

PHASE
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PHASE**PERFECT**[®] 480V

Digital Phase Converter

Operation & Installation Manual

Single-Phase to Three-Phase

Solid State Technology

97% Efficient



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Version 1.0

Introduction

PHASEPERFECT® 480V Digital Phase Converters are power switching-based devices that convert single-phase AC power to three-phase AC power to operate a variety of electrical equipment.

Our phase converters offer three-phase voltage balance and operates at 97% efficiency.

Model options range from 7.5 HP to 30 HP.

Output voltage is sinusoidal with very low harmonic content, making it safe to operate even sensitive electronic equipment.

Phase Perfect converters are available in NEMA Type 3R Outdoor Rainproof enclosures and features a locking cabinet and insect guards.



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 57701.

Obligations of the Original Owner

The original Bill of Sale must be presented in order to obtain “in-warranty” service.

Transportation to Phase Technologies or an Authorized Service Center is the responsibility of the original purchaser. Return transportation is provided by Phase Technologies.

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.


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 may be 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 10 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.


 **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 10 kA RMS symmetrical amperes, 480 VAC.


 **WARNING:** Wire used within the motor circuit and all field wiring terminals must be rated for at least 75° C.


 **WARNING:** Use wire size suitable for Class 1 circuits.


 **WARNING:** Input power connections should be made by a qualified electrician into a nominal 480V 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.


 **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 2-2.

 **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 2-2.

 **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 load may automatically restart after a trip has stopped it. Make sure power to the converter has been disconnected before approaching or servicing the equipment. Otherwise, serious injury may occur.

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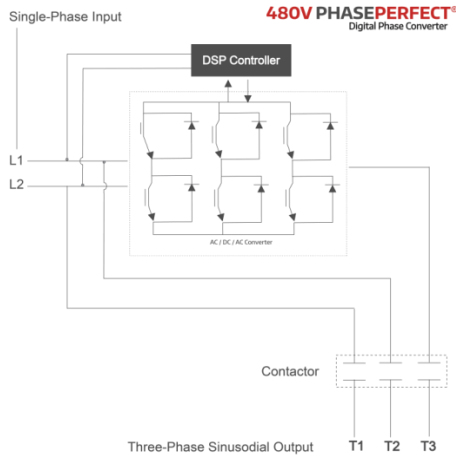
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Block Diagrams

PHASEPERFECT® 480V Series Design

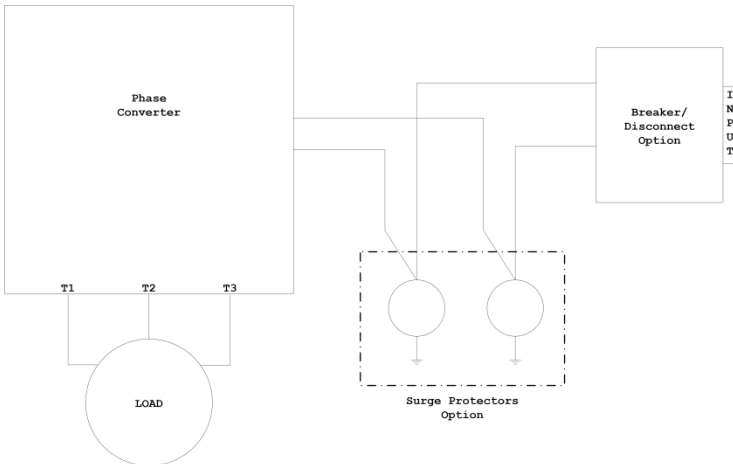
The diagram in Figure 1 illustrates the basic design of a PT480V, otherwise known as a Phase Perfect® Series Digital Phase Converter.

Figure 1 Basic Design of Phase Perfect® 480V



The diagram in Figure 2 illustrates the UL508A panel shop options.

Figure 2 Basic Design of Phase Perfect® 480V



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 480 VAC single-phase input will produce 480 VAC three-phase output).

The three-phase output will be balanced within 1% line-to-line.

Important Note:

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.

Models and Ratings

Phase Perfect[®] 480V Series Model Number Information (PT480V)

PT 4 10 R - B S

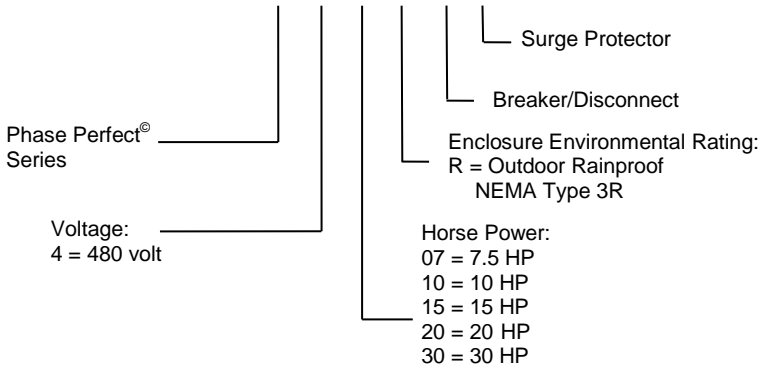
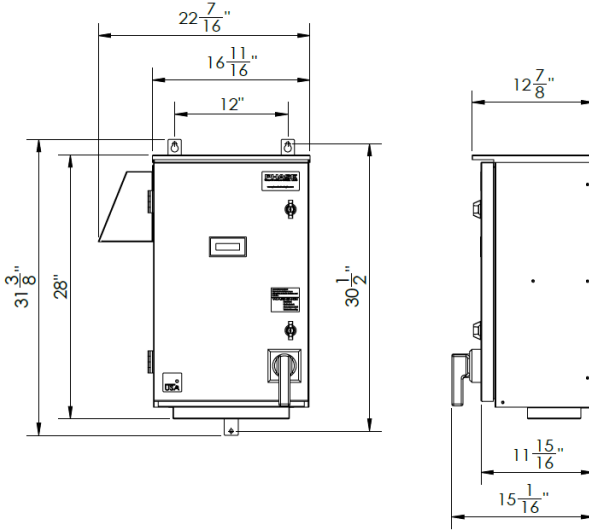


Table 1-1 Base Models and Ratings

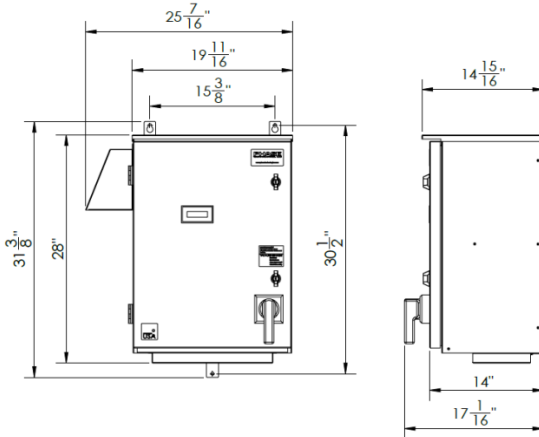
Model	Rated HP	Rated Input Voltage	Rated Input Current	Rated Output Voltage	Rated Output Current	Packaged Weight (lb.)
PT407	7.5	480V Single Phase	22A	480V Three Phase	13A	62
PT410	10		32A		18A	64
PT415	15		47A		27A	68
PT420	20		55A		32A	74
PT430	30		80A		46A	87

Dimensional Drawings

PT407R, PT410R, PT415R, PT420R (optional breaker disconnect handle pictured)



PT430R (optional breaker disconnect handle pictured)



Mounting the Unit

The Phase Perfect 480V[®] models are designed standard with NEMA 3R outdoor rated, rain proof enclosures. The unit should be securely mounted in an upright position onto a solid, non-flammable surface.

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:

- Corrosive gases or liquids
- Excessive vibration
- Airborne metallic particles

It should be securely mounted to a solid, non-flammable 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 1-1* of this document. Elevating the unit well above the ground will help to reduce the introduction of dust and contaminants into the enclosure.

CABLES, STRAPS OR CHAINS USED FOR LIFTING THESE UNITS MUST BE ATTACHED ONLY TO THE PROVIDED BRACKETS.

NOTE: Mounting Brackets:

For shipping purposes, mounting brackets located on the back of the unit may be installed upside down to accommodate shipping materials.

If your mounting brackets are not installed in an upright position, remove the mounting screws and turn to an upright position, and fasten the screws tightly.

Proper Ventilation

In order to provide proper ventilation, do not obstruct the open space around the enclosure. In order to maintain air circulation for adequate cooling, minimum clearance must be two inches (2") on each side, and six inches (6") 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 sure there is adequate ventilation to provide sufficient cooling for the unit.

LCD Display – Status Screen

PT 480V Series converters come with an illuminated status screen. When the unit is energized, the screen will display the current status of the unit including various operating parameters.

Internal IGBT
Component Temperature
(less than 110°C)

Figure 2-1 Status Screen





Operating Temperature


PT480V Series digital phase converters are intended for use in the following ambient temperature range: 0°C (32°F) to 50°C (122°F)


General Wiring Considerations


Installations must comply with all NEC and local electrical code requirements. Please follow all warnings and directions below:


 **WARNING:** Suitable for use in a circuit capable of delivering not more than 10 kA RMS symmetrical amperes, 480V maximum.


 **WARNING:** Wire used within the motor circuit and all field wiring terminals must be rated at least 75° C.

 **WARNING:** Use wire size suitable for Class 1 circuits.

 **WARNING:** Input power connections should be made by a qualified electrician into a nominal 480V circuit with adequate current carrying capacity. Branch circuit protection to the drive should be provided by appropriate size fuses or a 2 pole, linked circuit breaker.

 **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 copper conductors only.

 **CAUTION:** Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in Table 2-2.

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

Connecting to Field Wiring Terminals

Open the front cover of the enclosure to gain access to the wiring panel. Terminal blocks for connecting wires are located on a panel inside the enclosure of the unit.

Routing Power Cables

Power cables should enter only through the bottom of the converter enclosure directly beneath the power terminals. Enclosures are supplied with conduit openings, but if the conduit hole location needs to be moved, appropriately sized conduit openings must be created with a punch.

Important Note: Be sure to vacuum out the enclosure to remove any metal shavings that result from drilling the additional holes.


 **CAUTION:** Continuous metal conduit should be used on all power cables, both line and load side, to reduce conducted and emitted radiation of electromagnetic interference (EMI). The conduit must be securely grounded to the enclosure of the converter and the motor case.

Table 2-1 Power Terminal Descriptions

Terminal Name	Description
L1, L2	Input power terminals for single-phase input
T1, T2, T3*	Output power terminals for three-phase output
GND	Earth safety ground

*T3 is the manufactured phase

Note: AVOID USING T3 FOR SINGLE PHASE LOADS

Table 2-2 Field Wiring Power Terminal Specifications

Input and Output Power Terminals		
Models: PT407, PT410, PT415, PT420, PT430 J35 J29		
	Input / Output	Optional MCCB Disconnect
Allen wrench required	3/16"	1/8"

Wire Size	Torque
10-14 AWG	35 lb-in
8 AWG	40 lb-in
2/0 to 6 AWG	120 lb-in

Integrated Options

Breaker/Disconnect

An optional molded case circuit breaker (MCCB) and service entrance rated disconnect can be integrated into the unit.

Surge Protector


An optional surge protection device (SPD) can be integrated into the unit (Raycap Strikesorb[®]). This device will help protect the converter from high transient voltage surges.

ON/OFF Options

There are two ways to turn a PT480V 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 one to two seconds.

ON/OFF With a Low Power Remote Switch

The output of the converter can be turned ON or OFF with a low power switch connected to the AUX1 and COM Terminals.

When AUX1 to COM is closed, power is provided to the load after a delay of approximately one to two seconds. When the AUX1 and COM is opened, the output of the converter will be turned off.

AUX2 is located next to AUX1 on the circuit board. AUX2 to COM can be used as a backup remote ON/OFF switch if AUX1 becomes damaged.

See important notes and warning below

IMPORANT NOTE:

Do not use both AUX1 and AUX2 for the ON/OFF switch; only use **one** of the auxiliaries. If more than one on/off signal is desired, they must be wired in series.

In factory configuration, a jumper wire is installed to connect AUX1 to COM. Remove the jumper wire when connecting a remote switch.



WARNING! When the converter is turned OFF using a remote switch on the AUX Terminals, dangerous voltage is still present on the input lines and other locations inside the enclosure.

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

Table 3-1 Control Terminal Ratings and Descriptions

Terminal Designator	Description	Rating	Comments
AUX1	Auxiliary 1	< 5 volts, galvanically isolated	Digital input. Commonly used for ON/OFF control of output.
AUX2	Auxiliary 2		
COM	Common		Common for AUX terminals.
AUX3	Auxiliary 3		RESERVED - DO NOT USE
AUX4	Auxiliary 4		RESERVED - DO NOT USE


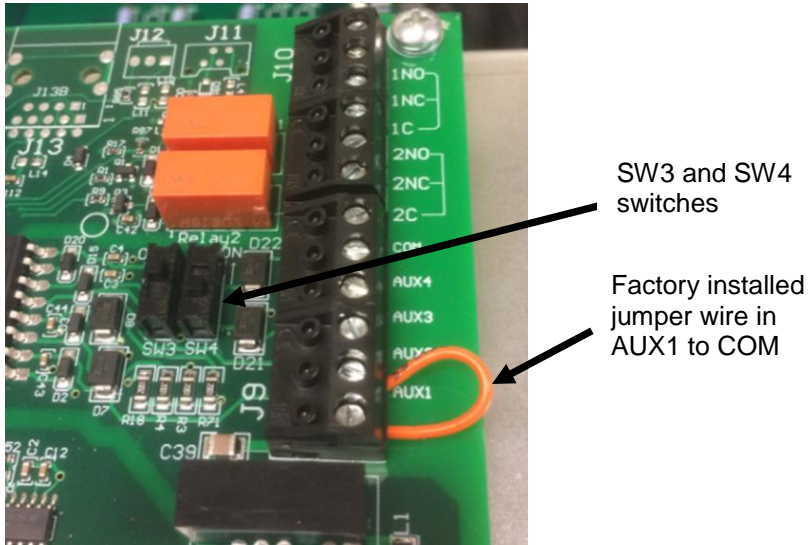
 **CAUTION!** Electrostatic discharge (ESD) can damage components on the printed circuit board. Touch your hand to bare metal on the converter case to discharge any potential ESD before touching the board.

Table 3-2 Modes for SW3 and SW4 (ON up, OFF down)


SW3	SW4	Result
OFF	OFF	Factory default
ON	OFF	LCD screen will show Master Fault Log (not resettable count of all faults) UNIT WILL NOT OPERATE WHILE IN THIS MODE
ON	ON	LCD screen will show User Fault Log (resettable count of all faults) UNIT WILL NOT OPERATE WHILE IN THIS MODE
OFF	ON	LCD screen will scroll various operating parameters – UNIT WILL OPERATE WHILE IN THIS MODE


Figure 3-1 Control Terminal Location




Fault Codes & Troubleshooting Tips

This section provides information on fault codes and troubleshooting tips for potential system problems.

 **WARNING!** In some instances, the converter 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 converter or its connected loads.


 **WARNING:** Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait 10 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 and serviced only by trained, licensed and qualified personnel. Follow instructions carefully and observe all warnings.

Always check the LCD display for fault codes if the drive or its load is not operating.

Fault Codes

A fault code will be displayed on the screen when the converter faults. See Table 4-1 for a list of fault codes.

 **WARNING:** Converter may restart automatically without warning after a fault when operating conditions permit. Make certain input power is disconnected before servicing the unit or its connected loads.

Faults with Auto Restart

The converter is programmed to automatically restart after certain faults with a restart delay of 60 seconds. Refer to Table 4-1, Fault Codes, to determine if a fault allows auto restart. The number 2 in the Notes column of the table indicates auto restart after 60 seconds for a maximum of 10 times before the VFD will remain OFF.

The display will count down the time to restart in seconds. Cycle input power OFF/ON to interrupt a time delay countdown and restart the converter.

A total of 10 restarts are allowed for auto restart faults. On the 11th fault the converter will remain off until input power is cycled OFF/ON.

Faults That Do Not Allow Auto Restart

Certain faults do not allow an auto restart. These faults generally indicate the possibility of damage to the converter and/or the load, or indicate the possibility of a dangerous condition. When this type of fault occurs, the display will indicate the fault and the converter will remain off until input power is cycled OFF/ON.


Refer to Table 4-1, Fault Codes, to determine if the fault allows an auto restart. The number 1 in the Notes column indicates that auto restart is not allowed. When this type fault occurs, contact the factory for assistance before restarting or troubleshoot the system thoroughly. See additional descriptions of the notes below.

Table 4-1 Fault Codes

TEXT MESSAGE	DESCRIPTION / COMMENTS	Notes
OUTPUT FAULT	Check for short circuit on output lines and load. Contact factory	1
INPUT FAULT	Check for short circuit on input lines. Contact factory	1
OVER TEMPERATURE	Internal temperature of the converter exceeded safe limits. Check fans and ventilation openings for obstruction. Reduce ambient temperature.	2
BUS OVERVOLTAGE	Sudden and severe regenerative power under high line voltage conditions may result in bus overvoltage.	2
HALL SENSE HIGH	A current large enough to exceed the maximum current rating of the hall effect sensor. May indicate a fault in the motor circuit	2
HIGH INPUT VOLT	Input voltage has exceeded a level for safe operation. Reduce input voltage.	2
Class 10 OVERLOAD	Output current has exceeded the operating limit of the converter.	2
OVERCURRENT IN	Input current has exceeded the operating limit of the converter. May be related to large current on the load side.	2
BUS VOLTAGE UNBALANCE	Potential causes include damage to capacitor on the bus or degradation of the balancing resistor on the bus.	2
TEMP SENSE FAULT	Solid state temperature sensor on the heat sink has failed or its cable is disconnected.	1

TEXT MESSAGE	DESCRIPTION / COMMENTS	Notes
OUTPUT OVERLOAD	Indicates a large and sudden overcurrent event on the output module. Check the motor circuit for faults.	2
LOW INPUT VOLT	Input voltage has fallen below a level for safe operation of the converter.	2
PRECHARGE FAIL	Pre-charge circuit has failed to charge bus capacitors to normal level.	1
DAC ERROR	Indicates the hall sensor may be damaged and may need to be replaced.	1

1 = Converter has shut down due to a potentially dangerous condition and will remain OFF until fault is cleared by cycling input power OFF/ON.

2 =  **WARNING:** Auto restart allowed for this fault. Load may restart automatically without warning after a fault when operating conditions permit. Make certain input power is disconnected before servicing the unit or its connected loads.

Fault Log

The Fault Log records the number of times a particular fault has occurred. To access the Fault Log, manipulate SW3 and SW4 per Table 3-2. The unit will not run when looking at the fault log.

There are two fault logs – Master and User Fault Log.

Master Fault Log:

Contains the non-resettable count of all faults for the life recorded on the main circuit board.

User Fault Log:

Is a count of faults also, but this list of faults is resettable. The count in the User Fault Log stops at 10 faults for each category. On the 11th fault, the unit will display the appropriate fault and the LCD screen will display “RESET? PWR CYCLE”.

Power cycling the unit will reset the fault that causes the reset back to zero.

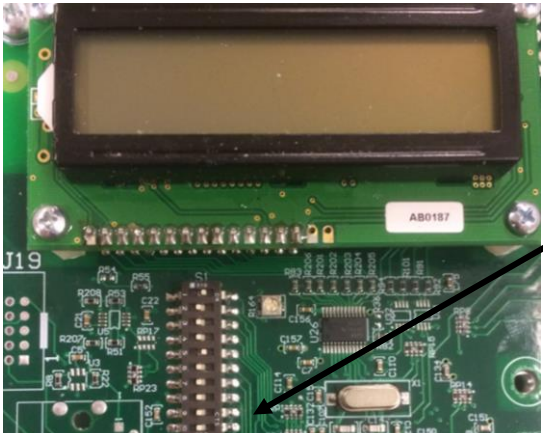
Important Note:

By default, the factory settings allow restarts when there is a fault.

If the user does not want the phase converter to auto-restart, switch #10 on the DIP switch array is located on the main control printed circuit board.

Toggle #10 switch to ON to eliminate auto-restarts.

Figure 4-1 Location of DIP Switch Array



Dip Switch Array – use only #10 to disable restarts

⚠ WARNING: Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait 10 minutes for internal charges to dissipate before opening the front cover to change the DIP switch.

⚠ CAUTION! Electrostatic discharge (ESD) can damage components on the printed circuit board. Touch your hand to bare metal on the converter case to discharge any potential ESD before touching the board.

Table 4-2 Troubleshooting

PROBLEM	POTENTIAL CAUSE	SOLUTION
Load not operating	Is a fault code indicated?	Based on the fault code, resolve any factors that are likely causing the fault. Clear the fault by cycling input power OFF/ON. Remove the load to help determine if the issue is internal or external of the unit.

PROBLEM	POTENTIAL CAUSE	SOLUTION
	Are AUX1 and AUX2 open?	Check the status of the switches or jumpers connected to AUX1 and AUX2 on the Control Terminals. AUX1 to COM OR AUX2 to COM must be closed for the unit to run.
	Are the signals to the Control Terminals corrupted?	Shielded cable is required for AUX terminal switch leads longer than 20 ft. Regular wire will induce capacitance in the line and corrupt control signals. Shielded cable is recommended for all Control signal cables.
	Are the input terminals L1 and L2 energized?	Check the main input fuses or breaker. Check the secondary circuit fuses. See Figure 4-2, <i>Fuse Location</i>
Motor is turning the wrong direction	Phase sequence on output terminals T1, T2, T3 is out of order	Swap any two of the three motor leads on the output terminals.

Routine Inspection and Maintenance

The converter should be inspected and cleaned at least annually, or more frequently if it is located in an excessively warm or dusty environment.

Power terminals: Inspect for loose connections and tighten to specifications in Table 2-2, Field Wiring Power Terminal Specifications.

Capacitors: Check for leakage or deformation.

Overall: Perform a visual inspection checking for things such as discolored wires or terminals, evidence of arcing, loose mounting screws, physical damage to the enclosure, etc.


Fans and heatsinks: Excessive dust buildup on the heatsink and cooling fan impellers may lead to overheating. Lightly brush and vacuum clean.

Instructions for fan replacement: Contact Customer Service for assistance in replacing the cooling fan in the event it should fail. Use only fans approved by Phase Technologies. Unapproved fans may not be able to move enough air to properly cool the unit, leading to component damage.

Line Filter Capacitors

Line filter capacitors are part of the inductor/capacitor (L/C) filters that filter harmonics from either the input lines or output lines of the converter. While it is extremely rare for the inductor to fail, capacitors are inherently more prone to degradation and failure and should be routinely monitored and/or replaced. Failure of the L/C filter can lead to increased harmonic levels which may damage equipment connected to the drive.

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 Table 4-2 below to identify the 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.

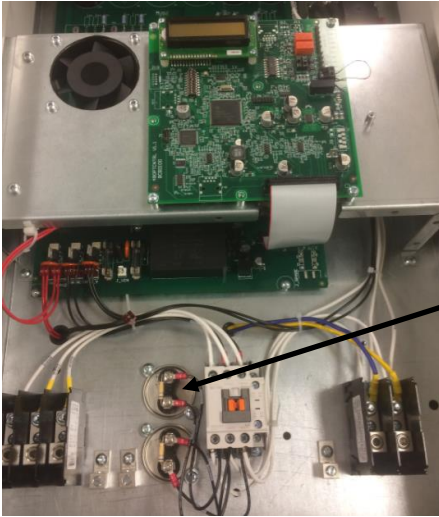
Remove the wires from both terminals of the capacitor in order to obtain an accurate measurement. Compare to the capacitor value in Table 7.

If any capacitor value is less than specified by more than **15%** contact Phase Technologies service department to order replacement capacitors. Call 605-343-7934 or visit phasetechnologies.com.

Table 7 Nominal Filter Capacitor Values in MicroFarads (uF)

Converter Model	Number of Capacitors	Capacitance (uF)
All Models	2	10 uF

Figure 4-2 Line Filter Capacitor Locations



Locations of Line
Filter Capacitors

Fuses

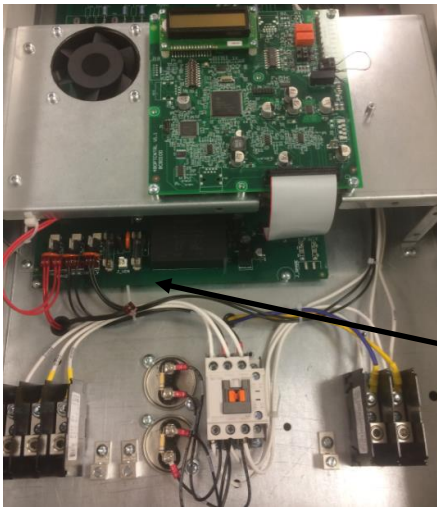
There are several field replaceable fuses in the drive. Each fuse is assigned a designator to help identify the fuse. Replacement fuses are available from the factory by contacting our Service Department at 605-343-7934 or visiting phasetechnologies.com.

Refer to Table 4-3 for fuse ratings.

Table 4-3 Fuses

Fuse Designator	Comments	250V Fuse Rating
F1	Located on the inverter board	3A Fast Blow
F3	Located on the inverter board	3A Fast Blow

Figure 4-2 Fuse Locations



Locations of F3 and F1 fuses

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