



# High Performance Output Sine Wave Filter

Installation, Operation, and Maintenance Manual



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C	Add UL information Added 362A, 420A, 480A Updated wire size / torques	8/19/15
D	Updates to drawings in Section 6	6/16/17
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We strive to provide the most up to date and accurate documentation available at the time of printing. Please visit [www.transcoil.com](http://www.transcoil.com) for the most recent revision of this manual.

# 1.0 Safety

## Safety Instructions Overview

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

The MotorShield™ is intended to be connected to the output terminals of a variable frequency drive (VFD). An AC motor is connected to the output terminals of the MotorShield™ and receives power from the VFD through the MotorShield™. The instructions, and particularly the safety instructions, for the VFD, motor and any other related equipment must be read, understood and followed when working on any of the equipment.

## Warnings and Cautions



This manual provides two types of safety instructions.

Warnings caution readers about conditions, which can, if proper steps are not taken, lead to a serious fault condition, physical injury, or death.

Cautions are used to draw attention to instructions. Failure to properly follow such instructions may lead to a malfunction and possible equipment damage.


## Warnings

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

<p><b>Warning</b></p> 	<p>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.</p>
<p><b>Warning</b></p> 	<p>General Warning: warns of situations that can cause physical injury and/or damage equipment by means other than electrical. The text next to this symbol describes ways to avoid the danger.</p>










## Cautions

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

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

**General Safety Instructions**

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

<p><b>Warning</b></p> 	<p>Be sure to read, understand, and follow all safety instructions.</p>
<p><b>Warning</b></p> 	<p>Dangerous Voltage is used in the operation of the MotorShield™. Only qualified electricians should carry out all electrical installation and maintenance work on the MotorShield™.</p>
<p><b>Warning</b></p> 	<p>Do not attempt any work on a powered MotorShield™. All sources of power must be disconnected before working on the MotorShield™.</p>
<p><b>Warning</b></p> 	<p>After removing power, always allow 5 minutes for the capacitors in the MotorShield™ and in the drive to discharge before working on the MotorShield™, the drive, the motor, or connecting wiring. Verify with a voltmeter to make sure that all sources of power have been disconnected and that all capacitors have discharged before beginning work.</p>
<p><b>Caution</b></p> 	<p>The drive output terminals, MotorShield™ and the motor cables are at a dangerously high voltage when power is applied to the drive regardless of motor operation.</p>
<p><b>Warning</b></p> 	<p>All wiring must be in accordance with the National Electrical Code (NEC) and/or any other codes that apply to the installation site.</p>
<p><b>Caution</b></p> 	<p>Visually inspect and secure all loose electrical connections before applying power to the filter. Failure to do so may result in filter damage or diminished filter performance.</p>
<p><b>Warning</b></p> 	<p>The MotorShield™, drive, motor, and other connected equipment must be properly grounded.</p>
<p><b>Warning</b></p> 	<p>Prior to operation, confirm the drive operation mode is set to Volts per Hertz mode prior to operation. Consult the drive manufacturer for proper configuration parameters. Failure to properly configure the drive could result in drive failure or filter component failure.</p>

## 2.0 General Information

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

### Intended Audience

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

### Caution



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

The ratings, dimensions, and weights given in this manual are approximate and should not be used for any purpose requiring exact data. Contact the factory in situations where certified data is required. All data is subject to change without notice.

### Installation Checklist

Adhere to the following installation checklist for a successful installation. These points are explained in detail in the subsequent sections of this manual.

- Make sure that the installation location is appropriate for the enclosure type selected.
- Select a mounting area that will allow adequate cooling air and maintenance access.
- Make sure that all wiring conforms to the requirements of the National Electrical Code (NEC) and/or other applicable electrical codes.
- Connect the MotorShield™ equipment grounding lug to the system ground of the premises wiring system. Use a properly sized grounding conductor.
- Wire the output power terminals of the VFD, T1(U), T2(V), & T3(W) to the input terminals of the MotorShield™, U, V, & W.
- Wire the output power terminals, of the MotorShield™, T1, T2, & T3 to the motor.
- Connect reactor and capacitor temperature switches to the appropriate fault monitoring circuit.
- Check the MotorShield™ nameplate to ensure rated voltage is appropriate for the power, drive and motor voltage.
- Make sure that the VFD is set for operating modes and ranges that are compatible with the MotorShield™.
- Confirm the drive operation mode is set to Volts per Hertz mode prior to operation. Consult the drive manufacturer for compatibility settings for use with sine wave filters.
- Check the installation thoroughly before operating the equipment.

### Receiving Inspection

The MotorShield™ has been thoroughly inspected, functionally tested at the factory and carefully packaged for shipment. When you receive the unit, you should immediately inspect the shipping

container and report any damage to the carrier that delivered the unit. Verify that the part number of the unit you received is the same as the part number listed on your purchase order.

### **TCI Limited Warranty Policy**

TCI, LLC ("TCI") warrants to the original purchaser only that its products will be free from defects in materials and workmanship under normal use and service for a period originating on the date of shipment from TCI and expiring after one (1) year of useful service, not to exceed eighteen (18) months from the date of shipment.

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

This warranty shall not apply if the product was:

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

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

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

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

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

### **Storage Instructions**

If the MotorShield™ 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.

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

The MotorShield™ is a 3-phase low-pass sine wave filter designed and developed by TCI to deliver conditioned power to motor loads driven by PWM drives with switching frequencies from 2 kHz to 16 kHz. Any drive control parameter which has the effect of reducing the carrier or switching frequency below 2 kHz at any time must be disabled. Some sine wave or long lead mode drive parameters or operating modes can have this effect. This filter is suitable for VFD drives configured to Volts per Hz modes only. Available for three phase voltage systems up to 460/480 Volts, the MotorShield™ is a passive LC filter connected in series with the output terminals of the variable frequency drive. This design removes the carrier frequency distortion from the output voltage waveform resulting in a nearly pure sine wave voltage profile.

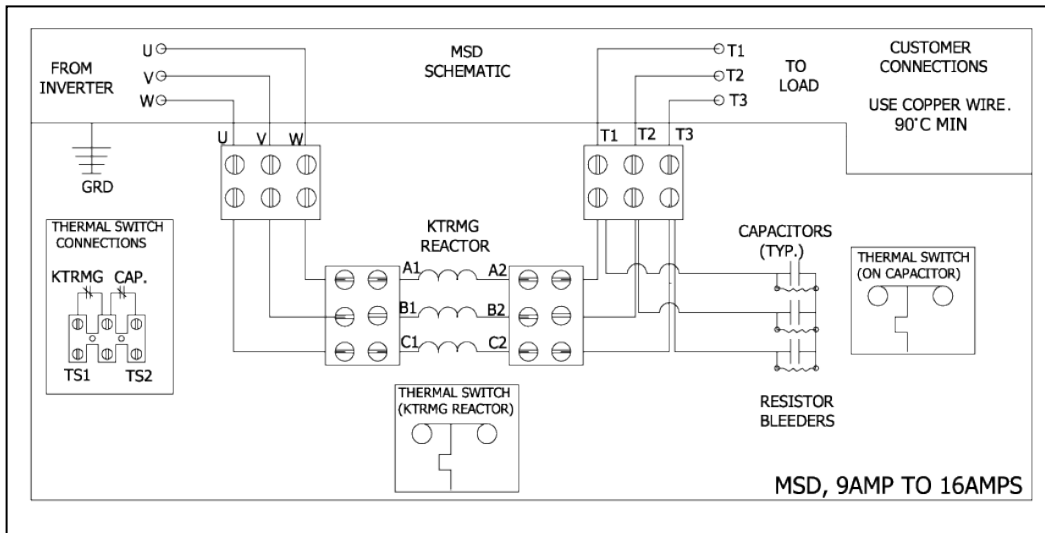
The MotorShield™ sine wave filter reduces the effects of the reflected wave phenomenon (dV/dt), which can cause motor heating, insulation damage, and excessive audible noise. The reduction of high frequency VFD output currents extends the life of motors and transformers and eliminates the need for special motor cables. The MotorShield™ reduces VFD ground fault problems and noise interference in transducer signals caused by stray high frequency harmonic currents.

The MotorShield™ is available in a UL Open Type and Type 1 and Type 3R enclosures which can be mounted adjacent to the VFD.

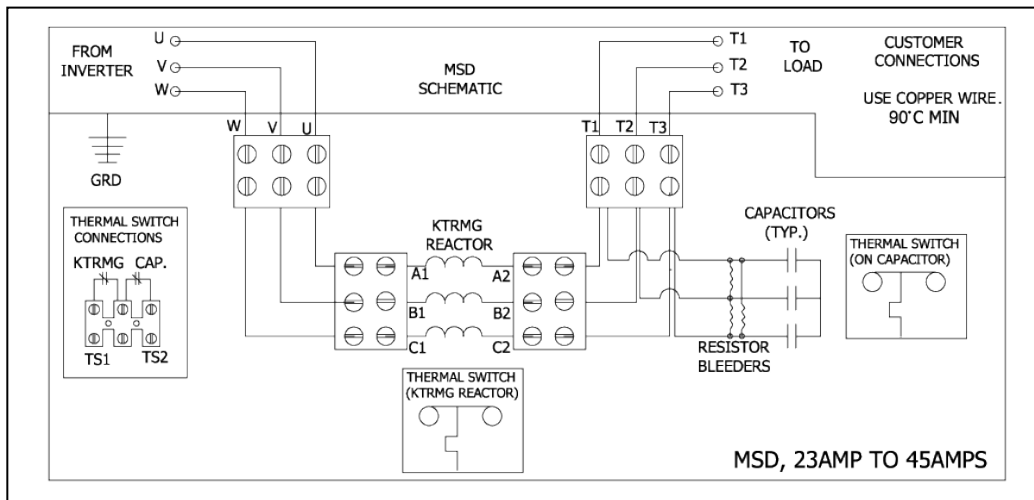
The MotorShield™ consists of the following standard features and components:

- An L-C power filter circuit with:
- A TCI 3-phase reactor
- High-endurance, harmonic-rated capacitors
- Compression terminals for ease and integrity of all power wiring
- Thermal switches on reactor and capacitor
- Suitable for all lead lengths extending up to 15,000 feet

Filter Configuration



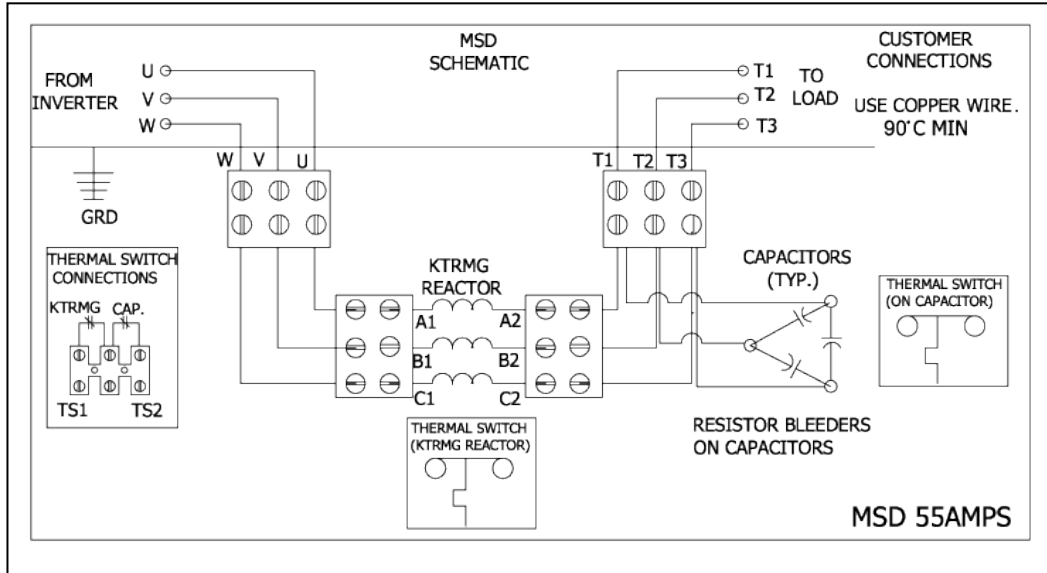
Typical Configuration\* for MSD 480 V 9A to 16A



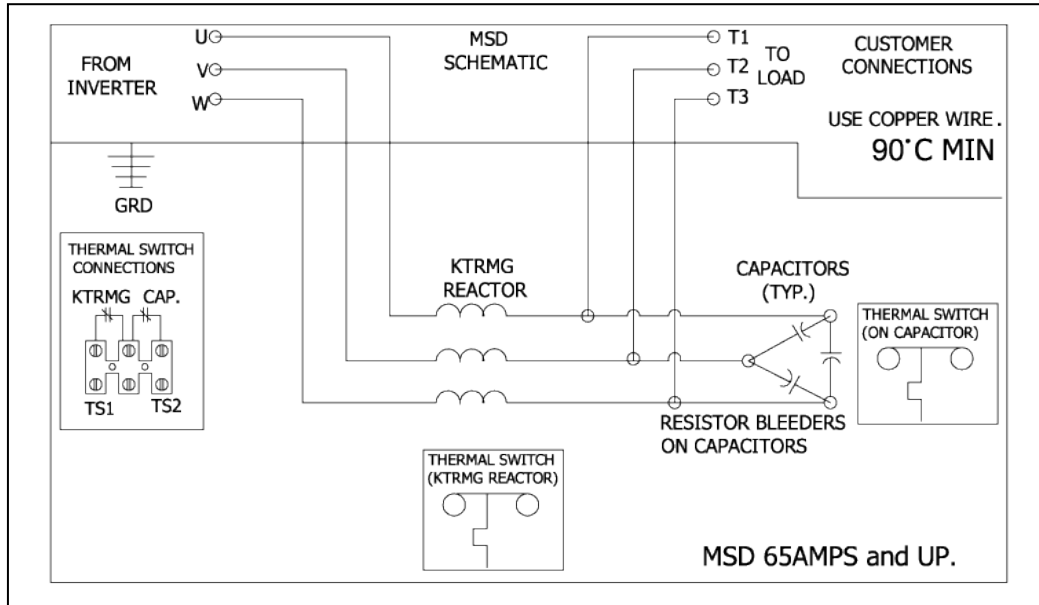
Typical Configuration\* for MSD 480 V 23A to 45A

Figure 1 - Typical Configurations for the MotorShield™ Filter

\*These drawings are for general reference only. Use the drawings supplied with the unit for installation.



Typical Configuration\* for MSD 480 V 55A



Typical Configuration\* for MSD 480 V 65A and up

**Figure 2: Typical Configurations for the MotorShield™ Filter**

\*These drawings are for general reference only. Use the drawings supplied with the unit for installation.

**Nameplate Data**

Figure 3 shows an example of a MotorShield™ nameplate. The following information is marked on the nameplate:

Part number: encoded model number explained on the following page

FLA: the rated continuous operating current (RMS amps)

System Voltage: the maximum VFD output voltage (fundamental)

Hz: the maximum VFD output frequency (fundamental)

Phase: 3 – The MotorShield™ is designed for use only with 3-phase loads.

Drawing and Schematic #: outline and mounting dimension of filter with schematic diagram

Manufacturing #: for TCI internal use

Enclosure Type: UL Type 1 / 3R

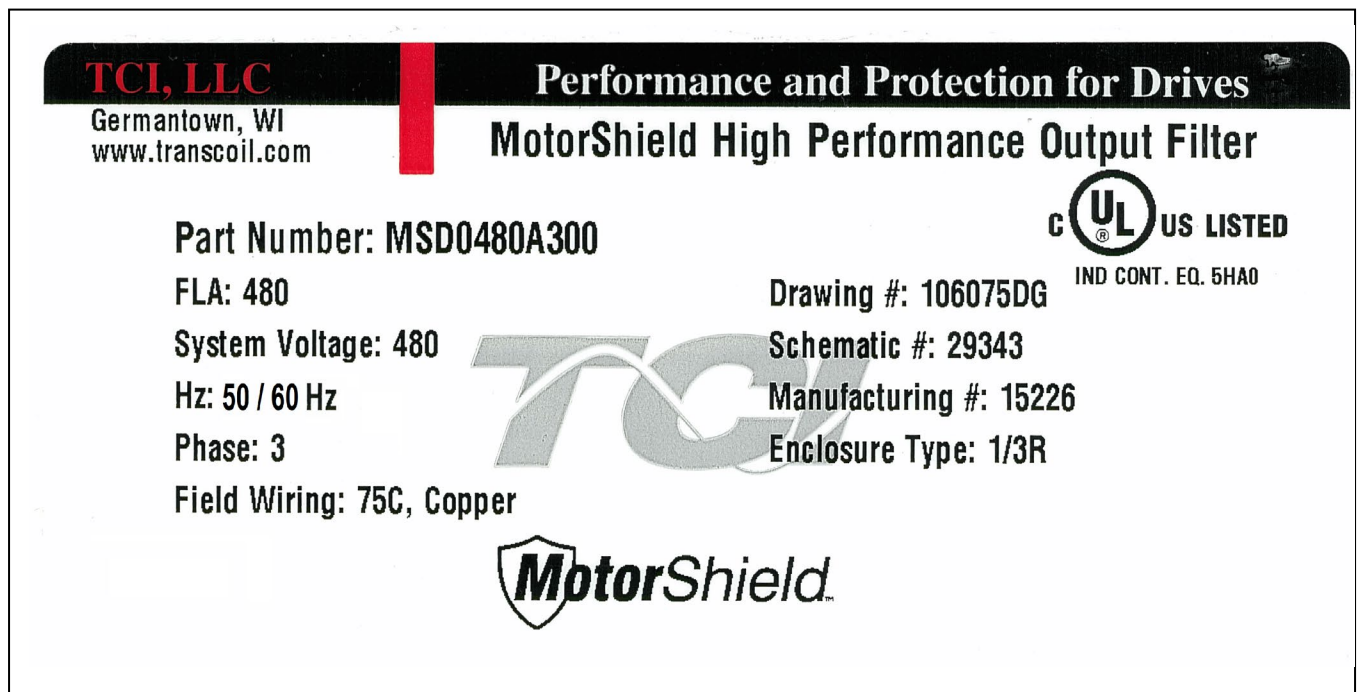
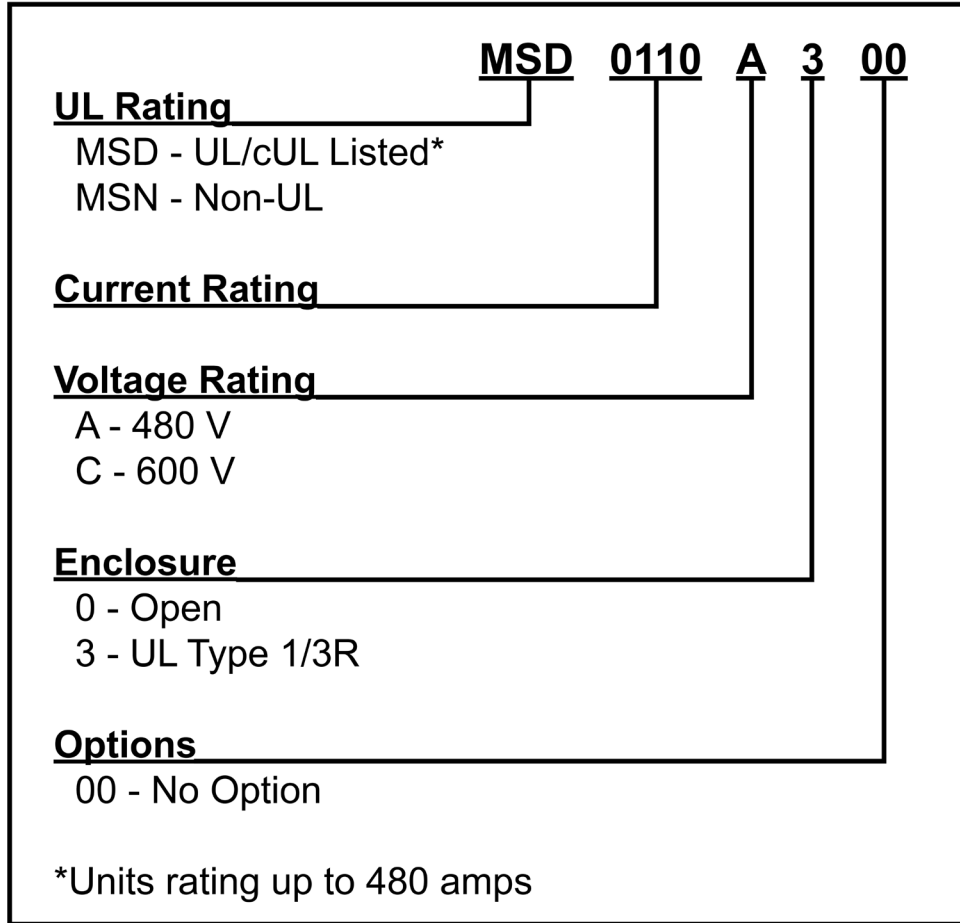


Figure 3 – Example of MotorShield™ Nameplate

**Part Number Encoding**

Figure 4 identifies the significance of each character in the MotorShield™ model number. The example model number, MSD0110A300 designates a MotorShield™ that is rated 110 Amps, 480 V.



**Figure 4 – MotorShield™ Model Number Encoding**

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

**Standard Product Ratings and Dimension Tables**

The following table lists the ratings and dimensions of the standard MotorShield™ models:

Table 1– MSD 480 Volt Models in UL Type 1/3R Enclosures

Model Number	Horsepower	Current Rating (Amps)	Weight	Height (in.)	Width (in.)	Depth (in.)	Watts Loss
MSD0009A300	5	9	57 lbs (25.9 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	102
MSD0012A300	7.5	12	58 lbs (26.3 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	116
MSD0016A300	10	16	58 lbs (26.3 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	145
MSD0023A300	15	23	75 lbs (34.0 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	210
MSD0030A300	20	30	75 lbs (34.0 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	244
MSD0035A300	25	35	75 lbs (34.0 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	303
MSD0045A300	30	45	90 lbs (40.8 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	304
MSD0055A300	40	55	105 lbs (47.6 Kg)	19.13 in (49 cm)	15.50 in (39 cm)	19.50 in (50 cm)	350
MSD0065A300	50	65	144 lbs (65 Kg)	22.13 in (56 cm)	20.43 in (52 cm)	28.50 in (72 cm)	374
MSD0080A300	60	80	162 lbs (73 Kg)	22.13 in (56 cm)	20.43 in (52 cm)	28.50 in (72 cm)	546
MSD0110A300	75	110	177 lbs (80 Kg)	22.13 in (56 cm)	20.43 in (52 cm)	28.50 in (72 cm)	645
MSD0130A300	100	130	187 lbs (85 Kg)	22.13 in (56 cm)	20.43 in (52 cm)	28.50 in (72 cm)	827
MSD0160A300	125	160	340 lbs (154 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	683
MSD0200A300	150	200	425 lbs (193 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1025
MSD0250A300	200	250	450 lbs (204 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1153
MSD0305A300	250	305	460 lbs (209 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1290
MSD0362A300	300	362	470 lbs (213 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1415
MSD0420A300	350	420	575 lbs (261 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1210
MSD0480A300	400	480	630 lbs (286 Kg)	36.00 in (91 cm)	28.40 in (72 cm)	36.86 in (94 cm)	1460
MSN0540A300	450	540	700 lbs (318 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	1610
MSN0600A300	500	600	713 lbs (323 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	1715
MSN0750A300	600	750	805 lbs (365 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	1805
MSN0850A300	700	850	850 lbs (386 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	2065
MSN0960A300	800	960	875 lbs (340 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	2195
MSN1080A300	900	1080	980 lbs (445 Kg)	63.95 in (163 cm)	24.58 in (62 cm)	44.00 in (112 cm)	2570

**Product Technical Specifications**

Table 2 lists the major technical specifications for the MotorShield™.

**Table 2 – MotorShield™ Technical Specifications**

Current Ratings	240 V: 5 – 248 Amps
	480 V: 5 – 1080 Amps
	600 V: 8 – 500 Amps
	Intermittent overload current of 150% for 1 minute out of every 60 minutes
VFD Output Voltage	240 V, 480 V and 600 V, 3-phase, at fundamental base frequency configured to Volts per Hz
VFD Output Frequency	Up to 80 Hz
VFD Carrier Frequency	2 kHz to 16 kHz
Filter Performance	<b>Maximum peak voltage of output waveform</b> 480 V models: 1000 V, 600 V models: 1,500 V
	<b>Maximum dV/dt of output waveform</b> 480 V models: 500 V/μs; 600 V models: 1,500 V/μs
<b>Environmental Conditions</b>	
Maximum Elevation	6,600 feet (2,000 m), derating required for operation above this level
Ambient Operating Temperature Range	-30°C (-22°F) to 40°C (104°F) Cooling provisions required for operation above this temperature
Ambient Storage Temperature Range	-40°C (-40°F) to 50 °C (122 °F)
Maximum Humidity	95%, non-condensing
<b>Reference Technical Standards</b>	
Enclosure Options	UL Open, Type 1/3R enclosure
Voltage Drop	3% at nominal voltage, frequency and rated current
Capacitors	High endurance design (no PCBs)
Agency Approvals	UL & cULus Listed (up to 480 amps)

## 3.0 Pre-installation Planning

### Verify the Application

Make sure that the MotorShield™ is correct for the application. The voltage and current ratings of the MotorShield™ must match the output voltage and current ratings of the connected variable frequency drive as it is configured for use with the connected motor. Follow NEC and local electrical codes and regulations for selection and placement of drive and load cables.


### Variable Frequency Drive Settings

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

- Maximum output frequency: 80 Hz
- PWM switching frequency between 2 kHz and 12 kHz, ideally 4kHz to 8kHz
- Mode of operation: "scalar" or "V/Hz" without DC braking unless the drive application has been confirmed by TCI Technical Support
- Consult VFD manual for other drive specific recommendations for use with sinewave filters, specific instructions may include but are not limited to: Disable any variable PWM switching frequency options and set drive to continuous 3-phase modulation.

### Environment

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

<p><b>Warning</b></p> 	<p>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).</p>
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Make sure that the installation location will not be exposed to corrosive or combustible airborne contaminants, excessive dirt or liquids. The unit must be installed in an environment where it will not be exposed to:

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

### 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.

The widest or deepest portion of the unit enclosure having ventilation openings must be a minimum of six inches from adjacent walls or other equipment. Any enclosure sides that do not have ventilation openings should be a minimum of three inches from adjacent walls or other equipment.

### Power Wiring

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



**Thermal Switch**

Two normally closed thermal switches wired in series. One opens if the filter reactor overheats, the second opens if the filter capacitors overheat. Connect these switches to monitoring equipment.

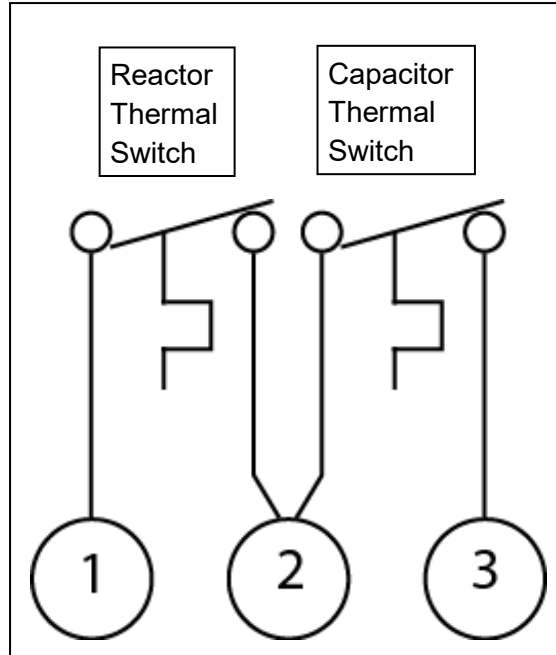





Figure 5: Thermal Switches

**Optional Features**

Additional wiring requirements may apply to MotorShield™ units that are equipped with optional features. For instructions covering these additional requirements, refer to drawings and/or other supplemental information furnished with the unit.

## 4.0 Installation Guidelines



<b>Warning</b> 	Be sure to read, understand, and follow all safety instructions provided in this manual prior to beginning work.
<b>Warning</b> 	Dangerous Voltage is used in the operation of the MotorShield™. Only qualified electricians should carry out all electrical installation and maintenance work on the MotorShield™.
<b>Warning</b> 	All wiring must be performed in accordance with the National Electrical Code (NEC) and/or any other codes that apply to the installation site.

### Wiring

Typical wiring diagrams for filters mounted in UL Type 1 / 3R enclosures can be found in Figure 6.

### Before Connecting

Always consult the drive manufacturer's safety, installation and operation instructions prior to connecting the MotorShield™ to the drive.

<b>Warning</b> 	Avoid contact with line voltage when checking for power. Failure to follow the safety instructions set forth in this manual can result in serious injury or death.
<b>Warning</b> 	Exercise caution when connecting the filter to the drive. Internal filter components may carry dangerous voltage which can cause death or serious injury upon contact.

### Over Temperature Switch

A set of over temperature switches is supplied to prevent damage to the filter in the rare case of overheating due to abnormal conditions. One switch measures capacitor case temperature, the other switch measures reactor core temperature.

**Table 3: Over Temperature NC Switch**

NC Switch opens on over-temperature		
Current Amps	Voltage	Contact Load
6	120 AC	Non-Inductive (UL)
4	240 VAC	Non-Inductive (UL)
8	12 VDC	Resistive loads (UL)
4	24 VDC	Resistive loads (UL)
1	120 VDC	Non-Inductive (CSA)
0.7	240 VAC	Non-Inductive (CSA)

### Field Wiring Connection Terminals

Compression type terminals are provided for all field wiring connections. The wire size capacity ranges and tightening torque for the grounding and power terminals are listed in Tables 4, 5 and 6.

**Table 4 – Motor Power Terminal Wire Size Capacity Range and Tightening Torque (Cu)**

Line/Load				Ground			
Amps	Min* Wire	Torque lb.-in	Refer to Table 5	Amps	Min* Wire	Torque lb.-in	Refer to Table 5
9	14 AWG	30 lb.-in (3.4 N-m)	A	9	14 AWG	35 lb.-in (4.0 N-m)	B
12	14 AWG	30 lb.-in (3.4 N-m)	A	12	14 AWG	35 lb.-in (4.0 N-m)	B
16	12 AWG	30 lb.-in (3.4 N-m)	A	16	12 AWG	35 lb.-in (4.0 N-m)	B
23	10 AWG	30 lb.-in (3.4 N-m)	A	23	10 AWG	35 lb.-in (4.0 N-m)	B
30	10 AWG	30 lb.-in (3.4 N-m)	A	30	10 AWG	40 lb.-in (4.5 N-m)	B
35	8 AWG	30 lb.-in (3.4 N-m)	A	35	8 AWG	40 lb.-in (4.5 N-m)	B
45	8 AWG	30 lb.-in (3.4 N-m)	A	45	8 AWG	45 lb.-in (5.1 N-m)	B
55	6 AWG	35 lb.-in (4.0 N-m)	A	55	6 AWG	45 lb.-in (5.1 N-m)	C
65	6 AWG	45 lb.-in (5.1 N-m)	C	65	6 AWG	45 lb.-in (5.1 N-m)	C
80	4 AWG	50 lb.-in (5.7 N-m)	C	80	4 AWG	50 lb.-in (5.7 N-m)	C
110	2 AWG	50 lb.-in (5.7 N-m)	C	110	2 AWG	50 lb.-in (5.7 N-m)	C
130	1 AWG	50 lb.-in (5.7 N-m)	D	130	1 AWG	375 lb.-in (42 N-m)	D
160	2/0 AWG	375 lb.-in (42 N-m)	D	160	2/0 AWG	375 lb.-in (42 N-m)	D
200	3/0 (Two 1/0 AWG)	375 lb.-in (42 N-m)	E	200	3/0 (Two 1/0 AWG)	375 lb.-in (42 N-m)	E
250	Two 1/0 AWG	375 lb.-in (42 N-m)	E	250	Two 1/0 AWG	375 lb.-in (42 N-m)	E
305	Two 2/0 AWG	375 lb.-in (42 N-m)	E	305	Two 2/0 AWG	375 lb.-in (42 N-m)	E
362	Two 4/0 AWG	375 lb.-in (42 N-m)	E	362	Two 4/0 AWG	375 lb.-in (42 N-m)	E
420	Two 300 kcmil	500 lb.-in (57 N-m)	F	420	Two 300 kcmil	500 lb.-in (57 N-m)	F
480	Two 350 kcmil	500 lb.-in (57 N-m)	F	480	Two 350 kcmil	500 lb.-in (57 N-m)	F

\* A larger wire can be used. See referenced table for wire range and torque.

**Table 5 – Wire Range Table**

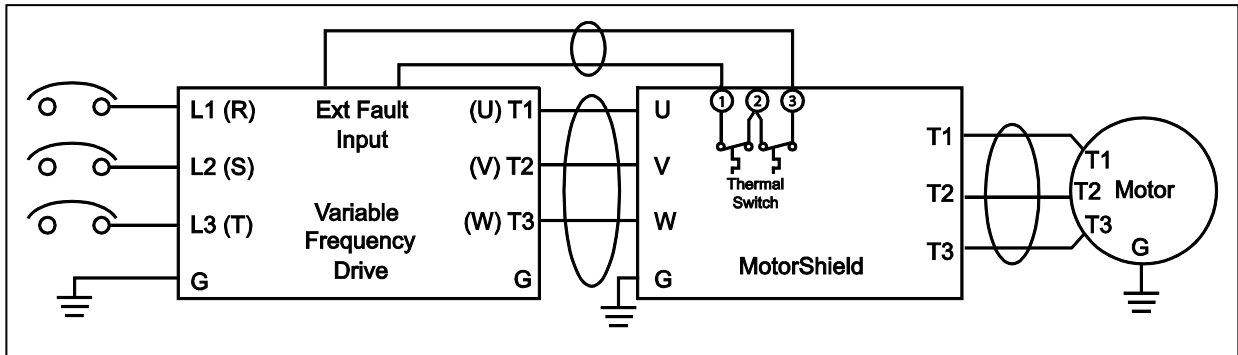
	Wire range	Torque lb.-in
A	1-4 AWG	35 lb.-in (4.0 N-m)
	6-14 AWG	30 lb.-in (3.4 N-m)
B	1/0-3 AWG	50 lb.-in (5.7 N-m)
	4-6 AWG	45 lb.-in (5.1 N-m)
	8 AWG	40 lb.-in (4.5 N-m)
	10-14 AWG	35 lb.-in (4.0 N-m)
C	2/0 -3 AWG	50 lb.-in (5.7 N-m)
D	250 kcmil - 4/0 AWG	375 lb.-in (42 N-m)
E	350 kcmil – 1 AWG	375 lb.-in (42 N-m)
F	600 kcmil – 4 AWG	500 lb.-in (57 N-m)

**Table 6 – Thermal Switch Block**

Wire range	Torque (lb.-in)
22-12 AWG	5 lb.-in (0.56 N-m)

**Connection Diagram**

Figure 6 shows the typical wiring connections between the MotorShield™ and the VFD and motor. Refer to the instructions for the VFD or other equipment to which the fault contact is connected. To prevent damage due to abnormal over temperature conditions, the use of an optional thermal interlock circuit with thermal switch is recommended to shut down the drive if internal reactor temperatures exceed its temperature rating.




**Figure 6 – Typical Connection Diagram**

**Grounding**

The MotorShield™ 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.

**Power Wiring**

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

<p><b>Caution</b></p> 	<p>Use wire that is appropriate for the voltage and current rating of the motor.</p> <p>Use copper wire with an insulation temperature rating of 90°C or higher.</p> <p>The wire size and the voltage ratings must conform to the requirements of the National Electrical Code (NEC) and/or other applicable electrical codes.</p> <p>Be sure to also follow the motor wiring instructions provided in the instruction manual for the VFD.</p>
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## 5.0 Operation

### Variable Frequency Drive Settings





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

Maximum output frequency: 80 Hz

PWM switching frequency between 2 kHz and 16 kHz. Since the MotorShield™ removes most of the harmonic content from the output waveform, quiet motor operation should be achieved with a switching frequency setting within this range. Running smaller current filters at 2 kHz switching frequency can be too noisy, increasing switching frequency to 4 kHz or higher is advised in these cases.

Mode of operation: "scalar" or "V/Hz" without DC braking unless the drive application has been confirmed by TCI Technical Support.

### Start Up (Commissioning)

<p><b>Caution</b></p> 	<p>Prior to start up, confirm the drive operation mode is set to Volts per Hertz. Consult the drive manufacturer for configuration instructions. Drive failure or filter component failure may occur as a result of improper drive operation mode configuration.</p>
<p><b>Caution</b></p> 	<p>Ensure drive output frequency is set between 2 kHz and 16 kHz. Failure to do so may result in damage to the filter.</p>
<p><b>Caution</b></p> 	<p>Thoroughly check the installation before applying power and operating the equipment for the first time.</p>
<p><b>Caution</b></p> 	<p>The MotorShield™ can be operated without a load connected to its output terminals (for example to facilitate confirmation of system wiring), however drive trip issues may occur. Operation of the MotorShield™ with motor leads connected to the MotorShield™ but open circuited at the motor is not recommended.</p>

### 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. MotorShield™ is designed to remove the majority of the negative effects of pulses and edges when applied to the motor terminals through both long and short lead lengths. As such, the best performance will be realized when a motor is connected and operating.

### Before Operating the VFD for the First Time

Make sure that the variable frequency drive is set for operation modes and ranges that are compatible with the MotorShield™ as described above.

## 6.0 Maintenance and Service

### Reliability and Service Life

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


### Periodic Maintenance

**Warning**

Only qualified electricians should carry out all electrical installation and maintenance work on the MotorShield™.

Disconnect all sources of power to the VFD and MotorShield™ before working on the equipment. Do not attempt any work on a powered MotorShield™.

- Check to see that the installation environment remains free from exposure to excessive dirt and contaminants. Refer to the **Pre-installation Planning** section of this manual.
- Check to make sure that the enclosure ventilation openings are clean and unobstructed.
- 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 and ground connections.
- All electrical connections must be re-torqued annually.

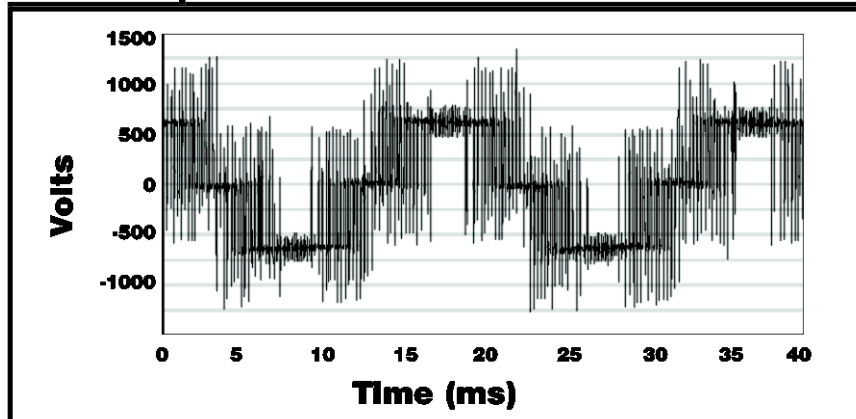
<p><b>Warning</b></p> 	<p>Only qualified electricians should carry out all electrical installation and maintenance work on the MotorShield™.</p> <p>Disconnect all sources of power to the VFD and MotorShield™ before working on the equipment. Do not attempt any work on a powered MotorShield™.</p>
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**Reactor and Capacitor Thermal Switches**

If the reactor thermal switch opens, it indicates that the MotorShield™ reactor is overheating. This may be caused by the MotorShield™ being applied to a current that exceeds its ratings, a switching frequency lower than its minimum specification, a motor frequency that exceeds maximum specifications, or blocked air flow. Check to make sure current, drive switching frequency, and drive output fundamental frequency meet product specifications. Check to make sure ventilation openings are open and not blocked or clogged. Ensure reactor is not covered with a thick layer of dirt and dust.

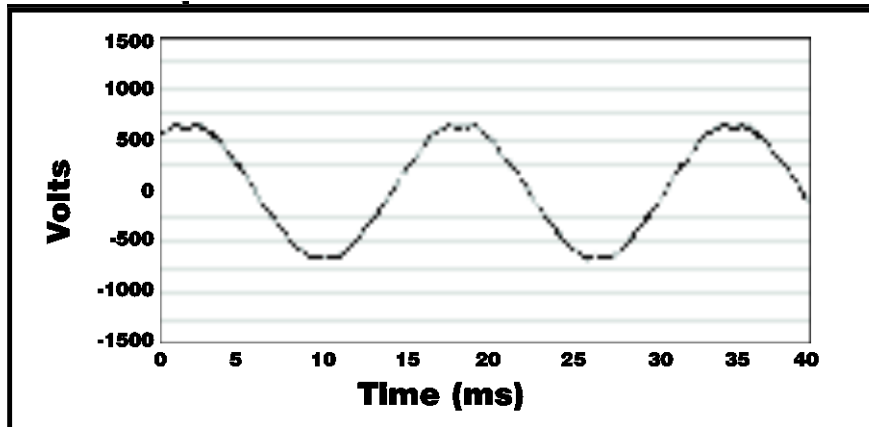
**Evaluating MotorShield™ Performance**

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




**Figure 7: Motor Input Waveform Before MotorShield™**

This waveform illustrates typical drive output and filter input voltages when measured from line to line.



**Figure 8: Waveform After MotorShield™**

This waveform illustrates typical filter output voltage waveforms when measured from line to line. If the measured waveform does not resemble a sine wave like this illustration, and looks more like the filter input waveform, troubleshoot filter wiring and components.

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

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

**Factory Contacts and Tech Support**

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

**Typical Outline Drawings**

Typical MotorShield™ drawings are provided on the TCI website. These drawings provide general information describing your MotorShield™ filter. All dimensions on the drawings are in inches. More specific information is provided by the drawings shipped with the unit. Be sure to carefully review the information provided by these drawings. The information on these drawings takes precedence over the information provided in this manual. You can find the drawings at <https://transcoil.com/products/motorshield-sinewave-filter/msd-ratings-tables/>





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