

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

**Artisan Technology Group**
(217) 352-9330 | sales@artisantg.com | artisantg.com

**Full-service, independent repair center**
with experienced engineers and technicians on staff.

**We buy your excess, underutilized, and idle equipment**
along with credit for buybacks and trade-ins.

**Custom engineering**
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

**Expert team | Trust guarantee | 100% satisfaction**

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

**Visit our website - *Click HERE***

# NDRIVE

**USER'S MANUAL**

**P/N: EDU170 (V1.3)**




AEROTECH, Inc. • 101 Zeta Drive • Pittsburgh, PA. 15238-2897 • USA
Phone (412) 963-7470 • Fax (412) 963-7459
Product Service: (412) 967-6440; (412) 967-6870 (Fax)

**www.aerotech.com**

If you should have any questions about the NDrive or comments regarding the documentation, please refer to Aerotech online at:

**http://www.aerotech.com.**

For your convenience, a product registration form is available at our web site.

Our web site is continually updated with new product information, free downloadable software and special pricing on selected products.

The NDrive User's Manual Revision History:

| | |
|---|---|
| V1.0 | April 23, 2002 |
| V1.1 | May 13, 2002 |
| V1.2 | September 3, 2002 |
| V1.3 | November 26, 2002 |

© Aerotech, Inc., 2002

# TABLE OF CONTENTS

**CHAPTER 1: INTRODUCTION** ..... 1-1

1.1. Product Overview ..... 1-1
1.2. Models, Options, and Packages ..... 1-2
1.3. NDrive Package ..... 1-4
1.4. Hardware Overview ..... 1-6

**CHAPTER 2: INSTALLATION AND CONFIGURATION** ..... 2-1

2.1. Introduction ..... 2-1
2.2. Safety Procedures and Warnings ..... 2-1
2.3. Motor and AC Power Connections ..... 2-2
2.4. Wiring, Grounding, and Shielding Techniques ..... 2-3
2.4.1. Minimizing EMI Interference ..... 2-3
2.4.2. AUXPWR (Auxiliary Power) Option ..... 2-4
2.4.3. 40/80 VDC Power Transformers ..... 2-4
2.4.4. Minimizing 50/60 HZ Line Interference ..... 2-5
2.5. Motor and Feedback Connections ..... 2-6
2.5.1. DC Brush Motor Configuration ..... 2-6
2.5.2. Brushless Motor Configuration ..... 2-7
2.5.3. Stepper Motor Configuration ..... 2-8
2.6. Motor Phasing Process ..... 2-9
2.6.1. Determining Phase/Hall Sequence ..... 2-9
2.6.2. Encoder Phasing ..... 2-10
2.7. FireWire Bus (J1, J2, J3) ..... 2-11
2.8. Device Settings ..... 2-14

**CHAPTER 3: TECHNICAL DETAILS** ..... 3-1

3.1. Part Number and Ordering Information ..... 3-1
3.2. RS-232 / RS-422 Port (J5) ..... 3-2
3.3. Secondary Encoder Channel (J6) ..... 3-3
3.4. Motor Feedback (MXH / MXU) (J7) ..... 3-4
3.4.1. Line Driver Encoder (Standard) ..... 3-7
3.4.2. MXH Options ..... 3-8
3.4.3. MXU Options ..... 3-10
3.5. Electrical Specifications ..... 3-11
3.6. NDrive Control Board Assembly ..... 3-12
3.7. NDrive Power Board Assembly ..... 3-14
3.8. LED Indicators ..... 3-16
3.9. NDrive Dimensions ..... 3-17

**CHAPTER 4: NDRIVE OPTIONS** ..... 4-1

4.1. Introduction ..... 4-1
4.2. -IOPSO# Option Board ..... 4-2
4.2.1. Brake Configuration Jumpers ..... 4-2
4.2.2. Analog Outputs (TB3) ..... 4-3
4.2.3. Brake / Relay (TB3) ..... 4-4
4.2.4. Analog Inputs (TB4) ..... 4-5
4.2.5. User Power Connector (TB5) ..... 4-6
4.2.6. Opto-Isolated Outputs (TB6) ..... 4-6

4.2.7. Opto-Isolated Inputs (TB7) ..... 4-9
4.2.8. Laser Firing / Position Synchronized Output (PSO) ..... 4-10
4.2.8.1. Single Axis Laser Firing ..... 4-14
4.2.8.2. Two/Three-Axis Laser Firing ..... 4-15
4.2.9. PSO / Absolute Encoder Interface (J8) ..... 4-16
4.2.10. SSINet (2 channel) (J9, J10) ..... 4-20
4.3. Ethernet (J4) ..... 4-22
4.4. Joystick Interface ..... 4-23

**CHAPTER 5: TROUBLESHOOTING** ..... 5-1

5.1. Problems, Causes, and Solutions ..... 5-1
5.2. Fault Status Display ..... 5-2
5.3. NDrive Control Board Test Points ..... 5-3
5.4. JTAG Programming Connector ..... 5-4
5.5. Using the RS-232 Boot Loader on the NDrive ..... 5-5
5.5.1. Setup ..... 5-5
5.5.2. Loading Code ..... 5-5
5.5.3. When finished loading ..... 5-6
5.6. Fuse / Battery Replacement ..... 5-7
5.7. Preventative Maintenance ..... 5-8
5.7.1. Cleaning ..... 5-8

**APPENDIX A: GLOSSARY OF TERMS** ..... A-1

**APPENDIX B: WARRANTY AND FIELD SERVICE** ..... B-1

**INDEX**

**REVISION HISTORY**

∇ ∇ ∇

# LIST OF FIGURES


Figure 1-1. NDrive Networked Digital Drives ..... 1-1
Figure 1-2. Functional Diagram ..... 1-4
Figure 1-3. PSO Diagram – Basic Single Axis Firing ..... 1-5
Figure 1-4. NDrive Hardware ..... 1-6

Figure 2-1. AUXPWR Option ..... 2-4
Figure 2-2. Back-Propagation Line Filter Connection ..... 2-5
Figure 2-3. Isolation Transformer Connection (eliminates 50/60 Hz AC Coupling) ..... 2-5
Figure 2-4. DC Brush Motor Configuration ..... 2-6
Figure 2-5. Brushless Motor Configuration ..... 2-7
Figure 2-6. Stepper Motor Configuration ..... 2-8
Figure 2-7. Motor Phasing ..... 2-10
Figure 2-8. Encoder Phasing Reference Diagram ..... 2-10
Figure 2-9. FireWire Daisy Chain ..... 2-13
Figure 2-10. Recommended Star Daisy Chain Configuration ..... 2-13

Figure 3-1. RS-232/RS-422 Connector (J5) ..... 3-2
Figure 3-2. Secondary Encoder Channel (J6) ..... 3-3
Figure 3-3. Limit and Hall Effect Inputs (J7) ..... 3-5
Figure 3-4. Optional MXH / MXU Analog Encoder Interface (J7) ..... 3-6
Figure 3-5. Line Driver Encoder Interface (Standard) J7 ..... 3-7
Figure 3-6. NDrive Control Board Assembly ..... 3-12
Figure 3-7. NDrive Power Board Assembly ..... 3-14
Figure 3-8. NDrive Dimensions (Front) ..... 3-17
Figure 3-9. NDrive Dimensions (Front and Side) ..... 3-18

Figure 4-1. –IOPSO# Option Board ..... 4-2
Figure 4-2. Analog Output Connector (TB3) ..... 4-3
Figure 4-3. Brake / Relay Connector (TB3) ..... 4-4
Figure 4-4. Optional Analog Input Connector (TB4) ..... 4-5
Figure 4-5. Connecting Outputs in Current Sinking Mode (-IOPSO, -IOPSO2) ..... 4-7
Figure 4-6. -IOPSO, -IOPSO2 Sinking Outputs (TB6) ..... 4-7
Figure 4-7. Connecting Outputs in Current Sourcing Mode (-IOPSO3, -IOPSO4) ..... 4-8
Figure 4-8. -IOPSO3, -IOPSO4 Sourcing Outputs (TB6) ..... 4-8
Figure 4-9. Connecting Inputs ..... 4-9
Figure 4-10. Opto-Isolated Input Connector (TB7) ..... 4-10
Figure 4-11. Advanced 1 - 3 Axis Firing ..... 4-12
Figure 4-12. Data Capture/Data Update Modes ..... 4-13
Figure 4-13. PSO Diagram – Basic Single Axis Firing ..... 4-14
Figure 4-14. Two/Three Axis Laser Firing Interconnection ..... 4-15
Figure 4-15. Absolute Encoder Interface (J8) ..... 4-17
Figure 4-16. PSO Interface (J8) ..... 4-18
Figure 4-17. Interfacing to RS-422 or Open-Collector Laser Firing Signal ..... 4-18
Figure 4-18. (RS-485) Absolute Encoder Interface (J8) ..... 4-19
Figure 4-19. J8/J9/J10 ..... 4-21
Figure 4-20. Ethernet Interface (J4) ..... 4-22

Figure 4-21. Joystick Interface ..... 4-23

∇ ∇ ∇

# LIST OF TABLES

Table 1-1. NDrive Models and Voltage Configurations ..... 1-2

Table 2-1. TB2 Main AC Power Input and Motor Power Output ..... 2-2
Table 2-2. TB1 Optional AC Power Supply Input (required for <70 VAC at TB2) ..... 2-2
Table 2-3. J1, J2, J3 FireWire Connector Pinouts ..... 2-11
Table 2-4. FireWire Card and Cable Part Numbers ..... 2-12
Table 2-5. NDrive Switch Settings (S2) ..... 2-14

Table 3-1. Ordering Information ..... 3-1
Table 3-2. J5 RS-232 / RS-422 Connector Pinouts ..... 3-2
Table 3-3. J6 Auxiliary I/O Connector Pinouts ..... 3-3
Table 3-4. Motor Feedback Connector Pinouts (J7) ..... 3-4
Table 3-5. MXH Multiplier Specifications (when output is via the SSINet) ..... 3-9
Table 3-6. Electrical Specifications ..... 3-11
Table 3-7. NDrive Control Board Jumper Selections ..... 3-13
Table 3-8. NDrive Power Board Jumper Selections ..... 3-15
Table 3-9. NDrive Power Board Fuse Information ..... 3-15
Table 3-10. LED Indicator Description ..... 3-16

Table 4-1. NDrive Options and Capabilities ..... 4-1
Table 4-2. –IOPSO# Option Board Jumpers ..... 4-2
Table 4-3. Analog Output Connector Pinouts (TB3) ..... 4-3
Table 4-4. Brake / Relay Connector Pinouts (TB3) ..... 4-4
Table 4-5. Voltage and Current Specifications (TB3) ..... 4-4
Table 4-6. Optional Analog Input Connector Pinouts (TB4) ..... 4-5
Table 4-7. User Power Connector Pinouts (TB5) ..... 4-6
Table 4-8. Opto-Isolated Output Connector Pinouts (TB6) ..... 4-6
Table 4-9. Output Specifications (TB6) ..... 4-6
Table 4-10. Opto-Isolated Input Connector Pinouts (TB7) ..... 4-9
Table 4-11. Laser Output Opto-Isolator Specifications ..... 4-11
Table 4-12. SSINet Cable Part Numbers ..... 4-15
Table 4-13. PSO / Absolute Encoder Interface Connector Pinouts (J8) ..... 4-16
Table 4-14. Laser Output Opto-Isolator Specifications ..... 4-17
Table 4-15. J9, J10 2-Channel SSINet Connector Pinouts ..... 4-20
Table 4-16. Ethernet Connector Pinouts (J4) ..... 4-22

Table 5-1. Amplifier Faults, Causes, and Solutions ..... 5-1
Table 5-2. 7 Segment Fault Status Display ..... 5-2
Table 5-3. NDrive Control Board Test Points ..... 5-3
Table 5-4. JTAG Programming Connector – Internal (P10) ..... 5-4
Table 5-5. Fuse Replacement Part Numbers (NDrive Power Board) ..... 5-7
Table 5-6. Battery Replacement Part Number (NDrive Control Board) ..... 5-7
Table 5-7. Preventative Maintenance ..... 5-8

Table R-1. Revisions ..... R-1

∇ ∇ ∇

# DECLARATION OF CONFORMITY

**Manufacturer's Name and Address**

Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238-2897

Declares that the product:

**Product Name:** NDrive

Conforms to the following product specifications:

| | | |
|---|---|---|
| **EMC:** | EN 61800-3:1997 | Class A Emissions |
| | EN 61326-1:1997 | Class A Emissions |
| | EN 55011:1998 | RFI Limits and Measurement |
| | EN 61000-3-2:1995 | Harmonic Current Emissions |
| | EN 61000-3-3:1995 | Voltage Fluctuation and Flicker |
| | EN 61000-4-2:1995 | ESD Immunity |
| | EN 61000-4-3:1995 | Radiated RFI/EMI Immunity |
| | EN 61000-4-4:1995 | EFT/Burst Immunity |
| | EN 61000-4-5:1995 | Surge Immunity |
| | EN 61000-4-6:1995 | Conducted Immunity |
| | EN 61000-4-11:1995 | Voltage Dips and Interruptions |
| **Safety:** | EN 61010-1:1993 | Safety Requirements |

and complies with EMC directive 89/336/EEC and 73/23/EEC low voltage directive.

Pittsburgh, PA
April, 2002

David F. Kincel
Quality Assurance Manager

Alex Weibel
Engineer Verifying Compliance

**General notes concerning the test setup.**

This product was tested at F-Squared Laboratories, in Burton, OH on April 16-18, 2002. The report numbers are NY011602-01-01E and NY011602-01-02E.

The NDrive was tested while powered from a 230VAC source with a brushless servomotor, connected via PMC-15 and BFC-15 (15 foot) cables. In order for the product to conform to the radiated emission standards, the motor cable must be shielded and the shield must be connected to the earth ground. A metal D-style connector with a metal backshell must be used when connecting to the D-style connectors on the NDrive. The shield of the feedback cable must be connected to the metal backshell.

The following modifications ensure compliance:

- Install a Ferrishield ferrite, P/N SS2034, on the Fire wire cable at the unit.
- Install a Curtis, P/N F1600CA-10, EMI line filter to the AC input.
- Install two Ferrishield ferrites, P/N SS2032 and CS1984, between the unit and the Curtis EMI line filter.
- Connect earth ground to the mounting screw at the AC input.
- Install a SCI, 25 pin, D-style, EMI filter adapter, P/N SCI-56-725-0, in series with the motor feedback cable at the unit.

Failure to follow the described procedures may cause excessive emissions or reduced immunity.

∇ ∇ ∇

# CHAPTER 1: INTRODUCTION

**In This Section:**


- Product Overview ..... 1-1
- Models, Options, and Packages ..... 1-2
- NDrive Package ..... 1-4
- Hardware Overview ..... 1-6


## 1.1. Product Overview

Aerotech's Network Digital Drives (NDrive) complement the Automation 3200 System (see Figure 1-1). Connected via the IEEE-1394 (FireWire®) communication bus, these drives provide deterministic behavior, auto-identification, and easy software setup from the NMotion SMC software controller. Featuring a high-speed Harvard architecture DSP, the drives have fully digital current and servo loops providing selectable 1-20 kHz servo loop closure, 40 MHz line driver encoder data rate, and an optional Ethernet port for access to third part networked I/O solutions. The NDrive also features an optional on-board brake relay, programmable resolution multiplication up to x 65,536, with a 200 kHz maximum amplified sine wave input frequency, and up to three-axis Position Synchronized Outputs (laser firing). In addition, the use of the commercially standard FireWire communication link makes integration to the Automation 3200 network plug-n-play easy.




**Figure 1-1. NDrive Networked Digital Drives**

## 1.2. Models, Options, and Packages

The NDrive is available in three models with continuous power, ranging from 1,360 to 4,080 watts. A list of these models, and the available voltage configurations, are shown in Table 1-1

**Table 1-1. NDrive Models and Voltage Configurations**

| Model | Peak Output Current | Continuous Output Current (peak) |
|---|---|---|
| NDRIVE10B | 10A | 5A |
| NDRIVE20B | 20A | 10A |
| NDRIVE30B-S | 30A | 15A |
| **Control Board Options** | | |
| -IOPSO | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sinking), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, single axis PSO, and brake relay | |
| -IOPSO2 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sinking), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, dual axis PSO, and brake relay | |
| -IOPSO3 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sourcing), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, single axis PSO, and brake relay | |
| -IOPSO4 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sourcing), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, dual PSO, and brake relay | |
| -PSOOPTO1 | Opto isolator for PSO, requires IOPSO*x* option (<+5V, high speed, high current, HCPL2601) | |
| -PSOOPTO2 | Opto isolator for PSO, requires IOPSO*x* option (<+15V, high speed, low current, 6N136) | |
| -PSOOPTO3 | Opto isolator for PSO, requires IOPSO*x* option (<+30V, low speed, high current, 4N33) | |
| -MXU4096 | Programmable encoder multiplier up to x 4,096, does not support single/dual axis PSO or quadrature output | |
| -MXU65536 | Programmable encoder multiplier up to x 65,536, does not support single/dual axis PSO or quadrature output | |
| -MXH | Programmable encoder multiplier up to x 2,048, supports single/dual axis PSO and encoder quadrature output | |
| -ENET | 10/100BASE-T Ethernet port | |
| **Power Board Options** | | |
| -S | Shunt resistor network | |
| -AUXPWR | Auxiliary 115/230 VAC input to power logic circuitry. Required for "keep alive" or 20-80 VDC bus operation. 20-80 VDC operation requires external transformer to generate 15-60 VAC bus power input. | |
| -HS | Heat sink with fins | |
| -3P | 3 Phase AC input | |

**Feature Summary:**

- Software configurable for brush, brushless and stepper motor operation
- Standard 100 VDC – 320 VDC, optional 20 VDC – 80 VDC
- Fully isolated power stage
- 5 VDC, 500 mA output for power encoder and Hall effect signals
- Two mounting orientations optimized for heat transfer or minimal panel space utilization
- Full protection against the following failure modes:
    1. Control supply under voltage
    2. Continuous current overload
    3. Power stage bias supply under-voltage
    4. Power stage output short circuit (phase to phase and phase to ground)
    5. DC bus over voltage
    6. IGBT device over temperature
- Line driver square wave or analog sine wave quadrature encoder primary position and velocity feedback
- Line driver square wave auxiliary quadrature encoder input

## 1.3. NDrive Package

The standard package includes the bus power supply that operates from 70-230 VAC (100 – 320 VDC). The power supply is included with the standard package for off-line operation without the need for an isolation transformer. Figure 1-2 is a functional diagram including options. In addition, a soft start circuit is included to prevent high inrush currents.

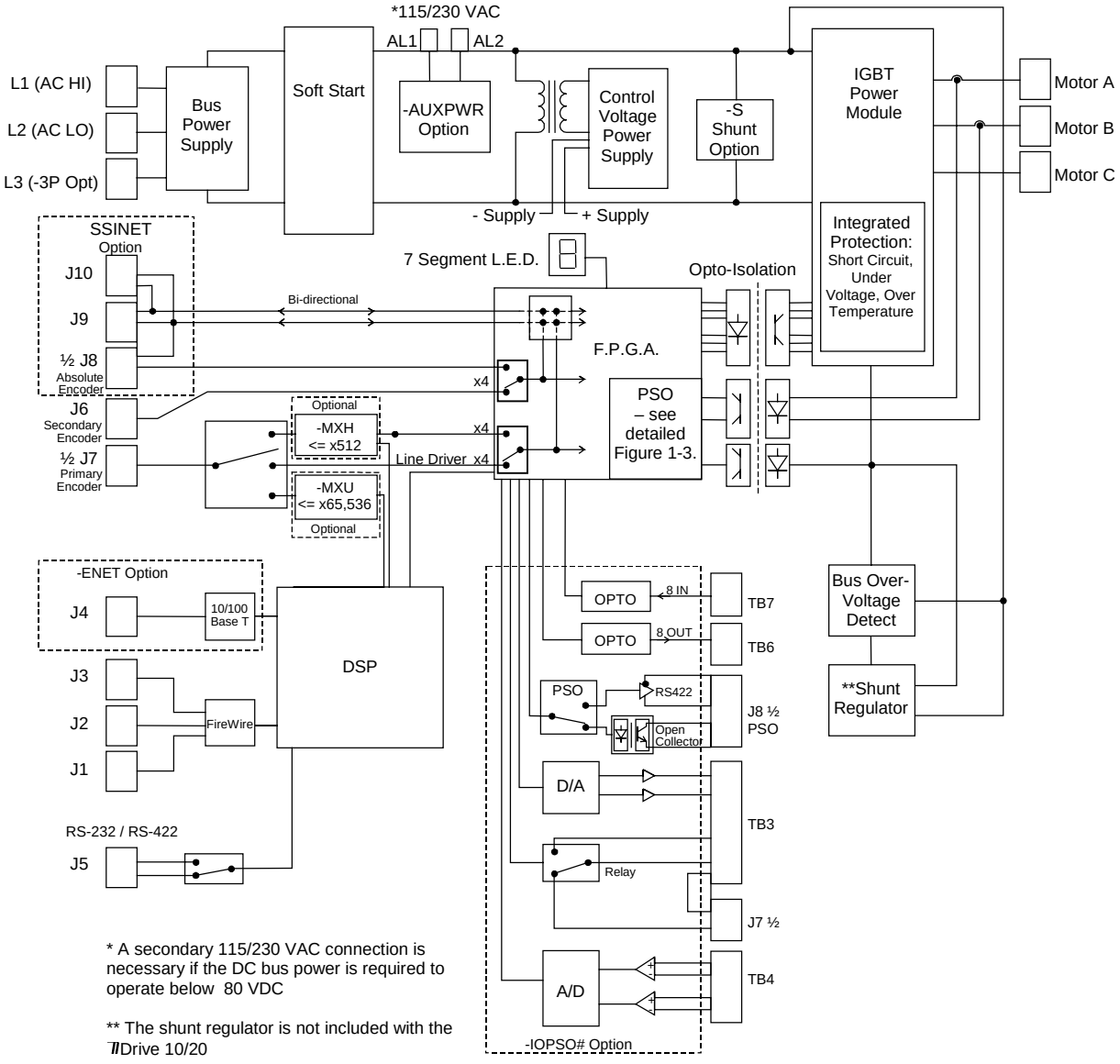



**Figure 1-2. Functional Diagram**

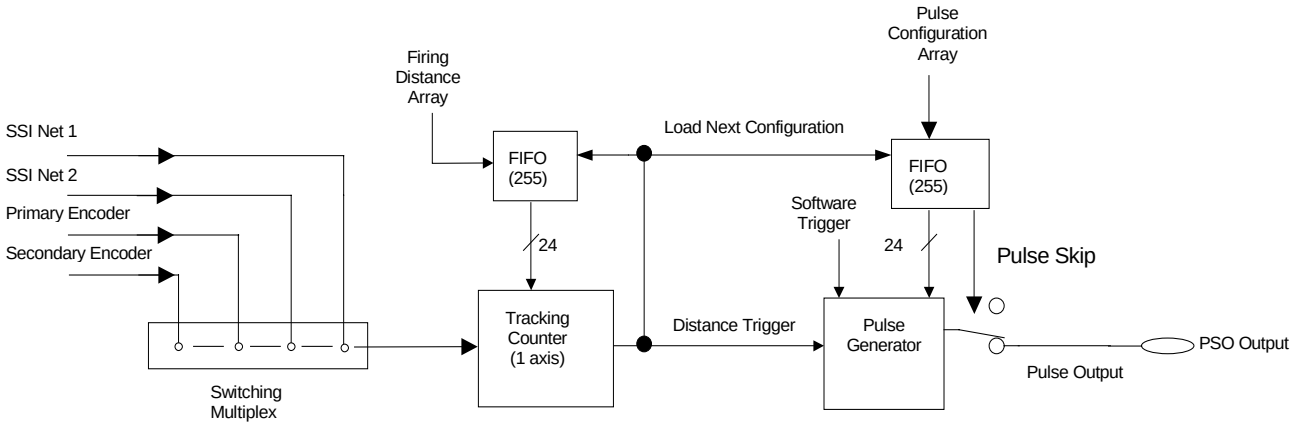



**Figure 1-3. PSO Diagram – Basic Single Axis Firing**

## 1.4. Hardware Overview

The NDrive consists of two power connections (motor power and input power), three FireWire ports an optional Ethernet connection, an RS-232/RS-422 connector, a 7 segment Fault Status display, LED indicator lamps, and two D-Style connectors for Auxiliary I/O (9-pin) and Motor Feedback (25 pin). An IOPSO# option is also available, which has connectors for PSO, absolute encoder, SSINet, analog I/O, digital I/O, and user power. Refer to Figure 1-4 for locations.

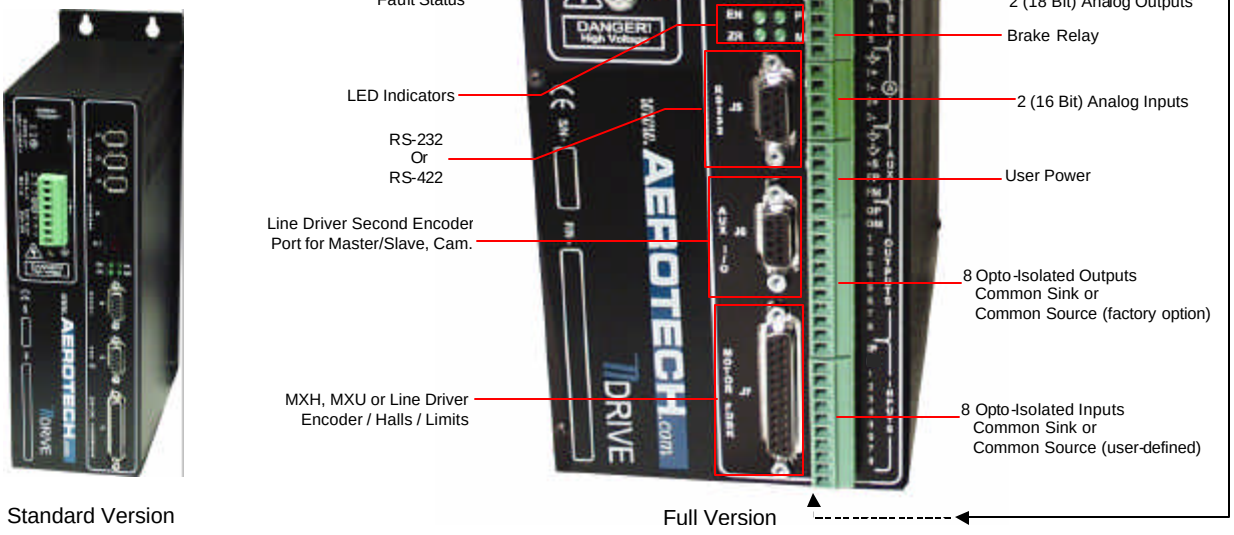



**Figure 1-4. NDrive Hardware**

∇ ∇ ∇

# CHAPTER 2: INSTALLATION AND CONFIGURATION

**In This Section:**


- Introduction .....2-1
- Safety Procedures and Warnings.....2-1
- Motor and AC Power Connections.....2-2
- Wiring, Grounding, and Shielding Techniques .....2-3
- Motor and Feedback Connections.....2-6
- Motor Phasing Process.....2-9
- FireWire Bus (J1, J2, J3).....2-11
- Device Settings.....2-14


## 2.1. Introduction

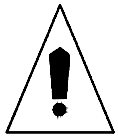
This section covers the hardware configurations using the switches, jumpers, connectors, and power hook-ups when used with a brush, brushless, or stepper motor. Wiring, grounding, shielding techniques, and the motor phasing process are also covered.

Aside from the obvious requirements of AC input and motor wiring, the only other typical requirement is to set the NDrive's number via switch S2.

## 2.2. Safety Procedures and Warnings

The following statements apply wherever the Warning or Danger symbol appears within this manual. Failure to observe these precautions could result in serious injury to those performing the procedures and/or damage to the equipment.

To minimize the possibility of electrical shock and bodily injury, ensure that the motor is decoupled from the mechanical system and no harm to personnel will result if the motor begins to spin.

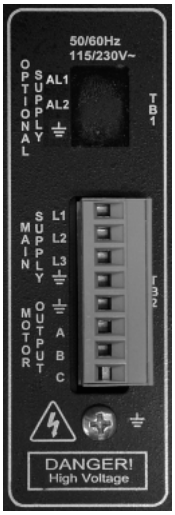



To minimize the possibility of electrical shock and bodily injury when any electrical circuit is in use, ensure that no person is exposed to the circuitry.



To minimize the possibility of bodily injury, make certain that all electrical power switches (all switches external to the amplifier) are in the off position prior to making any mechanical adjustments.






## 2.3. Motor and AC Power Connections

The three-phase motor terminal connections are made at connections **A, B,** and **C**.

Input power to the NDrive is made at the **L1** and **L2** terminals with earth ground connected to ⏚ (ground). Motor frame and shield connect to ⏚ (ground) as well. A three-phase power input is also available (**L3**).

**Table 2-1. TB2 Main AC Power Input and Motor Power Output**

| Pin # | Description | In/Out/Bi. |
|---|---|---|
| L1 | 115/240 Volt AC Input | Input |
| L2 | 115/240 Volt AC Input | Input |
| L3 | Optional 3-Phase AC Input* | Input |
| GND | From Earth Ground (Required for Safety) | Input |
| GND | Earth Ground to Motor (Required for Safety) | Input |
| ØA | Phase A Motor Power | Output |
| ØB | Phase B Motor Power | Output |
| ØC | Phase C Motor Power | Output |

If the AC bus input power is less than 70 VAC at TB2 **L1**, **L2** (or **L3**), the optional control power input must be used (**TB1**)**

**Table 2-2. TB1 Optional AC Power Supply Input (required for <70 VAC at TB2)**

| Pin # | Description | In/Out/Bi. |
|---|---|---|
| AL1 | Optional 115/230 VAC Control Power Input | Input |
| AL2 | Optional 115/230 VAC Control Power Input | Input |
| GND | From Earth Ground (Required for Safety) | Input |

* –3P option
** –AUXPWR option

## 2.4. Wiring, Grounding, and Shielding Techniques

To reduce electrical noise in the NDrive, the user should observe the motor and input power wiring techniques explained in the following sections (suitable for use on a circuit capable of delivering not more than 5,000A, 240V).

### 2.4.1. Minimizing EMI Interference

The NDrives are high efficiency PWM amplifiers operating at a 20 kHz switching rate.

This switching rate can generate Electromagnetic Interference (EMI) into the MHz band. To minimize this EMI, it is recommended that the motor leads be twisted together with the motor cable grounding wire and surrounded with a foil or braided shield.

In addition to the EMI effects, electro-static (capacitive) coupling to the motor frame is very high, requiring the frame to be grounded in order to eliminate a shock hazard. Additional electro-static coupling exists between the three twisted motor leads and the foil shield of the motor cable.

This coupling forces high frequency currents to flow through the returning earth ground of the motor cable. To minimize this problem and maintain low levels of EMI radiation, perform the following.

1. Use shielded cable to carry the motor current and tie the shield to earth ground.
2. Use a cable with sufficient insulation. This will reduce the capacitive coupling between the leads that, in turn, reduces the current generated in the shield wire.
3. Provide strong earth ground connections to the amplifier, additional heat sink, and the motor. Offering electrical noise a low impedance path to earth ground not only reduces radiated emissions, but also improves system performance.
4. If possible, do not route motor cables near cables carrying logic signals and use shielded cable to carry logic signals.

### 2.4.2. AUXPWR (Auxiliary Power) Option

If a NDRIVEXXB-AUXPWR amplifier was purchased, a separate AC input (TB1) has been included on the amplifier. The internal power supply of the NDrive requires a minimum of 70 VAC input to operate properly. The figure below shows the connection to the separate AC power board. The connection is made to the AC input board with a three terminal connector (Aerotech Part #ECK00213), provided.

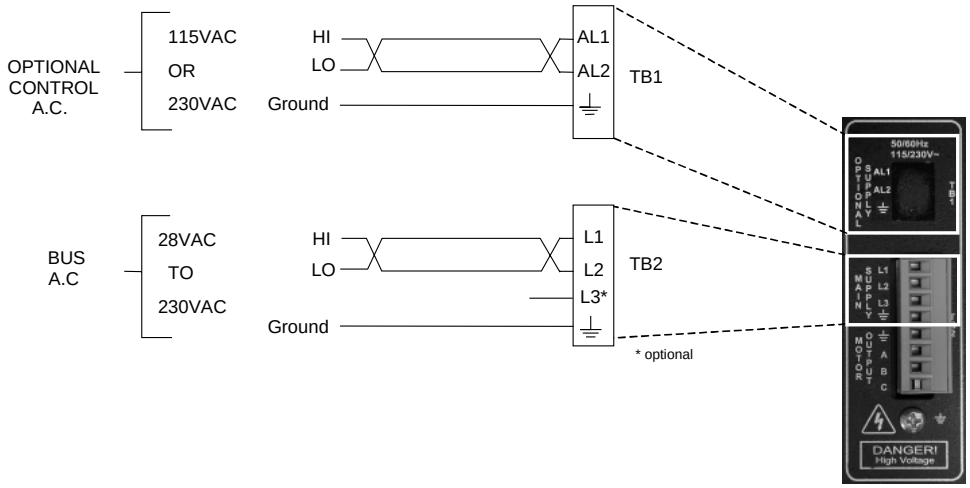



**Figure 2-1. AUXPWR Option**

### 2.4.3. 40/80 VDC Power Transformers

The TV0.3-56 power transformer is an optional accessory for the NDrive. The transformer allows the generation of 56 VAC from a 115 VAC and 230 VAC source respectively. When rectified by the NDrive, 56 VAC yields an 80 VDC power bus.

The TV0.3-28 power transformer is an optional accessory available for the NDrive. This transformer allows for the generation of 28 VAC from a 115 VAC or 230 VAC source, respectively. When rectified by the NDrive, 28 VAC yields a 40 VDC power bus.

### 2.4.4. Minimizing 50/60 HZ Line Interference

Operating the NDrive from an off-line source of 115 VAC or 230 VAC may create some additional issues.

First, there is a potential problem of EMI generated from the switching power stage of the NDrive propagating through the bridge rectifier and out through the **L1** and **L2** input AC line connections. Back-propagation of noise into the AC lines can be minimized using a line filter. An example of such a filter and proper connection to the NDrive is shown in Figure 2-2.

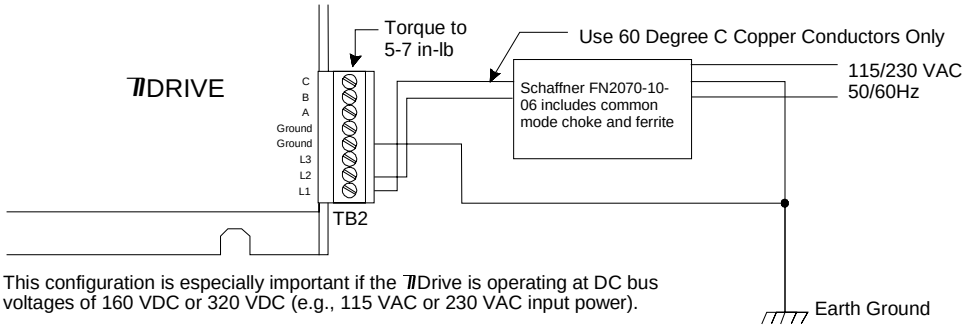



**Figure 2-2. Back-Propagation Line Filter Connection**

Second, a potential problem that exists with off line connections is 50/60 Hz electrostatic coupling between the frame of the AC motor and the **L1/L2** AC input power. Since **L1** is referenced to earth ground at the source, the DC bus of the amplifier "swings" at 50/60 Hz with respect to the motor frame.

The path of current caused by this coupling between the motor frame and the amplifier stage passes through the current feedback sensing devices of the amplifier. Depending on the magnitude of this current, a 50/60 Hz disturbance may be visible in the position error.

To eliminate this problem, an isolation transformer can be used to block the 50/60 Hz from being seen by the motor frame. Refer to Figure 2-3 for connection of this transformer.

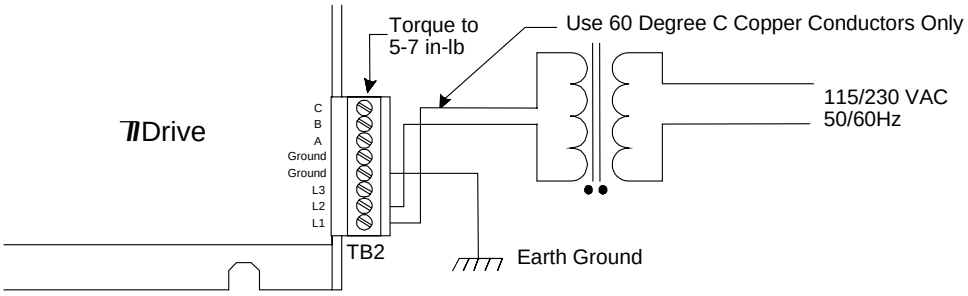



**Figure 2-3. Isolation Transformer Connection (eliminates 50/60 Hz AC Coupling)**

## 2.5. Motor and Feedback Connections

The NDrive can be integrated into a system using three basic configurations: DC Brush, brushless, and stepper motors. Each may have one or two feedback devices.

### 2.5.1. DC Brush Motor Configuration

The DC brush motor configuration is shown in Figure 2-4. See section 2.6.2. for the correct encoder phasing information if Aerotech's standard cabling is not used. Note that the tachometer feedback is not supported.

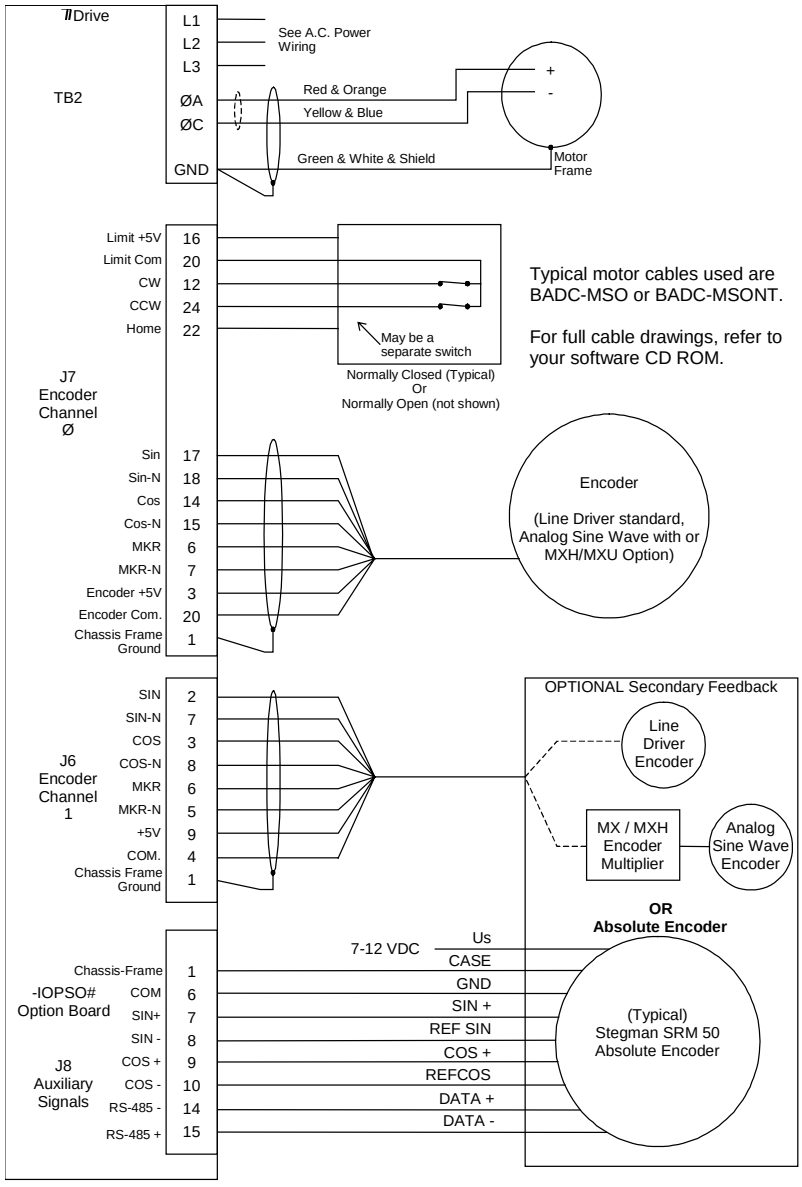



**Figure 2-4. DC Brush Motor Configuration**

## 2.5.2. Brushless Motor Configuration

This mode is used with a brushless motor only. See section 2.6., if Aerotech's standard cabling is not used, for information on correctly phasing the motor, encoder and Hall feedback devices.

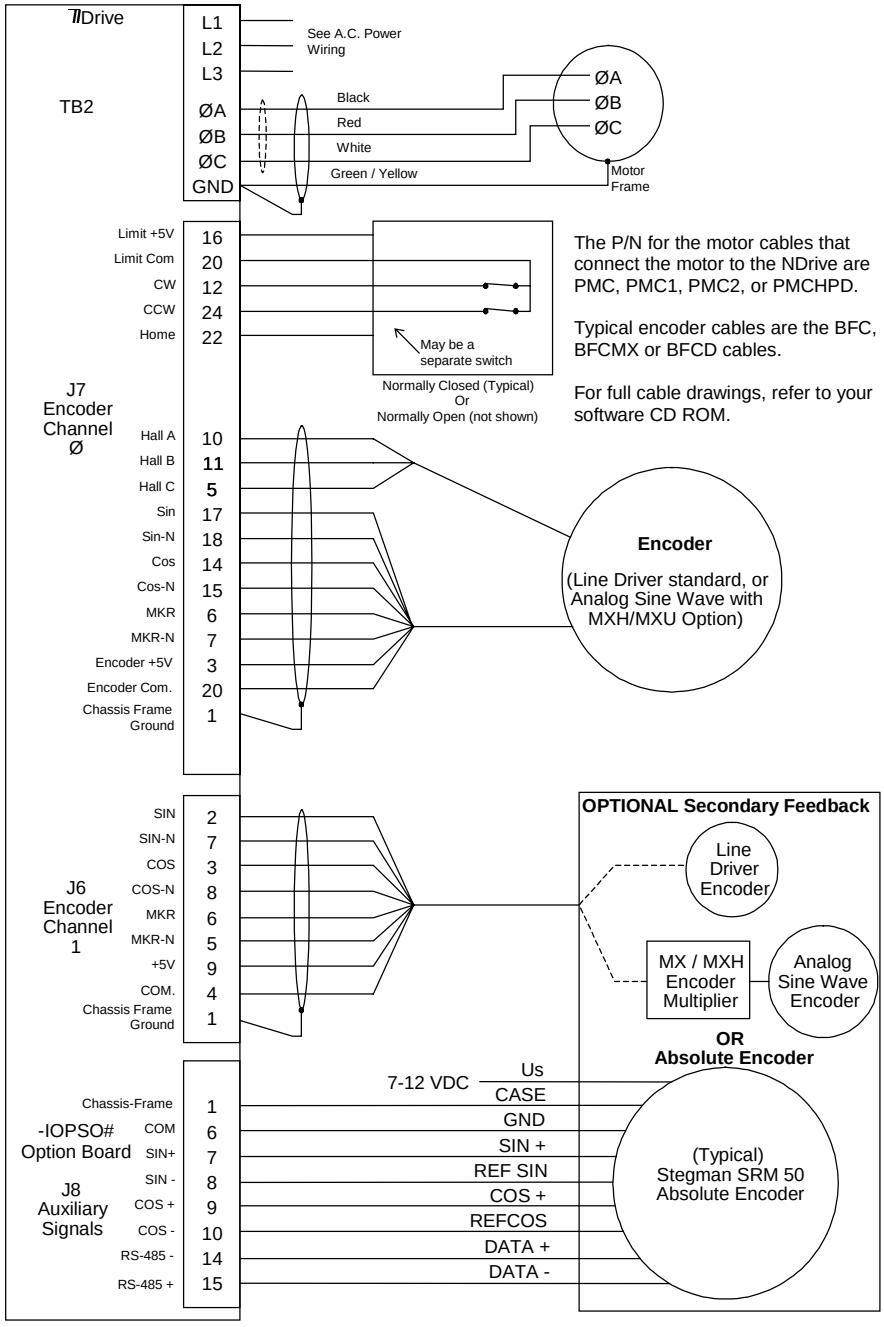



**Figure 2-5. Brushless Motor Configuration**

### 2.5.3. Stepper Motor Configuration

This mode is used with a stepper motor only. See section 2.6.2., if Aerotech's standard cabling is not used, for information on correctly phasing the motor feedback devices.

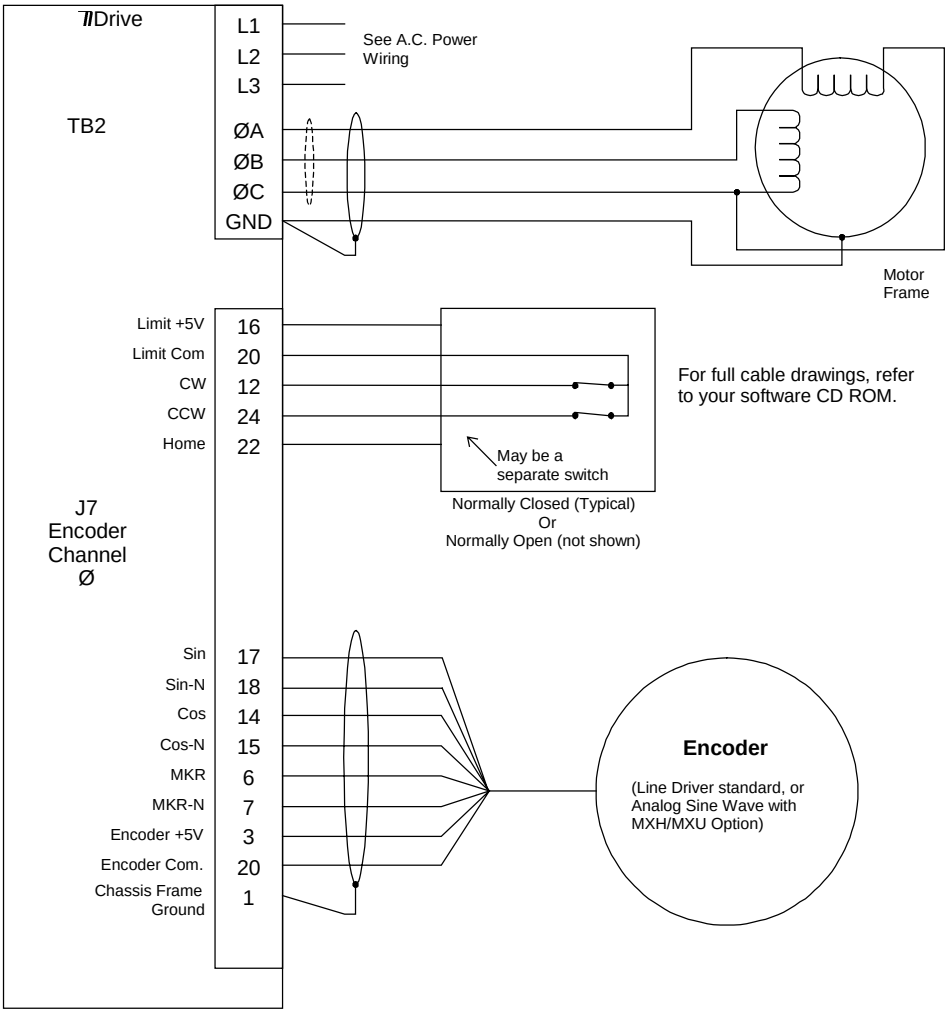



**Figure 2-6. Stepper Motor Configuration**

## 2.6. Motor Phasing Process

When configuring the NDrive to run a non-Aerotech brushless motor, the commutation signal input connections (labeled HALL A, B, C on connector J7 pins 10, 5, and 11) are typically required. These sequences and the generated output motor phase voltages (motor output connections A, B, and C) are shown in Figure 2-7. The voltages generated are made under the conditions of a positive rotation signal commanded. A "0" for the given HALL input indicates zero voltage or logic low, where a "1" indicates five volts or logic high.

If an Aerotech brushless motor is used with the NDrive, motor phase and HALL connections can be easily determined by referring to the system interconnection drawing in Figure 2-5.

### 2.6.1. Determining Phase/Hall Sequence

For a motor with an unknown phase/hall sequence, a simple test can be performed on the motor to determine the proper connections to the NDrive.

Before performing the following steps, ensure that the motor leads are completely disconnected from the amplifier.

WARNING

The tests outlined below do not require that the amplifier be turned on since Figure 2-7 illustrates the generated output voltage of the amplifier relative to the input Hall sequences.

The equipment needed for this test is a two-channel oscilloscope and three resistors (typically 10 K ohm, 1/2 watt) wired in a "Wye" configuration.

Connect the ends of the three resistors to motor terminals A, B, C. Use one channel of the oscilloscope to monitor motor terminal A with respect to the "Wye" neutral (eg., the point where all three resistors are connected together). Turn the shaft of the motor CCW and note the generated voltage. This voltage represents the "phase A to neutral" Counter EMF (CEMF). With the second oscilloscope probe, determine the Hall switch that is "in phase" with this voltage. Similarly, phase B and C should be aligned with the other two Hall switches.

Refer to Figure 2-7 and note the generated output voltages of the amplifier relative to the Hall sequences applied to **HALL A, HALL B,** and **HALL C** connections at connector **J7**. For proper operation, the CEMF generated motor phase voltages should be aligned to the amplifier's output generated voltage with the given Hall effect sequence shown in Figure 2-7.

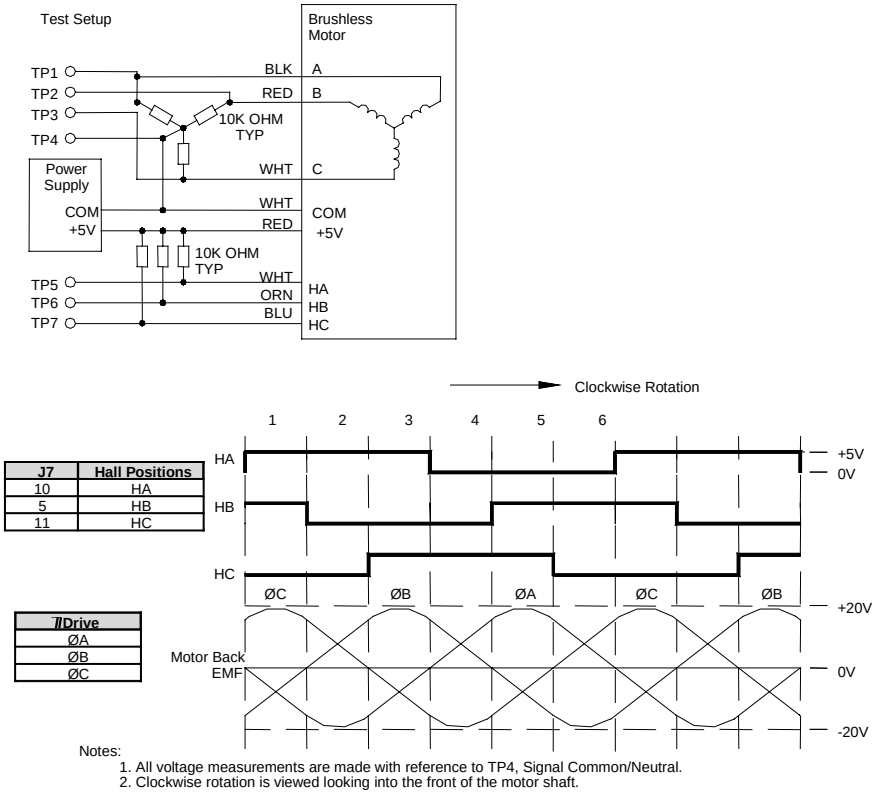



**Figure 2-7. Motor Phasing**

## 2.6.2. Encoder Phasing

Figure 2-8 illustrates the required encoder phasing for clockwise motor rotation, or positive forcer movement, through the stationary magnet track.

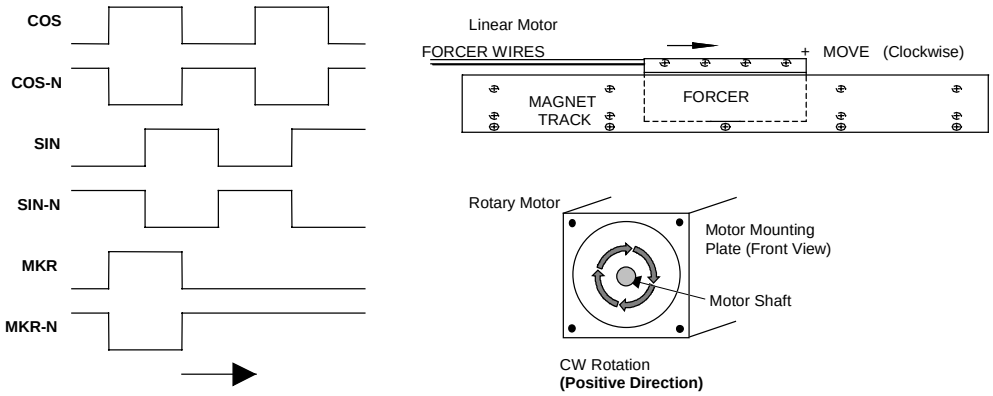



**Figure 2-8. Encoder Phasing Reference Diagram**

## 2.7. FireWire Bus (J1, J2, J3)




The FireWire bus is the high-speed communications media to the NDrive, operating at 400 megabits per second. All command and configuration information is sent via the FireWire. All three ports are effectively in parallel, allowing any port to be used when daisy-chaining the NDrive's together or with other devices such as the NPaq (as shown in Figure 2-9). The FireWire bus power is independent of the NDrive power, should the drive fail, communication will be maintained with the other devices.

**Table 2-3. J1, J2, J3 FireWire Connector Pinouts**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Bus Power | FireWire Adapter Power | In/Out |
| 2 | Physical Ground | FireWire Common (Isolated from Signal Common) | N/A |
| 3 * | TPB# – | Port # Communication Signal | Bidirectional |
| 4 * | TPB# + | Port # Communication Signal | Bidirectional |
| 5 * | TPA# – | Port # Communication Signal | Bidirectional |
| 6 * | TPA# + | Port # Communication Signal | Bidirectional |
| 7 | Frame | Chassis Frame | N/A |
| 8 | Frame | Chassis Frame | N/A |
| 9 | Frame | Chassis Frame | N/A |

* Port 0, 1, and 2, respectively, as represented in the table by a " # ".

The FireWire connector's J1-J3 have pin 1, the power pin, protected by a resettable fuse. Should an over-current condition occur, the device will open, to protect against the overload. To reset the device, remove the overload condition.




Before connecting any device to the FireWire bus, the device should be powered up and check out independently to prevent damaging linked equipment.



NDrives and NPaqs should always have their FireWire cables connected in a star configuration to minimize the FireWire cable lengths, see Figure 2-10.

Following is a chart showing the part numbers of the FireWire Bus PCI card and the various interconnect cables and their part numbers. The 4 pin to 6 pin cables are used with laptop PCs.

**Table 2-4. FireWire Card and Cable Part Numbers**

| Part Number | Description |
|---|---|
| NFire-PCI | FireWire OHCI compliant PCI interface card |
| NConnect-4500-66 | FireWire cable, 4.5 M (15 feet) long, 6 pin to 6 pin |
| NConnect-4500-46 | FireWire cable, 4.5 M (15 feet) long, 4 pin to 6 pin |
| NConnect-1800-66 | FireWire cable, 1.8 M (6 feet) long, 6 pin to 6 pin |
| NConnect-1800-46 | FireWire cable, 1.8 M (6 feet) long, 4 pin to 6 pin |
| NConnect-900-66 | FireWire cable, 900 mm (3 feet) long, 6 pin to 6 pin |
| NConnect-900-46 | FireWire cable, 900 mm (3 feet) long, 4 pin to 6 pin |
| NConnect-228-66 | FireWire cable, 228 mm (9 inches) long, 6 pin to 6 pin |

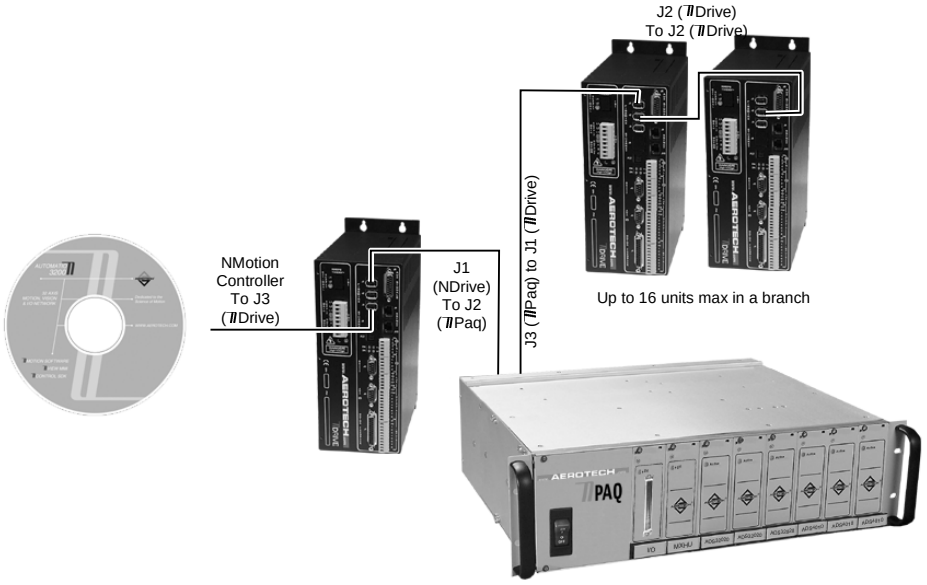



**Figure 2-9. FireWire Daisy Chain**

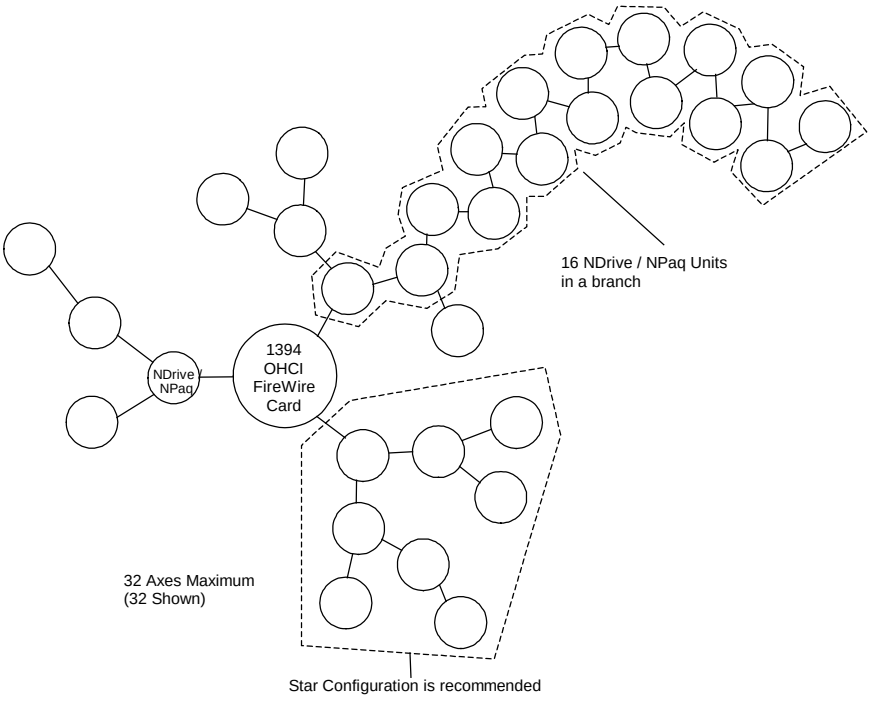
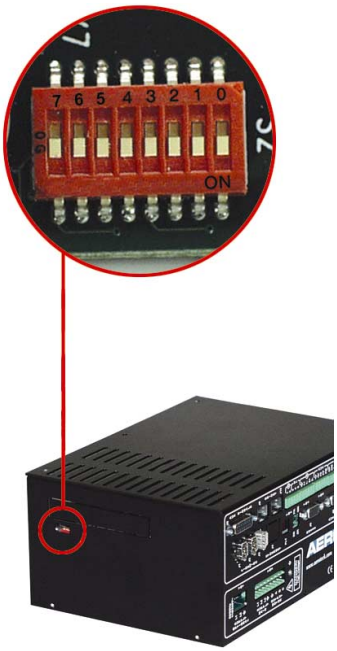



**Figure 2-10. Recommended Star Daisy Chain Configuration**




## 2.8. Device Settings

Each NDrive must have a unique address defined by switch S2. They must be sequential beginning with the first NDrive.

**Table 2-5. NDrive Switch Settings (S2)**

| NDrive # | Switch Settings * | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 ** | 6 ** | 5 ** | 4 | 3 | 2 | 1 | 0 |
| 1st | | | | ON | ON | ON | ON | ON |
| 2nd | | | | ON | ON | ON | ON | - |
| 3rd | | | | ON | ON | ON | - | ON |
| 4th | | | | ON | ON | ON | - | - |
| 5th | | | | ON | ON | - | ON | ON |
| 6th | | | | ON | ON | - | ON | - |
| 7th | | | | ON | ON | - | - | ON |
| 8th | | | | ON | ON | - | - | - |
| 9th | | | | ON | - | ON | ON | ON |
| 10th | | | | ON | - | ON | ON | - |
| 11th | | | | ON | - | ON | - | ON |
| 12th | | | | ON | - | ON | - | - |
| 13th | | | | ON | - | - | ON | ON |
| 14th | | | | ON | - | - | ON | - |
| 15th | | | | ON | - | - | - | ON |
| 16th | | | | ON | - | - | - | - |
| 17th | | | | - | ON | ON | ON | ON |
| 18th | | | | - | ON | ON | ON | - |
| 19th | | | | - | ON | ON | - | ON |
| 20th | | | | - | ON | ON | - | - |
| 21st | | | | - | ON | - | ON | ON |
| 22nd | | | | - | ON | - | ON | - |
| 23rd | | | | - | ON | - | - | ON |
| 24th | | | | - | ON | - | - | - |
| 25th | | | | - | - | ON | ON | ON |
| 26th | | | | - | - | ON | ON | - |
| 27th | | | | - | - | ON | - | ON |
| 28th | | | | - | - | ON | - | - |
| 29th | | | | - | - | - | ON | ON |
| 30th | | | | - | - | - | ON | - |
| 31st | | | | - | - | - | - | ON |
| 32nd | | | | - | - | - | - | - |

* Off is indicated by " - "

** The shaded cells (columns 7, 6, and 5) should be left in their factory-preset positions.

Information on connecting options such as analog and digital I/O, and laser firing is provided in Chapter 4: Options.

∇ ∇ ∇

# CHAPTER 3: TECHNICAL DETAILS

**In This Section:**


- Part Number and Ordering Information ..... 3-1
- RS-232 / RS-422 Port (J5) ..... 3-2
- Secondary Encoder Channel (J6) ..... 3-3
- Motor Feedback (MXH / MXU) (J7) ..... 3-4
- Electrical Specifications ..... 3-11
- NDrive Control Board Assembly ..... 3-12
- NDrive Power Board Assembly ..... 3-14
- LED Indicators ..... 3-16
- NDrive Dimensions ..... 3-17

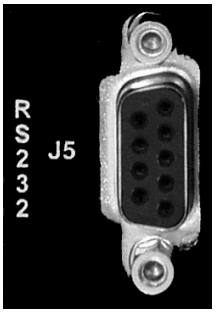

## 3.1. Part Number and Ordering Information

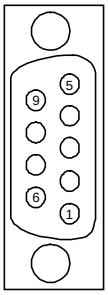
Order information with part numbers, models, and packages, is shown below (Table 3-1).

**Table 3-1. Ordering Information**

| Amplifier Series | Output Current, Peak | Operating Bus Voltage | Internal Shunt Power Resistor |
|---|---|---|---|
| NDrive | 10, 20, 30 | 100 – 320 VDC<br>(70 – 240 VAC) | S = Shunt regulator<br>(optional on NDrive10, NDrive20) |
| **Options** | | | |
| -IOPSO | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sinking), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, single axis PSO, and brake relay | | |
| -IOPSO2 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sinking), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, dual axis PSO, and brake relay | | |
| -IOPSO3 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sourcing), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, single axis PSO, and brake relay | | |
| -IOPSO4 | Expansion board with 8 opto-isolated inputs (sinking or sourcing) and outputs (sourcing), 2-18 bit analog outputs, 2-16 bit analog inputs, SSI Net, absolute encoder interface, dual axis PSO, and brake relay | | |
| -PSOOPTO1 | Opto isolator for PSO, requires IOPSO*x* option (<+5V, high speed, high current, HCPL2601) | | |
| -PSOOPTO2 | Opto isolator for PSO, requires IOPSO*x* option (<+15V, high speed, low current, 6N136) | | |
| -PSOOPTO3 | Opto isolator for PSO, requires IOPSO*x* option (<+30V, low speed, high current, 4N33) | | |
| -MXU4096 | Programmable encoder multiplier up to x 4,096, does not support single/dual axis PSO or quadrature output | | |
| -MXU65536 | Programmable encoder multiplier up to x 65,536, does not support single/dual axis PSO or quadrature output | | |
| -MXH | Programmable encoder multiplier up to x 2,048, supports single/dual axis PSO and encoder quadrature output | | |
| -ENET | 10/100BASE-T Ethernet port | | |
| -S | Shunt resistor network | | |
| -AUXPWR | Auxiliary 115/230 VAC input to power logic circuitry. Required for "keep alive" or 20-80 VDC bus operation. 20-80 VDC operation requires external transformer to generate 15-60 VAC bus power input. | | |
| -HS | Heat sink with fins | | |
| -3P | 3-Phase AC input | | |
| **Example** | | | |
| NDrive30B-S | 15 A cont., 30 A peak servo amplifier/power supply, w/shunt regulator | | |
| **Accessories** | | | |
| TV0.3-28 | 0.3 kVA autotransformer; 28 or 56 VAC out for 40 or 80 VDC bus, 115/230 VAC, 50/60 Hz input | | |
| TV0.3-56 | 0.3 kVA autotransformer; 56 or 115 VAC out for 80 or 160 VDC bus, 115/230 VAC, 50/60 Hz input | | |
| TV1.5 | 1.5 kVA isolation transformer; 115/230 VAC input; 28, 43, 56, 70, 115 VAC output | | |
| TV2.5 | 2.5 kVA isolation transformer; 115/230 VAC input; 28, 43, 56, 70, 115 VAC output | | |
| TV5 | 5 kVA isolation transformer; 115/230 VAC input; 28, 43, 56, 70, 115 VAC output | | |
| LF | AC Line Filter, general noise suppression (not for CE Compliance) | | |
| UFM | AC Line Filter Module (required to meet CE Compliance) | | |

## 3.2. RS-232 / RS-422 Port (J5)




Note that the RS-232C and RS-422 (a factory option) ports may not be used simultaneously, as they are one physical port, converted to each interface by the appropriate line driver/receiver, as shown in Figure 3-1. Connecting the RS-232 port to a user's PC requires only a standard 9-pin cable (not a null modem).

**Table 3-2. J5 RS-232 / RS-422 Connector Pinouts**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Frame | Chassis Frame | N/A |
| 2 | RS-232 TXD | RS-232 Transmit Output | Output |
| 3 | RS-232 RXD | RS-232 Receive Input | Input |
| 4 | RS-422 TXD+ | RS-422 Transmit Output + | Output |
| 5 | Common | Signal Common | N/A |
| 6 | RS-422 TXD- | RS-422 Transmit Output - | Output |
| 7 | RS-422 RXD+ | RS-422 Receive Input + | Input |
| 8 | RS-422 RXD- | RS-422 Receive Input - | Input |
| 9 | +5 Volt | +5 Volt Power Output * | Output |

* Total user +5 V power is limited to 500 mA, by internal resettable fuses.

The mating connector is a male 9-Pin D-style connector (Aerotech P/N ECK137, Cinch P/N DE-9P; backshell: Aerotech P/N ECK1021, Amphenol P/N 17-1724-2).

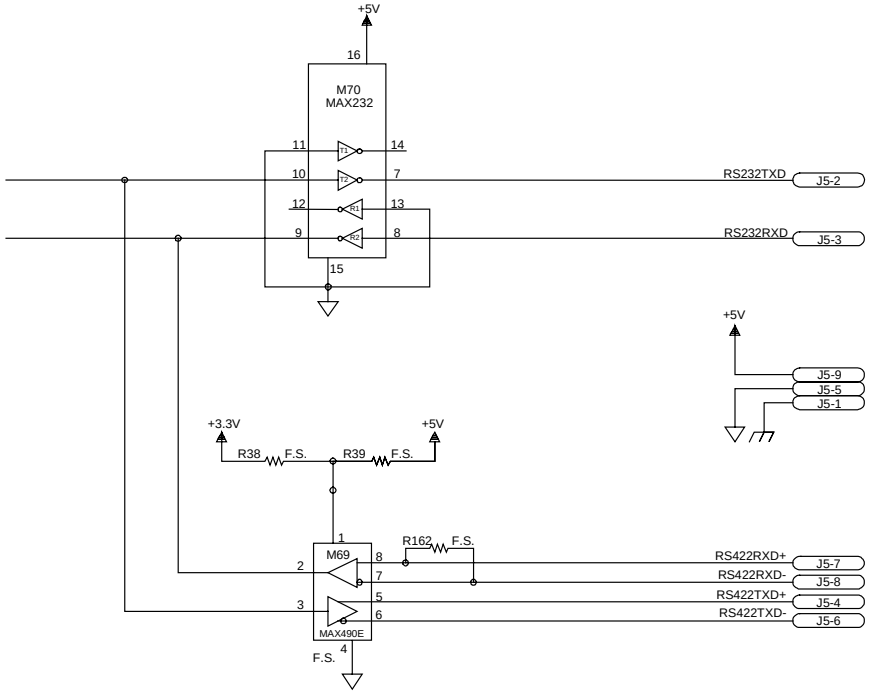
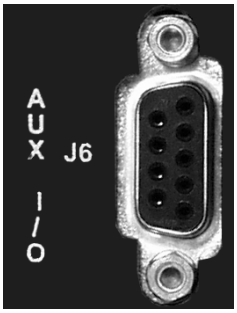
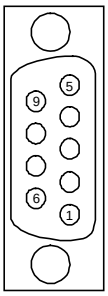



**Figure 3-1. RS-232/RS-422 Connector (J5)**

## 3.3. Secondary Encoder Channel (J6)




The J6 connector provides a secondary line driver encoder interface. This connection can be used as an input for master/slave operation or for dual loop systems or for an encoder input for two-axis laser firing (see Section 4.2.10 for more information). This interface may not be multiplied by the MXH/MXU options and must be a 5-volt line driver encoder. See section 2.6.2. Encoder Phasing, for more information. It allows up to a 10 MHz encoder signal, producing 40 million counts per second, after times four (x4) quadrature decoding.

**Table 3-3. J6 Auxiliary I/O Connector Pinouts**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Chassis Frame Ground | Chassis Frame Ground | Input |
| 2 | Auxiliary Sine + | Secondary Encoder Channel | Input |
| 3 | Auxiliary Cosine + | Secondary Encoder Channel | Input |
| 4 | Encoder Return | Signal Common | Input |
| 5 | Auxiliary Marker + | Secondary Encoder Channel | Input |
| 6 | Auxiliary Marker - | Secondary Encoder Channel | Input |
| 7 | Auxiliary Sine - | Secondary Encoder Channel | Input |
| 8 | Auxiliary Cosine - | Secondary Encoder Channel | Input |
| 9 | +5 Volt External | +5 Volt External * | Output |

* Total user +5 V power is limited to 500 mA, by internal resettable fuses.

The external power provided by the NDrive to the user is protected by a resettable fuse. Should an over-current condition occur, the device will open to protect against the overload. To reset the device, remove the overload condition.

The mating connector is a male 9 Pin D-style connector (Aerotech P/N ECK137, Cinch P/N DE-9P; backshell: Aerotech P/N ECK1021, Amphenol P/N 17-1724-2).

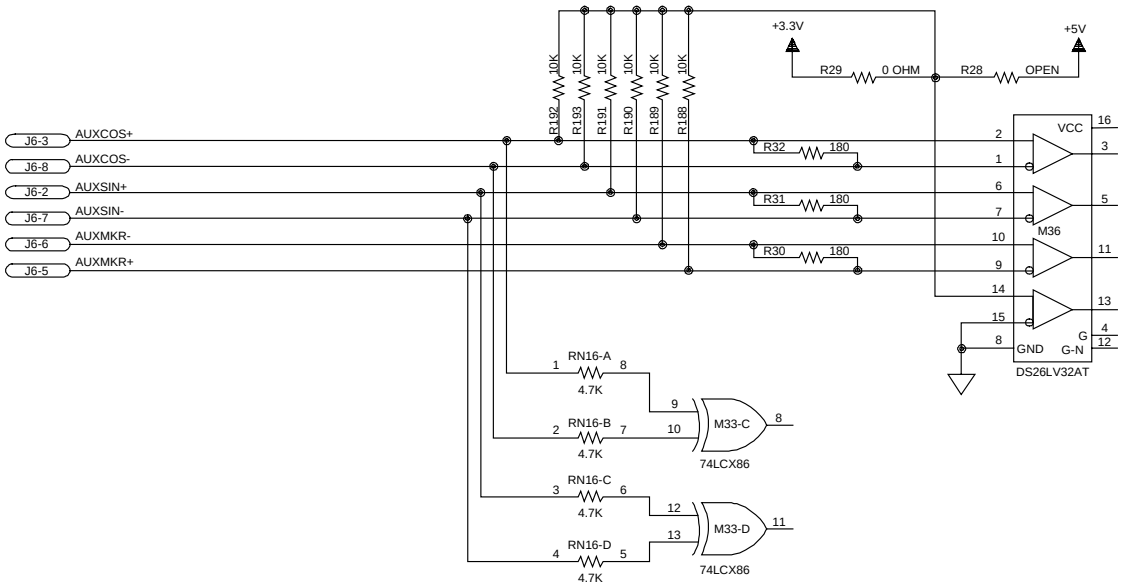
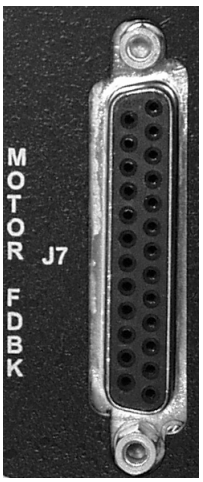
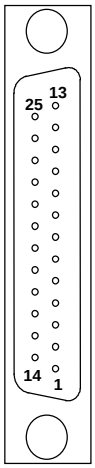



**Figure 3-2. Secondary Encoder Channel (J6)**




## 3.4. Motor Feedback (MXH / MXU) (J7)

The 25-pin "D" style connector contains all of the necessary feedback inputs to complete a servo loop. This port has inputs for a 3-channel encoder, three limit switches, and three Hall effect devices. Each of these inputs provides feedback for the microprocessor controlled position and velocity loops. The three encoder signals consists of the following: sine (SIN), cosine (COS), and marker (MKR) as well as their complimentary signals: sine-n (SIN-N), cosine-n (COS-N), and marker-n (MKR-N).

Two of the three limit inputs are end-of-travel sensing (CW Limit and CCW Limit) while the third is a reference limit (Home Limit). The Hall effect switch inputs are recommended for AC brushless motor commutation but not required. The pinouts for the connector are shown in Table 3-4.

The NDrive may be factory configured to accept a line driver encoder (standard) or analog sine wave encoder (MXH or MXU option). Note that the brake output is driven by the relay on the -IOPSO# options.

See Section 2.6.2., Encoder Phasing for information on interfacing non-Aerotech motors.

**Table 3-4. Motor Feedback Connector Pinouts (J7)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Frame | Chassis Frame | N/A |
| 2 | N.C. | No Connection | N/A |
| 3 | +5 Volt | +5 Volt Power for Encoder * | Output |
| 4 | Common | Signal Common | N/A |
| 5 | HB | Hall Effect Sensor B (Brushless Motors only) | Input |
| 6 | Mkr- | Encoder Marker Reference Pulse - | Input |
| 7 | Mkr+ | Encoder Marker Reference Pulse + | Input |
| 8 | N.C. | No Connection | N/A |
| 9 | N.C. | No Connection | N/A |
| 10 | HA | Hall Effect Sensor A (Brushless Motors only) | Input |
| 11 | HC | Hall Effect Sensor C (Brushless Motors only) | Input |
| 12 | CW/+Lmt. | Clockwise End of travel limit | Input |
| 13 | Brake - | Optional Brake - Output | Output |
| 14 | Cos+ | Encoder Cosine + | Input |
| 15 | Cos- | Encoder Cosine - | Input |
| 16 | +5 Volt | +5 Volt Power for Limit Switches * | Output |
| 17 | Sin+ | Encoder Sine + | Input |
| 18 | Sin- | Encoder Sine - | Input |
| 19 | N.C. | No Connection | N/A |
| 20 | Common | Signal Common for Limit Switches | N/A |
| 21 | Common | Signal Common for Encoder | N/A |
| 22 | Hm.Lmt. | Home Switch Input | Input |
| 23 | N.C. | No Connection | N/A |
| 24 | CCW/-Lmt. | Counterclockwise End of travel limit | Input |
| 25 | Brake + | Optional Brake + Output | Output |

* Total user +5 V power is limited to 500 mA, by internal resettable fuses.

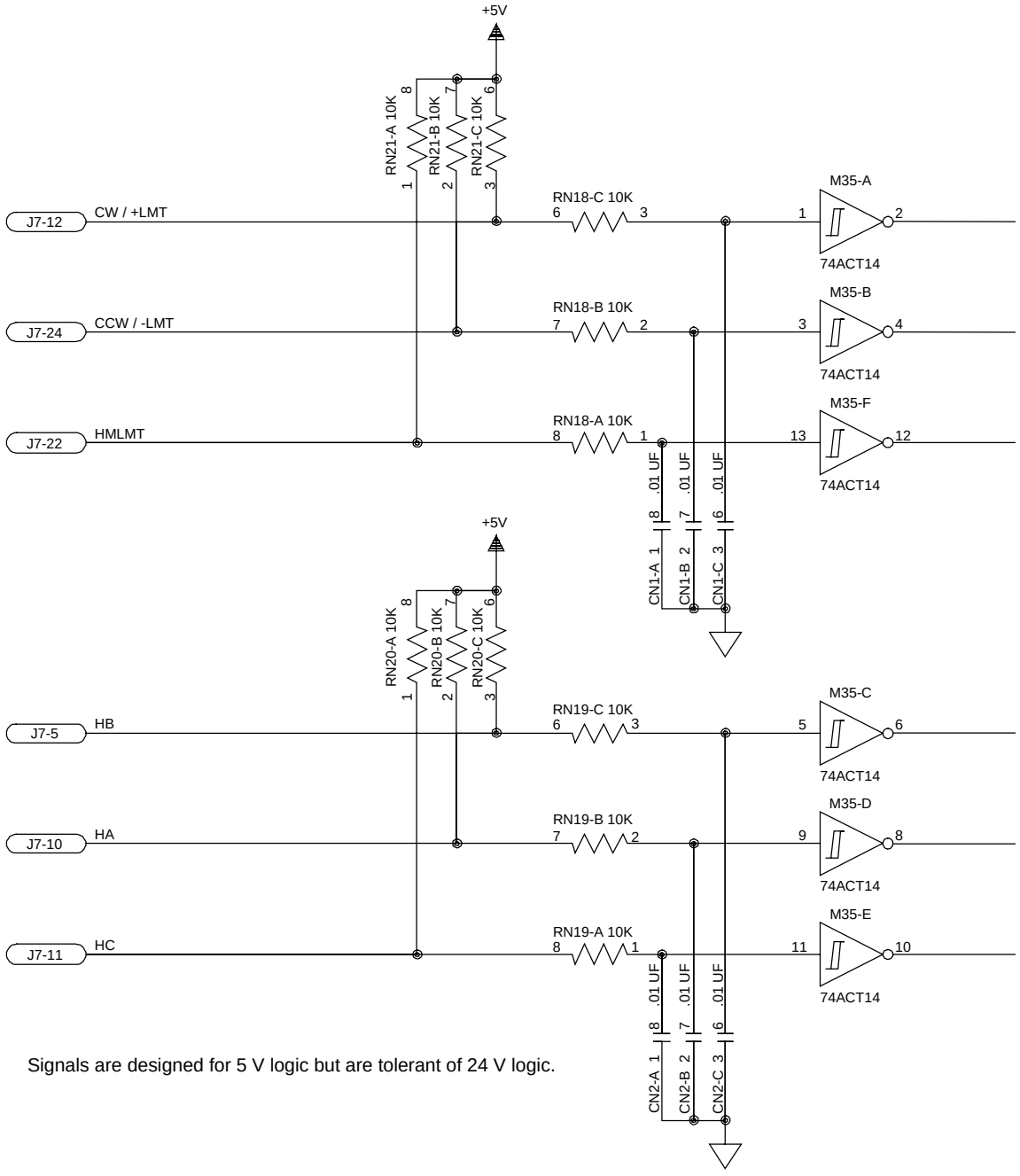



**Figure 3-3. Limit and Hall Effect Inputs (J7)**

All external power provided by the NDrive to the user is protected by a resettable fuse. Should an over-current condition occur, the device will open to provide protection against the overload. To reset the device, remove the over-current condition.

The mating connector is a male 25-pin D-Style connector (Aerotech P/N ECK101, Cinch P/N DB25P; Backshell: Aerotech P/N ECK656, Amphenol P/N 17-1726-2).

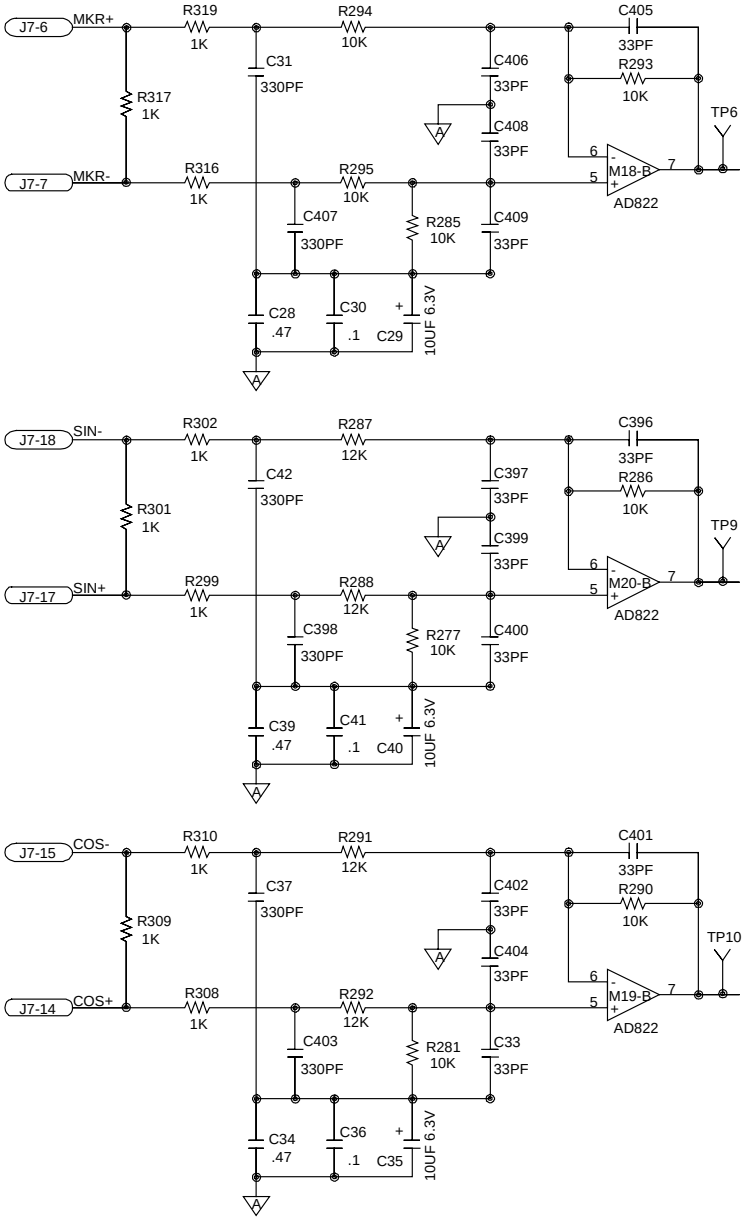



**Figure 3-4. Optional MXH / MXU Analog Encoder Interface (J7)**

### 3.4.1. Line Driver Encoder (Standard)

The standard encoder input is defined for a differential line driver encoder, in the range of 0 to +5 volts. It allows up to a 10 MHz encoder signal, producing 40 million counts per second, after times four (x 4) quadrature decoding. An analog encoder is used with the MXU/MXH option; see Figure 3-4 for more information.

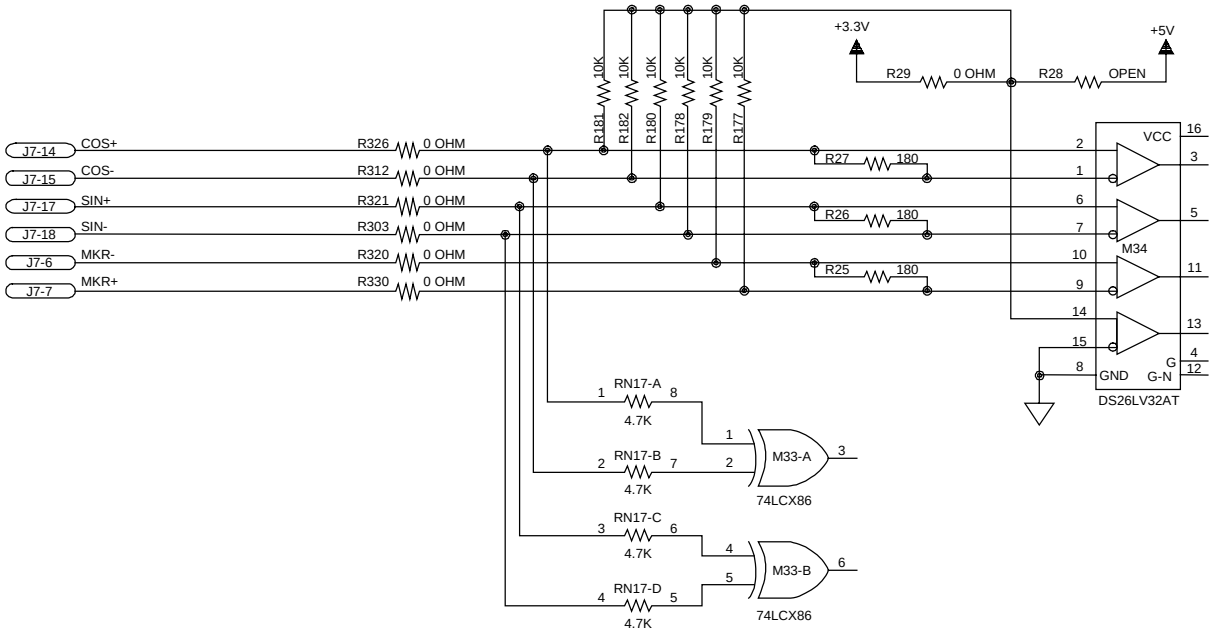



**Figure 3-5. Line Driver Encoder Interface (Standard) J7**

The NDrive is factory configured for either a square wave differential encoder (default), OR analog encoder (MXH/MXU options).

### 3.4.2. MXH Options

The MXH encoder input options are defined for a differential analog encoder in the range of 0 to +5 volts. The maximum encoder input frequency is limited to 200 kHz. See Table 3-5 for maximum input frequencies when the encoder signals output via the SSINet at varying maximum frequencies/pulse widths. The MXH multiplies the resolution up to 512 times, in addition to the controller's x 4 multiplication, providing a maximum of x 2048 multiplication. The multiplication factor is determined by the CfgFbkEncMultFactorMXH axis parameter. The MXH option should be adjusted for optimum performance via the CfgFbkEncCosGain, CfgFbkEncCosOffset, CfgFbkEncSineGain, CfgFbkEncSineOffset and CfgFbkEncPhase axis parameters. The –MXH option is compatible with the –IOPSO# options. See the NView MMI help file for more information. A differential line driver encoder may be used also, see Figure 3-5 for more information.

The specifications for the -MXH multiplier option are shown in Table 3-5. The following chart indicates the maximum specifications for the MXH option when the signals are output via the SSINet. Otherwise, the only limit is the maximum input frequency of 200 kHz. See Figure 3-5 for MXH/MXU typical input circuitry. The pinout is indicated in Table 3-4.

**Table 3-5. MXH Multiplier Specifications (when output is via the SSINet)**

| *CfgFbkEncMult-FactorMXH* Axis Parameter | Total Interpolation (1,2) | Clock Freq. (MHz) (3) | Max Input Freq (kHz) (4) | Min Edge Separation (µs) (4) | Min Pulse Width (µs) (4) |
|---|---|---|---|---|---|
| 10 | X40 | 40 | 200 | .025 | .025 |
| | | 20 | 200 | .05 | .05 |
| | | 10 | 200 | .1 | .1 |
| | | 5 | 125 | .2 | .2 |
| 50 | X200 | 40 | 200 | .025 | .025 |
| | | 20 | 100 | .05 | .05 |
| | | 10 | 50 | .1 | .1 |
| | | 5 | 25 | .2 | .2 |
| 100 | X400 | 40 | 100 | .025 | .025 |
| | | 20 | 50 | .05 | .05 |
| | | 10 | 25 | .1 | .1 |
| | | 5 | 12.5 | .2 | .2 |
| 200 | X800 | 40 | 50 | .025 | .025 |
| | | 20 | 25 | .05 | .05 |
| | | 10 | 12.5 | .1 | .1 |
| | | 5 | 6.25 | .2 | .2 |
| 250 | X1000 | 40 | 40 | .025 | .025 |
| | | 20 | 20 | .05 | .05 |
| | | 10 | 10 | .1 | .1 |
| | | 5 | 5 | .2 | .2 |
| 500 | X2000 | 40 | 20 | .025 | .025 |
| | | 20 | 10 | .05 | .05 |
| | | 10 | 5 | .1 | .1 |
| | | 5 | 2.5 | .2 | .2 |

1. Interpolation includes x 4 from quadrature – i.e., MXH50 has a net interpolation of x 200 (x 50 from MXH and x 4 from quadrature).
2. Configurable via the CfgFbkEncMultFactorMXH axis parameter from 1 to 512 in increments of 1.0, yielding a multiplication from X4 to x2048.
3. Defined by the CfgFbkEncMxhSetup axis parameter, for SSINet use.
4. Absolute maximum input frequency limited to 200 kHz due to 1.25 MHz sample rate, lesser limit applies only when signals are output via the SSINet.

### 3.4.3. MXU Options

There are two MXU encoder input options, -MXU4096 and –MXU65536. Both are defined for a differential analog encoder in the range of 0 to +5 volts. The maximum input frequency is always limited to 200 kHz. The -MXU4096 multiplies the resolution programmably up to 4096 times. The –MXU65536 multiplies the signal up to 65,536 times. Both options have their multiplication factor defined by the CfgFbkEncMultFactorMXU axis parameter.

The -MXU options should be adjusted for optimum performance via their CfgFbkEncCosGain, CfgFbkEncCosOffset, CfgFbkEncPhase, CfgFbkEncSineGain, CfgFbkEncSineOffset, CfgFbkEncMultFactorMXU axis parameters. See the NView MMI help file for more information. The –MXU options are not compatible with the –IOPSO# options because they do not generate a serial pulse stream as required by the PSO options. A differential line driver encoder may be used also, see Figure 3-5 for more information. See Figure 3-5 for MXH/MXU typical input circuitry. The pinout is indicated in Table 3-4.

## 3.5. Electrical Specifications

The electrical specifications for the NDrive are listed in Table 3-6.

**Table 3-6. Electrical Specifications**

| Model | | Units | NDrive10 | NDrive20 | NDrive30 |
|---|---|---|---|---|---|
| Output Voltage (depends on AC input voltage) | | VDC | 100-320 | | |
| Peak Output Current (2 sec) | | A(pk) | 10 | 20 | 30 |
| Continuous Output Current | | A(pk) | 5 | 10 | 15 |
| Peak Power Output (includes AC line droop) | | Watts | 2,720 | 5,440 | 8,160 |
| Continuous Power Output (includes AC line droop) | | Watts | 1,360 | 2,720 | 4,080 |
| Efficiency | | % | 97 | | |
| Power Amplifier Bandwidth (selectable through parameters) | | kHz | 5 kHz max | | |
| PWM Switching Frequency | | kHz | 20 | | |
| Minimum Load Inductance | | mH | 0.8 @ 160 VDC bus (1 mH @320 VDC) | | |
| Maximum Shunt Regulator Dissipation | | Watts | 40 (optional) | | 40 |
| Maximum Heat Sink Temperature | | deg C° | 65 | | |
| Heat Sink Size (Typical) | | Volume | 1' x 2' x 0.25" | | |
| Operating Temperature | | deg C° | 0 to 50 | | |
| Storage Temperature | | deg C° | -30 to 85 | | |
| Weight | Standard | lb (kg) | 5.0 (2.27) | | |
| | with –IOPSO# option | | 5.4 (2.45) | | |
| Modes of Operation | - Brushless<br>- Brush<br>- Stepper | | | | |
| Feedback Inputs | - **Hall A-Pin 10**, **Hall B-Pin 5**, **Hall C-Pin 11**: Hall effect device inputs for commutation, 0 to 5 VDC, internal pull-up, 10K input. Commutation signals used with brushless motors to provide motor rotation position information to the amplifier. This allows the amplifier to steer the three phases of the motor currents in such a fashion so as to provide rotation of the motor in the desired direction at the desired speed. TTL level input.<br>- **sine/sine-N-Pin 17, Pin 18**, **cosine/cosine-N-Pin 14, Pin 15**: Encoder input 0 to 5VDC, internal pull-up, 10K input. | | | | |
| Power Inputs (L1, L2, L3, Aux Power) | - AC input: AC HI, AC LO, earth ground (⏚), 70-230 VAC, 50-60 Hz, single phase. | | | | |
| Auxiliary Power Outputs | - **5V-Pin 16**: On board 5V power supply. 250 mA maximum output.<br>- **5V-Pin 3**: On board 5V power supply. Pin 3 is intended for powering an encoder. Can supply up to 500 mA of current. | | | | |
| Protective Features | - Output short circuit | - Peak over current | | | |
| | - DC bus over voltage | - RMS over current | | | |
| | - Over temperature | - Control power supply under voltage | | | |
| | - Power stage bias supply under voltage | - Designed to EN61010/U3101 | | | |
| Isolation | - Opto and transformer isolation between control and power stages. | | | | |
| Indicator (power) | - LED indicates drive power. | | | | |
| Indicator (enabled) | - LED indicates drive enabled. | | | | |

## 3.6. NDrive Control Board Assembly

Figure 3-6 highlights the important components located on the control board assembly. The NDrive is jumper selectable, providing the user with quick reconfiguration capability of operating modes. Table 3-7 list the jumpers and the default configurations for the NDrive Control board (the PSO / I/O board and jumper configurations are listed in Chapter 3).

S2 sets the NDrive address/channel number is the only user configured switch/jumper on the control board (see Table 2-5).

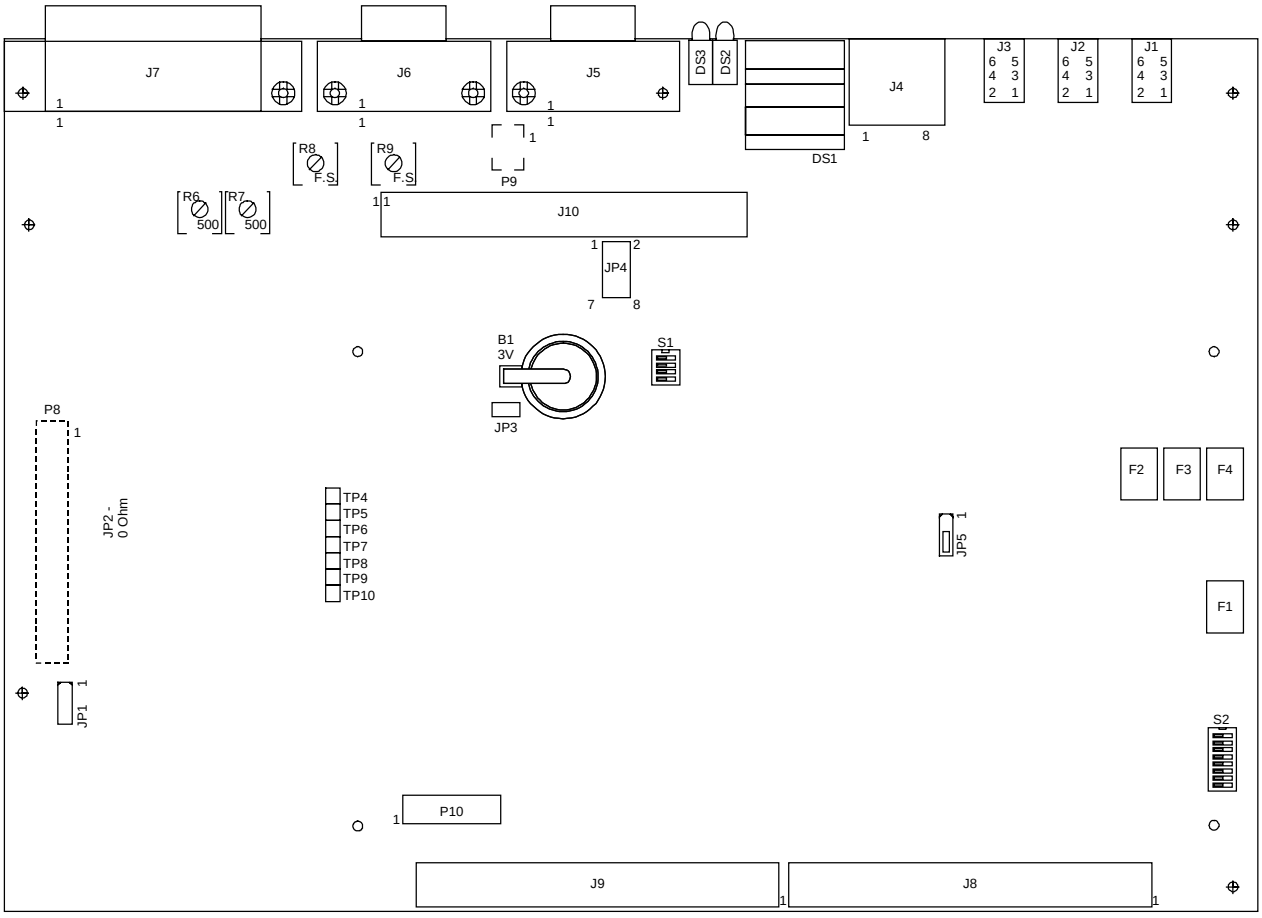



**Figure 3-6. NDrive Control Board Assembly**

**Table 3-7. NDrive Control Board Jumper Selections**

| Jumpers | Positions | Function |
|---|---|---|
| JP1 | 2-3 * | Signal Common connected to Frame Ground (Chassis) |
| | 1-2 | Signal Common isolated from Frame Ground (Chassis) |
| JP2 | 0 Ohm * | Encoder Fault Detection Active (0 Ohm Resistor) |
| | Out | Encoder Fault Detection Disabled (Resistor Removed) |
| JP3 | In * | 100 Ohm Terminator in for RS-485 port on J8 |
| | Out | No Termination for RS-485 port on J8 |
| JP4A | 1-2 | In for 100 Terminator on RS-422 Port 2 (J8, J9, J10) |
| JP4B | 3-4 | In for 100 Terminator on RS-422 Port 1 (J8, J9, J10) |
| JP4C | 5-6 | In for 100 Terminator on RS-422 Port 3 (J8, J9, J10) |
| JP4D | 7-8 | In for 100 Terminator on RS-422 Port 4 (J8, J9, J10) |
| JP5 | 1-2 | Watch Dog Timer Enabled |
| | 2-3 * | Watch Dog Timer Disabled |

* indicates default setting

Switch S1 is for factory use only and should not be changed by the user.



## 3.7. NDrive Power Board Assembly

Figure 3-7 highlights the important components located on the power board assembly. Table 3-8 lists the jumpers and their default configurations for the NDrive Power board.

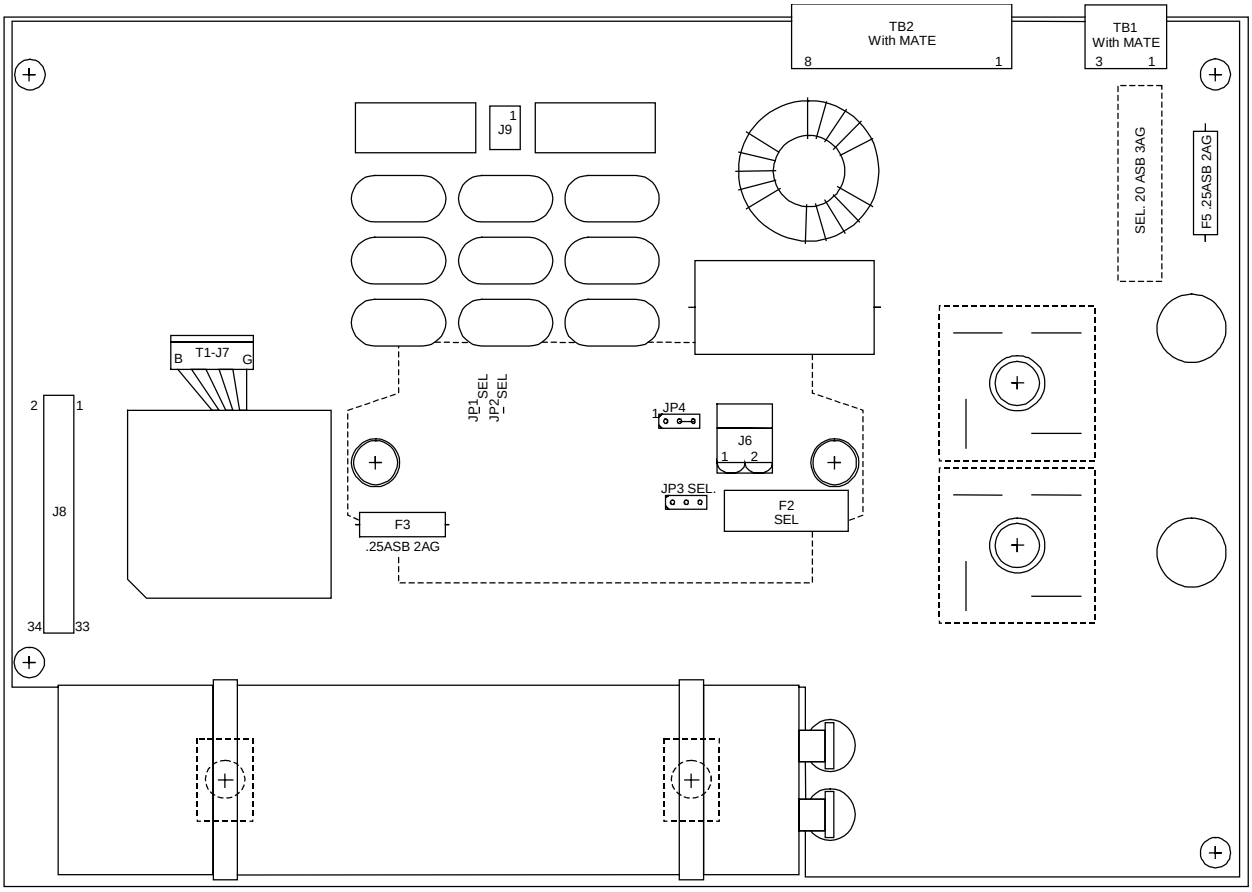



**Figure 3-7. NDrive Power Board Assembly**

**Table 3-8. NDrive Power Board Jumper Selections**

| Jumpers | Positions | Function |
|---|---|---|
| JP1 (F.S.) | In * | 70 – 115 VAC Input Power Applied at TB2 |
| | Out | Less than 70 VAC Input Power Applied at TB2 |
| JP2 (F.S.) | In * | 70 – 115 VAC Input Power Applied at TB2 |
| | Out | Less than 70 VAC Input Power Applied at TB2 |
| JP3 | 1-2 | Shunt Option Present (std. On NDrive30B-S) |
| | 2-3 | No Shunt Option Present (std. On NDrive10B, 20B) |
| JP4 | 1-2 | 115 VAC Shunt |
| | 2-3* | 230 VAC Shunt |

*** Default**

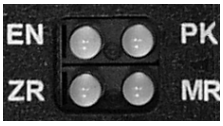
All jumpers are factory-configured and should not be changed by the user.



**Table 3-9. NDrive Power Board Fuse Information**

| Fuse | Description | Size |
|---|---|---|
| F1 | Supply Main Fusing for L1 VAC Bus Input | 20 A S.B. (3AG) |
| F2 | Shunt Option (-S) on 30 Amp Drive only | 2 A S.B. (5 mm) |
| F3 | Control Power Fuse | .25 A S.B. |
| F5 | Optional 115/230 VAC Control Power Supply Input | .25 A S.B. |

F1 and F2 are normal socketed fuses. F3 and F5 are soldered to the circuit board. See Chapter 5: Troubleshooting for fuse replacement information.




## 3.8. LED Indicators

The following LEDs are available on each NDrive. Full NDrive status is available via the NMotion SMC and its utilities.

**Table 3-10. LED Indicator Description**

| Label | Description |
|---|---|
| EN | Axis is enabled |
| ZR | Axis is in position (zero) |
| PK | Peak current commanded |
| MR | Axis is on the marker |

## 3.9. NDrive Dimensions

The outline dimensions for the NDrive are shown in Figure 3-8 and Figure 3-9. Units should be separated from each other and surrounded by one inch of free air space. This will also allow the standard nine-inch FireWire cable to interconnect them.

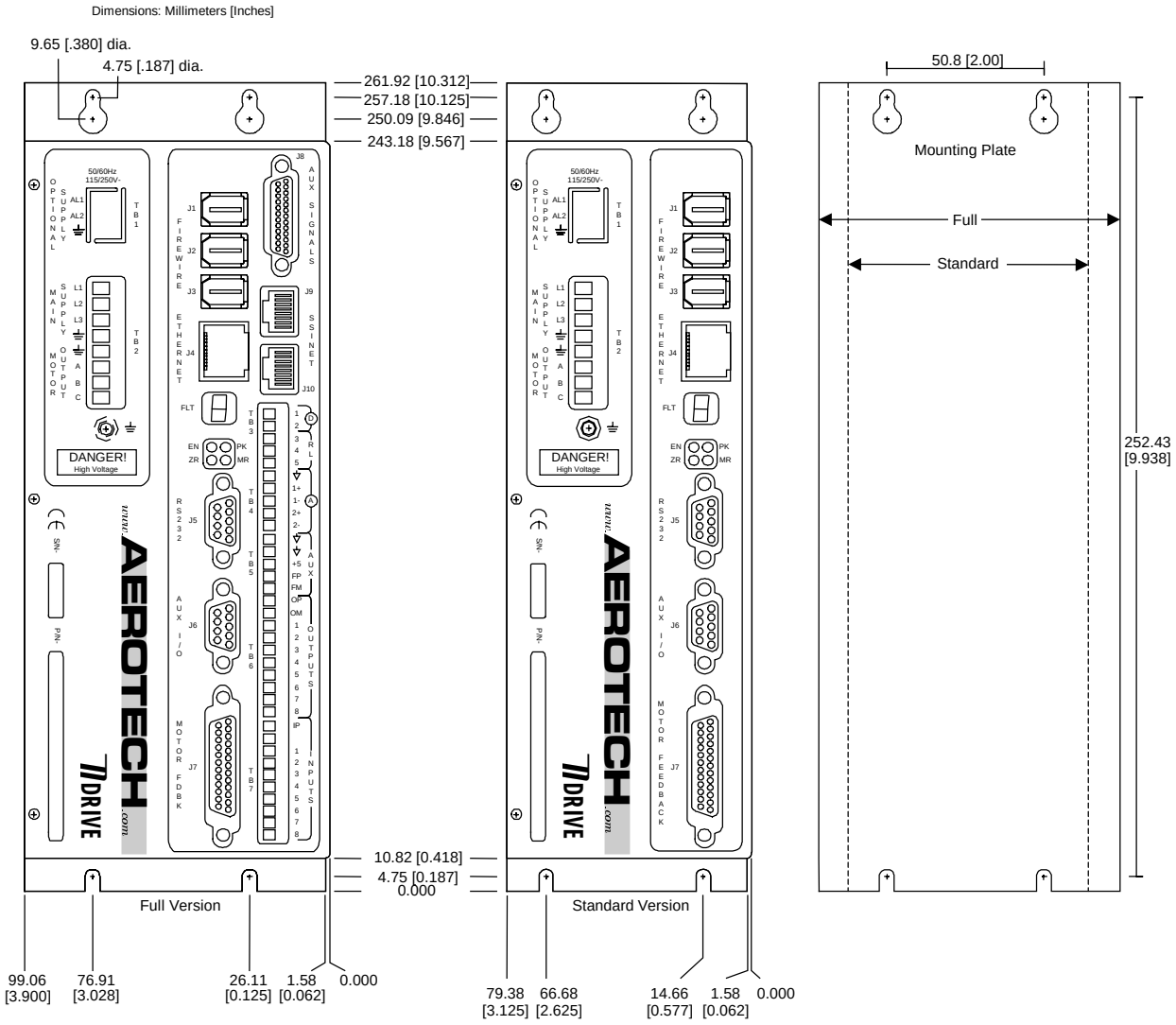



**Figure 3-8. NDrive Dimensions (Front)**

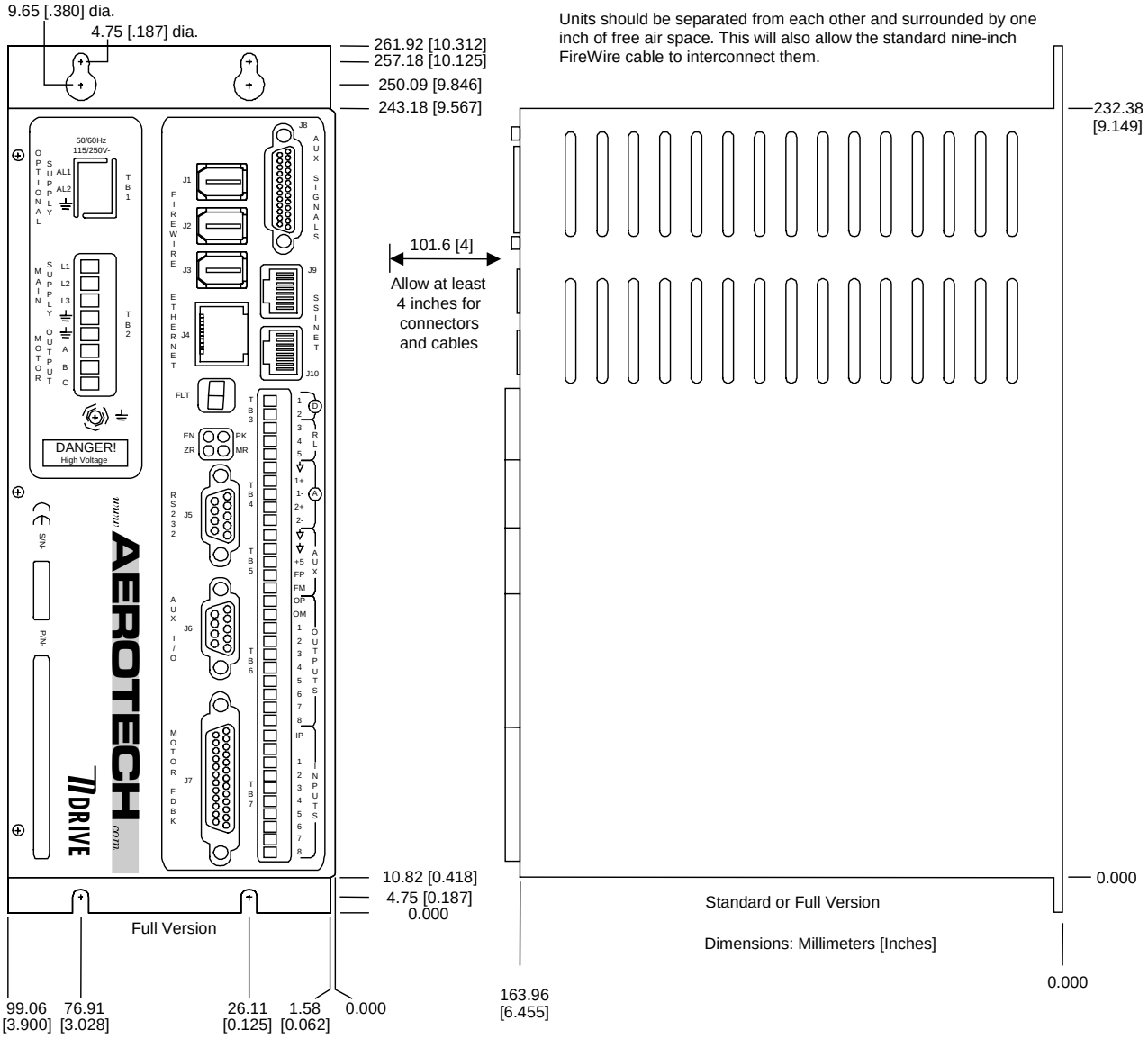



**Figure 3-9. NDrive Dimensions (Front and Side)**

∇ ∇ ∇

# CHAPTER 4: NDRIVE OPTIONS

**In This Section:**


- Introduction .....4-1
- -IOPSO# Option Board .....4-2
- Ethernet (J4).....4-22
- Joystick Interface.....4-23


## 4.1. Introduction

This section describes the various NDrive options.

**Table 4-1. NDrive Options and Capabilities**

| Option | | Capabilities |
|---|---|---|
| All -IOPSO# * options contain the following capabilities plus those listed per option name (IOPSO, IOPSO2, etc). | | - Two 18-bit analog outputs (+/- 10 Volts)<br>- Two 16-bit differential analog inputs (+/- 10 Volts)<br>- One fail safe brake (or user) relay output<br>- Eight optically isolated logic inputs (5 – 24 VDC), user defined as current sourcing or sinking.<br>- Two bidirectional RS-422 encoder inputs/outputs (SSINet)<br>- One absolute/RS-485 encoder interface for secondary encoder channel |
| | –IOPSO | - Single axis laser firing (PSO) with an RS-422 or optically isolated output<br>- Eight optically isolated current sinking logic outputs (5 – 24 VDC) |
| | –IOPSO2 | - Two axis laser firing (PSO) with an RS-422 or optically isolated output<br>- Eight optically isolated current sinking logic outputs (5 – 24 VDC) |
| | –IOPSO3 | - Single axis laser firing (PSO) with an RS-422 or optically isolated output<br>- Eight optically isolated current sourcing logic outputs (5 – 24 VDC) |
| | –IOPSO4 | - Two axis laser firing (PSO) with an RS-422 or optically isolated output<br>- Eight optically isolated current sourcing logic outputs (5 – 24 VDC) |
| * **Note** that the variations provide four combinations of single/dual-axis laser firing and current sourcing/sinking logic outputs. Reference Section 4.2.: -IOPSO# Option Board and Section 4.2.8.2.: Two/Three-Axis Laser Firing for the required information. | | |
| –ENET | | - 10/100 Base-T Ethernet port for ModBus©-TCP I/O support |
| –AUXPWR | | - Separate control power input for 20-80VDC bus as described in Chapter 2, section 2.4.2. |
| –MXH | | - Programmable encoder multiplication of an analog sine wave encoder up to x 2,048 (including controllers x4) |
| –MXU4096 | | - Programmable encoder multiplication of an analog sine wave encoder up to x 4,096 (including controllers x4) |
| –MXU65536 | | - Programmable encoder multiplication of an analog sine wave encoder up to x 65,536 (including controllers x4) |
| –3P | | - Provides 3 phase power input, described in Chapter 2 (Section 2.3.) |
| –S | | - Shunt regulator for regenerative energy dissipation, described in Chapter 3 (Section 3.5.) |
| –HS | | - Finned heat sink |

## 4.2. -IOPSO# Option Board

See the following sections for details on the connector pinout and technical information for the -IOPSO# options.

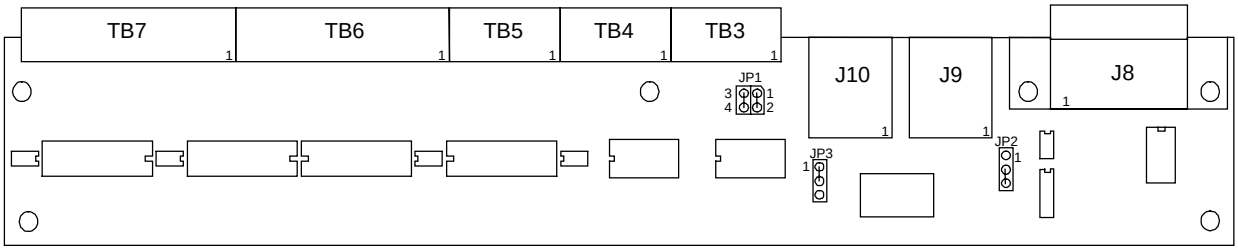



**Figure 4-1. –IOPSO# Option Board**

**Table 4-2. –IOPSO# Option Board Jumpers**

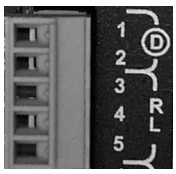
| Pin # | Setting | Description |
|---|---|---|
| JP1 | 1-2* | Brake Option (set 3-4, also) |
| | 3-4* | Brake Option (set 1-2, also) |
| | 1-3 | Auxiliary Output Option |
| JP2 | 1-2 | PSO (Laser Firing) Output Active High |
| | 2-3 * | PSO (Laser Firing) Output Active Low |
| JP3 | 1-2* | Input 1 |
| | 2-3 | External Reset Input from Input 1 |

* default setting

### 4.2.1. Brake Configuration Jumpers

Setting JP1 to 1-2, 3-4 allows connection of the brake relay to pins 13 and 25 of the motor feedback connector (J7). See Figure 4-3 in section 4.2.2. for more information

### 4.2.2. Analog Outputs (TB3)




Both analog outputs are driven by an 18-bit AD1868 digital to analog converter and buffered by TL084 op-amps, producing a single-ended output voltage in the range of +/- 10 volts. The output current is limited to less than 50 mA. Note that the analog outputs are referenced to TB4-1 (as shown in Figure 4-2).

**Table 4-3. Analog Output Connector Pinouts (TB3)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Analog 1 Out | Analog Output 1 | Output |
| 2 | Analog 2 Out | Analog Output 2 | Output |

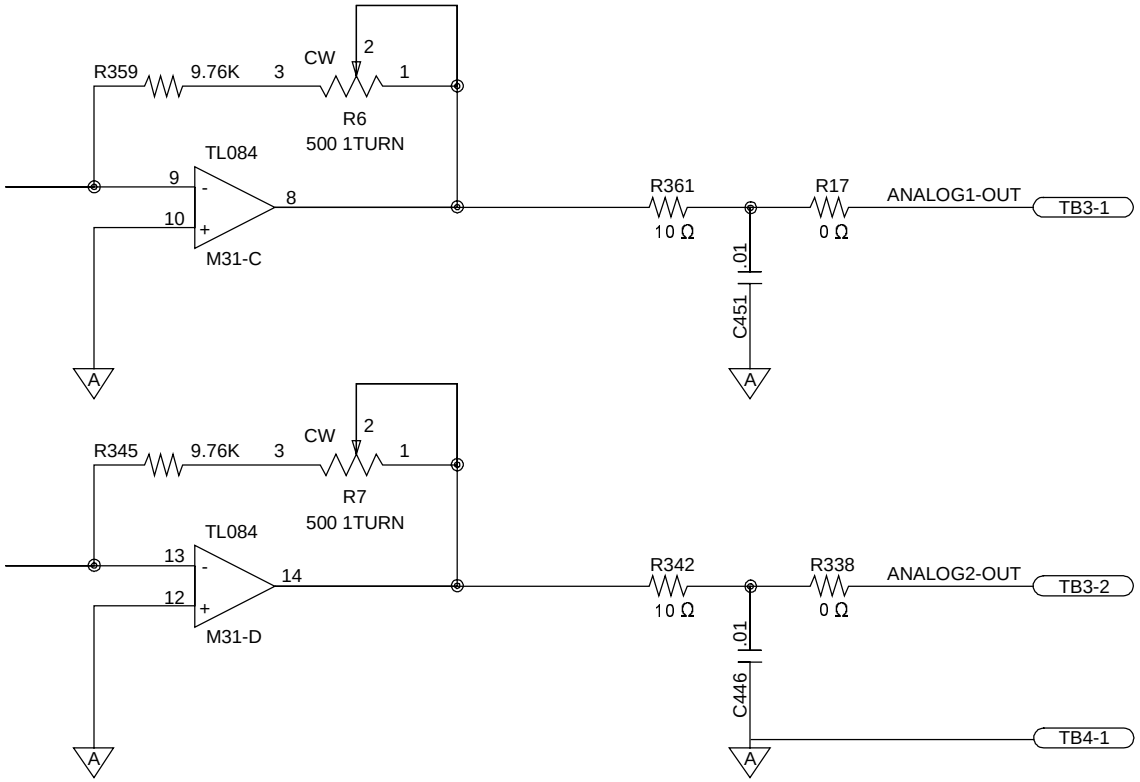
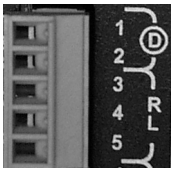



**Figure 4-2. Analog Output Connector (TB3)**




### 4.2.3. Brake / Relay (TB3)

The relay output is typically used to drive a fail-safe brake on a vertical axis; however, it may be used for any purpose. The normally open and normally closed contacts are provided to the user. See the FaultMaskBrake axis parameter in the NView MMI help file for information on activating the brake output, and Figure 4-3 for a typical connection with an inductive load. See Table 4-5 for the specifications for relay K1.

**Table 4-4. Brake / Relay Connector Pinouts (TB3)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 3 | Relay-N.C. | (Brake) Relay Output Normally Closed Contact | Output |
| 4 | Relay-Com. | (Brake) Relay Output Common Contact | Output |
| 5 | Relay-N.O. | (Brake) Relay Output Normally Open Contact (See JP1-A, JP1-B) | Output |

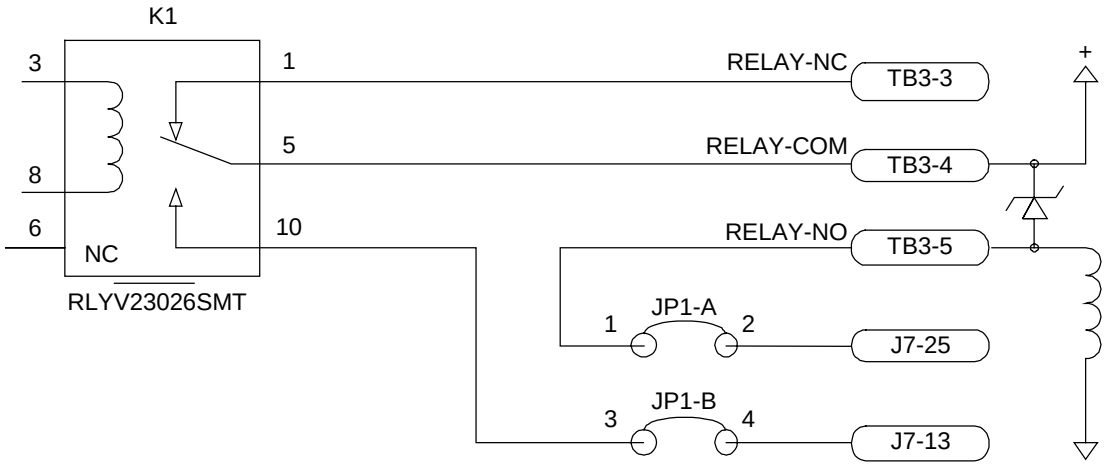
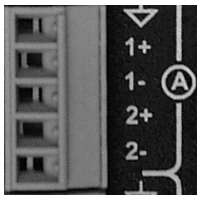



**Figure 4-3. Brake / Relay Connector (TB3)**

**Table 4-5. Voltage and Current Specifications (TB3)**

| **Relay K1 Contact Ratings** | |
|---|---|
| Maximum Switched Voltage | 150 VDC, 125 VAC |
| Maximum Switched Current | 1A |
| Maximum Carrying Current | 1A |
| Maximum Switched Power | 30W (DC), 60 VA (AC) |
| Note: Maximum switched power is voltage dependent. | |
| Initial Contact Resistance | 50 milliohms max. @ 10 mA, 6 VDC |

### 4.2.4. Analog Inputs (TB4)




Both analog inputs are differential, buffered by a precision unity gain differential INA105 amplifier and converted to digital by 16-bit ADS8320 analog to digital converter allowing an input voltage in the range of +/- 10 volts. Refer to Figure 4-4. To interface to a single-ended (non-differential) voltage, ground the negative (-) input and connect your signal to the positive (+) input.

**Table 4-6. Optional Analog Input Connector Pinouts (TB4)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | A Gnd. | Analog Common | N/A |
| 2 | Analog1 In + | Non-Inverting Analog Input 1 | Input |
| 3 | Analog1 In - | Inverting Analog Input 1 | Input |
| 4 | Analog2 In + | Non-Inverting Analog Input 2 | Input |
| 5 | Analog2 In - | Inverting Analog Input 2 | Input |

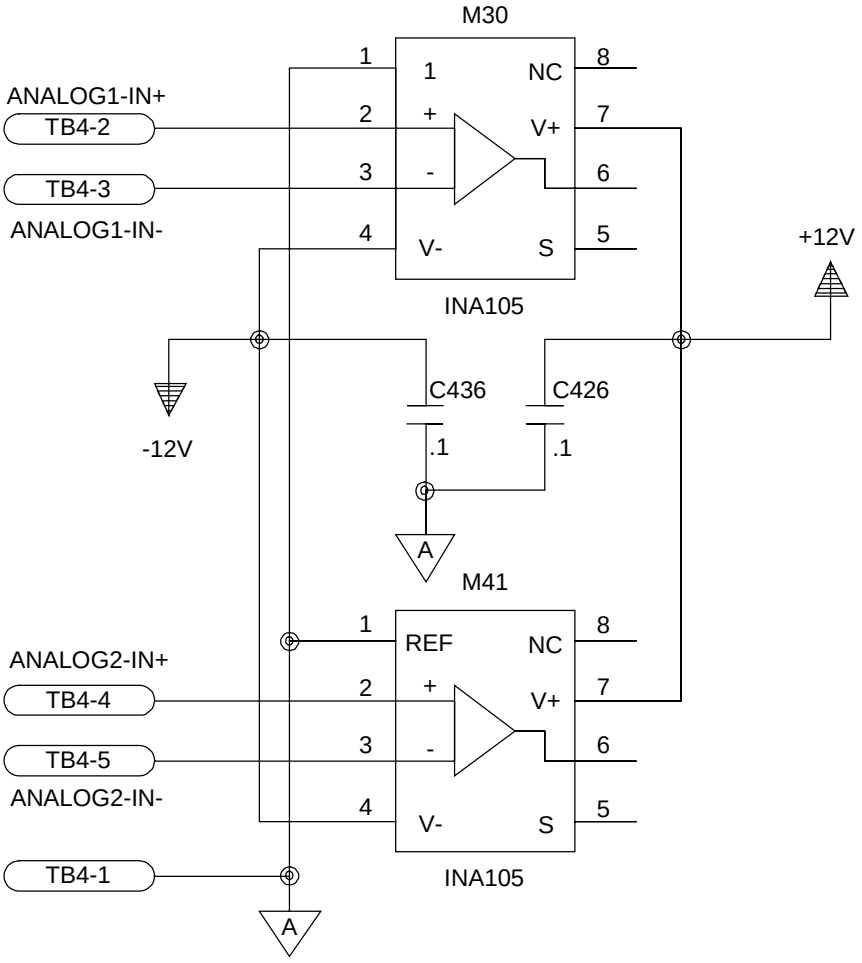



**Figure 4-4. Optional Analog Input Connector (TB4)**

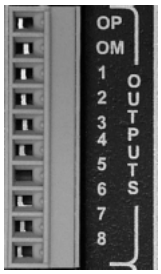



### 4.2.5. User Power Connector (TB5)

Refer to Figure 4-6. This connector allows the user to power the opto-isolated laser firing (PSO) output (see section 4.2.9.).

**Table 4-7. User Power Connector Pinouts (TB5)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | +5 External Rtn. | External +5 Volt Signal Common | N/A |
| 2 | +5 External Rtn. | External +5 Volt Signal Common | N/A |
| 3 | +5 Ext. | External +5 Volt Power | Output |
| 4 | FP | Power for PSO opto-isolated output | Input |
| 5 | FM | Common for PSO opto-isolated output | N/A |




### 4.2.6. Opto-Isolated Outputs (TB6)

The outputs are driven by a PS2506L-4 opto-isolator that is rated for 40 volts maximum and up to 150 mA, not to exceed 160 mW per channel. Figure 4-6 and Figure 4-8 show the outputs in current sinking and current sourcing modes, respectively. Figure 4-5 illustrates the typical user connections with the required pull-up resistors.

**Table 4-8. Opto-Isolated Output Connector Pinouts (TB6)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | OP | Output Common Plus (-IOPSO3, -IOPSO4) | Input |
| 2 | OM | Output Common Minus (-IOPSO, -IOPSO2) | Input |
| 3 | Output 1 | Output 1 (Optically-Isolated) | Output |
| 4 | Output 2 | Output 2 (Optically-Isolated) | Output |
| 5 | Output 3 | Output 3 (Optically-Isolated) | Output |
| 6 | Output 4 | Output 4 (Optically-Isolated) | Output |
| 7 | Output 5 | Output 5 (Optically-Isolated) | Output |
| 8 | Output 6 | Output 6 (Optically-Isolated) | Output |
| 9 | Output 7 | Output 7 (Optically-Isolated) | Output |
| 10 | Output 8 | Output 8 (Optically-Isolated) | Output |

**Table 4-9. Output Specifications (TB6)**

| Specification | Value |
|---|---|
| Maximum Power Dissipation | 160 mWatts / Channel |
| Maximum Output Voltage | 40 Volt Maximum |
| Maximum Output Current | 150 mAmps / Channel |
| Output Saturation Voltage | ~ 0.7 – 0.9 Volts |

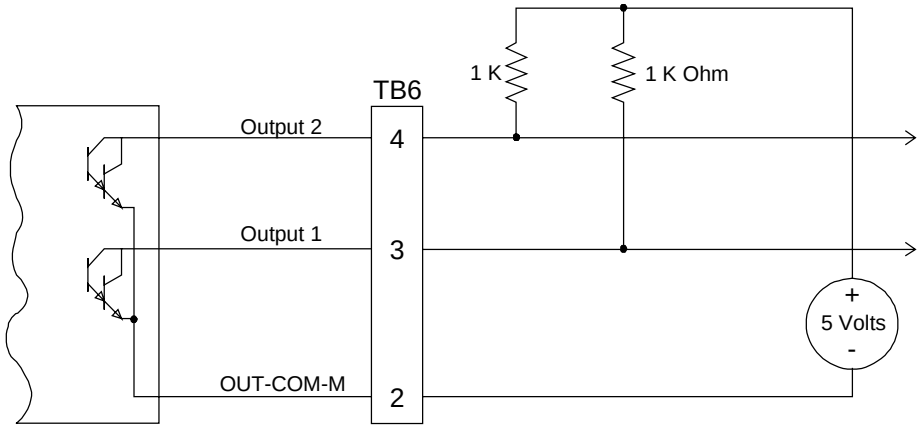



**Figure 4-5. Connecting Outputs in Current Sinking Mode (-IOPSO, -IOPSO2)**

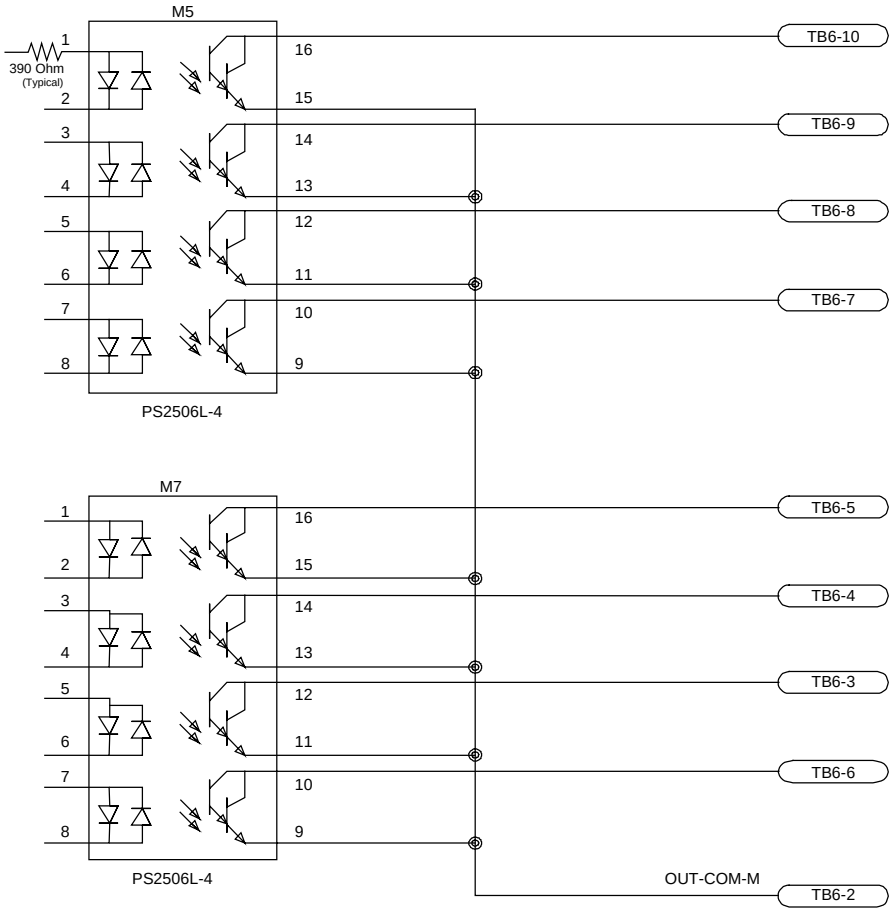



**Figure 4-6. -IOPSO, -IOPSO2 Sinking Outputs (TB6)**

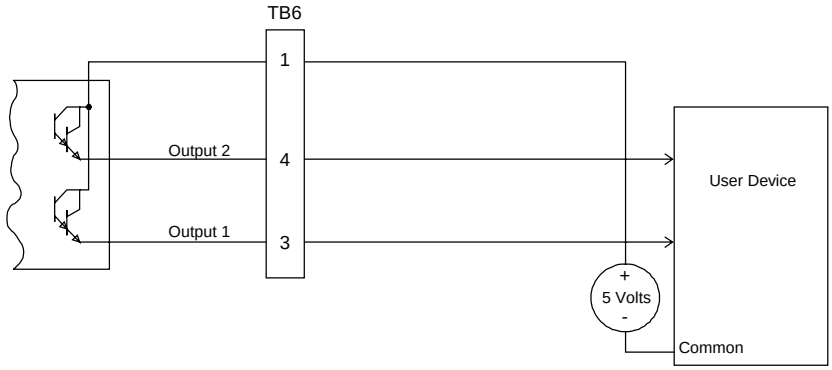



**Figure 4-7. Connecting Outputs in Current Sourcing Mode (-IOPSO3, -IOPSO4)**

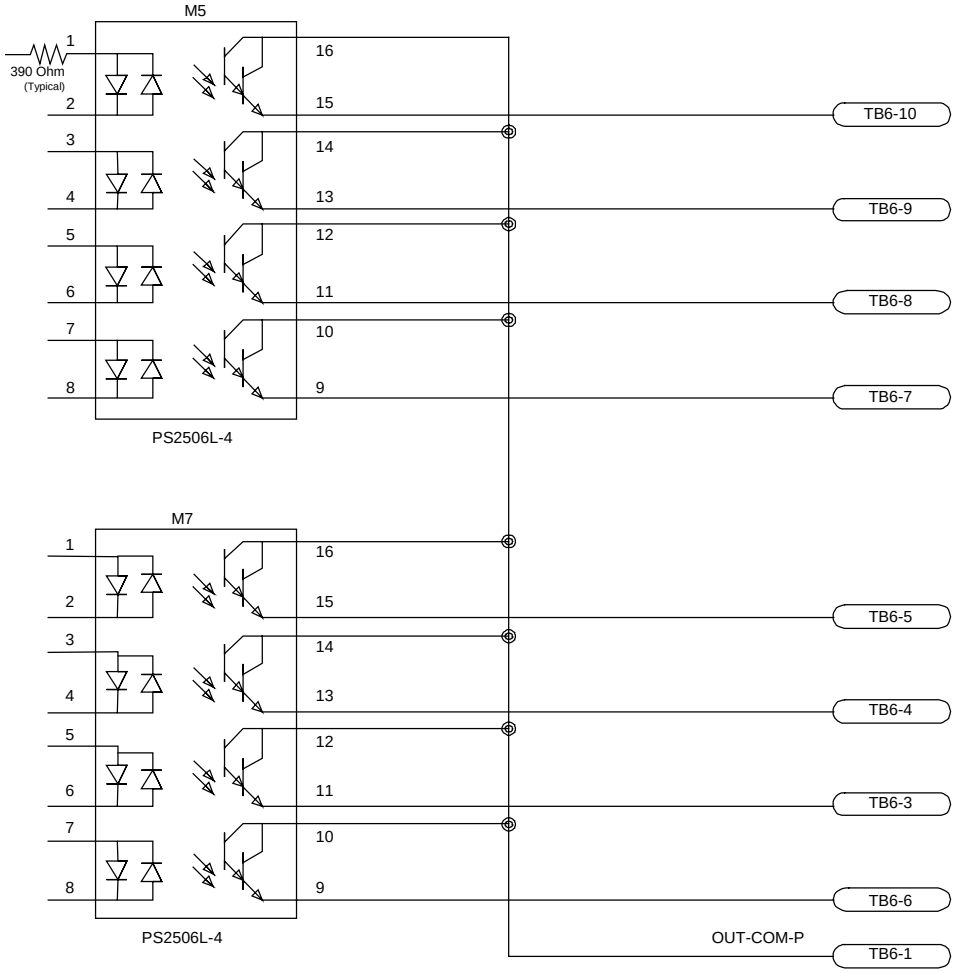
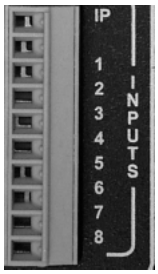



**Figure 4-8. -IOPSO3, -IOPSO4 Sourcing Outputs (TB6)**

### 4.2.7. Opto-Isolated Inputs (TB7)




The inputs are configured for 5-24 volt logic, using a higher input voltage, requires adding external series resistors to limit the current. The opto-isolator is a PS2506L-4. Figure 4-9 illustrates interfacing both an active device and a switch to the inputs. In either case, the power supply is required.

**Table 4-10. Opto-Isolated Input Connector Pinouts (TB7)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | IP | Input Common Plus | Input |
| 2 | | Reserved | |
| 3 | Input 1 | Input 1 (Optically-Isolated) | Input |
| 4 | Input 2 | Input 2 (Optically-Isolated) | Input |
| 5 | Input 3 | Input 3 (Optically-Isolated) | Input |
| 6 | Input 4 | Input 4 (Optically-Isolated) | Input |
| 7 | Input 5 | Input 5 (Optically-Isolated) | Input |
| 8 | Input 6 | Input 6 (Optically-Isolated) | Input |
| 9 | Input 7 | Input 7 (Optically-Isolated) | Input |
| 10 | Input 8 | Input 8 (Optically-Isolated) | Input |

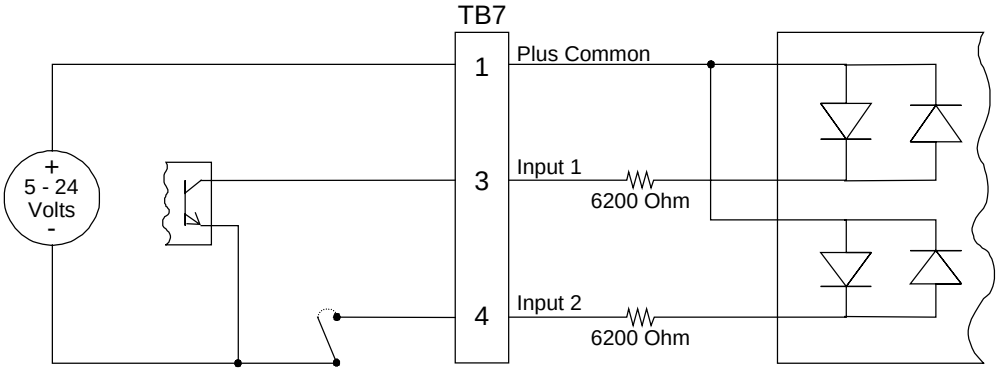



**Figure 4-9. Connecting Inputs**

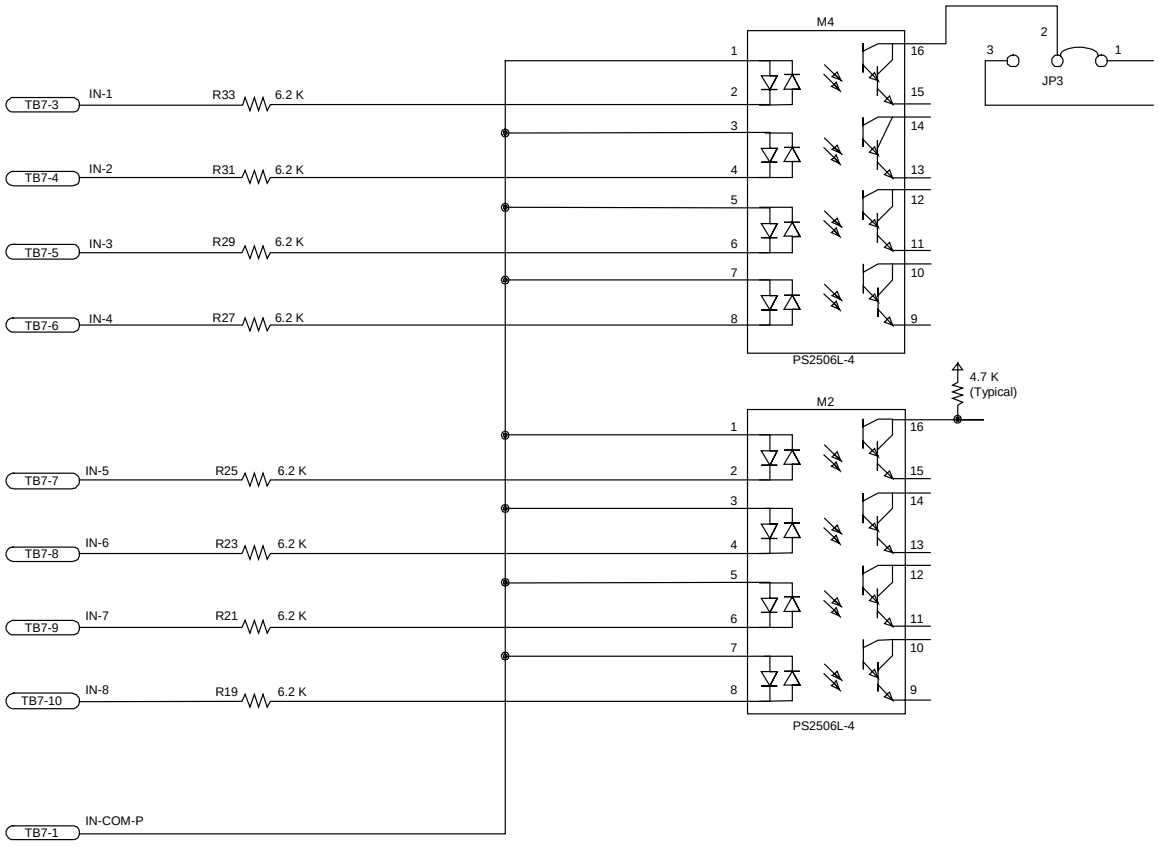



**Figure 4-10. Opto-Isolated Input Connector (TB7)**

### 4.2.8. Laser Firing / Position Synchronized Output (PSO)

The NDrive includes a Laser Firing or Position Synchronized Output (PSO) option. This PSO output may be programmed to generate a position-synchronized output based upon a user-defined trigger condition, most typically, but not limited to firing a laser. The NDrive offers two levels of laser firing, single axis and two/three axis. Single axis firing is standard (-IOPSO and –IOPSO3) and multi-axis is an option, -IOPSO2 or –IOPSO4. Trigger signals may be derived from the primary encoder channel, secondary encoder channel, either of the two SSINet ports or a software trigger. The SSINet ports may provide axes encoder signals or marker signals from another NDrive. All encoder input sources are limited to a 40 Mhz. data rate. The synchronized output pulse is solely generated within sophisticated and versatile high-speed hardware, allowing minimal delays between the trigger condition and the output. Refer to Figure 1-3 for a basic single-axis block diagram of the PSO capabilities, or Figure 4-11 and Figure 4-12 for a more detailed block diagram of the multi-axis capabilities that also apply to single-axis firing. The output may be either an open-collector output or a differential RS-422 output, see the Figures in Section 4.2.9. The opto-isolated output is available in three different configurations as show in Table 4-14. Additionally, the PSO options provide Data Capture and Data Update capabilities, also shown in Figure 4-11 and Figure 4-12. For programming information, refer to the NView MMI Help file or the NView MMI Programming Manual, EDU174.

**Table 4-11. Laser Output Opto-Isolator Specifications**

| Option (-n) | Nominal Frequency | Power Supply Voltage ($V_{Laser}$) | Output Current Sink |
|---|---|---|---|
| **HCPL-2601** (-PSOOPTO1 option, std) * | 5 MHz | 5 VDC | 10 mA |
| **6N136** (-PSOOPTO2 option) * | 750 kHz | 5-25 VDC | 2 mA |
| **4N33** (-PSOOPTO3 option) * | 10 kHz | 5-25 VDC | 50 mA |

* See Figure 4-16

The pre-scaler in the block diagram is used to scale, or normalize the resolution of axes with different machine step sizes. The PSO option operates in machine counts, so all axes must be scaled, or normalized to like units. This allows a trigger to be generated from a true vectorial position change. Each of the three possible tracking channels has a pre-scaler, which may be used to divide the number of encoder counts on that channel. Each pre-scaler defaults to 1 and may divide the input feedback pulses by up to 1,023.

The trigger condition may be a software trigger under program control, various other hardware triggers, or most typically a user-defined change in vectorial position, on up to (optionally) three axes. This vectorial position change is monitored via hardware, allowing an output pulse to be generated in less than 125 nanoseconds (50 nsec. for single axis) after the trigger is detected. This is accomplished via hardware that monitors the designated axes positions, calculates the sum of the squares of the axes positions and compares it to the desired (squared) position trigger value. All of the mathematical squaring of the positions occurs in hardware for speed. The comparison of the squared command to feedback position occurs at an 8 Mhz. rate for multi-axis firing and at a 20 Mhz. rate for single axis firing. Furthermore, this vectorial position trigger value is queued via a 255 level queue, in hardware to the triggering hardware, with each trigger advancing thru the queue to the next trigger value. This allows the trigger value to be specified as a series of incremental trigger points, if desired.

The absolute accuracy is excellent, although, point to point accuracy may vary, due to the calculated feedback squared firing distance jumping past the (internally squared) user programmed firing distance. This small error is accumulated and subtracted from the next firing distance, maintaining absolute accuracy. For example, if the user programs a trigger to occur after a vectorial change in position of 5 machine steps. Internally, this is squared, and the axes positions are internally squared and compared to 25. If they are equal to or greater than 25, a trigger event occurs. The comparison occurs at an 8 Mhz. rate (125 nano-seconds), so, should the sum of the square of the axes change in position be equal to 9 during a sample period, no trigger occurs. However, on the next sample, the sum of the squares of the axes positions could now be equal to 36. A trigger event would now occur (36 is greater than 25) and the remainder (11) is then stored to be summed with the squared feedback positions during the next sample period.

The output pulse is also user programmable. It may be a single, or multiple pulses per trigger event. It too is generated in hardware and fed from a 255 level queue, allowing trigger events to advance thru the queue, varying the output pulse per trigger event.

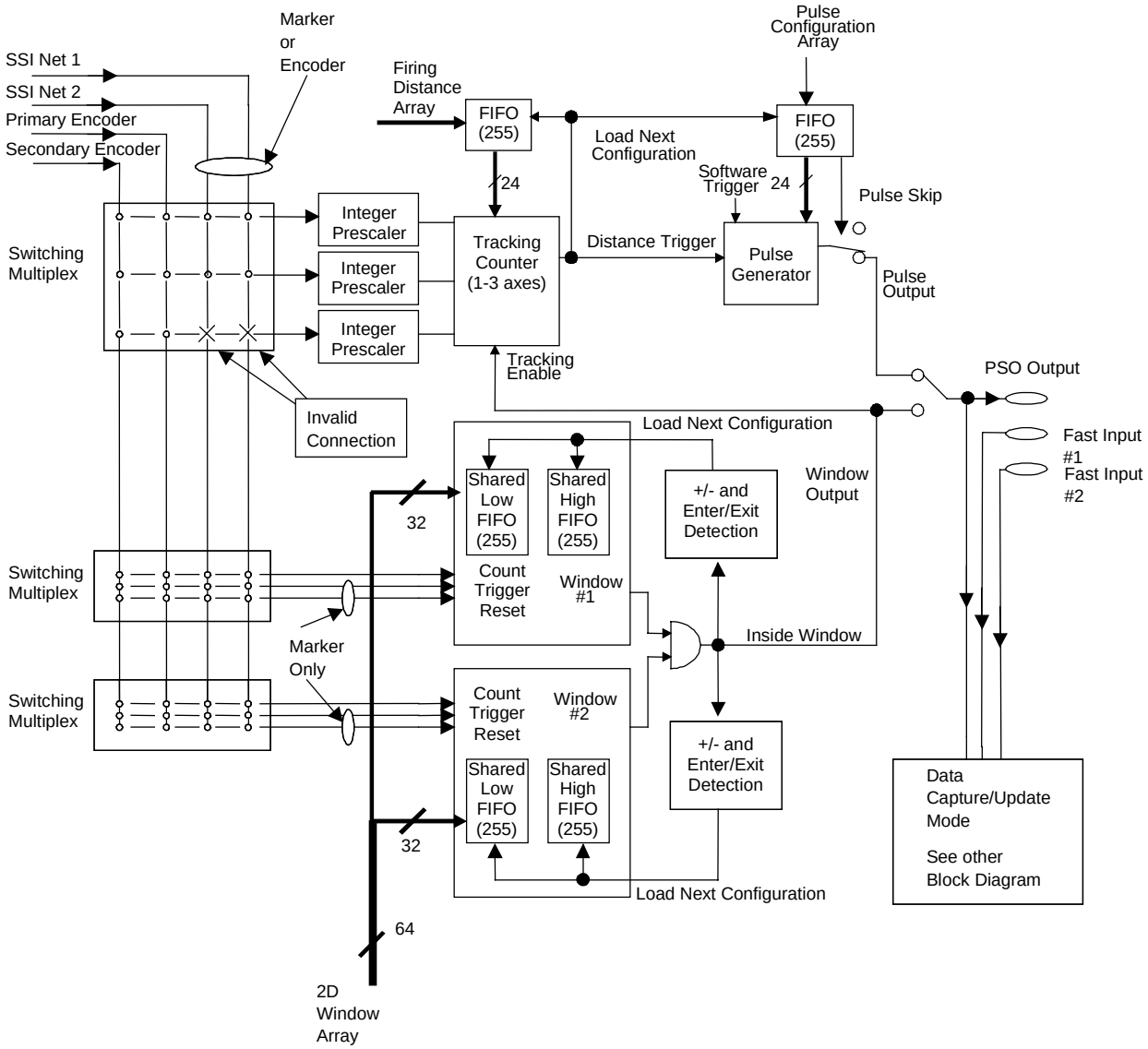



**Figure 4-11. Advanced 1 - 3 Axis Firing**

The window modes allow firing to occur, or be enabled, based upon axes being within a user-defined window. This window may be one or two-dimensional. The "+/- and Enter/Exit Detection" block within the block diagram is used to prevent false triggering due to one bit dither on axis, etc. Window modes may not be pre-scaled as shown in the block diagram.

The Data Capture and Data Update modes allow data to be captured or written to the I/O on the occurrence of the internal or external trigger. Data Capture mode allows position, digital inputs, etc. to be captured. Data Update mode allows analog or digital outputs to be set by the same trigger. The capture and update modes are defined in Figure 4-12. For

a full description of these modes, refer to the NView MMI help file or the N View MMI Programming Manual, EDU174.

These Capture/Update modes, share four FIFO's (queue's) with Window 1 and Window 2, preventing the window-firing modes from being used with the Capture/Update mode. Using a queue from a window, precludes using that window (1 or 2) for firing, however, queues from window 1 may be used for data capture/update mode, while queues from window 2 may be used for window firing purposes. The Capture/Update modes vary for Window 1 and Window 2, see Figure 2.

The data capture mode rate for analog inputs is limited to approximately 100,000 samples per second due to A/D conversion rate. The data update mode for analog outputs is limited to 500,000 Hertz due to internal serial bus design constraints.

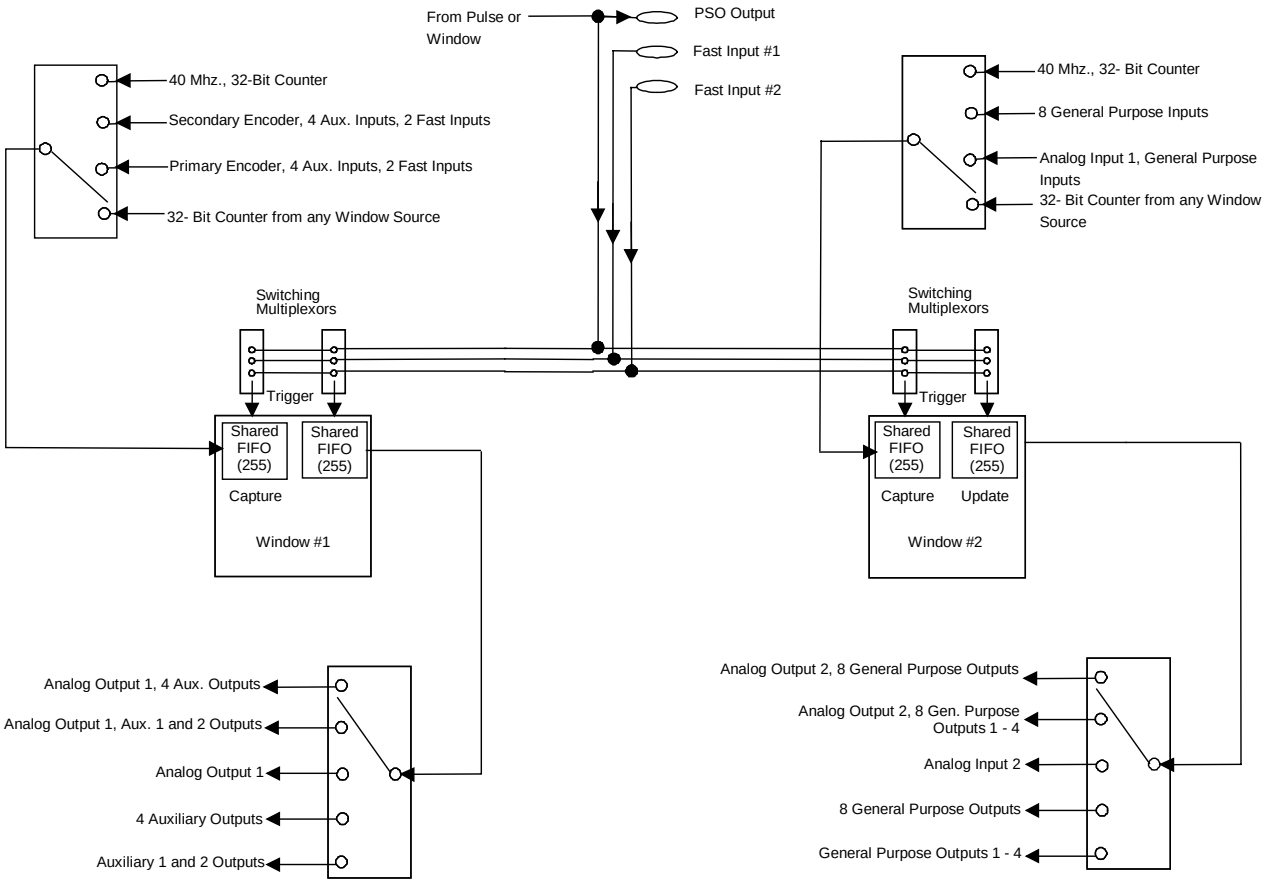



**Figure 4-12. Data Capture/Data Update Modes**

### 4.2.8.1. Single Axis Laser Firing

Single axis firing (-IOPSO and –IOPSO3 options) requires no additional encoder signals. It may be programmed to fire from the primary or secondary encoder channel. Single axis firing provides one feature not present with the multi-axes firing option, it allows for directional based firing. This means that you may program a firing distances for the positive and negative motion separately. Single axis window firing and Capture/Update modes may be used with single-axis firing, limited only by the use of the Windows internal shared queue's.

See Figure 4-13 for a basic single-axis block diagram of the PSO capabilities or Figure 4-11 and Figure 4-12 for a more detailed block diagram of the multi-axis capabilities that also apply to single-axis firing.

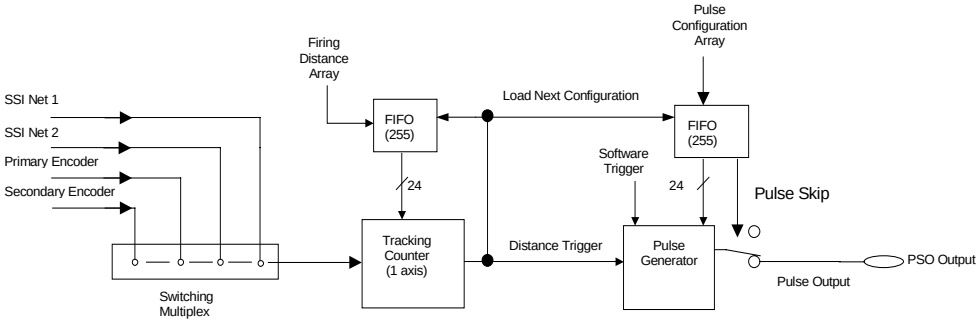



**Figure 4-13. PSO Diagram – Basic Single Axis Firing**

### 4.2.8.2. Two/Three-Axis Laser Firing

The NDrive allows two-axis laser firing via its –IOPSO2 and –IOPSO4 options. To accomplish this, the encoder signals from a second NDrive must be jumpered (or daisy-chained) from that NDrive to the NDrive with the –IOPSO2 or –IOPSO4 option. This requires an encoder signal from another axis via the J6 connector (Section 3.3) or via one of the two SSINet connectors. If the SSINet is used it requires a cable (see Table 4-12 and Figure 4-14) from J9 to J9 of each NDrive (J9 to J9 or J10 to J10 of the other NDrive, both connectors have two bidirectional ports). The ports on each drive must then be configured via their *PsoSsi1Config*/*PsoSsi2Config* and *PsoMrk1Config*/*PsoMrk2Config* axis parameters, out and in, respectively, so the encoder signals are supplied to the NDrive with the –IOPSO2 or –IOPSO4 option. The figure below also shows three-axis firing, which is very similar to two-axis firing. See the NView MMI help file for more information on parameter configurations.

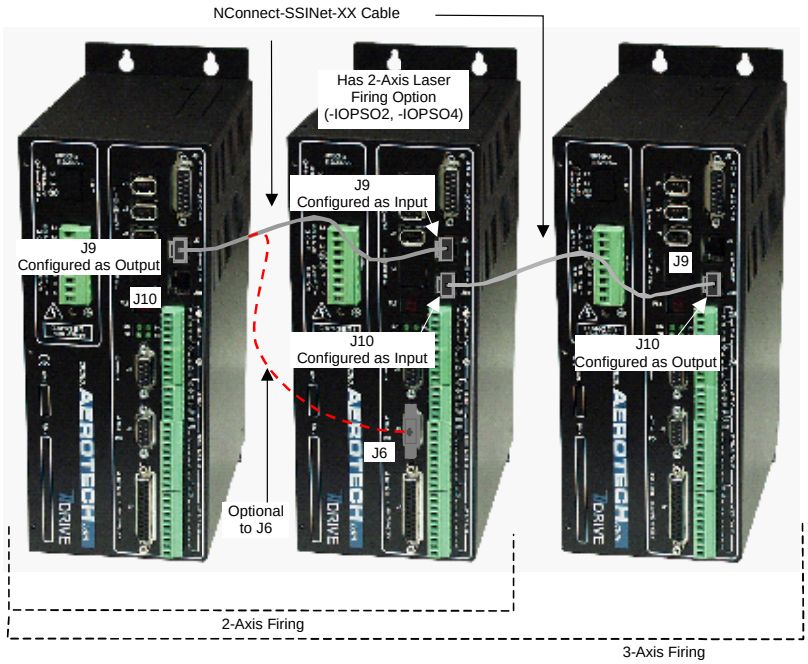
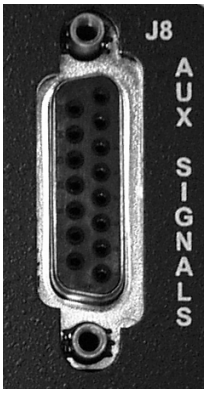



**Figure 4-14. Two/Three Axis Laser Firing Interconnection**

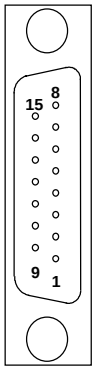
**Table 4-12. SSINet Cable Part Numbers**

| Part # | Description |
|---|---|
| NConnect-SSINet-4500 | 4.5 M (15 FT) SSINet Cable |
| NConnect-SSINet-3000 | 3.0 M (10 FT) SSINet Cable |
| NConnect-SSINet-1500 | 1.5 M (5 FT) SSINet Cable |
| NConnect-SSINet-900 | 490 M (3 FT) SSINet Cable |




## 4.2.9. PSO / Absolute Encoder Interface (J8)

This connector utilizes the RS-485 port and the (analog sine wave) encoder channel as an absolute encoder interface. The absolute encoder channel accepts a differential analog encoder up to 200 kHz. Typically, this is a 1 V P-P signal varying about a 2.5 V reference. See Figure 2-4, Figure 2-5, and Figure 2-6 in Section 2.5. for connection information. The two RS-422 channels provide buffered and/or multiplied MXH encoder signals to the user, for laser firing or other purposes. Additionally, the PSO option provides a open-collector or a RS-422 laser firing signal to the user. Only one of these signals may be used, as illustrated in Figure 4-16. Jumper JP2 defines the active state of the open-collector output, which has three options, as defined in Table 4-13. See Section 4.2.8. for more information on the laser firing (PSO) option. Note that the two RS-422 channels are two of the same channels available on the J9 and J10 connectors. For information on the RS-422 ports, see Figure 4-19 in Section 4.2.10.




See Figure 4-16 and Figure 4-17 for the firing output.

**Table 4-13. PSO / Absolute Encoder Interface Connector Pinouts (J8)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | Chassis Frame Ground | Chassis Frame Ground | N/A |
| 2 | RS-422-1M | RS-422 Channel 1 - | Bidirectional |
| 3 | RS-422-1P | RS-422 Channel 1 + | Bidirectional |
| 4 | RS-422-2M | RS-422 Channel 2 - | Bidirectional |
| 5 | RS-422-2P | RS-422 Channel 2 + | Bidirectional |
| 6 | Common (+5 Volt External) | Common | N/A |
| 7 | Absolute Sine + Input | Absolute Encoder Interface | Input |
| 8 | Absolute Sine - Input | Absolute Encoder Interface | Input |
| 9 | Absolute Cosine + Input | Absolute Encoder Interface | Input |
| 10 | Absolute Cosine – Input | Absolute Encoder Interface | Input |
| 11 | PSO-IOC/RS-422-M Output | PSO /RS-422 Output * | Output |
| 12 | PSO-RS-422-P Output | RS-422 + | Output |
| 13 | +5 Volt External – See Pin 6 | External +5 Volt supply | Output |
| 14 | RS-485-M | RS-485 – for Abs. Encoder | Bidirectional |
| 15 | RS-485-P | RS-485 + for Abs. Encoder | Bidirectional |



* Users are recommended to utilize the open-collector output where possible to maintain the isolation between the NDrive and laser. This prevents noise and current spikes (from laser firing pulses) from being conducted through the NDrive! This requires the user to power the opto-isolator at TB5 (see Section 4.2.5. for more information).

The mating connector is a male 15-pin D-Style connector (Aerotech P/N ECK100, Keltron P/N DN-15PYSH-G; Backshell: Aerotech P/N ECK1022, Amphenol P/N 17-1725-2).

**Table 4-14. Laser Output Opto-Isolator Specifications**

| Option (-n) | Nominal Frequency | Power Supply Voltage ($V_{Laser}$) | Output Current Sink |
|---|---|---|---|
| **HCPL-2601** (-PSOOPTO1 option, std) * | 5 MHz | 5 VDC | 10 mA |
| **6N136** (-PSOOPTO2 option) * | 750 KHz | 5-25 VDC | 2 mA |
| **4N33** (-PSOOPTO3 option) * | 10 KHz | 5-25 VDC | 50 mA |

* See Figure 4-16

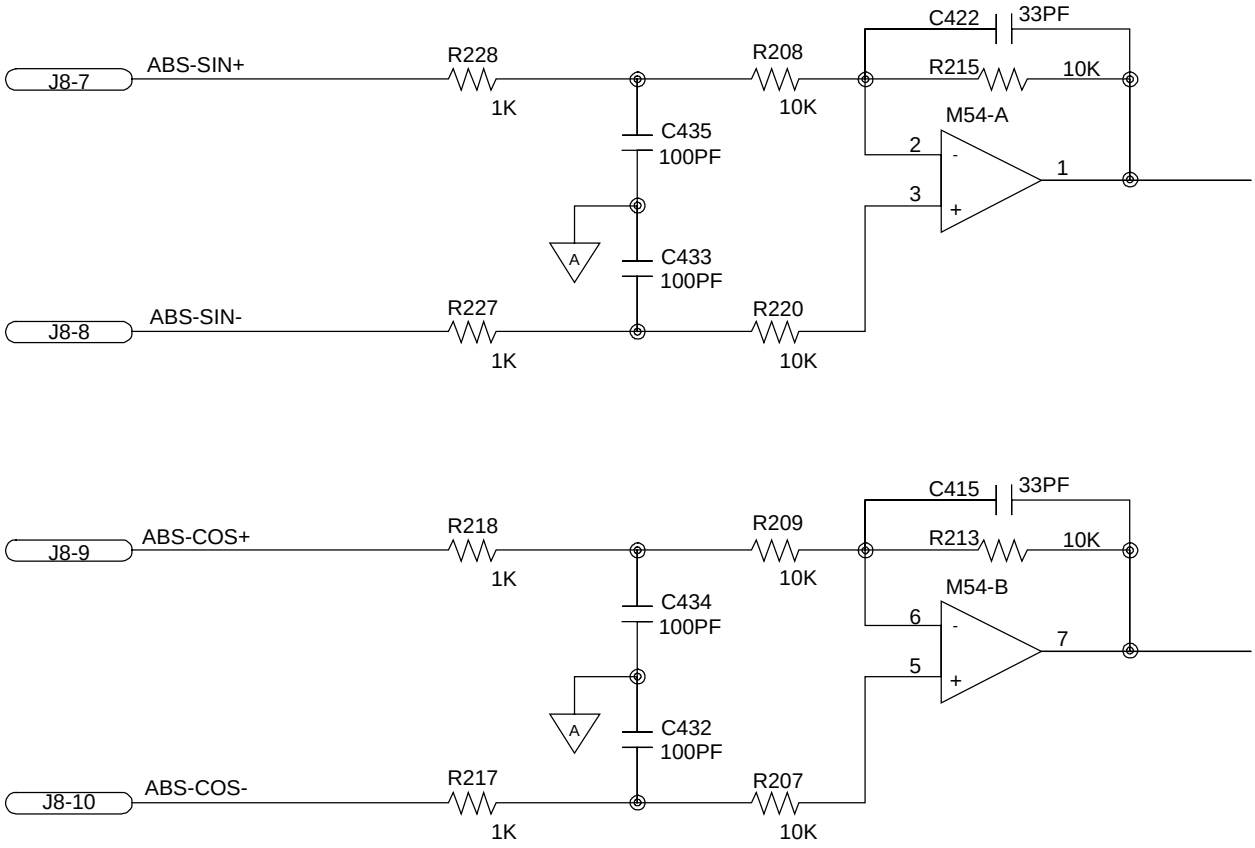



**Figure 4-15. Absolute Encoder Interface (J8)**

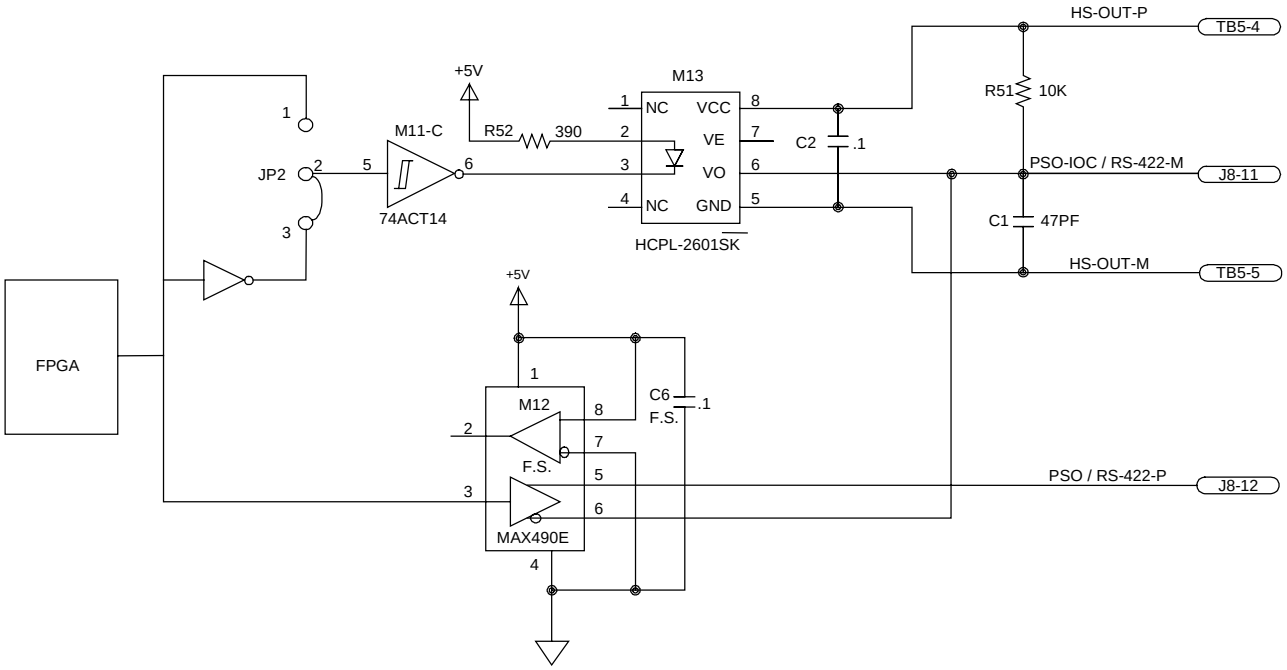
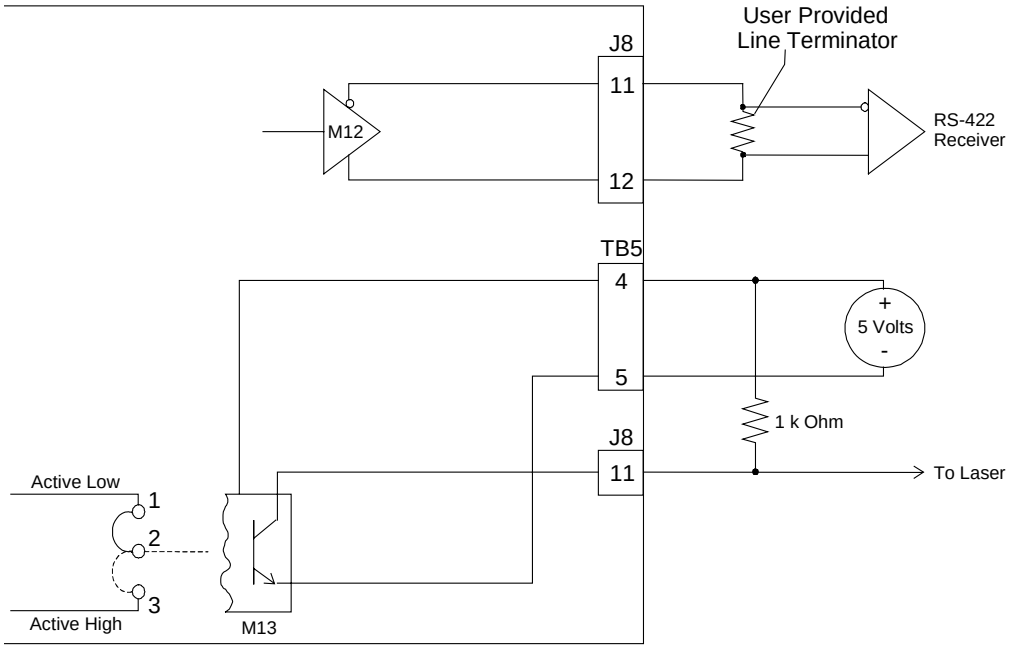



**Figure 4-16. PSO Interface (J8)**




Please note that J8 pin 11 is common between the two outputs, so only one of the interfaces may be used.

**Figure 4-17. Interfacing to RS-422 or Open-Collector Laser Firing Signal**

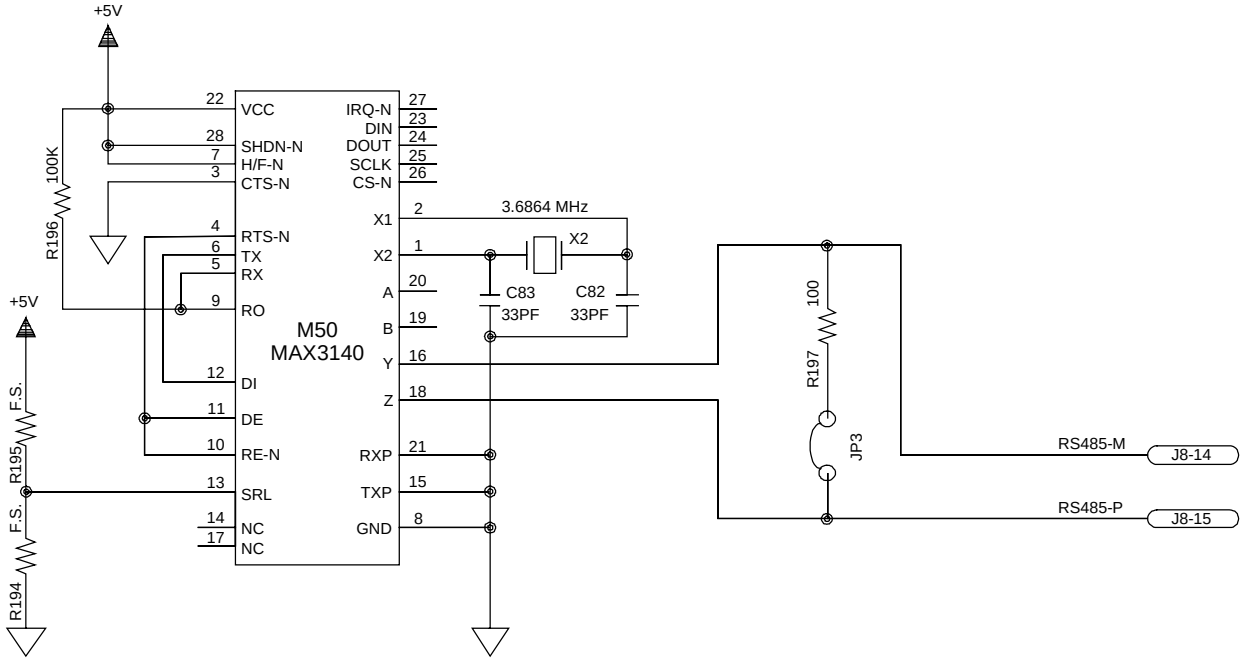
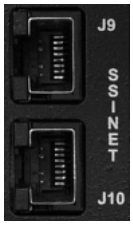



**Figure 4-18. (RS-485) Absolute Encoder Interface (J8)**

### 4.2.10. SSINet (2 channel) (J9, J10)




Each SSINet is a two-channel bidirectional RS-422 interface. Each of he two SSINet interfaces comprise two RS-422 channels, most typically for quadrature encoders. This allows one channel for the sine signal and one channel for the cosine singal. Alternatively, one of the SSINet interfaces may be used to provide an encoder marker signal to another NDrive for triggering purposes. In this case, only one of the RS-422 channesl within an SSINet interface is used.

It is designed for daisy-chaining encoder signals from one NDrive to another for 2 axes PSO (laser firing). This allows one NDrive containing the two-axis PSO option to track the vectorial position change of two axes in real-time. These encoder signals may also be used for user-defined purposes. Refer to Figure 4-19 and Figure 4-14. These four channels are bidirectional and configured via axis parameters. Note that channels 1 and 2 are also available on the J8 connector (see Section 4.2.9.). The signals from these ports will be the same as the differential line driver encoder signal input to the NDrive, unless the –MXH option is present. The signal output, when the –MXH option is present, will be of a pulse width determined by the –MXH clock frequency, as indicated in Table 3-5.

**Table 4-15. J9, J10 2-Channel SSINet Connector Pinouts**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | RS-422-1M | RS-422 Channel 1 - | Bidirectional |
| 2 | RS-422-1P | RS-422 Channel 1 + | Bidirectional |
| 3 | RS-422-4M | RS-422 Channel 4 - | Bidirectional |
| 4 | RS-422-3M | RS-422 Channel 3 - | Bidirectional |
| 5 | RS-422-3P | RS-422 Channel 3 + | Bidirectional |
| 6 | RS-422-4P | RS-422 Channel 4 + | Bidirectional |
| 7 | RS-422-2M | RS-422 Channel 2 - | Bidirectional |
| 8 | RS-422-2P | RS-422 Channel 2 + | Bidirectional |

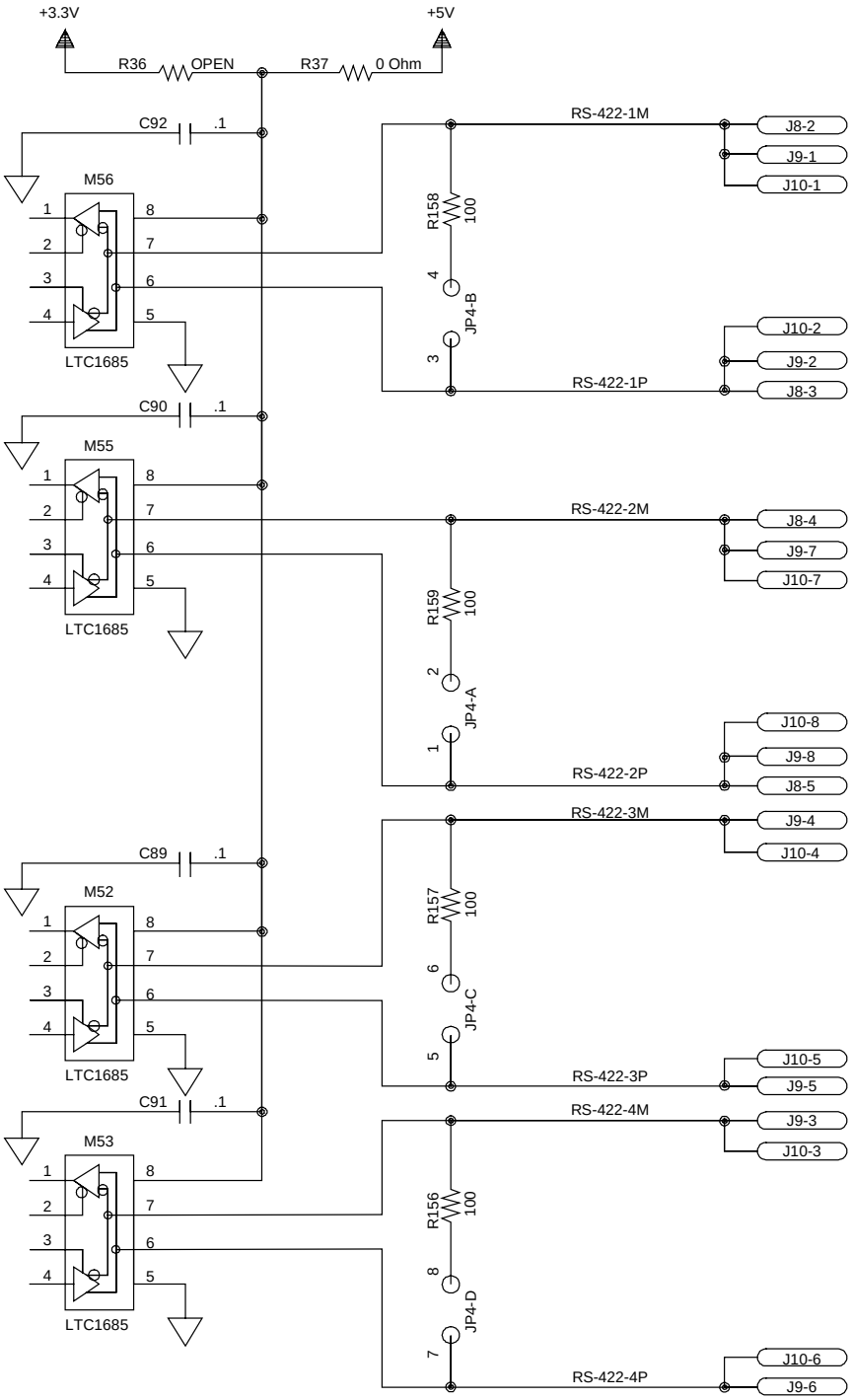
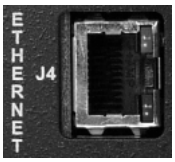



**Figure 4-19. J8/J9/J10**




## 4.3. Ethernet (J4)

The optional Ethernet port provides connectivity to a 10/100Base-T ModBus TCP network. Additionally, the -IOPSO# options provide analog and digital inputs and outputs, see section 4.2. for more info.

**Table 4-16. Ethernet Connector Pinouts (J4)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | TX + | Transmit Data + | Output |
| 2 | TX - | Transmit Data - | Output |
| 3 | RX + | Receive Data + | Input |
| 4 | Unused | RC Terminated | N/A |
| 5 | Unused | RC Terminated | N/A |
| 6 | RX - | Receive Data - | Input |
| 7 | Unused | RC Terminated | N/A |
| 8 | Unused | RC Terminated | N/A |

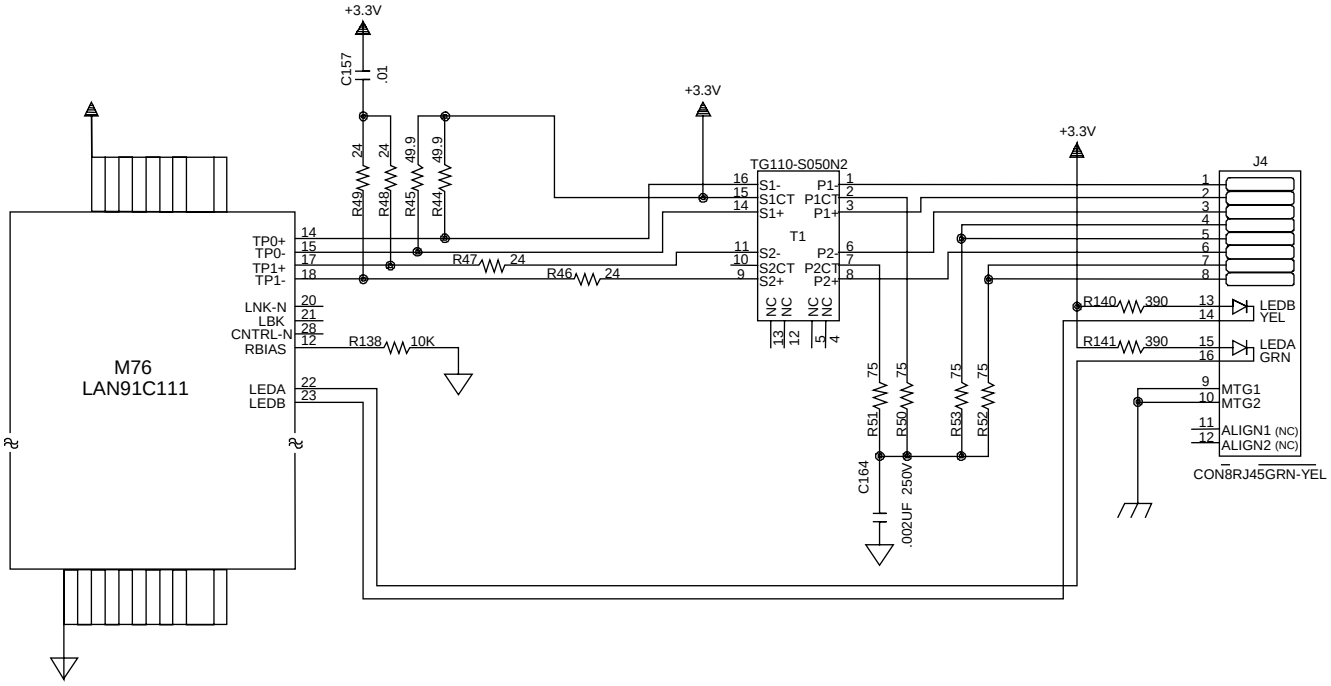



**Figure 4-20. Ethernet Interface (J4)**

## 4.4. Joystick Interface

The user can connect their own joystick and switches to the NDrive (Refer to Figure 4-21). The joystick interlock input in the logic low state indicates the connection of the joystick. The zero velocity null-point for each joystick connection is approximately 2.5 volts.

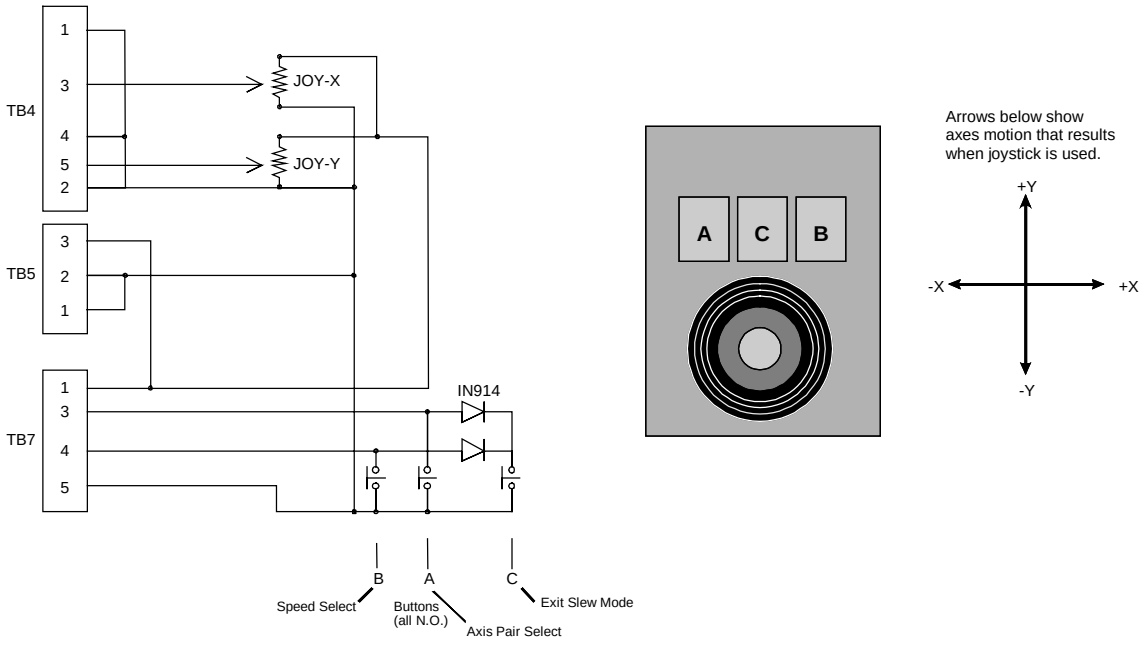



**Figure 4-21. Joystick Interface**

∇ ∇ ∇

# CHAPTER 5: TROUBLESHOOTING

**In This Section:**


- Problems, Causes, and Solutions ..... 5-1
- Fault Status Display ..... 5-2
- NDrive Control Board Test Points ..... 5-3
- JTAG Programming Connector ..... 5-4
- Using the RS-232 Boot Loader on the NDrive ..... 5-5
- Fuse / Battery Replacement ..... 5-7
- Preventative Maintenance ..... 5-8


## 5.1. Problems, Causes, and Solutions

This section covers symptoms, probable causes, and solutions related to NDrive operation. Table 5-1 lists the most common symptoms of irregular operation and the possible causes and solutions for these faults. More information can be found in the NView MMI help file.

Before performing the tests described in Table 5-1, be aware of **lethal voltages** inside the controller and at the input and output power connections. A qualified service technician or electrician should perform these tests.




**Table 5-1. Amplifier Faults, Causes, and Solutions**

| Symptom | Possible Cause and Solution |
|---|---|
| Motor spins uncontrollably. | Encoder (sine and cosine) signals are improperly connected. See Section 2.5. for motor phasing information. |
| Brushless motor will not spin. | Motor phases A, B, and C connected incorrectly relative to HA, HB, and HC Hall inputs. See Section 2.5. for motor phasing information. |
| Amplifier faults ("EN" LED deenergizes) when motor decelerates. | Bus over voltage detected (NDrive 10/20). This condition indicates an excessive regeneration condition. The NDrive 10/20 requires that a shunt regulator be mounted in the unit. |
| Amplifier Faults (EN LED deenergizes). | 1. RMS current exceeded - run at lower current.<br>2. Over temperature condition - Turn off and let amplifier cool down. Provide better ventilation.<br>3. Defective on board power supply - Return for repair. |

## 5.2. Fault Status Display

**Table 5-2. 7 Segment Fault Status Display**

| Code # | Meaning | Cause |
|---|---|---|
| 0001 | Position Error Fault | Pos Err Threshold Exceeded |
| 0002 | RMS Current Fault | RMS Threshold Exceeded (Fbk) |
| 0003 | Hardware Limit | Hardware Limit Switch Tripped |
| 0004 | Software Limit | Software Threshold Exceeded (Cmd) |
| 0005 | Drive Fault | Amplifier Hardware Fault |
| 0006 | Feedback Fault | No Feedback connected |
| 0007 | Hall Effect Fault | Bad Hall State |
| 0008 | Velocity Cmd Fault | Overspeed commanded |
| 0009 | ESTOP Fault | ESTOP toggled |
| 0010 | Velocity Error Fault | Vel Err Threshold Exceeded |
| | | |
| 0101 | Task 1 Error | Problem with independent motion cmd |
| 0102 | Task 2 Error | Problem with Ethernet |
| 0103 | Task 3 Error | Currently Undefined |
| 0104 | Task 4 Error | Currently Undefined |
| | | |
| 0 | FPGA Program Error | Hardware Failure |
| 1 | Memory Space Error | Problem with memory allocation |
| 2 | Routine Error | Problem setting up low-level drivers |
| 3 | No task 0 program | Missing Task 0 program |
| 4 | Memory Clear Error | Low Memory written as 0, but not read back as 0 |
| 5 | Unexpected Software Fault | Should Never Happen |
| 6 | Soft Start Not Engaged | Bus Power too low |
| 8 | Waiting for Firewire Power | Cable Not Connected |
| 9 | Unexpected Hardware Trap | Hardware Failure |



The L.E.D. flashes each digit sequentially on the single L.E.D.

## 5.3. NDrive Control Board Test Points

The following test points are available internal to the NDrive.

**Table 5-3. NDrive Control Board Test Points**

| Test Point | Function |
|---|---|
| TP4 | Signal Common (Analog and Digital) |
| TP5 | MXH/MXU Sine Signal 2.5 Volt Reference |
| TP6 | Marker Signal after Signal Conditioning (See Figure 3-3) |
| TP7 | MXH/MXU Cosine Signal 2.5 Volt Reference |
| TP9 | Sine Signal after Signal Conditioning (See Figure 3-3) |
| TP10 | Cosine Signal after Signal Conditioning (See Figure 3-3) |

## 5.4. JTAG Programming Connector

**Table 5-4. JTAG Programming Connector – Internal (P10)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | TDI | JTAG Data Input | Input |
| 2 | Common | Signal Common | N.A. |
| 3 | TDO | JTAG Data Output | Output |
| 4 | Common | Signal Common | N.A. |
| 5 | TCK | JTAG Programming Clock | Input |
| 6 | Common | Signal Common | N.A. |
| 7 | JTAG-TDI | Test Data Input | Input |
| 8 | - | Key Position (No Connection) | N.A |
| 9 | Reset | Reset | Input |
| 10 | TMS | Test Mode Select | Input |
| 11 | Power | 3.3 Volt Standard (5 Volt Optional) | Output |
| 12 | JTAG-TDO | Test Data Output | Output |
| 13 | DE-N | Data Enable | Input |
| 14 | TRST-N | Test Reset | Input |

## 5.5. Using the RS-232 Boot Loader on the NDrive

| | |
|---|---|
| ComBoot.exe | - the bootloader program |
| bootcode.lod | - mini bootstrap code for comboot.exe |
| ndboot.lod | - main bootloader code for NDrive |
| ndrive.lod | - firmware code file |
| ndfpga.lod | - fpga file |

ndboot.lod should already be burned into flash on the drive (so it may not be necessary to load and burn this code to flash again).

### 5.5.1. Setup

Remove the cover from the NDrive and locate the switch block marked S1. Set switch position "3" to "on" and switch position "4" to "off". This will put the unit in the bootload mode.

Connect an RS-232 cable to the unit and to the PC. This is a straight-through connection (no null modem cable is required).

Apply Power to the drive. Always be sure to cycle power to the drive before using the loader software, since it expects a clean boot in the bootload mode.

### 5.5.2. Loading Code

Run the software program ComBoot.exe. A graphical interface will come up. Select the desired COM port and press "Connect". The software should then indicate "Initialization of boot loaded complete". (This loads the small "bootcode.lod" to the NDrive.)

You should be able to individually load any one or all of the three .lod files into the NDrive. If the NDrive has never had boot code loaded, you must start with the ndboot.lod code file. If you only want new firmware (without new FPGA), then you should be able to just load the ndrive.lod file, etc.

TO LOAD THE BOOT CODE:

Type "ndboot.lod" into the text box by the Load button and then press the Load button. This will load the boot code to the drive. The indicator bar at the bottom of the window will indicate when loading is complete.

To store this boot code permanently to flash, press the "Burn" button in the Flash window. The indicator bar at the bottom of the window will indicate when loading is finished.

TO LOAD THE NEW FIRMWARE CODE:

Type "a.lod" into the text box in the window labeled "Boot File" and press the Load button. This will load the firmware code to the drive. The indicator bar at the bottom of the window will indicate when loading is complete.

To store this code permanently to flash, press the "Burn" button in the Flash window. The indicator bar at the bottom of the window will indicate when loading is finished.

TO LOAD THE FPGA CODE:

Type "ndfpga.lod" into the text box and press the Load button. This will load the fpga code to the drive. The indicator bar at the bottom of the window will indicate when loading is complete. This can be deceiving, however, since the code is one big chunk of memory. The indicator bar may be complete, but the actual device will be loaded when the message window indicates "loading complete".

To store this boot code permanently to flash, press the "Burn" button. The indicator bar at the bottom of the window will indicate when loading is finished.

TO COMPLETELY ERASE THE FLASH:

Load any one of the code files (ndboot.lod, ndrive.lod, ndfpga.lod) and press the Erase All. The flash can be erased from any of these programs.

### 5.5.3. When finished loading

Power down the NDrive and be sure to put switch S1 back to its original state (position 3 "off", position 4 "on"). Power the drive back on and the new firmware should be active.

## 5.6. Fuse / Battery Replacement

Table 5-5 lists the manufacturer and Aerotech's part number for typical replacement fuses. Additional fuse information can be found on the system drawing supplied with the unit.

**Table 5-5. Fuse Replacement Part Numbers (NDrive Power Board)**

| Fuse | Description | Third Party P/N | Aerotech P/N | Size |
|---|---|---|---|---|
| F1 | Supply Main Fusing for L1 VAC Bus Input | Littlefuse | EIF00118 | 20 A S.B. (3AG) |
| F2 | Shunt Option (-S) on 30 Amp Drive only | Littlefuse 235002 | EIF00195 | 2 A S.B. (5 mm) |
| F3 | Control Power Fuse | Littlefuse 230.250S | EIF01009 | .25 A S.B. |
| F5 | Optional 115/230 VAC Control Power Supply Input | Littlefuse 230.250S | EIF01009 | .25 A S.B. |

F1 and F2 are normal socketed fuses. F3-F5 are soldered to the circuit board.

Always disconnect the mains power connection before opening the NDrive chassis.




**Table 5-6. Battery Replacement Part Number (NDrive Control Board)**

| Battery | Description | Third Party P/N | Aerotech P/N |
|---|---|---|---|
| B1 | 3 V Coin Cell | RAY-O-VAC BR1225 | ECZ01079 |

## 5.7. Preventative Maintenance

The NDrive and external wiring should be inspected monthly. Inspections may be required at more frequent intervals, depending on the environment and use of the system. Table 5-7 lists the recommended checks that should be made during these inspections.



The NDrive (all Aerotech equipment) is not to be used in a manner not specified by Aerotech, Inc.

**Table 5-7. Preventative Maintenance**

| Check | Action to be Taken |
|---|---|
| Visually Check chassis for loose or damaged parts / hardware.<br>**Note**: Internal inspection is not required. | Parts should be repaired as required. If internal damage is suspected, these parts should be checked and repairs made if necessary. |
| Inspect cooling vents. | Remove any accumulated material from vents. |
| Check for fluids or electrically conductive material exposure. | Any fluids or electrically conductive material must not be permitted to enter the NDrive.<br>**Note**: Disconnect power to avoid shock hazard. |
| Visually inspect all cables and connections. | Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors. |

### 5.7.1. Cleaning

The NDrive should be wiped with a clean, dry (or slightly damp with water), soft cloth. Fluids and sprays are not recommended because of the chance for internal contamination, which may result in electrical shorts and/or corrosion. The electrical power must be disconnected from the NDrive while cleaning. Do not allow cleaning substances to enter the NDrive or on to any of the connectors. Cleaning labels should be avoided to prevent erasing of label information.

∇ ∇ ∇

# APPENDIX A: GLOSSARY OF TERMS

**In This Section:**


- Description..... A-1


## Description

The following section provides a quick reference of terms used through this manual.

**CEMF -** Counterelectromotive Force. Voltage generated by a motor.

**DIP switch -** Dual In-line Package switch. A set of tiny toggle switches built into a housing commonly used on printed circuit boards

**Hall effect devices -** A set of three electro-optical or magnetic switches mounted on the motor that produce a sequential pattern to provide proper motor commutation.

**HED -** Hall effect device.

**IGBT -** Insulated Gate Bipolar Transistor.

**PWM -** Pulse Width Modulation.

**RMS -** Root Mean square - The effective DC value of AC voltage or current.

**TTL -** Transistor - Transistor Logic.

# APPENDIX B: WARRANTY AND FIELD SERVICE

**In This Section:**


- Laser Products.....B-1
- Return Procedure.....B-1
- Returned Product Warranty Determination.....B-2
- Returned Product Non-warranty Determination.....B-2
- Rush Service.....B-2
- On-site Warranty Repair .....B-2
- On-site Non-warranty Repair .....B-2


Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, where or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

***Laser Products***

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

***Return Procedure***

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

***Returned Product Warranty Determination***

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an air freight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

***Returned Product Non-warranty Determination***

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time, the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

***Rush Service***

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

***On-site Warranty Repair***

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

***On-site Non-warranty Repair***

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

***Company Address***

Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238-2897
USA

Phone: (412) 963-7470
Fax: (412) 963-7459

∇ ∇ ∇

## Symbols

< 70 VAC AC Bus Input Power, 2-2
10/100BASE-T Ethernet, 1-2, 3-1, 4-1, 4-22
20 kHz Switching Rate, 2-3
-3P
  Capabilities, 4-1
-3P Option, 1-2, 2-2, 3-1, 4-1
40/80 VDC Power Transformer, 2-4
4N33, 4-11, 4-17
50/60 Hz Torque Disturbance, 2-5
6N136, 4-11, 4-17
7 Segment Fault Status Display, 5-2

## A

AC Power Connections, 2-2
Accessories, 3-1
AL1, 2-2
AL2, 2-2
Amplifier Faults, 5-1
Amplifier Related Problems, 5-1
Analog Inputs (TB4), 4-5
Analog Output Connector Pinouts, 4-3
Auxiliary I/O, 3-3
  Connector Pinouts, 3-3
Auxiliary Power Option, 2-4
-AUXPWR, 1-2, 3-1, 4-1
  Capabilities, 4-1
  TB1, 2-4
-AUXPWR, 2-4
-AUXPWR (Auxiliary Power) Option, 2-4
-AUXPWR Option, 2-2

## B

Back-Propagation Line Filter Connection, 2-5
Battery, 5-7
Battery Replacement, 5-7
Brake / Relay (TB3) Current Specifications, 4-4
Brake / Relay (TB3) Voltage Specifications, 4-4
Brake / Relay Connector Pinouts, 4-4
Brake Configuration Jumpers, 4-2
Brake Output Relay, 3-4
Brushless Motor Configuration, 2-6, 2-7, 2-9
Bus Power Supply, 1-4

## C

Capacitive Coupling, 2-3
CEMF, A-1
Cleaning, 5-8
Commutation Signal Input Connections, 2-9
Connector, 1-6
Connector Pinouts
  Auxiliary I/O, 3-3
  FireWire, 2-11
  J5, 3-2
  J6, 3-3
  J7, 3-4
  Motor Feedback, 3-4
  RS-232/RS-422, 3-2
Continuous Output Current, 1-2
Control Board, 3-12
  Assembly, 3-12
  Jumpers, 3-12, 3-13
  Test Points, 5-3
Control Board Options, 1-2, 3-1
  ENET, 1-2, 3-1, 4-1
  IOPSO, 1-2, 3-1, 4-1
  IOPSO2, 1-2, 3-1, 4-1
  IOPSO3, 1-2, 3-1, 4-1
  IOPSO4, 1-2, 3-1, 4-1
  MXH, 1-2, 3-1, 4-1
  MXU4096, 1-2, 3-1, 4-1
  MXU65536, 1-2, 3-1, 4-1
  PSOOPTO1, 1-2, 3-1
  PSOOPTO2, 1-2, 3-1
  PSOOPTO3, 1-2, 3-1
Current Sinking Mode, 4-7
Current Sourcing Mode, 4-8

## D

DC Brush Motor Configuration, 2-6
Determining Proper Connections to the NDrive
  Equipment, 2-9
  Test, 2-9
Device Settings, 2-14
Dimensions, 3-17, 3-18
DIP switch, 1-6, A-1
Drive Package, 1-4

## E

Electircal Noise Reduction, 2-3
Electrical Specifications, 3-11
Electrostatic Coupling, 2-5
EMI Interference, 2-3
EN LED Indicator, 3-16
Encoder Phasing, 2-10
-ENET, 1-2, 3-1, 4-1, 4-22
  Capabilities, 4-1
Ethernet (J4), 4-22

## F

Fault Status Display, 5-2
Features, 1-1
Feedback Connections, 2-6
Field Service Policy, B-1
FireWire, 2-11
  Card and Cable Part Numbers, 2-12
  Connector Pinouts, 2-11
  J1, 2-11
  J2, 2-11
  J3, 2-11
  Minimizing Cable Lengths, 2-11, 2-13
  Part Numbers, 2-12
  Preferred Configuration, 2-11, 2-13
FireWire Bus, 2-11
FireWire:, 2-11, 2-13
Fuse Replacement, 5-7
Fuses, 5-7

## G

Grounding Techniques, 2-3

## H

HALL A, 2-9
HALL B, 2-9
HALL C, 2-9
Hall effect device, A-1
Hardware Function, 1-6
Hardware Overview, 1-6
HCPL-2601, 4-11, 4-17
High Inrush Currents, 1-4
-HS, 1-2, 3-1
  Capabilities, 4-1
-HS Option, 4-1

## I

IGBT, A-1
Input Power, 1-6
  L1, L2, L3, 2-2, 2-5
  Main Supply, 2-2
  Motor Frame Connections, 2-2
  Shield Connection, 2-2
  TB1, 2-2
  Three-Phase Power Input, 2-2
Input Power Wiring Techniques, 2-3
Installation, 2-1
Integrated, 2-6
Integrated Configurations, 2-6
-IOPSO, 1-2, 3-1, 4-1, 4-7
  Capabilities, 4-1
-IOPSO#, 4-1
  Capabilities, 4-1
-IOPSO# Option
  Jumpers, 4-2
-IOPSO# Option Board, 4-2
  Analog Inputs (TB4), 4-5
  Analog Outputs, 4-3
  Brake/Relay (TB3), 4-4
  Opto-Isolated Inputs (TB7), 4-9
  Opto-Isolated Outputs (TB6), 4-6
  PSO / Absolute Encoder Interface (J8), 4-16
  SSINET (J9, J10), 4-20
  User Power Connector (TB5), 4-6
-IOPSO# Options
  Brake Output, 3-4
-IOPSO2, 1-2, 3-1, 4-1, 4-7, 4-15
  Capabilities, 4-1
-IOPSO3, 1-2, 3-1, 4-1, 4-8
  Capabilities, 4-1
-IOPSO4, 1-2, 3-1, 4-1, 4-8, 4-15
  Capabilities, 4-1
Isolation transformer, 2-5

## J

J1
  FireWire, 2-11
J10, 4-20
J2
  FireWire, 2-11
J3
  FireWire, 2-11
J4, 4-22
J5
  Connector Pinouts, 3-2
J5, 3-2
J6
  Connector Pinouts, 3-3
J6, 3-3
J7, 2-9, 3-4, 4-2
  Connector Pinouts, 3-4
J8, 4-16
J9, 4-20
Joystick Interface, 4-23
JTAG, 5-4
JTAG Programming Connector, 5-4
Jumpers
  Control Board, 3-13
  -IOPSO#, 4-2
  Power Board, 3-15

## L

L.E.D. Display, 5-2
L1 Input Terminal, 2-2, 2-5
L2 Input Terminal, 2-2, 2-5
L3 Input Terminal, 2-2
Laser Output Opto-Isolator Specifications, 4-11, 4-15, 4-17

LED indicator, 1-6
LED Indicators, 3-16
  Description, 3-16
  EN, 3-16
  MR, 3-16
  PK, 3-16
  ZR, 3-16
Limit and Hall Effect Inputs, 3-5
Line Driver Encoder (Standard), 3-7
Line Filter Connection, 2-5
Line Interference, 2-5
Logic High, 2-9
Logic Low, 2-9

## M

Models, 1-2
Motor, 1-6
Motor and Feedback Connection Basic
  Configurations, 2-6
  Brushless, 2-6
  DC Brush, 2-6
  Stepper, 2-6
Motor and Feedback Connections, 2-6
Motor Connections, 2-2, 2-6
Motor Feedback
  Connector Pinouts, 3-4
Motor Feedback, 3-4
  Connector, 4-2
  MXH/MXU, 3-4
Motor Frame Connection, 2-2
Motor Output Terminals
  A, B, and C, 2-2
Motor Phasing, 2-9, 2-10
MR LED Indicator, 3-16
-MXH, 1-2, 3-1, 4-1
  Capabilities, 4-1
-MXH Option
  Specifications, 3-9
    Clock Frequency, 3-9
    Interpolation, 3-9
    Max Input Frequency, 3-9
    Minimum Edge Separation, 3-9
    Minimum Pulse Width, 3-9
MXH/MXU, 3-4
  Options, 3-8
MXH/MXU Analog Encoder Interface (Optional), 3-6
-MXU4096, 1-2, 3-1, 4-1
  Capabilities, 4-1
-MXU65535
  Capabilities, 4-1
-MXU65536, 1-2, 3-1, 4-1

## N

NDrive Connection Test, 2-9
NDrive Hardware, 1-6
Noise
  Back-propagation, 2-5

## O

Operating Bus Voltages, 3-1
Optional AC Power Supply Input, 2-2
Optional Analog Input Connector Pinouts, 4-5
Options, 1-2, 4-1
Opto-Isolated Input Connector
  Pinouts, 4-9
Opto-Isolated Inputs (TB7), 4-9
Opto-Isolated Output Connector
  Current Sinking Mode, 4-7
  Current Sourcing Mode, 4-8
  Pinouts, 4-6
  Sinking Outputs, 4-7, 4-8
  Specifications, 4-6
Opto-Isolated Outputs (TB6), 4-6
Order Information, 3-1
Output Current, Peak, 1-2
Output Current, Peak, 3-1

## P

P10, 5-4
Part Number Information, 3-1
Part Numbers
  FireWire Card and Cables, 2-12
Phase/Hall Sequence, 2-9
Pinouts
  Analog Output Connector, 4-3
  Brake / Relay Connector, 4-4
  Optional Analog Input Connector, 4-5
  Opto-Isolated Input Connector, 4-9
  Opto-Isolated Output Connector, 4-6
  PSO / Absolute Encoder Interface (J8), 4-16
  SSINet (J9, J10), 4-20
  User Power Connector, 4-6
PK LED Indicator, 3-16
Power, 1-2
Power Board, 3-14
  Assembly, 3-14
  Fuses, 3-15
  Jumpers, 3-15
Power Board Options, 1-2, 3-1
  -3P (3-Phase AC Input), 1-2, 3-1, 4-1
  -AUXPWR (Auxiliary Power), 1-2, 3-1, 4-1
  -HS (Heat Sink), 1-2, 3-1, 4-1
  -S (Shunt), 1-2, 3-1, 4-1
Power Connections, 1-6, 2-2
Precautions, 2-1
Preventative Maintenance, 5-8
Product Overview, 1-1
PSO / Absolute Encoder Interface (J8), 4-16
PSO / Absolute Encoder Interface (J8)
  Pinouts, 4-16

-PSOOPTO1, 1-2, 3-1, 4-11, 4-17
-PSOOPTO2, 1-2, 3-1, 4-11, 4-17
-PSOOPTO3, 1-2, 3-1, 4-11, 4-17
PWM, A-1

## R

Relay K1 Contact Ratings, 4-4
Revision History, R-1
RMS, A-1
RS-232 Boot Loader, 5-5
RS-232/RS-422, 3-2
  Connector Pinouts, 3-2

## S

-S, 1-2, 3-1
  Capabilities, 4-1
-S Option, 4-1
S2
  Switch Settings, 2-14
Safety Procedures, 2-1
Secondary Encoder Channel, 3-3
Shield Connection, 2-2
Shielding Techniques, 2-3
Soft Start Circuit, 1-4
Specifications
  Opto-Isolated Output Connector, 4-6
SSINet (J9, J10)
  Pinouts, 4-20
SSINET (J9, J10), 4-20
Standard Encoder Input, 3-7
Standard Package, 1-4
Stepper Motor Configuration, 2-6, 2-8
Switch S2, 2-14
Switching Rate, 2-3

## T

TB1, 2-2, 2-4
  AL1, 2-2
  AL2, 2-2
  -AUXPWR, 2-4
  Ground, 2-2
  Optional AC Power Supply Input, 2-2
TB2, 2-2
TB3, 4-3, 4-4
TB3 (Brake / Relay) Current Specifications, 4-4
TB3 (Brake / Relay) Voltage Specifications, 4-4
TB4, 4-5
TB5, 4-6
TB6, 4-6
TB7, 4-9
Technical Details, 3-1
Three-Phase Motor Terminal Connections, 2-2
Three-Phase Power Input (optional), 2-2
Troubleshooting, 5-1
TTL, A-1
TV0.3-28 power transformer (optional), 2-4
TV0.3-56 power transformer (optional), 2-4
Two Axis Laser Firing, 4-15

## U

Unknown Phase/Hall Sequence, 2-9
User Power Connector (TB5), 4-6
User Power Connector Pinouts, 4-6

## V

Voltage configurations, 1-2

## W

Warnings, 2-1, 2-11
Warranty Policy, B-1
Wiring Techniques, 2-3

## Z

ZR LED Indicator, 3-16

∇ ∇ ∇

# REVISION HISTORY

**In This Section:**


- Revisions ..... R-1


## Revisions

The following section provides the user with general information regarding the latest changes to this manual. Extensive changes, if made, may not be itemized – instead, the section or chapter will be listed with "extensive changes" in the corresponding General Information cell.

**Table R-1. Revisions**

| Revision | Section(s) Affected | General Information |
|---|---|---|
| 1.3 | 1.1. | Text change. Figure 1-1 updated. |
| | 1.3. | Figure 1-2. updated. Figure 1-3. added. |
| | 2.5.1. – 2.5.3. | Figure 2-4. – Figure 2-6. updated. |
| | 2.7. | Warning added. Table 2-3 updated. |
| | 3.2. | Text updated. |
| | 3.3. | Text updated. |
| | 3.4. | Table 3-4. updated. |
| | 3.4.1. | Previously numbered as 3.4.2. |
| | 3.4.2. | Previously numbered as 3.4.1. Text and Table 3-5. updated. |
| | 3.4.3. | New section. |
| | 4.2.3. | Figure 4-3. updated. |
| | 4.2.5. | Table 4-7. updated. |
| | 4.2.8. | This and all subsections under 4.2.8. extensively changed (previously numbered as section 4.2.10). |
| | 4.2.9. | Text updated (previously numbered as section 4.2.8). |
| | 4.2.10. | Text updated (previously numbered as section 4.2.9). |
| | 4.4. | Figure 4-21. updated. |
| 1.2 | Declaration Of Conformity | Declaration of Conformity added |
| | 3.7. | Figure 3-7 updated (fuse removed). Table 3-9 updated (F1 information). |
| | 4.2.10. | SSINet cable information added (Figure 4-16 and Table 4-15). |
| | 4.4. | Figure 4-18 wiring updated. |
| | 5.5. | File names updated |
| | 5.5.2. | File names updated |
| | 5.6 | F1 and F2 fuse information updated. |

**Table R-1. Revisions**

| Revision | Section(s) Affected | General Information |
|---|---|---|
| 1.1 | 1.3. | Figure 1-2: Updated |
| | 2.3. | Text change (deletion) |
| | 2.4.2. | Text change (NDriveB-xx-AUXPWR becomes NDRIVEXXB-AUXPWR) |
| | 2.5.1. | Figure 2-4: Updated |
| | Chapter 3 | Pin drawings corrected (pin numbers) |
| | 3.3. | Table 3-3, Figure 3-2: AUXMKR+ and AUXMKR- swapped |
| | 3.4. | Figure 3-4: MKR+ and MKR- swapped |
| | 3.4.2. | Figure 3-5: MKR+ and MKR- swapped |
| | 3.6. | Table 3-7: jumper position/default setting updated (for JP5) |
| | 3.7. | Figure 3-7, Table 3-8, Table 3-9: Updated (F4 and JP5 deleted) |
| | 4.2.3. | Figure 4-3: Updated |
| | 4.2.8. | Figure 4-14: Updated |
| | 4.2.9. | Figure 4-15: Updated |
| | 5.2. | Table 5-2. Updated |
| | 5.6. | Table 5-5: Updated (F4 deleted) |

∇ ∇ ∇

**READER'S COMMENTS**

**NDrive User's Manual**
**P/N EDU 170, November 2002**

Please answer the questions below and add any suggestions for improving this document. Is the information:

| | Yes | No |
|---|---|---|
| Adequate to the subject? | ____ | ____ |
| Well organized? | ____ | ____ |
| Clearly presented? | ____ | ____ |
| Well illustrated? | ____ | ____ |
| Would you like to see more illustrations? | ____ | ____ |
| Would you like to see more text? | ____ | ____ |

How do you use this document in your job? Does it meet your needs?
What improvements, if any, would you like to see? Please be specific or cite examples.

_____

_____

_____

_____

_____

_____

Your name _____
Your title _____
Company name _____
Address _____
_____

Remove this page from the document and fax or mail your comments to the technical writing department of Aerotech.

AEROTECH, INC.
Technical Writing Department
101 Zeta Drive
Pittsburgh, PA. 15238-2897 U.S.A.
Fax number (412) 967-6870

AEROTECH®

**Artisan Technology Group** is an independent supplier of quality pre-owned equipment

## Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

## We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

## Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP