Power Series

User's Manual

Microprocessor-Based SCR Power Controller

CE

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

ISO 9001
Registered Company
Winona, Minnesota USA

WATLOW

U.S. English

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Made in the U.S.A.

Safety Alert CAUTION or WARNING

Electrical Shock Hazard CAUTION or WARNING

Safety Information in this Manual

Note, caution and warning symbols appear throughout this book to draw your attention to important operational and safety information.

A “NOTE” marks a short message to alert you to an important detail.

A “CAUTION” safety alert appears with information that is important for protecting your equipment and performance.

A “WARNING” safety alert appears with information that is important for protecting you, others and equipment from damage. Pay very close attention to all warnings that apply to your application.

The ⚠ symbol (an exclamation point in a triangle) precedes a general CAUTION or WARNING statement.

The ⚠ symbol (a lightning bolt in a lightning bolt in a triangle) precedes an electric shock hazard CAUTION or WARNING safety statement.

Technical Assistance

If you encounter a problem with your Watlow controller, see the Trouble-shooting Table in the Appendix and review all of your configuration information to verify that your selections are consistent with your application: inputs; outputs; alarms; limits; etc. If the problem persists after checking the above, you can get technical assistance from your local Watlow representative, or by dialing +1 (507) 454-5300, 7:00 a.m. to 5:00 p.m. Central Standard Time.

An applications engineer will discuss your application with you.

Please have the following information available when you call:

- Complete model number
- All configuration information
- User’s Manual
- Diagnostic Menu readings

Warranty and return information are on the back cover of this manual.

Your Comments

Your comments or suggestions on this manual are welcome. Please send them to the Technical Literature Team, Watlow Winona, 1241 Bundy Boulevard, P.O. Box 5580, Winona, Minnesota, 55987-5580 U.S.; Telephone: +1 (507) 454-5300; fax: +1 (507) 452-4507.

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Power Series
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Chapter One
Overview

Introduction

The Power Series is a state-of-the-art microprocessor-based Silicon Controlled Rectifier (SCR) power controller intended for controlling industrial heaters. This product is based on one package with several configurations that include single phase, three phase, and single phase-multizone capabilities. Each package configuration has a specific current rating depending on the number of phases switched. The switching capabilities include 65 to 250A rms at 50°C from 24 to 600V~ depending on the configuration or model number selected. See page 1.2 for additional information on the Power Series configuration options.

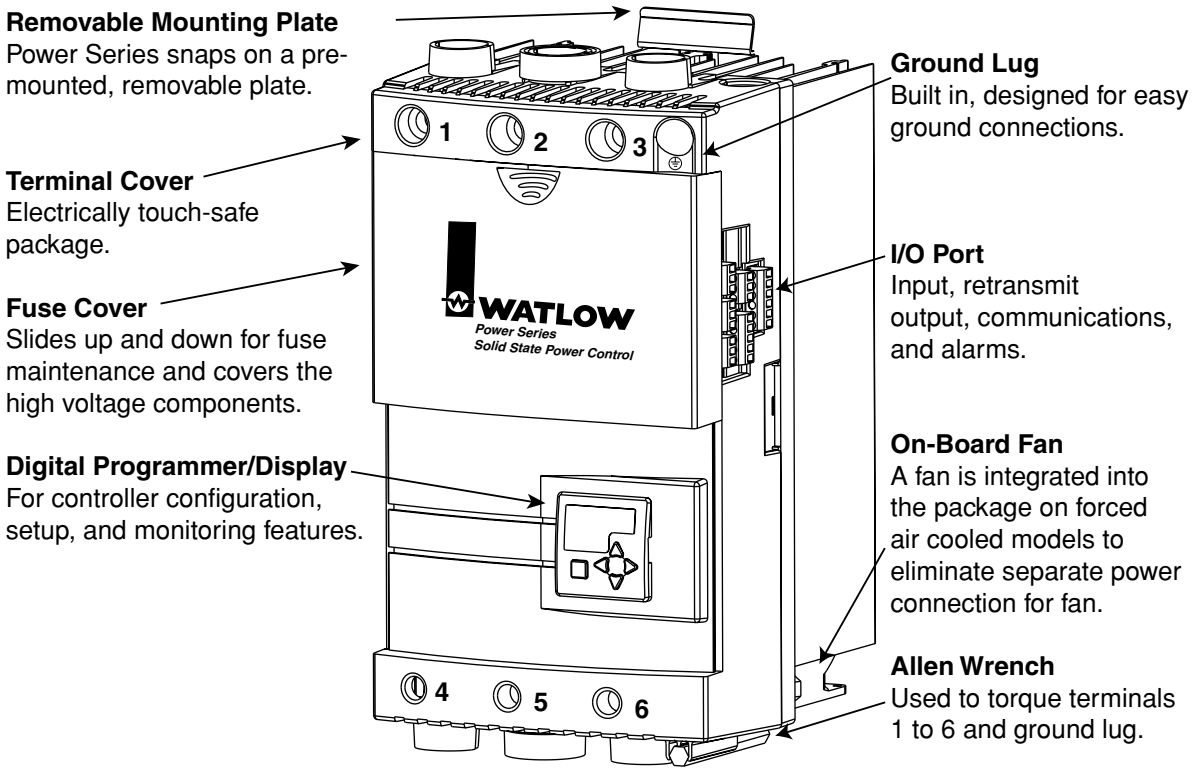


Figure 1.1 — Power Series features.

Single Phase

This configuration can be purchased with any or all the features available on the Power Series. The only limitations are the features selected by the customer upon purchase. It has the highest current rating of all configurations since it is only switching one phase of the ac line. It is intended for resistive heaters, but can also be used on transformer connected loads in the phase angle firing mode.

Three Phase, Two-Leg Configuration

This configuration is intended for zero cross firing into a stable resistive heater, i.e., nichrome element. Typically, a three phase, three-wire delta or ungrounded wye/star connected heater is most often used where only two of the three V~ line phases are switched. The third phase is a direct connection through a bussbar on board the Power Series and is controlled by the previous two phases. For this reason, a two-leg configuration should not be used for three phase grounded wye/star connected heaters. (For heaters that are required to be three phase grounded wye/star connected, see "Three Phase, Three-Leg Configuration" section below.)

Because this configuration does not allow phase angle firing, it should not be used on transformer coupled heaters and less stable resistance heaters such as silicon carbide, molybdenum disilicide, carbon graphite, or tungsten lamp heaters. This may cause premature heater failure or nuisance fuse blowing.

Heater current monitoring and kVA options are available with a three phase, two-leg configuration via the heater diagnostics option. Phase angle firing, including current limiting and heater bakeout, is not available.

Three Phase, Three-Leg Configuration

There are two Power Series configurations that include six SCR control. All features are available in these configurations.

The three-leg version is intended for phase angle firing into a transformer connected load or direct connection to heating that requires soft start and/or current limiting.

The four-wire configuration is intended for zero cross firing into a four-wire wye connected nichrome/resistive heater.

Single Phase, Multizone Configuration

This configuration is available in two and three single phase zones. Back-to-back SCRs are used and all of the features of a single phase unit are available. (Note that there is only one alarm relay and all zones in the controller must use the same control method.) This configuration is intended for applications with multiple command signals from independent control zones. The multizone platform offers reduced panel space compared to using multiple single phase power controllers.

Heater Diagnostics

Heater diagnostics is a key feature of the Power Series SCR power controller. Heater diagnostics may include all or only some of the features that require heater current monitoring, depending on the model selected. Heater current monitoring is only available with heater diagnostics installed on the controller. The features dependent on heater current monitoring are heater bakeout, current limiting, heater current and kVA monitoring, retransmit, and heater monitoring alarms such as open heater, heater out of tolerance, load balance, and shorted SCR detection/error. Heater diagnostics must also be installed if you need phase angle control with current limit.

2

Chapter Two
Installation

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

NOTE: Ground must be wired with the same size wire as line and load connections to a ground of sufficient current carrying capacity.

NOTE: Integral semiconductor fuses do not qualify as branch circuit protection.

The following two chapters will explain how to install the Power Series controller. Watlow power controllers are thoroughly tested before leaving the factory, so the Power Series controller is ready to install when you receive it.

Chapters 2 and 3 describe the steps required to install the Power Series controller. Refer to Chapter 2 for mounting information and Chapter 3 for input, power, and load wiring of the Power Series.

Before beginning installation, read through these chapters to gain an understanding of the entire installation. Consider the installation carefully. Plan the power, load, and input signal wiring before mounting the Power Series. Also consider the cabinet space, controller dimensions, wire bending radius, and airflow. Use good wiring practices to minimize electrical noise problems.

Power Series Wire Bending Radius at Base Current and Ambient Temperature Rating and Replacement Semiconductor Fuses

Minimum recommended wire sizes are based on the NEC 30°C ambient with not more than three current carrying conductors in raceway or cable, while also considering the Power Series 50°C enclosure temperature and semiconductor fuse rating. Use copper conductors only.

The terminal lug wire range for all Power Series amperages is 350 MCM to 6 AWG. The recommended terminal torque is 180 in.-lbs. (20 Nm.). Terminal lug ratings are for one wire per lug. Refer to page 3.1 for torque guidelines.

Power Series Current (Amps)	Minimum Recommended Wire Size (90C) (AWG)	Wire Bending Radius mm	Wire Bending Radius inches	Semiconductor Fuse Rating (Amps)	Watlow Replacement fuse P/N	Bussmann Replacement Fuse P/N
65	6 AWG	51	2.0	100	0808-0102-0100	170M1317
80	4	76	3.0	125	0808-0102-0125	170M1318
85	4	76	3.0	125	0808-0102-0125	170M1318
90	4	76	3.0	125	0808-0102-0125	170M1318
100	3	76	3.0	160	0808-0102-0160	170M1319
105	3	76	3.0	160	0808-0102-0160	170M1319
120	2	89	3.5	160	0808-0102-0160	170M1319
125	2	89	3.5	160	0808-0102-0160	170M1319
140	1	114	4.5	200	0808-0102-0200	170M1320
155	1/0	140	5.5	200	0808-0102-0200	170M1320
160	1/0	140	5.5	250	0808-0102-0250	170M1321
165	1/0	140	5.5	250	0808-0102-0250	170M1321
185	2/0	152	6.0	250	0808-0102-0250	170M1321
200	3/0	165	6.5	250	0808-0102-0250	170M1321
250	250 MCM	216	8.5	315	0808-0102-0315	170M1322

Power Series Dimensions

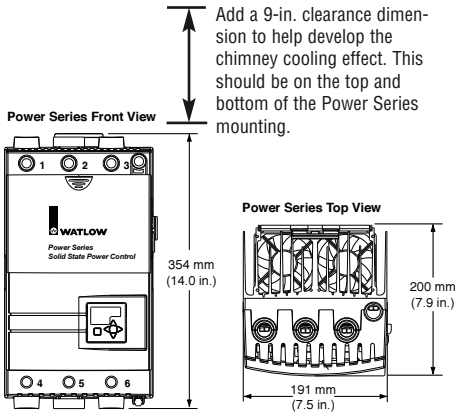


Figure 2.2a — Power Series dimensions.

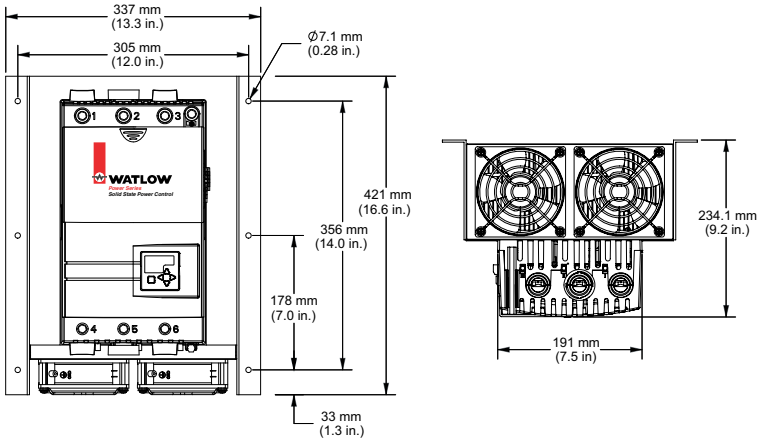


Figure 2.2aa — F35 model only.

Mounting the Power Series Controller

NOTE: The Power Series controller must be mounted vertically. When multiple units are used in one cabinet, it is best that they are mounted side-by-side when possible. If they are mounted one above the other, adequate spacing and airflow must be provided. See Enclosure Guidelines on page 2.3.

For models N20 through F30:

1. Determine the panel location for mounting the Power Series controller and punch or drill holes for the 4 mounting screws per the drawing below. The mounting plate can be used as a template.
2. Attach the Power Series mounting plate using 4 screws (customer supplied, #10 screw minimum, 1/4 inch screw maximum).
3. Align the heads of the shoulder screws on the back of the Power Series heat sink with the key slots on the mounting plate. Push the unit in, and then down until it snaps into place. Mounting is complete.

For F35 models:

F35 models are a bolt-down package. Drill and tap six holes per the above drawing for 1/4-inch 20 bolts.

Power Series Mounting Plate

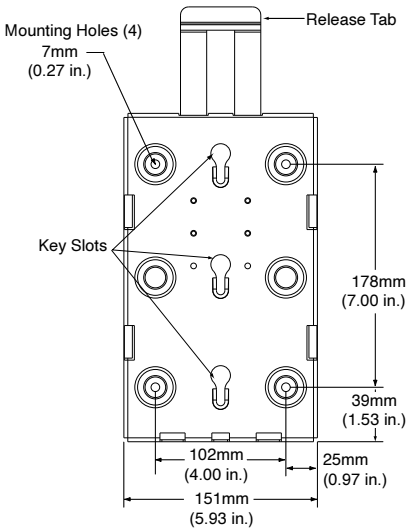


Figure 2.2b — Mounting plate dimensions.

Figure 2.2c — Installing the controller.

Enclosure Guidelines

The Power Series must be mounted in a suitable electrical enclosure. It must have adequate wire bending space and cooling. The maximum ambient temperature in the enclosure must not exceed 50°C (122°F) for name plate rating. For other output ratings and enclosure ambient temperatures, see output rating curves on pages 2.5 and 2.6.

To maintain the proper cooling, the enclosure must be large enough to dissipate the heat generated by the Power Series, or there must be some form of active cooling.

1. Air circulation — fans bring air into the bottom of the enclosure and louver plates to allow the air to exit the top of the enclosure. Filters are not recommended as they can become plugged and block air flow. To maintain 80 percent of the CFM of a fan, the outlet must be four times the area of the fan inlet. Ensure that each Power Series is within an unobstructed airstream.
2. Vortex coolers operate on compressed air and provide good cooling on a sealed enclosure, but are noisy and consume a lot of air.
3. Cabinet air conditioners work well on sealed enclosures.
4. Heat pipe coolers work well on sealed enclosures, but do not provide as much cooling as vortex coolers or air conditioners.

To determine how much cooling is required:

1. Determine the amperage load on the Power Series. Multiply the amperage by 1.2 and then by the number of phases controlled. This is the output power dissipated by the SCRs in watts. Add the watts dissipated by the controller's power supply (21W) and multiply the total power in watts by 3.41 to get BTUs per hour. Vortex coolers, heat pipe coolers, and air conditioner cooling are rated in BTUs removed.
2. Add up the watts generated by other electronics in the enclosure and multiply by 3.41 to get BTUs per hour.
3. Add up the total BTUs inside the enclosure and pick a cooling device that will remove that amount of BTUs.
4. For fan cooled enclosures, enclosure and fan manufacturers usually have free software programs and application notes to help size the fans for enclosures. If necessary, contact the Application Engineers at Watlow Controls for assistance.

Harsh Environment

The Power Series meets standards UL508, Pollution degree 3 for safety which states: "Conductive pollution occurs or non-conductive pollution occurs which becomes conductive due to condensation which is to be expected." However, Watlow recommends that the Power Series be used in a clean, dry environment to ensure long-term reliability.

CAUTION:
You may want to use a large screwdriver to press in on the release tab while you are pushing on the controller to avoid potential injury to your hands.

Removing the Power Series Controller

1. To release the Power Series controller from the mounting plate, press in on the release tab at the top of the mounting plate.
2. When the release tab is in, push up on the controller from the bottom to release it from the mounting plate. **Beware of sharp edges on the heat sink when you push upward. This will take some force!**
3. The F35 model does not use the standard mounting plate. See page 2.2 for mounting instructions. To remove: reverse the mounting operation.

Figure 2.4 — The F35 Power Series (right) is cooled with larger fans.

Maintaining the Power Series

- **Cleaning:** The heatsink fins must be kept clean for proper cooling and the printed circuit board should be free of conductive residue condensation.
- **Calibration:** Not normally necessary. See pages 6.15-6.16 for data restore and backup.
- **Retorquing:** See page 3.1 for torque guidelines.
- **Software backup and refresh:** Not necessary; see page A.7, Power Series Backup.

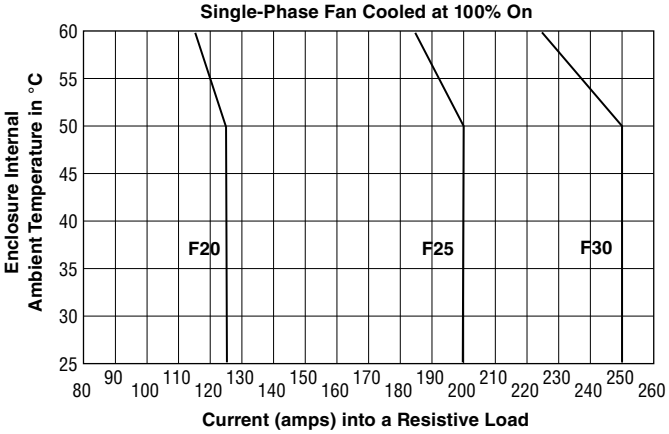
NOTE: All Power Series controllers have been 100 percent tested before shipment.

Power Series Output Rating Curves

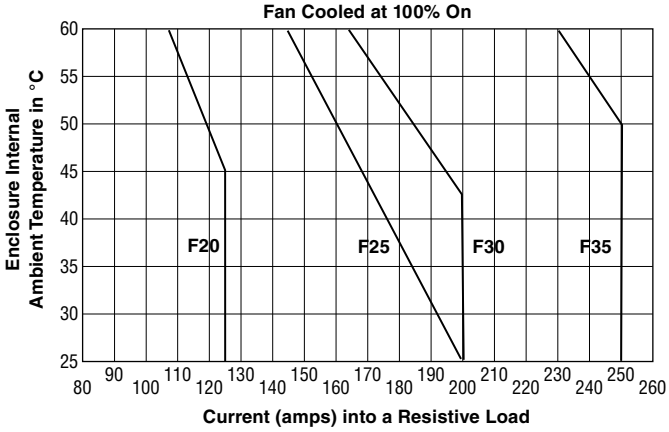
Fan Cooled

All curves are at 100% on with 90°C rated load wire and line wire connected. Note that each chart is slightly different on the amperage scale. The safe operating region is from 1 amp up to the specific curve for the output amperage code selected. For example: F25 Single-Phase is rated up to 200 amps at 50°C; F30 Single-Phase is rated for 250 amps at 50°C. See page 2.6 for Natural Convection Cooled output rating curves.

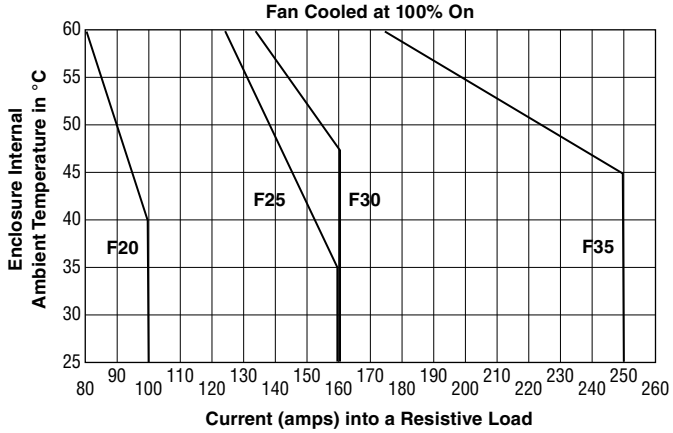
Single-Phase Fan Cooled at 100% On



3-Phase, 2-Leg and 2-Zone Multizone Fan Cooled at 100% On



3-Phase, 3-Leg and 3-Zone Multizone Fan Cooled at 100% On

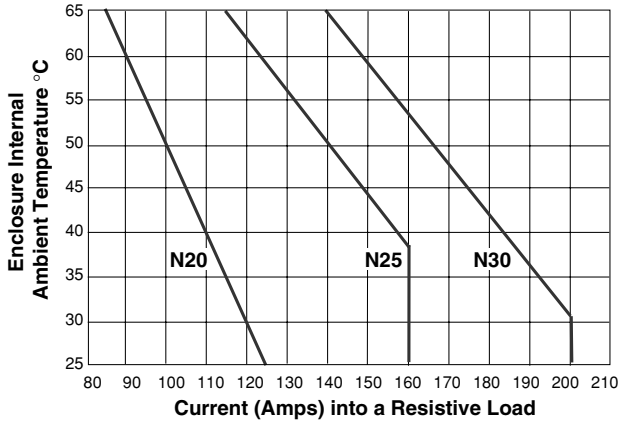


Power Series Output Rating Curves

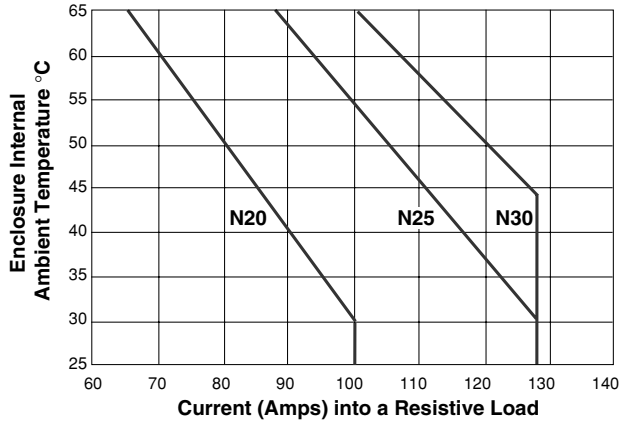
Natural Convection

All curves are at 100% on and with 90°C rated load wire and line wire connected. Note that each chart is slightly different on the amperage scale. The safe operating region is from 1 amp up to the specific curve for the output amperage code selected. For example: N25 Single Phase is rated up to 140 amps at 50°C; N30 Single Phase is rated for 165 amps at 50°C.

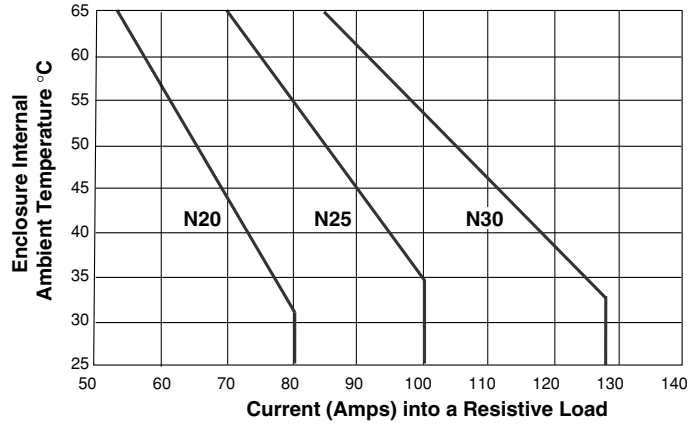
Single Phase Natural Convection at 100% On



3 Phase, 2-Leg and 2-Zone Multizone Natural Convection at 100% On



3 Phase, 3-Leg and 3-Zone Multizone Natural Convection at 100% On



3

Chapter Three
Wiring

Wiring the Power Series Controller

Wiring options depend on the model number. Check the terminal designation stickers on the right side of the controller and compare your model number to those shown here and with the model number breakdown in the Appendix (page A.10) of this manual.

Chapter 3 illustrates how to wire the inputs and outputs for all options. Refer to Figure 3.1 for terminal torque guidelines.

Torque Guidelines

- Properly torque terminals by holding for 30 seconds to allow for wires to settle and minimize loosening due to cold flow.
- Re-torque all terminals after 48 hours.
- Establish a maintenance program to re-torque line and load terminations every 3-6 months.

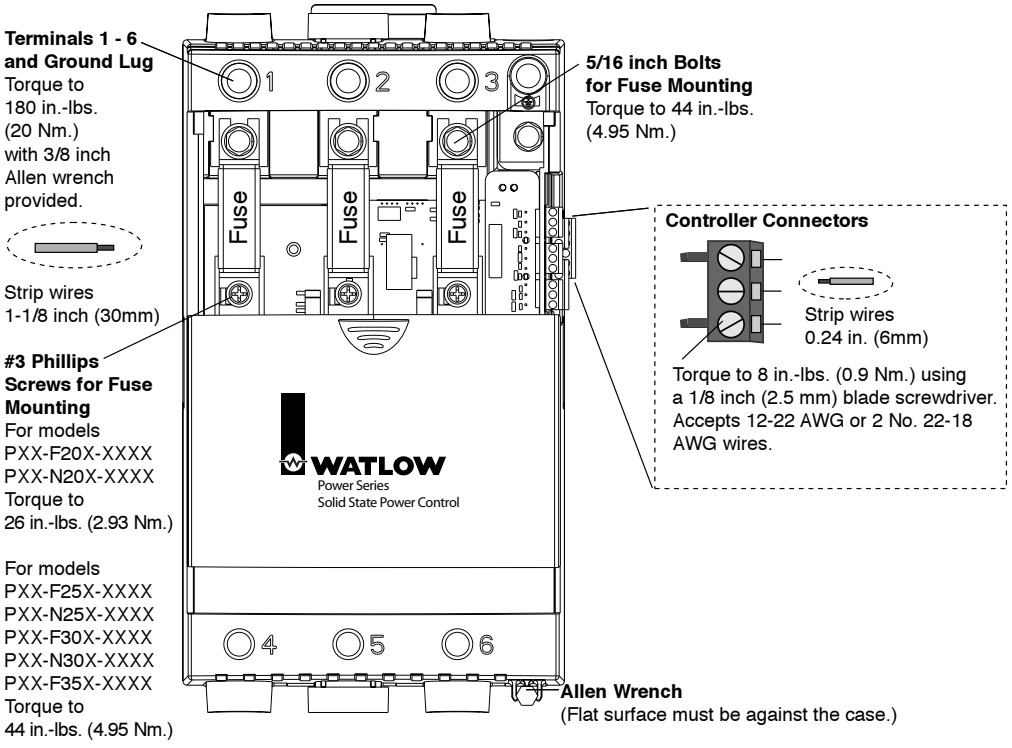


Figure 3.1 — Torque and wire stripping.

Input Wiring

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 Power Series. Failure to do so could result in damage, and/or injury or death.

NOTE:

Input, retransmit and communications external terminals have been designed for protection in case of direct contact in accordance with European Standard EN50178.

NOTE:

Insure ground is wired with the same size wire as line and load connections to a ground of sufficient current carrying capacity. (Refer to Chapter 2, p. 2.1, Power Series Wire Bending Radius at Base Current and Ambient Temperature Rating.)

NOTE:

Torque and wire strip guidelines:

- **Control wiring 1 thru 23.**
- **Strip wire to 0.24 inch (6mm). Torque to 8 in.-lbs. (0.9 Nm).**
- **Hold torque for 30 seconds to allow for wiring settling and cold flow. Re-torque after 48 hours.**
- **All line connections should be re-torqued every 3-6 months.**

Figure 3.2a – **Control Power and Alarm Wiring**

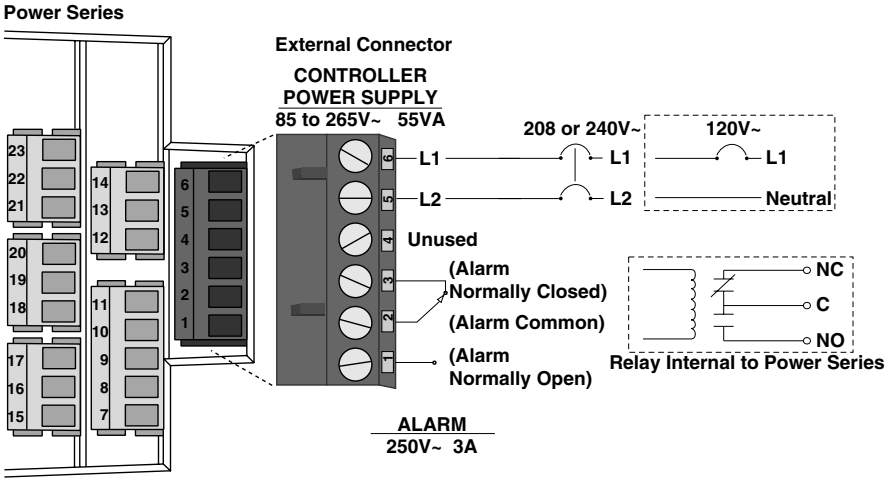


Figure 3.2b – **Retransmit Wiring**

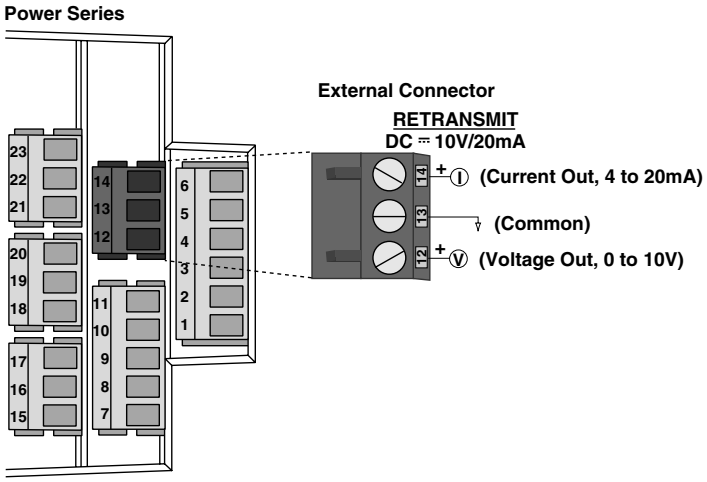
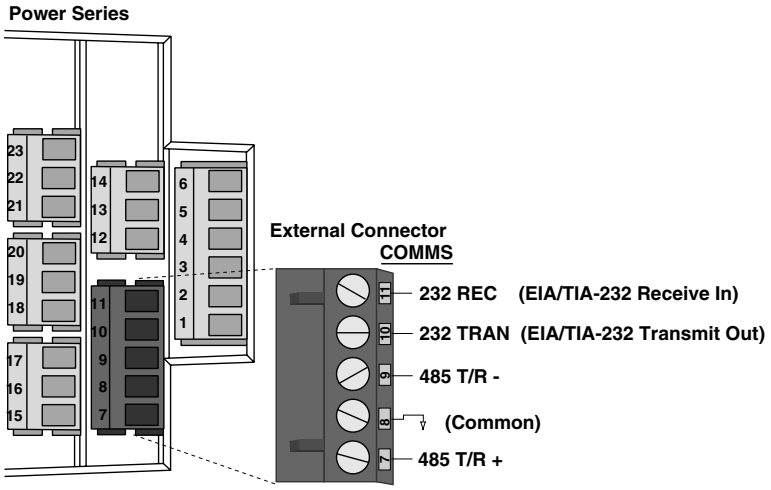


Figure 3.2c – **Communications Wiring**



NOTE:

Successful installation requires four steps:

- **Choose the controller's hardware configuration and model number (Appendix);**
- **Install the controller (Chapter Two);**
- **Wire the controller (Chapter Three); and**
- **Configure the controller (Chapters Four, Five and Six).**

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 Power Series. Failure to do so could result in damage, and/or injury or death.

Figure 3.3a – **Single Zone Input Wiring**

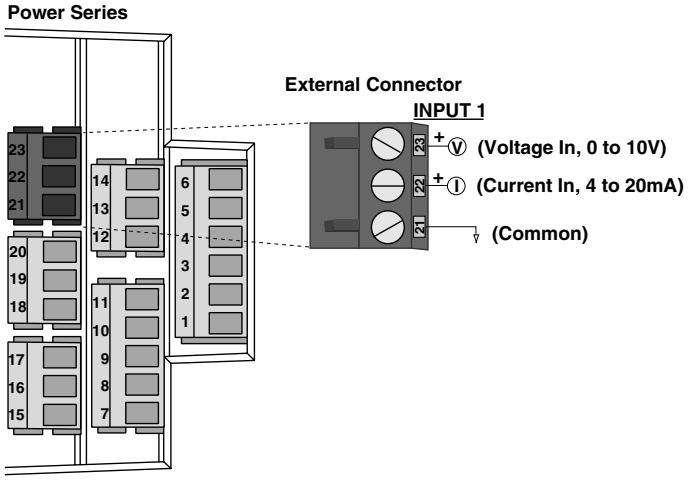


Figure 3.3b – **2-Zone Input Wiring**

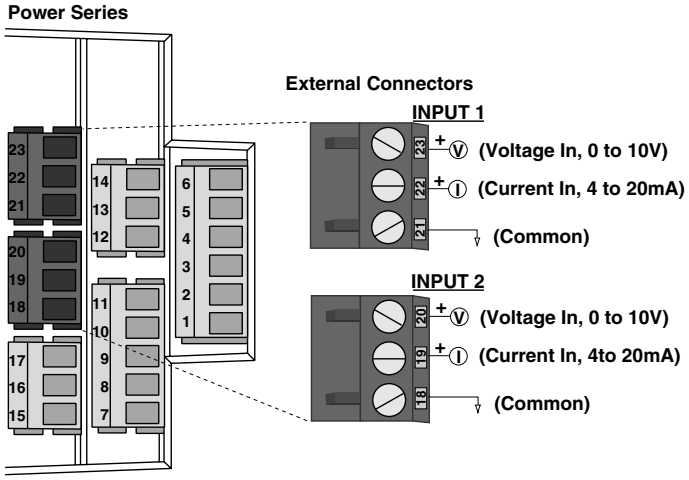
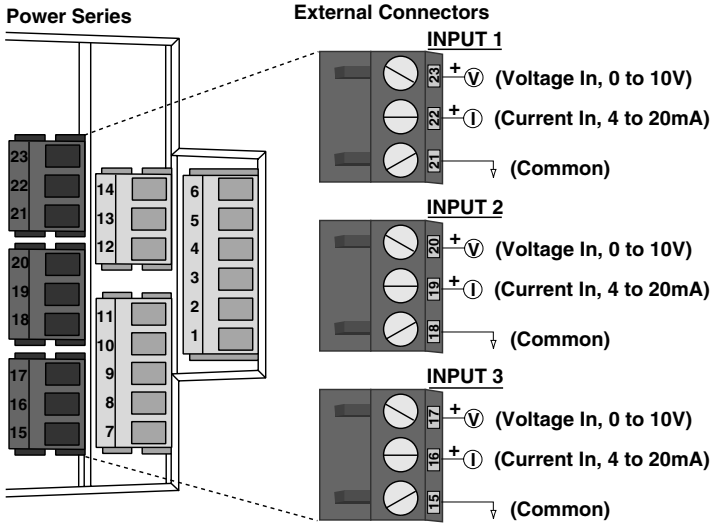


Figure 3.3c – **3-Zone Input Wiring**



Line Power/Output Wiring

NOTE:

Successful installation requires four steps:

- **Choose the controller's hardware configuration and model number (Appendix);**
- **Install the controller (Chapter Two);**
- **Wire the controller (Chapter Three); and**
- **Configure the controller (Chapters Four, Five and Six).**

WARNING:

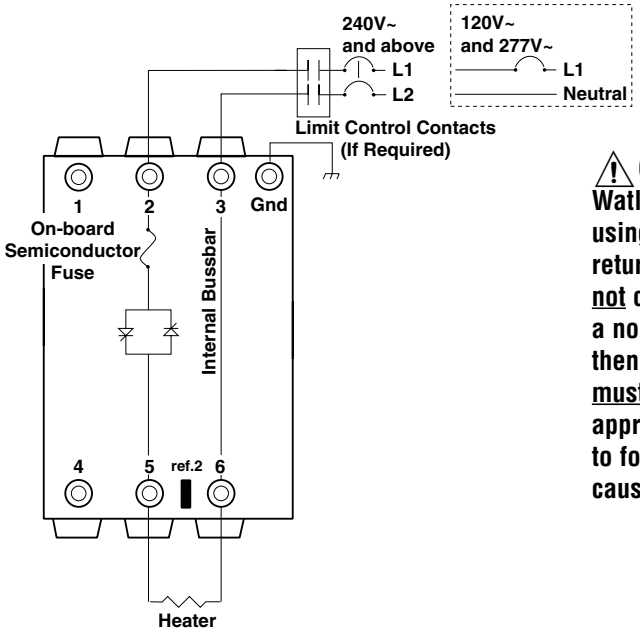
To avoid damage to property and equipment, and/or injury or loss of life, use National Electric Code (NEC) standard wiring practices to install and operate the Power Series. Failure to do so could result in damage, and/or injury or death.

NOTE:

Torque and wire strip guidelines:

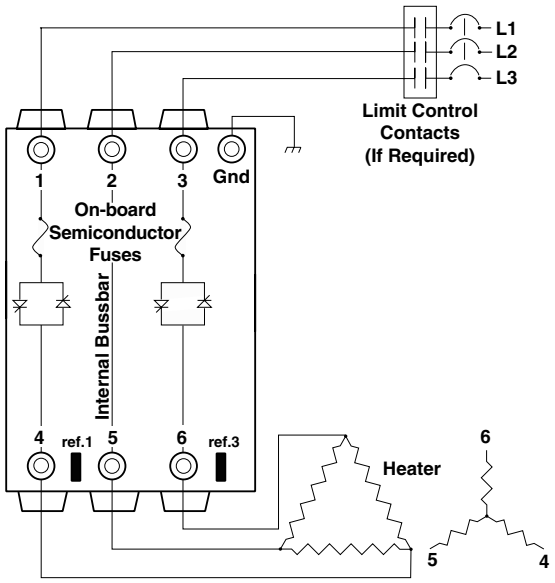
- **Connections 1 thru 6, and ground lug**
- **Strip wire 1-1/8 in. (30mm). Torque to 180 in.-lbs. (20 Nm).**
- **Hold torque for 30 seconds to allow for wiring settling and cold flow. Re-torque after 48 hours.**
- **All load connections should be re-torqued every 3-6 months.**

Figure 3.4a – **Single Phase Output Wiring (Model PC1X-XXXX-XXXX)**



⚠ CAUTION: Figure 3.4a shows the Watlow-recommended output wiring using the internal bussbar as a return current path and with ref. 2 not connected. Should a user choose a non-recommended wiring scheme, then ref. 2 or the internal bussbar must be connected to the appropriate line or neutral. Failure to follow these guidelines could cause damage to the Power Series.

Figure 3.4b – **3 Phase, 2-Leg, 4 SCR Output Wiring (Model PC2X-XXXX-XXXX)**



⚠ CAUTION: Figure 3.4b shows the Watlow-recommended output wiring using the internal bussbar as a return current path and with ref. 1 and 3 not connected. Should a user choose a non-recommended wiring scheme, then ref. 1 or ref. 3 or the internal bussbar must be connected to the appropriate line. Failure to follow these guidelines could cause damage to the Power Series.

NOTE: Our illustrations illustrate circuit breakers for branch circuit protection. Fuses can also be used.

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 Power Series. Failure to do so could result in damage, and/or injury or death.

WARNING:

Install high or low temperature limit control protection in systems where an over temperature fault condition could present a fire hazard or other hazard. Failure to install temperature limit control protection where a potential hazard exists could result in damage to equipment, property and injury to personnel.

NOTE:

For reference connections 1 to 3, use QC 0.250 in. wide and 0.032 in. thick compatible connection which is fully insulated with nylon and has a metal grip ring.

For 14-16 AWG: Molex/ETC AA-5261; 3M MNG14-250DFIX C-54-503X or equivalent.

Figure 3.5a – **3-Phase, 3-Leg, 6-SCR Output Wiring for 4-Wire Wye Application (Model PC4X-XXXX-XXXX)**

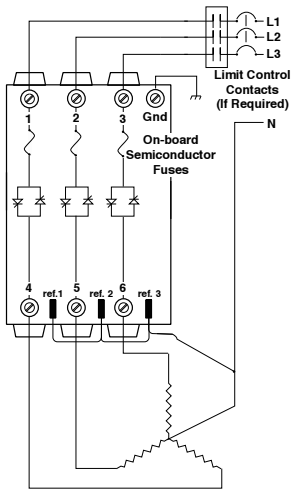
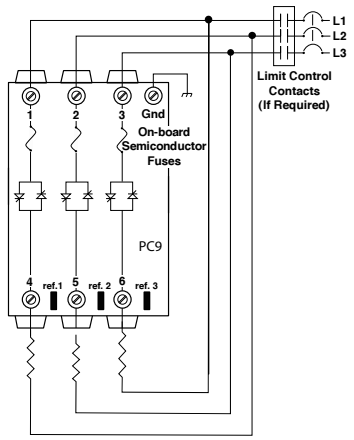


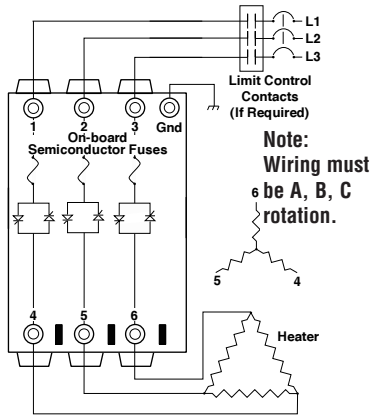
Figure 3.5b – **3-Phase, 3-Leg, 6-SCR Inside Delta**



Note: 1. Phasing must be as shown.

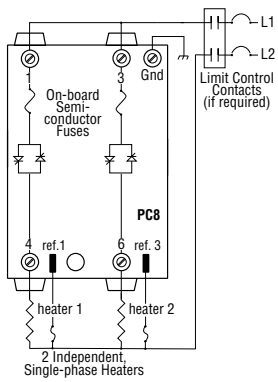
2. Do not connect Ref. terminals.

Figure 3.5c – **3 Phase, 3-Leg, 6-SCR Output Wiring (Model PC3X-XXXX-XXXX)**



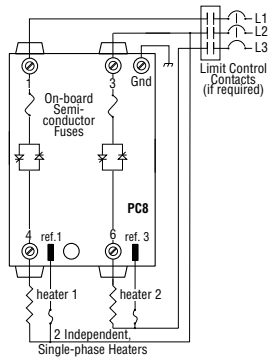
⚠ CAUTION: Do not connect ref. connections with PC3 models. Failure to follow this guideline could cause damage to the Power Series.

Figure 3.5d – ****Multizone Output Wiring**



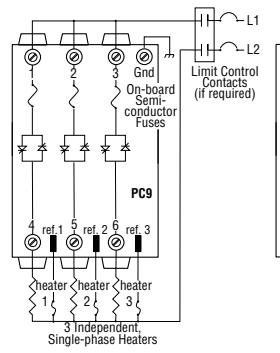
PC8X-XXXX-XXX1

Molex/ETC AA-5261; 3M MNG14-250DFIX C-54-503X or equivalent.

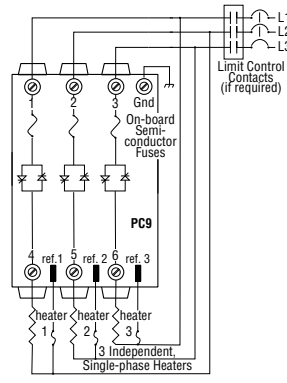


PC8X-XXXX-XXX3

Note: Wiring must be A, B, C rotation if phase control is selected.



PC9X-XXXX-XXX1

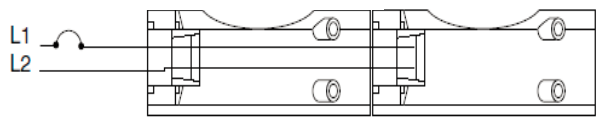


PC9X-XXXX-XXX3

Note: Wiring must be A, B, C rotation if phase control is selected.

Figure 3.5e – **Fan Wiring for 250A Models**

120 V, 50/60 Hz
14/12W
0.20/0.16A



****NOTE: Models PC8 and PC9 control legs are isolated so that they may be wired from phase-to-phase inside delta or phase-to-neutral, independent of how the other legs are wired.**

Wiring Example

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 Power Series. Failure to do so could result in damage, and/or injury or death.

WARNING:

Install high or low temperature limit control protection in systems where an over temperature fault condition could present a fire hazard or other hazard. Failure to install temperature limit control protection where a potential hazard exists could result in damage to equipment, property and injury to personnel.

NOTE: Our wiring example illustrates circuit breakers for branch circuit protection. Fuses can also be used.

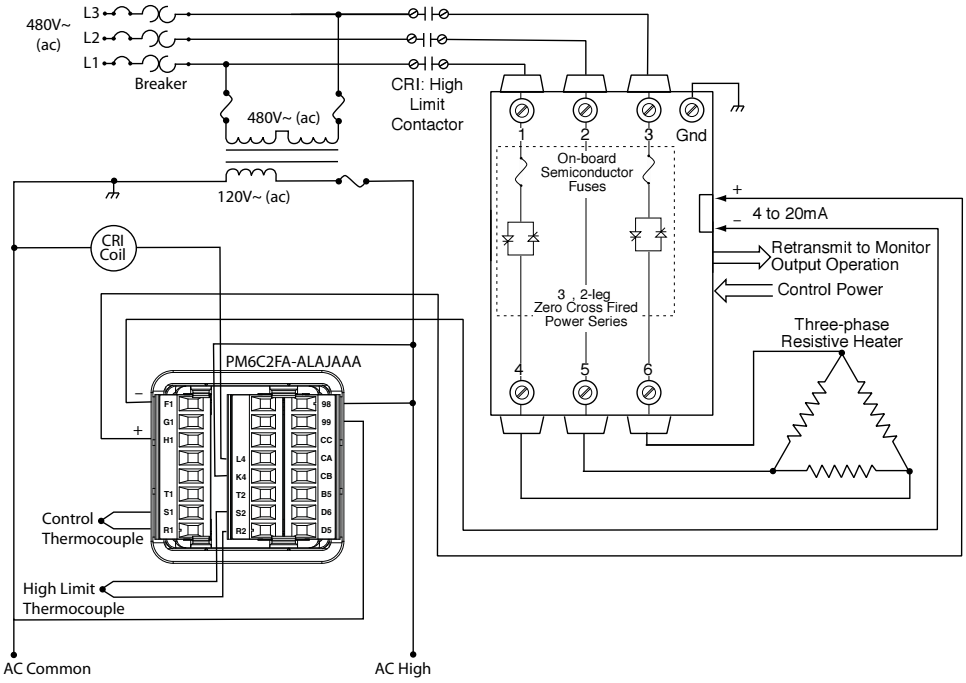


Figure 3.6 - System wiring example.

Recommended fusing options to meet 200KA SCCR. All other untested combinations are defaulted to 5KA per UL508A and NEC guidelines.

Power Series Model	Fuse Rating	Watlow Fuse P/N	Bussmann Fuse P/N
PC1X-N20	160	0808-0102-0160	170M1319
PC1X-N25	200	0808-0102-0200	170M1320
PC1X-N30	250	0808-0102-0250	170M1321
PC1X-F20	160	0808-0102-0160	170M1319
PC1X-F25	250	0808-0102-0250	170M1321
PC1X-F30	315	0808-0102-0315	170M1322
PC2(8)X-N20	125	0808-0102-0125	170M1318
PC2(8)X-N25	160	0808-0102-0160	170M1319
PC2(8)X-N30	160	0808-0102-0160	170M1319
PC2(8)X-F20	160	0808-0102-0160	170M1319
PC2(8)X-F25	250	0808-0102-0250	170M1321
PC2(8)X-F30	250	0808-0102-0250	170M1321
PC3(4,9)X-F35	315	0808-0102-0315	170M1322
PC2(8)X-F35	315	0808-0102-0315	170M1322
PC3(4,9)X-N20	100	0808-0102-0100	170M1317
PC3(4,9)X-N25	125	0808-0102-0125	170M1318
PC3(4,9)X-N30	160	0808-0102-0160	170M1319
PC3(4,9)X-F20	125	0808-0102-0125	170M1318
PC3(4,9)X-F25	200	0808-0102-0200	170M1320
PC3(4,9)X-F30	200	0808-0102-0200	170M1320

4

Chapter Four
Navigation and Software

Keys and Displays

This chapter explains keys, displays and navigation skills. You'll also find a complete software map.

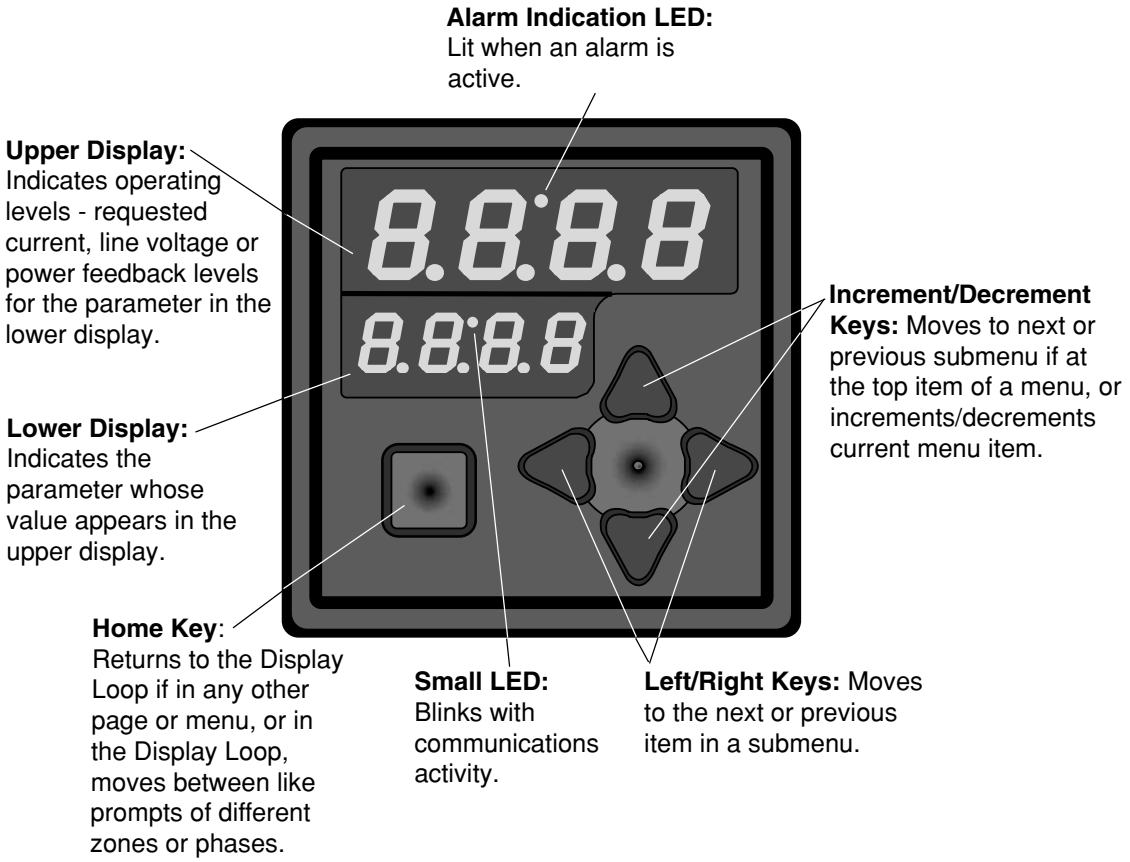
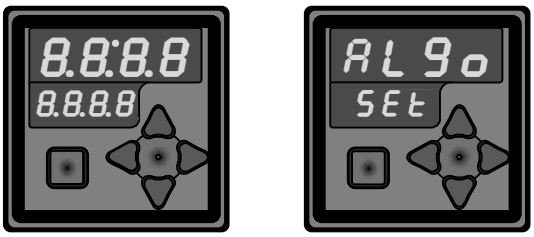


Figure 4.1 — Power Series keys and displays.

Navigating the Power Series

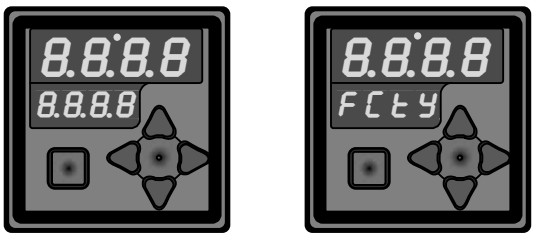
Choose a page (Setup or Factory) and press its key sequence. The page appears in the lower display.

Setup Page - for setting up the control, alarms, retransmit, and communications.



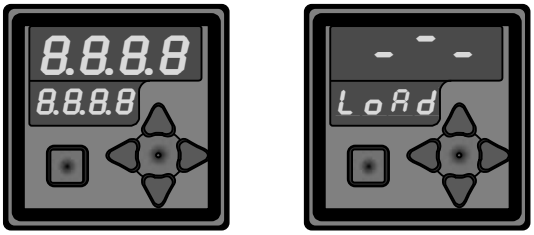
• **Setup Page:** From Display Loop, press ■ and ◄ keys together for 2 sec.

Factory Page - for calibration and diagnostic information.



• **Factory Page:** From Setup Page, press ■ and ◄ and ► keys together for 2 sec

Display Loop - for monitoring parameters and adjusting manual/digital input, and for clearing alarms if they are latched.



• **Display Loop:** From Setup or Factory Page, press the ■ key.

NOTE:
The Load Activity Indicator in the Display Loop indicates different things, dependent on whether heater diagnostics is installed. With heater diagnostics installed, it indicates load current has been detected. Without heater diagnostics installed, it indicates the SCRs are being gated and line voltage is present.

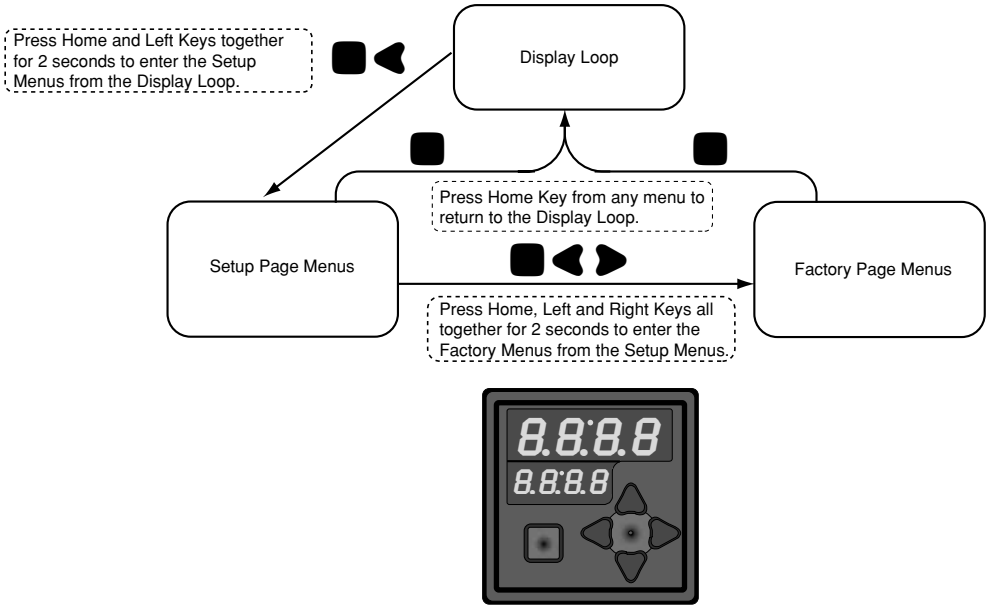
Press▼ or ▲ to find a specific menu in a page. The menu appears in the upper display and the page remains in the lower display.

Press ► to enter the list of parameters in the menu displayed. The menu's parameters appear in the lower display and the values in the upper display. To go backward through the parameter list press ◄ .

Press▼ or ▲ to select a value, either alpha or numeric, within a specific parameter.

Navigation

The Display Loop is used to monitor parameters and adjust manual/digital input, and to clear alarms if they are latched.



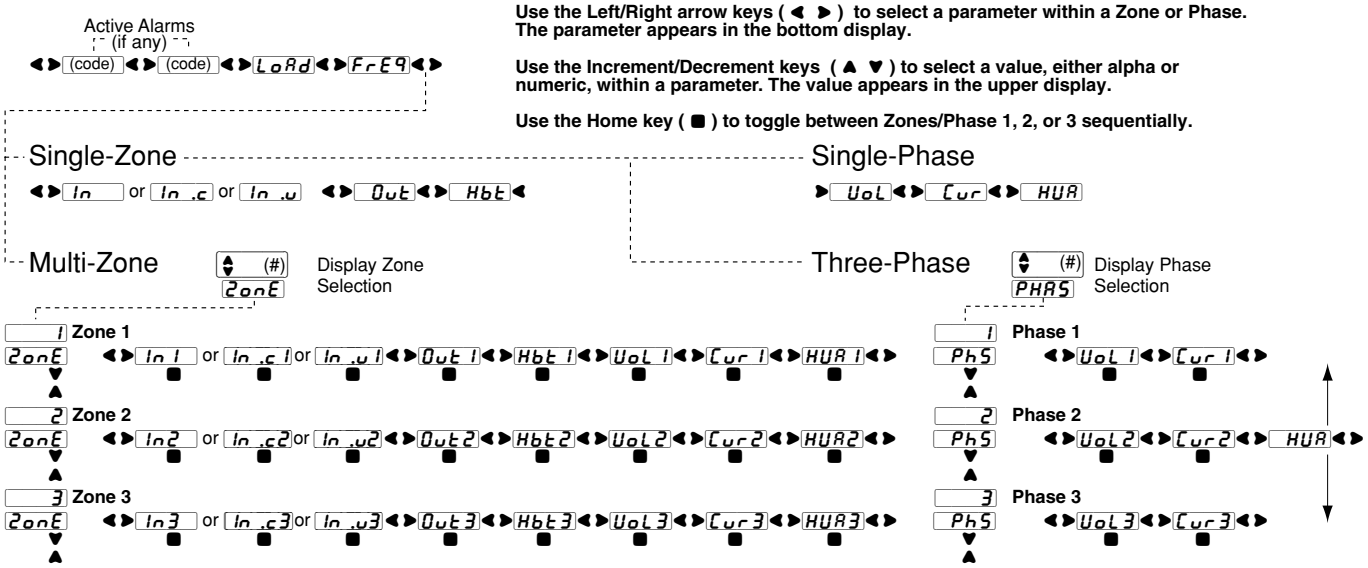
Display Loop

Use the Increment/Decrement keys (▲ ▼) to select a Zone or Phase within the Display Loop. The Zone/Phase appears in the upper display.

Use the Left/Right arrow keys (◄ ►) to select a parameter within a Zone or Phase. The parameter appears in the bottom display.

Use the Increment/Decrement keys (▲ ▼) to select a value, either alpha or numeric, within a parameter. The value appears in the upper display.

Use the Home key (■) to toggle between Zones/Phase 1, 2, or 3 sequentially.



NOTES:

What you see in each Page and in each Menu are factory set, depending on the options and settings of your controller.

The input signal method indicator will change depending on the input signal method chosen — digital, current, or volts.

Current operating parameters may be modified at any time with the use of the keypad or communications port.

NOTE: For an explanation of the parameters in the Display Loop, range information, Modbus address, and conditions for the parameter to appear, see pp. 6.1-6.4, Chapter Six, Parameters.

Setup Page Menus

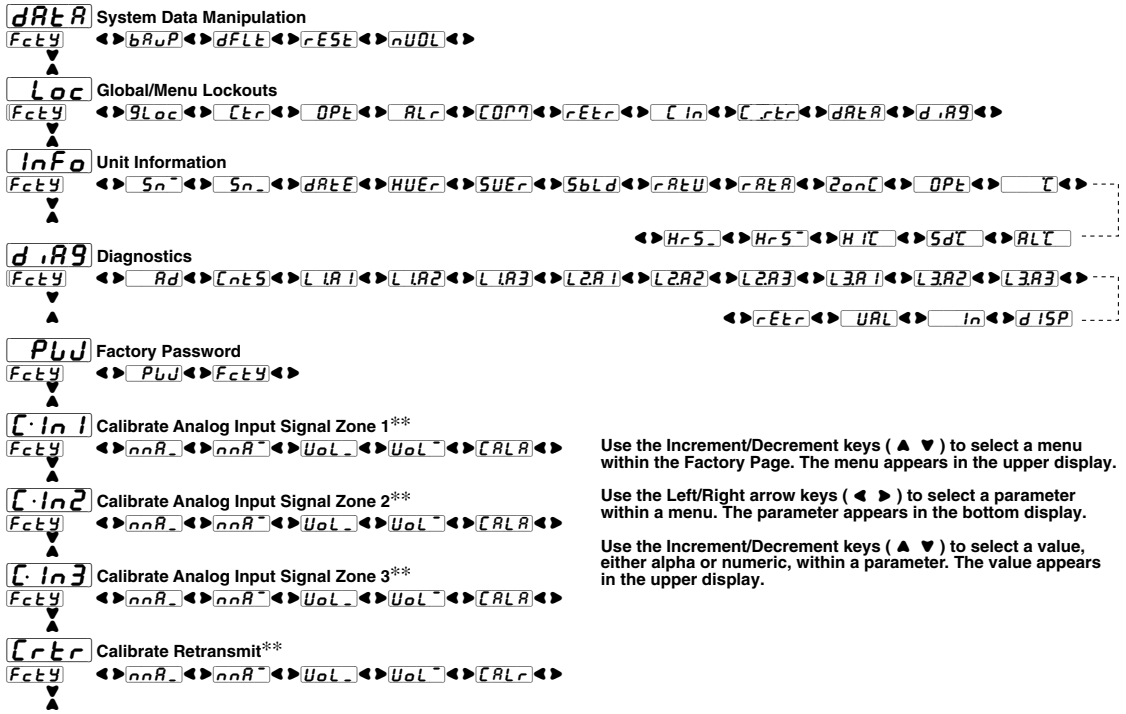
Use the Increment/Decrement keys (▲ ▼) to select a menu within the Setup Page. The menu appears in the upper display.

Use the Left/Right arrow keys (◄ ►) to select a parameter within a menu. The parameter appears in the bottom display.

Use the Increment/Decrement keys (▲ ▼) to select a value, either alpha or numeric, within a parameter. The value appears in the upper display.

*NOTE: This prompt will only appear in Ctr 1, and if the controller is 3 phase.

Factory Page Menus



Use the Increment/Decrement keys (▲ ▼) to select a menu within the Factory Page. The menu appears in the upper display.

Use the Left/Right arrow keys (◄ ►) to select a parameter within a menu. The parameter appears in the bottom display.

Use the Increment/Decrement keys (▲ ▼) to select a value, either alpha or numeric, within a parameter. The value appears in the upper display.

**NOTE: These menus and display prompts are only viewable in the Factory Mode using a password.

NOTE: For an explanation of the parameters in the Setup Page, (range information, Modbus address, and conditions for the parameter to appear), see Chapter Six, Parameters, pp. 6.5-6.14; for information on the Factory Page, see pp. 6.14-6.22.

5

Chapter Five
Control Methods and Features

Zero Cross

Zero cross (also known as burst firing) provides even output power with the lowest level of noise generation (RFI). Zero cross is the preferred method for controlling a resistive load.

The controller determines when the ac sine wave crosses the 0-volts point, then switches the load, minimizing RFI.

Zero cross control is available for all Power Series configurations.

Soft start and current limiting are not available with zero cross control.

Setup Page:

- Enter the Setup Page by holding ■ ◀ for 3 seconds.
- When the display reads AL.Lo, press ▶ until SEt is displayed. Press ▲▼ to select Ftb fixed time base, zero cross or UrtB variable time base, zero cross.

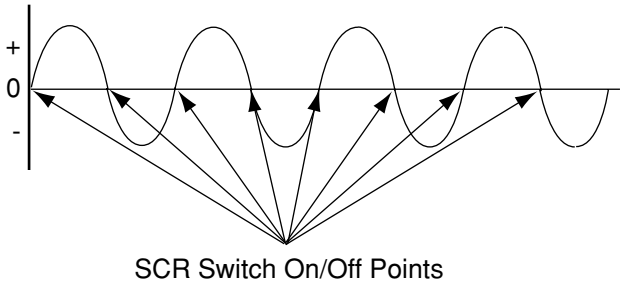


Figure 5.1a — Zero cross switching.

Fixed Time Base - Zero Cross

In the fixed time base control method, the selected percentage power level output is generated over a fixed time period (i.e. a fixed number of cycles), regardless of power level selected. Resolution of operator selectable power may be more precise than the fixed time base allows. Selected power output level is rounded to the closest possible power output value in full cycles as necessary.

Line voltage compensation is not used in the fixed time base control method.

Setup Page:

- Enter the Setup Page by holding ■ ◀ for 2 seconds.
- When the display reads AL.Lo, press ▶ until SEt is displayed. Press ▲▼ to select Ftb fixed time base, zero cross.
- Press ▶ until Ftb is displayed. Press ▲▼ to select 1SEC or 4SEC.

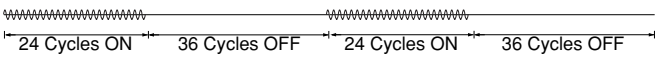


Figure 5.1b — 40% power, fixed time base, 60 Hz, 1 sec time base.

Variable Time Base - Zero Cross

In the variable time base control method, an optimal ratio of cycles on to cycles off is used to generate the desired power output. The number of cycles needed to completely generate a desired power level is variable in single cycle increments. Line voltage compensation algorithms are used to adjust the percentage power output while operating in this mode. Variable time base operation gives the best response time and resolution and provides for the longest heater life.

In single cycle variable time base below 50 percent power, the unit is never on for more than one consecutive full cycle. Above 50 percent power, the unit is not off for more than one consecutive full cycle while maintaining the proper output.

Line voltage compensation is active if selected; however, it can be disabled.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL9o, press ► until SEt is displayed. Press ▲ ▼ to select Urtb variable time base, zero cross. OFF AL9o

Figure 5.2a — 50% variable time base 1 cycle on, 1 cycle off.

Figure 5.2b — 40% single cycle variable time base 1 cycle on, 1 cycle off, 1 cycle on, 2 cycles off.

DC Contactor - Zero Cross

DC contactor control mode is a specialized version of zero cross control in which the analog control input is always used and percentage power output is fixed at 100 percent or 0 percent.

The off/on thresholds are 2.0V/3.5V for voltage input; 5.0mA/8.0mA for current input. This means the unit is off for an input voltage (current) of 2.0V(5.0mA) or lower, and 100% on for an input voltage (current) of 3.5V(8.0mA) or higher. Maximum input voltage is 10.0V.

In contactor mode use a four second cycle time to improve heater diagnostics operation.

Line voltage compensation is not used under dc contactor control, the output is either 100 percent on or 100 percent off.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL9o, press ► until SEt is displayed. Press ▲ ▼ to select cont dc contactor. OFF AL9o

NOTE: Heater Tolerance, Heater Open and Load Balance alarms do not work in DC Contactor control mode.

NOTE: Do not use variable time base settings in the temperature controller to drive a Power Series in contactor mode.

Phase Angle

The phase angle control method gates a limited portion of the line voltage cycle to the load based on percentage power selected. Soft start is always included when phase angle is selected.

Phase angle control may not be selected in a 3 phase, 2-leg system.

Line voltage compensation will be used to adjust the percentage power output while operating in this mode if selected.

Current limiting is a valid option with phase angle if the unit is equipped with heater diagnostics.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL9o, press ► until SEt is displayed. Press ▲ ▼ to select PH2t phase angle. OFF AL9o

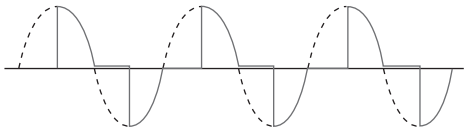


Figure 5.2c— Phase angle firing.

NOTE: The maximum output power is 99%. This is considered full on for the Power Series.

Soft Start

Soft start is a variation of phase angle control executed on **startup** in which there is a gradual increase in power until the final selected power output is reached. If soft start is selected, the system will execute the soft start sequence each time a zone starts active control. This happens at power-on and on recovery from an alarm such as "Line Loss." The soft start time is the time it takes to achieve 100 percent power after a zone restart. The actual time may be greater than the set time because of the resolution, but the actual time will never be less than the set time. Rate = 100.0 ÷ time. The actual power achieved is set by the temperature control input (see Figure 5.3a and 5.4a).

NOTE: Soft start is intended to be used only for slowly increasing power on the initial power request.

Soft start is available in single phase and 3 phase, 3-leg models only.

Soft start is always used in systems with phase angle control mode selected unless SoFt is set to 0.

Setup Page:

Adjustable Soft Start - On Power Up

- Enter the Setup Page by holding ■ ◀ for 2 seconds.
- When the display reads AL.Lo, press ▼ until CtrL / SEt is displayed. Press ▶ until SoFt 4.0 is displayed. Use the ▲▼ keys to set the desired soft start time in seconds.

NOTE: Repeat this procedure for each zone that you wish to configure.

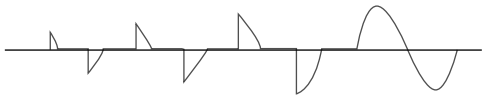


Figure 5.3a — Soft start.

Maximum Rate of Change

The maximum rate of change is used during phase angle controlled normal operation (after a soft start sequence ends), to cause large changes in requested power to be implemented gradually. The maximum rate of change of the power is defined as the percentage of power change allowed every 0.1 second. This prevents a sudden increase or decrease in current from one phase angle level to another level from one cycle to the next into a nonlinear load that could be damaged or blow a fuse.

Setup Page:

Adjustable Maximum Rate of Change On Signal Change

1) To begin programming, enter the Setup Page holding ■ ◀ keys for 2 seconds.
2) The control rate is to be set. Press ▲ key until the display reads SEt / CtrL Press ▶ until rAtE is in lower display. Use the ▲ or ▼ key to set the desired % output change per 0.1 seconds to reach the desired output power level when in phase angle control. The adjustable range is 0.1 to 100.0%
3) Press ■ key to exit setup page and start the Power Series.

Examples: If the signal changes from 0% to 100%

The power applied to the heater should not change by more than 100.0% every 0.1 second. 100.0% rate setting means it will take 0.1 sec. to go from 0 to 100% power.

The power applied to the heater should not change by more than 50.0% every 0.1 second. 50.0% rate setting means it will take 0.2 sec. to go from 0 to 100% power.

The power applied to the heater should not change by more than 20.0% every 0.1 second. 20.0% rate setting means it will take 0.5 sec. to go from 0 to 100% power.

The power applied to the heater should not change by more than 10% every 0.1 second. 10.0% rate setting means it will take 1.0 sec. to go from 0 to 100% power.

NOTE: The default for Maximum Rate of Change is set to 10%/0.1 second.

NOTE: Repeat this procedure for each zone that you wish to configure.

Heater Bakeout

If a system is shut down for long periods, some heaters can absorb moisture. With a standard power controller, turning the power full "on" when moisture is present, can cause the fuses or the heater to blow. However, with the Power Series you can now "bake out" the moisture in a wet heater before applying full power and destroying the heater.

During heater bakeout, the Power Series slowly increases voltage to the heater while monitoring the output current. If the heater achieves full output before the bakeout time expires, then the heater is dry and can be put into service. At all times, the output will not exceed the temperature controller set point.

If the output current reaches a user-specified trip point during the bakeout (as it would if arcing occurred in the heater), then the Power Series shuts off the output and activates an over-current trip error, HbOC. The operator should then lengthen the bakeout time and restart or just restart, depending on how long the initial bakeout ran. To start heater bakeout you must cycle the controller power. After a successful heater bakeout, the Power Series automatically switches to the operator pre-selected control mode (phase angle or zero cross).

NOTE: Heater bakeout is intended for magnesium oxide filled nichrome elements. A nichrome element heater can have a tolerance up to ± 10%. This tolerance could add to the maximum heater current during normal operation. For example, a 50-amp heater could draw 55 amps and still be a good and dry heater.

Heater bakeout may be selected in single phase (phase to neutral) and 3 phase, 6 SCR systems with any pre-selected control mode. You must also have the heater diagnostics option installed on your Power Series.

Heater bakeout operates with an over-current trip. The operator must set the maximum current allowed during heater bakeout using the HbOC prompt. This will set the maximum allowable load during heater bakeout.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads ALgo, press ▼ until OPt 1 / SEt is displayed. Press ► until OFF / Hbo is displayed. Use the ▲▼ keys to turn heater bakeout on.
- Press ► until rn in appears in the lower display. Use the ▲▼ keys to set the desired heater bakeout time in minutes.
- Press ► until HbC appears in the lower display. Use the ▲▼ keys to set the desired maximum load current during the heater bakeout process.

NOTE: Repeat this procedure for each zone that you wish to configure.

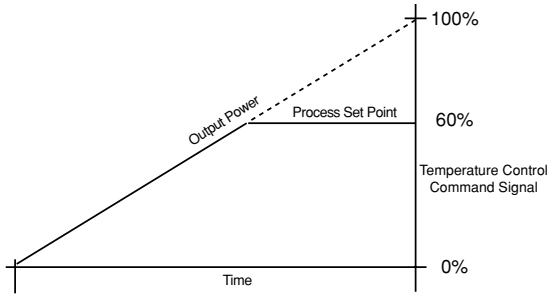


Figure 5.4a— Heater bakeout.

Heater Tolerance Detection

Heater tolerance detection allows you to detect a failed heater or a heater that is beginning to fail. An alarm is triggered if the load current drops below or rises above specific levels.

For example, if you have five heaters that draw 20 amps each, for a total load current of 100 amps at 100 percent power, you could program the heater tolerance alarm to trigger if the load current drops below 80 amps at 100 percent power. This would indicate that one of the heaters has failed (open.)

To monitor for a heater that is beginning to fail or age, you could watch for too little or too much current. For example, in Figure 5.4b the alarm is programmed to trigger if the load current drops below 90 amps, or rises above 110 amps at 100 percent power.

The Power Series automatically adjusts the set points, depending upon the percent power, as shown in the illustration below.

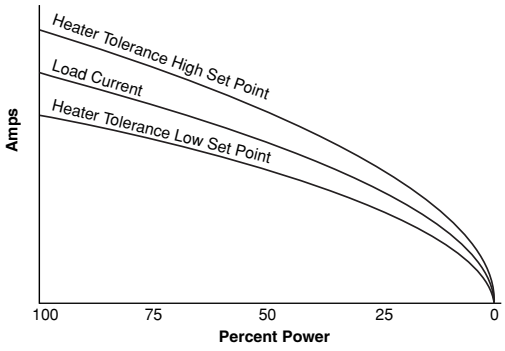


Figure 5.4b— Heater Tolerance Detection.

Current Limiting

The current limit uses the RMS current entered by the user. When a zone goes from 0.0% to a requested power greater than 0.0%, the software increments the output power by 0.1% increments per AC cycle until a current limit is detected. The software will continue to increment and decrement by 0.1% per AC cycle based on the current limit until the goal power is met. During normal operation (after the initial goal power is met), a detected current limit will cause decrements at 0.1% power per AC cycle until the current limit is no longer active. The software will continue to increment and decrement by 0.1% per AC cycle based on the current limit, until the goal power is again met.

Current limiting is available on units equipped with heater diagnostics, (P _ _ 1 - _ _ _ _ - _ _ _ _).

Current limiting is not available with 3 phase, 2-leg systems.

Current limiting is available under phase angle control operation.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL.Lo SEt, press ▼ until OPt.1 SEt is displayed. Press ► until OFF CL.1 is displayed.

  Use the ▲ ▼ keys to turn current limit on.
- Press ► until CL A appears in the lower display. Use the ▲ ▼ keys to set the desired current limit set point.

NOTE: Repeat this procedure for each zone that you wish to configure.

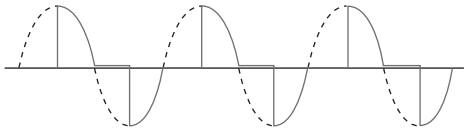


Figure 5.5 — Current limiting.

Inductive Load Adjustment

The effect of inductive loads on current readings with phase angle control can be factored in by requesting an Inductive Load Factor Adjustment. This feature is used to improve current measurement when phase angle firing into a transformer or other inductive loads.

The adjustment should be done with active phase angle control with a requested power of 5% to 50% in the zone of interest using a true RMS current meter.

NOTE: If an inductive load factor has been requested and the load is no longer inductive, the current reading will not be accurate. Use the CLr parameter in the IndF prompt to remove the inductive factor.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL.Lo SEt, press ▼ until OPt.1 SEt is displayed. Press ► until idLE IndF is displayed.

  Using the ▲ ▼ keys, select rES in the upper display.
- Press ► until ICur appears in the lower display. The upper display shows the current calculated by the system with no inductive factor. Read the actual current measured by a true RMS meter; use the ▲ ▼ keys until that value is displayed.
- Press ◄ until IndF appears in the lower display. Using the ▲ ▼ keys, select ACt in the upper display. After 5 seconds, the prompt will read idLE if the adjustment was successful, or Err if there was an error.
- To return to using no Inductive Load Factor, select CLr.

NOTE: Using the inductive load factor parameter the Power Series displayed current can only be increased to match the current reading of a true RMS meter. The Power Series displayed current reading cannot be decreased below what it initially calculated and displayed. The maximum inductive load factor increase allowed is 50% of the non-inductive current measured initially by the Power Series. If you exceed the allowable adjustment then the Power Series will display Err in the upper display and IndF in the lower display. In the event of an error push the up or down key to rES and start the process over.

Other Features

Baseline Voltage and Voltage Compensation

The baseline voltage is used by the controller to adjust the output so that the system power remains constant. This adjustment is called voltage compensation. The requested power is assumed to occur at the baseline voltage. If there are any deviations of the line voltage from the baseline voltage, the applied output power will be adjusted.

For example, the starting line voltage of the system is 121 volts and the baseline voltage is set to 121 volts. The requested power is set to 50.0 percent. After the system has been controlling, the line voltage drops to 110 volts. During the time that the line voltage is at 110 volts, the applied output power will be adjusted to ($121^2/110^2$) x .50 = 60.5 percent so that the system power remains constant.

The baseline voltage is also used for adjusting operating parameters in the software. It is important to adjust the baseline voltage to the normal operating voltage of the unit to enable it to operate at maximum accuracy.

Menu Lock

Menu locks allow a user to restrict access to parameters. If a lock is set on a menu, the parameters become read only. The system will not allow parameter to be changed, either from the keypad or through communications.

Factory Page:

- Enter the Factory Page by holding ■ ◄ ► for 2 seconds.
- When the display reads dAtA, press ▼ until LOC / FCTY is displayed. Press ► until UNL / GLOC is displayed.

Use Global Lockout GLOC to write protect all prompts by choosing locked LOC. If set to unlocked UNL, individual menu locks can be set by selecting each parameter in the Global/Menu Lockouts Menu and individually setting each to locked LOC or unlocked UNL.

Input

Signal Selection

You need to configure the Power Series for current, voltage or digital.

Setup Page:

- Enter the Setup Page by holding ■ ◄ for 2 seconds.
- When the display reads AL.Lo, press ▼ until CTR.1 / SET is displayed. Press ► until mA / In is displayed.

  Use the ▲▼ keys to select either current mA, volt VOLT, or digital d.IG.

NOTE: Repeat this procedure for each zone that you wish to configure.

Analog is typically 0-5V⎓ (dc), 1-5V⎓ (dc), 0-10V⎓ (dc), 4-20mA.

Digital is used for keypad manual control or communications to control the Power Series.

Digital input is entered from the keypad in the Display Loop on the In.1, In.2 or In.3 prompt.

Current inputs are hardware limited to 0 to 20mA, but may be scaled using the mA_ and mA‾ prompts. Note that the power will be fully off at the current specified by prompt mA_ +.2mA, and fully on at the current specified by prompt mA‾ -.2mA.

Voltage inputs are hardware limited to 0 to 10V, but may be scaled using the VOL_ and VOL‾ prompts. Note that the power will be fully off at the current specified by prompt VOL_ +.1V, and fully on at the current specified by prompt VOL‾ -.1V.

Alarms

An alarm takes some action, usually notifying an operator, when a control parameter leaves a defined range. A user can configure how and when an alarm is triggered and whether it turns off automatically when the alarm condition is over. A description of the alarms and errors, why they occur, and how to troubleshoot them can be found on pages A.4 - A.7.

Setup Page:

- Enter the Setup Page holding ■ ◀ for 2 seconds.
- When the display reads [AL.Lo] [SEt], press ♥ until [AL.r] [SEt] is displayed.

Global Alarm Configuration

The Global Alarm Configuration [GLbL] is used when all of the alarms in the system are to be configured in the same mode. If individual alarms need to be set to different configurations, the Global Alarm Configuration should be set to [OFF].

Alarm Standard

If an alarm is configured as "standard" [Std], the alarm indicators only occur while the alarm is active. The alarm indicators are the relay, which state is set in Active Relay State [AL.Sc] as either energized on alarm or de-energized on alarm, and the display, which has an indicator LED in the upper display and the descriptive prompt for the active alarm. When the alarm becomes inactive (and no other alarms are active) the alarm indicators are turned off.

Alarm Latched & Unlatching an Alarm Indicator

If an alarm is configured as "latched" [LAt], the alarm indicators remain active until the user deactivates them. For a latched alarm, the descriptive prompt on the display in the Display Loop will read [LAt], and the user can switch to [UnLA], if the alarm is cleared, to turn off the alarm indicators. Once alarm indicators have been turned off, the operator does not have to reconfigure an alarm as latched.

Alarm Silencing

If an alarm is configured as "silenced" [SIL], the relay does not activate on the active alarm, although the display indicators are still visible. When the alarm becomes inactive (and no other alarms are active) the display alarm indicators are turned off.

Alarm Latched and Silenced

If an alarm is configured as "latched and silenced" [LASI], only the display alarm indicators are active until the user deactivates them. The alarm displays must be switched off once the alarm has been cleared. See unlatching an alarm indicator above.

Active Relay State

For maximum flexibility, the Power Series controller can generate alarms from the energized or de-energized state of the relay. Creating an alarm from the de-energized state of the relay is the most reliable method of alarm generation since a power loss or any other control malfunction would cause an alarm.

Communications

Overview

A Power Series controller can also be programmed and monitored by connecting it with a personal computer or programmable logic controller (PLC) via serial communications. To use this communications option, a Power Series must be equipped with an EIA/TIA 232/485 (P_ _ _ - _ _ _ _ - 1 _ _ _) communications board.

To view or change controller settings with a personal computer, you need to run software that uses the Modbus™ RTU protocol to read or write to registers in the controller. See Chapter Six, Parameters, for the Modbus registers. These registers contain the parameter values that determine how the controller will function and the values that reflect the current input and output values of the system.

Parameters relating to communications appear in the Comms Menu (Setup Page). Match the Baud Rate [bAud] to that of the computer and select an Address [Addr] (1 to 247, default is 1).

The Power Series supports a maximum read of up to 32 registers. See appendix A.8 for Modbus registers.

Retransmit

Retransmitting Output Load Current or Load Power

The retransmit feature allows an output to retransmit an analog signal that can serve as an input variable for another device such as a chart recorder to document system performance over time.

To use the retransmit feature a Power Series must be equipped with heater diagnostics and a universal retransmit board (P_ _ 1 - _ _ _ _ - _ 1 _ _).

Setup Page:

- Enter the Setup Page by holding ■ ◀ for 2 seconds.
- When the display reads [AL 9o], press ▼ until [rEtr SEt] [rEtr SEt] is displayed. Press ▶:

  Select [CFG] to choose the type of output retransmitted, mA [mnA] or volts [VOLt].

  Select [tYPE] to choose the type of information that will be retransmitted.

  [nOnE] retransmit not active.

  [CUr] retransmits the load current of selected phase [PhAS] or zone [ZonE] if it is a multizone unit.

  [HUA] retransmits the load power of selected zone [ZonE] in all models.

  Select phase [PhAS] or zone [ZonE] to choose the phase/zone that will represent your retransmit signal. A three phase unit can only be single zone.

To scale the retransmit output signal, set the low value load current or kVA to be retransmitted with [Cur_] or [HUA_] and set the high value load current or kVA to be retransmitted with [Cur¯] or [HUA¯]. For example, if you want 4-20mA to represent a 50A to 250A current, set [Cur_] to 50 and [Cur¯] to 250. As the load current varies between 50 and 250A, the retransmit output will vary between 4mA and 20mA.

Current outputs are hardware limited to 0 to 20mA, but may be scaled using the [rt .C_] and [rt .C¯] prompts.

Voltage outputs are hardware limited to 0 to 10V, but may be scaled using the [rt .U_] and [rt .U¯] prompts.

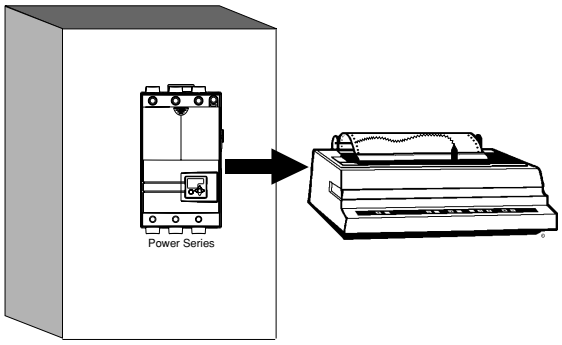


Figure 5.9a — Retransmitting a remote set point.

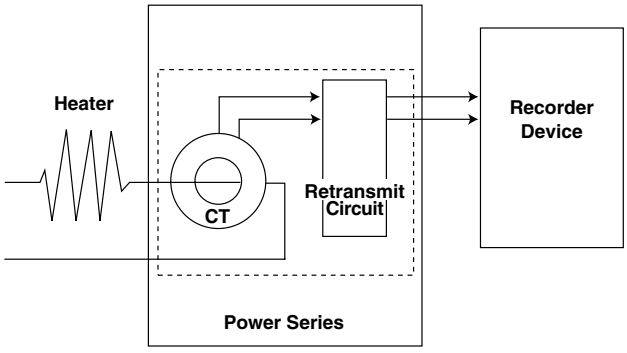


Figure 5.9b — Example circuit.

Fast Start Guide

Get Your Power Series Controlling Heat

Quick Setup - Single Phase Control

Apply power to the line and the electronics power supply. The displays will read [LoAd] [---]. If line is not connected, you may continue to program but display will show a line alarm and baseline voltage cannot be automatically programmed.

1) To begin programming, enter the Setup Page holding ■ ◀ keys for 2 seconds.

2) The control algorithm is to be set. Press ▲ key until the display reads [SEt] [AL9o] then press ▶ key until [AL9o] is in lower display.

Select one of the following using the ▲ key.

[cont] dc contactor
[OFF] non-operational (factory default value)
[Ftb] fixed time base, zero cross
[Urtb] variable time base, zero cross
[PH2t] phase angle

Press ◀ to go back to [SEt] [AL9o].

3) The control signal is to be set. Press ▼ key until [SEt] [Ctr 1] is displayed.

Press ▶ key until [In] is in lower display.

Using the ▲ key, select input signal type:

[nnA] current (factory default value)
[Volt] voltage
[d.9] keyboard or comms
[OFF] off

4) The signal range is to be set or fixed.

A) For choices of milliampere or volt, press ▶ key until [nnA_] or [Vol_] is in lower display. Enter the lower signal range provided using ▲ or ▼ key. Press ▶ key until [nnA¯] or [Vol¯] is in lower display. Enter the upper signal range provided using ▲ or ▼ key.

B) For choices of keyboard or comms, press ▶ key until [dFLt] is in the lower display. Enter the value using the ▲ or ▼ key.

5) The baseline voltage is to be set. Press ▶ key until [bL u] is in lower display. Using the ▲ or ▼ key, enter the nominal AC line voltage present at the top of the Power Series (like 120, 480 or 600). Alternatively, you may have the Power Series learn voltage value by pressing the ▶ key to [Lrn.U]. Using the ▲ or ▼ key, select [rE9] and the Power Series will set the baseline voltage to that measured. Line voltage compensation, under voltage alarm, and some internal operating parameters not referenced here are based on this value.

6) Press ■ key to exit setup page and start the Power Series.

7) Other settings may be required based on your application.

Note on navigation: Use ■ ◀ keys to get into the setup page and ■ key to return home *or* if in the display loop, use to move between like prompts of different zones or phases.

Press ▼ or ▲ key to find a specific menu in a page. The menu appears in the upper display and the page title remains in the lower display.

Press ▶ key to enter the list of parameters in the menu displayed on top. The menu's parameters now will appear in the lower display and the values in the upper display. To navigate backwards through the parameter list, press ◀ key. When back at the page level, again use the ▼ or ▲ key to find a specific menu on a page.

Press ▼ or ▲ to select a value, either alpha or numeric, within a specific parameter while in a menu.

Fast Start Guide

Quick Setup - Three Phase Control

Apply power to the line and the electronics power supply. The displays will read [LoAd] [- - -]. If line is not connected, you may continue to program but display will show a line alarm and baseline voltage cannot be automatically programmed.

1) To begin programming, enter the Setup Page holding ■ ◄ keys for 2 seconds.

2) The control algorithm is to be set. Press ▲ key until the display reads [SEt] [ALgo] then press ► key until [ALgo] is in lower display.

Select one of the following using the ▲ key.

[cont] dc contactor
[OFF] non-operational (factory default value)
[Ftb] fixed time base, zero cross
[Urtb] variable time base, zero cross
[PH2t] phase angle

Press ◄ to go back to [SEt] [ALgo].

3) The control signal is to be set. Press ▼ key until [SEt] [Ctr 1] is displayed.

Press ► key until [In] is in lower display.
Using the ▲ key, select input signal type:
[nnA] current (factory default value)
[VoLt] voltage
[d.9] keyboard or comms
[OFF] off

4) The signal range is to be set or fixed.

A) For choices of milliampere or volt, press ► key until [nnA_] or [VoL_] is in lower display. Enter the lower signal range provided using ▲ or ▼ key. Press ► key until [nnA¯] or [VoL¯] is in lower display. Enter the upper signal range provided using ▲ or ▼ key.

B) For choices of keyboard or comms, press ► key until [dFLt] is in the lower display. Enter the value using the ▲ or ▼ key.

5) The baseline voltage is to be set. Press ► key until [bL U] is in lower display. Using the ▲ or ▼ key, enter the nominal AC line voltage present at the top of the Power Series (like 120, 480 or 600). Alternatively, you may have the Power Series learn voltage value by pressing the ► key to [LrnU]. Using the ▲ or ▼ key, select [rEd] and the Power Series will set the baseline voltage to that measured. Line voltage compensation, under voltage alarm, and some internal operating parameters not referenced here are based on this value.

6) The load type is to be set. Press ► key until [tYPE] is in lower display.
Using the ▲ key, select load type:

[2L d] 3 ph, 2-leg delta (PC2x-xxxx-xxxx)
[2Lod] 3 ph, 2-leg open delta (PC2x-xxxx-xxxx)
[2LuY] 3 ph, 2-leg ungrounded wye (PC2x-xxxx-xxxx)
[nonE] unconfigured (PC2x-xxxx-xxxx, PC3x-xxxx-xxxx, PC4x-xxxx-xxxx)
[3L id] 3 ph, 3-leg, 6 SCR inside delta (PC3x-xxxx-xxxx)
[3L d] 3 ph, 3-leg, 6 SCR delta or ungrounded wye (PC3x-xxxx-xxxx)
[3LGY] 3 ph, 3-leg, 6 SCR grounded wye (PC4x-xxxx-xxxx)

8) Press ■ key to exit setup page and start the Power Series.

9) Other settings may be required based on your application.

Note on navigation: Use ■ ◄ keys to get into the setup page and ■ key to return home *or* if in the display loop, use to move between like prompts of different zones or phases.

Press ▼ or ▲ key to find a specific menu in a page. The menu appears in the upper display and the page title remains in the lower display.

Press ► key to enter the list of parameters in the menu displayed on top. The menu's parameters now will appear in the lower display and the values in the upper display. To navigate backwards through the parameter list, press ◄ key. When back at the page level, again use the ▼ or ▲ key to find a specific menu on a page.

Press ▼ or ▲ to select a value, either alpha or numeric, within a specific parameter while in a menu.

6

Chapter Six
Parameters

Display Loop

The resting-state display shows one of the following sets of data, depending on controller setup. The first prompt appears in the top display, the second in the bottom display.

Display	Parameter	Range (Modbus Value)	Default	Modbus Register read/write	Conditions for Parameters to Appear
System Information					
[ ] (alpha)	**Active Alarms** (if any) Displays present alarm conditions.	[ALr] Active (1) [LAt] Latched Active (2) [LAt] Latched Inactive (3) [UnLA] Unlatched (4)		181 to 190 r/w	Active: Any active unmasked alarm. Individual Modbus registers may have [UnLA] Unlatched (4) written to them to clear a latched alarm. **NOTE: a latched alarm must be [LAt] Latched Inactive (3) before it can be unlatched.**
[ ] (alpha)	**Display Loop Errors** (if any) Displays present error conditions.	[ ] Inactive (0) [Err] Active (1) (See Appendix A.7 for values)	n/a	195 r	Active: Any active error. **See Appendix, pp. A.4-7**.
[LoAd]	**Load Activity Indicator** Displays [-] if load has power applied.	[-] or [_] per display	[- - -]		Active: Always. Appears in display loop. (In single phase, single zone, only the center LED operates; in single phase, 2-zone, or 3-phase, 2-leg, only the outside LEDs operate; in 3-phase, 3-leg, and multizone, each zone operates a separate LED.)
[FrEq]	**Line Frequency (Hz)** Displays the AC line.	[47] to [63] [47 to 63]	n/a	198 r	Active: Always. Appears in Display Loop.
Single Zone / Single Phase					
[In]	**Analog (mA or V) or Numeric (%) Input Signal** Displays mA/V analog input; selects numeric % power.	[0.0] to [20.00] [mA] (0 to 2000) [0.0] to [10.00] [V] (0 to 1000) [0.0] to [100.0] [%] (0 to 1000) 0.1 increments	[0.0]	150 r [mA] 151 r [V] 5102 r/w [dig]	Active: Always. Appears in Display Loop.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
Out	**Output Power (%)** Displays present output power.	0.0 to 100.0 (0 to 1000)	0.0	159 r	Active: Always. Appears in Display Loop.
HbE	**Heater Bakeout Timeout** Displays the time left on a heater bakeout.	9999 to 0 [minutes] (9999 to 0)	n/a	157 r [1]	Active if heater diagnostics option is installed and heater bakeout is running in the zone.
UoL	**Line Potential (Volts) rms** Displays measured line voltage.	0 to 9999 (0 to 9999)	n/a	162 r	Active: Always. Appears in Display Loop.
Cur	**Load Current (Amps) rms** Displays measured load current.Peak current converted to rms, then multiplied by % power = average rms current measured by the onboard CT.	0 to 9999 (0 to 9999)	n/a	164 r	Active if heater diagnostics option is installed.
HUA	**Load Power (kVA)** Displays (est.) calculated load power.	0 to 9999 (0 to 9999)	n/a	156 r	Active if heater diagnostics option is installed.

Two Zone, Single Phase

1, 2 ZonE	**Display Zone Selection** Select Zone 1 or 2 for display.	1 to 2	1	n/a	Active with multizone configuration.
In 1, In 2	**Analog (mA or V) or Numeric (%) Input Signal** Displays mA/V analog input; selects numeric % power.	0.0 to 10.00 [V] (0 to 1000) 0.0 to 20.00 [mA] (0 to 2000) 0.0 to 100.0 [%] (0 to 1000) 0.1 increments	0.0	mA, r [1][2] 150,160 V, r [1][2] 151,161 dig, r/w [1][2] 5102, 5202	Active with multizone configuration.
Out 1, Out2	**Output Power (%)** Displays present output power.	0.0 to 100.0 (0 to 1000)	0.0	159 r [1] 169 r [2]	Active with multizone configuration.
Hbt 1, Hbt2	**Heater Bakeout Timeout** Displays the time left on a heater bakeout.	9999 to 0 [minutes] (9999 to 0)	n/a	157 r [1] 167 r [2]	Active if heater diagnostics option is installed and heater bakeout is running in the zone.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
Vol 1, Vol2	**Line Potential (Volts) rms** Read measured line voltage.	0 to 9999 (0 to 9999)	n/a	152 r [1] 172 r [2]	Active with multizone configuration.
Cur 1, Cur2	**Load Current (Amps) rms** Read measured line current.	00 to 9999 (0 to 9999)	n/a	154 r [1] 174 r [2]	Active with multizone configuration and heater diagnostics option is installed.
HUA 1, HUA2	**Load Power (kVA)** Read calculated (est.) load power.	0 to 9999 (0 to 9999)	n/a	156 r [1] 166 r [2]	Active with multizone configuration and heater diagnostics option is installed.

Three Zone, Single Phase

1, 2 3, ZonE	**Display Zone Selection** Select Zone 1, 2 or 3 for display.	1 to 3	1	n/a	Active with multizone configuration.
In 1, In 2, In 3	**Analog (mA or V) or Numeric (%) Input Signal** Displays mA/V analog input; selects numeric % power.	0.0 to 20.00 [mA] (0 to 2000) 0.0 to 10.00 [V] (0 to 1000) 0.0 to 100.0 [%] (0 to 1000) 0.1 increments	0.0	mA, r[1][2][3] 150,160,170 V, r[1][2][3] 151,161,171 dig, r/w [1][2][3] 5102, 5202, 5302	Active with multizone configuration.
Out 1, Out2, Out3	**Output Power (%)** Displays present output power.	0.0 to 100.0 [%] (0 to 1000)	0.0	159 r [1] 169 r [2] 179 r [3]	Active with multizone configuration.
Hbt 1, Hbt2, Hbt3	**Heater Bakeout Timeout** Displays the time left on a heater bakeout cycle.	9999 to 0 [minutes] (9999 to 0)	n/a	157 r [1] 167 r [2] 177 r [3]	Active if heater diagnostics option is installed and heater bakeout is running in the zone.
Vol 1, Vol2, Vol3	**Line Potential (Volts) rms** Read measured line voltage.	0 to 9999 [V] (0 to 9999)	n/a	152 r [1] 162 r [2] 172 r [3]	Active with multizone configuration.

NOTES:

What you see in each Page and in each Menu are factory set, depending on the options and settings in your controller.

Current operating parameters may be modified at any time with the use of a keypad or serial input.

The Input Signal Method Indicator will change depending on the Input Signal Method chosen — process, current, or volts.
NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
Cur 1, Cur2, Cur3	**Load Current (Amps) rms** Read measured line current.	00 to 9999 [A] (0 to 9999)	n/a	154 r [1] 164 r [2] 174 r [3]	Active with multizone configuration and heater diagnostics option is installed.
HUA 1, HUA2, HUA3	**Load Power (kVA)** Read calculated (est.) load power.	0 to 9999 [kVA] (0 to 9999)	n/a	156 r [1] 166 r [2] 176 r [3]	Active with multizone configuration and heater diagnostics option is installed.

Multi-Phase

In	**Analog (mA or V) or Numeric (%) Input Signal** Displays mA/V analog input; selects numeric % power.	0.0 to 20.00 [mA] (0 to 2000) 0.0 to 10.00 [V] (0 to 1000) 0.0 to 100.0 [%] (0 to 1000) 0.1 increments	0.0	151 r [V] 150 r [mA] 5102 r/w [dig]	Active: Always. Appears in Display Loop.
Out	**Output Power (%)** Displays present output power.	0.0 to 100.0 [%] (0 to 1000)	0.0	159 r	Active: Always. Appears in Display Loop.
1, 2, 3 PhAS	**Display Phase Selection 1 to 3** Select phase for display.	1 to 3	n/a		Active with multiphase configuration. 3-ph, 2 leg models do not show 2 PhAS.
Vol 1, Vol2, Vol3	**Line Potential (Volts) rms** Read measured line voltage.	00 to 9999 [V] (0 to 9999)	n/a	152 r [1] 162 r [2] 172 r [3]	Active with multiphase configuration. 3-ph, 2 leg models do not show Vol2.
Cur 1, Cur2, Cur3	**Load Current (Amps) rms** Read measured load current.	00 to 9999 [A] (0 to 9999)	n/a	154 r [1] 164 r [2] 174 r [3]	Active with multiphase configuration and heater diagnostics option is installed. 3-ph, 2 leg models do not show Cur2.

NOTE: In 3 phase, 2-leg systems, Cur2 is the current displayed; it is the average of phase 1 and phase 3 (Cur 1 and Cur3).

HUA	**Load Power (kVA)** Read calculated (est.) load power.	0 to 9999 [kVA] (0 to 9999)	n/a	156 r	Active with multiphase configuration and heater diagnostics option is installed.

Setup Page

To enter the Setup Page, press the Home and Left keys (■ ◄) together while in the Display Loop.

Each of the following menus in the Factory Page are selected by pressing the Increment/Decrement keys (▲ ▼). Each press of the button will scroll you up or down through these main menu options.

To select a parameter within a menu, use the Left/Right arrow keys (◄ ►). The parameter appears in the bottom display.

To select a value for each parameter (either alpha or numeric), use the Increment/Decrement keys (▲ ▼). The value appears in the upper display.

Pressing the Home key (■) in this menu will return you to the Display Loop.

The Setup Page contains ten menus:

Display	Parameter	Range (Modbus Value)	Default	Modbus Register read/write	Conditions for Parameters to Appear
SEt	**Setup Page Select** Go to a setup menu.	ALgo Control Algorithm Ctr1 Control Zone 1 OPt1 *Options Zone 1 Ctr2 Control Zone 2 OPt2 *Options Zone 2 Ctr3 Control Zone 3 OPt3 *Options Zone 3 ALr Alarms Configuration COM1 *Comms Configurations rEtr *Retransmit Configuration	ALgo		***NOTE: These menus are dependent on the hardware options that are installed in your controller. Please see the individual menus for the options that must be installed for each of these menus to appear.**

ALgo ***Setup Control Algorithm***
SEt ***Setup Page***

This menu is used to set the control algorithm for the system.

NOTE: Changing the algorithm will restart the system.

ALgo	**Power Control Algorithm Select** Select power control algorithm.	cont dc contactor (0) OFF non-operational (1) Ftb fixed time base, zero cross (2) Vrtb variable time base, zero cross (3) PH2t phase angle (4)	OFF non-operational (1)	55 r/w	Active: Always. cont is not available if any input on controller is digital. PH2t phase angle is not available with 3 phase, 2-leg controllers. **NOTE: Changing this parameter will restart the system.**
Ftb	**Fixed Time Base (Sec)** Set the fixed time base in seconds for selected zone.	1SEC 1 second (0) 4SEC 4 second (1)	1SEC 1 second (0)	56 r/w	Active if ALgo is set to Ftb.

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
UC	**Line Voltage Compensation** Automatically adjusts output duty cycle to compensate for line voltage fluctuations. Occurs for requested power from 5% to 95% and only applies to variable time base or phase angle control methods.	On on (0) OFF off (1)	On on (0)	80 r/w	Active: Always.

Ctr 1 Ctr2 Ctr3 ***Setup Control Zone 1, 2, and 3 Menus***
SEt SEt SEt ***Setup Page***

This menu is used to set up the control for the chosen zone.
Zone 1 is used if Input/Output Configuration is single phase, single zone, or three phase.
Zone 1 and 2 are used if Input/Output Configuration is single phase, two zones.
All zones are used if Input/Output Configuration is single phase, three zones.

In	**Input Signal Method Select (dig, mA, Volt)** Select the input signal method for chosen zone.	OFF off (0) mnA current (1) Volt voltage (2) d iG keyboard or comms (3)	mnA current (1)	5101 r/w [1] 5201 r/w [2] 5301 r/w [3]	Active: Always. d iG is not available if SEt ➧ ALGo in the Setup Page is set to cont.
dFLt	**Default Numeric Input Signal (%)** Selects the power-on level for chosen zone.	0.0 0 percent to 100.0 100 percent (0 to 1000)	0.0 (0)	5103 r/w [1] 5203 r/w [2] 5303 r/w [3]	Active if input signal method is set to d iG.
mnA_	**Analog Input Low Current (mA)** Sets current value which will correspond to 0% power if input is current type.	0.00 to mnA¯ [0 to mA high -5mA]	0.00 (0)	5011 r/w [1] 5021 r/w [2] 5031 r/w [3]	Active if In is set to mnA current.
mnA¯	**Analog Input High Current (mA)** Sets current value which will correspond to 100% power if input is current type.	mnA_ [+ 5mA] to 9999 [low mA + 5mA to mA 9999]	20.00 (2000)	5012 r/w [1] 5022 r/w [2] 5032 r/w [3]	Active if In is set to mnA current.
Vol_	**Analog Input Low Voltage (Volts)** Sets voltage value which will correspond to 0% power if input is voltage type.	0.00 to Vol¯ [- 2.5V] [0 to V high -2.5V]	0.00 (0)	5013 r/w [1] 5023 r/w [2] 5033 r/w [3]	Active if In is set to Volt voltage.

Display	Parameter	Range (Modbus Value)	Default	Modbus Register read/write	Conditions for Parameters to Appear
UoL_	**Analog Input High Voltage (Volts)** Sets voltage value which will correspond to 100% power if input is voltage type.	UoL_ [+ 2.5V] to 9999 [V low +2.5V to 99.99]	10.00 (1000)	5014 r/w [1] 5024 r/w [2] 5034 r/w [3]	Active if In is set to UoLt voltage.
Lrn.A	**Learn Input Learn Request (Hi, Lo)** Allows software to learn the high and low limits of the analog input signal.	Err invalid input signal (-1) idLE idle (0) LO low limit learn request (1) HI high limit learn request (2)	idLE idle (0)	5019 r/w [1] 5029 r/w [2] 5039 r/w [3]	Active if In is set to nonA current or UoLt voltage. Go to Lrn.A, set analog input to low limit and set the controller to LO low limit. Wait 5 sec. for automatic input of low data for controller. The display will go back to idLE when done. Go to Lrn.A, set the analog input to high limit and set the controller to HI high limit. Wait 5 sec. for automatic input of high data for controller. The display will go back to idLE when done.
bL U	**Baseline Voltage Read/Adjust** Shows the value for baseline voltage and allows manual adjust-ment of this value. Adjust to match voltage phase to phase for delta/ ungrounded wye loads or phase to neutral grounded wye loads.	Minimum to maximum line voltage (minimum to maximum line voltage)	Line Voltage rating	5594 r/w [1] 5595 r/w [2] 5596 r/w [3]	Active: Always.
Lrn.U	**Baseline Voltage Learn Request** Allows software to learn the baseline voltage on line connected to the zone chosen.	Err invalid input signal (-1) idLE idle (0) rEq learn request (1)	idLE idle (0)	5591 r/w [1] 5592 r/w [2] 5593 r/w [3]	Active: Always. Go to Lrn.U, set the controller to rEq. Wait 5 sec. for automatic input of data for controller. The display will go back to idLE when done.
tYPE	**Load Type Select** ***(Control Zone 1 only, 3 phase only.)*** Select the load type for Zone 1.	2L_d 3 ph, 2-leg delta (0) 2Lod 3 ph, 2-leg open delta (1) 2LuY 3 ph, 2-leg ungrounded wye (2) nonE unconfigured (3) 3L id 3 ph, 3-leg, 6 SCR inside delta (4) 3L_d 3 ph, 3-leg, 6 SCR delta or ungrounded wye (5) 3LgY 3 ph, 3-leg, 6 SCR grounded wye (7)	nonE unconfigured (3)	58 r/w	Active if controller is a 3 phase system which only has one zone. **NOTE: The parameters available are dependent on the controller's input/output configuration. The system does not operate unless this prompt is set to something other than nonE.** **NOTE: Changing this parameter will restart the system.**

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
rAtE	**Maximum Rate of Change (%/100msec)** Set maximum rate of power change of the power level for selected zone when input signal changes.	0.1 to 100.0 0.0 to 100.0% [.1% increments] (1 to 1000)	100.0 (100)	5104 r/w [1] 5204 r/w [2] 5304 r/w [3]	Active unless Input/Output configuration is 3 phase, 2-leg. Active if ALgo is set to Ph2t.
SoFt	**Soft Start Time (Sec)** Selects the time in seconds for the power level of the chosen zone to change from 0% to 100% when the power cycles.	0.0 to 120.0 0.0 to 120 seconds (.1 second increments) (0 to 1200)	4.0 (40)	5105 r/w [1] 5205 r/w [2] 5305 r/w [3]	Active unless Input/Output configuration is 3 phase, 2-leg. Active if ALgo is set to Ph2t.
rdLY	**Reactance Delay for Transformer Loads** Prevents half cycle errors and restarts on inductive loads. Increase value until half cycle errors no longer appear.	0.0 to 5.00 (0 to 500)	0.0 (0)	5108 r/w	Active if ALgo is set to Ph2t and tYPE is set to 3Ld or 3L id.

OPt 1 SEt OPt2 SEt OPt3 SEt ***Setup Options Zones 1, 2, and 3 Menus Setup Page***

This menu is used to set up the options for the chosen zone. This set of menus is available only if Heater Diagnostics is installed.

Zone 1 is used if Input/Output Configuration is single phase, single zone, or three phase.
Zone 1 and Zone 2 are used if Input/Output configuration is single phase, two zones.
All zones are used if Input/Output Configuration is single phase, three zones.

Hbo	**Heater Bakeout Select (On/Off)** Select heater bakeout option for chosen zone.	OFF off (0) On selected (1)	OFF off (0)	5110 r/w [1] 5210 r/w [2] 5310 r/w [3]	Active if heater diagnostics is installed. Active unless controller is 3 phase, 2 leg configuration.
M7 in	**Heater Bakeout Select Time** Selects the heater bakeout time in minutes for chosen zone.	0 to 9999 0 to 9999 minutes [1 minute increments] (0 to 9999)	1440 minutes (1440)	5111 r/w [1] 5211 r/w [2] 5311 r/w [3]	Active if heater diagnostics is installed. Active unless controller is 3 phase, 2 leg configuration. Active if Hbo is set to On.
HbC	**Heater Bakeout Over Current Trip** Sets the maximum heater current during heater bakeout. Output will shut down at this value.	0 to Cur 0 to Load Current Amps [1 Amp increment; maximum will be determined by Load Rating] (0 to Load Current Amps)	10.0% of load current	5116 r/w [1] 5216 r/w [2] 5316 r/w [3]	Active if heater diagnostics is installed. Active unless controller is 3 phase, 2 leg configuration. Active if Hbo is set to On.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
CL i	**Current Limit Select (On/Off)** Selects current limit method for selected zone. Used in phase angle control only.	OFF off (0) On on (1)	OFF off (0)	5112 r/w [1] 5212 r/w [2] 5312 r/w [3]	Active if heater diagnostics is installed. Active unless controller is 3 phase, 2 leg configuration. Active if AL go is set to Ph2t. **NOTE: Changing this parameter will restart the system.**
CL A	**Current Limit Set Point (A)** Selects the current limit set point for current limiting in chosen zone.	0 to CUr 0 to Load Current Amps [1 Amp increment; maximum will be determined by Load Rating] (0 to Load Current Amps)	10.0% of load current	5113 r/w [1] 5213 r/w [2] 5313 r/w [3]	Active if heater diagnostics is installed. Active unless controller is 3 phase, 2 leg configuration. Active if AL go is set to Ph2t and CL i is set to On. **NOTE: Changing this parameter will restart the system.**
tol_	**Low Tolerance Set Point (A)** Set heater tolerance low current set point for the selected zone. Value is current level for 100% requested power and is adjusted actual percentage of requested power.	0 to tol¯ 0 amps to High Tolerance Set Point [1 amp increments] (0 to Heater High Tolerance Set Point)	0 (0)	5114 r/w [1] 5214 r/w [2] 5314 r/w [3]	Active if heater diagnostics is installed. This set point will only be used if the requested power is above 20%.
tol¯	**High Tolerance Set Point (A)** Set heater tolerance high current set point for the selected zone. Value is current level for 100% full on.	tol_ to maximum system current [1 amp increments] (Heater Low Tolerance Set Point to max Load Current rating of the Power Series)	maximum system current	5115 r/w [1] 5215 r/w [2] 5315 r/w [3]	Active if heater diagnostics is installed. This set point will only be used if the requested power is above 20%.
indF	**Inductive Load Factor Request** Requests an inductive load factor adjustment.	Err invalid request (-1) idLE idle (0) rEq request inductive load factor adjustment (1) Act active load factor adjustment (2) CLr clears factor (3)	idLE idle (0)	5106 r/w [1] 5206 r/w [2] 5306 r/w [3]	Active if heater diagnostics is installed. Active unless Input/Output configuration is 3 phase, 2-leg. Active if AL go is set to Ph2t. **NOTE: Selecting Act or CLr will restart the system.**
ICur	**Inductive Current** Sets the actual measured current for an inductive load.	0 to load current rating	Active load current	5107 r/w [1] 5207 r/w [2] 5307 r/w [3]	Active if heater diagnostics is installed. Active unless Input/Output configuration is 3 phase, 2-leg. Active if AL go is set to Ph2t and indF is set to rEq.

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
ALr	***Setup Alarms Configuration Menu***				
SEt	***Setup Page***				
	This menu is used to set up the alarm configuration. For a definition of the alarm types — standard, latched, silenced, latched and silenced, see page 5.7.				
A.LSc	**Active Relay State** Select the relay state on an alarm condition.	ALC energized on alarm (0) ALO de-energized on alarm (1)	ALO de-energized on alarm (1)	850 r/w	Active: Always.
GLbL	**Global Alarm Configuration** Selects global alarm configuration. Configures all alarms to the same type or if set to OFF allows individual alarm configuration.	Std all alarms active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3) OFF off (4)	Std all alarms active (0)	851 r/w	Active: Always.
OPEn	**Heater Open Alarm Config.** Select heater open alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	860 r/w	Active if heater diagnostics is installed. Active if GLbL is set to OFF.
tol	**Heater Tolerance Alarm Config.** Selects heater tolerance alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	861 r/w	Active if heater diagnostics is installed. Active if GLbL is set to OFF.
Ot	**Heat Sink Over Temperature Alarm Config.** Select over temperature alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	862 r/w	Active if GLbL is set to OFF.
ALt	**Heat Sink Over Temperature Alarm Temperature** Select heat sink overtemp alarm configuration.	0 to SdC	Value equal to SdC or less. User adjustable. See Factory Menu for actual safety shutdown temp.	990 r/w	Active: Always. Output will de-energize at this heatsink shut down temperature (degrees C). The default maximum temperature is model number dependent.
LinE	**Line Loss Alarm Configuration** Selects the line loss alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	863 r/w	Active if GLbL is set to OFF.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
P.bAL	**Phase Balance Alarm Config.** Select phase balance configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	864 r/w	Active if controller is 3 phase, 3-leg configuration. Active if GLbL is set to OFF.
LbAL	**Load Balance Alarm Config.** Selects the load balance alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	865 r/w	Active if heater diagnostics is installed. Active if GLbL is set to OFF. Active if controller is 3 phase.
Ld.F	**Load Balance Percentage** Selects the minimum percentage difference between loads current in phases.	0 to 100 (0 to 100)	100 (100)	991 r/w	Active if heater diagnostics is installed. Active if controller is 3 phase.
FrEQ	**Frequency Out of Tolerance Alarm Configuration** Select frequency tolerance alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	866 r/w	Active if GLbL is set to OFF.
UC	**Voltage Compensation Alarm Config.** Selects the line compensation alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	867 r/w	Active if GLbL is set to OFF.
OU	**Over Voltage Alarm Config.** Selects the line overvoltage alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	868 r/w	Active if GLbL is set to OFF.
C.LJd	**Comms Watchdog Alarm Config.** Selects the communications watchdog alarm configuration.	Std active (0) LAt latched (1) SIL silenced (2) LASI latched and silenced (3)	Std active (0)	869 r/w	Active if communications is installed. Active if GLbL is set to OFF.

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Register read/write	Conditions for Parameters to Appear
COMM	***Setup Comms Configuration Menu***				
SEt	***Setup Page***				
	This menu is used to set up the communications parameters. This menu is not available unless Serial Communications is installed.				
Addr	**Unit Address Select** Select device address for communications.	1 to 247	1		Active if serial communications option is installed.
bAud	**Unit Baud Rate Select** Select baud rate for communications.	1200 1200 baud 2400 2400 baud 4800 4800 baud 9600 9600 baud 19.2 19.2K baud	9600 9600 baud		Active if serial communications option is installed.
uJd	**Watchdog Select (On/Off)** Turns on a watchdog for communications.	OFF off (0) On on (1)	OFF off (0)	85 r/w	Active if serial communications option is installed.
SEC	**Watchdog Timeout (Sec)** Selects a timeout in seconds for the communications watchdog.	0 to 9999 (0 to 9999)	9999 (9999)	86 r/w	Active if serial communications option is installed and uJd Watchdog is set to On.
PuJr	**Watchdog Failure Output Power Select** Selects the default power level for a watchdog timeout.	0.0 0 percent to 100.0 100 percent (0 to 1000)	0.0 0 percent (0)	87 r/w	Active if serial communications option is installed and uJd Watchdog is set to On.
rEtr	***Setup Retransmit Configuration Menu***				
SEt	***Setup Page***				
	This menu is used to set up the retransmit parameters. The menu is not available unless Retransmit and Heater Diagnostics are installed.				
CFG	**Retransmit Config. Select** Select type of retransmit output.	mA mA (0) VOLt volts (1)	mA mA (0)	870 r/w	Active if retransmit and heater diagnostics options are installed.
tYPE	**Retransmit Type Select** Select type of retransmit information; amps or kVA.	OFF none (0) CUr current (1) HUA kVA (2)	CUr current (1)	871 r/w	Active if retransmit and heater diagnostics options are installed.

Display	Parameter	Range (Modbus Value)	Default	Modbus Register read/write	Conditions for Parameters to Appear
PHAS	**Retransmit Phase Select** Select the phase with information to be retransmitted.	1 phase 1 (1) 2 phase 2 (2) 3 phase 3 (3)	1 phase 1 (1)	872 r/w	Active if retransmit and heater diagnostics options are installed. Active if controller is three phase. Active if rEtr ▶ tYPE is set to CUr or HUA.
ZonE	**Retransmit Zone Select** Select the zone with information to be retransmitted.	1 zone1 (1) 2 zone2 (2) 3 zone3 (3)	1 zone1 (1)	873 r/w	Active if retransmit and heater diagnostics options are installed. Active if controller is multi zone. Active if rEtr ▶ tYPE is set to CUr or HUA.
CUr_	**Minimum Amps Retransmit** Select minimum load current to be retransmitted.	0 to CUr¯ (0 to Maximum Amps Retransmit)	00 (0)	876 r/w	Active if retransmit and heater diagnostics options are installed. Active if rEtr ▶ tYPE is set to CUr.
CUr¯	**Maximum Amps Retransmit** Select maximum load current to be retransmitted.	CUr_ to load current (Minimum Amps Retransmit to load current)	load current	877 r/w	Active if retransmit and heater diagnostics options are installed. Active if rEtr ▶ tYPE is set to CUr.
HUA_	**Minimum kVA Retransmit** Select minimum load power to be retransmitted.	0 to HUA¯ (0 to Maximum kVA Retransmit)	0 (0)	878 r/w	Active if retransmit and heater diagnostics options are installed. Active if rEtr ▶ tYPE is set to HUA.
HUA¯	**Maximum kVA Retransmit** Select maximum load power to be retransmitted.	HUA_ to 9999 (Minimum kVA Retransmit to 9999)	9999 (9999)	879 r/w	Active if retransmit and heater diagnostics options are installed. Active if rEtr ▶ tYPE is set to HUA.
rt.C_	**Retransmit Output Low Current (mA)** Select output current that will correspond to CUr_ or HUA_.	0.00 to rt.C¯ (0 to Retransmit Output High Current)	0 (0)	882 r/w	Active if retransmit and heater diagnostics options are installed. Active if CFG is set to nonA.
rt.C¯	**Retransmit Output High Current (mA)** Select output current that will correspond to CUr¯ or HUA¯.	rt.C_ to 20.00 (Retransmit Output Low Current to 2000)	20.00 (2000)	883 r/w	Active if retransmit and heater diagnostics options are installed. Active if CFG is set to nonA.

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range	Default	Modbus Address read/write	Conditions for Parameters to Appear
rt.U_	**Retransmit Output Low Voltage (Volts)** Select voltage that will correspond to Cur or HUA.	0.00 to rt U (0 to Retransmit Output High Voltage)	0 (0)	880 r/w	Active if retransmit and heater diagnostics options are installed. Active if CFG is set to Volt.
rt.U	**Retransmit Output High Voltage (Volts)** Select voltage that will correspond to Cur or HUA.	rt U_ to 10.00 (Retransmit Output Low Voltage to 1000)	10.00 (1000)	881 r/w	Active if retransmit and heater diagnostics options are installed. Active if CFG is set to Volt.

Factory Page

To enter the Factory Page, press the Home, Left and Right keys (■ ◄ ►) together while in the Setup Page. Each of the following menus in the Factory Page are selected by pressing the Increment/Decrement keys (▲ ▼). Each press of the button will scroll you up or down through these main menu options.

To select a parameter within a menu, use the Left/Right arrow keys (◄ ►). The parameter appears in the bottom display.

To select a value for each parameter (either alpha or numeric), use the Increment/Decrement keys (▲ ▼). The value appears in the upper display.

Pressing the Home key (■) in this menu will return you to the Display Loop.

The Factory Page contains nine menus.

The Factory Mode parameters of the Factory Page are used for calibration of the Power Series. Since the Power Series is precalibrated at the factory; field calibration may only be necessary in the event that field service work is performed. Field calibration procedures are available at Watlow's website, http://www.watlow.com/.

*__NOTE: To enter the Factory Mode requires a password. Call Watlow at +1 (507) 454-5300, and ask an applications engineer for this password. Once the password is entered, the controller is in Factory Mode. The controller's power must be cycled to exit the Factory Mode.__

FctY **Factory Page**
Go to a factory menu.

Factory Mode ->
Requires factory password to access calibration parameters.

- dAtA System Data Manipulation
- Loc Global/Menu Lockouts
- InFo Unit Information
- diAG Diagnostics
- PUJ Factory Password
- C In1 Calibrate Analog Input Signal Zone 1*
- C In2 Calibrate Analog Input Signal Zone 2*
- C In3 Calibrate Analog Input Signal Zone 3*
- C rtr Calibrate Retransmit*

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
dAtA	***System Data Manipulation Menu***				
FctY	***Factory Page***				
	This menu is used to maintain the standard and backup system data.				
bAuP	**Backup Data Set*** Stores appropriate user configurable parameters into backup memory. See page A.7 for Power Series Backup information.	idLE no backup requested (0) ALL all parameters listed in system, zone 1, 2 and 3 (1) SYS system related parameters, includes locks, alarms, retransmit, comms, algorithm, load type, voltage compensation (2) Zn 1 zone 1 related parameters, includes all parameters in menus CtrL 1 and OPt 1 (3) Zn 2 zone 2 related parameters, includes all parameters in menus CtrL2 and OPt2 (4) Zn 3 zone 3 related parameters, includes all parameters in menus CtrL3 and OPt3 (5)	idLE no backup requested (0)	951 r/w	Active: Always.
dFLt	**Default Data Set*** Sets the appropriate parameters to the factory default values. See page A.7 for Power Series Backup information.	idLE (0) ALL (1) SYS (2) Zn 1 (3) Zn 2 (4) Zn 3 (5) **NOTE: See "Backup Data Set" above for description of the Modbus values 0 - 5.**	idLE disable restore (0)	952 r/w	Active: Always.
rESt	**Restore Data Set*** Restores the appropriate user configurable parameters from backup memory. See page A.7 for Power Series Backup information.	idLE (0) ALL (1) SYS (2) Zn 1 (3) Zn 2 (4) Zn 3 (5) **NOTE: See "Backup Data Set" above for description of the Modbus values 0 - 5.**	idLE disable restore (0)	950 r/w	Active: Always.

***NOTE: These prompts (Backup, Default, and Restore Data Set) allow the user to manipulate the EEPROM contents. See Appendix, p. A.7, for more information.**

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
nUOL	**Enable NVOL Storage** Enable/disable non-volatile memory.	On enable (0) OFF disable (1)	On (0)	959 r/w	Active: Always.

LOC *Global/Menu Lockouts Menu*
FctY *Factory Page*

This menu is used to set the lockout parameters. Locked means that the parameters in the menu cannot be changed.

GLOC	**Global Lockout** Sets the state of global lockout which allows all prompts to be write protected. If set to unlocked, individual menu locks can be set.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1350 r/w	Active: Always.
CtrL	**Control Setup Menus Lockout** Sets lock on all control setup menus.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1351 r/w	Active if GLOC is set to UnL.
OPt	**Options Setup Menus Lockout** Sets lock on all options setup menus.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1352 r/w	Active if GLOC is set to UnL. Active if heater diagnostics option is installed.
ALr	**Alarms Setup Menu Lockout** Sets lock on alarm configuration menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1353 r/w	Active if GLOC is set to UnL.
COM	**Comms Setup Menu Lockout** Sets lock on communications menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1354 r/w	Active if GLOC is set to UnL. Active if serial communications option is installed.
rEtr	**Retransmit Setup Menu Lockout** Sets lock on retransmit menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1355 r/w	Active if GLOC is set to UnL. Active if retransmit and heater diagnostics options are installed.
C In	**Analog Input Factory Menus Lockout** Sets lock on input calibration menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1356 r/w	Active if GLOC is set to UnL.
C rtr	**Retransmit Cal Factory Menu Lockout** Sets lock on retransmit calibration menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1357 r/w	Active if GLOC is set to UnL. Active if retransmit and heater diagnostics options are installed.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
dAtA	**System Data Factory Menu Lockout** Sets lock on system data menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1358 r/w	Active if 9LOC is set to UnL.
d iAG	**Diagnostics Factory Menu Lockout** Sets lock on diagnostics menu.	UnL Unlocked (0) LOC Locked (1)	UnL (0)	1359 r/w	Active if 9LOC is set to UnL.

InFo ***Unit Information Menu***
FctY ***Factory Page***

This menu is used to read unit information that is stored during manufacture.

Sn^	**Unit Serial Number High Digits** Reads the high digits of the serial number of the unit.	0 to 9999 (0 to 9999)	n/a	1 r	Active: Always.
Sn_	**Unit Serial Number Low Digits** Reads the low digits of the serial number of the unit.	0 to 9999 (0 to 9999)	n/a	2 r	Active: Always.
dAtE	**Manufactured Date (yymm)** Reads month and year of manufacture.	00 to 99 year (00 to 99) 00 to 99 month (00 to 52)	n/a	5 r	Active: Always.
HUEr	**Hardware Version** Reads hardware version of the unit.	0.0 to 9.999 (0 to 9999)	n/a	7 r	Active: Always.
SUEr	**Software Version** Reads software version of the unit.	0.0 to 9.999 (0 to 9999)	n/a	4 r	Active: Always.
Sbld	**Software Build Number** Reads software build level of the unit.	0.0 to 9.999 (0 to 9999)	n/a	30 r	Active: Always.
rAtU	**Unit Voltage Rating (Volts)** Reads load voltage of the unit.	0 to 680 (0 to 680)	n/a	51 r	Active: Always.

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
rAtA	**Unit Current Rating (Amps)** Reads load current of the unit.	0 to 245 (0 to 245)	n/a	50 r	Active: Always.
Zonc	**Number Zones Configured** Reads the number of zones that are configured.	1 single zone (1) 2 two zone (2) 3 three zone (3)	n/a	52 r	Active: Always.
OPt	**Configuration Installed Options** Reads the configuration of the hardware options.	nOnE none (0) c comms (1) r retransmit (2) rc comms/retransmit (3) h heater diagnostics (4) h c heater diagnostics/comms (5) hr heater diagnostics/retransmit (6) hrc heater diagnostics/comms/retransmit 2 (7)	n/a	54 r	Active: Always.
C	**Heat Sink Temp (°C)** Reads the current heat sink temp.	0 to 9999 (0 to 9999)	n/a	1590 r	Active: Always.
ALC	**Heat Sink Alarm Temp** Set the set point for the heat sink over temp alarm.	0 to SdC	n/a	990 r/w	Active: Always. Same as alarm temp in Setup Menu.
SdC	**Factory Safety Shutdown Temp** Indicates set point for factory safety shutdown.	Factory set.	n/a	57 r	Active: Always.
H iC	**Record High Heat Sink Temp** Indicates record high heat sink temp.	0 to 9999 (0 to 9999)	n/a	1591 r	Active: Always.
HrS"	**Accum Hours (10K - 100M)** Indicates accumulated system operating time (hours x 10000).	0 to 9999 (0 to 9999)	n/a	1960 r	Active: Always. Masked if hours <10000
HrS_	**Accum Hours (0 - 9999)** Accumulated system operating time (hours).	0 to 9999 (0 to 9999)	n/a	1961 r	Active: Always.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
d iAG	***Diagnostics Menu***				
FctY	***Factory Page***				
	This menu is to select diagnostics.				
Ad	**Select A/D Channel** Selects an analog to digital channel to read.	UrEF voltage reference input* tMMP heat sink temp input* A In 1 analog input 1* A In2 analog input 2* A In3 analog input 3* UoL 1 voltage input1* UoL2 voltage input2* UoL3 voltage input3* CUr 1 positive current input 1* CUr2 positive current input 2* CUr3 positive current input 3* CUr 1 negative current input 1* CUr2 negative current input 2* CUr3 negative current input 3* * Values 0 to 4095		1560 r 1561 r 1562 r 1563 r 1564 r 1565 r 1566 r 1567 r 1568 r 1569 r 1570 r 1571 r 1572 r 1573 r	Active: Always.
CntS	**Read Selected A/D Counts** Reads the selected analog to digital channel.	0 to 4095	n/a	n/a	Active: Always.
	Line Loss Alarms: The following nine parameters indicate line loss alarms that have occurred since power was last cycled. The parameters will only appear if there has been a line loss alarm and only for the line/s on which a line loss alarm has occurred. They will continue to appear until power is cycled again.				
L_A1	**Most Recent Line Loss Alarm Type**	uUOL (1) under voltage A .Cr (2) extra zero cross n .Cr (4) no zero cross POL (8) invalid line polarity n .Cr (16) no zero cross FrE9 (32) invalid frequency HCYC (64) load half cycle loss	nonE (0)	1540 r 1543 r 1546 r	Active for line on which line loss alarm has occurred since power cycle.
L_A2	**Previous Line Loss Alarm Type**			1541 r 1544 r 1547 r	
L_A3	**Least Recent Line Loss Alarm Type**			1542 r 1545 r 1548 r	
L_	indicates which phase 1, 2 or 3 experienced the alarm				

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Control Methods and Features.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
disP	**Display Test** Requests a display test.	idLE idle (0) rES enable display test (1)	idLE idle (0)	1513 r/w	Active: Always.
In	**Select Discrete Input** Requests a display of the state of the chosen input.	nonE (0) POS1 (1) POS2 (2) POS3 (3) OCr1 (4) OCr2 (5) OCr3 (6)	nonE (0)	1580 r/w	Active: Always. Factory mode only for write.
VAL	**Read Selected Input Value**	LO lo (0) HI hi (1) ---- undeterminate (2)	----	1581 r	Active if In is not set to nonE.
rEtr	**Retransmit Set Test Word** Sets retransmit test count.	0 to 4095 (0 to 4095)	0 (0)	1555 r/w	Active if retransmit option is installed. Factory mode only for write.

Factory Mode

The Factory Mode parameters of the Factory Page are used for calibration of the Power Series. Since the Power Series is precalibrated at the factory, field calibration may only be necessary in the event that field service work is performed. Field calibration procedures are available at Watlow's website, http://www.watlow.com/.

NOTE: To enter the Factory Mode requires a password. Call Watlow at +1 (507) 454-5300, and ask an applications engineer for this password. Once the password is entered, the controller is in Factory Mode. The controller's power must be cycled to exit the Factory Mode.

PWd ***Factory Password***
FCty ***Factory Page***

This menu is used to set the password for the Power Series' Factory Mode.

PWd	**Factory Password Entry** Enter factory password.	0 to 9999 (0 to 9999)	1234	1799 r/w	Active: Always.
FCty	**Factory Mode Request** Requests factory mode based on value set in Factory Password prompt.	OFF idle (0) rES request factory mode (1) Act factory mode active (2)	OFF idle (0)	1700 r/w	Active if factory password is valid.

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
[C In1] [C In2] [C In3] [FctY] [FctY] [FctY]	***Calibrate Analog Input Signal Zones 1, 2, and 3 Menus*** ***Factory Page***				
	This menu is used to set up the analog inputs. ***Input 1 is used if Input/Output Configuration is single phase, single zone or three phase.*** ***Input 1 and Input 2 are used if Input/Output Configuration is single phase, two zones.*** ***All zones are used if Input/Output Configuration is single phase, three zones.***				
	NOTE: Care should be taken to allow a buffer between each of the settings and their respective hardware limits to prevent unexpected operation because of noise or signal variations.				
[mnA_]	**Low mA Cal Point** Sets the low current value for the corresponding analog input calibration.	[0.000] to [mnA¯] [or [9.999] whichever is smaller] (0 to High mA Cal Point [or 9999])	[4.000] (4000)	5411 r/w [1] 5421 r/w [2] 5431 r/w [3]	Active if in factory mode.
[mnA¯]	**High mA Cal Point** Sets the high current value for the corresponding analog input calibration.	[mnA_] to [20.00] (Low mA Cal Point to 20000)*	[16.00] (16000)	5412 r/w [1] 5422 r/w [2] 5432 r/w [3]	Active if in factory mode.
	*NOTE: The display prompts are set to two decimal places because of the resolution of the display. The comms registers are set and stored with three decimal places of resolution.				
[UoL_]	**Low V Cal Point** Sets the low voltage value for the corresponding analog input calibration.	[0.000] to [UOL¯] (0 to High V Cal Point)	[1.000] (1000)	5413 r/w [1] 5423 r/w [2] 5433 r/w [3]	Active if in factory mode.
[UoL¯]	**High V Cal Point** Sets the high voltage value for the corresponding analog input calibration.	[UoL_] to [9.999] (Low V Cal Point to 9999)	[9.000] (9000)	5414 r/w [1] 5424 r/w [2] 5434 r/w [3]	Active if in factory mode.
[CALA]	**Calibrate Analog Input Request** Request analog input signal calibration.	[Err] invalid calibration (-1) [idLE] calibration inactive (0) [rEq] enables calibration request (1)	[idLE] calibration inactive (0)	5415 r/w [1] 5425 r/w [2] 5435 r/w [3]	Active if in factory mode.
	✔ **NOTE: The values entered in the preceding prompts are used with the corresponding analog to digital counts. The parameter [Err] will be displayed if the calibrations fails; otherwise the parameter will return to [idLE].**				
	NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Features.				

Display	Parameter	Range (Modbus Value)	Default	Modbus Address read/write	Conditions for Parameters to Appear
C rtr	***Calibrate Retransmit Menu***				
FctY	***Factory Page***				
	This menu is used to calibrate the retransmit output. This menu is available if Retransmit is installed.				
nnA_	**Retransmit Cal mA Low** Selects the low current value for retransmit cal.	0.000 to nnA¯ [or 9.999 whichever is smaller] (0 to Retransmit Cal mA High [or 9999])	4.000 (4000)	5710 r/w	Active if in factory mode. Active if retransmit option is installed.
nnA¯	**Retransmit Cal mA High** Set the high current value for retransmit cal.	nnA_ to 20.00 (Retransmit Cal mA Low to 20000)*	16.00 (16000)	5711 r/w	Active if in factory mode. Active if retransmit option is installed.
UoL_	**Retransmit Cal Volts Low** Set the low voltage value for retransmit cal.	0 to UOL¯ (0 to Retransmit Cal Volts High)	1.000 (1000)	5720 r/w	Active if in factory mode. Active if retransmit option is installed.
UoL¯	**Retransmit Cal Volts High** Set the high voltage value for retransmit cal.	UOL_ to 9.999 (Retransmit Cal Volts Low to 9999)	9.000 (9000)	5721 r/w	Active if in factory mode. Active if retransmit option is installed.
CALr	**Cal Retransmit Request** Request a retransmit calibration.	Err invalid calibration (-1) idLE calibration inactive (0) rEQ enables calibration request (1)	idLE calibration inactive (0)	5700 r/w	Active if in factory mode. Active if retransmit option is installed.

***NOTE: The display prompts are set to two decimal places because of the resolution of the display. The comms registers are set and stored with three decimal places of resolution.**

NOTE: For more information about how parameter settings affect the controller's operation, see Chapter Five, Features.

A

Appendix

Troubleshooting

All Units

Indication	Probable Cause	Corrective Action
No LED Display	• Controller power not present.	• Insure that the unit is plugged in and the power is on.
	• Display not seated properly.	• Check the display to make sure it is flush with plastic.
	• Bent or broken pins.	• Pull off the display and check the connection pins; repair or replace if necessary.
	• Faulty (malfunctioning) unit.	• Return the unit to the factory for repair.
Display Locked	• System error.	• Record error and address the cause of the error.
	• System error (no problem found).	• Record error and cycle controller power. If the problem persists, contact factory for assistance.
	• System error not displayed.	• Cycle controller power. If the problem persists, contact factory for assistance or return the unit to the factory for repair.
	• Alarm.	• Record alarm and address the cause of the alarm.
	• Alarm (no problem found).	• Record alarm and cycle controller power. If the problem persists, contact the factory for assistance.
No Heat	• Heater or load wire is not connected.	• Check the load or load wire; connect if necessary.
	• Blown fuse.	• Check the fuses and replace any if necessary.
	• SEt > AL9o is set to OFF.	• See page 6.5 to set power control algorithm.
	• Incorrect input wiring.	• Check the input wiring and ensure that it is connected properly. (See pages 3.2-3.3 for wiring.) Input can be monitored with In parameter in the Display Loop. With keyboard control, test by increasing output by % and checking for heat. **Be careful to not over heat anything.**
	• Line not connected or off, or the voltage is too low. Controller will indicate ALr (Line Loss Alarm) LinE.	• Insure that line power is connected and is on at the appropriate voltage.
	• Internal malfunction (core PCB, open SCR, gate drive inoperative, core to power supply and LM connection, power supply and line monitor PCB not seated properly on SCR).	• Return the unit to the factory for repair.
Partial Heat	• Line input voltage low.	• Insure that line power is connected and is on at the appropriate voltage. • Return the unit to the factory for repair.
Full or Partial Uncontrollable Heat	• Shorted SCR.	• If the controller has heater diagnostics installed, a shorted SCR will cause an error and shut down the remaining good SCRs. Return the unit to the factory for repair. If the controller does not have heater diagnostics installed, if output power (%) Out reads 0.0 and there is power to the heater, the SCR is shorted; return the unit to the factory for repair.
	• Input out of calibration.	• With input signal set for 0% power, check output power display; if it is not 0.0, check calibration. With input signal set for 100% power, check output power display; if it is not 100.0, check calibration.
	• Internal malfunction.	• Return the unit to the factory for repair.

All Units (continued)

Indication	Probable Cause	Corrective Action
Frequent Nuisance Fuse Blowing	• Improper fuse current rating.	• Refer to page 2.1; insure the fuses have the correct current rating.
	• Fuses improperly torqued.	• Refer to page A.6 for guidelines on proper torquing of fuses.
	• Inadequate ventilation or cooling in the cabinet.	• Refer to page 2.3 for enclosure guidelines and how to determine how much cooling is required.
	• Intermittent short in heater.	• Replace heater.

Single Phase Units

Indication	Probable Cause	Corrective Action
No Heat	• Power not routed through the internal bussbar. Controller will indicate [ALr] [LinE] (Line Loss Alarm).	• If power is not routed through or connected to the internal bussbar, Ref. 2 must be connected to another line or to neutral. (See page 3.4 for wiring.)

Multizone Units

Indication	Probable Cause	Corrective Action
No Heat	• Reference not connected.	• Reference connections to other lines or neutral must be made appropriately for each zone. (See page 3.5 for wiring.)
No current monitor on the display.	• Two phases are 180° out of phase of each other.	• When using the multizone feature, the 2 or 3 zones should be wired so that no two phases are 180° out of phase. See wiring diagram page 3.5, Figure 3.5C.

3 Phase, 2-Leg Units

Indication	Probable Cause	Corrective Action
No Heat	• Power not routed through the internal bussbar. Controller will indicate [ALr] [LinE] (Line Loss Alarm).	• If power is not routed through or connected to the internal bussbar, Ref. 1 or 3 (not both) must be connected to middle line. (See page 3.4 for wiring.)
	• Load Type Select [tYPE] for 3 phase is set to unconfigured [nonE].	• In the Setup Page, Setup Control Zone 1 menu, select the load type for Zone 1.

3 Phase, 3-Leg Units

Indication	Probable Cause	Corrective Action
No Heat	• Reference is not connected for 3 phase, 3-leg grounded wye unit.	• For 3 phase, 3 grounded wye models only, reference connections must be connected to neutral. (See page 3.5 for wiring.)
	• Load Type Select [tYPE] for 3 phase is set to unconfigured [nonE].	• In the Setup Page, Setup Control Zone 1 menu, select the load type for Zone 1.
Phase angle control ramps output power up, develops a [hCYL] error and shuts down	• Inductive load causing half cycle line loss errors [hCYL] . Reactance delay [rdLY] is set too low.	• Increase [rdLY] value until the half cycle line loss errors no longer occur..

Troubleshooting Alarms and Errors

Alarm / Error	Condition For Alarm or Error To Occur	
Alarms	Any alarms that are active will be represented in binary. As an example, if a Comms Watchdog and a Phase Balance Alarm exists, Modbus register 180 will contain 0x0210. Comms Watchdog = 0000001000000000 Phase Balance = 0000000000010000	Heater Open = 0x0001 Heater Tolerance = 0x0002 Over Temperature = 0x0004 Line Loss = 0x0008 Phase Balance = 0x0010 Load Balance = 0x0020 Frequency = 0x0040 Voltage Compensation = 0x0080 Over Voltage = 0x0100 Comms Watchdog = 0x0200
Heater Open Alarm	Alarm will occur when ≤ 2amps is detected (as measured by the Power Series) for > 20% requested power.	
Heater Tolerance Alarm	Alarm will occur when the load current detected is less than the value set in the Setup Page > Options Menu > tol_ or is greater than the value set in tol^. This will accomplish both the overcurrent condition alarm and the heater failure low current alarm. This will only occur if requested power is greater than 20 percent.	
Heat Sink Over Temperature Alarm	Alarm will occur when the heat sink temperature is greater than the value set in the Setup Page > Alr > ALt.	
Line Loss Alarm	Alarm will occur when the zero cross signal does not occur. Caused by loss of line polarity, zero cross or voltage level signal. Also caused by zero cross timing out of tolerance. This alarm will also occur when line voltage is < one-half baseline voltage.	
Phase Balance Alarm	Alarm will occur when measured voltage of one phase of a 3 phase, 3-leg system is > 20% different from any other.	
Load Balance Alarm	Alarm will occur when the load current is determined to be out of balance. User specified in the Setup Page > Alr > Ld iF. Default to 100%.	
Frequency Out of Tolerance Alarm	Alarm will occur if frequency is not within 47 to 63 Hz.	
Line Compensation Alarm	Alarm will occur if the voltage compensation routines cannot compensate for input line voltage changes; occurs for requested power from 5% to 95%, UrtB, Ph2t control if UC = On.	
Line Over Voltage Alarm	Alarm will occur if the line voltage is greater than the maximum rated voltage of the device. Caused by line voltage being over line voltage rating +10%.	
Communications Watchdog Alarm	Alarm will occur if no communications is detected for time specified in Out Watchdog timeout. Not available unless Serial Communications is installed.	

	Shut-down	Auto Recovery	Modbus Number	Corrective Action
	See individual alarms below.	**See individual alarms below.**	**180 r**	See individual alarms below for recommendations.
	No		**181 r/w (0-4)***	Check wiring connections from load terminal to heater and heater return. Replace heater if necessary.
	No		**182 r/w (2) (0-4)***	Check wiring connections from load terminal to heater and heater return. Verify adequate wire size. Replace heater if necessary.
	No		**183 r/w (4) (0-4)***	Provide more cabinet ventilation or cooling. Check the fan; if faulty, return to the factory for repair. Check to see that the heat sink is clean. If necessary increase heat sink over temperature value if it is below factory safety shutdown temperature. Return to factory for SCR voltage drop and thermistor evaluation.
	Yes	**Yes**	**184 r/w (8) (0-4)***	Check the line for high noise level and check wiring connections. Possible line sense circuitry error, return to factory for repair. Check FctY -> d iAG for L 1A 1, L2A 1, or L3A 1, to determine the type and location of the line loss. uUoL can be caused by line voltage < one-half baseline voltage. A .Cr can be caused by noisy line supplies. n .Cr can be caused by a missing line. POL can be caused by a line half cycle or a missing line. FrEQ can be caused by noisy line supplies. HCYC only active with heater diagnostics installed and indicates a half cycle loss detected in the load; can be caused by SCR non-conduction.
	Yes if PhSt	**Yes**	**185 r/w (0-4)***	Insure that the line voltage is the same for each phase. If line voltages are the same, check line voltages calibrations.
	Yes if Ld iF	**Yes**	**186 r/w (0-4)***	Address load balance on heaters.
	No		**187 r/w (0-4)***	Check the power supply line frequency. Power Series will not operate reliably outside 47 to 63 Hz. specification.
	No		**188 r/w (0-4)***	Check for major line voltage fluctuations.
	No		**189 r/w (0-4)***	Lower line voltage or damage to the unit may occur.
	Yes	**No**	**190 r/w (0-4)***	Insure that the source of communications to the unit is communicating without long interruptions. Verify the integrity of the communications signals from the controlling device. Return to the factory for repair.

***Inactive - 0, Active - 1, Latched Active - 2, Latched Inactive - 3, Unlatched - 4**

Alarm / Error	Condition For Alarm or Error To Occur	
Err **System Errors**	Any system-level errors that are active will be represented in binary. As an example, if the power source is losing half cycles and an over temperature condition exists, Modbus register 195 will contain 0x00C0. Over temperature Error = 0000000001000000 Half Cycle Loss = 0000000010000000	Heater Bakeout Overcurrent = 0x0001 SCR Short = 0x0002 System Configuration = 0x0004 AD Reference Fail = 0x0008 Checksum Error = 0x0010 Ram Error = 0x0020 Over Temperature Error = 0x0040 Half Cycle Loss = 0x0080 Phase Rotation = 0x0100
Err HbOC **Heater Bakeout Overcurrent Error**	Error will occur when the maximum heater current during heater bakeout has been exceeded.	
Err ShrE **Shorted SCR Error**	The shorted SCR error is detected by measuring current when the SCR is de-energized and comparing this reading to the current measured when the SCR is energized. A shorted SCR error is activated if the de-energized current reading is at least 10A and 25% or more of the energized current reading.	
Err Ad **Analog to Digital Failure Error**	Analog to digital failure error.	
Err ChE **Checksum Error**	Invalid checksum in non-volatile memory error.	
Err rAM **Ram Error**	Error will occur when RAM failure is detected.	
Err Ot **Over Temperature Error**	Error will occur when heat sink temperature is greater than factory shutdown temperature SdC.	
Err HCyL **Half Cycle Line Loss Error**	Error will occur if a load half cycle loss is detected during five consecutive zone restart attempts.	
Err P.rOt **Phase Rotation Error**	Incorrect phasing. Error will occur on a three-phase system with a 3L d load or on a multizone (PC8 and PC9) operating on a three-phase power supply under phase angle control if the phasing is incorrect. Must be A,B,C phase rotation (CW).	

Checking and Replacing Fuses

Ensure that all high voltage power is off. Slide the fuse cover down. Using an ohmmeter, measure the dc resistance of the fuse to determine if it is open. (Typical dc resistance is less than 1 ohm.)

If fuse is open, replace it by removing the old fuse using a 1/2 inch socket and a #3 Phillips screwdriver. Be careful not to drop washers off the bolt or screw ends. If they have dropped into the case, shake them out gently.

The bolt will have 2 washers. The bottom machine screw will have 2 or 3 washers, depending on the size of the SCR in the unit. **It is important that the washers are replaced in the exact order in which they were removed.** Take care installing the fuse so that its orientation matches the image that is printed on the PC board.

With the new Cooper Bussman fuse in the unit, torque the bolt to 44 inch-pounds and the screw as follows: For models PXX-F20X-XXXX and PXX-N20X-XXXX torque to 26 in.-lbs. (2.93 Nm.). For models PXX-F25X-XXXX, PXX-N25X-XXXX, PXX-F30X-XXXX, PXX-F35X-XXXX, and PXX-N30X-XXXX, torque to 44 in.-lbs. (4.95 Nm.). Close fuse cover. If unit was taken off the wall, observe all terminal torque specs when reconnecting wires. Unit should now be ready to resume operation. Reapply power to the controller and line/load terminals.

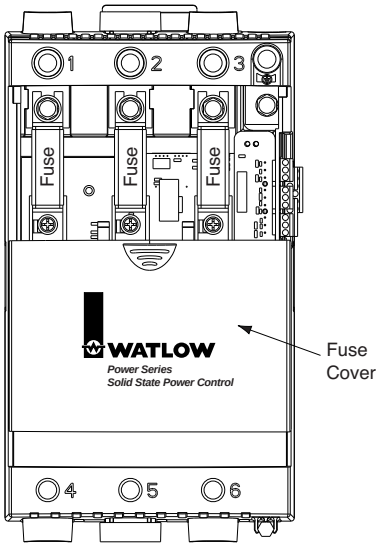


Figure A.6 — Fuse location.

Note: The fuse must be a Cooper Bussman to retain SCCR rating.

	Shut-down	Auto Recovery	Modbus Number	Corrective Action
	Yes	**No**	**195 r**	See individual errors below for recommendations.
	Yes	**No**	**195 r, (1)**	It's likely the heater is too wet for heater bakeout time selected. Increase heater bakeout time, cycle power to restart heater bakeout process.
	Yes	**No**	**195 r, (2)**	Check output with test instrument while Power (%) [OUt] is at [0.0]. If there is an output, return to the factory for a new SCR. If there is no output, check current calibration.
	Yes	**No**	**195 r, (4)**	Cycle control power. If problem persists, return to factory for repair.
	Yes	**No**	**195 r, (8)**	Cycle control power. If problem persists, return to factory for repair.
	Yes	**No**	**195 r, (16)**	Cycle control power. If problem persists, return to factory for repair.
	Yes	**No**	**195 r, (32)**	Cycle control power. If problem persists, return to factory for repair.
	Yes	**No**	**195 r, (64)**	Provide more cabinet ventilation or cooling. Check the fan; if faulty, return to factory for repair. Check to see that the heat sink is clean. Cycle control power to clear error. Return to factory for SCR voltage drop and thermistor evaluation.
	Yes	**No**	**195 r, (128)**	Line voltage is losing half cycles or SCR is not gating properly. If load is inductive, increase [rdLY] until error no longer occurs. Cycle control power to clear error.
	Yes	**No**	**195 r, (256)**	Three phase power is connected with incorrect phasing. Swap any two incoming phases. Cycle control power to clear error message.

Power Series Backup

There are three prompts which allow the user to manipulate the EEPROM contents: Backup Data Set, Default Data Set, and Restore Data Set. Each of these prompts have a choice of [ALL], [595], [2o 1], [2o 2], or [2o 3].

There are two sets of data stored in the controller; the first is the User EEPROM and it is what is read on every power on. The second is the Backup EEPROM.

The Default Data Set prompt will update the chosen configuration parameters in the User EEPROM to values that are listed in the manual as default. It will update the chosen input and retransmit calibration parameters in the User EEPROM to the values that are stored in the Backup EEPROM by the factory.

The Backup Data Set prompt will update the chosen configuration parameters in the Backup EEPROM from the current values stored in the User EEPROM. It will NOT overwrite the calibration parameters.

The Restore Data Set prompt will update the chosen configuration parameters in the User EEPROM from the current values stored in the Backup EEPROM. It will NOT overwrite the calibration parameters.

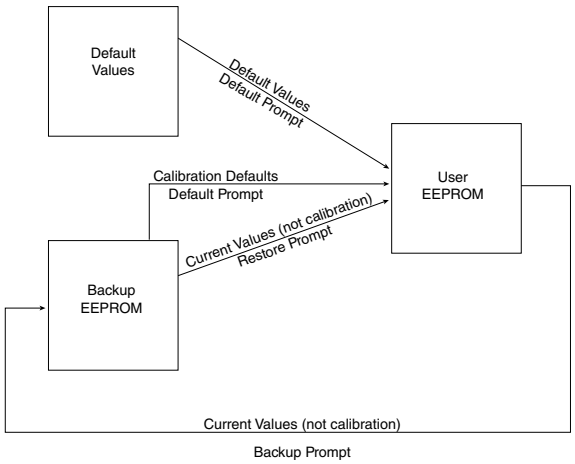


Figure A.7 — Power Series

Modbus Register Numbers

Relative Parameter Numbers (For Absolute Numbers, add 40001 to the Relative Number.)

1 Unit Serial Number High Digits
2 Unit Serial Number Low Digits
4 Software Version
5 Manufactured Date (yymm)
7 Hardware Version
30 Software Build Number
50 Unit Current Rating (Amps)
51 Unit Voltage Rating (Volts)
52 Number Zones Configured
53 Hardware Configured Type
54 Configuration Installed Options
55 Power Control Algorithm Select
56 Fixed Time Base (Sec)
57 Factory Safety Shutdown Temp
58 Load Type Select (Control Zone 1 only, 3 Phase only.)
80 Voltage Compensation (On/Off)
85 Comms Watchdog Select (On/Off)
86 Comms Watchdog Timeout (S)
87 Comms Watchdog Failure Output Power Select
150 Analog (mA) Input 1 Signal
151 Analog (V) Input 1 Signal
152 Line Potential (Volts) rms Line 1
153 A/D Counts Input 1
154 Load Current (Amps) rms Line 1
155 Single Phase 0.1 kVA Zone 1
156 Load Power (kVA) Zone 1
157 Heater Bakeout Timeout Zone 1
159 Output 1 Power (%)
160 Analog (mA) Input 2 Signal
161 Analog (V) Input 2 Signal
162 Line Potential (Volts) rms Line 2
163 A/D Counts Input 2
164 Load Current (Amps) rms Line 2
165 0.1 kVA Zone 2
166 Load Power (kVA) Zone 2
167 Heater Bakeout Timeout Zone 2
169 Output 2 Power (%)
170 Analog (mA) Input 3 Signal
171 Analog (V) Input 3 Signal
172 Line Potential (Volts) rms Line 3
173 A/D Counts Input 3
174 Load Current (Amps) rms Line 3
175 0.1 kVA Zone 3
176 Load Power (kVA) Zone 3
177 Heater Bakeout Timeout Zone 3
179 Output 3 Power (%)
180 Active Alarms
181 Heater Open alarm
182 Heater Tolerance Alarm
183 Heat Sink Over Temperature Alarm
184 Line Loss Alarm
185 Phase Balance Alarm
186 Load Balance Alarm
187 Frequency Out of Tolerance Alarm
188 Line Compensation Alarm
189 Line Over Voltage Alarm
190 Communications Watchdog Alarm
195 Active Errors
198 Line Frequency (Hz)
850 Active Relay State
851 Global Alarm Configuration
860 Heater Open Alarm Config.
861 Heater Tolerance Alarm Config.
862 Over Temperature Alarm Config.
863 Line Loss Alarm Configuration
864 Phase Balance Alarm Config.
865 Load Balance Alarm Config.
866 Frequency Out of Tolerance Alarm Configuration
867 Voltage Compensation Alarm Config.
868 Over Voltage Alarm Config.
869 Comms Watchdog Alarm Configuration
870 Retransmit Config. Select
871 Retransmit Type Select
872 Retransmit Phase Select
873 Retransmit Zone Select
876 Minimum Amps Retransmit
877 Maximum Amps Retransmit
878 Minimum kVA Retransmit
879 Maximum kVA Retransmit
880 Set Retransmit Output Low Voltage (Volts)
881 Set Retransmit Output High Voltage (Volts)
882 Set Retransmit Output Low Current (mA)
883 Set Retransmit Output High Current (mA)
950 Restore Data Set
951 Backup Data Set
952 Default Data Set
959 Enable NVOL Storage
990 Heat Sink Alarm Temp
991 Load Balance Percentage
1350 Global Lockout
1351 Control Setup Menus Lockout
1352 Options Setup Menus Lockout
1353 Alarms Setup Menu Lockout
1354 Comms Setup Menu Lockout
1355 Retransmit Setup Menu Lockout
1356 Analog Input Factory Menus Lockout
1357 Retransmit Cal Factory Menu Lockout
1358 System Data Factory Menu Lockout
1359 Diagnostics Factory Menu Lockout
1513 Display Test
1540 Line Loss Alarm, Most Recent Type, Line 1
1541 Line Loss Alarm, Previous Type, Line 1
1542 Line Loss Alarm, Least Recent Type, Line 1
1543 Line Loss Alarm, Most Recent Type, Line 2
1544 Line Loss Alarm, Previous Type, Line 2
1545 Line Loss Alarm, Least Recent Type, Line 2
1546 Line Loss Alarm, Most Recent Type, Line 3
1547 Line Loss Alarm, Previous Type, Line 3
1548 Line Loss Alarm, Least Recent Type, Line 3
1555 Retransmit Set Test Word
1560 to 1573 Read Selected A/D Counts
1580 Select Discrete Input
1581 Read Selected Input Value
1590 Heat Sink Temp (°C)
1591 Record High Heat Sink Temp
1700 Factory Mode Request
1799 Factory Password Entry
1960 Accum Hours (10K - 100M)
1961 Accum Hours (0 - 9999)
5011 Set Analog Input Low Current Scale (mA) Zone 1
5012 Set Analog Input High Current Scale (mA) Zone 1
5013 Set Analog Input Low Voltage Scale (Volts) Zone 1
5014 Set Analog Input High Voltage Scale (Volts) Zone 1
5019 Learn Input Request (Hi, Lo) Zone 1
5021 Set Analog Input Low Current Scale (mA) Zone 2
5022 Set Analog Input High Current Scale (mA) Zone 2
5023 Set Analog Input Low Voltage Scale (Volts) Zone 2
5024 Set Analog Input High Voltage Scale (Volts) Zone 2
5029 Learn Input Request (Hi, Lo) Zone 2
5031 Set Analog Input Low Current Scale (mA) Zone 3
5032 Set Analog Input High Current Scale (mA) Zone 3
5033 Set Analog Input Low Voltage Scale (Volts) Zone 3
5034 Set Analog Input High Voltage Scale (Volts) Zone 3
5039 Learn Input Request (Hi, Lo) Zone 3
5101 Input Signal Method Select (dig, mA, Volt) Zone 1
5102 Numeric (%) Input 1 Signal
5103 Default Numeric Input Signal (%) Zone 1
5104 Maximum Rate of Change (%/100msec) Zone 1
5105 Soft Start Time (Sec) Zone 1
5106 Inductive Load Factor Request Zone 1
5107 Inductive Load Current Zone 1
5110 Heater Bakeout Select (On/Off) Zone 1
5111 Heater Bakeout Select Time Zone 1
5112 Current Limit Select (On/Off) Zone 1
5113 Current Limit Set Point (A) Zone 1
5114 Low Tolerance Set Point (A) Zone 1
5115 High Tolerance Set Point (A) Zone 1
5116 Heater Bakeout Overcurrent Trip Zone 1
5201 Input Signal Method Select (dig, mA, Volt) Zone 2
5202 Numeric (%) Input 2 Signal
5203 Default Numeric Input Signal (%) Zone 2
5204 Maximum Rate of Change (%/100msec) Zone 2
5205 Soft Start Time (Sec) Zone 2
5206 Inductive Load Factor Request Zone 2
5207 Inductive Load Current Zone 2
5210 Heater Bakeout Select (On/Off) Zone 2
5211 Heater Bakeout Select Time Zone 2
5212 Current Limit Select (On/Off) Zone 2
5213 Current Limit Set Point (A) Zone 2
5214 Low Tolerance Set Point (A) Zone 2
5215 High Tolerance Set Point (A) Zone 2
5216 Heater Bakeout Overcurrent Trip Zone 2
5301 Input Signal Method Select (dig, mA, Volt) Zone 3
5302 Numeric (%) Input 3 Signal
5303 Default Numeric Input Signal (%) Zone 3
5304 Maximum Rate of Change (%/100msec) Zone 3
5305 Soft Start Time (Sec) Zone 3
5306 Inductive Load Factor Request Zone 3
5307 Inductive Load Current Zone 3
5310 Heater Bakeout Select (On/Off) Zone 3
5311 Heater Bakeout Select Time Zone 3
5312 Current Limit Select (On/Off) Zone 3
5313 Current Limit Set Point (A) Zone 3
5314 Low Tolerance Set Point (A) Zone 3
5315 High Tolerance Set Point (A) Zone 3
5316 Heater Bakeout Overcurrent Trip Zone 3
5411 Adjust Low mA Cal Point Zone 1
5412 Adjust High mA Cal Point Zone 1
5413 Adjust Low V Cal Point Zone 1
5414 Adjust High V Cal Point Zone 1
5415 Calibrate Analog Input Request Zone 1
5421 Adjust Low mA Cal Point Zone 2
5422 Adjust High mA Cal Point Zone 2
5423 Adjust Low V Cal Point Zone 2
5424 Adjust High V Cal Point Zone 2
5425 Calibrate Analog Input Request Zone 2
5431 Adjust Low mA Cal Point Zone 3
5432 Adjust High mA Cal Point Zone 3
5433 Adjust Low V Cal Point Zone 3
5434 Adjust High V Cal Point Zone 3
5435 Calibrate Analog Input Request Zone 3
5591 Baseline Voltage Learn Request Zone 1
5592 Baseline Voltage Learn Request Zone 2
5593 Baseline Voltage Learn Request Zone 3
5594 Baseline Voltage Read/Adjust Zone 1
5595 Baseline Voltage Read/Adjust Zone 2
5596 Baseline Voltage Read/Adjust Zone 3
5700 Cal Retransmit Request
5710 Retransmit Cal mA Low
5711 Retransmit Cal mA High
5720 Retransmit Cal Volts Low
5721 Retransmit Cal Volts High

Specifications (2214)

Power Bases
- Single phase, (2 SCRs)
- 3 phase, 2-leg control, (4 SCRs)
  Resistive load only, zero cross firing only
- 3 phase, 3-leg control, (6 SCRs)
- 3 phase, 3-leg control, (6 SCRs) for 4 wire wye loads
- Multizone, two and three single phase zones

Output Control Options
- Zero cross contactor, V⎓(dc) input
- Zero cross control, fixed time base
  - Time base 1 or 4 seconds with digital programmer
- Zero cross control, variable time base
- Phase angle control and phase angle control with current limit (not for 3 phase, 2-leg models)
  - Soft start factory default 4 seconds upon power-up, and adjustable from 0.0 to 120 seconds
  - Soft start upon input signal change, output rate of change adjustable to limit max rate of change from 0.1 to 100% per 0.1 second. Factory default 10%.
- Current transformer included when required
- Line voltage compensated (variable time base and phase angle controllers only)
- Standby or non-operational mode

Output Voltage and Current Rating
- 24V~(ac) to 120V~(ac)(+10%, -15%)
- 200V~(ac) to 480V~(ac)(+10%, -15%)
- 200V~(ac) to 600V~(ac)(+10%, -15%)
- 65 through 250 amps per pole, model dependent; see Output Amperage Chart and Rating Curves
- Minimum load 1 amp rms ac
- Typical leakage current 5mA
- SCCR 200KA with fusing recommendations on page 3.6.

Alarms
- Single alarm relay
- Latching or non-latching
- Alarm silencing (inhibit) on power up for alarm
- Alarm indication LEDs, shorted SCR, open heater, fuse
- Electromechanical relay, form C contact, software configurable
  - Minimum load current 10mA @ 5V⎓(dc)
  - Rated resistive loads: 3 amps @ 250V~(ac) or 30V⎓(dc) max., inductive load rating 1.5 amps with a power factor ≥ 0.4 without contact suppression

Heater Bakeout
- For single phase (phase to neutral) and 3 phase 6 SCR models only (not for 3 phase, 2-leg models)
- Soft start with over current trip, runs until programmed bakeout time expires, then goes zero cross or phase angle firing. Factory default of 24 hours.
- Adjustable 0 - 9999 minutes with over current trip
- Internal current transformer included

Command Signal Input

Analog
- DC contactor 3.5 to 10V⎓(dc), must turn off at 2.5V⎓(dc)
- Field selectable linear voltage and current of low and high points within 0-20mA and 0-10V⎓(dc)
- Manual control through front panel
- Factory default 0-20mA input
- Voltage input impedance 11kΩ nominal
- Current input impedance 100Ω nominal

Digital
- On-board digital programmer/display and optional serial communications

Retransmit
- Field selectable and scalable within 0-20mA , 800Ω maximum load or 0-10V⎓(dc), 1KΩ minimum load.
  The default is 4-20mA.
- Resolution:
  mA ranges = 5µA nominal
  V⎓(dc) = ranges 2.5mV nominal
- Calibration accuracy:
  mA ranges = ±20µA
  V⎓(dc) ranges = ±10mV
- Temperature Stability: 100ppm°C

Digital Programmer/Display and Communications Capabilities
- Programming functions
  - Adjust input and output control type, alarms and soft start. Heater bakeout and current limit prompts also.
- Monitoring functions
  - Display input and output values along with actual output current
- Data retention of digital programmer/display upon power failure via nonvolatile memory

Serial Communications
- RS-232 for single drop control
- EIA-485 for single or multidrop control
  - 32 units maximum can be connected. With additional 485 repeater hardware, up to 247 units may be connected
- Isolated
- Modbus™ RTU protocol
- 1200, 2400, 4800, 9600, 19200 baud rates
- Data format 8 data bits, no parity, one stop bit

Controller Power Supply
- Universal line voltage input range 100 to 240V~(ac) (+10%, -15%) @ 55VA maximum
- 50/60Hz ± 5% line frequency independent
- Controller line voltage for electronic power supply can be run on separate line voltage

Natural Convection and Fan Cooled Models
- Cabinet venting may be required

Power Dissipation (Watts)
- Approximately 1.25 watts/amp per controlled leg

Isolation
- Command signal to load and line/load to ground 2200V~(ac) minimum
- On-board semiconductor fuses provide SCR protection

Mounting
- Back panel mount on F35 models
- Other amperage ratings: Removable mounting plate
- Heat sink fins must be mounted in vertical orientation

High Current Terminals
- Touch safe
- 3/8 inch Allen head compression terminals will accept #6 AWG to 350 MCM wire. Allen wrench adapter (included) for 3/8 inch socket, or 10 mm, 6 point only.
- Torque to 180 in.-lbs. (20.3 Nm.)
- Wire strip to 30 mm (1-1/8 inch)

Controller Terminals
- Touch safe
- 2.5 mm (1/8 inch) blade screwdriver, accepts 12-22 AWG or 2 No. 22-18 AWG wires.
- Torque to 8 in.-lbs. (0.9 Nm.)
- Wire strip to 6 mm (0.24 inch)
- Requires 90C wire insulation rating on line and load terminals.

Operating Environment
- 50°C (122°F) base rating
  - 0 to 60°C (32 to 140°F) fan cooled
  - 0 to 65°C (32 to 149°F) natural convection cooled
- 0 to 90% RH, non-condensing
- Meets EN50178, Pollution degree 3

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

Dimensions
- Width x height x depth
  191 mm x 354 mm x 200 mm on N20 through F30 models
  (7.5 in x 14.0 in x 7.9 in)
  337 mm x 421 mm x 234.1 mm on F35 models
  (13.3 in x 16.6 in x 9.2 in)

Fan
- 120 V~(ac), 50/60 Hz, 14/12W, 0.20/0.16A on F35 models

Shipping Weight
- 10.3 kg. (23 lbs.) on N20 through F30 models
- 17.2 kg. (38 lbs.) on F35 models

Agency Approvals
- UL 508 and C-UL listed, file #E73741
- CE marked, see Declaration of Conformity on page A.14

Ordering Information

(1528)

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

P C _ _ - _ _ _ - _ _ _

Power Series = Microprocessor-Based Solid State Power Controller

Package Style

C = 65 to 250 Amps

Phase

1 = 1-phase
2 = 3-phase, 2-leg control (4 SCRs)
3 = 3-phase, 3-leg control (6 SCRs)
4 = 3-phase, 4-wire, wye connected load
8 = 2 single-phase zones (specify 01 or 03 for Custom)
9 = 3 single-phase zones (specify 01 or 03 for Custom)

Heater Diagnostics (includes current limit)

0 = None
1 = Heater Diagnostics (Current Limiting and Heater Bakeout are only available on single-phase and 3-phase, 3-leg Controllers)

Output Amperage Rating

(See Amperage Chart below; insert code number here.)

Output Voltage Rating

A = 24 to 120V~
B = 200 to 480V~
C = 200 to 600V~

Communications

0 = None
1 = EIA/TIA 232/485 communications, isolated (field selectable)

Feedback/Retransmit

0 = None
1 = Load current feedback (0 to 10V or 0 to 20mA scalable retransmit output) (Must have heater diagnostics selected.)

Custom

00 = None
AA = No Watlow logo with agency approval marks
AB - ZZ = Custom, consult factory for options
01 = Select for PC8 or PC9 using single-phase power supply, Watlow logo
03 = Select for PC8 or PC9 using multi-phase power supply, Watlow logo

IMPORTANT NOTES:

Phase Angle:
Phase angle and phase angle with current limit are available on single phase, and 3 phase/3-leg models only. To get current limiting, you must also order heater diagnostics.

Heater Bakeout:
Heater bakeout is available on single phase, and 3 phase/3-leg models with heater diagnostics.

Amperage Chart @ 50°C (122°F)

	Single Phase		2 Single Phase Zones 3 Phase, 2-Leg		3 Single Phase Zones 3 Phase, 3-Leg	
	Code	Amperage	Code	Amperage	Code	Amperage
Non Fan Cooled	N20	100A	N20	80A	N20	65A
	N25	140A	N25	105A	N25	85A
	N30	165A	N30	120A	N30	105A
Fan Cooled	F20	125A	F20	120A	F20	90A
	F25	200A	F25	160A	F25	140A
	F30	250A	F30	185A	F30	155A
			F35	250A	F35	225A

NOTE: User documentation may be available in French, German, Spanish, Italian, and Dutch, as well as English. Check Watlow's website (www.watlow.com/) for availability.

NOTE: See semiconductor fuses and holders on pages 2.1 and 3.6.

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Prompt Index

Declaration of Conformity

Power Series Power Controller

CE

WATLOW Electric Manufacturing Company ISO 9001 since 1996.
1241 Bundy Blvd.
Winona, MN 55987 USA

Declares that the following products:

Designation:	Power Series Power Control
Model Numbers:	PC (1, 2, 3, 4, 8 or 9)(0 or 1) – (N or F)(20, 25 or 30)(A, B or C) – (0 or 1)(0 or 1) any two letters or numbers.
Classification:	Power Control, Installation Category III, Pollution degree 3, IP00
Unit Supply:	100-240 V~ (85 – 264)(ac), 50 or 60 Hz, 60 VA
Load Supply:	24 to 600 V~ (ac), 50 or 60 Hz, 65 to 250 A depending on model.

Meets the essential requirements of the following European Union Directives by using the relevant standards show below to indicate compliance.

2004/108/EC Electromagnetic Compatibility Directive

EN 61326-1: 2013	**Electrical equipment for measurement, control and laboratory use – EMC requirements (Industrial Immunity, Class A[1,2,5] Emissions)** ***Not for use in a Class B environment without additional filtering.***
EN 61000-4-2:2009	Electrostatic Discharge Immunity
EN 61000-4-3:2010	Radiated Field Immunity 10V/m 80 MHz- 1GHz, 3V/m 1.4GHz-2.7GHz
EN 61000-4-4:2012	Electrical Fast-Transient / Burst Immunity
EN 61000-4-5:2006	Surge Immunity
EN 61000-4-6:2014	Conducted Immunity
EN 61000-4-11:2004	Voltage Dips, Short Interruptions and Voltage Variations
EN 61000-3-2:2009	Harmonic Current Emissions[4]
EN 61000-3-3:2013	Voltage Fluctuations and Flicker (Unit Supply)
EN 61000-3-11:2000	Voltage Fluctuations and Flicker[3] (Load Supply)

NOTES

[1]Use of an external filter is required to comply with conducted emissions limits. See note 5 below.

[2]A Line Impedance Stabilization Network (LISN) was used for conducted emissions measurements.

[3]To comply with flicker requirements will require a reduced source impedance.

[4]Phase angle control mode will not pass harmonics, burst fire control mode meets requirements.

2006/95/EC Low-Voltage Directive

EN 50178:1997 **Electronic equipment for use in power installations.**

Per 2012/19/EU W.E.E.E Directive  ***Please Recycle Properly.***

These devices contain lead solder and are not RoHS compliant.
They are Industrial Control Devices and fall outside the scope of 2011/65/EU Directive.

[5]Required External EMI Filters for Power Series with More Than 6 Amp Loads

An external ElectroMagnetic Interference (EMI) filter must be used in conjunction with the Power Series for loads in excess of six amperes (6A) at 150 to 250 KHz. Watlow has verified that the following tank filters will suppress EMI created by SCR power controllers to comply with the conducted emissions limits.

Description	Crydom Filter	Watlow Filter
Single-Phase 230 V~ (ac)	1F25	14-0019
Three-Phase 440 V~ (ac)	3F20	14-0020

Declaration of Conformity

Figure 1 - Tank Filter, 1Ø, 230 V~

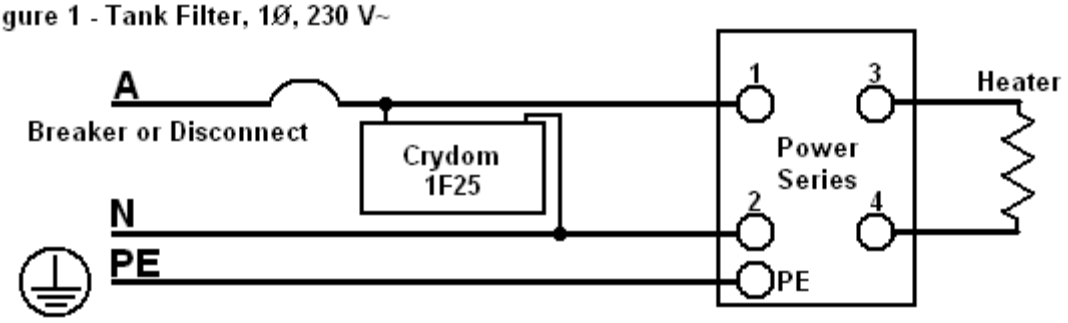
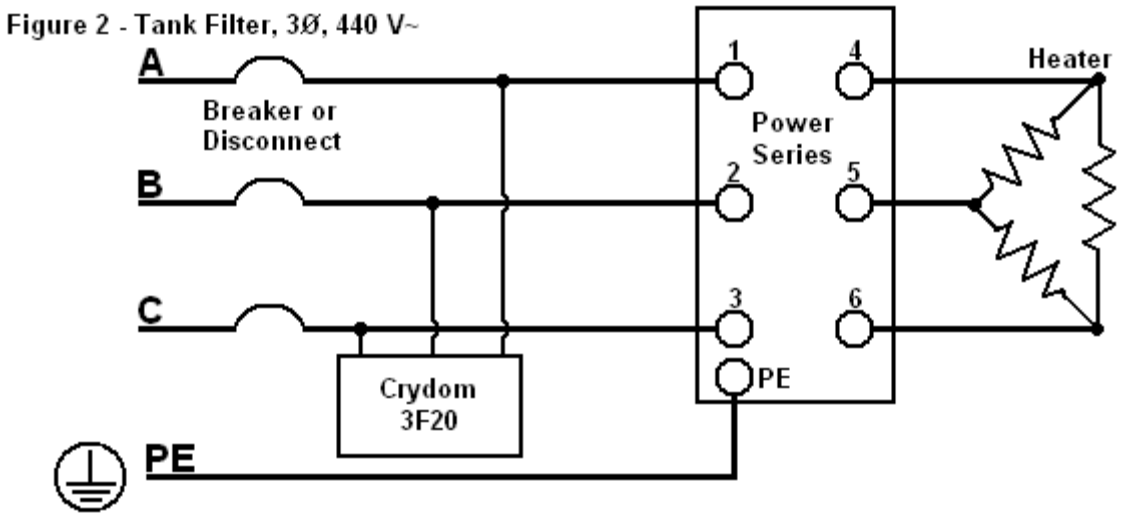


Figure 2 - Tank Filter, 3Ø, 440 V~



⚠ WARNING:
Tank filters may suppress desirable communications carried on power lines in the 150 to 250 KHz region. The filters may suppress carrier current such as that used for infant monitors and medical alert systems. Verify that suppressed carrier current or other desirable communications on power lines creates no hazard to people or property.

⚠ WARNING:
All filter installation and wiring must be performed by qualified personnel and conform to local and national electrical codes. Failure to observe this warning could result in damage to property, and or injury to death for personnel.

In-line power filters have been shown to properly suppress EMI; however, these filters must be rated for the entire load current and are generally more expensive than the tank filter specified. An In-line filter may be required if carrier current communications are used on site.

Joe Millanes	Winona, Minnesota, USA	September 2014
Name of Authorized Representative	Place of Issue	Date of Issue

Directory of Operations
Title of Authorized Representative

Signature of Authorized Representative

Power Series Software Map

Display Loop

(See the Power Series User's Manual)

Setup Page

Control Algorithm
- Power Control Algo Select
- Fixed Time Base
- Line Voltage Comp

Control Zone 1
- Input Signal Method Select
- Default Numeric Input Sig
- Set Analog Input Lo Cur
- Set Analog Input Hi Cur
- Set Analog Input Lo Volt
- Set Analog Input Hi Volt
- Learn Input Learn Req
- Baseline Volt Read/Adj
- Baseline Volt Learn Req
- Load Type Select
- Max Rate of Change
- Soft Start Time

Options Zone 1
- Heater Bakeout Select
- HBO Select Time
- HBO Current Trip
- Cur Limit Select
- Cur Limit Set Point
- Lo Tol Set Point
- Hi Tol Set Point
- Induct Load Factor Req
- Inductive Current

Control Zone 2
- Input Signal Method Select
- Default Numeric Input Sig
- Set Analog Input Lo Cur
- Set Analog Input Hi Cur
- Set Analog Input Lo Volt
- Set Analog Input Hi Volt
- Learn Input Learn Req
- Baseline Volt Read/Adj
- Baseline Volt Learn Req
- Max Rate of Change
- Soft Start Time

Options Zone 2
- Heater Bakeout Select
- HBO Select Time
- HBO Current Trip
- Cur Limit Select
- Cur Limit Set Point
- Lo Tol Set Point
- Hi Tol Set Point
- Induct Load Factor Req
- Inductive Current

Enter your settings on a photocopy of this page.

Control Zone 3
- Input Signal Method Select
- Default Numeric Input Sig
- Set Analog Input Lo Cur
- Set Analog Input Hi Cur
- Set Analog Input Lo Volt
- Set Analog Input Hi Volt
- Learn Input Learn Req
- Baseline Volt Read/Adj
- Baseline Volt Learn Req
- Max Rate of Change
- Soft Start Time

Options Zone 3
- Heater Bakeout Select
- HBO Select Time
- HBO Current Trip
- Cur Limit Select
- Cur Limit Set Point
- Lo Tol Set Point
- Hi Tol Set Point
- Induct Load Factor Req
- Inductive Current

Alarms Configuration
- Active Relay State
- Global Alarm
- Heater Open Alarm
- Heater To Alarm
- Heat Sink Over Temp Alarm
- Heat Sink Over Temp Alarm Temp
- Line Loss Alarm
- Phase Bal Alarm
- Load Bal Alarm
- Load Bal Percent
- Freq Out of Tol Alarm
- Volt Comp Alarm
- Over Volt Alarm
- Comms Watchdog Alarm

Comms Configurations
- Unit Address Select
- Unit Baud Rate Select
- Watchdog Select
- Watchdog Timeout
- Watchdog Fail Output Pwr Sel

Retransmit Configuration
- Retrans Select
- Retrans Type Select
- Retrans Phase Select
- Retrans Zone Select
- Min Amps Retrans
- Max Amps Retrans
- Min kVA Retrans
- Max kVA Retrans
- Set Retrans Output Lo Cur
- Set Retrans Output Hi Cur
- Set Retrans Output Lo Volt
- Set Retrans Output Hi Volt

Factory Page

System Data Manipulation
- Backup Data Set
- Default Data Set
- Restore Data Set
- Enable NVOL Storage

Global/Menu Lockouts
- Global Lockout
- Control Setup Menus Lock
- Options Setup Menus Lock
- Alrms Setup Menu Lock
- Comms Setup Menu Lock
- Retrans Setup Menu Lock
- Analog Input Menu Lock
- Retrans Menu Lock
- Sys Data Menu Lock
- Diag Menu Lock

Unit Information
- Unit Serial # Hi Digits
- Unit Serial # Lo Digits
- Mfg Date
- Hardware Version
- Software Version
- Software Build #
- Unit Volt Rating
- Unit Curt Rating
- # Zones
- Installed Options
- Heat Sink Temp
- Heat Sink Alarm Temp
- Safety Shutdown Temp
- Hi Heat Sink Temp
- Accum Hours
- Accum Hours

Diagnostics
- Select A/D Channel
- Read Selected A/D Counts

Line Loss Alarms:
- Most Recent
- Line Loss
- Alarm Type
- Previous
- Line Loss
- Alarm Type
- Least Recent
- Line Loss
- Alarm Type

- Display Test
- Select Discrete Input
- Read Selected Input Value
- Retrans Set Test Word

The Factory Page also includes calibration parameters that are not necessary for everyday use of the controller. Calibration parameters and procedures are explained in the Power Series User's manual.

How to Reach Us

TOTAL
CUSTOMER
SATISFACTION
3 Year Warranty

Quality and Mission Statement:

Watlow Winona will be the world's best supplier of industrial temperature control products, services, and systems by exceeding our customers', employees', and shareholders' expectations.

Contact

Your Authorized Watlow Distributor is:

- Phone: +1 (507) 454-5300.
- Fax: +1 (507) 452-4507.
- For technical support, ask for an Applications Engineer.
- To place an order, ask for Customer Service.
- To discuss a custom option, ask for the Power Series Product Manager.

Warranty

The Watlow Power Series 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

- Call or fax Customer Service for a Return Material Authorization (RMA) number before returning a controller.
- Put the RMA number on the shipping label, along with a written description of the problem.
- A restocking charge of 20% of the net price is charged for all standard units returned to stock.