Danaher Motion

SERVO**STAR**® SP3 Power Block

Installation Manual

KOLLMORGEN

giving our customers freedom of design

M-SS-010-0104

Record of Manual Revisions

ISSUE NO.	DATE	REVISIONS
1	08/01/01	Initial Release
2	01/16/02	Correction to AC wiring description; addition of Watchdog description
3	February, 2003	Rename connector C8 to C5 Hardware spec: remove reference to C7 (Weidmuller) Troubleshooting: add description of "F" fault (PWM Frequency)
4	February, 2003	Maximum PWM frequency is 15.5kHz Added definition of C5 mating connector

Copyright Information

Safety Instructions

Only qualified personnel are permitted to transport, assemble, commission, and maintain this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, commissioning and operation of motors, and who have the appropriate qualifications for their jobs. The qualified personnel must know and observe the following standards and regulations:

IEC 364 resp. CENELEC HD 384 or DIN VDE 0100
IEC report 664 or DIN VDE 0110
National regulations for safety and accident prevention or VBG 4

Read all available documentation before assembling and commissioning. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information regarding installation requirements.

It is vital to ensure that all system components are connected to earth ground. Electrical safety is provided through a low-resistance earth connection.

The SERVO**STAR**® product contains static sensitive components that can be damaged by incorrect handling. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface. Ground yourself (discharge any possible static electricity build-up) by touching an unpainted, metal, grounded surface.

Keep all covers and cabinet doors shut during operation. Otherwise, potential hazards could cause severe personal injury or damage to the product.

Be aware that during operation, the product has electrically charged components and hot surfaces. Control and power cables can carry a high voltage, even when the motor is not rotating.

Never disconnect or connect the product while the power source is energized to avoid electric arcing and hazards to personnel and electrical contacts.

After removing the power source from the equipment, wait at least 10 minutes before touching or disconnecting sections of the equipment that normally carry electrical charges (e.g., capacitors, contacts, screwed connections). To be safe, measure the electrical contact points with a meter before touching the equipment.

Safety symbols indicate a potential for personal injury or equipment damage if the recommended precautions and safe operating practices are not followed. Read and be familiar with the safety notices in this manual before attempting installation, operation, or maintenance to avoid serious bodily injury, damage to the equipment, or operational difficulty. The safety-alert symbols are:

"**Warning**" identifies hazards that could result in personal injury or death.

"**Caution**" identifies hazards that could result in personal injury or equipment damage.

"**Note**" identifies information required for your understanding or use of the equipment.

Directives and Standards

The SERVO**STAR**® SP3 Power Block has been successfully tested and evaluated to meet UL/cUL 508C for the U.S. and Canadian markets. This standard outlines the minimum requirements for electrically operated power conversion equipment (frequency converters and servo amplifiers), which are intended to eliminate the risk of fire, electric shock, or injury to persons, being caused by such equipment.

CE Mark Conformance

Servo drives are incorporated in electrical plants and machines for industrial use. When the servo drives are built into machines or plants, the operation of the drive is prohibited until the machine or plant meets the requirements of the EC Directive on Machines 89/392/EEC and the EC Directive on EMC (89/336/EEC). Directives EN 60204 and EN 292 must also be met.

In connection with the Low Voltage Directive 73/23/EEC, the harmonized standards of the EN 50178 series are applied to the amplifiers, together with EN 60439-1, EN 60146 and EN 60204.

The manufacturer of the machine or plant is responsible for ensuring that they meet the limits; which are required by the EMC regulations. Advice on the correct installation for EMC - such as shielding, grounding, arrangement of filters, treatment of connectors and the lay out of cabling can be found in this documentation.

Conformance with the EC Directive on EMC 89/336/EEC and the Low Voltage Directive 73/23/EEC is mandatory for the supply of servo drives within the European Community.

The servo drives have been tested by an authorized testing laboratory in a defined configuration with the system components deSP3 Power Blockribed in this documentation. Kollmorgen is not responsible for any divergence from the configuration and installation deSP3 Power Blockribed in this documentation and is not responsible for the performance of new measurements or ensuring that regulatory requirements are met.

Kollmorgen's SERVO**STAR** SP Power Block has been successfully tested and evaluated to the limits and requirements of the EC Directive on EMC (89/336/EEC) and the EC Directive on Low Voltage (72/73/EEC). The product lines have been evaluated to EN50178 and EN60204 as a component of a machine and other relevant standards.

The Electromagnetic Compatibility (EMC) of a system is identified in two parts: emissions and immunity. Emission refers to the generation of electromagnetic interference (EMI), and immunity refers to the suSP3 Power Blockeptibility levels of the equipment. Limits are derived from generic standards EN55081-2 and EN55082-2 for heavy industrial environment. The SERVO**STAR** series of drives and bus modules have been tested for radiated emissions, conducted emissions, EFT, ESD, surge, conducted immunity, and radiated immunity. These tests have been in accordance with EN55011, EN61000-4-2, ENV50140, IEC 1000-4-4, EN61000-4-5, and ENV50141.

Installation of the equipment is critical in designing system and machine electromagnetic compatibility (EMC). The user must apply the installation recommendations in this manual (see the sections on Installation and CE Filtering Techniques when mounting and installing the drive system for CE conformance.

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READ BEFORE INSTALLING

This manual is provided with your product to assist you in getting your SERVO**STAR**® SP3 Power Block installed and operational.

High voltage can be hazardous to personnel and equipment. Be sure a qualified electrician works on this equipment. To ensure safety, follow all national and local codes during installation as well as the safety precautions outlined in the front of this documentation.

1. Open the box(es) and remove all the contents. Check to ensure there is no visible damage to any of the equipment.

2. Mount the SP3 Power Block to the back panel. Refer to the Outline Dimensions for additional details. ***Metal-to-metal contact is important for electrical noise control!***

3. Wire the SP3 Power Block according to the System Wiring Diagram. Pay particular attention to the pinout connector details.

4. Connect solid earth ground to frames of all components.

5. Wire the main power (24 VDC).

6. Wire the motor and feedback. Refer to the Feedback Wiring Diagram for additional information.

7. Wire the Regen Resistor kit, if applicable.

8. Verify that all wiring is correct.

9. Verify that earth grounds are connected.

10. Verify all electrical and safety codes are met.

11. For the integrated 8F option:

    A. Connect the halls cable to connector C1.

    B. Connect the feedback connector C2.

    C. Connect the connector C3 to PMAC (The SP3 works with the standard PMAC motion controller).

    D. Connect the user flags connector C4.

    E. Connect the user flags connector C5.

12. For the Standard option:

    A. Connect the cable C2.

    B. Connect the 8F Delta Tau accessory.

13. Configure the SP3 Power Block for your particular motor, if this was not done at the factory.

14. Tune the SP3 Power block for the load and desired performance.

15. Enable the system.

UNPACKING AND INSPECTING

Open the box and remove all the contents. Check to ensure there is no visible damage to any of the equipment.

Electronic components in this amplifier are design-hardened to reduce static sensitivity. However, proper procedures should be used when handling to avoid damage to equipment.

Remove all packing material and equipment from the shipping container. Be aware that some connector kits and other equipment pieces may be quite small and can be accidentally discarded if care is not observed when unpacking the equipment. Do not dispose of shipping materials until the packing list has been checked.

Upon receipt of the equipment, inspect components to ensure that no damage has occurred in shipment. If damage is detected, notify the carrier immediately. Check all shipping material for connector kits, documentation, diskettes, CD-ROM, or other small pieces of equipment.

WARRANTY INFORMATION

All products covered in this manual are warranted to be free of defects in material and workmanship and to conform to the specifications stated either in this document or product catalog description. All Kollmorgen brushless motors and electronics are warranty for a period of 24 months from the time of installation or 30 months from time of shipment, which ever comes first. There are no other warranties, expressed or implied (including the warranty of merchantability and fitness for a particular purpose, which extends beyond this warranty. Kollmorgen warrants that the products covered in the manual are free from patent infringement when used for normal purposes.

USE AS DIRECTED

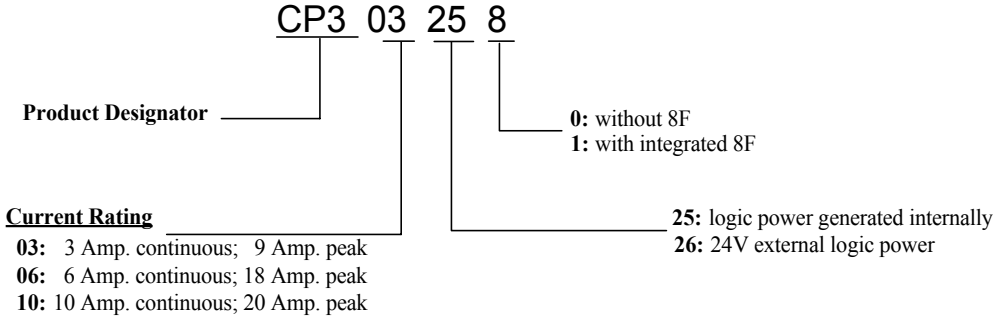
The following guidelines describe the restrictions for proper use of the SERVO**STAR** SP3 Power Block:

1. The amplifiers are components built into electrical equipment or machines and can only be used as integral components of such equipment.
2. The servo amplifiers are to be used only on earthed three-phase industrial mains supply networks (TN-system, TT-system with earthed neutral point).
3. The servo amplifiers must not be operated on power supply networks without an earth or with an asymmetrical earth.
4. If the servo amplifiers are used in residential areas, or in business or commercial premises, you must implement additional filter measures.
5. The servo amplifiers are only intended to drive brushless synchronous servomotors with closed-loop control of torque, speed, and position. The rated voltage of the motors must be at least as high as the DC-link voltage of the servo amplifier.

6. The servo amplifiers may only be operated in a closed switch gear cabinet, taking into account the ambient conditions defined in the environmental specifications.
7. Danaher Motion Kollmorgen guarantees the conformance of the servo amplifiers with the standards for industrial areas stated in the front of this manual only if Danaher Motion Kollmorgen delivers the components (motors, cables, amplifiers etc).

PART NUMBER

SERVO**STAR** SP3 Model Number



ELECTRICAL SPECIFICATIONS

Product Model		CP303	CP306	CP310
Main Input Power	Voltage (Vac_{L-L}) Nominal ±10%	110-230		230
	115Vac 1ϕ / 3ϕ	1/3		
	230Vac 1ϕ / 3ϕ	1/3		3ϕ only
	Line Frequency	47-63		
	KVA at 115 (1ϕ)	0.44	0.89	
	Continuous Current (amps) at 115VAC	3.9	7.7	
	Peak Current (amps) for 500 mSec 115VAC	11.7	23.1	
	Peak Current (amps) for 2 Sec 115AC	7.8	15.4	
	KVA at 230 (1ϕ)	0.89	1.8	
	Continuous Current (amps) at 230 (1ϕ)	3.9	7.7	
	Peak Current (amps) for 500mSec at 230 (1ϕ)	11.7	23.1	
	Peak Current (amps) for 2Sec at 230 (1ϕ)	7.8	15.4	
	Line Fuses (FRN-R, LPN, or equivalent)	10	20	
	KVA at 230 (3ϕ)	1.4	2.8	4.6
	Continuous Current (amps) at 230 (3ϕ)	3.5	7	12
	Peak Current (amps) for 500mSec at 230 (3ϕ)	10.5	21	36
	Peak Current (amps) for 2Sec at 230 (3ϕ)	7	14	24
	Line Fuses (FRN-R, LPN, or equivalent)	10	20	25
Logic Input Power	+24VDC Ext. Logic Voltage (volts)	22 - 27		
	+24VDC Ext. Logic Current (amps sink)	0.5		
SoftStart	Max. Surge Current (amps)	30		
	Max. Charge Time (sec)	0.25		
Protection Functions	Fault Contact Rating	1A		
	Fault Contact Closing Period (mSec)	Close = 3mS, Open = 2mS		
	OverTemperature trip (°C)	80°C		
	UnderVoltage Trip (nominal)	90 VDC		
	OverVoltage Trip	430 VDC		
	OverTemperature Trip	80°C		
	Internal heat dissipation (watts)	60	80	132
Main Output (Ma, Mb, Mc)	Continuous Power (KVA) at 115VAC 1ϕ Line Input (45° Ambient)	0.35	0.7	
	Continuous Power (KVA) at 230VAC 1ϕ Line Input (45°C Ambient)	0.7	1.4	
	Continuous Power (KVA) at 230VAC 3ϕ Line Input(45° Ambient)	1.1	2.2	3.5
	Continuous Current (Arms)	3	6	10
	Peak Current (Arms) for 500 mSec	9	18	20
	Peak Current (Arms) for 2 Sec	6	12	20
	PWM Frequency (kHz)	15.5	8	8
	PWM Motor Current Ripple (kHz)	31	16	16
	Form Factor (rms/avg)	≤1.01		
Environment	Operation temperature	5°C to 45°C		
	Storage temperature	-0°C to 70°C		
	Ambient humidity	10% to 90%		
	Atmosphere	with no corrosive gasses or dust		
	Altitude	Derate 5% per 1000-ft (300m) above 3300-ft (1000m)		
	Vibration	0.5 g		

Regen Information

Product Model		Cx03	Cx06	Cx10
External Shunt Regulator	Peak current (amps)	20		
	Minimum resistance (Ω)	20		
	Watts	200		
Application Information	Capacitance (Farads)	0.00082	0.00164	
	BUS Voltage (nominal) (VDC)	325		
	V_{HYS} (Regen circuit turn-off) (VDC)	370		
	V_{MAX} (Regen circuit turn-on) (VDC)	390		
External Regen Kits	ERH-26	✔	✔	✔

MOUNTING

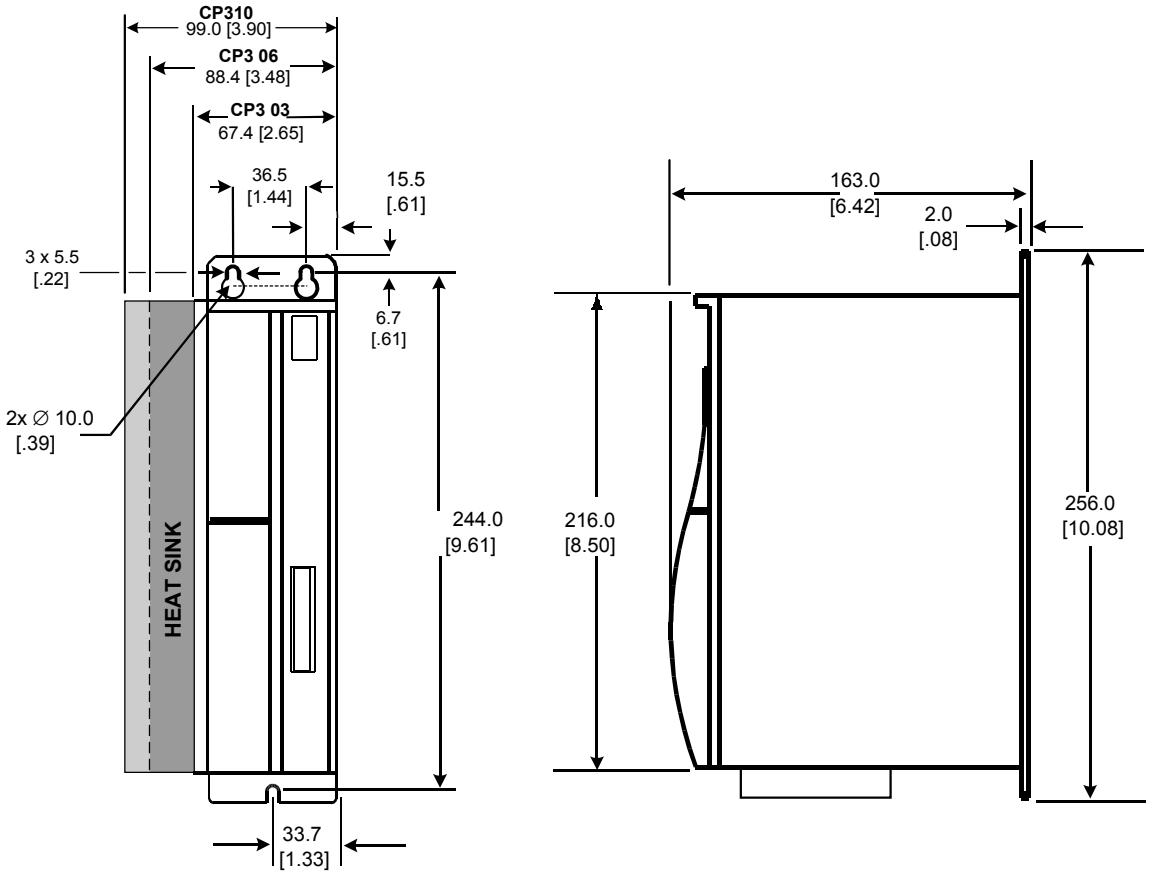
The SERVO**STAR** system should be operated and stored under the environmental conditions stated in the electrical specification tables. The system may be operated in higher temperature ambient conditions with a derating applied. Check with the factory for derating information.

Attention to proper installation and field wiring are of prime importance to ensure long-term and trouble-free operation. Follow the installation and wiring instructions in this document and incorporate all applicable electrical and safety codes, laws, and standards.

HARDWARE SPECIFICATIONS

Amplifier Model		CP303	CP306	CP310
Unit Weight	lbs / Kgs	3.56 / 1.61	4.9 / 2.22	5.94 / 2.69
Mounting Hardware	English (Metric)	10-32 (M4)		
	Applied Torque	20lb-in (2.26Nm)		
Connection Hardware	Line Screw Size/Torque	M3.5 / 12lb-in (1.35Nm)		
	BUS Screw Size/Torque			
	Motor Screw Size/Torque			
	Ground Screw Size/Torque			
Wire Size (AWG#)	Control Logic (AWG/ mm^2)	28 – 16 / 0.5 – 1.5		
	Motor Line (AWG/ mm^2)	14 / 0.25		
	Main Input (AWG/ mm^2)	14 / .25	12 / 4	
	Configurable I/O wire gauge	22-18 AWG (.3-.75mm^2) Ferrules recommended: 18 AWG Type H1 - 0/14 Weidmuller 4630.0 or equiv. 20 AWG Type H0 - 75/14 Weidmuller 4629.0 or equiv.		
	Spade Terminals	16/14 AWG (1.5mm^2): Hollingsworth XSS0954S or SS20947SF or equivalent 12/10 AWG (4-6mm^2): Hollingsworth XSS20836 or SS20832F or equivalent		
	Ring Terminals	8 AWG (10mm^2): Hollingsworth R3027BF or equiv. 6 AWG (16mm^2): Hollingsworth R4001BF or equiv. 4 AWG (25mm^2): Hollingsworth R5100BF or equiv. 2 AWG (35mm^2): Hollingsworth R7998BFN or equiv.		
Clearance Distance	Side-to-Side	0.5in (12.7mm)		
	Top/Bottom	2.5in (63.5mm)		
Mating Connector Hardware	CK100 Kit	Includes: C1, C2, C4		
	C3 Cable	Kollmorgen P/N: CBL-00022000-00 Vendor Info: HIROSE HIF6H-50D-1.27R		
	C5 Connector	Manufacturer: Weidmuller; PN 161570		
	Connector Screw Torque	2.25 lb-in (0.25m)		
	24V Logic (optional)	PCD ELFP02210 or equiv.		

OUTLINE DIMENSIONS



MOUNTING PRACTICES

The Kollmorgen SERVO**STAR** series of electronic system components are designed for panel assembly. This panel assembly is then mounted in a metallic enclosure. Enclosures are supplied by the manufacturers of the final product and meet the environmental IP rating of the end product. To ensure proper grounding (and to optimize EMC), the enclosure should have continuous ground continuity maintained between all metal panels. This ground continuity is intended to be both a safety ground and a high frequency ground. The units are mounted on a back plane installed into the enclosure. Ideally, the back plane should be an unpainted metallic surface to optimize electrical bonding of the frame and provide the lowest possible impedance path to earth ground. These enclosures also provide added safety.

The SERVO**STAR** units should be mounted vertically for proper ventilation. These products are designed for mounting in an electrical enclosure to protect them from physical and environmental damage.

Particular care should be used when layout of an enclosure is designed. Separate power wires from small signal wires. The following guidelines highlight some important wiring practices to implement:

1. Control and signal cables must be separated from power and motor cables. Distance of 20cm (8 in.) is sufficient in most cases.
2. Control and signal cables must be shielded to reduce the effects of radiated interference.
3. When control cables must cross power or motor cables, they should cross at an angle of 90 degrees, if possible. This reduces the field coupling effect.

CE FILTERING TECHNIQUES

The SERVO**STAR** system (power block, drive, motor) meets the CE Mark standards stated in the front of this manual. Apply proper bonding and grounding techniques, described earlier in this section, when incorporating EMC noise filtering components to meet this standard.

Noise currents often occur in two types. The first is conducted emissions passed through ground loops. The quality of the system-grounding scheme inversely determines the noise amplitudes in the lines. These conducted emissions are of a common-mode nature from line-to-neutral (ground). The second is radiated high-frequency emissions that are usually capacitively coupled from line-to-line and are differential in nature.

To properly mount the filters, the enclosure should have an unpainted metallic surface. This allows for more surface area to be in contact with the filter housing and provide a lower impedance path between the housing and the back plane. The back panel should have a high frequency ground strap connection to the enclosure frame and earth ground.

Input Power Filtering

The Danaher Motion Kollmorgen SERVO**STAR** electronic system components require EMI filtering in the input power leads to meet the conducted emission requirements for the industrial environment. This filtering blocks conducted-type emissions from exiting onto the power lines and provides a barrier for power line EMI.

Adequately size the system. The type of filter must be based on the voltage and current rating of the system and whether the incoming line is single- or three-phase. The implementation of the EMI filter should be done in accordance with the following guidelines:

- Filter should be mounted on the same panel as the drive.
- Filter should be mounted as close as possible to incoming cabinet power.
- When mounting the filter to the panel, remove any paint or material covering. Use an unpainted metallic back panel, if possible.

- Filters are provided with an earth connection. All ground connections should be tied to ground.
- Filters can produce high leakage currents. ***Filters must be earthed before connecting the supply!***
- Do not touch filters for a period of 10 seconds after removing the power supply.

Motor Line Filtering

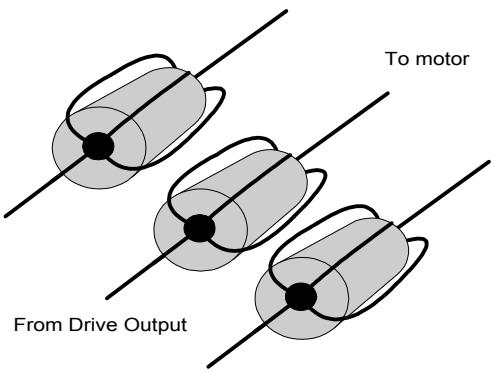
Motor filtering may not be necessary for CE compliance of SERVO**STAR** systems. However, this additional filtering increases the reliability of the system. Poor non-metallic enclosure surfaces and lengthy, unbonded (or unshielded) motor cables that couple noise line-to-line (differential) are some of the factors that may lead to the necessity of motor lead filtering.

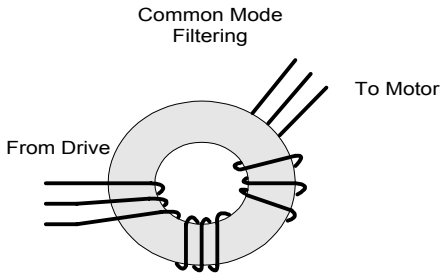
Motor lead noise is either common-mode or differential. The common-mode conducted currents occurs between each motor lead and ground (line-to-neutral). Differential radiated currents exists from one motor lead to another (line-to-line). The filtering of the lines feeding the motor provides additional attenuation of noise currents that may enter surrounding cables and equipment I/O ports in close proximity.

Differential mode currents commonly occur with lengthy motor cables. As the cable length increases, so does its capacitance and ability to couple noise from line-to-line. While every final system is different and every application of the product causes a slightly different emission profile, it may become necessary to use differential mode chokes to provide additional noise attenuation to minimize the radiated emissions. The use of a ferrite core placed at the drive end on each motor lead (shown in the diagram below), attenuates differential mode noise and lowers frequency (30 to 60 MHz) broadband emissions to within specifications. Kollmorgen recommends a Fair-Rite P/N 263665702 (or equivalent) ferrite core. Wrap each motor lead through the core several times as shown in the figure below:

Never wrap a ground lead through a core.

Differential Mode Filtering





Common mode currents occur from noise spikes created by the PWM switching frequency of the drive. The use of a ferrite or iron-powder core toroid, as shown in the figure above, places common mode impedance in the line between the motor and the drive. The use of a common mode choke on the motor leads may increase signal integrity of encoder outputs and associated I/O signals. The following is a list of toroidal and ferrite cores that can be used to make common mode chokes:

Toroidal Core Recommendations		
Manufacturer	**Mfg. Part #**	**Size**
Micrometals	T400-26D	OD 4in (102mm) ID 2.25in (57.2mm) HT 1.3in (33mm)
Micrometals	ST102-267	OD 1.025 in (26mm) ID 0.6 in (15.2mm) HT 0.475 in (12.1mm)
Micrometals	ST150-275B	OD 1.52 in (38.6mm) ID 0.835 in (21.2mm) HT 0.825 in (21mm)
Micrometals	ST200-275B	OD 2.01 in (51.1mm) ID 1.24 in (31.5mm) HT 1.025 in (26mm)
Magnetics	77930-A7	OD 1.09 in (27.7mm) ID 0.555in (14.1mm) HT 0.472in (11.99mm)
Fair-Rite	2643803802	OD 2.4in (61mm) ID 1.4in (35.55mm) HT 0.5in (12.7mm)

Pre-wound Common-Mode Chokes			
Manufacturer	**Mfg. Part #**	**Kollmorgen Part #**	**Description**
Schaffner	RD7137-36-0m5	A-96843-005	500µH 3 phase common mode choke. 36 amps continuous.
Schaffner	RD8137-64-0m5	A-96843-010	500µH 3 phase common mode choke. 64 amps continuous.

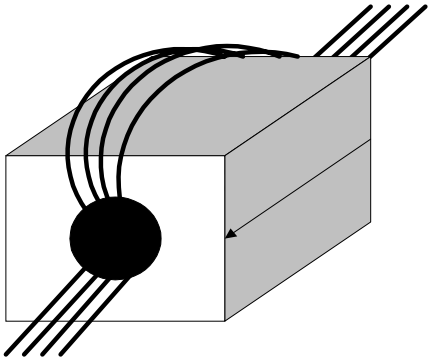
I/O Filtering

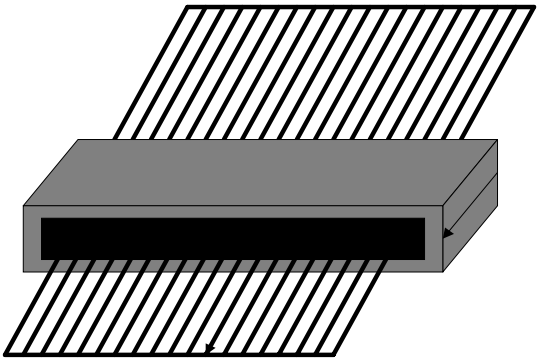
I/O filtering may be desired, depending on system installation, application, and integration with other equipment. It may be necessary to place ferrite cores on I/O lines to avoid unwanted signals entering and disturbing the drive system or other associated equipment. The following chart lists some ferrite parts that may be used for I/O filtering and noise attenuation. These parts are ideal for providing in-line common mode impedance for I/O lines (Fair-Rite Products Corporation also has a varied selection, which suits most applications).

I/O Filter Recommendations			
Manufacturer	**Manufacturer's Part #**	**Kollmorgen Part #**	**Description**
Ferrishield	SS33B2032	A-96770-003	Clamp on core
Ferrishield	SS33B2036	A-96769-005	Clamp on core
Ferrishield	FA28B2480	A-96771-003	Clamp on core flat cable clamp
Ferrishield	SA28B4340	A-96772-009	Clamp on core flat cable clamp
* Fair-Rite	2643167251		

**** This core must be used with the drives for CE compliance. It should be applied to the 24V input power lines and the Remote Enable lines (7&8 on C3 connector) with approximately 3 turns through the core.***

The following figure illustrates the use of multiple turns through a clamp-on core. The more turns created, the more impedance is added to the line. Avoid putting the shield in a clamp-on core. It is undesirable to place an impedance in-line with the shield. The use of ribbon cable may be common in many cabinets. Some ferrite clamps are designed just for ribbon cable use as shown below.





Flat cable clamp used with ribbon cable

GROUNDING

System grounding is essential for proper performance of the drive system. A ground bus bar is used as a single point ground for the system. Safety grounding is provided to all pieces of the system from a “star point”. A high frequency ground must also be provided that connects the back panel to the enclosure, and ultimately to earth ground. This high frequency ground is made with the use of a flat braid or copper bus bar. Do not use a standard wire for the high frequency ground. When connecting high frequency grounds, use the shortest braid possible.

BONDING

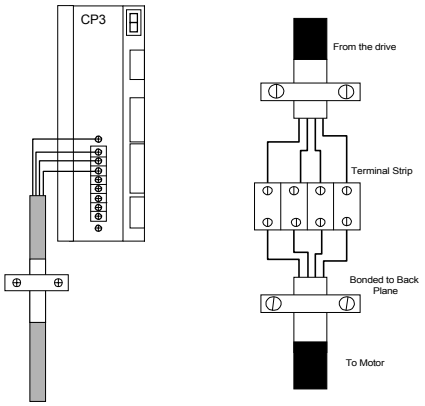
The proper bonding of shielded cables is *imperative* for minimizing noise emissions and increasing immunity levels of the drive system. Its effect is to reduce the impedance between the cable shield and the back panel. Kollmorgen recommends that all shielded cables be bonded to the back panel.

Power input wiring does not require shielding (screening) if the power is fed to the cabinet (enclosure) via metallized conduit. If metallized conduit is not implemented into the system, shielded cable is required on the power input wires and proper bonding technologies should be implemented.

The motor and feedback cables should have the shield exposed as close to the drive as possible. This exposed shield is bonded to the back panel using one of the two suggested methods below:

Non-insulated Cable Clamp

The following figures shows how cable bonding is implemented using non-insulated metallic cable clamps. The first figure demonstrates clamping to the back panel in the vicinity of the drive. The second shows a technique for bonding a terminal strip (for best results, it is recommended not to break the shielding of the cable).



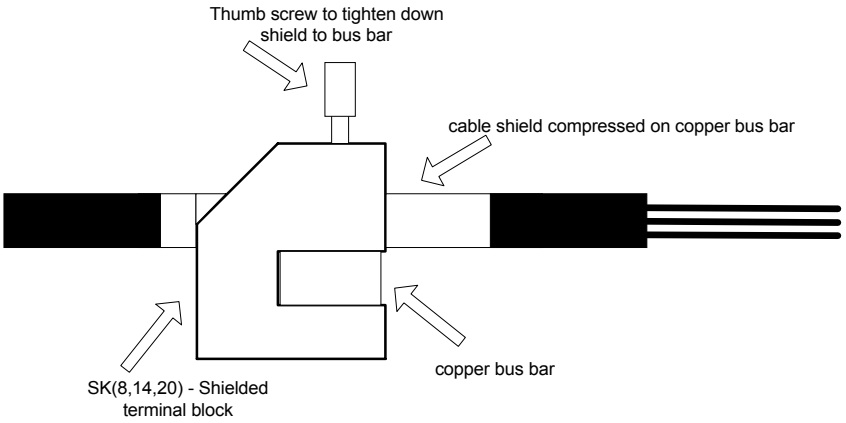
Power Block Clamp and Terminal Clamp

Alternative Bonding Methods

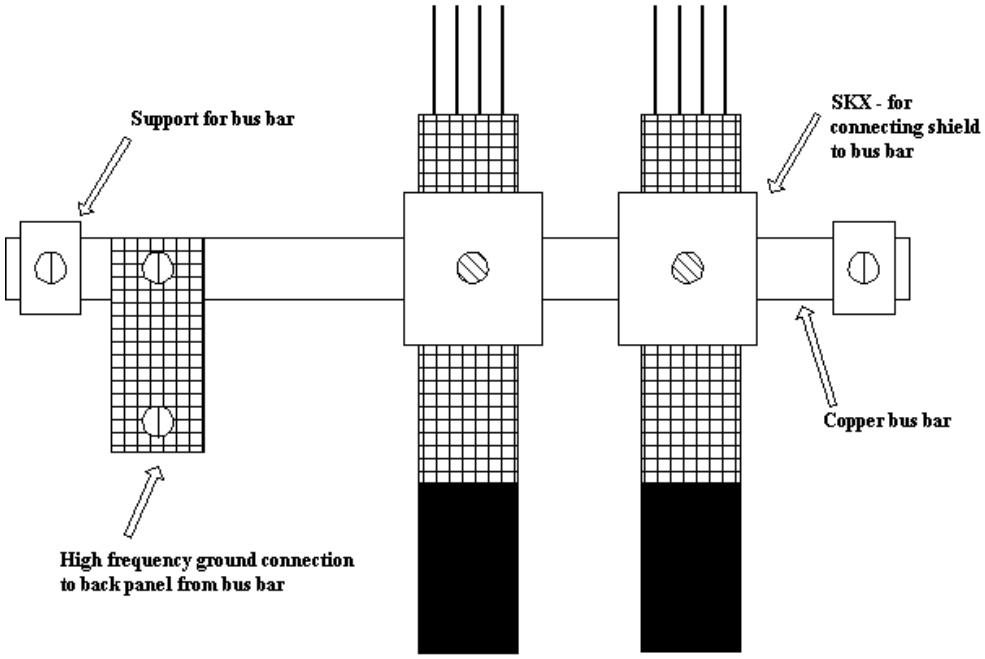
Another option is to use cable bonding clamps (offered by Phoenix Contact and others). When using the Phoenix Contact parts, make sure that a low impedance (high frequency) ground is connected from the ground bus bar to the back panel using a flat braid or a copper bus bar. The SK parts from Phoenix (SK8, SK14, & SK20) slide onto the bus bar. The cable (with exposed shield) is inserted through the SK piece and the thumbscrew on top of the SK piece is used to tighten the connection between the cable shield and the bus bar.

Phoenix Part Descriptions		
Phoenix Contact Part #	**Description**	**Cable Diameter Range**
3025163 (Type SK8)	Shielded terminal block - for placing the shield on bus bars.	SK8 (up to 8mm or 0.315 in)
3025176 (TypeSK14)	Shielded terminal block - for placing the shield on bus bars.	SK14 (8mm to 14mm or 0.551 in)
3025189 (Type SK20)	Shielded terminal block - for placing the shield on bus bars.	SK20 (14mm to 20mm or 0.787 in)
0404428 (Type AB/ServoStar)	Support for bus bar. 2 needed to mount ground bus.	N/A
0402174 (Type NLS-CU 3/10)	Bus bar material - 10mm x 3mm copper at varying lengths.	N/A

The next two figures represent a side and top view of the SK device that clamps down on the shield of the cable. The use of the Phoenix SK device is an excellent method for providing a low impedance path between the cable shield and the back panel.



Phoenix Contact - Side View



Phoenix Contact -Top View

SYSTEM WIRING

The SP3 Power Block is a PWM amplifier designed to drive a servo motor by using a PWM input from an external controller, specifically the Delta Tau Data Systems, Inc. PMAC®2 multi-axis controller. The SP3 consists of a smart power stage and an intelligent interface card for the switching power amplifier. The product allows for dynamic system performance and excellent control capabilities. Extensive protection features include encoder loss detection, peak over-current protection, I^2t drive protection, motor and drive over-temperature protection, and over- and under-voltage protection. Encoder and Hall effect signals are supported. All faults are displayed on a 7-segment display.

The SERVO**STAR** SP3 Power Block has two options: the Standard Option and the Integrated 8F Option. The Integrated 8F Option includes the interface features of the Delta Tau Data Systems, Inc.'s Accessory 8F® digital interface board, which is essentially built directly into the drive itself.

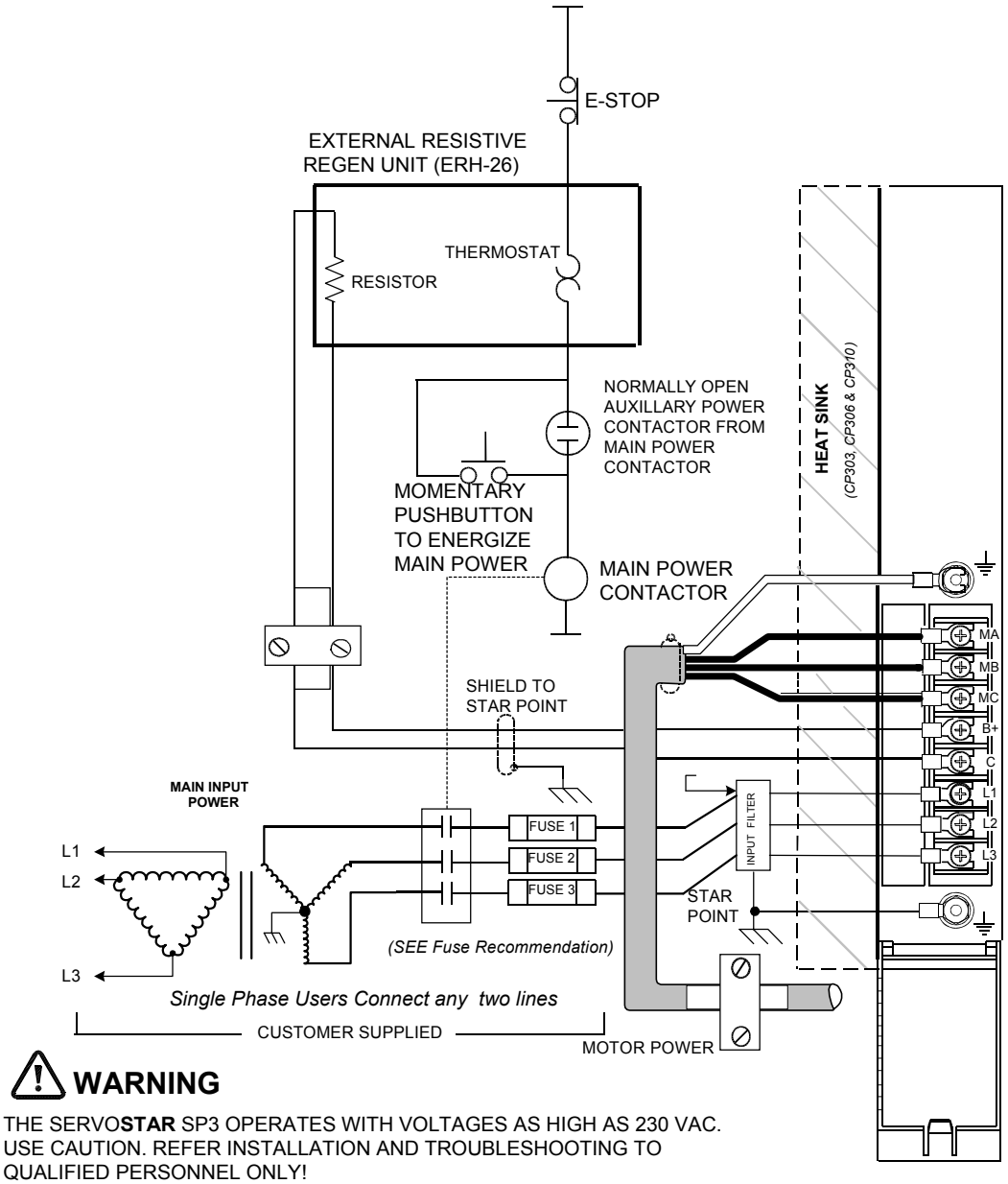
The following tables provide information about the main power terminal block and the optional 24 VDC logic power connector. Kollmorgen can provide cabling for each of these connections.

MAIN POWER CONNECTOR

The main power terminal block is on the front of the unit, and is protected by a plastic cover which snaps closed.

Power Connector	
Label	**Description**
Ma	Output to Motor Phase A
Mb	Output to Motor Phase B
Mc	Output to Motor Phase C
B+	300VDC Bus for External Regeneration Resistor
C	Common Bus for External Regeneration Resistor
L1	Line Input Phase 1
L2	Line Input Phase 2
L3	Line Input Phase 3

See the figure below for further details.



⚠ WARNING

THE SERVO**STAR** SP3 OPERATES WITH VOLTAGES AS HIGH AS 230 VAC. USE CAUTION. REFER INSTALLATION AND TROUBLESHOOTING TO QUALIFIED PERSONNEL ONLY!

HIGH VOLTAGE MAY EXIST UP TO 5 MINUTES AFTER INPUT VOLTAGE IS REMOVED.

24V LOGIC POWER CONNECTOR (OPTIONAL)

The logic power for the unit is generated internally, but there is an option available that allows for connection to an external 24 VDC logic power supply.

The optional 24 VDC logic power connector is a 2-pin header, located on the top of the unit. The pin towards the front of the unit is the 24 VDC input, and the pin towards the back is ground. The connector is not labeled on the unit.

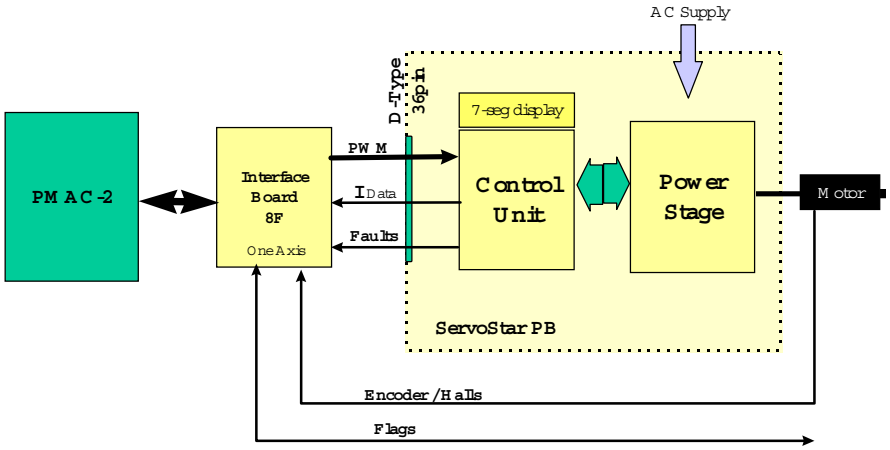
STANDARD OPTION

The Standard Option has a single connector. It is located on the front of the unit. Connector C2 interfaces between the SP3 and an external Delta Tau (or compatible) digital interface board, such as the Accessory 8F. Connector C2 is a standard mini-D-36 connector, with the pin descriptions below. A compatible point-to-point cable can be supplied by Delta Tau Data Systems, Inc.

Connector **C2** (Standard Option)			
Pin	Symbol	Function	Description
1	FC0	Feedback	Fault code bit
2	FC2	Feedback	Fault code bit
3	ADC_CLK+	Command	A/D converter clock
4	ADC_STB+	Command	A/D converter strobe
5	CURRENTA+	Feedback	Phase A actual current data
6	CURRENTB+	Feedback	Phase B actual current data
7	AENA+	Command	Amplifier enable
8	FAULT+	Feedback	Amplifier fault
9	PWMATOP+	Command	Phase A top command
10	PWMABOT+	Command	Phase A bottom command
11	PWMBTOP+	Command	Phase B top command
12	PWMBBOT+	Command	Phase B bottom command
13	PWMCTOP+	Command	Phase C top command
14	PWMCBOT+	Command	Phase C bottom command
15	PMAC_GND	Common	Reference voltage
16	PMAC_+5V	Power	+5V power from controller
17	NC		
18	NC		
19	FC1	Feedback	Fault code bit
20	FC3	Feedback	Fault code bit
21	ADC_CLK-	Command	A/D converter clock, return
22	ADC_STB-	Command	A/D converter strobe, return
23	CURRENTA-	Feedback	Phase A current data, reference
24	CURRENTB-	Feedback	Phase B current data, reference
25	AENA-	Command	Amplifier enable, return
26	FAULT-	Feedback	Amplifier fault, reference
27	PWMATOP-	Command	Phase A top command, return
28	PWMABOT-	Command	Phase A bottom command, return
29	PWMBTOP-	Command	Phase B top command, return
30	PWMBBOT-	Command	Phase B bottom command, return
31	PWMCTOP-	Command	Phase C top command, return
32	PWMCBOT-	Command	Phase C bottom command, return
33	PMAC_GND	Common	Reference voltage
34	PMAC_+5V	Power	+5V power from controller
35	NC		
36	NC		

The block diagram of the Standard Option is shown below. The Accessory 8F is shown in the figure below, but the SP3 can interface to other accessory boards in the same manner.

Standard Option Block Diagram



INTEGRATED 8F OPTION CONNECTOR

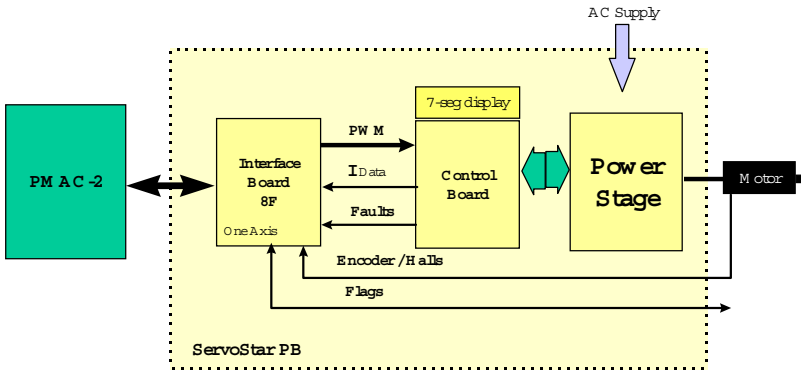
The Integrated 8F Option has the Accessory 8F integrated into the SP3 amplifier to handle the encoder interface and user I/O. It provides an integrated drive unit with direct connection through a flat cable to the PMAC2. An external interface board is not required, thus saving cost and space. This option has four connectors (C1 to C4) on the front panel and one connector (C5) on the top of the unit.

The PMAC2 has up to 4 machine-interface connectors, labeled JMACH1 through JMACH4. Each JMACH connector carries all of the control and feedback signals for 2 axes. The connector is a 100-pin male box header with a center key and pins on 0.050-inch centers. The signals are differential line driver/receiver pairs, at 5-volt CMOS levels.

The JMACHx connector pins 1 through 50 provide the interface for one axis. Connector pins 51 through 100 provide the interface for a second axis. A split cable is available from Kollmorgen to connect the 100-pin JMACH connector to two 50-pin connectors on separate drives.

All feedback signals to the PMAC pass through the amplifier, even if not related to the function of the amplifier (e.g., limit switch, home switch and encoder signals). The block diagram of the Integrated 8F Option is shown below.

Integrated 8F Option Block Diagram



SYSTEM INTERCONNECT

The following sections provide connector information and the system connections up to the motor power and feedback connections. Cabling purchased from Danaher Motion Kollmorgen directly completes the system connections. Customers making their own cables can refer to Appendix A for drive/motor pinout connections.

Connector C1: Hall Effect Device Feedback

Connector C1 interfaces between the SP3 and the Hall Effect Devices (HED) on the motor. These signals may be used when the feedback consists of HEDs only. The HED connections are repeated on connector C2, and only one should be used, since the signals are interconnected within the drive. Connector C1 is a 9 pin D-sub male with the pin descriptions below.

Connector C1 Hall Effect Device Feedback		
Function	**Symbol**	**Pin**
HED-1 reference	H1-	1
HED-2 reference	H2-	2
HED-3 reference	H3-	3
No Connection	NC	4
No Connection	NC	5
HED-1 input	H1+	6
HED-2 input	H2+	7
HED-3 input	H3+	8
No Connection	NC	9

Connector C2: Encoder Feedback

On the Integrated 8F Option, connector C2 is used for connection to the encoder. The HED connections are repeated on connector C1, and only one should be used, since the signals are interconnected within the drive. Danaher Motion Kollmorgen motor cables can be used. Connector C2 is a 25 pin D-sub female with the pin descriptions below.

Connector C2 Encoder Feedback			
PIN	**DESCRIPTION**	**FUNCTION**	**SYMBOL**
1	Encoder Channel A Input (High)	A	CHA+
2	Encoder Channel A Input (Low)	/A	CHA-
3	Shield	Shield	SHIELD
4	Encoder Channel B Input (High)	B	CHB+
5	Encoder Channel B Input (Low)	/B	CHB-
6	Shield	Shield	SHIELD
7	EV5 Return	E5V Return	PMAC_GND
8	EV5 Return	E5V Return	PMAC_GND
9	Hall 1	Hall 1	H1-
10	Hall 2	Hall 2	H2-
11	Hall 3	Hall 3	H3-
12	Shield	Shield	SHIELD
13	Thermostat High	Thermostat High	MOTOR THERMp
14	Shield	Shield	SHIELD
15	Encoder Index Channel Input (High)	Index	CHC+
16	Encoder Index Channel Input (Low)	/Index	CHC-
17	Shield Connection	Shield	SHIELD
18	EV5 Supply	E5V Supply	PMAC_+5V
19	EV5 Supply	E5V Supply	PMAC_+5V
20	EV5 Supply	E5V Supply	PMAC_+5V
21	Shield Connection	Shield	SHIELD
22	Hall 1	Hall 1	H1
23	Hall 2	Hall 2	H2
24	Hall 3	Hall 3	H3
25	Thermostat Low	Thermostat Low	MOTOR THERMn

Although pins 3, 6, 12, 14, 17, and 21 are annotated as shield connections, it is not recommended they be connected to these pins. It is recommended that all shields be tied to an electrically-conductive connector housing to connect the shields through the metal covers for the connectors.

Connector C3: PMAC Interface

Connector C3 is used for connection to the PMAC. Connector C3 is a 50-pin header with the pin descriptions below.

Connector C3 PMAC Interface				
Pin #	**PIN**	**SYMBOL**	**FUNCTION**	**DESCRIPTION**
1	A1	PMAC_+5V	Output / Input	+5V Power
2	B1	PMAC_+5V	Output / Input	+5V Power
3	A2	PMAC_GND	Common	Reference Voltage
4	B2	PMAC_GND	Common	Reference Voltage
5	A3	CHA+	Output	Pos. A Channel
6	B3	CHA-	Output	Neg. A Channel
7	A4	CHB+	Output	Pos. B Channel
8	B4	CHB-	Output	Neg. B Channel
9	A5	CHC+	Output	Pos. C Channel
10	B5	CHC-	Output	Neg. C Channel
11	A6	CHU +	Output	U Flag
12	B6	CHV +	Output	V Flag
13	A7	CHW +	Output	W FLAG
14	B7	CHT +	Output	T Flag
15	A8	USER +	Output	general purpose user flag
16	B8	PLIM +	Output	Positive Over-travel Limit
17	A9	MLIM +	Output	Negative Over-travel Limit
18	B9	HOME +	Output	Home Switch Input
19	A10	AFLT+	Output	Accessory Fault Flag
20	B10	NC		Not Connected
21	A11	NC		Not Connected
22	B11	NC		Not Connected
23	A12	ACLK+	Input	A/D Converter Clock
24	B12	ACLK-	Input	A/D Converter Clock
25	A13	ASTB+	Input	A/D Converter Strobe
26	B13	ASTB-	Input	A/D Converter Strobe
27	A14	ADAA+	Output	Chan. A ADC Serial Data
28	B14	ADAA-	Output	Chan. A ADC Serial Data
29	A15	ADAB+	Output	Chan. B ADC Serial Data
30	B15	ADAB-	Output	Channel B ADC Serial
31	A16	ENA+	Input	Amplifier Enable
32	B16	ENA-	Input	Amplifier Enable
33	A17	FLT+	Output	Amplifier Fault
34	B17	FLT-	Output	Amplifier Fault
35	A18	ATOP+	Input	Phase A Top Command.
36	B18	ATOP-	Input	Phase A Top Command
37	A19	ABOT+	Input	Phase A Bottom Command.
38	B19	ABOT-	Input	Phase A Bottom Command.
39	A20	BTOP+	Input	Phase B Top Command.
40	B20	BTOP-	Input	Phase B Top Command.
41	A21	BBOT+	Input	Phase B Bottom Command.
42	B21	BBOT-	Input	Phase B Bottom Command.
43	A22	CTOP+	Input	Phase B Top Command.
44	B22	CTOP-	Input	Phase B Top Command.
45	A23	CBOT+	Input	Phase B Bottom Command.
46	B23	CBOT-	Input	Phase B Bottom Command.
47	A24	PMAC_GND	Common	Reference Voltage
48	B24	PMAC_GND	Common	Reference Voltage
49	A25	PMAC_+5V	Output / Input	+5V Power
50	B25	PMAC_+5V	Output / Input	+5V Power

Connector C4: User Flags

Connector C4 returns status information to the user. Connector C4 is a 9 pin D-sub female with the pin descriptions below.

Connector C4 User Flags			
PIN #	**SYMBOL**	**FUNCTION**	**DESCRIPTION**
1	CD_DGND	Ground	Analog Common
2	CD_DGND	Ground	Analog Common
3	FL_RT	Input	Return For All Flags
4	MLIM	Input	Negative Limit Flag
5	USER	Input	General Capture Flag
6	SHIELD		
7	CD_12V+	Output	Flag Power
8	HOME	Input	Home Flag
9	PLIM	Input	Positive Limit Flag

Connector C5 User Flags

On the Integrated 8F Option, connector C5 repeats the user flags that are on connector C4. The signals on connectors C4 and C5 are interconnected within the drive. Connector C5 is an 8-pin header, located on the top of the drive, with the pin descriptions below.

Connector C5 User Flags			
PIN	**SYMBOL**	**FUNCTION**	**DESCRIPTION**
1	USER	Input	General Capture Flag
2	PLIM	Input	Positive Limit Flag
3	MLIM	Input	Negative Limit Flag
4	HOME	Input	Home Flag
5	FL_RT	Input	Return For All Flags
6	CD_DGND	Ground	Analog Common
7	CD_12V+	Output	Flag Power
8	CD_DGND	Ground	Analog Common

DIP SWITCHES

The over-current shut down and the fault code transmission are controlled by four of the ten DIP switches, which are located on the top of the SP3.

Two DIP switches (S401 numbers 1 and 4) are used for the I^2T feature. The settings are:

Feature	S401: Switch 1	S401:Switch 4
I^2T is active	down	down
I^2T is active	up	down
I^2T is active	down	up
I^2T is inactive	up	up

In the PPB, two switches provide a PMAC reading of the Hall effect if the fault detection function or the fault code are not required. The settings are:

Feature	S401 : Switch 9	S401 :Switch 10
Hall effect reading	up	up
Hall effect + Faults reading	up	down
Faults reading	down	down

TROUBLESHOOTING

DISPLAY

The 7-segment display on the front of the drive indicates the status of the drive. When the drive is disabled and there are no faults, the display is blank. When the drive is enabled, the decimal point is lit.

When a fault condition occurs, the drive is disabled. The LED displays the cause of the fault so you can readily determine the source of the problem. Faults are cleared by removing the cause of the fault, and then toggling the drive enable signal. The drive over-current fault (P1) can only be cleared by cycling the drive power. The following table shows the display fault codes and fault description. The PMAC code is discussed in the next section.

Display	PMAC Code (FCA-FCB-FCC-FCD)	Fault Description
t1	1011	Over-current shut-down
t2	1011	Motor over-temperature
t3	1011	Power amplifier over-temperature
o	1101	Power amplifier over-voltage
u	1110	Power amplifier under-voltage
≡		Watch dog
P1	1001	Drive over-current
P	1001	Power amplifier over-current
F	1100	PWM fault frequency
A1	1010	+12V under-voltage
A2	1010	-12V under-voltage
A3	1010	+5V under-voltage
A4	1010	Reference under-voltage

The following provides a description of some of the more important faults that may be detected by the SP3:

Motor Over-temperature: The Motor's External Thermostat input is monitored for an open circuit condition.

Drive Over-temperature: The internal heat sink temperature is monitored for an unsafe condition. The fault may be reset only after the drive cools.

Bus Over-voltage: This fault may occur during a regen operation where the BUS is raised to higher values than that produced by the power supply.

Bus Under-voltage: This fault may occur if the incoming line voltage droops or if a problem occurs in the power supply.

Power Stage Fault (Over-current): Hardware circuitry monitors load short-circuit, transistor failure, and instantaneous over-current. A power stage fault cannot be reset by toggling the enable line, but only by cycling the power.

Feedback Loss: Hardware detects a wire-break condition in encoder-based systems.

Power Supply Under-voltage: Hardware monitors the analog ± 12 VDC supply for out of tolerance voltages.

WATCHDOG

In order to prevent the Watchdog fault from being triggered, the following power up sequence must be used:

1. Power up the PMAC2 controller
2. Connect the SP3 to the PMAC2 controller
3. Turn the 24 VDC power on (for units that are supplied with separate 24V logic power)
4. Turn the AC power on.

F FAULT (MAXIMUM PWM FREQUENCY)

In order to prevent the Frequency Fault, the PMAC2 I900 parameter should be set such that the PWM frequency does not exceed 15.5kHz.

FAULT CODE TRANSMISSION

The SP3 transmits FC_A, FC_B, FC_C and FC_D fault code bits to the PMAC2 controller via lines CHU+, CHV+, CHW+ and CHT+ on connector C3. The following table shows the fault codes and fault description.

Display	PMAC Code (FCA-FCB-FCC-FCD)	Fault Description
t1	1011	Over-current shut-down
t2	1011	Motor over-temperature
t3	1011	Power amplifier over-temperature
o	1101	Power amplifier over-voltage
u	1110	Power amplifier under-voltage
≡		Watch dog
P1	1001	Drive over-current
P	1001	Power amplifier over-current
F	1100	PWM fault frequency
A1	1010	+12V under-voltage
A2	1010	-12V under-voltage
A3	1010	+5V under-voltage
A4	1010	Reference under-voltage

DIP switches 9 and 10 determine the signals transmitted to the PMAC2 on CHU+, CHV+, CHW+ and CHT+. These signal lines can carry either the Hall Effect sensor values or fault codes. CHU+, CHV+, CHW+, and CHT+ correspond to FC_A, FC_B, FC_C, and FC_D when faults are annunciated through the signal lines. The settings are shown in the following table.

Switch 9	Switch 10	Status	CHU+	CHV+	CHW+	CHT+
Open	Open		Hall A	Hall B	Hall C	Motor Over Temp
Closed	Closed		FC_A	FC_B	FC_C	FC_D
Open	Closed	No Faults	Hall A	Hall B	Hall C	Motor Over Temp
		Faults	FC_A	FC_B	FC_C	FC_D
Closed	Open	Not Used				

OVER-CURRENT SHUT-DOWN

DIP switches 1 and 4 enable or disable the over-current shut-down (fault display “t1”). The SP3 does not generate the current command, so the SP3 has no way of limiting the current besides a full shut-down. An over-current fault is generated if peak current is drawn for 1 second, or if 2/3 peak current is drawn for 2 seconds.

Switch 1	Switch 4	Description
Open	Open	Disabled
Closed	Closed	Enabled (factory default)
Open	Closed	Enabled
Closed	Open	Enabled

CURRENT SCALING

The SP3 measures the current of the drive and makes the value available to the user via a ±10-volt signal. The currents measured from the power board of the drive are IAA and ICC , but those signals are not available to the user. The voltage is scaled such that 10 Volts is equivalent to 125% of the peak current. The peak current value is based on the SP3 model, and the voltage is scaled accordingly, as shown below.

SP Model	Continuous Current (Amps RMS)	Peak Current (Amps RMS)	Value at 10V (Amps RMS)
CP3 03 xx	3	9	11.25
CP3 06 xx	6	18	22.5
CP3 10 xx	10	20	25.0

CUSTOMER SUPPORT

Danaher Motion is committed to quality customer service. Our goal is to provide the customer with information and resources as soon as they are needed. In order to serve in the most effective way, contact your local sales representative for order status and delivery information, product information and literature, and application and field technical assistance. If you are unaware of your local sales representative, please contact us at:

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