

***PF* Guard™**

PF Guard™ Power Factor Capacitor Bank Installation, Operation, and Maintenance Manual



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Introduction

Safety Instructions Overview

This section provides the safety instructions which must be followed when installing, operating, and servicing the PF Guard™ Power Factor Capacitor Bank. If neglected, physical injury or death may follow, or damage may occur to the unit or equipment connected to the PF Guard Capacitor Bank. The material in this chapter must be read and understood before attempting any work on, or with, the product.

The PF Guard unit is intended to be connected to the bus or power cables where one or more loads are connected. Three-phase power is connected to the input terminals of the unit and capacitive reactive current is supplied to the system through the PF Guard unit in response to the input signal being received from the CT connected to the monitored bus. The instructions, and particularly the safety instructions, for the electrical loads, drives, motors, and any other related equipment must be read, understood, and followed when working on any of the equipment.

Warnings and Cautions

This manual provides two types of safety instructions. Warnings are used to call attention to instructions that describe steps that must be taken to avoid conditions that can lead to a serious fault condition, physical injury, or death.

Cautions are used to call attention to instructions that describe steps that must be taken to avoid conditions that can lead to a malfunction and possible equipment damage.

Warnings

Readers are informed of situations that can result in serious physical injury and/or serious damage to equipment with warning statements highlighted by the following symbols:

<p>Warning</p> 	<p>Dangerous Voltage Warning: warns of situations where high voltage can cause physical injury and/or damage equipment. The text next to this symbol describes ways to avoid the danger.</p>
<p>Warning</p> 	<p>General Warning: warns of situations that can cause physical injury and/or damage equipment by means other than electrical. The text next to this symbol describes ways to avoid the danger.</p>
<p>Warning</p> 	<p>Electrostatic Discharge Warning: warns of situations in which an electrostatic discharge can damage equipment. The text next to this symbol describes ways to avoid the danger.</p>

Cautions

Readers are informed of situations that can lead to a malfunction and possible equipment damage with caution statements:

<p>Caution</p> 	<p>General Caution: identifies situations that can lead to a malfunction and possible equipment damage. The text describes ways to avoid the situation.</p>
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General Safety Instructions

These safety instructions are intended for all work on the PF Guard. Additional safety instructions are provided at appropriate points on other sections of this manual.

PF Guard™ Power Factor Capacitor Bank

Warning 	Be sure to read, understand, and follow all safety instructions.
Warning 	Only qualified electricians should carry out all electrical installation and maintenance work on the PF Guard.
Warning 	All wiring must be in accordance with the National Electrical Code (NEC) and/or any other codes that apply to the installation site.
Warning 	Disconnect all power before working on the equipment. Do not attempt any work on a powered PF Guard.
Warning 	The PF Guard capacitor bank must be properly grounded.
Warning 	After switching off the power, always allow 2 minutes for the capacitors in the PF Guard capacitor bank and in the drive to discharge. It is a good idea to check with a voltmeter to make sure that all sources of power have been disconnected and that all capacitors have discharged before beginning work.

Receiving Inspection and Storage

Thank you for selecting the PF Guard™ Power Factor Capacitor Bank. TCI has developed this product for use in bus and system level power factor correction applications that require leading reacting current to correct lagging power factor to a set target power factor (0.95 lagging power factor). This manual describes how to install, operate and maintain the PF Guard unit.

Receiving Inspection

The PF Guard capacitor bank has been thoroughly inspected and functionally tested at the factory and carefully packaged for shipment. When you receive the unit, you should immediately inspect the shipping container and report any damage to the carrier that delivered the unit. Verify that the part number of the unit you received is the same as the part number listed on your purchase order. Remove information packets from the enclosure to ensure air circulation is not blocked.

Storage Instructions

If the PF Guard capacitor bank is to be stored before use, be sure that it is stored in a location that conforms to published storage humidity and temperature specifications stated in the PF Guard™ Power Factor Capacitor Bank Technical Specifications. Store the unit in its original packaging.

TCI Limited Warranty Policy

TCI, LLC (“TCI”) warrants to the original purchaser only that its products will be free from defects in materials and workmanship under normal use and service for a period originating on the date of shipment from TCI. Please refer to www.transcoil.com for standard terms and conditions.

Installation

Intended Audience

This manual is intended for use by all personnel responsible for the installation, operation and maintenance of the PF Guard capacitor banks. Such personnel are expected to have knowledge of electrical wiring practices, electronic components and electrical schematic symbols.

Additional Information

<p>Caution</p> 	<p>This manual provides general information describing your PF Guard. Be sure to carefully review the more specific information that is provided by the drawings shipped with the unit. Information provided by the drawings takes precedence over the information provided in this manual.</p> <p>The ratings, dimensions and weights given in this manual are approximate and should not be used for any purpose requiring exact data. Contact the factory in situations where certified data is required. All data is subject to change without notice.</p>
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Installation Checklist

The following are the key points to be followed for a successful installation. These points are explained in detail in the following sections of this manual.

- Make sure that the installation location will not be exposed to direct sunlight, corrosive or combustible airborne contaminants, excessive dirt or liquids.
- Select a mounting area that will allow adequate cooling air and maintenance access. Ensure that fan exhaust has at least 6 inches clearance to any wall or surface.
- Make sure that all wiring conforms to the requirements of the National Electric Code (NEC) and/or other applicable electrical codes.
- Connect the PF Guard equipment-grounding lug to the system ground of the premises wiring system. Use a properly sized grounding conductor.
- Connect three-phase power to the input terminals of the PF Guard, L1, L2 & L3 in positive phase sequence (L1 – L2 – L3 phase sequence).
- Connect customer installed, externally connected phase A CT current sensor to the two CT terminals of the PF Guard TB-5 1 & 2. Remove the factory installed shorting screws from TB5 1&2 after the CT has been correctly installed.
- After initial power up confirm configured CT current sensor ratio and target power factor on door mounted power factor controller module.

Pre-installation Planning

Verify the Application

Make sure that the PF Guard unit is correct for the application. The voltage and frequency ratings of the unit must match the input voltage rating of the connected source. The line voltage distortion must not exceed 5% vTHD.

Warning 	The PF Guard is not suitable for applications where significant 3rd harmonic currents are present in the power system. Consult TCI tech support for applications in the presence of 3rd harmonics.
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Select a Suitable Location

Environment

Locating the PF Guard in a suitable environment will help ensure proper performance and a normal operating life. Refer to the environmental specifications listed in Table 6 and/or noted on the drawings furnished with the unit.

Warning 	Unless specifically labeled as approved for such use, this equipment is not suitable for use in an explosive atmosphere or in a "Hazardous (Classified) Location" as defined in article 500 of the National Electrical code.
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The unit must be installed in an area where it will not be exposed to:

- Direct sunlight
- Rain or dripping liquids
- Corrosive liquids or gasses
- Explosive or combustible gases or dust
- Excessive airborne dirt and dust
- Excessive vibration

Working Space

Provide sufficient access and working space around the unit to permit ready and safe installation, operation and maintenance. Make sure that the installation conforms to all working space and clearance requirements of the National Electrical Code (NEC) and/or any other applicable codes. Provide sufficient unobstructed space to allow cooling air to flow through the unit. For units with side exhaust, there must be at least 6 inches space to another surface.

Power Wiring

When selecting a mounting location for the PF Guard, plan for the routing of the power wiring.

The PF Guard standard terminal block input option does not include main input fuses or circuit protection so the installer is responsible for fuse protection, in accordance with Table 1 to preserve the high fault SCCR rating.

Installation Guidelines

Mounting

The PF Guard must be mounted vertically on a smooth, solid surface, free from heat, dampness, and condensation.

Wiring

Refer to Figure 5, “PFGuard Connection Diagram” for the location of customer connections for wiring the PF Guard.

Cable Entry Locations

The PF Guard enclosure is provided with a removable conduit wire entry plate. Installer should remove the wire entry plate from the PF Guard unit prior to machining a hole in the plate to prevent metal filings from contaminating the unit. The top side recommended cable entry location is shown in the drawings included with your PF Guard Unit. Alternate cable entry locations if available are illustrated on the unit installation drawing.

Field Wiring Connection Terminals

Compression type terminals are provided for all field wiring connections. The wire size capacity ranges and tightening torques for all field wiring connections are listed in the Terminal Torque and Wire Size section of this manual and in the drawings and other information shipped with the unit.

Grounding

The PF Guard panel equipment-grounding lug must be connected to the ground of the wiring system. The equipment-grounding connection must conform to the requirements of the National Electric Code (NEC) and/or any other codes that apply to the installation site. The ground connection must be made using a wire conductor. Metallic conduit is not a suitable grounding conductor. The integrity of all ground connections should be periodically checked.

Power Wiring

<p>Caution</p> 	<p>Use copper wire that is appropriate for the voltage and current rating of the equipment. The wire selection must conform to the requirements of the National Electrical Code and/or other applicable electrical codes. Use wire with an insulation temperature rating of 75°C or higher.</p>
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Connect three-phase power of the appropriate voltage and current capacity to the input terminal block or optional circuit protective device of the PF Guard unit input power terminals.

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Terminal Torque and Wire Size

Table 1: 480v PFCA - Standard Terminal Block Input Wiring Details

Total kVAR	Max Amps	Recommended Input Fuse Amps (optional) ²	Input wire range ¹	Torque (lb.-in.)
150	267	300 (T or J)	500 kcmil - 4 AWG Cu	375
200	356	400 (T or J)	(2) 500 - 250 kcmil Cu	375
250	444	500 (T or J)	(2) 500 - 250 kcmil Cu	375
300	533	600 (T or J)	(2) 500 - 250 kcmil Cu	375
400	711	800 (class L)	(3) 600 kcmil - 300 kcmil AL9CU	500
500	889	1000 (class L)	(4) 600 kcmil - 300 kcmil AL9CU	500
600	1067	1200 (class L)	(4) 600 kcmil - 300 kcmil AL9CU	500

1] This is the range for which the lug is rated. Consult local codes for input wire sizing based on fused ampacity. 75C wire unless otherwise noted.

2] If input fuse is not included then customer must supply this fuse to achieve the nameplate rated SCCR.

Table 2: 480v PFCA - Optional Feature Wiring Details

Total kVAR	Max Amps	Fuse Block Input Wire Range	Torque (Lb.in.)	Disconnect Switch Input Wire Range	Torque (Lb.in.)	Circuit Breaker Input Wire Range	Torque (Lb.in.)
150	267	(2) 250MCM-6	275	600MCM-#2	500	750MCM-500MCM	550
200	356	(2) 250MCM-6	275	600MCM-#2	500	750MCM-500MCM	550
250	444	(2) 600MCM-4/0	450	(2) 600MCM-#2	500	(2) 500MCM - #2	372
300	533	(2) 600MCM-4/0	450	(2) 600MCM-#2	500	(2) 500MCM - #2	372
400	711	na	na	(2) 600MCM-#2	500	(3) 500MCM - 3/0	300
500	889	na	na	(4) 600MCM-#2	500	(4) 500MCM - 4/0	275
600	1067	na	na	(4) 600MCM-#2	500	(4) 500MCM - 4/0	275

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List of Drawings

Please refer to Table 3 for a list of installation and outline drawings for the PF Guard 480V Type 1 Switched Units. Paper copies of the installation drawings are in the literature kit that is included with all type 1 units. Installation and Outline drawings are also available online for download at <http://www.transcoil.com/Products/PF-Guard-Capacitor-Bank/PF-Guard-Drawings.htm>.

Table 3 - Drawings for the PF Guard 480V Type 1 Switched Units

kVAR	Installation Drawing Number	General Schematic	CT Drawing	Customer Connection Drawings
150	106088DG	29608	26461	29874
200	106125DG	29783	26461	29874
250	106126DG	29784	26461	29874
300	106127DG	29785	26461	29874
400	106128DG	29786	26461	29874
500	106109DG	29763	26461	29874
600	106110DG	29787	26461	29874

Fuse Specifications

Always refer to the drawings and other information shipped with your unit.

Table 4 – Fuse Specifications for the PF Guard 480V Type 1 Switched Units

Total kVAR	Max Amps	Recommended Input Fuse Amps (optional) ¹	Full Step Fuse ² Amps (kVAR)	Half Step Fuse ² Amps (kVAR)
150	267	300 (class T or J)	110 (50)	60 (25)
200	356	400 (class T or J)	110 (50)	60 (25)
250	444	500 (class T or J)	110 (50)	60 (25)
300	533	600 (class T or J)	110 (50)	60 (25)
400	711	800 (class L)	175 (80)	110 (40)
500	889	1000 (class L)	200 (100)	110 (50)
600	1067	1200 (class L)	200 (100)	110 (50)

1) If input fuse is not included then customer must supply this fuse to achieve the rated SCCR.

2) Class T or Class J fuses required at listed rating to preserve High Fault SCCR rating, 100ka for disconnect switch inputs or 65ka for Circuit Breaker option.

Circuit Breaker Specifications

Always refer to the drawings and other information shipped with your unit.

Table 5 – Circuit Breaker Manufacturer Part Number and Trip Ratings

Total kVAR	Max Amps	Approx. Trip Rating	65KA
150	267	300	LGH340033G
200	356	400	LGH360033G
250	444	500	LGH360033G
300	533	600	NGH308033E
400	711	800	NGH312033E
500	889	1000	NGH312033E
600	1067	1200	NGH316033E

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PF Guard Start Up and Commissioning

<p>Caution</p> 	<p>Thoroughly check the installation before applying power and operating the equipment for the first time.</p>
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Before Applying Power for the First Time

Inspect the installation to make sure that all equipment has been completely and correctly installed in accordance with the Installation Guidelines section of this manual.

- Check to make sure power connections are tight and torqued to recommended torque value.
- Check that no metal contamination from enclosure modifications remains within enclosure prior to applying power.
- Make sure that ventilation openings are free from obstructions allowing air to flow into and out of PF Guard enclosure.
- Check that incoming CT wiring terminal blocks are torqued securely, loose CT connections can generate hazardous high voltages while equipment is operating.
- Remove customer supplied external and PF Guard internal CT shorting bars prior to operating PF Guard unit.
- Check to see that the cooling fan(s) are operating in units equipped with them. Fans will only operate when steps are engaged, and number of operating fans depends upon number of steps engaged. Steps can be manually operated via the door mounted power factor controller module. See controller documentation for instructions on manual step control.

Maintenance and Service

PF Guard Reliability and Service Life

The PF Guard has been designed to provide a service life that is over 130,000 hours. It has been thoroughly tested at the factory to assure that it will perform reliably from the time it is put into service. It is recommended that the following maintenance is performed once a year to ensure that the PF Guard unit will always operate reliably and provide the expected service life.

Note: Service life calculations assume 0% vTHD line distortion, nominal 480VAC input voltage, average annual ambient temperature of less than 40°C, and less than 10,000 contactor operations per year.

Periodic Maintenance

<p>Warning</p> 	<p>Only qualified electricians should carry out all electrical installation and maintenance work on the PF Guard.</p> <p>Disconnect all sources of power to the drive and PF Guard before working on the equipment. Do not attempt any work on a powered PF Guard.</p>
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Check to see that the installation environment remains free from exposure to excessive dirt and contaminants. Refer to the *Pre-installation Planning* section of this manual.

Check to make sure that the enclosure ventilation openings are clean and unobstructed.

In units provided with air filters:

Clean the air filters in units that have air inlets. Clean as often as necessary to prevent dirt build-up from impeding air flow.

Check the operation of the cooling fan.

Inspect the interior of the enclosure for signs of overheated components. Clean the interior of the enclosure whenever excess dirt has accumulated.

Torque all power wire connections, loose connections can overheat and damage the unit.

All electrical connections must be re-torqued annually.

Troubleshooting

<p>Warning</p> 	<p>Only qualified electricians should carry out all electrical installation and maintenance work on the PF Guard.</p> <p>Disconnect all sources of power to the PF Guard and connected equipment. Do not attempt any work on a powered PF Guard.</p> <p>The PF Guard contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the PF Guard before you attempt to service it. Check for zero voltage between all terminals on the capacitors. Also, check for zero voltage between all phases of the input terminals L1, L2 and L3. All setup, maintenance, and troubleshooting must be done by a qualified electrician. Failure to follow standard safety procedures may result in death or serious injury.</p> <p>Operating current transformers (CT) with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment. Prior to any maintenance work on the PF Guard unit verify all CT connections have a shorting bar in place.</p>
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Note: When disconnecting wires from components and terminations, mark the wires to correspond to their component and terminal connection.

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If the unit door mounted power factor controller does not power on when utility power applied:

- Check the controller modules fuses.
- Check main input fuses (only on PF Guard models that include them).
- Check main input disconnect switch or circuit breaker on/off position (only on PF Guard models that include these options).
- Confirm the voltage and frequency ratings of the unit match the input voltage rating of the connected source.

If the door mounted power factor controller RMS line current metering seems to be incorrect:

- Check the CT ratio configured on the door mounted power factor controller module and confirm the ratio matches the externally installed CT connected to TB-5.
- Confirm the unit's CT shorting bars on TB-5 have been removed.

If the door mounted power factor controller indicates a THD alarm or system power loss alarm:

- Uses a voltage power quality meter to confirm the utility line voltage total harmonic distortion (vTHD) is less than 8%. If vTHD exceeds 8% do not operate the PF Guard unit until the harmonic load generating the distortion is removed from the connected source.
- Use a digital multi meter (DMM) to confirm the input voltage to the unit is at the nominal range and frequency.

If a step failure is reported by the door mounted power factor controller module check the following:

- Check for an open blown capacitor step fuse. If available check the fuse monitor contactor or indicator light for indication of an open step fuse.
- Visually inspect step contactor for damage or non-operation.

If a step failure or over-temperature alarm is reported by the door mounted power factor controller module check the following:

- Check unit fan operation and air inlet for blockages. Each step detuning reactor has an embedded thermal protection switch that will cause the step to open if the reactor temperature exceeds its temperature rating.

If the door mounted power factor controller does not achieve the desired target power factor check the following:

- Confirm the externally mounted line current CT sensor is mounted one phase A of the source bus connection. Please refer to the connection diagram in Figure X for proper CT location.
- Confirm the phase order sequence of the incoming power is A B C.
- Confirm the externally mounted line current CT connection to TB-5 are connected and properly torqued.
- Confirm the unit's CT shorting bars on TB-5 have been removed.
- Confirm the unit is sized properly for the reactive power demand of the monitored bus. If all step contactors are in circuit and the power factor is still not close to the set target power factor additional PF Guard units may be required for the application.

Replacement Parts

If replacement parts are needed, please contact your TCI representative. To ensure that the PF Guard continues to perform to its original specifications, replacement parts should conform to TCI specifications.

Factory Contacts and Tech Support

For technical support, contact your local TCI distributor or sales representative. You can contact TCI directly at 800-TCI-8282. Select "Customer Service" or "Tech Support" and have your PF Guard nameplate information available.

Product Description

PF Guard™ Power Factor Capacitor Bank

Typical industrial loads, such as induction motors connected to pumps, chillers, and compressors draw lagging reactive power (inductive kVAR) from the utility source along with real power (kW) that does useful process work. The vector sum of the real power and reactive power a load draws is the apparent power (kVA). Power factor is the ratio between the real power and the total apparent power for a given load and is the standard measure of how efficiently electrical power is being used by a system. Non-unity power factor indicates sub-optimal power system efficiency and the resulting costs of non-unity power factor can be passed onto industrial users as power factor penalties and higher utility bills.

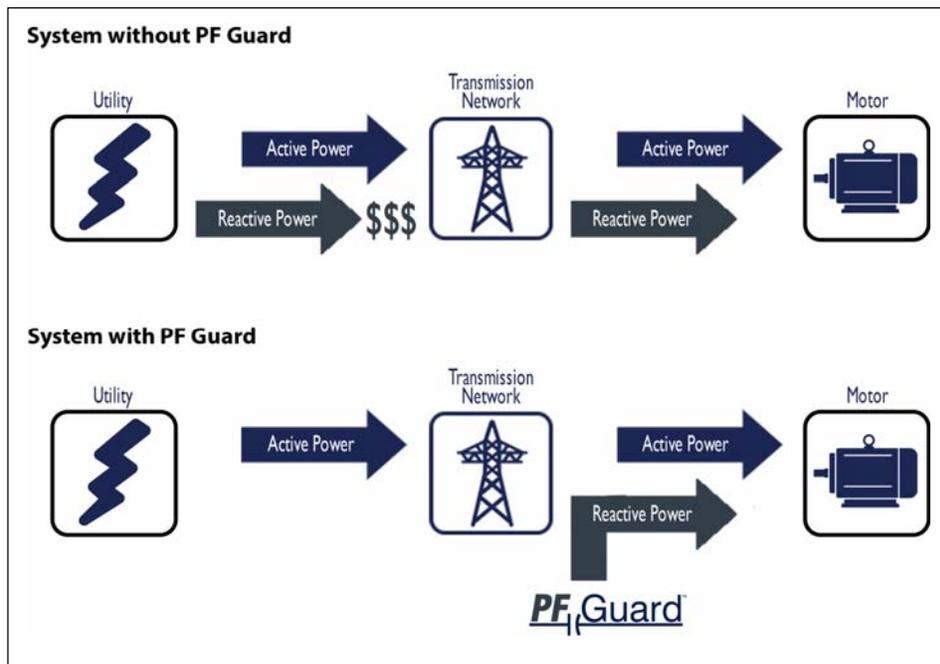


Figure 1: Typical PF Guard System Application

The PF Guard product provides capacitive reactive power to cancel the inductive reactive power generated by industrial loads thereby returning the system power factor to 0.95 lagging power factor and increasing system efficiency. The PF Guard is designed to automatically control power factor of a monitored bus by automatically switching on or off multiple banks of power factor correction capacitors. An external Current Transformer (CT) is installed on the source line current bus and monitored by an integrated power factor controller. The power factor controller also monitors the bus voltage and calculates power factor. Based on the calculated power factor the PF Guard will switch on or off capacitor bank steps to regulate the system to a target power factor setting (0.95 lagging power factor).

The PF Guard is designed for industrial loads where current and voltage harmonics are present. Modern loads such as variable frequency drives and phase controlled rectifiers generate higher order harmonics of the utility source frequency, typically starting at the 5th harmonic. To avoid oscillations and resonance issues on systems with such harmonics the PF Guard has integrated detuning reactors in series with the power factor correction capacitors. The detuning reactor is tuned to a frequency just under the 4th harmonic that prevents the power factor correction capacitors from sourcing harmonic currents.

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The PF Guard filters consist minimally of the following features and components:

- High-endurance, harmonic-rated capacitors
- A KDR detuning reactor to prevent system interaction due to voltage harmonics and provide inrush current limiting to capacitors
- Rugged contactors to allow automatic control of power factor
- Multiple steps of capacitor banks to provide fine tune control of system power factor.
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown
- Advanced door mounted power factor control unit to automatically control system power factor and assist with start up and commissioning of the unit
- Cooling fans to ensure adequate cooling and safe operating temperatures
- Compression terminals for ease and integrity of all power and control wiring
- Individual step fuses, sized to protect the step contactors
- Option main input fuses, circuit breaker or disconnect switch

Controller



Figure 2: PF Guard Controller Module

The integrated power factor controller module in the PF Guard is responsible for the safe and reliable operation of the unit's power factor step bank control contactors. The power factor controller module has a set target power factor (configurable from 0.7 inductive to unity to 0.7 capacitive with a default of 0.95 lagging power factor). When the power factor of the monitored bus differs from the target setting for more than a specified time the capacitor bank controller will activate the appropriate steps to bring the power factor optimally close to the target setting.

The controller will also monitor system conditions and the status of the de-tuned capacitor banks internal to the PF Guard and take self-protection action if a fault condition is detected. The controller detects over and under voltage conditions, excessive line voltage harmonic levels, over temperature, and internal step failures. When a fault condition is detected the controller will de-energize the affected step (or steps) to a fail-safe condition.

In addition to automatically energizing and de-energizing the PF Guard's internal power factor correction capacitor steps the controller module displays various system status values. The controller module includes an integrated LCD screen for display of system power factor, voltage, current, active power, reactive power, apparent power, voltage harmonics and other useful system status metrics.

NOTE: The voltage, current, power and harmonic metering on the PFGuard controller display are for reference only and not intended to be used as calibrated measurements. The power factor displayed on the PFGuard controller is the power factor of the fundamental load source voltage and current.

The PF Guard power factor controller comes fully configured from the factory but during system installation the pre-configured setup of the controller module should be confirmed. The end user should confirm that the setting of the current transformer (CT) ratio in the PF Guard power factor controller matches the ratio of the current transformer (CT) installed on the incoming bus. The end user should also confirm the target power factor setting during unit commissioning as not all applications require the default 0.95 lagging power factor. In the event the PF Guard controller module needs to be replaced or recommissioned the module contains built-in, self-calibration routines.

Please reference the included ESTAmat PFC-N12 User Manual for details regarding setup and operation of the PF Guard controller module or call TCI Technical Support at (800) 824-8282 or (414)-357-4541.

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Nameplate Data

The following information is marked on the nameplate:

- Part number: encoding is explained on the following page
- FLA/MAX: the rated continuous operating current (RMS amps)
- System Voltage: the rated 3-phase line voltage (RMS volts)
- Hz: the rated frequency (60 Hz)
- Phase: 3 – The PF Guard is designed for use only with 3-phase power
- SCCR – Short Circuit Current Rating
- Full Steps – Number of Full Steps, kVAR Rating
- Half Steps – Number of Half Steps, kVAR Rating
- Drawing #: outline and mounting dimension drawing number
- Schematic #: schematic diagram drawing number
- Manufacturing #: for TCI internal use
- Enclosure Type: UL designation

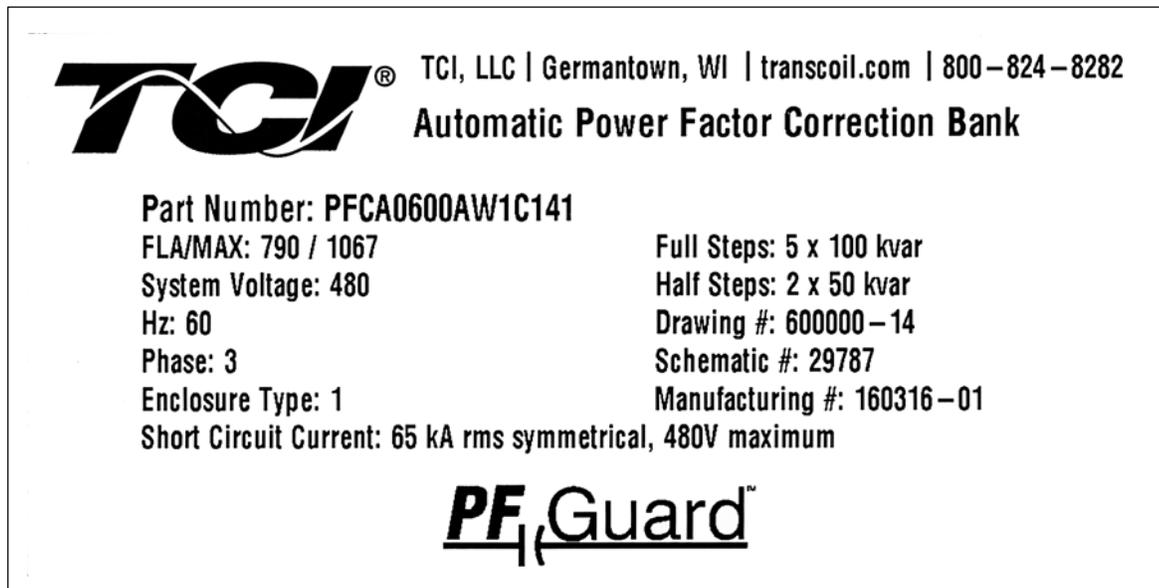


Figure 3: PF Guard Nameplate Data

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Part Number Encoding

Figure 3 identifies the significance of each character in the PF Guard part number.

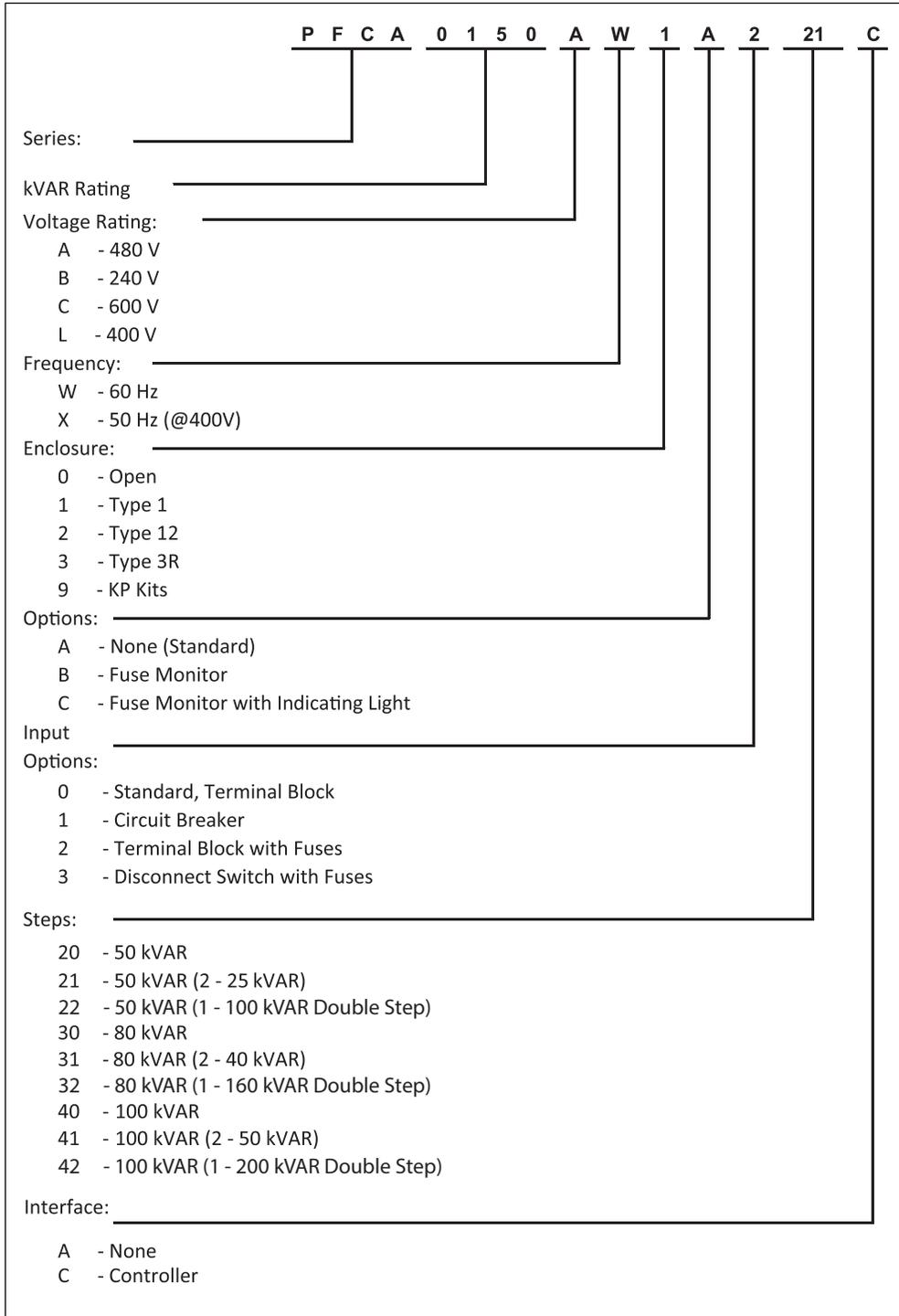


Figure 4 – PF Guard Part Number Encoding

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Table 6: Full Step and Half Step kVAR size for 480V 60Hz Standard PFGuard Model Types

Part Number	Without Controller	With Controller	Total kVAR	Full Steps Quantity x kVAR Size	Half Steps Quantity x kVAR Size
PFCA0150AW1A021	A	C	150	2 x 50 kVAR	2 x 25 kVAR
PFCA0200AW1A021	A	C	200	3 x 50 kVAR	2 x 25 kVAR
PFCA0250AW1A021	A	C	250	4 x 50 kVAR	2 x 25 kVAR
PFCA0300AW1A021	A	C	300	5 x 50 kVAR	2 x 25 kVAR
PFCA0400AW1A031	A	C	400	4 x 80 kVAR	2 x 40 kVAR
PFCA0500AW1A041	A	C	500	4 x 100 kVAR	2 x 50 kVAR
PFCA0600AW1A041	A	C	600	5 x 100 kVAR	2 x 50 kVAR
PFCA0150AW1A020	A	C	150	3 x 50 kVAR	N/A
PFCA0200AW1A020	A	C	200	4 x 50 kVAR	N/A
PFCA0250AW1A020	A	C	250	5 x 50 kVAR	N/A
PFCA0300AW1A020	A	C	300	6 x 50 kVAR	N/A
PFCA0400AW1A030	A	C	400	5 x 80 kVAR	N/A
PFCA0500AW1A040	A	C	500	5 x 100 kVAR	N/A
PFCA0600AW1A040	A	C	600	6 x 100 kVAR	N/A

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Product Technical Specifications

Table 6 lists the major technical specifications for the PF Guard.

Table 7 – PF Guard Technical Specifications

Technical Characteristics

Voltage Rating	480 VAC
Phase	3-Phase
Operating Frequency	60 Hz
Fuse Interrupt Rating	200kA
SCCR Rating	100kA: Terminal block with customer supplied fusing, disconnect switch, or fuse block
	5kA: Breaker only, 65kA: With customer supplied fusing
kVAR Rating(s)	150, 200, 250, 300, 400, 500, 600
Voltage Unbalance	1% maximum
Continuous Overvoltage	110%
Capacitor Tolerance	±5%
Expected Life	Over 130,000 operating hours
Maximum Harmonic Voltage	8%
Discharge Time	Less than 1 minute

Environmental Conditions

Operating Temperature	Enclosed: -10°C (+14°F) to +40°C (+104°F)
Storage Temperature	-30°C (-22°F) to +60°C (+140°F)
Relative Humidity	95% non-condensing
Operating Altitude	Up to 1,000 m without temperature derating
Cooling Method	Forced Air Convection

References Technical Standards

Protection (Enclosure)	UL Type 1
Agency Approvals	UL 508A

PF Guard™ Power Factor Capacitor Bank

Size, Weight, Watt Loss

Table 8 – Dimensions

kVAR	Dimensions H x W x D (inches)	Weight (lbs.)
150	96.3 x 24.1 x 23.0	735
200	96.3 x 36.1 x 27.0	990
250	96.3 x 36.1 x 27.0	1085
300	96.3 x 36.1 x 27.0	1205
400	96.3 x 72.0 x 27.0	2090
500	96.3 x 72.0 x 27.0	2105
600	96.3 x 72.0 x 39.0	2525

Table 9 – Reactor Watts loss

Total kVAR	Watts
150	659
200	855
250	1052
300	1248
400	1469
500	1829
600	2185

Capacitor Watts loss

The PF Guard capacitor losses are 0.5 watts per kVAR.

PF Guard™ Power Factor Capacitor Bank

Connection Diagram

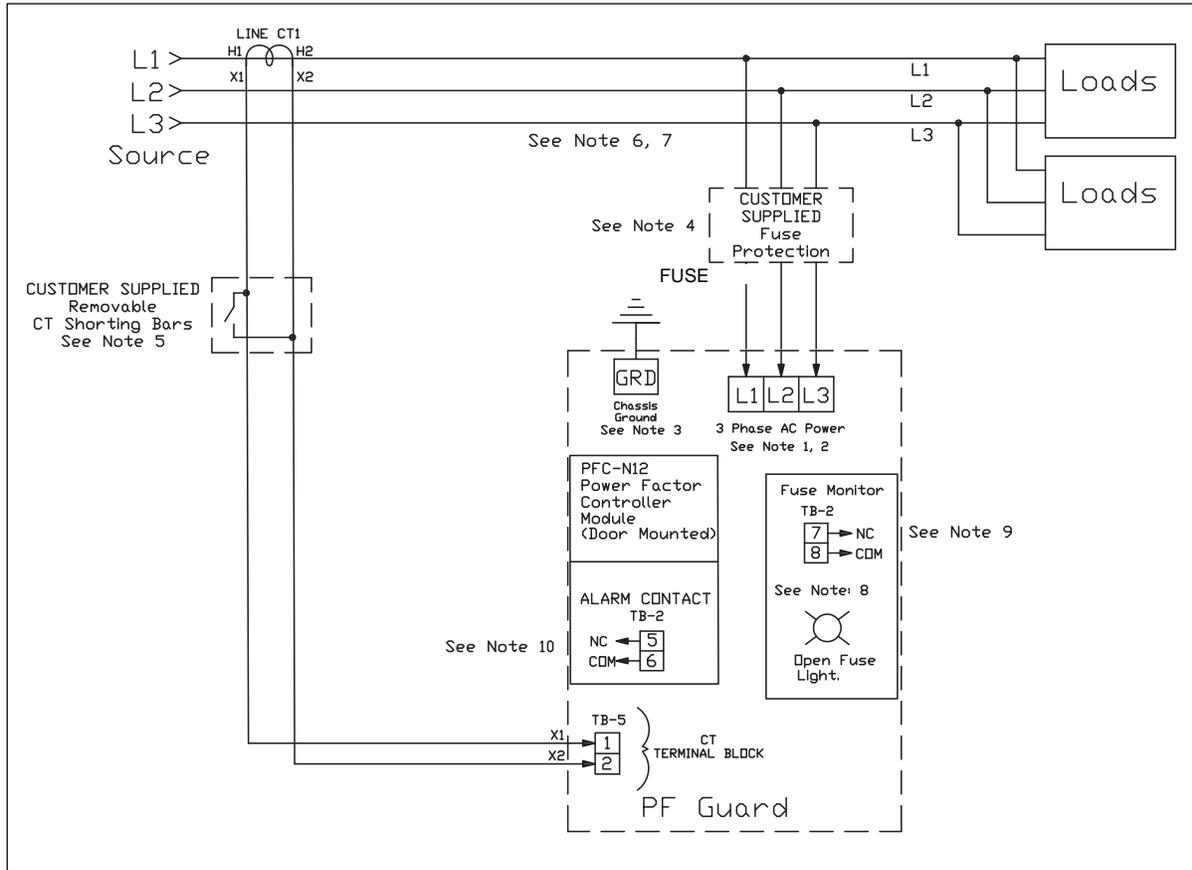


Figure 5: PFGuard Connection Diagram

Notes:

1. For connection wire size and tightening torque see Terminal Torque and Wire Size section of this manual
2. Wiring should be 75°C or higher insulated copper, with the appropriate voltage and current rating.
3. Chassis ground must be connected to the ground of the premises wiring system, in accordance with NEC and local codes. Connection must be made using a wire conductor.
4. Customer is responsible for fuse protection, if standard Terminal block or Circuit Breaker, main input option selected.
5. Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment.
6. Current transformer should be centered around conductor.
7. CT's are customer installed, and external to the PF Guard.
8. Fuse Monitor Option Available as Dry Contact or Open Fuse Light.
9. Fuse Monitor Contact is rated (10A resistive @ 240 VAC, 1/6 HP @ 120/240 VAC Max.).
10. TB-2 (5) and (6) Fault contact, is rated (250 VAC/5A Max.).

PF Guard™ Power Factor Capacitor Bank

Current Transformer

For accurate sensing of the line power factor it is important that the load sensing current transformers are properly installed.

Please use the Customer Connection Diagram #29874 included with your unit and referenced in the Product Description section of this manual.

<p>Warning</p> 	<p>All electrical installation and maintenance work on the PF Guard should be carried out by qualified electricians only. Failure to follow standard safety procedures may result in death or serious injury. Do not attempt any work on a powered PF Guard. Disconnect all sources of power to the PF Guard before working on the equipment. Check for zero voltage between all phases of the input lines.</p> <p>Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment.</p>
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Three phase power wires L1, L2 and L3 must be connected to the PF Guard in positive phase sequence (L1 leads L2, L2 leads L3).

It is necessary for the door mounted PF Guard power factor controller unit to monitor the phase “A” L1 line current at the source where power factor correction is required. The source monitor CT is externally mounted by the end user on their utility source connection.

Please reference Figure 4 - Connection Diagram for CT connections to the PF Guard unit.

The polarity of the CT is important; the “H1” marking on the CT must face the source. The secondary windings of the CT around conductor L1 should connect to TB-5 terminals 1 & 2. The secondary wire of the CT identified as “X1” must connect to the “X1” terminal of TB-5. Failure to maintain the correct polarity and phasing will cause a controller fault. If this should happen refer to the troubleshooting section.

Note: Units with black “TB-5” terminal blocks are shipped with two position shorting jumpers installed between positions 1 & 2. This is done for your safety and to prevent equipment damage. The jumpers are installed in the center of the block and can be identified by the gray top. After the load CTs are installed and wired, the CT shorting jumpers must be removed for correct unit operation. They can be removed with a standard flat blade screw driver.

Notes:

- CT wiring should be 75° C or higher insulated copper, with the appropriate voltage and current rating.
- Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment.
- The CT should be centered around the conductor.
- Source CT's are customer installed, and external to the PF Guard unit.
- See Table 3 for TCI CT drawing numbers. CT drawing contains CT part numbers available from TCI.
- Review all Pre-Installation and Installation instructions at the beginning of this manual.

Alarm Contact

The PF Guard controller modules has an alarm contact that can be used to communicate the status of the PF Guard Unit to an external monitoring system such as a PLC.

The alarm contact is closed under normal operation and opens under a system fault or grid failure. The contact is dry/voltage free, normally closed type. Table X list the specification of the alarm contact relay.

Relay Contact	Location	Contact Rating
Normally Closed Contact	TB-2 Pin 5 and Pin 6	250VAC / 5A Max

Options

Fuse Monitor

The PF Guard Fuse Monitor Option is used in conjunction with the PF Guard Unit to monitor the status of the PF Guard capacitor step fuses. If a blown fuse condition is detected the PF Guard Fuse Monitor Option will energize a SPDT relay contact.

The PF Guard Fuse Monitor can be connected to a programmable digital input available on most modern Programmable Logic Controllers (PLCs) or facility monitoring systems. The Fuse Monitor is available on 480V PF Guard units as a contact only or contact and fuse indicator light option.

Table 10 – Fuse Monitor Operation Modes and Output Table

Operating State	Input Voltage	PF Guard Unit	N.C. Relay Contact (TB2-7 TB2-8)
No Input Line Voltage	Not Present	X*	Closed
Input Line Voltage has Missing Phase	Phase Loss	X*	Closed
Input Line Voltage has Phase Reversal	Phase Reversal	X*	Closed
PF Guard Unit has Blown Step Fuse	Nominal	Blown step Fuse	Closed
PF Guard Fuse Monitor has Blown Fuse	Nominal	Blown Monitor Fuse	Closed
Nominal	Nominal	Fuses OK	Open

*X = don't care condition

Table 11 – PF Guard Fuse Monitor Relay Contact Specifications

Relay Contact	Location	Contact Rating
Normally Closed Contact	(TB2-7 TB2-8)	10A Resistive @ 240 VAC 1/6HP @ 120/240 VAC



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