MotorGuard

KMG High Performance Output Sine Wave Filter

Installation, Operation, and Maintenance Manual

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1.0 Safety Instructions

Overview

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

The MotorGuard is intended to be connected to the output terminals of a variable frequency drive (VFD). An AC motor is connected to the output terminals of the MotorGuard and receives power from the VFD through the MotorGuard. The instructions, and particularly the safety instructions, for the VFD, motor 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 caution readers about conditions, which can, if proper steps are not taken, lead to a serious fault condition, physical injury, or death.

Cautions are used to draw attention to instructions. Failure to properly follow such instructions may 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 marked with the following symbols:

Warning 	Dangerous Voltage Warning: warns of situations in which a high voltage can cause physical injury and/or equipment damage. 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 equipment damage 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 may 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 MotorGuard. 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 MotorGuard.
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 MotorGuard.
Warning 	The MotorGuard, VFD, motor, and other connected equipment must be properly grounded.
Warning 	The MotorGuard receives power from two or more sources. Three-phase power from the output terminals of the VFD is connected to the main input terminals of the MotorGuard. Power from a single-phase 120, 240 or 480 volt supply is connected to the MotorGuard for the cooling fan and PQconnect. The PQconnect alarm contacts may be connected to a circuit that receives power from another source. All of these sources of power must be disconnected before working on the MotorGuard.
Warning 	After switching off the power, always allow 5 minutes for the capacitors in the MotorGuard and in the VFD to discharge before working on the MotorGuard, the VFD, the motor, or connecting wiring. It is good practice 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.
Warning 	The VFD output terminals and the motor cables are at a dangerously high voltage when power is applied to the VFD regardless of motor operation.

2.0 Introduction

Thank you for selecting the KMG MotorGuard High Performance Output Filter. TCI has produced this filter for use in many PWM variable frequency drive (VFD) applications that require low distortion sine wave output power. This manual describes how to install, operate, and maintain the MotorGuard filter.

Intended Audience

This manual is intended for use by all personnel responsible for the installation, operation, and maintenance of the MotorGuard. 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 MotorGuard filter. More specific information is provided by the drawings shipped with the unit. Be sure to carefully review the information provided by these drawings. Information provided by the drawings shipped with the unit takes precedence over the information provided in this manual.

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 Electric Code (NEC) and/or other applicable electrical codes.
- Connect the MotorGuard equipment grounding lug to the system ground of the premises wiring system. Use a properly sized grounding conductor.
- Wire the output power terminals of the VFD, T1(U), T2(V), & T3(W) to the input terminals of the MotorGuard, U, V, & W.
- Wire the output power terminals, of the MotorGuard, T1, T2, & T3 to the motor.
- Connect control power to the MotorGuard.
- For PQconnect option: Connect the MotorGuard fault relay contact to the appropriate fault monitoring circuit.
- Make sure that the VFD is set for operating modes and ranges that are compatible with the MotorGuard.
- Check everything thoroughly before operating the equipment.

3.0 Receiving Inspection and Storage

Receiving Inspection

The MotorGuard 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.

Warranty Information

TCI, LLC ("TCI") warrants to the original purchaser only that MotorGuard 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 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:

- altered or repaired by anyone other than TCI;
- applied or used for situations other than those originally specified; or
- 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, 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 MotorGuard is to be stored before use, be sure that it is stored in a location that conforms to published storage humidity and temperature specifications stated in this manual. Store the unit in its original packaging.

4.0 Product Description

MotorGuard Sine Wave Filter

The MotorGuard is a low-pass sine wave filter designed and developed by TCI to deliver conditioned power to motor loads driven by PWM drives at a variety of lead lengths. The MotorGuard is available for 460/480 volt and 575/600 volt systems.

The MotorGuard is a passive filter connected in series with the output terminals of the variable frequency drive. It is designed to remove the carrier frequency distortion from the output voltage waveform. The use of this low-pass, L-R-C device will result in a nearly pure sine wave voltage profile. This design will reduce the effects of the reflected wave phenomenon, (dv/dt), such as insulation damage or premature failure in motors, transformers and VFD output cables. The MotorGuard will also reduce the effects of stray high frequency harmonic currents, thereby reducing VFD ground fault problems and noise interference in transducer signals.

The MotorGuard is available in two package configurations: Industrial and GP. The Industrial filter is a stand-alone device that can be furnished in its own enclosure and mounted adjacent to the VFD, and is also available on an open panel for mounting within an enclosure provided with the VFD or other equipment. The GP filter is furnished in its own enclosure and mounted adjacent to the VFD.

The MotorGuard is suitable for all lead lengths extending as far as 15,000 feet.

The MotorGuard consists of the following standard features and components:

- An R-L-C power filter circuit with:
  - A TCI 3-phase reactor specifically designed for the MotorGuard
  - Power resistors
  - High-endurance, harmonic-rated capacitors
- Bleeder resistors to ensure safe capacitor discharge upon filter shutdown.
- Compression terminals for ease and integrity of all power wiring.
- Cooling fans to ensure adequate cooling and safe operating temperatures.

Optional PQconnect:

- PQconnect provides unit status detection, metering, waveforms and power quality data. The PQconnect data is made available via basic Modbus RTU over RS485 serial connection.

Nameplate Data

Figure 1 shows an example of a MotorGuard nameplate. The following information is marked on the nameplate:

- Part number: encoded model number explained on the following page
- FLA: the rated continuous operating current (RMS amps)
- System Voltage: the maximum VFD output voltage (fundamental)
- Hz: the maximum VFD output frequency (fundamental)
- Phase: 3 – The MotorGuard is designed for use only with 3 phase motors.
- Drawing #: outline and mounting dimension of filter
- Schematic #: schematic diagram of filter
- Manufacturing #: for TCI internal use
- Enclosure Type: Industrial filters are open panel construction or NEMA 1 enclosed. GP filters are NEMA 1 or NEMA 3R enclosed.

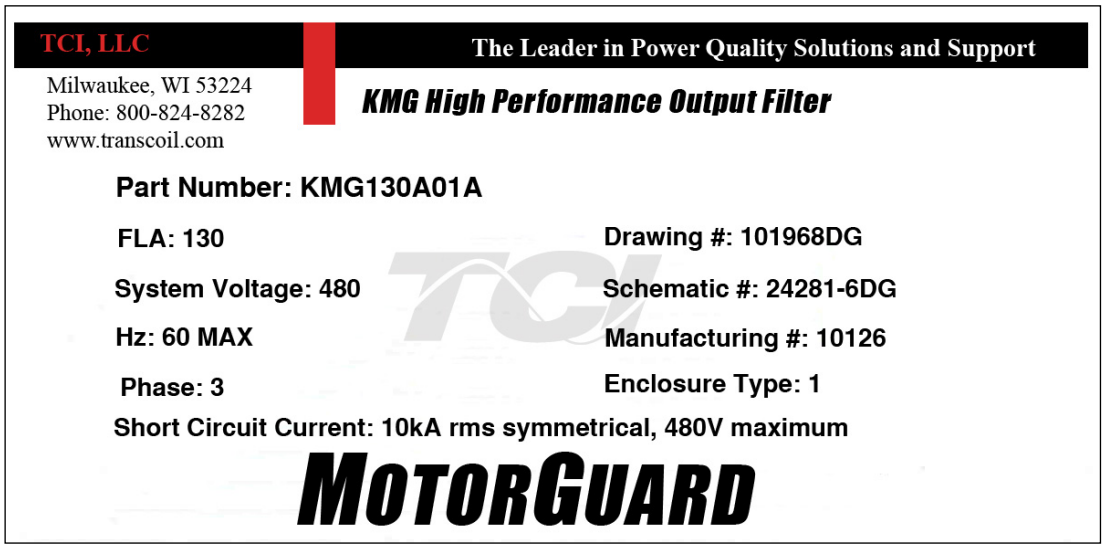


Figure 1: Example of MotorGuard Nameplate

Model Number Encoding

Figures 2 and 3 dentify the significance of each character in the MotorGuard model number. The example model number, KMG130A01A designates an Industrial MotorGuard that is rated 130 amps, 480 volts, and is furnished in a NEMA 1 enclosure.

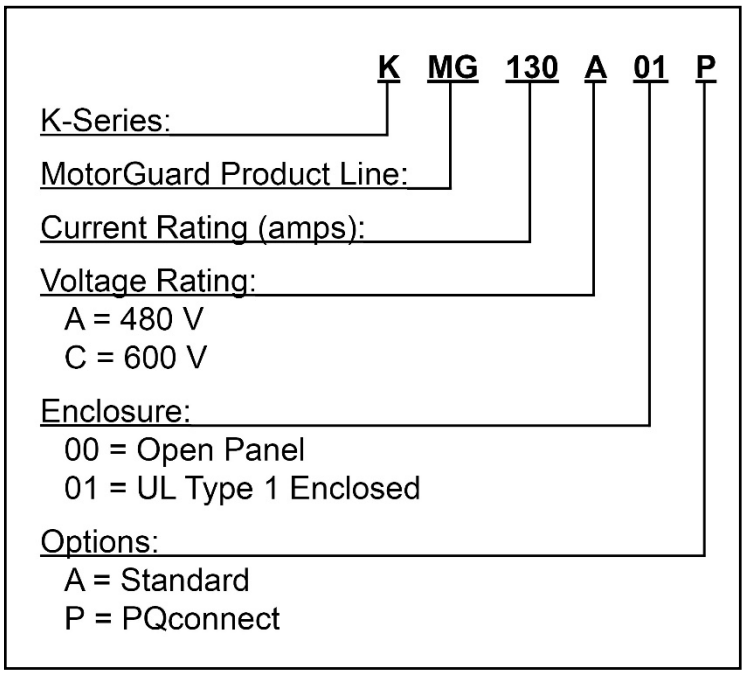


Figure 2: MotorGuard Model Number Encoding – Industrial Version

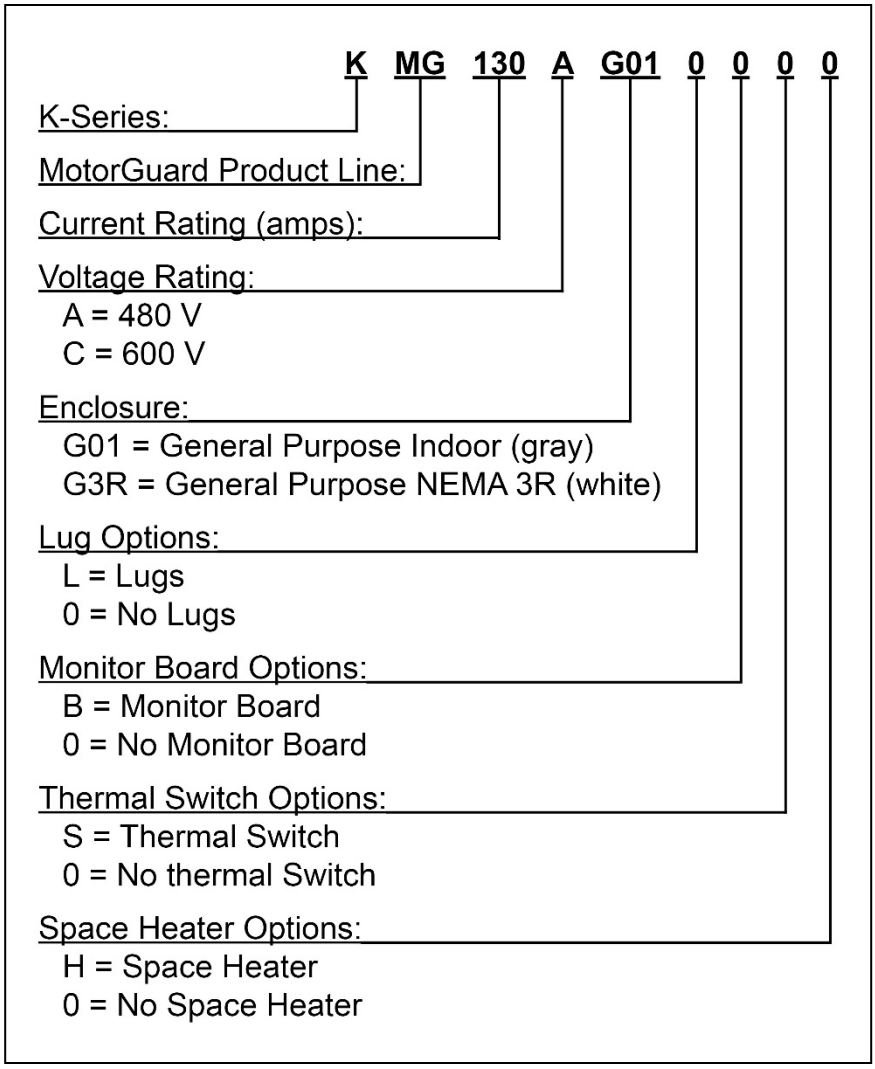


Figure 3: MotorGuard Model Number Encoding – General Purpose Version

The MotorGuard has a current rating rather than a horsepower rating. The rating and dimension tables in the following section list the nominal horsepower ratings corresponding to the current ratings of the standard models.

Standard Product Ratings and Dimension Tables

The following tables list the ratings and dimensions of the standard MotorGuard models:

- Table 1 lists 480 Volt models on open panels.
- Table 2 lists 480 Volt models in NEMA 1 enclosures.
- Table 3 lists 600 Volt models on open panels.
- Table 4 lists 600 Volt models in NEMA 1 enclosures.
- Table 5 lists 480 Volt models in NEMA 1 enclosures.
- Table 6 lists 480 Volt models in NEMA 3R enclosures.
- Table 7 lists 600 Volt models in NEMA 1 enclosures.
- Table 8 lists 600 Volt models in NEMA 3R enclosures.

Table 1: Industrial 480 Volt Models on Open Panels

Model Number	Nominal Horsepower	Current Rating (amps)	Heat Loss (Watts)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG8A00A	5	8	300	60	30.75	17.00	11.75
KMG12A00A	7.5	12	350	60			
KMG16A00A	10	16	400	70			
KMG23A00A	15	23	550	75			
KMG30A00A	20	30	650	85			
KMG35A00A	25	35	750	85			
KMG45A00A	30	45	850	100			
KMG55A00A	40	55	1000	115			
KMG65A00A	50	65	1100	160	56.00	17.00	11.75
KMG80A00A	60	80	1550	175			
KMG110A00A	75	110	1700	195			
KMG130A00A	100	130	2050	200			
KMG160A00A	125	160	2450	250			
KMG200A00A	150	200	3300	255			
KMG250A00A	200	250	3700	445	60.00	32.00	14.75
KMG305A00A	250	305	4700	460			
KMG362A00A	300	362	4650	475			
KMG420A00A	350	420	5400	580	60.00	32.00	16.38
KMG480A00A	400	480	6050	635			
KMG600A00A	500	600	7350	645			
KMG750A00A	600	750	8800	760	60.00	32.00	17.75

Table 2: Industrial 480 Volt Models in NEMA 1 Enclosures

Model Number	Nominal Horsepower	Current Rating (amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG8A01A	5	8	110	31.38 Wall Mounted	17.50	12.14
KMG12A01A	7.5	12	110			
KMG16A01A	10	16	120			
KMG23A01A	15	23	125			
KMG30A01A	20	30	140			
KMG35A01A	25	35	140			
KMG45A01A	30	45	155			
KMG55A01A	40	55	170			
KMG65A01A	50	65	245	56.00 Wall Mounted	17.52	16.40
KMG80A01A	60	80	260			
KMG110A01A	75	110	280			
KMG130A01A	100	130	300			
KMG160A01A	125	160	340			
KMG200A01A	150	200	345			
KMG250A01A	200	250	770	76.50 Free Standing	36.00	24.00
KMG305A01A	250	305	790			
KMG362A01A	300	362	800			
KMG420A01A	350	420	915			
KMG480A01A	400	480	970			
KMG600A01A	500	600	975			
KMG750A01A	600	750	1085			

Table 3: Industrial 600 Volt Models on Open Panels

Model Number	Nominal Horsepower	Current Rating (Amps)	Heat Loss (Watts)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG8C00A	5	8	400	60	30.75	17.00	11.75
KMG10C00A	7.5	10	400	65			
KMG12C00A	10	12	400	70			
KMG20C00A	15	20	550	75			
KMG25C00A	20	25	700	85			
KMG28C00A	25	28	750	90			
KMG35C00A	30	35	800	100			
KMG45C00A	40	45	950	115			
KMG55C00A	50	55	1200	160	56.00	17.00	11.75
KMG65C00A	60	65	1600	175			
KMG80C00A	75	80	1650	195			
KMG110C00A	100	110	2250	225			
KMG130C00A	125	130	2300	250			
KMG160C00A	150	160	2500	260	56.00	17.00	14.78
KMG200C00A	200	200	3500	450	60.00	32.00	14.75
KMG250C00A	250	250	4500	460			
KMG305C00A	300	305	5100	475			
KMG362C00A	350	362	6100	580			
KMG420C00A	400	420	6900	635			
KMG500C00A	500	500	7900	645	60.00	32.00	16.00
KMG600C00A	600	600	9000	750			

Table 4: Industrial 600 Volt Models in NEMA 1 Enclosures

Model Number	Nominal Horsepower	Current Rating (Amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG8C01A	5	8	115	31.38 Wall Mounted	17.50	12.14
KMG10C01A	7.5	10	115			
KMG12C01A	10	12	120			
KMG20C01A	15	20	135			
KMG25C01A	20	25	140			
KMG28C01A	25	28	145			
KMG35C01A	30	35	155			
KMG45C01A	40	45	175			
KMG55C01A	50	55	260	56.00 Wall Mounted	17.52	16.40
KMG65C01A	60	65	265			
KMG80C01A	75	80	265			
KMG110C01A	100	110	290			
KMG130C01A	125	130	295			
KMG160C01A	150	160	340			
KMG200C01A	200	200	770	76.50 Free Standing	36.00	24.00
KMG250C01A	250	250	775			
KMG305C01A	300	305	790			
KMG362C01A	350	362	975			
KMG420C01A	400	420	975			
KMG500C01A	500	500	1015			
KMG600C01A	600	600	1015			

Table 5: General Purpose 480 Volt Models in NEMA 1 Enclosures

Model Number	Nominal Horsepower	Current Rating (Amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG55AG010000	40	55	209	36.50	18.67	29.50
KMG65AG010000	50	65	215			
KMG80AG010000	60	80	235			
KMG110AG010000	75	110	220			
KMG130AG010000	100	130	225			
KMG160AG010000	125	160	250			
KMG200AG010000	150	200	260			
KMG250AG010000	200	250	595	64.00	24.17	42.00
KMG305AG010000	250	305	625			
KMG362AG010000	300	362	630			
KMG420AG010000	350	420	635			
KMG480AG010000	400	480	635			
KMG600AG010000	500	600	755			

Table 6: General Purpose 480 Volt Models in NEMA 3R Enclosures

Model Number	Nominal Horsepower	Current Rating (Amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG55AG3R0000	40	55	209	36.50	18.67	29.50
KMG65AG3R0000	50	65	215			
KMG80AG3R0000	60	80	235			
KMG110AG3R0000	75	110	220			
KMG130AG3R0000	100	130	225			
KMG160AG3R0000	125	160	250			
KMG200AG3R0000	150	200	260			
KMG250AG3R0000	200	250	595	64.00	24.17	42.00
KMG305AG3R0000	250	305	625			
KMG362AG3R0000	300	362	630			
KMG420AG3R0000	350	420	635			
KMG480AG3R0000	400	480	635			
KMG600AG3R0000	500	600	755			

Table 7: General Purpose 600 Volt Models in NEMA 1 Enclosures

Model Number	Nominal Horsepower	Current Rating (Amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG45CG010000	40	45	209	36.50	18.67	29.50
KMG55CG010000	50	55	235			
KMG65CG010000	60	65	235			
KMG80CG010000	75	80	266			
KMG110CG010000	100	110	275			
KMG130CG010000	125	130	280			
KMG160CG010000	150	160	290			
KMG200CG010000	200	200	570	64.00	24.17	42.00
KMG250CG010000	250	250	615			
KMG305CG010000	300	305	620			
KMG362CG010000	350	362	650			
KMG420CG010000	400	420	675			
KMG500CG010000	500	500	810			
KMG600CG010000	600	600				

Table 8: General Purpose 600 Volt Models in NEMA 3R Enclosures

Model Number	Nominal Horsepower	Current Rating (Amps)	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
KMG45CG3R0000	40	45	209	36.50	18.67	29.50
KMG55CG3R0000	50	55	235			
KMG65CG3R0000	60	65	235			
KMG80CG3R0000	75	80	266			
KMG110CG3R0000	100	110	275			
KMG130CG3R0000	125	130	280			
KMG160CG3R0000	150	160	290			
KMG200CG3R0000	200	200	570	64.00	24.17	42.00
KMG250CG3R0000	250	250	615			
KMG305CG3R0000	300	305	620			
KMG362CG3R0000	350	362	650			
KMG420CG3R0000	400	420	675			
KMG500CG3R0000	500	500	810			
KMG600CG3R0000	600	600				

Product Technical Specifications

Tables 9 and 10 list the major technical specifications for the MotorGuard product line.

Table 9: MotorGuard Technical Specifications – Industrial

Current ratings	Continuous current: 8 to 750 amps. See Rating and Dimension tables Intermittent current: 150% for 1 minute out of every 60 minutes
VFD Drive output voltage	460/480 and 575/600 V, 3 ph, at fundamental base frequency
VFD Drive output frequency	0 to 80 Hz
VFD Drive carrier frequency	2 kHz and 16 kHz, ideally 4 kHz to 8 kHz
Control power input	For fan operation.
Filter performance	Maximum peak voltage of output waveform – 480 V models: 1000 V – 600 V models: 1500 V Maximum dV/dt of output waveform – 480 V models: 500 V/µs – 600 V models: 1500 V/µs
Maximum elevation	3,300 feet (1,000 meters) as standard. Product must be equipped with special cooling provisions for operation above this level
Maximum ambient operating temperature	40 °C (104 °F) as standard. Product must be equipped with special cooling provisions for operation above this temperature.
Maximum ambient storage temperature	50 °C (122 °F)
Maximum humidity, operating or storage	95%, non-condensing.
Enclosure options	Open panel for mounting in an enclosure furnished by others NEMA 1 enclosure
Enclosure finish	Free standing enclosures: ANSI 61 gray Wall mount enclosures: White Matte (beige) Munsel 5.8Y7.83/1
Agency approvals or certifications	UL and cUL Listed to UL508A and CSA-C22.2 No. 14
Insertion impedance	Approximately 6.5% at 60 Hz & full load current
Fusing and protection:	Unit has internal fuse protection and a performance monitoring circuit.
Capacitors	Oil filled high endurance design (no PCBs)

Table 10: MotorGuard Technical Specifications – General Purpose

Current ratings	Continuous current: 55 to 600 amps. See Rating and Dimension tables Intermittent current: 150% for 1 minute out of every 60 minutes
VFD Drive output voltage	460/480 and 575/600 V, 3 ph, at fundamental base frequency
VFD Drive output frequency	0 to 80 Hz
VFD Drive carrier frequency	2 kHz and 16 kHz, Ideally 4 kHz to 8 kHz
Control power input	For fan operation.
Filter performance	Maximum peak voltage of output waveform – 480 V models: 815 V – 600 V models: 1,018 V Maximum dV/dt of output waveform – 480 V models: 5 V/µs – 600 V models: 6 V/µs
Maximum elevation	3,000 feet (1,000 meters) as standard. Product must be equipped with special cooling provisions for operation above this level
Maximum ambient operating temperature	40 °C (104 °F) as standard. Product must be equipped with special cooling provisions for operation above this temperature.
Maximum ambient storage temperature	50 °C (122 °F)
Maximum humidity, operating or storage	95%, non-condensing.
Enclosure options	General Purpose 3R enclosure
Insertion impedance	Approximately 6.5% at 60 Hz & full load current
Capacitors	Oil filled high endurance design (no PCBs)

5.0 Pre-installation Planning

Verify the Application

MotorGuard Ratings

Make sure that the MotorGuard is correct for the application. The voltage and current ratings of the MotorGuard must match the output voltage and current ratings of the connected variable frequency drive as it is configured for use with the connected motor.

Variable Frequency Drive Settings

Make sure that the variable frequency drive will be set for operation modes and ranges that are compatible with the MotorGuard:

- Maximum output frequency: 80 Hz
- PWM switching frequency between 2 kHz and 16 kHz, ideally 4 kHz to 8 kHz
- Mode of operation: "scalar" or "V/Hz" without DC braking unless the drive application has been confirmed by TCI Technical Support

Select a Suitable Location

Environment

Locating the MotorGuard in a suitable environment will help ensure proper performance and a normal operating life.

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.

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

- Corrosive liquids or gasses
- Explosive or combustible gases or dust
- Excessive airborne dirt and dust
- Excessive vibration

In addition to the above, products that are not in a 3R enclosure should not be exposed to:

- Direct sunlight
- Rain or excessive dripping liquids

Mounting Area

Select a mounting area that will allow sufficient cooling air to flow through the unit. Adequate space should be provided to allow access for maintenance.

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 that is dissipated by the MotorGuard. The maximum temperature of the air around the MotorGuard's capacitors and PQconnect should not exceed 50 °C (104 °F).

Power Wiring

The conduit and wiring from the output of the variable frequency drive to the motor must be routed to the MotorGuard and then to the motor. When selecting a mounting location for the MotorGuard, plan for the routing of the power wiring.

Control Wiring (for units with PQconnect)

The MotorGuard requires 120 VAC single-phase power for the PQconnect and cooling fan. The control power source must be ensured to be energized whenever the variable frequency drive is operating. A control power transformer is provided in the MotorGuard to allow control power to be obtained from the three-phase source that provides input power to the VFD. Fuses are provided on the control transformer, but the wires connecting control power to the MotorGuard will need to be appropriately protected at the power source.

Refer to the drawings furnished with your MotorGuard to determine the control power VA required.

Optional Features

Additional wiring requirements may apply to MotorGuard units that are equipped with certain optional features such as a space heater or 120 VAC control power supplied directly rather than through a control power transformer. For instructions covering these additional requirements, refer to drawings and/or other supplemental information furnished with the unit.

6.0 Installation Guidelines

Mounting

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

Wiring

Cable Entry Locations

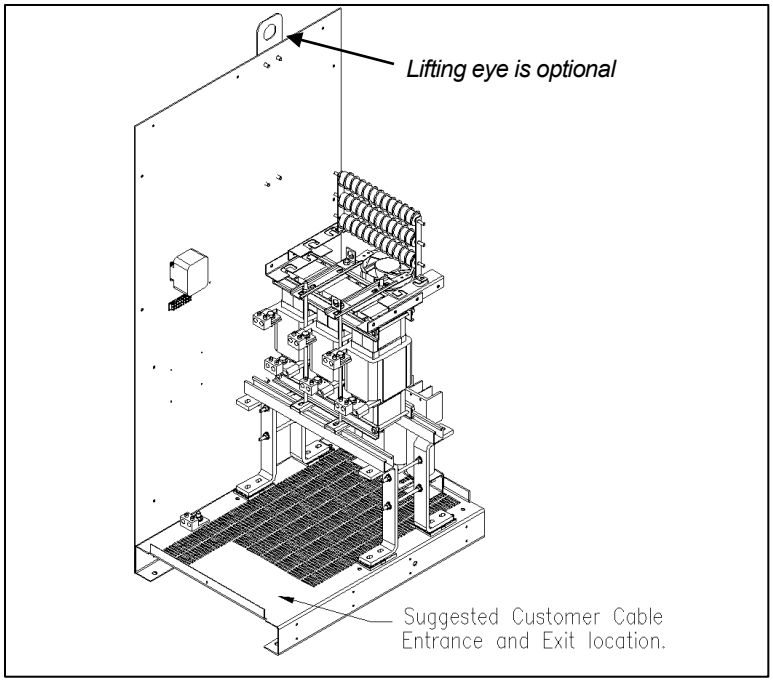


Figure 4: Cable Entry Location for General Purpose units

Field Wiring Connection Terminals

Compression type terminals may be provided for all field wiring connections. The control circuit terminals will accommodate 18 AWG to 10 AWG wire and should be tightened to 18 in.-lbs. torque. The wire size capacity ranges and tightening torque for the grounding and power terminals are listed in the following tables.

Table 11: Motor Power Terminal Wire Size Capacity Range and Tightening Torque (Cu or Al) - Industrial

KMG IND Model Numbers	Ground Lug		Input and Output Motor Power	
	Wire Size	Torque (in.-lb.)	Wire Size	Torque (in.-lb.)
KMG8A to KMG55A KMG8C to KMG45C	14 - 1/0 AWG	200	22 - 16 AWG 14 - 6 AWG 4 - 2 AWG and 1 AWG (7 & 19 strand only)	25 30 35
KMG65A to KMG130A KMG55C to KMG130C	6 - 2/0 AWG	120	6 - 2/0 AWG	120
KMG160A to KMG200A KMG160C to KMG200C	6 AWG - 250 MCM	275	6 AWG - 250 MCM	275
KMG250A to KMG305A KMG250C to KMG305C	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500
KMG362A KMG362C to KMG420C	(2) 4 AWG - 350 MCM	275	(2) 4 AWG - 350 MCM	275
KMG420A to KMG600A KMG500C to KMG600C	(2) 2 AWG - 600 MCM	500	(2) 2 AWG - 600 MCM	500
KMG750A	(3) 2 AWG - 600 MCM	375	(3) 2 AWG - 600 MCM	375

Table 12: Motor Power Terminal Wire Size Capacity Range and Tightening Torque (Cu or Al) – General Purpose

KMG GP Model Numbers	Ground Lug		Input and Output Motor Power	
	Wire Size	Torque (in.-lb.)	Wire Size	Torque (in.-lb.)
KMG55A KMG45C	14 - 1/0 AWG	200	22 - 16 AWG 14 - 6 AWG 4 - 2 AWG and 1 AWG (7 & 19 strand only)	25 30 35
KMG65A to KMG130A KMG55C to KMG130C	6 - 2/0 AWG	120	6 - 2/0 AWG	120
KMG160A to KMG200A KMG160C to KMG200C	6 AWG - 250 MCM	275	6 AWG - 250 MCM	275
KMG250A to KMG305A KMG250C to KMG305C	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500
KMG362A KMG362C to KMG420C	(2) 4 AWG - 350 MCM	275	(2) 4 AWG - 350 MCM	275
KMG420A to KMG600A KMG500C to KMG600C	(2) 2 AWG - 600 MCM	500	(2) 2 AWG - 600 MCM	500

Connection Diagram

Figure 5 shows the typical wiring connections between the MotorGuard and the VFD and motor. Note that separate conduits may be required for the control power and fault contact wiring. Refer to the instructions for the VFD or other equipment to which the fault contact is connected.

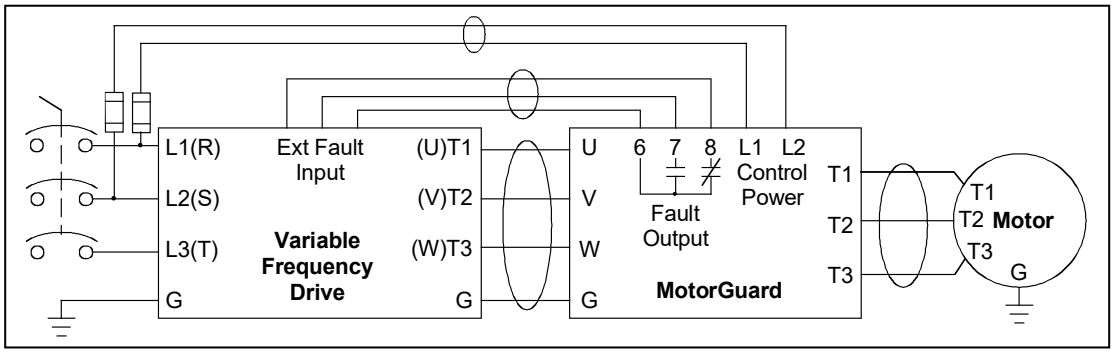


Figure 5: Typical Connection Diagram

Grounding

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

Power Wiring

Connect the output of the VFD, terminals T1(U), T2(V), & T3(W), to the input of the MotorGuard, terminals U, V, & W. Connect the motor to the output of the MotorGuard, terminals T1, T2, & T3.

Caution ⚠	Use wire that is appropriate for the voltage and current rating of the motor. For units rated less than 100 amps, use copper or aluminum wire with an insulation temperature rating of 60 °C or higher. For units rated 100 amps or more, use copper or aluminum wire with an insulation temperature rating of 75 °C or higher. The wire size and the voltage ratings must conform to the requirements of the National Electrical Code and/or other applicable electrical codes. Be sure to also follow the motor wiring instructions provided in the instruction manual for the VFD.

Control Wiring (for units with PQconnect)

Connect control power to the MotorGuard. Be sure to provide fuses or other appropriate protection for the control power wiring. Make sure that the voltage and VA capacity of the control power source matches the MotorGuard's control power input ratings. Refer to the drawings shipped with the unit.

Connect the MotorGuard PQconnect fault output relay contacts to the appropriate fault monitoring circuit. It may be connected to the VFD or to some supervisory control or alarm annunciation equipment.

Fuses

The table below lists the specifications for the LC power circuit fuses in the MotorGuard.

Table 13: RC Power Circuit Fuses for Industrial Model

480 V Models			600 V Models		
MotorGuard Rating (Amps)	Power Circuit Fuse Rating		MotorGuard Rating (Amps)	Power Circuit Fuse Rating	
	Amps	Type		Amps	Type
8	2	Class CC Bussmann type KLD-R or equivalent	8	2	Class CC Bussmann type KLD-R or equivalent
12	2.5		10	2	
16	4		12	2.5	
23	6		20	5	
30	8		25	6	
35	9		28	7	
45	12		35	9	
55	15		45	12	
65	20		55	15	
80	20		65	20	
110	30	Class T Bussmann type JJS or equivalent	80	25	
130	35		110	30	Class T Bussmann type JJS or equivalent
160	40		130	35	
200	50		160	40	
250	70		200	50	
305	80		250	70	
362	90		305	80	
420	110		362	90	
480	125		420	110	
600	150		500	125	
750	200		600	150	

Control Circuit Fuses

Refer to the drawings furnished with your MotorGuard for control circuit fuse specifications.

7.0 MotorGuard Operation

Variable Frequency Drive Settings

Make sure that the variable frequency drive is set for operation modes and ranges that are compatible with the MotorGuard:

- Maximum output frequency: 80 Hz
- PWM switching frequency between 2 kHz and 16 kHz, ideally 4 kHz to 8 kHz. Since the MotorGuard removes most of the harmonic content from the output waveform, quiet motor operation should be achieved with a switching frequency setting within this range.
- Mode of operation: "scalar" or "V/Hz" without DC braking unless the drive applications has been confirmed by TCI Technical Support

Start Up (Commissioning)

Caution 	Thoroughly check the installation before applying power and operating the equipment for the first time.
Caution 	Never Operate the MotorGuard without a load connected to its output terminals.

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.

Before Operating the VFD for the First Time

- Make sure that the MotorGuard monitor board configuration switches are properly set as described above.
- Make sure that the variable frequency drive is set for operation modes and ranges that are compatible with the MotorGuard as described above.

Operation

Since the MotorGuard is a passive filter, it is always operating whenever the variable frequency drive is operating. Whenever the VFD is operating, control power should be applied to the MotorGuard so that the MotorGuard's cooling fan will operate and prevent it from overheating. Control power is also required for the PQconnect.

8.0 Maintenance and Service

MotorGuard Reliability and Service Life

The MotorGuard has been designed to provide a service life that equals or exceeds the life of the variable frequency drive. It has been thoroughly tested at the factory to ensure that it will perform reliably from the moment it is put into service. The following periodic maintenance is recommended to ensure that the MotorGuard will always perform reliably and provide the expected service life.

Periodic Maintenance

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

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.

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

Check the integrity of all power, ground, and control wiring connections.

All electrical connections must be re-torqued annually.

For Units with PQconnect:

Check the status indicating lights on the monitor board as shown below.

Check the operation of the cooling fan.

Troubleshooting

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

9.0 PQconnect

Product Description

The PQconnect is an integrated controls option for TCI's industry sinewave filter used for filtering the output of variable frequency motor drives (VFDs). In the sinewave filter, the PQconnect provides unit status detection, metering, voltage waveform 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.

Modbus RTU

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.

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.

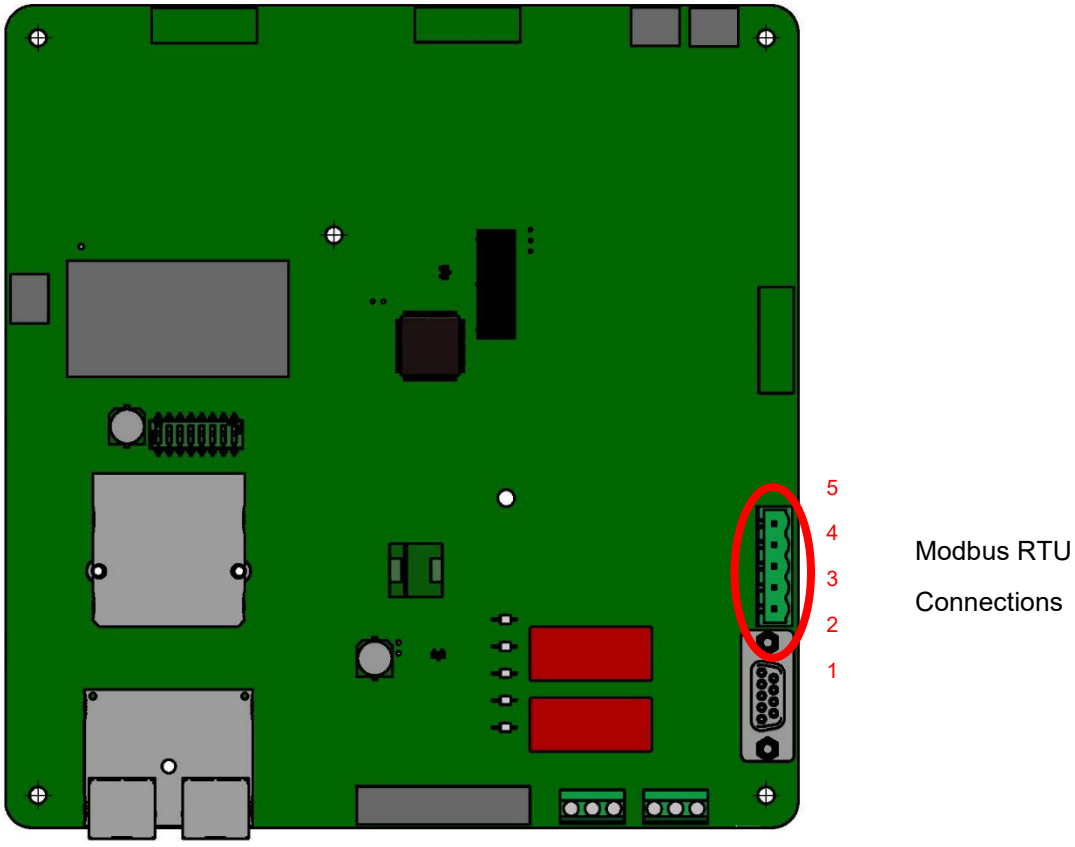


Figure 6: PQconnect Modbus RTU Connection

Modbus RTU Connections

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

Table 14: Modbus Connector Pin Definitions

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

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

Table 15: Modbus RTU Protocol Settings

Parameter	Value	Units
Baud Rate	38400	Bd
Data Bits	8	Bits
Stop Bits	1	Bits
Parity	Even	-
Slave ID	10	-

Table 16: Configuration Switches

SW1	Configure Modbus Connection on J5 Header	1 – Enable 560Ω bias resistor on D-.
		2 – Enable 120Ω termination resistor.
		3 - Enable 560Ω pull-up on D+.

The input and output registers from the HarmonicGuard® Passive filter are mapped to the Modbus Analog Output Holding Registers starting at address 40000. See **Tables 14-16** for definitions of the input register maps and **Tables 8-12** for output register maps. All input and output registers are two bytes in size and formatted as 16-bit signed integers.

Table 17: Network Interface OUTPUT/ Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
SYS_STATE	11	Output	0,1 = Initialization 2 = Power on Delay 3 = Fault Inhibit 4 = Reset 5 = Nominal 6 = Fault Detected 7 = Calibrate offsets 8 = Calibrate Check	Indicates the present state of the system state machine.
DSP_SW_VER	12	Output	Two 8bit ASCII Characters 0x0141 = ASCII for "A1"	Software revision code for processor.
DSP_MODEL_NUM	13	Output	103 = 480 V	System Model Number
V_OUT_A_RMS	30	Output	Volts RMS 4800 = 480.0 VRMSLL Range: 120 to 690 VRMSLL	Filter output RMS voltage phase A
V_OUT_B_RMS	31	Output		Filter output RMS voltage phase B
V_OUT_C_RMS	32	Output		Filter output RMS voltage phase C
V_OUT_A_THD	45	Output	% THVD 50 = 5.0% THVD	Filter output Phase A THVD (Voltage Total Harmonic Distortion)
V_OUT_B_THD	46	Output		Filter output Phase B THVD (Voltage Total Harmonic Distortion)
V_OUT_C_THD	47	Output		Filter output Phase C THVD (Voltage Total Harmonic Distortion)
T_BOARD	48	Output	250 = 25.0 C°	PCB temperature
V_OUT_FUND_HZ	100	Output	Range 1 to 500 Hz	Filter output fundamental frequency
V_IN_CARRIER_HZ	101	Output	Range 1kHz to 16 kHz	Filter input carrier frequency

Table 18: Network Interface OUTPUT/ Feedback Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
FAULT_A	200	Output	0 = Disabled To Enable desired fault detections, enter bit mask from table by converting to decimal Range: 0 to 65535	Example: Enabling all fault conditions is 1111 1111 1111 1111 in binary or 65535 decimal. Reference Fault codes Table Read only value.
FAULT_B	201	Output		
FAULT_A_ENABLE_RO	202	Output		If a fault is active and the bit corresponding to that status in this mask is set, the relay will be activated. Reference Fault codes Table Read only values. To change these values, modify the corresponding register in the setpoint section below.
FAULT_B_ENABLE_RO	203	Output		
FAULT_A_RELAY_ACTION_RO	204	Output		
FAULT_B_RELAY_ACTION_RO	205	Output		
SYS_POWER	250	Output	0 = Power Off 1 = Power On	Indicates if the filter has input power available Read only value.
SYS_FAULTED	251	Output	0 = Filter is operating 1 = Filter has detected a fault condition	Indicates filter has faulted. Read only value.
RATED_VOLTAGE_RO	260	Output	4800 = 480.0Vrms Range = 1200 to 6900	Filter rated voltage. Read only value.
RATED_FEQUENCY_RO	262	Output	60 = 60 Hz	Filter rated frequency Read only value.
MB_SLAVE_ADDRESS_RO	300	Output	10	Modbus slave address Read only value.
MB_BAUD_RATE_RO	301	Output	3840 = 38400 baud rate	Modbus baud rate Read only value.

Table 19: **Network Interface OUTPUT / Feedback Register Map**

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
MB_PARITY_RO	302	Output	2 = Even	Modbus Parity Read only value.
RELAY_CLOSE_DELAY_RO	320	Output	Relay close delay time in milliseconds Range 0 to 60 seconds	Delay time on fault relay being energized when any enabled fault condition is detected. This delay is in addition to any configured delay for a specific fault condition. Read only value. To change this value, modify the corresponding register in the setpoint section below.
RELAY_OPEN_DELAY_RO	321	Output	Relay open delay time in milliseconds Range 0 to 60 seconds	Delay time on fault relay being unenergized when all enabled fault detection conditions have cleared. Read only value. To change this value, modify the corresponding register in the setpoint section below.
OVERVOLTAGE_FAULT_ONSET_RO	322	Output	Default 125% Range 100 to 200	Overvoltage onset threshold in percent rated voltage. Example: if filter is rated for 480 V then it will fault on. Read only value. To change this value, modify the corresponding register in the setpoint section below.
OVERVOLTAGE_FAULT_CLEAR_RO	323	Output		Overvoltage fault clear threshold Read only value. To change this value, modify the corresponding register in the setpoint section below.
OVERVOLTAGE_FAULT_DELAY_RO	324	Output	Fault detection delay time in milliseconds. Default of 6 seconds. Range 0.02 to 60 seconds	Overvoltage fault delay time. Read only value. To change this value, modify the corresponding register in the setpoint section below.
HIGH_FREQUENCY_FAULT_ONSET_RO	325	Output	Default 125% Range 100 to 200	Filter output high frequency fault onset threshold. Example: Frequency higher than 125% of 500 Hz will trigger the fault. Read only value. To change this value, modify the corresponding register in the setpoint section below.
HIGH_FREQUENCY_FAULT_CLEAR_RO	326	Output		High frequency fault clear threshold Read only value. To change this value, modify the corresponding register in the setpoint section below.
HIGH_FREQUENCY_FAULT_DELAY_RO	327	Output	Fault detection delay time in milliseconds. Default of 6 seconds. Range 0.02 to 60 seconds	High frequency fault delay time. Read only value. To change this value, modify the corresponding register in the setpoint section below.

Table 20: Network Interface OUTPUT Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
PHASE_LOSS_FAULT_ONSET_RO	328	Output	Default = 60 = 60% Range 1 to 100	Phase loss fault onset threshold (average of the three filter output voltages) Read only value. To change this value, modify the corresponding register in the setpoint section below.
PHASE_LOSS_FAULT_CLEAR_RO	329	Output	Default = 55 = 55% Range 1 to 100	Phase loss fault clear threshold (average of the three filter output voltages) Read only value. To change this value, modify the corresponding register in the setpoint section below.
PHASE_LOSS_FAULT_DELAY_RO	330	Output	Fault detection delay time in milliseconds. Default of 12 seconds. Range 0.02 to 60 seconds	Phase loss fault delay time. Read only value. To change this value, modify the corresponding register in the setpoint section below.
THD_FAULT_ONSET_RO	331	Output	Default of 120 = 12.0% THD Range 2 to 100	Filter output high THVD fault onset threshold. Read only value. To change this value, modify the corresponding register in the setpoint section below.
THD_FAULT_CLEAR_RO	332	Output		THVD fault clear threshold Read only value. To change this value, modify the corresponding register in the setpoint section below.
THD_FAULT_DELAY_RO	333	Output	Fault detection delay time in milliseconds. **Default of 12** seconds. Range 0.02 to 60 seconds	Voltage Total Harmonic Distortion (THVD) fault delay time. Read only value. To change this value, modify the corresponding register in the setpoint section below.

Table 21: Network Interface OUTPUT Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
REACTOR_OT_DELAY_RO	337	Output	Fault detection delay time in milliseconds. Default of 12 seconds. Range 0.02 to 60 seconds	Tuning reactor overtemperature fault delay. Read only value. To change this value, modify the corresponding register in the setpoint section below.
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 Read only value.
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 Read only value.
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. Read only value.
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

Table 22: Fault Codes

Bits	Fault Descriptions
Register A	
0	No fault detected / enabled
1	Overvoltage Phase A
2	Overvoltage Phase B
3	Overvoltage Phase C
4	High Frequency Phase A-B
5	High Frequency Phase B-C
6	High Frequency Phase C-A
7	Phase Loss (Phase A)
8	Phase Loss (Phase B)
9	Phase Loss (Phase C)
10	High THVD Phase A
11	High THVD Phase B
12	High THVD Phase C
13	Under Temperature
14	Over Temperature
15	CPU Error
Register B	
0	Reactor Thermal Switch

Table 23: Network Interface INPUT/Setpoint Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
USER_STATE_REQ	500	Input	0 = Initialization 9 = Save current values to flash 150 = Load values from Flash 255 = Restore Defaults to Flash	Note that defaulting the flash will clear all calibration data and require that the calibration procedure be re-run with no voltage applied to the PQconnect board.
TRACE_GO_DONE	501	Input	0 = Capture Done 1 = Start Capture	Update trace data points for waveforms
RELAY_CLOSE_DELAY	505	Input	Relay close delay time in milliseconds Range 0 to 60 seconds	Delay time on fault relay being energized when any enabled fault condition is detected. This delay is in addition to any configured delay for a specific fault condition.
RELAY_OPEN_DELAY	506	Input	Relay open delay time in milliseconds Range 0 to 60 seconds	Delay time on fault relay being unenergized when all enabled fault detection conditions have cleared.
POWER_ON_DELAY	507	Input	Default 20 = 20 milliseconds Range 0.02 to 60 Seconds.	System power on delay
RATED_VOLTAGE	521	Input	4800 = 480 Vrms Range = 120 to 690 Vrms	Filter rated voltage
RATED_FREQUENCY	522	Input	50 = 50 Hz 60 = 60 Hz	Filter rated frequency
FAULT_A_ENABLE	540	Input	0 = Disabled To Enable desired fault detections, enter bit mask from table by converting to decimal Range: 0 to 65535	Example: Enabling all fault conditions is 1111 1111 1111 1111 in binary or 65535 decimal. Reference Fault codes Table 3
FAULT_B_ENABLE	541	Input		
FAULT_A_RELAY_ACTION	542	Input		If a fault is active and the bit corresponding to that status in this mask is set, the relay will be activated. Reference Fault codes Table 3
FAULT_B_RELAY_ACTION	543	Input		
MB_SLAVE_ADDRESS	560	Input	10	Modbus slave address
MB_BAUD_RATE	561	Input	3840 = 38400 baud rate	Modbus baud rate
MB_PARITY	562	Input	2 = Even	Modbus Parity

Table 24: Network Interface INPUT Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format and Examples	Description
OVERVOLTAGE_FAULT_ONSET	600	Input	**DEFAULT** = 125% Range 100 to 200	Set desired Overvoltage onset threshold in percent rated voltage
OVERVOLTAGE_FAULT_CLEAR	601	Input		Overvoltage fault clear threshold
OVERVOLTAGE_FAULT_DELAY	602	Input	Fault detection delay time in milliseconds. Default of 12 seconds. Range 0.02 to 60 seconds	Overvoltage fault delay time
HIGH_FREQUENCY_FAULT_ONSET	603	Input	Default 125% Range 100 to 200	Set desired High frequency fault onset threshold
HIGH_FREQUENCY_FAULT_CLEAR	604	Input	Default 125% Range 100 to 200	Set desired High frequency fault clear threshold
HIGH_FREQUENCY_FAULT_DELAY	605	Input	Fault detection delay time in milliseconds. Default of 6 seconds. Range 0.02 to 60 seconds	High frequency fault delay time
PHASE_LOSS_FAULT_ONSET	606	Input	Default = 60 = 60% Range 1 to 100	Phase loss fault onset threshold (average of the three filter output voltages)
PHASE_LOSS_FAULT_CLEAR	607	Input	Default = 55 = 55% Range 1 to 100	Phase loss fault clear threshold (average of the three filter output voltages)
PHASE_LOSS_FAULT_DELAY	608	Input	Fault detection delay time in milliseconds. Default of 12 seconds. Range 0.02 to 60 seconds	Phase loss fault delay time
THD_FAULT_ONSET	609	Input	Default = 20 = 20% Range 2 to 100	Set desired THVD fault onset threshold
THD_FAULT_CLEAR	610	Input	Default = 20 = 20% Range 2 to 100	Set desired THVD fault clear threshold
THD_FAULT_DELAY	611	Input	Fault detection delay time in milliseconds. Default of 6 seconds. Range 0.02 to 60 seconds	Voltage Total Harmonic Distortion (THVD) fault delay time
REACTOR_OT_DELAY	615	Input	Fault detection delay time in milliseconds. Default of 12 seconds. Range 0.02 to 60 seconds	Tuning reactor overtemperature fault delay

Table 25: Network Interface INPUT Register Map

SYS_NULL_EN	700	Input	0 = Disabled 1 = Enabled	System auto null calibration enable. This value auto clears to 0 when calibration complete.
SYS_SERIAL_NUM_2	810	Input	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	811	Input	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	812	Input	Parameter contains NN in the UUUULLLL-NN serial number format.	Unit serial number section - two-digit unit number

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 “B&B SmartWorx, Inc Model: USPTL4” RS-485 to USB converter. As another alternative RS-485 converter there is WINGONEER USB 2.0 to RS485 Serial Converter Adapter CP2104.

Figure 7: B&B SmartWorx, Inc Model: USPTL4 model RS-422/485 converter

With the example converter above, the user can make proper connections from the RS485 converter to the PQconnect J5 communication header. The table below indicates the positions where the RS485 connections lead to. Please ensure the correct dip switch settings are applied before installing.

Table 26: USPTL4 to J5 Header Connections

USPTL4 Pin Out	J5 Header Pinout
-	No connect
TDA (-)	A (Pin 2)
GND	GND (Pin 3)
TDB(+)	B (Pin 4)
-	No connect

USPTL4 RS485 Converter Dip Switch settings

All four switches of the B&B converter from the factory should be set to the ON position and should look like the following.

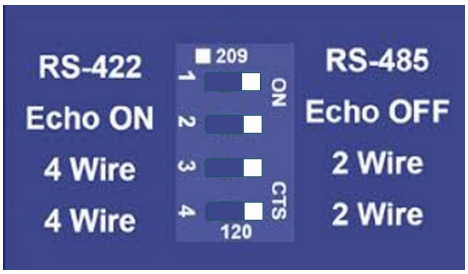
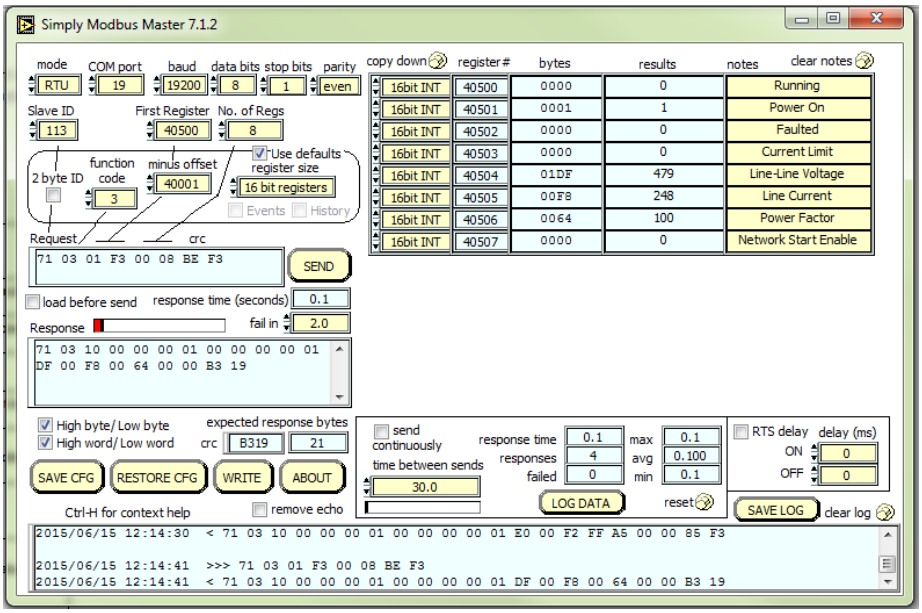


Figure 8: Dip Switch settings

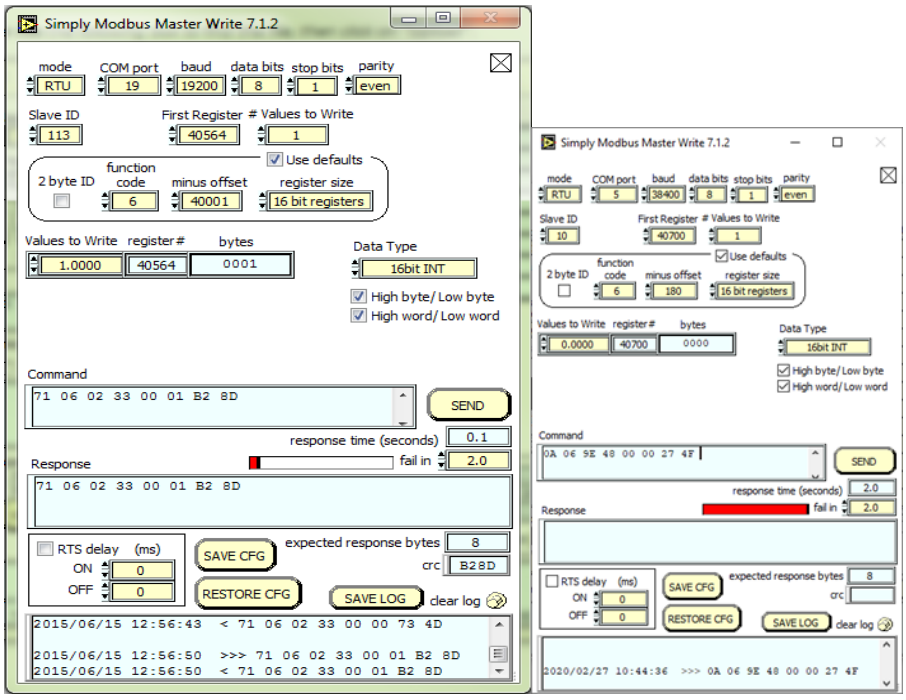
Example Setup Instructions to Read Data from the PQconnect Unit:

- 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:



- To change the voltage rating of the unit:
- Select the “WRITE” button on the screen shown above.
- The screen below will be shown. Configure the fields as shown in the picture.



- Select 4800 in the field “Values to Write” to change the voltage rating of the unit to 480 Vrms.

PCB Connections

Most customer connections to PQconnect will be made on the PCB. Refer to connection diagram in **Figure 9** and to drawing 24281-1PQ for the wiring schematic. The details of the power and communications terminals are shown in

Table 28 Form C relays are available on the PCB, these connections are shown in Table 27 Two relay outputs are available on the PCB.

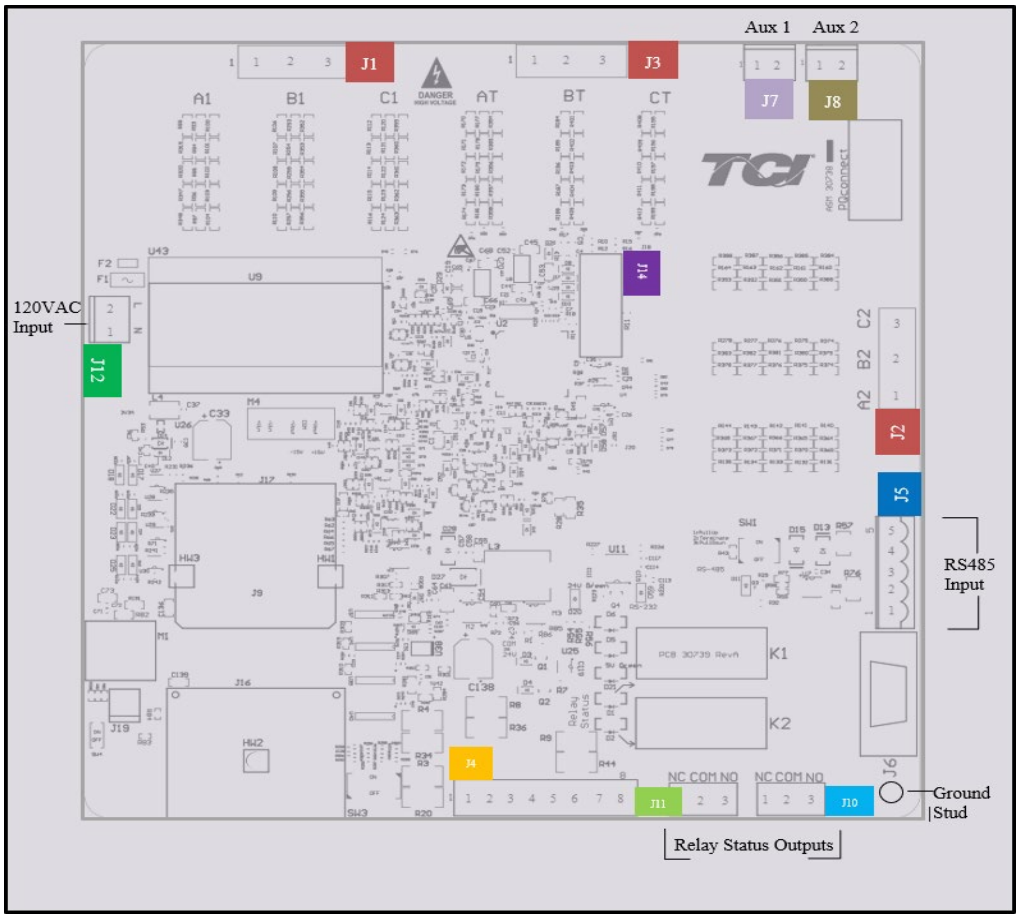


Figure 9: PQconnect Connections

Table 27: Form C Relay Contacts

Terminal	Pin	Description	Label	Tightening Torque	Wire Range
J7	1, 2	Reactor Thermal Switch	Customer contacts	3.5 lb-in (0.4 Nm)	28-12 AWG
J8	N/A	N/A	N/A	N/A	N/A
J11	1	Fault Relay	Normally Closed	4.4 lb-in (0.5 Nm)	28-14 AWG
	2		Common		
	3		Normally Open		
J10	1	Fault Relay Inverted	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

Table 28: Power & Communication Terminals

Terminal	Pin	Description	Label	Rating
J1	1	Tuning Reactor Output Connections	Phase A	600VAC
	2		Phase B	
	3		Phase C	
J2	1	Tuning Reactor Connections	Phase A (Output of Tuning reactor)	
	2		Phase B (Input of Tuning Reactor)	
	3		Not connected	
J3	1,2,3	Not Connected		N/A
J4	1-8	Not Connected		N/A
J5	1	RS485	Not Connected	N/A
	2		B (non-inverting)	
	3		Ground	
	4		A (inverting)	
	5		Not connected	
J12	1	Input Power from control power transformer	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).

Depending on the size of the line reactor, you have the option of different terminations based on the reactor. Table 18 provides examples of the terminations used for the voltage sense wires from the PQconnect to the line reactor. All recommendations are used with 18 AWG stranded wire.

Table 29: Voltage sense wire termination

Connector Termination	Manufacturer Part Number	Manufacturer	Description	Reactor Size
Metal tab	43178-4002	Molex, LLC	Blade Contact 18-20 AWG Crimp Male Blade	Small line reactors with six position terminal blocks.
3/8” Ring Lug	2-320573-4	TE Connectivity Amp Connectors	Ring Terminal Connector	Large line reactors with copper bus bar terminals
1/4” Ring Lug	2-31894-2	TE Connectivity Amp Connectors		
1/2” Ring Lug	61863-2	Tyco Electronics		

Note: Voltage sense wire terminals J1 & J3 accept wire gauges of 16-28 AWG with a tightening torque of 4.4 in-lb (0.5 Nm). Alternate/Equivalent tabs and ring lugs may be used for terminations. Please consult with TCI Tech-support if there are any questions for alternate parts.

Troubleshooting

Warning 	Only qualified electricians should carry out all electrical installation & maintenance work on the Sinewave filter. Disconnect all sources of power to the MFC and connected equipment before working on the equipment. Do not attempt any work on a powered MFC. The MFC unit contains high voltage 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 MFC is comprised of three major components; the PQconnect connectivity board, the tuning reactor, and the capacitors. The PQconnect PCB contains diagnostic LEDs. The locations of the LEDs are shown in **Figure 11** and their functions are listed in Table 30

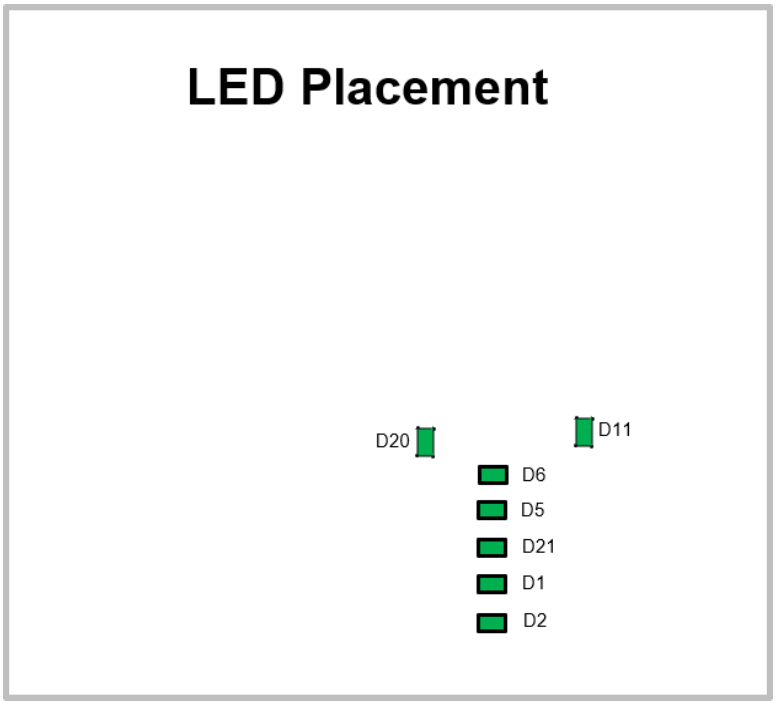


Figure 11: PQconnect LED Placements

Table 30: LED Functions

LED	LED Color	Description
D1	Green	Fault Relay
D2	Green	Fault Relay Inverted
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 slow blinks (2 = Register A faults, 3 = Register B faults), then blink fast depending on the fault. Table 21 summarizes the LED blinks based on the fault condition.

Table 31: LED Codes

Fault	Group (Slow blinks)	LED Specifier (Fast Blinks)
No fault detected/ enabled	2	1
Overvoltage Phase A		2
Overvoltage Phase B		3
Overvoltage Phase C		4
High frequency Phase A		5
High frequency Phase B		6
High frequency Phase C		7
Phase Loss (Phase A)		8
Phase Loss (Phase B)		9
Phase Loss (Phase C)		10
High THVD Phase A		11
High THVD Phase B		12
High THVD Phase C		13
Under Temperature		14
Over Temperature		15
CPU Error		16
Reactor Switch	3	1

Debug Fault conditions

Based on the fault condition there are various ways a fault can appear. **Before investigating the sinewave filter internally, disengage supply voltage to the filter**.

Table 32: Fault conditions

Fault Condition	Description	Debug
Overvoltage Phase A, B, or C	Filter has detected overvoltage on a phase(s)	Check input power connections to the filter.
High Frequency Phase A, B, or C	High Frequency detection on phase voltage(s)	Check fuses leading to filter capacitors If fuses are not blown, measure Capacitance of the capacitors Check power connections of the unit, reference drawing 24281-1PQ
Phase Loss Phase A, B, or C	Filter phase loss	Check fused disconnect or circuit breaker upstream of the filter. Check input power connections to the filter
High THVD Phase A, B, or C	High voltage Total Harmonic Distortion	Check fuses leading to filter capacitors If fuses are not blown, measure Capacitance of the capacitors Check power connections of the unit, reference drawing 24281-1PQ
Under Temperature	Filter ambient temperature is operating below threshold	Check fuses of control power transformers leading to the heater.
Over Temperature	Filter ambient temperature is operating above threshold	Check fuses of control power transformers leading to fans. Make sure fans are operating
CPU Error	Processor malfunction	Power cycle unit and if issue persists contact tech support
Reactor Switch	Reactor Thermal Switch open	Check thermal switch connections to PCB

Evaluating MotorGuard Performance

The MotorGuard performance can be evaluated by checking the output voltage waveform with an oscilloscope.

Warning	Only qualified electricians should carry out all electrical installation and maintenance work on the MotorGuard. Exercise caution when checking waveforms with an oscilloscope. Use a dual probe, differential input set-up, or other means of isolating the scope chassis from the motor voltage. Disconnect power when attaching and removing the probes.

Typical VFD Waveforms without Filtering

Figure 6 shows two examples of output voltage waveforms for a typical PWM variable frequency drive. The example labeled "VFD Output Voltage Waveform" is a "clean" waveform as it would appear with nothing connected to the VFD output terminals. The voltage peaks of this waveform are about 650 volts for a 480 volt drive. The example labeled "Motor Voltage Waveform" shows the typical waveform at the terminals of a motor located a distance away from the VFD. This waveform has voltage peaks of 1500 volts or higher due to the voltage spikes caused by the reflected wave phenomenon.

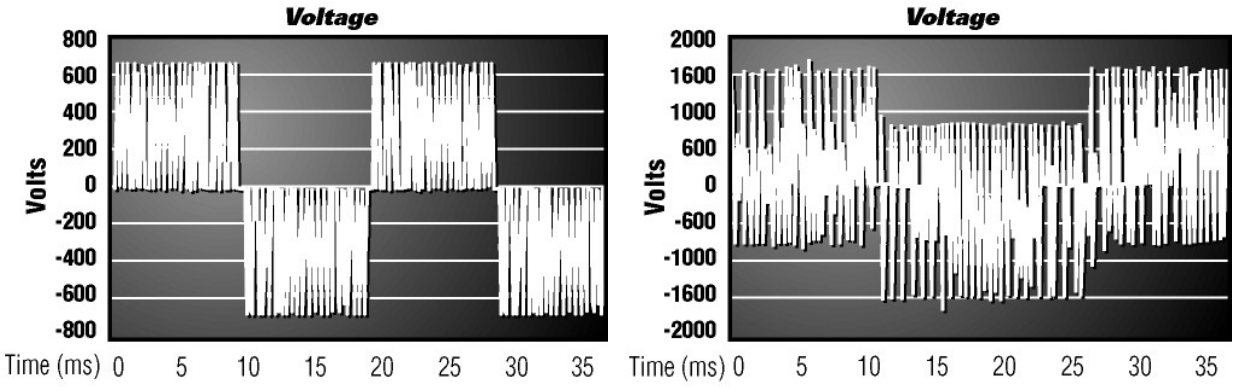


Figure 6 **VFD Output Voltage Waveform** **Motor Voltage Waveform With Reflected Voltage Spikes**

Filter Output Performance

Figure 7 shows the voltage waveform at the output of the MotorGuard or at the terminals of a motor connected to the MotorGuard.

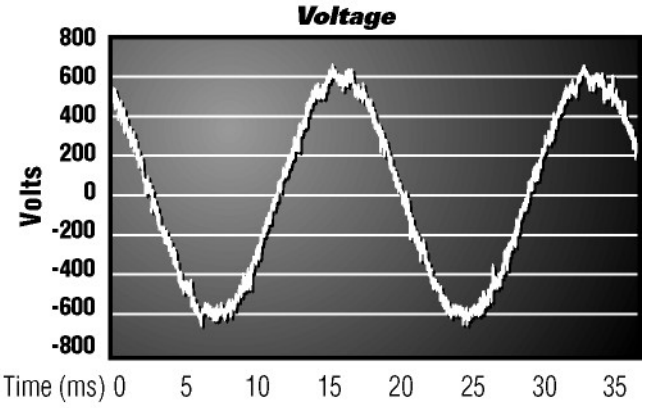


Figure 7 Motor Voltage Waveform Filtered by the MotorGuard

Replacement Parts

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

Factory Contacts and Tech Support

For technical support, contact your local TCI distributor or sales representative.

You can contact TCI directly at 800-824-8282. Select "Customer Service" or "Technical Support" and have your MotorGuard nameplate information available.

10.0 Drawings

Typical MotorGuard drawings are provided on the transcoil website. Please visit https://transcoil.com/products/motorguard-sinewave-filter/motorguard-industrial-drawings/

These drawings provide general information describing your MotorGuard filter. More specific information is provided by the drawings shipped with the unit. Be sure to carefully review the information provided by these drawings. This information takes precedence over the information provided in this manual.

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