

HSP

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



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Revision A

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Revision	Description	Date
1.0	Release	6/16/11
A	Removed "No contactor option", minor edits and corrections	8/21/17

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Introduction

Safety Instructions Overview

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

The HSP single-phase harmonic filter is intended to be connected to the input terminals of one or more variable frequency drives. Single-phase power is connected to the input terminals of the HSP and power is supplied to the drive or drives through the HSP. 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.




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.

Warnings

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

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







Cautions

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

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

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

<p>Warning</p> 	<p>Be sure to read, understand and follow all safety instructions.</p>
<p>Warning</p> 	<p>Only qualified electricians should carry out all electrical installation and maintenance work on the HSP single-phase harmonic filter.</p>
<p>Warning</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>Warning</p> 	<p>Disconnect all power before working on the equipment. Do not attempt any work on a powered HSP filter.</p>
<p>Warning</p> 	<p>The HSP single-phase harmonic filter, drive, motor, and other connected equipment must be properly grounded.</p>
<p>Warning</p> 	<p>After switching off the power, always allow 5 minutes for the capacitors in the HSP filter and in the drive to discharge before working on the HSP, the drive, the motor, or the connecting wiring. It is a good idea to check with a voltmeter to make sure that all sources of power have been disconnected and that all capacitors have discharged before beginning work.</p>

Receiving Inspection and Storage

Thank you for selecting the HSP Single-Phase Harmonic Filter. TCI has produced this filter for use in many variable frequency drive applications that require input power line harmonic current reduction. This manual describes how to install, operate and maintain the HSP single-phase harmonic filter.

Receiving Inspection

The HSP single-phase harmonic filter has been thoroughly inspected and functionally tested at the factory and carefully packaged for shipment. When you receive the unit, you should immediately inspect the shipping container and report any damage to the carrier that delivered the unit. Verify that the part number of the unit you received is the same as the part number listed on your purchase order.

TCI Limited Warranty Policy

TCI, LLC (“TCI”) warrants to the original purchaser only that its products will be free from defects in materials and workmanship under normal use and service for a period originating on the date of shipment from TCI and expiring at the end of the period described below:

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

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

This warranty shall not apply if the product was:

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

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

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

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

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

Storage Instructions

If the HSP single-phase harmonic 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 Table 1 (HSP Single-Phase Harmonic Filter Technical Specifications). Store the unit in its original packaging.

Pre-installation Planning

Verify the Application

HSP Ratings

Make sure that the HSP single-phase harmonic filter is correct for the application. The voltage ratings of the filter must match the input voltage rating of the connected drive. The horsepower and current ratings of the filter must be adequate for the connected load.

Select a Suitable Location

Environment

Locating the HSP in a suitable environment will help assure proper performance and a normal operating life. Refer to the environmental specifications listed in Table 3, 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.
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The unit must be installed in an area where it will not be exposed to:

- ◆ Precipitation or dripping liquids (unless in a 3R enclosure)
- ◆ Corrosive liquids or gasses
- ◆ Explosive or combustible gases or dust
- ◆ Excessive airborne dirt and dust
- ◆ Excessive vibration

Working Space

Provide sufficient access and working space around the unit to permit ready and safe installation, operation and maintenance. Make sure that the installation conforms to all working space and clearance requirements of the National Electrical Code (NEC) and/or any other applicable codes. Provide sufficient unobstructed space to allow cooling air to flow through the unit.

Mounting an Open Panel Unit

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

Power Wiring

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

For standard units with a line reactor included in the HSP: route the conduit and wiring from the power source to the filter and then to the variable frequency drive.

The HSP is provided with internal fuses. Additional fuses may be required at the connecting point to protect the tap conductors. Refer to the National Electrical Code (NEC) and/or any other applicable codes.

Installation Guidelines

Mounting

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

Wiring

Cable Entry Locations

The enclosed HSP single-phase harmonic filters are not provided with enclosure wiring knockouts. A selection can be made at the time of installation. Typical or recommended cable entry locations are shown in the drawings section of this manual.

Field Wiring Connection Terminals

Compression type terminals are provided for all field wiring connections. The control circuit terminals will accommodate 18 AWG to 10 AWG wire and should be tightened to 18 in.-lbs. torque. The wire size capacity ranges and tightening torque for the grounding and power terminals are listed in Table 1. Refer also to the drawings and other information shipped with the unit.

Table 1: Power Terminal Wire Size Capacity Range and Tightening Torque for Standard Units

HarmonicGuard Current Ratings	Ground Lug		Input and Output Power	
	Wire Size	Torque (in.-lb.)	Wire Size	Torque (in.-lb.)
14 to 45 Amps	14 - 1/0 AWG	200	18 AWG - 4 AWG	20
55 to 80 Amps	14 - 1/0 AWG	200	22 - 16 AWG or 14 - 6 AWG or 4 - 2 AWG or 1 AWG (7 & 19 strand only)	25 30 35
110 Amps	6 AWG - 250 MCM	275	6 AWG - 2/0 AWG	120
130 Amps	6 AWG - 250 MCM	275	Input: 6 AWG - 350 MCM Output: 6 AWG - 2/0 AWG	275 120
160 to 200 Amps	6 AWG - 250 MCM	275	Input: 6 AWG - 250 MCM Output: 6 AWG - 350 MCM	275 275
250 Amps	6 AWG - 250 MCM	275	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500
300 Amps	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	375	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	500
360 to 480 Amps	4 AWG - 600 MCM or (2) 1/0 AWG - 250 MCM	375	(2) 4 AWG - 350 MCM	375

Grounding

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

Power Wiring

Caution	<p>Use copper wire that is appropriate for the voltage and current rating of the equipment. The wire selection must conform to the requirements of the National Electrical Code and/or other applicable electrical codes.</p> <p>For units rated less than 100 amps, use wire with an insulation temperature rating of 60°C or higher.</p> <p>For units rated 100 amps or more, use wire with an insulation temperature rating of 75°C or higher.</p>
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Connect single-phase power of the appropriate voltage and current capacity to the branch circuit protective device then to the HSP input power terminals. **Note:** in large units, the input power conductors are connected directly to the input terminals on the line reactors.

Connect the output terminals of the HSP to the input power terminals of the variable frequency drive. **Note:** in large units, the output power conductors are connected directly to the output terminals on the line reactors. Refer to the variable frequency drive installation instructions for additional information.

HSP Harmonic Filter Operation

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

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

- ◆ Check to see that the cooling fan(s) are operating in units so equipped.

Installation

Intended Audience

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

Additional Information

Caution	<p>This manual provides general information describing your HSP single-phase harmonic 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.</p> <p>The ratings, dimensions and weights given in this manual are approximate and should not be used for any purpose requiring exact data. Contact the factory in situations where certified data is required. All data is subject to change without notice.</p>
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Installation Checklist

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


- Make sure that the installation location will not be exposed to direct sunlight, corrosive or combustible airborne contaminants, excessive dirt or liquids.
- Select a mounting area that will allow adequate cooling air and maintenance access.
- Make sure that all wiring conforms to the requirements of the National Electric Code (NEC) and/or other applicable electrical codes.
- Connect the HSP equipment-grounding lug to the system ground of the premises wiring system. Use a properly sized grounding conductor.
- Connect single-phase power to the input terminals of the HSP: L1 & L2.
- Connect the output power terminals, of the HSP: T1 & T2, to the input power terminals of the variable frequency drive.

Maintenance and Service

HSP Single-Phase Harmonic Filter Reliability and Service Life

The HSP 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 assure that it will perform reliably from the time it is put into service. The following periodic maintenance is recommended to assure that the HSP filter will always perform reliably and provide the expected service life.

Periodic Maintenance

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

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

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


Check the operation of the cooling fan.

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

Check the integrity of all power and ground wiring connections.

All electrical connections must be verified and re-torqued annually.

Troubleshooting

<p>Warning</p> 	<p>Only qualified electricians should carry out all electrical installation and maintenance work on the HSP single-phase harmonic filter.</p> <p>Disconnect all sources of power to the drive and HSP before working on the equipment. Do not attempt any work on a powered HSP single-phase harmonic filter.</p> <p>The harmonic filter contains high voltages and capacitors. Wait at least five minutes after disconnecting power from the filter before you attempt to service the harmonic filter. Check for zero voltage between all terminals on the capacitors. Also, check for zero voltage between all phases of the line side of the fuses, Fu1(a)–Fu2(a). All setup, maintenance, and troubleshooting must be done by a qualified electrician. Failure to follow standard safety procedures may result in death or serious injury.</p>
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Note: when disconnecting wires from components and terminations, mark the wires to correspond to their component and terminal connection.

Reference Drawings

When troubleshooting, refer to the drawings provided for the specific equipment. Typical drawings are provided in this manual.

Fuse Specifications

Table 2 lists the specifications for the L-R-C filter power circuit fuses in the HSP 480 volt models. Refer also to the drawings and other information shipped with the unit.

Table 2 – Fuse Specifications for HSP 480 Volt Models*

HSP Rating (HP)	Power Circuit Fuse Ratings	
	Amps	Type
5	15	Bussmann JKS or equivalent
7.5	15	
10	20	
15	20	
20	30	
25	40	
30	45	
40	60	
50	70	
60	80	
75	100	
100	150	

* contact factory for additional information

Table 3 – Fuse Specifications for HSP 240 Volt Models

HSP Rating (HP)	Power Circuit Fuse Ratings	
	Amps	Type
5	20	Class T, Fast Acting
7.5	25	
10	30	
15	40	
20	50	
25	70	
30	80	
40	110	
50	125	
60	175	
75	200	
100	300	

Replacement Parts

If replacement parts are needed, please contact your TCI representative. To assure that the HSP single-phase harmonic filter continues to perform to its original specifications, replacement parts should conform to TCI specifications.

Factory Contacts and Tech Support

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

You can contact TCI directly at 800-TCI-8282. Select "Customer Service" or "Tech Support" and have your HSP single-phase harmonic filter nameplate information available.

Product Description

HSP Drive-Applied Harmonic Filter

The HSP is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by variable frequency drives. The HSP is available for 240 and 480 volt systems. It is suitable for use with 1-phase diode bridge rectifier loads and 3-phase diode rectifier loads operated from only 2 lines (single phase) such as PWM AC drives.

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

The HSP filters consist of the following features and components.

- ◆ A KDS input series reactor to prevent system interaction and improve filter performance.
- ◆ An L-R-C harmonic filter circuit with:
 - A TCI 1-phase tuning reactor specifically designed for the HSP filter
 - High-endurance, harmonic-rated capacitors
- ◆ Bleeder resistors to ensure safe capacitor discharge upon filter shutdown.
- ◆ Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures.
- ◆ Compression terminals for ease and integrity of all power and control wiring.
- ◆ Resistor to dampen voltage rise.

Nameplate Data

The following information is marked on the nameplate:

- ◆ Part number: encoding is explained on the following page
- ◆ FLA: the rated continuous operating current (RMS amps)
- ◆ System Voltage: the rated 1-phase line voltage (RMS volts)
- ◆ Hz: the rated frequency (60 Hz)
- ◆ Phase: 1 – The HSP filter is designed for use only with 1-phase power.
- ◆ Drawing #: outline and mounting dimension drawing number
- ◆ Schematic #: schematic diagram drawing number
- ◆ Manufacturing #: for TCI internal use
- ◆ Enclosure Type: 3R

Part Number Encoding

Figure 1 identifies the significance of each character in the HSP part number. The example part number, HSP055AG3SC designates a HSP filter that is rated 55 amps, 480 volts, 60 Hz. It includes the standard 5% reactor, is tuned to the 5th harmonic, is furnished in General Purpose NEMA 3R enclosure and is designed for use with a 25 Hp drive.

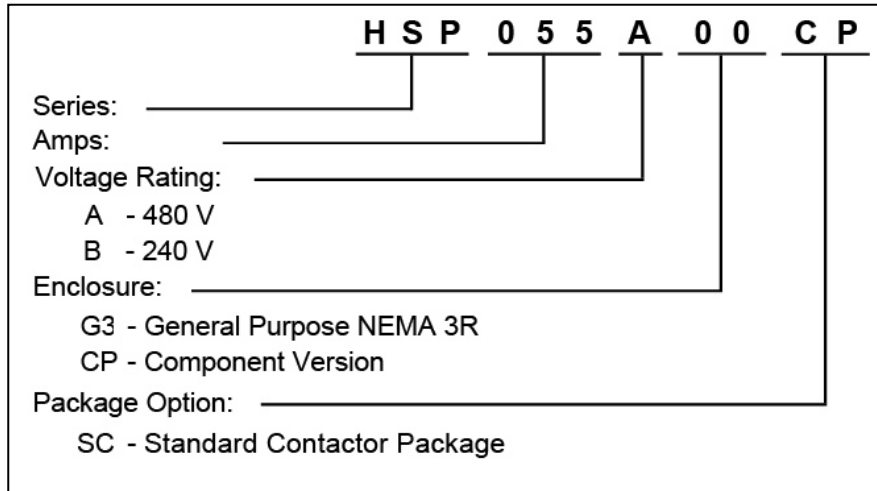


Figure 1: HSP Part Number Encoding

Product Technical Specifications

Table 3 lists the major technical specifications for the HSP single-phase Harmonic Filter.

Table 4 – HSP Single-Phase Harmonic Filter Technical Specifications

Voltage Ratings	240, 480 V, 1 phase, 60 Hz
Amp Ratings	240V: 28 – 432 amps; 480V: 14 – 216 amps
Harmonic Reduction	≤ 12% THID
Enclosure Options	Open Chassis; NEMA 3R
Storage Temperature	-40° to +60° C
Operating Temperature	Open: -40° to +50° C Enclosed: -40° to +40° C
Maximum Humidity	95%, non-condensing
Elevation	2,000m (6,600 ft) without derating

Drawings

Typical Outline Drawings and Schematic Diagrams

Typical HSP drawings are provided on the following pages. These drawings provide general information describing your HSP single-phase harmonic filter. More specific information is provided by the drawings shipped with the unit. Be sure to carefully review the information on the provided drawings. The information on the drawings provided with the filter takes precedence over the information provided in this manual.

Outline Drawing

The Outline drawing shows the overall enclosure dimensions. The major internal components are shown pictorially.

Schematic Diagrams

The Schematic Diagrams show the details of the HSP circuitry. The power circuit schematic shows the variations in input and output power connections.

Typical Outline Drawing

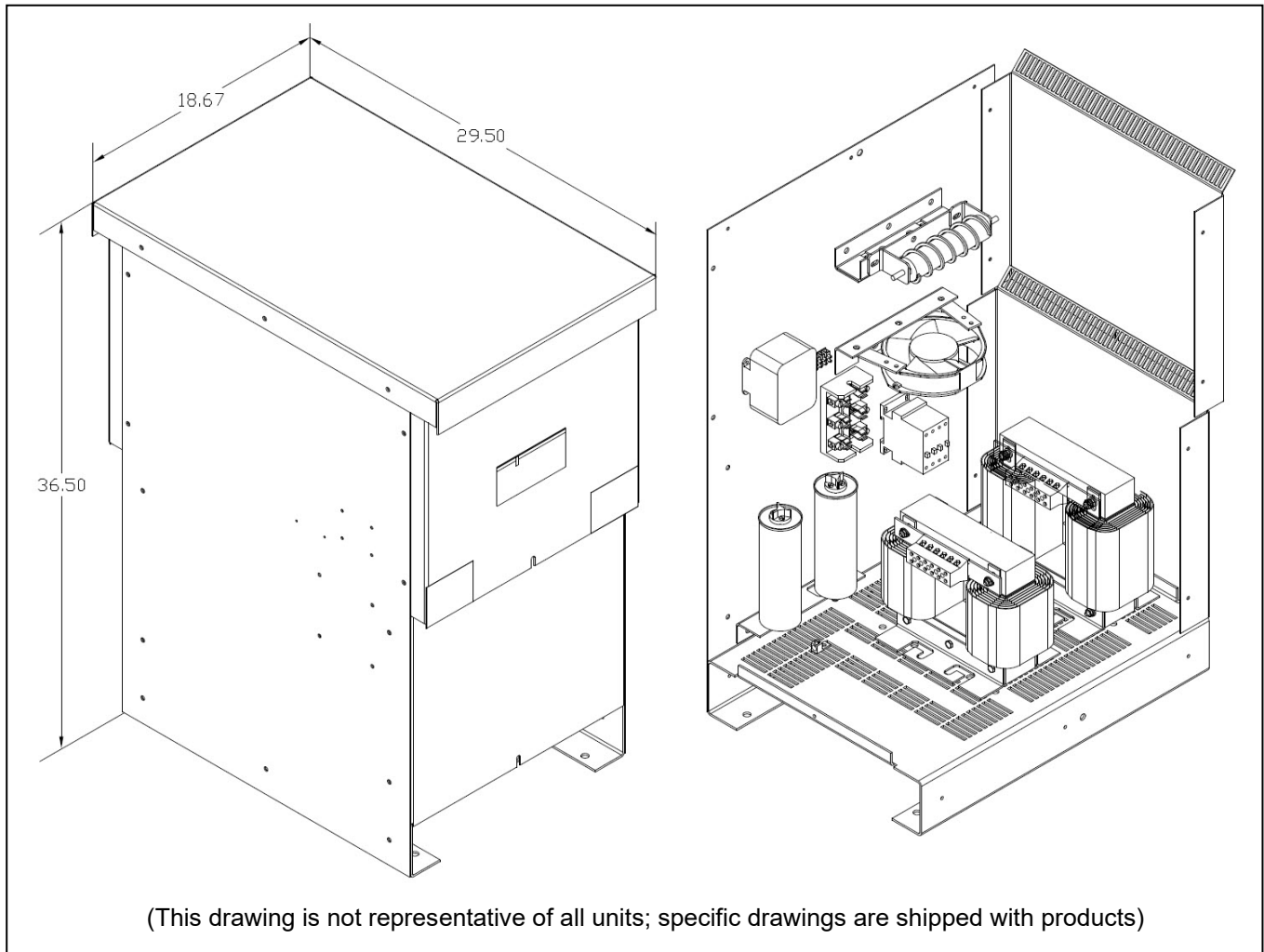


Figure 2: Typical HSP Outline Drawing

Typical Schematic 1

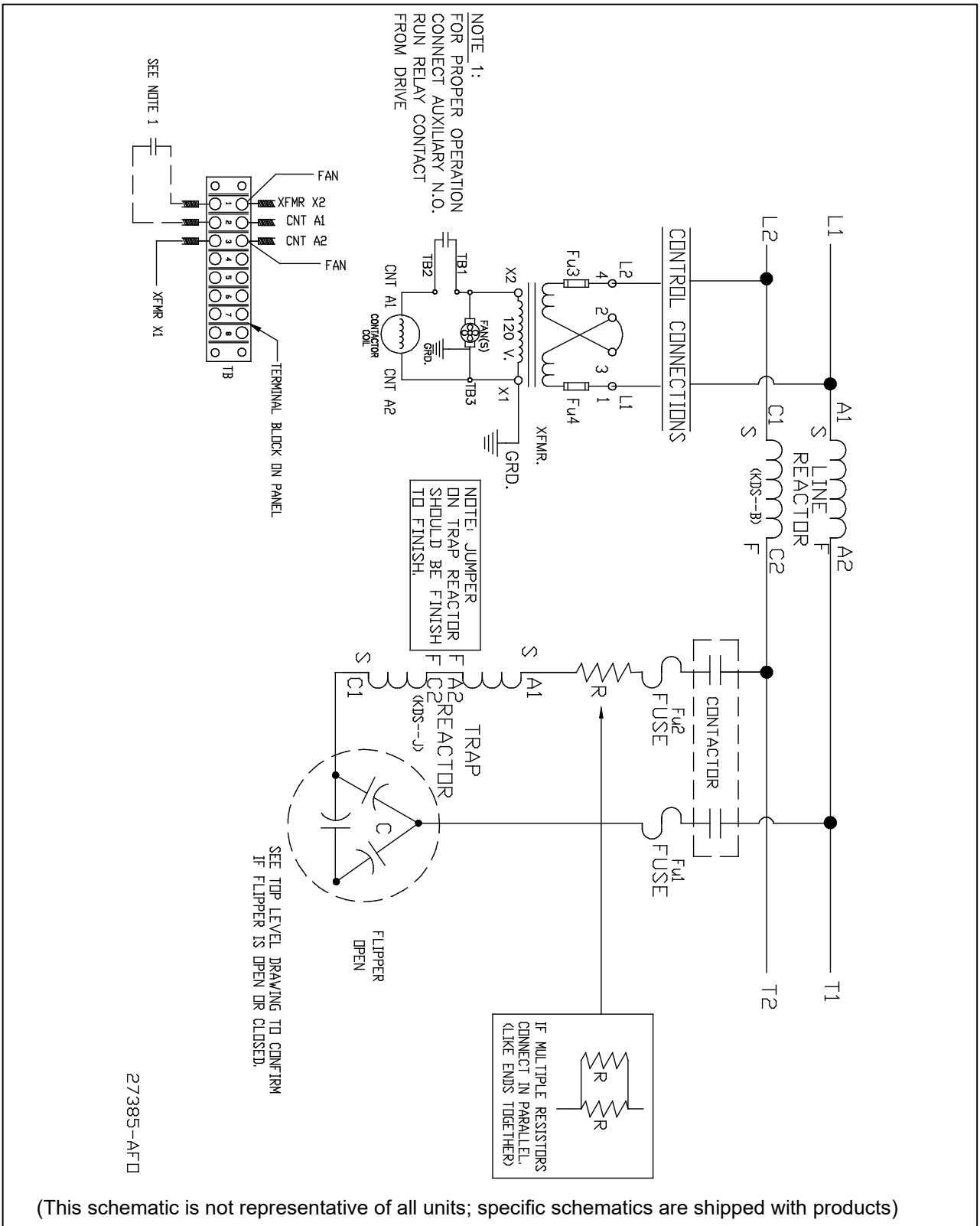


Figure 3: HSP Schematic with Fan and Flipper Open

Typical Schematic 2

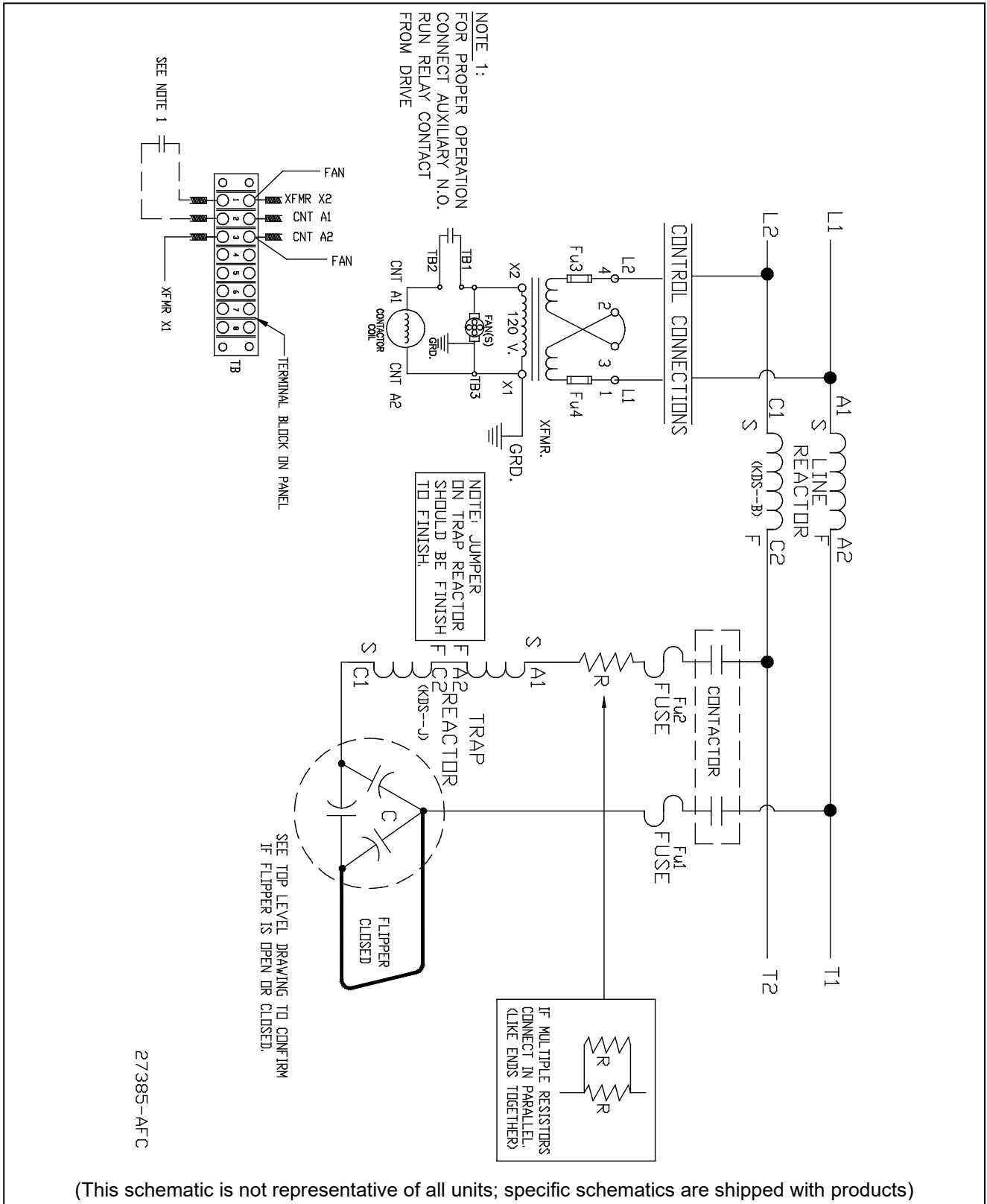


Figure 4: HSP Schematic with Fan and Flipper Closed

Standard (SC)

SC Option Models

This model is identified by the suffix “SC” in the part number. The SC version provides a contactor, control power transformer and connection terminals in the filter trap circuit which allows the VFD user to control the use of the HSP filter’s trap circuit. Simply use the drive relay run contact provided with the VFD to enable and disable the trap circuit. This virtually eliminates the possibility of leading power factor interacting with other devices on the power system and enables the user to perform trap circuit maintenance without shutting down the entire drive system.

Product Description

HSP SC Option Single-Phase Harmonic Filter

The HSP single-phase harmonic filter is a drive-applied harmonic filter designed and developed by TCI to reduce the harmonic currents drawn from the power source by variable frequency drives. The HSP SC option single-phase harmonic filter is for 240 & 480 volt systems.

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

The HSP SC Option consists of the following standard features and components.

- ◆ A KDS input series reactor to prevent system interaction and improve filter performance.
- ◆ An L-R-C harmonic filter circuit with:
 - A TCI 1-phase tuning reactor specifically designed for the HSP
 - High-endurance, harmonic-rated capacitors
- ◆ Bleeder resistors to ensure safe capacitor discharge upon filter shutdown.
- ◆ Filter enable/disable contactor with protection and drive interlock provisions.
- ◆ Cooling fans (on select models) to ensure adequate cooling and safe operating temperatures.
- ◆ Control transformer for fan and control voltage power.
- ◆ Compression terminals for ease and integrity of all power and control wiring.
- ◆ Resistor to dampen voltage rise.

Component Package Option (CP)

“CP” Option Models

The HSP “CP” Option is a harmonic filter component package designed and developed by TCI to allow qualified customers to build harmonic filters to reduce the harmonic currents drawn from the power source by variable frequency drives. The HSP “CP” Option is available for 240 & 480 volt systems. When properly designed, assembled, and installed, the completed product is intended to be suitable for use with 1-phase diode bridge rectifier loads such as PWM AC drives. SCR or thyristor loads such as DC drives would require a different filter configuration outside the scope of this product offering. Please contact TCI Technical Support for additional information.

Product Description

HSP CP Option Single-Phase Harmonic Filter

The HSP “CP” Option filter components is a package of the primary passive filter components needed to build a harmonic filter and installed on the input terminals of a variable frequency drive or drive system. The filter components are tuned to provide a low impedance path for the major harmonic currents demanded by the drive when following the schematic connections used by TCI in the HSP Single-Phase Harmonic Filter.

The HSP “CP” Option filter component package consists of the following components.

- ◆ A KDS input series reactor.
 - A TCI 1-phase tuning reactor specifically designed for the HSP filter.
 - High-endurance, harmonic-rated capacitors.
- ◆ Bleeder resistors to ensure safe capacitor discharge upon filter shutdown.
- ◆ Capacitor mounting brackets that allow for a neat and orderly mounting and connection of the cylindrical power capacitors.
- ◆ Resistor to dampen voltage rise.



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