How to Use the QPAC

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:

Fan Cooled 150Amp (150A @ 480V (ac), 3-phase)
Burst Fired, Variable Time Base
Open Heater, Shorted SCR Detector

Q32-481-150-BV2

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

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
Starting Out

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

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.

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.**

- **Top View**
  - 88.9mm (3.50 in) minimum
  - 106.4mm (4.19 in) maximum

- **Right Side View**
  - 21.11mm (0.83 in)

---

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

- **Top View**
  - 152.0mm (6.00 in)
  - 103.17mm (4.062 in)

- **Right Side View**
  - 25.4mm (1.00 in)
  - 24.6mm (0.97 in)
  - 12.7mm (0.50 in)
  - 7.1mm (0.281 in)

Ensure nut and washer are used below and above fuse.
QPAC Case Style C.

QPAC Case Style C

<table>
<thead>
<tr>
<th>Model</th>
<th>Amps</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
<th>Fans</th>
<th>Fuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPAC-01</td>
<td>150</td>
<td>330mm (13 in)</td>
<td>175mm (6.9 in)</td>
<td>260mm (10.25 in)</td>
<td>1</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-01</td>
<td>200</td>
<td>330mm (13 in)</td>
<td>175mm (6.9 in)</td>
<td>260mm (10.25 in)</td>
<td>1</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-01</td>
<td>300</td>
<td>330mm (13 in)</td>
<td>175mm (6.9 in)</td>
<td>260mm (10.25 in)</td>
<td>1</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-32</td>
<td>150</td>
<td>330mm (13 in)</td>
<td>348mm (14.0 in)</td>
<td>260mm (10.25 in)</td>
<td>2</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-32</td>
<td>200</td>
<td>330mm (13 in)</td>
<td>348mm (14.0 in)</td>
<td>260mm (10.25 in)</td>
<td>2</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-32</td>
<td>300</td>
<td>330mm (13 in)</td>
<td>348mm (14.0 in)</td>
<td>260mm (10.25 in)</td>
<td>2</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-33</td>
<td>150</td>
<td>330mm (13 in)</td>
<td>533mm (21.0 in)</td>
<td>260mm (10.25 in)</td>
<td>3</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-33</td>
<td>200</td>
<td>330mm (13 in)</td>
<td>533mm (21.0 in)</td>
<td>260mm (10.25 in)</td>
<td>3</td>
<td>on heat sink</td>
</tr>
<tr>
<td>QPAC-33</td>
<td>300</td>
<td>330mm (13 in)</td>
<td>533mm (21.0 in)</td>
<td>260mm (10.25 in)</td>
<td>3</td>
<td>on heat sink</td>
</tr>
</tbody>
</table>

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

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

Chapter 2: Install & Wire  QPAC User’s Guide  9
### Case Style E Mounting

QPAC Case Style E.

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

**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.**
### QPAC Wiring Data

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

*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.

*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.
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 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) turns the QPAC power control on. 0 to 1V= (dc) turns the power control off.
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 10KΩ minimum.

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 “Bias and Gain Adjustments,” Chapter 3.
**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), 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 1KΩ 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 250Ω resistor must be placed in parallel with the temperature control input, so that the temperature control signal will be a 1 to 5V (dc) 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.

<table>
<thead>
<tr>
<th>Current Transformer (Part Number)</th>
<th>Description</th>
<th>Interstage Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Used</td>
<td>5A : 20mA Interstage Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>16-0008</td>
<td>150A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>16-0045</td>
<td>200A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>16-0073</td>
<td>300A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>0004-0286-0400</td>
<td>400A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>0004-0286-0500</td>
<td>500A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>0004-0286-0600</td>
<td>600A : 6A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>0004-0287-0800</td>
<td>800A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
<tr>
<td>0004-0288-1000</td>
<td>1,000A : 5A Current Transformer</td>
<td>16-0176</td>
</tr>
</tbody>
</table>

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

![AL Control Card, Current Transformer Selection.](image)
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.
*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.
QPAC system Wiring Example

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) or 0 to 25mA to match the output of a specific temperature control. Input impedance for 4 to 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

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

**AF:** For 5KΩ 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 5KΩ 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 5KΩ 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 5KΩ 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.
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.
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.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No output</td>
<td>Fuses blown</td>
<td>Check and replace fuses</td>
</tr>
<tr>
<td></td>
<td>Incorrect input signal</td>
<td>Check temperature control output.</td>
</tr>
<tr>
<td></td>
<td>Input signal not adjusted</td>
<td>See “Bias and Gain Adjustment,” Chapter 3.</td>
</tr>
<tr>
<td></td>
<td>Wrong or missing control card</td>
<td>See “Input Wiring,” Chapter 2.</td>
</tr>
<tr>
<td></td>
<td>Transformer wiring</td>
<td>Check transformer connections.</td>
</tr>
<tr>
<td></td>
<td>Missing load wiring</td>
<td>See “Power and Load Wiring,” Chapter 2. The SCR(s) will not function without a load.</td>
</tr>
<tr>
<td>Heatsink temperature exceeded 86°C (187°F)</td>
<td>Clogged or non-operational fan</td>
<td>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.</td>
</tr>
<tr>
<td>Transformer hot</td>
<td>Incorrect transformer</td>
<td>Check product and transformer labels.</td>
</tr>
<tr>
<td>Uncontrolled output full on</td>
<td>Bad control card, or bias and gain out of adjustment</td>
<td>Unplug control card, try again. Readjust bias and gain.</td>
</tr>
<tr>
<td></td>
<td>Bad transformer</td>
<td>Unplug transformer wire and try again.</td>
</tr>
<tr>
<td></td>
<td>Bad power base</td>
<td>If full on or half on output present with no control card and no transformer, power base is bad, replace it.</td>
</tr>
<tr>
<td>Unbalanced output (QPAC-32 and QPAC-33)</td>
<td>Incorrect phase rotation</td>
<td>See “Phase Rotation Adjustment,” Chapter 3.</td>
</tr>
</tbody>
</table>

Specific to QPAC-33 Diagnostics

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

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power on</td>
<td>Yellow indicator light is on when power is applied to the control.</td>
</tr>
<tr>
<td>Phase Loss</td>
<td>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.</td>
</tr>
<tr>
<td>Phase Rotation</td>
<td>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.</td>
</tr>
<tr>
<td>Phase Lock Loop</td>
<td>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.</td>
</tr>
</tbody>
</table>
QPAC Specifications

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: ±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

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

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
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<tbody>
<tr>
<td>01</td>
<td>Single phase</td>
</tr>
<tr>
<td>32</td>
<td>3-phase, 2-leg</td>
</tr>
<tr>
<td>33</td>
<td>3-phase, 3-leg</td>
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**Operating and Output Voltage**

<table>
<thead>
<tr>
<th>Code</th>
<th>Voltage</th>
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<tbody>
<tr>
<td>12</td>
<td>120V~ (ac)</td>
</tr>
<tr>
<td>20</td>
<td>208V~ (ac)</td>
</tr>
<tr>
<td>24</td>
<td>240V~ (ac)</td>
</tr>
<tr>
<td>27</td>
<td>277V~ (ac)</td>
</tr>
<tr>
<td>38</td>
<td>380V~ (ac)</td>
</tr>
<tr>
<td>41</td>
<td>415V~ (ac)</td>
</tr>
<tr>
<td>48</td>
<td>480V~ (ac)</td>
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<tr>
<td>57</td>
<td>575V~ (ac)</td>
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</table>

**Cooling Fan Voltage**

Customer to supply wiring and hook-up.

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<th>Code</th>
<th>Voltage</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>120V~ (ac); required on all 3-phase models</td>
</tr>
<tr>
<td>2</td>
<td>240V~ (ac); required on all 3-phase models</td>
</tr>
</tbody>
</table>

**Output Current (Amps)**

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<th>Code</th>
<th>Current (Amps)</th>
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<td>150</td>
<td>150 amps</td>
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<tr>
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<tr>
<td>01K</td>
<td>1000 amps</td>
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**Input Control Card**

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<tr>
<td>CA</td>
<td>Solid-state ~ (ac) input (08-5285) contactor</td>
</tr>
<tr>
<td>CD</td>
<td>Solid-state ~ (dc) input (08-5286) contactor</td>
</tr>
<tr>
<td>BF</td>
<td>Burst fired, fixed time base (08-5289) 4 to 20mA</td>
</tr>
<tr>
<td>BV</td>
<td>Burst fired, variable time base (08-5342) 4 to 20mA</td>
</tr>
<tr>
<td>AF</td>
<td>Phase angle fired (08-5288) 4 to 20mA, not available on Q32.</td>
</tr>
<tr>
<td>AL</td>
<td>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.</td>
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**Open Heater/Shorted SCR Detector** (burst fire, zero cross models only)

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<td>0</td>
<td>None</td>
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<tr>
<td>1</td>
<td>Single-phase operation</td>
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<tr>
<td>2</td>
<td>Three-phase operation</td>
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<tr>
<td>Watlow Part Number</td>
<td>Model</td>
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<td>08-5362</td>
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<td>RPC-5411-05-60H</td>
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</tr>
<tr>
<td>RPC-5411-42-50H</td>
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</table>
### Accessories

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