PHASE®PERFECT® 240V
Digital Phase Converter

Operation & Installation Manual

- Single-Phase to Three-Phase
- Solid State Technology
- 97% Efficient
SAFETY MESSAGES AND WARNINGS

To ensure safe and reliable operation of the PT Series phase converter, it is important to carefully read this manual, and to read and observe all warning labels attached to the drive before installing the equipment. Please follow all instructions exactly, and keep this manual with the equipment at all times for quick and easy reference.

Definitions of Warning Signs and Symbols

⚠️ CAUTION: Indicates a potentially hazardous situation that could result in injury or damage to the product.

⚠️ WARNING: Indicates a potentially hazardous situation that could result in serious injury or death.

⚠️ HIGH VOLTAGE: Indicates high voltage. The voltage associated with the procedures or operations referenced could result in serious injury or death. Use caution and follow instructions carefully.
READ THESE WARNINGS BEFORE INSTALLING OR OPERATING THE EQUIPMENT!

⚠️ **WARNING:** Risk of electric shock. More than one disconnect switch is required to de-energize the equipment before servicing.

⚠️ **WARNING:** Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait 30 minutes for internal charges to dissipate before servicing the equipment.

⚠️ **HIGH VOLTAGE:** This equipment is connected to line voltages that can create a potentially hazardous situation. Electric shock could result in serious injury or death. This device should be installed only by trained, licensed and qualified personnel. Follow instructions carefully and observe all warnings.

⚠️ **WARNING:** This equipment should be installed and serviced by qualified personnel familiar with the type of equipment and experienced in working with dangerous voltages.

⚠️ **WARNING:** Installation of this equipment must comply with the National Electrical Code (NEC) and all applicable local codes. Failure to observe and comply with these codes could result in risk of electric shock, fire or damage to the equipment.

⚠️ **WARNING:** Control Terminals A, B, C, are rated at 240V. Disconnect power to the main input terminals before servicing these circuits.

⚠️ **CAUTION:** Circuit breakers or fuses, proper ground circuits, disconnects and other safety equipment and their proper installation are not provided by Phase Technologies, LLC, and are the responsibility of the end user.

⚠️ **CAUTION:** Failure to maintain adequate clearance may lead to overheating of the unit and cause damage or fire.

⚠️ **WARNING:** “Suitable for use in a circuit capable of delivering not more than 5 kA RMS symmetrical amperes, 240 V maximum.” For all models except PT3160.

⚠️ **WARNING:** “Suitable for use in a circuit capable of delivering not more than 10 kA RMS symmetrical amperes, 240 V maximum.” For model PT3160.

⚠️ **WARNING:** Wire used within the motor circuit and all field wiring terminals must be rated for at least 60 C.

⚠️ **WARNING:** Use wire size suitable for Class 1 circuits.
**WARNING:** Input power connections should be made by a qualified electrician into a nominal 240V circuit with adequate current carrying capacity. Branch circuit protection to the unit should be provided by appropriate size fuses or a 2 pole, linked circuit breaker. *Circuit breaker and fuse ratings for each model are listed in Table 3.*

**CAUTION:** Use 600 V vinyl-sheathed wire or equivalent. The voltage drop of the leads needs to be considered in determining wire size. Voltage drop is dependent on wire length and gauge. Use only Copper conductors.

**CAUTION:** Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in Table 4.

**CAUTION:** The input wire gauge must be sized to accommodate the single-phase input current, which will be significantly larger than the three-phase output current to the load.

**CAUTION:** The maximum wire gauge for the input terminals is listed in Table 4.

**CAUTION:** Never allow bare wire to contact the metal surfaces.

**CAUTION:** Never connect AC main power to the output terminals T1, T2, and T3.

**WARNING:** Under certain conditions, the motor may automatically restart after a trip has stopped it. Make sure power to the drive has been disconnected before approaching or servicing the equipment. Otherwise, serious injury may occur.

**CAUTION:** Line filter capacitors should be inspected annually at a minimum. If the equipment is frequently operated under heavy load, inspection every six months is recommended.

Replacement of the capacitors every three years is recommended. These capacitors suppress electrical noise caused by the switching of the IGBTs. If they are degraded the electrical noise can damage equipment connected to the converter.

See Section 8 ROUTINE MAINTENANCE.
OVERVIEW

Congratulations on your purchase of a Phase Perfect® digital phase converter (PT Series). This device features the latest advances in solid state power switching electronics to provide outstanding performance. It provides clean, balanced power for operating a wide variety of electrical equipment. The PT Series is available in a variety of configurations and sizes to fit your power needs.

KEY FEATURES AND BENEFITS:

- Clean, balanced power under all load conditions for even the most demanding applications
- Electronic power factor correction on the input module for efficient, utility-friendly operation
- IEEE 519 compliant
- Sinusoidal output voltage allows operation of all types of sensitive equipment
- Protects operated equipment from over-voltage, under-voltage and other adverse events
- 97% efficiency typical
- Simple to configure and install
- Remote ON/OFF switching capability standard on all models
- EMI filter options available to reduce both conducted and emitted noise (PT330, PT355, & PT380 only)
- Optional plasma display for 2 line, 32 character text display of status indicators and troubleshooting codes (Not available with EMI filter option package)
- New compact design in wall mounted enclosures
- Outdoor rainproof enclosures available*

*Note: This feature not available with EMI package
LIMITED WARRANTY

Phase Technologies equipment is warranted against defects in material and workmanship for a period of one year. This warranty covers both parts and labor for one year from the date of purchase by the original owner. Phase Technologies will repair or replace (at our option), at no charge, any part(s) found to be faulty during the warranty period specified. The warranty repairs must be performed by/at a Phase Technologies Authorized Service Center or at Phase Technologies LLC, Rapid City, SD 57703.

Obligations of the Original Owner

1. The original Bill of Sale must be presented in order to obtain “in-warranty” service.
2. Transportation to Phase Technologies or an Authorized Service Center is the responsibility of the original purchaser. Return transportation is provided by Phase Technologies.
3. Installations must comply with all national and local electrical codes.

Exclusions of the Warranty

This warranty does not cover any of the following: accident, misuse, fire, flood, and other acts of God, nor any contingencies beyond the control of Phase Technologies, LLC, including water damage, incorrect line voltage, improper installation, missing or altered serial numbers, and service performed by an unauthorized facility. Phase Technologies’ liability for any damages caused in association with the use of Phase Technologies’ equipment shall be limited to the repair or replacement only of the Phase Technologies’ equipment. No person, agent, distributor, dealer, or company is authorized to modify, alter, or change the design of this merchandise without express written approval of Phase Technologies, LLC.

INSTALLATIONS MUST COMPLY WITH ALL NATIONAL AND LOCAL ELECTRICAL CODE REQUIREMENTS.
# TABLE OF CONTENTS

Safety Messages and Warnings...................................................................ii  
Overview..................................................................................................v  
Warranty..................................................................................................vi

**Section 1: INTRODUCTION**  
Figure 1 Phase Perfect Block Diagram ................................................. 1  
Model Number Information................................................................... 2

**Section 2: INSTALLATION**  
Mounting the Unit..................................................................................3  
Electrical Connections............................................................................4  
Connecting to Field Wiring Terminals.....................................................4  
   - Figure 2 Field Wiring Terminals.........................................................4  
   - Table 1 Field Wiring Terminals..........................................................4  
General Wiring Considerations...............................................................5  
   - Table 2 Field Wiring Terminal Specifications ..................................6  
   Technical Bulletin: PT380 .................................................................7  
Field Wiring for Parallel Units .................................................................8  
Procedure for Installing Parallel Systems ............................................9  
   - Figure 3 Parallel Systems .................................................................9  
   - Figure 4 PT Series Parallel Field Wiring Diagram .........................10  
   - Figure 5 Parallel Wiring Diagram for Continuous Regenerative Mode...11  
Input Power Source  
   Considerations..................................................................................12  
   - Table 3 Input Circuit Breaker and Fuse Ratings.............................12  
   - Figure 6 Power Source Configuration............................................13

**Section 3: TYPICAL SYSTEM CONFIGURATIONS**  
Power Supply Configuration.................................................................14  
   - Figure 7 Power Supply Configuration............................................15  
Remote ON/OFF Control.......................................................................16  
   - Figure 8 Power Supply with Remote ON/OFF...............................17

**Section 4: OPERATION**  
ON/OFF Options ..................................................................................18  
Status Indicators...................................................................................19  
   Continued on next page

Version 2.0

vii
Section 5: STATUTUS INDICATORS AND TROUBLESHOOTING…….20
General Troubleshooting Tips……………………………………………….20
Table 4 Status Indicators……………………………………………………..22

Section 6: FEATURES AND SPECIFICATIONS………………………….24
Important Features of the Phase Perfect®……………………………….24
Table 5 Specifications ……………………………………………………..25
Table 6 Fuses ………………………………………………………………….25

Section 7: ROUTINE MAINTENANCE…………………………………….26
Heat Sinks and Cooling Fans………………………………………………26
Visual Inspection …………………………………………………………..26
Table 7 Nominal Filter Capacitor Values in Microfarads (uF)………26
Line Filter Capacitors………………………………………………………26
Figure 10 Line Filter Capacitors…………………………………………27

©Copyright 2018. All rights reserved.
All contents are property of Phase Technologies, LLC.

No portion of this publication or its contents may be duplicated by any means, electronic or otherwise, without the express written consent of Phase Technologies, LLC.

Contact Information

Phase Technologies, LLC
231 East Main St North
Rapid City, SD 57701

605-343-7934 – Main
605-343-7943 – Fax
866-250-7934 – Toll-Free

www.phasetechnologies.com
SECTION 1: INTRODUCTION

The diagram in Figure 1 illustrates the basic design of a PT Series phase converter:

**Figure 1  Phase Perfect Block Diagram**

The input module takes power from the input lines and charges a DC bus. The output module then draws power from the DC bus to generate an AC voltage referenced to L2 of the input.

L1 and L2 of the single-phase input pass directly through the phase converter to provide two legs of the three-phase output. A manufactured phase is combined with the two input legs to produce three-phase output power.

Hence, the three-phase output voltage will be equal to the single-phase input voltage (e.g. a 240 VAC single-phase input will produce 240 VAC three-phase output).
The three-phase output is delta configured. While the phase-to-phase voltages are equal, the phase-to-ground voltages are not equal. Phase-to-ground voltage for both T1 and T2 should be approximately 120V. Phase-to-ground for T3 should be approximately 208V. For three-phase loads that are designed for delta connection, the load derives its voltage phase-to-phase, so the phase-to-ground voltage should not affect the operation of the equipment.

If the connected load has a neutral connection and requires wye configured power, the output of the phase converter must be passed through a delta-to-wye isolation transformer before connection to the load.

**PT Series Model Number Information**

- **Basic Series**
- **Output Phase**: 3 = Three-phase
- **Output Amps**:
  - Listed Rating
    - 30-5 = 15 amps*
    - 30 = 30 amps
    - 55 = 55 amps
    - 80 = 80 amps
    - 110 = 110 amps
    - 160 = 160 amps
  - Max Rating
    - (18 amps)
    - (36 amps)
    - (64 amps)
    - (95 amps)
    - (130 amps)
    - (190 amps)
  - *The PT330-5 is a 15A Phase Perfect
- **Enclosure Environmental Rating**:
  - Blank = Indoor Type 1
  - R = Outdoor Rainproof Type 3R
- **Status Indicator**:
  - Blank = Colored LEDs
  - D = Text Display
- **Filtering**:
  - Blank = Single Stage L/C Filter
  - Powder Coated Steel
  - *E3 = Two Stage L/C Filter plus RF Filter, EMI Gasket
  - Powder Coated Aluminum
- **Only available for**:
  - PT330
  - PT355
  - PT380
- ***Note:**
  Units with the E3 option, the filters are rated per the “Listed Rating” under Output Amps. (left)
  (Applies only to PT330, PT355 & PT380)
SECTION 2: INSTALLATION

Models are available in Type 1 indoor or Type 3R rain proof enclosures. These devices when configured in NEMA 1 enclosures are to be used in a heated, controlled indoor environment. The unit should be securely mounted to a solid, non-flammable vertical surface.

Mounting the Unit

Properly locating the unit is important to the performance and normal operating life of the unit. The unit should be installed in a location free from:

- Excessive dirt and dust
- Corrosive gases or liquids
- Excessive vibration
- Airborne metallic particles

It is important that the unit be located away from excessive dirt and dust. It should be securely fastened to a solid, non-flammable vertical surface using the mounting brackets provided with the unit. Make sure the mounting surface is capable of bearing the weight of the unit. Weights for each model can be found in the Specification Table of this document. Elevating the unit well above the ground will help to reduce the introduction of dust and contaminants into the enclosure.

Larger models are provided with lifting eye bolts on the enclosure. CABLES, STRAPS OR CHAINS USED FOR LIFTING THESE UNITS MUST BE ATTACHED ONLY TO THE PROVIDED BRACKETS.

In order to provide proper ventilation, do not obstruct the open space around the enclosure. In order to maintain air circulation for cooling, minimum clearance must be 2 inches on each side, and 6 inches top and bottom. Make sure air intake and exhaust openings are not obstructed. If the unit is mounted in a small room, cabinet or building, make certain there is adequate ventilation to provide cooling for the unit.

 Ambient Temperature Rating
PT Series converters are intended for use in an ambient temperature no higher than 50°C.
Electrical Connections

This Section provides a description of general wiring considerations, as well as diagrams of typical input power wiring configurations, and discusses important considerations involved in input wiring from various sources.

Terminal blocks for connecting wires are located on a panel inside the enclosure of the unit. Figure 2 below illustrates typical wiring connections found on the panel.

Connecting to Field Wiring Terminals

Open the front cover of the enclosure to gain access to the wiring panel. The field wiring terminals of a typical unit are illustrated in Figure 2:

**Figure 2  Field Wiring Terminals**

Note: ABC CONTROL Terminals on parallel systems are located inside the Master Unit enclosure, not in the Junction Box.

![Figure 2  Field Wiring Terminals](image)

**Table 1  Field Wiring Terminals**

<table>
<thead>
<tr>
<th>TERMINAL</th>
<th>FUNCTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>Earth ground connection for source and load</td>
<td></td>
</tr>
<tr>
<td>L1, L2</td>
<td>Single-phase input terminals</td>
<td>See <em>Input Power Source Considerations</em> for proper connection</td>
</tr>
<tr>
<td>CONTROL</td>
<td>Connection to control the unit from a remote switch</td>
<td>Terminals are rated 240 VAC.</td>
</tr>
<tr>
<td>A B C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1, T2, T3</td>
<td>Three-phase output terminals</td>
<td>T3 is the manufactured phase</td>
</tr>
</tbody>
</table>
GENERAL WIRING CONSIDERATIONS

Installations must comply with all national and local electrical code requirements.

General Wiring Considerations Include:

1. All models except PT3160 are suitable for use in a circuit capable of delivering not more than 5 kA RMS symmetrical amperes, 240V maximum.
2. Model PT3160 is suitable for use in a circuit capable of delivering not more than 10 kA RMS symmetrical amperes, 240 V maximum.
3. Use 600 V vinyl-sheathed wire or equivalent. The voltage drop of the leads needs to be considered in determining wire size. Voltage drop is dependent on wire length and gauge.
4. Wire used within the motor circuit and all field wiring terminals must be rated for at least 60 C.
5. Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in Table 2.
6. Use wire size suitable for Class 1 circuits.
7. For models with three-phase output, the input wire gauge must be sized to accommodate the single-phase input current, which will be approximately 1.8 times the total three-phase output current to the load(s). For example, if the output load is 20 HP, the three-phase output current will be approximately 54 amps, and the single-phase input current will be approximately 97 amps.
8. The maximum wire gauge for the input terminals is listed in Table 2.
9. Never allow bare wire to contact the metal surfaces.
10. Never connect AC main power to the output terminals; T1, T2, and T3.
11. Input power connections should be made by a qualified electrician into a 208V or 240V circuit with adequate current carrying capacity and the appropriate sized breaker.

Branch circuit protection to the phase converter should be provided by appropriate size fuses or a 2 pole, linked circuit breaker. Input circuit breaker and fuse ratings for each model are listed in Table 3.
Table 2  Field Wiring Terminal Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>PT330-5</th>
<th>PT330</th>
<th>PT355</th>
<th>PT380*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Terminals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening Torque</td>
<td>16 in.-lb.</td>
<td>16 in.-lb.</td>
<td>120 in.-lb. (2/0-6 AWG)</td>
<td>275 in.-lb.</td>
</tr>
<tr>
<td>Wire Size</td>
<td>18 - 4 AWG</td>
<td>18 - 4 AWG</td>
<td>14 - 2/0 AWG</td>
<td>6 AWG - 250 MCM</td>
</tr>
<tr>
<td><strong>Output Terminals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening Torque</td>
<td>16 in.-lb.</td>
<td>16 in.-lb.</td>
<td>16 in.-lb.</td>
<td>50 in.-lb. (2 AWG)</td>
</tr>
<tr>
<td>Wire size</td>
<td>18 - 4 AWG</td>
<td>18 - 4 AWG</td>
<td>18 – 4 AWG</td>
<td>14 - 2 AWG*</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Model</th>
<th>PT3110</th>
<th>PT3160</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Terminals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening Torque</td>
<td>275 in. lbs</td>
<td>375 in. lbs</td>
</tr>
<tr>
<td>Wire Size</td>
<td>350kcmil – 6 AWG</td>
<td>500kcmil – 4 AWG</td>
</tr>
<tr>
<td><strong>Output Terminals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening Torque</td>
<td>120 in. lbs (2/0-6 AWG)</td>
<td>120 in. lbs (2/0-6 AWG)</td>
</tr>
<tr>
<td>Wire Size</td>
<td>2/0 – 14 AWG</td>
<td>500kcmil – 4 AWG</td>
</tr>
</tbody>
</table>
Technical Bulletin: 01/01/2018

Phase Perfect PT380 – Output Terminal Block & Wire Size

The recommended wire size on the output terminal block is currently listed as 14-2 AWG. Previously, the max output current of the PT380 was listed at 96A.

As of 01/01/2018, the max output current of the PT380 has been updated:
PT380 Max Output Current: 95A

To ensure that all installations are compliant with local electrical codes and with the PT380 installation requirements, the maximum output current should be rated at 95A. A 60°C, 2 AWG wire is compliant at 95 amps.
Field Wiring for Parallel Units

Models of the PT Series with output of 110 amps and 160 amps must be wired in parallel at the factory only. Parallel units are configured as a master and a slave connected to each other by conduit that contains control wires. Parallel units are connected with all control wires, and the two enclosures physically attached in the factory, then shipped as one unit.

A separate junction box containing input and output field wiring terminals is shipped with the unit. The junction box provides a common point of connection for the input and output output wires to field wired terminals.

CAUTION! The output wires of two systems in parallel must always be connected to a common point.

When Phase Perfect converters are used in continuous regenerative mode, the junction box connections are altered to improve the power factor of the regenerative power. Follow the connection diagram in Figure 5.

Procedure for Installing Parallel Systems

1. Mount and securely fasten the PT Series units on a wall or suitable vertical surface. See Section 2 Mounting the Unit for complete details on mounting.

2. Attach suitable conduit to the opening in the underside of each PT Series unit, then to the Junction Box as depicted in Figure 3.

3. Fasten the Junction Box securely to the wall.

4. Inside each PT Series enclosure is a pigtail of input and output wires. Pull the wires through the conduit into the Junction Box.

5. Each input and output wire is clearly marked with a label (L1, T1, etc.) and color coded to match a corresponding labeled and color coded field wiring terminal. Connect each wire to the top side of the appropriate terminal and torque to the value in Table 2.

6. The input wires and output wires from the PT Series units must be connected in parallel. For example, the wires labeled L1 from each PT Series unit must both be connected to the same terminal in the Junction Box labeled L1. See Figure 4 for a schematic representation of field wiring for parallel units.
CAUTION! Never connect unlike wires from the PT Series units to the same terminal in the Junction Box.

Otherwise, the units may be severely damaged, and the warranty will be void.

7. Pull source input wires and output wires to the load through conduit into the Junction Box and connect to the **bottom side** of the appropriate field wiring terminals. Torque to values in Table 2.

**Figure 3 Parallel Systems**

![Diagram of Parallel Systems](image)
Field wiring terminations are made on terminal blocks in the Junction Box.
Figure 5
PT SERIES PARALLEL FIELD WIRING DIAGRAM FOR CONVERTERS IN CONTINUOUS REGENERATIVE MODE

WARNING!
Converters used in continuous regenerative applications must configure from the factory for this use. Do not use this wiring configuration in a standard converter.
### Table 3 Input Circuit Breaker and Fuse Ratings

<table>
<thead>
<tr>
<th>Model</th>
<th>PT330-5</th>
<th>PT330</th>
<th>PT355</th>
<th>PT380</th>
<th>PT3110</th>
<th>PT3160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum fuse rating, Class RK5</td>
<td>35</td>
<td>70</td>
<td>125</td>
<td>200</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>Maximum fuse rating, Class 200</td>
<td>35</td>
<td>70</td>
<td>125</td>
<td>200</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>Maximum circuit breaker rating, amps</td>
<td>35</td>
<td>70</td>
<td>125</td>
<td>200</td>
<td>250</td>
<td>400</td>
</tr>
</tbody>
</table>

### Input Power Source Considerations

The unit can be operated from most input power sources ranging from 187 VAC to 260 VAC. However, specific input wiring issues must be considered when wiring to three-phase input sources.

⚠️ **WARNING!** Incorrect L1 and L2 wiring from some three-phase sources can result in high phase-to-ground voltage.

These considerations are outlined in:

Figure 6 *Power Source Configurations*: 
Figure 6 Power Source Configurations

**Single-phase, 120V/240V, 3 Wire**
In most installations, single-phase 240V input power will be taken from a 240V/120V center tap source. Connect L1 and L2 to the input terminals.

⚠️ **WARNING!**

**Three-phase, 240V/120V, Delta**
In some situations, single-phase 240V input power may be derived from a three-phase source as illustrated to the left.

Caution must be exercised if using such a source for power input to the unit. Power should only be derived from legs 1 & 2, with a center ground, as illustrated.

Power derived from legs 2 & 3, or 3 & 1, may result in output phase-to-ground voltage well above 200V.

To avoid potentially hazardous voltage, always verify the phase-to-ground voltage for the L1 and L2 inputs is approximately 120V.

⚠️ **WARNING!**

**Three-phase, 208Y/120V**
Single-phase 208V input power can be taken from two legs of a three-phase grounded-wye source.

There are two possible ways to connect L1 and L2 to the unit from any two legs. If the unit is connected incorrectly, the voltage from output line T3 to ground will be over 240V.

Reversing L1 and L2 on the input should lower the T3 to ground voltage to 120V.
Section 3: TYPICAL SYSTEM CONFIGURATIONS

A PT Series phase converter is designed to simplify installation, to provide maximum versatility, and to eliminate or minimize the need for external electrical components and related costs.

The output voltage of the unit is sinusoidal with very little harmonic content, eliminating the need for output filtering that would often be required for a variable frequency drive (VFD).

With little distortion of the input current, the unit does not require input filtering to comply with IEE519, the standard that sets limits for distortion of utility mains power.

All types of equipment, including inductive, resistive, and capacitive loads can be safely powered by a PT Series Phase Perfect.

Typical installations are diagrammed and explained below:
- A power supply configuration for use in powering multiple loads
- A configuration in which a remote switch turns the unit ON/OFF

Power Supply Configuration

The unit can be configured as a power supply to provide power to multiple loads of any type, including inductive, resistive, and capacitive loads.

**CAUTION!**
The wire connecting A to C at the top of the Control Terminal strip is **NOT** a jumper, and should **NOT** be removed.

Separate, properly sized breakers should be provided for each motor load to be powered. The power supply configuration used to power multiple motor loads or loads with integrated controls is illustrated in Figure 7:
Input Disconnect Switch

PT Series Phase Converter

3-phase load center with branch circuit protection for each load

Motor Load

Motor Starter Panel

Load with integrated controls

Each load must have independent over-current protection and controls.
Follow this procedure when wiring the unit as a power supply to provide three-phase power to multiple loads or to loads with integrated controls:

1. Verify that no input power is connected to the unit by turning the input disconnect to OFF, then lock and tag it.

2. Open the front cover to gain access to the wiring terminals. See the Section 2, Connecting to Field Wiring Terminals, for a drawing illustrating the wiring terminals.

3. Connect input power to the unit from an appropriate single-phase circuit. See the Section 2, Input Power Source Considerations, for additional information.

4. Before energizing the input power, measure the source voltage. Phase-to-phase voltage must be within the input range of 187-260VAC, and the phase-to-ground voltage should be half this value. For installations with one 240V power wire and a neutral, the 240V wire must be installed on L1.

5. Energize the unit before any loads are connected to the output and measure the output phase-to-phase voltages to ensure they are within the specified range. Because the three-phase output is delta-configured three-phase, the output phase-to-ground voltages will not be equal. T3-to-ground voltage will be higher than T1 or T2 to ground.

6. Turn the unit OFF by means of the input disconnect, lock and tag it, then wait at least 30 minutes for any internal charges to dissipate.

7. Connect the output wires to the output terminals. Torque the terminal screws to the values listed in Table 2 Field Wiring Terminal Specifications.

8. Close and latch front cover.

9. Turn the unit ON from the disconnect switch. Power will be available to the load circuits after an approximately five to eight second delay. Check any three-phase motor loads for correct rotation. If the motor rotation is incorrect, reverse any two of the three output power leads to that motor.

10. A low power remote switch may be wired into the Control Terminal of the unit to provide remote ON/OFF switching of the unit.
**WARNING!** When the converter is turned OFF using a remote switch on the Control Terminals, dangerous voltage is still present on the input lines, inside the enclosure and on certain output lines to ground.

Never open the enclosure or perform maintenance on the unit and its connected loads when the input disconnect switch is in the ON position.

**Remote ON/OFF Control**

**WARNING!** When the converter is turned OFF using a remote switch on the Control Terminals, dangerous voltage is still present on the input lines, inside the enclosure and on certain output lines to ground. Never open the enclosure or perform maintenance on the unit and its connected loads when the input disconnect switch in the ON position.

When a low power remote switch is connected to the Control Terminals, the unit and any connected loads can be switched ON/OFF by a remote switch.

**The remote switch must be rated at a minimum of 240 VAC, 0.5 amp.**

A PT Series power used to power a motor load with remote ON/OFF is illustrated in Figure 8:

**Figure 8 Power Supply with Remote ON/OFF**

- Input Power Source
- Input Disconnect Switch
- PT Series Phase Converter
- Motor Load

Remote switch rated 240V, 0.5A. Closed switch will energize the unit and start the load after a 5-8 second delay.

Make sure switch leads are connected to A & B on the Control Terminals.
Follow this procedure when wiring a remote switch to control the unit:

1. Verify that no input power is connected to the unit by turning the input disconnect to OFF, then lock and tag it.
2. Open the front cover to gain access to the wiring terminals. See the Section 2, Connecting to Field Wiring Terminals, for a drawing illustrating the wiring terminals.

**CAUTION!** The wire connecting A to C at the top of the Control Terminal is **NOT** a jumper, and should **NOT** be removed.

3. Verify that control terminals A and B are shorted together by a **metal** jumper. The unit is shipped from the factory in this configuration.

4. Remove the metal jumper and connect the remote switch leads to Control Terminals A and B. When operating, closing the remote switch will energize the unit and start the load after approximately a five to eight second delay. The control circuit should be rated for 240V, 0.5A. A 3A fuse labeled F501 protects the remote switch circuit.

**Section 4: OPERATION**

Operation of a PT Series phase converter is simple and straightforward after completion of installation and wiring.

**ON/OFF Options**

There are two ways to turn a PT Series phase converter ON and OFF:

**ON/OFF With Input Power Disconnect Switch**

In most cases, the unit should be installed with a disconnect switch on the line side of the unit. When in the OFF position, this disconnect switch will break the connection between the unit and the input power source.

**WARNING!** Make sure the input power disconnect switch is in the OFF position before opening the front cover to the unit. Opening the front cover with the switch in the ON position exposes the user to the risk of electric shock.

When the unit is energized, output power is provided to the load after a delay of approximately five to eight seconds.

**ON/OFF With a Low Power Remote Switch**

When Phase Perfect is configured with a remote ON/OFF switch on the Control Terminals, the input power disconnect switch is left in the ON
position. When the remote switch connected to the Control Terminals is closed, the unit energizes, and output power is provided to the load after a delay of approximately five to eight seconds. When the input power is ON, and the remote control switch is open, the unit is not energized and will not consume any power. No phase-to-phase voltage will be present on the output lines.

⚠️ **WARNING!** When the converter is turned OFF using a remote switch on the Control Terminals, dangerous voltage is still present on the input lines, inside the enclosure and on certain output lines to ground. Never open the enclosure or perform maintenance on the unit and its connected loads when the input disconnect switch in the ON position.

When either the input power disconnect switch is OFF, or the remote switch on the Control Terminals is open, the status LEDs will be off. If the unit is equipped with the optional text display, the status screen will be blank.

### Status Indicators

The GREEN, YELLOW, and RED status LEDs are found on the control printed circuit board inside the enclosure, or are mounted on the front cover when the unit is equipped with optional EMI enclosure. The status lights provide information about the operating status of the unit, and provide useful troubleshooting information.

An optional text display status screen is also available on some models that provides 2 row, 32 character text messages for status indicators.

Three basic status LED indications are:

- **STEADY GREEN** status LED
- **STEADY YELLOW** status LED
- **FLASHING RED** status LED

Note: The red and yellow status lights may flash briefly when starting heavy loads. This is normal and can be ignored.

Different combinations of the status LEDs provide information about the operating status of the unit, and can be used in troubleshooting.

A complete listing of status indicators is provided in the Section 6 *Status Indicators and Troubleshooting*. 

Version 2.0 19
Section 5: STATUS INDICATORS AND TROUBLESHOOTING

This section provides troubleshooting information for potential system problems.

⚠️ WARNING! In some instances, such as overheating, the unit will shut down, then automatically restart when conditions allow.

⚠️ Always disconnect input power from the unit and wait for internal electrical charges to dissipate before performing service on the unit or its connected loads.

General Troubleshooting Tips

After the system is properly connected to input power, turn the unit ON with the disconnect switch and/or input circuit breaker. It is always advisable to check the operating status of the converter before connecting any loads to the output.

If the unit fails to energize, and all status indicators are off, check the following:

1. Verify that the appropriate circuit breaker in the electrical source distribution panel is set ON and is properly sized.
2. Check the control circuit fuse, labeled F501, located on the panel inside the unit enclosure. If necessary, replace with appropriate 3A fuse.
3. Verify that the metal jumper on the Control Terminal is connected either A to B for power supply configuration. The unit will not operate unless the metal jumper or control circuit wires are connected to the appropriate control terminals. CAUTION! The wire connecting A to C at the top of the Control Terminal is NOT a jumper, and should NOT be removed.

Refer to the following Status Indicator Table for additional troubleshooting tips.
Status Indicators

The status lights and the optional text status screen provide are useful for detecting and diagnosing system problems. The Status Indicator Tables provide a list of status indicators, followed by a description and potential causes of the problem.

The GREEN, YELLOW, and RED status LEDs are found on the control printed circuit board inside the enclosure, or are mounted on the front cover when the unit is equipped with optional EMI enclosure. The status lights provide information about the operating status of the unit, and provide useful troubleshooting information.

An optional text display status screen mounted in the door of the enclosure is also available on some models that provide 2 row, 32 character text messages for status indicators.

See Table 4
### Table 4 Status Indicators

<table>
<thead>
<tr>
<th>LED INDICATOR</th>
<th>TEXT INDICATOR</th>
<th>COMMENTS AND TROUBLESHOOTING TIPS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEADY GREEN</td>
<td>SYSTEM ON NORMAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLASHING GREEN</td>
<td>STARTING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEADY YELLOW</td>
<td>STOPPED OVERTEMP WAIT FOR RESTART</td>
<td>Check for faulty fan, or ventilation opening obstructions. Reduce ambient temperature.</td>
<td>2</td>
</tr>
<tr>
<td>FLASHING GREEN STEADY YELLOW</td>
<td>DEFECTIVE TEMP SENSOR</td>
<td>Failed temp sensor (TM circuit board) or loose connection to TM circuit board</td>
<td>3</td>
</tr>
<tr>
<td>STEADY RED</td>
<td>C1 VOLTAGE LOW</td>
<td>Check charging circuit fuse (F701), relay and diode. Possible failed bus capacitor on VPOS</td>
<td>2</td>
</tr>
<tr>
<td>STEADY GREEN STEADY YELLOW</td>
<td>C2 VOLTAGE LOW</td>
<td>Check charging circuit fuse (F701), relay and diode. Possible failed bus capacitor on VNEG</td>
<td>2</td>
</tr>
<tr>
<td>FLASHING YELLOW FLASHING RED</td>
<td>C1 OVER VOLTAGE</td>
<td>Possible heavy power regeneration from load. Possible voltage sensing problem on EA200 circuit board</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING YELLOW</td>
<td>C2 OVER VOLTAGE</td>
<td>Possible heavy power regeneration from load. Possible voltage sensing problem on EA200 circuit board</td>
<td>3</td>
</tr>
<tr>
<td>STEADY GREEN FLASHING RED</td>
<td>POSSIBLE SHORT C1</td>
<td>Internal fault possible, contact factory</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN STEADY RED</td>
<td>POSSIBLE SHORT C2</td>
<td>Internal fault possible, contact factory</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING RED</td>
<td>IGBT FAULT INPUT MODULE</td>
<td>Possible failed IGBT or driver circuit board on input module</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN FLASHING RED</td>
<td>IGBT FAULT OUTPUT MODULE</td>
<td>Possible failed IGBT or driver circuit board on output module</td>
<td>3</td>
</tr>
<tr>
<td>STEADY YELLOW STEADY RED</td>
<td>INPUT FREQUENCY OUT OF RANGE</td>
<td>Input frequency must be 46-64 Hz. Generator source must be stable. Possible voltage distortion in source power.</td>
<td>2</td>
</tr>
<tr>
<td>STEADY YELLOW FLASHING RED</td>
<td>LOW INPUT V AUTO RESTART</td>
<td>Increase input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
<tr>
<td>FLASHING YELLOW STEADY RED</td>
<td>LOW INPUT V AUTO RESTART 1HR</td>
<td>Increase input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
<tr>
<td>STEADY GREEN STEADY RED</td>
<td>LOW INPUT V AUTO RESTART 10S</td>
<td>Increase input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
<tr>
<td>STEADY GREEN STEADY YELLOW STEADY RED</td>
<td>HIGH INPUT V AUTO RESTART</td>
<td>Decrease input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
<tr>
<td>STEADY GREEN STEADY YELLOW FLASHING RED</td>
<td>HIGH INPUT V AUTO RESTART 1HR</td>
<td>Decrease input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
</tbody>
</table>
**Table 4 Status Indicators** (Continued)

<table>
<thead>
<tr>
<th>LED INDICATOR</th>
<th>TEXT INDICATOR</th>
<th>COMMENTS AND TROUBLESHOOTING TIPS</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEADY GREEN FLASING YELLOW</td>
<td>HIGH INPUT V AUTO RESTART 10S</td>
<td>Decrease input voltage to specified input range if possible. See Note 1 below.</td>
<td>1</td>
</tr>
<tr>
<td>FLASHING GREEN STEADY YELLOW STEADY RED</td>
<td>OVERCURRENT INPUT 10S</td>
<td>Input current exceeded steady state maximum. Reduce load or increase input voltage if possible.</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN FLASHING YELLOW STEADY RED</td>
<td>OVERCURRENT OUTPUT 4S</td>
<td>Output current exceeded momentary maximum. Reduce load or increase input voltage if possible.</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN FLASHING YELLOW FLASHING RED</td>
<td>OVERCURRENT OUTPUT 10S</td>
<td>Output current exceeded steady state maximum. Reduce load or increase input voltage if possible.</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN STEADY YELLOW FLASHING RED</td>
<td>SYSTEM INTERRUPT CYCLE PWR OFF ON</td>
<td>Possible software code hang-up. Reboot by cycling input power OFF ON.</td>
<td>3</td>
</tr>
<tr>
<td>FLASHING GREEN FLASHING YELLOW</td>
<td>VOUT SENSE WIRE IS LOOSE</td>
<td>The output sense wire may be off or loose. The output voltage may be momentarily too low.</td>
<td>3</td>
</tr>
<tr>
<td>STEADY GREEN FLASHING YELLOW FLASHING RED</td>
<td>LINE CAPACITOR FAULT</td>
<td>Possible failure of capacitor(s) in the L/C filter. See Section 8 for information on measuring capacitance and/or replacing capacitors.</td>
<td>3</td>
</tr>
<tr>
<td>STEADY GREEN FLASHING YELLOW FLASHING RED</td>
<td>LINE CAPACITOR FAULT</td>
<td>Possible line cap fault</td>
<td>3</td>
</tr>
</tbody>
</table>

**Note 1:**
For high and low input voltage trip, the unit will attempt to restart after a 10 sec. delay, followed by another 10 sec. restart delay. If the unit does not successfully start on the second try, the cycle will be repeated after a 1 hr. delay. The restart cycle can be cancelled by cycling input power OFF ON.

**Note 2:**
⚠️ **WARNING!** Unit will restart automatically when condition returns to normal.

**Note 3:**
Unit will not automatically restart. Cycle input power OFF ON to restart.

For assistance, contact our **Service** department at Phase Technologies, (605) 343-7934.
Section 6: FEATURES AND SPECIFICATIONS

Important Features of the Phase Perfect®

- Clean, balanced power under all load conditions for even the most demanding applications
- Electronic power factor correction on the input module for efficient, utility-friendly operation
- IEEE 519 compliant
- Sinusoidal output voltage allows operation of all types of sensitive equipment
- Protects operated equipment from over-voltage, under-voltage and other adverse events
- 97% efficiency typical
- Simple to configure and install
- Remote ON/OFF switching capability standard on all models
- EMI filter options available to reduce both conducted and emitted noise
- Optional plasma display for 2 line, 32 character text display of status indicators and troubleshooting codes
- New compact design in wall mounted enclosures
- Outdoor rainproof enclosures available
- Clean power fed back to power grid under regenerative load conditions
### Table 5 Specifications

<table>
<thead>
<tr>
<th>MODEL</th>
<th>PT330-5</th>
<th>PT330</th>
<th>PT355</th>
<th>PT380</th>
<th>PT3110</th>
<th>PT3160</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>27A listed</td>
<td>54A listed</td>
<td>98A listed</td>
<td>143A listed</td>
<td>196A listed</td>
<td>285A listed</td>
<td></td>
</tr>
<tr>
<td>33A max</td>
<td>65A max</td>
<td>115A max</td>
<td>171A max</td>
<td>234A max</td>
<td>342A max</td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>15A listed</td>
<td>30A listed</td>
<td>55A listed</td>
<td>80A listed</td>
<td>110A listed</td>
<td>160A listed</td>
<td></td>
</tr>
<tr>
<td>18A max</td>
<td>36A max</td>
<td>64A max</td>
<td>95A max</td>
<td>130A max</td>
<td>190A max</td>
<td></td>
</tr>
<tr>
<td><strong>Rated output (240V)</strong></td>
<td>6.2 KVA listed</td>
<td>12.5 KVA listed</td>
<td>22.9 KVA listed</td>
<td>33.2 KVA listed</td>
<td>45.7 KVA listed</td>
<td>66.4 KVA listed</td>
</tr>
<tr>
<td></td>
<td>7.5 KVA max</td>
<td>14.9 KVA max</td>
<td>26.6 KVA max</td>
<td>39.4 KVA max</td>
<td>53.9 KVA max</td>
<td>78.9 KVA max</td>
</tr>
</tbody>
</table>

**General Specifications:**
- Enclosure: Type 1 indoor or Type 3R rain proof, wall mount, powder coated steel or powder coated aluminum
- Ambient temperature operating range: -10°C to +50°C
- Storage temperature range: -20°C to +60°C
- Typical efficiency at full load: 97%

### Table 6 Fuses

<table>
<thead>
<tr>
<th>FUSE ID</th>
<th>FUSE RATING</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>2 A, slow blow</td>
<td>Located on PCB PWR602</td>
</tr>
<tr>
<td>F2</td>
<td>5 A, slow blow</td>
<td>Located on PCB PWR602</td>
</tr>
<tr>
<td>F3</td>
<td>5 A, fast blow</td>
<td>Located on PCB PWR602</td>
</tr>
<tr>
<td>F501</td>
<td>3 A, fast blow</td>
<td>Panel mounted, protects CONTROL circuit</td>
</tr>
<tr>
<td>F701</td>
<td>12 A, slow blow</td>
<td>Panel mounted, protects DC bus charging circuit</td>
</tr>
</tbody>
</table>
Section 7: ROUTINE MAINTENANCE

Regular maintenance should be performed on your Phase Perfect converter to ensure safe and efficient operation. This maintenance should be performed at least annually or more frequently for converters operating under extreme conditions such as heavy continuous loads, high temperature environments and dusty, dirty conditions.

Heat Sinks and Cooling Fans

Remove the top cover and visually inspect the heat sinks and other components that are subject to air circulated by the cooling fans. Use compressed air to remove any accumulated dirt and debris. Make sure the cooling fans are operating, are clean and turn freely.

Visual Inspection

Inspect wires and components for discoloration due to overheating or arcing and/or deformation. Torque the terminals on the power connection to values in Table 2 Field Wiring Terminal Specifications.

Line Filter Capacitors

⚠️ CAUTION: Line filter capacitors should be inspected annually at a minimum. If the equipment is frequently operated under heavy load, inspection every six months is recommended.

Important: Do not operate the Phase Perfect® with degraded line filter capacitors.

Replacement of the capacitors every three years is recommended. These capacitors suppress electrical noise caused by the switching of the IGBTs. If they are degraded the electrical noise can damage equipment connected to the converter.

Line filter capacitors should be visually inspected and electrically tested on a routine basis. The capacitors can be observed by opening the front cover of the converter. See Figure 10 below to identify the line filter capacitors.
Table 7  Nominal Filter Capacitor Values in MicroFarads (uF)

<table>
<thead>
<tr>
<th>Converter Model</th>
<th>Number of Capacitors</th>
<th>Capacitance (uF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT330-5</td>
<td>2</td>
<td>40 uF</td>
</tr>
<tr>
<td>PT330</td>
<td>2</td>
<td>40 uF</td>
</tr>
<tr>
<td>PT355</td>
<td>4</td>
<td>40 uF</td>
</tr>
<tr>
<td>PT380</td>
<td>4</td>
<td>60 uF</td>
</tr>
<tr>
<td>PT3110</td>
<td>8</td>
<td>40 uF</td>
</tr>
<tr>
<td>PT3160</td>
<td>8</td>
<td>60 uF</td>
</tr>
</tbody>
</table>
Figure 10 Line Filter Capacitors* See Notes Below
Figure 10  Line Filter Capacitors (continued)

All Other PT Model Capacitors
Line Filter Capacitors

Visually inspect the line filter capacitors and the wires connected to them for any discoloration and for bulges in the canister.

Using a multi-meter set to measure capacitance; check the capacitance of each capacitor by measuring between the two terminals on the capacitor.

**Remove the wire from at least one terminal of the capacitor in order to obtain an accurate measurement.**

Compare to the capacitor value in Table 7.

If any capacitor value is less than specified by more than 15% contact Phase Technologies service department to order replacement capacitors.

Phase Technologies
605-343-7934
www.phasetechnologies.com

If you do not have a meter or other means to test the capacitors it is recommended to replace the capacitors every three years as a preventive measure.

---

PHASE TECHNOLOGIES, LLC

231 East Main Street North
Rapid City, SD  57701

605-343-7934 – Main
866-250-7934 – Toll Free
605-343-7943 – Fax

www.phasetechnologies.com