Allen-Bradley

Ultra5000 Intelligent Positioning Drives

(Catalog Numbers
2098-IPD-005, -005-DN
2098-IPD-010, -010-DN
2098-IPD-020, -020-DN
2098-IPD-030, -030-DN, -HV030, -HV030-DN
2098-IPD-HV050, -HV050-DN
2098-IPD-075, -075-DN,
2098-IPD-HV100, -HV100-DN
2098-IPD-150, -150-DN, -HV150, -HV150-DN
2098-IPD-HV220, -HV220-DN

Installation 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.

Chapter 3

Connecting Your Ultra5000

Chapter 4

Commissioning Your Ultra5000

Chapter 5

Maintaining Your Ultra5000

Appendix A

Specifications and Dimensions

Appendix B

Interconnect Diagrams

Appendix C

Catalog Numbers and Accessories

Appendix D

Wiring Three Phase Power to a Single Phase Ultra5000

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

Use this manual for designing, installing, programming, and troubleshooting the Ultra5000™ Intelligent Positioning Drive (IPD). If you do not have a basic understanding of the Ultra5000, contact your local Allen-Bradley representative for information on available training courses before using this product.

Purpose of this Manual

This manual describes the function and installation of the Ultra5000 products and standard Rockwell Automation/Allen-Bradley motors recommended for use with the Ultra5000. The manual is intended for engineers or technicians directly involved in the installation, operation, and field maintenance of the Ultra5000.

Contents of this Manual

Refer to the following listing for the descriptive contents of this installation 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 Ultra5000	Provides mounting information for the Ultra5000.
2	Ultra5000 Connector Information	Provides connection and wiring information for the Ultra5000.
3	Connecting Your Ultra5000	Provides steps to follow when applying power to the Ultra5000 for the first time.
4	Commissioning Your Ultra5000	Powering-up and configuring the Ultra5000 drive.
5	Maintaining Your Ultra5000	Provides diagnostic aids that help isolate problems with a drive.
Appendix A	Specifications and Dimensions	Provides physical, electrical, environmental, and functional specifications for the Ultra5000.
Appendix B	Interconnect Diagrams	Provides interconnect diagrams for the Ultra5000.
Appendix C	Catalog Numbers and Accessories	Provides catalog numbers and descriptions of the Ultra5000 and related products.
Appendix D	Wiring Three Phase Power to a Single Phase Ultra5000	Discusses star (Y) connection of single phase Ultra5000 drives to a three phase power source.

Related Documentation

The following documents contain additional information concerning related Allen-Bradley products. To obtain a copy, contact your local Rockwell Automation office or distributor, or access the documents on-line at **www.theautomationbookstore.com** or **www.ab.com/manuals/gmc**.

For:	Read This Document:	Catalog Number:
Active shunt installation instructions for: • 2098-IPD-005, -005-DN • 2098-IPD-010, -010-DN • 2098-IPD-020, -020-DN	300 Watt Active Shunt Regulator Installation Instructions	2090-IN001
Passive shunt installation instructions for: • 2098-IPD-075, -075-DN • 2098-IPD-150, -150-DN	900 Watt Passive Shunt Module Installation Instructions	2090-IN002
Passive shunt installation instructions for: • 2098-IPD-030, -030-DN	200 Watt Passive Shunt Module Installation Instructions	2090-IN003
Passive shunt installation instructions for: • 2098-IPD-HV030, -HV030-DN • 2098-IPD-HV050, -HV050-DN • 2098-IPD-HV100, -HV100-DN • 2098-IPD-HV150, -HV150-DN • 2098-IPD-HV220, -HV220-DN	2090 Series Passive Shunts Installation Instructions	2090-IN004
Ultraware™ installation instructions	Ultraware CD Installation Instructions	2098-IN002
Information on how to add a DeviceNet™ Expansion Kit to a Ultra5000 drive	Ultra5000 DeviceNet Expansion Kit Installation Instructions	2098-IN004
Information on programming the Ultra5000 using the Motion Library	Ultra5000 Motion Library C Programming Manual	2098-PM001
Information on communicating with the Ultra5000 using DeviceNet	Ultra5000 DeviceNet Reference Manual	2098-RM002
Information on configuring your Ultra5000 using Ultraware	Ultraware User Manual	2098-UM001
How to minimize and control system-level noise	System Design for Control of Electrical Noise	GMC-RM001
Information on attaching Ultra5000 drives to a DeviceNet network	DeviceNet Cable System Planning and Installation Manual	DNET-UM072

A copy of the DeviceNet Specification, Volumes I and II, Release 2.0 may be ordered from the web site **http://www.odva.org** of the Open Device Vendor Association.

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.

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

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 to contact Allen-Bradley for technical assistance, please review the information in the chapter Maintaining Your Ultra5000 first, then call your local Allen-Bradley representative. For the quickest possible response, please have the catalog numbers of your products available when you call.

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.

Installing Your Ultra5000

Chapter Objectives

This chapter provides system installation guidelines and procedures for mounting your Ultra5000. This chapter covers the following topics:

- Complying with European Union Directives
- Before Mounting Your System
- Bonding Your System
- Mounting Your Ultra5000 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, the hazard of personal injury and/or equipment damage exists.

Complying with European Union Directives

If this product is installed within the European Union or EEC regions and has the CE mark, the following regulations apply.

Note: Declarations of Conformity (DOCs) to EU Directives are available on-line at **www.ab.com/certification** for Motion Control products. The web site is the authoritative source for verifying compliance and suitability for use of this and other Rockwell Automation/Allen-Bradley products.
The web site also provides links to other certification agencies (UL, CSA, etc.).

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.

To meet CE requirements, the following additions are required:

- Install a power line filter between the AC power source and the drive input, as close to the drive as possible. (Refer to AC Line Filters on page C-3.)
- Terminate the motor power cable shield to the chassis clamp provided.
- To meet CE requirements, the following additions may also be required:
  - Run single-phase input wiring in conduit that is grounded to the enclosure.
  - Terminate the shields of the motor power cables and the motor feedback cables to the enclosure at the point of entry.

Low Voltage Directive

These units are tested to meet Council Directive 73/23/EEC Low Voltage Directive. The EN 60204-1 Safety of Machinery-Electrical Equipment of Machines, *Part 1-Specification for General Requirements* standard applies in whole or in part. Additionally, the standard EN 50178 *Electronic Equipment for use in Power Installations* applies in whole or in part.

Refer to *Appendix B* for interconnect information.

Before Mounting Your System

Before you mount your Ultra5000 system make sure you understand the following:

How to Store Your Ultra5000 Before Installation

The Ultra5000 should remain in the shipping container prior to installation. If the equipment is not to be used for a period of time, store it as follows:

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

How to Unpack the System

Each Ultra5000 ships with the following:

- One Ultra5000 drive
- One installation manual, publication 2098-IN001
- Two I/O connector plugs (28 pin CN1A and 14 pin CN1B)
- One screwdriver
- One clear plastic terminal strip cover

IMPORTANT Do not discard the clear plastic terminal strip cover. Installing the plastic strip on the power terminal strip provides a physical barrier and protection.

Ultra5000 drives with DeviceNet (2098-IPD-*xxx*-DN and -HV*xxx*-DN only) ship with the following additional items:

- One reference manual, publication 2098-RM002, for Ultra5000 drives with DeviceNet
- One DeviceNet connector plug for Ultra5000 drives with DeviceNet

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.

Minimum Mounting Requirements

There are several things that you need to take into account when preparing to mount the Ultra5000:

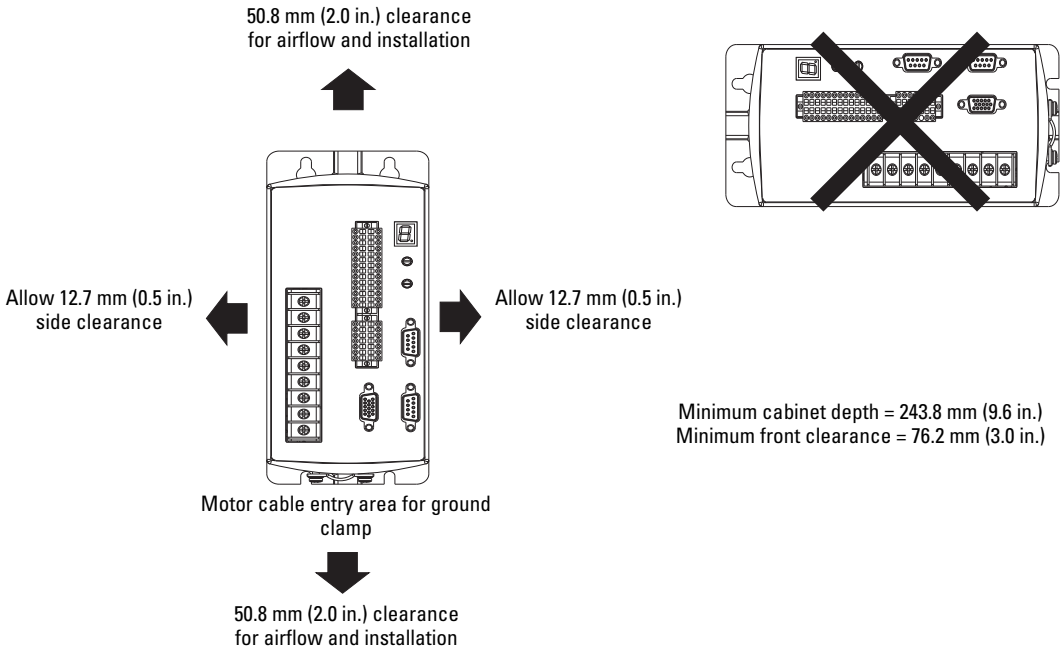
- The Ultra5000 is classified as IEC controlgear, and must be housed in an enclosure that meets IEC60529 requirements for electrical enclosure of controlgear.
- The ambient temperature of the location in which you will install the Ultra5000 must not exceed 55° C (131° F).
- You must install the enclosure on a flat, rigid, vertical surface that will not be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.
- You need to maintain minimum clearances (refer to Figure 1.1) within the enclosure for proper airflow, easy module access, and proper cable bend radius.

Refer to *Appendix A* for mounting dimensions, power dissipation, and environmental specifications for the Ultra5000.

Ventilation Requirements

This section provides information to assist you in sizing your cabinet and locating your Ultra5000 drive(s) inside the cabinet.

Figure 1.1
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 Power Dissipation on page A-5 for Ultra5000 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

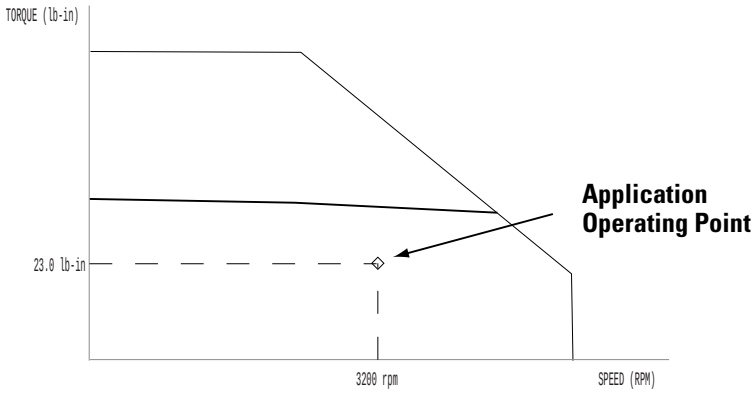
The Ultra5000 does not require isolation transformers. However, a transformer may be required to match the voltage requirements of the controller to the available service. To size a transformer for the main AC power inputs, the power output (KVA) of each axis must be known. This can be derived by calculating the horsepower for each axis and converting that horsepower into units of watts. If you are supplying power to more than one motor and an Ultra5000, 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 rating of the drive referenced in *General Power Specifications* on Page A-1.

Calculating Transformer Size Based on Speed/Torque Data

Base the transformer size on the operating point within the speed/torque curve for the drive and motor application as shown in Figure 1.2. The operating point for this hypothetical 230V drive/motor combination is 23 lb-in and 3200 rpm.

Figure 1.2
Transformer Sizing Based on Speed/Torque Data for Single Phase System



The formula and calculation are:

$$KVA = \frac{Speed(RPM) \times Torque(lb-in)}{63,025} \times \frac{746 Watts}{HP} \times \frac{KVA}{1000 Watts} \times 2.0$$

$$KVA = \frac{3200 rpm \times 23.0 lb-in}{42,250}$$

$$TransformerSize = 1.75 KVA$$

Definitions:
kW = power or real power
KVA = apparent power
Transformer KVA rating = (Sum of average output power of each axis) x 2.0.

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.
- A factor of 1.5 is used with a three phase system.

This factor minimizes the effects of the secondary line voltage sagging in the transformer during peak current periods.

IMPORTANT If you are using the Rockwell Automation/ Allen-Bradley system sizing program, the average speed and average torque data has already been calculated and can be used in the 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 Ultra5000/motor combination and use the values for the worst case continuous speed and torque.

Fuse Sizing

The Ultra5000 is listed by Underwriters Laboratories, Inc. with fuses sized as four times the continuous output current of the drives (FLA), according to UL 508C.

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 *General Power Specifications* in *Appendix A* for input current and inrush current specifications.

The Ultra5000 utilizes solid state motor short circuit protection rated as shown in the table below.

Drive Models:	Short Circuit Current Rating with No Fuse Restrictions:	Short Circuit Current Rating with Fuse Restrictions:
2098-IPD-*xxx-xx*	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).
2098-IPD-HV*xxx-xx*	Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 480V maximum.	Suitable for use on a circuit capable of delivering not more than 200,000 rms symmetrical amperes, 480V maximum, when protected by high interrupting capacity, current limiting fuses meeting UL 198C (Class CC, G, J, L, R, T).
		Mains Input Fuses Mains input fuses shall be dual element time delay types class RK5, J or CC only. Fuse current ratings shall be the following, or the closest standard value to these minimums: 2098-IPD-HV030-*xx* (3kW) 5 A 2098-IPD-HV050-*xx* (5kW) 8 A 2098-IPD-HV750-*xx* (10kW) 17 A 2098-IPD-HV100-*xx* (15kW) 25 A 2098-IPD-HV220-*xx* (22kW) 35 A
		Auxiliary Input Fuses Auxiliary input fuses shall be dual element time delay types class RK5, J or CC only. Fuse current rating shall be the following, or the closest standard value to these minimums. All drive sizes 0.4 A

Bonding Your System

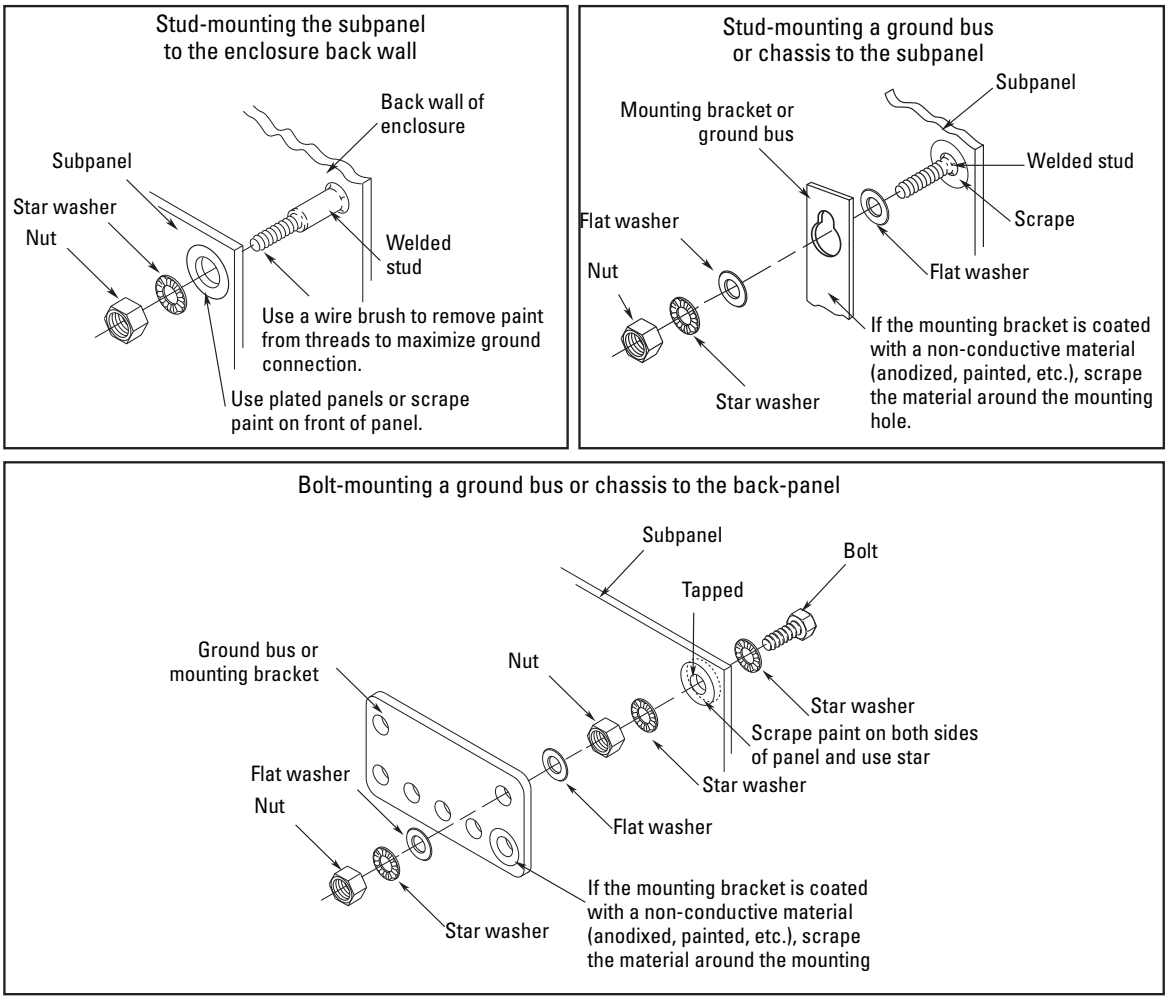
Bonding is the practice of connecting metal chassis, assemblies, frames, shields and enclosures to reduce the effects of electromagnetic interference (EMI).

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.

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.

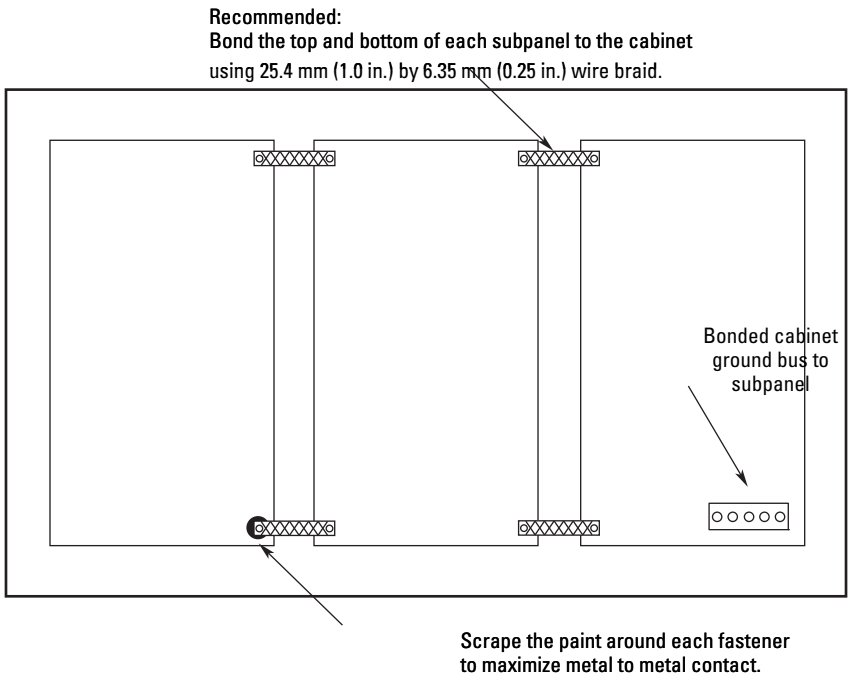
Figure 1.3
Recommended Bonding Practices



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



Mounting Your Ultra5000 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 product contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Follow static control precautions when you install, test, service, or repair this assembly.

Refer to Allen-Bradley publication 8000-4.5.2, Guarding Against Electrostatic Damage or any other applicable ESD Protection Handbook.

Failure to observe this precaution may result in damage to the equipment.

To mount your Ultra5000 drive:

1. Layout the positions for the Ultra5000 and accessories in the enclosure. Mounting hole dimensions for the Ultra5000 are shown in *Appendix A*.

2. Attach the Ultra5000 to the cabinet, first using the upper mounting slots of the drive and then the lower. The recommended mounting hardware is M5 metric (1/4-20) or #10 MS bolts. Observe bonding techniques as described in *Bonding Your System*.

2. Tighten all mounting fasteners.

Ultra5000 Connector Information

Chapter Objectives

This chapter provides connector information and procedures for wiring your Ultra5000 and making cable connections. This chapter includes:

- Understanding Ultra5000 Controller Functions
- Understanding Ultra5000 Connectors
- Understanding Ultra5000 I/O Specifications
- Understanding Motor Encoder Feedback Specifications
- Understanding Auxiliary Encoder Feedback Specifications
- Understanding the Serial Interface

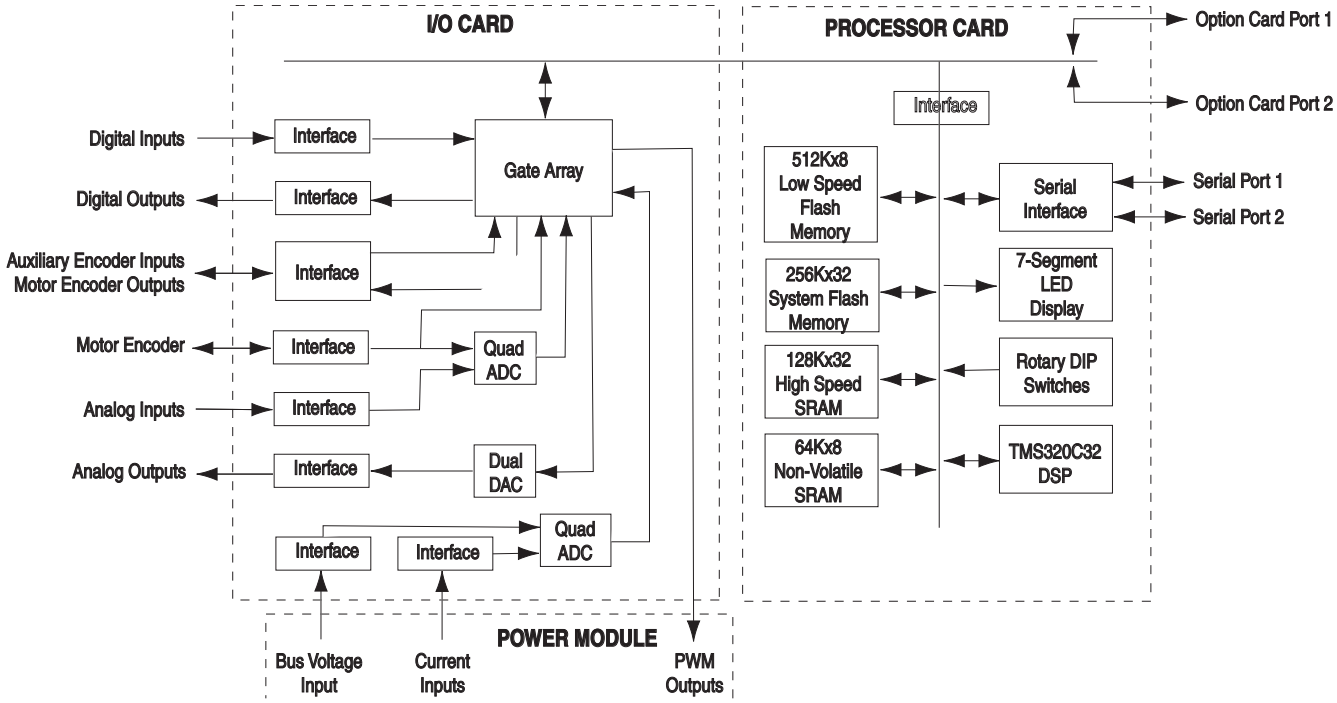
Understanding Ultra5000 Controller Functions

This section provides a short overview of the Ultra5000.

Ultra5000 Block Diagram

The Ultra5000 uses a two-stage circuit card solution with the capability of adding two additional option cards. The first stage is the processor circuit board and the second stage handles I/O connections including a power module interface. Figure 2.1 depicts the stages and the interfaces.

Figure 2.1
Block Diagram of Ultra5000 Controller Functions



Understanding Ultra5000 Connectors

The following table provides a brief description of the Ultra5000 front panel connectors and describes the connector type.

Designator	Description	Connector
CN1A	User Input/Output	28-pin, 3.5mm, double-row, plugable spring clamp
CN1B	User Input/Output	14-pin, 3.5mm, double-row, plugable spring clamp
CN2	Motor Feedback	15-pin high-density D-shell
CN3A	Main Serial Port	9-pin standard D-shell
CN3B	Auxiliary Serial Port	9-pin standard D-shell
TB	DC bus, Motor and AC power	9-position screw style barrier terminal strip (2098-IPD-005*xx*, -010-*xx*, and -020-*xx*)
TB1	DC bus, Motor, AC power, and Auxiliary AC power	11- or 12-position screw style barrier terminal strip (2098-IPD-030-*xx*, -075-*xx*, -150-*xx*, and HV*xxx-xx*)
TB2	Shunt	3-position screw style barrier terminal strip (2098-IPD-030-*xx*, -075-*xx*, -150-*xx*, and HV*xxx-xx*)

CN1A and CN1B signal connections on the Ultra5000 use plugable, spring-clamp connectors with 3.5mm spacing. Mating connectors for discrete user wiring are included with your Ultra5000.

CN2, CN3A and CN3B signal connections on the Ultra5000. Mating connectors for these D-shell type connectors are commonly available.

DeviceNet signal connections on the Ultra5000 with DeviceNet (2098-IPD-*xxx*-DN and -HV*xxx*-DN only) use a 5-pin DeviceNet connector. The mating connector is included with your Ultra5000.

For connector pin-outs and the location of connectors, switches, and status LEDs on:	For I/O, Motor Feedback and Serial Communications Port Connections refer to:	For Terminal Block (Power) Connections refer to:
2098-IPD-*xxx* Ultra5000 drives	Figure 2.2 and the tables on pages 2-5 through 2-7.	table on page 3-17.
2098-IPD-*xxx*-DN Ultra5000 drives with DeviceNet interface	Figure 2.5 and the tables on pages 2-13 through 2-15.	table on page 3-17.
2098-IPD-HV*xxx* high voltage (460VAC) Ultra5000 drives	Figure 2.7 and the tables on pages 2-5 through 2-17.	table on page 3-17.

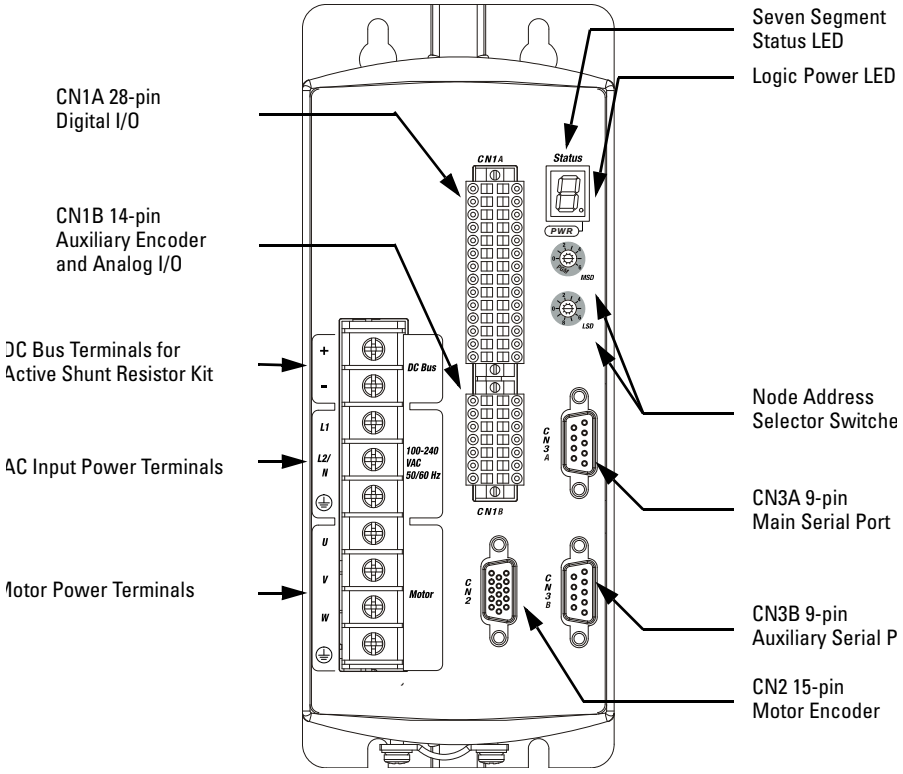
230V Ultra5000 Front Panel Connections

This section describes and provides a visual reference to the drive's connectors.

500W, 1 kW, and 2 kW Ultra5000 (2098-IPD-005, -010, and -020)

Use the figure below to locate the front panel connections on the Ultra5000 230V drives (500W, 1 kW, and 2 kW). Detailed descriptions of the connections are provided.

Figure 2.2
Ultra5000 Front Panel Connections for 2098-IPD-005, -010, and -020



I/O Connectors

CN1A (28-pin) and CN1B (14-pin) are plugable, double-row, spring clamp connectors with 3.5mm spacing. Maximum wire gauge for these connectors is 0.75 mm^2 (18 AWG).

The following tables provide the signal description and pin-outs for the CN1A and CN1B I/O connectors.

Note: These tables are arranged to match the drive's I/O pin arrangement..

CN1A Pin	Description	Signal
15	Digital Input 9	INPUT9
16	Digital Input 10	INPUT10
17	Digital Input 11	INPUT11
18	Digital Input 12	INPUT12
19	Digital Input 13	INPUT13
20	Digital Input 14	INPUT14
21	Digital Input 15	INPUT15
22	Digital Input 16	INPUT16
23	Digital Output 5	OUTPUT5
24	Digital Output 6	OUTPUT6
25	Digital Output 7	OUTPUT7
26	Relay Output 1+	OUTPUT8+
27	Relay Output 1-	OUTPUT8-
28	I/O Ground	IOCOM [1]

CN1A Pin	Description	Signal
1	Digital Input 1 [2]	INPUT1
2	Digital Input 2 [2]	INPUT2
3	Digital Input 3	INPUT3
4	Digital Input 4	INPUT4
5	Digital Input 5	INPUT5
6	Digital Input 6	INPUT6
7	Digital Input 7	INPUT7
8	Digital Input 8	INPUT8
9	Digital Output 1	OUTPUT1
10	Digital Output 2	OUTPUT2
11	Digital Output 3	OUTPUT3
12	Digital Output 4	OUTPUT4
13	Shield Termination	SHIELD
14	I/O Power Supply	IOPWR [1]

[1] The Ultra5000 0.5, 1.0, and 2.0 kW drives (2098-IPD-005-*xx*, 2098-IPD-010-*xx*, 2098-IPD-020-*xx*, and 2098-IPD-HV*xxx-xx* models) require a user supplied I/O power source. Refer to Digital I/O Power Supply on page 2-19 for more information.

[2] High speed inputs. Refer to Digital Inputs on page 2-20 for additional information.

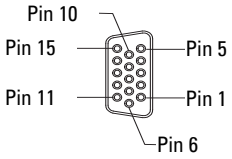
CN1B Pin	Description	Signal
8	5V Ground	+5VCOM
9	Analog Input 1	AIN1
10	Analog Input 2	AIN2
11	5V Ground	+5VCOM
12	Analog Output 1	AOUT1
13	Analog Output 2	AOUT2
14	Shield Termination	SHIELD

CN1B Pin	Description	Signal
1	5V Power Supply	+5V
2	Auxiliary Encoder I/O A+	AX+
3	Auxiliary Encoder I/O A-	AX-
4	Auxiliary Encoder I/O B+	BX+
5	Auxiliary Encoder I/O B-	BX-
6	Auxiliary Encoder I/O I+	IX+
7	Auxiliary Encoder I/O I-	IX-

Motor Encoder Connector

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

CN2 Pin	Description	Signal
1	Channel A+	AM+
2	Channel A-	AM-
3	Channel B+	BM+
4	Channel B-	BM-
5	Channel I+	IM+
6	Common	ECOM
7	Reserved on 2098-005-*xx*, -010-*xx*, -020-*xx*	–
	Encoder Power (+9V) on 2098-030-*xx*, -050-*xx*, -075-*xx*, -150-*xx*, -HV030-*xx*, -HV050-*xx*, -HV100-*xx*, -HV150-*xx*, and -HV220-*xx*	EPWR +9V
8	Commutation Channel S3	S3
9	Positive Overtravel Limit	+LIMIT
10	Channel I-	IM-
11	Thermostat	TS
12	Commutation Channel S1	S1
13	Commutation Channel S2	S2
14	Encoder Power (+5V)	EPWR +5V
15	Negative Overtravel Limit	-LIMIT

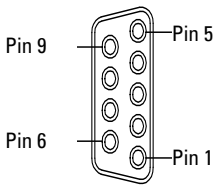


Connector Pinout

Serial Port Connectors

The following table provides the signal descriptions and pin-outs for the CN3A (Main) and CN3B (Auxiliary) serial port (9-pin) connectors. Refer to Default Serial Interface Settings on page 2-34 for additional information.

CN3 Pin	Description	Signal
1	RS-422/RS-485 Input+	RCV+
2	RS-232 Input	RCV
3	RS-232 Output	XMT
4	RS-422/RS-485 Output+	XMT+
5	Common	COM
6	Reserved	–
7	RS-422/RS-485 Input-	RCV-
8	RS-422/RS-485 Output-	XMT-
9	Reserved	–



Connector Pinout

Terminal Block

The following table lists the connections on the Ultra5000 230V drive (500W, 1 kW, and 2 kW) power terminal block (TB). Refer to Wiring Power Connections on page 3-14 for additional information.

Terminal Block (TB) Locations (2098-IPD-005*xx*, -010-*xx*, -020-*xx*)
DC Bus+ [1]
DC Bus- [1]
L1 (Main AC)
L2/N (Main AC)
Safety (Earth) Ground
U (Motor) [2]
V (Motor) [2]
W (Motor) [2]
Motor Case Ground

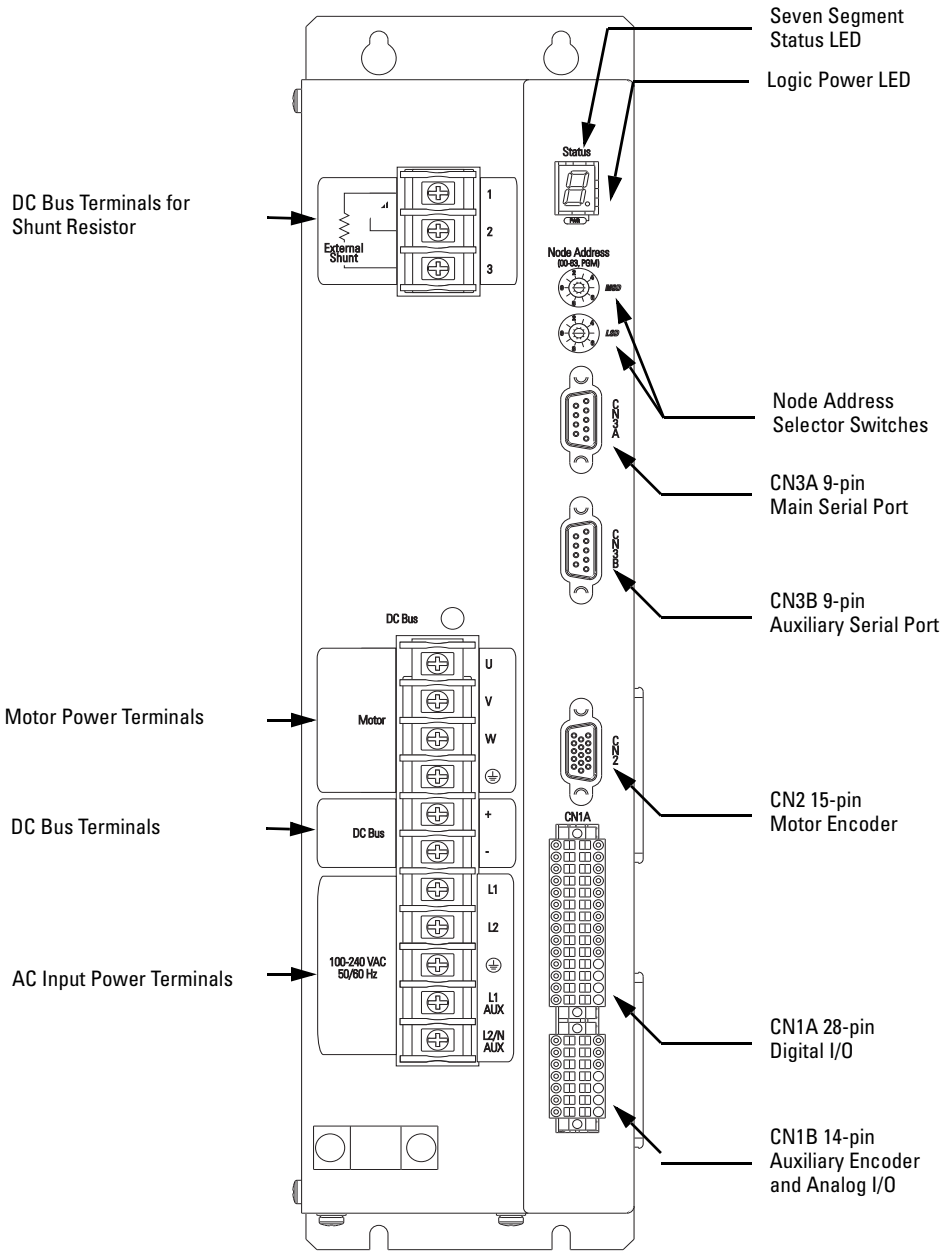
[1] Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

[2] 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.

3 kW Ultra5000 (2098-IPD-030)

Use the figure below to locate the front panel connections on the Ultra5000 230V drive (3 kW). Detailed descriptions of the digital connections are provided on pages 2-5 through 2-7. Power connections are described below.

Figure 2.3
Ultra5000 Front Panel Connections for 2098-IPD-030

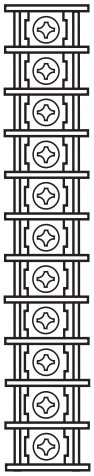


The following tables list the power and shunt connections on the terminal block (TB). Refer to Wiring Power Connections on page 3-14 for additional information.

Terminal Blocks

The following tables list the connections on the Ultra5000 230V drive (3 kW) power (TB1) and the shunt (TB2) terminal blocks. Refer to Wiring Power Connections on page 3-14 for additional information.

Terminal Block 1 (TB1) Locations (2098-IPD-030-*xx*)
U (Motor) [2]
V (Motor) [2]
W (Motor) [2]
Motor Case Ground
DC Bus+ [1]
DC Bus- [1]
L1 (Main AC)
L2/N (Main AC)
Safety (Earth) Ground
L1 (Aux AC) [3]
L2/N (Aux AC) [3]

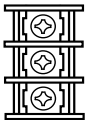


[1] Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

[2] 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.

3 The auxiliary AC power inputs require dual element time delay (slow acting) fuses to accommodate inrush current. Refer to the section *General Power Specifications* in *Appendix A* for the inrush current on the auxiliary AC power input.

Shunt Terminal Block 2 (TB2) Locations (2098-IPD-030-*xx*)
1 - Common Terminal for External or Internal Shunt [1]
2 - Internal Shunt Terminal [1]
3 - External Shunt Terminal [1]

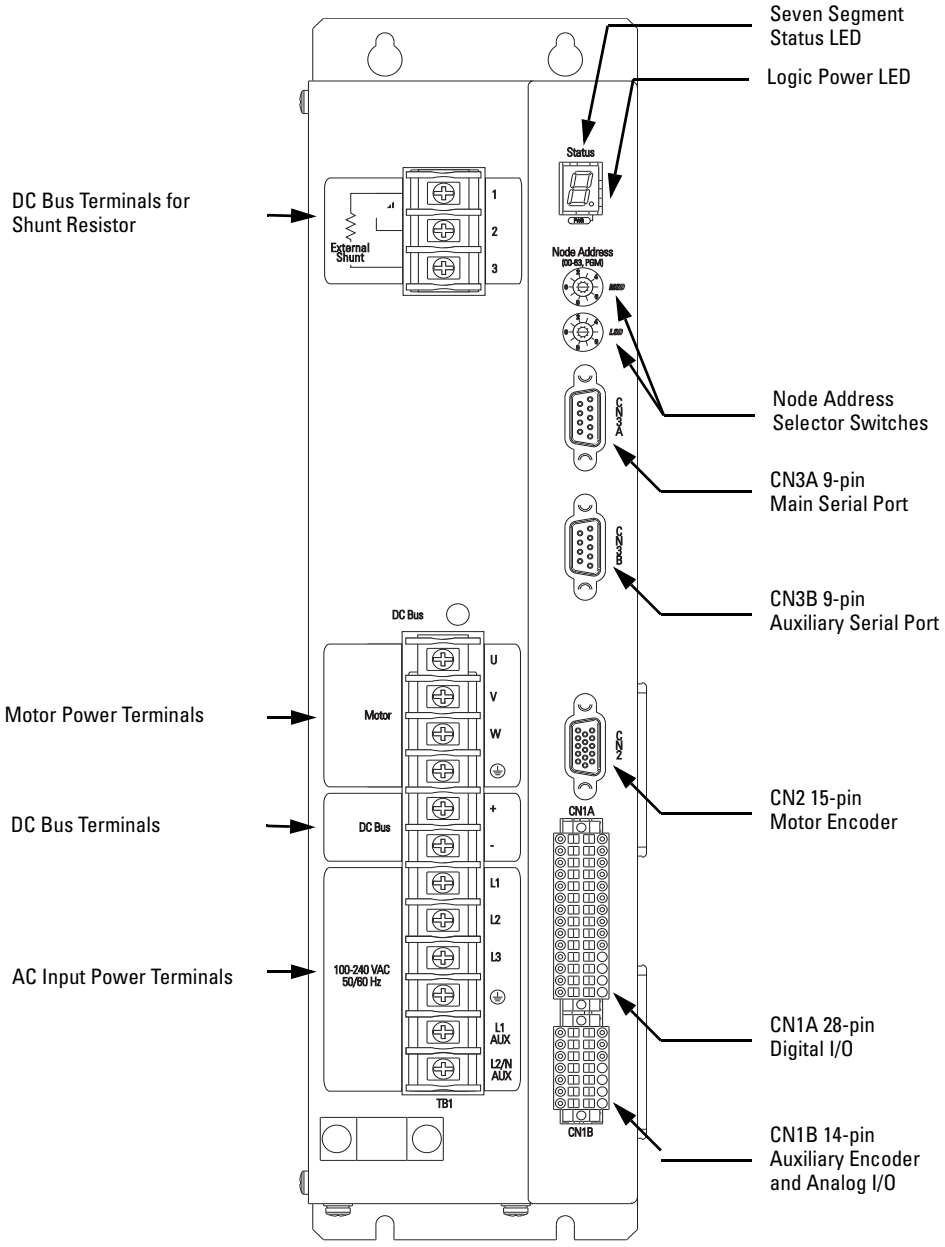


[1] A jumper, selecting the internal shunt, is factory installed between terminals 1 and 2. Remove the jumper for applications requiring an external shunt.
Refer to External Shunt Kits on page C-4 for information about available external shunt kits.

7.5 kW, and 15 kW Ultra5000 (2098-IPD-075, and -150)

Use the figure below to locate the front panel connections on the Ultra5000 230V drives (7.5 kW, and 15 kW). Detailed descriptions of the digital connections are provided on pages 2-5 through 2-7. Power connections are provided on page 2-11.

Figure 2.4
Ultra5000 Front Panel Connections for 2098-IPD-075, and -150



I/O Connectors

CN1A (28-pin) and CN1B (14-pin) are plugable, double-row, spring clamp connectors with 3.5mm spacing. Refer to the tables on page 2-5 for pin-outs.

Motor Encoder Connector

CN2 (15-pin) motor encoder connector is a standard D-shell connector. Refer to the table on page 2-6 for pin-outs.

Serial Port Connectors

The CN3A (Main) and CN3B (Auxiliary) are standard D-shell connectors for serial port (9-pin) communications. Refer to the table on page 2-7 for pin-outs.

Terminal Blocks

The following tables list the connections on the Ultra5000 230V drives (7.5 kW, and 15 kW) power (TB1) and the shunt (TB2) terminal blocks. Refer to Wiring Power Connections on page 3-14 for additional information.

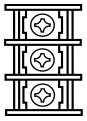
Terminal Block 1 (TB1) Locations (2098-IPD-075-*xx* and -150-*xx*)
U (Motor) [2]
V (Motor) [2]
W (Motor) [2]
Motor Case Ground
DC Bus+ [1]
DC Bus- [1]
L1 (Main AC)
L2 (Main AC)
L3 (Main AC)
Safety (Earth) Ground
L1 (Aux AC) [3]
L2/N (Aux AC) [3]

[1] Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

[2] 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.

3 The auxiliary AC power inputs require dual element time delay (slow acting) fuses to accommodate inrush current. Refer to the section *General Power Specifications* in *Appendix A* for the inrush current on the auxiliary AC power input.

Shunt Terminal Block 2 (TB2) Locations (2098-IPD-075-*xx* and -150-*xx*)
1 - Common Terminal for External or Internal Shunt [1]
2 - Internal Shunt Terminal [1]
3 - External Shunt Terminal [1]



[1] A jumper, selecting the internal shunt, is factory installed between terminals 1 and 2. Remove the jumper for applications requiring an external shunt.
Refer to External Shunt Kits on page C-4 for information about available external shunt kits.

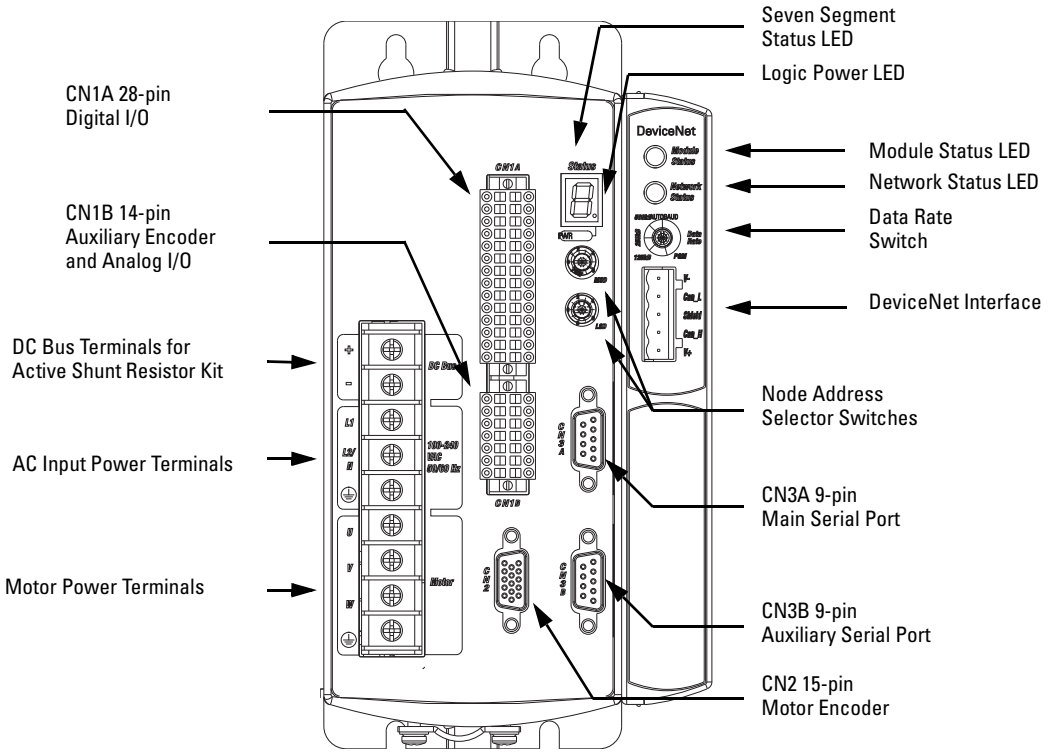
230V Ultra5000 with DeviceNet Front Panel Connections

This section describes and provides a visual reference to drive's having the DeviceNet interface.

500W, 1 kW, and 2 kW Ultra5000 with DeviceNet (2098-IPD-005-DN, -010-DN, and -020-DN)

Use the figure below to locate the front panel connections on the 230V Ultra5000 with DeviceNet drives (500W, 1 kW, and 2 kW). Detailed descriptions of the digital connections are provided on pages 2-5 through 2-7. Power connections are provided on page 2-11. DeviceNet connections are provided on page 2-14.

Figure 2.5
Ultra5000 with DeviceNet Front Panel Connections for 2098-IPD-005-DN, -010-DN, and -020-DN



I/O Connectors

CN1A (28-pin) and CN1B (14-pin) are plugable, double-row, spring clamp connectors with 3.5mm spacing. Refer to the tables on page 2-5 for pin-outs.

Motor Encoder Connector

CN2 (15-pin) motor encoder connector is a standard D-shell connector. Refer to the table on page 2-6 for pin-outs.

Serial Port Connectors

The CN3A (Main) and CN3B (Auxiliary) are standard D-shell connectors for serial port (9-pin) communications. Refer to the table on page 2-7 for pin-outs.

DeviceNet Connector

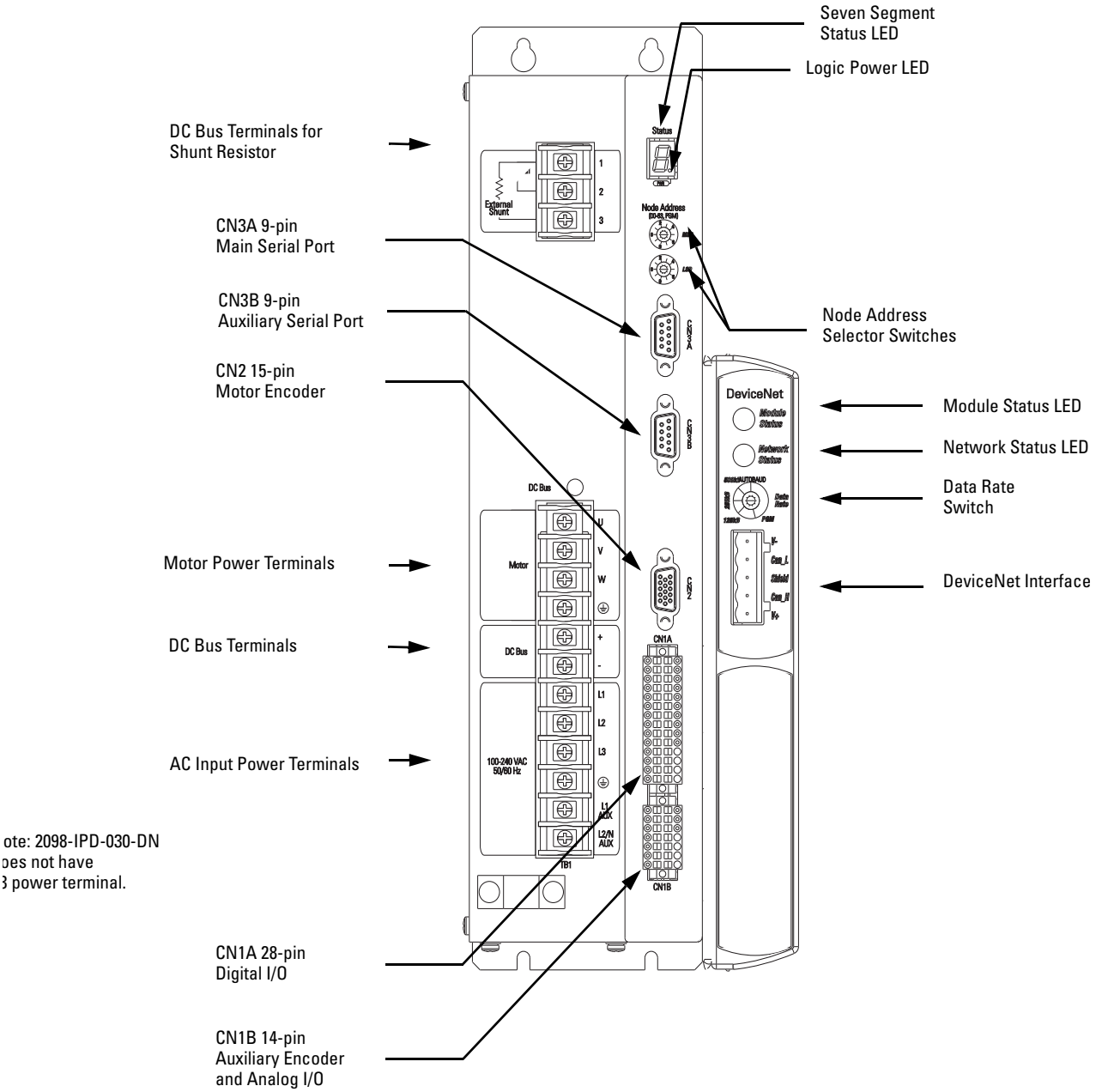
The following table provides the signal descriptions and pin-outs for the DeviceNet port (5-pin) connector.

Terminal	Signal	Description
1	V-	Network Power Common 24V DC
2	Can_L	Network Communication Signal Line
3	Shield	Shield
4	Can_H	Network Communication Signal Line
5	V+	Network Power 24V DC

3 kW, 7.5 kW, and 15 kW Ultra5000 (2098-IPD-005-DN, -010-DN, and -020-DN)

Use the figure below to locate the front panel connections on the 230V Ultra5000 with DeviceNet drives (3 kW, 7.5 kW, and 15 kW). Detailed descriptions of the connections are provided. Detailed descriptions of the digital connections are provided on pages 2-5 through 2-7. Power connections are provided on page 2-11. DeviceNet connections are provided on page 2-14.

Figure 2.6
Ultra5000 with DeviceNet Front Panel Connections for 2098-IPD-030-DN, -075-DN, and -150-DN



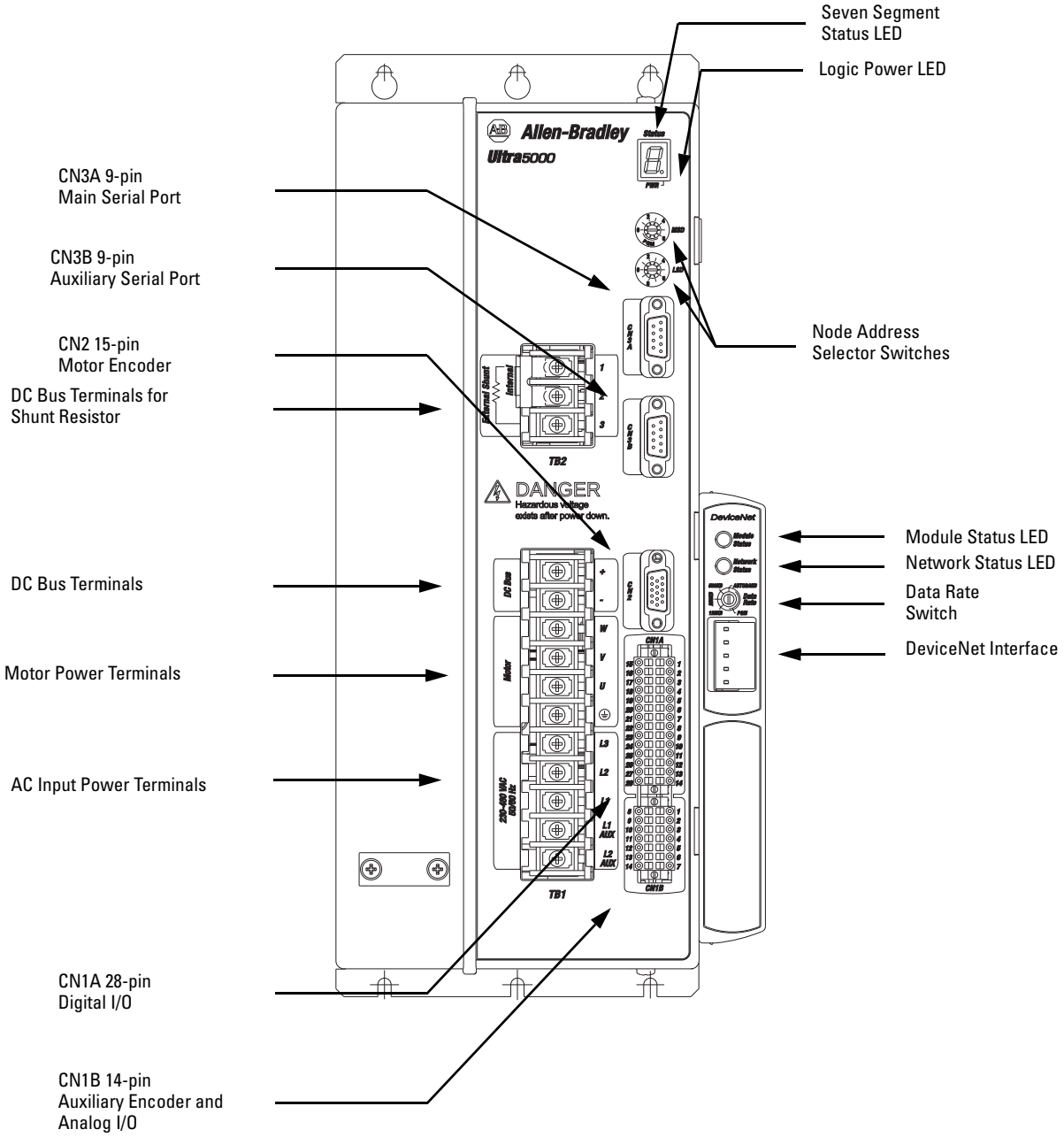
ote: 2098-IPD-030-DN
oes not have
3 power terminal.

460V Ultra5000 Front Panel Connections

Use the figure below to locate the front panel connections on the 460V Ultra5000 drives (3 kW, 5 kW, 10 kW, 15 kW and 22 kW).

Detailed descriptions of the digital connections are provided on pages 2-5 through 2-7. Power connections are provided on page 2-11. DeviceNet connections are provided on page 2-14.

Figure 2.7
Ultra5000 Front Panel Connections
for 2098-IPD-HV030-*xx*, -HV050-*xx*, -HV100-*xx*, -HV150-*xx*, and -HV220-*xx*



I/O Connectors

CN1A (28-pin) and CN1B (14-pin) are plugable, double-row, spring clamp connectors with 3.5mm spacing. Refer to the tables on page 2-5 for pin-outs.

Motor Encoder Connector

CN2 (15-pin) motor encoder connector is a standard D-shell connector. Refer to the table on page 2-6 for pin-outs.

Serial Port Connectors

The CN3A (Main) and CN3B (Auxiliary) are standard D-shell connectors for serial port (9-pin) communications. Refer to the table on page 2-7 for pin-outs.

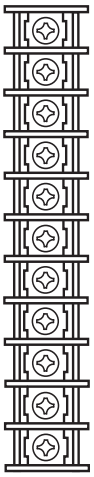
Terminal Blocks

The following tables list the connections on the 460V Ultra5000 drives (3 kW, 5 kW, 10 kW, 15 kW and 22 kW) power (TB1) and the shunt (TB2) terminal blocks. Refer to Wiring Power Connections on page 3-14 for additional information.

IMPORTANT The 2098-IPD-HV*xxx-xx* drives can be powered with 230-240 Vrms in order to be used in conjunction with motors designed for 230V operation. In such cases, the voltage levels used for shunting and DC bus overvoltage limits are adjusted to be compatible with the voltage limit of the motor.

.

Terminal Block 1 (TB1) Locations (2098-IPD-HV*xxx-xx*)
DC Bus+ [1]
DC Bus- [1]
W (Motor) [2]
V (Motor) [2]
U (Motor) [2]
Ground (Motor and Earth)
L3 (Main AC)
L2 (Main AC)
L1 (Main AC)
L1 (Aux AC) [3]
L2 (Aux AC) [3]

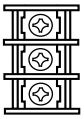


[1] Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

[2] 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.

3 The auxiliary AC power inputs require dual element time delay (slow acting) fuses to accommodate inrush current. Refer to the section *General Power Specifications* in *Appendix A* for the inrush current on the auxiliary AC power input.

Shunt Terminal Block 2 (TB2) Locations (2098-IPD-HV*xxx-xx*)
1 - Common Terminal for External or Internal Shunt [1]
2 - Internal Shunt Terminal [1]
3 - External Shunt Terminal [1]



[1] A jumper, selecting the internal shunt, is factory installed between terminals 1 and 2. Remove the jumper for applications requiring an external shunt.
Refer to External Shunt Kits on page C-4 for information about available external shunt kits.

Understanding Ultra5000 I/O Specifications

A description of the Ultra5000 input/output is provided on the following pages.

Digital I/O Power Supply

Power for the digital I/O on 0.5 kW, 1.0 kW, and 2.0 kW Ultra5000 230V drives (2098-IPD-005 through -020) and all 460V drives (2098-IPD-HV*xxx-xx*) must be provided by an external 12-24V dc power supply.

Power for the digital I/O on 3.0 kW through 15 kW Ultra5000 drives (2098-IPD-030 through -150) is provided by an external 12-24V dc power supply or by a 24V dc power source internal to the drive.

Two jumpers on the regulator board must be repositioned if the internal power source is to be used. Refer to Figure 3.2 on Page 3-3 for the location of the jumpers. The internal supply is fused by F1, a fast acting 1A fuse. The common for the internal supply is lightly referenced to ground, through a 1M ohm resistor. When using the internal 24V supply, the common must be grounded during installation to meet the European Low Voltage Directive.

The following table provides a description of the requirements for an external digital I/O power supply for all Ultra5000 drives (2098-IPD-005-*xx* through 2098-IPD-150-*xx*, and 2098-IPD-HV030-*xx* through 2098-IPD-HV220-*xx*).

Parameter	Description	Minimum	Maximum
I/O Power Supply Voltage	Voltage range of the external power supply for proper operation of the digital I/O.	10.8V	26.4V
I/O Power Supply Current	Current draw from the external power supply for the digital I/O, not including the relay output usage.	—	300 mA

The following table provides specifications on the internal digital I/O power supply for the 230V Ultra5000 3.0 kW through 15 kW drives (2098-IPD-030 through -150 only).

Parameter	Description	Minimum	Maximum
Output Voltage	Voltage difference between I/O PWR and I/O COM	21.6V	28.0V
Output Current	Current flow	—	300 mA

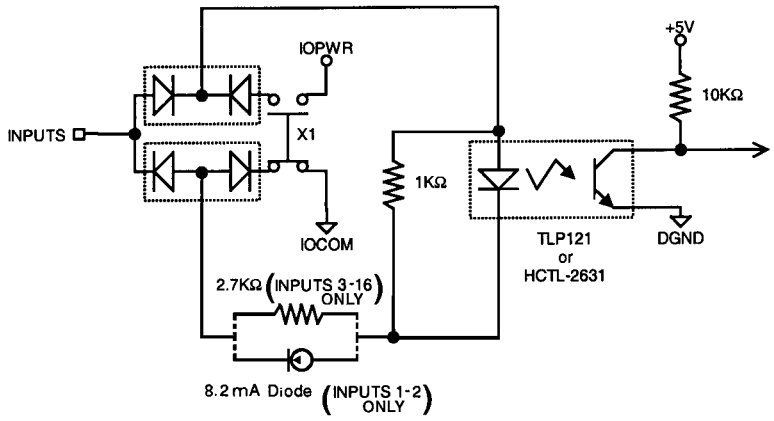
Digital Inputs

There are sixteen general purpose digital inputs. They are not connected in hardware to perform a particular function. All digital inputs have the same hardware configuration, shown in Figure 2.8.

IMPORTANT Configure your digital inputs, in a group, as active high (current sinking) or active low (current sourcing).

Inputs 1 and 2 use high-speed circuitry, with minimal propagation delays, suitable for use in registration applications. Any input can be assigned through firmware to latch the motor or auxiliary position in hardware.

Figure 2.8
Digital Input Circuit



Note: X1 is controlled through software to be "up" for active low and "down" for active high.

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

Parameter	Description	Minimum	Maximum
ON State Voltage, Active High Configuration	Voltage applied to the input, with respect to IOCOM, to guarantee an ON state.	10.8V	26.4V
ON State Voltage, Active Low Configuration	Voltage applied to the input, with respect to IOPWR, to guarantee an ON state.	-26.4V	-10.8V
ON State Current	Current flow to guarantee an ON State	3.0 mA	12.0 mA
OFF State Voltage, Active High Configuration	Voltage applied to the input, with respect to IOCOM, to guarantee an OFF state.	-1.0V	3.0V

Parameter	Description (Continued)	Minimum	Maximum
OFF State Voltage, Active Low Configuration	Voltage applied to the input, with respect to IOPWR, to guarantee an OFF state.	-3.0V	1.0V
Propagation Delay, High Speed Inputs	Signal propagation delay from the high speed digital input to the firmware accessible registers, active high or active low, turning ON or turning OFF.	—	0.5 mS
Propagation Delay, Low Speed Inputs	Signal propagation delay from the low speed digital input to the firmware-accessible registers, active high or active low, turning ON or turning OFF.	—	100 mS

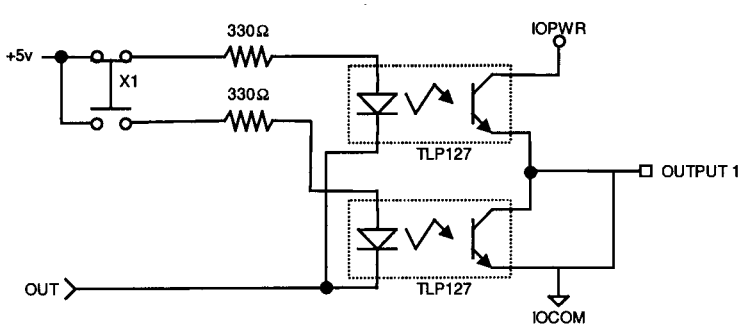
Digital Outputs

There are eight general purpose digital outputs. They are not connected in hardware to perform a particular function. Seven digital outputs are transistor outputs, and the drive has a single relay output (Output 8) with normally open contacts.

The configuration of the transistor outputs is shown in Figure 2.9, and the configuration of the relay output is shown in Figure 2.10.

IMPORTANT There is no overload protection on the transistor outputs. To some degree, the bipolar transistors limit their own current output, but they have not been designed to specifically protect against shorts to power or ground.

Figure 2.9
Transistor Output Hardware Configuration

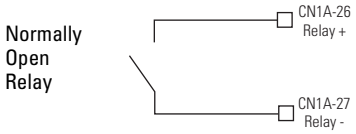


Note: X1 is controlled through software to be "up" for active high and "down" for active low.

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

Parameter	Description	Minimum	Maximum
ON State Current	Current flow when the output transistor is ON	—	50 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	—	1.5V
OFF State Voltage	Voltage across the output transistor when OFF	—	50V

Figure 2.10
Relay Output Hardware Configuration



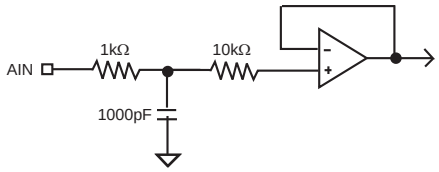
The following table provides a description of the relay output specifications.

Parameter	Description	Minimum	Maximum
ON State Current	Current flow when the relay is closed	—	1A
ON State Resistance	Contact resistance when the relay is closed	—	1W
OFF State Voltage	Voltage across the contacts when the relay is open	—	30V
OFF State Current	Current flow when the relay is open	—	0.01 mA

Analog Inputs

There are two single-ended general purpose analog inputs to use as needed. A 12 bit A/D converter digitizes the signal. The configuration of the input is shown in Figure 2.11.

Figure 2.11
Analog Input Configuration



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

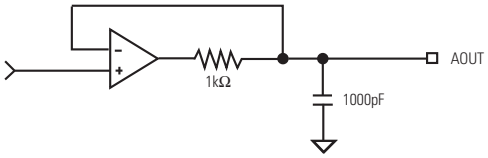
Parameter	Description	Minimum	Maximum
Resolution	Number of states that the input signal is divided into which is 2(to the number of bits).	12 bits	—
Input Impedance	Open circuit impedance measured between the + and - inputs.	10 kW	—
Input Signal Range	Voltage applied to the input - Usable	-10V	+10V
	Voltage applied to the input - Limit	-14V	+14V

Parameter	Description	Minimum	Maximum
Offset Error	Deviation from the correct value expected from analog-to-digital conversion when 0V is applied to the input.	—	50 mV
Gain Error	Deviation of the transfer function from unity gain, expressed in a percent of full scale.	—	1%
Propagation Delay	Delay from the input to the firmware-accessible registers.	—	100 mS

Analog Outputs

There are two analog outputs to use as needed. A 12 bit D/A converter generates an analog representation of the digital command value. The analog outputs are set to zero after the power comes up. Figure 2.12 shows the configuration of the analog outputs.

Figure 2.12
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(to the number of bits).	12 Bits	—
Output Current	Current capability of the output.	-2 mA	+2 mA
Output Signal Range	Range of the output voltage.	-10V	+10V
Offset Error	Deviation when the output should be at 0V.	—	50 mV
Gain Error	Deviation of the transfer function from unity gain, expressed in a percent of full scale.	—	1%

Understanding Motor Encoder Feedback Specifications

The Ultra5000 can accept motor encoder signals from the following types of encoders:

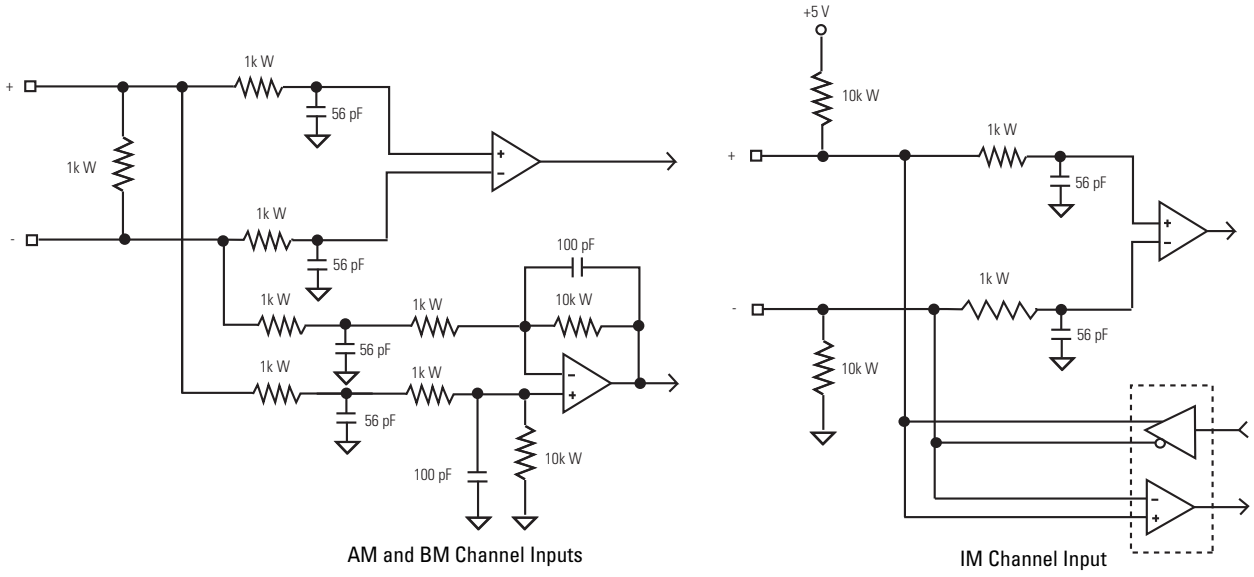
- Incremental encoders with TTL outputs, with or without Hall signals
- Sine/Cosine encoders, with or without Hall signals
- Intelligent absolute encoders
- Intelligent high-resolution encoders
- Intelligent incremental encoders

Note: The intelligent absolute, high-resolution, and incremental encoders are available only in Allen-Bradley motors.

AM, BM, and IM Inputs

AM, BM, and IM Input encoder signals are filtered using analog and digital filtering. The inputs also include illegal state change detection. Refer to Figure 2.13 for a schematic of the AM, BM, and IM inputs.

Figure 2.13
Schematic of the Motor Encoder Inputs



The Ultra5000 supports both TTL and Sine/Cosine encoders. The following table provides a description of the AM, BM, and IM inputs for TTL encoders.

Parameter	Description	Minimum	Maximum
AM, BM, and IM ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	+1.0V	+12.0V
AM, BM, and IM OFF State Input Voltage	Input voltage difference between the + input and the - input that is detected as an OFF state.	-1.0V	-12.0V
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
AM, BM Input Signal Frequency	Frequency of the AM or BM signal inputs. The count frequency is 4 times this frequency, since the circuitry counts all four transitions.	—	2.5 MHz
IM Pulse Width	Pulse width of the index input signal. Since the index is active for a percentage of a revolution, the speed will determine the pulse width.	125 nS	—
AM / BM Phase Error, 2.5 MHz Line Frequency	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-22.5°	+22.5°
AM / BM Phase Error, 1 MHz Line Frequency	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-45°	+45°

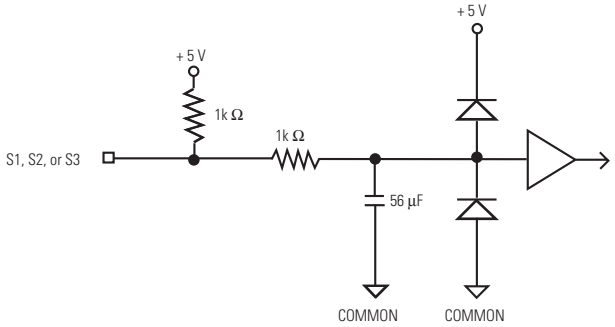
The following table provides a description of the AM and BM inputs for Sine/Cosine encoders.

Parameter	Description	Minimum	Maximum
AM and BM Input Signal Frequency	Frequency of the AM or BM signal inputs.	—	100 kHz
AM and BM Input Voltage	Peak-to-peak input voltages of the AM and BM inputs	0.5V (p-p)	2.0V (p-p)

Hall Inputs

The Ultra5000 uses Hall Signals to initialize the commutation angle for sinusoidal commutation. Hall Signals must be single-ended and can be either open collector type or TTL type. Figure 2.14 shows the configuration of the Hall inputs. If the motor does not have Hall signals, the drive can configured through software to omit the Hall signal requirement.

Figure 2.14
Hall Input Configuration



Thermostat Input

The Ultra5000 can monitor a thermostat signal from a motor and will generate a fault if the motor overheats. Figure 2.15 shows the configuration of the thermostat input. Figure 2.16 on page 2-28 shows a typical connection to a motor with a normally closed thermostat. The logic is designed so that an open condition will generate a fault. If the motor does not have a thermostat signal, the drive can be configured through software to ignore the signal.

Figure 2.15
Thermostat Input Configuration

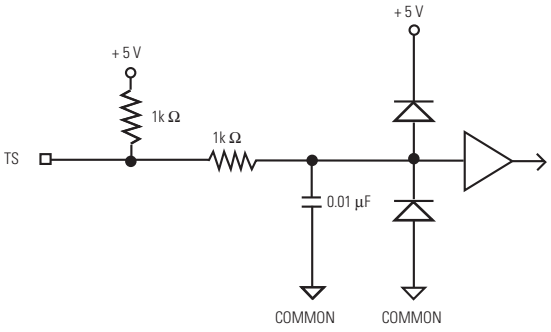
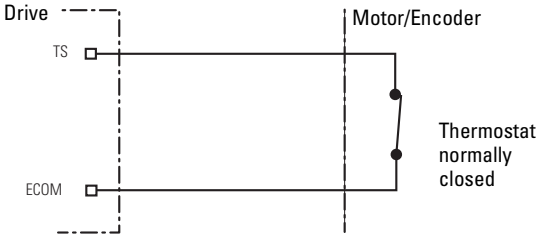


Figure 2.16
Typical Thermostat Connection



+ Limit and - Limit Inputs

The Ultra5000 drive includes overtravel limit inputs on the motor encoder connector that can be programmed to halt motion. The logic is designed so that an open condition will halt motion in the corresponding direction. If these signals are not used, the drive can be configured through software to ignore the inputs. Figure 2.17 shows the configuration of the +Limit and -Limit inputs. Figure 2.18 shows a typical connection to a motor with integral limit switches.

Figure 2.17
+ Limit and - Limit Input Configuration

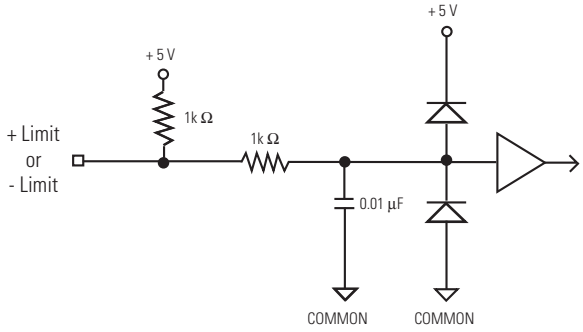
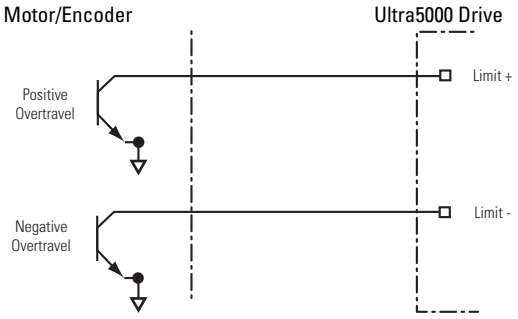


Figure 2.18
Typical + Limit and - Limit Connection



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, Hall signals are used to initialize the commutation angle, so the Hall signals must sequence properly and the phase relationship to the motor back-EMF signals must be understood. Figure 2.19 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 2.20 shows an example where the Hall signals have an offset of 60 degrees.

Figure 2.19
Sequencing and Phasing of the Hall Signals

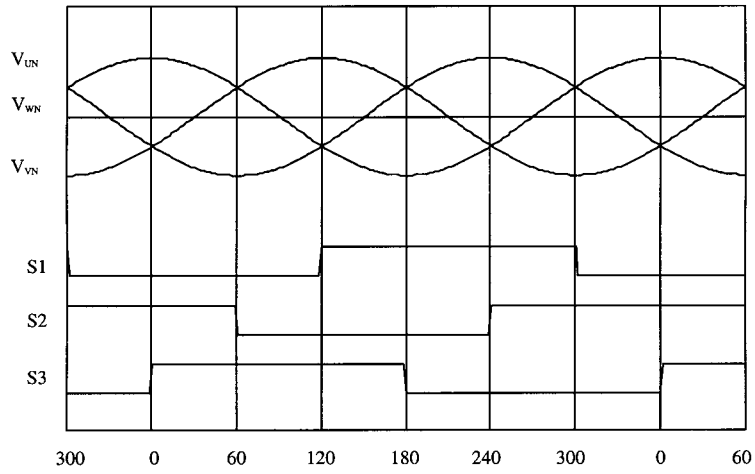


Figure 2.20
Sequencing and Phasing of the Hall Signals (60° Hall Offset Example)

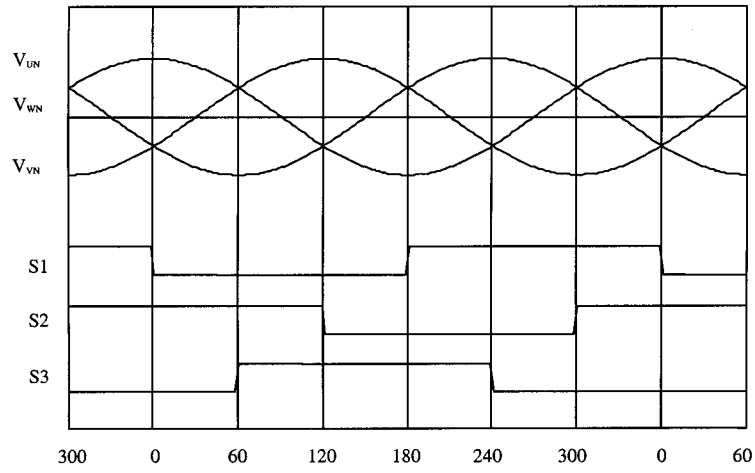


Figure 2.21 shows the proper phasing of TTL A/B encoder signals when positive current is applied.

Figure 2.21
Phasing of TTL A/B Encoder Signals

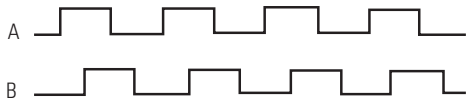
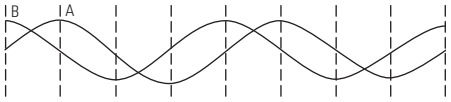


Figure 2.22 shows the proper phasing of Sine/Cosine encoder signals when positive current is applied.

IMPORTANT Notice that the Sine/Cosine encoder signals phasing is different than the phasing of the TTL encoders.

Figure 2.22
Phasing of Sine/Cosine Encoder Signals

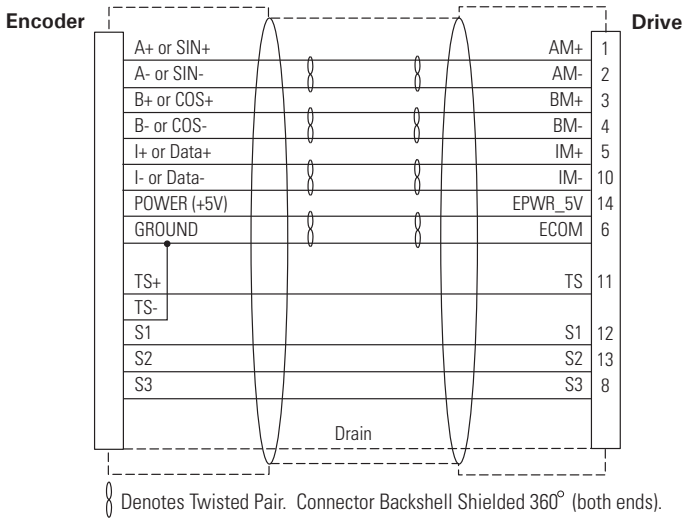


Motor Encoder Connection Diagram

Figure 2.23 shows a typical wiring diagram of a motor feedback cable. If the thermostat or limit signals are not available, no connections are required, but the drive must be configured through software to ignore these signals. Refer to *Appendix B* for specific Ultra5000 drive/motor interconnect diagrams.

IMPORTANT Total resistance of the wiring for encoder power and ground connections between the drive and motor must be less than 1.4 ohms.

Figure 2.23
Drive/Motor Wiring Diagram



Unbuffered Motor Encoder Outputs

The Ultra5000 passes the motor encoder signals directly to the CN1B Auxiliary Encoder Output connector without any conditioning.

Buffered Motor Encoder Outputs

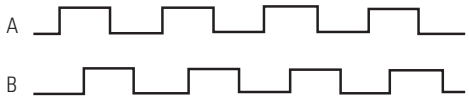
The Ultra5000 includes buffered motor encoder outputs. These signals are generated by the drive after filtering and processing the actual feedback from the motor. Programmable division is also available.

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.

Understanding Auxiliary Encoder Feedback Specifications

The Ultra5000 can accept an auxiliary encoder signal of the following type.

Figure 2.24
Auxiliary Encoder Input Signal Types



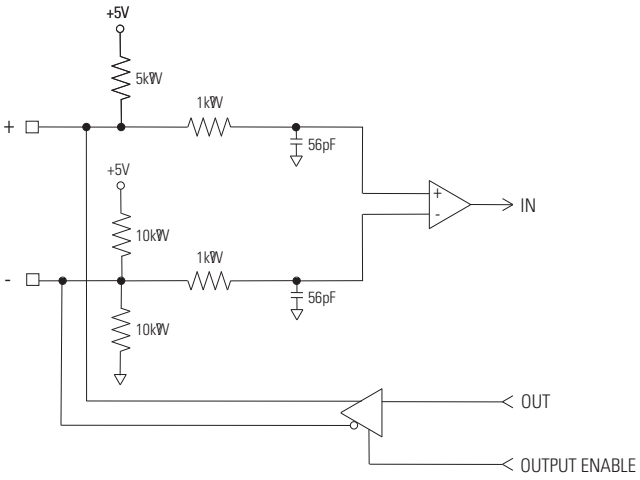
Auxiliary Encoder Interface

All encoder input signals (CN1B) are filtered using analog and digital filtering, including illegal state change detection.

The input circuitry includes pull-up and pull-down resistors for compatibility with single-ended and open collector signals, in addition to differential signals.

Figure 2.25 shows the configuration of the AX Auxiliary Encoder Input channel. The BX and IX channels have the same configuration.

Figure 2.25
Schematic of the Auxiliary Encoder Circuitry



The following table provides a description of the auxiliary encoder interface.

Parameter	Description	Minimum	Maximum
ON State Input Voltage	Input voltage difference between the + input and the - input that is detected as an ON state.	+1.0V	+7.0V
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 an encoder signal and logic ground.	-7.0V	+12.0V
DC Current Draw	Current draw into the + and - input.	-5mA	5mA
Signal Frequency	Frequency of the AX or BX signal inputs. Count frequency is 4 times this frequency for A/B/I type inputs.	—	2.5 MHz
IX Pulse Width, A/B/I Mode	Pulse width of the index input signal. Since the index is active for a percentage of a revolution, the speed will determine the pulse width.	125 nS	—
AX / BX Phase Error, 2.5 MHz Line Frequency, A/B/I Mode	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-22.5°	+22.5°
AX / BX Phase Error, 1 MHz Line Frequency, A/B/I Mode	Amount that the phase relationship between the AM and BM inputs can deviate from the nominal 90°.	-45°	+45°

Understanding the Serial Interface

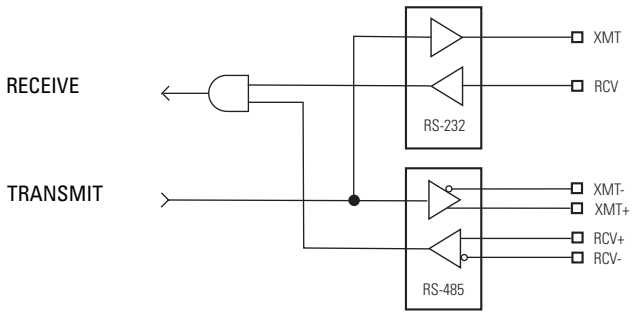
The Ultra5000 provides two physically identical serial ports (Main Serial Port CN3A and Auxiliary Serial Port CN3B) that implement the standard NRZ asynchronous serial format, and supports RS-232, RS-422, and RS-485 communication standards. However, functionality differs between the ports:

- The CN3A serial port communicates at a data rate fixed by the drive at 38400 baud. It is primarily for communications between a PC running Ultraware and the drive.
- The CN3B serial port's data rate is programmable via the drive's user (motion) program. It is primarily for communications between the drive and other devices requiring an interface to the user program.

Standard baud rates include 1,200, 2,400, 4,800, 9,600, 19,200, and 38,400 baud. Data lengths of 7 and 8 bits are supported.

The connector pinout dedicates separate pins for the RS-232 and RS-422/ RS-485 signals, so that the communication standard can be changed by just using a different cable. Refer to Figure 2.26 for the serial interface configuration.

Figure 2.26
Serial Interface Configuration



Default Serial Interface Settings

The default setting of the Ultra5000 serial interface is as follows:

Parameter	Default Setting
Baud Rate	38,400
Frame Format	8 Data, No Parity, One Stop

Connecting Your Ultra5000

Chapter Objectives

This chapter provides you with information for wiring your Ultra5000. This chapter includes these sections:

Before you begin these procedures, be sure to read and understand the information in the previous chapters of this manual.

Note: The procedures in this chapter do not include information regarding integration with other products.

Powering the Digital I/O

Depending on the model of the Ultra5000 drive, digital I/O power may be provided by the 24V dc power supply internal to the drive or by an external 12-24V power supply.

- A 2098-IPD-005 through -020 230V Ultra5000 drive and any 460V Ultra5000 drive (2098-IPD-HV030-*xx* through -HV220-*xx*) requires an external 12-24V power supply for proper operation of the digital I/O.
- A 2098-IPD-030 through -150 Ultra5000 drive's digital I/O is powered with an external 12-24V dc power supply, or by a 24V dc power source internal to the drive.

Requirements for an external digital I/O power supply are:

Parameter	Description	Minimum	Maximum
I/O Power Supply Voltage	Voltage range of the external power supply for proper operation of the digital I/O.	10.8V	26.4V
I/O Power Supply Current	Current draw from the external power supply for the digital I/O, not including the relay output usage.	—	300 mA

To convert a 230V Ultra5000 drive (2098-IPD-030 through -150) from the factory set external I/O power supply, a pair of jumpers on the regulator board must be repositioned. The following section describes how to access that board and change the location of the two jumpers.

Specifications on the internal digital I/O power supply are:

Parameter	Description	Minimum	Maximum
Output Voltage	Voltage difference between I/O PWR and I/O COM	21.6V	28.0V
Output Current	Current flow	—	300 mA

Accessing the Internal Digital I/O Power Supply

The 230V (2098-IPD-030 through -150) Ultra5000 drives can power the digital I/O from a 24V dc power source internal to the drive. Perform the following steps to change the digital I/O power source to the internal 24V dc power.

ATTENTION

DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds.

Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait a full 5 minutes to ensure that all voltages on the system bus have discharged.

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

ATTENTION

The Ultra5000 contains ESD (Electrostatic Discharge) sensitive parts.

To avoid damaging these parts, follow static control precautions when installing, testing, servicing, or repairing this assembly.

Refer to Allen-Bradley publication 800-4.5.2, *Guarding Against Electrostatic Discharge* or other appropriate handbooks on ESD protection.

1. Detach the right cover panel by removing the 3 screws (6-32 x 1/4) in the rear of the drive that secure the cover to the drive. Lift the rear of the cover and slide it forward until the connectors on the front of the drive are cleared. Then lift the cover off the drive. Figure 3.2 on page 3-3 shows the location of the screws and connectors.

   Note: This step assumes the I/O port (CN1A and CN1B) mating connectors were previously removed.

2. Relocate the digital I/O power jumpers on the regulator board. Figure 3.2 shows the location of the J12 and J13 jumpers. Move both jumpers from the EXT position to the INT position.

   Note: The fuse (F1) protects the circuit only when the internal power is selected.

3. Reinstall the cover.

Figure 3.1
Removal of Cover Panel from Ultra5000 Drive

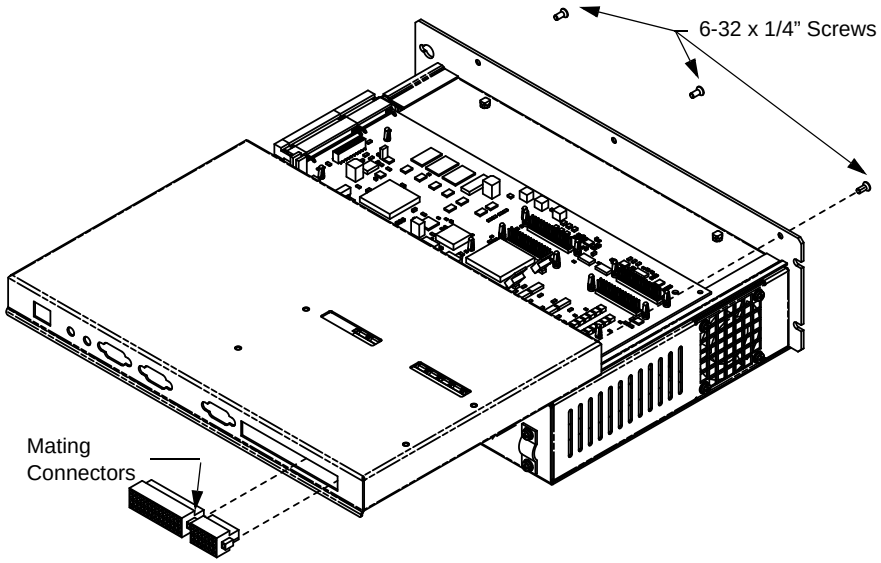
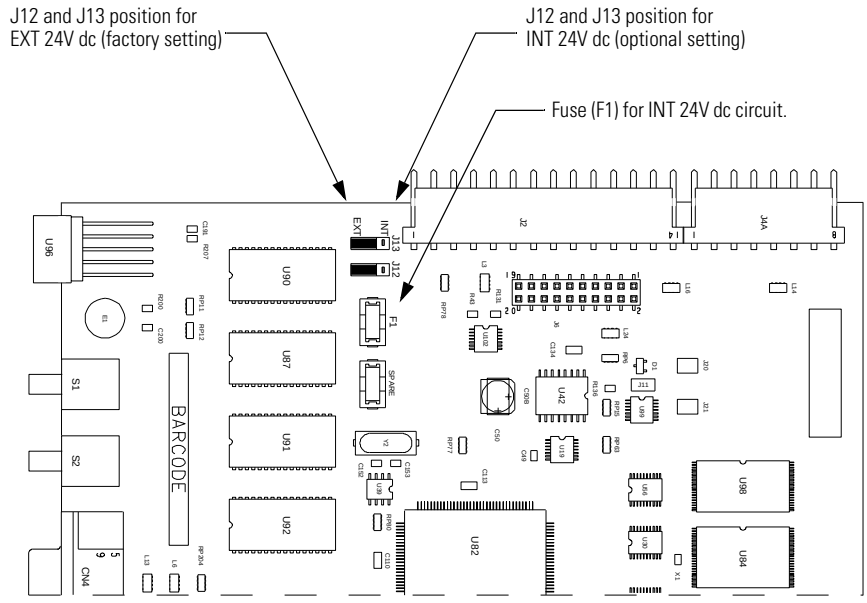


Figure 3.2
Jumper Settings for External or Internal Digital I/O Power



Understanding Basic Wiring Requirements

This section contains basic wiring information for the Ultra5000.

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.

The system is of an open type construction and care must be taken to prevent metal debris from falling into it.

Damage to the equipment could result if metal debris or other foreign matter contacts or lodges in the circuitry.

IMPORTANT

This section contains common PWM 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

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 mating connector kit catalog numbers.

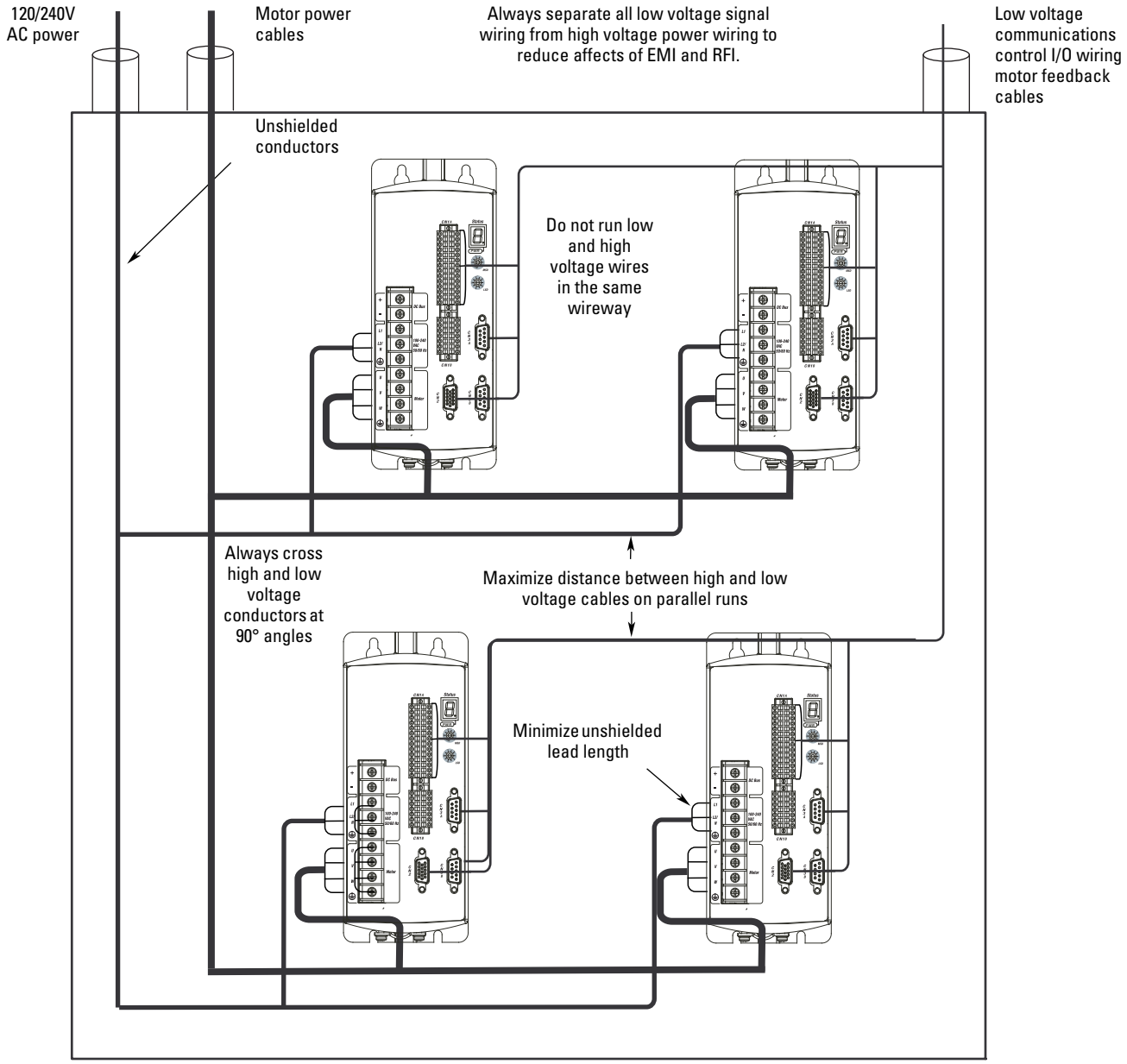
IMPORTANT

Factory made cables are recommended over hand-built cables and are designed to minimize EMI.

Routing High and Low Voltage Cables

Be aware that when you connect and route power and signal wiring on a machine or system, radiated noise from nearby relays (relay coils should have surge suppressors), 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. To minimize the levels of radiated noise, route machine power and signal lines separately.

Figure 3.3
Routing Power and Signal Cables Inside Your Cabinet



Grounding Your Ultra5000

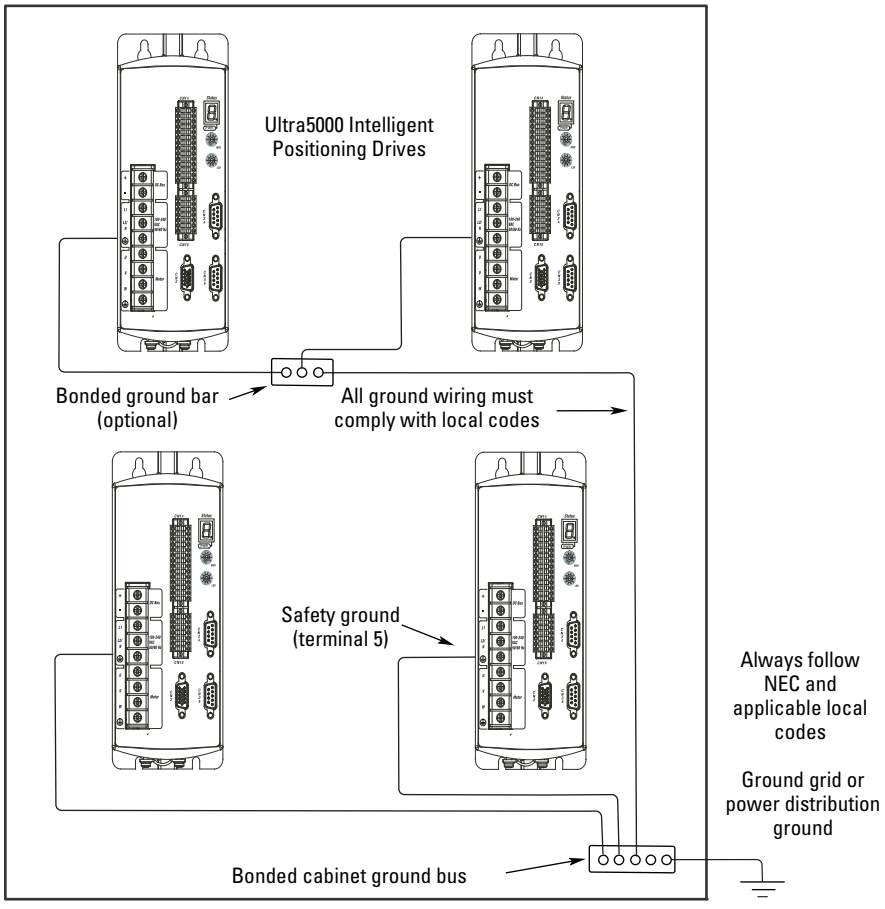
We recommend that all equipment and components of a machine or process system have a common earth ground point connected to their chassis. A grounded system provides a safety ground path for short circuit protection. Grounding your modules and panels minimize shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis. For CE grounding requirements, refer to *Appendix B*.

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 Ultra5000. Refer to *Appendix B* for the power wiring diagram for your Ultra5000 drive.

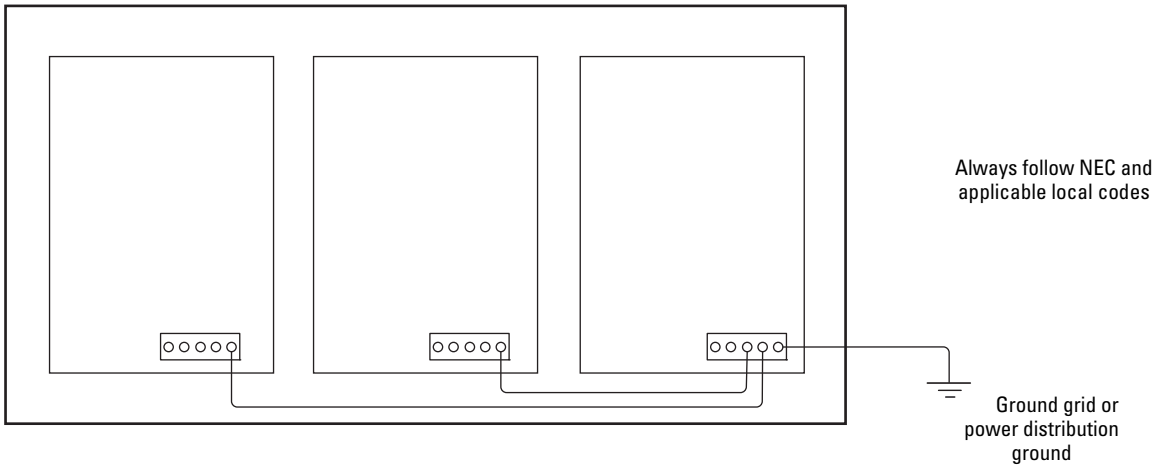
Figure 3.4
Safety Ground Configuration with Multiple Ultra5000 Systems on One Panel



Grounding Multiple Subpanels

To ground multiple subpanels, refer to the figure below.

Figure 3.5
Subpanels Connected to a Single Ground Point



Motor Power Cable Shield Termination

Factory supplied motor power cables for F-Series, H-Series, MP-Series, N-Series, and W-Series motors are shielded, and the power cable is designed to be terminated at the drive during installation. A small portion of the cable jacket is removed which exposes the shield braid. The exposed area must be clamped to the bottom of the drive chassis (refer to Figure 3.6) using the clamp provided.

ATTENTION

High voltage can be present on the shield of a power cable if the shield is not grounded.

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

Failure to observe these safety procedures could result in personal injury or equipment damage.

Figure 3.6
Motor Power Cable Shield Connection (bottom of drive)

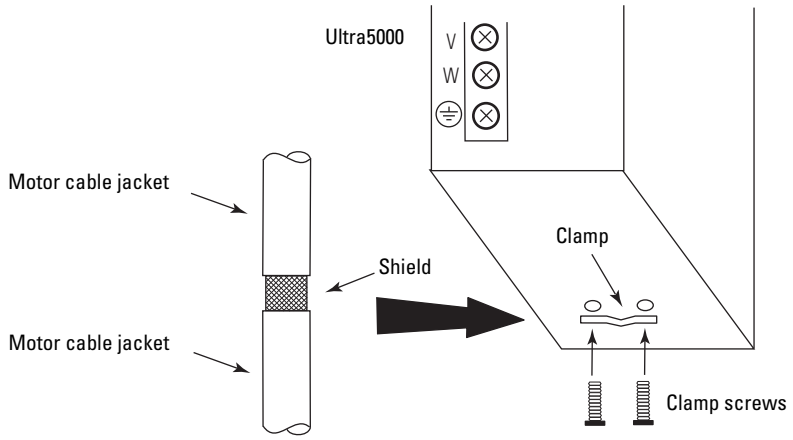
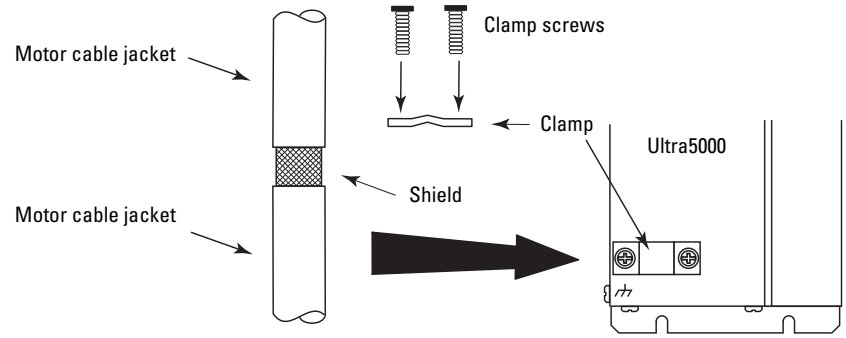
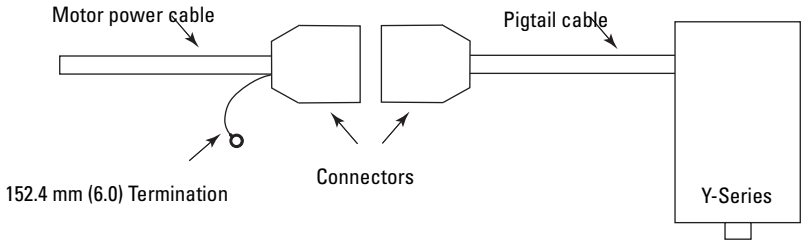


Figure 3.7
Motor Power Cable Shield Connection (front of drive)



Y-Series motors have a short pigtail cable which connects to the motor, but is not shielded. These motor power cables have a 152.4 mm (6.0 in.) shield termination wire with a ring lug that connects to the closest earth ground. The termination wire may be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening. Refer to Figure 3.8 for an illustration.

Figure 3.8
Y-Series Motor Power Cable Connection



Wiring Your Ultra5000

These procedures assume you have bonded and mounted your Ultra5000 to the subpanel and that there is no power applied to the system.

ATTENTION

This product contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Follow static control precautions when you install, test, service, or repair this assembly.

Refer to Allen-Bradley publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD Protection Handbook.

Failure to observe this precaution may result in damage to the equipment.

The following sections provide information and procedures on how to wire your Ultra5000.

Connecting Interface Cables

Connect all interface cables as shown in the table below.

This cable:	Plugs into this connector:
28-pin, Digital I/O	CN1A
14-pin, Auxiliary encoder/analog I/O	CN1B
15-pin, Motor encoder feedback	CN2
9-pin, Main serial port	CN3A
9-pin, Auxiliary serial port	CN3B

Wiring I/O Connections

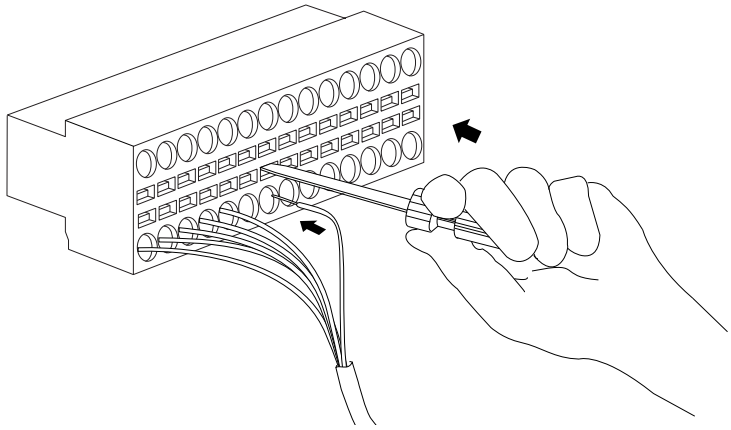
To wire your CN1A and CN1B I/O connectors:

1. Prepare your I/O wires by stripping approximately 6 mm (0.25 in.) of insulation from the end.

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

2. Using the small blade type screw driver supplied with your Ultra5000 (part number 9111-0031) depress the spring clamp next to the pin you're prepared to wire and insert the wire, as shown in Figure 3.9.

Figure 3.9
Inserting Wires into the Connector Housing



3. Remove the screw driver and gently pull on the wire to make sure it does not come out of its terminal. Re-insert and test any loose wires.

Connecting to a DeviceNet Network

A DeviceNet network is an arrangement of electrical power and device distribution. A DeviceNet network is planned and adjusted for optimal communications.

Before proceeding to add devices, you need to record the following:

- Network data rate
- Network cable system map (topology) to which you are connecting
- Distances between cable system components
- Device current draw and voltage drop for each device on the network
- Limitation of the trunk and drop cables

Refer to the table below for recommended trunk and drop lengths.

Data Rates	125 Kbps	250 Kbps	500 Kbps
Thick Trunk Line	500 m (1,640 ft)	250 m (820 ft)	100 m (328 ft)
Thin Trunk Lengths	100 m (328 ft)	100 m (328 ft)	100 m (328 ft)
Maximum Drop Length	6 m (20 ft)	6 m (20 ft)	6 m (20 ft)
Cumulative Drop Budget	156 m (512 ft)	78 m (256 ft)	39 m (128 ft)

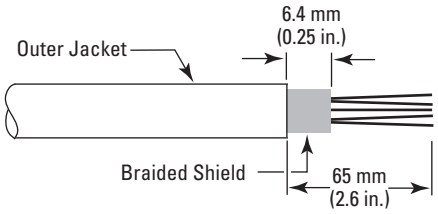
Refer to the DeviceNet Cable System Planning and Installation Manual, publication DNET-UM072, for specific guidance in calculating and attaching the Ultra5000 to a network.

Connecting Your DeviceNet Cable

To attach a plugable, open style, screw-connector to the DeviceNet cable:

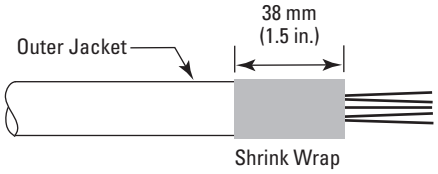
1. Strip 65 mm (2.6 in.) to 75 mm (2.96 in.) of the outer jacket from the end of the cable, leaving no more than 6.4 mm (0.25 in.) of the braided shield exposed.

Figure 3.10
Exposing the braided shield



2. Wrap the end of the cable with 38 mm (1.5 in.) of shrink wrap, covering part of the exposed wires and part of the outer jacket.

Figure 3.11
Adding shrink wrap

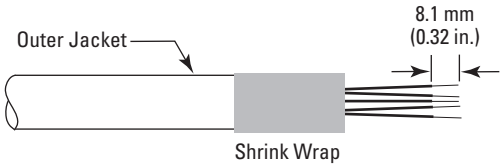


3. Strip 8.1 mm (0.32 in.) of the insulation from the end of each of the insulated wire.

   Note: Be careful not to nick, cut, or otherwise damage the individual strands of wire.

   Trim the last 6.5 mm (0.26 in.) of the bare wires so that the outside dimension does not exceed 0.17 mm (0.045 in.).

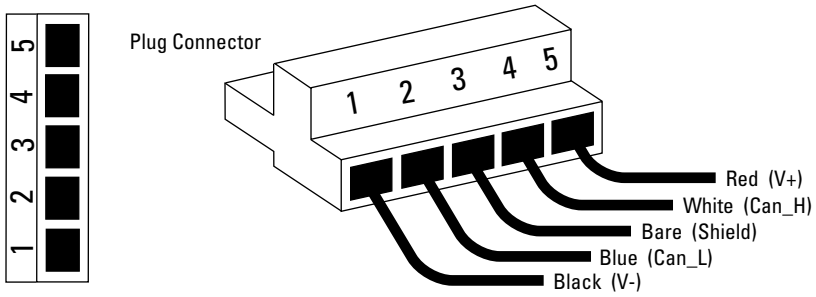
Figure 3.12
Exposing wire stands



4. Insert each wire into the appropriate clamping cavity of the plugable screw connector, according to the color of the cable insulation. Tighten the clamping screws to secure each wire.

5. Use an 1/8 inch flat blade screwdriver to firmly attach wires in the connector.

Figure 3.13
Wiring the DeviceNet connector



Terminal	Cable Color	Designation
5	Red	V +
4	White	Can_H
3	Bare	Shield
2	Blue	Can_L
1	Black	V -

6. Attach the Ultra5000 with DeviceNet to the DeviceNet network.

Assigning Your Ultra5000 DeviceNet Address

Use the following procedures to configure your Ultra5000 drive (2098-IPD-*xxx*-DN, and -HV*xxx*-DN) using Ultraware software and apply power to the drive.

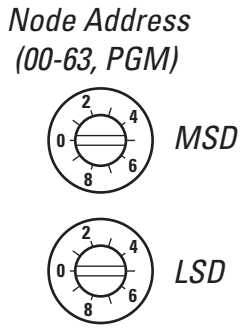
To configure your Ultra5000 drive with DeviceNet:

1. Verify that there is no power applied to the drive, and the DeviceNet cable is connected (refer to figures 2.2-2.7 for the connector location).

2. Set the node address for each drive in your system. Valid node addresses are 00-63 and PGM. The MSD rotary switch sets the most significant digit and the LSD rotary switch sets the least significant digit. Refer to figures 2.5 and 2.6 for the switch locations. Refer to the table below for examples.

For this Node Address:	Set the MSD switch to:	Set the LSD switch to:
10	1	0
11	1	1
12	1	2

Use the MSD and LSD rotary switches on the DeviceNet panel of the drive to set node addresses.

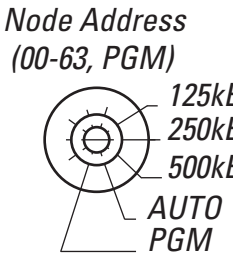


Note: Selecting an invalid node address (> 63) sets the node address according to a non-volatile parameter stored in the drive.

3. Set the data rate. Valid data rates are 125 kps, 250 kps, 500 kps, AUTO, and PGM. Refer to figures 2.5 and 2.6 for the switch location.

Note: Selecting AUTO automatically matches the device data rate to the rate of the network. Selecting PGM sets the data rate according to a non-volatile parameter stored in the drive.

Use the Data Rate rotary switch on the DeviceNet panel of the drive to set the data rate.



Wiring Power Connections

IMPORTANT The 2098-IPD-HVxxx-xx drives can be powered with 230-240 Vrms in order to be used in conjunction with motors designed for 230V operation. In such cases, the voltage levels used for shunting and DC bus overvoltage limits are adjusted to be compatible with the voltage limit of the motor.

Power wiring requirements are given in the table below.

Ultra5000 Drives:	Provide this input power:[1]	With this type of wire:	Phasing of main AC power:	Earth ground connection:	Terminal block torque values:
2098-IPD-005*xx*, -010-*xx*, and -02-*xx*	100-240V ac single phase	Copper with 75° C (194° F) minimum rating	Arbitrary	Required (for safe and proper system operation)	1.25 Nm (11 lb-in.)
2098-IPD-030-*xx*					
2098-IPD-075-*xx*	100-240V ac 3-phase				
2098-IPD-150-*xx*					2.26 Nm (20 lb-in.)
2098-IPD-HV*xxx-xx*	207-528V ac 3-phase				1.25 Nm (11 lb-in.)

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

For additional information refer to the *General Power Specifications* section in *Appendix A*. Refer to *Appendix B* for the power wiring diagram for your Ultra5000 drive.

The internal 5V dc power supply fuse opens at 3 amps and automatically resets itself when the current falls below 3 amps. There are no internal fuses requiring replacement.

The Ultra5000 utilizes solid state motor overload protection which operates in accordance with UL 508C.

Motor overload protection trips:	At:
Eventually	100% overload.
Within 8 minutes	200% overload.
Within 20 seconds	600% overload.

ATTENTION

High voltage can be present on the shield of a power cable if the shield is not grounded. Motor power connectors are to be used for connection purposes only - do not use them to turn the unit on and off.

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

Failure to observe these safety procedures could result in personal injury or equipment damage.

To wire your input power and motor connections:

1. Prepare your wires by stripping approximately 12 mm (0.50 in.) of insulation from the end.

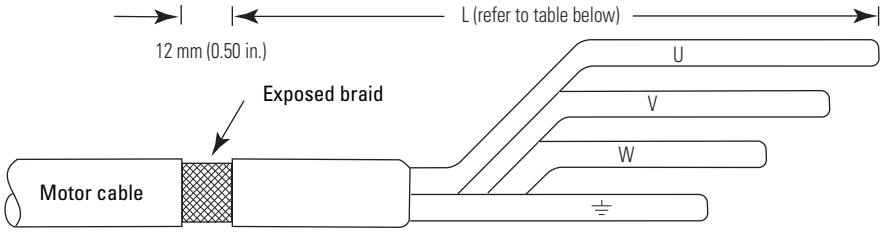
IMPORTANT Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

2. Check for continuity in the motor leads [wires marked U, V, and W (R, S, and T on W-Series)]. Verify that the resistance reading from each wire to earth ground is above 500k ohms, with the cable connected to the motor.

If your resistance reading is:	Then:
Above 500k ohms	Continue with step 3.
Below 500k ohms	Go to the chapter *Maintaining Your Ultra5000*.

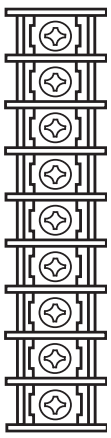
3. Prepare your motor cable for the cable shield clamp on the Ultra5000 drive by exposing 12 mm (0.50 in.) of cable shield braid, as shown in the figure below.

Figure 3.14
CE Clamp Cable Preparation



For these Ultra5000 drives:	The dimension L has this value:
2098-IPD-005 or -005-DN 2098-IPD-010 or -010-DN 2098-IPD-020 or -020-DN 2098-IPD-030, -030-DN, -HV030, or -HV030-DN 2098-IPD-HV050, or -HV050-DN 2098-IPD-075, or -075-DN 2098-IPD-HV100, or -HV100-DN	185 mm (7.25 in.)
2098-IPD-150, -150-DN, -HV150 or -HV150-DN 2098-IPD-HV220 or -HV220-DN	241 mm (9.50 in.)

4. Using a screw driver, loosen the screw for each of the terminal locations and attach wires as shown in the table below. Refer to *Appendix B* for the power wiring diagram for your Ultra5000 drive.

Terminal Block (TB) Locations (2098-IPD-005*xx*, -010-*xx*, -020-*xx*)	**Terminal Block 1 (TB1) Locations (2098-IPD-030-*xx*)**
DC Bus+ [1] DC Bus- [1] L1 (Main AC) L2/N (Main AC) Safety (Earth) Ground U (Motor) [2] V (Motor) [2] W (Motor) [2] Motor Case Ground	 U (Motor) [2] V (Motor) [2] W (Motor) [2] Motor Case Ground DC Bus+ [1] DC Bus- [1] L1 (Main AC) L2/N (Main AC) Safety (Earth) Ground L1 (Aux AC) [3] L2/N (Aux AC) [3]
Terminal Block 1 (TB1) Locations (2098-IPD-075-*xx* and -150-*xx*)	**Terminal Block Locations (2098-IPD-HV*xxx*-*xx*)**
U (Motor) [2] V (Motor) [2] W (Motor) [2] Motor Case Ground DC Bus+ [1] DC Bus- [1] L1 (Main AC) L2 (Main AC) L3 (Main AC) Safety (Earth) Ground L1 (Aux AC) [3] L2/N (Aux AC) [3]	 DC Bus+ [1] DC Bus- [1] W (Motor) [2] V (Motor) [2] U (Motor) [2] Ground (Motor and Earth) L3 (Main AC) L2 (Main AC) L1 (Main AC) L1 (Aux AC) [3] L2 (Aux AC) [3]

[1] Do not connect an external I/O power supply to the DC bus. The DC+ and DC- terminals connect directly to the power bus of the drive.

[2] 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.

3 The auxiliary AC power inputs require dual element time delay (slow acting) fuses to accommodate inrush current. Refer to the section *General Power Specifications* in *Appendix A* for the inrush current on the auxiliary AC power input.

5. Tighten each terminal screw to the appropriate torque value.

Ultra5000 Drives:	Terminal Block Torque Values:
2098-IPD-005xx, -010-xx, and -02-xx	1.25 Nm (11 lb-in.)
2098-IPD-030-xx	
2098-IPD-075-xx	
2098-IPD-150-xx	2.26 Nm (20 lb-in.)
2098-IPD-HVxxx-xx	1.25 Nm (11 lb-in.)

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

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.

7. To connect the motor power cable:

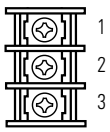
If your motor is:	Then:
F-Series, H-Series, MP-Series, N-Series, W-Series, or 1326AB-B*xxxx*-M2L or -S2L	1. Remove the two screws securing the cable shield clamp on the Ultra5000 drive (refer to figures 3.6 or 3.8 for the cable clamp location on your Ultra5000 drive). 2. Place the cable within the clamp and replace the screws (do not tighten). 3. Position the exposed portion of the cable braid directly in line with the clamp. 4. Tighten the screws with a torque of 0.9-1.1 Nm (8.0-10.0 lb-in.). 5. Continue with optional step 8 or step 9.
Y-Series	1. Connect the 152.4 mm (6.0 in.) termination wire to the closest earth ground (refer to Figure 3.8 for pigtail location). 2. Continue with optional step 8 or step 9.

8. Determine whether or not a shunt resistor is necessary

If your Ultra5000 catalog number begins with:	And your application requires:	Then:
2098-IPD-005 or -005-DN 2098-IPD-010 or -010-DN 2098-IPD-020 or -020-DN	no shunt	You are finished wiring your Ultra5000 power connections. Go to main step 9.
	external shunt	Connect an external active shunt module to the Terminal Block (TB) as shown in *300 Watt Active Shunt Module* on Page B-23.
2098-IPD-030 or -030-DN 2098-IPD-075 or -075-DN 2098-IPD-150 or -150-DN and -HV*xxx-xx*	internal shunt	Connect a jumper to TB2 between terminal 1 and 2 as shown in Figure 3.15. (For the location of TB2, refer to the chapter *Ultra5000 Connector Information* beginning on Page 2-1.)
	external shunt	Connect an external shunt resistor to TB2 between terminals 1 and 3 as shown in Figure 3.15. (For the location of TB2, refer to *Ultra5000 Connector Information* beginning on Page 2-1.)

Figure 3.15
Connecting Your Shunt Resistor

Connecting the Internal Shunt Resistor[1]



Connecting the External Shunt Resistor

[1] This is the factory default jumper setting for TB2.

9. You are finished wiring your Ultra5000 power connections. Go to the chapter *Commissioning Your Ultra5000* beginning on Page 4-1.

Commissioning Your Ultra5000

Chapter Objectives

This chapter provides you with information to apply power and configure your Ultra5000. This chapter includes these sections:

Before you begin these procedures, be sure to read and understand the information in the previous chapters of this manual.

Note: The procedures in this chapter do not include information regarding integration with other products.

General Startup Precautions

The following precautions pertain to all of the procedures in this chapter. Be sure to read and thoroughly understand them before proceeding.

ATTENTION

This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltages on the system bus network have been discharged before attempting to service, repair or remove this unit.

Only qualified personnel familiar with solid state control equipment and safety procedures in publication NFPA 70E or applicable local codes should attempt this procedure.

Failure to observe this precaution could result in damage to the equipment or severe bodily injury.

ATTENTION

This product contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Follow static control precautions when you install, test, service, or repair this assembly.

Refer to Allen-Bradley publication 8000-4.5.2, Guarding Against Electrostatic Damage or any other applicable ESD Protection Handbook.

Failure to observe this precaution may result in damage to the equipment.

Understanding Communication Switch Settings

The Ultra5000 communication address selector switches (MSD and LSD) allow setting a unique address for each Ultra5000 connected on a serial network. The switches allow setting addresses 0-99. Refer to Figure 2.2 for the switch locations. Addresses are reserved for use as shown in the table below.

Switch Settings:	Description:
0	Reserved for factory use only
1-63	Valid settings for normal drive operation
PGM Settings:	
64-95	Reserved for factory use only
96	Disable Program Auto Run mode. With this setting during power-up, programs are not allowed to run. This mode is useful to correct programming problems that may have caused communications loss when the program is running.
97	Set Factory Default Objects mode. With this setting during power-up, all internal firmware objects are reset to factory defaults. Any objects created by a user program are also reset. This mode is useful to return a drive to factory defaults.
98	Reserved for factory use only
99	Boot mode. With this setting during power-up, the only action that my be performed is to upgrade the drive firmware using Ultraware.

Note: Power to the drive must be cycled for firmware to scan and recognize an address switch change.

Applying Power To Your System

This procedure assumes you have wired your Ultra5000 system, verified the wiring, and are ready to begin using your Ultraware software. To apply power to your Ultra5000 system:

1. Disconnect any load to the motor. Ensure the motor is free of all linkages when initially applying power to the system.

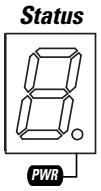
2. Set the communication address switches as shown in the example table below. For the location of the address switches, refer to Figure 2.2.

For example, if you have:	Set the MSD switch to:	Set the LSD switch to:
1 drive	0	1
2 drives	0	2
3 drives	0	3
:	:	:
64 drives	6	4

Note: Switch settings above 64 invoke special functions used for programming and troubleshooting. See *Understanding Communication Switch Settings* on Page 4-2.

3. Apply input power to the Ultra5000 and observe the front panel Logic Power indicator LED as shown in Figure 4.1.

Figure 4.1
Logic Power and Status LED Display



If the Logic Power LED is:	Then:
ON	Go to step 4.
Not ON	Check your input power connections. Repeat step 3.

4. Observe the front panel seven segment Status LED display as shown in Figure 4.1.

If the Status LED display on your:	Is:	Then:
2098-IPD-*xxx*, 2098-IPD-HV*xxx*, 2098-IPD-*xxx*-DN, and 2098-IPD-HV*xxx*-DN (all Ultra5000 drives)	Actively cycling segments in a full circle	The drive is ready. Go to *Configuring Your Ultra5000* on Page 4-5.
2098-IPD-*xxx*, 2098-IPD-HV*xxx*, 2098-IPD-*xxx*-DN, and 2098-IPD-HV*xxx*-DN (all Ultra5000 drives)	Actively cycle in a half circle with address switches set to MSD=9 and LSD=9	Go to *Understanding Communication Switch Settings* on Page 4-2 and reset your address switches according to the table.
2098-IPD-*xxx*, 2098-IPD-HV*xxx*, 2098-IPD-*xxx*-DN, and 2098-IPD-HV*xxx*-DN (all Ultra5000 drives)	Actively cycle in a half circle with address switches set according to the table in *Understanding Communication Switch Settings* on Page 4-2.	Your firmware requires an upgrade. Go to *Configuring Your Ultra5000* on Page 4-5.
2098-IPD-*xxx*, 2098-IPD-HV*xxx*, 2098-IPD-*xxx*-DN, and 2098-IPD-HV*xxx*-DN (all Ultra5000 drives)	Flashing an “E” followed by two numbers	Go to the chapter *Maintaining Your Ultra5000* beginning on Page 5-1.

Configuring Your Ultra5000

This procedure assumes you have successfully applied power to your system. To configure your Ultra5000 system:

1. Start your Ultraware software. Refer to the *Ultraware User Manual*, publication 2098-UM001, for information on starting the Ultraware software.

2. Open a recently used file or create a new file. Ultraware will scan for on-line drives.

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

4. Look for the Ultra5000 icon (Ultra5k) under the On-Line Drives tree. Refer to step 4 in the previous section, *Applying Power To Your System*.

If you were told:	Then:
The drive is ready	Go to step 5 below.
Your firmware requires an upgrade	1. Select **File** from the main menu bar. 2. Select **Upgrade Firmware**. 3. Go back to step 1 and repeat procedure.

5. The Ultra5000 icon indicates that your drive is detected.

If your Ultra5000 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 Ultra5000*, step 4.
Is not detected	1. Go to the previous section, *Applying Power To Your System*, step 3, and verify your address switch settings. 2. Check your serial cable connections. 3. Go to step 1 of this section.

6. Refer to the *Ultraware User Manual*, publication 2098-UM001,for further configuration and tuning instructions.

Maintaining Your Ultra5000

Chapter Objectives

This chapter provides a description of maintenance and troubleshooting activities for the Ultra5000. This chapter includes these sections:

Maintaining the Drive

The Ultra5000 Drive is designed to function with a minimum of maintenance.

ATTENTION

DC bus capacitors may retain hazardous voltages after input power has been removed, but will normally discharge in several seconds.

Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval listed on the warning on the front of the drive.

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

Periodic Maintenance

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

Cleaning the Drive

To clean the drive, use 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.

Inspecting the Cables

Ensure input power is disconnected before touching cables or connections and perform the following:

- Visually inspect all cables for abrasion.
- D-shell and Digital I/O connectors should be inspected for proper seating and signal continuity end-to-end.

General Troubleshooting

Refer to the *Error 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 Ultra5000 drive has an error, refer to the table below.

If the Logic Power LED is ON and the Status LED display on your:	Is:	Then:
2098-IPD-*xxx* or -HV*xxx* drive	Actively cycling segments in a full circle	Your Ultra5000 drive is ready.
2098-IPD-*xxx*-DN or -HV*xxx*-DN drive		
All drives	Flashing E, followed by two numbers	Your Ultra5000 drive has an error. Proceed to the section *Error Codes* below.

Error Codes

The following list is designed to help you resolve problems when an assigned error code or a problematic symptom (no error code) is encountered.

When a fault is detected, the 7-segment LED displays a flashing E followed by a two-digit error code, that registers one digit at a time. The error display is repeated until the problem is cleared.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
	Power (PWR) indicator not ON	No AC power or auxiliary logic power.	Verify power AC power or auxiliary +5V logic power is applied to the Ultra5000.
		Internal power supply malfunction.	Call your Allen-Bradley representative.
	7-Segment LED not cycling	Firmware corrupt	• Set node address to 99 and reload firmware. • Call your A-B representative.
	Small LED segment cycling	Node address set to 99	Change node address.
		Firmware corrupt	Set node address to 99 and reload firmware. Then cycle power.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
	Motor jumps when first enabled	Motor wiring error.	Check motor wiring.
		Incorrect motor chosen.	Verify the proper motor is selected.
	Digital I/O not working correctly	I/O power supply disconnected or incorrect I/O type	Verify: • I/O connections • I/O power source • I/O type (sinking/sourcing).
01 - 03	Reserved		Call your local Allen-Bradley representative.
04	Motor Overtemperature	Motor thermostat trips due to: • High motor ambient temperature and/or • Excessive current	• Operate within (not above) the continuous torque rating for the ambient temperature (40°C maximum). • Lower ambient temperature, increase motor cooling.
		Motor wiring error.	Check motor wiring.
		Incorrect motor selection.	Verify the proper motor has been selected.
05	IPM Fault	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.
		Ultra5000 temperature too high.	• Check for clogged vents or defective fan. • Ensure cooling is not restricted by insufficient space around the unit.
		Operation above continuous power rating.	• Verify ambient temperature is not too high. • Operate within the continuous power rating. • Reduce acceleration rates.
		Ultra5000 has a bad IPM output, short circuit, or overcurrent.	Remove all power and motor connections, and preform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, or send drive in for repair.
06 - 08	Reserved		Call your local Allen-Bradley representative.
09	Bus Undervoltage	Low AC line/AC power input.	• Verify voltage level of the incoming AC power. • Check AC power source for glitches or line drop. • Install an uninterruptible power supply (UPS) on your AC input.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
10	Bus Overvoltage	Excessive regeneration of power. When the motor is driven by an external mechanical power source, it may regenerate too much peak energy through the Ultra5000's power supply. The system faults to save itself from an overload.	• Change the deceleration or motion profile. • Use a larger system (motor and Ultra5000). • Use a resistive shunt.
		Excessive AC input voltage.	Verify input is below within specifications.
		Output short circuit.	Remove all power and motor connections, and preform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, or send drive in for repair.
		Motor cabling wires shorted together.	Disconnect motor power cables from the drive. If faults stop, replace cable.
		Internal motor winding short circuit.	Disconnect motor power cables from the motor. If the motor is difficult to turn by hand, it may need to be replaced.
11	Illegal Hall State	Incorrect phasing.	Check the Hall phasing.
		Bad connections.	• Verify the Hall wiring. • Verify 5V power supply to the encoder.
12 - 16	Reserved		Call your local Allen-Bradley representative.
14	DeviceNet Comm Fault	Drive has lost communications with DeviceNet interface.	Refer to Troubleshooting for DeviceNet Drives on page 5-6.
15 - 16	Reserved		Call your local Allen-Bradley representative.
17	User-Specified Current Fault	User-Specified average current level has been exceeded.	Increase to a less restrictive setting.
18	Overspeed Fault	Motor speed has exceeded 125% of maximum rated speed.	• Check cables for noise. • Check tuning.
19	Excess Position Error	Position error limit was exceeded.	• Increase the feed forward gain. • Increase following error limit or time. • Check position loop tuning.
20	Motor Encoder State Error	The motor encoder encountered an illegal transition.	• Replace the motor/encoder. • Use shielded cables with twisted pair wires. • Route the feedback away from potential noise sources. • Check the system grounds.
		Bad encoder.	Replace motor/encoder.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
21	Auxiliary Encoder state error	The auxiliary encoder encountered an illegal transition.	• Use shielded cables with twisted pair wires. • Route the encoder cable away from potential noise sources. • Bad encoder - replace encoder. • Check the ground connections.
22	Motor Thermal Protection Fault	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 Ultra5000 and motor. • Check tuning.
23	IPM Thermal Protection Fault	The internal filter protecting the drive from over heating has tripped.	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger Ultra5000 and motor. • Check tuning.
24	Excess Velocity Error	Velocity error limit was exceeded.	• Increase time or size of allowable error. • Reduce acceleration. • Check tuning.
25	Reserved		Call your local Allen-Bradley representative.
26	User-Specified Velocity Fault	User specified velocity level was exceeded.	Increase to a less restrictive setting.
27 - 28	Reserved		Call your local Allen-Bradley representative.
29	Encoder Output Frequency Exceeded	Encoder output frequency exceeds the maximum user specified value. This only applies when the encoder output mode is software.	• Increase the Output Encoder Limit parameter. • Increase the encoder output divider parameter.
30 - 33	Reserved		Call your local Allen-Bradley representative.
34	Ground Fault	Wiring error.	Check motor power wiring.
		Motor internal ground short.	Replace motor.
		Internal malfunction.	Disconnect motor power cable from drive and enable drive with current limit set to 0. If fault remains, call your A-B representative. If fault clears, then a wiring error or motor internal problem exists.
35	Precharge Fault	Low AC input voltage.	Check input AC voltage on all phases.
36	Power Circuitry Overtemperature	Excessive heat exists in the power circuitry.	• Reduce acceleration rates. • Reduce duty cycle (ON/OFF) of commanded motion. • Increase time permitted for motion. • Use larger Ultra5000 and motor. • Check tuning.

Error Code	Problem or Symptom	Possible Cause(s)	Action/Solution
37	AC Line Loss	One or more phases of the input AC power is missing.	Check input AC voltage on all phases.
38	Reserved		Call your local Allen-Bradley representative.
39	Self-sensing Commutation Startup Error	Motion required for self-sensing startup commutation was obstructed.	• Verify that there are no impediments to motion at startup, such as hard limits. • Increase self-sensing current if high friction or load conditions exist. • Check motor or encoder wiring using wiring diagnostics.
40 - 57	Reserved		Call your local Allen-Bradley representative.
58	Excess CPU Load	User function(s) inserted into sequencer take too much time.	Remove user function from sequencer or reduce size of user function.
59 - 99	Reserved		Call your local Allen-Bradley representative.

Troubleshooting for DeviceNet Drives

DeviceNet Module Status LED

Use the table below for troubleshooting the DeviceNet Module Status LED on your Ultra5000 (2098-IPD-*xxx*-DN, or -HV*xxx*-DN).

If the Module Status LED is:	Status is:	Potential Cause is:	Possible Resolution is:
Off	Not powered	No power	There is no power going to the device.
Steady-Green	Operational	Normal operation	Normal operation - no action needed.
Flashing-Green	Device is in stand-by	Processing or waiting for input	Normal operation - no action needed.
Flashing-Red	Recoverable fault	Not operational	Power cycle or reset the drive.
Steady-Red	Unrecoverable fault	Drive problem	Check drive for power-up error. Replace drive.
Flashing-Red/ Green	Self testing	Self-test in progress	The device is in self test, wait.

DeviceNet Network Status LED

Use the table below for troubleshooting the DeviceNet Network Status LED on your Ultra5000 (2098-IPD-*xxx*-DN, or -HV*xxx*-DN).

If the Network Status LED is:	Status is:	Potential Cause is:	Possible Resolution is:
Off	• Not powered • Not on-line	• No power going to the device • Failed Duplicate MAC ID check	1. Check the Module Status LED to verify that the drive is powered. 2. Check that one or more nodes are communicating on the network. 3. Check that at least one other node on the network is operational and the data rate is the same as the drive.
Flashing-green	• On-line • Not connected	• Passed Duplicate MAC ID check • No connection established	No action is needed. The LED is flashing to signify that there are no open communication connections between the drive and any other device. Any connection (I/O or explicit message) made to the drive over DeviceNet will cause the LED to stop flashing and remain Steady-ON for the duration of any open connection.
Steady-green	• On-line • Connected	One or more connections established	No action needed. This condition is normal.
Flashing-red	• On-line • Time-out	I/O connection timed out	1. Re-initiate I/O messaging by the master controller. 2. Reduce traffic or errors on the network so that messages can get through within the necessary time frame.
Steady-red	Network Failure	• Failed Duplicate MAC ID check • Bus-off	1. Ensure that all nodes have unique addresses. 2. If all node addresses are unique, examine network for correct media installation. 3. Ensure that all nodes have the same Data Rate.

Node Problems

Give particular attention to the task of setting initial addresses and data rates. Survey the network to ensure all assignments are known. Some nodes can be logically assigned to a group of devices, but physically located away from those devices. One incorrect node can cause other nodes to appear to be Bus-off (Steady-Red LED). If a node goes Bus-off and the device is reset only to go Bus-off again, the problem is likely not with the device, but rather the setting of the address, data rate, or a network-wide problem related to topology, grounding, intermittent power/data connections, or electrical noise. If a scanner goes Bus-off, nodes will not reallocate (Flashing-green or red) even if they are functioning correctly.

Device Failure - LED Status Check

A Steady-Red Module Status LED can mean an error. If the Network Status LED goes Steady-Red at power-up, it could mean there is a Duplicate MAC ID. The user response is to test all devices for unique addresses. If a Steady-Red LED remains on after the Duplicate MAC ID test shows all devices to have a unique node address, it means a Bus-off error. Do the following:

1. Check data rate settings.
2. If symptom persists, replace node address (with another address and correct data rate).
3. If symptom persists, replace tee tap.
4. If symptom persists, check topology.
5. If symptom persists, check power for noise with oscilloscope or power disturbance analyzer.

Scanner Problems

If using a scanner, check the scan list, data rate, and addresses of devices. Verify series and revision of the scanner is the latest. If the scanner is Bus-off, recycle the 24V supply and then reset the scanner. If the scanner goes Bus-off again, the problem is some combination of:

- Defective node device
- Incorrect node data rate
- Bad network topology
- Faulty wiring
- Faulty scanner
- Faulty power supply
- Bad grounding
- Electrical noise

Power Supply Problems

If a single power supply is used, add up the current requirements of all devices drawing power from the network. This total should be considered the minimum current rating in selecting the power supply used. In addition check the:

- Length and current level in trunk and drop cables
- Size and length of the cable supplying power to the trunk
- Voltage measured at the middle and ends of the network
- Noise in network power measured with an oscilloscope

Cable Installation and Design Problems

Cable installation and design refers to the physical layout and connections on the network. Walk the network if possible to determine the actual layout and connections. Network management software displays only a logical record of the network. Ensure that you have a diagram of the physical layout and a record of the information from the tables below.

Cable Checks
Number of nodes.
Individual drop lengths.
Branched drop length.
Cumulative drop length.
Total trunk length.
Power supply cable length and gauge.
Terminator locations and size.

Power Checks
Break the earth ground of the V- and Shield and verify >1.0 Mohm to frame ground with power supply off.
Use a multi-meter to check for short circuit between CAN_H and CAN_L, or CAN (H or L) to Shield, V- or V+.
Total power load and at its distribution points.
Spot check power for noise.

Adjusting the Physical Network Configuration

Ways to improve the efficiency of your physical network configuration include:

- Shortening the overall length of the cable system
- Moving the power supply in the direction of an overloaded cable section
- Moving devices from an overloaded cable section to a less loaded section
- Moving higher current loads closer to the power supply
- Adding another power supply to an overloaded network
- Moving the power supply from the end to the middle of the network

Specifications and Dimensions

Objectives

This appendix covers the following topics:

- Ultra5000 Specifications
- Dimensions

Ultra5000 Specifications

The following sections provide specifications for the Ultra5000.

General Power Specifications

2098-IPD-005-*xx*, -010-*xx*, and -020-*xx*

The table below lists general power specifications and requirements for the Ultra5000 230V drives.

Specification	Description		
	2098-IPD-005, 2098-IPD-005-DN	**2098-IPD-010, 2098-IPD-010-DN**	**2098-IPD-020, 2098-IPD-020-DN**
AC Input Voltage[1]	100-240V_{rms} Single Phase		
AC Input Frequency	47 - 63 Hz		
AC Input Current [2] Nominal Maximum inrush (230V ac input)	5A_{rms} 100A (0-peak)	9A_{rms} 100A (0-peak)	18A_{rms} 100A (0-peak)
Output Peak Current	7.5A (0-peak)	15A (0-peak)	30A (0-peak)
Continuous Output Current	2.5A (0-peak)	5A (0-peak)	10A (0-peak)
Energy Absorption Capability 115V ac input 230V ac input	 125 Joules 51 Joules		
Continuous Power Output 115V ac input 230V ac input	 0.25 kW 0.5 kW	 0.5 kW 1.0 kW	 1.0 kW 2.0 kW

[1] Specification is for nominal voltage. The absolute limits are ±10%, or 88-265V_{rms}.

[2] The 2098-005-*xx*, -010-*xx*, and -020-*xx* (230V) drives are limited to two contactor cycles per minute.

2098-IPD-030-*xx*, -075-*xx*, and -150-*xx*

The table below lists general power specifications and requirements for the Ultra5000 230V drives.

Specification	Description		
	2098-IPD-030, 2098-IPD-030-DN	**2098-IPD-075, 2098-IPD-075-DN**	**2098-IPD-150, 2098-IPD-150-DN**
AC Input Voltage[1]	100-240V_{rms} Single Phase	100-240V_{rms} Three Phase	
AC Input Frequency	47 - 63 Hz		
Main AC Input Current [2] Nominal, Maximum inrush, 230V ac input	 28A_{rms} 50A_{rms}	 30A_{rms} 50A_{rms}	 46A_{rms} 68A_{rms}
Auxiliary AC Input Current Nominal, 115V ac input Nominal, 230V ac input Maximum inrush, 115V ac input [3] Maximum inrush, 230V ac input [3]	 1.0A_{rms} 0.5A_{rms} 47A (0-peak) 95A (0-peak)	 1.0A_{rms} 0.5A_{rms} 47A (0-peak) 95A (0-peak)	 1.0A_{rms} 0.5A_{rms} 47A (0-peak) 95A (0-peak)
Continuous Output Current	15A (0-peak)	35A (0-peak)	65A (0-peak)
Intermittent Output Current	30A (0-peak)	75A (0-peak)	150A (0-peak)
Internal Shunt Continuous power Peak power	 50W 4.5 kW	 50W 10 kW	 180W 18 kW
External Shunt Minimum resistance Continuous power Peak power	 30 Ohms 2.4 kW 6 kW	 16.5 Ohms 4 kW 10 kW	 9 Ohms 8 kW 19 kW
Energy Absorption Capability 115V ac input 230V ac input	 203 Joules 96 Joules	 321 Joules 151 Joules	 563 Joules 265 Joules
Continuous Power Output 115V ac input 230V ac input	 1.5 kW 3 kW	 3.75 kW 7.5 kW	 7.5 kW 15 kW

[1] Specification is for nominal voltage. The absolute limits are ±10%, or 88-265V_{rms}.

[2] The 2098-030-*xx*, -075-*xx*, and -150-*xx* (230V) drives are limited to two contactor cycles per minute.

[3] 400 μs half wave sine, inrush current is processor controlled via soft start circuitry.

2098-IPD-HV030-*xx*, -HV050-*xx*, -HV100-*xx*, -HV150-*xx*, and -HV220-*xx*

The table below lists general power specifications and requirements for the Ultra5000 460V drives.

Specification	Description				
	2098-IPD-HV030 and 2098-IPD-HV030-DN	**2098-IPD-HV050 and 2098-IPD-HV050-DN**	**2098-IPD-HV100 and 2098-IPD-HV100-DN**	**2098-IPD-HV150 and 2098-IPD-HV150-DN**	**2098-IPD-HV220 and 2098-IPD-HV220-DN**
AC Input Voltage [1, 2]	230-480V_{rms} Three Phase				
AC Input Frequency	47 - 63 Hz				
Main AC Input Current [3] Nominal, 460V ac input Maximum inrush, 460V ac input	 4A_{rms} 6A_{rms}	 7A_{rms} 6A_{rms}	 14A_{rms} 6A_{rms}	 20A_{rms} 6A_{rms}	 28A_{rms} 6A_{rms}
Auxiliary AC Input Current Nominal, 230V ac input Nominal, 360V ac input Nominal, 480V ac input Maximum inrush, 230V ac input [4] Maximum inrush, 480V ac input [4]	 0.55A_{rms} 0.35A_{rms} 0.25A_{rms} 47A (0-peak) 68A (0-peak)	 0.55A_{rms} 0.35A_{rms} 0.25A_{rms} 47A (0-peak) 68A (0-peak)	 0.55A_{rms} 0.35A_{rms} 0.25A_{rms} 47A (0-peak) 68A (0-peak)	 0.55A_{rms} 0.35A_{rms} 0.25A_{rms} 47A (0-peak) 68A (0-peak)	 0.55A_{rms} 0.35A_{rms} 0.25A_{rms} 47A (0-peak) 68A (0-peak)
Continuous Output Current	7A (0-peak)	11A (0-peak)	23A (0-peak)	34A (0-peak)	47A (0-peak)
Intermittent Output Current	14A (0-peak)	22A (0-peak)	46A (0-peak)	68A (0-peak)	94A (0-peak)
Internal Shunt Continuous power Peak power	 100W 5.3 kW	 100W 5.3 kW	 200W 16 kW	 200W 25.6 kW	 400W 32 kW
External Shunt Minimum resistance Continuous power Peak power	 120 Ohms 3 kW 5.3 kW	 120 Ohms 5 kW 5.3 kW	 40 Ohms 10 kW 16 kW	 25 Ohms 15 kW 25.6 kW	 20 Ohms 22 kW 32 kW
Energy Absorption Capability 230V ac input with 230V motor 230V ac input with 460V motor 460V ac input	 58 Joules 517 Joules 219 Joules	 58 Joules 517 Joules 219 Joules	 88Joules 776Joules 329 Joules	 117 Joules 1034 Joules 439 Joules	 234 Joules 2069 Joules 878Joules
Continuous Power Output 230V ac input 460V ac input	 1.5 kW 3.0 kW	 2.5 kW 5.0 kW	 5.0 kW 10 kW	 7.5 kW 15 kW	 11 kW 22 kW

1 Specification is for nominal voltage. The absolute limits are ±10%, or 207-528V_{rms}.
2 The 2098-IPD-HVxxx-xx drives can be powered with 230-240 Vrms in order to be used in conjunction with motors designed for 230V operation. In such cases, the voltage levels used for shunting and DC bus overvoltage limits are adjusted to be compatible with the voltage limit of the motor.
3 The 2098-HV*xxx -xx* (460V) drives are limited to three contactor cycles per minute.
4 400 μs half wave sine, inrush current is processor controlled via soft start circuitry.

Physical and Environmental

The table below lists physical and environmental specifications and requirements.

Specification	Description	
Weight	Kg	Lbs
2098-IPD-005	1.77	(3.9)
2098-IPD-010	2.07	(4.55)
2098-IPD-020	2.05	(4.51)
2098-IPD-030	6.16	(13.58)
2098-IPD-075	9.23	(20.35)
2098-IPD-150	13.96	(30.78)
2098-IPD-005-DN	2.11	(4.7)
2098-IPD-010-DN	2.41	(5.3)
2098-IPD-020-DN	2.39	(5.3)
2098-IPD-030-DN	6.55	(14.43)
2098-IPD-075-DN	9.62	(21.20)
2098-IPD-150-DN	14.35	(31.63)
2098-IPD-HV030	8.55	(18.8)
2098-IPD-HV050	8.55	(18.8)
2098-IPD-HV100	10.44	(22.96)
2098-IPD-HV150	10.44	(22.96)
2098-IPD-HV220	14.1	(31.0)
2098-IPD-HV030-DN	8.89	(19.6)
2098-IPD-HV050-DN	8.89	(19.6)
2098-IPD-HV100-DN	10.78	(23.72)
2098-IPD-HV150-DN	10.78	(23.72)
2098-IPD-HV220-DN	14.44	(31.77)
Operating Temperature	0^{o} C to 55^{o} C (32^{o} F to 131^{o} F)	
Storage Temperature	-40^{o} C to 70^{o} C (-40^{o} F to 158^{o} F)	
Humidity	5% to 90% non-condensing	
Altitude	1500 m (5000 ft) Derate 3% for each 300 m above 1500m	
Vibration Operating/Non-operating	10 to 2000 Hz, 2 g peak, 0.015 in. maximum displacement	
Shock Non-operating	15 g 11 ms half sine	
UL Listed to U.S. and Canadian safety standards	UL 508 C File E145959	

Power Dissipation

The maximum power losses Ultra5000 are shown below to help in sizing an enclosure and any required ventilation. Typical heat losses can run approximately one-half maximum power losses.

Catalog Number	Maximum Loss (Watts)
2098-IPD-005, 005-DN	48 + dissipative shunt
2098-IPD-010, -010-DN	48 + dissipative shunt
2098-IPD-020, -020-DN	50 + dissipative shunt
2098-IPD-030, -030DN	150 + dissipative shunt
2098-IPD-075, -075DN	300 + dissipative shunt
2098-IPD-150, -150DN	500 + dissipative shunt
2098-IPD-HV030, -030-DN	175 + dissipative shunt
2098-IPD-HV050, -050-DN	175 + dissipative shunt
2098-IPD-HV100, -100-DN	350 + dissipative shunt
2098-IPD-HV150, -150-DN	350 + dissipative shunt
2098-IPD-HV220, -220-DN	600 + dissipative shunt

User Programming

The table below lists physical and programming specifications.

Specification	Description
Language	Compiled ANSI C subset with Library of Motion Functions
Programming Environment	Full-featured Color Syntax Editor and C Compiler Integrated with Ultraware
Operating System	Real-time, multi-tasking, field upgradable flash
User Program Memory	512 Kbytes
	Flash Memory, 100,000 Write Cycles
Non-Volatile Memory	16 Kbytes (approximately 4000 non-volatile user variables)
	nvSRAM (High speed SRAM/EEPROM)

Control

The table below lists control specifications.

Specification	Description
Processor	Texas Instruments TMS320C32 32 Bit Floating Point Digital Signal Processor
Clock Speed	60 MHz
Commutation	3 Phase Sinusoidal, Space Vector Modulated (SVM)
Current Loop	SVM - 125 µsec update rate
Velocity Loop	Digital PI - 250 µsec update rate
Position Loop	Digital PI - 500 µsec update rate
Position Range	32-bit signed
Velocity Range	32-bit floating point
Acceleration Range	32-bit floating point
Electronic Gearing	64-bit signed

Inputs and Outputs

The table below lists I/O specifications.

Specification	Description
General Purpose Digital Inputs	16 Optically Isolated 12-24 Volt Inputs
Inputs/Outputs - Sinking/Sourcing Selection	Software Selectable as a Group to be Active High, Current Sinking or Active Low, Current Sourcing
General Purpose Digital Outputs	7 Optically Isolated 12-24 Volt Outputs - 50 Milliamperes Maximum
General Purpose Relay Output	1 Normally Open Relay - 30 Volts dc Maximum, 1A Maximum Current
General Purpose I/O Response	100 µsec
High Speed Input Response	< 1 µsec (Inputs 1 and 2)
Position Capture Response	< 1 µsec (Input 1, Input 2, Motor Encoder Index, and Auxiliary Encoder Index)
General Purpose Analog Inputs	2 12-Bit Analog to Digital Converters (+/- 10V, single-ended)
General Purpose Analog Outputs	2 12-Bit Digital to Analog Converters (+/- 10V, +/- 2mA, single-ended)

Communications

The table below lists the communication specifications for serial communications and the optional DeviceNet interface.

Specification	Description
Serial:	
Ports	Two RS-232/RS-422/RS-485
Baud Rates	1200, 2400, 4800, 9600, 19200, and 38400 baud
DeviceNet (option):	
Power Consumption from Network	60 mA
Data Rates	125 kps, 250 kps, and 500 kps
Node Addresses	01-63
Messaging Capabilities	Explicit, polled I/O

Motor Feedback

The table below lists motor feedback specifications.

Specification	Description
Encoder Types	Incremental, Sine/Cosine, Intelligent, and Absolute
Maximum Input Frequency	100 kHz (Sine/Cosine Input)
	2.5 MHz (TTL Input) per channel
Commutation Startup	Hall Sensor

Auxiliary Feedback

The table below lists auxiliary feedback specifications.

Specification	Description
Input Modes	A quad B
Input Types	Differential
Maximum Signal Frequency	2.5 MHz

Connectors

The table below lists connector specifications. Refer to *Appendix C* for a list of mating connectors available from other suppliers.

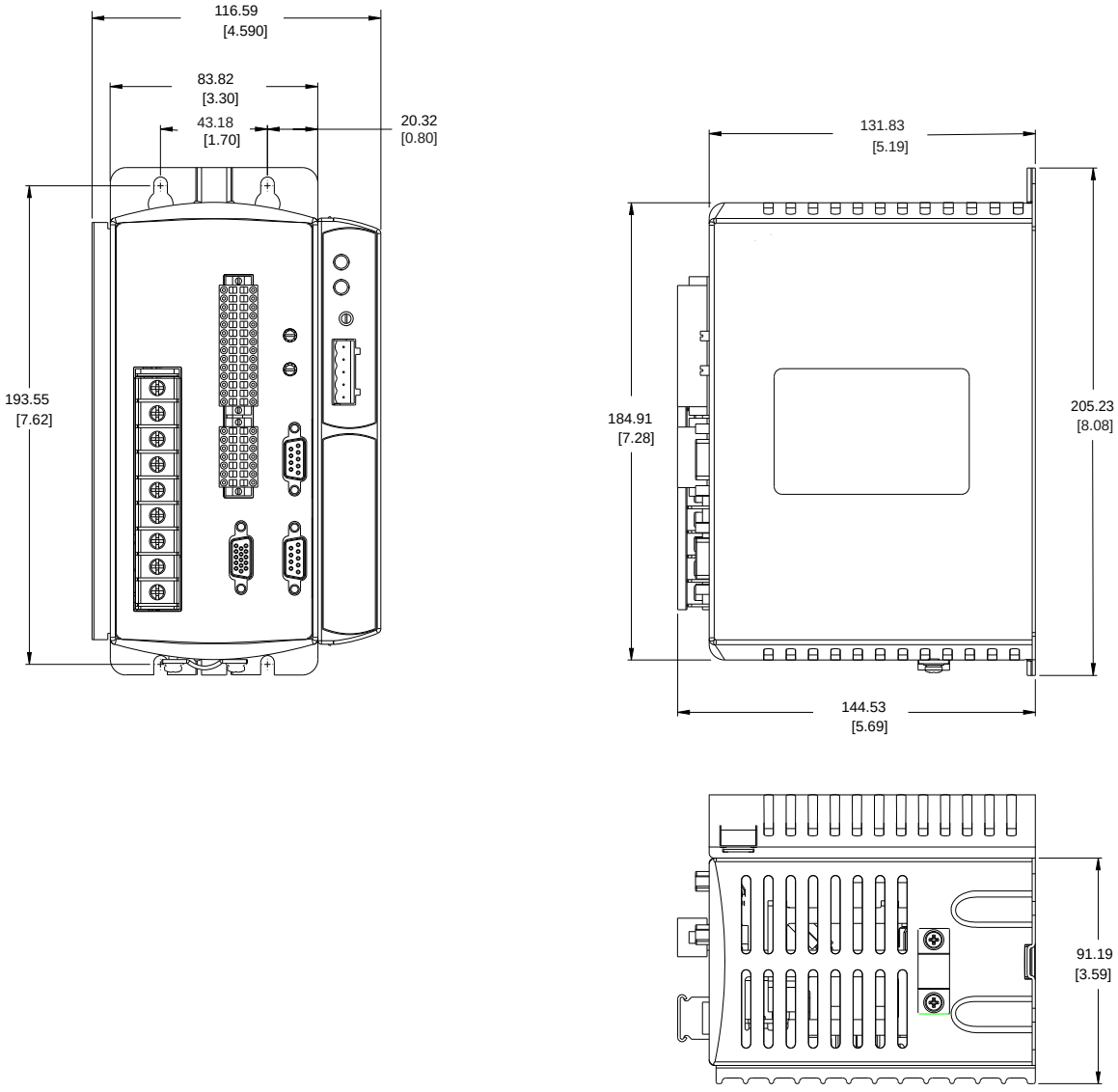
Connector	Specification	Description
CN1A	Digital I/O Connector	28 Position Plugable Spring Clamp Terminal Block
CN1B	Auxiliary Feedback/Analog I/O Connector	14 Position Plugable Spring Clamp Terminal Block
CN2	Motor Feedback Connector	15 Position High Density Female D-Sub Connector
CN3A and CN3B	Serial Port Connectors	9 Position Female D-Sub Connector
TB1 and TB2	Main and Auxiliary AC, DC Bus, Motor Power, and Shunt Connectors	Screw Terminal Block

Dimensions

The following diagrams show the dimensions and mounting hole locations for the Ultra5000 drives.

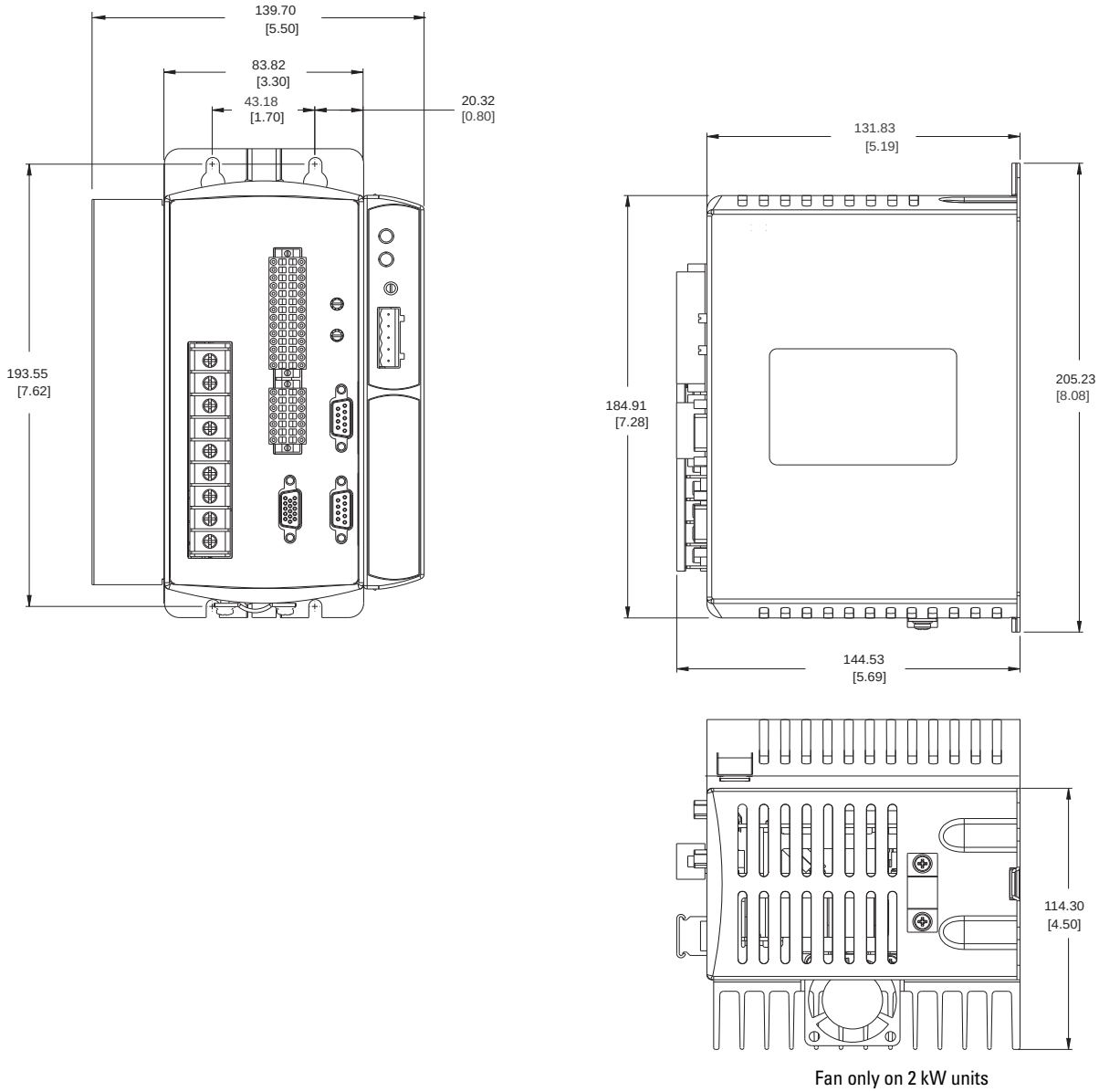
Note: The DeviceNet Interface is an add-on feature available with all Ultra5000 drives. Overall dimensions are provided for each Ultra5000 drive that include and exclude the DeviceNet interface.

Figure A.1
Dimensions and Mounting Diagram
(2098-IPD-005-*xx*)



Note: Inch dimensions are shown in brackets

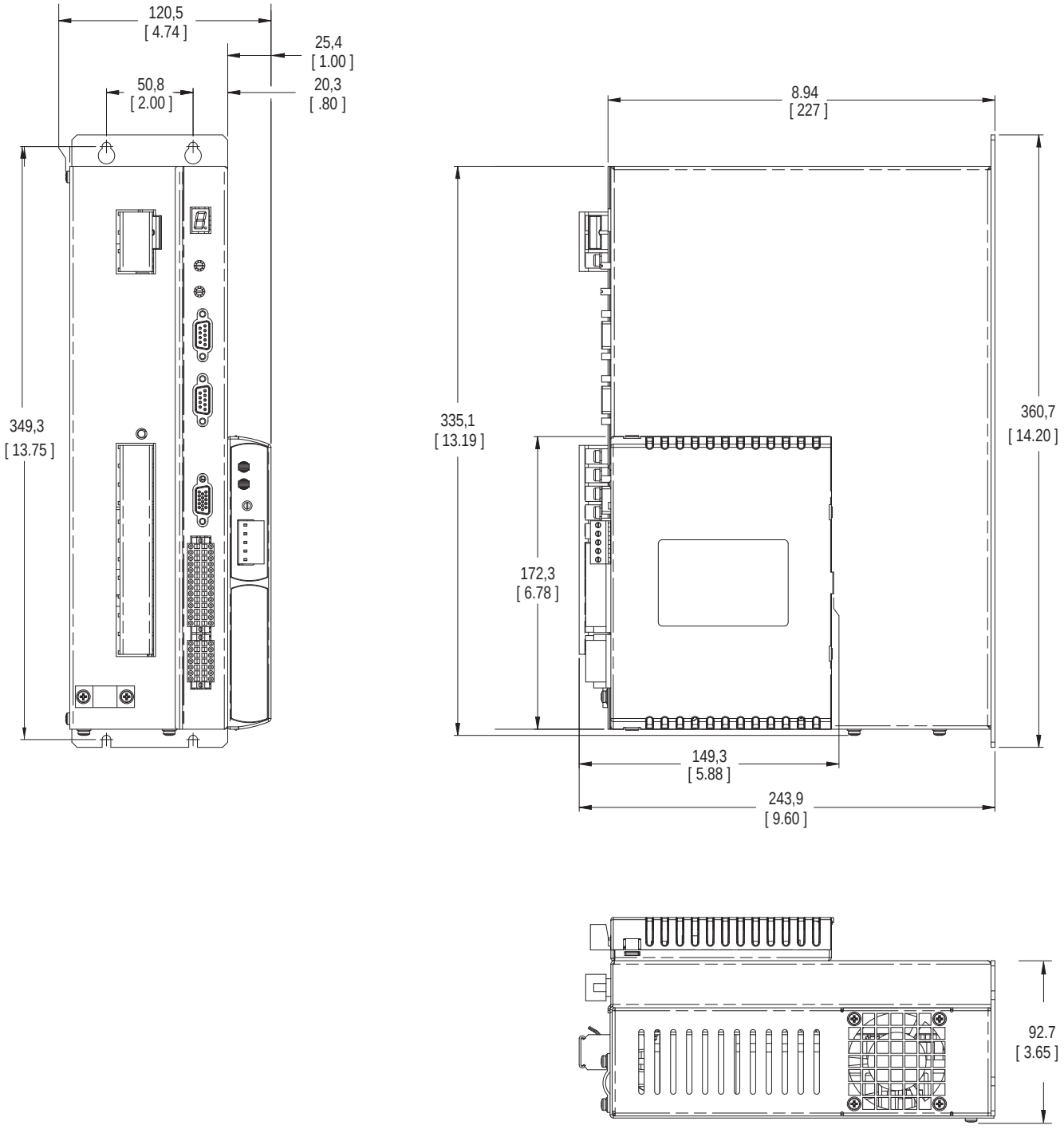
Figure A.2
Dimensions and Mounting Diagram
(2098-IPD-010-*xx* and 2098-IPD-020-*xx*)



Fan only on 2 kW units

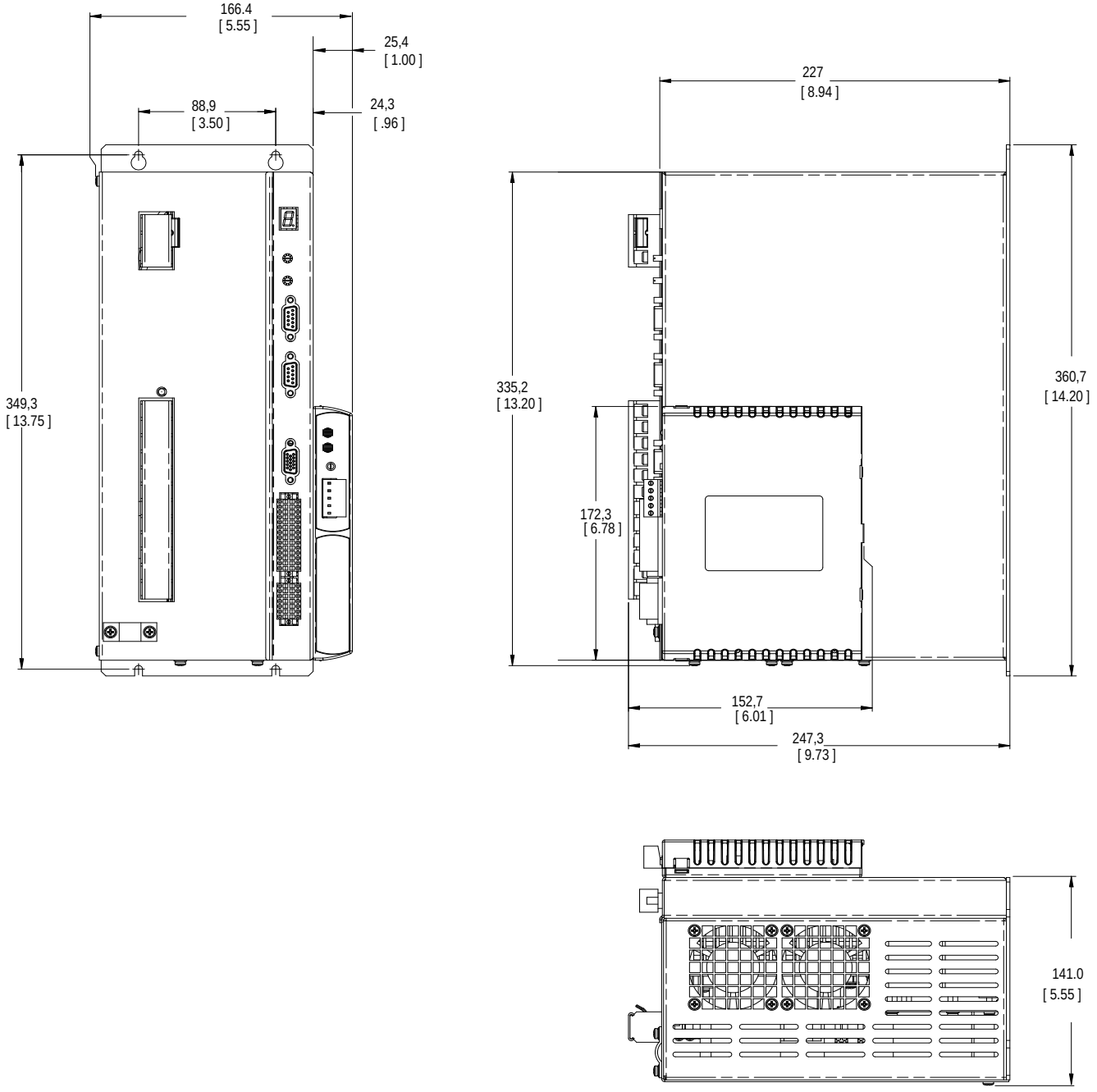
Note: Inch dimensions are shown in brackets

Figure A.3
Dimensions and Mounting Diagram
2098-IPD-030-*xx*



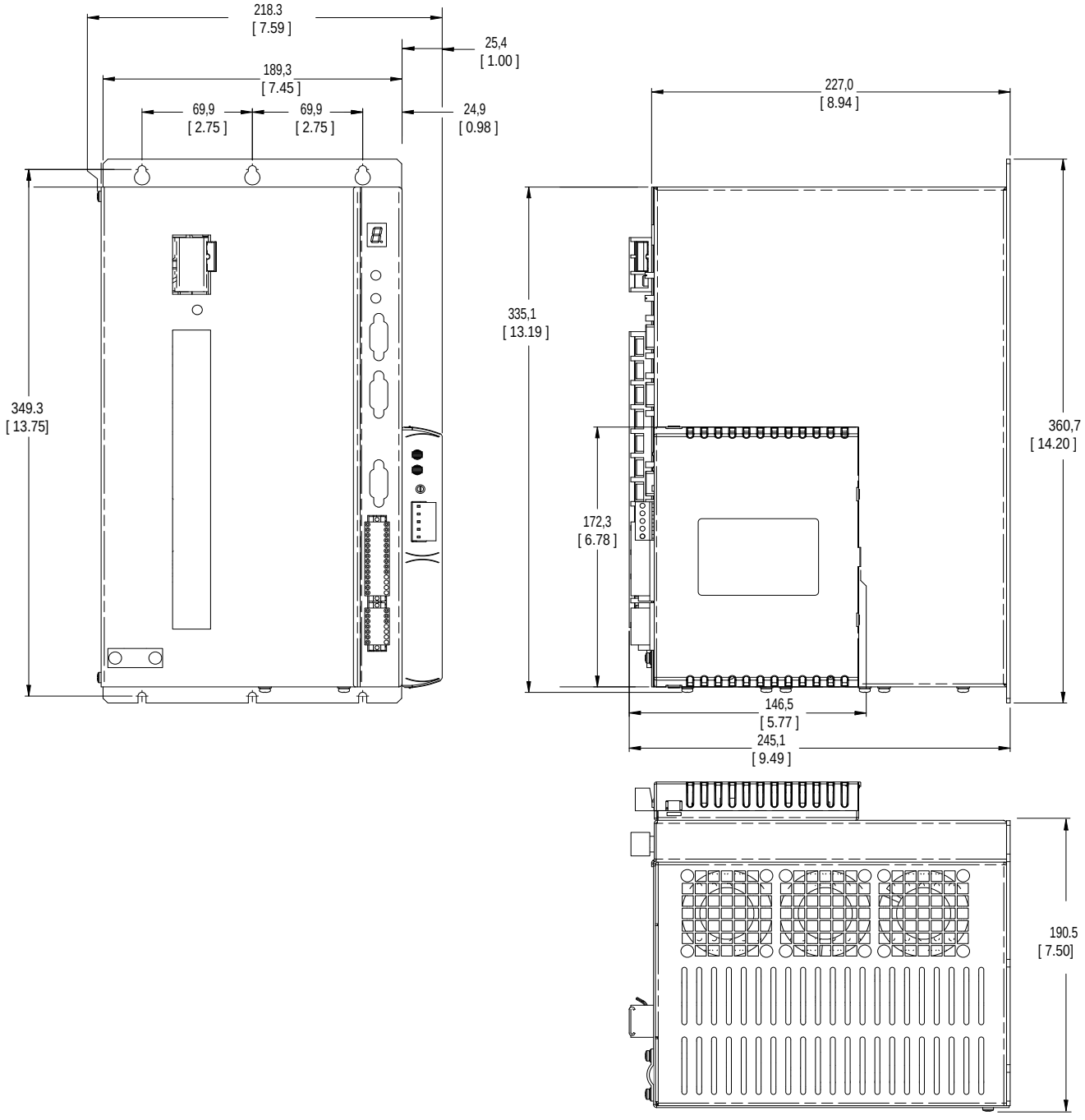
Note: Inch dimensions are shown in brackets

Figure A.4
Dimensions and Mounting Diagram
2098-IPD-075-*xx*



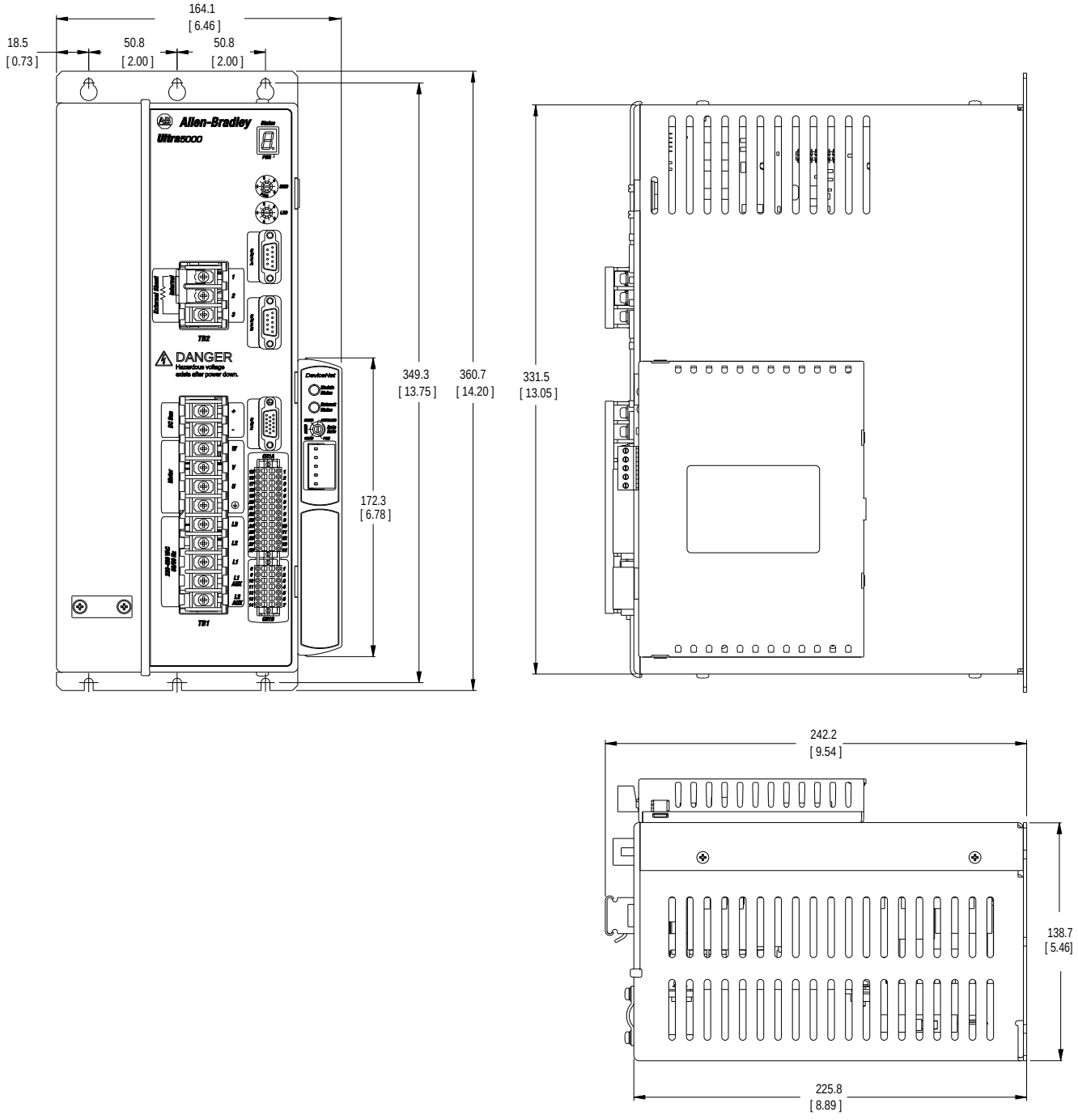
Note: Inch dimensions are shown in brackets

Figure A.5
Dimensions and Mounting Diagram
2098-IPD-150-*xx*



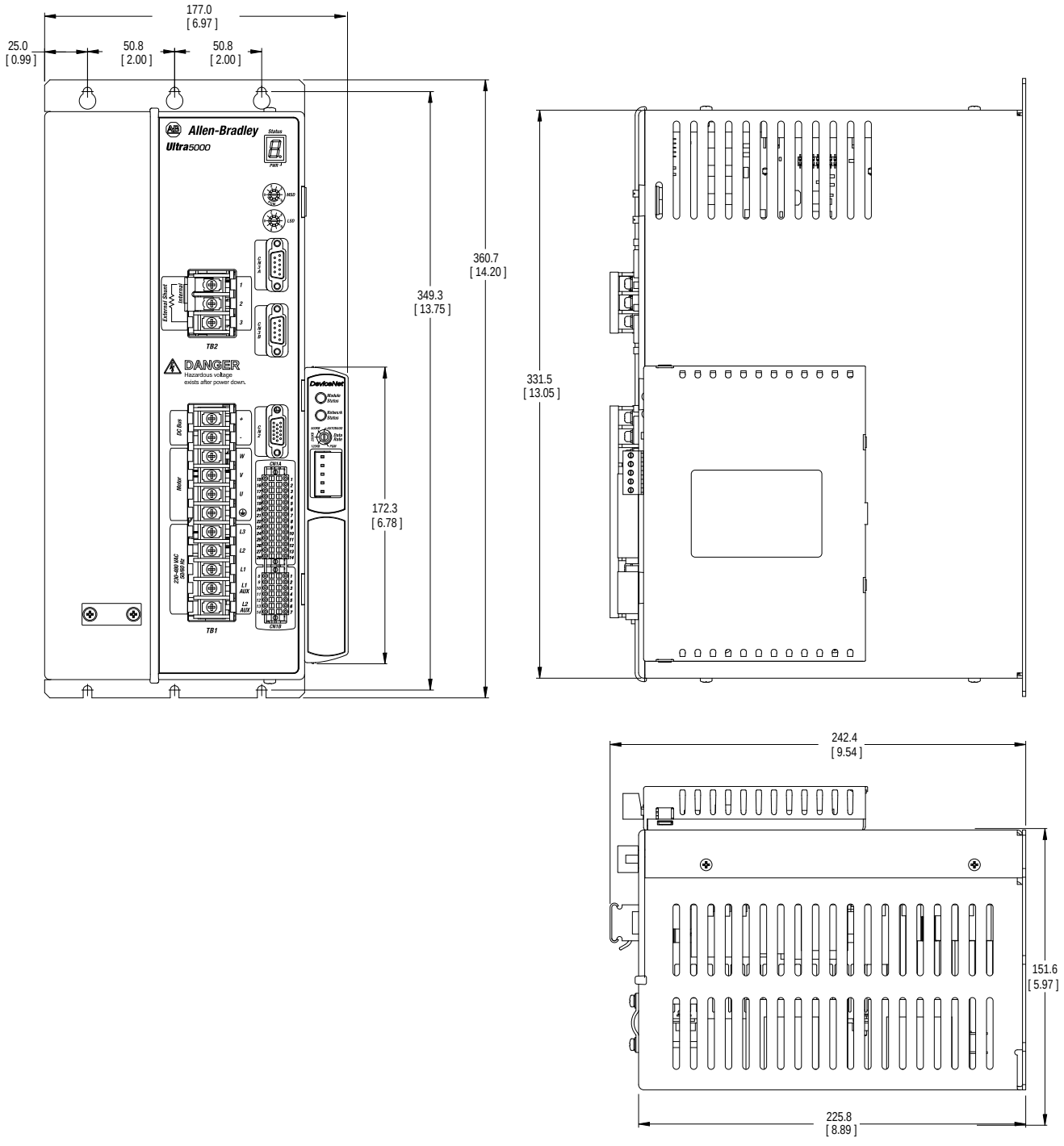
Note: Inch dimensions are shown in brackets

Figure A.6
Dimensions and Mounting Diagram
2098-IPD-HV030-*xx* and 2098-IPD-HV050-*xx*



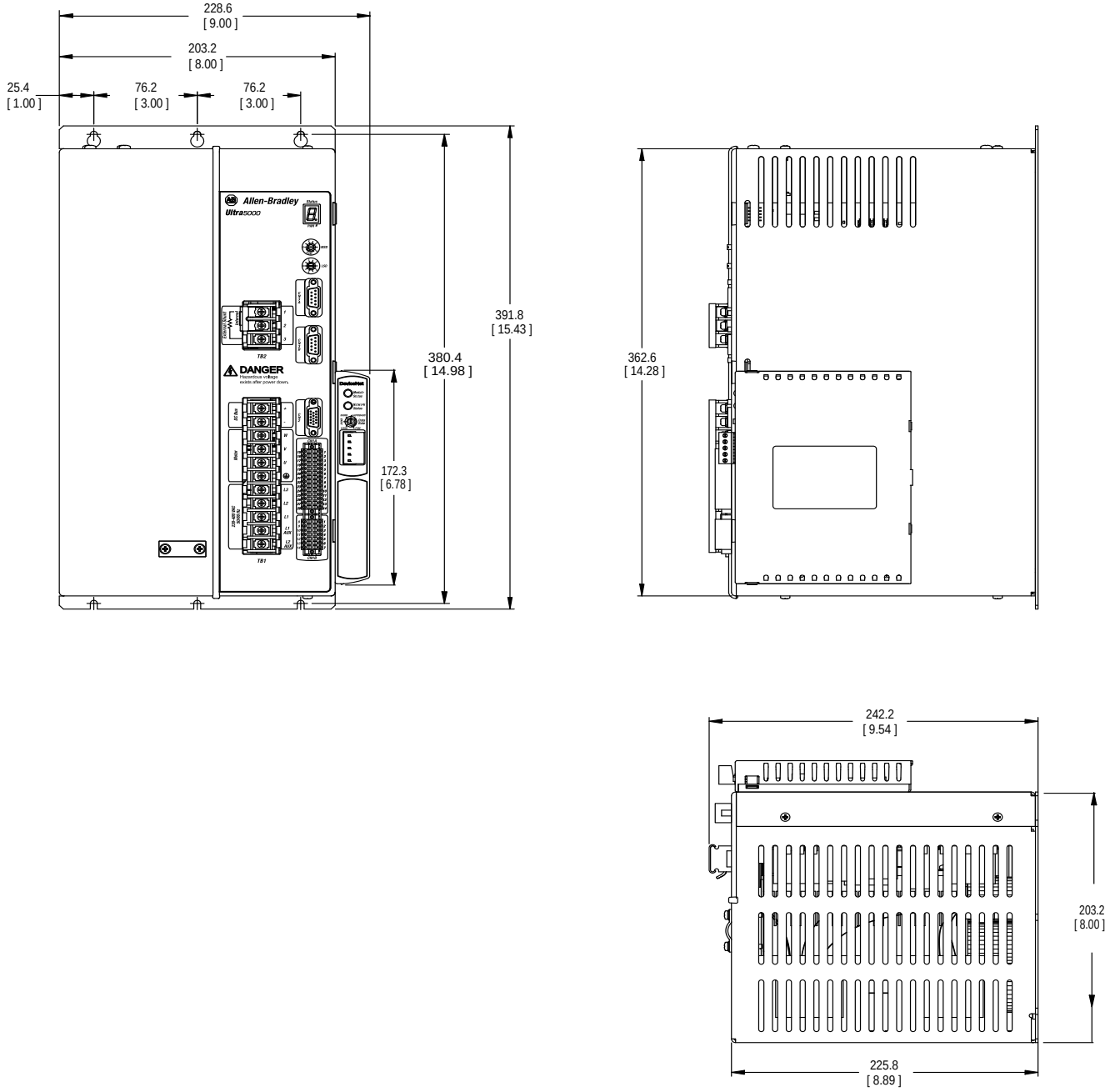
Note: Inch dimensions are shown in brackets

Figure A.7
Dimensions and Mounting Diagram
2098-IPD-HV100-*xx* and 2098-IPD-HV150-*xx*



Note: Inch dimensions are shown in brackets

Figure A.8
Dimensions and Mounting Diagram
2098-IPD-HV220-*xx*



Note: Inch dimensions are shown in brackets

Interconnect Diagrams

Objectives

This appendix contains the following interconnect diagrams:

Ultra5000 and Motor Cable Diagrams

This section provides information to assist you in wiring your MP, N, H/F, W, and Y-Series motors when connecting to your Ultra5000.

Ultra5000 Drive and Motor Cable Combinations

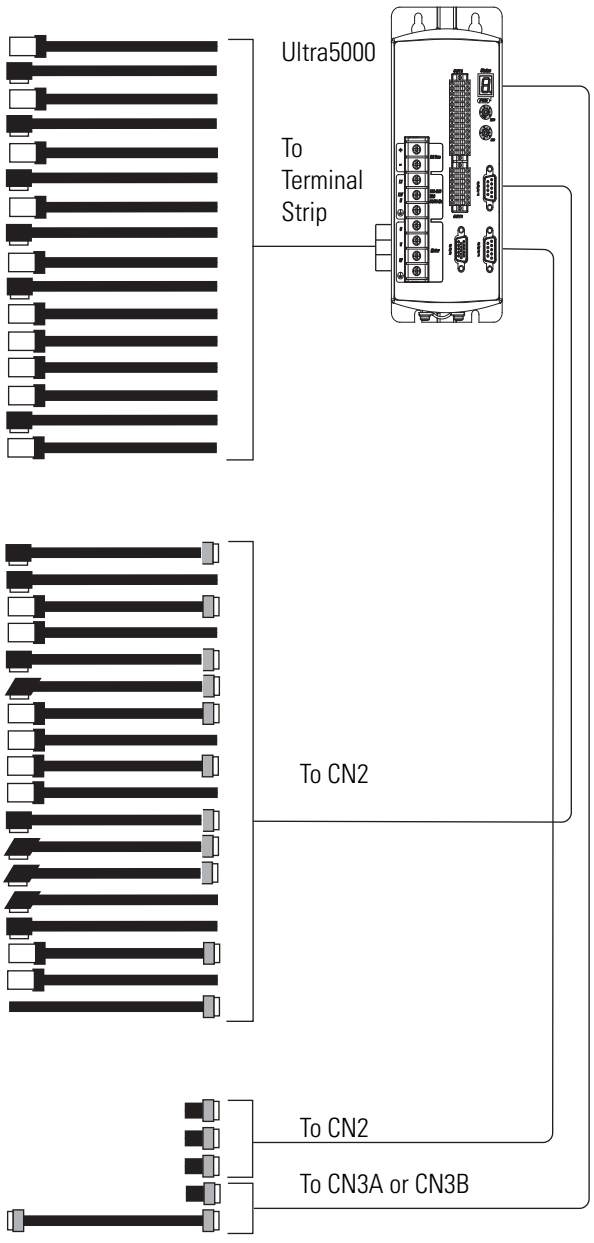
The following figures describe the motor power, feedback, and interface cables you will need for your specific Ultra5000 and motor combination.

Figure B.1
Ultra5000 Motor/Drive Cable Connections

Motor Power Cables	Catalog Number
500W, 1 kW, 2 kW Ultra5000 to H-Series Motors	2090-UXNPAH-16Sxx
500W, 1 kW, 2 kW Ultra5000 to H-Series Motors	2090-UXNPAH-16Rxx
15 kW Ultra5000 to H-Series Motors	2090-UXNPAH-6Sxx
15 kW Ultra5000 to H-Series Motors	2090-UXNPAH-6Rxx
2 or 3 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-14Sxx
2 or 3 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-14Rxx
7.5 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-10Sxx
7.5 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-10Rxx
15 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-8Sxx
15 kW Ultra5000 to H and F-Series Motors	2090-UXNPAHF-8Rxx
500W, 1 kW, 2 kW Ultra5000 to MP-Series Motors	2090-UXNPAMP-16Sxx
2 or 3 kW Ultra5000 to MP-Series Motors	2090-UXNPAMP-14Sxx
7.5 kW Ultra5000 to MP-Series Motors	2090-UXNPAMP-10Sxx
500W, 1 kW, 2 kW Ultra5000 to N-Series Motors	2090-UXNPAN-16Sxx
500W, 1 kW, 2 kW Ultra5000 to N-Series Motors	2090-UXNPAN-16Rxx
500W, 1 kW, 2 kW Ultra5000 to Y-Series Motors	2090-UXNPAY-16Sxx

Feedback Cables	Catalog Number
Ultra5000 CN2 port to H-Series Motors, RA	2090-UXNFBH-Rxx
Flying Leads on drive-end to H-Series Motor, RA	2090-UXNFDH-Rxx
Ultra5000 CN2 port to H and F-Series Motors	2090-UXNFBHF-Sxx
Flying Leads on drive-end to H and F-Series Motor	2090-UXNFDHF-Sxx
Ultra5000 CN2 port to H and F-Series Motors, RA	2090-UXNFBHF-Rxx
Ultra5000 CN2 port to H and F-Series Motors, RA, skewed	2090-UXNFBHF-Kxx
Ultra5000 CN2 port to MP-Series Motors	2090-UXNFBMP-Sxx
Flying Leads on drive-end to MP-Series Motor	2090-UXNFDMP-Sxx
Ultra5000 CN2 port to N-Series Motors	2090-UXNFBN-Sxx
Flying leads on drive-end to N-Series Motors	2090-UXNFDN-Sxx
Ultra5000 CN2 port to N-Series Motors, RA	2090-UXNFBN-Rxx
Ultra5000 CN2 port to N-Series Motors, RA, skewed	2090-UXNFBN-Kxx
Ultra5000 CN2 port to N-Series Motors, RA, skewed	2090-UXNFDN23-Kxx
Flying leads on drive-end to N-Series Motors, RA, skewed	2090-UXNFDN23-Kxx
Flying leads on drive-end to N-Series Motors, RA	2090-UXNFDN-Rxx
Ultra5000 CN2 port to Y-Series Motors	2090-UXNFBY-Sxx
Flying Leads on drive-end to Y-Series Motor	2090-UXNFDY-Sxx
Drive Feedback Cable (CN2) to flying leads, straight	2090-UXNFM-Sxx

Interface Cables and Kits	Catalog Number
Ultra5000 CN2 port drive mounted breakout board	2090-UXBB-DM15
CN2 Breakout Board Kit (see description on page C-8	2090-UXBK-D15xx
CN2 Breakout Board Cable (see description on page C-8	2090-UXBC-D15xx
Ultra5000 CN3 port drive mounted breakout board	2090-UXBB-DM09
Ultra5000 CN3 port to personal computer	2090-UXPC-D09xx



Standard cable lengths are; 01, 03, 09, 15, 30 meters (3.3, 9.8, 29.5, 49.2, 98.5 ft). Where xx is the length in meters.
2090-UXBC-D15xx *is* limited to 1, 3, 9 or 15 meters (3.3, 9.8, 29.5, or 49.2 ft).
e.g., Length of 2090-UXBB-DM15 is a fixed 15 meters (listed as Ultra5000 CN2 port drive mounted breakout board under Interface Cables and Kits).

Ultra5000 to Motor Interconnect Diagrams

Figure B.2
Ultra5000 to 1326AB-B*xxxx*-M2L or -S2L Motor Configuration (mating connector)

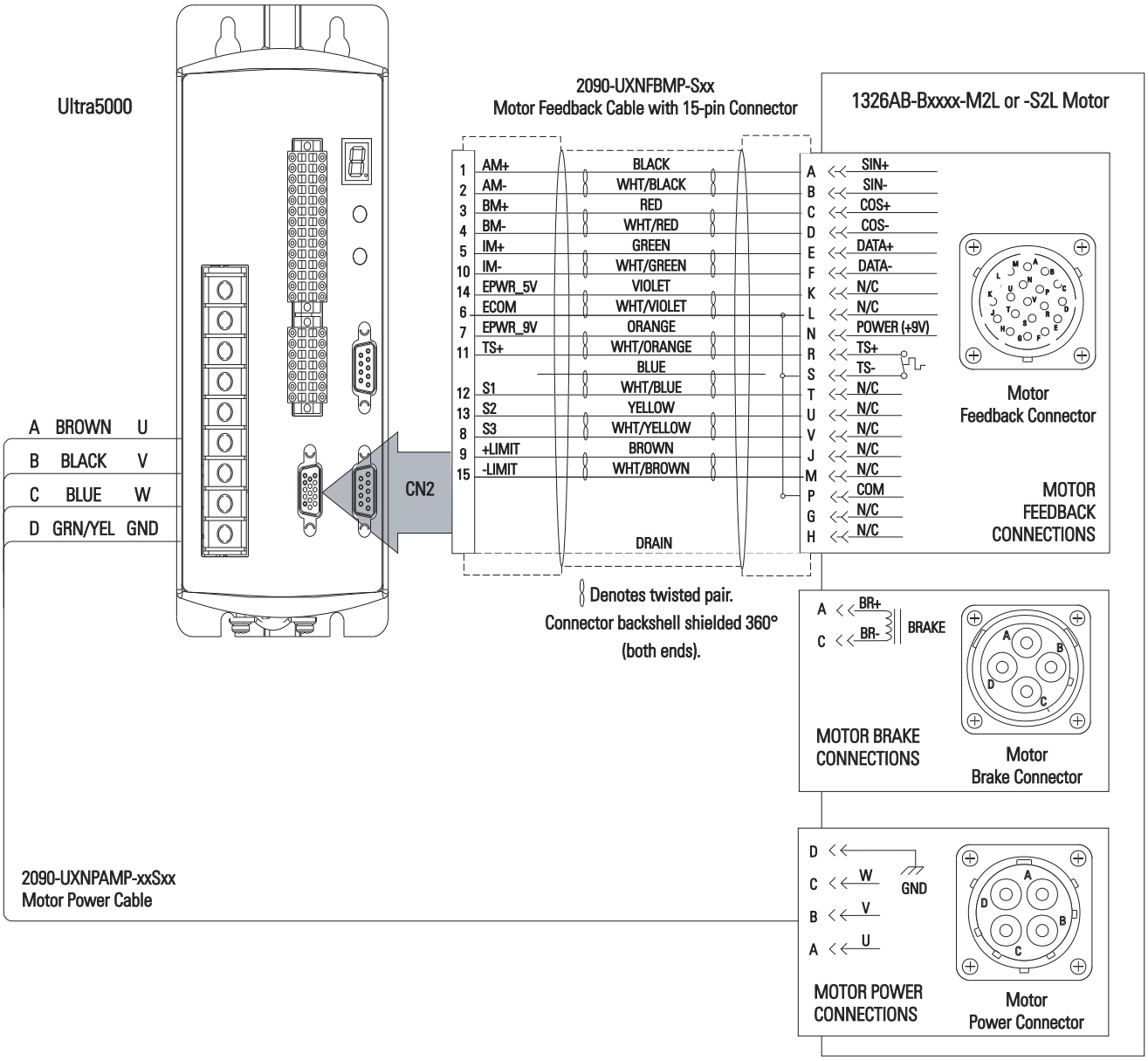


Figure B.3
Ultra5000 to 1326AB-B*xxxx*-M2L or -S2L Motor Configuration (flying leads)

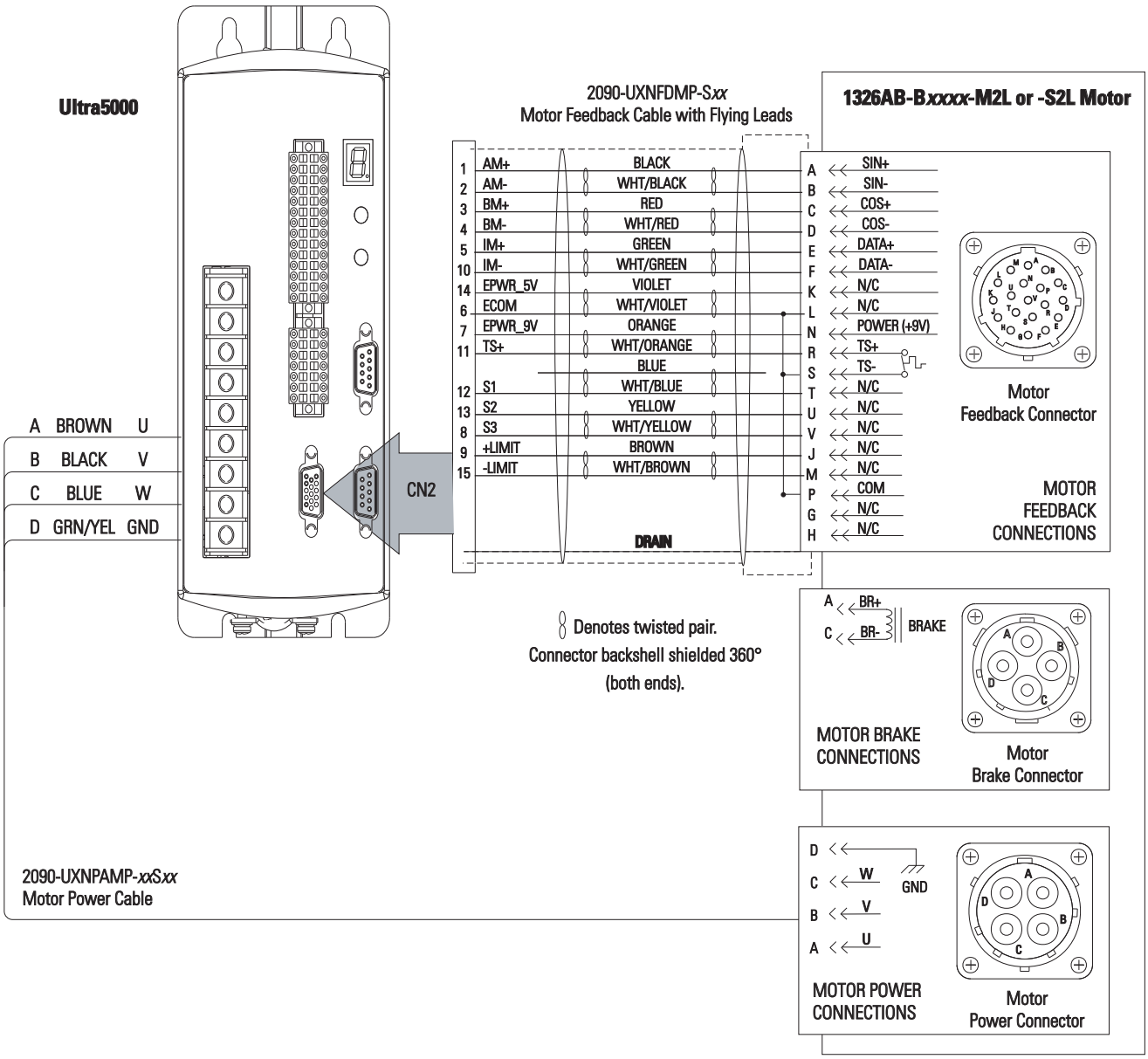


Figure B.4
Ultra5000 to MP-Series Motor Configuration (mating connector)

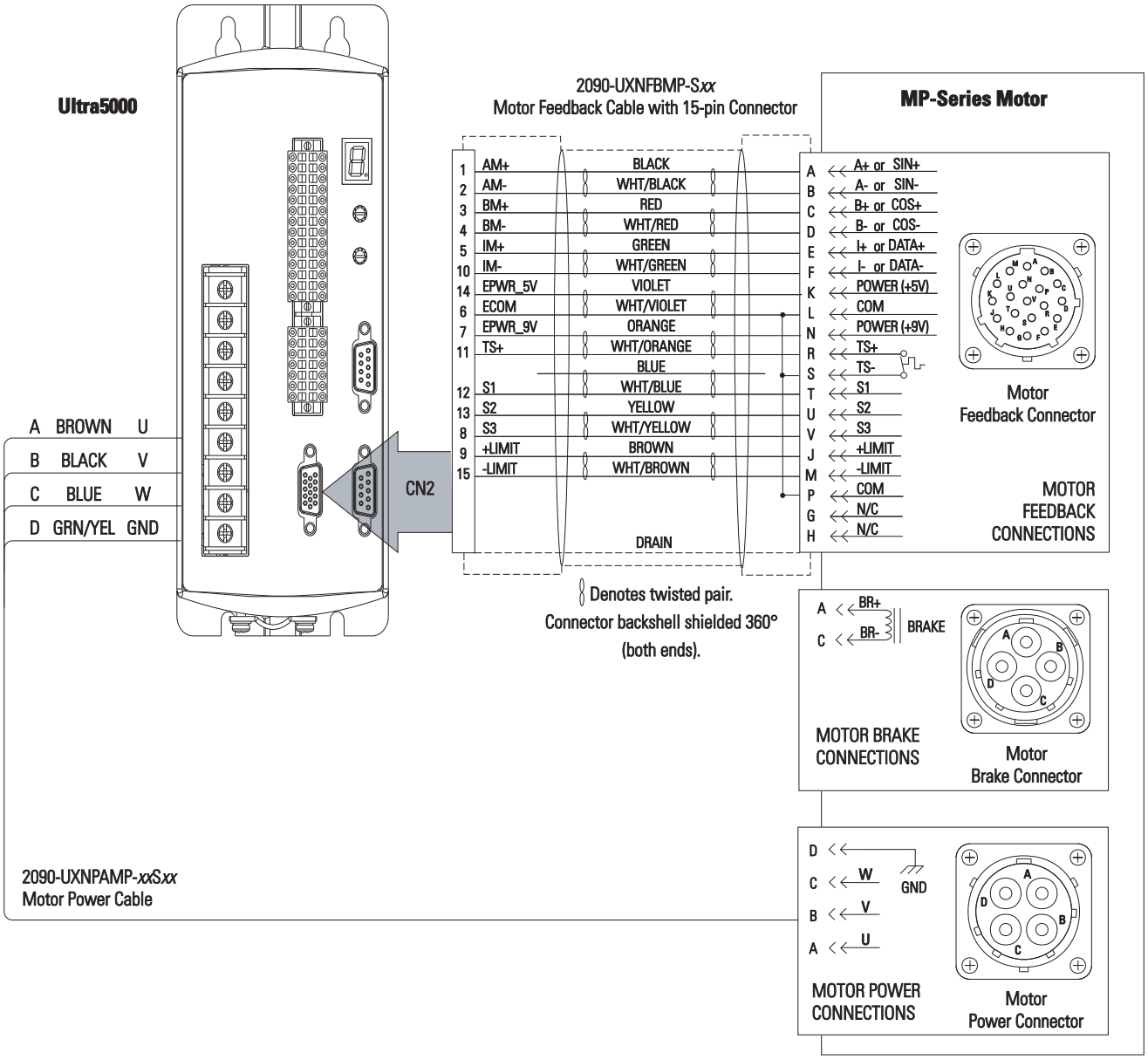


Figure B.5
Ultra5000 to MP-Series Motor Configuration (flying leads)

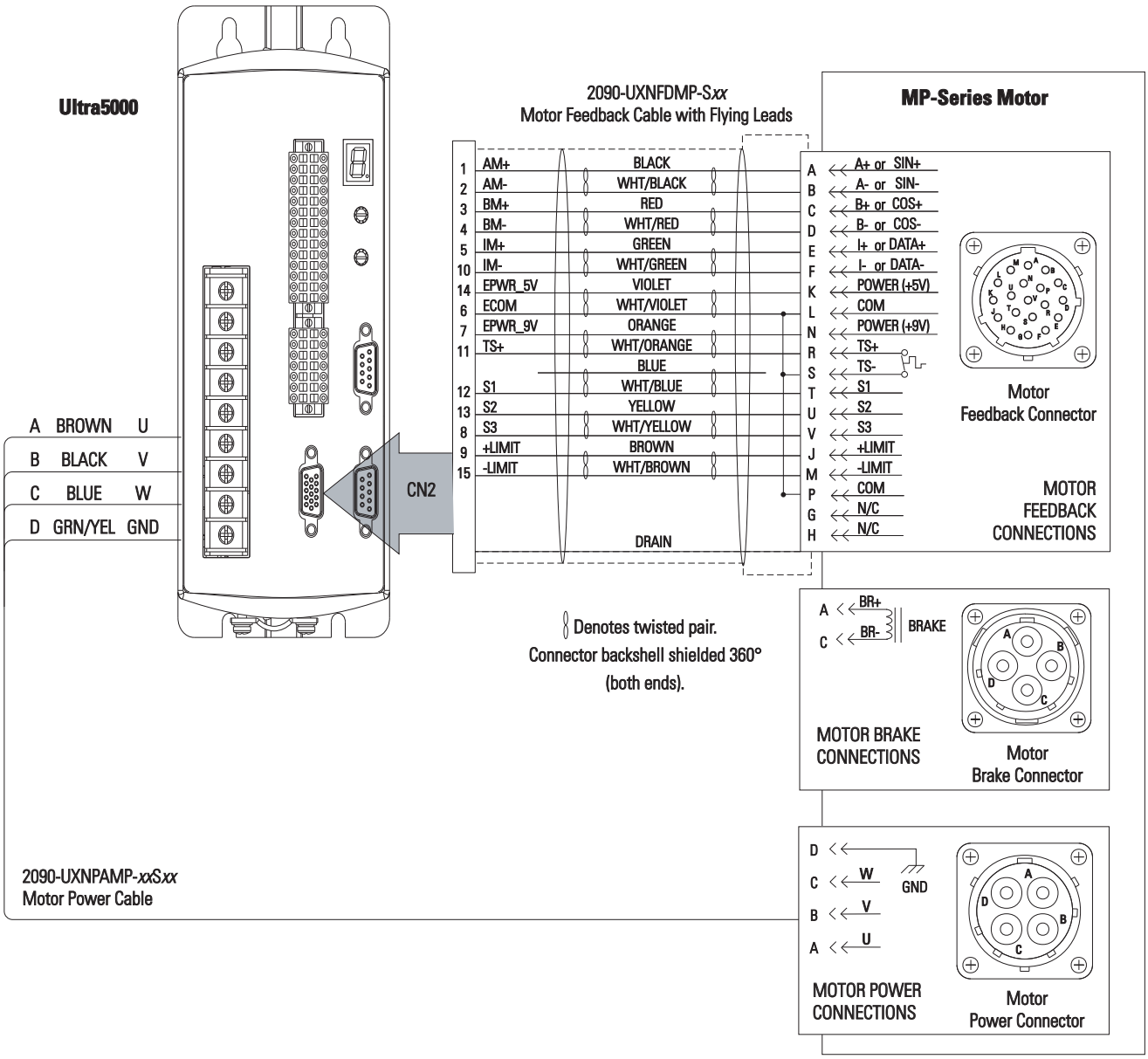


Figure B.6
Ultra5000 to N-Series Motor Configuration (mating connector)

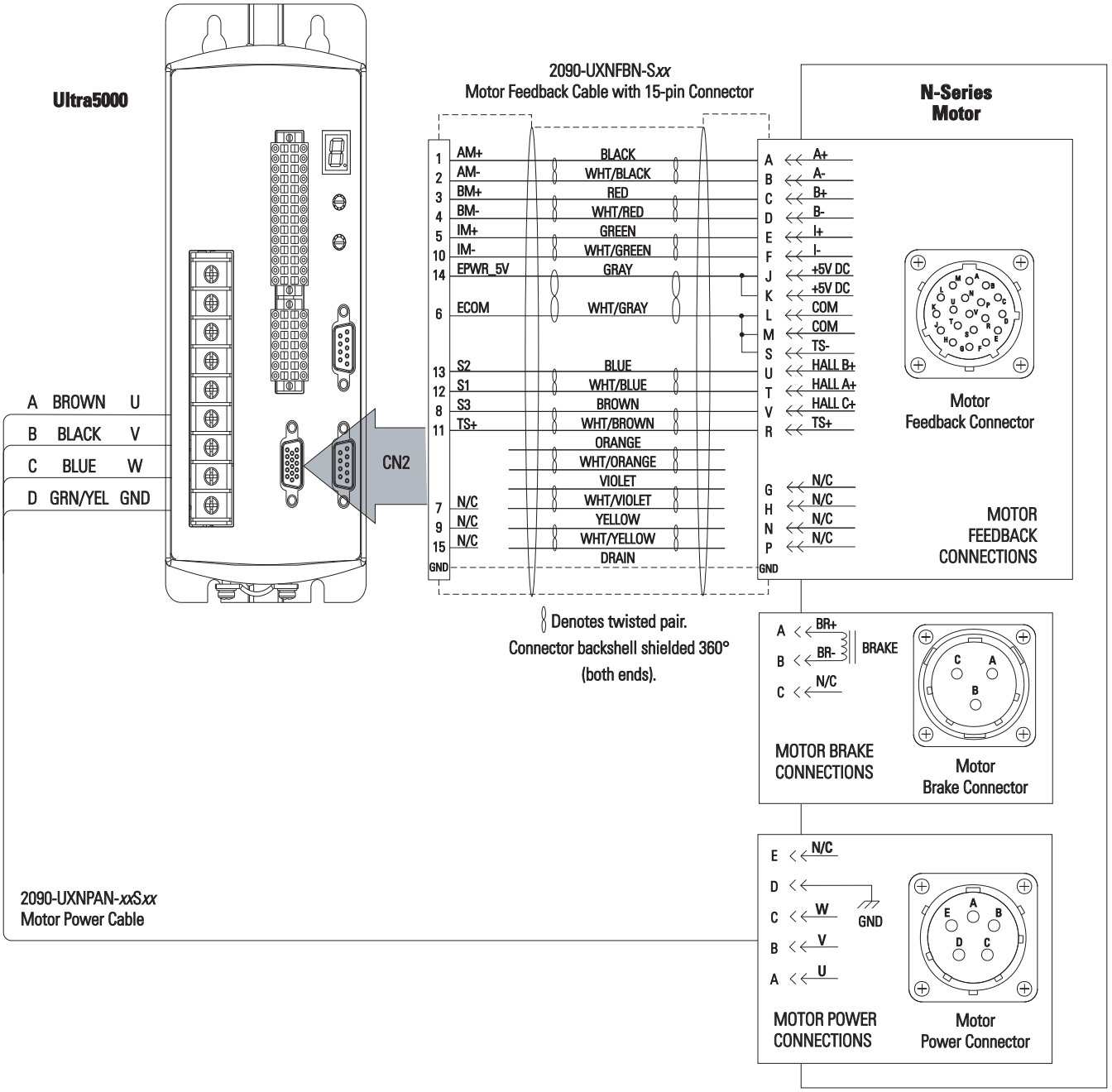


Figure B.7
Ultra5000 to N-Series Motor Configuration (flying leads)

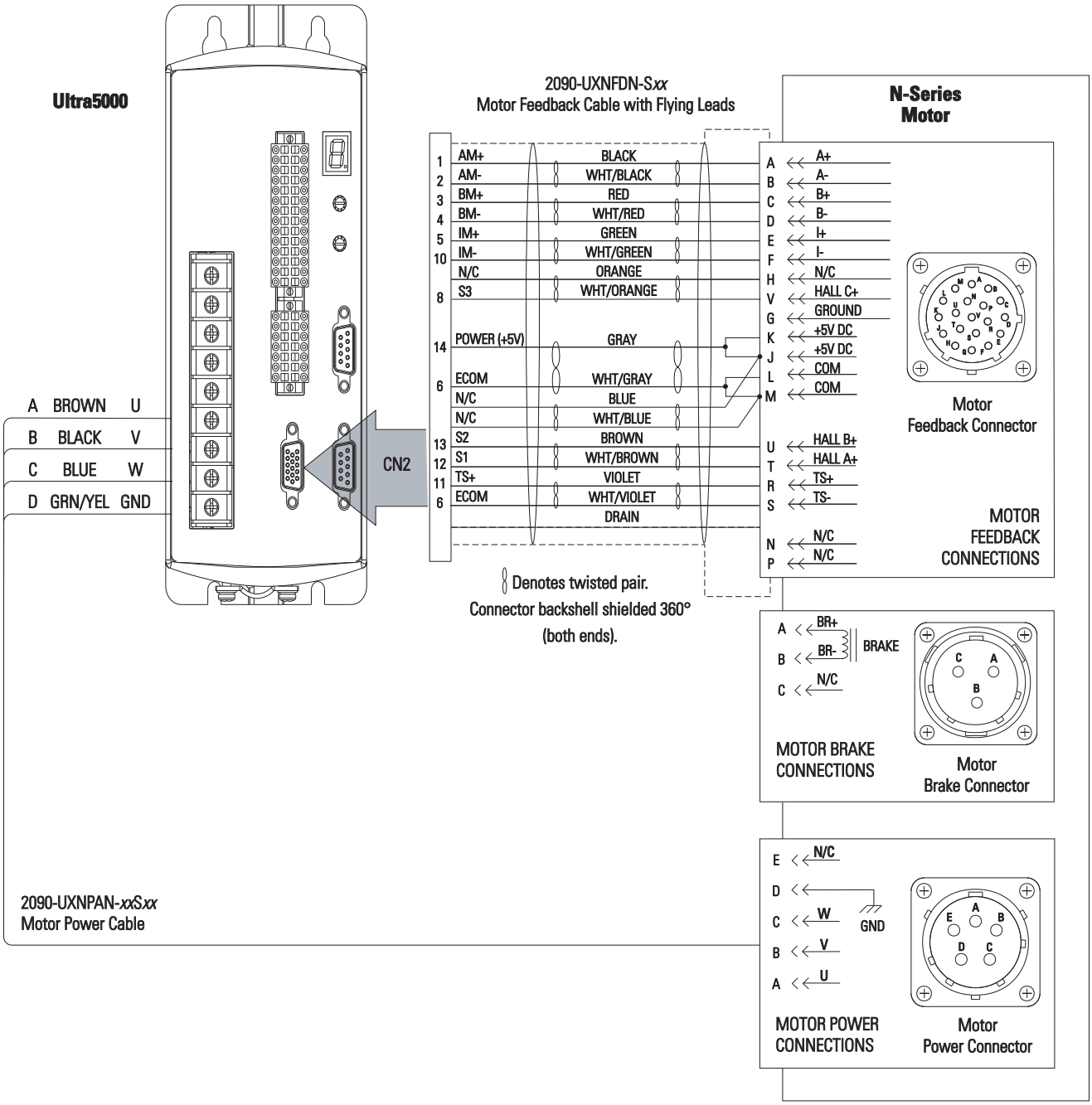


Figure B.8
Ultra5000 to H-, and F-Series Motor Configuration (mating connector)

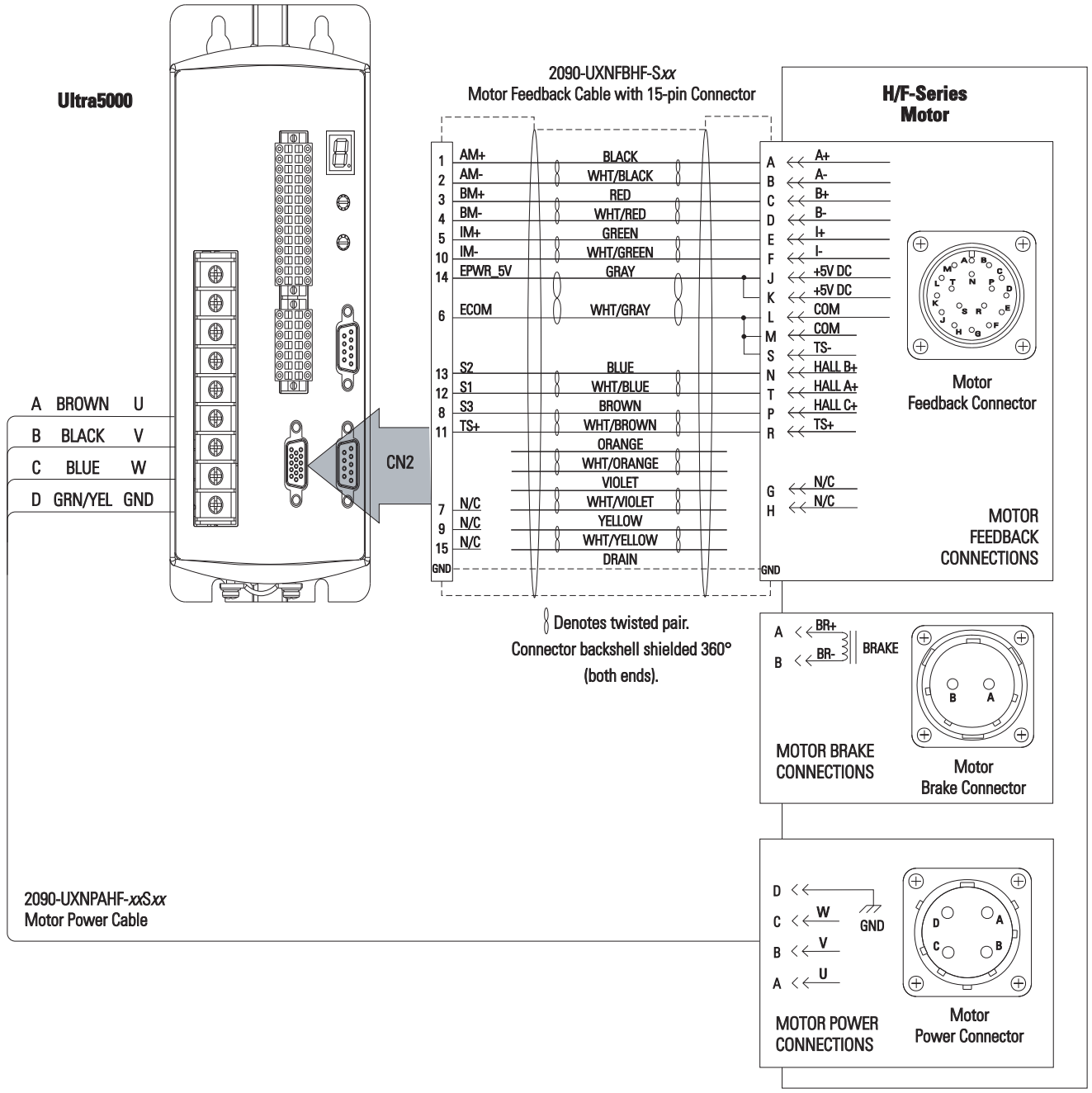


Figure B.9
Ultra5000 to H-, and F-Series Motor Configuration (flying leads)

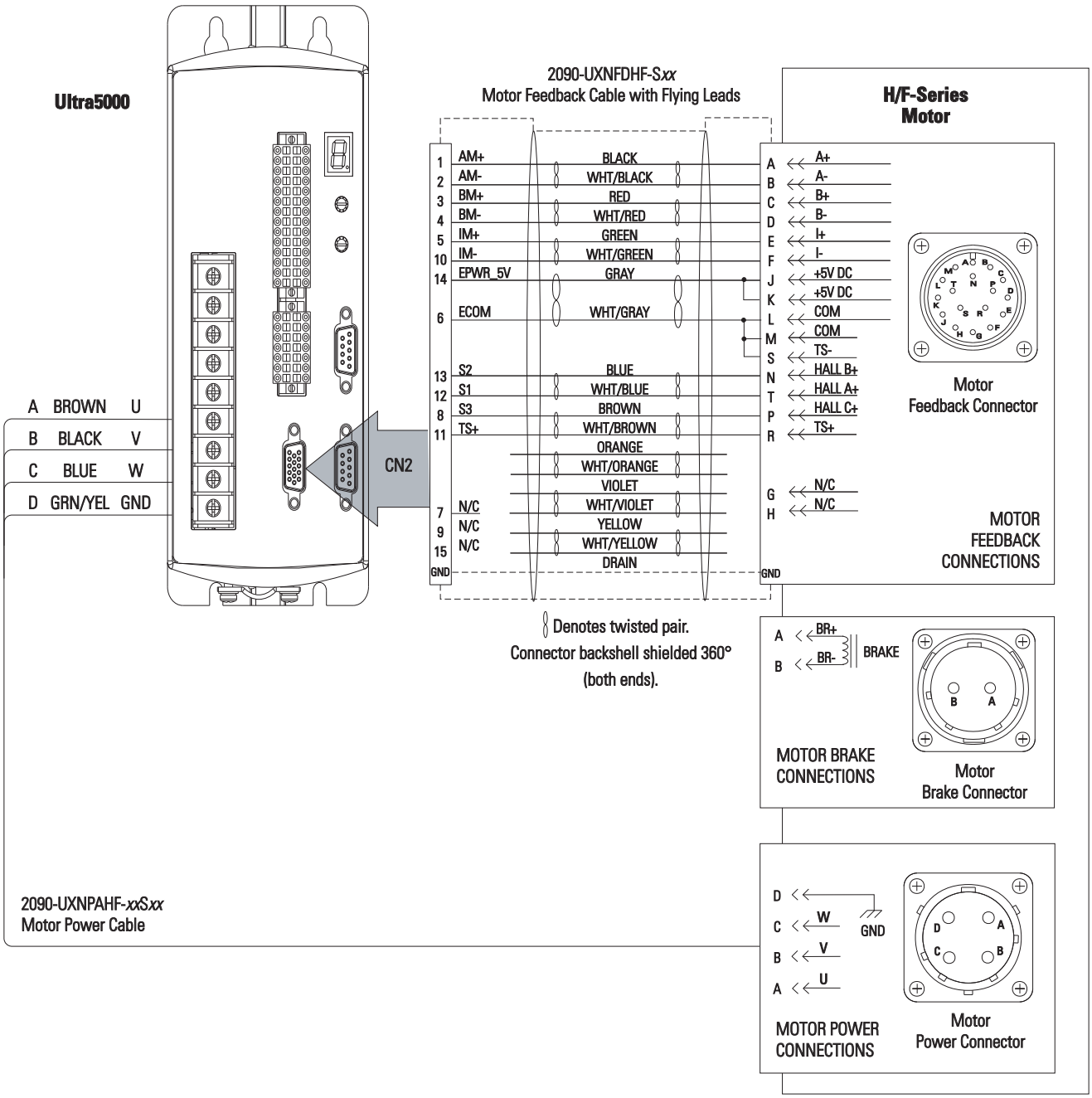


Figure B.10
Ultra5000 to W-Series Motor Configuration (mating connector)

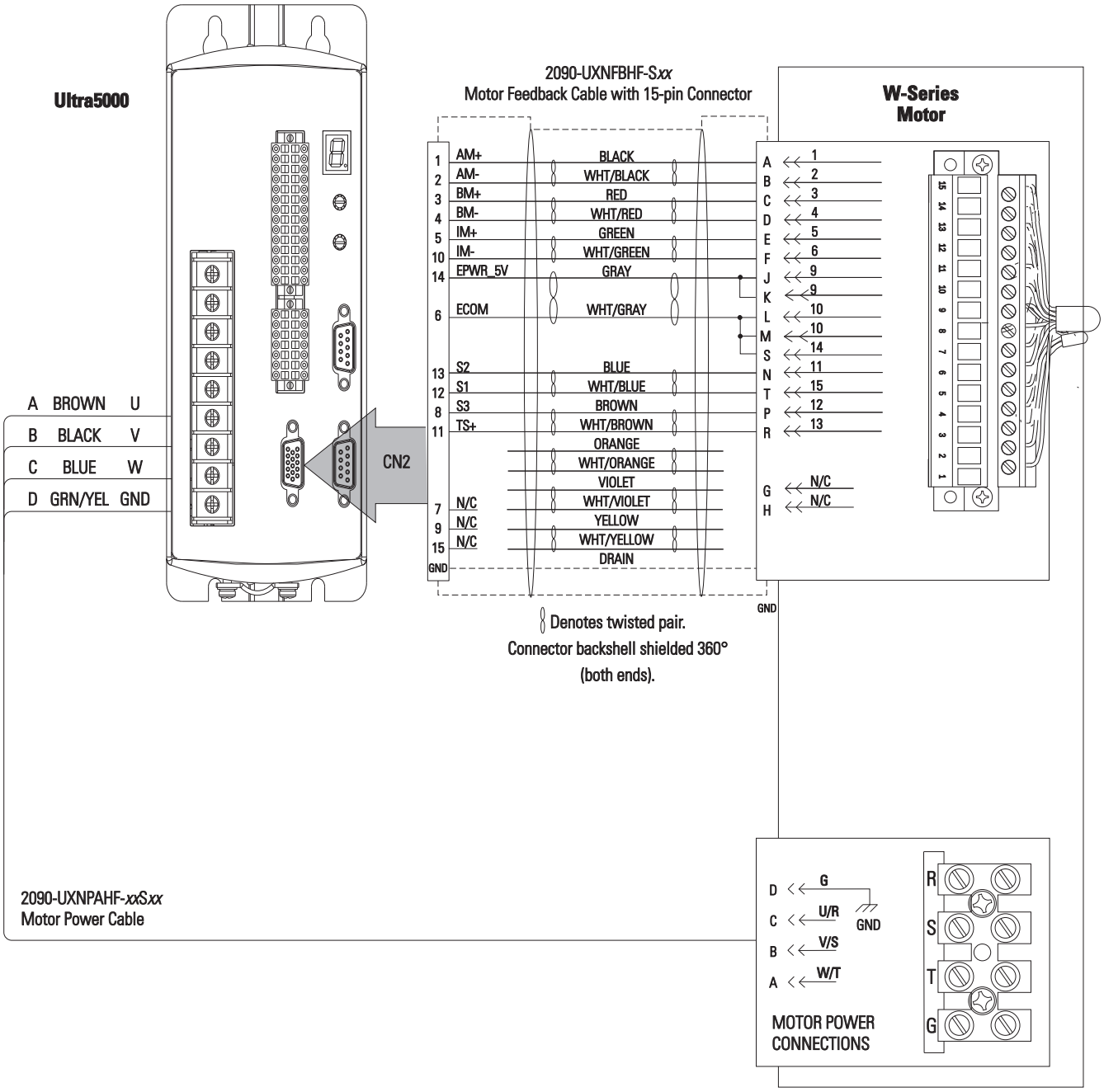


Figure B.11
Ultra5000 to W-Series Motor Configuration (flying leads)

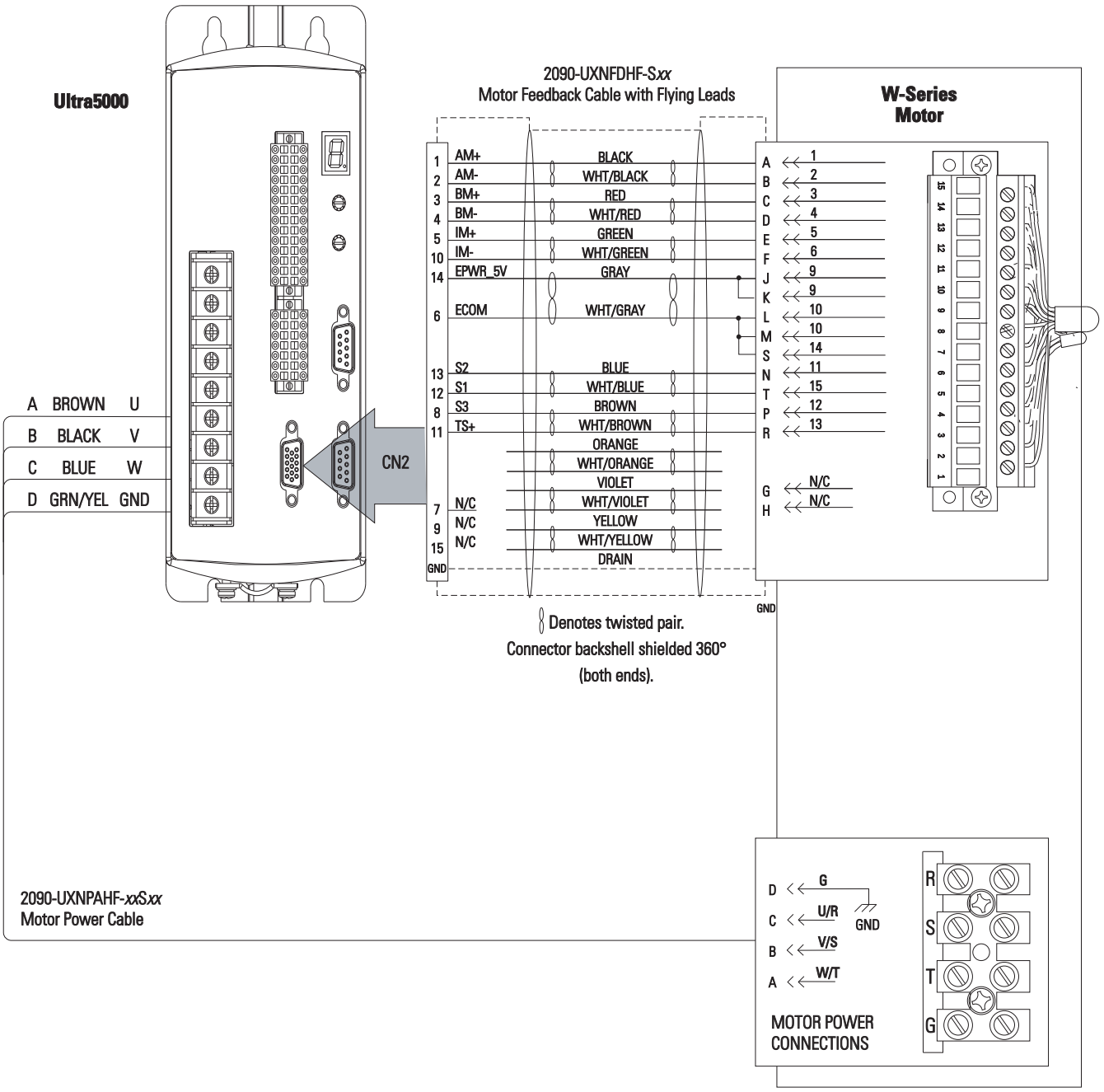


Figure B.12
Ultra5000 to Y-Series Motor Configuration (mating connector)

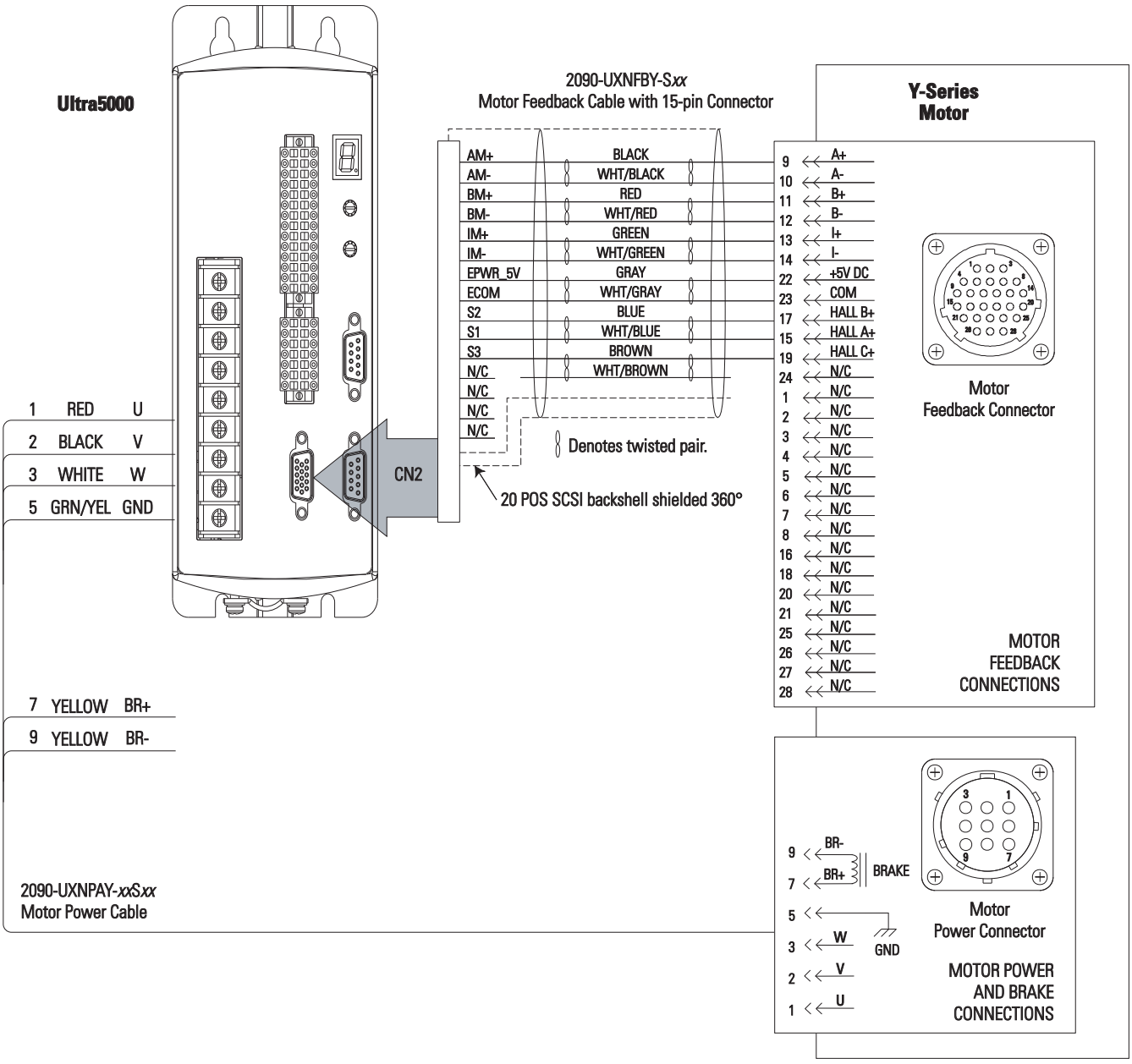
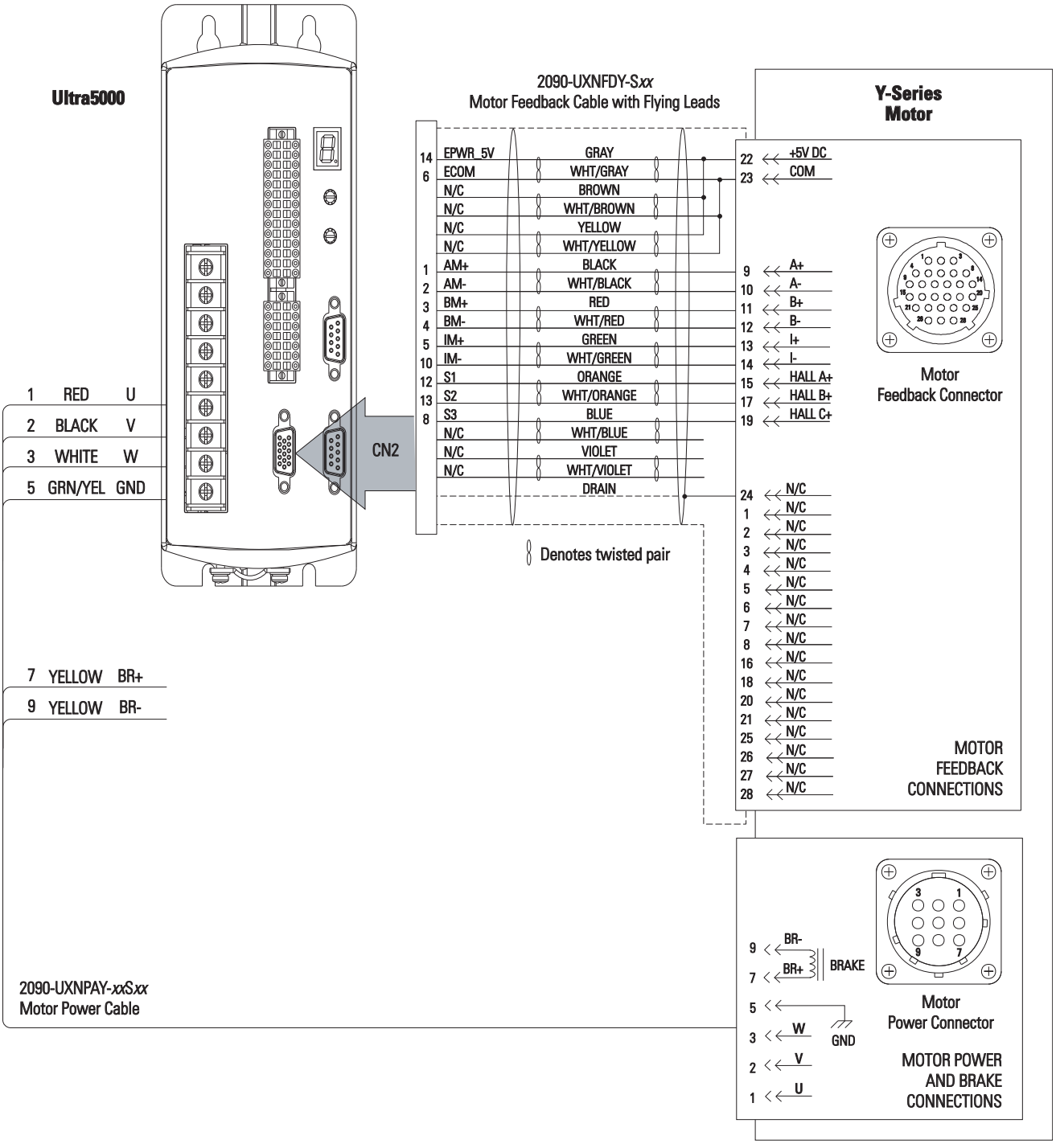


Figure B.13
Ultra5000 to Y-Series Motor Configuration (flying leads)



Ultra5000 Power Wiring Diagrams

This section provides information to assist you with AC input and motor power wiring to your Ultra5000 drive.

Figure B.14
Typical Power Wiring of Ultra5000 System
2098-IPD-005-*xx*, -010-*xx*, and -020-*xx*

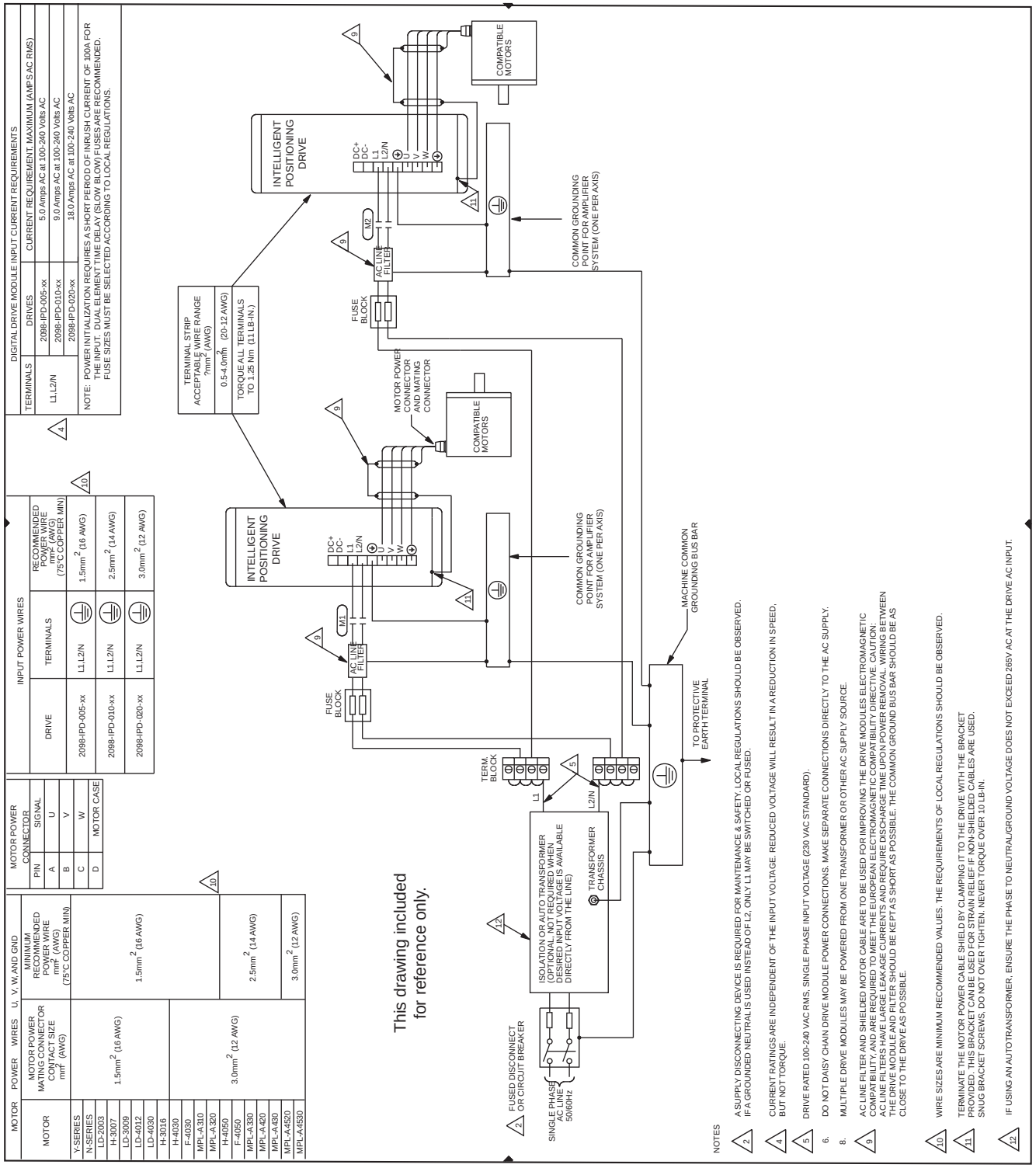


Figure B.15
Typical Power Wiring of Ultra5000 System
2098-IPD-030-*xx*

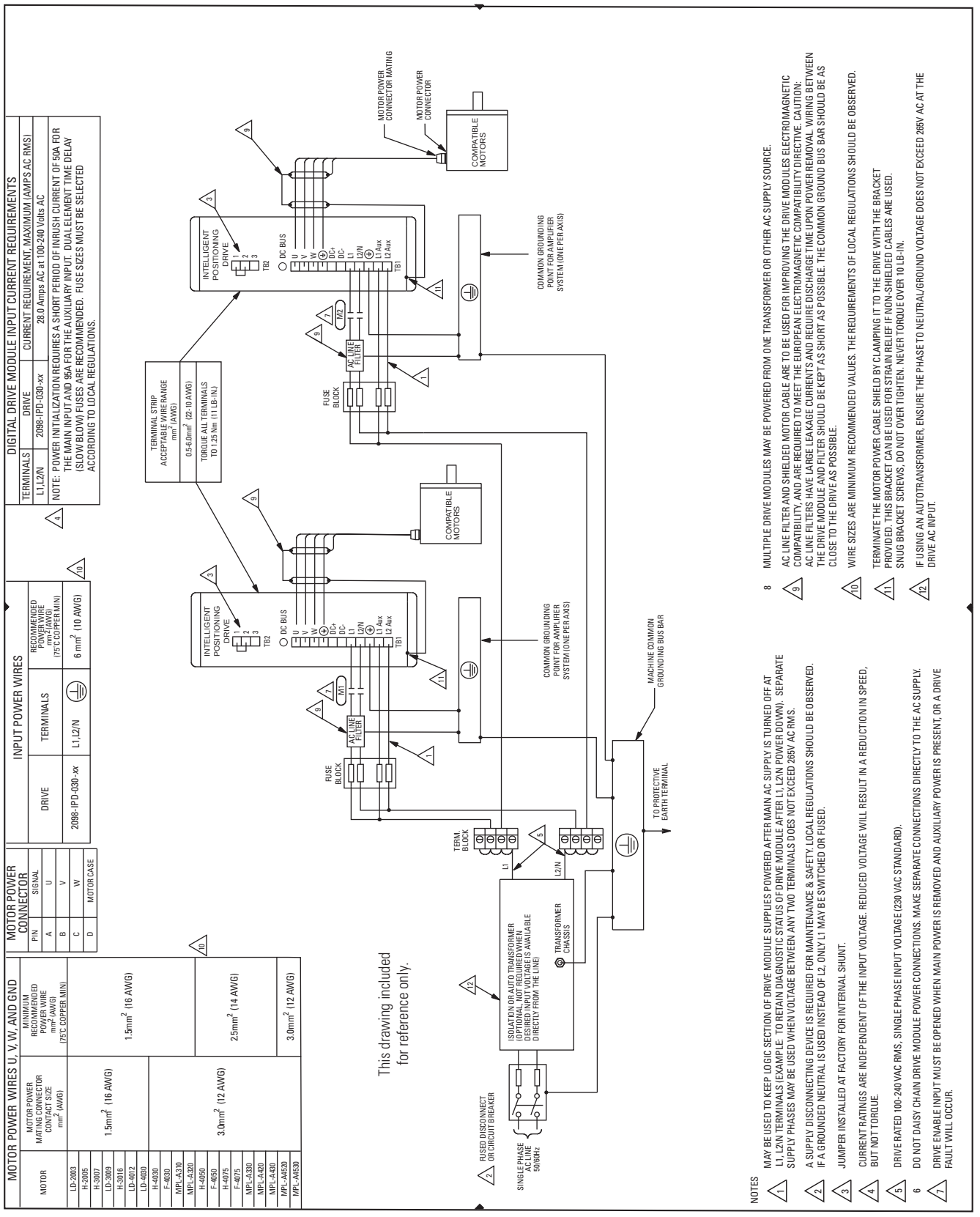
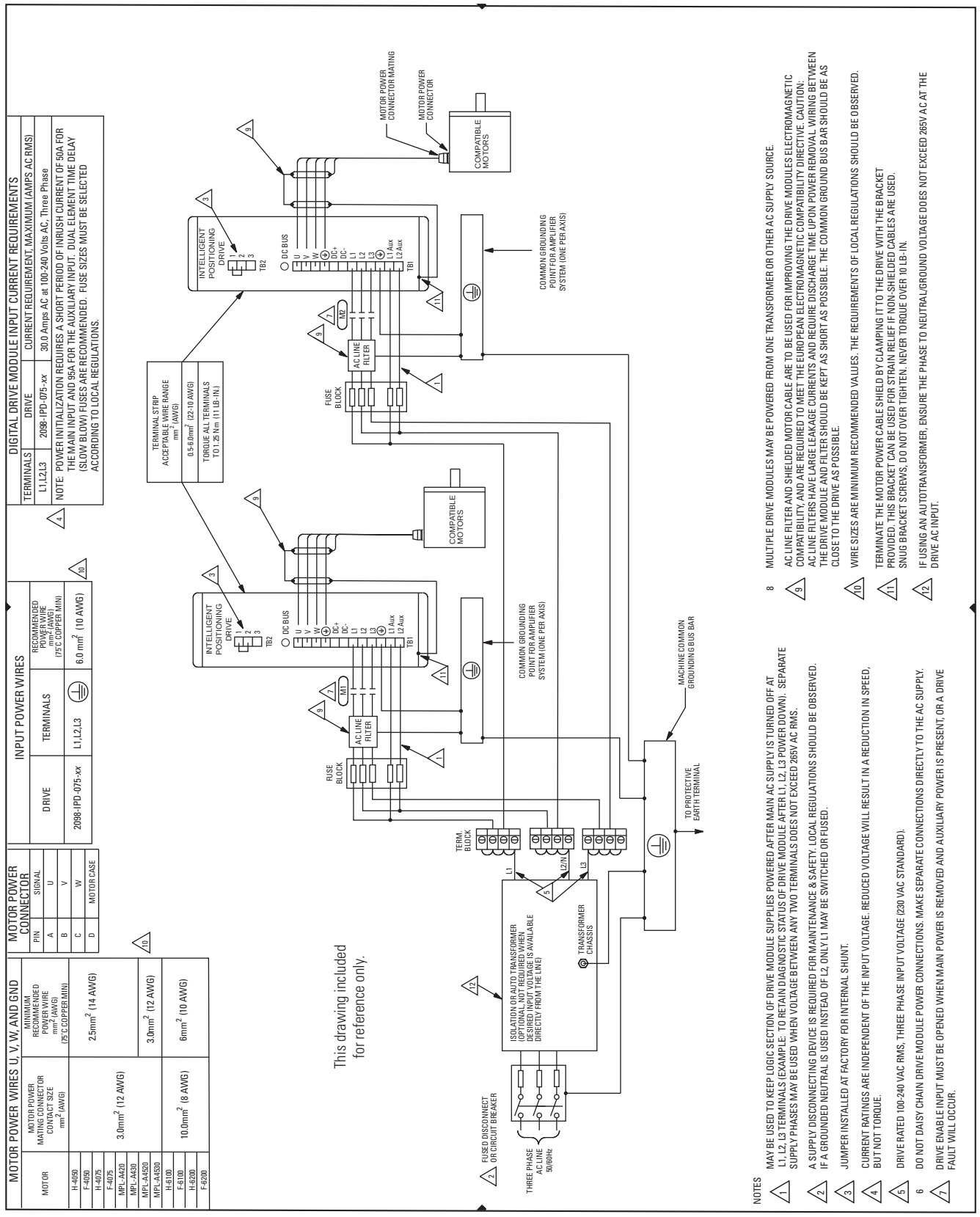


Figure B.16
Typical Power Wiring of Ultra5000 System
2098-IPD-075-*xx*



NOTES

1. MAY BE USED TO KEEP LOGIC SECTION OF DRIVE MODULE SUPPLIES POWERED AFTER MAIN AC SUPPLY IS TURNED OFF AT L1, L2, L3 TERMINALS (EXAMPLE: TO RETAIN DIAGNOSTIC STATUS OF DRIVE MODULE AFTER L1, L2, L3 POWER DOWN). SEPARATE SUPPLY PHASES MAY BE USED WHEN VOLTAGE BETWEEN ANY TWO TERMINALS DOES NOT EXCEED 265V AC RMS.
2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTENANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2, ONLY L1 MAY BE SWITCHED OR FUSED.
3. JUMPER INSTALLED AT FACTORY FOR INTERNAL SHUNT.
4. CURRENT RATINGS ARE INDEPENDENT OF THE INPUT VOLTAGE. REDUCED VOLTAGE WILL RESULT IN A REDUCTION IN SPEED, BUT NOT TORQUE.
5. DRIVE RATED 100-240 VAC RMS, THREE PHASE INPUT VOLTAGE (230 VAC STANDARD).
6. DO NOT DAISY CHAIN DRIVE MODULE POWER CONNECTIONS. MAKE SEPARATE CONNECTIONS DIRECTLY TO THE AC SUPPLY.
7. DRIVE ENABLE INPUT MUST BE OPENED WHEN MAIN POWER IS REMOVED AND AUXILIARY POWER IS PRESENT, OR A DRIVE FAULT WILL OCCUR.
8. MULTIPLE DRIVE MODULES MAY BE POWERED FROM ONE TRANSFORMER OR OTHER AC SUPPLY SOURCE.
9. AC LINE FILTER AND SHIELDED MOTOR CABLE ARE TO BE USED FOR IMPROVING THE DRIVE MODULES ELECTROMAGNETIC COMPATIBILITY, AND ARE REQUIRED TO MEET THE EUROPEAN ELECTROMAGNETIC COMPATIBILITY DIRECTIVE. CAUTION: AC LINE FILTERS HAVE LARGE LEAKAGE CURRENTS AND REQUIRE DISCHARGE TIME UPON POWER REMOVAL. WIRING BETWEEN THE DRIVE MODULE AND FILTER SHOULD BE KEPT AS SHORT AS POSSIBLE. THE COMMON GROUND BUS BAR SHOULD BE AS CLOSE TO THE DRIVE AS POSSIBLE.
10. WIRE SIZES ARE MINIMUM RECOMMENDED VALUES. THE REQUIREMENTS OF LOCAL REGULATIONS SHOULD BE OBSERVED.
11. TERMINATE THE MOTOR POWER CABLE SHIELD BY CLAMPING IT TO THE DRIVE WITH THE BRACKET PROVIDED. THIS BRACKET CAN BE USED FOR STRAIN RELIEF IF NON-SHIELDED CABLES ARE USED. SNUG BRACKET SCREWS, DO NOT OVER TIGHTEN. NEVER TORQUE OVER 10 LB-IN.
12. IF USING AN AUTOTRANSFORMER, ENSURE THE PHASE TO NEUTRAL/GROUND VOLTAGE DOES NOT EXCEED 265V AC AT THE DRIVE AC INPUT.

Figure B.17
Typical Power Wiring of Ultra5000 System
2098-IPD-150-*xx*

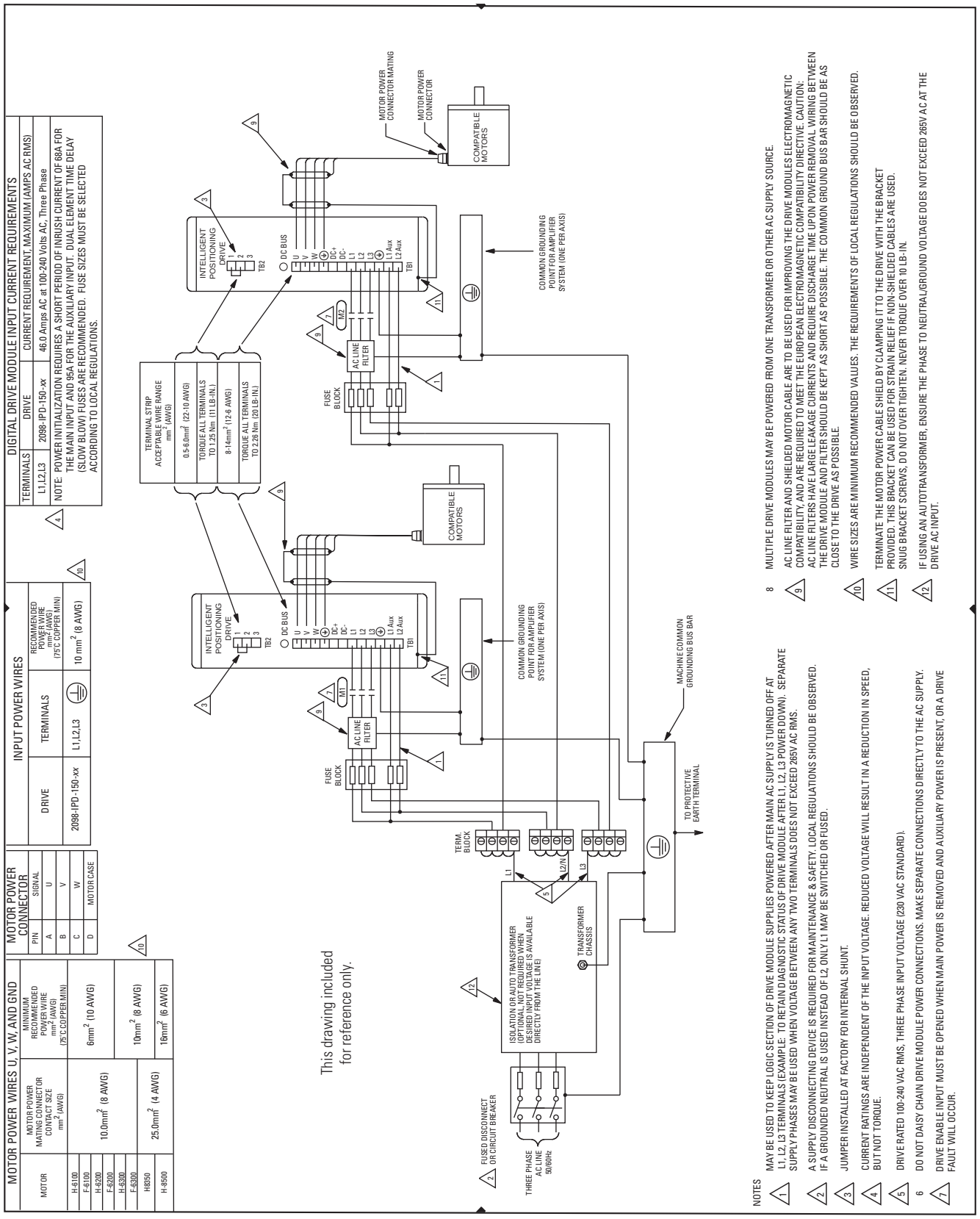
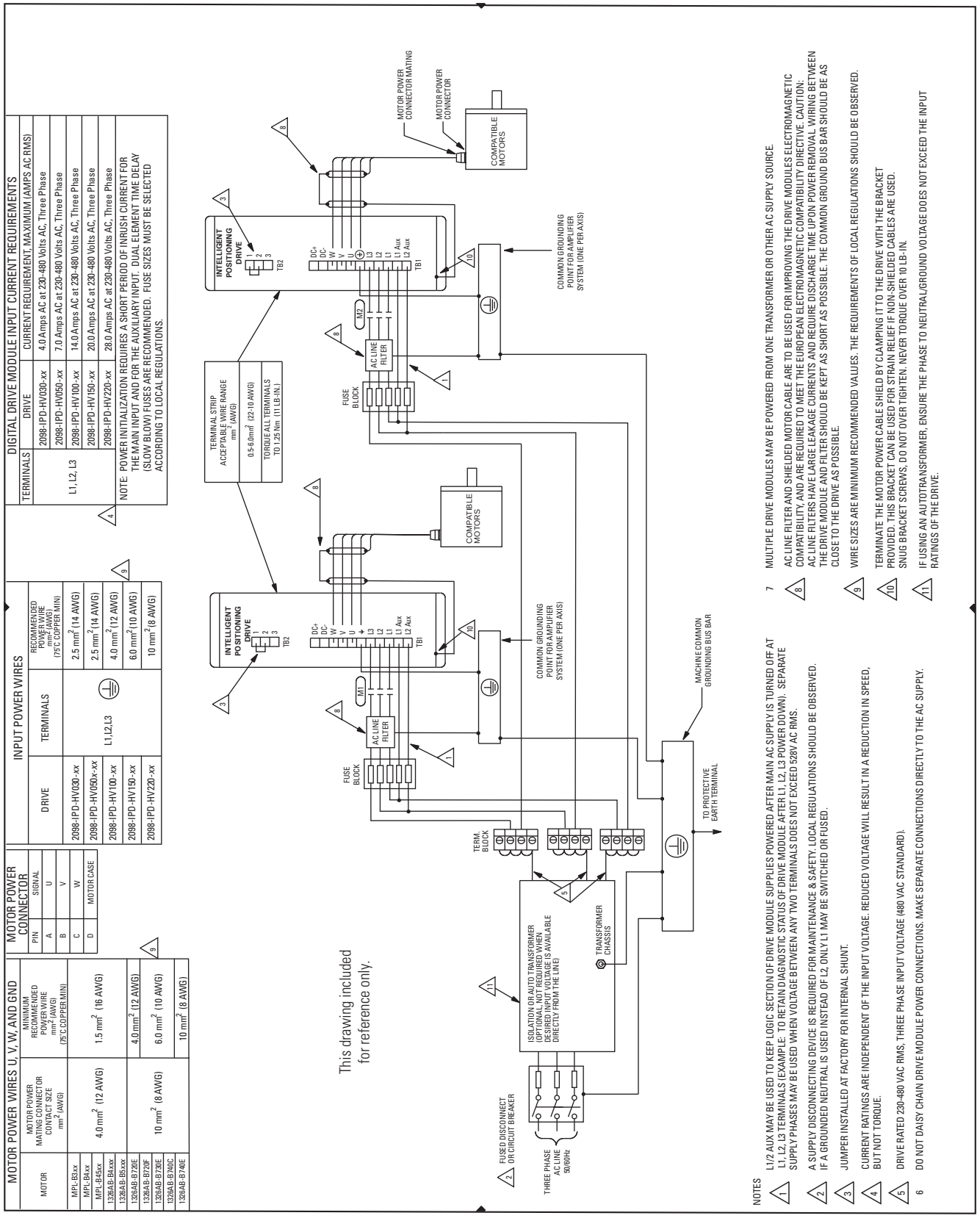


Figure B.18
Typical Power Wiring of Ultra5000 System
2098-IPD-HV*xxx-xx*



NOTES

1. L1/2 AUX MAY BE USED TO KEEP LOGIC SECTION OF DRIVE MODULE SUPPLIES POWERED AFTER MAIN AC SUPPLY IS TURNED OFF AT L1, L2, L3 TERMINALS (EXAMPLE: TO RETAIN DIAGNOSTIC STATUS OF DRIVE MODULE AFTER L1, L2, L3 POWER DOWN). SEPARATE SUPPLY PHASES MAY BE USED WHEN VOLTAGE BETWEEN ANY TWO TERMINALS DOES NOT EXCEED 528V AC RMS.
2. A SUPPLY DISCONNECTING DEVICE IS REQUIRED FOR MAINTENANCE & SAFETY. LOCAL REGULATIONS SHOULD BE OBSERVED. IF A GROUNDED NEUTRAL IS USED INSTEAD OF L2, ONLY L1 MAY BE SWITCHED OR FUSED.
3. JUMPER INSTALLED AT FACTORY FOR INTERNAL SHUNT.
4. CURRENT RATINGS ARE INDEPENDENT OF THE INPUT VOLTAGE. REDUCED VOLTAGE WILL RESULT IN A REDUCTION IN SPEED, BUT NOT TORQUE.
5. DRIVE RATED 230-480 VAC RMS, THREE PHASE INPUT VOLTAGE (480 VAC STANDARD).
6. DO NOT DAISY CHAIN DRIVE MODULE POWER CONNECTIONS. MAKE SEPARATE CONNECTIONS DIRECTLY TO THE AC SUPPLY.
7. MULTIPLE DRIVE MODULES MAY BE POWERED FROM ONE TRANSFORMER OR OTHER AC SUPPLY SOURCE.
8. AC LINE FILTER AND SHIELDED MOTOR CABLE ARE TO BE USED FOR IMPROVING THE DRIVE MODULES ELECTROMAGNETIC COMPATIBILITY, AND ARE REQUIRED TO MEET THE EUROPEAN ELECTROMAGNETIC COMPATIBILITY 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.
9. WIRE SIZES ARE MINIMUM RECOMMENDED VALUES. THE REQUIREMENTS OF LOCAL REGULATIONS SHOULD BE OBSERVED.
10. TERMINATE THE MOTOR POWER CABLE SHIELD BY CLAMPING IT TO THE DRIVE WITH THE BRACKET PROVIDED. THIS BRACKET CAN BE USED FOR STRAIN RELIEF IF NON-SHIELDED CABLES ARE USED. SNUG BRACKET SCREWS, DO NOT OVER TIGHTEN. NEVER TORQUE OVER 10 LB-IN.
11. IF USING AN AUTOTRANSFORMER, ENSURE THE PHASE TO NEUTRAL/GROUND VOLTAGE DOES NOT EXCEED THE INPUT RATINGS OF THE DRIVE.

Using an Emergency Stop Contactor

Some applications require that a contactor be inserted between the motor and Ultra5000 for emergency stop purposes. To determine if this is necessary, perform a hazard analysis of the machine. If used, the contactor must not simply break the motor current, it must switch a 3-phase resistive load in parallel with the motor windings. The three resistors provide dynamic braking and a category zero stop. The resistors also prevent continuous arcing at the main contacts when breaking DC currents, such as when the motor is at stall.

It is important to sequence the E-stop string to disable the drive prior to or at the same time the contactor is released. Conversely, upon power-up the contactor must be fully engaged before the drive is enabled. Use an auxiliary contact on the contactor for the drive enable circuit for sequencing.

ATTENTION

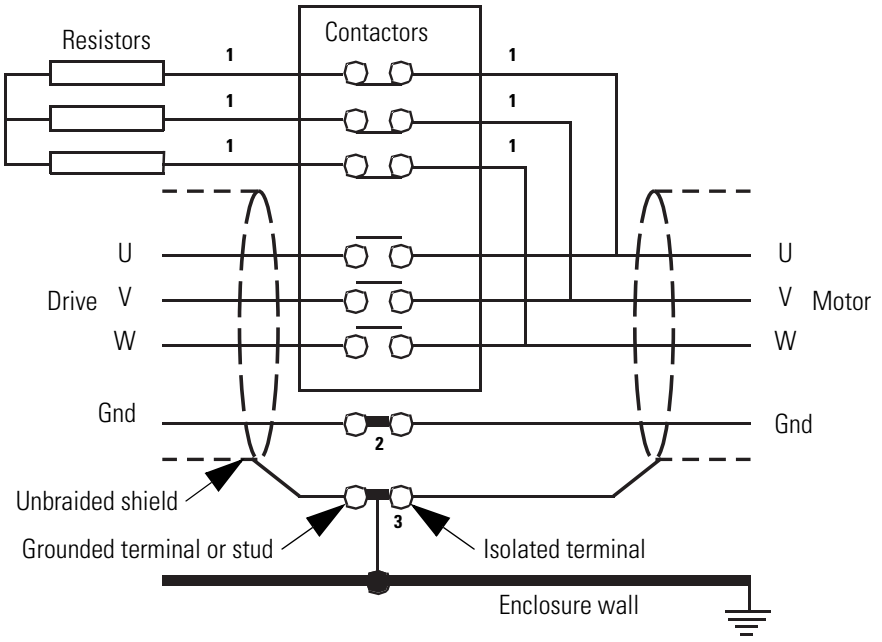
To avoid personal injury and/or equipment damage, do not simply break the motor current. This can result in very high voltages due to motor inductance, prolonged arcing in the contactor, and eventually can cause fire in extreme cases.

Shield and ground cable connection methods are shown in Figure B.19.

ATTENTION

Implementation of safety circuits and risk assessment is the responsibility of the machine builder. Please reference international standards EN1050 and EN954 estimation and safety performance categories. For more information refer to Understanding the Machinery Directive, publication SHB-900.

Figure B.19
Emergency Stop Contactor Wiring



[1] Exposed power wiring conductors that are not shielded are a source of RFI noise. Keep exposed conductors as short as possible and isolated from sensitive devices and wiring.

[2] The safety ground (GND) and shield connections are permanently connected. This is essential for electrical safety.

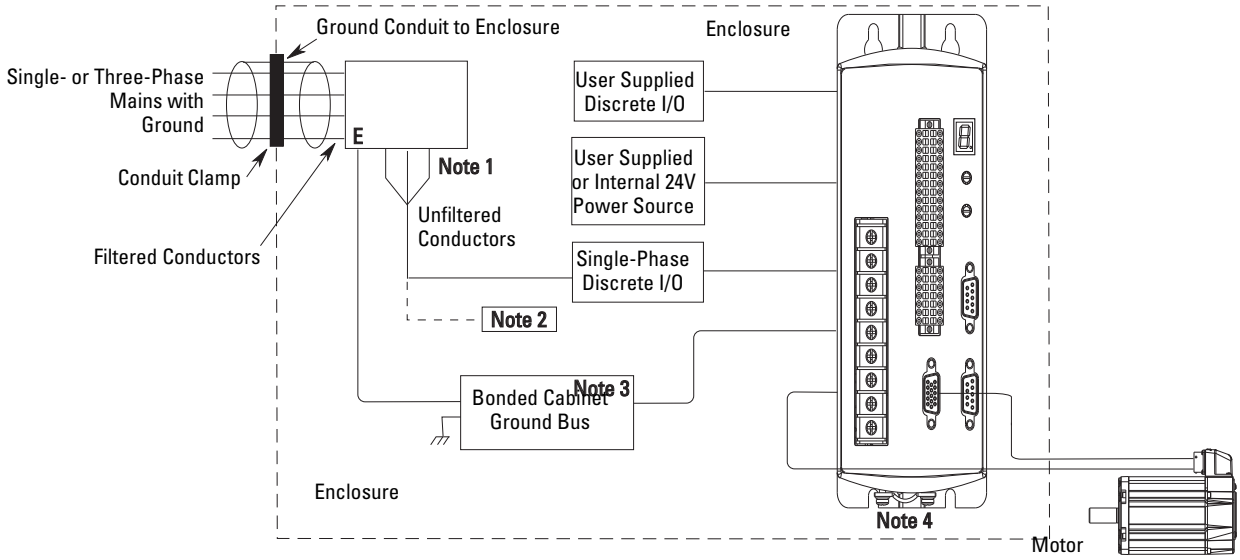
[3] Unbraid all cable shields and bond together, connecting directly to the grounded terminal or stud. Do not use the shield drain wire for this bonded connection.

IMPORTANT The safety ground is not connected to local ground at the point where the contactor is inserted in the lines, but the shield is. This is done for EMC reasons.

Grounding for Ultra5000 CE Requirements

This section provides information to assist you in complying with CE requirements. Figure B.20 briefly outlines Ultra5000 CE requirements. Refer to Complying with European Union Directives on page 1-1 for information on how to determine compliance of specific products.

Figure B.20
Ultra5000 CE Requirements



1 Mount the filter as close to the Ultra5000 as possible. If the distance exceeds 600 mm (2.0 ft), use a strap (greater in width than length) rather than a wire, to connect the ground between the Ultra5000 and the filter. This is particularly important for attenuation of higher frequency emissions (5-30 MHz).

Shield or separate the wires connecting the AC power to the filter from other power cables (e.g., connections between the Ultra5000 and the filter, motor power cable, etc.). The best method of achieving this is to mount the filter near where the AC power enters the enclosure. If the connections are not separated from each other, the EMI on the Ultra5000 side of the filter can couple over to the source side of the filter, thereby reducing or eliminating the filter's effectiveness. The coupling mechanism can radiate or allow stray capacitance between the wires.

Filters need to be on all lines for filtering to be effective. When multiple power cables enter an enclosure, an unfiltered line can contaminate a filtered line.

Bond the filter and the Ultra5000 to a grounded conductive surface (the enclosure) to establish a high frequency (HF) connection. To achieve the HF ground, the contact surface interface between the filter, Ultra5000, and the enclosure should be free from paint or any other type of insulator.

2 The filter shown is sized for one Ultra5000. Equivalent filters may be used for multiple units. Size the filter following the manufacturers recommendations.

3 Ground bar is customer-supplied item.

4 Clamp motor power cable shield for EMC termination.

IMPORTANT All AC power in the cabinet must be filtered to reduce EMI.

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.

Ultra5000 Shunt Module Information

This section directs you to information sources for wiring an active or passive shunt module to your Ultra5000 drive.

300 Watt Active Shunt Module

Use the 2090-UCSR-A300 active shunt module with the Ultra5000 (2098-IPD-005-*xx*, -010-*xx*, and -020-*xx*) drives.

Use shielded, high temperature 75° C (167° F), 600V, 2.5-4.0 mm^2 (12-14 AWG), 3.05 m (10 ft) maximum, copper wire. Follow one of the methods given below to reduce the effects of EMI noise:

- Install wires using twisted pairs (two turns per foot minimum), as shown in the figure above. Keep unshielded wires as short as possible.
- Use shielded, twisted cable (ground shield at shunt and drive).
- Use shielded metal conduit (ground conduit at shunt and drive).

For more information, refer to the *300 Watt Active Shunt Regulator Installation Instructions*, publication 2090-IN002.

200 Watt Passive Shunt Module

A 2090-UCSR-P200 passive shunt module can be used with the 230V Ultra5000 drive (2098-IPD-030-*xx*).

Use shielded, high temperature 75° C (167° F), 600V, 2.5 mm^2 (14 AWG), 3.05 m (10 ft) maximum, copper wire. Follow one of the methods given below to reduce the effects of EMI noise:

- Install wires using twisted pairs (two turns per foot minimum), as shown in the figure above. Keep unshielded wires as short as possible.
- Use shielded, twisted cable (ground shield at shunt and drive).
- Use shielded metal conduit (ground conduit at shunt and drive).

For more information, refer to the *200 Watt Passive Shunt Module Installation Instructions*, publication 2090-IN003.

900 Watt Passive Shunt Module

Use the 2090-UCSR-P900 passive shunt module with the Ultra5000 drives (2098-IPD-075-*xx* or 2098-IPD-150-*xx*).

Use shielded, high temperature 75° C (167° F), 600V, 10 mm^2 (8 AWG), 3.05 m (10 ft) maximum, copper wire. Follow one of the methods given below to reduce the effects of EMI noise:

- Install wires using twisted pairs (two turns per foot minimum), as shown in the figure above. Keep unshielded wires as short as possible.
- Use shielded, twisted cable (ground shield at shunt and drive).
- Use shielded metal conduit (ground conduit at shunt and drive).

For more information, refer to the *900 Watt Passive Shunt Module Installation Instructions*, publication 2090-IN001.

2090 Passive Shunt Module

A 2090-SR*xxx-xx* passive shunt module can be used with 460V Ultra5000 drives (2098-IPD-HV030-*xx*, -HV050-*xx*, -HV100-*xx*, -HV150-*xx*, *and* -HV220-*xx*) operating with 460V or 230V input power.

Note: Fusing on the 2090-SR*xxx-xx* passive shunt module must be changed to accommodate 230V input power.

Use shielded, high temperature 105° C (221° F), 600V, 6 mm^2 (10 AWG), 3.05 m (10 ft) maximum, braided copper wire to connect between the drive's TB2-1 and TB2-3 external shunt terminals and the shunt module terminals. Follow one of the methods below to reduce the effects of EMI noise:

- Install wires using twisted pairs (two turns per foot minimum). Keep unshielded wires as short as possible.
- Use shielded, twisted cable (ground shield at shunt and drive).
- Use shielded metal conduit (ground conduit at shunt and drive).

For more information, refer to the *2090 Series Passive Shunts Installation Instructions*, publication 2090-IN004.

Catalog Numbers and Accessories

Chapter Objectives

This appendix lists the Ultra5000 drives and accessory items in tables by catalog number providing detailed descriptions of each component. This appendix describes catalog numbers for:

- Ultra5000 Drives
- Ultraware Software
- AC Line Filters
- External Shunt Kits
- Motor Power Cables
- Motor Feedback Cables
- Ultra5000 Interface Cables
- Break Out Boards, Cables, and Kits
- Mating Connector Kits

Contact your local Allen-Bradley sales office for additional information. Refer to the Motion Control Selection Guide, publication GMC-SG001, for details on products.

Ultra5000 Drives

Use the following table to identify Ultra5000 240V drives with ratings of 500W, 1 kW, and 2 kW.

Description	Catalog Number
Ultra5000 Intelligent Positioning Drives	2098-IPD-005, 2098-IPD-010, 2098-IPD-020
Ultra5000 Intelligent Positioning Drives with DeviceNet	2098-IPD-005-DN, 2098-IPD-010-DN, 2098-IPD-020-DN

Use the following table to identify Ultra5000 240V drives with ratings of 3 kW, 7.5 kW, and 15 kW.

Description	Catalog Number
Ultra5000 Intelligent Positioning Drives	2098-IPD-030, 2098-IPD-075, 2098-IPD-150
Ultra5000 Intelligent Positioning Drives with DeviceNet	2098-IPD-030-DN, 2098-IPD-075-DN, 2098-IPD-150-DN

Use the following table to identify Ultra5000 460V drives with ratings of 3 kW, 5 KW, 10 kW, 15 kW, and 22 kW.

Description	Catalog Number
Ultra5000 Intelligent Positioning Drives	2098-IPD-HV030, 2098-IPD-HV050, 2098-IPD-HV100, 2098-IPD-HV150, 2098-IPD-HV220
Ultra5000 Intelligent Positioning Drives with DeviceNet	2098-IPD-HV030-DN, 2098-IPD-HV050-DN, 2098-IPD-HV100-DN, 2098-IPD-HV150-DN, 2098-IPD-HV220-DN

Ultraware Software

The Ultra5000 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.

Description	AC Line Filter Fuse Block	Roxburgh Part Number	Catalog Number
AC Line Filter (6 Amp, Single phase)	6 Amp	MIF06	2090-UXLF-106
AC Line Filter (10 Amp, Single phase)	10 Amp	MIF10	2090-UXLF-110
AC Line Filter (23 Amp, Single phase)	23 Amp	MIF23	2090-UXLF-123
AC Line Filter (36 Amp, Single phase)	36 Amp	MDF36	2090-UXLF-136
AC Line Filter (50 Amp, Single phase)	50 Amp	MDF50	2090-UXLF-150
AC Line Filter (36 Amp, Three phase)	36 Amp	MDF336	2090-UXLF-336
AC Line Filter (50 Amp, Three phase)	50 Amp	MDF350	2090-UXLF-350
AC Line Filter (70 Amp, Three phase)	70 Amp	MDF370	2090-UXLF-370
AC Line Filter (23 Amp, Three phase, 480V)	23 Amp	MIF323	2090-UXLF-HV323
AC Line Filter (30 Amp, Three phase, 480V)	30 Amp	MIF330	2090-UXLF-HV330
AC Line Filter (50 Amp, Three phase, 480V)	50 Amp	MIF350	2090-UXLF-HV350

External Shunt Kits

External shunts are available for use with Ultra5000 drives. Refer to Related Documentation on page P-3 to locate Installation Instructions for these shunts.

Use the following tables to identify external shunt kits available for Ultra5000 drives. Refer to Ultra5000 Shunt Module Information on page B-23 for basic wiring guidelines.

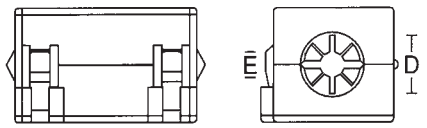
If your drive is:	You may use this shunt	Catalog Number
2098-IPD-005, -005-DN	300 Watt Active Shunt Module with 300 Watt Active Shunt Ferrites	2090-UCSR-A300 [1]
2098-IPD-010, -010-DN		
2098-IPD-020, -020-DN		
2098-IPD-030, -030-DN	200 Watt Passive Shunt Module	2090-UCSR-P200
2098-IPD-075, -075-DN	900 Watt Passive Shunt Module	2090-UCSR-P900
2098-IPD-150, -150-DN		
2098-IPD-HV030, -HV030-DN 2098-IPD-HV050, -HV050-DN	900 Watt 2090 Passive Shunt Module	2090-SR120-09 [2]
2098-IPD-HV100, -HV100-DN	900 Watt 2090 Passive Shunt Module	2090-SR040-09 [2]
2098-IPD-HV100, -HV100-DN	1800 Watt 2090 Passive Shunt Module	2090-SR040-18 [2]
2098-IPD-HV150, -HV150-DN	900 Watt 2090 Passive Shunt Module	2090-SR025-09 [2]
2098-IPD-HV150, -HV150-DN	1800 Watt 2090 Passive Shunt Module	2090-SR025-18 [2]
2098-IPD-HV220, -HV220-DN	3600 Watt 2090 Passive Shunt Module	2090-SR020-36 [2]

[1] A 300W Active Shunt may be labelled with the obsolete Catalog Number 1398-SR3AF.

[2] Refer to 2090 Series Passive Shunts on page C-5 for general specifications.

300 Watt Active Shunt Ferrites

Ferrites are used at both ends of the DC Bus wires for CE radiated emissions compliance. Use the following table to select a ferrite assembly.

Box shaped ferrite assembly in fully enclosed nylon case. End ports are surrounded with flexible spring flutes to grip a range of cable diameters from.125 to.500" (3.2 to 12.7mm). FerriShield, Inc. 350 Fifth Avenue, Suite 7310 New York, NY 10118-7591			
Mfg. Part/No.	**D**	**E**	**Impedance**
SS28B2034	0.250	0.120	125 Ω
SS28B2037	0.350	0.200	154 Ω
SS28B2032	0.500	0.200	230 Ω

2090 Series Passive Shunts

2090-Series of Passive Shunts compatible with 460V Ultra5000 drives (i.e., -HV) are shown in the following table:

Applicable Drives	**Shunt Catalog No.**	**Shunt Ratings:**			
		Resistance [1]	**Peak Power @ 460V**	**Peak Power @ 230V**	**Power Continuous**
2098-IPD-HV030-*xx* 2098-IPD-HV050-*xx*	2090-SR120-09	120 – 148 Ohms	5.3 kW	1.33 kW [2]	900W
2098-IPD-HV100-*xx*	2090-SR040-09	40 – 51 Ohms	16.0 kW	4.0 kW [2]	900W
2098-IPD-HV100-*xx*	2090-SR040-18	40 – 49 Ohms	16.0 kW	4.0 kW [2]	1800W
2098-IPD-HV150-*xx*	2090-SR025-09	25 – 32 Ohms	25.6 kW	6.4 kW [2]	900W
2098-IPD-HV150-*xx*	2090-SR025-18	25 – 31 Ohms	25.6 kW	6.4 kW [2]	1800W
2098-IPD-HV220-*xx*	2090-SR020-36	20 – 25 Ohms	32.0 kW	8.0 kW [2]	3600W

[1] Tolerance = +20%, - 0%

[2] Replacement of the 460V fuse with the supplied 230V fuse kit is required to convert these shunts for use with Ultra Series HV drives operating on 230V input power.

Cables

Use the following tables to identify motor power, feedback, interface, and brake cables for your Ultra5000. Length of cable *xx* is in meters (01, 03, 09, 15, and 30) unless otherwise noted.

Motor Power Cables

Applicable Drive(s)	Description	Catalog Number
2098-IPD-005, -010, -020	H-Series Motor Power Cable, non-flex, 16 AWG, right angle	2090-UXNPAH-16R*xx*
	H and W-Series Motor Power Cable, non flex, 16 AWG, straight	2090-UXNPAH-16S*xx*
	MP-Series Motor Power Cable, non flex, 16 AWG, straight	2090-UXNPAMP-16S*xx*
	N-Series Motor Power Cable, non-flex, 16 AWG, right angle	2090-UXNPAN-16R*xx*
	N-Series Motor Power Cable, non flex, 16 AWG, straight	2090-UXNPAN-16S*xx*
	Y-Series Motor Power Cable, non flex, 16 AWG, straight	2090-UXNPAY-16S*xx*
2098-IPD-020, -030, -HV030	H and F-Series Motor Power Cable, non-flex, 14 AWG, right angle	2090-UXNPAHF-14R*xx*
	H, F and W-Series Motor Power Cable, non flex, 14 AWG, straight	2090-UXNPAHF-14S*xx*
	MP-Series Motor Power Cable, non flex, 14 AWG, straight	2090-UXNPAMP-14S*xx*
2098-IPD-030, -050, -075, -100, -150, -HV030, -HV050, -HV100, -HV150	MP-Series and 1326AB-B*xxxx*-M2L or -S2L Motor Power Cable, non flex, 16 AWG, straight	2090-UXNPBMP-16S*xx*
2098-IPD-075	H and F-Series Motor Power Cable, non-flex, 10 AWG, right angle	2090-UXNPAHF-10R*xx*
	H and F-Series Motor Power Cable, non flex, 10 AWG, straight	2090-UXNPAHF-10S*xx*
	MP-Series Motor Power Cable, non flex, 10 AWG, straight	2090-UXNPAMP-10S*xx*
2098-IPD-075, -100, -150, -220, -HV100, -HV150 -HV220	MP-Series and 1326AB-B*xxxx*-M2L or -S2L Motor Power Cable, non flex, 8 AWG, straight	2090-UXNPBMP-10S*xx*
2098-IPD-075, -100, -150, -HV100, -HV150	MP-Series Motor Power Cable, non flex, 8 AWG, straight	2090-UXNPBMP-14S*xx*
2098-IPD-150, --220, HV150, -HV220	MP-Series Motor Power Cable, non flex, 8 AWG, straight	2090-UXNPBMP-8S*xx*
2098-IPD-150, -HV150	H-Series Motor Power Cable, non-flex, 6 AWG, right angle	2090-UXNPAH-6R*xx*
	H-Series Motor Power Cable, non-flex, 6 AWG, straight	2090-UXNPAH-6S*xx*
	H-8*xxx* Motor Power Cable, non-flex, 6 AWG, straight	2090-UXNPAHF-6S*xx*
	H and F-Series Motor Power Cable, non-flex, 8 AWG, right angle	2090-UXNPAHF-8R*xx*
	H and F-Series Motor Power Cable, non-flex, 8 AWG, straight	2090-UXNPAHF-8S*xx*

Motor Feedback Cables

Applicable Drive(s)	Description	Catalog Number
All 2098-IPD-*xxx* and -HV*xxx*	H, F and W-Series Motor Feedback Cable, non-flex, connector at both ends, right angle, skewed	2090-UXNFBHF-K*xx*
	H, F and W-Series Motor Feedback Cable, non-flex, connector at both ends, right angle	2090-UXNFBHF-R*xx*
	H, F and W-Series Motor Feedback Cable, non-flex, connector at both ends, straight	2090-UXNFBHF-S*xx*
	H-Series Motor Feedback Cable, non-flex, connector at both ends, right angle	2090-UXNFBH-R*xx*
	1326AB-B*xxxx*-M2L or -S2L Motor Feedback Cable, non-flex, connector at both ends, straight	2090-UXNFBMP-S*xx*
	MP-Series Motor Feedback Cable, non-flex, connector at both ends, straight	2090-UXNFBMP-S*xx*
	N-Series Motor Feedback Cable, non-flex, connector at both ends, right angle, skewed	2090-UXNFBN23-K*xx*
	N-Series Motor Feedback Cable, non-flex, connector at both ends, right angle, skewed	2090-UXNFBN-K*xx*
	N-Series Motor Feedback Cable, non-flex, connector at both ends, right angle	2090-UXNFBN-R*xx*
	N-Series Motor Feedback Cable, non-flex, connector at both ends, straight	2090-UXNFBN-S*xx*
	Y-Series Motor Feedback Cable, non-flex, connector at both ends, straight	2090-UXNFBY-S*xx*
	H, F and W-Series Motor Feedback Cable, non-flex, motor connector to flying leads, straight	2090-UXNFDHF-S*xx*
	H, F and W-Series Motor Feedback Cable, non-flex, motor connector to flying leads, right angle	2090-UXNFDH-R*xx*
	1326AB-B*xxxx*-M2L or -S2L Motor Feedback Cable, non-flex, motor connector to flying leads, straight	2090-UXNFDMP-S*xx*
	MP-Series Motor Feedback Cable, non-flex, motor connector to flying leads, straight	2090-UXNFDMP-S*xx*
	N-Series Motor Feedback Cable, non-flex, motor connector to flying leads, right angle, skewed	2090-UXNFDN23-K*xx*
	N-Series Motor Feedback Cable, non-flex, motor connector to flying leads, right angle	2090-UXNFDN-R*xx*
	N-Series Motor Feedback Cable, non-flex, motor feedback connector to flying leads, straight	2090-UXNFDN-S*xx*
	Y-Series Motor Feedback Cable, non-flex, motor feedback connector to flying leads, straight	2090-UXNFDY-S*xx*
	Drive Feedback Cable, non-flex, CN2 connector to flying leads, straight	2090-UXNFM-S*xx*

MP-Series Motor Brake Cable

Description	Catalog Number
MP-Series and 1326AB-B*xxxx*-M2L or -S2L motor brake cable, 0.75 mm^2 (18 AWG)	2090-UXNBMP-18S*xx*

Ultra5000 Interface Cables

Description	Catalog Number
Interface cable, PanelView to Ultra5000	2090-U5PV-D09*xx*
Serial Interface Cable, 9-pin D-shell, CN3 to personal computer.	2090-UXPC-D09*xx*

Break Out Boards, Cables, and Kits

Use the following table to identify your break out board components.

Description	Catalog Number
Panel mount Break Out Board, 15-pin, high density D-shell, CN2	2090-UXBB-D15
Break Out Board Cable, 15-pin, high density D-shell, CN2. Length of cable *xx* is in meters (01, 03, 09 and 15).	2090-UXBC-D15*xx*
Break Out Board Kit. Contains CN2 break out board and cable of length *xx*.	2090-UXBK-D15*xx*
Drive mounted Break Out Board for 15-pin CN2 connector.	2090-UXBB-DM15
Drive mounted Break Out Board for 9-pin CN3A and CN3B connectors.	2090-UXBB-DM09

Mating Connector Kits

The Ultra5000 has two serial connectors, one motor feedback connector, two I/O connectors, and one terminal block for power connections. Use the following table to identify the mating connector kits for your Ultra5000. Refer to the chapter *Ultra5000 Connector Information* beginning on page 2-1 for pin, signal, and wiring information.

Description	Catalog Number
Mating Connector Kit (9-pin D-shell)	2090-UXCK-D09
Mating Connector Kit (15-pin high density D-shell)	2090-UXCK-D15
Mating Connector Kit (Terminal Block)	2090-UXCK-TB

The following table lists mating connectors that are not available from Rockwell Automation. Please contact Amp at 1-800-522-6752 or a distributor for additional information.

Connector Components	CN2 **Motor Feedback** 15-Pin High-Density D-Shell	CN3 **Serial** 9-Pin Standard-Density D-Shell
Mating Connector	748364-1	205204-4
Crimp Pin Contacts	748333-4 [1]	5-66506-7 [2]
Unshielded Backshell Kit	748678-1	748678-1
Shielded Backshell Kit	745171-5	745171-5
Ferrules [3]	745508-6	745508-6

[1] Accepts 22-28 AWG wire.

[2] Accepts 20-24 AWG wire.

[3] Ferrules are only required for use with shielded backshell kits.

Wiring Three Phase Power to a Single Phase Ultra5000

Objectives

This appendix discusses connecting single phase Ultra5000 drives to a star (Y) connected three phase power source. The three main aspects of installation are:

- Mandatory Neutral Connection of Isolation Transformer
- Three Phase Line Filtering Requirements for EMC
- Voiding of CE Compliance

ATTENTION

The three phase isolation transformer and neutral in line filter applications described in this document have not been tested for EMC by Rockwell Automation, and products used in such installations are not considered CE marked by Rockwell Automation.

If this three phase isolation transformer and neutral in line filter application is used, the responsibility for EMC validation lies with the user and CE marking of the system becomes the user's responsibility.

If CE compliance is a customer requirement, single phase line filters which have been tested by Rockwell and specified for the product should be used. Refer to AC Line Filters on page C-3.

Applicable Drives

This appendix applies to the following Ultra5000 drives:

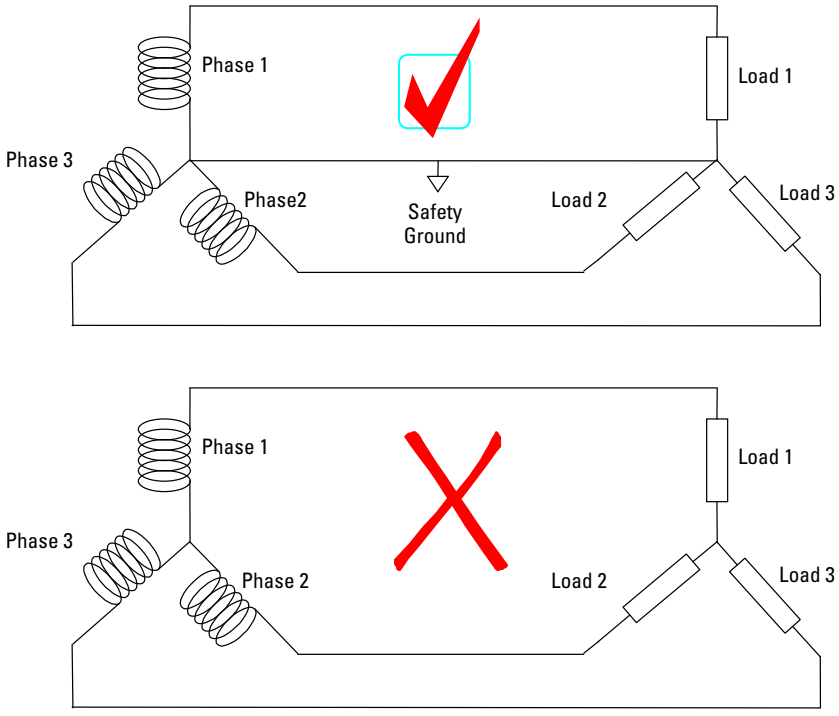
- 2098-IPD-005
- 2098-IPD-010
- 2098-IPD-020
- 2098-IPD-030
- 2098-IPD-005-DN
- 2098-IPD-010-DN
- 2098-IPD-020-DN
- 2098-IPD-030-DN

Mandatory Neutral Connection of Isolation Transformer

A neutral must be connected (shown in the upper diagram of Figure D.1) when single phase drives are attached to a three phase isolating transformer secondary. It is not necessary that all three phases be loaded with drives, but each drive must have its power return via the neutral connection.

Failure to connect the neutral (shown in the lower diagram of Figure D.1) can result in supply voltage swings at the individual loads (i.e., drives). This occurs when the neutral point moves vectorially as a result of load variations normally experienced by the individual drives. The supply voltage swing may cause undervoltage and overvoltage trips on the drives, and the drive can be damaged if the overvoltage limit is exceeded.

Figure D.1
Mandatory Neutral Connection with Safety Ground of Isolation Transformer



Any unbalance in load currents will result in unbalanced voltages which could exceed the voltage limit of the load.

Adding a Safety Ground to the Isolation Transformer

Provided that the transformer used is an isolating transformer, it is a good idea to fit a safety ground to the neutral connection. This will do two things:

1. Prevent the system floating, and thereby avoid any high voltages that might otherwise occur (e.g., through static), and
2. Provides a solid earth path for fault conditions.

ATTENTION

If the supply transformer is an auto transformer, a safety earth ground should not be added.

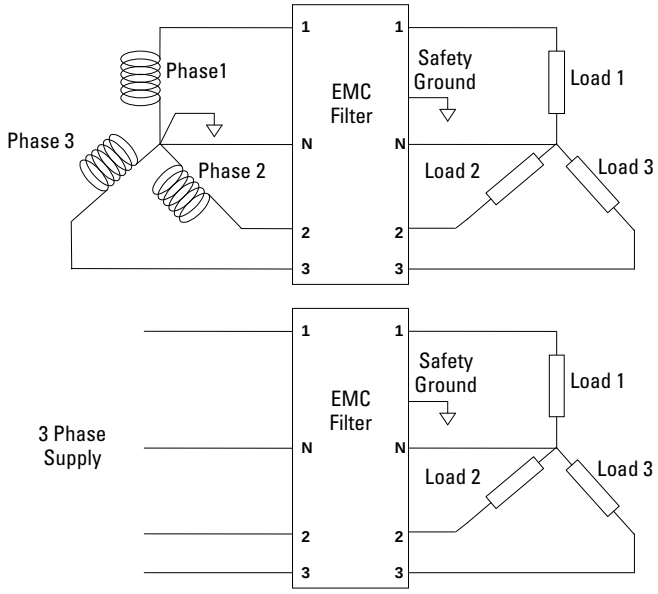
A safety earth ground should already be fitted elsewhere in the system, and fitting another would create a bolted short.

Three Phase Line Filtering Requirements for EMC

If a three phase line filter is used, it is important that the filter include a neutral connection as shown in Figure D.2. This applies if three phase is brought directly into the filter (i.e., no isolating transformer present). The reasons are as follows:

- The normal components in filters of this kind are inductance and capacitance.
- The inductive elements are normally toroids which are placed around the three phases of the device. The neutral will carry return currents due to the unbalanced nature of the loads so it is vital that the neutral return is included in the toroidal inductors. (Note: Toroidal inductors are sometimes referred to as common mode chokes, or ferrite cores.) If the neutral is not included, the net power current through the choke (Kirchoff's Laws) will not be zero which causes the chokes to saturate with a reduction in filtering performance.
- Filters with this design requirement are available (e.g. Schaffner FN 256 three phase and neutral filter). It is important to ensure that the three phase current rating of the filter adequately covers the application requirements.

Figure D.2
Mandatory Neutral Connection of Three Phase Line Filter



Three phase EMC filter feeding multiple single phase loads
A three phase and neutral filter is required

Voiding of CE Compliance

The three phase and neutral in line filter applications described above may not be adequate from an EMC aspect for CE compliance. Therefore EMC validity and CE marking by Rockwell Automation is voided when three phase and neutral in line filters are used.

ATTENTION

The three phase isolation transformer and neutral in line filter applications described in this document have not been tested for EMC by Rockwell Automation, and products used in such installations are not considered CE marked by Rockwell Automation..

If this three phase isolation transformer and neutral in line filter application is used, the responsibility for EMC validation lies with the user and CE marking of the system becomes the user's responsibility.

If CE compliance is a customer requirement, single phase line filters which have been tested by Rockwell and specified for the product should be used. Refer to AC Line Filters on page C-3.

Numerics

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Publication 2098-IN001E-EN-P — April 2002
Supersedes Publication 2098-IN001D-EN-P — January 2002

0013-1079-004