Allen-Bradley

ULTRA 200 Series Digital Servo Drives

User Manual

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.

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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Preface

This manual provides a step-by-step approach to building a servo system using a ULTRA 200 Series drive. The manual is divided into chapters that cover specific phases of the system design process; from ordering components that will complement the performance of the ULTRA 200 Series drive, to receiving, installing and verifying the drive's functionality.

Chapters and appendices in the manual include:

- Safety
- Selecting Other System Components
- ULTRA Master Installation
- Unpacking, Inspecting and Storing
- Installation
- Interfaces
- Power Connections
- Application and Configuration Examples
- Tuning
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- Cable Diagrams, Schematics and Examples
- TouchPad Instructions
- Creating Custom Motor Files
- Electromagnetic Compatibility Guidelines for Machine Design
- Dynamic Braking Resistor Selection
- Specifications

The intent of the manual is to assemble a high-performance servo system in a methodical manner. By making correct decisions and taking appropriate actions a servo system that performs "as designed" can be assured.

About This Manual

This manual provides instructions on how to setup and connect the ULTRA 200 Series drive to a controlling device and a motor. A ULTRA 200 Series drive may operate in one of several different functional modes. The hardware connections necessary to run the drive are explained and basic software instructions are provided for common set up procedures. For detailed explanation of software instructions, refer to the comprehensive on-line instructions available in the ULTRA Master software.

This manual explains how to install your ULTRA 200 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.

This manual is organized into chapters and appendixes. 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	Reviews the major features of the ULTRA 200 Series drives and identifies motors and signal types that are compatible.
ULTRA Master Installation	Explains how to install, access and exit ULTRA Master.
Unpacking, Inspecting and Storing	Lists what should be included with your ULTRA 200 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 200 Series drive.
Interfaces	Provides comprehensive information about the signals available on each connector. 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 under the following connectors. • J1 – Controller Diagrams show cable connections needed for common interfaces. • J2 – Encoder Details information about the encoder signals, Hall Effect switches and thermostat connections available through this connector. • J3 – Auxiliary Port Provides a second controller connection that duplicates the first 26 pins on J1, the Controller connector • J4 and J5 – Serial Port Diagrams and instructions detail how to connect one or more drives using RS-232 communications in a single or daisy-chain connection, or to connect several drives using Multi-Drop RS-485. • A1, A2, and COM – Analog Outputs Describes the connections that allow monitoring of the analog command signals with external equipment.

Title	Description
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: • Analog Control in velocity or torque mode • Preset Controller in velocity or torque mode • Position Follower (Master Encoder) in velocity mode • Position Follower (Step/Direction) in velocity mode • Position Follower (Step Up/Step Down) in velocity mode • Incremental Indexing • Registration Indexing • Absolute Indexing • Modifying User Units
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 operator indicators available on the front panel. Operating or Error Messages are explained.
Maintenance and Troubleshooting	Describes the minimal maintenance necessary with the ULTRA 200 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 200 Series drives.
Cable Diagrams, Schematics and Examples	Provides schematics and cabling examples.
TouchPad Instructions	Describes how to program a ULTRA 200 Series drive using the optional TouchPad device. Tables reference the various motor types that are programmed to work with the ULTRA 200 Series drive. A *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 200 Series drive.
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 200 Series drives in a tabular format.

Additional Instructions and Manuals

Host Commands and ULTRA Master

All ULTRA 200 Series drives are setup through serial Host Commands. The drives may 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 on-line. Host Command information is available through a comprehensive on-line reference manual. ULTRA Master information is available through Help menus. The on-line documents provide 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 200 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 may be used to monitor and configure the ULTRA 200 Series drive. The TouchPad command structure is similar to the structure of ULTRA Master, but operates through an abbreviated keypad interface. The card *TouchPad Instructions* 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 Instructions” which begins on page C-1. The *TouchPad Command Tree Card* is a graphical presentation of both the operational instructions and the command structure for the ULTRA 200 Series drives. You may find it convenient to refer to the card when using the TouchPad with a drive.

Symbols and Conventions

Typographical and Wording Conventions

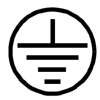
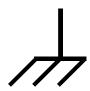
This manual uses the following typographical and wording conventions:

Example	Description
»	Text preceded by right guillemet explains how to access the particular function in the preceding paragraph. For example, To Start ULTRA Master in Windows » Choose the icon ULTRA Master.
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.

Graphical Symbols and Warning Classifications

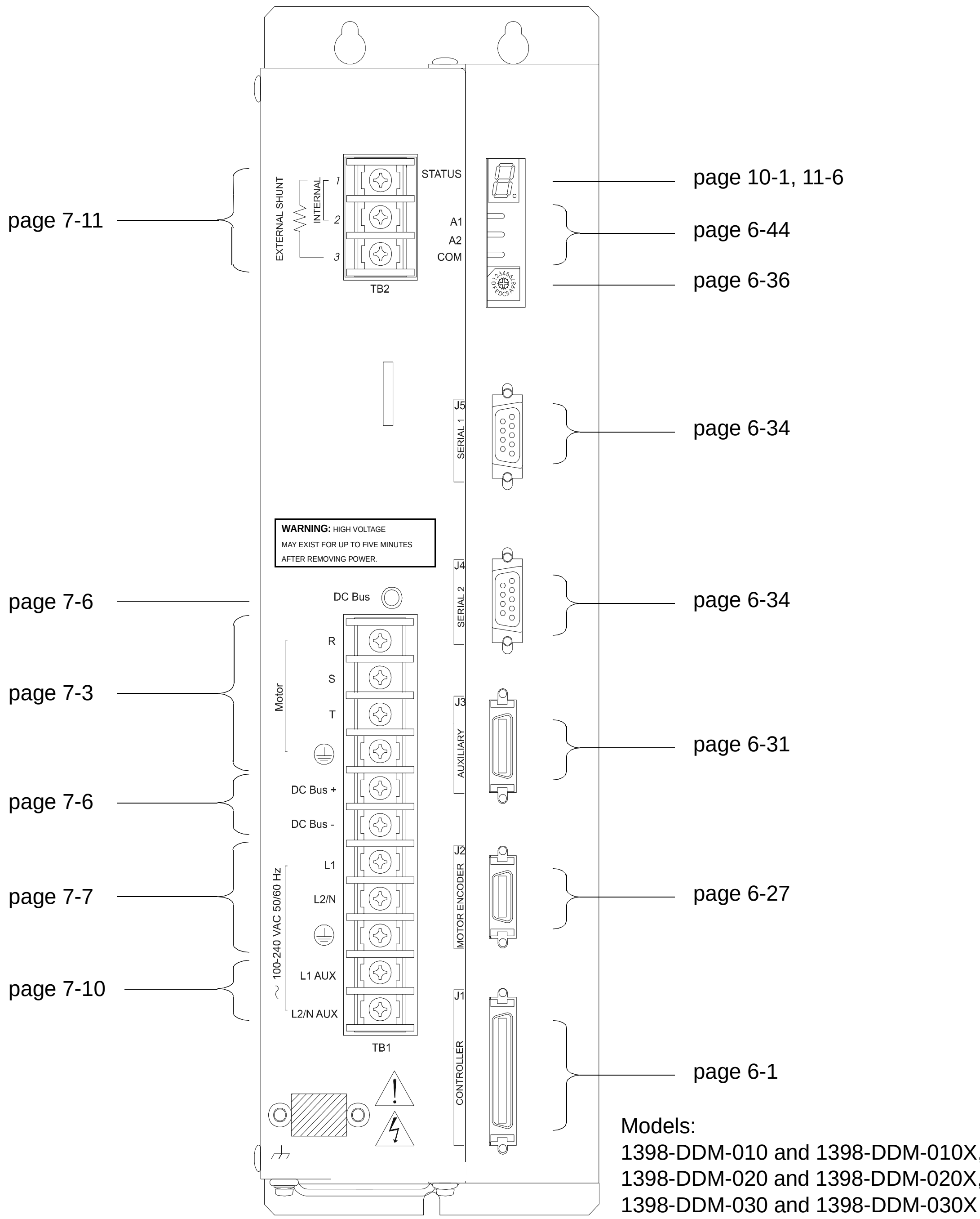
This manual uses the following graphical symbols and warning classifications. The use of a symbol and signal word is based on an estimation of the likelihood of exposure to the hazardous situation and what could happen as a result of exposure to the hazard.

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.

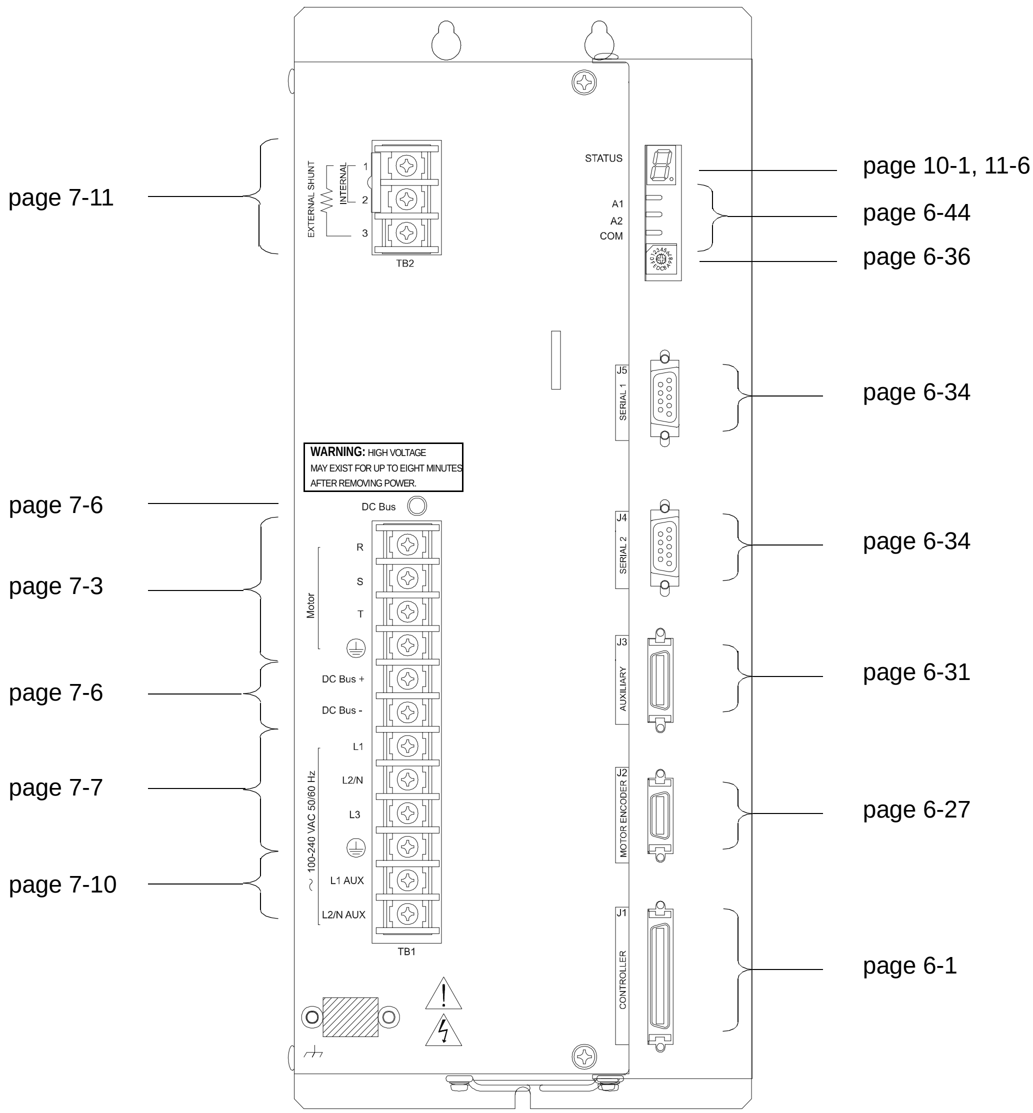
Pictorial Index

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

Product Parts Explained (sheet 1 of 3)

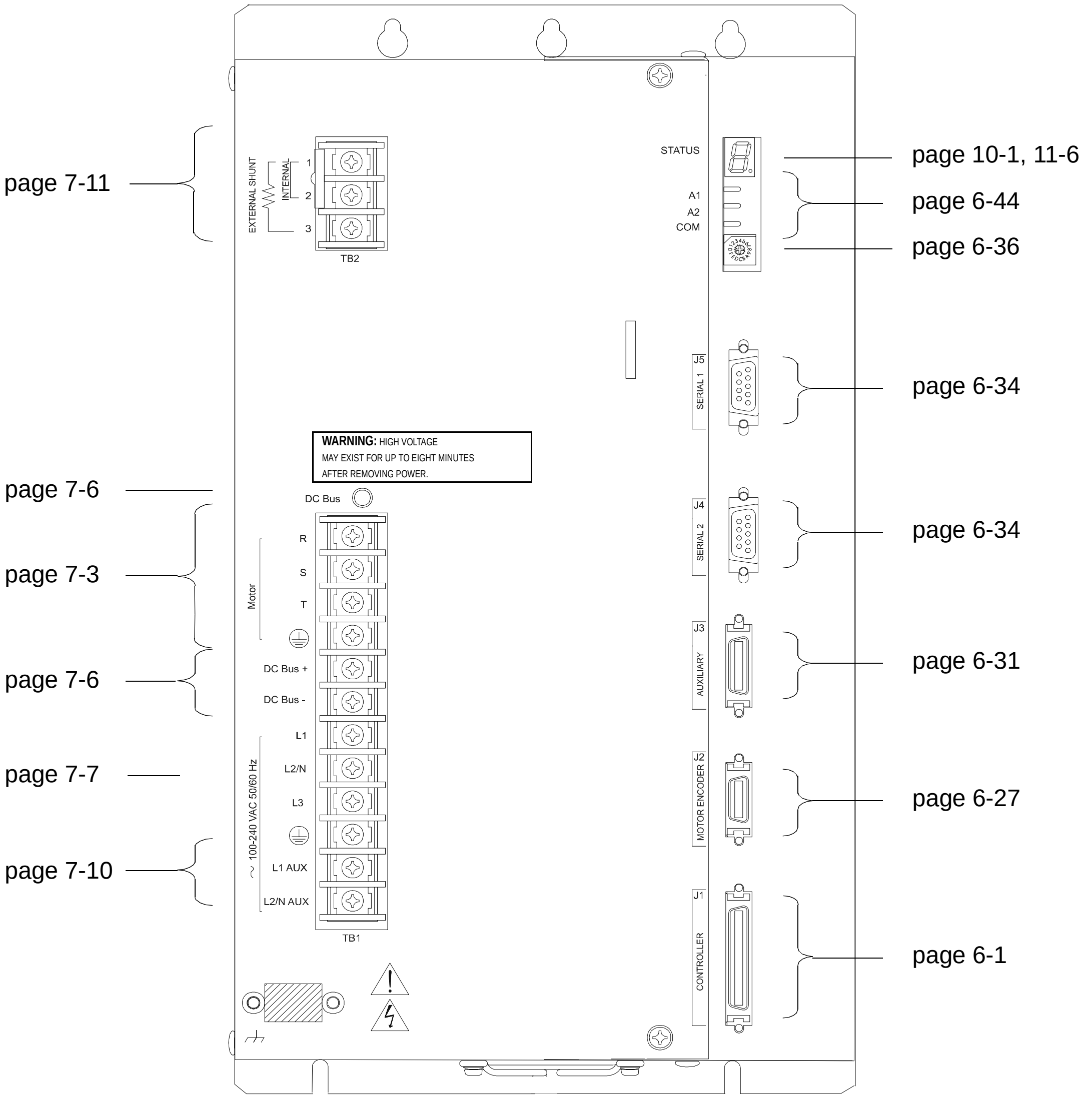


Product Parts Explained (sheet 2 of 3)



Models:
1398-DDM-075 and 1398-DDM-075X

Product Parts Explained (sheet 3 of 3)



Models:
1398-DDM-150 and 1398-DDM-150X

Safety

Installing and Using the ULTRA 200 Series

Read the complete manual before attempting to install or operate the ULTRA 200 Series drive. By reading the manual you will become familiar with practices and procedures that allow you to operate the ULTRA 200 Series drive safely and effectively.

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. The main hazards which can be encountered in the use of this equipment are:

- Electric shock hazards
- Electric fire hazards
- Mechanical hazards
- Stored energy hazards

These hazards must be controlled by suitable machine design, using the safety guidelines which follow. There are no chemical or ionizing radiation hazards.

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 exceed 450 VDC or 240 VAC within the ULTRA 200 Series. All circuits, including the connections on the front panel, should be considered “hot” when main or auxiliary 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 official First Aiders.

Safety Guidelines

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.

- 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.
- 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. These safety notes do not represent a complete list of the steps necessary to ensure safe operation of the equipment. Contact your nearest Allen-Bradley representative for additional information.

- 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.
- All non-qualified personnel are kept at 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 and auxiliary power and measure the DC bus voltage to verify it has reached a safe level or wait for the time indicated in the warning 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 ULTRA 200 Series.
- Never connect the DC- 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 the ULTRA 200 Series before maintaining or repairing the unit.
- When operating a 1398-DDM-075 or 1398-DDM-075X with a single phase power input, the current limits must be set correctly.
- Motors without thermal protection devices require a valid thermal time constant. Otherwise the motor overload protection will not function properly.

Selecting Other System Components

The Allen-Bradley ULTRA 200 Series drives are part of a family of digital drives that use microcontrollers to 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.

This chapter reviews the ULTRA 200 Series and associated motors, command sources and interfaces. Selection of complementary servo components allows you to efficiently connect other devices to your ULTRA 200 Series drive. Pertinent information about each is provided to assist you in planning your servo system.

ULTRA 200 Series Overview

Drive Power Ratings

Several power levels of ULTRA 200 Series drives are available. All models have integral power supplies and shunt regulators and are functionally equivalent. They differ only in output power and physical size:

- 1398-DDM-010 and 1398-DDM-010X with continuous output power of 1000 Watts using a single phase power source
- 1398-DDM-020 and 1398-DDM-020X with continuous output power of 2000 Watts using a single phase power source
- 1398-DDM-030 and 1398-DDM-030X with continuous output power of 3000 Watts using a single phase power source
- 1398-DDM-075 and 1398-DDM-075X with continuous output power of 3000 Watts using a single phase power source
- 1398-DDM-075 and 1398-DDM-075X with continuous output power of 7500 Watts using a three phase power source
- 1398-DDM-150 and 1398-DDM-150X with continuous output power of 15000 watts using a three phase power source.

The ULTRA 200 Series drives, when combined with Allen-Bradley brushless servomotors, provide continuous torque ranging from 0.34 Nm to 50.8 Nm (3 to 450 lb-in) and peak torque ranging from 1.02 Nm to 125 Nm (9 lb-in to 1100 lb-in).

Interface Cables

Standard Allen-Bradley 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 these cables is required for compliance to the European Electromagnetic Compatibility (EMC) Directive and to protect your warranty rights.

ULTRA 200 Series Features

Stand-alone Design

A single unit fully encloses all electronics, including both the power supply and a built-in shunt regulator. An external transformer is *not* required on the main power line. All connectors and indicators are accessible and clearly marked on the front panel.

High Performance Microcontroller Technology

Dual microcontrollers perform all digital current, velocity and position loop calculations as well as the motor commutation calculation.

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

- ±10 Volt analog interface – position, 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 (available only on 1398-DDM-010X, 1398-DDM-020X, 1398-DDM-030X, 1398-DDM-075X and 1398-DDM-150X.

Encoder Control

A single, motor mounted encoder provides complete commutation information and velocity feedback.

Encoder Output

A selectable output allows the encoder resolution to be specified for maximum performance without adding circuitry. Outputs are differential line drivers capable of dividing the motor encoder signal, PPR (pulses per revolution), 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. Selections include:

- Five selectable, 24 Volt, current sinking, optically isolated, active high inputs.
- One dedicated, control (ENABLE), current sinking, optically isolated, active high input.
- Four selectable, 24 Volt, current sourcing, optically isolated, active high outputs.
- Two dedicated (BRAKE and DRIVE READY), normally open relay outputs.

Analog I/O

Two analog inputs are dedicated to current limits and two analog outputs can be customized to fit the application:

- Two dedicated 10 bit, 0 – 10 Volt, analog inputs (+I LIMIT and -I LIMIT)
- Two selectable, ±10 Volt analog outputs, one 12-bit and one 8-bit (ANALOG1 and ANALOG2).

AC Input Power

ULTRA 200 Series drives are powered directly from a main 100-240 VAC line:

- 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030 and 1398-DDM-030X require single-phase main power
- 1398-DDM-075 and 1398-DDM-075X require either single phase or three-phase main power.
- 1398-DDM-150 and 1398-DDM-150X require three-phase main power.

Personality Module

EEPROM (electrically erasable programmable read-only memory) stores both motor and application specific settings and parameters for the drive in a removable personality module. This module simplifies installation, set up, maintenance and reduces spares requirements.

Multiple Protection Circuits

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

- Seven segment drive status display
- Overtemperature, short circuit and overcurrent protection for the power output
- I^2T (power-time) protection
- Bus Overvoltage
- Bus Undervoltage
- Overspeed
- Fault diagnostics
- Fused power supply outputs
- Three watchdog timers provide fail-safe operation

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.
- Critical information is available with complete 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.

Communications

One serial port, with two connectors, allows from 1 to 32 drives to be connected in parallel using four-wire RS-485 communications. The serial interface allows the user to program a drive using any PC or host computer that permits RS-232 or four-wire RS-485 communications.

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.

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.

Motors

The ULTRA 200 Series is compatible with many motors, both Allen-Bradley motors and motors from other manufacturers. Drive and motor parameters for all compatible Allen-Bradley motors are programmed into each ULTRA 200 Series drive at the factory. Allen-Bradley motors that are compatible with the ULTRA 200 Series of drives include all:

- F-Series
- H-Series
- N-Series
- Y-Series

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

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 used with the ULTRA 200 Series. Appendix D, “Creating Custom Motor Files” explains how to configure the drive to control a custom motor.

European Union Requirements

ULTRA 200 Series drives conform to the following European Union Directives:

- Machinery Directive (89/392/EEC, Article 4.2 and Annex II, sub B)
- 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:
  – Installation of AC line filters between the power source and the drive, and
  – Use of Allen-Bradley cables to connect motors. See "European Union EMC Directives" on page 5-6; Appendix A, "Options and Accessories" lists the mentioned equipment and Allen-Bradley part number.

Allen-Bradley motors available for use with ULTRA 200 Series drives include all:

- F-Series motors
- H-Series motors
- Y-Series motors
- N-Series motors

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.
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

Version Level

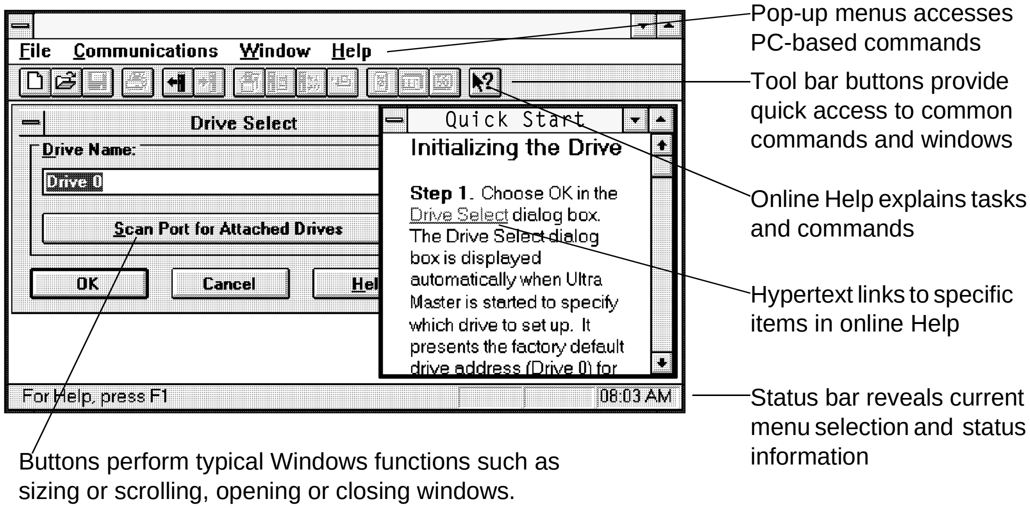
The release level and date for ULTRA Master may be displayed by selecting **About** ULTRA Master from the Help menu. This information also appears in the initial ULTRA Master screen. The About ULTRA Master window includes additional data about system resources typically displayed in Windows Help.

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.

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.`**

The ULTRA Master start-up screen will open.

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

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.

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

Unpacking, Inspecting and Storing

This chapter describes four steps which should ensure that the drive functions correctly. The steps include:

- Unpacking the ULTRA 200 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 200 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 drive checkout 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 Allen-Bradley to obtain a Return Material Authorization (RMA). Do this as soon as possible after receipt of the unit.

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 200 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
- A single phase or three phase 100-240 VAC, 50/60 Hz power source. Standard wall outlet power is suitable for verification testing of ULTRA 200 Series drives, except the 1398-DDM-150 or 1398-DDM-150X, which require three phase power.
- 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. Appendix A, “Options and Accessories” lists the cables.

During the test, power is removed several times. Measure the DC bus voltage at TB1 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 are encountered during this procedure, refer to “Fuse and Jumper Locations” on page 11-4, review other appropriate sections in this manual, or call your local Allen-Bradley 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 Setup

Make the connections described below and shown in Figure 4.1.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 200 Series.

- An Allen-Bradley cable connects the 9-pin serial port of the ULTRA 200 Series to a 9-pin D-shell connector on a serial port of the PC. Allen-Bradley cables are available in various lengths for connecting between J4 or J5 and a computer. Appendix A, "Options and Accessories" lists the cables.
- A three wire cable is shown in the figure below, solely for illustrative purposes.

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

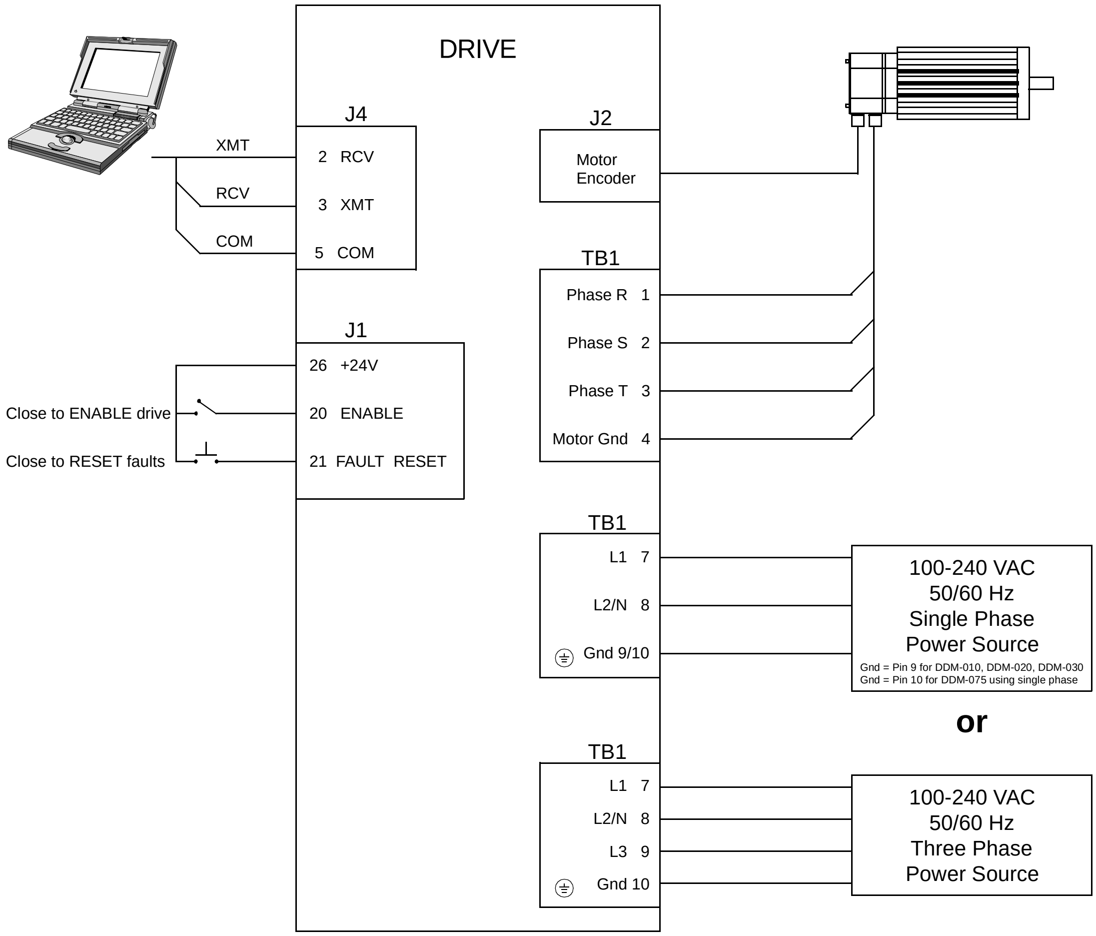
3. Connect a jumper wire with a toggle switch between J1-20 (ENABLE) and J1-26 (+24VDC). This provides manual control for enabling or disabling the drive. Figure 4.1 shows the jumper, including its normally open toggle switch.

4. Connect a power cable between the external 100/240 VAC, 50/60 Hz power source:

ATTENTION: When operating the model 1398-DDM-075 or 1398-DDM-075X with single-phase power the current limits must be set correctly.

- A 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X connects to the L1, L2/N and ⏚ (Gnd) connections on TB-1 when using a single phase power source.
- A 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X connects to the L1, L2, L3 and ⏚ (Gnd) connections on TB-1 when using a three phase power source.

Figure 4.1 Connection Diagram



Drive Checkout Test

This test sequentially verifies that:

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

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

Before beginning “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.

Initial Power-up

1. Verify the AC power is within specifications.
2. Switch the AC Power to ON and verify:
   - green DC BUS LED is ON
   - display is *not* flashing.
3. Switch the power OFF and wait until the DC Bus Voltage is below 30 Volts, to prevent electrical shock.
4. Connect the motor windings to:
   - R (TB1-1)for the Phase R winding
   - S (TB1-2) for the Phase S winding
   - T (TB1-3) for the Phase T winding
   - ⏚ (TB1-4) for the Ground connection.
5. Switch AC Power ON again and verify:
   - green DC BUS LED is ON
   - display is *not* flashing.
6. Switch the power OFF and wait until the DC Bus Voltage is below 30 Volts, to prevent electrical shock.

Communications Verification

7. Start ULTRA Master on the PC.
8. Close any windows that are open in ULTRA Master.
9. Select **PC Set Up** from the Communications menu in ULTRA Master.
10. 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 11-6 if communication problems are encountered.

11. Switch AC power ON.

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

13. 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 11-6 for instructions on how to perform these checks.

Initial Drive Operation

14. When the message appears that a motor must be selected, choose **OK**. The Drive Select dialog box is selected with Motor Selection active.

15. Select the appropriate motor from the drop-down Motor Selection box.

16. Choose **OK** when the message appears advising that the drive must reset. A change in motor parameters requires a software reset.

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

18. Select the **Control Panel** icon from the Drive Window. The drive displays “H” (Control Panel mode). Refer to “Operating Messages” on page 10-1 for an explanation of drive displays.

19. Close the connection between J1-26 and J1-20 to enable the drive.

20. Holding torque should be sufficient so that the shaft is either immovable or very resistant to rotation.

21. 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 Chapter 11, “Maintenance and Troubleshooting” for instructions on how to correct the motor power connections at TB1-1, -2, -3 and -4 or the encoder feedback connections at J2.

22. Choose **Set to Zero**. The motor will stop rotating.

23. Choose **Drive Disable** and verify the motor shaft can be rotated by hand.

24. Choose **Drive Enable** and verify the motor shaft has holding torque. (i.e., The shaft cannot be moved or moves with resistance.)

25. Open the connection between J1-26 and J1-20 to disable the drive.

26. Choose **Close** from the Control Panel window.

A drive completing these steps is functional. If the ULTRA 200 Series drive did *not* pass the steps above, refer to "Troubleshooting" on page 11-6.

Note: For information on testing digital and analog signals, refer to "Testing Digital Outputs" on page 11-12, "Testing Digital Inputs" on page 11-14, "Testing Analog Outputs" on page 11-14 and "Testing Positive and Negative Current Limits" on page 11-15

Storing the Unit

Return the ULTRA 200 Series 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 70° C (-40° to 158° F)

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: 30.5 cm (12 in.)
   - Adequate sizing and/or ventilation to dissipate the heat generated by the ULTRA 200 Series drives. Refer to "Power Dissipation" on page G-7 for the amount of heat generated by ULTRA 200 Series drives and enclosure sizing equations.
2. Minimum unobstructed surrounding space for cooling air intake and fan exhaust:
   - Above: 5 cm (2 in.)
   - Below: 5 cm (2 in.)
   - Sides: 1.25 cm (0.5 in.)
   - Front: 7.5 cm (3.0 in.) 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 mounting hardware should meet the following weight, vibration and shock, altitude and humidity, airflow clearance, and temperature requirements. Unit weights are:
   - 1398-DDM-010 and 1398-DDM-010X: 5.80 Kg (13.78 lbs)
   - 1398-DDM-020 and 1398-DDM-020X: 6.36 Kg (14.02 lbs)
   - 1398-DDM-030 and 1398-DDM-030X: 6.48 Kg (14.28 lbs)
   - 1398-DDM-075 and 1398-DDM-075X: 9.67 Kg (21.32 lbs)
   - 1398-DDM-150 and 1398-DDM-150X: 14.06 Kg (31.00 lbs)

Vibration and shock, altitude and humidity limits are:

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

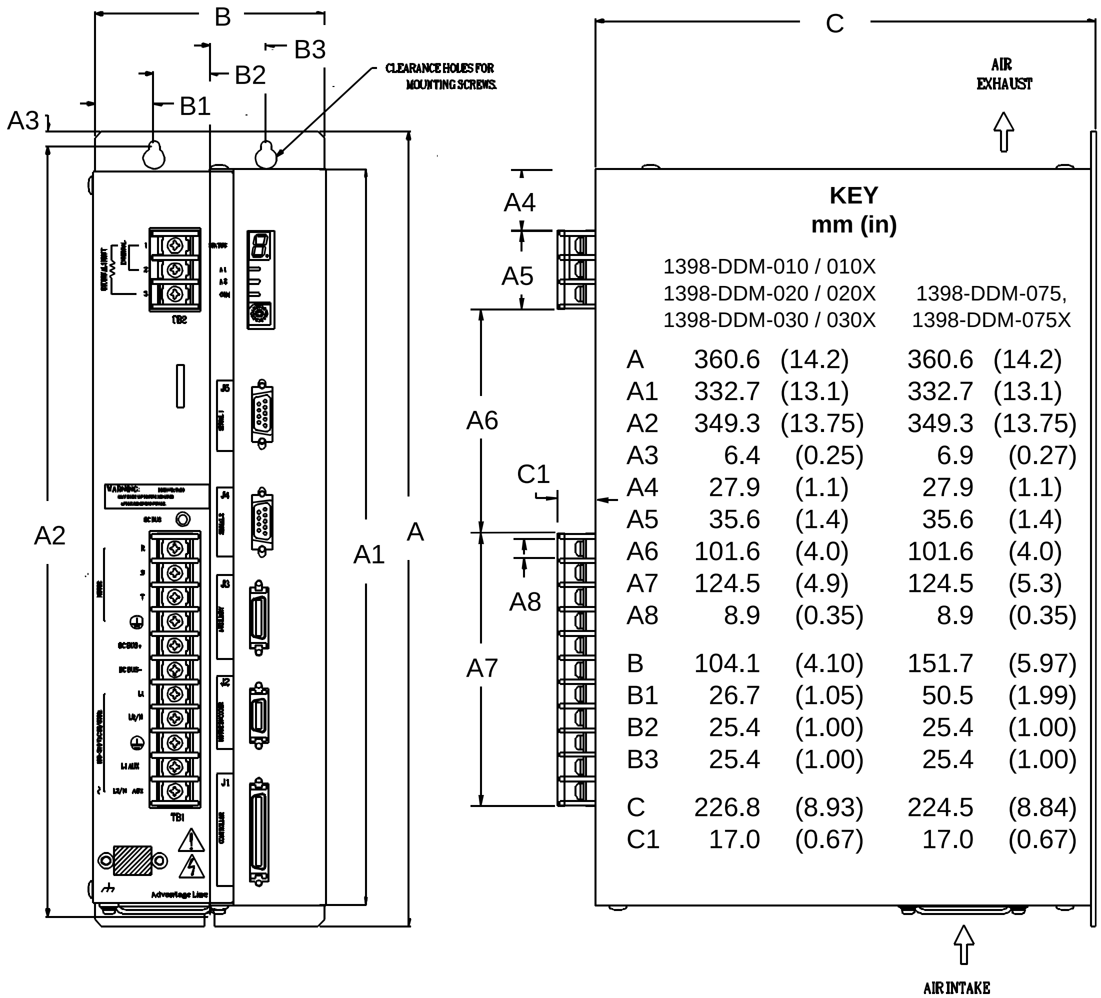
Ambient operating temperature range and airflow clearances are:

- 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 5.1. The recommended size of mounting hardware is:

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

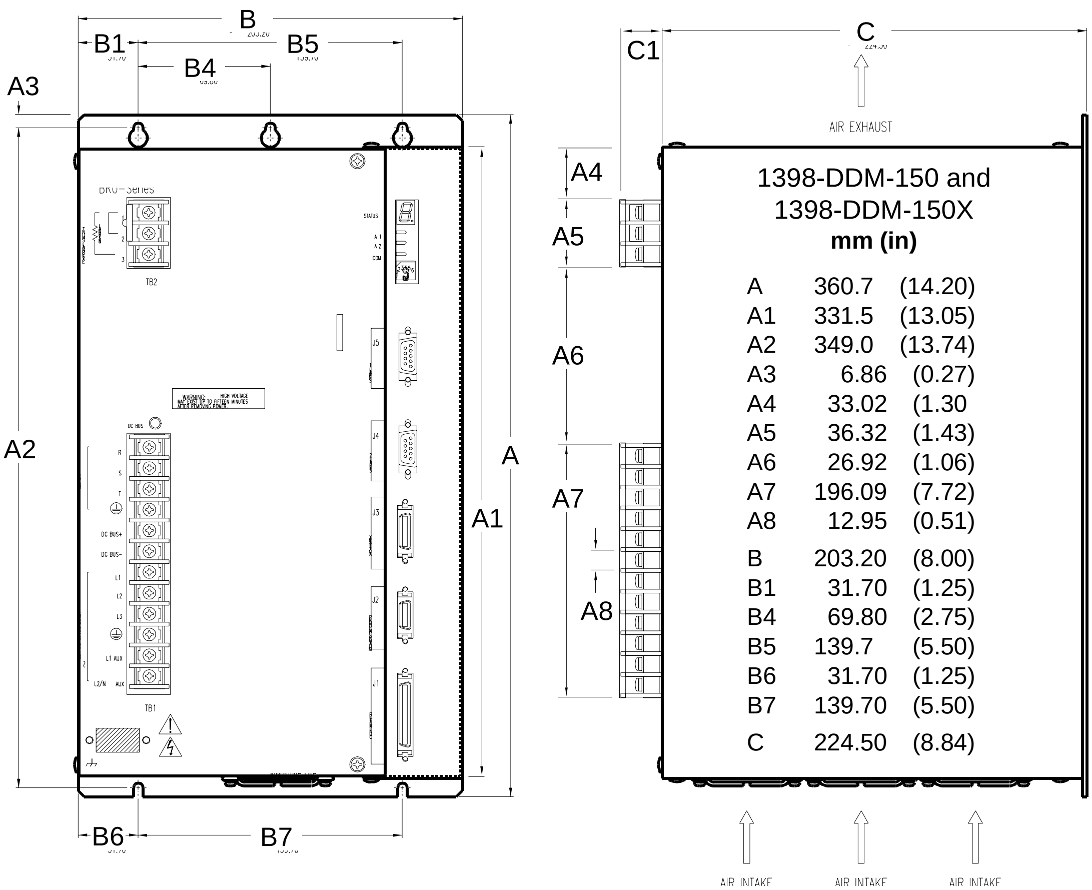
Figure 5.1 **1398-DDM Mounting Dimensions** (sheet 1 of 2)



KEY
mm (in)

	1398-DDM-010 / 010X 1398-DDM-020 / 020X 1398-DDM-030 / 030X		1398-DDM-075, 1398-DDM-075X	
A	360.6	(14.2)	360.6	(14.2)
A1	332.7	(13.1)	332.7	(13.1)
A2	349.3	(13.75)	349.3	(13.75)
A3	6.4	(0.25)	6.9	(0.27)
A4	27.9	(1.1)	27.9	(1.1)
A5	35.6	(1.4)	35.6	(1.4)
A6	101.6	(4.0)	101.6	(4.0)
A7	124.5	(4.9)	124.5	(5.3)
A8	8.9	(0.35)	8.9	(0.35)
B	104.1	(4.10)	151.7	(5.97)
B1	26.7	(1.05)	50.5	(1.99)
B2	25.4	(1.00)	25.4	(1.00)
B3	25.4	(1.00)	25.4	(1.00)
C	226.8	(8.93)	224.5	(8.84)
C1	17.0	(0.67)	17.0	(0.67)

Figure 5.1 **1398-DDM Mounting Dimensions** (sheet 2 of 2)



Interface Connections

Input/output and power cables connect to the front panel of a ULTRA 200 Series drive, no internal connections are necessary.

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.

I/O Connections are fully described in the following sections:

- "J1 – Controller" on page 6-1 defines the controller connections
- "J2 – Encoder" on page 6-27 defines the motor encoder connections
- "J3 – Auxiliary Port" on page 6-31 defines the auxiliary controller connections
- "J4 and J5 – Serial Port" on page 6-34 defines the RS-232/RS-485 serial port connections

Power Connections are fully described in the following sections:

- "TB1 – DC Bus and AC Power" on page 7-1 defines the power connections.
- "TB2 – Shunt Regulator" on page 7-11 defines the internal and external shunt connections.

Figure 6.44 on page 6-45 shows these inputs and outputs on a general level. Specific operational set ups are depicted in Figure 8.1 through Figure 8.12 (pages 8-2 through 8-45, respectively). These figures cover position, velocity and torque mode controls for:

- Analog Controllers,
- Preset Controllers,
- Position Followers, or
- Indexing controllers (available only on 1398-DDM-010X, 1398-DDM-020X, 1398-DDM-030X, 1398-DDM-075X and 1398-DDM-150X).

Wiring

Wiring sizes and practices, as well as grounding and shielding techniques are described in the sections listed below. Refer to the "Power Wiring Diagrams" on page 5-11 for graphic depictions and recommended wire gaging.

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.

Minimum wire gages for power cables are listed in:

- "Motor Power Contact and Wire Sizing Recommendations" on page 7-5
- "AC Input Power Sizing Requirements" on page 7-9
- "Auxiliary Power Sizing Requirements" on page 7-10

Electromagnetic Compatibility

General Guidelines

Appendix E, "Electromagnetic Compatibility Guidelines for Machine Design" contains guidelines for reducing electrical noise and increasing electromagnetic compatibility (EMC) plus a discussion of electromagnetic interference (EMI).

European Union EMC Directives

The ULTRA 200 Series drives are designed and tested to meet the European EMC Directive. Declarations of conformity, which enumerate the standards used, are available upon request. Two installation requirements are necessary to meet the directives:

1. Use of an external AC line filter on the main AC input, and
2. Use of Allen-Bradley cables.

Qualified AC Line Filters

Listed below are AC line filters that have been qualified for use with ULTRA 200 Series drives. Filters equivalent to those listed are widely available, and Allen-Bradley does not recommend one manufacturer over another. The machine builder is responsible for the suitability of the filter selection when using different filters. 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 the manufacturer.

Table 5.1: Qualified AC Line Filters

Drive	Manufacturer and Part Number	
	Schaffner (1-800-367-5566)	**Roxburgh** (01724-281770) (011 44 1724 281770 from the USA)
1398-DDM-010 and 1398-DDM-010X	FN 350-12	MIF 10 or MDF 16
1398-DDM-020 and 1398-DDM-020X	FN 350-20	MIF 23 or MDF 18
1398-DDM-030 and 1398-DDM-030X	FN 350-30	MIF 32 or MDF 36
1398-DDM-075 and 1398-DDM-075X	FN 351-36	MIF 330 or MDF 336
1398-DDM-150 and 1398-DDM-150X		MDF 350

Allen-Bradley AC Line Filters

An AC line filter is *not* required on the auxiliary line input, when it is used. Refer to “Options and Accessories” on page A-2 for part numbers.

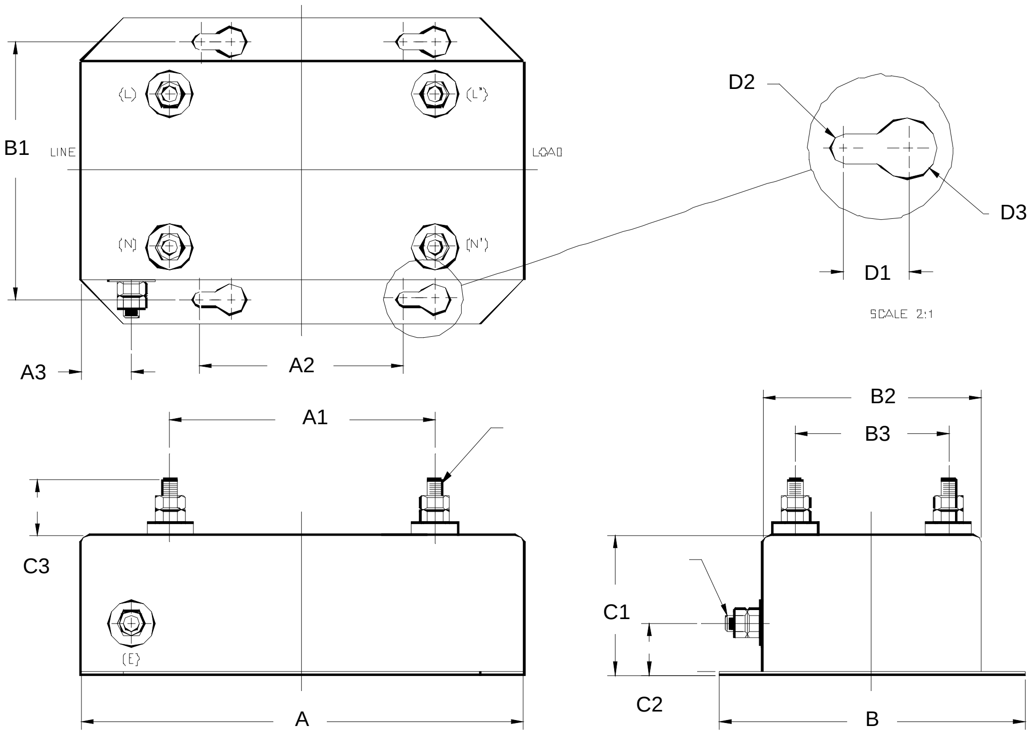
► **Note:** The ordering of an Allen-Bradley part number will result in a Roxburgh line filter being received.

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.

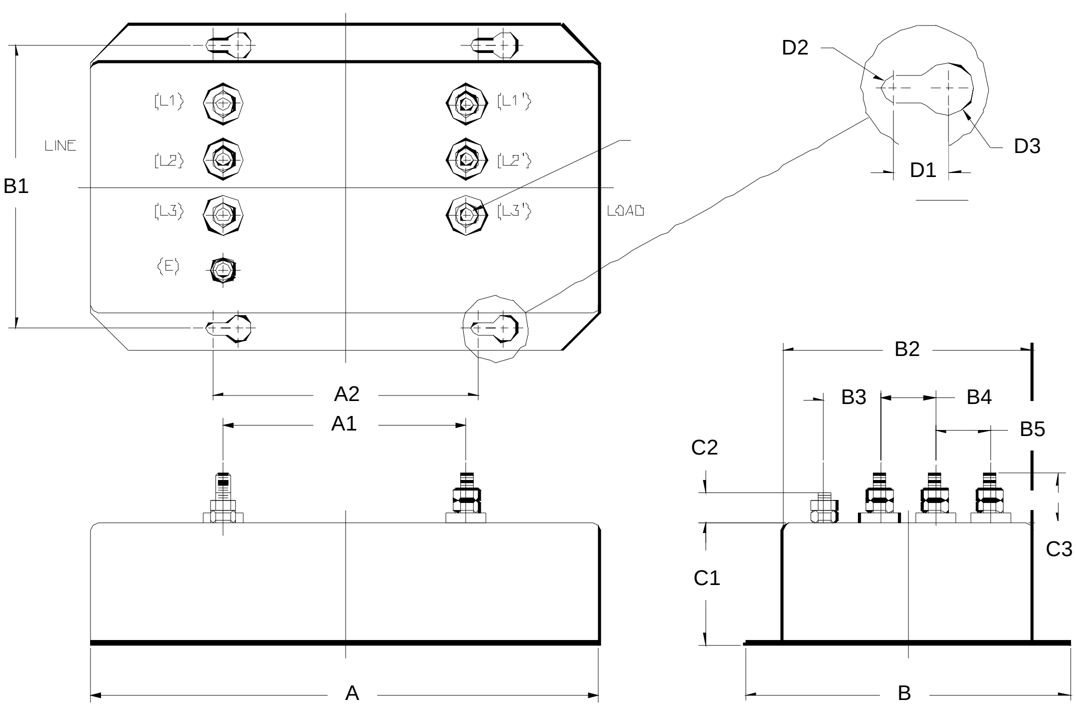
Mounting dimensions for single and three phase AC line filters available from Allen-Bradley are illustrated in Figure 5.2 and Figure 5.3, with corresponding numbers in Table 5.2 and Table 5.3.

Wiring diagrams for Allen-Bradley AC line filters follow in Figure 5.4.

Figure 5.2 MDF AC Line Filter Mounting Diagrams



MDF Single-phase



MDF Three-phase

Table 5.2: MDF AC Line Filter Dimensions

DIMENSION	SINGLE PHASE 36 A and 50 A		THREE PHASE 36 A		THREE PHASE 50 A		THREE PHASE 70 A	
	mm	in	mm	in	mm	in	mm	in
A	174	6.85	230	9.06	230	9.06	238	9.37
A1	104 (2)	4.09 (2)	110 (3)	4.33 (3)	110 (3)	4.33 (3)	150 (3)	5.91 (3)
A2	80 (2)	3.15 (2)	120 (3)	4.72 (3)	120 (3)	4.72 (3)	120 (2)	4.72 (2)
A3	20	0.79	–	–	–	–	–	–
B	120	4.74	147	5.79	147	5.79	186	7.32
B1	101 (2)	3.98 (2)	128 (2)	5.04 (2)	128 (2)	5.04 (2)	167 (2)	6.57 (2)
B2	86	3.39	113	4.45	113	4.45	152	5.98
B3	60 (2)	2.36 (2)	25	0.98	25	0.98	40	1.57
B4	–	–	25 (2)	0.98 (2)	25 (2)	0.98 (2)	40 (2)	1.57 (2)
B5	–	–	25 (2)	0.98 (2)	25 (2)	0.98 (2)	40 (2)	1.57 (2)
C	77	3.03	77	3.03	77	3.03	114	4.49
C1	55	2.17	55	2.17	55	2.17	85	3.35
C2	20	0.79	14	0.55	14	0.55	14	0.55
C3	22 (4)	0.87 (4)	22 (6)	0.87 (6)	22 (6)	0.87 (6)	29 (6)	1.14 (6)
D1	12	0.47	12	0.47	12	0.47	12	0.47
D2	6	0.24	6	0.24	6	0.24	6	0.24
D3	12	0.47	12	0.47	12	0.47	12	0.47
Connectors	M6 (5)		M6 (7)		M6 (7)		M8 (6) and M6 (earth)	

NOTE:
Line filters are manufactured to millimeter dimensions (inches are approximate conversions).

Figure 5.3 MIF Single Phase AC Line Filter Mounting Diagram

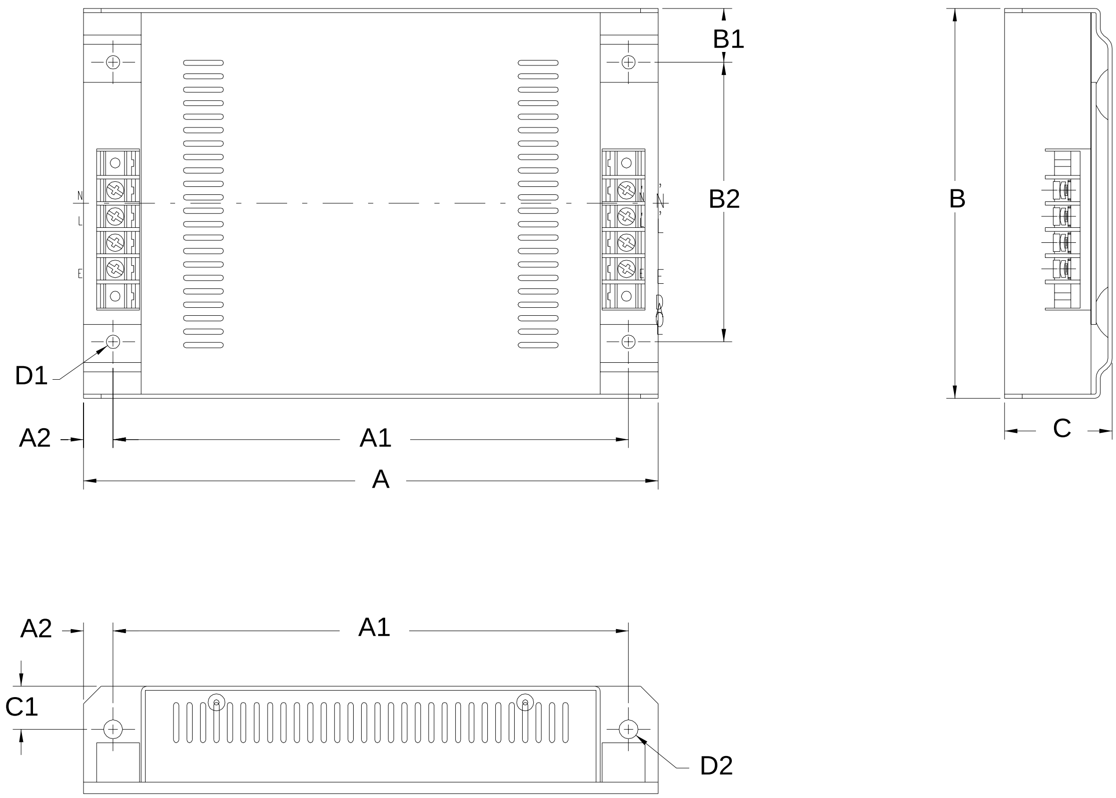


Table 5.3: MIF AC Line Filter Dimensions

DIMENSION	SINGLE PHASE 10 A		SINGLE PHASE 23 A	
	mm	in	mm	in
A	214	8.43	214	8.43
A1	192 (2)	7.56 (2)	192 (2)	7.56 (2)
A2	11 (2)	0.43 (2)	11 (2)	0.43 (2)
B	145	5.71	204	8.03
B1	20 (2)	0.79 (2)	20 (2)	0.79 (2)
B2	104 (2)	4.09 (2)	164 (2)	6.46 (2)
C	40	1.57	47	1.85
C1	16 (2)	0.63 (2)	19 (4)	0.75 (4)
D1	5 (4)	0.20 (4)	5 (4)	0.20 (4)
D2	7 (4)	0.28 (4)	7 (4)	0.28 (4)
Connectors	M4		M4	

NOTE:
Line filters are manufactured to millimeter dimensions (inches are approximate conversions).

Figure 5.4 Power Wiring Diagrams (sheet 1 of 3)

1398-DDM-010 or 1398-DDM-010X,

1398-DDM-020 or 1398-DDM-020X,

1398-DDM-030 or 1398-DDM-030X

MOTOR POWER WIRES R,S,T,GND		
MOTOR	MOTOR POWER MATING CONNECTOR CONTACT SIZE (GAUGE/mm)	MINIMUM RECOMMENDED POWER WIRE (GAUGE/mm²) (75°C COPPER MIN)
LD-2003	16 AWG/1.5mm	16 AWG/1.5mm
H/S-2005		
H/S-3007		
LD-3009		
H/S-3016		
LD-4012		
LD-4030		
H/S-4030	12 AWG/3.0mm	
F-4030		
H/S-4050		14 AWG/2.5mm
F-4050		
H/S-4075		
F-4075		

MOTOR POWER CONNECTOR	
PIN	SIGNAL
A	R
B	S
C	T
D	MOTOR CASE

INPUT POWER WIRES		
DRIVE	TERMINAL(S)	RECOMMENDED POWER WIRE (GAUGE/mm) (75°C COPPER MIN.)
ALL	L1 AUX, L2/N AUX	16 AWG/1.5mm 2
DDM-010	L1,L2/N,	14 AWG/2.5mm 2
DDM-020	L1,L2/N,	12 AWG/3.0mm 2
DDM-030	L1,L2/N,	10 AWG/6mm 2

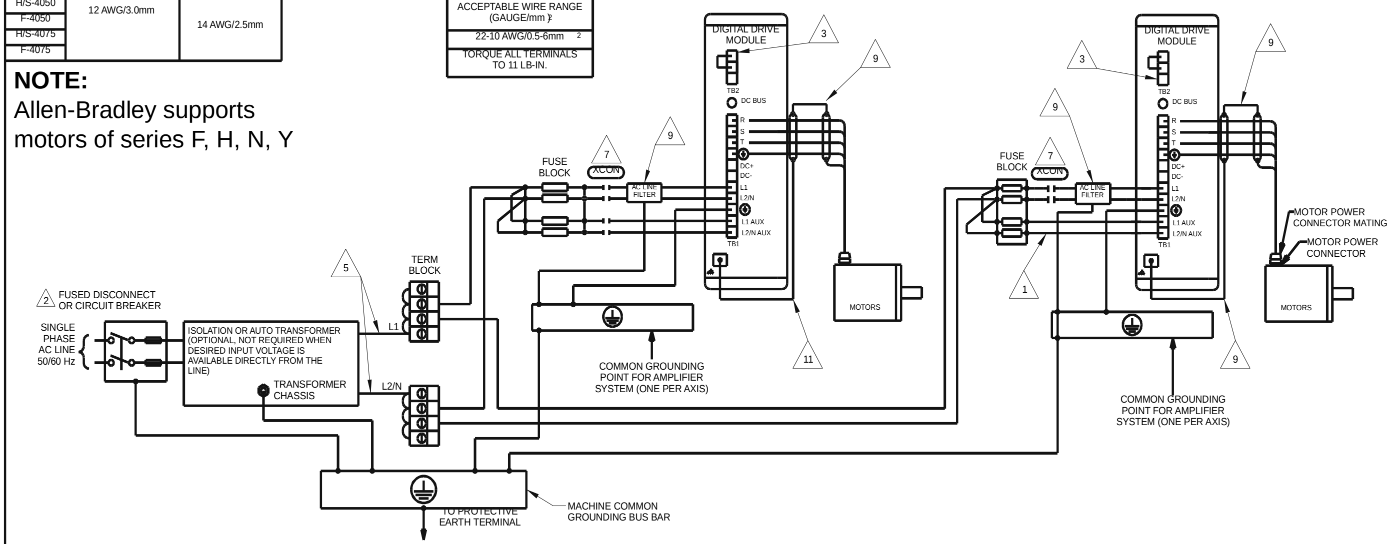
AC AUXILIARY POWER INPUT (OPTIONAL)

DIGITAL DRIVE MODULE INPUT CURRENT REQUIREMENTS	
DRIVE TERMINALS	CURRENT REQUIREMENT, MAXIMUM (AMPS AC RMS)
L1 AUX, L2/N AUX	1.0 Amps AC at 115 Volts AC 0.5 Amps AC at 230 Volts AC
L1,L2/N, DDM-010	10.0 Amps AC at 100-240 Volts AC
L1,L2/N, DDM-020	19.0 Amps AC at 100-240 Volts AC
L1,L2/N, DDM-030	28.0 Amps AC at 100-240 Volts AC

NOTE: POWER INITIALIZATION REQUIRES A SHORT PERIOD OF INRUSH CURRENT OF 50A FOR THE MAIN INPUT AND 95A FOR THE AUXILIARY INPUT. DUAL ELEMENT TIME DELAY (SLOW BLOW) FUSES ARE RECOMMENDED. FUSE SIZES MUST BE SELECTED ACCORDING TO LOCAL REGULATIONS.

TERMINAL STRIP ACCEPTABLE WIRE RANGE (GAUGE/mm)2
22-10 AWG/0.5-6mm 2
TORQUE ALL TERMINALS TO 11 LB-IN.

NOTE:
Allen-Bradley supports motors of series F, H, N, Y



NOTES

1. MAY BE USED TO KEEP LOGIC SECTION OF DRIVE MODULE SUPPLIES POWERED AFTER MAIN MOTOR SUPPLY IS TURNED OFF AT L1, L2/N TERMINALS (EXAMPLE: TO RETAIN DIAGNOSTIC STATUS OF DRIVE MODULE AFTER L1, L2/N POWER DOWN). SEPERATE SUPPLY PHASES MAY BE USED WHEN VOLTAGE BETWEEN ANY TWO TERMINALS DOES NOT EXCEED 265 VAC RMS.
2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTAINANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2 OR L2/AUX, ONLY L1 MAY BE SWITCHED OR FUSED.
3. JUMPER INSTALLED AT FACTORY FOR INTERNAL SHUNT. SEE DRAWING 9101-1328 FOR TERMINAL WIRING OF EXTERNAL SHUNT OPTION TERMINALS.
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.
7. DRIVE ENABLE INPUT MUST BE OPENED WHEN MAIN POWER IS REMOVED AND AUXILIARY POWER IS PRESENT, OR A DRIVE FAULT WILL OCCUR.
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. THE AUX INPUT HAS AN INTERNAL FILTER. 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 OVERR 10 LB-IN.

REV	ECO	BY	REVISION DESCRIPTION	DATE	CHKR
C	22455	BK	CHANGE NOTE 1	_	_
B	21782	GW	CHANGE NOTE 11	2-21-96	RB
A	21732	JM	RELEASED	1-22-96	BB

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 ±.01
.XXX ±.005
DESIGN POST

DRAWN BY	DATE	DESIGN ENGR	DATE
JM	1-9-96	MC	1-22-96

DIAG., POWER WIRING CONNECTIONS, DDM-010, -020, -030

PART NO. 9101-1431

SCALE	DWG SIZE	SHEET
1:1	C	1 of 1

Figure 5.4 Power Wiring Diagrams (sheet 2 of 3)

1398-DDM-075 or 1398-DDM-075X

MOTOR POWER WIRES R,S,T,GND		
MOTOR	MOTOR POWER MATING CONNECTOR CONTACT SIZE (GAUGE/mm²)	MINIMUM RECOMMENDED POWER WIRE (GAUGE/mm²) (75°C COPPER MIN)
H/S-4050, F-4050, H/S-4075, F-4075	12 AWG/3.0mm²	14 AWG/2.5mm²
H/S-6100, F-6100, H/S-6200, F-6200	8 AWG/10.0mm²	10 AWG/6.0mm²

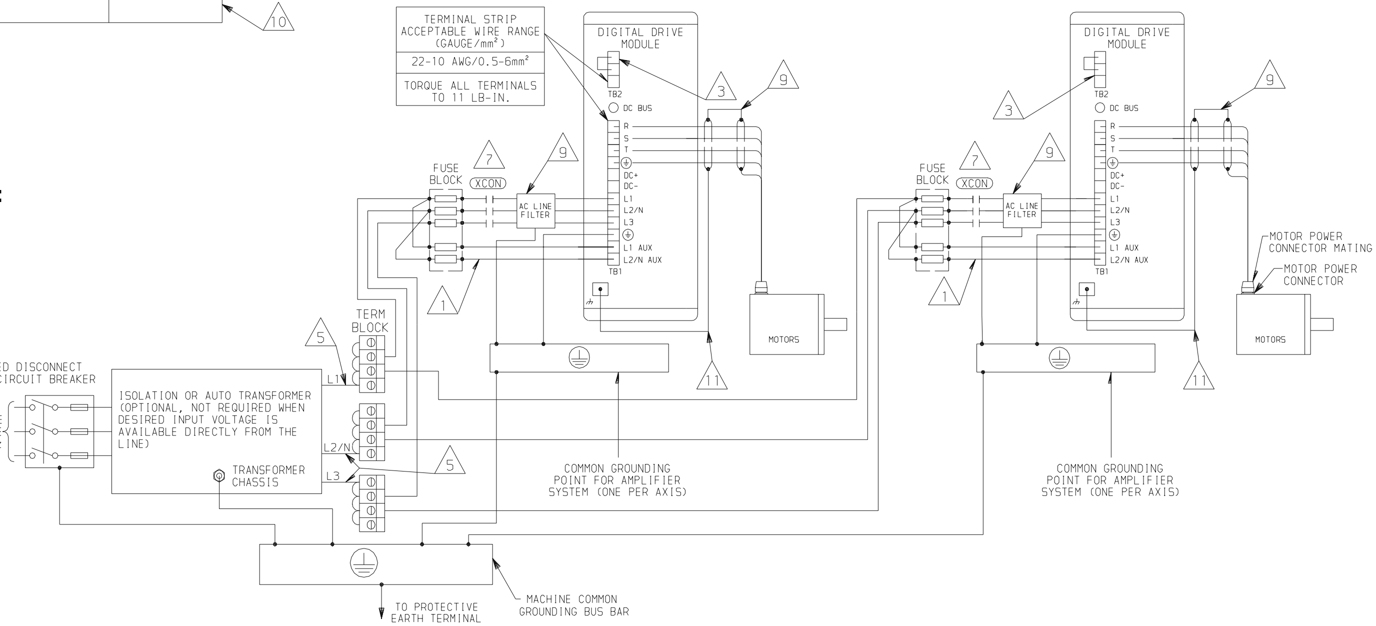
MOTOR POWER CONNECTOR	
PIN	SIGNAL
A	R
B	S
C	T
D	MOTOR CASE

INPUT POWER WIRES		
DRIVE	TERMINAL(S)	RECOMMENDED POWER WIRE (GAUGE/mm²) (75°C COPPER MIN)
ALL	L1 AUX, L2/N AUX	16 AWG/1.5mm²
DDM-075	L1,L2/N, L3	10 AWG/2.5mm²

DIGITAL DRIVE MODULE INPUT CURRENT REQUIREMENTS	
ADVANTAGE TERMINALS	CURRENT REQUIREMENT, MAXIMUM (AMPS AC RMS)
L1 AUX,L2/N AUX	1.0 Amps AC at 115 Volts AC 0.5 Amps AC at 230 Volts AC
L1,L2/N,L3 DDM-075	28.0 Amps at 100-240 Volts AC Three Phase
L1,L2/N DDM-075	28.0 Amps at 100-240 Volts AC Single Phase

NOTE: POWER INITIALIZATION REQUIRES A SHORT PERIOD OF INRUSH CURRENT OF 50A FOR THE MAIN INPUT AND 95A FOR THE AUXILIARY INPUT. DUAL ELEMENT TIME DELAY (SLOW BLOW) FUSES ARE RECOMMENDED. FUSE SIZES MUST BE SELECTED ACCORDING TO LOCAL REGULATIONS.

NOTE:



NOTES

1. MAY BE USED TO KEEP LOGIC SECTION OF DRIVE MODULE SUPPLIES POWERED AFTER MAIN MOTOR SUPPLY IS TURNED OFF AT L1, L2/N, L3 TERMINALS (EXAMPLE: TO RETAIN DIAGNOSTIC STATUS OF DRIVE MODULE AFTER L1, L2/N, L3 POWER DOWN).
2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTAINANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2 OR L2/AUX, ONLY L1 MAY BE SWITCHED OR FUSED.
3. JUMPER INSTALLED AT FACTORY FOR INTERNAL SHUNT. SEE DRAWING 9101-1328 FOR TERMINAL WIRING OF EXTERNAL SHUNT OPTION TERMINALS.
4. CURRENT RATINGS ARE INDEPENDENT OF THE INPUT VOLTAGE. REDUCED VOLTAGE WILL RESULT IN A REDUCTION IN SPEED, BUT NOT TORQUE. DRIVE RATED 35/75 AMPS FOR THREE PHASE INPUT, 15/50 AMPS FOR SINGLE PHASE INPUT.
5. DRIVE RATED 100-240 VAC RMS, SINGLE OR THREE PHASE INPUT VOLTAGE (230 VAC STANDARD).
6. DO NOT DAISY CHAIN DRIVE MODULE POWER CONNECTIONS. MAKE SEPARATE CONNECTIONS DIRECTLY TO THE AC SUPPLY.
7. DRIVE ENABLE INPUT MUST BE OPENED WHEN MAIN POWER IS REMOVED AND AUXILIARY POWER IS PRESENT, OR A DRIVE FAULT WILL OCCUR.
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. THE AUX INPUT HAS AN INTERNAL FILTER. 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	CHKR
B	21782	GW	CHANGE NOTE 11.	--	--
A	21732	JM	RELEASED	1-22-96	BB

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 ±1° FRACTIONS: ±1/64" DECIMALS .XX±.020 .XXX±.010	DRAWN BY JM DATE 1-11-96	DESIGN ENGR MC DATE 1-22-96
	DIAG, POWER WIRING CONNECTIONS, DDM-075	
	PART NO. 9101-1432	
	SCALE N/A	DWG SIZE C / SHEET 1 of 1

Figure 5.4 **Power Wiring Diagrams** (sheet 3 of 3)

1398-DDM-150 or 1398-DDM-150X

MOTOR POWER WIRES R,S,T,GND		
MOTOR	MOTOR POWER MATING CONNECTOR CONTACT SIZE (GAUGE/mm²)	MINIMUM RECOMMENDED POWER WIRE (GAUGE/mm²) (75°C COPPER MIN)
H/S-6100, F-6100, H/S-6200, F-6200	8 AWG/10.0mm²	10 AWG/6.0mm²
H/S-6300, F-6300	8 AWG/10.0mm²	8 AWG/10.0mm²
H/S-8350	4 AWG/25.0mm²	8 AWG/10.0mm²
H/S-8500	4 AWG/25.0mm²	6 AWG/16.0mm²

MOTOR POWER CONNECTOR	
PIN	SIGNAL
A	R
B	S
C	T
D	MOTOR CASE

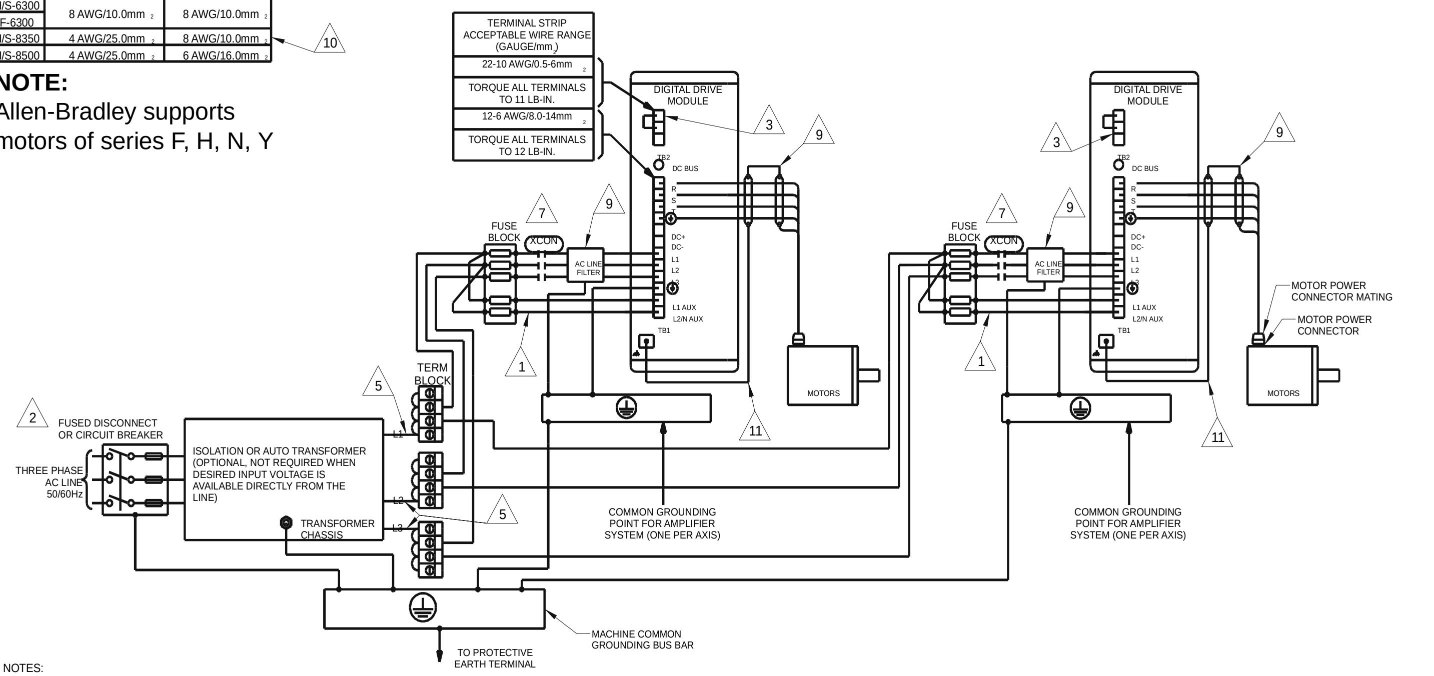
INPUT POWER WIRES		
DRIVE	TERMINAL(S)	RECOMMENDED POWER WIRE (GAUGE/mm²) (75°C COPPER MIN)
ALL	L1 AUX, L2/N AUX	16 AWG/1.5mm²
DDM-150	L1,L2,L3, ⏚	8 AWG/10.0mm²

AC AUXILIARY POWER INPUT (OPTIONAL)

DIGITAL DRIVE MODULE INPUT CURRENT REQUIREMENTS		
DRIVE TERMINALS		CURRENT REQUIREMENT, MAXIMUM (AMPS AC RMS)
L1, L2, L3	DDM-150	46.0 Amps (RMS) at 100-240 Volts AC Three Phase

NOTE: POWER INITIALIZATION REQUIRES A SHORT PERIOD OF INRUSH CURRENT OF 70A (PEAK) FOR THE MAIN INPUT AND 105A (PEAK) FOR THE AUXILIARY INPUT. DUAL ELEMENT TIME DELAY (SLOW BLOW) FUSES ARE RECOMMENDED. FUSE SIZES MUST BE SELECTED ACCORDING TO LOCAL REGULATIONS.

NOTE:
Allen-Bradley supports motors of series F, H, N, Y



NOTES:

1. MAY BE USED TO KEEP LOGIC SECTION OF DRIVE MODULE SUPPLIES POWERED AFTER MAIN MOTOR SUPPLY IS TURNED OFF AT L1, L2, L3 TERMINALS (EXAMPLE: TO RETAIN DIAGNOSTIC STATUS OF DRIVE MODULE AFTER L1, L2, L3 POWER DOWN).
2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTENANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2/N AUX, ONLY L1 AUX MAY BE SWITCHED OR FUSED.
3. JUMPER INSTALLED AT FACTORY FOR INTERNAL SHUNT. SEE DRAWING 9101-1328 FOR TERMINAL WIRING OF EXTERNAL SHUNT OPTION TERMINALS.
4. CURRENT RATINGS ARE INDEPENDENT OF THE INPUT VOLTAGE. REDUCED VOLTAGE WILL RESULT IN A REDUCTION IN SPEED, BUT NOT TORQUE. DRIVE RATED 65/150 AMPS (PEAK) FOR THREE PHASE INPUT.
5. DRIVE RATED 100-240 VAC RMS (230 VAC STANDARD).
6. DO NOT DAISY CHAIN DRIVE MODULE POWER CONNECTIONS. MAKE SEPARATE CONNECTIONS DIRECTLY TO THE AC SUPPLY.
7. DRIVE ENABLE INPUT MUST BE OPENED WHEN MAIN POWER IS REMOVED AND AUXILIARY POWER IS PRESENT, OR A DRIVE FAULT WILL OCCUR.
8. MULTIPLE DRIVE MODULES MAY BE POWERED FROM ONE TRANSFORMER OR OTHER AC SUPPLY SOURCE.
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REV	ECO	BY	REVISION DESCRIPTION	DATE	CHKR
A	22597	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 ±.01
.XXX ±.005
DESIGN POST

DRAWN BY	DATE	DESIGN ENGR	DATE
JM	11-11-97		

DIAG, POWER WIRING, DDM-150

PART NO. 9101-1634

SCALE	DWG SIZE	SHEET
N/A	C	1 of 1

Interfaces

This chapter provides information about:

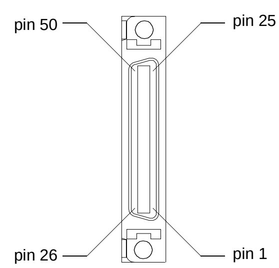
- Interface signals available on the ULTRA 200 Series drive
- Commonly encountered interface cabling methods
- Optional signal extension kits and standard Allen-Bradley cables.

J1 – Controller

J1 is a 50 pin female mini-D connector (AMP 2-178238-7) for connecting a host computer or controller to the ULTRA 200 Series 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.

Allen-Bradley cables are available in various lengths for connecting between J1 and a suitable controller. Appendix A, "Options and Accessories" lists the cables. "J1 Terminal Strip/Breakout Board" on page 6-26 details the optional signal extension kit that is available.

Pin	Signal	Description	Pin	Signal	Description	Pin	Signal	Description
1	+5VDC	Encoder +5V DC	21	RESET	Fault Reset	41		Reserved
2	ECOM	Encoder Common	22	COMMAND+	Analog Command+	42	OUTPUT1	Selectable Output 1
3	+5VDC	Encoder +5V DC	23	COMMAND-	Analog Command-	43	OUTPUT2	Selectable Output 2
4	ECOM	Encoder Common	24	READY+	Drive Ready+	44	OUTPUT3	Selectable Output 3
5	+24VDC	Isolated +24 VDC	25	READY-	Drive Ready-	45	OUTPUT4	Selectable Output 4
6	24VCOM	Isolated 24V Common	26	+24VDC	Isolated +24 VDC	46		Reserved
7	AOUT+	Motor Encoder Output Channel A+	27	+I LIMIT	Positive Current Limit	47		Reserved
8	AOUT-	Motor Encoder Output Channel A-	28	ACOM	Analog Common	48		Reserved
9	BOUT+	Motor Encoder Output Channel B+	29	-I LIMIT	Negative Current Limit	49	BRAKE+	Brake Enable+
10	BOUT-	Motor Encoder Output Channel B-	30	ANALOG1	Analog Output 1	50	BRAKE-	Brake Enable-
11	IOUT+	Motor Encoder Output Channel I+	31	ANALOG2	Analog Output 2			
12	IOUT-	Motor Encoder Output Channel I-	32	INPUT1	Selectable Input 1			
13	24VCOM	Isolated 24V Common	33	INPUT2	Selectable Input 2			
14	AX+	Auxiliary Encoder Channel A+	34	INPUT3	Selectable Input 3			
15	AX-	Auxiliary Encoder Channel A-	35	INPUT4	Selectable Input 4			
16	BX+	Auxiliary Encoder Channel B+	36		Reserved			
17	BX-	Auxiliary Encoder Channel B-	37		Reserved			
18	IX+	Auxiliary Encoder Channel I+	38		Reserved			
19	IX-	Auxiliary Encoder Channel I-	39		Reserved			
20	ENABLE	Drive Enable	40		Reserved			



Digital I/O Power

ULTRA 200 Series drives provide +24VDC and +5VDC to power external devices within the following specifications.

24 Volt I/O Power

One isolated 24 Volt power supply is accessible from the connector:

- The allowable load is ≤500 mA.
- The pin-outs are:

+24VDC	J1-5	J1-26	J3-5	J3-26
24VCOM	J1-6	J1-13	J3-6	J3-13

This supply is intended for powering the digital I/O circuitry.

The 24 VCOM is a floating ground. It must be grounded during installation to meet the European Low Voltage Directive (LVD).

The +24 Volt power supply is internally fused by F1, a 1 Amp, fast acting fuse. Refer to “Fuse and Jumper Locations” on page 11-4, for the location of F1.

► **Note:** If an external +24VDC power source will power the I/O, remove jumpers P5 and P6. Refer to “Fuse and Jumper Locations” on page 11-4, for the location of the jumpers.

Table 6.1: 24 Volt Power Supply Specifications

Parameter	Description	Minimum	Maximum
Output Voltage (VDC)	Voltage difference between +24VDC and 24VCOM	21.6	26.4
Output Current (mA)	Current flow	0	500

5 Volt I/O Power

One +5 Volt power supply is accessible from the connector:

- The allowable load is ≤250 mA.
- The pin-outs are:

+5 VDC	J1-1	J1-3	J3-1	J3-3
ECOM	J1-2	J1-4	J3-2	J3-4

This supply is intended for powering an auxiliary encoder.

The +5 Volt power supply is internally fused by F2, a 1 Amp, fast acting fuse. Refer to “Fuse and Jumper Locations” on page 11-4, for the location of F2.

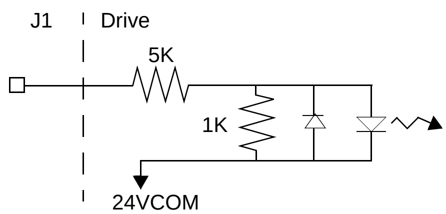
Table 6.2: 5 Volt Power Supply Specifications

Parameter	Description	Minimum	Maximum
Output Voltage (VDC)	Voltage between +5VDC and +5VCOM	4.75	5.25
Output Current (mA)	Current flow	0	250

Digital Inputs

ULTRA 200 Series drives have active high, current sinking inputs, which prevent disconnects and ground faults from activating a drive.

Figure 6.1 Digital Input Circuit



Two discrete input circuits types are available on the J1 connector. Both circuits support logic type interfaces with 24 Volt, optically isolated, single ended and active high, current sinking characteristics.

Dedicated Control Circuits

The ENABLE input interfaces with switch closures or sourcing type outputs. The input channel sinks 4.5 mA nominal.

Selectable Circuits

INPUT 1, INPUT 2, INPUT 3, INPUT 4 and FAULT RESET operate with switch closures or sourcing type circuitry. Each input channel sinks 4.5 mA nominal. Selectable inputs are:

- Drive Mode Select
- Integrator Inhibit
- Follower Enable
- Forward Enable
- Reverse Enable
- Preset Select A
- Preset Select B
- Preset Select C
- Operation Mode Override
- Start Index
- Define Home
- Start Homing
- Remove COMMAND Offset

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

Table 6.3: General and Dedicated Inputs

Digital Input	Pin Number	Function/Description	Internal Connections
ENABLE	J1-20	Enables and disables the drive. Motor torque cannot be applied unless the ENABLE input is active.	J3-20
FAULT RESET	J1-21	General purpose input selectable to one of several drive functions. Refer to Table 6.4 for I/O configuration.	J3-21
INPUT 1	J1-32		
INPUT 2	J1-33		
INPUT 3	J1-34		
INPUT 4	J1-35		

Table 6.4: INPUT1, INPUT2, INPUT3, INPUT4 and FAULT RESET 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 on page 6-5 lists the valid Operation Mode and Operation Mode Override combinations.

Table 6.4: INPUT1, INPUT2, INPUT3, INPUT4 and FAULT RESET Functions (continued)

<table>
<tr><th>Function</th><th colspan="5">Description</th></tr>
<tr><td rowspan="11">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 rowspan="2"></td><td colspan="3">BINARY CODE</td><td></td></tr>
<tr><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">This selection is available only on selectable INPUT 2, and a change from inactive to active is sensed as a registration or home sensor.
NOTE: During the homing routine with an indexing drive, an inactive to active state transition will be registered as the home sensor, even if selectable Input 2 is not configured as registration sensor. This allows Input 2 to have a dual feature role.</td></tr>
<tr><td>Remove COMMAND 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.

The specifications for these inputs are as follows:

Table 6.5: Digital Input Specifications

Parameter	Description	Minimum	Maximum
ON state Voltage	Voltage applied to the input to guarantee an ON state	20 VDC	28 VDC
ON state Current	Current flow into the input to guarantee an ON state.	3.5 mA	5.5 mA
OFF state Voltage	Voltage applied to the input to guarantee an OFF state.	-1 VDC	3 VDC
OFF state Current	External leakage current into the input to guarantee an OFF state.	-0.5 mA	0.5 mA

Input Interface Circuit Examples

Figure 6.2 Drive Input Connected to a Switch/Relay Contact

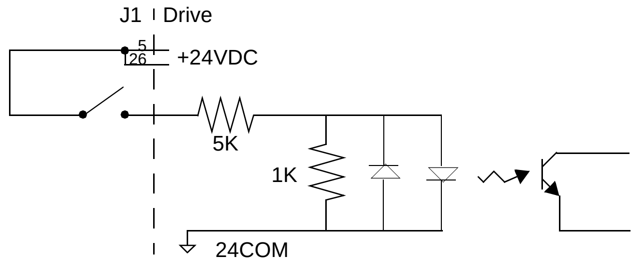


Figure 6.3 Drive Input Connected to an Opto-Isolator

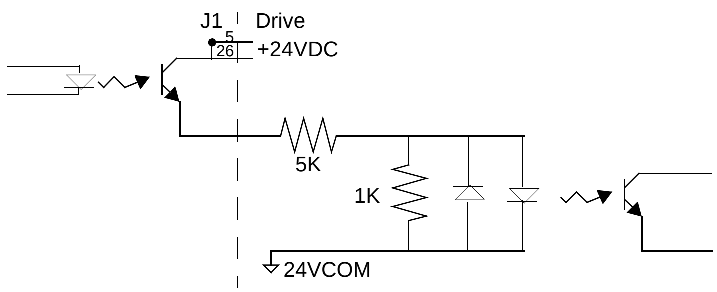


Figure 6.4 Drive Input Connected to an Active High Sourcing Transistor

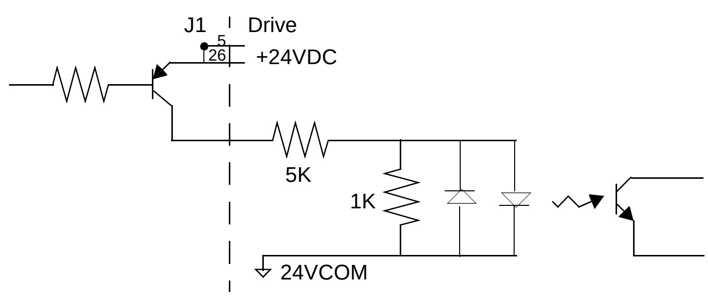


Figure 6.5 Drive Input Connected to Active Low Output using a Switch/Relay

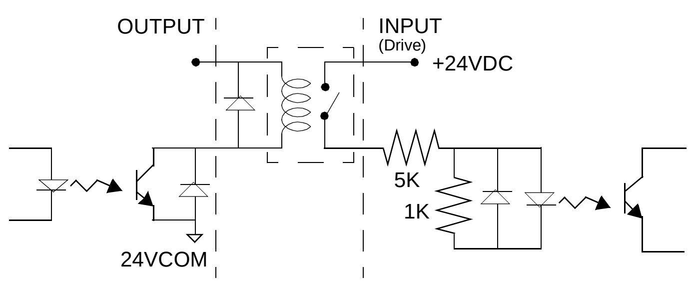


Figure 6.6 **Drive Input Connected to Active Low Output using an Opto-Isolator**

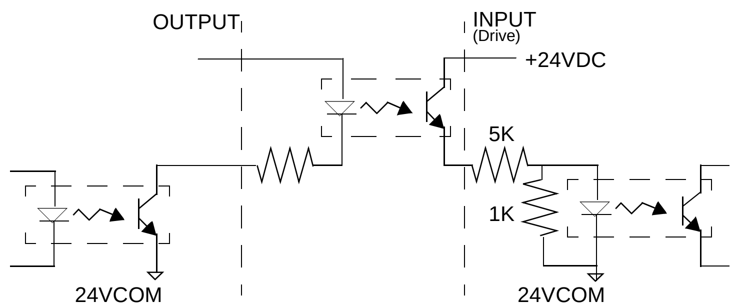
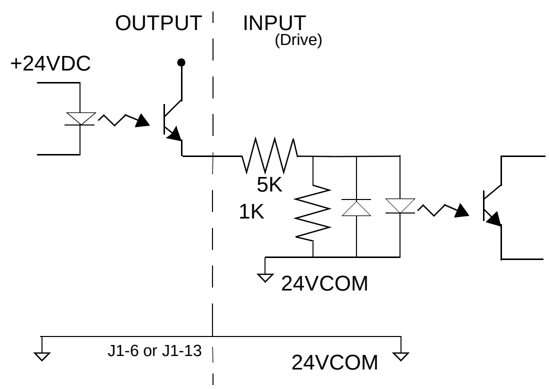


Figure 6.7 **Drive Input Connected to Sourcing Output**



Digital Outputs

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

- Dedicated relay outputs
- Selectable transistor based outputs

Both types support 24 VDC logic interfaces:

Dedicated Relay Outputs

BRAKE and DRIVE READY. Each output is a normally open relay. The brake contacts are rated for 1 Amp at 50 Volts. The Drive Ready contacts are rated for 100 mA at 50 Volts.

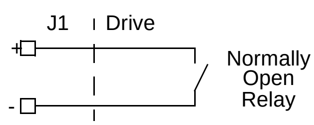
If an option, such as 90V brake, requires more power, a user provided relay may be driven by these outputs up to the specified levels.

Selectable Transistor Outputs

OUTPUT 1, OUTPUT 2, OUTPUT 3, and OUTPUT 4 are 24 VDC, optically isolated, active high, current sourcing, single ended transistor output channels. Each channel sources a maximum of 50 mA.

Ready and Brake Circuits

Figure 6.8 READY and BRAKE Circuits



The specifications for these outputs are as follows:

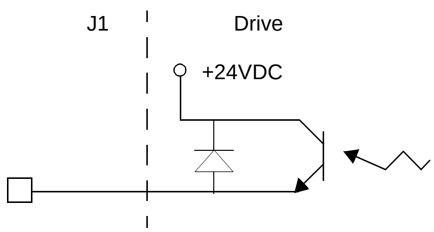
Table 6.6: READY Output Specifications

Parameter	Description	Maximum
ON state resistance	Internal resistance between J1-24 (+) and J1-25 (-) when the contacts are closed.	1 Ohm
ON state current	Current flow through the relay when contacts are closed.	100 mA
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.	50 Volts

Table 6.7: BRAKE Output Specifications

Parameter	Description	Maximum
ON state resistance	Internal resistance between 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 A
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.	50 Volts

Figure 6.9 Digital Output Circuit



Selectable Output Circuits

Table 6.8: General and Dedicated Outputs

Digital Output	Pin Number	Function/Description	Internal Connections
READY	J1-24 (+) J1-25 (-)	Relay closure indicates the drive does *not* have a fault. (Refer to "READY Output Specifications" on page 6-9)	J3-24 (+) J3-25 (-)
BRAKE	J1-49 (+) J1-50 (-)	Relay closure releases the brake. Delay time is selectable. (Refer to "BRAKE Output Specifications" on page 6-10)	
OUTPUT 1	J1-42	General purpose output. Selectable from one of several drive functions. (Refer to Table 6.9)	
OUTPUT 2	J1-43		
OUTPUT 3	J1-44		
OUTPUT 4	J1-45		

Table 6.9: OUTPUT1, OUTPUT2, OUTPUT3 and OUTPUT4 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.

Table 6.9: OUTPUT1, OUTPUT2, OUTPUT3 and OUTPUT4 Functions (continued)

Function	Description
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.

Table 6.10: Transistor Output Specifications

Parameter	Description	Minimum	Maximum
ON state Voltage	Voltage difference between the +24 VDC 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 +24 VDC 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

Output Interface Circuit Examples

Figure 6.10 Drive Output Connected to an Opto-Isolator

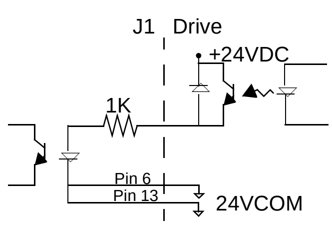


Figure 6.11 Drive Output Connected to an LED Indicator

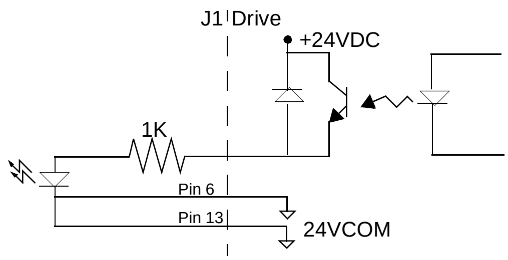


Figure 6.12 Drive Output Connected to a Resistive Load

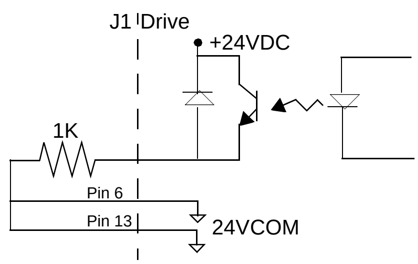


Figure 6.13 Drive Output Connected to a Switch/Relay

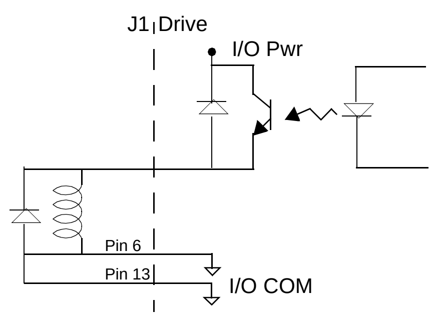


Figure 6.14 Drive Output Connected to Active Low Input using a Switch/Relay

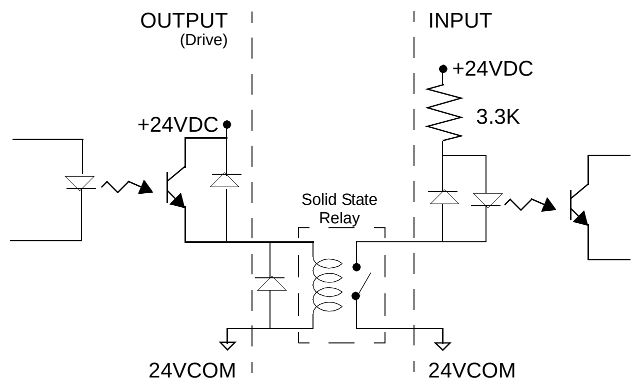


Figure 6.15 Drive Output Connected to Active Low Input using an Opto-Isolator

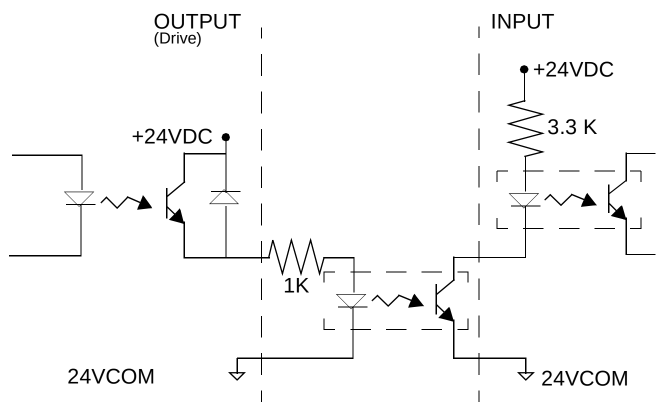
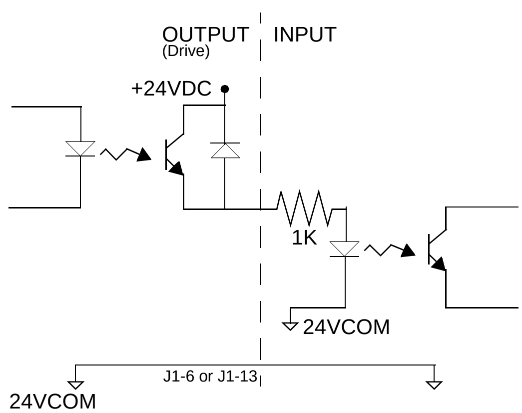


Figure 6.16 Drive Output Connected to Active High (Sinking) Input



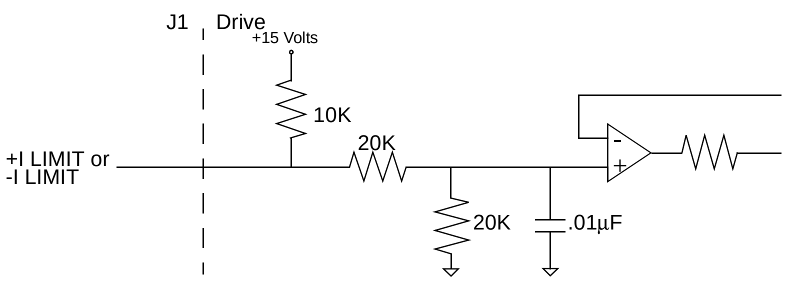
Analog Inputs

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

- The current limiting inputs support 0 to +10 Volt signals
- The command input supports 0 to ±10 Volt signals.

Positive Current Limit (+I LIMIT) and Negative Current Limit (-I LIMIT)

Figure 6.17 Positive and Negative Current Limit Circuits



The +I LIMIT and -I LIMIT are current limit inputs to the drive. They have a range of 0 to +10 Volts (where 10 Volts corresponds to maximum drive current). +I LIMIT limits current for producing positive torque, and -I LIMIT limits current for producing negative torque. The +I LIMIT and -I LIMIT are tied together for balanced current limiting. The analog +I LIMIT or -I LIMIT signals are converted into a digital word by a 10-bit ADC (analog to digital converter). If the +I LIMIT and -I LIMIT inputs are not connected, current is not limited.

Table 6.11: Analog Inputs +I LIMIT and -I LIMIT

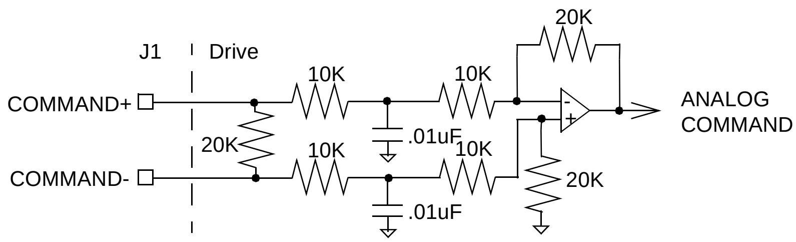
Analog Input	Pin Number	Description
Positive Current Limit (+I LIMIT)	J1-27	Limits the peak positive current command, which produces positive torque.
Negative Current Limit (-I LIMIT)	J1-29	Limits the peak negative current command, which produces negative torque.

Table 6.12: Positive and Negative Current Limit Imput Specification

Specification	Description	Minimum	Maximum
Resolution	Number of units that the input voltage is converted to.	10 Bits	
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

Figure 6.18 Analog COMMAND Input Circuit



The analog command signal to the drive has a range of ±10 Volts. The signal is either a torque, velocity or position command, depending on the software configuration of the drive. The differential input is processed by a 16 bit analog to digital converter (ADC) to produce a digital value.

Table 6.13: Analog Command Input

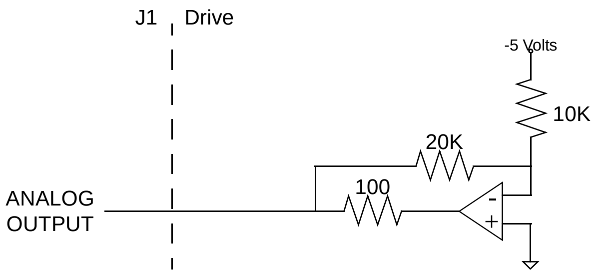
Analog Input	Pin Number	Description	Internal Connections
COMMAND	J1-22 (+) J1-23 (+)	Analog command signal is a differential type signal to drive the servo controller. Separate scale and offset parameters are used for the input, depending on whether the signal is a position, velocity or torque command.	J3-22 (+) J3-23 (-)

Table 6.14: Analog Command Input Specifications

Specification	Description	Minimum	Maximum
Resolution (Bits)	Number of units that the input voltage is converted to.	16	
Input Impedance (kOhms)	Open circuit impedance measured between (+) and (-).	13.3	
Input Signal Range (Volts)	Allowable voltage applied between (+) and (-) inputs.	0	±10

Analog Outputs

Figure 6.19 ANALOG 1 and ANALOG 2 Output Circuits



Two selectable outputs are available for monitoring by the user: ANALOG 1 (J1-30) and ANALOG 2 (J1-31). A 12 bit digital to analog converter (DAC) generates ANALOG 1. ANALOG 2 is a filtered PWM signal with 8 bit resolution and a carrier frequency of 32.8 kHz. Both outputs are scaled to a range of -10 to +10 Volts.

ATTENTION: The user may need to provide an external circuit to delay output of the analog signal when the signal is used to perform an operation. After reset both analog outputs may be in an indeterminate state for a short period before they stabilize at the setting stored in memory. Failure to observe this precaution could result in severe bodily injury.

Table 6.15: Analog Outputs: ANALOG 1 and ANALOG 2

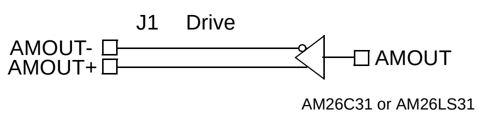
Analog Output	Pin Number	Description	Internal Connections
ANALOG 1	J1-30	Selectable analog output with 12 bit resolution. Displays the selected firmware variable along with selectable scale and offset (refer to the ULTRA Master – I/O Configuration section).	A1
ANALOG 2	J1-31	Selectable analog output with 8 bit resolution. Displays the selected firmware variable along with selectable scale and offset (refer to the ULTRA Master – I/O Configuration section).	A2
ACOM	J1-28	Analog Common (return).	COM

Table 6.16: Analog Output Specifications

Specification	Description	Minimum	Maximum
ANALOG 1 Output Resolution (Bits)	Number of units that the ANALOG1 output voltage is converted into.	12	
ANALOG 2 Output Resolution (Bits)	Number of units that the ANALOG2 output voltage is converted into.	8	
Output Current (mA)	Allowable current draw of the load	-2	+2
Output Signal Range (Volts)	Voltage range of the signal	-10	+10

Motor Encoder Output Signals

Figure 6.20 Output Encoder Interface Circuit



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 (*fout*) 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 *linecount* is the number of encoder lines/revolution of the motor mounted encoder, and *N* is the output divider from the software selected parameter (1, 2, 4 or 8).

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:

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

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

Table 6.17: Motor Encoder Output Signal

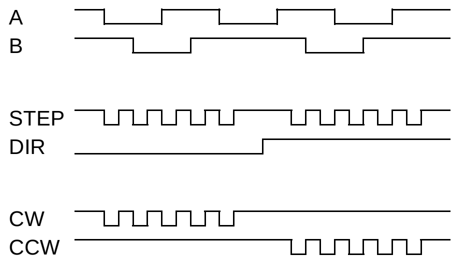
Encoder Output	Pin Number	Description	Internal Connections
AOUT (+) AOUT (-)	J1-7 (+) J1-8 (-)	Motor Output Channels A(+) and A(-). Differential TTL levels from line driver. Signal resolution is selectable.	J3-7 (+) J3-8 (-)
BOUT (+) BOUT (-)	J1-9 (+) J1-10 (-)	Motor Output Channels B(+) and B(-). Differential TTL levels from line driver. Signal resolution is selectable.	J3-9 (+) J3-10 (-)
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.	J3-11 (+) J3-12 (-)

Table 6.18: Motor Encoder Output Specifications

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

Auxiliary Encoder Inputs

Figure 6.21 Auxiliary Encoder Input Types



The ULTRA 200 Series 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
- 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.

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 6.22 Auxiliary Encoder Input Circuit

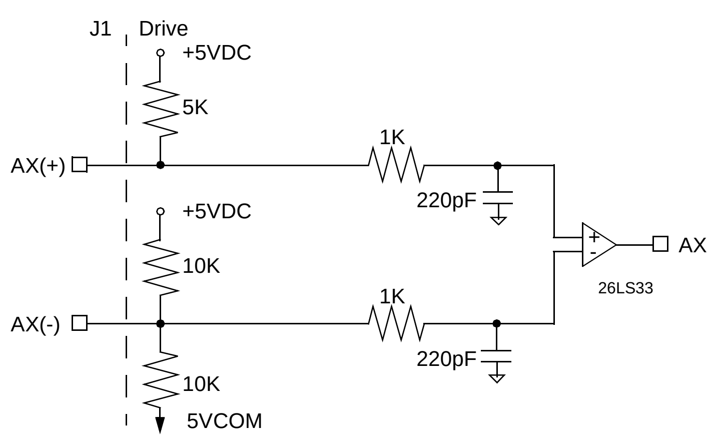


Table 6.19: Auxiliary Encoder/Step and Diection/CW & CCW (Step Up & Down) Signals

Auxiliary Encoder Input	Pin Number	Description	Internal Connections
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. (Refer to ULTRA Master – Drive Setup.)	J3-14 (+) J3-15 (-)
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. (Refer to ULTRA Master – Drive Setup.)	J3-16 (+) J3-17 (-)
IX (+) and IX (-)	J1-18 (+) J1-19 (-)	Auxiliary Input Channels I(+) and I(-). Differential, quadrature, or TTL level encoder inputs.	J3-18 (+) J3-19 (-)

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 selectable under software control.

Table 6.20: Quadrature Interface Specifications

Specification	Description	Minimum	Maximum
ON State Voltage (Volts)	Voltage difference between the + and – inputs that indicate an ON state.	1.0	+15
OFF State Voltage (Volts)	Voltage difference between the + and – inputs that indicates an OFF state.	-1.0	-15
Common Mode Voltage (Volts)	Voltage difference between an encoder signal input and the reference ground of the drive.	-15	+15
Current Draw (mA)	Current draw into the + input or – input	-5	+5
A or B Signal Frequency (MHz)	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
Index Pulse Width (nsec)	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	

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.

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).

Figure 6.23 External Encoder Interface via TTL Differential Line Drivers

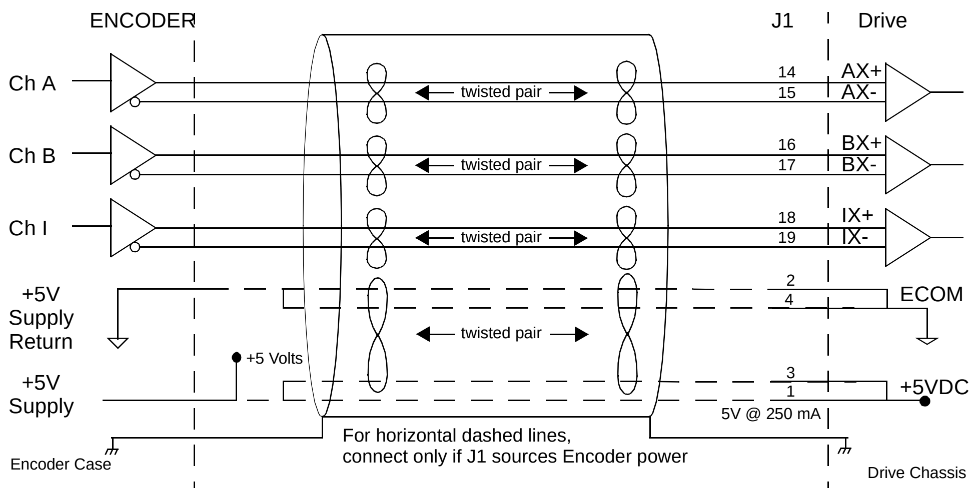


Figure 6.24 Complementary Encoder Interface via 7406 Line Drivers with Pull-up Resistors

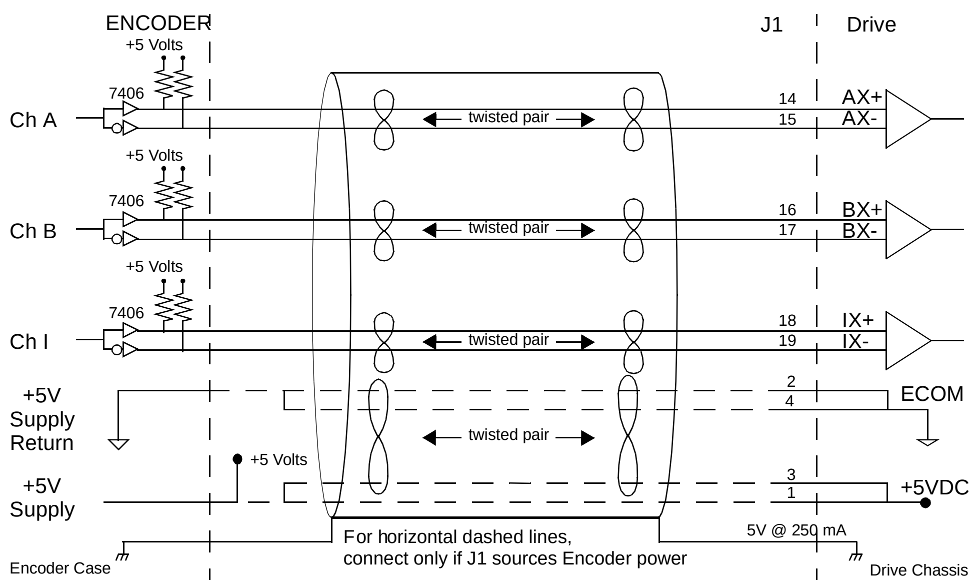


Figure 6.25 Complementary Encoder Interface via Standard TTL Logic

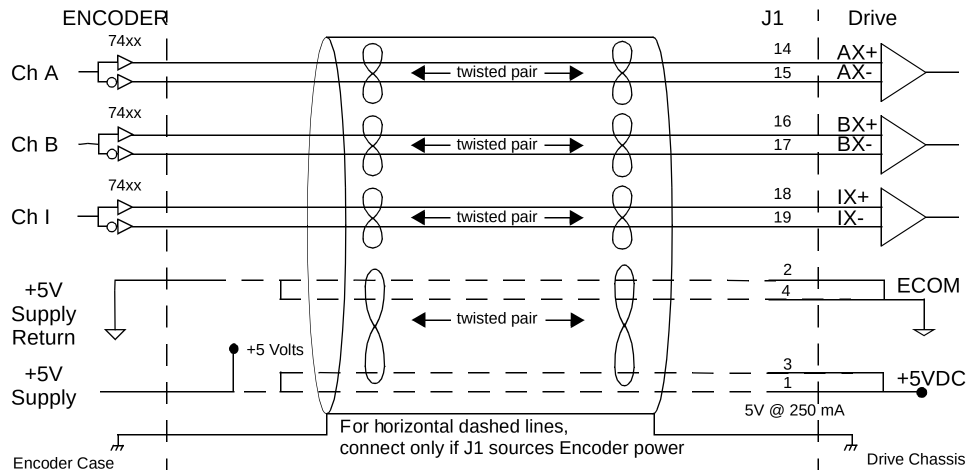


Figure 6.26 Single-Ended Encoder Interface via Open Collector Transistor without Pull-up (not recommended)

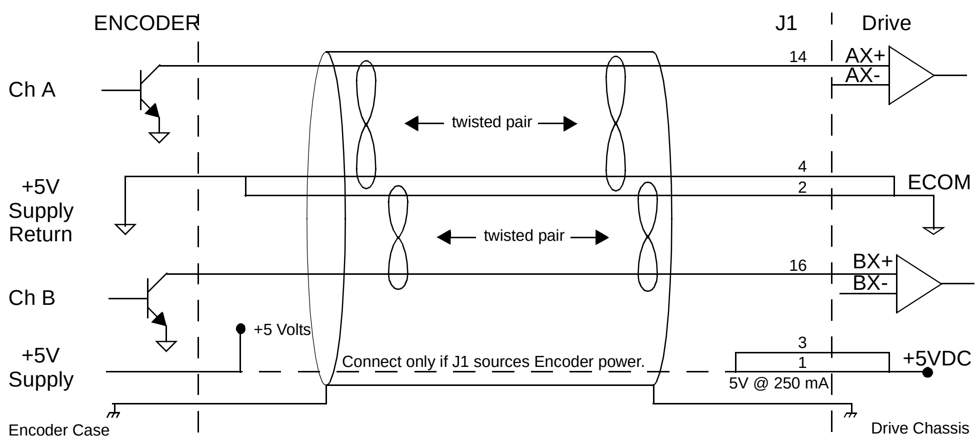


Figure 6.27 Single-Ended Encoder Interface via Standard TTL Signals (not recommended)

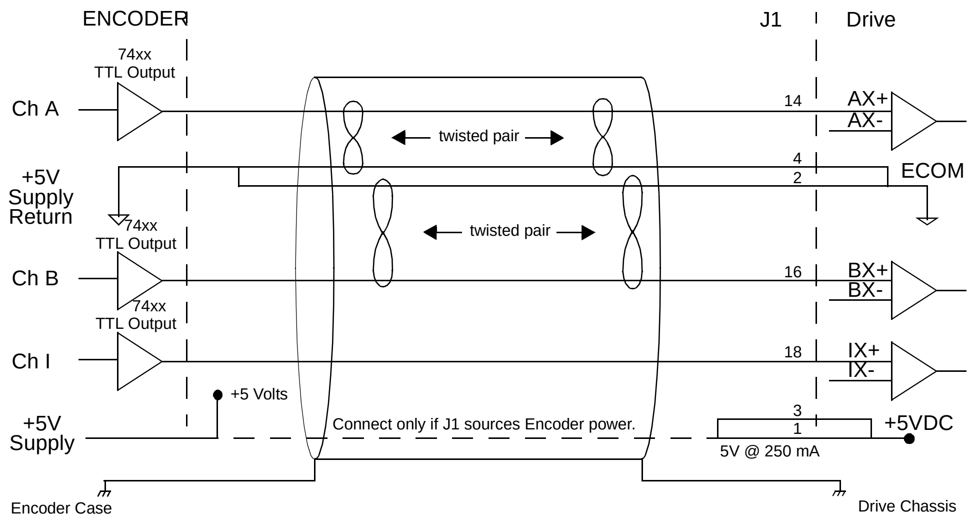


Figure 6.28 Single-Ended Encoder Interface via Open Collector Transistor with 5 VDC to 12 VDC Pull-up (not recommended)

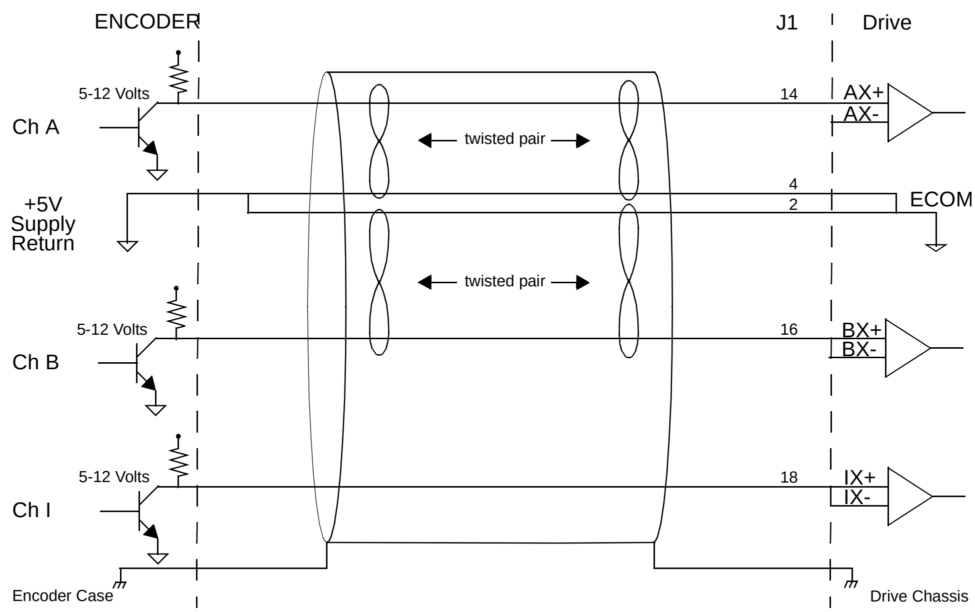


Figure 6.29 Single-Ended Encoder Interface via Open Collector Transistor with 24 VDC Pull-up (not recommended)

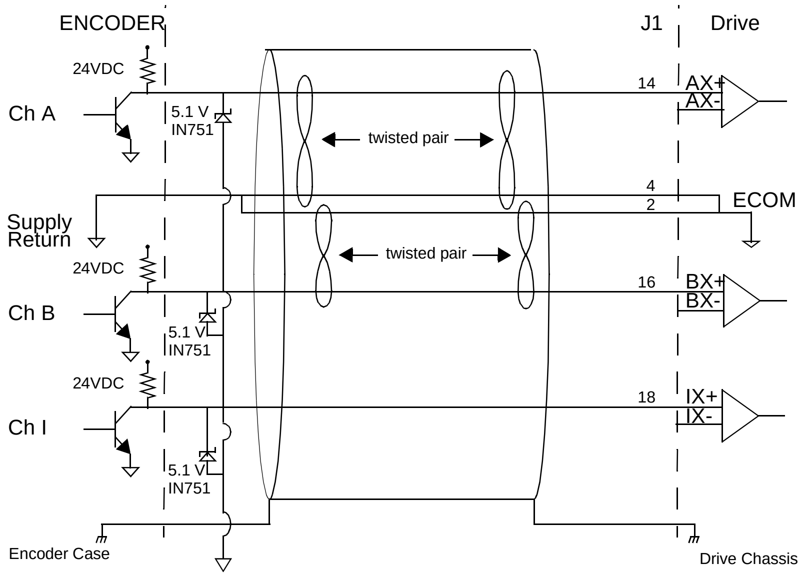


Table 6.21: Step/Direction and CW/CCW (Step Up/Step Down) Interface Specifications

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

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

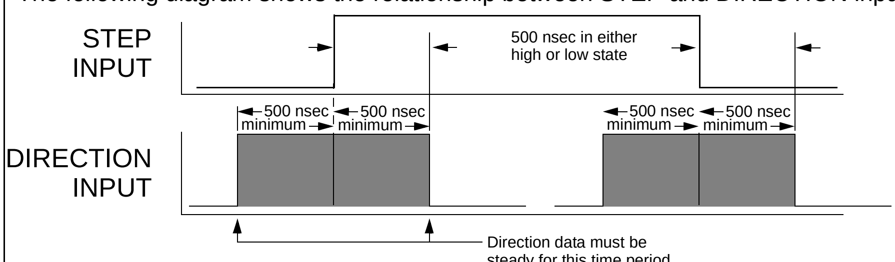


Figure 6.30 External Step/Direction Interface via TTL Differential Line Drivers

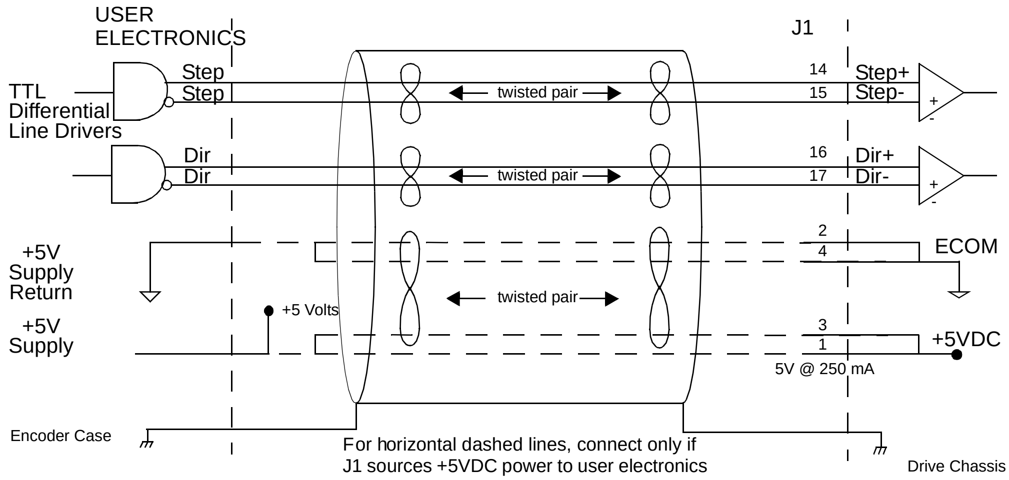


Figure 6.31 External Step/Direction Interface via Single-Ended TTL Line Drivers (not recommended)

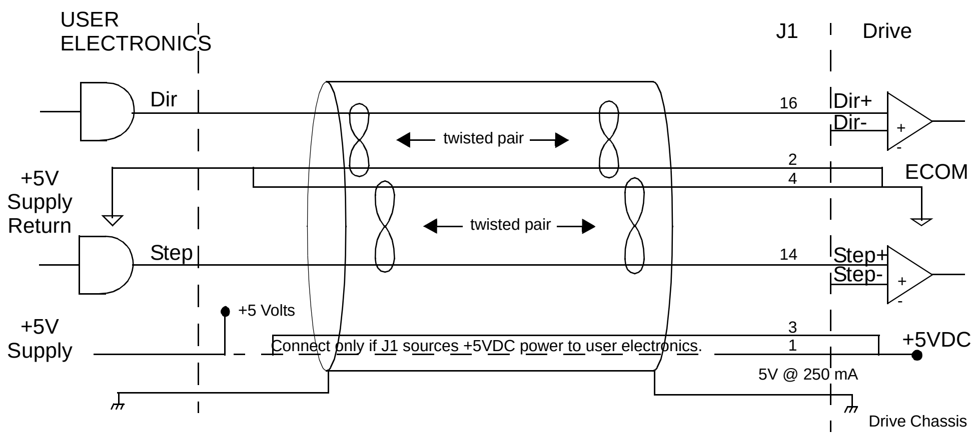


Figure 6.32 External CW/CCW (Step Up/Step Down) Interface via TTL Differential Line Drivers

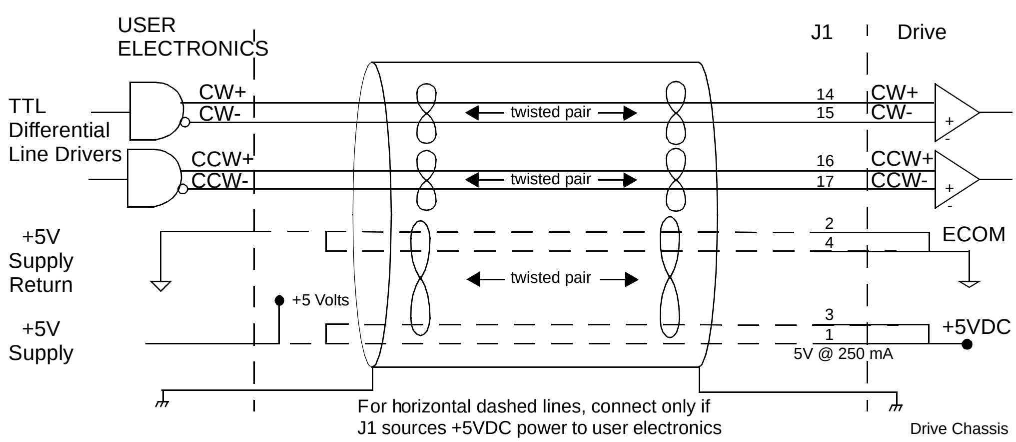
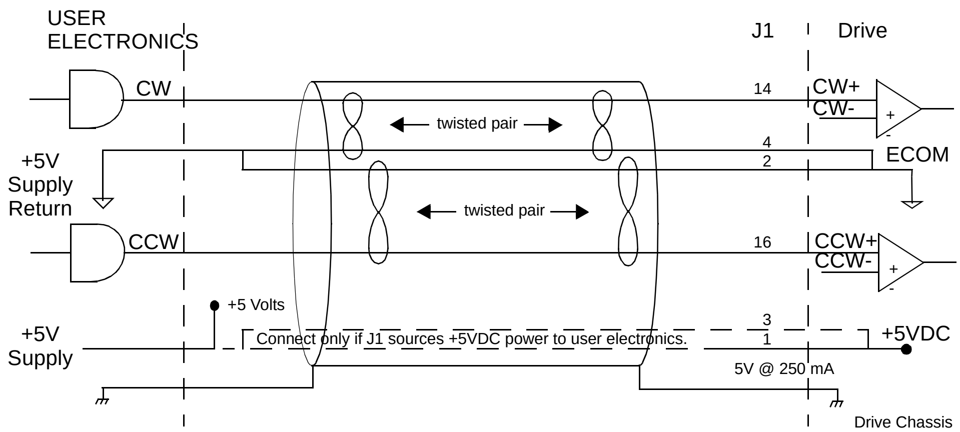


Figure 6.33 External CW/CCW (Step Up/Step Down) Interface via Single-Ended Line Drivers (not recommended)



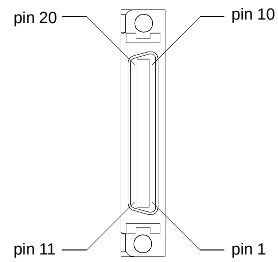
J1 Terminal Strip/Breakout Board

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 “Options and Accessories” on page A-1.

“Cabling Examples” on page B-26 depicts the use of this kit to pass a cable through a bulkhead.

J2 – Encoder

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	HALL A	Hall Effect A
4	ECOM	Encoder Common	14	HALL B	Hall Effect B
5	SENSE (+)	Encoder Power Sense (+)	15	HALL C	Hall Effect C
6	SENSE (-)	Encoder Power Sense (-)	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 (-)



J2 is a 20 pin female mini-D ribbon connector (AMP 2-178238-2). It connects the motor encoder, hall effect switches, and the thermostat to the ULTRA 200 Series drive. Contact between the connector shell and a grounded chassis provides shield termination.

ATTENTION: Ensure that the encoder signals are connected as shown in Figure 6.36. Incorrect connection of the encoder signals will result in improper rotor position, incorrect commutation and/or a runaway motor condition.

Allen-Bradley cables are available in various lengths for connecting between J2 and an encoder. “Options and Accessories” on page A-1 lists the cables that are available. “J2 Terminal Strip/Breakout Board” on page 6-30 details the optional signal extension kit.

Figure 6.34 Motor Encoder Interface Circuit

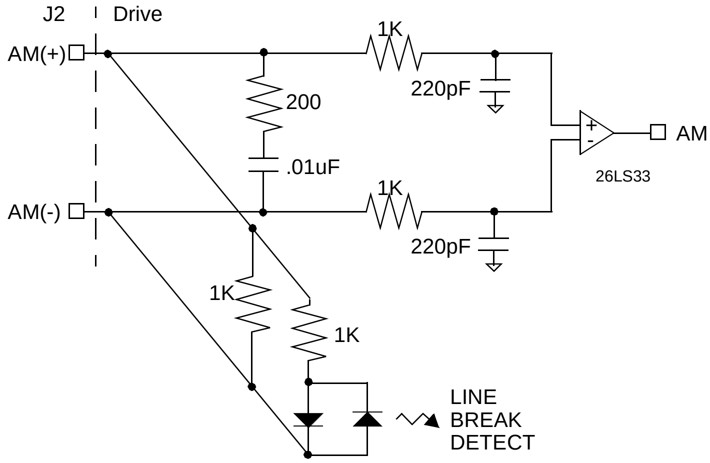


Figure 6.35 Hall Effect Sensor Circuit

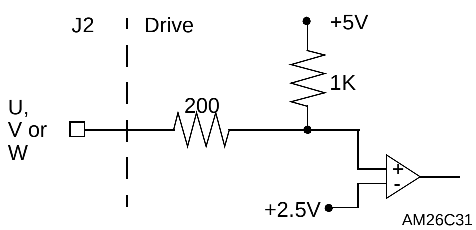


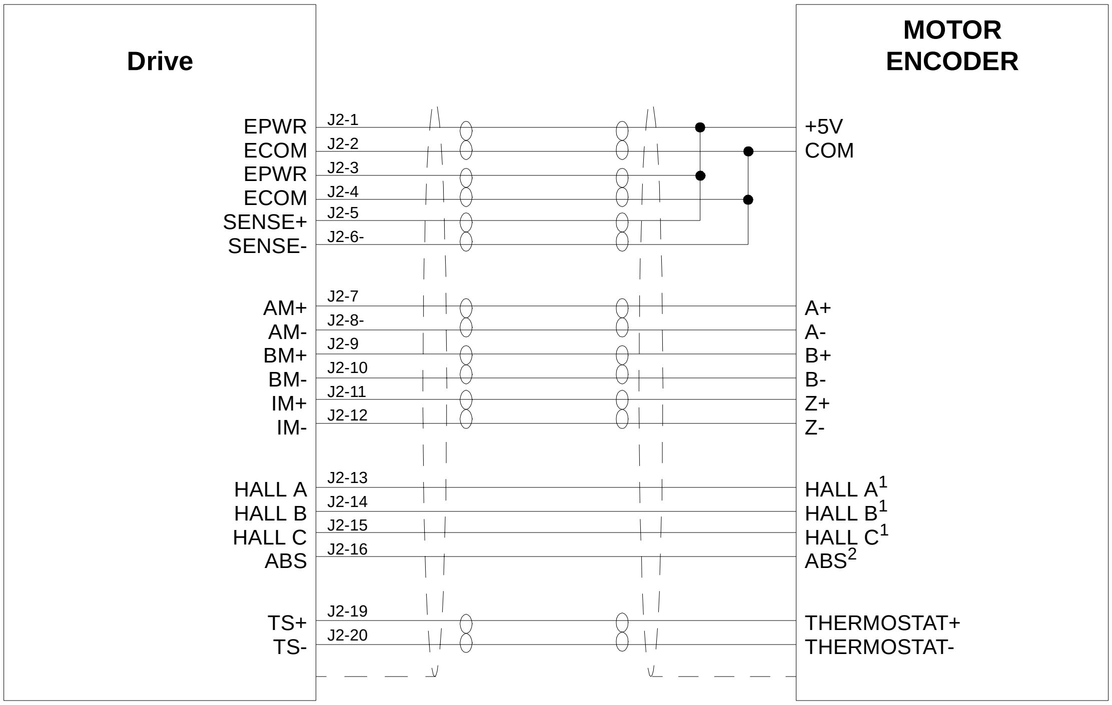
Table 6.22: J2- Motor Encoder Connector Pin-Outs

Motor Encoder	Pin Number	Description
EPWR	J2-1 J2-3	Encoder power Internally fused (F3) is 1A, fast acting.
ECOM	J2-2 J2-4	Encoder common
SENSE (+) SENSE (-)	J2-5 (+) J2-6 (-)	Encoder power sense NOTE: The SENSE+ signal must be connected to the EPWR signal, and the SENSE- signal must be connected to the ECOM signal at the encoder for the motor encoder signals to be received properly by the drive.
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.

Table 6.22: J2- Motor Encoder Connector Pin-Outs (continued)

Motor Encoder	Pin Number	Description
HALL A	J2-13	Hall Effect A sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor. The input signal interfaces to both a differential and single-ended Hall effect sensor, using either a TTL level signal or open collector signal. A differential output connects only the (+) output to the drive. Software determines when the hall effect sensors are in an illegal state.
HALL B	J2-14	Hall Effect B sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor. The input signal interfaces to both a differential and single-ended Hall effect sensor, using either a TTL level signal or open collector signal. A differential output connects only the (+) output to the drive. Software determines when the hall effect sensors are in an illegal state.
HALL C	J2-15	Hall Effect C sensor logic level input. Internally pulled up to +5VDC through a 1 kOhm resistor. The input signal interfaces to both a differential and single-ended Hall effect sensor, using either a TTL level signal or open collector signal. A differential output connects only the (+) output to the drive. Software determines when the hall effect sensors are in an illegal state.
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 thermostat inputs, with an open condition indicating a motor overtemperature fault.

Figure 6.36 ULTRA 200 Series Motor Encoder Connections



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

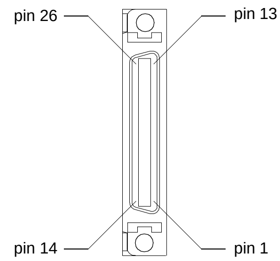
J2 Terminal Strip/Breakout Board

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 “Options and Accessories” on page A-1.

“Cabling Examples” on page B-26 depicts the use of this kit to pass a cable through a bulkhead.

J3 – Auxiliary Port

Pin	Signal	Description	Pin	Signal	Description
1	+5VDC	Encoder +5V DC	14	AX+	Auxiliary Channel A+
2	ECOM	Encoder Common	15	AX-	Auxiliary Channel A-
3	+5VDC	Encoder +5V DC	16	BX+	Auxiliary Channel B+
4	ECOM	Encoder Common	17	BX-	Auxiliary Channel B-
5	+24VDC	Isolated +24 VDC	18	IX+	Auxiliary Channel I+
6	24VCOM	Isolated 24V Common	19	IX-	Auxiliary Channel I-
7	AOUT+	Motor Output Channel A+	20	ENABLE	ENABLE
8	AOUT-	Motor Output Channel A-	21	RESET	FAULT RESET
9	BOUT+	Motor Output Channel B+	22	COMMAND+	Analog Command+
10	BOUT-	Motor Output Channel B-	23	COMMAND-	Analog Command-
11	IOUT+	Motor Output Channel I+	24	READY+	READY+
12	IOUT-	Motor Output Channel I-	25	READY-	READY-
13	24VCOM	Isolated 24V Common	26	+24VDC	+Isolated +24 VDC



J3 is a 26 pin female mini-D ribbon connector (AMP 2-178238-4). It duplicates the first 26 pins of J1, the Controller connector, which are discussed in detail beginning on page 6-1. Contact between the connector shell and the grounded chassis provides shield termination.

Allen-Bradley cables are available in various lengths for connecting between J3 and an auxiliary unit. “Options and Accessories” on page A-1 lists the cables that are available.

Table 6.23: J3 – Auxiliary Connector Pin-Outs

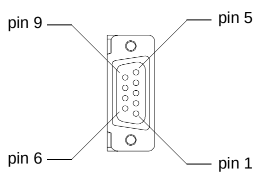
Motor Encoder	Pin Number	Description	Internal Connections
+ 5V	J3-1 J3-3	Encoder +5 VDC @ 250 mA power source for auxiliary encoder electronics. The output is fused internally by a 1 Amp fast acting fuse (F2). Refer to “5 Volt Power Supply Specifications” on page 6-4.	J1-1, J1-3 J3-1, J3-3
ECOM	J3-2 J3-4	Encoder common. Signal reference for the auxiliary encoder. Refer to “5 Volt Power Supply Specifications” on page 6-4.	J1-2, J1-4 J3-2, J3-4
+ 24V	J3-5 J3-26	Isolated + 24 VDC @ 500 mA power source for external I/O connection. This output is fused internally by a 1 Amp fast acting fuse (F1). Refer to “24 Volt Power Supply Specifications” on page 6-3.	J1-5 J1-26
24VCOM	J3-6 J3-13	Isolated 24 Volt common. Refer to “24 Volt Power Supply Specifications” on page 6-3.	J1-6 J1-13
AOUT (+) AOUT (-)	J3-7 (+) J3-8 (-)	Motor Output Channels A(+) and A(-). Differential TTL levels from line driver. Refer to “Motor Encoder Output Signal” on page 6-18 and Figure 6.20.	J1-7 (+) J1-8 (-)
BOUT (+) BOUT (-)	J3-9 (+) J3-10 (-)	Motor Output Channels B(+) and B(-). Differential TTL levels from line driver. Refer to “Motor Encoder Output Signal” on page 6-18 and Figure 6.20.	J1-9 (+) J1-10 (-)
IOUT (+) IOUT (-)	J3-11 (+) J3-12 (-)	Motor Output Channels I(+) and I(-). Differential TTL levels from line driver.) Refer to “Motor Encoder Output Signal” on page 6-18 and Figure 6.20.	J1-11 (+) J1-12 (-)
AX+ and AX-, or Step+ and Step-, or CW (Step Up+) and CW (Step Up-)	J3-14 (+) J3-15 (-)	Auxiliary Channel A(+) and A(-). Differential, quadrature, or TTL level encoder input. The signals are selectable as AX+ and AX-, or Step+ and Step-, or CW (Step Up+) and CW (Step Up-). For encoder information refer to “Quadrature Interface Specifications” on page 6-20 and Figure 6.23, 6.24, 6.25, 6.26, 6.27, 6.28 and 6.29. For stepper information refer to“Step/Direction and CW/CCW (Step Up/Step Down) Interface Specifications” on page 6-24 and Figure 6.30, 6.31, 6.32 and 6.33.	J1-14 (+) J1-15 (-)

Table 6.23: J3 – Auxiliary Connector Pin-Outs (continued)

Motor Encoder	Pin Number	Description	Internal Connections
BX+ and BX-, or DIR+ and DIR-, or CCW (Step Down+) and CCW (Step Down-)	J3-16 (+) J3-17 (-)	Auxiliary Channel B(+) and B(-). Differential, quadrature, or TTL level encoder input. The signals are selectable as BX+ and BX-, or DIR+ and DIR-, or CCW (Step Down+). and CCW (Step Down-). For encoder information refer to “Quadrature Interface Specifications” on page 6-20 and Figure 6.23, 6.24, 6.25, 6.26, 6.27, 6.28 and 6.29. For stepper information refer to“Step/Direction and CW/CCW (Step Up/Step Down) Interface Specifications” on page 6-24 and Figure 6.30, 6.31, 6.32 and 6.33.	J1-16 (+) J1-17 (-)
IX (+) IX (-)	J3-18 (+) J3-19 (-)	Differential, quadrature, or TTL level encoder input. The signals are selectable. For encoder information refer to “Quadrature Interface Specifications” on page 6-20 and Figure 6.23, 6.24, 6.25, 6.26, 6.27, 6.28 and 6.29.	J1-18 (+) J1-19 (-)
ENABLE	J3-20	Enables and disables the drive. Refer to “Digital Input Specifications” on page 6-6 and Figure 6.1.	J1-20
FAULT RESET	J3-21	General purpose input, selectable to one of several drive functions. Refer to “Digital Input Specifications” on page 6-6 and Figure 6.1.	J1-21
COMMAND (+) COMMAND (-)	J3-22 (+) J3-23 (-)	Analog command signal is a differential type signal that drives the servo controller. Separate scale and offset parameters are used for the input, depending on whether the signal is a position, velocity or torque command. Refer to “Analog Command Input” on page 6-15 and Figure 6.18.	J1-22 (+) J1-23 (-)
READY (+) READY (-)	J3-24 (+) J3-25 (-)	Contact closure indicates the drive is ready to follow commands. Refer to “READY Output Specifications” on page 6-9 and Figure 6.8.	J1-24 (+) J1-25 (-)

J4 and J5 – Serial Port

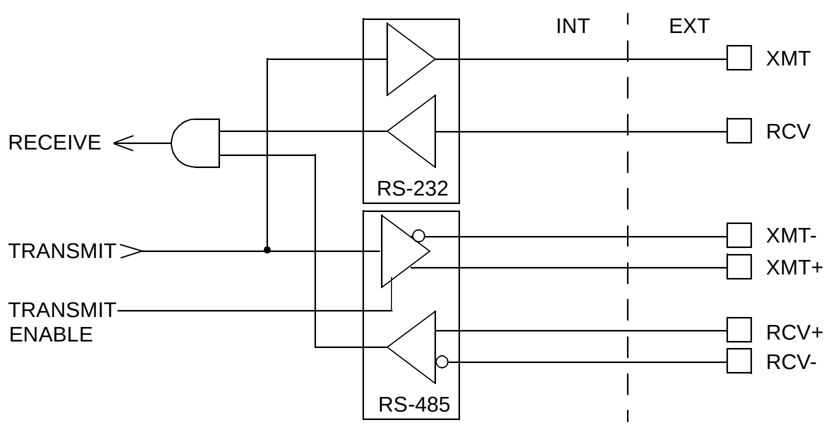
Pin	Signal	Description	Use
1	RCV(+)	Receive (+)	RS-485 (four wire)
2	RCV	Receive	RS-232
3	XMT	Transmit	RS-232
4	XMT(+)	Transmit (+)	RS-485 (four wire)
5	COM	+5 VDC Common	
6		Reserved[a]	
7	RCV(-)	Receive (-)	RS-485 (four wire)
8	XMT(-)	Transmit (-)	RS-485 (four wire)
9		Reserved[1]	



a. Do *not* connect any device to J4-6, J5-6, J4-9 or J5-9 except an Allen-Bradley TouchPad.

J4 and J5 are 9 pin female D-shell (AMP 205204-4, pins AMP 66506-3) connectors. Each connector is a serial interface that allows communication with another ULTRA 200 Series drive, a PC, a terminal, a host computer, a controller or an optional TouchPad. The signals on J4 and J5 are internally connected, which allows daisy-chain connection of several drives. The shell of the connector is grounded to the chassis for shield termination.

Figure 6.37 RS-232/485 Interface Circuit



The serial interface of the ULTRA 200 Series 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 200 Series drives allowable on an 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.

Allen-Bradley cables are available in various lengths for connecting to the serial port of an ULTRA 200 Series drive and a control unit, such as a PC. “Options and Accessories” on page A-1 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.

The following table lists the pin-outs for J4 and J5.

Table 6.24: J4 and J5 – Serial Port Connector Pin-Outs

Signal	Pin Number	Description	Internal Connections
RCV (+) RCV (-)	J4 - 1 (+) J4 - 7 (-)	RS-485 differential receiver input (to drive)	J5 - 1 (+) J5 - 7 (-)
XMT (+) XMT (-)	J4 - 4 (+) J4 - 8 (-)	RS-485 differential transmitter output (from drive)	J5 - 4 (+) J5 - 8 (-)
COM	J4 - 5	Common serial port interface	J5 - 5
	J4 - 6	Reserved[a]	J5 - 6
RCV	J4 - 2	RS-232 receiver input (to drive)	J5 - 2
XMT	J4 - 3	RS-232 transmitter output (from drive)	J5 - 3
	J4 - 9	Reserved[1]	J5 - 9

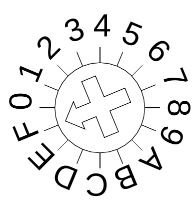
a. Do *not* connect any device to J4-6, J5-6, J4-9 or J5-9, except an Allen-Bradley TouchPad.

Serial Communications Overview

ULTRA 200 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, either through hardware (a physical address) or software. All physical addresses are set using the 16 position rotary switch on the front panel of the drive. Software based addresses are selected by setting the rotary switch to position F, as shown, which forces the drive to used the address stored in the personality module EEPROM of the drive.

Figure 6.38 Sixteen Position Rotary Addressing Switch



The following table shows the relationship between drive addresses, whether set by hardware or software. It also lists the communications settings, whether mandatory (default) settings or software selectable.

Table 6.25: Drive Addressing

Address Range		Communications
Hardware[1]	Software[1]	
0	N/A	Factory Default • 9600 baud rate • 8 Data • 1 Stop Bit • No Parity
1–A	N/A	Software Selected Settings include: • 1200, 2400, 4800, 9600 and 19200 baud rates • 8 Data Bits • 1 Stop Bit • Even, Odd or No Parity
B–E	N/A	Reserved
F	1–32	Software Selected

1. Hardware (rotary address switch) and software (address and communications settings) changes are not immediate; they are logged but do not become active until *after* the drive is RESET.

Addressing Examples:

- Setting the rotary switch to position 0 forces the drive to communicate using the factory default settings (refer to Table 6.25). The drive ignores any software address assigned to it. However, the drive may be assigned a unique name.

Note: This setting ensures that communications with the drive can be established at any time.

- Setting the rotary switch to position 1 assigns the drive to physical address 1. The communications parameters may be modified, but software addressing is not enabled.
- Setting the rotary switch to position F, as shown in Figure 6.38, forces the drive to read its address from EEPROM.
  ULTRA Master software supports the addressing range, 1 to 32, which is stored in EEPROM.

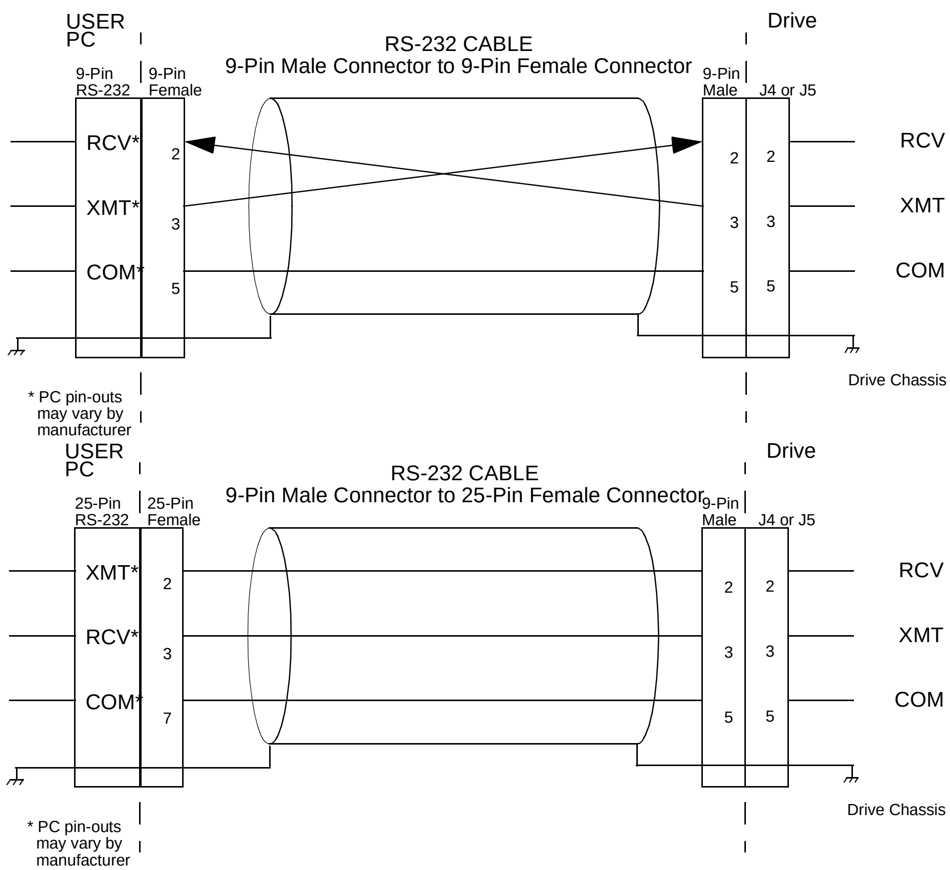
Each drive may be assigned a unique name of up to 32 characters in length; a name is often easier to remember than the address of a drive. ULTRA Master software automatically associates a drive name with the correct drive address.

RS-232 Connections

The physical address is set using the 16 position rotary switch on the front panel.

Note: Do *not* connect any device to J4-6, J5-6, J4-9 or J5-9 except an Allen-Bradley TouchPad.

Figure 6.39 RS-232 Connection Diagrams



Single Axis RS-232 Set Up

A single ULTRA 200 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.

The following steps outline how to select the communications options:

1. Set the rotary switch to zero (0), which forces default communications with the drive.
2. Connect an RS-232 cable between the computer and a serial connector on the drive (J4 or J5).

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

- Switch drive power to ON
- Start ULTRA Master on the attached PC
- Choose **CANCEL** from the Drive Select window
- Select **Communications** from the menu
- Select **PC Set Up** from the pull down menu
- Verify the port settings, and if necessary, change them, then choose **OK**.
- Select **Communications** from the menu
- Select **Read Drive Parameters** from the pull down menu
- Choose **OK** in the Drive Select window.

4. Verify that ULTRA Master reads the drive parameters. If not, refer to "Troubleshooting" on page 11-6.

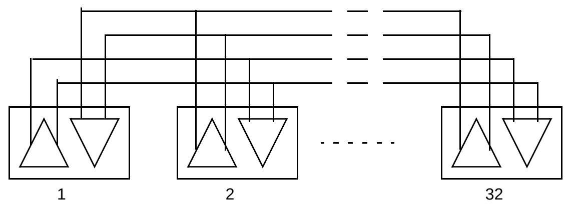
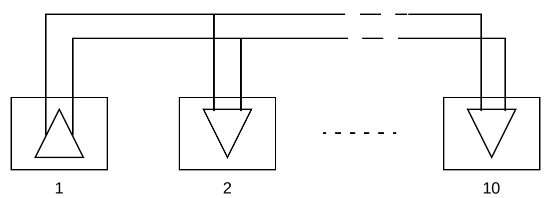
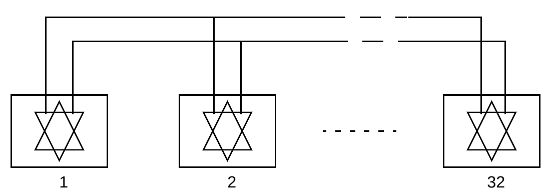
The cable diagrams provide wiring examples for both 9 pin and 25 pin serial ports from an IBM compatible personal computer to the drive. RS-232 pin-outs vary between computer manufacturers. Check the hardware reference manual of your machine to ensure correct signal connections between the computer and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

Four Wire RS-485 Connections

The ULTRA 200 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.

Figure 6.40 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 200 Series drives	

Multiple Axes Four-Wire RS-485 Communications

Note: Do *not* connect any device to J4-6, J4-9, J5-6 or J5-9 except an Allen-Bradley TouchPad.

1. Set the rotary address switch on each drive to an unassigned address:
   - If physical addressing is used, set the rotary switch to a previously unused address (1-A).
   - If software addressing is used, set the rotary switch to address F and then select a previously unused address (1 - 32) in ULTRA Master.
2. Connect cables between:
   - The host computer and the serial port on the initial drive (J4) in the multiple drive configuration.
   - The other serial port on the initial drive (J5) and the serial port on the next drive (J4) in the multiple drive configuration
3. Verify the communication settings on the computer are correct:
   - Start ULTRA Master on the attached PC
   - Choose CANCEL from the Drive Select window
   - Select Communications from the menu
   - Select PC Set Up from the pull down menu.
   - Verify the port settings, and if necessary, change them, then choose OK.

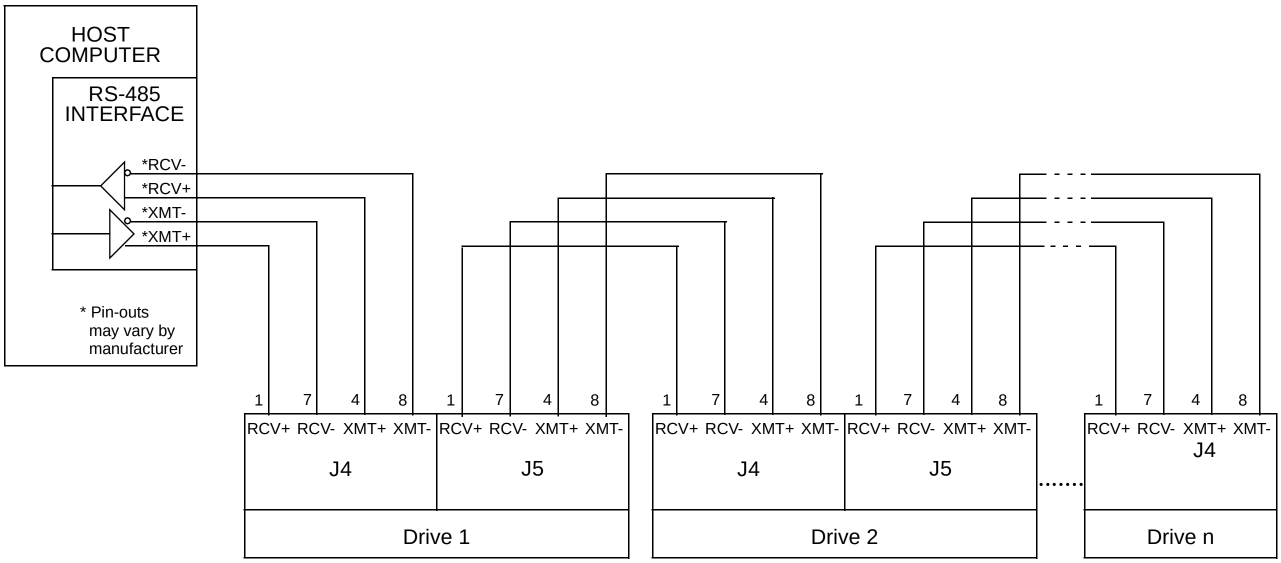
Note: Address 0 is the preferred address for the initial configuration of a drive. It forces the drive to the default communications parameters.

4. Verify the ability to communicate between the computer and the connected drives by:
   - Switch drive power to ON
   - Select Communications from the menu
   - Select Read Drive Parameters from the pull down menu
   - 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)
   - Choose OK in the Drive Select window.
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.

Four wire RS-485 connections are shown below. The cable diagram provides a wiring example of a daisy chain connection in a typical installation A multi-drop cable (Figure 6.42) may also be used.

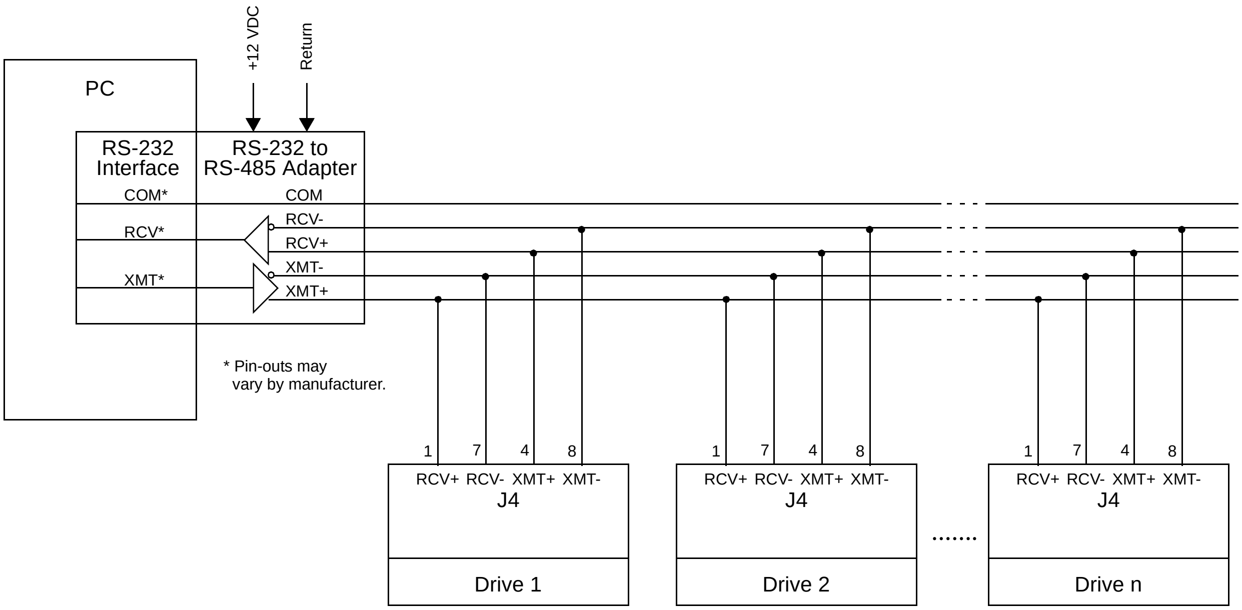
Note: RS-485 pin-outs vary between manufacturers. Check the hardware reference manual to ensure correct signal connections between the host computer and the drive.

Figure 6.41 Four Wire RS-485 Daisy Chain Connection Diagram



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. A daisy chain wiring configuration may also be used as shown in Figure 6.41.

Figure 6.42 RS-232 to RS-485 Multi-Drop Connection Diagram

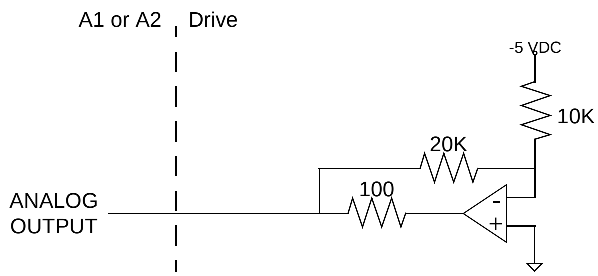


NOTE:
This example uses a 2-channel RS-232 to RS-485 adapter, manufactured by B&B Electronics (815.433.5100).

A1, A2, and COM – Analog Outputs

Analog outputs may be monitored with external equipment, such as an oscilloscope, on the external output pins A1 (ANALOG 1), A2 (ANALOG 2) and COM (COMMON). These output signals are parallel connections to the analog command signals available on connector J1. Refer to “Analog Outputs” on page 6-16.

Figure 6.43 ANALOG 1 and ANALOG 2 Output Circuits



A 12-bit digital-to-analog converter (DAC) generates ANALOG 1. ANALOG 2 is a filtered PWM signal with 8 bit resolution and a carrier frequency of 32.8 kHz. Both outputs are scaled to a range of -10 to +10 Volts.

Table 6.26: Analog outputs ANALOG 1 and ANALOG 2

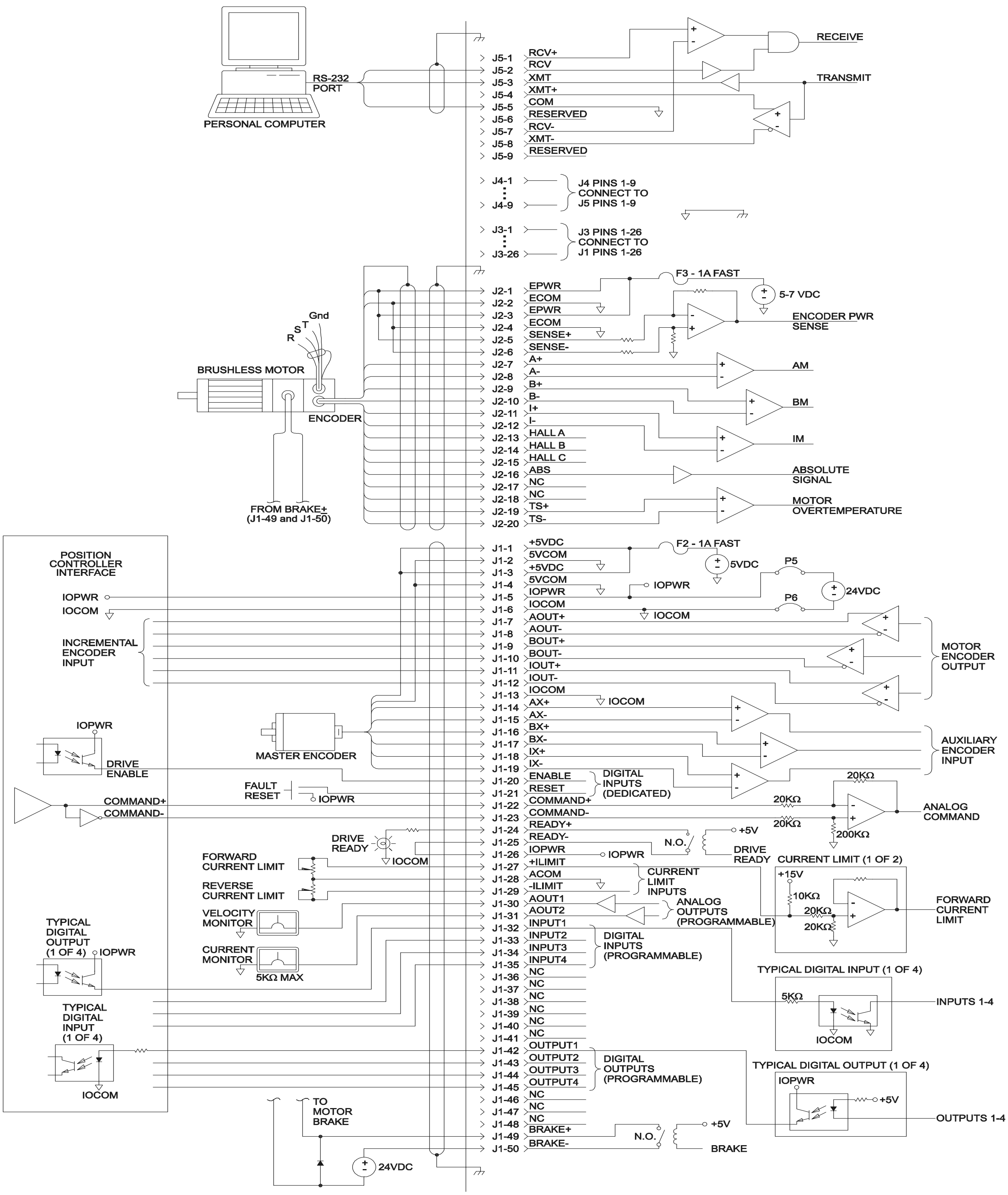
Analog Output	Pin Number	Description	Pin Number
ANALOG 1	A1	Selectable analog output with 12 bit resolution. Displays any firmware variable with selectable scale and offset.	J1-30
ANALOG 2	A2	Selectable analog output with 8 bit resolution. Displays any firmware variable with selectable scale and offset.	J1-31
COMMON	COM	Analog Common return.	J1-28

Table 6.16 on page 6-17 lists the output specifications for the signals.

Interface Connections

Shown here are typical components and connections for a ULTRA 200 Series drive.

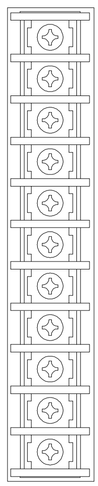
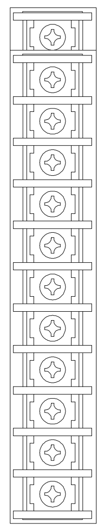
Figure 6.44 1398-DDM Interface Connection Diagram



Power Connections

TB1 – DC Bus and AC Power

Refer to Figure 5.4 on page 5-11 for power wiring connection diagrams for the drives.

Description	Identifier	1398-DDM-010 and 1398-DDM-010X 1398-DDM-020 and 1398-DDM-020X 1398-DDM-030 and 1398-DDM-030X	Terminal	1398-DDM-075 and 1398-DDM-075X 1398-DDM-150 and 1398-DDM-150X	Identifier	Description
R phase power to motor	R		1		R	R phase power to motor
S phase power to motor	S		2		S	S phase power to motor
T phase power to motor	T		3		T	T phase power to motor
Motor case ground	⏚		4		⏚	Motor case ground
DC Bus + voltage	DC BUS +		5		DC BUS +	DC Bus + voltage
DC Bus - voltage	DC BUS -		6		DC BUS -	DC Bus - voltage
100/240 VAC input power	L1 (Line 1)		7		L1 (Line 1)	100/240 VAC input power
100/240 VAC input power	L2 (Line 2)/ N (Neutral)		8		L2 (Line 2)/ N (Neutral)	100/240 VAC neutral
Safety (earth) ground	⏚		9		L3 (Line 3)	100/240 VAC input power for three phase[1]
Auxiliary 100/ 240 VAC input power	L1 AUX		10		⏚	Safety (earth) ground
Auxiliary 100/ 240 VAC input power	L2/N AUX		11		L1 AUX	Auxiliary 100/ 240 VAC input power
1 **CAUTION:** When operating 1398-DDM-075 with a single phase power input the current limits must be set correctly.			12		L2 AUX	Auxiliary 100/ 240 VAC neutral for three phase

The 1398-DDM-075 and 1398-DDM-075X are rated for either single phase or three phase power inputs. When connected to a single phase input, the user must change the current limits of the drive. The following drive parameters must be set:

- Positive Current Limit: 50 A peak
- Negative Current Limit: 50 A peak
- Average Current: 15 A continuous

An explanation of how to set these values is contained in ULTRA Master on-line help.

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.

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

ATTENTION: Failure to set the current limits for single phase operation of the 1398-DDM-075 or 1398-DDM-075X can result in drive malfunction and potential damage.

Motor Power Cabling

Terminals 1 through 4 connect the drive to the windings of the motor.

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

Table 7.1 lists the drive terminals and typical motor connections; Table 7.2 lists the minimum wire size for making power wiring connections.

Table 7.1: TB1 – Motor Power Terminals

Motor Phase Signal	Description	Terminal
R[1]	R phase from drive	TB1-1
S[1]	S phase from drive	TB1-2
T[1]	T phase from drive	TB1-3
⏚ [1]	Ground for the motor case	TB1-4

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

1.The I-Series and V-Series motors require swapping of the R and S motor power leads when connecting to the drive.

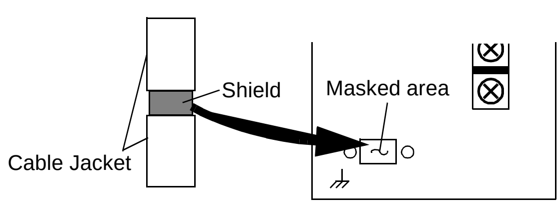
Refer to Appendix A, "Options and Accessories" for a list of available Allen-Bradley cables.

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.

Allen-Bradley 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 at the left front of the drive chassis using the clamp provided near the bottom. It is critical for EMC performance that the shield wires be clamped against the area of the chassis which is not painted. This section of the chassis is labeled with the chassis ground symbol.

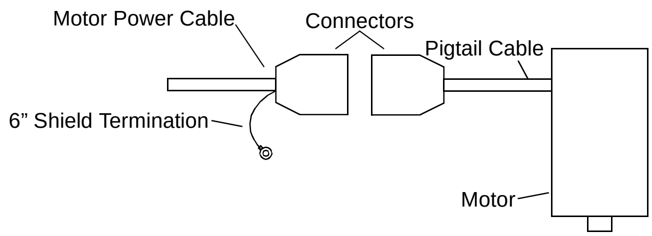
Figure 7.1 Motor Power EMC Shield Connection



Y-Series Power Cables

Y-Series motors have a short “pigtail” cable which connects to the motor but is not shielded. The motor power cables have a 6 inch shield termination wire with a ring lug which should be connected to the closest earth ground. This shield termination 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.

Figure 7.2 Pigtail Ground



ATTENTION: High voltage may be present on the terminals of the ULTRA 200 Series 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 7.2: Motor Power Contact and Wire Sizing Recommendations

Motor	Motor Power Mating Maximum Contact Size		Minimum Recommended 90°C Power Wire[a]	
	mm^2	AWG	mm^2	AWG
H-2005	1.5	16	1.5	16
H-3007	1.5	16	1.5	16
H-3016	1.5	16	1.5	16
H-4030, F-4030	4.0	12	1.5	16
H-4050, F-4050	4.0	12	2.5	14
H-4075, F-4075	4.0	12	2.5	14
H-6100, F-6100	10.0	8	4.0	12
H-6200, F-6200	10.0	8	10.0	8
H-6300, F-6300	10.0	8	10.0	8
H-8350	25.0	4	16.0	6
H-8500	25.0	4	16.0	6
N-Series	1.5	16	1.5	16
Y-Series	1.5	16	1.5	16

a. Recommendations are based on motor ratings only. If the drive in the system cannot deliver rated power to the motor, then smaller wire sizes may be required for connection to the drive.

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

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. Follow these guidelines:

- The 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.

DC Bus

Terminals 5 and 6 have voltage present when AC power is applied to the drive. The DC Bus LED also illuminates when voltage is present on the terminals.

Figure 7.3 Emergency Stop Contactor Wiring

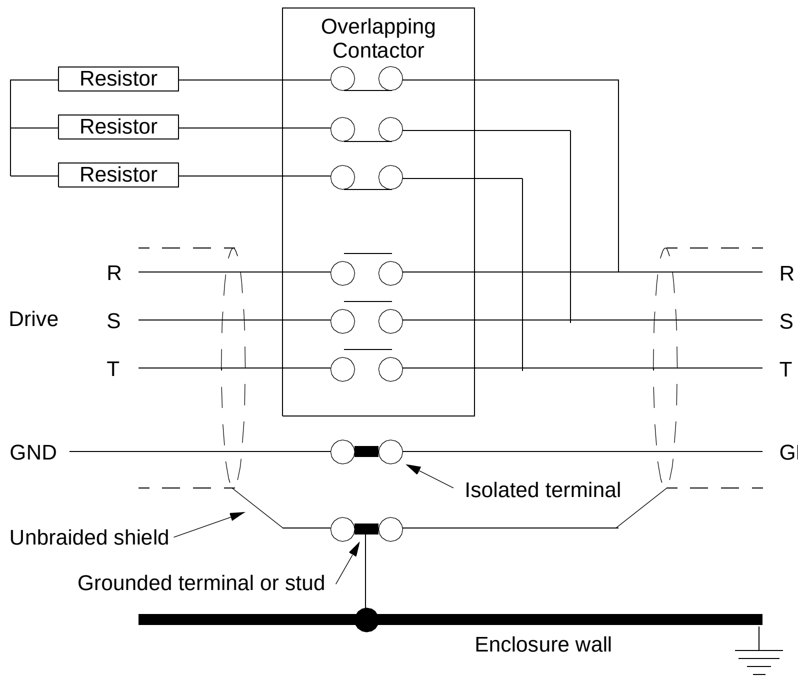


Table 7.3: TB1 – DC Bus Terminals

Signal	Description	Terminal
DC Bus +	Positive DC Bus voltage signal	TB1-5
DC Bus -	Negative DC Bus voltage signal	TB1-6
NOTE: Torque all terminal connections to 1.25 Nm (11.0 lb-in).		

AC Power Cabling

The ULTRA 200 Series drives require 100 to 240 VAC rms power with an input frequency of 47 - 63 Hz. The 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030 and 1398-DDM-030X require single phase input power. The 1398-DDM-075 and 1398-DDM-075X may use either single or three-phase input power, but the 1398-DDM-150 and 1398-DDM-150X require three-phase input power. “ULTRA 200 Series Power Ratings” on page G-5 lists the output power characteristics of the ULTRA 200 Series drives. The AC input supplies power to the motor and the drive logic as the default factory setting. An auxiliary power source may provide input power to the drive I/O independent of the motor power. Alternatively, the drive may be powered by an external DC power source.

Terminals 7, 8 and 9 are the single phase AC input power connections for the 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030 and 1398-DDM-030X. Terminals 7, 8, 9 and 10 are the three phase AC input power connections for the three-phase 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 and 1398-DDM-150X. Terminals 7, 8 and 10 are the AC input power connections when the 1398-DDM-075 and 1398-DDM-075X are powered from a single-phase input. .

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 ULTRA 200 Series drive. Ensure that the drive is connected to a safety (earth) ground.

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

Table 7.4: TB1 – AC Power Terminals

Signal	Description	Terminal	
		1398-DDM-010 and 1398-DDM-010X, 1398-DDM-020 and 1398-DDM-020X, 1398-DDM-030 and 1398-DDM-030X	**1398-DDM-075 and 1398-DDM-075X, 1398-DDM-150 and 1398-DDM-150X**
L1	100/240 Volts AC Line 1 input power.	TB1-7	TB1-7
L2/N	100/240 Volts AC Line 2 input power. (Neutral on single-phase drive: 1398-DDM-010, -020, -030, -075 and 1398-DDM-150)	TB1-8	TB1-8
L3	240 Volts AC Line 3 input power. Available only on three-phase drives: 1398-DDM-075 and 1398-DDM-150.	not used	TB1-9
⏚	Safety (earth) ground	TB1-9	TB1-10
NOTE: Torque all terminal connections to 1.25 Nm (11.0 lb-in).			

The inputs to the main (logic and motor supply) and the auxiliary (logic supply only) power sources are separated. This permits independent powering of the control power and the motor power. This dual power sourcing is useful for troubleshooting and diagnostics.

Table 7.5: AC Input Power Sizing Requirements

Model	Current		Requirements		
	Input[1] (rms Amps)	**Inrush** (peak Amps)	**Fuse** (Amps)	**Wire** (AWG)	**Transformer** [2] (kVA)
1398-DDM-010, 1398-DDM-010X	10	50	10	14	2
1398-DDM-020, 1398-DDM-020X	19	50	20	12	4
1398-DDM-030, 1398-DDM-030X	28	50	30	10	6
1398-DDM-075, 1398-DDM-075X single phase	28	50	30	10	6
1398-DDM-075[3], 1398-DDM-075X three phase	28	50	30	10	12
1398-DDM-150, 1398-DDM-150X	46	68	60	6	20

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 200 Series is four times the motor rated continuous current (converted to an RMS value). The ULTRA 200 Series 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 200 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).

2. The ULTRA 200 Series drives do *not* require an isolation transformer. The recommended transformer sizes are the minimum that is adequate for most servo applications. Larger transformers provide an additional safety factor. The additional safety factor may occur in applications that require minimum bus voltage sag when the motor must accelerate to high speed in minimum time or in applications with high continuous power requirements.

3. The ULTRA 200 Series three phase products require 240 VAC line to line power. This is not available in Europe, where the three phase power distribution is 400 VAC line to line, 240 VAC line to neutral. In Europe a transformer is required to supply the correct three phase voltage. In Europe the ULTRA 200 Series single phase units may run directly off the line to neutral voltage.

The inputs to the main (logic and motor supply) and the auxiliary (logic supply only) power sources are separated. This permits the logic power to operate independently of the motor. This dual power sourcing is useful for troubleshooting and diagnostics.

Auxiliary Power

Auxiliary AC (Terminals 10 and 11) supplies power to the logic/control circuits and fault logic. The main and auxiliary power must be connected in phase.

Table 7.6: Auxiliary Power Terminals

Signal	Description	Terminal	
		1398-DDM-010, 1398-DDM-010X 1398-DDM-020, 1398-DDM-020X 1398-DDM-030, 1398-DDM-030X	**1398-DDM-075, 1398-DDM-075X 1398-DDM-150, 1398-DDM-150X**
L1 AUX	Auxiliary 100/240 Volts AC Line 1 input	TB1-10	TB1-11
L2 AUX IN	Auxiliary 100/240 Volts AC Line 2 input (or neutral)	TB1-11	TB1-12
NOTE: Torque all terminal connections to 1.25 Nm (11.0 lb-in).			

AUX power is supplied to a switching power supply. This input accepts Voltages from 100 to 240 VAC rms single phase with an input frequency 47-63 Hz.

The auxiliary (logic supply only) and the main (logic and motor supply) power sources are separated. This permits the logic power to operate independently of the motor. This dual power sourcing is useful for troubleshooting and diagnostics.

Table 7.7: Auxiliary Power Sizing Requirements

Voltage Input (Volts AC)	Current		Requirements	
	Input[1] (Amps AC)	**Inrush** (Amps peak)	**Wire** mm^2 (AWG)	**Transformer[2]** (VA)
100	1.0	47	1.5 (16)	250
240	0.5	95	1.5 (16)	250

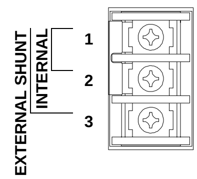
1. Dual element, time delay (slow acting) fuses are required to accommodate inrush current at the auxiliary terminals during power-up. Local regulations must be observed when selecting fuses.

2. The ULTRA 200 Series drives do *not* require an isolation transformer. The recommended transformer sizes are the minimum that is adequate for most servo applications. Larger transformers provide an additional safety factor. The additional safety factor may occur in applications that require minimum bus voltage sag when the motor must accelerate to high speed in minimum time or in applications with high continuous power requirements.

TB2 – Shunt Regulator

The ULTRA 200 Series drive has a built-in shunt regulator. The figure depicts the internal shunt selection with a factory installed jumper between terminals TB-1 and TB-2. Removal of the internal shunt jumper and installation of an external shunt between terminals TB-1 and TB-3 allows voltage to be dissipated at a faster rate than possible with the internal shunt.

Terminal	Identifier	Description
TB2-1	1 (Internal or External)	Positive DC bus
TB2-2	2 (Internal)	Internal shunt regulator resistor
TB2-3	3 (External)	Shunt regulator transistor collector



The shunt regulator is enabled when the DC bus increases to a specific value (420 VDC). An increase in DC bus voltage always occurs when the drive decelerates the motor and its load. This is due to the current flow from the motor to the DC bus. When the energy transferred from the rotating inertia causes the DC bus voltage to exceed 420 VDC the shunt is enabled and the excess energy (>420 VDC) is dissipated as heat.

ATTENTION: High voltage is present on the terminals of the ULTRA 200 Series drive. Remove power and disconnect the power cable before making or removing any connection. Failure to observe this precaution could result in severe bodily injury or loss of life.

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.

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

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

Table 7.8: TB2 – Shunt Regulator Terminals

Terminal	Description
TB2-1	Positive DC bus
TB2-2	Internal shunt regulator resistor
TB2-3	Shunt regulator transistor collector
NOTE: Torque all terminal connections to 11.0 lb-in.	

Table 7.9: Internal Shunt Power Ratings for Drive Models

Drive Model	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
Continuous Shunt Power (Watts)	50	50	50	50	180
Peak Shunt Power (kWatts)	4.5	4.5	4.5	10.0	19.0

If the application requires a higher continuous power dissipation, the ULTRA 200 Series provides easy access to an external shunt connection. Connecting an external resistor requires disabling of the internal shunt resistor. Figure 7.4 depicts the use of one or more shunt resistors to provide 1X, 4X or 9X resistance (200 Watts to 2.4 kWatts).

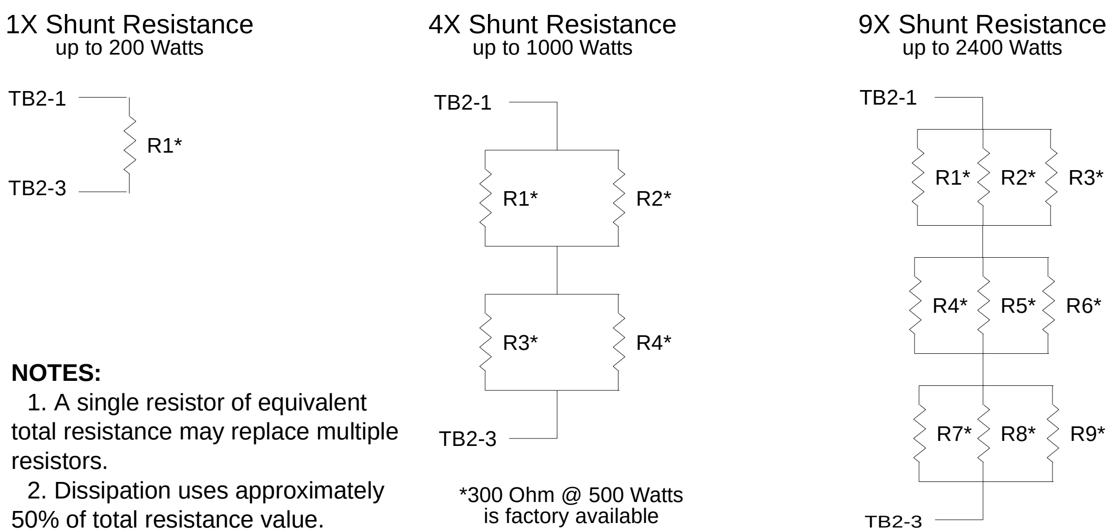
Table 7.10: Maximum External Shunt Power Ratings for Drive Models

Drive Model	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
Continuous Shunt Power (kWatts)	2.4	2.4	2.4	4.0	8.0
Peak Shunt Power (kWatts)	6.0	6.0	6.0	10.0	19.0

Table 7.11: Minimum Ratings for Customer Supplied External Shunt Resistor

Drive Model	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
Minimum Resistance ± 10% (Ohms)	30	30	30	16.5	9
Wire size mm^2 (AWG)	2.5 (14)	2.5 (14)	2.5 (14)	2.5 (14)	6.0 (10)

Figure 7.4 External Shunt Wiring Examples



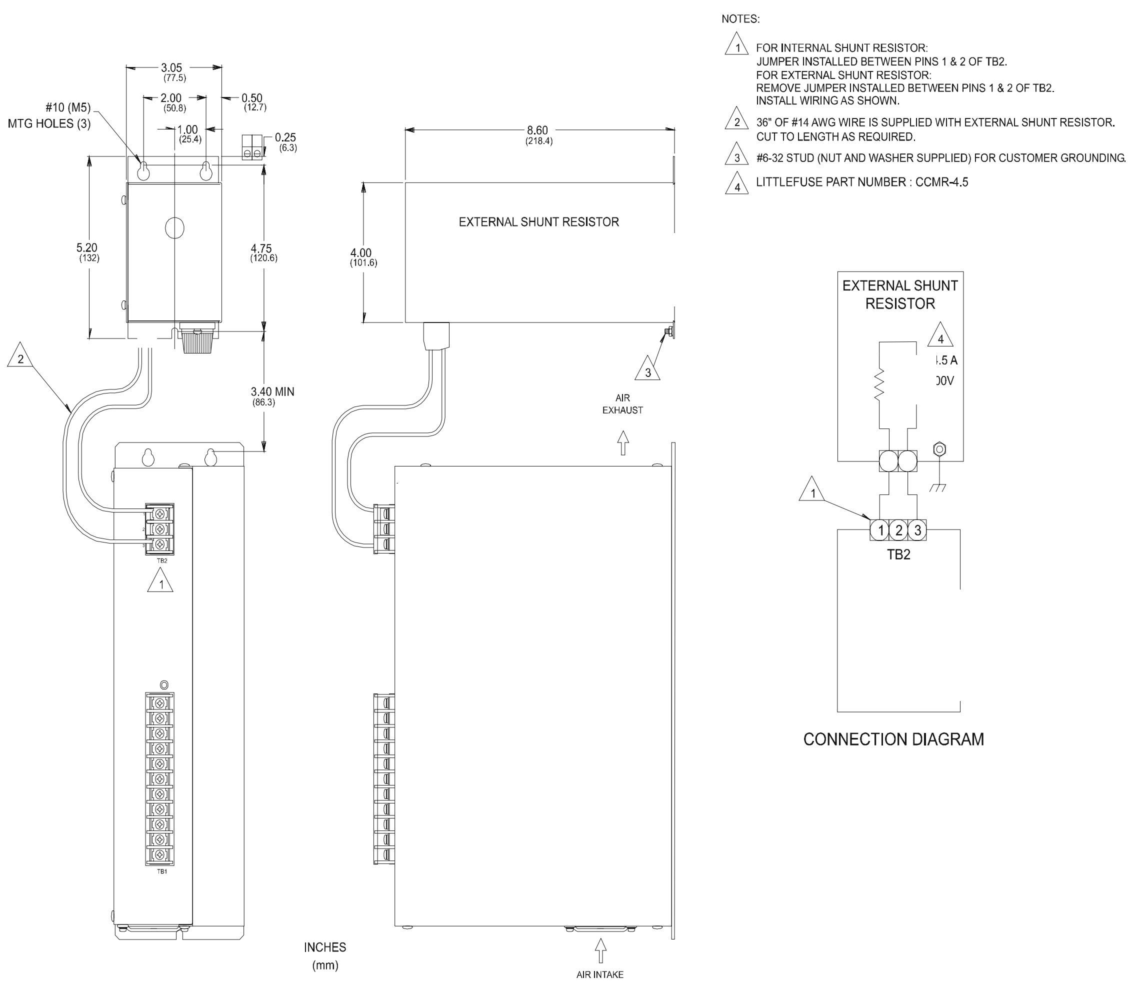
External Shunt Connection

The following procedure outlines the installation of an external shunt resistor.

1. Remove jumper between TB1-1 and TB1-2, the internal shunt connection. The jumper is supplied with the drive.
2. Wire an external shunt resistor between TB1-1 and TB1-3, the external shunt connections. Use wire of the size recommended in "Minimum Ratings for Customer Supplied External Shunt Resistor" on page 7-13.
3. Torque all terminals to 11.0 lb-in.

▶ **Note:** A fan may increase the dissipation capability of the shunt resistor.

Figure 7.5 External Shunt Mounting Diagram



Application and Configuration Examples

This section explains how to install and verify the ULTRA 200 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 8-45.

Analog Control

The ULTRA 200 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 Setup

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.

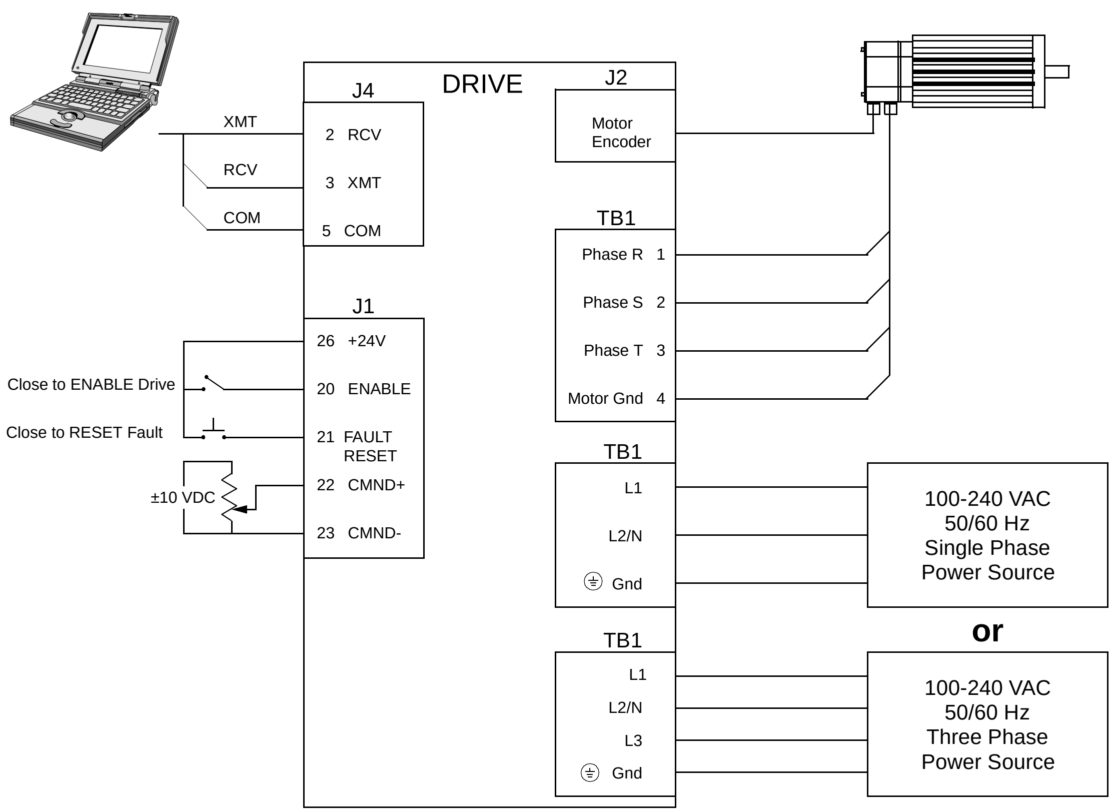
5. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   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 the drive to a 100/240 VAC, 50/60 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

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:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to “Operating Messages” 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 11-11 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.

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.

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. Close any open windows or dialogs.

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.

Preset Controller

The ULTRA 200 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 Setup

Make the connections described below and shown in 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.

3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.

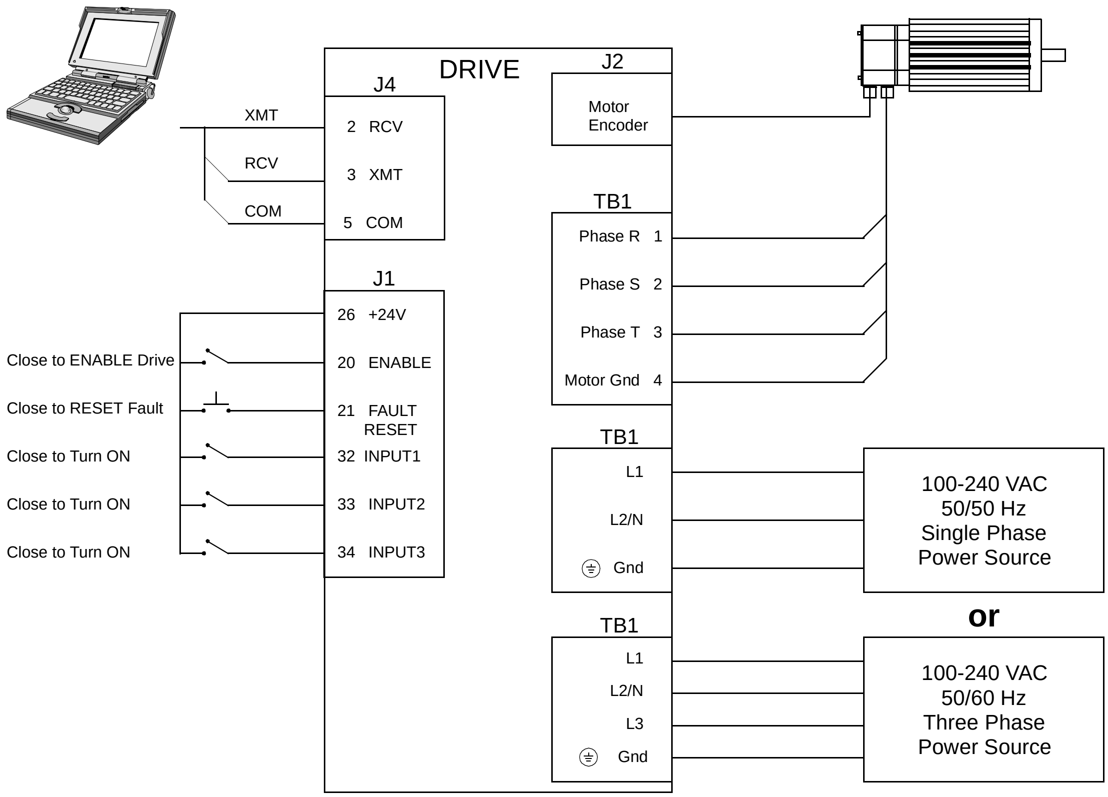
4. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-33 (INPUT2) and J1-26 (I/O PWR)
   - J1-34 (INPUT3) and J1-26 (I/O PWR)
   - Connect a switch between J1-21 (FAULT RESET) and J1-26 (I/O PWR).

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.

5. Connect the drive to a 100/240 VAC, 50/60 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

Connection Diagram

Figure 8.2 Preset Controller Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:

- green DC BUS LED is ON
- display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to "Operating Messages" 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 11-11 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 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. Select the **I/O Configuration** command icon from the Drive window.
18. 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**
    - **Input 4** to **Not Assigned**

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.

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

► **Note:** Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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.

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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. 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.

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.

Position Follower (Master Encoder)

The ULTRA 200 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 Setup

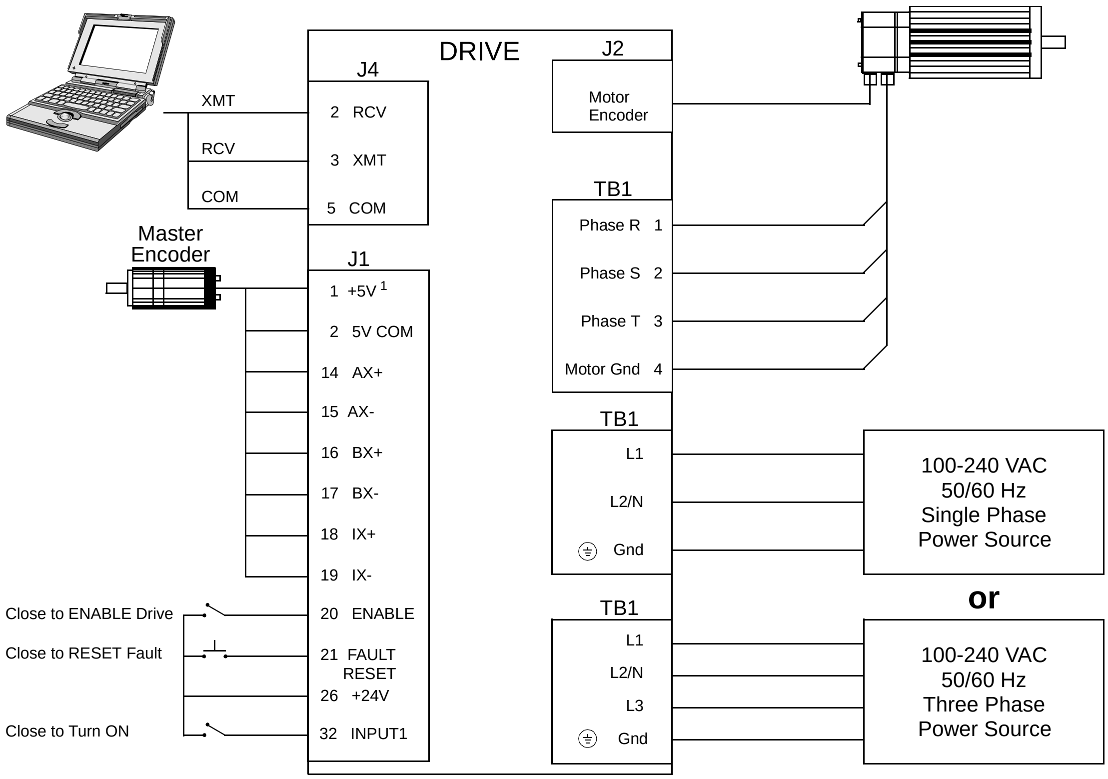
Make the connections described below and shown in Figure 8.3. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 200 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 the drive to a 100/240 VAC, 50/60 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

Connection Diagram

Figure 8.3 Master Encoder Connection Diagram



Note 1.
Refer to Figure 6.23, 6.24, 6.25, 6.26, 6.27, 6.28 and 6.29 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:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to “Operating Messages” 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 11-11 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, 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.
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 4.
    - **Not Assigned** as Outputs 1 through 4.
20. Choose **Close** to exit the I/O Configuration window.

Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. 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.

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.

Position Follower (Step/Direction)

The ULTRA 200 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 200 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 Setup

Make the connections described below and shown in 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).

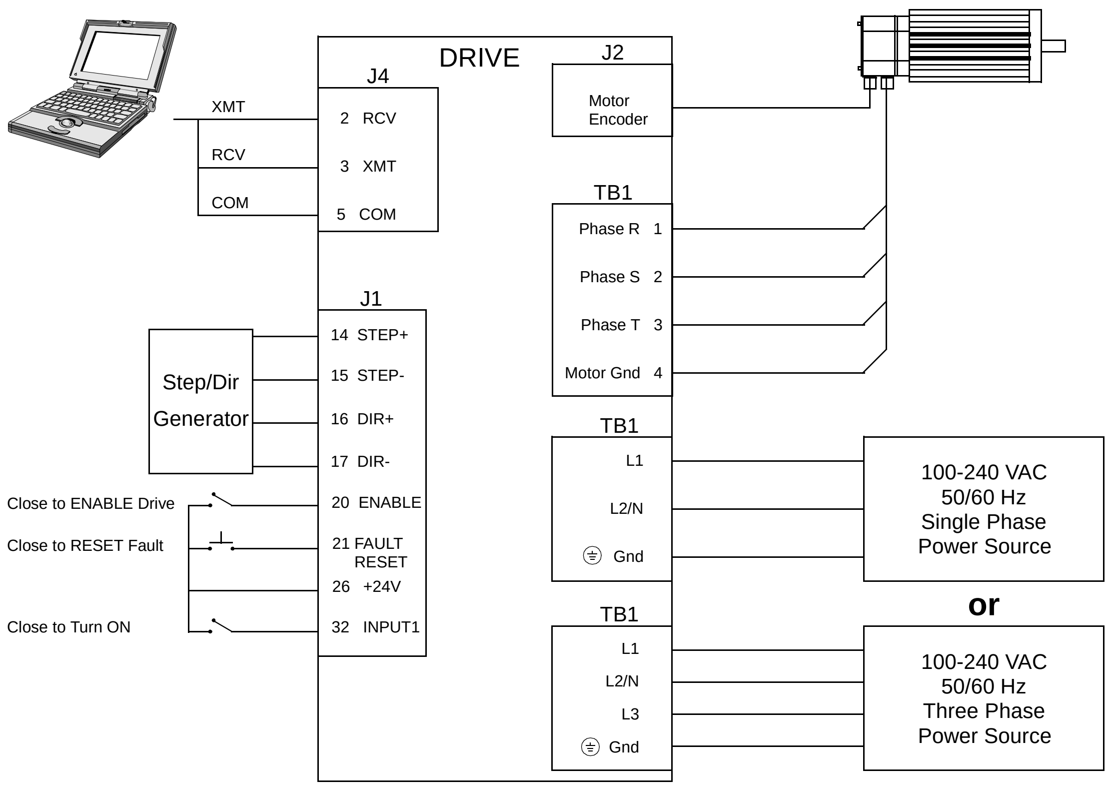
These connections provide manual control for enabling or disabling the drive and resetting faults. The figure below shows the jumper, including normally open toggle switches.

6. Connect the drive to a 100/240 VDC, 50/60 Hz power source appropriate to the drive:

- Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
- Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

Connection Diagram

Figure 8.4 Step/Direction Controller Connection Diagram



Note 1. Refer to Figure 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:

- green DC BUS LED is ON
- seven segment display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to “Operating Messages” 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 11-11 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. Select the **I/O Configuration** command icon from the Drive Window.

18. 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 4.
    - **Not Assigned** as Outputs 1 through 4.

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

Tuning

► **Note:** Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. 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.

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.

Position Follower (Step Up/ Step Down)

The ULTRA 200 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 Setup

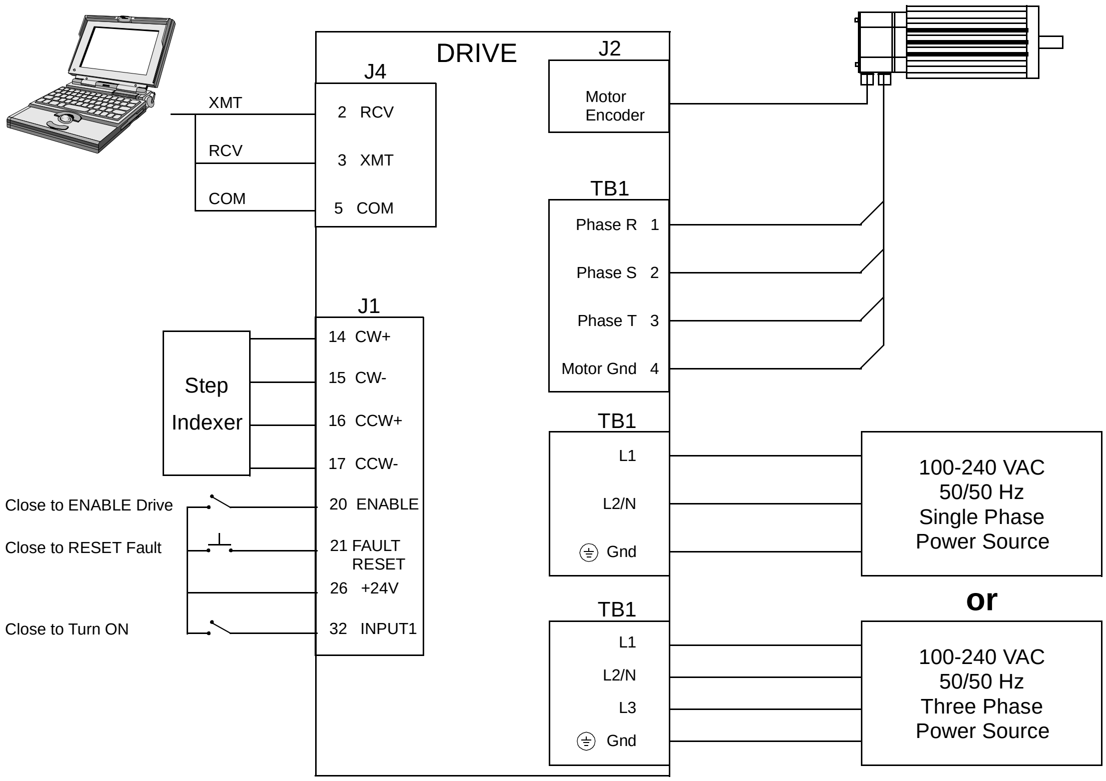
Make the connections described below and shown in Figure 8.5. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 200 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 200 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 the drive to a 100/240 VAC, 50/50 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

Connection Diagram

Figure 8.5 Step Up/Step Down Controller Connection Diagram



Note 1. Refer to Figure 6.32 and 6.33 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:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to “Operating Messages” 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 11-11 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. Select the **I/O Configuration** command icon from the Drive Window.
18. 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 4.
    - **Not Assigned** as Outputs 1 through 4.
19. Choose **Close** to exit the I/O Configuration window.

Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. 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.

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.

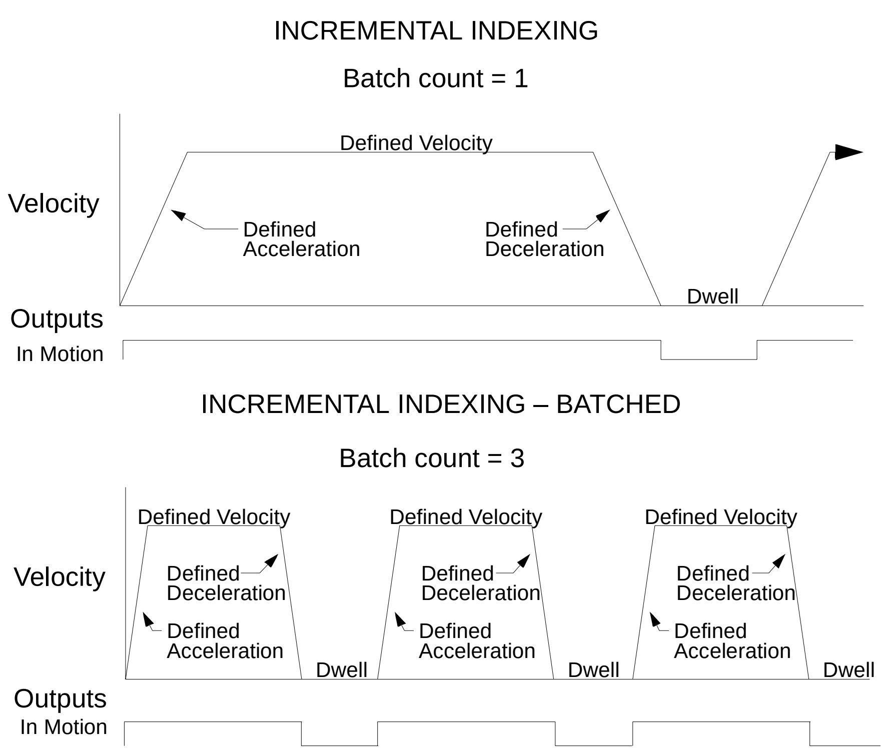
Incremental Indexing

Note: This feature is available only on drives capable of indexing: 1398-DDM-010X, 1398-DDM-020X, 1398-DDM-030X, 1398-DDM-075X and 1398-DDM-150X.

The ULTRA 200 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



Hardware Setup

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.

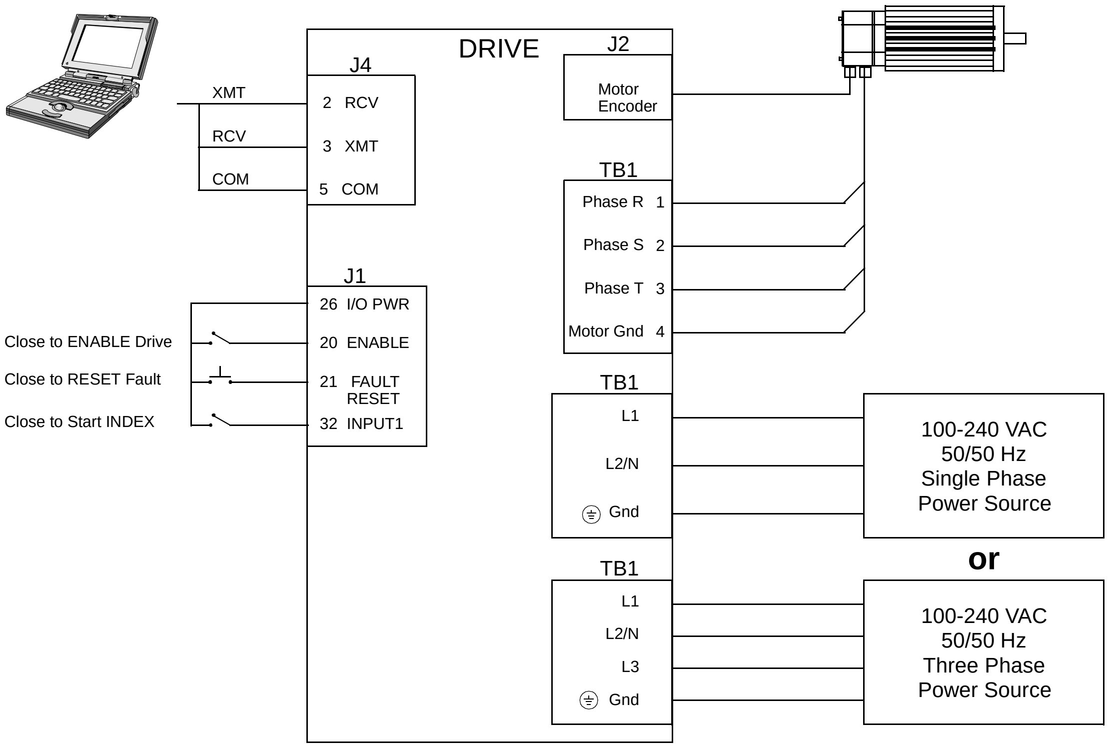
1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 200 Series. A simple 3 wire cable is depicted in the figure below.
2. Connect a Motor/Feedback cable from the motor to the J2 connector on the ULTRA 200 Series.
3. Connect a Power cable from the motor to TB1 (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 the drive to a 100/240 VAC, 50/50 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

Connection Diagram

Figure 8.7 Incremental Indexing Connection Diagram



Configuration

Carefully check all connections before entering these parameters.

1. Switch the AC Power to ON and verify:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to "Operating Messages" 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 11-11 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. Enter the following values for Index 0. Refer to "Incremental Indexing Examples" on page 8-27 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. Select the **I/O Configuration** command icon from the Drive Window.

18. 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 4.
- **Not Assigned** as Outputs 1 through 4.

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

Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. 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.

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.

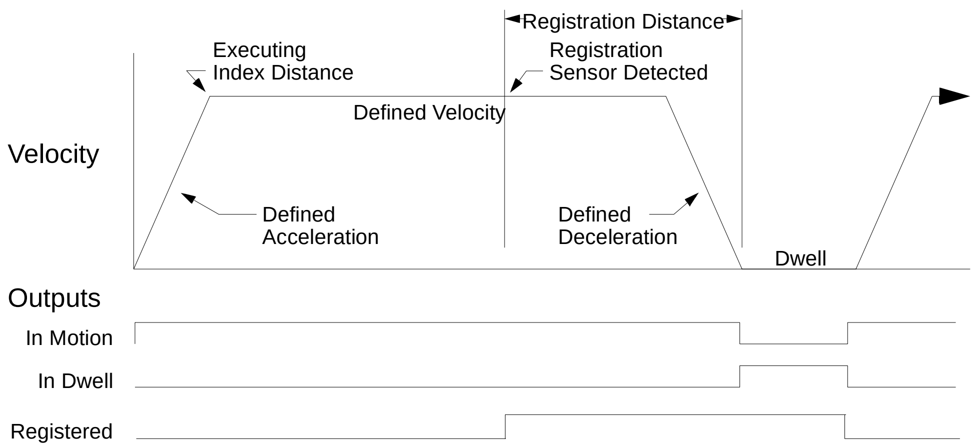
Registration Indexing

Note: This feature is available only on drives capable of indexing: 1398-DDM-010X, 1398-DDM-020X, 1398-DDM-030X, 1398-DDM-075X and 1398-DDM-150X.

The ULTRA 200 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 Setup

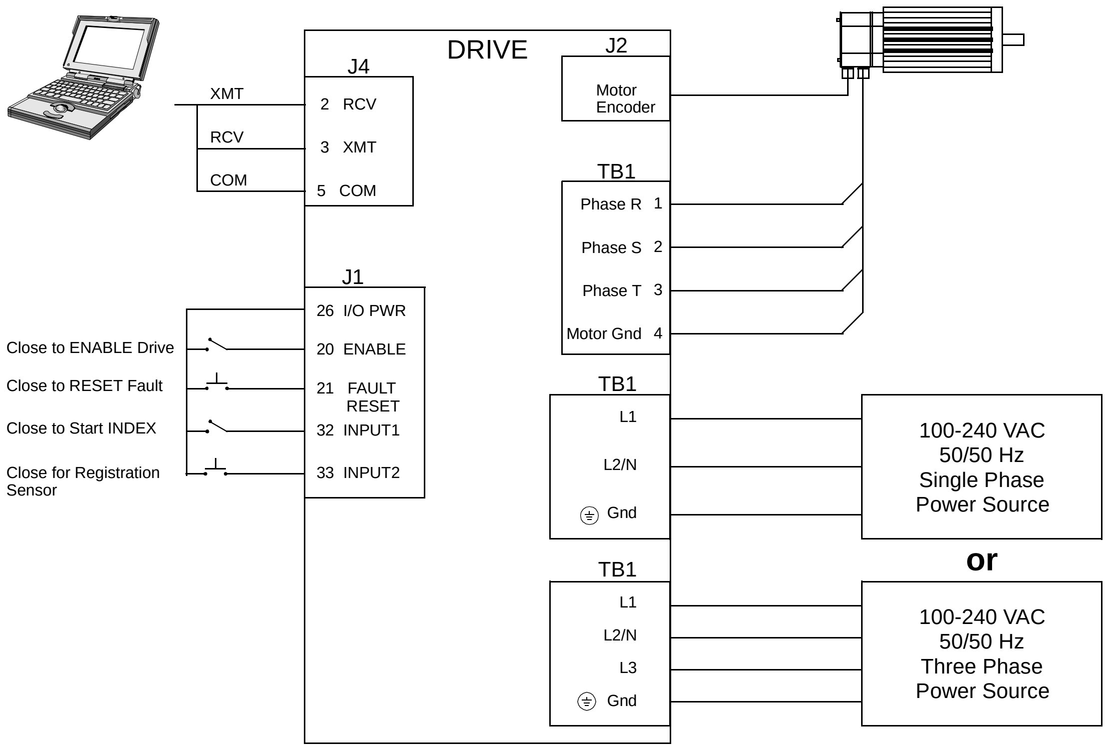
Make the connections described below and shown in the Figure 8.9. The appendix “Options and Accessories” on page A-1 lists the interconnect cables available from the factory.

1. Connect an RS-232 cable between the serial port on the PC and the J4 connector on the ULTRA 200 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 200 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.
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 the drive to a 100/240 VAC, 50/50 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

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:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to “Operating Messages” 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 11-11 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. Enter the following values for Index 0.

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

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

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

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

18. 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 Inputs 3 and 4.
- **Not Assigned** as Outputs 1 through 4.

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

Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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.

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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. 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.

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.

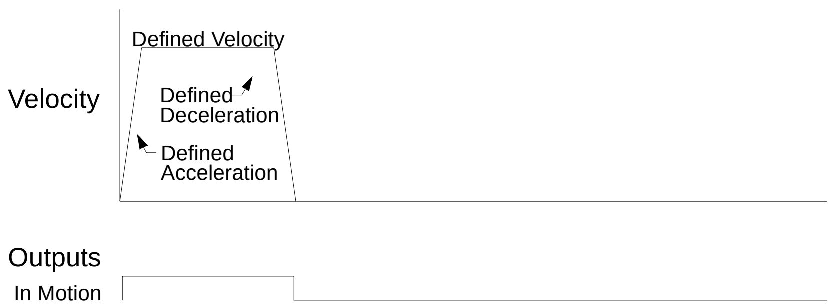
Absolute Indexing

The ULTRA 200 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.

Note: This feature is available only on drives capable of indexing: 1398-DDM-010X, 1398-DDM-020X, 1398-DDM-030X, 1398-DDM-075X and 1398-DDM-150X.

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

Figure 8.10 Absolute Indexing Examples



Hardware Setup

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 200 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 200 Series.
3. Connect a Power cable from the motor to TB1 (terminals R, S, T and ⏚) on the drive.

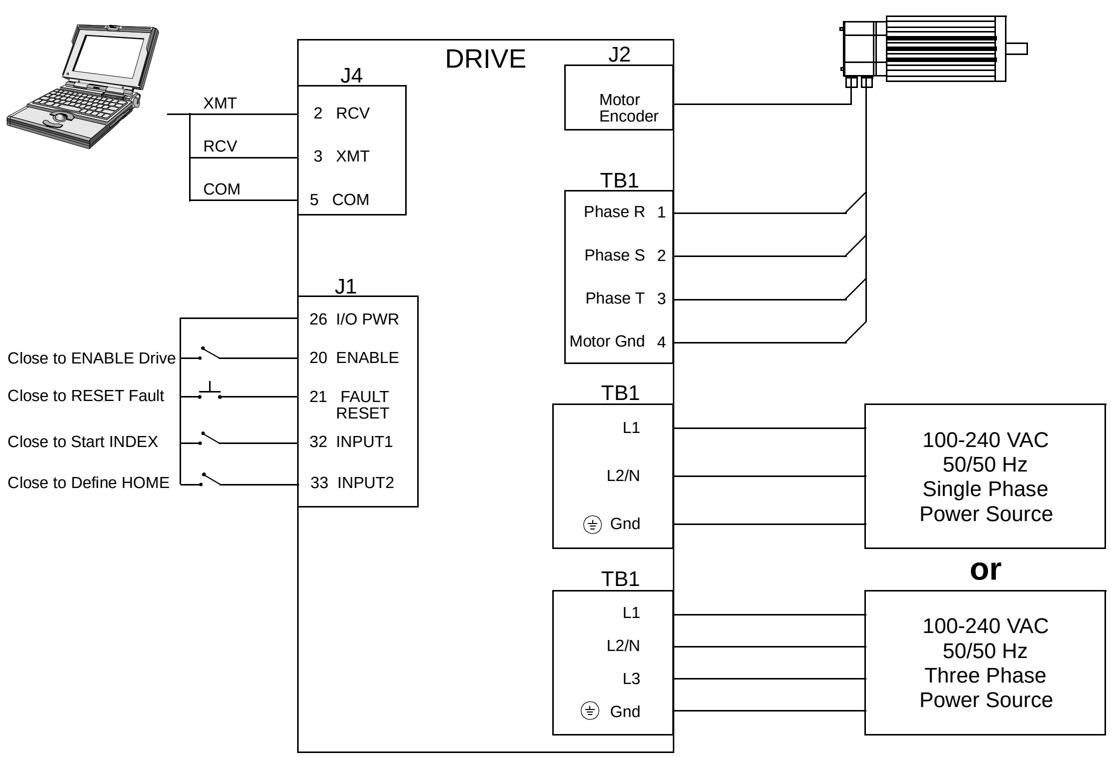
4. Connect a jumper wire with a toggle switch between the following pins:
   - J1-20 (ENABLE) and J1-26 (I/O PWR)
   - J1-32 (INPUT1) and J1-26 (I/O PWR)
   - J1-33 (INPUT2) and J1-26 (I/O PWR)
   - J1-21 (FAULT RESET) and J1-26 (I/O PWR).

   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 the drive to a 100/240 VAC, 50/50 Hz power source appropriate to the drive:
   - Single Phase: 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X
   - Three Phase: 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X

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:
   - green DC BUS LED is ON
   - display shows an operational status: A, F or P (Analog, Follower or Preset mode of operation). Refer to "Operating Messages" 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 11-11 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. Select the **I/O Configuration** command icon from the Drive Window.

18. 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 Inputs 3 and 4.
    - **Not Assigned** as Outputs 1 through 4.

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

Tuning

Note: Do *not* attempt to Auto Tune systems that have gravitational effects. The ULTRA 200 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. 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.

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.

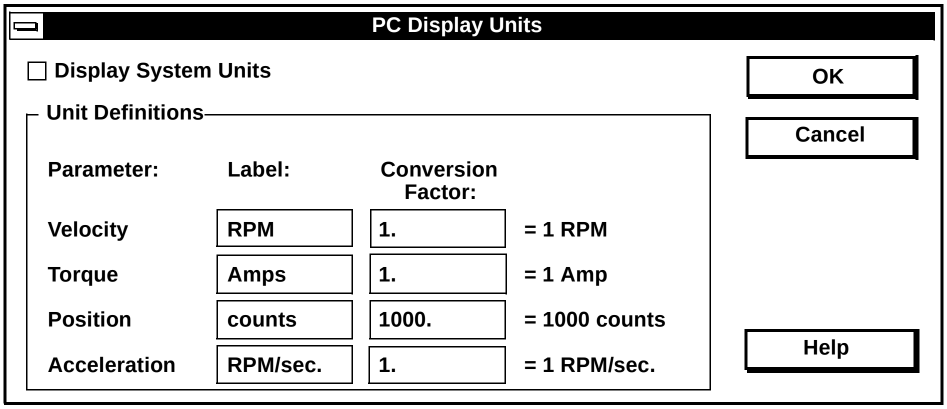
When motion is required:

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.

Modifying User Units

The units displayed for any ULTRA 200 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 8 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.

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

Tuning

ULTRA 200 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

1. Tune the velocity loop first and then, if the drive uses following or step/direction commands, tune the position loop.

2. 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.

3. To increase stiffness, increase the I-gain setting. It rejects load disturbance and compensates for system friction.

4. To reduce velocity loop overshoot, increase P-gain or D-gain, or decrease I-gain.

5. To reduce mechanical resonance, use a stiffer mechanical coupling or select a nega-tive (-) D-gain value. Alternatively, decrease the low-pass filter value and the velocity loop update rate.

6. 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.

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 using a negative D-gain value and by reducing the P-gain, I-gain, velocity loop update rate or low-pass filter value. The D-term of the PID velocity regulator (see the velocity and torque current conditioning structure) subtracts (or adds) a proportion of the motor acceleration from the velocity error. The D-gain has the effect of increasing the acceleration current if the motor is accelerating in the wrong direction, but reducing the acceleration current if the motor is already accelerating in the right direction. When used in this way the D-gain dampens an oscillating or ringing system. In the case of motor-load mechanical resonance, a positive D-gain actually worsens the situation. When a negative D-gain value is used in a mechanically resonating system it may be thought of as subtracting the *load* acceleration (the opposite sign of the motor acceleration since the system is resonating). This tends to bring the motor and load back into phase with each other and therefore reduces or eliminates mechanical resonance.

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.

Figure 9.1 Velocity Loop Structure

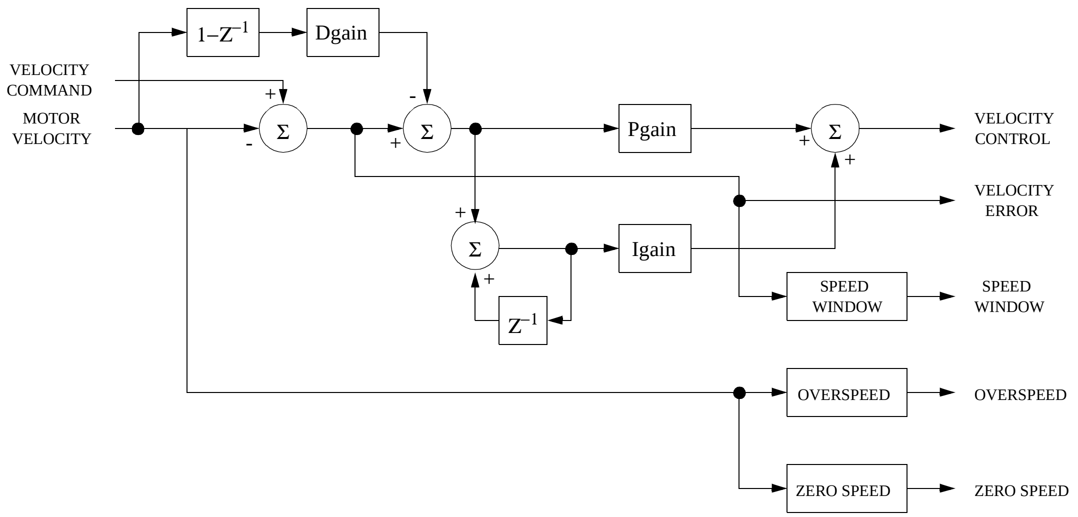
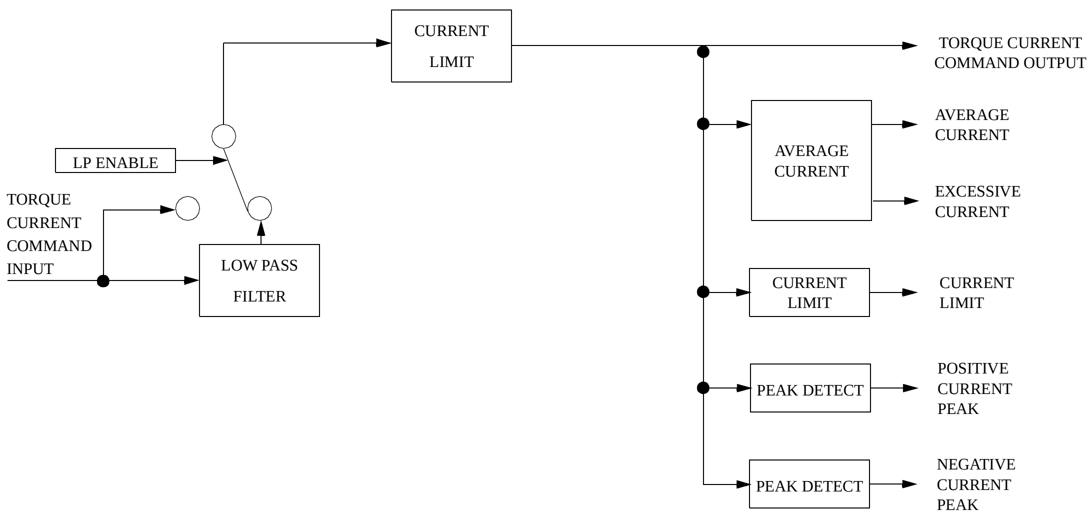


Figure 9.2 Torque Current Conditioning Structure



Backlash

Backlash between the motor and load effectively unloads the motor over a small angle. Within this small angle, the increased bandwidth 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 velocity loop gain parameters. Adjustments do not require special equipment. This mode will tune a drive for constant velocity loop response across different applications. The results will 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 is required to perform tuning on a ULTRA 200 Series drive. The optional TouchPad does not support tuning.

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

- Distance sets the rotation limit of the motor. This is the maximum distance the motor is allowed to move during any one test. (Note: a test 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 these procedures.

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, 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.

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.

Manual Tune Mode

Manual tuning may be used to adjust the gain settings and filter frequency of the velocity 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 9-4 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. A 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.

Gains

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.
D-gain	Differential gain of the velocity regulator. Positive D-gain decreases the amount of overshoot caused by the I-gain. Negative D-gain decreases the torsional resonance between the motor and the load.

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. Note: Kp-gain is only for use with the position following mode.
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.

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:

- Adjust the frequency range to remove (filter) the noise produced by encoder resolution.
- Reduce 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.

Manual Tuning

Manual tuning may be used to adjust the gain control parameters P, I, D 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
- 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.

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.

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 controls parameters Kp, Kd, Kff, Ki, and Ki Zone Filters 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 Position Motor Feedback signal.
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

Figure 9.3 Signal Nomenclature

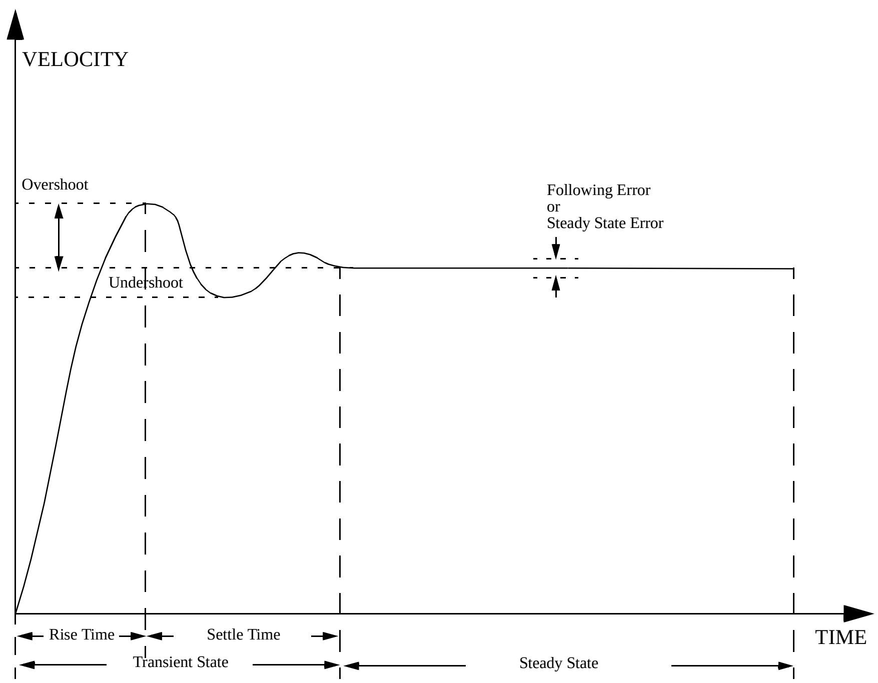
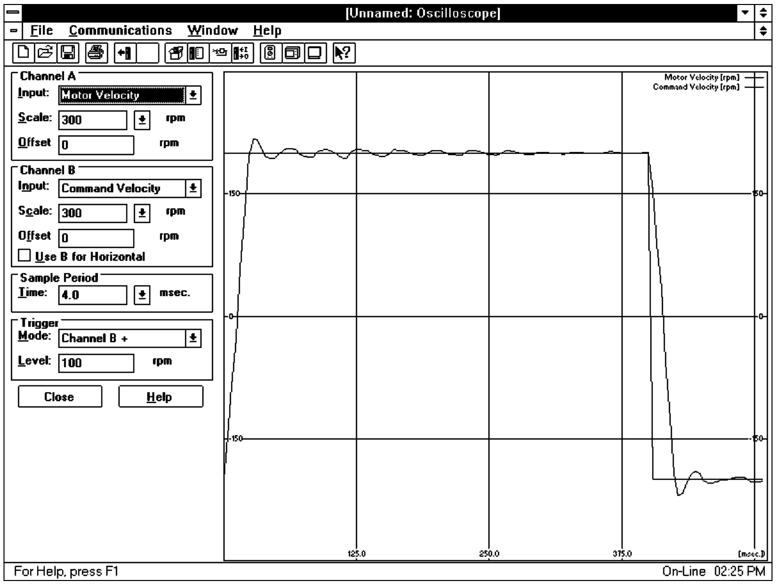
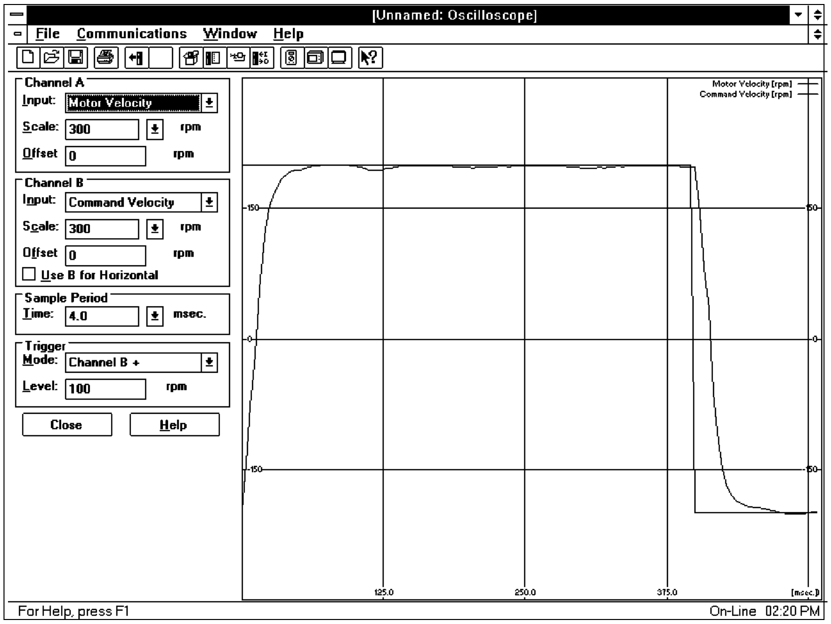


Figure 9.4 Underdamped Signal



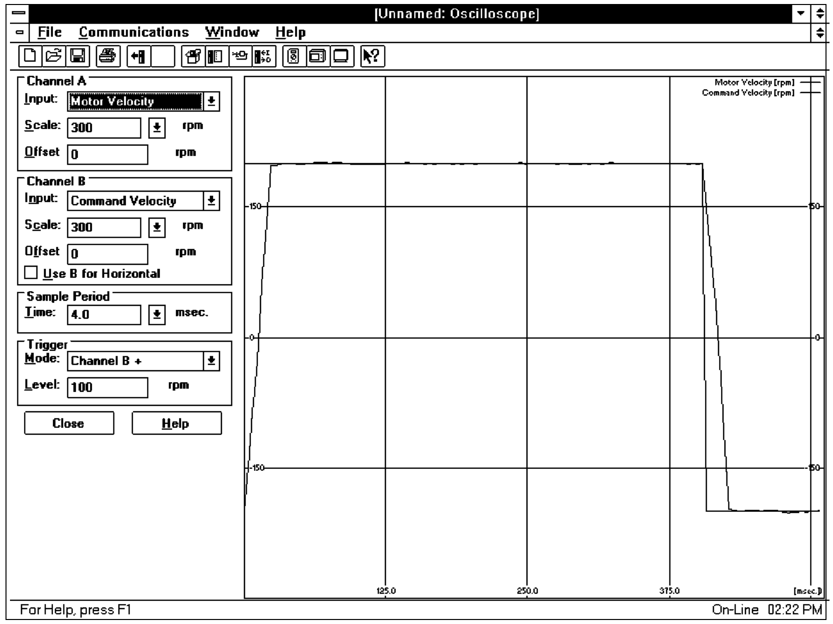
UNDERDAMPED
Motor Velocity consistently overshoots the Velocity Command. To correct:
- Decrease P-gain
- Decrease I-gain

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.

Status Display

Two front panel indicators display the status of the drive on a continuous basis:

- The Status display shows the operating mode of the drive.
- The DC Bus LED lights whenever the bus is energized.

The 7-segment Status display indicates the drive status and operating mode. After power-up or reset the operating mode is indicated by a single letter message. In the event of a fault, a flashing code is displayed.

Operating Messages

The drive operates in one of five command modes. The mode of operation is displayed by the 7-segment display whenever the drive is powered-up and operational. The Analog mode of operation, “A”, is the default mode of operation. A sixth mode, “L”, indicates a firmware modification routine is in progress.

The displays and their meaning are:

A = Analog

F = Follower, Master Encoder, Step/Direction, or Step Up/Down

H = Control Panel mode (controlled through the serial port.)

L = Load Firmware (the in-process state, “L” [loading] is indicated by a flashing period.)

P = Preset or Indexing

– = Tuning mode (the Tuning mode in ULTRA Master is active.)

Refer to“Application and Configuration Examples” beginning on page 8-1 for information on configuring the ULTRA 200 Series drives in any of these command modes.

Error Messages

If there is a fault, the drive provides specific error messages. 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.

The Status display indicates faults by flashing the letter "E", followed by additional digits to indicate the error. The error display repeats until the drive is reset or powered down. For example, "E....0....9........E....0....9........E....0....9..." indicates an Bus Undervoltage fault. When an error occurs, the error code and the service time of the error is logged into a Fault History record stored in EEPROM.

Run Time fault handling executes every 1 millisecond (1 kHz rate). Thus the maximum time interval between an error occurring and the fault action is 1 millisecond.

The following errors are only available when the drive is in a specific configuration:

- Auxiliary Encoder State and Excessive Following errors require the drive to be in the position follower mode.
- Illegal Hall State error requires the motor to be configured as having a hall switch input signal.

Run-Time Error Codes

"Maintaining and Troubleshooting the ULTRA 200 Series" lists the error codes and possible actions or solutions to take when resolving the error condition.

Table 10.1: Run-Time Error Codes

Status Display	Error Code	Fault Description
E....0....1	01	+24 VDC Fuse blown
E....0....2	02	+5 VDC Fuse blown
E....0....3	03	Encoder Power Fuse blown
E....0....4	04	Motor Overtemperature, Thermostat
E....0....5	05	IPM Fault (Overtemperature / Overcurrent / Short Circuit)
E....0....6	06	Channel IM Line Break
E....0....7	07	Channel BM Line Break
E....0....8	08	Channel AM Line Break
E....0....9	09	Bus Undervoltage
E....1....0	10	Bus Overvoltage
E....1....1	11	Illegal Hall State
E....1....2	12	Unused interrupt - sub processor
E....1....3	13	Unused interrupt - main processor
E....1....4	14	Reserved
E....1....5	15	Reserved
E....1....6	16	Reserved
E....1....7	17	Excessive Average Current

Table 10.1: Run-Time Error Codes (continued)

Status Display	Error Code	Fault Description
E....1....8	18	Motor Overspeed
E....1....9	19	Excessive Following Error
E....2....0	20	Motor Encoder State Error
E....2....1	21	Auxiliary Encoder State Error
E....2....2	22	Motor Thermal Protection
E....2....3	23	IPM Thermal Protection
E....2....4	24	Velocity Error
E....2....5	25	Commutation Angle Error
E....2....6	26	Reserved
E....2....7	27	Axis not Homed
E....2....8	28	No Motor Selected
E....2....9	29	Motor Selection not in Table
E....3....0	30	Personality Write Error
E....3....1	31	Service Write Error
E....3....2	32	CPU Communications Error

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:

The drive is powered-down while a firmware upgrade is loading into flash memory. A program memory error occurs when power is reapplied. To remedy the problem, reload the firmware using ULTRA Master.

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.

A personality EEPROM error results when a personality module is *not* installed or is improperly installed in the drive. Installation of the personality EEPROM will fix this error.

Table 10.2 lists the Power-Up Error Codes.

Table 10.2: Power-Up Error Codes

Status Display	Error Code	Fault Description
E....5....1	51	Program Memory Boot Block Error
E....5....2	52	Program Memory Main Block Error
E....5....3	53	Uninitialized Personality EEPROM Error
E....5....4	54	Personality EEPROM Read Error
E....5....5	55	Personality EEPROM Data Corruption
E....5....6	56	Main Processor Watchdog Error
E....5....7	57	Sub Processor Watchdog Error
E....5....8	58	Main Processor RAM Error
E....5....9	59	Sub Processor RAM Error
E....6....0	60	Uninitialized Service EEPROM Error
E....6....1	61	Service EEPROM Read Error
E....6....2	62	Service EEPROM Data Corruption Error
E....6....3	63	Main Processor A/D Converter Error
E....6....4	64	Sub Processor A/D Converter Error
E....6....5	65	ANALOG1 Output Error
E....6....6	66	Gate Array Error
E....6....7	67	ANALOG2 Output Error
E....6....8	68	Inter-Processor Communication Error
E....6....9	69	Sub Processor Initialization Error
E....7....0	70	Sub Processor SRAM Error
E....7....1	71	Sub Processor Code Loading Error
E....7....2	72	Sub Processor Start-up Error
E....7....3	73	Sub Processor Checksum Error
E....7....4	74	Personality EEPROM Write Error
E....7....5	75	Service EEPROM Write Error
E....7....6	76	Software Clock Error
E....7....7	77	Sub Processor Communication Checksum Error
E....7....8	78	Sine Table Generation Error

Table 10.2: Power-Up Error Codes (continued)

Status Display	Error Code	Fault Description
E....7....9....n	79-n	Personality 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
E....8....0....1	80-1	Service Data Out of Range (Drive Type)
E....8....1	81	Motor Block Checksum Error
E....8....2	82	Mask ROM Checksum Error
E....8....3	83	Personality EEPROM Incompatibility
E....8....4	84	Service EEPROM Incompatibility

Maintenance and Troubleshooting

Maintenance

The ULTRA 200 Series drive is designed to function with minimum maintenance.

Periodic Maintenance

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

Cleaning

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

Cable Inspection

Inspect the connections, particularly the power connections, to ensure their tightness.

- All power connections should be torqued to 1.4 Nm (12 lb-in).
- D-shell signal connectors can be inspected for proper seating.
- Visually inspect all cables for abrasion.

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.

Fuse Replacement

The +24VDC, +5VDC and Motor Encoder power lines are fused for protection. All fuses are 1A fast acting fuses, Refer to Appendix A, “Options and Accessories” for the part number and Figure 11.1 for fuse locations. A spare fuse, F4, is included on the circuit board for convenience.

EEPROM Personality Module

The serial EEPROM, or personality module, stores all the drive setup parameters. The setup parameters configure the drive to match a particular motor and operate in a particular mode of operation.

The personality module may be removed from a ULTRA 200 Series drive and installed in another drive. By transferring the personality module from a drive to another drive, the drive’s “personality” is moved to the new drive. Alternatively, the data stored in the EEPROM may be transferred using ULTRA Master software to a peripheral device, such as diskette or tape.

The only time you may need to remove the personality module is if you do *not* have a PC available and your drive is down.

EEPROM Removal/Replacement

To remove the EEPROM from a drive:

1. Remove all power from the drive

2. Disconnect all connections to the front of the drive.

3. Remove the protective cover by removing the screws attaching the right-side cover to the chassis.

ATTENTION: The circuits in the drive are potential sources of severe electrical shock. Follow the safety guidelines to avoid shock.

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4. Refer to Figure 11.1 for the location of the personality module.

5. Grasp the EEPROM with an IC chip puller to remove the personality module.

To install the EEPROM on a drive:

1. Remove all power from the drive.

2. Remove all connections to the front of the drive.

3. Remove the protective cover by removing the screws attaching the right-side cover to the chassis.

ATTENTION: Electronic components are subject to damage by static electricity. Follow Electrostatic Discharge (ESD) practices while handling components.

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4. Refer to Figure 11.1 for the location of the personality module.

5. Align the notch on the front of the personality module and the matching notch on the socket.
6. Place the properly orientated personality module in the IC chip insertion tool. Ensure the chip and socket notches are aligned.
7. Push the personality module firmly into the socket.
8. Install the protective cover and tighten the screws.
9. Reconnect the cables to the front of the drive.
10. Reapply power to the drive.

► **Note:** Some combinations of firmware and personality modules are incompatible; they will generate an error message after replacement. Consult “Error Codes” on page 11-6 for the recommended action/ solution.

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.

To transfer the data from the drive to a PC:

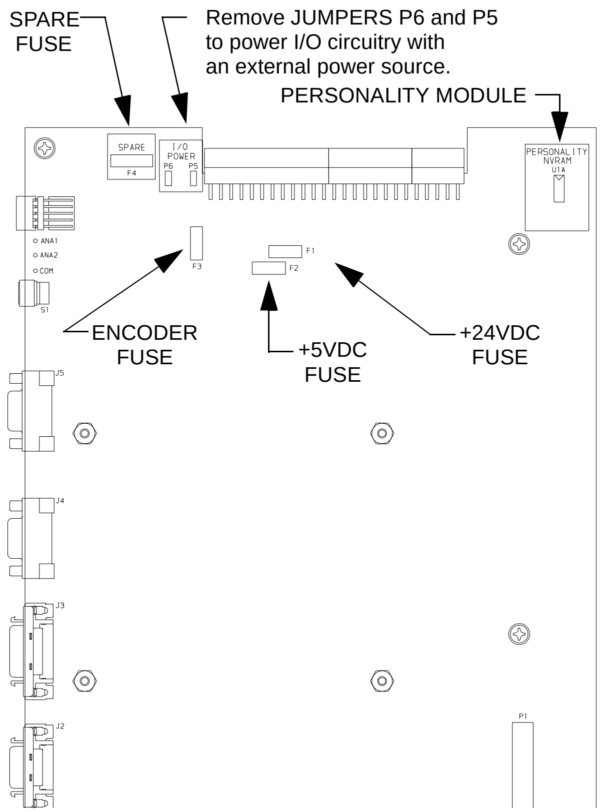
1. While on-line with a drive, click on **File** in the toolbar menu.
2. Select **Save As...**, the Save As window will appear.
3. Enter the file name and press ENTER or choose OK to save.

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 appears, 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.

Figure 11.1 Fuse and Jumper Locations



Firmware Upgrading

ULTRA 200 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 extensive checks and controls through message boxes which ensure that the loading of firmware is performed properly. Messages ensure that:

- The drive is off-line
- The correct firmware file is used.

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.

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

Two front panel indicators display the status of the drive on a continuous basis:

- The Status display indicates the operating mode of the drive (A, F, P, etc.).
- The DC Bus LED lights whenever the main AC input is connected to line voltage.

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

Error Codes

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

Table 11.1: Troubleshooting Guide

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Status display not lit.		No AC power	Verify power (115/230VAC single phase or 230 VAC three phase) is applied to the drive.
		Blown power fuse(s)	Check for open circuits in the AC line fuses.
DC BUS LED not lit.		No Bus power	Verify AC power is applied to the drive Check for open circuit breakers in AC line.
		Blown power fuse(s)	Check fuses.
Motor jumps when first enabled		Motor encoder wiring error	Check motor encoder wiring. See Figure 6.36 on page 30 to verify connection of encoder power sense signals.
		Incorrect motor chosen in personality module	Select the proper motor in ULTRA Master.
Digital I/O not working correctly		24V power supply disconnected	Verify P5/P6 jumper settings are correct.
+24V Fuse Blown	01	F1 Blown	The fuse on the I/O isolated +24 VDC power supply has tripped. Check/replace fuse F1 if necessary. Check for shorts on I/O or +24VDC output

Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
+5V Fuse Blown	02	F2 Blown	The fuse on the encoder power output for the +5 VDC power supply has tripped. Check/replace fuse F2 if necessary. Check for shorts on Encoder output signals or +5V output. Check that J4 pin 9 or J5 pin 9 is not connected to an external circuit.
Encoder Fuse Blown	03	F3 blown	Check for shorts on motor Encoder signals and cable wiring. Check/replace fuse F3 if necessary.
		Bad encoder	Replace encoder and or motor.
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	Lower ambient temperature. Operate within (not above) the continuous torque rating for the ambient temperature (40°C maximum).
IPM Fault	05	Motor cables shorted	Verify continuity of motor power cable and connector.
		Motor winding shorted internally	Check for short on motor's R,S,T and Gnd windings.
		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.
Channel IM line	06	Bad connections	Verify continuity of the encoder cable. Verify continuity of the IM+ and IM- wiring signals.
		Bad Encoder	Replace the motor or the encoder.

Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Channel BM line	07	Bad connections	Verify continuity of the encoder cable and connectors. Verify continuity of the BM+ and BM- wiring signals.
		Bad Encoder	Replace the motor or the encoder.
Channel AM line	08	Bad connections	Verify continuity of the encoder cable. Verify continuity of the AM+ and AM- wiring signals.
		Bad Encoder	Replace the motor or the encoder.
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 main VAC 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		

Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
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. 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 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 Phasing is incorrect	Check motor phasing.
		Motor encoder phasing is incorrect	Check encoder phasing.
Excess Following Error	19	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	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.

Table 11.1: Troubleshooting Guide (continued)

Problem or Symptom	Error Code	Possible Cause(s)	Action/Solution
Auxiliary Encoder state error	21	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	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. User larger drive and motor.
IPM Thermal Protection Fault	23	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. User larger drive and motor.
Velocity Error	24	Velocity error exceeded the specified limit and time parameters.	Increase time or size of allowable error.
Commutation Angle Error	25	Encoder index location is inconsistent.	Replace encoder. Check encoder and motor power wiring.
RESERVED	26		
Axis not Homed	27	An absolute indexing move was attempted without first homing the axis.	Home the drive before attempting an absolute indexing profile.
No Motor Selected	28	No motor was selected when the drive was enabled.	Select a motor before enabling the drive.
Motor Information Missing	29	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	30-53		Call the factory.
Personality EEPROM Read Error	54	Personality EEPROM is incompatible with the drive firmware	Upgrade firmware.
		Hardware is malfunctioning.	Call the factory.
RESERVED	55-82		Call the factory.
Personality EEPROM Incompatibility	83	Personality EEPROM cannot be used with an indexing drive.	Use a non-indexing drive.

RS-232 Communication Test

This test verifies the functionality of the communications port on an MS-DOS® based personal computer.

The test uses 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 6-38.
4. If the communication cable is OK, do the following:
   - **A.** Disconnect the communication cable from the drive.
     - (a) Jumper pin 2 and 3 on the D connector of the communication cable.
     - (b) Close and exit from ULTRA Master
   - **B.** Select the **Terminal** from the Program Manager (Terminal is usually is in the Accessories group)
   - **C.** Select **Settings** from the Main menu
     - (a) Select **Terminal Emulation** from the drop down menu
     - (b) Choose **DEC VT-100**
     - (c) Choose **OK** to close the dialog box
   - **D.** Select **Settings** from the Main menu
     - (a) Select **Communications** from the drop down menu
     - (b) Choose **COM1** (or the number of the communication port the drive is connected to) from the Connections sliding list.
     - (c) Set Baud Rate to **9600**
     - (d) Set Data Bits to **8**
     - (e) Set Stop Bits to **1**
     - (f) Set Parity to **NONE**
     - (g) Set Flow Control to **XON/XOFF**
     - (h) Choose **OK** to close the dialog box.
5. Type any character on the keyboard. The character should echo back on the screen.

A. If you see the character on the screen swap pins 2 and 3, close the Windows Terminal and restart ULTRA Master.

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

(a) Disconnect the cable from your PC.

(b) Jumper Pins 2 and 3 on the communication port of the PC.

(c) Type any character on the keyboard.

(1) If the character echoes back, the communication port is OK and the cable or the connectors are defective. Replace the communication cable assembly.

(2) 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.

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

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 following values when it is selected or deselected:

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

(a) If the box is checked, the resistance should read approximately 1 Ohm.

(b) 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.

(a) If the box is checked, the resistance should read approximately 1Ohm.

(b) 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 24 VCOM (J1-6).

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

(a) If the box is checked, the voltmeter should read approximately +24 VDC.

(b) 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.

(a) If the box is checked, the voltmeter should read approximately +24 VDC.

(b) If the box is not checked, the voltmeter should read approximately 0 VDC.

E. Digital Output 3, then measure the voltage between J1-44 and J1-13.

(a) If the box is checked, the voltmeter should read approximately +24 VDC.

(b) If the box is not checked, the voltmeter should read approximately 0 VDC.

F. Digital Output 4, then measure the voltage between J1-45 and J1-13.

(a) If the box is checked, the voltmeter should read approximately +24 VDC.

(b) 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, return the unit for repair.

Testing Digital Inputs

This test verifies the functionality of the selectable inputs.

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. Enable the drive by closing 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.
   F. Connect J1-33 to J1-26. The Input 4 indicator activates.
3. Choose **Close** to exit the I/O Display window.

If you determine that a digital input is defective, return the unit for repair.

Testing Analog Outputs

The following tests verify the functionality of the analog outputs.

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 + 24 VDC.
2. Disconnect the connections to J1-30.
3. From the Output Diagnostics window select **Analog Output 1**.
4. Enter 1000 in the D/A level box.
5. Connect a DC voltmeter across analog test points A1 and COM. The meter should read approximately 1 Vdc.

6. Repeat step 11.1 using different positive or negative values for the D/A Level. Verify the meter reads the values you enter.

Testing Analog Output 2

1. Disable the drive, by opening the connections between the ENABLE input and the + 24 VDC.
2. Disconnect the connections to J1-31.
3. Select **Output Diagnostics** icon from the Drive Window.
4. From the Output Diagnostics window select **Analog Output 2**.
5. Enter 1000 in the D/A level box.
6. Connect a DC voltmeter across analog test points A2 and COM. The meter should read approximately 1 VDC.
7. Repeat step 11.1 using different positive or negative values for the D/A Level. Verify the meter reads the values you enter.

If either output is defective, return the unit for repair.

Testing Positive and Negative Current Limits

The following tests verify the functionality of the analog +I LIMIT and -I LIMIT inputs.

The tests require:

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

Testing Positive Current Limit

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 +24VDC.
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 and Figure 6.44 on page 6-45 for an interconnect diagram.
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.

Testing Negative Current Limit

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 +24VDC.

3. Disconnect the connections to J1-29 and J1-28.

4. Connect the 10K potentiometer between J1-29 and J1-28.
   Refer to "J1 – Controller" on page 6-1 for a diagram showing the location of the pins and Figure 6.44 on page 6-45 for an interconnect diagram.

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 an analog input is defective, return the unit for repair.

Testing Encoder Inputs

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

The tests require:

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

To test encoder inputs:

1. Disable the drive by opening the connections between the ENABLE input and +24VDC.
2. Choose the **Drive Parameters** command icon from ULTRA Master.
3. Choose **Master Encoder** as the Command Source.
4. Choose the **Drive Set Up** command icon from ULTRA Master.
5. Choose **Divide by 1** as the Master Encoder Command Input.
6. Make the following hardware connections:
   - Disconnect all connections to J3.
   - Connect the motor encoder to J2.
   - Jumper the Encoder Inputs to the Encoder Outputs by connecting the following pins:

     J1-7 to J1-14
     J1-8 to J1-15
     J1-9 to J1-16
     J1-10 to J1-17
     J1-11 to J1-18
     J1-12 to J1-19
7. Choose the **Encoder Diagnostics** command icon from ULTRA Master.
8. Choose **Zero Count** for both the Motor Encoder and Master Position Input.
9. 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.

Options and Accessories

ULTRA 200 Series drives conformance to the European Union Directives is contingent on:

- Installation of AC line filters between the power source and the drive, and
- Use of Allen-Bradley cables to connect F-, H-, N- or Y- motors to a 1398-DDM-010, 1398-DDM-010X, 1398-DDM-020, 1398-DDM-020X, 1398-DDM-030, 1398-DDM-030X, 1398-DDM-075, 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X drive. Diagrams and schematics for all Allen-Bradley cables are shown in Appendix B, “Cable Diagrams, Schematics and Examples”.

ULTRA 200 Series Drives

Model	Description
1398-DDM-010	1000 Watt Universal Drive, single phase 100-240 VAC @ 50/60 Hz
1398-DDM-010X	1000 Watt Universal Indexing 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-020X	2000 Watt Universal Indexing 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-030X	3000 Watt Universal Indexing 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
1398-DDM-075X	7500 Watt Universal Indexing Drive, single or three phase 100-240 VAC @ 50/60 Hz
1398-DDM-150	15000 Watt Universal Drive, three phase 100-240 VAC @ 50/60 Hz
1398-DDM-150X	15000 Watt Universal Indexing Drive, three phase 100-240 VAC @ 50/60 Hz

Fuses

Description	Part Number
1 Ampere, fast acting, inline (Littelfuse R451001, or equivalent) for 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	*

NOTE:
*Contact Littelfuse at (847) 824-1188 for part numbers.

Options and Accessories

Description	Part Number
TouchPad	1398-HM1-001
AC Line Filter (6 A_{rms} Continuous, Single Phase) for 1398-DDM-005 or 1398-DDM-005X	9101-1516
AC Line Filter (10 A_{rms} Continuous, Single Phase) for 1398-DDM-009 or 1398-DDM-009X, 1398-DDM-010X or 1398-DDM-010X	9101-1517
AC Line Filter (23 A_{rms} Continuous, Single Phase) for 1398-DDM-019 or 1398-DDM-019X, 1398-DDM-020 or 1398-DDM-020X	9101-1518
AC Line Filter (30 A_{rms} Continuous, Single Phase) for 1398-DDM-030 or 1398-DDM-030X	9101-1387
AC Line Filter (55 A_{rms} Continuous, Single Phase) for 1398-DDM-075 or 1398-DDM-075X	9101-1388
AC Line Filter (50 A_{rms} Continuous, Three Phase) for 1398-DDM-150 or 1398-DDM-150X	9101-1575
AC Line Filter (36 A_{rms} Continuous, Three Phase) for 1398-DDM-075 or 1398-DDM-075X	9101-1389
J1 to 50-pin Terminal Strip (Breakout Board), includes 1m (3ft) cable and mounting hardware	9101-1391
J2 to 25-pin Terminal Strip (Breakout Board), includes 1m (3ft) cable and mounting hardware	9101-1392
External Shunt Resistor for 1398-DDM-010 or 1398-DDM-010X, 1398-DDM-020 or 1398-DDM-020X, 1398-DDM-030 or 1398-DDM-030X	9101-1079
Fuse for External Shunt Resistor (Littelfuse CCMR-4.5) for 1398-DDM-010 or 1398-DDM-010X, 1398-DDM-020 or 1398-DDM-020X, 1398-DDM-030 or 1398-DDM-030X	*

Publications

Description	Publication Number
Manuals	
• TouchPad Card	1398-5.5
• Installation Manual 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	1398-5.0
• Installation Manual 1398-DDM-005 or 1398-DDM-005X, 1398-DDM-009 or 1398-DDM-009X, 1398-DDM-019 or 1398-DDM-019X	1398-5.2

Interface Cables

Diagrams and schematics for cables listed below are shown in Appendix B, "Interface Cables", beginning on page B-3.

Description	m (ft)	Part Number
J1 to customer supplied connector (no connector)	3 (10)	9101-1370-010
	7.6 (25)	9101-1370-025
	15 (50)	9101-1370-050
	23 (75)	9101-1370-075
J3 to customer supplied connector (no connector) (ULTRA 200 Series drives only)	3 (10)	9101-1368-010
	7.6 (25)	9101-1368-025
	15 (50)	9101-1368-050
	23 (75)	9101-1368-075
J3 to J3 (Master/Follower) (ULTRA 200 Series drives only)	0.6 (2)	9101-1463-002

Serial Interface Cables

Diagrams and schematics for cables listed below are shown in Appendix B, "Interface Cables", beginning on page B-11.

Description	m (ft)	Part Number
J4/J5 to PC [RS-232] (9 pin D-shell connector)	3 (10)	9101-1372-010
	7.6 (25)	9101-1372-025
	15 (50)	9101-1372-050
J4/J5 to customer supplied connector (no connector)	3 (10)	9101-1379-010
	7.6 (25)	9101-1379-025
	15 (50)	9101-1379-050
J4/J5 to J4/J5 four wire RS-485 communications	1 (3)	9101-1374-001
J4/J5 D-shell 9-pin Mating Connector (AMP 205204-4)		003-5529-001
J4/J5 Crimp Pins for Connector (AMP 66506-3)		0003-5326-001

Encoder Feedback Cables

Diagrams and schematics for cables listed below are shown in Appendix B, “Interface Cables”, beginning on page B-14.

Description	m (ft)	Part Number
F- or H-Series Motor to customer supplied connector	3 (10)	9101-1365-010
(i.e., no connector)	7.6 (25)	9101-1365-025
	15 (50)	9101-1365-050
(ULTRA 200 Series drives only)	23 (75)	9101-1365-075
(ULTRA 200 Series drives only)	30 (100)	9101-1365-100
J2 to F- or H-Series Motor	3 (10)	9101-1366-010
	7.6 (25)	9101-1366-025
	15 (50)	9101-1366-050
(ULTRA 200 Series drives only)	23 (75)	9101-1366-075
(ULTRA 200 Series drives only)	30 (100)	9101-1366-100
N-Series Motor to customer supplied connector	3 (10)	9101-1469-010
(i.e., no connector)	7.6 (25)	9101-1469-025
	15 (50)	9101-1469-050
(ULTRA 200 Series drives only)	23 (75)	9101-1469-075
(ULTRA 200 Series drives only)	30 (100)	9101-1469-100
J2 to N-Series Motor	3 (10)	9101-1468-010
	7.6 (25)	9101-1468-025
	15 (50)	9101-1468-050
(ULTRA 200 Series drives only)	23 (75)	9101-1468-075
(ULTRA 200 Series drives only)	30 (100)	9101-1468-100
Y-Series Motor to customer supplied connector (i.e., no	3 (10)	9101-1373-010
connector)	7.6 (25)	9101-1373-025
	15 (50)	9101-1373-050
(ULTRA 200 Series drives only)	23 (75)	9101-1373-075
(ULTRA 200 Series drives only)	30 (100)	9101-1373-100
J2 to Y-Series Motor	3 (10)	9101-1375-010
	7.6 (25)	9101-1375-025
	15 (50)	9101-1375-050
(ULTRA 200 Series drives only)	23 (75)	9101-1375-075
J2 to customer supplied connector	3 (10)	9101-1380-010
(i.e., no connector)	7.6 (25)	9101-1380-025
	15 (50)	9101-1380-050
(ULTRA 200 Series drives only)	23 (75)	9101-1380-075
(ULTRA 200 Series drives only)	30 (100)	9101-1380-100

Motor Power Cables

Diagrams and schematics for cables listed below are shown in Appendix B, “Interface Cables”, beginning on page B-21.

Description	m (ft)	Part Number
Drive to 2000 or 3000 Motors (F- or H-Series)	3 (10)	9101-1381-010
	7.6 (25)	9101-1381-025
	15 (50)	9101-1381-050
(ULTRA 200 Series drives only)	23 (75)	9101-1381-075
(ULTRA 200 Series drives only)	30 (100)	9101-1381-100
Drive to 4000 Motors (F- or H-Series)	3 (10)	9101-1382-010
	7.6 (25)	9101-1382-025
	15 (50)	9101-1382-050
(ULTRA 200 Series drives only)	23 (75)	9101-1382-075
(ULTRA 200 Series drives only)	30 (100)	9101-1382-100
Drive to 6100 or 6200 Motors (F- or H-Series) for 1398-DDM-030 or 1398-DDM-030X, 1398-DDM-075 or 1398-DDM-075X	3 (10)	9101-1383-010
	7.6 (25)	9101-1383-025
	15 (50)	9101-1383-050
(ULTRA 200 Series drives only)	23 (75)	9101-1383-075
(ULTRA 200 Series drives only)	30 (100)	9101-1383-100
Drive to 8000 Motors (F- or H-Series) for 1398-DDM-150 or 1398-DDM-150X	3 (10)	9101-1384-010
	7.6 (25)	9101-1384-025
	15 (50)	9101-1384-050
(ULTRA 200 Series drives only)	23 (75)	9101-1384-075
(ULTRA 200 Series drives only)	30 (100)	9101-1384-100
Drive to 6300 Motors (F- or H-Series) for 1398-DDM-150 or 1398-DDM-150X	3 (10)	9101-1399-010
	7.6 (25)	9101-1399-025
	15 (50)	9101-1399-050
(ULTRA 200 Series drives only)	23 (75)	9101-1399-075
(ULTRA 200 Series drives only)	30 (100)	9101-1399-100
Drive to N-Series Motors	3 (10)	9101-1467-010
	7.6 (25)	9101-1467-025
	15 (50)	9101-1467-050
(ULTRA 200 Series drives only)	23 (75)	9101-1467-075
(ULTRA 200 Series drives only)	30 (100)	9101-1467-100
Drive to Y-Series Motors	3 (10)	9101-1385-010
	7.6 (25)	9101-1385-025
	15 (50)	9101-1385-050
(ULTRA 200 Series drives only)	23 (75)	9101-1385-075
(ULTRA 200 Series drives only)	30 (100)	9101-1385-100

Connector Kits

Connector kits provide the ability to construct custom length cables. Kits are available for all ULTRA 200 Series connectors. Each kits 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 ribbon cable solder cup, squeeze latch	9101-1476
J2	20 pin mini D-shell, 24-30 AWG ribbon cable solder cup, squeeze latch	9101-1477
J3	26 pin mini D-shell, 24-30 AWG ribbon cable solder cup, squeeze latch	9101-1478
J4 or J5	50 pin D-shell solder cup 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 200 Series drives. The connectors are *not* available from Allen-Bradley. Please contact the manufacturer or a distributor for additional information. Manufacturer phone numbers are:

3M: 1-800-225-5373,
AMP: 1-800-522-6752

ULTRA 200 Series drive conformance to the European EMC Directive is contingent on the use of Allen-Bradley cables.

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

Cable Diagrams, Schematics and Examples

Factory supplied cables allow ULTRA 200 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.

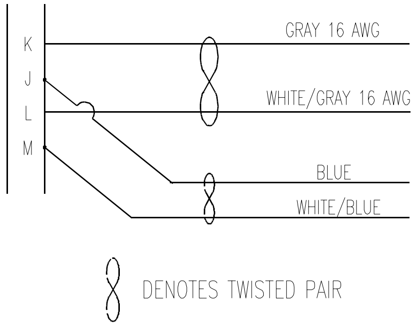
The information below applies to all factory supplied cables.

- 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

Feedback and Control Cables		Motor Power Cables	
Connector	**mm (in.)**	**Cable**	**mm (in.)**
Controller (J1)	171.45 (6.75)	9101-1190	76.2 (3)
Encoder (J2)	129.54 (5.10)	9101-1191	76.2 (3)
		9101-1192	120.65 (4.75)
		9101-1193	177.8 (7)
		9101-1381	76.2 (3)
		9101-1382	76.2 (3)
		9101-1383	120.65 (4.75)
		9101-1384	152.4 (6)
		9101-1385	88.9 (3.5)
		9101-1399	152.4 (6)
		9101-1467	76.2 (3)

- 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:



Interface Cables

Figure B.1 J1 to J3 Interface Cable (P/N 9101-1367)

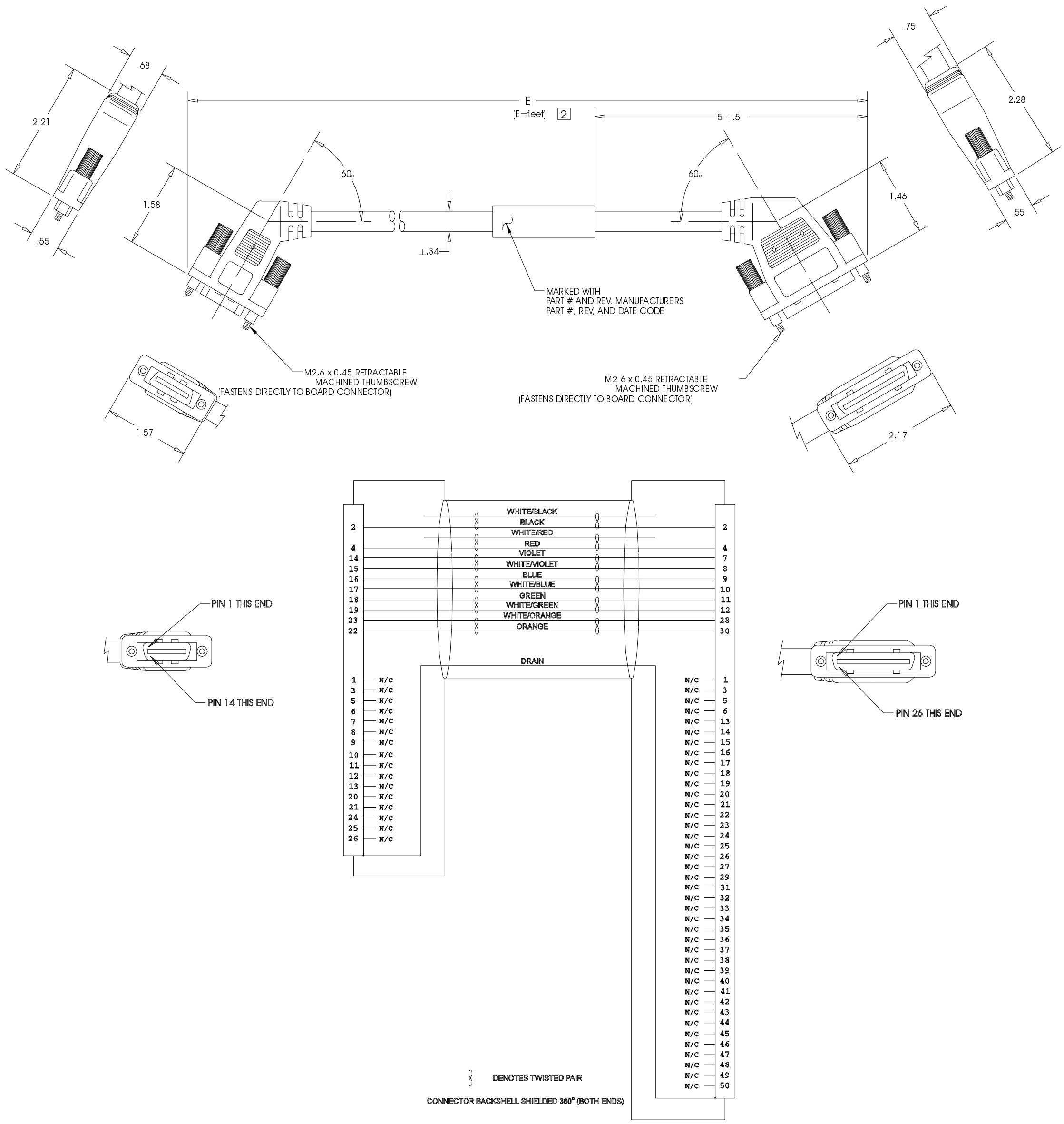


Figure B.2 J1 to No Connector Interface Cable (P/N 9101-1370)

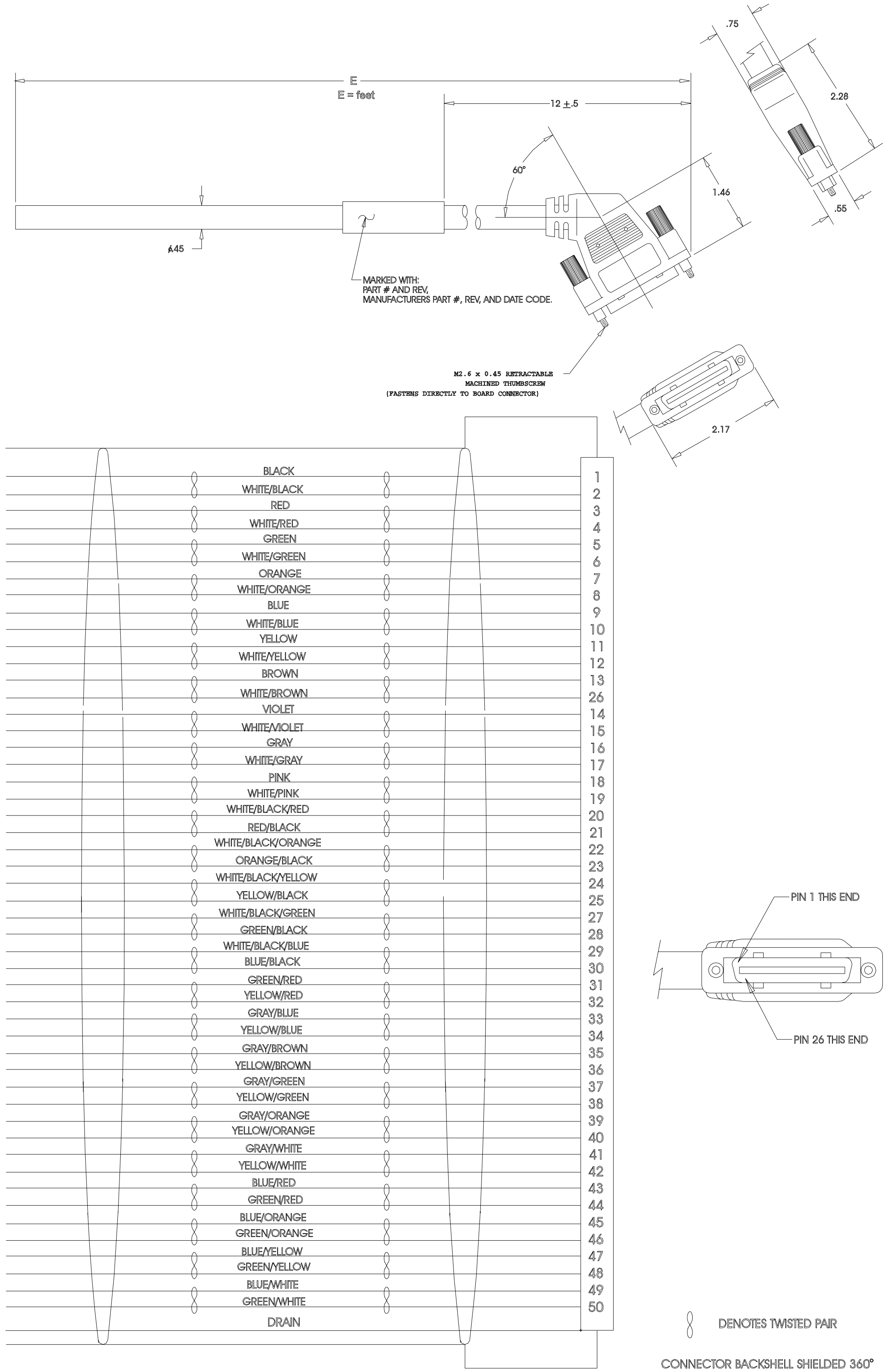


Figure B.3 J3 to J3 Interface Cable (P/N 9101-1463)

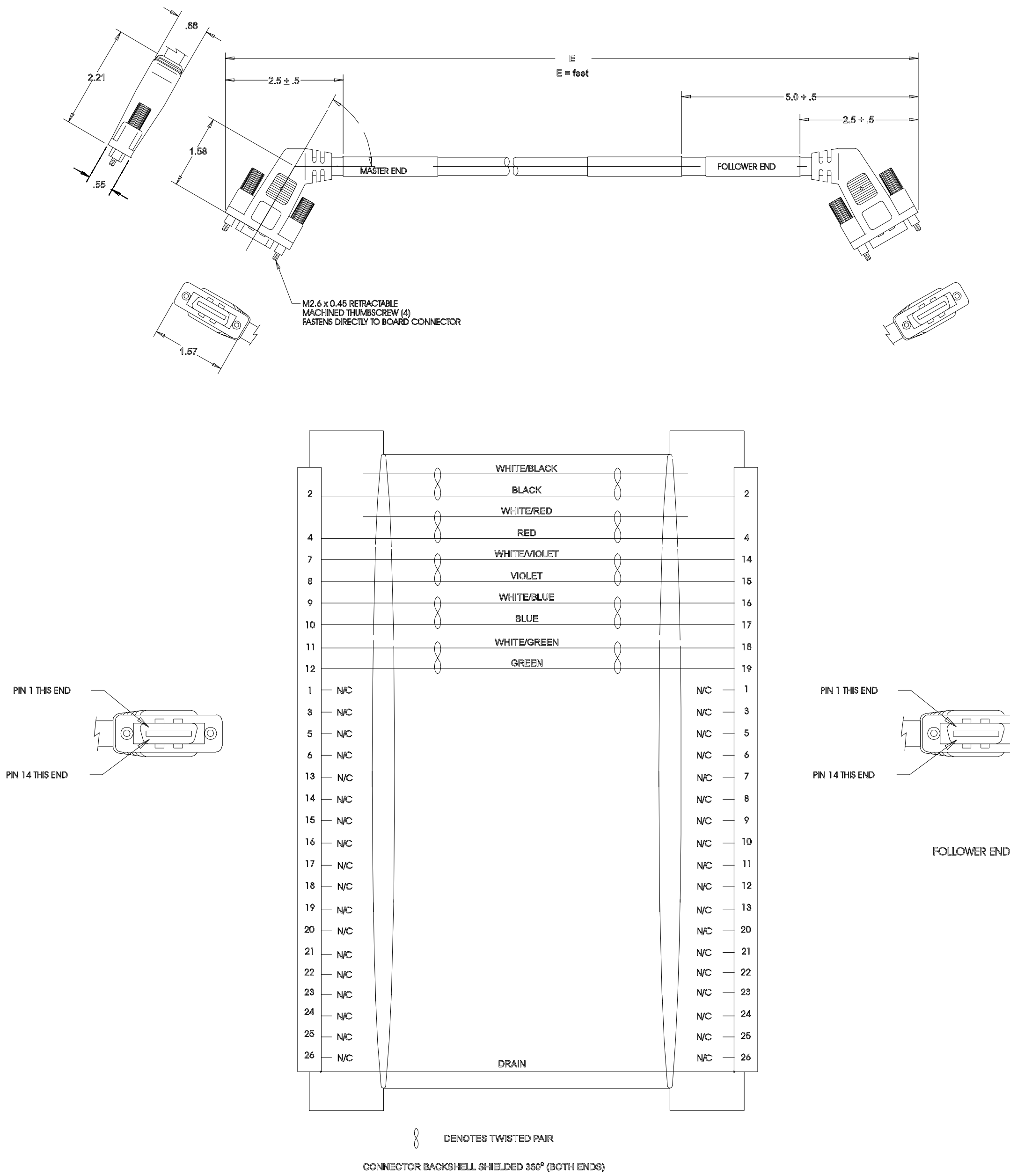


Figure B.4 J3 to No Connector Interface Cable (P/N 9101-1368)

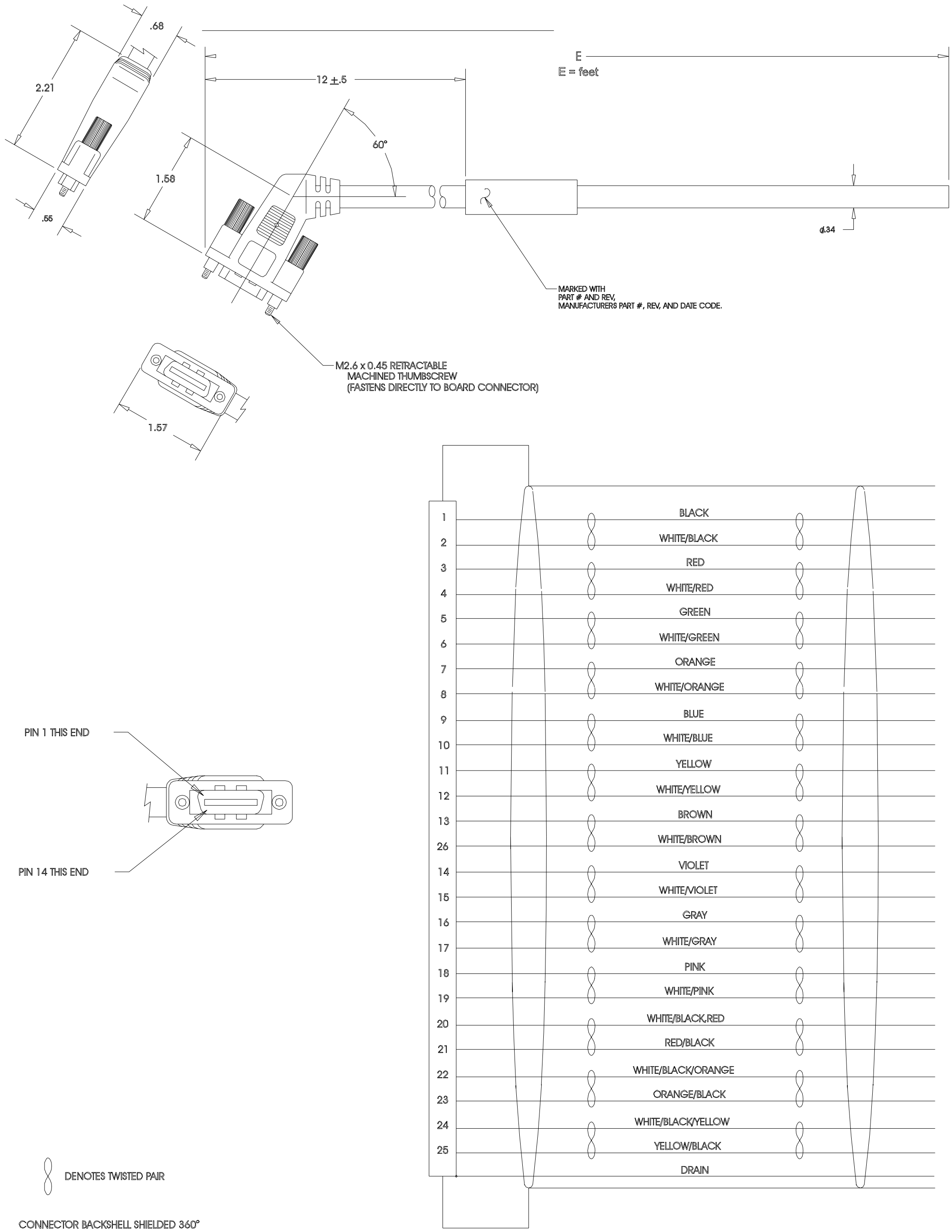
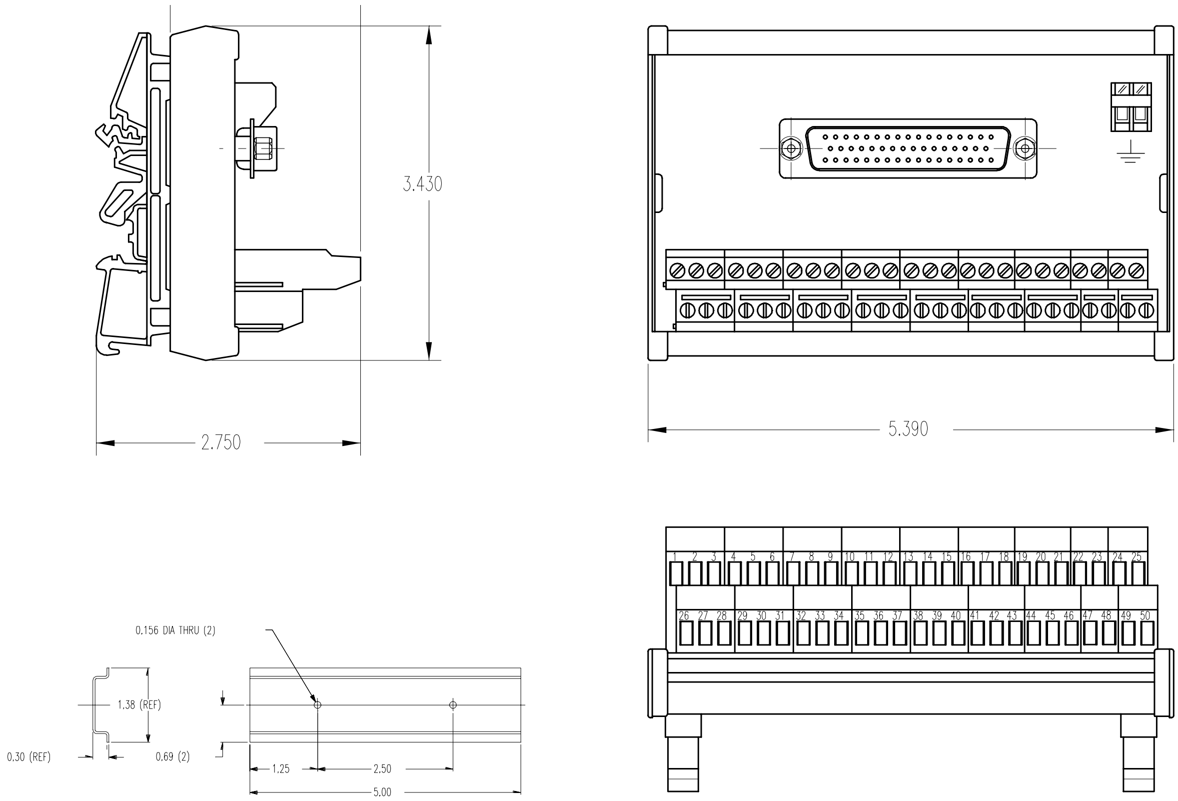


Figure B.5 J1 to 50-pin Terminal Block Kit Diagram (P/N 9101-1391 and 9101-1560)



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-26 depict the use of this kit to pass a cable through a restricted bulkhead.

Figure B.6 J1 to 50-pin D-Connector Cable (P/N 9101-1369)

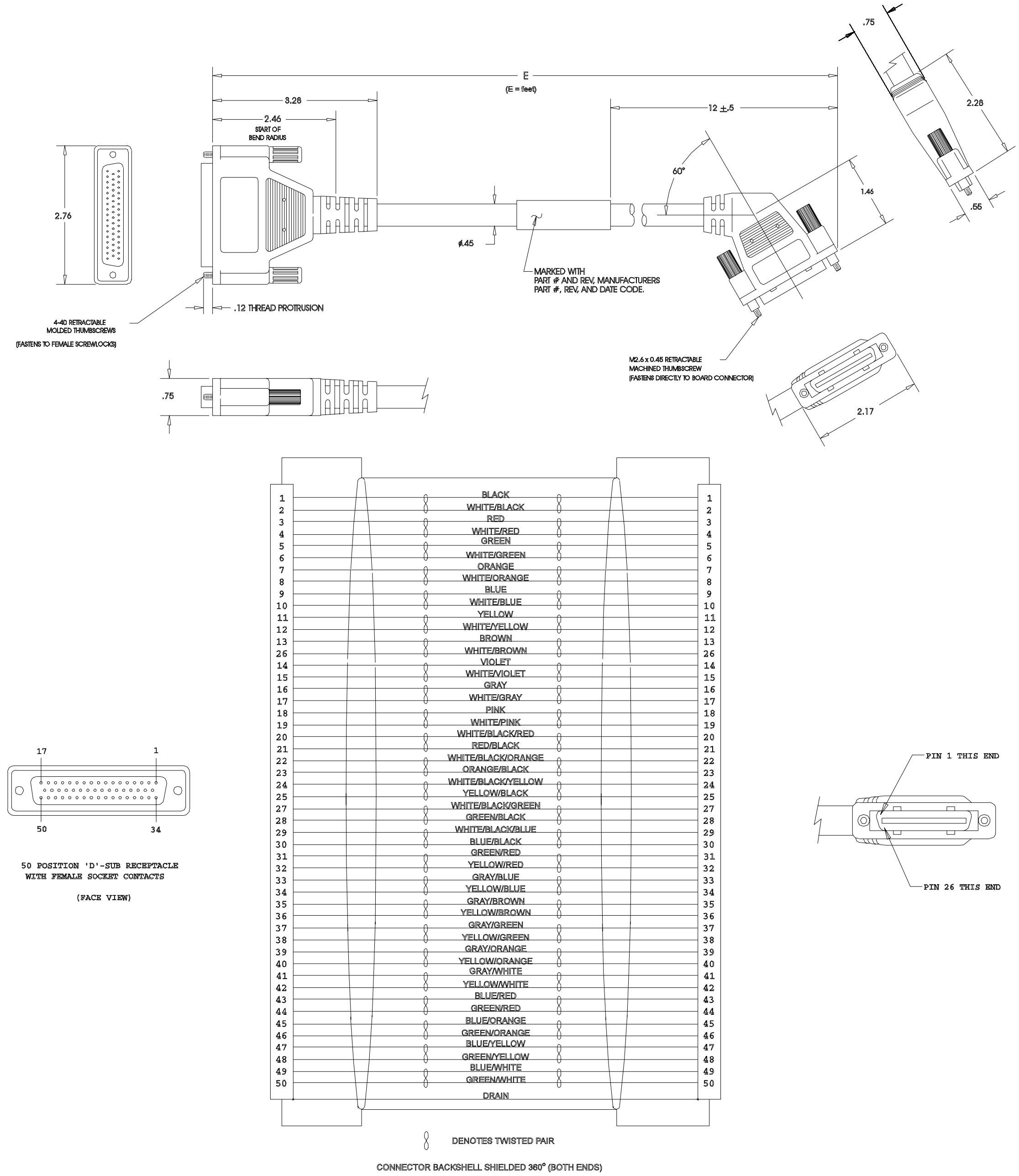
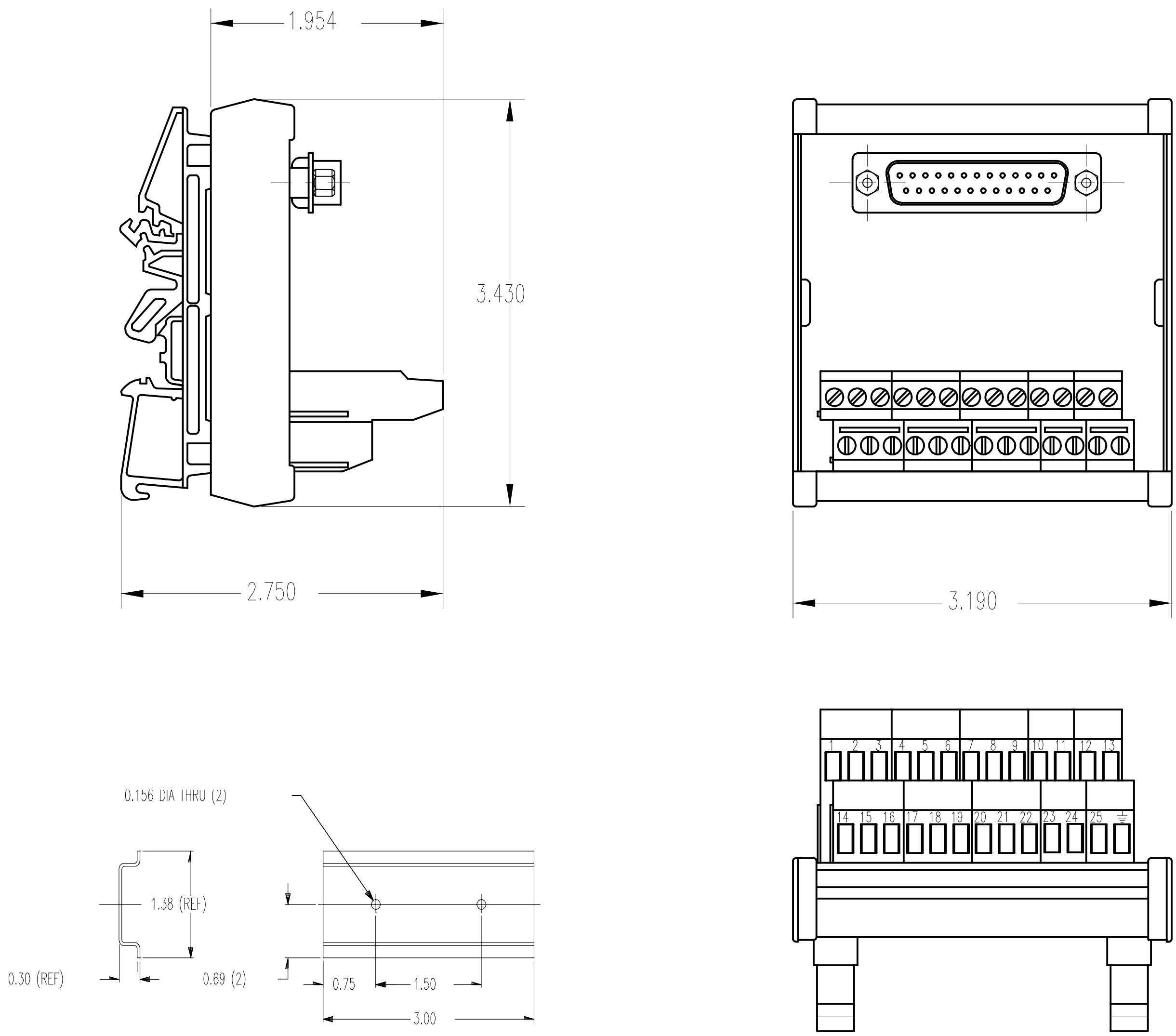


Figure B.7 J2 to 25-pin Terminal Block Kit Diagram (P/N 9101-1392)



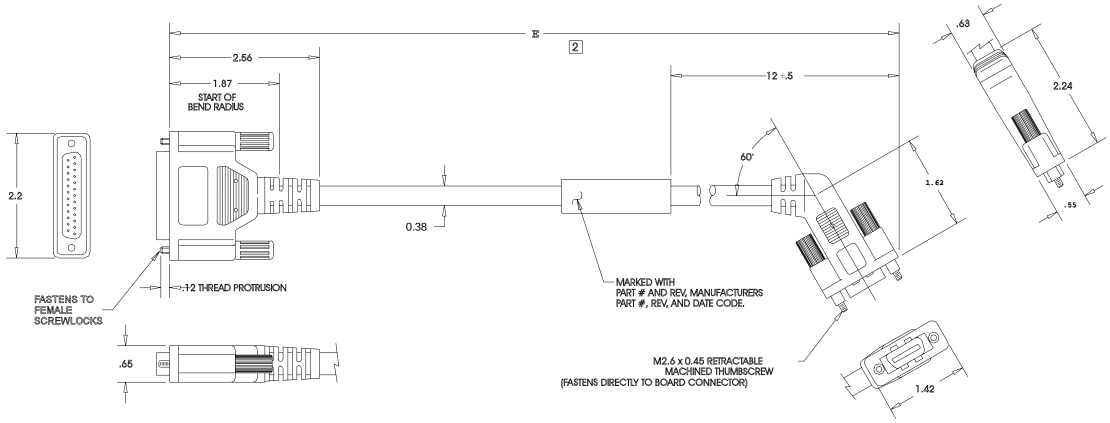
Mounting bracket 0002-7068 (shown) and cable 9101-1371-003 (next page) supplied with kit.

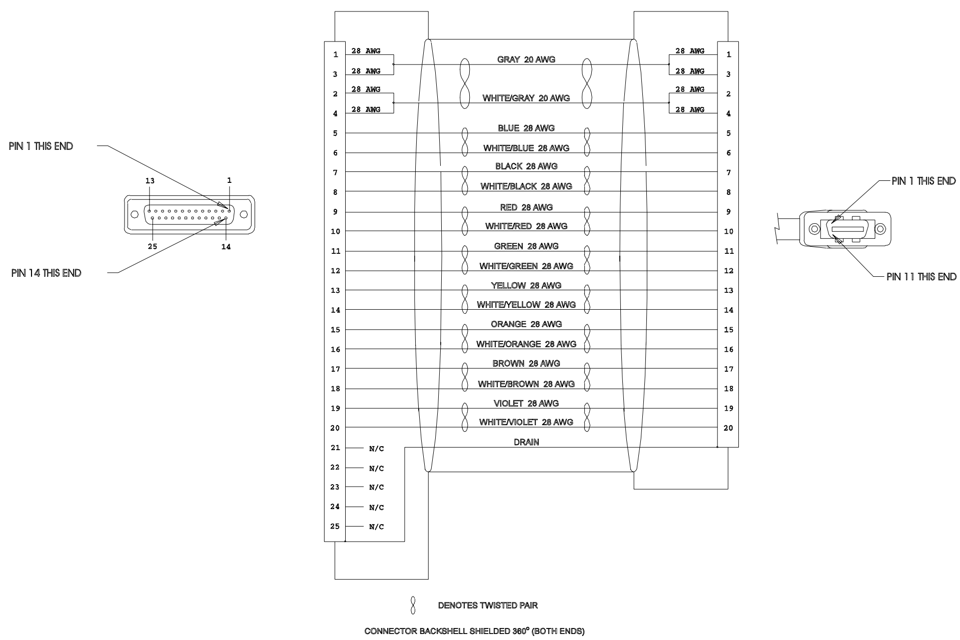
NOTES:

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-26 depict the use of this kit to pass a cable through a restricted bulkhead.

Figure B.8 J2 to 25-pin D-Connector Cable (P/N 9101-1371)





Serial Interface Cables

Figure B.9 J5 to 9-pin D-Shell Interface Diagram (P/N 9101-1372)

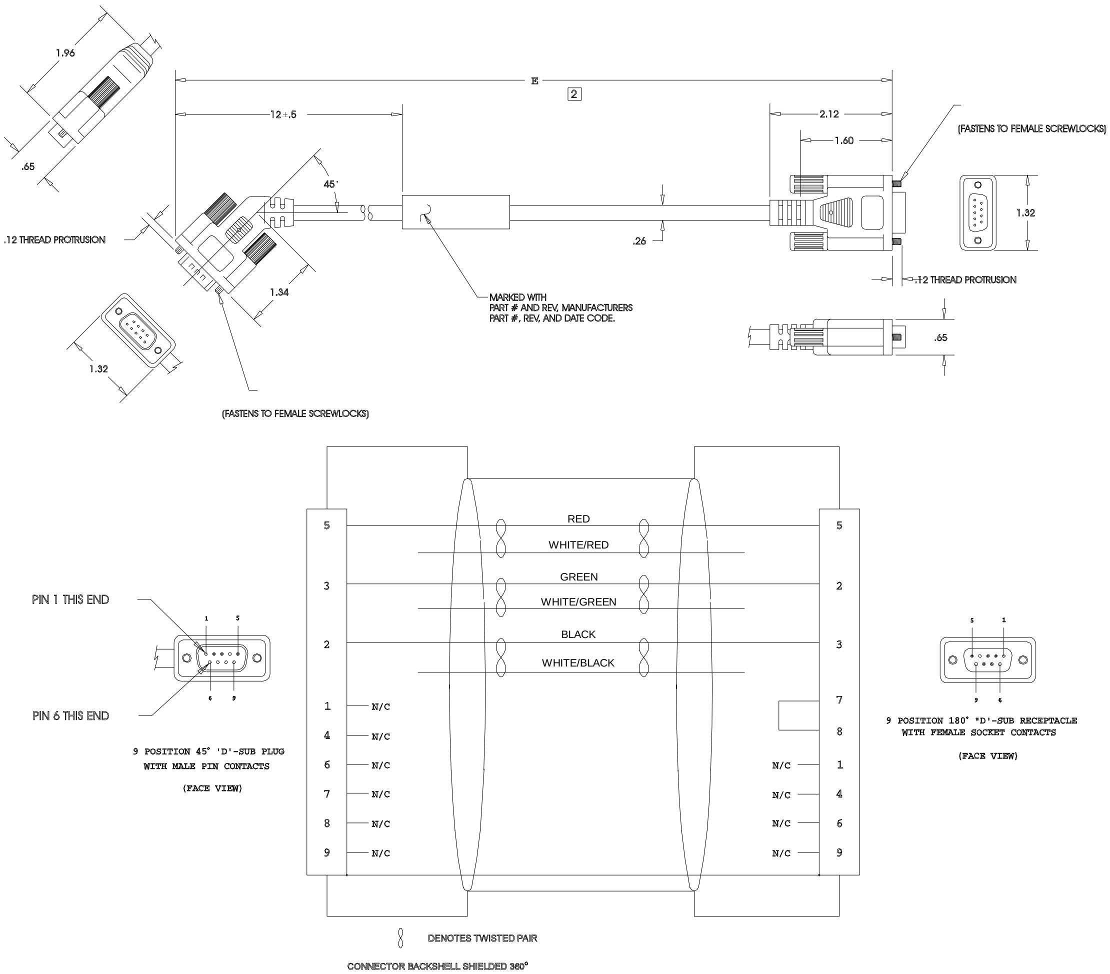


Figure B.10 J5 to J5 Serial Interface Cable (P/N 9101-1374)

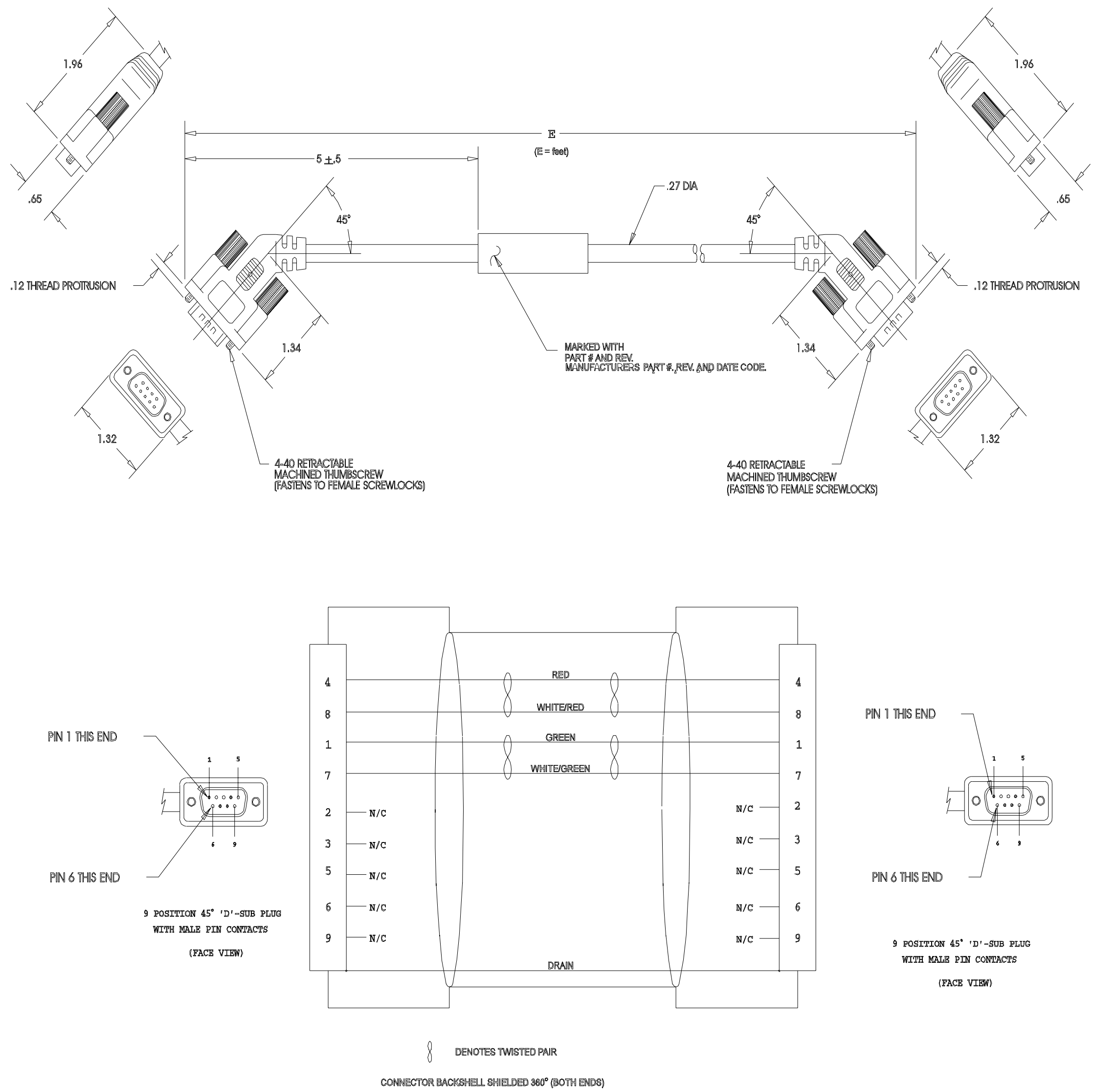
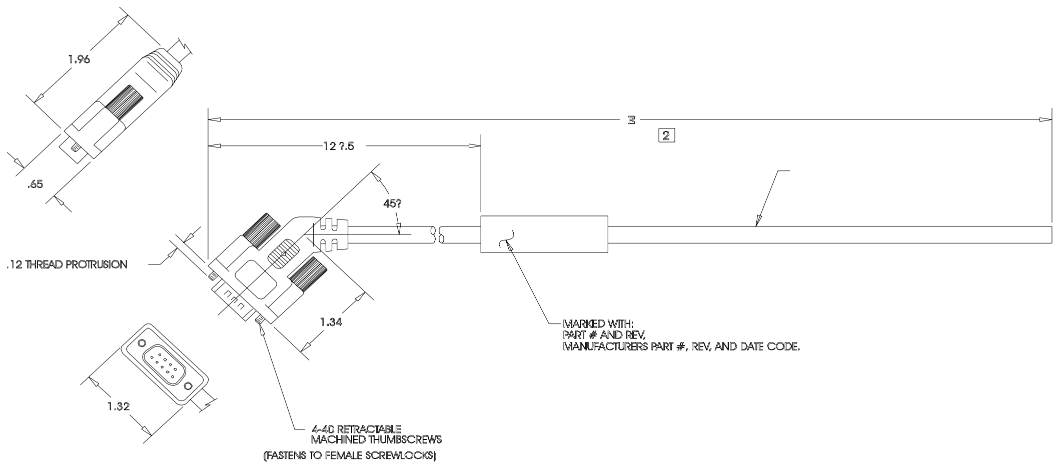
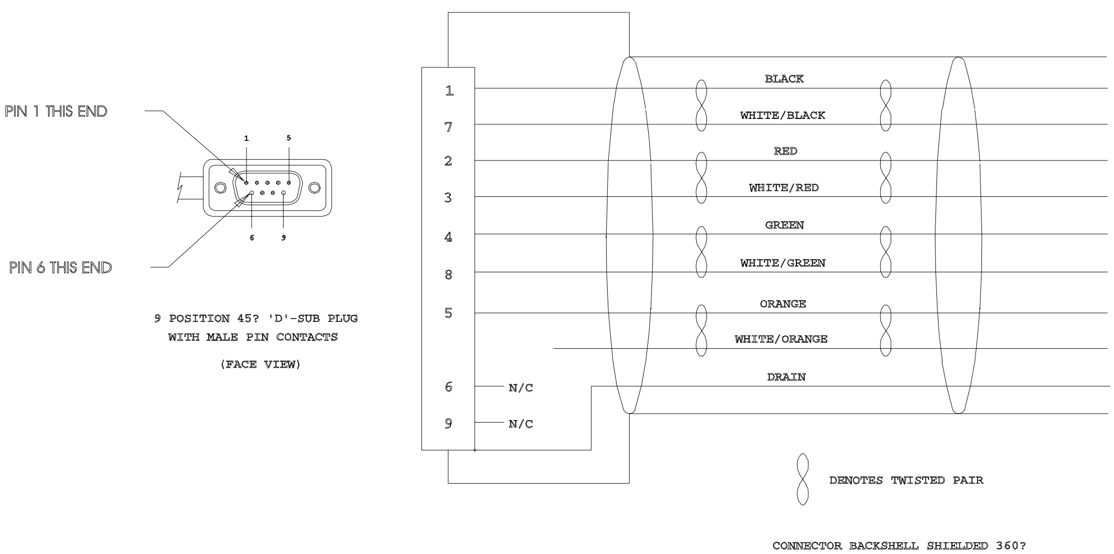


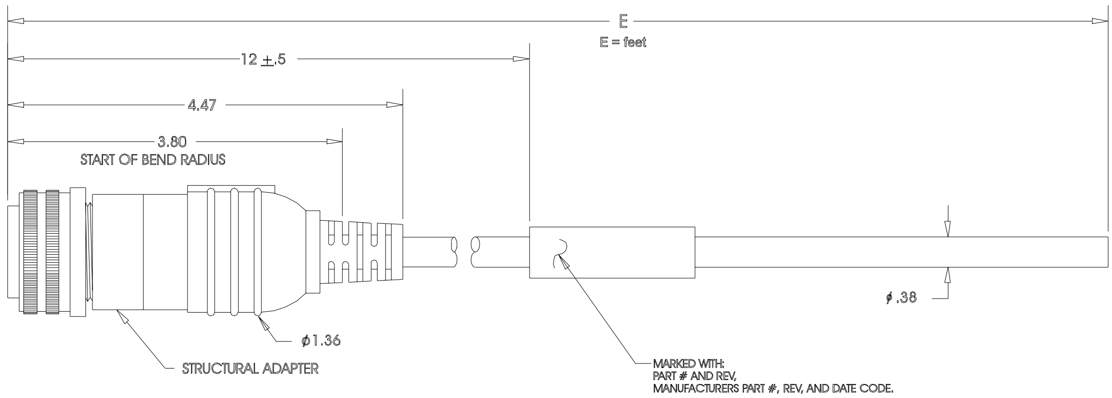
Figure B.11 J5 to No Connector Serial Interface Cable (P/N 9101-1379)





Encoder Feedback Cables

Figure B.12 F- or H-Series Motors to No Connector Encoder Cable (P/N 9101-1365)



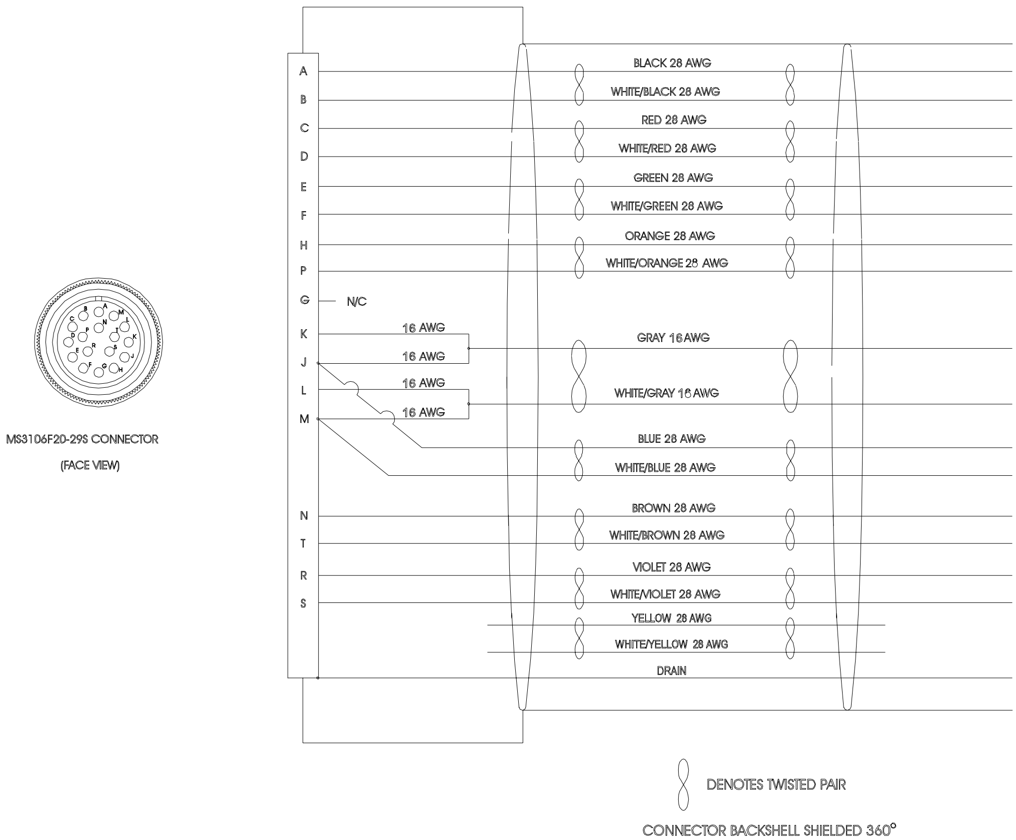
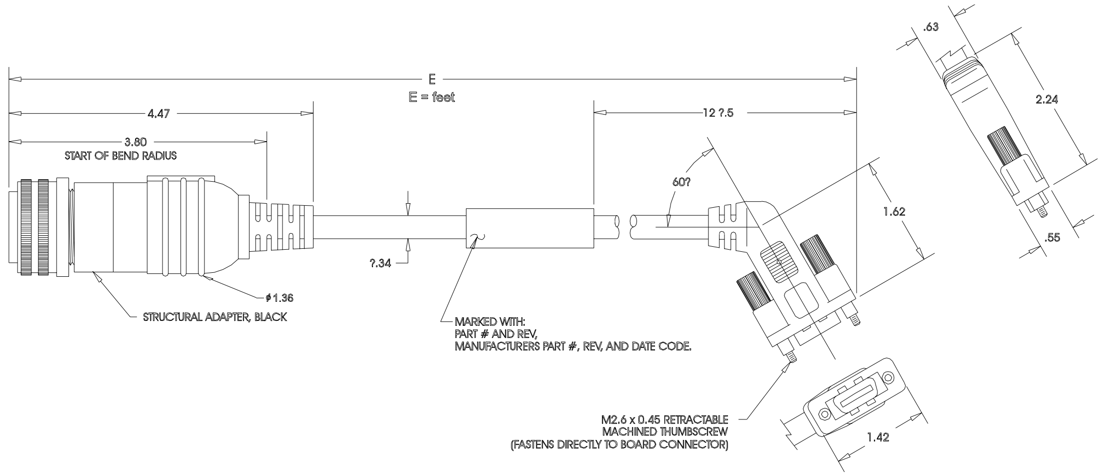


Figure B.13 J2 to F- or H-Series Encoder Cable (P/N 9101-1366)



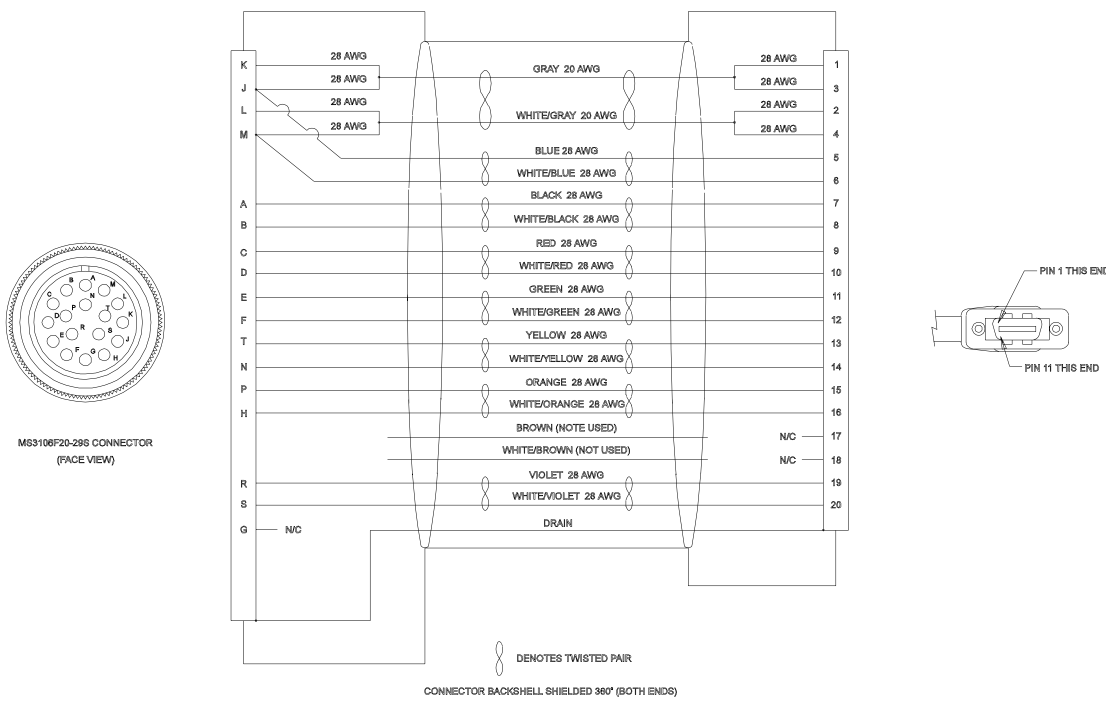
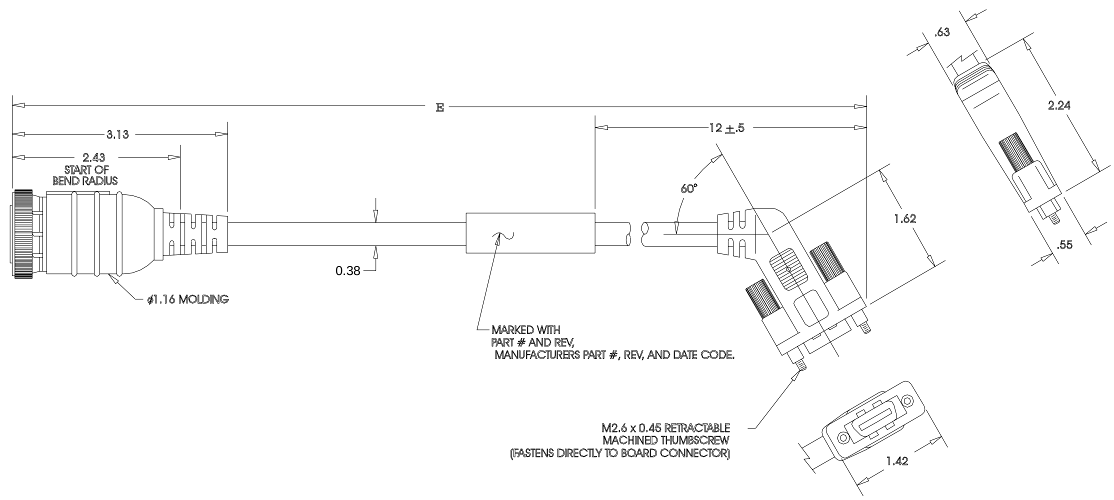


Figure B.14 J2 to Y-Series Encoder Cable (P/N 9101-1375)



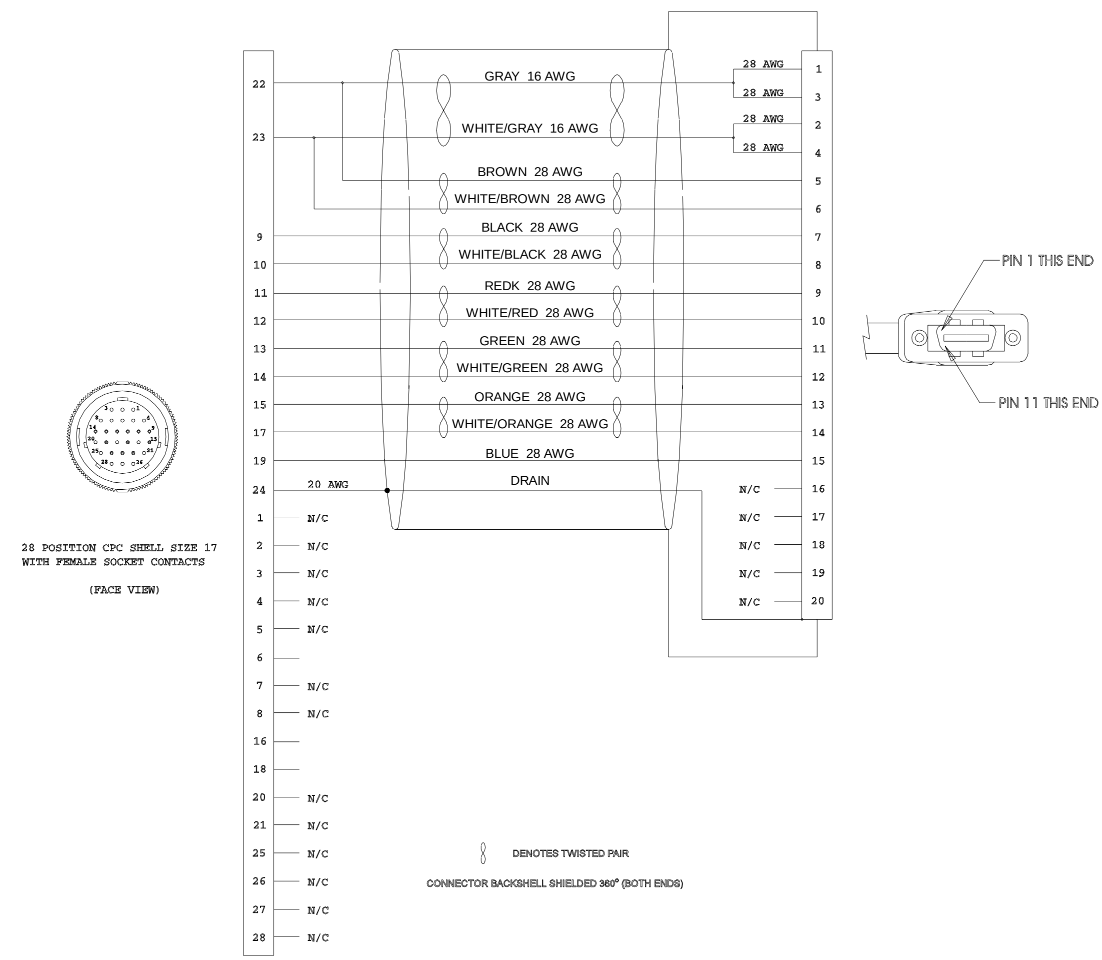


Figure B.15 No Connector to Y-Series Encoder Cable (P/N 9101-1373)

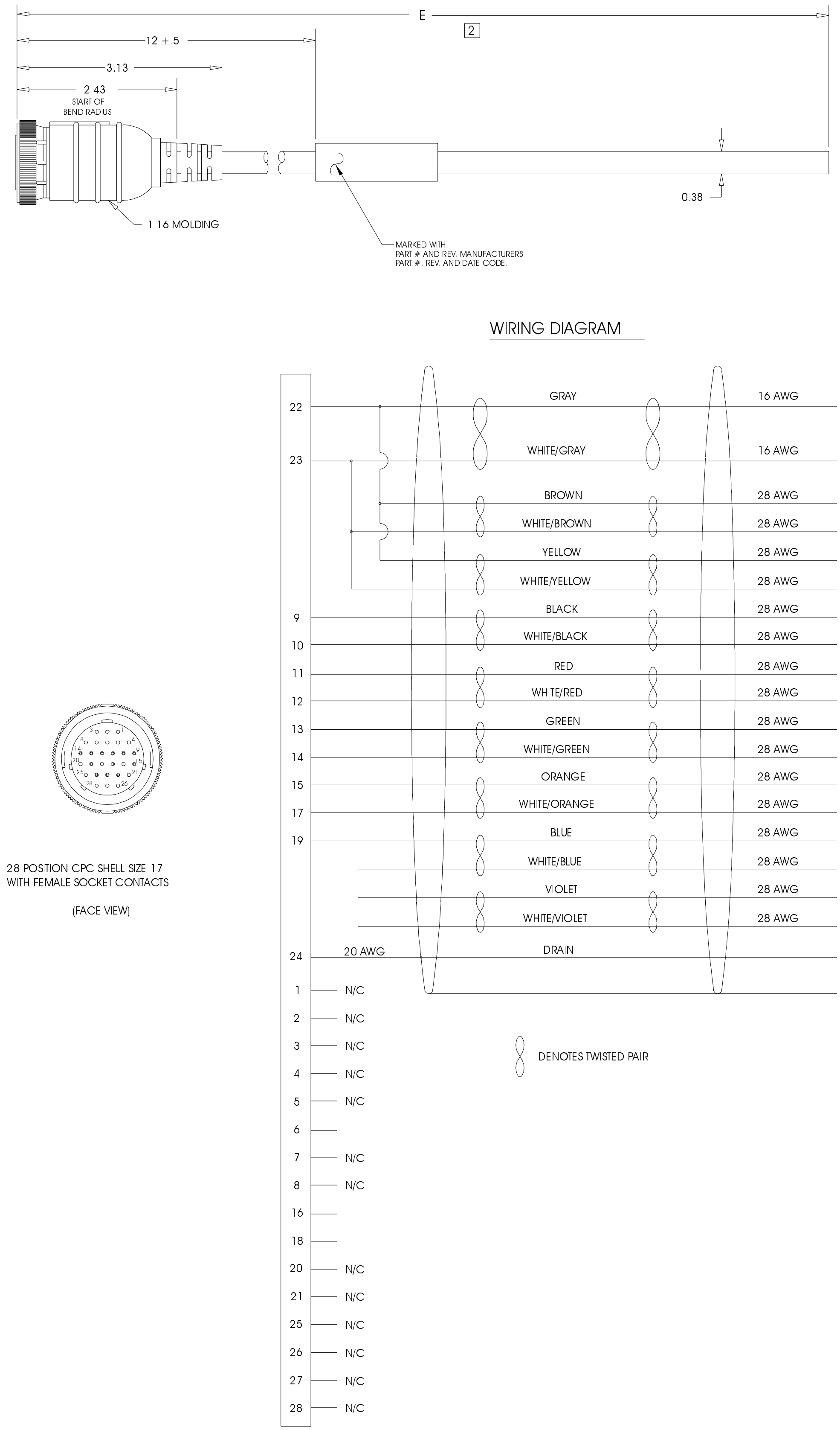
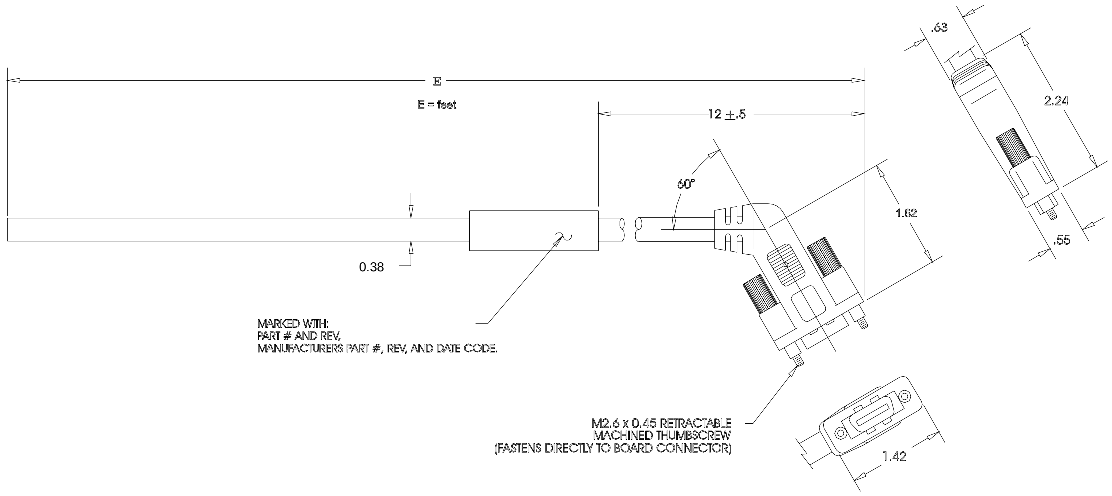
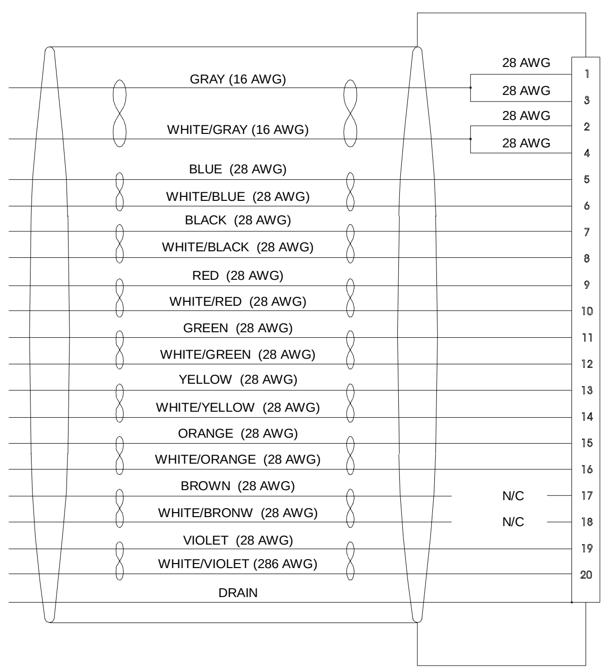
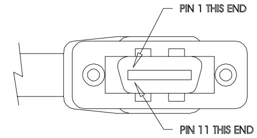


Figure B.16 J2 to No Connector Encoder Cable (P/N 9101-1380)



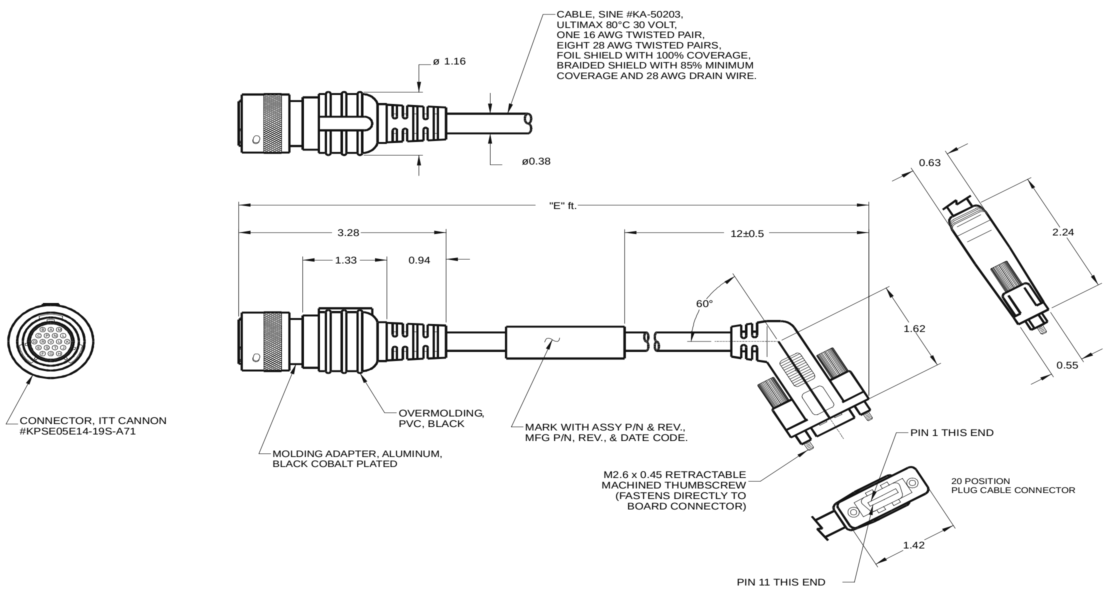




DENOTES TWISTED PAIR

CONNECTOR BACKSHELL SHIELDED 360°

Figure B.17 J2 to N-Series Encoder Cable (P/N 9101-1468)



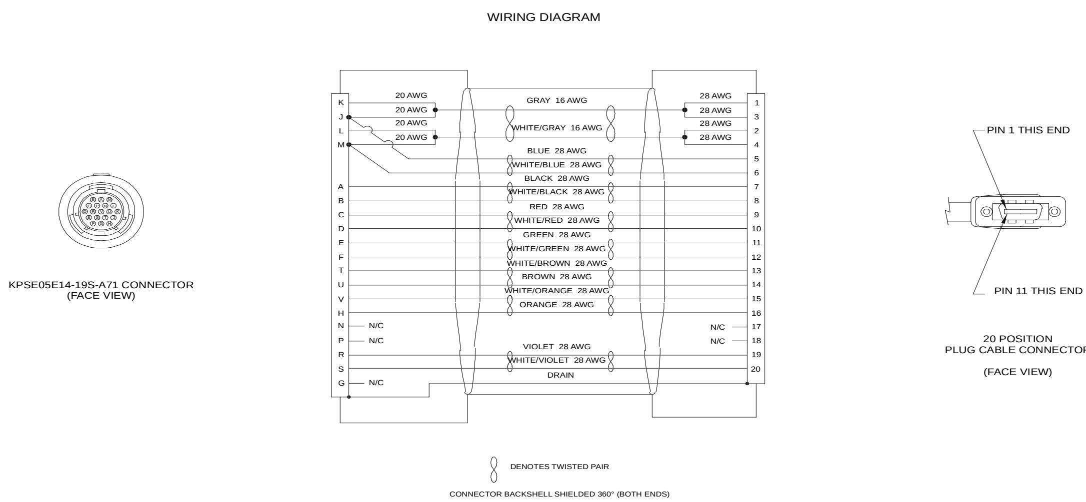
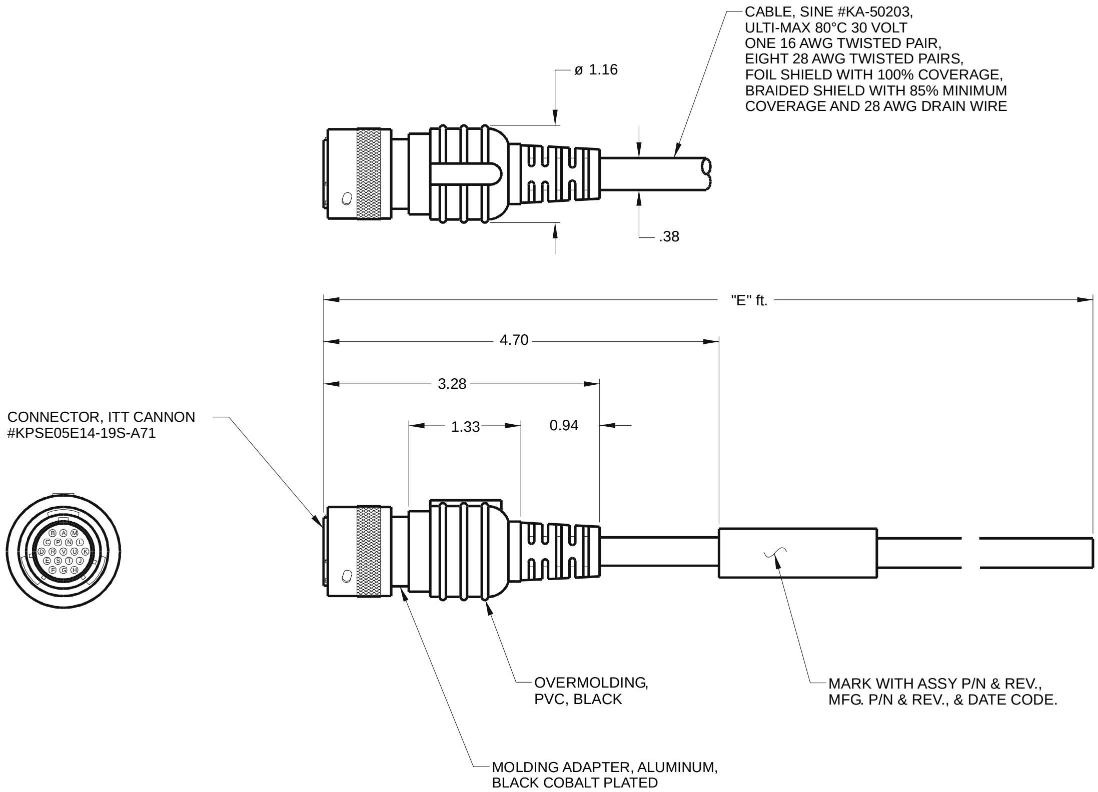
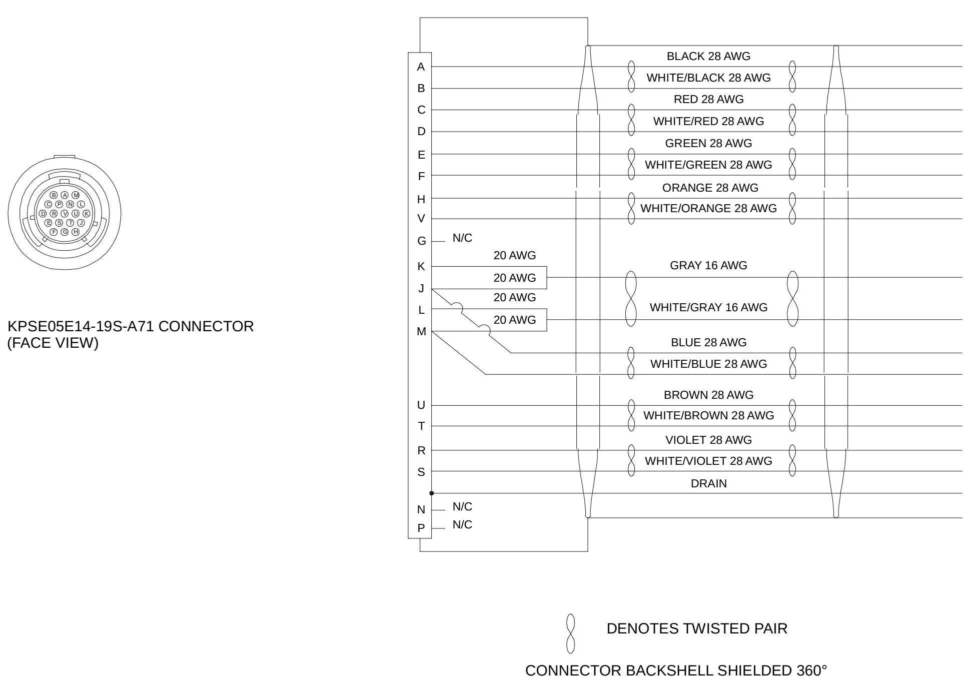


Figure B.18 No Connector to N-Series Encoder Cable (P/N 9101-1469)



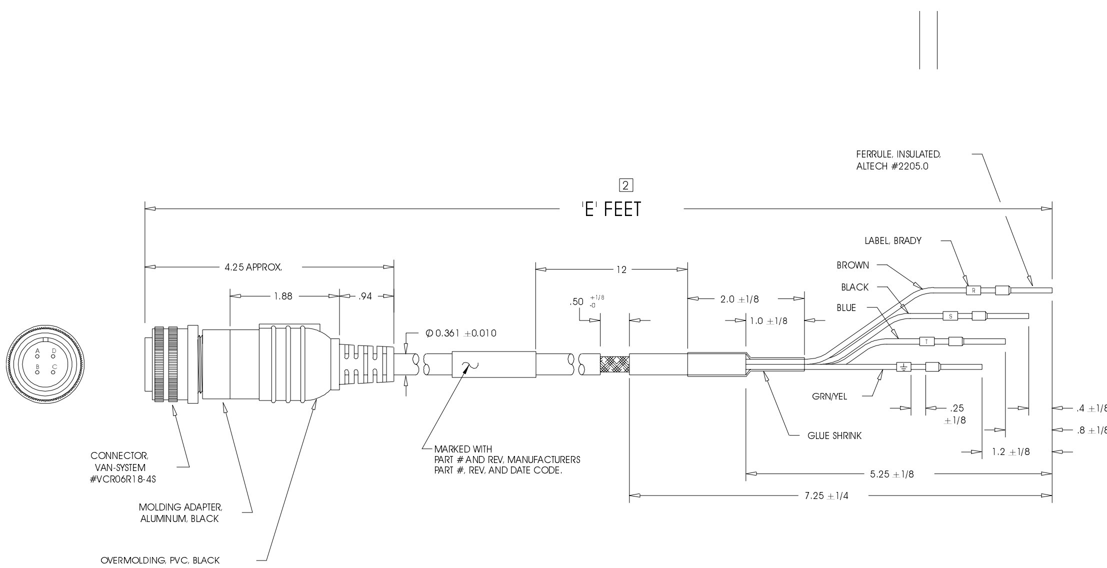
WIRING DIAGRAM



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)



DRAWING 9101-1381

Figure B.20 4000 F- or H-Series Power Cable (P/N 9101-1382)

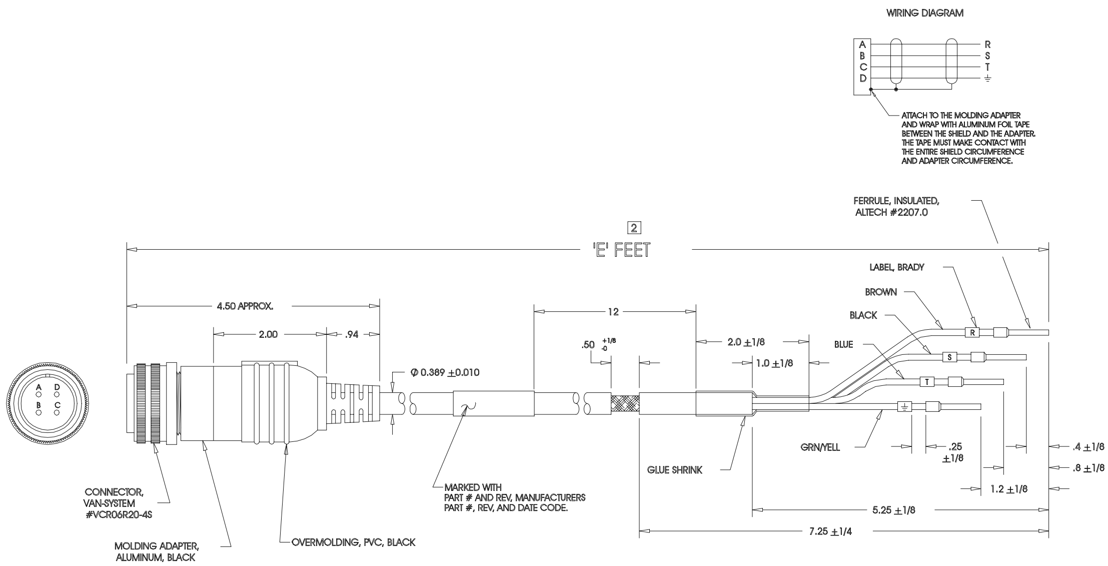


Figure B.21 6100 or 6200 F- or H-Series Power Cable (P/N 9101-1383)

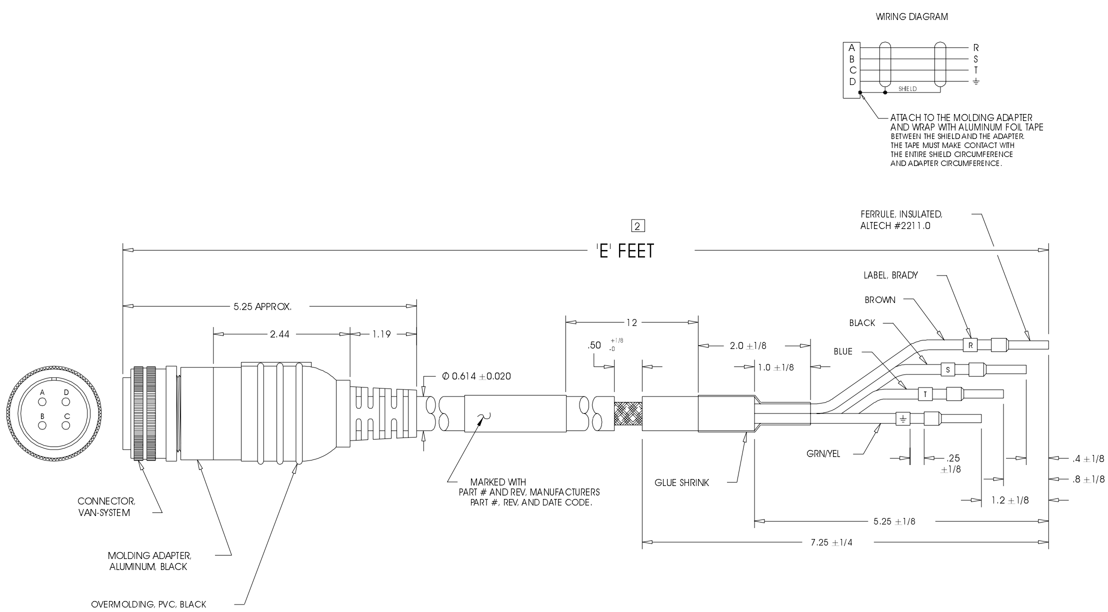


Figure B.22 6300 H-Series Power Cable (P/N 9101-1399)

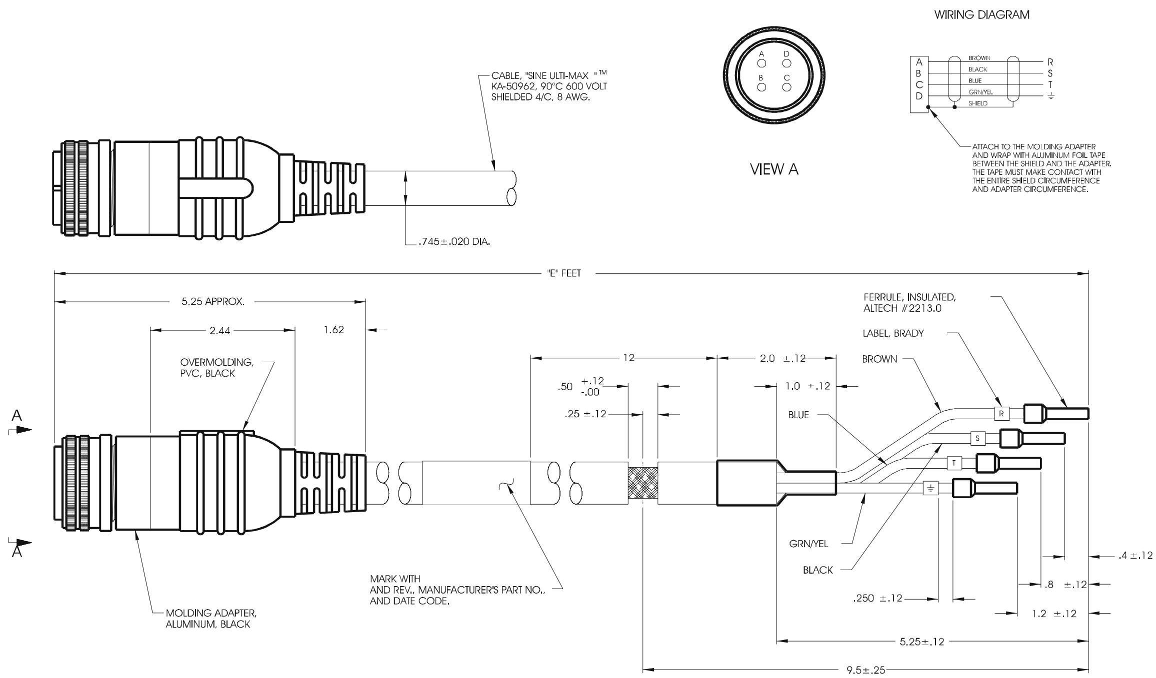


Figure B.23 8000 H-Series Power Cable (P/N 9101-1384)

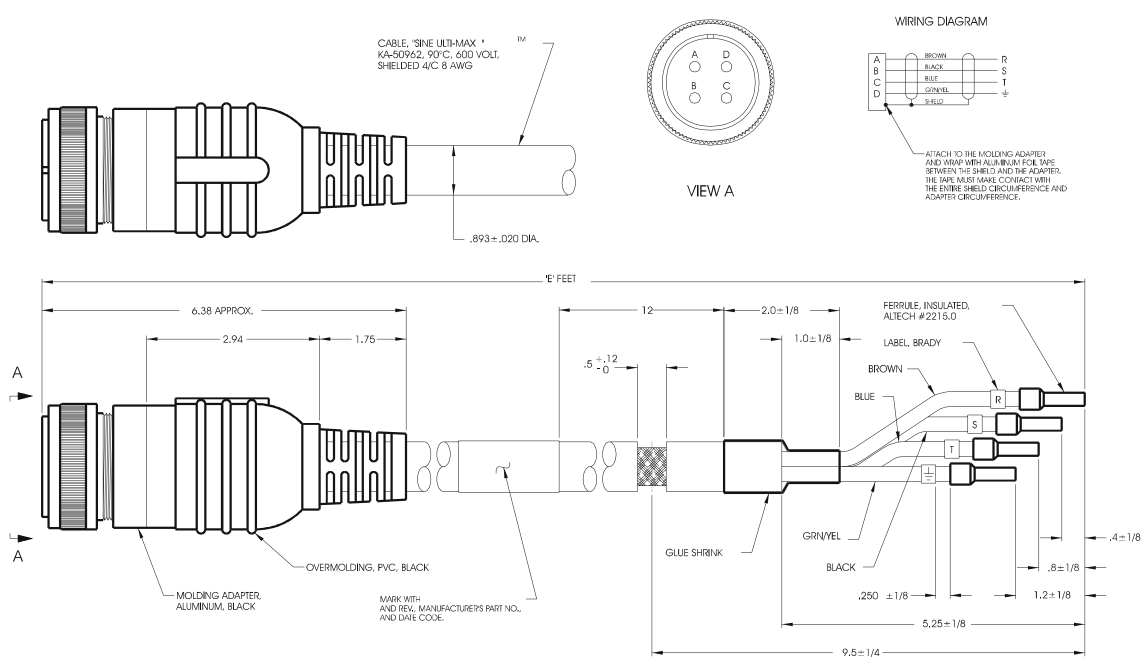
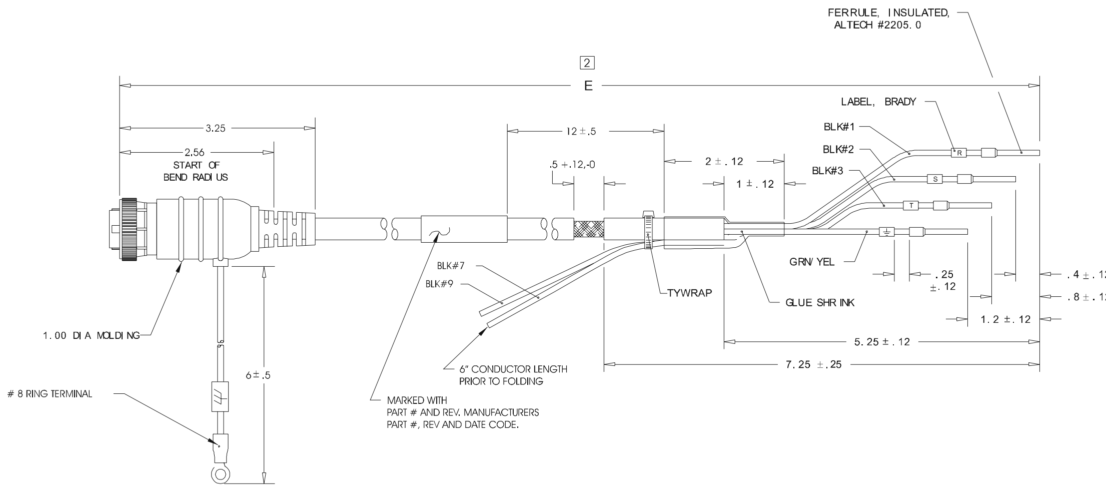


Figure B.24 Y-Series Power Cable (P/N 9101-1385)



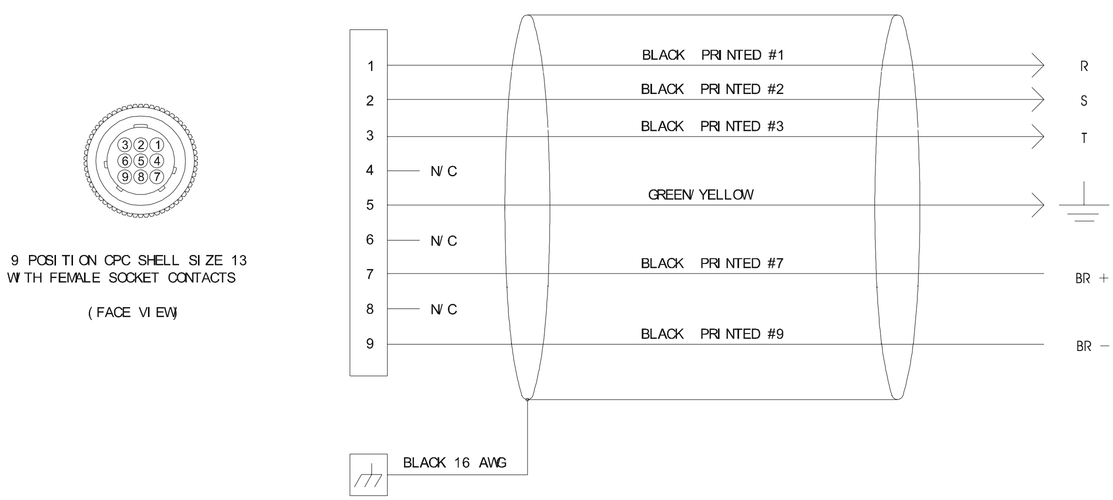
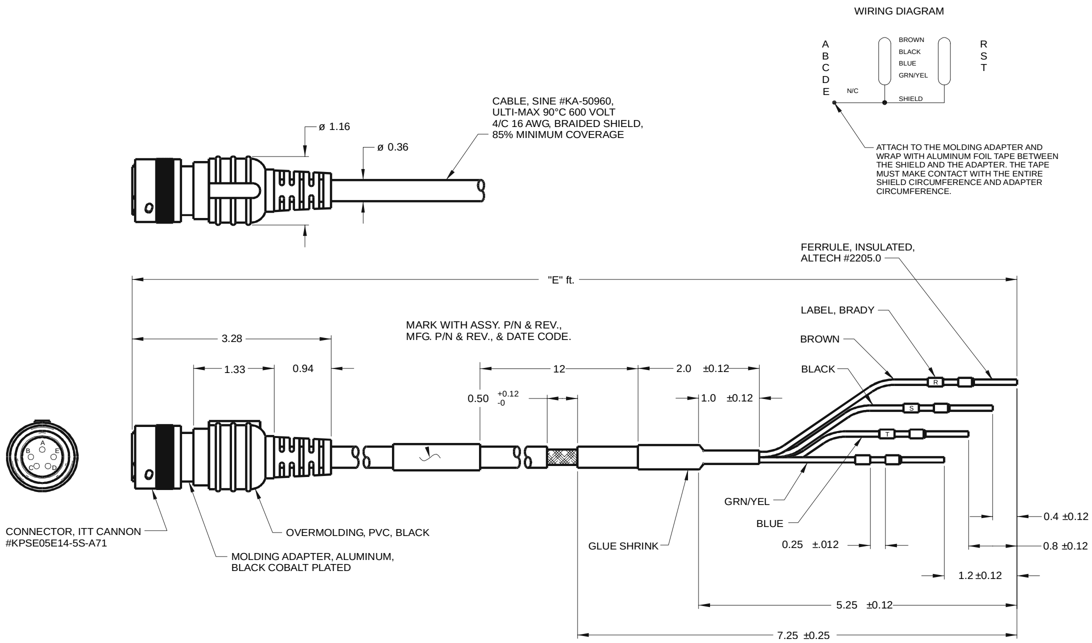
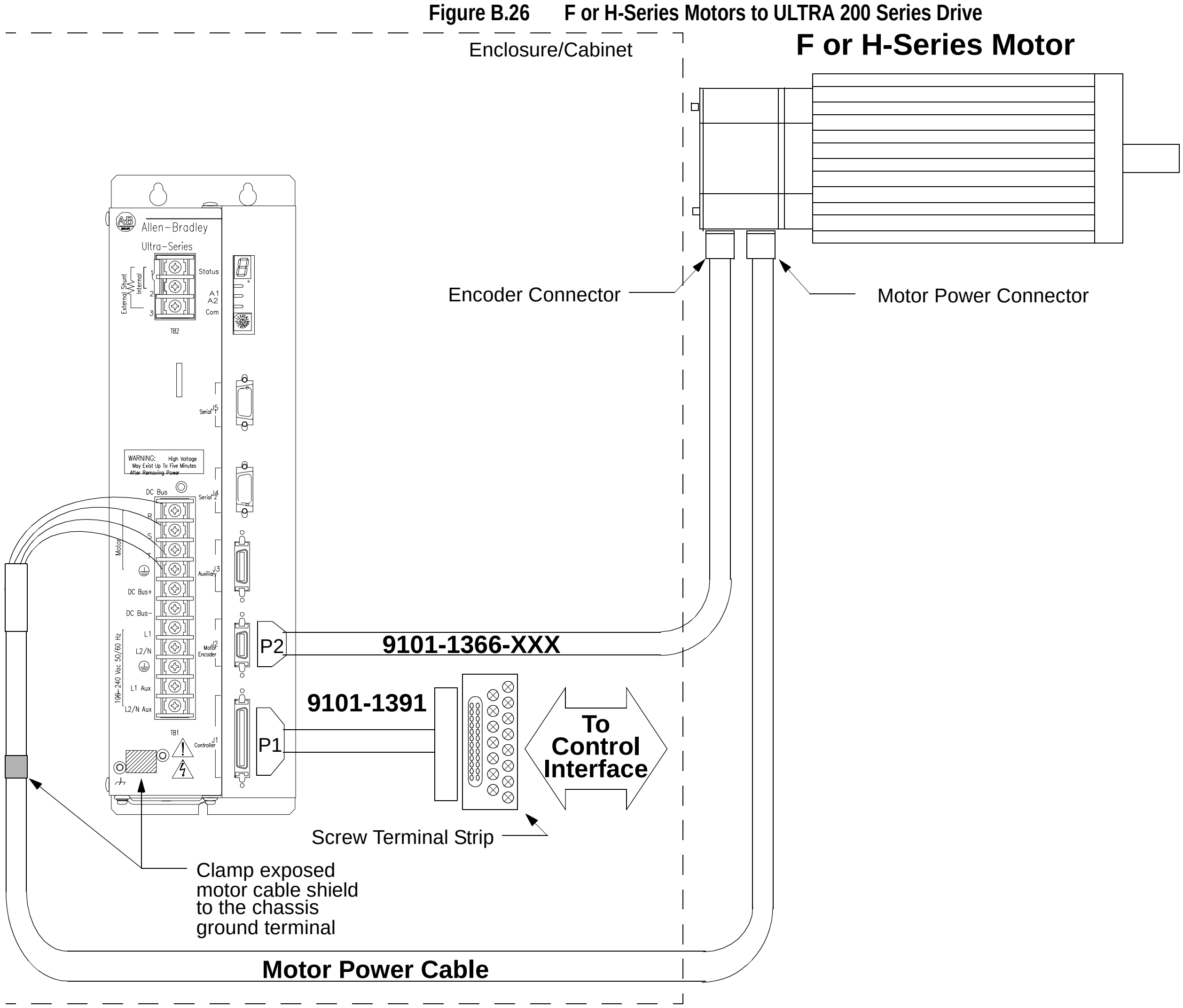


Figure B.25 N-Series Power Cable (P/N 9101-1467)



Cabling Examples

Figure B.26 F or H-Series Motors to ULTRA 200 Series Drive



Notes:

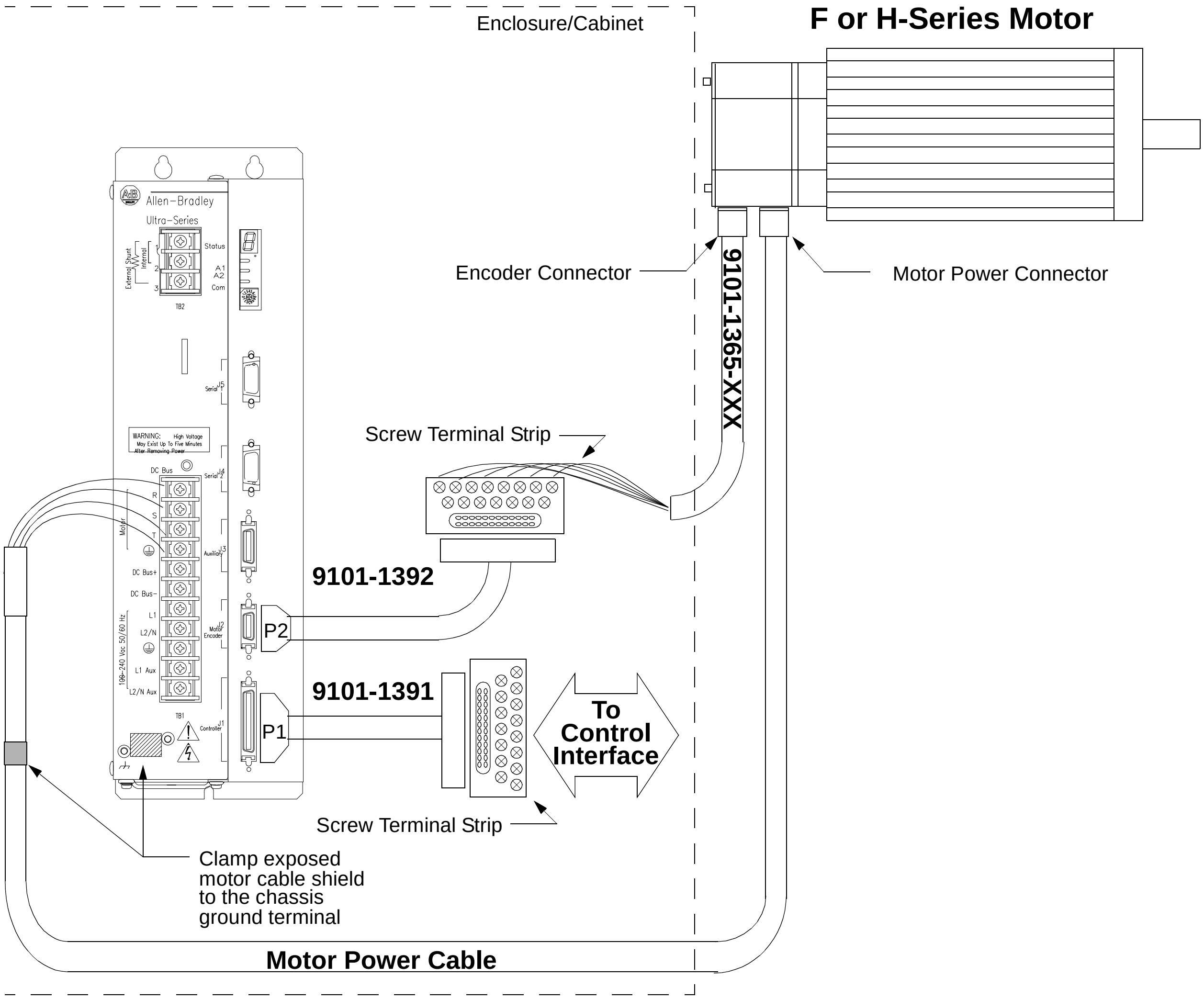
This wiring method should be used to run cables through a bulkhead or enclosure without removing the connectors.

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 Series cables for applications requiring the CE mark. 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.

Figure B.27 F- or H-Series Motors to ULTRA 200 Series Drive using P2 Terminal Strip



NOTES:

This wiring method provides the option to run cables through a restrictive bulkhead or enclosure.

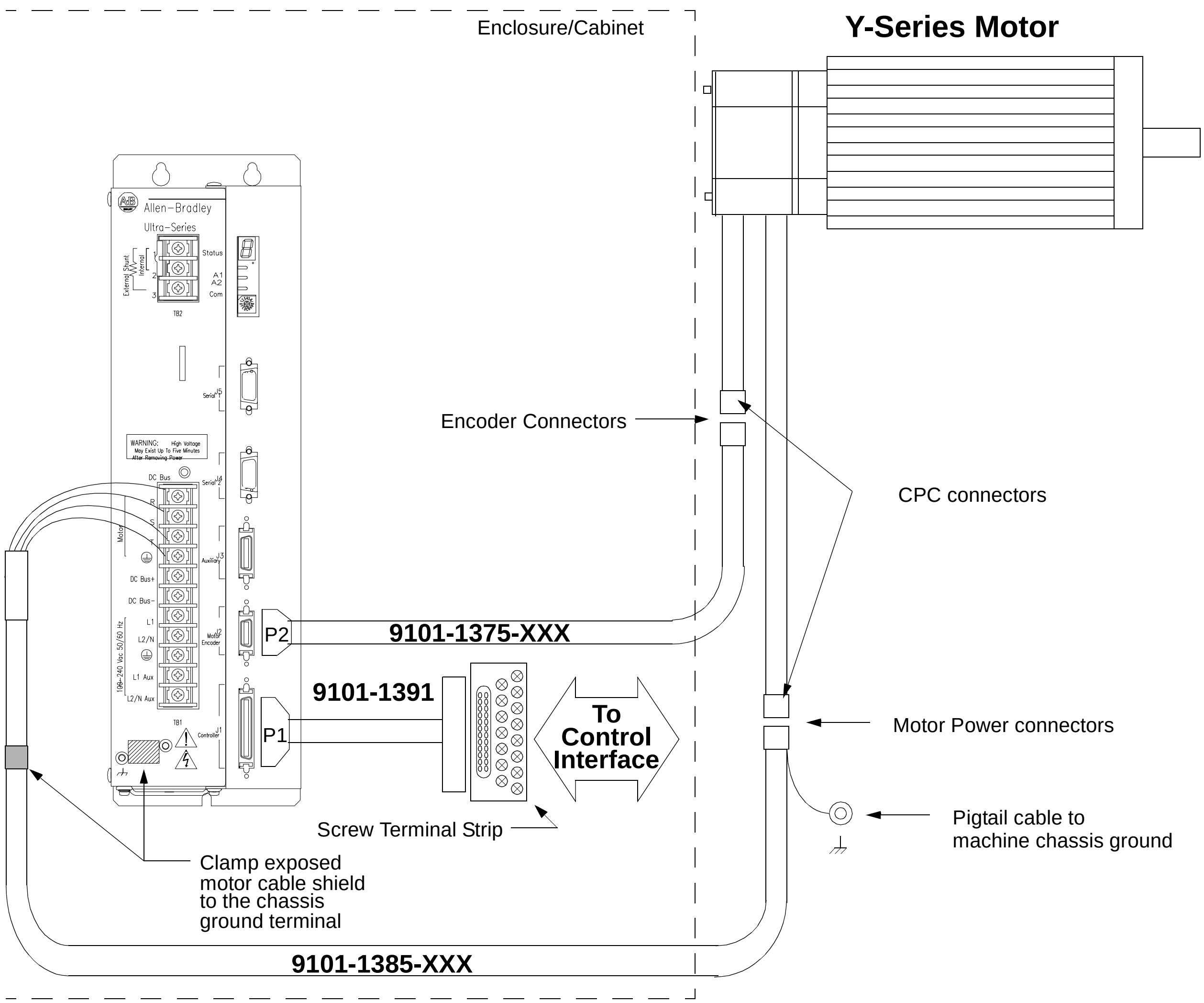
Cable 9101-1365-XXX has a connectors on the motor end only. The cable connector is molded and potted to the cable and may not be disassembled. Refer to the schematic for cable 9101-1366-XXX for information on wiring this cable to the J2 Terminal Strip.

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 200 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.

Figure B.28 Y-Series Motors to ULTRA 200 Series Drive



Notes:

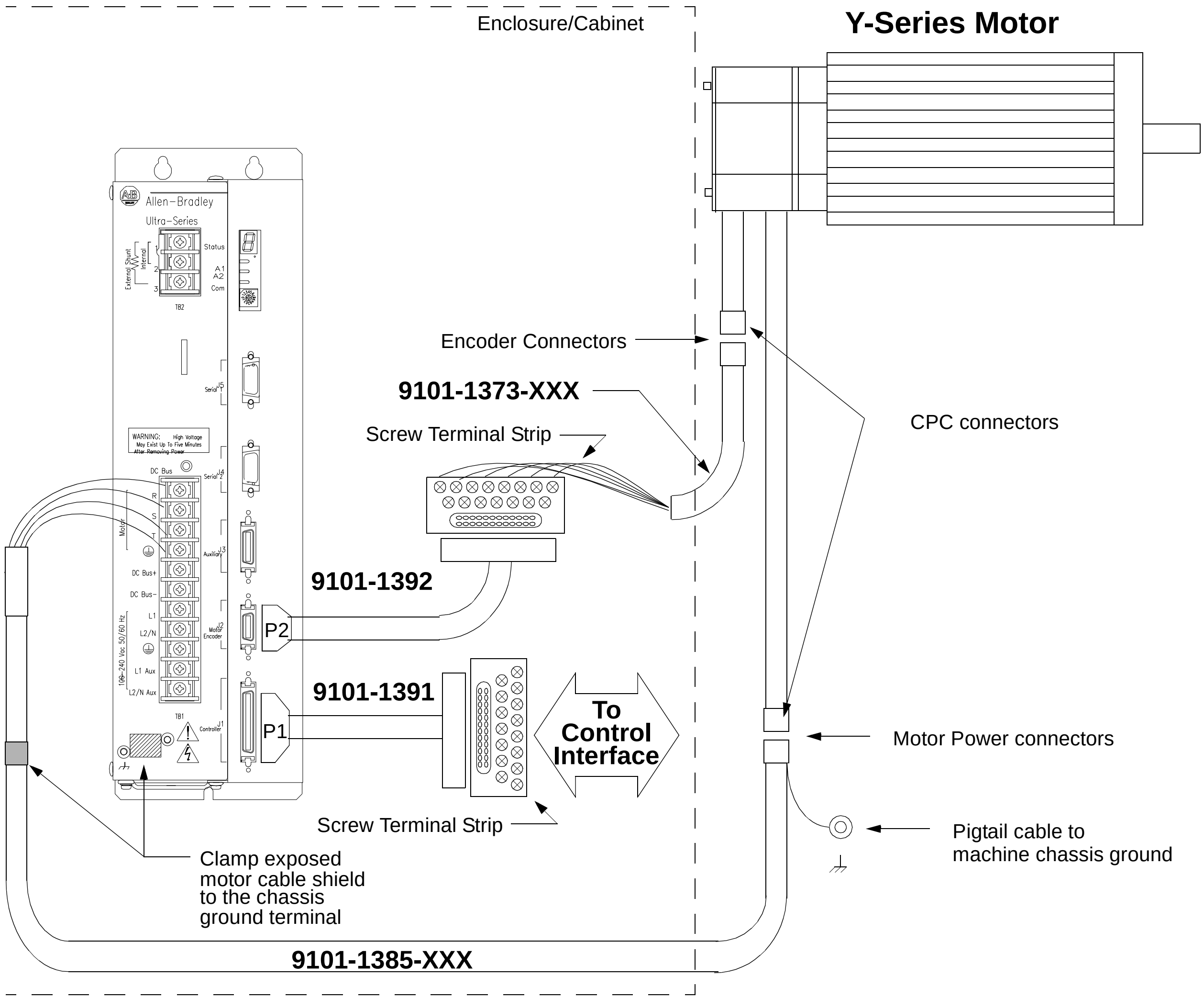
This wiring method should be used to run cables through a bulkhead or enclosure without removing the connectors.

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.

Motor Power Cables - Use ULTRA Series cable, 9101-1385-XXX, for applications requiring the CE mark. The shield on the motor power cable must be properly grounded at both ends.

Figure B.29 Y-Series Motors to ULTRA 200 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.

Adaptor Kits 9101-1391 and 9101-1392 include a 3 foot cable, 50-pin (9101-1391) or 25-pin screw (9101-1392) terminal strip and mounting bracket. The cables have a 50 or 25-pin Mini D ribbon connector at the drive end and a 50 or 25-pin D connector at the terminal strip end.

Motor Power Cables - Use ULTRA Series cable, 9101-1385-XXX, for applications requiring the CE mark. The shield on the motor power cable must be properly grounded at both ends.

Y-Series Motors have 1 meter (39 inch) cables attached.

Allen-Bradley 9/Series CNC Family Connections

The tables below list 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 ULTRA 200 Series drive.

Table B.1: 9/260 or 9/290 to Breakout Board

9/260 or 9/290 8520-ASM-3		Drive Connections	
J1, J2, J3 Pin	Signal	J2 Pin	Signal
3	CHA_HI	7	MtrEncdr Input Chnl A+
4	CHB_HI	9	MtrEncdr Input Chnl B+
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		Drive Connections	
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

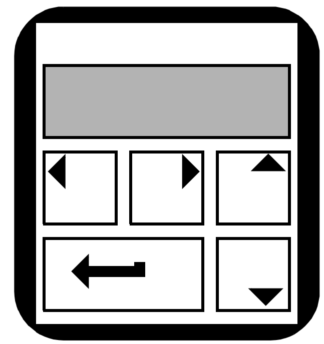
9/230 8520-ASM-4		Drive Connections	
Pin	Signal	J2 Pin	Signal
11	CHA_HI	7	MtrEncdr Input Chnl A+
10	CHB_HI	9	MtrEncdr Input Chnl B+
39	CHZ_HI	11	MtrEncdr Input Chnl Index+
41	CHA_LO	8	MtrEncdr Input Chnl A-
40	CHB_LO	10	MtrEncdr Input Chnl B-
9	CHZ_LO	12	MtrEncdr Input Chnl Index-
NOTE: A-B 845 encoders 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		Drive Connections	
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-
40	CHB_LO	10	Mtr Output Chnl B-
9	CHZ_LO	12	Mtr Output Chnl Index-

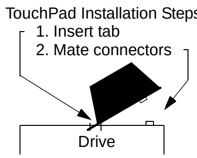
NOTE:
A-B 845 encoders are usually wired with the A- signal into the A+ signal on the Allen-Bradley drive

TouchPad Command Tree Ver12.10

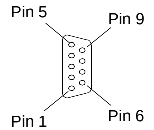


Installation and Operation

1. Power down the drive and remove all serial connections.
2. Install the TouchPad as shown.



Pin 1	Receive +
Pin 2	Not used
Pin 3	Not used
Pin 4	Transmit +
Pin 5	+5VDC Common
Pin 6	TouchPad Sense
Pin 7	Receive -
Pin 8	Transmit -
Pin 9	+5VDC



3. Reapply power to the drive. TouchPad communications are: Address 0, 19200 Baud, 8 Data bits, 1 Stop bit and No Parity. Drive EEPROM settings are overridden by the TouchPad.
4. Verify the **FW Ver##.##** displayed during Self Test is correct. An incorrect match causes an error. The number must agree with that listed for the Command Tree on the reverse side.
5. Depress the Mode/Enter key to select the Mode of Operation: Parameter or Modify.
6. Depress the arrow keys to display a parameter or modify the value of a parameter. The diagram on the reverse side depicts the structure of the TouchPad Command Tree.

Supplemental Instructions

Refer to the *Installation Manual* for additional instructions.

1. Eight alphanumeric characters are displayed. Parameters longer than eight characters may require scrolling with the Left and Right Arrow keys.
2. Flashing characters appear in the Modify mode.
   - Replace characters by scrolling through the list of ASCII characters using the Up or Down arrow key.
   - Change the cursor position using the Right and Left arrow keys.
3. If a parameter change results in an invalid entry, a message appears.
   - Errors alternately display **Error** and a name.
     Press the Mode/Enter key to clear an error.
   - Warnings momentarily display a name.
     Warnings are automatically cleared.

   Refer to the *Installation Manual* for a list of errors and warnings.
4. Parameter settings may not exceed the maximum or minimum parameter limits, regardless of the cursor position.
   For example, if 5200 rpm is the maximum rpm setting and **5**000 is the parameter setting while the cursor location is in the 1000 position, the parameter will only increment to **5**200 when the Up arrow key is depressed. However, depressing the Down arrow key will decrement the parameter to **4**000.
5. The most significant digit is reserved when a parameter allows a negative (-) setting. The Up or Down arrow key toggles the minus sign.
6. DRVSETUP, I/OCONFIG and STATUS parameters provide lists from which a choice may be selected:
   - A filled arrow, ➡, precedes the active choice.
   - Unfilled arrows, ⇨, precede inactive choices.

   The Mode/Enter key selects a choice.

TouchPad Commands

Commands are entered by depressing 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.

Key	Function
Mode/Enter	Toggles the display between two operating modes. • **Parameter** mode shows the abbreviated command name of the selected parameter. • **Modify** mode shows the setting, often a number, for the selected parameter. Key functions in each mode are explained below.

The TouchPad Command Tree is depicted on the reverse side. Refer to the on-line ULTRA Master help menus for command names, parameter ranges and limits.

	Mode of Operation	
Key	**Parameter**	**Modify**
Left Arrow	**Previous Branch** Selects the previous branch in the command tree. For example: DRVPARAM ◀ DRVSETUP	**Move Left** Moves the character selection to the left, advancing the cursor setting. For example: 000**5**2**00** ◀ 000**5**200
Right Arrow	**Next Branch** Selects the next branch in the command tree. For example: DRVSETUP ▶ DRVPARAM	**Move Right** Moves the character selection to the right, lowering the cursor setting. For example: 000**5**200 ▶ 0005**2**00
Down Arrow	**Next Parameter** Selects the next parameter down the branch of the command tree. For example: DRVSETUP ▼ MotorSel	**Decrement Character** Decreases the character that is selected. For example: 2 ▼ 1, or B ▼ A
Up Arrow	**Previous Parameter** Selects the next parameter up the branch of the command tree. For example: Drv Mode ▲ DRVPARAM	**Increment Character** Increases the character that is selected. For example: 1 ▲ 2, or A ▲ B
Up and Down Arrows Press both keys at the same time	Not functional in this mode.	**Undo Change** Restores a changed parameter to its original setting. NOTE: This command must be performed before exiting the parameter.
Mode/Enter	**Next Mode/Last Parameter** On a parameter, enters the **Modify** mode of operation. On a branch title, selects the last parameter modified.	**Next Mode** Returns to **Parameter** mode of operation.

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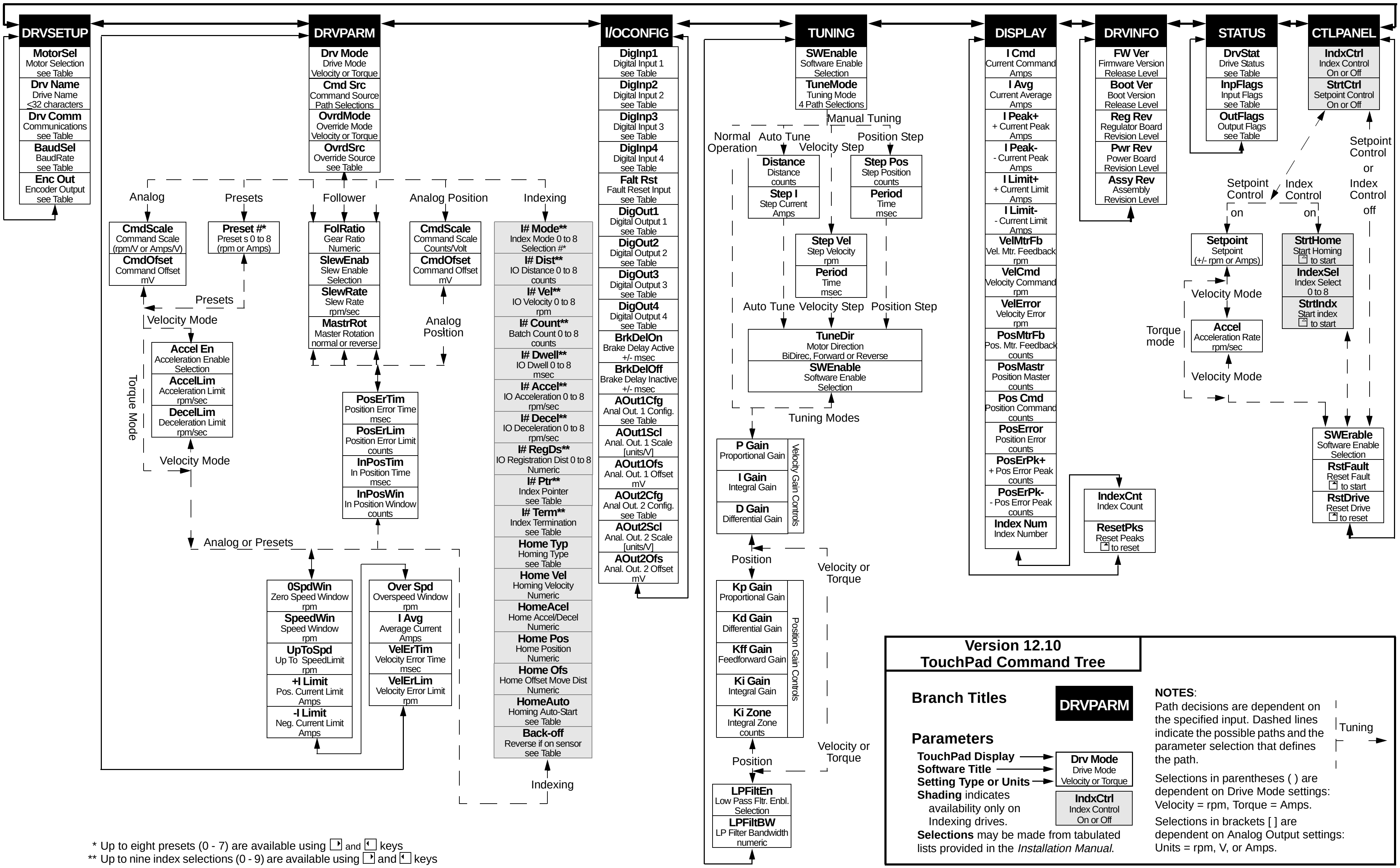


* Up to eight presets (0 - 7) are available using and keys
** Up to nine index selections (0 - 9) are available using and keys

TouchPad Instructions

The optional TouchPad is a compact and rugged device for interfacing with ULTRA 200 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 200 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 200 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.

ATTENTION: Ignoring this step may result in damage to the drive.

2. Plug the TouchPad into the serial port on the ULTRA 200 Series drive by latching the tab into the drive and then mating the connector as shown.

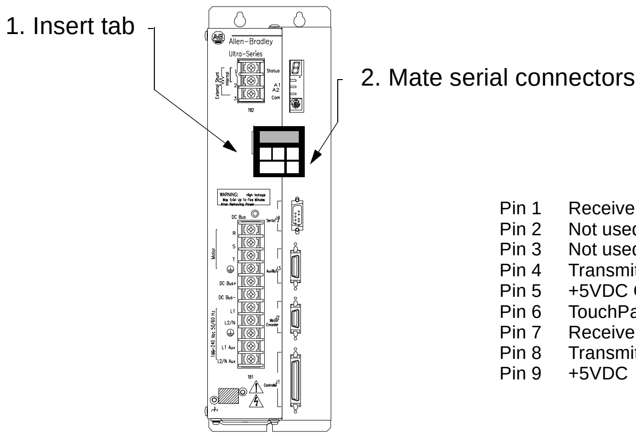
3. Power-up the drive. Installing the TouchPad defaults the drive to the following settings:

The personality module settings stored in the drive are not affected by the installation or removal of the TouchPad.

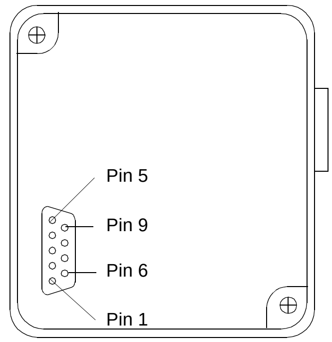
4. Verify the **Ver##.##** displayed is correct at power-up. The version number designates the type of drive and its firmware level. Figure C.2 explains this display.

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.

Figure C.1 **TouchPad Connection and Pinouts**

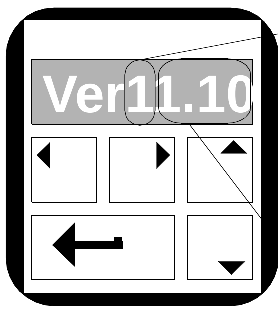


Pin 1 Receive +
Pin 2 Not used
Pin 3 Not used
Pin 4 Transmit +
Pin 5 +5VDC Common
Pin 6 TouchPad Sense
Pin 7 Receive -
Pin 8 Transmit -
Pin 9 +5VDC



- Address 0
- 19200 Baud
- 8 Data bits
- 1 Stop bit
- No Parity bit

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)

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 illustrates the structure.

TouchPad Commands

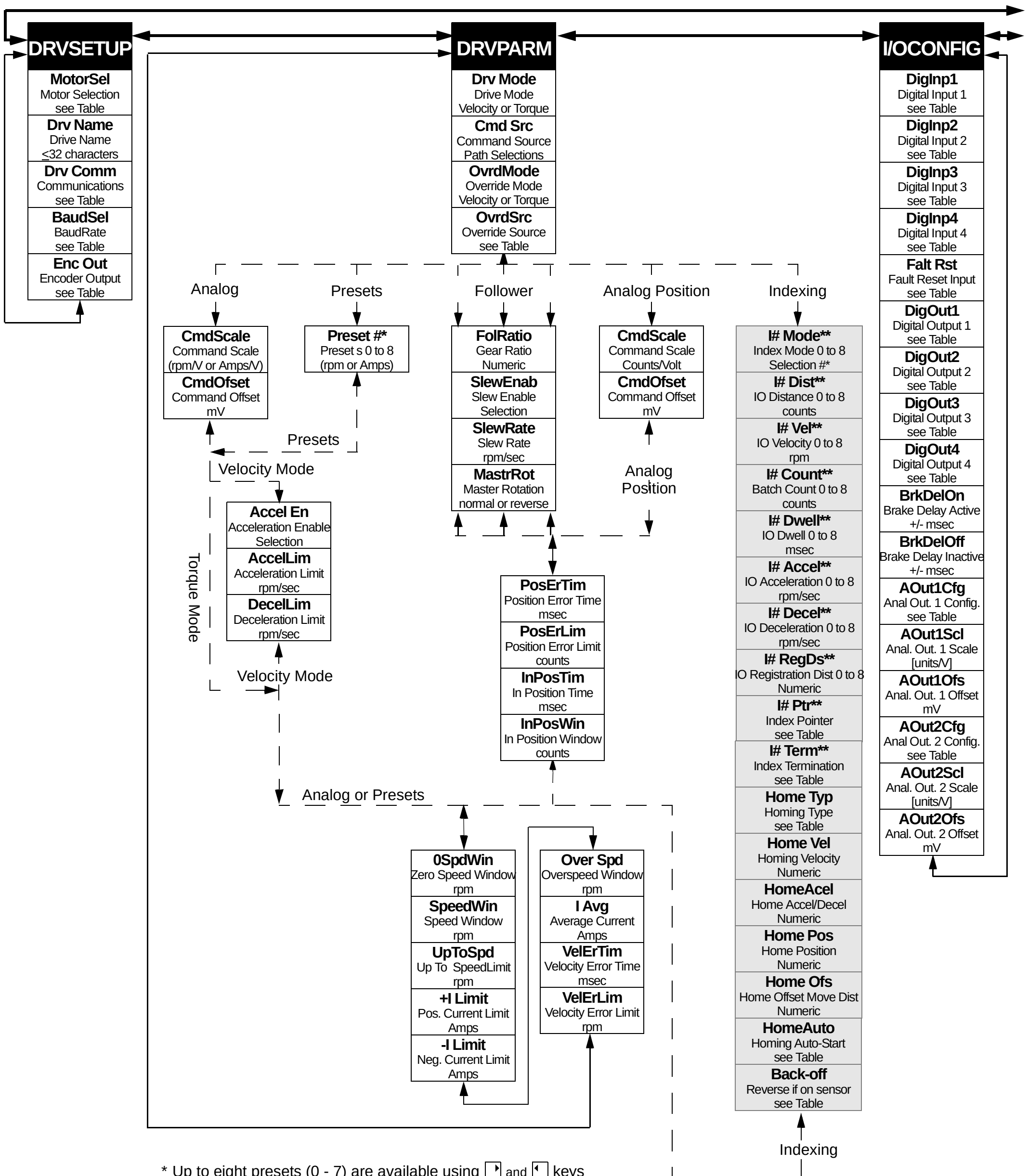
Commands are entered by pressing a single key or combination of keys. Two modes of operation are available. Parameter mode allows you to move through the TouchPad Command Tree to each parameter. Modify mode allows you to monitor and change each parameter, often while the drive is operational.

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.

The Parameter mode displays for the TouchPad Command Tree are explained in the “Supplemental Instructions” on page C-6.

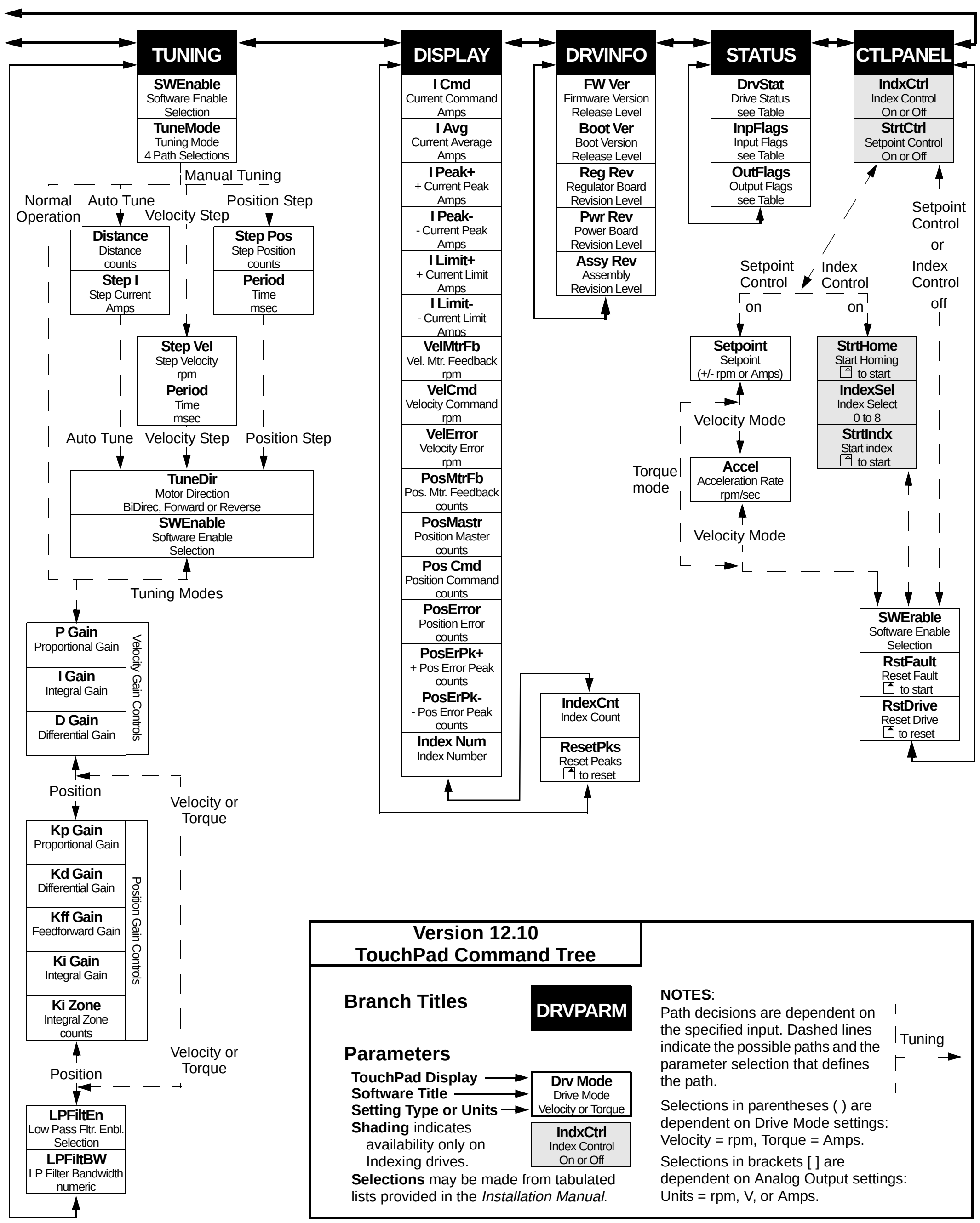
	Mode of Operation	
Key	**Parameter**	**Modify**
Left Arrow	**Previous Branch/Decrement #** Selects the previous branch in the command tree, or Decreases the Preset number when in Preset Drive Parameter mode.	**Move Left** Moves the flashing character selection to the left, advancing the level of the 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.

Figure C.3 TouchPad Command Tree (sheet 1 of 2)



* Up to eight presets (0 - 7) are available using ▶ and ◀ keys
** Up to nine index selections (0 - 9) are available using ▶ and ◀ keys

Figure C.3 TouchPad Command Tree (sheet 2 of 2)



Supplemental Instructions

Motor Selection

Enter a Motor Identification number to load the correct motor parameters into the drive. Table C.2 and Table C.3 list the motors available in the motor table directory.

Displays

Selection of a motor defines default operating parameters for the drive and motor combination.

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.

- 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 page C-13 for items in each list. Table C.17, “Drive Status List for TouchPad” on page C-16 is read-only; 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, it is displayed in full.

  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

Table C.1 lists the possible fault, error and warning messages that may appear on the TouchPad. The items below describe the different types of messages.

- 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 11-6.

- 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.
CmdNoEnb	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.
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.

Motor Table

Table C.2: TouchPad Motor Table Identification by Motor Series

Motor	ID	Motor	ID	Motor	ID	Motor	ID
B14H1050	551	B14H1056	558	B14H1060	560	B14H1066	562
B14J1050	559	B14J1050	559	B14J1060	563	B18H1070	564
B18H1076	566	B18H1080	568	B18H1086	570	B18J1070	567
B18J1080	571	B90H1015	557	B90H1025	561	B90H1035	565
B90H1045	569						

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				

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-M-N	1560	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	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						

Table C.2: TouchPad Motor Table Identification by Motor Series (continued)

Motor	ID	Motor	ID	Motor	ID	Motor	ID
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
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						

Table C.3: TouchPad Motor Table Identification by Motor ID

ID	Motor	ID	Motor	ID	Motor	ID	Motor
				15	F-4030-Q-H	16	F-4075-R-H
17	F-6100-R-H	18	F-6200-R-H	19	F-6300-R-H	20	H-2005-K-H
21	H-3007-N-H	22	H-3016-N-H	23	H-4030-P-H	24	H-4030-M-H
25	H-4050-P-H	26	H-4075-R-H	27	H-6100-Q-H	28	H-6200-Q-H
29	H-6300-Q-H	30	H-8350-S-H	31	H-8500-S-H		
						68	Y-1002-2
69	Y-1002-1	70	Y-1003-2	71	Y-1003-1	72	Y-2006-2
73	Y-2006-1	74	Y-2012-2	75	Y-2012-1		
77	Y-3023-2						
81	N-3406-2-H	82	N-3412-2-H	83	N-4214-2-H	84	N-4220-2-H
85	N-5630-2-H	86	N-5637-2-H	87	N-5647-2-H		
				259	F-4050-Q-F		
				271	F-4030-Q-F		
						272	F-4075-R-F
273	F-6100-R-F	274	F-6200-R-F	275	F-6300-R-F	276	H-2005-K-F
277	H-3007-N-F	278	H-3016-N-F	279	H-4030-P-F	280	H-4030-M-F
281	H-4050-P-F	282	H-4075-R-F	283	H-6100-Q-F	284	H-6200-Q-F
285	H-6300-Q-F	286	H-8350-S-F	287	H-8500-S-F		
				335	N-2302-1-F	336	N-2304-1-F
				515	F-4050-Q-J		
				527	F-4030-Q-J	528	F-4075-R-J
529	F-6100-R-J	530	F-6200-R-J	531	F-6300-R-J	532	H-2005-K-J
533	H-3007-N-J	534	H-3016-N-J	535	H-4030-P-J	536	H-4030-M-J
537	H-4050-P-J	538	H-4075-R-J	539	H-6100-Q-J	540	H-6200-Q-J
541	H-6300-Q-J	542	H-8350-S-J	543	H-8500-S-J		
593	N-3406-2-J	594	N-3412-2-J	595	N-4214-2-J	596	N-4220-2-J
597	N-5630-2-J	598	N-5637-2-J	599	N-5647-2-J		
				771	F-4050-Q-K		
				783	F-4030-Q-K	784	F-4075-R-K

Table C.3: TouchPad Motor Table Identification by Motor ID (continued)

ID	Motor	ID	Motor	ID	Motor	ID	Motor
785	F-6100-R-K	786	F-6200-R-K	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	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		
				1027	F-4050-Q-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	1051	H-6100-Q-L	1052	H-6200-Q-L
1053	H-6300-Q-L	1054	H-8350-S-L	1055	H-8500-S-L		
				1283	F-4050-Q-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		
				1539	F-4050-Q-N		
				1551	F-4030-Q-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		

TouchPad Options

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

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

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
+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
5v Fuse	+5 VDC Fuse blown
EncFuse	Encoder Power Fuse blown
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

Table C.17: Drive Status List for TouchPad (continued)

Display	Parameter
PersWrt	Personality Write Error
ServWrt	Service Write Error
CPUComm	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
Input1	Input 1 Input Flag
Input2	Input 2 Input Flag
Input3	Input 3 Input Flag
Input4	Input 4 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
Outpt3	Output 3 Flag
Outpt4	Output 4 Flag

Creating Custom Motor Files

Each motor controlled by a ULTRA 200 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 200 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.)

Motor Parameter Set

The motor parameter set configures the ULTRA 200 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.

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.

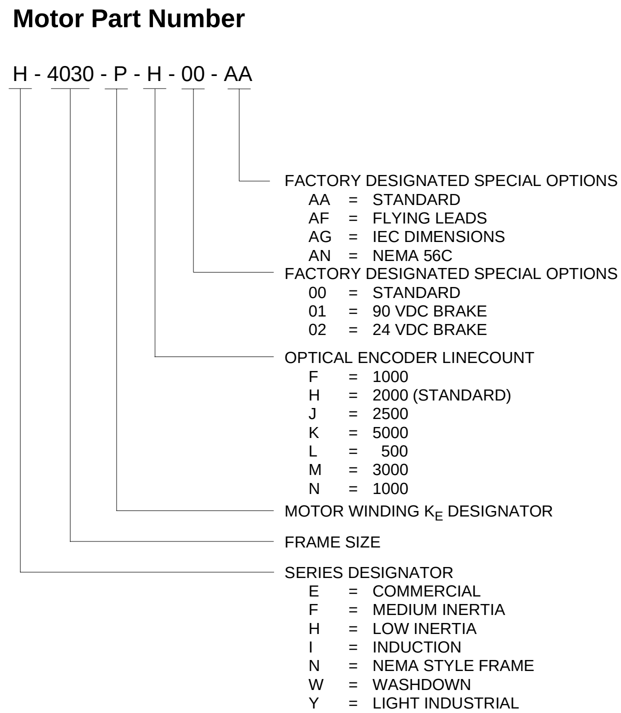
Text String

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.

Figure D.1 Allen-Bradley Motor Naming Convention



Motor Phasing

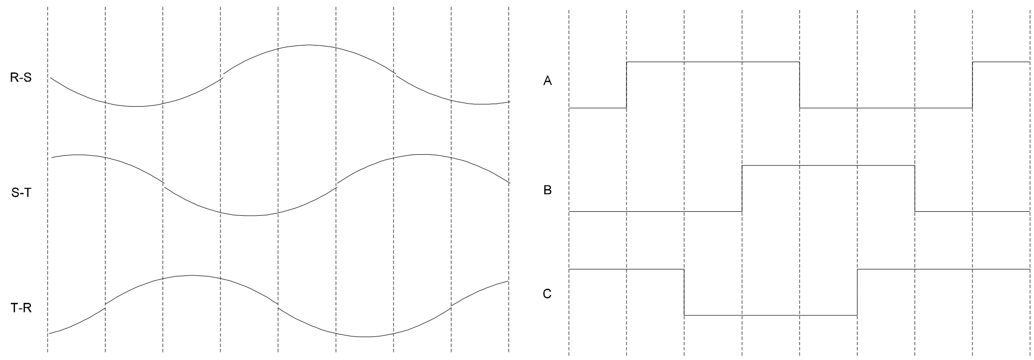
The phasing of the back-EMF and Hall feedback signals must be verified before a custom motor file can be created. Allen-Bradley motors use back-EMF and Hall feedback signals phased as shown in Figure D.2. Motors not manufactured by Allen-Bradley require the back-EMF and Hall feedback signals be phased to match those of Allen-Bradley motors. Often this requires swapping of the R- 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).

Figure D.2 Required Back-EMF and Hall Signal Phasing for Clockwise Rotation



(a) Required Back-EMF Phasing (b) Required Hall Feedback Phasing

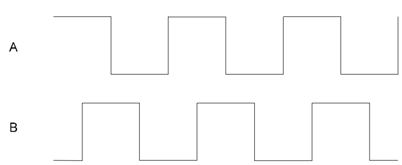
Many motor manufacturers include drawings in their data sheets that identify the phasing of the back-EMF and Hall feedback signals, or an application engineer may have access to an internal document listing the information. As a last resort, the motor can be rotated in the lab to check the phasing.

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.

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.

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:

$$1\frac{\text{Newton}\cdot\text{meter}}{\text{Amp}} = 8.85075\frac{\text{inch}\cdot\text{pound}}{\text{Amp}} = 141.612\frac{\text{ounce}\cdot\text{inch}}{\text{Amp}}$$

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 200 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:

$$1 \cdot \mathrm{Kg} \cdot \mathrm{cm}^2 = 0.0001 \cdot \mathrm{Kg} \cdot \mathrm{m}^2 = \frac{1}{1129.85} \cdot \mathrm{in} \cdot \mathrm{lb} \cdot \mathrm{s}^2 = \frac{1}{70.6155} \cdot \mathrm{oz} \cdot \mathrm{in} \cdot \mathrm{s}^2$$

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:

$$1 \cdot \frac{\mathrm{Volts}}{1000\ \mathrm{RPM}} = 1.414 \cdot \frac{\mathrm{Volts(rms)}}{1000\ \mathrm{RPM}}$$

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.

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.

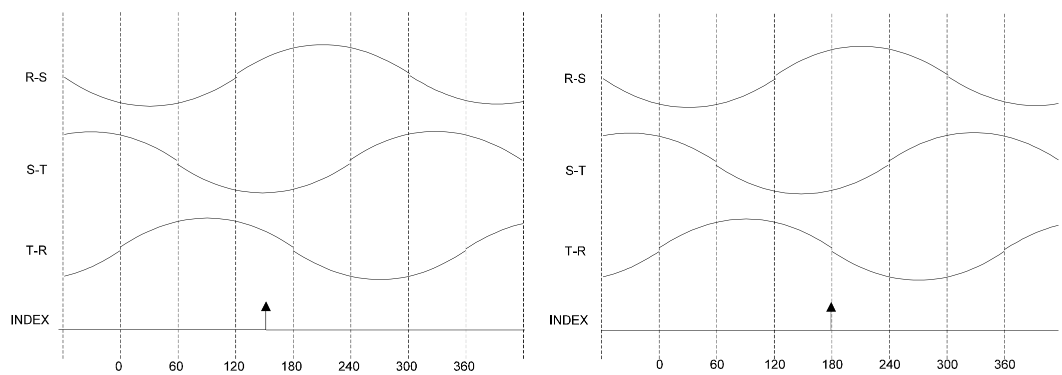
Index Offset

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)

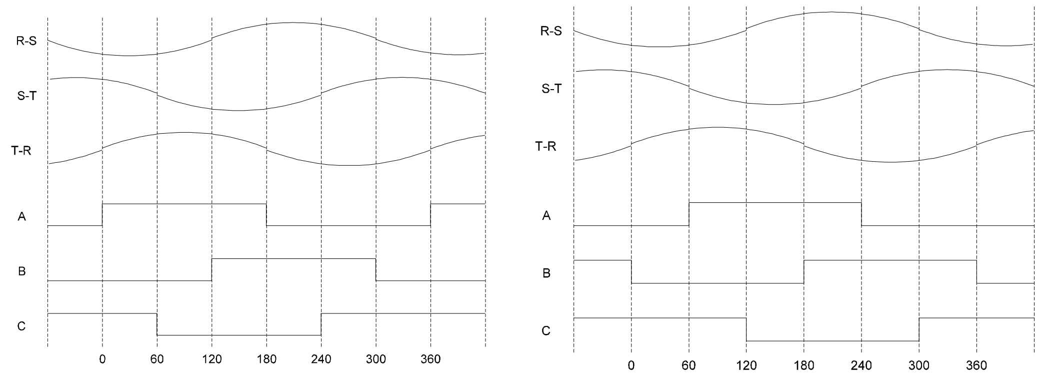
Hall Offset

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.

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.

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 200 Series drives.

Some manufacturers specify the inductance in milliHenries/phase. The phase-to-phase inductance is twice the per phase value.

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:

$$1 \cdot \text{Amps} = 1.414 \cdot \text{Amps(rms)}$$

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.

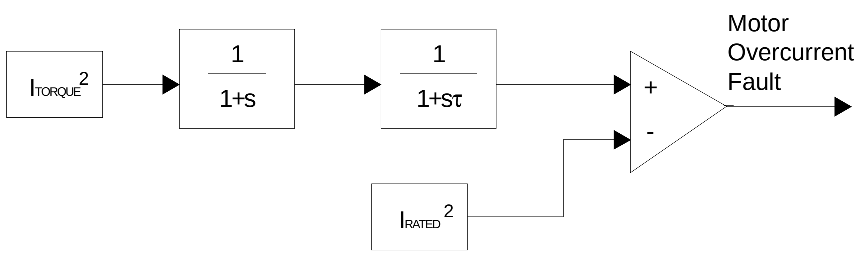
The thermal time constant value, also known as the cool down time constant, identifies how fast the motor winding temperature dissipates heat. The value is entered in seconds. The thermal time constant value can be in the range from 1 to 65535 seconds.

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.

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.

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.

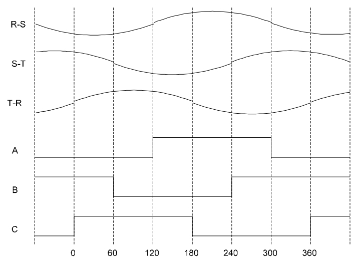
Manufacturer's Data

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, below. 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:

$$V_{MAX} = \left(80\frac{\text{rev}}{\text{min}}\right)\cdot(50) = 4000\ \frac{\text{rev}}{\text{min}}$$

The torque constant of the motor, before gearing, is computed as:

$$K_T = \left(270\frac{\text{in}\cdot\text{lb}}{\text{Amp}}\right)\cdot\left(\frac{1}{8.85075}\frac{\text{N}\cdot\text{m}}{\text{in}\cdot\text{lb}}\right)\cdot\left(\frac{1}{50}\right) = 0.61\frac{\text{N}\cdot\text{m}}{\text{Amp}}$$

The back-EMF constant of the motor, before gearing, is computed as:

$$K_E = \left(1.1\frac{\text{Volts}}{\text{RPM}}\right)\cdot\left(\frac{1000}{1}\frac{\text{RPM}}{\text{KRPM}}\right)\cdot(2)\cdot\left(\frac{1}{50}\right) = 44\frac{\text{Volts}}{\text{KRPM}}$$

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:

$$J_M = \left(5\ \text{in}\cdot\text{lb}\cdot\text{s}^2\right)\cdot\left(1129.85\frac{\text{Kg}\cdot\text{cm}^2}{\text{in}\cdot\text{lb}\cdot\text{s}^2}\right)\cdot\left(\frac{1}{50^2}\right) = 2.26\ \text{Kg}\cdot\text{cm}^2$$

The resistance and inductances are also specified as per phase values, and are computed as:

$$R_{L\text{-}L} = \left(3.7\frac{\text{Ohms}}{\text{Phase}}\right)\cdot(2) = 7.4\ \text{Ohms}$$

$$L_{L\text{-}L} = \left(5.0\frac{\text{mH}}{\text{Phase}}\right)\cdot(2) = 10.0\ \text{mH}$$

The thermal constant is specified in minutes, and is computed as:

$$\text{thermal time constant} = (30\ \text{min})\cdot\left(60\frac{\text{sec}}{\text{min}}\right) = 1800\ \text{sec}$$

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
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

CURRENT LOOP	
Current Feedforward:	0 degrees / kRPM

ELECTRICAL	
Resistance:	7.4 Ohms
Inductance:	10.0 mH

RATINGS	
Continuous Torque:	1.4 Amps
Peak Torque:	3.8 Amps
Thermal Time Constant:	Checked, 1800 sec
Integral Thermostat:	Unchecked
Maximum Speed:	4000 RPM

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.

Electromagnetic Compatibility Guidelines for Machine Design

This appendix provides background information about Electromagnetic Interference (EMI) and machine design guidelines for Electromagnetic Compatibility (EMC). The ULTRA 200 Series installation requirements for compliance to the European Electromagnetic Compatibility Directive are specified in “European Union Requirements” on page 2-7. AC Line Filters necessary for European EMC compliance are listed in Chapter 5, “Installation”.

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.

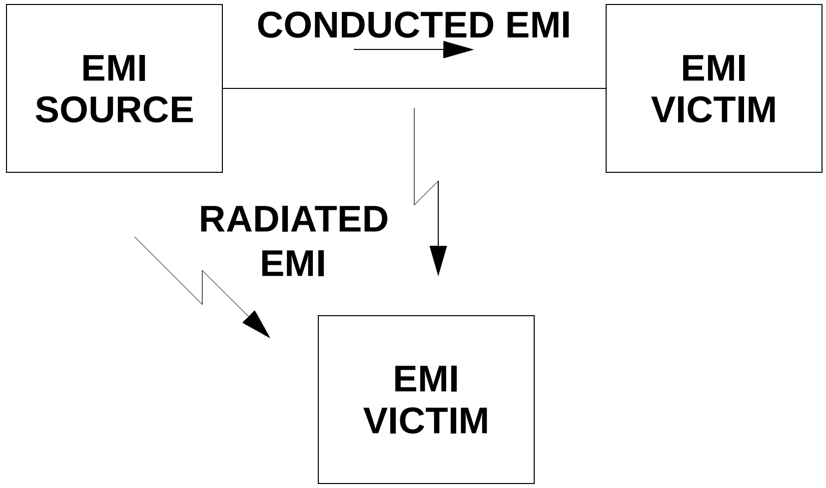
The majority of installations do not exhibit noise problems. However, the filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

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).

Figure E.1 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.

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 series (IEC 1000-4 and IEC801), EN55011 (LISDR11), 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.

Figure E.1 EMI Source-Victim Model



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.

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 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).

One alternative to AC line filters to reduce the conducted EMI emitting from the drive. This allows nearby equipment to operate undisturbed. In most 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.

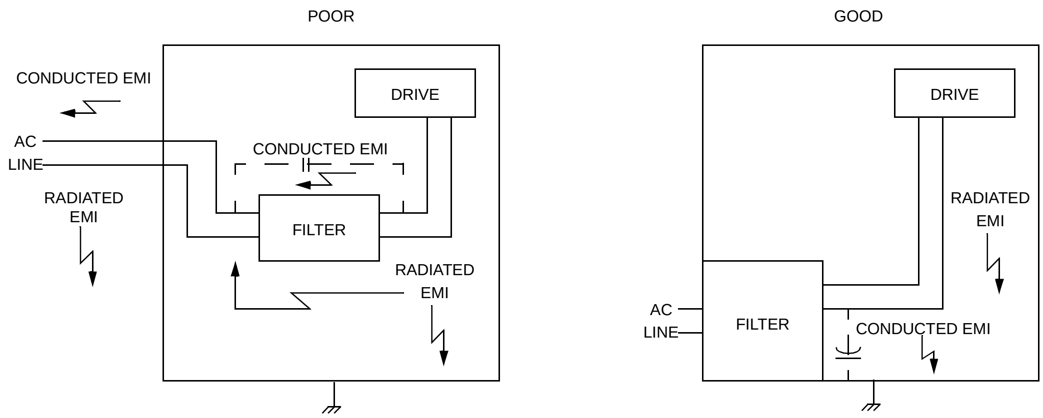
AC Line Filter Selection

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. If the distance exceeds 1 foot, then 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.

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.

Table E.1: AC Line Filter Installation



ATTENTION: Before applying power, the filter must be safety grounded. Without a proper ground, current leakage could build to a hazardous level.

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, as is used in the ULTRA 200 Series, 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.

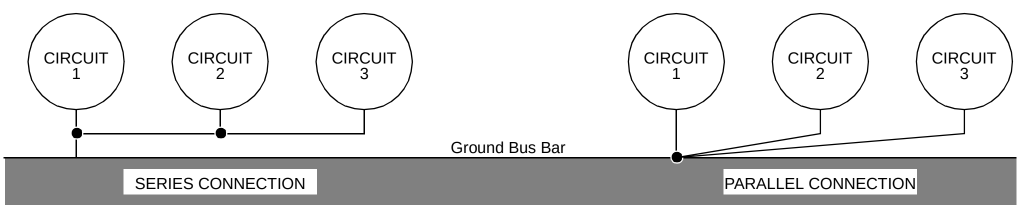
Grounding

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 20 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.

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.2 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.

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 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.

The following suggestions are recommended for all installations, especially since they are inexpensive.

1. 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.
2. Signal cables from other circuits should not pass within 1 foot of the drive.
3. The length or parallel runs between other circuit cables and the motor or power cable should be minimized. A rule of thumb is 1 foot of separation for each 30 feet of parallel run. The 1 foot separation can be reduced if the parallel run is less than 3 feet.
4. Cable intersections should always occur at right angles to minimize magnetic coupling.
5. Do not route any cables connected to the drive directly over the drive vent openings. Otherwise the cables will pick up the emissions leaked through the vent slots.
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. Allen-Bradley offers encoder cables in various lengths that have special terminations.

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.

Dynamic Braking Resistor Selection

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 7-6 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

$$\tau = 0.866\left[\frac{(R + 2R_L)(J_M + J_L)}{K_E K_T}\right] \tag{1}$$

$$i(t) = \frac{K_E \omega_o e^{-t/\tau}}{0.866(R + 2R_L)}$$

$$E(t) = \frac{1}{2}(J_L + J_M)\omega_o^2 e^{-2t/\tau}$$

$$P(t) = \left[\frac{(J_L + J_M)\omega_o^2}{2\tau}\right]e^{-2t/\tau} = 1.154\left[\frac{K_E K_T \omega_o^2}{(R + 2R_L)}\right]e^{-2t/\tau} \qquad (2)$$

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:

$$P_{AVE} = \frac{1}{2}(J_M + J_L)\omega_o^2\left(\frac{1}{4\tau}\right) = 0.144\frac{K_E K_T \omega_o^2}{(R + 2R_L)} \qquad (3)$$

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).

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:

$K_T := 0.74 \qquad R := 0.9 \qquad J_m := 0.00068$

$K_E := 90 \qquad K_E := \dfrac{K_E \cdot 60}{2 \cdot \pi \cdot 1000} \qquad K_E = 0.859$

Load Inertia, Dynamic Braking Resistance and Velocity in MKS Units:

$R_L := 4 \cdot R \qquad J_L := 10 \cdot J_m \qquad \omega_o := \dfrac{3000 \cdot 2 \cdot \pi}{60} \qquad \omega_o = 314$

Time vector:

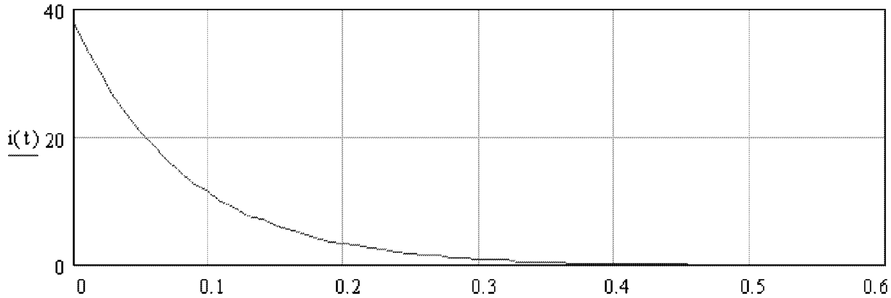
$t := 0, 0.01, \ldots 0.5$

Time Constant (seconds):

$\tau := \dfrac{0.866(R + 2 \cdot R_L) \cdot (J_m + J_L)}{K_E \cdot K_T} \qquad \tau = 0.083$

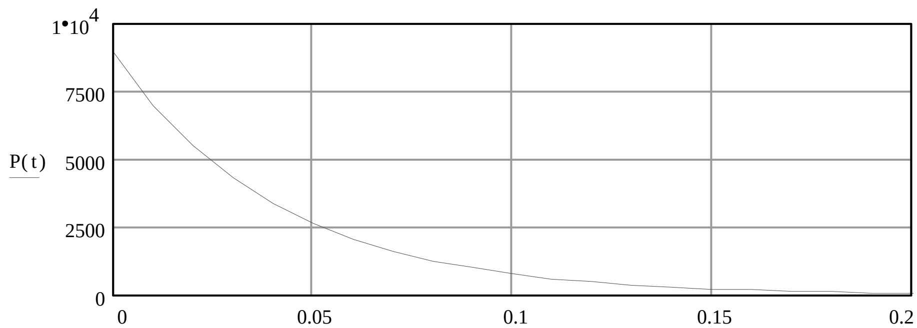
Current Calculation (Amps):

$$i(t) := \frac{K_E \cdot \omega_o \cdot e^{\frac{-t}{\tau}}}{0.866(R + 2 \cdot R_L)}$$



Instantaneous Power Calculation (Watts):

$$P(t) := \left[\frac{1.154 \cdot K_E \cdot K_T \cdot \omega_o^2}{(R + 2 \cdot R_L)}\right] \cdot e^{\frac{-2 \cdot t}{\tau}}$$



Average Power (Watts):

$$P_{ave} := \dot{0}.144\left[\frac{K_E \cdot K_T \cdot \omega_o^2}{R + 2 \cdot R_L}\right]$$

$$P_{ave} = 1116$$

Specifications

Item	Specification
Agency Approvals	
UL and cUL	UL508C File E145959
CE mark	Low Voltage Directive and Electromagnetic Compatibility Directive Certificate of Conformity from TUV Product Service
Environmental	
Operating Temperature 1398-DDM-010 or 1398-DDM-010X, 1398-DDM-020 or 1398-DDM-020X, 1398-DDM-050 or 1398-DDM-050X, 1398-DDM-075 or 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X	 0^{o}C to 55^{o}C (32^{o}F to 131^{o}F) 0^{o}C to 55^{o}C (32^{o}F to 131^{o}F) 0^{o}C to 55^{o}C (32^{o}F to 131^{o}F) 0^{o}C to 55^{o}C (32^{o}F to 131^{o}F) 0^{o}C to 50^{o}C (32^{o}F to 122^{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
Weight 1398-DDM-010 or 1398-DDM-010X, 1398-DDM-020 or 1398-DDM-020X, 1398-DDM-050 or 1398-DDM-050X, 1398-DDM-075 or 1398-DDM-075X, 1398-DDM-150 or 1398-DDM-150X	 5.80 Kg (13.78 lbs) 6.36 Kg (14.02 lbs) 6.48 Kg (14.28 lbs) 9.67 Kg (21.32 lbs) 14.06 Kg (31.00 lbs)
Dielectric Withstanding Voltage (HI-Pot)	
Main AC	1000 VAC for 1 minute, <5.0mA leakage current
Auxiliary AC	1414 (1500) VDC for 1 minute, <5.0mA leakage current **NOTE**: EMI filter capacitors on Aux AC require VDC tests.
Motor Encoder Interface	
Power Output	5 to 7 Volts DC, Adjustable, Automatic Sensing, Fused
Encoder Inputs	A/B, Differential, 26LS33 input, 1 MHz (4 MHz Quadrature) Maximum Signal Frequency, Line Break Detection, 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 Daisy-chain connections accommodated by two connectors
Status Display	7 segment LED
Address Switch	16-position Rotary DIP
Digital Inputs	

Item	Specification
Selectable (5)	24 Volt, Optically Isolated, Single ended, Active High, Current Sinking, 4.5 mA nominal
ENABLE	24 Volt, Optically Isolated, Single ended, Active High, Current Sinking, 4.5 mA nominal
Digital Outputs	
Selectable (4)	24 Volt, Optically Isolated, Single-ended, Active High, Current Sourcing, 50 mA maximum
BRAKE	24 Volt, Normally Open Relay, 1 A
READY	24 Volt, Normally Open Relay, 100 mA
Digital I/O Power Supply	Isolated 24V @ 250 mA, fused
Analog Inputs	
Positive Current Limit (+I LIMIT)	0 to 10 Volt, 10-bit, single-ended, 5 kOhm input Impedance
Negative Current Limit (-I LIMIT)	0 to 10 Volt, 10-bit, single-ended, 5 kOhm input Impedance
COMMAND	±10 Volt, Differential, 16-bit, 13 kOhm input Impedance, offset software adjustable
Analog Outputs	
ANALOG1	0 to 10 Volt, 12-bit, 2 mA maximum
ANALOG2	0 to 10 Volt, 8-bit, 2 mA maximum
Auxiliary Encoder Signal Input	
	26LS33 Input, 4 MHz Count Frequency Differential/Single-ended A/B Step/Direction CW/CCW
5 Volt Power Supply	5V @ 250 mA, fused
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
CPU/Memory	
Parameter Data Retention	20 years
Microcontrollers (2)	Motorola 68HC16
EPROM	128 kB Flash Memory
RAM	34 kB
User Parameter Memory (2)	512 kB Serial EEPROM
Motor Overload Protection	Motor overload protection operates within 8 minutes at 200% overload, and within 20 seconds at 600% overload.
PWM Carrier Frequency	
1398-DDM-010 or 1398-DDM-010X,	10 kHz/5 kHz
1398-DDM-020 or 1398-DDM-020X,	10 kHz/5 kHz
1398-DDM-050 or 1398-DDM-050X,	10 kHz/5 kHz
1398-DDM-075 or 1398-DDM-075X,	10 kHz/5 kHz
1398-DDM-150 or 1398-DDM-150X	5 kHz
Current Regulation	
Type	Digital, PI with Back-EMF compensation, Synchronous
-3dB Bandwidth	1.2 kHz
-45° Bandwidth	600 Hz
Resolution	10-bit
Speed Regulation	
Type	Digital, PID

Item	Specification
Update Rate	5 kHz
-3dB Bandwidth	150 Hz
-45° Bandwidth	50 Hz
Ripple	±2 RPM @ 1000 RPM
Resolution	16-bit
Position Regulation	
Type	Digital, PID with Feedforward
Filters	
Low Pass	Digital, 0 - 1000 Hz, -3 dB Bandwidth, Selectable
Software Controls	
Data Collection (2)	128 samples @ 5 kHz Sample Rate
Firmware	Field Upgradeable via Flash Memory
Operating Modes	Torque or Velocity
Command Sources	Analog Auxiliary Encoder Presets Step/Direction CW/CCW Indexing
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
Power-Up Faults	EPROM Checksum EEPROM Checksum SRAM Write/Read Watchdog Reset A/D Conversion D/A Conversion Interprocessor Communication

Item	Specification
Run-Time Faults	Motor Overtemperature Bus Overvoltage IPM Fault Overspeed Excess Error Encoder State Change Encoder Line Break Fuse 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)

Power

Table G.1: ULTRA 200 Series Power Ratings

	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
Auxiliary AC Input Voltage (rms Volts nominal) Frequency (Hz) Current (A_{rms} @ 100 V_{rms}) (A_{rms} @ 240 V_{rms})	 100 to 240 47 - 63 1.0 0.5	 100 to 240 47 - 63 1.0 0.5	 100 to 240 47 - 63 1.0 0.5	 100 to 240 47 - 63 1.0 0.5	 100 to 240 47 - 63 1.0 0.5
Main AC Input Voltage (rms Volts nominal) Frequency (Hz) Current (rms Amps)	 100 to 240, 1∅ 47 - 63 10	 100 to 240, 1∅ 47 - 63 19	 100 to 240, 1∅ 47 - 63 28	 100 to 240, 1∅ or 3∅ 47 - 63 30	 100 to 240, 3∅ 47 - 63 46
Bus Voltage (Volts DC)	141-339	141-339	141-339	141-339	141-339
Peak Output Current (Amps)	10	20	30	50, 1∅ 75, 3∅	150
Continuous Output Current (Amps)	5	10	15	15, 1∅ 35, 3∅	65
Peak Shunt Power (built in resistor) (kWatts)	4.5	4.5	4.5	10.0	18.0
Continuous Shunt Power (built in resistor) (Watts)	50	50	50	50	180
Peak Shunt Power (external resistor) (kWatts)	6.0	6.0	6.0	10.0	19.0
Continuous Shunt Power (external resistor) (kWatts)	2.4	2.4	2.4	4.0	8.0
Bus Capacitance Energy Absorption (from 325-420 Vdc Bus)[a] (Joules)	41	69	97	152	266

Table G.1: ULTRA 200 Series Power Ratings (continued)

	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
Bus Capacitance (μF)	1170	1950	2730	4290	7520
Peak Power Output[b]					
(kWatts @ 120 V_{rms})	1.25	2.5	3.75		
(kWatts @ 240 V_{rms})	2.5	5	7.5	14, 1∅ 20, 3∅	36
Continuous Power Output[2]					
(kWatts @ 120 V_{rms})	0.6	1.2	1.8	3.5	
(kWatts @ 240 V_{rms})	1.0	2.0	3	7.5, 3∅	15, 3∅

a. Bus capacitance energy absorption is based on the following equations:

$$\varepsilon = \frac{1}{2}C(V^2{}_f) - \frac{1}{2}C(V^2{}_i)$$

$$\varepsilon = \frac{1}{2}C(420)^2 - \frac{1}{2}C(325)^2$$

$$\frac{1}{2}C \cdot (420^2 - 325^2) = C(35387)$$

$$\text{if } C = 7520\mu F,\ \varepsilon = 266$$

b. Power outputs are based on the following equation:

$$\text{Output Power (in Watts)} = \left(\sqrt{\frac{3}{2}}\right)(0.85)(\text{input rms Volts})(\text{output Amps})$$

Power Dissipation

The ULTRA 200 Series controller dissipates power that results in cabinet heating. The following table lists power dissipation values for the ULTRA 200 Series drives. Calculate the cabinet cooling requirements using the power dissipation information and formulas below.

Current as % of Rated Continuous Current	1398-DDM-010, 1398-DDM-010X	1398-DDM-020, 1398-DDM-020X	1398-DDM-030, 1398-DDM-030X	1398-DDM-075, 1398-DDM-075X	1398-DDM-150, 1398-DDM-150X
100	75 W	100 W	150W	300 W	500 W

NOTE:
These values do not include internal or external shunt regulator power (regenerated power). Refer to “TB2 – Shunt Regulator” on page 7-11 for shunt regulator dissipation values.

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:

$$T_F = 4.08 * (Q/A) + 1.1$$

or

$$T_C = 2.27 * (Q/A) + 0.61$$

where:

T_F = Temperature difference between inside air and outside ambient (°F)

T_C = Temperature difference between inside air and outside ambient (°C)

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

A

B

C

D

J

K

L

M

S

U

V

W

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