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Epsilon Ei Indexing Drive Installation Manual



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Rev. A1
Date: April 3, 2000
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This document has been prepared to conform to the current released version of the hardware and software system. Because of our extensive development efforts and our desire to further improve and enhance the product, inconsistencies may exist between the product and documentation in some instances. Call your customer support representative if you encounter an inconsistency.

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When you call, please be at your computer, have your documentation in hand, and be prepared to provide the following information:

- Product version number, found by choosing About from the **Help** menu.
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- Exact wording of any messages that appear on your screen.
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Document Conventions

Manual conventions have been established to help you learn to use this manual quickly and easily. As much as possible, these conventions correspond to those found in other Microsoft Windows documentation.

Menu names and options are printed in bold type: the **File** menu.

Dialog box names begin with uppercase letters: the Axis Limits dialog box.

Dialog box field names are in quotes: "Field Name".

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Button names are in italic: *OK* button.

Source code is printed in Courier font: `Case ERMS`.

In addition, you will find the following typographic conventions throughout this manual.

This	Represents
bold	Characters that you must type exactly as they appear. For example, if you are directed to type **a:setup**, you should type all the bold characters exactly as they are printed.
italic	Place holders for information you must provide. For example, if you are directed to type *filename*, you should type the actual name for a file instead of the word shown in italic type.
ALL CAPITALS	Directory names, file names, key names, and acronyms.
SMALL CAPS	Non-printable ASCII control characters.
KEY1+KEY2 example: (Alt+F)	A plus sign (+) between key names means to press and hold down the first key while you press the second key.
KEY1,KEY2 example: (Alt,F)	A comma (,) between key names means to press and release the keys one after the other.

Safety Instructions

General Warning

Failure to follow safe installation guidelines can cause death or serious injury. The voltages used in the product can cause severe electric shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to it. The installation must comply with all relevant safety legislation in the country of use.

Qualified Person

For the purpose of this manual and product, a “qualified person” is one who is familiar with the installation, construction and operation of the equipment and the hazards

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involved. In addition, this individual has the following qualifications:

- Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Is trained in the proper care and use of protective equipment in accordance with established safety practices.
- Is trained in rendering first aid.



Warning

For the purpose of this manual and product, "Warning" indicates death, severe personal injury or substantial damage CAN result if proper precautions are not taken.



Caution

For the purpose of this manual and product, "Caution" indicates minor personal injury or property damage CAN result if proper precautions are not taken.



Note

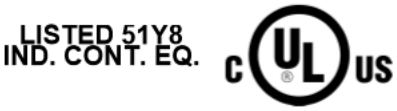
For the purpose of this manual and product, "Note" indicates information about the product or the respective part of the manual which is essential to highlight.

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Underwriters Laboratories Listed



The Epsilon Digital Servo Drives are marked with the "UL Listed" label after passing a rigorous set of design and testing criteria developed by UL (UL508C). This label indicates that UL certifies this product to be safe when installed according to the installation guidelines and used within the product specifications.

The "conditions of acceptability" required by UL are:

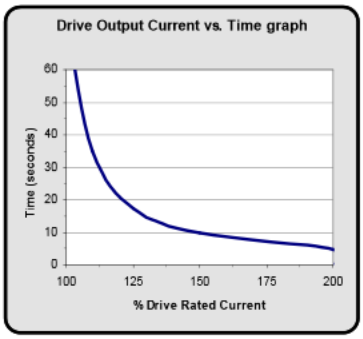
- The Epsilon drive surrounding air ambient temperature must be 40° C (104° F) or less for full rated output and up to 50° C (122° F) with output current derated to 3% for every degree above 40° C (104° F).
- This product is suitable for use on a circuit of delivering not more than 5000 RMS symmetrical amperes, 240 volts maximum.
- Motors must incorporate an overload protection device such as an overtemperature switch.

Drive overload protection

The Epsilon drive output current overload protection is provided by the drive and is not adjustable. This overload protection is based on maximum output current capacity. It will allow up to 200 percent of the drive rated current to be delivered for the amount of time determined by the following chart.

Rated output current(Amps RMS)		
Drive Model	**Continuous**	**Peak**
Ei-202	1.8	3.6
Ei-203	3.0	6.0
Ei-205	5.0	10.0

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CE Declaration of Conformity

CE

The Epsilon Digital Servo Drives are marked with the "Conformite Europeenne Mark" (CE mark) after passing a rigorous set of design and testing criteria. This label indicates that this product meets safety and noise immunity and emissions (EMC) standards when installed according to the installation guidelines and used within the product specifications.

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Declaration of Conformity

Manufacturer's Name:	EMERSON Motion Control
Manufacturer's Address:	1365 Park Road Chanhassen, MN 55317 USA

Declares that the following products:

Products Description:	Epsilon Series Digital Servo Drive
Model Number:	Eb-202, Ei-202, Eb-203, Ei-203, Eb-205 and Ei-205
System Options:	This declaration covers the above products with the ECI-44 Screw Terminal Interface.

Conforms to the following product specification:

Electromagnetic Compatibility (EMC):

EN 55011/1991 Class A Group 1, CISPR 11/1990 Class A Group 1

EN 61800-3, 1996:	IEC 1000-4-2/1995: EN 61000-4-2, 6kV CD IEC 1000-4-3/1995: EN 61000-4-3, ENV 50140/1993, 80% AM, 10V/m @ 3 m IEC 1000-4-4/1995: EN 61000-4-4, 2 kV ALL LINES EN 61000-4-5, 1kV L-L, 2kV L-G EN 61000-4-11, 300 ms/1000 ms 100% DIP ENV 50204/1995, Pulse, 900 MHz, 50% DTY, 200 Hz

Supplementary information:

The products herewith comply with the requirements of the Low Voltage Directive (LVD) 73/23/EEC and EMC Directive 89/336/EEC

This electronic drive product is intended to be used with an appropriate motor, electrical protection components and other equipment to form a complete end product or system. It must only be installed by a professional assembler who is familiar with requirements for safety and electromagnetic compatibility ("EMC"). The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used. Refer to the product manual for installation guidelines.



August 18, 1999

Bradley Schwartz/ VP Engineering — Date

European Contact:

Sobetra Automation
Langeveldpark Lot 10
P. Dasterleusstraat 2
1600 St. Pieters Leeuw, Belgium

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Introduction

Overview

The Epsilon drives are stand-alone, fully digital brushless servo drives designed and built to reliably provide high performance and flexibility without sacrificing ease of use.

The use of State-Space algorithms make tuning very simple and forgiving. The drives are designed to operate with up to a 10 :1 inertia mismatch right out of the box. Higher (50 :1 and more) inertial mismatches are possible with two simple parameter settings.

The drives can be quickly configured to many applications in less than 5 minutes with PowerTools software on a PC running Windows 95, 98 or NT 4.0.

Complete diagnostics are provided for quick troubleshooting. A diagnostic display on the front of the drive informs the user the operational or fault status. The last 10 faults are stored in non-volatile memory along with a time stamp for easy recall.

Epsilon drives operate at 42 to 264 VAC standalone or at 12 to 375 VDC with an A.P.S. (Alternate Power Supply) and are available in two power ratings. The drive will fit in a 6 inch deep enclosure with cables connected.

- Epsilon E(x)-202 – 650 Watts (1.8 amps cont, 3.6 amps peak)
- Epsilon E(x)-203 – 1100 Watts (3.0 amps cont, 6.0 amps peak)
- Epsilon E(x)-205 – 1750 Watts (5.0 amps cont, 10.0 amps peak)

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The MG and NT motors that are matched to the Epsilon drives provide low inertia, high power to size ratios, and encoder feedback for accurate positioning.

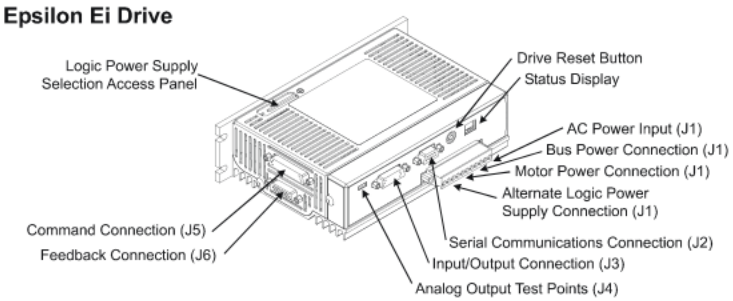


Figure 1: Epsilon Ei Drive Feature Location

Features

- Digital drive design using DSP, ASIC and surface mount technologies.
- Input power is rated at 42 to 264 VAC (10 to 264 VAC or 12 to 375 VDC when using an A.P.S.).
- Small mounting footprint.
- Alternative logic power supply option.
- Thirteen optically isolated inputs and seven optically isolated outputs.
- Built-in RS-232C to RS-485 converter for multi-drop applications.
- RS-232C/485 serial communications interface using industry standard Modbus® protocol up to 19.2 kbaud.

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- Diagnostic and operating mode status display.
- Extensive fault sensing and diagnostics, including storage and time stamping of the last ten faults.
- Maximum input response time is 500 µs for command and input functions.
- Peak torque up to three times continuous torque rating.
- Sinusoidal commutation for efficiency and smooth motion.
- Smooth velocity regulation.
- No potentiometers or selector switches.
- No tuning needed for no-load up to 10:1 inertia mismatch.
- High performance tuning based on inertia ratio, friction and response with PowerTools software (available separately).
- Four velocity presets.
- Removable connectors for easy installation.
- Scalable Encoder Output.
- Travel Limit Functions.
- Access to bus voltage for external shunt.
- Able to operate non-EMERSON motors with encoders.

How this Manual is Organized

This manual is divided into the following major sections:

Introduction

This section introduces you to the Epsilon Ei hardware and software features, requirements and operation.

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Safety Considerations

This section describes a number of safety precautions that need to be addressed in a system design.

Diagnostics and Troubleshooting

This section explains various diagnostic and troubleshooting aids.

Installation

This section describes the Epsilon Ei Indexing Drive hardware features including mounting, AC power wiring, I/O wiring and drive communications.

Options and Accessories

This section describes the various options and accessories for the Epsilon Ei drive.

Specifications

This section contains the specifications for the Epsilon Ei drive.

Reference Materials

The following related reference and installation manuals may be useful with your particuliar system.

- *Epsilon Ei Indexing Drive Installation Manual* (P/N 400501-04)
- *Epsilon and E Series Drives Reference Manual* (P/N 400501-01)
- *PowerTools Software User's Guide* (P/N 400503-01)
- *Epsilon and E Series Drive Parameters Reference Manual* (P/N 400504-01)

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Safety Considerations

Overview

This chapter describes the safety issues which need to be addressed in the system design when using this product. Specifically, it includes:

- Safety Precautions
- Enclosure Design
- Setting Up, Commissioning and Maintenance
- Safety of Machinery

Safety Precautions

This product is intended for professional incorporation into a complete system. If you install the product incorrectly, it may present a safety hazard. The product and system may use high voltages and currents, carries a high level of stored electrical energy, or is used to control mechanical equipment which can cause injury.

You should give close attention to the electrical installation and system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. Read and follow this safety information and the instruction manual carefully.

Enclosure

This product is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination. This product

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is designed for use in an environment classified as pollution degree 2 in accordance with IEC664-1. This means that only dry, non-conducting contamination is acceptable.

Setup, Commissioning and Maintenance

It is essential that you give careful consideration to changes to drive settings. Depending on the application, a change could have an impact on safety. You must take appropriate precautions against inadvertent changes or tampering. Restoring default parameters in certain applications may cause unpredictable or hazardous operation.

Safety of Machinery

Within the European Union all machinery in which this product is used must comply with Directive 89/392/EEC, Safety of Machinery.

The product has been designed and tested to a high standard, and failures are very unlikely. However the level of integrity offered by the product's control function – for example stop/start, forward/reverse and maximum speed – is not sufficient for use in safety-critical applications without additional independent channels of protection. All applications where malfunction could cause injury or loss of life must be subject to a risk assessment, and further protection provided where needed.



Warning

General warning
Failure to follow safe installation guidelines can cause death or serious injury. The voltages used in this unit can cause severe electric shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to this equipment. The installation must comply with all relevant safety legislation in the country of use.

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AC supply isolation device

The AC supply must be removed from the drive using an approved isolation device or disconnect before any servicing work is performed, other than adjustments to the settings or parameters specified in the manual. The drive contains capacitors which remain charged to a potentially lethal voltage after the supply has been removed. Allow at least 6 minutes for Epsilon 205, 3 minutes for Epsilon 202/203 and 30 seconds for E Series drives after removing the supply before carrying out any work which may involve contact with electrical connections to the drive.

Products connected by plug and socket

A special hazard may exist where the drive is incorporated into a product which is connected to the AC supply by a plug and socket. When unplugged, the pins of the plug may be connected to the drive input, which is only separated from the charge stored in the bus capacitor by semiconductor devices. To avoid any possibility of electric shock from the pins, if they are accessible, a means must be provided for automatically disconnecting the plug from the drive (e.g., a latching contactor).

Grounding (Earthing, equipotential bonding)

The drive must be grounded by a conductor sufficient to carry all possible fault current in the event of a fault. The ground connections shown in the manual must be followed.

Fuses

Fuses or over-current protection must be provided at the input in accordance with the instructions in the manual.

Isolation of control circuits

The installer must ensure that the external control circuits are isolated from human contact by at least one layer of insulation rated for use at the applied AC supply voltage.

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Installation

Overview

This chapter describes how to install the drive, motor and cables. Specifically, it includes:

- Basic Installation Notes
- Mechanical Installation
- Electrical Installation
- Serial Communications

Basic Installation Notes

You are required to follow all safety precautions during start-up such as providing proper equipment grounding, correctly fused power and an effective Emergency Stop circuit which can immediately remove power in the case of a malfunction. See the "Safety Considerations" section for more information.

Electromagnetic Compatibility (EMC)

Drives are designed to meet the requirements of EMC. Under extreme conditions an drive might cause or suffer from disturbances due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the drive is incorporated complies with the relevant EMC legislation in the country of use.

The following instructions provide you with installation guidance designed to help you meet the requirements of the EMC Directive 89/336/EEC.

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Adhering to the following guidelines will greatly improve the electromagnetic compatibility of your system, however, final responsibility for EMC compliance rests with the machine builder, and EMERSON Motion Control cannot guarantee your system will meet tested emission or immunity requirements.

If you need to meet EMC compliance requirements, EMI/RFI line filters must be used to control conducted and radiated emissions as well as improve conducted immunity.

Physical location of these filters is very important in achieving these benefits. The filter output wires should be kept as short as possible (12 inches is suggested) and routed away from the filter input wires.

- Choose an enclosure made of a conductive material such as steel, aluminum or stainless steel.
- Devices mounted to the enclosure mounting plate, which depend on their mounting surfaces for grounding, must have the paint removed from their mounting surfaces and the mating area on the mounting plate to ensure a good ground. See the, "Achieving Low Impedance Connections" section for more information.
- If grounding is required for cable grommets, connectors and/or conduit fittings at locations where cables are mounted through the enclosure wall, paint must be removed from the enclosure surface at the contact points.
- AC line filter input and output wires and cables should be shielded, and all shields must be grounded to the enclosure.

Achieving Low Impedance Connections

Noise immunity can be improved and emissions reduced by making sure that all the components have a low impedance connection to the same ground point. A low impedance connection is one that conducts high frequency current with

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very little resistance. Impedance cannot be accurately measured with a standard ohmmeter, because an ohmmeter measures DC resistance. For example, a 12 inch long 8 gauge round wire has a significatly higher impedance than a 12 inch long 12 gauge flat braided conductor. A short wire has less impedance than a larger one.

Low impedance connections can be achieved by bringing large areas of conductive surfaces into direct contact with each other. In most cases this requires paint removal because a ground connection through bolt threads is not sufficient. However, component materials should be conductive, compatible and exhibit good atmospheric corrosion resistance to prevent loss through corrosionwhich will hinder the low impedance connection. Enclosure manufacturers offer corrosion resistant, unpainted mounting plates to help.

Bringing components into direct contact cannot always be achieved. In these situations a conductor must be relied upon to provide a low impedance path between components. Remember a flat braided wire has lower impedance than a round wire of a large guage rating.

A low impedance connection should exist between the following components, but not limited to:

- Enclosure and mounting plate
- Servo amplifier chassis and mounting plate
- EMI/RFI AC line filter chassis and mounting plate
- Other interface equipment chassis and mounting plate
- Other interface equipment chassis and electrical connectors
- Enclosure and conduit fittings or electrical connectors
- Enclosure mounting plate and earth ground
- Motor frame and conduit fittings or electrical connectors

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- Encoder chassis and electrical connector

A good rule to follow when specifying conductors for high frequency applications is to use a metal strap with a length to width ratio that is less than 3:1.

AC Line Filters

The AC line filters used during EMERSON Motion Control's compliance testing are listed below. These filters are capable of supplying the drive input power to the specified drive under maximum output power conditions.

Epsilon	Schaffner Part #	EMERSON Part #	Rating
Ei-202, Ei-203*	FN2070-10/08	960307-01	10A, 240V, 1 Ø
	FS5278-16/08	960305-01	16A, 240V, 1 Ø
Ei-205	FS5278-16/08	960305-01	
	FN-258/16	960304-01	16A, 480V, 3 Ø

Alternately, EMERSON Motion Control has also seen good results with the following line filters:

Drive	Part #	Rating
Ei-202, Ei-203, Ei-205	**Corcom** 20EQ1	20A, 240V, 1 Ø
Ei-202	Schaffner FN 2070-6-06	6A, 240V, 1 Ø

AC Line Filter Installation Notes

- It is critical that you keep the filter inputs routed away from any electrical noise sources or shield them to prevent noise from being induced into them and carried out of the enclosure.
- EMC criteria can be met in installations where multiple drives are supplied through a single filter, however, it is the installers responsibility to verify EMC compliance.

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- The filter characteristics of most three phase line filters will suffer if the phase to phase loading is unbalanced.

Cable to Enclosure Shielding

Shielded motor, feedback, serial communications and external encoder cables were used for EMERSON Motion Control's compliance testing and are necessary to meet the EMC requirements. Each cable shield was grounded at the enclosure wall by the type of grommet described earlier and shown in the figure below.

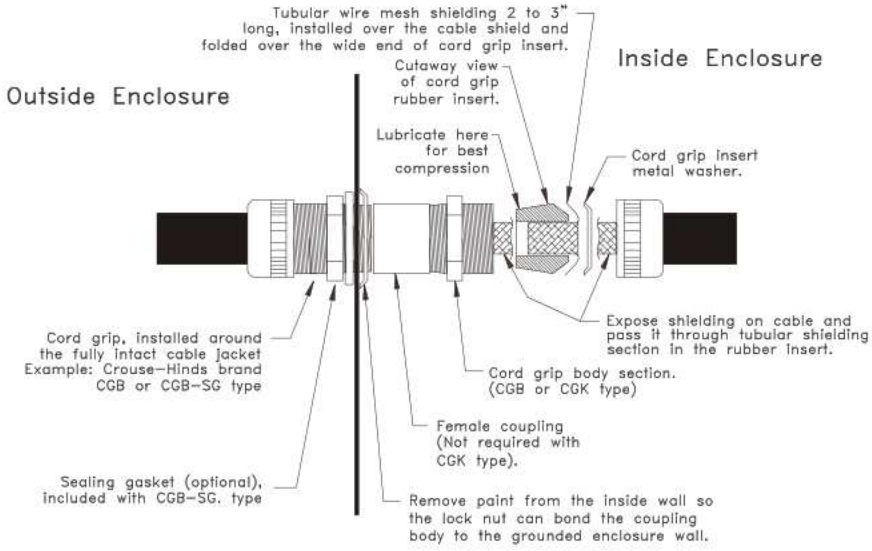


Figure 2: Through Wall Shield Grommet

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Cable Type	EMERSON Cable Model	Shielded Cable Grommet Kit Part #	Conduit Dimension Hole Size	Actual Hole Size
Motor Cable, 16 Ga	CMDS	CGS-050	1/2" pipe	7/8"
Motor Cable, 12 Ga	CMMS	CGS-050	1/2" pipe	7/8"
Feedback Cable	CFOS	CGS-050	1/2" pipe	7/8"
Flex Motor Cable, 16 Ga	CMDF	CGS-050	1/2" pipe	7/8"
Flex Motor Cable, 12 Ga	CMMF	CGS-075	3/4" pipe	1 1/16"
Flex Feedback Cable	CFCF, CFOF	CGS-063	3/4" pipe	1 1/16"
External Encoder	ENCO	CGS-038	1/2" pipe	7/8"
AC Power	user supplied	user supplied		

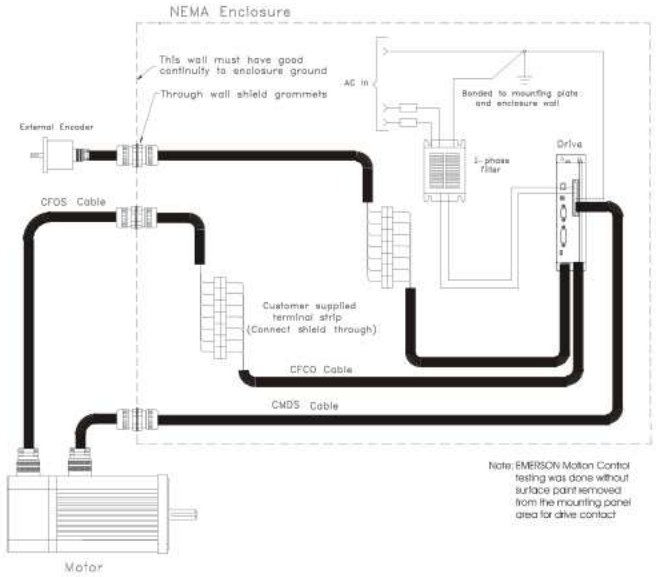


Figure 3: AC Filter and Cable Connections

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Environmental Considerations

If the installation environment contains atmospheric contaminants such as moisture, oils, conductive dust, chemical contaminants and metallic particles, you must protect the drive from these by mounting it in a protective enclosure typically rated NEMA 12.

If the ambient temperature inside the enclosure will exceed 40° C (104° F), you may require forced air cooling depending on the RMS loading.



Note

For Epsilon drives, surrounding air ambient temperature can be up to 50°C (122° F) with 3% linear derating for every degree above 40° C (104° F)

The amount of cooling depends on the size of the enclosure, the thermal transfer of the enclosure to the ambient air and the amount of power being dissipated inside the enclosure. Consult your enclosure manufacturer for assistance with determining cooling requirements.

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Wiring Notes

- To avoid problems associated with EMI (electromagnetic interference), you should route high power lines (AC input power and motor power) away from low power lines (encoder feedback, serial communications, etc.).
- If a neutral wire (not the same as Earth Ground) is supplied from the building distribution panel, it should never be bonded with PE wire in the enclosure.
- You should consider future troubleshooting and repair when installing all wiring. All wiring should be either color coded and/or tagged with industrial wire tabs.
- As a general rule, the minimum cable bend radius is ten times the cable outer diameter.
- All wiring and cables, stationary and moving, must be protected from abrasion.
- Ground wires should not be shared or "daisy-chained" with other equipment.
- Ensure that full metal to metal surface contact is made between the enclosure ground lug and the metal enclosure, not simply through the mounting bolt and threads.
- All inductive coils must be suppressed with appropriate devices, such as diodes or resistor/capacitor (RC) networks.

Mechanical Installation

Drive Mounting

Drives must be back mounted vertically on a metal surface such as a NEMA enclosure. A minimum spacing of two inches must be maintained above and below the drive for ventilation.

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Side by side drive spacing requirements vary by drive size and RMS loading. Additional space may be necessary for wiring and cable connections.

For drive dimensions, weights and mounting specifications, see the "Specifications" section.

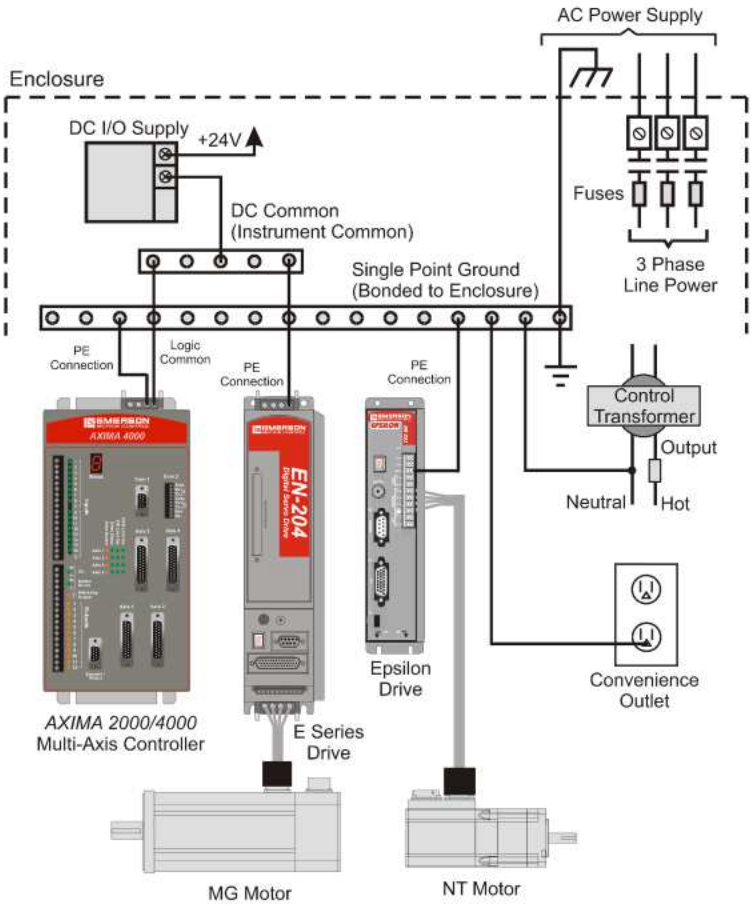
Motor Mounting

Motors should be mounted firmly to a metal mounting surface to ensure maximum heat transfer for maximum power output and to provide a good ground.

For motor dimensions, weights and mounting specifications, see the "Specifications" section.

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Electrical Installation



Note: The aluminum heatsink is electrically connected to the PE terminal.

Figure 4: Typical System Grounding Diagram

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Power Supply Requirements

The examples below show AC power connections for single phase and three phase drives. These examples are shown for reference only. Local electrical codes should be consulted before installation.

Warning

The Protective Earth (PE) wire connection is mandatory for human safety and proper operation. This connection must not be fused or interrupted by any means. Failure to follow proper PE wiring can cause death or serious injury.

The Ei-202, Ei-203 and Ei-205 drives require 42 to 264 VAC single phase power or 60 to 375 VDC power or may operate as low as 9 VAC or 12 VDC if using an A.P.S. Logic Supply input. An Epsilon drive can be connected to any pair of power phases on a 1 Ø or 3 Ø power source that is grounded as shown in the following diagrams.

Note

The maximum voltage applied to the drive terminals must not exceed 264 VAC phase to phase and phase to PE ground. This can be accomplished by referencing the AC supply to earth ground.

Caution

Do not connect or disconnect AC power by inserting or removing the AC power connector. Using the connector in this manner even once will damage the connector making it unusable.

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AC Supplies NOT Requiring Transformers

If the distribution transformer is configured as shown in the figures below, the AC power supply can be connected directly to the amplifier terminals.

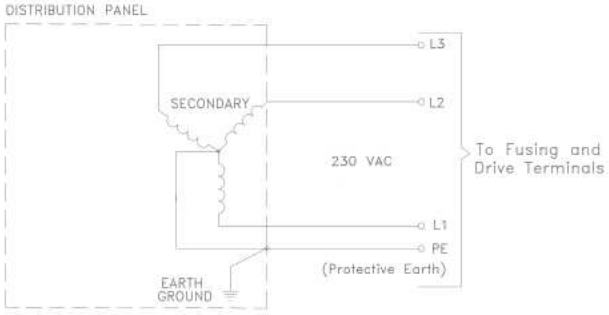


Figure 5: Earth Grounded WYE Distribution Transformer

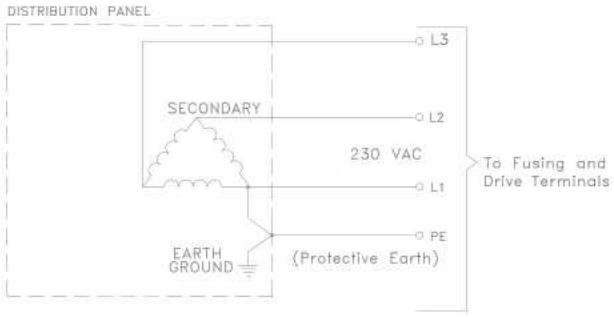


Figure 6: Earth Grounded Delta Distribution Transformer

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AC Supplies Requiring Transformers

If the distribution transformer is configured as shown in the figures below, an isolation transformer is required.

If an isolation transformer is used between the power distribution point and the drives, the transformer secondary must be grounded for safety reasons as shown in the figures below.

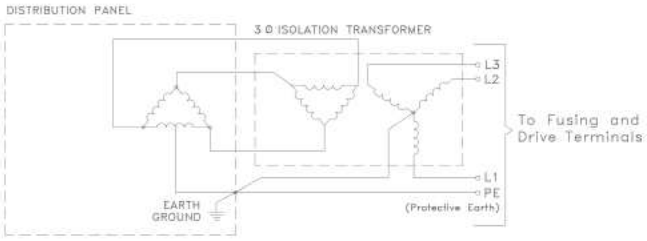


Figure 7: Three Phase Delta (with mid-phase GND) Distribution to a Three-Phase Delta/WYE Isolation Transformer

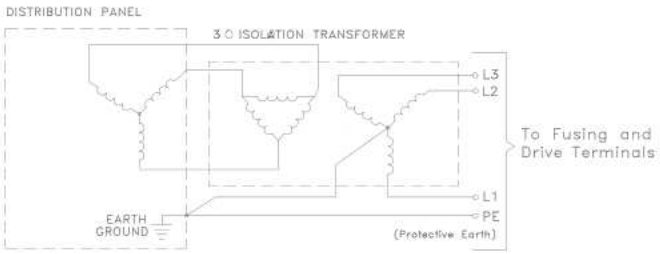


Figure 8: Three Phase WYE (ungrounded) Distribution to a Three-Phase Delta/WYE Isolation Transformer

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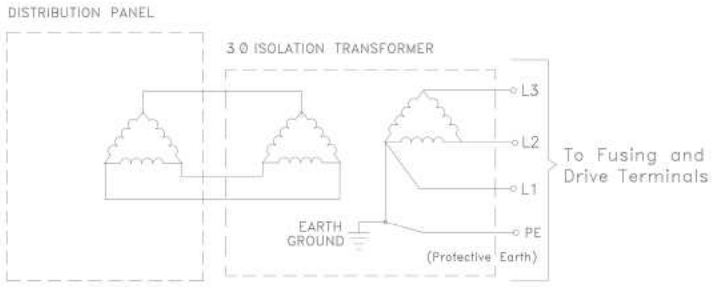


Figure 9: Delta to Delta Isolation Transformer

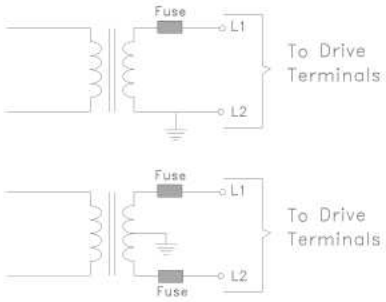


Figure 10: Single Phase Power Supply Connections

Transformer Sizing

If your application requires a transformer, use the following table for sizing the KVA rating. The values in the table are based on "worst case" power usage and can be considered a conservative recommendation. You can down-size the values only if the peak power usage is less than the transformer continuous power rating. Other factors that may influence the required KVA rating are high transformer ambient

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temperatures (>40° C or >104° F) and drive operation near the maximum speeds.

Drive/Motor Combination	Suggested KVA Rating
Ei-202 or Ei-203 / NT-207	1.0
Ei-202 / NT-212	1.2
Ei-203 / NT-212	1.7
Ei-203 / MG-316	1.7
Ei-205 / MG-340	3.0

At speeds near the maximum operating speed, transformer output voltage drop may become a critical issue for proper operation. Typically, higher KVA transformers have lower voltage drop due to lower impedance.

Line Fusing and Wire Size

You must incorporate over current protection for the incoming AC power with the minimum rating shown here. EMERSON Motion Control recommends Bussman type: KTK-R, KTK or LPN or equivalent.

Drive Model	External AC Line Fuse	Recommended Minimum AC/PE Line Wire Gauge
Ei-202	6 Amp LPN	16 AWG
Ei-203	8 Amp LPN	16 AWG
Ei-205	12 Amp LPN	16 AWG



Warning

The Protective Earth (PE) wire connection is mandatory for human safety and proper operation. This connection must not be fused or interrupted by any means. Failure to follow proper PE wiring can cause death or serious injury.

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Drive Model	Input Voltage (VAC)	Frequency (Hz)	Input Current (Amps RMS) at Full Drive Ouput Current	Inrush Current (Amps) 1 st Cycle	2nd Cycle
Ei-202	240 / 1 Ø	47 - 63	4.3	140 (2 ms)	20 (2 ms)
Ei-203	240 / 1 Ø	47 - 63	6.5	140 (2 ms)	20 (2 ms)
Ei-205	240 / 1 Ø	47 - 63	10.8	140 (5 ms)	30 (2 ms)

This inrush current specification assumes the drive has been powered off for at least eight minutes at 40° C ambient or five minutes at 25° C ambient. If this amount of time has not elapsed since power off, the inrush current will be higher.

Input Power Connections



Note

Power must be "Off" for a minimum of 6 minutes for the Epsilon Ei-205 drive and 3 minutes for the Epsilon Ei-202/ 203 drives before unplugging the power connection, if the Logic Power Supply jumper is in the 24 VDC Alternate Power Supply position. If the Logic Power Supply jumper is in the AC power location it is safe to unplug the power connector 30 seconds after removing AC power. This will ensure the bus voltage has bled down to a safe level (below 50 VDC).

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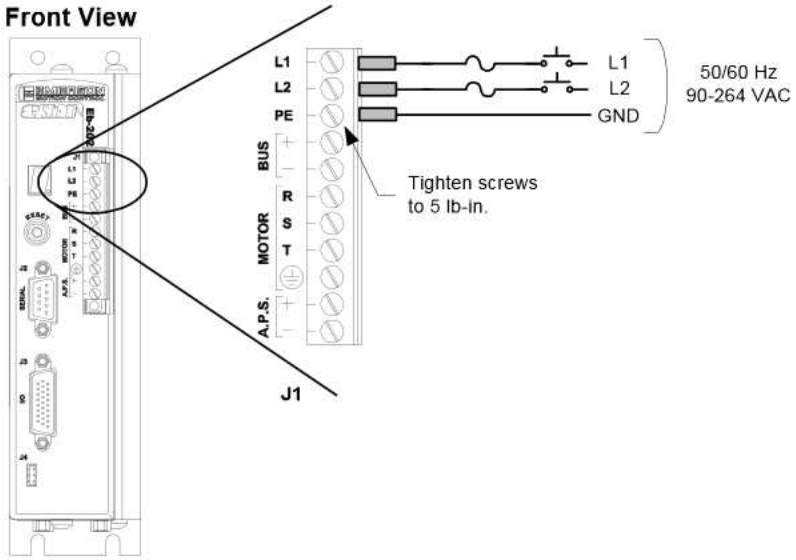


Figure 11: Epsilon AC Power Wiring Diagram

Caution

Do not connect or disconnect AC power by inserting or removing the AC power connector. Using the connector in this manner, even once, will damage the connector making it unusable.

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Alternate Power Supply Wiring

An Alternate Power Supply (A.P.S.) allows the drive to retain motor position information and serial communications when the main AC power supply is disconnected. You must reset the drive, either using the reset button or a reset input, after AC power is re-applied if the backup supplies have been active.

Voltage Range	Current	Inrush Current
18-30 VDC	0.5 A maximum 0.7 A peak (0.4 A maximum 0.6 A peak if external encoder is not used)	80 A for 1 ms if not limited by power supply

Using the A.P.S. supply input to power the drive logic and motor encoder allows the drive bus to operate at DC voltages below 42 VAC (60 VDC bus). The drive will operate down to 12 VDC on the bus (9 VAC on L1 and L2). However the low DC bus monitoring must be disabled to prevent faults at these low DC bus voltage level. This can be done with PowerTools software on the Advanced tab in Details mode.



Caution

Do not wire AC line into the A.P.S. input. Doing so will damage the drive.



Warning

Do not open the A.P.S. jumper access panel until at least six minutes after the main AC power has been removed from the drive L1 and L2 terminals.

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Note

Connecting 24V common on the A.P.S. to chassis ground reduces offset voltage in the analog diagnostic outputs.

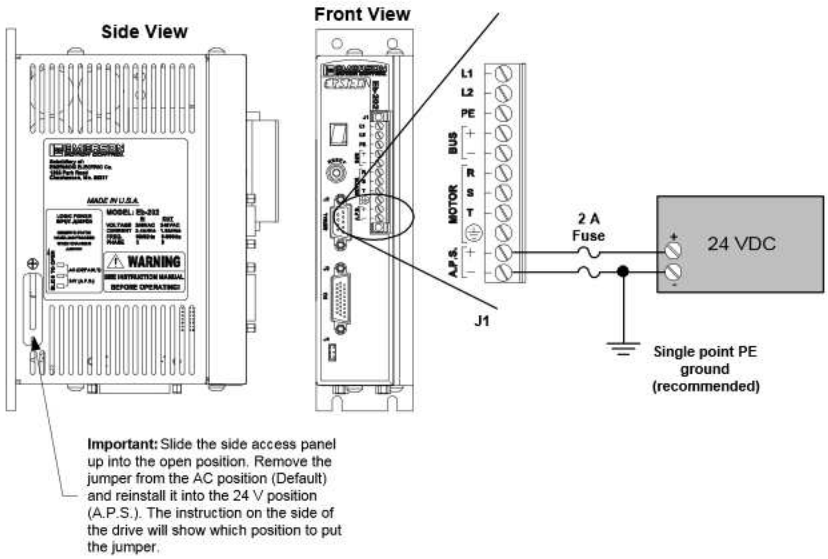


Figure 12: Epsilon Alternate Power Supply Wiring Diagram

Enabling A.P.S. power is done by sliding open the access panel on the side of the drive. Then move the jumper into the A.P.S. position using needle nose pliers as shown in the figure above.

Use static control procedures when handling the jumper inside the drive case.

The A.P.S. input is isolated from all other circuits on the Epsilon drive including the DC bus, logic and I/O. This permits

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you to use one common 24 VDC power supply for multiple drives without concern for ground loops and noise coupling between drives. The A.P.S. connection will generate some high frequency ripple (.25 Amps at 80 Mhz) on the A.P.S. power lines. This may disturb sensitive equipment that shares the same power supply.

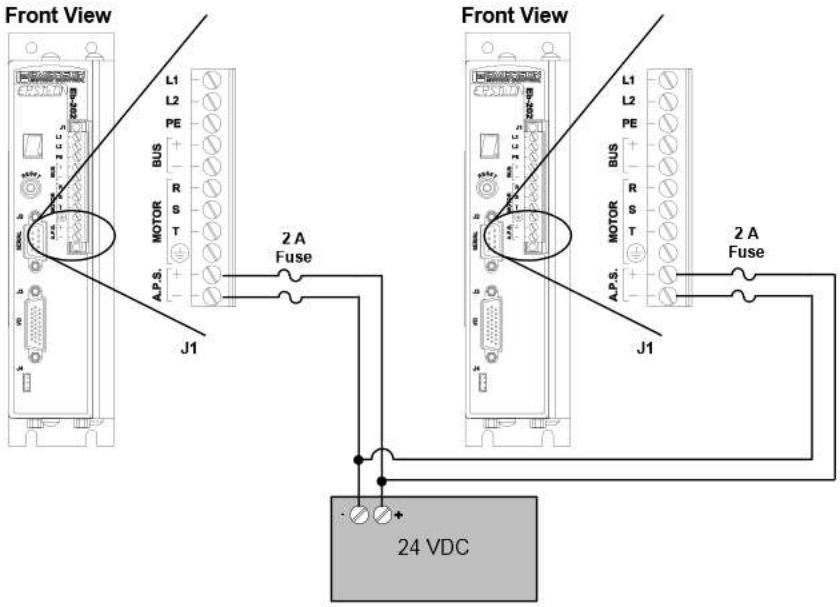


Figure 13: Multiple A.P.S. Wiring Diagram

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Motor Power Wiring

Motors are equipped with up to three male MS (Military Style) connectors, one for stator connections, one for encoder connections and one for the brake (if so equipped).

Stator connections from the drive to the motor are made with the CMDS cable. This cable has a female MS style connector on the motor end and four individual wires and shield that connect to the motor power connector on the front of the drive.

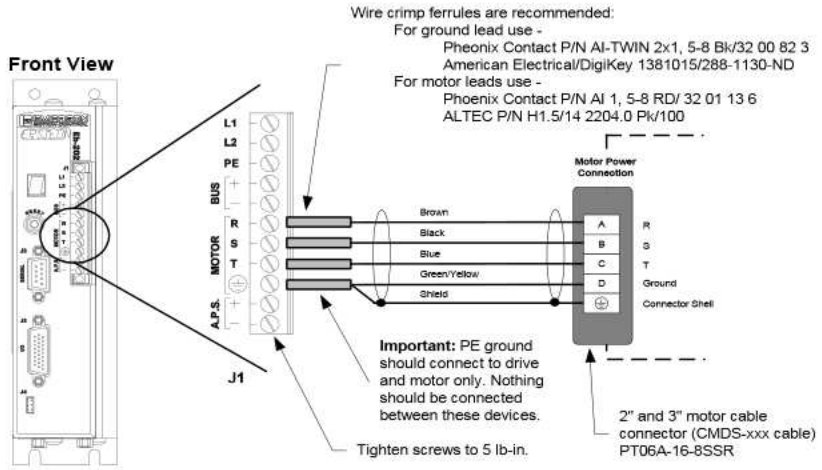


Figure 14: Epsilon Motor Power Wiring Diagram

Note

The motor ground wire and shields must be run all the way back to the amplifier terminal and must not be connected to any other conductor, shield or ground.

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Motor Feedback Wiring

Encoder feedback connections are made with the CFCS cable. This cable has an MS style connector on the motor end and a 26-pin high density "D" connector on the drive end.

For A, A, B, B and Z, Z pairs, the CFCS cable uses low capacitance (~10 pf/ft) wire to get a characteristic impedance of 120 ohms. This impedance match is important to minimize signal loss and ringing.

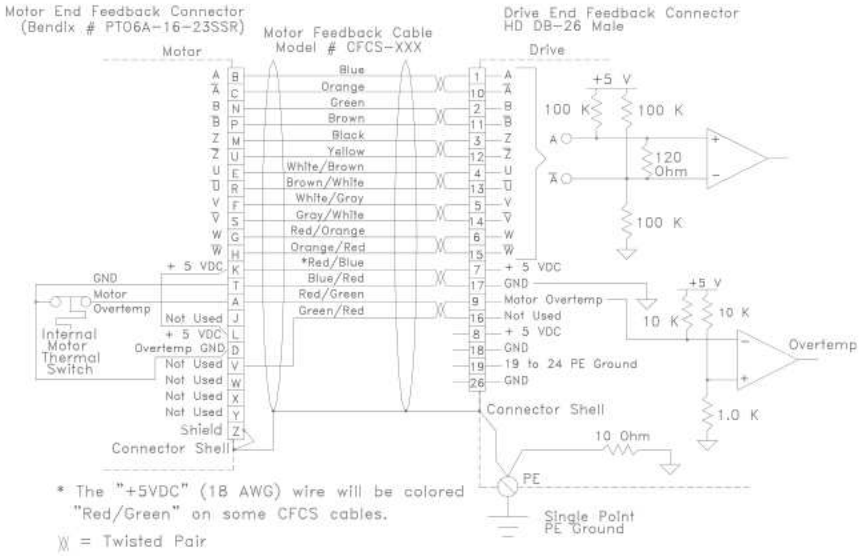


Figure 15: Motor Feedback Connector Pinout

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Motor Brake Wiring

Motors equipped with brakes have a three-pin MS style connector. The EMERSON Motion Control brake power cable (model CBMS-XXX) has an MS style connector on the motor end and three wire leads on the amplifier end (see wiring diagram below).

You must provide a DC power supply rated at +24 VDC with a 2 amp minimum current capacity for the brake. If you use this voltage source to power other accessories such as I/O or more than one brake, you must increase its current capability.

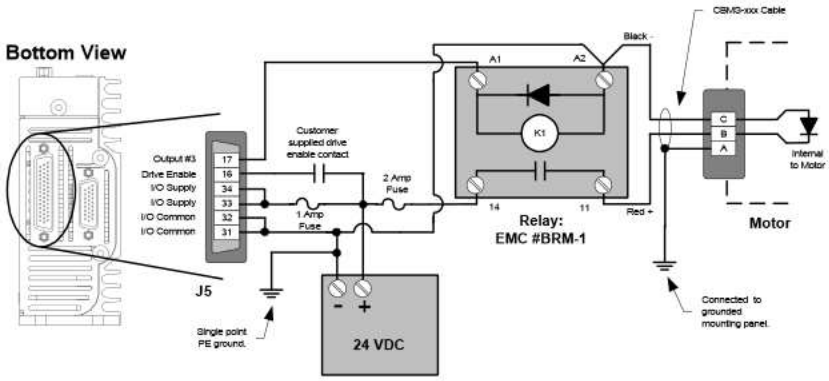


Figure 16: Epsilon Brake Wiring Diagram using the Command Connector

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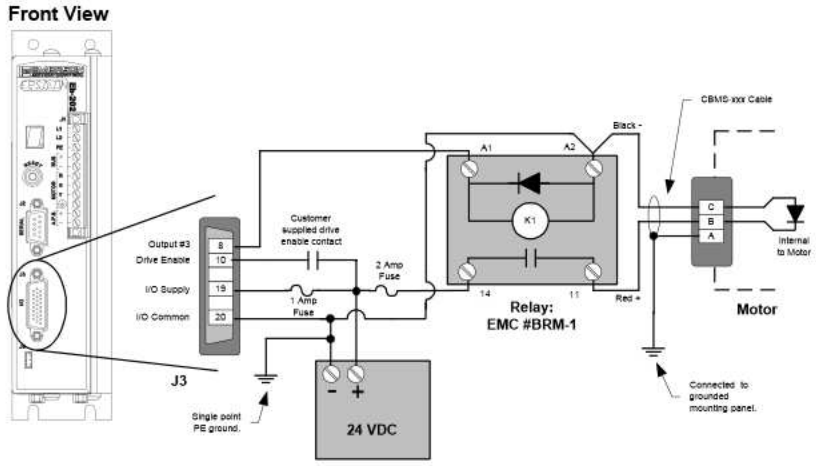


Figure 17: Epsilon Brake Wiring Diagram using the I/O Connector

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Input/Output and Drive Enable Wiring

Ei drives are equipped with thirteen optically isolated input lines (one is dedicated to a drive enable function) and seven optically isolated output lines. They are designed to operate from a +10 to 30 VDC source. All inputs and outputs are configured as sourcing. You are responsible for choosing a load that will limit each output's current to less than 150 mA.

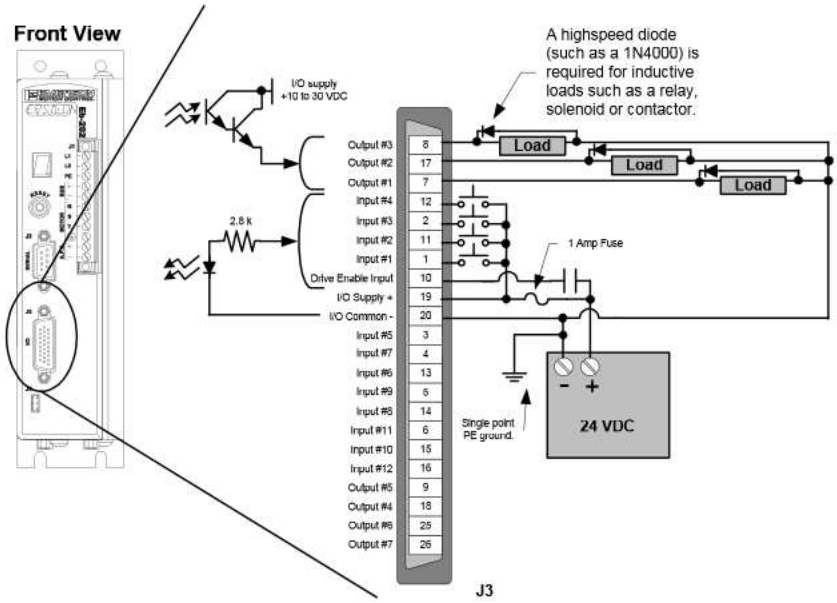


Figure 18: Epsilon Input/Output Wiring Diagram

The I/O connector is a 26-pin male connector on the front of the drive. EMERSON Motion Control offers a low profile interface plug and cable (EIO-xxx) for connections.

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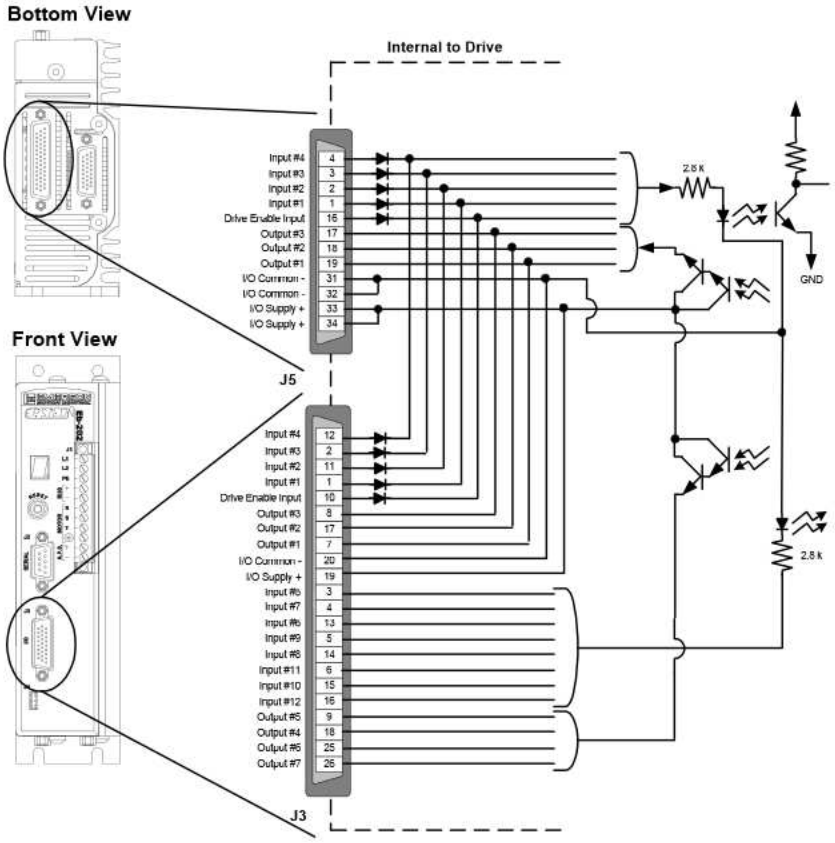


Figure 19: Epsilon I/O and Command Connector Internal Connections

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Note

If loads are applied to the same output signal on both Command Connector and I/O Connector, the sum total current loading must be limited to 150 mA per output signal.

Command Connector Wiring

All command and some digital I/O signals are available using the 44-pin Command Connector.

If you are interfacing your drive(s) using field wiring, you may use the optional External Connection Interface (ECI-44) which provides a convenient screw terminal connection strip. Connect one end of the CMDX command cable to your drive and the other end to the ECI-44.

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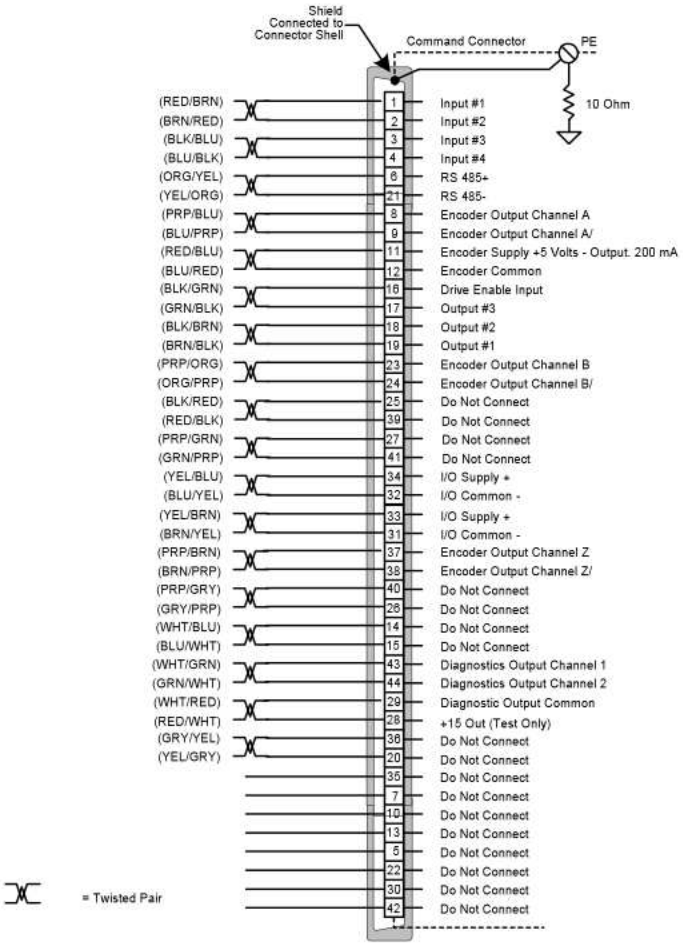


Figure 20: Command Connector and Cable Wiring Colors

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Function	Pin Numbers	Electrical Characteristics
Inputs and Drive Enable	1, 2, 3, 4, 16	10-30 V ("On") 0-3 V ("Off") optically isolated
Outputs	17, 18, 19	10-30 VDC sourcing 150 mA
I/O Supply	33, 34	10 - 30 VDC @ 1 Amp maximum
I/O Common	31, 32	I/O return
Encoder Supply Output +5 V	11	+5 V (200mA) output fused internally
Encoder Common 0 V	12	0.0 V, 10 ohms away from PE
Encoder Out	8, 9, 23, 24, 37, 38	Differential line driver output (RS 422)
Diagnostic Output	43, 44	± 10 VDC 10 mA maximum analog diagnostic, ref. to pin 29
Diagnostic Output Common	29	0.0 V, 10 ohms away from PE. 0 ohms away from Encoder Common 0 V (pin 12)
RS 485 ±	6, 21	Same signals as the Serial Connector
+15 out	28	10 mA supply. ref. pin 29 (for test purposes only.)

Command Cables

The CMDO, CMDX and CDRO cables are all command cables that plug into the Command Connector.

The CMDO and CMDX cables both use the same straight connector style, same color code and carry the full complement of signals available from the Command Connector. The difference is the CMDO cable has a male connector on one end with open wires on the other while the CMDX cable has male connectors on both ends.

For information about CMDO-XXX and CMDX-XXX (18 pair cable) cable wire colors, see the "Specifications" section.

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Note

Some CMDO and CMDX cables may have White/Yellow and Yellow/White wires in place of the White/Orange and Orange/White shown in the figure above (pins 6 and 21).

The CMDX cable has the identical signal pinout and wire colors, but has a 44-pin connector on each end.

The CDRO cable includes only the most commonly used signals to reduce the cable outer dimension and has a connector at only one end. The 45 degree connector design used on the CDRO cable also reduces the spacing requirement below the drive.

For information about the CDRO-XXX (13 pair cable) cable wire colors the Specifications section.

Encoder Output Signal Wiring

The default encoder output resolution is 2048 lines per motor revolution. This resolution is adjustable in one line per revolution increments with PowerTools software. The range is between 200 and the actual motor encoder density.



Note

Encoder outputs meet RS-422 driver specifications and can drive up to 10 RS-422 signal receivers. The default encoder output resolution is 2048 lines per motor revolution. This resolution is adjustable in one line per revolution increments with PowerTools software. The range is between 200 and the actual motor encoder density.

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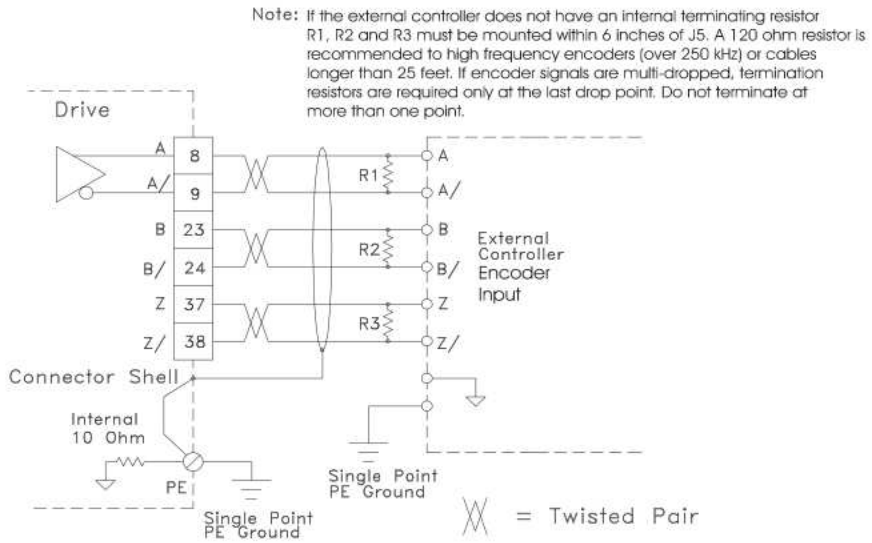


Figure 21: Command Connector Encoder Output Wiring

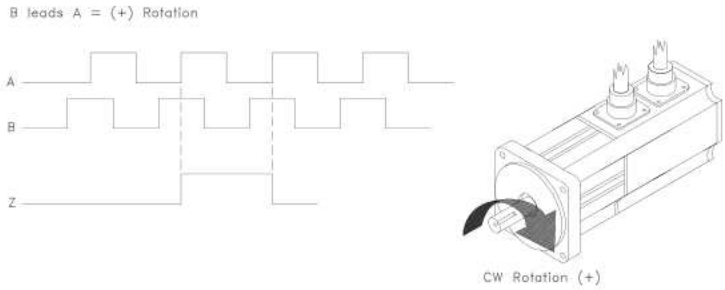


Figure 22: Direction Convention Diagram

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Serial Communications

Serial communications with the drive is provided through the female DB-9 connector located on the front of the drive. The serial interface is either three wire non-isolated RS-232C or two wire non-isolated RS-485. RS-485 is also available through the 44-pin Command Connector.

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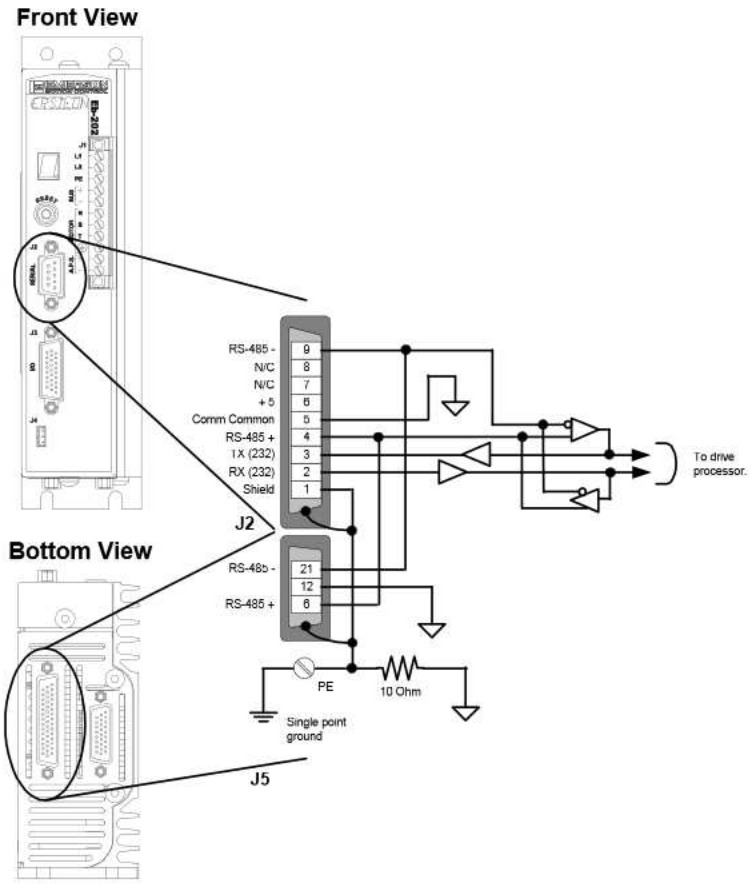


Figure 23: Epsilon RS-232 and RS-485 Internal Connections between the Command Connector and the Serial Communication Connector

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Caution

When connecting the serial port of your PC to the serial port of the drive, verify that your PC's ground is the same as the drive PE ground. Failure to do so can result in damage to your PC and/or your drive.

Note

Communication errors can usually be avoided by powering the computer or host device off of a convenience outlet that is mounted in the enclosure and whose neutral and ground are wired to the same single ended point ground that the drives and controllers are using.

This is sometimes beneficial even with battery powered computers.

Modbus Communications

The drive's serial communication protocol is Modbus RTU slave with a 32 bit data extension. The Modbus protocol is available on most operator interface panels and PLC's.

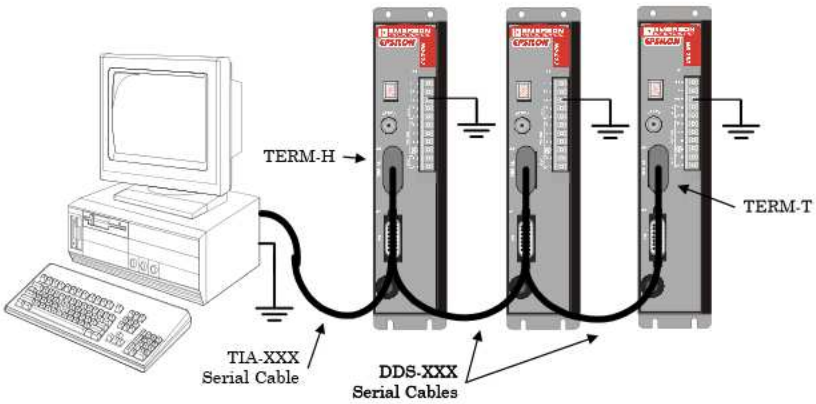
Serial Communications Specifications	
Max baud rate	19.2k
Start bit	1
Stop bit	2
Parity	none
Data	8

EMERSON Motion Control's Motion Interface panels are supplied with a Modbus master communications driver.

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Multi-Drop Communications

The RS-485 option (pins 4 and 9) is provided for multi-drop configurations of up to 32 drives. EMERSON Motion Control provides a special multi-drop serial cable which allows you to easily connect two or more drives.



Note:
The terminating resistor packs, TERM-H and TERM-T, should be installed on the first (TERM-H) and last (TERM-T) drive in the string if the total cable length is over 50 feet.

Figure 24: Multi-Drop Wiring Diagram

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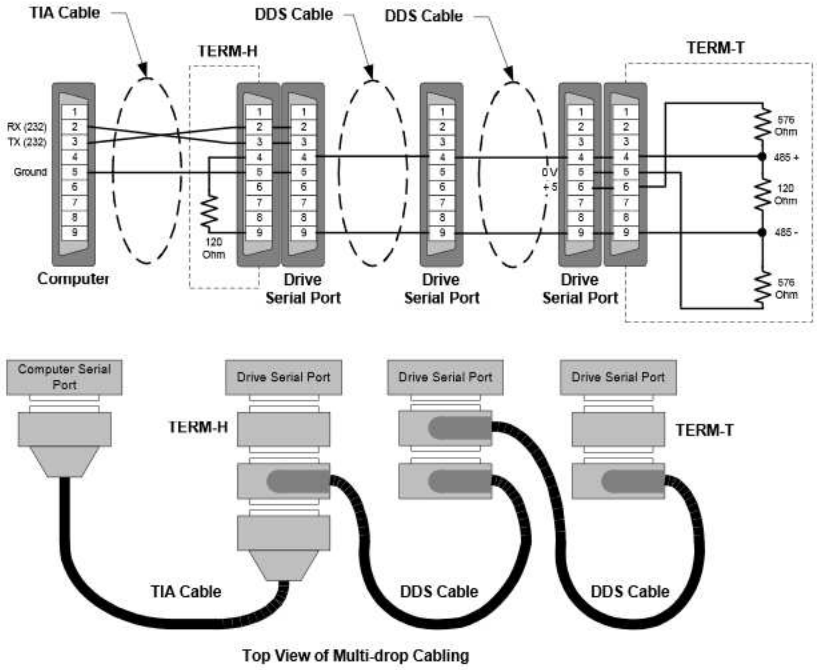


Figure 25: Multi-Drop Wiring Pinout

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Diagnostics and Troubleshooting

Overview

This section provides you with guidelines and hints on troubleshooting various problems that may be encountered during setup and operation. Specifically, it includes:

- Diagnostic Display
- Fault Codes
- Diagnostics Output Test Points
- Drive Faults
- Control Panel
- Troubleshooting

Diagnostic Display

The diagnostic display on the front of the drive shows drive status and fault codes. When a fault condition occurs, the drive will display the fault code, overriding the status code.

The decimal point is “On” when the drive is enabled and the stop input is not active. This indicates that the drive is ready to run and any motion command will cause motion. Motion commands will not cause motion unless you are Ready (R) and the decimal point is “On”.

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Display Indication	Status	Description
	Brake Engaged (Output "Off")	Motor brake is mechanically engaged. This character will only appear if the Brake output function is assigned to an output line.
	Ready	The Epsilon Ei or FM-2 and E Series drive system is functioning normally and is ready to execute a motion command.
	Indexing	Index in progress. Other motion commands do not function.
	Jogging	Jog function in progress. Other motion commands do not function.
	Homing	Home cycle in progress. Other motion commands do not function.
	Stop or Travel Limit Decel	*Stop* or *Travel Limit Decel* in progress.
	RMS Foldback	Motor torque is limited to 80 percent.

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Display Indication	Status	Description
	Stall Foldback (E Series drive only)	Drive output current is limited to 80 percent of drive stall current.
	Ready to Run	Drive enabled, no *Stop* input.

Fault Codes

A number of diagnostic and fault detection circuits are incorporated to protect the drive. Some faults, like high DC bus and amplifier or motor over temperature, can be reset with the Reset button on the front of the drive or the Reset input function. Other faults, such as encoder faults, can only be reset by cycling power "Off" (wait until the diagnostics display turns "Off"), then power "On".

The drive accurately tracks motor position during fault conditions. For example, if there is a "Low DC Bus" fault where the power stage is disabled, the drive will continue to track the motor's position provided the logic power is not interrupted.

The +/- Limit faults are automatically cleared when the fault condition is removed. The table below lists all the fault codes in priority order from highest to lowest. This means that if two

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faults are active, only the higher priority fault will be displayed.

Display	Fault	Action to Reset	Bridge Disabled
	Watchdog Timer	Button or Input	Yes
	Power Up Test	Power	Yes
	Drive Overtemp (Epsilon drive only)	Cool down, Cycle Power	Yes
	NVM Invalid	Button or Input	Yes
	Invalid Configuration	Button or Input	Yes
	Power Module	Button or Input	Yes
	High DC Bus	Button or Input	Yes

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Display	Fault	Action to Reset	Bridge Disabled
	Low DC Bus	Button or Input	Yes
	Encoder State	Power	Yes
	Encoder Hardware	Power	Yes
	Motor Overtemp	Button or Input	Yes
	Overspeed	Button or Input	Yes
	Max Following Error (Position mode)	Button or Input	Yes
	Travel Limit +/-	Auto	No
	All "On"	Normally on for one second during power up	Yes

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Fault Descriptions

W — Watchdog Timer

The watchdog timer ensures that the firmware is operating normally. If the firmware fails to reset this timer every 10 ms, the drive hardware will be reset, all inputs and outputs will be cleared ("Off"), and a Watchdog Timer fault is generated.

A — Drive Overtemp

Indicates the drive IGBT temperature has reached 100° C.

T — Power Up Test

This fault indicates that the power-up self-test has failed. This fault cannot be reset with the reset command or reset button.

N — NVM Invalid

At power-up the drive tests the integrity of the non-volatile memory. This fault is generated if the contents of the non-volatile memory are invalid.

U — Invalid Configuration

If this occurs call EMERSON Motion Control Service.



Caution

Damage may occur to the drive, motor or both if the fault is cleared using the Reset button when the setup data in the FM does not match the current drive and motor.

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Z Power Module

This fault is generated when a power stage over-temperature, over-current or loss of power stage logic supply occurs. This can be the result of a motor short to ground, a short in the motor windings, a motor cable short or the failure of a switching transistor.

It can also occur if the drive enable input is cycled "Off" and "On" rapidly (>10 Hz).

This fault should not be allowed to occur repeatedly. System changes should be made to eliminate Z fault events. Drive power stage will become degraded if allowed to continue.



Note

If a cause for Z faults cannot be determined, write down all observations prior to and after the Z faults and contact Emerson Motion Control Technical Service.

H High DC Bus

This fault will occur whenever the voltage on the DC bus exceeds 415 VDC. The most likely cause of this fault would be an open shunt fuse, a high AC line condition or an application that requires an external shunt (e.g., a large load with rapid deceleration).

U Low DC Bus

This fault will occur whenever the voltage on the DC bus drops below 60 volts. The most likely cause of this fault is a reduction (or loss) of AC power. A 50 ms debounce time is used with this fault to avoid faults caused by intermittent power disruption.

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P Encoder State

Certain encoder states and state transitions are invalid and will cause the drive to report an encoder state fault. This is usually the result of noisy encoder feedback caused by poor shielding.

E Encoder Hardware

If any pair of encoder lines are in the same state, an encoder line fault is generated. The most likely cause is a missing or bad encoder connection.

M Motor Overtemp

This fault is generated when the motor thermal switch is open due to motor over-temperature or incorrect wiring.

O Overspeed

This fault occurs when the actual motor speed exceeds the Overspeed Velocity Limit parameter. This parameter can be accessed with PowerTools software.

F Max Following Error

This fault is generated when the following error exceeds the following error limit (default following error limit is .2 revs). With PowerTools you can change the Following Error Limit value on disable in the Position tab.

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Travel Limit +/-

This fault is caused when either the + or - Travel Limit input function is active.

"All On"

This is a normal condition during power up of the drive. It will last for less than 1 second. If this display persists, call EMERSON for service advice.

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Diagnostic Analog Output Test Points

The drive has two 8-bit real-time analog outputs which may be used for diagnostics, monitoring or control purposes. These outputs are referred to as Channel 1 and Channel 2. They can be accessed from the Command Connector on the drive or from the Diagnostics Analog Output Pins located on the front of the drive.

Each Channel can be programmed to the following sources:

Analog Output Source options

- Velocity Command
- Velocity Feedback
- Torque Command (equates to Torque Command Actual parameter)
- Torque Feedback
- Following Error

Default Analog Output Source

- Channel 1 = Velocity Feedback
- Channel 2 = Torque Command

Output	Source	Offset	Scale
1	Velocity Feedback	0	600 RPM/volt
2	Torque Command	0	30 percent/volt for selected motor

The DGNE cable was designed to be used with either an oscilloscope or a meter. The wires are different lengths to avoid shorting to each other. However, if signals do get shorted to GND, the drive will not be damaged because the circuitry is protected.

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Note

Connecting the A.P.S. 24V return to chassis ground reduces output offset voltage.

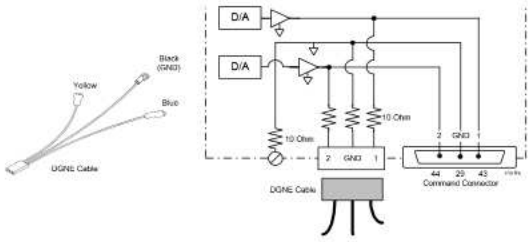


Figure 26: Diagnostic Cable (DGNE) Diagram

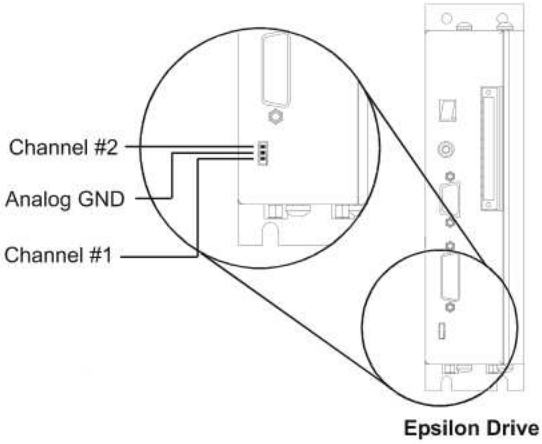


Figure 27: Epsilon Location

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Drive Faults

The Drive Faults Detected dialog box is automatically displayed whenever a fault occurs. There are three options in this dialog box: Reset Faults, Ignore Faults and Help.



Figure 28: Drive Faults Detected Dialog Box

Resetting Faults

Some drive faults are automatically reset when the fault condition is cleared. Others require drive power to be cycled or the drive to be "rebooted" to be cleared. If you wish to continue working in the PowerTools software without resetting the fault, click the *Ignore Fault* button.

To reset faults that can be reset with the *Reset Faults* button, simply click the *Reset Faults* button in the Drive Faults Detected dialog box or push the Reset button on the front of the drive where the fault occurred.

Viewing Active Drive Faults

To view all active drive faults, select the View Faults command from the **Device** menu. The dialog box displayed is the same as Active Drive Faults dialog box described above.

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Rebooting the Drive

To reboot the drive, cycle power or select the Reboot Drive command from the **Device** menu. This command reboots the drive attached to the active Configuration Window.

Watch Window

This feature allows you to customize a window to monitor drive parameters which you select from a complete list of drive parameters. From this window you can watch the parameters you selected in real time. This feature is only available when you are online with the drive.



Note

You cannot change the values of the parameters while they are being displayed in the Watch Window. The parameter in the setup screens will look like they have been changed when they actually have not.



Note

It is normal to have the Watch Window show up with the three motor parameters already selected. If you do not need to view them, simply push the *Clear All* button and select the parameters you wish to view.

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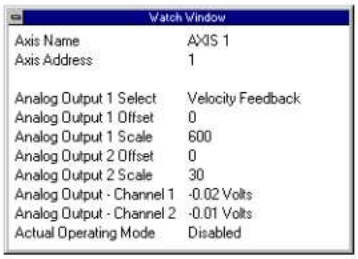


Figure 29: Watch Window

Note

Parameters selected and displayed in the Watch Window cannot be updated from the tabs. To update a parameter, delete it from the Watch Window selection.

The Watch Window is accessed by selecting Watch Drive Parameters from the **Tools** menu or by clicking on the Watch Window icon on the toolbar.

The Watch Window will automatically appear as soon as you select a parameter from the Select Drive Parameters dialog box. After you have selected the parameters you wish to watch, click the *Close* button. The Select Drive Parameters dialog box will close and the Watch Window will remain open.

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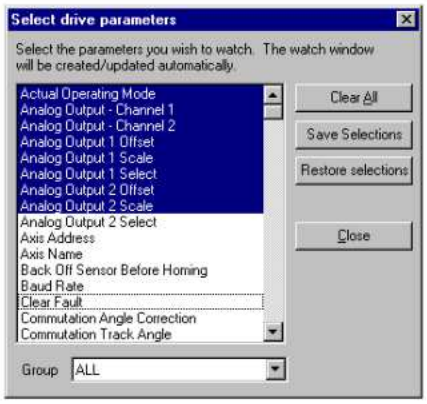


Figure 30: Select Drive Parameters Dialog Box

Group

This list box enables you to view the complete list of parameters or just a group of parameters you are interested in. The groups include:

Analog Out	Fault Log	Setup
Communication	Home (Ei only)	Status
Digital Inputs	ID	Torque
Digital Outputs	Index (Ei only)	Tuning
Execution	Motor	User Def Motor
Fault Counts	Position	Velocity

Clear All Button

This button is used to clear all the parameter selections that were previously selected.

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Save Selections Button

This button saves the parameter selections. This enables you to restore the same list of parameters for use in future online sessions.

Restore Selections Button

This button restores the parameter selections previously saved. This enables you to restore the list of parameters you created in a previous online session.

View Motor Parameters

When online with the drive this feature allows you to display a pre-defined Watch Window to monitor three motor parameters. These parameters are normally used when testing the setup of a User Defined Motor for commutation accuracy.

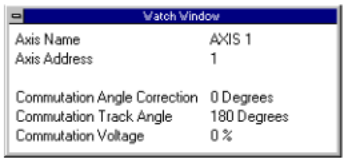


Figure 31: View Motor Parameters Window

The View Motor Parameters window is accessed by selecting View Motor Parameters from the **Tools** menu.

Control Panel

PowerTools-FM software is capable of monitoring the performance of the drive. The Control Panel allows the user to jog, in-

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dex or home the drive with the click of a button. This tool helps reduce the time required to setup and simplifies diagnostics.



Figure 32: Control Panel Dialog Box

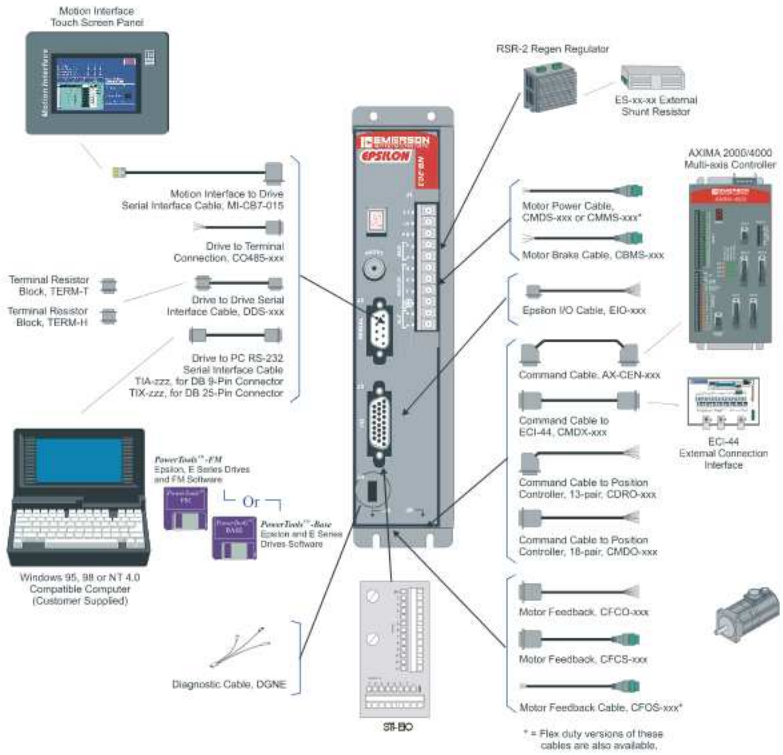
Keyboard Commands

Key	Action
SPACEBAR	Activate the control with the "focus" to allow keyboard-based Jog, Index and Homing control. Jogging stops whenthe spacebar is released.
ESC	Stops motion started with the control panel.
TAB	Moves focus to next control. The order of movement is generally from left to right and from top to bottom.
SHIFT+TAB	Moves focus to preceding control. The order of movement is generally from right to left and from bottom to top.

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Options and Accessories

Epsilon Ei Indexing Drive Options



ECI-44 External Connector Interface

The ECI-44 allows access to all command and input and output signals. The ECI-44 should be mounted close to the drive and away from any high voltage wiring. The ECI-44 comes complete with the hardware necessary for mounting to most DIN rail mounting tracks.

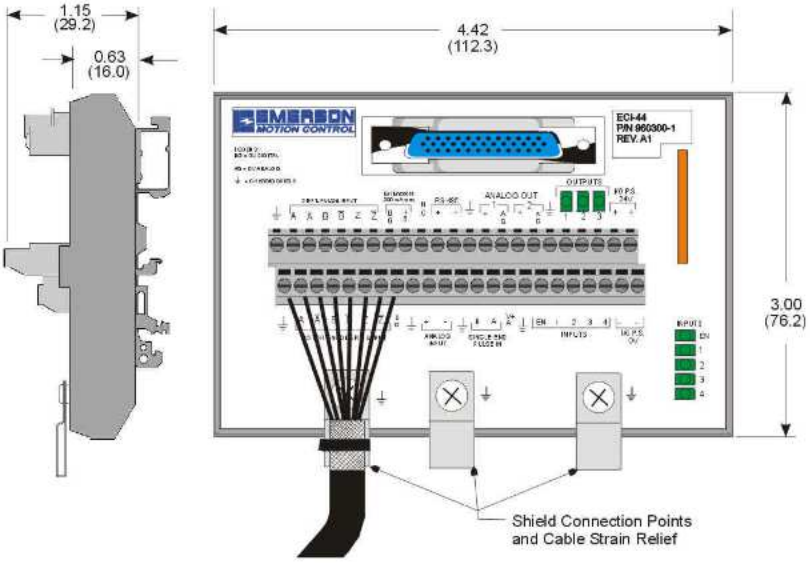


Figure 33: Dimensions of ECI-44

Note

Shield connection points are connected to the shell of the 44-pin "D" connector on the ECI-44.

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Use tie wraps to provide a strain relief and a ground connection at the shield connection points.

If you do not wish to use the DIN rail mounting hardware, the ECI-44 can be disassembled and the mounting clips removed.

The ECI-44 wire range is #18 to 24 AWG stranded insulated wire.



Note

Wiring should be done with consideration for future troubleshooting and repair. All wiring should be either color coded and/or tagged with industrial wire tabs. Low voltage wiring should be routed away from high voltage wiring.

STI-EIO Interface

The STI-EIO interface allows access to all digital input and output signals. The STI-EIO mounts directly to the J3 connector on the drive. See Figure 34 on page 66.



Note

Shield connection points are connected to the shell of the 44-pin "D" connector on the STI EIO.

The STI-EIO wire range is #18 to 24 AWG stranded insulated wire.



Note

Wiring should be done with consideration for future troubleshooting and repair. All wiring should be either color coded and/or tagged with industrial wire tabs. Low voltage wiring should be routed away from high voltage wiring.

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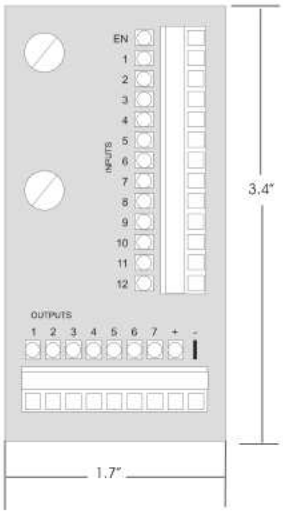


Figure 34: Dimensions of STI-EIO

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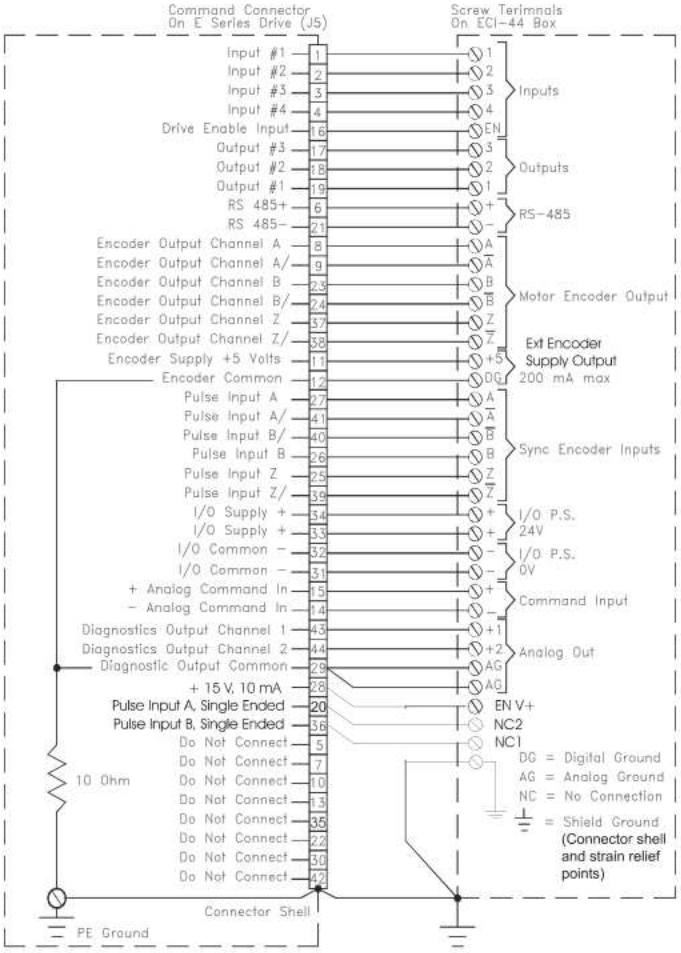


Figure 35: ECI-44 Signal Connections

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Specifications

Overview

This chapter describes the drive/motor specifications and cable diagrams. Specifically, it includes:

- Drive and Motor Specifications
- Power Dissipation
- Speed Torque Curves
- Epsilon Drive Dimensions
- MG Motor Dimensions and NT Motor
- Cable Diagrams
- Vendor Contact Information

Drive Specifications

	Epsilon Series
Power Requirements	42 - 264 VAC, 1 Ø, 47 - 63 Hz 240 VAC for rated performance or 12 - 375 VDC when using an A.P.S. Logic Supply Input and disabled Low DC Bus alarm.
Auxiliary Power Supply/ Auxiliary Logic Power Input	For logic backup, 24 VDC, 0.5A
Switching Frequency	20 kHz
Power Supply Output	5 VDC, 250 mA maximum for master encoder usage
Efficiency - Drive	202/203: 93% at full rated output power 205: 95% at full rated output power
Ingress Protection (IP) Rating	Drive: IP20 MG motors: IP65 NT motors: IP65/IP54 Molded motor and feedback cables: IP65

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	Epsilon Series
Serial Interface	RS-232 / RS-485 Internal RS-232 to RS-485 converter Modbus protocol with 32 bit data extention 9600 or 19.2 k baud
Control Inputs	**Analog command:** ±10 VDC 14 bit, 13 bit, 100 kohm impedance, differential **Digital inputs:** (5) 10-30 VDC, 2.8 kohm impedance; current sourcing signal compatible (active high); max input response time is 500 µs; optically isolated **Input debounce:** 0-2000 ms
Control Outputs	**Diagnostic analog outputs:** (2) ±10 VDC (single ended, 20 mA max) 10 bit software selectable output signals **Digital outputs:** (3) 10-30 VDC 150 mA max, current sourcing, (active high) optically isolated: Input debounce: Programmable range, 0 to 200 ms **Motor temp sensor (analog):** 0 to +5 VDC (single ended), 10 Kohm impedance
Pulse Mode	**Interface:** Software selectable differential (RS422) or single ended (TTL Schmitt Trigger) **Maximum input frequency:** Differential - 2 MHz per channel; 50% duty cycle (8 MHz count in quadrature) Single ended - 1 MHz per channel; 50% duty cycle (4 MHz count in quadrature) **Ratio Capabilities:** 20 to 163,840,000 PPR Input Device = AM26C32 V_{diff} = 0.1 - 0.2 V $V_{common\ mode}$ max = +/- 7 V Input impedance each input to 0 V = 12 - 17 kohm

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	Epsilon Series
Encoder Output Signal	Differential line driver, RS-422 and TTL compatible Scalable in one line increment resolution up to 2048 lines/rev of the motor (MG and NT) Output Device = AM26C31 20 mA per channel, sink and/or source $V_{out\ Hi}$ @ 20 mA = 3.8 - 4.5 V $V_{out\ Lo}$ @ 20 mA = 0.2 - 0.4 V $V_{out\ diff}$ w/100 ohm termination = 2.0 - 3.1 V $V_{out\ common\ mode}$ w/100 ohm termination = 0.0 - 3.0 V $I_{out\ short\ circuit}$ = 30 - 130 mA
Shunt Resistor Capacity/ Regeneration Capacity	**Internal:** At full speed, full torque decel and 5:1 inertial load for Eb 202/203 with NT-212 or Eb-205 with MG-340. Repetition frequency limited only by drive RMS capacity. No internal shunt resistor. **External:** Bus connection provided for external regeneration unit (EMC model RSR-2 with a 20 ohms resistor) 15 ARMS capacity.
Fault Detection Capability	Low DC bus (can be disabled) High DC bus Power Stage fault Logic power Encoder state Encoder line break Drive overtemperature Motor over temperature Overspeed Travel limit (+) Travel limit (-) Pulse mode position error Watchdog timer Power-up self test failure Non-volatile memory invalid
Cooling Method	Ei-202, Ei-203 Ei-205: Convection

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	Epsilon Series
Environmental	**Ambient temperature range for rated output:** 32° F to 104° F (O° C to 40° C) **Maximum ambient operating temperature:** 104° F to 122° F (40° C to 50° C) with power derating of 3%/°C **Rated altitude:** 3,280 feet (1000 m) **Vibration:** 10 - 2000 Hz at 2g **Humidity requirement:** 10 - 95% non-condensing **Storage temperature:** -13 °F to 167 °F (-25 °C to 75 °C)
Derating	**Temperature:** Operation in ambient temperature over 50° C (122° F) not recommended. Drive output power must be derated by 3 %/°C between 104° F to 122° F (40° C to 50° C) **Derating altitude:** Above 3,280.8 ft (1000 m) reduce output by 1% per 328.08 ft (100 m)
Standards and Agency Approvals	UL listed Canadian UL listed CE Mark: Low voltage directive; EMC directive
Accessory Specifications	
Amplifier Weights	Ei-202 3.3 lb (1.5 kg) Ei-203 3.3 lb (1.5 kg) Ei-205 3.7 lb (1.7 kg) *Add 1 lb for shipping.

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Drive and Motor Combination Specifications

Drive	Motor	Cont. Torque lb-in (Nm)	Peak Torque lb-in (Nm)	Power HP @ Rated Speed (kWatts)	Inertia lb-in-sec^2 (kg-cm^2)	Max speed RPM	Encoder resolution lines/rev	Motor Ke VRMS/ krpm	Motor Kt lb-in/ ARMS (Nm/ ARMS)
Ei-202	MG-205	5 (0.56)	13.5 (1.53)	0.31 (0.23)	0.00008 4 (0.95)	5000	2048	28.3	4.1 (0.46)
	MG-208	6.7 (0.76)	13.2 (1.49)	0.53 (0.4)	0.00014 4 (0.163)	5000	2048	28.3	4.1 (0.46)
	NT-207	7.3 (0.82)	15.2 (1.72)	0.45 (0.34)	0.00009 4 (0.1063)	5000	2048	35	5.124 (0.58)
	NT-212	9.2 (1.04)	18 (2.03)	0.71 (0.53)	0.00016 4 (0.185)	5000	2048	34.7	5.08 (0.57)
Ei-203	MG-205	5 (0.56)	15.0 (1.69)	0.31 (0.23)	0.00008 4 (0.95)	5000	2048	28.3	4.1 (0.46)
	MG-208	9.1 (1.03)	20 (2.26)	0.58 (0.43)	0.00014 4 (0.163)	5000	2048	28.3	4.1 (0.46)
	MG-316	15.8 (1.79)	31.8 (3.59)	1.0 (0.75)	0.00049 8 (0.562)	4000	2048	37.6	5.5 (0.62)
	NT-212	12.5 (1.41)	27 (3.05)	0.8 (0.6)	0.00016 4 (0.185)	5000	2048	34.7	5.08 (0.57)
Ei-205	NT-212	12.5 (1.41)	30 (3.4)	0.8 (0.6)	0.00016 4 (0.185)	5000	2048	34.7	5.08 (0.57)
	MG-316	18.6 (2.1)	52 (5.9)	1.00 (0.75)	0.00049 8 (0.562	4000	2048	37.6	5.5 (0.62)
	MG-340	39.5 (4.5)	83 (9.4)	1.8 (1.4)	0.00125 (1.414)	3000	2048	55	8.0 (0.90)

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Motor Brake Specifications

Motor	Holding Torque lb-in (Nm)	Added Inertia lb-in-sec2 (kg-cm2)	Added Weight lb (kg)	Coil Voltage (VDC)	Coil Current (Amps)	Mechanical Disengagement Time	Mechanical Engagement Time
MGE-2XXCB	10 (1.13)	0.000025 (0.0282)	1.8 (0.55)	24 (±10%)	0.48 (±10%)	25 ms	40 ms
MGE-316CB MGM-340CB	50 (5.6)	0.00015 (0.1693)	2.4 (1.1)	24 (±10%)	0.52 (±10%)	100 ms	250 ms
GE/M-455CB MG-490CB MG-4120CB	220 (24.9)	0.000412 (0.4652)	5.8 (2.6)	24 (±10%)	0.88 (±10%)	100 ms	250 ms

Motor Weights

Motor	Weight lb (kg) without Brake	Weight lb (kg) with Brake
MGE-205	3.0 (1.36)	N/A
MGE-208	4.0 (1.8)	5.8 (2.6)
MGE-316	8.3 (3.8)	10.7 (4.9)
MGE/M-340	14.6 (6.6)	17.0 (7.7)
MGE/M-455	18.5 (8.4)	24.3 (11.0)
MGE/M-490	27.0 (12.3)	32.8 (14.9)
MGE/M-4120	38.0 (17.3)	43.8 (19.9)
NT-207	3 (1.36)	N/A
NT-212	4 (1.81)	N/A

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Axial/Radial Loading

Motor	Max Radial Load (lb.)	Max. Axial Load (lb.)
MGE-205	20	15
MGE-208	20	15
MGE-316	40	25
MGM-340	40	25
MGE/M-455	100	50
MGE/M-490	100	50
MGE/M-4120	100	50

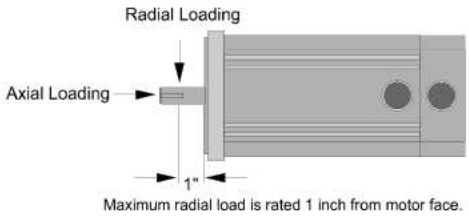


Figure 36 Axial/Radial Loading

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IP Ratings

Motor	Rating
MG (all)	IP65
NT-207	IP65
NT-207 (w/o seals)	IP54
NT-212	IP65
NT-212 (w/o seals)	IP54

Encoder Specifications

Motor	Density	Output Type	Output Frequency	Output Signals	Power Supply
MG and NT	2048 lines/rev	RS422 differential driver	250 kHz per channel	A, B, Z, Comm U, Comm W, Comm V and all complements	5V, 200 mA ±10%

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Power Dissipation

In general, the drive power stages are 90 to 95 percent efficient depending on the actual point of the torque speed curve the drive is operating. Logic power losses on the Epsilon drive are 11 W with normal loads to 15 W with additional loads such as external encoder and low input voltage (<22 VDC on A.P.S. or 120 VAC on AC input).

The values shown in the table below represent the typical dissipation that could occur with the drive/motor combination specified at maximum output power.

Drive Model	Logic Power Losses (typ) Drive (Pld) (Watts)	Maximum Power Stage Losses (Pp) (Watts)	Total Power Losses (Watts)
Ei-202 / MG-205	11	25	36
Ei-202 / NT-207		25	36
Ei-202 / NT-212		30	41
Ei-203 / NT-207		30	41
Ei-203 / MG-208		55	66
Ei-203 / NT-212		55	66
Ei-203 / MG-316		60	71
Ei-205 / NT-212		55	66
Ei-205 / MG-316		72	83
Ei-205 / MG-340		88	99

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Power Dissipation Calculation

Calculating actual dissipation requirements in an application can help minimize enclosure cooling requirements, especially in multi-axis systems. To calculate dissipation in a specific application, use the following formula for each axis and then total them up. This formula is a generalization and will result in a conservative estimate for power losses.

$$TPL = \frac{TRMS * Vmax}{1500} + Pld + Psr$$

Where:

TPL = Total power losses (Watts)
TRMS = RMS torque for the application (lb-in)
Vmax = Maximum motor speed in application (RPM)
Pld = Logic Power Losses Drive (Watts)
Psr = Shunt Regulation Losses (Watts)-(RSR-2 losses or equivalent)



Note

TRMS * Vmax / 1500 = Power Stage Dissipation = Pp

A more accurate calculation would include even more specifics such as actual torque delivered at each speed plus actual shunt regulator usage. For help in calculating these please contact our Application Department with your system profiles and loads.

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Speed Torque Curves

Continuous ratings of the MG and NT motors are based on 100°C (212° F) motor case temperature and 25°C (77° F) ambient temperature with the motor mounted to an aluminum mounting plate as shown in the table below.

Motor	Mounting Plate Size
MG-205 and 208, NT-207 and 212	6" x 6" x .25"
MG-316 through 490	10" x 10" x .375
MG-4120	12" x 16" x .5"

- Speed torque curves are based on 240 VAC drive operation.
- All specifications are ±5 percent due to motor parameter variations.

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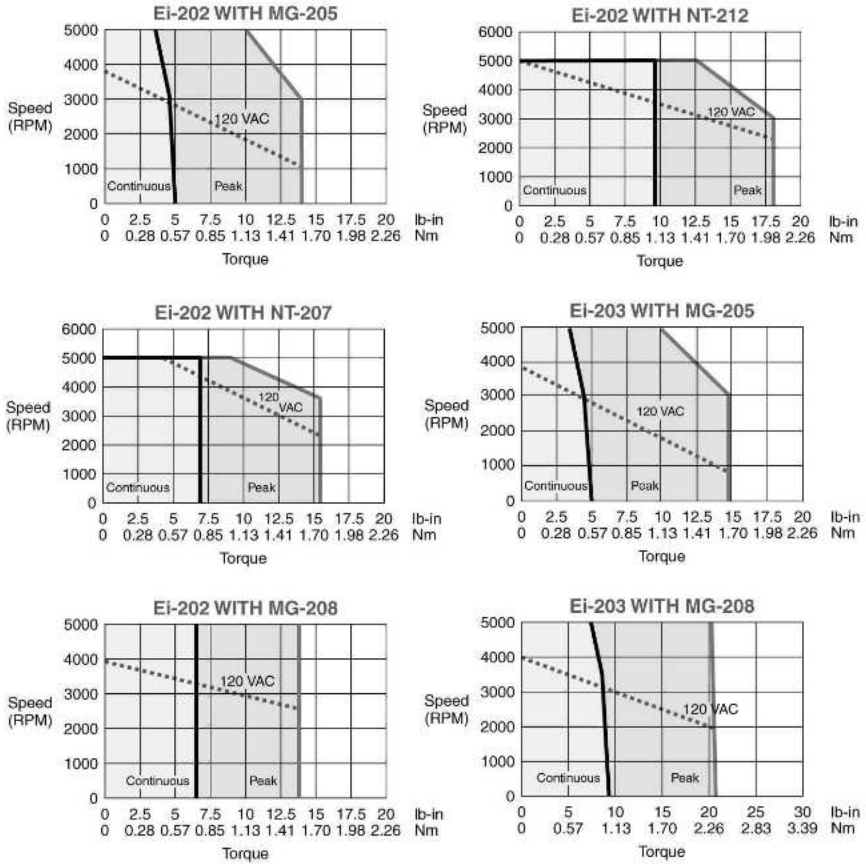


Figure 37: Speed Torque Curves (Sheet 1 of 2)

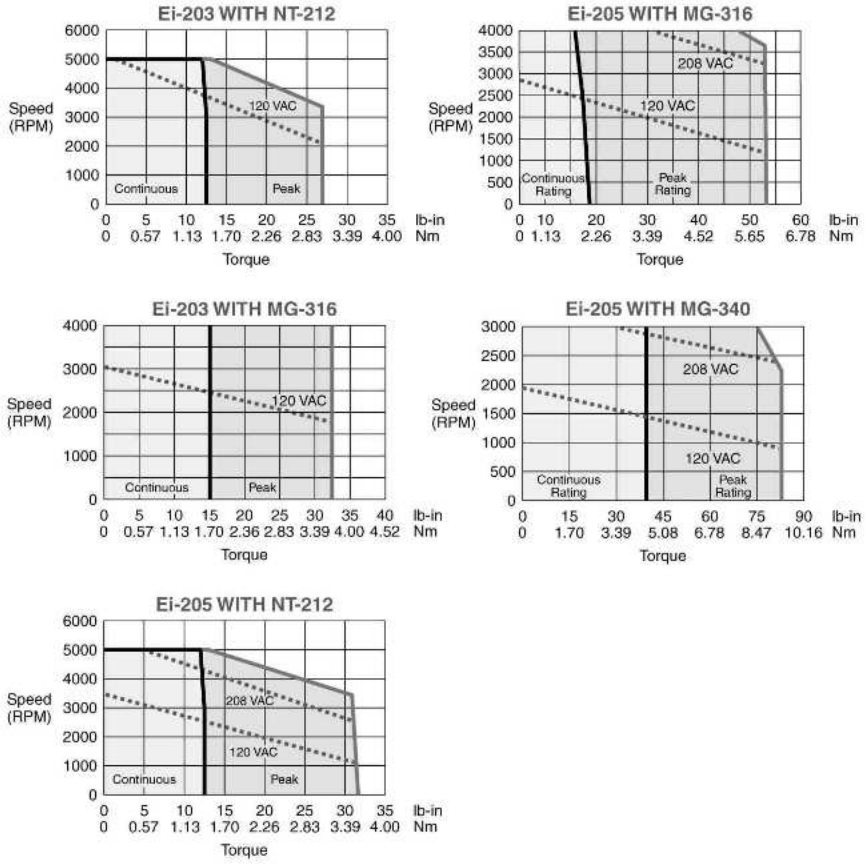


Figure 38: Speed Torque Curves (Sheet 2 of 2)

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Epsilon Drive Dimensions: Ei 202, Ei 203, Ei 205

The following table applies to A* and B* as shown in Figure 39.

Drive Model	Dimension A* (shown in inches/mm)	Dimension B* (shown in inches/mm)
Ei-202	2.10 [53.3]	.45 [11.4]
Ei-203	2.10 [53.3]	.45 [11.4]
Ei-205	3.56 [90.42]	.7 [17.78]

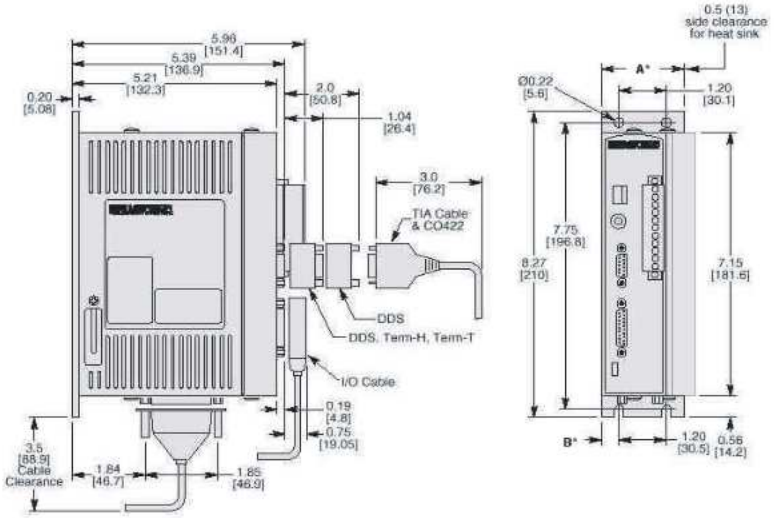
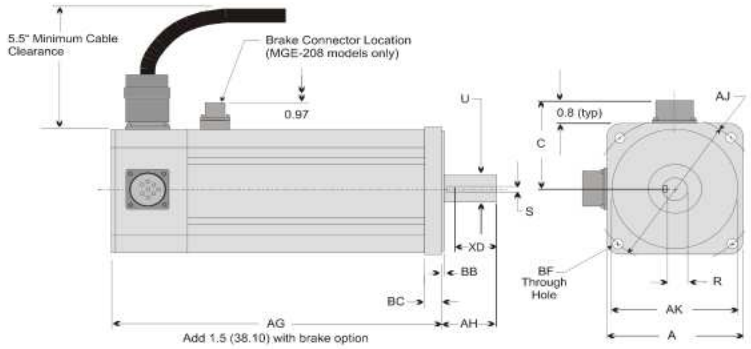


Figure 39: Drive Dimensions

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MG Motor Dimensions

MGE-205 and 208 Motors

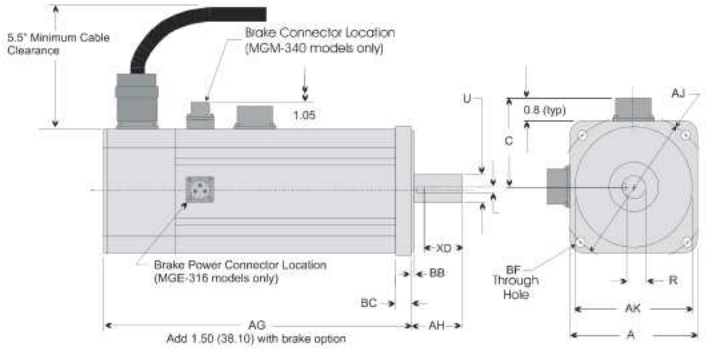


MGE-205 and 208 Mounting Dimensions inches (mm)

	AG	A	BC	AH	U Max	XD	S Min	R	C Max	AJ	BB	AK	BF
205	5.60 (143.0)	2.25 (57.2)	.46 (11.2)	1.20 (30.5)	.375 (9.525)	.563 (14.3)	.127 (3.23)	0.30 (7.62)	2.0 (51)	2.625 (66.68)	.063 (1.60)	1.502 (38.15)	.205 (5.21)
208	6.75 (171.4)	2.25 (57.2)	.46 (11.2)	1.20 (30.5)	.375 (9.525)	.563 (14.3)	.127 (3.23)	0.30 (7.62)	2.0 (51)	2.625 (66.68)	.063 (1.60)	1.502 (38.15)	.205 (5.21)

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MGE-316 and 340 Motors

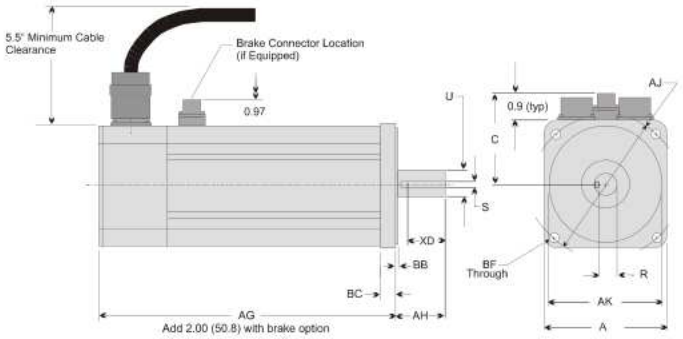


MGE-316E, MGM-316M and MGM-340 Mounting Dimensions inches (mm)						
	AG	A	BC	AH	U Max	XD
316 E	7.24 (184.0)	3.31 (84.0)	.44 (11.2)	1.21 (30.7)	.4997 (12.69)	.90 (22.9)
316 M	7.24 (183.9)	3.50 (89.0)	0.44 (11.2)	1.20 (30.5)	.5512 (14.0)	0.79 (20.0)
340	10.24 (260.1)	3.50 (89.0)	.44 (11.2)	1.20 (30.6)	.5512 (14.0)	.787 (20.0)

MGE-316E, MGM-316M and MGM-340 Mounting Dimensions inches (mm)							
	S Min	R	C Max	AJ	BB	AK	BF
316 E	.1265 (3.213)	.42 (10.7)	2.50 (64.0)	3.875 (98.43)	.06 (1.6)	2.877 (73.08)	.233 (66.0)
316 M	0.20 (5.08)	0.43 (10.9)	2.5 (64.0)	3.937 (108.0)	0.12 (3.0)	3.15 (80.0)	.276 (7.01)
340	.197 (5.0)	.429 (10.9)	2.50 (64.0)	3.937 (100.00)	.118 (3.0)	3.150 (80.01)	.276 (7.01)

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MGE-455, 490 and 4120 Motors

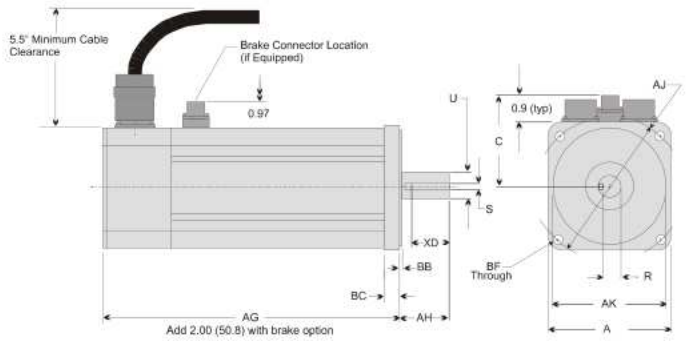


MGE-455, 490 and 4120 Mounting Dimensions inches (mm)							
	AG	A	BC	AH	U Max	XD	S Min
455	8.61 (218.7)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.6245 (15.862)	1.50 (38.1)	.1875 (4.763)
490	11.11 (282.10)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.8750 (22.225)	1.50 (38.1)	.1875 (4.763)
4120	13.61 (345.70)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.8750 (22.225)	1.50 (38.1)	.1875 (4.763)

MGE-455, 490 and 4120 Mounting Dimensions inches (mm)						
	R	C Max	AJ	BB	AK	BF
455	.51 (13.0)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC
490	.77 (19.6)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC
4120	.77 (19.6)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC

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MGM-455, 490 and 4120 Motors



MGE-455, 490 and 4120 Mounting Dimensions inches (mm)							
	AG	A	BC	AH	U Max	XD	S Min
455	8.61 (218.7)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.6245 (15.862)	1.50 (38.1)	.1875 (4.763)
490	11.11 (282.10)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.8750 (22.225)	1.50 (38.1)	.1875 (4.763)
4120	13.61 (345.70)	5.00 (127.0)	.53 (13.5)	190 (48.2)	.8750 (22.225)	1.50 (38.1)	.1875 (4.763)

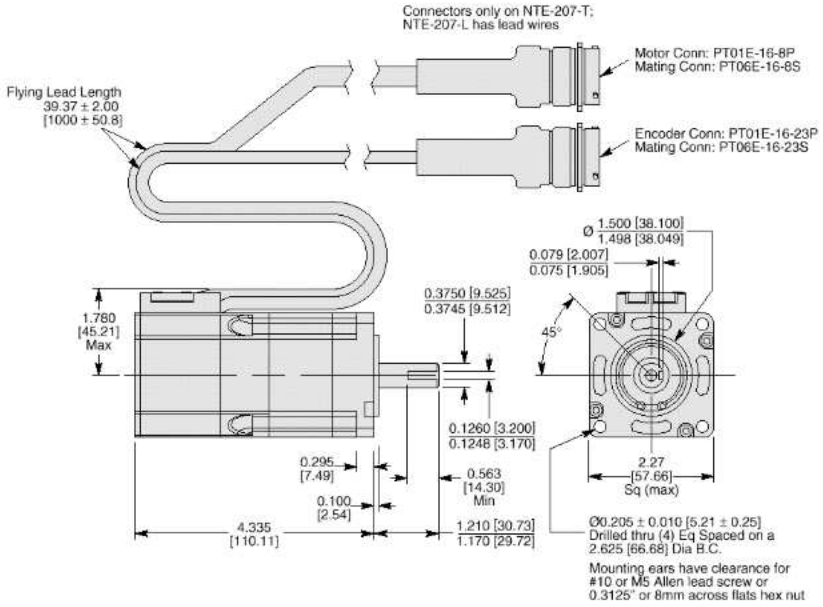
MGE-455, 490 and 4120 Mounting Dimensions inches (mm)						
	R	C Max	AJ	BB	AK	BF
455	.51 (13.0)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC
490	.77 (19.6)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC
4120	.77 (19.6)	3.20 (81.3)	5.875 (149.23)	.10 (2.50)	4.500 (114.30)	3/8-16 UNC

Note

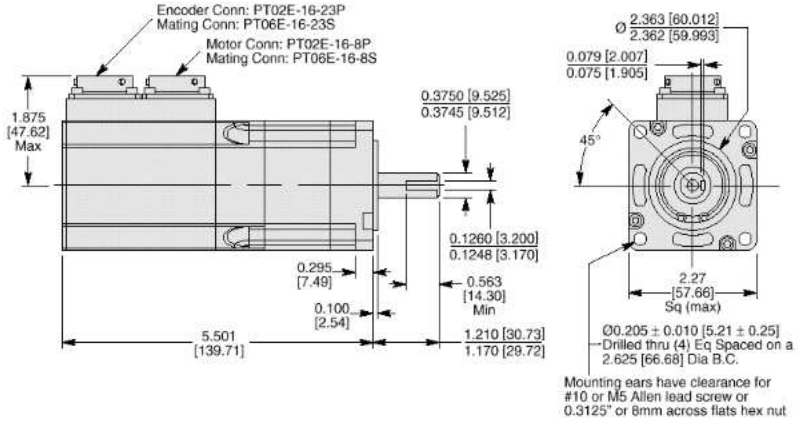
Mounting ears have clearance for #10 or M5 Allen head screw or .3125" or 8mm across flats hex nut.

NT Motor Dimensions

NTE-207 Motors; English Face (NEMA 23 with 3/8 inch shaft)



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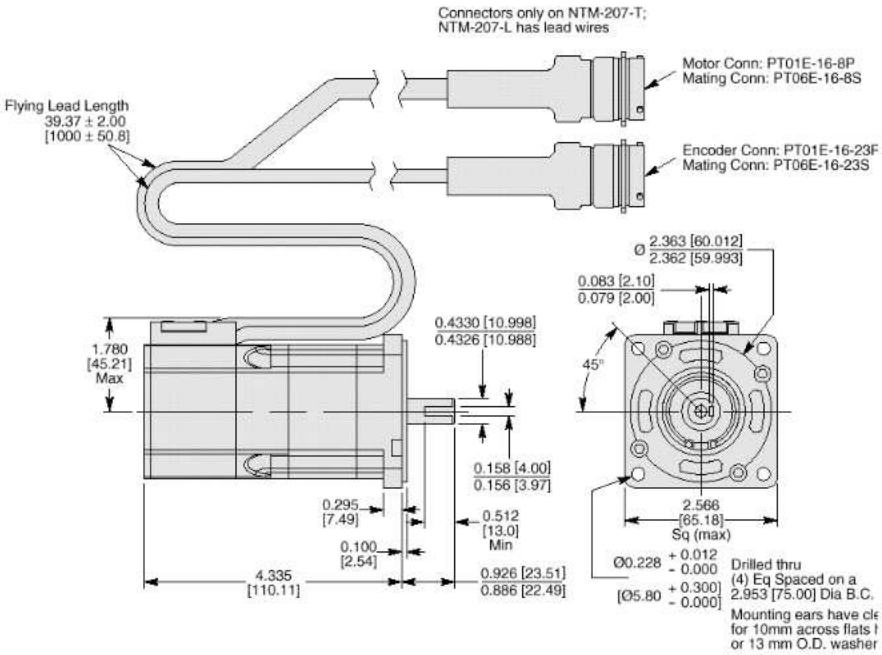


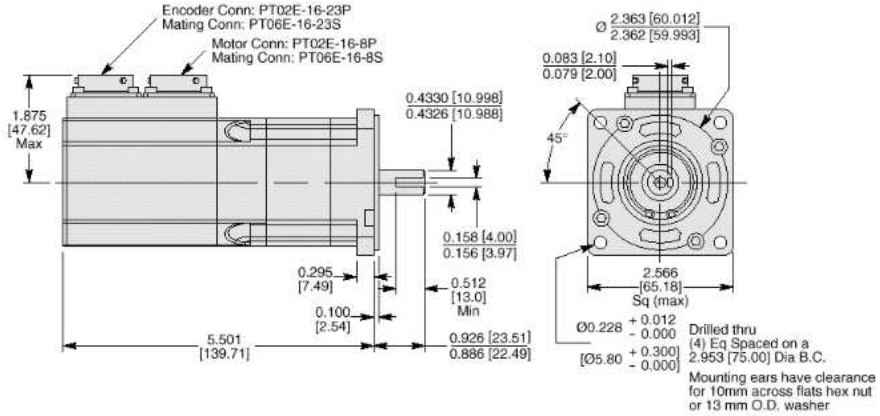
Note

Mounting ears have clearance for #10 or M5 Allen head screw or .3125" or 8mm across flats hex nut.

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NTM-207 Motors; Metric Face



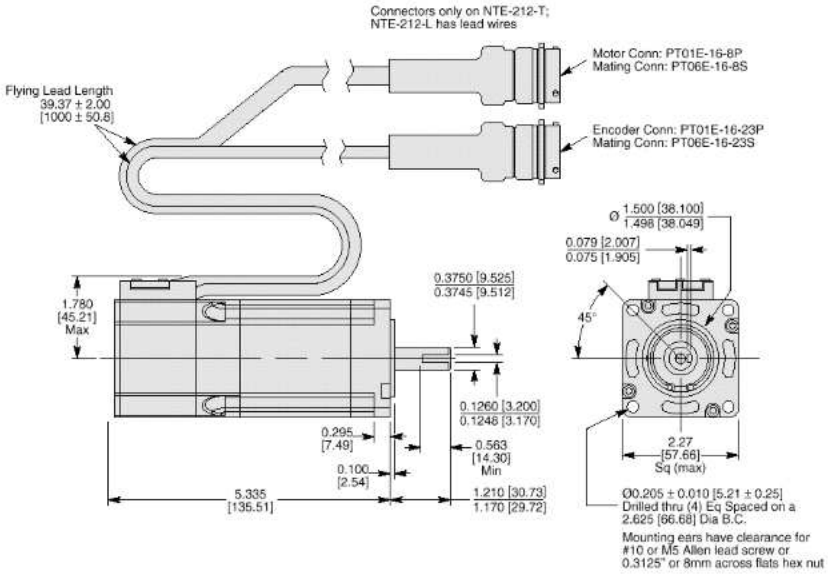


Note

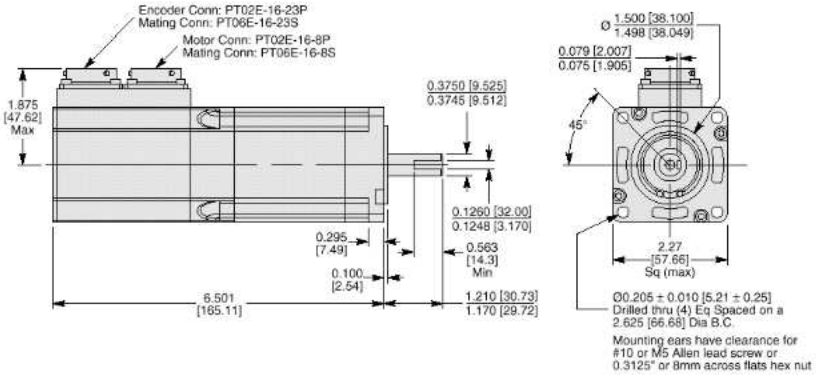
Mounting ears have clearance for 10mm across flats hex nut or 13mm O.D. washer.

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NTE-212 Motors; English Face (NEMA 23 with 3/8 inch shaft)



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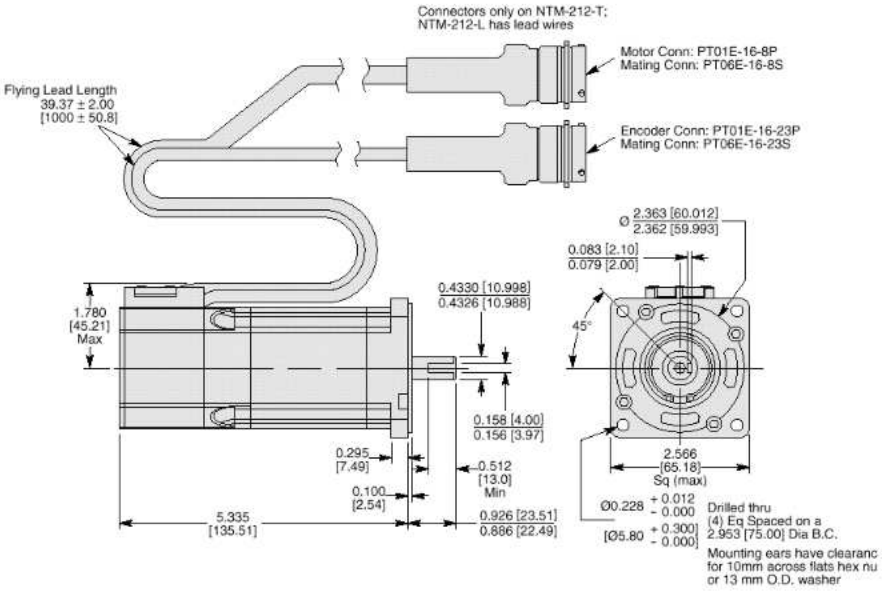


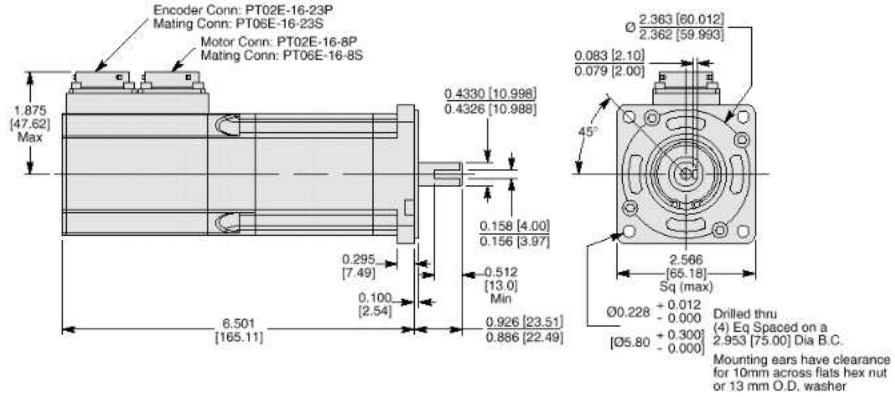
Note

Mounting ears have clearance for #10 or M5 Allen head screw or .3125" or 8mm across flats hex nut.

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NTM-212 Motors; Metric Face





Note

Mounting ears have clearance for 10mm across flats hex nut or 13mm O.D. washer.

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Cable Diagrams

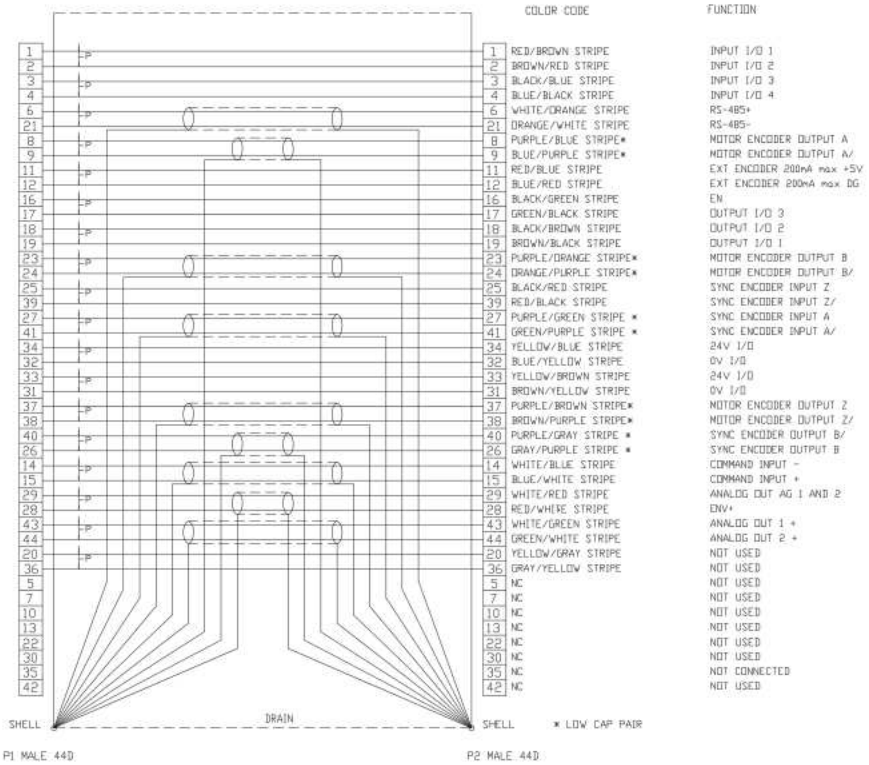
Drive Signal	CMDX, CMDO, ECI-44	CDRO	AX4-CEN
Analog In +	X	X	X
Analog In -	X	X	X
Encoder Out A	X	X	X
Encoder Out A/	X	X	X
Encoder Out B	X	X	X
Encoder Out B/	X	X	X
Encoder Out Z	X	X	X
Encoder Out Z/	X	X	X
Pulse In A	X	X	
Pulse In A/	X	X	
Pulse In B	X	X	
Pulse In B/	X	X	
Pulse In Z	X		
Pulse In Z/	X		
Pulse In A (single ended)	X		X
Pulse In B (single ended)	X		X
I/O Input Drive Enable	X	X	X
I/O Input #1	X		
I/O Input #2	X		
I/O Input #3	X		
I/O Input #4	X	X	X
I/O Output #1	X	X	X
I/O Output #2	X	X	X
I/O Output #3	X	X	X
I/O Power + In (1st wire)	X	X	X
I/O Power + In (2nd wire)	X	X	X
I/O Power 0V In (1st wire)	X	X	X
I/O Power 0V In (2nd wire)	X		
Analog Out 0V	X	X	X

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Drive Signal	CMDX, CMDO, ECI-44	CDRO	AX4-CEN
Analog Out #1 +	X	X	X
Analog Out #2 +	X	X	X
External Encoder +5 Power Out (200 ma)	X	X	X
+15V Power Out (10 ma)	X		
RS-485 +	X		
RS-485 -	X		

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CMDX-XXX Cable

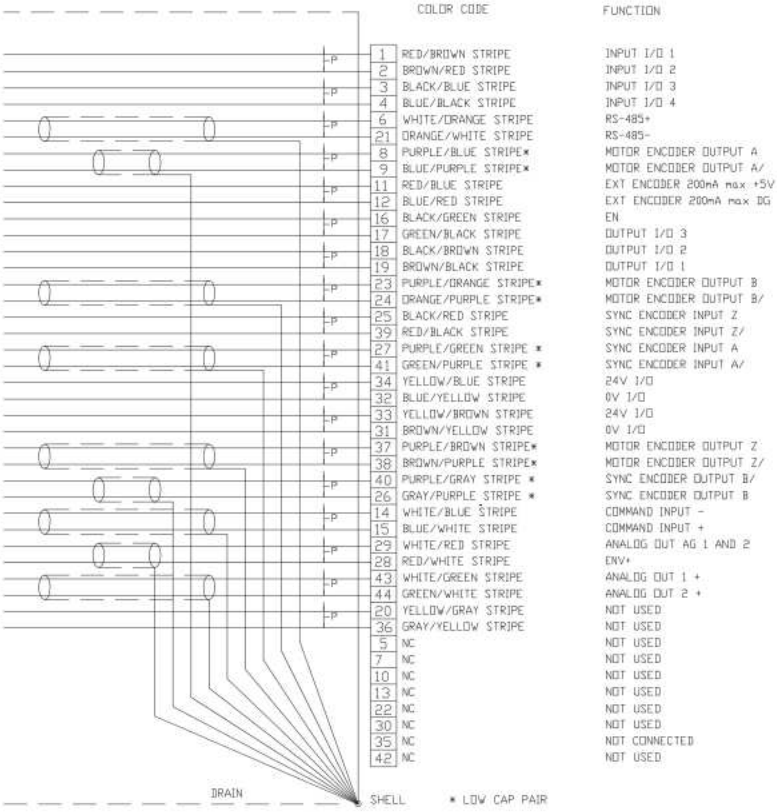


Note

Some CMDX cables may have White/Yellow and Yellow/White wires in place of the White/Orange and Orange/White shown in the figure above (pins 6 and 21).

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CMDO-XXX Cable

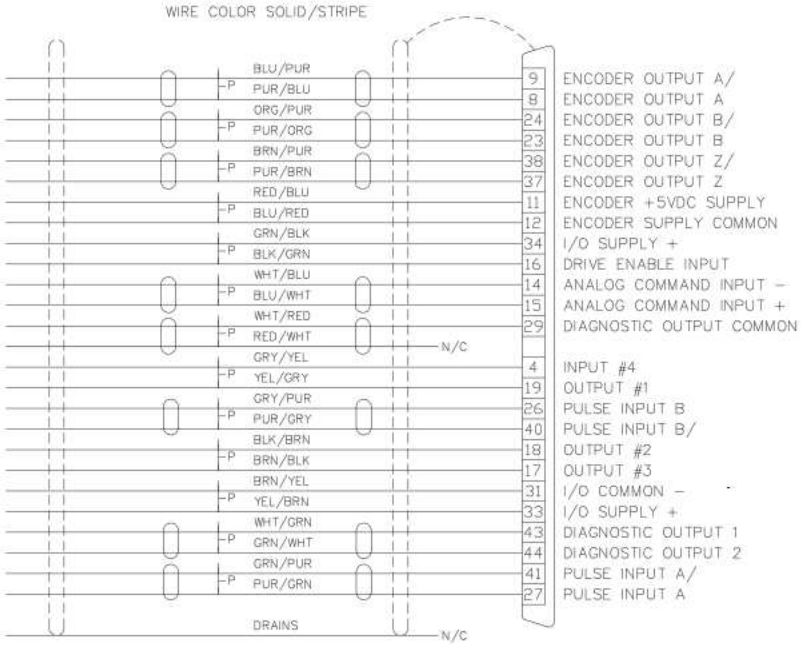


Note

Some CMDO cables may have White/Yellow and Yellow/White wires in place of the White/Orange and Orange/White shown in the figure above (pins 6 and 21).

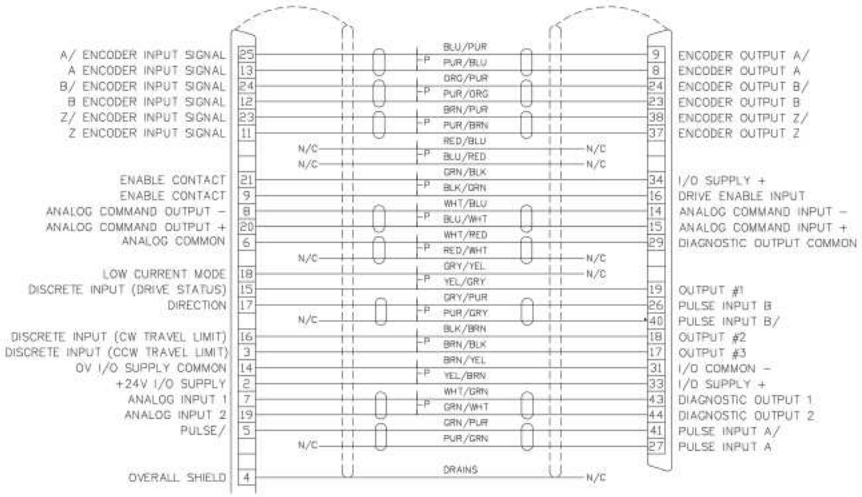
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CDRO-XXX Cable



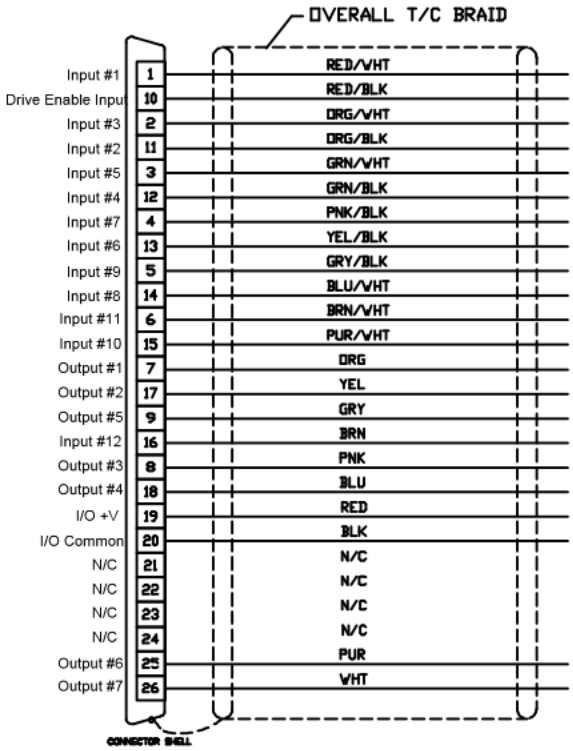
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AX-CEN-XXX Cable



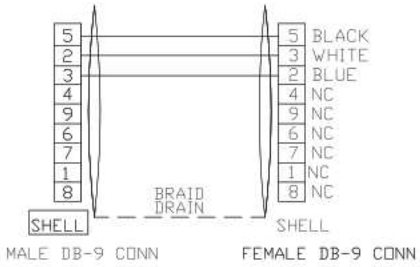
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EIO-XXX Cable

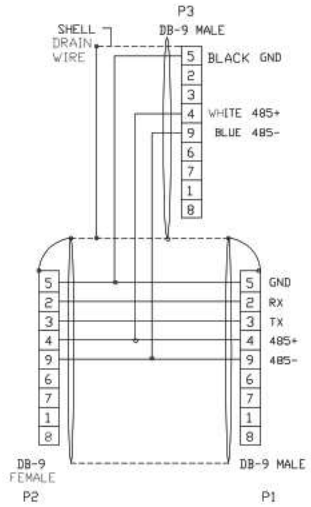


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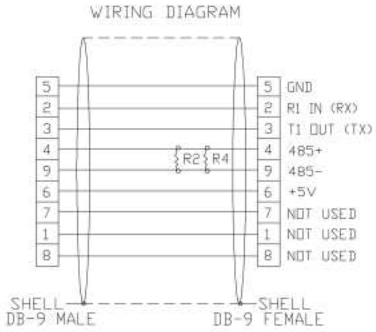
TIA-XXX Cable



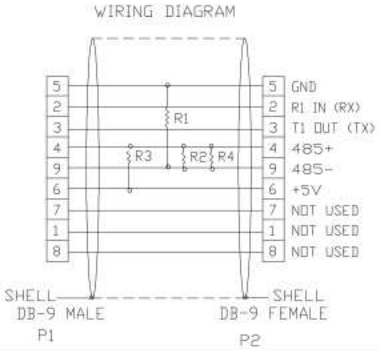
DDS-XXX Cable



TERM-H (Head) Terminator



TERM-T (Tail) Terminator



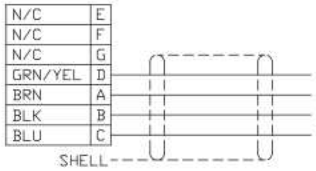


Note

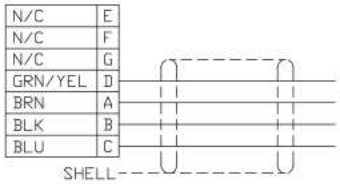
See the "Multi-drop Communications" section for resistor values.

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CMDS-XXX Cable

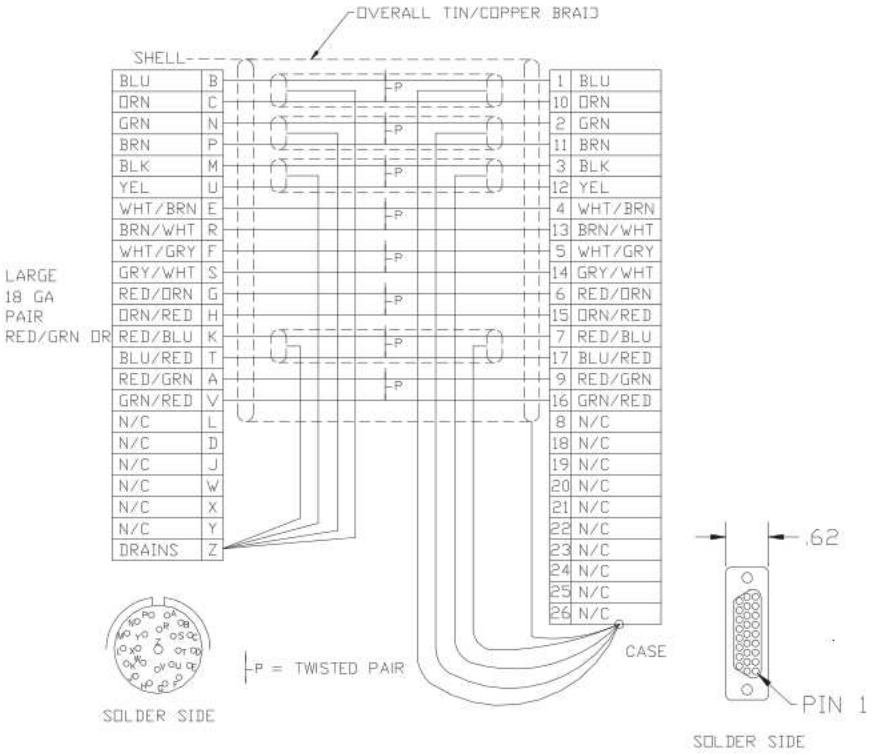


CMMS-XXX Cable



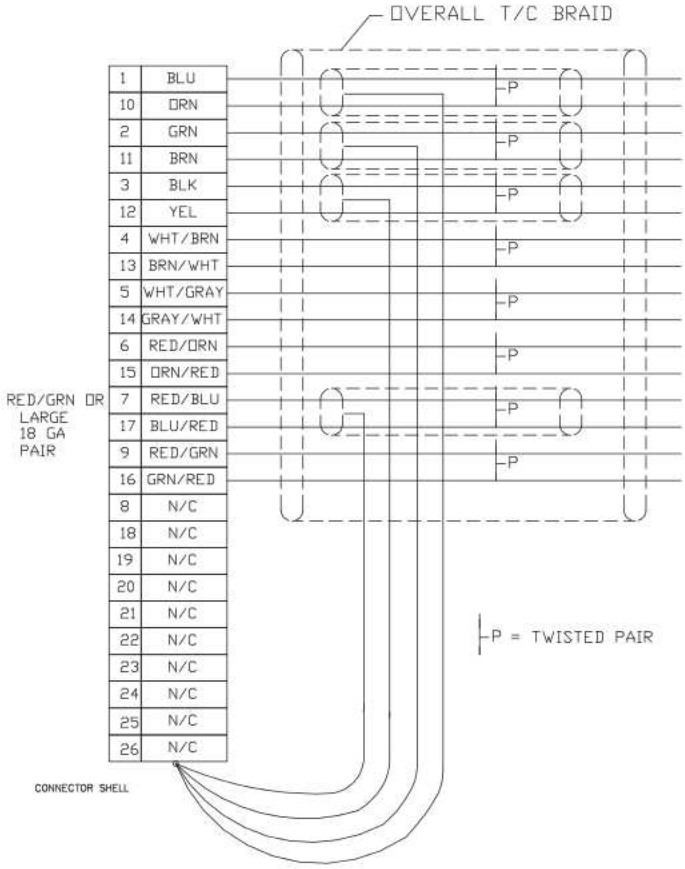
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CFCS-XXX Cable

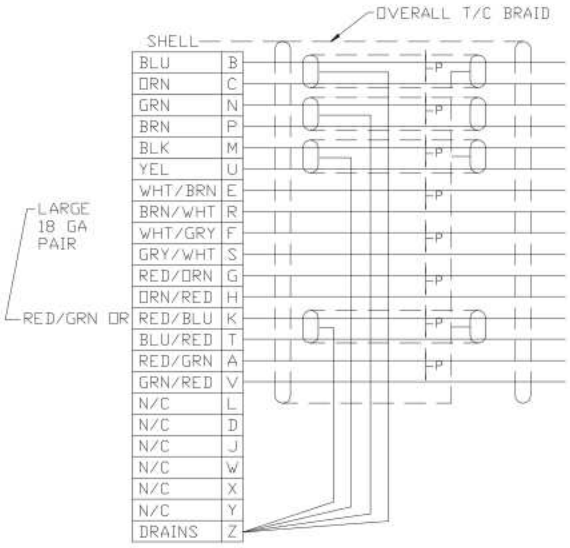


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CFCO-XXX Cable



CFOS-XXX Cable



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Vendor Contact Information

Schaffner (AC Line Filters)
(800) 367-5566 or (201) 379-7778 www.schaffner.com

Cooper Industries, Inc.
Crouse-Hinds Division (Cable Shield Grommets)
(315) 477-5531 www.crouse-hinds.com

Bussman
P.O. Box 14460
St. Lois, MO. 63178-4460
(314) 394-3877 www.bussman.com

Littelfuse
800 E. Northwest Hwy
Des Plaines, IL. 60016
(847) 824-0400 www.littelfuse.com

Wickmann USA
4100 Shirlel Dr.
Atlanta, GA. 30336
(404) 699-7820 www.wickmann.com

Corcom
844 E. Rockland Road
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(847) 680-7444 www.corcom.com

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