

PHASE PERFECT®

PHASE CONVERTERS

OPERATION & INSTALLATION MANUAL

PHASE TECHNOLOGIES, LLC

DANGER: HIGH VOLTAGE

Electric shock could result in death or injury. Please consult qualified personnel for installation.

DANGER – Risk of Electric Shock

Please wait 30 minutes before servicing

Congratulations on your purchase of a revolutionary Phase Perfect® Phase Converter. Phase Perfect® utilizes the latest advances in solid state power switching technology to produce balanced three-phase power from a single-phase source. Digital processor control ensures that the phase-to-phase voltages are always balanced from no-load to full-load conditions. Phase Perfect® can operate all types of three-phase equipment without worrying about voltage balance.

KEY FEATURES AND BENEFITS OF PHASE PERFECT®

- Output voltages balanced to +/- 1% under all load conditions for even the most demanding applications
- Electronic power factor correction on the input module for efficient, utility-friendly operation
- Sinusoidal output voltage allows operation of all types of sensitive equipment
- Protects operated equipment from over-voltage, under-voltage and single phasing
- 95-97% efficiency typical
- Simple to configure and install
- When equipped with the optional Motor Starter, Phase Perfect® can start and protect a single motor load. The optional Motor Starter includes a contactor and solid state motor overload protection.
- For applications such as pumping, the converter and the load can be switched ON and OFF automatically by a remote switch.

LIMITED WARRANTY

Phase Technologies products are 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 57702.

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.

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

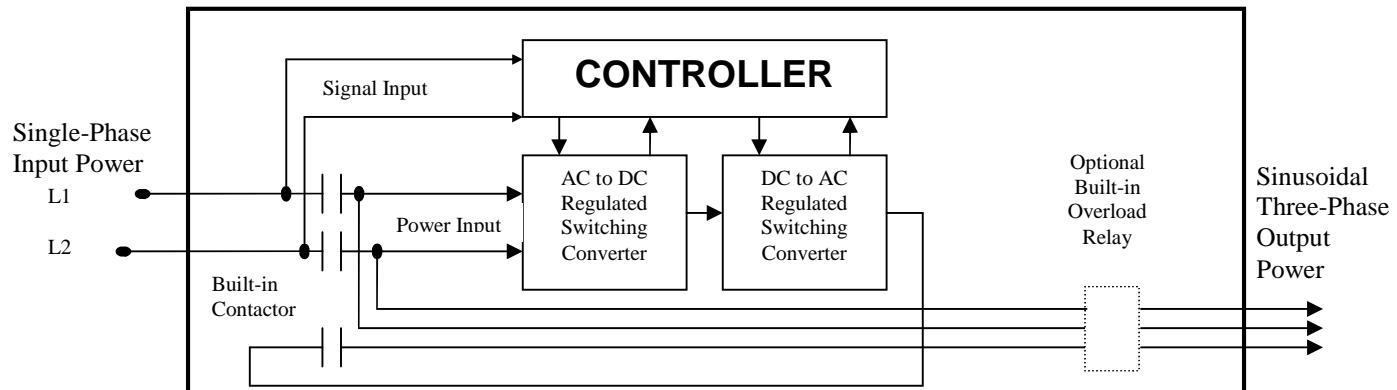
- 1. INTRODUCTION**
- 2. INSTALLATION**
 - 2.1 PHYSICAL INSTALLATION
 - 2.2 ELECTRICAL INSTALLATION
 - 2.2.1 WIRE TERMINAL CONNECTIONS
 - 2.2.1.1 GENERAL WIRING CONSIDERATIONS
 - 2.2.1.2 INPUT WIRING CONSIDERATIONS
 - 2.2.2 TYPICAL SYSTEM CONFIGURATIONS
 - 2.2.2.1 POWER SUPPLY CONFIGURATION
 - 2.2.2.2 MOTOR STARTER CONFIGURATION
 - 2.2.2.3 MOTOR STARTER WITH REMOTE ON/OFF CONTROL
 - 3. OPERATION**
 - 3.1 ON/OFF FUNCTION
 - 3.2 STATUS LIGHTS
 - 4. MOTOR OVERLOAD RELAY INFORMATION**
 - 4.1 777 MOTOR STARTER OPTION
 - 4.2 STANDARD MOTOR STARTER OPTION
 - 5. TROUBLESHOOTING**
 - 5.1 GENERAL TROUBLESHOOTING TIPS
 - 5.2 FUSES
 - 5.3 TROUBLESHOOTING WITH STATUS LIGHTS
 - 6. CARE AND MAINTENANCE**
 - 7. FEATURES AND SPECIFICATIONS**
 - 7.1 FEATURES
 - 7.2 SPECIFICATIONS

1. INTRODUCTION

Phase Perfect® converts single-phase electrical power to three-phase power. The diagram in Figure 1 illustrates the basic design of Phase Perfect®:

Figure 1

PHASE PERFECT® BLOCK DIAGRAM



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. Therefore, **the three-phase output voltage of Phase Perfect 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. When T1 and T2 to ground voltage is 120V, T3 to ground voltage will 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.**

Unlike other converter technologies, Phase Perfect® actively monitors input and output currents and voltages to maintain voltage balance under all load conditions, near unity power factor, and sinusoidal output with very little harmonic distortion.

Phase Perfect® can be configured as a three-phase power supply or as a motor starter depending on the application, and is designed to eliminate the need for most additional external electrical components and controls. Phase Perfect® can also be configured to accept input from a remote control switch, automatically controlling a pump motor, or other single-motor load.

2. INSTALLATION

Models are available in Type 1 indoor or Type 3R rain proof enclosures. The unit should be securely mounted to a level surface and care taken to minimize the introduction of dust and other contaminants into ventilation openings.

2.1 PHYSICAL INSTALLATION

Properly locating Phase Perfect® 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. Phase Perfect® should be mounted on a clean, flat horizontal surface. Elevating the unit above the ground will help to reduce the introduction of dust and contaminants into the enclosure.

Models DPC-20 and DPC-30 are provided with lifting brackets inside the enclosure. CABLES, STRAPS OR CHAINS USED FOR LIFTING THESE UNITS MUST BE ATTACHED ONLY TO THE PROVIDED BRACKETS. Access the brackets by removing the top cover of the enclosure. Brackets with a hole for attaching lifting equipment are located on each side-wall of the enclosure.

In order to provide proper ventilation, do not obstruct the open space under and around the enclosure. Make sure air intake and exhaust openings are not obstructed. If the unit is mounted in a small room, cabinet or shed, make certain there is adequate ventilation to provide cooling for the unit.

2.2 ELECTRICAL INSTALLATION

Electrical connections to the Phase Perfect® are made behind the front cover of the enclosure, as described in section 2.2.1. Phase Perfect® is available configured for use as a motor starter with single motor loads, or configured as a power supply for multiple loads. These configurations are described in section 2.2.2.

Status lights provide information about the status of the Phase Perfect® unit, and about the entire system into which the unit is wired. The status lights are very useful in troubleshooting system problems. Detailed information on the use of the status lights for troubleshooting purposes is found in section 5.2.

A panel with terminal blocks for connecting wires is found behind the front cover. Section 2.2.1 below illustrates the wiring connections and controls found on the panel. Section 2.2.1.1 provides a description of general wiring considerations. Section 2.2.1.2 provides diagrams of typical input power wiring configurations, and discusses important considerations involved in input wiring from various sources.

2.2.1 WIRE TERMINAL CONNECTIONS

Remove the front cover of the enclosure to gain access to the wiring panel. The wiring panel and key components of Model DPC-20 are illustrated below:

Figure 2

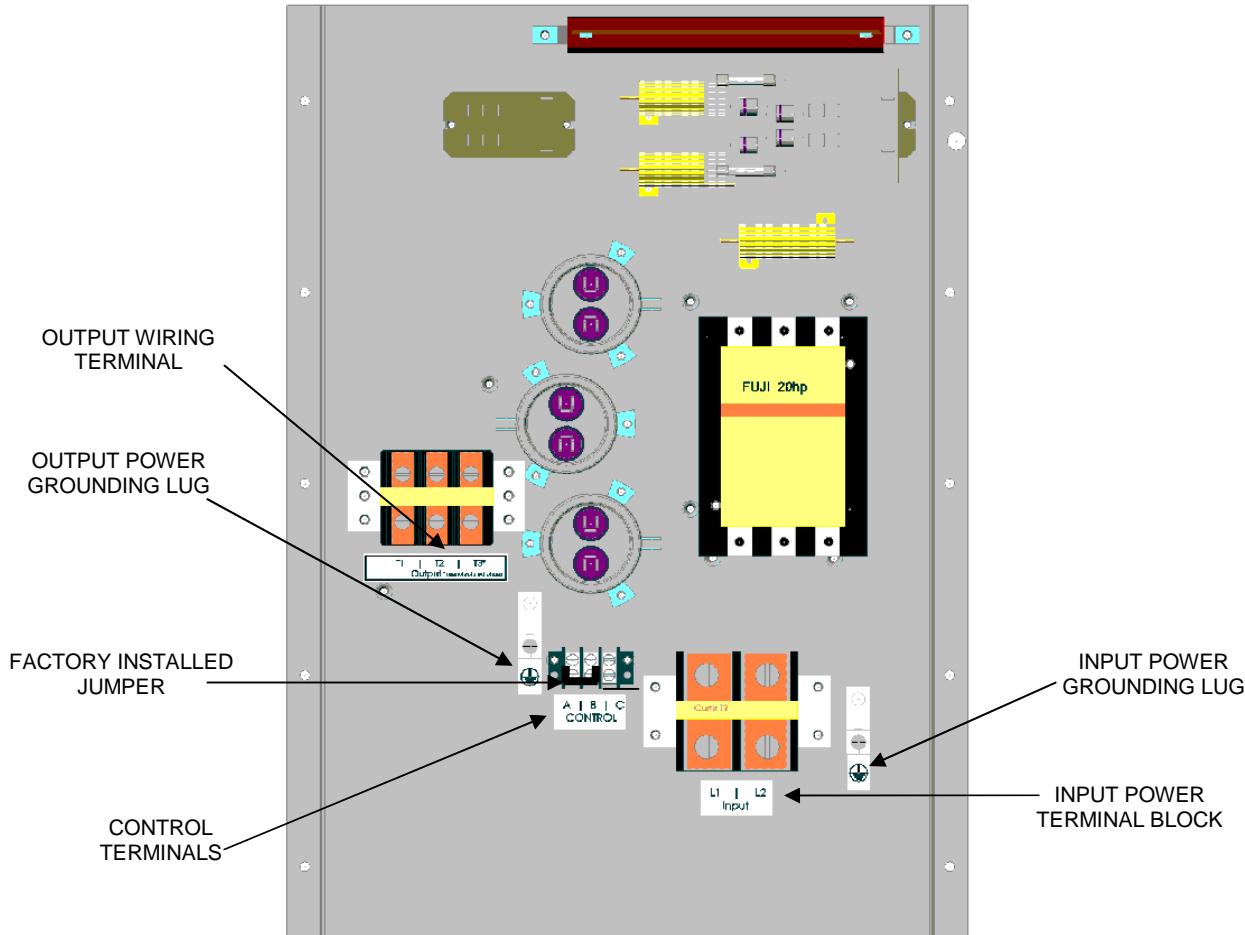


Table 1

CONNECTION	FUNCTION	COMMENTS
GND	EARTH GROUND FOR SINGLE-PHASE INPUT POWER	
L1, L2	SINGLE-PHASE INPUT POWER TERMINALS	
JUMPER FROM A TO B	ENABLES THE OPTIONAL MOTOR OVERLOAD RELAY (WHEN INCLUDED)*	SHIPPED FROM FACTORY WITH JUMPER FROM A TO B MOTOR OVERLOAD RELAY IS DE-ACTIVATED IF CONTROL JUMPER IS CONNECTED FROM B TO C.
JUMPER FROM B TO C	CONFIGURES UNIT AS POWER SUPPLY	REPLACE JUMPER WITH THE LEADS OF AN APPROPRIATE RATED SWITCH CIRCUIT FOR REMOTE ON/OFF CONTROL UNIT WILL NOT OPERATE WITH-OUT JUMPER OR REMOTE SWITCH CIRCUIT CONNECTED
GND	EARTH GROUND FOR THREE-PHASE OUTPUT POWER	
T1, T2, T3	THREE-PHASE OUTPUT POWER TERMINALS	T3 IS THE MANUFACTURED PHASE

*The solid state overload relay is present only when the optional Motor Starter feature is ordered. The Motor Starter option allows Phase Perfect® to start and protect single motor loads. Models DPC-A10, DPC-20 and DPC-30 are equipped with a remote reset button on the front of the enclosure so that the overload relay can be reset without opening the enclosure. **There is no need to move the jumper from A-B to B-C if the converter is not equipped with the optional Motor Starter.**

2.2.1.1 GENERAL WIRING CONSIDERATIONS

Installations must comply with all national and local electrical code requirements. General Wiring Considerations Include:

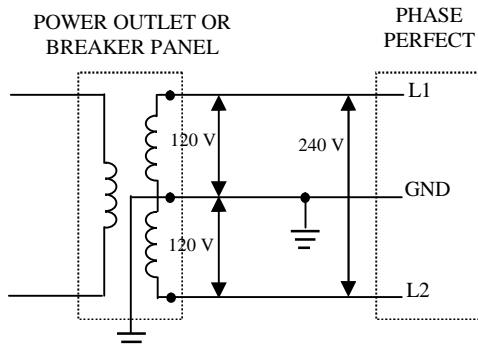
1. **This Unit Is Suitable For Use In A Circuit Capable Of Delivering Not More Than 5 kA RMS Symmetrical Amperes, 240 V Maximum.**
2. Use 600 V vinyl-sheathed wire or equivalent. The voltage drop of the leads needs to be considered in determining wire size. Voltage drop is dependent on wire length and gauge.
3. Wire used within the motor circuit and all field wiring terminals must be rated for 60 C
4. Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in Table 1.
5. Use wire size suitable for Class 1 circuits.
6. 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 88 amps.
7. The maximum wire gauge for the input terminals is listed in Table 1.
8. Never allow bare wire to contact the metal surfaces.
9. Never connect AC main power to the output terminals T1, T2, and T3.
10. Input power to Phase Perfect® should be wired by a qualified electrician into a 208V or 240 V circuit with adequate current carrying capacity and the appropriate sized breaker. Branch circuit protection to the phase converter should be provided by an appropriate size, 2 pole, linked circuit breaker. Circuit breaker size for each model Phase Perfect® is listed in Table 2.

Table 2

Model:	DPC-A10	DPC-20	DPC-30
Input Terminals			
Tightening torque	16 in.-lb.	50 in.-lb.	275 in.-lb.
Max. wire size	14 - 6 AWG	6 - 1/0 AWG	6 AWG – 250 MCM
Output Terminals			
Tightening torque	16 in.-lb.	45 in.-lb (4-6 AWG) 40 in.-lb. (8AWG) 35 in.-lb. (10-16 AWG)	50 in.-lb.
Wire size	14 - 6 AWG	16 – 4 AWG	6 - 1/0 AWG
Optional overload relay			
Tightening torque	14 in.-lb.	35 in.-lb.	150 in.-lb.
Max. wire size	14 - 6 AWG	2 AWG	8-1/0 AWG
Circuit Breaker			
Amps	60 - 70	110 - 125	175 - 200

2.2.1.2 INPUT WIRING CONSIDERATIONS

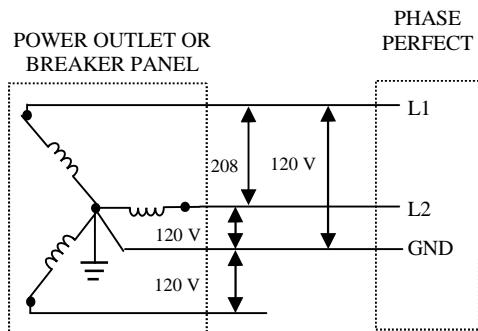
Phase Perfect® can be operated from most typical input power sources ranging from 187 to 255VAC, including 120/240VAC single-phase sources with a grounded center tap, or single-phase power derived from two legs of a three-phase source. However, specific input wiring issues must be considered when wiring to three-phase input sources. **Incorrect L1 and L2 wiring from some three-phase sources can damage the unit.** These considerations are outlined below in Figure 3:



Single-phase, 120/240VAC, 3 Wire

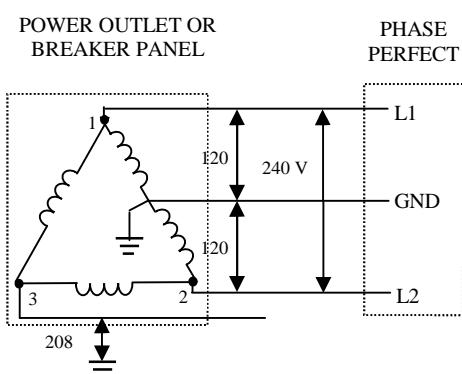
In most installations, single-phase 240VAC input power will be taken from a single-phase 120/240VAC center tap source. L1 and L2 from the source are connected to the input terminals of Phase Perfect. There is no neutral connection, only a safety ground.

In some cases single-phase power may be derived from two legs of a three-phase source. **TO AVOID POSSIBLE DAMAGE TO THE UNIT, ALWAYS VERIFY THAT THE INPUT LINE VOLTAGES L1-TO-GROUND AND L2-TO GROUND ARE APPROXIMATELY 120 VOLTS PRIOR TO CONNECTING INPUT POWER TO PHASE PERFECT.**



Three-phase, 208/120VAC, Grounded-Wye

Single-phase 208VAC 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 generated phase-to-ground voltage will be 240VAC, causing the unit to shutdown and the yellow status light to flash. In this event reverse the L1 and L2 input connections.



Three-phase, 240/120VAC, Delta

WARNING!

In rare situations single-phase 240VAC input power is derived from a three-phase source as illustrated to the left. **EXTREME CAUTION** must be exercised if using such a source for power input to the unit. Power can only be taken across points 1 and 2, with a center ground, as illustrated. Power taken across points 2 and 3, or 3 and 1, will **DAMAGE** the unit. **To avoid possible damage, always verify the voltage to ground for the L1 and L2 inputs to be approximately 120VAC**

2.2.2 TYPICAL SYSTEM CONFIGURATIONS

Phase Perfect® is designed to simplify installations, to provide maximum versatility, and to eliminate or minimize the need for external electrical components and related costs. The output of Phase Perfect® is sinusoidal, eliminating the need for output filtering that would often be required for a variable frequency drive (VFD). Electronic power factor correction on the input module does not distort the input current, so input filters are not required. When equipped with the optional Motor Starter, Phase Perfect® can start and protect a single-motor load, eliminating the need for a three-phase starter panel in many single-motor applications. All types of equipment, including inductive, resistive, and capacitive loads can be safely powered by Phase Perfect®.

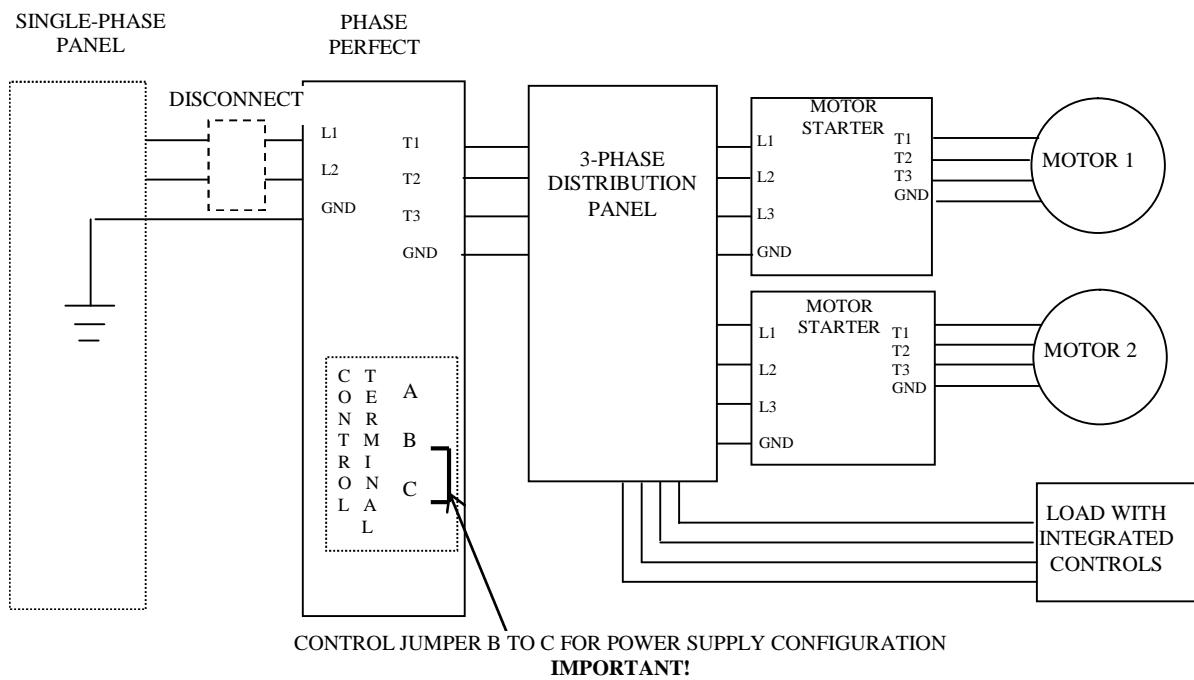
Three typical Phase Perfect® installations are diagrammed and explained below: (1) a power supply configuration for use in powering multiple three-phase loads, (2) a motor starter configuration for use with a single-motor load, and (3) a pump configuration in which a pressure or level switch automatically controls power to the pump.

2.2.2.3 POWER SUPPLY CONFIGURATION

Phase Perfect® can be configured as a power supply to provide three-phase power to multiple loads of any type, including inductive, resistive, and capacitive loads. If the Phase Perfect® converter is equipped with the **optional** Motor Starter feature, the jumper on the Control Terminals should be set to connect B to C for power supply operation. Connecting B to C on the Control Terminal will disable the motor overload relay when it is present. **The jumper is a metal tab on the bottom of the Control Terminal, it is NOT the wire connecting A to C at the top of the Control Terminal which should NOT be moved.**

The power supply configuration used to power multiple motor loads or loads with integrated controls is illustrated in Figure 4:

Figure 4



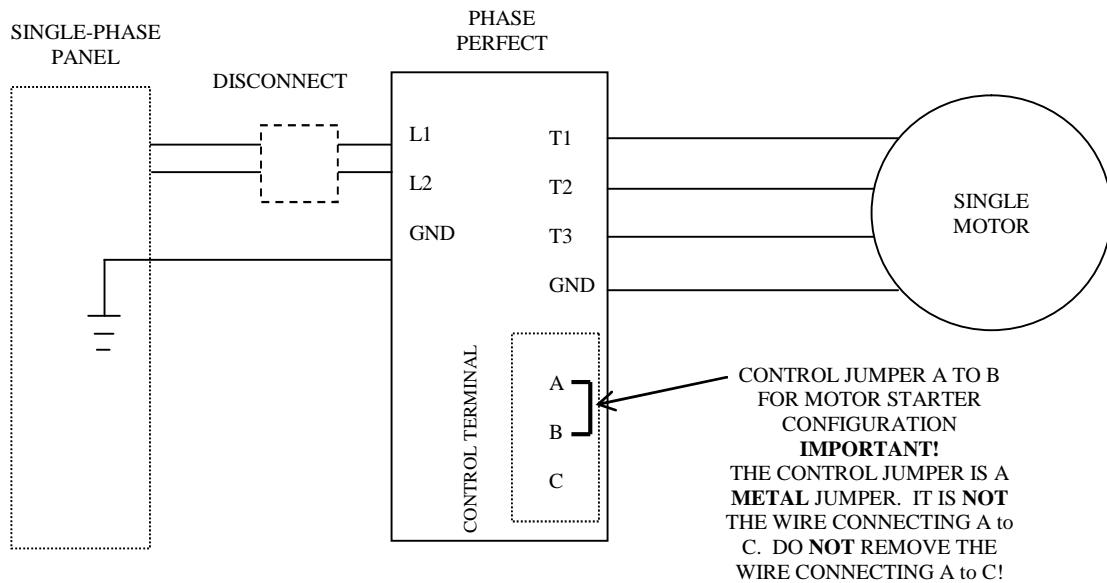
Follow this procedure when wiring Phase Perfect® as a power supply to provide three-phase power to multiple loads or to loads with integrated controls:

1. Verify that no input power is connected to Phase Perfect®.
2. Remove the front cover to gain access to the wiring terminals. See section 2.2.1, "Wiring to Phase Perfect® Terminals," for a drawing illustrating the components found under the front cover.
3. If your Phase Perfect® is equipped with the optional Motor Starter, it is shipped from the factory with a metal jumper connecting Control Terminals A and B. Remove the metal jumper between terminals A and B, then install the jumper between terminals B and C. **WARNING!** The wire connecting A to C at the top of the Control Terminal is **NOT** a jumper, and should **NOT** be removed.
4. **With the control terminal jumper between terminals B and C Phase Perfect® is configured as a three-phase power supply and the optional motor overload relay is disabled.**
5. Connect input power to Phase Perfect® from an appropriate single-phase circuit. See section 2.2.1.2, "Input Wiring Considerations," for additional information.
6. Before energizing the input power, measure the source voltage. It must be within the input range of 187-260VAC.
7. Start the converter before any loads are connected to the output and measure the output phase-to-phase voltages. They should all be approximately equal to the input voltage. Because the 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.
8. Turn OFF Phase Perfect® by means of the input disconnect, wait a safe interval for any internal charges to dissipate, then connect the output to the motor and non-motor loads as illustrated in Figure 4. Three-phase output power wire connections are made to the T1, T2, and T3 output terminals, and secured with the terminal block screws.
9. Re-attach the front cover.
10. Turn Phase Perfect® ON from the disconnect switch. **Power will be available to the load circuits after an approximately five to eight second delay.** Check each motor for correct rotation. If the motor rotation is incorrect reverse any two of the three output power leads to that motor.
11. **WARNING!** A low power remote switch wired into the Control Terminal of Phase Perfect® is intended to control the converter and its connected loads. **When the converter is turned OFF using a remote switch on the Control Terminals, dangerous voltage is still present on the input lines and on certain output lines to ground.** Always make sure the converter is disconnected from the input lines when performing service on the converter or any connected loads.

2.2.2.1 MOTOR STARTER CONFIGURATION

With the Motor Starter option, Phase Perfect® can be used to start and protect single-motor loads, eliminating the need for a three-phase starter panel. An appropriate sized disconnect must be installed on the input side of Phase Perfect®. The optional overload relay can be adjusted for motor ratings up to the rated HP capacity of the converter. See section 4 "Motor Overload Relay Information" for more information. The motor starter configuration used to power a single motor is illustrated in Figure 5:

Figure 5



Follow this procedure when wiring Phase Perfect® as a motor starter to power a single motor:

1. Verify that no input power is connected to Phase Perfect®.
2. Remove the front cover to gain access to the wiring terminals. See section 2.2.1, "Wiring to Phase Perfect® Terminals," for a drawing illustrating the components found under the front cover.
3. If your Phase Perfect® is equipped with the optional Motor Starter, it is shipped from the factory with a metal jumper connecting Control Terminals A and B. **WARNING!** The wire connecting A to C at the top of the Control Terminal is **NOT** a jumper, and should **NOT** be removed.
4. Verify that control terminals A and B are shorted together by a **metal** jumper. Phase Perfect® is shipped from the factory in this configuration. When contacts A and B are shorted together the optional motor protection unit is enabled, and Phase Perfect is configured as a motor starter.
5. Set the motor overload relay to the desired settings:
 - a. Adjust the trip current to the appropriate current for the motor load being powered. The trip rating is 120% of the dial setting.
 - b. Set the overload relay to auto or manual reset as desired. For auto reset, push and turn the reset button clockwise to the Auto position. The button will remain depressed. **WARNING! In this position the relay will reset automatically approximately two minutes after tripping, providing power to the load without warning.** For manual reset, push and turn the reset button to the manual position. In this position, pushing the button resets the overload relay. Additional information on the motor protection unit is provided in Section 4, "Motor Overload Relay."
6. Connect input power to Phase Perfect® from an appropriate single-phase circuit. See section 2.2.1.2, "Input Wiring Considerations," for additional information.
7. Before energizing the input power, measure the source voltage. It must be within the input range of 187-260VAC.
8. Start the converter before any loads are connected to the output and measure the output phase-to-phase voltages. They should all be approximately equal to the input voltage. Because the 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.

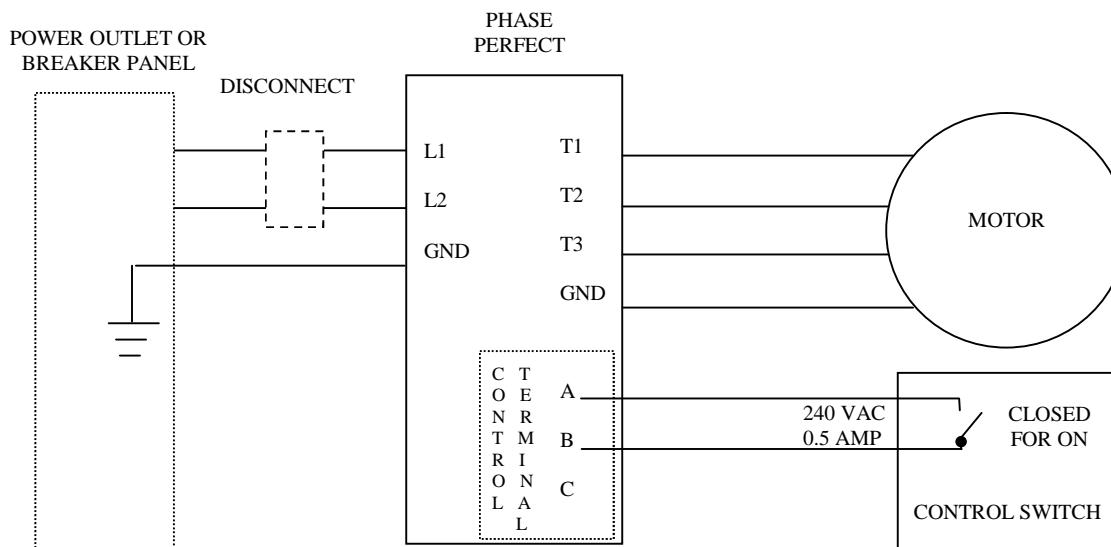
9. Turn OFF Phase Perfect® by means of the input disconnect, wait a safe interval for any internal charges to dissipate, then connect the output to the motor load as illustrated in Figure 5. Three-phase output power wire connections are made to the T1, T2, and T3 output terminals, and secured with the terminal block screws.
10. Re-attach the front cover.
11. Turn Phase Perfect® ON from the disconnect switch. Power will be available to the load after an approximately five to eight second delay. Check the motor for correct rotation. If the motor rotation is incorrect reverse any two of the three output power leads to that motor.
12. Note: A low power remote switch can be wired into Phase Perfect® to control the motor as described in the following section, "MOTOR STARTER WITH REMOTE ON/OFF CONTROL."

2.2.2.2 MOTOR STARTER WITH REMOTE ON/OFF CONTROL

WARNING! A low power remote switch wired into the Control Terminal of Phase Perfect® is intended to control the converter and its connected loads. **When the converter is turned OFF using a remote switch on the Control Terminals, dangerous voltage is still present on the input lines and on certain output lines to ground.** Always make sure the converter is disconnected from the input lines when performing service on the converter or any connected loads.

When equipped with the optional Motor Starter feature Phase Perfect® can be used to power individual pumps or other single-motor loads which are automatically switched ON/OFF by a remote switch such as a pressure switch or level switch with at least a 240 VAC, 0.5 amp rating. This feature can eliminate the need for an external three-phase starter panel to control the load. Phase Perfect® incorporates a contactor and adjustable motor overload relay, providing the necessary components of a motor starter. The built-in overload relay can be adjusted for a wide range of motor HP ratings. The installation is similar to the motor starter configuration, with the addition of an ON/OFF control switching mechanism. The configuration used to power an individual motor with control circuit is illustrated in Figure 6:

Figure 6



Follow this procedure when wiring Phase Perfect® to power a motor controlled by a remote switch such as a level or pressure switch:

1. Verify that no input power is connected to Phase Perfect®.
2. Remove the front cover to gain access to the wiring terminals. See section 2.2.1, "Wiring to Phase Perfect® Terminals," for a drawing illustrating the components found under the front cover.
3. If your Phase Perfect® is equipped with the optional Motor Starter, it is shipped from the factory with a metal jumper connecting Control Terminals A and B. **WARNING!** The wire connecting A to C at the top of the Control Terminal is **NOT** a jumper, and should **NOT** be removed.
4. Verify that control terminals A and B are shorted together by a **metal** jumper. Phase Perfect® is shipped from the factory in this configuration. When contacts A and B are shorted together, the optional motor protection unit is enabled, and Phase Perfect is configured as a motor starter.
5. 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 converter 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 located on the wiring panel protects the remote switch circuit.
6. Set the motor overload relay to the desired settings:
 - c. Adjust the trip current to the appropriate current for the motor load being powered. The trip rating is 120% of the dial setting.
 - d. Set the overload relay to auto or manual reset as desired. For auto reset, push and turn the reset button clockwise to the Auto position. The button will remain depressed. **Warning! In this position the relay will reset automatically approximately two minutes after tripping, providing power to the load without warning.** For manual reset, push and turn the reset button to the manual position. In this position, pushing the button resets the overload relay. Additional information on the motor protection unit is provided in Section 4, "Motor Overload Relay."
7. Connect input power to Phase Perfect® from an appropriate single-phase circuit. See section 2.2.1.2, "Input Wiring Considerations," for additional information.
8. Before energizing the input power, measure the source voltage. It must be within the input range of 187-260VAC.
9. Start the converter before any loads are connected to the output and measure the output phase-to-phase voltages. They should all be approximately equal to the input voltage. Because the 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.
10. Turn OFF Phase Perfect® by means of the input disconnect, wait a safe interval for any internal charges to dissipate, then connect the output to the motor load as illustrated in Figure 5. Three-phase output power wire connections are made to the T1, T2, and T3 output terminals, and secured with the terminal block screws.
11. Re-attach the front cover.
12. Turn Phase Perfect® ON from the disconnect switch. When the remote switch is closed the load will start after an approximately five to eight second delay. Check the motor for correct rotation. If the motor rotation is incorrect reverse any two of the three output power leads to that motor.

3. OPERATION

Operation of the Phase Perfect® unit is straightforward after completion of installation and wiring.

3.1 ON/OFF FUNCTION

When Phase Perfect® is configured as a motor starter (see section 2.2.1) or a power supply (see section 2.2.3), power to the Phase Perfect® unit is turned ON/OFF by a properly installed

disconnect switch or the input circuit breaker. When switched on, output power is provided to the load after a delay of approximately five to eight seconds.

When Phase Perfect is equipped with the optional Motor Starter and configured to control a motor (see section 2.2.2) or other load via a control circuit, the input power is left on. When a remote switch on the Control Terminals is closed, output power is applied to the load after a delay of approximately five to eight seconds. When the input power is on, and the control switch is open, Phase Perfect® will not consume any power and phase-to-phase voltage will not 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 and on certain output lines to ground.** When either the input power is off, or the switch on the Control Terminals is open, the front panel green status light will be OFF.

3.2 STATUS LIGHTS

The GREEN, YELLOW, and RED status lights are found on the front panel of Phase Perfect®. The status lights cannot be viewed in direct sunlight, and should be shaded for clear viewing. The status lights provide information about the status of the Phase Perfect® unit, and provide useful troubleshooting information about the entire system into which Phase Perfect® is wired.

Three basic status light indications are:

- **GREEN STATUS LIGHT ON Steady:** Power ON, Control Switch Closed (if present)
- **YELLOW STATUS LIGHT ON Steady:** Internal Converter Temperature Too High
- **RED STATUS LIGHT Flashing:** Internal Short in Converter, Consult Factory

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

In addition to the basic status light functions indicated above, **flashing status lights and combinations of status lights are designed to indicate and help troubleshoot a wide range of potential problems.** A complete listing of status light indications is provided in Section 5.3, "Status Lights."

4. MOTOR OVERLOAD RELAY INFORMATION

When equipped with the optional Motor Starter feature, Phase Perfect® provides motor overcurrent protection through a solid state motor overload relay. Two types of motor overload relay are available, the standard overload relay and the SymCom 777®.

4.1 777 MOTOR STARTER OPTION

When Phase Perfect® is equipped with the optional 777 Motor Starter, a SymCom 777® motor overload relay provides advanced motor protection features not available with the Standard Motor Starter. The 777 Motor Starter also includes HOA controls integrated into the Phase Perfect® enclosure for pumping applications.

The 777 Motor Starter option is for operating single motor loads only. Moving the jumper to B-C on the Control Terminal will not bypass the motor overload relay. **When equipped with the 777 Motor Starter, Phase Perfect® cannot be operated in power supply mode.**

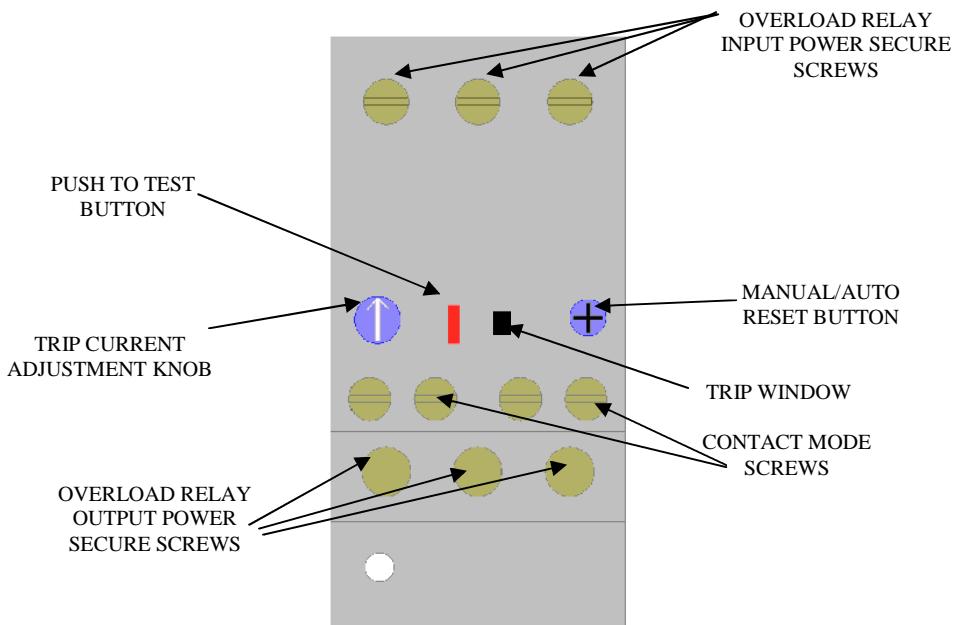
Complete operating instructions for the SymCom 777 motor overload relay are enclosed in the phase converter shipment carton.

4.2 STANDARD MOTOR STARTER OPTION

The motor overload relay provides a current adjustment range suitable for a wide motor horsepower range up to the capacity of the converter. The motor overload relay is enabled when Phase Perfect® is used in the motor starter configuration by shorting Control Terminals A and B

together. The overload relay should be disabled by shorting terminals B and C together when Phase Perfect® is used in the power supply configuration. This section provides detailed information on the overload relay, as illustrated below:

OVERLOAD RELAY



The following points describe adjustment and features of the motor protection unit.

1. **TRIP CURRENT ADJUSTMENT BUTTON**—Used to adjust the current trip limit for protecting single-motor loads. To adjust the trip current, turn the dial until the desired current is aligned with the pointer. The trip rating is 120% of the dial setting. Consult motor specifications for appropriate current limits.
2. **MANUAL/AUTO RESET BUTTON**—Used to control automatic and manual reset features of the overload relay, and to reset the motor protection unit if it trips out. The unit is shipped from the factory in the manual mode. Automatic reset of the overload relay is often desirable for applications such as unattended pumps. Manual reset is typically used when the converter and load are readily accessible.
 - a. For auto reset, push and turn the reset button clockwise to the Auto position. The button will remain in the IN position. The unit will reset automatically approximately two minutes after tripping. **ATTENTION: Do not use the automatic reset mode in applications where unexpected automatic restart of the motor can cause injury to persons or damage to equipment.**
 - b. For manual reset push and turn the reset button to the Manual position. In this position the button must be manually pushed to reset the overload relay.
 - c. To manually trip the overload relay, push and turn the button counterclockwise to the trip position. Releasing the button reverts the unit to the manual position.
 - d. To reset the overload relay push the button.
3. **TEST BUTTON**—Will shut OFF Phase Perfect and power to the load when pushed.
4. **TRIP INDICATOR WINDOW**—A yellow indicator will be visible on the relay if it has tripped due to an overload condition. The overload relay can be reset by pushing the manual/auto reset button IN when the button is in the manual position.

5. **OUTPUT POWER SECURE SCREWS**—Used to secure power wires in place between the motor protection unit and the load.
6. **INPUT POWER SECURE SCREWS**—Used to secure input power wires from Phase Perfect® electronics to the overload relay in place. Factory pre-installed wires at this location should not be removed or altered.
7. **CONTACT MODE SCREWS**—Used to secure wires to configure the contact mode of the overload relays. **Wires connected to the NC contacts are pre-wired at the factory, and should not be removed.**

More detailed information on the motor overload relay is available in the relay operation and installation manual which is enclosed in the converter with the relay. For further support on the motor overload relay, contact the Field Support Manager at Phase Technologies, (605) 343-7934.

5. TROUBLESHOOTING

This section provides troubleshooting information for potential system problems.

5.1 GENERAL TROUBLESHOOTING TIPS

After the system is properly connected to input power, turn the Phase Perfect® 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 turn ON, and all status lights are OFF, check the following:

1. Verify that the appropriate circuit breaker in the building's electrical distribution box is set ON and is properly sized.
2. Check for blown fuses. See Table 3 below in Section 5.2 for details on fuses.
3. Verify that the metal jumper on the Control Terminal is connected either A to B for motor starter configuration, or B to C for power supply configuration. The unit will not operate unless the metal jumper or control circuit wires are connected to the appropriate control terminals. **WARNING!** The wire connecting A to C at the top of the Control Terminal is **NOT** a jumper, and should **NOT** be removed.

For single-motor applications utilizing the Motor Starter feature, if the converter turns ON but power is not provided to the load:

1. Check the TRIP INDICATOR WINDOW on the motor protection unit to see if it has tripped. If tripped, push the AUTO/MANUAL RESET button on the motor protection unit.
2. Verify that the overload relay current limit is appropriately set for the load.

Refer to Section 5.3 on status light information for additional troubleshooting tips.

5.2

Table 3 Fuses

FUSE IDENTIFICATION	PHASE CONVERTER MODEL		
	DPC-A10	DPC-20	DPC-30
F501	3 amp fast blow	3 amp fast blow	3 amp fast blow
F701	4 amp slow blow	8 amp slow blow	12 amp slow blow
Main PCB F1	2 amp slow blow	2 amp slow blow	2 amp slow blow
Main PCB F2	2 amp slow blow	2 amp slow blow	2 amp slow blow
Main PCB F3	1 amp slow blow	1 amp slow blow	1 amp slow blow
Daughter PCB*	3 amp fast blow	3 amp fast blow	3 amp fast blow

*Blown fuse on the Daughter PCB may indicate failed filter capacitors. Contact manufacturer.

5.3 STATUS LIGHTS

The status lights provide a very useful tool for detecting and diagnosing system problems. The table on the following page provides a list of status light modes, the indicated problem, and potential causes of the problem.

STATUS LIGHT TROUBLESHOOTING TABLE

STATUS LIGHT MODE	INDICATED PROBLEM	POTENTIAL CAUSES	SUGGESTED FIXES	NOTES
Steady Green	System normal			
Steady Yellow	System overheated	<ul style="list-style-type: none"> -Blockage of air intake and exhaust -Ambient temperature too high. (ambient temp. should not exceed 40 C) -Internal dirt buildup -Failed cooling fan 	<ul style="list-style-type: none"> -Make certain vents are clear. -Verify adequate clearance between unit and surroundings. -Ensure that building is adequately vented. -Avoid direct sunlight. -Contact factory. -Note: fan is temp. controlled, and does not operate continuously. 	1
Flashing Red	Fault	Internal short in unit	Contact manufacturer	2
Steady Red & Green	Input voltage too low	Low utility line voltage	<ul style="list-style-type: none"> -Ensure the input line voltage between L1 and L2 is above 187VAC 	3
Steady Red & Yellow	PLL not in sync	<ul style="list-style-type: none"> -Distorted line voltage -Input frequency not in range 56-64Hz 	<ul style="list-style-type: none"> -Eliminate line noise from source -Connect to source with correct frequency 	3
Flashing Green & Yellow	Output current too high	<ul style="list-style-type: none"> -Short between T3 & T1 or T2 -Excessive load 	<ul style="list-style-type: none"> -Eliminate short -Ensure steady state current is within ratings. Higher current is OK for momentary load startup 	2
-Steady Green & Yellow -Steady Red -Flashing Red & Green	DC buss charging circuit error	Blown fuse in charging circuit Buss capacitor shorted	<ul style="list-style-type: none"> -Check fuse in charging circuit -Contact manufacturer 	3
Flashing Yellow	Output voltage (T3 to GND) too high	Grounded-wye three-phase input used with L1 and L2 reversed	-Reverse L1 and L2	2
Flashing Red, Green & Yellow	-Abnormal DC bus voltage -Faulty temp sensor	<ul style="list-style-type: none"> -T3 to ground fault -Faulty temp sensor -Load exceeds output rating, either steady state or momentary 	<ul style="list-style-type: none"> -Eliminate short -Reduce load 	2
Steady Red, Yellow & Green	Filter capacitor short	Failed filter capacitor	Contact manufacturer	2
Steady Red & Yellow	Input voltage too high	High utility line voltage	Ensure input line voltage between L1 and L2 is below 255 VAC	3

Notes:

1. **WARNING: The unit will automatically turn back ON after internal temperature reaches acceptable levels.**
2. The output will remain de-energized until the input disconnect switch is cycled OFF/ON, or the remote control switch is cycled OFF/ON.
3. The unit will automatically turn back ON 15 seconds after the problem is corrected.

If problems cannot be corrected, contact the Field Support Manager at Phase Technologies, (605) 343-7934.

6 CARE AND MAINTENANCE

Under normal operating conditions it is recommended that a routine inspection of the converter be performed every six months. Inspection procedures are listed below.

1. Make certain input power to the converter has been turned off at the input disconnect and the recommended time has elapsed for internal electrical charges to dissipate.

2. Remove front and rear covers of the converter.
3. If excess dust or other contaminants have accumulated inside the enclosure, clean and remove with compressed air.
4. Inspect cooling fans to make sure the fan blades are clean and rotate freely.
5. Inspect wiring connections and terminations for any sign of overheating or corrosion.
6. Inspect capacitors for any sign of damage. A failed capacitor may rupture and leak.
7. Be careful not to touch printed circuit boards unnecessarily. Electrostatic discharge (ESD) from your body may damage components on circuit boards. It is advisable to touch the converter case with your hand to discharge any ESD before touching any components inside the converter.

Line Filter Capacitors

⚠ CAUTION: Line filter capacitors should be inspected annually at a minimum. **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.

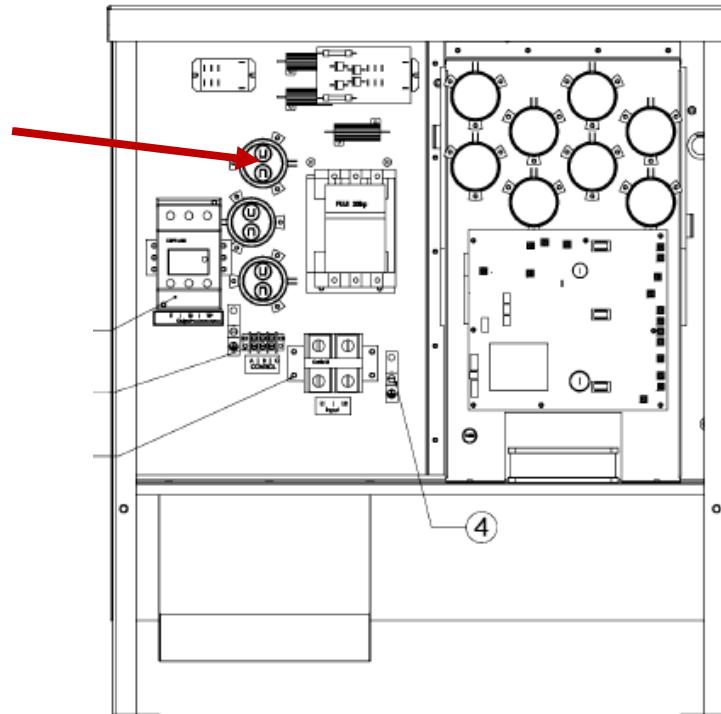
Line filter capacitors should be visually inspected and electrically tested on a routine basis. The capacitors can be observed by opening the front cover of the converter. See the photos below to identify the line filter capacitors.

Table 7 Nominal Filter Capacitor Values in MicroFarads (uF)

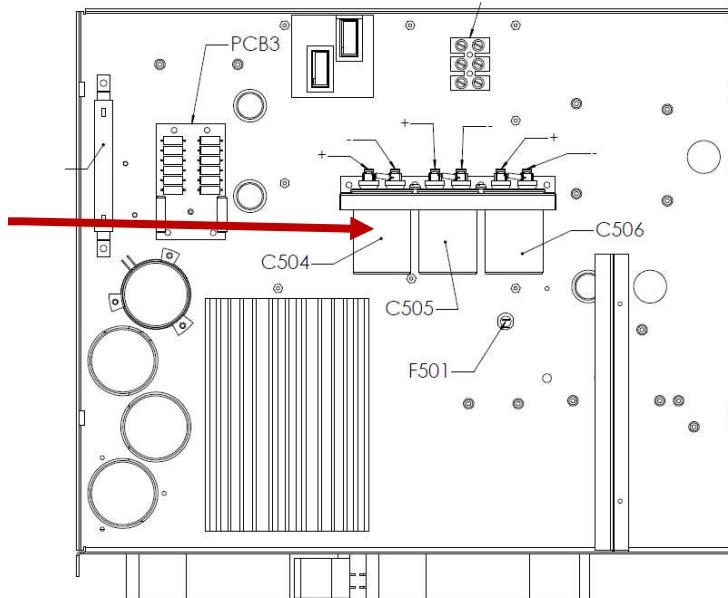
Converter Model	Number of Capacitors	Capacitance (uF)
DPC-A10	3	40 uF
DPC-20	3	40 uF
DPC-30	3	60 uF

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

Filter capacitor location for
DPC-20 and DPC-30
(three capacitors total)



Filter capacitor location for DPC-A10 (three capacitors total). Capacitors are located in the back cavity and are accessible only by removing the top cover. Only the top of the capacitors will be visible.



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 25% contact Phase Technologies customer support at 605-343-7934 to order replacement capacitors. 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. Do not operate the converter with degraded capacitors!

7 FEATURES AND SPECIFICATIONS

7.1 FEATURES

- Electronic power factor correction
- High efficiency
- Balanced output voltages
- Automatic brownout and over-voltage protection
- Fault protection and overload protection
- Optional built-in motor starter capability
- Clean power fed back to power grid during regenerative load situations

7.2 SPECIFICATIONS Specifications subject to change without notice

Model:	DPC-A10	DPC-20	DPC-30
Input current characteristics:	True sinusoidal, (2.3% THD)		
Power factor:	.99 all load conditions		
Rated steady state single-phase input current:	50 amps	88 amps	136 amps
Input voltage:	187 V to 260 V		
Output Power Characteristics:	Three-phase, sinusoidal (3.4% THD)		
Phase to phase voltage balance: [*]	better than 1%		
Rated steady state output current:	29 amps	54 amps	80 amps
Service factor output current:	36 amps	64 amps	96 amps
Momentary overload current, 4 seconds	150 amps	280 amps	400 amps
Rated HP:	10	20	30
Output voltage:	Equal to input voltage		
Service factor:	1.2	1.2	1.2
Power Consumption on Standby	100 watts	240 watts	400 watts
Enclosure:	Type 1 indoor or 3R rain proof	Type 1 indoor or 3R rain proof	Type 1 indoor or 3R rain proof
Weight:	123 lb.	230 lb.	330 lb.
Dimensions (H x W x D in.):	Type 1 indoor 22 x 21 x 12 Type 3R rainproof 27 x 21 x 12	30 x 27 x 15	32 x 36 x 15
		34 x 27 x 15	37 x 36 x 15

^{*}NEMA MG1 standard for voltage unbalance

PROTECTIVE FUNCTIONS

Undervoltage: Automatic shutdown below 187 V, then resets ON when voltage >199 V

Oversupply: Automatic shutdown above 260 V, then resets ON when voltage < 260 V

Motor overload protection: Solid state, trip class 10, motor overload relay (only included on models with Motor Starter option)

Internal overheating: Heatsink temperature sensor

GENERAL

Efficiency: 95-97% typical

Operating temperature range: -10 C to 40 C

Storage temperature range: -20 C to 60 C