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Allen-Bradley

ULTRA
100 Series
Drives
(Cat. No. 1398-5.2)

Installation Manual

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Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

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Throughout this manual we use notes to make you aware of safety considerations. For example:



ATTENTION: This symbol identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid the hazard
- recognize the consequences



Note: This symbol identifies information that is critical for successful application and understanding of the product.

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Read this preface to familiarize yourself with the rest of the manual. This preface covers the following topics:

- who should use this manual
- the purpose and contents of this manual
- storing the product
- related documentation
- conventions used in this manual
- safety precautions
- Rockwell Automation support for Allen-Bradley products

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting the ULTRA 100 Series family of products

If you do not have a basic understanding of the ULTRA 100 Series, contact your local Allen-Bradley representative for information on available training courses before using this product.

Purpose of this Manual

This manual is a user guide for the ULTRA 100 Series. It gives you an overview of the ULTRA 100 Series family and describes the procedures you use to install, setup, use, and troubleshoot the ULTRA 100 Series.

ULTRA 100 Series Product Receiving and Storage Responsibility

You, the customer, are responsible for thoroughly inspecting the equipment before accepting the shipment from the freight company. Check the item(s) you receive against your purchase order. If any items are obviously damaged, it is your responsibility to refuse delivery until the freight agent has noted the damage on the freight bill. Should you discover any concealed damage during unpacking, you are responsible for notifying the freight agent. Leave the shipping container intact and request that the freight agent make a visual inspection of the equipment.

Leave the drive in its shipping container prior to installation. If you are not going to use the equipment for a period of time, store it:

- in a clean, dry location
- within an ambient temperature range of -40 to 70° C (-40 to 158° F)
- within a relative humidity range of 5% to 95%, non-condensing

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- in an area where it cannot be exposed to a corrosive atmosphere
- in a non-construction area

The “Drive Checkout Test” on page 2-3 is useful to verify that the unit is operating correctly after delivery.

Rockwell Automation Support

Rockwell Automation offers support services worldwide.

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Local Product Support

Contact your local Allen-Bradley representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact Rockwell Automation for technical assistance, please review the information in the *Troubleshooting* chapter first. Then call your local Allen-Bradley distributor. For the quickest possible response, we recommend that you have the part and model numbers and/or software revision level of your products available when you call. The Rockwell Automation Technical Support number is (216) 646-6800.

Purpose and Contents of this Manual

This manual is a user guide for the ULTRA 100 Series. It gives you an overview of the ULTRA 100 Series family and describes the procedures you use to install, setup, use, and troubleshoot the ULTRA 100 Series.

This manual provides instructions on how to setup and connect the ULTRA 100 Series drive to a controlling device and a motor. A ULTRA 100 Series drive can operate in one of several different functional modes. The hardware connections necessary to run the drive are detailed in this manual and basic software instructions are provided for common setup procedures. For detailed explanation of software instructions, refer to the comprehensive online instructions available in the ULTRA Master software.

The instructions in this manual detail how to install your ULTRA 100 Series drive using ULTRA Master software with a personal computer. If you are using a TouchPad device, abbreviated command titles are displayed but the setup steps remain the same. If you are using the serial Host Command Language to control the drive, comprehensive instructions are accessible through the Host Command Reference icon displayed in the ULTRA Master window.

This manual is organized into numbered chapters and alphabetical appendices. The topics covered in each chapter and section are briefly described. Typographical conventions, warning and cautions specific to the drive, and complementary manuals are also described.

Title	Description
Safety	Lists general safety requirements that must be followed when installing or servicing the drive.
Selecting Other System Components	Identifies motors and signal types that are compatible with ULTRA 100 Series drives.
ULTRA Master Installation	Provides snapshot instructions for installing, accessing and exiting ULTRA Master.

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Title	Description
Unpacking, Inspecting and Storing	Lists what should be included with your ULTRA 100 Series drive and instructs you on how to perform a basic functional test before installing or storing the drive.
Installation	Instructs you on how to physically install your ULTRA 100 Series drive.
Interfaces	Each signal or set of signals is identified by: Power requirements for driving the signal. Functions performed by the signal. Specifications, including ON and OFF states. Schematic depictions of the circuit design for each signal type. The signals are grouped by the connector on which they are present.
• J1 – Controller	Diagrams depict the cable connections necessary for common controller interfaces.
• J2 – Encoder	Provides comprehensive information about the encoder signals, Hall Effect switches and thermostat connections available through this connector.
• J5 – Serial Port	Diagrams and instructions detail how to communicate with a drive using serial communications.
Power Connections	Provides information on making motor power, DC bus and AC Power connections.
Application and Configuration Examples	Describes the hardware and software set up necessary to install the drive as one of the following types operating in a specific mode:
• Analog Control	Velocity or torque mode
• Preset Controller	Velocity or torque mode
• Position Follower (Master Encoder)	Velocity mode
• Position Follower (Step/Direction)	Velocity mode
• Position Follower (Step Up/Down)	Velocity mode
• Incremental Indexing	Velocity mode
• Registration Indexing	Velocity mode
• Absolute Indexing	Velocity mode
Tuning	Provides instructions on how to tune a drive and motor combination using the autotuning or manual tuning features in ULTRA Master.
Status Display	Discusses the Status LED indicator on the front panel. Operating or Error Messages accessible through the TouchPad or a PC are explained.
Maintenance and Troubleshooting	Describes the minimal maintenance necessary with the ULTRA 100 Series drives and provides a comprehensive troubleshooting chart of potential problems and their solutions.
Options and Accessories	Lists the optional equipment available for the ULTRA 100 Series drives. Schematics and cabling examples are provided.
TouchPad Instructions	Describes how to program an ULTRA 100 Series drive using the optional TouchPad device. Tables reference the various motor types that are programmed to work with the ULTRA 100 Series drive. A copy of the *TouchPad Command Tree* card for the current firmware version is bound into the manual.
Creating Custom Motor Files	Describes how to create a custom motor file for use with an ULTRA 100 Series drive.

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Title	Description
Electromagnetic Compatibility Guidelines for Machine Design	Describes common electrical noise problems and suggests methods to ensure ElectroMagnetic Compatibility.
Dynamic Braking Resistor Selection	Provides equations to assist in sizing resistors for dynamic braking.
Specifications	Details the design and operational specifications for the ULTRA 100 Series drives in a tabular format.

Related Documentation

The following documents contain additional information concerning related Allen-Bradley products. To obtain a copy, contact your local Allen-Bradley office or distributor.

For	Read This Document	Document Number
An overview of the ULTRA Series family.	ULTRA Series Brochure	1398-1.0
A description and specifications for the ULTRA Series family.	ULTRA Series Product Data	1398-2.0
An article on wire sizes and types for grounding electrical equipment	National Electrical Code	Published by the National Fire Protection Association of Boston, MA.
A complete listing of current Allen-Bradley documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages.	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Allen-Bradley Industrial Automation Glossary	AG-7.1

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Additional Instructions and Manuals

Host Commands and ULTRA Master

All ULTRA 100 Series drives are setup through serial Host Commands. The drives can be configured directly through the Host Command language or indirectly through the ULTRA Master software. ULTRA Master is a graphical user interface that provides a visual method of accessing the Host Command language through the Microsoft Windows Operating System.

All documentation for both the Host Commands and ULTRA Master is online. Host Command information is available through a comprehensive online reference manual. ULTRA Master information is available through Help menus. The online information provides in-depth explanations of the Host Command language as well as the menus, windows and dialog boxes that make ULTRA Master a convenient method for programming ULTRA 100 Series drives.

To access the Host Command Reference

- Click on the Host Command Reference icon in the ULTRA Master program group.

To access ULTRA Master Help

- Open ULTRA Master by clicking on the ULTRA Master icon in the ULTRA Master group, and
- Press the F1 key.

TouchPad

The optional TouchPad can be used to monitor and configure the ULTRA 100 Series drive. The TouchPad command structure is similar to the structure of ULTRA Master, but operates through an abbreviated keypad interface. A *TouchPad Instructions* card is provided with the TouchPad. It describes the installation and operational instructions in a pocket-sized directory. The *TouchPad Command Tree* card and additional instructions for the TouchPad are included in the section titled “TouchPad Commands”, which begins on page C-3. The *TouchPad Command Tree* card is a graphical presentation of both the operational instructions and the command structure for the ULTRA 100 Series drives. You may find it convenient to refer to the *TouchPad Command Tree* card when using the TouchPad with a ULTRA 100 Series drive.

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Symbols and Conventions

Typographical and Wording Conventions

This manual uses the following typographical and wording conventions:

Example	Description
Drive Set Up	Text shown in this font and underlined indicates a Hot Key (keystroke combination) to quickly access a command. For example, Choose **Drive Set Up**. indicates typing ALT+D followed by ENTER accesses this command.
ULTRA Master	Text shown in this font is information to enter in a window or dialog box. For example, Choose the icon ULTRA Master**.**
win	Text in lower case bold is information to enter at a keyboard. For example, To start Windows from the DOS prompt, type **win** and then press ENTER.
ALT+F4[a]	Keys that should be pressed simultaneously are shown with a plus sign (+) between the key names. This example closes the active window.
ALT, F, N	Keys that should be pressed in sequence are shown with a comma (,) between the key names. This example opens the File menu and then opens a new file.
Choose	The wording indicates that an icon or a command is to be selected from a window or a command box. For example, the instruction for accessing the command icon Drive Set Up states: Choose **Drive Set Up**.
Select	The wording indicates that options are to be defined or selected from a list. For example, the instruction for accessing or entering information states: Select Drive Type and Motor Model from the respective list box.
Type	The wording indicates that commands are to be entered into a command box. For example, the instruction for loading ULTRA Master states: Type **a:setup** and then press **ENTER**.
▶	Tips provide hints or shortcuts that are useful to know. For example, **Note:** ULTRA Master always displays the Help menu – Quick Start – when it is first accessed. To disable this automatic display, choose the menu item **Show Quick Start** from the Help menu.

a. Microsoft® Windows™ reserves certain multiple keystroke combinations to activate Windows commands.

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Graphical Symbols

This manuals uses the following graphic symbols.

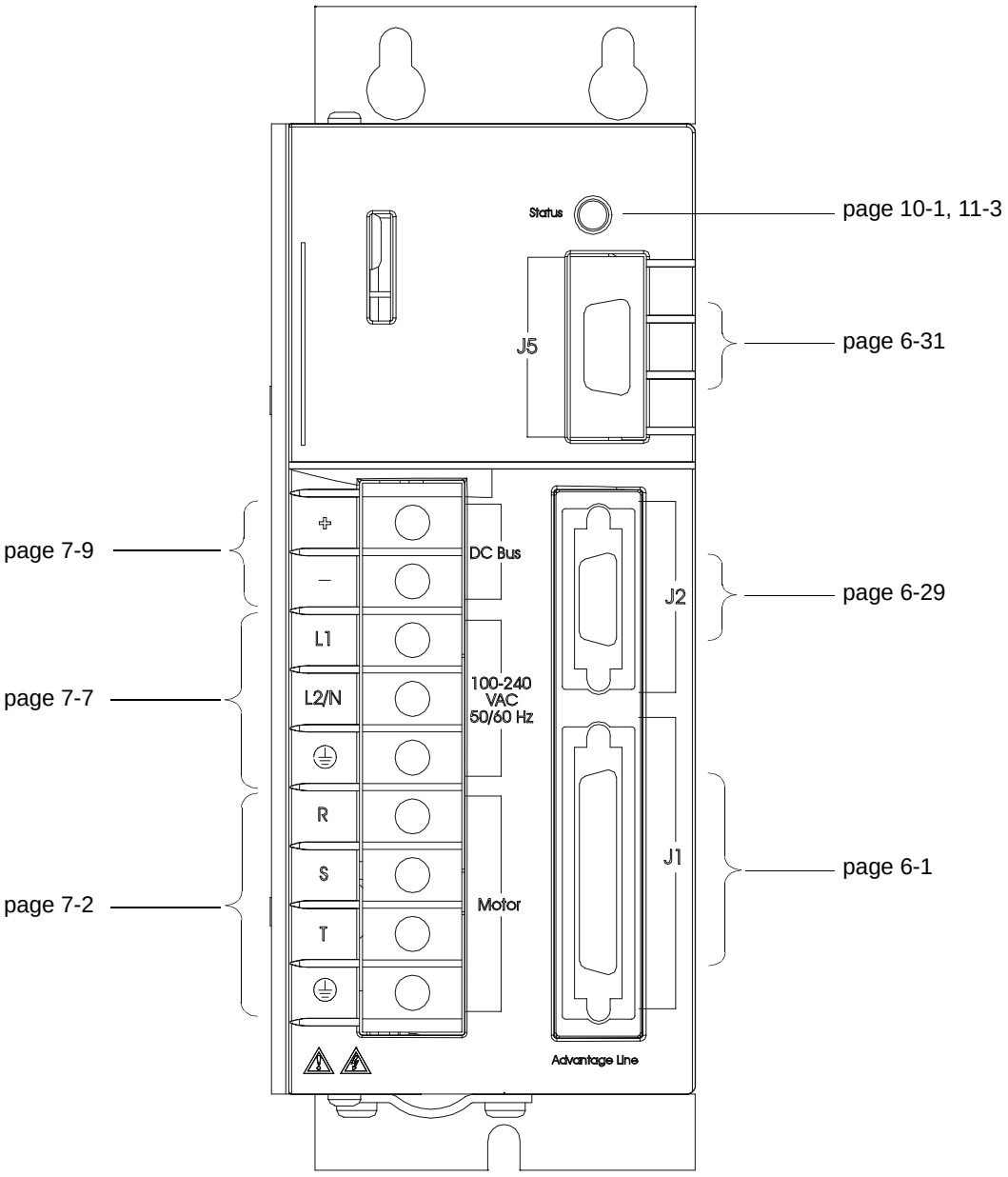
Example	Description
	Protective conductor terminal (Earth ground)
	Chassis terminal (not a protective ground)
	Symbol plus ATTENTION: These notices provide information intended to prevent potential personal injury and equipment damage.

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Pictorial Index

Shown here is a face view of the product, with pointers to where individual parts are discussed.

Product Parts Explained



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Safety

Installing and Using the ULTRA 100 Series Drive

Read the complete manual before attempting to install or operate the drive. By reading the manual you will become familiar with practices and procedures that allow you to operate the drive safely and effectively.

You should always adhere to the “General Safety Guidelines” on page 1-3. Specific Warnings and Cautions appear throughout the manual.

Potential Hazards

The equipment described in this manual is intended for use in industrial drive systems. This equipment can endanger life through rotating machinery and high voltages, therefore it is essential that guards for both electrical and mechanical parts are *not* removed.

Hazards which can be encountered in the use of this equipment are:

- Electric Shock
- Electric Fire
- Mechanical
- Stored Energy

These hazards must be controlled by safe machine design, using specific local regulations, normal safety guidelines and the specific notices that follow. There are no chemical or ionizing radiation hazards.

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Voltage Potentials



ATTENTION: DC bus capacitors may retain hazardous voltages for several minutes after input power has been removed, but will normally discharge in several seconds. Measure the DC bus voltage to verify it has reached a safe level each time power is removed before working on the drive; or wait for the time indicated in the warning on the front of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.

Voltage potentials for the internal drive circuitry vary from 325 Volts above to 325 Volts below earth ground for a 240 Volt input. Voltages can reach 450 VDC within the drive. All circuits, including the connections on the front panel, should be considered “hot” when power is connected and for the time specified in the warning on the front of the drive after power is removed.

Your Responsibilities

As the user or person installing this drive, you are responsible for determining the suitability of the product for the intended application. Rockwell Automation is neither responsible nor liable for indirect or consequential damage resulting from the inappropriate use of this product.

A qualified person is someone who is familiar with all safety notes and established safety practices, with the installation, operation and maintenance of this equipment and the hazards involved. For more detailed definitions, refer to IEC 364.

It is recommended that anyone who operates or maintains electrical or mechanical equipment should have a basic knowledge of First Aid. As a minimum, they should know where the First Aid equipment is kept and the identity of the trained First Responders in the facility.

Safety notes do not represent a complete list of the steps necessary to ensure safe operation of the equipment. If you wish further information, please contact the nearest distributor of Rockwell Automation products.

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General Safety Guidelines

This section covers general safety guidelines for electronic devices. Safety information specific to ULTRA 100 Series drives begins on page 1-1.

Hazards which can be encountered in the use of this equipment are:

- Electric Shock
- Electric Fire
- Mechanical
- Stored Energy

There are no chemical or ionizing radiation hazards.

Electrical shock and fire hazards are avoided by using normal installation procedures for electrical power equipment in an industrial environment. Installation must be undertaken by suitably qualified personnel. Note that this amplifier must be installed in an industrial cabinet such that access is restricted to suitable qualified personnel.

Mechanical hazards are associated with potentially uncontrolled movement of the motor shaft. If this imposes a risk in the machine, then appropriate precautions must be made to electrically disconnect the motor from the drive when personnel have access to moving parts of the machine. Note also that the motor must be securely mounted at all times.

Stored energy hazards are both electrical and mechanical.

1. Electrical hazards can be avoided by disconnecting the drive from its power source and measuring the DC bus voltage to verify it has reached a safe level or by waiting for the time indicated in the warning on the front of the drive prior to removing the protective covers or touching any connections.
2. Mechanical hazards require a risk analysis on the effects of stored mechanical energy when the machine is running at speed, as well as the potential for the conversion of electrical energy stored in the drive being converted to mechanical energy. Electrical energy may be stored in drive for the time indicated in the warning on the front of the drive.

The following points should be observed for the safety of personnel:

- Only qualified personnel familiar with the equipment are permitted to install, operate and maintain the device.
- System documentation must be available and observed at all times.

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- All non-qualified personnel should maintain a safe distance from the equipment.
- The system must be installed in accordance with local regulations.
- The equipment is intended for permanent connection to a main power input. It is *not* intended for use with a portable power input.
- Do *not* power up the unit without the covers in place and the protective conductor connected.
- Do *not* operate the unit without connecting the motor conductor to the appropriate terminal on the drive.
- Always remove power before making or removing *any* connection on the unit.
- Before removing the cover of the unit, shut off the main power and measure the DC bus voltage to verify it has reached a safe level or wait for the time as indicated on the front of the drive.
- Do *not* make any connections to the internal circuitry. Connections on the front panel are the only points where users should make connections.
- Be careful of the DC bus and shunt terminals. High voltage is present when power is applied to the drive.
- Never connect the DC- (negative) terminal to earth ground, the drive requires a floating DC bus.
- Do *not* use the ENABLE input as a safety shutdown. Always remove power to a drive before maintaining or repairing the unit.
- Motors without thermal protection devices require a valid thermal time constant. Otherwise the motor overload protection will not function properly.

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Unpacking, Inspecting and Storing

This chapter describes the steps which ensure that the drive will function as specified. The steps include:

- Unpacking the ULTRA 100 Series drive
- Inspecting the drive for shipping damage
- Testing the basic functionality of the drive
- Guidelines for storing the drive.

Unpacking the Drive

1. Remove the ULTRA 100 Series drive from the shipping carton and remove all packing materials from the unit. The materials and carton may be retained for storage or shipment of the drive.
2. Check all items against the packing list. A label located on the side of the unit identifies:
   - model number
   - serial number
   - manufacturing date code.

Inspection Procedure

To protect your investment and ensure your rights under warranty, we recommend the following steps be performed upon receipt of the unit:

- Inspect the unit for any physical damage that may have been sustained during shipment.
- Perform the Inspections Test to verify the functionality of the unit.

If you find damage, either concealed or obvious, contact your buyer to make a claim with the shipper. If degraded performance is detected when testing the unit, contact your distributor or Rockwell Automation to obtain a Return Material Authorization (RMA). Do this as soon as possible after receipt of the unit.

“Our Warranty” on page Help-7 summarizes the period and conditions under which ULTRA 100 Series drives are warranted against defects.

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Testing the Unit

Drives are burned-in and individually tested before they leave the factory. However, damage may occur during shipping. Perform the procedures below to ensure the ULTRA 100 Series drive is operational and undamaged.

Abbreviated directions for connecting the drive to a motor and a PC are provided.

The test requires:

- Approximately 20 minutes to complete
- A motor with appropriate power and encoder cables
- A PC with the ULTRA Master software package installed
- An RS-232 communications cable
- An external I/O power supply
- A single phase 100-240 VAC, 50/60 Hz power source. Standard wall outlet power is suitable for verification testing of ULTRA 100 Series drives.
- A test cable constructed from two normally open switches, several pieces of 1.5 mm^2 (16 AWG) wire and a mating connector. Connectors are listed in "Mating Connectors" on page A-6. The Appendix "Options and Accessories" on page A-1 lists the cables.

During the test, power is removed several times. Always measure the DC Bus voltage to verify the bus capacitors are fully discharged, or wait for the time indicated in the warning on the front of the drive. The bus capacitors must be fully discharged for the subsequent steps to be valid.

If problems arise during this procedure, refer to "Troubleshooting" on page 11-3 and review other relevant sections in this manual, or call your local distributor.



ATTENTION: Perform the initial power-up with the motor shaft disconnected from a load and the shaft key removed. Improper wiring or undiscovered shipping damage could result in undesired motor motion. Be prepared to remove power if excessive motion occurs.

Hardware Set Up

Make the connections described below and shown in Figure 2.1. "Options and Accessories" on page A-1 lists the interconnect cables available from the factory.

1. Connect an external I/O power supply (12-24 VDC) to J1-5 and J1-6, or J1-26 and J1-13.

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2. Connect an RS-232 cable between the serial port on the PC and the J5 connector on the ULTRA 100 Series drive. A simple 3 wire cable is depicted in the figure below.

3. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 100 Series drive.

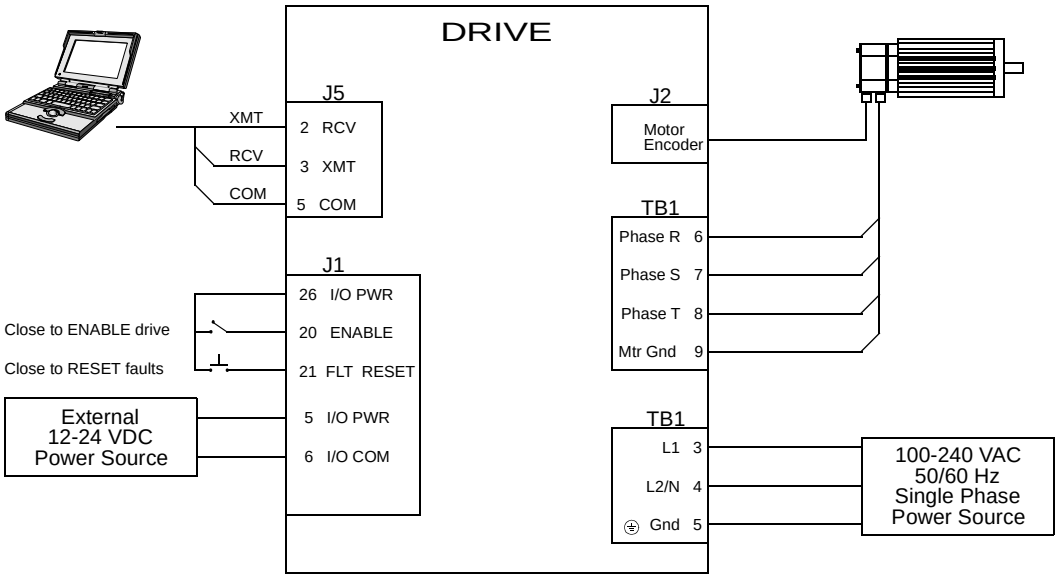
4. Connect a jumper wire with a toggle switch with a toggle switch between the following pins:

   - J1-20 (ENABLE) and J1-26 (I/O PWR).
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including its normally open toggle switches.

5. Connect a Power Cable between an external 100-240 VAC, 50/60 Hz power source and the L1, L2/N and ⏚ (Gnd) connections.

Figure 2.1 Host Mode Connection Diagram



Drive Checkout Test

ATTENTION: Be prepared to disable the drive or remove input power if excessive motor motion occurs while performing the following steps.

This test sequentially verifies that:

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- Drive power wiring is correct and start-up logic is functioning.
- The drive and motor are correctly wired
- Drive serial communications are operational

Before beginning the “Initial Power-up”, please check the following:

- All wiring and mounting to verify correct installation
- Input voltages to ensure they do *not* exceed specifications for the drive or motor.

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Initial Power-up

1. Verify the AC power is within specifications at the terminal strip.
2. Switch the AC Power to ON and verify the Status LED is green
3. Switch the power OFF and wait until the DC Bus Voltage is below 30 Volts.
4. Connect the motor windings to:
   - R (TB1-6)for the Phase R winding
   - S (TB1-7) for the Phase S winding
   - T (TB1-8) for the Phase T winding
   - ⏚ (TB1-9) for the Ground connection.
5. If a brake motor is being used for the test, connect the brake relay:
   - BRAKE ENABLE + (J1-49) to the Motor Brake +
   - BRAKE ENABLE - (J1-50) to the Motor Brake -.
6. Switch AC Power ON again and verify the STATUS LED is green
7. Switch the power OFF and wait until the DC Bus Voltage is below 30 Volts.

Communications Verification

8. Start ULTRA Master on the PC.
9. Close any windows that are open in ULTRA Master.
10. Select **PC Set Up** from the Communications menu in ULTRA Master.
11. Verify the communication port settings match those of the drive, then select **OK**. Factory default drive settings are:
    - Baud Rate: **9600**
    - Data Bits: **8**
    - Parity: **None**
    - Stop Bits: **1**
    - Serial Port: **COM1**

    Assignment of communications ports on PCs varies between manufacturers. The COM port setting for the drive and PC must match. Refer to “Troubleshooting” on page 11-3 if communication problems are encountered.
12. Switch AC power ON.

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13. Select **Read Drive Parameters** from the Communications menu in ULTRA Master.

14. Select **OK** in the Drive Select dialog box. A dialog box indicating that the PC is reading drive parameters should appear.

    If this dialog box does *not* appear, a message appears that advises you to check the COM settings and the communication cable. If necessary, refer to “Troubleshooting” on page 11-3 for instructions on how to perform these checks.

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Initial Drive Operation

1. When the message appears that a motor must be selected, choose **OK**. The Drive Set Up dialog box is selected with Motor Model active.
2. Select the appropriate motor from the drop-down Motor Model box.
3. Choose **OK** when the message appears advising that the drive must reset. A change in motor parameters requires reselection of the firmware based drive/motor tables. The software reset prevents improper sequencing of these table parameters.
4. Choose **Close** from the Drive Set Up window.
5. Select the **Control Panel** icon from the Drive Window.
6. Close the connection between J1-26 and J1-20 to enable the drive.
7. Holding torque should be sufficient so that the shaft is either immovable or very resistant to rotation.
8. Move the Slide Bar in the Control Panel window to the right and then to the left. Verify that the motor rotates:
   - CW as the Slide Bar is moved right of center, and
   - CCW as the Slide Bar is moved left of center.

   If the motor rotates in the wrong direction (CCW when the slide bar is set to the right of center) or jumps and locks-up, motor phasing and encoder feedback phasing may be incorrect. If necessary, refer to the Troubleshooting chapter for instructions on how to correct the motor power connections at TB1-1, 2, 3 and 4 or the encoder feedback connections at J2.
9. Choose **Set to Zero**. The motor will stop rotating.
10. Choose **Drive Disable** and verify the motor shaft can be rotated by hand.
11. Choose **Drive Enable** and verify the motor shaft has holding torque. (i.e., The shaft cannot be moved or moves with resistance.)
12. Open the connection between J1-26 and J1-20 to disable the drive.
13. Choose **Close** from the Control Panel window.

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A drive completing these steps is functional. If the ULTRA 100 Series drive did *not* pass the steps above, refer to “Troubleshooting” on page 11-3.

Note: For information on testing the digital and analog signals refer to “Testing Digital Outputs” on page 11-9, “Testing Digital Inputs” on page 11-11, “Testing Analog Output” on page 11-11 and “Testing Analog Input” on page 11-12.

Storing the Unit

Return the drive to its shipping carton using the original packing materials to enclose the unit.

Store the drive in a clean, dry place that will *not* exceed the following ranges:

- Humidity: 5% to 95%, non-condensing
- Storage temperature: -40° to 158° Fahrenheit (-40° to 70° Celsius).

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Selecting Other System Components

This chapter reviews the ULTRA 100 Series 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X drives, command sources and interfaces for the drives, and complementary motors and accessory equipment. Selection of complementary servo components allows you to efficiently connect other devices to your microdrive. Pertinent information about each is provided to assist you in planning your servo system.

ULTRA 100 Series Overview

The ULTRA 100 Series drives are part of a family of universal digital drives. ULTRA 100 Series drives use microcontrollers to digitally manage the current, velocity, and position. All system and application parameters are set in software, which ensures repeatability of all functions and prevents element drift.

A single unit fully encloses all electronics. An external transformer is *not* required on the power line. All connectors and indicators are accessible and clearly marked on the front panel.

ULTRA 100 Series Features

Drive Power Ratings

Several power levels of ULTRA 100 Series drives are available. All models have integral power supplies[1] and use a single phase power source. They differ only in physical size, indexing capability and output power:

- 1398-DDM-005 and -005X with continuous output power of 500 Watts.
- 1398-DDM-009 and -009X with continuous output power of 1000 Watts.
- 1398-DDM-019 and -019X with continuous output power of 2000 Watts.

The ULTRA 100 Series drives, when combined with brushless servo motors, provide continuous torque ranging from 0.17 Nm to 2.5 Nm (1.5 to 22.5 lb-in) and peak torque ranging from 0.48 Nm to 7.12 Nm (4.3 lb-in to 63 lb-in).

1. 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X require an external 12-24VDC power source for I/O.

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High Performance Microcontroller Technology

All digital current, velocity and position loop calculations as well as the motor commutation calculation are performed by a microcontroller.

IPM Technology

IPM (Intelligent Power Module) technology in the output stage provides a high frequency, digital PWM (Pulse Width Modulation) sine wave that controls the current loop, including overcurrent, short circuit and overtemperature protection.

Analog and Digital Interfaces

All ULTRA 100 Series drives allow the user to select one of the following analog or digital command interfaces:

- ±10 Volt analog interface - velocity or torque control
- Presets (from one to eight binary inputs) - torque or velocity control
- Quadrature encoder digital interface - electronic gearing position follower
- Step/Direction digital interface - position control
- CW/CCW (step up/step down) interface - position control
- Indexing - position control from a single point in one of three ways
- Operating mode override - alternate movement interface

Encoder Control

A single, motor mounted encoder provides complete commutation information and velocity feedback. Low velocity regulation is enhanced by the use of a 5000 PPR (pulses per revolution) incremental encoder.

Encoder Output

A selectable output allows the encoder resolution to be specified for maximum performance without added circuitry. Outputs are differential line drivers capable of dividing the motor encoder signal by a factor of 1, 2, 4 or 8.

Digital I/O

Digital I/O channels allow the user to program the drive to fit the specific application. Power for the I/O must be supplied by an 12-24 VDC external I/O power source. Selections include:

- Four selectable (INPUT1, INPUT2, INPUT3 and FAULT RESET), optically isolated, active high inputs.

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- One dedicated, control (ENABLE), optically isolated, active high input.
- Two selectable, optically isolated and short circuit protected, active high outputs.
- Two dedicated (BRAKE/DRIVE ENABLED and DRIVE READY), normally open relay outputs.

Analog I/O

A dedicated analog input provides current limiting capabilities, while the analog output can be customized to fit the application:

- One dedicated 0 - 10 Volt, analog input (EXTERNAL CURRENT LIMIT)
- One selectable, ±10 Volt analog output.

AC Input Power

ULTRA 100 Series drives covered by this manual are powered directly from a main 100-240 VAC single phase line.

Personality Module

EEPROM (electrically erasable programmable read only memory) stores both motor and application specific settings and parameters for the drive.

Multiple Protection Circuits

Device and circuit protection, and diagnostic information is provided by:

- Bi-color single point LED
- Overtemperature, short circuit and overcurrent protection for the power output
- I^2T (power-time) protection for the motor and the power drive
- Bus Overvoltage
- Bus Undervoltage
- Overspeed
- Fault diagnostics
- Watchdog timers provide fail-safe operation.

Command Sources

Serial Command Sources

ULTRA 100 Series drives are configured and controlled via a serial communication link. Commands may be issued from a variety of sources through a serial communications port. Possible command sources include:

- Personal computers

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- Host computers
- Programmable Logic Controllers
- Motion controllers
- TouchPad.

The serial communication interface for the ULTRA 100 Series supports:

- RS-232 and the four wire RS-485 communications standards
- NRZ (non-return to zero) asynchronous serial format
- Baud rates: 1200, 2400, 4800, 9600 and 19200
- Parity generation and checking: Even, Odd or None.

Connection of communication cables between the drive and user-supplied equipment is described in the following sections:

- One ULTRA 100 Series drive - “Single Axis RS-232 Set Up” on page 6-34
- Multiple ULTRA 100 Series drives - “Multiple Axes Four-wire RS-485 Communications” on page 6-35.

Analog Command Sources

In the analog mode of operation, the ULTRA 100 Series drive requires a variable ±10 Volt DC external analog signal capable of driving the servo regulator’s command input at an input impedance of 13.3 kOhms. Choose a source such as a PLC (programmable logic controller), the DAC (digital-to-analog converter) of a computer, or a motion controller that meets this requirement.

Differential or single-ended line drivers may supply the signals for the auxiliary encoder inputs, step and direction inputs, and step up/down inputs. The differential signal must be capable of supplying at least 5 mA with 2.0 Volts across the + and - inputs. A differential signal source provides the best noise margin of all the interface circuit options. Single-ended signals from TTL drivers must be capable of sourcing or sinking 5 mA.

In preset mode, the controlling device should be able to source 10 mA into the digital inputs.

I/O Interface

Analog Input

One analog input channel is accessible to the user. The analog input limits the peak current available from the drive.

- I LIMIT (current limit)

The analog signal must be within 0-10 Volt range and single-ended.

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If this signal is not provided, the peak current of the drive may be set in software through the Drive Parameter window.

Analog Output

One analog output channel may be defined by the user through software:

- ANALOG is a ±10 Volt signal. The allowable current draw of the load is ±2 mA

This analog output is designed for monitoring purposes only. This signal should not be used for control purposes due to the relatively high ripple voltage (1%).

Digital Inputs

Note: Power for the I/O must be supplied by an external 12-24 VDC power source.

Control Inputs

One optically isolated, single ended, active high, dedicated control input provides the controller ENABLE function. This input operates with switch closure or sourcing type transistor outputs.

The current rating is 10 mA maximum.

Selectable Inputs

Four optically isolated, single ended, active high inputs (INPUT1, INPUT2, INPUT3 and FAULT RESET) support logic type interfaces. The input circuits operate with switch closure or sourcing type transistor circuits.

The current rating of each input is 10 mA maximum.

Digital Outputs

Control Outputs

Two normally open relays are dedicated control outputs to the following signals:

- BRAKE/DRIVE ENABLED
- DRIVE READY.

The current ratings of each relay is 1 Amp at 30 VDC.

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If using a motor with the 90VAC brake option, a user-provided relay may be driven by these outputs up to the specified levels. Refer to Figure 6.10 on page 6-10 for information about the necessary hardware connections. Consult the I/O Configuration in the on-line ULTRA Master help for additional information about the software parameters.

Selectable Outputs

Two optically isolated, single ended, active high, current sourcing, discrete output channels provide logic outputs under software control.

Each selectable output channel is capable of sourcing 50 mA maximum and is optically isolated and short circuit protected.

Auxiliary Encoder Interface

The external encoder I/O port permits quadrature type encoder signals for applications, such as electronic gearing.

Encoder Inputs

Software automatically selects the appropriate input based on the command source:

- Master Encoder
- Step/Direction
- Step Up/Step Down.

Encoder Output

The resolution of the encoder output channel is under software control. The motor encoder signal is divided by 1, 2, 4 or 8 to provide an output from a differential line driver measured in PPR (pulses per revolution). The maximum encoder frequency output is 1 MHz (4 MHz quadrature).

▶ **Note:** If a controller requires synchronization to a specific output state, refer to “IOUT Signal Generation” on page 6-18 for additional information.

ULTRA Master Software

A Windows-based software interface provides start-up selections. Tasks are organized for efficient set up, control and maintenance. Context sensitive, on-line help provides immediate assistance.

- Set up is simplified by a series of logically arranged set up screens.
- Files can be stored and printed for on-line or off-line modification, and on-site or off-site back-up.
- Diagnostic and set up tools make system integration easy.

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- Critical information is available with complete Windows-based on-line help.
- Serial Host Language commands are explained through on-line help.
- User defined velocity, acceleration, position and torque parameters.
- Tuning and diagnosis is aided with an on-screen dual channel digital oscilloscope.
- On-screen meters and software tools provide rapid debugging and measurement.

Autotuning

Digital auto tuning allows easy setup. All adjustments are made in software, which immediately sets the servo system compensation parameters. This eliminates the time-consuming adjustments required by potentiometers.

Agency Approvals

- UL listed
- cUL listed
- CE marked.

Interface Cables

Standard motor power and encoder feedback cables, as well as communications cables, are available to complete your motion control system and provide reliable, trouble free start-up. Refer to “Options and Accessories” on page A-1 for optional equipment. Use of factory supplied cables is required for compliance to the European Electromagnetic Compatibility (EMC) Directive and to protect your warranty rights.

Motors

The ULTRA 100 Series is compatible with many motors, both Allen-Bradley motors and motors from other manufacturers. Drive and motor parameters for all compatible motors are programmed into each ULTRA 100 Series drive at the factory. Allen-Bradley motors that are compatible with the ULTRA 100 Series drives include:

- F-Series motors
- H-Series motors
- N-Series motors
- W-Series motors
- Y-Series motors.

ULTRA Master software speeds drive and motor set up by predefined parameters for each drive and motor combination.

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Refer to the Torque/Speed curves in the Allen-Bradley Standard Product Catalog and Handbook (Publication 1398-2.0) or contact your local Allen-Bradley distributor for motor sizing and compatibility assistance.

Custom motors or motors not manufactured by Allen-Bradley may be interfaced, refer to “Creating Custom Motor Files” on page D-1 and, if necessary, contact Product Support for assistance.

Options

- Power and feedback cables are potted and molded with 360 degree shielding.
- AC line filters.
- Breakout boards for I/O control and encoder interface.
- TouchPad - a compact and highly portable input and display device.

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European Union Requirements

ULTRA 100 Series drives conform to the following European Union Directives:

- Low Voltage Directive (72/23/EEC, 93/68/EEC)
- Electromagnetic Compatibility Directive (89/336/EEC, 92/31/EEC, 93/68/EEC)

Compliance with the EEC Directives is contingent on two conditions:

1. Installation of AC line filters between the power source and the drive, and
2. Use of factory authorized cables to connect motors. "European Union EMC Directives" on page 5-7 and "Options and Accessories" on page A-1 lists this equipment and associated part numbers.

Use of this product with other non-CE products or in a manner inconsistent with established testing requirements invalidates the CE registration declaration.

Allen-Bradley motors currently available for use with ULTRA 100 Series drives in installations requiring CE marking include:

- F-Series motors
- H-Series motors
- LD-Series motors
- S-Series motors
- Y-Series motors

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ULTRA Master Installation

Installation of ULTRA Master on a PC is covered in this chapter, which:

- Lists the minimum PC hardware and software necessary to run ULTRA Master.
- Provides step-by-step instructions on how to load ULTRA Master.
- Shows you how to start and quit ULTRA Master and introduces the Drive Window,
  the main command window for ULTRA Master.
- Instructs you on how to access on-line help.

Instructions for using the features available in ULTRA Master are detailed in on-line help. To access the Help menu, depress the **F1** key.

Hardware and Software Requirements

The minimum personal computer (PC) requirements to run the software are:

- A DOS computer with a 286 microprocessor
- A hard disk, with 2.0 MB of free disk space
- 3½ inch, 1.44MB floppy disk drive
- 2 MB of RAM
- A Video Graphics Array (VGA) monitor
- Microsoft Windows version 3.1
- A mouse is recommended.

Windows must be installed on your PC. If Windows is *not* already installed, refer to the appropriate Microsoft manual to install Windows on your computer.

Installing ULTRA Master

To install ULTRA Master software on a hard drive:

1. Make a backup copy of the ULTRA Master disk in one of the following ways:
   - Copy the ULTRA Master disk using the disk menu in the Windows File Manager.
   - If your computer has only one floppy disk drive, type from the DOS command line prompt **`diskcopy a: b:`** and then press **ENTER**. The software will prompt you when to insert the SOURCE (ULTRA Master) disk and when to insert the TARGET (blank) disk.

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2. If Windows is *not* running, type **win** at the DOS prompt (**C:>**). If Windows is already running, close any open applications.
3. Insert the ULTRA Master disk into a 1.44MB floppy disk drive, typically drive A:, and close the drive door.
4. Choose **Run**, from the File menu in Windows Program Manager.
5. Type **a:setup** and then press **ENTER**. A message box will appear saying that the setup is initializing. The message box may be present for up to 40 seconds, depending on the speed of the PC.
6. A dialog box requires you to confirm whether or not ULTRA Master should be installed on the hard drive (C: drive) of the PC.
   - To install ULTRA Master, choose **Continue**, or press **ENTER**, and continue with the next step.
   - To stop the installation, choose **Exit**. You are returned to Windows.
7. Setup then asks where you would like to install ULTRA Master.
   - To accept the path that Setup proposes in the **Path:** box (c:\ultramst\...), choose **Continue,**
   - To choose another directory, type a new path in the **Path:** box, and then choose **Continue**. You will *not* have the opportunity to confirm your entry so type carefully.
   - To return to the initial Setup window, choose **Back**.
   - To stop the installation, choose **Exit**. You will return to Windows.
   - To obtain on-line help with the installation, Choose **Help**.
8. A status bar will keep you informed of the installation progress. When Setup is complete, choose **OK** or press **ENTER** to return to Windows.

Starting and Quitting ULTRA Master

Setup automatically creates the ULTRA Master program group and then returns you to Windows. The ULTRA Master program group provides access to the ULTRA Master application icon,

From the C:> Prompt

1. Type **win c:\ultramst\ultramst.exe.**

▶ **Note:** This step assumes ULTRA Master was loaded into the *c:\ultramst* directory during setup.

The ULTRA Master start-up screen will open.

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From Windows

1. Choose the ULTRA Master program group from the Program Manager in Windows.

Note: If the ULTRA Master window is *not* active, hold down ALT and press TAB (ALT+TAB) until the ULTRA Master title bar and icon are highlighted, or select ULTRA Master from the list in the Window menu.

2. Choose the ULTRA Master icon from the ULTRA Master program group.

The ULTRA Master start-up screen will open.

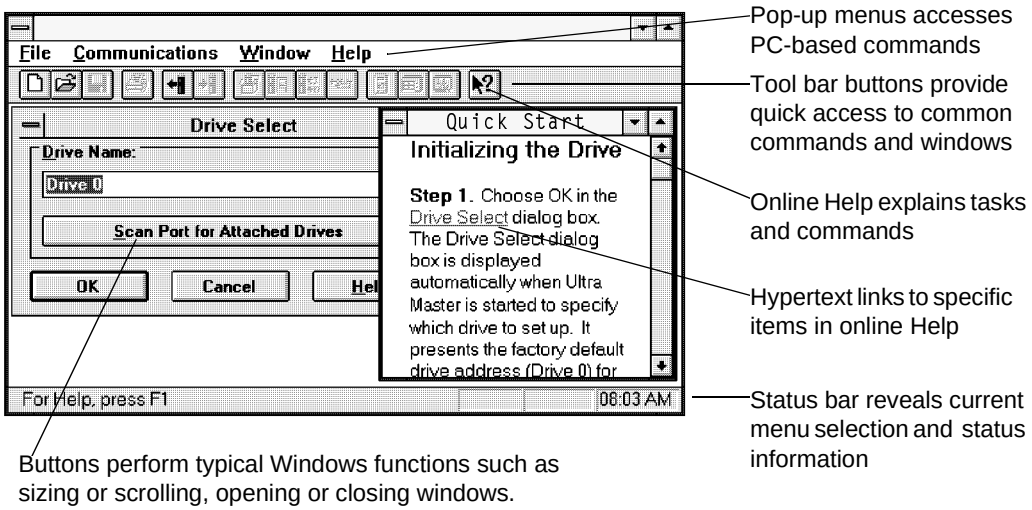
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The ULTRA Master Start-Up Screen

When ULTRA Master starts for the first time, its default instructions are:

- Display the Help menu - Quick Start.
- Present the Drive Select window. The Drive Select window offers Drive 0, which is the default drive address assigned at the factory.

The default ULTRA Master Start-up screen is shown below. The comments point out many of the Windows controls that are available in ULTRA Master.



Note: ULTRA Master displays the Help menu – Quick Start – when it is first accessed. To disable this automatic display, deselect the menu item **Show Quick Start** from the Help menu.

Version Level

The release level and date for ULTRA Master may be displayed by selecting **About** ULTRA Master from the Help menu. This information also appears in the initial ULTRA Master screen. The About ULTRA Master window includes additional data about system resources typically displayed in Windows Help.

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Miscellaneous Files

The readme File

A file, titled README, may be included in the ULTRA Master directory. This file contains installation instructions, change notes from previous revisions, and information that became available after this manual was printed. After you install ULTRA Master you can access this file by choosing the Read Me icon in the ULTRA Master window or by using Microsoft Write or an equivalent application program to view the file **`readme.wri`** in the directory path where ULTRA Master is installed.

Firmware Files

Firmware files are supplied in the Miscellaneous directory on the ULTRA Master diskette. The current revision level of drive firmware, excluding the TouchPad firmware, is displayed in the Drive Information window of ULTRA Master. The current revision level of TouchPad firmware is displayed as part of the TouchPad initialization when a TouchPad is connected to the drive.

The types of files and their functions are:

- Firmware – Main Operating firmware for the drive
- Boot Block – Drive Initialization firmware for the drive

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Installation

Mechanical Installation Requirements

1. Mount the unit in an enclosure providing protection to IP54 (protected against dust and splashing water), or IP65 (dust free and protected against water jets) if the work environment is poor. Many NEMA (National Electrical Manufacturers Association) Type 4 cabinets provide this level of protection. Minimum cabinet requirements are:

   - Depth: 243.8 cm (9.6 inches).
   - Adequate sizing and/or ventilation to dissipate the heat generated by the ULTRA 100 Series drives. Refer to "Power Dissipation" on page G-5 for the amount of heat generated by ULTRA 100 Series drives and enclosure sizing equations.

2. Minimum unobstructed surrounding space for cooling air intake (and fan exhaust from the 1398-DDM-019 and -019X):

   - Above: 50.8 cm (2 inches)
   - Below: 50.8 cm (2 inches)
   - Sides: 1.25 cm (0.5 inches)
   - Front: 76.2 cm (3.0 inches) for cable clearance.



ATTENTION: If the cabinet is ventilated, use filtered or conditioned air to prevent the accumulation of dust and dirt on electronic components. The air should be free of oil, corrosives, or electrically conductive contaminates.

3. Position the drive in a vertical position on a flat, solid surface that meets the following weight, vibration and shock, altitude and humidity, airflow clearance, and temperature requirements.

   Unit weights are:

   - 1398-DDM-005 and 1398-DDM-005X: 1.7 Kg (3.7 Lbs)
   - 1398-DDM-009 and 1398-DDM-009X: 2.05 Kg (4.5 Lbs)
   - 1398-DDM-019 and 1398-DDM-019X: 2.0 Kg (4.4 Lbs)

   Vibration and shock, altitude and humidity limits are:

   - Vibration: 2g at 10 to 2000 Hz
   - Shock: 15g 11 msec half sine

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- Altitude: 1500 meters (5000 feet),
  Derate power performance 3% for each 300 m above 1500 m (1000 ft above 5000 ft).
- Humidity: 5% to 95% non-condensing

Ambient operating temperature range and airflow clearances are:

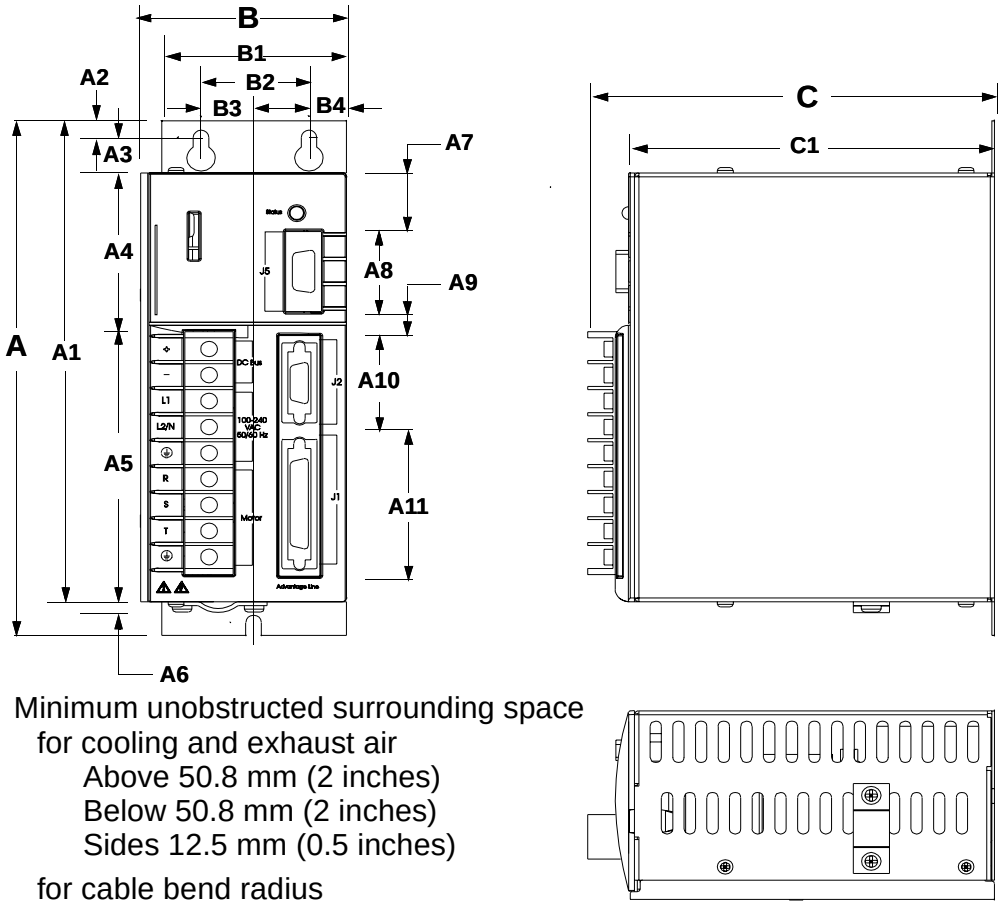
- 0 ° to 55° Celsius (32° to 131° Fahrenheit).
- 50.8 mm (2 inches) above and below unit for airflow.

4. Bolt the unit to the cabinet using the mounting slots in the drive. Mounting dimensions are shown in Figure 5.2. The recommended size of mounting hardware is:

- M5 Metric (1/4-20 equivalent), or
- #10 MS bolts

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Figure 5.1 1398-DDM-005 and -005X Mounting Dimensions



Minimum unobstructed surrounding space

for cooling and exhaust air

Above 50.8 mm (2 inches)

Below 50.8 mm (2 inches)

Sides 12.5 mm (0.5 inches)

for cable bend radius

Front 76.2 mm (3 inches)

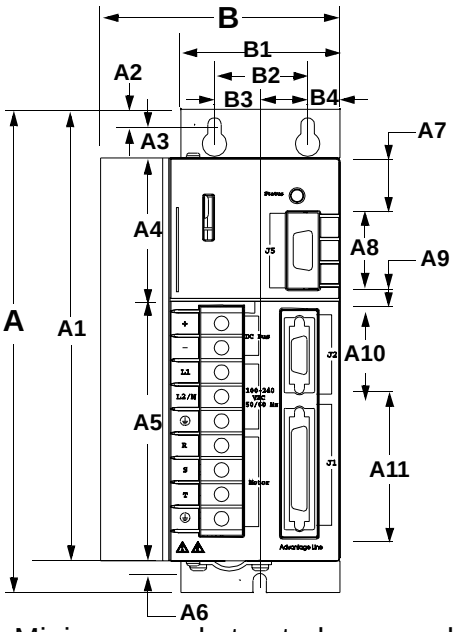
Table 5.1: 1398-DDM-005 and -005X Mounting Dimensions

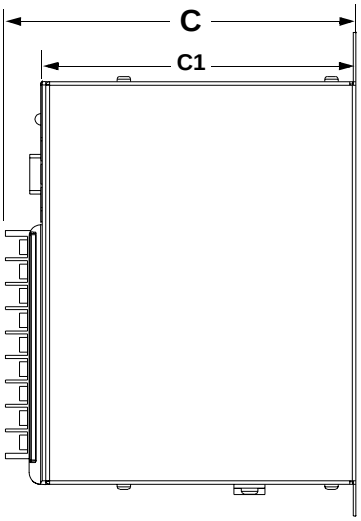
	Dimension			Dimension	
	mm	inches		mm	inches
A	198.12	7.80	B	72.60	2.86
A1	184.9	7.28	B1	65.02	2.56
A2	6.35	0.25	B2	38.10	1.50
A3	13.0	0.51	B3	18.54	0.73
A4	60.7	2.39	B4	13.21	0.52
A5	94.49	3.72	B5	5.58	0.22
A6[a]	5.0	0.20			
A7	22.10	0.87	C	146.05	5.75
A8	31.75	1.25	C1	129.03	5.08
A9	8.64	0.34			
A10	31.75	1.25			
A11	57.15	2.25			

a. Power Cable bracket extends up to 20 mm (0.80 inch)

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Figure 5.2 1398-DDM-009 and -009X, 1398-DDM-019 and -019X Mounting Dimensions





Minimum unobstructed surrounding space

for cooling and exhaust air

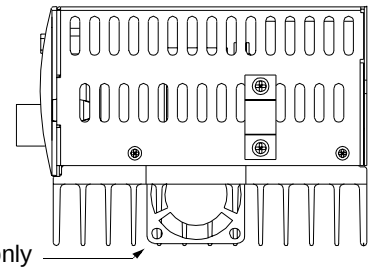
Above 50.8 mm (2 inches)

Below 50.8 mm (2 inches)

Sides 12.5 mm (0.5 inches)

for cable bend radius

Front 76.2 mm (3 inches)



NOTE: Fan on 1398-DDM-019 only

Table 5.2: 1398-DDM-009 and -009X, 1398-DDM-019 and -019X Mounting Dimensions

	Dimension			Dimension	
	mm	inches		mm	inches
A	198.12	7.80	B	97.30	3.83
A1	184.9	7.28	B1	65.02	2.56
A2	6.35	0.25	B2	38.10	1.50
A3	13.0	0.51	B3	18.54	0.73
A4	60.7	2.39	B4	13.21	0.52
A5	94.49	3.72	B5	5.58	0.22
A6[a]	5.0	0.20			
A7	22.10	0.87	C	146.05	5.75
A8	31.75	1.25	C1	129.03	5.08
A9	8.64	0.34			
A10	31.75	1.25			
A11	57.15	2.25			

a. Power Cable bracket extends up to 20mm (0.80 inch)

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Interface Connections

Input/Output and power cables connect to the front panel of a ULTRA 100 Series drive, no internal connections are necessary.



ATTENTION: Perform the initial power-up with the motor shaft disconnected from a load and the shaft key removed. Improper wiring or undiscovered shipping damage could result in undesired motor motion. Be prepared to remove power if excessive motion occurs.

I/O Connections, including the external I/O power supply, are fully described in the following sections:

- "J1 – Controller" on page 6-1 defines the controller connections
- "J2 – Encoder" on page 6-29 defines the motor encoder connections
- "J5 – Serial Port" on page 6-31 defines the RS-232/RS-485 serial port connections

Power Connections are fully described in the following sections:

- Chapter 7, "Power Connections" defines the AC, DC Bus and Motor power connections.

Specific operational set ups are depicted in Figure 8.1 through Figure 8.11 (pages 8-2 through 8-45, respectively). These figures cover velocity and torque mode controls for:

- Analog Controllers in velocity or torque modes,
- Preset Controllers in velocity or torque modes,
- Position Followers using a Master Encoder,
- Position Followers using a Step/Direction signal,
- Position Followers using Step Up/Down signals,
- Incremental Indexing over a specific distance,
- Registration Indexing from a mark, or
- Absolute Indexing to a home position.

Wiring

Wiring sizes and practices, as well as grounding and shielding techniques are described in the sections listed below. Refer to Chapter 7, "Power Connections".

The descriptions represent common wiring practices and should prove satisfactory in the majority of applications.



Note: Cables, listed in Appendix A, "Options and Accessories", are *not* rated for continuous flexing.

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Minimum wire gages for power cables are listed in:

- “Motor Power Contact and Wire Size Recommendations” on page 7-4,
- “AC Input Power Sizing Requirements” on page 7-8.

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Electromagnetic Compatibility

General Guidelines

Refer to Appendix E, “Electromagnetic Compatibility Guidelines for Machine Design” for an in-depth discussion of electromagnetic compatibility (EMC) and electromagnetic interference (EMI).

European Union EMC Directives

The ULTRA 100 Series drives are designed and tested to meet the European EMC Directive. Declarations of conformity, which enumerate the standards used, are included in the manual.

Installation requirements necessary to meet this directive are:

1. Use of factory supplied cables,
2. Use of an external AC line filter, and



ATTENTION: Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels prior to handling the equipment. Failure to observe this precaution could result in severe bodily injury.

3. If an external supply powers the I/O, grounding of this power supply is required.

Refer to Appendix A, “Options and Accessories” for part numbers. The following diagrams show the mounting dimensions for single phase AC Line Filters available from Rockwell Automation.

Table 5.3 shows a typical filter selection matrix for ULTRA 100 Series drives. All the filters identified below are manufactured by Schaffner or Roxburgh and are widely available. There are many AC line filter manufacturers whose filters can be successfully integrated. Rockwell Automation recommends Schaffner or Roxburgh filters based on our test results, but the machine builder is responsible for the suitability of the filter selection in a specific application. These filters can be used for distributing power to multiple drives, rather than using an individual filter for each drive. Further information is available from Schaffner (1-800-367-5566) or Roxburgh (01724.281770 [011.44.1724.281770 from the USA]).

AC line filters for use with ULTRA 100 Series drives are listed in Table 5.3.

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Table 5.3: AC Line Filters for ULTRA 100 Series drives

Drive	Part Number		
	Roxburgh	Schaffner	Allen-Bradley
1398-DDM-005 and 1398-DDM-005X	MIF 06, MDF 06	FN 350-8	9101-1516
1398-DDM-009, 1398-DDM-009X and 1398-DDM-010	MIF 10, MDF 16	FN 350-12	9101-1517
1398-DDM-019, 1398-DDM-019X and 1398-DDM-020	MIF 23, MDF 18	FN 350-20	9101-1518
1398-DDM-030	MIF 32, MDF 36	FN 350-30	9101-1387
1398-DDM-075 (3- phase)	MIF 330, MIF 336	FN 351-36	9101-1389

The Roxburgh filters differ in the number of stages. The MDF (Motor Drive Filters) filters are single stage filters; the MIF (Motor Inverter Filters) filters are three-stage filters. The three-stage filter will remove more of the noise, but the cost is more panel space in the higher current filters. In the lower current filters (<50 A), the panel space used is less for the MIF filters.

The Schaffner filters are single-stage filters. These differ from the Roxburgh filters in component types, values and placement. The leakage current is generally lower, but the amount of attenuation is lower too. These filters will work if the amount of noise in the environment is low, or if the design of the machine is such that only a nominal amount of attenuation is needed.

Basic guidelines for reducing electrical noise and increasing electromagnetic compatibility (EMC) are listed in Appendix E, “Electromagnetic Compatibility Guidelines for Machine Design”.

AC Line Filters

This section contains the filter mounting diagram in Figure 5.3 and the specifications in Table 5.4, followed by the wiring diagram in Figure 5.4.

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Figure 5.3 MIF Single Phase AC Line Filter Mounting Diagram

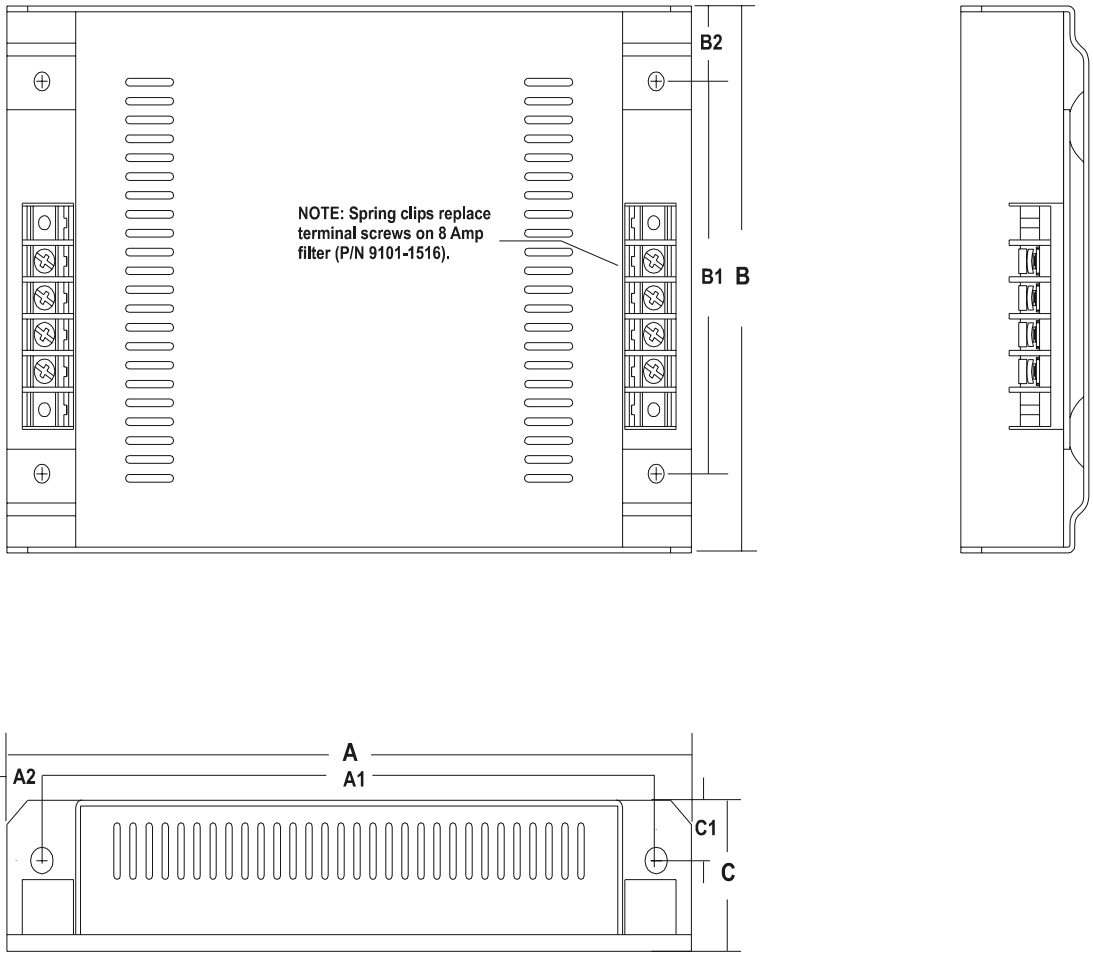


Table 5.4: MIF Single Phase AC Line Filter Engineering Specifications

	SINGLE PHASE 6A P/N 9101-1516		SINGLE PHASE 10A P/N 9101-1517		SINGLE PHASE 23A P/N 9101-1518	
DIMENSIONAL DATA						
MEASUREMENT	**mm**	**in**	**mm**	**in**	**mm**	**in**
A	170	6.7	214	8.4	214	8.4
A1	152	6.0	192	7.6	192	7.6
A2	9	0.4	11	0.4	11	0.4
B	92	3.6	145	5.7	204	8.0
B1	55	2.2	104	4.1	164	6.6
B2	18	0.7	20	0.8	20	0.8
C	25	1.0	40	1.6	47	1.8
C1	10	0.4	16	0.6	19	0.8
C2	15	0.6	24	1.0	28	1.0
ELECTRICAL and MECHANICAL SPECIFICATIONS						
Voltage/Freq.	250 VAC @ 50/50 Hz		250 VAC @ 50/50 Hz		250 VAC @ 50/50 Hz	

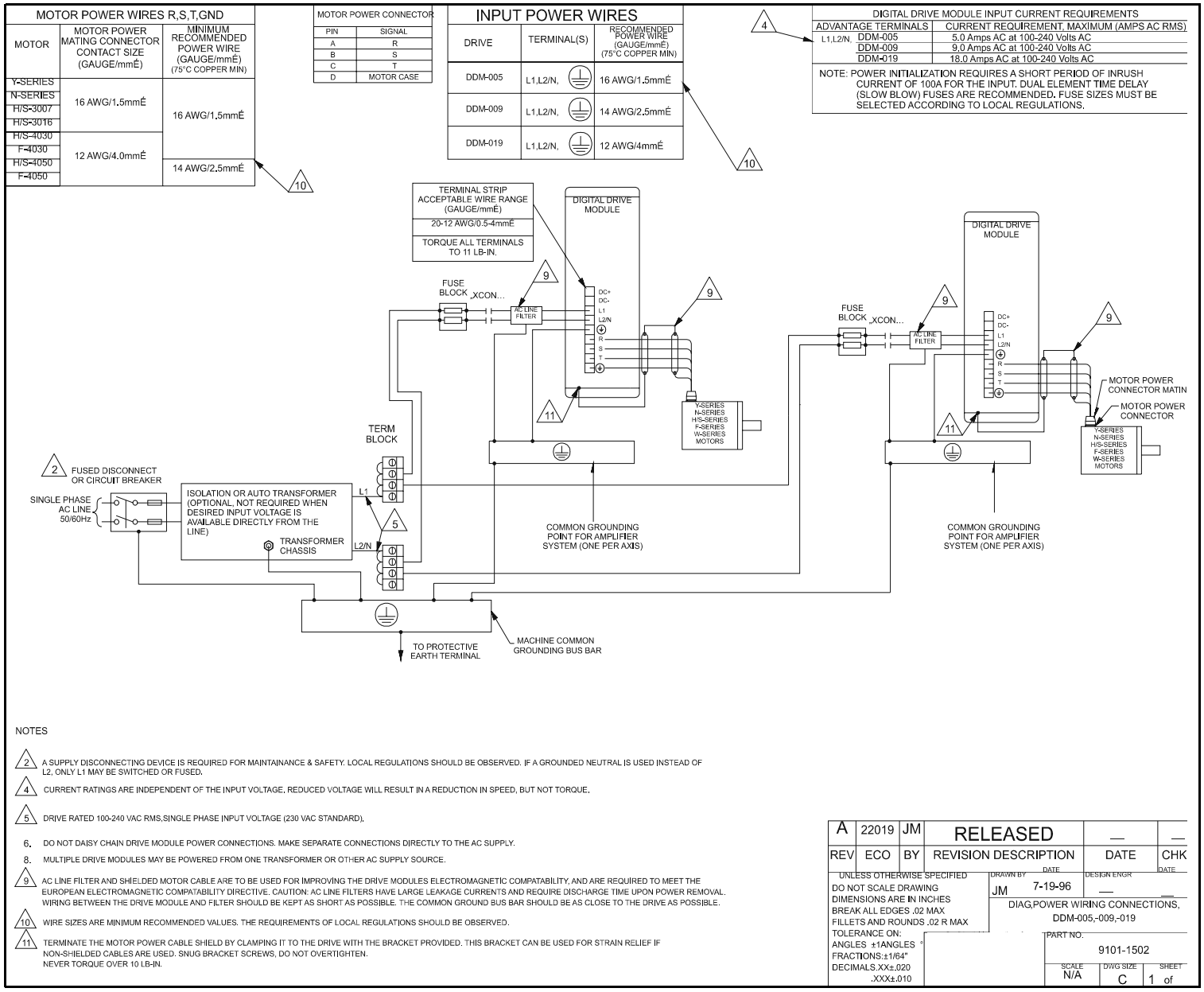
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Table 5.4: MIF Single Phase AC Line Filter Engineering Specifications (continued)

	SINGLE PHASE 6A P/N 9101-1516		SINGLE PHASE 10A P/N 9101-1517		SINGLE PHASE 23A P/N 9101-1518	
DIMENSIONAL DATA						
MEASUREMENT	**mm**	**in**	**mm**	**in**	**mm**	**in**
Current	6A @ 50°C		10A @ 50°C		23A @ 50°C	
Overload Current	150% 1 minute 200% 1 second		150% 1 minute 200% 1 second		150% 1 minute 200% 1 second	
Temperature	-25 to 95°C		-25 to 95°C		-25 to 95°C	
Leakage Current	5 mA @ 240V, 50 Hz		46 mA @ 240V, 50 Hz		200 mA @ 250V, 50 Hz	
Electric Strength	2500 VAC/1 minute		2500 VAC/1 minute		2500 VAC/1 minute	
Power Loss	3.5 Watts (full load)		2.7 Watts (full load)		10 Watts (full load)	
Terminals	2mm sq. spring clamp		M4 screw cross/ sq. 2x 2.5mm		M4 screw cross/ sq. 2x 2.5mm	
Weight	0.3 Kg (0.66 lb)		0.95 Kg (2.0 lb)		1.6 Kg (2.5 lb)	
Back Mounting	4 x M4		4 x M4		4 x M4	
Side Mounting	2 x M5		2 x M6		2 x M6	
Line filters are manufactured to millimeter dimensions (inches are approximate conversions).						

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Figure 5.4 Power Wiring Diagram



NOTES

2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTAINANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2, ONLY L1 MAY BE SWITCHED OR FUSED.
4. CURRENT RATINGS ARE INDEPENDENT OF THE INPUT VOLTAGE. REDUCED VOLTAGE WILL RESULT IN A REDUCTION IN SPEED, BUT NOT TORQUE.
5. DRIVE RATED 100-240 VAC RMS,SINGLE PHASE INPUT VOLTAGE (230 VAC STANDARD).
6. DO NOT DAISY CHAIN DRIVE MODULE POWER CONNECTIONS. MAKE SEPARATE CONNECTIONS DIRECTLY TO THE AC SUPPLY.
8. MULTIPLE DRIVE MODULES MAY BE POWERED FROM ONE TRANSFORMER OR OTHER AC SUPPLY SOURCE.
9. AC LINE FILTER AND SHIELDED MOTOR CABLE ARE TO BE USED FOR IMPROVING THE DRIVE MODULES ELECTROMAGNETIC COMPATABILITY, AND ARE REQUIRED TO MEET THE EUROPEAN ELECTROMAGNETIC COMPATABILITY DIRECTIVE. CAUTION: AC LINE FILTERS HAVE LARGE LEAKAGE CURRENTS AND REQUIRE DISCHARGE TIME UPON POWER REMOVAL. WIRING BETWEEN THE DRIVE MODULE AND FILTER SHOULD BE KEPT AS SHORT AS POSSIBLE. THE COMMON GROUND BUS BAR SHOULD BE AS CLOSE TO THE DRIVE AS POSSIBLE.
10. WIRE SIZES ARE MINIMUM RECOMMENDED VALUES. THE REQUIREMENTS OF LOCAL REGULATIONS SHOULD BE OBSERVED.
11. TERMINATE THE MOTOR POWER CABLE SHIELD BY CLAMPING IT TO THE DRIVE WITH THE BRACKET PROVIDED. THIS BRACKET CAN BE USED FOR STRAIN RELIEF IF NON-SHIELDED CABLES ARE USED. SNUG BRACKET SCREWS, DO NOT OVERTIGHTEN. NEVER TORQUE OVER 10 LB-IN.

REV	ECO	BY	REVISION DESCRIPTION	DATE	CHK
A	22019	JM	RELEASED	—	—

UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DIMENSIONS ARE IN INCHES
BREAK ALL EDGES .02 MAX
FILLETS AND ROUNDS .02 R MAX
TOLERANCE ON:
ANGLES ±1ANGLES °
FRACTIONS:±1/64"
DECIMALS.XX±.020
.XXX±.010

DRAWN BY JM 7-19-96
DESIGN ENGR — —
DIAG,POWER WIRING CONNECTIONS, DDM-005,-009,-019
PART NO. 9101-1502
SCALE N/A
DWG SIZE C
SHEET 1 of

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Interfaces

This chapter provides information about:

- Interface signals available on the ULTRA 100 Series drive
  - J1 - The Controller interface for commanding and reporting motion
  - J2 - The Encoder interface for reporting movement by the motor
  - J5 - The Serial interface for communicating with the drive.
- Commonly encountered interface cabling methods
- Optional signal extension kits and standard cables.

J1 – Controller

J1 is a 50 pin female mini-D connector (AMP 2-178238-7) for connecting a host computer or controller to the drive. Contact between the connector's shell and the grounded chassis provides shield termination. This section lists the connector pin-outs and provides signal specifications.

Cables are available in various lengths for connecting between J1 and a suitable controller. The appendix "Options and Accessories" on page A-1 lists the cables. "J1 Terminal Strip/Breakout Board" on page 6-24 details the optional signal extension kit that is available. "Interface Cable Examples" beginning on page 6-21 depict various interface cable types commonly encountered in applications.

Digital I/O Power

The drive requires an external 12 to 24VDC power source for the inputs and outputs.

External I/O Power

The external I/O power supply must be capable of supplying at least 250 mA.

The pin-outs are:

I/O PWR (12 to 24 Volts)	J1-5	J1-26
I/O COM	J1-6	J1-13

The external I/O COM must be grounded to meet the European Low Voltage Directive (LVD).

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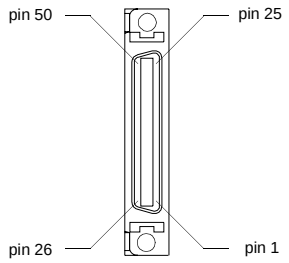
Table 6.1: J1 Controller Pin-Outs

Pin & Signal		Description	Pin & Signal		Description	Pin & Signal		Description
1	+5VDC	Encoder +5V DC	20	ENABLE	Drive Enable	39		Reserved
2	ECOM	Encoder Common	21	RESET	Fault Reset	40		Reserved
3	+5VDC	Encoder +5V DC	22	CMND+	Analog Command+	41		Reserved
4	ECOM	Encoder Common	23	CMND-	Analog Command-	42	OUTPUT 1	Selectable Output 1
5	I/O PWR	External I/O Power (12-24 VDC)	24	READY+	Drive Ready+	43	OUTPUT 2	Selectable Output 2
6	I/O COM	External I/O Common	25	READY-	Drive Ready-	44		Reserved
7	AOUT+	Motor Encoder Output Channel A+	26	I/O PWR	External I/O Power (12-24 VDC)	45		Reserved
8	AOUT-	Motor Encoder Output Channel A-	27	I LIMIT	Current Limit	46		Reserved
9	BOUT+	Motor Encoder Output Channel B+	28	ACOM	Analog Common	47		Reserved
10	BOUT-	Motor Encoder Output Channel B-	29		Reserved	48		Reserved
11	IOUT+	Motor Encoder Output Channel I+	30		Reserved	49	BRAKE+	Brake Enable+ (Drive Enabled+)
12	IOUT-	Motor Encoder Output Channel I-	31	ANALOG 1	Analog Output 1	50	BRAKE-	Brake Enable (Drive Enabled-)

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Table 6.1: J1 Controller Pin-Outs (continued)

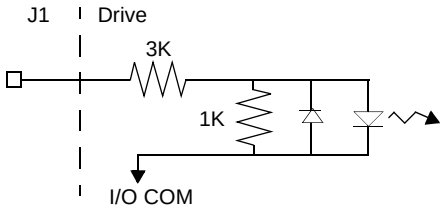
Pin & Signal		Description	Pin & Signal		Description	Pin & Signal	Description
13	I/O COM	External I/O Common	32	INPUT1	Selectable Input 1		
14	AX+/ CW+/ STEP+	Auxiliary Encoder Channel A+	33	INPUT2	Selectable Input 2		
15	AX-/CW-/ STEP-	Auxiliary Encoder Channel A-	34	INPUT3	Selectable Input 3		
16	BX+/ CCW+/ DIR+	Auxiliary Encoder Channel B+	35		Reserved		
17	BX-/ CCW-/ DIR-	Auxiliary Encoder Channel B-	36		Reserved		
18	IX+	Auxiliary Encoder Channel I+	37		Reserved		
19	IX-	Auxiliary Encoder Channel I-	38		Reserved		



Digital Inputs

ULTRA 100 Series drives have active high inputs, which prevent disconnects and ground faults from activating a drive. The typical ON time for an input to be recognized is 2.0 msec.

Figure 6.1 Digital Input Circuit



Two discrete input circuits types are available on the J1 connector. Both circuits support logic type interfaces with optically isolated, single ended and active high characteristics.

Dedicated Control Circuits

The ENABLE input interface with switch closures or sourcing type outputs.

Selectable Circuits

INPUT 1, INPUT 2, INPUT 3 and FAULT RESET operate with switch closures or sourcing type circuitry. Selectable inputs are:

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Not Assigned (default)	Reverse Enable	Start Index
Drive Mode Select	Operation Mode Override	Define Home
Integrator Inhibit	Preset Select A	Sensor (available only on INPUT 2)
Follower Enable	Preset Select B	Remove COMMAND Offset
Forward Enable	Preset Select C	
Fault Reset	Start Homing	

Refer to the I/O Configuration section of the on-line ULTRA Master Help for information on choosing the input type for each channel.

Table 6.2: General and Dedicated Inputs

Digital Input	Pin Number	Function/Description
ENABLE	J1-20	Enables and disables the drive. Motor torque cannot be applied unless the ENABLE input is active.
FAULT RESET	J1-21	General purpose input selectable to one of several drive functions. Refer to ULTRA Master on-line Help and Table 6.3 for I/O configuration.
INPUT 1	J1-32	
INPUT 2	J1-33	
INPUT 3	J1-34	

Table 6.3: INPUT1, INPUT2 and INPUT3 Functions

Function	Description
Drive Mode Select	Active[1] state configures the drive for Torque Mode. Inactive[2] state selects the personality EEPROM setting as the command source.
Integrator Inhibit	Active[1] state zeros the Velocity Loop Error Integrator.
Follower Enable	Active[1] state allows the position loop to track the AUXILIARY POSITION LOOP signal when in the Follower mode.
Forward Enable	Active[1] state allows forward commands in velocity mode only. If this input is inactive or not connected, no velocity command will be allowed in the forward direction. If motion is in progress when the input is pulled low or disconnected, the drive halts immediately without deceleration control. The COMMAND signal is clamped internally to 0 Volts.
Reverse Enable	Active[1] state allows reverse commands in velocity mode only. If this input is inactive or not connected, no velocity command will be allowed in the reverse direction. If motion is in progress when the input is pulled low or disconnected, the drive halts immediately without deceleration control. The COMMAND signal is clamped internally to 0 Volts.
Operation Mode Override	Active[1] state selects the Operation Mode Override setting as the command source. Inactive[2] state selects the Operation Mode setting as the command source. Table 6.4 lists the valid Operation Mode and Operation Mode Override combinations.

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Table 6.3: INPUT1, INPUT2 and INPUT3 Functions (continued)

<table>
<tr><td rowspan="10">Preset Select A
Preset Select B
Preset Select C</td><td colspan="5">Active[a] or Inactive[b] states select one of the eight presets shown in the following binary table:</td></tr>
<tr><td></td><td colspan="3">BINARY CODE</td><td></td></tr>
<tr><td></td><td>C</td><td>B</td><td>A</td><td>Description</td></tr>
<tr><td>Preset 0</td><td>0</td><td>0</td><td>0</td><td>Preset 0 or Index 0 is selected.</td></tr>
<tr><td>Preset 1</td><td>0</td><td>0</td><td>1</td><td>Preset 1 or Index 1 is selected.</td></tr>
<tr><td>Preset 2</td><td>0</td><td>1</td><td>0</td><td>Preset 2 or Index 2 is selected.</td></tr>
<tr><td>Preset 3</td><td>0</td><td>1</td><td>1</td><td>Preset 3 or Index 3 is selected.</td></tr>
<tr><td>Preset 4</td><td>1</td><td>0</td><td>0</td><td>Preset 4 or Index 4 is selected.</td></tr>
<tr><td>Preset 5</td><td>1</td><td>0</td><td>1</td><td>Preset 5 or Index 5 is selected.</td></tr>
<tr><td>Preset 6</td><td>1</td><td>1</td><td>0</td><td>Preset 6 or Index 6 is selected.</td></tr>
<tr><td>Preset 7</td><td>1</td><td>1</td><td>1</td><td>Preset 7 or Index 7 is selected.</td></tr>
<tr><td>Start Index</td><td colspan="5">A change from inactive to active starts an indexing move.</td></tr>
<tr><td>Define Home</td><td colspan="5">A change from inactive to active defines the home position for absolute indexing.</td></tr>
<tr><td>Sensor</td><td colspan="5">A change from inactive to active is sensed as a registration or home sensor.
NOTE: This selection is available only on INPUT 2.</td></tr>
<tr><td>Remove COM-MAND Offset</td><td colspan="5">A change from inactive to active sets the offset of the analog COMMAND input to achieve a zero command.</td></tr>
<tr><td>Fault Reset</td><td colspan="5">A change from inactive to active will clear any faults and re-enable the drive, if any faults were pending.</td></tr>
<tr><td>Start Homing</td><td colspan="5">A change from inactive to active will start the homing procedure.</td></tr>
</table>

a. Active state indicates current flow through the input optocoupler

b. Inactive state indicates no current flow.

Specifications for these inputs are listed in Table 6.5.

Table 6.4: Operation and Override Mode Combinations

	Operation Override Modes							
Operation Modes	Analog Velocity	Analog Torque	Preset Velocity	Preset Torque	Follower Master Encoder	Follower Step/Dir	Follower Step Up/ Down	Indexing
Analog Velocity	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Analog Torque	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Preset Velocity	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Preset Torque	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Follower Master Encoder	Yes	Yes	Yes	Yes	No	No	No	Yes
Follower Step/Dir	Yes	Yes	Yes	Yes	No	No	No	Yes
Follower Step Up/Down	Yes	Yes	Yes	Yes	No	No	No	Yes
Indexing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Input Interface Circuit Examples

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Table 6.5: Digital Input Specifications

Parameter	Description	Mini-mum	Maxi-mum
ON state Voltage	Voltage applied to the input to guarantee an ON state	10.8 VDC	28 VDC
ON state Current	Current flow into the input to guarantee an ON state	3.0 mA	10.0 mA
OFF state Volt-age	Voltage applied to the input to guarantee an OFF state	-1 VDC	2 VDC
OFF state Cur-rent	External leakage current into the input to guarantee an OFF state	-0.5 mA	0.5 mA

Figure 6.2 Drive Input Connected to a Switch/Relay Contact

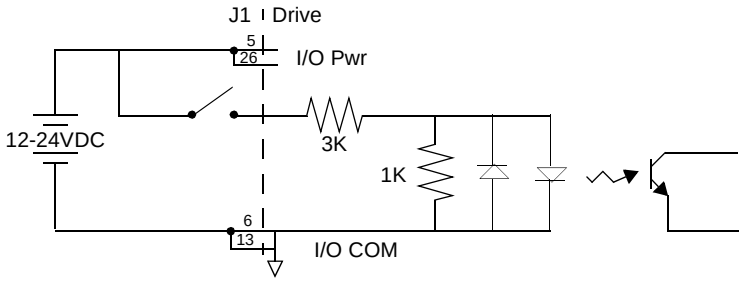


Figure 6.3 Drive Input Connected to an Opto-Isolator

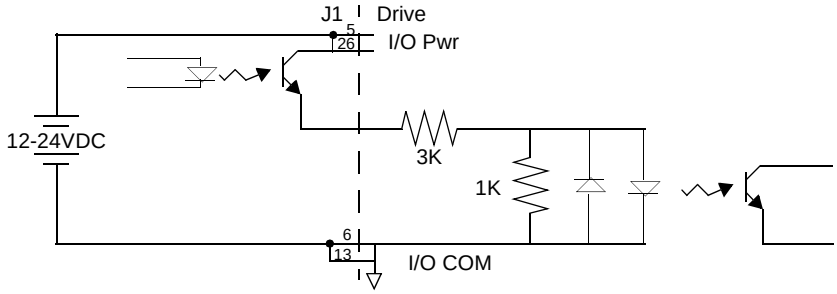
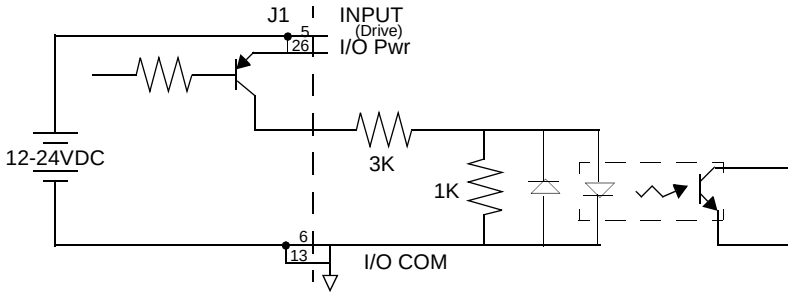


Figure 6.4 Drive Input Connected to an Active High Sourcing Transistor



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Figure 6.5 Drive Input Connected to Active Low Output using a Switch/Relay

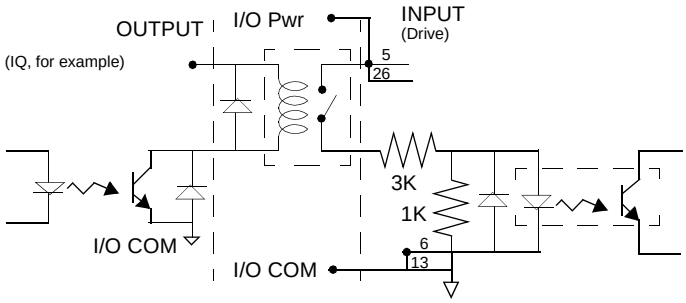


Figure 6.6 Drive Input Connected to Active Low Output using an Opto-Isolator

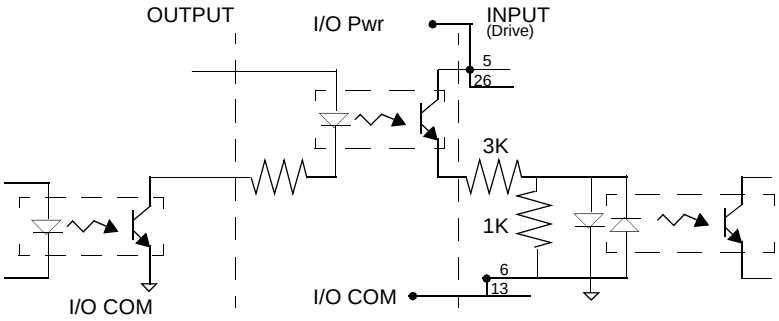
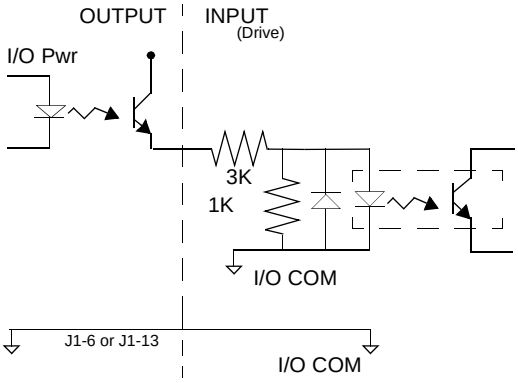


Figure 6.7 Drive Input Connected to Sourcing Output



Digital Outputs

Two types of discrete output circuits are available on the J1 connector:

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- Dedicated relay outputs
- Selectable transistor based outputs

Both types support 12-24 VDC logic interfaces:

Dedicated Relay Outputs

BRAKE/DRIVE ENABLED and DRIVE READY. Each output is a normally open relay. The relays are rated for 1 Amp at 30 VDC.

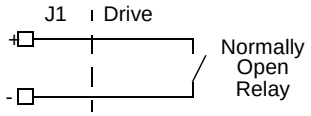
Note: The Brake contacts may be used to control 24VDC brakes on Allen-Bradley motors with a 4” frame or smaller. A user provided relay may be driven by these outputs if higher power levels are required. Refer to Figure 6.10 for examples.

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Selectable Transistor Outputs

OUTPUT 1 and OUTPUT 2 are optically isolated and short circuit protected, active high, single ended transistor output channels. Each channel sources a maximum of 50 mA.

Figure 6.8 READY and BRAKE/DRIVE ENABLED Circuits



READY and BRAKE/DRIVE ENABLED Circuits

Specifications for these outputs are listed in Table 6.6.

Table 6.6: READY and BRAKE/DRIVE ENABLED Output Specifications

Parameter	Description	Maximum
ON state resistance	Internal resistance between J1-24 (+) and J1-25 (-) or J1-49 (+) and J1-50 (-) when the contacts are closed.	1 Ohm
ON state current	Current flow through the relay when contacts are closed.	1 Amp
OFF state current	Leakage current from either output when the relay contacts are open.	0.01 mA
OFF state Voltage	Voltage difference between the outputs with open relay contacts.	30 Volts

Figure 6.9 Digital Output Circuit

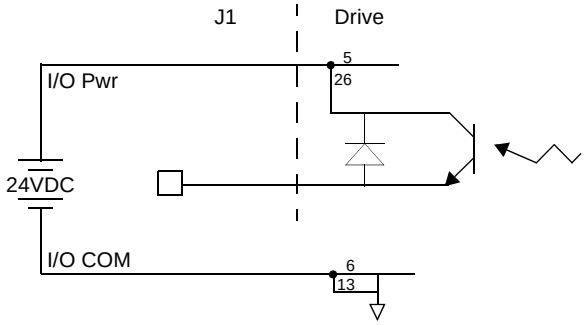
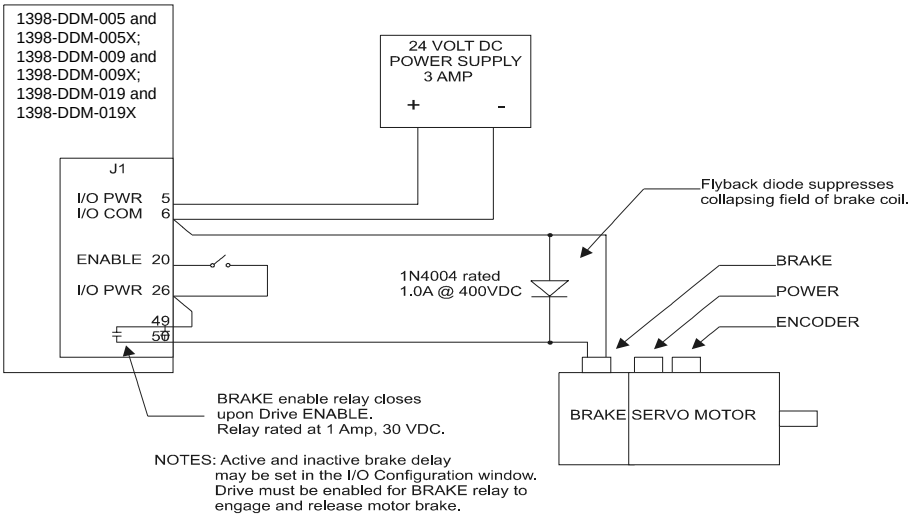


Figure 6.10 depicts a typical applications for the BRAKE/DRIVE ENABLE outputs. Table 6.7 lists the current draw for 24VDC and 90VDC brake coils on Allen-Bradley motors suitable for use with models 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X.

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Figure 6.10 BRAKE/DRIVE ENABLE Application Examples



Suggested brake wiring when 24VDC brake current exceeds 500mA or for 90VDC brakes:

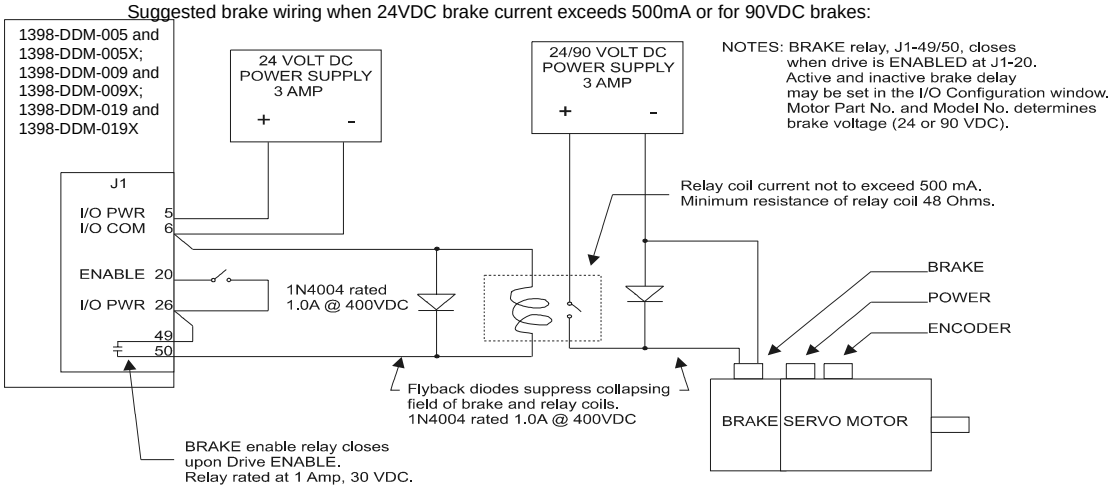


Table 6.7: Current Draw for Brake Motor Coils

MOTOR	24VDC	90VDC	MOTOR	24VDC	90VDC
F-4000	0.88A	0.26A	Y-1002	0.26A	NA
			Y-1003	0.26A	NA
H-3000	0.60A	0.098A	Y-2006	0.31A	NA
H-4000	0.69A	0.17A	Y-2012	0.31A	NA
			Y-3023	0.37A	NA

Output Interface Circuit Examples

Analog Inputs

Two types of analog input circuits are available on the J1 connector:

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Table 6.8: Selectable Output Circuits

Digital Output	Pin Number	Function/Description
READY	J1-24 (+) J1-25 (-)	Relay closure indicates the drive is operational and does *not* have a fault. Refer to “READY and BRAKE/DRIVE ENABLED Output Specifications” on page 6-9
BRAKE	J1-49 (+) J1-50 (-)	Relay closure releases the brake. Delay time is selectable (Refer to ULTRA Master - I/O configuration) and may be used as a drive enabled output. This signal is the inverse of the ENABLE output, although a time delay may be selected. Refer to “READY and BRAKE/DRIVE ENABLED Output Specifications” on page 6-9
OUTPUT 1	J1-42	General purpose output. Selectable from one of several drive functions. (Refer to ULTRA Master - I/O configuration on-line Help and Table 6.9.)
OUTPUT 2	J1-43	General purpose output. Selectable from one of several drive functions. (Refer to ULTRA Master - I/O configuration on-line Help and Table 6.9.)

Table 6.9: OUTPUT1 and OUTPUT2 Functions

Function	Description
In Position	An active state indicates the position window condition is satisfied, and the zero speed condition is satisfied. The position window and zero speed range are selectable settings.
Within Window	An active state indicates the position window condition is satisfied. The position window range is a selectable setting.
Zero Speed	An active state indicates the velocity loop zero speed signal is active. The zero speed limit is a selectable setting.
Speed Window	An active state indicates the velocity loop speed window is active. The speed window range is a selectable setting.
Current Limit	An active state indicates the torque current is limited.
Up To Speed	An active state indicates the velocity loop AT SPEED signal is active. The at speed level is a selectable setting.
Drive Enabled	An active state indicates the ENABLE signal is active and no fault is detected.
Bus Charged	An active state indicates the DC bus is energized.
Disabling Fault	An active state indicates a fault disabled the drive.
In Motion	An active state indicates the indexing sequence is in the motion portion.
In Dwell	An active state indicates the indexing sequence is in the dwell portion.
Sequence Complete	An active state indicates all batches of the indexing sequence are finished.
Registered	An active state indicates the indexing move has been adjusted after sensing the registration sensor.
At Home	An active state indicates the drive is at the home position.
Axis Homed	An active state indicates the drive has been homed.
NOTE: Refer to the I/O Configuration section of the ULTRA Master on-line Help for further explanation of these output signals.	

- The current limiting input supports 0 to +10 Volt signals

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Table 6.10: Transistor Output Specifications

Parameter	Description	Minimum	Maximum
ON state Voltage	Voltage difference between the external I/O power supply and the output when the transistor is ON	0 VDC	1.5 VDC
ON state current	Current flow when the transistor is ON	0 mA	50 mA
OFF state Voltage	Voltage difference between the external I/O power supply and the output when the transistor is OFF	0 Volts	50 Volts
OFF state current	Leakage current from the output when the transistor is OFF	-0.1 mA	0.1 mA

Figure 6.11 Drive Output Connected to an Opto-Isolator

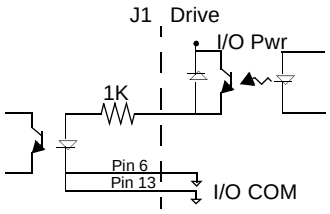


Figure 6.12 Drive Output Connected to an LED Indicator

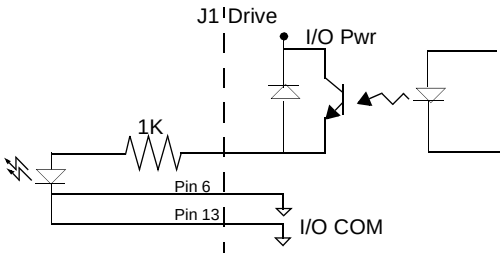
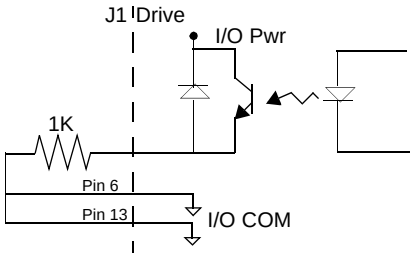


Figure 6.13 Drive Output Connected to a Resistive Load



- The command input supports 0 to ±10 Volt signals.

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Figure 6.14 Drive Output Connected to a Switch/Relay

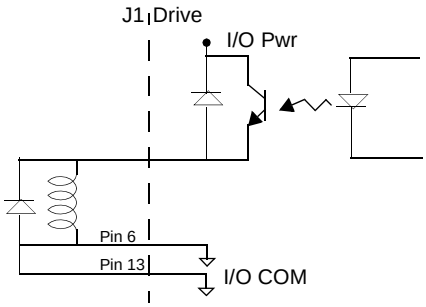


Figure 6.15 Drive Output Connected to Active Low Input using a Switch/Relay

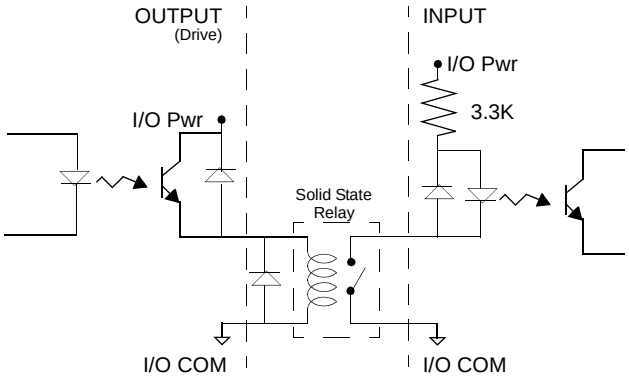
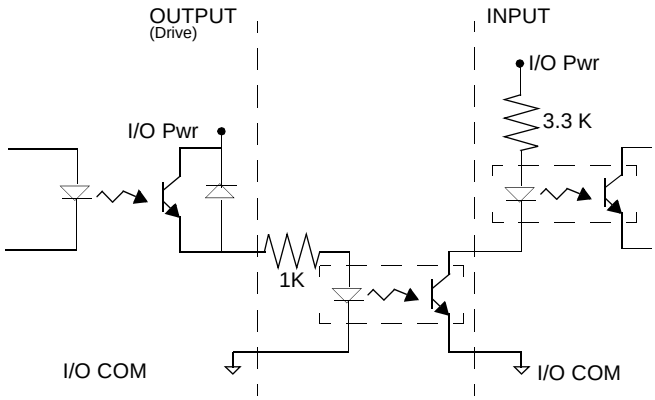


Figure 6.16 Drive Output Connected to Active Low Input using an Opto-Isolator



External Current Limit (I LIMIT)

ILIMIT limits the current, which provides torque, to the motor. The range is 0 to +10 Volts (where 10 Volts corresponds to maximum drive current).The analog I LIMIT signal is converted into a digital word by a 10-bit ADC (analog to digital converter). If the I LIMIT input is *not* connected, current is not limited.

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Figure 6.17 Drive Output Connected to Active High (Sinking) Input

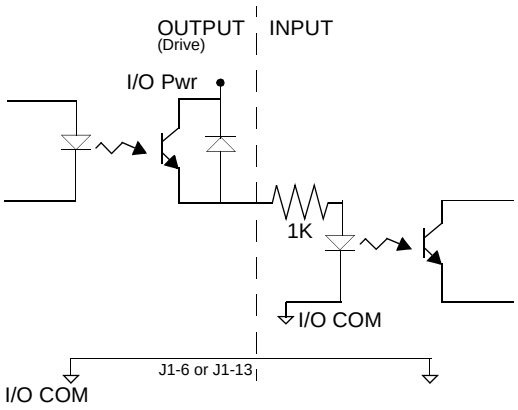


Figure 6.18 External Current Limit Circuit

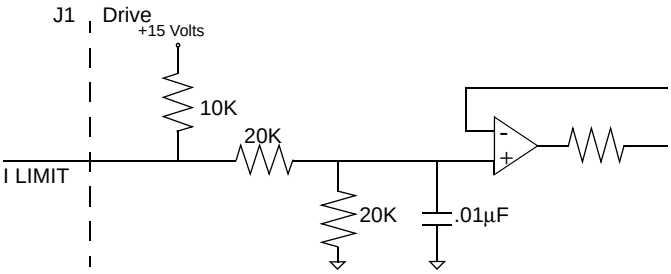


Table 6.11: Analog Inputs (I LIMIT)

Analog Input	Pin Number	Function/Description
Current Limit (I LIMIT)	J1-27	Limits the peak current command, which produces torque

Table 6.12: External Current Limit Input Specification

Parameter	Description	Minimum	Maximum
Maximum Current	Short circuit between the input and ground		-1.5 mA
Input Signal Range	Allowable voltage applied to the input	0 Volts	+10 Volts

Command Input

The analog command signal to the drive has a range of ±10 Volts. The signal is either a torque or a velocity command, depending on the software configuration of the drive. The differential input is processed by a 14 bit analog to digital converter (ADC) to produce a digital value.

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Figure 6.19 Analog COMMAND Input Circuit

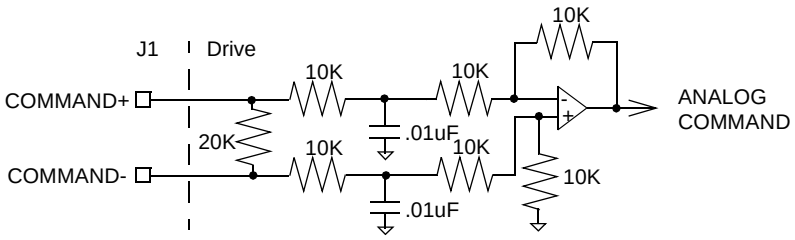


Table 6.13: Analog Command Input

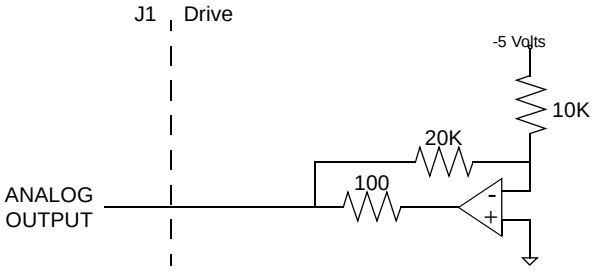
Analog Input	Pin Number	Description
COMMAND	J1-22 (+) J1-23 (-)	Analog command signal is a differential type signal to drive the servo controller. If the drive is in Velocity Mode configuration, the differential COMMAND signal is the velocity command. If the drive is in Torque Mode configuration, the differential COMMAND signal is the torque or current command. Separate scale and offset parameters are used for the input, depending on whether the signal is a velocity command or a torque current command.

Table 6.14: Analog Command Input Specifications

Parameter	Description	Minimum	Maximum
Input Impedance	Open circuit impedance measured between (+) and (-)	13.3 kOhms	
Input Signal Range	Allowable voltage applied between (+) and (-) inputs	0 Volts	±10 Volts

Analog Output

Figure 6.20 ANALOG 1 Output Circuit



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A selectable output is available for monitoring by the user: ANALOG 1 (J1-31).

ATTENTION: The user must provide an external circuit to ignore the analog output signal for two seconds after power-up. After reset the analog output may be in an indeterminate state for a short period before it stabilizes at the software controlled setting. Failure to observe this precaution could result in severe bodily injury.

Table 6.15: Analog Outputs: ANALOG 1

Analog Output	Pin Number	Description
ANALOG 1	J1-31	Selectable analog output. Displays the selected firmware variable along with selectable scale and offset. The scale or offset are calculated as shown below.
ACOM	J1-28	Analog Common (return).

Table 6.16: Analog Output Specifications

Parameter	Description	Minimum	Maximum
Output Current	Allowable current draw of the load	-2 mA	+2 mA
Output Signal Range	Voltage range of the signal	-10 Volts	+10 Volts

The following signals can be mapped to the analog output.

- Current – Command
- Current – Average
- Current – Peak +
- Current – Peak -
- Current – Input Limit +
- Current – Input Limit -
- Velocity – Motor Feedback
- Velocity – Command
- Velocity – Error
- Position – Motor Feedback
- Position – Command
- Position – Error
- Position – Error Peak +
- Position – Error Peak -

The following signals can also be monitored when ULTRA Master is configured for Advanced Mode.

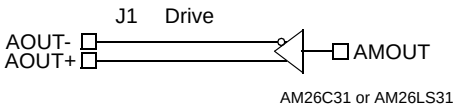
- Position – Master
- Position – Loop Output
- Velocity – Loop Output
- Torque Current
- Field Current
- Torque Voltage Command

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Filter Output	Field Voltage Command
R-Phase Current	Analog COMMAND Input
T-Phase Current	Bus Voltage

Motor Encoder Output Signal

Figure 6.21 Output Encoder Interface Circuits



The motor quadrature encoder signals are supplied to an external position controller. The signals are differential, quadrature, and TTL level. The output resolution is selectable and can be divided by 1, 2, 4 or 8.

The signal frequency (f_{out}) of the motor encoder output in Hertz (Hz) can be calculated with the equation:

$$f_{out} = \frac{Vm \cdot linecount}{60 \cdot N}$$

where:

Vm is the motor encoder velocity in rpm
Line count is the number of encoder lines/revolution of the
motor mounted encoder, and

If the device connected to the motor encoder output counts all edges, the count frequency is four times f_{out}.

For example, a motor with a 2000 line encoder is rotating at 3000 rpm, and the Motor Encoder Output signal is set to **Divide by 1**, the encoder signal frequency is:

$$f_{out} = \frac{3000 \cdot 2000}{60 \cdot 1} = 100kHz$$

A counter counting all edges registers 400 kHz for this example.

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Table 6.17: Motor Encoder Output Signal

Analog Output	Pin Number	Description
AOUT (+) AOUT (-)	J1-7 (+) J1-8 (-)	Motor Output Channels A(+) and A(-). Differential TTL levels from line driver. Signal resolution is selectable.
BOUT (+) BOUT (-)	J1-9 (+) J1-10 (-)	Motor Output Channels B(+) and B(-). Differential TTL levels from line driver. Signal resolution is selectable.
IOUT (+) IOUT (-)	J1-11 (+) J1-12 (-)	Motor Output Channels I(+) and I(-). Differential TTL levels from line driver. Output pulse occurs once per motor shaft revolution.

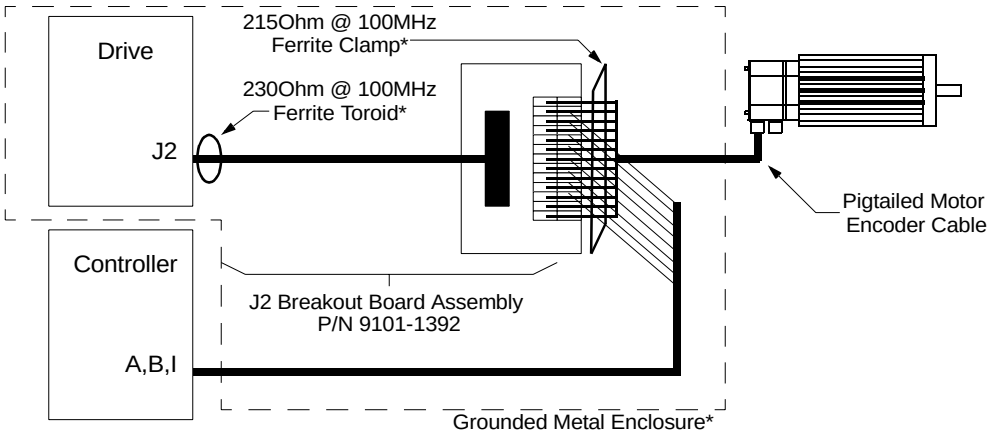
Table 6.18: Motor Encoder Output Specifications

Parameter	Description	Minimum	Maximum
Differential Output Voltage	Voltage measured between the (+) and (-) pins with R_L = 100 Ohm.	2.0 Volts	
Output Current	Current flowing out of the (+) or (-) pin.	-20 mA	+20 mA

IOUT Signal Generation

The Index output signal (IOUT) is *not synchronized* to a particular state of the A and B output signals (AOUT and BOUT). Some controllers, such as those used in the CNC industry, use the condition I=1, A=1, B=1 to indicate a home position. In such applications the encoder outputs from the drive *cannot be used*, since it cannot be guaranteed that the IOUT signal will be active during the state AOUT=1, BOUT=1. Instead, the unbuffered motor encoder signals can be used as shown in Figure 6.22. The J2 Breakout Board assembly connects the motor encoder signals directly to the position feedback of the controller.

Figure 6.22 J2 Breakout Board Assembly – European Union EMC Compliance



NOTE:
An asterik (*) indicates an installation option to comply with EU EMC Directives. Either a grounded metal enclosure or ferrite cores provide the requisite EMC protection.

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Note: If a controller connected to the drive requires the Index Output (IOUT) signal to be synchronized to a particular state of the A and B Outputs (AOUT and BOUT) the unbuffered encoder outputs from the motor must be used. (Required for use with A-B 1746, 1771, 4100 and 1354 motion controllers.)

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J2 Breakout Board Assembly – European Union EMC Compliance

Two options are available to achieve EMC compliance when a ULTRA 100 Series drive uses the J2 Breakout Board Assembly to transfer an unbuffered encoder signal to a control device. Either method of installation reduces the radiated emissions to an acceptable level. Be aware that either installation option is in addition to the EMC requirements specified elsewhere in this manual.

- Install the drive and J2 breakout board assembly (terminal block and cable), and the pigtailed cable inside a grounded metal enclosure.

- or -

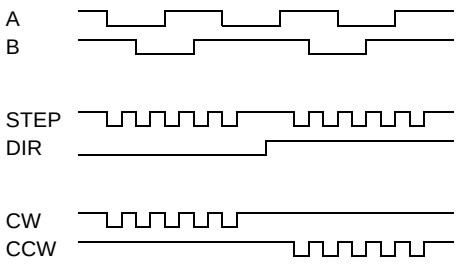
- Install ferrites of an appropriate rating at the specific locations:

1. J2 Cable – 230 Ohm @ 100 MHz toroid (FerriShield P/N SS28B2032) immediately adjacent to the J2 connector on the drive.
2. Pigtailed Motor Encoder Cable – 215 Ohm @ 100 MHz ribbon cable clamp (Fair-Rite P/N 2643164051 and two clips Fair-Rite P/N 0199001401) over the unshielded conductors.

Note: Drives are tested using specific installation methods, and the information above is based on successful tests. If the drives are installed in this manner, then compliance with European EMC requirements may be expected, although it is impossible to guarantee that a specific installation will meet EMC requirements without testing it.

Auxiliary Encoder Input Types

Figure 6.23 Auxiliary Encoder Inputs



The drive may be electronically geared by a remote signal. Electronic gearing may be driven by any of the following three signals:

A master incremental encoder that generates quadrature encoder signals

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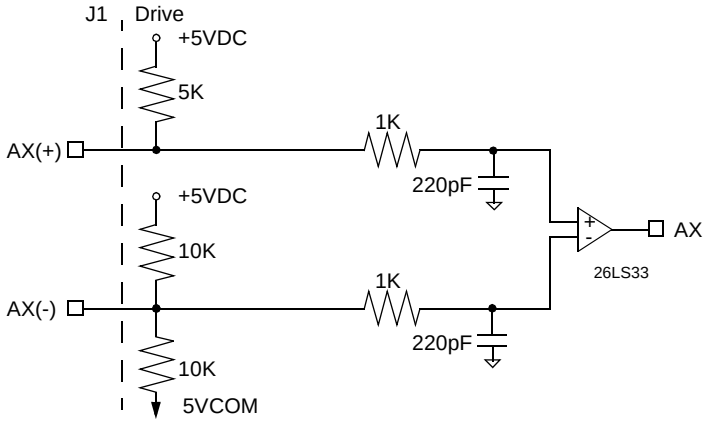
Step and direction signals, such as those created by indexers for step motors

CW (Step Up)/CCW (Step Down) signals, typically used with stepper indexers.

Note: The use of differential signals is strongly recommended. Single-ended signals are susceptible to noise, which may cause intermittent or continuous errors.

Note: To improve noise immunity, terminate cable shields at both ends of the cable. Connect shields to the backshell of the connector with a complete circumferential (360°) termination. The cable connector should then connect to chassis ground (not signal ground).

Figure 6.24 Auxiliary Encoder Input Circuit



The input circuits shown in the following diagrams support connections to differential TTL line drivers, single-ended TTL line drivers and open collector devices. These inputs are under software control.

Interface Cable Examples

The use of differential signals is highly recommended. This is due to the immunity of differential signals to common mode interference. Single-ended encoder interface circuits are **not recommended**, and may result in system malfunction.

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Table 6.19: Motor Encoder Output Signal

Auxiliary Encoder Input	Pin Number	Description
AX + and AX-, or Step + and Step-, or CW+ (Step Up+) and CW- (Step Up-)	J1-14 (+) J1-15 (-)	Auxiliary Channels A(+) and A(-). Differential, quadrature, or TTL level encoder input. The signal input and resolution are selectable.
BX (+) and BX(-), or DIR (+) and DIR(-), or CCW+ (Step Down+) and CCW- (Step Down-)	J1-16 (+) J1-17 (-)	Auxiliary Channels B(+) and B(-). Differential, quadrature, or TTL level encoder inputs. The signal input and resolution are selectable.
IX (+) and IX (-)	J1-18 (+) J1-19 (-)	Auxiliary Input Channels I(+) and I(-). Differential, quadrature, or TTL level encoder inputs.

Table 6.20: Quadrature Interface Specifications

Specification	Description	Minimum	Maximum
ON State Voltage	Voltage difference between the + and - inputs that indicate an ON state.	1.0 Volts	+15 Volts
OFF State Voltage	Voltage difference between the + and - inputs that indicates an OFF state.	-1.0 Volts	-15 Volts
Common Mode Voltage	Voltage difference between an encoder signal input and the reference ground of the drive.	-15 Volts	+15 Volts
Current Draw	Current draw into the + input or - input	-5 mA	+5 mA
A or B Signal Frequency	Frequency of the A or B line inputs. Count frequency is 4 times this frequency, since the circuitry counts each of the four transitions in a single line.		1 MHz
Index Pulse Width	Pulse width of the index signal. The index signal is active for a percentage of the revolution, therefore the speed of the encoder dictates the pulse width.	500 nsec	

To improve noise immunity, a cable shield should terminate at both ends of the cable. Shields should connect to the backshell of the connectors with termination around the full circumference (360°). The connectors should attach to chassis ground (not signal common).

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Figure 6.25 External Encoder Interface via TTL Differential Line Drivers

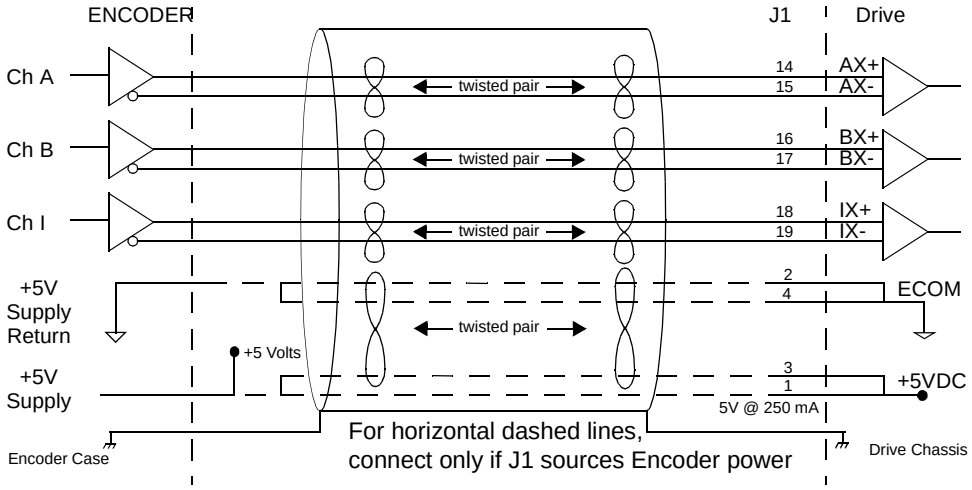
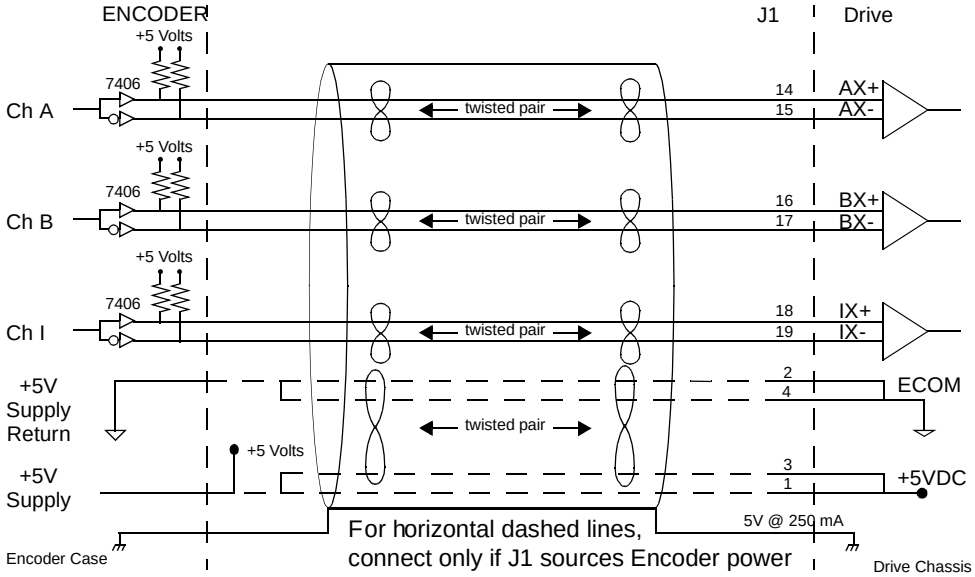


Figure 6.26 Complementary Encoder Interface via 7406 Line Drivers with Pull-up Resistors



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Figure 6.27 Complementary Encoder Interface via Standard TTL Logic

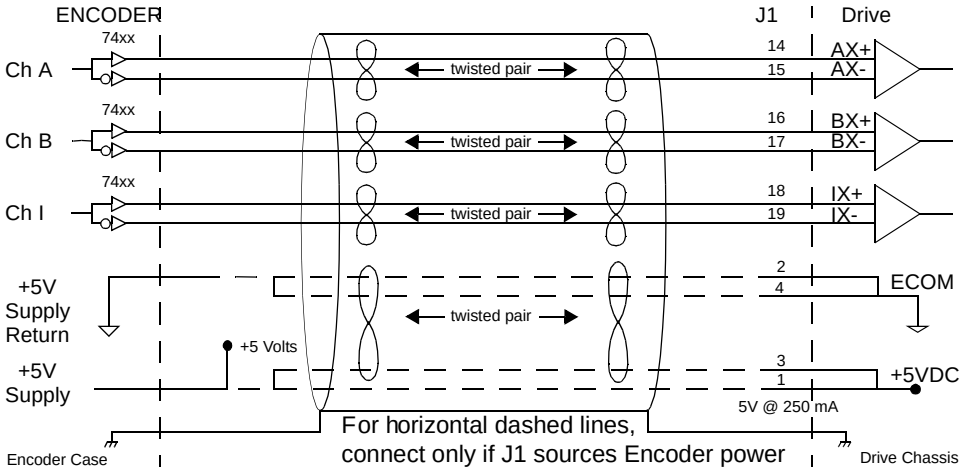
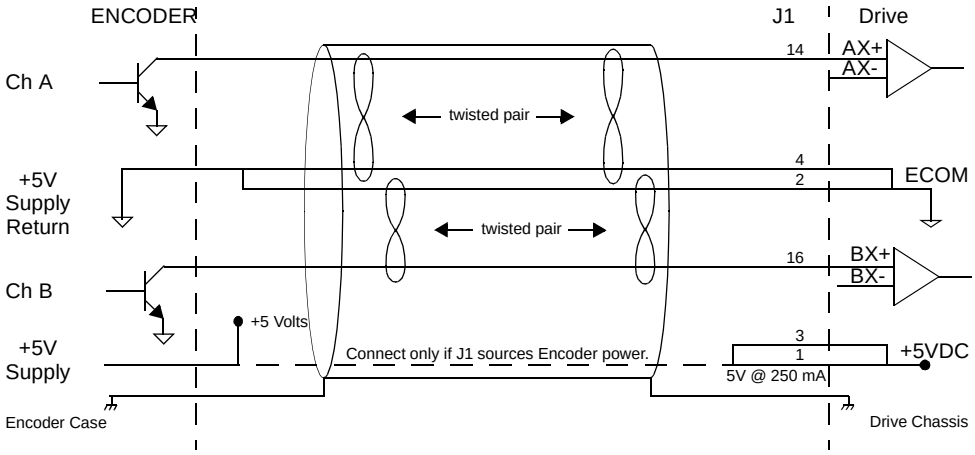


Figure 6.28 Single-Ended Encoder Interface via Open Collector Transistor without Pull-up (not recommended)



J1 Terminal Strip/Breakout Board

A 50-pin terminal strip kit is available for extending the signals from the J1 connector. The kit includes a 1 meter (3-foot) interface cable, a 50-pin terminal strip and mounting hardware. Refer to Appendix A, “Options and Accessories”.

“Cabling Examples” on page B-24 depicts the use of this kit to pass a cable through a bulkhead.

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Figure 6.29 Single-Ended Encoder Interface via Standard TTL Signals (not recommended)

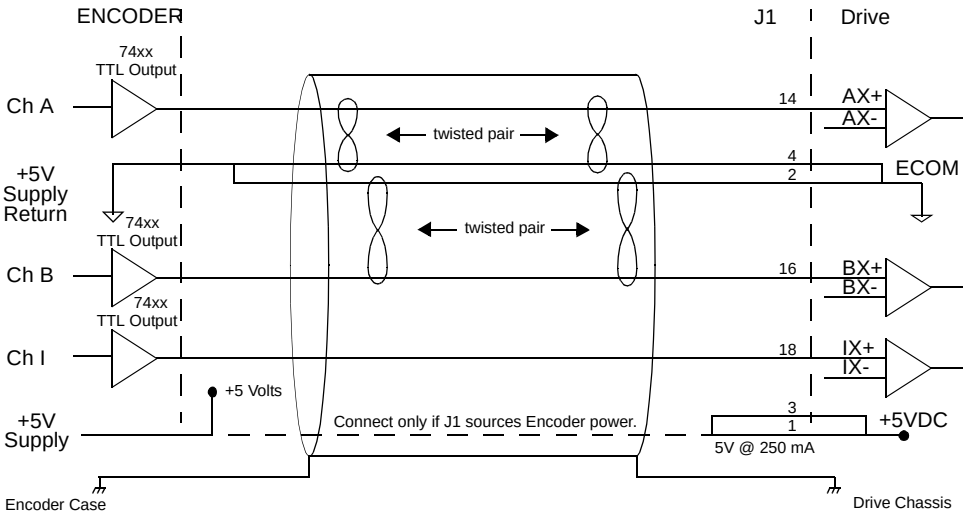
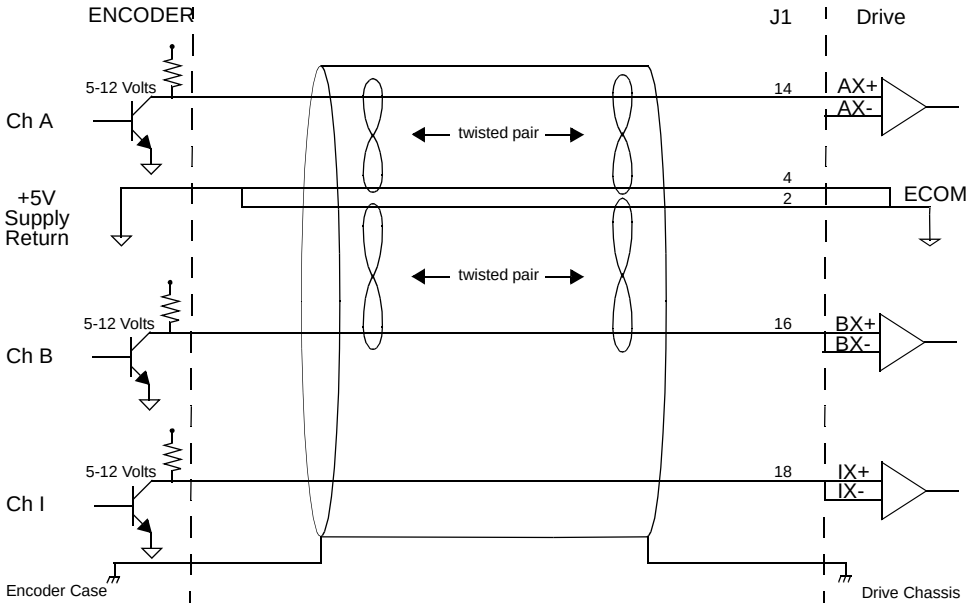


Figure 6.30 Single-Ended Encoder Interface via Open Collector Transistor with 5 VDC to 12 VDC Pull-up (not recommended)



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Figure 6.31 Single-Ended Encoder Interface via Open Collector Transistor with 24 VDC Pull-up (not recommended)

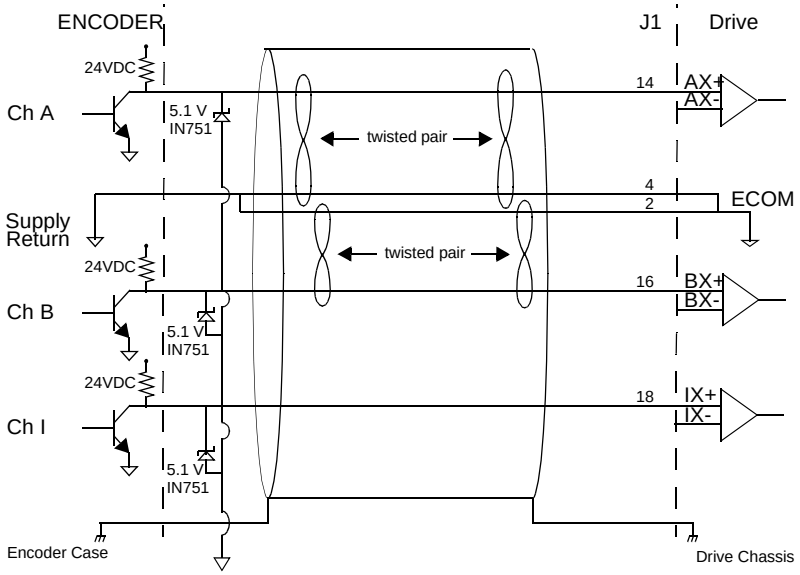
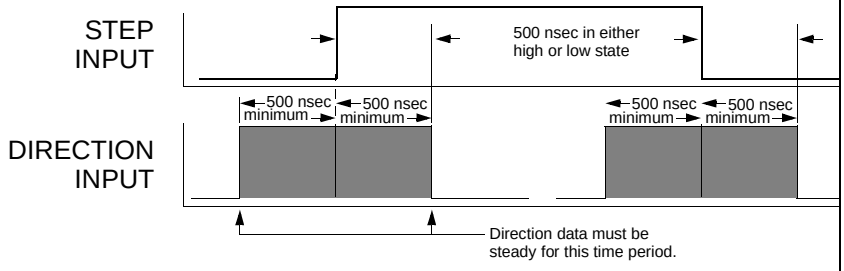


Table 6.21: Step/Direction and CW/CCW (Step Up/Step Down) Interface Specifications

Specification	Description	Minimum	Maximum
Signal frequency	Frequency of the input signal.		1 MHz
Pulse Width	Time interval the step (CW/CCW) signal must remain in a single state for detection.	500 nsec	
Setup Time	Time interval the direction (CW/CCW) signal must be stable before the corresponding step (CCW/CW) signal changes state.	500 nsec	

The following diagram shows the relationship between STEP and DIRECTION inputs.



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Figure 6.32 External Step/Direction Interface via TTL Differential Line Drivers

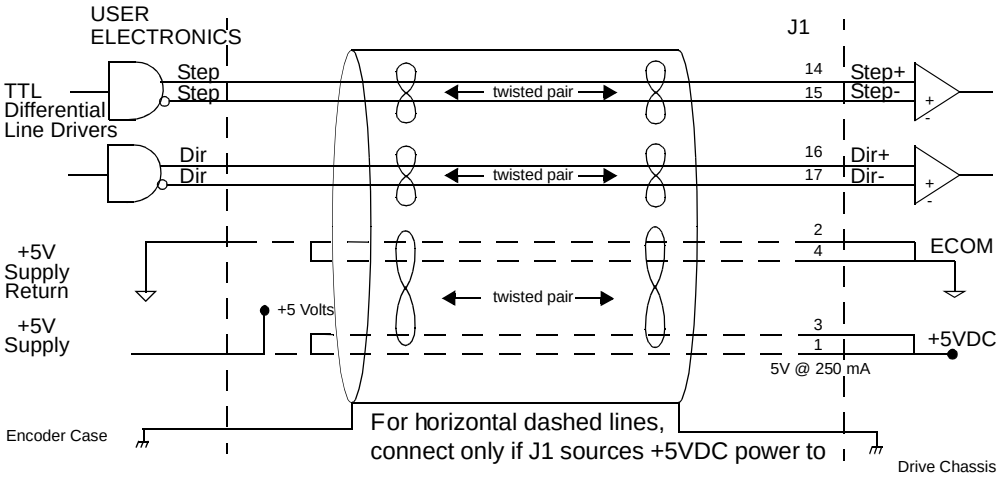


Figure 6.33 External Step/Direction Interface via Single-Ended TTL Line Drivers (not recommended)

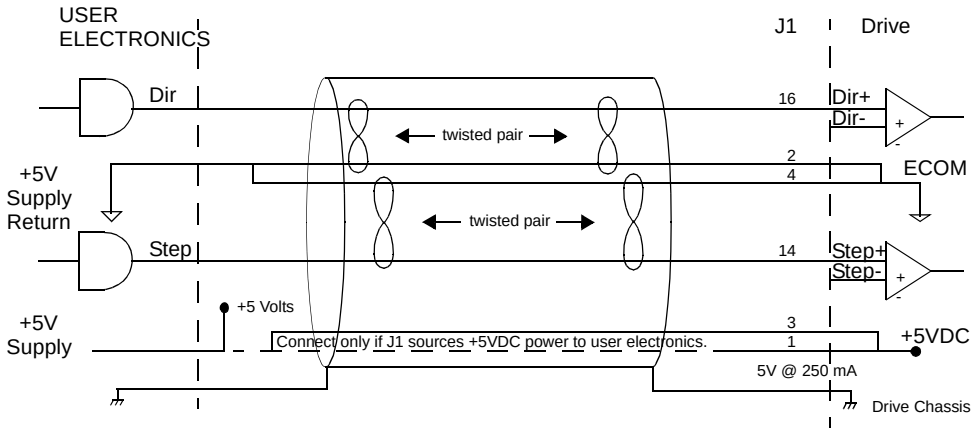
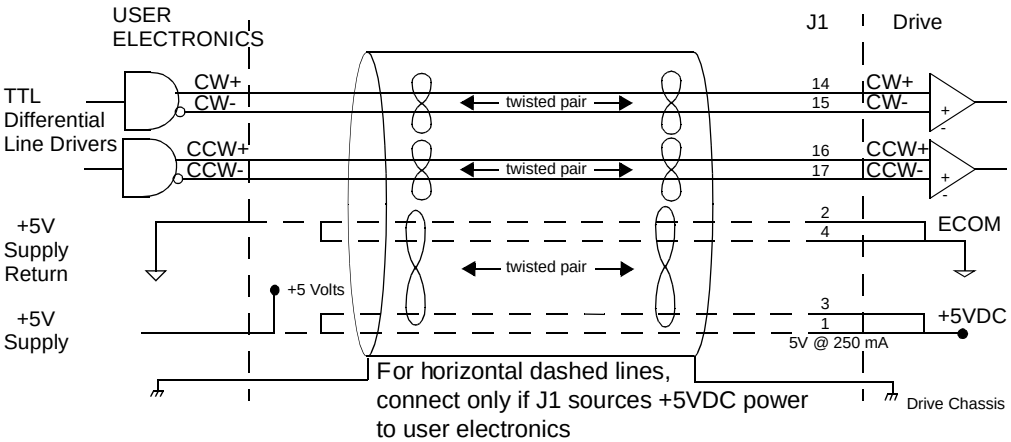


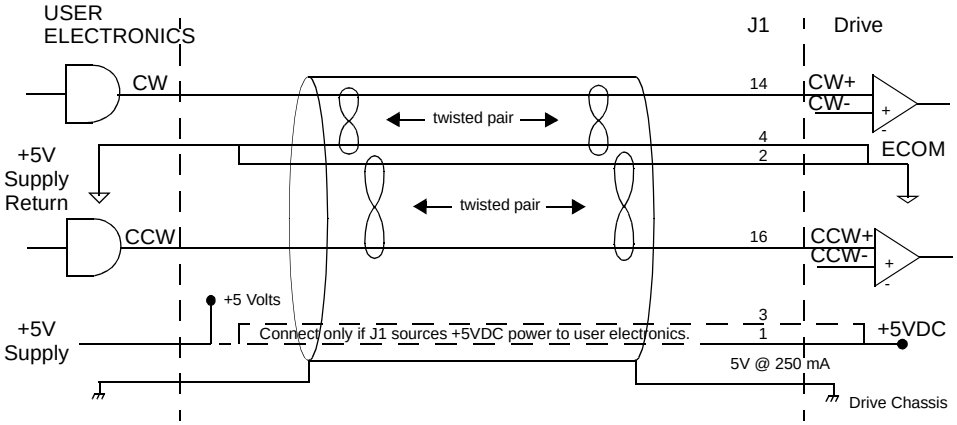
Figure 6.34 External CW/CCW (Step Up/Step Down) Interface via TTL Differential Line Drivers (sheet 1 of 2)



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Figure 6.34 **External CW/CCW (Step Up/Step Down) Interface via TTL Differential Line Drivers** (sheet 2 of 2)

Figure 6.35 **External CW/CCW (Step Up/Step Down) Interface via Single-Ended Line Drivers (not recommended)**

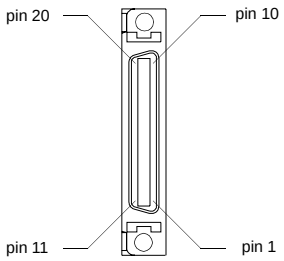


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J2 – Encoder

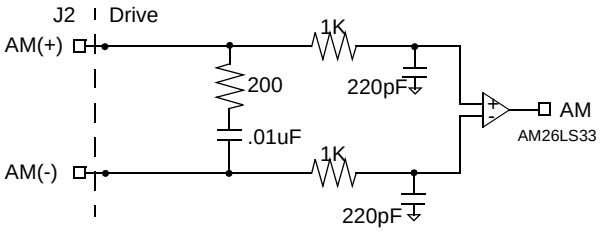
Cables are available in various lengths for connecting between J1 and a suitable controller. Appendix A, “Options and Accessories” lists the cables. “J2 Terminal Strip/Breakout Board” on page 6-30 details the optional signal extension kit.

Pin & Signal		Description	Pin & Signal		Description
1	EPWR	Encoder Power	11	I (+)	Motor Encoder Input Channel I(+)
2	ECOM	Encoder Common	12	I (-)	Motor Encoder Input Channel I(-)
3	EPWR	Encoder Power	13	A	Hall Effect A
4	ECOM	Encoder Common	14	B	Hall Effect B
5	EPWR	Encoder Power	15	C	Hall Effect C
6	ECOM	Encoder Common	16	ABS	Absolute Position
7	A (+)	Motor Encoder Input Channel A(+)	17		Reserved
8	A (-)	Motor Encoder Input Channel A(-)	18		Reserved
9	B (+)	Motor Encoder Input Channel B(+)	19	TS(+)	Thermal Switch (+)
10	B (-)	Motor Encoder Input Channel B(-)	20	TS(-)	Thermal Switch (-)



ATTENTION: Ensure that encoder signals are connected properly. Incorrect connection of encoder signals will result in improper rotor position and/or incorrect commutation.

Figure 6.36 Motor Encoder Interface Circuit



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Figure 6.37 Hall Effect Sensor Circuit

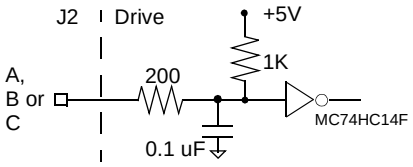


Table 6.22: J2 – Motor Encoder Connector Pin-Outs

Motor Encoder	Pin Number	Function/Description
EPWR	J2-1 J2-3 J2-5	Encoder power.
ECOM	J2-2 J2-4 J2-6	Encoder common
A+ A–	J2-7 (+) J2-8 (–)	Motor Encoder Input Channel A+ and Channel A–. Accepts TTL level signals from a line driver.
B+ B–	J2-9 (+) J2-10 (–)	Motor Encoder Input Channel B+ and Channel B–. Accepts TTL level signals from a line driver.
I+ I–	J2-11 (+) J2-12 (–)	Motor Encoder Input Channel I+ and Channel I–. Accepts TTL level signals from a line driver. Output pulse occurs once per motor shaft revolution. [a]
HALL A	J2-13	Hall Effect A sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor.
HALL B	J2-14	Hall Effect B sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor.
HALL C	J2-15	Hall Effect C sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor.
ABS	J2-16	Absolute Position used on Allen-Bradley motors for commutation.
	J2-17 J2-18	Reserved
TS+ TS–	J2-19 J2-20	Thermal Switch + and Thermal Switch – are a motor overtemperature signal.[a]

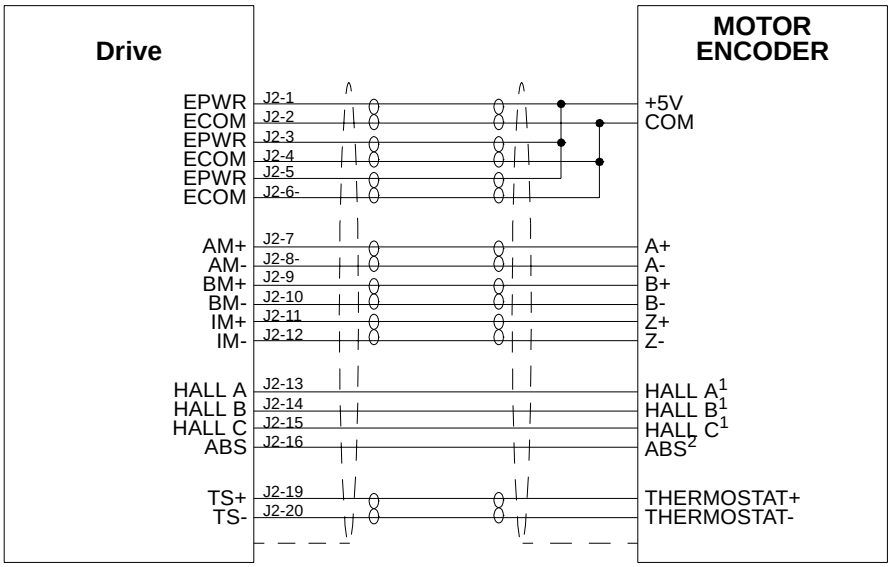
a. ULTRA Master software automatically determines the presence or absence of a motor thermal switch signal based on the motor selected in the Drive Select window. Allen-Bradley F-, H-, N- and S-Series motors typically have thermal switches and signal continuity is provided on these motors. LD- and Y-Series motors do not have thermal switches and signal continuity is *not* required.

J2 Terminal Strip/Breakout Board

A 25-pin terminal strip kit is available for extending the encoder signals from the J2 connector. The kit includes a 3-foot (1 meter) interface cable a 25-pin terminal strip, and mounting hardware. Refer to Appendix A, “Options and Accessories”.

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Figure 6.38 ULTRA 100 Series Motor Encoder Connections



NOTES:

1. For encoders with differential Hall ouputs (A+, A-, B+, B-, C+ and C-) connect only the + outputs to the drive.
2. The ABS signal is only available on selected Allen-Bradley encoders.

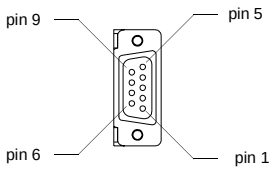
"Cabling Examples" on page B-24 depicts the use of this kit to pass a cable through a bulkhead.

J5 – Serial Port

J5 is a 9 pin female D-shell connector. This connector is a serial interface that allows communication with another ULTRA 100 Series drive, a PC, a terminal, a host computer, a controller or an optional TouchPad. The shell of the connector is grounded to the chassis for shield termination.

Table 6.23: J1 Controller Pin-Outs

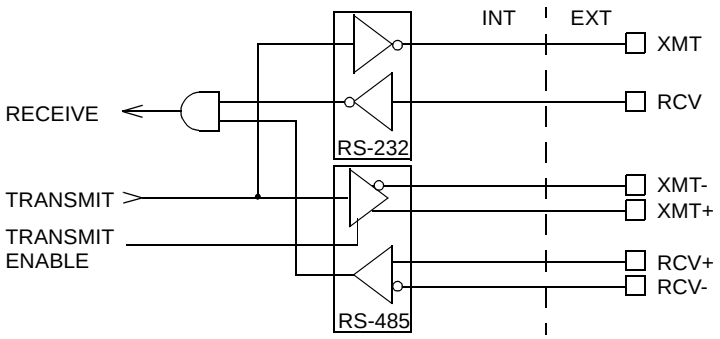
Pin & Signal		Description	Description
1	RCV(+)	Receive (+)	RS-485 (four wire)
2	RCV	Receive	RS-232
3	XMT	Transmit	RS-232
4	XMT(+)	Transmit (+)	RS-485 (four wire)
5	COM	+5 VDC Common	
6		Reserved[a]	
7	RCV(-)	Receive (-)	RS-485 (four wire)
8	XMT(-)	Transmit (-)	RS-485 (four wire)
9		Reserved[a]	



a. Do *not* connect any device to J5-6 or J5-9 except a TouchPad.

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Figure 6.39 RS-232/485 Interface Circuit



The serial interface of the drive uses the standard NRZ asynchronous serial format, and supports both the RS-232 and the four wire RS-485 communications standards.

- Standard baud rates include 1200, 2400, 4800, 9600 and 19200 baud. 9600 is the factory default setting.
- Even, odd, and no parity generation/checking are supported. No parity is the factory default setting.
- The maximum number of ULTRA 100 Series drives allowable on a four-wire RS-485 bus is 32.
- The maximum length of an RS-232 cable is 15 meters (50 feet).
- The maximum length of an RS-485 cable is 1220 meters (4000 feet) with 0.20 mm^2 (24 AWG) wire.

Cables are available in various lengths for connecting between the serial port of a drive and a control unit, such as a PC. Appendix A, “Options and Accessories” lists the cables, and the male and female connectors for the cables.

Note: The shell of the connector is grounded to the chassis for shield termination.

Table 6.24 lists the pin-outs for J5.

Table 6.24: J5 - Serial Port Connector Pin-Outs

Auxiliary Encoder Input	Pin Number	Description
RCV (+) RCV (-)	J5 - 1 (+) J5 - 7 (-)	RS-485 differential receiver input (to drive)
XMT (+) XMT (-)	J5 - 4 (+) J5 - 8 (-)	RS-485 differential transmitter output (from drive)
COM	J5 - 5	Common serial port interface
	J5 - 6	Reserved[a]

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Table 6.24: J5 - Serial Port Connector Pin-Outs (continued)

RCV	J5 - 2	RS-232 receiver input (to drive)
XMT	J5 - 3	RS-232 transmitter output (from drive)
	J5 - 9	Reserved[a]

a. Do *not* connect any device to J5-6, or J5-9, except a TouchPad.

Serial Communications Overview

ULTRA 100 Series drives communicate via a standard NRZ (non-return to zero) asynchronous serial format, which supports either RS-232 or four wire RS-485. The pin-out arrangement on the drive serial ports provides self-sensing of the communication standard. To change from RS-232 to four wire RS-485 requires a simple change of the cable.

In multiple drive installations, a unique address must be assigned to each drive through software. The factory default drive address is setting is Address 0. All addresses changes are made through ULTRA Master software selection. Up to 32 (1 through 32) are supported.

Note: Changes to address and communications settings are not immediate; they are logged but do not become active until after the drive is RESET.

Each drive may be assigned a unique name of up to 32 characters in length; a name is often easier to remember than the address of a drive. ULTRA Master software automatically associates a drive name with the correct drive address.

RS-232 Connections

The address of each drive is set using ULTRA Master software. Refer to the ULTRA Master on-line Help.

Note: Do *not* connect any device to J5-6 or J5-9 except a TouchPad.

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Single Axis RS-232 Set Up

A single ULTRA 100 Series drive may be selected using RS-232 communications. After cabling is attached to the unit and the drive address is assigned, configuration of (i.e., communications with) the unit may proceed.

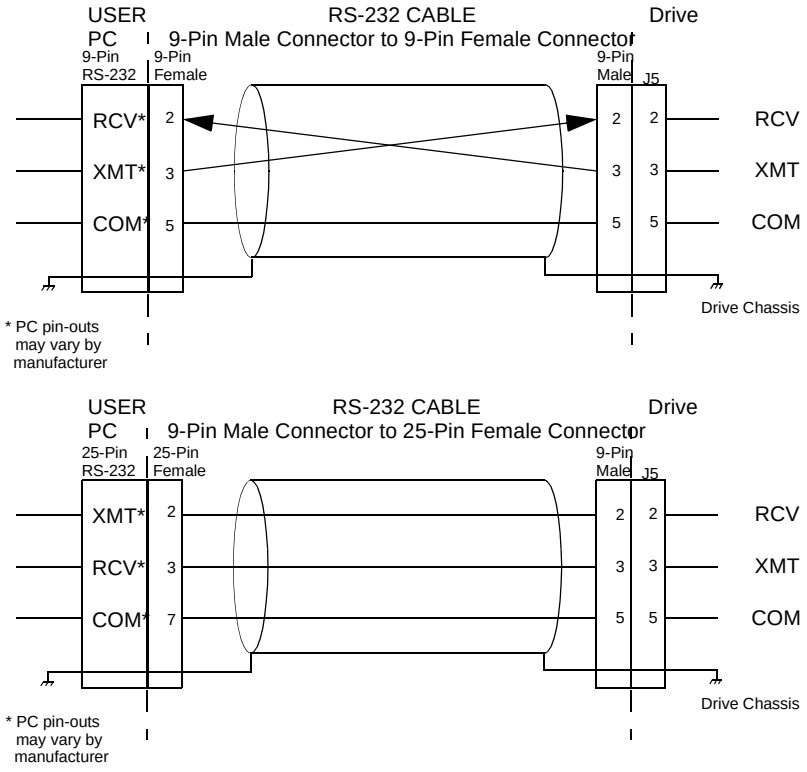
Factory default settings for a ULTRA 100 Series drive are:

- Address 0
- 9600 Baud
- 8 Data, No Parity, 1 Stop bit

The following steps outline how to select the communications options:

1. Connect an RS-232 cable between the computer and a serial connector on the drive (J5).

Figure 6.40 RS-232 Connection Diagrams



2. Verify the computer can communicate with the drive by performing the following:

   A. Switch drive power to ON

   B. Start ULTRA Master on the attached PC

   C. Choose **CANCEL** from the Drive Select window

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D. Select **Communications** from the menu

E. Select **PC Set Up** from the pull down menu

F. Verify the port settings, and if necessary, change them, then choose **OK**.

G. Select **Communications** from the menu

H. Select **Read Drive Parameters** from the pull down menu

I. Choose **OK** in the Drive Select window.

3. Verify that ULTRA Master reads the drive parameters. If not, refer to "Troubleshooting" on page 11-3.

Note: The Scan Port for Attached Drives option in the Drive Select window of ULTRA Master will identify any attached drives. If a drive is identified, but cannot be communicated with, the Baud Rate selection must be modified.

The cable diagrams provide wiring examples for both 9 pin and 25 pin serial ports from an IBM compatible personal computer to the drive. RS-232 pin-outs vary between computer manufacturers. Check the hardware reference manual of your machine to ensure correct signal connections between the computer and the drive.

Four Wire RS-485 Connections

The ULTRA 100 Series drives use a variation of the RS-485 standard, known as four-wire RS-485. Four-wire RS-485 uses one differential signal for host to drive transmissions, and another differential signal for drive to host transmissions. (The RS-485 standard specifies a single differential signal for transmissions in both directions.)

The four-wire RS-485 configuration also allows the host to use a RS-422 type interface. Because the host is driving multiple receivers and receiving from multiple transmitters, RS-422 is limited to multiple axes connections with 10 or less drives. The figure below summarizes the four-wire RS-485, RS-422, and RS-485 standards.

Multiple Axes Four-wire RS-485 Communications

1. Communicate with each individual dr4ive and assign it an unused address (1 - 32) from ULTRA Master - Drive Set Up.

2. Wire drives using four-wire RS-485 multi-drop cable or terminal strips. Figure 6.42 illustrates a typical multi-drop connection using an RS-232 to RS-485 converter.

3. Verify the communication settings on the computer are correct:

A. Start ULTRA Master on the attached PC

B. Choose CANCEL from the Drive Select window

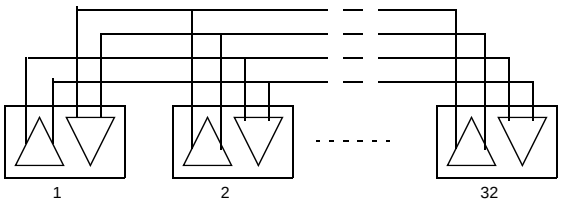
C. Select Communications from the menu

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Figure 6.41 RS-485/RS-422 Communication Comparison

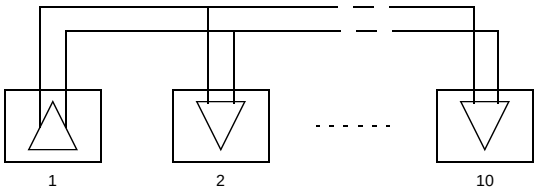
Four Wire RS-485

Differential
4 Wires
2 Signal pairs
1 to 32 transmitters
1 to 32 receivers



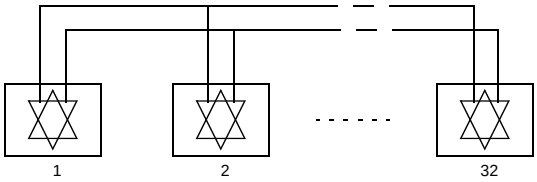
RS-422

Differential
4 Wires
2 Signal pairs
1 Transmitter
1 to 10 receivers



RS-485 Standard

Differential
2 Wires
1 Signal pair
1 to 32 transmitters
1 to 32 receivers



NOTE: Not applicable to ULTRA 100 Series drives

Note: Do *not* connect any device to J5-6 or J5-9 except a TouchPad.

Note: Flat ribbon cabling is *not* recommended for RS-485 connections.

D. Select PC Set Up from the pull down menu.

E. Verify the port settings, and if necessary, change them, then choose OK.

Note: Address 0 is the preferred address for the initial configuration of a drive. It forces the drive to the default communications parameters.

4. Verify the ability to communicate between the computer and the connected drives by:

A. Switch drive power to ON

B. Select Communications from the menu

C. Select Read Drive Parameters from the pull down menu

D. Select the drive to communicate with from Drive Select window. The drive must have an address that matches one of the drive addresses in the chain. A list of connected drives can be generated by pushing the “Scan Port for Attached Drives” button.

E. Choose OK in the Drive Select window.

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5. Verify that ULTRA Master loads the drive parameters. If not, refer to the troubleshooting section.

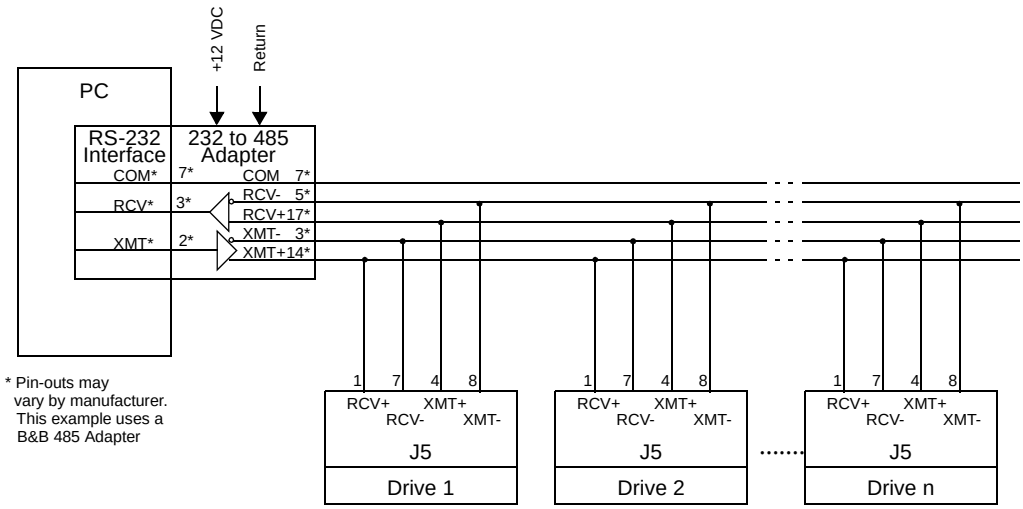
6. Repeat the preceding two steps for each additional drive.

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Multiple Axes RS-232 Communications

Multiple axes systems may be controlled by a computer with an RS-232 serial port. An RS-232 serial communication port may be converted to four wire RS-485 communication by attaching an RS-232 to four-wire RS-485 converter. The figure below depicts the use of such a device.

Figure 6.42 RS-232 to RS-485 Connection Diagram

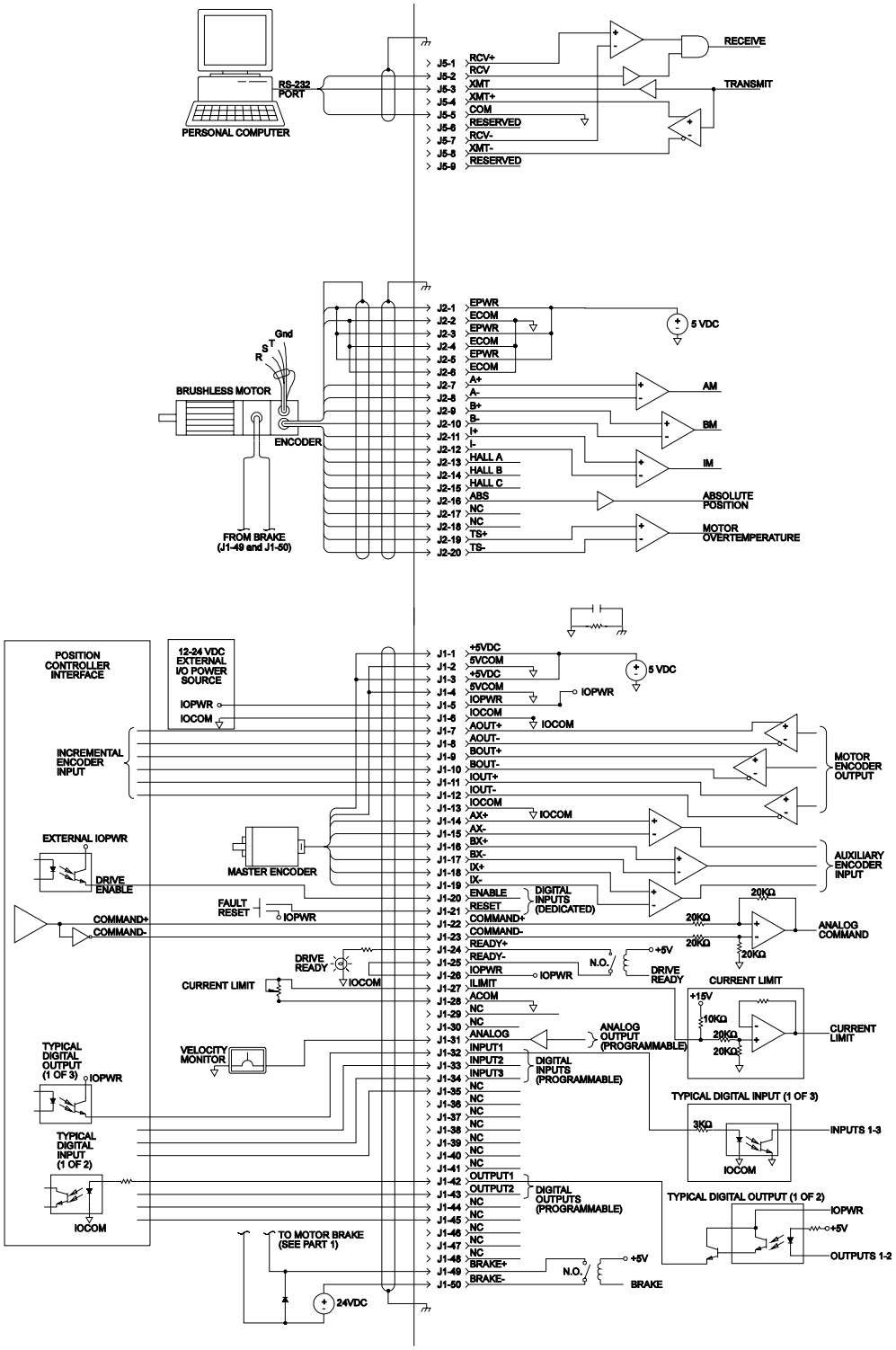


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Interface Connections

Shown here are typical components and connections for a ULTRA 100 Series drive, models 1398-DDM-005 and 1398-DDM-005X, 1398-DDM-009 and 1398-DDM-009X, 1398-DDM-019 and 1398-DDM-019X.

Figure 6.43 1398-DDM Interface Connection Diagram



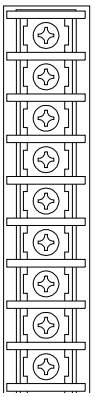
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Power Connections

DC bus, single phase AC power and motor connections are provided on the Terminal Block (TB-1).

Table 7.1: TB1 - DC Bus and AC Power Terminal Block Connections

Description	Identifier	Terminal	1398-DDM-005 and -005X 1398-DDM-009 and -009X 1398-DDM-019 and -019X
DC Bus + voltage	DC BUS +	1	
DC Bus - voltage	DC BUS -	2	
100-240 VAC input power	L1 (Line 1)	3	
100-240 VAC input power	L2 (Line 2)/ N (Neutral)	4	
Safety (earth) ground	⏚	5	
R phase power to motor	R	6	
S phase power to motor	S	7	
T phase power to motor	T	8	
Motor case ground	⏚	9	

Power Wiring Connection Diagrams for the 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X are provided in Figure 5.4 on page 5-11. Wiring for the external I/O power is described and depicted in the chapter “Application and Configuration Examples” on page 8-1.



ATTENTION: DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the warning on the front of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.



ATTENTION: Motor power connectors are for assembly purposes only. They should not be connected or disconnected while the drive is powered.

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Motor Power Cabling

TB1-6, TB1-7, TB1-8 and TB1-9 are the terminals for connecting the drive to the windings of a motor.

Note: Proper phasing of these outputs relative to the motor terminals is critical. Double check the connections after wiring the motor

Table 7.3 on page 7-7 lists the drive terminals and typical motor connections. Table 7.4 lists the minimum wire size for making power wiring connections.

Motor Phase Signal	Description	Terminal
R	R phase from drive	TB1-6
S	S phase from drive	TB1-7
T	T phase from drive	TB1-8
⏚	Ground for the motor case	TB1-9

NOTE: Torque all terminal connections to 1.25 Nm (11.0 lb-in).

Refer to Appendix A, “Options and Accessories” for a list of available Rockwell Automation cables.

Shield Termination of Power Cables



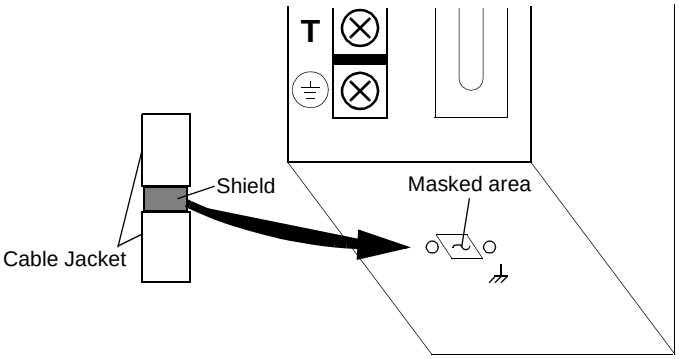
ATTENTION: Shielded power cables must be grounded at a minimum of one point for safety. Failure to ground a shielded power cable will result in potentially lethal voltages on the shield and anything connected to it.

F-Series, H-Series, N-Series, S-Series and W-Series Motor Power Cable

Factory supplied motor power cables are shielded. The power cable is designed to be terminated at the drive during installation. A small portion of the cable jacket is stripped, which exposes the shield wires. The exposed area must be clamped to the bottom of the drive chassis using the clamp provided. It is critical for EMC performance that the shield wires be clamped against the area of the chassis which is not painted.

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Figure 7.1 Motor Power EMC Shield Connection



Power cable shield termination clamp on bottom of
1398-DDM-005, 1398-DDM-009 and 1398-DDM-019

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LD-Series and Y-Series Motor Cables

LD-Series and Y-Series motors have a short “pigtail” cable which connects to the motor but is not shielded. These motor power cables have a 6 inch shield termination wire with a ring lug which should be connected to the closest earth ground. The shield termination wire may be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening.

ATTENTION: High voltage may be present on the terminals of the drive. Remove power and disconnect the power cable before making or removing any connection.

ATTENTION: Do not tin (solder) the exposed leads on cables. Solder contracts over time and may loosen the connection.

Figure 7.2 LD and Y-Series Motor Cable Termination

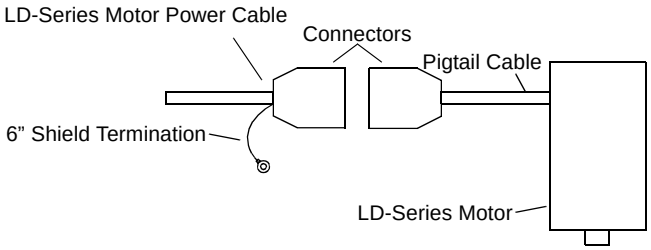


Table 7.2: Motor Power Contact and Wire Size Recommendations

Motor Size	Motor Power Mating Maximum Contact Size mm^2 (AWG)[a]	Minimum Recommended 90°C Power Wire mm^2 (AWG)
2005 through 3016	1.5 (16)	1.5 (16)
4030	4 (12)	1.5 (16)
4050	4 (12)	2.5 (14)

a. W-Series motors provide terminal strip power contacts, rather than MS connectors with pins.

Motor Overload Protection

The drive utilizes solid state motor overload protection which operates:

- within 8 minutes at 200% overload

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- within 20 seconds at 600% overload

Power Supply Protection

The feedback encoder, auxiliary encoder and optional TouchPad are powered by a single internal power supply. The power supply has a “resettable” fuse that opens at 3 amps and automatically resets itself when the current falls below 3 amps.There are no internal fuses requiring replacement.

Emergency Stop Wiring

An overlapping contactor may be inserted between the motor and the drive for emergency stop purposes. The contactor must not simply break the motor current, it also must switch a three phase resistive load in parallel with the motor windings.

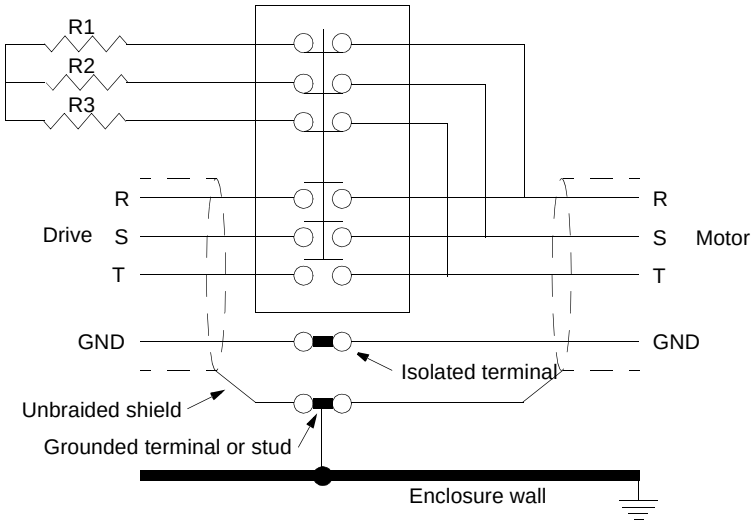
The three resistors provide dynamic braking. In addition, they prevent continuous arcing at the main contacts when breaking DC currents, such as when the motor stalls. Simply breaking the motor current can result in high voltages due to motor inductance, which will cause prolonged arcing in the contactor. In extreme cases, the prolonged arcing could result in the contactor catching fire. An overlapping contactor provides the required timing by engaging the braking contactors before the drive contactors disengage.

Figure 7.3 depicts a contactor installation with resistive loads. Guidelines for the installation include:

- Resistor values should be one to four times the winding resistance for good braking performance. Refer to Appendix F, “Dynamic Braking Resistor Selection” for resistor sizing equations.
- Screen and ground cables should be connected as shown.
- Shields should be unbraided (not a drain wire soldered to the shield).
- Connection lengths should be minimized.
- Safety ground (GND) and shield connections are permanently connected. This is essential for electrical safety.
- EMC guidelines require connection of the shield at the point where the contactor is inserted.

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Figure 7.3 Emergency Stop Contactor Wiring



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AC Power Cabling

The 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X drives require single phase, 100 to 240 VAC rms power with an input frequency of 47 - 63 Hz. “Power” on page G-5 lists the output power characteristics of the drives. The AC input supplies power to the motor. Alternatively, the drive may be powered by an external DC power source. In either case, an external power source must provide input power to the I/O.

TB1-3, TB1-4 and TB1-5 are the single phase AC input power terminals for the 1398-DDM-005 and -005X, 1398-DDM-009 and -009X, 1398-DDM-019 and -019X.



ATTENTION: The user is responsible for conforming with all applicable local, national and international codes. Wiring practices, grounding, disconnects and overcurrent protection are of particular importance. Failure to observe this precaution could result in severe bodily injury or loss of life.



ATTENTION: High voltage may be present on the terminals of the drive. Remove power and disconnect the power cable before making or removing any connection.



ATTENTION: Do not tin (solder) the exposed leads on cables. Solder contracts over time and may loosen the connection.

Table 7.3: TB1 - AC Power Terminals

Signal	Description	Terminal
L1	100 to 240 Volts AC Line 1 input power	TB1-3
L2/N	100 to 240 Volts AC Neutral	TB1-4
⏚	Safety (earth) ground	TB1-5

NOTE: Torque all terminal connections to 1.25 Nm (11.0 lb-in).

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Table 7.4: AC Input Power Sizing Requirements

Drive Model	Input Current	Inrush Current	Fuse Size[1]	Wire Size mm (AWG)	Transformer Size[a]	
1398-DDM-005 or 1398-DDM-005X	5 A AC_{rms}	75 A peak	5 A	1.5 (16)	1 kVA min	100 kVA max
1398-DDM-009 or 1398-DDM-009X	9 A AC_{rms}	100 A peak	10 A	2.5 (14)	2 kVA min	100 kVA max
1398-DDM-019 or 1398-DDM-019X	18 A AC_{rms}	100 A peak	20 A	4.0 (12)	4 kVA min	100 kVA max

1. In the United States, the National Electrical Code (NEC), specifies that fuses must be selected based on the motor full load amperage (FLA), which is not to be confused with the drive input current. The largest fuse allowed under any circumstances is four times the motor FLA. Therefore the largest fuse permissible for use with the ULTRA 100 Series is four times the motor rated continuous current (converted to an RMS value). The Digital Servo Drive has been evaluated and listed by Underwriters Laboratories Inc. with fuses sized as four times the continuous output current of the drives (FLA), according to UL 508C.

In almost all cases fuses selected to match the drive input current rating will meet the NEC requirements and provide the full drive capabilities. Dual element, time delay (slow acting) fuses should be used to avoid nuisance trips during the inrush current of power initialization. The fuse sizes listed are recommended values, but local regulations must be determined and adhered to.

The ULTRA 100 Series utilizes solid state motor short circuit protection rated as follows:

Short Circuit Current Rating with No Fuse Restrictions:

Suitable for use on a circuit capable of delivering not more than 5000 RMS symmetrical Amperes, 240 Volts maximum.

Short Circuit Current Rating with Fuse Restrictions:

Suitable for use on a circuit capable of delivering not more than 200,000 RMS symmetrical Amperes, 240 Volts maximum, when protected by high interrupting capacity, current limiting fuses (Class CC, G, J, L, R, T).

a. Technical Note Number 1 details Transformer Sizing requirements for a variety of applications.

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DC Bus

TB1-1 and TB1-2 are the DC Bus connections for an external shunt.



ATTENTION: External shunt resistors connect directly to the power bus. For safety reasons, external shunt resistors must be enclosed.



ATTENTION: DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the warning on the front of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.



ATTENTION: Do *not* connect an external I/O power supply to the DC Bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

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Application and Configuration Examples

This section explains how to install and verify the ULTRA 100 Series drive for various modes of operation. The procedures verify the installation by:

- Showing how the power and logic wiring is connected.
- Selecting the Operation Mode setup for the drive.
- Tuning the drive for a particular motor type and size.
- Verifying the basic functionality of the drive and motor combination.

How to modify the units of measurement for ULTRA Master displays is explained on page 8-50.

Analog Control

The ULTRA 100 Series drive can be set up as an analog drive in either the Velocity or Torque mode by making the hardware connections and performing the software setup and tuning described below. The connection diagram depicts the minimum hardware necessary. Interfacing the drive to an external controller requires similar circuitry from the controller to J1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

Hardware Set Up

Make the connections described below and shown in the figure.

1. Connect a ±10VDC power source between J1-22 and J1-23 (ANALOG CMND +/-) to provide the analog speed or torque command.
2. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the drive. A simple 3 wire cable is depicted in the figure below.
3. Connect a Motor/Feedback cable from the motor to the J2 connector on the drive.
4. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
5. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)

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- J1-21 (FAULT RESET) and J1-26 (I/O PWR).

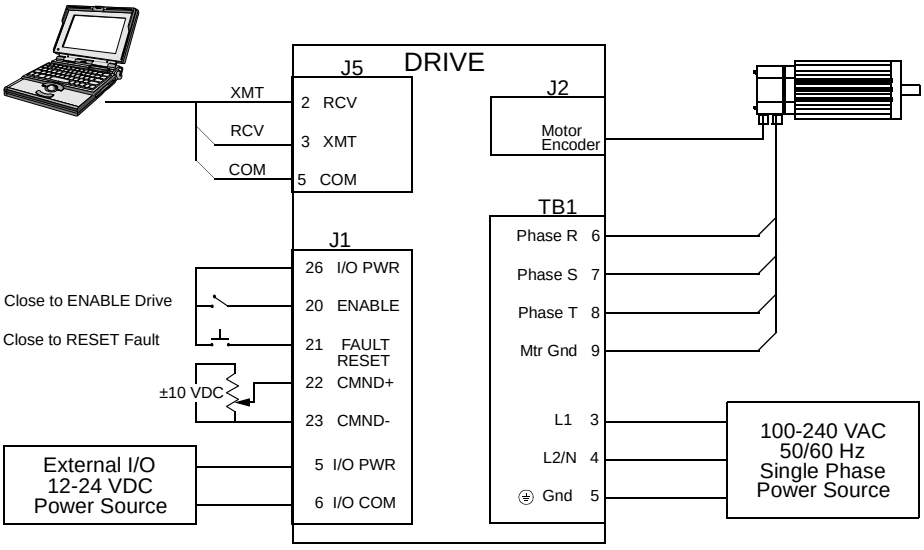
These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.

6. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).

7. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

Connection Diagram

Figure 8.1 Analog Controller Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:

   - Status LED is green. Refer to “Status Indicator” on page 10-1 for an explanation of the display codes.

2. Start ULTRA Master on the PC.

3. Choose **Cancel** from the Drive Select dialog box.

4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer’s communication settings.

5. Verify the communications port settings of the PC match those of the drive.

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- If the settings are correct, select **OK** in the Port - Settings dialog box.
- If the settings are different, correct the Port - Settings to allow communications with the drive.

  Factory default communications Port - Settings for the drive are:

  – Baud Rate: **9600**
  – Data Bits: **8**
  – Parity: **None**
  – Stop Bits: **1**
  – Serial Port: **COM1**

Refer to "RS-232 Communication Test" on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Set Up window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**.
12. Select the Operation Mode parameters for the drive:

Velocity Mode Settings	Torque Mode Settings
Analog Velocity Input as the Operation Mode	**Analog Torque Input** as the Operation Mode

13. Choose **Close** to exit the Drive Set Up window.
14. Choose the **Drive Parameters** icon from the Drive window and then select the **Analog** tab.
15. Enter appropriate **Scale** and **Offset** values for the input.
16. Verify the Status indicator is green.

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Tuning

Note: Do *not* attempt to Tune a drive with the Command mode set for **Analog Torque Input**. If the drive is set to torque mode, continue with the Operation section below.

Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window. The drive must be configured in Velocity mode for tuning to be effective.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Open the switch between J1-26 and J1-20 to disable the drive.
8. Choose **Normal Drive Operation** from the Tuning window.
9. Choose **Close** to exit the Tuning windows.
10. Verify the Status indicator is green.
11. Close any open windows or dialogs.

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Operation

The drive is now configured as an Analog Controller in either the velocity or torque mode.

- The current loop is compensated properly for the selected motor.
- The servo parameters have been setup with an unloaded motor.
- The motor speed or current is commanded through the analog input.

The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.

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Preset Controller

The ULTRA 100 Series drive can be set up as a preset controller in the Velocity or Torque mode by making the connections described below. Three discrete digital inputs provide the programmable speed or torque control. Up to eight different preset speed or torque settings can be selected by using the three digital inputs in various binary combinations, as shown in the table below. The connection diagram depicts the minimum hardware necessary. Interfacing the drive to a controller requires similar circuitry from the controller to J1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

Table 8.1: Preset Binary Inputs

	Inputs			
	C	**B**	**A**	**Description**
Preset 0	0	0	0	Preset 0 is a preprogrammed speed or current. All inputs are OFF[1].
Preset 1	0	0	1	Preset 1 is a preprogrammed speed or current. Only Preset Select A input is ON[2].
Preset 2	0	1	0	Preset 2 is a preprogrammed speed or current. Only Preset Select B input is ON[2].
Preset 3	0	1	1	Preset 3 is a preprogrammed speed or current. Preset Select A and Preset Select B are ON[2].
Preset 4	1	0	0	Preset 4 is a preprogrammed speed or current. Only Preset Select C input is ON[2].
Preset 5	1	0	1	Preset 5 is a preprogrammed speed or current. Preset Select A and Preset Select C are ON[2].
Preset 6	1	1	0	Preset 6 is a preprogrammed speed or current. Preset Select B and Preset Select C are ON[2].
Preset 7	1	1	1	Preset 7 is a preprogrammed speed or current. All Preset Select inputs are ON[2].

1. A preset input signal that is OFF is inactive, which means no current flows through the optocoupler.

2. A preset input signal that is ON is active, which means current flows through the optocoupler.

Hardware Set Up

Make the connections described below and shown in the Figure 8.2. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the drive. A simple 3 wire cable is depicted in the figure below.

2. Connect a Motor/Feedback cable from the motor to the J2 connector on the drive.

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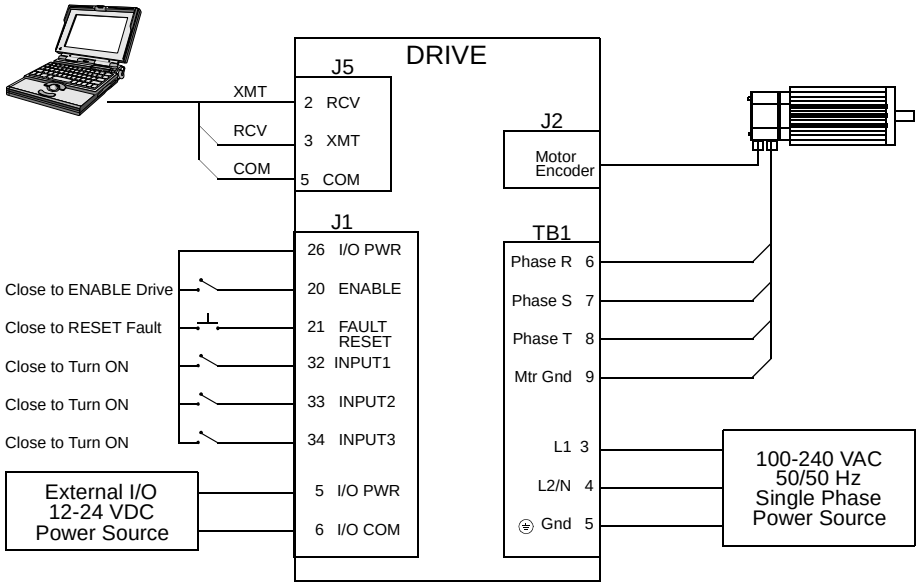
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-33 (INPUT2) and J1-26 (I/O PWR)
   - J1-34 (INPUT3) and J1-26 (I/O PWR)
   - Connect a switch between J1-21 (FAULT RESET) and J1-26 (I/O PWR).

These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.

1. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
2. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

Connection Diagram

Figure 8.2 Preset Controller Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

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1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to “Status Indicator” on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer’s communication settings
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.
   - If the settings are different, correct the Port - Settings to allow communications with the drive.

     Factory default communications Port - Settings for the drive are:

     – Baud Rate: **9600**
     – Data Bits: **8**
     – Parity: **None**
     – Stop Bits: **1**
     – Serial Port: **COM1**

     Refer to the section “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.
6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.



Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**,

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12. Select the Operation Mode parameter for the drive:

Velocity Mode Settings	Torque Mode Settings
Preset Velocities as the Operation Mode	**Preset Torques** as the Operation Mode

13. Choose **Close** from the Drive Setup window.

14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Preset** tab.

15. Enter the appropriate parameters for the Command mode in which the drive will operate:

Velocity Mode Settings	Torque Mode Settings
Enter the appropriate velocity value for each speed required	Enter the appropriate current value for each torque required

    Up to eight presets (0-7) may be programmed.

16. Choose **Close** to exit the Drive Parameters window.

17. Verify the Status indicator is green.

18. Select the **I/O Configuration** command icon from the Drive window.

19. Assign one of the three Preset Selects (A, B and C) to each of the Digital Input Assignments. For example, the following selects three presets:

    - **Input 1** to **Preset Select A**
    - **Input 2** to **Preset Select B**
    - **Input 3** to **Preset Select C**

    The presets provide up to eight binary combinations of speed or current. Unassigned preset inputs should be set to **Not Assigned**, which forces an OFF state.

20. Verify all Digital Output Assignments are **Not Assigned**.

21. Choose **Close** to exit the I/O Configuration window.

Tuning

Note: Do *not* attempt to Tune a drive with the Command mode set for **Preset Torques**. If the drive is set to Torque mode, continue with the Operation section below.

Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

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1. Choose the **Tuning** command icon from the Drive window. The drive must be configured in Velocity mode for tuning to be effective.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as a Preset Controller in Velocity or Torque mode.

- The servo parameters have been setup with the unloaded motor.
- The motor speed or current is controlled through the digital inputs.

The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

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When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close any of the switches for INPUT1, INPUT2 or INPUT3 to run the drive at the programmed preset speed or torque.

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Position Follower (Master Encoder)

The ULTRA 100 Series can be electronically geared to a master incremental encoder generating quadrature encoder signals by making the hardware connections and performing the software setup and tuning described below. The connection diagram depicts the minimum hardware necessary. Interfacing the drive to an external controller requires similar circuitry from the controller to J1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

Hardware Set Up

Make the connections described below and shown in the Figure 8.3. The appendix "Options and Accessories" on page A-1 lists the interconnect cables available from the factory.

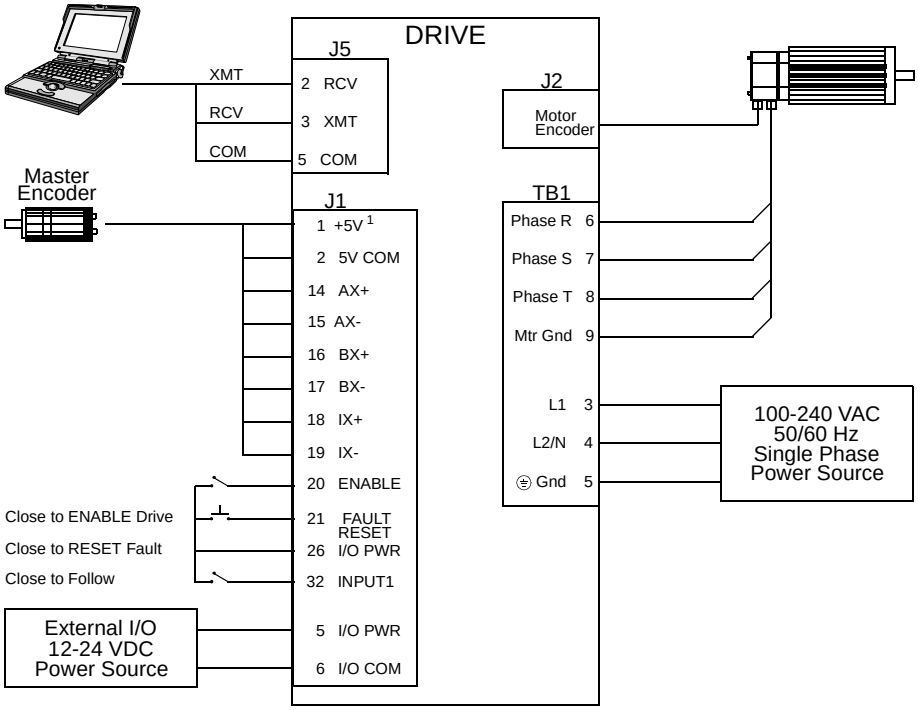
1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 100 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the drive.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect the Master Encoder to the drive as shown in the diagram.
5. Connect a jumper wire with a switches between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.
6. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
7. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

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Connection Diagram

Figure 8.3 Position Follower (Master Encoder) Connection Diagram



Note: Refer to Figure 6.25, 6.26, 6.27, 6.28, 6.29, 6.30 and 6.31 for additional details on the Control Interface

Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to "Status Indicator" on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer's communication settings.
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.
   - If the settings are different, correct the Port - Settings to allow communications with the drive.

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Factory default communications Port - Settings for the drive are:

– Baud Rate: **9600**
– Data Bits: **8**
– Parity: **None**
– Stop Bits: **1**
– Serial Port: **COM1**

Refer to “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**,
12. Select **Follower: Master Encoder** as the Operation Mode for the drive.
13. Choose **Close** from the Drive Setup window.
14. Choose the **Drive Parameter** command icon from the Drive window, and then select the **Follower** tab.
15. Enter an appropriate **Gear Ratio** as the Follower Input. The default Gear Ratio is 1:1 (motor encoder pulses:master pulses). If a Gear Ratio of 3:1 is entered, the motor is moved 3 encoder pulses for every incoming master pulse.
16. Choose **Close** to exit the Drive Parameters window.
17. Verify the Status indicator is green.
18. Select the **I/O Configuration** command icon from the Drive Window.

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19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:
    - **Follower Enable** as Input 1
    - **Not Assigned** as Inputs 2 through 3.
    - **Not Assigned** as Inputs 1 and 2.
20. Choose **Close** to exit the I/O Configuration window.
21. Verify the Status indicator is green.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as a Position Follower (Master Encoder).

- The current loop is compensated properly for the selected motor.
- The servo parameters have been setup with the unloaded motor.
- The motor position is controlled by the master encoder input.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close the switch between J1-26 and J1-32 to enable following.

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Position Follower (Step/ Direction)

The ULTRA 100 Series drive can be set up as a Position Follower using Step/Direction commands by making the hardware connections and performing the software setup and tuning described below. This configuration allows the ULTRA 100 Series drive to electronically gear or drive a servo motor using step and direction signals that typically control a stepper drive. The connection diagram depicts the minimum hardware necessary. Interfacing the drive to a stepper indexer requires similar circuitry from the stepper indexer to J1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad may also may be used.

Hardware Set Up

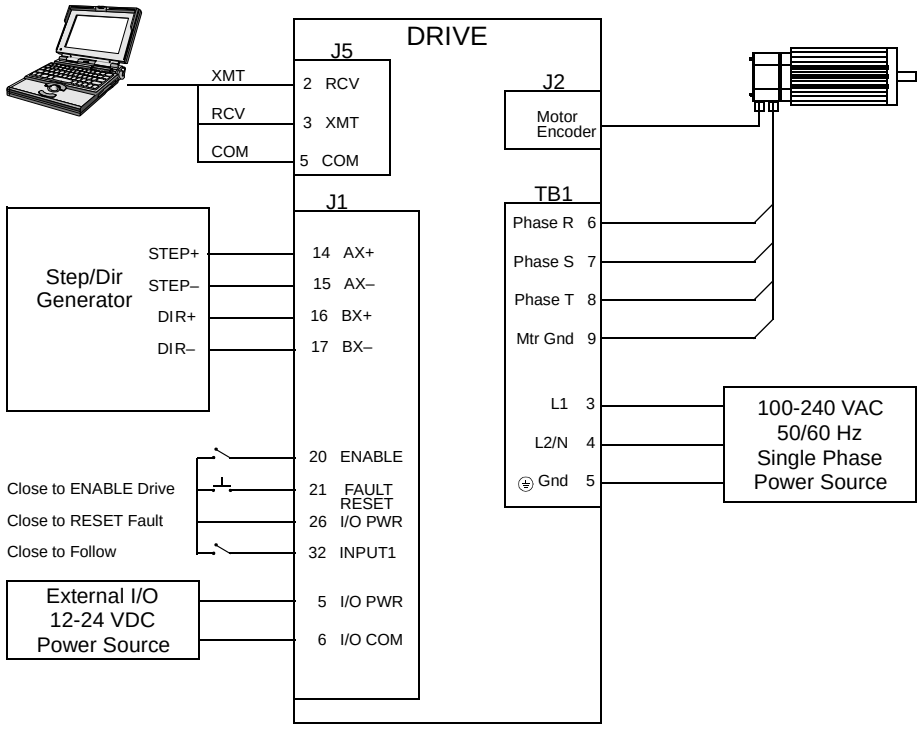
Make the connections described below and shown in the Figure 8.4. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the drive. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the drive.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect the Step/Direction signals to the drive as shown in the diagram.
5. Connect a jumper wire with a switches between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).
6. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
7. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

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Connection Diagram

Figure 8.4 Position Follower (Step/Direction) Connection Diagram



Note: Refer to Figure 6.25, 6.26, 6.27, 6.28, 6.29, 6.30 and 6.31 for additional details on the Control Interface Cable.

Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to "Status Indicator" on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer's communication settings.
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.

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- If the settings are different, correct the Port - Settings to allow communications with the drive.

  Factory default communications Port - Settings for the drive are:

  – Baud Rate: **9600**
  – Data Bits: **8**
  – Parity: **None**
  – Stop Bits: **1**
  – Serial Port: **COM1**

Refer to “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**,
12. Select **Follower: Step/Direction** as the Operation Mode for the drive.
13. Choose **Close** to exit the Drive Set Up window.
14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Follower** tab.
15. Enter an appropriate **Gear Ratio** as the Follower Input. The default Gear Ratio is 1:1 (motor encoder pulses:master pulses). If a Gear Ratio of 3:1 is entered, the motor is moved 3 encoder pulses for every incoming step pulse.
16. Choose **Close** to exit the Drive Parameters window.
17. Verify the Status indicator is green.
18. Select the **I/O Configuration** command icon from the Drive Window.

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19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:
    - **Follower Enable** as Input 1
    - **Not Assigned** as Inputs 2 through 3.
    - **Not Assigned** as Outputs 1 and 2.
20. Choose **Close** to exit the I/O Configuration window.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as a Position Follower (Step/Direction).

- The servo parameters have been setup with the unloaded motor.
- The motor position is controlled by the step/direction inputs.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close the toggle switch between J1-26 and J1-32 to enable following.

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Position Follower (Step Up/ Down)

The ULTRA 100 Series can be set up as a Position Following using Step Up and Step Down signals typically used to control stepper drives. The connection diagram depicts the minimum hardware necessary. Interfacing the drive to a controller requires similar circuitry from the indexer to J1. Instructions are provided to configure the drive with ULTRA Master software.

Hardware Set Up

Make the connections described below and shown in the Figure 8.5. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

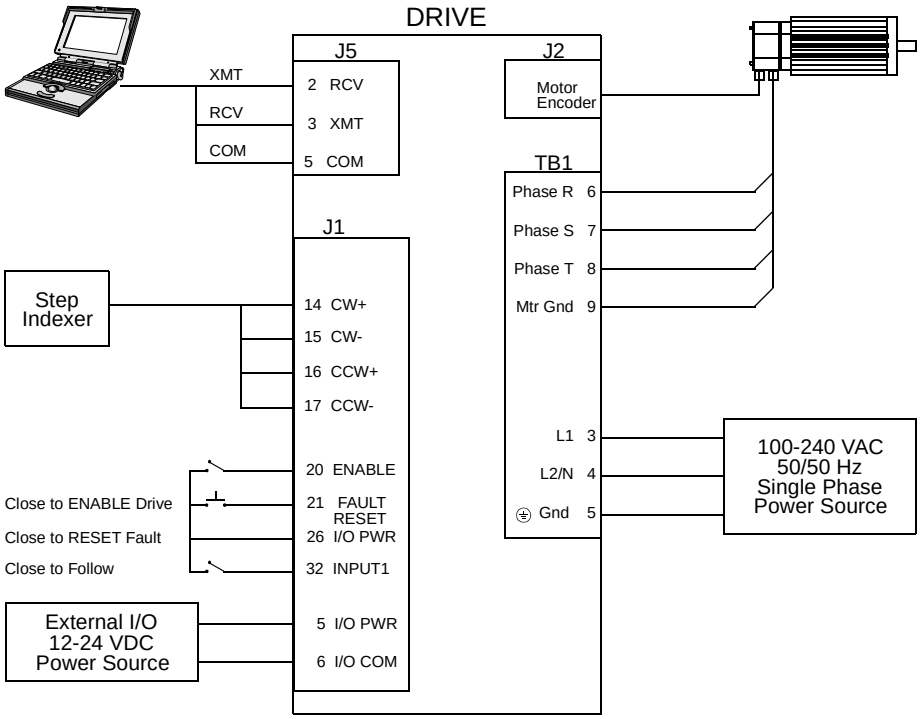
1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 100 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 100 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect the Stepper Indexer to the drive as shown in the diagram.
5. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.
6. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
7. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

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Connection Diagram

Figure 8.5 Position Follower (Step Up/Down Controller) Connection Diagram



Note: Refer to Figure 6.34 and 6.35 for additional details on the Control Interface Cable.

Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to "Status Indicator" on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer's communication settings.
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.

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- If the settings are different, correct the Port - Settings to allow communications with the drive.

  Factory default communications Port - Settings for the drive are:

  – Baud Rate: **9600**
  – Data Bits: **8**
  – Parity: **None**
  – Stop Bits: **1**
  – Serial Port: **COM1**

Refer to “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**,
12. Select **Follower: Step Up/Step Down** as the Operation Mode for the drive.
13. Choose **Close** to exit the Drive Set Up window.
14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Follower** tab.
15. Enter an appropriate **Gear Ratio** as the Follower Input. The default Gear Ratio is 1:1 (motor encoder pulses:master pulses). If a Gear Ratio of 3:1 is entered, the motor is moved 3 encoder pulses for every incoming step pulse.
16. Choose **Close** to exit the Drive Parameters window.
17. Verify the Status indicator is green.
18. Select the **I/O Configuration** command icon from the Drive Window.

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19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:
    - **Follower Enable** as Input 1
    - **Not Assigned** as Inputs 2 through 3.
    - **Not Assigned** as Outputs 1 and 2.
20. Choose **Close** to exit the I/O Configuration window.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as either a Position Follower (Step Up/ Step Down).

- The servo parameters have been setup with the unloaded motor.
- The motor position is controlled by the step indexer.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close the toggle switch between J1-26 and J1-32 to enable following.

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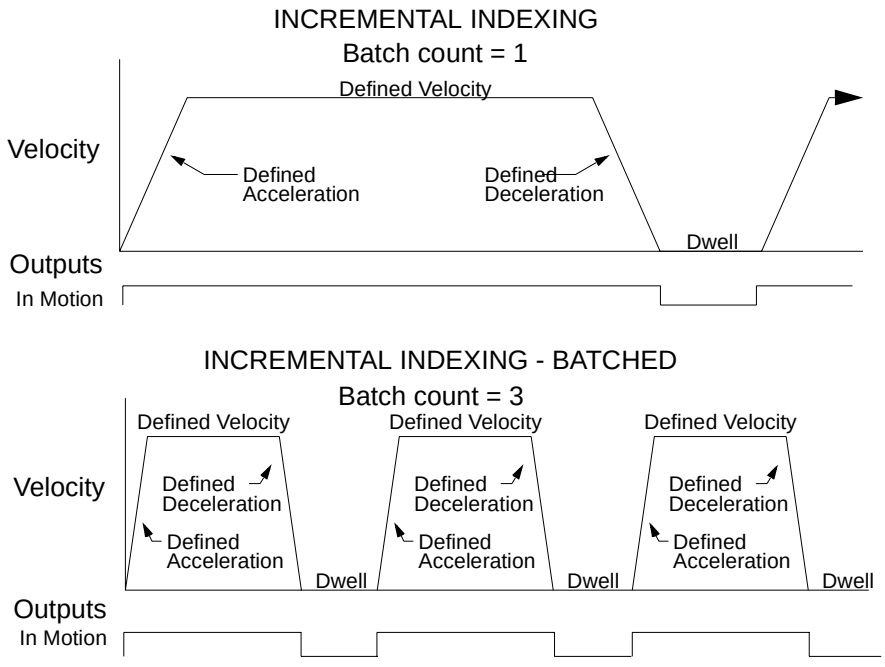
Incremental Indexing

Note: This feature is available only on drives capable of indexing: 1398-DDM-005X, 1398-DDM-009X and 1398-DDM-019X.

The ULTRA 100 Series drive can be set up as a incremental indexer by making the hardware connections and performing the software setup and tuning described below. A connection diagram depicts the minimum hardware necessary. Interfacing the drive to an external controller requires similar circuitry from the controller to J1, refer to "J1 – Controller" on page 6-1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

The following examples depict a simple incremental index move and a batched (multiple) move using incremental indexing.

Figure 8.6 Incremental Indexing Examples



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Hardware Set Up

Make the connections described below and shown in the Figure 8.7. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 100 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 100 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.
5. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
6. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

Connection Diagram

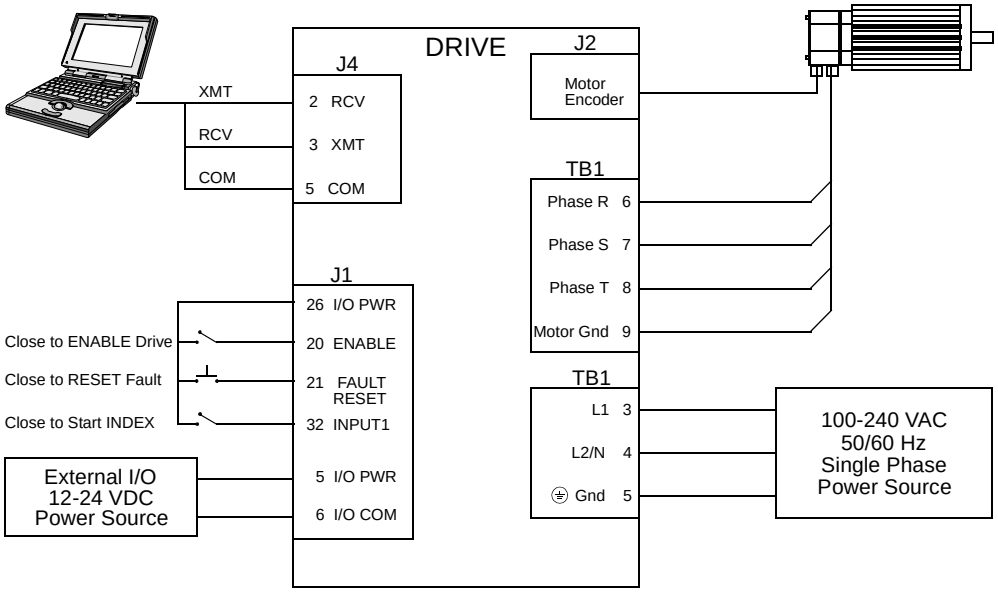
Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to “Status Indicator” on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer’s communication settings.

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Figure 8.7 Incremental Indexing Connection Diagram



5. Verify the communications port settings of the PC match those of the drive.

   - If the settings are correct, select **OK** in the Port - Settings dialog box.
   - If the settings are different, correct the Port - Settings to allow communications with the drive.

     Factory default communications Port - Settings for the drive are:

     – Baud Rate: **9600**
     – Data Bits: **8**
     – Parity: **None**
     – Stop Bits: **1**
     – Serial Port: **COM1**

   Refer to the section “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

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9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.

10. Select or verify the correct motor model number from the drop down Motor Model list.

11. If a message advises that the drive must be reset, choose **Yes**.

12. Select **Indexing** as the Operation Mode for the drive.

13. Choose **Close** to exit the Drive Set Up window.

14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Indexing tab**.

15. Enter the following values for Index 0. Refer to "Incremental Indexing Examples" on page 8-30 for examples of Single and Batched Incremental Indexing profiles.

Single Move Settings	Batched Move Settings
Incremental as Mode	**Incremental** as Mode
8000 as Distance	**8000** as Distance
1 as the Batch Count	**3** as the Batch Count
0 as Dwell	**1000** as Dwell
Appropriate values for Acceleration and Deceleration	Appropriate values for Acceleration and Deceleration

16. Choose **Close** to exit the Drive Parameters window.

17. Verify the Status indicator is green.

18. Select the **I/O Configuration** command icon from the Drive Window.

19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:

    - **Start Index** as Input 1
    - **Not Assigned** as Inputs 2 through 3.

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- **Not Assigned** as Outputs 1 and 2.

20. Choose **Close** to exit the I/O Configuration window.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as an Incremental Indexing controller.

- The servo parameters have been setup with the unloaded motor.
- Motion is commanded through the inputs.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close the toggle switch between J1-26 and J1-32 to start Index 0.

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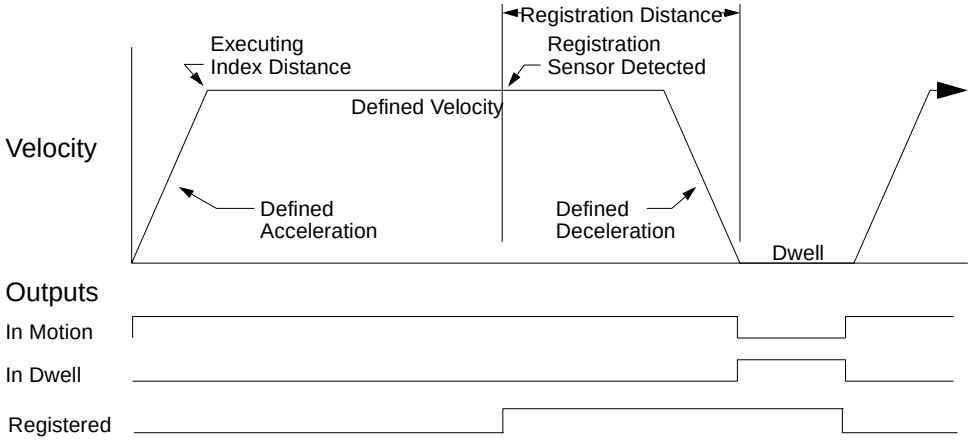
Registration Indexing

Note: This feature is available only on drives capable of indexing: 1398-DDM-005X, 1398-DDM-009X and 1398-DDM-019X.

The ULTRA 100 Series drive can be set up as a registration indexer by making the hardware connections and performing the software setup and tuning described below. A connection diagram depicts the minimum hardware necessary. Interfacing the drive to an external controller requires similar circuitry from the controller to J1, refer to “J1 – Controller” on page 6-1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

The following example depicts a batched (multiple) move using registration indexing.

Figure 8.8 Registration Indexing Examples



Hardware Set Up

Make the connections described below and shown in the Figure 8.9. Appendix A, “Options and Accessories” lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 100 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 100 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.

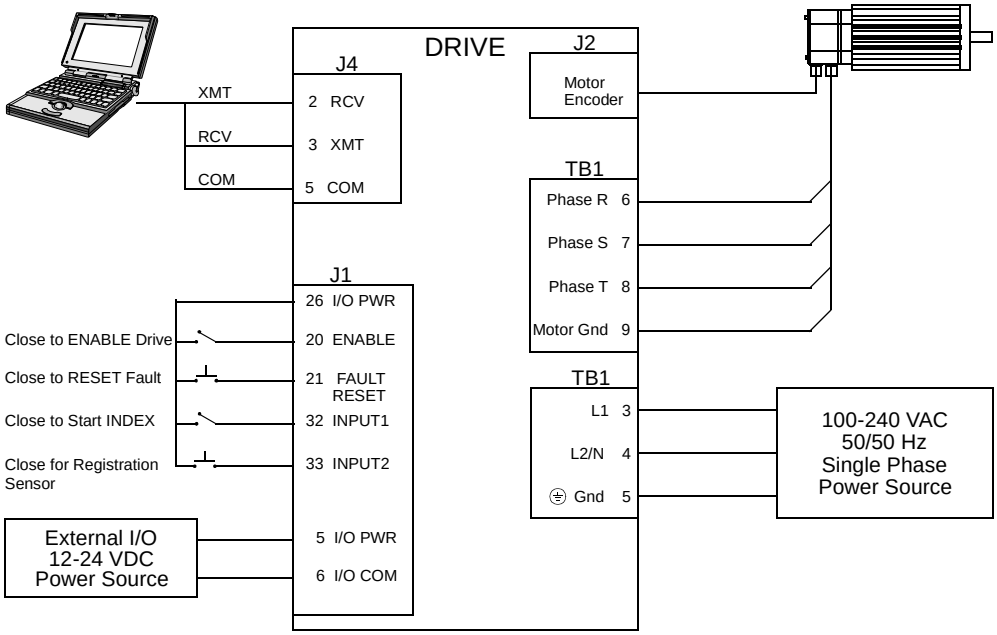
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4. Connect the Index Sensor to the drive as shown in the diagram.
5. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-33 (INPUT2) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.
6. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
7. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

Connection Diagram

Figure 8.9 Registration Indexing Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:

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- Status LED is green. Refer to “Status Indicator” on page 10-1 for an explanation of the display codes.

2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer’s communication settings.
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.
   - If the settings are different, correct the Port - Settings to allow communications with the drive.

     Factory default communications Port - Settings for the drive are:

     – Baud Rate: **9600**
     – Data Bits: **8**
     – Parity: **None**
     – Stop Bits: **1**
     – Serial Port: **COM1**

     Refer to “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.
6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**.
12. Select **Indexing** as the Operation Mode for the drive.

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13. Choose **Close** to exit the Drive Set Up window.

14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Indexing** tab.

15. Enter the following values for Index 0.

Single Move Settings	Batched Move Settings
Registration as Mode	**Registration** as Mode
8000 as Distance	**8000** as Distance
	8000 as Registration Distance
1 as the Batch Count	**3** as the Batch Count
0 as Dwell	**1000** as Dwell
Appropriate values for Acceleration and Deceleration	Appropriate values for Acceleration and Deceleration

Note: The Registration Distance must be longer than the Deceleration Distance or the move will not be registered.

16. Choose **Close** to exit the Drive Parameters window.

17. Verify the Status indicator is green.

18. Select the **I/O Configuration** command icon from the Drive Window.

19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:
    - **Start Index** as Input 1
    - **Registration Sensor** as Input 2.
    - **Not Assigned** as Input 3.
    - **Not Assigned** as Outputs 1 and 2.

20. Choose **Close** to exit the I/O Configuration window.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as a Registration Indexing controller.

- The servo parameters have been setup with the unloaded motor.
- Motion is commanded through the inputs.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

1. Close the switch between J1-26 and J1-20 to enable the drive.
2. Close the toggle switch between J1-26 and J1-32 to start Index 0.
3. Close the toggle switch between J1-26 and J1-33 to simulate registration.

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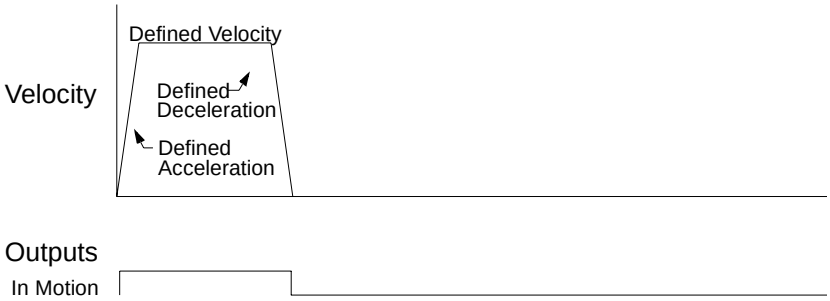
Absolute Indexing

Note: This feature is available only on drives capable of indexing: 1398-DDM-005X, 1398-DDM-009X and 1398-DDM-019X.

The ULTRA 100 Series drive can be set up as a absolute indexer by making the hardware connections and performing the software setup and tuning described below. A connection diagram depicts the minimum hardware necessary. Interfacing the drive to an external controller requires similar circuitry from the controller to J1, refer to “J1 – Controller” on page 6-1. Instructions are provided to configure the drive using a PC with ULTRA Master software, but the optional TouchPad also may be used.

The following example depicts a simple move from a home position.

Figure 8.10 Absolute Indexing Examples



Hardware Set Up

Make the connections described below and shown in the Figure 8.11. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 100 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 100 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
4. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)

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- J1-33 (INPUT2) and J1-26 (I/O PWR)
- J1-21 (FAULT RESET) and J1-26 (I/O PWR).

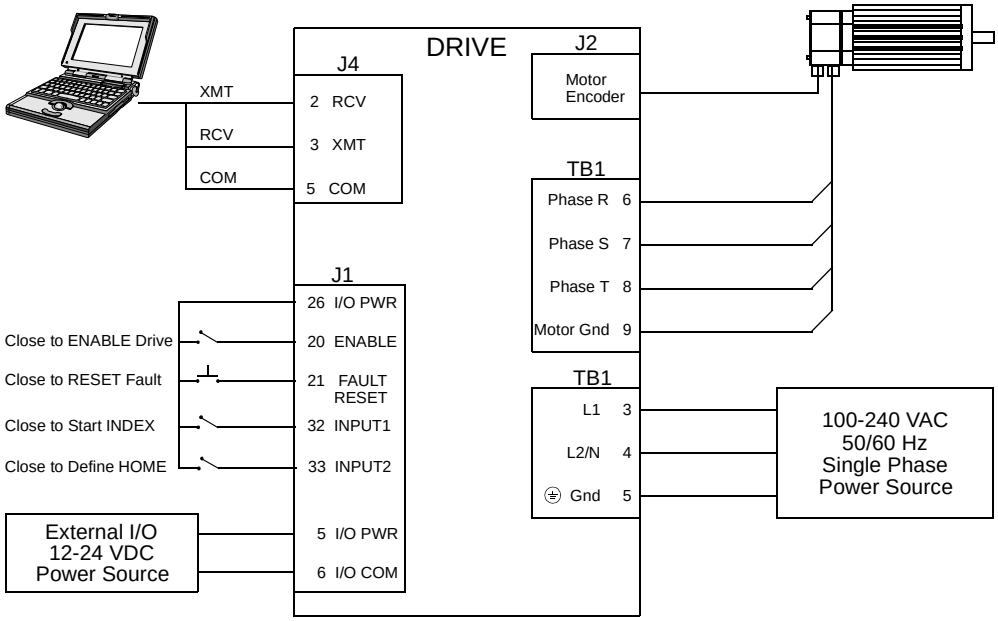
These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.

5. Connect an external 12 to 24 VDC power source for powering I/O to J1-5 (I/O PWR) and J1-6 (I/O COM).
6. Connect the drive to a single phase 100-240 VAC, 50/60 Hz power source.

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Connection Diagram

Figure 8.11 Absolute Indexing Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - Status LED is green. Refer to “Status Indicator” on page 10-1 for an explanation of the display codes.
2. Start ULTRA Master on the PC.
3. Choose **Cancel** from the Drive Select dialog box.
4. Select **PC Set Up** from the Communications menu in ULTRA Master to display the personal computer’s communication settings.
5. Verify the communications port settings of the PC match those of the drive.
   - If the settings are correct, select **OK** in the Port - Settings dialog box.
   - If the settings are different, correct the Port - Settings to allow communications with the drive.

     Factory default communications Port - Settings for the drive are:

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– Baud Rate: **9600**
– Data Bits: **8**
– Parity: **None**
– Stop Bits: **1**
– Serial Port: **COM1**

Refer to “RS-232 Communication Test” on page 11-8 for troubleshooting instructions.

6. Select **Read Drive Parameters** from the Communications menu.
7. Verify the Drive Name and Address are correct for the drive that is being addressed.
8. Choose **OK** to load the drive parameters.

Note: A motor must be selected for the parameters to load.

9. If the message box appears that a motor must be selected, select **OK**. The Drive Setup window is displayed with Motor Model selection parameter active. The motor may be selected from the drop down box. If this message box does not appear, the motor displayed in the Motor Model box was previously selected.
10. Select or verify the correct motor model number from the drop down Motor Model list.
11. If a message advises that the drive must be reset, choose **Yes**.
12. Select **Indexing** as the Operation Mode for the drive.
13. Choose **Close** to exit the Drive Set Up window.
14. Choose the **Drive Parameters** command icon from the Drive window and then select the **Indexing** tab.
15. Select the following values for Index 0:

    Absolute as Mode
    8000 as Position
    1 as Batch Count
    0 as Dwell
    Appropriate values for Velocity, Acceleration and Deceleration

16. Choose **Close** to exit the Drive Parameters window.
17. Verify the Status indicator is green.
18. Select the **I/O Configuration** command icon from the Drive Window.

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19. Select an appropriate digital input from the pull-down lists available as Digital Input Assignments in the I/O Configuration window.
    For example:
    - **Start Index** as Input 1.
    - **Define Home** as Input 2.
    - **Not Assigned** as Input 3.
    - **Not Assigned** as Outputs 1 and 2.
20. Choose **Close** to exit the I/O Configuration window.

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Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 100 Series will *not* hold initial position.

1. Choose the **Tuning** command icon from the Drive window.
2. Select **AutoTune** from the Tuning mode group.
3. Select the appropriate values for the following Auto Tune commands:
   - **Distance** and
   - **Step Current**.
4. Select the appropriate entry for the Motor Direction:
   - **BiDirectional**,
   - **Forward Only** or
   - **Reverse Only**.
5. Close the toggle switch between J1-26 and J1-20 to enable the drive.



ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

6. Choose **Start** from the Tuning window. The drive powers the motor shaft for a short period and then motion will cease. Then ULTRA Master displays the calculated gains and disables the drive.
7. Choose **Normal Drive Operation** from the Tuning window.
8. Open the switch between J1-26 and J1-20 to disable the drive.
9. Choose **Close** to exit the Tuning window.
10. Verify the Status indicator is green.
11. Close any open windows or dialog boxes.

Operation

The drive is now configured as a Absolute Indexing controller.

- The servo parameters have been setup with the unloaded motor.
- Motion is commanded through the inputs.

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The firmware saves the parameters in EEPROM memory. Thus the drive can be power cycled and, after power-up, will use the parameters selected in the steps above.

When motion is required:

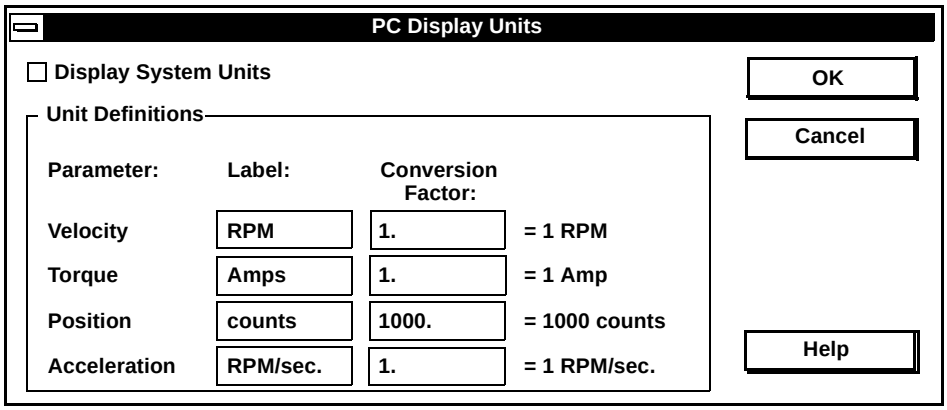
1. Close the switch between J1-20 and J1-26 to enable the drive.
2. Close the toggle switch between J1-32 and J1-26 to start Index 0.
3. Close the switch between J1-33 and J1-26 to define the Home position.

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Modifying User Units

The units displayed for any ULTRA 100 Series drive may be modified using a PC with ULTRA Master software. The PC Display Units help menu defines the various parameters displayed by ULTRA Master. Default settings for Units are shown in Figure 8.12.

Figure 8.12 PC Display Units – Default Dialog



Changing the Display Units Settings

The following example changes the Label and Conversion Factor for the Position and Acceleration parameters. This example assumes a 2000 line encoder (8000 pulses/revolution).

- Position - from Counts to Motor Revolutions
- Acceleration - from RPM/sec^2 to Revs/sec^2

1. Choose the **Drive Parameters** command icon from the Drive window and then select the **Units** button. The PC Display Units dialog appears with default settings as shown.
2. Select the Position Label cell, and change **counts** to **Mtr Revs**.

Note: Labels are limited to eight characters.

3. Select the Position Conversion Factor cell, and change **1000** to **0.125**.
   Mathematically 1/8 (0.125) of a motor revolution is 1000 counts, given that the motor has a 2000 line (8000 count) encoder.
4. Select the Acceleration Label cell, and change **RPM/sec** to **Revs/sec**.
5. Select the Acceleration Conversion Factor cell, and change **1.** to **.016**.
   Mathematically 1.6 x 10^{-2} revs/sec^2 is 1 RPM/sec, given the motor has a 2000 line (8000 count) encoder.

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6. Choose **OK** to exit the PC Display Units dialog.

The modified units will be displayed where appropriate within the ULTRA Master windows. For example, these changes cause the Indexing tab in the Drive Parameters window to display:

- Distance in Mtr Revs
- Acceleration in Revs/sec^2
- Deceleration in Revs/sec^2

The following units were not effected by the changes:

- Dwell in msec
- Velocity in RPM

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Tuning

ULTRA 100 Series drives are tuned quickly and easily for a wide variety of applications. Two tuning modes are available through the software:

- Auto Tune
- Manual Tune

Tuning Guidelines

The following tuning guidelines briefly describe the tuning adjustments. These guidelines provide you with a basic reference point should the application require additional adjustments.

General Tuning Rules

- Tune the velocity loop first and then, if the drive uses following or step/direction commands, tune the position loop.
- To widen the velocity loop bandwidth, increase the P-gain setting, decrease the I-gain setting or increase the low-pass filter bandwidth. This provides a faster rise time and increases drive response.
- To increase stiffness, increase the I-gain setting. It rejects load disturbance and compensates for system friction.
- To reduce velocity loop overshoot, increase P-gain or decrease I-gain.
- To reduce mechanical resonance, use a stiffer mechanical coupling or decrease the low-pass filter value and the velocity loop update rate.
- If the motor oscillates, decrease either individually or together the:
  – P-gain
  – I-gain
  – low-pass filter bandwidth.

High Inertia Loads

Proper compensation of load inertia may not be simply a matter of increasing the P-gain and I-gain settings. Problems are often encountered when tuning systems with a high load to motor inertia ratio.

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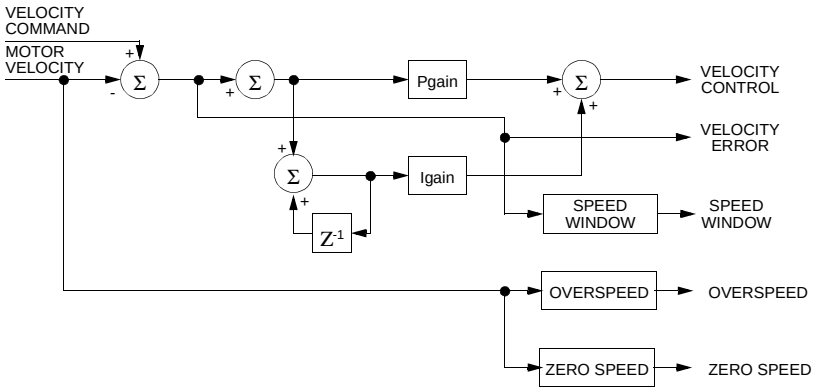
Mechanical Resonance

Mechanical resonance between the motor and the load occurs when the motor and load are oscillating with the same frequency but opposite phase: when the motor is moving clockwise the load is moving counter clockwise. The amplitude of the motor and load oscillations is such that the total momentum of the oscillating system is zero. In the case of a high load to motor inertia ratio this means that the motor may be moving quite a lot while the load is not moving nearly as much. Mechanical resonance occurs as a result of compliance (springiness) between the motor inertia and load inertia. It may result from belts, flexible couplings or the finite torsional stiffness of shafts. In general, the stiffer the couplings, the higher the resonant frequency and lower the amplitude. If the motor shaft is directly coupled to the load, a mechanically resonating system usually emits a buzz or squeal at the motor.

There are several ways of dealing with this problem but they fall into two groups: change the mechanical system or change the servo-motor response. Changing the mechanical system might involve reducing the inertia ratio via gearboxes or pulleys, or by increasing the stiffness of the couplings. For very high performance systems and systems with low resonance frequencies the mechanics may require changing to effectively deal with the resonance.

The second way of dealing with mechanical resonance is by changing the servo-motor response. This may be done by reducing the P-gain, I-gain, velocity loop update rate or low-pass filter value.

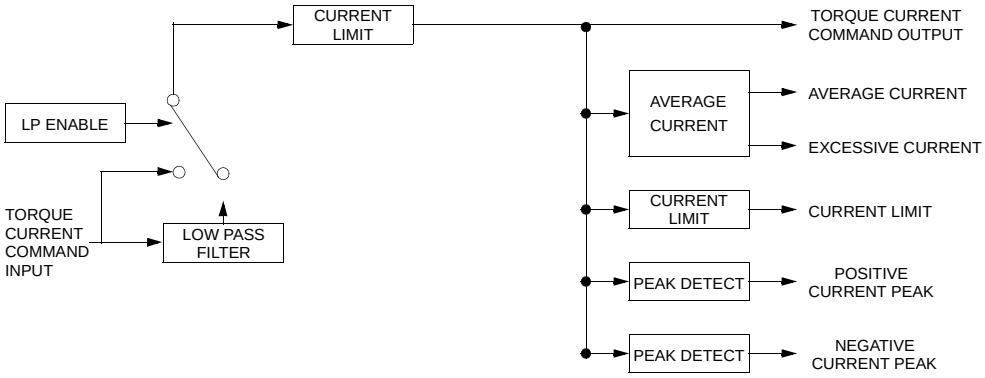
Figure 9.1 Velocity Loop Structure



Reducing the value of the P-gain, low-pass filter frequency and the update frequency all have the effect of reducing the servo-motor bandwidth. As long as the resonating frequency is fairly high this will likely be acceptable, but if the resonating frequency is low it may be necessary to modify the mechanics of the system.

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Figure 9.2 Torque Current Conditioning Structure



Backlash

Backlash between the motor and load effectively unloads the motor over a small angle. Within this small angle, the increased gain can result in oscillations. Some backlash may be unavoidable, especially with gear reduction. If backlash is present, the inertia match between the load and motor must be properly sized for good servo performance (load inertia should roughly equal motor inertia). Gearing reduces the inertia reflected to the motor by the square of the gear reduction from motor to load. Therefore, the gear ratio must provide the required match.

Auto Tune Mode

The Auto Tune mode uses a “self-tuning” algorithm that automatically adjusts the drive’s position and velocity loop gain parameters. Adjustments do not require special equipment. This mode will tune a drive for constant response across different applications. The results often provide acceptable response, but in general should be considered a starting point.

Tuning parameters adjustments are set to achieve a reasonable bandwidth and servo response based on the system inertia and friction. Auto tune may be used when a significant amount of compliance or backlash exists (for example, belt systems) in the mechanical load, but precise tuning requires the load be fully coupled to the motor. Instability problems occur when the load is not fully coupled to the motor.

▶ **Note:** The autotune algorithm will not provide satisfactory results in systems with significant gravitational effects.

Auto Tuning

A PC running ULTRA Master or the TouchPad is required to perform tuning on the drive.

Before auto tuning is invoked, three autotuning parameters must be set:

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- Distance sets the rotation limit of the motor. This is the maximum distance the motor is allowed to move during any one test.

Note: Autotuning in the bi-directional mode includes two different tests.

- Step Current sets the amount of current given to the motor during the test. If this is set too low, a system may not move enough to gather sufficient data, if it is set too high the test will be too short and very jerky.
- Motor Direction (Forward Only/Reverse Only/Bi-directional) sets the rotational direction for the test. The bi-directional test does the same test in both directions, with the forward rotation first.

Auto tune procedures are explained for each drive configuration in "Application and Configuration Examples" starting on page 8-1. The following steps generalize the ULTRA Master tuning procedures. Similar procedures apply for the TouchPad.

When autotuning is selected, the drive rotates the motor shaft for a short time interval, typically a few seconds. Motor movement should *not* exceed 30 seconds.

ATTENTION: Rotating motor shafts can cause extensive damage and injury. Motors must be properly guarded during testing and installation.

1. Choose the **Tuning** command icon from the Drive window.
2. Choose **Auto Tune** from the Tuning window. This activates the Auto Tune Command and Motor Direction boxes within the Tuning window. Then enter or select:
   - appropriate values for **Distance** in the Auto Tune Command box,
   - appropriate values for **Step Current** in the Auto Tune Command box, and
   - an appropriate motor rotation in the Motor Direction box on a PC, either:

     – **BiDirectional**, if the motor will be powered in both the forward and reverse directions.

     – Forward Only, if the machinery is designed to operate only in the forward direction.

     – Reverse Only, if the motor will be powered only in the reverse direction.

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Use the default settings if you are uncertain about what values to enter. The default settings are set to values appropriate to the drive and motor combination selected during drive initialization.

3. Enable the drive.
4. Choose **Start** from the Tuning window. The drive rotates the motor shaft and then motion will cease. The calculated gains are displayed and the drive is disabled.
5. Disable the drive manually.
6. Choose **Normal Drive Operation** from the Tuning window.
7. Enable the drive.
8. Choose **Close** to exit the Tuning window.

Note: Auto tuning does not have a velocity limit, but it does adhere to the motor Overspeed setting in the Drive Parameters window.

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Manual Tune Mode

Manual tuning may be used to adjust the gain settings and filter frequency of the velocity and position regulator. The following sections briefly explain these settings. An understanding of the function for each type of gain and filtering will allow you to effectively tune the system.

Two types of manual tuning are available:

- Velocity tuning
- Position tuning.

Before manual tuning is invoked, the Velocity, Distance and Motor Direction parameters must be set. Refer to “Auto Tune Mode” on page 9-3 for information on setting these parameters.

The velocity loop should always be tuned *before* the position loop, as velocity loop tuning affects the position loop response.

Gain settings and signal filtering are the primary methods to electrically tune a system. An understanding of the types of gain and their purposes, as well as a general understanding of filtering, are essential background knowledge to properly tune a servo system.

Filters

The velocity regulator has one low pass filter. The filter bandwidth range is from 1 Hz to 992 Hz. The filter serves two purposes:

- Adjusts the frequency range to remove or filter the noise produced by encoder resolution.
- Reduces the amount of the mechanical resonance in the mechanical system (e.g., belt systems).

Similar results may often be achieved by reducing the update rate of the velocity loop.

Gains

Manual Tuning

Manual tuning may be used to adjust the gain control parameters P and I, and the filters. A square wave is generated by the drive to assist in the adjustment. Manual velocity tuning requires the following:

- Step Period value to be specified

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Table 9.1: Velocity Loop Gains

Parameter	Description
P-gain	Proportional gain of the velocity regulator. P-gain controls the bandwidth of the velocity regulator by adjusting the control response proportional to the error. The P term of the velocity regulator commands an acceleration current that is proportional to the velocity error.
I-gain	Integral gain of the velocity regulator. Integration in the velocity regulator forces the motor velocity to precisely follow the commanded velocity. This assumes operation under steady state conditions (velocity command or load does not change). I-gain controls: • The stiffness or the ability to reject load torque disturbance. • The amount of velocity overshoot, which may cause the system to become unstable or oscillate. The I term of the velocity regulator commands an acceleration current proportional to the integral of the velocity error.

Table 9.2: Position Loop Gains

Parameter	Description
Kp-gain	Proportional gain of the position loop. Kp-gain changes: • The position loop bandwidth. • The settling time of the position loop. In general, the higher the value of Kp-gain the faster the settling time. However, a high value of Kp-gain with inadequate velocity loop bandwidth results in overshoot and ringing.
Kd-gain	Differential gain of the position loop. Provides position loop damping and reduces overshoot caused by Kp or Ki gain.
Kff-gain	Feedforward gain of the position loop. Kff-gain reduces following error. However, a high value of Kff-gain can result in position overshoot. A reduction in following error allows the system to more closely approximate gear driven systems.
Ki-gain	Integral gain of the position loop. Ki-gain decreases the time period for the error to decay. A non-zero value of Ki allows integration in the position loop which eliminates the steady state following error. However, a non-zero value for Ki may introduce overshoot and ringing, which cause system instability (oscillation). **NOTE:** Ki-gain is used in conjunction with the Ki Zone value. Ki Zone is the area around the commanded position where Ki-gain is active.
NOTE: Position Loop Gains are used in the Position Following mode only.	

- Step Velocity value to be specified.

▶ **Note:** Always tune the velocity loop *before* the position loop, as Velocity loop tuning affects the position loop response.

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Tuning the Velocity Loop

The Auto Tune procedure provides a starting point for velocity loop tuning. Manual tuning is desirable when very precise adjustments are required.

The following steps describe how to manually tune the velocity loop. These steps precede the manual position loop tuning procedure, which should follow velocity loop tuning.

1. Disable the drive.
2. Choose **Manual Tune (Velocity Step)** from the Tuning window.
3. Enter the desired step **Velocity (rpm)** of the internal square wave generator.
4. Enter the desired **Time** to complete one cycle of the square wave of the internal step velocity.
5. Select the desired Motor Direction (**Forward Only**, **Reverse Only**, or **Bi-Directional**).
6. Select the **Oscilloscope**.
7. Enable the drive.
8. Choose **Start**. The motor should start moving and the oscilloscope will display the commanded velocity and the motor velocity.
9. While monitoring the motor velocity waveform, increase P-gain until the desired rise time is achieved.
10. While monitoring the motor velocity waveform, increase I-gain until an acceptable amount of overshoot is reached.
11. Apply filtering by selecting **Filters**, and then select **Filter Enable**.
12. While monitoring the motor velocity waveform, decrease the filter **Bandwidth** until the overshoot begins to increase (in many applications the filter is not necessary).
13. Choose **Stop**.
14. Disable the drive.
15. Choose **Normal Drive Operation**.
16. Choose **Close**.
17. Enable the drive.

The drive's velocity loop is tuned.

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Tuning the Position Loop

Specify the step period and step position values, and then input a square wave to the position loop. Adjust the gain parameters Kp, Kd, Kff, Ki, and Ki Zone to tune the system.

Note: Tune the velocity loop before attempting to tune the position loop. The bandwidth of the velocity loop must be set before position loop tuning is attempted.

1. Disable the drive.
2. Choose **Manual Tune (Position Step)** from the tuning window.
3. Enter an appropriate **Distance count** (step position) for the internal square wave.
4. Enter an appropriate time to complete one cycle of the square wave for the internal step position.
5. Select the desired Motor Direction **(BiDirectional**, **Forward Only** or **Reverse Only**).
6. Select the **Oscilloscope**.
7. Enable the drive.
8. Choose **Start**. The motor will move and the oscilloscope will display the commanded position and motor position.
9. Increase the **Kp** gain while monitoring the signal on the scope. The Kp gain should be adjusted until the desired rise time is achieved, with no overshoot. Refer to Figure 9.3.
10. Increase **Ki** very slowly until the signal begins to overshoot.
11. Increase **Kd** very slowly to remove the overshoot caused by Ki.
12. In general you may leave the **Kff** gain set to 100.
13. Choose **Stop**.
14. Disable the drive.
15. Choose **Normal Drive Operation**.
16. Choose **Close**.
17. Enable the drive.

The position loop has been tuned. The drive may be operated as a master encoder, step/direction or step up/down configuration.

Velocity Loop Tuning Examples

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Figure 9.3 Signal Nomenclature

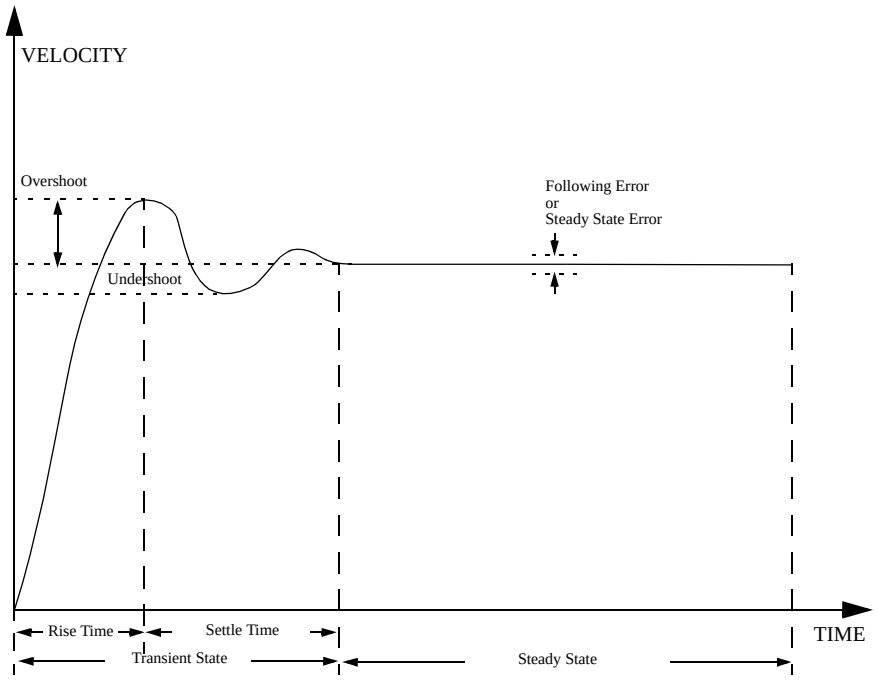
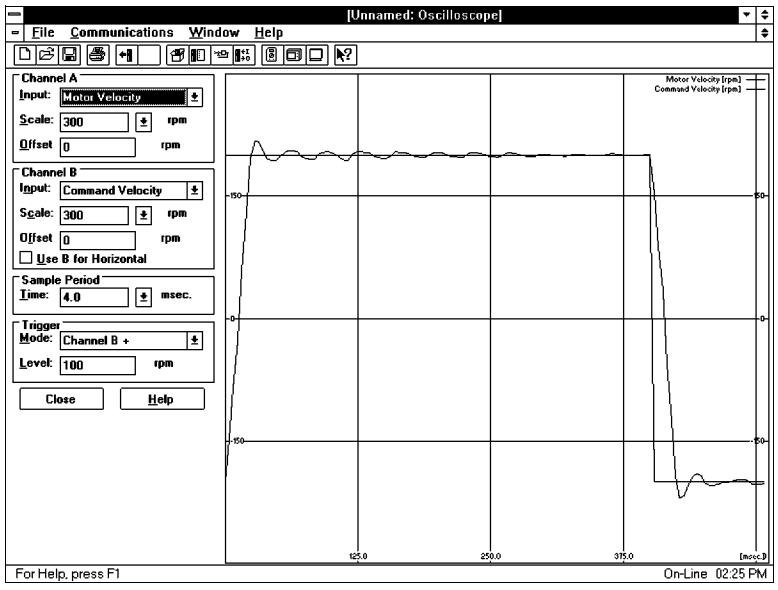


Figure 9.4 Underdamped Signal

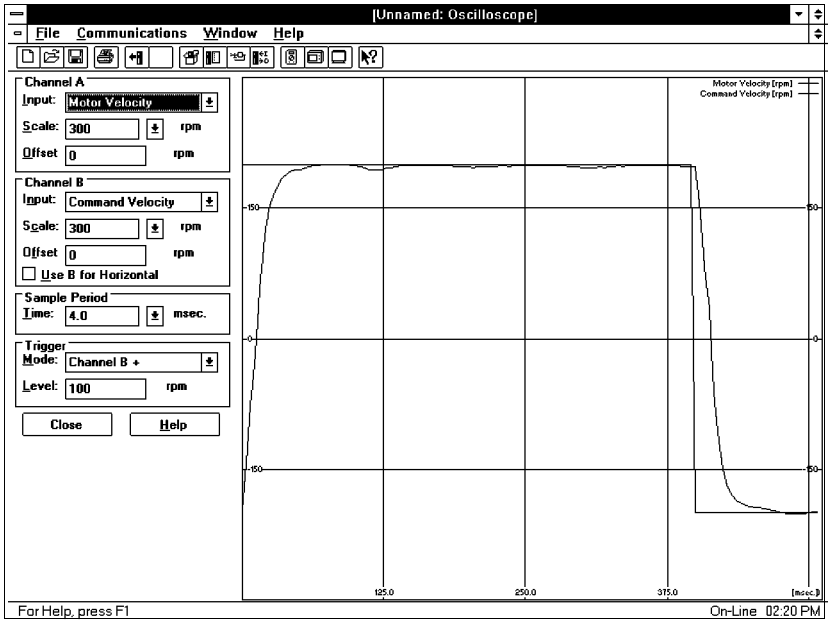


UNDERDAMPED
Motor Velocity consistently overshoots the Velocity Command. To correct:

Decrease P-gain
Decrease I-gain

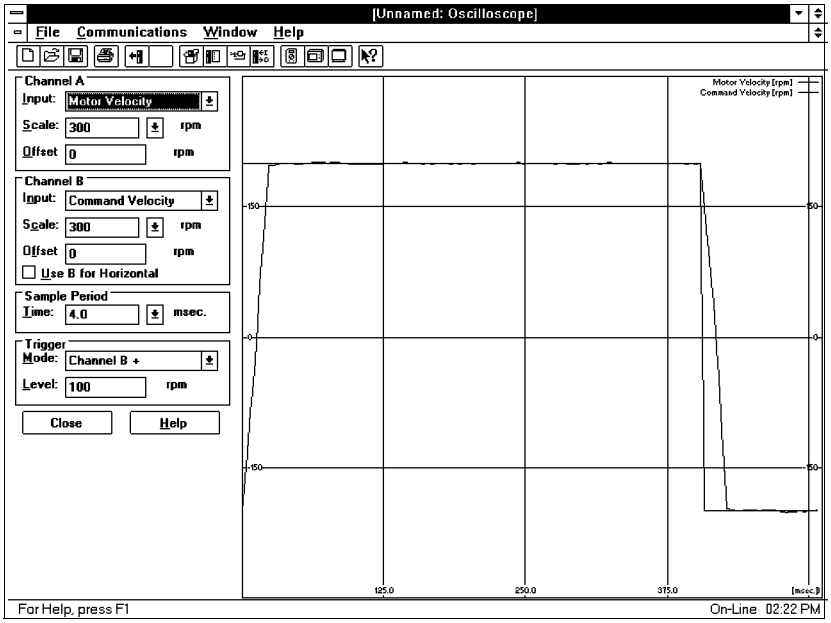
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Figure 9.5 Overdamped Signal



OVERDAMPED
Motor Velocity consistently undershoots the Velocity Command. To correct:
Increase I-gain
Increase P-gain

Figure 9.6 Critically Damped Signal (Ideal Tuning)



CRITICALLY DAMPED
Motor Velocity quickly settles to the Velocity Command.

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Status Display

A single front panel indicator displays the status of the drive on a continuous basis:

- The Status LED lights whenever the bus is energized.

Status Indicator

The Status indicator is a three level LED, which indicates the current operational state of the drive. The status level is indicated by the color of the LED.

- Green = Normal operation
- Blinking Green/Orange = Drive Fault
- Orange = Hardware malfunction
- Blank = Power not supplied or hardware malfunction

Refer to “Troubleshooting” beginning on page 11-3 for troubleshooting tables.

Error Messages

If there is a fault, the specific error messages may be accessed by attaching a PC or TouchPad to the ULTRA 100 Series drive. Faults are detected by the drive in two ways: power-up hardware and run-time faults. A power-up fault usually requires servicing of the hardware, while a run-time fault can be cleared by resetting the drive.

“Maintenance and Troubleshooting” lists error codes and possible actions or solutions to take when resolving the error condition.

Run Time Error Codes

Table 10.1: List of Run Time Error Codes

Error Code	Fault Description
01 - 03	Reserved
04	Motor Overtemperature, Thermostat
05	IPM Fault (Overtemperature / Overcurrent / Short Circuit)
06 - 08	Reserved
09	Bus Undervoltage
10	Bus Overvoltage
11	Illegal Hall State
12 - 16	Reserved
17	Excessive Average Current
18	Motor Overspeed
19	Excessive Following Error
20	Motor Encoder State Error

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Table 10.1: List of Run Time Error Codes (continued)

Error Code	Fault Description
21	Auxiliary Encoder State Error
22	Motor Thermal Protection
23	IPM Thermal Protection
24	Excess Velocity Error
25	Commutation Angle Error
26	Reserved
27	Axis not Homed
28	No Motor Selected
29	Motor Selection not in Table
30	EEPROM Write Error
31 - 50	Reserved

Power-Up Error Codes

A power-up error indicates in almost all cases that the drive should be returned to the factory for service. In general, any occurrence of a Power-up error should be treated with extreme caution. It may indicate the hardware is marginal.

Situations that may cause drive hardware errors, and which can be remedied outside the factory include:

A watchdog time-out error may result from electrical “noise” (electromagnetic interference - EMI), a firmware error, or a hardware malfunction. The context of the watchdog error needs to be investigated to determine the source of the problem.

Table 10.2 lists the Power-Up Error Codes.

Table 10.2: List of Power-Up Error Codes

Error Code	Fault Description
51	Program Memory Boot Block Error
52	Program Memory Main Block Error
53	Uninitialized Personality EEPROM Error
54	Personality EEPROM Read Error
55	Personality EEPROM Data Corruption
56	Processor Watchdog Error
57	Reserved
58	Processor RAM Error
59	Reserved
60	Uninitialized Service EEPROM Error
61	Service EEPROM Read Error
62	Service EEPROM Data Corruption Error
63 - 73	Reserved
74	Personality EEPROM Write Error
75 - 78	Reserved

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Table 10.2: List of Power-Up Error Codes (continued)

Error Code	Fault Description
79-n	Data Out of Range where n = suberror parameter 1 - Serial baud rate selection 2 - Serial stop bits/parity selection 3 - Position Loop Kp 4 - Position Loop Ki 5 - Position Loop Kff 6 - Position Loop Kd 7 - Gear ratio 8 - Encoder Output Divider 9 - Velocity Loop Update Period 10 - Velocity Loop P Gain 11 - Velocity Loop I Gain 12 - Velocity Loop D Gain 13 - Reserved 14 - Analog Command Velocity Offset 15 - Analog Command Torque Offset 16 - User D/A Variable Selection 17 - Command Source 18 - Drive Mode (Torque/Velocity) 19 - Tuning Direction 20 - Motor/Encoder User Alignment Offset 21 - Encoder Size 22 - Motor Torque Constant 23 - Motor Inertia 24 - Motor Back EMF 25 - Motor Resistance per Phase 26 - Motor Inductance per Phase 27 - Motor Commutation Type 28 - Motor Encoder Hall Offset 29 - Motor Encoder Index Offset 30 - Motor Pole Count
80-1	Service Data Out of Range (Drive Type)
81	Reserved
82	Mask ROM Block Checksum Error
83 - 99	Reserved

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Maintenance and Troubleshooting

This section provides a description of suggested maintenance activities and an in-depth troubleshooting chart.

Maintenance

The ULTRA 100 Series drive is designed to function with minimum maintenance.



ATTENTION: DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the warning on the front of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.

Periodic Maintenance

Normally the only maintenance required is removal of superficial dust and dirt from the drive and a quick check of cabling insulation and connections.

Cleaning

To clean the drive, use an OSHA approved nozzle that provides compressed air under low pressure $\leq$20 kPa (30 psi) to blow the exterior surface and the vents clean.

Cable Inspection

Inspect the cables, particularly the power connections, to verify the connection.

- All power connections should be torqued to 1.2 Nm (11 lb-in).
- D-shell connectors can be inspected for proper seating and signal continuity.
- Visually inspect all cables for abrasion.

Data Transfer

After you have configured the drive and tuned the drive, the data stored in the EEPROM personality module should be saved off-line. Saving the parameters off line will allow you to clone several machines with the same mechanics and provides an emergency backup of the drive data.

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To transfer the data from the drive to a PC:

1. While on-line with a drive, click on **File** in the toolbar menu.
2. Select **Save As...**, the Save As window will appear.
3. Enter the file name and press ENTER or choose OK to save.

To transfer the data from a PC to a drive:

1. Close all windows in ULTRA Master.
2. Choose **File** in the toolbar menu.
3. Choose **Open**.
4. Select the desired file name or enter the file name to be loaded and press ENTER or choose OK.

   If you do not know the name of the file to be loaded, select the correct directory from the **Directories** box and select the file name from the displayed list of file names.
   The ULTRA Master Off-Line Drive window will appear along with the selected file name.
5. Select **Communications** from the toolbar menu.
6. Select **Overwrite Drive Parameters**.
   The Drive Select window will appear.
7. Select the drive to be configured, and then press **ENTER** or choose **OK** to load the parameters into the personality module.

Firmware Upgrading

ULTRA 100 Series drives may be upgraded in the field to the latest version of firmware. Firmware versions are available from the Allen-Bradley Product Support group. The procedure describes how to reload the firmware installed in your drive using the Upgrade Firmware command available in ULTRA Master software.

ULTRA Master provides checks and controls through message boxes which ensure that the loading of firmware is performed properly.

Firmware Upgrade Procedure using ULTRA Master

1. Copy the new firmware into the Firmware subdirectory of the ULTRA Master application directory.
2. Start ULTRA Master.

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3. When the Drive Select window appears, select **Cancel**. The Drive Select window closes without connecting to the drive.

4. Choose **Upgrade Firmware** from the File menu. The Drive Select window will appear.

5. Select the drive to upgrade, and then select **OK**. The Select Firmware File window will appear.

6. The Select Firmware File window contains a list of firmware files identified by version information. Only the files that can be applied to the connected drive are displayed, which minimizes the danger of transferring an incorrect file. To select the firmware files:

   - Select the appropriate file to upgrade the drive firmware.
   - Select **OK** when the file is highlighted.

   A visual indicator traces the progress of the firmware upgrade.



Note: Do *not* remove power or reset either the drive or the PC during the upgrade. Any interruption of the firmware upgrade could cause the drive to become *inoperable*.

7. When the upgrade is complete a dialog box confirms completion of the upgrade and reminds you that the drive must be reset at this time.

   - Select **Yes** if you want to perform a software reset of the drive.
   - Select **No** if you wish to reset the drive by removing power.

Troubleshooting

A single LED on the front panel indicates the status of the drive on a continuous basis:

- Green = Normal operation
- Blinking Green/Orange = Drive Fault
- Orange = Hardware malfunction
- Blank = Power not supplied or hardware malfunction

A table of problems, potential causes, and appropriate actions to take to resolve the problem is included below.

If problems persist after attempting to carefully troubleshoot the system, please contact your local distributor for further assistance.

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Error Codes

Error codes may be accessed by attaching either a PC with ULTRA Master software or a TouchPad to the serial port (J5):

- ULTRA Master displays errors in two windows: **Fault History** and **Display Fault Status**,
- The TouchPad display errors in the **DrvStat** parameter under the **STATUS** branch title.

Table 11.1: Troubleshooting Guide

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
STATUS LED not lit		No AC power	Verify power (115/230VAC single phase) is applied to the drive.
		Internal power supply malfunction.	Call factory
Motor jumps when first enabled		Motor encoder wiring error	Check motor encoder wiring. See Figure 6.38 on page 31
		No Absolute signal at J2-16	Monitor Absolute signal at J2-16.
		Incorrect motor chosen in personality module	Select the proper motor in ULTRA Master.
Digital I/O not working correctly		I/O power supply disconnected	Verify connections and I/O power source
Motor Overtemperature	04	Motor TS+ (J2-19) and TS- (J2-20) pins open	Verify TS+ (J2-19) and TS- (J2-20) connections for continuity.
		Motor thermostat trips due to: High motor ambient temperature, and/or Excessive RMS torque	Operate within (not above) the continuous torque rating for the ambient temperature (40°C maximum). Lower ambient temperature.
IPM Fault	05	Motor cables shorted	Verify continuity of motor power cable and connector.
		Motor winding shorted internally	Check for short on R,S,T and Gnd windings of the motor.
		Drive temperature too high	Check for clogged or defective fan. Ensure cooling is not restricted by insufficient space around the unit.
		Operation above continuous power rating	Verify ambient temperature is not too high (above 60° C). Operate within the continuous power rating.
		Output short circuit or overcurrent	Drive has a bad IPM, replace drive.

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Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Bus Undervoltage	09	Low AC line/AC power input (100 V AC minimum for safe drive operation)	Verify voltage level of the incoming VAC power. Check AC power source for glitches or line drop (below 90 VAC). Install an uninterruptible power supply (UPS) on your VAC input.
Bus Overvoltage	10	Excessive regeneration of power When the drive is driven by an external mechanical power source, it may regenerate too much peak energy through the drive's power supply. The system faults to save itself from an overload.	Change the deceleration or motion profile and/or reduce the reflected inertia of your mechanical system. Use a larger system (motor and drive).
		Excessive AC input voltage	Verify input is below 264 VAC.
		Output short circuit	Check for shorts.
		Motor cabling wires shorted together	Check for shorts.
		Internal motor winding short circuit	Check for shorts.
Illegal Hall State	11	Incorrect phasing Bad connections	Check the Hall phasing. Verify the Hall wiring.
RESERVED	12		
RESERVED	13		
RESERVED	14		
RESERVED	15		
RESERVED	16		
Excessive Average Current	17	Excessive time at peak current	Reduce acceleration rates Reduce duty cycle (ON/OFF) of commanded motion. Increase time permitted for motion. Mechanical jam or excessive frictional load. User larger drive and motor.
		Software parameter set too low	Increase Average Current parameter to a less restrictive setting.
		Insufficient bus voltage	Correct the under voltage condition or intermittent AC power or install a larger size transformer.
		Motor Phasing is incorrect	Check motor phasing.

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Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Motor Overspeed	18	OVERSPEED parameter in the drive set to low for the application	Using ULTRA Master (refer to Drive Parameters section) set Overspeed parameter to an acceptable range for the application.
		Motor commanded to run above Overspeed setting	Reduce command from position controller or change velocity parameter in the position controller.
		Motor encoder phasing is incorrect	Check encoder phasing.
Excess Following Error	19	The software position error limit was exceeded	Increase the feed forward gain to 100%. Increase the following error window (refer to ULTRA Master Drive Parameters section). Retune the drive to reduce the following error. Increase the slew limit window (refer to ULTRA Master Drive Parameters).
Motor Encoder State Error	20	The motor encoder encountered an illegal transition	Replace the motor/encoder Use shielded cables with twisted pair wires. Route the feedback away from potential noise sources. Check the system grounds.
		Bad encoder	Replace motor/encoder.
Auxiliary Encoder state error	21	The auxiliary encoder encountered an illegal transition	Use shielded cables with twisted pair wires. Route the encoder cable away from potential noise sources. Bad encoder - replace encoder Check the ground connections
Motor Thermal Protection Fault	22	The internal filter protecting the motor from overheating has tripped.	Reduce acceleration rates Reduce duty cycle (ON/OFF) of commanded motion. Increase time permitted for motion. Use larger drive and motor.
IPM Thermal Protection Fault	23	The internal filter protecting the IPM at slow speed has tripped.	Reduce acceleration rates Reduce duty cycle (ON/OFF) of commanded motion. Increase time permitted for motion. Use larger drive and motor.
Excess Velocity Error	24	Velocity exceeded allowable range.	Increase time or size of allowable error. Reduce acceleration.

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Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Commutation Angle Error	25	Bad encoder	Replace encoder or motor/ encoder. Check wiring of motor encoder index signal.
RESERVED	26		
RESERVED	27		
No Motor Selected	28	No motor was selected when the drive was enabled.	Select a motor before enabling the drive.
Motor Information Missing	29	The motor number is referencing a motor that is not currently in the drive.	Select a motor that is in the drive. Update the motor tables in the drive (contact the factory).
RESERVED	30-99		Call the factory.

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RS-232 Communication Test

This test verifies communications between an ULTRA 100 Series drive and a personal computer by connecting the XMT pin to the RCV pin. The jumper bypasses the potentially defective cable and remote unit.

Test equipment requirements are:

- A PC running ULTRA Master
- The Terminal mode available in Microsoft® Windows™.

1. Close all ULTRA Master windows.
2. Select **Communication** from ULTRA Master and verify your communication settings.
3. Verify the communication cable pin out and check cable continuity. Refer to “RS-232 Connection Diagrams” on page 6-34.
4. If the communication cable is OK, do the following:

   A. Disconnect the communication cable from the drive (but leave the cable connected to the PC).

   B. Jumper pins 2 and 3 on the D connector of the communication cable.

   C. Close and exit from ULTRA Master.

   D. Select the **Terminal** from the Program Manager (Terminal is usually in the Accessories group).

   E. Select **Settings** from the Main menu:

   – Select **Terminal Emulation** from the drop down menu,
   – Choose **DEC VT-100,**
   – Choose **OK** to close the dialog box.

   F. Select **Settings** from the Main menu

   – Select **Communications** from the drop down menu
   – Choose **COM1** (or the number of the communication port the drive is connected to) from the Connections sliding list.
   – Set Baud Rate to **9600**
   – Set Data Bits to **8**
   – Set Stop Bits to **1**
   – Set Parity to **NONE**
   – Set Flow Control to **XON/XOFF**
   – Choose **OK** to close the dialog box.

5. Type any character on the keyboard. The character should echo back on the screen.

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If you see the character on the screen remove the jumper between pins 2 and 3, close the Windows Terminal and restart ULTRA Master.

If the character does *not* echo back on the screen, do the following:

- Disconnect the cable from your PC.
- Jumper Pins 2 and 3 on the communication port of the PC.
- Type any character on the keyboard.

  – If the character echoes back, the communication port is OK and the cable or the connectors are defective. Replace the communication cable assembly.
  – If the character did *not* echo back, the communication port is defective. Replace the communication port.

Testing Digital Outputs

This test verifies the functionality of the selectable outputs.

Test equipment requirements are:

- A PC running ULTRA Master
- A multimeter.

This test assumes there are no error codes displayed, and the I/O power supply (internal for 1398-DDM-010, -020, -030 or -075 and external for 1398-DDM-005, -005X, -009, -009X, -019 or -019X) for the drive is connected correctly.



Note: Disconnect the outputs from any external hardware while performing this test.

1. Disable the drive by opening the switch connecting J1-26 and J1-20.
2. From the Drive Window select the **Output Diagnostics** command icon.
3. Verify each of the Digital Outputs in the Output Diagnostics window registers the appropriate readings on a multimeter when the following values are set:



Note: This test assumes that I/O power is 24 VDC.

   A. Drive Ready box, then measure the resistance between J1-24 and J1-25.

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– If the box is checked, the resistance should read approximately 1 Ohm.
– If the box is not checked, the resistance should read very high (> 1 MOhm).

B. Brake Enable box, then measure the resistance between J1-49 and J1-50.

– If the box is checked, the resistance should read approximately 1Ohm.
– If the box is not checked, the resistance should be very high (> 1 MOhm).

A load is necessary to test the transistor outputs listed below. A 1 kOhm resistor may be connected from the transistor output (J1-42, J1-43, J1-44 or J1-45) to the I/O COM (J1-6).

C. Digital Output 1, then measure the voltage between J1-42 and J1-13.

– If the box is checked, the voltmeter should read approximately +24 VDC.
– If the box is not checked, the voltmeter should read approximately 0 VDC.

D. Digital Output 2, then measure the voltage between J1-43 and J1-13.

– If the box is checked, the voltmeter should read approximately +24 VDC.
– If the box is not checked, the voltmeter should read approximately 0 VDC.

4. After the test has been completed you may select Close to exit Output Diagnostics window.

If you determine that a digital output is defective, refer to “Return Procedure” on page Help-7 to return the unit.

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Testing Digital Inputs

This test verifies the functionality of the selectable inputs.

Note: This test assumes that I/O power is 24 VDC.

Test equipment requirements are:

- A PC running ULTRA Master
- A jumper wire.

It assumes there are no error codes displayed, and the 24V power supply is connected correctly.

1. Disable the drive by opening the switch connecting J1-26 and J1-20.
2. Choose the I/O Display command icon from the Drive Window.
   - **A.** Connect J1-20 to J1-26. The Enable indicator activates.
   - **B.** Connect J1-21 to J1- 26. The Reset Faults indicator activates.
   - **C.** Connect J1-31 to J1-26. The Input 1 indicator activates.
   - **D.** Connect J1-32 to J1-26. The Input 2 indicator activates.
   - **E.** Connect J1-33 to J1-26. The Input 3 indicator activates.
3. Choose **Close** to exit the I/O Display window.

If you determine that a digital input is defective, please refer to “Return Procedure” on page Help-7 to return the unit for repair.

Testing Analog Output

The following tests verify the functionality of the analog outputs.

Note: This test assumes that I/O power is 24 VDC.

Test equipment requirements are:

- A PC running ULTRA Master
- A voltmeter.

Testing Analog Output 1

1. Disable the drive, by opening the connections between the ENABLE input and the I/O Power (I/O PWR).
2. Disconnect the connections to J1-31.
3. Select **Output Diagnostics** icon from the Drive Window.

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4. From the Output Diagnostics window select **Analog Output 1**.
5. Enter 1000 in the D/A level box.
6. Connect a DC voltmeter across analog test points J1-31 and J1-28. The meter should read approximately 1 Vdc.
7. Repeat step using different positive or negative values for the D/A Level. Verify the meter reads the values you enter.

If you determine that the output is defective, please refer to “Return Procedure” on page Help-7 to return the unit.

Testing Analog Input

The following test verifies the functionality of the analog input.

Note: This test assumes that I/O power is 24 VDC.

The tests require:

- a PC running ULTRA Master, and
- a 10 kOhm potentiometer.

Testing the Current Limit Input

1. Verify the accuracy of the potentiometer with an ohmmeter before installing.
2. Disable the drive by opening the connections between the ENABLE input and the I/O Power (I/O PWR).
3. Disconnect the connections to J1-27 and J1-28.
4. Connect the 10K potentiometer between J1-27 and J1-28. Refer to “J1 – Controller” on page 6-1 for a diagram showing the location of the pins.
5. Choose the **Drive Signals** command icon from ULTRA Master.
6. Choose **Set Up**, if the Drive Signals Set Up window is not already active.
7. Choose **Current - Input Limit +** as the analog signal.
8. Choose **OK** to close the Set Up window and activate the Drive Signals window.
9. Slowly adjust the potentiometer while viewing the Drive Signals window. The Current - Input Limit + value should update as the potentiometer is adjusted.

If you determine that the analog input is defective, refer to “Return Procedure” on page Help-7 to return the unit.

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Testing Encoder Inputs

The following test verifies both reception and transmission of the line count from an encoder by the drive.

Note: This test assumes that I/O power is 24 VDC.

The tests require:

- a PC running ULTRA Master, and
- a motor encoder.

Testing Encoder Inputs

1. Disable the drive by opening the connections between the ENABLE input and I/O Power (I/O PWR).
2. Choose the **Drive Set Up** command icon from ULTRA Master.
3. Choose **Divide by 1** as the Motor Encoder Output Signal.
4. Make the following hardware connections:
   - Connect the motor encoder to J2.
   - Jumper the Auxiliary Encoder Inputs to the Motor Encoder Outputs by connecting the following pins:

J1-7 to J1-14	J1-10 to J1-17
J1-8 to J1-15	J1-11 to J1-18
J1-9 to J1-16	J1-12 to J1-19

5. Choose the **Encoder Diagnostics** command icon from ULTRA Master.
6. Choose **Zero Count** for both the Motor Encoder and Master Position Input.
7. Slowly rotate the encoder shaft by hand while observing the counts for both the Motor Encoder and Master Position Input. The Motor Encoder and Master Position Input line counts should be equal.

If you determine that the analog input is defective, refer to “Return Procedure” on page Help-7 to return the unit.

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Options and Accessories

ULTRA 100 Series drives conformance to the European Union Directives is contingent on:

1. Installation of AC line filters between the power source and the drive, and
2. Use of factory supplied cables to connect F-, H-, LD- N-, S-, W- or Y-Series motors to a drive. Diagrams and schematics for all Rockwell Automation cables are shown in Cable Diagrams, Schematics and Examples, beginning on page B-1.

ULTRA 100 Series Drives

	Description
1398-DDM-005	500 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-005X	500 Watt Universal Indexing Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-009	1000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-009X	1000 Watt Universal Indexing Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-019	2000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-019X	2000 Watt Universal Indexing Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-010	1000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-020	2000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-030	3000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-075	7500 Watt Universal Drive, single or three phase 100-240 VAC @ 50/60 Hz

Fuses

Description	Part Number
1 Ampere, fast acting, inline for 1398-DDM-010, -020, -030 or -075 (Littelfuse R451001, or equivalent)	0006-9071-001
Fuse for 1398-DDM-010, -020, -030 or -075 External Shunt Resistor (Littelfuse CCMR-4.5 or equivalent)	0006-9070-001

Options and Accessories

Interface Cables

Diagrams and schematics for these cables are shown beginning on page B-3.

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Description	Part Number
TouchPad	9101-1386
AC Line Filter for 1398-DDM-005 or -005X (6 A_{rms} continuous, single phase)	9101-1516
AC Line Filter for 1398-DDM-009, -009X or -010 (10 A_{rms} continuous, single phase)	9101-1517
AC Line Filter for 1398-DDM-019, -019X or -020 (23 A_{rms} continuous, single phase)	9101-1518
AC Line Filter for 1398-DDM-030 (30 A_{rms} continuous, single phase)	9101-1387
AC Line Filter for 1398-DDM-075 (55 A_{rms} continuous, single phase)	9101-1388
AC Line Filter for 1398-DDM-075 (36 A_{rms} continuous, three phase)	9101-1389
J1 to 50-pin Terminal Strip (breakout board), includes 1m (3 ft) cable and mounting hardware	9101-1391
J1 to 50-pin Terminal Strip (breakout board), includes 3m (10 ft) cable and mounting hardware	9101-1560
J2 to 25-pin Terminal Strip (breakout board), includes 1m (3 ft) cable and mounting hardware	9101-1392
DDM-010/020/030 External Shunt Resistor	9101-1183
Fuse for 1398-DDM-010/020/030 External Shunt Resistor (Littelfuse CCMR-4.5)	0006-9070-001
Manuals	
TouchPad Instructions	0013-1039
ULTRA 100 Series Installation Manual for 1398-DDM-010, -020, -030 or -075	0013-1040
ULTRA 100 Series Installation Manual for 1398-DDM-005,-005X, -009, -009X, -019 or -019X	0013-1044

Description		Part Number
J1 to customer supplied connector (no connector)	3 m (10 ft)	9101-1370-010
	7.6 m (25 ft)	9101-1370-025
	15 m (50 ft)	9101-1370-050
	23 m (75 ft)	9101-1370-075
J3 to customer supplied connector (no connector) (1398-DDM-010, -020, -030 and -075 only)	3 m (10 ft)	9101-1368-010
	7.6 m (25 ft)	9101-1368-025
	15 m (50 ft)	9101-1368-050
	23 m (75 ft)	9101-1368-075
J3 to J3 Master/Follower (1398-DDM-010, -020, -030 and -075 only)	0.6 m (2 ft)	9101-1463-002
J2 to 50-pin D-connector (for 50-pin terminal block)	1 m (3 ft)	9101-1369-003
J2 to 50-pin D-connector (for 50-pin terminal block)	3 m (10 ft)	9101-1369-010

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Serial Interface Cables

Diagrams and schematics for these cables are shown beginning on page B-11.

Description		Part Number
J4/J5 to PC [RS-232] (9 pin D-shell connector)	3 m (10 ft)	9101-1372-010
	7.6 m (25 ft)	9101-1372-025
	15 m (50 ft)	9101-1372-050
J4/J5 to customer supplied connector (no connector)	3 m (10 ft)	9101-1379-010
	7.6 m (25 ft)	9101-1379-025
	15 m (50 ft)	9101-1379-050
J4/J5 to J4/J5 four wire RS-485 communications	1m (3ft)	9101-1374-001
J4/J5 D-shell 9-pin Mating Connector (AMP 205204-4)		0003-5529-001
J4/J5 Crimp Pins for Connector (AMP 66506-3)		0003-5326-001

Encoder Feedback Cables

Diagrams and schematics for these cables are shown beginning on page B-14.

Description		Part Number
F-, H- or S- Series Motors to customer supplied connector (i.e., no connector)	3 m (10 ft)	9101-1365-010
	7.6 m (25 ft)	9101-1365-025
	15 m (50 ft)	9101-1365-050
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	23 m (75 ft)	9101-1365-075
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	30 m (100 ft)	9101-1365-100
F-, H- or S- Series Motors to J2	3 m (10 ft)	9101-1366-010
	7.6 m (25 ft)	9101-1366-025
	15 m (50 ft)	9101-1366-050
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	23 m (75 ft)	9101-1366-075
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	30 m (100 ft)	9101-1366-100
N- Series Motors to customer supplied connector (no connector)	3 m (10 ft)	9101-1469-010
	7.6 m (25 ft)	9101-1469-025
	15 m (50 ft)	9101-1469-050
	23 m (75 ft)	9101-1469-075
	30 m (100 ft)	9101-1469-100
N- Series Motors to J2	3 m (10 ft)	9101-1468-010
	7.6 m (25 ft)	9101-1468-025
	15 m (50 ft)	9101-1468-050
	23 m (75 ft)	9101-1468-075
	30 m (100 ft)	9101-1468-100
LD-Series and Y-Series Motors to customer supplied connector (no connector)	3 m (10 ft)	9101-1373-010
	7.6 m (25 ft)	9101-1373-025
	15 m (50 ft)	9101-1373-050
(1398-DDM-005, -009 and -019 require Rev D or higher cable)	23 m (75 ft)	9101-1373-075

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Description		Part Number
(1398-DDM-005, -009 and -019 require Rev D or higher cable)	30 m (100 ft)	9101-1373-100
LD-Series and Y-Series Motors to J2	0.6 m (2 ft)	9101-1375-002
	3 m (10 ft)	9101-1375-010
	7.6 m (25 ft)	9101-1375-025
	15 m (50 ft)	9101-1375-050
(1398-DDM-005, -009 and -019 require Rev D or higher cable)	23 m (75 ft)	9101-1375-075
J2 to customer supplied connector (no connector)	3 m (10 ft)	9101-1380-010
	7.6 m (25 ft)	9101-1380-025
	15 m (50 ft)	9101-1380-050
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	23 m (75 ft)	9101-1380-075
(1398-DDM-005, -009 and -019 require Rev C or higher cable)	30 m (100 ft)	9101-1380-100

Motor Power Cables

Diagrams and schematics for these cables are shown beginning on page B-21 .

Description		Part Number
Drive to 2000 or 3000 Motors (H- or S-Series)	3 m (10 ft)	9101-1381-010
	7.6 m (25 ft)	9101-1381-025
	15 m (50 ft)	9101-1381-050
	23 m (75 ft)	9101-1381-075
	30 m (100 ft)	9101-1381-100
Drive to 4000 Motors (F-, H- or S-Series)	3 m (10 ft)	9101-1382-010
	7.6 m (25 ft)	9101-1382-025
	15 m (50 ft)	9101-1382-050
	23 m (75 ft)	9101-1382-075
	30 m (100 ft)	9101-1382-100
1398-DDM-030 or 1398-DDM-075 to 6000 Motors (F-, H- or S-Series)	3 m (10 ft)	9101-1383-010
	7.6 m (25 ft)	9101-1383-025
	15 m (50 ft)	9101-1383-050
	23 m (75 ft)	9101-1383-075
	30 m (100 ft)	9101-1383-100
1398-DDM-075 to 6000 Motors (F-, H- or S-Series) **NOTE:** This cable is *not* CE marked	3 m (10 ft)	9101-2179-010
	7.6 m (25 ft)	9101-2179-025
	15 m (50 ft)	9101-2179-050
	23 m (75 ft)	9101-2179-075
1398-DDM-150 to 6000 Motors (F-, H- or S-Series)	3 m (10 ft)	9101-1399-010
	7.6 m (25 ft)	9101-1399-025
	15 m (50 ft)	9101-1399-050
	23 m (75 ft)	9101-1399-075
	30 m (100 ft)	9101-1399-100

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Description		Part Number
1398-DDM-150 to 8000 Motors (F-, H- or S-Series)	3 m (10 ft)	9101-1384-010
	7.6 m (25 ft)	9101-1384-025
	15 m (50 ft)	9101-1384-050
	23 m (75 ft)	9101-1384-075
	30 m (100 ft)	9101-1384-100
Drive to N-Series Motors	3 m (10 ft)	9101-1467-010
	7.6 m (25 ft)	9101-1467-025
	15 m (50 ft)	9101-1467-050
	23 m (75 ft)	9101-1467-075
	30 m (100 ft)	9101-1467-100
Drive to LD-Series and Y-Series Motors	0.6 m (2 ft)	9101-1385-002
	3 m (10 ft)	9101-1385-010
	7.6 m (25 ft)	9101-1385-025
	15 m (50 ft)	9101-1385-050
	23 m (75 ft)	9101-1385-075
	30 m (100 ft)	9101-1385-100

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Connector Kits

Connector kits provide the ability to construct custom length cables. Kits are available for all ULTRA 100 Series connectors. Each kit consists of the appropriate 3M connector with the corresponding plastic backshell, and instructions.

Connector	Type	Part Number
J1	50 pin mini D-shell, 24-30 AWG cable solder cup, squeeze latch	9101-1476
J2	20 pin mini D-shell, 24-30 AWG cable solder cup, squeeze latch	9101-1477
J3	26 pin mini D-shell, 24-30 AWG cable solder cup, squeeze latch	9101-1478
J4 or J5	9 pin D-shell for RS-232 or RS-485	9101-1479

Mating Connectors

The following connectors are listed solely to provide a cross-reference of mating connectors for the J1, J2 or J3 connectors on the ULTRA 100 Series drives. ULTRA 100 Series drive conformance to the European EMC Directive is contingent on the use of Rockwell Automation cables.

These connectors are *not* available from Rockwell Automation. Please contact the manufacturer or a distributor for additional information. Manufacturer phone numbers are: 3M 1-800-225-5373 and AMP 1-800-522-6752

1398-DDM	Mating Connector	Mating Backshell	Description
J1	AMP 2-175677-7	AMP 176793-7	50-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Plastic Backshell, Squeeze Latch
	3M 10150-6000EC[1]	3M 10350-A200-00	50-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Metal Backshell, Squeeze Latch
	3M 10150-3000VE	3M 10350-52F0-008	50-pin Mini D Ribbon, 24-30 AWG, Solder Cup, Plastic Backshell, Squeeze Latch
J2	AMP 2-175677-2	AMP 176793-2	20-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Plastic Backshell, Squeeze Latch
	3M 10120-6000EC[1]	3M 10320-A200-00	20-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Metal Backshell, Squeeze Latch
	3M 10120-3000VE	3M 10320-52F0-008	20-pin Mini D Ribbon, 24-30 AWG, Solder Cup, Plastic Backshell, Squeeze Latch
J3	AMP 2-175677-4	AMP 176793-4	26-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Plastic Backshell, Squeeze Latch
	3M 10126-6000EC[1]	3M 10326-A200-00	26-pin Mini D Ribbon, 28-30 AWG, Insulation Displacement, Metal Backshell, Squeeze Latch
	3M 10126-3000VE	3M 10326-52F0-008	26-pin Mini D Ribbon, 24-30 AWG, Solder Cup, Plastic Backshell, Squeeze Latch

1. For use with MDR Hand Press Tool Kit, 3M part number 3829

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Cable Diagrams, Schematics and Examples

Factory supplied cables allow ULTRA 100 Series drives to conform to the European Union Directives when connecting the drive to motors, controllers or computers. The following diagrams provide information on the cables available from the factory.

Refer to Appendix A, “Options and Accessories” for ordering information.

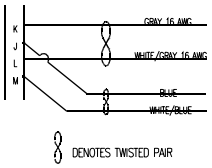
The information below applies to all factory supplied cables.

- Wire Insulation Type: Polyvinyl Chloride
- Conductor size: 0.08 mm^2 (28 AWG) tinned copper, except as noted below.
  [0.25 mm^2 (24 AWG) on 9101-1372, 9101-1374 and 9101-1379]
  [1.5 mm^2 (16 AWG) on 9101-1190, 9101-1381, 9101-1385 and 9101-1467]
  [2.5 mm^2 (14 AWG) on 9101-1191 and 9101-1382]
  [6 mm^2 (10 AWG) on 9101-1192 and 9101-1383]
  [10 mm^2 (8 AWG) on 9101-1384 and 9101-1399]
  [16 mm^2 (6 AWG) on 9101-1193]
- Braid Shield Coverage: 85% minimum
- Jacket Material: Thermoplastic elastomer
- Moldings: 105°C (221°F) Black PVC
- Minimum Bend Radius

Control Cables		Motor Power Cables	
Connector	mm (in.)	Cable	mm (in.)
Controller (J1)	171.45 (6.75)	9101-1190	91.70 (3.6)
Encoder (J2)	129.54 (5.10)	9101-1191	98.80 (3.9)
		9101-1192	156.00 (6.1)
		9101-1193	226.80 (8.9)
		9101-1381	91.70 (3.6)
		9101-1382	98.80 (3.9)
		9101-1383	156.00 (6.1)
		9101-1384	226.80 (8.9)
		9101-1385	106.70 (4.2)
		9101-1399	189.25 (7.5)
		9101-1467	91.70 (3.6)

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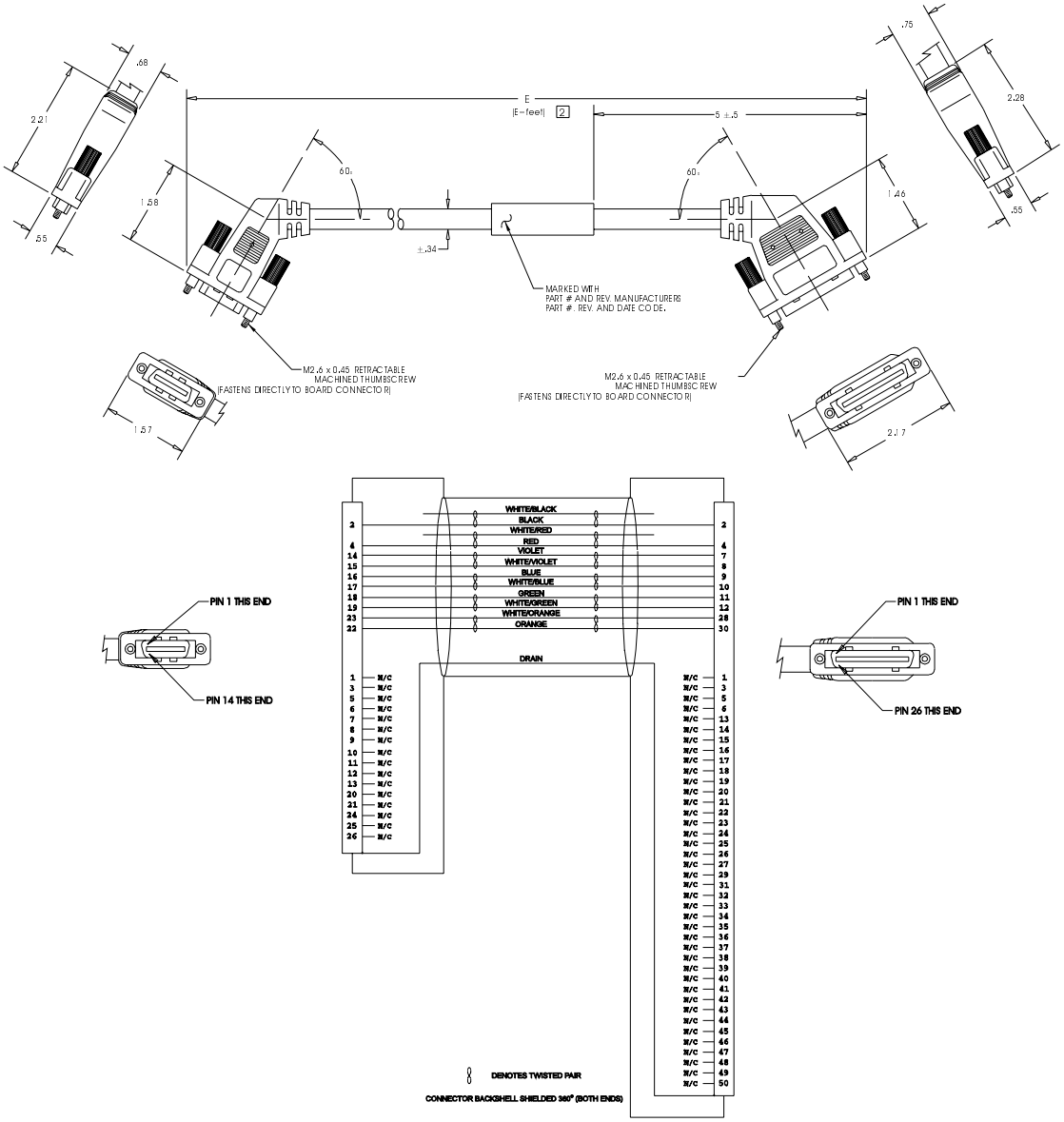
- Cables are manufactured to inch dimensions. Millimeter dimensions are approximate conversions from inches.
- Alternate field wiring diagram for F-, H-, or N-Series encoder cables is shown below:



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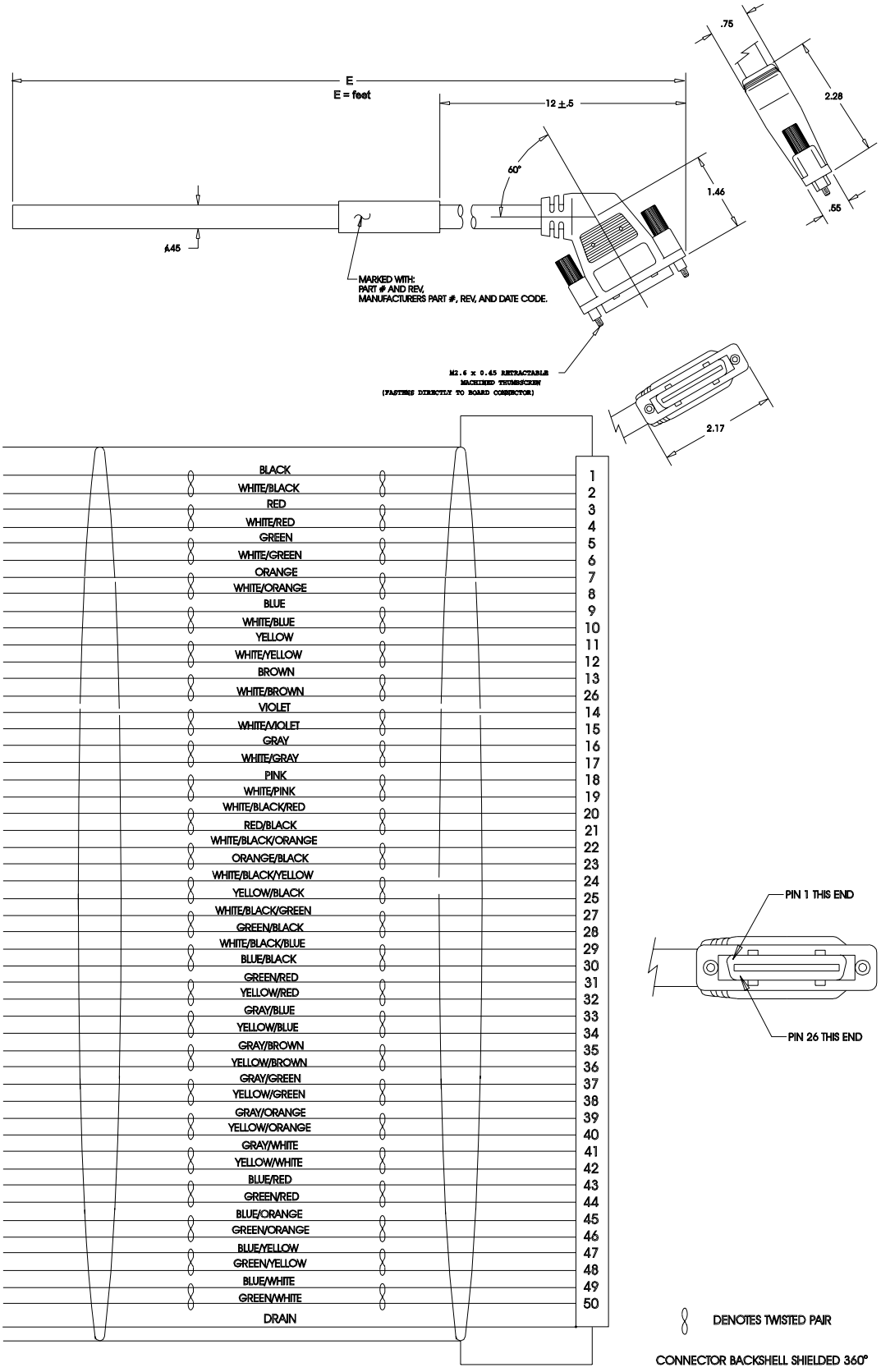
Interface Cables

Figure B.1 J1 to J3 Interface Cable (P/N 9101-1367)



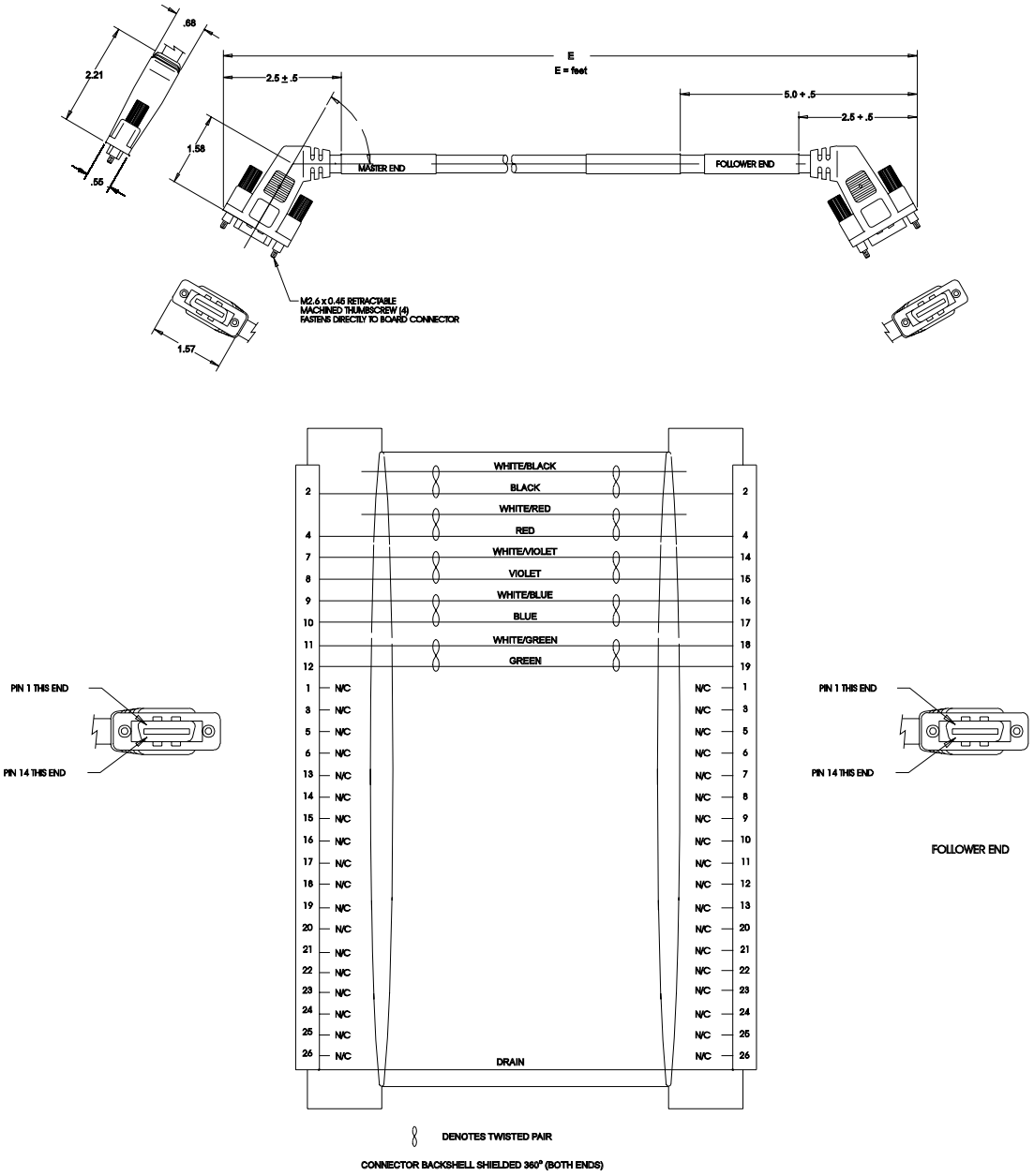
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Figure B.2 J1 to No Connector Interface Cable (P/N 9101-1370)



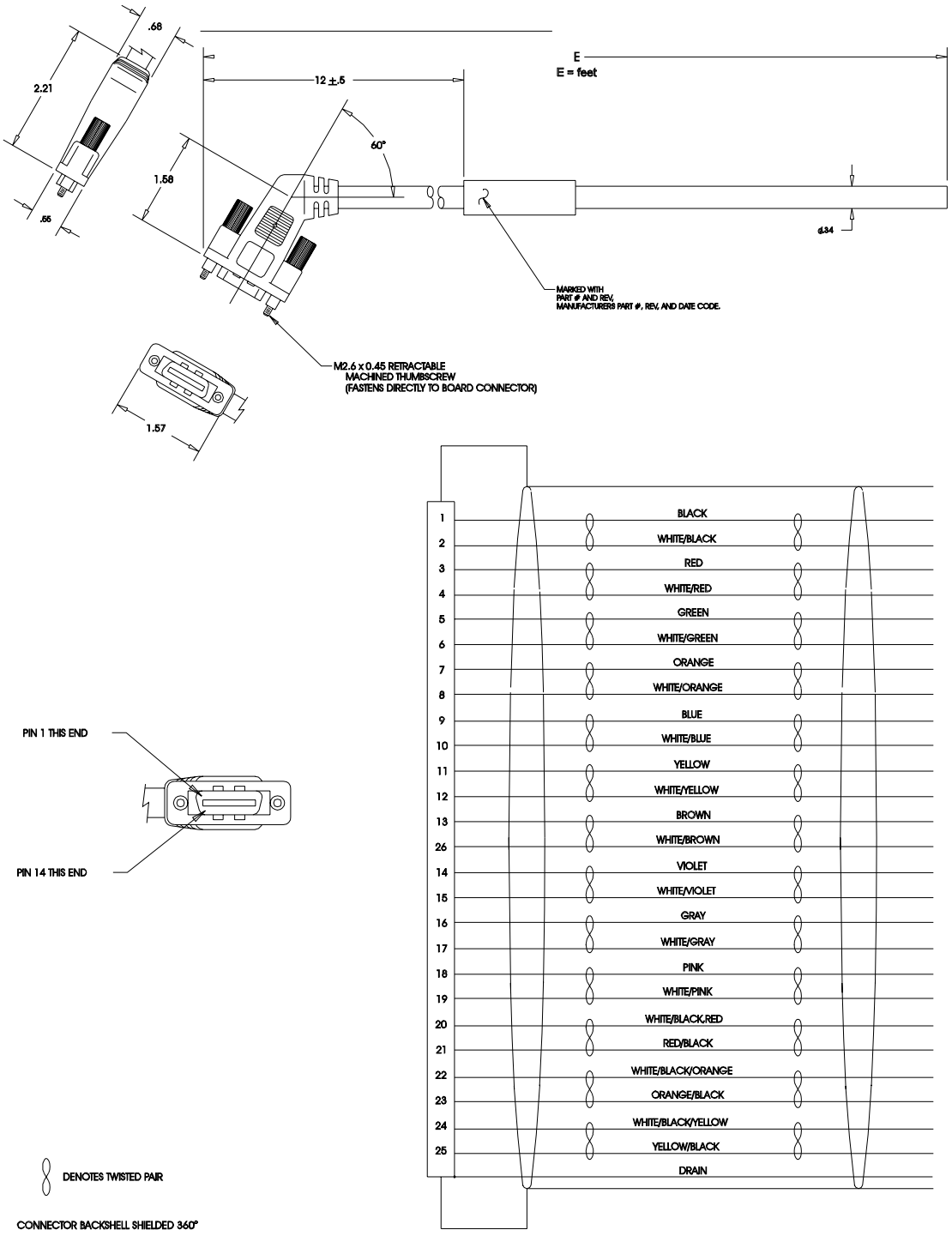
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Figure B.3 J3 to J3 Interface Cable (P/N 9101-1463)



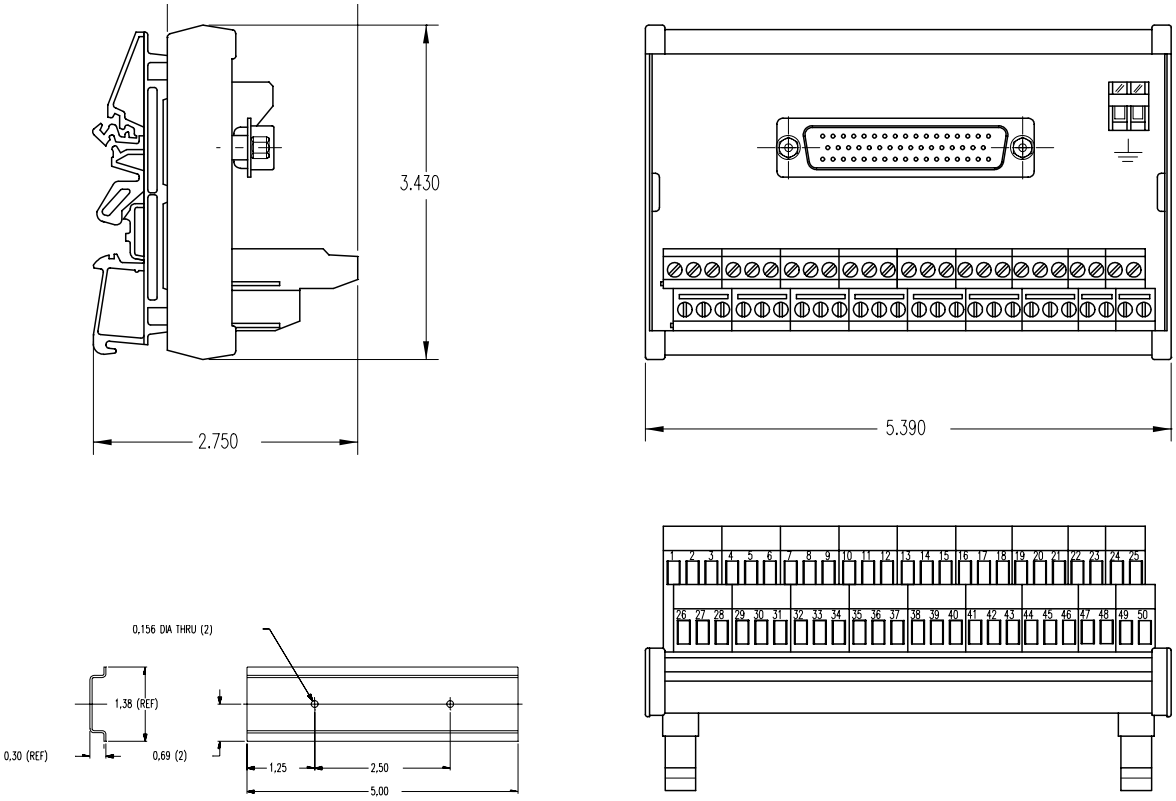
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Figure B.4 J3 to No Connector Interface Cable (P/N 9101-1368)



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Figure B.5 J1 to 50-pin Terminal Block Kit Diagram (P/N 9101-1391 and 9101-1560)

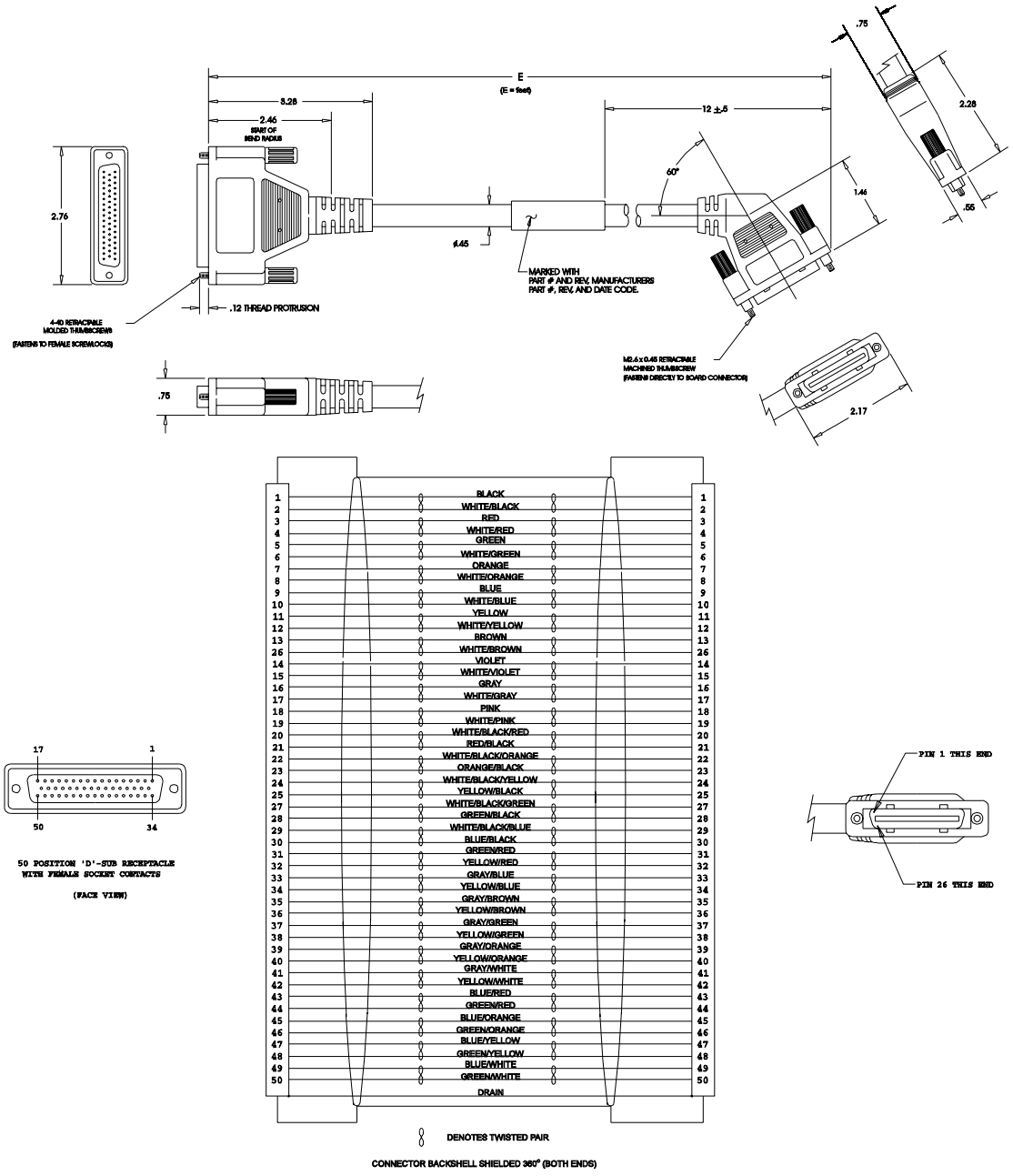


Mounting bracket 0002-7069 (shown) and cable 9101-1369-003 supplied with 9101-1391 kit.
Mounting bracket 0002-7069 (shown) and cable 9101-1369-010 supplied with 9101-1560 kit.

NOTES:
The terminal block and cable provide a one-to-one transfer of the signals from the connector to the respective pin(s) on the terminal block.
The cabling examples beginning on page B-24 depict the use of this kit to pass a cable through a restricted bulkhead.

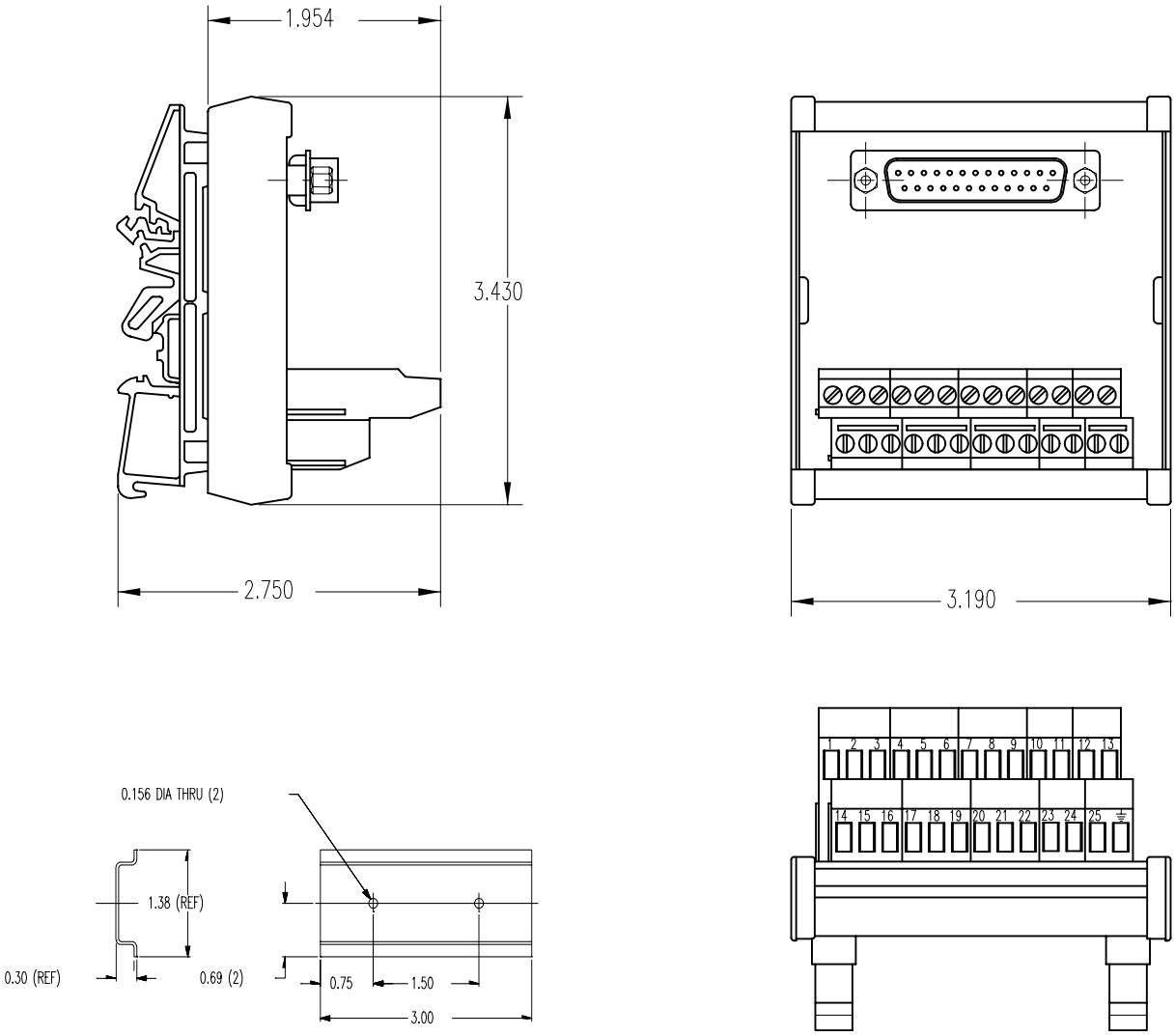
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Figure B.6 J1 to 50-pin D-Connector Cable (P/N 9101-1369)



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Figure B.7 J2 to 25-pin Terminal Block Kit Diagram (P/N 9101-1392)

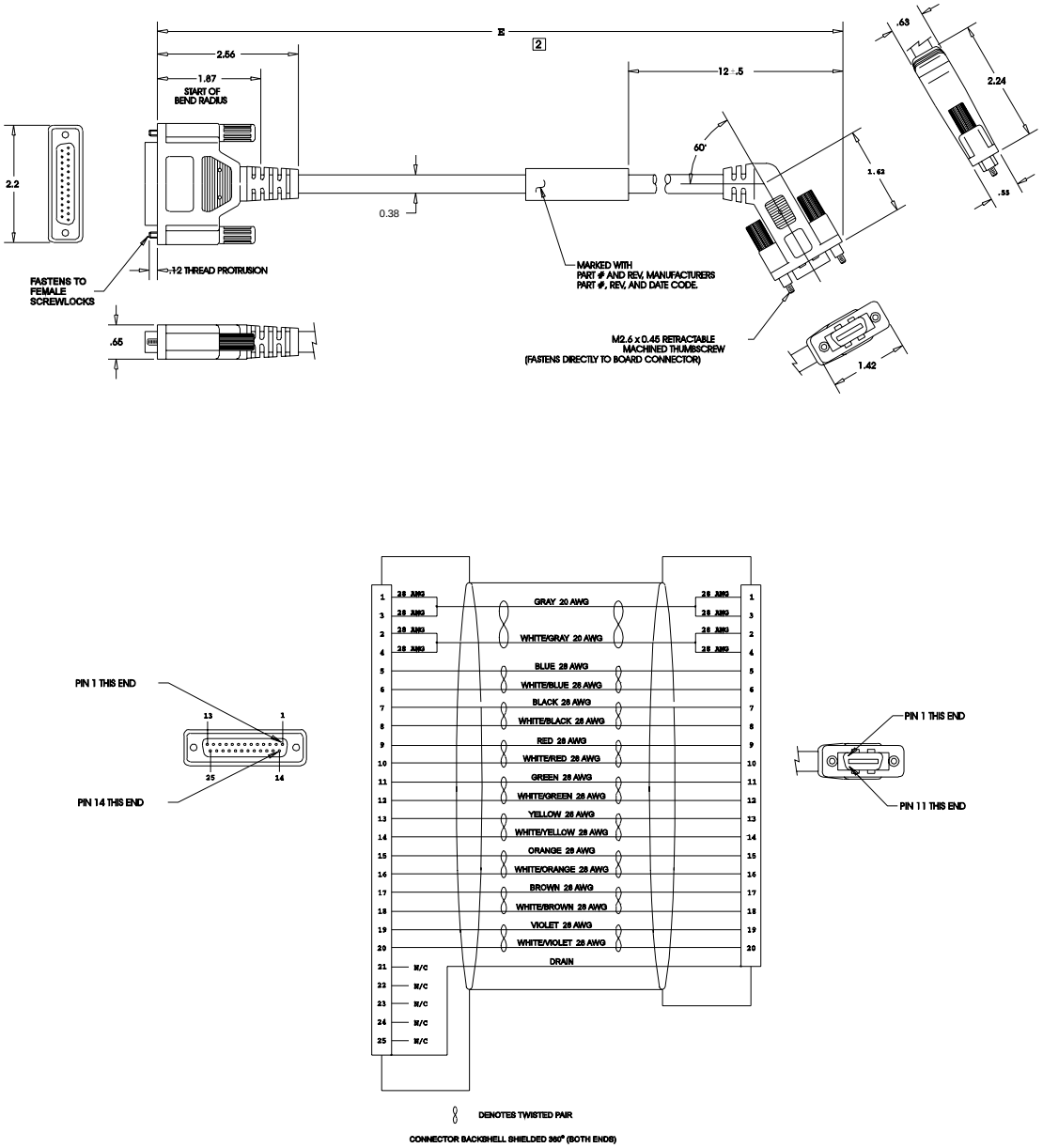


Mounting bracket 0002-7068 (shown) and cable 9101-1371-003 (next page) supplied with kit.

NOTES:
The terminal block and cable provide a one-to-one transfer of the signals from the connector to the respective pin(s) on the terminal block.
The cabling examples beginning on page B-24 depict the use of this kit to pass a cable through a restricted bulkhead.

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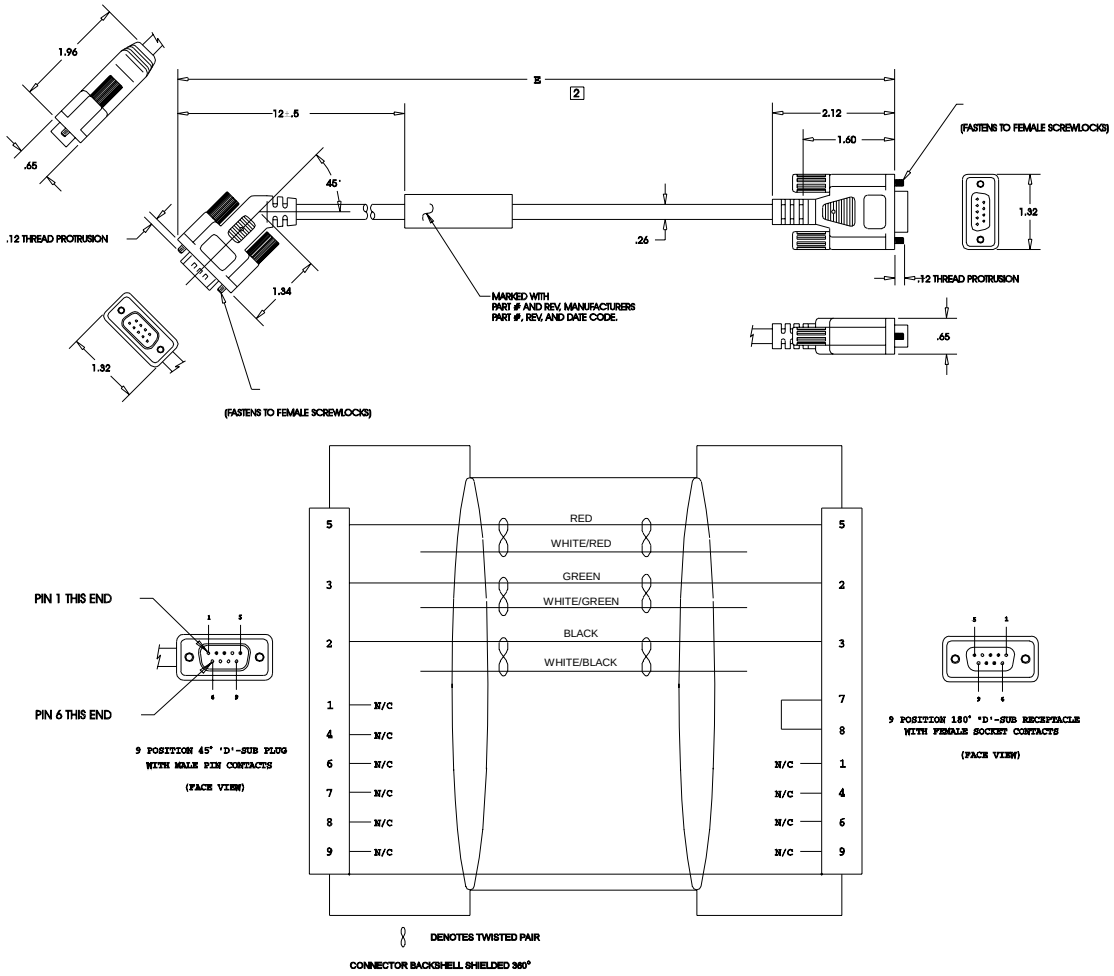
Figure B.8 J2 to 25-pin D-Connector Cable (P/N 9101-1371)



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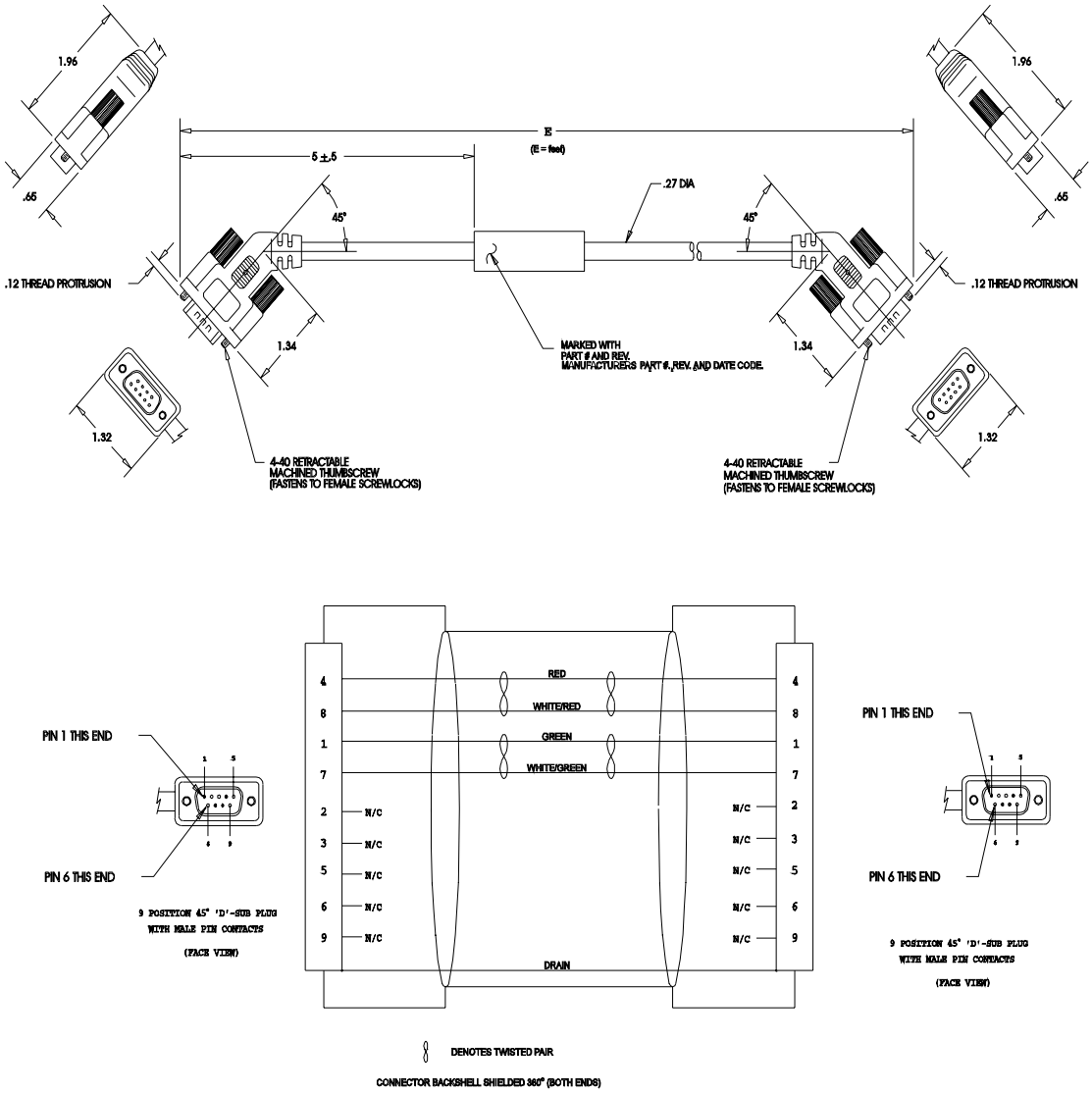
Serial Interface Cables

Figure B.9 J5 to 9-pin D-Shell Interface Diagram (P/N 9101-1372)



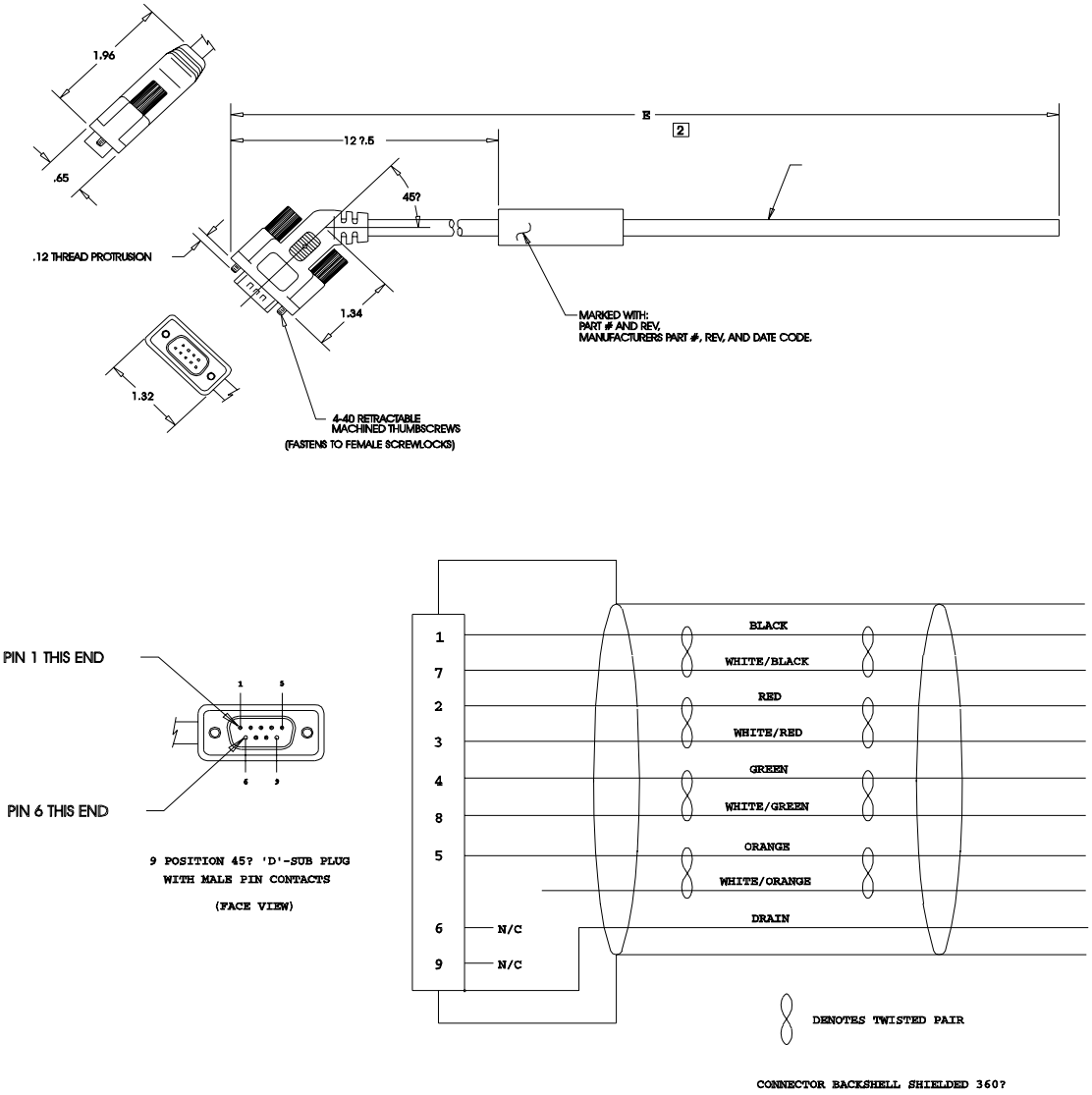
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Figure B.10 J5 to J5 Serial Interface Cable (P/N 9101-1374)



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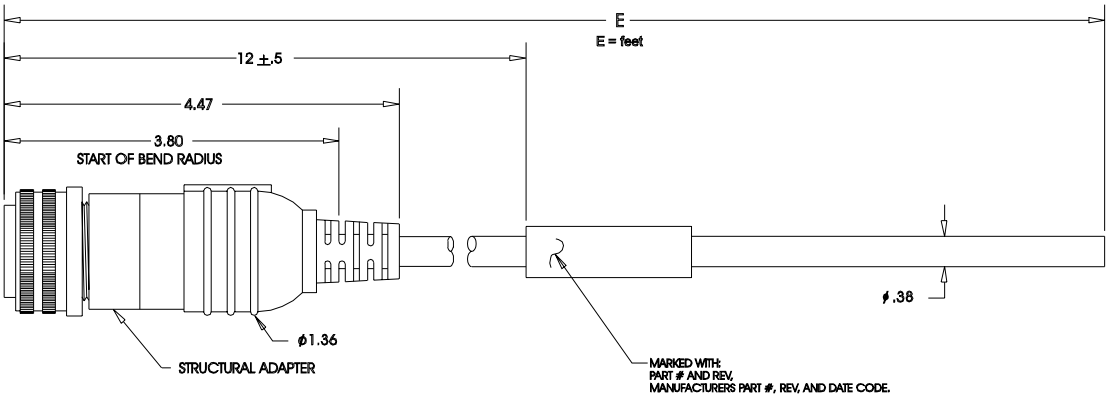
Figure B.11 J5 to No Connector Serial Interface Cable (P/N 9101-1379)

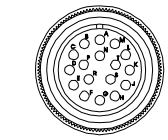


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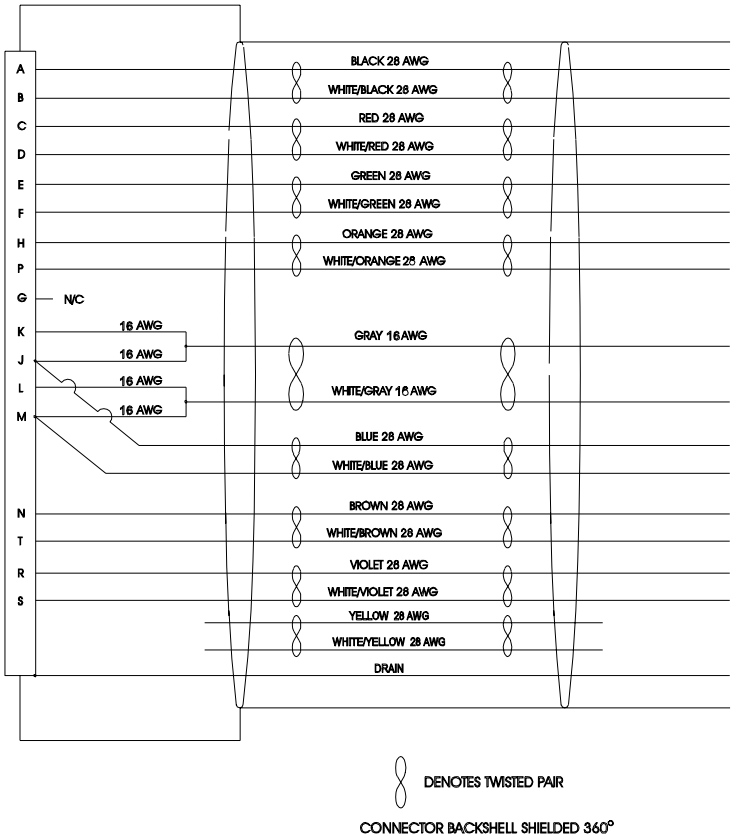
Encoder Feedback Cables

Figure B.12 F- or H-Series Motors to No Connector Encoder Cable (P/N 9101-1365)



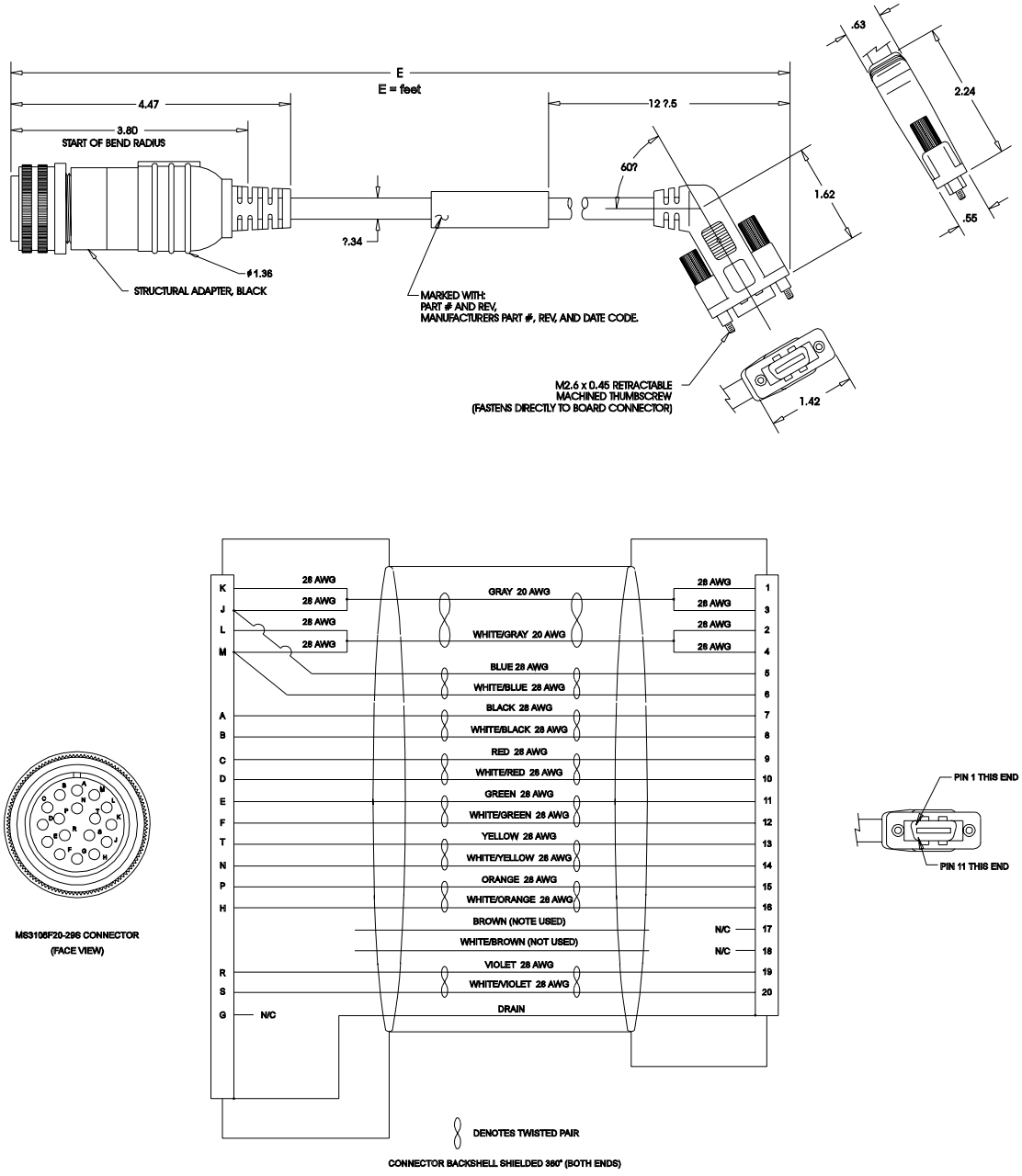


MS3106F20-29S CONNECTOR
(FACE VIEW)



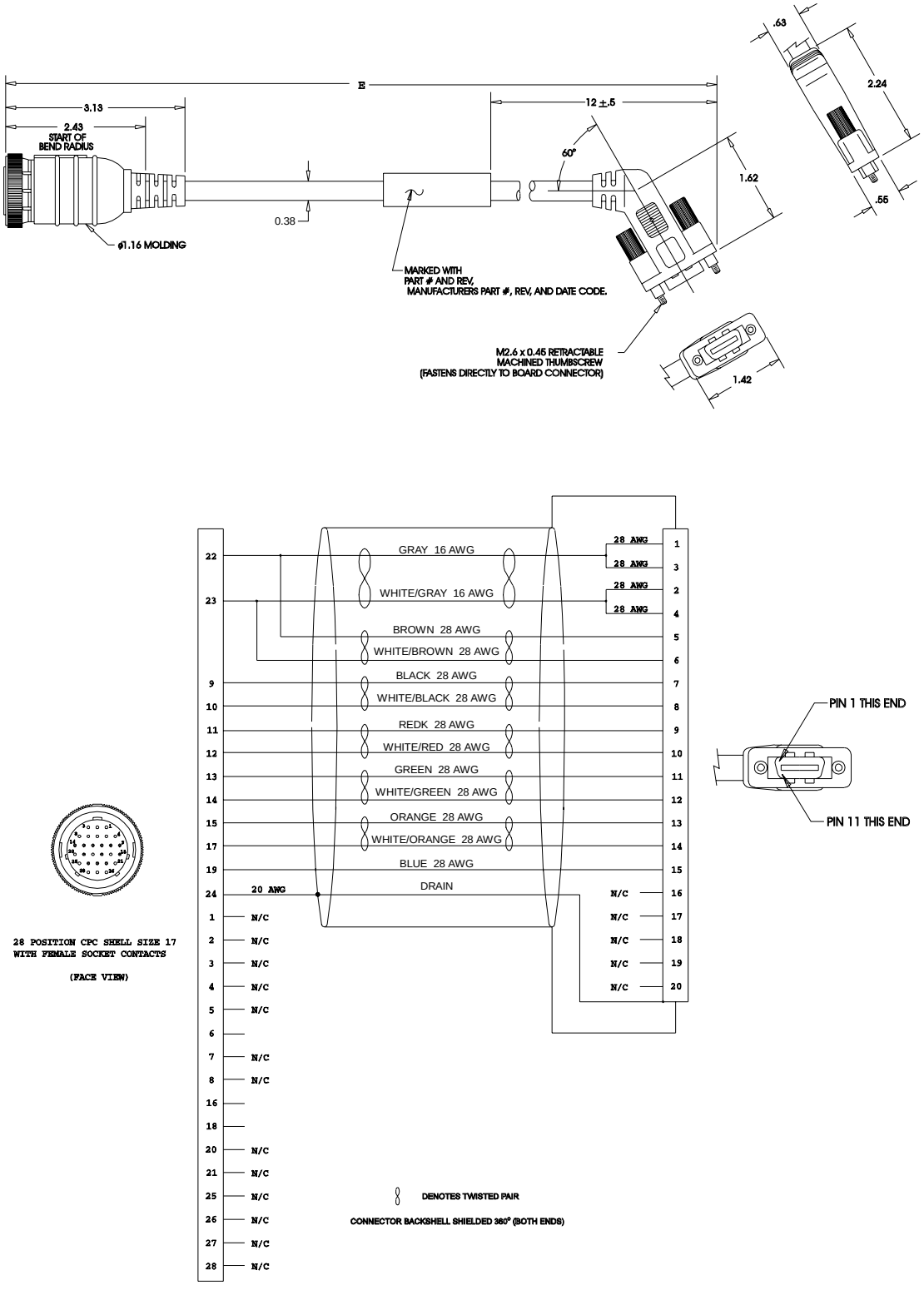
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Figure B.13 J2 to F- or H-Series Encoder Cable (P/N 9101-1366)



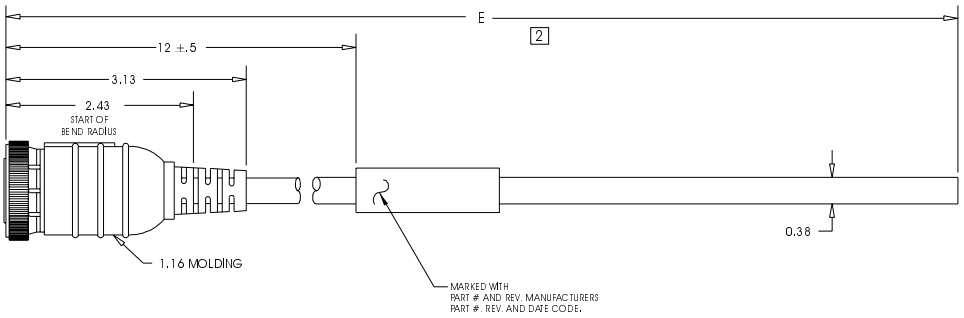
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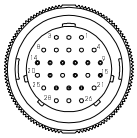
Figure B.14 J2 to Y-Series Encoder Cable (P/N 9101-1375)



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Figure B.15 No Connector to Y-Series Encoder Cable (P/N 9101-1373)

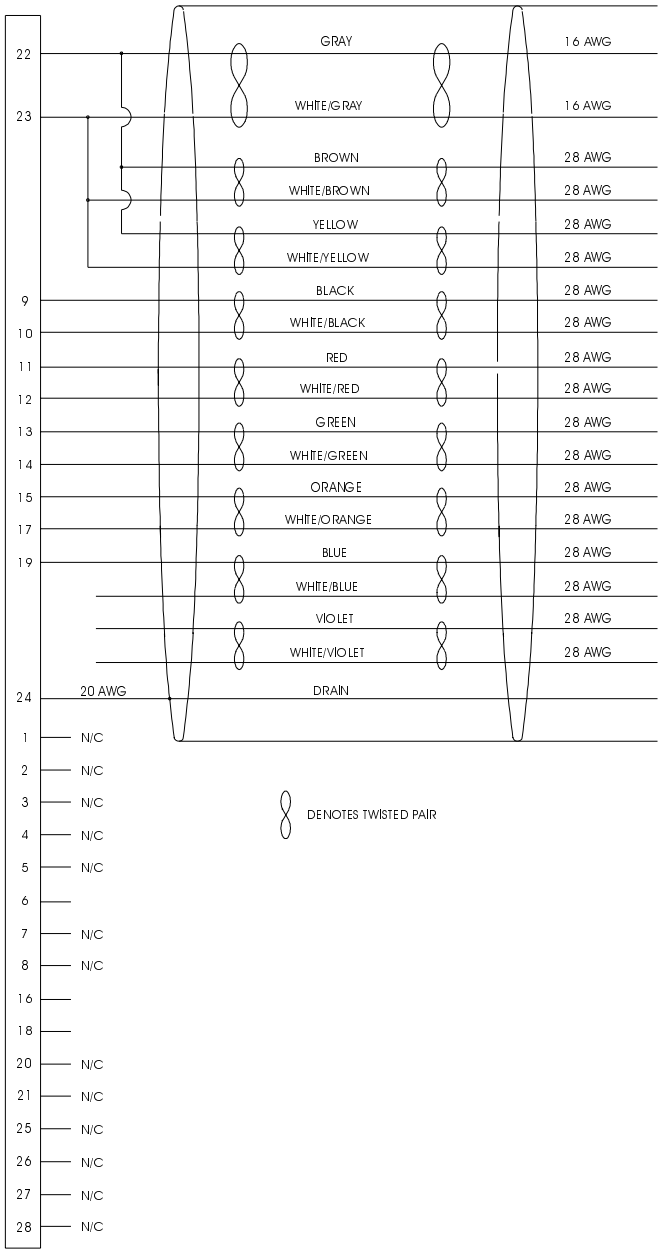




28 POSITION CPC SHELL SIZE 17
WITH FEMALE SOCKET CONTACTS

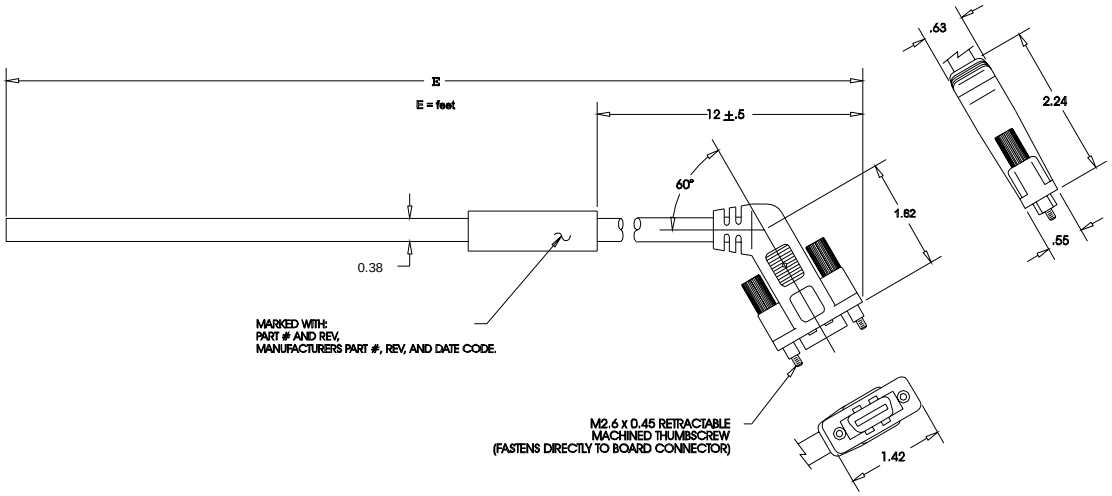
(FACE VIEW)

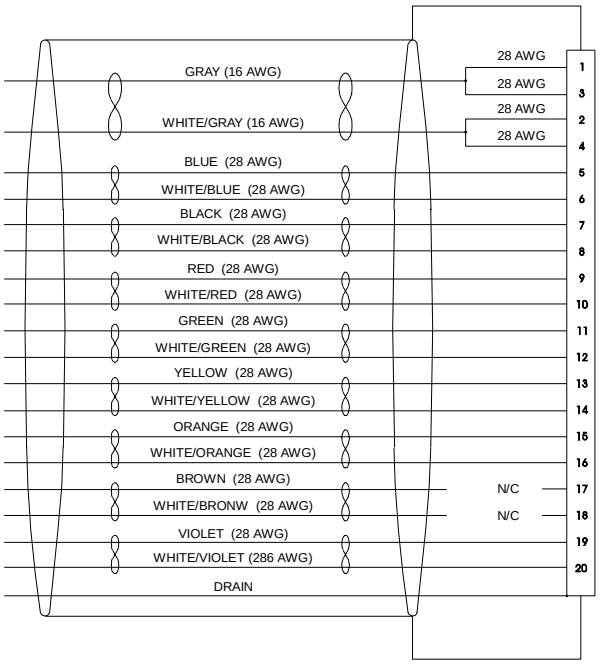
WIRING DIAGRAM

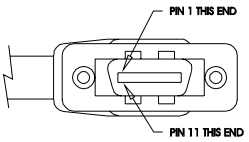


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Figure B.16 J2 to No Connector Encoder Cable (P/N 9101-1380)





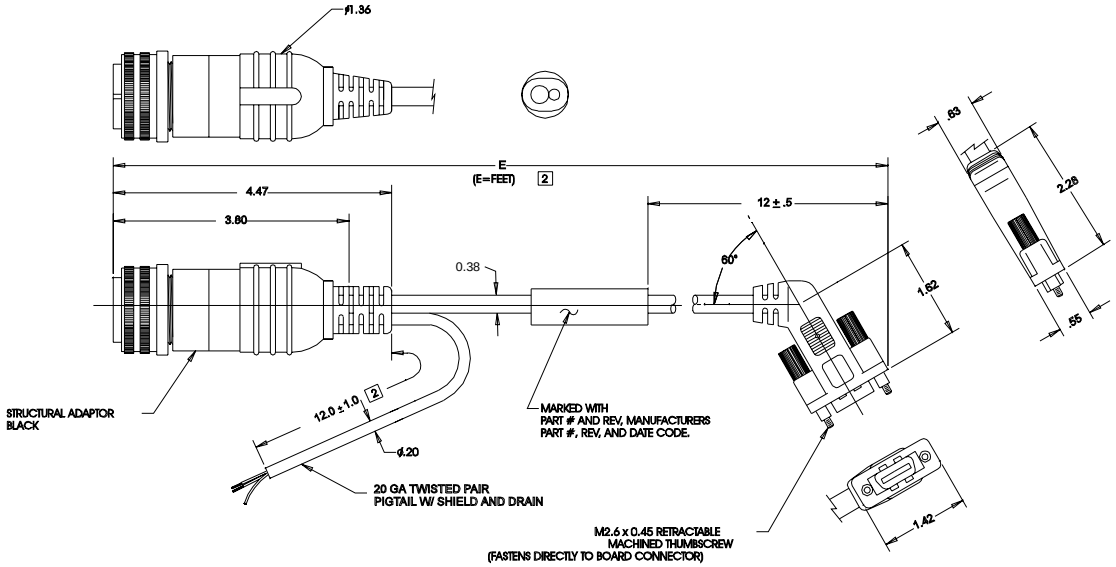


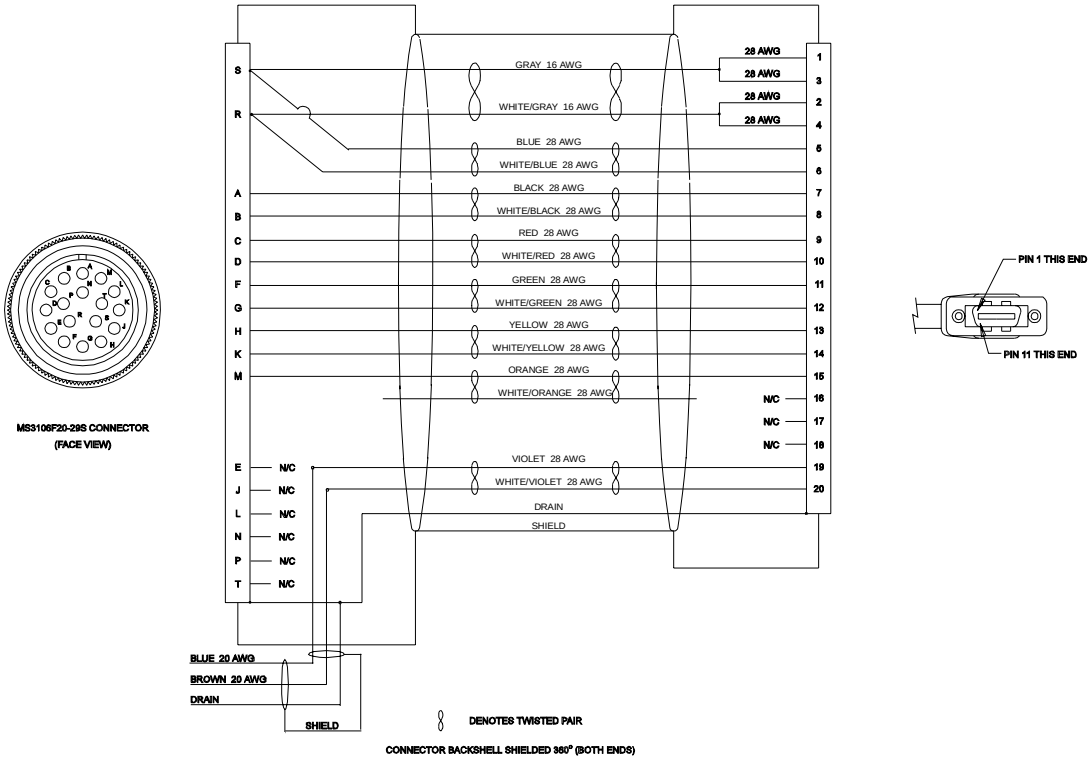
DENOTES TWISTED PAIR

CONNECTOR BACKSHELL SHIELDED 360°

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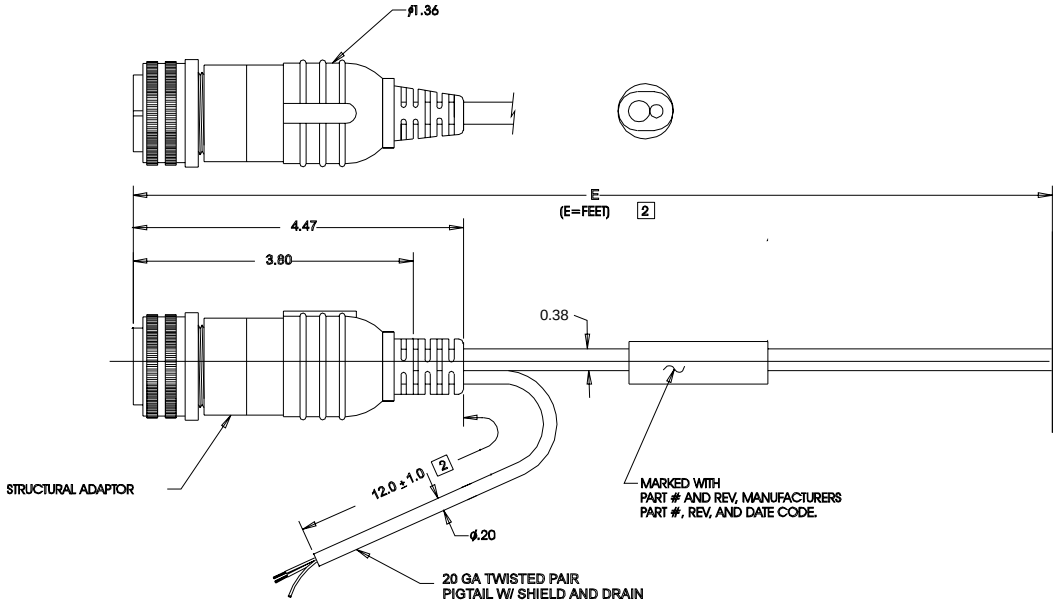
Figure B.17 Reliance HR2000 Encoder Cable (P/N 9101-1445)

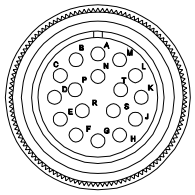




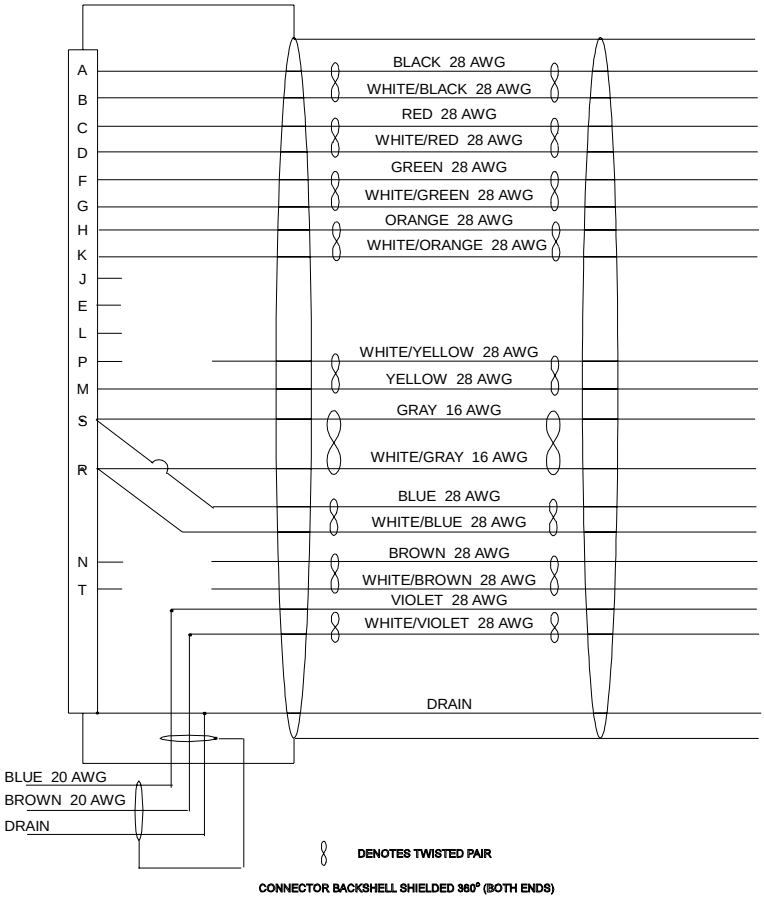
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Figure B.18 Reliance HR2000 to No Connector Encoder Cable (P/N 9101-1446)





MS3106F20-29S CONNECTOR
(FACE VIEW)

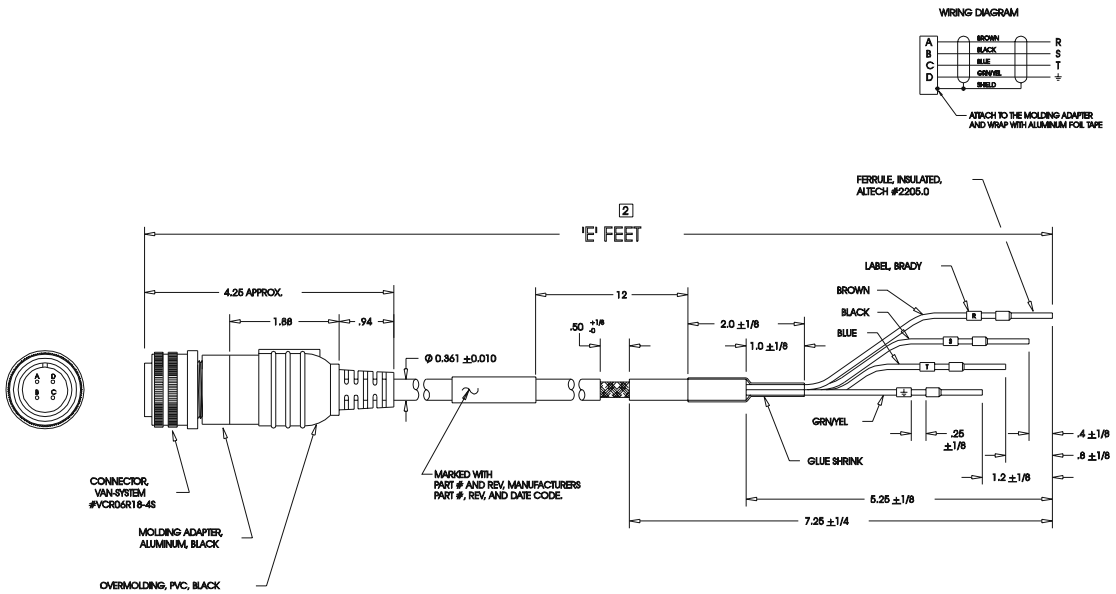


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Motor Power Cables

ATTENTION: Shielded power cables must be grounded at a minimum of one point for safety. Failure to ground a shielded power cable will result in potentially lethal voltages on the shield and anything connected to it.

Figure B.19 2000 or 3000 F- or H-Series Power Cable (P/N 9101-1381)



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Figure B.20 4000 F- or H-Series Power Cable (P/N 9101-1382)

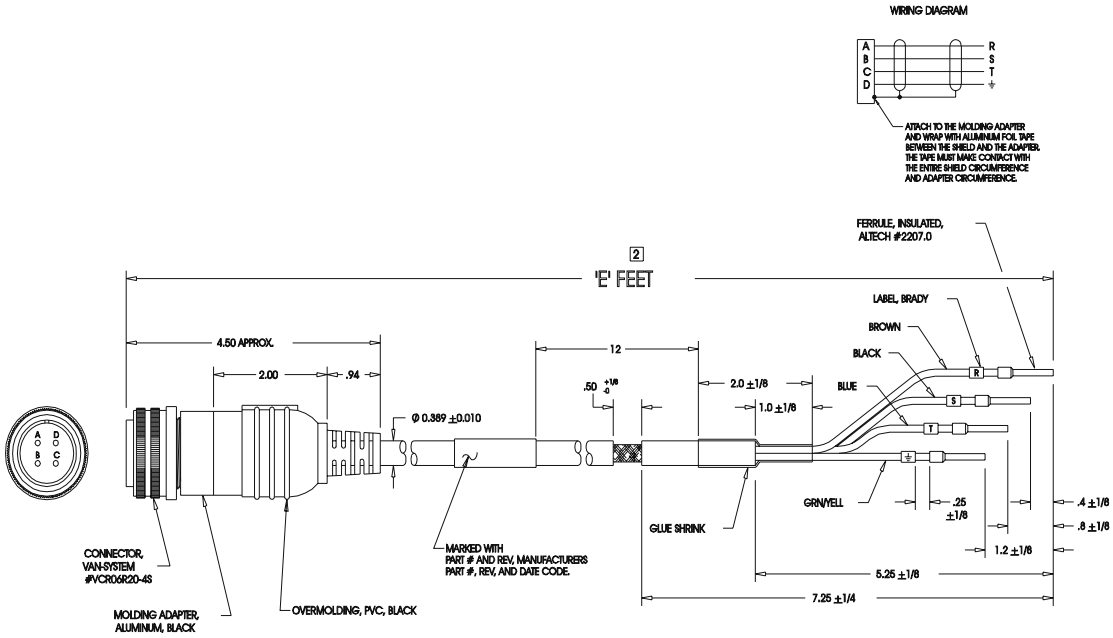
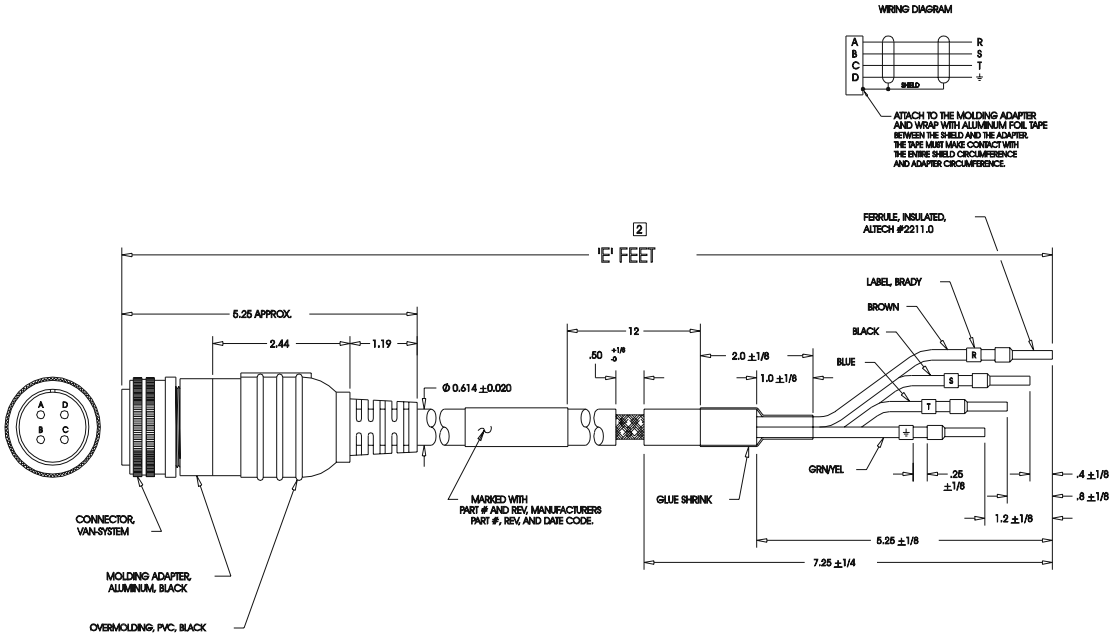
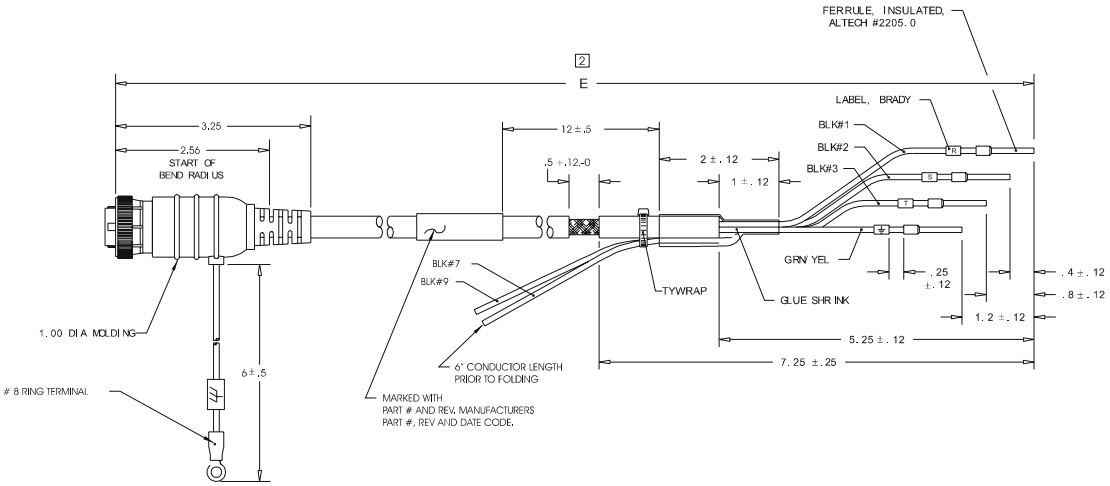


Figure B.21 6000 F- or H-Series Power Cable (P/N 9101-1383)



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Figure B.22 Y-Series Power Cable (P/N 9101-1385)



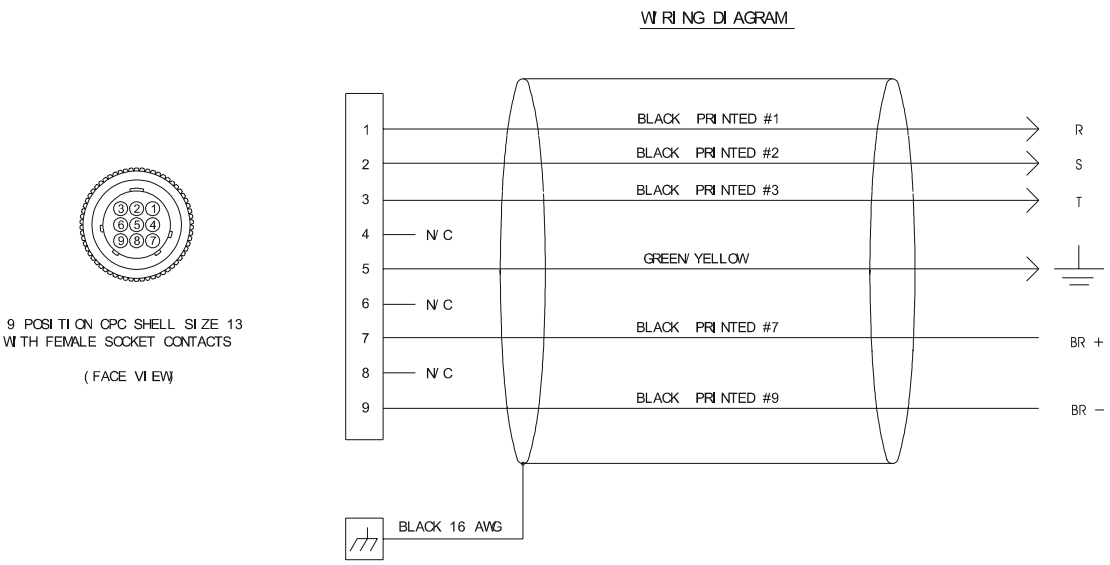
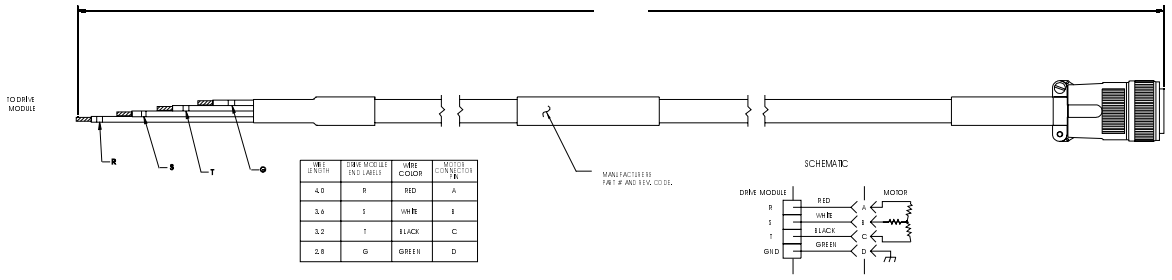


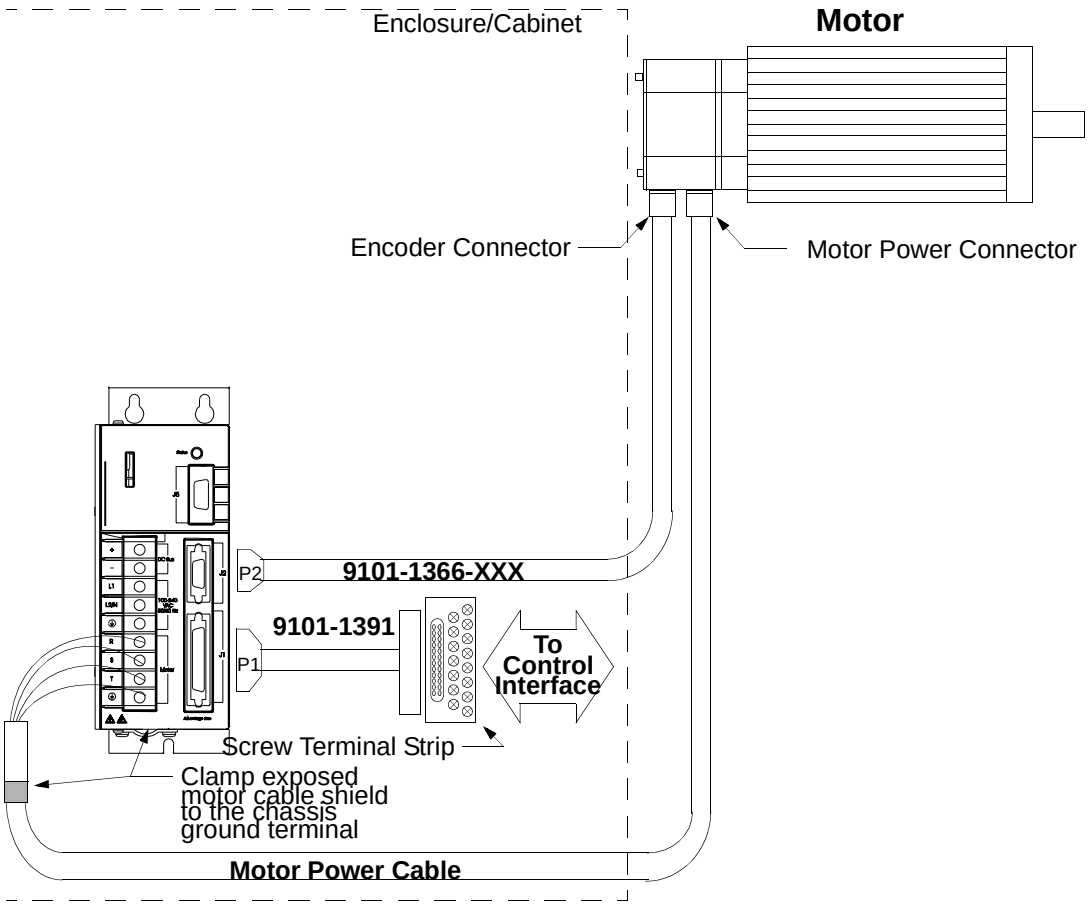
Figure B.23 1398-DDM-075 to 6000 Motors (F- or H-Series) (P/N 9101-2179)



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Cabling Examples

Figure B.24 F- or H-Series Motors to ULTRA 100 Series Drive



NOTES:

This wiring method should be used to run cables through a bulkhead or enclosure without removing the connectors.

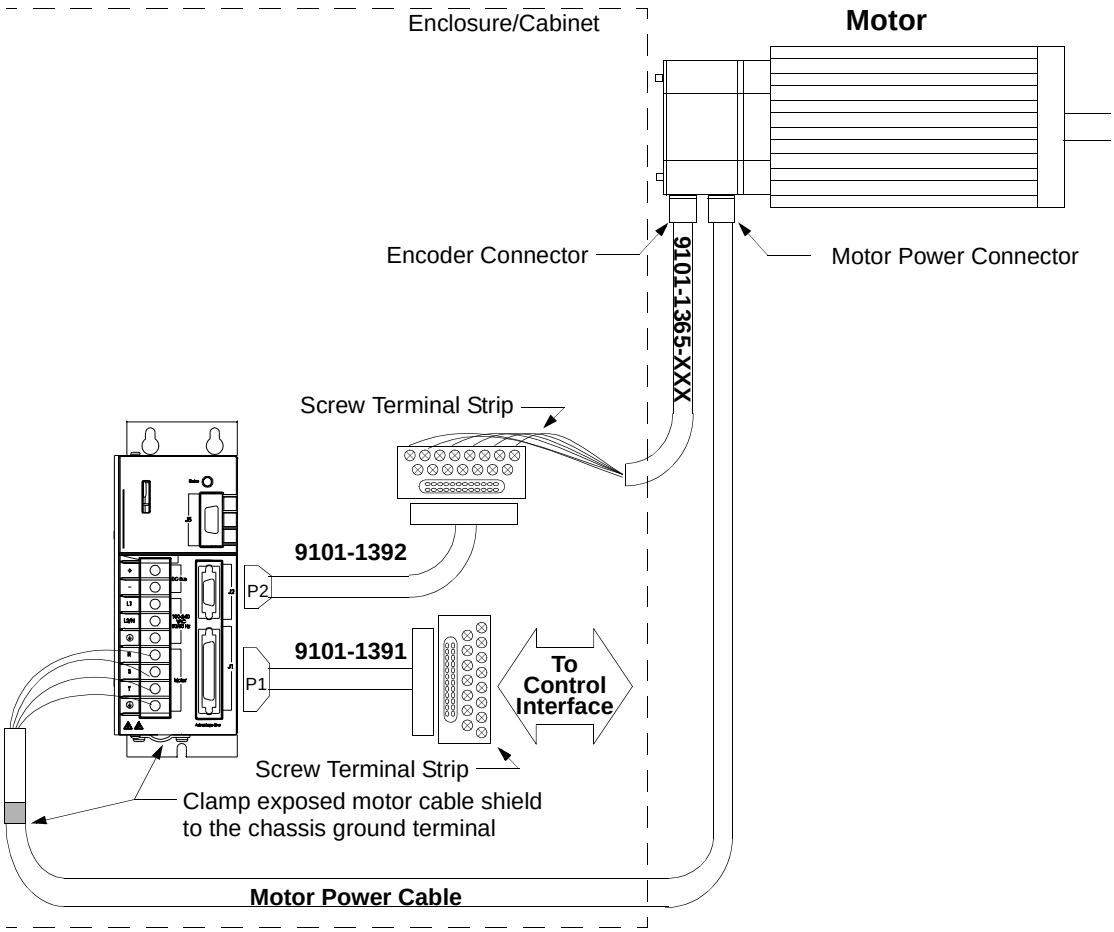
Cable 9101-1366-XXX has connectors on both ends. The connectors are molded and potted to the cable and may not be disassembled.

Adaptor Kit 9101-1391 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 50-pin Mini D ribbon connector at the drive end and a 50-pin D connector at the terminal strip end.

Motor Power Cables - Use ULTRA 100 Series cables if the CE Mark is required. Other cables may be used if the CE Mark is not an issue. In either case, the shield on the motor power cable must be properly grounded at both ends; the shield is grounded at the motor end when the MS connector is mated.

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Figure B.25 F- or H-Series Motors to ULTRA 100 Series Drive using P2 Terminal Strip



NOTES:

This wiring method provides the option to run cables through a restrictive bulkhead or enclosure.

Cable 9101-1365-XXX has a connectors on the motor end only. The cable connector is molded and potted to the cable and may not be disassembled. Refer to the schematic for cable 9101-1366-XXX for information on wiring this cable to the J2 Terminal Strip.

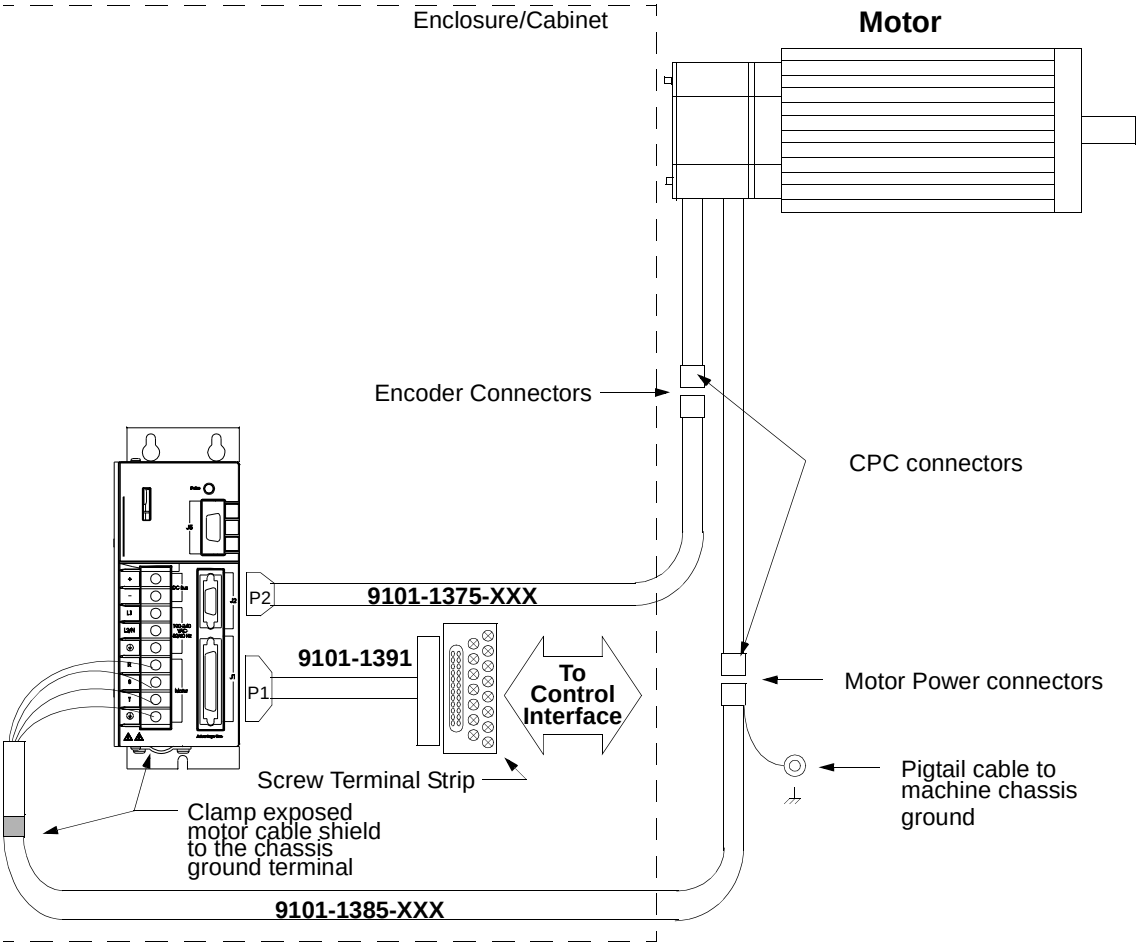
Adaptor Kit 9101-1391 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 50-pin Mini D ribbon connector at the drive end and a 50-pin D connector at the terminal strip end.

Adaptor Kit 9101-1392 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 20-pin Mini D Ribbon connector at the drive end and a 20-pin D connector at the terminal strip end.

Motor Power Cables - Use ULTRA 100 Series cables if the CE Mark is required. Other cables may be used if the CE Mark is not an issue. In either case, the shield on the motor power cable must be properly grounded at both ends; the shield is grounded at the motor end when the MS connector is mated.

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Figure B.26 Y-Series Motors to ULTRA 100 Series Drive



NOTES:

This wiring method should be used to run cables through a bulkhead or enclosure without removing the connectors.

Cable 9101-1375-XXX has connectors on both ends. The connectors are molded and potted to the cable and may not be disassembled.

Adaptor Kit 9101-1391 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 50-pin Mini D ribbon connector at the drive end and a 50-pin D connector at the terminal strip end.

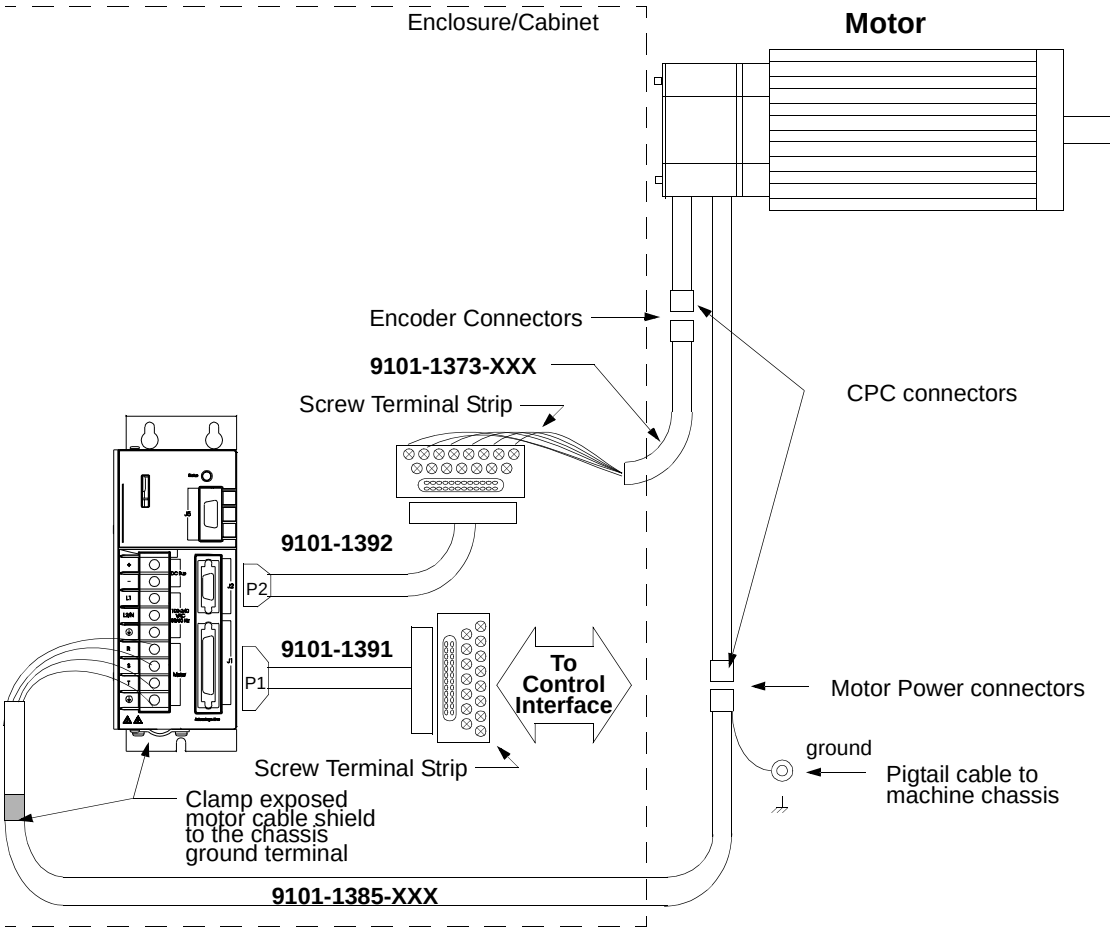
LD-Series Motors have 1 meter (39 inch) cables attached.

Allen-Bradley 9/Series CNC Family Connections

Table B.1 lists the connections necessary between the connectors on Allen-Bradley 9/Series CNC Controllers. The controller may be wired to either a Breakout Board connection from the J2 connector or directly to the J1 connector on a Digital Servo Drive drive.

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Figure B.27 Y-Series Motors to ULTRA 100 Series Drive using P2 Terminal Strip



NOTES:

This wiring method provides the option to run cables through a restrictive bulkhead or enclosure.

Cable 9101-1373-XXX has a connector on the motor end only. The cable connector is molded and potted to the cable and may not be disassembled. Refer to the schematic for cable 9101-1375-XXX for information on wiring this cable to the J2 Terminal Strip.

Adaptor Kit 9101-1391 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 50-pin Mini D ribbon connector at the drive end and a 50-pin D connector at the terminal strip end.

Adaptor Kit 9101-1392 includes the 3 foot cable, screw terminal strip and mounting bracket. The cable has a 20-pin Mini D Ribbon connector at the drive end and a 20-pin D connector at the terminal strip end.

LD-Series Motors have 1 meter (39 inch) cables attached.

Table B.1: 9/260 or 9/290 to Breakout Board

9/260 or 9/290 8520-ASM-3		Breakout Board Connections via J2 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
J1, J2, J3 Pin	**Signal**	**J2 Pin**	**Signal**
3	CHA_HI	7	MtrEncdr Input Chnl A+
4	CHB_HI	9	MtrEncdr Input Chnl B+

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Table B.1: 9/260 or 9/290 to Breakout Board (continued)

9/260 or 9/290 8520-ASM-3		Breakout Board Connections via J2 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
5	CHZ_HI	11	MtrEncdr Input Chnl Index+
12	CHA_LO	8	MtrEncdr Input Chnl A-
13	CHB_LO	10	MtrEncdr Input Chnl B-
14	CHZ_LO	12	MtrEncdr Input Chnl Index-
NOTE: A-B 845 encoders are usually wired with the A- signal into the A+ signal on the Allen-Bradley drive			

Table B.2: 9/260 or 9/290 to J1 Connector

9/260 or 9/290 8520-ASM-3		J1 Connections 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
J1, J2, J3 Pin	**Signal**	**J1 Pin**	**Signal**
3	CHA_HI	7	Mtr Output Chnl A+
4	CHB_HI	9	Mtr Output Chnl B+
5	CHZ_HI	11	Mtr Output Chnl Index+
12	CHA_LO	8	Mtr Output Chnl A-
13	CHB_LO	10	Mtr Output Chnl B-
14	CHZ_LO	12	Mtr Output Chnl Index-
9	DRIVE	22	Analog Cmd+
18	DRIVE.RET	23	Analog Cmd-
NOTE: A-B 845 encoders are usually wired with the A- signal into the A+ signal on the Allen-Bradley drive			

Table B.3: 9/230 to Breakout Board

9/230 8520-ASM-4		Breakout Board Connections via J2 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
Pin	**Signal**	**J2 Pin**	**Signal**
11	CHA_HI	7	MtrEncdr Input Chnl A+
10	CHB_HI	9	MtrEncdr Input Chnl B+
39	CHZ_HI	11	MtrEncdr Input Chnl Index+
41	CHA_LO	8	MtrEncdr Input Chnl A-
40	CHB_LO	10	MtrEncdr Input Chnl B-
9	CHZ_LO	12	MtrEncdr Input Chnl Index-
NOTE: A-B 845 encoders are usually wired with the A- signal into the A+ signal on the Allen-Bradley drive			

Table B.4: 9/230 to J1 Connector

9/230 8520-ASM-4		J1 Connections 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
Pin	**Signal**	**J1 Pin**	**Signal**
11	CHA_HI	7	Mtr Output Chnl A+
10	CHB_HI	9	Mtr Output Chnl B+
39	CHZ_HI	11	Mtr Output Chnl Index+
41	CHA_LO	8	Mtr Output Chnl A-

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Table B.4: 9/230 to J1 Connector (continued)

9/230 8520-ASM-4		J1 Connections 1398-DDM-005, -005X, -009, -009X, -019 or -019X	
40	CHB_LO	10	Mtr Output Chnl B-
9	CHZ_LO	12	Mtr Output Chnl Index-
NOTE: A-B 845 encoders are usually wired with the A- signal into the A+ signal on the Allen-Bradley drive			

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TouchPad Instructions

The optional TouchPad is a compact and rugged device for interfacing with ULTRA 100 Series drives. It provides the operator with a convenient device for accessing status information, program variables, and control functions, plus message display capabilities on any ULTRA 100 Series drive.

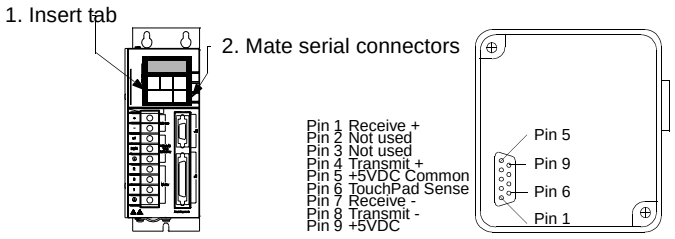
An 8-character dot matrix display and a sealed-membrane type keyboard are housed in a compact case. A locking tab and a single 9-pin D shell serial connector on the backpanel connects the TouchPad to any ULTRA 100 Series drive via four-wire RS-485 communications.

Four cursor keys and a Mode/Enter key provide access to the TouchPad menus and enable the user to select and change parameters, activate commands, and monitor drive variables. The TouchPad also allows the user to display drive status and diagnostic information, and to control functions, such as distances, speeds, and other alphanumeric data.

Installation and Operation

1. Power down the drive.
2. Plug the TouchPad into the serial port on the ULTRA 100 Series drive by latching the tab into the drive and then mating the connector as shown.

Figure C.1 TouchPad Connection and Pinouts



3. Power-up the drive. Installing the TouchPad defaults the drive to the following settings:

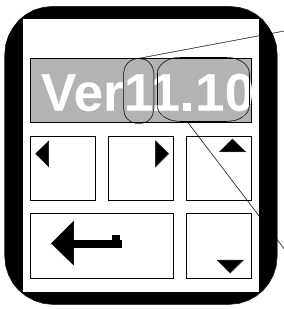
- Address 0
- 19200 Baud
- 8 Data bits
- 1 Stop bit
- No Parity bit

The personality module settings stored in the drive are not affected by the installation or removal of the TouchPad.

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4. Verify the **Ver##.##** displayed is correct at power-up. The version number designates the type of drive and its firmware level. Figure C.2 explains this display.

Figure C.2 TouchPad Version Number Display



Drive Type:

1 = 1398-DDM-010 or 1398-DDM-010X,
1398-DDM-020 or 1398-DDM-020X,
1398-DDM-030 or 1398-DDM-030X,
1398-DDM-075 or 1398-DDM-075X,
1398-DDM-150 or 1398-DDM-150X

2 = 1398-DDM-005 or 1398-DDM-005X,
1398-DDM-009 or 1398-DDM-009X,
1398-DDM-019 or 1398-DDM-019X

Firmware Level:

1.00 = Version 1.00
1.10 = Version 1.10
2.00 = Version 2.00 (Indexing capable)

If you are referring to the TouchPad Command Tree card, verify the version number display and the Drive Type and Firmware Version of the card are the same.

5. After self-test is completed, the TouchPad display defaults to the branch title **DRVSETUP**.

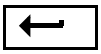
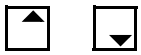
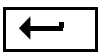
6. Horizontal and vertical movement through the TouchPad Command Tree and parameter modification is explained below. The “TouchPad Command Tree (sheet 1 of 2)” on page C-4 depicts the structure of the TouchPad Command Tree.

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TouchPad Commands

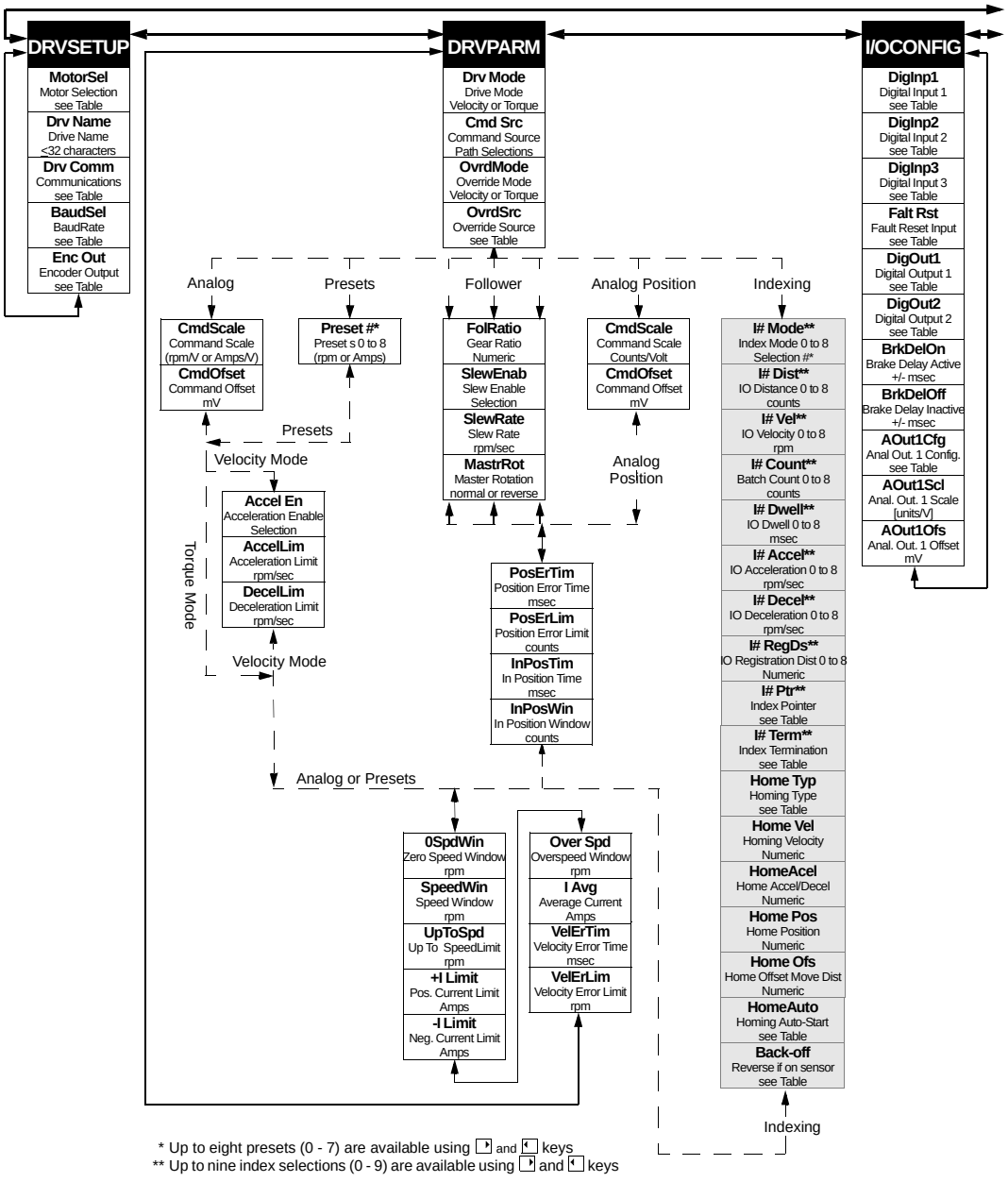
Commands are entered by pressing a single key or combination of keys. Two modes of operation are available. Parameter mode allows you to move through the TouchPad Command Tree to each parameter. Modify mode allows you to monitor and change each parameter, often while the drive is operational.

The Parameter mode displays for the TouchPad Command Tree are depicted on the “Supplemental Instructions” on page C-6.

Key	Function	
 **Mode/Enter**	Toggles the parameter display between the two operating modes. **Parameter** mode shows the abbreviated command name of the selected parameter. Refer to the TouchPad Command Tree Chart for a full text definition. **Modify** mode shows the setting, often a number, for the selected parameter. Key functions in each mode are explained below.	
	Mode of Operation	
Key	**Parameter**	**Modify**
 **Left Arrow**	**Previous Branch/Decrement #** Selects the previous branch in the command tree, or Decreases the Preset number when in Preset Drive Parameter mode.	**Move Left** Moves the flashing character selection to the left, advancing the level of the cursor setting. For example: **00052**00 ◻ **0005**200
 **Right Arrow**	**Next Branch/Increment #** Selects the next branch in the command tree, or Increases the Preset number when in Preset Drive Parameter mode.	**Move Right** Moves the flashing character selection to the right, lowering the level of the cursor setting. For example: **0005**200 ◻ **00052**00
 **Down Arrow**	**Next Parameter** Selects the next parameter down the branch of the command tree.	**Decrement Character** Decreases the selected character(s). For example: 2 ◻ 1, or B ◻ A
 **Up Arrow**	**Previous Parameter** Selects the next parameter up the branch of the command tree.	**Increment Character** Increases the selected character(s). For example: 1 ◻ 2, or A ◻ B
 **Up & Down Arrows** *Press both keys at the same time*	Not functional in this mode.	**Undo Change/Escape** Restores a changed parameter to its original setting. **NOTE:** This command must be performed before moving to another parameter or branch.
 **Mode/Enter**	**Next Mode/Last Parameter** When displaying a parameter, enters the **Modify** mode of operation. When displaying a branch title, selects the last parameter modified in branch.	**Next Mode** Returns the display to the **Parameter** mode of operation.

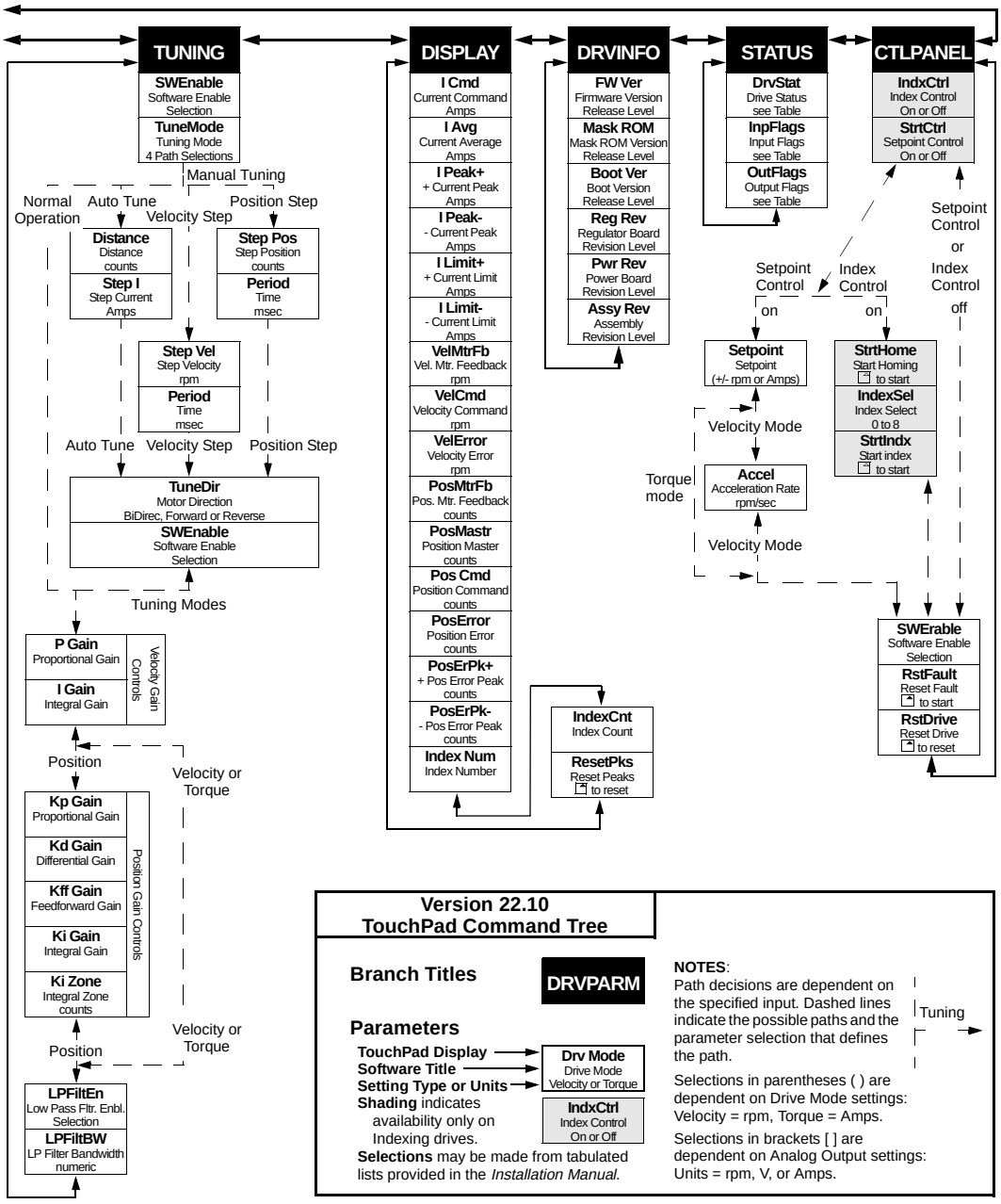
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Figure C.3 TouchPad Command Tree (sheet 1 of 2)



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Figure C.3 TouchPad Command Tree (sheet 2 of 2)



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Supplemental Instructions

Motor Selection

Enter a Motor Identification number to load the correct motor parameters into the drive. Table C.2 on page C-11 and Table C.3 on page C-13 list the motors available in the motor table directory. Selection of a motor defines default operating parameters for the drive and motor combination.

Analog Output Scaling

Selection of Analog Output Scaling through the TouchPad requires manual input of the scaling parameters. To calculate the necessary scaling parameters, first determine the Command Source (Analog or Preset/Follower). If Analog is the Command source, then determine the Drive Mode (Velocity or Torque).

Depending on the Command Source/Drive Mode, calculate the scaling information to be input at the Analog Output Scaling display as follows:

Analog in Velocity Mode

1. Divide the desired velocity scale (rpm) by the maximum motor speed (rpm) and multiply that value by 16383.

Analog in Torque Mode

1. Divide the desired current scale by the lesser of the following:
   - Motor Continuous Current (Amps) times 3, or
   - Drive Rated Current (Amps)
2. Multiply that value by 8191.

Preset/Follower

1. Enter the desired position (in counts).

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Displays

Text

A drive name longer than eight characters may require scrolling with the Left, ◄, and Right, ►, arrow keys. Drive names may be up to 32 characters in length.

Flashing characters in the Modify mode display are the characters that are active.

- Change the cursor position and resolution using the ► and ◄ keys. For example: If the Drv Name in the Modify mode displays **InFeed** with the F flashing, pressing the ► key causes the first **e** to flash.
- Press the ▲ or ▼ keys to increment or decrement a character by scrolling through the list of valid ASCII characters. For example, If the Drv Name in the Modify mode displays **InFfed** with the lowercase **f** is flashing, pressing the ▼ key causes the flashing character to decrement to **e**.

Numeric

Flashing characters in the Modify mode display are the numbers that are active.

- Change the cursor position and resolution using the ► or ◄ key. For example: If the Over Spd in the Modify mode displays **5200** and **52** is flashing, pressing the ► key causes **520** to flash.
- Press the ▲ or ▼ key to increment or decrement these numbers. For example: If the Over Spd value is **5200** and **52** is flashing, pressing the ▲ key causes the setting to increment by 100 rpm each time the key is pressed.
- Parameter values may not exceed the maximum or minimum limits, regardless of the cursor position.
  For example: If the SpeedWin setting is **5000** rpm and the Maximum Speed in the motor table is **5200**, pressing the ▲ key increases the parameter to **5200** (the upper limit), but pressing the ▼ key decrements the parameter to **4000**.

The most significant digit is reserved when a parameter allows a negative (-) setting or the parameter provides a list of possible selections. The ▲ or ▼ key toggles the minus sign.

List

The most significant digit is reserved for an active/inactive selection marker when a parameter provides a list of possible selections.

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- A filled arrow, ➧, in the most significant digit indicates the active setting from a list of possible settings. Inactive settings are indicated by a unfilled arrow, ⇨.
  For example: If the drive is functioning as Preset Controller in the Velocity mode, pressing the ⌄ key from DRVPARAM scrolls through the **CmdSrc** list which includes ➧**Presets**, ⇨**AuxEnc**, ⇨**StepDir**, ⇨**StepU/D**, and ⇨**Analog**.
- The Mode/Enter, ↵, key selects a parameter from the list.
- List selections that are undefined are indicated by ➧ **Unknown**. This display indicates the TouchPad data table is incompatible with the drive.

Lists are associated with all parameters, except **DISPLAY** and **DRVINFO**. Refer to the tables beginning on page C-16 for the items in each list. Table C.17, “Drive Status List for TouchPad” on page C-19 is a read-only list, all other lists contain possible parameter selections. After an option is selected, the display reverts to the parameter from which the option was selected. For example: Selection of the EncAlign parameter under STATUS provides the options ➧ Normal and ⇨ Align. Selection of either option returns you to the EncAlign display.

Ratio

A **FolRatio** (gear ratio) longer than eight characters may require scrolling with the › and ‹ keys. The ratios are numeric values that increment or decrement by 1 each time the ⌃, or ⌄, key is pressed.

The method of display is dependent on the length of the ratios:

- If the ratio is eight characters or less, the complete ratio is displayed.
  For example, a Master to Follower ratio of one-thousand to nine-hundred is displayed as **1000:900**.
- If the ratio requires more than eight characters the ratio is displayed in two parts: a Master Ratio and a Follower Ratio. The position of the colon (:) after or before each numeric value indicates Master or Follower for these larger ratios.
  The › and ‹ keys toggle between the Master Ratio and the Follower Ratio.
  For example: A Master to Follower ratio on 1001:1000 is displayed in two separate displays. The Master Ratio is displayed as **1001:** and pressing › displays the Follower Ratio **:1000**.

Fault/Error/Warning

C.1lists the possible fault, error and warning messages that may appear on the TouchPad. The items below describe the different types of messages.

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- The TouchPad displays **Fault** and a description. A Fault message requires additional troubleshooting of the drive.
  Clear the fault display by depressing the ↑ and ↓ keys simultaneously.
  Fault codes are stored in the TouchPad parameter **DrvStat** and are explained with troubleshooting guidelines in Table 11.1 on page 11-4.
- The TouchPad alternately displays **Error** and the error name. Clear an error by pressing the ↵ key.
- The TouchPad momentarily displays and then clears a warning when an invalid entry is made.

Table C.1: TouchPad Fault/Error/Warning Displays

Display	Level	Description
BufOvFlo	Error	Communications buffer overflowed.
Can'tDo	Error	An invalid function type encountered in the TouchPad data table. The TouchPad data table is incorrect for the drive.
Checksum	Error	The checksum of the command is in error. Information is corrupted.
Cmd-NoEnb	Error	The command is not enabled.
DataDisp	Warning	The parameter is a live data display and cannot be modified.
DrvEnabl	Warning	The parameter cannot be changed while the drive is enabled.
Fault	Fault	Drive fault detected.
InvlData	Warning	Invalid data was entered for the parameter.
InvldFn	Error	Illegal function code received by drive. The TouchPad data table is incorrect for the drive.
InvldRsp	Error	Invalid Response received from drive. Received code did not match transmitted code.
Lower Lim	Warning	The lower limit of the parameter has been reached.
NoMemory	Error	TouchPad memory has been exhausted.
NoRetSel	Warning	Mode/Enter key incorrectly pressed.
OverRng	Error	Value from drive is too large to display.
RAMWrite	Error	An error was detected while writing the drive's parameter memory.
ReadOnly	Warning	The parameter is Read Only and cannot be modified.

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Table C.1: TouchPad Fault/Error/Warning Displays (continued)

Display	Level	Description
Timeout	Error	The communications port timed out.
UnxpChar	Error	The communications port received an unexpected character.
UpperLim	Warning	The upper limit of the parameter has been reached.

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Motor Table

Table C.2: TouchPad Motor Table Identification by Motor Series

Motor	ID
B14H1050	551
B14H1056	558
B14H1060	560
B14H1066	562
B14J1050	559
B14J1060	563
B18H1070	564
B18H1076	566
B18H1080	568
B18H1086	570
B18J1070	567
B18J1080	571
B90H1015	557
B90H1025	561
B90H1035	565
B90H1045	569

Motor	ID
E-3618-E-F	297
E-3622-H-F	298
E-3626-L-F	296
E-3629-L-F	299
E-3633-L-F	300

Motor	ID
F-4030-Q-F	271
F-4030-Q-H	15
F-4030-Q-J	527
F-4030-Q-K	783
F-4030-Q-L	1039
F-4030-Q-M	1295
F-4030-Q-N	1551
F-4050-Q-F	259
F-4050-Q-H	3
F-4050-Q-J	515
F-4050-Q-K	771
F-4050-Q-L	1027
F-4050-Q-M	1283
F-4050-Q-N	1539
F-4075-R-F	272
F-4075-R-H	16
F-4075-R-J	528
F-4075-R-K	784
F-4075-R-L	1040
F-4075-R-M	1296
F-4075-R-N	1552
F-6100-R-F	273
F-6100-R-H	17
F-6100-R-J	529
F-6100-R-K	785
F-6100-R-L	1041
F-6100-R-M	1297
F-6100-R-N	1553
F-6200-R-F	274
F-6200-R-H	18
F-6200-R-J	530
F-6200-R-K	786
F-6200-R-L	1042
F-6200-R-M	1298
F-6200-R-N	1554
F-6300-R-F	275
F-6300-R-H	19
F-6300-R-J	531
F-6300-R-K	787
F-6300-R-L	1043
F-6300-R-M	1299
F-6300-R-N	1555

Motor	ID
H-2005-K-F	276
H-2005-K-H	20
H-2005-K-J	532
H-2005-K-K	788
H-2005-K-L	1044
H-2005-K-M	1300
H-2005-K-N	1556
H-3007-N-F	277
H-3007-N-H	21
H-3007-N-J	533
H-3007-N-K	789
H-3007-N-L	1045
H-3007-N-M	1301
H-3007-N-N	1557
H-3016-N-F	278
H-3016-N-H	22
H-3016-N-J	534
H-3016-N-K	790
H-3016-N-L	1046
H-3016-N-M	1302
H-3016-N-N	1558
H-4030-M-F	280
H-4030-M-H	24
H-4030-M-J	536
H-4030-M-K	792
H-4030-M-L	1048
H-4030-M-M	1304
H-4030-M-N	1560
H-4030-P-F	279
H-4030-P-H	23
H-4030-P-J	535
H-4030-P-K	791
H-4030-P-L	1047
H-4030-P-M	1303
H-4030-P-N	1559
H-4050-P-F	281
H-4050-P-H	25
H-4050-P-J	537
H-4050-P-K	793
H-4050-P-L	1049
H-4050-P-M	1305
H-4050-P-N	1561

Motor	ID
H-4075-R-F	282
H-4075-R-H	26
H-4075-R-J	538
H-4075-R-K	794
H-4075-R-L	1050
H-4075-R-M	1306
H-4075-R-N	1562
H-6100-Q-F	283
H-6100-Q-H	27
H-6100-Q-J	539
H-6100-Q-K	795
H-6100-Q-L	1051
H-6100-Q-M	1307
H-6100-Q-N	1563
H-6200-Q-F	284
H-6200-Q-H	28
H-6200-Q-J	540
H-6200-Q-K	796
H-6200-Q-L	1052
H-6200-Q-M	1308
H-6200-Q-N	1564
H-6300-Q-F	285
H-6300-Q-H	29
H-6300-Q-J	541
H-6300-Q-K	797
H-6300-Q-L	1053
H-6300-Q-M	1309
H-6300-Q-N	1565
H-8350-S-F	286
H-8350-S-H	30
H-8350-S-J	542
H-8350-S-K	798
H-8350-S-L	1054
H-8350-S-M	1310
H-8350-S-N	1566
H-8500-S-F	287
H-8500-S-H	31
H-8500-S-J	543
H-8500-S-K	799
H-8500-S-L	1055
H-8500-S-M	1311
H-8500-S-N	1567

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Table C.2: TouchPad Motor Table Identification by Motor Series (continued)

Motor	ID
I-5300-R-F	385
I-6600-T-F	386
LD-2003-K-H	32
LD-3009-L-H	33
LD-4012-L-H	7
LD-4030-O-H	34
N-2302-1-F	335
N-2304-1-F	336
N-3406-2-H	81
N-3406-2-K	849
N-3412-2-H	82
N-3412-2-K	850
N-4214-2-H	83
N-4214-2-K	851
N-4220-2-H	84
N-4220-2-K	852
N-5630-2-H	85
N-5630-2-K	853
N-5637-2-H	86
N-5637-2-K	854
N-5647-2-H	87
N-5647-2-K	855
P14A5803	572
P18A6103	577
P18A6104	573
P21M301	578
P21M302	575
P21M303	576
P21M304	579
P21M305	574
P21M306	1920
P21M307	1923
P21M308	1924
P25G229	1925
P28G206	1926

Motor	ID
S-2005-K-F	264
S-2005-K-H	8
S-2005-K-J	520
S-2005-K-K	776
S-2005-K-L	1032
S-2005-K-M	1288
S-2005-K-N	1544
S-3007-N-F	260
S-3007-N-H	4
S-3007-N-J	516
S-3007-N-K	772
S-3007-N-L	1028
S-3007-N-M	1284
S-3007-N-N	1540
S-3016-N-F	261
S-3016-N-H	5
S-3016-N-J	517
S-3016-N-K	773
S-3016-N-L	1029
S-3016-N-M	1285
S-3016-N-N	1541
S-4030-M-F	266
S-4030-M-H	10
S-4030-M-J	522
S-4030-M-K	778
S-4030-M-L	1034
S-4030-M-M	1290
S-4030-M-N	1546
S-4030-P-F	265
S-4030-P-H	9
S-4030-P-J	521
S-4030-P-K	777
S-4030-P-L	1033
S-4030-P-M	1289
S-4050-P-F	257
S-4050-P-H	1
S-4050-P-J	513
S-4050-P-K	769
S-4050-P-L	1025
S-4050-P-M	1281
S-4050-P-N	1537
S-4075-R-F	258
S-4075-R-H	2
S-4075-R-J	514

Motor	ID
S-4075-R-K	770
S-4075-R-L	1026
S-4075-R-M	1282
S-4075-R-N	1538
S-6100-Q-F	267
S-6100-Q-H	11
S-6100-Q-J	523
S-6100-Q-K	779
S-6100-Q-L	1035
S-6100-Q-M	1291
S-6100-Q-N	1547
S-6200-Q-F	268
S-6200-Q-H	12
S-6200-Q-J	524
S-6200-Q-K	780
S-6200-Q-L	1036
S-6200-Q-M	1292
S-6200-Q-N	1548
S-6300-Q-F	262
S-6300-Q-H	6
S-6300-Q-J	518
S-6300-Q-K	774
S-6300-Q-L	1030
S-6300-Q-M	1286
S-6300-Q-N	1542
S-8350-S-F	269
S-8350-S-H	13
S-8350-S-J	525
S-8350-S-K	781
S-8350-S-L	1037
S-8350-S-M	1293
S-8350-S-N	1549
S-8500-S-F	270
S-8500-S-H	14
S-8500-S-J	526
S-8500-S-K	782
S-8500-S-L	1038
S-8500-S-M	1294
S-8500-S-N	1550

Motor	ID
Y-1002-1	69
Y-1002-2	68
Y-1003-1	71
Y-1003-2	70
Y-2006-1	73
Y-2006-2	72
Y-2012-1	75
Y-2012-2	74
Y-3023-2	77
W-3016-N-H	35
W-4030-P-H	36
W-4050-P-H	37
W-4075-R-H	38

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Table C.3: TouchPad Motor Table Identification by Motor ID

ID	Motor	ID	Motor	ID	Motor	ID	Motor
1	S-4050-P-H	74	Y-2012-2	300	E-3633-L-F	565	B90H1035
2	S-4075-R-H	75	Y-2012-1	335	N-2302-1-F	566	B18H1076
3	F-4050-Q-H	77	Y-3023-2	336	N-2304-1-F	567	B18J1070
4	S-3007-N-H	81	N-3406-2-H	385	I-5300-R-F	568	B18H1080
5	S-3016-N-H	82	N-3412-2-H	386	I-6600-T-F	569	B90H1045
6	S-6300-Q-H	83	N-4214-2-H	513	S-4050-P-J	570	B18H1086
7	LD-4012-L-H	84	N-4220-2-H	514	S-4075-R-J	571	B18J1080
8	S-2005-K-H	85	N-5630-2-H	515	F-4050-Q-J	572	P21M301
9	S-4030-P-H	86	N-5637-2-H	516	S-3007-N-J	573	P21M303
10	S-4030-M-H	87	N-5647-2-H	517	S-3016-N-J	574	P21M308
11	S-6100-Q-H	257	S-4050-P-F	518	S-6300-Q-J	575	P21M305
12	S-6200-Q-H	258	S-4075-R-F	520	S-2005-K-J	576	P21M306
13	S-8350-S-H	259	F-4050-Q-F	521	S-4030-P-J	577	P21M302
14	S-8500-S-H	260	S-3007-N-F	522	S-4030-M-J	578	P21M304
15	F-4030-Q-H	261	S-3016-N-F	523	S-6100-Q-J	579	P21M307
16	F-4075-R-H	262	S-6300-Q-F	524	S-6200-Q-J	593	N-3406-2-J
17	F-6100-R-H	264	S-2005-K-F	525	S-8350-S-J	594	N-3412-2-J
18	F-6200-R-H	265	S-4030-P-F	526	S-8500-S-J	595	N-4214-2-J
19	F-6300-R-H	266	S-4030-M-F	527	F-4030-Q-J	596	N-4220-2-J
20	H-2005-K-H	267	S-6100-Q-F	528	F-4075-R-J	597	N-5630-2-J
21	H-3007-N-H	268	S-6200-Q-F	529	F-6100-R-J	598	N-5637-2-J
22	H-3016-N-H	269	S-8350-S-F	530	F-6200-R-J	599	N-5647-2-J
23	H-4030-P-H	270	S-8500-S-F	531	F-6300-R-J	769	S-4050-P-K
24	H-4030-M-H	271	F-4030-Q-F	532	H-2005-K-J	770	S-4075-R-K
25	H-4050-P-H	272	F-4075-R-F	533	H-3007-N-J	771	F-4050-Q-K
26	H-4075-R-H	273	F-6100-R-F	534	H-3016-N-J	772	S-3007-N-K
27	H-6100-Q-H	274	F-6200-R-F	535	H-4030-P-J	773	S-3016-N-K
28	H-6200-Q-H	275	F-6300-R-F	536	H-4030-M-J	774	S-6300-Q-K
29	H-6300-Q-H	276	H-2005-K-F	537	H-4050-P-J	776	S-2005-K-K
30	H-8350-S-H	277	H-3007-N-F	538	H-4075-R-J	777	S-4030-P-K
31	H-8500-S-H	278	H-3016-N-F	539	H-6100-Q-J	778	S-4030-M-K
32	LD-2003-K-H	279	H-4030-P-F	540	H-6200-Q-J	779	S-6100-Q-K
33	LD-3009-L-H	280	H-4030-M-F	541	H-6300-Q-J	780	S-6200-Q-K
34	LD-4030-O-H	281	H-4050-P-F	542	H-8350-S-J	781	S-8350-S-K
35	W-3016-N-H	282	H-4075-R-F	543	H-8500-S-J	782	S-8500-S-K
36	W-4030-P-H	283	H-6100-Q-F	551	B14H1050	783	F-4030-Q-K
37	W-4050-P-H	284	H-6200-Q-F	557	B90H1015	784	F-4075-R-K
38	W-4075-R-H	285	H-6300-Q-F	558	B14H1056	785	F-6100-R-K
68	Y-1002-2	286	H-8350-S-F	559	B14J1050	786	F-6200-R-K

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Table C.3: TouchPad Motor Table Identification by Motor ID (continued)

ID	Motor
69	Y-1002-1
70	Y-1003-2
71	Y-1003-1
72	Y-2006-2
73	Y-2006-1

ID	Motor
287	H-8500-S-F
296	E-3626-L-F
297	E-3618-E-F
298	E-3622-H-F
299	E-3629-L-F

ID	Motor
560	B14H1060
561	B90H1025
562	B14H1066
563	B14J1060
564	B18H1070

ID	Motor
787	F-6300-R-K
788	H-2005-K-K
789	H-3007-N-K
790	H-3016-N-K
791	H-4030-P-K

ID	Motor
792	H-4030-M-K
793	H-4050-P-K
794	H-4075-R-K
795	H-6100-Q-K
796	H-6200-Q-K
797	H-6300-Q-K
798	H-8350-S-K
799	H-8500-S-K
849	N-3406-2-K
850	N-3412-2-K
851	N-4214-2-K
852	N-4220-2-K
853	N-5630-2-K
854	N-5637-2-K
855	N-5647-2-K
1025	S-4050-P-L
1026	S-4075-R-L
1027	F-4050-Q-L
1028	S-3007-N-L
1029	S-3016-N-L
1030	S-6300-Q-L
1032	S-2005-K-L
1033	S-4030-P-L
1034	S-4030-M-L
1035	S-6100-Q-L
1036	S-6200-Q-L
1037	S-8350-S-L
1038	S-8500-S-L
1039	F-4030-Q-L
1040	F-4075-R-L
1041	F-6100-R-L
1042	F-6200-R-L
1043	F-6300-R-L
1044	H-2005-K-L
1045	H-3007-N-L
1046	H-3016-N-L
1047	H-4030-P-L
1048	H-4030-M-L
1049	H-4050-P-L
1050	H-4075-R-L

ID	Motor
1055	H-8500-S-L
1281	S-4050-P-M
1282	S-4075-R-M
1283	F-4050-Q-M
1284	S-3007-N-M
1285	S-3016-N-M
1286	S-6300-Q-M
1288	S-2005-K-M
1289	S-4030-P-M
1290	S-4030-M-M
1291	S-6100-Q-M
1292	S-6200-Q-M
1293	S-8350-S-M
1294	S-8500-S-M
1295	F-4030-Q-M
1296	F-4075-R-M
1297	F-6100-R-M
1298	F-6200-R-M
1299	F-6300-R-M
1300	H-2005-K-M
1301	H-3007-N-M
1302	H-3016-N-M
1303	H-4030-P-M
1304	H-4030-M-M
1305	H-4050-P-M
1306	H-4075-R-M
1307	H-6100-Q-M
1308	H-6200-Q-M
1309	H-6300-Q-M
1310	H-8350-S-M
1311	H-8500-S-M
1537	S-4050-P-N
1538	S-4075-R-N
1539	F-4050-Q-N
1540	S-3007-N-N
1541	S-3016-N-N
1542	S-6300-Q-N
1544	S-2005-K-N
1545	S-4030-P-N
1546	S-4030-M-N

ID	Motor
1551	F-4030-Q-N
1552	F-4075-R-N
1552	F-4075-R-N
1553	F-6100-R-N
1554	F-6200-R-N
1555	F-6300-R-N
1556	H-2005-K-N
1557	H-3007-N-N
1558	H-3016-N-N
1559	H-4030-P-N
1560	H-4030-M-N
1561	H-4050-P-N
1562	H-4075-R-N
1563	H-6100-Q-N
1564	H-6200-Q-N
1565	H-6300-Q-N
1566	H-8350-S-N
1567	H-8500-S-N
1920	P14A5803
1923	P18A6103
1924	P18A6104
1925	P25G229
1926	P28G206

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Table C.3: TouchPad Motor Table Identification by Motor ID (continued)

ID	Motor
1051	H-6100-Q-L
1052	H-6200-Q-L
1053	H-6300-Q-L
1054	H-8350-S-L

ID	Motor
1547	S-6100-Q-N
1548	S-6200-Q-N
1549	S-8350-S-N
1550	S-8500-S-N

ID	Motor

ID	Motor

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TouchPad Options and Lists

Table C.4: Option Selections for the TouchPad

DRVPARM		TUNING	
Parameter	**Options**	**Parameter**	**Options**
AccelEn	Enable/Disable	SWEnable	Enable/Disable
SlewEnab	Enable/Disable		
I OverRd	Enable/Disable		
STATUS		**CTLPANEL**	
Parameter	**Options**	**Parameter**	**Options**
SWEnable	Enable/Disable	SWEnable	Enable/Disable
EncAlign	Normal/Align	Start	Normal/CtlPanel
RmvOfst	↑ to Rmv		

TouchPad Lists

Table C.5: Drive Communications Parameter List for the TouchPad

Display	Parameter
00	7 Data Bits, 1 Stop Bit, Even Parity
01	7 Data Bits, 1 Stop Bit, Odd Parity
02	8 Data Bits, 1 Stop Bit, No Parity
03	8 Data Bits, 1 Stop Bit, Even Parity
04	8 Data Bits, 1 Stop Bit, Odd Parity

Table C.6: Baud Rate Parameter List for TouchPad

Display	Parameter
00	1200 Baud
01	2400 Baud
02	4800 Baud
03	9600 Baud
04	19200 Baud

Table C.7: Encoder Output Parameter List for TouchPad

Display	Parameter
÷ by 1	Divide Encoder counts by 1
÷ by 2	Divide Encoder counts by 2
÷ by 4	Divide Encoder counts by 4
÷ by 8	Divide Encoder counts by 8

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Table C.8: IO Mode Parameter List for TouchPad

Display	Parameter[a]
Inc	Incremental Indexing
Abs	Absolute Indexing
Reg	Registration Indexing

a. Parameters available only if the drive supports Indexing.

Table C.9: Index Pointer Parameter List for TouchPad

Display	Parameter[a]
00	Index 0
01	Index 1
02	Index 2
03	Index 3
04	Index 4
05	Index 5
06	Index 6
07	Index 7
08	RAM Index

a. Parameters available only if the drive supports Indexing.

Table C.10: Index Termination Parameter List for TouchPad

Display	Parameter[a]
Stop	Stop
NxtINow	Start another Index immmediately
NxtIWt	Start another Index at next Start Index transition

a. Parameters available only if the drive supports Indexing.

Table C.11: Home Type Parameter List for TouchPad

Display	Parameter[a]
Sns/Mrk	Home to Sensor, then to Marker
Marker	Home to Marker
Sensor	Home to Sensor

a. Parameters available only if the drive supports Indexing.

Table C.12: Homing Auto-Start Parameter List for TouchPad

Display	Parameter[a]
Disable	Auto-Start Homing inactive
Enb/Rst	Auto-Start Homing if not already Homed
Enable	Auto-Start on every Enable

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a. Parameters available only if the drive supports Indexing.

Table C.13: Reverse Enable for Homing

Display	Parameter[a]
Inactive	No reversing if started on Sensor
Active	Reverse if started on Sensor

a. Parameters available only if the drive supports Indexing.

Table C.14: Digital Input Parameter List for TouchPad

Display	Parameter
Not Asgn	Not Assigned (not used)
DrvMode	Drive Mode
IntInh	Integrator Inhibit
FolEnab	Follower Enable
FwdEnab	Forward Enable
RevEnab	Reverse Enable
CMD Ovrd	Analog COMMAND Input Override
PreSelA	Preset Select Line A
PreSelB	Preset Select Line B
PreSelC	Preset Select Line C
StrtInd	Start Index
DefHome	Define Home
Registr	Registration/Sensor
-CmdOfs	Remove Command Offset
Home	Start Homing
FaltRst	Fault Reset

Table C.15: Digital Output Parameter List for TouchPad

Display	Parameter
Not Asgn	Not Assigned (not used)
InPos	In Position
PosWin	Within Position
0 Speed	Zero Speed
SpdWin	Speed Window

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Table C.15: Digital Output Parameter List for TouchPad (continued)

Display	Parameter
+ILimit	Positive Current Limit
-ILimit	Negative Current Limit
UpToSpd	Up to Speed
DrvEnab	Drive Enable
BusChg	Bus Charged
Fault	Disabling Fault
AtHome	At Home
SeqEnd	Sequence Complete
Moving	In Motion
InDwell	In Dwell
Homed	Axis Homed

Table C.16: Analog Output Parameter List for TouchPad

Display	Parameter
I Cmd	Current Command
I Avg	Average Current Command
IPeak+	Positive Current Peak
IPeak-	Negative Current Peak
ILimit+	Positive Current Limit
ILimit-	Negative Current Limit
VelMtr	Motor Velocity
VelCmd	Velocity Command
VelErr	Velocity Error
PosMtr	Motor Position
PosCmd	Position Command Slewed
PosErr	Position Error
PosEPk+	Positive Position Peak Error
PosEPk-	Negative Position Peak Error
PosMstr	Master Position

Table C.17: Drive Status List for TouchPad

Display	Parameter
DrvEnab	Drive Enabled
DrvRdy	Drive Ready
+24 Fuse	+24 VDC Fuse blown

not applicable to 1398-DDM-005, 1398-DDM-005X, 1398-DDM-009, 1398-DDM-009X, 1398-DDM-019 or 1398-DDM-019X

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Table C.17: Drive Status List for TouchPad (continued)

Display	Parameter
5v Fuse	+5 VDC Fuse blown *not applicable to 1398-DDM-005, 1398-DDM-005X, 1398-DDM-009, 1398-DDM-009X, 1398-DDM-019 or 1398-DDM-019X*
EncFuse	Encoder Power Fuse blown *not applicable to 1398-DDM-005, 1398-DDM-005X, 1398-DDM-009, 1398-DDM-009X, 1398-DDM-019 or 1398-DDM-019X*
MtrOvT	Motor Thermostat Overtemperature
IPMFalt	IPM Fault (Overtemperature/Overcurrent/Short Circuit)
IMLinBk	Channel IM Line Break
BMLinBk	Channel BM Line Break
AMLinBk	Channel AM Line Break
BusOvV	Bus Undervoltage
BusUndV	Bus Overvoltage
IlglHal	Illegal Hall State
SubIntr	Unused Interrupt - sub processor
MainInt	Unused Interrupt - main processor
ExsAvgI	Excessive Average Current
OvSpeed	Motor Overspeed
ExsFErr	Excessive Following Error
MtrEnc	Motor Encoder State Error
MstrEnc	Auxiliary Encoder State Error
MtrThrm	Motor Thermal Protection
IPMThrm	IPM Thermal Protection
EnNoMtr	No Motor Selected while enabling drive
MtrType	Motor Selection not in Table
PersWrt	Personality Write Error
ServWrt	Service Write Error
CPU-Comm	CPU Communications Error
MtrOvt	Motor Overtemperature
IPMFalt	IPM Fault
ExsVErr	Excess Velocity Error
Comutat	Commutation Angle Error
Not Homd	Axis Not Homed

NOTE:
The Drive Status display is read-only. **DrvEnab** and **DrvRdy** indicate that the drive is functional. The other displays indicate an error condition.

Table C.18: Input Flags Parameter List for TouchPad

Display	Parameter
FltRst	Fault Reset Input Flag
ENABLE	Drive Enable Input Flag

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Table C.18: Input Flags Parameter List for TouchPad (continued)

Display	Parameter
Input1	Input 1 Input Flag
Input2	Input 2 Input Flag
Input3	Input 3 Input Flag

Table C.19: Output Flags Parameter List for TouchPad

Display	Parameter
READY	Ready Output Flag
BRAKE	Brake Output Flag
Outpt1	Output 1 Flag
Outpt2	Output 2 Flag

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Creating Custom Motor Files

Each motor controlled by a ULTRA 100 Series drive requires a unique parameter set. The parameter set provides the drive with information about the motor necessary for proper commutation, precise control and protection.

Two types of motor parameter sets can be selected for a ULTRA 100 Series drive using ULTRA Master software:

- Standard motors parameters reside in a motor lookup table stored in the drive. Up to 65535 motors may be stored in the drive.
- Custom motor parameters are created off-line and downloaded to the drive's personality module (EEPROM). Only one custom motor may be stored in the drive.



Note: Additional custom motors may be stored off-line as files accessible via a personal computer.

This appendix defines the motor parameters and explains how the drive uses the parameters to control the motor. A step-by-step example details how to set up a motor file for an application using the motor's parameters. Difficulties commonly encountered when creating custom motor files also are explained.



Note: ULTRA Master Advanced is required to access Custom Motor features. The Help menu in ULTRA Master explains how to access the Advanced features.

Drive and Motor File Configuration with ULTRA Master

At startup ULTRA Master examines the contents of the /MOTORDIR subdirectory to determine the list of motors it will display. If a custom motor file is to appear, it must be copied into the /MOTORDIR directory before ULTRA Master is started. Each motor file is a binary file that contains:

- the motor parameter set,
- a table ID number, and
- a text string.

Because they are binary files, only ULTRA Master can be used for editing and generation (i.e., you cannot edit motor files using a text editor.)

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Motor Parameter Set

The motor parameter set configures the ULTRA 100 Series drive to control a specific motor. Motor parameters provide information about the electrical properties, ratings and construction of the motor. Subsequent sections of this appendix explain these properties with meaningful depth. For now it is sufficient to know that accurate and complete definition of the motor's properties is necessary to achieve good performance.

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Table ID

The table ID number tells ULTRA Master whether the motor file represents a standard motor or a custom motor:

- Standard motor table IDs occupy the range 0 to 65534.
- The custom motor table ID is 65535 (also known as “-1”).

Standard motor parameter sets are stored in the drive as well as in the motor file. Thus ULTRA Master needs to transmit only the table ID to select the motor model from the drive's personality EEPROM. For custom motor files, ULTRA Master must transmit not only the custom motor’s table ID but also the complete motor parameter set from the custom motor file.

Text String

The text string allows ULTRA Master to display a meaningful name in the motor model window. The text string displays one of three possible messages when a motor is loaded into the drive:

- “H-4030-P-H”, or equivalent if a valid motor model number is loaded.
- “Custom” if a custom motor file is loaded.
- “Unknown” if an unrecognized motor file is loaded.

The text string translates the table ID into a real motor model number for display. For example, the user can select the text string “H-4030-P-H” rather than entering the table ID #23. Figure D.1 defines the text string format of Allen-Bradley motors.

Motor Phasing

The phasing of the back-EMF and Hall feedback signals must be verified before a custom motor file can be created. Allen-Bradley motors use back-EMF and Hall feedback signals phased as shown in Figure D.2. Motors not manufactured by Allen-Bradley require the back-EMF and Hall feedback signals be phased to match those of Allen-Bradley motors. Often this requires swapping of the R-, S-, and T-phase control signals with each other, as well as swapping the Hall A, Hall B, and Hall C signals with each other.

Back-EMF and Hall Signals

Figure D.2(a) shows the required phasing of the *line-to-line* back-EMF signals and Figure D.2(b) shows the proper phasing of the Hall feedback signals, when the motor is rotating clockwise (CW) *as seen looking at the motor shaft from the load*.

The relationship of the Hall signals to the back-EMF signals is not important at this stage. However, the sequencing of the back-EMF signals must conform to Figure D.2(a), and the sequencing of the Hall feedback signals must conform to Figure D.2(b).

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Figure D.1 Allen-Bradley Motor Naming Convention

Motor Part Number

H - 4030 - P - H - 00 - AA

FACTORY DESIGNATED SPECIAL OPTIONS
- AA = STANDARD
- AF = FLYING LEADS
- AG = IEC DIMENSIONS
- AN = NEMA 56C

FACTORY DESIGNATED SPECIAL OPTIONS
- 00 = STANDARD
- 01 = 90 VDC BRAKE
- 02 = 24 VDC BRAKE

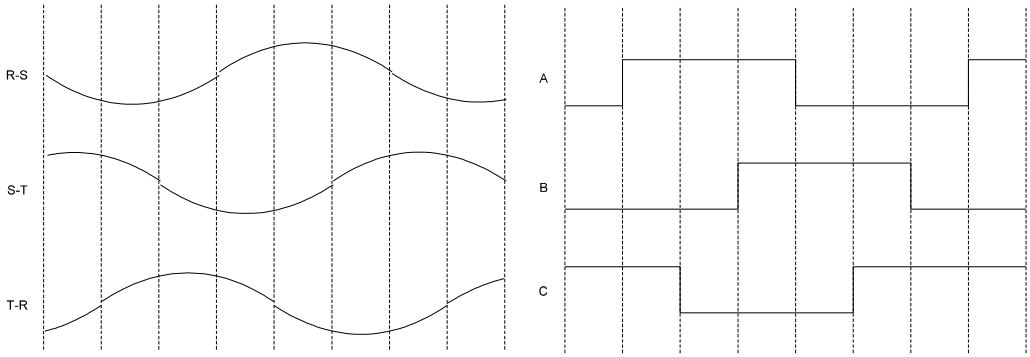
OPTICAL ENCODER LINECOUNT
- F = 1000
- H = 2000 (STANDARD)
- J = 2500
- K = 5000
- L = 500
- M = 3000
- N = 1000

MOTOR WINDING K_E DESIGNATOR

FRAME SIZE

SERIES DESIGNATOR
- E = COMMERCIAL
- F = MEDIUM INERTIA
- H = LOW INERTIA
- I = INDUCTION
- N = NEMA STYLE FRAME
- W = WASHDOWN
- Y = LIGHT INDUSTRIAL

Figure D.2 Required Back-EMF and Hall Signal Phasing for Clockwise Rotation



(a) Required Back-EMF Phasing (b) Required Hall Feedback Phasing

Many motor manufacturers include drawings in their data sheets that identify the phasing of the back-EMF and Hall feedback signals, or an application engineer may have access to an internal document listing the information. As a last resort, the motor can be rotated in the lab to check the phasing.

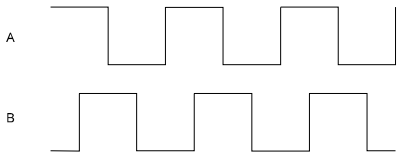
If the phasing is not correct, the respective leads must be physically swapped to correct the sequencing. A custom motor file cannot be created until the sequencing is correct because the offset of the Hall signals from the Allen-Bradley standard must be defined, and swapping wires affects the offset value.

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Encoder Sequencing

Separate from the phasing of the commutation and motor power signals, the encoder A quad B signals must sequence properly. The A channel must lead the B channel for CW motion *when viewed looking at the motor shaft from the load*. Figure D.3 depicts this encoder signal sequencing. If the encoder phasing is not as shown in Figure D.3, the encoder leads must be swapped.

Figure D.3 Phasing of the Encoder Signals for Clockwise Rotation



Motor Parameter Definitions

The parameters to configure in a custom motor file are defined below. ULTRA Master arranges motor parameters in an index card format. The groupings are:

- General,
- Feedback,
- Current Loop,
- Electrical, and
- Ratings.

General Parameters

Motor Model

The motor model field is a text display from which a motor is selected.

If the motor model text string is changed, ULTRA Master assumes that a new motor file is being created, and the user must supply a new filename. This prevents the text string being changed on an existing motor file. However, a filename may be recycled by:

1. Assign the new file a tentative filename.
2. Delete the old file.
3. Rename the new file, using the old filename.

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Table ID

The table ID value determines whether the motor file represents a standard motor or a custom motor. A table ID in the range of 0 to 65534 identifies a standard motor file, and a table ID of 65535 (also known as table ID “-1”) identifies a custom motor file. Users may define motor parameters for multiple custom motors on a PC, but only one custom motor files may be stored on the drive. (i.e., All custom motor files have the table ID value of “-1”.)

Motor File

The motor file is the filename of the custom motor file, it is different from the motor model text field. The filename can have up to 8 characters and must have a .MTR extension. If the motor model text string is altered, ULTRA Master prompts the user for a new filename.

Synchronous/Induction

This field identifies whether the motor is a synchronous (permanent magnet) motor or an induction motor. The motor type informs ULTRA Master which fields are valid for a particular motor, and which fields are invalid (grayed).

These instructions only cover permanent magnet motors, so the *Synchronous* box must be checked.

Number of Poles

The number of poles specifies the number of electrical cycles in two mechanical revolutions. For example, a 6-pole motor will have three electrical cycles per mechanical cycle. The firmware can support only 2-, 4-, 6-, and 8-pole motors.

Occasionally a manufacturer specifies the number of pole pairs in a motor data sheet. Pole pairs should not be confused with the number of poles. A 6-pole motor has 3 pole pairs.

K_T (Torque Constant)

The torque constant, also known as the torque sensitivity, specifies the amount of torque that the motor can produce with a given value of sinusoidal current. The torque constant is measured in units of N-m/Amp, and its range is 0.0002 to 15.9998 N-m/Amp.

Conversion formulas between N-m/Amp, in-lb/Amp, and oz-in/Amp, are:

$$1\frac{\text{Newton}\cdot\text{meter}}{\text{Amp}} = 8.85075\frac{\text{inch}\cdot\text{pound}}{\text{Amp}} = 141.612\frac{\text{ounce}\cdot\text{inch}}{\text{Amp}}$$

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The denominator units of the required torque constant are peak Amps, rather than rms Amps. To convert the torque constant from units of N-m/Amp(rms), use the formula:

$$1\frac{\text{Newton}\cdot\text{meter}}{\text{Amp}} = 0.707\frac{\text{Newton}\cdot\text{meter}}{\text{Amp(rms)}}$$

Many Allen-Bradley motors specify the torque constant in units of N-m/rmsA/phase. In this case, in addition to conversion from rms Amps to peak Amps, the value needs to be multiplied by three because it has been defined as “per phase”.

If a motor operates with trap drives, the torque constant is specified as a “square wave” torque constant. However, ULTRA 100 Series drives are sinusoidal drives and the torque constant must be specified as a “sine wave” torque constant or “sinusoidal” torque constant. To convert between sinusoidal torque constants and square wave torque constants, usually a factor of 5-10% is required. The motor manufacturer should be able to specify the sinusoidal torque constant, even if it is not shown in the data sheet.

J_M (Inertia)

The rotor inertia specifies the inertia of the motor, not including the load, and is required in units of Kg-cm^2. The inertia can be in the range of 0.0156 to 1023.9844 Kg-cm^2.

The conversion formulas between Kg-cm^2, Kg-m^2, in-lb-s^2, and oz-in-s^2 are:

$$1\cdot\text{Kg}\cdot\text{cm}^2 = 0.0001\cdot\text{Kg}\cdot\text{m}^2 = \frac{1}{1129.85}\cdot\text{in}\cdot\text{lb}\cdot\text{s}^2 = \frac{1}{70.6155}\cdot\text{oz}\cdot\text{in}\cdot\text{s}^2$$

K_E (Back EMF)

The back-EMF is the peak value of the line-to-line sinusoidal EMF generated at 1000 RPM, and is required in units of Volts/KRPM or Volts/1000 RPM. The back-EMF value can be in the range of 0.0039 to 255.9961 Volts/KRPM.

Note that the required value is a peak value, rather than an rms value. To convert the back-EMF from units of Volts(rms)/kRPM, use the formula:

$$1\cdot\frac{\text{Volts}}{1000\ \text{RPM}} = 1.414\cdot\frac{\text{Volts(rms)}}{1000\ \text{RPM}}$$

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Also, a line-to-line value is required, rather than a line-to-neutral. A line-to-line value equals a line-to-neutral value times two.

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Feedback Parameters

Linecount

The encoder linecount, or size, specifies the number of encoder lines per mechanical revolution of the motor, and is required in units of lines/mechanical revolution. The linecount value can be in the range from 100 to 15000 lines/rev.

Note that the linecount value is in units of lines/rev, rather than counts/rev. The number of lines/rev will be 1/4th of the number of counts/rev.

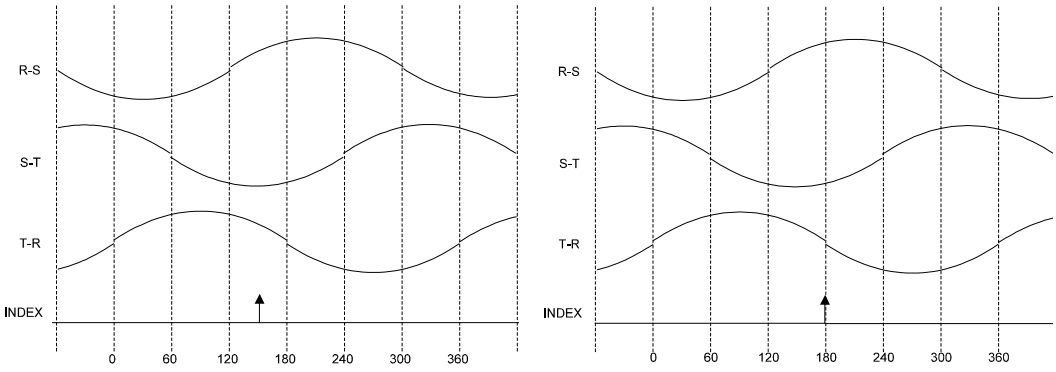
Index Offset

The index offset specifies the offset of the encoder index signal from the Allen-Bradley standard, and is required in units of electrical degrees. If the startup commutation type specifies that the index be used for the final commutation angle measurement, then the drive uses the index offset to determine the commutation angle when the index is first located (the rising edge). The index offset value can be in the range from 0 to 359 degrees.

For custom motor files, this parameter is not required. Set it to 0, since only the Hall signals are needed for most custom motor files.

Figure D.4(a) shows the Allen-Bradley standard index location, and Figure D.4(b) shows an example of a 30^{o} index offset.

Figure D.4 Index Offsets



(a) Allen-Bradley Index Location (0^{o} Offset) (b) Non-Standard Index Location (30^{o} Offset)

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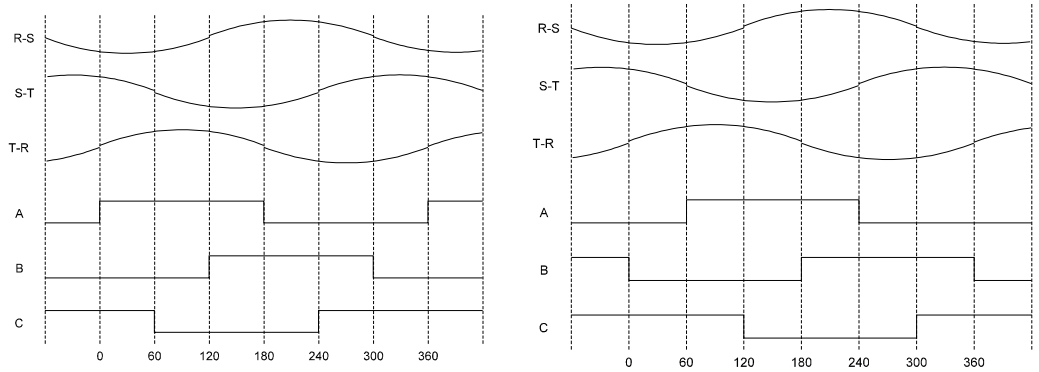
Hall Offset

The Hall offset specifies the offset of the Hall feedback signals relative to the Allen-Bradley standard. The drive uses the Hall offset to determine the commutation angle at startup. Hall offset is specified as a value in the range from 0 to 359 electrical degrees.

The Hall signals, as well as the line-to-line back-EMF voltages, must sequence according to the Allen-Bradley standard (refer to Figure D.2 and the “Motor Phasing” on page D-3). The Hall offset value is the value the drive uses to correct for Hall signals that are shifted from the line-to-line back-EMF.

Figure D.5(a) shows the Allen-Bradley standard for orientation of the Hall signals to the line-to-line back-EMF voltages. Figure D.5(b) shows an example of a 60^{o} Hall offset from the standard location.

Figure D.5 Hall Offsets



(a) Allen-Bradley Hall Location (0^{o} Offset) (b) Non-Standard Hall Location (60^{o} Offset)

Startup Commutation

The startup commutation list box specifies the type of commutation to be used at startup. The choices are:

- 6-Step ABS/Index,
- 8-Step ABS/Index,
- Hall/Index, and
- Hall/Hall.

The different types of startup are identified by their initial and final commutation angle measurement. For example, the 6-Step ABS/Index startup uses the 6-Step ABS for the initial commutation angle measurement, and the index signal for the final commutation angle measurement.

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The Hall/Hall type of startup commutation should be used unless the motor is a special version of an Allen-Bradley motor. The reasons for this are:

- The ABS signal is only available on Allen-Bradley motors.
- Hall/Hall commutation means that the location of the Index signal is unimportant.

If the drive is set up for Hall/Hall startup commutation, the initial commutation angle is determined by the state of the three Hall feedback inputs: 001, 010, 011, 100, 101, or 110. When the motor begins moving, a transition from one Hall state to another (for example, 001 to 101) identifies a precise commutation angle, and the measurement is completed. After the final Hall measurement occurs, the encoder A/B inputs are used to track the commutation angle.

Invert Direction

The invert direction check box may be used as a substitute for swapping the motor phase leads and Hall feedback signal wires. This option is valid only if the motor runs backwards from the Allen-Bradley standard and only if counter-clockwise (CCW) rotation produces the same motor power and Hall feedback sequencing as rotating an Allen-Bradley motor clockwise (CW).

The invert direction check box may also be checked for some Allen-Bradley motors, where the definition of forward is opposite that of Allen-Bradley (i.e., CCW rather than CW). In such a case, a software inversion is preferable to the physical swapping of leads, because the signals look identical when rotated CCW rather than CW.

For custom motors, other than those mentioned above, leave this box unchecked and swap the motor power and Hall feedback signals to correct the phasing.

Electrical Parameters

Resistance

The resistance value is the measured *phase-to-phase* resistance of the stator winding in Ohms. The resistance is used to set the current regulator gains, and is critical to current loop performance. The resistance value can be in the range from 0.0039 to 255.9961Ω.

The ratio of motor inductance to motor resistance is defined as the electrical time constant of the motor. This value should always be checked to verify that it is in an acceptable range. Electrical time constants less than ~1mS, and higher than ~50mS, present difficulties for current regulation and should be avoided.

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Some manufacturers specify the resistance in Ohms/phase. The phase-to-phase resistance requested by ULTRA Master is twice the per phase value.

Inductance

The inductance value is the measured *phase-to-phase* inductance in milliHenries of the stator winding. The inductance is used to set the current regulator gains, and is critical to current loop performance. The inductance value can be in the range from 0.0039 to 255.9961mH.

The ratio of motor inductance to motor resistance is defined as the electrical time constant of the motor. Always verify this value is in a reasonable range. Electrical time constants less than ~1mS, and higher than about ~50mS, present difficulties in the current regulator and should be avoided.

Inductances less than ~1mH suffer from high current ripple, and are not recommended for use with the ULTRA 100 Series drives.

Some manufacturers specify the inductance in milliHenries/phase. The phase-to-phase inductance is twice the per phase value.

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Rating Parameters

Continuous Torque

Continuous torque specifies the rated current of the motor in peak Amps. (Note: Continuous torque is peak Amps, rather than rms.) The drive uses the continuous torque current value in its motor thermal protection software. The drive generates a fault if the square of the actual current, after passing through a low pass filter, exceeds the square of the continuous torque current value. The square is used because the power dissipation in the motor is approximated as I^2R losses. The continuous torque value may be in the range from 0.0078 to 255.9922 Amps.

Some manufacturers specify the rated current of a motor in rms Amps. To convert from rms Amps to peak Amps, use the formula:

$$1 \cdot \text{Amps} = 1.414 \cdot \text{Amps(rms)}$$

Occasionally a manufacturer specifies only the rated torque, and does not include the rated current specification. In such a case, the rated current can be computed using the rated torque and the torque constant. A factor of 1.1 is included to allow for degradation of the torque constant at high temperatures, etc. The formula, assuming the torque constant has already been converted to N-m/A(peak), is:

$$I_{RATED} = 1.1 \cdot \frac{\text{rated torque in N} \cdot \text{m}}{K_T}$$

Peak Torque

The peak or maximum torque specifies the maximum current capability of the motor in peak Amps. (Note: This is peak Amps, rather than rms.) The drive uses the maximum torque value to limit the current applied to the motor. At run-time, the instantaneous current of the drive is limited to the *minimum* of this value, the drive's peak rating, the analog current limit inputs, and the software current limits. The maximum torque value can be in the range from 0.0078 to 255.9922 Amps.

Some manufacturers specify the maximum current of a motor in rms Amps. To convert from rms Amps to peak Amps, use the formula:

$$1 \cdot \text{Amps} = 1.414 \cdot \text{Amps(rms)}$$

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Occasionally a manufacturer specifies only the maximum instantaneous torque, and does not include the maximum current specification. In such a case, the peak current can be computed using the peak torque and the torque constant. A factor of 1.1 is included to allow for degradation of the torque constant at high temperatures, etc. The formula, assuming the torque constant has already been converted to N-m/A(peak), is given by:

$$I_{PEAK} = 1.1 \cdot \frac{\text{maximum torque in N} \cdot \text{m}}{K_T}$$

Thermal Time Constant

The thermal time constant check box indicates if a valid thermal time constant exists for the motor. If this check box is not selected, the motor thermal protection software is disabled.

Enabling of the motor thermal protection software is recommended, even if the thermal time constant is not known. This software feature significantly reduces the chance of damage to the motor, even when the motor has an integral thermostat.

The thermal time constant value, also known as the cool down time constant, identifies how fast the motor winding temperature dissipates heat. The value is entered in seconds. The thermal time constant value can be in the range from 1 to 65535 seconds.

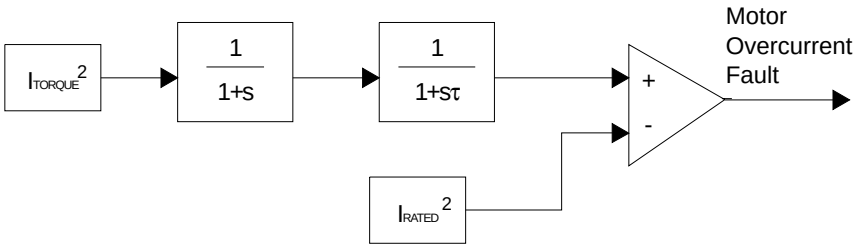
The thermal time constant of the motor is measured by stabilizing the motor temperature at its rated condition, disabling the drive, and measuring the time for the hottest part of the motor winding to drop 63% of the difference from ambient. Allen-Bradley, as well as many other motor manufacturers, specifies this parameter for motors, although it may not be published in catalogs or data sheets.

If the thermal time constant of a motor is unknown or unavailable, an estimated value is preferable to disabling the motor thermal protection software. A reasonable substitute is to find an Allen-Bradley motor with similar capability, and use its thermal time constant value for the custom motor.

The motor thermal protection algorithm filters the square of the torque current (using the motor thermal time constant value) and generates a motor thermal protection fault if the output of the filter exceeds the square of the motor's continuous torque current rating. The square of the current is used because the power dissipated in the motor is approximated as I2R losses. Figure D.6 shows the method to be used for protection, with t defined as the motor thermal time constant.

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Figure D.6 Motor Thermal Protection Software Method



Integral Thermostat

The integral thermostat check box should be checked if the motor has a built-in thermostat. If this box is not checked, the thermostat inputs to the drive are ignored.

When the integral thermostat check box is selected, a motor overtemperature fault is displayed if the thermostat inputs to the drive are in an open state.

Maximum Speed

This value specifies the maximum speed in RPM that the motor can safely maintain on a continuous basis. The maximum speed value can be in the range from 0.00002 to 32767.99998 RPM.

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Example of Custom Motor File Creation

The following is an example of a custom motor. A 50:1 gear is included inside this motor. The example illustrates how to configure a custom motor.

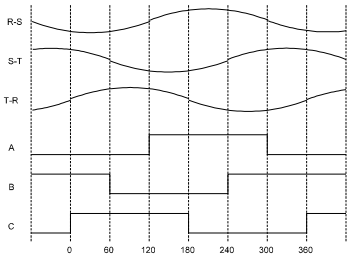
Manufacturer's Data

The following specifications were taken from the manufacturer's data sheet:

- Reduction Ratio = 1:50
- Rated Current = 1.4 Amp
- Maximum Current = 3.8 Amp
- Maximum Speed = 80 RPM
- Torque Constant = 270 in-lb/Amp
- BEMF = 1.1 Volt/RPM per phase
- Motor Resistance = 3.7Ω per phase
- Motor Inductance = 5.0mH per phase
- Thermal Time Constant = 30 minutes
- Moment of Inertia = 5.1 in-lb-sec^2
- Encoder Linecount = 1500 lines/rev
- No Integral Thermostat

A check with the manufacturer yielded that the motor has 8 poles, and that the line-to-line back-EMF and Hall signals are as shown in Figure D.7. The figure indicates that no lead swapping is necessary but the Hall offset is 120^o.

Figure D.7 Back-EMF and Hall Signals, Clockwise Rotation



Parameter Conversions

The 1:50 gearing makes this motor an unusual case. The motor file must be generated as if the motor and gear are two separate devices. The inertia, torque, speed, etc., must be computed based on the *motor* side of the gearing, rather than the load side.

The maximum speed of the motor, before gearing, is computed as:

The torque constant of the motor, before gearing, is computed as:

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$$V_{MAX} = \left(80\frac{rev}{min}\right)\cdot(50) = 4000\ \frac{rev}{min}$$

$$K_T = \left(270\frac{in\cdot lb}{Amp}\right)\cdot\left(\frac{1}{8.85075}\frac{N\cdot m}{in\cdot lb}\right)\cdot\left(\frac{1}{50}\right) = 0.61\frac{N\cdot m}{Amp}$$

The back-EMF constant of the motor, before gearing, is computed as:

$$K_E = \left(1.1\frac{Volts}{RPM}\right)\cdot\left(\frac{1000}{1}\frac{RPM}{KRPM}\right)\cdot(2)\cdot\left(\frac{1}{50}\right) = 44\frac{Volts}{KRPM}$$

Note that the back-EMF was specified as a per phase value, and is doubled to obtain a line-to-line value.

The motor inertia, before gearing, is computed as:

$$J_M = \left(5\ in\cdot lb\cdot s^2\right)\cdot\left(1129.85\frac{Kg\cdot cm^2}{in\cdot lb\cdot s^2}\right)\cdot\left(\frac{1}{50^2}\right) = 2.26\ Kg\cdot cm^2$$

The resistance and inductances are also specified as per phase values, and are computed as:

$$R_{L\text{-}L} = \left(3.7\frac{Ohms}{Phase}\right)\cdot(2) = 7.4\ Ohms$$

$$L_{L\text{-}L} = \left(5.0\frac{mH}{Phase}\right)\cdot(2) = 10.0\ mH$$

The thermal constant is specified in minutes, and is computed as:

$$\text{thermal time constant} = (30\ min)\cdot\left(60\frac{sec}{min}\right) = 1800\ sec$$

Custom Motor File

The custom motor file parameters are as follows:

GENERAL	
Motor Model:	A_CUSTOM
Table ID:	-1
Motor File:	CUSTOM21.MTR
Motor Type:	Synchronous
Number of Poles:	8
Kt:	0.61 N-m/Amp

CURRENT LOOP	
Current Feedforward:	0 degrees / kRPM

ELECTRICAL	
Resistance:	7.4 Ohms
Inductance:	10.0 mH

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Jm:	2.26 kg-cm^2
Ke:	44.0 Volts/kRPM

FEEDBACK	
Linecount:	1500 lines/rev
Index Offset:	0 degrees
Hall Offset:	120 degrees
Startup Commutation:	Hall / Hall
Invert Direction:	Unchecked

RATINGS	
Continuous Torque:	1.4 Amps
Peak Torque:	3.8 Amps
Thermal Time Constant:	Checked, 1800 sec
Integral Thermostat:	Unchecked
Maximum Speed:	4000 RPM

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Troubleshooting Custom Motor Files

Problem	Possible Causes
Motor locks at a certain location. Motor jumps once at startup. Motor runs away. Low torque production.	1. Motor phasing is incorrect. 2. Hall Offset is incorrect. 3. Incorrect startup commutation. 4. Incorrect encoder phasing. 5. Incorrect pole count. 6. Incorrect encoder linecount.
High audible noise from motor. Velocity loop difficult to stabilize. Shaft vibration.	1. Incorrect motor resistance. 2. Incorrect motor inductance. 3. Inductance too low. 4. Electrical time constant too low. 5. Low encoder linecount.
Underdamped velocity response. Overdamped velocity response.	1. Incorrect motor inertia. 2. Incorrect torque constant.

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Electromagnetic Compatibility Guidelines for Machine Design

This appendix provides background information about Electromagnetic Interference (EMI) and machine design guidelines for Electromagnetic Compatibility (EMC). Installation requirements for compliance to the European Electromagnetic Compatibility Directive are specified in “European Union Requirements” on page 3-9. AC Line Filters necessary for European EMC compliance are listed in “AC Line Filters” on page 5-8.

Perhaps no other subject related to the installation of industrial electronic equipment is so misunderstood as electrical noise. The subject is complex and the theory easily fills a book. This section provides guidelines that can minimize noise problems.

The majority of installations do not exhibit noise problems. However, the filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

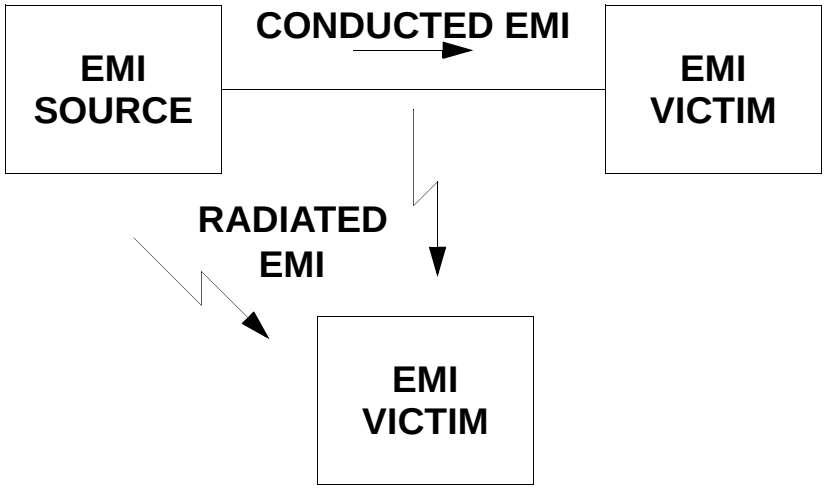
Electrical noise has two characteristics: the generation or emission of electromagnetic interference (EMI), and response or immunity to EMI. The degree to which a device does not emit EMI, and is immune to EMI is called the device’s Electromagnetic Compatibility (EMC).

Equipment which is to be brought into the European Union legally requires a specific level of EMC. Since this applies when the equipment is brought into use, it is of considerable importance that a drive system, as a component of a machine, be correctly installed.

“EMI Source-Victim Model” shows the commonly used EMI model. The model consists of an EMI source, a coupling mechanism and an EMI victim. Devices such as servo drives and computers, which contain switching power supplies and microprocessors, are EMI sources. The mechanisms for the coupling of energy between the source and victim are conduction and radiation. Victim equipment can be any electromagnetic device that is adversely affected by the EMI coupled to it.

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Figure E.1 EMI Source-Victim Model



Immunity to EMI is primarily determined by equipment design, but how you wire and ground the device is also critical to achieving EMI immunity. Therefore, it is important to select equipment that has been designed and tested for industrial environments. The EMI standards for industrial equipment include the EN61000-4-X series (IEC 1000-4-X and IEC801-X), EN55011 (CISPR11), ANSI C62 and C63 and MIL-STD-461. Also, in industrial environments, you should use encoders with differential driver outputs rather than single ended outputs, and digital inputs/outputs with electrical isolation, such as those provided with optocouplers.

The EMI model provides only three options for eliminating the EMC problem:

- reduce the EMI at the source,
- increase the victim's immunity to EMI (harden the victim), or
- reduce or eliminate the coupling mechanism.

In the case of servo drives, reducing the EMI source requires slowing power semiconductor switching speeds. However, this adversely affects drive performance with respect to heat dissipation and speed/torque regulation. Hardening the victim equipment may not be possible, or practical. The final, and often the most realistic solution is to reduce the coupling mechanism between the source and victim. This can be achieved by filtering, shielding and grounding.

Filtering

As mentioned above, high frequency energy can be coupled between circuits via radiation or conduction. The AC power wiring is one of the most important paths for both types of coupling mechanisms. The AC line can conduct noise into the drive from other devices, or it can conduct noise directly from the drive into other devices. It can also act as an antenna and transmit or receive radiated noise between the drive and other devices.

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One method to improve the EMC characteristics of a drive is to use an isolation AC power transformer to feed the amplifier its input power. This minimizes inrush currents on power-up and provides electrical isolation. In addition, it provides common mode filtering, although the effect is limited in frequency by the interwinding capacitance. Use of a Faraday shield between the windings can increase the common mode rejection bandwidth, (shield terminated to ground) or provide differential mode shielding (shield terminated to the winding).

Note: "Common mode" noise is present on all conductors referenced to ground. "Differential mode" noise is present on one conductor referenced to another conductor.

One alternative to AC line filters to reduce the conducted EMI emitting from the drive. This allows nearby equipment to operate undisturbed. In many cases an AC line filter will not be required unless other sensitive circuits are powered off the same AC branch circuit. The basic operating principle is to minimize the high frequency power transfer through the filter. An effective filter achieves this by using capacitors and inductors to mismatch the source impedance (AC line) and the load impedance (drive) at high frequencies.

For drives brought into use in Europe, use of the correct filter is essential to meet emission requirements. Detailed information on filters is included in the manual and transformers should be used where specified in the manual.

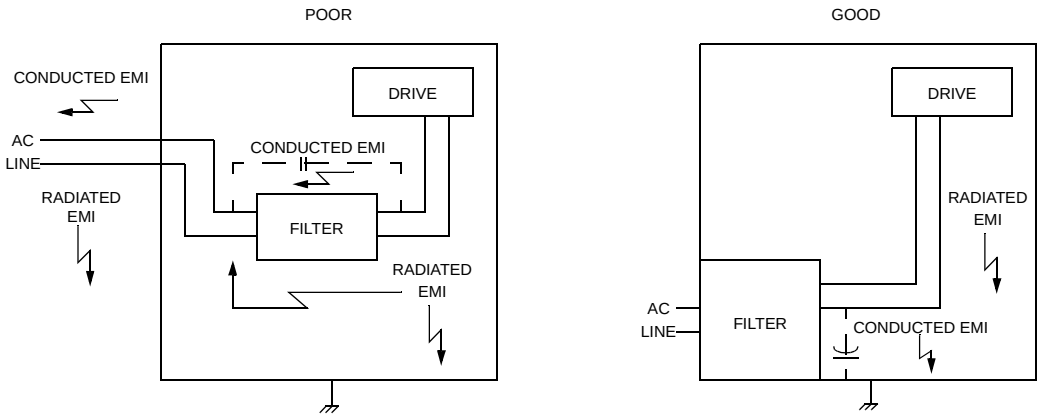
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AC Line Filter Selection

Selection of the proper filter is only the first step in reducing conducted emissions. Correct filter installation is crucial to achieving both EMI attenuation and to ensure safety. All of the following guidelines should be met for effective filter use.

1. The filter should be mounted to a grounded conductive surface.
2. The filter must be mounted close to the drive input terminals, particularly with higher frequency emissions (5-30 MHz). If the distance exceeds 600mm (2 feet), a strap should be used to connect the drive and filter, rather than a wire.
3. The wires connecting the AC source to the filter should be shielded from, or at least separated from the wires (or strap) connecting the drive to the filter. If the connections are not segregated from each other, then the EMI on the drive side of the filter can couple over to the source side of the filter, thereby reducing, or eliminating the filter effectiveness. The coupling mechanism can be radiation, or stray capacitance between the wires. The best method of achieving this is to mount the filter where the AC power enters the enclosure. “AC Line Filter Installation” shows a good installation and a poor installation.

Figure E.2 AC Line Filter Installation



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When multiple power cables enter an enclosure, an unfiltered line can contaminate a filtered line external to the enclosure. Therefore, all lines must be filtered to be effective. The situation is similar to a leaky boat. All the holes must be plugged to prevent sinking.



ATTENTION: Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels prior to handling the equipment. Failure to observe this precaution could result in severe bodily injury.

If the filter is mounted excessively far from the drive, it may be necessary to mount it to a grounded conductive surface, such as the enclosure, to establish a high frequency (HF) connection to that surface. To achieve the HF ground, direct contact between the mounting surface and the filter must be achieved. This may require removal of paint or other insulating material from the cabinet or panel.

The only reasonable filtering at the drive output terminals is the use of inductance. Capacitors would slow the output switching and deteriorate the drive performance. A common mode choke can be used to reduce the HF voltage at the drive output. This will reduce emission coupling through the drive back to the AC line. However, the motor cable still carries a large HF voltage and current. Therefore, it is very important to segregate the motor cable from the AC power cable. More information on cable shielding and segregation is contained in the section on shielding.

Grounding

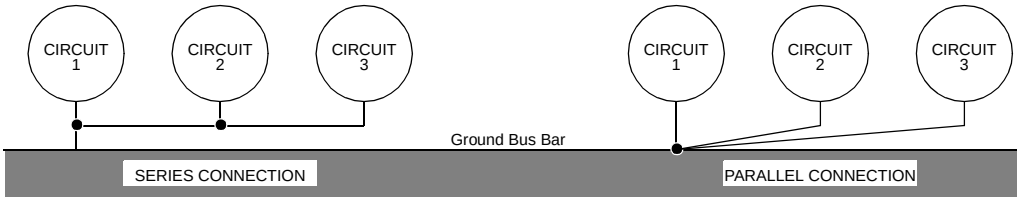
High frequency (HF) grounding is different from safety grounding. A long wire is sufficient for a safety ground, but is completely ineffective as an HF ground due to the wire inductance. As a rule of thumb, a wire has an inductance of 8 nH/in regardless of diameter. At low frequencies it acts as a constant impedance, at intermediate frequencies as an inductor, and at high frequencies as an antenna. The use of ground straps is a better alternative to wires. However the length to width ratio must be 5:1, or better yet 3:1, to remain a good high frequency connection.

The ground system's primary purpose is to function as a return current path. It is commonly thought of as an equipotential circuit reference point, but different locations in a ground system may be at different potentials. This is due to the return current flowing through the ground systems finite impedance. In a sense, ground systems are the sewer systems of electronics and as such are sometimes neglected.

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The primary objective of a high frequency ground system is to provide a well defined path for HF currents and to minimize the loop area of the HF current paths. It is also important to separate HF grounds from sensitive circuit grounds. “Single Point Ground Types” shows single point grounds for both series (daisy chain) and parallel (separate) connections. A single point, parallel connected ground system is recommended.

Figure E.3 Single Point Ground Types



A ground bus bar or plane should be used as the “single point” where circuits are grounded. This will minimize common (ground) impedance noise coupling. The ground bus bar (GBB) should be connected to the AC ground, and if necessary, to the enclosure. All circuits or subsystems should be connected to the GBB by separate connections. These connections should be as short as possible, and straps should be used when possible. The motor ground conductor must return to the ground terminal on the drive, not the GBB.

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Shielding and Segregation

The EMI radiating from the drive enclosure drops off very quickly over distance. Mounting the drive in an enclosure, such as an industrial cabinet, further reduces the radiated emissions. The cabinet should have a high frequency ground and the size of the openings should be minimized. In addition, the drive is considered an “open” device which does not provide the proper IP rating for the environment in which it is installed. For this reason the enclosure must provide the necessary degree of protection. An IP rating or Nema rating (which is similar to IP) specifies the degree of protection that an enclosure provides.

The primary propagation route for EMI emissions from a drive is through cabling. The cables conduct the EMI to other devices, and can also radiate the EMI. For this reason, cable segregation and shielding are important factors in reducing emissions. Cable shielding can also increase the level of immunity for a drive. For example:

- Shield termination at both ends is extremely important. The common misconception that shields should be terminated at only one end originates from audio applications with frequencies $\leq$20 kHz. RF applications must be terminate the shield at both ends, and possibly at intermediate points for exceptionally long cables.
- When shielded cables are not terminated at the cable connection and pass through the wall of a cabinet, the shield must be bonded to the cabinet wall to prevent noise acquired inside the cabinet from radiating outside the cabinet, and vice versa.
- When shielded cables are terminated to connectors, the shield must be provide complete 360° coverage and terminate through the connector backshell. The shield must *no*t be grounded inside the connector through a drain wire. Grounding the shield inside the connector couples the noise on the shield to the signal conductors sharing the connector and virtually guarantees failure to meet European EMC requirements.
- The shield must be continuous. Each intermediate connector must continue the shield connection through the backshell.
- All cables, both power and signal, should use twisted wire pairing.

The shield termination described above provides a coaxial type of configuration which provides magnetic shielding, and the shield provides a return path for HF currents that are capacitively coupled from the motor windings to the frame. If power frequency circulating currents are an issue, a 250 VAC capacitor should be used at one of the connections to block 50/60 Hz current while passing HF currents. Use of a properly shielded motor cable is essential to meet European EMC requirements.

The following suggestions are recommended for all installations.

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1. Motor cables must have a continuous shield and be terminated at both ends. The shield must connect to the ground bus bar or drive chassis at the drive end, and the motor frame at the motor end. Use of a properly shielded motor cable is essential to meet European EMC requirements.

2. Signal cables (encoder, serial, analog) should be routed away from the motor cable and power wiring. Separate steel conduit can be used to provide shielding between the signal and power wiring. Do not route signal and power wiring through common junctions or raceways.

3. Signal cables from other circuits should not pass within 300 mm (1 ft.) of the drive.

4. The length or parallel runs between other circuit cables and the motor or power cable should be minimized. A rule of thumb is 300 mm (1 ft.) of separation for each 10 m (30 ft.) of parallel run. The 30 mm (1 ft.) separation can be reduced if the parallel run is less than 1 m (3 ft.).

5. Cable intersections should always occur at right angles to minimize magnetic coupling.

6. The encoder mounted on the brushless servo motor should be connected to the amplifier with a cable using multiple twisted wire pairs and an overall cable shield. Encoder cables are offered in various lengths that have correct terminations.

Persistent EMI problems may require additional countermeasures. The following suggestions for system modification may be attempted.

1. A ferrite toroid or “doughnut” around a signal cable may attenuate common mode noise, particularly RS-232 communication problems. However, a ferrite toroid will not help differential mode noise. Differential mode noise requires twisted wire pairs.

2. Suppress each switched inductive device near the servo amplifier. Switch inductive devices include solenoids, relay coils, starter coils and AC motors (such as motor driven mechanical timers).

3. DC coils should be suppressed with a “free-wheeling” diode connected across the coil.

4. AC coils should be suppressed with RC filters (a 200 Ohm ½ Watt resistor in series with a 0.5 uF, 600 Volt capacitor is common).

Following these guidelines can minimize noise problems. However, equipment EMC performance must meet regulatory requirements in various parts of the world, specifically the European Union. Ultimately, it is the responsibility of the machine builder to ensure that the machine meets the appropriate requirements as installed.

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DynamicBrakingResistorSelection

This appendix provides equations to assist in sizing resistors for dynamic braking.

A properly sized resistive load may be required to dynamically brake the system by dissipating the energy stored in a motor. The section “Emergency Stop Wiring” on page 7-5 depicts the necessary circuitry.

Winding inductance is ignored in this analysis, which allows the load on the motor winding to be considered as purely resistive when dynamic braking occurs. This simplifies the evaluation to a scalar analysis, instead of a vector analysis. For simplicity, friction, damping and load torque also are ignored in the equations.

Dynamic Braking Equations

Equations for the magnitutde of instanteous velocity, and per phase current, energy and power are derived by solving the differential equation governing the motor velocity. The equations are shown below.

Table F.1: Dynamic Braking Resistor Parameters

Parameter	Description	Parameter	Description
i(t)	Phase Current	R_L	Line-Neutral Dynamic Braking Resistance
E(t)	Per Phase Energy	K_E	Peak Line-to-Line Back EMF
J_m	Motor Inertia	K_T	Peak Line-to-Line Torque Constant
J_L	Load Inertia	ω_o	Initial Angular Velocity
P(t)	Per Phase Power	w	Angular Velocity
R	Motor Line-to-Line Resistance	t	Time

$$\omega(t) = \omega_o e^{-t/\tau}$$

where

$$\tau = 0.866\left[\frac{(R + 2R_L)(J_M + J_L)}{K_E K_T}\right] \quad (1)$$

$$i(t) = \frac{K_E \omega_o e^{-t/\tau}}{0.866(R + 2R_L)}$$

$$E(t) = \frac{1}{2}(J_L + J_M)\omega_o^2 e^{-2t/\tau}$$

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$$P(t) = \left[\frac{(J_L + J_M)\omega_o^2}{2\tau}\right] e^{-2t/\tau} = 1.154\left[\frac{K_E K_T \omega_o^2}{(R + 2R_L)}\right] e^{-2t/\tau} \quad (2)$$

For this type of response, 98% of the energy will be dissipated in 4 time constants. Therefore the average power for each dynamic braking event can be calculated as:

$$P_{AVE} = \frac{1}{2}(J_M + J_L)\omega_o^2\left(\frac{1}{4\tau}\right) = 0.144\frac{K_E K_T \omega_o^2}{(R + 2R_L)} \quad (3)$$

Equation 1 is used in equation 2 and 3 to put the power in terms of the motor parameters and the dynamic braking resistance (i.e., independent of the load inertia).

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Sample Calculations

The following example uses an H4075 motor with a 10 times inertia mismatch and dynamic braking resistors sized at four times the motor winding resistance. The average power of the motor is 1116 Watts for the selected paramters, but it is unlikely that a resistor with this Wattage is required. Pulse type currents, such as this example, require sufficient thermal mass to absorb the energy and to dissipate or accomodate the peak Voltage. Adequate information for intermittent duty cycle and surge current applications is seldom provided by resistor manufacturers. However, often they will assist in resistor selection when supplied with the current profile.

Note: The equations using the symbol ":=" are "assigned" in Mathcad®.

H4075 Motor Parameters in MKS Units:

$K_T := 0.74$ $R := 0.9$ $J_m := 0.00068$

$K_E := 90$ $K_E := \frac{K_E \cdot 60}{2 \cdot \pi \cdot 1000}$ $K_E = 0.859$

Load Inertia, Dynamic Braking Resistance and Velocity in MKS Units:

$R_L := 4 \cdot R$ $J_L := 10 \cdot J_m$ $\omega_o := \frac{3000 \cdot 2 \cdot \pi}{60}$ $\omega_o = 314.159$

Time vector:

$t := 0, 0.01, \ldots 0.5$

Time Constant (seconds):

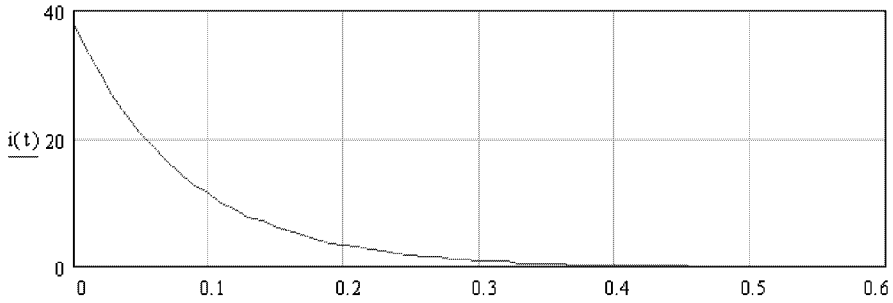
$\tau := \frac{0.866(R + 2 \cdot R_L) \cdot (J_m + J_L)}{K_E \cdot K_T}$ $\tau = 0.083$

Current Calculation (Amps):

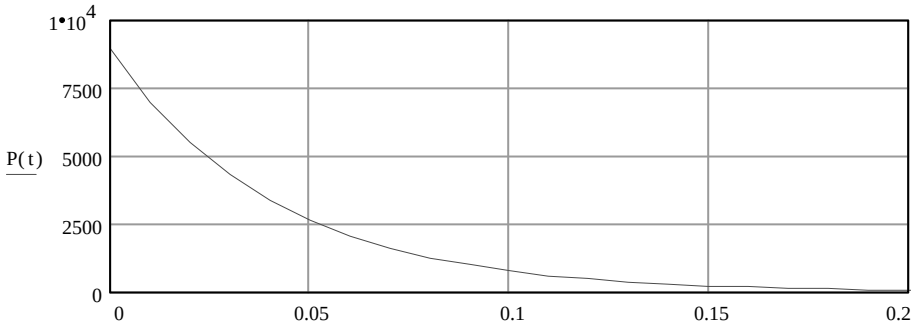
Instantaneous Power Calculation (Watts):

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$$i(t) := \frac{K_E \cdot \omega_o \cdot e^{\frac{-t}{\tau}}}{0.866(R + 2 \cdot R_L)}$$



$$P(t) := \left[\frac{1.154 \cdot K_E \cdot K_T \cdot \omega_o^2}{(R + 2 \cdot R_L)}\right] \cdot e^{\frac{-2 \cdot t}{\tau}}$$



Average Power (Watts):

$$P_{ave} := 0.144\left[\frac{K_E \cdot K_T \cdot \omega_o^2}{R + 2 \cdot R_L}\right]$$

$$P_{ave} = 1116$$

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Specifications

Agency Approvals	
UL and cUL	UL 508C File E145959
CE mark	Low Voltage Directive and Electromagnetic Compatibility Directive Certificate of Conformity from TUV Product Service
Environmental	
Operating Temperature	0^{o}C to 55^{o}C (32^{o}F to 131^{o}F)
Storage Temperature	-40^{o}C to 70^{o}C (-40^{o}F to 158^{o}F)
Humidity	5% to 95% non-condensing
Altitude	1500 meters (5000 feet) Derate 3% for each 300 m above 1500 m (1000 ft. above 5000 ft.)
Vibration	10 to 2000 Hz @ 2g
Shock	15g 11 millisecond half sine
Dielectric Withstanding (Hi-Pot)	
Main AC	1414 (1500) VDC for 1 minute, <5mA leakage current
NOTE: Metal Oxide Varistors (MOVs) between line and earth ground must be removed when testing. Internal EMI filter capacitors require testing with DC Voltage.	
Weight	
1398-DDM-005, -005X	1.7 Kg (3.7 Lbs)
1398-DDM-009, 009X	2.05 Kg (4.5 Lbs)
1398-DDM-019, -019X	2.0 Kg (4.4 Lbs)
Motor Encoder Interface	
Signal Output Power	5 Volts DC
Encoder Inputs	A/B, Differential, 26LS33 input, 1 MHz (4 MHz Quadrature) Maximum Signal Frequency, 1/T Low Speed Measurement
Thermostat Inputs	Normally closed
Hall Inputs	Single-ended, 5 Volt Logic
ABS Input	0 to 5 Volt, 10-bit
User Interface	
Serial Port	RS-232 or four wire RS-485, 1200 to 19200 baud
Status Display	3 Level LED
Addressing	Software selected
Digital Inputs	
Selectable (4)	12-24 Volt, Optically Isolated, Single ended, Active High, 4.5 mA nominal
ENABLE	12-24 Volt, Optically Isolated, Single ended, Active High, 4.5 mA nominal. Minimum ON time = 1.5 msec.

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	Digital Outputs
Selectable (2)	12-24 Volt, Short Circuit Protected, Optically Isolated, Single-ended, Active High, 50 mA maximum
BRAKE	Normally Open Relay, 1 A
READY	Normally Open Relay, 100 mA
Digital I/O Power Supply	User supplied 12 to 24 VDC
	Analog Inputs
Current Limit (I LIMIT)	0 to 10 Volt, single-ended, 5 kOhm input Impedance
COMMAND	±10 Volt, Differential, 13 kOhm input Impedance, offset software adjustable
	Analog Outputs
ANALOG1	0 to 10 Volt, 8 bits, 2 mA maximum
	Auxiliary Encoder Input
Auxiliary Encoder Signal Input	26LS33 Input, 4 MHz Count Frequency Differential/Single-ended A/B Step/Direction CW/CCW
	Motor Encoder Output
Motor Encoder Output	AM26C31 or AM26LS31 Differential Driver, Divide by 1, 2, 4, or 8 Differential output is 2.0 Vdc across a 100 Ohm load
	Memory
Parameter Data Retention	20 years
	Motor Protection
Motor Overload Protection	The drive utilizes solid state motor overload protection which operates: • within 8 minutes at 200% overload • within 20 seconds at 600% overload
	Speed Regulation
Type	Digital, PI
-3dB Bandwidth	300 Hz
-45° Bandwidth	50 Hz
Ripple	±0.44 rpm with 5000 line encoder
Speed Range	1:8000 rpm
	Position Regulation
Type	Digital, PI with Feedforward
	Filters
Low Pass	Digital, 0 - 1000 Hz, -3 dB Bandwidth, Selectable

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	Software Controls
Data Collection (2)	128 samples @ 5 kHz Sample Rate
Firmware	Factory installed EEPROM
Operating Modes	Torque, Velocity or Position
Command Sources	Analog
	Auxiliary Encoder
	Presets
	Step/Direction
	CW/CCW
	Indexing: Incremental, Registration, Absolute (Indexing on 1398-DDM-005X, -009X and -019X only)
Autotuning	Position and
	Velocity Loop
Manual Tuning	Position or
	Velocity Loop
User Set-up	ULTRA Master or TouchPad
Diagnostics	Motor or Auxiliary Encoder Checks
	Digital Output Override
	Analog Output Override
Serial Protocol	7-bit ASCII, Checksum, Active Response

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	Software Controls (cont.)
Power-Up Faults	EPROM Checksum
	EEPROM Checksum
	SRAM Write/Read
	Watchdog Reset
	A/D Conversion
	D/A Conversion
Run-Time Faults	Motor Overtemperature
	Bus Overvoltage
	IPM Fault
	Overspeed
	Excess Error
	Encoder State Change
	Illegal Hall State
Selectable Digital Inputs	Drive Mode Select
	Integrator Inhibit
	Follower Enable
	Forward Enable
	Reverse Enable
	Operation Mode Override
	Preset Selects
	Start Index
	Define Home
	Remove Command Offset
	Start Homing
	Sensor
Selectable Digital Outputs	In-Position
	Within Window
	Zero Speed
	Speed Window
	± Current Limit
	Up To Speed
	Drive Enabled
	Bus Charged
	Disabling Motion
	In Motion
	In Dwell
	Sequence Complete
	Registered
	At Home
	Axis Homed
	Speed Control Command
Range	0 to ±32,767 RPM (actual maximum speed depends on the motor/drive combination)

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Power

	1398-DDM-005 & 1398-DDM-005X	1398-DDM-009 & 1398-DDM-009X	1398-DDM-019 & 1398-DDM-019X
AC Input Voltage and Frequency	100-240 Vac_{rms} nominal Single Phase 47 - 63 Hz	100-240 Vac_{rms} nominal Single Phase 47 - 63 Hz	100-240 Vac_{rms} nominal Single Phase 47 - 63 Hz
AC Input Current	5 A_{rms}	9 A_{rms}	18 A_{rms}
Bus Voltage	141-339 Vdc	141-339 Vdc	141-339 Vdc
Output Peak Current	7.5 Amps	15 Amps	30 Amps
Continuous Output Current (peak)	2.5 Amps	5 Amps	10 Amps
Bus Capacitance Energy Absorption (from 325-400 Vdc Bus)[a]	38 Joules C=1410uF	51 Joules C=1880uF	51 Joules C=1880uF
Peak Power Output[b]	120 Vac 0.9 kWatts 240 Vac1.8 kWatts	120 Vac 1.3 kWatts 240 Vac 2.7 kWatts	120 Vac 2.7 kWatts 240 Vac 5.5 kWatts
Continuous Power Output[b]	120 Vac 0.3 kWatts 240 Vac 0.6 kWatts	120 Vac 0.6 kWatts 240 Vac 1.2 kWatts	120 Vac 1.2 kWatts 240 Vac 2.5 kWatts

a. Bus capacitance energy absorption is based on the following equations:

$$\varepsilon = \frac{1}{2}C(V^2_f) - \frac{1}{2}C(V^2_i)$$

$$\varepsilon = \frac{1}{2}C(420)^2 - \frac{1}{2}C(325)^2$$

$$\frac{1}{2}C \cdot (420^2 - 325^2) = C(35387)$$

$$\text{if} C = 17 \times 470\text{uF}, E = 282$$

b. Power outputs are based on the following equation:

$$\text{kWatts} = \left(\text{VAC} \times \frac{I_{Rmax}}{\sqrt{2}} \times \sqrt{3}\right) \times 0.85$$

Power Dissipation

ULTRA 100 Series drives dissipate power that results in cabinet heating. The following table lists power dissipation values. Calculate the cabinet cooling requirements using the power dissipation information and formulas below.

Current as % of Rated Continuous Current	1398-DDM-005 & 1398-DDM-005X	1398-DDM-009 & 1398-DDM-009X	1398-DDM-019 & 1398-DDM-019X
100	48 W	48 W	50 W
NOTE: These values do *not* include external shunt regulator power (regenerated power).			

Maximum power losses are shown to help size a NEMA 12 or equivalent enclosure and to ensure the required ventilation. Typical power losses are about one-half maximum power losses.

When sizing an enclosure with no active method of heat dissipation, the following equation approximates the size of enclosure necessary:

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$$T = 4.08 * (Q/A) + 1.1$$

where:
T = Temperature difference between inside air and outside ambient (°F)
Q = Heat generated in enclosure (watts)
A = Enclosure surface area in ft.^{2} = (2dw + 2dh + 2wh) / 144
d = Depth in inches
h = Height in inches
w = Width in inches

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