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EN Drives

Installation Manual

P/N 400501-02
Revision: A5
Date: January 10, 2003
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EN Drives
Installation Manual



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Part Number: 400501-02

Revision: A5

Date: January 2003

Printed in United States of America

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U.S.A.

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- The type of controller or product you are using

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- Exact wording of any messages that appear on your screen
- What you were doing when the problem occurred
- How you tried to solve the problem

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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® compatible software 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."

Button names are in italic: *OK* button.

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

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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	Placeholders 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.

⚠WARNING

"Warning" indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

⚠ CAUTION

"Caution" indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.

CAUTION

"Caution" used without the safety alert symbol indicates a potentially hazardous situation that, if not avoided, may result in property damage.

Note

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

EN **EN Only**

For the purpose of this manual and product, the "EN" symbol indicates information about the EN drive specifically.

Throughout this manual, the word "drive" refers to an EN drive.

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

- Is trained and authorized to energize, de-energize, clear and 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.

Reference Materials

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

- *PowerTools Software User's Guide* (P/N 400503-01)
- *FM-1 Speed Module Reference Manual* (P/N 400506-01)
- *FM-2 Indexing Module Reference Manual* (P/N 400507-01)
- *FM-3 Programming Module Reference Manual* (P/N 400508-01)
- *FM-4 Programming Module Reference Manual* (P/N 400509-01)
- *FM-3 and FM-4 Connectivity Reference Manual* (P/N 400508-04)
- *RSR-2 Regen Regulator Installation Manual* (400513-01)
- *Flexible Cables Reference Manual* (400512-01)
- *ALP-130 and ALP-430 Installation Manual* (400514-01)
- *Drive Parameters Reference Manual* (400504-01)

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The EN 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:

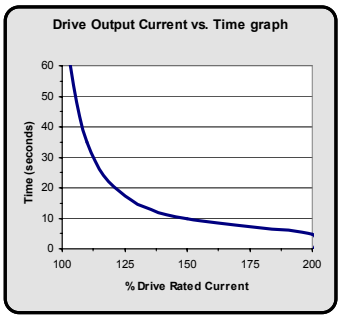
- The drive surrounding air ambient temperature must be 40° C (104° F) or less.
- The EN drive surrounding air ambient temperature can be up to 50°C (122° F) with 3% linear derating for every degree above 40° C (104° F)
- This product is suitable for use on a circuit of delivering not more than 5000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

Drive Overload Protection

The drive output current overload protection is provided by the drive and is not adjustable. This overload protection is based on maximum continuous 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**
EN-204	4.5	9
EN-208	9	18
EN-214	13	26

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CE Declaration of Conformity

CE

The EN 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:	Control Techniques
Manufacturer's Address:	12005 Technology Drive Eden Prairie, MN 55344 USA

Declares that the following products:

Products Description:	E Series Digital Servo Drive
Model Number:	EN-204, EN-208 and EN-214
System Options:	This declaration covers the above products with the ALP-130 Backup Logic Power Supply and ECI-44 Screw Terminal Interface.

Conforms to the following product specification:

Electomagnetic Compatibility (EMC):

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

EN 50082-2/1995:	IEC 1000-4-2/1995; EN 61000-4-2, 4kV 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 IEC 1000-4-8/1993; EN 61000-4-8, 30 A/m ENV 50141/1993, 80% AM, 10V, .15-80 MHz 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.



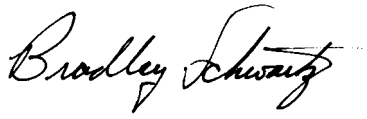
December 2, 1997

Bradley Schwartz/ VP Engineering — Date

European Contact:

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

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Declaration of Conformity	
Manufacturer's Name:	Control Techniques
Manufacturer's Address:	12005 Technology Drive Eden Prairie, MN 55344 USA
Declares that the following products:	
Products Description:	Drive Accessories
Model Number:	RSR-2 and ALP-430
Conforms to the following product specification:	
The products herewith comply with the requirements of the Low Voltage Directive (LVD) 73/23/EEC. These products are considered components and as such, the EMC Directive (89/336/EEC) does not apply.	
Supplementary information:	
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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Safety Considerations

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, carry a high level of stored electrical energy, or are used to control mechanical equipment that 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 that prevents access except by trained and authorized personnel and that prevents the ingress of contamination. This product 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

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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.

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 EN 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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Introduction

EN Drives

The EN 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 EN base drive can be quickly configured to many applications in less than 5 minutes with PowerTools-FM software on a PC running Windows® 95, 98, NT 4.0 and 2000.

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

The EN drives are designed to accept a line of function modules that further enhance its use in various applications.

- FM-1 Speed Module offers the user eight digital Torque presets, two additional Summation modes, and an Alternate Operating mode.
- FM-2 Indexing Module enables the user to initiate up to 16 different indexes, jogging, and a single home routine.
- FM-3 FM-3DN and FM-3PB Programming Modules offer complex motion profiling. A complex motion profile consists of two or more indexes that are executed in sequence such that the final velocity of each index except the last is non-zero. Logical instructions between index statements can provide a powerful tool for altering motion profiles 'on the fly'.
- FM-4 FM-4DN and FM-4PB Programming Modules offer complex motion profiling, along with multi-tasking user programs. A complex motion profile consists of two or more indexes that are executed in sequence such that the final velocity of each index except the last is non-zero. Logical instructions between index statements can provide a powerful tool for altering motion profiles 'on the fly'.

The FM Function modules define complex motion by a configuration file that includes setups and function assignments. For the FM-3 and FM-4 modules, the configuration file also includes programs. The configuration file is created using PowerTools-FM or PowerTools Pro. The FM-1 and FM-2 modules use PowerTools-FM software, and the FM-3, FM-3DN, FM-3PB, FM-4, FM-4DN and FM-4PB modules use PowerTools Pro software. Setup views have the same look and feel as dialog boxes. The wiring of input and output functions is done

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through assignments in the software. PowerTools software is an easy-to-use Microsoft® Windows® based setup and diagnostics tool.

EN Drive

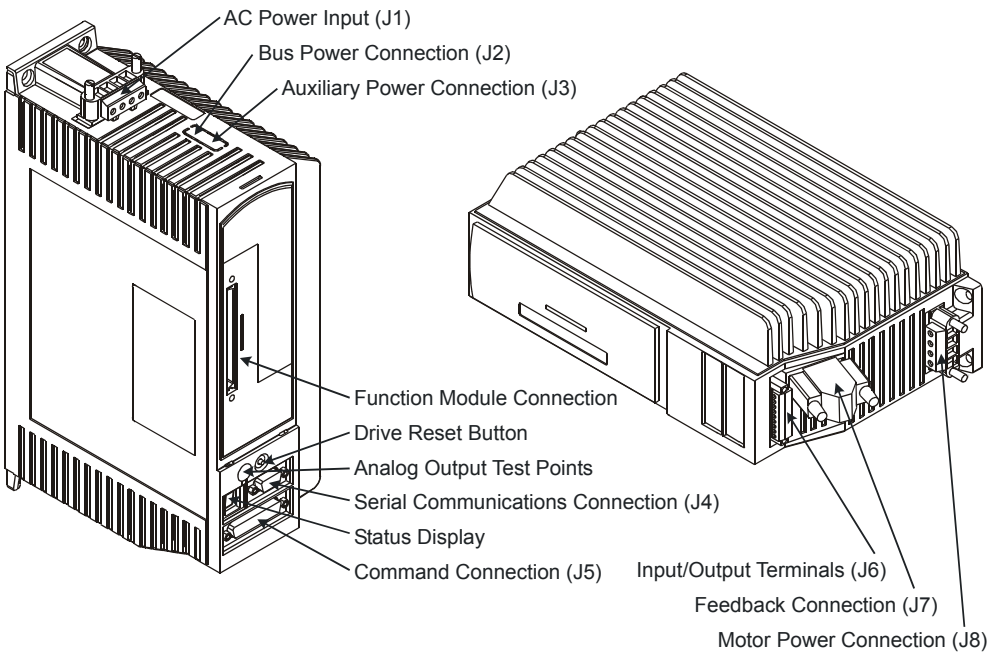


Figure 1: EN Drives Feature Location

EN Drives are rated at 90 to 264 VAC input voltage.

EN drives are available in three power ratings

Drive Model	Power Rating	Continuous Current	Peak Current
EN-204	1750 W	4.5 A RMS	9.0 A RMS
EN-208	2750 W	9.0 A RMS	18.0 A RMS
EN-214	4340 W	13 A RMS	26 A RMS

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

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Installation

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 a 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.

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 Control Techniques 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. In addition:

- 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.

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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 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 significantly higher impedance than a 12 inch long 12 gauge flat braided conductor. A short wire has less impedance than a long 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 corrosion which 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 gauge 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
- 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.

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AC Line Filters

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

EN Model	Schaffner Part #	Control Techniques Part #	Rating
EN-204	FS5278-16/08	960305-01	16A, 240V, 1 Ø
EN-208	FS5278-16/08	960305-01	
EN-214	FN-258/16	960304-01	16A, 480V, 3 Ø

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

EN Model	Part #	Rating
EN-204	**Schaffner** FN 2070M-16/8 **Corcom** 20EQ1	20A, 240V, 1 Ø
EN-208	**Schaffner** FN 2070M-16/8 **Corcom** 20EQ1	

AC Line Filter Installation Notes

- 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. Questions on this subject should be directed to the filter manufacturer.
- It is critical that you keep the filter inputs routed away from any electrical noise sources to prevent noise from being induced into them and carried out of the enclosure.

Cable to Enclosure Shielding

Shielded motor, feedback, serial communications and external encoder cables were used for Control Techniques' 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 2.

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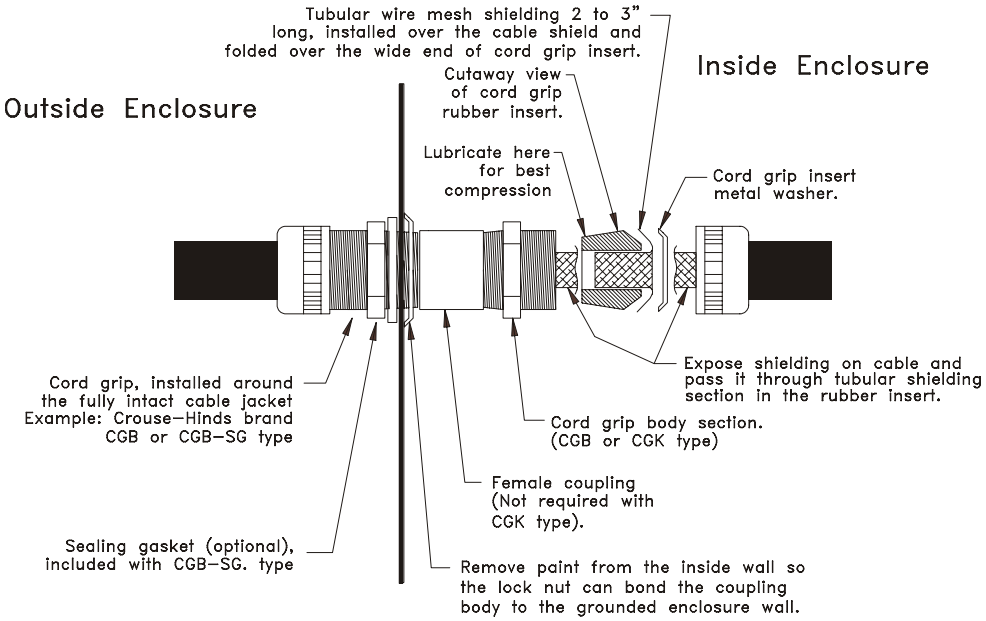


Figure 2: Assembly Drawing for Shielded Cable Grommet Kits In Table Below.

Cable Type	Cable Model	Shielded Cable Grommet Kit Model	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-A	CGS-063	3/4" pipe	1 1/16"
External Encoder	ENCO	CGS-038	1/2" pipe	7/8"
AC Power	user supplied	user supplied	user supplied	user supplied

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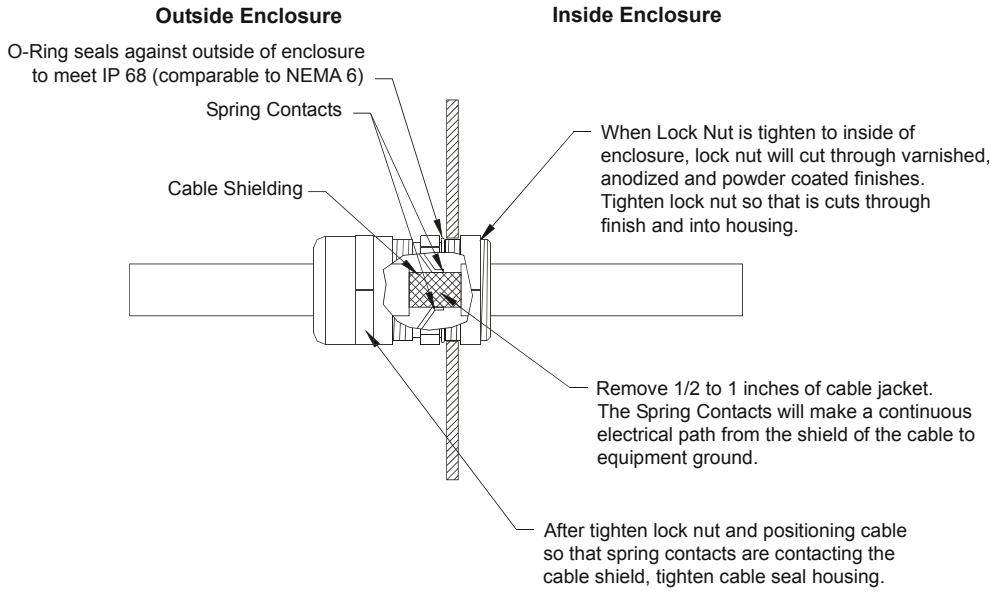


Figure 3: Assembly Drawing for Shielded Cable Grommet Kits Listed in Table Below.

Cable Type	Cable Model	Shielded Cable Grommet Kit Model	Actual Hole Size
Motor Cable, 16 Ga	CMDS	CGS-047	0.8125 or 13/16"
Motor Cable, 12 Ga	CMMS	CGS-069	1.125 or 1 1/8"
	4X12SS	CGS-069	1.125 or 1 1/8"
Motor Cable, 8 Ga	CMLS	CGS-098	1.5 or 1 1/2"
Feedback Cable	CFOS	CGS-047	0.8125 or 13/16"
	MGFS	CGS-047	0.8125 or 13/16"
Flex Motor Cable, 16 Ga	CMDF	CGS-047	0.8125 or 13/16"
	4X16SF	CGS-047	0.8125 or 13/16"
Flex Motor Cable, 12 Ga	CMMF	CGS-069	1.125 or 1 1/8"
	4X12SF	CGS-069	1.125 or 1 1/8"
Flex Feedback Cable	CFCF	CGS-069	1.125 or 1 1/8"
	CFOF-A	CGS-069	1.125 or 1 1/8"
	MGFF	CGS-069	1.125 or 1 1/8"
External Encoder	ENCO	CGS-047	0.8125 or 13/16"

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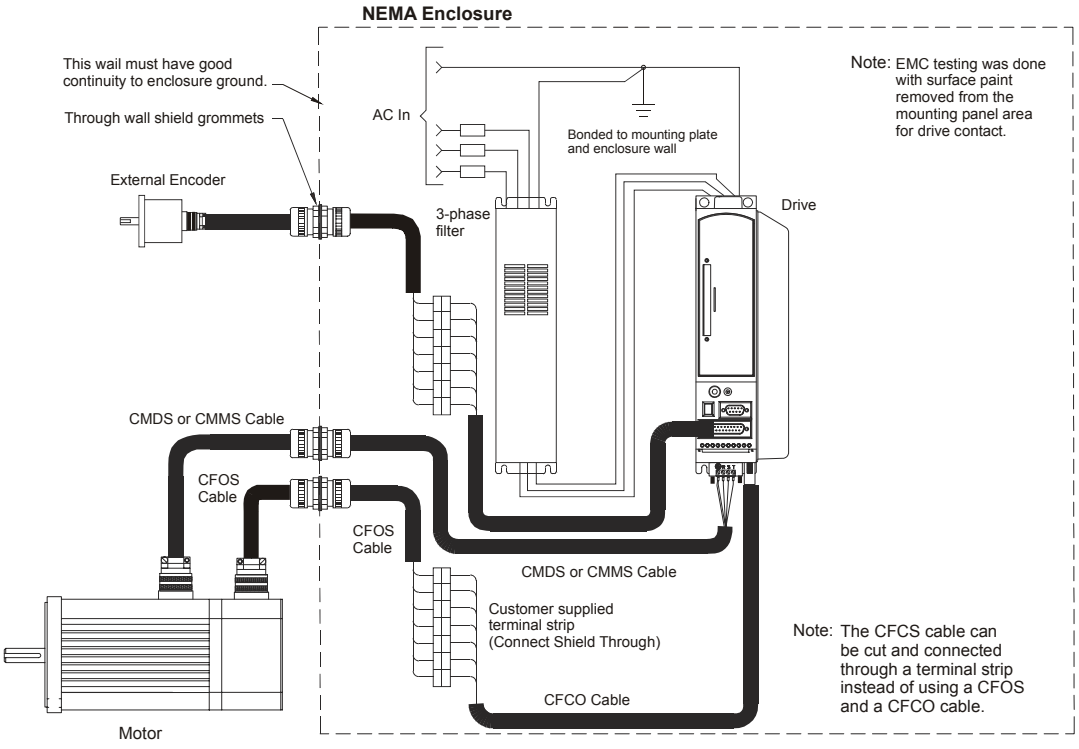


Figure 4: AC Filter and Cable Connections for EN Drives

Environmental Considerations

If the product will be subjected to atmospheric contaminants such as moisture, oils, conductive dust, chemical contaminants and metallic particles, you must mount it vertically in a metal NEMA type 12 enclosure.

If the ambient temperature inside the enclosure will exceed 40° C (104° F), you must consider forced air cooling.

Note

It is necessary to maintain the drive surround air ambient temperature at 40° C (104° F) [50°C (122ºF) with derating of 3% per degree above 40° C].

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 with other equipment.
- Ensure that metal to metal 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. 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

System Grounding

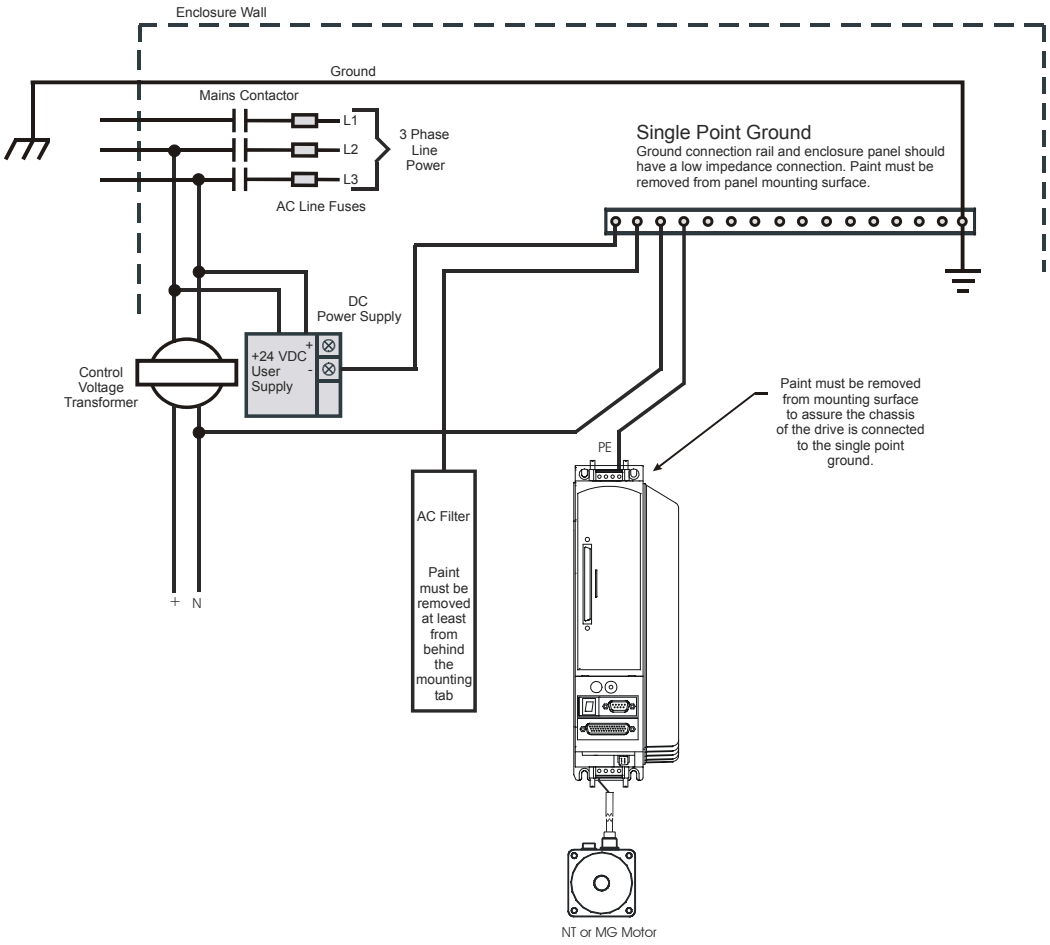


Figure 5: Typical System Grounding Diagram

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.

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⚠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.

⚠WARNING

The EN-204 and EN-208 drives require 90 to 264 VAC single phase power. The EN-214 can operate with single or three phase 90 to 264 VAC. If single phase power is used with the EN-214, you must de-rate the output power available by 20 percent.

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 the 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.

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.

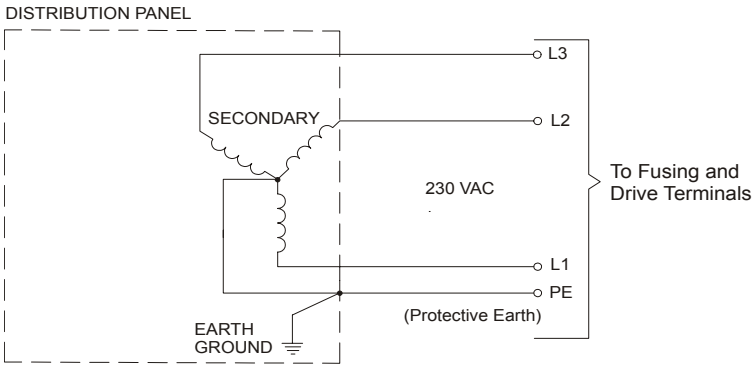


Figure 6: Earth Grounded WYE Distribution Transformer

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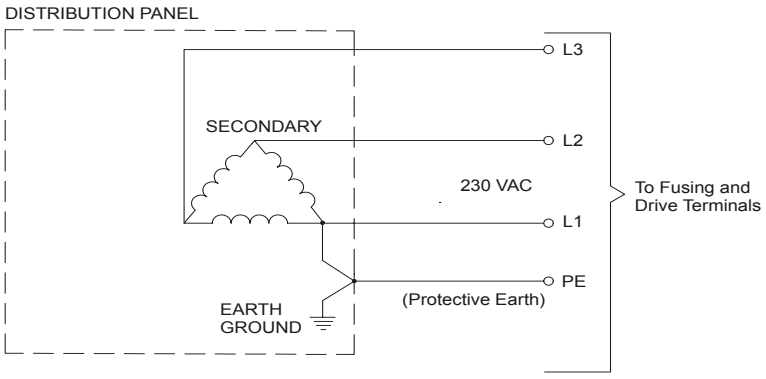


Figure 7: Earth Grounded Delta Distribution Transformer

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.

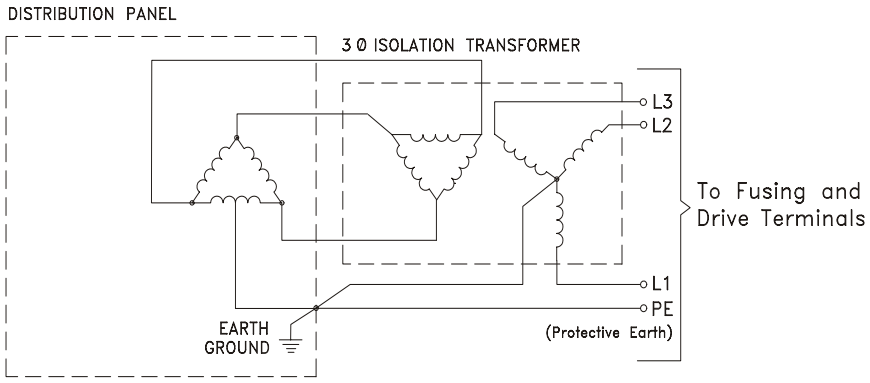


Figure 8: Three Phase Delta (with mid-phase GND) Distribution to a Three-Phase Delta/WYE Isolation Transformer

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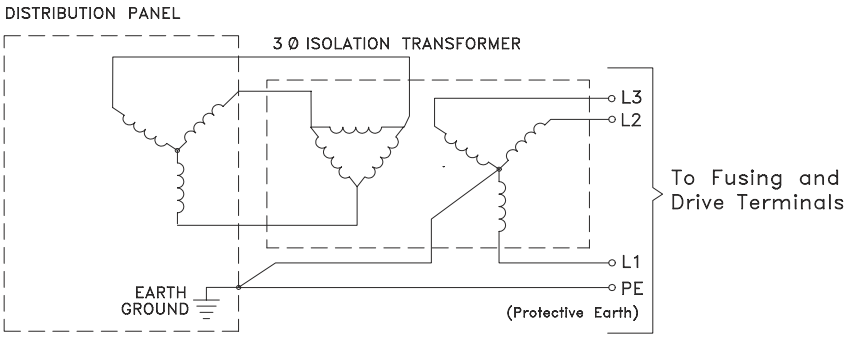


Figure 9: Three Phase WYE (ungrounded) Distribution to a Three-Phase Delta/WYE Isolation Transformer

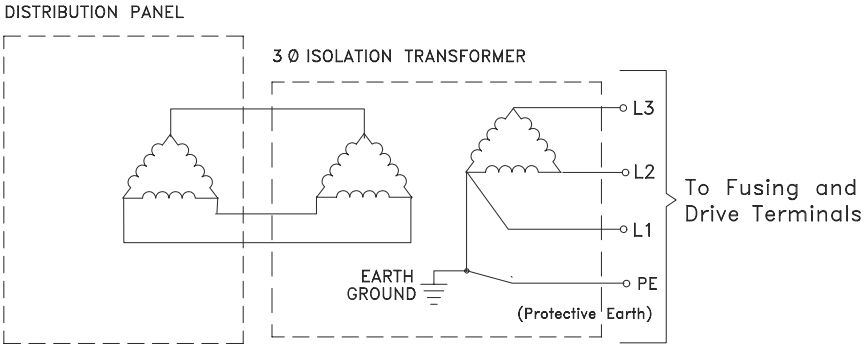


Figure 10: Delta to Delta Isolation Transformer

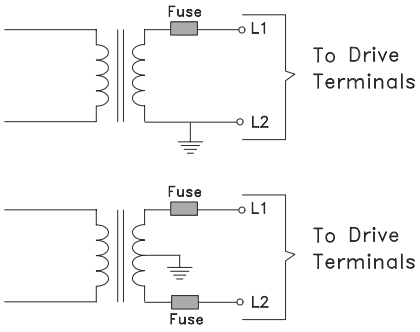


Figure 11: Single Phase Power Supply Connections

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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. Worst case power usage assumes a motor and drive are running at the max. continuous operating point continuously (Max Torque, Max Speed). You can down-size the values only if the maximum power usage is less than the transformer continuous power rating. Other factors that may influence the required KVA rating are high transformer ambient temperatures (>40° C or >104° F) and drive operation near the maximum speeds.

To calculate the power usage of an application use the following formula:

RMS Torque (lb-in) • Avg Velocity (RPM) • 1.1830^{-5} = Continuous Power (KW)

Selecting a proper transformer for the application depends on the type of motion the application requires. For applications with continuous velocity motion, multiply the Continuous Power by 1.5 and select the closest transformer size greater than or equal to this result. For applications that require positioning (multiple starts and stops) use a multiplier of 2 to determine the transformer size.

It is always better to oversize the transformer. Transformer life is directly dependent on the temperature of the windings and if the transformer is undersized the life of the transformer can be decreased. Undersizing may also lead to a voltage drop of the secondary under heavy load conditions.

Drive/Motor Combination	Suggested KVA Rating
EN-204/NT-207	0.44
EN-204/NT-212	0.77
EN-204/MG-205	0.22
EN-204/MG-208	0.44
EN-204/MG-316	0.76
EN-208/NT-320	0.76
EN-208/NT-330	1.28
EN-208/NT-345	1.67
EN-208/NT-355	1.99
EN-208/MG-316	0.76
EN-208/MG-340	1.49
EN-208/MG-455	1.85
EN-214/NT-345	1.67
EN-214/NT-355	1.99
EN-214/MG-455	1.85
EN-214/MG-490	2.84
EN-214/MG-4120	4.26

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Transformer output voltage drop may become a limiting factor at motor speeds and loads near maximum ratings. 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. Control Techniques recommends Bussman type: KTK-R, RK1or equivalent.

Drive Model	External AC Line Fuse	Recommended Minimum AC/PE Line Wire Gauge
EN-204	KTK-R 15 Amp 1Ø	14 AWG
EN-208	RK1 20 Amp 1Ø	12 AWG
EN-214	RK1 20 Amp 3Ø	12 AWG

Drive Model	Input Voltage (VAC)	Frequency (Hz)	Input Current (Amps RMS) at full drive output current		Inrush Current (Amps) 1st Cycle	2nd Cycle
			1 Ø	3 Ø		
EN-204	90 - 264 / 1 Ø	47 - 63	9.5 A	-	140 (8ms)	50 (8 ms)
EN-208	90 - 264 / 1 Ø		19 A	-	140 (8ms)	50 (8 ms)
EN-214	90 - 264 / 1 - 3 Ø		20 A*	14 A	100 (5 ms) 3 Ø	40 (5 ms) 3 Ø

* This is at 20% derated drive output only current as required when using single-phase AC power.

Input Power Connections

According to UL requirements, the EN drive is suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical amperes, 240 volts maximum.

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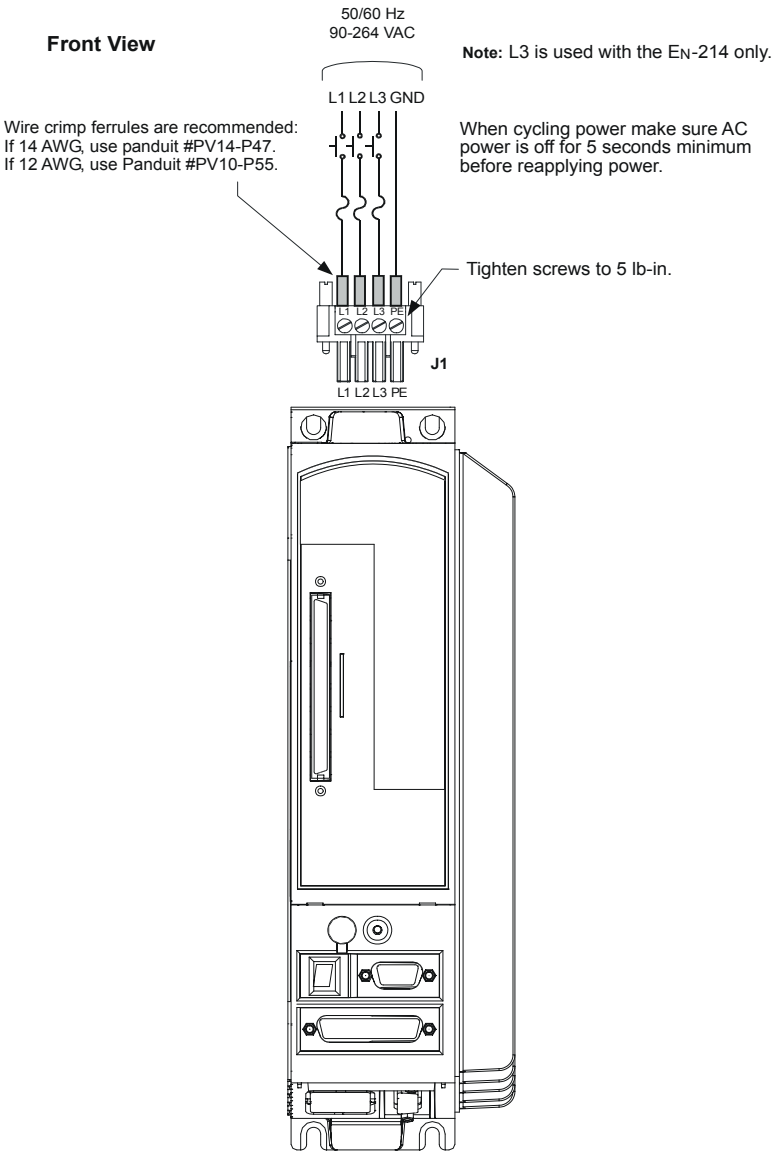


Figure 12: EN AC Power Wiring Diagram

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⚠ 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.

Auxiliary Logic/Alternate Power Wiring Supply

Auxiliary Power Supply (APS) 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.

Auxiliary Logic Power Usage

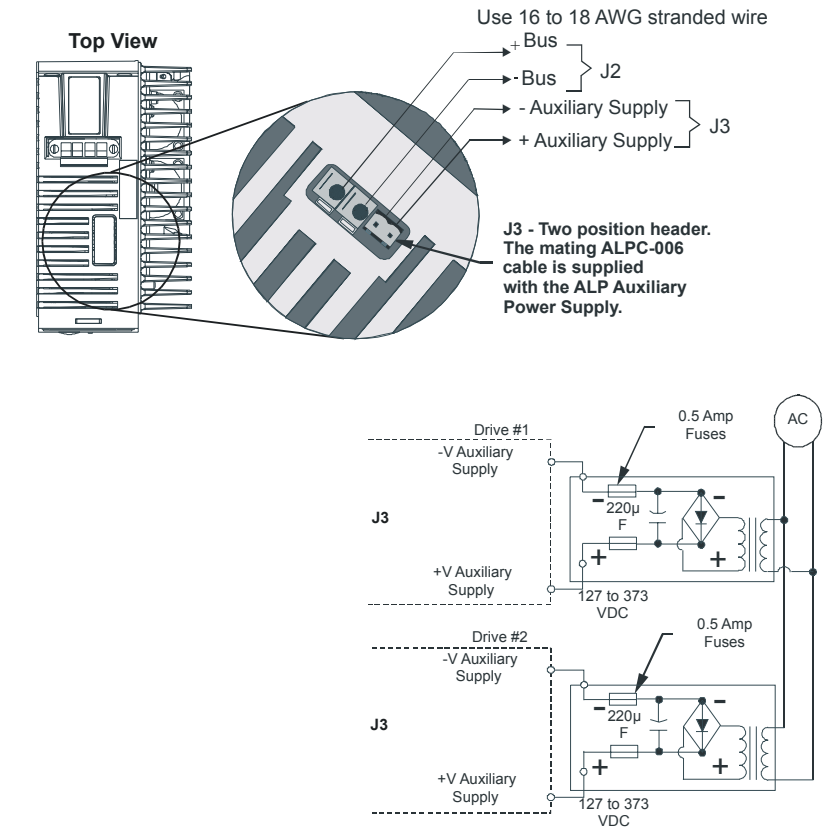


Figure 13: EN Auxiliary Power Supply Wiring Diagram

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As shown in Figure 13, the auxiliary logic power connector is accessed through a plastic punch-out tab located on top of the drive that reads "BUS/AUX". The auxiliary logic power for each EN drive must be individually transformer isolated from the AC supply. The voltage range is 127 to 373 VDC, at 21 Watts. This can be accomplished by isolating, rectifying and filtering 90 to 264 VAC.

System	Power	Voltage
EN Drive Only	15 watts	127 to 373 VDC (Transformer isolated, rectified and filtered 90 to 264 VAC)
EN Drive with FM Module	21 watts	

Control Techniques offers Auxiliary Logic Power Supplies (models ALP-130 and -430) that supply enough power for one EN drive with an FM module and four EN drives with FM module's respectively. See the "Options and Accessories" section for more information.

Model	Input	Output	IP	Rated Ambient Temperature	Weight
ALP-130	115/230 VAC 60 Watts	140 VDC 30 Watts	20	50° C (122° F)	6.4 lbs (2.9 kg)
ALP-430	115/230 VAC 40-60 Watts	140 VDC (4) x 20 Watts	20	50° C (122° F)	7.7 lbs (3.5 kg)

⚠WARNING

Do not connect AC power directly into the auxiliary logic connector. You must wire this connection correctly with transformer isolated 127 to 373 VDC power. Failure to do so can cause death, serious injury or equipment damage. Also, use caution when removing the plastic punch-out tab. AC power must be disconnected for at least 30 seconds before removing the tab.

Motor Power Wiring

MG and NT Motors are equipped with up to three male MS (Military Standard) 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 or CMMS cable have a female MS style connector on the motor end and four individual wires and shield that connect to the motor power connector on the bottom of the drive.

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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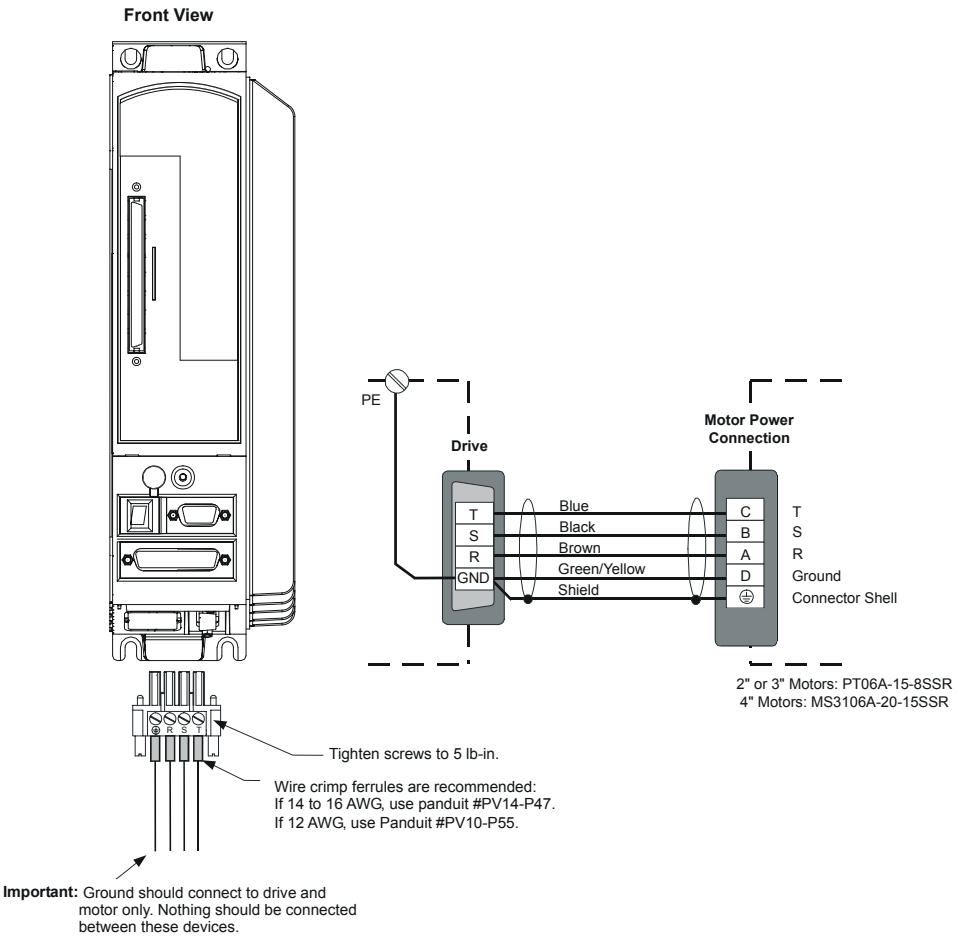


Figure 14: EN Motor Power Wiring Diagram

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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.

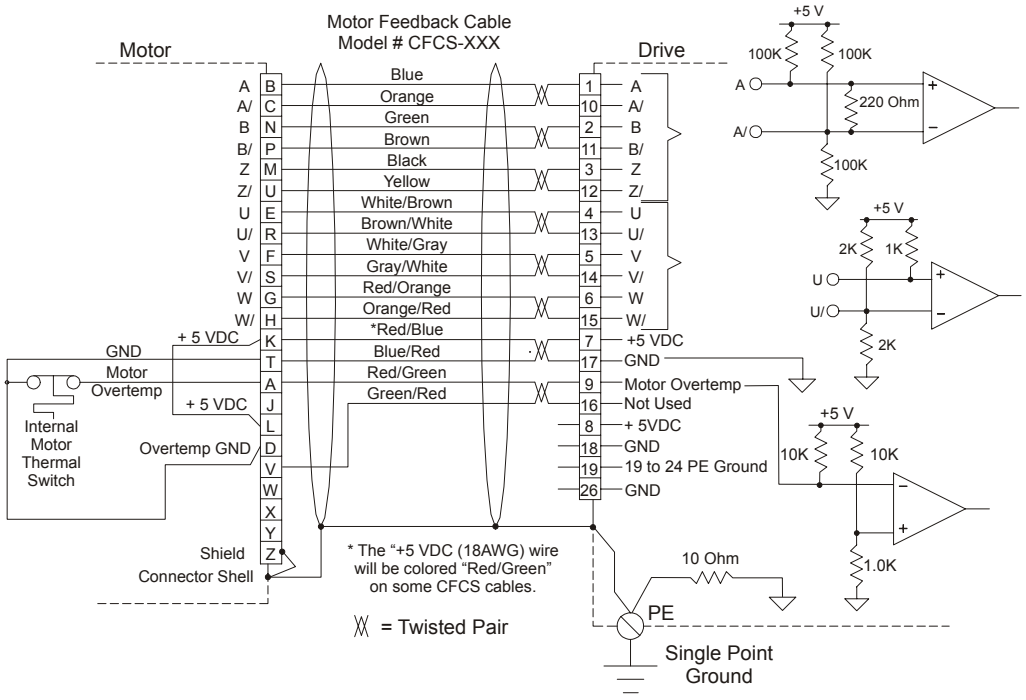


Figure 15: Motor Feedback Connector Pinout

Connection of encoder commutation signals to the drive

EN drives with a part number of 960500-08 or higher (part number label is located on the top of the drive by the AC Input connector) are capable of receiving U, V and W commutation signals from either a differential or common-collector source. Figure 15 shows the input impedance for the U, U/, V, V/, W and W/ inputs on the drive. For single-ended encoder outputs, leave U/, V/, and W/ unconnected at the drive.

EN drives with a part number of 960500 -07 or lower can only accept differential U,V,W, signals.

Note

The indexing pulses A, A/, B, B/, Z, and Z/ must come from a differential source.

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Motor Brake Wiring

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

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.

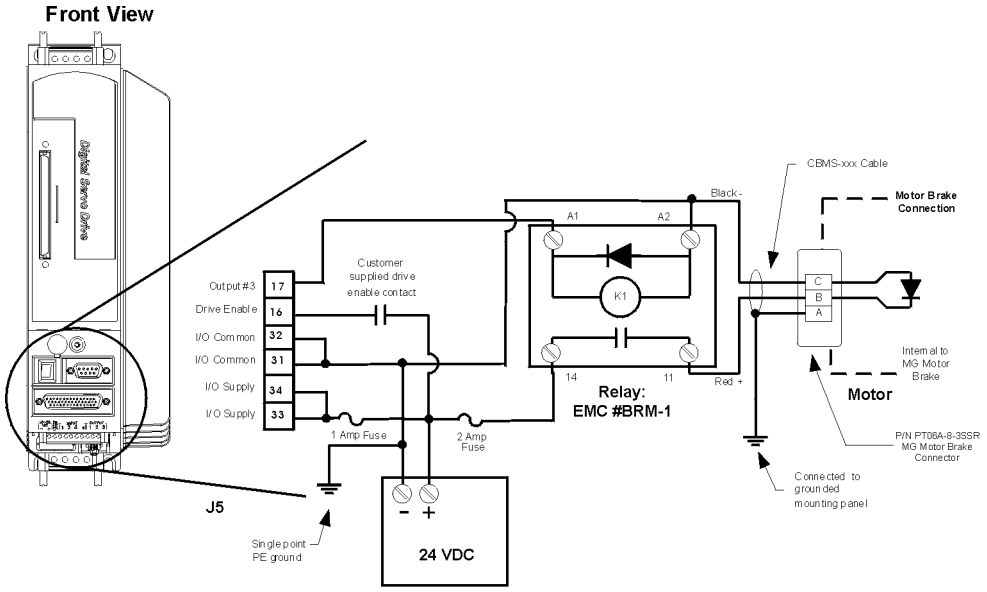


Figure 16: EN Brake Wiring Diagram using the Command Connector

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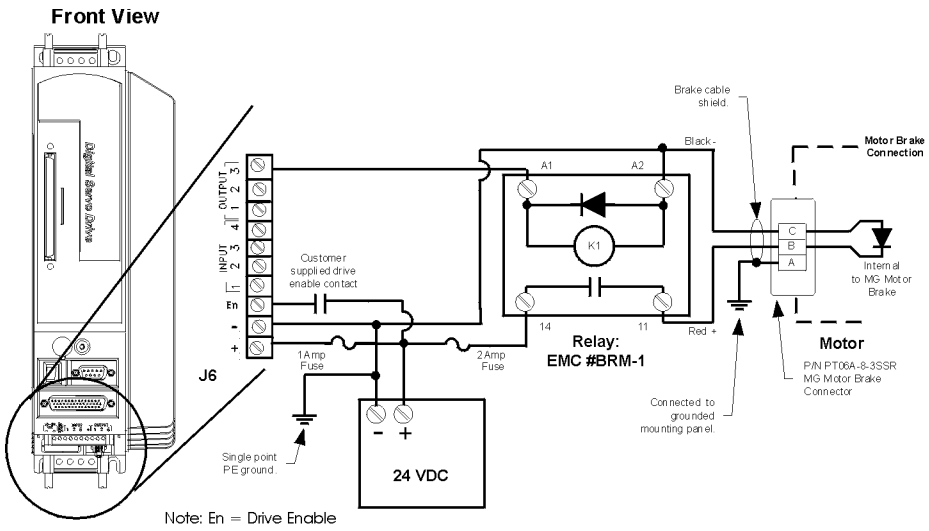


Figure 17: EN Brake Wiring Diagram using the I/O Connector

Input/Output and Drive Enable Wiring

Drives are equipped with five optically isolated input lines (one is dedicated to a drive enable function) and three 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.

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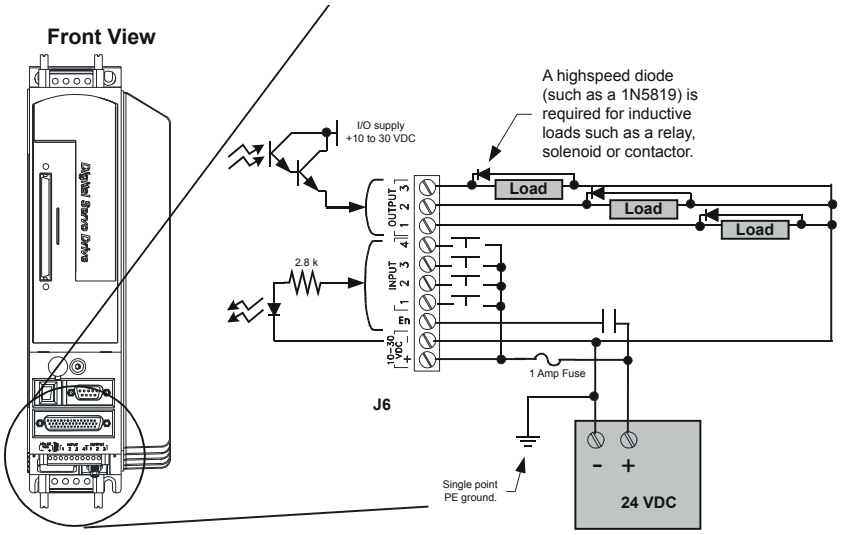


Figure 18: EN Input/Output Wiring Diagram

Note

The I/O connector is a 10-pin removable terminal block. It is recommended that #18 to 24 AWG stranded wire be used.

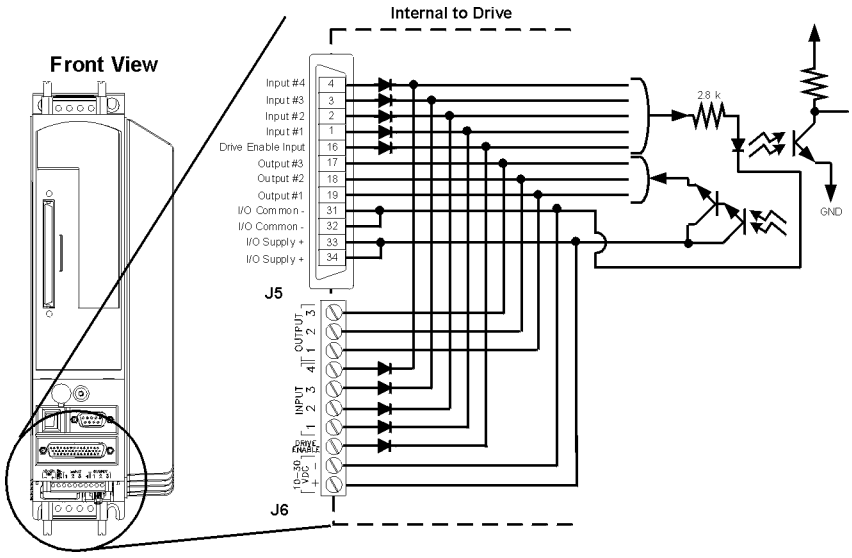


Figure 19: EN I/O Connector to Command Connector Internal Connections

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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 (J5) Wiring

All command, 3 output and 4 input signals are available using the 44-pin Command Connector.

If you are interfacing your drive(s) to an AXIMA 2000 or 4000 multi-axis controller, simply connect the 44-pin connector of your AX4-CEN-XXX cable to the drive and the 25-pin connector to the AXIMA multi-axis controller.

If you are interfacing your drive(s) to an AXIMA or any other motion controller, you may use either the CDRO-XXX or CMDO-XXX cables or 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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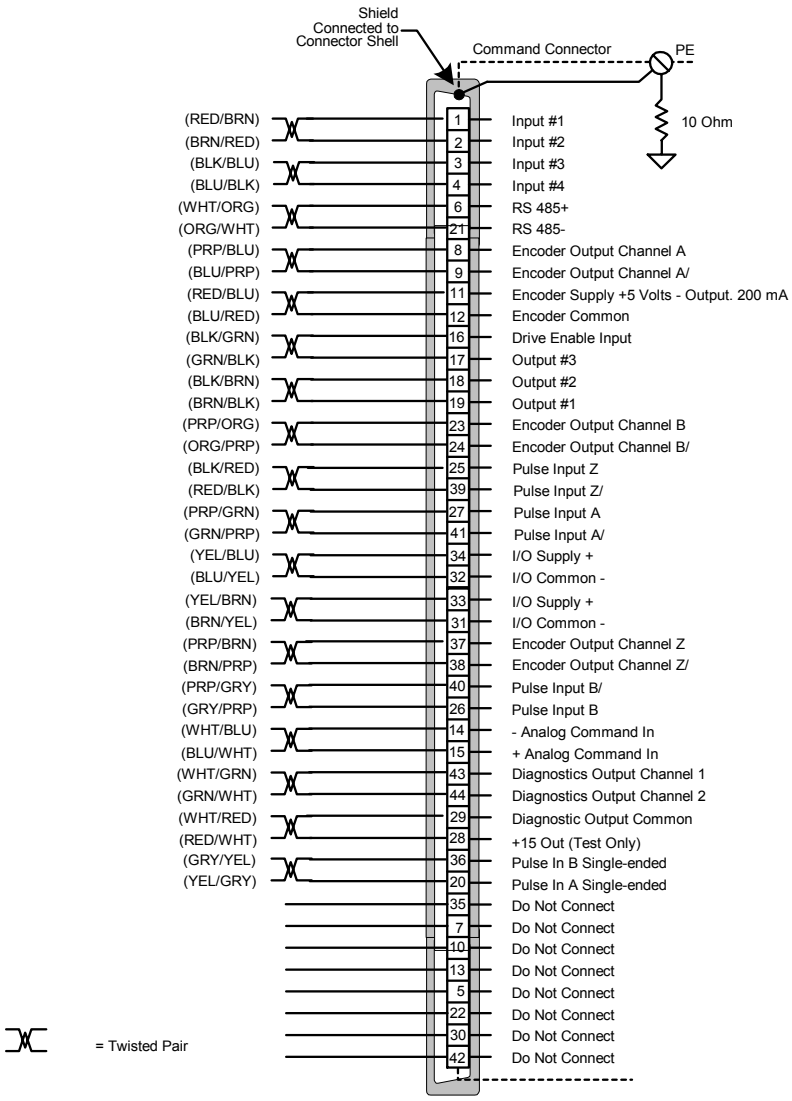


Figure 20: Command Connector (J5) Pinout and CMDO-XXX Wire Colors

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For information about Command Connector pinout and CMDO-XXX cable wire colors, see the "Specifications" section.

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
Pulse Inputs Differential	25, 26, 27, 39, 40, 41	5 V, 200 mV differential, 60 mV hysteresis, RS-422 compatible
Pulse Inputs Single Ended	20, 36	TTL, 330 ohm pull-ups to internal 5 V, 1.5 V = low, 3.5 V = high
Encoder Supply Output +5 V	11	+5 V (200mA) output self-resetting 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)
Analog In	14, 15	± 10 VDC differential command
Diagnostic Output	43, 44	± 10 VDC 10 mA maximum. Analog diagnostic output, ref. to pin 29
Diagnostic Output Common	29	0.0 V, 10 ohms away from PE 0 ohms away from Encoder Common 0V (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 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.

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 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 enclosure spacing requirement below the drive.

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

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Analog Command Wiring

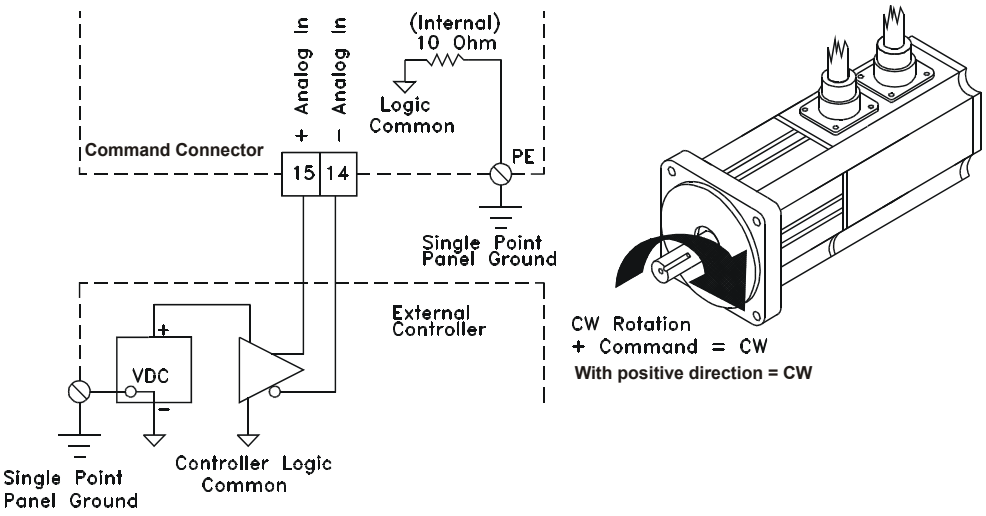


Figure 21: Analog Command, Differential Wiring Diagram

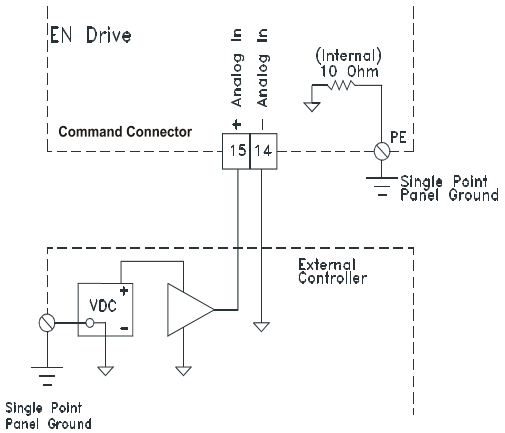


Figure 22: Analog Command, Single Ended Wiring Diagram

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Encoder Output Signal Wiring

The encoder outputs meet RS-422 line driver specifications and can drive up to ten RS-422 signal receivers.

The default encoder output scaling is set to output the actual motor encoder resolutions. The standard MG and NT motors have 2048 lines per revolution. With PowerTools this resolution is adjustable in one line per revolution increments up to the density of the encoder in the motor.

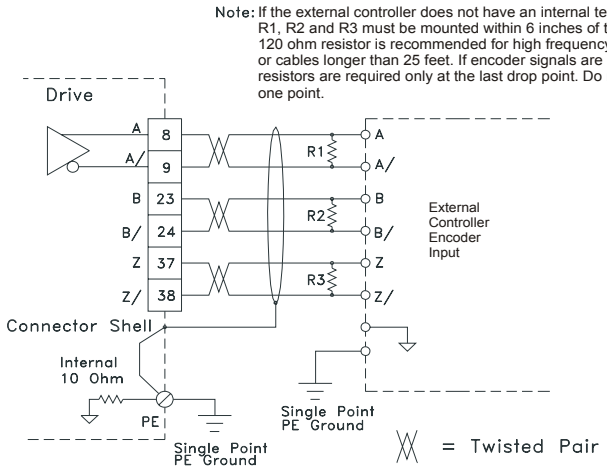


Figure 23: Command Connector Encoder Output Wiring

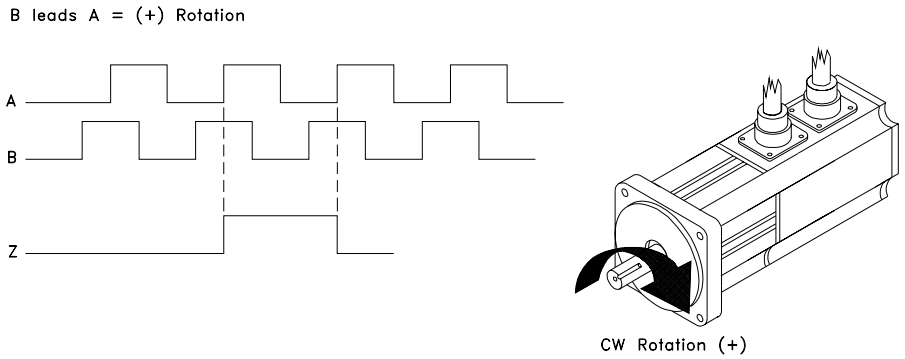


Figure 24: Direction Convention Diagram

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Pulse Mode Wiring, Differential Inputs

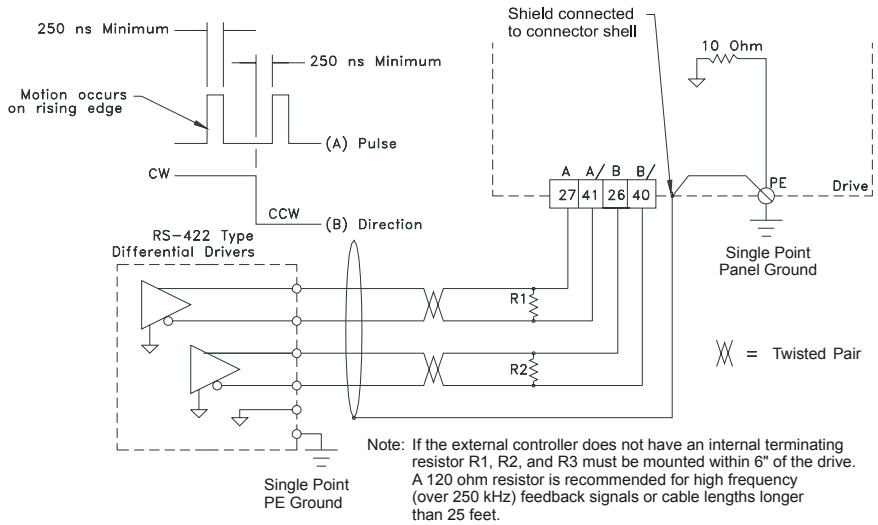


Figure 25: Pulse Mode, Differential Output to Differential Input

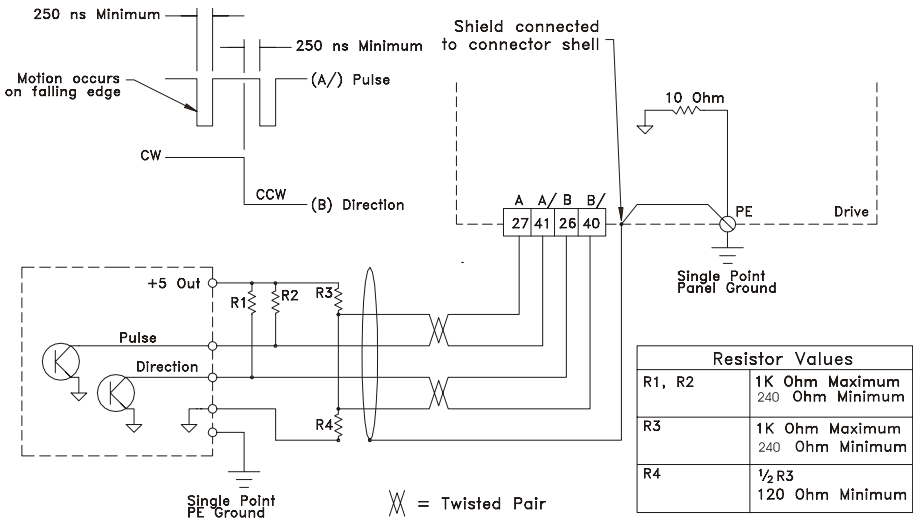


Figure 26: Pulse Mode, Single Ended Output to Differential Input

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Pulse Mode Wiring, Single Ended Inputs

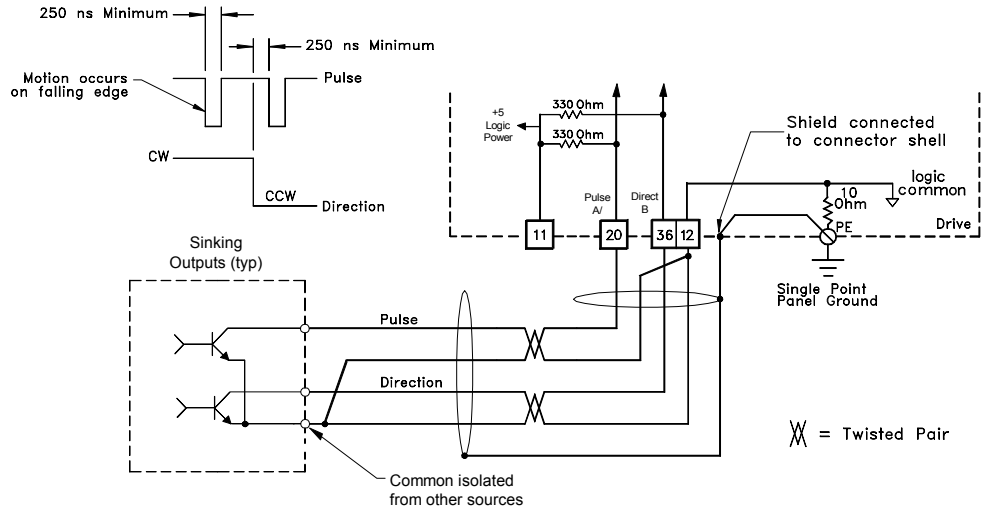


Figure 27: Pulse Mode, Single Ended Output to Single Ended Input (twisted pair cable)

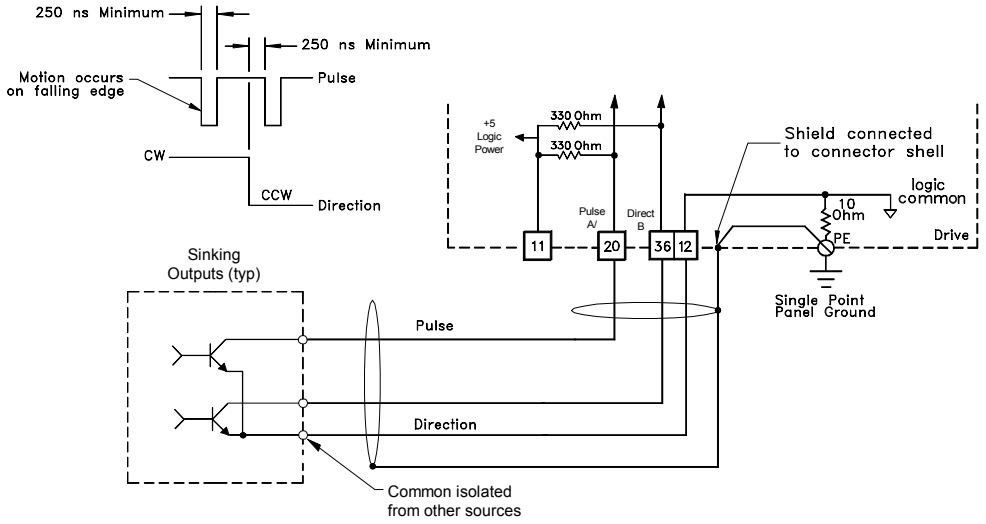


Figure 28: Pulse Mode, Single Ended Output to Single Ended Input (non-twisted pair cable)

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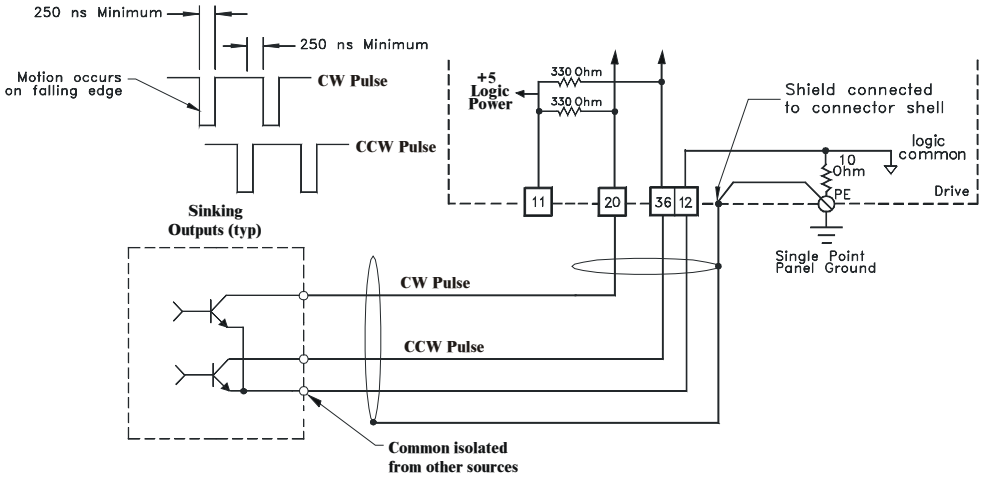


Figure 29: Pulse/Pulse Mode, Single Ended Output to Single Ended Input (non-twisted pair cable)

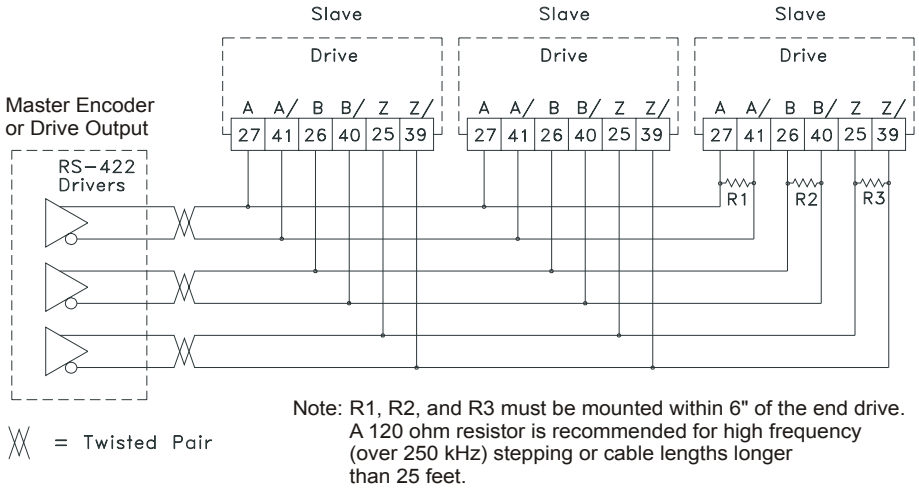


Figure 30: Master/Slave Encoder Connections

Note

Encoder outputs meet RS-422 driver specifications and can drive up to 10 RS-422 signal receivers. Each differential pulse input is an RS-422 line receivers. The default encoder

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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 1 and the actual motor encoder density.

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.

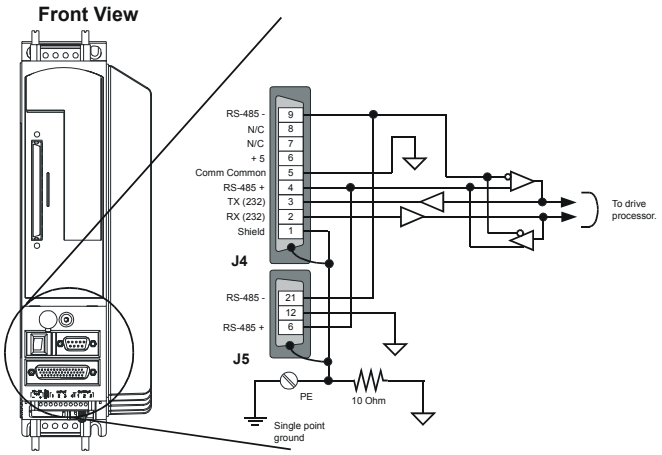


Figure 31: EN Drive RS-232 and RS-485 Internal Connections between the Command Connector and the Serial Communication Connector

⚠ 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.

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Modbus Communications

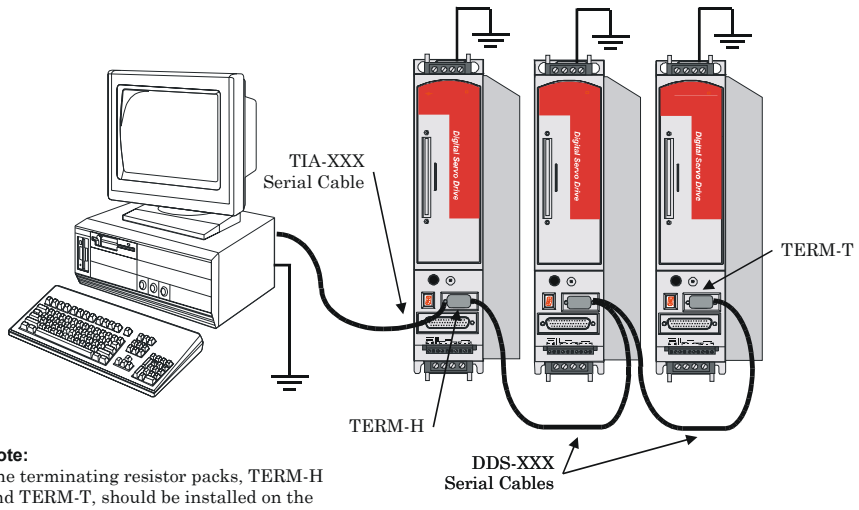
The drive's serial communication protocol is Modbus RTU slave with a 32 bit data extension. The Modbus protocol is available on most operator interface panels and PLC's.

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

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

Multi-Drop Communications

The RS-485 option (pins 4 and 9) is provided for multi-drop configurations of up to 32 drives. Control Techniques 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 32: EN Multi-Drop Wiring Diagram

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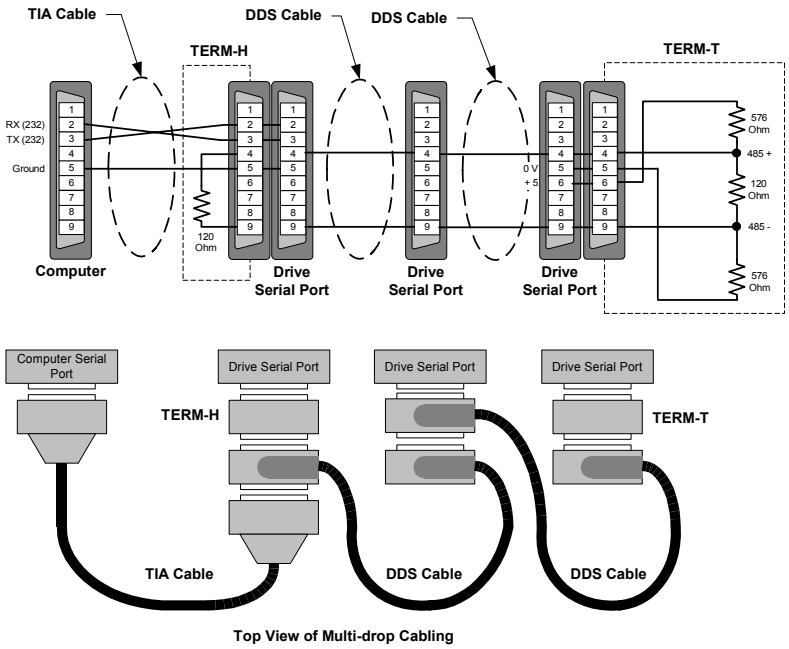


Figure 33: Multi-Drop Wiring Pinout

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Diagnostics and 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 will respond to motion commands. Commands will not cause motion unless the decimal point is “On”.

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. See Brake Operation section for detailed description of Brake Output function.
	Disabled	Power Stage is disabled.
	Position	Pulse mode operation.
	Velocity	Velocity mode operation.
	Torque	Torque mode operation.
	Summation	Summation mode operation.
	RMS Foldback	Motor torque is limited to 80 percent.
	Stall Foldback (EN drive only)	Drive output current is limited to 80 percent of drive stall current.

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Display Indication	Status	Description
.	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 status 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 +/- Travel 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 faults are active, only the higher priority fault will be displayed.

Display	Fault	Action to Reset	Bridge Disabled
I	Power Up Test	Cycle Power	Yes
N	NVM Invalid	Reset Button or Input Line	Yes
U	Invalid Configuration (EN drive only)	Reset Button or Input Line	Yes
Z	Power Module	Reset Button or Input Line	Yes
H	High DC Bus	Reset Button or Input Line	Yes

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Display	Fault	Action to Reset	Bridge Disabled
	Low DC Bus	Reset Button or Input Line	Yes
	Encoder State	Cycle Power	Yes
	Encoder Hardware	Cycle Power	Yes
	Motor Overtemp	Allow Motor to cool down, Reset Button or Input Line	Yes
	RMS Shunt Power (EN drives only)	Reset Button or Input Line	Yes
	Overspeed	Reset Button or Input Line	Yes
	Following Error (Pulse mode only)	Reset Button or Input Line	Yes
	Travel Limit +/-	Auto	No
	All "On"	Normally "On" for one second during power-up	Yes

Fault Descriptions

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.

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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.

Invalid Configuration

A function module was attached to the drive on its previous power-up. To clear, press and hold the Reset button for 10 seconds.

Drive Overtemp

Indicates the drive IGBT temperature has reached 100°C (212°F).

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).

High DC Bus

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

	High DC Bus Threshold	Low DC Bus Threshold
EN	440	96

Low DC Bus

This fault will occur whenever the voltage on the DC bus drops below the Low DC Bus threshold. 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. .

	High DC Bus Threshold	Low DC Bus Threshold
EN	440	96

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EC 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. For some types of custom motors it may be necessary to disable this fault. Refer to the Advanced Tab section of Setting Up Parameters for more information.

EE Encoder Hardware

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

MT Motor Overtemp

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

SW RMS Shunt Power

This fault is generated when RMS shunt power dissipation is greater than the design rating of the internal shunt.

OS Overspeed

This fault occurs in one of two circumstances:

1. When the actual motor speed exceeds the Overspeed Velocity Limit parameter or 150% of motor maximum operating speed. This parameter can be accessed with PowerTools software.

2. If the combination of command pulse frequency and Pulse Ratio can generate a motor command speed in excess of the fixed limit of 13000 RPM, an Overspeed Fault will be activated. In Pulse mode operation and any Summation mode which uses Pulse mode, the input pulse command frequency is monitored and this calculation is made. For example, with a Pulse Ratio of 10 pulses per motor revolution, the first pulse received will cause an Overspeed fault even before there is any motor motion.

FE 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 or disable in the Position tab. The Following Error Limit is functional in Pulse mode only.

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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 Control Techniques for service advice.

Normally, "All On" for less than one second during power-up. All segments dimly lit when power is "Off" is normal when an external signal is applied to the encoder inputs (motor or master) or serial port from an externally powered device. The signals applied to the inputs cannot exceed 5.5V level required to drive logic common or drive damage will occur.

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 provides a programmable Analog Output Source.

Analog Output Source options are:

- 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

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

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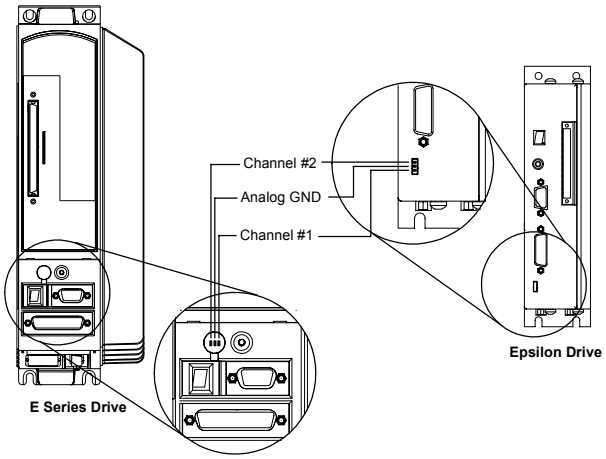


Figure 34: Diagnostic Analog Output Test Points

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.

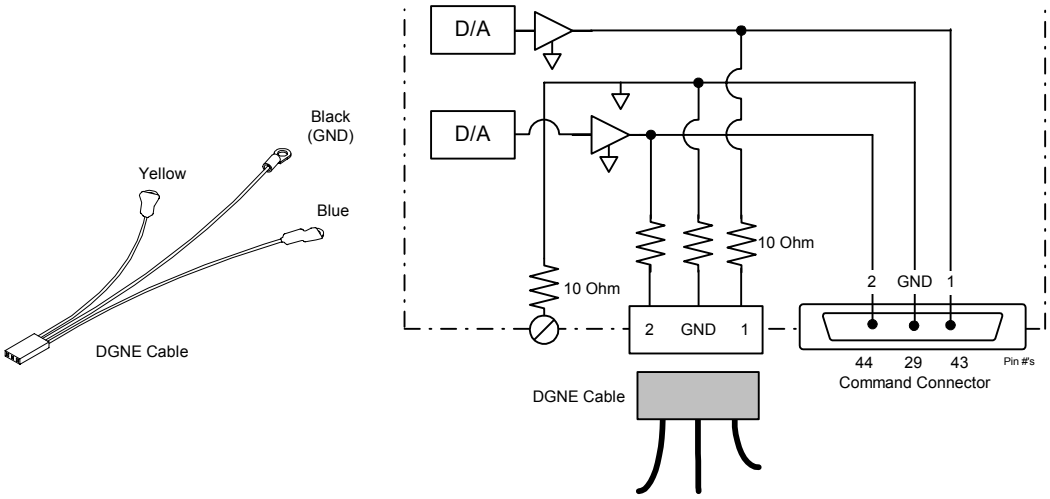


Figure 35: Diagnostic Cable (DGNE) Diagram

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Drive Faults

The Active Drive Faults dialog box is automatically displayed whenever a fault occurs. There are two options in this dialog box: Reset Faults and Ignore Faults.

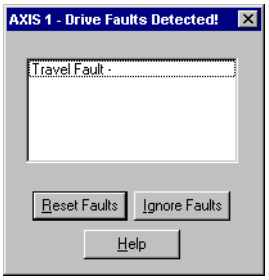


Figure 36: Active Drive Faults Detected Dialog Box

Resetting Faults

Some drive faults are automatically reset when the fault condition is cleared. Other faults require drive power to be cycled or the drive to be "rebooted". If you wish to continue working in the PowerTools-FM 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 or by clicking on the View Faults icon on the toolbar. The dialog box displayed is the same as Active Drive Faults Detected dialog box described above.

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.

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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. To update a parameter, delete it from the Watch Window selection.

Note

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

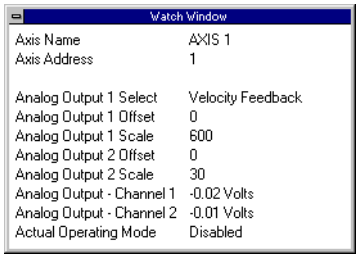


Figure 37: Watch Window

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.

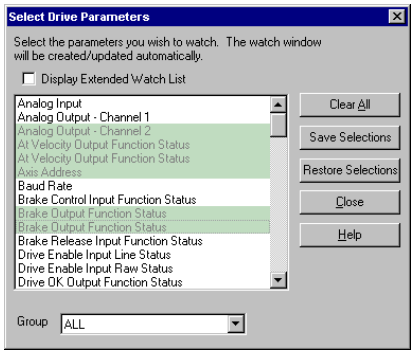


Figure 38: Select Drive Parameters Dialog Box

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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 In, Analog Out, Communication, Digital Inputs, Execution, Fault Counts, Fault Log, ID, Input Functions, Motor, Output Functions, Position, Setup, Status, Torque, Tuning, User Defined Motor, and Velocity.

Clear All Button

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

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.

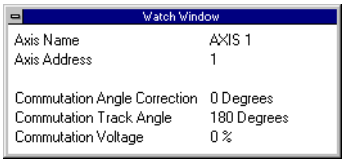


Figure 39: View Motor Parameters Window

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

Error Messages

PowerTools will pop-up an error message box to alert you to any errors it encounters. These message boxes will describe the error and offer a possible solution.

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The table below list the of common problems you might encounter when working with PowerTools software along with the error message displayed, the most likely cause and solution.

Problem/Message	Cause	Solution
Time-out while waiting for device response. The attempted operation has been cancelled. (see fault: No device selected)	Loss of serial communications.	Check the serial connection to the device and try operation again.
The attached device(s) do not have valid revisions, or do not have matching revisions.	Attempting to broadcast to drive without matching firmware revisions.	Program each drive individually.
Unable to communicate with device [Address x]	The device that you are attempting to communicate with is no longer available.	Check all connections and verify that you are using the correct baud rate then try again.
The specified drive type (name) does not match the actual drive type (name). Please make necessary corrections.	The drive type you selected in the “Drive Type” list box does not match the drive you are downloading to.	Change the drive type selected in the “Drive Type” list box to match the drive you are downloading to.
Non-Control Techniques device attached (address). When trying to program more than one drive, only EMC drives of the same type can be attached to the network.	This error is caused When you attempting to perform an upload or download to multiple drives and one or more of the drives are not the same type.	Disconnect the device(s) that has been specified and try the operation again or program each device individually.
You have changed a parameter which will not take affect until the drive has been rebooted. Before you reboot the drive, you will need to save your setup to NVM. Do you wish to save your setup to drive NVM now?	See message.	Yes/No.
(Operation Name) The attempted operation has been cancelled.	Communication error.	Retry operation. Check connection to drive.
Invalid entry. The entry exceeds the precision allowed by this field. The finest resolution this field accepts is (value).	Entered a value out of range.	Enter a value within the range of that field. The status bar displays information on the currently selected object or action.
The device was disconnected during the upload. The upload was not complete.	Connection to the device was lost (a time-out occurred).	Check the connection to the device and try again.
The device was disconnected during the download. The download was not complete.	Connection to the device was lost (a time-out occurred).	Check the connection to the device and try again.
No device selected.	No device selected during flash upgrade.	Select device(s) from list box.
The drive at address is use.		Close any other windows that are using the same addresses and try again.

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Specifications

Drive Specifications

EN Drive Specifications		
Power Requirements	**AC Input Voltage:**	90 - 264 VAC, 47-63 Hz (240 VAC for rated performance) EN-204: 1Ø EN-208: 1Ø EN-214: 3Ø (for 1Ø operation, drive output power must be derated by 20%)
	AC Input Current:	EN-204: 9.5 Arms (140A for 8ms inrush) EN-208: 19 Arms (140A for 8ms inrush) EN-214: 20 Arms 1Ø (140A for 5ms inrush) EN-214: 14 Arms 3Ø (100A for 5ms inrush)
	Output Continuous Current (RMS):	EN-204: 4.5 Arms EN-208: 9 Arms EN-214: 13 Arms (for 1Ø, derate by 20%)
	Output Peak Current:	EN-204: 9 A EN-208: 18 A EN-214: 26 A (for 1Ø, derate by 20%)
	Continuous Output Power:	EN-204: 1.8 kW EN-208: 3.6 kW EN-214: 5.2 kW
Switching Frequency		20 kHz
Logic Supply		Internal
Auxiliary Power Supply/ Auxiliary Logic Power Input		127 - 373 VDC, 22 W
Encoder Supply Output		+5 VDC, 250 mA
Efficiency		93%
Regeneration	**Internal Energy Absorption (230V):**	EN-204: 79 Joules EN-208: 50W Resistor plus 79 Joules EN-214: 50W Resistor plus 79 Joules
	Internal Energy Absorption (115V):	EN-204: 150 Joules EN-208: 50W Resistor plus 150 Joules EN-214: 50W Resistor plus 150 Joules
	External:	Connection to RSR-2 with external resistor, 20 Ohms min, 15 Arms, 2 kW

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EN Drive Specifications		
Control Inputs	**Analog Command:**	(1) ±10 VDC 14 bit, 100 kOhm impedance, Differential
	Analog Maximum Voltage Input Rating:	Differential = +/- 14 VDC, each input with reference to analog ground = +/- 14 VDC
	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
	Pulse:	**Interface:** Software selectable differential (RS-422) 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) 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
	Motor Overtemperature:	(1) 0 to +5 VDC, 10 kOhm impedance, Single ended
Control Outputs	**Analog Outputs (Diagnostic):**	(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
	Pulse Differential:	Differential line driver, RS-422 and TTL compatible 20 mA per channel, sink and/or source Scalable in one line increment resolution up to 2048 lines/rev of the motor (MG and NT) Output Device = AM26C31 $V_{out\ Hi}$ @ 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

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EN Drive Specifications		
Fault Detection Capability		Low DC bus High DC bus Power Stage fault Logic power Encoder state Encoder line break Motor over temperature Overspeed Travel limit (+) Travel limit (-) Pulse mode position error RMS shunt power fault Function module error Power-up self test failure Non-volatile memory invalid
Environmental	**Ambient temperature range for rated output:**	32° F to 104° F (0° C to 40° C)
	Maximum Ambient operating temperature:	32° F to 122° F (0° C to 50° C) with power derating of 3.5%/1.8° F (1° C) above 104° F (40° C)
	Rated Altitude:	3,280 feet (1000 m)
	Vibration:	10 - 2000 Hz at 2g
	Humidity:	10 - 95% non-condensing
	Storage Temperature:	-13° to 167° F (-25° to 75° C)
	Ingress Protection (IP):	IP20
Standards and Agency Approvals		UL Listed Canadian UL Listed CE Mark: Low voltage directive; EMC directive
Cooling Method		EN-204, EN-208: Convection EN-214: Integral fan
Serial Interface		RS-232 / RS-485 Internal RS-232 to RS-485 converter Modbus protocol with 32 bit data extension 9600 or 19.2 k baud
Drive Weights		EN-204 6.4 lb (2.9 kg) EN-208 7.7 lb (3.5 kg) EN-214 8.9 lb (4.0 kg)
Accessory Specifications	**ALP-130:**	Input 115/230 VAC; Output 140 VDC, 30 W
	ALP-430:	Input 115/230 VAC; Output 140 VDC, (4)x20 W

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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)
EN-204	NT-207	7.5 (0.85)	15 (1.72)	0.6 (0.44)	0.000094 (0.106)	5000	2048	35	5.12 (0.58)
	NT-212	12.5 (1.41)	27 (3.05)	1.03 (0.77)	0.000164 (0.185)	5000	2048	35	5.08 (0.185)
	MG-205	5.2 (0.59)	15.6 (1.76)	0.38 (0.28)	0.000084 (0.095)	5000	2048	28.3	4.1 (0.46)
	MG-208	9.1 (1.03)	27.3 (3.09)	0.64 (0.48)	0.000144 (0.163)	5000	2048	28.3	4.1 (0.46)
	MG-316	18.6 (2.10)	41.9 (4.73)	1.00 (0.75)	0.000498 (0.562)	4000	2048	37.6	5.5 (0.62)
EN-208	NT-320	19.65 (2.22)	37.5 (4.24)	1.02 (0.76)	0.000328 (0.3703)	4000	2048	29	3.5 (0.3955)
	NT-330	31.5 (3.56)	62 (7.01)	2.00 (1.49)	0.000438 (0.4945)	4000	2048	36	5.04 (0.5695)
	NT-345	47 (5.31)	85 (9.60)	2.24 (1.67)	0.000668 (0.7542)	3000	2048	50	7.13 (0.8056)
	NT-355	55.5 (6.27)	105 (11.86)	2.64 (1.97)	0.000888 (1.0026)	3000	2048	50	7.3 (0.8249)
	MG-316	18.6 (2.10)	55.8 (6.31)	1.00 (0.75)	0.000498 (0.562)	4000	2048	37.6	5.5 (0.62)
	MG-340	48 (5.65)	133.0 (15.0)	2.00 (1.49)	0.00125 (1.414)	3000	2048	55.0	8.0 (0.90)
	MG-455	68 (7.68)	139.1 (15.72)	2.46 (1.83)	0.00338 (3.819)	3000	2048	60.0	8.8 (0.99)
EN-214	NT-345	47 (5.31)	99 (11.19)	2.24 (1.67)	0.000668 (0.7542)	3000	2048	50	7.13 (0.8056)
	NT-355	55.5 (6.27)	116 (13.11)	2.64 (1.97)	0.000888 (1.0026)	3000	2048	50	7.3 (0.8249)
	MG-455	68 (7.68)	201.0 (22.71)	2.46 (1.83)	0.00338 (3.819)	3000	2048	60.0	8.8 (0.99)
	MG-490	100 (11.30)	208.0 (23.50)	3.75 (2.79)	0.00648 (7.319)	3000	2048	58.9	8.6 (0.97)
	MG-4120	132 (14.92)	257.0 (29.03)	5.30 (3.95)	0.00938 (10.593)	3000	2048	71.8	10.5 (1.19)

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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
NTE/M-2XX -CBNS, -LBNS, -TBNS	20 (2.26)	0.000106 (0.12)	1 (0.46)	24 (±10%)	0.33 (±10%)	28 ms	14 ms
NTE/M-3XX -CBNS, -LBNS, -TBNS	88.5 (10)	0.000968 (1.093)	1 (0.46)	24 (±10%)	0.65 (±10%)	43 ms	13 ms
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
MGE/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
NTE/M-207	3.0 (1.36)	4 (1.81)
NTE/M-212	4 (1.81)	5 (2.268)
NTE/M-320	6 (2.72)	8.55 (3.88)
NTE/M-330	7.3 (3.31)	9.85 (4.47)
NTE/M-345	10 (4.54)	12.55 (5.70)
NTE/M-355	12.3 (5.58)	14.85 (6.74)
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)
MGM-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)

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Axial/Radial Loading

Motor	Max Radial Load (lb.)	Max. Axial Load (lb.)
NTE/M-207	20	15
NTE/M-212	20	15
NTE/M-320	40	25
NTE/M-330	40	25
NTE/M-345	40	25
NTE/M-355	40	25
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

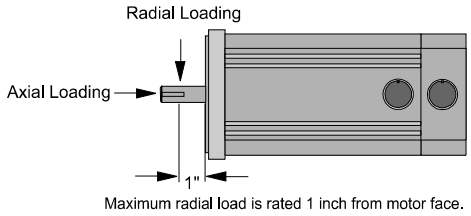


Figure 40: Axial/Radial Loading

IP Ratings

Motor	Rating
MG (all)	IP65
NTE/M-207	IP65
NTE/M-207 (w/o seals)	IP54
NTE/M-212	IP65
NTE/M-212 (w/o seals)	IP54
NTE/M-3XX (all)	IP65

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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%

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 EN drive is 11 W minimum to 21 W depending on external loading such as FM modules and input voltages. 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)
EN-204/NT-207	21	37	58
EN-204/NT-212		59	80
EN-204/MG-205		30	51
EN-204/MG-208		50	71
EN-204/MG-316		82	103
EN-208/NT-320		135	156
EN-208/NT-330		175	196
EN-208/NT-345		185	206
EN-208/NT-355		211	232
EN-208/MG-340		160	181
EN-208/MG-455		200	221
EN-214/NT-345		192	213
EN-214/NT-355		221	242
EN-214/MG-490		300	321
EN-214/MG-4120		430	451

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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.

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

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

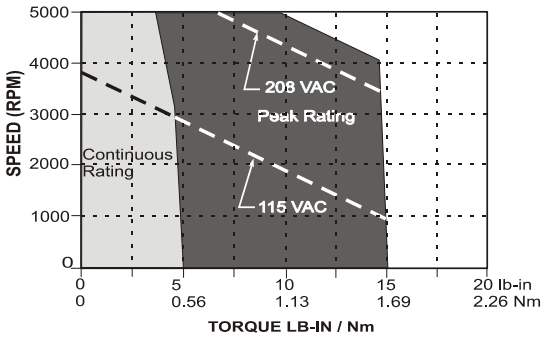
Continuous ratings of the MG and NT motors are based on 100°C (212°F) motor case temperature and 25°C (77°F) ambient temperature with the motor mounted to an aluminum mounting plate as shown in the table below

Motor	Mounting Plate Size
MG-205 and 208, NT-207 and 212	6” x 6” x .25”
MG-316 through 490 and NT-320 through NT-355	10” x 10” x .375
MG-4120	12” x 16” x .5”

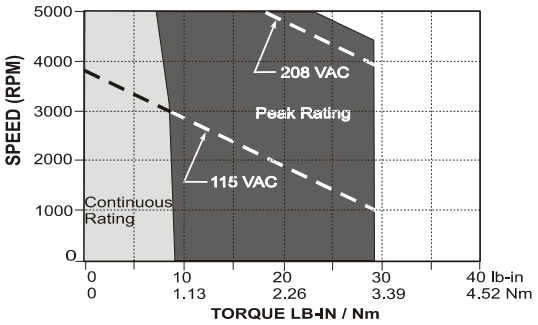
- Speed torque curves are based on 240 VAC drive operation.
- All specifications are ±5 percent due to motor parameter variations.

MG Motors

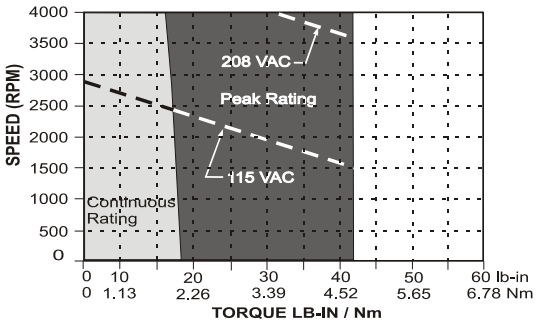
MG-205 with EN-204



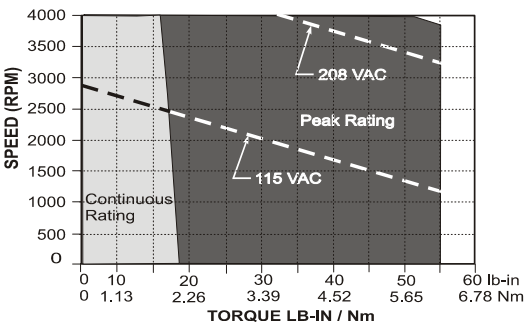
MG-208 With EN-204



MG-316 with EN-204

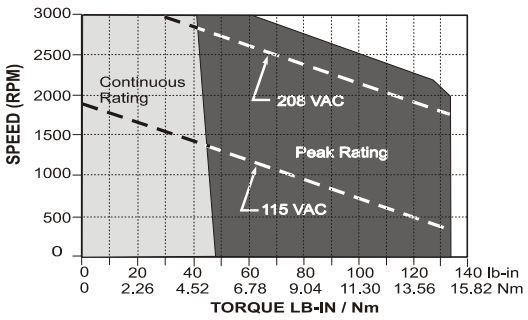


MG-316 with EN-208

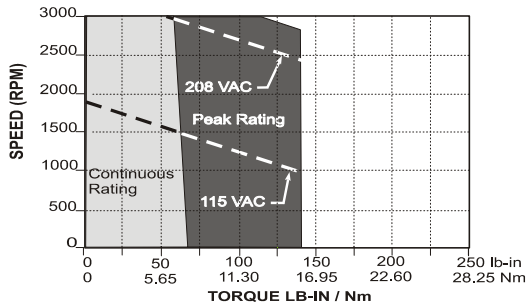


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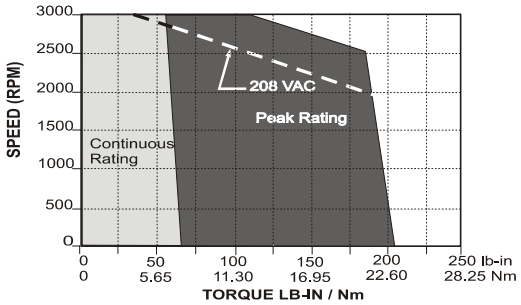
MG-340 with EN-208



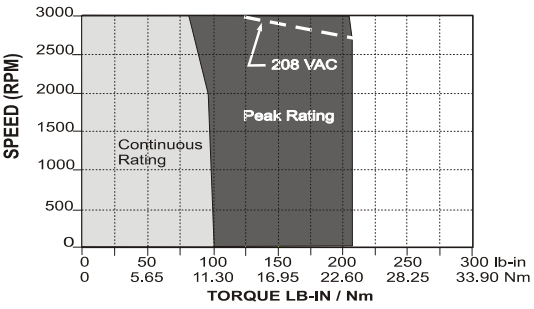
MG-455 with EN-208



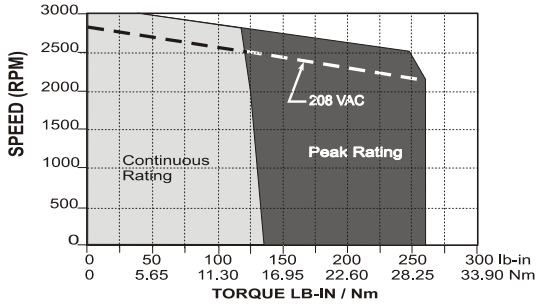
MG-455 with EN-214



MG-490 with EN-214

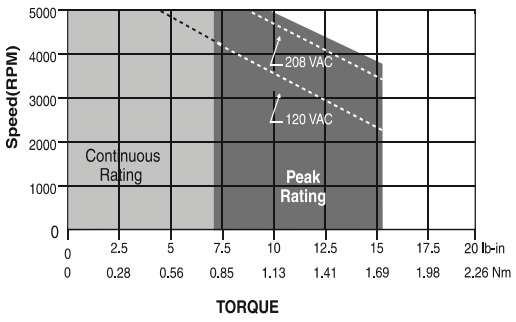


MG-4120 with EN-214

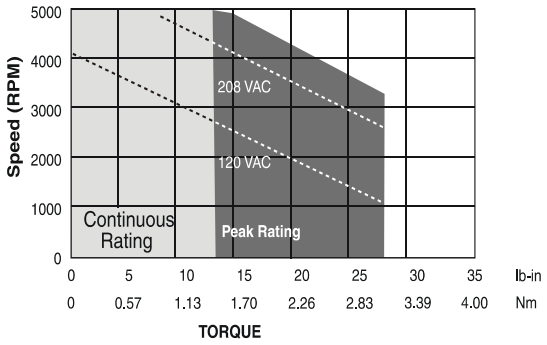


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NT-207 with EN-204

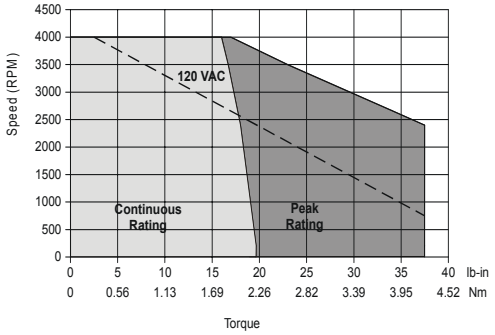


NT-212 with EN-204

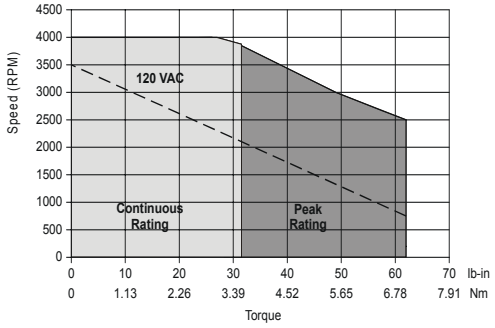


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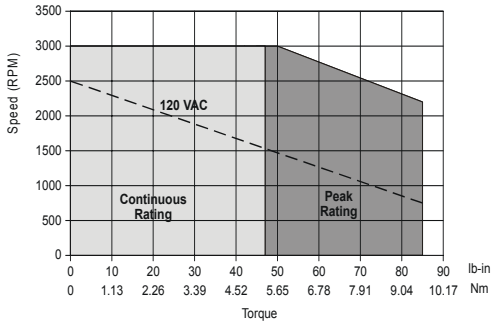
NT-320 with EN-208



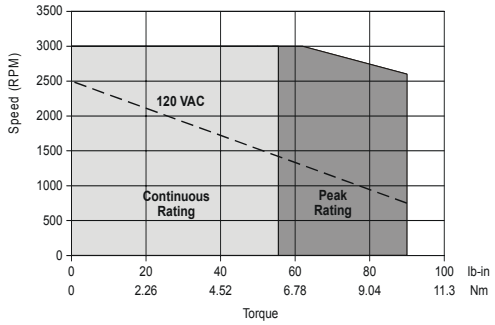
NT-330 with EN-208



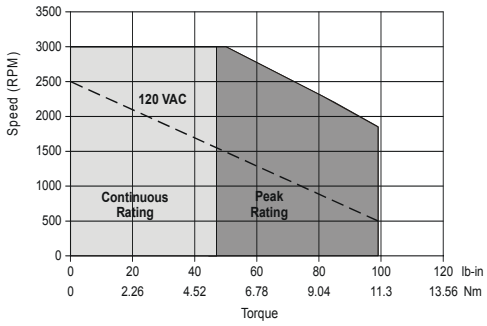
NT-345 with EN-208



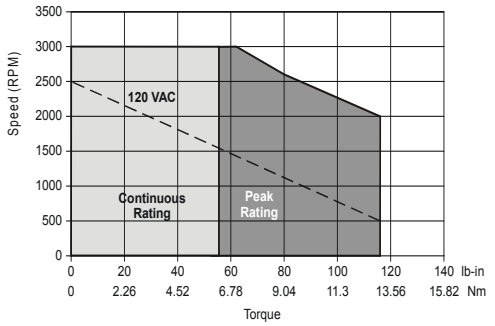
NT-355 with EN-208



NT-345 with EN-214

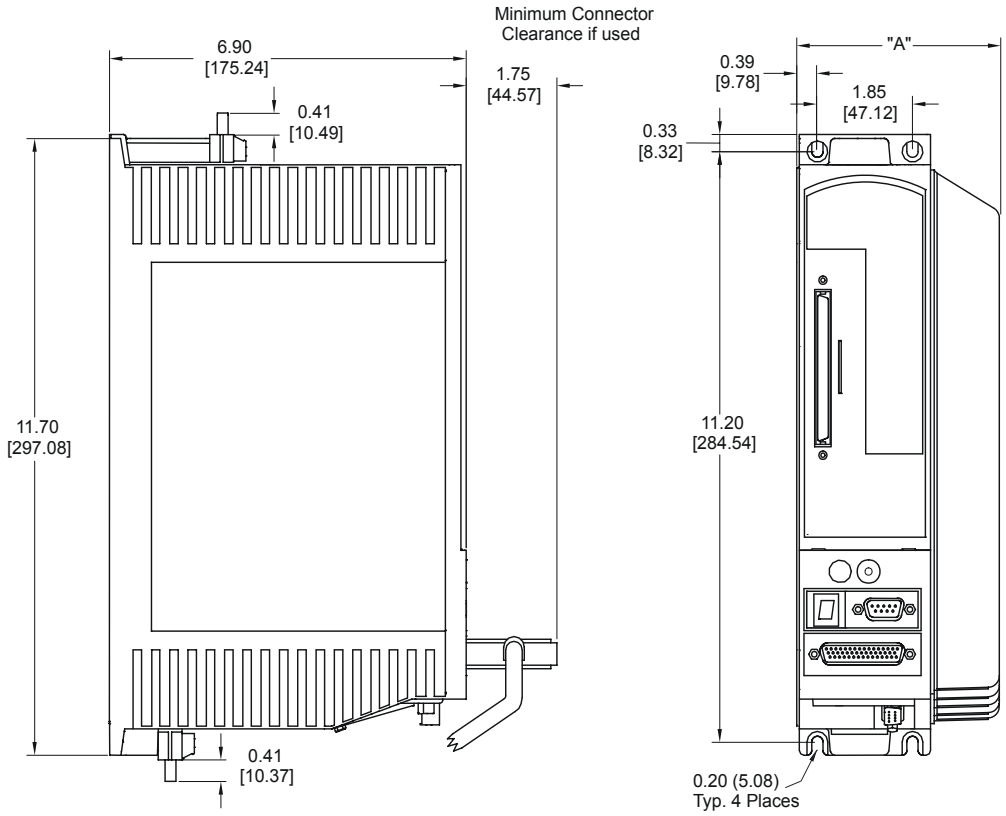


NT-355 with EN-214



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EN Drive Dimensions

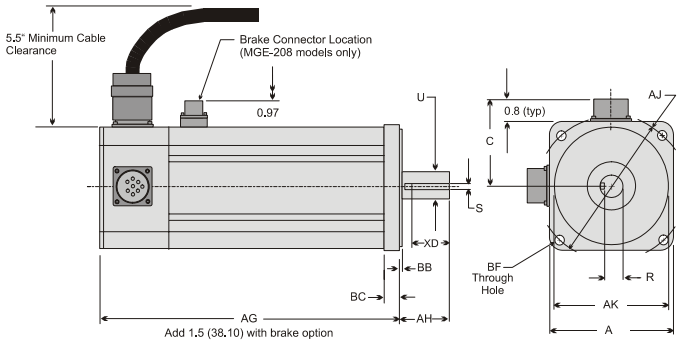


Model	Dim “A”
EN-204	2.93 [74.4]
EN-208	3.43 [87.1]
EN-214	3.93 [99.8]

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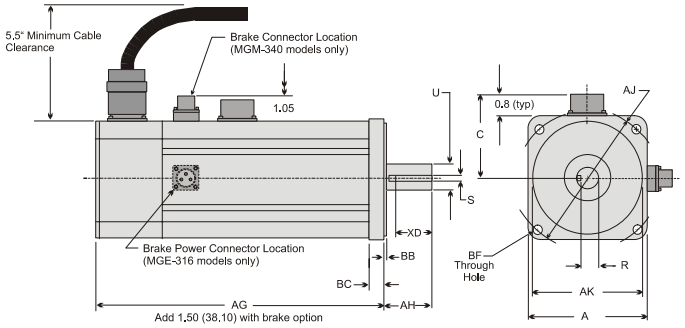
MG Motor Dimensions

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)	0.46 (11.2)	1.20 (30.5)	0.375 (9.525)	0.563 (14.3)	0.127 (3.23)	0.300 (7.62)	2.0 (51)	2.625 (66.68)	0.063 (1.60)	1.502 (38.15)	0.205 (5.21)
208	6.75 (171.4)	2.25 (57.2)	0.46 (11.2)	1.20 (30.5)	0.375 (9.525)	0.563 (14.3)	0.127 (3.23)	0.300 (7.62)	2.0 (51)	2.625 (66.68)	0.063 (1.60)	1.502 (38.15)	0.205 (5.21)

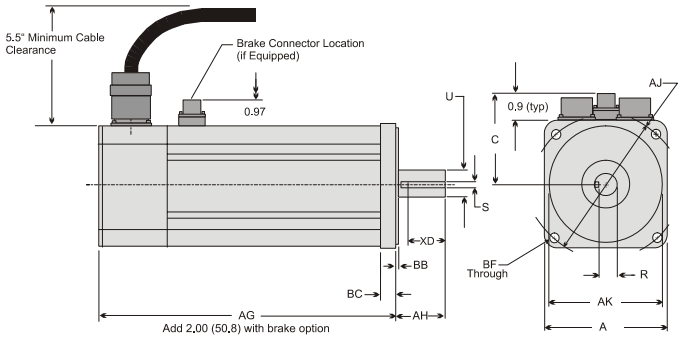
MGE-316 and 340 Motors



MGE-316 and MGM-340 Mounting Dimensions inches (mm)													
	AG	A	BC	AH	U Max	XD	S Min	R	C Max	AJ	BB	AK	BF
316	7.24 (184.0)	3.31 (84.0)	0.44 (11.2)	1.21 (30.7)	0.4997 (12.69)	0.90 (22.9)	.1265 (3.213)	0.42 (10.7)	2.50 (64.0)	3.875 (98.43)	0.06 (1.600)	2.877 (73.08)	0.233 (66.0)
340	10.24 (260.1)	3.50 (89.0)	0.44 (11.2)	1.20 (30.6)	0.5512 (14.000)	0.787 (20.0)	.197 (5.00)	0.429 (10.90)	2.50 (64.0)	3.937 (100.00)	0.118 (3.00)	3.150 (80.01)	0.276 (7.01)

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MGE-455, 490 and 4120 Motors



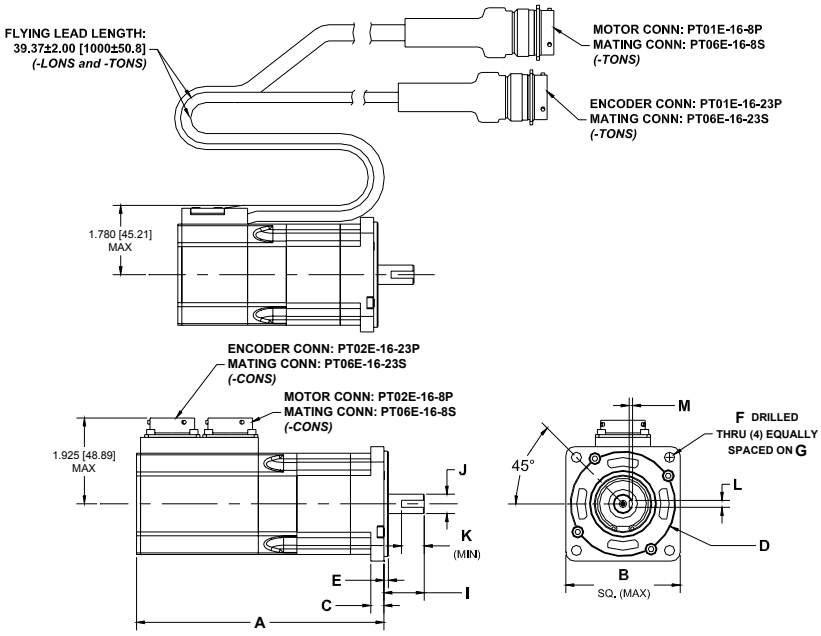
MGE-455, 490 and 4120 Mounting Dimensions inches (mm)													
	AG	A	BC	AH	U Max	XD	S Min	R	C Max	AJ	BB	AK	BF
455	8.61 (218.7)	5.00 (127.0)	0.53 (13.5)	190 (48.2)	0.6245 (15.862)	1.50 (38.1)	0.1875 (4.763)	0.51 (13.0)	3.20 (81.3)	5.875 (149.23)	0.10 (2.50)	4.500 (114.30)	3/8-16 UNC
490	11.11 (282.10)	5.00 (127.0)	0.53 (13.5)	190 (48.2)	0.8750 (22.225)	1.50 (38.1)	0.1875 (4.763)	0.77 (19.6)	3.20 (81.3)	5.875 (149.23)	0.10 (2.50)	4.500 (114.30)	3/8-16 UNC
4120	13.61 (345.70)	5.00 (127.0)	0.53 (13.5)	190 (48.2)	0.8750 (22.225)	1.50 (38.1)	0.1875 (4.763)	0.77 (19.6)	3.20 (81.3)	5.875 (149.23)	0.10 (2.50)	4.500 (114.30)	3/8-16 UNC

MGM-455, 490 and 4120 Mounting Dimensions mm (inches)													
	AG	A	BC	AH	U Max	XD	S Min	R	C Max	AJ	BB	AK	BF
455	216.0 (8.59)	121.0 (4.764)	13.0 (0.51)	50.5 (1.99)	19.000 (0.7480)	40.0 (1.58)	6.00 (.236)	15.5 (0.61)	70.3 (2.77)	145.00 (5.709)	3.00 (0.118)	110.10 (4.331)	10.00 (0.394)
490	281.7 (11.09)	121.0 (4.764)	13.0 (0.51)	50.5 (1.99)	24.000 (0.9449)	37.1 (1.46)	7.963 (.3135)	19.9 (0.78)	70.3 (2.77)	145.00 (5.709)	3.00 (0.118)	110.10 (4.331)	10.00 (0.394)
4120	343.1 (13.59)	121.0 (4.764)	13.0 (0.51)	50.5 (1.99)	24.000 (0.9449)	37.1 (1.46)	7.963 (.3135)	19.9 (0.78)	70.3 (2.77)	145.00 (5.709)	3.00 (0.118)	110.10 (4.331)	10.00 (0.394)

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NT Motor Dimensions

NTE-207 and 212 Motors; English Face (NEMA 23 with 3/8 inch shaft)



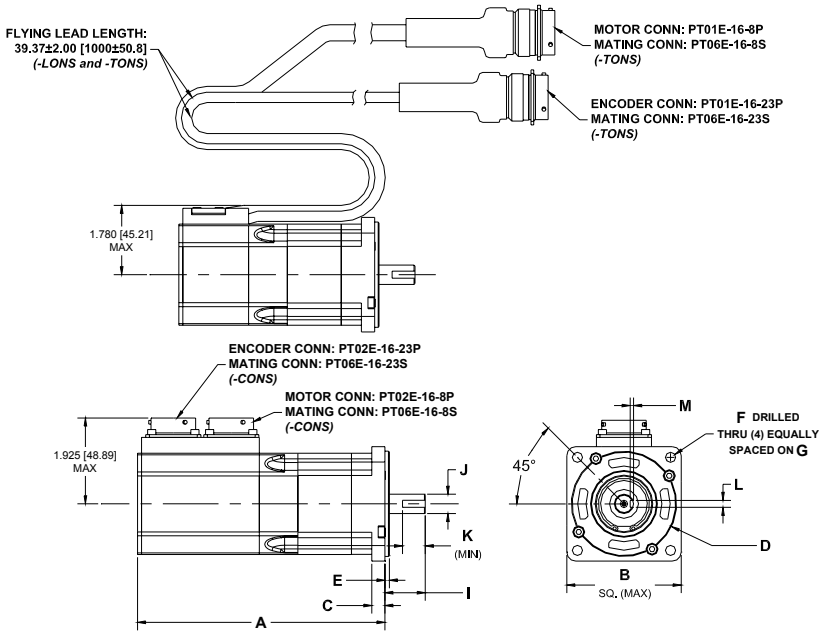
NTE-207, 212 -CONS,TONS and LONS Mounting Dimensions inches (mm)												
	A	B	C	D Max	E	F	G	I Max	J Max	K Min	L Min	M Min
207-CONS	5.55 (140.96)	2.27 (57.66)	0.295 (7.49)	1.50 (38.10)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)
207-TONS/ LONS	4.390 (111.51)	2.27 (57.66)	0.295 (7.49)	1.50 (38.10)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)
212-CONS	6.555 (166.36)	2.27 (57.66)	0.295 (7.49)	1.50 (38.10)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)
212-TONS/ LONS	5.39 (136.91)	2.27 (57.66)	0.295 (7.49)	1.50 (38.10)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)

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 and 212 Motors; Metric Face



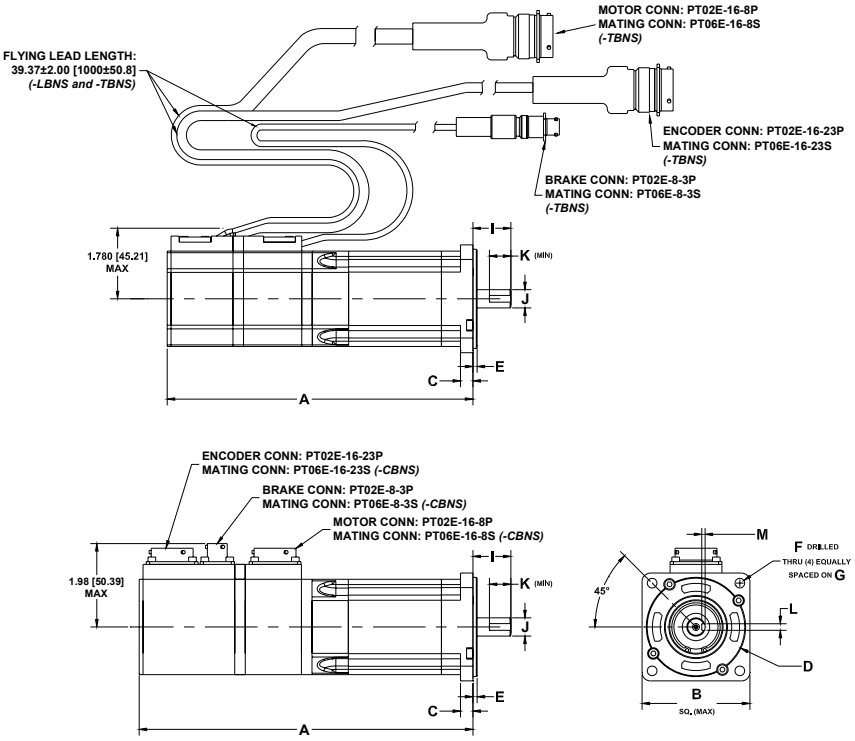
NTM-207, 212 -CONS,TONS and LONS Mounting Dimensions mm (inches)												
	A	B	C	D Max	E	F	G	I Max	J Max	K Min	L Min	M Min
207-CONS	140.96 (5.55)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.0 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
207-TONS/ LONS	111.51 (4.39)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.0 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
212-CONS	166.36 (6.55)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.0 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
212-TONS/ LONS	136.91 (5.39)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.0 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)

Note

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

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NTE-207 and 212 Brake Motors; English Face (NEMA 23 with 3/8 inch shaft)



NTE-207, 212 -CBNS, TBNS and LBNS Mounting Dimensions inches (mm))												
	A	B	C	D Max	E	F	G	I Max	J Max	K Min	L Min	M Min
207-CBNS	6.945 (176.40)	2.27 (57.66)	0.295 (7.49)	1.50 (38.100)	0.10 (2.54)	0.205 (5.21)	2.625 (5.21)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)
207-TBNS/ LBNS	6.277 (159.44)	2.27 (57.66)	0.295 (7.49)	1.50 (38.100)	0.10 (2.54)	2.05 (5.21)	2.625 (66.68)	1.210 (30.73)	0.375 (9.525)	0.70 (17.78)	1.498 (38.049)	0.075 (1.905)
212-CBNS	7.945 (201.80)	2.27 (57.66)	0.295 (7.49)	1.50 (38.100)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.21 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)
212-TBNS/ LBNS	7.277 (184.84)	2.27 (57.66)	0.295 (57.66)	1.50 (38.100)	0.10 (2.54)	0.205 (5.21)	2.625 (66.68)	1.210 (30.73)	0.375 (9.525)	0.70 (17.78)	0.1248 (3.17)	0.075 (1.905)

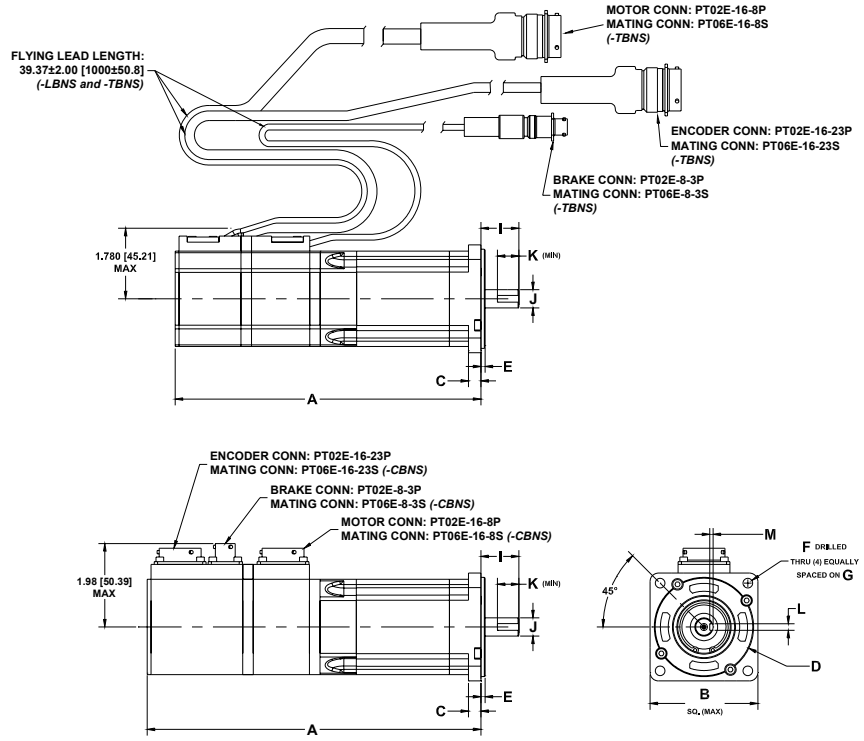
Note

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

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NTE-207 and 212 Brake Motors; Metric Face

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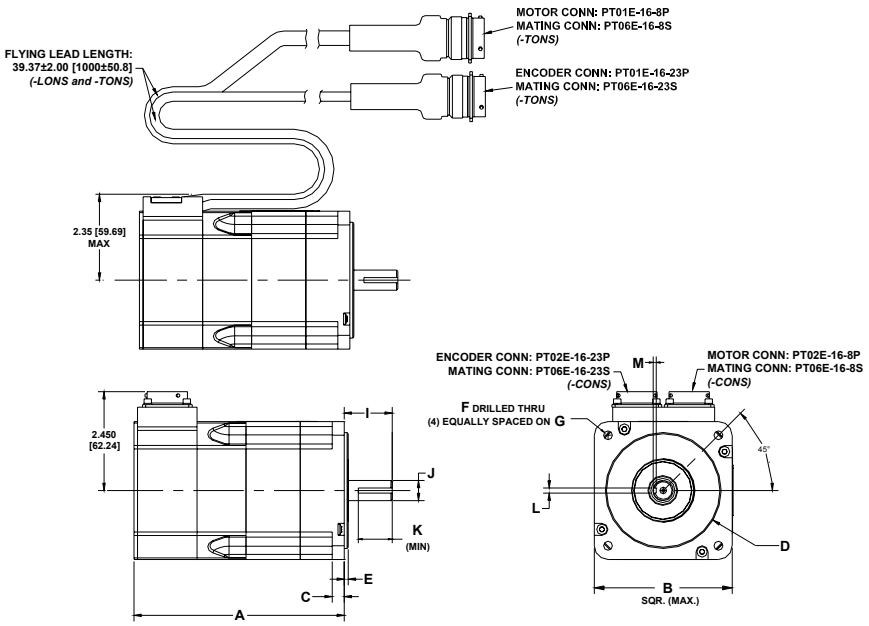
NTM-207, 212 -CBNS, TBNS and LBNS Mounting Dimensions mm (inches)												
	A	B	C	D Max	E	F	G	I Max	J Max	K Min	L Min	M Min
207-CBNS	176.40 (6.945)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.00 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
207-TBNS/ LBNS	159.44 (6.277)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.80 (0.228)	75.00 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
212-CBNS	201.80 (7.945)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.8 (0.228)	75.00 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)
212-TBNS/ LBNS	184.84 (7.277)	65.18 (2.566)	7.49 (0.295)	60.012 (2.363)	2.54 (0.10)	5.8 (0.228)	75.00 (2.953)	23.51 (0.926)	10.999 (0.433)	13.0 (0.512)	3.97 (0.156)	2.0 (0.079)

Note

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

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NTE/M-320, 330, 345 and 355 Motors



NTE-320, 330, 345, 355 -CONS, TONS and LONS Mounting Dimensions, inches (mm) NTM-320, 330, 345, 355-CONS, TONS, and LONS Mounting Dimensions, mm (inches)												
	A	B	C	D Max	E	F	G	I Max	J Max	K Min	L Min	M Min
NTE-320	5.218 (132.53)	3.42 (86.87)	0.30 (7.62)	2.875 (73.03)	0.10 (2.54)	0.22 (5.59)	3.875 (5.59)	1.21 (30.73)	0.50 (12.7)	0.84 (21.34)	0.125 (3.18)	0.073 (1.85)
NTE-330	5.818 (147.78)	3.42 (86.87)	0.30 (7.62)	2.875 (73.03)	0.10 (2.54)	0.22 (5.59)	3.875 (5.59)	1.21 (30.73)	0.50 (12.7)	0.84 (21.34)	0.125 (3.18)	0.073 (1.85)
NTE-345	7.018 (178.26)	3.42 (86.87)	0.30 (7.62)	2.875 (73.03)	0.10 (2.54)	0.22 (5.59)	3.875 (5.59)	1.21 (30.73)	0.50 (12.7)	0.84 (21.34)	0.125 (3.18)	0.073 (1.85)
NTE-355	8.218 (208.74)	3.42 (86.87)	0.30 (7.62)	2.875 (73.03)	0.10 (2.54)	0.22 (5.59)	3.875 (5.59)	1.21 (30.73)	0.50 (12.7)	0.84 (21.34)	0.125 (3.18)	0.073 (1.85)
NTM-320	132.53 (5.218)	86.87 (3.42)	7.62 (0.3)	80.0 (3.15)	3.0 (0.118)	7.01 (0.276)	100.0 (3.937)	30.73 (1.21)	14.0 (0.5512)	20.0 (0.787)	5.0 (0.1969)	2.45 (0.096)
NTM-330	147.78 (5.818)	86.87 (3.42)	7.62 (0.3)	80.0 (3.15)	3.0 (0.118)	7.01 (0.276)	100.0 (3.937)	30.73 (1.21)	14.0 (0.5512)	20.0 (0.787)	5.0 (0.1969)	2.45 (0.096)
NTM-345	178.26 (7.018)	86.87 (3.42)	7.62 (0.3)	80.0 (3.15)	3.0 (0.118)	7.01 (0.276)	100.0 (3.937)	30.73 (1.21)	14.0 (0.5512)	20.0 (0.787)	5.0 (0.1969)	2.45 (0.096)
NTM-355	208.74 (8.218)	86.87 (3.42)	7.62 (0.3)	80.0 (3.15)	3.0 (0.118)	7.01 (0.276)	100.0 (3.937)	30.73 (1.21)	14.0 (0.5512)	20.0 (0.787)	5.0 (0.1969)	2.45 (0.096)

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Motor Wiring Color Cable

Motor Encoder Cable	Motor Encoder Connector Pin # (CONS/TONS)	Signal Name	Motor Cable Colors (Current)	Motor Cable Colors (Previous)	CFCO Cable Colors
(8 Pair Shielded Cable)	B	A	Blue	Blue	Blue
	C	A/	Orange	Blue/White	Orange
	N	B	Green	Green	Green
	P	B/	Brown	Green/White	Brown
	M	Z	Black	Yellow	Black
	U	Z/	Yellow	Yellow/Black	Yellow
	E	U	White/Brown	Brown	White/Brown
	R	U/	Brown/White	Brown/White	Brown/White
	F	V	White/Gray	Orange	White/Gray
	S	V/	Gray/White	Orange/Black	Gray/White
	G	W	Red/Orange	Violet	Red/Orange
	H	W/	Orange/Red	Violet/White	Orange/Red
	K,L	+5VDC	Red/Blue	Red	Red/Blue
Jumper Installed CONS and TONS	T	0V COMMON	Blue/Red	Red/White	Blue/Red
	D	THERM Ground	Green/Red	Black	Green/Red
***LONS ONLY	A	THERM Signal	Red/Green	White	Red/Green
	Z	*ENCODER SHIELD	N/C	N/C	*Shield

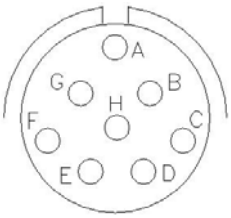
Motor Power Cable	Motor Power Connector PIN #	Power Connections	Motor Power Cable Colors (CONS)	Motor Power Cable Colors (TONS/LONS)	4X16SS Cable Colors (EMC Cables)
(4 Wire Shielded Cable)	A	R	Red	Brown	Brown
	B	S	Black	Black	Black
	C	T	Blue	Blue	Blue
	D, E	**PE (Ground)	**Green/Yellow	**Green/Yellow	**Green/Yellow
Motor Power Connections	Shell	*Power Shield	*Shield	*Shield	*Shield

*Encoder Shield and Power Shield must be separated from each other all the way back to the amplifier. They can be connected to the same enclosure walls via individual shielded grommets (i.e., CGS-xxx).

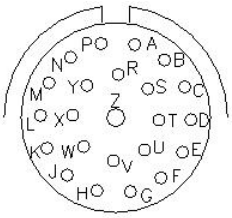
**Protected Earth Ground can be connected at the motor and the amplifier only with no connections to anything else in between, including frame ground.

***For proper thermal switch operation in a LONS motor, jumper THERM Ground (Green/Red) to OV Common (Blue/Red).

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Motor Power Connector: PT02E-16-8P
Mating Connector: PT06E-16-8S



Encoder Connector: PT02E-16-23P
Mating Connector: PT06E-16-23S

Cable Diagrams

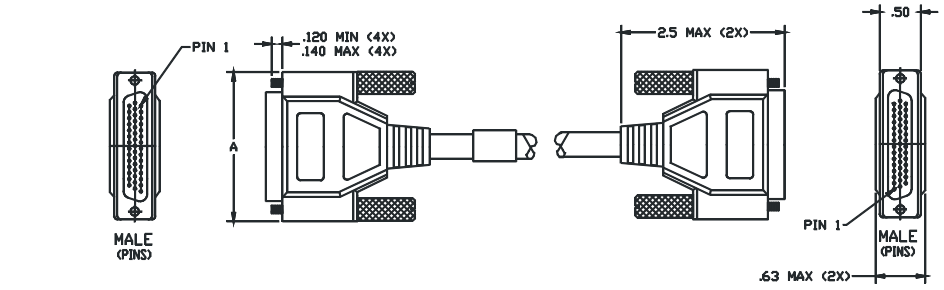
Drive Signal	CMDX, CMDO, ECI-44	CDRO	AX4-CEN
Analog Command In +	X	X	X
Analog Command In -	X	X	X
Encoder Out A	X	X	X
Encoder Out A/	X	X	X
Encoder Out B	X	X	X
Encoder Out B/	X	X	X
Encoder Out Z	X	X	X
Encoder Out Z/	X	X	X
Pulse In A	X	X	
Pulse In A/	X	X	
Pulse In B	X	X	
Pulse In B/	X	X	
Pulse In Z	X		
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

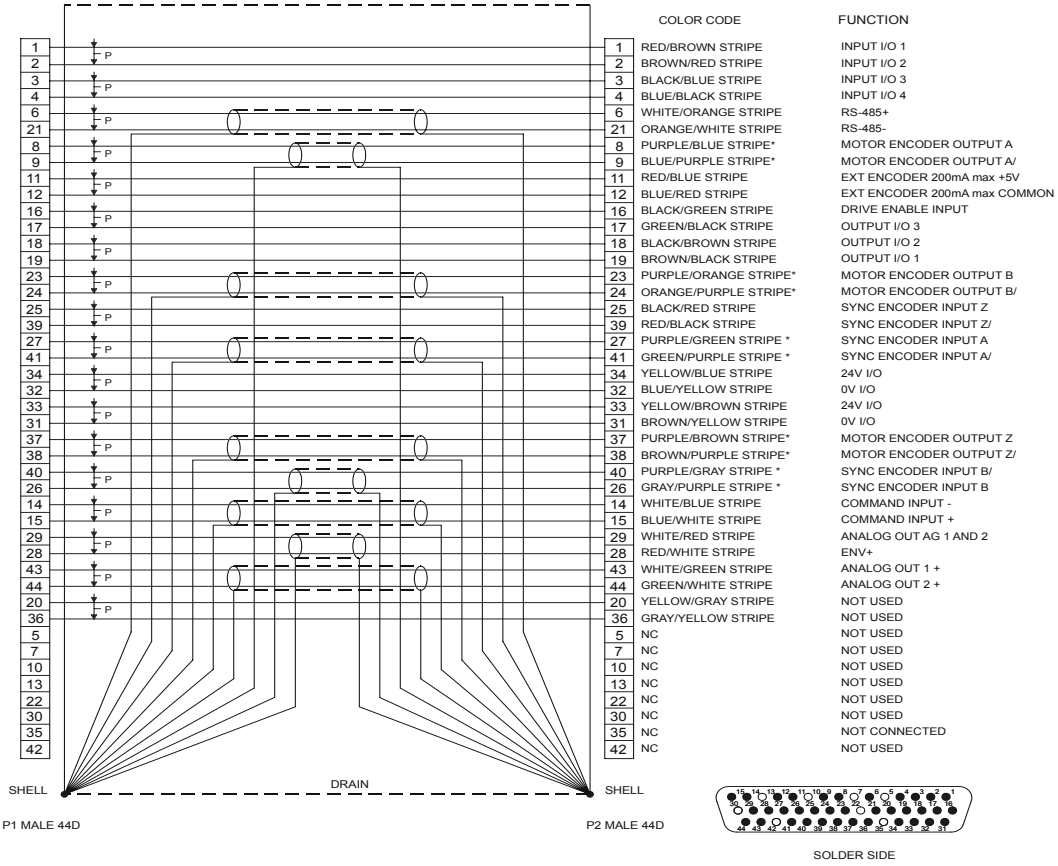
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Drive Signal	CMDX, CMDO, ECI-44	CDRO	AX4-CEN
I/O Power + In (1st wire)	X	X	X
I/O Power + In (2nd wire)	X	X	X
I/O Power 0V In (1st wire)	X	X	X
I/O Power 0V In (2nd wire)	X		
Analog Out 0V	X	X	X
Analog Out Channel #1 +	X	X	X
Analog Out Channel #2 +	X	X	X
External Encoder +5 Power Out (200 ma)	X	X	
External Encoder Common	X	X	
+15V Power Out (10 ma)	X		
RS-485 +	X		
RS-485 -	X		

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CMDX-XXX Cable





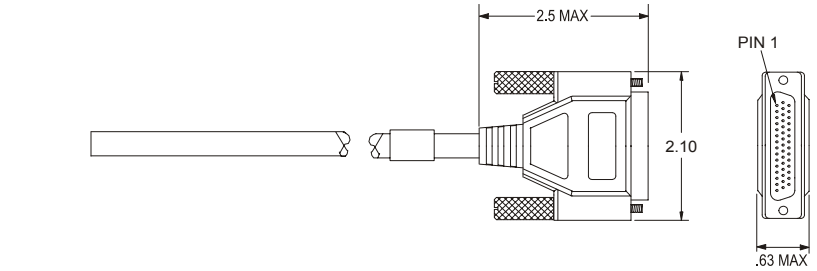
	COLOR CODE	FUNCTION
1	RED/BROWN STRIPE	INPUT I/O 1
2	BROWN/RED STRIPE	INPUT I/O 2
3	BLACK/BLUE STRIPE	INPUT I/O 3
4	BLUE/BLACK STRIPE	INPUT I/O 4
6	WHITE/ORANGE STRIPE	RS-485+
21	ORANGE/WHITE STRIPE	RS-485-
8	PURPLE/BLUE STRIPE*	MOTOR ENCODER OUTPUT A
9	BLUE/PURPLE STRIPE*	MOTOR ENCODER OUTPUT A/
11	RED/BLUE STRIPE	EXT ENCODER 200mA max +5V
12	BLUE/RED STRIPE	EXT ENCODER 200mA max COMMON
16	BLACK/GREEN STRIPE	DRIVE ENABLE INPUT
17	GREEN/BLACK STRIPE	OUTPUT I/O 3
18	BLACK/BROWN STRIPE	OUTPUT I/O 2
19	BROWN/BLACK STRIPE	OUTPUT I/O 1
23	PURPLE/ORANGE STRIPE*	MOTOR ENCODER OUTPUT B
24	ORANGE/PURPLE STRIPE*	MOTOR ENCODER OUTPUT B/
25	BLACK/RED STRIPE	SYNC ENCODER INPUT Z
39	RED/BLACK STRIPE	SYNC ENCODER INPUT Z/
27	PURPLE/GREEN STRIPE *	SYNC ENCODER INPUT A
41	GREEN/PURPLE STRIPE *	SYNC ENCODER INPUT A/
34	YELLOW/BLUE STRIPE	24V I/O
32	BLUE/YELLOW STRIPE	0V I/O
33	YELLOW/BROWN STRIPE	24V I/O
31	BROWN/YELLOW STRIPE	0V I/O
37	PURPLE/BROWN STRIPE*	MOTOR ENCODER OUTPUT Z
38	BROWN/PURPLE STRIPE*	MOTOR ENCODER OUTPUT Z/
40	PURPLE/GRAY STRIPE *	SYNC ENCODER INPUT B/
26	GRAY/PURPLE STRIPE *	SYNC ENCODER INPUT B
14	WHITE/BLUE STRIPE	COMMAND INPUT -
15	BLUE/WHITE STRIPE	COMMAND INPUT +
29	WHITE/RED STRIPE	ANALOG OUT AG 1 AND 2
28	RED/WHITE STRIPE	ENV+
43	WHITE/GREEN STRIPE	ANALOG OUT 1 +
44	GREEN/WHITE STRIPE	ANALOG OUT 2 +
20	YELLOW/GRAY STRIPE	NOT USED
36	GRAY/YELLOW STRIPE	NOT USED
5	NC	NOT USED
7	NC	NOT USED
10	NC	NOT USED
13	NC	NOT USED
22	NC	NOT USED
30	NC	NOT USED
35	NC	NOT CONNECTED
42	NC	NOT USED

Note

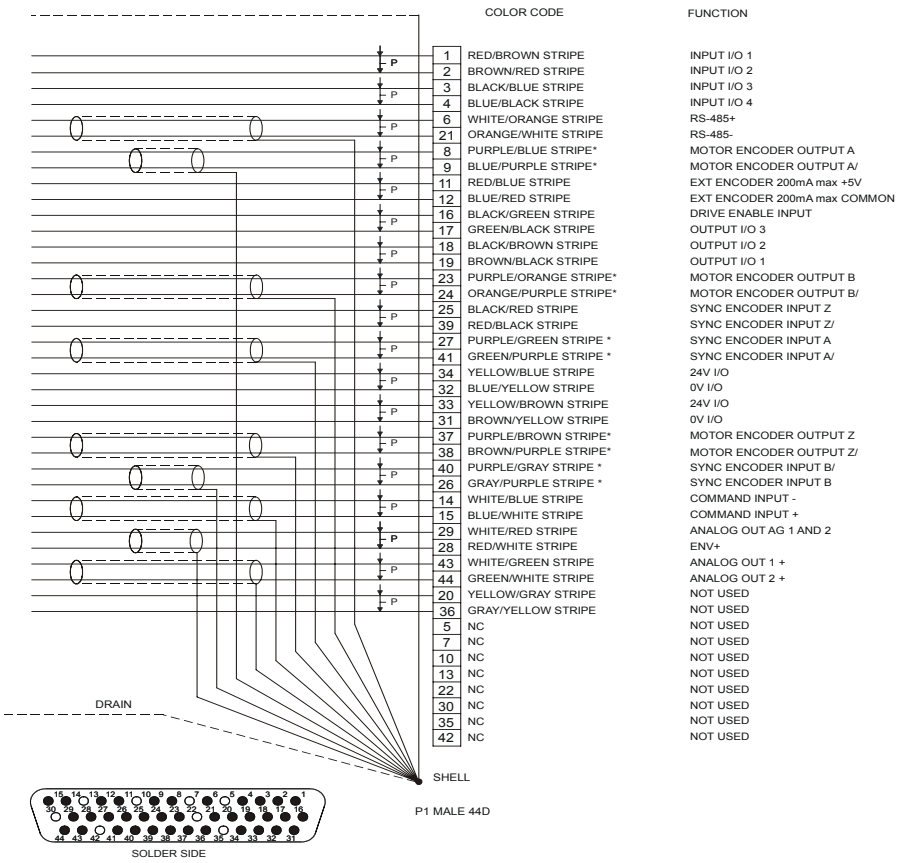
Some CMDX cables may have White/Yellow and Yellow/White wires in place of the White/Orange and Orange/White shown in the figure above (pins 6 and 21).

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CMDO-XXX Cable



	COLOR CODE	FUNCTION
1	RED/BROWN STRIPE	INPUT I/O 1
2	BROWN/RED STRIPE	INPUT I/O 2
3	BLACK/BLUE STRIPE	INPUT I/O 3
4	BLUE/BLACK STRIPE	INPUT I/O 4
6	WHITE/ORANGE STRIPE	RS-485+
21	ORANGE/WHITE STRIPE	RS-485-
8	PURPLE/BLUE STRIPE*	MOTOR ENCODER OUTPUT A
9	BLUE/PURPLE STRIPE*	MOTOR ENCODER OUTPUT A/
11	RED/BLUE STRIPE	EXT ENCODER 200mA max +5V
12	BLUE/RED STRIPE	EXT ENCODER 200mA max COMMON
16	BLACK/GREEN STRIPE	DRIVE ENABLE INPUT
17	GREEN/BLACK STRIPE	OUTPUT I/O 3
18	BLACK/BROWN STRIPE	OUTPUT I/O 2
19	BROWN/BLACK STRIPE	OUTPUT I/O 1
23	PURPLE/ORANGE STRIPE*	MOTOR ENCODER OUTPUT B
24	ORANGE/PURPLE STRIPE*	MOTOR ENCODER OUTPUT B/
25	BLACK/RED STRIPE	SYNC ENCODER INPUT Z
39	RED/BLACK STRIPE	SYNC ENCODER INPUT Z/
27	PURPLE/GREEN STRIPE *	SYNC ENCODER INPUT A
41	GREEN/PURPLE STRIPE *	SYNC ENCODER INPUT A/
34	YELLOW/BLUE STRIPE	24V I/O
32	BLUE/YELLOW STRIPE	0V I/O
33	YELLOW/BROWN STRIPE	24V I/O
31	BROWN/YELLOW STRIPE	0V I/O
37	PURPLE/BROWN STRIPE*	MOTOR ENCODER OUTPUT Z
38	BROWN/PURPLE STRIPE*	MOTOR ENCODER OUTPUT Z/
40	PURPLE/GRAY STRIPE *	SYNC ENCODER INPUT B/
26	GRAY/PURPLE STRIPE *	SYNC ENCODER INPUT B
14	WHITE/BLUE STRIPE	COMMAND INPUT -
15	BLUE/WHITE STRIPE	COMMAND INPUT +
29	WHITE/RED STRIPE	ANALOG OUT AG 1 AND 2
28	RED/WHITE STRIPE	ENV+
43	WHITE/GREEN STRIPE	ANALOG OUT 1 +
44	GREEN/WHITE STRIPE	ANALOG OUT 2 +
20	YELLOW/GRAY STRIPE	NOT USED
36	GRAY/YELLOW STRIPE	NOT USED
5	NC	NOT USED
7	NC	NOT USED
10	NC	NOT USED
13	NC	NOT USED
22	NC	NOT USED
30	NC	NOT USED
35	NC	NOT USED
42	NC	NOT USED

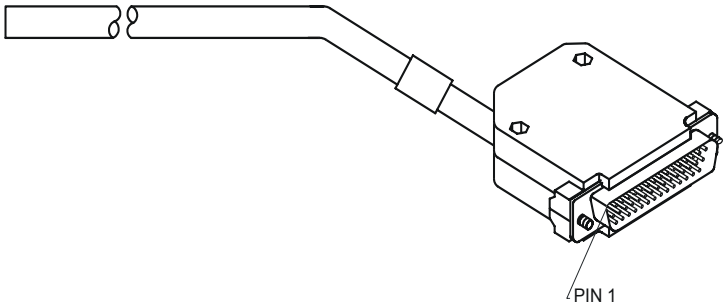


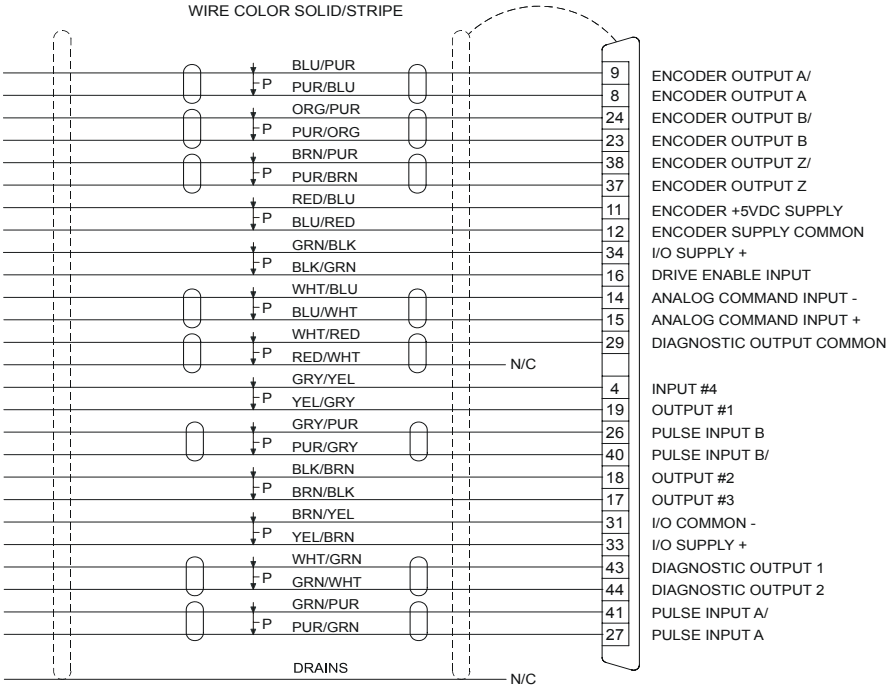
Note

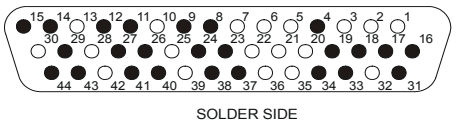
Some CMDO cables may have White/Yellow and Yellow/White wires in place of the White/Orange and Orange/White shown in the figure above (pins 6 and 21).

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CDRO-XXX Cable

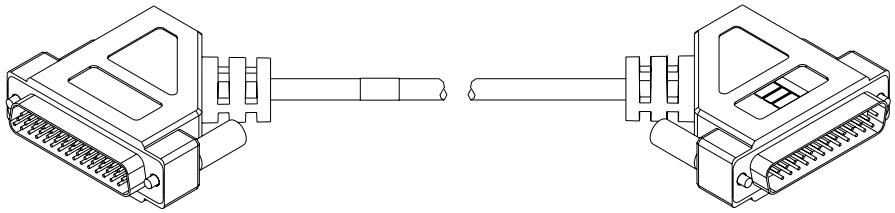


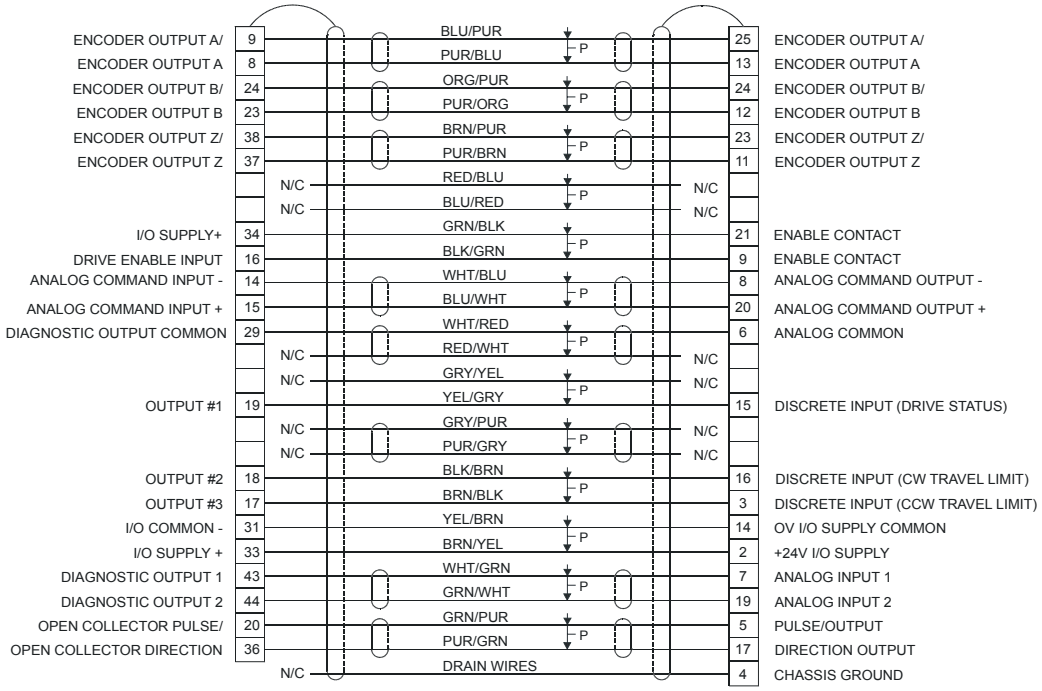




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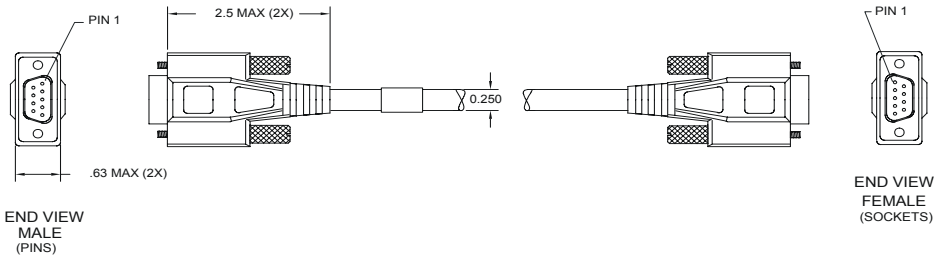
AX4-CEN-XXX Cable

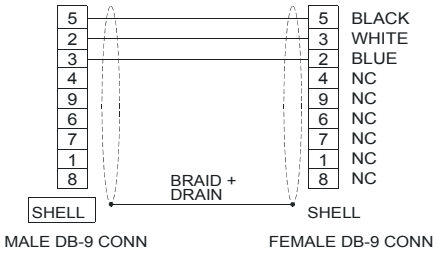




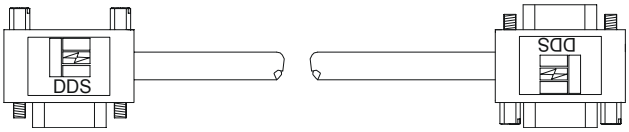
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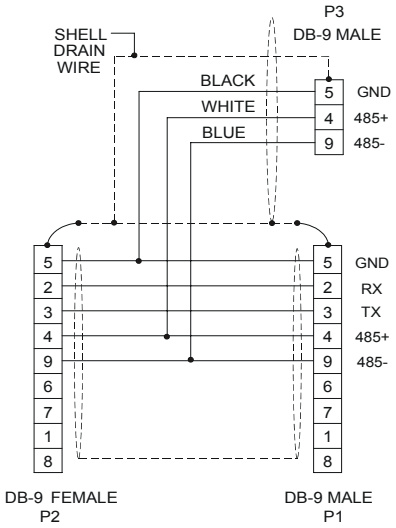
TIA-XXX Cable





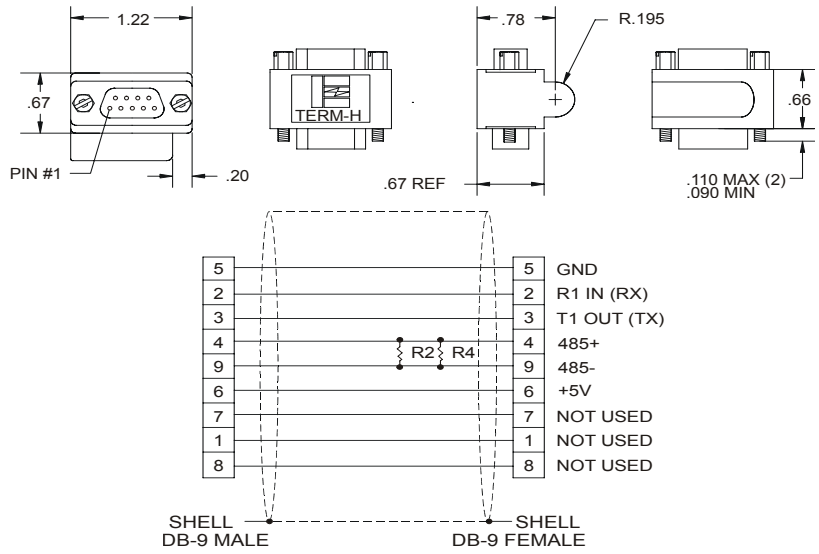
DDS-XXX Cable



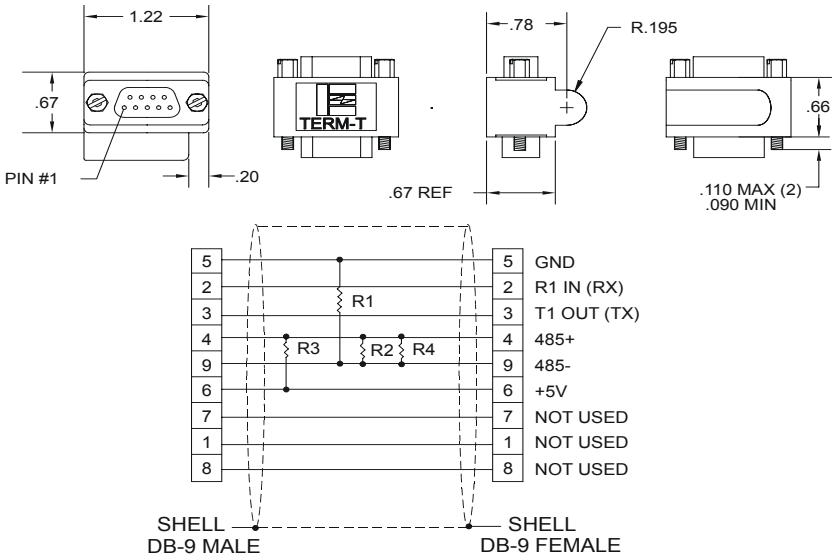


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TERM-H (Head) Terminator



TERM-T (Tail) Terminator

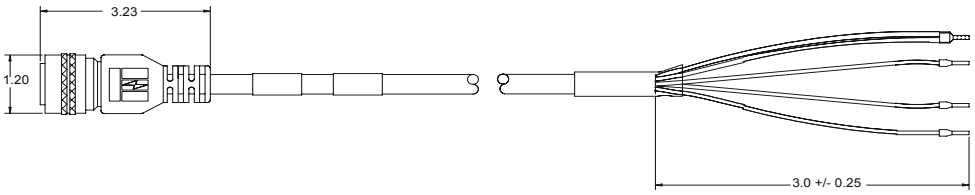


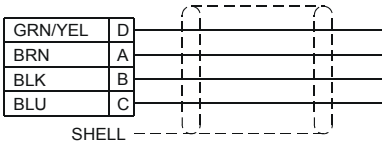
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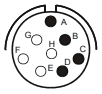
See the "Multi-drop Communications" section in the *EN Reference Manual* (P/N 400501-01) for resistor values.

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CMDS-XXX Cable

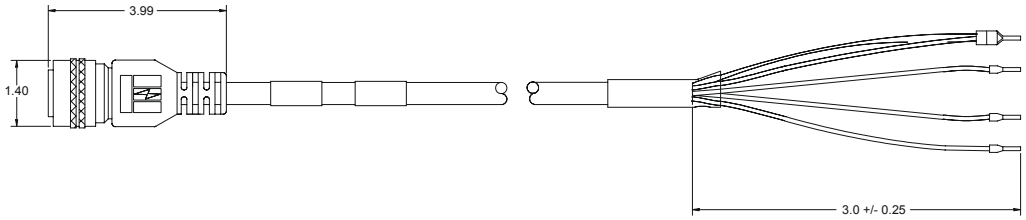


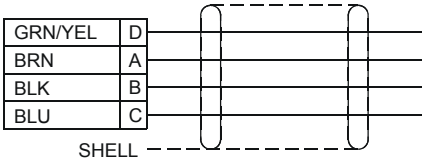


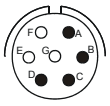


SOLDER SIDE

CMMS-XXX Cable



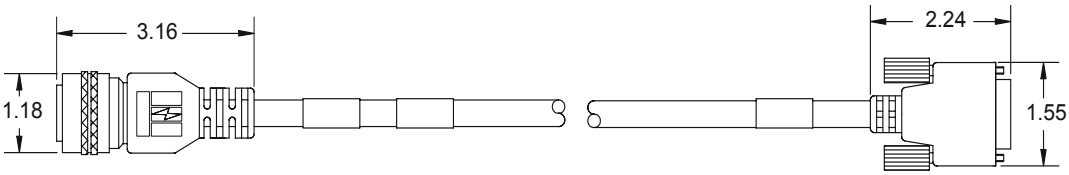


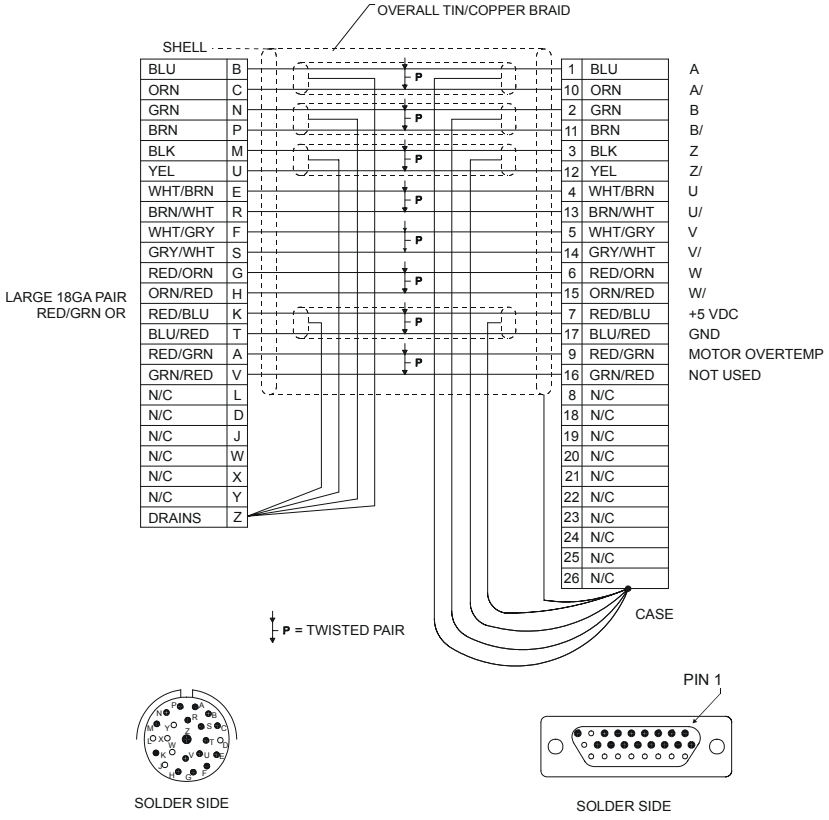


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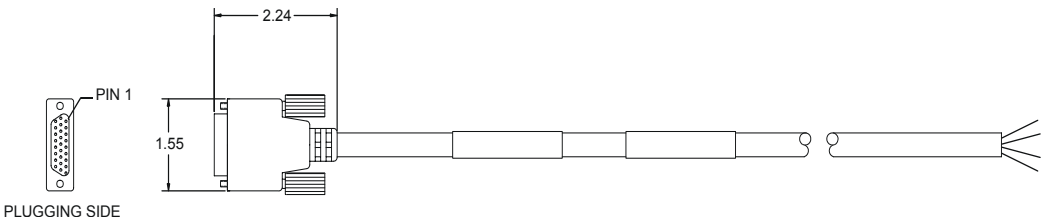
CFCS-XXX Cable

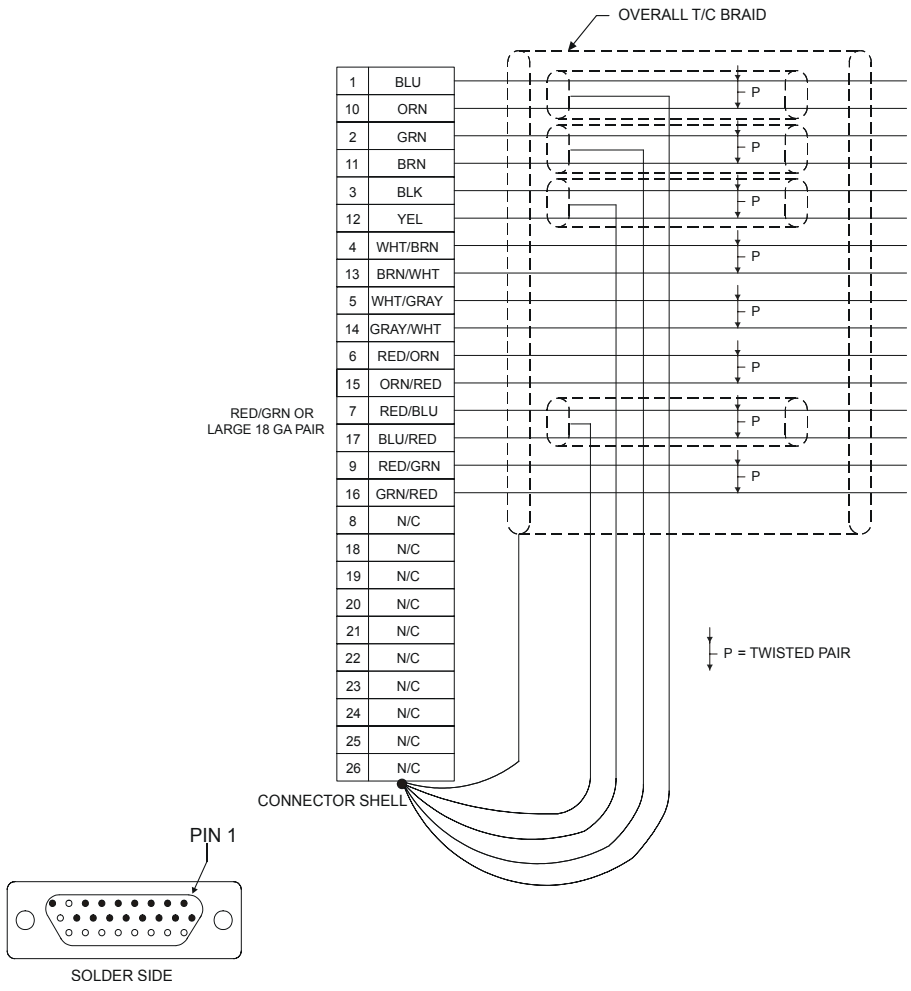




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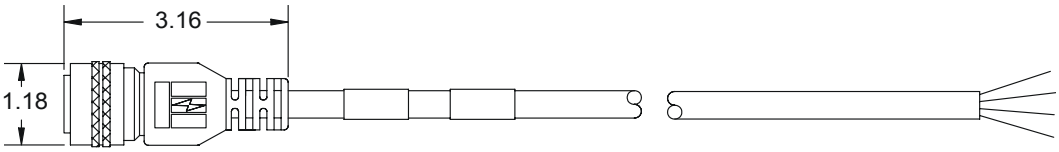
CFCO-XXX Cable

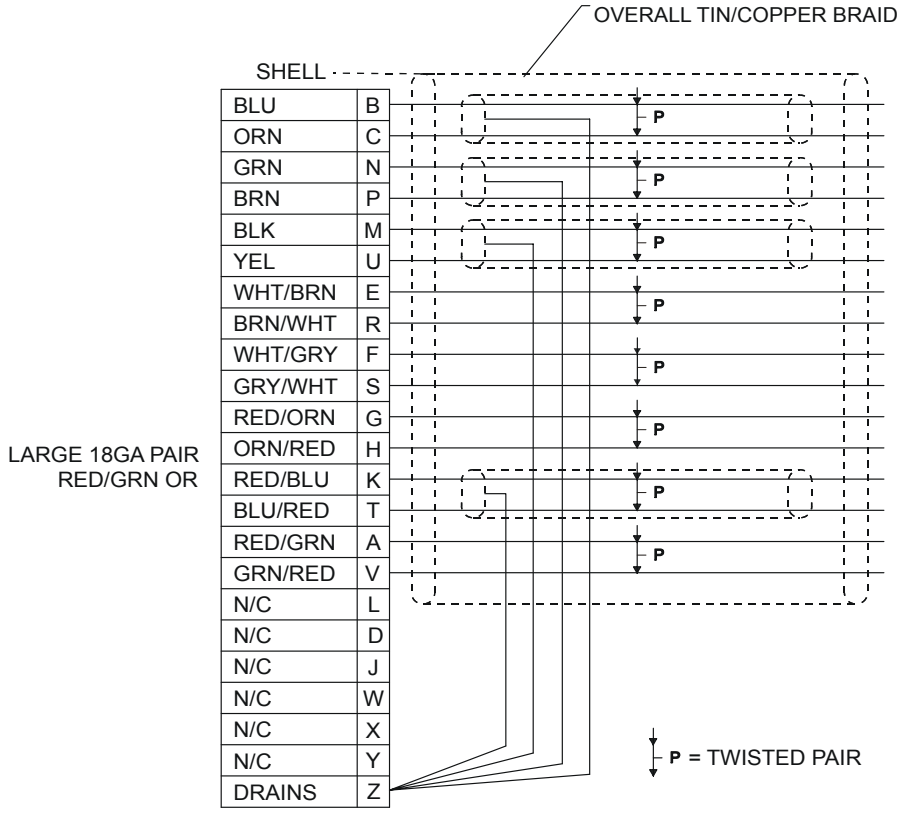


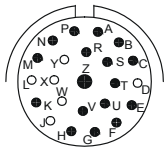


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CFOS-XXX Cable







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Glossary

µs

Microsecond.

A

Amps.

ARMS

Amps (RMS).

AWG

American Wire Gauge.

Baud Rate

The number of binary bits transmitted per second on a serial communications link such as RS-232. (1 character is usually 10 bits.)

Check Box

In a dialog box, a check box is a small box that the user can turn “On” or “Off” with the mouse. When “On” it displays an X in a square; when “Off” the square is blank. Unlike option (radio) buttons, check boxes do not affect each other; any check box can be “On” or “Off” independently of all the others.

CRC

Cyclical Redundancy Check.

Dialog Box

A dialog box is a window that appears in order to collect information from the user. When the user has filled in the necessary information, the dialog box disappears.

DIN Rail

Deutsche Industrie Norm Rail

DLL

In Microsoft Windows, a Dynamic Link Library contains a library of machine-language procedures that can be linked to programs as needed at run time.

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Downloading

The transfer of a complete set of parameters from PowerTools or an FM-P.

EEPROM

An EEPROM chip is an Electrically Erasable Programmable Read-Only Memory; that is, its contents can be both recorded and erased by electrical signals, but they do not go blank when power is removed.

EMC

Electromagnetic Compatibility

EMI - Electro-Magnetic Interference

EMI is noise which, when coupled into sensitive electronic circuits, may cause problems.

Firmware

The term firmware refers to software (i.e., computer programs) that are stored in some fixed form, such as read-only memory (ROM).

FM

Function Module - device which is attached to the front of the drive to provide additional functionality.

Hysteresis

For a system with an analog input, the output tends to maintain it's current value until the input level changes past the point that set the current output value. The difference in response of a system to an increasing input signal versus a decreasing input signal.

I/O

Input/Output. The reception and transmission of information between control devices. In modern control systems, I/O has two distinct forms: switches, relays, etc., which are in either an on or off state, or analog signals that are continuous in nature generally depicting values for speed, temperature, flow, etc.

Inertia

The property of an object to resist changes in rotary velocity unless acted upon by an outside force. Higher inertia objects require larger torque to accelerate and decelerate. Inertia is dependent upon the mass and shape of the object.

Input Function

A function (i.e., Stop, Preset) that may be attached to an input line.

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Input Line

The actual electrical input, a screw terminal.

Least Significant Bit

The bit in a binary number that is the least important or having the least weight.

LED

Light Emitting Diode.

List Box

In a dialog box, a list box is an area in which the user can choose among a list of items, such as files, directories, printers or the like.

mA

Milliamp.

MB

Mega-byte.

Most Significant Bit

The bit in a binary number that is the most important or that has the most weight.

ms

Millisecond.

NVM

Non-Volatile Memory.

NTC

Negative Temperature Coefficient Resistor

Option Button

See Radio Button.

Opto-isolated

A method of sending a signal from one piece of equipment to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photosensitive transistor). These optical components provide electrical isolation.

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Output Function

A function (i.e., Drive OK, Fault) that may be attached to an output line.

Output Line

The actual transistor or relay controlled output signal.

Parameters

User read only or read/write parameters that indicate and control the drive operation.

PE

Protective Earth.

PID

Proportional-Integral-Derivative. An acronym that describes the compensation structure that can be used in many closed-loop systems.

PLC

Programmable Logic Controller. Also known as a programmable controller, these devices are used for machine control and sequencing.

PowerTools-FM

Windows®-based software to interface with the EN drives and FM-1 and FM-2 Function Modules.

Radio Button

Also known as the Option Button. In a dialog box, radio buttons are small circles only one of which can be chosen at a time. The chosen button is black and the others are white. Choosing any button with the mouse causes all the other buttons in the set to be cleared.

RAM

RAM is an acronym for Random-Access Memory, which is a memory device whereby any location in memory can be found, on average, as quickly as any other location.

RMS

Root Mean Squared. For an intermittent duty cycle application, the RMS is equal to the value of direct current which would produce the equivalent heating over a long period of time.

ROM

ROM is an acronym for Read-Only Memory. A ROM contains computer instructions that do not need to be changed, such as permanent parts of the operating system.

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RPM

Revolutions Per Minute.

Serial Port

A digital data communications port configured with a minimum number of signal lines. This is achieved by passing binary information signals as a time series of 1's and Ø's on a single line.

Uploading

The transfer of a complete set of parameters from PowerTools or an FM-P.

VAC

Volts, Alternating Current.

VDC

Volts, Direct Current.

Windows, Microsoft

Microsoft Windows is an operating system that provides a graphical user interface, extended memory and multi-tasking. The screen is divided into windows and the user uses a mouse to start programs and make menu choices.

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