HarmonicGuard® Series Drive-Applied Harmonic Filter Installation, Operation, and Maintenance Manual

Including information for: HGP with PQconnect

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Performance Guarantee

Select and install the appropriate HarmonicGuard® Passive Harmonic Filter in a variable torque, variable frequency AC drive application, within our published technical specifications and we guarantee that the input current distortion will be less than or equal to 5% THID for standard HGP Series filters at full load, and less than 8% at 30% load. If a properly sized and installed filter fails to meet its specified THID level, TCI will provide material for necessary modifications or replacement filter at no charge.

HG filters can also provide similar performance in other drive applications such as constant torque, DC drives and other phase-controlled rectifiers, but actual THID levels can vary by load and/or speed and therefore cannot be guaranteed. Consult factory for assistance when applying HGP filters on these types of equipment.

MINIMUM SYSTEM REQUIREMENTS:

The guaranteed performance levels of this filter will be achieved when the following system conditions are met:

Frequency: 60Hz ± 0.75Hz

System Voltage: Nominal System Voltage (line to line) ±10%

Balanced Line Voltage: Within 0.5%

Background Voltage Distortion: < 0.5% THVD

The input VFD current waveform shall be consistent with that of a VFD with 3% AC line reactance at full load.

NOTE: The presence of background voltage distortion will cause motors & other linear loads to draw harmonic currents.

Additional harmonic currents may flow into the HGP filter if there is harmonic voltage distortion already on the system.

If higher levels of harmonic voltage distortion (2%-5%) are present, please use the high background distortion version of the HGP filter.

***For PQconnect:** To run PQvision software, minimum system requirements are Windows 7 and 1280x720 resolution.

Revision	Description	Date
A	Release	10/16/13
B	Added Fuse Monitor Option	02/03/14
C	Added Heater & Vibration Pad Options	09/10/14
D	Added 600V Option Changed P/N to 28557-1	11/24/14
E	Updated Part Numbering System Added Floor Stand Option	01/04/16
F	Updated 480V Watts Loss Updated Table 3	03/28/17
G	Updated 600V and 400V Fuse Recommendation Table	06/19/17
H	Updated 480V and 600V Watt Loss Updated Part Numbering System Update Fuse Tables	01/31/18
I	Added PQconnect information Modbus Register Maps PQconnect Hardware/Software Troubleshooting the board	11/01/18

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Introduction

Safety Instructions Overview

This section provides the safety instructions which must be followed when installing, operating, and servicing the HarmonicGuard® Passive (HGP) filter. If neglected, physical injury or death may follow, or damage may occur to the filter or equipment connected to the HGP filter. The material in this chapter must be read and understood before attempting any work on or with the product.

The HGP filter is intended to be connected to the input terminals of one or more VFDs. Three-phase power is connected to the input terminals of the HGP and power is supplied to the VFD or VFDs through the HGP. The instructions, and particularly the safety instructions for the VFDs, 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:

Warning 	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.
Warning 	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.
Warning 	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.

Cautions

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

Caution 	General Caution: identifies situations that can lead to a malfunction and possible equipment damage. The text describes ways to avoid the situation.

General Safety Instructions

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

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 HGP filter.
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 HGP filter.
Warning 	The HGP filter, drive, motor, and other connected equipment must be properly grounded.
Warning 	After switching off the power, always allow 5 minutes for the capacitors in the HGP filter and in the drive to discharge before working on the HGP, the drive, the motor, or the connecting wiring. 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 HarmonicGuard® Passive (HGP) filter. TCI has produced this filter for use in many variable frequency drive (VFD) applications that require input power line harmonic current reduction. This manual describes how to install, operate and maintain the HGP filter.

Receiving Inspection

The HGP filter 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.

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 and expiring at the end of the period described below:

Product Family	Warranty Period
KLR, KDR	For the life of the drive with which they are installed.
HGA, KLC, KLCUL, KMG, MSD, V1k	One (1) year of useful service, not to exceed 18 months from the date of shipment.
PF Guard, HGP, HGL, HG7, KH, 3H, KRF	Three (3) years from the date of shipment.
KCAP, KTR, KMP	Five (5) years from the date of shipment.
All Other Products	One (1) year of useful service, not to exceed 18 months from the date of shipment.

The foregoing limited warranty is TCI's sole warranty with respect to its products and TCI makes no other warranty, representation, or promise as to the quality or performance of TCI's products. THIS EXPRESS LIMITED WARRANTY IS GIVEN IN LIEU OF AND EXCLUDES ANY AND ALL EXPRESS OR IMPLIED WARRANTIES INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This warranty shall not apply if the product was:

a) Altered or repaired by anyone other than TCI;
b) Applied or used for situations other than those originally specified; or
c) Subjected to negligence, accident, or damage by circumstances beyond TCI's control, including but not limited to, improper storage, installation, operation, or maintenance.

If, within the warranty period, any product shall be found in TCI's reasonable judgment to be defective, TCI's liability and the Buyer's exclusive remedy under this warranty is expressly limited, at TCI's option, to (i) repair or replacement of that product, or (ii) return of the product and refund of the purchase price. Such remedy shall be Buyer's sole and exclusive remedy. TCI SHALL NOT, IN ANY EVENT, BE LIABLE FOR INCIDENTAL DAMAGES OR FOR CONSEQUENTIAL DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF INCOME, LOSS OF TIME, LOST SALES, INJURY TO PERSONAL PROPERTY, LIABILITY BUYER INCURS WITH RESPECT TO ANY OTHER PERSON, LOSS OF USE OF THE PRODUCT OR FOR ANY OTHER TYPE OR FORM OF CONSEQUENTIAL DAMAGE OR ECONOMIC LOSS.

The foregoing warranties do not cover reimbursement for removal, transportation, reinstallation, or any other expenses that may be incurred in connection with the repair or replacement of the TCI product.

The employees and sales agents of TCI are not authorized to make additional warranties about TCI's products. TCI's employees and sales agents' oral statements do not constitute warranties; these shall not be relied upon by the Buyer and are not part of any contract for sale. All warranties of TCI embodied in this writing and no other warranties are given beyond those set forth herein.

TCI will not accept the return of any product without its prior written approval. Please consult TCI Customer Service for instructions on the Return Authorization Procedure.

Storage Instructions

If the HGP filter is to be stored before use, be sure that it is in a location that conforms to published storage humidity and temperature specifications stated in the HarmonicGuard® Passive Filter Technical Specifications. Store the unit in its original packaging.

Pre-installation Planning

Verify the Application

HGP Ratings

Make sure that the HGP filter is correct for the application. The voltage ratings of the filter must match the input voltage rating of the connected drive. The horsepower and current ratings of the filter must be appropriate for the connected load.

Select a Suitable Location

Environment

Locating the HGP in a suitable environment will help ensure proper performance and a normal operating life. Refer to the environmental specifications listed in Table 2 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 (NEC).

The unit must be installed in an area where it will not be exposed to:

- Direct sunlight
- Rain or dripping liquids (unless filter is in a Type 3R enclosure)
- 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. Keep the widest or deepest portion of the unit enclosure having ventilation openings a minimum of six inches from adjacent walls or other equipment. The unit enclosure sides that do not have ventilation openings should be kept a minimum of three inches from adjacent walls or other equipment.

Mounting an Open Panel Unit

If you are mounting an open panel unit in your own enclosure, you must provide an enclosure that is adequately sized and ventilated sufficiently to prevent overheating. The rating and dimension tables for open panel units list the watts of heat loss dissipated by the HGP filter. The maximum temperature of the air around the HGP filter capacitors, line reactor, and tuning reactor should not exceed 50°C (122°F).

Power Wiring

When selecting a mounting location for the HGP filter, plan for the routing of the power wiring.

Route the conduit and wiring from the power source to the filter and then to the VFD.

The HGP is provided with internal fuses.

Installation Guidelines

Mounting

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

Wiring

Cable Entry Locations

The enclosed HGP filters are not provided with enclosure wiring knockouts. A location can be selected at the time of installation. Typical or recommended cable entry locations are shown in the drawings section of this manual.

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 drawings and other information shipped with the unit.

Grounding

The HGP 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 Electrical 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

Caution 	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 (NEC) and/or other applicable electrical codes. For units rated less than 100 amps, use wire with an insulation temperature rating of 60°C or higher. For units rated 100 amps or more, use wire with an insulation temperature rating of 75°C or higher.

Connect three-phase power of the appropriate voltage and current capacity to the circuit protective device to the HGP input power terminals.

Note: in large units, the input power conductors are connected directly to the input terminals on the line reactors.

Connect the output terminals of the HGP to the input power terminals of the VFD.

Note: in large units, the output power conductors are connected directly to the output terminals on the line reactors. Refer to the VFD installation instructions for additional information.

HGP Filter Operation

Caution	Thoroughly check the installation before applying power and operating the equipment for the first time.

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 see that the cooling fan(s) are operating in units so equipped.
- Check to make sure power connections are torqued to recommended torque value.

Operation

Since the HGP is a passive filter, it is always operating whenever the drive is operating.

Installation

Intended Audience

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

Additional Information

Caution	
	This manual provides general information describing your HGP filter. 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. 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.

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.
- ☐ Make sure that all wiring conforms to the requirements of the National Electrical Code (NEC) and/or other applicable electrical codes.
- ☐ Connect the HGP 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 HGP, L1, L2 & L3.
- ☐ Connect the output power terminals, of the HGP, T1, T2 & T3, to the input power terminals of the VFD.

Maintenance and Service

HGP Filter Reliability and Service Life

The HGP has been designed to provide a service life that equals or exceeds the life of the VFD. 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 HGP filter will always operate reliably and provide the expected service life.

Periodic Maintenance

Warning	
	Only qualified electricians should carry out all electrical installation and maintenance work on the HGP filter. Disconnect all sources of power to the drive and HGP before working on the equipment. Do not attempt any work on a powered HGP.

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.

Clean the air filter in units that have filtered 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 filter.

All electrical connections must be re-torqued annually.

Troubleshooting

Warning 	Only qualified electricians should carry out all electrical installation and maintenance work on the HGP filter. Disconnect all sources of power to the drive and HGP before working on the equipment. Do not attempt any work on a powered HGP filter. The harmonic filter contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the filter before you attempt to service the harmonic filter. Check for zero voltage between all terminals on the capacitors. Also, check for zero voltage between all phases of the line side of the fuses, Fu1(a)–Fu2(a)–Fu3(a), and all input terminals L1, L2 and L3 of the line reactor (KDR). 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.

Note: when disconnecting wires from components and terminations, mark the wires to correspond to their component and terminal connection.

Replacement Parts

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

Fuse Specifications

Always refer to the drawings and other information shipped with your unit. Consult applicable wiring codes, UL and NEC, for current limiting and disconnect requirements.

100 kA SCCR Fusing Requirements

See Table 1 for line fusing requirements that must be supplied to comply with the 100kA SCCR.

Table 1 – Customer Installed Line Fuse Requirements to comply with the 100kA SCCR

Voltage	Size	Customer Installed Line Fuse Requirements to Comply with the 100 kA SCCR
600	≤ 40	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
600	> 40	No requirement for SCCR
480	≤40	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
480	> 40	No requirement for SCCR
440	≤30	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
440	> 30	No requirement for SCCR
415	≤30	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
415	> 30	No requirement for SCCR
240	≤ 10	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
240	> 10	No requirement for SCCR
208	≤ 10	Use appropriately rated Class J, T, or L fuse less than or equal to 60 A
208	> 10	No requirement for SCCR

Provisional 480V Fuse Table

The fuse tables, provided below (Tables 2, 3, 4, 5, 6, 7, and 8), show the fuse ratings of the included branch circuit fuse internal to the HGP unit as a fuse replacement reference.

The fuse tables also show a typical line fuse or circuit breaker current rating for overcurrent protection, given the unit's nameplate power rating, if necessary, based on the installation. The line current fuses listed below are typical values given the unit power rating, not required values. Line fusing ratings are determined by the installer, based on input conductor sizing and protection required for downstream equipment. Any drawings or documentation included with the unit literature kit take precedence over the fuse tables below.

Note that to achieve a 100kA SCCR, the customer provided line fuse must be installed as per the requirements in Table 1 and sized following NEC (National Electrical Code) guidelines for the source conductors selected by the installer. The branch fuses are required to be installed at the shown ratings.

Table 2 – Fuse Table for HGP 480 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
1.5	20	30
3	20	30
5	20	30
7.5	20	30
10	20	30
15	20	30
20	20	60
25	20	60
30	20	60
40	30	60
50	30	80
60	50	90
75	50	125
100	60	150
125	80	200
150	100	225
200	125	300
250	150	350
300	175	450
350	200	500
400	225	600
450	250	600
500	300	800
600	350	800
700	400	1000
800	500	1100
900	250/250 (Parallel Branches)	1200
1000	300/300 (Parallel Branches)	1400
1100	350/350 (Parallel Branches)	1500
1200	350/350 (Parallel Branches)	1600
1250	400/400 (Parallel Branches)	1800

Table 3 – Fuse Table for HGP 440 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
2.5	20	30
3	20	30
5	20	30
7.5	20	30
10	20	30
15	20	60
20	20	60
25	20	60
30	30	60
40	30	80
50	50	90
60	50	125
75	60	150
100	80	200
125	100	225
150 & 175	125	300
200	150	350
250	175	450
300	225	600
350	300	600
400	300	800
500	350	800
600	400	1000
650 & 700	500	1100
750	250/250 (Parallel Branches)	1200
800 & 850	300/300 (Parallel Branches)	1400
900 & 1000 & 1050	400/400 (Parallel Branches)	1800

Table 4 – Fuse Table for HGP 380-415 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
2	20	30
3	20	30
7.5	20	30
10	20	30
15	20	60
20	20	60
25 & 30	30	60
40	30	80
50	50	125
60	60	150
75	80	200
100	100	225
125	125	250
150	125	300
175	150	350
200	175	450
250	200	500
300	300	600
350	300	800
400 & 450	350	800
500	400	1000
600	500	1100
700	300/300 (Parallel Branches)	1350
750	300/300 (Parallel Branches)	1500
800	400/400 (Parallel Branches)	1500
900	400/400 (Parallel Branches)	1600
950	400/400 (Parallel Branches)	1800

Table 5 – Fuse Table for HGP 240 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
5	20	30
7.5	20	30
10	20	60
15	30	60
20	50	70
25	50	80
30	60	80
40	80	120
50	100	150
60	125	200
75	150	225
100	175	300
125	200	400
150	225	450
200	250	600
250	500	800
300	250/250 (Parallel Branches)	900
400	400/400 (Parallel Branches)	1100

Table 6 – Fuse Table for HGP 208 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
5	20	30
7.5	20	30
10	30	60
15	50	60
20	50	70
25	60	80
30	80	100
40	125	150
50	125	175
60	150	200
75	175	250
100	225	350
150	350	450
200	500	600
250	300/300 (Parallel Branches)	800
300	400/400 (Parallel Branches)	900

Table 7 – Fuse Table for HGP 600 Volt, 60Hz Models

HGP Rating (HP)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
5	20	30
7.5	20	30
10	20	30
15	20	30
25	20	35
30	20	40
40	20	50
50	30	60
60	30	80
75	40	100
100	45	125
125	60	150
150	70	175
200	80	250
250	100	300
300	125	350
350	150	400
400	175	500
450	175	500
500	200	600
600	300	700
700	300	800
800	300	1000
900	350	1100

Table 9 – Fuse Table for HGP 380-415 Volt, 50Hz Models

HGP Rating (kW)	Branch Circuit Fuse Current Rating (Included Internal to HGP Unit) (J or T)	Typical Line Current Fuse or Circuit Breaker Rating (Customer Supplied)
2.2	20	20
3	20	20
4	20	20
5.5	20	20
7.5	20	20
9.3	20	25
11	20	30
15	20	40
18.5	30	50
22	30	60
30	30	80
37	40	100
45	40	125
55	60	150
75	75	200
90	100	225
110	125	300
132	125	350
160	150	400
200	200	500
250	250	600
315	300	800
355	350	800
400	400	900
450	450	1000
500	500	1200
560	300/300 (Parallel Branches)	1200
630	300/300 (Parallel Branches)	1400
710	350/350 (Parallel Branches)	1600
800	400/400 (Parallel Branches)	1800
900	450/450 (Parallel Branches)	2000

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 HGP filter nameplate information available.

Product Description

HGP Drive-Applied Filter

The HGP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by VFDs. The published HGP voltage, Power (Hp or kW) and current ratings apply to matching power (Hp or kW) rated standard VFDs with six-pulse diode bridge rectifiers. The HGP may also be sized to filter other loads such as SCR six-step drives, SCR Direct Current (DC) motor drives, thyristor furnaces, battery chargers, electroplating supplies or other types of nonlinear loads. In many cases, the filter power rating (Hp or kW) will differ from load power rating (Hp or kW). Please contact TCI Technical Support for additional information and support on sizing HGP harmonic filters for your non six-pulse diode front end VFD applications.

The HGP is a passive filter connected in series with the input terminals of a VFD or several VFDs that operate as a group. It is designed to provide a low impedance path for the major harmonic currents demanded by the drive. The filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the drive. It is also available on an open panel for mounting within an enclosure with the drive or other equipment.

The HGP filters consist minimally of the following features and components:

- A KDR tuned series reactor to prevent system interaction and improve filter performance
- An L-C-L filter circuit with:
- A TCI three-phase tuning reactor specifically designed for the HGP filter
- High-endurance, harmonic-rated capacitors
- Larger filters may have multiple tuned circuits. Consult fuse tables to determine if the filter in question has “parallel” branches.
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown
- Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures
- Compression terminals for ease and integrity of all power and control wiring
- Fuses - sized to protect the capacitor wiring

Nameplate Data

The following information is marked on the nameplate:

- Part number: encoding is explained on the following page
- FLA: the rated continuous operating current (RMS amps)
- System Voltage: the rated three-phase line voltage (RMS volts)
- Hz: the rated frequency
- Phase: 3 – The HGP filter is designed for use only with three-phase power
- Drawing #: outline and mounting dimension drawing number
- Schematic #: schematic diagram drawing number
- Manufacturing #: for TCI internal use
- Enclosure Type: UL designation or "Open" panel construction

Part Number Encoding

Figure 1 identifies the significance of each character in the HGP part number. The example part number, HGP0150AW1C1000 designates an HGP filter that is rated 150Hp, 480 volts, 60 Hz, Type 1 Enclosure, with contactor, PQconnect with Modbus RTU, no other options. It includes a line reactor, tuning reactor, and capacitors in a UL Type 1 enclosure. It is designed for use with a 150Hp drive.

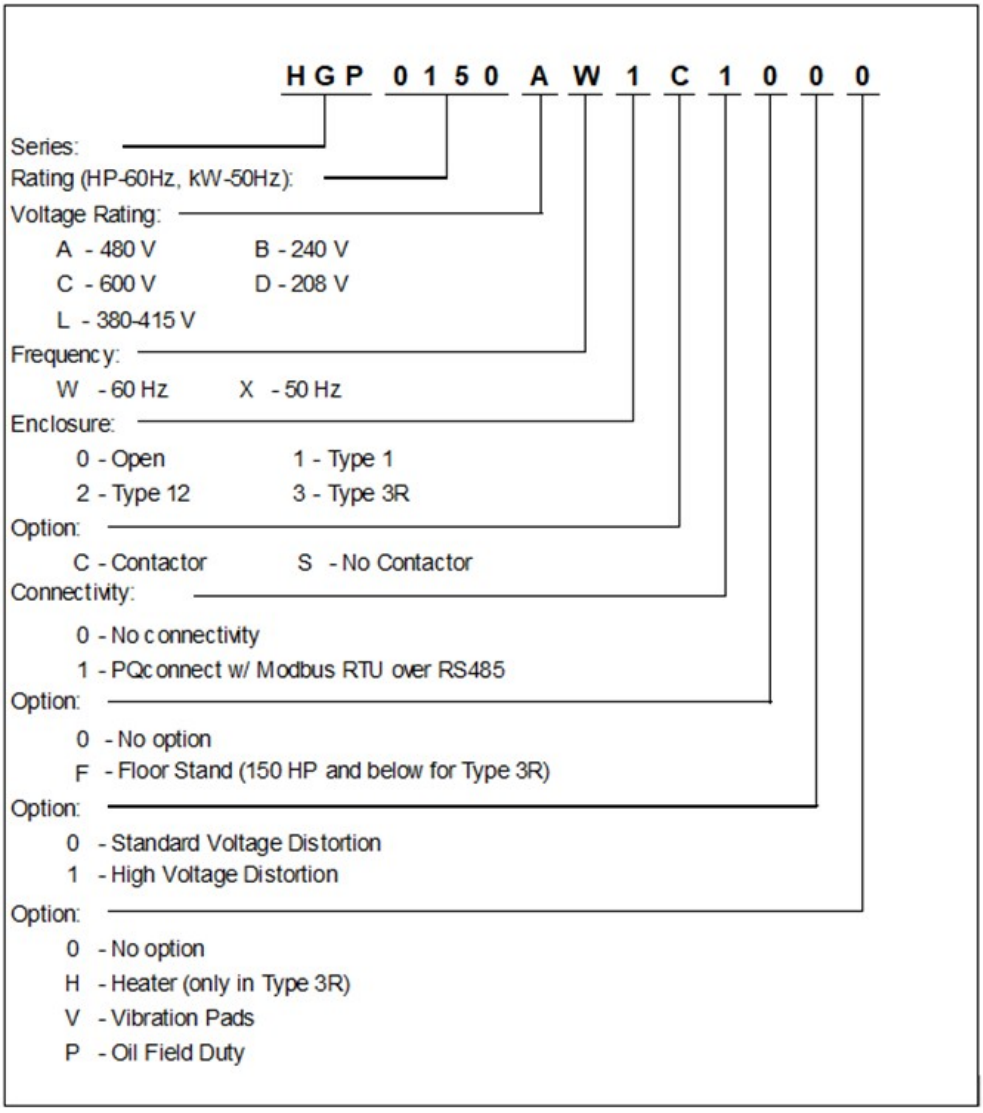


Figure 1 – HGP Part Number Encoding

Product Technical Specifications

Table 9 lists the major technical specifications for the HGP Filter.

Table 9 – HGP Technical Specifications

TECHNICAL SPECIFICATIONS	
Voltage / Frequency Rating	208, 240, 480, 600 VAC- 60 Hz 380 - 415 VAC- 50 Hz
Phase	3Ø
Motor drive input power rating range	208, 240 VAC: 5 - 100 Hp 380 - 415 VAC: 4 - 1000 KW 480, 600 VAC: 5 - 1250 Hp
THID	Less than 5% at full load
SCCR (Short Circuit Current Rating)	100 kA
Immunity from Voltage Distortion	Less than 5% THID at full load with THVD as high as 5%*
Efficiency	Greater than 99%
Overload Capability	200% of current rating for 3 minutes
Communication Options	Modbus RTU over RS485

ENVIRONMENTAL CONDITIONS	
Operating Temperature	Open: 50°C (122°F), Enclosed: 40°C (104°F)
Storage Temperature	60°C (140°F)
Elevation	Up to 2,000 m without derating. Consult factory for higher elevations.
Humidity	95% non-condensing
Protection Category	Open Chassis, UL Type 1, UL Type 3R, and UL Type 12 enclosure
Cooling Method	Natural or Forced Air Convection
REFERENCE TECHNICAL STANDARDS	
Agency Approvals	c UL us LISTED, FC, RoHS

Table 10 – 480V HGP Watts loss

HP	Open	Type 1	Type 3R
3	110	110	125
5	110	110	125
7.5	140	140	160
10	160	160	175
15	215	215	230
20	260	260	275
25	310	310	325
30	265	265	280
40	460	460	500
50	490	490	525
60	650	650	675
75	800	800	850
100	775	775	800
125	900	900	900
150	1150	1150	1200
200	1425	1500	1500
250	1575	1625	1650
300	1975	2020	2025
350	1800	1875	1875
400	1950	2000	2025
450	2175	2550	2275
500	2500	2875	2575
600	1975	2375	2075
700	2150	2550	2575
800	2200	2600	2600
900	3650	4100	4100
1000	4050	4500	4500

Table 11 – 600V HGP Watts loss

HP	Open	Type 1	Type 3R	Kit
15	170	170	185	145
30	275	275	295	250
40	450	450	480	420
50	450	450	500	425
60	620	620	660	575
75	775	775	800	725
100	800	800	850	750
125	850	850	900	800
150	1100	1100	1175	1050
200	1350	1400	1400	1275
250	1500	1575	1575	1425
300	1450	1500	1500	1375
350	1825	1900	1900	1750
400	1450	1875	1550	1325
450	1950	2350	2010	1800
500	1800	2200	1875	1650
600	1850	2250	1925	1700
700	2100	2500	2500	2000
800	2400	2800	2800	2300
900	2450	2850	2850	2300

Contactor Option (C)

The Contactor Option includes a contactor, control power transformer and connection terminals in the filter circuit which allows the VFD user to control the insertion of this circuit through the use of a relay contact in the VFD. It is recommended that the VFD contact be programmed to open the contactor below 33% motor power. For variable torque (fan) loads this will be approximately below 70% speed, so the at-speed contact may be used. This reduces the possibility of leading power factor interacting with other devices on the power system. Contactor logic should also maintain the contactor closed in cases where the VFD is bypassed and the filter is not bypassed.

Product Description

HGP C Option Filter

The HGP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by VFDs. The published HGP voltage, Power (Hp or kW) and current ratings apply to matching power (Hp or kW) rated standard VFDs with six-pulse diode bridge rectifiers. The HGP may also be sized to filter other loads such as SCR six-step drives, SCR Direct Current (DC) motor drives, thyristor furnaces, battery chargers, electroplating supplies or other types of nonlinear loads. In many cases, the filter power rating (Hp or kW) will differ from load power rating (Hp or kW). Please contact TCI Technical Support for additional information and support on sizing HGP harmonic filters for your non six-pulse diode front end VFD applications.

The HGP harmonic filter is a passive filter connected in series with the input terminals of a VFD or several VFDs that operate as a group. It is designed to provide a low impedance path for the major harmonic currents demanded by the VFD. The filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the VFD. It is also available on an open panel for mounting within an enclosure with the VFD or other equipment.

The HGP Contactor Option consists of the following standard features and components:

- A KDR tuned series reactor
- A TCI three-phase tuning reactor specifically designed for the HGP filter
- High-endurance, harmonic-rated capacitors
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown, located on capacitors
- Filter enable/disable contactor with protection and drive interlock provisions
- Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures
- Control power transformer
- Compression terminals for ease and integrity of all power and control wiring
- Fuses
- Contactor

No Contactor Option (S)

The No Contactor Option includes high quality harmonic-grade capacitors and line reactors. This filter will meet the majority of application requirements found today. This cost-effective product is available as an open panel version, in a UL Type 1 or UL Type 12 enclosure, or in an UL Type 3R enclosure. The open panel is perfect for inclusion in a MCC section or easy installation into industry standard enclosures. The UL Type 1 enclosed units maintain the same vertical profile as the open panel design. This design is perfect for applications where floor space is at a premium. The UL Type 3R enclosure protects the filter from harsh conditions.

Product Description

HGP S Option Filter

The HGP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by VFDs. The published HGP voltage, Power (Hp or kW) and current ratings apply to matching power (Hp or kW) rated standard VFDs with six-pulse diode bridge rectifiers. The HGP may also be sized to filter other loads, such as SCR six-step drives, SCR Direct Current (DC) motor drives, thyristor furnaces, battery chargers, electroplating supplies or other types of nonlinear loads. In many cases, the filter power rating (Hp or kW) will differ from load power rating (Hp or kW). Please contact TCI Technical Support for additional information and support on sizing HGP harmonic filters for your non-six-pulse diode front end VFD applications.

The HGP harmonic filter is a passive filter connected in series with the input terminals of a VFD or several VFDs that operate as a group. It is designed to provide a low impedance path for the major harmonic currents demanded by the VFD. The filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the VFD. It is also available on an open panel for mounting within an enclosure with the VFD or other equipment.

The HGP No Contactor Option consists of the following standard features and components:

- A KDR tuned series reactor.
- A TCI three-phase tuning reactor specifically designed for the HGP filter.
- High-endurance, harmonic-rated capacitors.
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown, located on capacitors.
- Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures.
- Control Power transformer on enclosed units requiring auxiliary cooling fans.
- Compression terminals for ease and integrity of all power and control wiring.
- Fuses

Fuse Monitor with Contactor Option (F)

The Fuse Monitor with Contactor Option includes a voltage monitor module and relay that can be connected to a VFD or other device. The fuse monitor will indicate a fuse failure and communicate this condition through the relay to a connected device.

This option includes a contactor, control power transformer, and connection terminals in the filter circuit which allows the VFD user to control the insertion of this circuit through the use of a relay contact in the VFD. It is recommended that the drive contact be programmed to open the contactor below 33% motor power. For variable torque (fan) loads this will be approximately below 70% speed, so the at-speed contact may be used. This reduces the possibility of leading power factor interacting with other devices on the power system. Contactor logic should also maintain the contactor closed in cases where the VFD is bypassed and the filter is not bypassed.

Product Description

HGP F Option Filter

The HGP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by VFDs. The published HGP voltage, Power (Hp or kW) and current ratings apply to matching power (Hp or kW) rated standard VFDs with six-pulse diode bridge rectifiers. The HGP may also be sized to filter other loads such as SCR six-step drives, SCR Direct Current (DC) motor drives, thyristor furnaces, battery chargers, electroplating supplies or other types of nonlinear loads. In many cases, the filter power rating (Hp or kW) will differ from load power rating (Hp or kW). Please contact TCI Technical Support for additional information and support on sizing HGP harmonic filters for your non six-pulse diode front end VFD applications.

The HGP harmonic filter is a passive filter connected in series with the input terminals of a VFD or several VFDs that operate as a group. It is designed to provide a low impedance path for the major harmonic currents demanded by the VFD. The filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the VFD. It is also available on an open panel for mounting within an enclosure with the VFD or other equipment.

The HGP F Option consists of the following standard features and components:

- A KDR tuned series reactor
- A TCI three-phase tuning reactor specifically designed for the HGP filter
- High-endurance, harmonic-rated capacitors
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown, located on capacitors
- Filter enable/disable contactor with protection and drive interlock provisions.
- Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures
- Control power transformer
- Compression terminals for ease and integrity of all power and control wiring
- Fuses
- Contactor
- Voltage monitor module to report status of fuses to control

Fuse Monitor without Contactor Option (G)

The Fuse Monitor without Contactor Option includes a voltage monitor module and relay that can be connected to a VFD or other device. The fuse monitor will indicate a fuse failure and communicate this condition through the relay to a connected device.

Product Description

HGP G Option Filter

The HGP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by VFDs. The published HGP voltage, Power (Hp or kW) and current ratings apply to matching power (Hp or kW) rated standard VFDs with six-pulse diode bridge rectifiers. The HGP may also be sized to filter other loads such as SCR six-step drives, SCR Direct Current (DC) motor drives, thyristor furnaces, battery chargers, electroplating supplies or other types of nonlinear loads. In many cases, the filter power rating (Hp or kW) will differ from load power rating (Hp or kW). Please contact TCI Technical Support for additional information and support on sizing HGP harmonic filters for your non six-pulse diode front end VFD applications.

The HGP harmonic filter is a passive filter connected in series with the input terminals of a VFD or several VFDs that operate as a group. It is designed to provide a low impedance path for the major harmonic currents demanded by the VFD. The filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the VFD. It is also available on an open panel for mounting within an enclosure with the VFD or other equipment.

The HGP G Option consists of the following standard features and components:

- A KDR tuned series reactor
- A TCI three-phase tuning reactor specifically designed for the HGP filter
- High-endurance, harmonic-rated capacitors
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown, located on capacitors
- Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures
- Control Power transformer on enclosed units requiring auxiliary cooling fans
- Compression terminals for ease and integrity of all power and control wiring
- Fuses
- Voltage monitor module to report status of fuses to control

Filter and Fuse Monitor Operation

HGP Filter Overview

The HarmonicGuard® Passive (HGP) Filter provides a low impedance path for the major harmonic currents demanded by Variable Frequency Drives (VFDs). This greatly reduces the amount of harmonic currents flowing through the electrical power distribution system, bringing those harmonic currents in line with the IEEE-519 standard for harmonic distortion mandated by an increasing number of utilities.

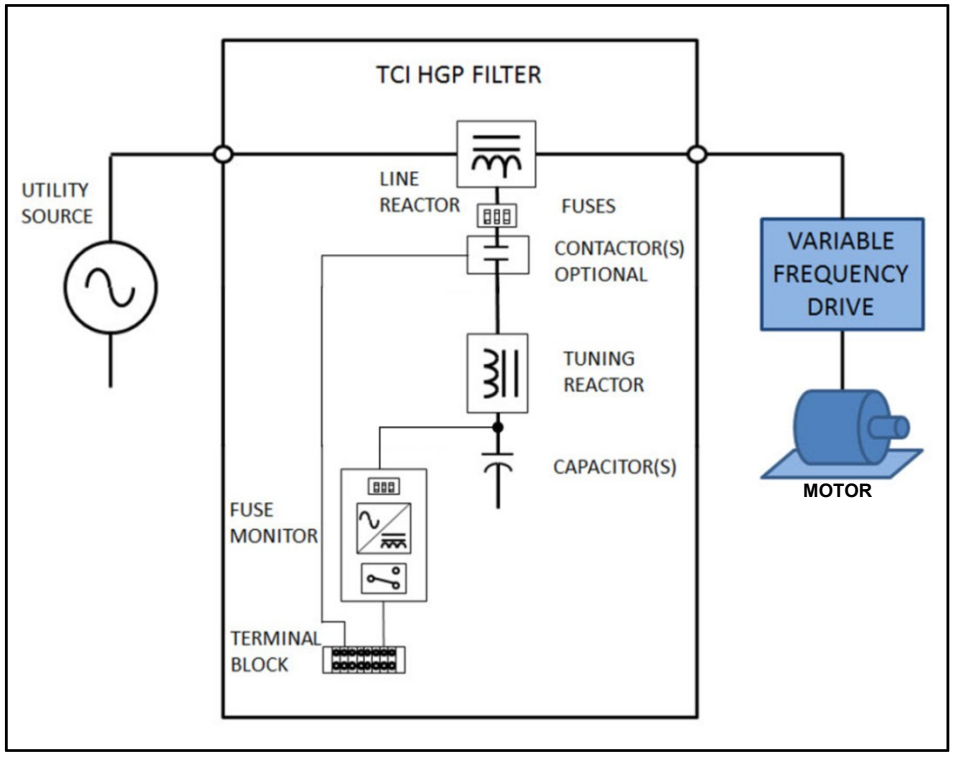
The HGP Filter includes branch fuses on the harmonic trap circuit capacitors. These fuses are included in the design to prevent damage to the capacitors in the event of excessive harmonic trap current if the filter is misapplied.

HGP Fuse Monitor Overview

The HGP Fuse Monitor Option is used in conjunction with the HGP filter to monitor the status of the HGP branch circuit capacitor fuses and optional contactor. If three-phase power with correct phase sequence is presented to sense terminals of fuse monitor, the SPDT relay contact will change state as illustrated in Table 12. Additionally, the Fuse Monitor Option is used to indicate the state of the optional contactor that allows users to remove the capacitors from the circuit, eliminating the possibility of leading power factor. The HGP Fuse Monitor Option will energize a SPDT relay contact if line power is applied to the filter, the fuses are intact, and the optional contactor was energized and closed. Finally, the Fuse Monitor Option provides the additional benefit of detecting drive input voltage phase reversal and loss of phase.

The HGP Fuse Monitor can be connected to a programmable digital input available on most modern VFDs and/or Programmable Logic Controllers (PLCs). Once the status of the HGP Fuse Monitor is routed to a programmable digital input, the status of the Fuse Monitor can be relayed on the VFDs or PLCs integrated communications field bus or Industrial Ethernet network interface. The Fuse Monitor is available on 480V and 600V HGP filters.

Figure 2– HGP Filter and Fuse Monitor Option Block Diagram



Fuse Monitor Operation and Relay Specifications

The fuse monitor relay contact is a single pole, double throw (SPDT) dry type contact. Terminal Block connection TBa-7 is the Common Connection, TBa-6 is the Normally Closed (NC) Connection, and TBa-8 is the Normally Open (NO) Connection. If three-phase power with correct phase sequence is presented to sense terminals of fuse monitor, the SPDT relay contact will change state as illustrated in Table 12 below.

Table 12 – Fuse Monitor Operation Modes and Output Table

Operating State	Input Voltage	HGP Filter	N.C. Relay Contact (TBa-6 TBa-7)	N.O. Relay Contact (TBa-7 TBa-8)	Monitor Status LED
No Input Line Voltage	Not Present	X*	Closed	Open	Off
Input Line Voltage has Missing Phase	Phase Loss	X*	Closed	Open	Blinking Red
Input Line Voltage has Phase Reversal	Phase Reversal	X*	Closed	Open	Solid Red
HGP Filter has Blown Trap Fuse	Nominal	Blown Trap Fuse	Closed	Open	Blinking Red or Off
HGP Fuse Monitor has Blown Fuse	Nominal	Blown Monitor Fuse	Closed	Open	Blinking Red or Off
HGP Filter Contactor is Open	Nominal	Contactor Open	Closed	Open	Off
Nominal	Nominal	Contactor Closed	Open	Closed	Solid Green
Nominal	Nominal	No Contactor Option Installed	Open	Closed	Solid Green

*X = don't care condition

** During unit power on / restart monitor LED will be blinking green

Table 13 – HGP Filter Fuse Monitor Relay Contact Specifications

Relay Contact	Location	Contact Rating
Normally Open Contact	(TBa-7 TBa-8)	10A @ 277V AC/ 7A @ 30VDC 1 HP @ 250V AC, 1/2HP @125V AC, C300 Pilot Duty
Normally Closed Contact	(TBa-6 TBa-7)	10A @ 277V AC/ 7A @ 30VDC 1 HP @ 250V AC, 1/2HP @125V AC, C300 Pilot Duty

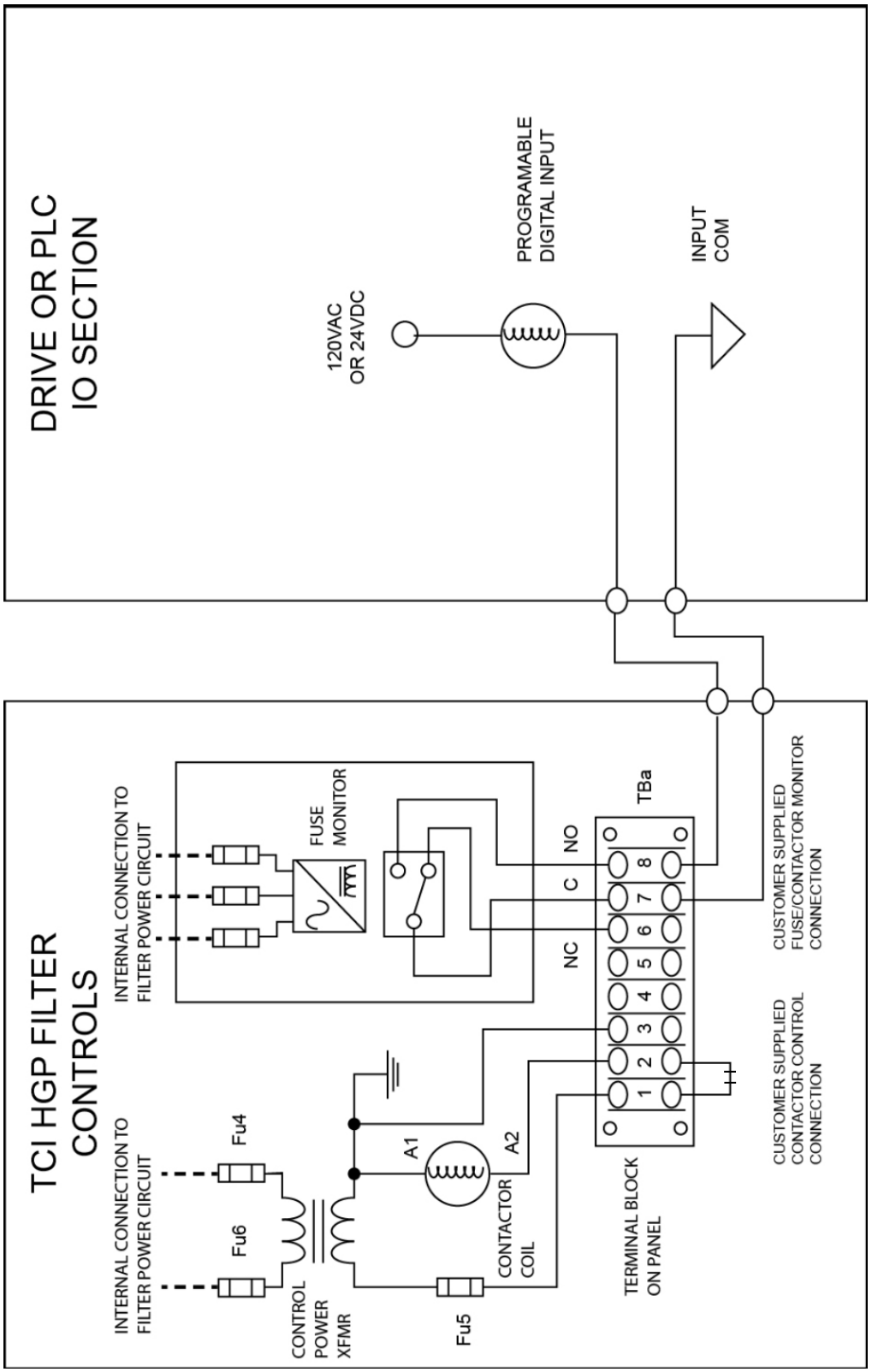


Figure 3 – HGP Filter Fuse Monitor Typical Connection Circuit Diagram

Typical Voltage Distortion Option (0)

The Typical Voltage Distortion Option, intended for applications with levels of background voltage distortion less than 2%, is a configuration that enables the HGP filter to achieve lower levels of current harmonic distortion in applications with low background voltage distortion.

This performance option is available in all of the package options.

High Voltage Distortion Option (1)

The High Voltage Distortion Option, intended for applications with levels of background voltage distortion of 2% or higher, is a configuration that enables the HGP filter to achieve lower levels of current harmonic distortion in applications with high background voltage distortion.

This performance option is available in all of the package options.

Heater Option (H)

The Heater Option is intended for use in applications which require the environmental protection of a NEMA 3R enclosure. The heater is mounted to the interior of the enclosure and protects sensitive electronic equipment from the harmful effects of corrosion and condensation.

The Heater option is available for all 3R enclosures.

Vibration Pad Option (V)

The Vibration Pad Option is intended for use in applications which require environmental noise protection. The resilient mounting material is placed between the reactor and the interior of the enclosure and dampens noise produced by the reactor.

The Vibration Pad option is available for all enclosure types.

Floor Stand Option (F)

The Floor Stand Option is intended for use in applications which require the HGP enclosure to be elevated from the floor. The Floor Stand option consists of 12” steel feet available for Type 3R enclosures 150Hp and below.

Oilfield Duty Option (P)

The Oilfield Duty Option features components designed specifically for oil and gas field applications to handle the additional electrical stress. Designed for cyclical loads these units will be available in Type 3R enclosures and will be for use with Hp ranges from 40 to 200Hp.

PQconnect Connectivity (1)

Product Description

HGP Drive-Applied Filter with PQconnect

The PQconnect is an integrated controls option for TCI's industry leading passive harmonic filter used for filtering the input of variable frequency motor drives (VFDs). In the passive harmonic filter, the PQconnect provides basic tuned circuit contactor control and provides unit status detection, metering, waveforms and power quality data. The PQconnect data is made available via basic Modbus RTU over RS485 serial connection. The PQconnect is UL listed and intended for commercial and industrial applications.

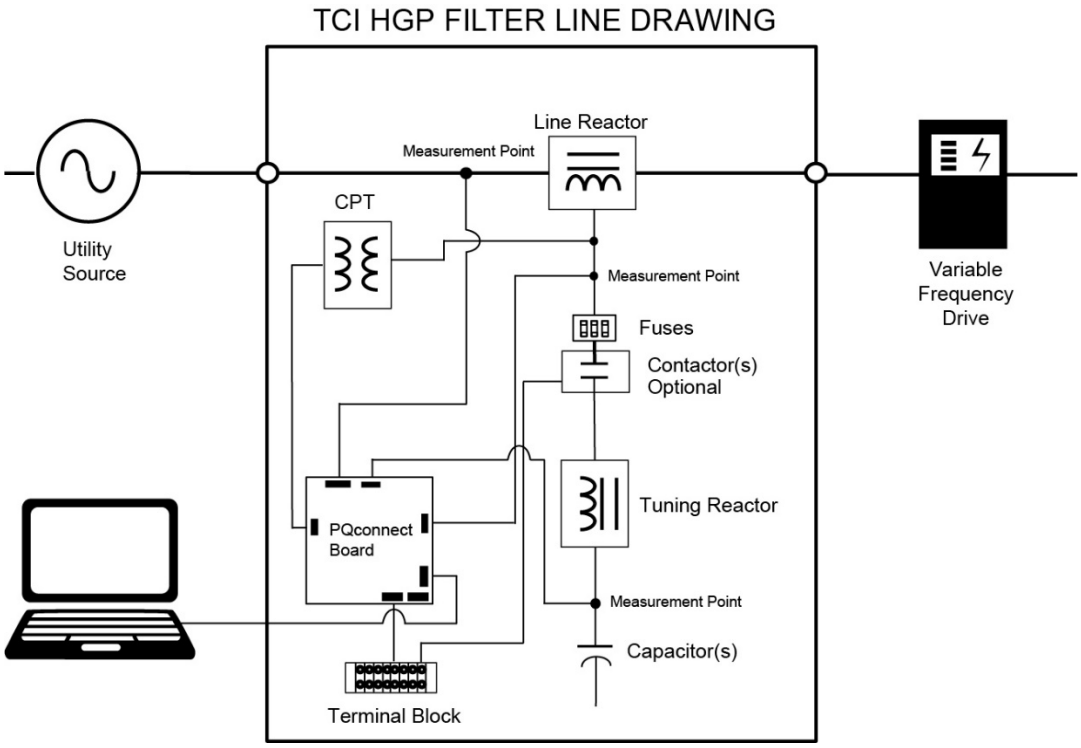


Figure 4 – HGP Filter with PQconnect Typical Connection Diagram

Modbus RTU

Introduction

The PQconnect Modbus RTU network communication interface transmits and receives command and status data from the PQconnect Modbus master over a RS-485 serial link. Modbus RTU is a simple serial communications protocol originally developed by Modicon for use with Programmable Logic Controllers (PLCs) in control of industrial devices. Modbus RTU is commonly supported by most PLCs and is an open, royalty-free communications standard.

Wiring and Configuration

The PQconnect implements a Modbus RTU Master/Slave device, which supports two-wire RS-485 signal levels. The PQconnect communication port used for the Modbus RTU interface is connected directly to the PCB. The communication port is located on the side of the PQconnect board.

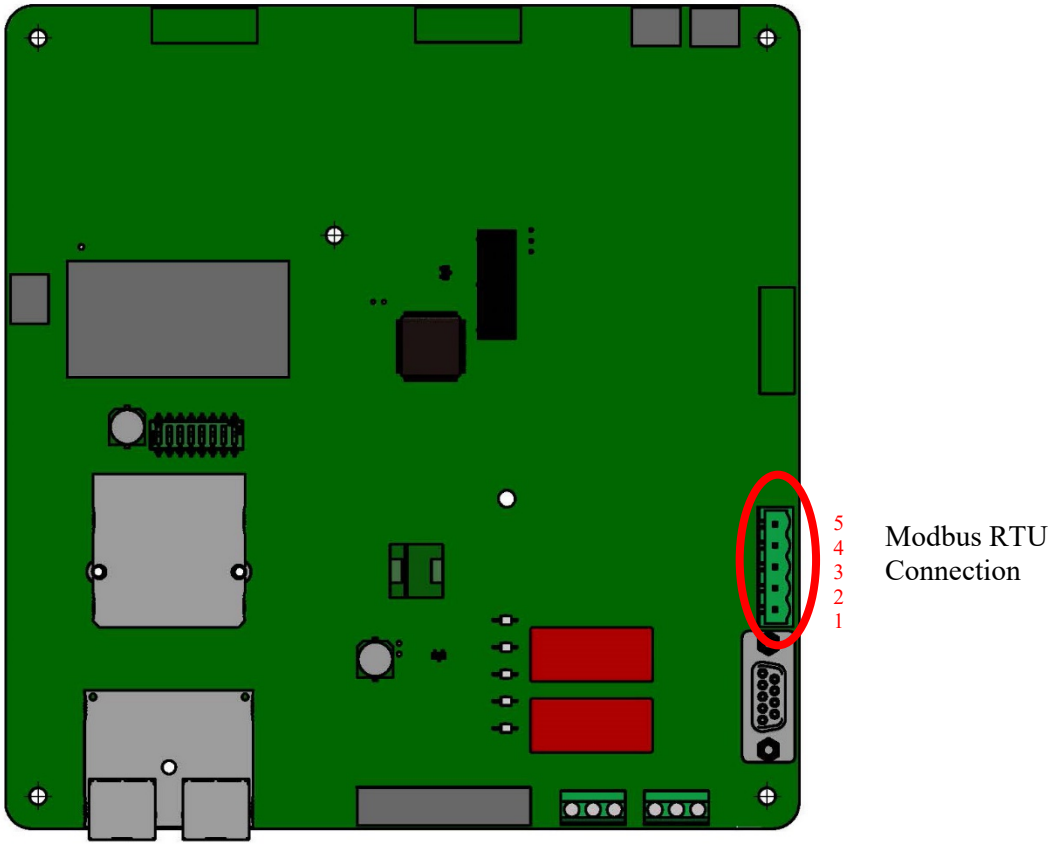


Figure 5 – PQconnect Modbus RTU Connection

PQvision Display Connections

The hardware pinout for the J5 communication header and default settings are shown below.

Table 14: Modbus Connector Pin Definitions

J5 Header Pinout	Signal Name	Signal Type
1	No connect	-
2	D-	RS-485 A (inverting)
3	GND	RS-485 SC/G
4	D+	RS-485 B (non-inverting)
5	No connect	-

The default protocol settings for the RS-485 Modbus RTU interface is shown below.

Table 15: Modbus RTU Protocol Settings

Parameter	Default Value	Units
Baud Rate	115200	Bd
Data Bits	8	Bits
Stop Bits	1	Bits
Parity	Even	-
Slave ID	10	-

The default settings can be modified via the PQconnect system menu. A Tech level access password is required to change these parameters. Ensure the board communicates to the desktop app and then First go to Menu → Settings → Device settings → Change to desired Modbus parameters → Apply → Menu → Save Settings. Finally cycle power to the HGP, this will reboot the PQconnect with the desired Modbus parameters.

The network interface on the PQconnect allows the user to control the contactor and show internal status data of the HarmonicGuard® Passive filter. The PQconnect PC application (PQvision) access a ModbusRTU master device for the network interface (see the PQvision application display connections).

Table 16: Configuration Switches

SW1	Configure Modbus Connection on J5 Header	1 – Enable 560Ω pull-down on D-.
		2 – Enable 120Ω termination resistor.
		3 - Enable 560Ω pull-up on D+.
J20	Remove jumper to use default Modbus settings on next reboot.	

The input registers from the HarmonicGuard® Passive filter are mapped to Modbus register address 40000, see **tables 17-19** for definitions of the input register maps. The output registers are mapped to Modbus register address 40500, see **Tables 23-28** All input and output registers are two bytes in size and formatted as 16-bit signed integers.

Note: All parameters with an asterisk (*) in the description will require the Tech level access codes parameter key A: 0825 and parameter key B: 2014.

Register Map

Write Parameters:

Table 17: Network Interface INPUT/Setpoint Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
PARAM_USER_CMD_REQ	500	Input	9 = Save Current Values to Flash 21 = Set User Access 25 = Set Access to Tech Access (access key needs to be set to 0825 for key A and 2014 for key B) 150 = Load Values from Flash 200 = Restore Defaults to Flash	
TRACE_GO_DONE	501	Input	0 = Capture Done 1 = Start Capture	Trace Data points for waveforms
SYS_RESET	502	Input	0 = No Command 1 = Reset Contactor Closed	Reset contactor
PARAM_KEY_A	503	Input	Enter Key A	Read/write parameters under Tech Access
PARAM_KEY_B	504	Input	Enter Key B	
CT_RATIO	505	Input	XXXX:5 where XXXX is the primary turns count of the CT 1000 = 1000:5 Range 5 to 10000	Dual Tuned Circuit Current Transformer (CT) ratios* ***Note:*** *Only required for units with dual tuned circuits*
SYS_CONTROL_MODE	510	Input	0 = Always off 1 = Always on 2= Auto load 3 = Auto kVAR 4 = External 5 = No contactor	Contactor control; keep contactor always off/on, auto turn on/off based on desired load or kVAR, external relay input. *
SYS_AUTO_CONTACTOR_CLOSED	511	Input	0 = Disable 1 = Enable	Contactor auto reclose*
RATED_CURRENT	520	Input	1000 = 100 A Range = 30 to 15000	Filter rated current*
RATED_VOLTAGE	521	Input	4800 = 480Vrms Range = 1200 to 6900	Filter rated voltage*
RATED_FREQUENCY	522	Input	500 = 50 Hz 600 = 60 Hz	Filter rated frequency*

Write Parameters:

Table 18: Network Interface INPUT/Setpoint Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
STATUS_FILTER_A_ENABLE	530	Input	0 = Disabled To Enable desired status detections, enter bit mask from table by converting to decimal Range: 0 to 65535	Example: Enabling lower three status conditions is 0000 0000 0000 0111 in binary or 7 decimal. Reference table 20 below for filter status detections. *
STATUS_FILTER_B_ENABLE	531	Input		
STATUS_LINE_ENABLE	532	Input		Example: Enabling the first three, the sixth, ninth, and sixteenth conditions is 1000 0001 0010 0111 in binary or 33063 decimal. Reference table 21 below for line status detections. *
STATUS_FILTER_LOAD_ENABLE	533	Input		Example: Enabling all status conditions is 1111 1111 1111 1111 in binary or 65535 decimal. Reference table 22 below for load status detections. *
STATUS_FILTER_A_RELAY_ACTION	540	Input	0 = Disabled To Enable desired status detections, enter bit mask from table by converting to decimal Range: 0 to 65535	If a status is active and the bit corresponding to that status in this mask is set, the relay will be activated. Reference table 20 below for filter status detection bits. *
STATUS_FILTER_B_RELAY_ACTION	541	Input		
STATUS_LINE_RELAY_ACTION	542	Input		If a status is active and the bit corresponding to that status in this mask is set, the relay will be activated Reference table 21 below for line status detection bits. *
STATUS_FILTER_LOAD_RELAY_ACTION	543	Input		If a status is active and the bit corresponding to that status in this mask is set, the relay will be activated. Reference table 22 below for load status detection bits. *
CNT_CLOSE_LOAD_THERSHOLD	570	Input	50 = 50 % Range 10 to 100	Contactor close threshold in percent rated current*
CNT_CLOSE_LOAD_HYSTERESIS	571	Input	Default: 5 = 5% Range 2 to 50	Contactor will open when it reaches the hysteresis *
CNT_CLOSE_KVAR_THERSHOLD	572	Input	100 = 100 kVAR Range -1000 to 1000	Contactor close threshold for kVAR control*
CNT_CLOSE_KVAR_HYSTERESIS	573	Input	Default: 10 = 10% Range 5 to 100	Contactor will open when it reaches the hysteresis *
CNT_CLOSE_DELAY	574	Input	Default: 5 = 5 seconds Range 1 to 3600	Contactor Close Delay*

CNT_OPEN_DELAY	575	Input	Default: 5 = 5 seconds Range 1 to 3600	Contactor Open Delay*

Write Parameters:

Table 19: Network Interface INPUT/Setpoint Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
SYS_PF_STEP_1_KVAR	576	Input	5 = 5 kVAR Steps Range 1 to 200	Desired filter kVAR for contactor to enable*
SYS_PF_STEP_2_KVAR	577	Input	5 = 5 kVAR Steps Range 1 to 200	Filter Second Tuned Circuit kVAR (Only used for filters with dual tuned circuits) *
CNT_AUTO_RECLOSE_DELAY	580	Input	Default 300 = 300 seconds Range 120 to 3600	Contactor auto re-close delay time*
CNT_POWER_ON_DELAY	581	Input	Default 1 = 1 seconds Range 0 to 3600	System Power on Delay*
CNT_AUTO_RECLOSE_ATTEMPTS	582	Input	Default 5 = 5 attempts Range 1 to 15	Maximum number of contactors auto re-close attempts allowed*
CNT_AUTO_RECLOSE_TIMESPAN	583	Input	Default 1800 = 1800 seconds Range 300 to 3600	Maximum number of contactors auto re-close attempts time span*
MB_SLAVE_ADDRESS	600	Input	Default = 10 Range 0 to 255	Modbus RTU Device Slave Address*
MB_BAUD_RATE	601	Input	11520 = 115200 baud rate 3840 = 38400 baud rate	Modbus RTU Device Baud Rate*
MB_PARITY	602	Input	0 = None 1 = Odd 2 = Even	Modbus RTU Device Parity*
SYS_INPUT_1_CONFIG	610	Input	0 = Disabled 1 = Reset Command 2 = External Control Input	Customer external control input*
SYS_INPUT_2_CONFIG	611	Input	0 = Disabled 1 = Reset Command 2 = Temperature Switch Input	Optional thermal switch for filters tuning reactor*
FAULT_PHASE_ROTATION	693	Input	1 = ABC Rotation Expected 2 = ACB Rotation Expected	Filter expected input phase orientation*
SYS_CNT_MIN_OFF_TIME	800	Input	Default: 60 = 60 seconds Range 30 to 300	Contactor Minimum open time*

Table 20: Filter Status References

16-bit values	
Register A	
Bit	**Status Detection**
0	TUNE_PHASE_LOSS_A
1	TUNE_PHASE_LOSS_B
2	TUNE_PHASE_LOSS_C
3	TUNE_BALANCE_LOSS_A
4	TUNE_BALANCE_LOSS_B
5	TUNE_BALANCE_LOSS_C
6	TUNE_UNDERCURRENT_A
7	TUNE_UNDERCURRENT_B
8	TUNE_UNDERCURRENT_C
9	TUNE_OVERCURRENT_A
10	TUNE_OVERCURRENT_B
11	TUNE_OVERCURRENT_C
12	UNDER_TEMP
13	OVER_TEMP
14	CPU_ERROR
15	REACTOR_THERMAL_SW
Register B	
0	RECLOSE_LIMIT

Table 21: Filter Line Status References

16-bit values	
Bit	**Status Detection**
0	PHASE_LOSS_A
1	PHASE_LOSS_B
2	PHASE_LOSS_C
3	OVERVOLTAGE_A
4	OVERVOLTAGE_B
5	OVERVOLTAGE_C
6	FILTER_FREQ_MISMATCH
7	HIGH_VOLTAGE_THD
8	LINE_PHASE_ROTATION

Table 22: Filter Load Status References

16-bit values	
Bit	**Status Detection**
0	BALANCE_A
1	BALANCE_B
2	BALANCE_C
3	OVERCURRENT_A
4	OVERCURRENT_B
5	OVERCURRENT_C

Read Parameters:

Table 23: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
DSP_SW_VER	12	Output	Two 8bit ASCII Characters 0x0141 = ASCII for "A1"	Software revision code for processor.
DSP_MODEL_NUM_RO	13	Output	103 = 480V	System Model Number
LINE_VOLTAGE	20	Output	4800 = 480V Range 1200 to 6900	Filter input voltage
LINE_FREQ	21	Output	600 = 60 Hz 500 = 50 Hz	Filter input frequency
LINE_ROT	22	Output	1 = ABC Rotation Expected 2 = ACB Rotation Expected	Filter input phase orientation
LINE_LOCK	23	Output	0 = Not locked 1 = Locked	
V_LINE_AB_RMS	30	Output	Volts RMS 4800 = 480 VRMSLL Range: 0 to 10000	Source Utility Line Phase to Phase Voltage (A-B)
V_LINE_BC_RMS	31	Output		Source Utility Line Phase to Phase Voltage (B-C)
V_LINE_CA_RMS	32	Output		Source Utility Line Phase to Phase Voltage (C-A)
V_LOAD_AB_RMS	50	Output		Filter Output Phase to Phase Voltage (A-B)
V_LOAD_BC_RMS	51	Output		Filter Output Phase to Phase Voltage (B-C)
V_LOAD_CA_RMS	52	Output		Filter Output Phase to Phase Voltage (C-A)
V_TRAP_A_RMS	70	Output		Filter Tuned Circuit Phase A Voltage
V_TRAP_B_RMS	71	Output		Filter Tuned Circuit Phase B Voltage
V_TRAP_C_RMS	72	Output		Filter Tuned Circuit Phase C Voltage)
I_LINE_A_RMS	36	Output	Amps RMS 1,000 = 1,000 ARMS Range: 0 to 10,000	Filter Input Current Phase A
I_LINE_B_RMS	37	Output		Filter Input Current Phase B
I_LINE_C_RMS	38	Output		Filter Input Current Phase C
I_LOAD_A_RMS	56	Output		Filter Output Current Phase A
I_LOAD_B_RMS	57	Output		Filter Output Current Phase B
I_LOAD_C_RMS	58	Output		Filter Output Current Phase C
I_TUNE_A_RMS	76	Output		Filter Tuned Circuit Current Phase A
I_TUNE_B_RMS	77	Output		Filter Tuned Circuit Current Phase B
I_TUNE_C_RMS	78	Output		Filter Tuned Circuit Current Phase C
I_LINE_A_THD	39	Output	% THID 50 = 5.0% THID Range: 0 to 100	Phase A THID for line current feedback
I_LINE_B_THD	40	Output		Phase B THID for line current feedback
I_LINE_C_THD	41	Output		Phase C THID for line current feedback
I_LOAD_A_THD	59	Output		Phase A THID for load current feedback
I_LOAD_B_THD	60	Output		Phase B THID for load current feedback
I_LOAD_C_THD	61	Output		Phase C THID for load current feedback

Read Parameters:

Table 24: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
I_TUNE_A_THD	79	Output	% THID 50 = 5.0% THID Range: 0 to 100	Phase A THID for tuned circuit current feedback
I_TUNE_B_THD	80	Output		Phase B THID for tuned circuit current feedback
I_TUNE_C_THD	81	Output		Phase C THID for tuned circuit current feedback
V_LINE_AB_THD	33	Output	% THVD 50 = 5.0% THVD Range: 0 to 100	A-B Phase to Phase THVD
V_LINE_BC_THD	34	Output		B-C Phase to Phase THVD
V_LINE_CA_THD	35	Output		C-A Phase to Phase THVD
V_LOAD_AB_THD	53	Output		A-B Phase to Phase THVD
V_LOAD_BC_THD	54	Output		B-C Phase to Phase THVD
V_LOAD_CA_THD	55	Output		C-A Phase to Phase THVD
V_TRAP_A_THD	73	Output		Tuning circuit A Phase THVD
V_TRAP_B_THD	74	Output		Tuning circuit B Phase THVD
V_TRAP_C_THD	75	Output		Tuning circuit C Phase THVD
I_LINE_A_TDD	42	Output	% iTDD 50 = 5.0% iTDD Range: 0 to 100	Filter input total Demand Distortion Phase A iTDD
I_LINE_B_TDD	43	Output		Filter input total Demand Distortion Phase B iTDD
I_LINE_C_TDD	44	Output		Filter input total Demand Distortion Phase C iTDD
SYS_POWER_ON	201	Output	0 = Power Off 1 = Power On	Indicates if the filter has input power available
SYS_STATUS_OK	202	Output	0 = Filter is operating 1 = Filter has faulted	Indicates filters status
SYS_AT_CAPACITY	203	Output	0 = Nominal 1 = At Capacity	Indicates if the filter is running at its maximum current capacity
SYS_STATE	256	Output	0,1 = Initialization 2 = Power on Delay 3 = Unit Self State Inhibit 4 = Reset 5 = Force Open Contactor 6 = Force Close Contactor 7 = Auto Load Open 8 = Auto Load Close 9 = Auto kVAR Close 10 = Auto kVAR Open 11 = External Open 12 = External Close 13 = No Contactor 14 = Contactor Closed Inhibited 15 = Calibrate offsets 16 = Calibrate Magnitude 17 = No Communication 18 = Communication configuration 19 = Calibrate Check	Indicates the present state of the system state machine.

Read Parameters:

Table 25: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
P_LOAD_APPARENT_TOTAL	120	Output	100 = 100 kVA Range: 0 to 1000	Total Filter output apparent power
P_LOAD_REAL_TOTAL	121	Output	100 = 100kW Range: 0 to 1000	Total Filter output real power
P_LOAD_REACTIVE_TOTAL	122	Output	100 = 100 kVAR Range: -1000 to 1000	Total Filter output reactive power; Negative number indicates inductive power. Positive number indicates capacitive power
P_LOAD_POWER_FACTOR	123	Output	1,000 = 1.00 Unity PF -95 = 0.95 Lagging PF 95 = 0.95 Leading PF Range = -99 to 1000	Filter output Displacement Power Factor - Negative values indicate lagging power factor
I_LINE_A_HARM_1	140	Output	Fundamental = 1000 = 100% Range 0 to 1000	Filter input phase A spectrum data. Data points from the fundamental to the 25th harmonic. If the user would like the full spectrum data points up to the 50th harmonic; the user will have to run the full data capture command.
I_LINE_A_HARM_3	141	Output		
I_LINE_A_HARM_5	142	Output		
I_LINE_A_HARM_7	143	Output		
I_LINE_A_HARM_11	144	Output		
I_LINE_A_HARM_13	145	Output		
I_LINE_A_HARM_17	146	Output		
I_LINE_A_HARM_19	147	Output		
I_LINE_A_HARM_23	148	Output		
I_LINE_A_HARM_25	149	Output		
I_LINE_B_HARM_1	160	Output	Fundamental = 1000 = 100% Range 0 to 1000	Filter input phase B spectrum data. Data points from the fundamental to the 25th harmonic. If the user would like the full spectrum data points up to the 50th harmonic; the user will have to run the full data capture command.
I_LINE_B_HARM_3	161	Output		
I_LINE_B_HARM_5	162	Output		
I_LINE_B_HARM_7	163	Output		
I_LINE_B_HARM_11	164	Output		
I_LINE_B_HARM_13	165	Output		
I_LINE_B_HARM_17	166	Output		
I_LINE_B_HARM_19	167	Output		
I_LINE_B_HARM_23	168	Output		
I_LINE_B_HARM_25	169	Output		
I_LINE_C_HARM_1	180	Output	Fundamental = 1000 = 100% Range 0 to 1000	Filter input phase C spectrum data. Data points from the fundamental to the 25th harmonic. If the user would like the full spectrum data points up to the 50th harmonic; the user will have to run the full data capture command.
I_LINE_C_HARM_3	181	Output		
I_LINE_C_HARM_5	182	Output		
I_LINE_C_HARM_7	183	Output		
I_LINE_C_HARM_11	184	Output		
I_LINE_C_HARM_13	185	Output		
I_LINE_C_HARM_17	186	Output		
I_LINE_C_HARM_19	187	Output		
I_LINE_C_HARM_23	188	Output		

I_LINE_C_HARM_25	189	Output		

Read Parameters:

Table 26: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
CNT_CLOSED	200	Output	0 = Contactor Closed 1 = Contactor Open	Indicates the status of the Filters tuned circuit contactor.
STATUS_FILTER_A	210	Output	0 = Disabled To Enable desired status detections, enter bit mask from table by converting to decimal Range: 0 to 65535	Reference table 20 above for filter status detections.
STATUS_FILTER_B	211	Output		
STATUS_FILTER_A_ENABLE_RO	220	Output		
STATUS_FILTER_B_ENABLE_RO	221	Output		
STATUS_FILTER_A_RELAY_ACTION_RO	230	Output		
STATUS_FILTER_B_RELAY_ACTION_RO	231	Output		
STATUS_FILTER_A_CNT_ACTION_RO	240	Output		
STATUS_FILTER_B_CNT_ACTION_RO	241	Output		
STATUS_LINE	212	Output		Reference table 21 above for line status detections.
STATUS_LINE_ENABLE_RO	222	Output		
STATUS_LINE_RELAY_ACTION_RO	232	Output		
STATUS_LINE_CNT_ACTION_RO	242	Output		
STATUS_FILTER_LOAD	213	Output		Reference table 21 above for load status detections.
STATUS_FILTER_LOAD_ENABLE_RO	223	Output		
STATUS_FILTER_LOAD_RELAY_ACTION_RO	233	Output		
STATUS_FILTER_LOAD_CNT_ACTION_RO	243	Output		
SYS_CONTROL_MODE_RO	250	Output	0 = Always off 1 = Always on 2= Auto load 3 = Auto kVAR 4 = External 5 = No contactor	Contactor control; keep contactor always off/on, auto turn on/off based on desired load percentage or kVAR, external relay input.
TRACE_GO_DONE_RO	251	Output	0 = Capture Done 1 = Start Capture	Indicates waveform data
SYS_AUTO_FAULT_RESET_RO	252	Output	0 = Disabled 1 = Enabled	Displays auto contactor reset
CT_RATIO_RO	253	Output	XXXX:5 where XXXX is the primary turns count of the CT 1000 = 1000:5 Range 5 to 10000	Dual Turned Circuit Current Transformer (CT) ratios Note: Only required for units with two tuned circuits
PARAM_ACCESS_LEVEL_RO	254	Output	0 = Base access 1 = Tech access	Level of parameter access to read and/or change parameter inputs

Read Parameters:

Table 27: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
CNT_STATUS	257	Output	0 = Contactor Closed 1 = Contactor Open	Contactor command status
RATED_VOLTAGE_RO	260	Output	4800 = 480Vrms Range = 1200 to 6900	Filter rated voltage
RATED_CURRENT_RO	261	Output	1000 = 100 A Range = 30 to 15000	Filter rated current
RATED_FREQUENCY	262	Output	50 = 50 Hz 60 = 60 Hz	Filter rated frequency
CNT_CLOSE_LOAD_THRESHOLD_RO	270	Output	50 = 50 % Range 10 to 100	Contactor close threshold based on the load *
CNT_CLOSE_LOAD_HYSTERESIS_RO	271	Output	Default: 5 = 5% Range 2 to 50	Contactor will open when it reaches the hysteresis percentage
CNT_CLOSE_KVAR_THRESHOLD_RO	272	Output	100 = 100 kVAR Range -1000 to 1000	Contactor close threshold for kVAR control*
CNT_CLOSE_KVAR_HYSTERESIS_RO	273	Output	Default: 10 = 10% Range 5 to 100	Contactor will open when it reaches the hysteresis percentage
CNT_CLOSE_DELAY_RO	274	Output	Default: 5 = 5 seconds Range 1 to 3600	Displays set value of contactor closed delay time
CNT_OPEN_DELAY_RO	275	Output	Default: 5 = 5 seconds Range 1 to 3600	Displays set value of contactor open delay time
CNT_AUTO_RECLOSE_DELAY_RO	280	Output	Default 300 = 300 seconds Range 120 to 3600	Indicates contactor auto reclose delay time
CNT_POWER_ON_DELAY_RO	281	Output	Default 0 = 0 seconds Range 0 to 3600	Indicates contactors power on delay time
CNT_AUTO_RECLOSE_ATTEMPS_RO	282	Output	Default 5 = 5 attempts Range 1 to 15	Indicates set value of attempts
CNT_AUTO_RECLOSE_TIMESPAN_RO	283	Output	Default 1800 = 1800 seconds Range 300 to 3600	Displays timespan of contactor to reclose
CNT_AUTO_RECLOSE_TIMER_RO	284	Output		Displays count down time for contactor to reclose
SYS_CNT_MIN_OFF_TIME_RO	285	Output	Default: 60 = 60 seconds Range 30 to 300	Minimum time off for contactor re-closures
SYS_CNT_MIN_OFF_TIMER	286	Output		Displays count down time for contactor re-closures
MB_SLAVE_ADDRESS_RO	300	Output	Default = 10 Range 0 to 255	Modbus slave address
MB_BAUD_RATE_RO	301	Output	3840 = 38400 baud rate 11520 = 115200 baud rate	Modbus baud rate
MB_PARITY_RO	302	Output	0 = None 1 = Odd 2 = Even	Modbus Parity
RELAY_INPUT_STATUS	320	Output	0 = Enabled 1 = Disabled	Digital relay status

Read:

Table 28: Network Interface OUTPUT/Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
RELAY_INPUT_1_CONFIG_RO	321	Output	0 = Disabled 1 = Reset Command 2 = External Control Input	Customer external control input
RELAY_INPUT_2_CONFIG_RO	322	Output	0 = Disabled 1 = Reset Command 2 = Temperature Switch	Optional thermal switch for filters tuning reactor*
SYS_SERIAL_NUM_2_RO	350	Output	Parameter contains UUUU in the UUUULLLL-NN serial number format.	Unit serial number section - upper 16 bits of 32-bit unit job number
SYS_SERIAL_NUM_1_RO	351	Output	Parameter contains LLLL in the UUUULLLL-NN serial number format.	Unit serial number section - lower 16 bits of 32-bit unit job number
SYS_SERIAL_NUM_0_RO	352	Output	Parameter contains NN in the UUUULLLL- NN serial number format.	Unit serial number section - two-digit unit number
SYS_NULL_STAT	400	Output	0 = Not calibrated 1 = Unit is calibrated	System auto null status *
SYS_NULL_TMR	401	Output	0 = Unit is not calibrating 1 = Unit is Calibrating	System null timer; indicates whether the unit is calibrating*
SYS_INT_HB	402	Output	Range 0 to 65535	Processor internal heartbeat. Internal counter that counts up and rolls over to zero used to verify processor clock operation. *
SYS_BG_HB	403	Output	Range 0 to 65535	Processor background heartbeat. Internal counter that counts up and rolls over to zero used to verify processor clock operation *

Operation

PQvision PC application Screen Elements

This section focuses on the operation of the PQvision application. The PC application contains several screens that allow the user to monitor the status of the HarmonicGuard® Passive filter. Additionally, the PQvision application can be used for contactor control and basic setup of the HarmonicGuard® Passive filter. Enter password 08252014 to enable tech access.

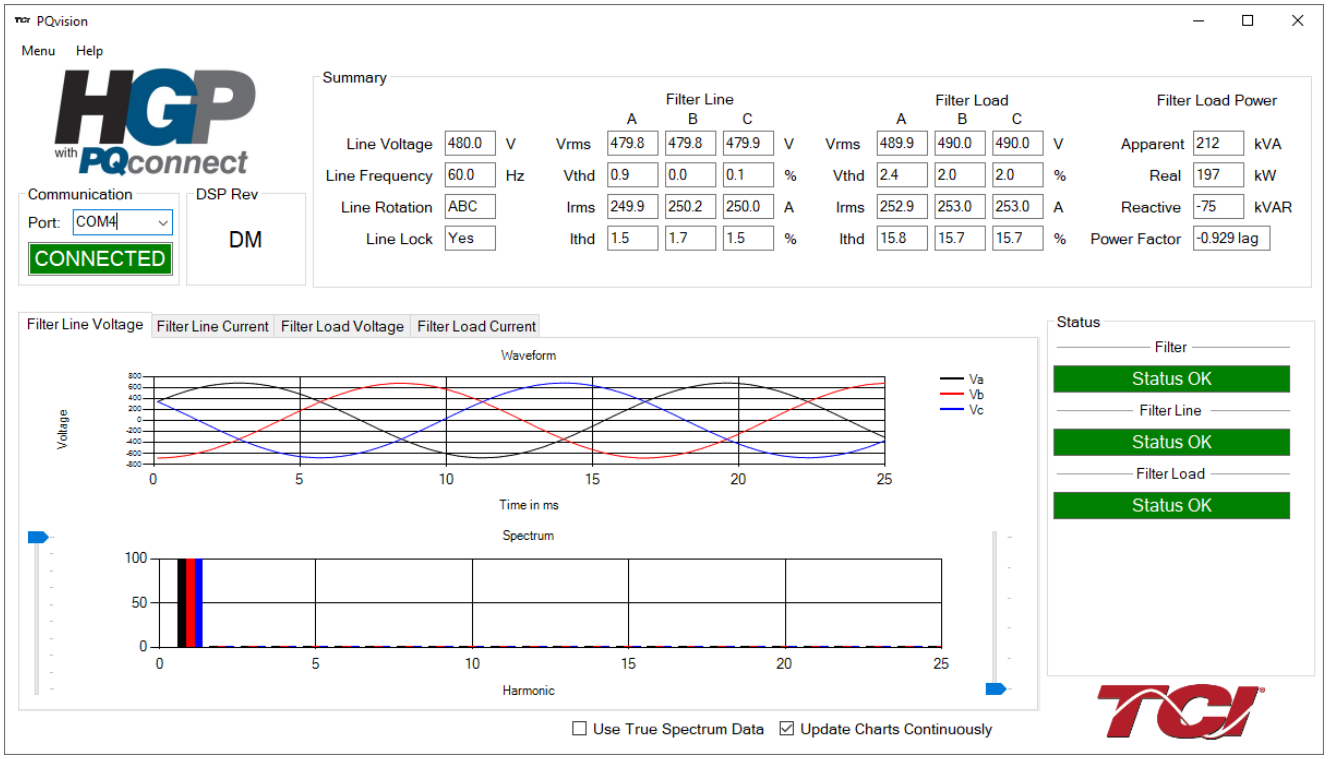


Figure 6: PQvision Desktop Application

Table 29: PQvision PC Naviagation

Options	Description
Toolbar	Communication Status and Communication Port To determine the COM port, go to Device Manager Ports (COM & LPT) and finding “USB Serial Port” ***Note:*** *If Modbus settings differ from the default values above; Set and save desired Modbus settings, then cycle power of the HarmonicGuard® Passive filter.*
	DSP Rev: Latest software revision will be displayed To update the software, select “Software Update” under the menu “Tech access is required to perform the update”
	Menu: Save settings, about screen, software update, tech access Settings – Modbus, contactor control, kVAR settings, alert management view ***Figure 7***
	Help – Direct links to the TCI Home page and tech-support contact information.

Table 30: PQvision PC Navigation

Summary Data	(THVD) Displays the Total Harmonic Distortion of the utility Line/Load voltage as a percentage
	(THID) Displays the Total Harmonic Distortion of the utility Line/Load current as a percentage
	Displays three-phase real power (P) of the filter input/output in kW
	Displays three-phase reactive power (Q) of the filter input/output in kVAR
	Displays three-phase apparent power (S) of the filter input/output in kVA
	Displays filters output power factor. 1.00 indicates unity power factor. A negative power factor indicates lagging power factor
	Displays the current utility line frequency in Hz
	Displays the supply voltage into the HarmonicGuard® Passive filter
	Displays the filters input/output phase current in Amps RMS
	Displays Line rotation
Waveforms	The PQconnect PC application supports capture and display of real time system voltage and current data. Three phase waveform data can be viewed for Filter Line/Load Voltage, and Filter Line/Load Current. Phase A – Black Phase B – Red Phase C – Blue
	Harmonic Spectrum (Left toggle to zoom in on the spectrum and right to increase the spectrum to the 50th harmonic) the value of the fundamental is 100.
Status Detections	Status alerts for the input, output and of the filter will display according to severity of the alerts Hovering over status alert will give a brief description of what the problem may be.

Figure 7 below allows the user to set their desired Modbus settings. (Note: if changing Modbus setting one must restart the PQconnect by cycling power to the HarmonicGuard® Passive filter) As well as controlling the contactor and enabling/ disabling alerts.

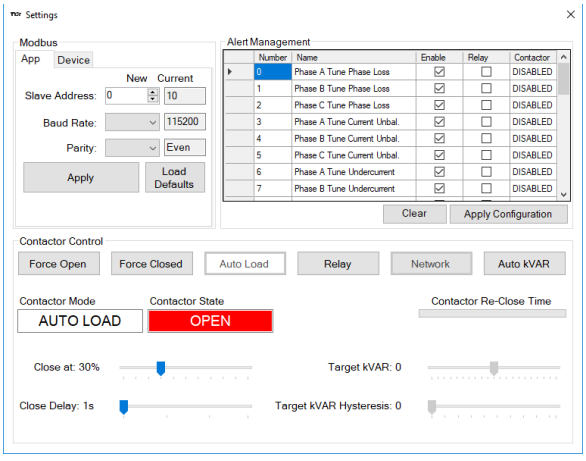


Figure 7: PQvision Settings

PQconnect Hardware

Example Application Using "Simply Modbus Master 8.1.0"

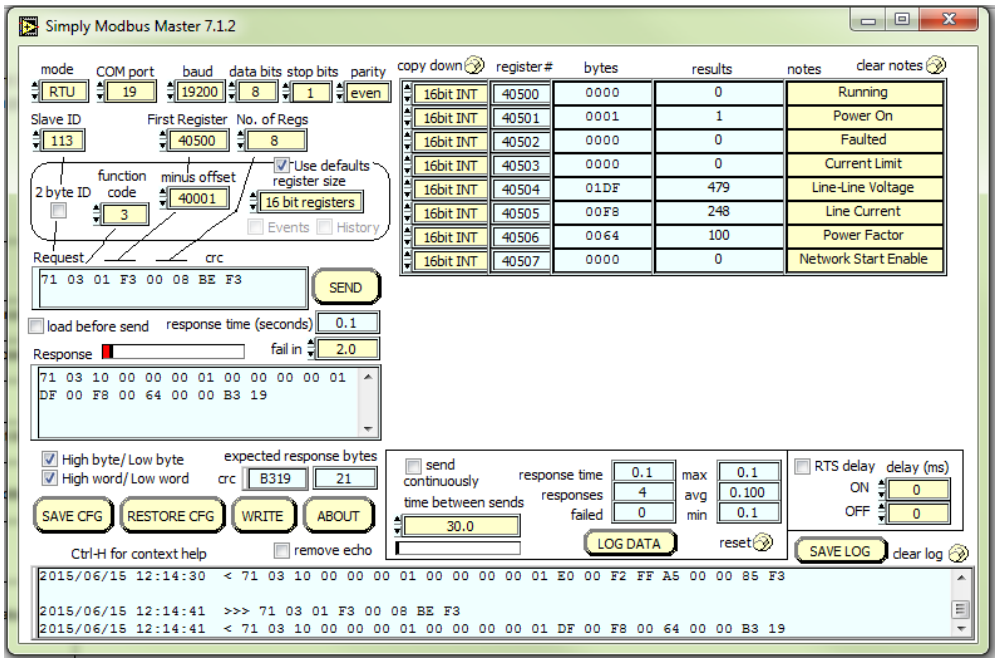
The Modbus RTU network interface port is configured for RS-485 signal levels. The following example uses an RS-485 to USB converter to connect the PQconnect to a laptop PC running the Modbus RTU master application. The picture below shows an example "US Converters Model: XS890" model RS-485 to USB converter. As another alternative RS-485 converter there is WINGONEER USB 2.0 to RS485 Serial Converter Adapter CP2104.

Figure 8: US Converters Model: XS890" model RS-485 to USB converter

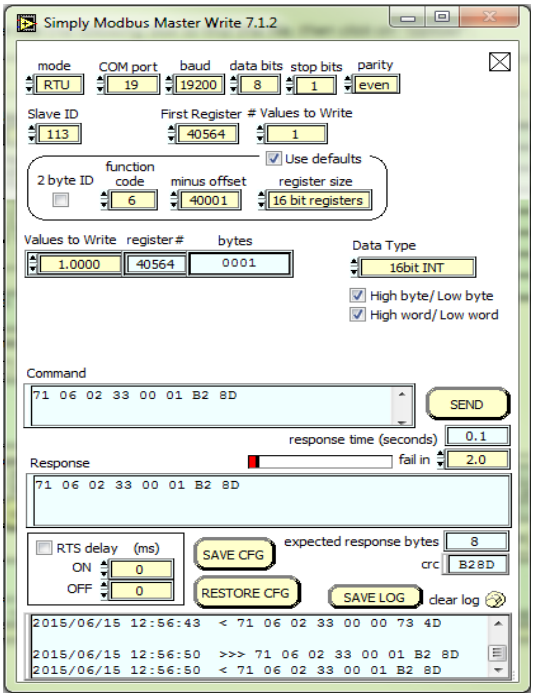
Example Setup Instructions to Read Data from the PQconnect Unit:

- Connect the cable to the communication header on the side of the board
- Connect USB end to the computer
  - Determine the assigned COM port number for the RS-485 to USB converter using the computer device manager control panel.
  - The converter used in this example typically enumerates between the range of COM5 to COM20 on a standard laptop computer running the Microsoft windows operating system
- Open the Simply Modbus Master software
  - Can be downloaded from the link below:
  - http://www.simplymodbus.ca/manual.htm
  - The trial version of the software is free and fully functional for this task hence no License key is necessary
- Next, configure the fields in the screen as shown below. These are again the default settings of the PQconnect COM port.
  - Note: The "notes" section of the display data registers are filled in manually

Example Setup Instructions to Write Data to the PQconnect Unit:



- In order to control the contactor in the unit, first the user will need tech access by writing the parameter keys
  - Navigate to the settings menu and then select force open or force close button.
  - The contactor state box will indicate if the contactor is open or closed.
- Next, select the “WRITE” button on the screen shown above.
- The screen below will be shown. Configure the fields as shown in the picture.



- Select “0” in the field “Values to Write” to close the contactor or “1” to open the contactor.
- Verify via the PQvision software that the unit is receiving commands by going to the screen shown below.

PQconnect Quick Start Unit Software Setup

- Verify connections to the PCB via ModbusRTU over RS485 before filter is energized
- Download PQvision software found on our website: https://transcoil.com/wp-content/uploads/2018/11/PQvision-Setup-v1.zip
- Enter password: 08252014 to access software package
- Select communication port (Data should be shown after the board communicates)
    - Note: Default Modbus settings of the application are below.
    - Baud rate: 115200
    - Parity: Even
    - Slave Address: 10
    - See PQconnect Display connections section for changing the default settings

PCB Connections

Most customer connections to PQconnect will be made on the PCB. Refer to connection diagrams in **Figure 9**. The details of the power and communications terminals are shown in **Table 31**. Form C relays are available on the PCB, these connections are shown in **Table 32**. Two relay outputs are available on the PCB.

The relay contactor control command input connection on J11 of the PCB allows the user to open/close the contactor of the HarmonicGuard® Passive filter. The second relay (input connections on J12) is optional and could be used for a second contactor for dual tuned circuit filters or as a secondary status detection.

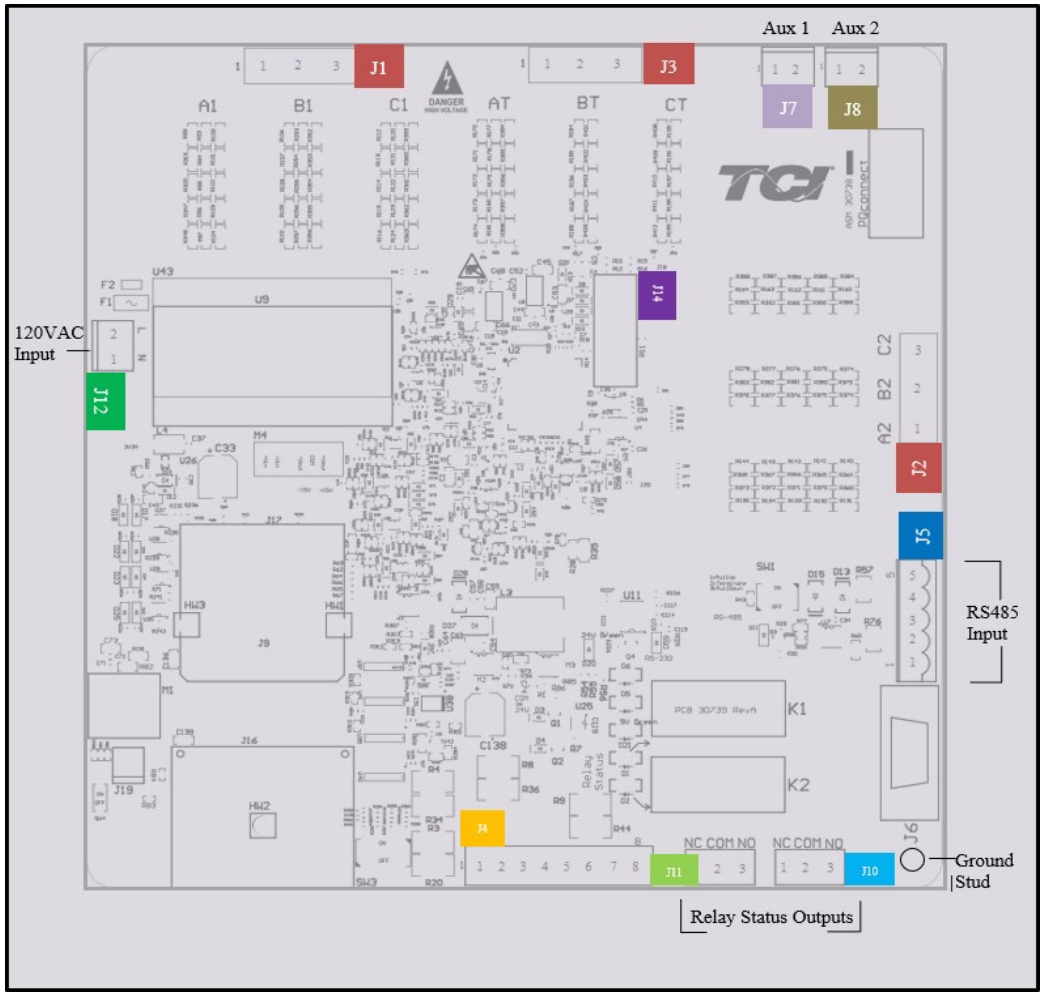


Figure 9: PQconnect Connections

Table 31: Power & Communications Terminals

Terminal	Pin	Description	Label	Rating
J1, J2, J3	1	Phase A	For factory use; Measurement connection points	600VAC
	2	Phase B		
	3	Phase C		
J4	1,2,3,4	Current transformer connections	For factory use; Only used for filters with dual tuned circuits	N/A
	5,6,7,8	Not Connected		N/A
J5	1	RS485	Not Connected	N/A
	2		A (D-)	
	3		Ground	
	4		B (D+)	
	5		Not connected	
J12	1	Input Power	Neutral	120 VAC
	2		Line	
J14	1-14	Micro Programming	For factory use	N/A

Note: The power terminals on the PQconnect accepts 28 to 14 AWG stranded wire, with a tightening torque of 4.4 in-lb (0.5 Nm).

Table 32: Form C Relay Contacts

Terminal	Pin	Description	Label	Tightening Torque	Wire Range
J7	1, 2	Optional External control	Customer contacts	3.5 lb-in (0.4 Nm)	28-12 AWG
J8	1, 2	Optional thermal switch for tuning reactor	For factory use	3.5 lb-in (0.4 Nm)	28-12 AWG
J11	1	Relay 1 Contactor Control	Normally Closed	4.4 lb-in (0.5 Nm)	28-14 AWG
	2		Common		
	3		Normally Open		
J10	1	Relay 2 Optional Fault	Normally Closed	4.4 lb-in (0.5 Nm)	28-14 AWG
	2		Common		
	3		Normally Open		

Note: Form-C relay contacts are gold plated with a load rating of 5.0A @ 120VAC

The filter is set to control the contactor pickup/drop-out at 30% of load current by factory default. This setting can be changed in the tech access page from the settings menu.

Troubleshooting

HarmonicGuard® Passive Filter Status Warning

If the desktop interface indicates a status warning, hover over the status detection for a brief description. Depending on the condition there are multiple ways to try and clear the status warnings.

Warning 	Only qualified electricians should carry out all electrical installation & maintenance work on the HGP. Disconnect all sources of power to the and connected equipment before working on the equipment. Do not attempt any work on a powered HGP. This HGP unit contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the filter before attempting to service the conditioner. Check for zero voltage between all terminals on the capacitors. Also, check for zero voltage between all phases of the input and output lines. All maintenance and troubleshooting must be done by a qualified electrician. Failure to follow standard safety procedures may result in death or serious injury. **Unless an external disconnect means has been provided everything ahead of the filter circuit breaker, including the reactors, will still be energized.**

Receiving Inspection

The connectivity board has been thoroughly inspected and functionally tested at the factory and carefully packaged for shipment. After receiving the unit, immediately inspect the shipping container and report any damage to the carrier that delivered the unit. Verify that the part number of the unit received is the same as the part number listed on the purchase order.

Connectivity Board Problem

The HGP is comprised of five major components; the PQconnect connectivity board, the line reactor, the tuning reactor, the contactor and the capacitors. The PQconnect PCB contains diagnostic LEDs. The locations of the LEDs are shown in **Figure 10** and their functions are listed in **Table 33**.

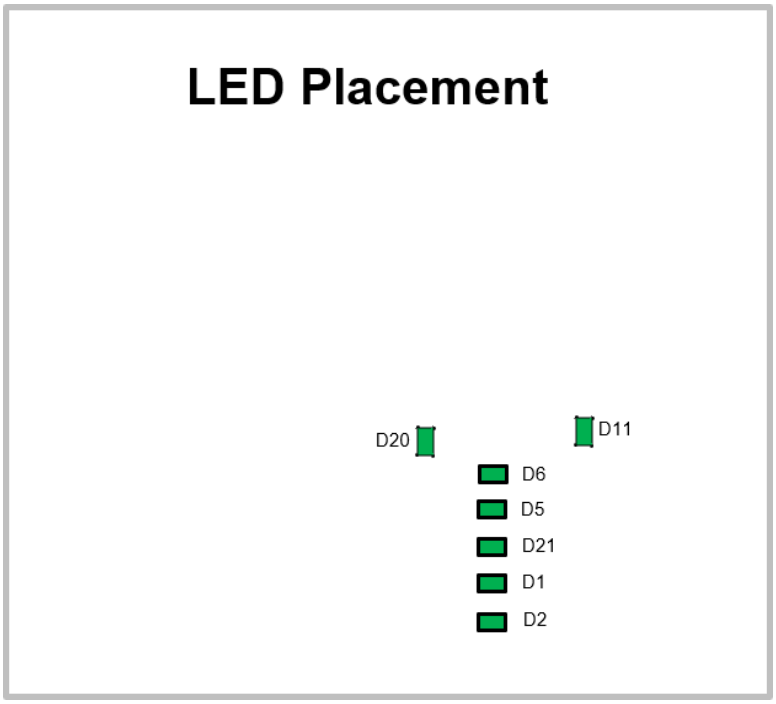


Figure 10: PQconnect LED Placements

Table 33: LED Functions

LED	LED Color	Description
D1	Green	Tuned circuit contactor control 1
D2	Green	Optional 2nd Status LED/ tuned circuit contactor control 2
D5	Green	Status LED
D6	Green	Microprocessor Status LED
D11	Green	RS485 Communication is active
D20	Green	24V LED
D21	Green	5V LED

Note: Status LED's will blink according to the filter status. The microprocessor status LED will blink 1hz if the filter is okay, however if there has been an alert the LED will blink according to the status detection. . It will initially start with a slow blink (1 = filter lower, 2 = filter upper, 3 = filter input, 4 = filter load) then blink fast depending on the status code.

For example, with a filter status detection of a phase loss in phase C, the LED will have a slow blink and then two fast blinks.

Contactor Problem

Parameter 257 Contactor Status can be used to determine why the PQconnect board is not closing the tuned circuit contactor. The follow tables 34-36 define what a specific contactor status code value means and list potential resolutions to allow the contactor to close.

Note that some setpoint parameters require tech level parameter access to be viewable over the serial connection or via the PQvision software. The tech level parameter access key is available above.

Table 34: Contactor Codes	Description	Resolution
1	Contactor is already commanded closed.	The PQconnect is presently commanding the tuned circuit contactor to be closed. If the contactor is not closing check the wiring from the PCB J11 control relay header to the tuned circuit contactor and 120VAC control power transformer.
2	Contactor is open due to a Force Open control mode.	The present contactor control mode (feedback parameter 250) is set to Force Open. This control mode will keep the contactor open at all times. To change the control mode see setpoint parameter 510.
3	Contactor is open due to an automatic load control mode and insufficient load Amps to close the contactor.	The present contactor control mode (feedback parameter 250) is set to Automatic Load Control and the measured filter load Amps are below the configured close threshold (feedback parameter 270). The contactor will be closed when the filter load Amps exceed the close threshold. The contactor close filter load current threshold can be adjusted via setpoint parameter 570. The contactor close threshold parameter is scaled in units of percent rated nameplate filter current.
4	Contactor is open due to an automatic kVAR control mode.	The present contactor control mode (feedback parameter 250) is set to Automatic kVAR Control and closing the contactor would exceed the max allowable kVAR flowing to the source to be exceeded (feedback parameter 272). The contactor will be closed when the inductive load kVAR minus the capacitive tuned circuit kVAR of the passive filter is below the max kVAR setpoint parameter. The max kVAR setpoint parameter can be adjusted via setpoint 572.
5	Contactor is open due to an external contactor open command.	The present contactor control mode (feedback parameter 250) is set to External Control and the external command is set to open the contactor. The external contactor control command is wired to the PQconnect PCB header J7 where shorting pins 1 and 2 of that header equal a close command. The internal state of the external control command can be audited via feedback parameter 320 in bit position 0. If an external contactor close command is correctly being input to the PQconnect board then confirm the J7 header input is configured as the external control command by verifying feedback parameter 321 is set to a value of 2=external command input. If the input configuration parameter 321 is not set to 2=external command input the input configuration can be changed via setpoint parameter 610.
6	Contactor is open because the PQconnect has been configured without a contactor.	The present contactor control mode (feedback parameter 250) is set to No Contactor Mode. No Contactor mode is typically reserved for HGP units that do not include a tuned circuit control contactor. If your HGP unit does include a tuned circuit contactor but the PQconnect is configured to not support a contactor please call TCI technical support.

Table 35: Contactor codes

Code	Description	Resolution
7	Contactor is open due status detection.	The contactor is open due to a filter, filter line, or filter load status detection being detected that is configured to open the tuned circuit contactor when detected. The PQconnect continuously monitors the internal conditions of the HGP passive filter and the external conditions of the filter line and load currents and voltages. Some status conditions, such as tuned circuit overcurrent, are configured to open the tuned circuit contactor when detected as a self-protection feature. The presently configured contactor open actions can be audited using feedback parameters 240-Filter A, 241-Filter B 242-Filter Line and 243 Filter Load. The set or clear status of these contactor open status detections can be viewed via feedback parameters 210-Filter A, 211-Filter B 212-Filter Line and 213 Filter Load. Also, the present value of all status detections and wither they are configured to open the tune circuit contactor when detected can be viewed via the PQvision software settings menu screen. To reset all status conditions and attempt to re-close the contactor the unit can be power cycled, a serial command can be sent over the network interface via setpoint parameter 502, or an external wired reset command can be input to the PQconnect PCB at header J8 where shorting pins 1 and 2 of that header equal a close command. The internal state of the external wired reset command can be audited via feedback parameter 320 in bit position 1. If an external reset command is correctly being input to the PQconnect board then confirm the J8 header input is configured as the external reset command by verifying feedback parameter 322 is set to a value of 1=external reset command input. If the input configuration parameter 322 is not set to 1=external reset command input the input configuration can be changed via setpoint parameter 611.
8	Contactor is open due to a parameter inhibit condition.	The contactor is open because the PQconnect is still loading stored parameters in flash memory. This condition should clear shortly after the unit is powered up. If this contactor status condition persists power cycle the unit and call TCI technical support if the condition does not clear.
9	Contactor is open due to a unit power on delay.	The contactor is open because the PQconnect is waiting for the configured power on delay time to expire. The power on delay time in units of seconds can be viewed via feedback parameter 281. The power on delay time can be adjusted via setpoint parameter 581.
10	Contactor is open due to a calibration inhibit.	The contactor is open because the unit is presently undergoing an internal calibration procedure, or no calibration data has been stored to the unit's flash memory. If this contactor status condition persists power cycle the unit and call TCI technical support if the condition does not clear.
11	Contactor is being held open due to the minimum reclose timer.	An internal contactor close event is pending but the contactor is being held open because it was recently closed, and the minimum reclose time has not been yet achieved. The minimum contactor re-close time in units of seconds is viewable via feedback parameter 285. This time out period allows any residual stored charge in the tune circuit capacitors to be dissipated by bleeder resistors before the tune circuit is re-energized. If a minimum time is not enforced between repeated contactor close events the contactor may re-close and apply line voltage out of phase with the residual voltage on the tuned circuit capacitors. This could cause high currents to flow through the tuned circuit contactor and potentially blow the contactor protective fuses. The remaining time on the minimum contactor re-close timer can be viewed on feedback parameter 286.
12	Contactor is being held open due to close delay timer.	An internal contactor close event is pending but the contactor is being held open because the configured contactor close delay time out period has not yet been achieved. The automatic contactor control modes (load current control and line kVAR control) are configured with contactor close and open delay timers to avoid changing the contactor state due to short transient conditions. The presently configured contactor close delay time in units of seconds is viewable via feedback parameter 274. The contactor close delay time can be adjusted via setpoint parameter 574
13	Contactor is being held open due to the auto reclose delay	An internal contactor automatic reclose event is pending but the contactor is being held open because the configured automatic re-close time has not been achieved yet. The PQconnect continuously monitors the internal conditions of the HGP passive filter and the external conditions of the filter line and load currents and voltages. Some status conditions are configured to open the tuned circuit contactor when detected as a self-protection feature. An optional feature can be enabled (feedback parameter 252) to attempt to re-close the tuned circuit contactor after a status condition has been detected. The auto reclose enable setpoint parameter is parameter 511 and the auto reclose delay time setpoint parameter is parameter 580.

Table 36: Contactor codes

Code	Description	Resolution
14	Contactor is being held open due to auto reclose limit being reached.	An internal contactor automatic reclose event is pending but the contactor is being held open because the number of re-close attempts in a set time period has been exceeded. The PQconnect continuously monitors the internal conditions of the HGP passive filter and the external conditions of the filter line and load currents and voltages. Some status conditions are configured to open the tuned circuit contactor when detected as a self-protection feature. An optional feature can be enabled (feedback parameter 252) to attempt to re-close the tuned circuit contactor after a status condition has been detected. However, if too many re-close attempts (parameter 282) are made within a set time period (parameter 283) the unit will stop attempting to auto reclose. To debug which status conditions caused the contactor open event the presently configured contactor open actions can be audited using feedback parameters 240-Filter A, 241-Filter B 242-Filter Line and 243 Filter Load. The set or clear status of these contactor open status detections can be viewed via feedback parameters 210-Filter A, 211-Filter B 212-Filter Line and 213 Filter Load. Also, the present value of all status detections and wither they are configured to open the tune circuit contactor when detected can be viewed via the PQvision software settings menu screen. When the auto re-close limit has been reached a power cycle of the passive filter unit is required to clear the condition and allow the contactor to re-close.

Warning 	Many electronic components located within the filter are sensitive to static electricity. Voltages imperceptible to human touch can reduce the life, affect performance and/or destroy sensitive electronic devices. Use proper electrostatic discharge (ESD) procedures when servicing the filter and its circuit boards.

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