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POWER CONTROL SERIES

ROBICON

SERIES 1PCI
SINGLE-PHASE
SCR POWER CONTROLLER
USER'S MANUAL

Manual Number: 19000324
Version 1.1
July 03

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1PCI is a product line of SCR power controllers from ASIRobicon.
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TABLE OF CONTENTS

SCR Power Controller 1

PREFACE vi

CHAPTER 1: Introduction 1

1.1. General Description 1
1.2. Operation 2
1.3. Features 2
1.3.1. Soft Start Feature 2
1.3.2. CL/OC-D Feature 2
1.3.3. Normally Open (NO) Heat Sink Thermostat Feature 3
1.3.4. Voltage Surge Protection Feature 3
1.3.5. Undervoltage Protection Feature 3
1.3.6. 50/60 Hz Operation Feature 3
1.4. Options 3
1.4.1. Power Regulation (PR) Option 3
1.4.2. Soft Start Options 4
1.4.3. Normally Closed (NC) Thermostat Option 4
1.4.4. Liquid Cooled Option 4
1.5. Hardware Components 4
1.6. Technical Specifications 5
1.7. Ordering Information 6
1.8. Safety Precautions and Warnings 7

CHAPTER 2: Setup and Operation 1

2.1. Introduction 1
2.2. Unpacking the 1PCI Power Controller 1
2.3. Mounting the 1PCI 1
2.4. Fan Wiring (Models Rated 180 A and Higher) 1
2.5. Wiring Heat Sink Thermostats 2
2.6. Input/Output Wiring 2
2.7. Voltages 2
2.8. Options 2
2.9. Standard Operation and Setup Methods 3
2.9.1. 4-20 mA Control of Power Output (As Shipped from Factory) 4
2.9.2. Temperature Controller 4
2.9.3. Manual Control with a Remote Potentiometer 5
2.9.4. Auto/Manual Control with a Controller or Remote Potentiometer 5
2.9.5. Shutdown (Output Disabled) 6
2.9.6. Controlling Several 1PCIs in Parallel with One Controller 6
2.9.7. Single-phase Overcurrent Trip (OC) 7
2.9.8. Single-phase Current Limit (CL) 7
2.9.9. Current Limit/Overcurrent Trip-Remote Reset (CL/OC-RR) 7
2.9.10. Reset Push-button (User Supplied) 7

CHAPTER 3: Troubleshooting 1

3.1. Introduction 1
3.2. Static Precautions When Servicing 1
3.3. Troubleshooting Typical Symptoms 2
3.3.1. Diagnosing Environmental Problems 2
3.3.2. Checking Input Power and Load Connections 3
3.3.3. Further Diagnosis of Common 1PCI Symptoms 3
3.4. Communications with the Factory 5
3.5. Spare Parts Orders - Routine or Emergency 6
3.6. Drawing List 7

CHAPTER 4: Warranty Policy and Product Liability 1

4.1. Guarantee and Product Liability 1
4.2. In-House Repair Services 1
4.3. Field Service Repairs 2
Readers' Comments Form 1

Startup/Warranty Registration and Service Solutions 5

NOTES 1

INDEX i

LIST OF TABLES

Table 1-1. General Specifications of 1PCI Models 5

Table 1-2. Ordering Information for the 1PCI Series 6

Table 2-3. Heat Sink Thermostat Connections (Recommended) 2

Table 2-4. Lug Size Information 2

Table 2-5. Matching SCR Power Control to External Controller Signal 4

Table 3-6. Torque Specifications for Slotted-head and Hex-head Screws 3

Table 3-7. Torque Specifications for Socket-head Screws (All Conductor Sizes) 3

Table 3-8. Troubleshooting the 1PCI (Symptoms and Solutions) 4

Table 3-9. Vendor Part Numbers 1PCI Fuse Specifications 5

Table 3-10. 1PCI Spare Parts List 6

Table 3-11. 1PCI Drawing List 8

LIST OF FIGURES

Figure 1-1. Typical 1PCI Series Power Controller 1
Figure 1-2. Key Hardware Components of a Typical 1PCI Series Power Controller 4
Figure 2-3. Typical 1PCI Line and Load Connections 3
Figure 2-4. Automatic Controller Input Connections 5
Figure 2-5. Remote Control with a Potentiometer 5
Figure 2-6. Auto/Manual Control with Controller and Remote Potentiometer 6
Figure 2-7. Shutdown (Output Disabled by Contact Closure) 6
Figure 2-8. Controlling Several 1PCIs Connected in Parallel 6

LIST OF DRAWINGS

405586 ..... Outline 1PCI 25-60 Amps
405486 ..... Outline and Mounting 1PCI 90-120 Amps
405840 ..... Outline 1PCI 180 and 225 Amps
405590 ..... Outline 1PCI Power Control Phase Angle 350-500 Amps
405591 ..... Outline 1PCI 650 Amp SCR Power Controller
405490 ..... Outline and Assembly 1PCI 800-1200 Amps
374162 ..... Schematic 1PCI 25-60 Amps
374160 ..... Schematic 1PCI 90-225 Amps
374151 ..... Schematic 1PCI 350-1200 Amps

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PREFACE

This section gives the operator an overview of topics that are covered in each of the sections in this manual as well as conventions used throughout this manual. It is recommended that the operator read and understand this entire manual before attempting to start the unit. Users who are familiar with this and other ASIRobicon products may choose to review these chapters before start-up. The 1PCI SCR Power Controller Operations Manual contains information on the following topics.

CHAPTER 1: INTRODUCTION

This chapter contains an introduction to the 1PCI SCR power controller. Included is a general description of the system components, features, technical specifications, and safety precautions.

CHAPTER 2: SETUP AND OPERATION

This chapter contains information about unpacking the SCR power controller, where it should be stored and mounting considerations. Mounting considerations include voltage and current ratings, ventilation requirements, cable accessibility issues, wiring issues, and standard operation and setup methods.

CHAPTER 3: TROUBLESHOOTING

This chapter is provided as a reference if problems arise with the configuration, startup or operation of the 1PCI SCR Power Controller.

CHAPTER 4: WARRANTY

This chapter contains warranty and liability policies for the 1PCI SCR Power Controller.

RELATED DRAWINGS

READERS' COMMENTS FORM

POST SALE SERVICE SOLUTION INFORMATION

STARTUP/WARRANTY INFORMATION CARD

NOTES

INDEX

The following conventions are used throughout this manual.

- An "In This Section" box begins each chapter and outlines some of the key issues that are addressed in the chapter along with the corresponding page numbers.
- Important notes are enclosed in boxes for higher visibility and easy reference.
- The symbols ⚠ and ⚡ may appear in the outer margins to warn the reader of potential hazards such as electrical shock or equipment damage.
- The symbol ☝ may appear in the outer margins to provide quick visual references of important notes and concepts.
- Software flags and variables are shown in lowercase italic font (e.g., *sw_estop_f*).
- Test points are shown in uppercase, boldface, 8 point Arial font (e.g., **TB1A**).
- This manual uses the symbol " ∇ ∇ ∇ " to indicate the end of a chapter.

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CHAPTER 1: INTRODUCTION

In This Section:

- General Description 1-1
- Operation 1-2
- Features 1-2
- Options 1-3
- Hardware Components 1-4
- Technical Specifications 1-5
- Ordering Information 1-6
- Safety Precautions and Warnings 1-7

1.1. General Description

Series 1PCI power controllers provide control of single-phase power to resistive and inductive loads. The 1PCI utilizes infinite firing angle resolution for precise SCR control. This manual covers the 1PCI series of power controllers which are rated from 15 through 1200 amperes. Addition technical specifications can be found later in Table 1-1 on page 1-5.

The 1PCI is a single-phase, phase-fired power controller, and can operate with a wide variety of input signals and line voltages. The 1PCI's RMS output voltage is proportional to the control input signal, with the output voltage regulated to ±0.5% with a ±10% line voltage change. The 1PCI features a 0-180 degree phase controlled, high-current firing circuit which provides high immunity to possible SCR firing disturbances. Other features are soft-start, automatic restart circuitry, current limit and over current trip features. Terminals are provided to permit connection of a variety of external control methods. A typical 1PCI Series power controller is shown in Figure 1-1.

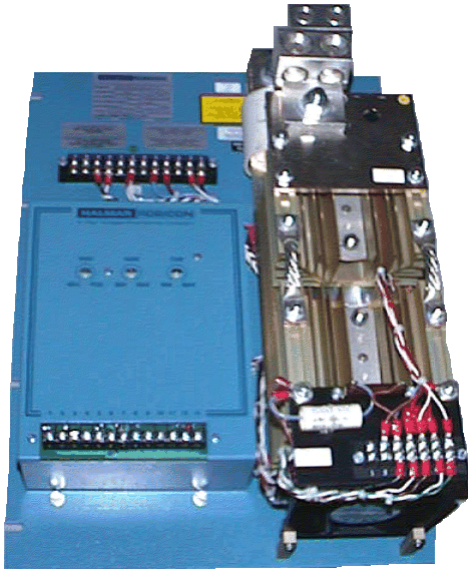


Figure 1-1. Typical 1PCI Series Power Controller

1.2. Operation

The 1PCI accomplishes power control by the switching action of a pair of inverse-parallel power SCRs. The switching (or gating) of the SCRs is controlled by a cosine intercept firing control circuit synchronized "in phase" with the line frequency (either 50 or 60 Hz). The digital firing circuit may be manually controlled by the *bias* control, or controlled automatically (or manually) by one of several external methods. Screwdriver-adjusted *bias* and *gain* controls are used to set up the 1PCI for operation by external control. Chapter 3 describes how to implement the various control methods.

1.3. Features

Key features of the 1PCI power controller are listed below. These features are explained in the sections that follow.

- soft start
- current limit and overcurrent trips
- heat sink thermostat feature
- voltage surge suppression
- undervoltage protection
- 50/60 Hz operation.

1.3.1. Soft Start Feature

The increasing rate of the output voltage RMS value is limited to prevent high inrush currents with transformer-coupled loads or with elements having high cold-to-hot resistance ratios. With a nominal gain setting, the rate of increase is limited to approximately 100% per second. Additional protective circuits prevent excessive output bursts due to the fluctuations of reapplied AC supply voltage. The standard ramp time is 1 second. Optional ramp times are available. Refer to Section 1.4.2. Soft Start Options on page 1-4.



Regarding response time, the equivalent time constant (64% response) is approximately 50 msec, independent of control input impedance, except that the maximum rate of output increase is limited by the soft start circuit.

1.3.2. CL/OC-D Feature

The linear current limit feature acts to prevent output current from exceeding a preset setpoint even though load resistance may be less than that defined by the ratio of maximum output voltage to rated output current. Cold load inrush currents may be 10 times to 20 times the rated current until high temperature elements come up to heat. The setpoint range is 0 to 150% of rated current.

A high-speed electronic overload trip or *chop-off limiter* protects the semiconductors against any load shorts. The overcurrent trip monitors the output using current transformer feedback. With one-half cycle of the fault occurring, the controller automatically shuts off the SCRs. The trip point is adjustable from 40% to 350% of the SCR power control's current transformer rating. In the instantaneous trip mode, the on-board relay changes state, but will reset after approximately 100 ms. In reclosing operations, 3 attempts are made, after which the on-board relay latches. Reset is accomplished by interrupting power or by a remote reset. This feature is normally used on special RF generator fuseless designs.

1.3.3. Normally Open (NO) Heat Sink Thermostat Feature

Normally open (N.O.) heat sink thermostats are available on the 1PCI power controller series. These thermostats, which close on high heat sink temperature (200°F), may be used to initiate a customer's alarm, shunt trip, unit shutdown, or other function for SCR protection.

If desired, normally-closed (N.C.) thermostats may be ordered as an option rather than normally-open (standard). Heat sink thermostats are optional on units with current ratings lower than 180 amperes, and can be ordered with either N.O. or N.C. contacts. N.O. is standard on units with fans (180A and above). It is recommended that the N.O. thermostats are to be connected to the gate trigger terminals 3 and 4 to shut down the unit if the fans fail or if cabinet air temperature is too high.

1.3.4. Voltage Surge Protection Feature

MOV-capacitor-resistor networks connected in parallel with each thyristor provide combined voltage surge dv/dt protection. Thyristor ratings are selected to provide a minimum safety factor of 2.5 times the nominal RMS of the AC supply voltage and typical suppressed dv/dt values.

1.3.5. Undervoltage Protection Feature

The gate trigger unit (GTU) automatically deactivates when the VAC falls below approximately 70% of nominal. Normal operation resumes when the line recovers to 80% of AC supply.

> The (GTU) is an all-semiconductor printed circuit board that combines the noise immunity of cosine intercept linear phase control with space-saving digital logic circuitry, hard drive gate output circuits and a voltage regulator preamplifier. The GTU drives an inverse parallel pair of connected SCRs for the phase being controlled.



1.3.6. 50/60 Hz Operation Feature

The 1PCI SCR power controller can operate at either 50 Hz or 60 Hz automatically. No hardware or software frequency configuration is necessary. When shipped from the factory, all 1PCI controllers are operational at either 50 Hz or 60 Hz (± 1 Hz).

1.4. Options

Several options are available from ASIRobicon, and are described below. Additional options are available. For more information, contact ASIRobicon.

> 1PCIs require current transformers (CTs), which are integral on models rated from 15 through 225 amperes. On models rated at 350 amperes and higher, the CTs are shipped separately.



1.4.1. Power Regulation (PR) Option

Power regulation compares the feedback and control signals so the output power will be linear to the control signal and will be regulated to maintain a selected constant power level at the controller output despite line and load changes.

The 1PCI includes switch **SW1** - a three-position switch (voltage, current, feedback) which is used to change the regulation mode. The *feedback* position is used for the power regulation option and should not be selected unless the PR option is supplied. The *feedback* position may also be used to regulate an external feedback signal connected to pin 8. In this case, the external signal must be positive. A voltage of 6 VDC minimum and 10 VDC maximum is recommended.

1.4.2. Soft Start Options

The standard soft start feature has a 1 second ramp time as discussed previously. The user can order soft start with an optional *fast ramp* of 47 ms or the optional *extended ramp* of 4 seconds.

1.4.3. Normally Closed (NC) Thermostat Option

Although normally open (NO) heat sink thermostats are available on the 1PCI power controller series, a normally closed (NC) thermostat is also available as an option. Refer to Section 1.3.3 on page 1-3 for additional information.

1.4.4. Liquid Cooled Option

A liquid cooled version of the 1PCI is available. For information on liquid cooled units, please call the factory.

1.5. Hardware Components

Some of the key hardware components of a typical 1PCI are listed below in Figure 1-2.

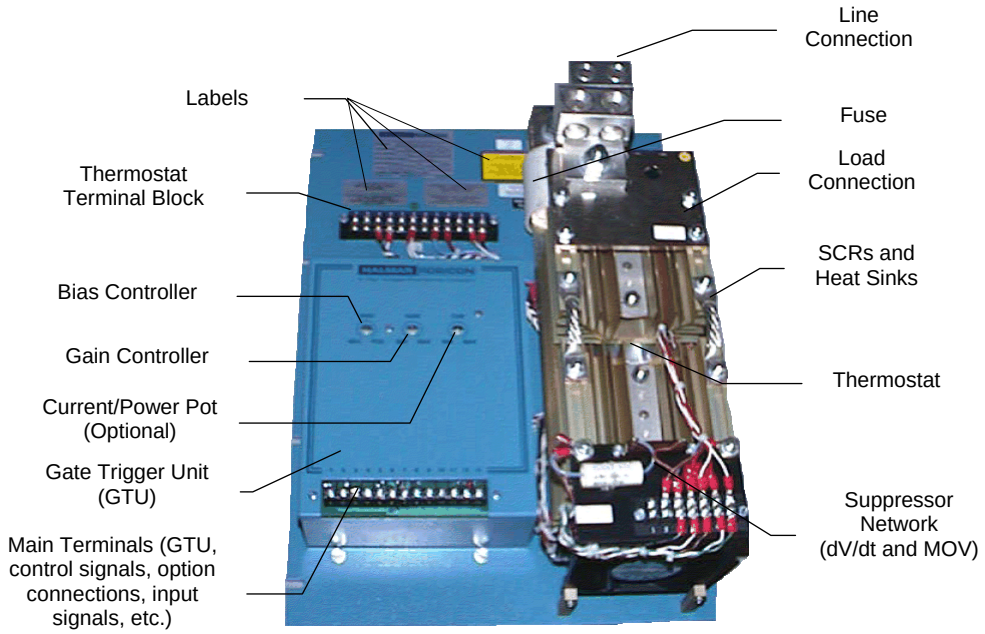


Figure 1-2. Key Hardware Components of a Typical 1PCI Series Power Controller

The 1PCI system shown in Figure 1-2 is a typical configuration. Models will differ significantly in appearance based on configured options, ratings and features.

1.6. Technical Specifications

Specifications for the 1PCI SCR power controller are given in Table 1-1.

Table 1-1. General Specifications of 1PCI Models

Specification	Description
Input line voltages [1]	120, 208, 240, 277, 380, 415, 480, or 600 Vac ±10%, single-phase
Line frequency	50/60 Hz (± 1 Hz)
Current ratings[1]	15, 25, 40, 60, 90, 120, 180, 225, 350, 500, 650, 800, 1000, or 1200 amps
Thermostat contact rating	120 Vac, 5A; Resistive; Normally open (NO) (NC is optional)
Control method choices (customer-supplied)	1. Potentiometer; 5 KΩ to 100 KΩ, 1/2 watt 2 Dry contact closure 3. Temperature controller or process controller [2]
Input signal choices	1. 0-1.5 v (min); 0-15 v (max); terminal 1 (-) and terminal 5 (+) 150 KΩ impedance [2] 2. 0-3 mA (min); 0-30 mA (max); terminal 1 (-) and terminal 2 (+) 249 Ω, 0.5 watt standard input impedance [2]
Control signal isolation	From SCRs: 2,500 Vac From AC power input lines: 2,500 Vac From chassis: 500 Vac
Power output regulation	±0.5% per ±10% line voltage change
Power output linearity vs. control signal input	±2%
Power SCR protection	Current surge protection: Subcycle I^2T semiconductor fuse Voltage transients (dv/dt): Metal oxide varistor (MOV) and RC RC snubber across each SCR pair All SCRs have PIV rating of 1,400 v.
Fan cooling Power (as applicable)	180 A through 500 A units: 0.21 amps, 25 VA (50 Hz) 0.19 amps, 23 VA (60 Hz) 650 A through 1200 A units: 1.4 amps, 168 VA (50 Hz) 1.2 amps, 144 VA (60 Hz)
Ambient temperature range	Operation: 32°F to 122°F (0°C to 50°C) Storage: 14°F to 158°F (-10°C to 70°C)
Weight and Dimensions	Current Rating (amps) / lbs / Kg / Height / Width / Depth 15, 25, 40, 60 — 16.5 — 7.5 — 11.00 — 8.125 — 6.875 90, 120 — 16.5 — 7.5 — 9.00 — 9.000 — 9.062 180, 225 — 20.0 — 9.1 — 16.69 — 9.440 — 9.310 350, 500 — 24.0 — 10.6 — 21.00 — 14.250 — 7.880 650 — 47.0 — 21.4 — 24.00 — 16.750 — 12.000 800, 1000, 1200 — 71.0 — 32.3 — 33.00 — 16.750 — 14.500
Outline and mounting	See appropriate drawing in back of manual.

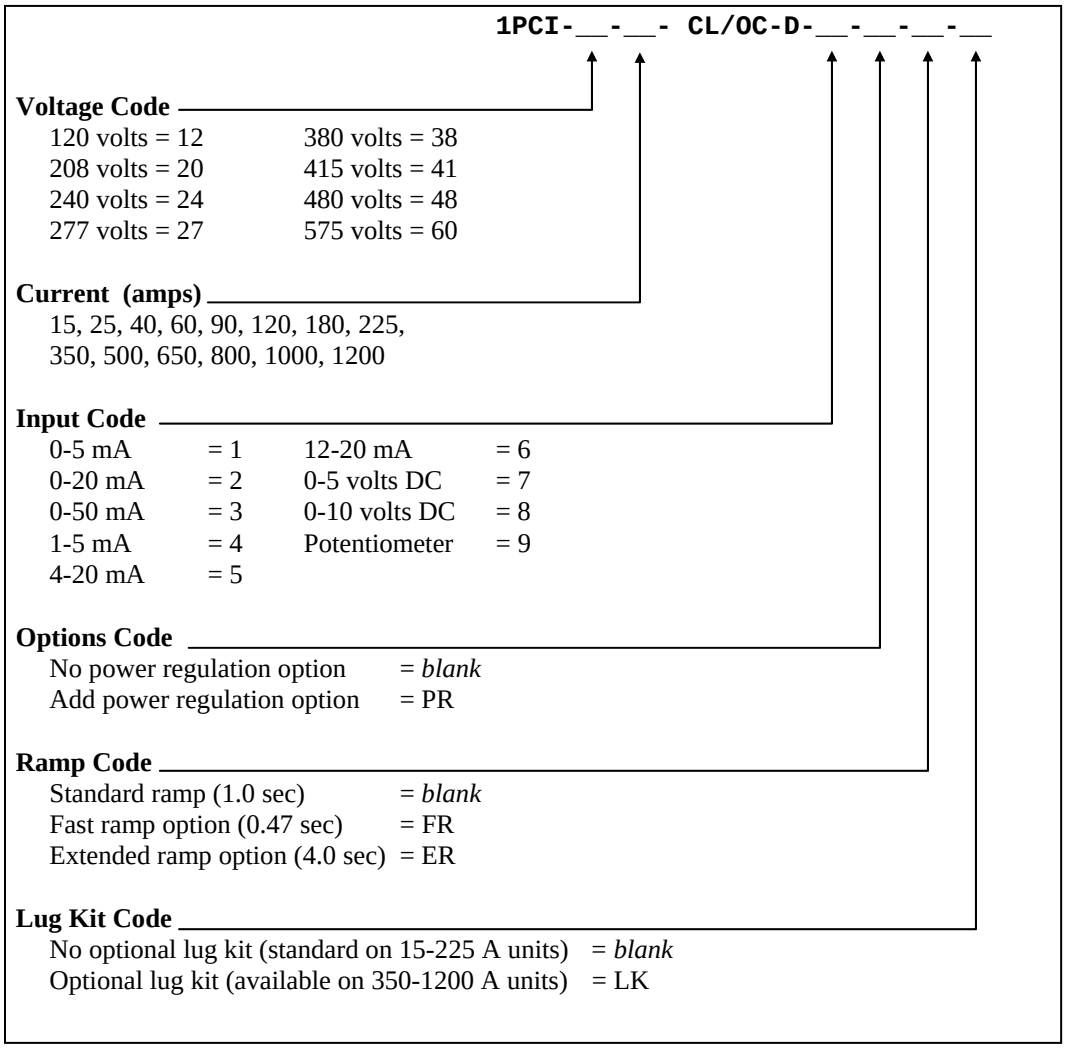
[1] - Item is to be specified with order.

[2] - For temperature controller or process controller applications, the output type (e.g., 4-20 mA, 0-10 Vdc, etc.) must be specified. Refer to Table 1-2 on page 1-6.

1.7. Ordering Information

1PCI SCR power controllers are ordered by part number. The actual part number defines many of the features of the controller (e.g., the voltage, current, input type, etc.) as well as options. Refer to Table 1-2 for ordering information.

Table 1-2. Ordering Information for the 1PCI Series



For example, use the following part number to order a single-phase power controller that is 480 V, 120 A, has a 4-20 mA input with a power regulation option, an extended ramp, and no lug kit (not necessary).

1PCI-48-120-CL/OC-D-5-PR-ER

Note: Voltage and current ratings are implicit in the model number.

Attention! The 1PCI should be tested and operated with an adequate load since an open output will have line voltage at the load connections. A minimum test load of 3A (AC) is recommended.

1.8. Safety Precautions and Warnings

The 1PCI power controllers are designed with considerable thought to personal safety. However, as in any electrical or electronic equipment, there are exposed connections that present **potentially lethal voltages**. In addition to the high voltages that are present, the heat sinks may become thermally hot to the touch. The warnings shown below should be followed when working in or near 1PCI Series power controllers.

Caution - Electrical Hazard! Only qualified individuals should install, operate, troubleshoot, and maintain this product. A qualified individual is "one familiar with the construction and operation of the equipment and the hazards involved."	
Caution - Electrical Hazard! Never touch any component of the 1PCI until verifying that it is neither thermally hot nor electrically live.	
Caution - Electrical Hazard! Always work with one hand, wear insulated or rubber safety shoes, and wear safety glasses. Also, always work with another person present.	
Never connect any grounded (i.e., non-isolated) meters or oscilloscopes to the 1PCI system.	
Never connect or disconnect any meters or wiring while the 1PCI system is energized.	
Always be careful to prevent meter leads from shorting together or from touching other terminals.	
Never store flammable material on or near the 1PCI system. This includes equipment drawings and manuals.	

Additional safety precautions and warnings appear throughout this manual. These important messages should be followed to reduce the risk of personal injury or equipment damage.

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CHAPTER 2: SETUP AND OPERATION

In This Section:

- Introduction 2-1
- Unpacking the 1PCI Power Controller 2-1
- Mounting the 1PCI 2-1
- Fan Wiring (Models Rated 180 A and Higher). 2-1
- Wiring Heat Sink Thermostats 2-2
- Input/Output Wiring 2-2
- Voltages 2-2
- Options 2-3
- CT Installation 2-3
- Standard Operation and Setup Methods 2-3

2.1. Introduction

This section of the manual explains how to install, setup and operate the 1PCI power controller.

2.2. Unpacking the 1PCI Power Controller

Due to the wide range of controller sizes in the 1PCI Series, packaging is divided into two categories. Large sized controllers are securely wrapped and packaged onto pallets for shipment. Smaller controllers are shipped in foam-filled boxes. In either case, exercise care in handling and unpacking the 1PCI controller.

Upon delivery, immediately inspect the container for visible signs of damage. Report any damage to the appropriate carrier.



2.3. Mounting the 1PCI

Determine the voltage and current ratings from the nameplate of the unit. Then determine space and mounting hole requirements by referring to the outline drawing (at the end of Chapter 3) that applies to your model's current rating. Mount the unit so that the line and load connections are at the top and ensure that upward air flow over the heat sink fins is unrestricted. On high current models, allow adequate clearance for routing the relatively large diameter input and output lines.

Caution! Printed circuit boards contain sensitive components that can be damaged by electrostatic discharge (ESD). Avoid handling the printed circuit board unless ESD protection has been observed. Details concerning ESD protection can be found in the Troubleshooting Section of this manual.



2.4. Fan Wiring (Models Rated 180 A and Higher)

1PCI models with cooling fans require 120 Vac power which must be supplied by the customer. Power requirements are shown in the Technical Specifications section of Chapter 1.

Fan connection terminals (120 Vac) for the 1PCI are shown in the drawings in the back of this manual. Locate the correct drawing for your model's current rating.



Caution! It is the customer's responsibility to ensure that applying fan power precedes, or coincides with, the turn-on of the line voltage source to be controlled by the 1PCI.

Caution! It is the customer's responsiblity to ensure that applying fan power precedes, or coincides with, the turn-on of the line voltage source to be controlled by the 1PCI.

2.5. Wiring Heat Sink Thermostats

The recommended connections for the heat sink thermostat are shown below in Table 2-3.

Table 2-3. Heat Sink Thermostat Connections (Recommended)

Terminal Number	Trigger Circuit Terminal Number	Function
23	3	Inhibits the SCR output in the event of a fan failure or high ambient temperature conditions.
24	4	

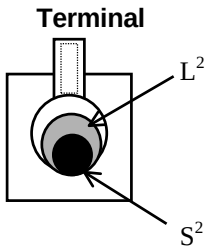
2.6. Input/Output Wiring

Using appropriately sized and insulated conductors for the voltage and current ratings of your model, make connections as shown in Figure 2-3 (on page 2-3). (Refer to Table 2-4 for wire size information.) Torque specifications of bolted connections can be found at the end of Chapter 3: Troubleshooting.

Note: Wiring rated at 75°C is required for all 1PCI model current ratings.

Warning! Branch circuit overcurrent protection is required and must be provided in accordance with the national and local codes of the inspecting authority.

Table 2-4. Lug Size Information



Current Rating	Size Range, Each Conductor S	L
15, 25, 40, 60, 90, 120 A	8 AWG	0 AWG
180, 225 A	6 AWG	250 MCM [1]
350 A through 1200 A	*not applicable*	

[1] - MCM = 1,000 CM (circular mils). 1 CM = Area OD circle of 0.001 in diameter.
[2] - L = Largest allowable conductor size. S = Smallest allowable conductor size.

Note: For units at 350-1200 A, wire lugs are mounted directly to the bus bar.

2.7. Voltages

The 1PCI may be ordered for any line voltage shown in the technical specifications portion of Chapter 1.

2.8. Options

Options, if ordered by the customer, have been installed and set up at the factory. However, if the current transformers (CTs) are shipped loose, they should be placed on the load lines when the load lines are connected (see Figure 2-3), and wired as indicated on the applicable option schematic (located at the end of this manual).

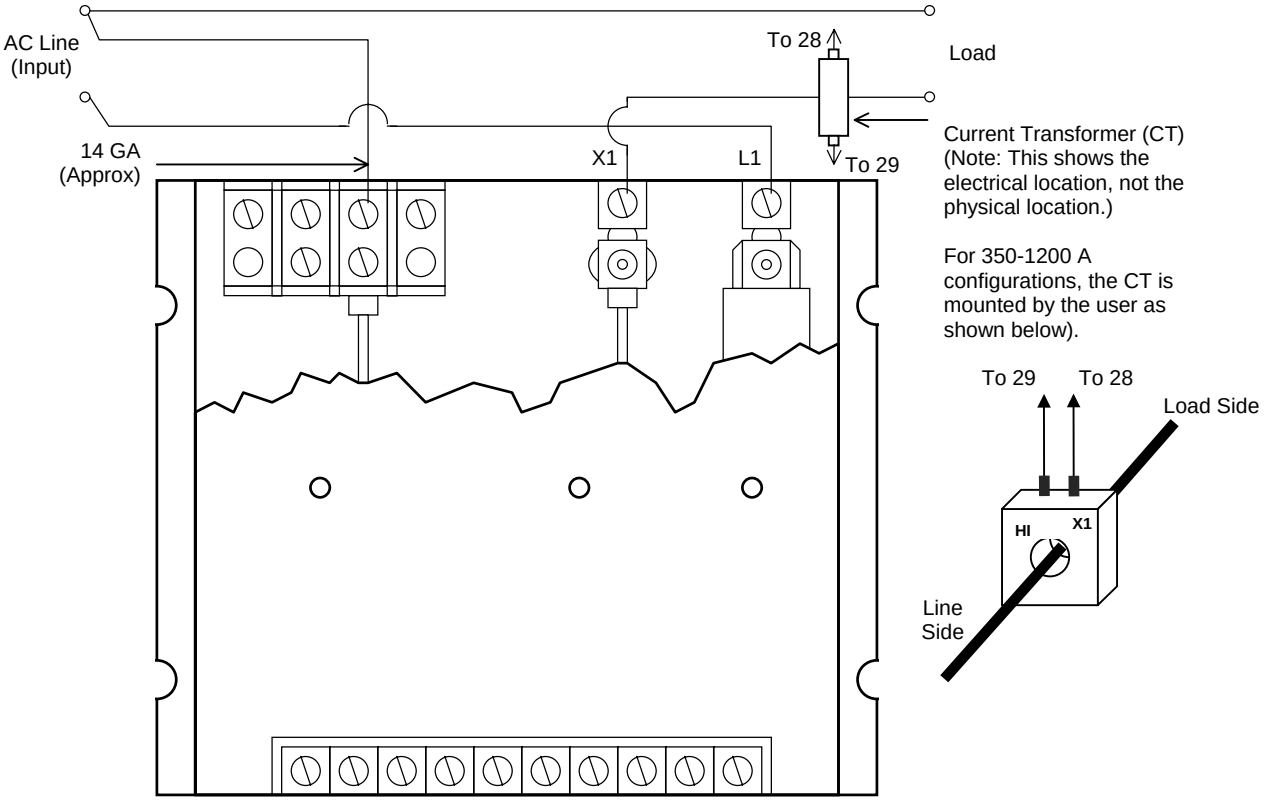


Figure 2-3. Typical 1PCI Line and Load Connections

2.9. Standard Operation and Setup Methods

This section provides information necessary for proper setup and operation of various methods used to control the 1PCI. These methods are:

1. Internal manual control of power output
2. Temperature controller
3. Manual control with a remote potentiometer
4. Auto/manual control with a controller or potentiometer
5. On/off control (shutdown - output disabled)
6. Controlling several 1PCIs connected in parallel
7. Single-phase overcurrent trip (OC)
8. Single-phase current limit (CL)
9. Current limit/overcurrent trip - remote reset.

Each of these operation methods is explained in the sections that follow.

Caution - Electrical Hazard! Hazardous voltages exist at the 1PCI output terminals and at the load when the input voltage is connected. This condition exists even when the 1PCI is set to deliver zero output, by any of the control methods described in this section. The line input fused disconnect or circuit breaker must be open or OFF to perform maintenance of any kind, including at the load.

Note: For the following procedures, measurements of the output voltage should be made with an analog voltmeter.

_____1. Apply power to the unit.
_____2. Apply a 4.0 mA DC input signal. Verify that the output current is zero (0).
_____3. Apply a 20.0 mA DC input signal. The output current should be at the maximum level. The output voltage should be the input voltage minus 2 VDC.
_____4. Apply a 12.0 mA DC input signal (50%). The output should be approximately one half the rated current and approximately one half the full RMS output voltage.



It is not necessary to adjust the bias and gain values - they are set at the factory based on each customer's order.

2.9.2. Temperature Controller

A wide range of controller outputs can be used to drive the 1PCI. The range of acceptable full scale output voltages is 1.5 to 15 VDC for non-isolated input configuration (5 to 10 VDC for isolated inputs). Since most controllers have a current output, the input impedance of the 1PCI may have to be changed to accommodate your controller. Table 2-5 depicts some typical alterations to the impedance of the 1PCI to match it to various controllers.

Table 2-5. Matching SCR Power Control to External Controller Signal

Input Type	Input Signals	Input Impedance [1]
Voltage Input	0-1.5 V to 0-15 V 1-5 V or 2-10 V	150 KΩ
Current Input	0-1 mA to 0-3 mA 0-3 mA to 0-30 mA 4-20 mA	249 Ω

[1] *- Consult factory for other input impedances.*

Calibration of a 1PCI for use with a temperature controller with a 4-20 mA DC output can be accomplished using the procedure that follows.

1. Apply the minimum temperature or 4.0 mA DC.
2. With a volt meter connected from X1 to L2, adjust the BIAS to get a voltage reading as near to zero as possible. If available, an ammeter is better to use than a volt meter because it allows the operator to make a zero adjustment more accurately.
3. Apply the maximum temperature or 20.0 mA DC.
4. Adjust the GAIN so that the full controller output is read on a volt meter or ammeter.

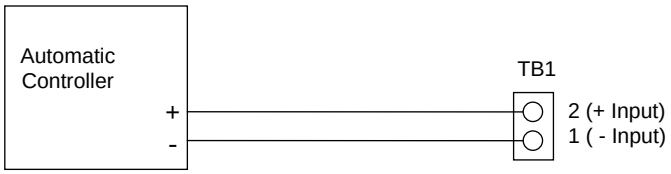


Figure 2-4. Automatic Controller Input Connections

2.9.3. Manual Control with a Remote Potentiometer

This potentiometer may be located on a remote panel near other controls related to the process being powered by the 1PCI. It may be calibrated to correspond to a percentage of rated power output, process temperature, or some other parameter. The potentiometer may be 2 KΩ to 100 KΩ, and should be rated at 1/2 watt, minimum.

_____1. With the power to the 1PCI turned off, connect the potentiometer as shown in Figure 2-5. The CW position is the full power output position. Terminal **TB1-5** is internally connected to a positive DC voltage source.
_____2. Adjust the manual pot to the full CCW position.
_____3. Adjust the **BIAS** pot so that the output current is zero.
_____4. Adjust the manual pot to the full CW position.
_____5. Adjust the **GAIN** pot for just full output voltage or current.
_____6. Adjust the current limit of the output needs to be current limited. Note that the current limit is adjusted at the factory for the full current rating on the label.

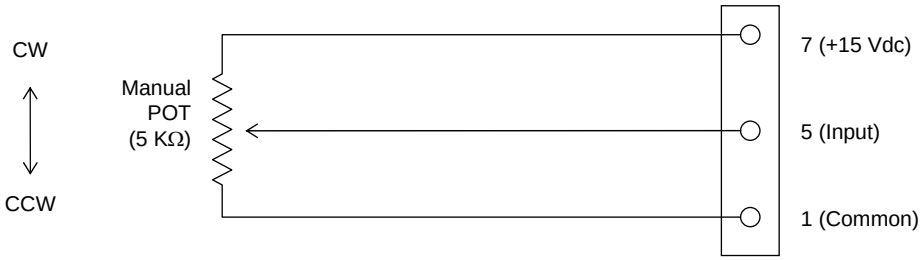


Figure 2-5. Remote Control with a Potentiometer

Caution - Electrical Hazard! Hazardous voltages exist at the exposed 1PCI heat sinks and at the load unless the line-source fused disconnect or circuit breaker is open or off. This is true even when the SCRs are turned off. Always remove power to the unit before attempting service.

2.9.4. Auto/Manual Control with a Controller or Remote Potentiometer

Select and install the remote potentiometer as detailed in the previous section. Install the **AUTO/MAN** switch in the same general location as the remote manual potentiometer.

With the power to the 1PCI turned off, connect the switch, potentiometer, and controller as shown in Figure 2-6. Note that the full CW position of the potentiometer is the full-power-output position.

Set the **AUTO/MAN** switch to AUTO and calibrate the system as described in Steps 1 through 8 in Section 2.9.2: Temperature Controller on page 2-4.

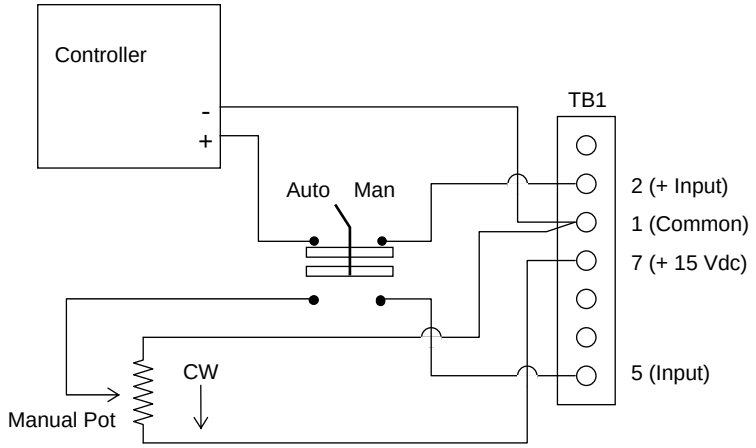


Figure 2-6. Auto/Manual Control with Controller and Remote Potentiometer

2.9.5. Shutdown (Output Disabled)

The output of the 1PCI may be disabled as shown in Figure 2-7.

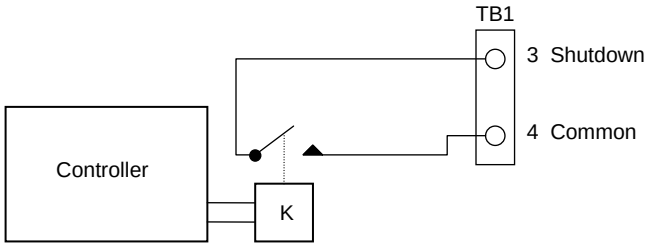


Figure 2-7. Shutdown (Output Disabled by Contact Closure)

2.9.6. Controlling Several 1PCIs in Parallel with One Controller

Multiple control of parallel connected 1PCIs with a single controller is outlined below.

1. Connect each unit as shown in Figure 2-8. Refer to Section 2.9.2: Temperature Controller on page 2-4.
2. Remove the external shunt resistor **R101** on all of the units.
3. Connect the remaining units as shown in Figure 2-8.
4. Connect the appropriate impedance matching resistor (RC) for your controller across the output terminals of the controller as shown in Figure 2-8. This will assure proper operation of all controllers. RC is usually 250Ω or 500Ω.
5. Calibrate the system as outlined in Section 2.9.2: Temperature Controller on page 2-4.

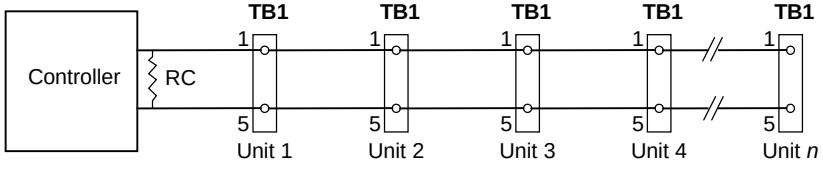


Figure 2-8. Controlling Several 1PCIs Connected in Parallel

2.9.7. Single-phase Overcurrent Trip (OC)

Review the setup procedure for the **BIAS** and **GAIN** controls (refer to Section 2.9.2: Temperature Controller on page 2-4). Then make the following adjustments:

_____1. Adjust the OC potentiometer fully CCW (P5).
_____2. Adjust **BIAS** and **GAIN** as described in Section 2.9.2: Temperature Controller on page 2-4.
_____3. With the power controller at full output, adjust OC LEVEL potentiometer CW until the unit shuts off.
_____4. Adjust the OC potentiometer slightly CCW.
_____5. Momentarily press the RESET push-button.

2.9.8. Single-phase Current Limit (CL)

Review the setup procedure for the BIAS and GAIN controls (refer to Section 2.9.2: Temperature Controller on page 2-4). Then make the following adjustments:

_____1. Adjust the CURRENT LIMIT potentiometer fully CW (P3).
_____2. Adjust BIAS and GAIN as previously described.
_____3. Adjust the CURRENT LIMIT potentiometer full CCW.
_____4. Increase the input control signal to demand full output.
_____5. Adjust the CURRENT LIMIT potentiometer until maximum current level is reached.

2.9.9. Current Limit/Overcurrent Trip-Remote Reset (CL/OC-RR)

After reviewing Section 2.9.2: Temperature Controller on page 2-4, make the following adjustments:

_____1. With the OC LEVEL potentiometer fully CW, complete the adjustments described in Section 2.9.8: Single-phase Current Limit (CL).
_____2. With the power controller at full output, adjust the OC LEVEL potentiometer CCW until the unit shuts off.
_____3. Adjust the OC LEVEL potentiometer slightly CW.
_____4. Momentarily press the RESET push-button.

2.9.10. Reset Push-button (User Supplied)

_____1. Connect a normally-closed (N.C.) push-button switch to **TB2**, terminals **12** and **13**.
_____2. Remove jumper **J3** from the PC board.



NOTE: O.C. trip relay contacts are available at terminals **TB2-9**, **TB2-10**, and **TB2-11**.

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CHAPTER 3: TROUBLESHOOTING

In This Section:

- Introduction 3-1
- Static Precautions When Servicing.....3-1
- Troubleshooting Typical Symptoms.....3-2
- Diagnosing Environmental Problems.....3-2
- Checking Input Power and Load Connections 3-3
- Further Diagnosis of Common 1PCI Symptoms.....3-3
- Communications with the Factory.....3-5
- Spare Parts Orders 3-6
- Drawing List 3-7

3.1. Introduction

Although service is seldom necessary (due to the inherent long-term reliability of solid-state components and conservative design), ASIRobicon emphasizes customer satisfaction by maintaining rapid-response, cooperative customer service. If operational difficulties occur, ASIRobicon will provide replacement parts for units quickly, courteously and efficiently. If servicing problems arise that are not within the scope of standard troubleshooting outlined in this chapter, service is readily available from the factory.

If a problem arises, perform the following steps to ensure quick, efficient and effective diagnosis and corrective action.

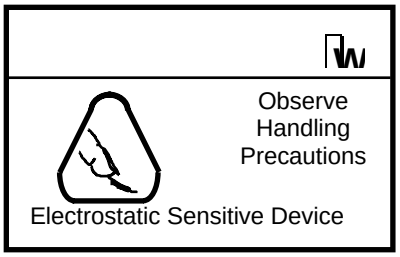
- Observe proper static precautions
- Troubleshoot typical symptoms (i.e., environmental problems, input power and load connections, and 1PCI problems)
- Comprehensive 1PCI testing.

Each of these operations is outlined in the sections that follow.

3.2. Static Precautions When Servicing

Servicing of the 1PCI unit should be performed by qualified personnel only, following the procedures described in this section.

If troubleshooting indicates a need to replace a component on a printed circuit board or possibly the entire board, measures to prevent electrostatic discharge (ESD) damage must be taken.



Caution - Electrical Hazard! Hazardous voltages exist at the exposed 1PCI heat sinks and at the load unless the line source fused disconnect or circuit breaker is open or off. This is true even when the SCRs are turned off. Always remove power to the unit before attempting service.



1. **ALWAYS** wear a wrist strap connected to ground through a 1 megohm resistor when working on printed circuit boards.
2. Use a soldering iron with a grounded tip.
3. Use a non-static generating solder sucker (metallic) or solder removal braid.

4. Transport static sensitive components in static shielding bags or rails. A new printed circuit board should be treated as a static sensitive device. A part completely insulated on a board does not make the part static-safe.
5. If possible, perform printed circuit board maintenance at a workstation that has a conductive covering which is grounded through a 1 megohm resistor. If a conductive tabletop cover is unavailable, a clean steel or aluminum tabletop is an excellent substitute.
6. Keep plastic, vinyl, Styrofoam or other non-conductive materials away from printed circuit boards. They are good static generators that do not give up their charge easily.
7. Return goods to ASIRobicon is static-safe packaging. This will limit further component damage from ESD.
8. **CAUTION:** Do not touch any printed circuit board unless you are wearing a grounded wrist strap, as circuit damage may occur.



Note: A field service grounding kit is available from ASIRobicon. Grounding kits are also available commercially and can be purchased through most electronic wholesalers.

3.3. Troubleshooting Typical Symptoms

The 1PCI is considered to be operating properly when its output voltage can be satisfactorily varied from 0% to 97% of the available input voltage by a control signal. Improper operation of the unit is usually indicated by one of the following symptoms:

1. No output
2. Full output at all times, with no change resulting from a control signal change
3. Output variable from some intermediate value to maximum, but cannot be brought to zero
4. Output variable from zero to some intermediate value, but cannot be brought to maximum.

The symptoms listed may be caused by one or more of the following:

- an environmental problem
- faulty input-power or load connections
- the 1PCI itself.

3.3.1. Diagnosing Environmental Problems

Check to see that none of the following environmental problems exist.

Inadequate Cooling. For models with separate power and trigger modules, allow at least an inch of air space (in any direction) between the heat sinks and any item or structure near the 1PCI power modules. Heat sink fins should be free of dust or dirt for proper heat transfer, and free of obstructions which could prevent proper airflow.

Contamination. The unit should be periodically cleaned of all dust and dirt. However, certain kinds of dust or particles are particularly conductive. A small accumulation of conductive material can cause component failures from arc-over or complete shorts.

High Ambient Temperature. Lack of a proper ambient-temperature check before installation, or an increase in ambient temperature, can result in numerous problems. Check the ambient temperature under existing conditions. If it is 122°F (50°C) or lower, ambient temperature should not be a problem. If it is above 122°F (50°C), steps should be taken to provide more cooling, or the 1PCI should be moved to a cooler location, or call the ASIRobicon service department.

Excessive Vibration. A significant degree of pitched or unpitched vibration can cause numerous problems. If vibration is isolated as a probable cause of improper operation, standard vibration-isolation mounting techniques should be employed.

3.3.2. Checking Input Power and Load Connections

Turn off the power to the 1PCI and check all power connections, input and output, to make sure they are mechanically secure and free of corrosion. Make the same checks at the power source and load. Visually check insulation on input and load wiring for evidence of damage or overheating. Torque specifications are given in Table 3-6 and Table 3-7.

Table 3-6. Torque Specifications for Slotted-head and Hex-head Screws

	Torque (in-lbs)		
I/O Conductor Size, AWG or Circular Mils	**Slot Width [1] ≤ 1/4″**	**Slot Width [1] > 1/4″**	**Hex Head (All)**
6-4 AWG	35	45	110
2 AWG	40	50	150
1 AWG	--	50	150
1/0-2/0 AWG	--	50	180
3/0-4/0 AWG	--	--	250
250-350 CM	--	--	325

[1] - Screwdriver blade width to match

Table 3-7. Torque Specifications for Socket-head Screws (All Conductor Sizes)

Socket Size (inches) (Across Flats)	Torque (in-lbs)
3/16″	120
1/4″	200
5/16″	275
3/8″	375
1/2″	500

NOTE: All input/output conductors should have a minimum temperature rating of 75°C.

3.3.3. Further Diagnosis of Common 1PCI Symptoms

Table 3-8 provides a comprehensive guide for troubleshooting the 1PCI. Refer to this table for possible causes and solutions.

Table 3-8. Troubleshooting the 1PCI (Symptoms and Solutions)

Symptom	Possible Cause	Solution
No output even with manual control (BIAS) turned full CW.	(1a) Open SCR fuse (1b) SCRs not firing	Remove and check the fuse. If it has opened, install a good fuse in the circuit (see Table 3-9), and apply power to the 1PCI. If the output is fully controllable in manual control mode (using the new fuse), then resume normal operation. If the power output is still zero, contact ASIRobicon service.
Maximum power at all times regardless of control setting.	(2a) All SCR networks are shorted	**On units rated above 225 A:** Remove the fuse and check the front-to-back SCR pairs by measuring resistance between the cathode of the SCR being checked and an unanodized portion of the heat sink. On the Rx1 scale, the resistance should be infinite in both directions. If a shorted component is indicated in any of these checks, replace it. **On units rated at 225 A and below:** Remove the fuse and check the front-to-back SCR pairs by measuring resistance between terminals L1 (of the SCR) and X1. On the Rx1 scale, the resistance should be infinite in both directions. If a shorted component is indicated in any of these checks, replace it.
	(2b) Firing control section defective	Replace the fuse (see Table 3-9) and return the power to the unit. If the problem persists, contact ASIRobicon service.
Output is variable, but can't be brought to zero with BIAS control	(3a) SCR network shorted	Check SCR network per solution 2a (above).
	(3b) Firing control section defective	Contact ASIRobicon service for assistance.
Output is variable, but can't be brought to maximum with GAIN control	(4) Firing control section defective	Contact ASIRobicon service for assistance.

Table 3-9 lists the replacement fuses for the various 1PCI models. The 1PCI may come supplied with fuses having identifying numbers different from the numbers shown in the table. In such a case, the fuse may be replaced either with an identical fuse or the one shown in the table.



Note: Arbitrary substitution of improper fuses may void the warranty. The 1PCI may be supplied originally with fuses with identifying numbers different from the ones shown in the table. Either fuses with original number or with the number given in the table may be used for replacement.

Table 3-9. Vendor Part Numbers 1PCI Fuse Specifications

Amps	Buss	Gould-Shawmut	Carbone-Ferraz	Brush
15	KAC25	*n/a*	*n/a*	*n/a*
25	FWP-35	A70P35-4	*n/a*	XL70F035
40	FWP-50A	A70P50-4	A070F050	*n/a*
60	FWH-70A	*n/a*	*n/a*	*n/a*
90	FWP-125A	A70P125-4	A070F125	*n/a*
120	FWP-150A	A70P150-4	A070F150	*n/a*
180	FWP-225A	A70P225-4	A070F225	*n/a*
225	FWP-300A	A70P300-4	A070F300	*n/a*
350	FWP-450A	*n/a*	A070F450	*n/a*
500	FWP-600A	A70P600-4	A070F600	*n/a*
650	FWP-800A	A70P800-4	A070F800	*n/a*
800	FWP-1000A	A70P1000-4	A070F1000	*n/a*
1000	FWP-1200A	A70P1200-4	A070F1200	*n/a*
1200	*n/a*	A70P1600-4	A070F1600	*n/a*

3.5. Spare Parts Orders - Routine or Emergency

Requests for spare parts should be directed to the Inside Sales Department at ASIRobicon during normal hours, if possible, or via any method shown above for off-hours. Often we can provide same-day delivery under critical circumstances. When contacting us, please present as much information as possible. This includes the following information: the related equipment model number, the serial number, the required part name, any identifying part or vendor number(s), and your schedule requirements. An approved purchase order number should be given with your order.

The following table lists the minimum recommended quantities for spare parts for the 1PCI. As spares are used, replacements should be ordered.

The listed SCR current ratings are the half-wave average values. The calculation for half-wave average value is nameplate current times 0.45.

Table 3-10. 1PCI Spare Parts List

Size	Item	Item Number	Qty Used
15 Amp	Fuse, 25 Amp 600 Volt SCR Module PWB Assy, #1 DVDT Trigger, PWB Assy.	004096 068059 168100.04 *consult factory*	1 1 1 1
25 Amp	Fuse, 35 Amp 700 Volt SCR Module PWB Assy, #1 DVDT Trigger, PWB Assy.	261277.22 087451 168100.05 *consult factory*	1 1 1 1
40 Amp	Fuse, 50 Amp 700 Volt SCR Module PWB Assy, #1 DVDT Trigger, PWB Assy.	261277.24 087451 168100.05 *consult factory*	1 1 1 1
60 Amp	Fuse, 70A, 700V PCB assembly, 1PCI trigger PCB assembly, SCR module #1, *DVDT VAR* SCR/dual package, 92 A, 1400 V	261277.26 *consult factory* 168100.05 H011024	1 1 1 1
90 Amp	Fuse, 125 A, 700 V PCB assembly, 1PCI trigger PCB assembly, SCR module #1, *DVDT VAR* SCR/dual package, 92 A, 1400 V*	261277.30 *consult factory* H023870 H011024	1 1 1 1
120 Amp	Fuse, 150 A, 700 V PCB assembly, 1PCI trigger PCB assembly, SCR module #2, *DVDT VAR* SCR/dual package, 142 A, 1400 V*	261277.31 *consult factory* H023871 H017371	1 1 1 1
180 Amp	Fan, axial, 115 Vac, 110 CFM Fuse, 225 A, 700 V PCB assembly, 1PCI trigger PCB assembly, SCR module #2, *DVDT VAR* SCR/dual package, 142 A, 1400 V*	H018659 H018813 *consult factory* H023871 H017371	1 1 1 1 1

Size	Item	Item Number	Qty Used
225 Amp	Fan, axial, 115 Vac, 110 CFM Fuse, 300 A, 700 V PCB assembly, 1PCI trigger PCB assembly, SCR module #2, *DVDT VAR* SCR/dual package, 162 A, 1400 V*	H018659 261277.34 *consult factory* H023871 H019070	1 1 1 1 1
350 Amp	Fan, axial, 115 Vac, 110 CFM Fuse, 450 A, 700 V Lug kit, single-phase 350 A, CSA Certified PCB assembly, 1PCI trigger SCR 298 A, 1400 V	H018659 H019253 H020477 *consult factory* 068237	1 1 1 1 2
500 Amp	Fan, axial, 115 Vac, 110 CFM Fuse, 600 A, 700 V PCB assembly, 1PCI trigger SCR 508 A, 1400 V Varistor, 660 V	H018659 261277.38 *consult factory* H020035 H026669	1 1 1 2 1
650 Amp	Fan, axial, 115 Vac, 350 CFM Fuse, 800 A, 700 V PCB assembly, 1PCI trigger SCR 589 A, 1400 V Varistor, 660 V	074892 261277.40 *consult factory* 261095.34 H026669	1 1 1 2 1
800 Amp	Fan, axial, 115 Vac, 350 CFM Fuse, 1000 A, 700 V PCB assembly, 1PCI trigger SCR 719 A, 1400 V Varistor, 660 V	074892 261277.42 *consult factory* 261300.34 H026669	1 1 1 2 1
1000 Amp	Fan, axial, 115 Vac, 350 CFM Fuse, 1200 A, 700 V PCB assembly, 1PCI trigger SCR 1329 A, 1400 V Varistor, 660 V	074892 085293 *consult factory* H020038 H026669	1 1 1 2 1
1200 Amp	Fuse, 1600 Amp 700 Volt SCR 1329 A, 1400 V Varistor, 660V PCB assembly, 1PCI Trigger Fan 115 Volt, 350 CFM	H013430 H020038 H026669 (2157) *consult factory* 074892 (5736)	1 2 1 1 1

3.6. Drawing List

This section contains drawings that show outline dimensions, installation wiring, and printed circuit board component locations, as well as an overall schematic of the 1PCI. These drawings are useful in installing and troubleshooting all 1PCI models. Table 3-11 lists the drawings in the order of their appearance.

Table 3-11. 1PCI Drawing List

Drawing Title	Drawing Number
Outline and Mounting, 1PCI - 15 through 60 A	405586
Schematic, 1PCI - 15 A through 60 A	374162
Outline and Mounting, 1PCI - 90 through 120 A	405486
Outline and Mounting, 1PCI - 180 through 225 A	405840
Schematic, 1PCI - 90 through 225 A	374160
Outline and Mounting, 1PCI - 350 through 500 A	405590
Outline and Mounting, 1PCI - 650 A	405591
Outline and Mounting, 1PCI - 800 through 1200 A	405490
Schematic, 1PCI - 350 A through 1200 A	374151

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CHAPTER 4: WARRANTY POLICY AND PRODUCT LIABILITY

In This Section:

- Guarantee and Product Liability 4-1
- In-House Repair Service 4-1
- Field Service Repairs 4-2

This chapter details the warranty policy of ASIRobicon products as well as product liability information. ASIRobicon's standard warranty policy is listed below. Note that the warranty policy for a particular job agreement may be different from the standard policy. When in doubt about warranty information, consult the factory.

4.1. Guarantee and Product Liability

ASIRobicon's "standard" warranty policy is listed as follows. When in doubt about warranty and/or product liability issues, consult the factory. All products are warranted for a period of two years from date of shipment against defects in materials or workmanship. Guarantee repairs are to be performed FOB (free on board) ASIRobicon factory to qualify for no charges. ASIRobicon's liability and customer's exclusive remedy under this warranty are expressly limited to repair, replacement, or repayment of the purchase price. Whether there shall be repair, replacement, or repayment is to be exclusively ASIRobicon's decision. ASIRobicon is not liable for incidental and consequential damages.

This warranty shall not apply to major devices or equipment such as transformers not manufactured by the seller or to equipment or parts which shall have been repaired or altered by others than the seller so as, in its judgment, to affect adversely the same, or which shall be subject to negligence, accident, or damage by circumstances beyond the seller's control. For equipment and parts not manufactured by the seller, the warranty obligations of the seller shall in all respects conform and be limited to the warranty extended to the seller by the supplier.



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NOTES

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INDEX

Note that locator page numbers appear in regular type faces for standard index references (e.g., 7-10). For index references that correspond to items found in tables, the locator page numbers are shown in an italic type face (e.g., *6-24*). For index references that correspond to items found in figures and illustrations, the locator page numbers are shown in a boldface type face (e.g., **3-3**). Illustrations that appear in tables have locator page numbers that are both boldface and italic (e.g., ***6-16***).

—Numbers—

1 megohm resistor, 3-2
1PCI line, 2-3
1PCI power controllers, 1-1
1PCI series power controller, 1-4
50/60 Hz operation, 1-3

—A—

alarm, 1-3
ambient temperature, 1-5
analog voltmeter, 2-3, 2-4
arc-over, 3-2
auto control, 2-5
auto/manual switch, 2-5
auto/manual control, 2-3, 2-6
automatic controller, 2-5
automatic restart circuitry, 1-1

—B—

bias control, *1-2*, 2-4
branch circuit, 2-2

—C—

calibration, 2-4
CCW, 2-4
chop-off limiter, *1-2*
CL, 2-3, 2-7
CL/OC-D feature, 1-2
cold-to-hot resistance, 1-2
conditions, 4-2
contamination, 3-2
control, 4-1
  input impedance, 1-2
  input signal, 1-1
  signal input, 1-5
  signal isolation, 1-5
  signals, 1-3
controller, 1-2
  outputs, 2-4
cooling fans, 2-1
cosine intercept circuit, 1-2
cosine intercept linear phase control, 1-3
CTs, 1-3, 2-2
  installation, 2-3
current, 2-1
  limit, 1-1, 1-2, 2-3, 2-7
  output, 2-4
  ratings, 1-5, 2-1
  transformer, 1-2, 1-3, 2-2
    feedback, 1-2
    installation, 2-3
    rating, 1-2

—D—

digital firing circuit, 1-2
digital logic circuitry, 1-3
dimensions, 1-5
drawing, 3-1, 3-7
dv/dt protection, 1-3

—E—

electrostatic discharge (ESD), 2-1
elements, 1-2
equipment drawings, 1-7
excessive vibration, 3-3
expedited service, 4-2
extended ramp, *1-4*

—F—

factory, 4-1
fan power, 2-2
fan wiring, 2-1
fan cooled, 1-2
fast ramp, *1-4*
feedback, 1-3
flammable material, 1-7
fuses, 3-4

—G—

gain, 2-4
  controls, *1-2*
gate trigger unit (GTU), 1-3
gating, 1-2

—H—

hard drive gate output circuits, 1-3
hardware, 1-1, 1-4

hazardous voltages, 2-3, 2-5
heat sinks, 1-7
  temperature, 1-2
  thermostat, 1-2, 1-3, 2-2
hex-head screws, 3-3
high ambient temperature, 3-2
high inrush currents, 1-2
high-speed electronic overload trip, 1-2

—I—

inadequate cooling, 3-2
inductive loads, 1-1
infinite firing angle resolution, 1-1
in-house repair, 4-1
input
  impedance, 2-4
  line voltages, 1-5
  power, 3-1, 3-3
  signal choices, 1-5
  wiring, 2-1, 2-2
installation, 1-7, 2-1
  CTs, 2-3
instantaneous trip mode, 1-2
insulation, 1-7
internal manual control, 2-3, 2-4
inverse, 1-3
inverse-parallel, 1-2

—K—

key hardware components, 1-4

—L—

line frequency, 1-5
linear current limit, 1-2
load
  connections, 2-3, 3-3
  resistance, 1-2
  shorts, 1-2

—M—

manual control, 2-3, 2-5
maximum output voltage, 1-2
meters, 1-7
mounting, 1-5, 2-1
MOV-capacitor-resistor networks, 1-3

—N—

N.C. (normally closed), 1-3, 1-4
N.O. (normally open), 1-2, 1-3
nameplate, 2-1
noise, 1-3
nominal gain setting, 1-2
non-warranty, 4-1, 4-2

—O—

OC, 2-3, 2-7
on/off control, 2-3
on-board relay, 1-2
operation, 1-7, 2-1, 2-3
order, 1-1, 1-6
oscilloscopes, 1-7
outline, 1-5
outline drawing, 2-1
output
  bursts, 1-2
  current, 1-2
  disabled, 2-6
  power, 1-3
  wiring, 2-2
overcurrent, 1-1, 2-3
  trips, 1-2, 2-3
    monitors, 1-2
  remote reset, 2-7

—P—

parallel, 2-6
phase controlled, 1-1
potentiometer, 2-5
power control, 1-2
power output, 2-4
  linearity, 1-5
  regulation, 1-5
power regulation, 1-3
power SCR protection, 1-5
PR option, 1-3
preset setpoint, 1-2
process temperature, 2-5
protective circuits, 1-2

—R—

ramp time, 1-2
rated power output, 2-5
remote control, 2-5
remote panel, 2-5
remote potentiometer, 2-3, 2-6
remote reset, 1-2
reset push-button, 1-2, 2-7
resistive loads, 1-1
response time, 1-2
RMS output voltage value, 1-1, 1-2, 1-3

—S—

safety, 1-7
  glasses, 1-7
  precautions, 1-1, 1-7
  shoes, 1-7
screwdriver-adjusted controls, 1-2
SCRs, 1-2
  firing disturbances, 1-1
  power control, 2-4
  protection, 1-3
semiconductors, 1-2
setpoint range, 1-2
setup, 2-1, 2-3
shunt trip, 1-3
shutdown, 2-6
single-phase current limit, 2-7
single-phase overcurrent trip, 2-7
single-phase power, 1-1
slotted-head screws, 3-3
socket-head screws, 3-3
soft start feature, 1-1, 1-2, 1-4
soldering iron, 3-2
spare parts orders, 3-5
standard operation, 2-1, 2-3
static, 3-1
static shielding bags, 3-2
substitution, 3-4
SW1, **1-3**
switching, 1-2

—T—

temperature controller, 2-3, 2-4
terminals, 1-1
terms, 4-2
thermally hot, 1-7
thermostats, 1-2, 1-3
  contact rating, 1-5
thyristor, 1-3
torque specifications, 2-2, 3-3
transformer-coupled loads, 1-2
transformers, 4-1
trip point, 1-2
troubleshooting, 1-7

—U—

undervoltage protection, 1-2, 1-3
unit shutdown, 1-3
unpacking, 2-1

—V—

voltage, 2-1, 2-2
  regulator preamplifier, 1-3
  surge protection, 1-3
  surge suppression, 1-2

—W—

warnings, 1-7
warranty, 4-2
warranty repairs, 4-1
water cooled, 1-4
weight, 1-5
wrist strap, 3-2

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