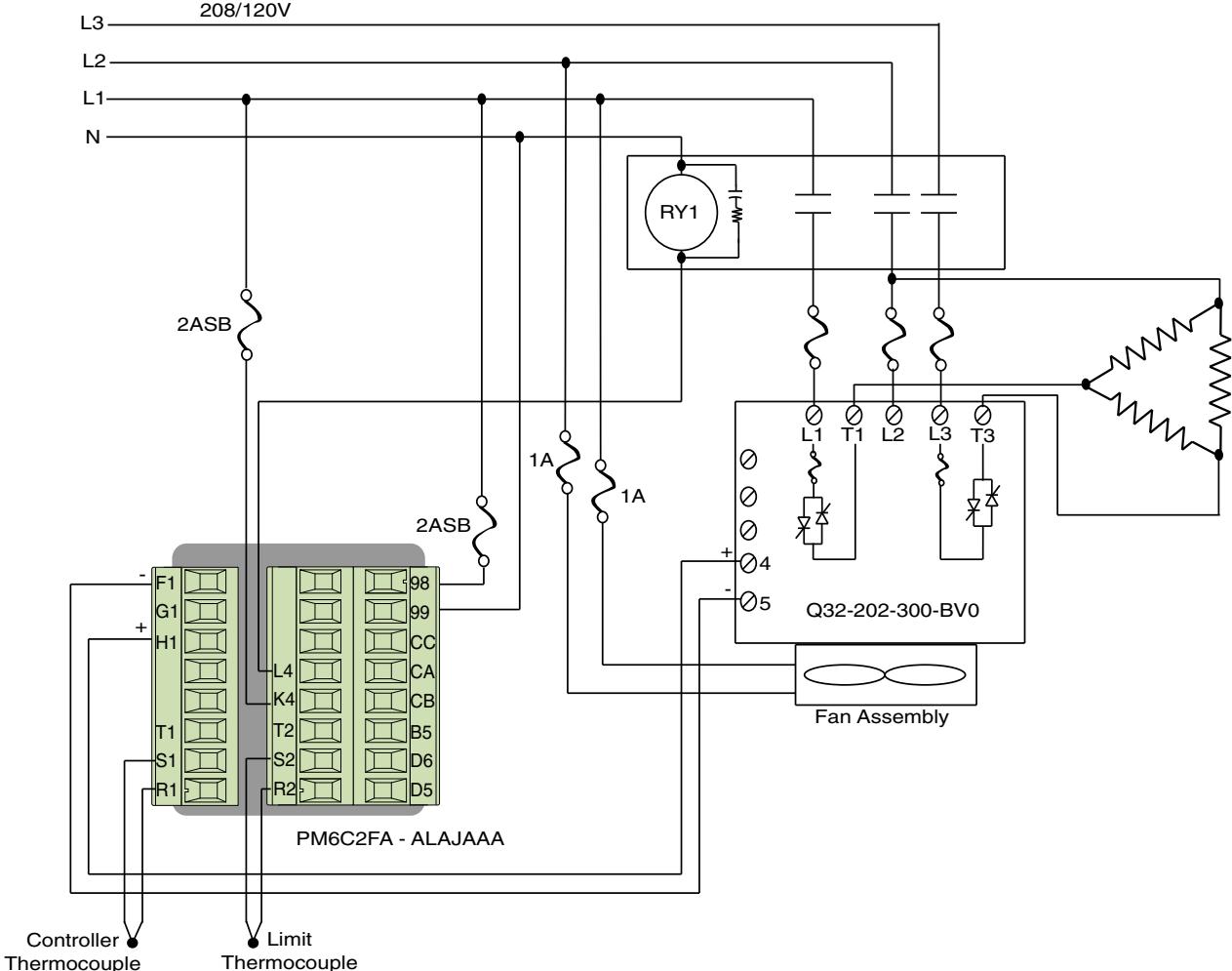
A shorted SCR will energize the shorted SCR light.

System Wiring

QPAC system Wiring Example

*QPAC System Wiring
Example, 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 below.



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.

Chapter 3

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 proper phase rotation. 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 indicator lights in the upper left hand corner of the Power Base motherboard. If the phase rotation indicator light 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 to 20mA but can be adjusted over a range of 0 to 12V_{DC} (dc) or 0 to 25mA to match the output of a specific temperature control. Input impedance for 4 to 20mA input is 250 Ω . The input impedance can be changed to 5K Ω to accept a voltage by performing the following procedure for each card.

Voltage Input Conversions

(See Accessories in the Appendix for card part numbers.)

AF: For 5K Ω input, move J2 jumper, located on the lower left of the AF card next to the TB-2 connector, Terminal 5. See the AL (Rev. B) Control Card figure in this chapter.

AL: For 5K Ω input, replace the J2 jumper to the 5V position, located on the lower left of the AL card. See the AF (Rev. H) Control Card figure in this chapter.

BF: For 5K Ω input, remove resistor R3, located on the lower left of the QBF card next to the TB-2 connector, Terminal 5. See the BF (Rev. D) Control Card figure in this chapter.

BV: For 5K Ω input, remove the external resistor attached to the J3 connector plug. See the BV (Rev. B) Control Card figure in this chapter.

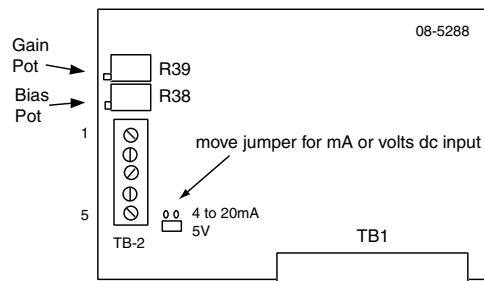
Adjustment Procedure

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.

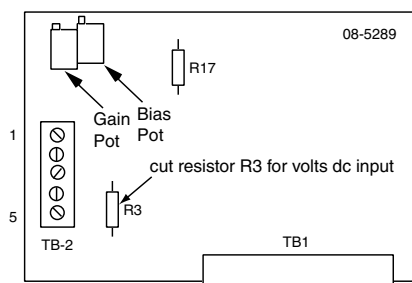
Bias and Gain

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 4.2mA. 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 and 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 19.8mA.
 - 4b. **BV and 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 19.8mA.
 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.

AF (Rev. H) Control Card.

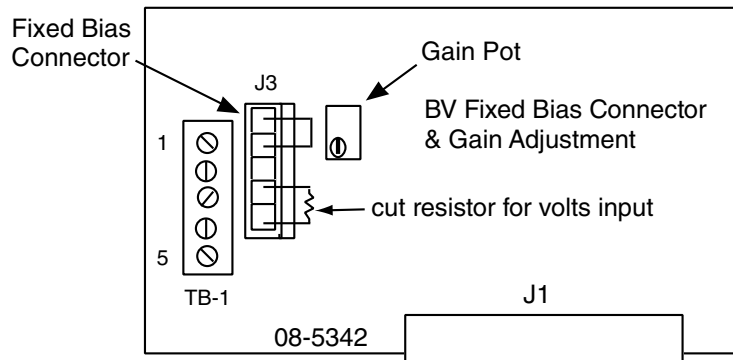


BF (Rev. D) Control Card.



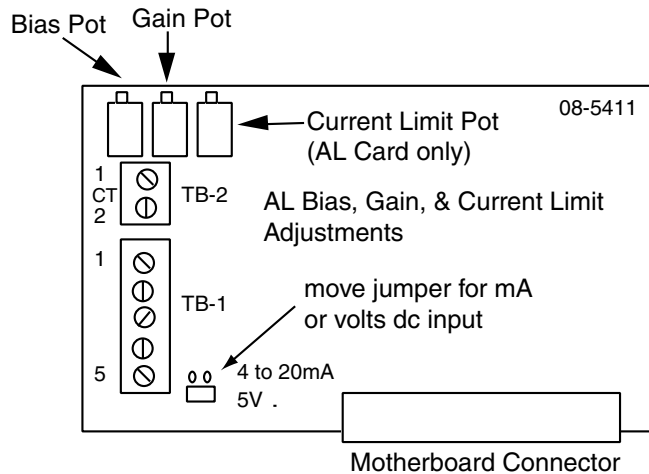
Bias and Gain

BV (Rev. B) Control Card.



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

(AL Card only)

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 the AL (Rev. B) Control Card figure above. 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.

Appendix

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. The problem may be with the QPAC's control card, transformer or power base. Use this QPAC Troubleshooting Guide to assist with troubleshooting.

QPAC Troubleshooting Guide.

Symptom	Probable Cause	Corrective Action
No output	Fuses blown	Check and replace fuses
	Incorrect input wiring	See "Input Wiring," Chapter 2.
	Incorrect input signal	Check temperature control output.
	Input signal reversed	See "Input Wiring," Chapter 2.
	Input signal not adjusted	See "Bias and Gain Adjustment," Chapter 3.
	Wrong or missing control card	See "Input Wiring," Chapter 2.
	Transformer wiring	Check transformer connections.
	Missing load wiring	See "Power and Load Wiring," Chapter 2. The SCR(s) will not function without a load.
Heatsink temperature exceeded 86°C (187°F)	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 and transformer labels.
Uncontrolled output full on	Bad control card, or bias and gain out of adjustment	Unplug control card, try again. Readjust bias and 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 it.
Unbalanced output (QPAC-32 and QPAC-33)	Incorrect phase rotation	See "Phase Rotation Adjustment," Chapter 3.

The QPAC Service Manual is available at http://www.watlow.com/downloads/en/manuals/qpacse_a.pdf.

Specific to QPAC-33 Diagnostics

The QPAC-33 has four indicator lights for diagnostics. During normal operation, all four will be lit.

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

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

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.
- 120V~ (ac) through 575V~ (ac)
- 150 through 1,000 amps per switched leg.

Agency Approvals

- UL 508 listed and cULus up to 1,000 amps on Q01 and Q32 models, File #E73741.
- UL 508 listed and cULus up to 300 amps only on Q33 models, File E73741.

SCCR - Short Circuit Rating

- UL witness tested to 200,000A available fault current Q01, Q32 150-1000A to 480V~ (ac) Q33 units and over 480V~ (ac) units not tested

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 to 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 to 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 to 20mA≡ (dc)
- Input impedance 250Ω (clip resistor for 5kΩ voltage input), or manual control input

AF Phase angle control

- Process input factory set @ 4 to 20mA≡ (dc)
- Input impedance 250Ω (move jumper 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 to 20mA≡ (dc)

Specifications

- Input impedance 250Ω (move jumper for 5kΩ voltage input), or manual control input
- Soft start approximately 6 seconds upon power-up, 1 second upon set point change
- Current and interstage transformers included.
- Available on Q01 and Q33 models only.

Line Voltage/Power

- 50/60 Hz ~ (ac) line frequency, Q32 and Q33 calibration line frequency dependent
- Voltage: $\pm 10\%$, 120, 208, 240, 277, 380, 415, 480, 575V~ (ac)

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 and RC snubber network standard (MOV comes only on Q33 [3-phase, 3-leg])
- (Q32) third 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

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

Storage Temperature

- -40 to 85°C (-40 to 185°F)

Options

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

Weight

Phase			
Amps	1Ø Q01	3Ø, 2 leg Q32	3Ø, 3 wire Q33
150	6.8 kg (15 lbs)	16.3 kg (36 lbs)	22.7 kg (50 lbs)
200	6.8 kg (15 lbs)	16.3 kg (36 lbs)	22.7 kg (50 lbs)
300	6.8 kg (15 lbs)	16.3 kg (36 lbs)	22.7 kg (50 lbs)
400 to 600	19.9 kg (44 lbs)	38.5 kg (85 lbs)	45.4 kg (100 lbs)
800 to 1,000	22.2 kg (49 lbs)	54.4 kg (120 lbs)	61.2 kgs (135 lbs)

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
- 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~ (ac)

Cooling Fan Voltage³

Customer to supply wiring and hook-up.

- 1 = 120V~ (ac); required on all 3-phase models
- 2 = 240V~ (ac); required on all 3-phase models

Output Current (Amps)

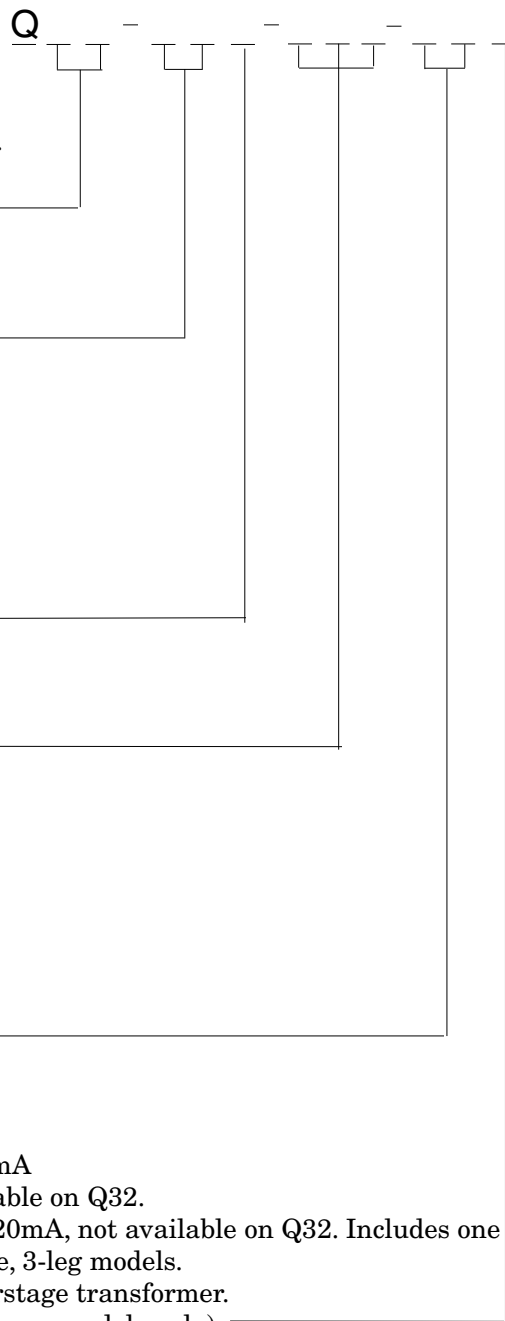
- 150 = 150 amps
- 200 = 200 amps
- 300 = 300 amps
- 400 = 400 amps
- 500 = 500 amps
- 600 = 600 amps
- 800 = 800 amps
- 01K = 1000 amps

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 to 20mA
- BV = Burst fired, variable time base (08-5342) 4 to 20mA
- AF = Phase angle fired (08-5288) 4 to 20mA, not available on Q32.
- AL = Phase angle fired w/current limit (08-5411) 4 to 20mA, not available on Q32. Includes one current transformer. Add a second CT for 3-phase, 3-leg models.
AL models 150 amps and above require one interstage transformer.

Open Heater/Shorted SCR Detector^{4,5} (burst fire, zero cross models only)

- 0 = None
- 1 = Single-phase operation
- 2 = Three-phase operation



Accessories

Accessories

Watlow Part Number	Model	Description
08-5362		Manual Control Kit
16-0176	5A : 20mA	Interstage Transformer
0004-0286-0400	400 : 5A	Current Transformer
0004-0286-0500	500 : 5A	Current Transformer
0004-0286-0600	600 : 5A	Current Transformer
0004-0287-0800	800 : 5A	Current Transformer
0004-0288-1000	1000 : 5A	Current Transformer
16-0008	150A : 5A	Current Transformer
16-0045	200A : 5A	Current Transformer
16-0073	300A : 5A	Current Transformer

Watlow Part Number	Models	Description
17-7053	QPAC 150A up to 480V	Fuse, Semiconductor 200A @ 500V Blade, Bussmann FWH-200B
17-7015	QPAC 150A, 575V only	Fuse, Semiconductor 200A @ 700V Blade, Bussmann FWP-200A
17-7054	QPAC 200A up to 480V	Fuse, Semiconductor 250A @ 500V Blade, Bussmann FWH-250A
17-7016	QPAC 200A, 575V only	Fuse, Semiconductor 250A @ 700V Blade, Bussmann FWP-250A
17-7056	QPAC 300A up to 480V	Fuse, Semiconductor 400A @ 500V Blade, Bussmann FWH-400A
17-7019	QPAC 300A, 575V only	Fuse, Semiconductor 400A @ 700V Blade, Bussmann FWP-400A
17-7057	QPAC 400A up to 480V	Fuse, Semiconductor 500A @ 500V Blade, Bussmann FWH-500A
0808-0110-0000	QPAC 400A, 575V only	Fuse, Semiconductor 500A @ 500V Blade, Bussmann FWP-500A
17-7058	QPAC 500A up to 480V	Fuse, Semiconductor 600A @ 500V Blade, Bussmann FWH-600A
0808-0109-0000	QPAC 500A, 575V only	Fuse, Semiconductor 600 A @ 700V Blade, Bussmann FWP-600A
0808-0108-0000	QPAC 600A up to 575V	Fuse, Semiconductor 800 A @ 700V Blade, Bussmann FWP-600A
17-7082	QPAC 800A up to 575V	Fuse, Semiconductor 1000A @ 700V Blade, Bussmann 170M6714
17-7012	QPAC 1000A up to 575V	Fuse, Semiconductor 1250A @ 700V Blade, Bussmann 170M6766
17-5064	QPAC 150 to 300A, 575V Applications only	Fuse Holder, Semiconductor, externally mounted
08-7210	all	Bias and Gain Card, use w/BV Input Control Card
25-0020	QPAC – 150 to 300A	Cooling Fan, 115V, 105 CFM 114.3 x 114.3mm (4.5 x 4.5 in)
25-0027	QPAC – 400 to 1000A	Cooling Fan, 115V, 260 CFM 152.4mm (6 in)
25-0022	QPAC – 150 to 300A	Cooling Fan, 230V, 105 CFM 114.3 x 114.3mm (4.5 x 4.5 in)
25-0028	QPAC – 400 to 1000A	Cooling Fan, 230V, 260 CFM 152.4mm (6 in)
18-1064	Q33 – 400 to 600 A	Diode, 1400A 1200V, SD1100C..C Series IR
18-1068	Q33 – 1000A	Diode, 1170A 1200V, SD1100C..L Series IR
18-1044	Q33 – 150 to 300A	Diode, 250A, 1000V, 1N3742R ST
RPC-5405-0000	all	DH (Open Heater/Shorted SCR Detector) Card
08-5288	Q01, Q33	Input Control Card, Phase-angle w/AF (4 to 20 mA)
RPC-5411-05-50H	Q01, Q33	Input Control Card, Phase-angle, w/AL (0 to 5V $\overline{\text{ac}}$ (dc), 50 Hz)
RPC-5411-05-60H	Q01, Q33	Input Control Card, Phase-angle, w/AL (0 to 5V $\overline{\text{ac}}$ (dc), 60 Hz)
RPC-5411-42-50H	Q01, Q33	Input Control Card, Phase-angle, w/AL (4 to 20 mA, 50 Hz)

Accessories

Watlow Part Number	Models	Description
RPC-5411-42-60H	Q01, Q33	Input Control Card, Phase-angle, w/AL (4 to 20mA, 60 Hz)
08-5289	all	Input Control Card, Zero-cross, w/BF (4 to 20mA)
RPC-5342-50HZ	all	Input Control Card, Zero-cross, w/BV (4 to 20mA, 50 Hz)
RPC-5342-60HZ	all	Input Control Card, Zero-cross, w/BV (4 to 20mA, 60 Hz)
08-5285	all	Input Control Card, Zero-cross, w/CA (ac input)
08-5286	all	Input Control Card, Zero-cross, w/CD (dc input)
08-5287	Q01	Motherboard Assembly
08-5320	Q32	Motherboard Assembly
08-5337	Q33	Motherboard Assembly
RPC-5338-150	Q33 all	SCR Driver Board 08-5338
18-5052	Q01, Q32 – 150 to 300A	SCR Stud, 300A, 1200V, ST
18-5214	QPAC – 400 to 600A	SCR, 500A, 1200V, E-PUK
18-5215	QPAC – 800A	SCR, 910A, 1200V, HP
18-5216	QPAC – 1000A	SCR, 1470A, 1200V, HP
08-5302	QPAC – 150 to 400A, 120V	Transformer Assembly, Plug-in, 120V
08-5303	QPAC – 150 to 300A, 208/240V	Transformer Assembly, Plug-in, 208/240V
08-5304	QPAC – 150 to 300A, 277V	Transformer Assembly, Plug-in, 277V
08-5306	QPAC – 150 to 300A, 380V	Transformer Assembly, Plug-in, 380V
08-5308	QPAC – 150 to 300A, 415V	Transformer Assembly, Plug-in, 415V
08-5305	QPAC – 150 to 300A, 480V	Transformer Assembly, Plug-in, 480V
08-5307	QPAC – 150 to 300A, 575V	Transformer Assembly, Plug-in, 575V
Z100-0818-0000	QPAC – 400 to 1000A, 120V	Transformer Assembly, Plug-in, 120V
Z100-0819-0000	QPAC – 400 to 1000A, 208/240V	Transformer Assembly, Plug-in, 208/240V
Z100-0820-0000	QPAC – 400 to 1000A, 277V	Transformer Assembly, Plug-in, 277V
Z100-0823-0000	QPAC – 400 to 1000A, 380V	Transformer Assembly, Plug-in, 380V
Z100-0822-0000	QPAC – 400 to 1000A, 415V	Transformer Assembly, Plug-in, 415V
Z100-0821-0000	QPAC – 400 to 1000A, 480V	Transformer Assembly, Plug-in, 480V
Z100-0824-0000	QPAC – 400 to 1000A, 575V	Transformer Assembly, Plug-in, 575V

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 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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