Allen-Bradley

Ultra1500™ Digital Servo Amplifiers

(Catalog Numbers 2092-DA1, 2092-DA2, 2092-DA3, 2092-DA4, and 2092-DA5)

User Manual

Rockwell Automation

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 :

ATTENTION	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 a hazard
- recognize the consequences

IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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Preface

Introduction

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

- Who Should Use this Manual
- Purpose of this Manual
- Contents of this Manual
- Product Receiving and Storage Responsibility
- Related Documentation
- Conventions Used in this Manual
- Allen-Bradley Support

Who Should Use this Manual

Use this manual for integrating, installing, and wiring your Ultra1500™ digital servo amplifier. The manual is intended for engineers or technicians directly involved in the installation and wiring of the Ultra1500 drive, as well as those responsible for incorporating the Ultra1500 into a control system.

If you do not have a basic understanding of the Ultra1500, contact your local Allen-Bradley representative for information on available training courses before using this product.

Purpose of this Manual

This manual provides setup, configuration, and troubleshooting procedures for the Ultra1500. Detailed wiring diagrams, and other installation guidelines can be found in this manual.

Contents of this Manual

Refer to the following listing for the descriptive contents of this manual.

Chapter	Title	Contents
	Preface	Describes the purpose, background, and scope of this manual. Also specifies the audience for whom this manual is intended.
1	*Installing Your Ultra1500*	Provides mounting information for the Ultra1500.
2	*Ultra1500 Connector Data*	Provides signal descriptions for the I/O, encoder, and serial interface connectors, and describes terminal connections for the drive power system.
3	*Connecting Your Ultra1500*	Provides connection and wiring information for the Ultra1500.
4	*Commissioning Your Ultra1500*	Provides procedures for quickly configuring your Ultra1500 drive.
5	*Ultra1500 Application Examples*	Provides application examples for interfacing to control systems, special features on the Ultra1500 drive, and detailed descriptions of tuning the drive system.
6	*Maintaining and Troubleshooting Your Ultra1500*	Provides troubleshooting tables that define the Ultra1500 status LED error codes.
Appendix A	*Specifications and Dimensions*	Provides physical, electrical, environmental, and functional specifications for the Ultra1500.
Appendix B	*Interconnect and Cable Diagrams*	Provides interconnect diagrams for the Ultra1500.
Appendix C	*Catalog Numbers and Accessories*	Provides catalog numbers and descriptions of the Ultra1500 and related products.
Appendix D	*Ultra1500 Operator Interface*	Provides information on the Operator Interface built into the Ultra1500.

Product Receiving and Storage Responsibility

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

Store the product in its shipping container prior to installation. If you are not going to use the equipment for a period of time, store it using the following guidelines.

- Use a clean, dry location.
- Maintain an ambient temperature range of -40 to 70° C (-40 to 158° F).
- Maintain a relative humidity range of 5% to 95%, non-condensing.
- Store it where it will not be exposed to a corrosive atmosphere.
- Store it in a non-construction area.

Related Documentation

The following documents contain additional information concerning related Allen-Bradley products. To obtain a copy, contact your local Allen-Bradley office, distributor, or download them from **www.rockwellautomation.com/literature**

For:	Read This Document:	Catalog Number:
Basic information on configuring and troubleshooting your Ultra1500	*Ultra1500 Digital Drive Quick Start*	2092-QS001*x*-EN-P
Ultraware™ Installation Instructions	*Ultraware CD Installation Instructions*	2098-IN002*x*-EN-P
Instructions on how to communicate with, configure or adjust parameters, and monitor Ultra family drives.	*Access on-line Ultraware Help files through the Help menu or the F1 key whenever Ultraware software is active.*	2098-UWCPRG
The instructions needed to program a motion application	*Logix™ Controller Motion Instruction Set Reference Manual*	1756-RM007*x*-EN-P
More detailed information on the use of ControlLogix® motion features and application examples	*ControlLogix Motion Module Programming Manual*	1756-RM086*x*-EN-P
Detailed information on configuring and troubleshooting your ControlLogix motion module	*ControlLogix Motion Module Setup and Configuration Manual*	1756-UM006*x*-EN-P
Detailed information on the MicroLogix™ programming language	*MicroLogix 1200/1500 Instruction Set Reference Manual*	1762-RM001*x*-EN-P
Detailed information on configuring your MicroLogix 1200 PLC	*MicroLogix 1200 Programmable Controllers User Manual*	1762-UM001*x*-EN-P
Detailed information on configuring your MicroLogix 1500 PLC	*MicroLogix 1500 Programmable Controllers User Manual*	1764-UM001*x*-EN-P
Detailed information on configuring and troubleshooting your SoftLogix™ PCI card	*SoftLogix Motion Card Setup and Configuration Manual*	1784-UM003*x*-EN-P
A glossary of industrial automation terms and abbreviations	*Allen-Bradley Industrial Automation Glossary*	AG-7.1
Information, examples, and techniques designed to minimize system failures caused by electrical noise	*System Design for Control of Electrical Noise Reference Manual*	GMC-RM001*x*-EN-P
A description and specifications for the Ultra Family including motors and motor accessories	*Motion Control Selection Guide*	GMC-SG001*x*-EN-P
Drive and motor sizing with application analysis software	Motion Analyzer CD (v4.1 or above)	PST-SG003*x*-EN-C
An article on wire sizes and types for grounding electrical equipment	*National Electrical Code*	Published by the National Fire Protection Association of Boston, MA.
For declarations of conformity (DoC) currently available from Rockwell Automation	Rockwell Automation Product Certification website	www.ab.com/certification/ce/docs

Conventions Used in this Manual

The following conventions are used throughout this manual.

- Bulleted lists such as this one provide information, not procedural steps
- Numbered lists provide sequential steps or hierarchical information
- Words that you type or select appear in bold
- When we refer you to another location, the section or chapter name appears in italics

Allen-Bradley Support

Allen-Bradley offers support services worldwide, with over 75 Sales/Support Offices, 512 authorized Distributors and 260 authorized Systems Integrators located throughout the United States alone, plus Allen-Bradley representatives in every major country in the world.

Local Product Support

Contact your local Allen-Bradley representative for:

- Sales and order support
- Product technical training
- Warranty support
- Support service agreements

Technical Product Assistance

If you need technical assistance, contact your local Allen-Bradley representative or Rockwell Automation Technical Support by phone at (440) 646-5800 or on-line at **www.ab.com/support**. Please have the catalog numbers of your products available when you contact technical support.

Comments Regarding this Manual

To offer comments regarding the contents of this manual, go to **www.ab.com/manuals/gmc** and download the *Motion Control Problem Report* form. Mail or fax your comments to the address/fax number given on the form.

Chapter **1**

Installing Your Ultra1500

Chapter Objectives

This chapter provides system installation guidelines and procedures for mounting your Ultra1500. This chapter covers the following topics:

- Complying with European Union (CE) and TTMRA (C-Tick) Directives
- Ultra1500 System Overview
- Ultra1500 Servo System Overviews Before Mounting Your System
- HF Bonding Your System
- Planning Your Panel Layout
- Mounting Your Ultra1500 Drive

ATTENTION

The following information is a guideline for proper installation. The National Electrical Code and any other governing regional or local codes overrule this information. The Allen-Bradley Company cannot assume responsibility for the compliance or the noncompliance with any code, national, local or otherwise, for the proper installation of this system or associated equipment. If you ignore codes during installation, hazard of personal injury and/or equipment damage exists.

Complying with EU and TTMRA Directives

If this product is installed within the European Union (EU) or EEC regions and has the CE mark, or within the Australian and New Zealand markets and has the C-Tick mark, the following regulations apply.

Note: Declarations of Conformity (DOCs) to European Union Directives and Trans-Tasman Mutual Recognition Arrangement (TTMRA) Directives are available on-line at **www.ab.com/certification/ce/docs**. The web site is the authoritative source for verifying compliance and suitability for use of this and other Rockwell Automation/Allen-Bradley products.

CE EMC Directive

This unit is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) using a technical construction file and the following standards, in whole or in part:

- EN 50081-2 EMC - Emission Standard, Part 2 - Industrial Environment
- EN 50082-2 EMC - Immunity Standard, Part 2 - Industrial Environment
- EN 61800-3 - Adjustable Speed Electrical Power Drive Systems, Part 3 - EMC Product Standard including specific test methods

The product described in this manual is intended for use in an industrial environment.

C-Tick EMC Directive

This unit is tested to meet C-Tick EMC using a technical construction file and the following standards, in whole or in part:

- AS/NZS CISPR 11:2002 (Group 1, Class A)
- Radiocommunications Act: 1992
- Radiocommunications (Electromagnetic Compatibility) Standard: 1998
- Radiocommunications (Compliance Labeling - Incidental Emissions) Notice:1998

Low Voltage Directive

These units are tested to meet Council Directive 73/23/EEC Low Voltage Directive. The standard EN 50178 *Electronic Equipment for use in Power Installations* applies in whole or in part.

Refer to *Appendix B* for interconnect information.

Meeting Emission Requirements

To meet emission requirements the following components are required:

- Install an AC line filter (2090-UXLF-*xxx* or -HV*xxx*) between the AC power source and the drive input, and as close to the drive as possible (refer to *Appendix C* for available AC line filters).
- Connect both Main and Control input power to the load side of the AC line filter for the drive.
- Use 2090 series motor power and feedback cables and terminate the power cable shields to the drive chassis and motor/machine frame.
- Install the Ultra1500 system inside an enclosure (grounded to the enclosure), and run input power wiring in conduit outside of the enclosure.
- Separate signal and power cables as shown in *Planning Your Panel Layout* of this chapter.
- Install ferrites on the AC input power cable, and motor (output) power cable, and motor feedback cable nearest the drive. Steward 28A2024-QAO has demonstrated compliance on the motor feedback cable, and Steward 28R2024-ORO has been qualified with the power cables.

Ultra1500 System Overview

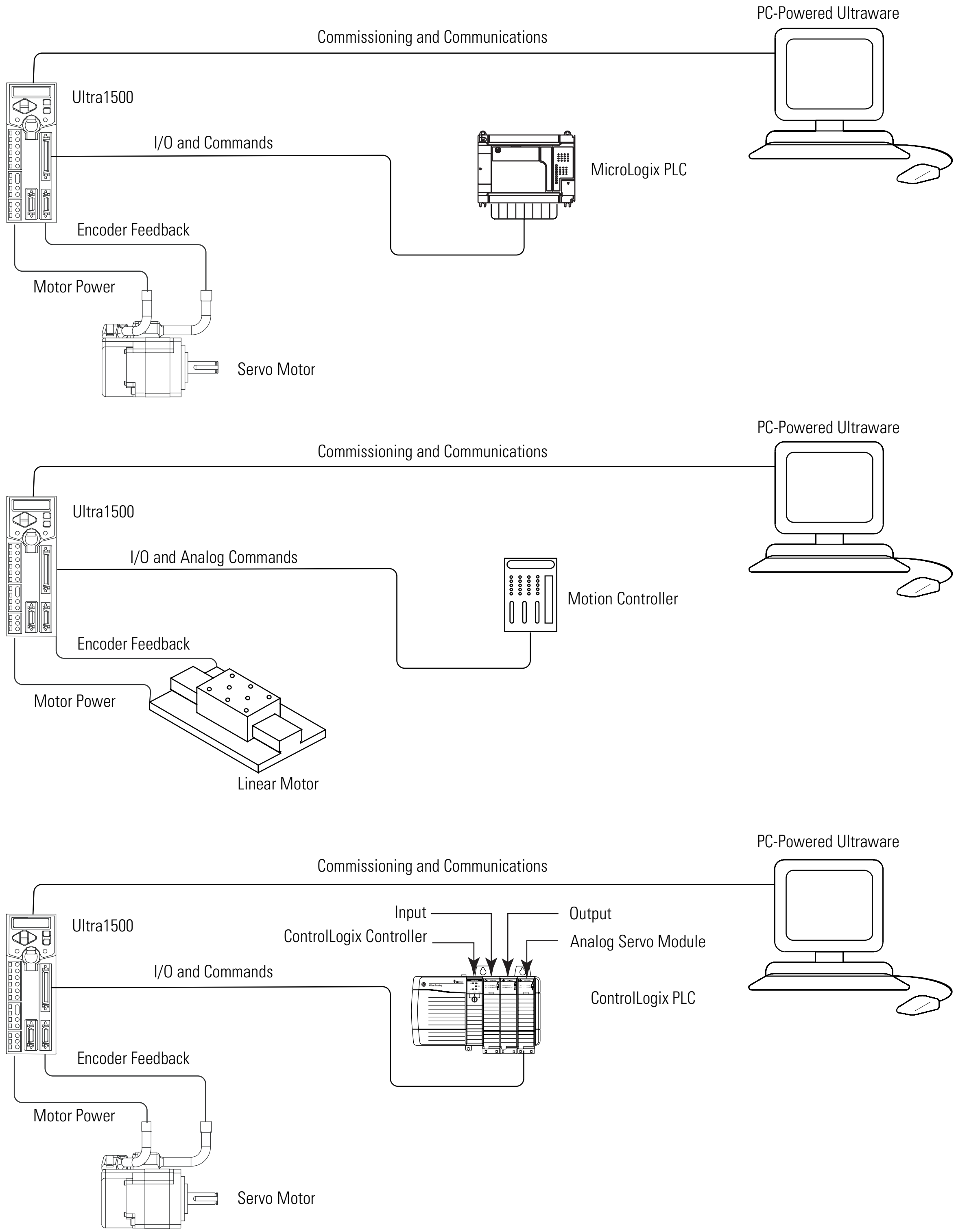
This section provides an overview of the Ultra1500 system components and a typical installation.

Ultra1500 System Component	Catalog Numbers	Description
Ultra1500 Drives	2092-DA*x*	Ultra1500 with 1.4, 2.4, 4.7, 10.7, and 16.4 Amperes continuous output current and 230 Volts input power.
Ultraware Software	2098-UWCPRG	Ultra1500 drives are configured using Ultraware software.
3.6V Battery	2090-DA-BAT	3.6 Volt lithium battery necessary for absolute positioning with the TL-Series motors.
Servo Motors	TL-Series	TL-Series motors are available for use with the Ultra1500. Note: Other motors can be used with an Ultra1500, as long as they include incremental encoder feedback and Hall signals. (F-, H-, N-, and Y-Series motor are compatible with the Ultra1500).
AC Line Filters	2090-UXLF-*xxx*	AC line filters rated for 6, 10, and 23 Amperes are available for Ultra1500 drive systems.
Cables	TL-Series Motor Power, Feedback, and Brake cables	Motor power, feedback, and brake cables include quick connect/quick-release connectors at the motor. Power and brake cables have flying leads on the drive end connectors that connect to servo motors. Standard feedback cables have angled, molded connectors on the drive end and connectors that connect to servo motors. Drive mounted connector kits are also available.
ControlLogix/ SoftLogix Platforms	1756-M02AE module 1784-PM02AE PCI card	The analog servo module serves as a link between the ControlLogix/SoftLogix platform and Ultra1500 system. The servo card supplies an analog command signal to the Ultra1500.
MicroLogix 1200/ 1500 platforms	1762-L24BXB 1762-L40BXB, 1764-28BXB	MicroLogix 1200 and 1500 programmable logic controllers with pulse train outputs allow simple PLC-based motion solutions with the Ultra1500.
RSLogix™ 5000 Software	9324-RLD300ENE	RSLogix 5000 provides support for programming, commissioning, and maintaining the Logix family of controllers.
RSLogix500 Software	9324-RL0300ENE	RSLogix500 provides support for programming, commissioning, and maintaining the SLC 500 and MicroLogix controller families.

Note: Refer to *Appendix C* for a complete list of catalog numbers for the Ultra1500 system components listed above.

Typical Ultra1500 system installation are shown in Figure 1.1.

Figure 1.1
Ultra1500 Servo System Overviews Before Mounting Your System



Unpacking Modules

Each Ultra1500 ships with the following:

- One Ultra1500 drive,
- Three removable plugs mounted on the power connectors of the drive,
- One connector tool for opening wire clamps on power connectors, and
- One Ultra1500 Quick Start manual (publication 2092-QS001*x*-EN-P)

Remove all packing material, wedges, and braces from within and around the components. After unpacking, check the item(s) name plate catalog number against the purchase order.

System Mounting Requirements

There are several things that you need to take into account when preparing to mount the Ultra1500:

- The Ultra1500 must be enclosed in a grounded conductive enclosure offering protection as defined in standard EN 60529 (IEC 529) to IP22 such that they are not accessible to an operator or unskilled person, in order to comply with UL® and CE requirements. A NEMA 4X enclosure exceeds these requirements providing protection to IP66.
- The ambient temperature of the location in which you will install the Ultra1500 must not exceed 50° C (122° F).
- You must install the Ultra1500 vertically on the panel (refer to Figure 1.2 for mounting orientation).
- You must install the panel on a flat, rigid, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.
- You need to maintain minimum clearances (refer to Figure 1.2) for proper airflow, easy module access, and proper cable bend radius.
- The Ultra1500 can operate at elevations to 1000 m (3280 ft) without derating, however, the continuous current rating must be de-rated by 3% for each additional 300 m (984 ft) up to 3000 m (9842 ft). Consult your local Allen-Bradley representative prior to operating above 3000 m (9842 ft).

ATTENTION

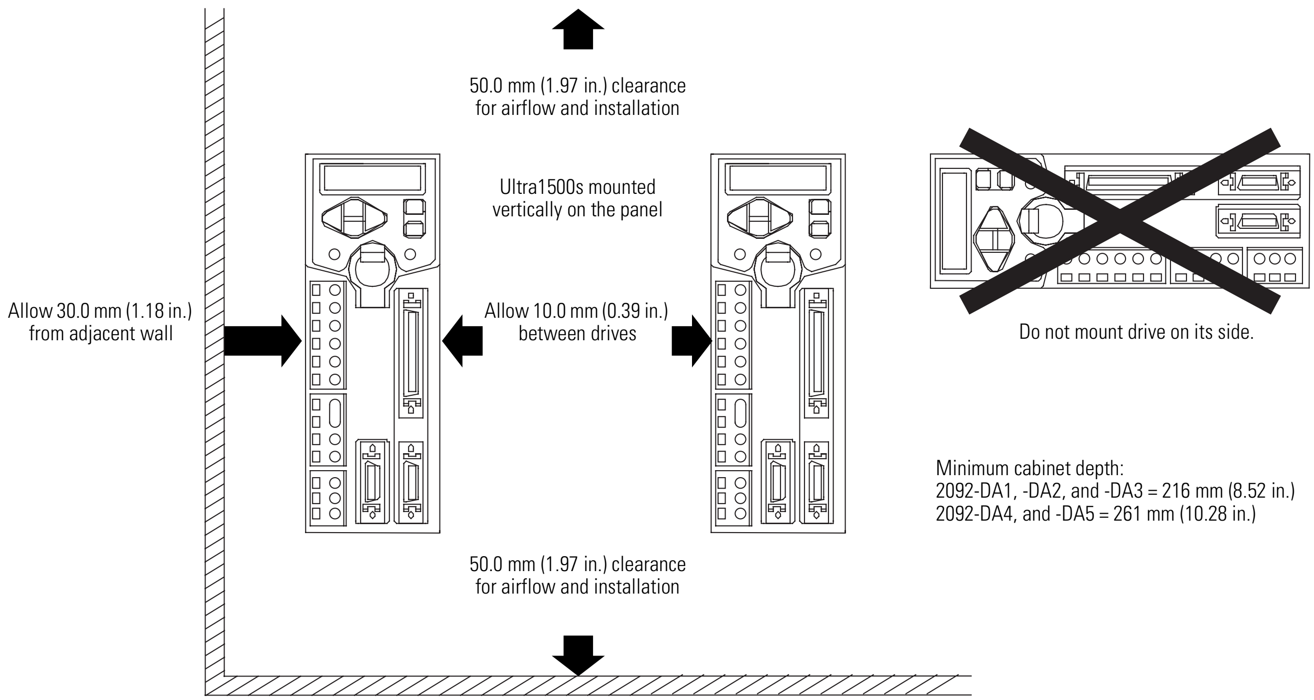
Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

Refer to *Appendix A* for mounting dimensions, power dissipation, and environmental specifications for the Ultra1500.

Ventilation Requirements

This section provides information to assist you in sizing your cabinet and locating your Ultra1500 drive(s) inside the cabinet.

Figure 1.2
Minimum Clearance Requirements



IMPORTANT	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.

Refer to *Appendix A* for Ultra1500 power dissipation specifications.

Sizing an Enclosure

As an additional aid in sizing an enclosure, with no active method of heat dissipation, either of the following approximate equations can be used:

Metric	Standard English
$A = \frac{0.38Q}{1.8T - 1.1}$	$A = \frac{4.08Q}{T - 1.1}$
Where T is temperature difference between inside air and outside ambient (°C), Q is heat generated in enclosure (Watts), and A is enclosure surface area (m^2). The exterior surface of all six sides of an enclosure is calculated as	Where T is temperature difference between inside air and outside ambient (°F), Q is heat generated in enclosure (Watts), and A is enclosure surface area (ft^2). The exterior surface of all six sides of an enclosure is calculated as
A = 2dw + 2dh + 2wh	A = (2dw + 2dh + 2wh) / 144
Where d (depth), w (width), and h (height) are in meters.	Where d (depth), w (width), and h (height) are in inches.

Transformer Sizing

The Ultra1500 does not require isolation transformers. However, a transformer may be required to match the voltage requirements of the controller to the available service. To size a transformer for the Main power inputs, the power output (KVA) of each axis must be known. This can be derived by calculating the Watts for each axis. If you are supplying power to more than one motor and an Ultra1500, simply add the kW ratings together from each calculation to get a system kW total.

IMPORTANT If using an autotransformer, ensure that the phase to neutral/ground voltages do not exceed the input voltage ratings of the drive.

Definitions:

kW = power or real power
KVA = apparent power

Transformer KVA rating = (Sum of average output power of each axis) x 2.0.

IMPORTANT	If you are using the Allen-Bradley system sizing program, the average speed and average torque data has already been calculated and can be used in the above equation. If you are not sure of the exact speed and torque in your application, another approach is to look at the speed/torque curve for your Ultra1500/motor combination and use the values for the worst case continuous speed and torque.

IMPORTANT	Calculations are multiplied by a factor to compensate for the power and loss elements within a power system. A factor of 2.0 is used with a single phase system and a factor of 1.5 is used with a three phase system. This factor should minimize the effects of the secondary line voltage sagging in the transformer during peak current periods.

Fuse Sizing

In the United States, the National Electric Code (NEC) specifies that fuses must be selected based on the motor full load amperage (FLA). The typical fuse size should be 300% of the motor FLA for non-time delay fuses (and time-delay class CC fuses) or 175% of motor FLA for time delay fuses. If these ratings are not high enough for starting currents, the NEC allows non-time delay fuses (and time-delay class CC fuses) to be sized up to 400% of the motor FLA and time-delay fuses to be sized up to 225% of the motor FLA.

In most 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. Refer to the section *Ultra1500 Power Specifications* in *Appendix A* for fuse recommendations, as well as input current and inrush current specifications.

The Ultra1500 utilizes solid state motor short circuit protection rated as shown in the table below.

Drive Models:	Input Power Type	Short Circuit Current Rating with No Fuse Restrictions:	Short Circuit Current Rating with Fuse Restrictions:
2092-DA-*xxx*	Main Power and Control Power	Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240V maximum.	Suitable for use on a circuit capable of delivering not more than 200,000 rms symmetrical amperes, 240V maximum, when protected by high interrupting capacity, current limiting fuses meeting UL 198C (Class CC, G, J, L, R, T).

Wiring to the control power terminals (L1C and L2C) of the drive should be 2.5 mm^2 (14 AWG) minimum and fusing for the control power should be selected to properly protect the wire. For example, if 60° C (140° F) wire is used, the fuse should not exceed 8A. If 75° C (167° F) wire is used, the fuse should not exceed 13A. Refer to *Fuse and Contactor Specifications* in *Appendix A* for fuse recommendations.

HF Bonding Your System

Bonding is the practice of connecting metal chassis, assemblies, frames, shields and enclosures to reduce the effects of electromagnetic interference (EMI). For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, refer to the *System Design for Control of Electrical Noise Reference Manual* (publication GMC-RM001*x*-EN-P).

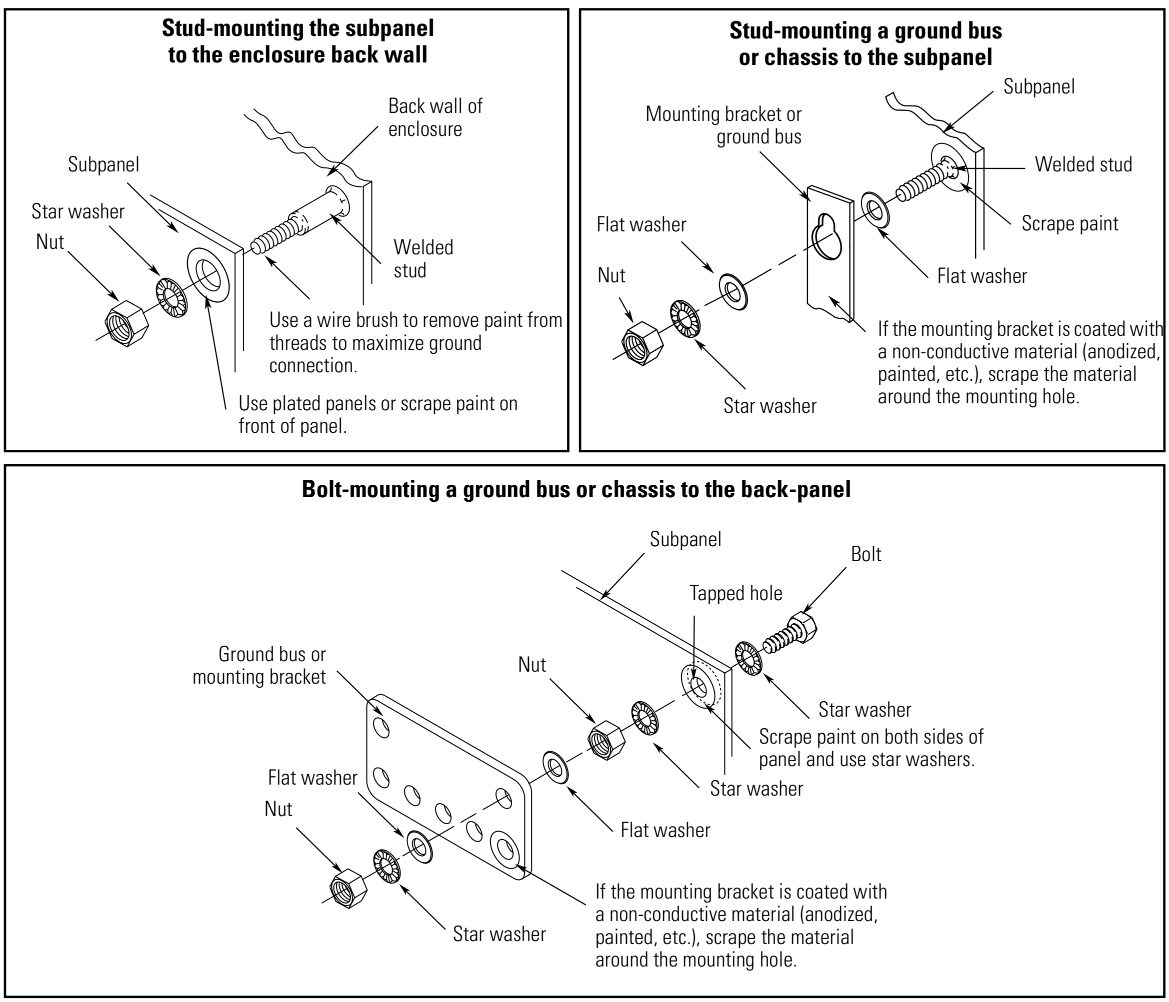
Bonding Modules

Unless specified, most paints are not conductive and they act as insulators. To achieve a good bond between modules and the subpanel, surfaces need to be paint-free or plated. Bonding metal surfaces creates a low-impedance exit path for high-frequency energy.

IMPORTANT To improve the bond between the drive and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Improper bonding blocks that direct exit path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can effect the operation of other microprocessor controlled equipment. The illustrations that follow (refer to Figure 1.3) show details of recommended bonding practices for painted panels, enclosures, and mounting brackets.

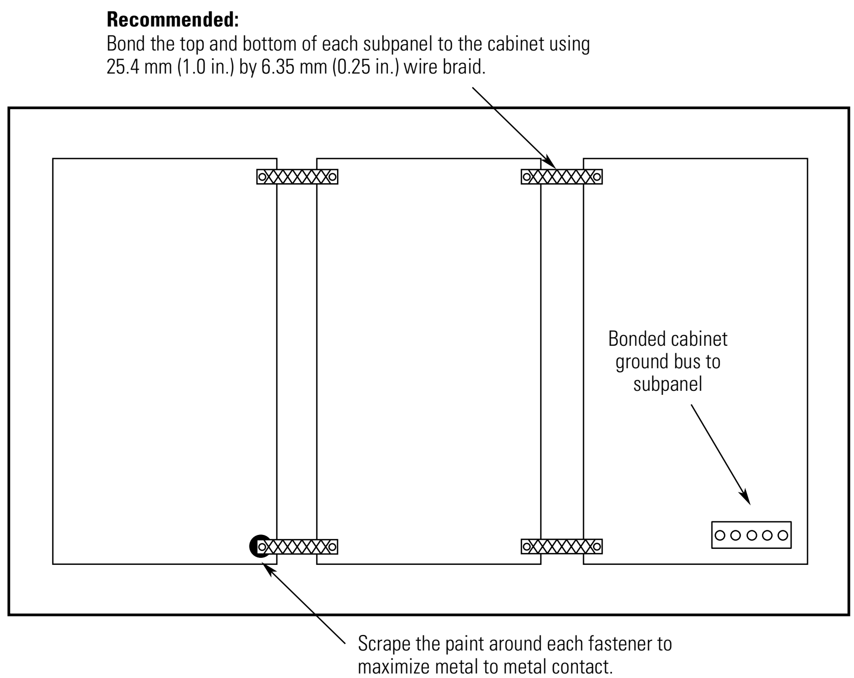
Figure 1.3
Recommended Bonding Practices



Bonding Multiple Subpanels

Bonding multiple subpanels creates a common low impedance exit path for the high frequency energy inside the cabinet. Subpanels that are not bonded together may not share a common low impedance path. This difference in impedance may affect networks and other devices that span multiple panels. Refer to the figure below for recommended bonding practices.

Figure 1.4
Multiple Subpanels and Cabinet



Planning Your Panel Layout

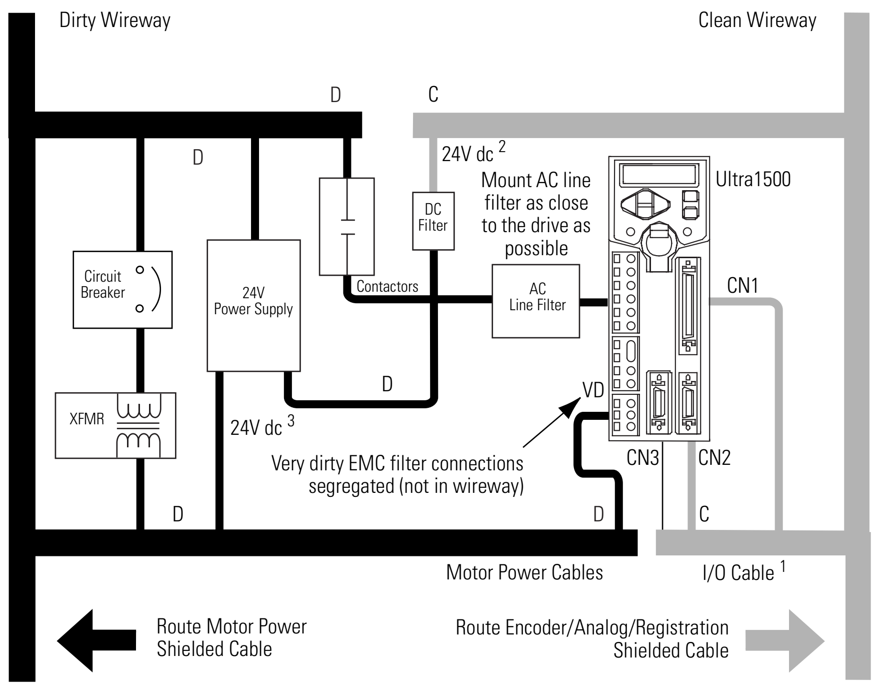
This section outlines the practices which minimize the possibility of noise-related failures as they apply specifically to Ultra1500 installations. For more information on the concept of electrical noise reduction, refer to *System Design for Control of Electrical Noise Reference Manual* (publication GMC-RM001*x*-EN-P).

Establishing Noise Zones

Observe the following guidelines when laying out your panel (refer to Figure 1.5 for zone locations).

- The clean zone (C) is above and beneath the Ultra1500 and includes CN1, CN2, and CN3 signals, and the DC filter (grey wireways).
- The dirty zone (D) is left of the Ultra1500 (black wireways) and includes the circuit breakers, transformer, AC line filter, contactors, 24V dc power supply, and motor (output) power cables.
- The very dirty zone (VD) is limited to where the AC line (EMC) filter AC output jumpers over to the Ultra1500. Shielded cable is required only if the very dirty cables enter a wireway.

Figure 1.5
Establishing Noise Zones



1 If I/O cable contains (dirty) relay wires, route cable with motor (output) power wires in dirty wireway.
2 This is a clean 24V dc available for CN1 I/O power supply. The 24V enters the clean wireway and exits to the right.
3 This is a dirty 24V dc available for motor brakes and contactors. The 24V enters the dirty wireway and exits to the left.

Cable Categories for the Ultra1500

The table below indicates the zoning requirements of cables connecting to the Ultra1500.

Wire/Cable	Connector	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
L1, L2, L3 (shielded cable)	Input Power		X			X
L1, L2, L3 (unshielded cable)		X				
U, V, W (motor power)	Output Power		X			X
24V Wiring	CN1		X			
Motor Feedback	CN2			X		X
Serial Communications	CN3			X		X

Mounting Guidelines to Reduce Electrical Noise

When mounting an AC line (EMC) filter refer to the sections below for guidelines designed to reduce system failures caused by excessive electrical noise.

ATTENTION

High voltage exists in AC line filters. The filter 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. Failure to observe this precaution could result in personal injury.

AC Line Filters

Observe the following guidelines when mounting your AC line (EMC) filter (refer to Figure 1.5 for an example).

- Mount the AC line filter and bonded cabinet ground bus on the same panel as the Ultra1500, and as close to the Ultra1500 as possible.
- Good HF bonding to the panel is critical. For painted panels, refer to Figure 1.3.
- Segregate input and output wiring as far as possible.

IMPORTANT

CE test certification applies only to AC line filter and single drive. Multiple drive loads may perform satisfactorily, but the user takes legal responsibility.

Mounting Your Ultra1500 Drive

The procedures in this section assume you have prepared your panel and understand how to bond your system. For installation instructions regarding other equipment and accessories, refer to the instructions that came with each of the accessories for their specific requirements.

ATTENTION

This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

To mount your Ultra1500 drive:

1. Layout the position for the Ultra1500 and accessories in the enclosure (refer to *Establishing Noise Zones* for panel layout recommendations). Dimensions for the Ultra1500 are shown in Figure 1.6.

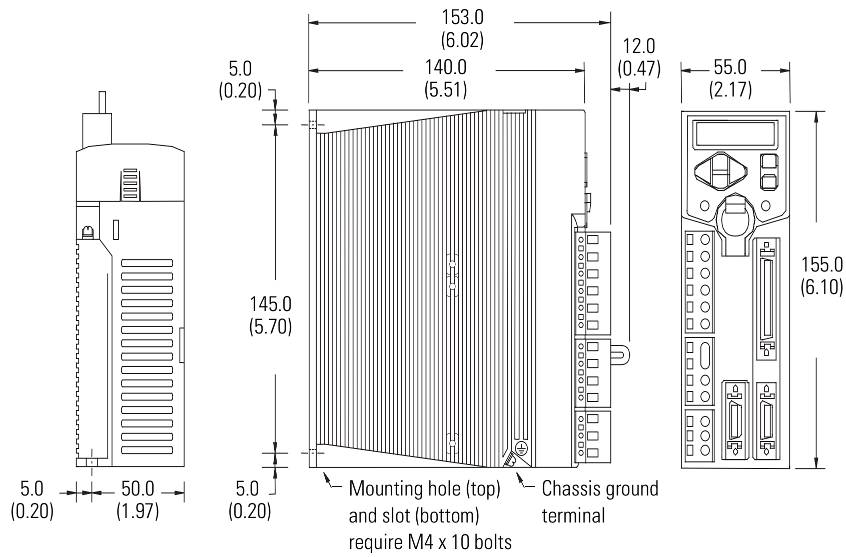
2. Attach the Ultra1500 to the cabinet, first using the lower mounting slots of the drive and then the upper. The recommended mounting hardware is M4 x 10 metric bolts for 2092-DA1 through 2092-DA3 drives, or M5 x 10 metric bolts for 2092-DA4 and 2092-DA5 drives. Observe bonding techniques as described in *HF Bonding Your System*.

   IMPORTANT To improve the bond between the Ultra1500 and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

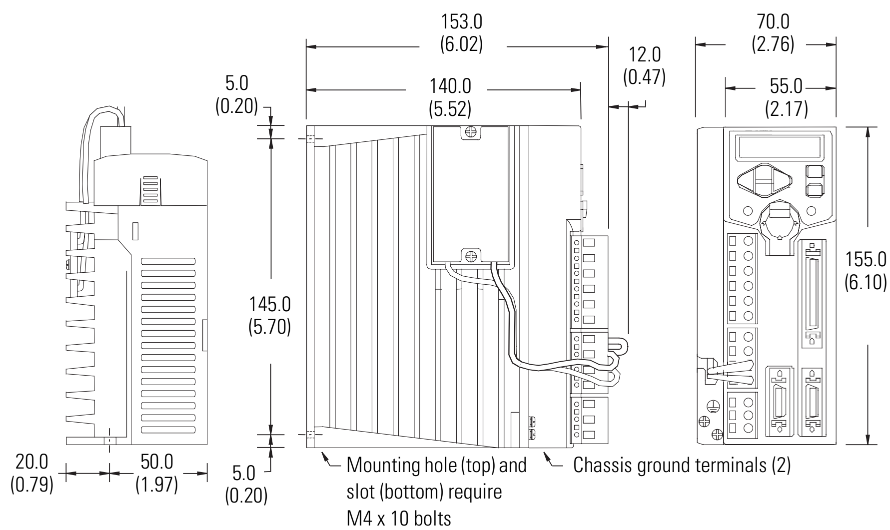
3. Tighten all mounting fasteners.

Figure 1.6
Ultra1500 Mounting Diagrams and Measurements

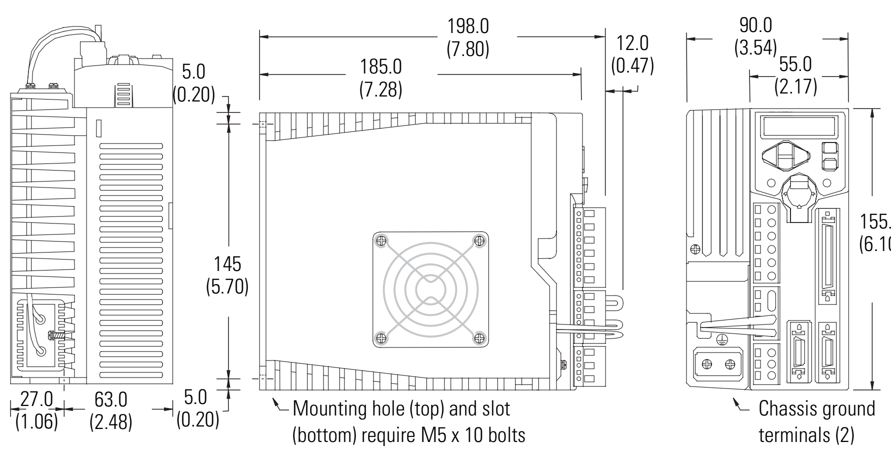
2092-DA1 and 2092-DA2



2092-DA3



2092-DA4 and 2092-DA5



Dimensions are in millimeters (inches). Drives are designed to metric dimensions; inches are a mathematical conversion.

Ultra1500 Connector Data

Chapter Objectives

This chapter provides I/O, encoder, and serial interface connector locations and signal descriptions for your Ultra1500. This chapter includes:

- Understanding Ultra1500 Connectors
- Understanding Ultra1500 I/O Specifications
- Understanding Ultra1500 Motor Encoder Feedback Specifications
- Understanding Ultra1500 Power and Ground Connections
- Understanding the Ultra1500 Serial Interface

Understanding Ultra1500 Connectors

The following table provides a brief description of the Ultra1500 front panel connectors and describes the connector type.

Designator	Description	Connector
CN1	User Input/Output	50-pin, mini-D
CN2	Motor Feedback	20-pin, mini-D
CN3	Serial Port	20-pin, mini-D
Input Power	Main AC Power (L1–L3), Control AC Power (L1C, L2C), and DC Bus Negative (N) [1]	Six-position, single row, spring clamp connectors with 7.5 mm spacing (Wago 231-206/026-000)
DC Bus and Shunt Power	Diode Bridge Output (P1), DC Bus Positive (P2), and Shunt Resistor (B1–B2)	Four-position, single row, spring clamp connectors with 7.5 mm spacing (Wago 231-204/026-000)
Output Power	Motor Power Phases (U, V, and W)	Three-position, single row, spring clamp connectors with 7.5 mm spacing (Wago 231-203/026-000)

1 DC Bus Negative is labelled DC- on the removable connector, but N is embossed on the drive cover.

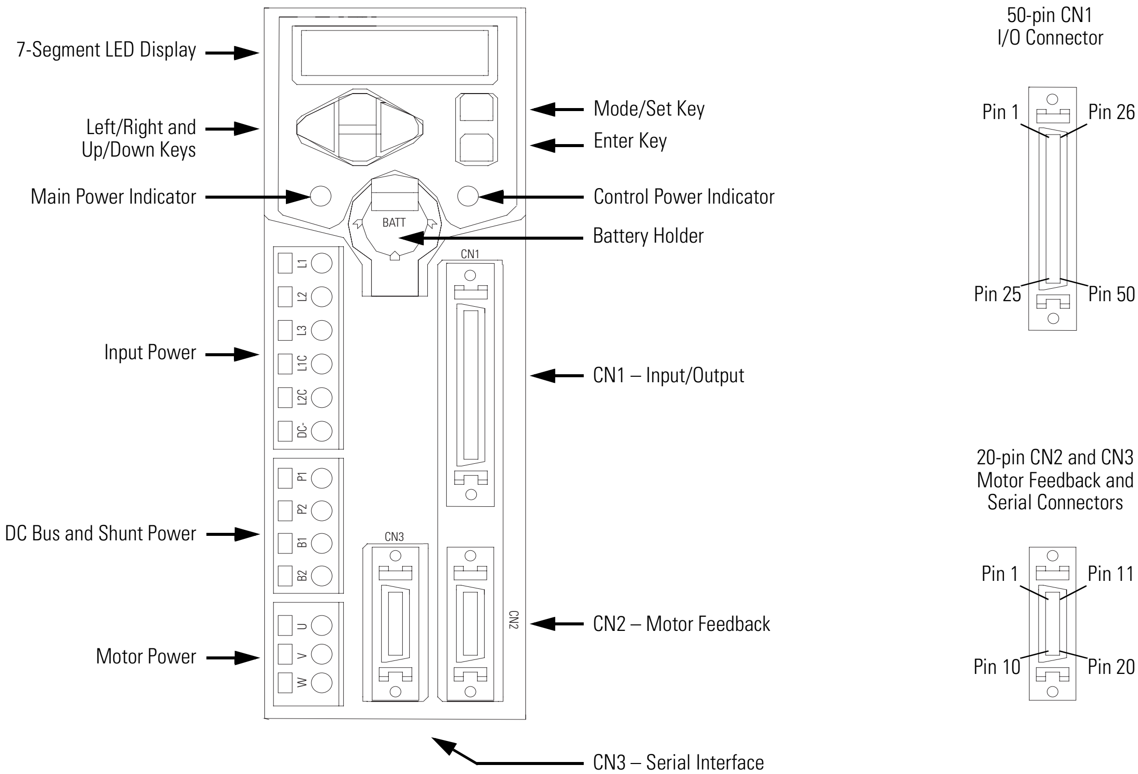
ATTENTION

The N terminal (labelled DC- on the removable connector) IS NOT an Input Power connection.

Ultra1500 Front Panel Connections

Use the figure below to locate the front panel connections on the Ultra1500 drives.

Figure 2.1
Ultra1500 Front Panel Connections



Note: Ultra1500 Operator Interface controls are described in *Appendix D*.

ATTENTION

The N terminal (labelled DC- on the removable connector) IS NOT an Input Power connection.

I/O Connector – CN1

The following table provides the signal descriptions and pin-outs for the CN1 input/output (50-pin) connector.

CN1 Pin	Description	Signal
1	External 24V Power for Inputs 1–7	+24V IN
2		+24V IN
3	Digital Input 1	INPUT 1
4	Digital Input 2	INPUT 2
5	Digital Input 3	INPUT 3
6	Digital Input 4	INPUT 4
7	Digital Input 5	INPUT 5
8	Digital Input 6	INPUT 6
9	Digital Input 7	INPUT 7
10	Reserved	–
11	Follower Input A +	AX+
12	Follower Input A -	AX-
13	Follower Input B +	BX+
14	Follower Input B -	BX-
15	Reserved	–
16	Reserved	–
17	Encoder Z-Pulse +	Z-PULSE+
18	Encoder Z-Pulse -	Z-PULSE-
19	Velocity Command Input +	VCMD+
20	Velocity Command Input -	VCMD-
21	Current Command Input +	ICMD+
22	Current Command Input -	ICMD-
23	Analog Output 2	AOUT2
24	Reserved	–
25	3.6V Battery -	BAT-

CN1 Pin	Description	Signal
26	Reserved	–
27	Analog Output Common Ground	ACOM
28	Analog Output 1	AOUT1
29	Buffer Encoder Channel A +	AM+
30	Buffer Encoder Channel A -	AM-
31	Buffer Encoder Channel B +	BM+
32	Buffer Encoder Channel B -	BM-
33	Buffer Encoder Channel Z +	IM+
34	Buffer Encoder Channel Z -	IM-
35	Reserved	–
36	Reserved	–
37	Fault Code Output 1	FAULT 1
38	Fault Code Output 2	FAULT 2
39	Fault Code Output 3	FAULT 3
40	Fault Code Output Common Ground	F COM
41	Digital Output 1 +	OUTPUT 1+
42	Digital Output 1 -	OUTPUT 1-
43	Digital Output 2 +	OUTPUT 2+
44	Digital Output 2 -	OUTPUT 2-
45	Fault Output +	FAULT+
46	Fault Output -	FAULT-
47	Digital Output 3 +	OUTPUT 3+
48	Digital Output 3 -	OUTPUT 3-
49	3.6V Battery +	BAT+
50	Reserved	–

Motor Feedback Connector – CN2

The following table provides the signal descriptions and pin-outs for the CN2 motor feedback (15-pin) connector.

CN2 Pin	Description	Signal
1	Encoder Ground	ECOM
2	Motor Thermal Switch	TS
3	Channel A +	A+
4	Channel A -	A-
5	Channel B +	B+
6	Channel B -	B-
7	Channel Z +	I+
8	Channel Z -	I-
9	Reserved	–
10	Serial + / Hall Feedback S1	S1/SD+

CN2 Pin	Description	Signal
11	Reserved	–
12	Reserved	–
13	Serial -	SD-
14	Hall Feedback S2	S2
15	Reserved	–
16	Hall Feedback S3	S3
17	Reserved	–
18	3.6V Battery +	BAT+
19	3.6V Battery -	BAT-
20	Encoder +5V Power	EPWR

Serial Port Connector – CN3

The following table provides the signal descriptions and pin-outs for the CN3 serial port (20-pin) connector.

CN3 Pin	Description	Signal
1	Logic Ground	GND
2	Reserved	–
3	Logic Ground	GND
4	Reserved	–
5	Logic Ground	GND
6	Reserved	–
7	Reserved	–
8	Logic Power (Reserved)	VCC
9	Logic Power (Reserved)	VCC
10	Logic Power (Reserved)	VCC

CN3 Pin	Description	Signal
11	RS-232 Output	XMT
12	RS-232 Input	RCV
13	Reserved	–
14	Reserved	–
15	Reserved	–
16	Reserved	–
17	Reserved	–
18	Reserved	–
19	Reserved	–
20	Reserved	–

Understanding Ultra1500 I/O Specifications

A description of the Ultra1500 input/output is provided starting below.

Digital I/O Power Supply

All Ultra1500 drives require an external 24V power supply for proper operation of the digital inputs. The following table provides a description of the digital I/O power supply.

Note: A single 24V power supply can be used to power the digital I/O on multiple drives, provided the cumulative minimum current requirements are met.

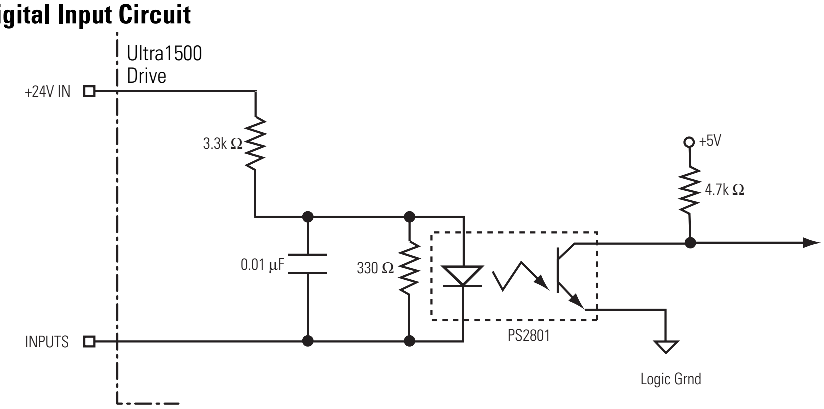
Parameter	Description	Minimum	Maximum
I/O Power Supply Voltage	Voltage range of the external power supply for proper operation of the digital I/O.	21.6V	26.4V
I/O Power Supply Current	Current draw per drive from the external power supply for the digital inputs.	—	64 mA

Digital Inputs

There are seven opto-isolated digital inputs. Any input can be configured for one of the following functions using Ultraware software: Drive Enable, Positive Overtravel, Negative Overtravel, Positive Current Limit, Negative Current Limit, Fault Reset, Integrator Inhibit, Operation Mode Override, Zero Speed Clamp Enable, Reset Multiturn Data, Preset Selects, Preset Direction, Alternate Gain Select, Position Strobe, and Pause Follower.

Digital inputs are active low, current sourcing. All have the same configuration, as shown in Figure 2.2.

Figure 2.2
Digital Input Circuit

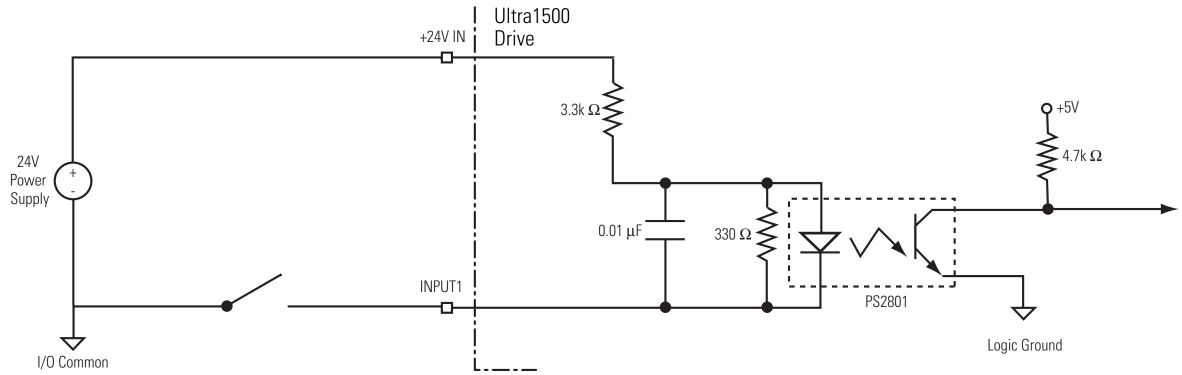


The following table provides a description of the digital input specifications.

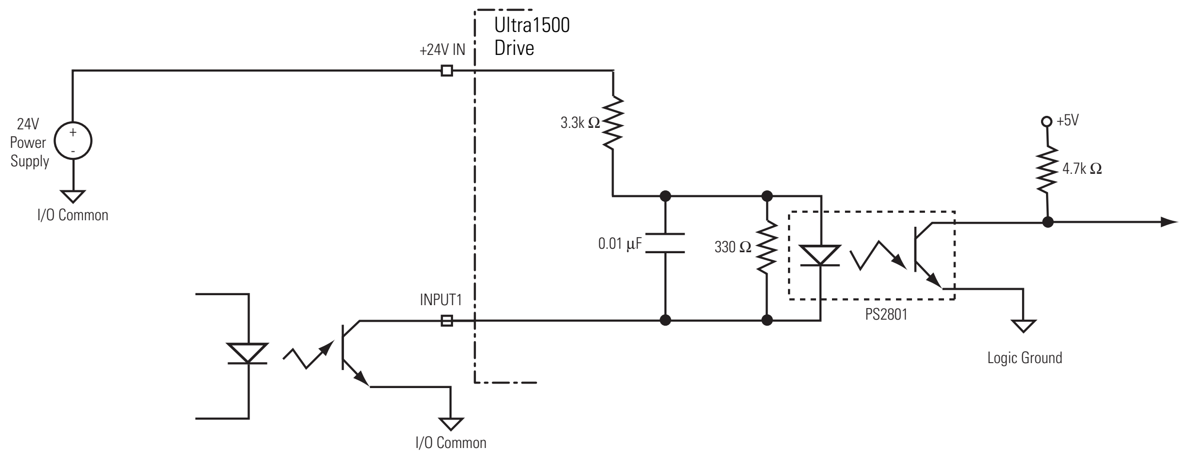
Parameter	Description	Minimum	Typical	Maximum
ON State Voltage	Voltage applied to the input, with respect to I/O common, to guarantee an ON state.	—	—	2V
ON State Current	Current flow to guarantee an ON State	—	6.9 mA	—
OFF State Voltage	Voltage applied to the input, with respect to the positive terminal of the 24V power supply, to guarantee an OFF state.	—	-1 V	—
Firmware Scan Delay	Signal delay from the digital input to the firmware-accessible registers.	—	6 ms	—

Figure 2.3 depicts common interface types for Ultra1500 Digital Inputs.

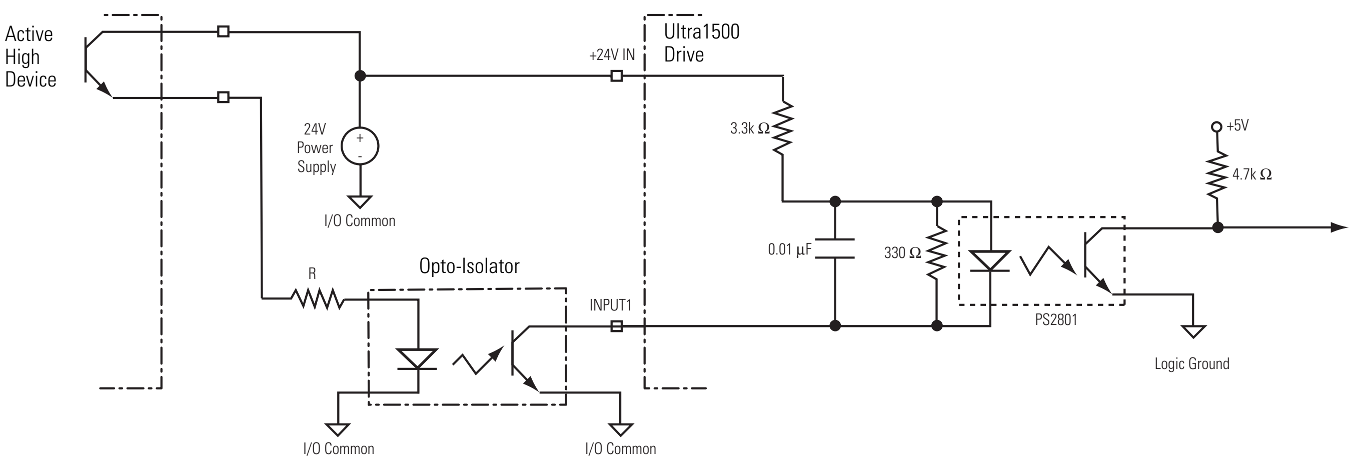
Figure 2.3
Digital Input Interface Examples



Drive Input Connected to Switch/Relay Contact



Drive Input Connected to Opto-Isolator



Drive Input Connected to Active High Output

Digital Outputs

There are three opto-isolated transistor outputs (OUTPUT 1, OUTPUT 2, OUTPUT 3) that can be configured for the following functions using Ultraware software: Up To Speed, Brake, Within Speed Window, Within Near Window, Within Position Window, Velocity Limited, Current Limited, Warning, Absolute Position Valid, and Ready.

Alarm outputs include an alarm signal (FAULT), and 3-bits of fault information (FAULT 1, FAULT 2, FAULT 3) that can be decoded. When there is a fault, the alarm signal is activated and the three alarm code outputs indicate which of eight different fault types is active.

The following table shows how drive faults are assigned to groups.

Fault Group	Fault Code Output State			Possible Faults
	FAULT1	FAULT2	FAULT3	
0	ON	ON	ON	No faults
1	ON	ON	OFF	E.005 IPM Error E.054 Current Feedback Offset E.057 PWM Hardware Error E.079 Shunt Overcurrent Protection
2	ON	OFF	ON	E.004 Motor Overtemperature E.022 Motor Continuous Current Overload E.023 Drive Overload E.036 Drive Overtemperature E.075 Shunt Overload Protection E.101 Motor Power Cable Open E.102 Motor Instantaneous Current Overload E.103 Motor Mismatch E.104 Continuous Power Overload
3	ON	OFF	OFF	E.028 Encoder Data Range Error E.030 Encoder Cable Open E.031 Encoder Data Parameter Error E.083 Absolute Encoder Battery Error E.084 Absolute Encoder Overspeed E.085 Absolute Encoder Multi-turn Count Error E.086 Encoder Single-Turn Count Error E.105 Encoder Type Mismatch E.106 Encoder Communication Error
4	OFF	ON	ON	E.009 Bus Undervoltage E.010 Bus Overvoltage E.037 AC Line Loss
5	OFF	ON	OFF	E.018 Motor Overspeed E.019 Excess Position Error E.056 Watchdog Timeout E.108 Position Command Frequency Error
6	OFF	OFF	ON	E.053 User Parameter Initialization Error E.055 User Parameter Checksum Error E.058 User Parameter Range Error E.107 Special Communication Error
7	OFF	OFF	OFF	E.060 Drive Initialization Error E.100 Drive Set Up

The OUTPUT 1, OUTPUT 2, OUTPUT 3, and FAULT outputs have the same configuration, shown in Figure 2.4. The FAULT 1, FAULT 2, FAULT 3 outputs have the same configuration, shown in Figure 2.5.

Figure 2.4
Transistor Output Hardware Configuration for OUTPUT 1, OUTPUT 2, OUTPUT 3, and FAULT Signals

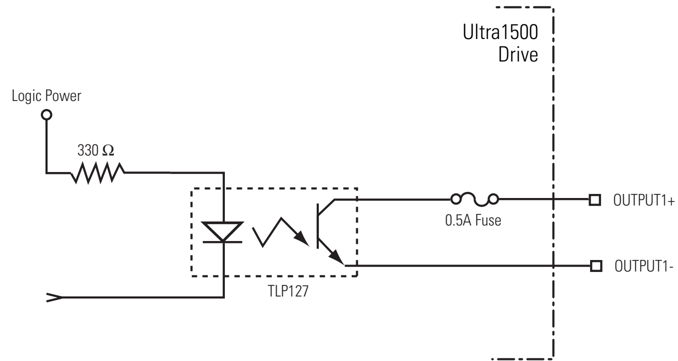
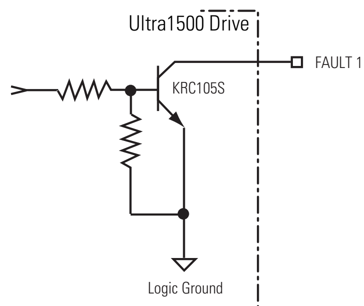


Figure 2.5
Transistor Output Hardware Configuration for FAULT1, FAULT2, and FAULT3 Signals



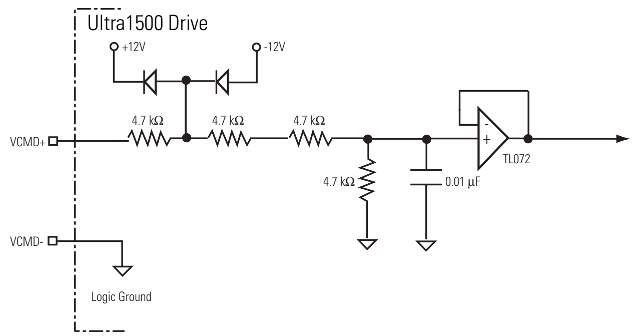
The following table provides a description of the digital output specifications.

Parameter	Description	Minimum	Maximum
ON State Current	Current flow when the output transistor is ON	—	20 mA
OFF State Current	Current flow when the output transistor is OFF	—	0.1 mA
ON State Voltage	Voltage across the output transistor when ON	—	1.2V
OFF State Voltage	Voltage across the output transistor when OFF	—	28V

Analog Inputs

The Ultra1500 has two single-ended analog inputs. One is dedicated as the command input for Analog Velocity mode, and the second is dedicated as the command input for Analog Current mode. The two inputs are identical, and Figure 2.6 shows the configuration of the analog input.

Figure 2.6
Analog Input Configuration



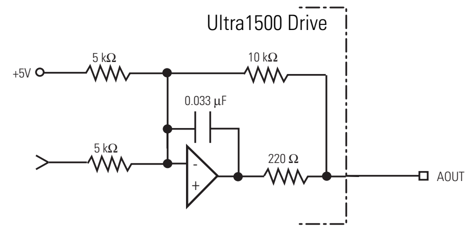
The following table provides a description of the analog input specifications.

Parameter	Description	Minimum	Maximum
VCMD Resolution	Number of states that the input signal is divided into [which is 2$^{\text{(to the number of bits)}}$].	16 bits	—
ICMD Resolution		12 bits	—
Input Impedance	Open circuit impedance measured between the positive (+) input and analog common.	19 kΩ	—
Input Signal Range	Voltage applied to the input	-10V	+10V

Analog Outputs

The Ultra1500 contains two analog outputs that can be configured through Ultraware software to represent internal drive variables. Figure 2.7 shows the configuration of the analog outputs. The following table provides a description of the analog outputs.

Figure 2.7
Analog Output Configuration



IMPORTANT Output values can vary during power-up until the specified power supply voltage is reached.

The following table provides a description of the analog output specifications.

Parameter	Description	Minimum	Maximum
Resolution	Number of states that the output signal is divided into, which is $2^{(\text{to the number of bits})}$.	8 Bits	—
Output Current	Current capability of the output.	-10 mA	+10 mA
Output Signal Range	Range of the output voltage.	-10V	+10V

Position Command Inputs

The Ultra1500, when operating in follower mode, accepts position command signals from a controller.

Position command inputs can be A quad B, Step/Direction, or Step Up/ Step Down format as shown in Figure 2.8.

Figure 2.8
Position Command Input Signal Types

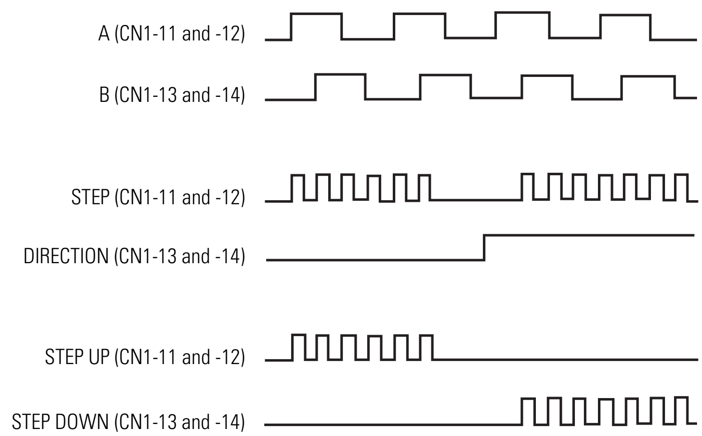
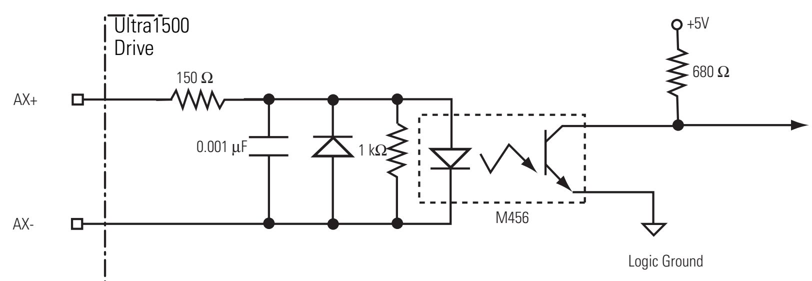


Figure 2.9 shows the configuration of the Position Command inputs, and the following table provides descriptions of these inputs.

Figure 2.9
Position Command Interface Example

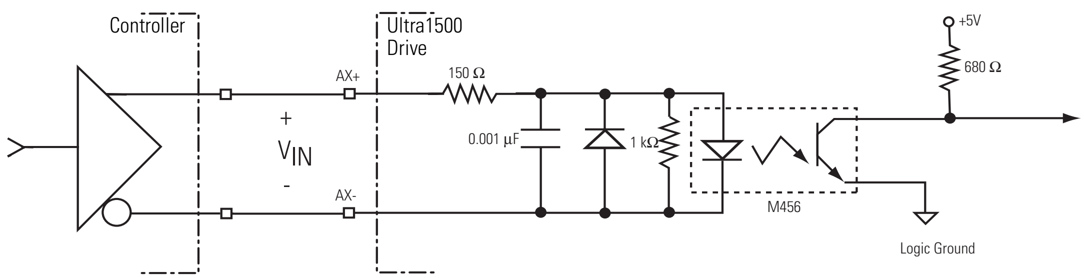


Parameter	Description	Minimum	Maximum
ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	2.8V	3.7V

Parameter	Description (Continued)	Minimum	Maximum
OFF State Input Voltage	Input voltage difference between the + input and the - input that is detected as an OFF state.	1V	-3V
Signal Frequency (open collector input drive)	Input frequency of the AX or BX inputs. Count frequency is four times this frequency for A/B type inputs, and equal to this frequency for Step/Direction and Step Up/Step Down inputs.	—	250 kHz
Signal Frequency (differential driver input drive)	Input frequency of the AX or BX inputs. Count frequency is four times this frequency for A/B type inputs, and equal to this frequency for Step/Direction and Step Up/Step Down inputs.	—	900 kHz

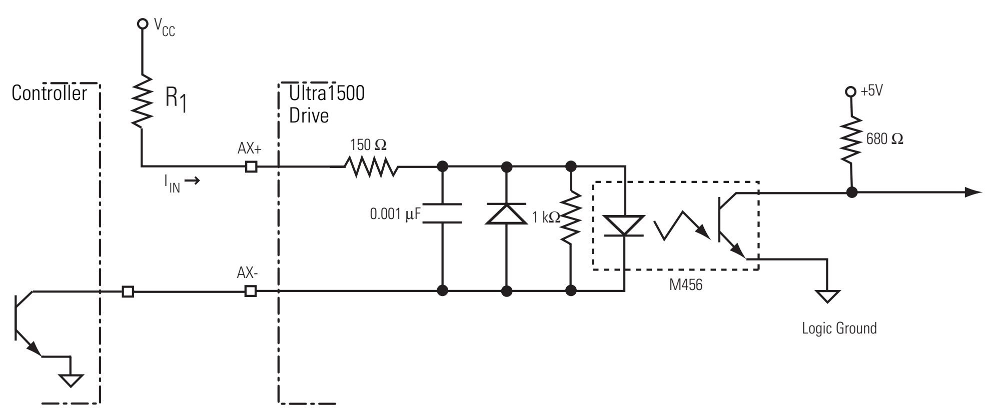
Figure 2.3 depicts common interface types for Ultra1500 Position Commands.

Figure 2.10
Position Command Interface Examples



V_{IN} must be between 2.8V and 3.7V for an ON state to be recognized.

Line Driver Interface



R_1 must be chosen so that the input current, I_{IN}, is between 7mA and 15mA for an ON state to be recognized:

V_{CC}	R_1	V_{CC}	R_1	V_{CC}	R_1
5V	180 Ω	12V	1 kΩ	24V	2.2 kΩ

Open Collector Interface

Understanding Ultra1500 Motor Encoder Feedback Specifications

The Ultra1500 can accept motor encoder signals from the following types of encoders:

- 5 Volt Incremental Encoders with TTL outputs and Hall signals
- 5 Volt Serial Encoders with battery-backed multi-turn capability

5 Volt Incremental Encoders

Incremental encoders must have differential drivers for A±, and B± inputs. The marker inputs, I±, are not used by the drive, but must be differential if the drive needs to output a marker signal to a controller. The drive supports a maximum line frequency of 4,000,000 lines per second or 16,000,000 counts per second.

Hall inputs S1, S2, and S3 are single-ended 5V logic, and can also be open collector type.

5 Volt Serial Encoders

The Ultra1500 supports a serial encoder, known as the SA35. The SA35 device is a multi-turn absolute device with 131,072 counts/revolution, and can track ±32767 revolutions when battery power is present. This encoder is available in selected Allen-Bradley servo motors, such as the TL-Series.

The drive is able to automatically detect the motor connected, since the SA35 serial encoders contain unique motor model identifiers. Serial communications with the encoder use a baud rate of 2.5MHz with bi-directional RS-485 transmission.

A 3.6V battery is required to support the multi-turn capability of the SA35 encoder. The drive supports two methods of battery connections:

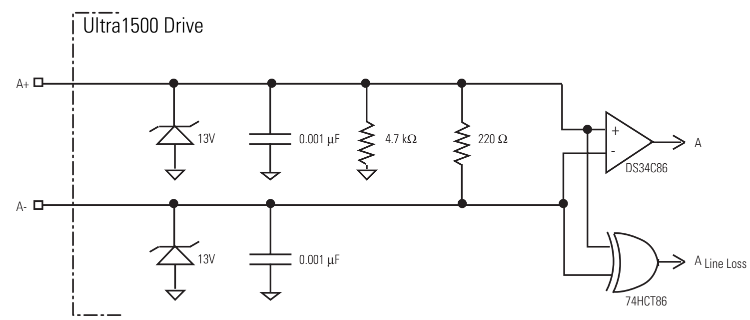
- A single, ½-size AA battery installed on the drive, or
- An external battery can be connected to I/O connector (CN1), pins 25 and 49.

See the section *Absolute Positioning* on page 5-16 for more details on battery-backed absolute encoders.

A, B, and I Inputs

A, B, and I input encoder signals are filtered using analog and digital filtering. Refer to Figure 2.11 for a schematic of the A, B, and I inputs. The inputs have line loss detection using exclusive-OR gates that can be disabled in Ultraware if electrical noise results in nuisance faults.

Figure 2.11
Schematic of the Motor Encoder Inputs



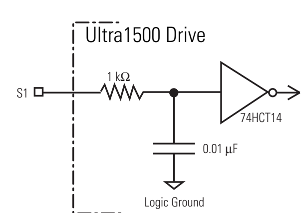
The following table provides a description of the A, B, and I inputs.

Parameter	Description	Minimum	Maximum
A, B, and I ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	+1.0V	+7.0V
A, B, and I OFF State Input Voltage	Input voltage difference between the + input and the - input that is detected as an OFF state.	-1.0V	-7.0V
Common Mode Input Voltage	Potential difference between any encoder signal and logic ground.	-7.0V	+12.0V
DC Current Draw	Current draw into the + or - input.	-30 mA	30 mA
A, B Input Signal Frequency	Frequency of the A or B signal inputs. The count frequency is 4 times this frequency, since the circuitry counts all four transitions.	—	4 MHz

Hall Inputs

The Ultra1500 uses Hall signals to initialize the commutation angle for sinusoidal commutation with incremental encoders. Hall signals must be single-ended and can be either open collector type or TTL type. Figure 2.12 shows the configuration of the Hall inputs (S1, S2, and S3).

Figure 2.12
Hall Input Configuration



Thermostat Input

The Ultra1500 can monitor a thermostat or thermistor signal from a motor and generates a fault if the motor overheats. Figure 2.13 shows the configuration of this drive input. Figure 2.14 on page 2-16 shows a typical connection to a motor with a normally closed thermostat. The logic is designed so that an open or high-impedance condition will generate a fault. If the motor does not have this signal, the drive can be configured through Ultraware software to ignore the input.

Figure 2.13
Thermostat Input Configuration

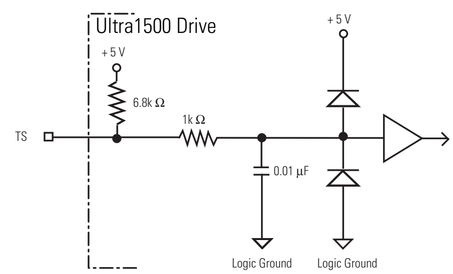
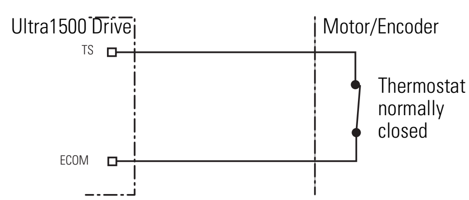


Figure 2.14
Typical Thermostat Connection



Encoder Phasing

For proper motor commutation and control, it is important that the motor feedback signals are phased properly. The drive has been designed so that a positive current applied to a motor will produce a positive velocity and increasing position readings, as interpreted by the drive. Additionally, if Hall signals are used to initialize the commutation angle, the Hall signals must sequence properly and the phase relationship to the motor back-EMF signals must be understood. Figure 2.15 shows the proper sequencing of the Hall signals when positive current is applied to the motor. If the Hall signals are out of phase with the back-EMF signals, the drive can be configured through software to compensate for the phase offset, as long as the sequencing of the Hall signals is correct. Figure 2.16 shows an example where the Hall signals have an offset of 60 degrees.

Figure 2.15
Sequencing and Phasing of the Hall Signals

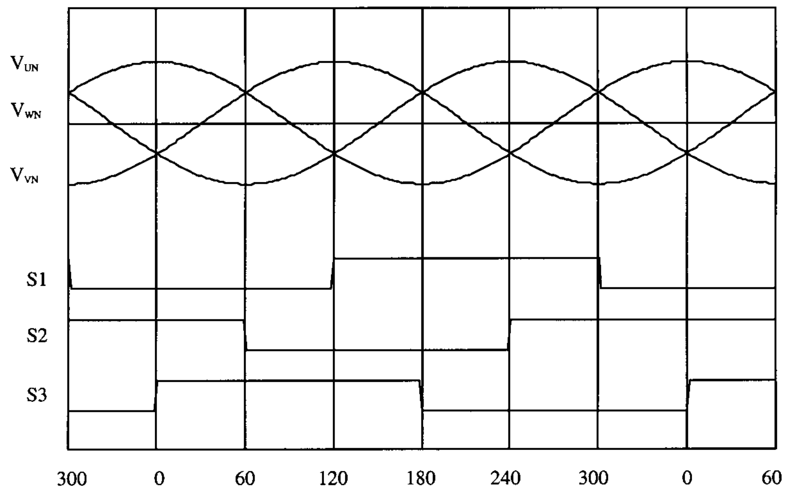


Figure 2.16
Sequencing and Phasing of the Hall Signals (60° Hall Offset Example)

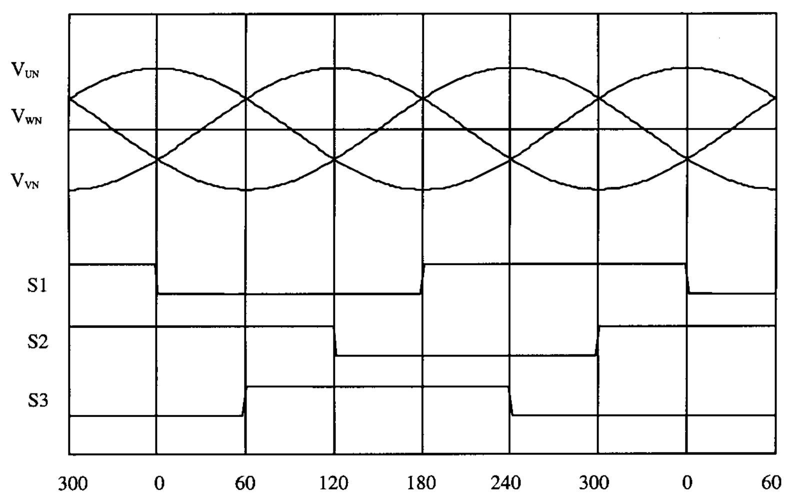
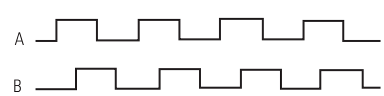


Figure 2.17 shows the proper phasing of TTL A/B encoder signals when positive current is applied.

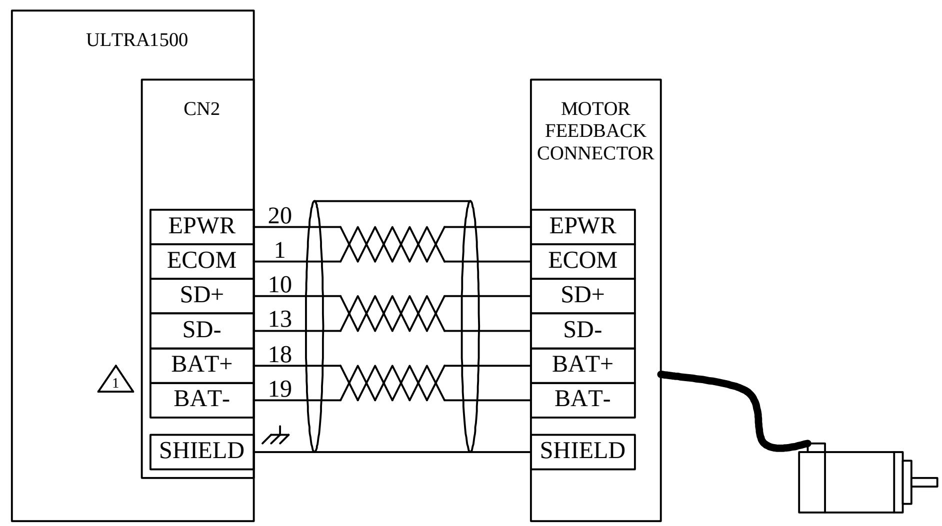
Figure 2.17
Phasing of TTL A/B Encoder Signals



Motor Encoder Connection Diagrams

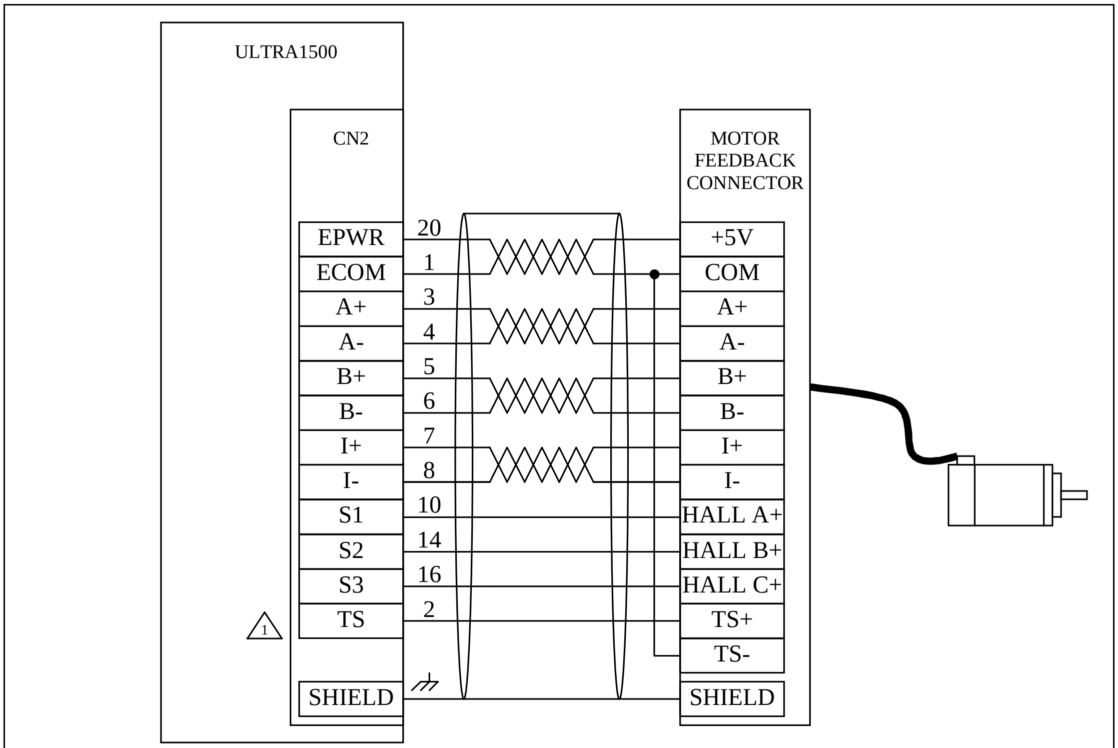
Figures 2.18 through 2.22 show typical wiring diagrams for motor feedback cables from various motors. If the thermostat, limit, or Hall signals are not available, no connections are required, but the drive must be configured through software to ignore these signals.

Figure 2.18
Serial Encoder to Drive Wiring Diagram



NOTES:
1. IF MULTI-TURN ABSOLUTE FEEDBACK IS NOT NEEDED IN THE APPLICATION, THE BATTERY CONNECTIONS TO PINS 18 AND 19 OF CN2 ARE NOT NECESSARY.

Figure 2.19
Incremental Encoder to Drive Wiring Diagram



NOTES:

1. IF THE MOTOR DOES NOT HAVE A THERMISTOR OR THERMOSTAT, THE THERMOSTAT INPUT OF THE ULTRA1500 FOUND ON PIN 2 OF CN2 SHOULD BE LEFT DISCONNECTED.

Figure 2.20
Anorad Linear Motor to Drive Wiring Diagram

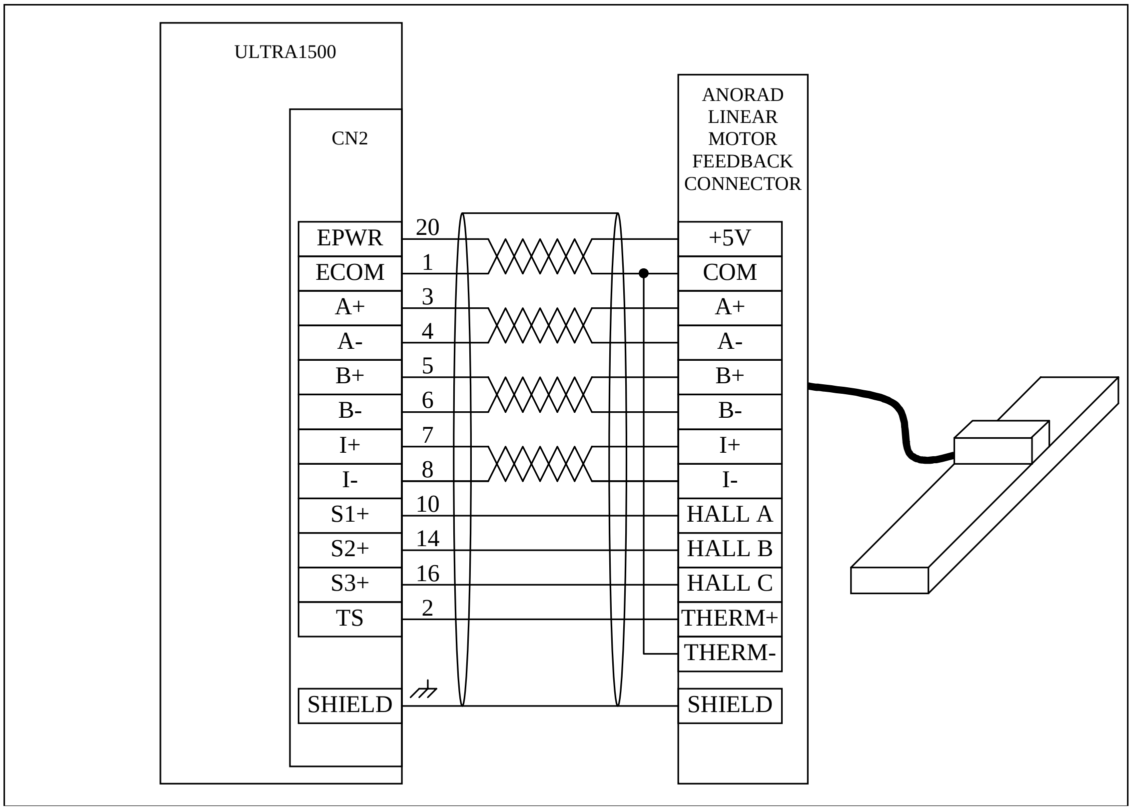
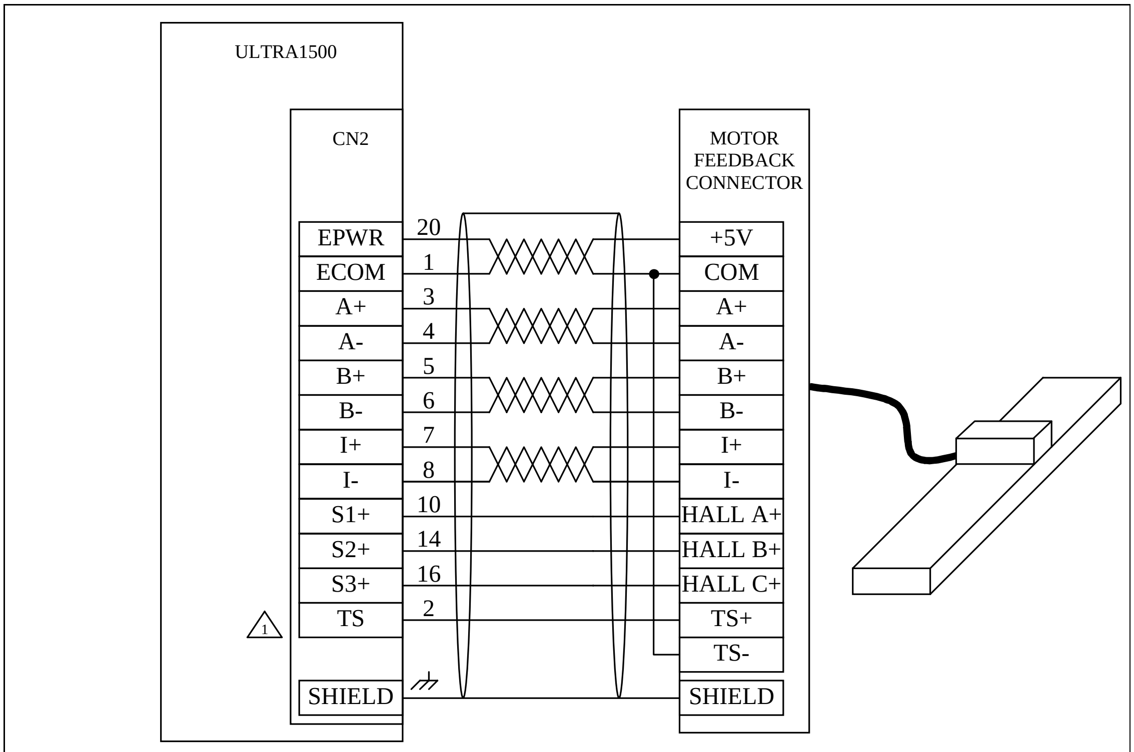


Figure 2.21
Third Party Linear Motor to Drive Wiring Diagram



NOTES:
1. IF THE MOTOR DOES NOT HAVE A THERMISTOR OR THERMOSTAT, THE THERMOSTAT INPUT OF THE ULTRA1500 FOUND ON PIN 2 OF CN2 SHOULD BE LEFT DISCONNECTED.

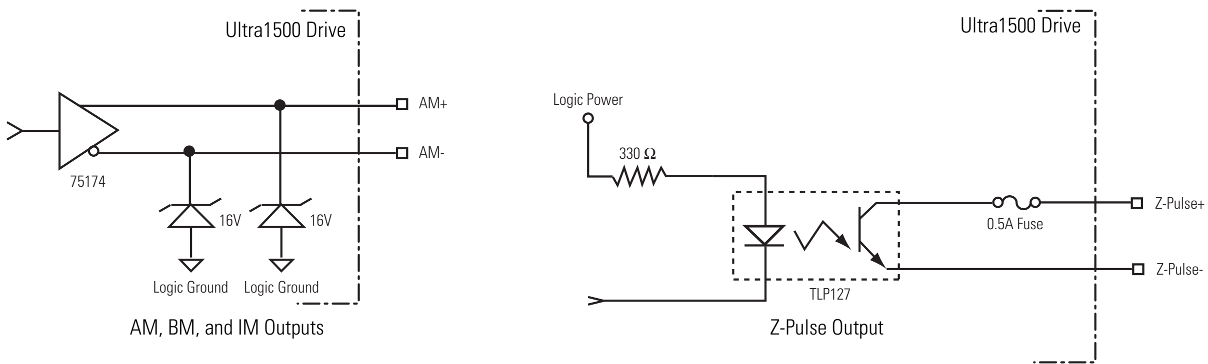
IMPORTANT Total resistance of the wiring for +5V encoder power and ground connections between the drive and motor must be less than 2 Ohms.

Buffered Motor Encoder Outputs

The Ultra1500 includes buffered motor encoder outputs. These signals are generated by the drive after filtering and processing the actual feedback from the motor.

The buffered motor encoder outputs use RS-485 differential drivers and have a maximum signal frequency of 2.5 MHz. The drivers can drive a 2V differential voltage into a 100 ohm load. Figure 2.22 shows the configuration of the Ultra1500 encoder outputs.

Figure 2.22
Motor Encoder Outputs



Index Pulses

The Ultra1500 has two separate differential outputs that provide an index pulse for use with controllers. In the case of a rotary motor with a serial encoder, the marker pulse is generated in the drive hardware.

- The differential buffered encoder output, Channel IM+ and Channel IM- (CN1-33 and CN1-34), provide a buffered version of the encoder marker pulse. As with the AM and BM channel outputs, the time duration of the signal states depend on the rotational speed.
- The Z-Pulse differential outputs, (CN1-17 and CN1-18), provide an opto-isolated marker signal that has a minimum time duration of 800 μsec. At low speeds, the two marker outputs are identical, however at high speeds the Z-pulse output will enforce a minimum time duration of 800 μsec.

On incremental motor encoders, the index output (IM+ and IM-) is a buffered version of the encoder index, and it is not altered. However, the AM and BM signals are both inverted from the encoders signals. If the controller requires non-inverted AM and BM outputs (e.g., if the controller gates the index with a particular AM/BM state), the + and - signals of the AM and BM outputs can be swapped before connecting to the controller.

With serial encoders, the index output (IM+ and IM-) is generated by the drive hardware, since the serial encoders do not have an actual index signal. The generated index signal is two counts in width, and phasing to a particular A/B state is arbitrary. The index signal is generated at the zero location of the fractional revolutions for the encoder.

5 Volt Encoder Power Supply

All Ultra1500 drives supply 5V dc for the operation of the encoder. The following table provides a description of the auxiliary encoder power supply.

Parameter	Description	Minimum	Maximum
Output Voltage	Voltage range of the external power supply for proper operation of an encoder.	4.75V	5.25V
Output Current	Current draw from the external power supply for the encoder.	—	150 mA

Pin	Signal	Description
CN2-20	EPWR	Encoder Power Out (+5V)
CN2-1	ECOM	Encoder Ground

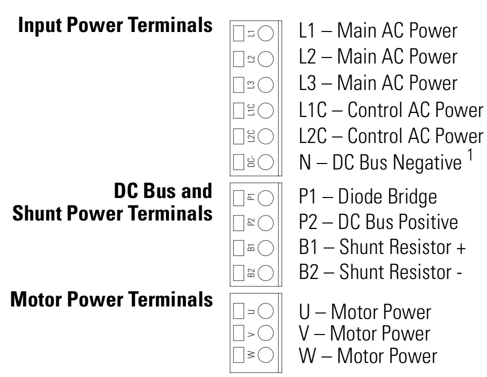
Understanding the Ultra1500 Serial Interface

The Ultra1500 includes one serial port that implements a proprietary binary protocol for serial communication. The RS-232 interface operates at a fixed 38,400 baud, with 8 data bits, no parity, and one stop bit.

Understanding Ultra1500 Power and Ground Connections

The Ultra1500 has three single-row, spring clamp connectors (six, four, and three position) that provide access to the drive's power system. Refer to Figure 2.1 on page 2-2 for the location of these terminals.

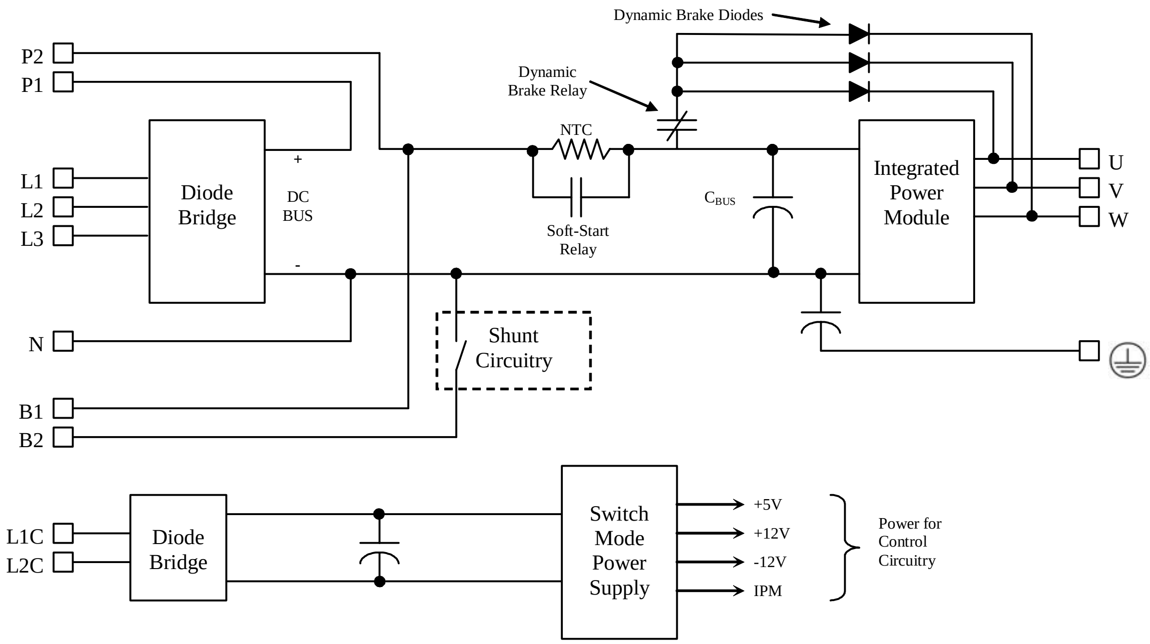
Figure 2.23
Ultra1500 Power Terminals



1 DC Bus Negative is labelled DC- on the removable connector, but N on the drive cover.

A simplified diagram of the power circuitry internal to the drive is shown in Figure 2.24.

Figure 2.24
Simplified Ultra1500 Internal Power Circuitry



Note: DC Bus Negative is labelled N on the drive cover, but DC- on the removable connector.

Input Power Connectors

The following power connections are made to an Ultra1500 drive through a six position terminal connector.

Main Power – L1, L2, and L3

L1 and L2 are single-phase main AC power input connections for the 2092-DA1, 2092-DA2, and 2092 -DA3 drives. L1, L2, and L3 are three-phase main AC power input connections for the 2092-DA4 and 2092 -DA5.

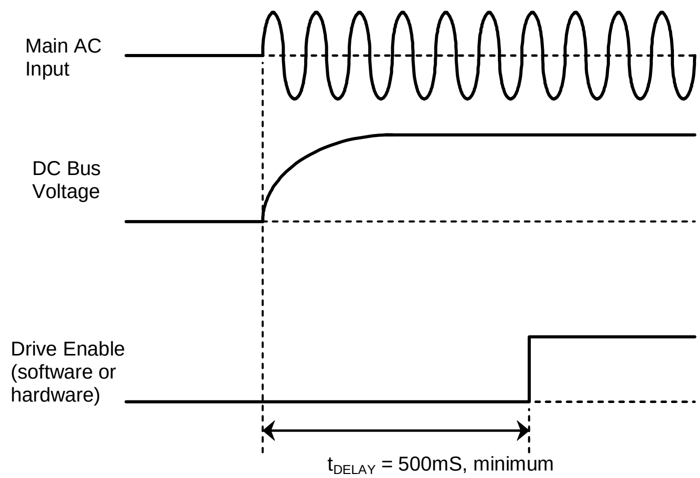
Note: The L3 terminal is not used with the 2092-DA1, 2092-DA2, and 2092-DA3 models, as they require single-phase input power.

ATTENTION

The main AC power inputs should not be removed and re-applied at a rate exceeding once every 2 minutes. Ensure that your control timing guarantees this minimum period to avoid damaging the drive.

IMPORTANT The drive requires 500 ms after the main AC input has been applied before it can be enabled, as shown in Figure 2.25.

Figure 2.25
Timing Requirement s of the Drive Enable Input



Control Power – L1C and L2C

L1C and L2C are the single-phase control power inputs for all Ultra1500 drives. These AC inputs power drive logic and I/O circuitry.

DC Bus Negative – N

N is the negative side of the DC power bus on all 2092 drives.

Note: The positive side (P) of the DC power bus is provided on the DC Bus and Shunt power connector.

If the 2092 drive is to be powered from a DC source, the DC power supply is connected to P2 on the DC Bus and Shunt power connector, and N on the Main Input power connector. The L1, L2, L3, and P1 terminals should be disconnected.

ATTENTION The N terminal (labelled DC- on the removable connector) IS NOT an Input Power connection.

DC Bus and Shunt Power Connectors

The following power connections are made to an Ultra1500 drive through a four position terminal connector.

Diode Bridge and DC Bus Positive – P1 and P2

P1 is an output from the diode bridge of the Ultra1500 drive.

Note: P1 is jumpered at the factory to P2. Replacing the jumper with an inductor may improve harmonic distortion.

P2 is the positive side of the DC power bus on all Ultra1500 drives.

Note: The negative side (-) of the DC power bus is provided by the N terminal on the Main Input Power connector (and is labelled DC- on the removable connector).

Internal Shunt Resistor – B1 and B2

B1 and B2 are connections for the internal shunt resistor. B1 connects to the positive (+) shunt terminal and B2 connects to the negative (-) shunt terminal.

Note: The B1 and B2 terminal are not used with the 2092-DA1 and 2092-DA2 drives, as these drives do not have internal shunt resistors.

Motor Power Connectors

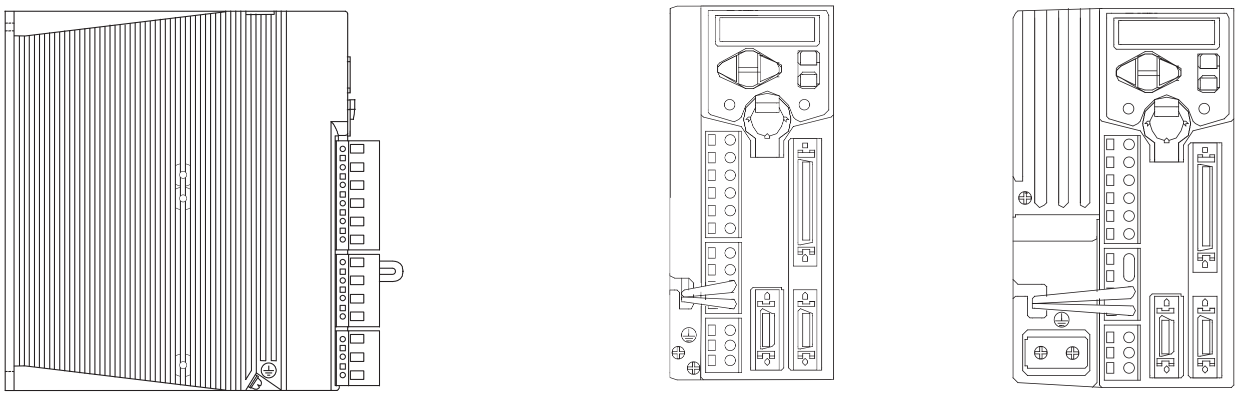
The U, V, and W phases of motor power are provided by an Ultra1500 drive through the three-position terminal connector. The motor power cable attaches to this terminal.

Ground Connection

The location of ground connections for the Ultra1500 drives are shown in Figure 2.26.

- The 2092-DA1 and 2092-DA2 drives have one ground screw, which is shared with the AC power ground connection. It is located on the side of the drive, in the lower front area of the heatsink.
- The 2092-DA3, 2092-DA4, and 2092-DA5 drives have two grounding screws. One screw for motor power and one screw for input power. They are located on the front of the heatsink.

Figure 2.26
Ultra1500 Ground Connections



Chassis ground terminal
2092-DA1 and 2092-DA2
Left-side View

Chassis ground terminals (2)
2092-DA3
Front View

Chassis ground terminals (2)
2092-DA4 and 2092-DA5
Front View

Connecting Your Ultra1500

Chapter Objectives

This chapter provides procedures for wiring your Ultra1500 and making cable connections. This chapter includes:

- Understanding Basic Wiring Requirements
- Determining Your Type of Input Power
- Grounding Your Ultra1500
- Power Wiring Requirements
- Connecting Input Power
- Connecting Motor Power
- Understanding Feedback and I/O Cable Connections

Understanding Basic Wiring Requirements

This section contains basic wiring information for the Ultra1500.

ATTENTION

Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the drive removed from the enclosure. Because the drive is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

IMPORTANT

This section contains common servo system wiring configurations, size, and practices that can be used in a majority of applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

Building Your Own Cables

IMPORTANT	Factory made cables are designed to minimize EMI and are recommended over hand-built cables to ensure system performance.

When building your own cables, follow the guidelines listed below.

- Connect the cable shield to the connector shells on both ends of the cable for a complete 360° connection.
- Use a twisted pair cable whenever possible, twisting differential signals with each other, and single-ended signals with the appropriate ground return.

Refer to *Appendix C* for drive connector kit catalog numbers.

Routing Power and Signal Wiring

Be aware that when you route power and signal wiring on a machine or system, radiated noise from nearby relays, transformers, and other electronic drives, can be induced into motor or encoder feedback, communications, or other sensitive low voltage signals. This can cause system faults and communication problems.

Refer to *Chapter 1* for examples of routing high and low voltage cables in wireways. Refer to *System Design for Control of Electrical Noise Reference Manual* (publication GMC-RM001*x*-EN-P) for more information.

Determining Your Type of Input Power

Before you wire your Ultra1500 system you must determine the type of input power you are connecting to. The Ultra1500 is designed to operate only in grounded environments.

Grounded Power Configuration

The grounded power configuration allows you to ground your single-phase or three-phase power at a neutral point. Match your secondary to one of the examples below and be certain to include the grounded neutral connection.

Figure 3.1
Three-Phase Power Configuration (WYE Secondary)

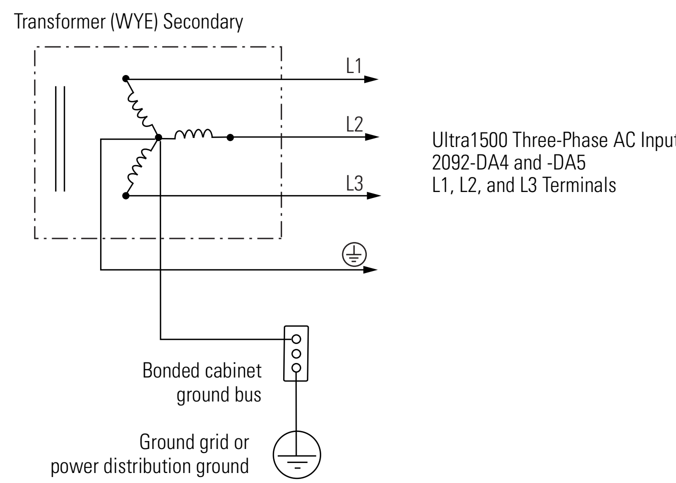


Figure 3.2
Three-Phase Grounded Power Configuration (Delta Secondary)

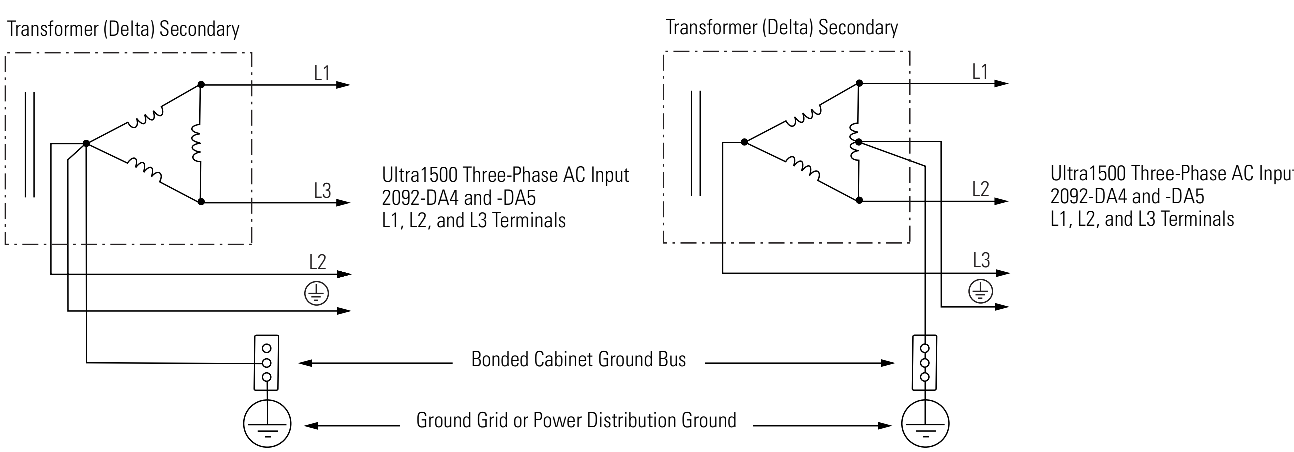


Figure 3.3
Single-Phase Grounded Power Configuration

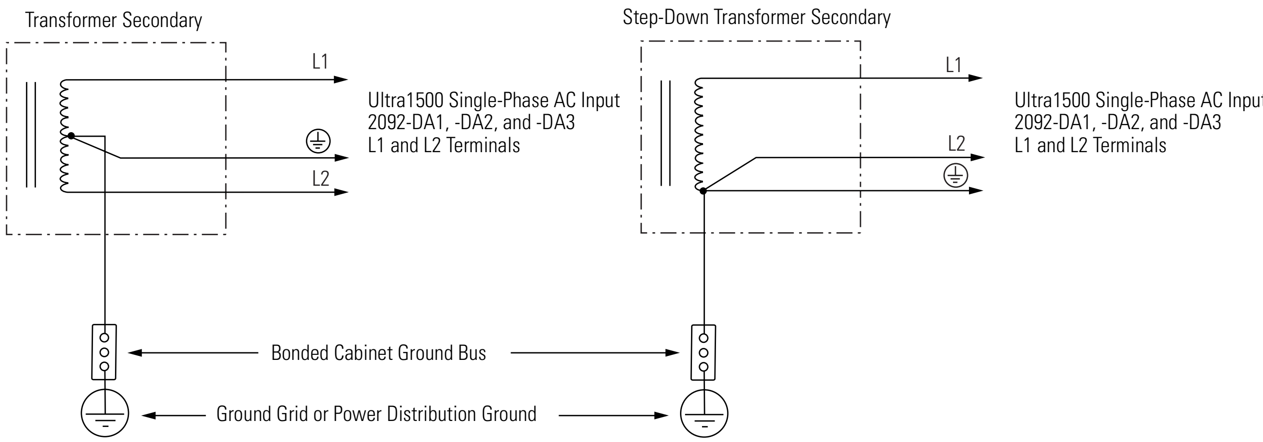
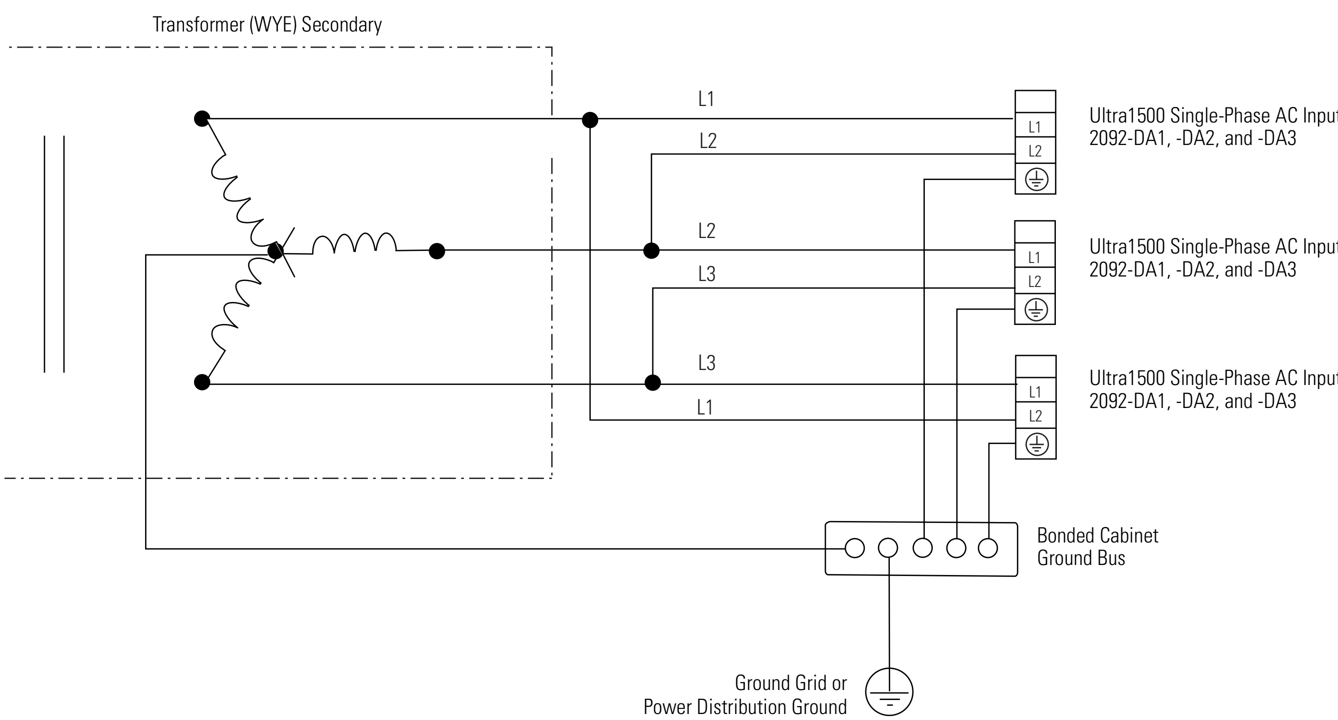


Figure 3.4
Single-Phase Amplifiers on Three-Phase Power



For more information on single-phase amplifiers running on three-phase power, refer to *Appendix D*.

Grounding Your Ultra1500

All equipment and components of a machine or process system should have a common earth ground point connected to their chassis. A grounded system provides a safety ground path for short circuit protection. Grounding your modules and panels minimize shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis. For CE grounding requirements, refer to *Meeting Emission Requirements* in *Chapter 1*.

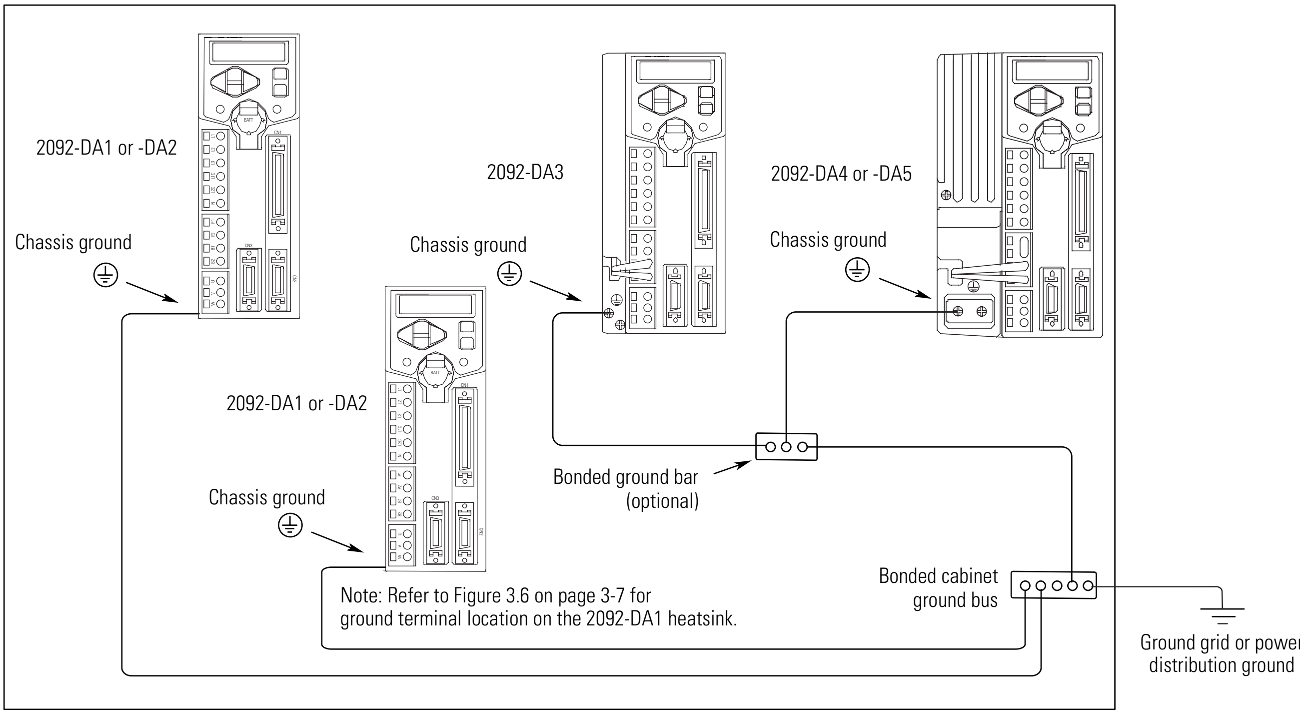
IMPORTANT To improve the bond between the Ultra1500 and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Grounding Your System to the Subpanel

ATTENTION The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system. Refer to the illustration below for details on grounding your Ultra1500. Refer to *Appendix B* for the power wiring diagram for your Ultra1500 drive.

Refer to *HF Bonding Your System* on page 1-11 for details on subpanel grounding.

Figure 3.5
Chassis Ground Configuration (Multiple Ultra1500 Systems on One Panel)



Always follow NEC and applicable local codes

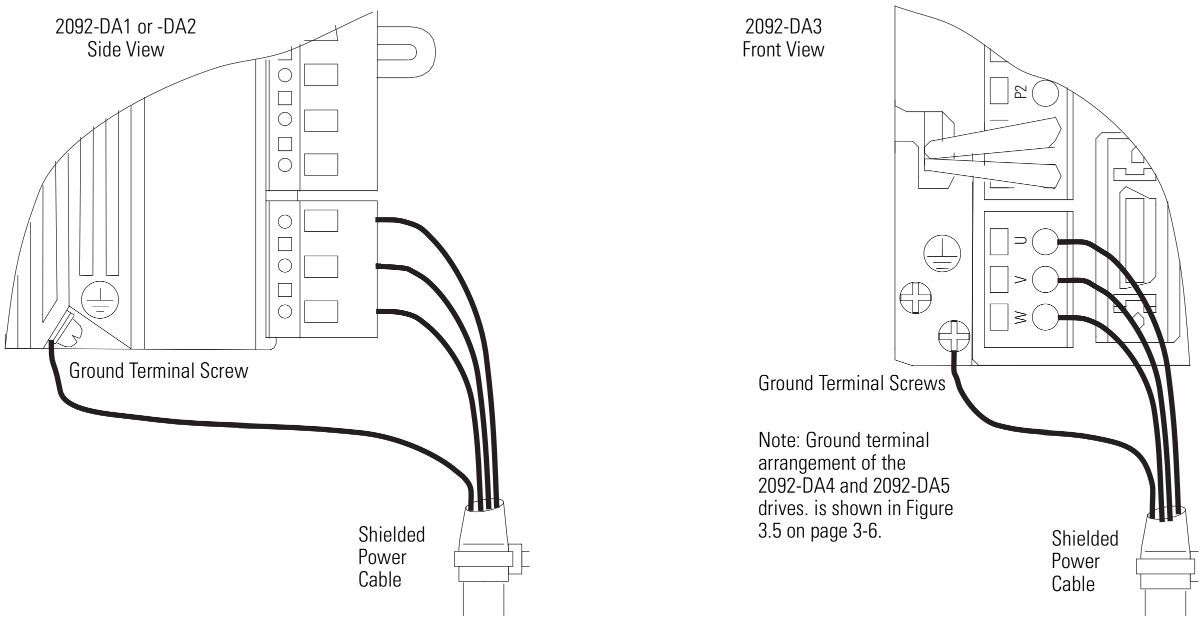
Motor Power Cable Shield Termination

Factory supplied motor power cables for TL-Series motors are shielded, and the power cable is designed to be terminated at the drive during installation. A separate lugged ground wire connects to the shield braid. The lugged wire must be connected to the ground terminal on the drive's heatsink (refer to Figure 3.6 for location).

ATTENTION

To avoid hazard of electrical shock, ensure shielded power cables are grounded at a minimum of one point for safety.

Figure 3.6
Motor Power Cable Shield Connection



Safety Precautions

Observe the following safety precautions when wiring your Ultra1500 drive.

ATTENTION

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

Do not attempt to defeat or override the drive fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. If you do not correct a drive or system malfunction, it could result in personal injury and/or damage to the equipment as a result of uncontrolled machine system operation.

Test equipment (such as an oscilloscope or chart recorder) must be properly grounded. Failure to include an earth ground connection could result in a potentially fatal voltage on the oscilloscope chassis.

Power Wiring Requirements

Power wiring requirements are given in the tables below. Wire should be copper with 75° C (167° F) minimum rating, unless otherwise noted. Phasing of main AC power is arbitrary, but earth ground connection is required for safe and proper operation.

IMPORTANT The National Electrical Code and local electrical codes take precedence over the values and methods provided.

Ultra1500 Main AC Power Wiring Requirements

The table below lists the main AC wiring requirements for the Ultra1500 drives. Refer to Figure 3.7 for power terminal positions.

Ultra1500 Drives	Description	Connects to Input Power Terminal	Wire Size mm^2 (AWG)	Ground Screw(s) Torque Value Nm (lb-in.)
2092-DA1	Input Power [1] 200–240V ac single-phase	L1, and L2	2.5 (14)	1.25 (11)
2092-DA2				
2092-DA3				
2092-DA4	Input Power [1] 200–240V ac three-phase	L1, L2, L3		
2092-DA5				

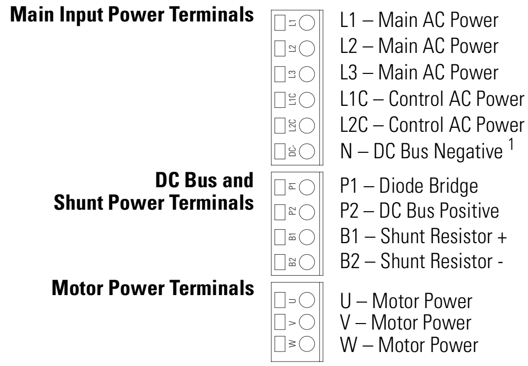
Ultra1500 Control Power Wiring Requirements

The table below lists the Control Power wiring requirements for the Ultra1500 drives. Refer to Figure 3.7 for power terminal positions.

Ultra1500 Drives	Description	Connects to Input Power Terminal	Minimum Wire Size mm^2 (AWG)	Ground Screw Torque Nm (lb-in.)
2092-DA1	Input Power [1] 200–240V ac single-phase	L1C and L2C	2.5 (14)	1.25 (11)
2092-DA2				
2092-DA3				
2092-DA4				
2092-DA5				

[1] The input power may be optionally isolated through a transformer.

Figure 3.7
Ultra1500 Power Terminal Positions



1 DC Bus Negative is labelled DC- on the removable connector, but N on the drive cover.

ATTENTION

The N terminal (labelled DC- on the removable connector) IS NOT an Input Power connection.

ATTENTION

This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

ATTENTION

To avoid personal injury and/or equipment damage, ensure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.

To avoid personal injury and/or equipment damage, ensure motor power connectors are used for connection purposes only. Do not use them to turn the unit on and off.

To avoid personal injury and/or equipment damage, ensure shielded power cables are grounded to prevent potentially high voltages on the shield.

Connecting Input Power

This procedure assumes you have mounted your Ultra1500 drive and are ready to wire your AC input power.

IMPORTANT To ensure system performance, run wires and cables in the wireways as established in *Chapter 1*.

A power wiring diagram for the Ultra1500 is shown in Figure 3.8.

Figure 3.8
Ultra1500 Power Wiring Diagram

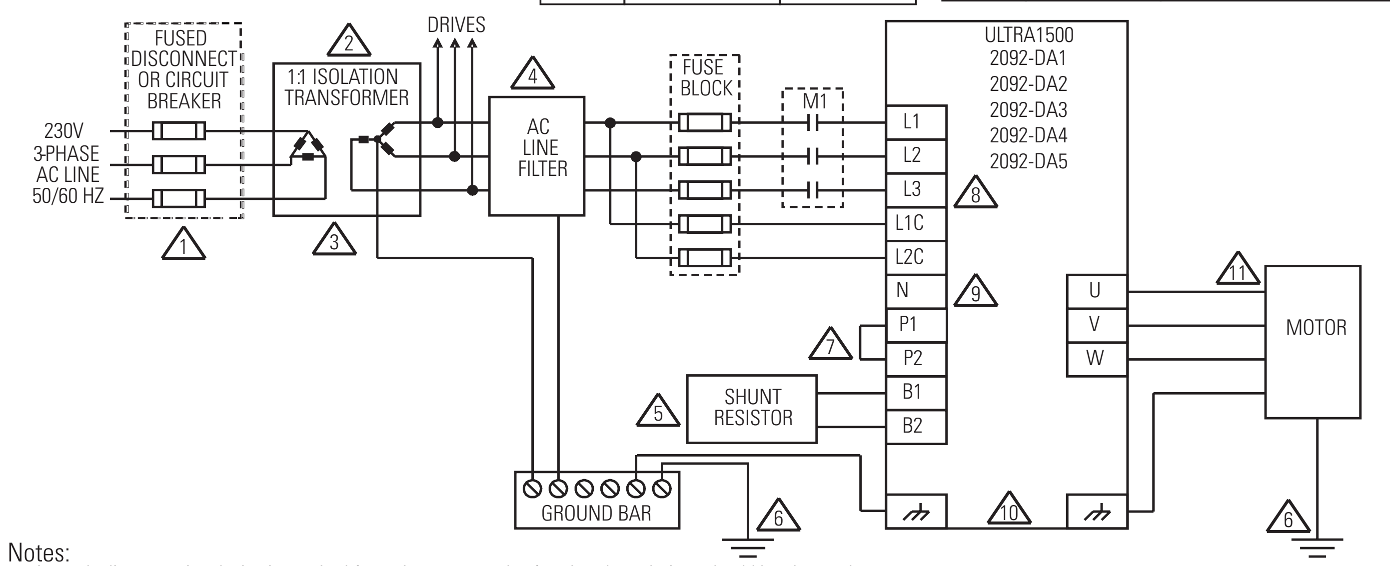
MOTOR POWER WIRES U, V, W, AND GND		
MOTOR	MOTOR POWER MATING CONNECTOR CONTACT SIZE	MINIMUM RECOMMENDED POWER WIRE SIZE (75^0 C COPPER)
TL-SERIES	2.5 mm^2 (14 AWG)	2.5 mm^2 (14 AWG)

TERMINAL STRIP ACCEPTABLE WIRE RANGES
0.8 - 2.5 mm^2 (28 - 12 AWG)

MOTOR POWER CONNECTOR	
PIN	SIGNAL
A	U
B	V
C	W
D	MOTOR CASE (GROUND)

INPUT POWER WIRES		
DRIVE	TERMINALS	MINIMUM RECOMMENDED POWER WIRE SIZE (75^0 C COPPER)
2092-DA1	L1, L2, L1C, L2C, GND	2.5 mm^2 (14 AWG)
2092-DA2	L1, L2, L1C, L2C, GND	2.5 mm^2 (14 AWG)
2092-DA3	L1, L2, L1C, L2C, GND	2.5 mm^2 (14 AWG)
2092-DA4	L1, L2, L3, L1C, L2C, GND	2.5 mm^2 (14 AWG)
2092-DA5	L1, L2, L3, L1C, L2C, GND	2.5 mm^2 (14 AWG)

DIGITAL DRIVE MODULE INPUT CURRENT REQUIREMENTS		
DRIVES	TERMINALS	MAXIMUM CURRENT REQUIREMENT, (AMPS, AC RMS)
2092-DA1	L1, L2, GROUND	3.3 AMPS AC at 200-240 VOLTS AC
2092-DA2	L1, L2, GROUND	5.5 AMPS AC at 200-240 VOLTS AC
2092-DA3	L1, L2, GROUND	8.0 AMPS AC at 200-240 VOLTS AC
2092-DA4	L1, L2, L3, GROUND	11.0 AMPS AC at 200-240 VOLTS AC
2092-DA5	L1, L2, L3, GROUND	15.0 AMPS AC at 200-240 VOLTS AC
ALL	L1C, L2C	2.0 AMPS AC at 200-240 VOLTS AC



Notes:
1. A supply disconnecting device is required for maintenance and safety. Local regulations should be observed.
2. If using an isolation transformer, ensure the phase to neutral/ground voltage does not exceed the input ratings of the drive.
3. Isolation transformer is optional. If used, the secondary of the transformer must be grounded.
4. AC line filter and shielded motor cable are to be used for improving the drive module's electromagnetic compatiblity (EMC), and are required to meet European EMC directive. CAUTION: AC line filters have large leakage currents and require discharge time upon power removal. Wiring between the drive module and filter should be kept as short as possible. The common ground bus bar should be as close to the drive as possible.
5. Internal shunt resistor is present only on 2092-DA3, 2092-DA4, and 2092-DA5 drives. B1 and B2 should be left disconnected on 2092-DA1 and 2092-DA2 drives.
6. High-frequency grounding, using heavy braided wires, should connect together the electronic equipment, electrical enclosure, machine frame, and motor housing.
7. If the power factor or harmonic distortion needs improvement, the jumper from P1 to P2 can be replaced with an inductor.
8. 2092-DA1, 2092-DA2, and 2092-DA3 drives are single-phase AC input drives; input power is not connected to L3 on these drives. .
9. DC Bus Voltage connection - NOT an AC power input. (DC- is labelled on the connector, but drive cover is embossed with N.)
10. 2092-DA1 and 2092-DA2 drives have one grounding screw on the heatsink. 2092-DA3, 2092-DA4, and 2092-DA5 drives have two grounding screws on the heatsink. Tighten the ground terminal screw(s) to 1.25 Nm (11 lbs-in.)
11. Refer to manual included with motor for power, feedback, and brake interconnect information (pinouts and/or wire colors).
12. Wire sizes are minimum recommended values. Local regulations should be observed.

IMPORTANT The AC input power lines (L1, L2, L3, L1C, and L2C) require dual element time delay (slow acting) fuses to accommodate inrush current. Refer to the section *Ultra1500 Power Specifications* in *Appendix A* for the inrush current on the AC power inputs, as well as fuse recommendations.

To wire your input power:

1. Prepare your wires by stripping approximately 8 mm (0.33 in.) of insulation from the end.

IMPORTANT Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

Ferrules 2mm (0.79 in.) in diameter may be attached to the wires at this point. Ferrules ensure that wires strands are not inadvertently exposed.

Note: The Ultra1500 motor power cables listed in *Appendix C* for use with the TL-Series motors have ferrules, and do not require stripping.

2. Route the power cable to your Ultra1500 drive.

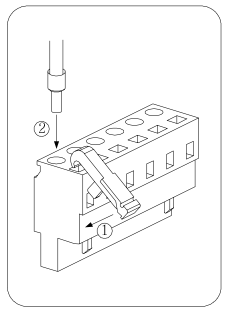
3. Locate the six-position Input Power terminal block and remove the plastic connector. Refer to *Understanding Ultra1500 Connectors* in *Chapter 2* for the front panel connections of your Ultra1500 drive.

4. Using the connector tool provided with the drive (Wago 231-131 shown in Figure 3.9), open the clamp for each of the terminal locations and insert wires as shown in the table below.

If you have this drive:	Insert this wire from the power supply:	Into this terminal on Input Power Connector:
2092-DA1, 2092-DA2, or 2092-DA3	L1 (main AC)	L1
	L2 (main AC)	L2
	Ground (main AC)	⏚ 2092-DA1 and -DA2 on side of heatsink 2092-DA3 on front of heatsink
	L1C (control AC)	L1C
	L2C (control AC)	L2C
2092-DA4 or 2092-DA5	L1 (main AC)	L1
	L2 (main AC)	L2
	L3 (main AC)	L3
	Ground (main AC)	⏚ 2092-DA4 and -DA5 on front of heatsink
	L1C (control AC)	L1C
	L2C (control AC)	L2C

IMPORTANT The DC bus connections should not be used for connecting multiple drives together. Contact your Allen-Bradley representative for further assistance if the application may require DC power connections.

Figure 3.9
Using the Power Connector Tool



1. Open terminal locking clamp with connector tool as shown.
2. Insert wire, and then release tool.
3. Gently pull on the wire to make sure it is secure.

5. Tighten the ground terminal screw. to 1.25 Nm (11 lbs-in.).

6. Gently pull on each wire to make sure it does not come out of its terminal. Re-insert any loose wires.

7. Re-insert the Input Power connector on the terminal block. The connector is keyed to prevent incorrect installation.

Connecting Motor Power

This procedure assumes you have wired your input power and are ready to wire the motor power connections.

IMPORTANT Torque the ground screws securing the wires to 1.25 Nm (11 lbs-in.).

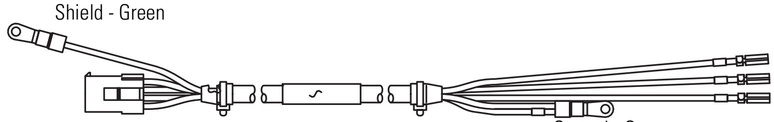
IMPORTANT To ensure system performance, run wires and cables in the wireways as established in *Chapter 1*.

Refer to Figure 3.8 for the power wiring diagram for your Ultra1500.

Wiring Motor Power

When using TL-Series motors refer to Figure 3.10 for your motor power cable configuration.

Figure 3.10
Motor Power Cable for TL-Series Motors (2090-DANPT-16Sxx)



To wire power from the drive to your motor:

1. Route the motor power cable to your Ultra1500 drive.

IMPORTANT	To ensure system performance, run wires and cables in the wireways as established in *Chapter 1*.

2. Ground the Shield lug on the motor end of the 2090-DANPT-16Sxx cable assembly to an unpainted, metallic machine frame near the motor. Refer to *Bonding Modules* on page 1-12 for recommended methods..

3. Using the connector tool (Wago 231-131 shown in Figure 3.9) provided with the drive, open the clamp for each of the terminal locations and attach wires as shown in the table below.

Insert the motor power wires from a TL-Series servo motor:	Into this terminal on the 4-pin Motor Power Connector
U / Brown	U
V / Black	V
W / Blue	W

IMPORTANT	Ensure motor power is wired with proper phasing relative to the motor terminals. On some motors, the motor leads may be labeled R, S, and T which correspond to U, V, and W respectively.

4. Connect the Ground wire to a terminal screw on the drive, and tighten the ground terminal screw to 1.25 Nm (11 lbs-in.).

5. Gently pull on each wire to make sure it does not come out of its terminal. Re-insert any loose wires.

6. Re-insert the Motor Power connector on the terminal block. The connector is keyed to prevent incorrect installation.

Understanding Feedback and I/O Cable Connections

Factory made cables with premolded connectors are designed to minimize EMI and are recommended over hand-built cables to improve system performance. However, other options may be available for building your own feedback and I/O cables. Refer to the table below for the available options.

Drive Connector	Connector Option	Option Catalog Number	Reference
CN1 I/O Connector	CN1 Control Cable, premolded cable with 50-pin connector to drive, flying leads to controller	2090-DAIO-D50xx [1]	• *Understanding Ultra1500 I/O Specifications* beginning on page 2-5.
	CN1 mini-D Connector Kit (50 pin solder cup type)	9101-1476	
CN2 Feedback Connector	CN2 Feedback Cable for TL-Series Motors, premolded cable with motor connector, and 20-pin connector at drive end.	2090-DANFCT-S*xx* [1]	• *Understanding Ultra1500 Motor Encoder Feedback Specifications* beginning on page 2-14.
	CN2 mini-D Connector Kit (20 pin solder cup type)	9101-1477	
CN3 Serial Connector	PC Cable, premolded cable with connectors both ends	2090-DAPC-D09*xx* [1]	• *Understanding the Ultra1500 Serial Interface* beginning on page 2-23.
	CN2 mini-D Connector Kit (20 pin solder cup type)	9101-1477	

1 Cable length (xx) is specified in meters: xx = 01, 03, 09, etc. Consult *Motion Control Selection Guide* (GMC-SG001*x*-EN-P) for additional information.

Commissioning Your Ultra1500

This chapter describes how to configure you Ultra1500 drive using Ultraware software. The chapter includes these sections:

- Applying Power to Your Ultra1500 Drive
- Detecting Your Ultra1500 Drive
- Configuring your Ultra1500 Drive
- Testing Your Motor

Applying Power to Your Ultra1500 Drive

This procedure assumes that you have:

- wired your Ultra1500 system,
- verified the wiring, and
- are ready to begin using the Ultraware software.

To apply power to your Ultra1500 drive:

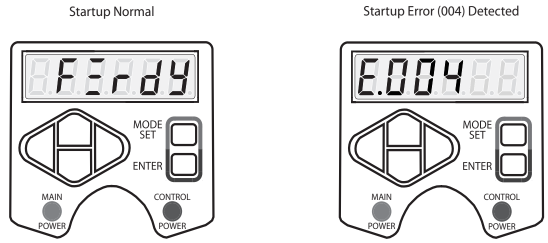
1. Disconnect any load to the motor.

IMPORTANT	Ensure the motor is free of all linkages when initially applying power to the system.

2. Apply main and control input power to the Ultra1500, and observe the Operator Interface on the front of the drive. The drive should enter a normal startup, as outlined below and shown in Figure 4.1.

If the Main Power, and Control Power LEDs are:	Then:
ON	Go to step 3.
OFF	Check your input power connections and repeat step 2, above.

Figure 4.1
Ultra1500 Operator Interface at Startup



3. Verify the status of the drive startup, as outlined below and shown in Figure 4.1.

If the six characters on the 7-segment display indicate:	Then:
rdY in the three least significant characters	The drive is ready. Go to *Detecting Your Ultra1500 Drive*
E. in the most significant character followed by a text string or error code number.	Refer to *Error Displays* on page 6-5 to troubleshoot the fault condition. Note: If a TL-Series motor is not connected, a fault condition is normal. Go to *Detecting Your Ultra1500 Drive*.

Detecting Your Ultra1500 Drive

This procedure assumes you have successfully applied power to your drive. Follow the steps below to ensure your Ultra1500 drive is communicating with your Ultraware software.

To detect your Ultra1500 drive:

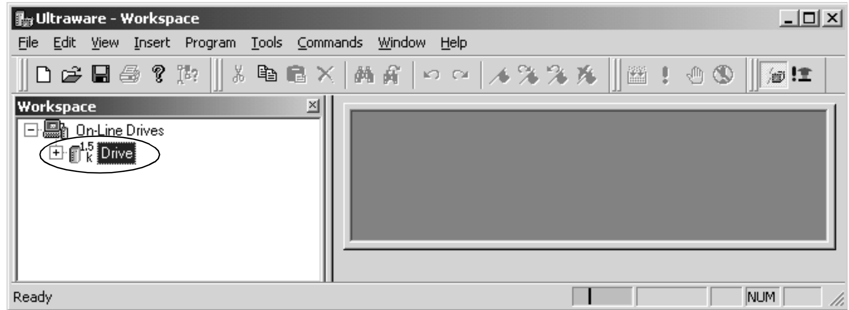
1. Start your Ultraware software.

   Note: Refer to the Ultraware Installation Instructions (publication 2098-IN002B-EN-P) and/or the Ultraware on-line Help for more information on installing and starting the software.

2. Ultraware will scan for on-line drives.

3. Click on the **Stop Scanning** button when your drive is detected, or wait for the scan to complete.

4. Look for the Ultra1500 icon (1.5k) under the On-Line Drives tree. The Ultra1500 icon indicates that your drive is detected.



5. 5.Click on the **[+]** next to the Ultra1500 icon to expand the branch menu (as indicated in the window above).

If your Ultra3000 drive:	**Then:**
Is detected and listed under the On-Line Drives tree	The software and hardware are communicating and the system is ready. Go to the section *Configuring your Ultra1500 Drive*.
Is not detected	Check your serial cable, and then repeat steps 1 through 5.

Configuring your Ultra1500 Drive

This procedure assumes you have power applied to your drive and the drive is detected by the Ultraware software.

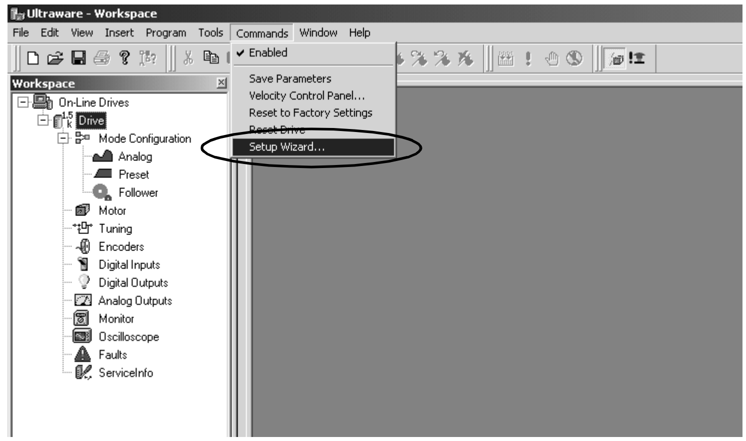
Ultraware software provides a simple yet powerful way to configure your Ultra1500 for a variety of applications. The Setup Wizard walks you through configuration screens that prompt you to make selections when appropriate. Typically, few adjustments are needed after using the Setup Wizard.

Note: In some applications, additional configuration may be necessary using the Ultraware properties setup screens.

To configure your Ultra1500 drive:

1. Start Ultraware software and allow it to detect the Ultra1500 drive.

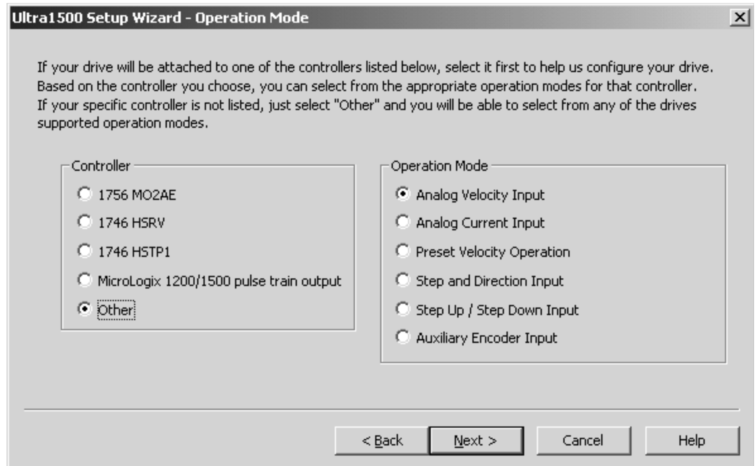
2. Invoke the Setup Wizard by highlighting the Drive branch, and then select the Setup Wizard from the Commands menu:



3. The initial step for the Ultraware Setup Wizard is to recommend resetting the drive parameters to factory settings.

- If this is a drive being configured for the first time, this step is not necessary.
- If this is a drive that has previously been configured, this step is strongly recommended.

4. Ultraware prompts for the type of Controller and the Operation Mode of the drive. The Controller selection helps Ultraware determine many of the drive settings. The Operation Mode setting dictates additional parameters that must be selected on subsequent screens.



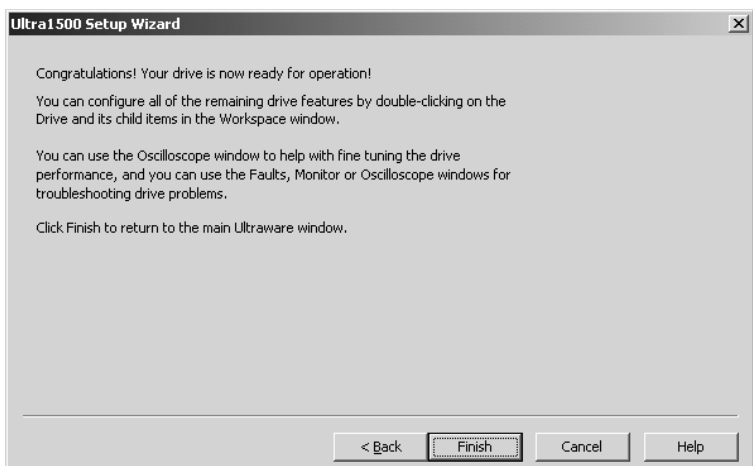
5. Depending on the Controller and Operation Mode selections, the next one or two screens prompt for configuration settings that are applicable.
   - Input scales are needed for Analog Current or Analog Velocity modes.
   - Gear Ratio is needed for Follower modes.
   - In the case of Preset Velocity mode, preset velocities and digital input assignments are required.

6. The Setup Wizard next prompts for a motor to be selected. If the drive is already connected to a TL-Series motor, the following screen appears:

7. After the motor is selected, the Setup Wizard allows an autotune procedure to execute. Autotune sets the tuning gains to values appropriate for the motor and load.

Note: In the case of Analog Current operation mode, this tuning step is not necessary, since the external controller is responsible for the velocity and position loops.

8. The Ultraware Setup Wizard is now complete, and the drive is ready for operation. In some applications, additional setup may be necessary.



Testing Your Motor

This procedure assumes:

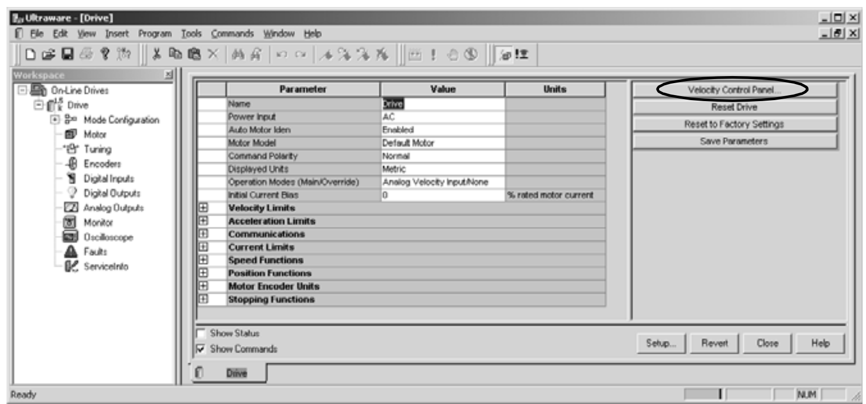
- Power is applied to the Ultra1500 drive,
- Ultraware software is running,
- Ultraware has detected the drive, and
- the Ultra1500 drive is configured.

In this procedure you enable the drive and set the motor velocity to test the motor.

Note: Refer to the Help file provided with Ultraware for more information on using the velocity control panel.

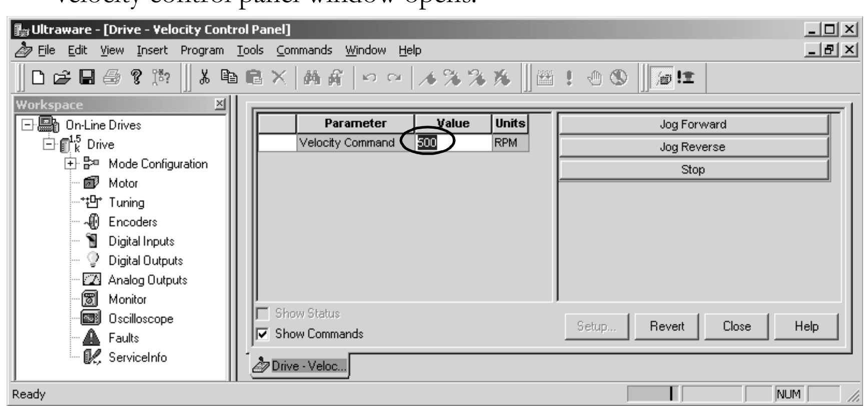
To test your motor:

1. Double-click the **Ultra1500 icon**. The Drive Properties window opens.



Note: Actual values depend on your application.

2. Select **Velocity Control Panel** (as indicated in the window above). The velocity control panel window opens.



3. Enter an appropriate low speed in the Velocity Command value field.

4. Activate the hardware ENABLE input to the drive.

   Note: The hardware ENABLE (Drive Enable in Ultraware) must be assigned to one of the general-purpose digital inputs.

5. Press the **Jog Forward** or **Jog Reverse** button.

6. Observe the motor. The motor should be moving at the speed (velocity) you entered in step 3.

7. Press the **Stop** button.

8. Inactivate the hardware ENABLE input, and verify the motor stops.

9. Close the Velocity Control Panel window.

Ultra1500 Application Examples

Chapter Objectives

This chapter provides instructions on using the Ultra1500 with various types of equipment as part of a digital servo system. This chapter includes these sections:

- ControlLogix 1756-M02AE System
- MicroLogix Follower
- Absolute Positioning
- Using the Internal Dynamic Brake
- Tuning Descriptions
- Control Block Diagrams

ControlLogix 1756-M02AE System

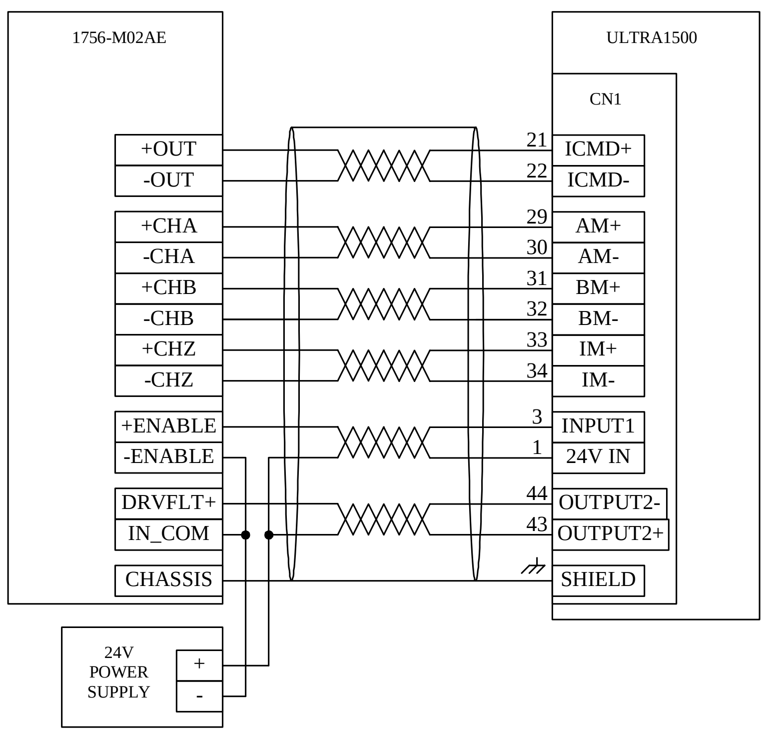
The Ultra1500 can be integrated into an Allen-Bradley ControlLogix PLC system using the 1756-M02AE Analog Encoder Servo Module. In this configuration, the drive can be operated in either Analog Velocity or Analog Current mode.

The Ultra1500 drive can be connected to a TL-Series motor with a battery-backed, multi-turn serial absolute encoder, and the absolute position can be provided to the ControlLogix system via the buffered encoder feedback connections. Refer to *Absolute Positioning* on page 5-16 for details on extracting the absolute position from the drive to a controller.

Control Connections

Figure 5.1 shows the recommended control wiring connections between the 1756-M02AE and the Ultra1500 when the drive is operated in Analog Current mode

Figure 5.1
Ultra1500 and 1756-M02AE Control Wiring Example.



In Figure 5.1, the 1756-M02AE provides a current command to the drive and the 1756-M02AE closes the velocity loop. Alternatively, the 1756-M02AE can provide a velocity command to the drive, and the drive can be responsible for the velocity loop closure. In that case, the 1756-M02AE command outputs should be connected to CN1 pins 19 and 20, instead of CN1 pins 21 and 22, and the Ultra1500 should be operated in Analog Velocity mode.

In this example, one general purpose input and one general purpose output of the Ultra1500 are used. INPUT1 must be configured to have Drive Enable functionality using Ultraware, and OUTPUT2 must be configured to have Ready functionality.

Configuring the Ultra1500

The Setup Wizard in Ultraware provides a quick method to configure the Ultra1500 for use with a ControlLogix system using a 1756-M02AE module. Refer to *Configuring the Ultra1500* on page 5-11 for setup details.

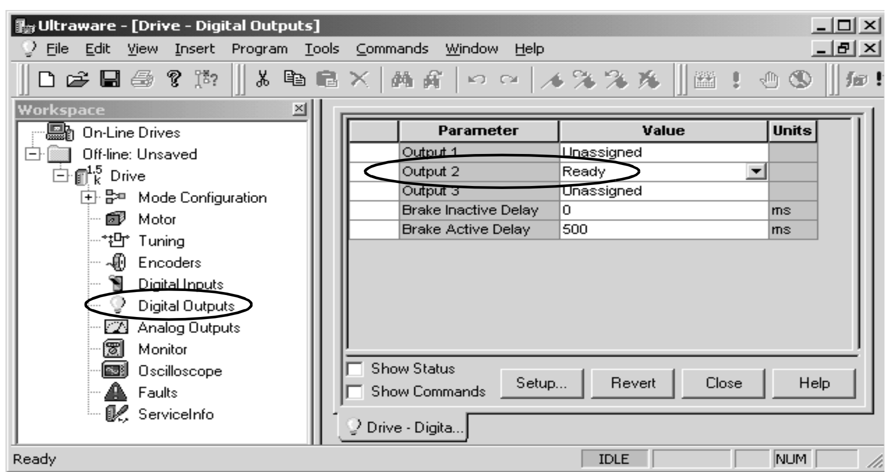
The Ultraware Setup Wizard will prompt for an Operation Mode setting. Either Analog Current mode or Analog Velocity mode is possible for use with the 1756-M02AE. This choice affects the configuration of the 1756-M02AE servo module, and the following section assumes that the Ultra1500 drive has been configured for Analog Current mode.

In addition to the configuration provided by the Setup Wizard, one of the digital outputs in the drive must be configured for Ready functionality.

1. Double-click on **Digital Outputs** icon in Ultraware to open the Digital Output properties window.

2. Select **Ready** as the value of Output 2.

Figure 5.2
Ultra1500 Digital Outputs Window



Configuring the 1756-M02AE

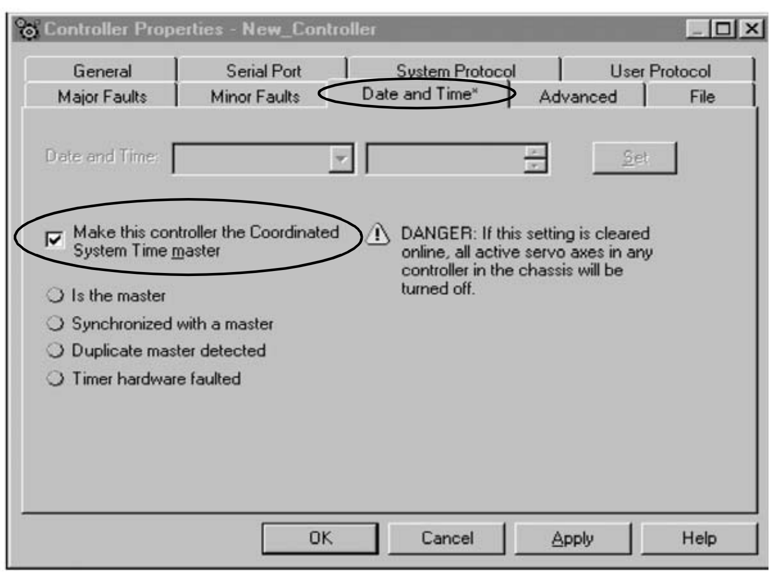
This procedure assumes that you have finished wiring and configuring your Ultra1500 drive. For greater detail on the RSLogix5000 software as it applies to

ControlLogix and SoftLogix modules, refer to the table below for the appropriate publication.

For:	Refer to this Document	Publication Number
Detailed information on configuring and troubleshooting your ControlLogix motion module	*ControlLogix Motion Module Setup and Configuration Manual*	1756-UM006*x*-EN-P
Detailed information on configuring and troubleshooting your SoftLogix™ PCI card	*SoftLogix Motion Card Setup and Configuration Manual*	1784-UM003*x*-EN-P

To configure your analog motion module and create a program including your 2092-DA*x* drive:

1. Apply power to your Logix chassis/PC containing the analog motion module and open your RSLogix5000 software.
2. Select **New** in the File menu. The New Controller window opens.
   - Select controller type
   - Name the file
   - Select the ControlLogix chassis size
   - Select the ControlLogix processor slot
3. Select **OK**.
4. Select **Controller Properties** in the edit menu. The Controller Properties window opens.
5. Select the **Date and Time** tab. The following window opens.



6. Check the box **Make this controller the Coordinated System Time master**.

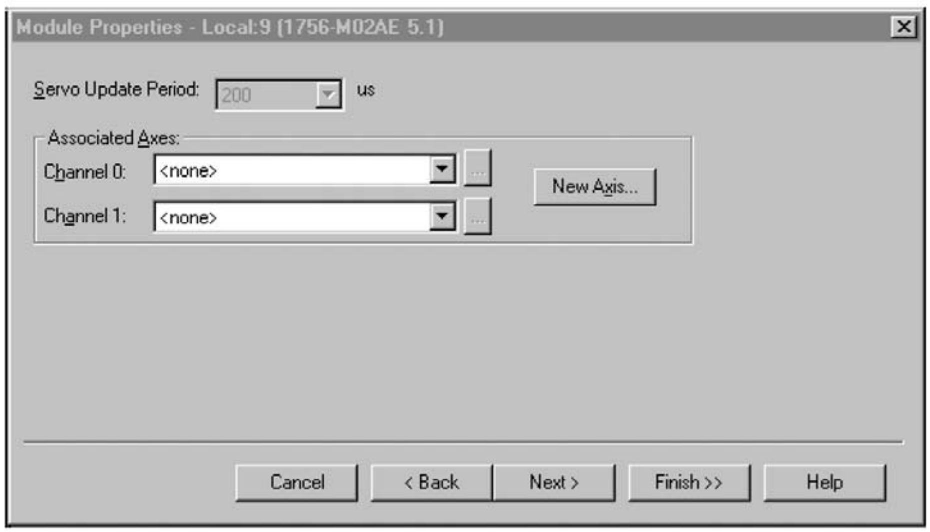
7. Select **OK**.

8. Right-click on I/O Configuration in the explorer window and select **New Module**. The Select Module Type window opens.

9. Select **1756-M02AE** or **1784-PM02AE** as appropriate for your actual hardware configuration.

10. Select **OK**. The Module Properties wizard opens.
    - Name the module
    - Select the slot where your module resides
    - Select an Electronic Keying option.

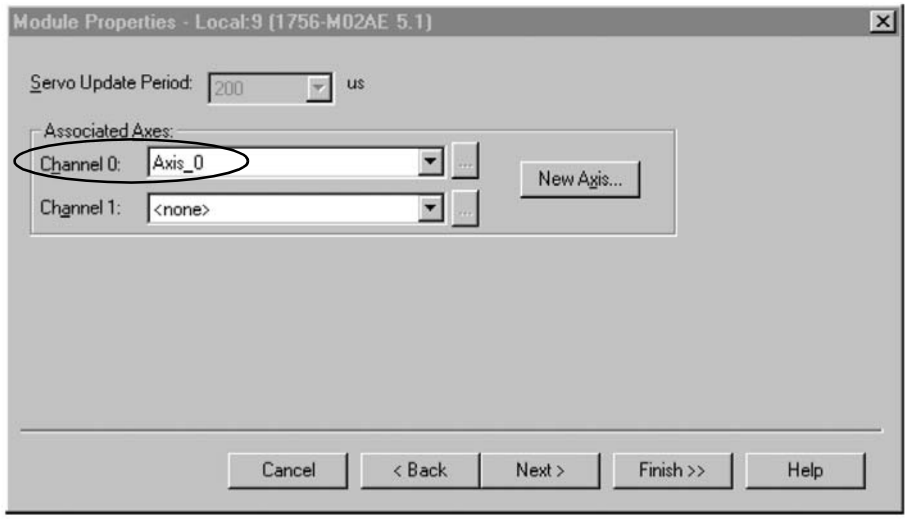
11. Select **Next** until the following Associated Axes window opens.



12. Select the **New Axis** button. The New Tag window opens.
    - Name the axis
    - Select AXIS_SERVO as the Data Type

13. Select **OK**.

14. Assign your axis to a node address (as shown in the Associated Axes window below).



15. Select **Finish**.

16. Right-click **Motion Groups** in the explorer window and select **New Motion Group**. The New Tag window opens.

17. Name new motion group.

18. Select **OK**. New group appears under Motion Group folder.

19. Drag-and-drop axis from Ungrouped Axis folder to your new Motion Group folder.

20. Download your program to the Logix processor.

Testing and Tuning Your Axis

This procedure assumes that you have configured your Ultra1500 and the analog motion module.

ATTENTION

Before proceeding with testing and tuning your axes, verify that the drive is not faulted.

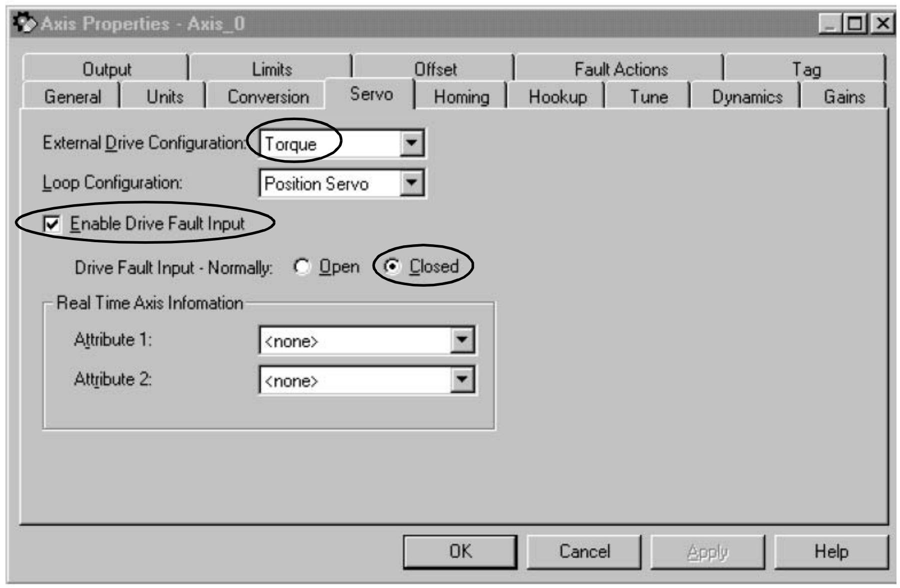
Note: For detailed testing and tuning information, refer to the appropriate Logix motion module setup and configuration manual for specific instructions and troubleshooting.

To test and tune your axis:

1. Remove the load from your axis.

2. Right-click on the axis in your Motion Group folder in the explorer window and select **Axis Properties**. The Axis Properties window opens.

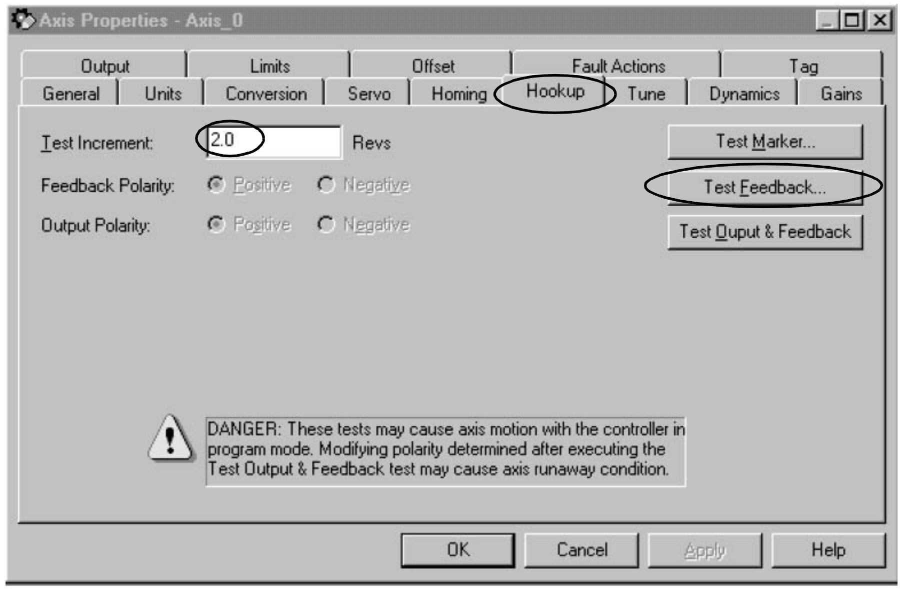
3. Select the **Servo** tab.



4. Select **Torque** as the External Drive Configuration.

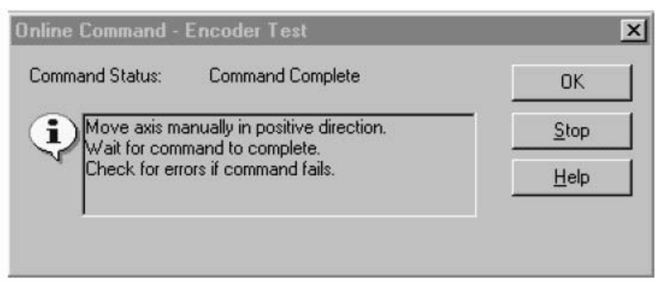
5. Check the box **Enable Drive Fault Input**, and select **Normally Closed**.

6. Select the **Hookup** tab.



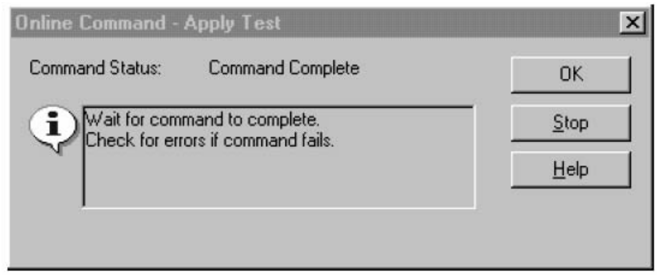
7. Select **2.0** as the number of revolutions for the test (or another number more appropriate for your application).

8. Select the **Test Feedback** button to verify feedback connections. The Online Command – Encoder Test window opens. When the test completes, the Command Status changes from Executing to Command Complete.



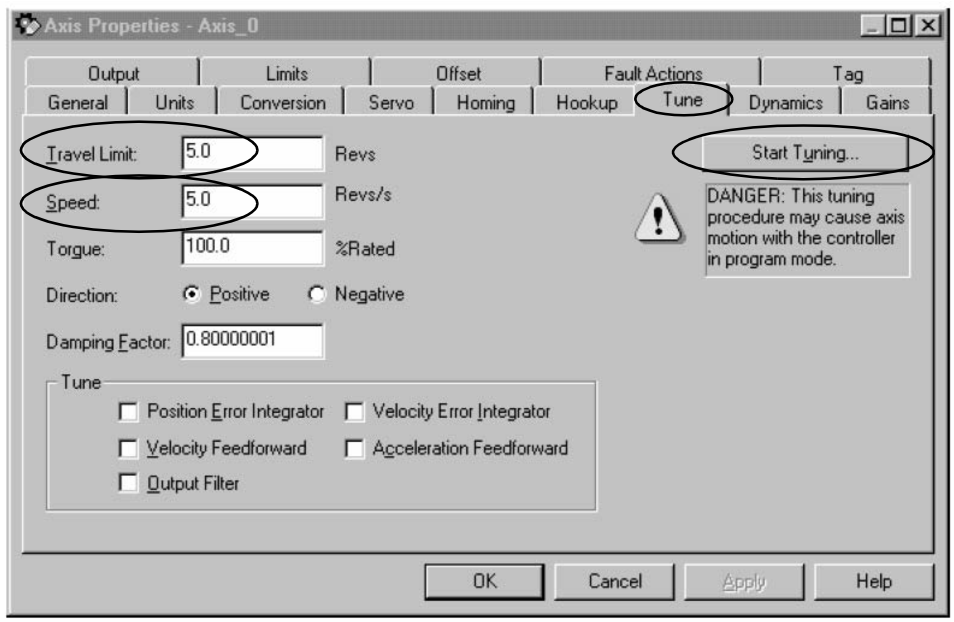
9. Select **OK**.

10. The Online Command – Apply Test window opens. When the test completes, the Command Status changes from Executing to Command Complete.



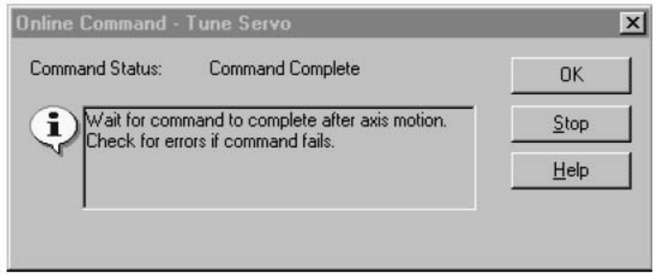
11. Select **OK**.

12. Select the **Tune** tab.

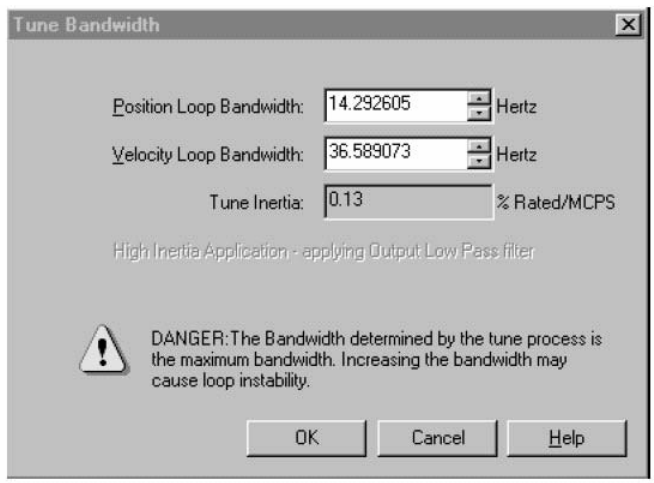


13. Enter values for Travel Limit and Speed. In this example the Travel Limit is 5 revs and the Speed is set to 5 revs/s.
Note: Actual values (Revs) depend on your application.

14. Select the **Start Tuning** button to auto-tune your axis. The Online Command – Tune Servo window opens. When the test completes, the Command Status changes from Executing to Command Complete.



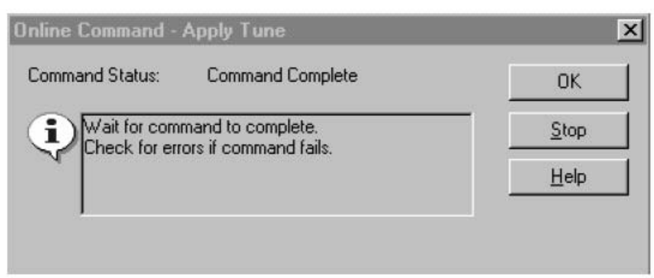
15. Select **OK**. The Tune Bandwidth window opens.



Note: Actual bandwidth values depend on your application.

16. Select **OK**.

17. The Online Command – Apply Tune window opens. When the test completes, the Command Status changes from Executing to Command Complete.



18. Select **OK**.

MicroLogix Follower

The Ultra1500 can be integrated into a MicroLogix PLC system as a positioning drive. The following MicroLogix devices offer pulse train output (PTO) capability:

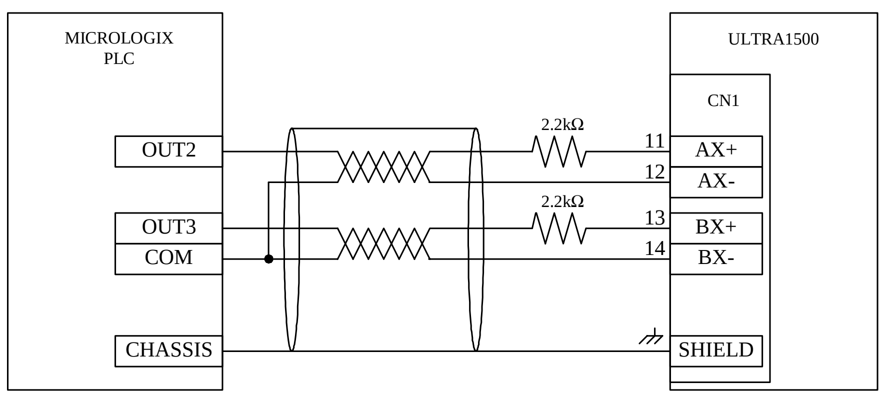
Programmable Logic Controller	Catalog Number
MicroLogix 1200	1762-L24BXB
	1762-L40BXB
MicroLogix 1500	1764-28BXB

In this configuration, the Ultra1500 drive is operated in Follower mode, and the controller provides step and direction commands to the drive.

Control Connections

Figure 5.3 shows the recommended connections for a typical system using a MicroLogix controller with the Ultra1500. The 2.2kΩ resistor is necessary in order to limit the current through the opto-isolator input of the Ultra1500, since the Ultra1500 AX and BX inputs are designed for 5V interfaces, and the MicroLogix outputs have 24V levels.

Figure 5.3
Ultra1500 to MicroLogix Control Wiring Example



Configuring the Ultra1500

The Setup Wizard in Ultraware provides a quick method to configure the Ultra1500 for use with a MicroLogix controller in follower mode. Refer to *Configuring the Ultra1500* on page 5-3 for setup details.

The Ultraware Setup Wizard will prompt for a Gear Ratio setting. The Gear Ratio parameter will determine how many motor encoder counts will result from each command count from the controller. Since the frequency of the pulse train output from the MicroLogix controller is limited to 20 kHz, the gear ratio will need to be set so that the maximum motor speed of the application requires less than a 20 kHz input frequency.

For example, a TL-Series motor with 131,072 counts/revolution and a maximum application speed of 5000 rpm will result in a motor encoder frequency of 10,922,667 counts/second. To maximize resolution, the Gear Ratio parameter should be set to 15:8192, as shown in the following equation.

$$\frac{20000Hz}{10992667Hz} = \frac{15}{8192}$$

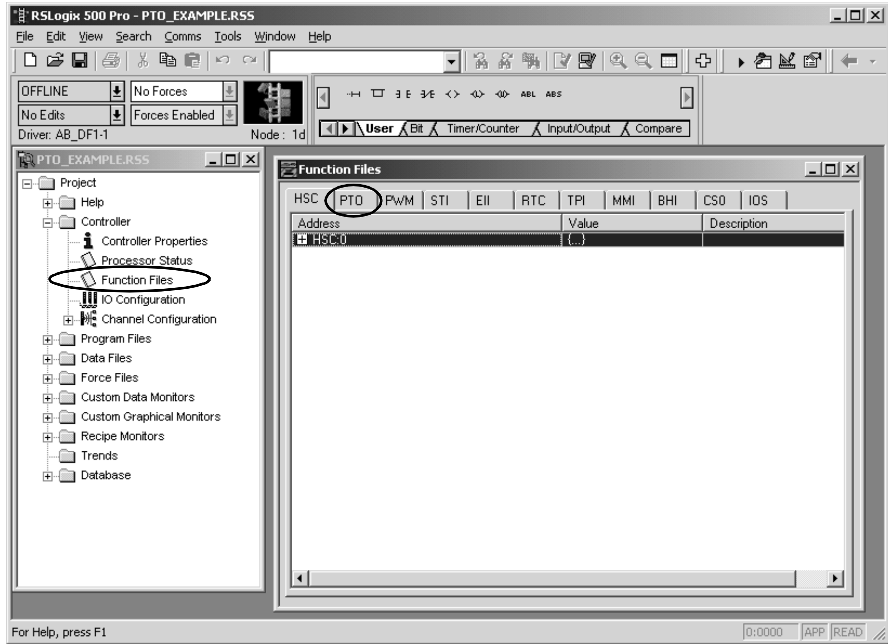
Configuring the MicroLogix Controller

This procedure assumes that you have finished wiring and configuring your Ultra1500 drive. For greater detail on the RSLogix500 software and MicroLogix 1200 and MicroLogix 1500 controllers, refer to the table below for the appropriate publication.

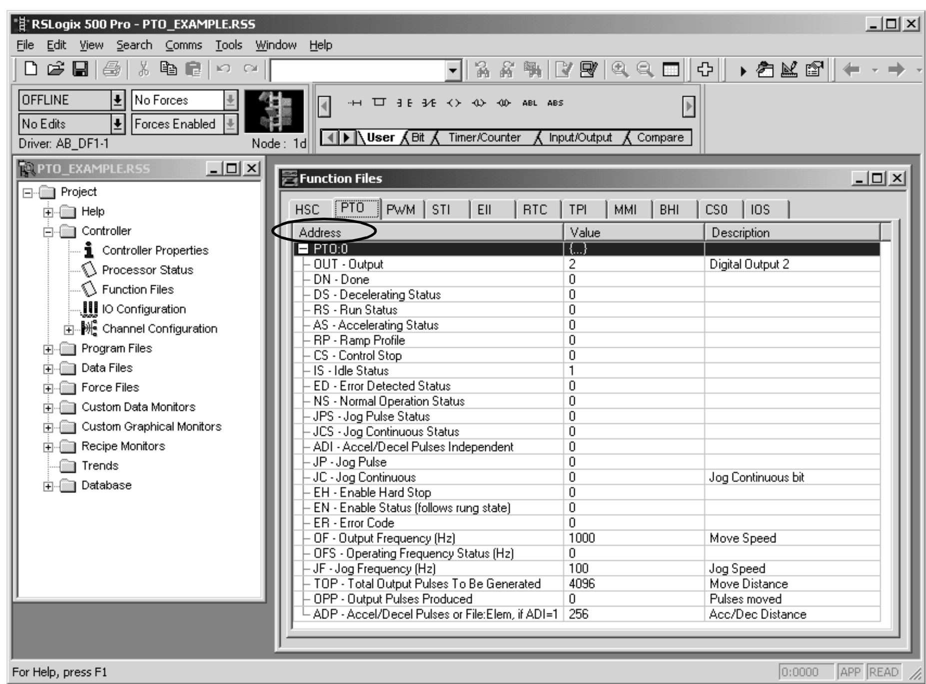
For:	Refer to this Document:	Publication Number:
Detailed information on configuring your MicroLogix 1200 PLC	*MicroLogix 1200 Programmable Controllers User Manual*	1762-UM001D-EN-P
Detailed information on configuring your MicroLogix 1500 PLC	*MicroLogix 1500 Programmable Controllers User Manual*	1764-UM001B-EN-P
Detailed information on the MicroLogix programming language	*MicroLogix 1200/1500 Instruction Set Reference Manual*	1762-RM001E-EN-P

The motion functionality of the MicroLogix 1200/1500 system is embedded in the Pulse Train Output (PTO) feature, which allows a frequency-controlled pulse stream to be output from the controller. In the RSLogix500 software, the

PTO configuration parameters can be accessed directly using the Function Files window found in the Controller folder of the project tree:



Select the **PTO** tab of the function files window to access all PTO-related configuration parameters:



The PTO settings are typically embedded in the program instructions, with some of the settings initialized at the start of the program, and others set according to the application needs.

The PTO functionality provides the pulse generation capability necessary for Step/Direction or Step Up/Step Down follower mode operation. The PTO feature allows a simple motion profile to be generated directly from the controller. The pulse profile has three primary components:

- Total number of pulses to be generated
- Accelerate/decelerate intervals
- Run interval

The total number of pulses to be generated (which corresponds to the distance traveled) is defined, as well as how many pulses to use for each acceleration/deceleration period. The number of pulses not used in the acceleration/deceleration period defines how many pulses will be generated during the constant velocity or run portion of the move.

The interface to the PTO sub-system is accomplished by scanning a PTO instruction in the main program file, or by scanning a PTO instruction in any of the subroutine files. A typical operating sequence of a PTO instruction is as follows:

1. The rung that a PTO instruction is on becomes true.
2. The PTO instruction is started, and pulses are produced based on the acceleration/deceleration (ACCEL) parameters, which define the number of ACCEL pulses and the type of profile: s-curve or trapezoid.
3. The ACCEL phase completes.
4. The RUN phase is entered, and the number of pulses defined for RUN is output.
5. The RUN phase completes.
6. Decelerate (DECEL) is entered, and pulses are produced based on the acceleration/deceleration parameters, which defines the number of DECEL pulses and the type of profile: s-curve or trapezoid.
7. The DECEL phase completes.
8. The PTO instruction is DONE.

Testing Your Axis

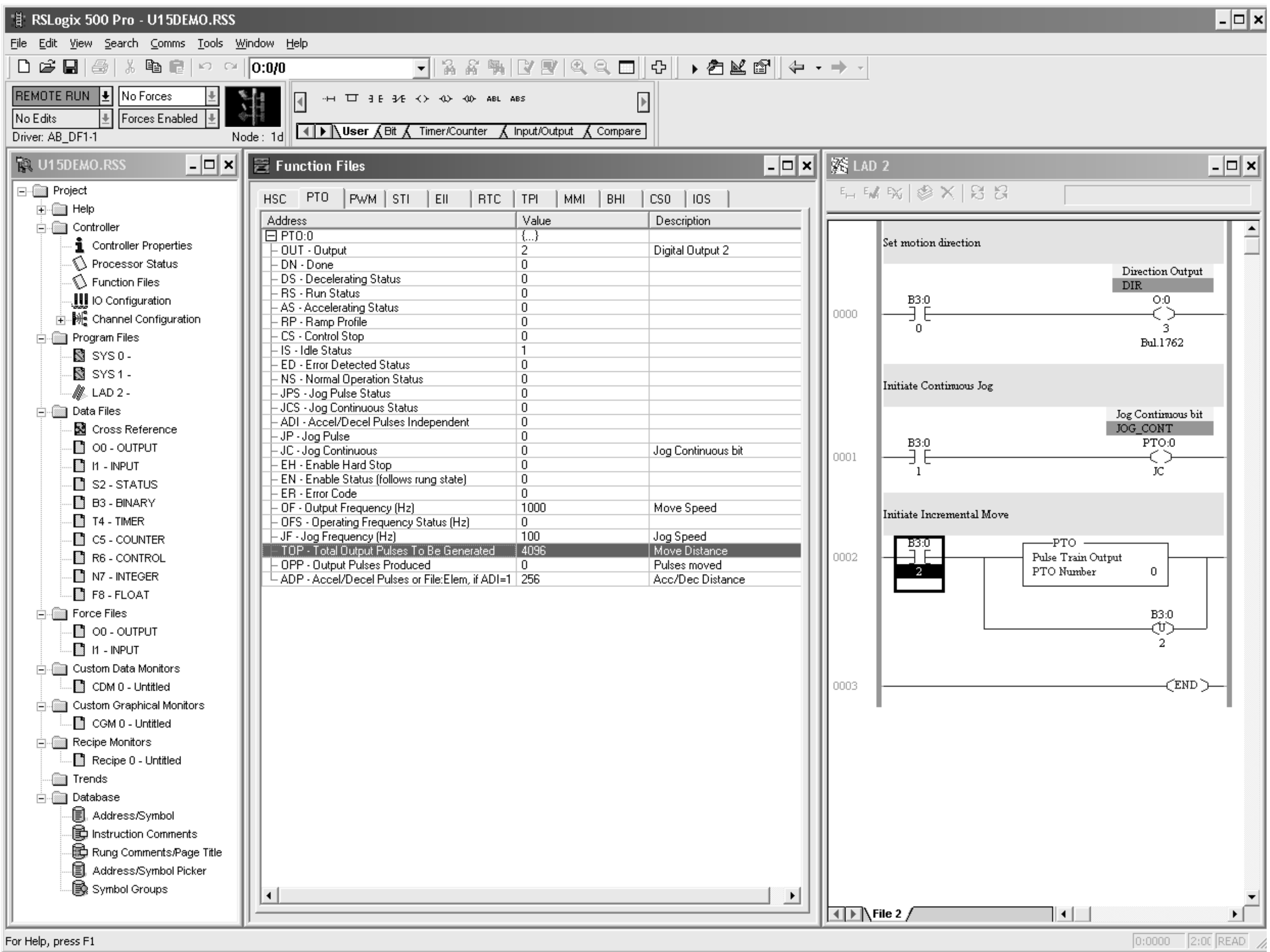
This procedure assumes that you have configured your Ultra1500 and the MicroLogix controller, and have previously tested your drive-motor interface.

Refer to *Testing Your Motor* on page 4-7 to verify that the drive and motor are operating normally.

ATTENTION

Before proceeding with testing your axis, verify that the drive is not faulted.

To test your axis, a very simple program can be written using the RSLogix500 software to jog the axis in both directions, using the Jog capability of the PTO functionality, as shown in the following figure:



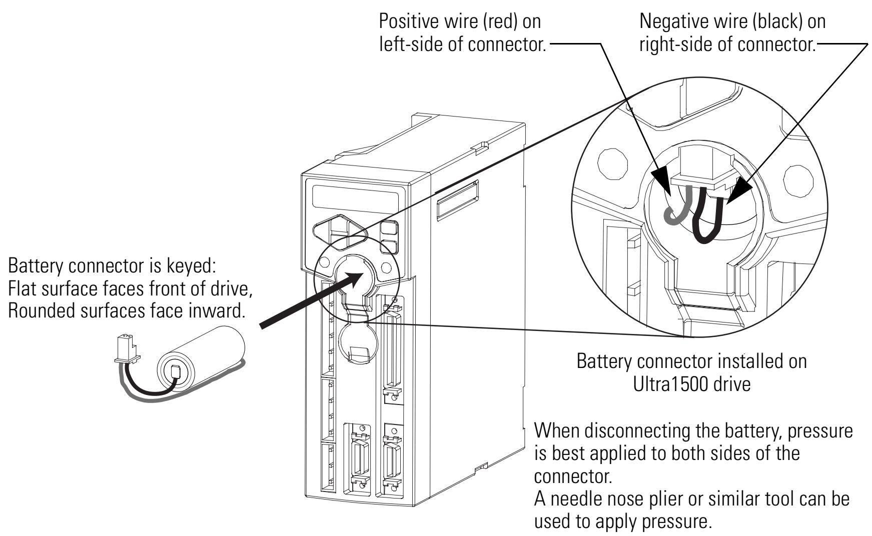
Absolute Positioning

The Ultra1500 can be used with the TL-Series motors, which have serial encoders with battery-backed, multi-turn absolute position capability. The absolute position of the motor is read from the encoder by the drive, and the drive in turn provides the absolute position to the external controller.

Encoder Battery Installation

In order to make use of the multi-turn absolute capability of the TL-Series motors, a 3.6V battery must be connected to the motor. The Ultra1500 provides two methods to connect a battery. The easiest method is to install a ½-size AA lithium battery, as shown in Figure 5.4, in the battery compartment of the Ultra1500.

Figure 5.4
Ultra1500 Battery Installation.



To install a new battery, or replace an existing battery; perform the following steps:

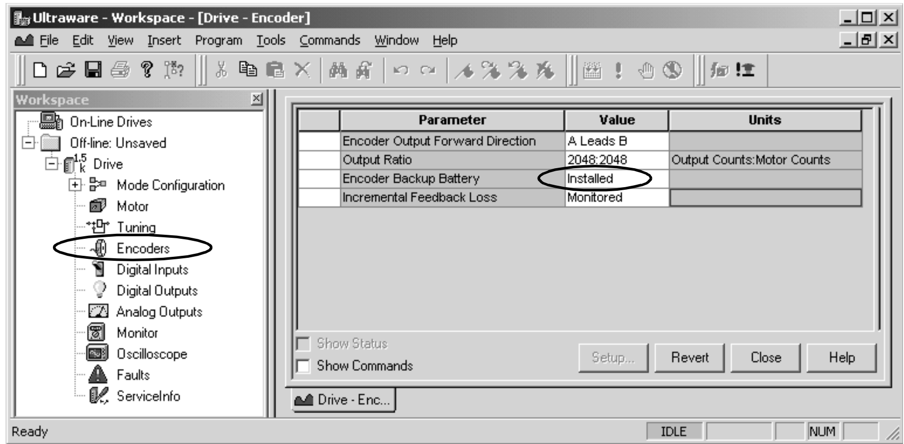
1. For a new installation or if a battery low voltage fault has occurred, remove main and control AC power from the drive. Otherwise, if this is a maintenance update or if a battery low voltage warning has occurred, remove only the main AC power but retain the control AC power so that the absolute position of the motor is not lost when the existing battery is disconnected.

2. Open the BATT compartment door. See Figure 5.4 for location. If the battery needs to be removed, disconnect battery by carefully pulling downward on the connector. Slightly raise the BATT door for clearance, and slide battery out of the drive. Note: Pressure is best applied to both sides of the connector. A needle nose pliers or similar tool can be used to apply pressure.

3. Identify the polarity of the new battery and its connector as shown in the figure, and then slide the battery into the drive.

4. Affix the connector as shown in the figure, and close the BATT compartment door.

5. If this is a new installation, make sure that the Encoder Backup Battery parameter is set to Installed in the Encoders window of Ultraware.



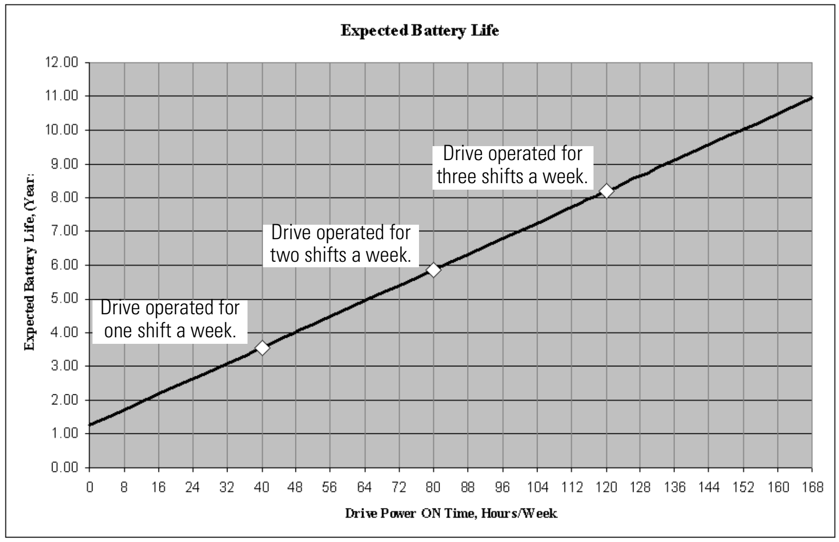
6. If this is a new installation or if a battery low voltage fault occurred, the axis must be homed to establish the absolute reference position for motion.

Instead of using the battery compartment of the Ultra1500, an external 3.6V battery can be connected to pins 25 and 49 of the CN1 connector of the Ultra1500 drive. This method allows a potentially larger capacity battery to be used, for example if extra long battery life is desired.

Encoder Battery Life

The absolute encoder used in the TL-Series motors requires a small amount of current from the battery. When the control power is not present in the drive, the only encoder power is from the battery and the current draw is approximately 100A. The current draw is substantially less when the control power of the drive is applied, and is typically less than 10A. Therefore, the expected battery life will depend on the amount of time that the drive has control power applied, as shown in Figure 5.5.

Figure 5.5
Ultra1500 Expected Battery Life



In Figure 5.5, three data points are highlighted. For example, if the control power of the drive is applied for 40 hours per week, (and the encoder uses battery power the remaining 128 hours in the week), the expected battery life is about 3.5 years. In applications where machine downtime is a concern, replacing the battery once a year or once every two years may be a prudent measure to avoid any interruption.

Battery Voltage Loss Detection

The encoder in the TL-Series motors monitors the battery voltage at all times, and supplies the Ultra1500 drive with battery status that is in turn relayed to the user through the status display of the drive.

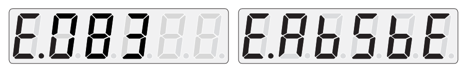
ATTENTION

The upper controller is responsible for managing the system behavior in the event of a loss of absolute position, which may require re-homing of the machinery to avoid incorrect motion.

If the battery voltage is above 3.1 Volts, the encoder will be satisfied with the battery voltage and no warnings or errors are reported.

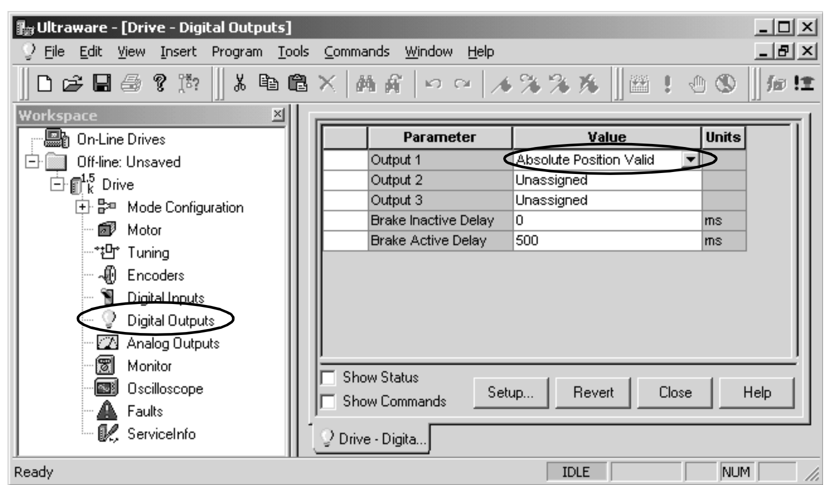
If the battery voltage is between 2.8 Volts and 3.1Volts, the encoder will transmit a battery warning to the drive, which is indicated to the user via the status display as the warning message:

If the battery voltage is less than 2.8 Volts, the encoder will transmit a battery error to the drive, which is indicated to the user via the status display as the error message:



Since the battery is stored in the drive and the motor feedback cabling provides the battery voltage to the encoder, it is important to note that any disconnection of the motor feedback connectors at the drive end or motor end will result in a battery error. The encoder latches a battery fault condition, and a Fault Reset must be issued to the drive in order to clear the fault in the encoder. (A simple power cycle will not clear the battery error, even if the battery is replaced or reconnected.)

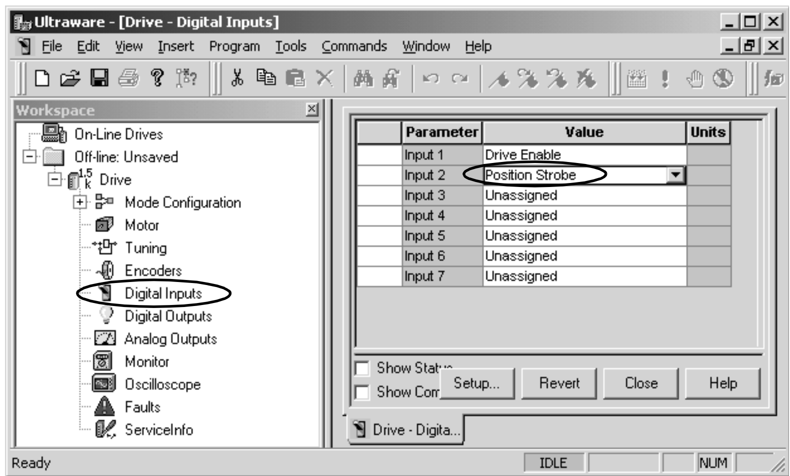
The Ultra1500 provides a method for an external position controller to monitor the state of the absolute position feedback, in order to determine if a loss of absolute position has occurred. Using Ultraware, the Absolute Position Valid signal can be mapped to a digital output as shown in the figure below:



This signal is used by the controller to indicate when absolute position motion is not possible, and a homing procedure is necessary.

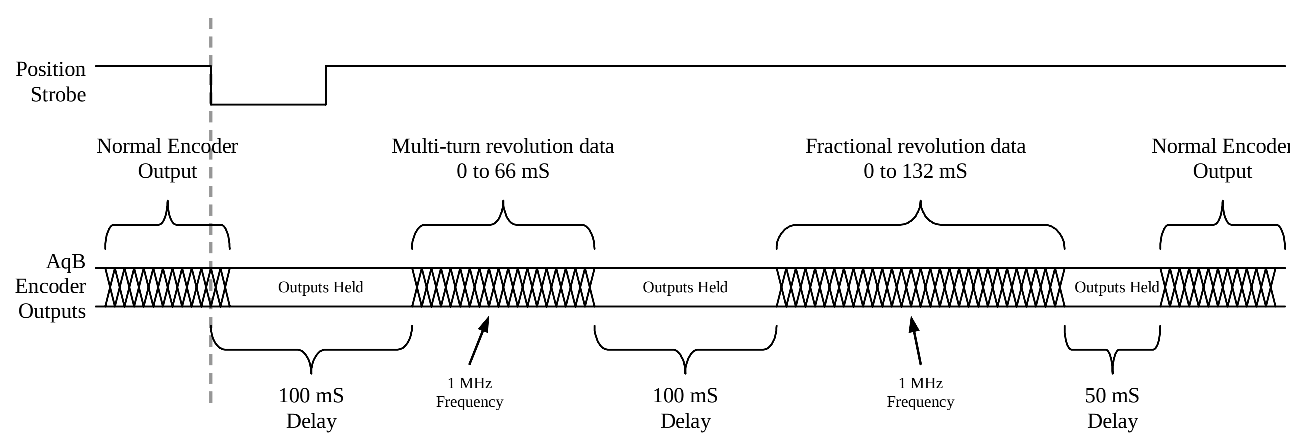
Extracting Absolute Position from the Drive

The absolute position of the Ultra1500 can be extracted via the encoder outputs on pins 29 through 32 of connector CN1 using a digital input of the drive to request the transfer. Refer to See Figure 5.1 on page 5-2 for an example of this using the 1756-M02AE Analog Encoder Servo Module.
A digital output of the controller must be connected to one of the general purpose inputs of the drive. (If the PLC digital output is active high, it must be converted with an external circuit to active low to properly drive the Ultra1500 input.) This digital input must be assigned to have Position Strobe functionality:



The active-going transition (an active state is when the opto-isolator is turned ON and the input voltage is 0V) of the Position Strobe input starts a time-based sequence in which the absolute position data is transferred via the A and B encoder outputs of the drive, as shown in Figure 5.6.

Figure 5.6
Ultra1500 Absolute Position Extraction Timing Diagram



In Figure 5.6 it can be seen that the drive hardware and firmware executes the following sequence when the active-going transition of the Position Strobe input is detected:

1. Hold the encoder outputs for 100 ms. The delay provides time for the controller to prepare its counter to receive multi-turn data.

2. Output the multi-turn revolution data at a fixed output frequency of 1,000,000 counts/second. The length of time for this process step will be determined by the multi-turn revolution data. (If the multi-turn revolution data is -1 revolutions, a value of 65535 will be transmitted, resulting in the maximum time of 66 ms.)

3. Hold the encoder outputs for 100 ms again. This delay provides time for the controller to read the multi-turn data, and to prepare to receive single-turn data.

4. Output the fractional revolution data at a fixed output frequency of 1,000,000 counts/second. The length of time for this process step will be determined by the fractional revolution data. (If the fractional revolution data is 131071 counts, this step will take the maximum time of 132 ms.)

5. Hold the encoder outputs for 50 ms.

6. The encoder outputs are allowed to track the motor encoder inputs.

ATTENTION

The Ultra1500 does not track any movement of the motor during the absolute position transfer, which can take up to 450ms. During this transfer, the motor should not be moved and the Ultra1500 should be disabled.

Therefore, the following algorithm can be used by a controller to extract the absolute position from the drive:

1. Ensure that the Ultra1500 drive is disabled, and the motor is stationary. Any movement of the motor during the absolute transfer process will not be accounted for by the controller, since the motor encoder inputs are ignored by the drive during the transfer.

2. Set the digital output of the controller inactive, which means that the Position Strobe function is off. The A and B encoder outputs of the drive may still change state.

3. Change the state of the digital output of the controller to active, (meaning that the input voltage to the drive is 0 Volts and the opto-isolator is turned ON). This active-going edge will start a time-based sequence in which the absolute position data is transferred via the A and B encoder outputs of the drive.

4. Delay 10 ms from the active-going edge of the position strobe, then zero the position counter of the controller.

5. Delay an additional 175 ms. During this time the drive will increment the counter in the position controller to correspond to the number of revolutions of the motor shaft from the zero position.

6. Read the value of the position counter in the controller. Multiply this value by the number of motor encoder counts per revolution. (In a ControlLogix application, this is specified as the “Conversion Constant” for the axis.) The counter value should be interpreted as a 16 bit signed number. (In a ControlLogix environment, assign the result of the multiplication to a temporary variable declared as type INT.) The result is a signed value corresponding to the number of revolutions.

7. Clear the controller position counter in preparation for receiving the fractional portion of a revolution.

8. Delay another 240 ms. During this time the drive will increment the position counter to correspond to the fractional portion of a revolution of the motor shaft from the zero position.

9. Read the value of the position counter and add this to the revolution count saved in step 6. Set the position counter to this value.

10. The position counter should now be tracking the absolute position of the drive.

Using the Internal Dynamic Brake

The Ultra1500 incorporates a dynamic brake relay that can short together the motor windings under certain conditions. The circumstances in which the dynamic brake relay is employed are selectable by the user.

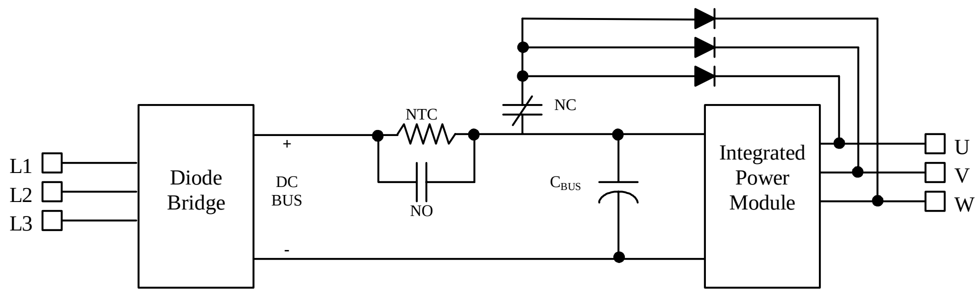
ATTENTION

The internal dynamic brake relay does not qualify for any safety certification. Implementation of safety circuits and risk assessment is the responsibility of the machine builder. Reference international standards EN1050 and EN954 estimation and safety performance categories. For more information refer to *Understanding the Machinery Directive* (publication SHB-900).

Basic Circuit Operation

Figure 5.7 shows the internal arrangement of the dynamic brake relay, indicated by the NC label. When the dynamic brake relay is engaged, (in the NC, or normally closed, position), the three motor phases are shorted together through diodes. The diodes in the integrated power module (IPM) in conjunction with the three diodes shown in the figure, effectively short the motor windings to each other and also to the positive terminal of the DC bus.

Figure 5.7
Ultra1500 Dynamic Braking Relay Circuitry



In the figure, it is important to notice that the dynamic brake relay contacts utilize the same controlling coil as the soft-start thermistor circuitry. This interdependence can be important in certain applications. The possible states of the dynamic brake and soft start contacts are as follows:

Condition	Soft-Start Circuitry	Dynamic Brake Circuitry
Control power not applied to drive.	The thermistor isolates the bus capacitance from the AC inputs and the current is restricted by the thermistor impedance.	The motor windings are shorted together to the positive DC bus level through diodes.
Control power applied to drive, and the relay coil is not energized by the firmware because one of the following conditions exists: 1. Drive is disabled and Fault and Disable Braking selection is Brake and Hold. 2. Drive is disabled, Fault and Disable Braking selection is Brake and Release, and motor speed is nonzero. 3. Drive is disabled, Fault and Disable Braking selection is Free Stop and Hold, and the motor is stopped.	The thermistor isolates the bus capacitance from the AC inputs and the current is restricted by the thermistor impedance.	The motor windings are shorted together to the positive DC bus level through diodes.
Control power applied to drive, and the relay coil is energized by the firmware because one of the following conditions exists: 1. Drive is enabled. 2. Drive is disabled and Fault and Disable Braking selection is Free Stop. 3. Drive is disabled, Fault and Disable Braking selection is Free Stop and Hold, and motor speed is nonzero. 4. Drive is disabled, Fault and Disable Braking selection is Brake and Release, and the motor is stopped.	The thermistor is shorted out by the relay contacts, and the current between the AC inputs and the bus capacitance is not restricted.	The motor windings are isolated from each other.

Circuit Protection

The Ultra1500 will not allow the drive to be enabled if the motor characteristics are such that the dynamic braking circuitry could be damaged in the event of a stop. (Even if the Fault and Disable Braking parameter of the drive is set to Free Stop, a loss of control power will also activate the dynamic braking circuitry.)

ATTENTION

The Ultra1500 dynamic braking circuitry was designed to operate with the TL-Series motor family with reasonable load inertias and stopping frequencies. If your application requires high load inertias (greater than 10:1) and/or stopping frequencies greater than once every 5 minutes, consult your Allen-Bradley representative before using the internal dynamic brake circuitry.

The current required to stop the motor is dependent on several motor characteristics such as speed, inductance, resistance, and back-EMF constant. The drive uses the following formula to determine if the stopping current will exceed the circuit ratings:

$$[2 \cdot I_{Peak}]^2 < \frac{[K_E \cdot V_{Max}]^2}{R^2 + [\omega_E L]^2}$$

where:

I_{Peak} = intermittent current rating of the drive in Amps (0–peak)

K_E = phase-neutral back-EMF constant of the motor in Volts/rpm or Volts/m/s (0–peak)

V_{Max} = maximum speed of the motor in rpm or m/s

R = motor phase-neutral resistance in Ohms

L = motor phase-neutral inductance in Henries

ω_E = maximum electrical frequency of the motor in radians/second.

The maximum electrical frequency can be expressed as follows:

$$\omega_E = \frac{V_{Max} \cdot \frac{2\pi}{60}}{P/2} \qquad (rotary \quad motors)$$

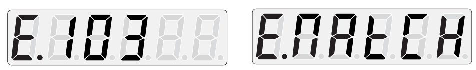
$$\omega_E = V_{Max} \cdot \frac{2\pi}{D} \qquad (linear \quad motors)$$

where:

P = pole count of the motor

D = electrical cycle length of the motor in meters.

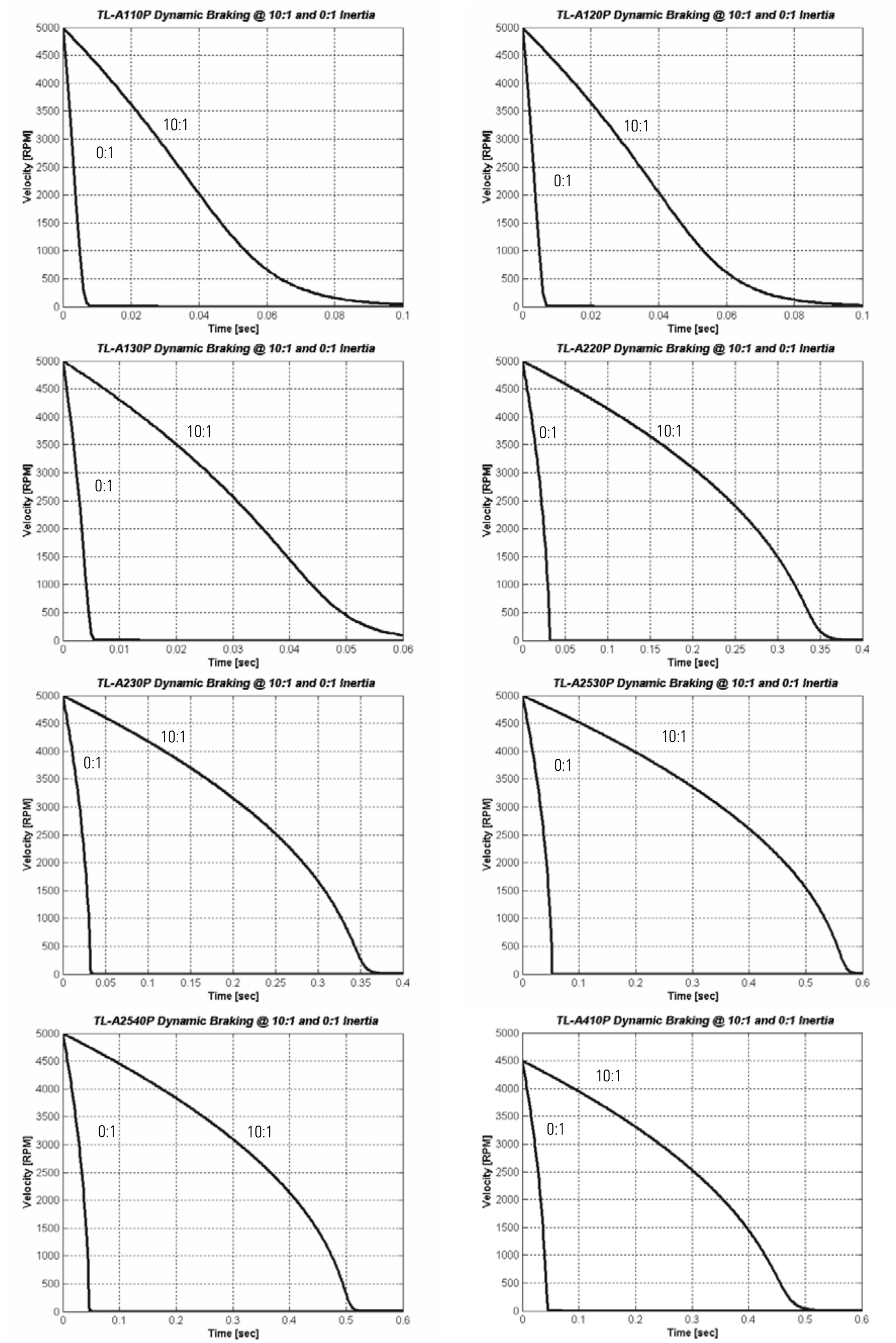
If the drive detects that the stopping current is excessive, the drive-motor match fault will be displayed when a Drive Enable is attempted:



Stopping Profiles

Figure 5.8 depicts calculated stopping profiles for TL-Series motors when used with the Ultra1500. If the load: motor inertia ratio is greater than 10:1, the stopping time will be longer and additional heating will occur in the drive. Repetitive stopping rates should not exceed one stop every 5 minutes. A brief flurry of 2–3 stops within a minute will not damage the drive, as long as the inertia ratio is less than 10:1 and an adequate period of time with no stopping follows.

Figure 5.8
Dynamic Braking Times from Maximum Velocity



Tuning Descriptions

This section provides explanations of the Ultra1500 tuning parameters available for adjustment.

Current Regulator Settings

Although the current regulator of the Ultra1500 is automatically tuned using the electrical parameters of the motor, there are three settings available to the user:

- Gain
- Low Pass Filter Bandwidth
- Resonant Frequency Suppression

Gain

The Gain parameter lowers the current loop bandwidth from its optimum setting, and can be set to Low, Medium, or High. The default value of High results in a bandwidth of approximately 2 kHz. The Medium setting results in a 33% reduction from the High setting. The Low setting results in a 67% reduction from the high setting. This parameter can de-tune the current regulator to reduce audible noise at the expense of performance. Some linear motor systems have particularly high levels of acoustic noise, and the application may require quieter operation. The velocity and position loops should be re-tuned after changing this parameter.

Low Pass Filter Bandwidth

The Low Pass Filter Bandwidth parameter sets the cutoff frequency of the pass filter that is applied to the current command input for the current regulator. It can be set in the range 0–10,000 Hz. The filter is disabled when this value is set to 0. This filter reduces noise generated by low encoder resolutions or mechanical resonance in the system. This filter setting also limits the current loop bandwidth. The velocity and position loops should be re-tuned after changing this parameter.

Resonant Frequency Suppression

The Resonant Frequency Suppression parameter sets the center frequency of a stop-band (notch) filter that is applied to the current command input for the current regulator. It can be set in the range 0–10,000 Hz. This filter attenuates a narrow band of frequencies centered at the parameter setting. It is useful to reduce the effects of a mechanical resonance.

The Ultraware screen capture in Figure 5.9 shows the velocity feedback and current command for a load with a mechanical resonance at approximately 458 Hz. The motor is rotating at approximately 200 rpm with a light torque load.

Figure 5.9
Resonance Effects at 200rpm

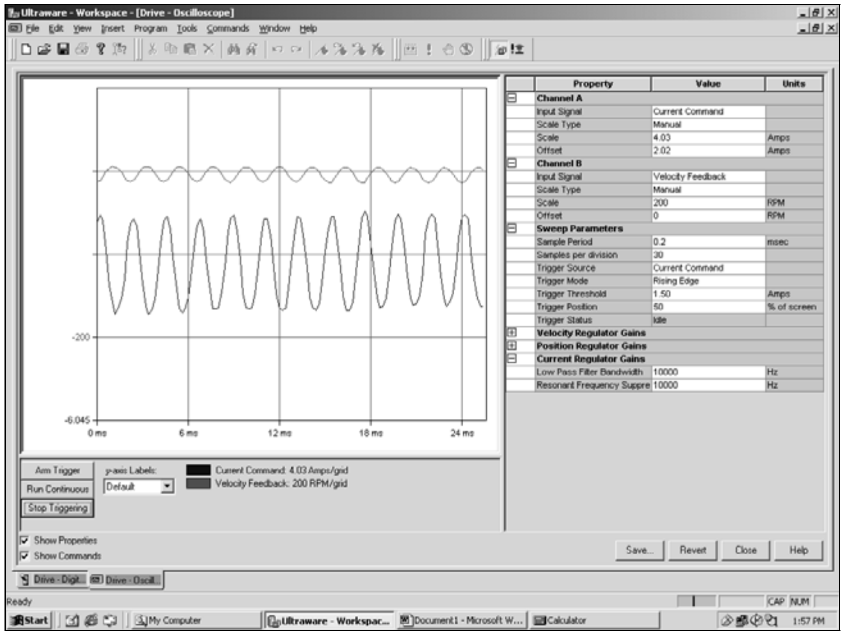


Figure 5.10 shows the effect of the Resonant Frequency Suppression filter. The Resonant Frequency Suppression parameter is set to 458 Hz, the Low Pass Filter is set to 10000 Hz. The current and velocity waveforms appear very smooth as compared to the original waveforms.

Figure 5.10
458 Hz Notch Filter Setting.

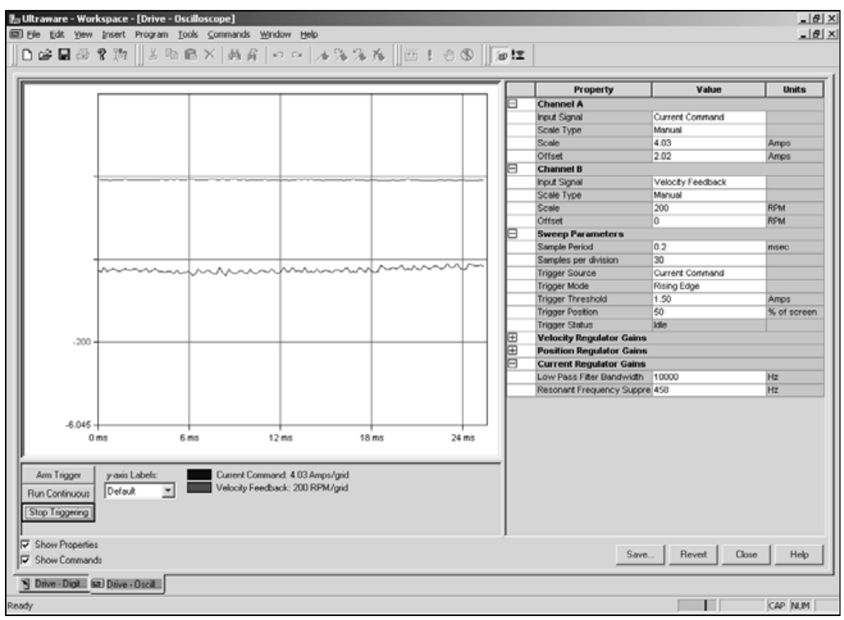
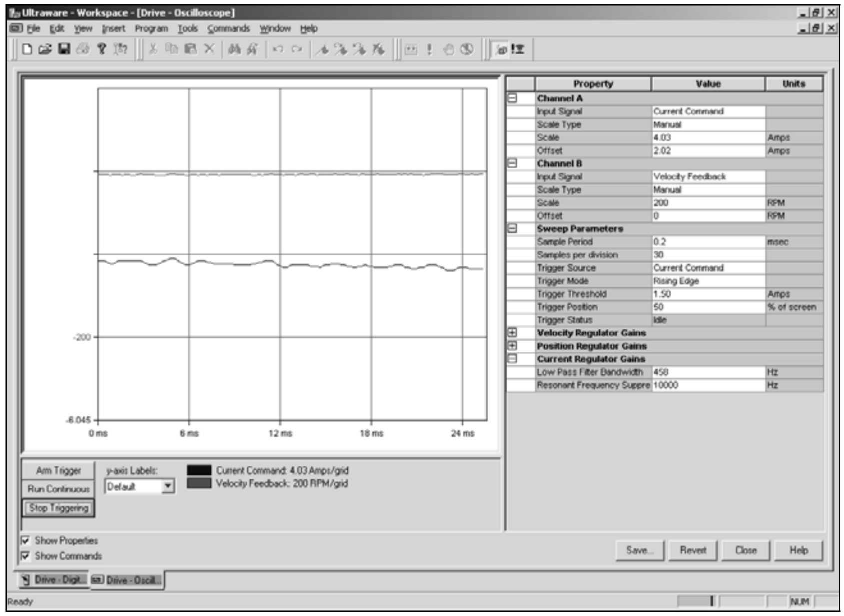


Figure 5.11 shows the effect of the Low Pass Filter. The Low Pass Filter parameter is set to 458 Hz, and the Resonant Frequency Suppression is set to

10000 Hz. The current and velocity waveforms appear very smooth as compared to the original waveforms.

Figure 5.11
458 Hz Low Pass Filter Setting



Velocity Regulator Settings

The velocity regulator includes the following parameters available for adjustment by the user:

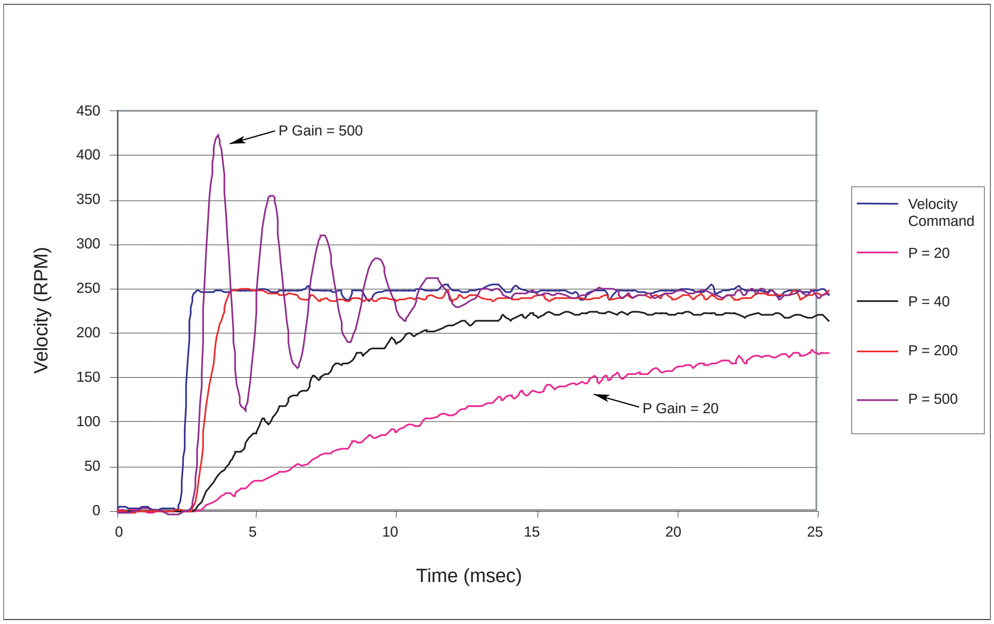
- P Gain
- Integrator Time
- Integrator Mode
- Integrator Threshold
- D Gain
- Low Pass Filter Bandwidth

P Gain

The P Gain parameter sets the proportional response of the velocity regulator. It can be in the range of 0–500. The regulator uses this gain to generate an acceleration command proportional to the velocity error. Larger gains result in larger acceleration commands, a faster response, and increasing stiffness of the system for a given velocity error. P Gain settings that are too large may cause instability, while settings that are too small may result in loose or sloppy system dynamics.

Figure 5.12 shows the effect of varying the P Gain to the velocity step response, with the Integral Time and D Gain set to zero. The response takes more time to approach the command value for smaller values of P Gain and responds more quickly with higher values. Excessive P Gain can result in instability and an oscillatory response.

Figure 5.12
Velocity Regulator Step Response with Varying P Gain.



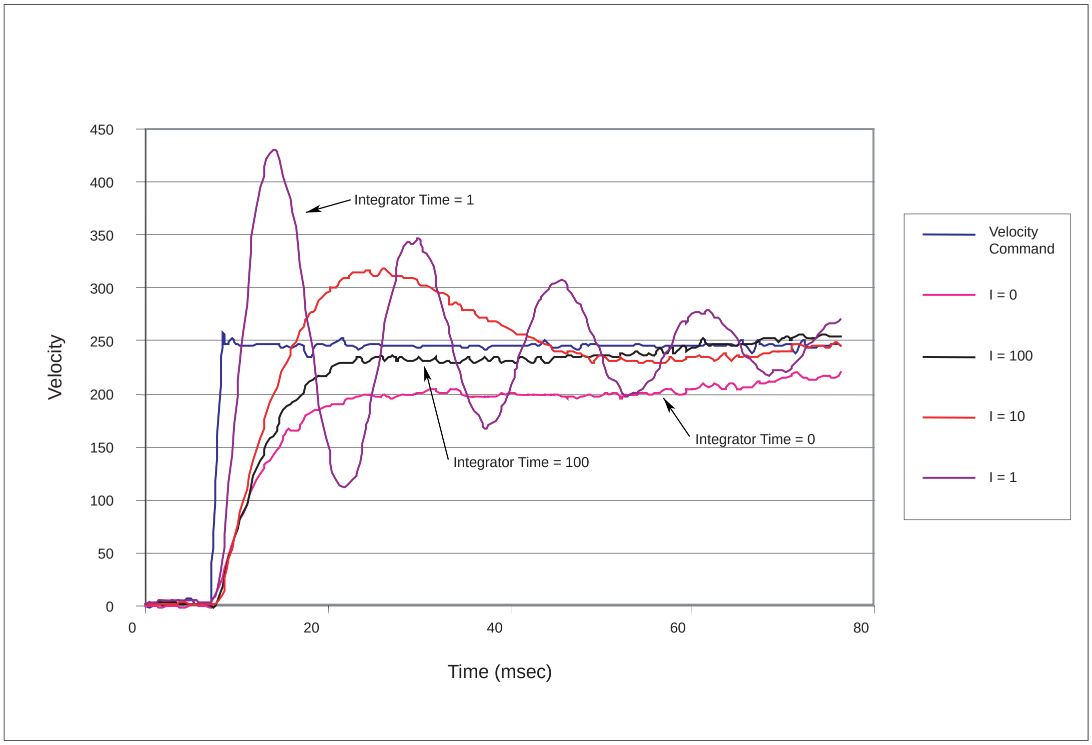
Integrator Time

The Integrator Time parameter sets the integral response of the velocity regulator. It can be in the range 0–60,000. This parameter setting has an inverse relationship to amount of Integral Gain in the regulator. Smaller values result in more Integral Gain and less stability. Larger values result in less Integral Gain and more stability. However, a value of zero results in zero Integral Gain, effectively disabling the velocity loop integrator.

Integration in the regulator forces the feedback velocity to track the command velocity when the velocity command is constant (so called “steady state” or “zero frequency”), and the load in not changing. Excessive regulator integration can result in oscillatory responses and system instability.

Figure 5.13 shows the effect of varying the Integrator Time parameter to the velocity step response with the P Gain set to 30 and the D Gain set to zero. The response becomes more oscillatory as the Integral Time is decreased, (and the Integral Gain is effectively increased).

Figure 5.13
Velocity Regulator Step Response with Varying Integrator Time



Integrator Mode

The Integrator Mode parameter controls how the integral term is applied to the velocity regulator. It can be set to Always On, High Current Disable, Velocity Command Disable, or Position Error Disable. This parameter introduces a nonlinear control to the integrator (preventing it from integrating in certain conditions) that may be useful in reducing or eliminating overshoot in the velocity response from integrator windup. Integrator windup occurs when the current regulator is saturated but the velocity error is not eliminated, and usually causes overshoot during command changes

.

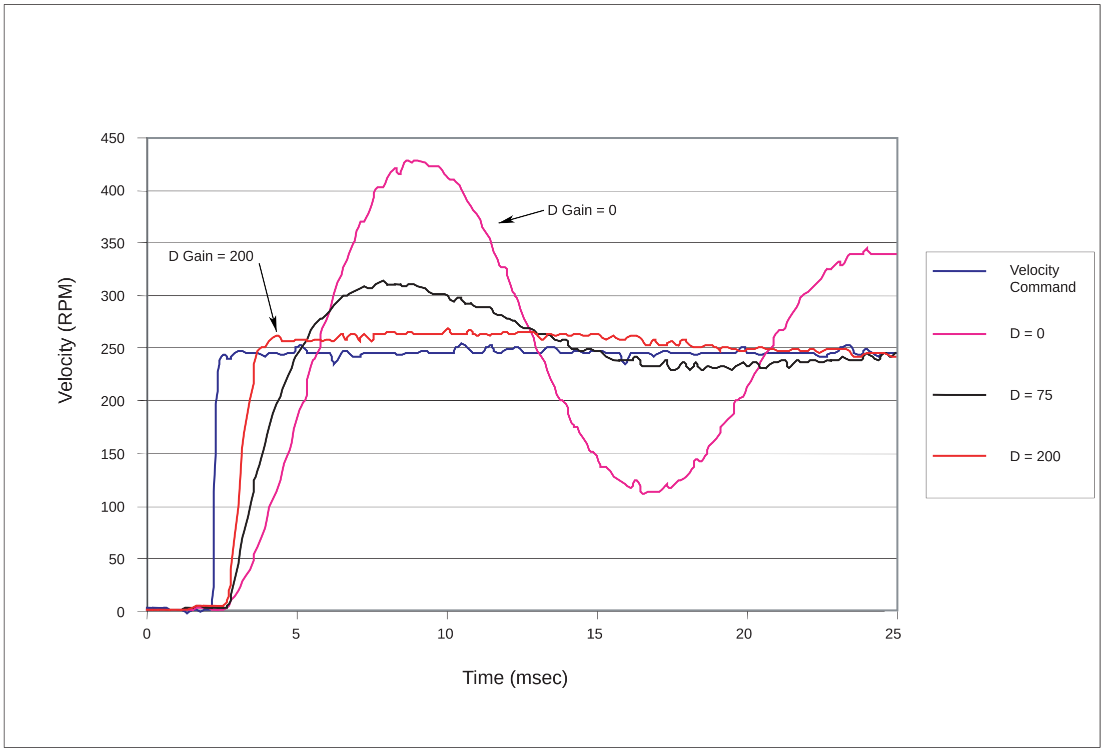
Integrator Mode Setting	Description
Always On	The velocity regulator integral term is always used.
High Current Disable	This parameter value is specified as a percentage of the motor continuous current rating. The velocity regulator integral term is updated normally when the current command is less than the Integrator Threshold setting. When the current command exceeds this parameter setting, the integral term is held at a constant value until the current command is less than this parameter setting. This setting can reduce integrator windup caused by acceleration or deceleration.
Velocity Command Disable	The velocity regulator integral term is updated normally when the velocity command is less than the Integrator Threshold setting. When the velocity command exceeds this parameter setting, the integral term is held at a constant value until the velocity command is less than this parameter setting. This may be useful when the steady state error is only a concern below some threshold velocity. The drive enforces two addition constraints to this Integrator Mode. Both the feedback and command velocity must exceed a minimum value in order for the integral term to be held. The minimum value is 2 radians/second (mechanical) for rotary motors and 2 radians/second (electrical) for linear motors.
Position Error Disable	The velocity regulator integral term is updated normally when the position error is less than the Integrator Threshold setting. When the position error exceeds this parameter setting, the integral term is held at a constant value until the position error is less than this parameter setting.

D Gain

The D Gain parameter generates a control signal proportional to the derivative of the velocity error. It can be in the range 0–10,000. This gain provides damping to the velocity loop response that can reduce oscillations. The D Gain can also improve the speed of the response for large changes in the command signal.

Figure 5.14 shows the affect of varying the D Gain. The P Gain and Integral Time were deliberately set to cause an oscillatory response. Upon application of the step input, the error derivative is large and positive for the first update and then it is negative and decreasing for the remainder of the response. The result of the positive error derivative for the first update is that the regulator provides a large compensation that result in a faster response. This large positive compensation only occurs for a single update. This can be seen in the figure below, where the response reaches the command level more quickly as the D Gain setting is increased. After the first update, the error derivative is negative because the error is decreasing. The D Gain control signal works as an anticipatory kind of control. It subtracts from the overall regulator compensation so that the overshoot is reduced.

Figure 5.14
Velocity Regulator Step Response with Varying D Gain



Low Pass Filter Bandwidth

The Low Pass Filter Bandwidth parameter sets the bandwidth frequency of the low pass filter that is applied to the velocity command input for the velocity regulator. It can be set in the range 0–10,000 Hz. This filter is disabled when the setting is 0. This filter may be useful in reducing noise on the analog velocity command. It will also soften the edge of a step command input to the velocity regulator. This filter setting affects the velocity loop bandwidth.

Position Regulator Settings

The position regulator includes the following parameters available for adjustment by the user:

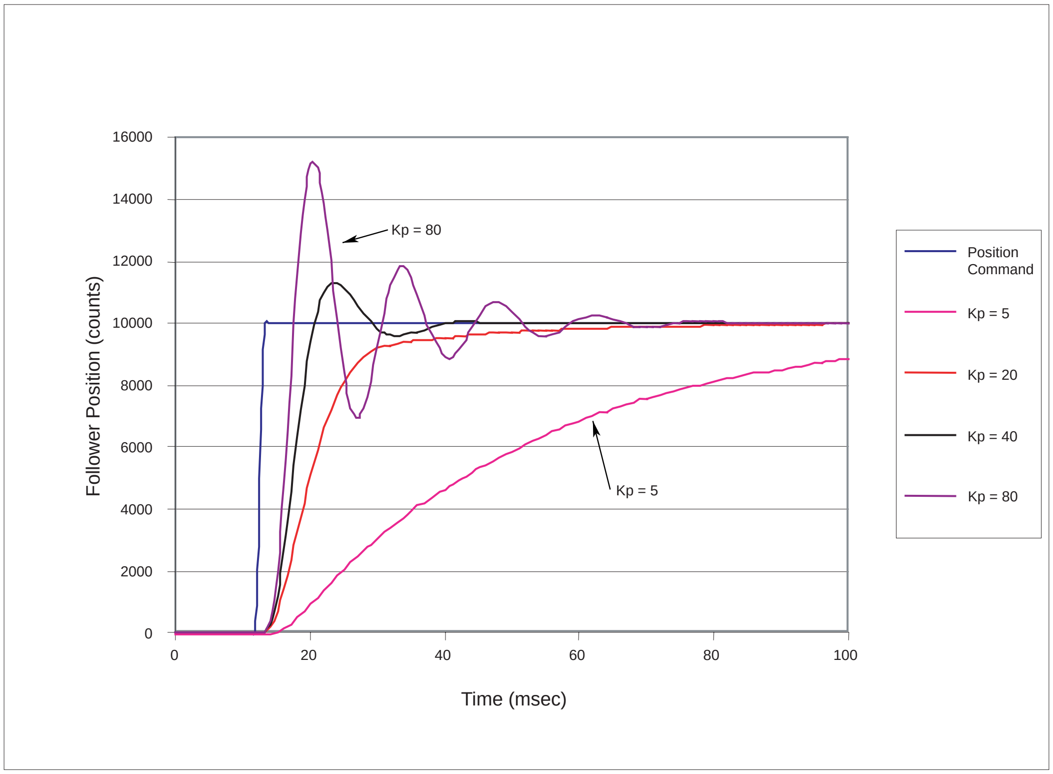
- Kp
- Kff
- Kff Low Pass Filter Bandwidth
- High Error Output Offset
- High Error Output Threshold

Kp

The Kp parameter sets the proportional response of the position regulator. It can be in the range 0–700. The regulator uses this gain to generate a velocity command proportional to the position error. Larger gains result in larger velocity commands, faster response, and increased stiffness in the system for a given position error. Kp settings that are too large will cause instability, and Kp settings that are too small results in loose or sloppy system dynamics.

Figure 5.15 shows the effect of varying the Kp setting on the position step response with the feedforward gain (Kff) set to zero. The response takes more time to approach the command value for smaller values of Kp and responds more quickly with increasing Kp values. Excessive Kp gain value can result in reduced stability and an oscillatory response.

Figure 5.15
Position Regulator Step Response with Varied Kp



Kff

The Kff parameter controls the amount of velocity command feedforward applied in the position regulator. Larger gains result in reduced following error, but too much gain causes position response overshoot.

In Figure 5.16 and 5.17, Kp = 20, (the default value), and Kff is varied from 0 to 100%. Figure 5.16 illustrates the effect of the Kff gain on the step response. The step change in position command results in a large velocity command. As the Kff term is increased, it affects the response more. When Kff = 50, the system response is good, with the quickest rise time and no overshoot. When Kff = 100 the response is faster, but has some overshoot (that could be reduced by increasing the Integrator Time setting of the velocity loop).

Figure 5.16
Position Regulator Step Response with Varied Kff

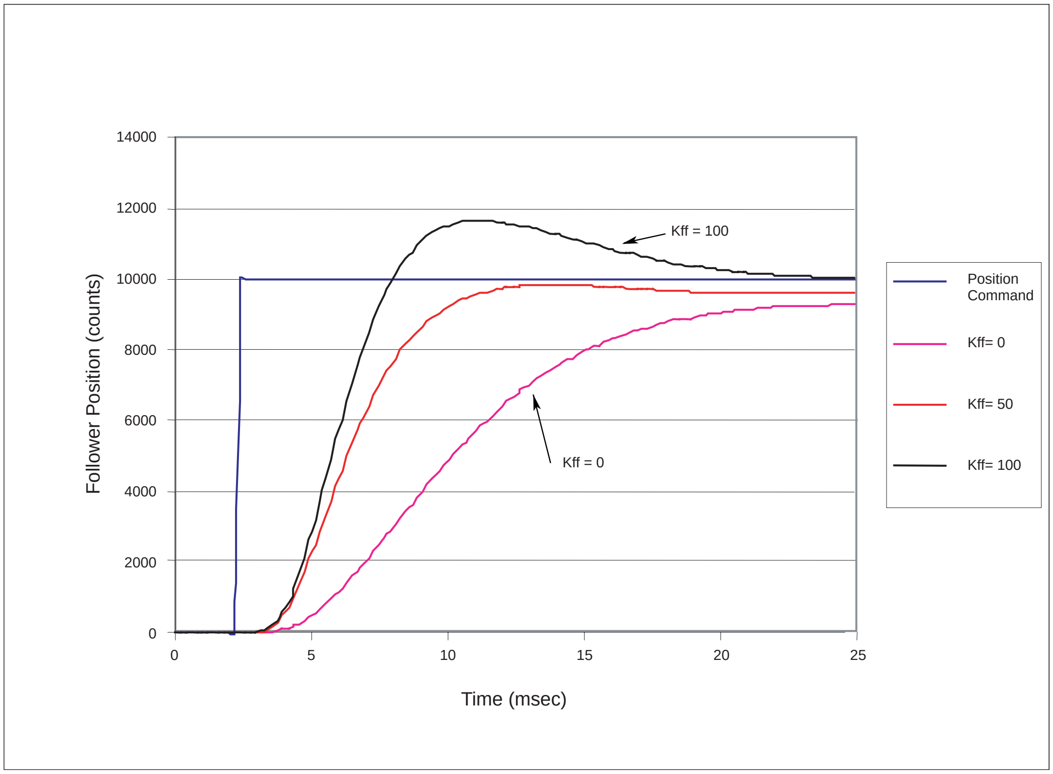
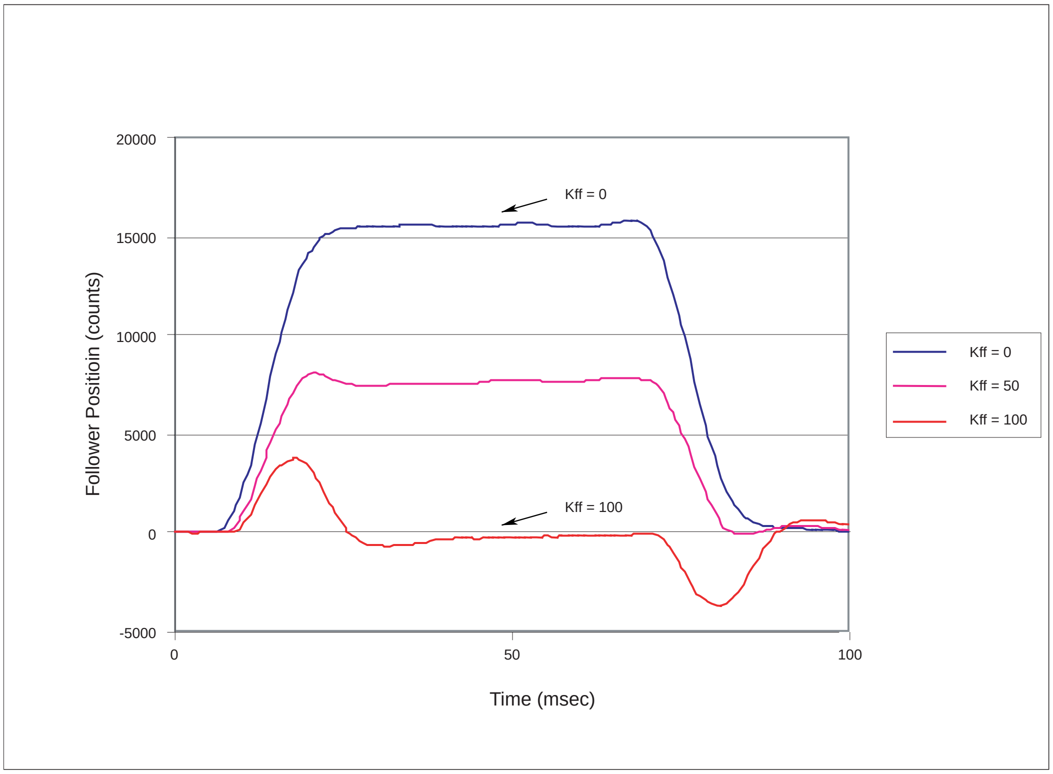


Figure 5.17 illustrates the effect of the Kff gain on the follower response or position error for a typical motion profile. The steady state error is reduced as the Kff term is increased. When Kff is 100, the steady state error is almost zero, but there is some error during the acceleration and deceleration portions of the profile. The velocity loop tuning can determine the effectiveness of the position loop feedforward term.

Figure 5.17
Position Regulator Response During Move with Varied Kff



Kff Low Pass Filter Bandwidth

The Kff Low Pass Filter Bandwidth parameter sets the bandwidth frequency of the low pass filter that is applied to the velocity feedforward command of the position regulator. It can be set in the range of 0–800 Hz. The filter is disabled when this value is set to 0. This parameter softens the velocity command from the feedforward term for large changes in the position command, and reduces quantization noise caused by the differentiation of the position command. It also reduces overshoot in the position response, along with reducing the Kff feedforward gain value.

High Error Output Offset

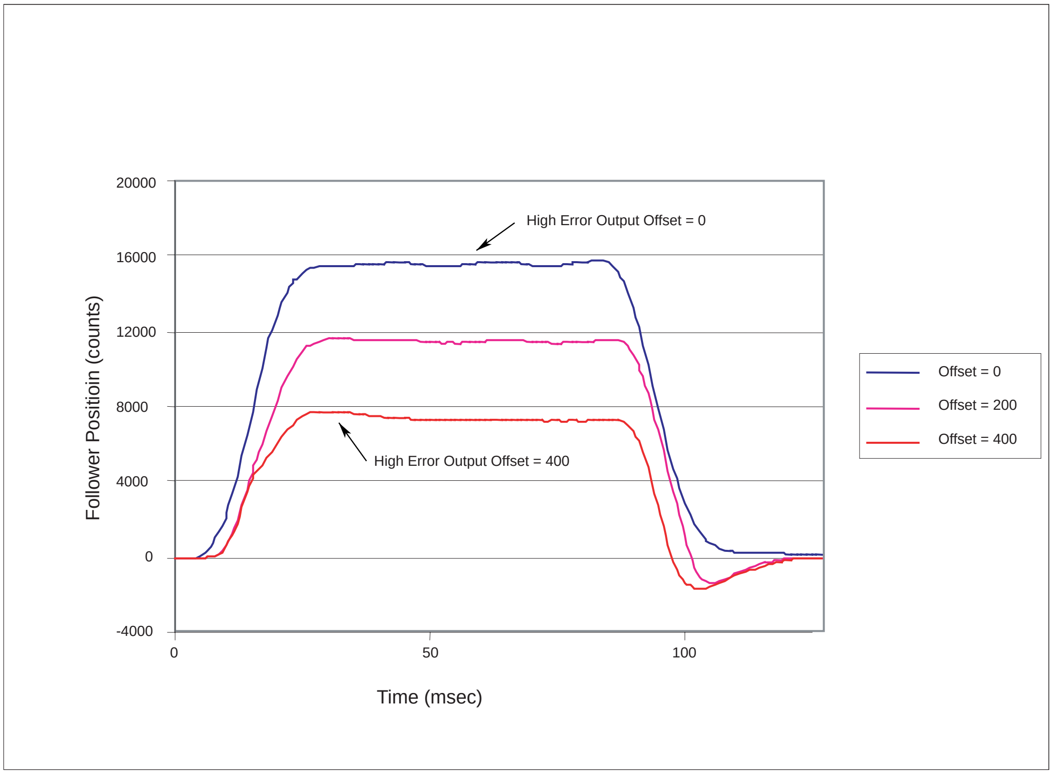
The High Error Output Offset parameters control a constant velocity command offset that is added to the position regulator output when the position error exceeds the High Error Output Threshold. The High Error Output Offset parameter can be set in the range of 0–450 (rpm or mm/ second). This offset reduces position error.

High Error Output Threshold

The High Error Output Threshold parameter sets the position error level at which the High Error Output Offset is applied. The High Error Output Threshold parameter can be set in the range of 0–50,000 counts.

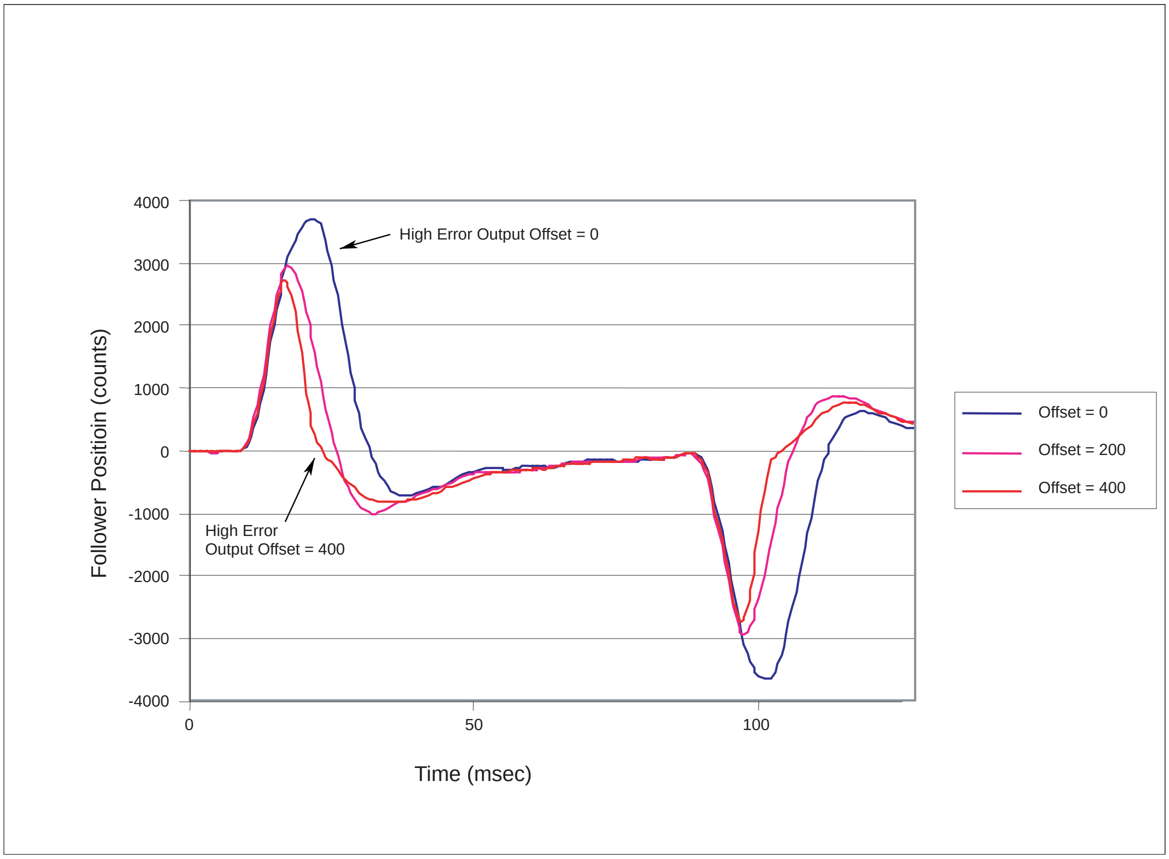
Figure 5.18 shows the effect of varying the offset value on the position error during a typical motion profile. In the first figure, the drive was operated with the position regulator default gain settings, (Kp = 20, Kff = 0), and the threshold was set to 2000 counts. The plot clearly illustrates that the offset reduces the steady state error by a fixed amount, and increasing the offset further reduces the error. Using the offset also results in some overshoot at the end of the deceleration when the offset value is removed from the position regulator output (when counts < 2000). This overshoot increases with larger offsets.

Figure 5.18
Position Regulator Response During Move with Varied Error Offset



In Figure 5.19, Kff = 100 and the steady state error is almost eliminated by use of the feedforward gain. Applying the offset does decrease the amount of error during the acceleration and deceleration but results in slightly more overshoot at the end of the deceleration. Varying the offset and threshold values to other values not illustrated here can affect the position error in substantially different ways. For example, setting the offset value to small values can result in a forced oscillation of the position error around zero when the shaft should be stationary.

Figure 5.19
Position Regulator Response During Move with Varied Error Offset



Control Block Diagrams

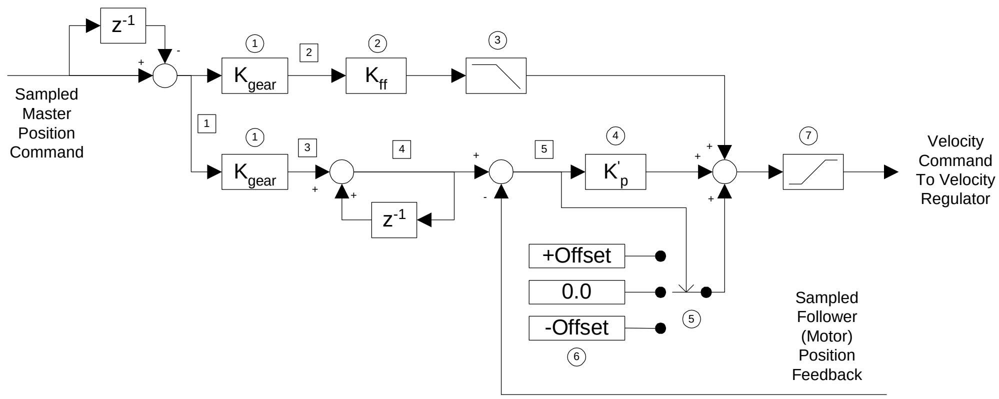
This section includes graphical representation and descriptions of the regulators, control modes, and settings of the Ultra1500. Details are provided in the following areas:

- Position Regulator
- Velocity Regulator
- Analog Velocity Mode
- Preset Velocity Mode
- Jog Mode
- Analog Current Mode
- Dual Current Command Mode

Position Regulator

Figure 5.20 shows the block diagram of the position regulator in the Ultra1500

Figure 5.20
Position Regulator Block Diagram



<u>Block/Switch Definitions:</u>

1. Mode Configuration : Follower : Gear Ratio
2. Tuning Window : Main Position Regulator Gains : K_{ff}
3. Tuning Window : Main Position Regulator Gains : K_{ff} Low Pass Filter Bandwidth
4. Tuning Window : Main Position Regulator Gains : K_p
5. Tuning Window : Main Position Regulator Gains : High Error Output Threshold
6. Tuning Window : Main Position Regulator Gains : High Error Output Offset
7. Velocity command limt to motor rated speed

<u>Signal Definitions:</u>

[1] Delta position command (velocity command): master counts
[2] Velocity command: follower counts
[3] Delta position : follower counts. Fractional counts are managed here for a lossless conversion.
[4] Position command : follower counts
[5] Position Error : follower counts

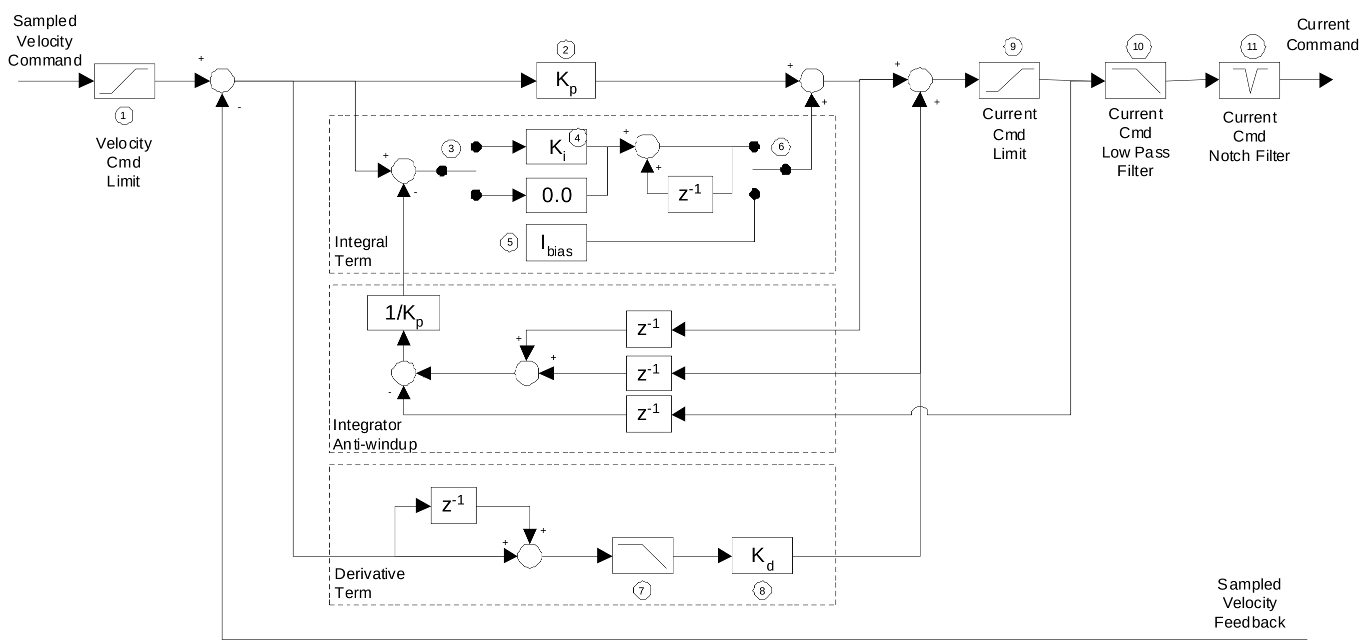
Block/Switch definitions shown in Figure 5.20 refer to the Ultraware parameter names where applicable.

The Ultra1500 uses a fixed frequency (5 kHz) to sample data and perform computations (i.e., the sample or update rate is 200 µs). A z^{-1} block in the figure indicates a delay of one update period, or 200 µs. This implies that any signal multiplied by a z^{-1} block will use the signal from the previous update in the calculation for the current update.

Velocity Regulator

Figure 5.21 shows the block diagram of the velocity regulator in the Ultra1500:

Figure 5.21
Velocity Regulator Block Diagram



Block/Switch Definitions:

1. Main Drive Window : Velocity Limits : Velocity Limit Mode & Manual Velocity Limit
2. Tuning Window : Main Velocity Regulator Gains : P.
3. Tuning Window : Main Velocity Regulator Gains : Integrator Mode.
4. Tuning Window : Main Velocity Regulator Gains : Integral Time. Ki is the inverse of the Integral Time
5. Main Drive Window : Initial Current Bias
6. The integral term is set to the initial current bias when the drive is disabled.
7. A 30 Hz low pass filter is applied to the derivative of the error. The user cannot change this parameter setting
8. Tuning Window : Main Velocity Regulator Gains : D.
9. Main Drive Window : Current Limits; Main Drive Window : Stopping Functions : Maximum Stopping Current
10. Tuning Window : Main Current Regulator Gains : Low Pass Filter Bandwidth
11. Tuning Window : Main Current Regulator Gains : Resonant Frequency Suppression

Block/Switch definitions shown in Figure 5.21 refer to the Ultraware parameter names where applicable.

The Ultra1500 uses a fixed frequency (5 kHz) to sample data and perform computations (i.e., the sample or update rate is 200 μs). A z^{-1} block in the figure indicates a delay of one update period, or 200 μs. This implies that any signal multiplied by a z^{-1} block will use the signal from the previous update in the calculation for the current update.

The velocity command limit is set to the minimum of the following:

- Zero if the velocity command is in the direction of an active overtravel limit,
- Manual Velocity Limit (if activated),
- Analog Velocity Limit (if activated), and
- Motor rated speed.

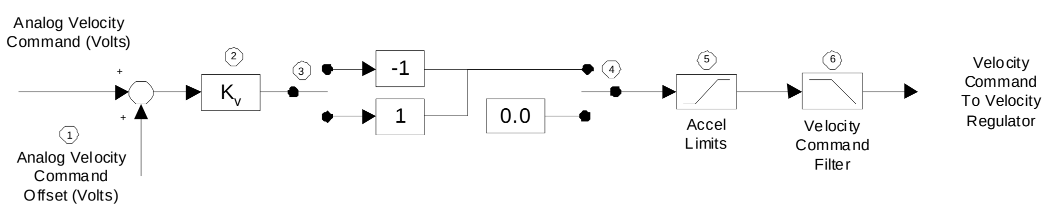
The current command limit is set to the minimum of the following:

- Positive / Negative Internal Current Limit,
- Positive / Negative External Current Limit,
- Stopping Current (if activated), and
- Drive Peak / Motor Peak Current Rating.

Analog Velocity Mode

Figure 5.22 shows the block diagram of the analog velocity mode for the Ultra1500:

Figure 5.22
Analog Velocity Mode Block Diagram



Block/Switch Definitions

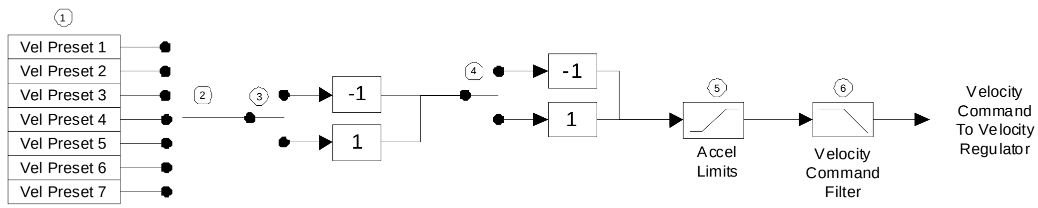
1. Mode Configuration : Analog : Velocity Command Offset
2. Mode Configuration : Analog : Velocity Scale
3. Main Drive Window : Command Polarity
4. Main Drive Window : Speed Functions : Zero Clamp
   Digital Inputs : Zero Speed Clamp Enable
5. Main Drive Window : Accleration Limits
6. Tuning : Main Velocity Regulator Gains : Low Pass Filter Bandwidth

Block/Switch definitions shown in Figure 5.22 refer to the Ultraware parameter names where applicable.

Preset Velocity Mode

Figure 5.23 shows the block diagram of the preset velocity mode for the Ultra1500:

Figure 5.23
Preset Velocity Mode Block Diagram



Block/Switch Definitions:

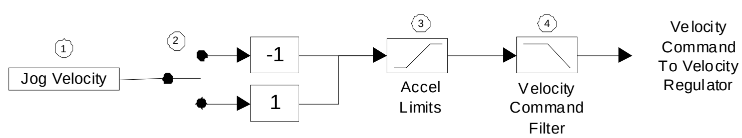
1. Mode Configuration : Preset : Preset Velocities
2. Digital Inputs : Preset Select 1,2,3
3. Digital Inputs : Preset Direction
4. Main Drive Window : Command Polarity
5. Main Drive Window : Accleration Limits
6. Tuning : Main Velocity Regulator Gains : Low Pass Filter Bandwidth

Block/Switch definitions shown in Figure 5.23 refer to the Ultraware parameter names where applicable.

Jog Mode

Figure 5.24 shows the block diagram for the jog mode (also known as Velocity Control Panel in Ultraware):

Figure 5.24
Jog Mode Block Diagram



Block/Switch Definitions:

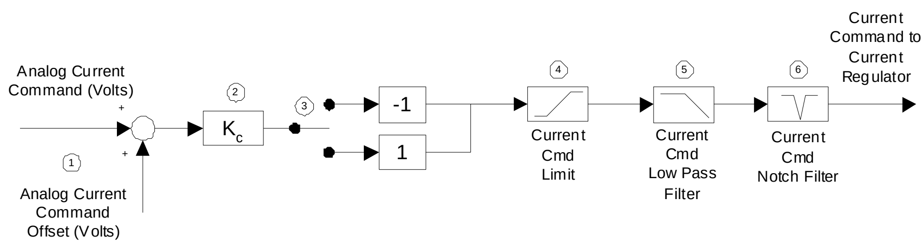
1. Main Drive Window : Velocity Control Panel : Velocity Command
2. Main Drive Window : Command Polarity
3. Main Drive Window : Accleration Limits
4. Tuning : Main Velocity Regulator Gains : Low Pass Filter Bandwidth

Block/Switch definitions shown in Figure 5.24 refer to the Ultraware parameter names where applicable.

Analog Current Mode

Figure 5.25 shows the block diagram for the analog current mode of the Ultra1500:

Figure 5.25
Analog Current Mode Block Diagram



Block/Switch Definitions:

1. Mode Configuration : Analog : Current Command Offset
2. Mode Configuration : Analog : Current Scale
3. Main Drive Window : Command Polarity
4. Main Drive Window : Current Limits; Main Drive Window : Stopping Functions : Maximum Stopping Current
5. Tuning Window : Main Current Regulator Gains : Low Pass Filter Bandwidth
6. Tuning Window : Main Current Regulator Gains : Resonant Frequency Suppression

Block/Switch definitions shown in Figure 5.25 refer to the Ultraware parameter names where applicable.

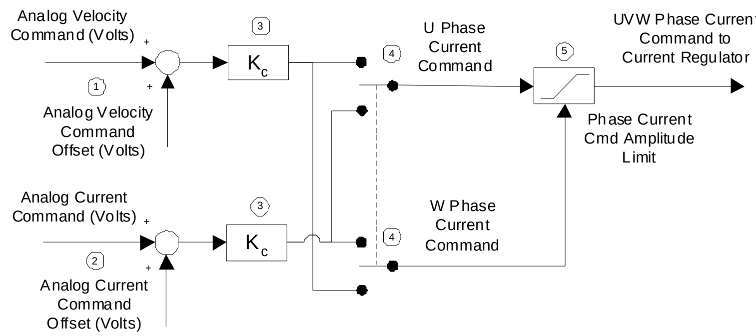
The current command limit is set to the minimum of the following:

- Positive / Negative Internal Current Limit,
- Positive / Negative External Current Limit,
- Stopping Current (if active), and
- Drive Peak / Motor Peak Current Rating.

Dual Current Command Mode

Figure 5.26 shows the block diagram for the dual current mode of the Ultra1500:

Figure 5.26
Dual Current Mode Block Diagram



Block/Switch Definitions:

1. Mode Configuration : Analog : Velocity Command Offset
2. Mode Configuration : Analog : Current Command Offset
3. Mode Configuration : Analog : Current Scale
4. Main Drive Window : Command Polarity
5. Main Drive Window : Current Limits; Main Drive Window : Stopping Functions : Maximum Stopping Current

Block/Switch definitions shown in Figure 5.26 refer to the Ultraware parameter names where applicable.

In this operating mode, an external controller performs all commutation functions, and the Ultra1500 drive functions as a simple three-phase current regulator.

- If the command polarity is set to Normal, the U phase current command comes from the analog velocity input and the W phase current command comes from the analog current input.
- If the command polarity is set to Inverted, the U phase current command comes from the analog current input and the W phase current command comes from the analog velocity input.

The current command limit is set to the minimum of the following:

- Positive / Negative Internal Current Limit,
- Positive / Negative External Current Limit,
- Stopping Current (if active), and
- Drive Peak / Motor Peak Current Rating.

Chapter 6

Maintaining and Troubleshooting Your Ultra1500

Chapter Objectives

This chapter provides a description of maintenance and troubleshooting activities for the Ultra1500. This chapter includes these sections:

- Safety Precautions
- Maintaining Your Ultra1500 Drive
- Status Indicators and the Operator Interface
- General Troubleshooting

Safety Precautions

Observe the following safety precautions when troubleshooting your Ultra1500 drive.

ATTENTION

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

Do not attempt to defeat or override the drive fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. If you do not correct a drive or system malfunction, it could result in personal injury and/or damage to the equipment as a result of uncontrolled machine system operation.

Test equipment (such as an oscilloscope or chart recorder) must be properly grounded. Failure to include an earth ground connection could result in a potentially fatal voltage on the oscilloscope chassis.

Maintaining Your Ultra1500 Drive

The Ultra1500 is designed to function with a minimum of maintenance.

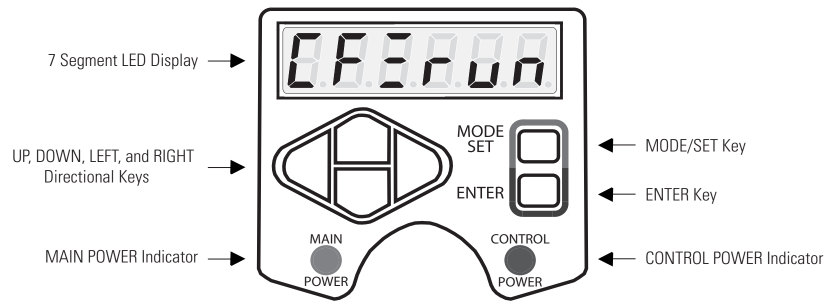
To maintain your Ultra1500 drive:

- Clean the drive periodically, using an OSHA approved nozzle that provides compressed air under low pressure, less than 20 kPa (30 psi), to blow the exterior surface and the vents clean.
- Visually inspect all cables for abrasion.
- Cable connectors should be inspected for proper seating and signal continuity end-to-end.
- If installed, replace the battery as described on page 5-17.

Status Indicators and the Operator Interface

The Operator Interface provides immediate access to Ultra1500 drive status and settings. The major features of the Ultra1500 Operator Interface are identified in Figure 6.1 and briefly described below. Refer to *Ultra1500 Operator Interface* on page D-1 for detailed information about using the operator interface.

Figure 6.1
Ultra1500 Operator Interface



- The 7-Segment LED displays status, parameters, functional commands, and allows drive monitoring.
- The MAIN POWER indicator illuminates when the drive's DC bus is charged by application of 200–240V power to the L1, L2 and L3 main power pins.

ATTENTION

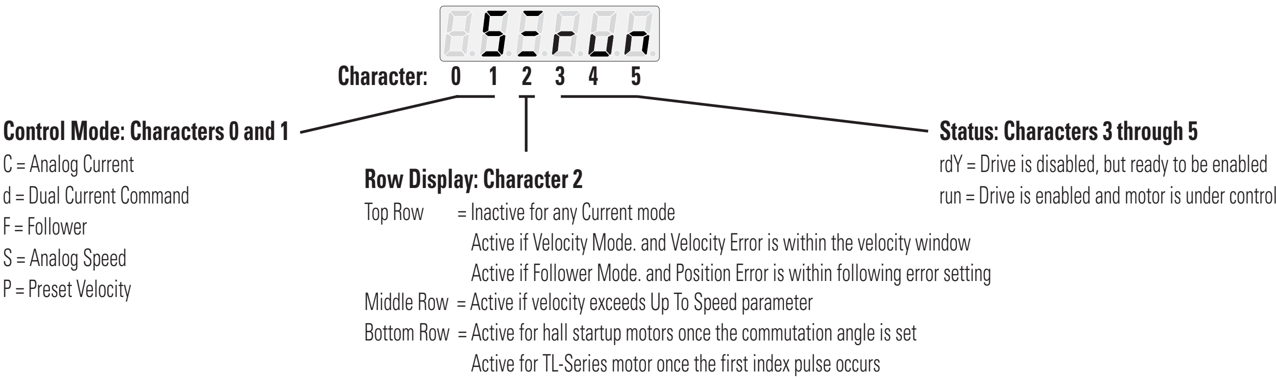
DC bus capacitors retain hazardous voltages after input power has been removed. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait a full 3 minutes to ensure that all voltages on the system bus are discharged.

Failure to observe this precaution could result in severe bodily injury or loss of life.

- The CONTROL POWER illuminates when the drive's control electronics are powered by application of 200–240V power to the L1C and L2C control power pins.
- The MODE/SET, ENTER, and directional keys provide the operator with access to drive functions and program the drive. Refer to *Ultra1500 Operator Interface* on page D-1 for more information.
- The 7-segment displays provide operational information when the drive is functioning, or warning/error messages when abnormalities are encountered.

  Normal operational information consists of six characters that display data in three categories. The categories consist of a Control Mode (characters 0 and 1), a Row Display (2), and Status (3 to 5). Figure 6.2 depicts these categories and defines the information provided.

Figure 6.2
Operational Drive Displays



General Troubleshooting

Refer to the *Fault Codes* section below to identify problems, potential causes, and appropriate actions to resolve the problems. If problems persist after attempting to troubleshoot the system, please contact your Allen-Bradley representative for further assistance. To determine if your Ultra1500 drive has an error, refer to the table immediately below.

If the Main Power and Control Power LEDs are ON and the Status Display on the Drive is:	Then:
Displays 'rdy' in the three right-most characters	The Ultra1500 drive is ready.
Displays 'Pot' or 'not'	The Ultra1500 drive encountered an Overtravel Condition and motion restrictions are in effect.
Displays a three-digit warning message	The Ultra1500 drive is functional, but a drive warning is displayed. Proceed to the section *Warning Messages* below.
Alternates between a three-digit error code and a six-digit text message	An Ultra1500 drive error has occurred. Proceed to the section *Error Displays* below.

Overtravel Condition

Overtravel displays (see the following table) occur if the drive detects an overtravel condition.

Overtravel Display	Possible Cause	Action/Solution
 Positive Overtravel	A Positive Overtravel condition is detected.	Apply motion in a negative direction to back off limit.
 Negative Overtravel	A Negative Overtravel condition is detected.	Apply motion in a positive direction to back off limit.

Fault Codes

The following list of assigned error codes is designed to help you resolve problems.

Warning Messages

Warnings are drive abnormalities that allow motor control to continue. Warnings are displayed on the drive's Status display using the last three segments of the display to display an abbreviated title.

Warning Display	Description	Possible Cause(s)	Action/Solution
bAt	Absolute Encoder Battery	3.1V or less output from encoder battery or external power supply.	Replace battery. Note: Battery replacement may cause loss of absolute position. Homing may be necessary.
PrE	Power Up Overspeed	Control power is applied to the drive while the motor is in motion.	After verifying motor has stopped, recycle control power.
oCC	Over Current Command	Improper setting of analog current scale	Verify scaling parameter corresponds to analog signal range.
		System cannot meet motion profile	• Verify velocity loop tuning. • Verify system sizing.
		Incorrect current limit settings	Verify current limits do not restrict current to less than system capabilities.
oSC	Over Speed Command	Improper setting of analog velocity scale	Verify scaling parameter corresponds to analog signal range.
		System cannot meet motion profile	• Verify position loop tuning. • Verify system sizing.
P In	Digital I/O Assignment	Inappropriate assignment of digital inputs	• If operated in preset mode, verify presets are assigned. • If operated in a normal/override mode, verify the override function is assigned.

Error Displays

Errors are serious abnormalities that cause loss of motor control. The Error display alternates between a three-digit error code and a six-digit text message. The error displays repeat until the problem is cleared.

Error Display		Description	Possible Cause(s)	Action/Solution
Code	Text			
E.004	E.Mtrot	E004 Motor Overtemperature	Motor thermal switch trips due to: • High motor ambient temperature, and/or • Excessive current	• Operate within (not above) the continuous torque rating for the ambient temperature. • Lower ambient temperature, or increase motor cooling.
			Motor wiring error	Check motor wiring.
			Incorrect motor selection	Verify the proper motor has been selected.

Error Display Code	Error Display Text	Description	Possible Cause(s)	Action/Solution
E.005	E.IPMFt	E005 IPM Error	Motor cables shorted	Verify continuity of motor power cable and connector.
			Motor winding shorted internally	Disconnect motor power cables from the motor. If the motor is difficult to turn by hand, it may need to be replaced.
			Drive temperature too high	• Check for clogged vents or defective fan. • Ensure cooling is not restricted by insufficient space around the drive.
			Operation above continuous power rating	• Verify ambient temperature is not too high. • Operate within the continuous power rating. • Reduce acceleration rates.
			Drive has a bad IPM output, short circuit, or overcurrent	Remove all power and motors connections, then perform a continuity check from the DC bus to the U, V, and W motor terminals. If continuity exists, check for wire fibers between terminals, or send drive in for repair.
E.009	E.UdvtG	E009 Bus Undervoltage	Low AC line/AC power input	• Verify voltage level of the incoming AC power. • Check AC power sources for glitches or line drop. • Install uninterruptible power supply (UPS) on the AC input.
			Attempted to enable drive without main power active.	Apply main power before enabling drive.
E.010	E.ovvtG	E010 Bus Overvoltage	Excessive regeneration of power (i.e., When the motor is driven by an external mechanical force, it may regenerate too much peak energy through the drive's power supply and the drive faults to save itself from an overload.)	• Verify shunt circuit. • Adjust motion profile to stay within the range of the regenerative resistor. • Replace regenerative transistor. • Replace drive.
			Excessive AC input voltage	Verify input is within specification.
E.018	E.ovSPd	E018 Motor Overspeed	Motor speed exceeds maximum	• Confirm encoder wiring. • Retune drive system. • Verify input gain of external speed or torque command.
E.019	E.PoSEr	E019 Excess Position Error	Position error exceeds permitted value	• Increase following error limit. • Check position loop tuning.
E.022	E.ConoL	E022 Motor Continuous Current Overload	The internal filter protecting the motor from overheating has tripped	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger drive and motor. • Checking tuning.
E.023	E.drvoL	E023 Drive Overload	The motion application requires average drive current in excess of rated capability	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger drive and motor. • Check tuning.
E.028	E.EnCdE	E028 Encoder Data Range Error	Encoder not programmed correctly	Replace motor.
			Encoder memory corrupted	
E.030	E.EnCoP	E030 Encoder Cable Open	Communication not established with an intelligent encoder.	• Verify motor selection. • Verify the motor supports automatic identification. • Verify encoder wiring.
			Hall error	
E.031	E.EnCPE	E031 Encoder Data Parameter Error	Encoder not programmed correctly	Replace motor.
			Encoder memory corrupted	

Error Display Code	Error Display Text	Description	Possible Cause(s)	Action/Solution
E.036	E.drvot	E036 Drive Overtemperature	Excessive heat exists in the drive	• Verify cooling fan operation (2092-DA4 and 2092-DA5 only). • Check tuning. • Reduce acceleration rate. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger drive and motor.
E.037	E.ACoFF	E037 AC Line Loss	Poor quality power	Increase Ride Through time.
			Attempted to enable drive without main power active	Apply main power before enabling drive.
			Phase connection missing	Remove power and verify all physical connections.
			Fault Delay parameter is set too short	Increase the Fault Delay parameter setting.
E.053	E.PInIt	E053 User Parameter Initialization Error	Error in parameter memory storage	• Reinitialize parameter. • Reset drive to factory defaults.
E.054	E.oFSEt	E054 Current Feedback Offset	Defective hardware	Replace drive.
E.055	E.CHSUM	E055 User Parameter Checksum Error	Checksum error	• Confirm and reset parameter. • Reset drive to factory defaults.
E.056	E.CPUFt	E056 Watchdog Timeout	Excessive system noise	Verify wiring and installation methods.
			Defective hardware	Replace drive.
E.057	E.HWArE	E057 PWM Hardware Error	Defective hardware	Contact A-B.
E.058	E.rAnGE	E058 User Parameter Range Error	Range of parameter is invalid	• Enter parameter with value(s) within range. • Reset drive to factory defaults.
E.060	E.dInIt	E060 Drive Initialization Error	Hardware error	Replace drive.
E.075	E.SHtoL	E075 Shunt Overload Protection	Power at regenerative resistor exceeds the permitted value	Adjust motion profile to stay within the range of the regenerative resistor.
			Shunt resistor is disconnected or damaged	• Verify resistor connection. • Verify resistance of shunt resistor.
E.079	E.SHtoC	E079 Shunt Overcurrent Protection	Shunt current exceeded allowable instantaneous value	• Verify shunt is not shorted or damaged. • Verify load energy is not excessive during deceleration.
E.083	E.AbSbE	E083 Absolute Encoder Battery Error	Encoder Backup Battery parameter is set to installed, but a battery is not installed.	Set Encoder Backup Battery parameter to Not Installed.
			Battery voltage is sensed below 2.7V dc.	• Confirm battery voltage and connection. • Replace battery.
E.084	E.AbSoS	E084 Absolute Encoder Overspeed	Battery powered encoder is mechanically rotated at high speed while drive is powered down	• Mechanically disengage motor from system. • Cycle power to drive and reset alarm.
E.085	E.AbSCt	E085 Absolute Encoder Multi-turn Count Error	Noise in the encoder	Cycle power to drive and reset alarm.
			Defective encoder	Replace motor.
E.086	E.EnCCt	E086 Encoder Single-Turn Count Error	Noise in the encoder	Cycle power to drive and reset alarm.
			Defective encoder	Replace motor.

Error Display Code	Error Display Text	Description	Possible Cause(s)	Action/Solution
E.100	E.SEtUP	E100 Drive Set Up	The drive operating mode and motor selection are incompatible.	Change the operating mode and/or the motor selection, and reset the drive.
E.101	E.CAbLE	E101 Motor Power Cable Open	Motor cable open	Verify power connection between motor and drive.
E.102	E.InSOL	E102 Motor Instantaneous Current Overload	Motion profile requires a peak current for an excessive time interval	• Verify motor wiring. • Adjust accel/decel time. • Confirm motor selection.
			Defective current feedback sensing	Verify phase currents.
E.103	E.MAtCH	E103 Motor Mismatch	Dynamic braking current of the selected motor exceeds twice the drive peak current rating	Install a different motor.
E.104	E.PWrOL	E104 Continuous Power Overload	Motion application requires average drive power in excess of rated capability	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger drive and motor. • Check tuning.
E.105	E.EnCtP	E105 Encoder Type Mismatch	Motor encoder signals do not match drive configuration	Verify motor selection.
			Defective encoder	Replace motor.
E.106	E.EnCCE	E106 Encoder Communication Error	Wiring between drive and encoder is faulty or disconnected, or EMI (noise) disrupts encoder signals.	• Verify encoder wiring. • Contact A-B.
E.107	E.SErCE	E107 Special Communication Error	Communications error between host and drive (noise)	• Verify serial cable. • Check for noise on serial interface.
E.108	E.CdFrE	E108 Position Command Frequency Error	Input frequency limit exceeded	• Verify hardware type selected in the drive matches the physical hardware. • Change from open collector to line drive. • Reduce the speed command. • Apply gearing.

Specifications and Dimensions

Chapter Objectives

This appendix covers the following topics:

- Certifications
- Ultra1500 Power Specifications
- Ultra1500 General Specifications
- Dimensions

Certifications

The Ultra1500 is certified for the following when the product or package is marked.

- UL listed to U.S. and Canadian safety standards (UL 508 C File E145959)
- CE and C-Tick marked for all applicable directives

Note: Refer to **www.ab.com/certification/ce/docs** for more information.

Ultra1500 Power Specifications

The following sections provide power specifications for the Ultra1500.

Ultra1500 Power Specifications

The tables below lists general power specifications and requirements for the Ultra1500 drives (2092-DA*x*).

Main Input Power

Drives	2092-DA1	2092-DA2	2092-DA3	2092-DA4	2092-DA5
Input Voltage [1]	200–240 Vrms, 1ϕ			200–240 Vrms, 3ϕ	
Input Current [2]	3.3 Arms	5.5 Arms	8.0 Arms	11.0 Arms	15.0 Arms
Input Frequency	47–63 Hz				
Inrush Current [2]	200 Apeak, maximum				
Power Cycling	0.5 power cycles/minute maximum				
Delay before Drive Enable	500ms, minimum (after main power is applied)				

1 Specifications are for nominal voltage. The absolute limits are +/-10% (180–265 Vrms).

2 Power initialization requires a short period of inrush current. Dual element time delay (slow blow) fuses are recommended in *Fuse and Contactor Specifications* on page A-4.

Control Input Power

Input Voltage [1]	200–240 Vrms, 1ϕ
Input Current [2]	2.0 Arms
Input Frequency	47–63 Hz
Inrush Current [2]	75 Apeak, maximum

1 Specifications are for nominal voltage. The absolute limits are +/-10% (180–265 Vrms).

2 Power initialization requires a short period of inrush current. Dual element time delay (slow blow) fuses are recommended in *Fuse and Contactor Specifications* on page A-4.

Input Power Connector

Description	Pluggable cage-clamp, 7.5mm spacing
Manufacturer	Wago 231-206/026-000
Acceptable Wire Gauge	2.5–0.5 mm^2 (14–20 AWG)
Operating Tool	Wago 231-131
Pinout	Refer to Input Power Connectors on page 2-24

DC Bus and Shunt Circuitry

Drives	2092-DA1	2092-DA2	2092-DA3	2092-DA4	2092-DA5
Voltage	254–400 VDC				
Capacitance	660 μF			990 μF	
Discharge Time (to < 50V)	3 minutes, maximum				
Overvoltage Detect	410V				
Undervoltage Detect	230V				
Shunt Circuitry	No		Yes		
Shunt Turn-on Voltage	–		390V		
Shunt Turn-off Voltage	–		380V		
Internal Shunt Resistance	–		50Ω		30Ω
Continuous Shunt Power	–		30W	50W	70W
Intermittent Shunt Power	–		3kW		5kW

DC Power and Shunt Connector

Description	Pluggable cage-clamp, 7.5mm spacing
Manufacturer	Wago 231-204/026-000
Acceptable Wire Gauge	14–20 AWG
Operating Tool	Wago 231-131
Pinout	DC Bus and Shunt Power Connectors are described beginning on page 2-25

Output Power

Drives	2092-DA1	2092-DA2	2092-DA3	2092-DA4	2092-DA5
Continuous Output Current	1.4 Apeak, maximum	2.4 Apeak, maximum	4.7 Apeak, maximum	10.7 Apeak, maximum	16.4 Apeak, maximum
Intermittent Output Current	3.4 Apeak, maximum	7.2 Apeak, maximum	11.3 Apeak, maximum	24.8 Apeak, maximum	43.4 Apeak, maximum
PWM Frequency	10 kHz				
Internal Power Dissipation (not including internal shunt dissipation)	50W, maximum			100W, maximum	150W, maximum

Output Power Connector

Description	Pluggable cage-clamp, 7.5mm spacing
Manufacturer	Wago 231-203 /026-000
Acceptable Wire Gauge	14–20 AWG
Operating Tool	Wago 231-131
Pinout	Refer to Motor Power Connectors on page 2-26

Fuse and Contactor Specifications

Use class CC, J, or R class fuses, with current ratings as indicated in the table below. The table below lists fuse examples recommended for use with the Ultra1500 drives.

Refer to *Power Wiring Requirements* in *Chapter 3* for input wire size.

Catalog Number	Input Type	Input Voltage	Recommended Bussmann® Fuse			Recommended Allen-Bradley Contactor [1]
			Class CC	Class J	Class RK5	
2092-DA1	Main Input Power	230V, 1ϕ	FNQ-R-7	N/A	N/A	100-M05N*xy*
2092-DA2	Main Input Power	230V, 1ϕ	FNQ-R-7	N/A	N/A	100-M09N*xy*
2092-DA3	Main Input Power	230V, 1ϕ	FNQ-R-10	N/A	N/A	100-M12N*xy*
2092-DA4	Main Input Power	230V, 3ϕ	FNQ-R-15	LPJ-15	N/A	100-C16*xy*
2092-DA5	Main Input Power	230V, 3ϕ	FNQ-R-20	LPJ-20	N/A	100-C23*xy*
2092-DA1, 2092-DA2, 2092-DA3, 2092-DA4, and 2092-DA5	Control Input Power	230V, 1ϕ	FNQ-R-7-1/2	LPJ-6	FRS-R-2-1/2	N/A

1 For contactors, *x* represents coil voltage, and *y* represents number of contacts.

Power Dissipation Specifications

Use the following table to size an enclosure and calculate required ventilation for the Ultra1500. Typical heat losses run approximately one-half maximum power losses. The maximum power losses are shown below.

Catalog Number	**Maximum Loss** Watts
2092-DA1	50
2092-DA2	50
2092-DA3	50 + dissipative shunt
2092-DA4	100 + dissipative shunt
2092-DA5	150 + dissipative shunt

Ultra1500 General Specifications

The following sections provide physical, environmental, control, I/O, communication, feedback, connector, and AC line filter specifications for the Ultra1500 drives.

Physical and Environmental Specifications

Drives	2092-DA1	2092-DA2	2092-DA3	2092-DA4	2092-DA5
Operating Temperature	0° C to 50° C (32° F to 122° F)				
Operating Shock	15 G, Half Sine, 11 ms				
Operating Vibration	5–500 Hz @ 2.5 G, 0.381 mm (0.015 in.) maximum displacement				
Weight	0.9 kg (2.0 lbs)	0.9 kg (2.0 lbs)	1.2 kg (2.6 lbs)	2.1 kg (4.6 lbs)	2.1 kg (4.6 lbs)
Certification	UL, CE, and C-Tick				

Control Specifications

CN1 Controller Connector

Description	50-pin, mini-D
Manufacturer	3M 10250-52X2JL
Mating Connector Kit	Allen-Bradley 9101-1476
Pinout	Refer to I/O Connector – CN1 on page 2-3

CN2 Motor Feedback Connector

Description	20-pin, mini-D
Manufacturer	3M 10220-L8A9VE
Mating Connector Kit	Allen-Bradley 9101-1477
Pinout	Refer to Motor Feedback Connector – CN2 on page 2-4

CN3 Serial Communications Connector

Description	20-pin, mini-D
Manufacturer	3M 10220-L8A9VE
Mating Connector Kit	Allen-Bradley 9101-1477
Pinout	Refer to Serial Port Connector – CN3 on page 2-4

Current Loop

Update Period	50 µS
-3dB Bandwidth	2 kHz, typical
-45^{o} Bandwidth	350 Hz, typical
Type	PI, Flux Vector Control, Space Vector Modulation
Features	Notch Filter, Low Pass Filter, Automatically tuned using motor parameters

Velocity Loop

Update Period	200 µS
-3dB Bandwidth	550 Hz achievable through tuning
Type	PID
Features	Low Pass Filter, Online Inertia Identification, Velocity Observer

Position Loop

Update Period	200 µS
Type	P with Kff
Features	Low Pass Filter

Digital Inputs

Quantity	7 general purpose, opto-isolated
Type	Active low, single-ended (switch closure to common activates)
Input Current	6 mA, typical
Input Voltage	21.6–26.4 Volts
Propagation Delay	50 µs
Firmware Scan Delay	6 ms
Assignable Functions	Alternate Gain Select, Current Limit – Negative, Current Limit – Positive, Drive Enable, Fault Reset, Integrator Inhibit, Operation Mode Override, Overtravel – Negative, Overtravel – Positive, Pause Follower, Position Strobe, Preset Direction, Preset Select 1 to 3, Reset Multi-turn Data, Zero Speed Clamp Enable

Digital Outputs

Quantity	3 general purpose, opto-isolated
Type	Differential (both collector and emitter available for connection)
Output Current	20 mA, maximum
Output Voltage	21.6–26.4 Volts
Propagation Delay	50 µs
Firmware Scan delay	2 ms
Assignable Functions	Absolute Position Valid, Brake, Current Limited, Ready, Up to Speed, Velocity Limited, Warning, Within Near Window, Within Position Window, Within Speed Window

Fault Outputs

Quantity	1 fault output and three binary fault code outputs
Type (Fault Output)	Differential (both collector and emitter available for connection)
Type (Fault Code Outputs)	Single-ended, open collector
Output Current	20 mA, maximum
Output Voltage	21.6–26.4 Volts
Propagation Delay	50 µs
Firmware Scan delay	2 ms

Analog Outputs

Quantity	2 general purpose, voltage source
Type	PWM, 8-bit
Response	4 ms, typical
Output Voltage	-10 to +10 Volts
Output Current	10 mA, maximum

Encoder Outputs

Signals	AM+/-, BM+/-, IM+/-, Z-PULSE+/-
Type	Differential, TTL logic
Frequency	2.5 MHz, maximum
Output Current	20 mA, maximum

Command Inputs

Operating Modes	Analog Velocity, Analog Current, Preset Velocity, Follower, Dual Current Command
Analog Velocity Input	-10 to +10 Volt, single-ended, 16-bit A/D conversion
Analog Current Input	-10 to +10 Volt, single-ended, 12-bit A/D conversion
Follower Input	5 Volts, opto-isolated
Follower Types	Step/Direction, Step Up, Step Down, Master Encoder

Motor Control

Encoder Supported	Incremental AqB with Hall Commutation Feedback, Tamagawa Serial
Supply Voltage	5 Volts
AqB Input Frequency	4,000,000 lines/second, maximum
Serial Encoder Frequency	2.5 MHz, typical
Encoder Backup Battery	3.6 Volts, ½ AA

Built-in User Interface

Display	Six-character, 7-segment display
Keypad	Mode/Set, Enter, ⇧, ⇨, ⇩, ⇦ keys
Modes	Status Display, Parameter Editing, Variable Monitoring, Command Execution

Serial Interface

Physical Interface	RS-232
Baud Rate	38,400 bits/sec
Frame Format	8 data, no parity
Protocol	Binary, custom format

AC Line Filter Specifications

The following AC line filters are compatible with the Ultra1500 drives.

AC Line Filter Catalog Number	Specifications							
	Voltage	Phase	Current	Power Loss	Weight kg (lb.)	Humidity	Vibration	Operating Temperature
2090-UXLF-106	250V ac 50/60 Hz	Single	6A @ 50° C (122° F)	3.5W	0.3 (0.66)	90% RH	10–200 Hz @ 1.8 g	-25 to 85° C (-13 to 185 ° F)
2090-UXLF-110			10A @ 50° C (122° F)	2.7W	0.95 (2.0)			
2090-UXLF-HV323	520V ac 50/60 Hz	Three	23A @ 50° C (122° F)	20W	1.6 (3.5)			

[1] Contact your Allen-Bradley representative for availability.

Use the table below to determine which AC line filter is best suited for your Ultra1500 drive.

Ultra1500 Drives	AC Line Filter Catalog Number
2092-DA1	2090-UXLF-106
2092-DA2	
2092-DA3	2090-UXLF-110
2092-DA4	2090-UXLF-HV323
2092-DA5	

Maximum Cable Lengths

Power, feedback and brake cables for connection to TL-Series motors are available in standard lengths up to 30 m (98.4 ft)

Dimensions

The figures below provide basic outline dimensions for the Ultra1500 drives. Refer to *Chapter 1* beginning on page 1-1 for additional drive dimensions, mounting hole locations, drive clearance requirements, and other information.

Figure A.1
Ultra1500 Basic Outline Dimensions (2092-DA1 and 2092-DA2)

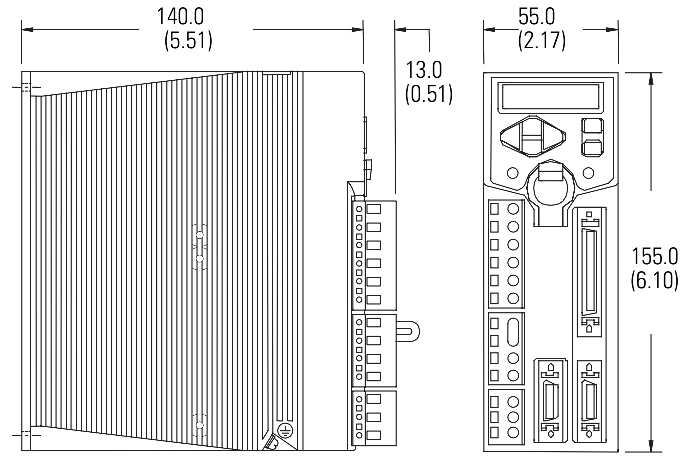


Figure A.2
Ultra1500 Basic Outline Dimensions (2092-DA3)

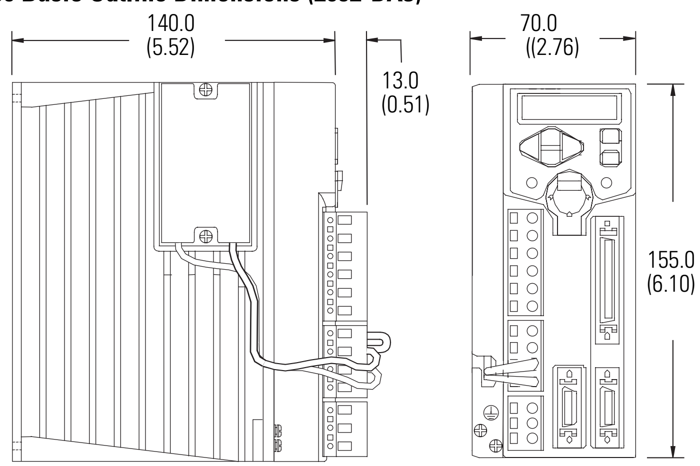
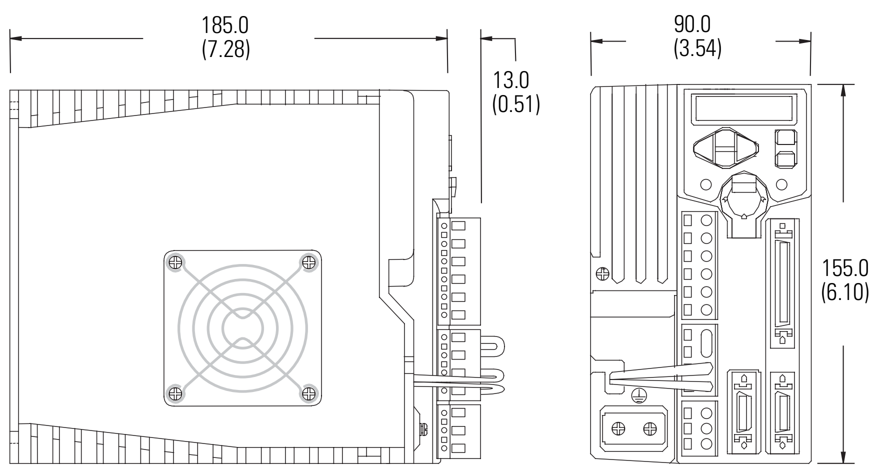


Figure A.3
Ultra1500 Basic Outline Dimensions (2092-DA4 and 2092-DA5)



Interconnect and Cable Diagrams

Chapter Objectives

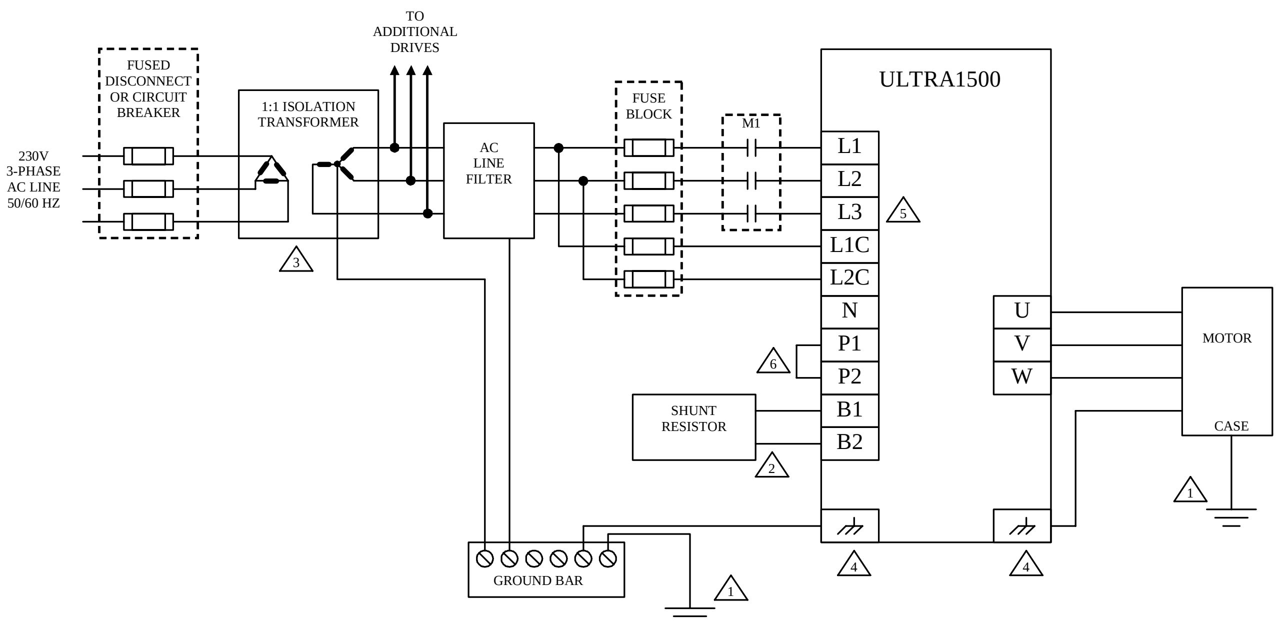
This appendix contains the following interconnect diagrams and cable assembly drawings that show you how to connect your Ultra1500 to the other parts of a motion control system:

- Power Connections
- CN1 I/O Control Connections
- ControlLogix 1756-M02AE System Connections
- SoftLogix 1784-PM02AE System Connections
- Generic Controller Connections
- MicroLogix 1200/1500 Connections
- TL-Series Motor Connections
- Generic Rotary Motor Connections
- Anorad Linear Motor Connections
- Generic Linear Motor Connections
- Host Communications Connections
- TL-Series Motor Power Cable Assembly (2090-DANPT-16Sxx)
- CN1 Control Cable Assembly (2090-DAIO-D50xx)
- CN2 Feedback Cable Assembly for TL-Series Motors (2090-DANFCT-Sxx)
- CN3 PC Communications Assembly (2090-DAPC-D09xx)

Power Connections

Figure B.1 shows the recommended power wiring for a typical Ultra1500 drive and motor system.

Figure B.1
Ultra1500 Simplifier Power Wiring Diagram



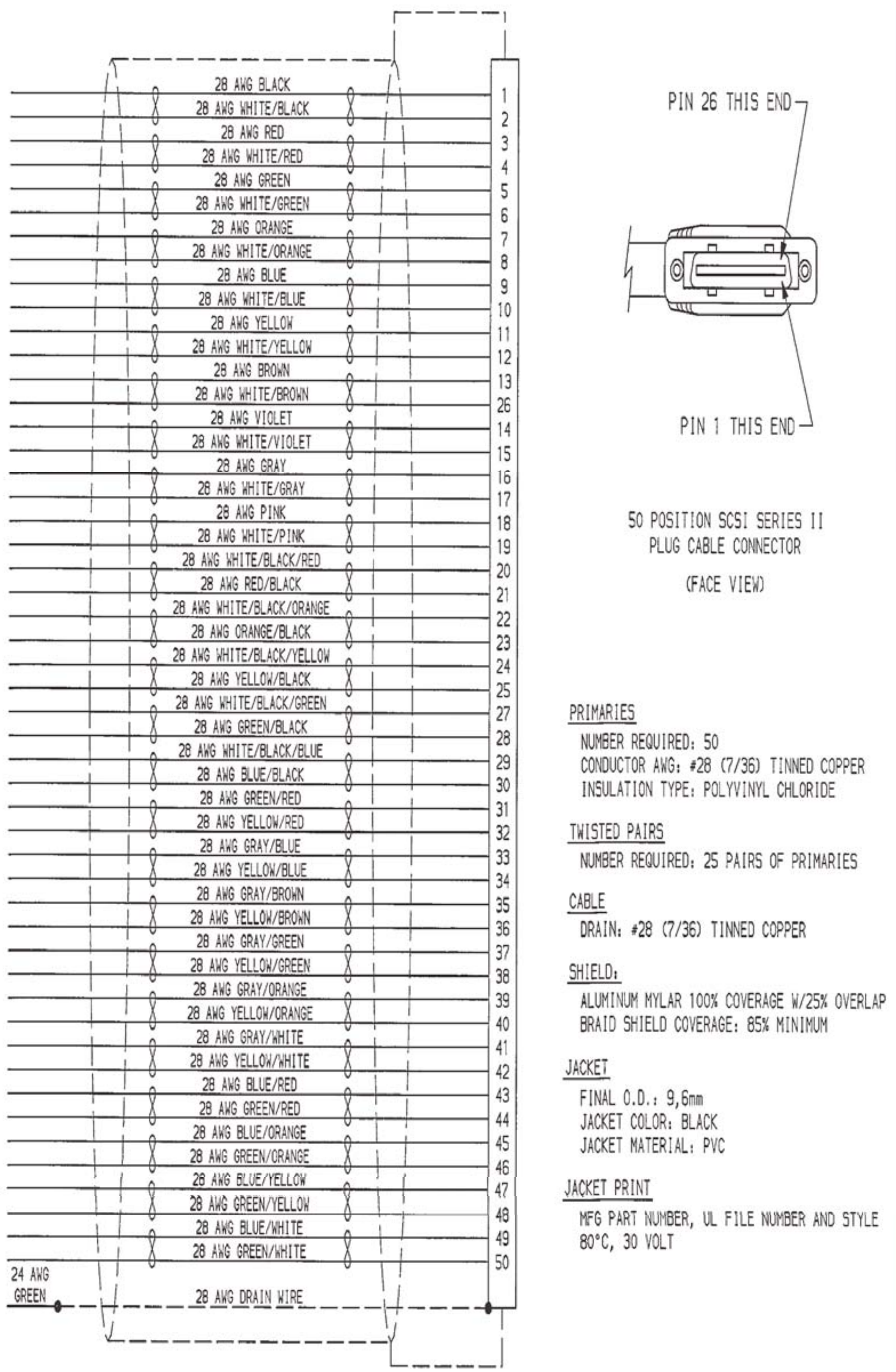
NOTES:

1. HIGH-FREQUENCY GROUNDING USING HEAVY BRAIDS SHOULD CONNECT TOGETHER THE ELECTRONIC EQUIPMENT, THE ELECTRICAL ENCLOSURE, THE MACHINE FRAME AND THE MOTOR HOUSING.
2. THE INTERNAL SHUNT RESISTOR IS ONLY PRESENT ON THE 2092-DA3, 2092-DA4, AND 2092-DA5 MODELS. B1 AND B2 SHOULD BE LEFT DISCONNECTED ON THE 2092-DA1 AND 2092-DA2 MODELS.
3. AN ISOLATION TRANSFORMER IS OPTIONAL. IF USED, THE SECONDARY OF THE TRANSFORMER MUST BE GROUNDED.
4. THE 2092-DA1 AND 2092-DA2 MODELS HAVE ONE GROUNDING SCREW ON THE HEATSINK, AND THE 2092-DA3, 2092-DA4, AND 2092-DA5 MODELS HAVE TWO GROUNDING SCREWS ON THE HEATSINK.
5. THE 2092-DA1, 2092-DA2, AND 2092-DA3 MODELS ARE SINGLE-PHASE AC INPUT, AND L3 SHOULD BE LEFT DISCONNECTED.
6. THE JUMPER FROM P1 TO P2 CAN BE REPLACED WITH AN INDUCTOR, IF THE POWER FACTOR OR HARMONIC DISTORTION NEEDS IMPROVEMENT.

CN1 I/O Control Connections

Figure B.2 shows typical input/output connections to the CN1 control connector of the Ultra1500.

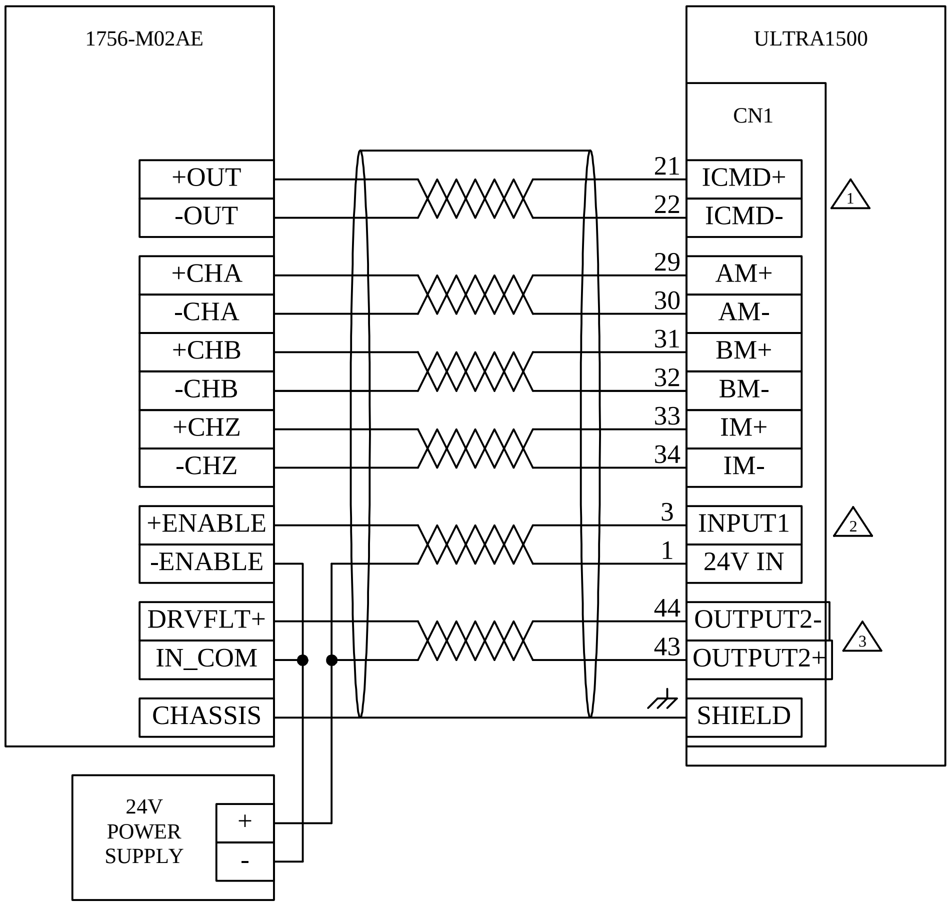
Figure B.2
Ultra1500 CN1 I/O Control Interface Diagram



ControlLogix 1756-M02AE System Connections

Figure B.3 shows the recommended connections for a typical 1756-M02AE system using an Allen-Bradley ControlLogix PLC control system.

Figure B.3
Ultra1500 to 1756-M02AE System Interface Diagram



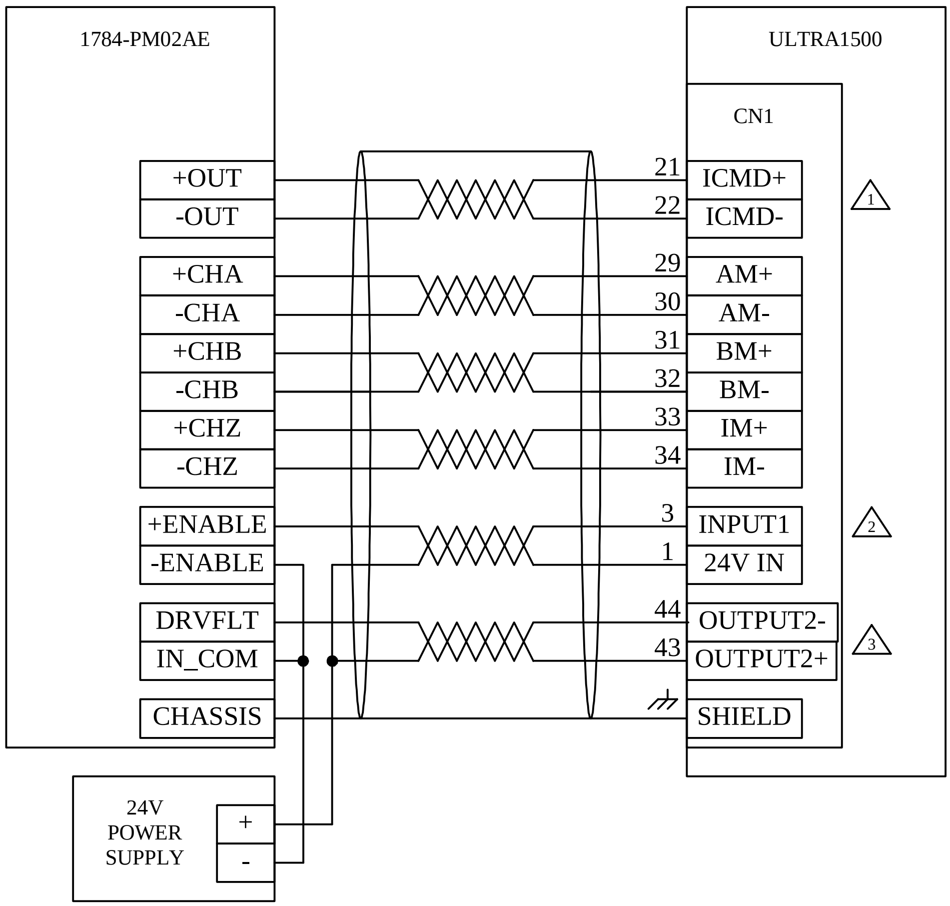
NOTES:

1. IN THIS EXAMPLE, THE 1756-M02AE PROVIDES A CURRENT COMMAND TO THE DRIVE AND CLOSES THE VELOCITY LOOP. IF THE APPLICATION REQUIRES THE DRIVE TO CLOSE THE VELOCITY LOOP, THE VELOCITY COMMAND OF THE 1756-M02AE SHOULD BE CONNECTED TO THE ANALOG VELOCITY COMMAND INPUT OF THE DRIVE INSTEAD, FOUND ON PINS 19 AND 20.
2. INPUT1 MUST BE CONFIGURED TO HAVE ENABLE FUNCTIONALITY USING ULTRAWARE.
3. OUTPUT2 MUST BE CONFIGURED TO HAVE DRIVE READY FUNCTIONALITY USING ULTRAWARE.

SoftLogix 1784-PM02AE System Connections

Figure B.4 shows the recommended connections for a typical 1784-PM02AE system using an Allen-Bradley SoftLogix5800 control system.

Figure B.4
Ultra1500 to 1784-PM02AE System Interface Diagram



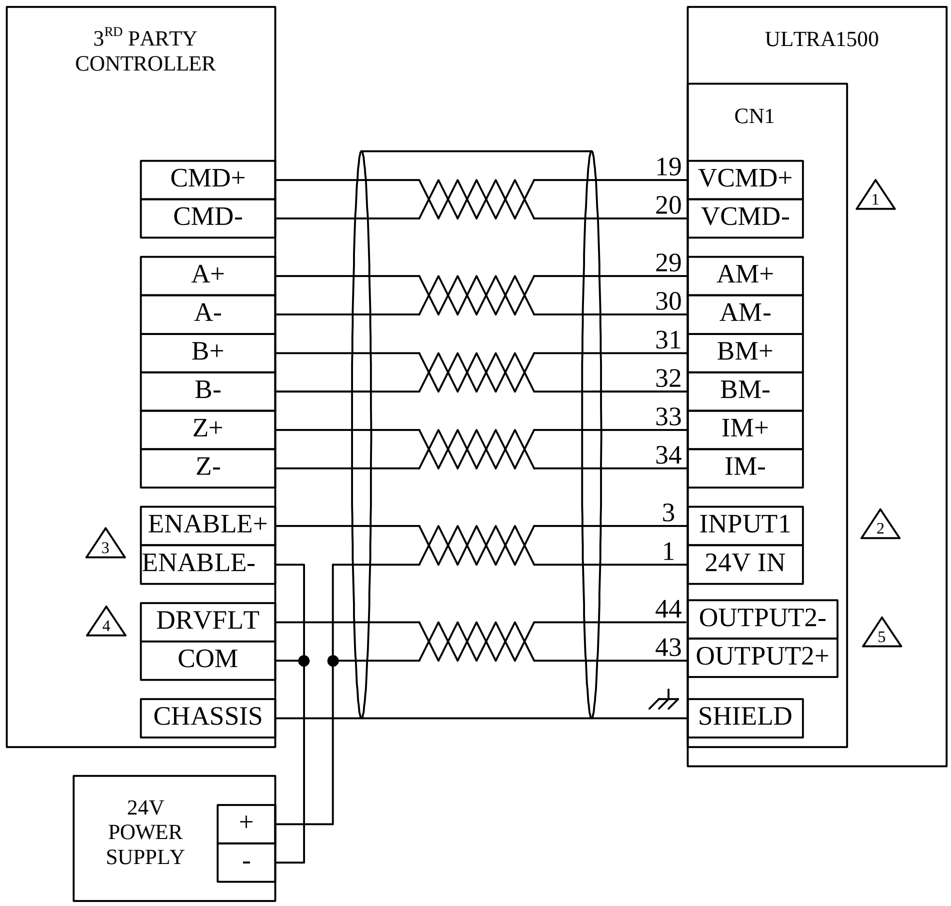
NOTES:

1. IN THIS EXAMPLE, THE 1784-PM02AE PROVIDES A CURRENT COMMAND TO THE DRIVE AND CLOSES THE VELOCITY LOOP. IF THE APPLICATION REQUIRES THE DRIVE TO CLOSE THE VELOCITY LOOP, THE VELOCITY COMMAND OF THE 1784-PM02AE SHOULD BE CONNECTED TO THE ANALOG VELOCITY COMMAND INPUT OF THE DRIVE INSTEAD, FOUND ON PINS 19 AND 20.
2. INPUT1 MUST BE CONFIGURED TO HAVE ENABLE FUNCTIONALITY USING ULTRAWARE.
3. OUTPUT2 MUST BE CONFIGURED TO HAVE DRIVE READY FUNCTIONALITY USING ULTRAWARE.

Generic Controller Connections

Figure B.5 shows the recommended connections for a typical system using a generic motion controller.

Figure B.5
Ultra1500 to Generic Controller System Interface Diagram



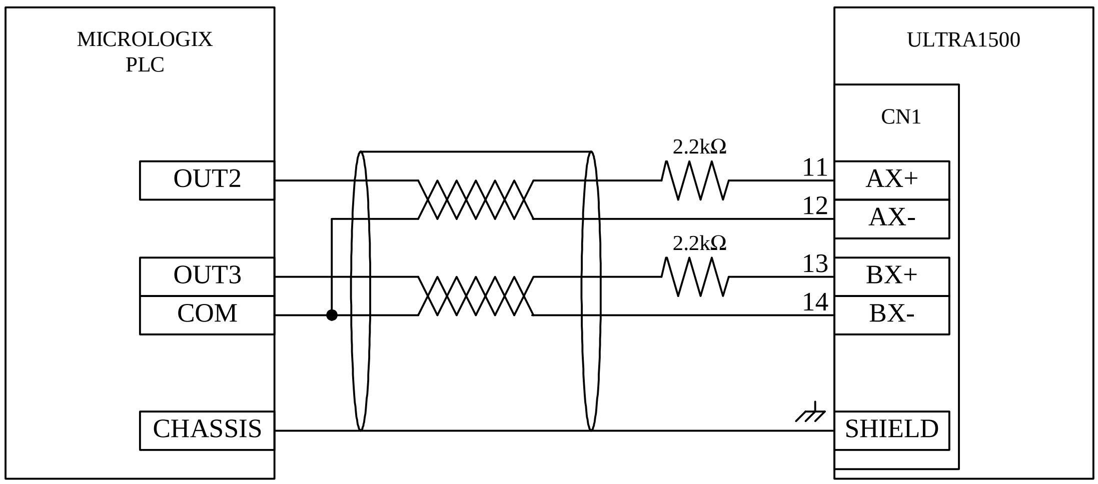
NOTES:

1. IN THIS EXAMPLE, THE CONTROLLER PROVIDES A VELOCITY COMMAND TO THE DRIVE AND THE DRIVE CLOSES THE VELOCITY LOOP. IF THE APPLICATION REQUIRES THE CONTROLLER TO CLOSE THE VELOCITY LOOP, THE CURRENT COMMAND OF THE CONTROLLER SHOULD BE CONNECTED TO THE ANALOG CURRENT COMMAND INPUT OF THE DRIVE INSTEAD, FOUND ON PINS 21 AND 22.
2. INPUT1 MUST BE CONFIGURED TO HAVE ENABLE FUNCTIONALITY USING ULTRAWARE.
3. THIS DRAWING ASSUMES THAT THE ENABLE OUTPUTS OF THE CONTROLLER ARE RELAY CONTACTS. CHECK THE INSTALLATION MANUAL FOR OTHER POSSIBLE CONFIGURATIONS.
4. THIS DRAWING ASSUMES THAT THE DRIVE FAULT INPUT OF THE CONTROLLER IS ACTIVE HIGH, CURRENT SINKING. CHECK THE INSTALLATION MANUAL FOR OTHER POSSIBLE CONFIGURATIONS.
5. OUTPUT2 MUST BE CONFIGURED TO HAVE DRIVE READY FUNCTIONALITY USING ULTRAWARE.

MicroLogix 1200/1500 Connections

Figure B.6 shows the recommended connections for a typical system using a MicroLogix 1200 or 1500 programmable logic controller with the Ultra1500. In this example, the Ultra1500 is operating in Follower mode and the PLC provides Step and Direction commands to the drive.

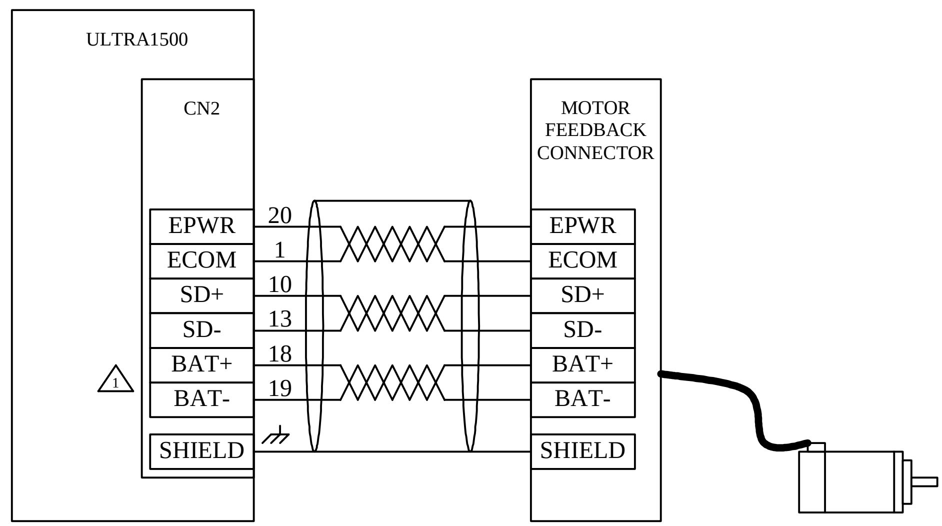
Figure B.6
Ultra1500 to MicroLogix 1200/1500 System Interface Diagram



TL-Series Motor Connections

Figure B.7 shows the recommended feedback wiring for the TL-Series motors to the Ultra1500.

Figure B.7
Ultra1500 and TL-Series Motor Feedback Wiring Diagram

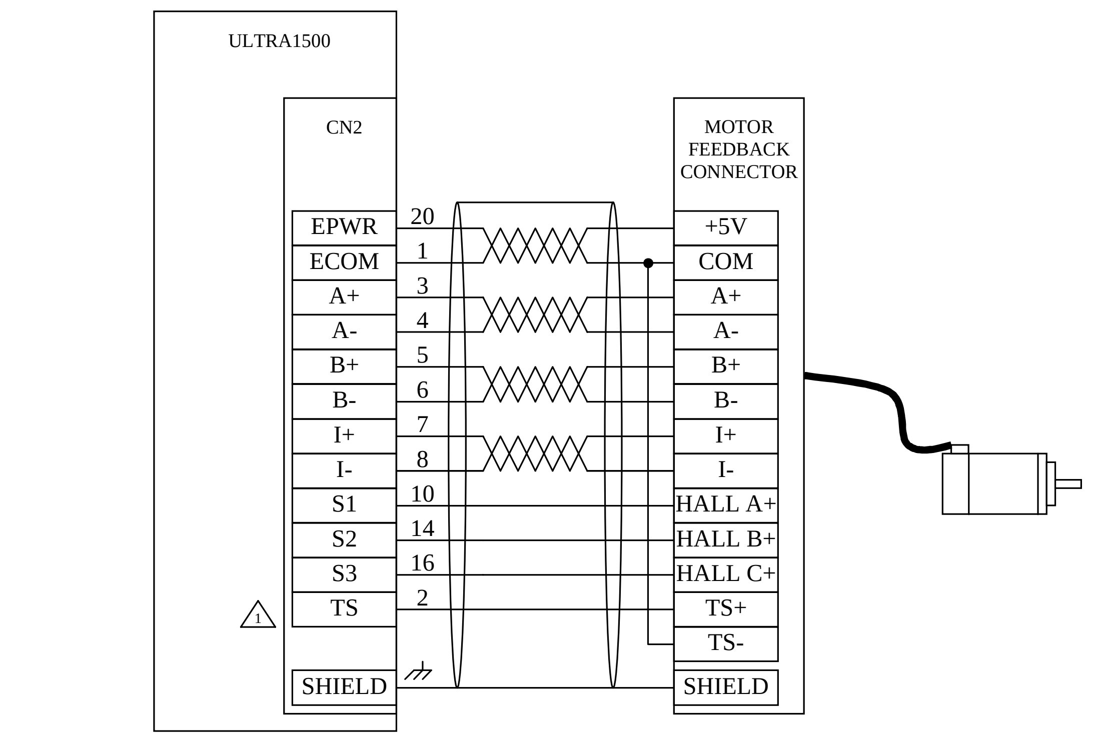


NOTES:
1. IF MULTI-TURN ABSOLUTE FEEDBACK IS NOT NEEDED IN THE APPLICATION, THE BATTERY CONNECTIONS TO PINS 18 AND 19 OF CN2 ARE NOT NECESSARY.

Generic Rotary Motor Connections

Figure B.8 shows the recommended feedback wiring for a generic rotary motor with an incremental AQB encoder and Hall signals.

Figure B.8
Ultra1500 and Generic Rotary Motor Feedback Wiring Diagram

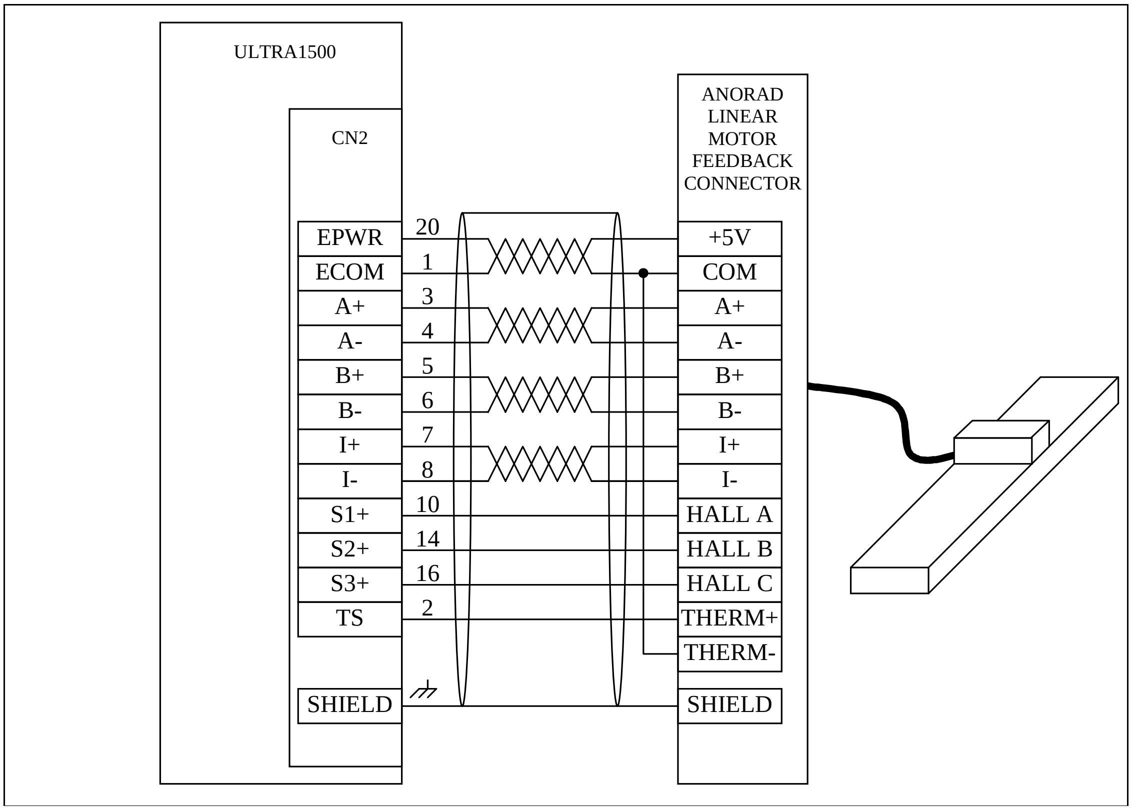


NOTES:
1. IF THE MOTOR DOES NOT HAVE A THERMISTOR OR THERMOSTAT, THE THERMOSTAT INPUT OF THE ULTRA1500 FOUND ON PIN 2 OF CN2 SHOULD BE LEFT DISCONNECTED.

Anorad Linear Motor Connections

Figure B.9 shows the recommended feedback wiring for an Anorad linear motor.

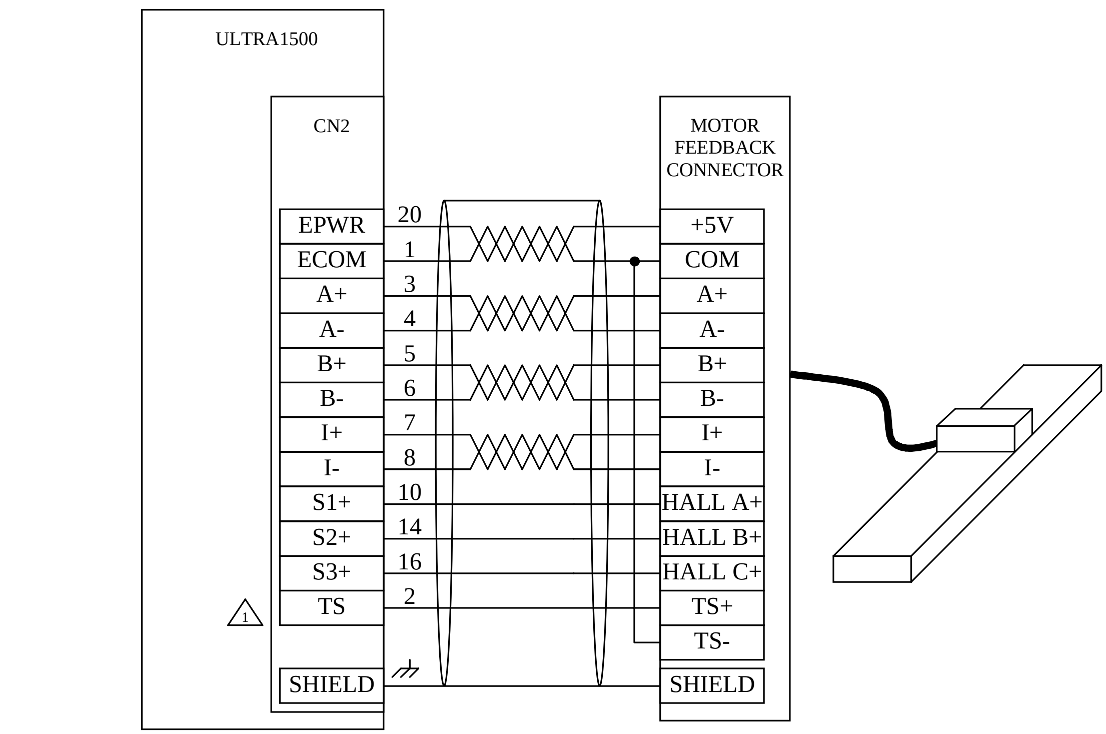
Figure B.9
Ultra1500 and Anorad Linear Motor Feedback Wiring Diagram



Generic Linear Motor Connections

Figure B.10 shows the recommended feedback wiring for a 3rd party linear motor with an incremental AQB encoder and Hall signals.

Figure B.10
Ultra1500 and Generic Linear Motor Feedback Wiring Diagram

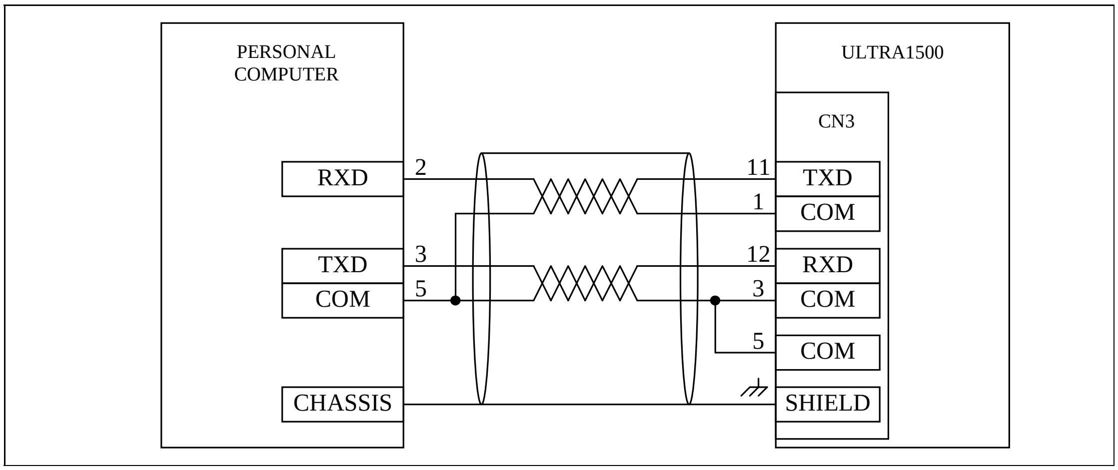


NOTES:
1. IF THE MOTOR DOES NOT HAVE A THERMISTOR OR THERMOSTAT, THE THERMOSTAT INPUT OF THE ULTRA1500 FOUND ON PIN 2 OF CN2 SHOULD BE LEFT DISCONNECTED.

Host Communications Connections

Figure B.11 shows the connections between a personal computer and the Ultra1500 drive. These connections are necessary when Ultraware is used for configuration or monitoring the drive, or if a PC-based software program is used to communicate with the drive directly using serial commands

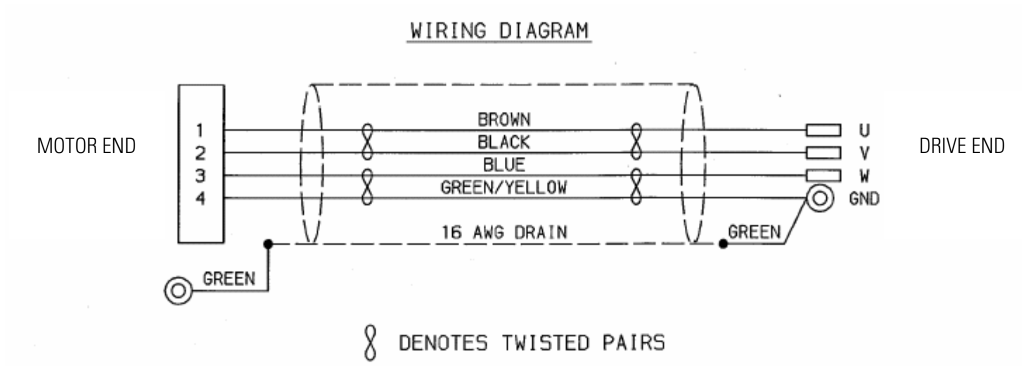
Figure B.11
Ultra1500 and Personal Computer Communications Port Wiring Diagram.



TL-Series Motor Power Cable Assembly (2090-DANPT-16Sxx)

Figure B.12 shows the wiring diagram for the motor power cable assembly sold by Allen-Bradley (catalog number 2090-DANPT-16Sxx) to interface the Ultra1500 drive to the TL-Series motor family.

Figure B.12
TL-Series Motor Power Cable Diagram



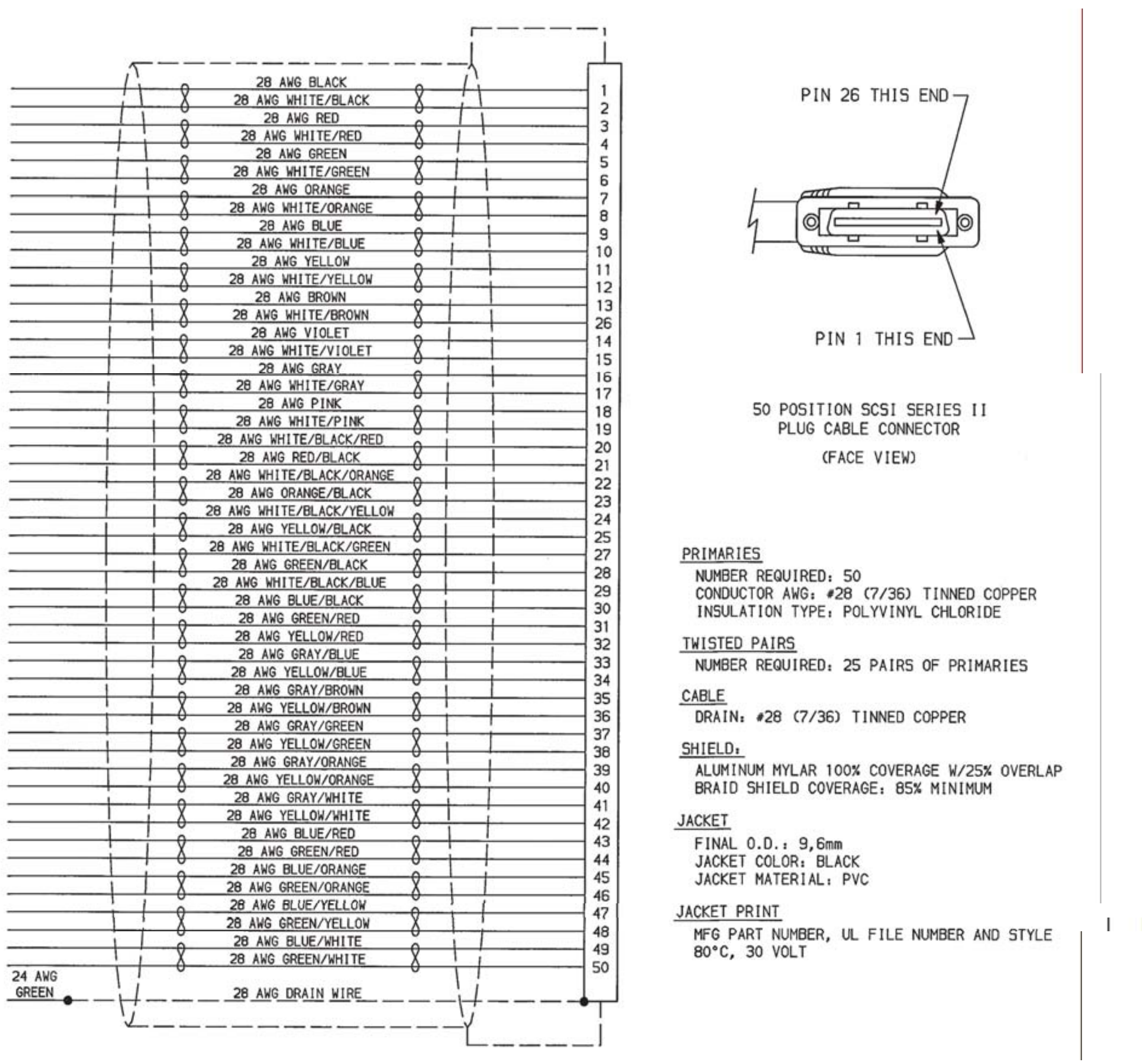
CN1 Control Cable Assembly (2090-DAIO-D50xx)

Figure B.13 shows the wiring diagram for the CN1 control cable assembly sold by Allen-Bradley (catalog number 2090-DAIO-D50xx) to interface the Ultra1500 drive to a motion controller.

Figure B.13
CN1 Control Cable Diagram

Wiring Diagram

Drive End

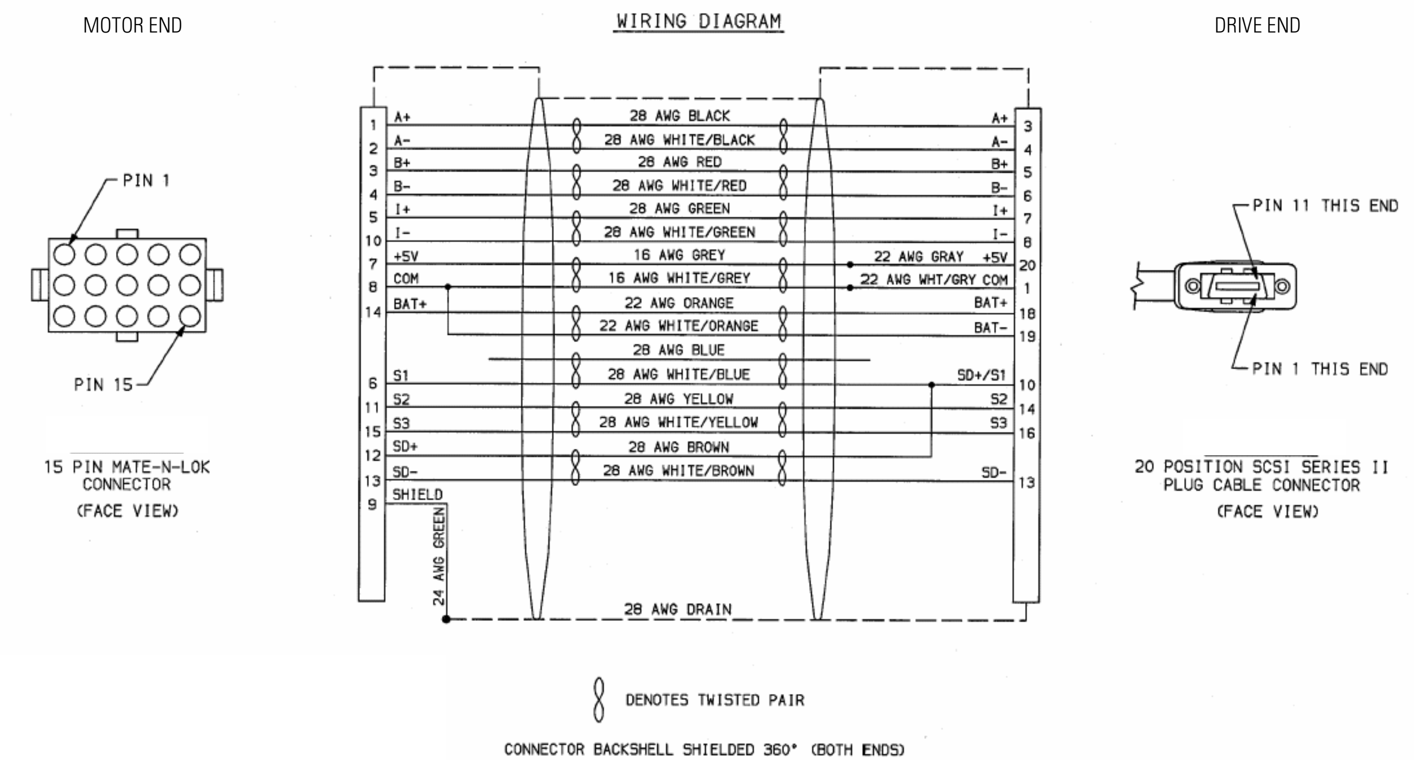


8 Denotes Twisted Pair

CN2 Feedback Cable Assembly for TL-Series Motors (2090-DANFCT-Sxx)

Figure B.14 shows the wiring diagram for the motor feedback cable assembly sold by Allen-Bradley (catalog number 2090-DANFCT-Sxx) to interface the Ultra1500 drive to the TL-Series motor family. This cable assembly includes connections for serial encoders as well as incremental encoders.

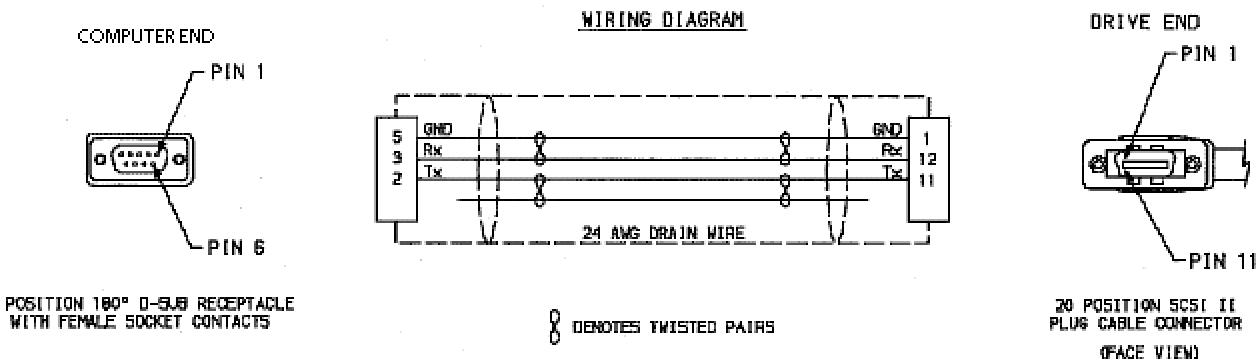
Figure B.14
TL-Series Motor Feedback Cable Diagram.



CN3 PC Communications Assembly (2090-DAPC-D09xx)

Figure B.15 shows the wiring diagram for the CN3 PC communications cable assembly sold by Allen-Bradley (catalog number 2090-DAPC-D09xx) to interface the Ultra1500 drive to a host computer.

Figure B.15
Ultra1500 CN3 PC Communications Cable Diagram



Catalog Numbers and Accessories

Chapter Objectives

This appendix lists the Ultra1500 drives and accessory items in tables by catalog number providing detailed descriptions of each component. This appendix describes catalog numbers for:

- Ultra1500 Drives
- Ultraware Software
- AC Line Filters
- Motor Power Cables
- Motor Feedback Cables
- Motor Brake Cables
- Interface Cables
- Connector Kits
- Battery

Contact your local Allen-Bradley sales office for additional information. Refer to the *Motion Control Selection Guide* (publication (GMC-SG001*x*-EN-P) for details on products.

Ultra1500 Drives

Use the following table to identify Ultra1500 drives based on Continuous Output Current, or Intermittent Output Current.

Continuous Output Current	Intermittent Output Current	Catalog Number
1.4A (0–peak)	3.4A (0–peak)	2092-DA1
2.4A (0–peak)	7.2A (0–peak)	2092-DA2
4.7A (0–peak)	11.3A (0–peak)	2092-DA3
10.7A (0–peak)	24.8A (0–peak)	2092-DA4
16.4A (0–peak)	43.4A (0–peak)	2092-DA5

Ultraware Software

The Ultra1500 drives are configured using Ultraware. Ultraware is a Windows® based application that allows drive configuration to be done off-line and saved to disk.

Description	Catalog Number
Ultraware Software	2098-UWCPRG

AC Line Filters

Use the following table to identify the AC Line Filter for your application.

AC Line Filter Description	AC Line Filter Fuse Block	Catalog Number
AC Line Filter (single phase) for 2092-DA1 and 2092-DA2 drives	6 Amp	2090-UXLF-106
AC Line Filter (single phase) for 2092-DA3 drive	10 Amp	2090-UXLF-110
AC Line Filter (three-phase) for 2092-DA4 and 2092-DA5 drive	23 Amp	2090-UXLF-HV323

Cables

Use the following tables to identify motor power, feedback, interface, and brake cables for your Ultra1500 drive. Length of cable *xx* is in meters. Power, feedback and brake cables for connection to TL-Series motors are available in standard lengths up to 30 m (98.4 ft).

Motor Power Cables

Description	Catalog Number
Power Cable for TL-Series Motors, ferruled leads to drive	2090-DANPT-16S*xx*

Motor Feedback Cables

Description	Catalog Number
CN2 Feedback Cable for TL-Series Motors, connectors both ends	2090-DANFCT-S*xx*

Motor Brake Cables

Description	Catalog Number
Brake Cable for TL-Series Motors, ring lugs to drive	2090-DANBT-18S*xx*

Interface Cables

Description	Catalog Number
CN1 Control Cable, connector to drive, flying leads to controller	2090-DAIO-D50*xx*
CN3 Communications Cable, connectors both ends	2090-DAPC-D09*xx*

Connector Kits

Use the following table to identify connector kits for your Ultra1500 drive.

Description	Catalog Number
50 pin Mini-D Connector Kit (solder cup type) for CN1	9101-1476
20 pin Mini-D Connector Kit (solder cup type) for CN2 and CN3	9101-1477

Battery

Use the following table to identify the battery for your Ultra1500 drive.

Description	Catalog Number
3.6 Volt, ½-size AA, Lithium Battery	2090-DA-BAT

Ultra1500 Operator Interface

Chapter Objectives

This appendix describes the Ultra1500 drive status and setting displays that can be accessed and modified through the Operator Interface. This appendix includes these sections:

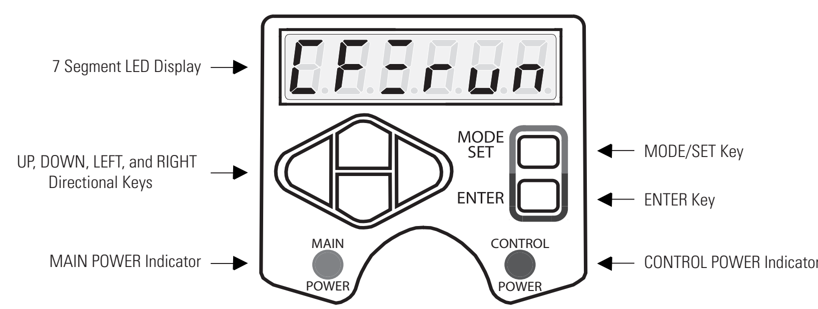
- Using the Operator Interface
- Mode Displays
- Parameter Groupings

The on-line help supplied with Ultraware also contains information about Ultra1500 Operator Interface functions.

Using the Operator Interface

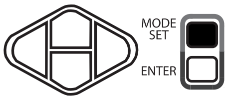
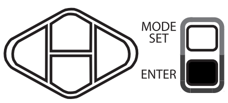
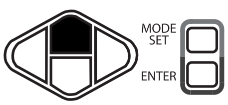
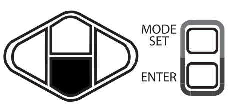
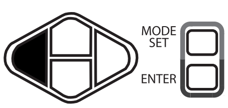
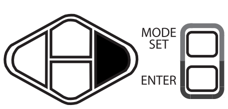
The Operator Interface provides immediate access to Ultra1500 drive status displays and monitoring, parameter settings, or functional commands. The major features of the Ultra1500 Operator Interface are identified in Figure D.1 and described below.

Figure D.1
Ultra1500 Operator Interface



- The 7-Segment LED displays status, parameters, function commands, and allows drive monitoring.
- The MAIN POWER indicator illuminates when the drive's DC bus is charged by application of 200–240V power to the L1, L2 and L3 Main Power pins.
- The CONTROL POWER illuminates when the drive's control electronics are powered by application of 200–240V power to the L1C, and L2C Control Power pins.
- The MODE/SET, and ENTER keys provide the operator with access to drive functions. The directional keys (UP, DOWN, LEFT, and RIGHT edit drive function settings. These keys allow the operator to monitor and change the drive's program.

The following briefly explains the MODE/SET, ENTER, and directional keys and their use.

Key	Name	Function	Example
	SET	Saves the current value of the setting in memory.	To save any change: • Press and hold SET until the display blinks.
	MODE	Toggles the display between the four modes. NOTE: The Status mode is the default display at power-up.	To advance the display through the various mode displays: 1. Press MODE to advance from the Status mode (default display) to Set Parameter mode, 2. Press MODE again to advance to Monitor mode. 3. Press MODE again to advance to the Function mode. 4. Press MODE once more to return to the Status mode.
	ENTER	Enter or exit a display containing the settings for the selected mode. NOTE: Before exiting the display, SET must be pressed and held until the display blinks to save any modified value to memory.	To access the settings for Pr-0.00 from the Status mode: 1. Press MODE to advance to the initial Parameter display (PR-0.00). 2. Then press ENTER to access the parameter's value (01 is the default setting).
	UP	Increments the value to a larger integer. A non-functional key in the Status mode.	In any Parameter Setting, Monitor, or Function mode: • Press and hold the UP key to scroll to the maximum value.
	DOWN	Decrements the value to a smaller integer. A non-functional key in the Status mode.	In any Parameter Setting, Monitor, or Function mode: • Press and hold the DOWN key to scroll to the minimum value.
	LEFT	Shifts the active digit to the left. An invalid key for the Status mode.	In the Set Parameter mode: 1. Press LEFT to move from least to the most significant digit in parameters (PR-x.x**X** to PR-x.**X**x. 2. Press LEFT again to move to the groups digit (PR-**X**.xx).
	RIGHT	Shifts the active digit to the right. An invalid key for the Status mode.	In the Set Parameter mode: 1. Press RIGHT to move from least significant digit in parameters to the groups digit (PR-x.x**X** to PR-**X**.xx). 2. Press RIGHT again to move to the most significant digit in Parameters (Pr-x.**X**x).

Mode Displays

Function Mode

The Function mode displays fourteen drive functions, although four functions have restricted access. To perform an non-reserved drive function:

1. Enter the Function mode by pressing the MODE key.

   The display indicates the selected Function by displaying (where *nn* is a function number from the table below).

2. Select the function to perform from the list below using either the UP or DOWN key: Select from: 00 the Jog function, 01 the Run Auto Tuning function, through 12 the Reset to Factory Settings function.

   Functions 02, 07, 09, and 13 display, but are Reserved functions.

Function Number and Command Abbreviation		Description	Notes
00	-JoG-	Jog	Parameter 2.01 and the Velocity Control Panel window of Ultraware store the jog velocity.
01	-AUto-	Run Auto Tuning	
02	2-PULS	Reserved	Not accessible to user
03	At-SCo	Remove Velocity Input Offset	
04	At-CCo	Remove Current Input Offset	
05	AJ-SCo	Manually Adjust Velocity Input Offset	Parameter 6.00 and the Analog window of Ultraware stores Velocity Input Offset.
06	AJ-CCo	Manually Adjust Current Input Offset	Parameter 6.01 and the Analog window of Ultraware stores Current Input Offset.
07	AT-PCo	Reserved	Not accessible to user
08	AL-rST	Fault Reset	
09	AH-CLr	Reserved	Not accessible to user
10	EnCrSt	Absolute Encoder Reset	
11	2-GAIn	Copy Main Gains to Alternate	
12	Pr-rST	Reset to Factory Settings	
13	tStrun	Reserved	Not accessible to user

3. Press the ENTER key to load the function. An abbreviated text message indicates the function to be performed.
   For example, Function 00 displays the text message -JoG-.

   Note: Some functions can only be performed if the drive resides in a particular status.

If you are performing this function:	Complete the following step(s) to:
00 -JoG-	Perform a Jog (00) function: **1.** Press MODE to select the JoG-On display Note: MODE toggles between JoG-On and JoG-OFF. **2.** Press the UP key to jog in the forward direction, or the DOWN key to jog in the reverse direction. **3.** Press MODE to select JoG-OFF. **4.** Press the ENTER key to return to the Function Mode display.
05 AJ-SCo 06 AJ-SCo	Manually Adjust Velocity Input Offset (05) function, or Manually Adjust Current Input Offset (06) function: **1.** Press MODE to display the default (0.0) value. **2.** Press the UP or DOWN to increase or decrease the offset value by one unit each time the key is pressed. The default display is 0.0, but a value is set and stored when the drive is commissioned. The commissioned value increments when UP is pressed, or decrements when DOWN is pressed [i.e., The total UP entries are added to (DOWN entries are subtracted from) the commissioned value.] Note: The Velocity Input Offset (05) is stored in Pr 6.00, Current Input Offset in Pr 6.01, or in the Analog window of Ultraware. **3.** Press the SET key to execute the function. An incrementing border indicates the function is executing. The text message -donE- displays upon completion. **4.** Press the ENTER key to return to the Function Mode display.
01 -AUto- 03 At-SCo 04 At-CCo 08 AL-rST 10 EnCrSt 11 2-GAIn 12 Pr-rST	Perform the other non-reserved function(s). **1.** Press the SET key to execute the function. An incrementing border indicates the function is executing. The text message -donE- displays upon completion. **2.** Press the ENTER key to return to the Function Mode display.

Monitor Mode

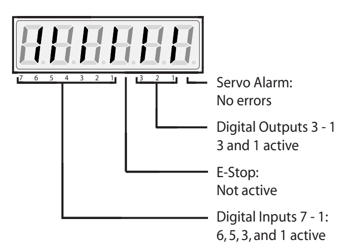
The Monitor mode displays numerical data about drive and motor functions. To access the monitor data:

1. Enter the Monitor mode by pressing the MODE key. The display indicates the selected Function by displaying d15-nn
(where *nn* is a variable number from the tables below).

2. Using either the UP, DOWN, RIGHT, or LEFT keys, select a Variable Number listed the appropriate table below. Select from: 00 the Velocity Feedback variable, 01 the Velocity Command variable, through 20 the Output Power Limit Ratio variable.

   The table on page D-5 defines the variables that can be selected for the monitor.

3. Press the ENTER key to display the value of the variable.

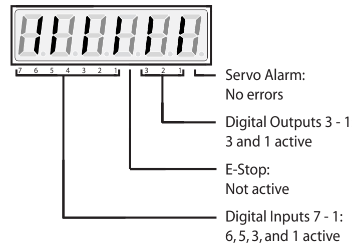
Variable Numbers	Name	Unit
00	Velocity Feedback	rpm or mm/sec
01	Velocity Command	rpm or mm/sec
02	Velocity Error	rpm or mm/sec
03	Current Command	0.1% of motor rated continuous torque
04	Follower Position	counts
05	Master Position	counts
06	Position Error	counts
07	Position Command Count Frequency	0.1 kilocounts/sec
08	Commutation Angle	0.1° (degrees)
09	Mechanical Angle	0.1° (degrees)
10	Shunt Power Limit Ratio	%
11	Bus Voltage	V
12	Absolute Rotations	revolutions
13	Velocity Command Offset	mV
14	Current Command Offset	mV
15	Input and Output State	

Variable Numbers	Name	Unit
16	Error History	Up to eight alarms stored in numerical order (most recent =1, to oldest =8) with error code number: Most significant digit is alarm number (1–8), Least significant six digits are the error code number referenced in the *Error Displays* beginning on page 6-5. e.g., 1-E004 = most recent error is a Motor Overtemp
17	Firmware Version	e.g., vEr*x.yy* where *x* = version, *yy* = revision
18	Motor Temperature	%
19	Instantaneous Output Power	Watts
20	Output Power Limit Ratio	%

This table defines only those variables that can be selected for the following parameters:

Pr-5.12 Analog Output 1: Signal on page D-28,
Pr-5.13 Analog Output 2: Signal on page D-28,
Pr-6.07 Fault Detail Setup: Channel A on page D-30
Pr-6.08 Fault Detail Setup: Channel B on page D-30,
Pr-6.09 Fault Detail Setup: Channel C on page D-30, and
Pr-6.10 Fault Detail Setup: Channel D on page D-31.

Variable Numbers	Name	Unit
00	Velocity Feedback	rpm or mm/sec
01	Velocity Command	rpm or mm/sec
02	Velocity Error	rpm or mm/sec
03	Current Command	0.1% of motor rated continuous torque
04	Follower Position	counts
05	Master Position	counts
06	Position Error	counts
07	Position Command Count Frequency	0.1 kilocounts/sec
08	Commutation Angle	0.1° (degrees)
09	Mechanical Angle	0.1° (degrees)
10	Shunt Power Limit Ratio	%
11	Bus Voltage	V
12	Absolute Rotations	revolutions
13	Velocity Command Offset	mV
14	Current Command Offset	mV

Variable Numbers	Name	Unit
15	Input and Output Status	
16	Error History	Up to eight alarms stored in numerical order (most recent =1, to oldest =8) with error code number: Most significant digit is alarm number (1–8), Least significant six digits are the error code number referenced in the *Error Displays* beginning on page 6-5. e.g., 1-E004 = most recent error is a Motor Overtemp
17	V Phase Current	0.001 A
18	W Phase Current	0.001 A
19	Motor Temperature	%
20	Analog Command - Velocity	0.01 V
21	Analog Command - Current	0.01 V
22	Current Feedback	0.01 V
23	Hall State	–
24	Motor Feedback Position	counts
25	Instantaneous Output Power	Watts
26	Output Power Limit Ratio	%
27	Instantaneous Shunt Power	Watts
28	Drive Utilization	%
29	Reserved	–

Status Mode

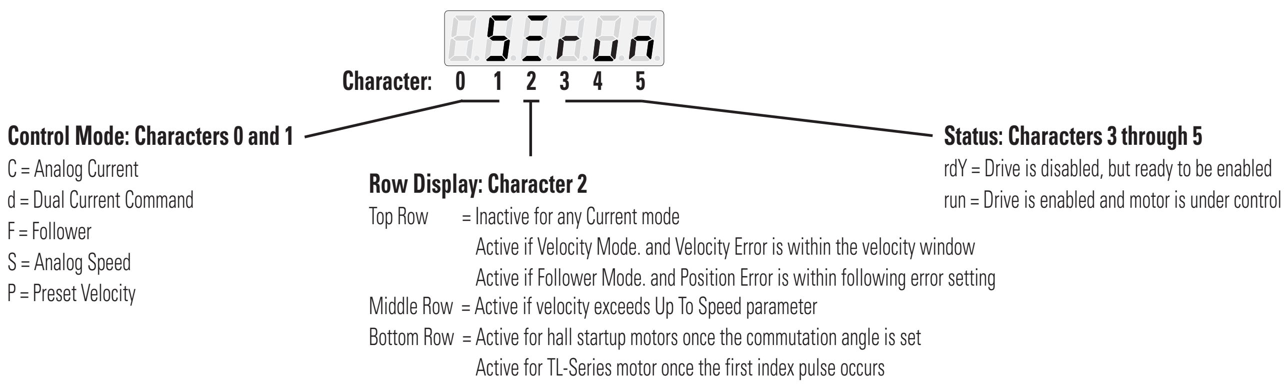
The Status mode provides normal operational information, fault indicators, and positive or negative overtravel indicators. The operational information displayed may be grouped into three categories:

- Control Mode (characters 0 and 1),
- Row Display (character 2), and
- Status (characters 3 through 5).

Figure D.2 shows these categories and briefly defines the information provided by each category.

Refer to *Maintaining and Troubleshooting Your Ultra1500* beginning on page 6-1 for a complete listing and description of Warning Messages, Error Displays, and Overtravel Conditions.

Figure D.2
Operational Drive Displays



Set Parameter Mode

The Set Parameter mode allows adjustments to the parameters that control drive operation. Parameters are grouped into the following categories:

Parameter Group	Type of Parameter
Group 0	Basic drive system and I/O settings
Group 1	Gain and gain tuning settings
Group 2	Speed control settings
Group 3	Position control settings
Group 4	Torque control settings
Group 5	Supplementary drive system and I/O settings
Group 6	Supplementary gain settings and fault reports

To display parameter settings:

1. Enter the Set Parameter mode by pressing the MODE key.
   The text message Pr-*x.xx* indicates the Set Parameter mode is active.

2. After you select a parameter, the active digit flashes.
   The UP or DOWN key increments or decrements the parameter number.
   The LEFT and RIGHT key moves the active digit within the parameter.

3. Press the ENTER key to display the current value of the parameter.

4. Modify the current value of the parameter with the directional keys, and save the modified value in memory by pressing the SET key.

5. Press the ENTER key a second time to return to the Set Parameter display, where you can modify parameter settings.

   For example: Enter the Set Parameter mode by pressing the MODE key (The text message Pr-*x.xx* indicates the Set Parameter mode is active). Select a parameter and navigate through the parameter using the navigational keys (the active digit flashes). Press the ENTER key to display the current value of the parameter. Modify the parameter setting by using the LEFT and RIGHT key to move between digits, and the UP or DOWN key to increment or decrement the flashing parameter value. Press and hold the SET key to save the new parameter setting (the display momentarily blanks to indicate the setting is saved). Lastly press ENTER to return to the Set Parameter display.

Parameter Groupings

This section defines the parameters controlling drive operation. Parameters are grouped by the category they reside in.

Group 0 Parameters

Group 0 Parameters provide basic drive system and I/O settings.

Pr-0.00 Operation Modes

Range:	**Value**	**Normal Operating Mode**	**Override Operating Mode**
	1	Follower	Follower
	2	Analog Velocity Input	Analog Velocity Input
	3	Analog Current Input	Analog Current Input
	4	Analog Velocity Input	Follower
	5	Analog Current Input	Follower
	6	Analog Current Input	Analog Velocity Input
	7	Preset Velocity	Preset Velocity
	8	Preset Velocity	Follower
	9	Preset Velocity	Analog Velocity Input
	10	Preset Velocity	Analog Current Input
	11	Dual Current Control	Dual Current Control
Default:	2		
Ultraware Link:	Main/Override		

Pr-0.01 Motor and Encoder Selection

Applicable Operating Mode	All	
Data Size:	4 digits	
Digit 0:	Auto Motor Identification	
Range:	**Value**	**Description**
	0x0	Disable automatic motor identification
	0x1	Enable automatic motor identification
Default:	1	
Digit 1:	Encoder Backup Battery (Single- or Multi-turn Absolute Encoder)	
Range:	**Value**	**Description**
	0x0	Backup battery installed (multi-turn)
	0x1	Backup battery not installed (single-turn)
Default:	1	
Digit 2:	Incremental Feedback Loss (Encoder Line Break Detection)	
Range:	**Value**	**Description**
	0x0	Enable encoder feedback loss error checking
	0x1	Disable encoder feedback loss error checking
Default:	0	
Digit 3:	Reserved	
Default:	0	

Pr-0.02 Basic Motor Operations

Applicable Operating Mode	All	
Data Size:	4 digits	
Digits 0:	Fault and Disable Braking	
Range:	**Value**	**Description**
	0x0	Brake and hold
	0x1	Brake and release
	0x2	Free stop
	0x3	Free stop and hold
Default:	1	

Digit 1:	Overtravel Stop Method	
Range:	**Value**	**Description**
	0x0	Stop by change of mode to Normal Current. Set stopping current with Overtravel Current limit parameter (Pr-4.05).
	0x1	Dynamic Brake
Default:	0	

Digit 2:	Command Polarity (Direction of Motor Rotation)	
Range:	**Value**	**Description**
	0x0	The command signal is not inverted so that a positive command value results in CW Rotation, (as viewed from shaft end).
	0x1	The command signal is inverted so that a positive command value results in CCW Rotation, (as viewed from shaft end).
Default:	0	

Digit 3:	Power Input (Phase Loss Monitoring)	
Range:	**Value**	**Description**
	0x0	Enable AC phase loss detection fault monitoring.
	0x1	Disable AC phase loss detection fault monitoring.
Default:	0	

Pr-0.03 Autotuning Functions

Applicable Operating Mode	All
Data Size:	4 digits

Digits 0 to 1:	Reserved

Digit 2:	Autotuning Speed
Range:	2 to 9
Default:	7
Units:	rpm/100

Digit 3:	Online Tuning Response (Dynamic Tuning Response Speed)	
Range:	**Value**	**Description**
	0x0	Off

	0x1	Slowest
	0x2	Slower
	0x3	Slow
	0x4	Medium-Slow
	0x5	Medium
	0x6	Medium-Fast
	0x7	Fast
	0x8	Faster
	0x9	Fastest
Default:	0	
Units:	–	

Pr-0.04 Inertia Ratio

Range:	0 to 6000
Default:	0
Units:	(Load Inertia / Motor Inertia) * 100
Ultraware Link:	Inertia Ratio

Pr-0.05 Input Signal Assignment - Group 1

Range for all digits:	0 to 8		
	Value	**Description**	
	0	Input Signal OFF	
	1 to 7	Input signal assigned to hardware inputs 1 through 7	
	8	Input Signal ON	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Drive Enable	0x1
	1	Overtravel – Positive	0x8
	2	Overtravel – Negative	0x8
	3	Integrator Inhibit	0x0
Applicable Operating Mode	All		

Pr-0.06 Input Signal Assignment - Group 2

Range for all digits:	0 to 8	
	Value	**Description**
	0	Input Signal OFF
	1 to 7	Input signal assigned to hardware inputs 1 through 7

	8	Input Signal ON	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Fault Reset	0x0
	1	Current Limit – Negative	0x0
	2	Current Limit – Positive	0x0
	3	Operation Mode Override	0x0
Applicable Operating Mode	All		

Pr-0.07 Input Signal Assignment - Group 3

Range for all digits:	0 to 8		
	Value	**Description**	
	0	Input Signal OFF	
	1 to 7	Input signal assigned to hardware inputs 1 through 7	
	8	Input Signal ON	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Preset Direction	0x0
	1	Preset Select 1	0x0
	2	Preset Select 2	0x0
	3	Preset Select 3	0x0
Applicable Operating Mode	All		

Pr-0.08 Input Signal Assignment - Group 4

Range for all digits:	0 to 8		
	Value	**Description**	
	0	Input Signal OFF	
	1 to 7	Input signal assigned to hardware inputs 1 through 7	
	8	Input Signal ON	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Zero Clamp	0x0
	1	Pause Follower	0x0
	2	Alternate Gain Select	0x0
	3	Absolute Encoder Reset of multi-turn data	0x0
Applicable Operating Mode	All		

Pr-0.09 Input Signal Assignment - Group 5

Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Position Strobe	0x0
	1	Reserved	0x0
	2	Reserved	0x0
	3	Reserved	0x0
Applicable Operating Mode	All		

Pr-0.10 Output Signal Assignment – Group 1

Range for all digits:	0 to 3		
	Value	**Description**	
	0	Output Signal OFF	
	1 to 3	Output signal assigned to hardware outputs 1 through 3	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	In Position	0x0
	1	Up To Speed	0x0
	2	Brake control	0x0
	3	Within Speed Window	0x0
Applicable Operating Mode	All		

Pr-0.11 Output Signal Assignment – Group 2

Range for all digits:	0 to 3		
	Value	**Description**	
	0	Output Signal OFF	
	1 to 3	Output signal assigned to hardware outputs 1 through 3	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Current Limited	0x0
	1	Velocity Limited	0x0
	2	Near Position	0x0
	3	Warning	0x0
Applicable Operating Mode	All		

Pr-0.12 Output Signal Assignment – Group 3

Range for all digits:	0 to 3		
	Value	**Description**	
	0	Output Signal OFF	
	1 to 3	Output signal assigned to hardware outputs 1 through 3	
Data Size:	4 digits		
Digits:	**Digit**	**Description**	**Default**
	0	Absolute Position Valid	0x0
	1	Drive Ready	0x0
	2	Reserved	0x0
	3	Reserved	0x0
Applicable Operating Mode	All		

Pr-0.13 Drive Address

Range:	1 to 255
Default:	1
Ultraware Link:	Drive Address

Pr-0.14 Password

This parameter is Reserved.

Group 1 Parameters

Group 1 Parameters provide drive gain and gain tuning settings.

Pr-1.00 Reserved

This parameter is Reserved.

Pr-1.01 Main Velocity Regulator Gains: P

Range:	0 to 500
Default:	60
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Main Velocity Regulator Gains: P

Pr-1.02 Main Velocity Regulator Gains: Integrator Time

Range:	0 to 60000
Default:	26
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Main Velocity Regulator Gains: Integrator Time

Pr-1.03 Main Position Regulator Gains: Kp

Range:	0 to 700
Default:	20
Units:	Hz
Applicable Operating Mode:	Follower
Ultraware Link:	Main Position Regulator Gains: Kp

Pr-1.04 Main Current Regulator Gains: Lowpass Filter Bandwidth

Range:	0 to 10000
Default:	300
Units:	Hz
Applicable Operating Mode:	All
Ultraware Link:	Main Current Regulator Gains: Lowpass Filter Bandwidth

Pr-1.05 Main Velocity Regulator Gains: Low Pass Filter Bandwidth

Range:	0 to 10000
Default:	1000
Units:	Hz
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Main Velocity Regulator Gains: Low Pass Filter Bandwidth

Pr-1.06 Reserved

This parameter is Reserved.

Pr-1.07 Main Current Regulator Gains: Resonant Frequency Suppression

Description:	Suppresses vibration by cutting off the Current Command in the assigned frequency band.
Range:	0 to 10000
Default:	10000

Units:	Hz
Applicable Operating Mode:	All
Ultraware Link:	Main Current Regulator Gains: Resonant Frequency Suppression

Pr-1.08 Position Regulator Kff Gain: Kff

Range:	0 to 100
Default:	0
Units:	%
Applicable Operating Mode:	Follower
Ultraware Link:	Position Regulator Kff Gain: Kff

Pr-1.09 Main Position Regulator Gains: Kff Low Pass Filter Bandwidth

Range:	0 to 800
Default:	200
Units:	Hz
Applicable Operating Mode:	Follower
Ultraware Link:	Main Position Regulator Gains: Kff Low Pass Filter Bandwidth

Pr-1.10 Main Velocity Regulator Gains: Integrator Mode

Description:	During transient response, Speed Response Overshoot can be suppressed by speed controller change from Proportion Integration (PI) Controller into Proportion (P) Controller. It reduces Position completion time during Position Control.	
Range:	**Value**	**Description**
	0x0	Do not use P/PI Mode Conversion.
	0x1	When Current Command exceeds Current Value in [Pr-1.11], Speed Controller is changed from PI Controller to P Controller.
	0x2	When Speed Command exceeds Speed Value in [Pr-1.11], Speed Controller is changed from PI Controller to P Controller.
	0x3	When Position error exceeds Position error Value in [Pr-1.11], Speed Controller is changed from PI Controller to P Controller
Default:	0	
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity	
Ultraware Link:	Main Velocity Regulator Gains: Integrator Mode	

Pr-1.11 Main Velocity Regulator Gains: Integrator Hold Threshold

Range:	0 to 3000	
Default:	100	
Units:	**If Pr-1.10 equals:**	**Then the Units are measured in:**
	1	% of rated continuous current
	2	rpm for rotary motors mm/sec for linear motors
	3	Counts
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity	
Ultraware Link:	Main Velocity Regulator Gains: Integrator Hold Threshold	

Pr-1.12 Main Position Regulator Gains: High Error Output Offset

Range:	0 to 450
Default:	0
Units:	rpm for rotary motors mm/sec for linear motors
Applicable Operating Mode:	Follower
Ultraware Link:	Main Position Regulator Gains: High Error Output Offset

Pr-1.13 Main Position Regulator Gains: High Error Output Threshold

Range:	0 to 50000
Default:	1000
Units:	Counts
Applicable Operating Mode:	Follower
Ultraware Link:	Main Position Regulator Gains: High Error Output Threshold

Pr-1.14 Main Current Regulator Gains: Gain

Range:	**Value**	**Description**
	0x0	High bandwidth
	0x1	Medium bandwidth (0.6667 * high)
	0x2	Low bandwidth (0.3334 * high)
Default:	0x0	
Applicable Operating Mode:	All	
Ultraware Link:	Main Current Regulator Gains: Gain	

Group 2 Parameters

Group 2 Parameters provide speed control settings.

Pr-2.00 Analog Velocity Command Scale

Range:	100 to 20000
Default:	5000
Units:	rpm/V*10 for rotary motors
	mm/sec/V*10 for linear motors
Applicable Operating Mode:	Analog Velocity

Pr-2.01 Jog Velocity Command

Range:	0 to 5000
Default:	500
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	All

Pr-2.02 Acceleration Limits: Acceleration

Range:	0 to 60000
Default:	0
Units:	msec
Applicable Operating Mode:	Analog Velocity, Preset Velocity, Follower
Ultraware Link:	Acceleration Limits: Acceleration

Pr-2.03 Acceleration Limits: Deceleration

Range:	0 to 60000
Default:	0
Units:	msec
Applicable Operating Mode:	Analog Velocity, Preset Velocity, Follower
Ultraware Link:	Acceleration Limits: Deceleration

Pr-2.04 Acceleration Limits: S-Curve Time

Range:	0 to 5000
Default:	0
Units:	msec
Applicable Operating Mode:	Analog Velocity, Preset Velocity, Follower
Ultraware Link:	Acceleration Limits: S-Curve Time

Pr-2.05 Preset Velocity 1

Range:	-5000 to 5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Preset Velocity
Ultraware Link:	Preset Velocity 1

Pr-2.06 Preset Velocity 2

Range:	-5000 to 5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Preset Velocity
Ultraware Link:	Preset Velocity 2

Pr-2.07 Preset Velocity 3

Range:	-5000 to5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Preset Velocity
Ultraware Link:	Preset Velocity 3

Pr-2.08 Preset Velocity 4

Range:	-5000 to5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Preset Velocity
Ultraware Link:	Preset Velocity 4

Pr-2.09 Preset Velocity 5

Range:	-5000 to5000
Default:	0
Units:	rpm for rotary motors

	mm/sec for linear motors
Applicable Operating Mode	Preset Velocity
Ultraware Link:	Preset Velocity 5

Pr-2.10 Preset Velocity 6

Range:	-5000 to5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode	Preset Velocity
Ultraware Link:	Preset Velocity 6

Pr-2.11 Preset Velocity 7

Range:	-5000 to5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode	Preset Velocity
Ultraware Link:	Preset Velocity 7

Pr-2.12 Manual Velocity Limit

Range:	1 to 10000
Default:	10000
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Manual Velocity Limit

Pr-2.13 Velocity Limits: Velocity Limit Mode

Range:	**Value**	**Description**
	0x0	Disabled
	0x1	Limited by (Pr-2.12).
	0x2	Limited by Analog Speed Command Value (except Analog Speed Mode).
	0x3	Limited by lesser one between (Pr-2.12) and Analog Speed Command.
Default:	0	
Applicable Operating Mode	All	
Ultraware Link:	Velocity Limits: Velocity Limit Mode	

Group 3 Parameters

Group 3 Parameters provide position control settings.

Pr-3.00 Follower Configuration

Data Size:	**4 digits**	
Digit 0:	Command Type	
Range:	**Value**	**Description**
	0x0	CW + CCW, Positive logic
	0x1	CW + CCW, Negative logic
	0x2	Pulse Line + Sign, Positive Logic
	0x3	Pulse Line + Sign, Negative Logic
	0x4	A Phase + B Phase, Positive Logic
	0x5	A Phase + B Phase, double input multiplication, Positive Logic
	0x6	A Phase + B Phase, quadruple input multiplication, Positive Logic
Default:	0x0	
Note:	For values 0x4, 0x5, and 0x6, Motor Counts = : Master Lines * MULT * [(4 * Pr-3.01)/Pr-3.02] Where the multiplier (MULT) is 1, 2, and 4 for values 0x4, 0x5, and 0x6 respectively.	
Applicable Operating Mode:	Follower	
Digit 1:	Controller Output Type	
Range:	**Value**	**Description**
	0	Line Drive
	1	Open Collector
Default:	0	
Applicable Operating Mode:	Follower	
Digit 2:	Encoder Output Forward Direction	
Range:	**Value**	**Description**
	0	During Forward Rotation, Encoder Output Phase A have a lead of 90× over Phase B.
	1	During Forward Rotation, Encoder Output Phase B have a lead of 90× over Phase A.
Default:	0	
Applicable Operating Mode:	All	
Digit 3:	Reserved	

Pr-3.01 Gear Ratio Follower Lines

	Gear Ratio Follower Lines
Range:	1 to 65535
Default:	1
Units:	Counts/4 = Lines
Applicable Operating Mode:	Follower
Ultraware Link:	Gear Ratio Follower Lines

Pr-3.02 Gear Ratio, Master Counts

Range:	1 to 65535
Default:	4
Units:	Counts
Applicable Operating Mode:	Follower
Ultraware Link:	Gear Ratio, Master Counts

Pr-3.03 Encoder Output Ratio, Output Counts

Range:	1 to 65535
Default:	2048
Units:	Counts
Applicable Operating Mode:	All
Ultraware Link:	Output Ratio, Output Counts

Pr-3.04 Encoder Output Ratio, Motor Counts

Range:	1 to 65535
Default:	2048
Units:	Counts
Applicable Operating Mode:	All
Ultraware Link:	Output Ratio, Motor Counts

Group 4 Parameters

Group 4 Parameters provide torque control settings.

Pr-4.00 Analog Current Scale

Range:	0 to 1000
Default:	333

Units:	% of rated continuous current/V*10
Applicable Operating Mode:	Analog Current, Dual Current
Ultraware Link:	Current Scale

Pr-4.01 Current Limits: Positive Internal

Range:	0 to 500
Default:	500
Units:	% of motor rated continuous current
Applicable Operating Mode:	All
Ultraware Link:	Current Limits: Positive Internal

Pr-4.02 Current Limits: Negative Internal

Range:	0 to 500
Default:	500
Units:	% of motor rated continuous current
Applicable Operating Mode:	All
Ultraware Link:	Current Limits: Negative Internal

Pr-4.03 Current Limits: Positive External

Range:	0 to 500
Default:	100
Units:	% of motor rated continuous current
Applicable Operating Mode:	All
Ultraware Link:	Current Limits: Positive External

Pr-4.04 Current Limits: Negative External

Range:	0 to 500
Default:	100
Units:	% of motor rated continuous current
Applicable Operating Mode:	All
Ultraware Link:	Current Limits: Negative External

Pr-4.05 Stopping Functions: Maximum Stopping Current

Range:	0 to 500
Default:	500
Units:	% of motor rated continuous current
Applicable Operating Mode:	All
Ultraware Link:	Stopping Functions: Maximum Stopping Current

Pr-4.06 Initial Current Bias

Ultraware Link:	Initial Current Bias
Description:	Prevents the downturn of vertical load during initial operation
Range:	-100 to100
Default:	0
Units:	% of motor rated continuous current
Applicable Operating Mode:	All

Group 5 Parameters

Group 5 Parameters provide supplementary drive system and I/O settings

Pr-5.00 Position Functions: In Position Size

Description:	If the position error is within the limit set in In Position Size and a digital output is defined as In Position, then the digital output is turned ON.
Range:	0 to 2500
Default:	10
Units:	Counts
Applicable Operating Mode:	Follower
Ultraware Link:	Position Functions: In Position Size

Pr-5.01 Position Functions: Near Position Size

Description:	If the position error is within the limit set in Near Position Size and a digital output is defined as Near Position, then the digital output is turned ON.
Range:	0 to 2500
Default:	20
Units:	Counts
Applicable Operating Mode:	Follower
Ultraware Link:	Position Functions: Near Position Size

Pr-5.02 Speed Functions: Speed Window

Description:	If the speed error is within the limit set in Speed Window and a digital output is defined as Within Speed Window, then the digital output is turned ON.
Range:	0 to 1000
Default:	10
Units:	rpm for rotary motors

	mm/sec for linear motors
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Speed Functions: Speed Window

Pr-5.03 Speed Functions: Up to Speed

Description:	If the motor's speed is higher than this speed and a digital output is defined as Up to Speed, then the digital output is turned ON.
Range:	1 to 5000
Default:	20
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Speed Functions: Up to Speed

Pr-5.04 Speed Functions: Zero Clamp

Description:	An Analog Speed Command less than the Zero Clamp speed is ignored and the commanded motor speed is set to zero.
Range:	0 to 5000
Default:	0
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	Analog Velocity
Ultraware Link:	Speed Functions: Zero Clamp

Pr-5.05 Brake Inactive Delay

Description:	Brake Inactive delay is the time from when Drive Enable command is received to when the brake is released.
Range:	0 to 1000
Default:	0
Units:	10 msec
Applicable Operating Mode:	All
Ultraware Link:	Brake Inactive Delay

Pr-5.06 Stopping Functions: Disable Delay

Description:	Disable Delay is the time from when Drive Disable command is received to when the command is actually executed.
Range:	0 to 1000
Default:	0

Description:	Disable Delay is the time from when Drive Disable command is received to when the command is actually executed.
Range:	0 to 1000
Units:	10 msec
Applicable Operating Mode:	All
Ultraware Link:	Stopping Functions: Disable Delay

Pr-5.07 Brake Active Delay

Description:	Brake Active Delay is the time from when Drive Disable command is received to when the brake starts operating.
Range:	0 to 1000
Default:	50
Units:	10 msec
Applicable Operating Mode:	All
Ultraware Link:	Brake Active Delay

Pr-5.08 Stopping Functions: Braking Application Speed

Description:	Braking Application Speed is the feedback speed, after disabling the drive, below which the motor brake is engaged.
Range:	0 to 1000
Default:	100
Units:	rpm for rotary motors
	mm/sec for linear motors
Applicable Operating Mode:	All
Ultraware Name:	Braking Application Speed

Pr-5.09 Following Error Limit

Description:	A Follower Error fault occurs when the difference between position command and actual position is greater than value set by the Following Error Limit parameter.
Range:	0 to 99999
Default:	20480
Units:	Counts
Applicable Operating Mode:	Follower
Ultraware Link:	Following Error Limit

Pr-5.10 AC Line Loss Fault Delay

Description:	AC Line Loss Fault Delay is the time allowed for power to be down without triggering of a power down fault.
Range:	20 to 1000
Default:	20

Units:	msec
Applicable Operating Mode:	All
Ultraware Link:	AC Line Loss Fault Delay

Pr-5.11 Reserved

This parameter is Reserved.

Pr-5.12 Analog Output 1: Signal

Description:	The drive signal assigned to channel 1 from the Channel Setup dialog box in the Oscilloscope window.
Range:	1 to 99999
Default:	0x00
Applicable Operating Mode:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Ultraware Link:	Analog Output 1: Signal

Pr-5.13 Analog Output 2: Signal

Description:	The drive signal assigned to channel 2 from the Channel Setup dialog box in the Oscilloscope window.
Range:	1 to 99999
Default:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Applicable Operating Mode:	All
Ultraware Link:	Analog Output 2: Signal

Pr-5.14 Analog Output 1: Scale

Description:	The amplitude of the channel 1 input signal to be displayed by the oscilloscope.
Range:	1 to 99999
Default:	500
Units:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Applicable Operating Mode:	All
Ultraware Link:	Analog Output 1: Scale

Pr-5.15 Analog Output 2: Scale

Description:	The amplitude of the channel 2 input signal to be displayed by the oscilloscope.
Range:	1 to 99999
Default:	500

Units:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Applicable Operating Mode:	All
Ultraware Link:	Analog Output 2: Scale

Group 6 Parameters

Group 6 parameters provide supplementary gain settings and fault reports.

Pr-6.00 Analog Velocity Command Offset

Description:	The offset to the Analog Velocity Command input.
Range:	-10000 to 10000
Default:	0
Units:	0.1 mV
Applicable Operating Mode:	Analog Velocity
Ultraware Link:	Analog Velocity Command Offset

Pr-6.01 Analog Current Command Offset

Description:	The offset to the Analog Current Command input.
Range:	-10000 to 10000
Default:	0
Units:	0.1 mV
Applicable Operating Mode:	Analog Current
Ultraware Link:	Analog Current Command Offset

Pr-6.02 Reserved

This parameter is Reserved.

Pr-6.03 Reserved

This parameter is Reserved.

Pr-6.04 Velocity Regulator D Gain

Description:	Gain value for the velocity loop that is derived from the velocity error.
Range:	0 to 1000

Default:	0
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Main Velocity Regulator Gains: D

Pr-6.05 Reserved

This parameter is Reserved.

Pr-6.06 Fault Detail Setup: Sample Period

Description:	The time, in 0.2 msec increments, between signal samples. 50 samples constitute a fault trace.
Range:	1 to 99
Default:	5
Units:	0.2 msec
Ultraware Link:	Fault Detail Setup: Sample Period

Pr-6.07 Fault Detail Setup: Channel A

Description:	Selects the drive signal to assign to a Channel A.
Range:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Default:	0x00
Ultraware Link:	Fault Detail Setup: Channel A

Pr-6.08 Fault Detail Setup: Channel B

Description:	Selects the drive signal to assign to Channel B.
Range:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Default:	0x03
Ultraware Link:	Fault Detail Setup: Channel B

Pr-6.09 Fault Detail Setup: Channel C

Description:	Selects the drive signal to assign to Channel C.
Range:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Default:	0x0B
Ultraware Link:	Fault Detail Setup: Channel C

Pr-6.10 Fault Detail Setup: Channel D

Description:	Selects the drive signal to assign to Channel D.
Range:	See *Monitor Variable Numbers* (except 0x0F) beginning on page *D-6*.
Default:	0x10
Ultraware Link:	Fault Detail Setup: Channel D

Pr-6.11 Alternate Gain: VReg P Gain

Description:	This command allows you to set an Alternate Velocity Regulator P Gain for use in system tuning.
Range:	0 to 1000
Default:	60
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Alternate Gain Values: VReg P Gain

Pr-6.12 Alternate Gain: VReg Integrator Time

Description:	This command allows you to set an Alternate Velocity Regulator Integrator Time for use in system tuning.
Range:	0 to 60000
Default:	26
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Alternate Gain Values: VReg Integrator Time

Pr-6.13 Alternate Gain: PReg Kp Gain

Description:	This command allows you to set an Alternate Position Regulator Kp Gain for use in tuning.
Range:	0 to 700
Default:	20
Units:	Hz
Applicable Operating Mode:	Follower
Ultraware Link:	Alternate Gain Values: PReg Kp Gain

Pr-6.14 Alternate Gain: IReg Low Pass Bandwidth

Description:	This command allows you to set an Alternate Low Pass Bandwidth for use in tuning.
Range:	0 to 10000
Default:	300
Units:	Hz
Applicable Operating Mode:	All
Ultraware Link:	Alternate Gain Values: IReg Low Pass Bandwidth

Pr-6.15 Alternate Gain: VReg Low Pass Bandwidth

Description:	This command allows you to set an Alternate Velocity Regulator Low Pass Bandwidth for use in tuning.
Range:	0 to 10000
Default:	1000
Units:	Hz
Applicable Operating Mode:	Follower, Analog Velocity, Preset Velocity
Ultraware Link:	Alternate Gain Values: VReg Low Pass Bandwidth

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Publication 2092-UM001D-EN-P — July 2005 0013-2065-004-01
Supersedes publication 2092-UM001C-EN-P — October 2004