HARMONICGUARD®
ACTIVE

HarmonicGuard® Series Bus-Applied Active Harmonic Filter

Supplied in Rockwell CENTERLINE 2100 Low Voltage Motor Control Enclosures

Installation, Operation, and Maintenance Manual

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Revision	Description	Date
A	Rockwell Review Release	08/15/16
B	Updated Part Number System; Product Dimensions; Technical Specifications; Installation Guidelines, Added Wiring Diagram for Incoming Supply	09/22/17

We strive to provide the most up to date and accurate documentation available at the time of printing.
Please visit www.transcoil.com for the most recent revision of this manual.

Section 1

HGA Quick Start Unit Software Setup for HMI Revision B

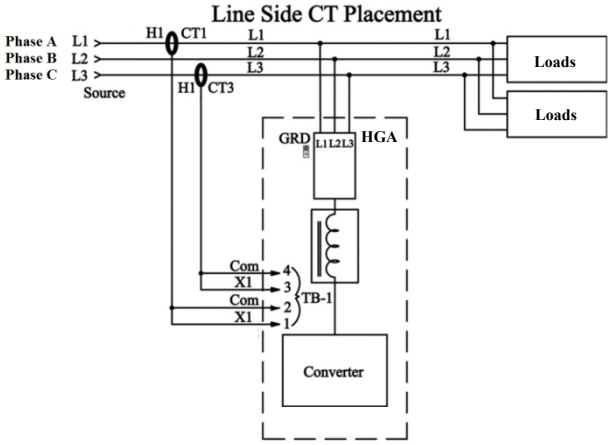
Warning 	Be sure to read, understand, and follow all safety instructions.
Warning 	Only qualified electricians should carry out all electrical installation and maintenance work on the HarmonicGuard® Active (HGA) filter.
Warning 	All wiring must be in accordance with the National Electrical Code (NEC) 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 HGA filter.
Warning 	The HGA filter and other connected equipment must be properly grounded.
Warning 	The HGA filter may receive power from two or more sources. Three-phase power is connected to the main input terminals of the HGA filter. All of these sources of power must be disconnected before working on the HGA filter.
Warning 	After switching off the power, always allow 5 minutes for the capacitors in the HGA filter and connected equipment, if applicable, to discharge before working on the HGA filter, connected equipment, or the connecting wiring. It is good practice to check with a voltmeter to ensure that all sources of power have been disconnected and that all capacitors have discharged before beginning work.

1) Verify Unit External Connections

NOTE: If unit is configured for load side operation, reference the User Manual for Load Side CT Placement diagram.

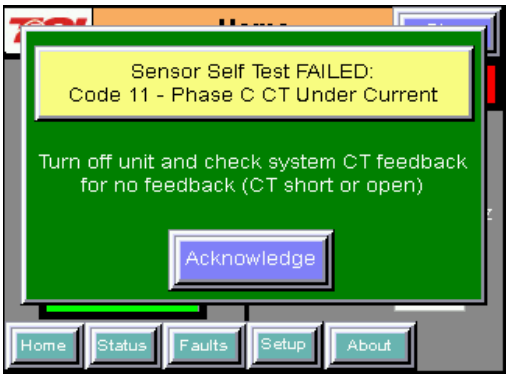
- Phase A, B, C power connection, with positive A-B-C phase rotation expected
- CT H1 Terminal is pointing toward the source
- CT feedback on phases A & C to TB-1
- Leave CT shorting bars in place on TB-1
- With the HGA circuit breaker open, energize the source to the HGA
- Close the HGA circuit breaker
- Fans and HMI should come on in < 5 seconds
- HMI will start on Home screen
- Load(s) have an integral 5% line reactance or equivalent DC bus choke

Warning	Hazardous voltages are present when unit is energized



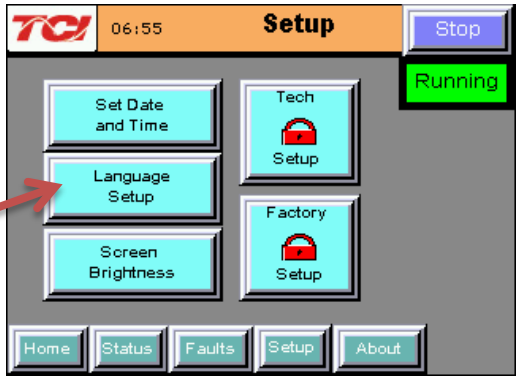
NOTE: Built In Sensor Wiring Error Detection

- The active filter has an automatic sensor wiring error detection algorithm built into the controls.
- If a sensor wiring error is detected, please reference the Sensor Error Auto Detection section.



NOTE: Language Selection and Date / Time

- The active filter supports several languages including English, French and Spanish.
- Press “Setup” to navigate to Setup screen and press the “Language Setup” button.
- Select language setting from the language setup pop-up screen.
- Press the “Set Date and Time” button to change the configured system time.



2) Converter Check – 1

- Press “Setup” to navigate to Setup screen
- Next, select “Tech Setup” and enter the password:

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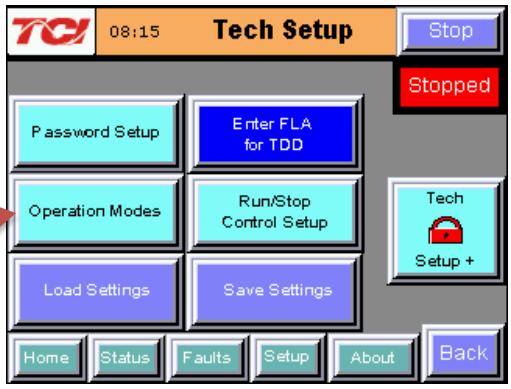
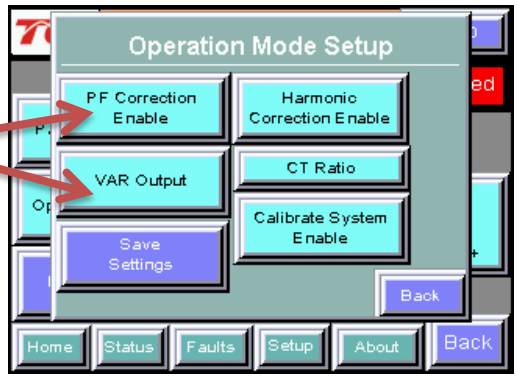
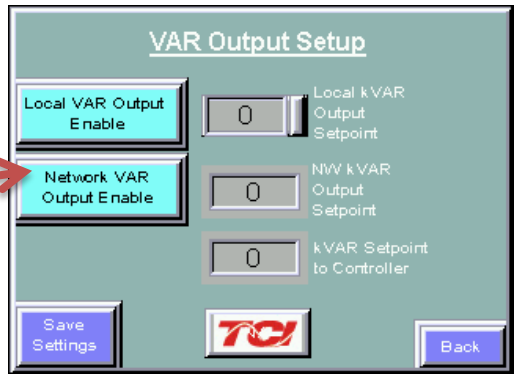
- Select the “Operation Modes” button



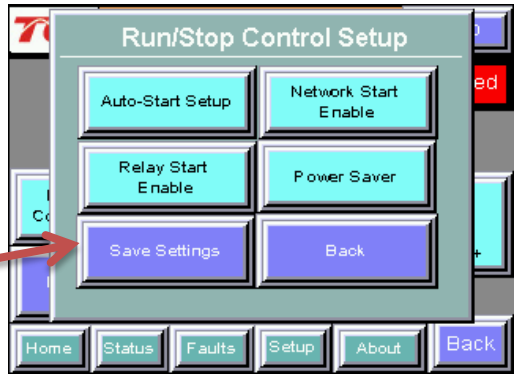
- On the “Operation Mode Setup” screen, ensure “PF Correction Enable” and “Harmonic Correction Enable” buttons are OFF (Blue). If buttons are green, press to toggle off
- Select the “CT Ratio” button and enter CT ratio to match the external current transformers wired to the unit. Select the “Back” button

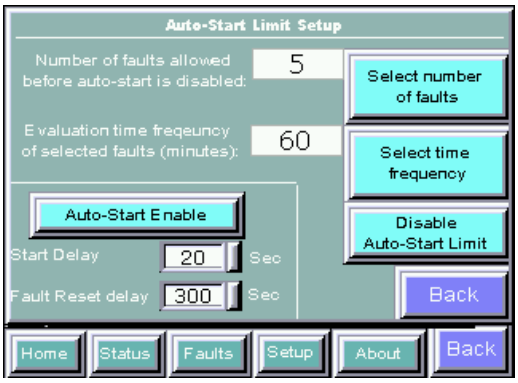
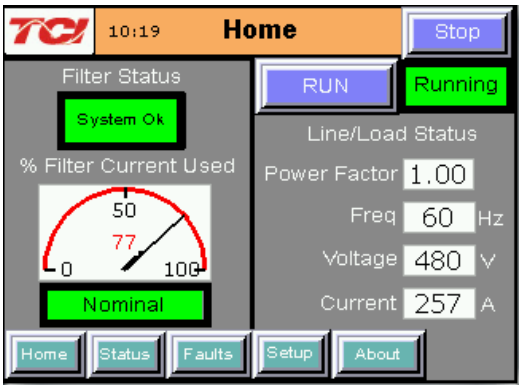
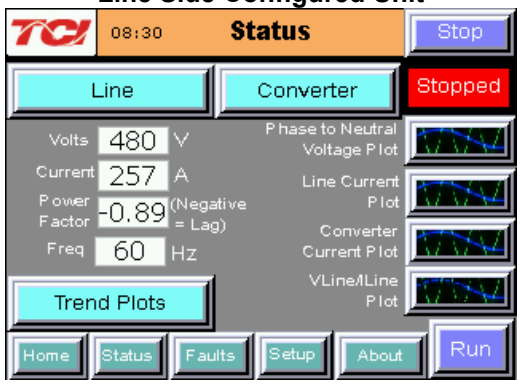
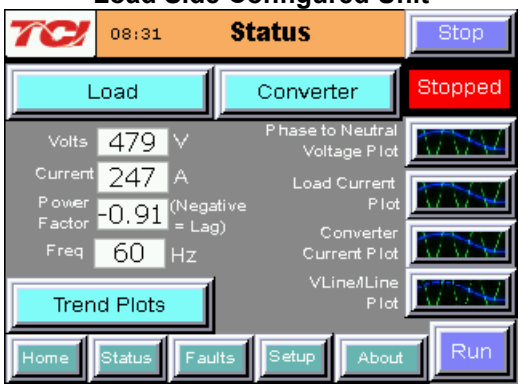


- Next, select the “VAR Output” button and ensure the “Local VAR Output Enable” and “Network VAR Output Enable” are OFF (Blue). If buttons are green, press to toggle off
- Select the “Back” buttons to return to the “Tech Setup” screen



- On this pop-up screen, ensure the “Auto-Start Setup” button is OFF (Blue). If button is ON (Green), press to toggle off.
- Navigate back to “Tech Setup” screen
- Now, select “Save Settings”
- Press “Home” to navigate to Home screen

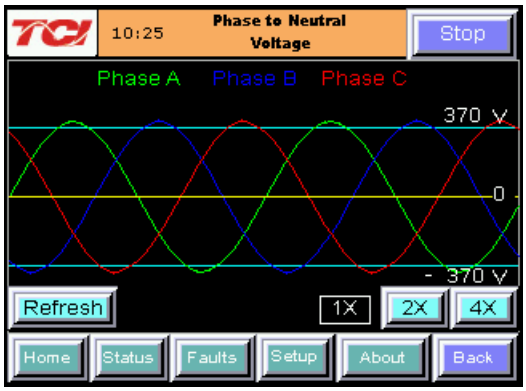


Warning  Hazardous voltages are present when unit is energized	
3) Home Screen Check • Compare "Freq" to expected line frequency • Compare "Voltage" to expected line voltage • "Current" is expected to be zero because unit is not running and CT inputs are shorted • If status indicates a Fault, press "Stop" button to reset condition	
4) Status Screen Check **Note:** The Line/Load button and Line/Load Current Plot will say "Line" if a master/ line side unit or say "Load" if it is a slave/load side unit. • Press "Status" to navigate to Status screen • Compare "Volts" to expected line voltage • Compare "Freq" to expected line frequency • "Current" expected to be zero, if unit is not running and CT inputs are shorted	**Line Side Configured Unit**  **Load Side Configured Unit** 

5) Phase Rotation Check

- Press “Phase to Neutral Voltage Plot” button
- Check that the current peaks follow the following sequence from left to right: Phase A (Green), Phase B (Blue), Phase C (Red)
- Equipment is phase rotation sensitive, if phase rotation is incorrect, power down unit and rewire to adjust phase rotation by swapping two incoming phase connections

Warning	Improper operation will occur if input voltage phase rotation is incorrect.



6) Running Converter

Press “Setup” to navigate to the setup screen
Select the “Tech Setup” button and enter the password:

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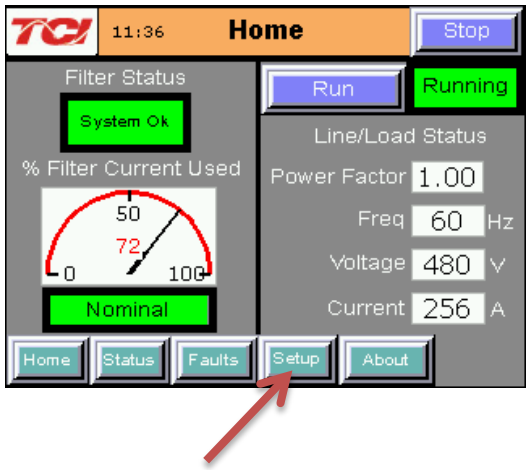
- Select the “Next” button from the splash screen
- Select the “Operation Modes” button
- On the “Operation Mode Setup” screen, ensure “PF Correction Enable” and “Harmonic Correction Enable” buttons are OFF (Blue). If buttons are green, press to toggle off TODO and VAR output off.
- Select the “VAR Output” button and ensure the “Local VAR Output Enable” and “Network VAR Output Enable” are OFF (Blue). Select the “Back” buttons to go back to “Tech Setup” screen
- Select the “Home” button from navigation bar
- Select the “Run” button to start unit operation



7) Remove CT Shorting Bars

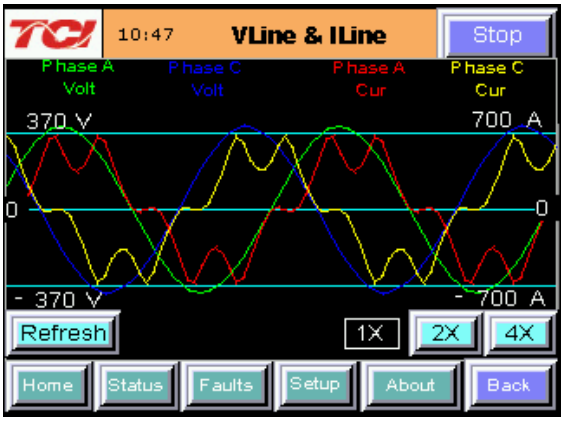
- Press “Stop” to turn off unit
- Disconnect power from cabinet
- Turn off the built in door breaker AND
- Turn off the upstream feeder breaker
- Open the cabinet door and remove shorting bars from CTs connected to TB-1

Warning	Lethal voltages may be present. Wait 5 minutes for DC bus voltage to drop to safe levels.
Warning	Check for voltage in cabinet with a DMM before working inside cabinet.

8) Current Polarity #1

- Power up unit
- From Home screen press “Run” to turn on unit
- Press “Status” to navigate to Status screen
- Select “VLine/ILine” screen
- Note: Lightly loaded conditions (less than 20% CT rating) will not have enough current to show up on ILine plot
- Check that Phase A to Neutral voltage peak lines up with Phase A current (use zoom if necessary)
- Check that Phase C to Neutral voltage peak lines up with Phase C current
- Power system down and check CT installation location and orientation if Phase A plots differ significantly from Phase C plots

Warning	
⚠	Open circuit CT outputs can result in high voltages and damage to equipment.



Warning	
⚠	Wiring the CT incorrectly can lead to improper operation, which includes unit operating in limit and/or contributing to rather than correcting harmonics.

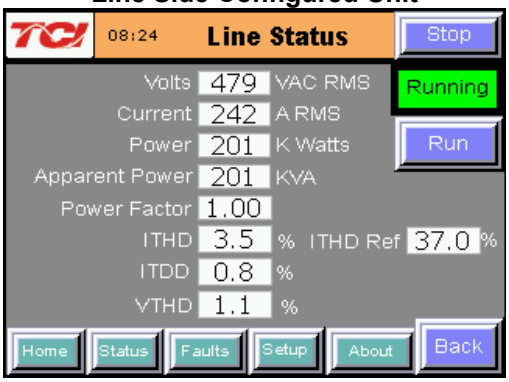
NOTE: If using a Line Side (master) unit, the screen title will say “Line Status” and if using a Load Side (slave) unit, the screen title will say “Load Status”.
Also: See notes under each screen.

9) Current Polarity #2

- Navigate to Status screen
- Depending on unit configuration, select either the “Line” or “Load” button
- Verify that the fields match expected values for the power system
- If they do not, verify correct CT installation

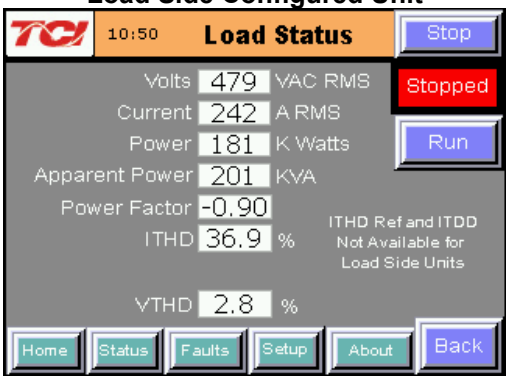
NOTE: If secondary CT current is less than 1A, ITHD will be unavailable.

Line Side Configured Unit



NOTE: If system voltage is less than 480V, the VTHD value will be unavailable. If CT secondary feedback current is less than 1 Amp, the ITHD and ITHD Ref values will be unavailable.

Load Side Configured Unit



NOTE: If system voltage is less than 480V, the VTHD value will be unavailable. Load Side units do not report ITDD or ITHD Ref values. If CT secondary feedback current is less than 1 Amp, the ITHD value will be unavailable.

10) Final Setup

- Press “Setup” to navigate to setup screen
- Select the “Tech Setup” button and enter the password:

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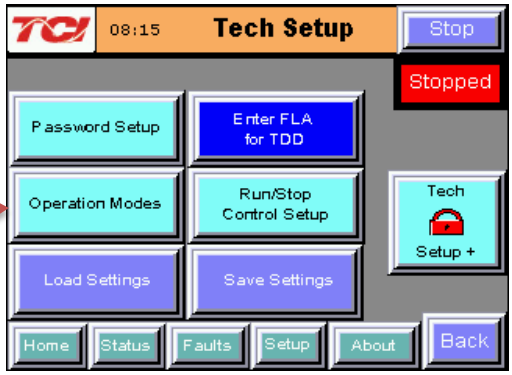
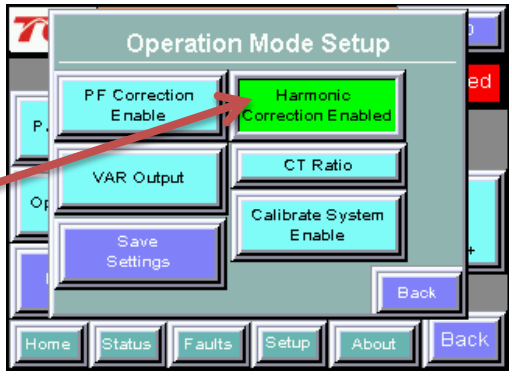
- Select the next button from the splash screen
- Select the “Operation Modes” button

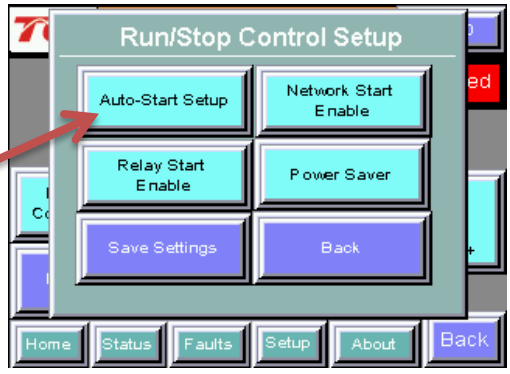


- On the “Operation Mode Setup” screen, select the “Harmonic Correction Enable” button and ensure the button is ON (Green)

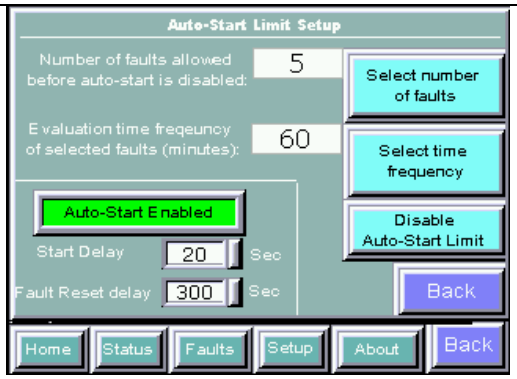
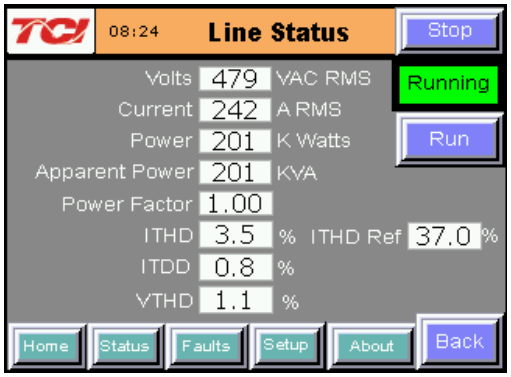
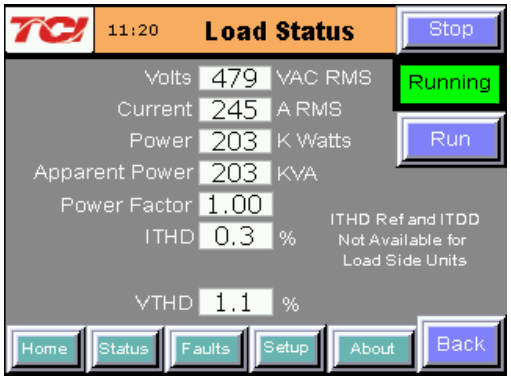
NOTE: If unit is sized with sufficient capacity to provide power factor correction, select the “PF Correction Enable” button and ensure the button is ON (Green).



- Select the “CT Ratio” button and confirm the configured CT ratio matches the external current transformers that are wired to the unit
- Select the “Back” button and then from “Tech Setup” screen, select “Run/Stop Control Setup”



- Select “Auto-Start Setup”
- On this screen, select the “Auto-Start Enable” button and ensure the button is ON (Green)
- Navigate back to the “Tech Setup” screen and select the “Save Settings” button
- Navigate to the “Home” screen and press the “Run” button. The unit will start to operate. With the Auto-Start option enabled, the units will now automatically restart after future power on/off cycles of the unit or non-critical system faults

Warning  When Auto Start is enabled unit may operate without operator input.	
11) Final Check **NOTE:** If unit is configured for load side operation, reference the User Manual for Load Side CT Placement diagram. • Navigate to the Status screen • Navigate to Line/Load status • Note the corrected voltage, current, power and THD	 **Line Side**  **Load Side**

2 Section 2

Safety Instructions

2.1.1 Overview

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

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

2.1.2 Warnings and Cautions

This manual provides two types of safety instructions. Warnings are used to call attention to instructions, which describe steps, which must be taken to avoid conditions, which 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.

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

2.1.4 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.

2.1.5 General Safety Instructions

These safety instructions are intended for all work on the HGA filter. 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 HGA 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 HGA filter.
Warning 	The HGA filter and other connected equipment must be properly grounded.
Warning 	The HGA filter may receive power from two or more sources. Three-phase power is connected to the main input terminals of the HGA filter. All of these sources of power must be disconnected before working on the HGA filter.
Warning 	After switching off the power, always allow 5 minutes for the capacitors in the HGA filter and connected equipment to discharge before working on the HGA filter, associated equipment, or the connecting wiring. It is good practice to check with a voltmeter to ensure that all sources of power have been disconnected and that all capacitors have discharged before beginning work.

General Terminology

Throughout this manual, many different terms are used. A list of some typical terms can be found below. These are provided in order to assist with the overall understanding of the manual. Please feel free to contact TCI directly if there are any questions regarding any portion of this manual.

HarmonicGuard® Active Filter – TCI's brand name for a real time filter that mitigates harmonics while also maintaining near unity power factor. An Active Harmonic Filter is any piece of equipment that actively monitors and changes the incoming AC line current.

HGA – The term commonly used in place of the entire brand name of HarmonicGuard® Active filter.

Active Harmonic Filter - An active harmonic filter is a piece of equipment that reads the incoming voltage and current and injects current waveforms that cancel distortion. This term is commonly used in place of the entire brand name of HarmonicGuard® Active filter.

Bus-Applied Filter – A shunt device connected in parallel to the load. This is an active filter designed to mitigate the harmonics associated with multiple loads. The filter is directly connected to a main bus as can be found in a typical Motor Control Center. The filter is sized for the amount of corrective current needed to be injected to cancel the offending harmonics. A Digital Signal Processor (DSP) pulse width modulated controller is used for switching Insulated Gate Bipolar Transistor (IGBT) in order to cancel the harmonics.

Power Converter - The power converter is the digital filter module of the HarmonicGuard® Active filter.

Non-Linear Load Input Line Inductor – The three phase line reactor connected at the input of an adjustable frequency drive or other non-linear load.

Converter Inductor – The three phase inductor maintains a uniform air gap to give highly consistent and predictable inductance. These inductors are connected to the inverter which buffers the inverter output from the analog portion of the filter, the source, and connected drives.

Current Transformer (CT) – The device that monitors the incoming AC current waveform typically sized to handle the total connected load.

3 ■ Section 3

Introduction

Thank you for selecting TCI's HarmonicGuard® Active filter. TCI has produced this filter for use in variable speed drive and non-linear load applications that require input power line harmonic current reduction and power factor correction. This manual describes how to install, operate, and maintain the HarmonicGuard® Active filter.

3.1.1 Intended Audience

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

3.1.2 Additional Information

Caution	
⚠	This manual provides general information describing your HGA 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.

3.1.3 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, excessive vibration, corrosive or combustible airborne contaminants, excessive dirt, or liquids.
- Select a mounting area that will allow adequate cooling air flow 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 HGA filter 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 HGA filter, L1, L2, & L3.
- Ensure that the CTs are properly installed and connected to the proper terminals inside the HGA filter (see CT Installation section of IOM Manual).
- Check everything thoroughly before applying power to the equipment.
- Check the panel and the inside of the enclosure for any foreign objects, dirt, or loose hardware.

Receiving Inspection and Storage

3.2.1 Receiving Inspection

The HarmonicGuard® Active 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. Please refer to www.transcoil.com for standard terms and conditions.

3.3.1 Storage Instructions

If the HarmonicGuard® Active filter 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.

Long-Term Storage

In the case of long-term storage, defined as any period greater than eighteen (18) months, TCI Technical Support must be contacted prior to applying power.

Product Description

HarmonicGuard® Active filter

The HarmonicGuard® Active filter is an active harmonic filter designed and developed by TCI to relieve the power distribution system of the issues associated with harmonic currents that flow within the power distribution network caused by non-linear loads. The typical configuration can be found in **Figure 3.1**

The topology of the bus-applied (three phase, three wire) HGA consists of major components or modules:

Component 1 is made up of two current transformers (CTs) installed on phases A and C of the AC bus that is to be acted upon by the filter. The purpose of the CTs are to supply information to the HGA regarding the integrity of the composite AC bus current with regard to the distortion (non-sinusoidal waveform) and displacement power factor relative to the AC bus voltage. These signals will result in the HGA injecting currents that will return the AC line current to near sinusoidal shape and at unity power factor. Note, the CTs are located outside the HGA enclosure.

Component 2 is the HGA input circuit breaker (optional). This is provided to protect the HGA for destructive over current conditions if a malfunction occurs within the HGA circuitry. It also provides a convenient disconnect means and field wiring point for the installer of the filter equipment.

Components 3 and 4 are the high frequency converter inductors. These inductors provide the proper inductance to the power converter.

Component 5 is the power electronic converter module. The Power Converter Module (PCM) is the heart of the HarmonicGuard® Active filter and is what differentiates the HGA from other types of harmonic mitigation. The PCM provides several highly complex electronic functions controlled by the on board DSP controller. The PCM continuously senses the AC bus line voltage and currents, processes the information at "nearly real time" by means of the instructions resident within the DSP program code, properly controls the six IGBT's to operate in a safe manner that injects current into the AC bus grid that ensures the AC bus current is sinusoidal and near unity power factor. Power converter contains a pre-charge circuit which consists of two SCRS and two pre-charging resistances which control the inrush current.

3.4.1 Filter Configuration

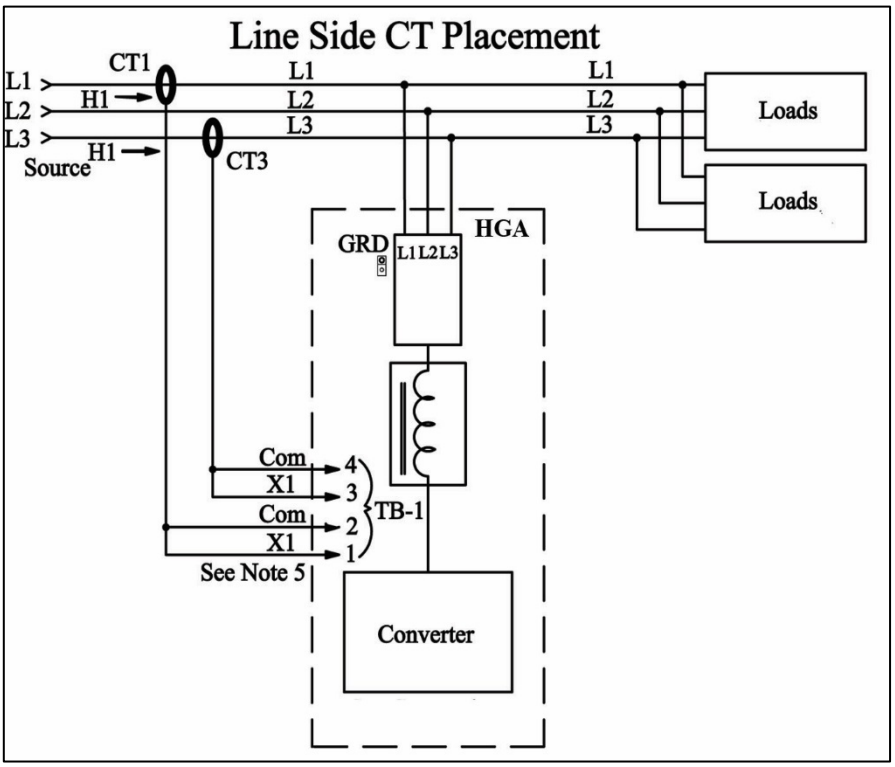


Figure 3.1: Typical Configuration of the HarmonicGuard® Active Filter

*This drawing is for general reference only. Use the drawings supplied with the unit for installation.

3.4.2 Nameplate Data

Figure 3.2 shows a typical HarmonicGuard® Active filter nameplate. The following information is marked on the nameplate:

- Part number: Encoding is explained on the following page
- Corrective Current: The maximum amount of RMS Corrective Current the unit can deliver.
- System Voltage: The rated 3-phase line voltage (RMS volts)
- Hz: The rated frequency (60 Hz)
- Phase: 3, 3 Wire – The HGA is designed for use with only 3 wire systems with balanced 3-phase voltage source.
- Drawing #: Outline and mounting dimension drawing number
- Schematic #: Schematic diagram drawing number
- Serial #: For unit tracking purposes
- Enclosure Type: Type 1

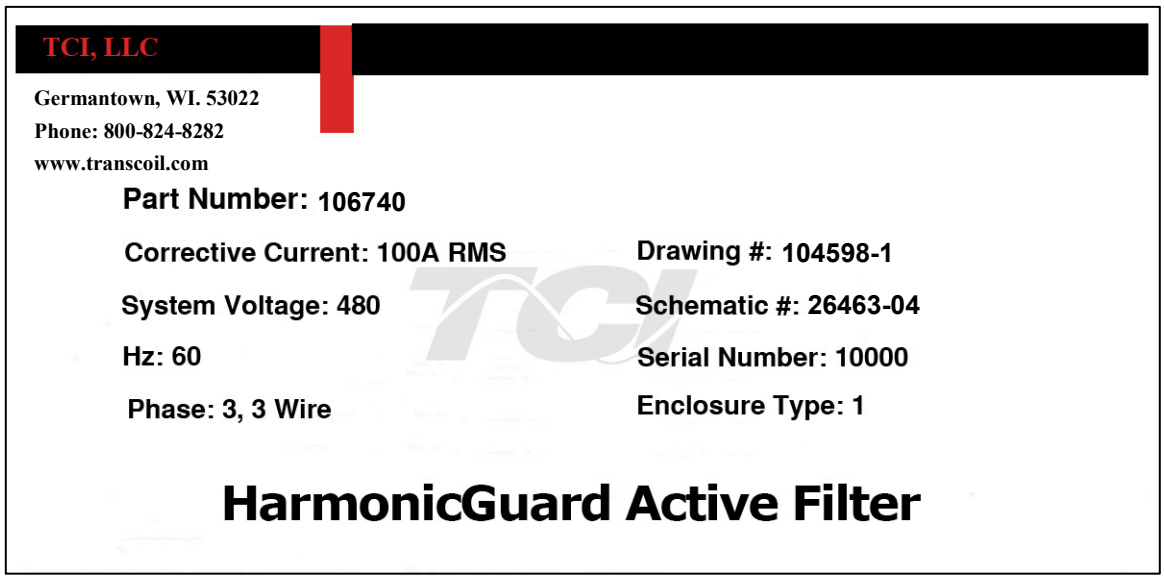


Figure 3.2 : Typical HarmonicGuard® Nameplate

3.4.3 HGA Part Numbering System – 480V Type 1

Temperature: 40° C
Current: 50, 100, 150, 200, 250, 300
Voltage: 480
Enclosure: UL Type 1

Error! Reference source not found. **3.1** lists part numbers of active filters in Rockwell LVMCC sections. All units contain an HMI Interface Module Package.

Part Number	Description
106733	HGA, 50A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Modbus RTU RS485
106734	HGA, 100A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Modbus RTU RS485
106735	HGA, 150A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Modbus RTU RS485
106736	HGA, 200A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, Modbus RTU RS485
106737	HGA, 250A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, Modbus RTU RS485
106738	HGA, 300A, 480V, Type 1 MCC, 35"W, HMI, 65kAIC, Modbus RTU RS485
106739	HGA, 50A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Ethernet/IP
106740	HGA, 100A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Ethernet/IP
106741	HGA, 150A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, Ethernet/IP
106742	HGA, 200A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, Ethernet/IP
106743	HGA, 250A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, Ethernet/IP
106744	HGA, 300A, 480V, Type 1 MCC, 35"W, HMI, 65kAIC, Ethernet/IP
106745	HGA, 50A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, DeviceNet
106746	HGA, 100A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, DeviceNet
106747	HGA, 150A, 480V, Type 1 MCC, 20"W, HMI, 65kAIC, DeviceNet
106748	HGA, 200A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, DeviceNet
106749	HGA, 250A, 480V, Type 1 MCC, 25"W, HMI, 65kAIC, DeviceNet
106750	HGA, 300A, 480V, Type 1 MCC, 35"W, HMI, 65kAIC, DeviceNet

Table 3.1: HarmonicGuard® Active Part Number Encoding

Standard Product Ratings and Dimension Tables

3.5.1 480V 40°C

Table 3.2: MCC Section

Current (A)	Heat Loss (Watts)	Dimensions (in. [cm]) H x W x D		
50	3,176	98.5 [250.2]	20 [50.8]	20 [50.8]
100	4,000	98.5 [250.2]	20 [50.8]	20 [50.8]
150	5,250	98.5 [250.2]	20 [50.8]	20 [50.8]
200	7,432	98.5 [250.2]	25 [63.5]	20 [50.8]
250	9,182	98.5 [250.2]	25 [63.5]	20 [50.8]
300	10,500	98.5 [250.2]	35 [88.9]	20 [50.8]

Table 3.3: HarmonicGuard® Active Filter Technical Specifications

Voltage ratings	480V, 3 phase, 60 Hz, three wire systems
Phase Sequence	Positive phase rotation: A-B-C (or L1-L2-L3)
Load types	3-phase diode bridge rectifier loads such as PWM AC drives *3-phase controlled rectifier (SCR or thyristor) loads, such as DC drives
Current ratings	See Corrective Current Ratings in Table 3.1
Maximum elevation	1,000 meters (3,280 feet) For every 100 meters (328 feet) over 1,000, de-rate by 1%. Maximum elevation is 3,000 meters (6,560 feet). For applications above 3000 meters consult factory.
Maximum Ambient operating temperature	40°C (104°F)
Minimum Ambient operating temperature	0°C (32°F) for ULType 1.
Ambient storage temperature	-20°C to 60°C for UL Type 1
Maximum humidity, operating or storage	95%, non-condensing
Enclosure options	UL Type 1 Enclosed
Agency approvals or certifications	UL and cUL Listed
Electronic overload / over current protection	Factory calibrated processor controlled electronic over current fault, and over load.
Over current protection:	All units have internal circuit breaker for protection of the converter section of the HGA. The customer must supply branch circuit protection.

*Please consult TCI regarding optimum filter performance when applied to DC drives.

4 ■ Section 4

Pre-installation Planning

4.1.1 Verify the Application

HGA Ratings

Make sure that the HarmonicGuard® Active filter is correct for the application and sized for load. The voltage ratings of the HGA must match the input voltage rating of the connected AC bus.

4.1.2 Select a Suitable Location

Environment

Locating the HarmonicGuard® Active filter in a suitable environment will help assure proper performance and a normal operating life. Refer to the environmental specifications listed in **Figure 3.2**, marked on the unit's nameplate 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).

UL Type 1 and MCC mounted chassis units shall be installed in a pollution degree 2 environment (UL 508) where it will not be exposed to:

- Direct sunlight
- Rain or dripping liquids
- Corrosive liquids or gases
- Explosive or combustible gases or dust
- Excessive airborne dirt and dust
- Excessive vibration [0.152 mm (0.006 in.) displacement, 1G peak]

4.1.3 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. Refer to the applicable installation drawing for clearances.

Installation Guidelines

4.2.1 Mounting

The HGA must be mounted vertically on a smooth, solid surface, free from heat, dampness, and condensation. Refer to the applicable installation drawing for clearances. Refer to the CENTERLINE 2100 Low Voltage Motor Control Center Installation Manual for information on anchoring and securing an MCC.

4.2.2 Rooftop Cooling Vents

The MCC section ships from TCI with separate covers for the rooftop cooling vents. These vents should be installed in the roof upon receipt of MCC section. The active filter must have sufficient cooling to operate without shutdown. See **Figure 4.1** to see how to snap hoods over rooftop cooling openings. For adequate airflow, installation location should have 12" clearance between top surface of MCC enclosure to roof above MCC vents.

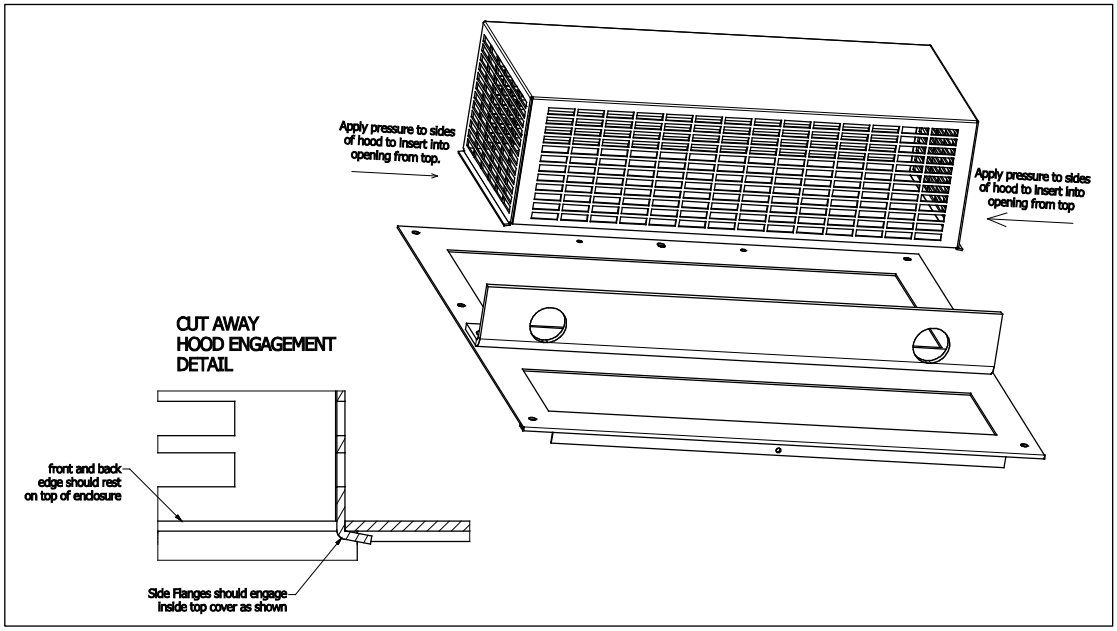


Figure 4.1: MCC Snap-in Hood

4.2.3 Wiring

Cable Entry Locations

Wiring will enter the Low Voltage Motor Control Center section through the upper and lower wiring sections.

Circuit Breaker

See tables below for field wiring terminal wire size and tightening torque information.

Field Wiring Connection Terminals

Compression type terminals are provided for all field wiring connections. The wire size (75°C copper) capacity ranges and tightening torque for the grounding and power terminals are listed in the tables that follow. Refer also to the drawings and other information shipped with the unit. When paired with and fed from a Rockwell MCC, the Active Filter will be fed from an MCC bucket using a Rockwell 140G circuit breaker.

Table 4.1: 480V - Power Terminal Wire Size Capacity Range and Tightening Torque for Active Filter Ground Lug

Filter Size	Ground Lugs		
480V Units	**Wire Size***	**Torque In-Lbs (Nm)**	**Wire Type**
45A to 100A	6 AWG - 2/0	50 (5.7)	CU/AL
150A	6 AWG - 2/0	50 (5.7)	CU/AL
200A	4 AWG - 2/0	50 (5.7)	CU/AL
250A	6 AWG - 250 MCM	375 (42.4)	CU
300A	3 AWG - 500 MCM	375 (42.4)	CU/AL

Note: Wire size range listed is for lug as per lug manufacturer. Follow NEC guidelines for sizing ampacity of power conductors.

Table 4.2: 480V - Power Terminal Wire Size Capacity Range and Tightening Torque for Active Filter Models with Rockwell Allen Bradley Circuit Breakers

Filter Size	MFG	Breaker IC	CB Power Terminals		
480V			**Wire Size***	**Torque In-Lbs (Nm)**	**Wire Type**
45A to 50A	Rockwell Allen Bradley	65 kA	14 to 1/0 Awg	62 (7)	CU Only
90A to 100A	Rockwell Allen Bradley	65 kA	14 to 1/0 AWG	62 (7)	CU Only
150A	Rockwell Allen Bradley	65 kA	4 to 300 MCM	200 (23)	CU/AL
200A	Rockwell Allen Bradley	65 kA	4 to 300 MCM	200 (23)	CU/AL
300A	Rockwell Allen Bradley	65 kA	(2) 2/0 - 250 MCM	274 (31)	CU/AL
45A to 50A	Rockwell Allen Bradley	100 kA	14 to 1/0 Awg	62 (7)	CU Only
90A to 100A	Rockwell Allen Bradley	100 kA	14 to 1/0 AWG	62 (7)	CU Only
150A	Rockwell Allen Bradley	100 kA	4 to 300 MCM	200 (23)	CU/AL
200A	Rockwell Allen Bradley	100 kA	4 to 300 MCM	200 (23)	CU/AL
250A	Rockwell Allen Bradley	100 kA	(2) 2/0 - 250 MCM	274 (31)	CU/AL
300A	Rockwell Allen Bradley	100 kA	(2) 2/0 - 250 MCM	274 (31)	CU/AL

***Note**: Wire size range listed is for lug as per lug manufacturer. Follow NEC guidelines for sizing ampacity of power conductors.

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. Use wire with an insulation temperature rating of 75°C or higher.

Connection Diagram

Figure 4.2 shows the typical wiring connections between the models of the HGA and the load. Refer to the drawings furnished with the unit for more specific information.

- The input 3-phase AC voltage source must be connected in a positive ABC phase rotation from L1-L2-L3 for correct unit operation.

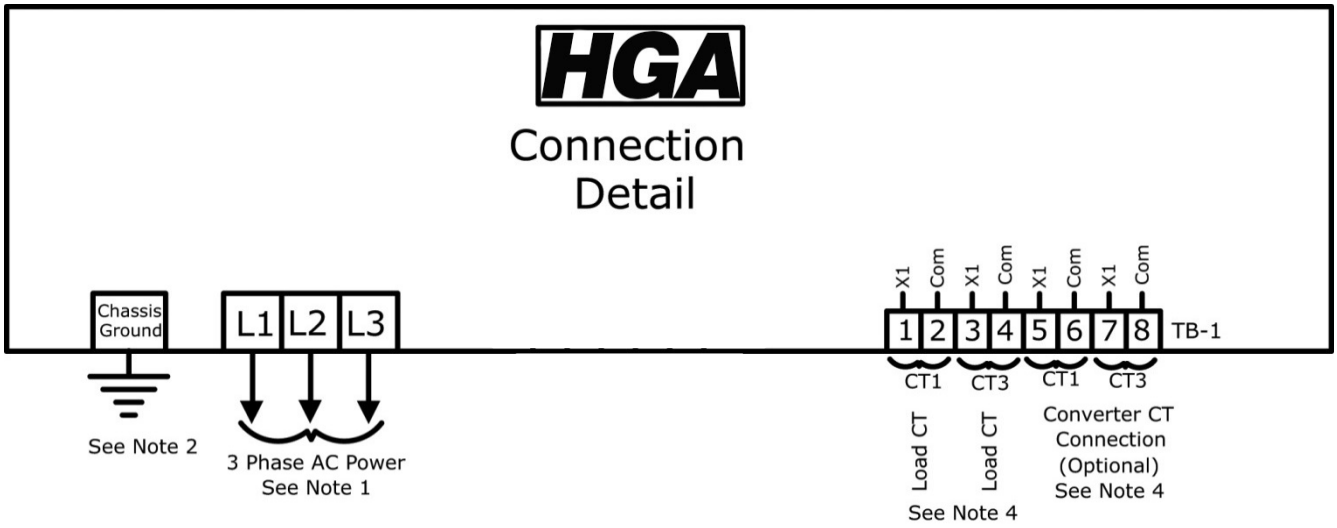


Figure 4.2: Load Connection Diagram

Notes:

1. Wiring should be 75°C or higher insulated copper, with the appropriate voltage and current rating.
2. Chassis ground must be connected to the ground of the premises wiring system, in accordance with NEC and local codes. Connection must be made using a wire conductor.
3. Terminal TB-I & J25 wire range is 30-12 AWG, tightening torque is 4.4 IN-LB (0.5 NM).
4. Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals, which may be dangerous to personnel or equipment.

4.2.4 Current Transformer Installation

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

Warning 	All electrical installation and maintenance work on the HGA should be carried out by qualified electricians only. Failure to follow standard safety procedures may result in death or serious injury. Do not attempt any work on a powered HGA. Disconnect all sources of power to the drive and HGA before working on the equipment. Check for zero voltage between all phases of the input and output lines. **Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment.**

It is necessary for the HGA to monitor the current in Phase "A" (L1) and Phase "C" (L3). Stand-alone HGA filters are designed for Line Side current transformer (CT) placement, as shown in **Figure 4.3**. It is important that both CTs are on the same side of the HGA. The CTs should be centered around the conductor. Optional Load Side CT placement is available for single units as shown in diagram 4.3. Customer should also remove ALC internal CT shorting jumpers for normal filter operation. Remove the two terminal jumpers from block TB as show in Figure 4.4.

The polarity of the CT is important; the "H1" marking on the CT must face the source. The secondary windings of the CT around conductor L1 should connect to TB-1 terminals 1 & 2 and the CT around conductor L3 should connect to TB-1 terminals 3 & 4. The secondary wire of the CT identified as "X1" must connect to the "X1" terminal of TB-1 for both CTs. Failure to maintain the correct polarity and phasing will cause an over-current fault. If this should happen, refer to the troubleshooting section.

Note: Units with black "TB-1" terminal blocks are shipped with two position shorting jumpers installed between positions 1 & 2 and 3 & 4. This is done for your safety and to prevent equipment damage. The jumpers are installed in the center of the block and can be identified by the gray top. After the load CTs are installed and wired, these jumpers must be removed for correct unit operation. They can be removed with a standard flat blade screw driver.

Note: CT operation can be verified via the HMI touchscreen feedback waveform plot screens. Reference the HMI VLine & ILine Waveform Plot Sub Screen in **Section 7** for details.

Table 4.3: CT Range by Model Size

Amps	CT Min Ratio	CT Max Ratio	Notes
50/100, 480V	250:5	3000:5	***Factory technician start up required to use CTs outside of the published range.***
150, 480V	300:5	4000:5	
200, 480V	750:5	3000:5	
250, 480V	600:5	5000:5	
300, 480V	1000:5	4500:5	

4.2.5 Current Transformer Placement

The exact CT placement is dependent on the HGA's configuration and size. Please refer to the following current transformer diagrams for the installation that applies to your configuration.

The HGA is factory configured for Line/Bus Applied/Master operation.

Maximum CT Wire Length

The values shown in **Table 4.4** represent the worst case max CT wire length given the lowest CT Volt-Amp rating, supplied by TCI, in the given CT ratio range. Many CTs, especially ratios above 2000:5, have more VA capability and can support longer wire runs. If a longer CT cable run is required, the max wire length for a specific CT can be determined following the max CT wire length determination method shown in TCI CT drawing 26461. Please consult TCI Technical Support if needed for guidance on the max CT wire length determination.

Table 4.4: Max CT wire length by Wire Gauge

Wire Gauge (AWG)	Max Length for CTs below 1000:5 (feet)	Max Length for CTs 1000:5 and above (feet)
#8	120	250
#10	65	155
#12	40	100
#14	25	60

HGA

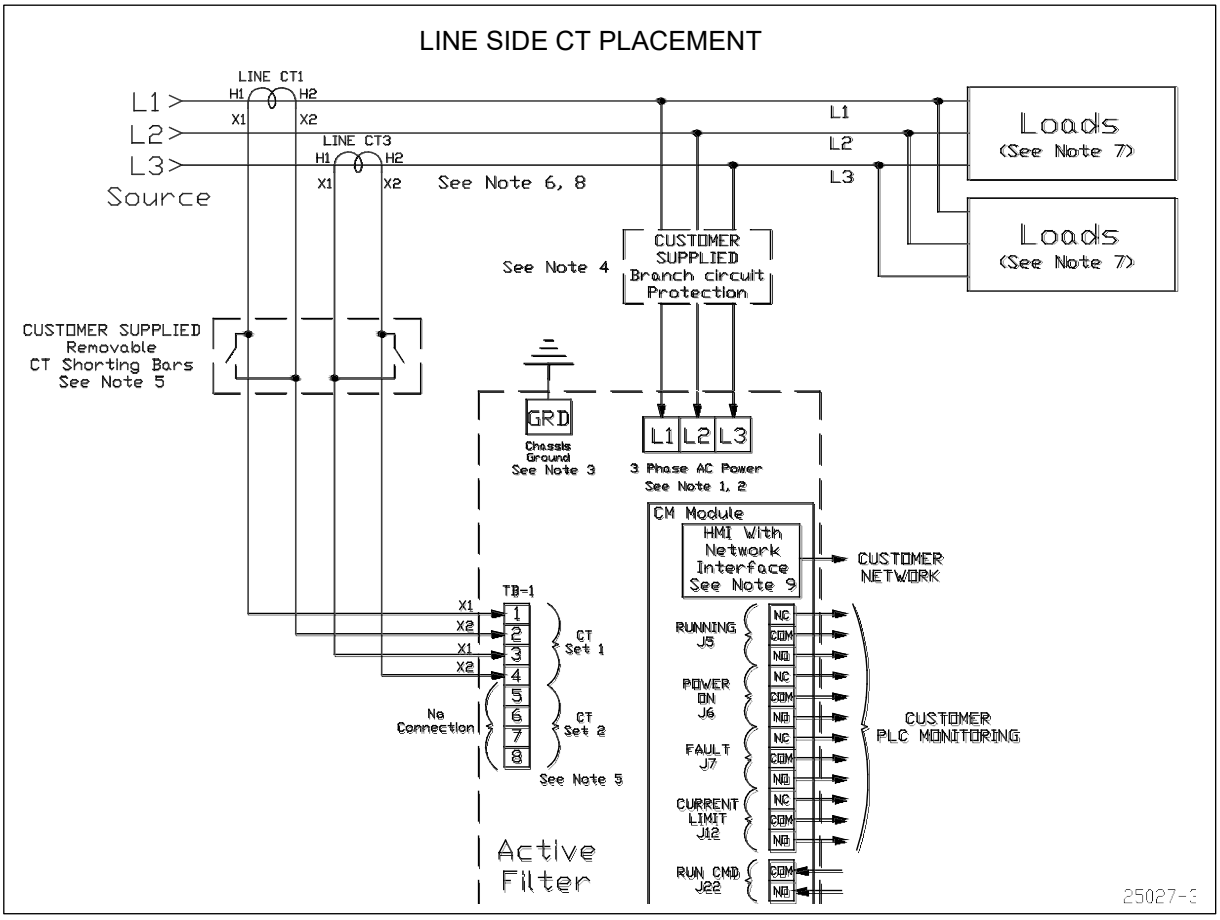


Figure 4.3: HGA 480V Single Unit Line Side / Bus Applied Connection Diagram

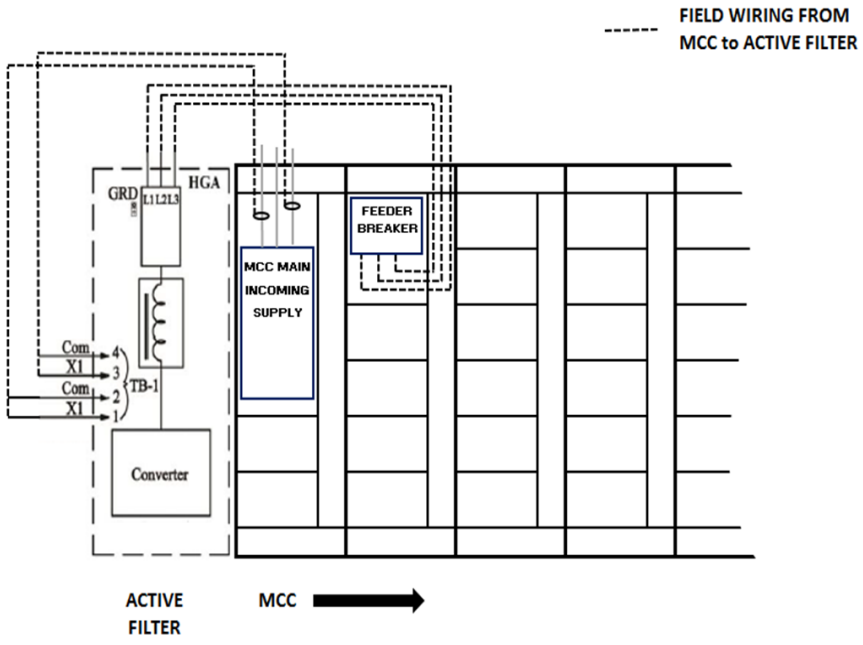


Figure 4.4: Wiring to MCC Main Incoming Supply

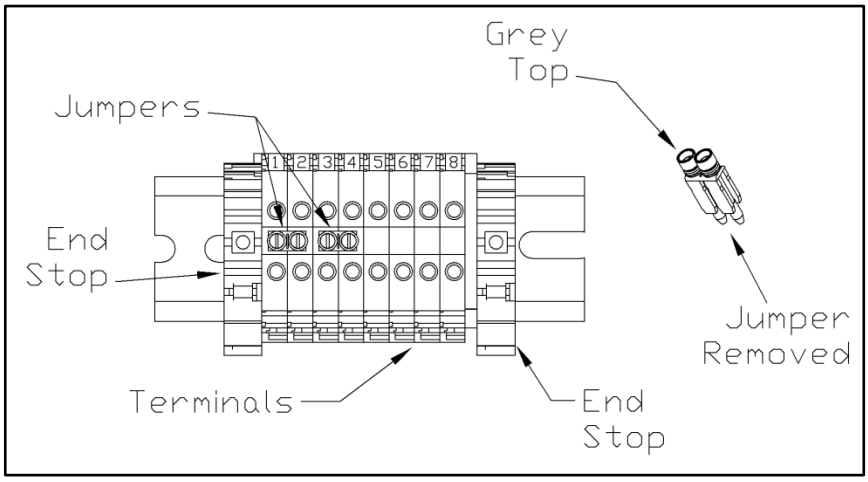
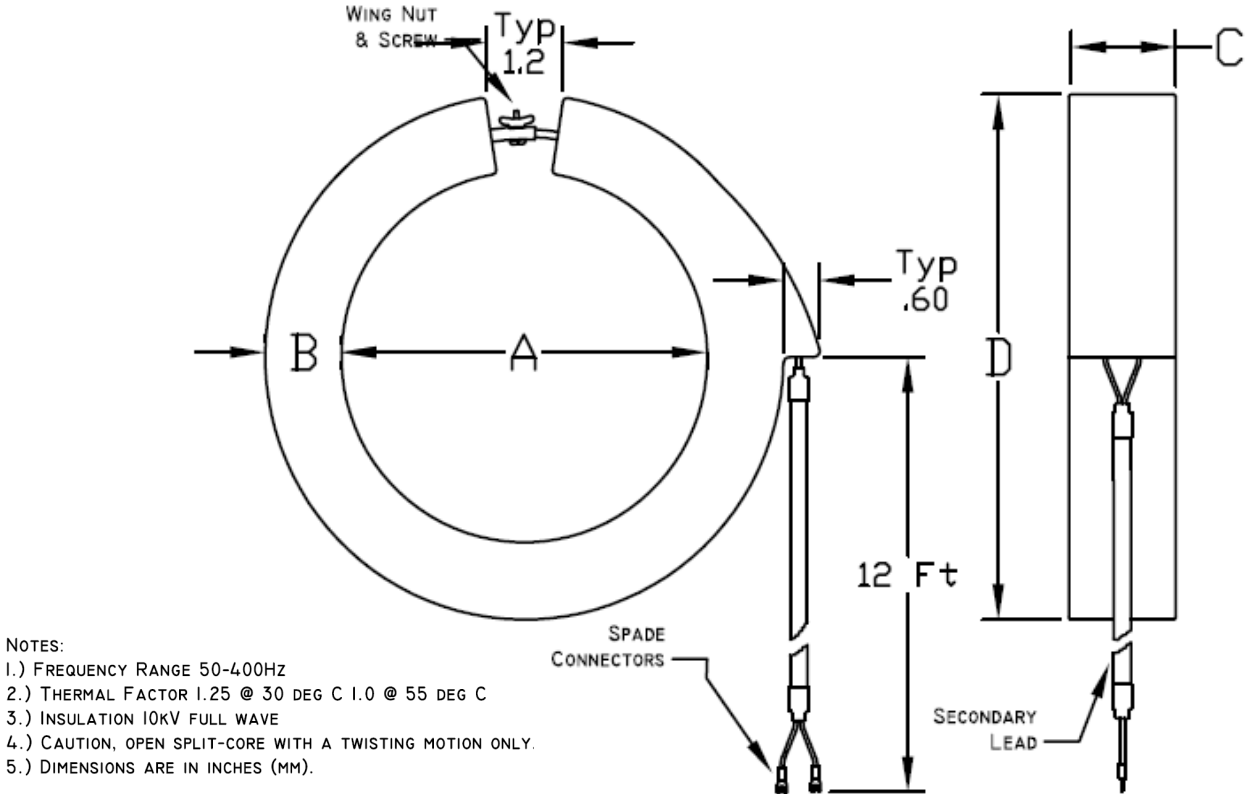


Figure 4.5: TB-1 Terminal Block

During installation, customer to remove customer supplied CT shorting jumpers shown in diagram 4.3. Customer should also remove ALC internal CT shorting jumpers for normal filter operation. Remove the two terminal jumpers from terminal block TB as shown in Figure 4.4.

Notes:

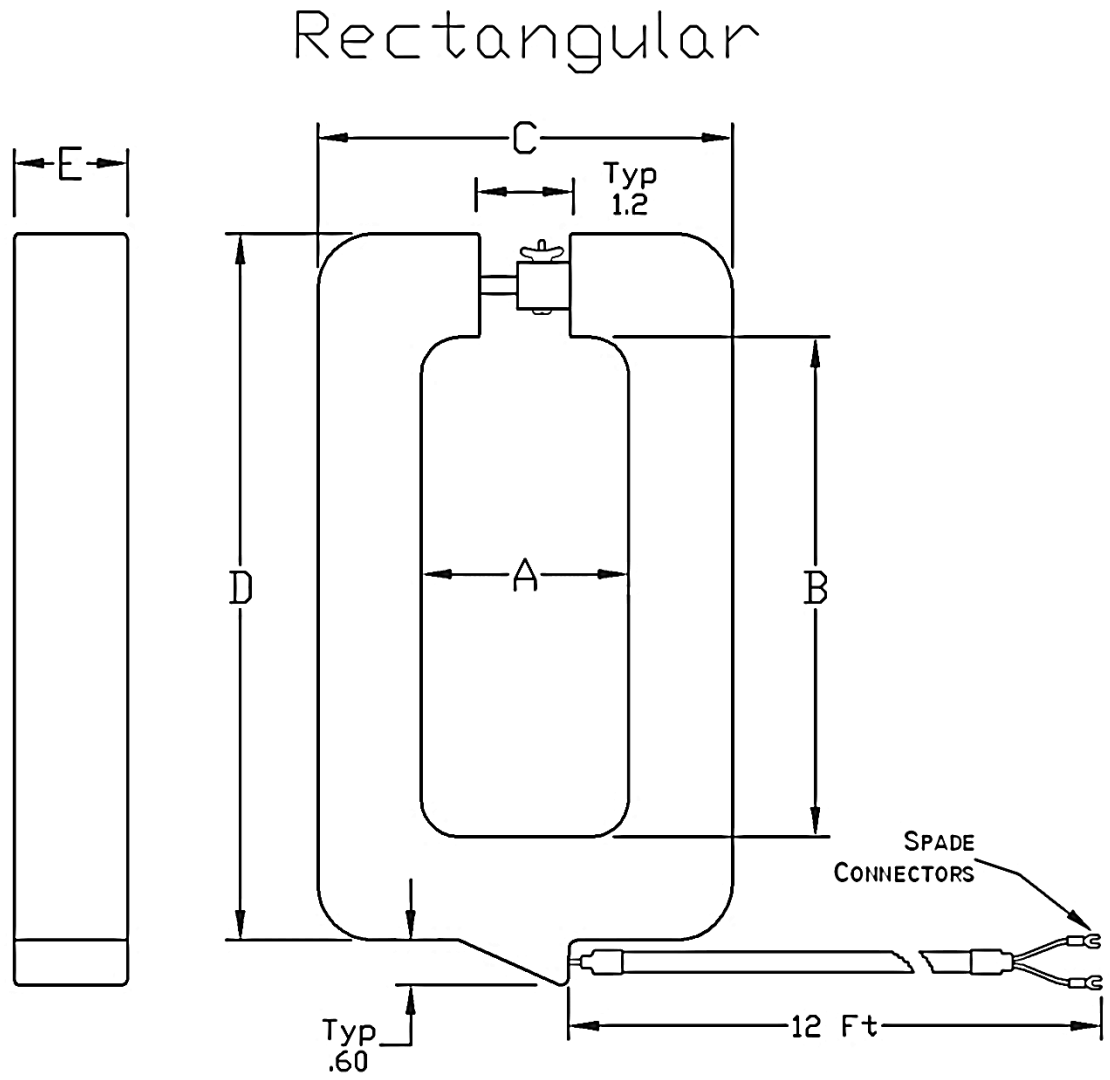
1. Wiring should be 75°C or higher insulated copper, with the appropriate voltage and current rating.
2. Chassis ground must be connected to the ground of the premises wiring system, in accordance with NEC and local codes. Connection must be made using a wire conductor.
3. Customer is responsible for branch circuit protection.
4. Terminal TB-1 & J25 wire range is 30-45 Awg, tightening torque is 4.4 in-lb (.5 Nm).
5. Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals, which may be dangerous to personnel or equipment.
6. Current transformers should be centered around the conductor.
7. Load(s) have an integral 3% line reactance or equivalent DC bus choke to optimize Active Filter utilization, consult TCI for Active filter capacity with less than 3%.
8. Source CT's are customer installed and external to the active filter.



NOTES:
1.) FREQUENCY RANGE 50-400Hz
2.) THERMAL FACTOR 1.25 @ 30 DEG C 1.0 @ 55 DEG C
3.) INSULATION 10KV FULL WAVE
4.) CAUTION, OPEN SPLIT-CORE WITH A TWISTING MOTION ONLY.
5.) DIMENSIONS ARE IN INCHES (MM).

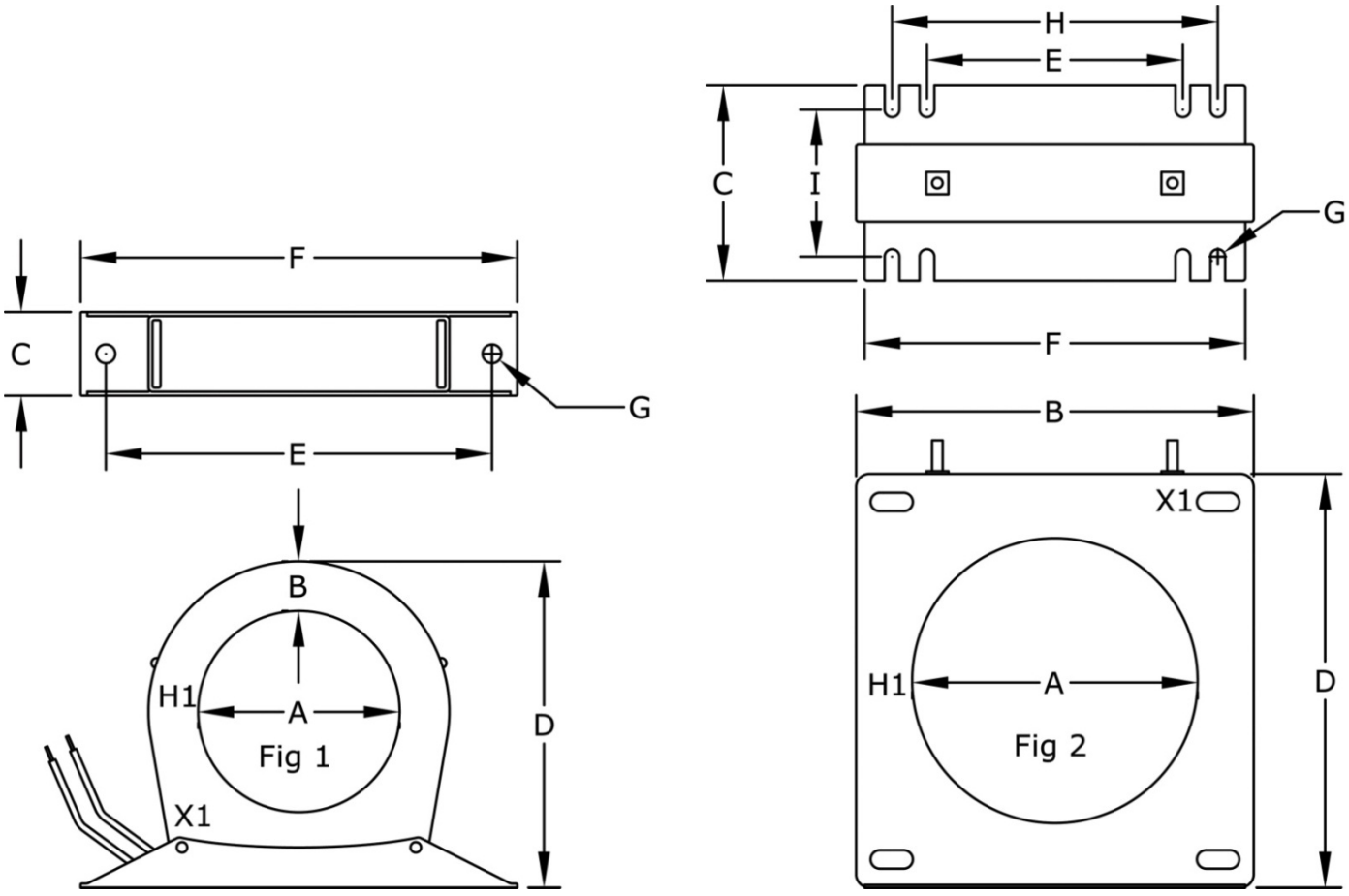
				Dimensions in Inches (mm)			
Catalog #	Current Ratio	VA Rating	Burden Value (Ohms)	A	B	C	D
KCTF0200B04	200:5	2.5	0.1	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF0400B04	400:5	2.5	0.1	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF0500B04	500:5	2.5	0.1	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF0500B06	500:5	2.5	0.1	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF0600B06	600:5	5.0	0.2	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF0600B04	600:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF0800B04	800:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF1000B04	1000:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF1000B06	1000:5	5.0	0.2	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF1200B04	1200:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF1500B04	1500:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF1600B04	1600:5	15	0.6	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF1600B06	1600:5	15	0.6	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF1600B08	1600:5	15	0.6	8 (203.2)	1 1/4 (31.8)	1 1/2 (38.1)	10.5 (266.7)
KCTF2000B04	2000:5	25	1.0	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF2000B06	2000:5	25	1.0	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF3000B06	3000:5	45	1.8	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCTF5000B08	5000:5	45	1.8	8 (203.2)	1 1/4 (31.8)	1 1/2 (38.1)	10 1/2 (266.7)
KCT3F1200B04	1200:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCT3F1500B04	1500:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCT3F1600B04	1600:5	15	0.6	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCT3F2000B06	2000:5	25	1.0	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCT3F2500B06	2500:5	35	1.4	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCT3F3000B06	3000:5	45	1.8	6 (152.4)	1 1/4 (31.8)	1 1/2 (38.1)	8 1/2 (215.9)
KCT3F1000B04	1000:5	5.0	0.2	4 (101.6)	1 1/4 (31.8)	1 1/2 (38.1)	6 1/2 (165.1)
KCTF3000B08	3000:5	45.0	1.8	8 (203.2)	1 1/4 (31.8)	1 1/2 (38.1)	10 1/2 (266.7)

Figure 4.6: Current Transformer Diagram – Round



Catalog #	Current Ratio	VA Rating	Burden Value (Ohms)	A	B	C	D	E
KCTF0500A02	500:5	2.5	0.1	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF1000A02	1000:5	5.0	0.2	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF1200A02	1200:5	5.0	0.2	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF1600A02	1600:5	15	0.6	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF2000A02	2000:5	25	1.0	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF3000A02	3000:5	45	1.8	2 3/4 (69.9)	6 5/8 (168.3)	5 1/2 (139.7)	9 3/8 (238.1)	1 1/2 (38.1)
KCTF5000A04	5000:5	45	1.8	4 (101.6)	11 (279.4)	6 1/2 (165.1)	13 3/8 (339.7)	1 1/2 (38.1)

Figure 4.7: Current Transformer Diagram – Rectangular



Catalog #	Current Ratio	VA Rating	Burden Value (Ohms)	A	B	C	D	E	F	G	H	I	Fig
KCTF0500B03	500:5	25.0	1.0	2 (50.8)	.99 (25.2)	1 1/4 (31.8)	4.7 (119.4)	5 3/4 (146.1)	6 1/2 (165.1)	0.28 (7.1)	N/A	N/A	1
KCTF0800B2.5	800:5	35.0	1.40	2 (50.8)	.99 (25.2)	1 1/4 (31.8)	4.7 (119.4)	5 3/4 (146.1)	6 1/2 (165.1)	0.28 (7.1)	N/A	N/A	1
KCTF1000B03	1000:5	13.8	0.55	3 (76.2)	0.74 (19.1)	1 1/4 (31.8)	4.7 (119.4)	5 3/4 (146.1)	6 1/2 (165.1)	0.28 (7.1)	N/A	N/A	1
KCTF1200B03	1200:5	10.0	0.40	3 (76.2)	0.74 (19.1)	1 1/4 (31.8)	4.7 (119.4)	5 3/4 (146.1)	6 1/2 (165.1)	0.28 (7.1)	N/A	N/A	1
KCTF1600C4.3	1600:5	15.0	1.00	4.3 (109.2)	5.9 (149.9)	2.9 (73.7)	6.2 (157.5)	3.8 (96.5)	5.7 (144.8)	0.22 (5.6)	4.9 (124.5)	2.2 (55.9)	2
KCTF2000B03	2000:5	13.8	0.55	3 (76.2)	0.74 (19.1)	1 1/4 (31.8)	4.7 (119.4)	5 3/4 (146.1)	6 1/2 (165.1)	0.28 (7.1)	N/A	N/A	1
KCTF2500C4.3	2500:5	20.0	0.80	4.3 (109.2)	5.9 (149.9)	2.9 (73.7)	6.2 (157.5)	3.8 (96.5)	5.7 (144.8)	0.22 (5.6)	4.9 (124.5)	2.2 (55.9)	2
KCTF0800C4.3	800:5	30.0	1.20	4.3 (109.2)	5.9 (149.9)	2.9 (73.7)	6.2 (157.5)	3.8 (96.5)	5.7 (144.8)	0.22 (5.6)	4.9 (124.5)	2.2 (55.9)	2
KCTF1000C4.3	1000:5	30.0	1.20	4.3 (109.2)	5.9 (149.9)	2.9 (73.7)	6.2 (157.5)	3.8 (96.5)	5.7 (144.8)	0.22 (5.6)	4.9 (124.5)	2.2 (55.9)	2
KCTF2000C4.3	2000:5	20.0	0.80	4.3 (109.2)	5.9 (149.9)	2.9 (73.7)	6.2 (157.5)	3.8 (96.5)	5.7 (144.8)	0.22 (5.6)	4.9 (124.5)	2.2 (55.9)	2

Figure 4.8: Current Transformer Diagram – Solid Core

Grounding

The HarmonicGuard® Active filter 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 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.

4.2.6 CM Module Serial Cable Connection for MCC Mounted Units

Overview

The HGA unit's communications module (CM) is installed in the door of the MCC section. The CM module assembly contains the HMI touchscreen, communications interface PCB, and any network interface gateway included with the unit.

One end of the serial cable is plugged into the communications interface PCB on the CM module. The other end of the communications cable is plugged into one or more power converters on the main active filter chassis.

CM Module Serial Cable Connection

See **Figure 4.9** for the location of the J2 Chassis Communication Cable connection on the CM module.

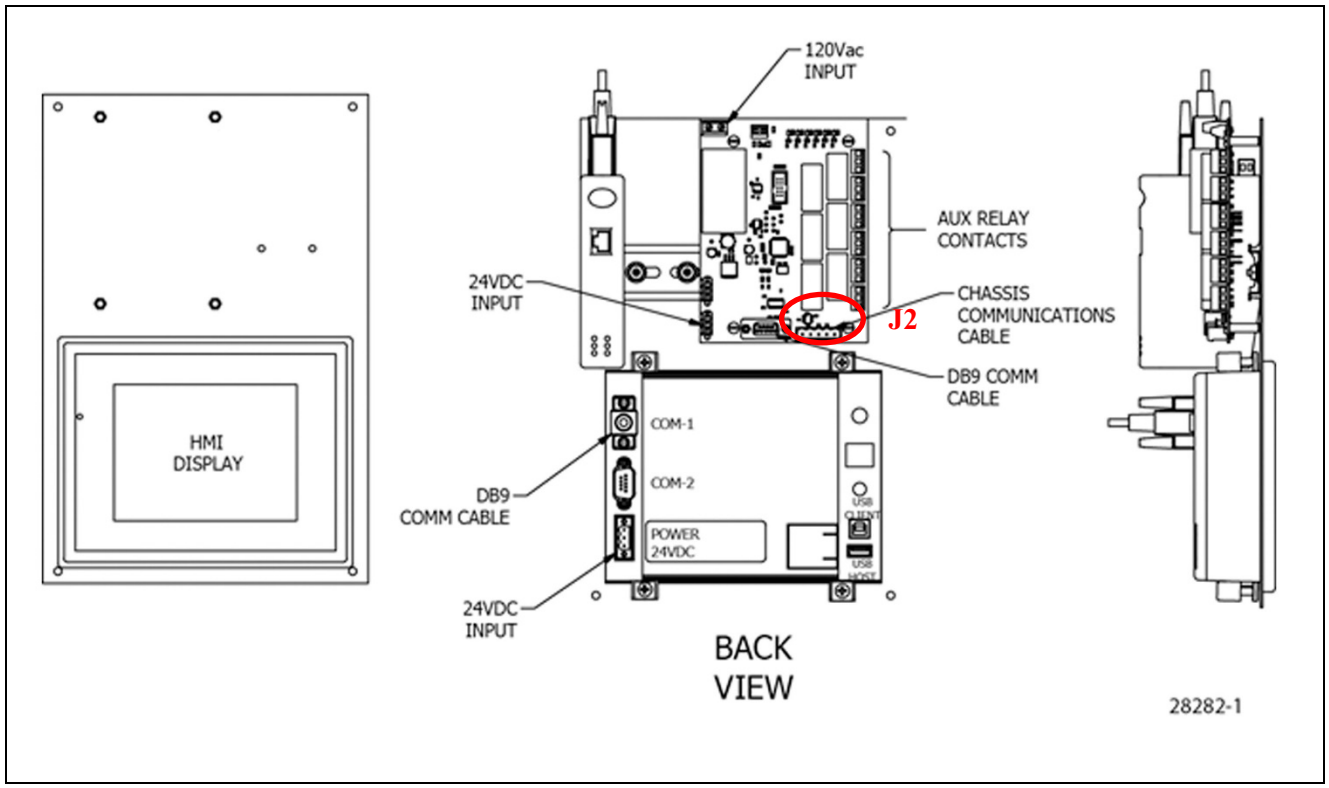
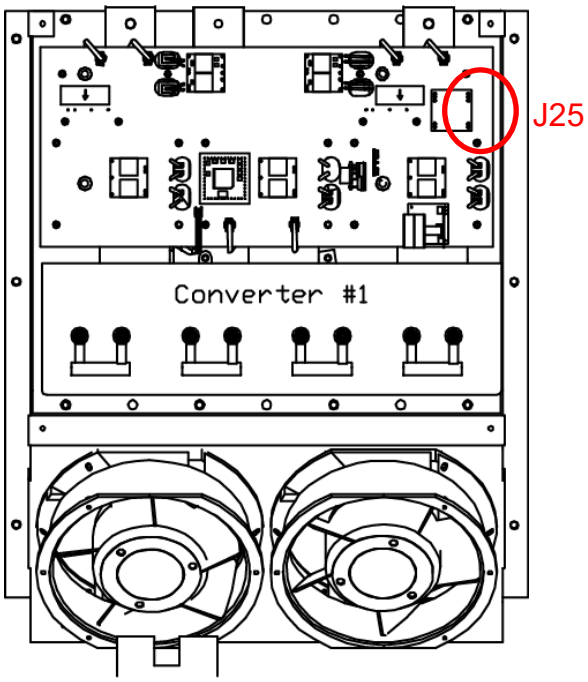


Figure 4.9: HGA CM Module with Chassis Communications Cable Serial Connector J2 Highlighted

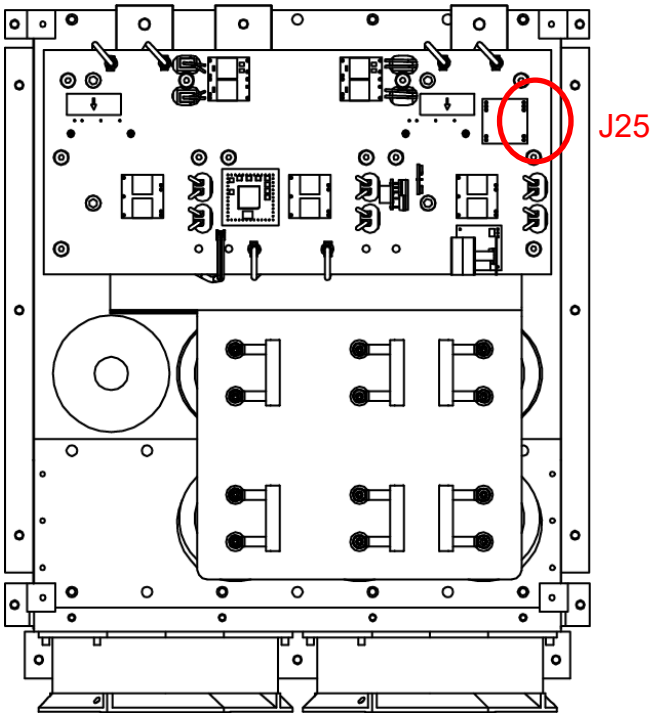
Power Converter Serial Cable Connections

NOTE: Do not connect the serial cable while the HGA unit is powered. Remove and lockout power prior to installing the serial cable.

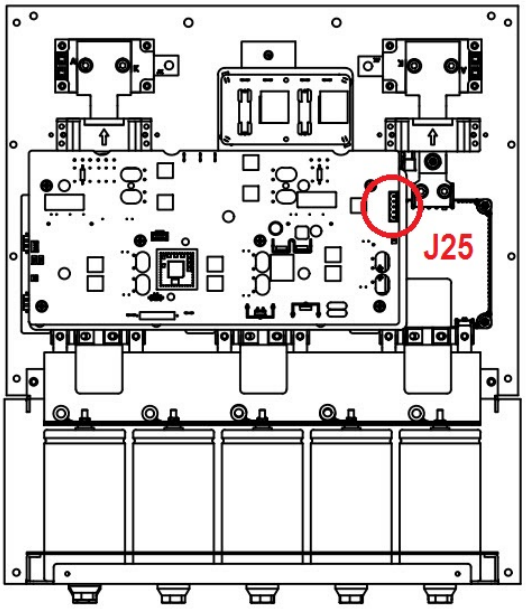
The power converter is located on the bottom half of the HGA panel. See **Figure 4.10** for the location of the J25 connection on the power converter module. The J25 connection is below the power converter arch shield.



480V 50A/100A/200A



480V 150A/300A



480V 250A/500A

Figure 4.10: HGA Power Converter Module with Serial Connector J25 Highlighted in Red

4.2.7 Serial Cable Termination Setup

NOTE: The serial cable termination configuration for the HGA units are setup during assembly and test of the unit. For new installations, the end user does not need to manually configure the serial cable termination DIP switches on the power converters. These instructions only need to be followed if a new power converter is being installed for repair.

In the HGA, the serial communications cable between the Communications Interface PCB and the Power Converters is implemented with RS-485 differential transceivers. These differential transceivers are very robust in noisy industrial environments, as long as the serial communication bus is properly configured with a termination resistor at each end of the communications cable.

In the HGA, the Communications Interface PCB is one end point of the serial communications bus and has a built in bus termination resistor that is always in circuit.

The other end point of the serial communications cable will be at one of the active filter power converters. The power converter at the end of the communications cable should be configured with the bus termination resistor in circuit or ON. The bus termination resistor on/off DIP switch is located near the J25 serial cable header (reference **Figure 4.11**)

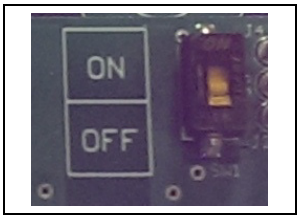


Figure 4.11: Power Converter PCB Serial Cable Termination Resistor ON/OFF Switch.

For single power converter systems (480V 50A, 100A, 150A), the bus termination resistor DIP switch should always be set to on. For systems with two or more power converters (480V 200A 300A), only the bus termination resistor DIP switch of the power converter at the end of the serial cable should be set ON. For multi power converter systems, additional power converters located in the middle of the serial communication cable should have their bus termination resistors out of circuit or OFF (reference **Figure 4.12**).

A piece of thin, adhesive tape will be covering the bus termination switch. This tape is used to keep the conformal PCB sealant out of the switch mechanism during PCB assembly. This covering will need to be removed in order to change the switch's ON/OFF position.

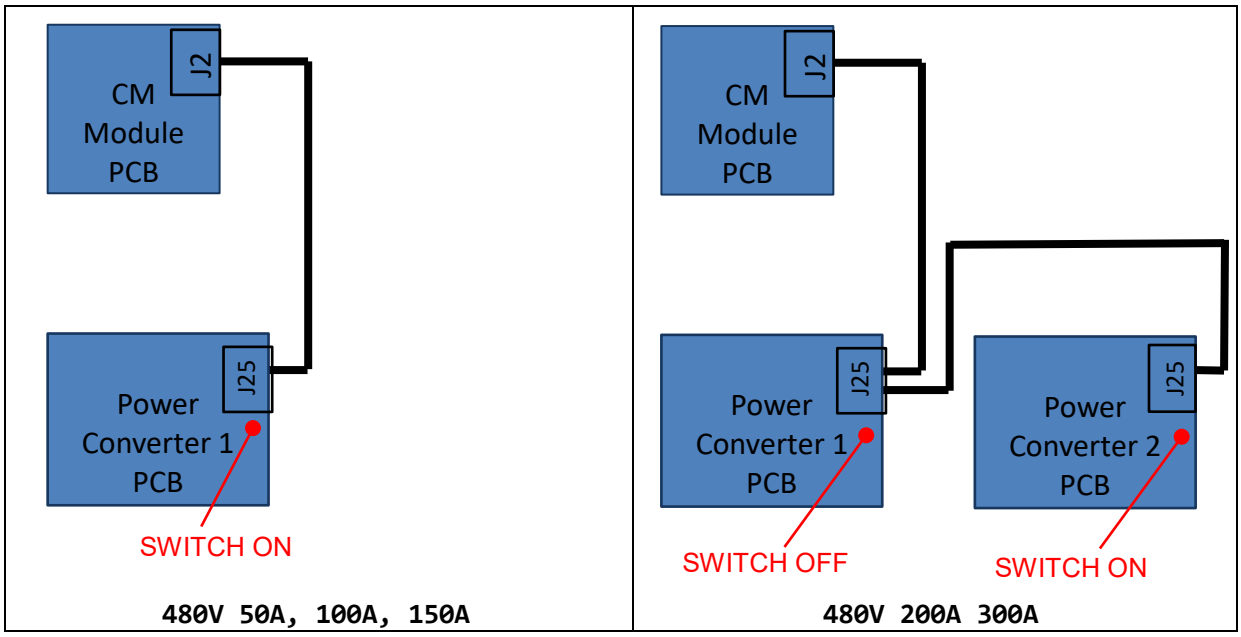


Figure 4.12: HGA Serial Cable Connection Diagram and Serial Bus Termination Switch Configuration

HarmonicGuard® Active Filter Operation

4.3.1 Adjustments

- The HGA has been factory calibrated and thoroughly tested. There is no need to make any adjustments.

4.3.2 Start Up (Commissioning)

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.

- If it is a floor mount unit, check to see that it is securely anchored to the floor.
- Check the panel and the inside of the enclosure for any foreign objects, dirt, metal filings, wire whiskers, and loose hardware.
- Verify that any covers or guards, which were removed during installation, were reinstalled.
- Ensure that the unit is properly grounded.
- Check for properly tightened connections.

4.3.3 General Operation

Please reference **Section 1** for the first time power up procedure.

Warning	
	Since the HGA is an active filter, it is always operating whenever the power is applied.

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

Warning	
	Be aware that everything ahead of the circuit breaker will still be energized. It is important to note that the lack of lit LEDs does not necessarily mean that the HGA is not receiving power from an external source.

5 ■ Section 5

Maintenance and Service

5.1.1 HGA Reliability and Service Life

The HGA has been designed and thoroughly tested at the factory to ensure that it will perform reliably from the time it is put into service. The following periodic maintenance is recommended to ensure that the HarmonicGuard® Active filter will always perform reliably and provide the expected service life.

5.1.2 Periodic Maintenance

The following checks should be conducted monthly or more frequently when installed in harsh or dusty environments.

- Check to see that the installation environment remains free from excessive vibration, exposure to excessive dirt, moisture, and contaminants. Refer to the **Section 4** 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 for any dust or dirt build-up on the fans and heat sink fins.
- 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.
- Check the integrity of all power, ground, and control wiring connections.
- All electrical connections must be re-torqued annually.

Warning 	Many electronic components located within the filter are sensitive to static electricity. Voltages imperceptible to human touch can reduce the life and affect performance, or destroy sensitive electronic devices. Use proper electrostatic discharge (ESD) procedures when servicing the filter and its circuit boards.
Warning 	Only qualified electricians should carry out all electrical installation and maintenance work on the HGA. Disconnect all sources of power to the drive and HGA before working on the equipment. Do not attempt any work on a powered HGA. This HGA unit contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the filter before you attempt 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 will still be energized.**

Reference Drawings

Electrical schematic drawings for typical HGA configurations are listed in **Table 5.1** General Schematic for HGA Units by Frame Size.

There could be slight differences between your unit and the configurations shown in this manual. It is recommended that you refer to the drawings provided with your specific equipment when conducting troubleshooting operations. Reference schematics are also available online for download at www.transcoil.com on the HGA active filter product page.

Table 5.1: General Schematic for HGA Units by Frame Size

HGA Frame Size	Schematic
50-100A	26463-04
150A	29070
200A	29071
250A	29071
300A	29071

5.1.3 Overload / Over Current Protected

The filter has factory set built-in electronic overload and over current protection. If the converter current exceeds the preset instantaneous peak, the converter will shut down to prevent permanent damage to the converter, and at which time, it will indicate a fault. Faults that do not automatically reset can be cleared by pressing the stop button on the HMI display.

An indication that the filter is going into overload will be observed by a gradual worsening of the total harmonic distortion (THD), or power factor, as the load increases. The HGA filter units can be paralleled to increase total corrective current capability if a unit is undersized for a particular application. Call TCI technical support for options to expand the installed system current capability.

Circuit Breaker Protection

Each converter section is protected by a thermo magnetic circuit breaker; in the event the HGA experiences a catastrophic failure, or a destructive over current condition should occur. It also provides a convenient disconnect means to isolate the converter from the power source. The size and type of circuit breaker must not be altered without consulting TCI engineering since the circuit breaker is an integral part of the UL file.

Notes:

- MCC mounted chassis units can be provided without circuit breakers. The end user must protect the HGA with the following UL listed thermal magnetic common trip molded case circuit breaker.
- 50Amp to 100 Amp 480V: A max peak let-through current of 26 kA in correspondence with a short circuit of 100 kA at 480 volt. The trip current for the 50A active filters must be 100 Amps and the 100A active filters must be 125 Amps.
- 150Amp 480V: A max peak let-through current of 35 kA in correspondence with a short circuit of 100 kA at 480 volt. The trip current for the 150A active filter must be 175Amps.
- 200Amp 480V: A max peak let-through current of 35 kA in correspondence with a short circuit of 100 kA at 480 volt. The trip current for the 200A active filter must be 225 Amps.
- 250Amp 480V: A max peak let-through current of 55 kA in correspondence with a short circuit of 100 kA at 480 volt. The trip current for the 300A active filter must be 300 Amps.
- 300Amp 480V: A max peak let-through current of 55 kA in correspondence with a short circuit of 100 kA at 480 volt. The trip current for the 300A active filter must be 350 Amps.

Table 5.2: Active Filter 65kAIC Circuit Breaker Manufacturer Part Number and Trip Ratings.

65kAIC HGA Circuit Breaker Rating		
HGA Unit Rating*	**Allen Bradley Circuit Breakers - Option 4000**	
480VAC	**Amps****	**MFG P/N**
45A to 50A	100	140G-G6C3-D10
90A to 100A	125	140G-H6F3-D12
150A	175	140G-J6F3-D17
200A	225	140G-J6F3-D22
250A	275	140G-K6F3-D30
300A	350	140G-K6F3-D40

*The HGA controls have a current limit that limits the filter output current to the amp rating of the active filter.
**Circuit Breaker trip should be set to Amps listed following manufacturer's instructions.

Table 5.3: Active Filter 100kAIC Circuit Breaker Manufacturer Part Number and Trip Ratings.

100kAIC HGA Circuit Breaker Rating		
HGA Unit Rating*	**Allen Bradley Circuit Breakers - Option 5000**	
480VAC Units	**Amps****	**MFG P/N**
50A	100	140G-H0F3-D10
100A	125	140G-H0F3-D12
150A	175	140G-J0F3-D17
200A	225	140G-J0F3-D22
250A	275	140G-K0F3-D30
300A	350	140G-K0F3-D40

*The HGA controls have a current limit that limits the filter output current to the amp rating of the active filter.
**Circuit Breaker trip should be set to Amps listed following manufacturer's instructions.

Warning 	If the system breaker has been tripped, do not attempt to re-energize the HGA unit until the cause of the trip has been determined.

Pre-Charge Circuit Over Current Protection

SCR's are used to limit the converter power up in-rush current to a safe level once the converter DC voltage has reached the threshold, SCRS will be turned on and the charging resistor will be cut off from the unit. If for some reason this circuitry should malfunction, class CC fuses are in the circuit to limit the max current as not to exceed the ratings of the components.

Note: on the 50, 100, 200 amp units the fuses are located on the chassis; on the 150, 250, 300 amp units the fuses are located on a separate circuit board above the chassis.

Over Temperature Protection

The converter has a thermal fold back mechanism that will automatically reduce unit output current as the converter temperature approaches its shutdown threshold. Additionally, the converter has an internal heat sink over temperature protection which will shut down the converter if the threshold is exceeded. The fans will continue to run and once the heat sink cools down the converter will automatically restart if the auto restart feature is enabled.

There is a secondary over temperature circuit which monitor the temperature of the power resistors and inductors located on the chassis of the HGA. The sensor is a snap action switch activated when the over temperature threshold is reached. This over temp would be an indication that cooling fans have failed or there is a problem with the filtering inductor or converter. The fans will continue to run and once the thermal switch resets the converter will automatically restart if the auto restart feature is enabled.

Note that if a fault continues to occur repeatedly this likely indicates something more serious with the operation of the converter or filtering inductors has occurred. In this case the unit will shut down on an auto restart limit fault once the set number of faults has occurred in a set time frame as configured on the HMI. In this case the fault will remained latched until the fault is reset manually via the local HMI installed in the unit.

The HMI display can be used to diagnose which fault has occurred using the Active Faults and Fault History screens. Reference Table 7.12 Fault Codes for fault nomenclature.

5.1.4 Troubleshooting

Current Transformer Orientation Troubleshooting

Failure to maintain the correct polarity and phasing of the current transformers (CTs) will cause an over current fault on power up. The converter will never attempt to run; it will stay in a stopped condition. Possibly the CTs are installed backwards or the secondary wiring is incorrect, if this is suspected, refer to the steps below to isolate the error.

Note: CT operation can be verified via the HMI touchscreen feedback waveform plot screens. Reference the HMI VLine & ILine Waveform Plot Sub Screen in **Section 6** for details.

Warning	Only qualified electricians should carry out all electrical installation and maintenance work on the HGA. Failure to follow standard safety procedures may result in death or serious injury. Disconnect all sources of power to the drive and HGA before working on the equipment. Do not attempt any work on a powered HGA. Also, check for zero voltage between all phases of the input and output lines. **Operating current transformers with the secondary winding open can result in a high voltage across the secondary terminals which may be dangerous to personnel or equipment.**

1. If the CTs and wiring is easily accessible, double check the CT orientation for proper direction and trace the secondary wiring against the applicable diagrams in **Section 4** for polarity, phasing and connection to terminal TB-1. Correct any errors and apply power for proper power-up, if it doesn't clear the fault, or if accessibility is too difficult, proceed to step #2.
2. There is a possibility that the CTs markings are different from the diagrams provided in **Section 4**. This could affect the polarity, to verify this try reversing the two leads on TB-1 positions 1 & 2, do the same with wires in positions 3 & 4. Apply power for proper power-up; if it doesn't proceed to #3.
3. Reverse just one set of CT leads at a time, first 1 & 2; verify power-up. If it doesn't work, put wires 1 & 2 back and now try the same with wires 3 & 4. Apply power for proper power-up; if it doesn't replace all wiring to its original positions and proceed to #4.
4. There is a possibility that the phasing of the CT L1 and L3 are incorrect. To test this theory, swap the two wires on TB-1 positions 1 & 2 with the two wires in positions 3 & 4. Apply power for proper power-up; if it doesn't, repeat steps 2 and 3.
5. If the HGA doesn't indicate a run status after completion of steps 1 through 4, contact TCI technical support for further assistance.

System Failure

The Digital Signal Processor is continually monitoring the performance and fault status of the filter. It will shut down the converter section if the processor should sense a fault. The filter is also equipped with a circuit breaker providing a second layer of over current protecting for the converter section. The circuit breaker can also serve as a means of electrical isolation from the system power grid. It is recommended, by TCI, that all power to the HarmonicGuard® Active filter be disconnected. If you elect to service the HGA by using the circuit breaker to isolate the converter section, please take special note of the following warnings:

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

Warning	
	Only qualified electricians should carry out all electrical installation and maintenance work on the HGA. Disconnect all sources of power to the drive and HGA before working on the equipment. Do not attempt any work on a powered HGA. This HGA unit contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the filter before you attempt 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.**

Required Equipment

- AC voltmeter and ammeter or multimeter designed for true RMS measurements in a harmonic rich circuit and suitable for the rated current and voltage marked on the nameplate. The meter should have 1000 volt minimum isolation.
- Clamp-on current probe suitable for the rated current and voltage marked on the nameplate.
- Clip-on voltage probes suitable for the rated voltage marked on the nameplate. Select probes that can be securely clipped on to the test points without shorting between points or falling off.

Note: When disconnecting wires from components and terminations, mark the wires to correspond to their component and terminal connection. Extreme Care should be taken when removing the fast-on terminals from the circuit board. Excessive force will result in damaging the interface board and require the converter to be repaired by TCI authorized personnel only.

Converter Inspection

- Verify that power has been removed from converter and 5 minutes has passed before inspection.
- Remove plastic cover from over converter section.
- Visually check the circuit boards for debris, contamination, overheated traces, burnt circuit board, overheated, cracked, or broken components, corrosion, and poor solder joints.
- Check all wires and terminals connected to the circuit boards.
- Check all electrolytic capacitors for bulges, ruptures, popped vent plugs, discoloration, or leakage.
- Check the power semiconductors mounted to heat-sink for cracked cases, ruptures, debris, arcing, and burning.
- Check for any loose connections, if no apparent damage is found to the power semiconductors.
- Measure resistance of power semiconductors using a multi-meter set on the diode check setting, see **Figure 5.2**. Look for opens, ∞, or dead short readings. With the red lead of your meter connected to the far right negative terminal of the capacitor bank, measure with the black lead of the meter to each of the three output terminals (bus bars), the reading should be approximately 0.35Ω. Reverse the meter leads and repeat measuring to each terminal. This time a low reading will be present, which will continue to increase; this is an indication of a capacitor charging. Next, connect the black meter lead to the "positive capacitor terminal" and again measure to each of the output terminals with the other lead; the reading should be approximately 0.35Ω. Reverse the meter leads and repeat measuring to each terminal. Again, it will be a low reading, which will continue to increase. If the readings are as described, in all likelihood the power semiconductors are good. If any readings are opens or dead shorts, it will be an indication that something is bad in the power section. Do not reapply power if you are not sure the IGBT's are good.

5.1.5 Troubleshooting Flow Chart

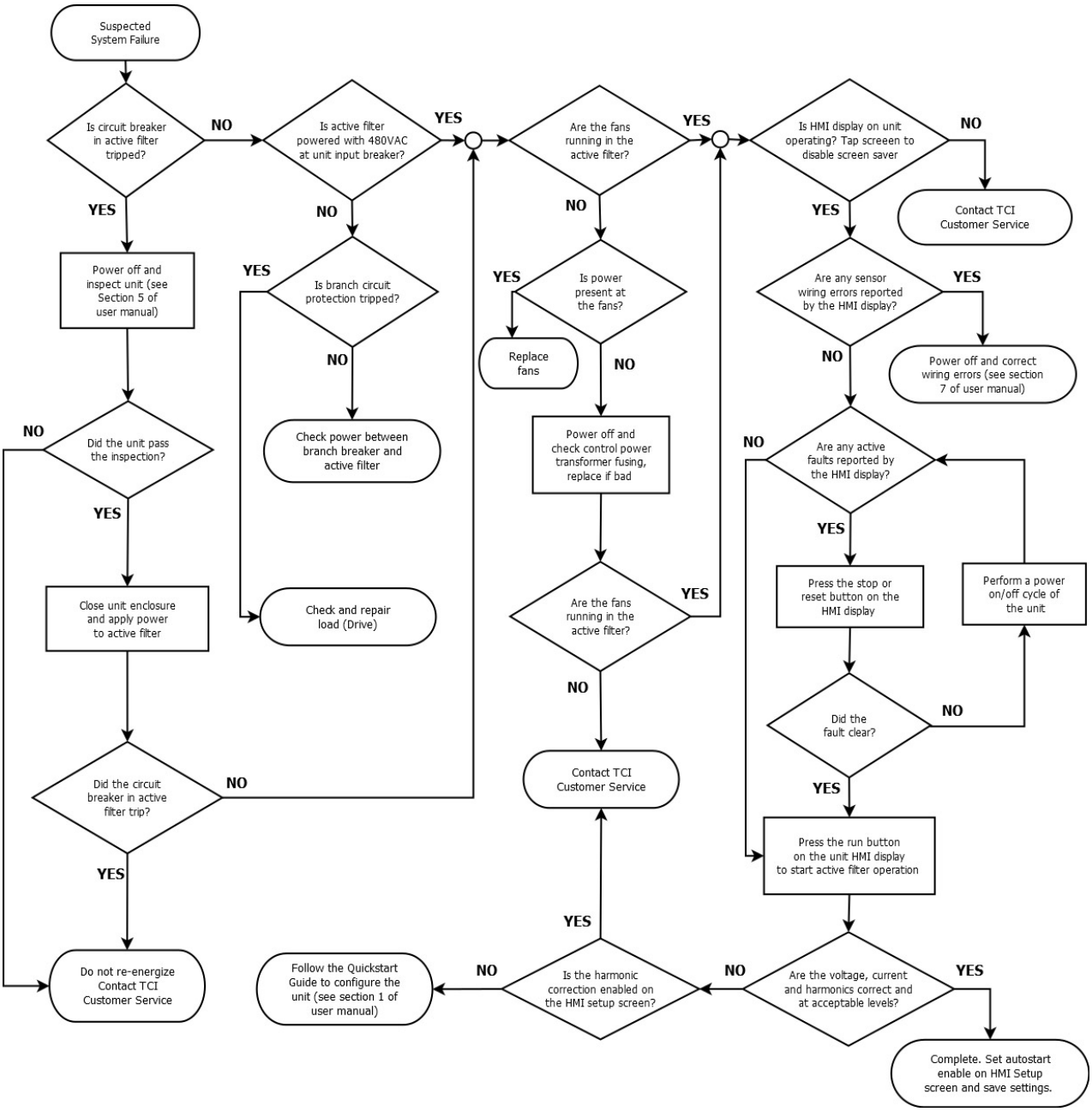


Figure 5.1: HGA System Troubleshooting Flowchart

5.1.6 Power Component Layout

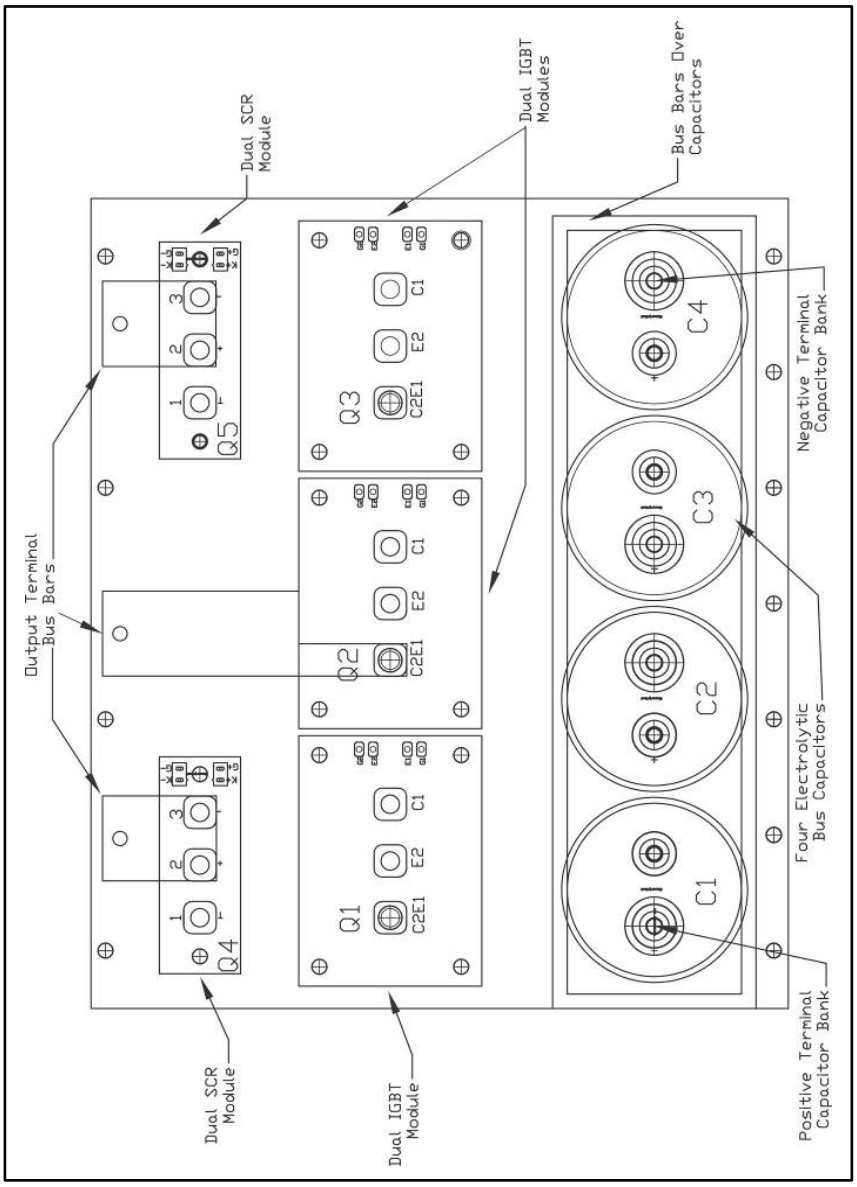


Figure 5.2: 50, 100, 200 Amp Power Component Layout

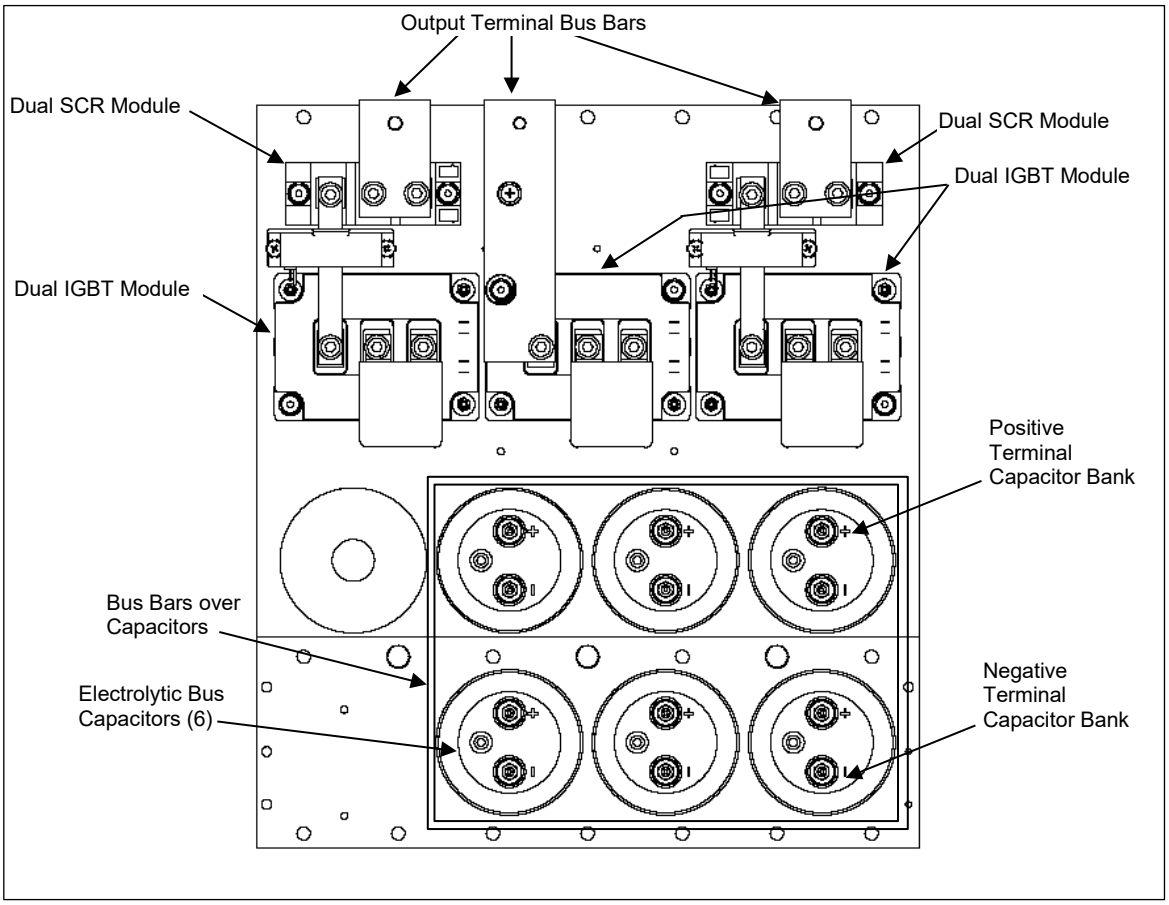


Figure 5.3: 150, 300 Amp Power Component Layout

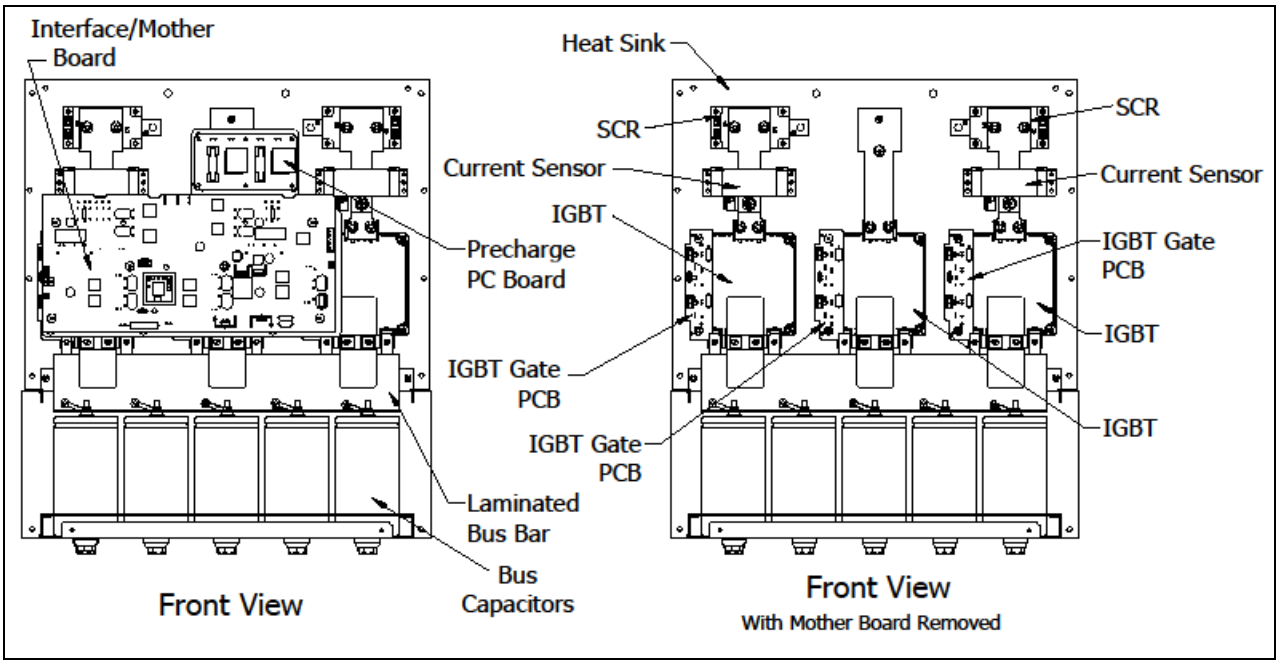


Figure 5.4: 250 Amp Power Component Layout

Warning	
	Only qualified personnel should operate the HarmonicGuard® Active filter with the door open. Failure to follow standard safety procedures may result in death or serious injury. Do not attempt any work on a powered filter converter. The HGA contains high voltages and capacitors. Wait at least five minutes, after disconnecting power from the converter, before you attempt servicing. Check for zero voltage between all terminals to the converter. **Be aware, everything ahead of the circuit breaker will still be energized.**

5.1.7 Replacement Parts

If replacement parts are needed, please contact your TCI representative. To ensure that the HarmonicGuard® Active filter continues to perform to its original specifications, replacement parts should conform to TCI specifications. Use of non-TCI approved components will void all warranties.

5.1.8 Factory Contacts and Technical Support

For technical support, contact your local TCI distributor or sales representative. You can contact TCI directly at 1-800-824-8282. Select "Customer Service" or "Technical Support" and have your HarmonicGuard® Active filter nameplate information and any drawings available.

Outline and Mounting Dimension Drawings

The installation diagrams listed in **Table 5.4** shows the overall enclosure dimensions, the conduit access areas and the wiring connection points. The installation diagrams also show the major internal components pictorially. A paper copy of the installation diagram is included in the literature kit shipped with all units. Installation drawings are also available online for download at www.transcoil.com/Products/HGA-Active-Harmonic-Filter.htm.

Table 5.4: HGA MCC Installation Drawing Table

Voltage (V)	Current (A)	Diagram
480	50	104598-1
480	100	104598-1
480	150	105732-1
480	200	106153-1
480	250	106153-1
480	300	105734-1

6 ■ Section 6

HMI Introduction

The Interface Module provides the user with a convenient way to monitor the operation of TCI's HarmonicGuard® Active filter and allows for the ability to adjust run-time set-points under password control. This section describes how to install, operate, and maintain the Interface Module.

Overview

The Interface Module has three major components; the Interface PCB, the HMI Display and an optional network Communications Gateway (see **Figure 6.1**).

The interface PCB contains a Chassis Communications Port that connects to the power converter of the HarmonicGuard® Active filter. The interface PCB translates status and commands data between the power converter controls and the HMI Display. The interface PCB also contains the 24V Relay I/O for basic status monitoring and run/stop control of the HarmonicGuard® Active filter.

The HMI Display is a 6" color Touchscreen display containing a series of status screens that provide the user with a convenient way to monitor the operation of the HarmonicGuard® Active filter. The HMI display also contains an integrated ModbusRTU network connection for remote monitoring of the HarmonicGuard® Active filter.

The optional network Communications Gateway can be connected to the integrated ModbusRTU network connection in the HMI Display to translate the ModbusRTU protocol to an alternate Fieldbus or Industrial EtherNet protocol, such as EtherNet/IP.

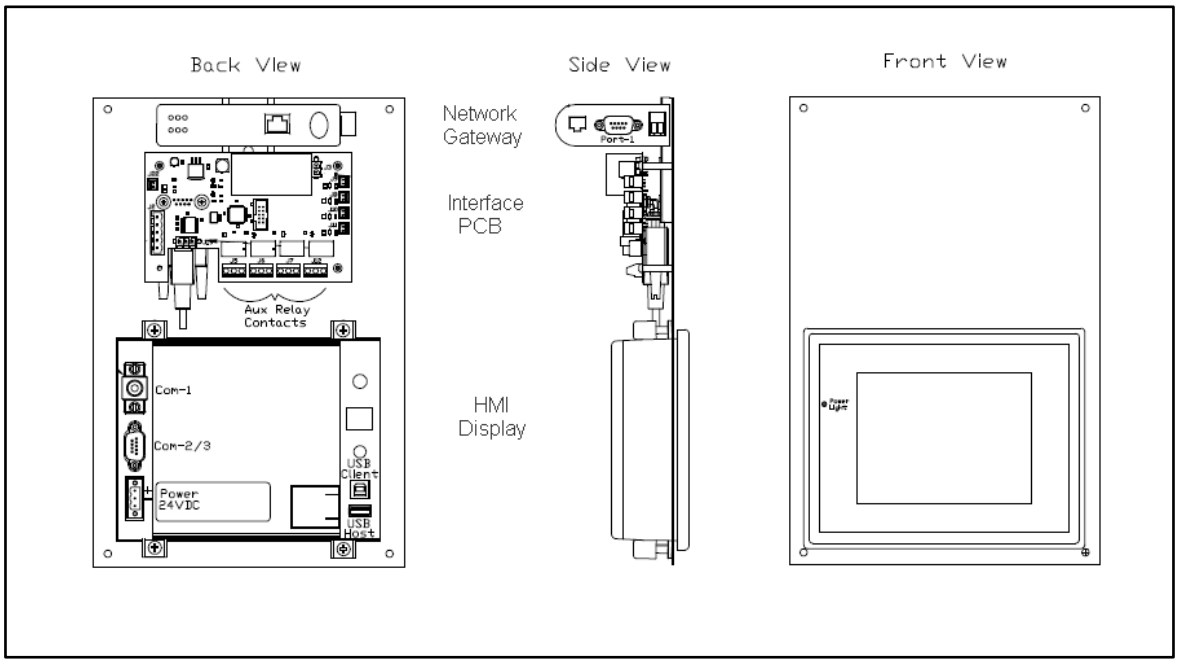


Figure 6.1: Interface Module Components

Additional Information

Caution	
	This section provides general information describing the Interface Module. Be sure to carefully review the more specific information provided by the drawings shipped with the module. Information from by the drawings takes precedence over the information provided in this section. The information and ratings 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.

Receiving Inspection

The Interface Module 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. See appendix for part numbering details.

Installation Guidelines

6.2.1 Checklist

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

- Make sure the installation location will not be exposed to direct sunlight, excessive vibration, corrosive or combustible airborne contaminants, excessive dirt or liquids.
- Select a mounting area that will allow adequate cooling air.
- Make sure that all wiring conforms to the requirements of the National Electrical Code (NEC) and/or other applicable electrical codes.
- Ground the HMI display by using the grounding terminal. Not only does this act as a safety, but it also filters out electrical noise.
- Check all connections and components thoroughly before applying power to the equipment.
- Check the panel and the inside of the enclosure for any foreign objects, dirt and/or loose hardware.

6.2.2 Location

Environment

The location of the Interface Module should be a suitable environment to assure proper performance and a normal operating life. Refer to the environmental specifications furnished in this manual and noted on the drawings with the Interface Module.

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).

- Display front rated Type 1 & 4X (indoor)
- Avoid direct sunlight
- Avoid corrosive liquids or gases
- Avoid explosive or combustible gases or dust
- Avoid excessive airborne dirt and dust (Pollution Degree 2, according to EN50178 and UL508C)
- Avoid excessive vibration (0.152 mm (0.006 in.) displacement, 1G peak)

6.2.3 Mounting

Mounting requires at least a depth of 4” (102 mm). The Interface Module will mount in a panel with a thickness of 0.02 to 0.35 inch (0.5-9.0 mm) with an opening 6.79” by 5.21” (173 by 133 mm). Fit the Interface Module assembly into the opening carefully pressing on all four corners. Use the mounting hardware (4 sets) to secure the assembly on the corners.

Warning: To avoid damaging the case, do not exceed a tightening torque of 3.47 to 4.34 lbs-in (0.39-0.49 Nm). Care should be taken not to mount the Interface Module too close to a heat source (such as power resistors), which could be located behind the Interface Module.

Caution 	The display panel is waterproof. But care should be taken to prevent grease, corrosive liquids and sharp objects from contacting the front panel.

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

6.2.4 Wiring

Note: Some of the following sections only apply if the Interface Module is not factory installed.

A wiring block diagram of the Interface Module components is available in **Figure 6.2**.

When selecting a mounting location for the unit, plan for the routing of commutation and power cable. Keep the wiring away from power wires, where electrical noise could be induced. All wiring should conform to the requirements of the National Electrical Code (NEC) and/or other applicable electrical codes. The length of the communication cable between the Interface module chassis communication port and the HarmonicGuard® Active filter power converter module should not exceed 25 feet (7.6 meters).

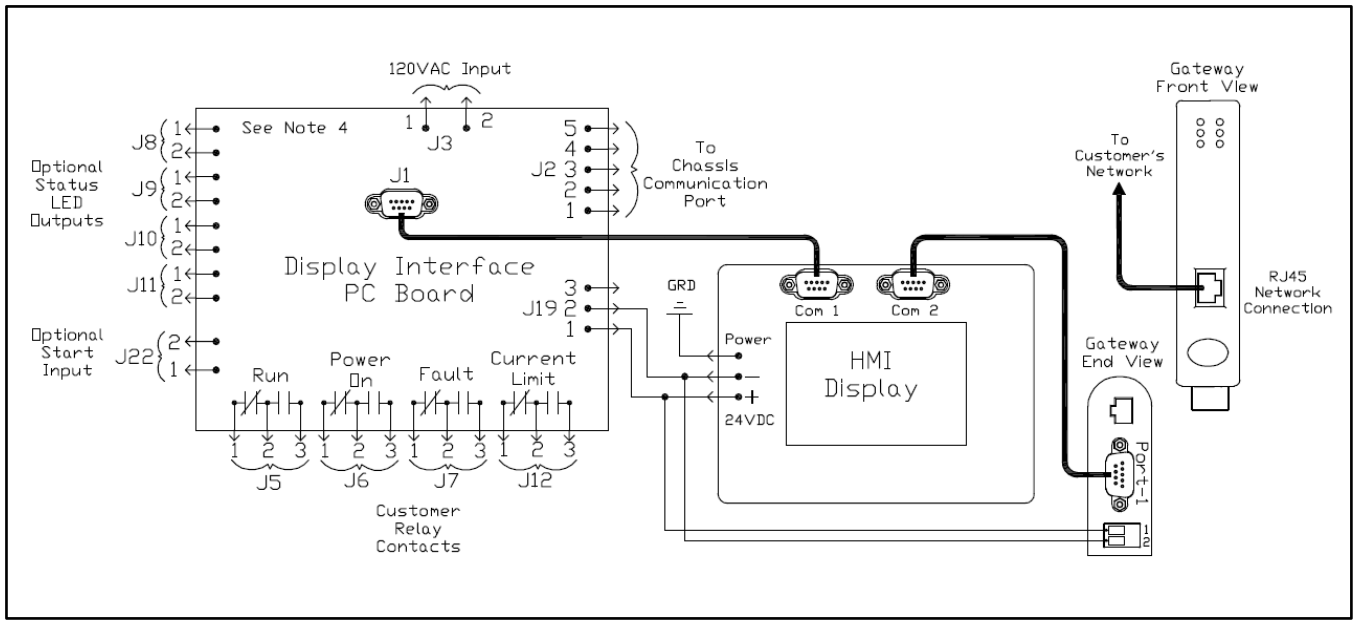


Figure 6.2: Interface Module Connections

Interface PCB Connections

Most customer connections to the Interface module will be made on the Interface PCB. Refer to connection diagrams in **Figure 6.3**. The details of the power and communications terminals are shown in **Table 6.1**. Form C relays are available on the Interface PCB, these connections are shown in **Table 6.2**. Four outputs are available on the Interface PCB.

The relay start command input connection on J22 of the interface PCB allows a contact closure to send a run command to the HarmonicGuard® Active filter. The relay start command input will only be acknowledged, if the Relay Run/Stop Enable is set to Enabled on the HMI Display setup screen. Pressing stop locally, via the HMI Display, will set the enable for the relay start command to DISABLED.

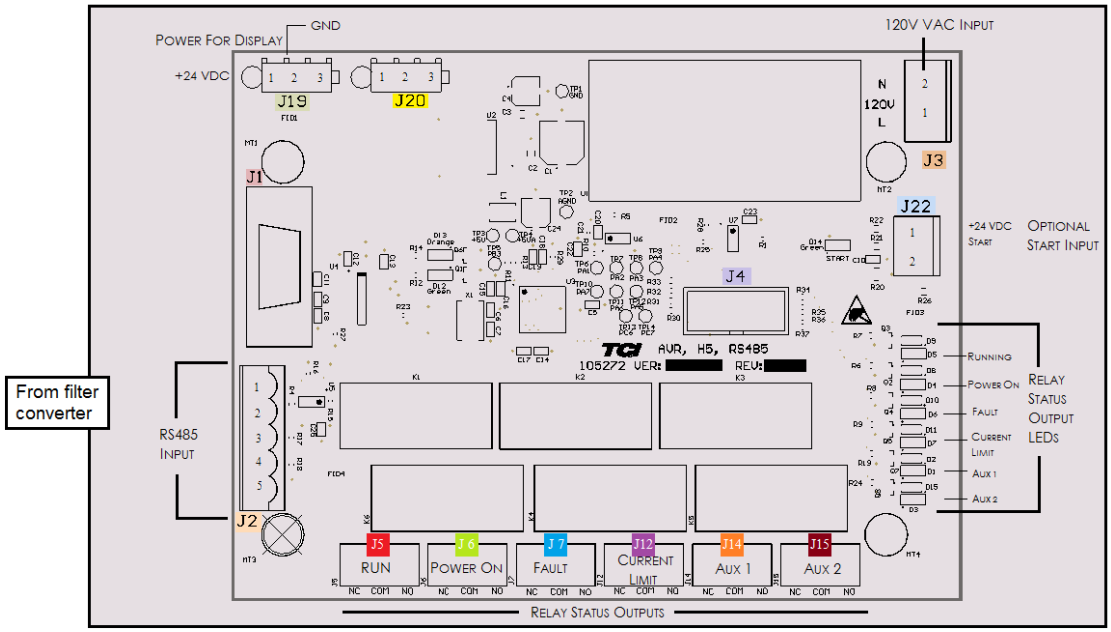


Figure 6.3: Interface PCB connections

Table 6.1: Power & Communications Terminals

Terminal	Pin	Description	Label	Rating
J1	1	HMI Display	For factory use	N/A
J2	1	RS485	Not Connected	N/A
	2		B	
	3		Ground	
	4		A	
	5		Not connected	
J3	1	Input Power	Neutral	120 VAC
	2		Line	
J4	1	Micro Programming	For factory use	N/A
J19	1	HMI Power Supply	24 VDC	24 VDC
	2		Common	
	3		Not Connected	
J22	1	Start Command	24 VDC	Contact Closure
	2		Start	

Note: The power terminal on the back of the HMI display accepts 28 to 14 AWG stranded wire with a tightening torque of 4.4 in-lb (0.5 Nm).

Table 6.2: Form C Relay Contacts

Terminal	Pin	Description	Label	Tightening Torque	Wire Range
J5	1	Run	Normally Closed	4.4 lbs-in (0.5 Nm)	28-14 Awg
	2		Common		
	3		Normally Open		
J6	1	Power On	Normally Closed	4.4 lbs-in (0.5 Nm)	28-14 Awg
	2		Common		
	3		Normally Open		
J7	1	Fault	Normally Closed	4.4 lbs-in (0.5 Nm)	28-14 Awg
	2		Common		
	3		Normally Open		
J12	1	Current Limit	Normally Closed	4.4 lbs-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 0.6A @ 125VAC general use; 0.2A @ 250VAC, 0.6A @ 125VAC, 2A @ 30VDC resistive. The minimum permissible load rating is 10uA, 10mVDC.

HMI Display Connections

Note: The following section describes the default ModbusRTU network connection available on the base model. If an optional advanced network Communications Gateway is included in the Interface Module, see the appendix for the specific Communications Gateway configuration.

The HMI display implements a ModbusRTU slave device over RS-485. This network connection is available on the COM2/3 DB9 connector on the back of the HMI Display (see **Figure 6.4**).

The output registers from the HarmonicGuard® Active filter are mapped to Modbus register address 40500. The input registers to the HarmonicGuard® Active filter are mapped to Modbus register address 40564. For definitions of the input and output data available via the network connection, see **Table 6.3** and **Table 6.4**.

If the optional network Communications Gateway is present, the integrated ModbusRTU interface on the HMI Display will not be available. When configured, the Communications Gateway will occupy the ModbusRTU COM2/3 DB9 connector on the back of the HMI Display.

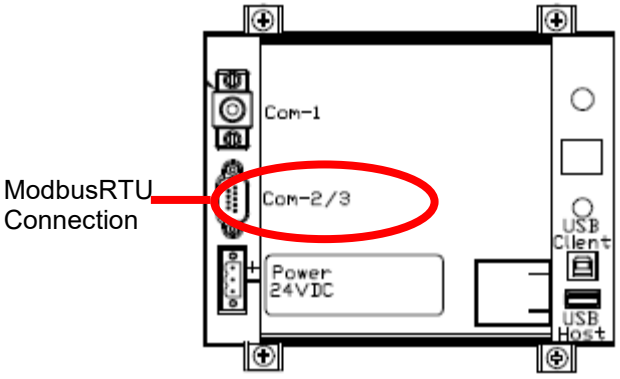


Figure 6.4: HMI ModbusRTU Connection

Table 6.3: Modbus Connector Pin Definitions

COM2/3 DB9 Pin	Signal Name	Signal Type
1	no connect	-
2	no connect	-
3	no connect	-
4	D+	RS-485 B (non-inverting)
5	GND	RS-485 SC/G
6	no connect	-
7	no connect	-
8	no connect	-
9	D-	RS-485 A (inverting)

Table 6.4: ModbusRTU Protocol Settings

Parameter	Default Value	Units
Baud Rate	19200	bps
Data Bits	8	bits
Stop Bits	1	bits
Parity	Even	-
Slave ID	113	-

Communications Gateway Connections (Optional)

If an optional advanced network Communications Gateway is included in the Interface Module, see **Appendix A** for the specific Communications Gateway wiring details.

If the optional network Communications Gateway is present, the integrated ModbusRTU interface on the HMI Display will not be available. When configured, the Communications Gateway will occupy the ModbusRTU COM2/3 DB9 connector on the back of the HMI Display.

7 ■ Section 7

Operation

7.1.1 HMI Screen Elements

This section focuses on the operation of the HMI Display. The HMI Display contains several screens that allow the user to monitor the status of the line/load and the HarmonicGuard® Active filter. Additionally, the HMI display can be used for local run/stop control and basic setup of the HarmonicGuard® Active filter.

Table 7.1: General HMI Screen Elements

HMI Graphic Element	Example	Description
Buttons		Buttons will appear raised or depressed, depending on set point and command conditions.
Indicators		Indicator status fields will appear flat and are read only.
Numerical Displays		Display fields will appear flat. Numerical displays are read only.
Numerical Entry Fields		Numerical Entry fields appear indented. Selecting them will open a keypad for numerical entry.
Navigation Bar		The Navigation Bar allows for easy navigation between the five major HMI screens. The Navigation Bar appears on all HMI screens.
Title Bar		The Title Bar contains the current system time, screen selection, and a stop button to turn off the system. The Navigation Bar appears on all HMI screens.

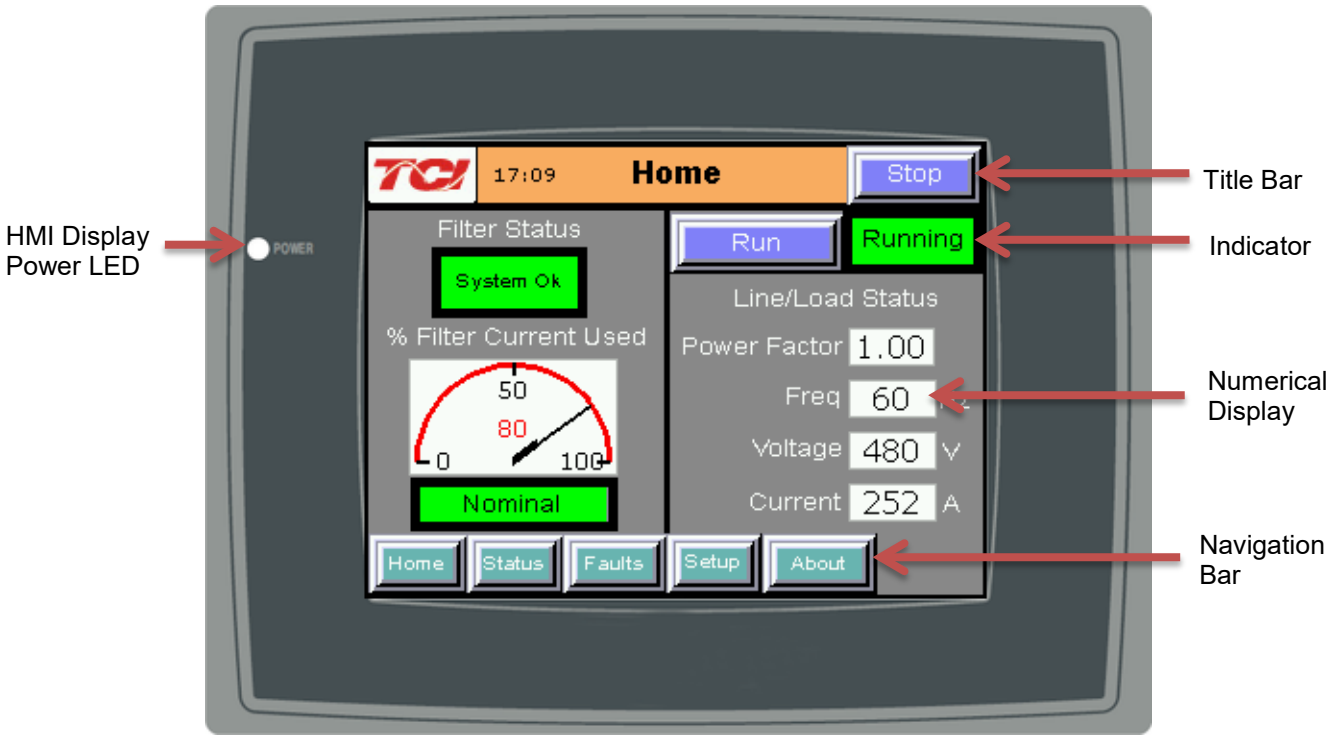


Figure 7.1: HMI Display

7.1.2 Initialization

When first powered, the green LED (Power) on the HMI Display will light (see **Figure 7.1**).

After a five second boot up sequence, the Home Screen will be displayed. If the home screen is not displayed and power is available to the HMI Display, see **Section 8 – Troubleshooting**, for diagnosing common problems.

7.1.3 HMI Screens

Home Screen

The Home screen displays a dashboard of overall filter status information and allows the user to run and stop the HarmonicGuard® Active filter.

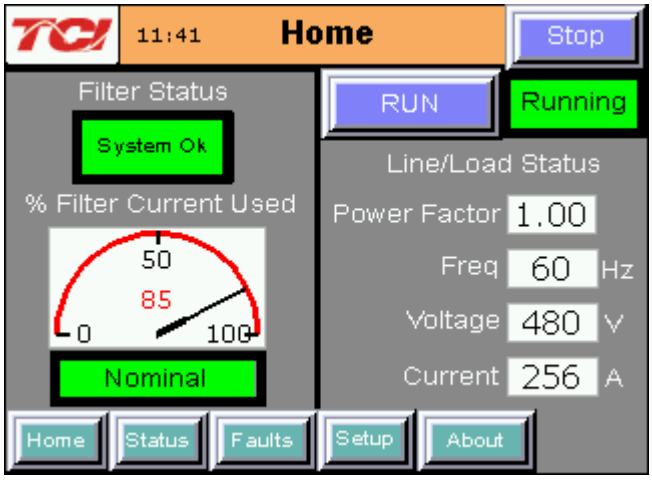


Figure 7.2: Home Screen

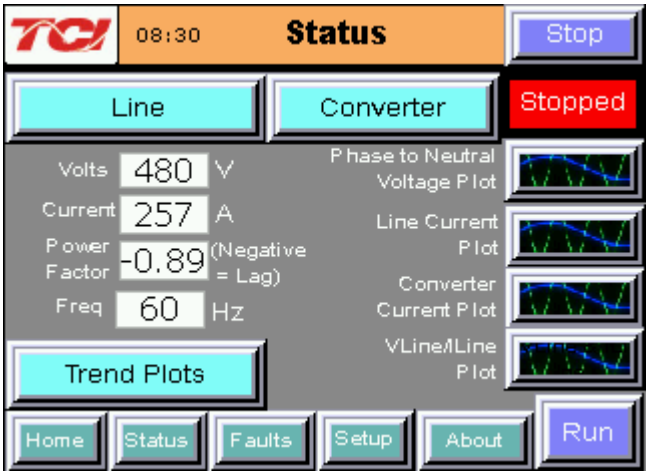
Table 7.2: Home Screen Elements

Screen Element	Description
Filter Status Display	Indicates if a converter fault is active and preventing the HarmonicGuard® Active filter from running. If a fault occurs, the indicator will flash red and display "Fault". Specific Fault codes can be viewed on the "Fault" Screen.
% Filter Current Used Display	This gauge displays the current filter capacity as a percentage of total available capacity. In normal operation, the display will read "Nominal". If the unit output corrective current is above 95% of maximum capacity, the indicator light will turn red and display "At Capacity". When the converter is at capacity, the Relay K4 (J12 Connector), and J11 Contacts used for a remote indicator will also be energized. If the monitor continually displays "At Capacity," a second filter may be required to handle the load. Please contact TCI for assistance.
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
System State Indicator (located immediately below stop button)	When the HarmonicGuard® Active filter is in a stop mode, the "Status" light will turn red and display "Stopped". When the converter is running, the status light will be green and will display "Running". The status light will also show if the HarmonicGuard® Active filter is in Input line Sync mode, Reset mode, Precharge mode, Calibrate mode, Power Save mode or Faulted. When the HarmonicGuard® Active filter is faulted, it will shut down automatically.
Power Factor Display	Displays current line/load power factor. 1.00 indicates unity power factor. A negative power factor indicates lagging power factor.
Line Frequency Display	Displays the current utility line frequency in Hz.
Supply Voltage	Displays the supply voltage coming into the HarmonicGuard® Active filter.
Line/Load Current Display	Displays the current line/load phase current in Amps RMS. **NOTE:** The displayed current is affected by the CT Ratio configuration on the "Setup" page.

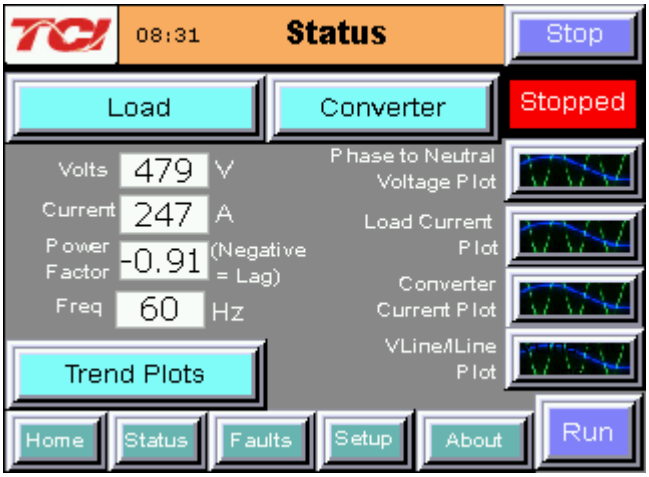
Status Screen

The Status screen shows more specific information on the performance of the system such as current and voltage waveforms, Power Factor and information specific to the Line/Load screen and Converter screen.
NOTE: The Status Screen will indicate if unit is Line Side/Load Side. The “Line/Load” button and the “Line/Load Current Plot” text changes to show Line or Load status. **NOTE:** The Status Screen will indicate if unit is Line Side/Load Side. The “Line/Load” button and the “Line/Load Current Plot” text changes to show Line or Load status.

Figure 7.3 explains the main “Status” Screen.



Line Side



Load Side

NOTE: The Status Screen will indicate if unit is Line Side/Load Side. The “Line/Load” button and the “Line/Load Current Plot” text changes to show Line or Load status.

Figure 7.3: Status Screen

Table 7.3: Status Screen Elements

Screen Element	Description
Line/Load Button	Use this button to get to the "Line/Load Status" Sub Screen (see **Figures 7.8 and 7.9**).
Volts Display	Displays the current utility phase to phase line voltage in Volts RMS.
Current Display	Displays the current line/load phase current in Amps RMS.
Power Factor Display	Displays current line/load power factor. A value of 1.00 indicates unity power factor. A negative power factor indicates lagging power factor.
Frequency Display	Displays the current utility line frequency in Hz.
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
Converter Button	This button will take the user to the "Converter Status" Sub Screen (see **Figure 7.4**).
Phase to Neutral Voltage, Line Voltage, Line/Load Current, Converter Current, and VLine/ILine Waveform Screens	The "Waveform" screen buttons will take the user to one of the four real-time waveform capture screens: Phase to Neutral voltage, Line Voltage, Line Current, Converter current, or VLine/ILine plot (see **Figures 7.11**).
Trend Plots Screen	When the user presses the "Trend Plots" button, the Historical Trend screen menu is displayed (see **Figure 7.12**).

Converter Status Sub-Screen

The converter status sub screen shows the present status of the HarmonicGuard® Active filter power converter module.

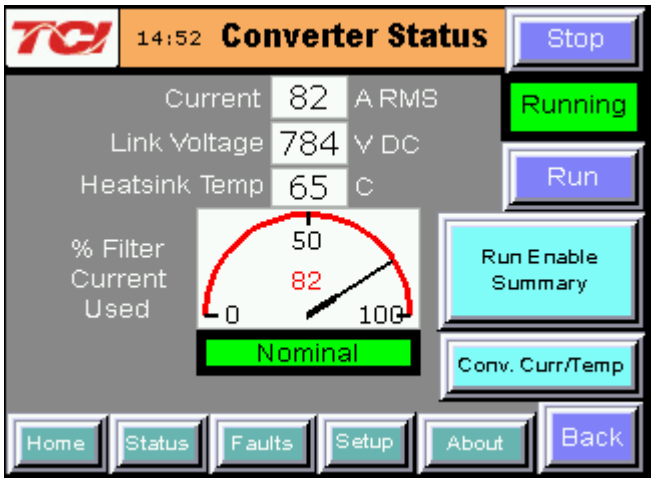


Figure 7.4: Converter Status Sub Screen

Table 7.4: Converter Status Screen Elements

Screen Element	Description
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
Current Display	Displays the present HarmonicGuard® Active filter output corrective current in Amps RMS.
Link Voltage Display	Displays the internal DC Link Bus voltage of the HarmonicGuard® Active filter in Volts DC.
Heatsink Temp Display	Displays the present HarmonicGuard® Active filter power converter heat sink temperature in Degrees Celsius.
% Filter Current Used Display	This gauge displays the current filter capacity as a percentage of total available capacity. In normal operation, the display will read "Nominal". If the unit output corrective current is above 95% of maximum capacity, the indicator light will turn red and display "At Capacity". When the converter is at capacity, the Relay K4 (J12 Connector), and J11 Contacts used for a remote indicator will also be energized. If the monitor continually displays "At Capacity," a second filter may be required to handle the load. Please contact TCI for assistance.
Run Enable Summary	Displays the current state of all enables that affect the running of the HarmonicGuard® Active filter. If a button is red, that option is disabled and if it is green, that option is enabled. If the "Auto Start" is enabled, a countdown timer will run to the right of the button, when the count reaches 0 the converter will start (See **Figure 7.5**).
Conv. Curr/Temp Button	Displays current and temperature levels for each individual converter in the unit.
Back Button	Returns user to the main status screen.

Run Enable Summary Sub-Screen

The Run Enable Summary sub screen shows the state of all the enables that affect the running of the HarmonicGuard® Active filter.

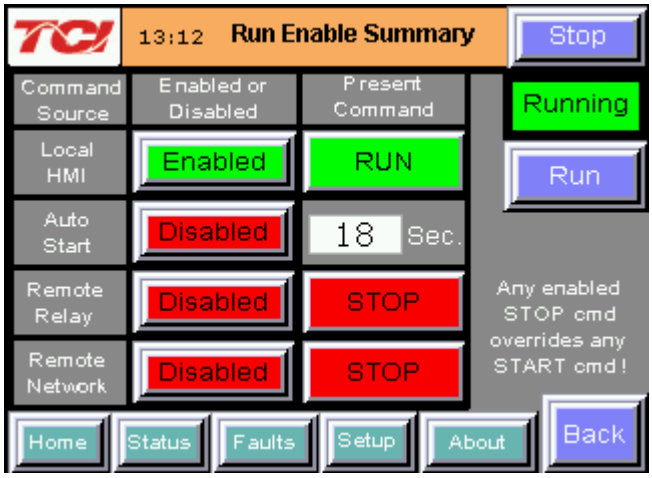


Figure 7.5: Run Enable Summary Screen (RUN)

When the HMI Stop button is pressed locally on the HMI, the unit enters a Run Inhibit state and will show a "Run Inhibit Active" message on the Run Enable Summary Screen center right. When the Run Inhibit is Active, the unit will not be allowed to start remotely via a Network start, Remote relay start, or Auto-start command. The Run Inhibit is cleared by pressing the HMI Run button locally on the HMI display.

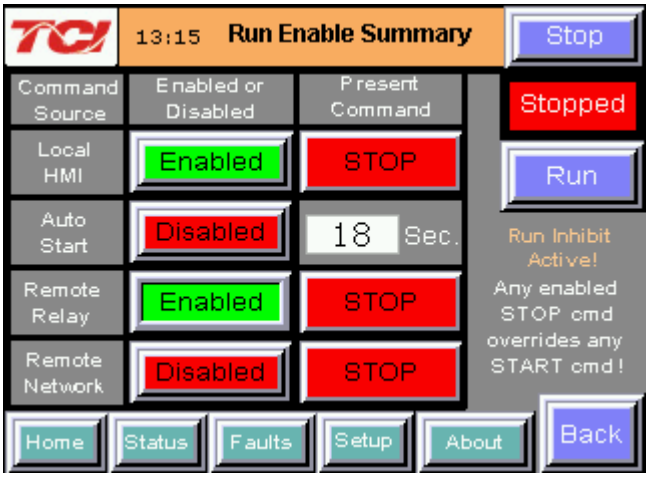


Figure 7.6: Run Enable Summary Screen (STOP)

Table 7.5: Run Enable Summary Sub Screen Elements

Screen Element	Description
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
Local HMI	This option is always enabled. The "Present Command" field will be green and say RUN if the local HMI run button has been pressed and the unit is operational. It will be red and say STOP if the unit is stopped locally or in the Run Inhibit state.
Auto Start	Changes to green, if enabled and the countdown timer (to the right of the button) will start. When it reaches 0, the HarmonicGuard® Active filter will start.
Remote Relay	Changes to green, if enabled. If enabled, the HarmonicGuard® Active filter can be remotely turned on with a contact closure.
Remote Network	Changes to green, if enabled. If enabled, the HarmonicGuard® Active filter can be remotely stopped/started with a contact closure. When the contact is closed, the unit will run and when opened, the unit will stop. When enabled and the option is active, the field to the right will be green and read "RUN".
Back	This button will take you back to the converter status screen.

Converter Current/Temperature Sub-Screen

The Converter Current/Temperature screen displays the current and temperature levels for each individual converter that is present in the unit. These values are represented as "Converter Current" and "Converter Temperature" throughout the HMI.

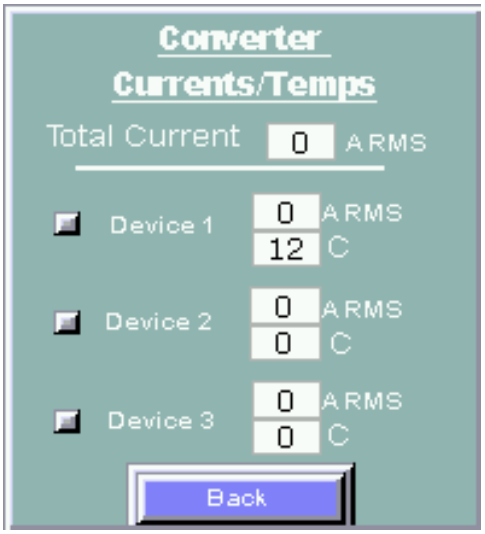


Figure 7.7: Converter Current/Temperature Screen

Line/Load Status Sub-Screen

The Line/Load Status Sub Screen shows more specific information regarding the source or Load Voltage, Current, Power, Power Factor and THD measurements.

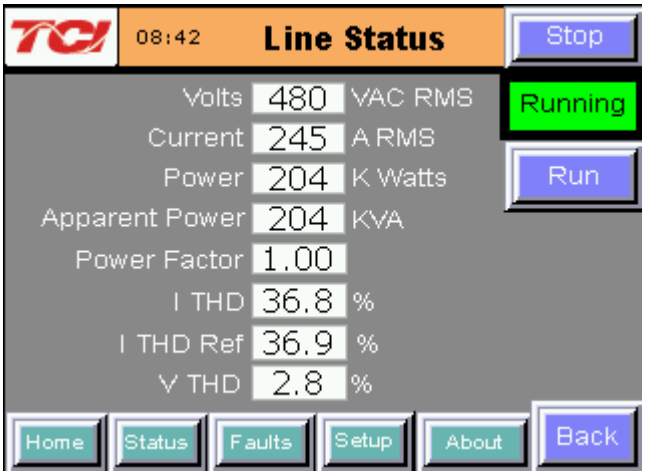


Figure 7.8: Line Status Sub Screen

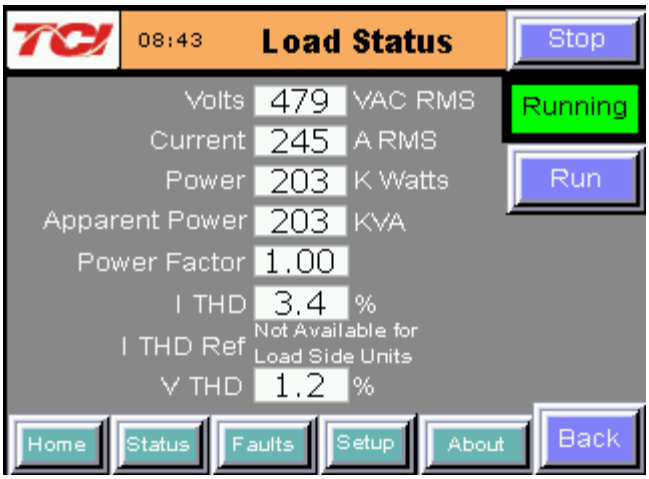


Figure 7.9: Load Status Sub Screen

Table 7.6: Line/Load Status Screen Elements

Screen Element	Description
Volts Display	Displays the current utility phase to phase line voltage in Volts RMS.
Current Display	Displays the current line/load phase current in Amps RMS. **NOTE:** The displayed current is affected by the CT Ratio configuration on the "Setup" page.
Power Display	The three phase real power (P) of the line/load in kW.
Apparent Power	The three phase apparent power (S) of the line/load in kVA.
Power Factor Display	Displays current line/load power factor. 1.00 indicates unity power factor. A negative power factor indicates lagging power factor.
I THD Display	Displays the Total Harmonic Distortion of the utility Line/Load current as a percentage. **NOTE**: If the secondary CT current is less than 1 amp, a "Low Current Feedback" message will be displayed. The Low Current Feedback message indicates the accuracy of the ITHD calculation is degraded.
V THD Display	Displays the Total Harmonic Distortion of the utility line Voltage as a percentage.
I THD Ref Display	Displays the reference Total Harmonic Distortion of the utility Line current in percent. This THD display is the uncorrected THD of the Line taken when the HarmonicGuard® Active filter was not running. **NOTE**: If the secondary CT current is less than 1 amp, a "Low Current Feedback" message will be displayed. The Low Current Feedback message indicates the accuracy of the ITHD calculation is degraded. **NOTE**: For units configured with load side, CT feedback the iTHD reference display is not available.
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
Back Button	Returns user to the main Status Screen.

Waveform Plot Sub-Screens

The HMI display supports capture and display of real time system voltage and current data. Three phase waveform data can be viewed for Line Voltage, Line/Load Current, and Converter Corrective Current.

The waveform screens contain a zoom feature, which supports three magnitude scales: 1X, 2X and 4X (see **Figure 7.10**). The Refresh button on the waveform screens will update the plot with new data from the HarmonicGuard® Active filter converter.

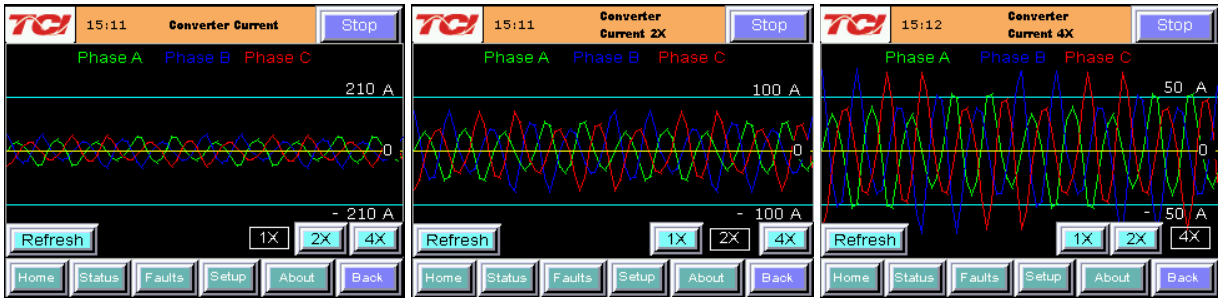


Figure 7.10: Example Waveform Plot Screens (Converter Corrective Current)

Table 7.7: Waveform Plot Sub Screen Elements

Screen Element	Description
Refresh Button	The "Refresh" button will reload the data from the HarmonicGuard® Active filter power converter controller and redraw the waveform plot.
1X, 2X, and 4X Buttons	Waveform zoom buttons will redraw the present data at a different scale.

VLine & ILine Waveform Plot Sub-Screen

The VLine & ILine Waveform Plot Sub Screen is available to verify the proper installation of the HarmonicGuard® Active filter power connections and system current CT feedbacks. The waveform plot shows voltage and current feedback for both Phase A and C on the same plot. When the HarmonicGuard® Active filter is powered, but in the stopped state this plot can be used to check for the following:

- Proper Line Voltage phase rotation.
- Proper Line/Load Current phase rotation.
- Proper Line Voltage and Line/Load Current relative polarity and phase.
- Missing/Open Circuit System Current CT Feedback.

In the event that the HarmonicGuard® Active filter performance is degraded, the VLine & ILine waveform plot should be examined as a means to determine if any system connection errors are present. Prior to examining the VLine & ILine waveform plot, the HarmonicGuard® Active filter should be put in the stopped state by pressing the stop button in the upper right corner of the HMI screen. **Figure 7.11** shows the VLine & ILine waveform plot sub screen for a properly connected, but non-running HarmonicGuard® Active filter when connected to a typical non-linear, rectifier load. Note, the following characteristics:

- Phase C voltage (Blue) leads Phase A voltage (Green).
- Phase C current (Yellow) leads Phase A current (Red).
- Phase A voltage (Green) and Phase A current (Red) are in phase and the same polarity.
- Phase C voltage (Blue) and Phase C current (Yellow) are in phase and the same polarity.

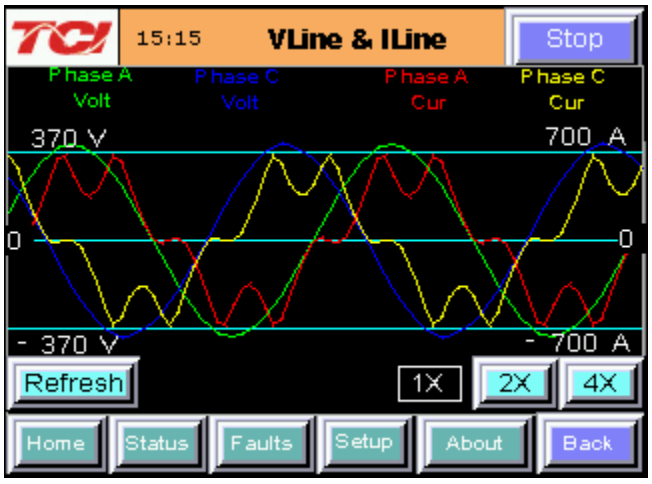
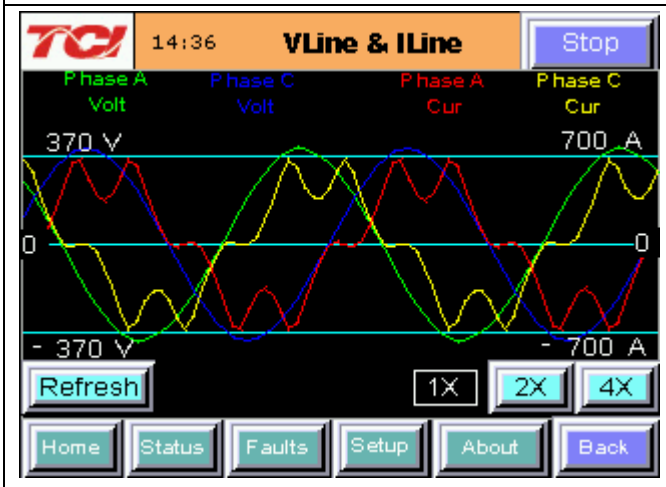


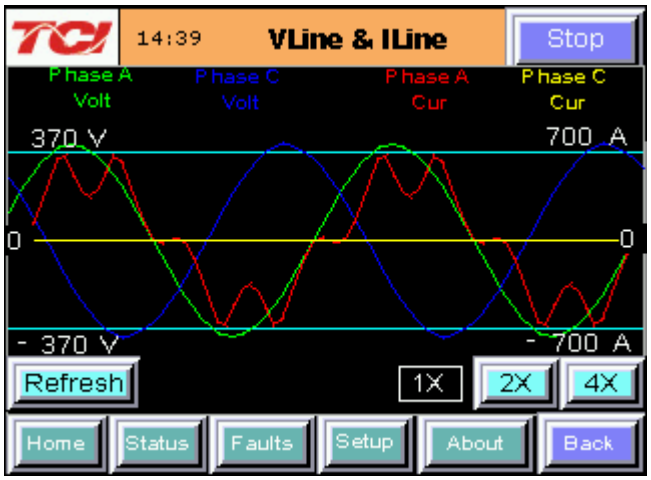
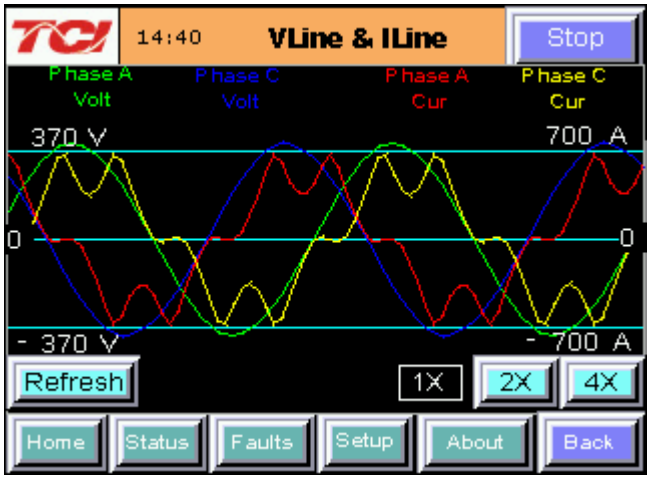
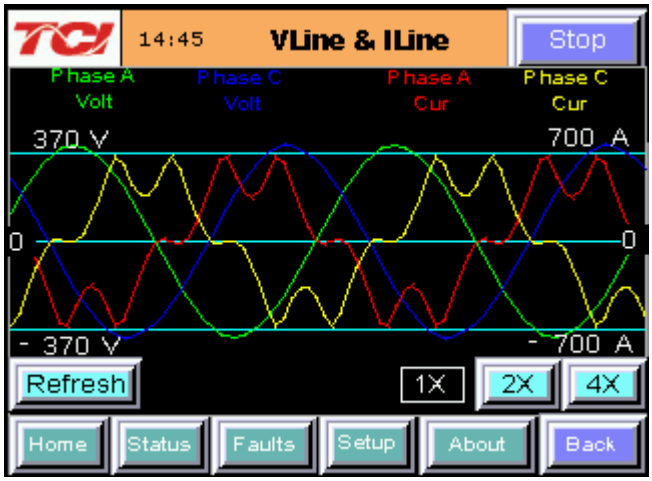
Figure 7.11: VLine & ILine Waveform Plot of a Properly Connected HarmonicGuard® Active filter (unit in stopped state)

Note: The example VLine & ILine Waveform Plot screens apply to rectifier loads only. For low power factor loads, the VLine & ILine waveform screen will appear different.

Table 7.8 outlines how the VLine & ILine Waveform Plot Sub Screen will appear with various connection errors present in the system.

Table 7.8: VLine & ILine Waveform Plot Screen Examples when Typical Connection Errors Present in System

VLine & ILine Waveform Plot Sub Screen with Rectifier Load	Connection Error Description	Connection Error Resolution
	Phase rotation is Incorrect: Phase A leads Phase C instead of Phase C leading Phase A.	To correct, swap Phase A and Phase C HarmonicGuard® Active filter power connections AND swap Phase A and Phase C system CT current feedback, then recheck plot.

	Phase C system CT current feedback missing: Phase C current is zero while Phase A current is present.	Check Phase C CT for open circuit or loose connection.
	Phase A and Phase C CT current feedback swapped: Phase A current (red) in phase with Phase C voltage (blue) instead of Phase A voltage (green).	To correct swap, Phase A and Phase C system CT current feedback and recheck plot.
	Phase A current (red) is opposite polarity of Phase A voltage (green) and Phase C current (yellow) is opposite polarity of Phase C voltage (blue).	To correct, re-install both Phase A and Phase C system CTs with polarity arrow in opposite direction OR swap positive and negative connections of each CT at HGA filter terminal block then recheck plot.

Historical Trend Plot Menu Sub-Screen

From the historical trend plot menu sub screen, you can view trend graphs of various HarmonicGuard® Active filter system signals (see **Figure 7.12**).

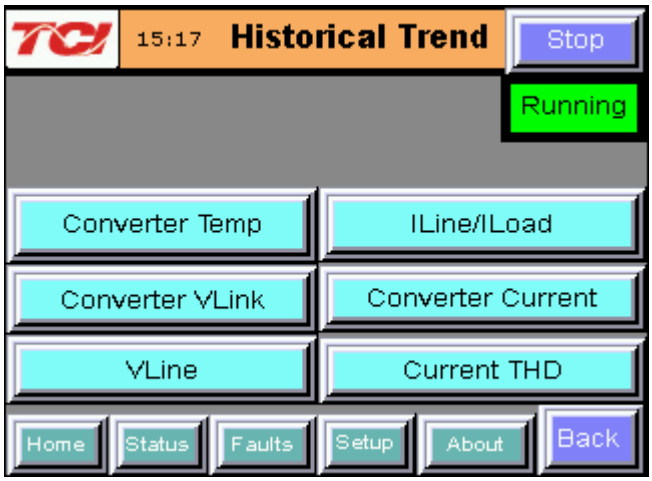


Figure 7.12: Historical Trend Plot Menu Sub Screen

Table 7.9: Historical Trend Plot Menu Sub Screen Elements

Screen Element	Description
Converter Temp Button	Opens the HarmonicGuard® Active filter heatsink temperature historical trend graph screen. This signal is sampled every 15 seconds and historical data is maintained for 10 hours.
Converter VLink Button	Opens the HarmonicGuard® Active filter DC Link Voltage historical trend graph screen. This signal is sampled every 3 seconds and 2 hours of historical data is maintained.
VLine Button	Opens the utility input RMS voltage historical trend graph screen. This signal is sampled every 3 seconds and 2 hours of historical data is maintained.
ILine/ILoad Button	Opens the line/load RMS current historical trend graph screen. This signal is sampled every 3 seconds and historical data is maintained for 2 hours.
Converter Current Button	Opens the HarmonicGuard® Active filter RMS current historical trend graph screen. This signal is sampled every 3 seconds and 2 hours of historical data is maintained.
Current THD Button	Opens the line/load Total Harmonic Distortion historical trend graph screen. This signal is sampled every 3 seconds and 2 hours of historical data is maintained.

Historical Trend Plot Sub Screens

The historical trend plot screens graph time-stamped feedback data over an extended period of time. Once the trend plot display data buffer is full, the oldest data is overwritten. Historical data can be viewed using the integrated scroll bars of the trend plot. All trend plot data is maintained between the power on/off cycles of the HarmonicGuard® Active filter. See **Figure 7.13** for an example of a typical trend graph (trend plot example is for the HarmonicGuard® Active filter power converter heatsink temperature measurement).

Figure 7.13: Example Historical Trend Plot Sub Screen

Table 7.10: Trend Plot Screen Elements

Screen Element	Description
Run/Stop Button	Runs and stops the HarmonicGuard® Active filter.
Plot Scale Display (located on the left side of the graph)	Indicates the magnitude of the samples of the trend plot. The scale varies with each of the trend plots.
Right Timestamp	Indicates the date and time the right-most sample displayed on the screen was taken.
Left Timestamp	Indicates the date and time the left-most sample displayed on the screen was taken.
Scroll Bar	Allows the user to scroll through all sample points available in the trend plot data buffer.
Trend Plot Display	The historical graph of the value being sampled over time.

Fault Screen

This button takes the user to the "Active Fault" screen (see **Figure 7.14**), which lists all of the active faults. The faults will stay in this list until the "Reset" or "Stop" button is pressed or the fault self clears. From here, the user can also go to the "Fault History" screen.

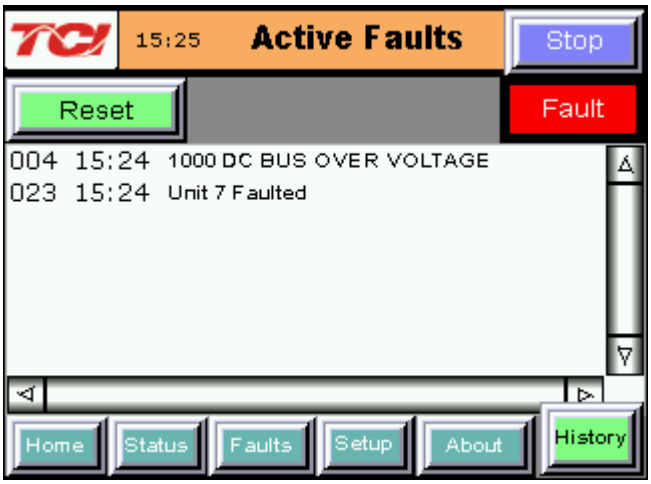


Figure 7.14: Fault Screen

Table 7.11: Fault Screen Elements

Screen Element	Description
Stop Button	Turns off the HarmonicGuard® Active filter.
Reset Button	This button will remove all faults from the list, if the fault conditions have cleared. Once cleared, a fault will still be viewable in the fault history log.
Fault Trip Entry Display	When a fault occurs, the fault screen will display information about the fault including the (from left to right across the screen): Fault bit mask number Fault timestamp Fault code Fault description
History Button	This button will take the user to the "Fault History" sub screen, where previous faults can be reviewed.

Table 7.12: Fault Codes

Fault Code	Critical or Non-critical Fault	Auto or Manual Reset	Fault Description
10	Critical	Manual*	Desat (IGBT Gate Driver)
30	Non-critical	Auto	Internal CPU Fault 1
156	Non-critical	Auto	Internal CPU Fault 2
555	Non-critical	Auto	Internal CPU Fault 3
1000	Non-critical	Auto	DC Bus Overvoltage
1250	Non-critical	Auto	DC Bus Under voltage
3000	Non-critical	Auto	Overcurrent on Phase A
3010	Non-critical	Auto	Overcurrent on Phase B
3020	Non-critical	Auto	Overcurrent on Phase C
4000	Non-critical	Auto	Heat Sink Over Temperature
4250	Non-critical	Auto	Under temperature
4500	Non-critical	Auto	Exhaust Over Temperature
7000	Non-critical	Auto	Calibration Fault
7010	Non-critical	Auto	Communications Fault
7050	Critical	Manual*	Auto-start Restart Limit Exceeded
Unit N Faulted	Non-critical	Auto	Fault location indication. Fault originated in Unit N where N is in the range 1 to 8. For factory configured parallel systems the unit numbers are sequential ordered from left to right when looking at the front of the system. Unit 1 is the left most unit in the system.

*Critical faults flagged with a manual reset require a HMI stop button or run/stop switch stop command at the unit to clear.

Fault History Sub Screen

The "Fault History" sub screen (See **Figure 7.15**), contains up to 120 entries that mark the onset and clearing of system faults. At the onset of a fault condition, an entry will be generated in the fault history marked with an "O" on the left side of the fault entry. When a fault clears, an entry will be generated in the fault history marked with an "X" on the left side of the fault entry.

The Fault History persists through power on/off cycles. In the event the fault history log exceeds the max number of 120 entries, the oldest entry will be overwritten by new entries.

Figure 7.15: Fault History Sub Screen

Table 7.13: Fault History Log Entry Format

Column (from left to right)	Format	Description
Onset/Clear Marker	O = Fault Onset X = Fault Cleared	Marks the start and end of a fault in the fault history.
Timestamp	HH:MM MM/DD/YYYY	Time and date the fault entry was logged.
Fault Code	Four digit code	Fault code (see **Table 7.12**).
Fault Description	Text	A short text description of the fault.

Setup Screen

Note: Some set-up screens are password protected to prevent changes that could damage the filter.

When the user presses the "Setup" button, a screen will appear where the Date, Time, Language, and Screen Brightness can be selected.

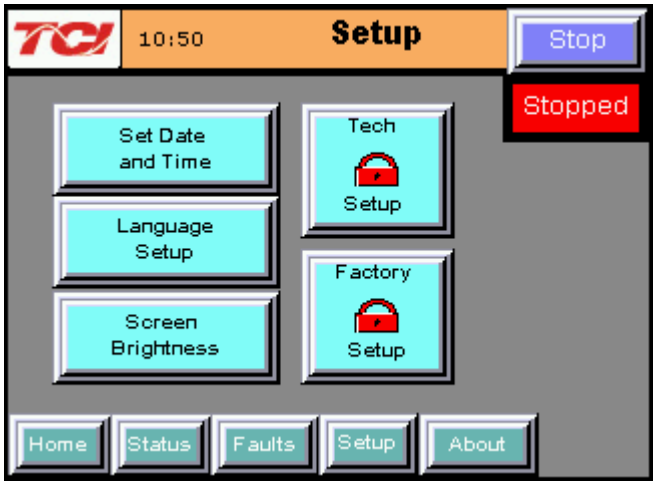
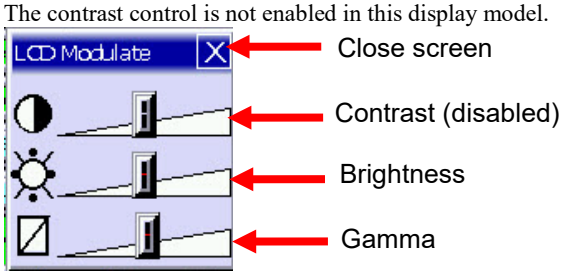


Figure 7.16: Setup screen

Table 7.14: Setup Screen Elements

Screen Element	Description
Set Date and Time	Presents a sub screen, which allows the user to change the date and time displayed on the screen. The date and time are also used for time stamps in the fault history and historical trend plots.
Language Setup	Allows user to select Language (English, Spanish, French)
Screen Brightness	This option allows the user to change the brightness and gamma of the display. The contrast control is not enabled in this display model.  NOTE: Screen is designed to be viewed at chest level. If viewing from below and screen appears "light" in color, adjust Gamma to the left. Adjust to right if screen appears too dark.
Tech Setup	This button is password protected. Takes user to "Tech Setup" screen. Outline to follow.
Factory Setup	This button is password protected and used during the factory and TCI technician setup only.

Tech Setup Screen

To continue to the Tech Setup page, select the "Tech Setup" button and enter the Tech Password: **08252014.**

Next, a splash screen will appear displaying, "The Filter is about to stop" (see **Figure 7.17**). Choosing "Next" will stop the filter and take the user to the "Tech Setup" screen (see **Figure 7.18**). Pressing the "Back" button returns the user to the "Home" screen and does not turn off the filter. If the filter is off, this splash screen will not appear.

Figure 7.17: Setup Transition Sub Screen

The Tech Setup Screen (see **Figure 7.18**) allows basic configuration of the HarmonicGuard® Active filter operation.
Note: It is recommended that the new settings are saved when changes are made. See the description of the "Save Settings" button in **Table 7.17**.

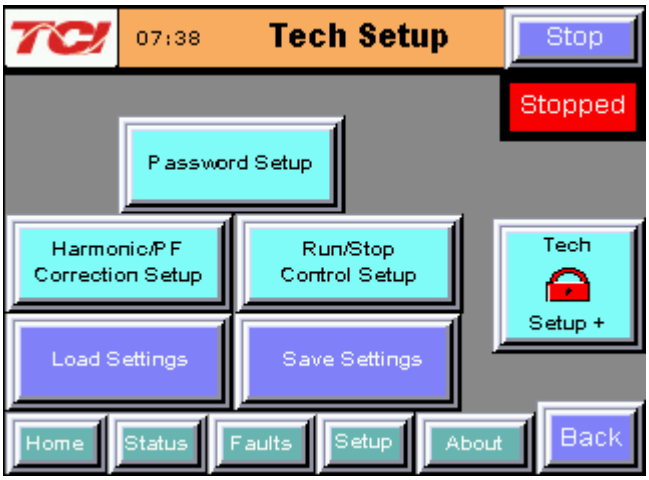
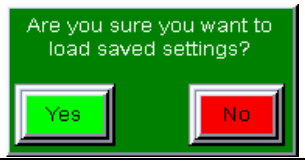
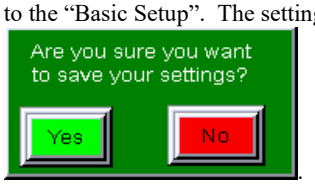


Figure 7-18: Tech Setup Screen

Table 7.15: Tech Setup Screen Elements

Screen Element	Description
Harmonic/PF Correction Setup	Takes user to “Harmonic/PF Correction Setup” sub screen. Outline to follow.
Password Setup	This button is password protected. Takes user to pop-up screen where passwords can be re-configured.
Run/Stop Control Setup	Takes user to “Run/Stop Control Setup” sub screen. Outline to follow.
Load Settings	This button will restore the user saved settings from non-volatile persistent memory. A confirmation screen will pop up asking “Are you sure you want to load saved settings”. If “Yes” is chosen, any temporary changes made to the working set point parameters will be lost and the user saved settings will be restored. If “No” is pressed, the user will be sent back at the “Basic Setup” screen. 
Save Settings	This button will save the current working settings to non-volatile memory that persist when power is removed from the unit. To save the current settings, choose “Yes” on the confirmation screen or choose “No” to cancel and go back to the “Basic Setup”. The settings will not be saved if “No” is chosen. 
Tech Setup +	The password protected Tech Setup + button opens up application specific setup screens for advanced configuration of the active filter. Access to this HMI screen is not needed for basic system installation and commissioning. If a specialized setup feature is required for your application, an authorized TCI field service representative will provide instruction on those features.

Harmonic/PF Correction Setup Sub-Screen

Allows for selection of Harmonic and PF correction, CT Ratio, and system calibration.

NOTE: If button is GREEN, the option is ENABLED. If button is BLUE, the option is DISABLED.

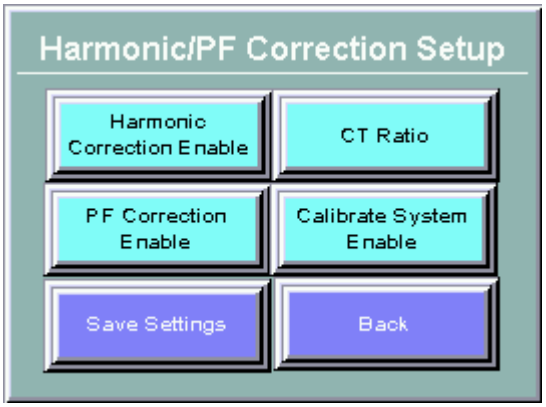
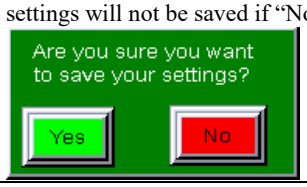


Figure 7.19: Tech Setup Screen

Table 7.16: Harmonic/PF Correction Setup Screen Elements

Screen Element	Description
Harmonic Correction Enable	This option turns the Automatic Harmonic Correction on or off. This option is on by default. If both harmonic correction and power factor correction are enabled and the HarmonicGuard® Active filter is at its maximum capacity, the power factor correction will automatically be phased back to allow the system to continue correcting harmonics.
PF Correction Enable	This option turns the Automatic Power Correction on or off. This option is on by default. If both harmonic correction and power factor correction are enabled and the HarmonicGuard® Active filter is at its maximum capacity, the power factor correction will automatically be phased back to allow the system to continue correcting harmonics.
CT Ratio	The CT ratio button opens a pop up sub screen that allows selection of the turn ratio of the system line or load current transducers (CTs). The CT ratio is expected to be in terms of primary current to 5A of secondary current. For example, a 1000:5 CT means that for 1000A of primary current there are 5A of current in the CT secondary winding connected to the active filter. See user manual **Table 4.3** for the allowable CT range for a particular active filter unit type.
Calibrate System Enable	This button initiates the active filter sensor calibration procedure. There is no need to calibrate the unit unless instructed by authorized TCI field service personnel. The active filter ships from the factory with all sensors fully calibrated, so calibration is not required at the time of unit startup. This button is available for recalibration of the unit during field service trips. The calibration process will only run if the unit is in the nominal stopped state. Calibration should be done when the system bus is at no-load.
Save Settings	This button will save the current working settings to non-volatile memory that persist when power is removed from the unit. To save the current settings choose “Yes” on the confirmation screen or choose “No” to cancel and go back to the “Basic Setup”. The settings will not be saved if “No” is chosen. 
Back	Takes user back to the Tech Setup screen

Run/Stop Control Setup Sub-Screen

Allows user to configure control settings.

NOTE: If button is GREEN, the option is ENABLED. If button is BLUE, the option is DISABLED.

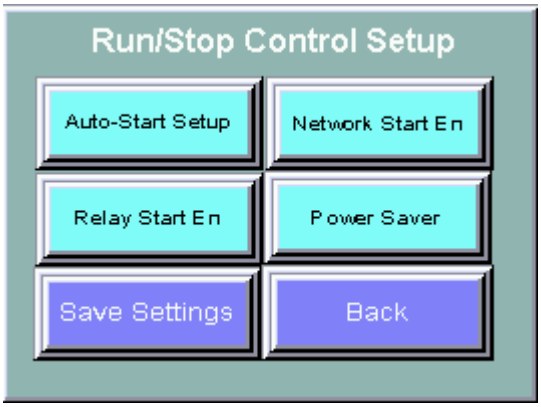
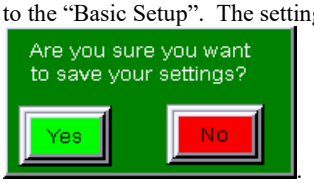


Figure 7.20: Tech Setup Screen

Table 7.17: Run/Stop Control Setup Screen Elements

Screen Element	Description
Auto-Start Setup	Takes user to Auto-Start Setup sub screen.
Relay Start Enable	This option allows the Active Line Conditioner to be remotely turned on or off via an external relay. J2 on the interface requires a switch closure to turn on the converter. If the stop button is pressed locally on the HMI Display, the unit will be put into an inhibit state and not respond to relay run commands until either the run button is pressed on the HMI display or the unit is power cycled. Once the run button is pressed, the relay start/stop command will again control the unit.
Network Start Enable	This option allows the Active Line Conditioner to be remotely turned on or off across a network connection. If the stop button is pressed locally on the HMI Display, the unit will be put into an inhibit state and not respond to network run commands until either the run button is pressed on the HMI display or the unit is power cycled. Once the run button is pressed, the network start/stop command will again control the unit.
Power Saver	This button opens the power save feature sub screen. The power save feature allows the unit to turn off its internal power converter, if the system line current iTHD and/or Power factor drops below a set threshold. The line current Amp threshold depends on the system CTs installed with the active filter. For example, a power save threshold set to 10% with 1000:5 CTs installed would result in the filter turning off, if less than 100A of current is measured via the line/load CTs. Both the line current threshold amps and percentage are displayed on the power save sub screen. The iTHD% and Power Factor turn on threshold level can also be set on the power save sub screen. In order to go into power save mode, the RMS current level must be below the threshold. To come out of power save mode, first, the RMS current level must be above the set RMS current threshold, then either the iTHD must be above the set iTHD threshold or the power factor must be below the power factor threshold. The power save feature has a five second on/off delay and threshold hysteresis built in to prevent limit cycling of the active filter, when the system current level is near the power save feature threshold.
Save Settings	This button will save the current working settings to non-volatile memory that persist when power is removed from the unit. To save the current settings, choose “Yes” on the confirmation screen or choose “No” to cancel and go back to the “Basic Setup”. The settings will not be saved if “No” is chosen. 
Back	Takes user back to the Tech Setup screen

Auto Start Setup Sub-Screen

Allows user to configure the parameters necessary to use the Auto-Start option.

NOTE: If button is GREEN, the option is ENABLED. If button is BLUE, the option is DISABLED.

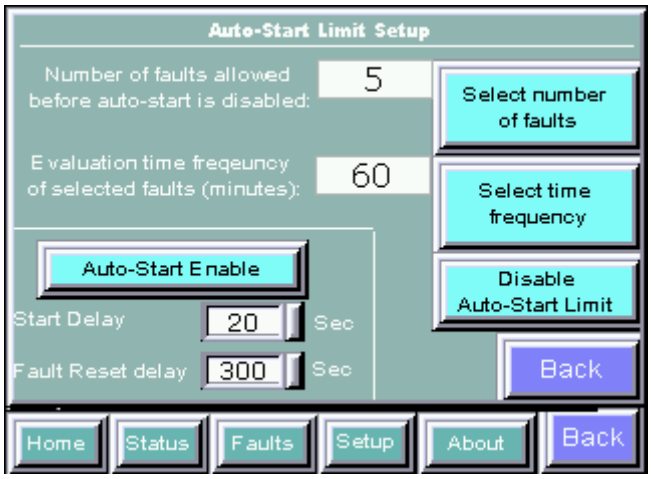


Figure 7.21: Auto Start Setup Screen

Table 7.18: Auto-Start Setup Screen Elements

Screen Element	Description
Auto-Start Enable	This option will set the converter to start automatically after a programmed delay, after power is applied or after a fault occurs. This option is on by default.
Select number of faults	Allows user to select number of faults allowed to occur before auto start option is disabled.
Select time frequency	Allows user to select the time allowed between faults before auto start option is disabled.
Disable Auto-Start Limit	The disable auto start limit button will disable the frequency limit or the number of allowed unit auto-starts after a fault is detected.
Start Delay	The start delay is the time, in seconds, the active filter will wait, after a power up or after a fault, before auto starting the harmonic and/or power factor correction, if the auto start feature is enabled.
Fault Reset Delay	The fault reset delay is the time, in seconds, the active filter will wait, after a fault is detected, prior to attempting to auto-clear the fault and restart harmonic and/or power factor correction, if the auto-start feature is enabled.
Back	Takes user back to the Tech Setup screen.

About Screen

The About Screen (see **Figure 7.22**) displays model number, serial number, and software/firmware version information regarding the filter, as well as the CT ratio.

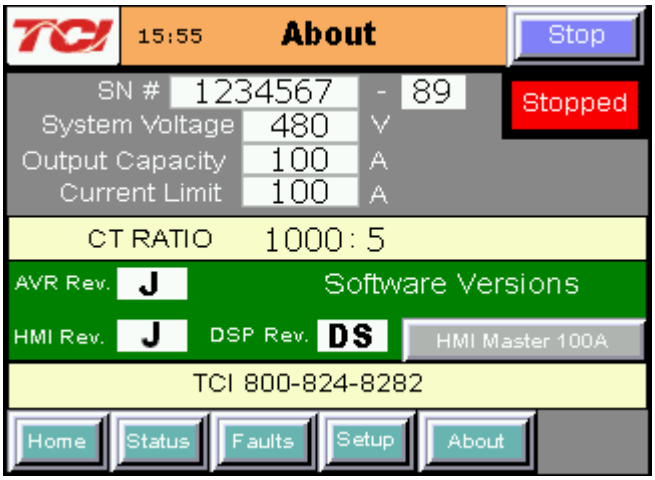


Figure 7.22: About Screen

Table 7.19: About Screen Elements

Screen Element	Description
Stop Button	Turns off the HarmonicGuard® Active filter.
Serial # Display	Displays the pre-programmed factory serial number of the HarmonicGuard® Active filter.
Total Output Current Display	Displays the total corrective current capacity in Amps RMS of the HarmonicGuard® Active filter.
System Voltage Display	Displays the line voltage the HarmonicGuard® Active filter is set to run on.
CT Ratio Display	Displays the CT ratio the HarmonicGuard® Active filter is set to run on.
DSP Type Display	Displays the Digital Signal Processor type used in the HarmonicGuard® Active filter power converter controller.
DSP Revision Display	Displays the software revision of the installed Digital Signal Processor used in the HarmonicGuard® Active filter power converter controller.
AVR Revision Display	Displays the software revision of the installed microcontroller in the Interface PCB.
HMI Revision Display	Displays the software revision of the HMI Display application code.
Current Limit	Displays the configured corrective current limit in Amps RMS for the unit. The current limit will typically match the unit capacity unless the unit has been derated for a specific application, such as high altitude or elevated ambient temperature.

Sensor Wiring Error Auto Detection Sub Screen

Some HarmonicGuard® Active filter models are equipped with voltage and current feedback sensor wiring error detection algorithms. The detection algorithms run briefly on unit power up and check the unit sensors for signatures of common wiring errors, such as incorrect ACB phase rotation (instead of the required ABC rotation) and inverted system CT polarity.

The Sensor Wiring Error Sub Screen is a pop up screen, which is not accessible from any of the main navigation screens. The screen is only displayed if a wiring error is detected. If no sensor wiring errors are detected, the pop up screen will remain hidden.

If a Sensor Wiring Error is detected, the HGA will be inhibited from running until system power is removed from the unit and the error is corrected.

The Sensor Wiring Error Detection feature is comprised of several independent detection algorithms. The two main categories of algorithms are voltage based detections and current based detections. The voltage based detection algorithms monitor the three phase line voltage input for proper ABC phase rotation, polarity, balance and nominal magnitude. The current based detection algorithms monitor the system Current Transformer (CT) sensor feedback for proper phase rotation, polarity, balance, and CT open or shorted conditions. The current base detections are only engaged if a minimum level of load current is present during power up. Both the voltage and current detection algorithms can be globally or individually configured by TCI qualified personnel via the password protected Technician level Setup Screen.

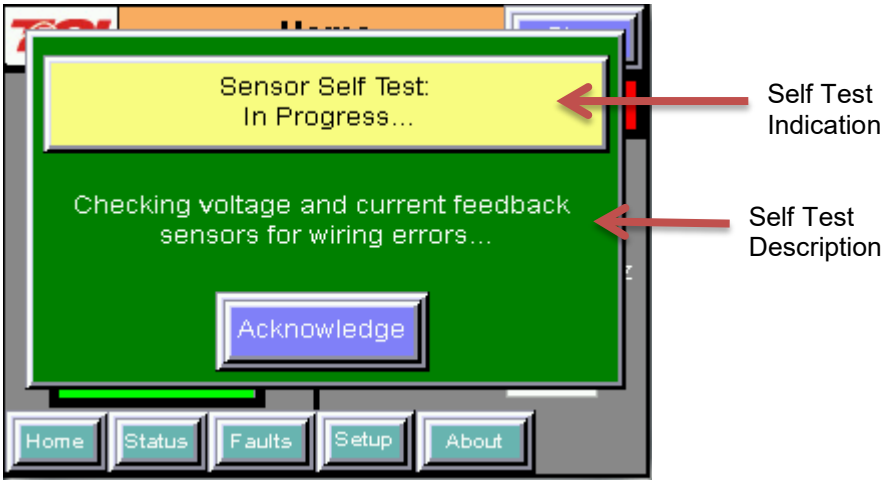


Figure 7.23: Sensor Wiring Error Self Test Sub Screen

Table 7.20: Sensor Wiring Error Self Test Sub Screen Elements

Screen Element	Description
Self Test Result Indication	Displays the current Pass/Fail/In-Progress State of the Sensor Wiring Error Auto Detection feature. When a sensor wiring error is detected, the specific fault code will be shown.
Self Test Result Description	When a sensor wiring error is detected one or more corrective actions will be displayed here, for a list of suggested resolutions.
Acknowledge Button	Pressing the “Acknowledge” button will hide the Sensor Wiring Error Self Test Sub Screen, so other screens can be examined, in order to trouble shoot the wiring error. If a user attempts to operate the unit while a sensor wiring error is still present by pressing the Run or Stop buttons, the screen will reappear.

Table 7.21: Sensor Wiring Error Code Table

Error Code	Error	Suggested Corrective Action
0	No Error	No corrective action required.
1	Self Test In Progress	No correction action required. Typically the self test will complete and auto clear in less than 10 seconds after power up.
2	Line Voltage Synch	Turn off unit and check 3 phase AC input voltage wiring for missing phase connection or low line voltage.
3	Input Over Voltage	Turn off unit and check 3 phase AC input voltage wiring for high line voltage
4	Reverse Voltage Phase Rotation	Turn off unit and check 3 phase AC input voltage wiring for A, B, C phase rotation or missing phase connection.
5	Phase A Input Under Voltage	Turn off unit and check 3 phase AC input voltage wiring for missing phase or low line voltage.
6	Phase B Input Under Voltage	Turn off unit and check 3 phase AC input voltage wiring for missing phase or low line voltage.
7	Phase C Input Under Voltage	Turn off unit and check 3 phase AC input voltage wiring for missing phase or low line voltage.
8	Reverse CT Current Rotation	Turn off unit and check system CT feedback for A, B, C phase rotation, inverted CT polarity, or CT short/open.
9	Phase A CT Under Current	Turn off unit and check system CT feedback for no feedback (CT short or open).
10	CT Under Current	Turn off unit and check system CT feedback for no feedback (CT short or open).
11	Phase C CT Under Current	Turn off unit and check system CT feedback for no feedback (CT short or open).
12	Phase A CT Polarity	Turn off unit and check system CT phase A feedback for incorrect polarity or reverse phase rotation.
13	CT Polarity	Turn off unit and check system CT phase A and C feedback for incorrect polarity or reverse phase rotation.
14	Phase C CT Polarity	Turn off unit and check system CT feedback phase C for incorrect polarity or reverse phase rotation.
15	Phase Power Imbalance	Turn off unit and check CT feedback and 3 phase AC input voltage for incorrect polarity or reverse phase rotation.

Network Interface

The network interface on the Interface Module allows basic Run/Stop commands and internal status data and can be communicated to and from the HarmonicGuard® Active filter. The HMI display implements an integrated ModbusRTU slave device for the network interface (see the HMI Display Connection section) or an optional network communications gateway can be used, such as EtherNet/IP to implement other protocols (see **Appendix C**).

The input/output register maps of the data available from the network interface are available in **Table 7.22** and **Table 7.23**. All input and output registers are two bytes in size and formatted as 16 bit signed integers. For the base address of the input and output data sections, please reference the connection sections in this manual specific to the configured protocol. For the integrated ModbusRTU network interface, reference the HMI Display Connection section. If an option Communications Gateway is configured, reference the appendix.

Table 7.22: Network Interface OUTPUT Register Map

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
SYS_RUNNING	0	Output	0 = Idle 1 = Running	Indicates if the HGA filter is currently running or in the idle state
SYS_POWER_ON	1	Output	0 = Power Off 1 = Power On	Indicates if the HGA filter has input power available
SYS_FAULTED	2	Output	0 = Not faulted 1 = Faulted	Indicates if the HGA filter is faulted
SYS_IN_I_LIMIT	3	Output	0 = Nominal 1 = At Capacity	Indicates if the HGA filter is running at its maximum capacity
V_LINE_LL_RMS	4	Output	Volts RMS 480 = 480 VRMSLL Range: 0 to 1,000	Source Utility Line Phase to Phase Voltage
I_LINE_RMS	5	Output	Amps RMS 1,000 = 1,000 ARMS Range: 0 to 10,000	Line/Load Phase Current
I_LINE_PF	6	Output	100 = 1.00 Unity PF -95 = 0.95 Lagging PF 95 = 0.95 Leading PF Range = -99 to 100	Line/Load Displacement Power Factor - Negative values indicate lagging power factor
SYS_NW_START_EN	7	Output	0 = Network Run Disabled 1 = Network Run Enabled	Network Run/Stop command enable setpoint
SYS_STATE	8	Output	0,1 = Initialization 2 = Fault inhibit 3 = Input inhibit 4 = Fault reset 5 = Stop 6,7 = Pre Charge 8 = Run 9 = Fault 10 = Calibration 11 = Power Save 13 = Communication Configuration 14 = Calibration Self Check	Present control state of power converter
I_CONV_RMS	9	Output	Amps RMS 100=100Amps Range: 0 to current rating of unit	Active filter correction injection current
FAULT_ACTIVE	10	Output	System fault code indicator bits.	Each bit represents whether the assigned fault was detected. A value of binary 1 indicates the assigned fault was detected and a value of zero indicates the assigned value was not detected.
FAULT_LOCATION	11	Output	16 position bit-mapped value Bit0 = Power Converter 1 Fault (leftmost position) Bit1 = Power Converter 2 Fault Bit3= Power Converter 3 Fault	System fault location indicator bits. Each bit represents whether a fault was detected in a particular power converter. A value of binary 1 indicates the assigned power converter detected a fault and a value of 0 indicates the assigned power converter did not detect a fault.

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
MB_INHIBIT_ACTIVE	12	Output	16 position bit-mapped value: Bit - Fault 0 - IGBT Gate 1 - Exhaust OT 2 - Internal CPU 3 - DC Bus OV 4 - DC Bus UV 5 - Phase A OC 6 - Phase B OC 7 - Phase C OC 8 - HW Phase A OC 9 - HW Phase B OC 10 - HW Phase 10 OC 11 - Power Conv OT 12 - Power Conv UT 13 - Unit Cal 14 - Com Fault 15 - Restart Limit	System wiring error unit inhibit code. Please reference the HGA IOM Sensor Wiring Error Code **Table 7.21** for a list of error codes and their definitions. For units equipped with an HMI touchscreen, the error code definitions are also displayed on the unit's local HMI.
T_CONV	13	Output	Degrees C 25=25C	Primary power converter heatsink temperature
SYS_INT_HB	14	Output	Range 0 to 65535	Processor internal heartbeat. Internal counter that counts up and rolls over to zero used to verify processor clock operation.
SW_DSP	15	Output	Two 8bit ASCCI Characters 0x3144 = ASCCI for "D1"	Software revision code for power converter processor.
AVR_SW_VER	16	Output	Two 8bit ASCCI Characters 0x3144 = ASCCI for "D1"	Software revision code for communications interface processor
ID_HMI_SW_VER	17	Output	Two 8bit ASCCI Characters 0x3144 = ASCCI for "D1"	Software revision code for HMI touchscreen processor.
SYS_MODEL_NUM	18	Output	8,9,16=Line Side Control 12,13,18=Load Side Control	Active filter Line or Load controls configuration.
SYS_SERIAL_NUM_2	19	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	20	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	21	Output	Parameter contains NN in the UUUULLLL- NN serial number format.	Unit serial number section - two digit unit number
MB_ID_SYS_CURRENT_LIMIT	22	Output	Amps RMS100=100AmpsRange: 0 to current rating of unit	Active filter current limit setpoint. Sometimes the current limit of the unit is set lower than max capacity of the model to derate for altitude or ambient temperature.
SYS_CAPACITY	23	Output	Percent injection current used 100=100% Range: 0 to 100	Present injection current capacity of active filter in units of percent of max capacity.

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
CT_RATIO	24	Output	XXXX:5 where XXXX is the primary turns count of the CT. 1000 = 1000:5 CT Range: 100 to 10000	Line or Load Current Transformer (CT) turns ratio.
SYS_IN_T_LIMIT	25	Output	0 = Unit not in thermal limit 1 = Unit in thermal limit	Indicator that unit is in thermal limit current foldback. Active filter correction current reduced due to power converter heatsink temperature approaching trip level.
SYS_PWR_SV	26	Output	0 = Unit not in power save mode 1 = Unit in power save mode.	Indicator for unit in power save mode, where a run command is present but correction demand is below turn on threshold.
I_LINE_THD	27	Output	% THD 50=5.0% THD Range: 0 to 100	iTHD for line current feedback (for units configured for line side/bus applied control) or iTHD for load current feedback (for units configured for load size/drive applied control).
I_LINE_THD_REF	28	Output	% THD 50=5.0% THD Range: 0 to 100	iTHD of line current feedback BEFORE active filter turn on. In cases of low signal feedback, this value will be zeroed out.
V_LINE_THD	29	Output	% THD 50=5.0% THD Range: 0 to 100	vTHD of line voltage at injection point. In cases of low signal feedback, this value will be zeroed out.

Table 7.23: Network Interface INPUT Register Map

Parameter Name	I/O Reg Address Offset	Direction	Format	Description
SYS_NW_START_IN	0	Input	0 = Network Command Stop 1 = Network Command Run	Remote Network Run/Stop command to the HGA
Unused	1	Input	-	-
Unused	2	Input	-	-
Unused	3	Input	-	-
Unused	4	Input	-	-
Unused	5	Input	-	-
Unused	6	Input	-	-
Unused	7	Input	-	-

The network Run/Stop command allows a remote network to send a run command to the HarmonicGuard® Active filter. The network command input will only be acknowledged if the Network Run/Stop Enable is set to ENABLED on the HMI Display setup screen. If the stop button is pressed locally on the HMI Display, the unit will be put into an inhibit state and not respond to network run commands until either the run button is pressed on the HMI display or the unit is power cycled. Once the run button is pressed, the network start/stop command will again control the unit.

8 ■ Section 8

Maintenance

8.1.1 Clock Battery Replacement

The HMI Display Real Time Clock is maintained by a non-rechargeable battery internal to the HMI Display. Change the battery every ten years or as needed. The system will continue to function as an active filter with a dead battery but HMI information (fault logs and trend plots) will not be maintained between power cycles.

To replace the battery, open the battery cover on the back of the HMI Display (see **Figure 8.1**) and remove the old battery. Dispose or recycle the old battery in accordance with any applicable national, state/provincial, and local requirements. Install new battery and close battery cover.

Replacement Battery Type: 3V Lithium CR2032 x Quantity 1

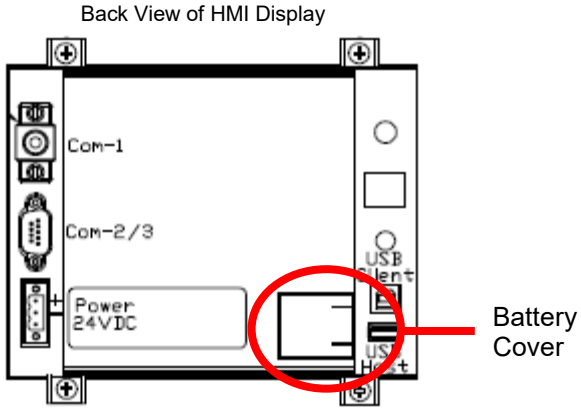


Figure 8.1: HMI Display Battery Location

8.1.2 Software Field Upgrades

In the event the HMI Display application software needs to be upgraded, the USB host port on the back panel of the HMI Display (see **Figure 8-2**) can be used for field upgrades. Software upgrade instructions will be sent with any software updates provided by TCI.

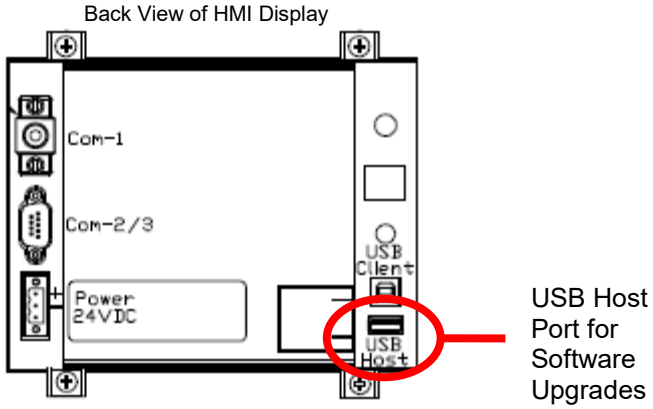


Figure 8-2: HMI Display USB Host Location

Troubleshooting

8.2.1 HarmonicGuard® Active Filter Fault

If the display indicates a fault has occurred, proceed to the fault screen by choosing the "Fault" menu screen button. To see if this is a recurring fault, hit the "History" button from inside the "Fault" screen. To clear a fault, press the "Reset" button from inside the "Fault" Screen or the "Stop" button from any screen.

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

8.2.2 Interface Module Problem

The Interface Module is comprised of four major components; the HMI display, the Interface PCB, the cabling and an optional Gateway. The Interface PCB contains diagnostic LEDs. The locations of the LEDs are shown in **Figure 8.3** and their functions are listed in **Table 8.1**.

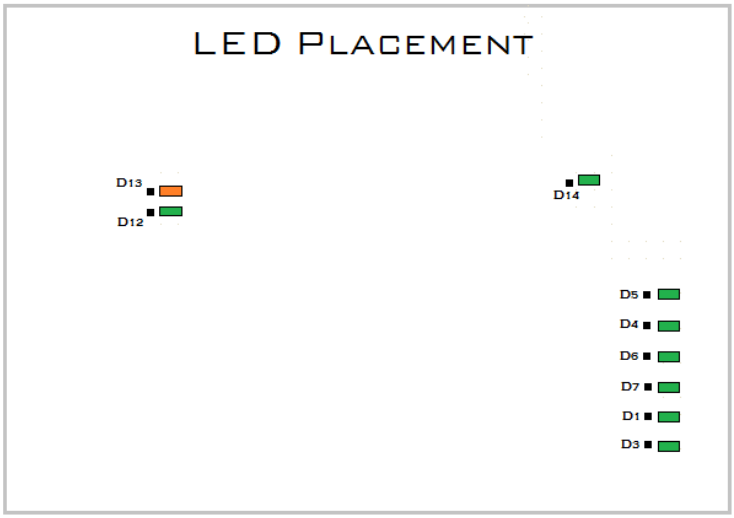


Figure 8.3: Communications Board LED placement

Table 8.1: LED Functions

LED	LED Color	Description (LED Color)
D1	Green	AUX 1
D3	Green	AUX 2
D4	Green	Running Relay Energized
D5	Green	Power-On Relay Energized
D6	Green	Fault Relay Energized
D7	Green	Current Limit Relay Energized
D12	Green	RS485 Communication is active from converter
D13	Orange	RS485 Communication is active to converter
D14	Green	Input Run Command Present

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.

8.2.3 Fault Troubleshooting Notes

- To reboot the system, remove power to the filter and Interface Module, wait a few minutes and then reapply. If this does not work, check all the cable and connections and try again. If the problem is still not resolved, replace the Interface Module assembly.
- If no buttons are pressed for 5 minutes, the screen will turn off. To reactivate, touch anywhere on the screen.
- If the HMI Display shows a “COM 1 Station 1: Communication Error” across the bottom of the screen, check the serial cable between HMI Display COM1 and Interface PCB J1.
- If the HMI Display shows a “NO COM” indication on the system state indicator or a 7010 Communications Fault in the fault screen, check the serial cable between Interface PCB J2 and the HarmonicGuard® Active filter power converter module J25 (100A/50A units) or J7 (200A units).
- For technical support, contact TCI directly at 1-800-824-8282. Select "Customer Service" or "Technical Support".

8.2.4 Fault Troubleshooting Flow Chart

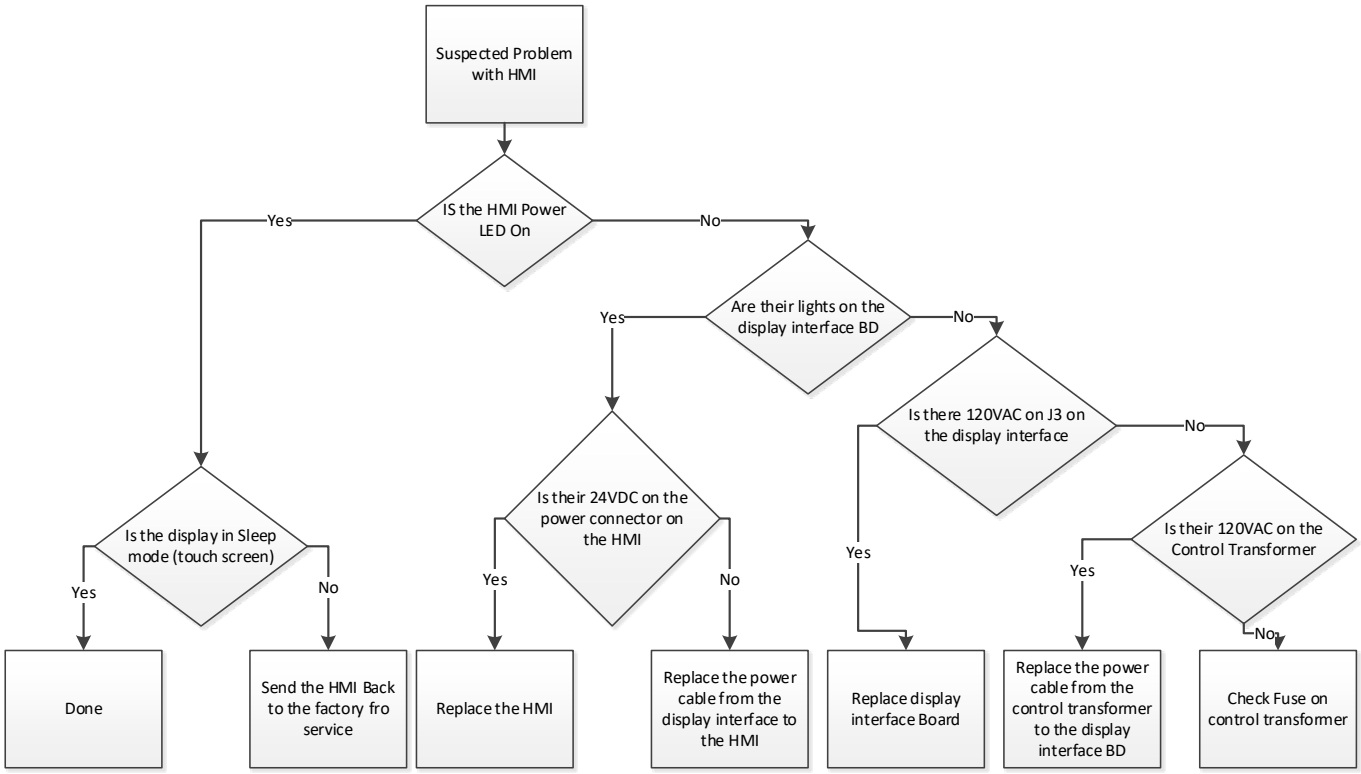


Figure 8.4: HMI Troubleshooting Flow Chart

9 ■ Section 9

Appendix A – Installation Diagram

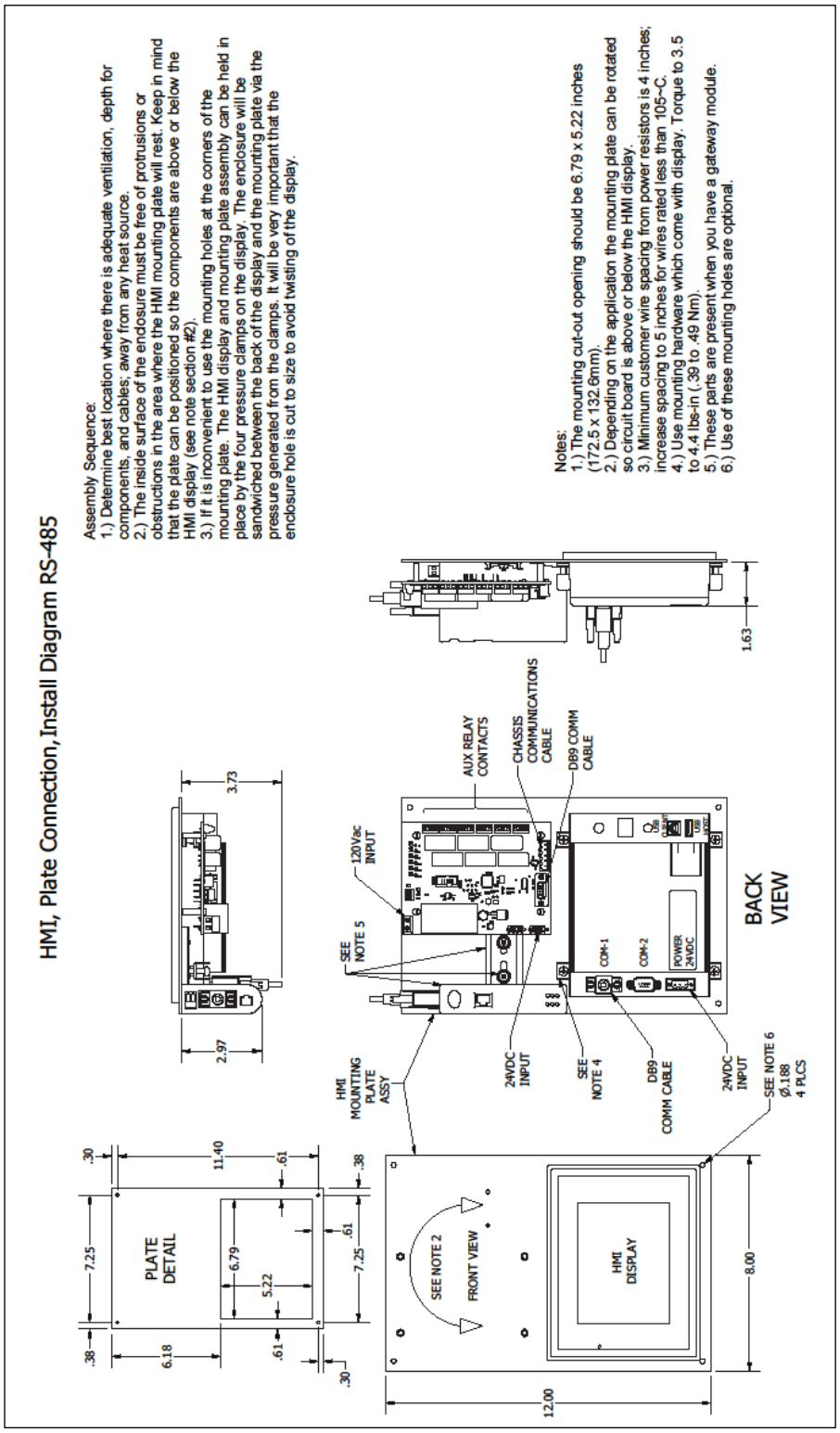


Figure 9.1: Installation Diagram

Appendix B – EtherNet/IP Gateway Option

9.2.1 Introduction

The EtherNet/IP network Communications Gateway translates command/status data to/from the HMI Display's integrated network interface from the ModbusRTU protocol to EtherNet/IP. The EtherNet/IP Communications Gateway is implemented using a third party, industry leading EtherNet/IP solution from HMS Anybus Communicator Product Line (Anybus Communicator AB7007).

Table 9.1: EtherNet/IP Communications Gateway Key Features

Feature	Description
Profile Support	EtherNet/IP level 2 I/O Server CIP, EtherNet/IP Adapter Class Device
Connection	10/100 MBit twisted pair RJ45 Connection
Galvanic Isolation	Transformer isolated EtherNet interface
TCP/IP Settings	Web Browser Based Configuration
Baud Rate	10/100 MBit auto detect
Protocol Conformance	Fully compliant EtherNet/IP gateway (ODVA File Number E-090-10070). See HMS website (www.hms.se) for Conformance Test Results.

Note: The optional network Communications Gateway part number and hardware is identical for the EtherNet/IP interface and the Modbus TCP/IP interface. Verify you are referencing the appropriate Appendix section for the network protocol you have selected.

9.2.2 Wiring

Connection of the HarmonicGuard® Active filter Interface Module to the end user's upstream EtherNet/IP network occurs at the RJ45 connection (see **Table 9.1**) on the Communications Gateway. The Communication Gateway is mounted on the back panel of the Interface Module (see **Figure 9.2**).

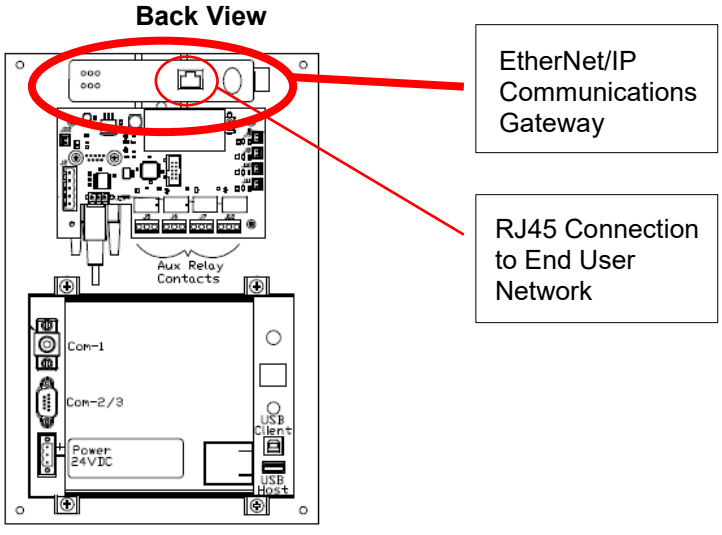
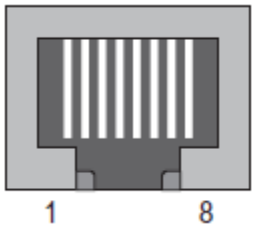


Figure 9.2: EtherNet/IP Communications Gateway Location

Table 9.2: EtherNet/IP Connector Pinout



Pin Number	Description
1	TD+
2	TD-
3	RD+
6	RD-
4, 5, 7, 8	Termination

9.2.3 Configuration

To configure the IP address of the EtherNet/IP communications gateway, connect the gateway to the EtherNet network then open a web browser window and type in the default IP address of the gateway (see **Table 9.3**) and press enter. The Communications Gateway configuration page should load (see **Figure 9.3**).

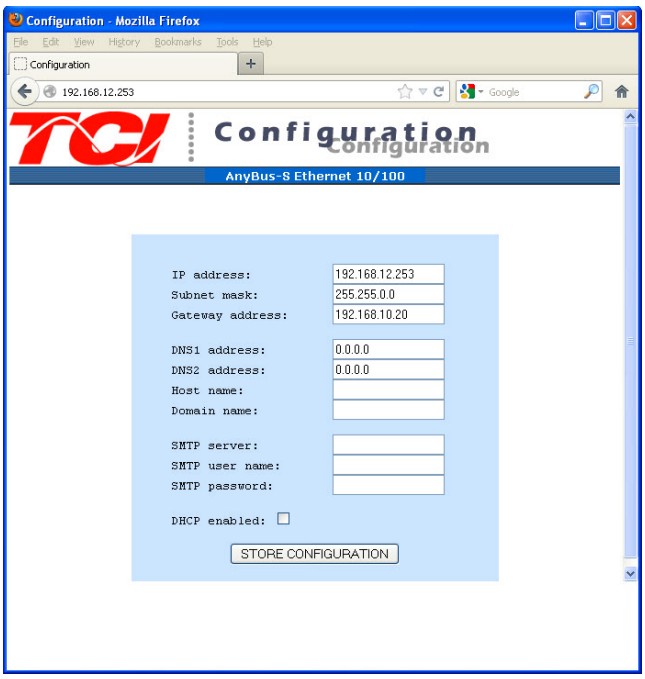


Figure 9.3: EtherNet/IP Gateway Configuration Page

Table 9.3: Gateway Default Settings

Setting	Default Value
IP Address	192.168.0.1
Gateway	255.255.255.0
Subnet	255.255.255.0
DHCP	Off

To update the IP address, type in a new IP address on the configuration page and then click on the STORE CONFIGURATION button. After the new IP address is stored, cycle power to the Communication Gateway to load the new IP address.

The EtherNet/IP Communications Gateway supports implicit EtherNet/IP I/O and explicit EtherNet/IP CIP Message commands. For an example of communication with the Gateway using explicit CIP Message commands via a PLC, please reference the following application note from HMS: *Reading/writing data from Anybus-S EtherNet/IP using ControlLogix5000 MSG instruction.*

The EDS file for the EtherNet/IP Communications Gateway is available via TCI technical support (direct dial: 414-357-4541, email (tech-support@transcoil.com) or from the TCI website (www.transcoil.com/Support.htm)).

For advanced configuration options, such as IP Access Control, reference the HMS Anybus Communicator Serial EtherNet/IP Gateway User Manual available on the HMS website (www.hms.se)

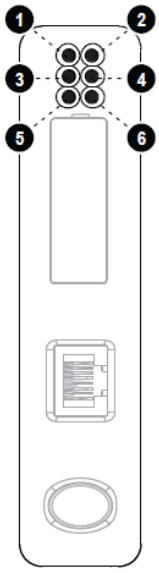
9.2.4 Register Map

For a description of the input and output data available over the network interface, reference **Section 7** in this user manual.

9.2.5 Operation

The Communication Gateway has six LED indicators that show the current status of the EtherNet/IP and sub-network communications. The translation of the LED indicators are described in **Table 9.4**.

Table 9.4: EtherNet/IP Gateway LED Diagram



Gateway Front View

LED Number	Indication	Translation
1 (Module Status)	Off Green Flashing Green Flashing Red Red Flashing Green/Red	No Power Normal Operation Configuration Missing Minor Fault, Recoverable Major Fault, Unrecoverable Self-Test in Progress
2 (Network Status)	Off Green Flashing Green Red Flashing Red Flashing Green/Red	No IP Address Online, Connection(s) Established Online, No Connection Established Duplicate IP Address Connection(s) Timed Out Self-Test in Progress
3 (Link)	Off Green	No Link Connected to EtherNet Network
4 (Activity)	Off Flashing Green	No EtherNet Activity Receiving/Transmitting Packets
5 (Subnet Status)	Flashing Green Green Red	Running, Transaction Error Detected Running Transaction error, timeout
6 (Device Status)	Off Flashing Green/Red Green Flashing Green Red Flashing Red	Power Off Invalid or Missing Configuration Initializing Running Bootloader Mode Note the LED flash sequence and contact Technical Support

9.2.6 HMS Gateway to PLC Master Example

HMI slave connected through Anybus gateway to PLC Master:

9.2.7 Required Equipment

- Anybus gateway programmed with TCI Anybus configuration
- HMI display connected to Anybus gateway
- Local Area Network (LAN) routers
- Rockwell ML1100 PLC
- LED Network for output display
- EtherNet RS45 cables

9.2.8 Setup

- Connect the RJ45 cable to the EtherNet Port on the Anybus gateway from a router (LAN).
- Connect the PLC to the router (LAN) via RJ45 cable.
- The network setup is displayed in **Figure 9.4**.

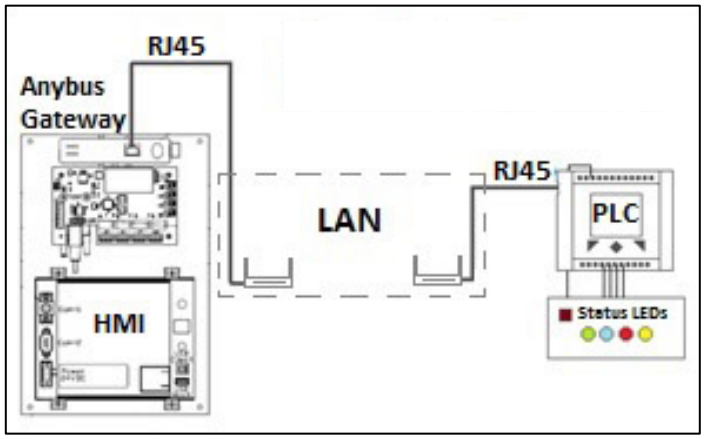


Figure 9.4: Anybus Gateway Network Setup with PLC Example

9.2.9 Programming

- Once all the connections are set, the PLC is programmed with the required configuration.
- The PLC and the Anybus are first established on the RSLinx network.
- The EtherNet Driver option is selected in RSLinx to find the PLC and the Gateway by typing the IP addresses for the respective devices in the EtherNet Driver configuration.
- Once the Devices are found by RSLinx, RSLogix Micro is opened to program the PLC.
- There is no need to change PLC channel configuration settings.
- As per the example, a ladder logic diagram has been presented (see **Figure 9.5**).
- Data files N7 (integer) and N18 (integer) are created with 8 words and 1 word respectively.

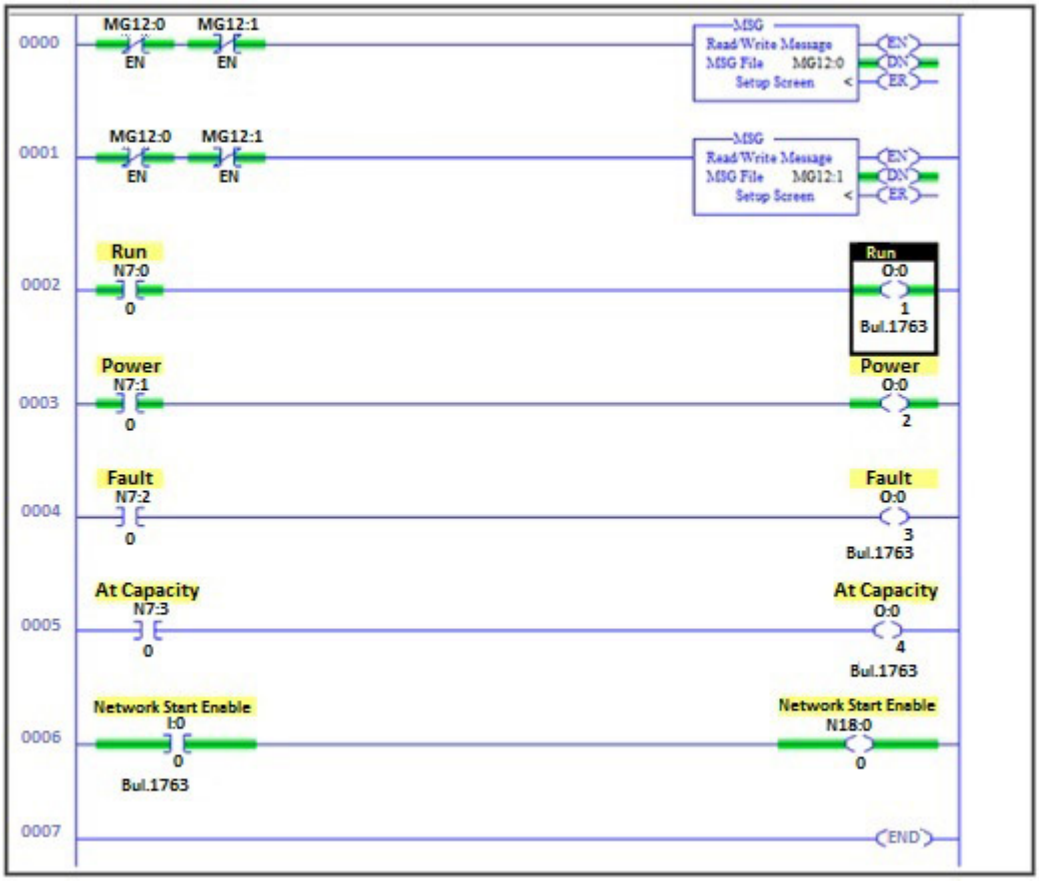


Figure 9.5: Ladder Logic Diagram

- Data file MG 12 is a message file containing 2 elements 0 and 1.
- The Message Structure settings are shown in **Figure 9.6** (write command) and **Figure 9.7** (read command).

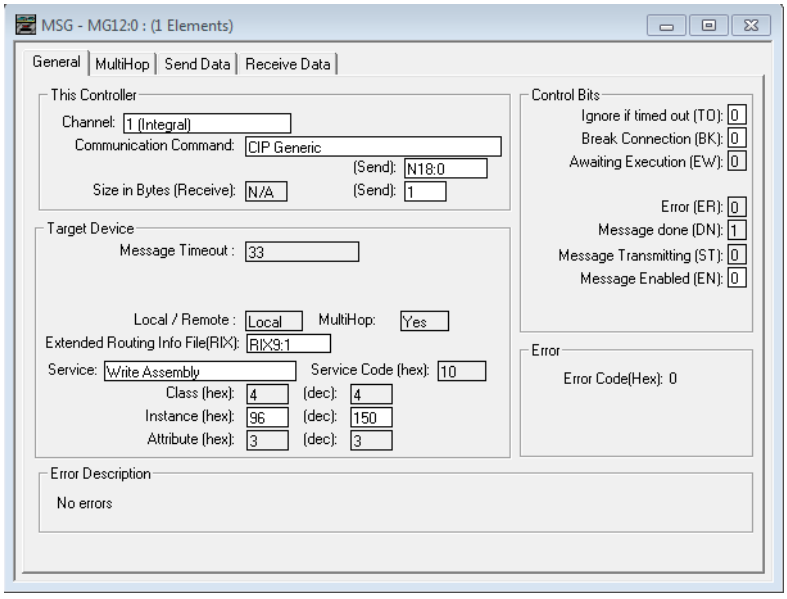


Figure 9.6: Message Structure (Write Command) Settings

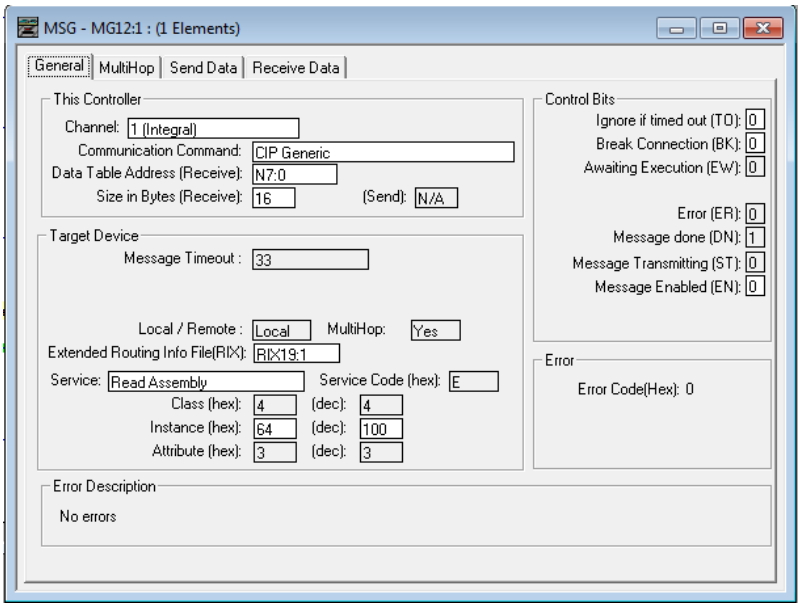


Figure 9.7: Message Structure (Read Command) Settings

- Data files RIX 19 and RIX9 hold the message read and write information respectively.
- The Anybus gateway configuration is programmed for 16 bit I/O registers.
- 1 PLC word (2 bytes) = 1 Anybus 16 bit I/O register.
- As there are 8 registers in total the “Size in Bytes (Receive)” will equal 16, 2 bytes for each PLC word.
- The above steps set the PLC settings to successfully communicate and exchange data with the Anybus gateway.
- The program can now be downloaded on to the PLC and set to run.

Appendix C – Modbus TCP/IP Gateway Option

9.3.1 Introduction

The Modbus TCP/IP network Communications Gateway translates command/status data to/from the HMI Display's integrated network interface from the Modbus RTU protocol to Modbus TCP/IP. Modbus TCP/IP (also Modbus-TCP) is simply the Modbus-RTU protocol with a TCP interface that runs on EtherNet. The Modbus TCP/IP Communications Gateway is implemented using a third party, industry leading Modbus TCP/IP solution from HMS Anybus Communicator Product Line (Anybus Communicator AB7007).

Table 9.5: Modbus TCP/IP Communications Gateway Key Features

Feature	Description
Profile Support	Modbus/TCP class 0, class 1 and partially class 2 slave functionality
Connection	10/100 MBit twisted pair RJ45 Connection
Galvanic Isolation	Transformer isolated EtherNet interface
TCP/IP Settings	Web Browser Based Configuration
Baud Rate	10/100 MBit auto detect
Protocol Conformance	Fully compliant Modbus TCP/IP gateway. See HMS website (www.hms.se) for Conformance Test Results.

Note: The optional network Communications Gateway part number and hardware is identical for the EtherNet/IP interface and the Modbus TCP/IP interface. Verify you are referencing the appropriate Appendix section for the network protocol you have selected.

9.3.2 Wiring

Connection of the HarmonicGuard® Active filter Interface Module to the end user's upstream Modbus TCP/IP network occurs at the RJ45 connection (see **Table 9.1** and **9.5**) on the Communications Gateway. The Communication Gateway is mounted on the back panel of the Interface Module (see **Figure 9.8**).

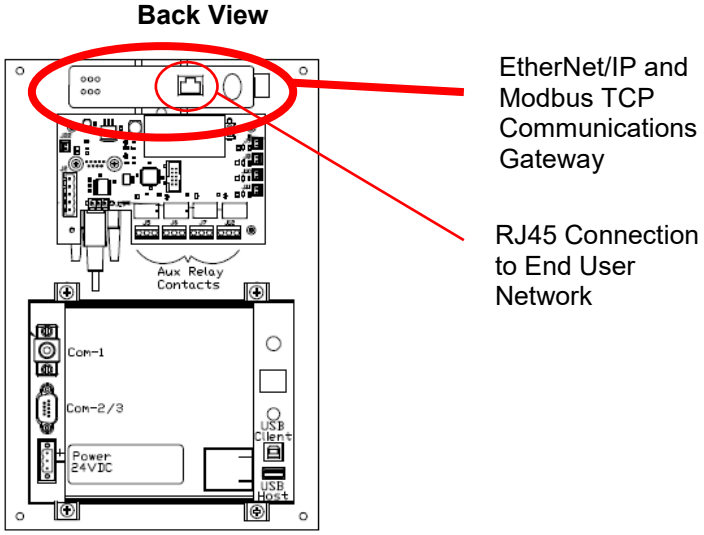
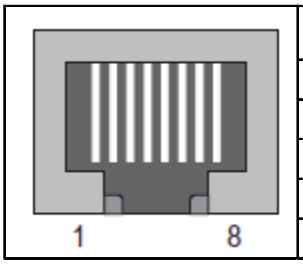


Figure 9.8: Modbus TCP/IP Communications Gateway Location

Table 9.6: Modbus TCP/IP Connector Pinout

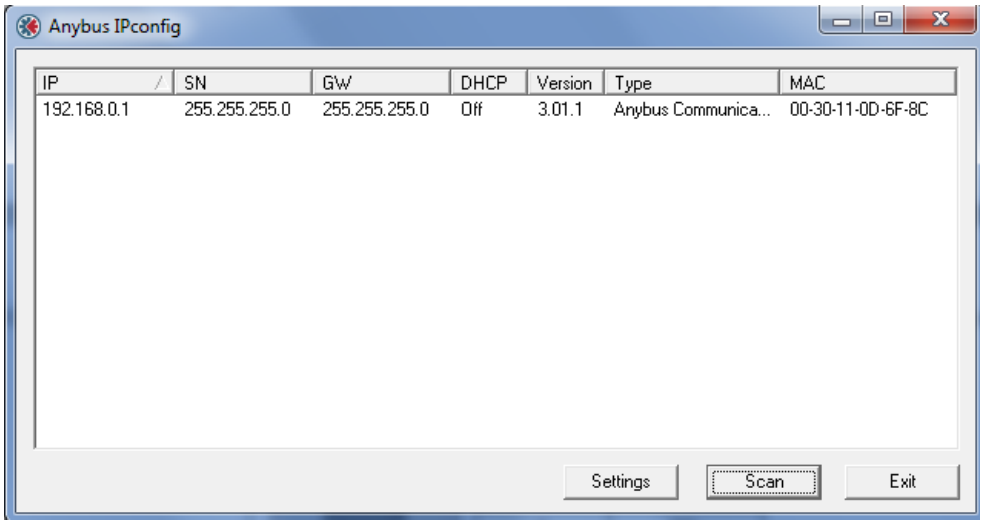


Pin Number	Description
1	TD+
2	TD-
3	RD+
6	RD-
4, 5, 7, 8	Termination

9.3.3 Configuration

To configure the IP address of the Modbus TCP/IP communications gateway, there are two options. The preferred method is to use the IPConfig tool provided by HMS. This can be downloaded for free from their website www.anybus.com.

For this option, first connect your computer to the same network as the Anybus module. Next, open the IPConfig tool. Select "Scan" and the device should be present on the screen with the default IP address shown below



To change this to your desired IP address, simply select it, right click and go to "Configuration". Here you will enter your new address and network information.

You can also connect the gateway to the EtherNet network and then open a web browser window and type in the default IP address of the gateway (see **Table 9.7**) and press enter. The Communications Gateway configuration page should load (see **Figure 9.9**).

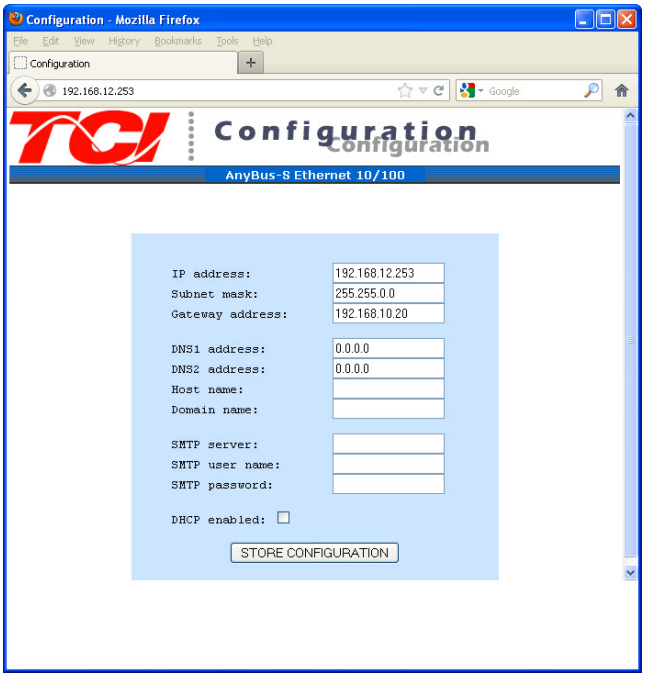


Figure 9.9: Modbus TCP/IP Gateway Configuration Page

Table 9.7: Gateway Default Settings

Setting	Default Value
IP Address	192.168.0.1
Gateway	255.255.255.0
Subnet	255.255.255.0
DHCP	Off

To update the IP address, type in a new IP address on the configuration page and then click on the STORE CONFIGURATION button. After the new IP address is stored, cycle power to the Communication Gateway to load the new IP address.

For advanced configuration options, such as IP Access Control, reference the HMS Anybus Communicator Serial Modbus TCP/IP Gateway User Manual available on the HMS website (www.hms.se)

9.3.4 Register Map and Address Offsets

For a description of the input and output data registers available over the network interface, reference **Section 7** in this user manual.

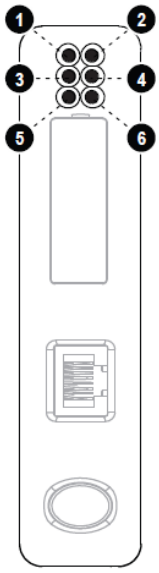
For the Modbus TCP interface, the HGA output status data registers from the HGA, which contain unit status, voltage, current, etc., are in Modbus register space 30000 (3x Input Registers). This register space should be accessed via Modbus Function Code 04 Read Input Registers.

For the Modbus TCP interface, the HGA input command data register to the HGA, which contains the unit run stop command, are in Modbus register space 40000 (4x Holding Registers). This register space should be accessed via Modbus Function code 06 Write Single Register.

9.3.5 Operation

The Communication Gateway has six LED indicators that show the current status of the Modbus TCP/IP and sub-network communications. The meanings of the LED indicators are described in **Table 9.8**.

Table 9.8: Modbus TCP/IP Gateway LED Diagram



Gateway Front View

LED Number	Indication	Meaning
1 (Module Status)	Off Green Flashing Green Flashing Red Red Flashing Green/Red	No Power Normal Operation Configuration Missing Minor Fault, Recoverable Major Fault, Unrecoverable Self-Test in Progress
2 (Network Status)	Off Green Flashing Green Red Flashing Red Flashing Green/Red	No IP Address Online, Connection(s) Established Online, No Connection Established Duplicate IP Address Connection(s) Timed Out Self-Test in Progress
3 (Link)	Off Green	No Link Connected to EtherNet Network
4 (Activity)	Off Flashing Green	No EtherNet Activity Receiving/Transmitting Packets
5 (Subnet Status)	Flashing Green Green Red	Running, Transaction Error Detected Running Transaction Error, Timeout
6 (Device Status)	Off Flashing Green/Red Green Flashing Green Red Flashing Red	Power Off Invalid or Missing Configuration Initializing Running Bootloader Mode Note the LED flash sequence and contact customer support

9.3.6 HMS Gateway Example

HMI slave connected through Anybus gateway to Simply Modus Master:

- Required Equipment
- Anybus gateway programmed with TCI Anybus configuration
- HMI display connected to Anybus gateway
- Local Area Network (LAN) routers
- Simply Modbus Master Software
- EtherNet RJ45 cables

- Setup
  - Connect the RJ45 cable to the EtherNet Port on the Anybus gateway from a router (LAN).
  - Connect the PC to the router (LAN) via RJ45 EtherNet cable.
  - The network setup is displayed in **Figure 9.10**.

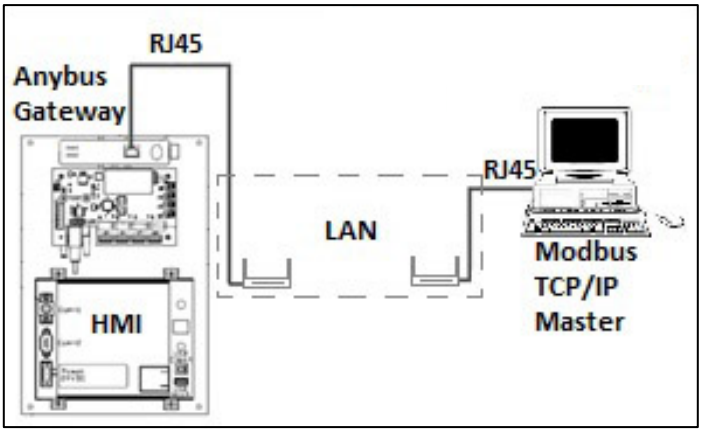


Figure 9.10: Network Setup with PC Example

- Programming
  - Once all connections are set, the Modbus TCP master is set for communication.
  - In our example the Modbus TCP master is "Simply Modbus," see **Figure 9.11**.

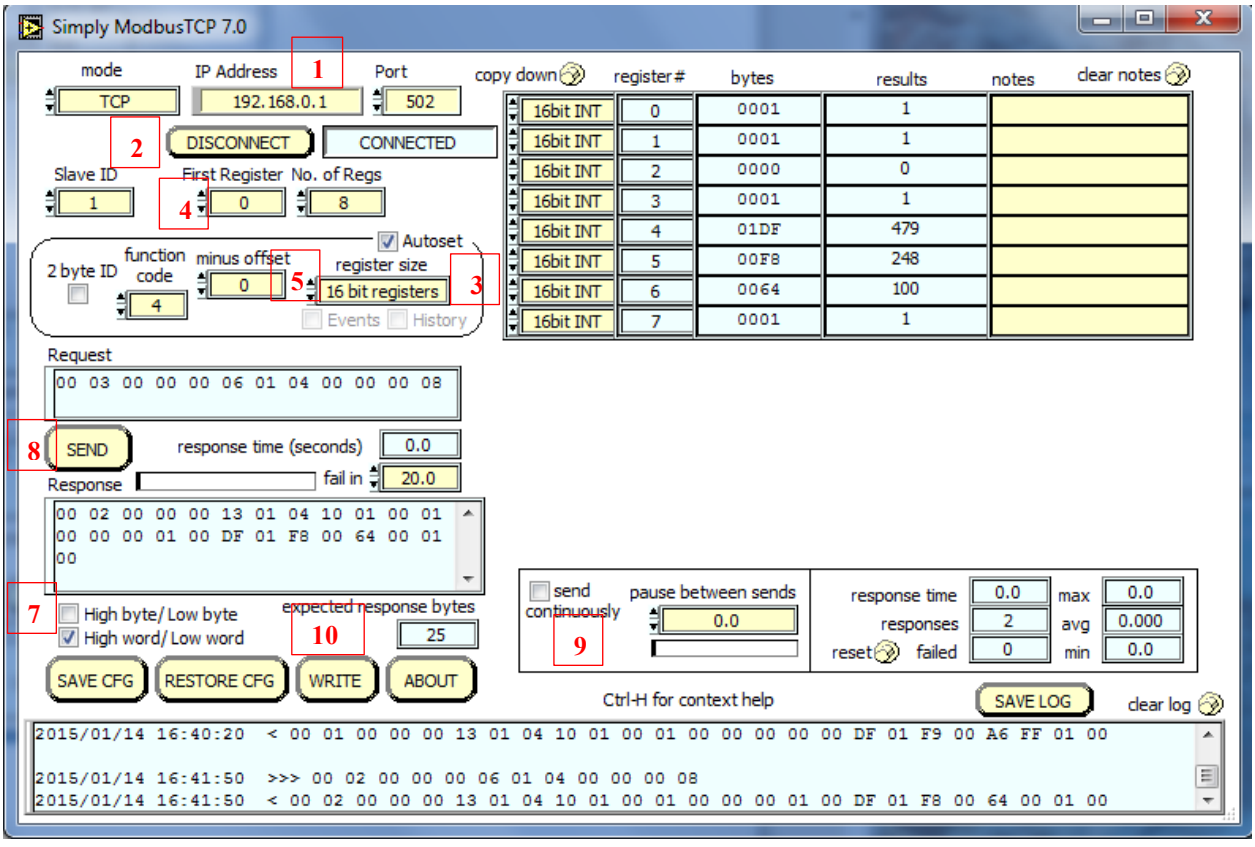


Figure 9.11: Simply Modbus Screen

- Read HMI Data
- Open Simply Modbus and enter the IP address set for the Modbus TCP/IP gateway **(1)**.
- Select mode as TCP and then hit CONNECT **(2)**. Once connected, a disconnect option will appear in place of NOT CONNECTED.
- Set the register size as 16 bits **(3)**.
- Select the first register as "0" and No. of Regs to 8 **(4)**.
- Set the minus offset at "0" **(5).**
- Set the function code to 4 **(6).**
- Uncheck the High Byte / Low Byte Check box **(7).**
- Click SEND **(8)**. The HMI data will appear on the table in the upper right side of the Simply Write Modbus application. For register map definitions, please reference the network interface reference **Section 7** in this user manual for data format and scaling.
- To receive data continuously, decrease the "pause between sends" to 0.0 and check send continuously **(9)**.

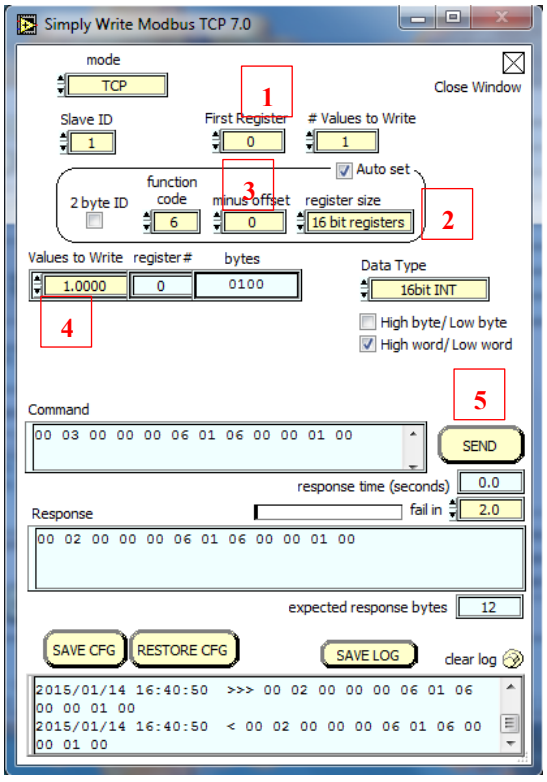


Figure 9.12: Simply Write Modbus Screen

- Write To HMI
    - Reference **Figure 9.11** and click the write command in the Simply Write Modbus main window (see **Figure 9.11** position 10).
    - Select the first register value as “0” **(1)**.
    - Select the data type as 16 bit INT **(2)**.
    - Set the minus offset to “0” **(3).**
    - Write the value as “1” in register number “0” **(4)** and hit SEND **(5)**. The unit will begin to run if the network run command enable is enabled. If the network run command enable is off/disabled, the network run command will be ignored.
    - Sending “0” in the same command will stop the unit.
    - The changes can be observed in the main window, see **Figure 9.12**.

NOTE: HGA unit will only respond to a network run command, if the network run command enable is enabled via the HGA unit’s HMI setup screen. See setup screen documentation in **Section 7** for information on how to enable the network run command. The network run command enable can only be enabled via the HMI on the HGA unit.

Appendix D – ModbusRTU Master

9.4.1 Introduction

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

9.4.2 Wiring and Configuration

The HGA implements a ModbusRTU slave device, which can be accessed by a connected ModbusRTU master that supports two wire RS-485 signal levels. The HGA HMI communication port used for the Modbus RTU interface is COM3. The COM3 serial connection header is shared with the COM2 port. The COM2/COM3 port is located on the back of the HMI display.

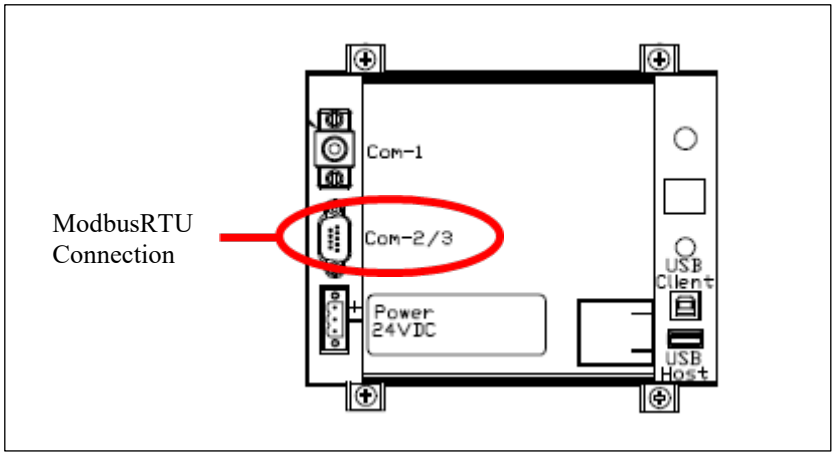


Figure 9.13: Modbus RTU Connection

The hardware pinout for the HMI COM3 port and the default settings are shown below.

COM2/3 DB9 Pin	Signal Name	Signal Type
1	no connect	-
2	no connect	-
3	no connect	-
4	D+	RS-485 B (non-inverting)
5	GND	RS-485 SC/G
6	no connect	-
7	no connect	-
8	no connect	-
9	D-	RS-485 A (inverting)

The default protocol settings for the RS-485 ModbusRTU interface on COM3 are show below.

Parameter	Default Value	Units
Baud Rate	19200	bps
Data Bits	8	bits
Stop Bits	1	bits
Parity	Even	-
Slave ID	113	-

The default settings can be modified via the HMI system menu. Please reference *the HMI Modbus RTU COM Change Instructions* document to change the default protocol settings.

9.4.3 Register Map

Read:

Parameter Name	I/O Reg Address Offset	Direction	Data Values and Examples	Description
SYS_RUNNING	0	Output	0 = Running 1 = Idle	Indicates if the HGA filter is currently running or in the idle state
SYS_POWER_ON	1	Output	0 = Power Off 1 = Power On	Indicates if the HGA filter has input power available
SYS_FAULTED	2	Output	0 = Not faulted 1 = Faulted	Indicates if the HGA filter is faulted
SYS_IN_I_LIMIT	3	Output	0 = Nominal 1 = At Capacity	Indicates if the HGA filter is running at its maximum capacity
V_LINE_LL_RMS	4	Output	Volts RMS 480 = 480 VRMSLL Range: 0 to 1,000	Source Utility Line Phase to Phase Voltage
I_LINE_RMS	5	Output	Amps RMS 1,000 = 1,000 ARMS Range: 0 to 10,000	Line/Load Phase Current
I_LINE_PF	6	Output	100 = 1.00 Unity PF -95 = 0.95 Lagging PF 95 = 0.95 Leading PF Range = -99 to 100	Line/Load Power Factor - Negative values indicate lagging power factor
SYS_NW_START_EN	7	Output	0 = Network Run Disabled 1 = Network Run Enabled	Network Run/Stop command enable setpoint

Write:

Parameter Name	I/O Reg Address Offset	Direction	Format	Description
SYS_NW_START_IN	0	Input	0 = Network Command Stop 1 = Network Command Run	Remote Network Run/Stop command to the HGA
unused	1	Input	-	-
unused	2	Input	-	-
unused	3	Input	-	-
unused	4	Input	-	-
unused	5	Input	-	-
unused	6	Input	-	-
unused	7	Input	-	-

Example Application Using "Simply Modbus Master 7.2.1"

The ModbusRTU network interface COM3 port is configured for RS-485 signal levels. The following example uses an RS-485 to USB converter to connect the HGA HMI to a laptop PC running the ModbusRTU master application. The picture below shows an example "US Converters Model: XS890" model RS-485 to USB converter.

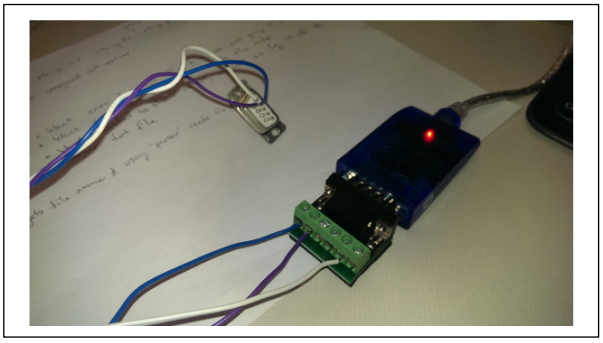
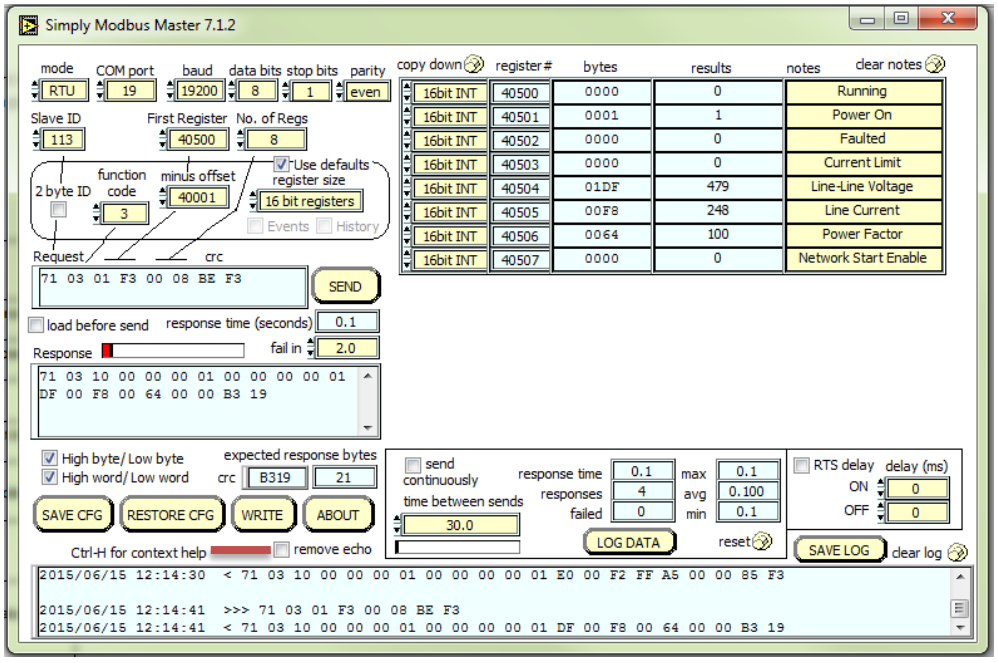


Figure 9.14: US Converters Model: XS890" model RS-485 to USB converter

Example Setup Instructions to Read Data from the HGA Unit:

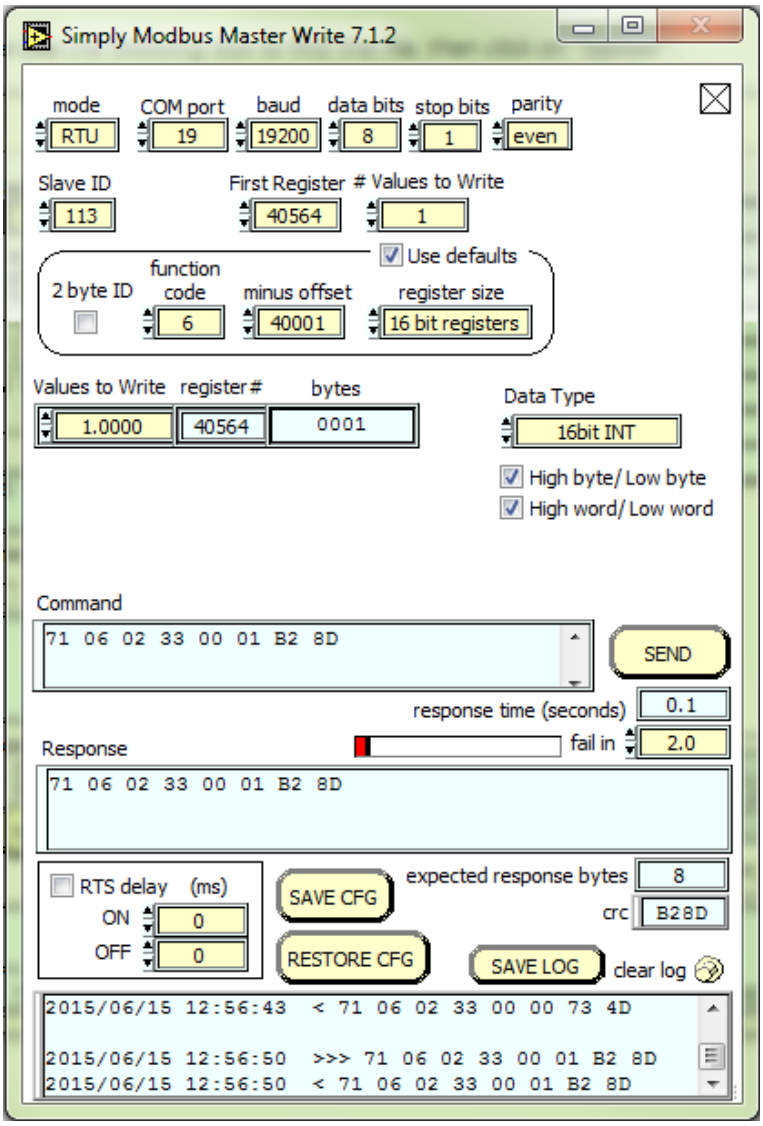
- Connect the cable to COM2/3 on back of HMI
- Connect USB end to the computer
  - Determine the assigned COM port number for the RS-485 to USB converter using the computer device manager control panel.
  - The converter used in this example typically enumerates between the range of COM5 to COM20 on a standard laptop computer running the Microsoft windows operating system.
- Configure the computer COM port settings to match the default settings used by the HGA HMI COM3 port listed above (baud, parity, stop bit(s), slave ID, etc...)
- Open the Simply Modbus Master software
  - Can be downloaded from the link below:
  - 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 HMI COM3 port.
  - **Note:** The "notes" section of the display data registers are filled in manually



- Select the “SEND” button and the data available on the network will be displayed.
    - Start and stop the unit using the HMI to see the changes in the fields.

Example Setup Instructions to Write Data to the HGA Unit:

- In order to start/stop the unit, first the “Network Start Enable” parameter must be enabled on the HMI manually.
    - Navigate to the Tech Setup page and then select the “Run/Stop Control Setup” button.
    - Select the “Network Start En” button once there. It will turn green and display “Network Start”.
- Next, select the “WRITE” button on the screen shown above.
- You will be brought to the screen shown below. Configure the fields as shown in the picture.



- Select “1” in the field “Values to Write” to turn the unit on or “0” to turn the unit off.
- Verify via the HMI that the unit is receiving commands by going to the screen shown below.

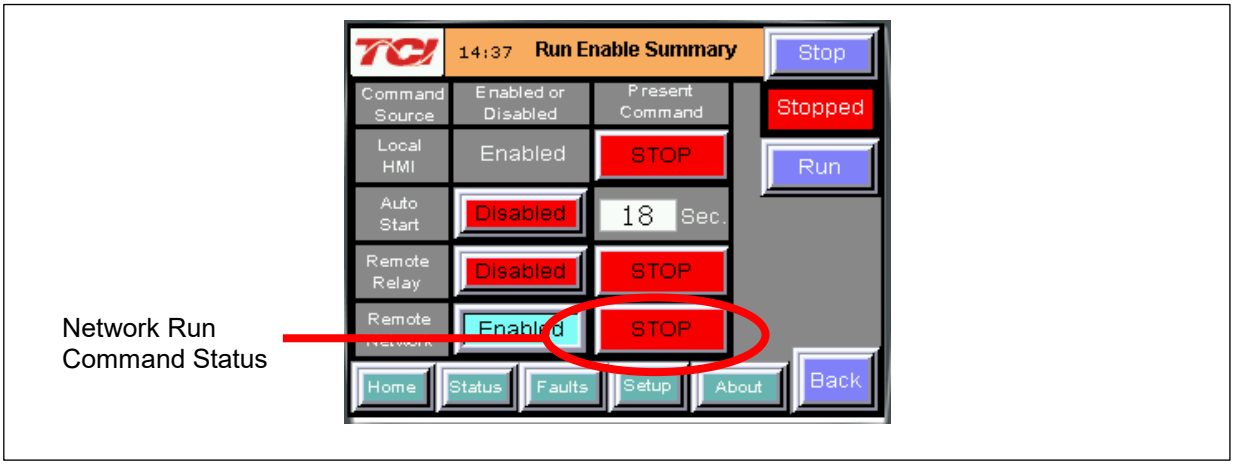


Figure 9.15: HGA with Remote Network Enabled

- This can be accomplished by selecting the "Status" page on the bottom of the screen, choosing the blue "Converter" button, and selecting "Run Enable Summary".
- The picture above shows the unit with the Remote Network enabled and the converter in the OFF state. The status indicator of the "Remote Network," in the "Present Command" column, will echo the start/stop command from the Simply Modbus ModbusRTU master.

Appendix E – DeviceNet Gateway Option

9.5.1 Introduction

DeviceNet is a node priority based communication protocol. Each device on the network has a node address. To write/read data, terminal node addresses needs to be programmed into the devices.

The DeviceNet network Communications Gateway translates command/status data to/from the HMI Display's integrated network interface from the ModbusRTU protocol to DeviceNet. The DeviceNet Communications Gateway is implemented using a third party, industry leading DeviceNet solution from HMS Anybus Communicator Product Line (Anybus Communicator AB7007).

Table 9.1 – DeviceNet Communications Gateway Key Features

Features	Details
Profile Support	I/O Slave messaging: Bit strobe, Polling, Cyclic, COS, Explicit Messaging
Connection	Multi-drop to up to 31 nodes
Galvanic Isolation	Standard for both bus side and serial side
Application Interface	RS232, RS422, RS485
Baud Rate	125, 250, 500 kbit/s
Protocol Conformance	CE, UL & cUL marked

9.5.2 Wiring

Pin	Signal	Description
1	V -	DeviceNet bus power, negative supply voltage
2	CAN L	Can L bus line
3	Shield	Cable shield
4	CAN H	CAN H bus line
5	V +	DeviceNet bus power, positive supply voltage

Figure 9.16: DeviceNet TCP/IP Connector Pinout

Connection of the HarmonicGuard® Active filter Interface Module to the end user's upstream DeviceNet network occurs at the DeviceNet connection (see **Table 9.1**) on the Communications Gateway. The Communication Gateway is mounted on the back panel of the Interface Module (see **Figure 9.17**).

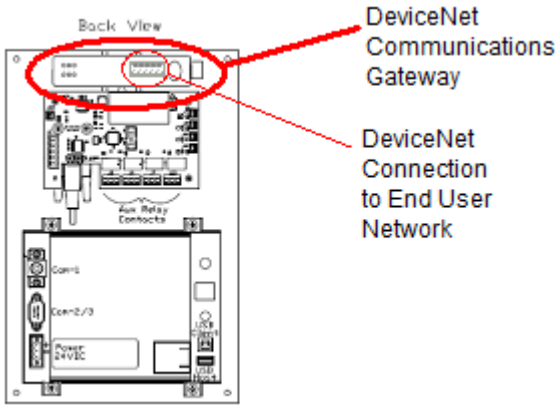


Figure 9.17: DeviceNet TCP/IP Communications Gateway Location

9.5.3 Configuration

To configure the DeviceNet gateway on the DeviceNet network, a node ID needs to be configured on the DeviceNet. The Node address can be assigned by setting the configuration switches on the anybus, as shown in the image.

Figure 9.18: Anybus Configuration Switches

The values of the switches represent are listed in the table below:

Baudrate	sw. 1	sw. 2
125k	OFF	OFF
250K	OFF	ON
500K	ON	OFF
(reserved)	ON	ON

Mac ID	sw. 3	sw. 4	sw. 5	sw. 6	sw. 7	sw. 8
0	OFF	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	ON
...	...	...	...	...	...	...
62	ON	ON	ON	ON	ON	OFF
63	ON	ON	ON	ON	ON	ON

Figure 9.19: Anybus Switch Values

After a node address has been assigned, the gateway can be connected to the DeviceNet network by using RSNetworks for DeviceNet devices.

The EDS file for the DeviceNet Communications Gateway is available via TCI technical support (direct dial: 414-357-4541, email tech-support@transcoil.com) or from the TCI website (www.transcoil.com/Support.htm).

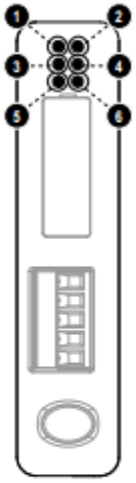
For advanced configuration options, reference the HMS Anybus Communicator Serial DeviceNet Gateway User Manual available on the HMS website (www.hms.se)

9.5.4 Operation

The Communication Gateway has six LED indicators that show the current status of the Modbus TCP/IP and sub-network communications. The translations of the LED indicators are described in **Figure 9.8**.

Table 9.9: DeviceNet TCP/IP Gateway LED Diagram

#	State	Status
1 - Network Status	Off	Not powered / not online
	Green	Link OK, On line, Connected
	Green, flashing	On line, Not connected
	Red	Critical Link Failure
	Red, flashing	Connection timeout
2 - Module Status	Off	No power to device
	Green	Device Operational
	Green, flashing	Data size bigger than configured
	Red	Unrecoverable fault
	Red, flashing	Minor Fault
3 - (Not used)	-	-
4 - (Not used)	-	-
5 - Subnet Status[a]	Off	Power off
	Green, flashing	Running correctly, but one or more transaction error(s) have occurred
	Green	Running
	Red	Transaction error/timeout or subnet stopped
6 - Device Status	Off	Power off
	Alternating Red/Green	Invalid or missing configuration
	Green	Initializing
	Green, flashing	Running
	Red	Bootloader mode[b]
	Red, flashing	IIf the Device Status LED is flashing in a sequence starting with one or more red flashes, please note the sequence pattern and contact the HMS support department



HMS Gateway Example

HMI slave connected through Anybus Gateway to a DeviceNet network. The end node for this setup is a DeviceNet Scanner that is connected to a ML1500 PLC.

- Hardware Requirements:
  - HMI display Anybus gateway assembly.
  - 1770 Allen Bradley KFD with respective serial cable.
  - 1769 DeviceNet Scanner.
  - Bus terminator cap.
  - MicroLogix 1500 PLC.
  - DeviceNet cables
- LED Network for Output display:
  - Software Requirements:
  - Anybus configuration manager.
  - RSLinx classics.
  - RSNetworx.
  - RSLogix 500 (Micro).

- Setup:
  - Connect Anybus gateway on the HMI assembly using a DeviceNet cable to the 1770 Allen Bradley KFD.
  - Connect the 1770 Allen Bradley KFD to the 1769 DeviceNet Scanner using another DeviceNet cable.
  - Attach the 1769 DeviceNet Scanner to the ML1500 PLC using the pin header present on the scanner; similarly attach the bus terminator cap to the other end of the scanner to finalize PLC assembly.

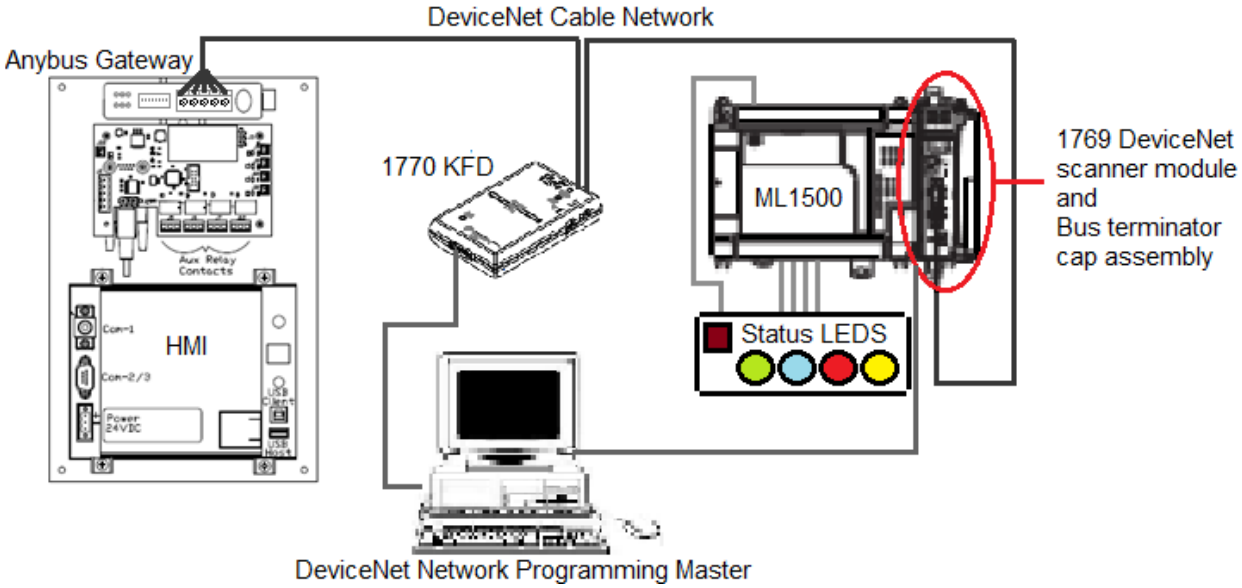


Figure 9.20: DeviceNet Network Setup

9.5.5 Establishing Correct Network Settings

The baud rate and node address are two important aspects of DeviceNet network, a mismatch in baud rate or a clash of node addresses will produce a red network status LED on the DeviceNet devices. The baud rate and node address for the three network devices can be set as following:

1. *Anybus Gateway* – The gateway is equipped with 8 switches, as described in the appendix DeviceNet network section. These switches can be manipulated, as described, to match network baud rate and provided the gateway with a distinct node address.
2. *1770 KFD* – The network settings and node address for the KFD are set in RSLinx. The RSLinx software is used to obtain nodes in a network. The KFD provides RSLinx the access to the DeviceNet network nodes.
3. *1769-SDN DeviceNet Scanner* – The network and baud rate settings for the scanner are given on page 40 of the DeviceNet Scanner Module (http://literature.rockwellautomation.com/idc/groups/literature/documents/um/1769-um009_-en-p.pdf).

Once the corrected baud rate and individual node addresses are assigned for the devices on the network, the network and module LEDs on each device should be green.

9.5.6 RSLinx Classics Settings

- In RSLinx, a new network is defined by clicking on the communications and then the configure drives option.
- From the menu that appears, select the 1770KFD DeviceNet option to view all devices on the DeviceNet network.
- Once selected, a window will appear with the Serial port and DeviceNet port settings drop down menus.
- Select the Serial port, as listed in Device Manager in the window's control panel. The data rate for the Serial port can be specified to 19200.
- For DeviceNet node address, choose an address not assigned to the Anybus Gateway or the DeviceNet scanner, in order to avoid address conflict.
- The data rate is selected to 250K, for this example.
- The same data rate is set in the Anybus Gateway through the switches present on the Gateway and in the Scanner through the ML1500 PLC.
- Once OK is selected, the KFD will access the network. Once connected, a box will appear to name the network. This confirms the connection is successful.
- By clicking on the network in the RSLinx main window, it can be seen that the software automatically populates the right window panel with active devices on the network.
- Similarly, for the ML1500 PLC, the RS232 option is selected in the Configure Drivers screen drop down menu.
- Once the PLC is found, it can be used in RSLogix to program the DeviceNet scanner and establish a ladder diagram for the LED status display.
- Similar to the PLC, RSNetworx uses the 1770KFD network to changes properties on the Devices found on the DeviceNet network.

9.5.7 RSNetworx

In RSNetworx, the first step is to open tools and follow the EDS wizard option. The EDS wizard is used to load the EDS file for the Anybus Gateway on the RSNetworx database. The EDS file will be provided in the Anybus Gateway CD.

- Next, go to the network option and select online.
- In the window that appears, select the DeviceNet network setup in RSLinx.
- The software will populate the devices online on the graph window of RSNetworx.
- Once all devices are on the network, without errors and the network is online, right click on the 1769 SDN. Then, go to properties.
- A new window will appear, go to the scanlist tab.
- Move the Anybus Communicator from the Available Devices to the Scanlist.
- Then, click on the Anybus Communicator under the scanlist section.
- Once the Anybus option is highlighted, click on the Edit I/O Parameters button in the same window.
- A new window will appear, check the "Polled" option.
- Put the input size as 16 Bytes and the Output Sizes as 2 Bytes.
- The Bytes sizes are as defined in the Anybus Configuration manager.
- Hit "Ok" and click "Yes" on the next two windows that appear.
- Click on the Module tab of the 1769 SDN scanner Module window.
- In the platform drop down menu, select Micrologix.
- Keep slot as 1.

- Move to the Input tab of the 1769 SDN scanner module window.
- From here you can observe that the registers 0-65 are read only.
- Therefore, the Anybus data is saved in the registers 66-73, each register being 16 bits.
- Similarly in the output tab, the first 2 registers are read only. The 3rd register will say Anybus Communicator, meaning that the anybus data is redirected and mapped to that register in the 1769 SDN.
- Once set, click on “Apply” and then click “OK”.
- The 1769 DeviceNet Scanner is now also set for proper communication with Anybus Communicator.

9.5.8 RSLogix

RSLogix is used to program the ML1500 PLC. Once in RSLogix, a new file is created and the PLC ML1500 Revision C is selected in the list of compatible PLCs. The “Who Active” option is used to connect the live PLC to the software. In RSLogix, the IOConfiguration option present on the left panel is selected. A new window will open, from the list of items present on the right panel, select the 1769 DeviceNet Scanner.

- Once selected, the DeviceNet Scanner will move to spot 1 in the left panel of the window, given that no other I/O modules are attached to the PLC.
- Click on the ReadI/O option. The program will attempt to read the IO profile of the DeviceNet scanner. Once found, a message box confirming the same will appear.
- In the IOConfiguration screen, click on the Adv. Config option located on the bottom left.
- In this option, the Input and Output words can be selected for the Scanner. Select 73 Input words and 3 Output words.
- The first 65 input words are reserved; the words 66-73 are used to store the HMI data coming in from the Anybus Gateway. Similarly, the first 2 output words are reserved, leaving 1 word for HMI data.
- The Input and Output data files present on the left panel of the RSLogix software hold the DeviceNet Scanner register values.
- The reserved word definitions can be reviewed in the scanner manual, they serve as status bits. The ouput bit O: 1.0 is the run bit for the scanner and can be toggled in the output data file.
- Once the data files are understood, the PLC is put into run mode and the data from the HMI can be seen in the IO data files.

Based on this information, the below ladder diagram was built to observe the HMI status and report it though the DeviceNet network on a LED status setup.

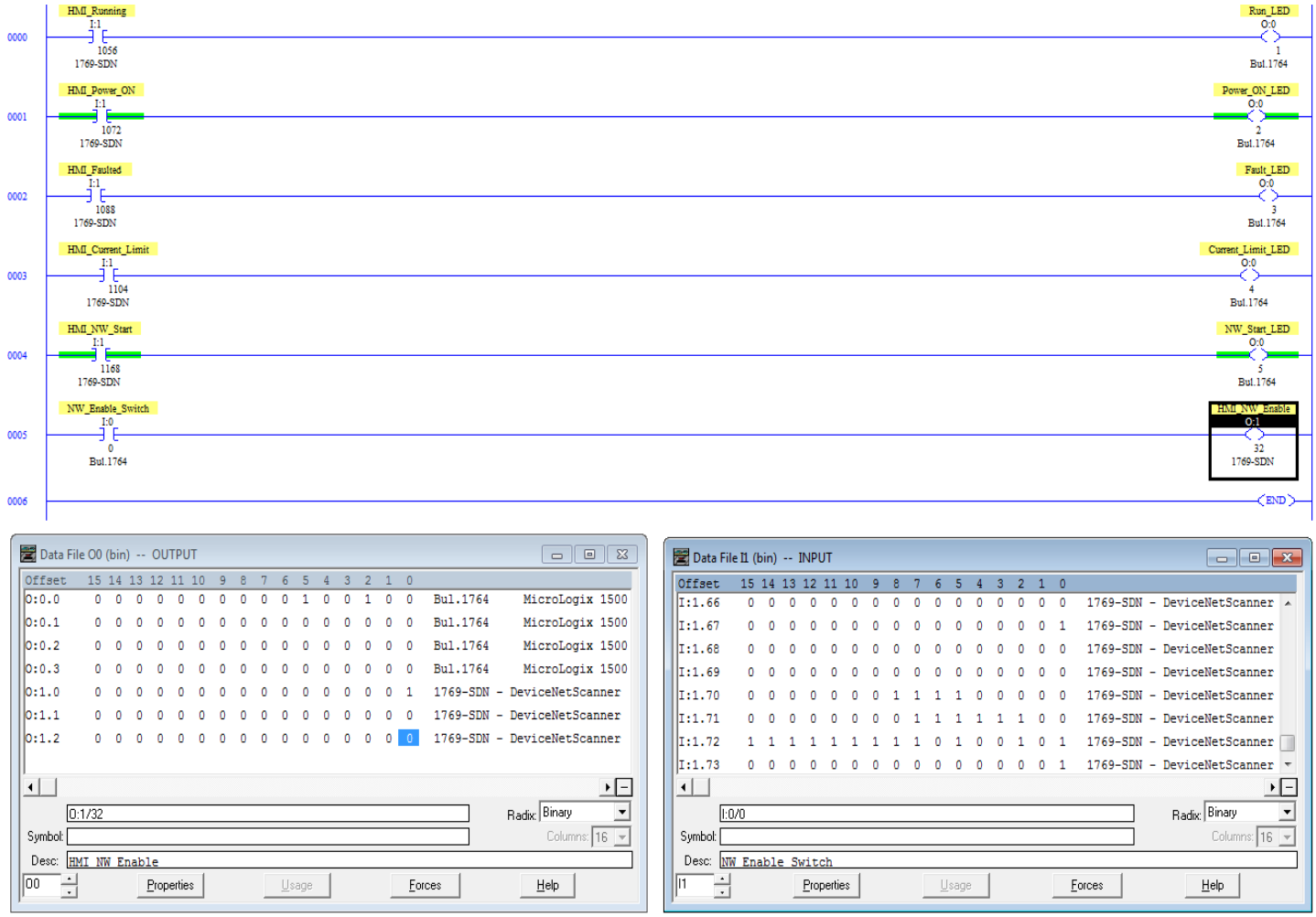


Figure 9.21: Ladder Diagram Observing HMI Status

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