KOLLMORGEN

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SERVO**STAR**® S- and CD-Series Electromagnetic Compatibility

This document has been prepared to provide guidance for installing Danaher Motion's Kollmorgen SERVO**STAR**® S and SERVO**STAR**® CD servo drives and systems. The installation of the equipment is critical in designing for system and machine Electromagnetic Compatibility (EMC). Pay particular attention to filtering, wiring, cable screening, grounding, and bonding.

The EMC of a system can be identifyed in two parts: emissions and immunity. Emissions refers to the generation of electromagnetic interference (EMI) and immunity refers to the susceptability levels of the equipment. The SERVO**STAR** S- and SERVO**STAR** CD-series of drives and power supplies have been tested for both emissions and immunity. The equipment has been evaluated per EMC directive 89/336/EEC and harmonized standards. Limits were derived from generic standards EN55081-2 and EN55082-2 for heavy industrial environment. The SERVO**STAR** series of drives and power supplies have been tested for radiated emissions, conducted emissions, EFT, ESD, surge, conducted immunity, and radiated immunity. These tests have been done in accordance with EN55011, EN61000-4-2, ENV50140, IEC 1000-4-4, EN61000-4-5, and ENV50141.

Installation and Mounting

Danaher Motion's Kollmorgen SERVO**STAR**-series of electronic system components are designed for panel assembly and mounted in a metallic enclosure. Enclosures are supplied by the manufacturers of the final product. To optimize EMC, the enclosure must have continuous ground continuity maintained between all metal panels. This ground continuity is intended to be both safety ground and high frequency ground. The units must be mounted on a backplane installed in the enclosure. Ideally, the backplane is an unpainted metallic surface. The unpainted surface allows more surface area to be in contact with the filters, allowing for a lower impedance path between the filters and the backplane. The back panel must have a high frequency ground strap connection to the enclosure frame and earth ground.

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Power Supply Filtering

One method of reducing conducted noise is to use EMI filters in the input power leads. These filters block conducted emissions from exiting onto the power lines and also provide a barrier for EMI that may be present on the power lines that may affect the equipment. Size these filters for the voltage and current rating of the system. A single input line filter is used for multi-axis control. These filters are mounted as close to the incoming power as possible so noise is not capacitively coupled into other signal leads and cables. Similar care should be taken when routing wires from the load side of the filter to the power supply. These lines may be noisy and should be separated from other sensitive cabling to avoid unwanted coupling of noise. These filters are either single- or 3-phase, depending on the input power. Some manufacturers of these filters are: Corcom, Delta, Eichhoff, Schaffner, and Tokin. Most manufactures are able to recommend the best filter design for motor control application. In this document, Danaher Motion has provided specific filters that adequately attenuate the conducted noise to levels well below the appropriate CE limits.

The SERVO**STAR** electronic system components require EMI filters in the input power leads to meet the conducted emission requirements for the industrial environment. The implementation of the EMI filter should be done in accordance with the following guidelines:

- Filter must be mounted on the same panel as the motor drive and power supply.
- Filter must be mounted as close as possible to incoming cabinet power.
- Filter must be mounted as close as possible to power supply. If separation exceeds 30cm (1 ft.), flat cable (braid) may be used for the high frequency connection between filter and power supply.
- When mounting the filter to the panel, paint or other covering material should be removed before mounting the filter. Use an unpainted metallic back panel, if possible.
- Filters are provided with an earth connection. All ground connections must be tied to ground.
- Filter can produce high leakage currents. Filters must be grounded before connecting the supply!
- Wait 10 seconds after removal of the supply before touching the filter!

Power Supply Model Number	Recommended EMI Line Filter	Kollmorgen Part Number
PA08 (Single phase)	Filter Concepts SF10	
PA08 (3 phase)	Schaffner FN258-30/07	A-96776-003
PA28	Schaffner FN258-30/07	A-96776-003
PA50	Schaffner FN258-55/07	A-96776-005
PA75	Schaffner FN258-75/34	A-96777-001
PA85	Schaffner FN258-100/35	A-96777-002
PALM	Corcom F7202A	A-97181
PA14 (single phase)	Filter Concepts SF15	
PA14 (3 phase)	Schaffner FN258-30/07	A-96776-003
Cx03 (single phase)	Filter Concepts SF7	
(3 phase)	Schaffner FN258-7/07	A-96776-001
Cx06 (single phase)	Filter Concepts SF15	
(3 phase)	Schaffner FN258-16/07	A-96776-002
Cx10 (3 phase)	Schaffner FN258-16/07	A-96776-002

The filters called out in the table above are used on a one-to-one correspondence with the drive. If drives are paralled off one filter, it needs to be sized. Drives can be ganged off one EMI filter as shown in Figure 7.

Motor Line Filtering

Motor filtering may not be necessary for CE compliance on the SERVO**STAR** systems, although this additional filtering may increase the reliability of the system. This filtering can be in the form of differential mode or common mode. The common mode currents exist on all lines feeding the motor (with respect to ground) and the differential mode currents exist from line to line. The filtering of the lines feeding the motor provide additional attenuation of noise currents that can enter surrounding cables and I/O ports of equipment in close proximity. Lengthy motor cables require filtering.

While every final system is different and every application of the product causes a slightly different emission profile, it may be necessary to provide additional noise attenuation for the purpose of radiated emissions. Differential mode currents (due to line-to-line capacitance of the cable) are attenuated with the use of differential mode chokes. The use of a ferrite on each motor lead placed at the drive end attenuates noise levels to within the appropriate specification. The use of ferrite cores (one in each motor lead) reduces differential mode noise currents and lower frequency (30-60 MHz) broadband emissions. Fair-Rite P/N 263665702 or equivalent can be used as the ferrite core.

Chokes

Another method of filtering is the use of common mode chokes. The use of a ferrite or iron powder core toroid places common mode impedance in the line between the motor and the drive. Noise spikes as a result of the PWM switching frequency is reduced with the use of common mode chokes. The use of a common mode choke on the motor leads increase signal integrity of encoder outputs and associated input and output signals. The following is a list of toroidal cores that can be used to make common mode chokes.

Manufacturer	Manufacturer's 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 .6 in (15.2mm) HT .475 in (12.1mm)
Micrometals	ST150-275B	OD 1.52 in (38.6mm) ID ..835 in (21.2mm) HT .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 .555in (14.1mm) HT .472in (11.99mm)
Fair-Rite	2643803802	OD 2.4in (61mm) ID 1.4in (35.55mm) HT .5in (12.7mm)

The following is a list of pre-wound common-mode chokes available from Danaher Motion or Schaffner.

Manufacturer Part#	DanaherMotion 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.

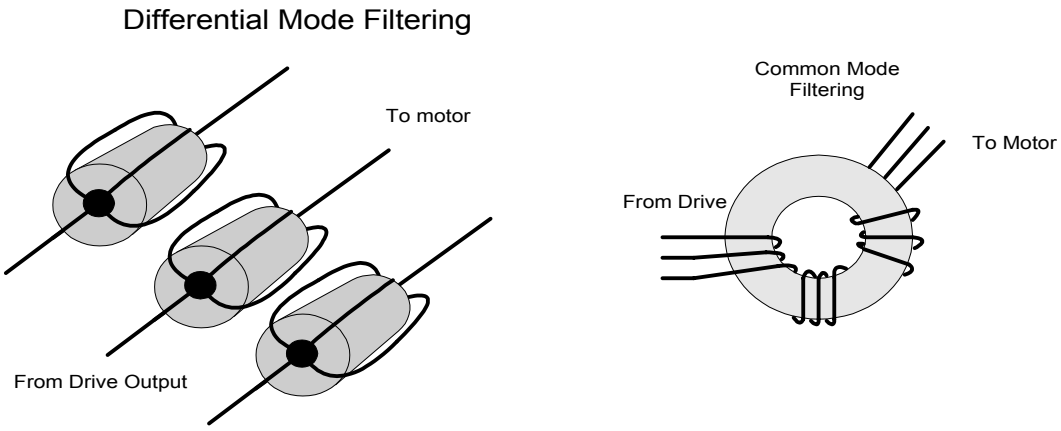

Figure 1

Grounding and Bonding

System grounding is essential for proper performance from the drive system. A ground bus bar is used as a single point ground for the system. Safety grounding must be provided to all pieces of equipment from a **STAR** point. In addition to the safety grounding, a high frequency ground must be provided to connect the back panel to the enclosure and ultimately to earth ground. The objective is to provide an extremely low impedance path between the filters, drives, power supplies, and earth ground. This high frequency ground is accomplished with the use of a flat braid or copper bus bar. It is important not to rely on a standard wire for the high frequency ground. In general, a wire has an inductance of 8 nH/in regardless of diameter. At higher frequencies, this unwanted inductance between grounds equates to limited filter performance. When connecting high frequency grounds, use as short a braid as possible.

Bonding of shielded cables is *imperative* for compliance. The motor cables must have the shield exposed as close to the drive as possible. This exposed shield is bonded to the back panel using Phoenix components (Figure 2) or an uninsulated metal cable clamp. Bonding reduces the impedance between the cable shield and the back panel. Feedback cables are also bonded to the back panel. It is recommended that all shielded cables be bonded to the back panel. Proper bonding reduces emissions from the system and increases immunity levels of the system. Power input wiring does not need to be shielded (screened) if the power is fed to the cabinet (enclosure) via metallized conduit. If the metallized conduit is used with proper high frequency grounds, bonding technology and recommended wire routing, power wire shielding has no effect. If metallized conduit is not used in the system, shielded cable is required on the power input wires and proper bonding technologies must be implemented.

Figure 2 displays examples of cable bonding close to the drive (both the S and CD drives) using a non-insulated metallic cable clamp and cable bonding when the use of a terminal strip is implemented.

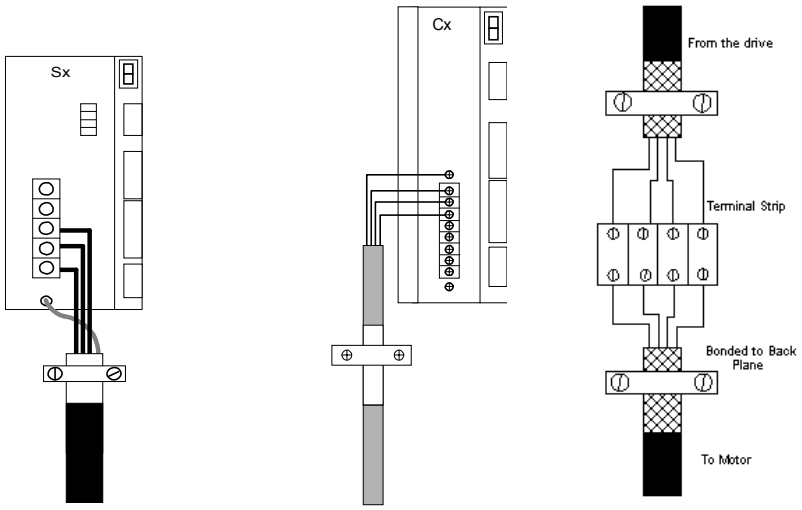

Figure 2

Avoid the terminal strip, if possible. It is best to have no breaks in the armor (shielding) of the cable.

Phoenix Contact Parts

When using Phoenix contact parts for cable bonding, 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 Pheonix (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 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 inches
3025176 TypeSK14	Shielded terminal block - for placing the shield on bus bars.	SK14 8mm to 14mm or 0.551 inches
3025189 Type SK20	Shielded terminal block - for placing the shield on bus bars.	SK20 14mm to 20mm or 0.787 inches
0404428 Type AB/SS	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

Figure 3 represents a side view of the SK device that clamps down on the shield of the cable.

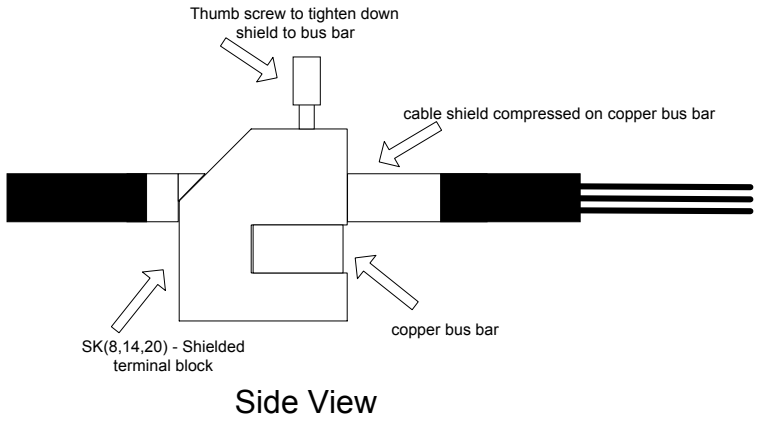

Figure 3

The use of the Phoenix SK device provides a low impedance path between cable shield and the back panel. Figure 4 and Figure 5 are top views of two (2) cables being clamped using the Phoenix contact devices.

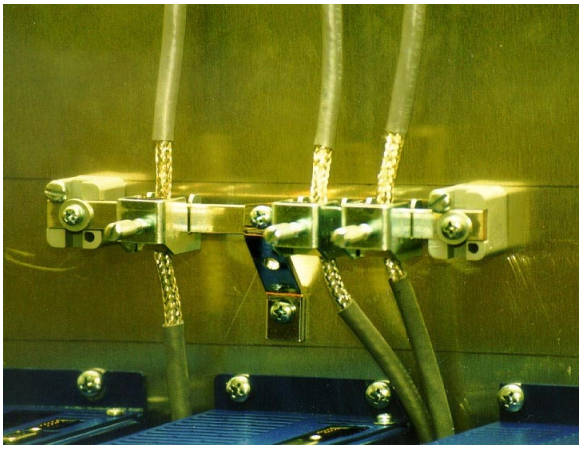

Figure 4

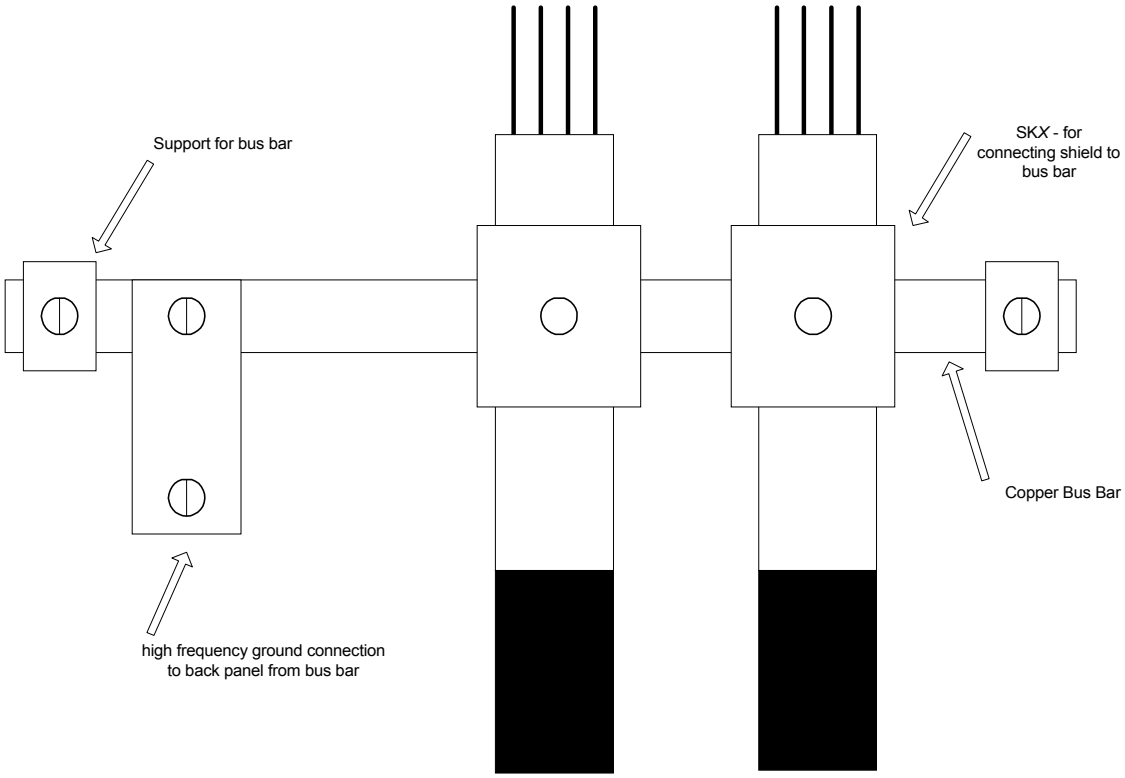

Figure 5

The cable shields are clamped to the bus bar and the bus bar has a high frequency strap connecting it to the back panel. This connection is imperative.

Wiring Practices

Exercise care when designing the layout of an enclosure. Separate power wires from small signal wires. The following guidelines highlight some important wiring practices:

- Control and signal cables must be separated from power and motor cables. A distance of 20 cm (8 in) is sufficient in most cases.
- Control and signal cables must be shielded to reduce the effects of radiated interference.
- Where control cables must cross power or motor cables, they should cross a 90° angle, if possible. This reduces the coupling effect.

Additional I/O Filtering

I/O filtering (not a necessity for CE compliance) 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 an in line common mode impedance for I/O lines.

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

The following illustrates the use of multiple turns through a clamp on core.

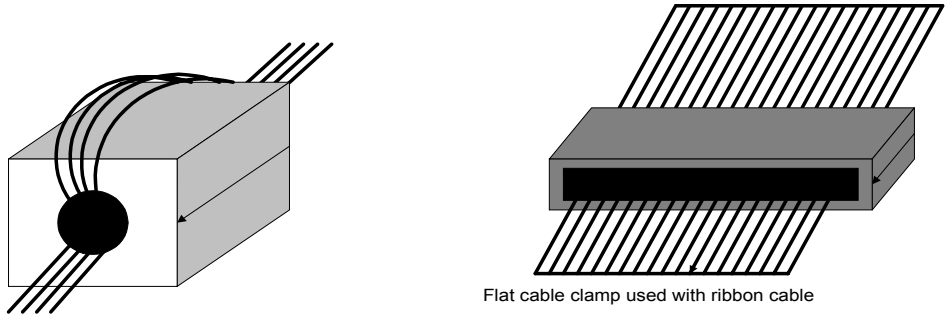

Figure 6

The more turns that are put through, the more impedance is added to the line. Avoid putting the shield in the clamp on the 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 (Figure 6). The Fair-Rite Products Corporation has a varied selection suitable for most applications.

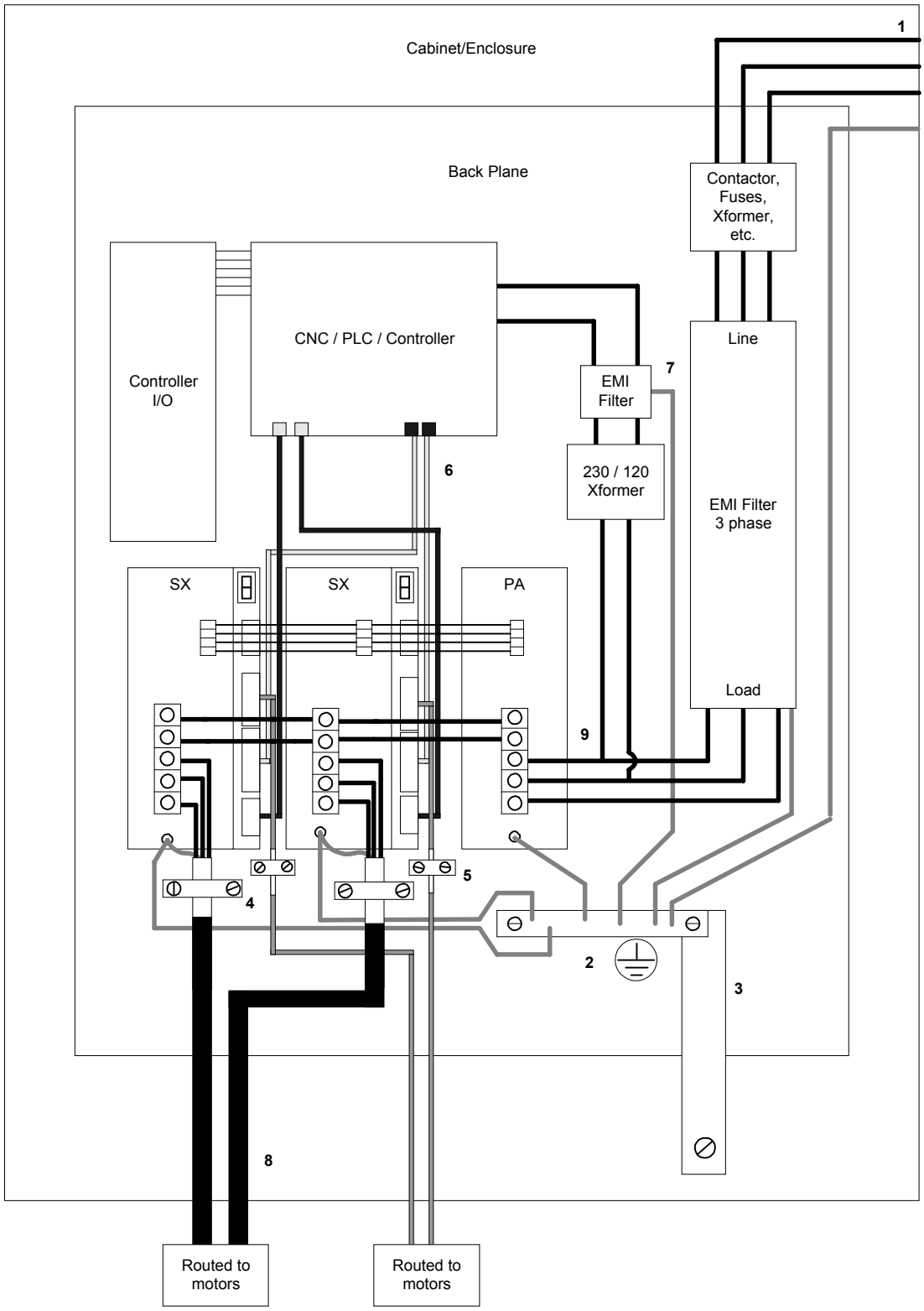
Cabinet/Enclosure
1
Back Plane
Contactor,
Fuses,
Xformer,
etc.
Controller
I/O
CNC / PLC / Controller
Line
EMI
Filter
7
6
230 / 120
Xformer
EMI Filter
3 phase
SX
SX
PA
Load
9
5
4
2
3
8
Routed to
motors
Routed to
motors

Figure 7

Figure 7 Notes

1. Input power - Enters enclosure from metal conduit. This bars the need for shielded input power cable.
2. Single-point ground. A bus bar (ground bus) is an excellent way to achieve this.
3. High frequency ground between non conductive back panel and enclosure. A high frequency ground is required between the enclosure and earth ground also.
4. Bonding of the motor cables. The use of armored (screened) motor cables that are bonded as close to the drive as possible is essential for CE compliance and strongly recommended to better the overall performance and reliability of the system.
5. Screened and bonded feedback cabling is recommended for increased immunity and lower risk of radiation. Since the motor cable and feedback cable are in close proximity at the motor this feedback cable bonding is necessary. Also, separate the feedback and motor cables as much as possible. This decreases the chances of the feedback signals getting corrupted.
6. Control signals (I/O) should be kept separate from all power and motor cables. Keep all control wiring as short as possible and use screened wire. Separation distance of 20cm (8in) should be sufficient in most cases. Where control cables must cross power cables, they should cross with an angle of 90 degrees.
7. Connect safety grounds to filters. This is critical to keep ground currents from causing personal injury.
8. When motor cables exit enclosure, keep in separate wireway or conduit from feedback and other control wiring. Separation distance of 20cm (8in) should be sufficient.
9. Input power wires should be kept clear of I/O and signal wires.

Figure 8 shows a typical system configuration utilizing good grounding/bonding and filtering methods.

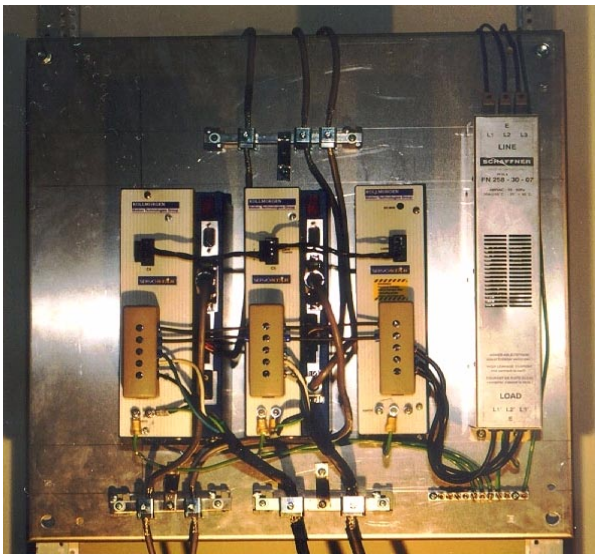

Figure 8

Manufacturers

Schaffner

Schaffner Electronik AG
Nordstrasse 11
CH-4708 Luterbach
Switzerland
Phone 065 802 626
Fax 065 802641

North America
Schaffner EMC Inc.
9-B Fadem Road
Springfield, NJ 07081
Phone 201 379-7778
Fax 201 379-1151

Corcom

World Headquarters
844 E. Rockland Road
Livertyville, Il 60048
Phone 708 680-7400
Fax 708 680-8169

East Coast Sales Office
17 Sarah's Way
Fairhaven, MA 02719
Phone 508 992-4495
Fax 508 992-3798

West Coast Sales Office
6700 Fallbrook Ave.
Suite 160
West Hills, CA 91307
Phone 818 226-4306
Fax 818 704-1757

Fair-Rite

Fair-Rite Products Corp.
P.O. Box J
One Commercial Row
Wallkill, NY 12589
Phone 914 895-2055
Fax 914 8985-2629
E-Mail ferrites@fair-rite.com

FerriShield

FerriShield Interference Control Components
Empire State Building
350 Fifth Ave., Suite 7505
New York, NY 10118-7591
Phone 212 268-4020
Fax 212 268-4023

Micrometals

Micrometals, Iron Powder Cores
5615 E. La Palma
Anaheim, CA 92807
Phone 800 356-5977
Fax 714 970-0400
Worldwide 714 970-9400

Filter Concepts

Filter Concepts Inc.
2624 South Rouselle Street
Santa Ana, CA 92707 USA
Phone 714 545-7003
Fax 714 545-4607

Magnetics

Magnetics
P.O. Box 391
Butler, PA 16003-0391
Phone 412 282-8282
800 245-3984
Fax 412 282-6955

Phoenix

Pheonix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111-0100
Phone 800 888-7388
Fax 717 948-3475