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# Ndrive HP 10/20/30
# USER'S MANUAL

P/N: EDU170 (Revision 1.14)




Dedicated to the Science of Motion

Aerotech, Inc.
101 Zeta Drive, Pittsburgh, PA, 15238
ph: 412-963-7470 fax: 412-963-7459
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## Product Registration

Register online at: http://www.aerotech.com/prodreg.cfm

## Technical Support

**United States**:

Phone: 412-967-6440
Fax: (412) 967-6870
Email: service@aerotech.com

**United Kingdom:**

Phone: +44 118 9409400
Fax: +44 118 9409401
Email: service@aerotech.co.uk

**Germany**:

Phone: +49 911 9679370
Fax: +49 911 96793720
Email: service@aerotechgmbh.de

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# DECLARATION OF CONFORMITY

| | |
|---|---|
| Manufacturer's Name and Address: | Aerotech, Inc.<br>101 Zeta Drive<br>Pittsburgh, PA 15238-2897 |

Declares that the product: **Ndrive HP 10/20/30**

Conforms to the following product specifications, with the exceptions listed below.

| | | |
|---|---|---|
| EMC: | EN 61800-3:1997 | EMC requirements for power drives |
| | EN 61326-1:1997 | EMC requirements for laboratory equipment |
| | 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 61010-1:2001 | Safety Requirements |

Use: This product is intended for light industrial manufacturing or laboratory use.

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

Exceptions to the test standards include:

ESD Immunity testing per EN 61000-4-2 resulted in the unit reseting to a safe state when the FireWire connector was directly subjected to the ESD test requirements. This condition has been further minimzed on revision A of the product to prevent the possibility of this occurrence.

Voltage Dips and Interruptions per EN61000-4-11 was successfully tested internally at Aerotech on April 26, 2002

EFT/Burst Immunity per EN 61000-4-4 resulted in the unit reseting to a safe state when the cables were subjected to the EFT test requirements (Not applicable for cables less than 3 meters in length).

Pittsburgh, PA David F. Kincel

April, 2002 Quality Assurance Manager

Alex Weibel

Engineer Verifying Compliance



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### 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 HP 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 HP. The shield of the feedback cable must be connected to the metal backshell.

**The following modifications ensure compliance:**

- Install a snap-on Ferrishield ferrite attenuator, P/N SS28B2034, on the FireWire cable at the unit.
- Install a Curtis, P/N F1600CA-10, EMI line filter on the AC input.
- Install two snap-on Ferrishield ferrite attenuators, P/N SS28B2032 and CS28B1984, on the AC cable between the EMI line filter and the Ndrive.
- Connect earth ground to the mounting screw at the AC input.
- Install a SCI, 25-pin, D-style, Spectrum EMI filter adapter, P/N SCI-56-725-001, in series with the motor feedback cable at the unit. Current generation units (Revision A) have integral filtering built-in, which should preclude the use of this EMI filter, based upon similar product testing.

**Safety related requirements to ensure compliance (exceptions to EN 61010-1):**

- The Ndrive must be installed within an enclosure with construction compliant unlimited circuits.
- The end user is responsible for meeting the final protective ground requirements.
- The AC power inlet located on the front of the Ndrive is the power disconnect. The end user is responsible for determining and providing a supply disconnect for the system.
- The end user is responsible for preventing unexpected startup.
- Connection requirements are described in the technical documentation provided with the product. The end user is responsible for making the proper connections and meeting any required interlock requirements for the product application.
- Voltages greater than 60V may be present inside the Ndrive after a discharge time of 5 seconds.
- The end user must provide protection for power interruption / restoration, if required.
- The end user must provide earth fault current protection, if required.
- The end user must provide protection against lightning and power switching surges, if required.
- Control and Emergency Stop requirements are to be determined and provided by the end user.
- Wire and cabling provided with the Ndrive meet Aerotech's electrical and listed environmental requirements. The end user must meet the final requirements.




Failure to follow these procedures may result in serious injury, damage and/or excessive emissions or reduced immunity of the equipment.

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# CHAPTER 1: INTRODUCTION

Aerotech's Network Digital Drives (Ndrive HP) 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 party networked I/O solutions. The Ndrive HP 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 HP 10/20/30 Networked Digital Drives*



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## 1.1. Feature Summary

- Software configurable for brush, brushless and stepper motor operation
- Standard 100 VDC – 320 VDC Bus, optional 20 VDC – 80 VDC Bus, requires the -AUXPWR option
- Fully isolated power stage
- 5 VDC, 500 mA fused user output power for encoder and Hall effect signals, etc.
- 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 sense
- Line driver square wave or analog sine wave quadrature encoder primary position and velocity feedback
- Line driver square wave auxiliary quadrature encoder input or output for PSO (laser firing), etc.
- 4 opto-isolated user outputs standard
- 6 opto-isolated user inputs standard, 2 of which are high speed
- 2 differential analog inputs (one standard and one available with the –IOPSO option)
- 2 analog outputs (one standard and one available with the –IOPSO option)



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## 1.2. Connection Overview

The Ndrive HP consists of two power connections (motor power and input power), three FireWire ports, an optional Ethernet connection, an RS-232/RS-422 connector, LED indicator lamps and two D-Style connectors for Auxiliary I/O (15 and 26 pin) and Motor Feedback (25 pin). An –IOPSO or -IOPSOH option is also available, which has connectors for PSO, absolute encoder, SSI Net, analog I/O, digital I/O, and user power. Refer to Figure 1-2 for connector locations.

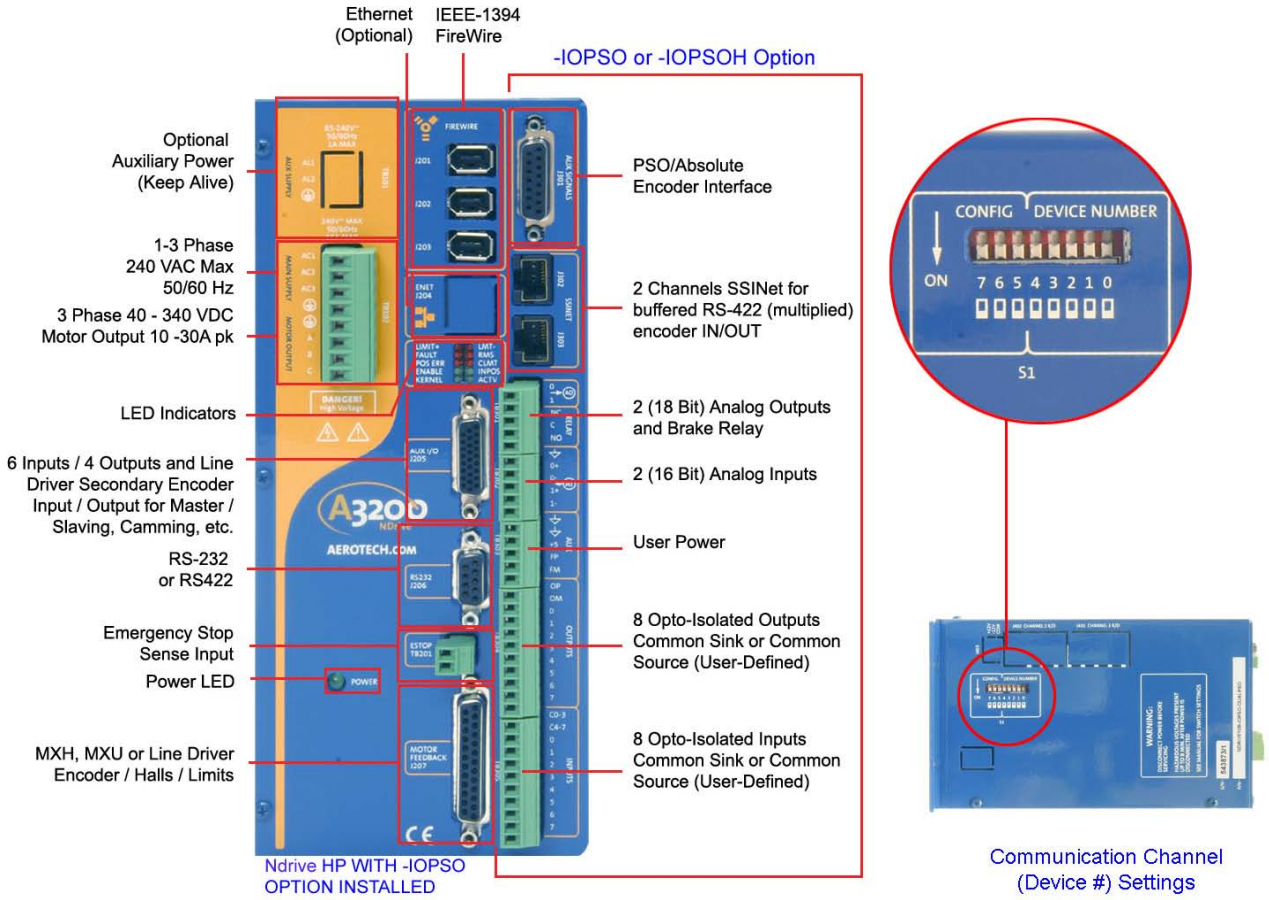


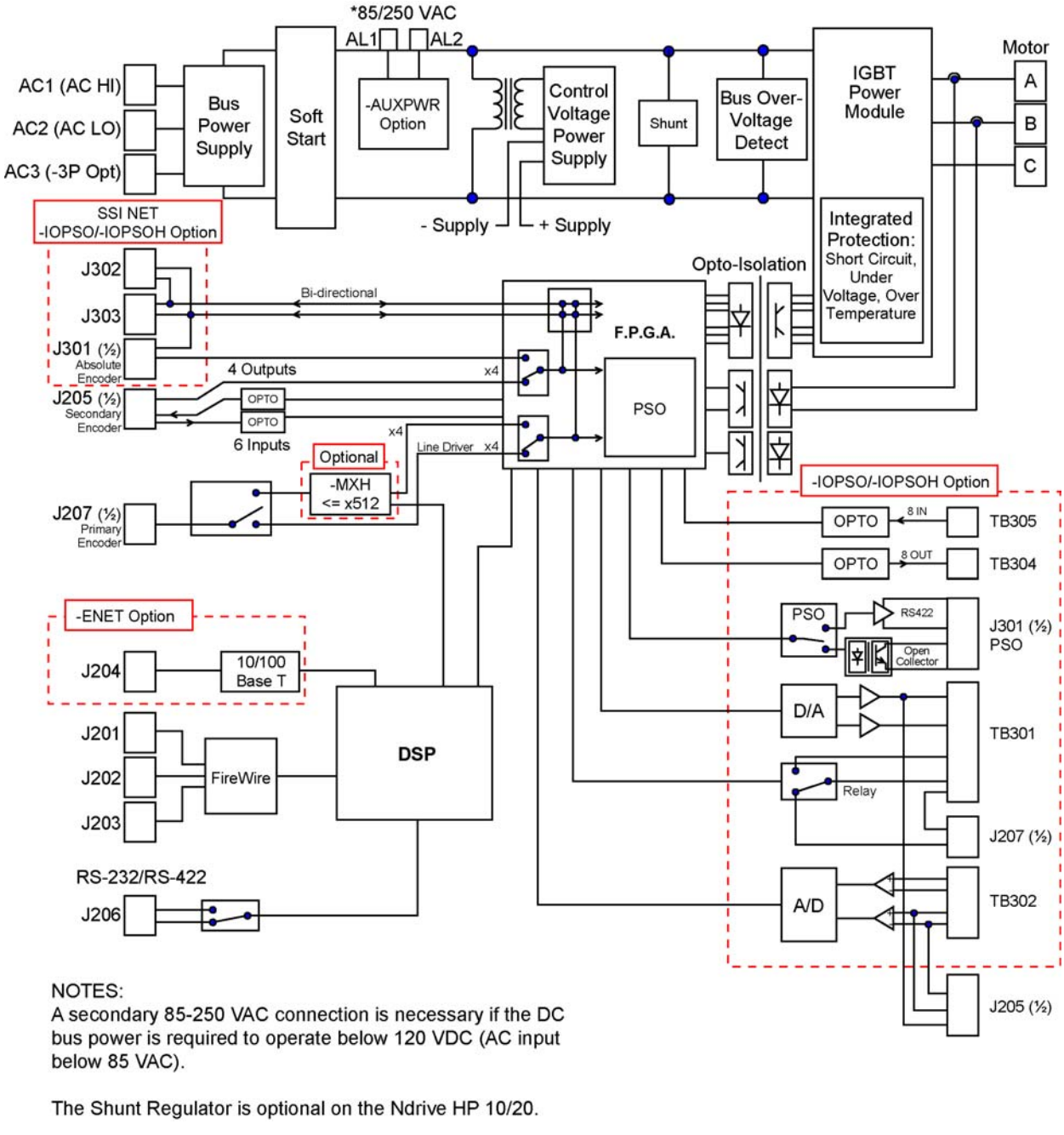

*Figure 1-2. Ndrive HP Hardware*



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## 1.3. Functional Diagram

The standard package includes the bus power supply that operates from 85-250 VAC (120 – 350 VDC). The power supply is included with the standard package for off-line operation without the need for an isolation transformer. A soft start circuit is included to prevent high inrush currents.




NOTES:
A secondary 85-250 VAC connection is necessary if the DC bus power is required to operate below 120 VDC (AC input below 85 VAC).

The Shunt Regulator is optional on the Ndrive HP 10/20.

*Figure 1-3. Functional Diagram*



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## 1.4. Ordering Information

The Ndrive HP 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. See Table 1-2 for a list of available accessories.

**Table 1-1. Models, Options, and Voltage Configurations**

| Model | Peak Output Current | Continuous Output Current (peak) |
|---|---|---|
| Ndrive HP 10B | 10 | 5 |
| Ndrive HP 20B | 20 | 10 |
| Ndrive HP 30B-S | 30 | 15 |
| **Options** | | |
| –IOPSO and –IOPSOH | - One additional 18-bit analog outputs (+/- 10 Volts)<br>- One additional 16-bit differential analog inputs (+/- 10 Volts)<br>- One fail safe brake (or user) relay output<br>- 8 optically isolated logic inputs (5 – 24 VDC), user defined as current sourcing or sinking.<br>- Two bi-directional RS-422 encoder inputs/outputs (SSI Net)<br>- One absolute/RS-485 encoder interface for secondary encoder channel<br>- Optically isolated laser firing (PSO) output<br>- Eight in/out optically isolated current sourcing/sinking logic outputs (5 - 24 VDC); rated for 1 ampere on the -IOPSOH option. | |
| –DUALPSO | Two axis Position Synchronized Output (Laser Firing) | |
| –TRIPLEPSO | Three axis Position Synchronized Output (Laser Firing) | |
| –PSOOPTO1 | Opto isolator for PSO (5V, high speed, high current, HCPL2601), standard. | |
| –PSOOPTO2 | Opto isolator for PSO (15VDC, high speed, low current, 6N136) | |
| –PSOOPTO3 | Opto isolator for PSO (30VDC, low speed, high current, 4N33) | |
| –PSOOPTO4 | Opto isolator for PSO (5-25VDC, 40kHz, 50mA, TIL117-M) | |
| –MXH | Programmable encoder multiplier up to x 2,048, supports PSO (laser firing) and encoder quadrature output | |
| –ENET | 10/100BASE-T Ethernet port | |
| MCK-NDRIVE | Mating connector kit for J206 and J207 (J205 is always provided) | |
| –S | Shunt resistor network (Standard on the Ndrive HP 30) | |
| –AUXPWR | Auxiliary 85-240 VAC input to power logic circuitry. Required for "keep alive" or 40-80 VDC bus operation. 40-120 VDC operation requires external transformer to generate 28-85 VAC bus power input. | |
| –HS | Heat sink with fins | |
| –3P | 3 Phase AC input | |

* Consult factory for availability



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**Table 1-2. Accessories**

| 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) |
| JI | Industrial Joystick |



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## 1.5. Specifications

### 1.5.1. Electrical Specifications

**Table 1-3. Electrical Specifications**

| Description | | Units | Ndrive HP 10 | Ndrive HP 20 | Ndrive HP 30 |
|---|---|---|---|---|---|
| Main Supply Input Voltage | | VAC | 240 VAC Max. (Single or 3 Phase) | | |
| Main Supply Input Frequency | | Hz | 50-60 | | |
| Main Supply Inrush Current | | A | 23 | | |
| Main Supply Maximum Continuous Input Power | | Watts | 1500 | 3000 | 4500 |
| Optional Supply Input Voltage | | VAC | 85-240 | | |
| Optional Supply Input Frequency | | Hz | 50-60 | | |
| Optional Supply Maximum Input Power | | Watts | 100 | | |
| Output Voltage (depends on AC input voltage) See 2.4.2. | | VDC | 40-350 | | |
| 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 (parameter selectable) | | kHz | 5 kHz max | | |
| PWM Switching Frequency | | kHz | 20 | | |
| Minimum Load Inductance | | mH | 1 mH @320 VDC (0.8 @ 160 VDC bus) | | |
| Maximum Shunt Regulator Dissipation | | Watts | 40 (optional) | 40 | |
| Maximum Heat Sink Temperature | | C° | 65 | | |
| Heat Sink Size (Typical) | | Volume | 1' x 2' x 0.25" | | |
| Weight | Standard | lb (kg) | 5.0 (2.27) | | |
| | with –IOPSO or –IOPSOH option | | 5.4 (2.45) | | |
| **Modes of Operation** | Brushless, Brush, and 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 three motor phases currents to be varies, or commutated to rotate the motor in the desired direction and 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. | | | | |
| **Auxiliary Power Outputs** | **5V-Pin 16**: On board 5V power supply. 500 mA maximum output.<br>**5V-Pin 3**: On board 5V power supply. 500 mA maximum output (for encoder). | | | | |
| **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/UL3101 | | |
| **Isolation** | Optical and transformer isolation between control and power stages. | | | | |
| **Indicator (power)** | LED indicates drive power. | | | | |
| **Indicator (enabled)** | LED indicates drive enabled. | | | | |



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### 1.5.2. Mechanical Specifications

The outline dimensions for the Ndrive HP are shown in Figure 1-4 and Figure 1-5. Units should be separated from each other and surrounded by one inch of free air space. This will also allow the standard 228 mm (9 inch) FireWire cable to interconnect them.

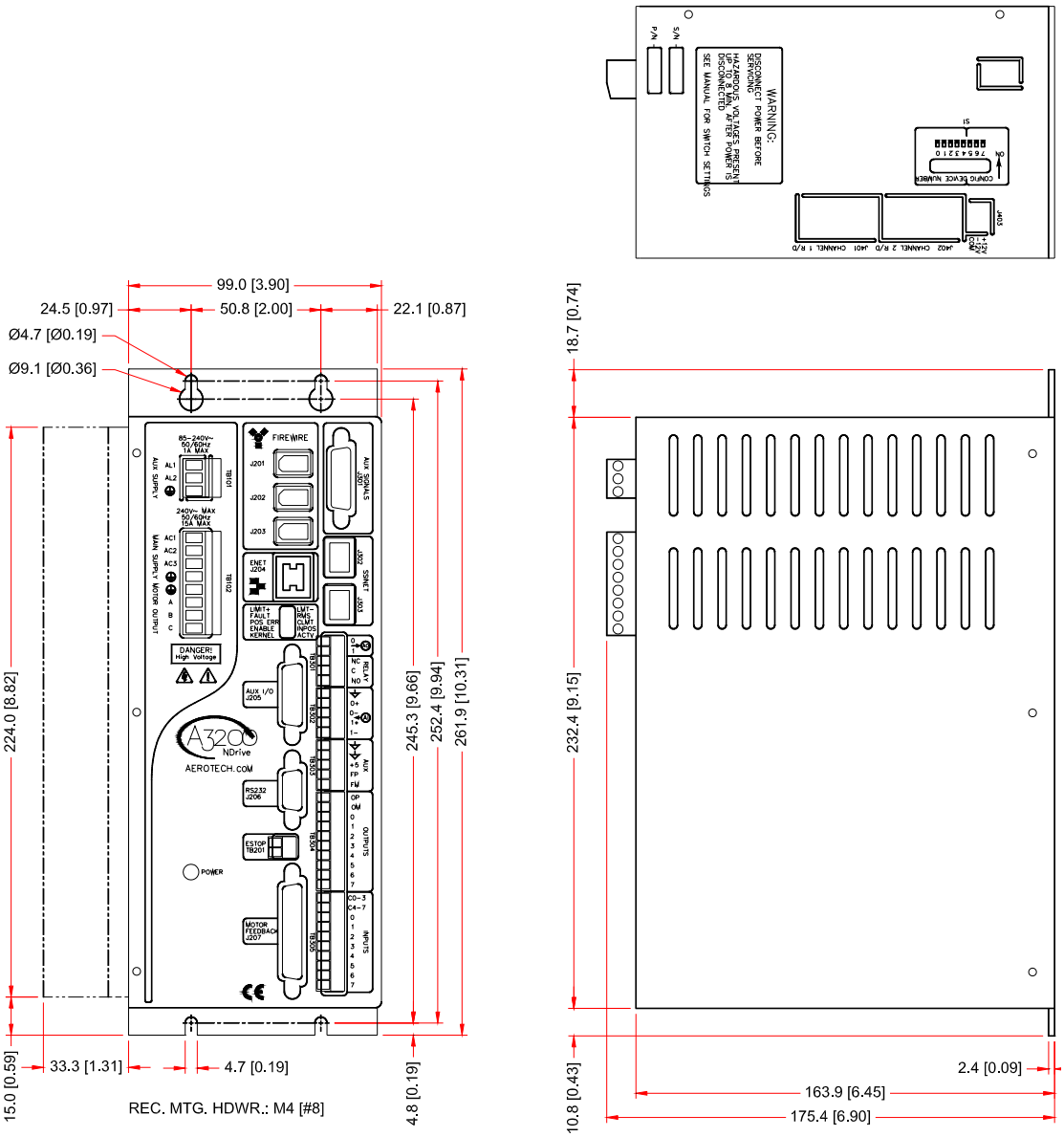



*Figure 1-4. Ndrive HP Dimensions (with -IO Option)*




The Ndrive HP case temperature may exceed 75°C in some applications.



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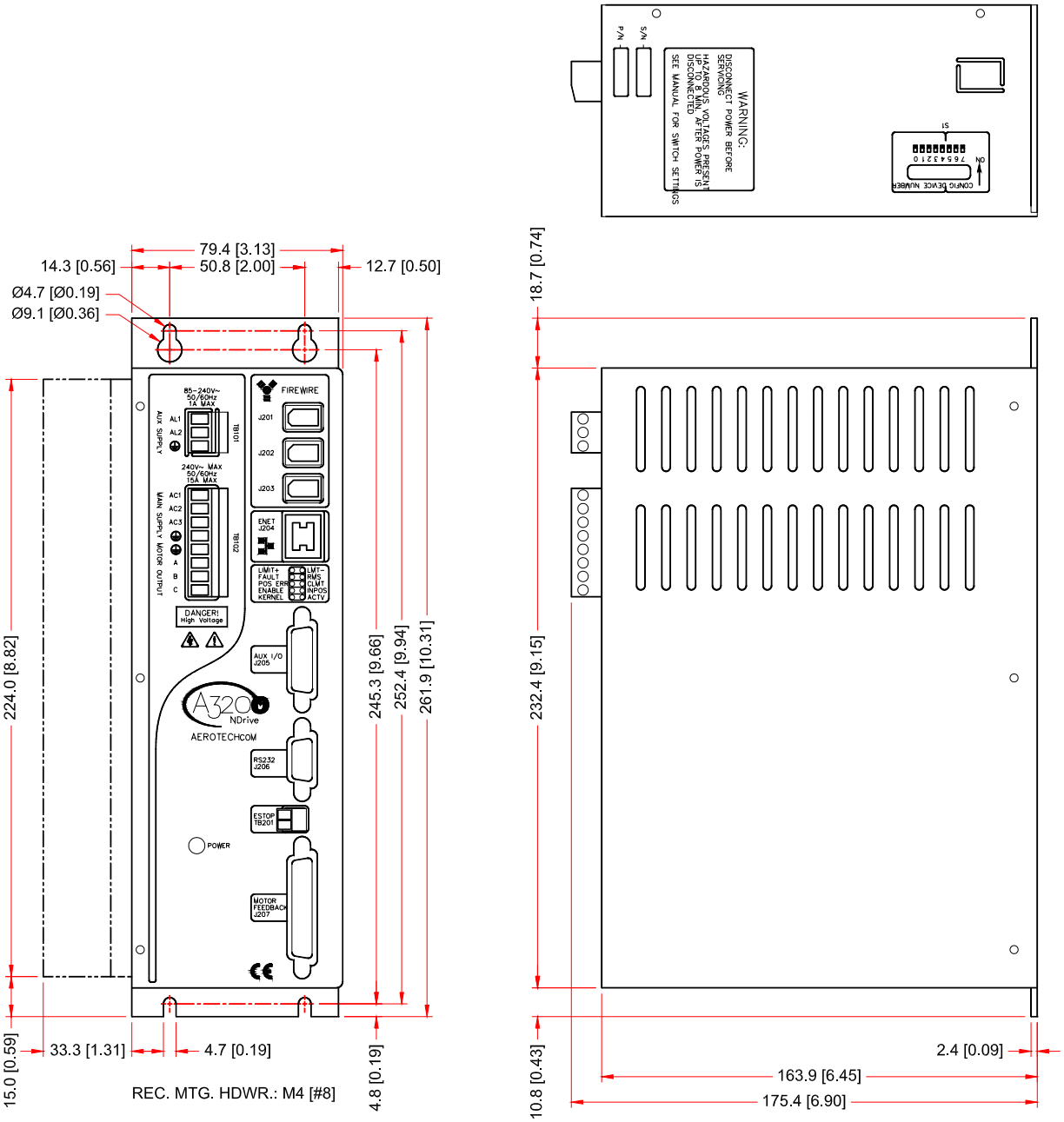



*Figure 1-5. Ndrive HP Dimensions (without the -IO Option)*




The Ndrive HP case temperature may exceed 75°C in some applications.



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### 1.5.3. Environmental Specifications

The environmental specifications for the Ndrive HP are listed below.

- Temperature: Ambient
  - Operating - 5° - 40°C (41° - 104°F)
  - Storage - -20 - 70°C (-4 - 158°F)
- Humidity: Maximum relative humidity is 80% for temperatures up to 31°C. Decreasing linearly to 50% relative humidity at 40°C. Non-condensing.
- Altitude: Up to 2000 m.
- Pollution: Pollution degree 2 (normally only non-conductive pollution).
- Use: Indoor use only.

∇ ∇ ∇



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# CHAPTER 2: INSTALLATION and CONFIGURATION

This section covers the hardware configurations using the switches, jumpers, connectors, and power connections 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 HPs communication channel number via switch S2.

## 2.1. 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.




If the equipment is used in a manner not specified by the manufacturer, the protection by the equipment may be impaired. The user should practice caution when following the given procedures. Deviation from this may result in damage to the equipment or machinery.




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.



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## 2.2. 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).




Signal shielding is very important and the wiring should be physically isolated from motor, AC power and all other power wiring.

### 2.2.1. Minimizing EMI Interference

The Ndrive HPs 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 connect 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.
5. Ferrite beads or Aerotech's FBF-1 or FBF-2 filter adapters, may be used on the motor leads to reduce the effects of amplifier EMI/RFI, produced by PWM (pulse width modulation) amplifiers. Refer to the FBF-1 and FBF-2 drawings on your software or documentation CD ROM for more information on the ferrite beads.

**Table 2-1. Ferrite Bead Part Numbers**

| Wire Gauge | Aerotech PN. | Third Party PN. |
|---|---|---|
| 1.62814mm (#14 AWG) | EIZ01027 | #2643002402 Elna Fair-Rite Products |
| 1.29032mm (#16 AWG) | EIZ01025 | #2643250402 Elna Fair-Rite Products |
| 1.02362mm (#18 AWG) | EIZ01001 | #2673000801 Elna Fair-Rite Products |
| 0.81280mm (#20 AWG) | EIZ01025 | #2643250402 Elna Fair-Rite Products |



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

Operating the Ndrive HP from an off-line source of 115 VAC or 230 VAC may create some additional issues. 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 **AC1** and **AC2** input AC line connections. Back-propagation of noise into the AC lines can be minimized using a line filter (refer to Figure 2-1).

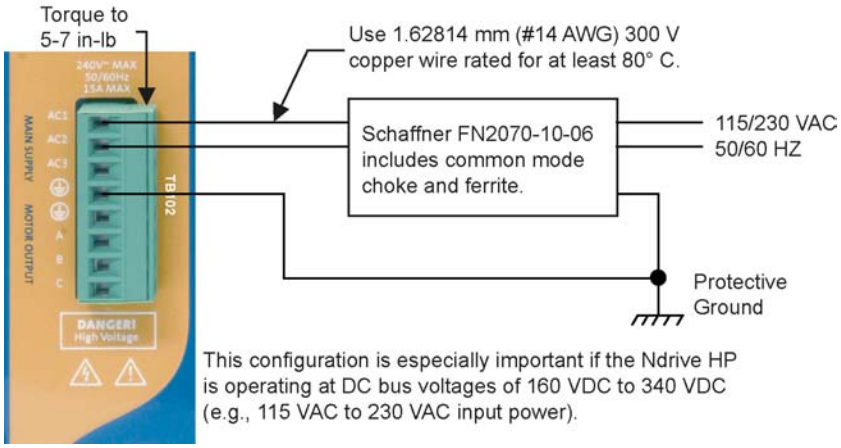



*Figure 2-1. Back-Propagation Line Filter Connection*

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 **AC1/AC2** AC input power. Since **AC1** 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 2-2).

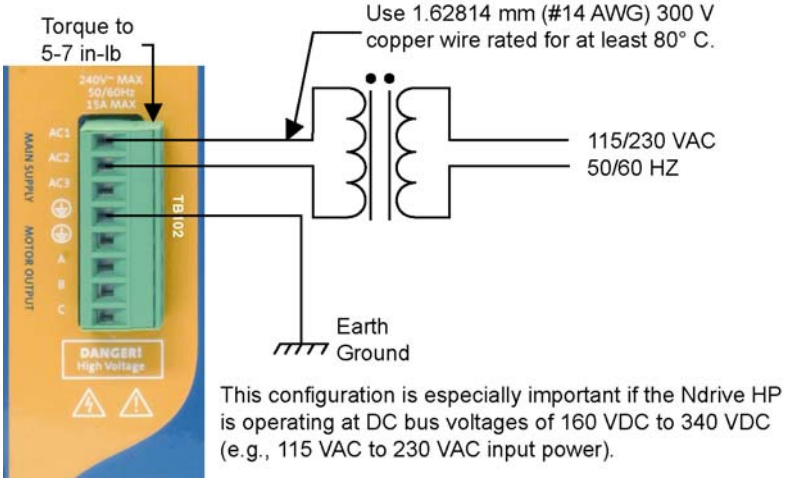



*Figure 2-2. Isolation Transformer Connection (Eliminates 50/60 Hz AC Coupling)*



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## 2.3. Power Connections

The Ndrive HP may powered by one or two separate AC voltages. One for motor bus power and optionally a second for control power, as described in the following two sub-sections. If the optional control power input is present, it must be powered.

### 2.3.1. Control Power Connections (TB101)

The -AUXPWR option allows the Ndrive HP to remain operational when the motor power is removed, such as when an external emergency stop circuit is required. If the Ndrive HP was purchased with the -AUXPWR option, a separate AC input (TB101) has been included on the amplifier. The internal power supply of the Ndrive HP requires a minimum of 85 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. See Section 2.4. for various typical AC wiring options. TB101 is also typically utilized when an emergency stop circuit is present. See Section 2.10 for a typical ESTOP sense input wiring configuration.

The AUXPWR input is an option that, if present, **must be powered**. It is typically used when the AC bus input power is less than 85 VAC at TB102 **AC1**, **AC2** (or **AC3**). TB101 is also typically utilized when an emergency stop circuit is present. Optional Supply Connections to AL1, AL2 and the Protective Ground should be at least 1.02362 mm (#18 AWG) wire rated @ 300 V (3 Amp external fusing may be required for AL2, AL1 is fused internally at 3 Amps).

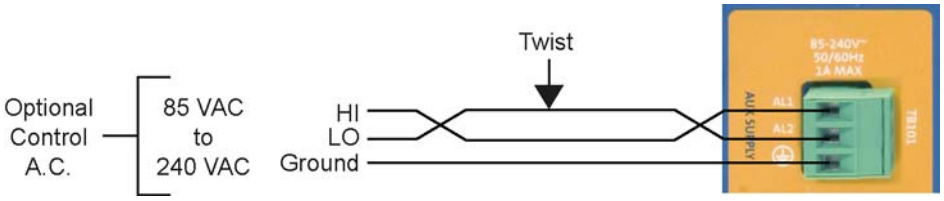



*Figure 2-3. AUXPWR Option*

**Table 2-2. TB101 Auxiliary AC Supply Input (when TB102 AC input < 85 VAC)**

| Label | Description | Wire Size |
|---|---|---|
| AL1 | Optional 85-240 VAC Control Power Input | 1.02362 mm (#18 AWG) |
| AL2 | Optional 85-240 VAC Control Power Input | 1.02362 mm (#18 AWG) |
| ⏚ | Protective Ground (Required for Safety) | 1.02362 mm (#18 AWG) |



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### 2.3.2. Motor Power Connections (TB102)

The three-phase motor terminal connections are made at connections **A, B,** and **C**. Motor Connections ØA, ØB, ØC and its Protective Ground should be made with 1.62814 mm (#14 AWG) wire rated at 300 V. Motor frame and shield connect to ⏚ (ground).

Input power to the Ndrive is made at the **AC1** and **AC2** terminals with earth ground connected to ⏚ (ground). A three-phase power input is also available (**AC3**, requires 3 Phase Option). Connections at AC1, AC2 and AC3 and its Protective Ground should be made with 1.62814 mm (#14 AWG) wire rated at 300V.

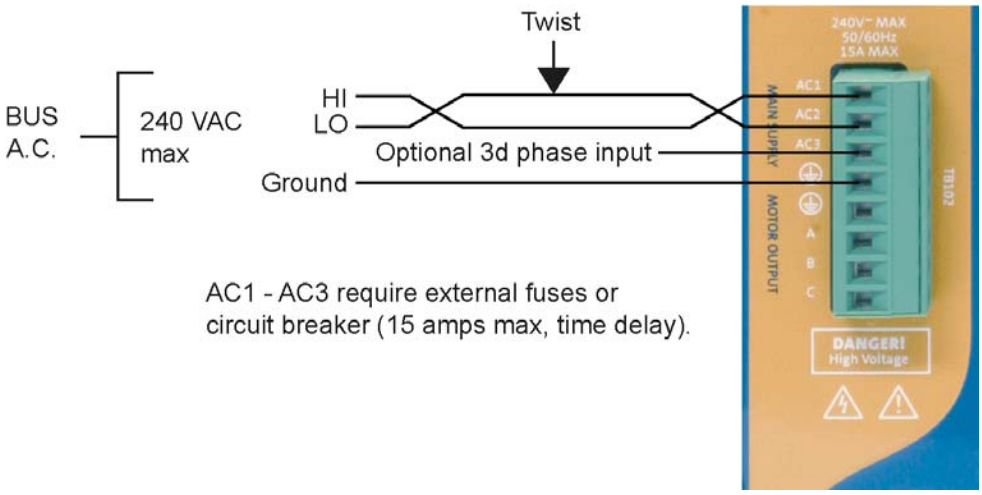



*Figure 2-4. Bus Power*

**Table 2-3. TB102 Main AC Power Input and Motor Power Output**

| Label | Description | Wire Size |
|---|---|---|
| AC1 | 240 Volt Max. AC Input | 1.62814 mm (#14 AWG) |
| AC2 | 240 Volt Max. AC Input | 1.62814 mm (#14 AWG) |
| AC3 | Optional 3-Phase AC Input* (240 VAC Max) | 1.62814 mm (#14 AWG) |
| ⏚ | Protective Ground (Required for Safety) | 1.62814 mm (#14 AWG) |
| ⏚ | Protective Ground to Motor (Required for Safety) | 1.62814 mm (#14 AWG) |
| ØA | Phase A Motor Power | 1.62814 mm (#14 AWG) |
| ØB | Phase B Motor Power | 1.62814 mm (#14 AWG) |
| ØC | Phase C Motor Power | 1.62814 mm (#14 AWG) |

External fuses or circuit breaker (15 Amps Max., time delay type) are required for the AC 1, AC2 and AC3 AC inputs for optimum protection. The protective devices should be located near the Ndrive HP. For optimum protection, use 12 Amp protective devices if possible (15 Amp devices may be required in applications requiring maximum power).



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### 2.3.3. 40/80 VDC Power Transformers

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

The TV0.3-28 power transformer is an optional accessory available for the Ndrive HP. 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.

The following three figures illustrate the six combinations available for both AC input voltages and all three DC bus voltages, as well as the use of the -AUXPWR option.

A TM3 and TM5 transformer package is also available to power up to four Ndrives, providing 300 or 500 watts of power.



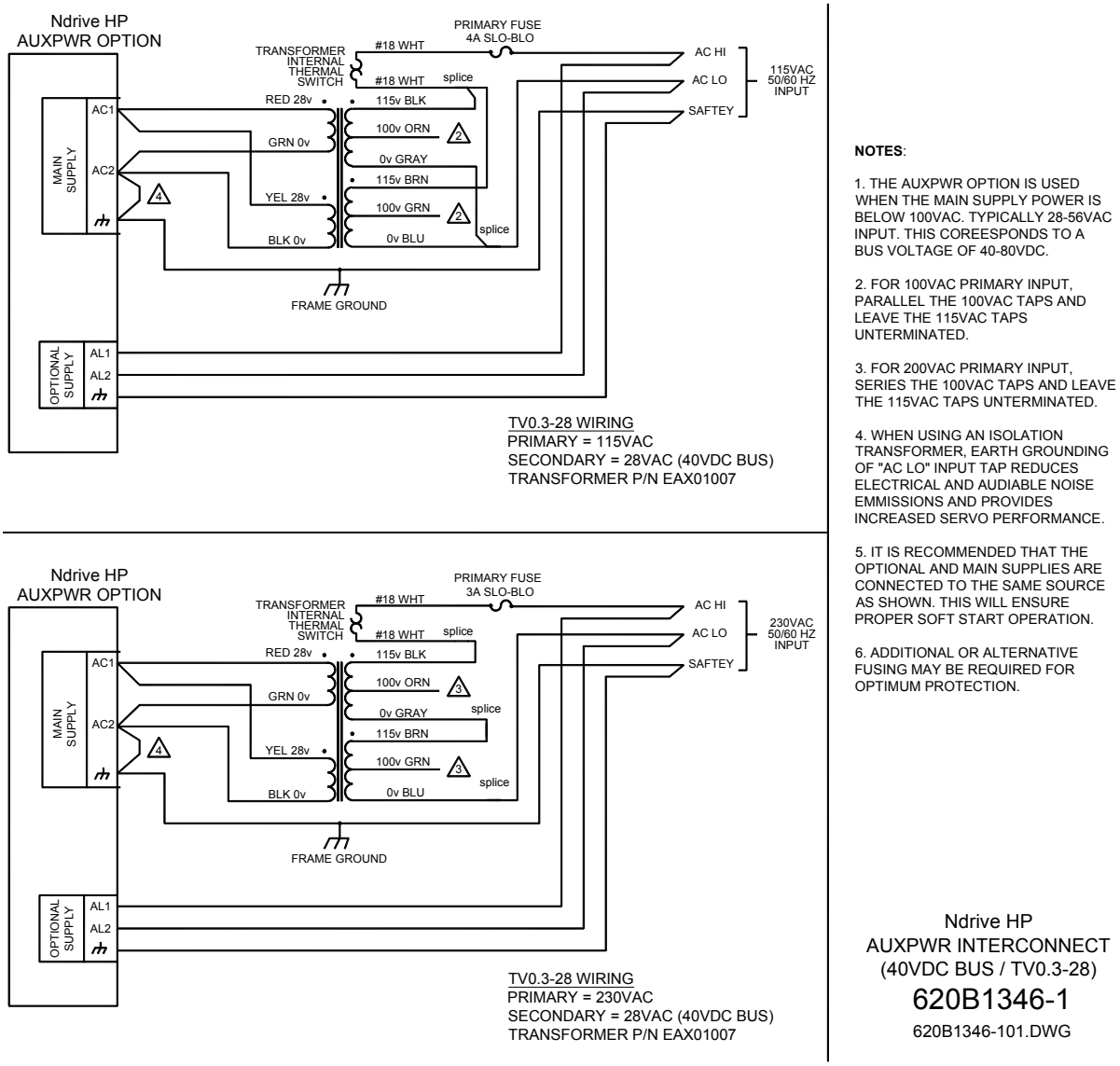
*Figure 2-5. TM3 and TM5 Transformer Options*



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## 2.4. Typical AC Wiring with AUXPWR Option

The user may connect an Ndrive to a 115/230 VAC source and generate a 40, 80 160 VDC Bus for the motor power. The following three figures illustrate the six combinations available for both AC input voltages and all three DC bus voltages, as well as the use of the -AUXPWR option.




**NOTES**:

1. THE AUXPWR OPTION IS USED WHEN THE MAIN SUPPLY POWER IS BELOW 100VAC. TYPICALLY 28-56VAC INPUT. THIS COREESPONDS TO A BUS VOLTAGE OF 40-80VDC.

2. FOR 100VAC PRIMARY INPUT, PARALLEL THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

3. FOR 200VAC PRIMARY INPUT, SERIES THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

4. WHEN USING AN ISOLATION TRANSFORMER, EARTH GROUNDING OF "AC LO" INPUT TAP REDUCES ELECTRICAL AND AUDIABLE NOISE EMMISSIONS AND PROVIDES INCREASED SERVO PERFORMANCE.

5. IT IS RECOMMENDED THAT THE OPTIONAL AND MAIN SUPPLIES ARE CONNECTED TO THE SAME SOURCE AS SHOWN. THIS WILL ENSURE PROPER SOFT START OPERATION.

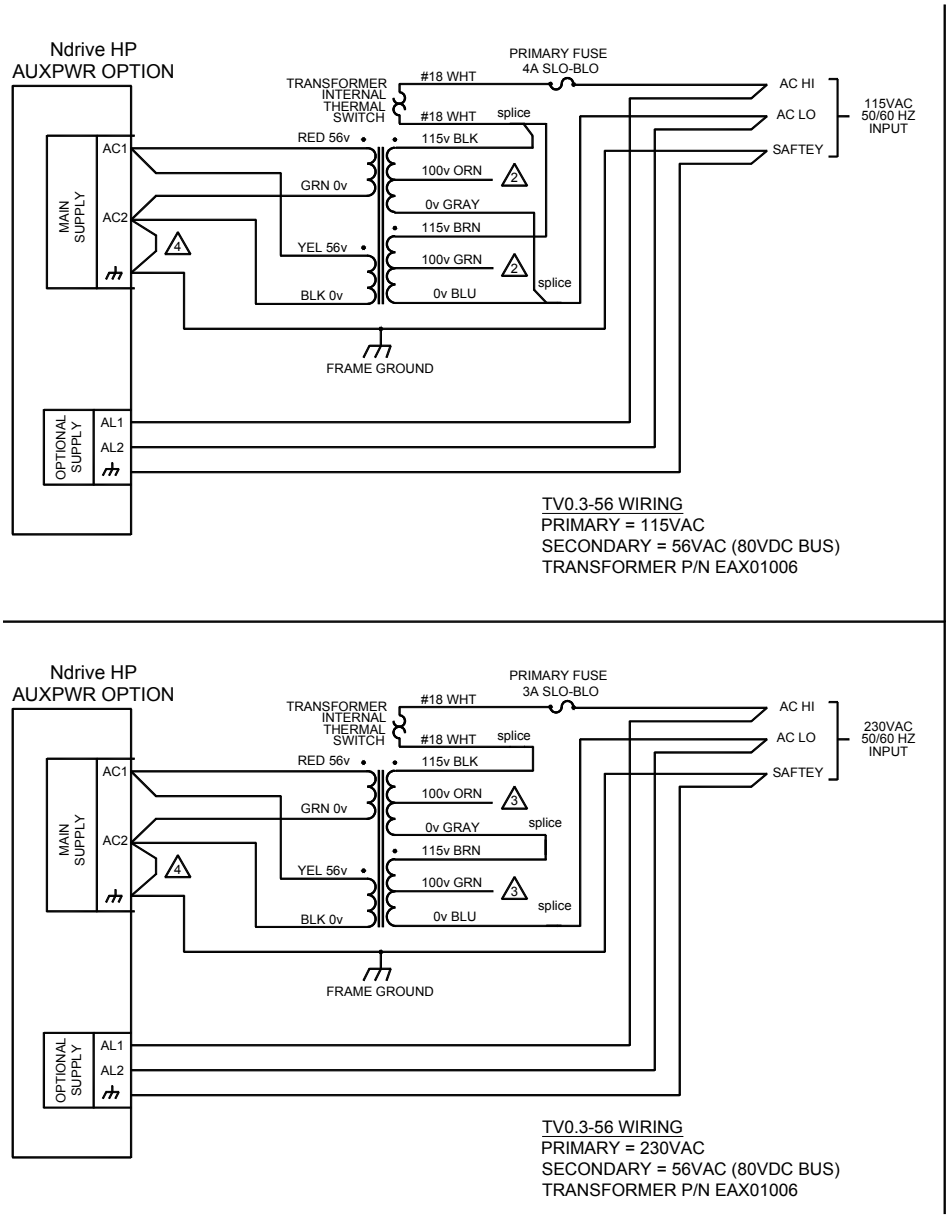
6. ADDITIONAL OR ALTERNATIVE FUSING MAY BE REQUIRED FOR OPTIMUM PROTECTION.

Ndrive HP
AUXPWR INTERCONNECT
(40VDC BUS / TV0.3-28)
620B1346-1
620B1346-101.DWG

*Figure 2-6. 40 Volt DC Bus from 115 and 230 VAC Source*



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**NOTES**:

1. THE AUXPWR OPTION IS USED WHEN THE MAIN SUPPLY POWER IS BELOW 100VAC. TYPICALLY 28-56VAC INPUT. THIS COREESPONDS TO A BUS VOLTAGE OF 40-80VDC.

2. FOR 100VAC PRIMARY INPUT, PARALLEL THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

3. FOR 200VAC PRIMARY INPUT, SERIES THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

4. WHEN USING AN ISOLATION TRANSFORMER, EARTH GROUNDING OF "AC LO" INPUT TAP REDUCES ELECTRICAL AND AUDIABLE NOISE EMMISSIONS AND PROVIDES INCREASED SERVO PERFORMANCE.

5. IT IS RECOMMENDED THAT THE OPTIONAL AND MAIN SUPPLIES ARE TURNED ON AT THE SAME TIME TO ENSURE PROPER SOFT START OPERATION.

6. ADDITIONAL OR ALTERNATIVE FUSING MAY BE REQUIRED FOR OPTIMUM PROTECTION.

Ndrive HP
AUXPWR INTERCONNECT
(80VDC BUS / TV0.3-56)

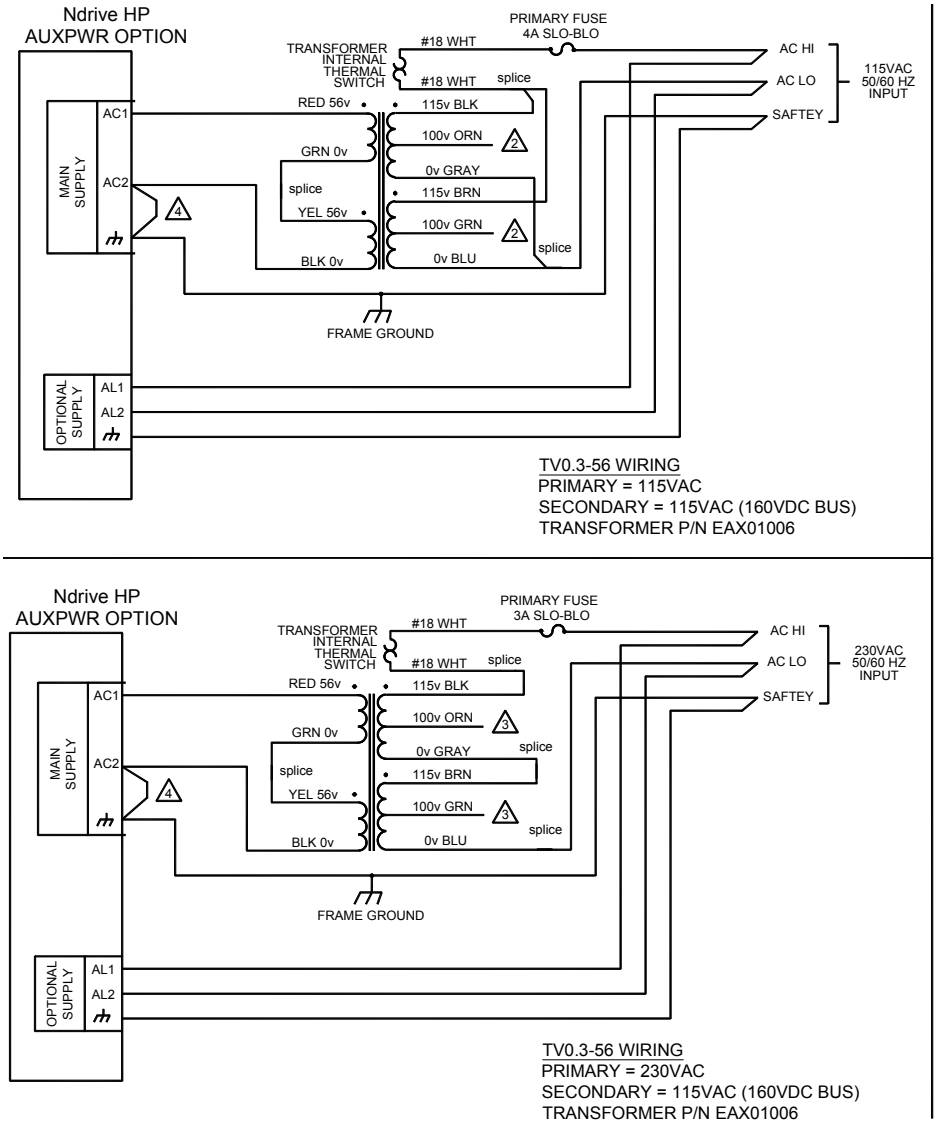
620B1346-2

620B1346-201.DWG

*Figure 2-7. 80 Volt DC Bus from 115 and 230 VAC Source*



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**NOTES**:

1. THE AUXPWR OPTION IS USED WHEN THE MAIN SUPPLY POWER IS BELOW 100VAC. TYPICALLY 28-56VAC INPUT. THIS COREESPONDS TO A BUS VOLTAGE OF 40-80VDC. THE CONFIGURATION SHOWN IS FOR ISOLATED 115VAC (160VDC BUS) OPERATION.

2. FOR 100VAC PRIMARY INPUT, PARALLEL THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

3. FOR 200VAC PRIMARY INPUT, SERIES THE 100VAC TAPS AND LEAVE THE 115VAC TAPS UNTERMINATED.

4. WHEN USING AN ISOLATION TRANSFORMER, EARTH GROUNDING OF "AC LO" INPUT TAP REDUCES ELECTRICAL AND AUDIABLE NOISE EMMISSIONS AND PROVIDES INCREASED SERVO PERFORMANCE.

5. IT IS RECOMMENDED THAT THE OPTIONAL AND MAIN SUPPLIES ARE CONNECTED TO THE SAME SOURCE AS SHOWN. THIS WILL ENSURE PROPER SOFT START OPERATION.

6. ADDITIONAL OR ALTERNATIVE FUSING MAY BE REQUIRED FOR OPTIMUM PERFORMANCE.

Ndrive HP
AUXPWR INTERCONNECT
(160VDC BUS / TV0.3-56)
620B1346-3
620B1346-301.DWG

*Figure 2-8. 160 Volt DC Bus from 115 and 230 VAC Source*



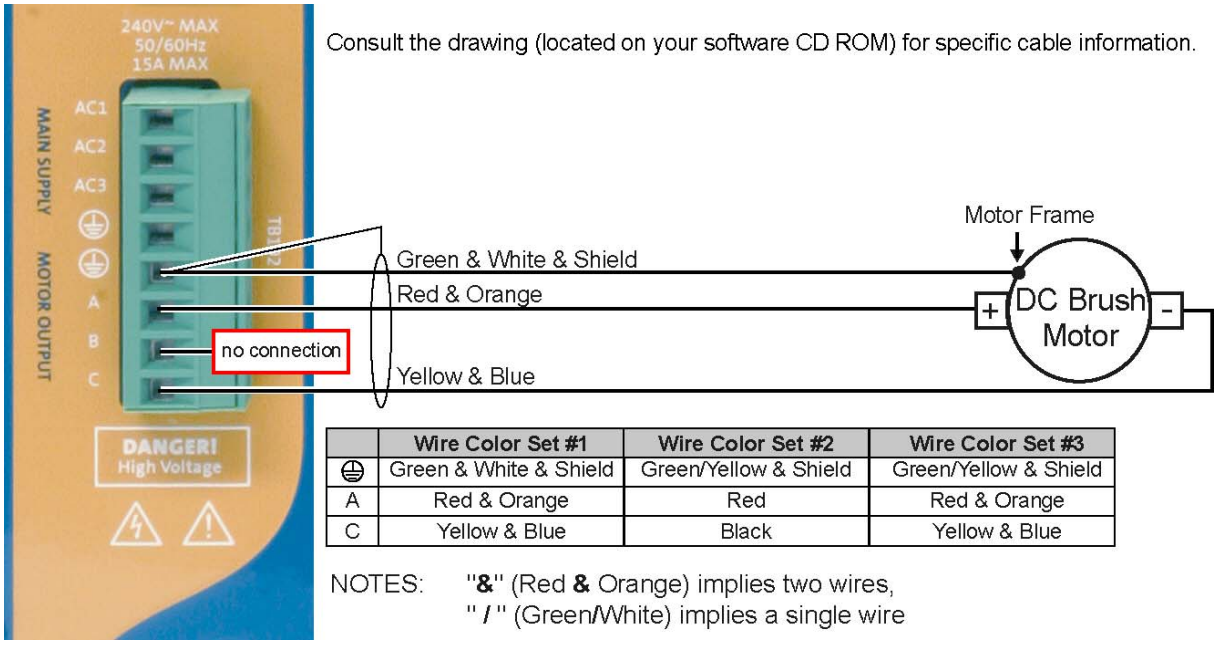
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## 2.5. Motor and Feedback Connections

The Ndrive HP can be integrated into a system using three basic configurations: DC Brush (Velocity or Torque mode), brushless, and stepper motors. Brush and brushless motors may have two feedback devices.

### 2.5.1. DC Brush Motor in Torque Mode Configuration

The DC brush motor configuration is shown in Figure 2-9. See Section 2.6.1 for the correct encoder phasing information if Aerotech's standard cabling is not used.




| | Wire Color Set #1 | Wire Color Set #2 | Wire Color Set #3 |
|---|---|---|---|
| ⏚ | Green & White & Shield | Green/Yellow & Shield | Green/Yellow & Shield |
| A | Red & Orange | Red | Red & Orange |
| C | Yellow & Blue | Black | Yellow & Blue |

NOTES: "**&**" (Red **&** Orange) implies two wires,
" **/** " (Green/White) implies a single wire

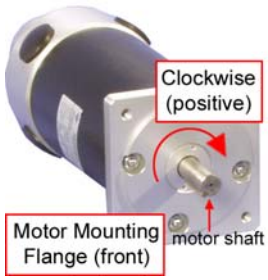
*Figure 2-9. DC Brush Motor (Torque Mode) Configuration*



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#### 2.5.1.1. DC Brush Motor Phasing

If an Aerotech motor is used with Aerotech provided cabling, no motor phasing process is required.




A DC brush motor is phased correctly when a positive motion command causes clockwise (CW) motor rotation, as viewed looking at the motor from the front mounting flange. This assumes the CntsPerMetricUnit/CntsPerEnglishUnit/CntsPerRotaryUnit axis parameters are set to a positive value. This required phasing, is determined solely by which motor lead is connected to the ØA and ØC motor terminals. Motor phasing is unrelated to the resultant direction of motion commanded from within a motion program. After correctly phasing the motor, you may reverse the motor direction when commanding a positive move from a motion program, by negating the sign of the CntsPerMetricUnit/CntsPerEnglishUnit/CntsPerRotaryUnit axis parameters.

To determine this, connect a voltmeter to the motor leads of an un-powered motor. Rotate the motor by hand clock-wise (CW). Swap the voltmeter connections to the motor until the voltmeter indicates a positive voltage. The motor lead now connected to the positive lead of the voltmeter, is the + motor lead as indicated in the Figure above, and should be connected to the ØA motor terminal. The other motor lead connects to the ØC motor terminal.



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### 2.5.2. DC Brush Motor with Tachometer Feedback Configuration

The DC brush motor configuration is shown in Figure 2-10. See section 2.6.1 for the correct encoder phasing information if Aerotech's standard cabling is not used. The tachometer may be connected to TB302 or J205 as shown in the picture below. Note, that tachometer feedback uses analog input 0, so it may not be used when tachometer feedback is used. To configure the axis parameters in this mode, see the "Brush Motors in Velocity Mode" topic in the Nview HMI help.

The analog input that the tachometer is connected to is scaled for ± 10V input maximum. The tachometer voltage must not exceed ± 10 volts or the velocity loop will become unstable, possible causing a runaway condition. Based upon the tachometer voltage rating, a resistor-scaling network may be required to limit the tachometer voltage to ± 10V at maximum speed. If noise is present on the tachometer signal, a high quality 1 uF capacitor may be required across the tachometer leads, before any voltage divider, required to limit the maximum input voltage to the analog input.

The motor and tachometer are correctly phased, when rotated clockwise by hand and the tachometer generates a positive voltage as displayed on analog input 0 and the motors back EMF generates a negative voltage at motor terminal A (with the voltmeter common probe at motor terminal C).

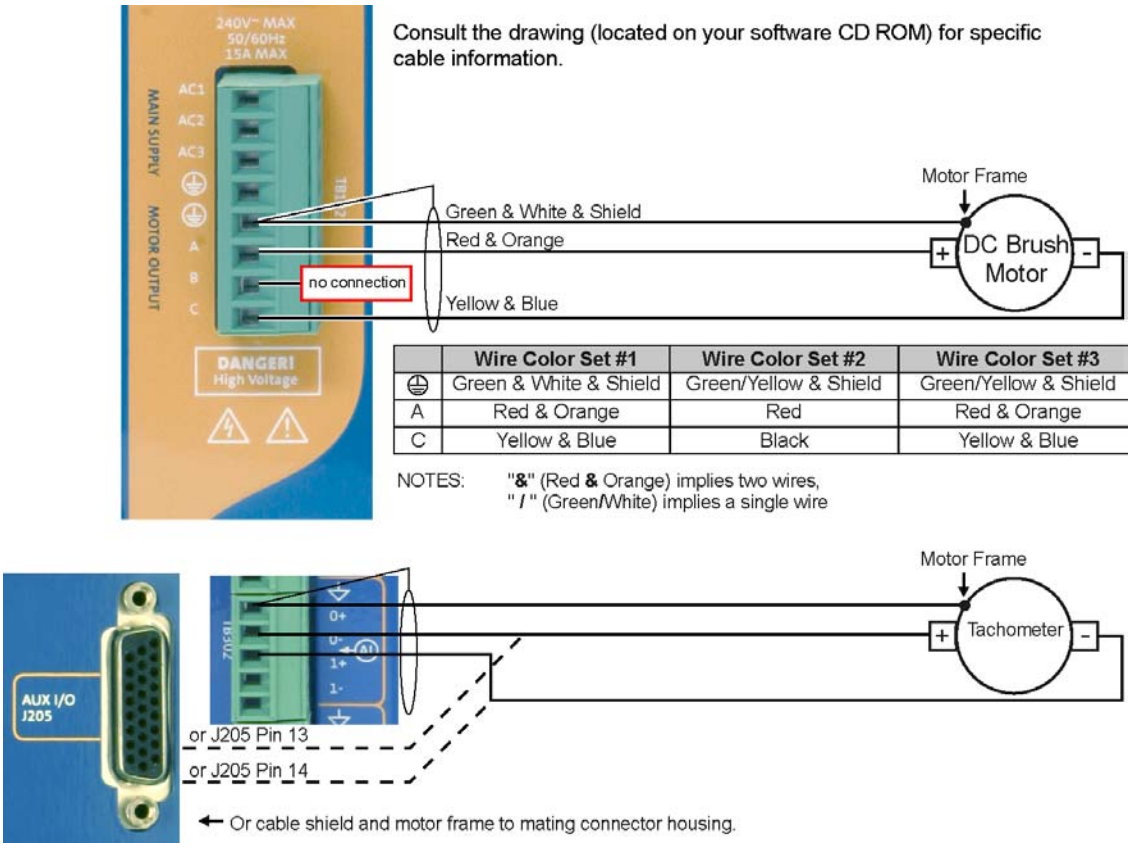


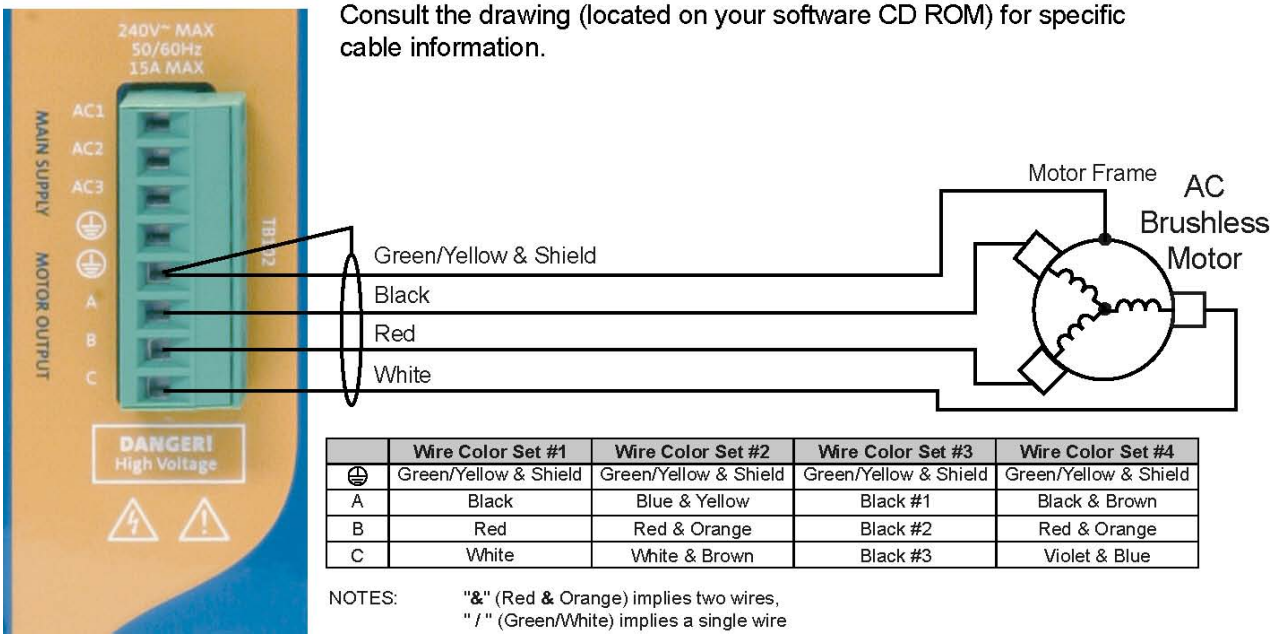

*Figure 2-10. DC Brush Motor Wiring with Tachometer*



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### 2.5.3. 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.




| | Wire Color Set #1 | Wire Color Set #2 | Wire Color Set #3 | Wire Color Set #4 |
|---|---|---|---|---|
| ⏚ | Green/Yellow & Shield | Green/Yellow & Shield | Green/Yellow & Shield | Green/Yellow & Shield |
| A | Black | Blue & Yellow | Black #1 | Black & Brown |
| B | Red | Red & Orange | Black #2 | Red & Orange |
| C | White | White & Brown | Black #3 | Violet & Blue |

NOTES: "**&**" (Red **&** Orange) implies two wires,
" / " (Green/White) implies a single wire

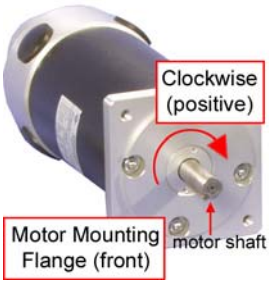
*Figure 2-11. Brushless Motor Configuration*



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### 2.5.3.1. Brushless Motor Phasing

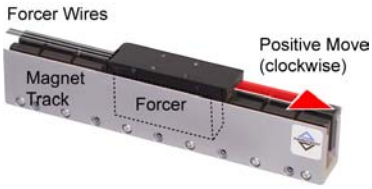
When configuring the Ndrive HP to run a non-Aerotech brushless motor, the motor leads (A, B and C on TB102) must be correctly connected for proper operation. If an Aerotech motor is used with Aerotech provided cabling, no motor phasing process is required.




NOTE

If an Aerotech brushless motor is used with the Ndrive HP, motor phase and Hall connections can be easily determined by referring to the system interconnection drawing in Figure 2-11.

An AC brushless motor is correctly phased when a positive motion command causes clockwise (CW) motor rotation, as viewed looking at the motor from the front mounting flange. This assumes a positive CntsPerMetricUnit/CntsPerEnglishUnit / CntsPerRotaryUnit axis parameter. This required phasing is determined by which motor lead is connected to the ØA, ØB and ØC motor terminals.




Motor phasing is unrelated to the direction of motion commanded from within a motion program. After correctly phasing the motor, you may reverse the motor direction when commanding a positive move from a motion program, by negating the sign of the CntsPerMetricUnit / CntsPerEnglishUnit/CntsPerRotaryUnit axis parameter.

NOTE

Be sure to first configure the axis parameters before running the A3200\Programs\Samples\MsetDebug.Pgm. See the “Getting Started” section in the Nview help for configuration information.

Motor phasing may be determined by two methods. The first of which, is by actively driving the motor open loop, under program control. The A3200\Programs\Samples\MsetDebug.Pgm may be used for this purpose. The motor phasing is correct when the program causes the motor to move in a positive direction, as defined in Figure 2-17. Swapping any two motor lead connections, will correct a reversed motor rotation.

The second method is a non-powered method, whereby the motor is disconnected from the controller and connected in the test configuration as defined in Figure 2-14 This will identify motor (and Hall signal) leads A, B and C. These sequences and the generated output motor phase voltages (motor output connections ØA, ØB, and ØC) are shown in Figure 2-14 The voltages generated are made by moving the motor/forcer by hand in a positive (CW) motion direction.



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### 2.5.3.2. Brushless Motor Hall-Effect Feedback Connections

The Hall-Effect feedback signals on an AC brushless motor are correctly phased when the hall states correspond to the states at each of the electrical angles shown in Figure 2-14 The Hall states, which correspond to the electrical angles, are indicated in Figure 2-14 A “0” for the given Hall input indicates zero voltage or logic low, where a “1” indicates five volts or logic high. These logic levels may be viewed within the Nstat utility, on the Diagnostic tab, as shown in Figure 2-13.

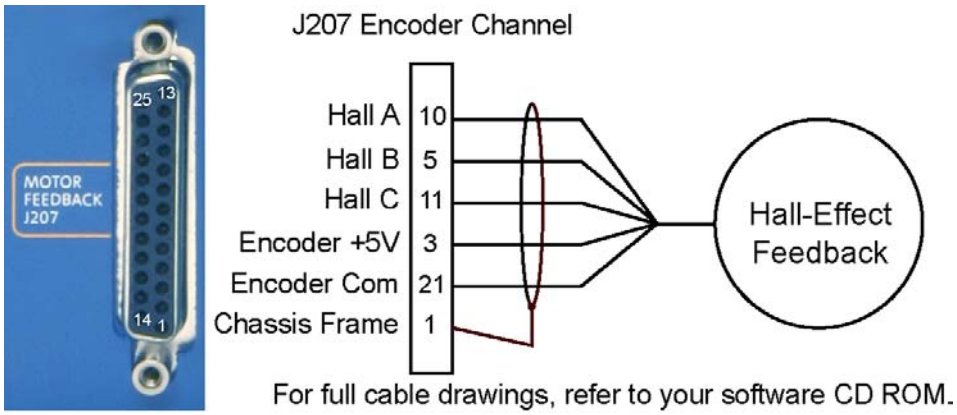



*Figure 2-12. Hall-Effect Feedback Connections*

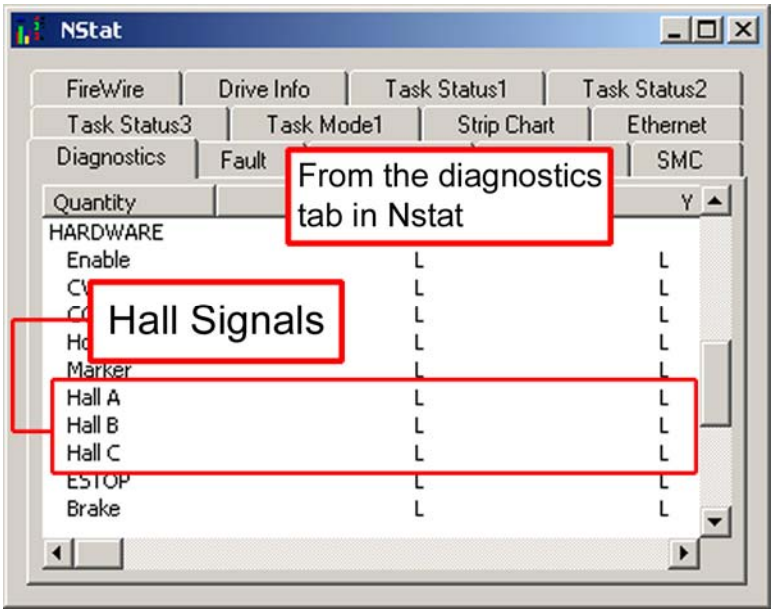



*Figure 2-13. Hall-Effect Feedback Inputs in the Nstat Utility*



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#### 2.5.3.3. Hall-Effect Phasing

For an AC brushless motor with an unknown hall sequence, one of two simple tests can be performed on the motor to determine the proper connections to the Ndrive HP.




Be sure to first configure the axis parameters before running the A3200\Programs\Samples\MsetDebug.Pgm. See the "Getting Started" section in the Nview help for configuration information.

The first of which, is by actively driving the motor under program control. The A3200\Programs\Samples\MsetDebug.Pgm may be used for this purpose. The hall signals must be swapped until they generate the sequence as defined in Figure 2-14. After the Hall sequence is correct, the program can then correctly determine if a commutation offset is required. The test program will indicate the required value of the CfgMotOffsetAng axis parameter to correctly phase the motor.

The second method is a non-powered method, whereby the motor is disconnected from the controller and connected in the test configuration as defined in Figure 2-14. This will identify the hall signal (and motor) leads A, B and C. The equipment needed for the non-powered test is a two-channel oscilloscope and three resistors (typically 10 K ohm, 1/2 watt) wired in a Wye configuration.




The tests outlined below do not require that the amplifier be turned on since Figure 2-14 illustrates the generated output voltage of the amplifier relative to the input Hall sequences.



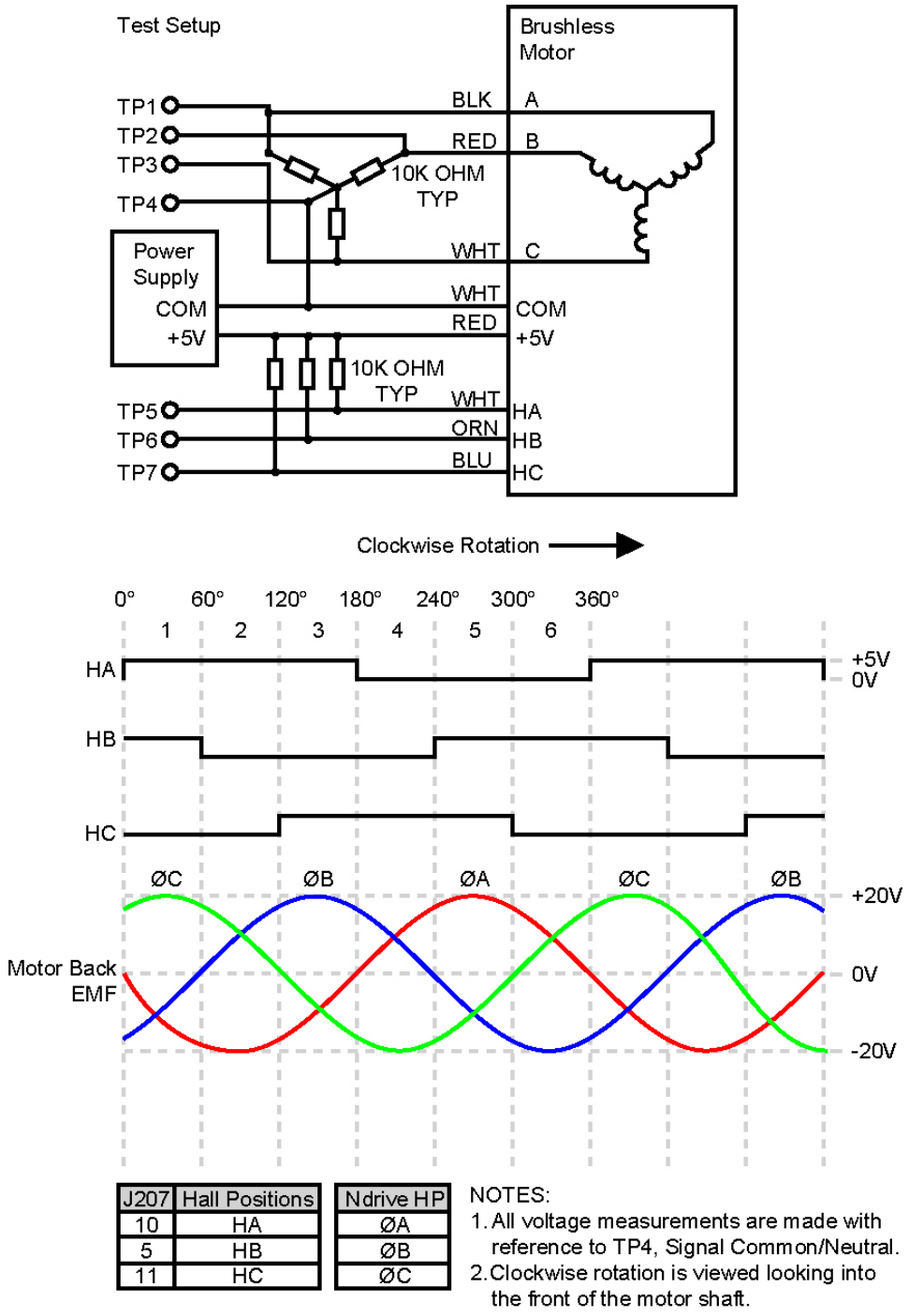

Before performing the test in Figure 2-14, ensure that the motor leads are completely disconnected from the amplifier.

Connect the ends of the three resistors to three motor leads. 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 CW 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. This will identify each motor and hall lead, which are in-phase with each other. Any motor and hall lead set may be phase A. The relative phasing between this set and the other two sets will then determine which is phase B and phase C.

Refer to Figure 2-14 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 J207. 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 2-14.



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| J207 | Hall Positions |
|---|---|
| 10 | HA |
| 5 | HB |
| 11 | HC |

| Ndrive HP |
|---|
| ØA |
| ØB |
| ØC |

NOTES:
1. All voltage measurements are made with reference to TP4, Signal Common/Neutral.
2. Clockwise rotation is viewed looking into the front of the motor shaft.

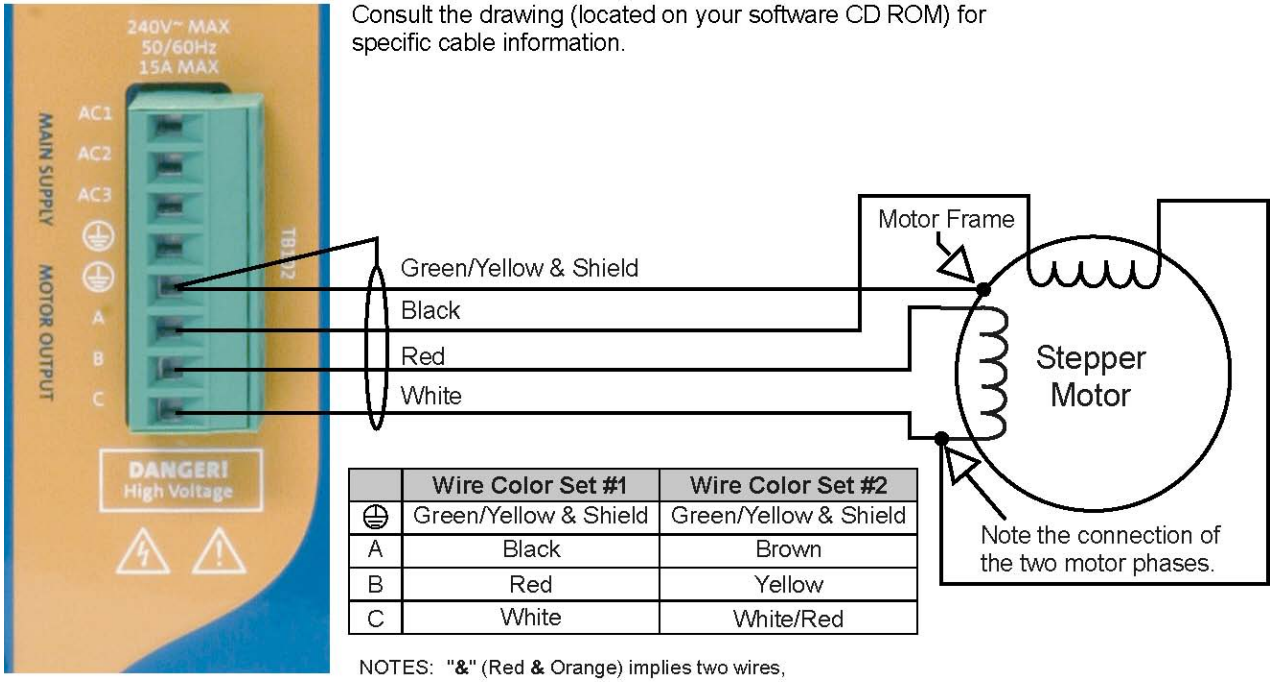
*Figure 2-14. Motor Phasing*



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### 2.5.4. Stepper Motor Configuration

This mode is used with a stepper motor only. See Section 2.6.1, if Aerotech's standard cabling is not used, for information on correctly phasing the motor feedback devices.




| | Wire Color Set #1 | Wire Color Set #2 |
|---|---|---|
| ⏚ | Green/Yellow & Shield | Green/Yellow & Shield |
| A | Black | Brown |
| B | Red | Yellow |
| C | White | White/Red |

NOTES: "&" (Red & Orange) implies two wires,
" / " (Green/White) implies a single wire

*Figure 2-15. Stepper Motor Configuration*

#### 2.5.4.1. Stepper Motor Phasing Process

A stepper motor is phased correctly when a positive motion command causes the motor to rotate in a clockwise (CW) direction, assuming a positive scaling factor, as determined by the CntsPerMetricUnit/CntsPerEnglishUnit/CntsPerRotaryUnit axis parameter. To correct the phasing, reverse the connections to the θA and θB terminals on the Ndrive HP. This is important because the end of travel (EOT) limit inputs are relative to motor rotation. After correctly phasing the motor, you may reverse the motor direction when commanding a positive move from a motion program, by negating the sign of the CntsPerMetricUnit/CntsPerEnglishUnit/CntsPerRotaryUnit axis parameter.



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## 2.6. Encoder Feedback Connections

One encoder feedback device must always be used for all motor types, except for stepper motors. Each of the two encoder channels in the Ndrive HP, accept a differential line driver encoder. DC Brush and brushless motors may have a separate position and a velocity feedback device. An analog sine wave encoder may be used with Aerotech's MXH multiplier box to multiply the encoder resolution and simultaneously convert it to a differential line driver encoder signal, acceptable by the Ndrive HP.

NOTE

Signal shielding is very important and the wiring should be physically isolated from motor, AC power and all other power wiring.

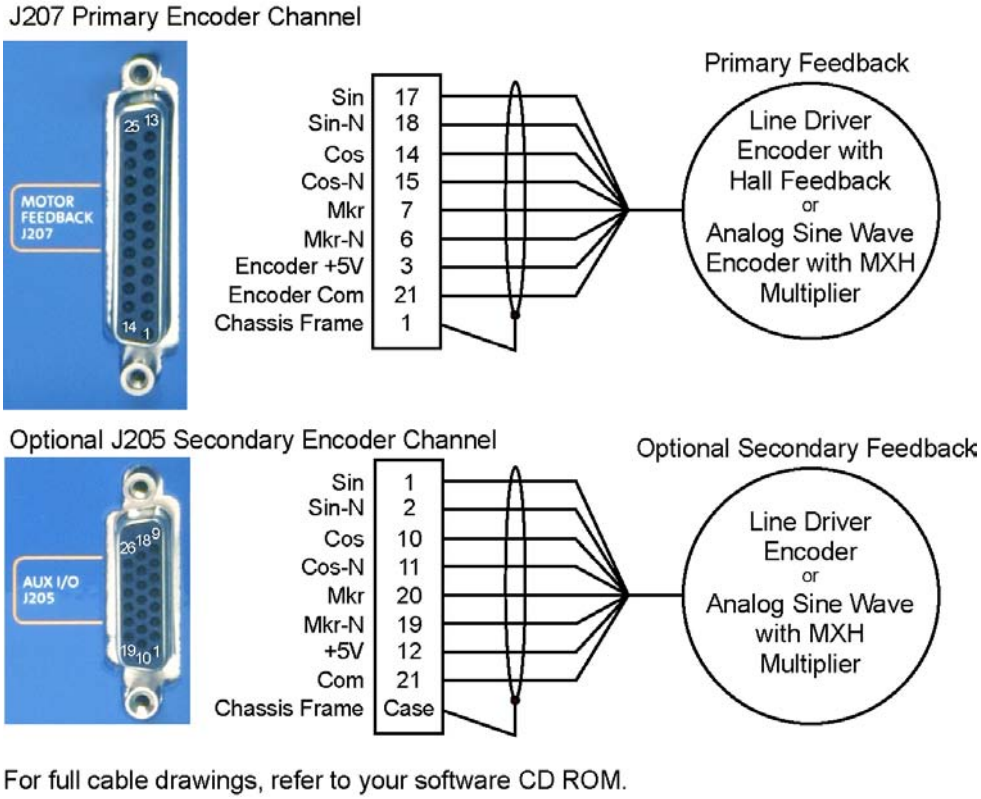



*Figure 2-16. Encoder Feedback Connections*



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### 2.6.1. Encoder Phasing

Figure 2-17 illustrates the required encoder phasing for clockwise motor rotation, or positive forcer movement through the stationary magnet track. If the motor is not visible, or may not be manually moved by hand, it may be actively driven open loop, under program control, by running the A3200\Programs\Samples\MsetDebug.Pgm program. This program will move the motor in a positive direction, allowing the position of the encoder to be monitored in the "Pos Fdbk" field of the Diagnostics tab of the Nstat utility, as shown in Figure 2-18. The program should cause the encoder to produce a more positive position as the program executes. If it counts more negative, swap the connections to the controllers SIN and the SIN-N encoder inputs, or you may invert the sign of the CfgFbkVelMultiplier and CfgFbkPosMultiplier parameters. However, if this axis is configured for dual loop, two feedback devices, one for position and one for velocity feedback, invert the sign of only the one parameter associated with the incorrectly phased feedback device.

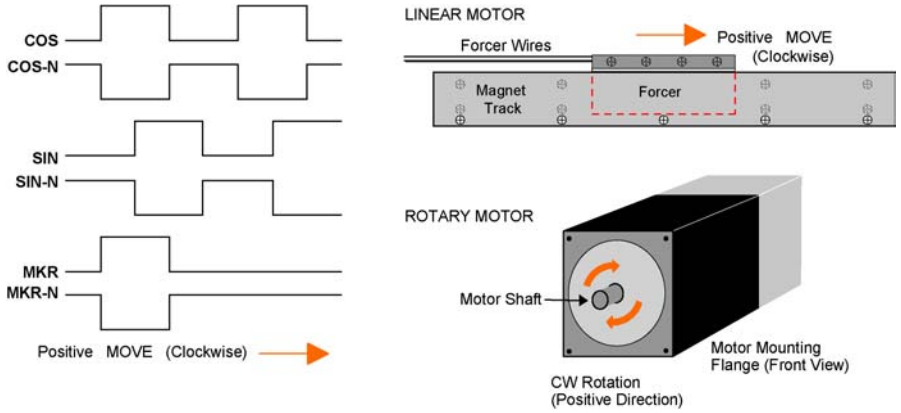



*Figure 2-17. Encoder Phasing Reference Diagram*

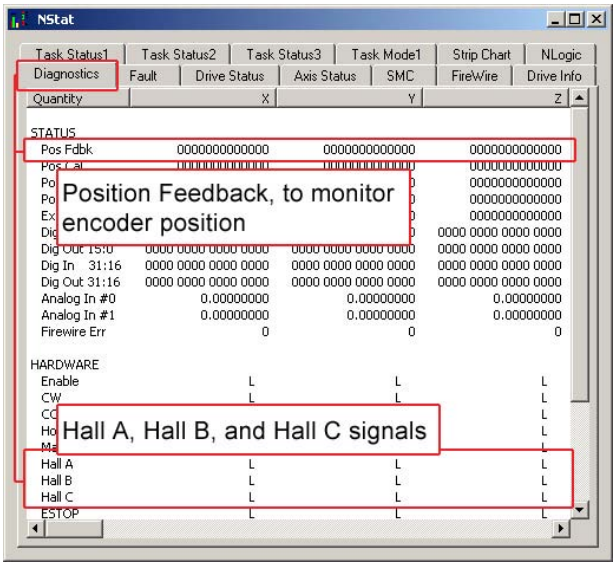


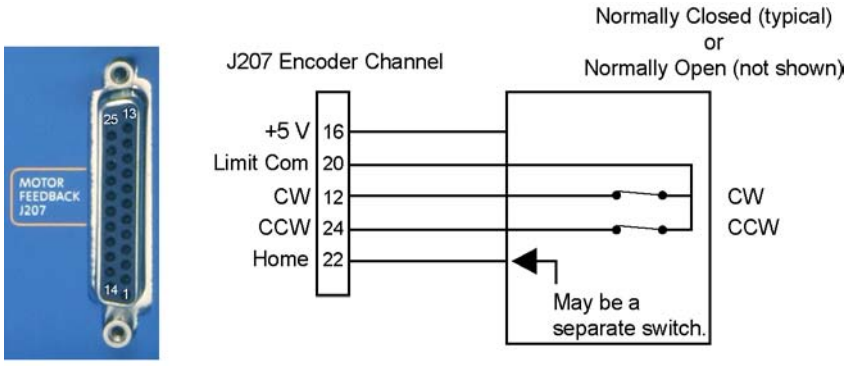

*Figure 2-18. Encoder and Hall Signals in the Nstat Utility Program*



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## 2.7. End of Travel (EOT) Limit Input Connections

End of Travel (EOT) Limits are required to define the end of the physical travel. They are also used for homing, which defines an absolute reference for the user coordinate system. EOT Limits are relative to positive motion, which is defined as clockwise rotary motion or positive linear motor motion. Positive or clockwise motion is stopped by the CW or clockwise EOT limit input, etc.




For full cable drawings, refer to your software CD ROM.

*Figure 2-19. End of Travel Limit input Connections*

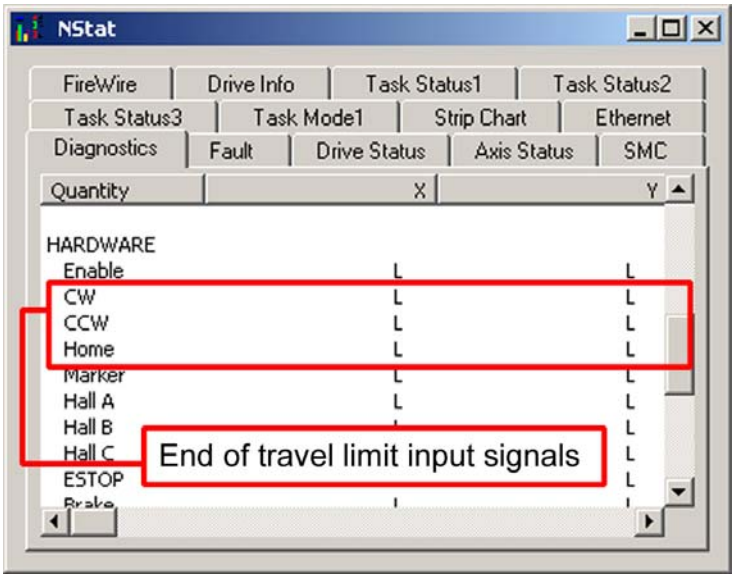



*Figure 2-20. Limit Inputs in the Nstat Utility*

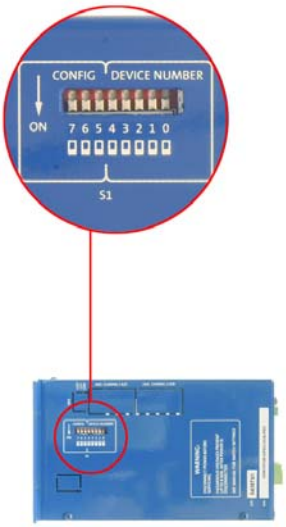
### 2.7.1. End of Travel (EOT) Limit Phasing

If the EOT limits are reversed, swap the connections to the CW and CCW inputs at the Ndrive HP J207 connector. The level of the EOT limit inputs may be viewed on the Diagnostic tab of the Nstat utility, as shown in Figure 2-19.



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## 2.8. Communication Channel Settings




Each Ndrive HP must have a unique communication channel number defined by switch S2. It is recommended that they be sequential beginning with the first device number. The 1st device as indicated by the switch settings in row 1 of the following table will be configured by the Axis 1 parameters in the Nparam utility. Assuming all axes are selected on the "Axis" menu in Nparam, they will be the parameters in the first column. The Ndrive configured as Row 2 indicates below, will be configured by the axis parameters in column 2 of the Nparam utility, etc.

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

**Table 2-4. Ndrive HP Switch Settings (S2)**

| Ndrive # | Switch Settings - (Off is indicated by " - " ) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| 2 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | - |
| 3 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | - | ↓ |
| 4 | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | - | - |
| 5 | ↓ | ↓ | ↓ | ↓ | ↓ | - | ↓ | ↓ |
| 6 | ↓ | ↓ | ↓ | ↓ | ↓ | - | ↓ | - |
| 7 | ↓ | ↓ | ↓ | ↓ | ↓ | - | - | ↓ |
| 8 | ↓ | ↓ | ↓ | ↓ | ↓ | - | - | - |
| 9 | ↓ | ↓ | ↓ | ↓ | - | ↓ | ↓ | ↓ |
| 10 | ↓ | ↓ | ↓ | ↓ | - | ↓ | ↓ | - |
| 11 | ↓ | ↓ | ↓ | ↓ | - | ↓ | - | ↓ |
| 12 | ↓ | ↓ | ↓ | ↓ | - | ↓ | - | - |
| 13 | ↓ | ↓ | ↓ | ↓ | - | - | ↓ | ↓ |
| 14 | ↓ | ↓ | ↓ | ↓ | - | - | ↓ | - |
| 15 | ↓ | ↓ | ↓ | ↓ | - | - | - | ↓ |
| 16 | ↓ | ↓ | ↓ | ↓ | - | - | - | - |
| 17 | ↓ | ↓ | ↓ | - | ↓ | ↓ | ↓ | ↓ |
| 18 | ↓ | ↓ | ↓ | - | ↓ | ↓ | ↓ | - |
| 19 | ↓ | ↓ | ↓ | - | ↓ | ↓ | - | ↓ |
| 20 | ↓ | ↓ | ↓ | - | ↓ | ↓ | - | - |
| 21 | ↓ | ↓ | ↓ | - | ↓ | - | ↓ | ↓ |
| 22 | ↓ | ↓ | ↓ | - | ↓ | - | ↓ | - |
| 23 | ↓ | ↓ | ↓ | - | ↓ | - | - | ↓ |
| 24 | ↓ | ↓ | ↓ | - | ↓ | - | - | - |
| 25 | ↓ | ↓ | ↓ | - | - | ↓ | ↓ | ↓ |
| 26 | ↓ | ↓ | ↓ | - | - | ↓ | ↓ | - |
| 27 | ↓ | ↓ | ↓ | - | - | ↓ | - | ↓ |
| 28 | ↓ | ↓ | ↓ | - | - | ↓ | - | - |
| 29 | ↓ | ↓ | ↓ | - | - | - | ↓ | ↓ |
| 30 | ↓ | ↓ | ↓ | - | - | - | ↓ | - |
| 31 | ↓ | ↓ | ↓ | - | - | - | - | ↓ |
| 32 | ↓ | ↓ | ↓ | - | - | - | - | - |



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## 2.9. Connecting Multiple Drives

Following are two interconnection diagrams and a chart showing the part numbers of the FireWire Bus PCI card and the various interconnect cables and their part numbers.

**Table 2-5. FireWire Card and Cable Part Numbers**

| Part Number | Description |
|---|---|
| NFire-PCI | FireWire OHCI compliant PCI interface card |
| NFire-Multi | FireWire card, with USB 2.0 and GigaBit Ethernet LAN |
| NFire-PCI-TI-LP | Low Profile OHCI compliant PCI FireWire card |
| NConnect-4500-66 | FireWire cable, 4.5 M (15 feet) long, 6 pin to 6 pin |
| NConnect-1800-66 | FireWire cable, 1.8 M (6 feet) long, 6 pin to 6 pin |
| NConnect-900-66 | FireWire cable, 900 mm (3 feet) long, 6 pin to 6 pin |
| NConnect-381-66 | FireWire cable, 381 mm (15 inches) long, 6 pin to 6 pin |
| NConnect-228-66 | FireWire cable, 228 mm (9 inches) long, 6 pin to 6 pin |

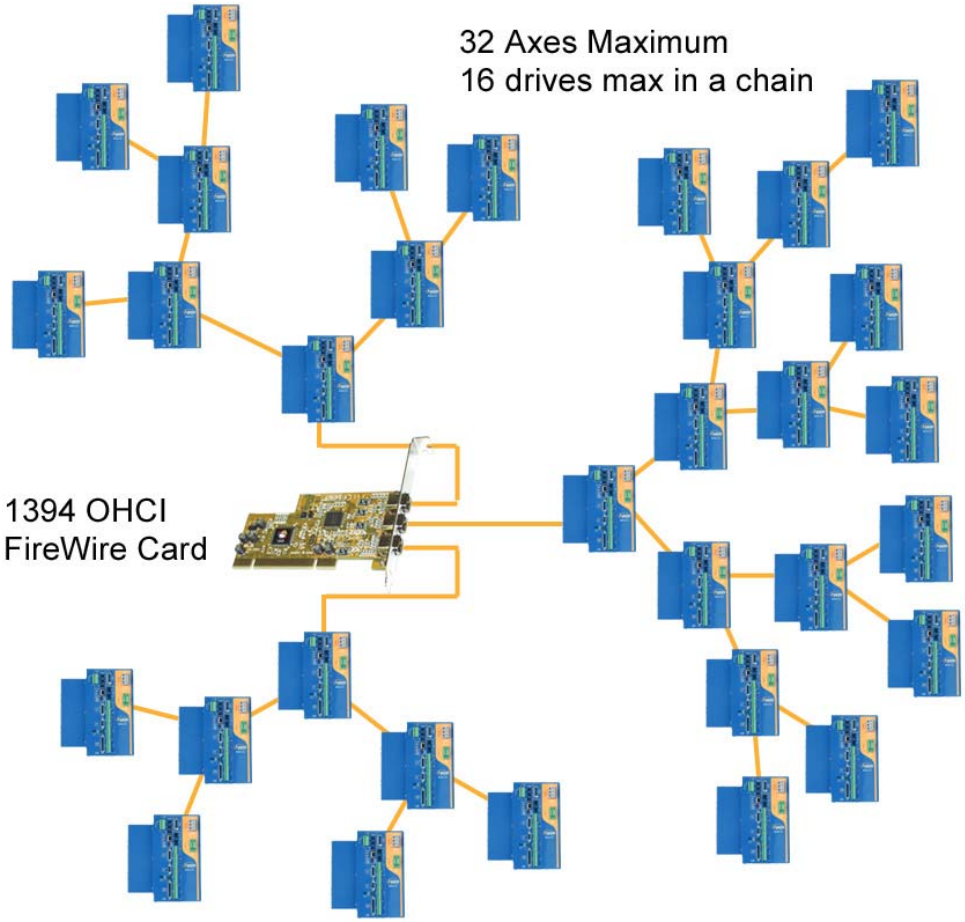



*Figure 2-21. Recommended Star Daisy Chain Configuration*



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*Figure 2-22. FireWire Daisy Chain*

NOTE

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

WARNING

Ndrive HPs, HLs, CPs, MPs, Nservos, Nsteps and Npaqs should always have their FireWire cables connected in a star configuration to minimize the FireWire cable lengths (see Figure 2-21).

### 2.9.1. I/O and Signal Wiring Requirements

The I/O, communication, and encoder feedback connections are typically very low power connections. Wire and connectors used for signal wiring should be rated for at least 30 V and have a current capacity of at least 0.25 Amp. Wires and connectors used for low voltage power connections such as +5V should have a current capacity of at least 1 Amp (encoder feedback +5V supply may require 0.6 Amps in some applications). In some applications, especially when there are significant wire distances, a larger wire size may be required to reduce the voltage drop that occurs along the wire. This increase may be necessary in order to keep the voltage within a specified range at a remote point.

When signal wiring is in close proximity to wiring operating at voltages above 60 Volts the insulation rating of the signal wiring will also need to be rated for the higher voltage. Signal wiring should have a voltage rating of at least 300 Volts when in proximity to AC power or motor power wiring.

WARNING

Signal shielding is very important and the wiring should be physically isolated from motor, AC power and all other power wiring.



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## 2.10. Emergency Stop Sense Input (TB201)




This input is to be activated by an external fail-safe emergency stop circuit. It is not intended to be an emergency stop circuit in itself. It is scaled for an input voltage of 5-24 volts. Using a higher input voltage requires adding an external series resistor to limit the current.

If the ESTOP bit is enabled in the FaultMask axis parameter, the ESTOP input must be driven to prevent the ESTOP fault condition.

For typical ESTOP wiring, see the following drawing.

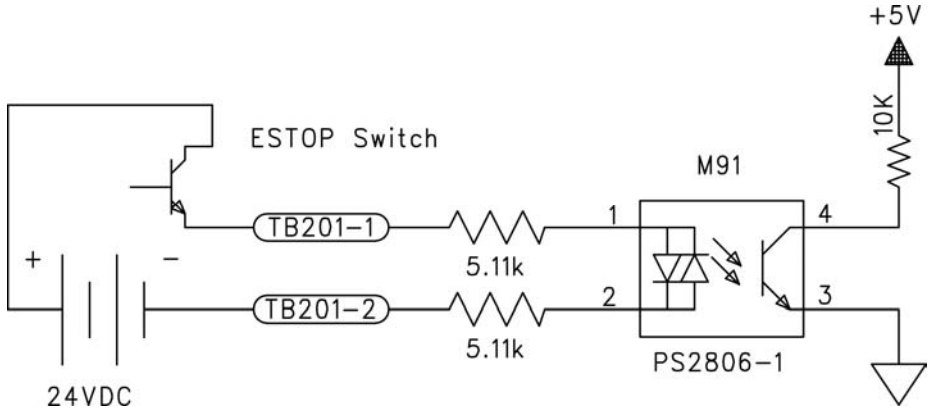



*Figure 2-23. ESTOP Sense Input (TB201)*




Connecting the E-Stop input to a relay or other EMI/RFI noise producing device/circuit, requires one or more noise suppression devices, such as those in Table 2-6, or other appropriate devices.

**Table 2-6. Electrical Noise Suppression Devices**

| Device | Aerotech P.N. | Third Party P.N. |
|---|---|---|
| RC (.1uf / 200 ohm) Network | EIC240 | Electrocube RG1782-8 |
| Varistor | EID160 | Littlefuse V250LA40A |



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### 2.10.1. Typical ESTOP Interface

The user may connect an emergency stop circuit to the Ndrive. It will disable power to the motor by removing power to the power stage of the drive, while maintaining power to the control section, as shown in the following Figure 2-24. For Rev. 0, see Appendix D.

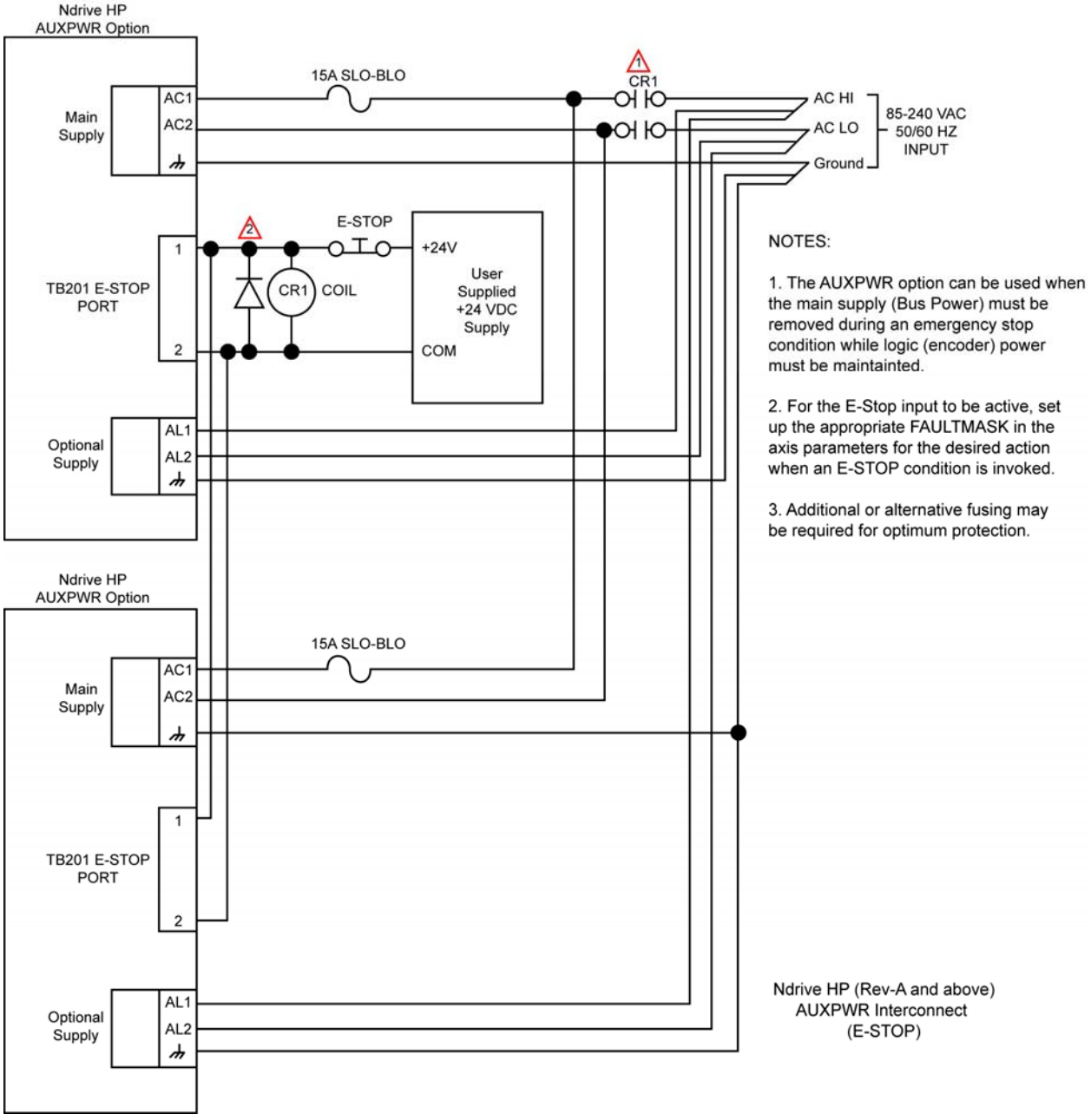



*Figure 2-24. Typical Emergency Stop Circuit*



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## 2.11. PC Configuration and Operation Information

The Getting Started Guide (PN: EDU175) included with the Nmotion SMC's software package, provides a quick start guide with basic information. The Nview help included with the software provides additional information for configuring the Ndrive HP to the PC as well as information on hardware requirements, getting started, utilities and system operation, and on using the Nview HMI user application.

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# CHAPTER 3: TECHNICAL DETAILS

## 3.1. Auxiliary I/O Connector (J205)

The J205, Auxiliary I/O connector provides 6 inputs, 4 outputs and a secondary bi-directional RS-422 line driver encoder interface. See the following sub-sections for details on each type of signal within the J205 connector.

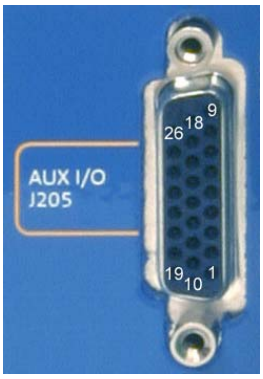



**Table 3-1. Auxiliary I/O Connector Pin Assignment (J205)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Auxiliary Sine + | Secondary RS-422 Channel - Sine+ | Bi-directional |
| 2 | Auxiliary Sine - | Secondary RS-422 Channel - Sine- | Bi-directional |
| 3 | In 12 + | Input 12 High Speed Opto. + (user interrupt) | Input |
| 4 | In 12 - | Input 12 High Speed Opto. - (user interrupt) | Input |
| 5 | In 13 + | Input 13 High Speed Opto. + (user interrupt) | Input |
| 6 | In 13 - | Input 13 High Speed Opto. - (user interrupt) | Input |
| 7 | Out 8 | Output 8 | Output |
| 8 | Out 9 | Output 9 | Output |
| 9 | Out 10 | Output 10 | Output |
| 10 | Auxiliary Cosine + | Secondary RS-422 Channel - Cosine+ | Bi-directional |
| 11 | Auxiliary Cosine - | Secondary RS-422 Channel - Cosine- | Bi-directional |
| 12 | +5 Volt | +5 Volt (500mA. max.)* | Output |
| 13 | Analog 0 In+ | Analog Input 0 + (Differential) | Input |
| 14 | Analog 0 In- | Analog Input 0 - (Differential) | Input |
| 15 | Out Com | Output Common | - |
| 16 | Out 11 | Output 11 / optional PSO Laser Firing Output | Output |
| 17 | In 8 | Input 8 | Input |
| 18 | In 9 | Input 9 | Input |
| 19 | Auxiliary Marker - | Secondary RS-422 Channel - Mrk+ / PSO out. | Bi-directional |
| 20 | Auxiliary Marker + | Secondary RS-422 Channel - Mrk- / PSO out. | Bi-directional |
| 21 | Common (+5 Volt ) | Common (+5 Volt User Supply) | - |
| 22 | Analog 0 Out | Analog Output 0 | Output |
| 23 | A Gnd | Analog Common | - |
| 24 | In Com | Input Common | - |
| 25 | In 10 | Input 10 | Input |
| 26 | In 11 | Input 11 | Input |

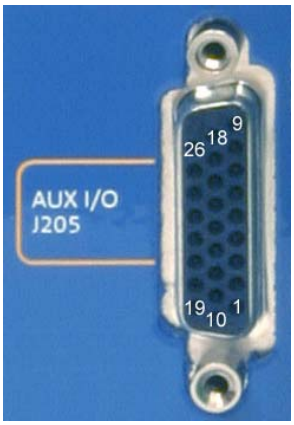
* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.



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**Table 3-2. Auxiliary I/O Connector Mating Connector (J205)**

| | Aerotech | Third Party Source |
|---|---|---|
| Connector | ECK01259 | Kycon K86-AA-26P |
| Back shell | ECK00600 | Cinch DA24658 |
| Screw Locks, Qty. 2 | EIZ00294 | TRW D-20419-16 |




All of the external power provided by the Ndrive HP to the user is limited to 500 mAmps and protected by a re-settable fuse. Should an over-current condition occur, the device will open to protect against the overload. To reset the device, remove the overload condition.




Please note, that the inputs and outputs on the Auxiliary connector (J205), begin with number 8, as shown in Table 3-1. Inputs and outputs 0 – 7 are present on the optional –IOPSO card.

### 3.1.1. Secondary Encoder Channel (J205)

The encoder channel can be used as an input for master/slave operation (handwheel) or for dual feedback systems or for an encoder input/output for multi-axis laser firing (see Chap. 4 for more information). The EncoderDivider axis parameter configures the input/output state of this encoder channel. This interface may not be multiplied by the MXH option and must be a 5-volt RS-422 line driver encoder. It allows up to an 8 MHz encoder signal (31 nsec minimum edge separation), producing 32 million counts per second, after times four (x4) quadrature decoding. See Table 3-2 for the mating connector part number. The Auxiliary Marker output has a 0.02 us propagation delay typical, when used as the PSO firing output.

**Table 3-3. Auxiliary Encoder Pin Assignment on Connector J205**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Auxiliary Sine + | Secondary RS-422 Channel - Sine+ | Bidirectional |
| 2 | Auxiliary Sine - | Secondary RS-422 Channel - Sine- | Bidirectional |
| 10 | Auxiliary Cosine + | Secondary RS-422 Channel - Cosine+ | Bidirectional |
| 11 | Auxiliary Cosine - | Secondary RS-422 Channel - Cosine- | Bidirectional |
| 12 | +5 Volt | +5 Volt (500mA. max.)* | Output |
| 19 | Auxiliary Marker - | Secondary RS-422 Channel - Mrk+ / PSO out. | Bidirectional |
| 20 | Auxiliary Marker + | Secondary RS-422 Channel - Mrk- / PSO out. | Bidirectional |
| 21 | Common (+5 Volt ) | Common (+5 Volt User Supply) | - |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.



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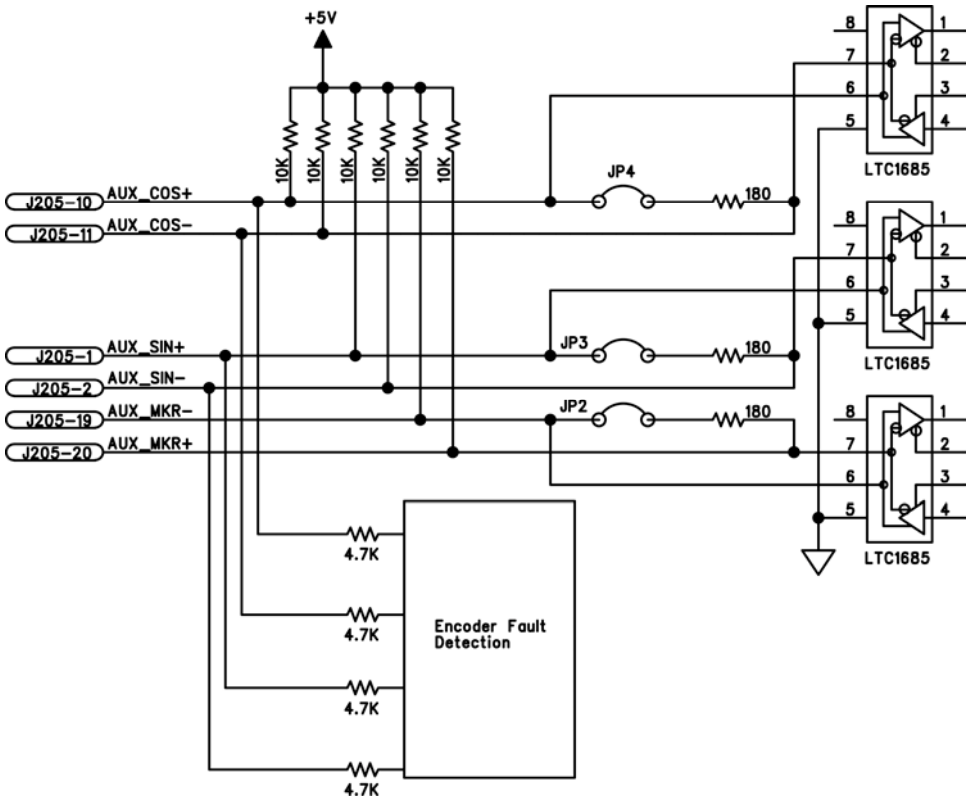
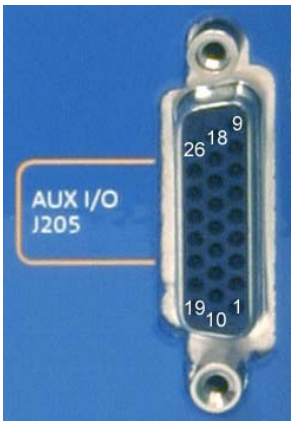



*Figure 3-1. Secondary Encoder Channel (J205)*



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### 3.1.2. User Outputs 8-11 (J205)

All outputs (Figure 3-2) are rated for 40 volts and 80 mAmps per channel. Power dissipation may not exceed 90 mWatts per channel.

* Output 11, shown in the following Figure, may be defined as a low-speed PSO (Laser Firing output), however, it is only rated for a maximum output frequency of 1 kHz, with a typical propagation delay of 250 us. The auxiliary marker output on pins 19 and 20 of J205 may be opto-isolated by the user and software configured as the PSO output via the EncoderDivider axis parameter and the PSOCONTROL command, see the Nview help for more information. See Section 3.2 for more information on the PSO option.

See Table 3-2 for the mating connector part number.

**Table 3-4. User Outputs Pin Assignment on Connector J205**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 7 | Out 8 | Output 8 | Output |
| 8 | Out 9 | Output 9 | Output |
| 9 | Out 10 | Output 10 | Output |
| 12 | +5 Volt | +5 Volt (500mA. max.)* | Output |
| 15 | Out Com | Output Common | - |
| 16 | Out 11 | Output 11 / optional PSO Laser Firing Output | Output |
| 21 | Common (+5 Volt) | Common (+5 Volt User Supply) | - |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

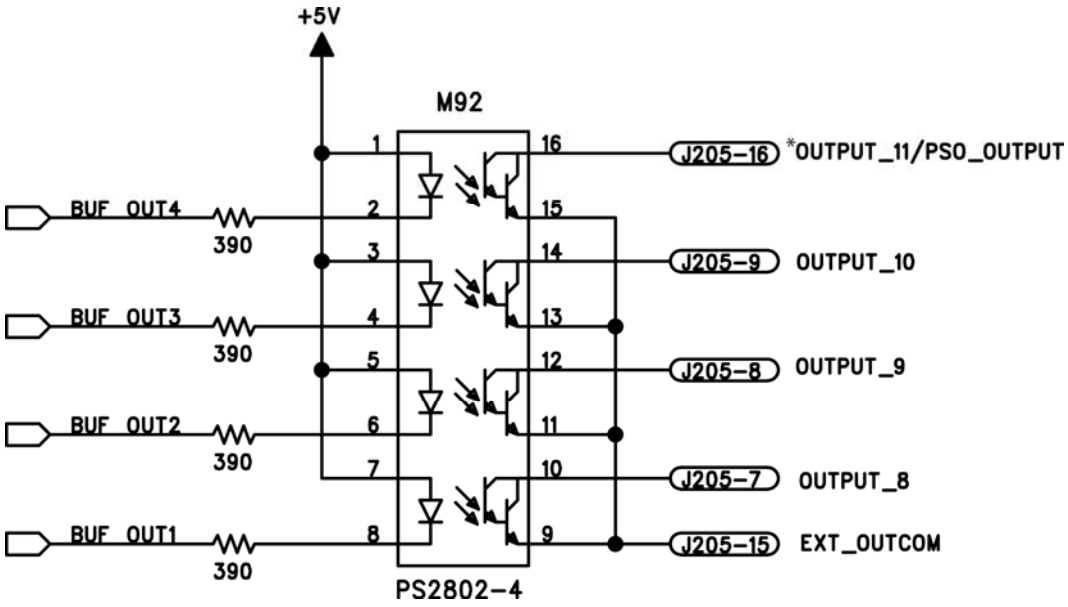
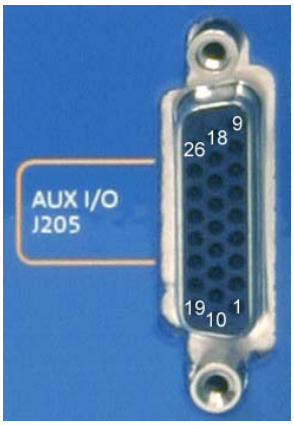



*Figure 3-2. User Outputs (J205)*



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### 3.1.3. User Inputs 8-11 (J205)




Inputs 8-11, as shown in Figure 3-3, are scaled for an input voltage of 5-24 volts. A higher input voltage requires adding external series resistors to limit the current to 20 milliamps. Inputs 8-10 may also be used as CW, CCW and Home EOT limit inputs, respectively, by setting bit 22 of the DriveIOConfig axis parameter.

See Table 3-2 for the mating connector part number.

**Table 3-5. User Inputs Pin Assignment on Connector J205**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 12 | +5 Volt | +5 Volt (500mA. max.)* | Output |
| 17 | In 8 | Input 8 / CCW EOT Input | Input |
| 18 | In 9 | Input 9 / CW EOT Input | Input |
| 21 | Common (+5 Volt) | Common (+5 Volt User Supply) | - |
| 24 | In Com | Input Common | - |
| 25 | In 10 | Input 10 / Home Input | Input |
| 26 | In 11 | Input 11 | Input |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

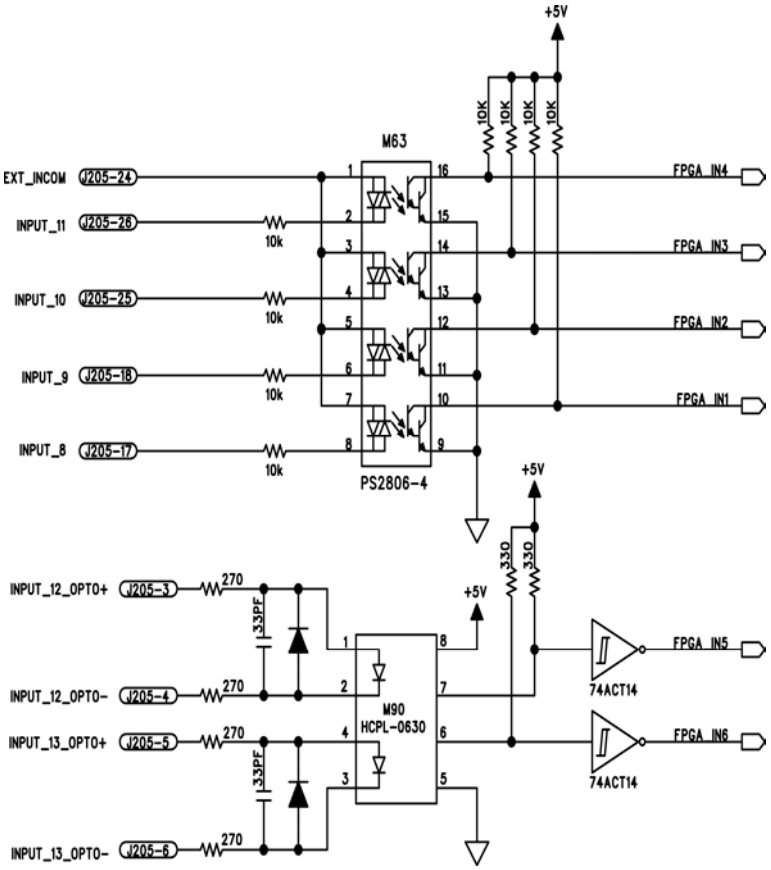
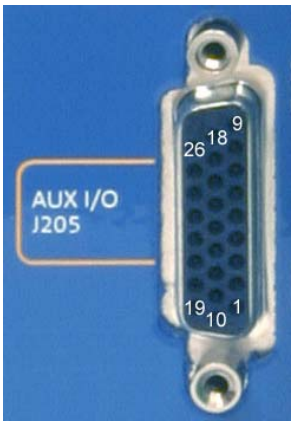



*Figure 3-3. All User Inputs 8-13 (J205)*



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### 3.1.4. High Speed User Inputs 12-13 (J205)

The high-speed inputs shown in Figure 3-3, are scaled for a 5 volt input voltage. A higher input voltage requires adding an external series resistor to limit the current to 7 milliamps. For example, 24 volt operation requires an external 2,700 ohm 1/2 watt resistor in series with one of the input pins. The high-speed inputs (inputs 12 and 13) have a delay of 50 nanoseconds (typical).

See Table 3-2 for the mating connector part number.

**Table 3-6. High Speed User Inputs Pin Assignment on Connector J205**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 3 | In 12 + | Input 12 High Speed Opto. + (user interrupt) | Input |
| 4 | In 12 - | Input 12 High Speed Opto. - (user interrupt) | Input |
| 5 | In 13 + | Input 13 High Speed Opto. + (user interrupt) | Input |
| 6 | In 13 - | Input 13 High Speed Opto. - (user interrupt) | Input |
| 12 | +5 Volt | +5 Volt (500mA. max.)* | Output |
| 21 | Common (+5 Volt ) | Common (+5 Volt User Supply) | - |
| 24 | In Com | Input Common | - |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

### 3.1.5. Analog Input 0 (J205)

The analog inputs accept a signal within the range of -10 through +10 volts DC. Signals outside this range may damage the input. For analog input technical information, see Section 4.1.4.

See Table 3-2 for the mating connector part number.

**Table 3-7. Auxiliary I/O Connector Pin Assignment (J205)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 13 | Analog 0 In+ | Analog Input 0 + (Differential) | Input |
| 14 | Analog 0 In- | Analog Input 0 - (Differential) | Input |
| 23 | A Gnd | Analog Common | - |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

### 3.1.6. Analog Output 0 (J205)

The analog output may be programmed to output a signal within the range of -10 through +10 volts DC. For analog output technical information, see Section 4.1.2. Shown in the Table below are the pins relating to the signals described in this section.

See Table 3-2 for the mating connector part number.

**Table 3-8. Auxiliary I/O Connector Pin Assignment (J205)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 22 | Analog 0 Out | Analog Output 0 | Output |
| 23 | A Gnd | Analog Common | - |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.



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

The Ndrive includes a Position Synchronized Output (PSO or Laser Firing) option. This feature may be programmed to generate an output synchronized to axes positions, based upon a user-defined trigger condition, most typically, but not limited to firing a laser. The Ndrive offers three levels of laser firing, single axis (std.) and two and three axis. Trigger signals may be derived from the primary encoder channel, secondary encoder channel, either of the two optional SSI Net ports or a software trigger. Both SSI Net ports may provide axes encoder signals or marker signals to/from another Ndrive at a maximum of a 20 MHz. data rate (50 nsec. minimum edge separation). Single axis tracking is limited to a 20 MHz. data rate and multi-axis to a 5 MHz tracking rate. The PSOTRACK command may be used to scale the encoder input signal to limit the maximum tracking 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. Single axis PSO laser firing latency is 200 nanoseconds. -DUALPSO and -TRIPLEPSO laser firing latency is 275 nanoseconds, not including the propagation delay of the output device. Refer to Figure 3-4 for a basic single-axis block diagram of the PSO capabilities, or Figure 3-5 and Figure 3-6 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 (dedicated PSO output or user output 11) or a differential RS-422 output. The opto-isolated output is available in three different configurations as shown in Table 3-9. Additionally, the PSO options provide Data Capture and Data Update capabilities, also shown in Figure 3-5 and Figure 3-6. For programming information, refer to the Nview HMI Help.

**Table 3-9. PSO Encoder Signal Sources and Pre-Scaling Methods**

| Encoder Signal Source | Max. Data Rate (w/o pre-scalar) | Encoder Input (pre-scalar) | Encoder Output (pre-scalar) |
|---|---|---|---|
| Primary Encoder | 32 Mhz. | PSOTRACK cmd. | CfgFbkEncQuadDivider axis parameter (MXH only) |
| Secondary Encoder | 32 Mhz. | PSOTRACK cmd. | None |
| SSI Net Ports 1 and 2 | 20 Mhz. | PSOTRACK cmd. | CfgFbkEncMxhSetup axis parameter |

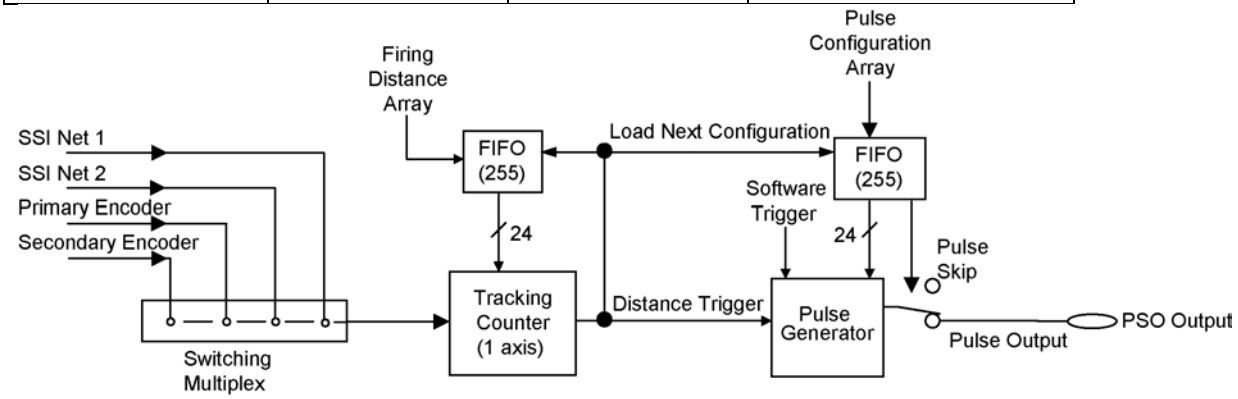



*Figure 3-4. PSO Diagram – Basic Single Axis Firing*



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**Table 3-10. PSO Output Sources**

| PSO Output Type | Maximum Frequency | Standard or Option | Requires User Isolation |
|---|---|---|---|
| High Speed Opto-Isolator - J301 | Table 4-14 | -IOPSO option | No |
| Opto-Isolated Output 11 - J205 | 1 KHz | Standard | No |
| RS-422 Marker output on Secondary Encoder - J205 | 10 MHz | Standard | Yes |

The pre-scaler in the block diagram is used to normalize the resolution of axes with different machine step sizes or to scale down (divide) the maximum input frequency to the PSO tracking hardware. The PSO hardware 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 one to three axes. This vectorial position change is monitored via hardware, allowing an output pulse to be generated in less than 275 nanoseconds (200 nsec. for single axis) after the trigger is detected, not including the propagation delay of the output device. 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.

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 an axis, etc. Window modes may not be pre-scaled as indicated in the block diagram.



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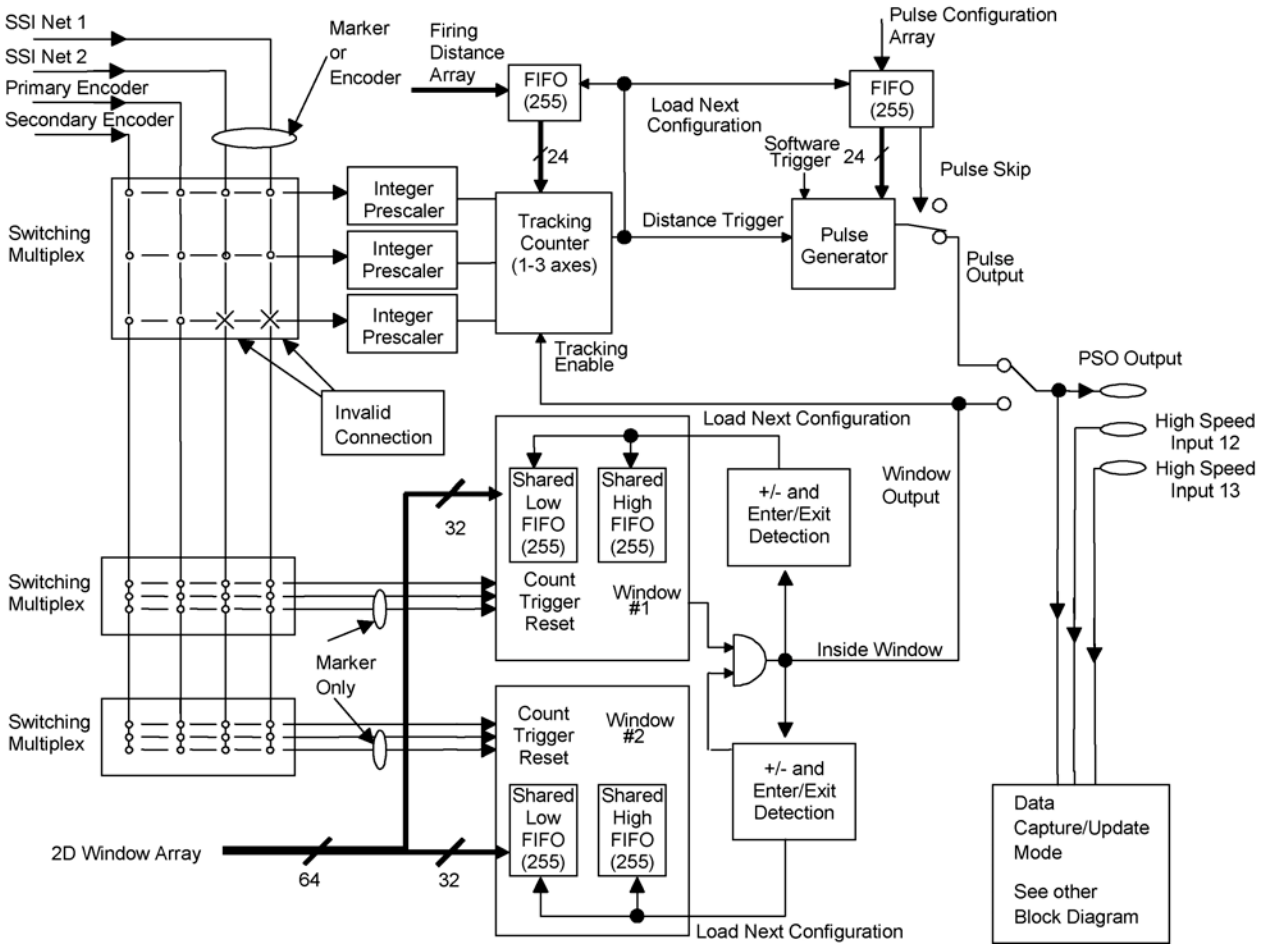



*Figure 3-5. Advanced 1 - 3 Axis Firing*

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 3-6. For a full description of these modes, refer to the Nview HMI help.

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 3-6.

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.



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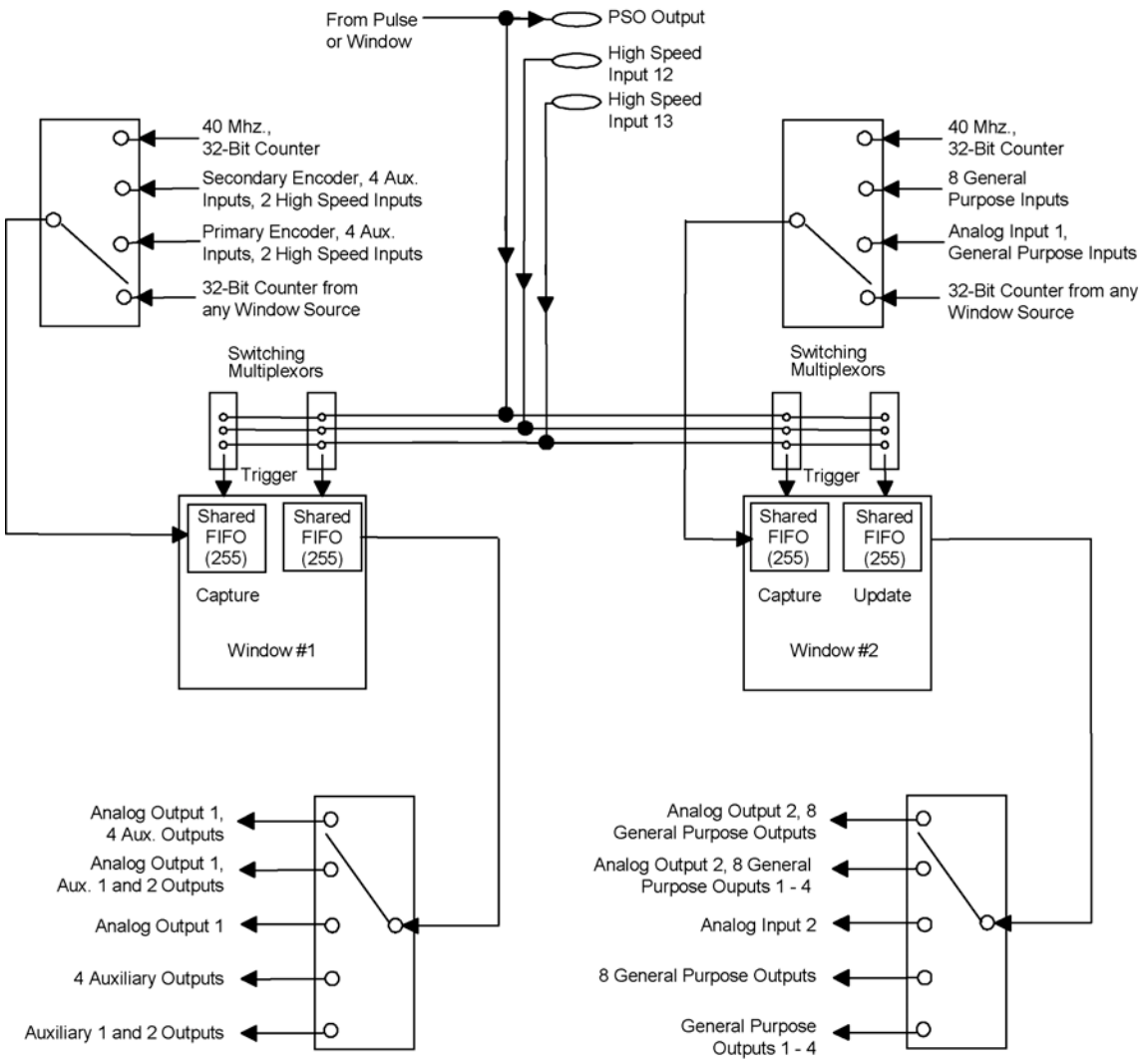



*Figure 3-6. Data Capture/Data Update Modes*

### 3.2.1. Single Axis Laser Firing

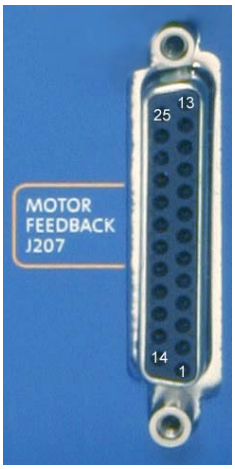
Single axis firing requires no additional encoder signals and is capable of tracking the axis position at up to a 20 MHz. tracking rate (50 nsec. minimum edge separation). It may be programmed to fire from any available encoder source, see Table 3-9. Single axis firing provides one feature not present 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 queues.

See Figure 3-4 for a basic single-axis block diagram of the PSO capabilities or Figure 3-5 and Figure 3-6 for a more detailed block diagram of the multi-axis capabilities that also apply to single-axis firing.



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## 3.3. Motor Feedback (J207)




The 25-pin "D" style connector contains all of the required feedback inputs for a servo loop. This connector has inputs for a 3-channel encoder, three limit switches, and three Hall-effect devices. Each of these inputs provides feedback for the DSP microprocessor controlled position, velocity and current loops.

See Section 2.6.1 Encoder Phasing for information on interfacing non-Aerotech motors.

**Table 3-11. Motor Feedback Connector Pin Assignment (J207)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Frame | Chassis Frame | N/A |
| 2 | Thermistor | Motor over temperature Thermistor | Input |
| 3 | +5 Volt | +5 Volt Power for Encoder (500mA. max.)* | 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 | +5V Power for Limit Switches (500mA. max.)* | 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 an internal re-settable fuse.

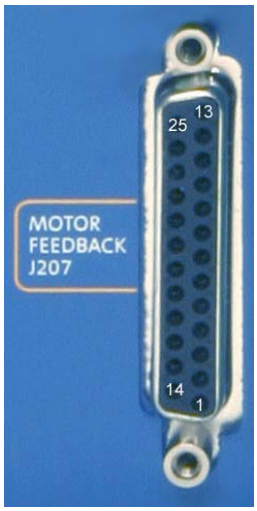
**Table 3-12. Motor Feedback Connector Mating Connector (J207)**

| | Aerotech | Third Party Source |
|---|---|---|
| Connector | ECK00101 | Cinch P/N DB25P |
| Back shell | ECK00656 | Amphenol P/N 17-1726-2 |

All of the external power provided by the Ndrive to the user is limited to 500 mAmps and protected by a re-settable fuse. Should an over-current condition occur, the device will open to protect against the overload. To reset the device, remove the overload condition.



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### 3.3.1. End of Travel Limit Inputs

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). All of the end of travel limit inputs accept 5-24 VDC logic signals. The Pin Assignment for the connector is shown in the table below.

See Table 3-12 for the mating connector part number.

Alternatively, opto-isolated user inputs 8-10 may be used as the end-of-travel limit inputs (see Section 3.1.3).

**Table 3-13. End of Travel Limit Inputs Pin Assignment on Connector J207**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 12 | CW/+Lmt. | Clockwise End of travel limit | Input |
| 16 | +5 Volt | +5 Volt Power for Limit Switches (500mA. max.)* | Output |
| 20 | Common | Signal Common for Limit Switches | N/A |
| 22 | Hm.Lmt. | Home Switch Input | Input |
| 24 | CCW/-Lmt. | Counterclockwise End of travel limit | Input |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

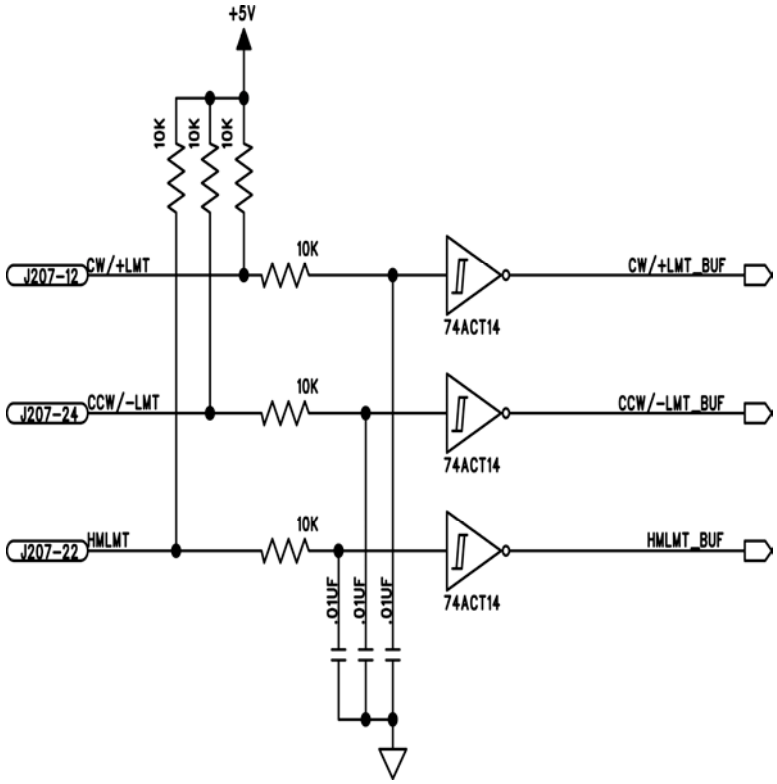



*Figure 3-7. End of Travel Limit Inputs*



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### 3.3.2. Hall Effect and Thermistor Inputs




The Hall-effect switch inputs are highly recommended for AC brushless motor commutation but not absolutely required; see the Nview help for more information on axis configuration. The Hall-effect inputs accept 5-24 volt DC logic signals. The Pin Assignment for the connector is shown in the table below.

The thermistor input is used to detect an over temperature condition in a motor, via a positive temperature coefficient device. That is, as the temperature of the device increases, so does the resistance of the device. Under normal operating conditions, the resistance of the thermistor is low (i.e., 100 ohms). This will be seen as a low input signal. After the temperature causes the thermistor's resistance to increase above 1K ohms, the signal will be seen as a logic high, triggering an over temperature fault.

See Table 3-12 for the mating connector part number.

**Table 3-14. Hall-Effect Inputs Pin Assignment on Connector J207**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 3 | +5 Volt | +5 Volt Power for Encoder (500mA. max.)* | Output |
| 5 | HB | Hall Effect Sensor B (Brushless Motors only) | Input |
| 10 | HA | Hall Effect Sensor A (Brushless Motors only) | Input |
| 11 | HC | Hall Effect Sensor C (Brushless Motors only) | Input |
| 21 | Common | Signal Common for Encoder | N/A |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

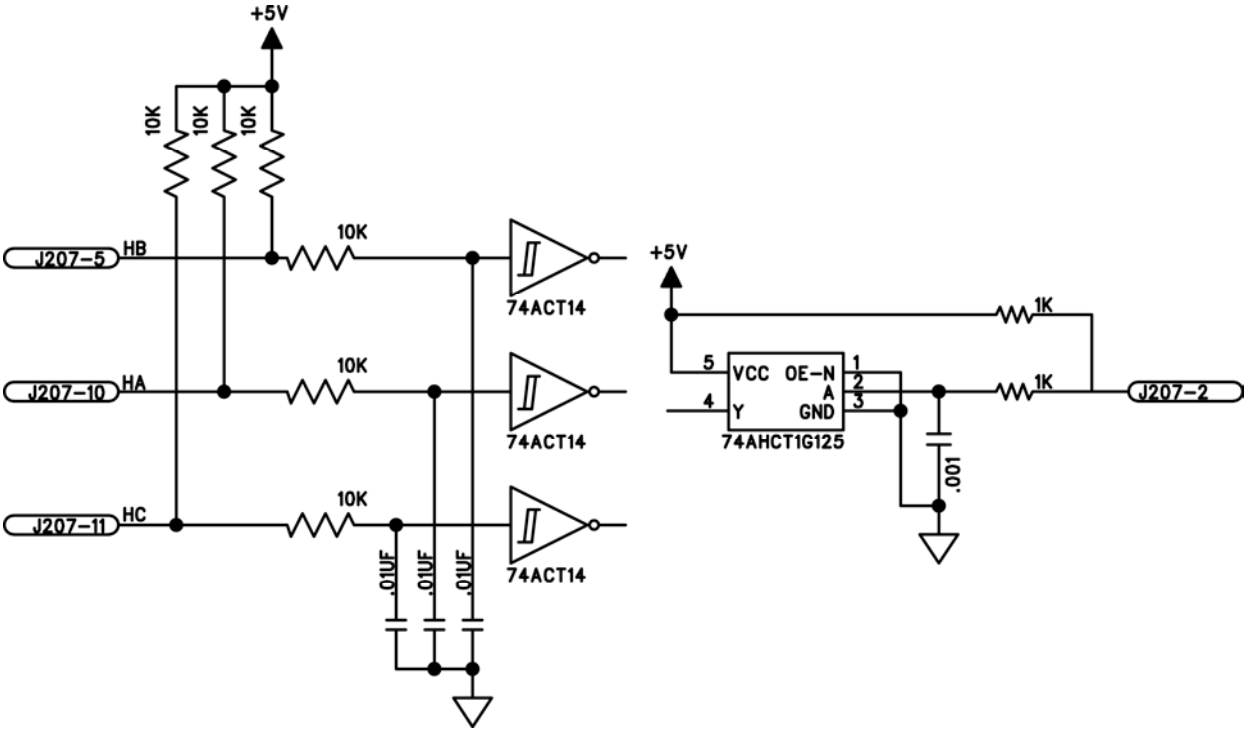
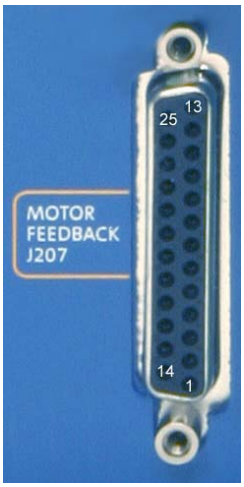



*Figure 3-8. Hall-Effect and Thermistor Inputs (J207)*



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### 3.3.3. Brake Output

The brake output provides a direct connection to the brake the relay on the optional -IOPSO board. The brake output will be present on this connector only when the -IOPSO option board is present, allowing the brake signal to utilize the existing feedback cable without the need for additional wiring.

See Section 4.1.3 for more information on the brake output.

See Table 3-12 for the mating connector part number.

**Table 3-15. Brake Output Pin Assignment on Connector J207**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 13 | Brake - | Optional Brake Relay - Output | Output |
| 25 | Brake + | Optional Brake Relay + Output | Output |

### 3.3.4. Encoder Interface

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).

The encoder interface accepts an RS-422 differential quadrature signal in the range of 0 to 5 Volts DC. It allows up to an 8 MHz encoder signal (31 nsec minimum edge separation), producing 32 million counts per second, after times four (x4) quadrature decoding.

Typically, the encoder interface accepts this RS-422 signal in line driver format; however, it may be factory configured as an option to accept this signal as an analog signal for the MXH option (see Section 3.3.4.2 for more information).

See Section 2.6.1. Encoder Phasing for information on interfacing non-Aerotech motors.

See Table 3-12 for the mating connector part number.

**Table 3-16. Motor Feedback Connector Pin Assignment (J207)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Frame | Chassis Frame | N/A |
| 3 | +5 Volt | +5 Volt Power for Encoder (500mA. max.)* | Output |
| 6 | Mkr- | Encoder Marker Reference Pulse - | Input |
| 7 | Mkr+ | Encoder Marker Reference Pulse + | Input |
| 14 | Cos+ | Encoder Cosine + | Input |
| 15 | Cos- | Encoder Cosine - | Input |
| 17 | Sin+ | Encoder Sine + | Input |
| 18 | Sin- | Encoder Sine - | Input |
| 21 | Common | Signal Common for Encoder | N/A |

* Total user +5 V power is limited to 500 mA, by an internal re-settable fuse.

All external power provided by the Ndrive to the user is protected by a re-settable 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.



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### 3.3.4.1. Line Driver Encoder (Standard)

The primary encoder input is standardly configured for a differential line driver encoder, in the range of 0 to +5 volts. It allows up to an 8 MHz encoder signal (31 nsec minimum edge separation), producing 32 million counts per second, after times four (x4) quadrature decoding. An analog encoder is used with the MXH option; see Figure 3-10 for more information.



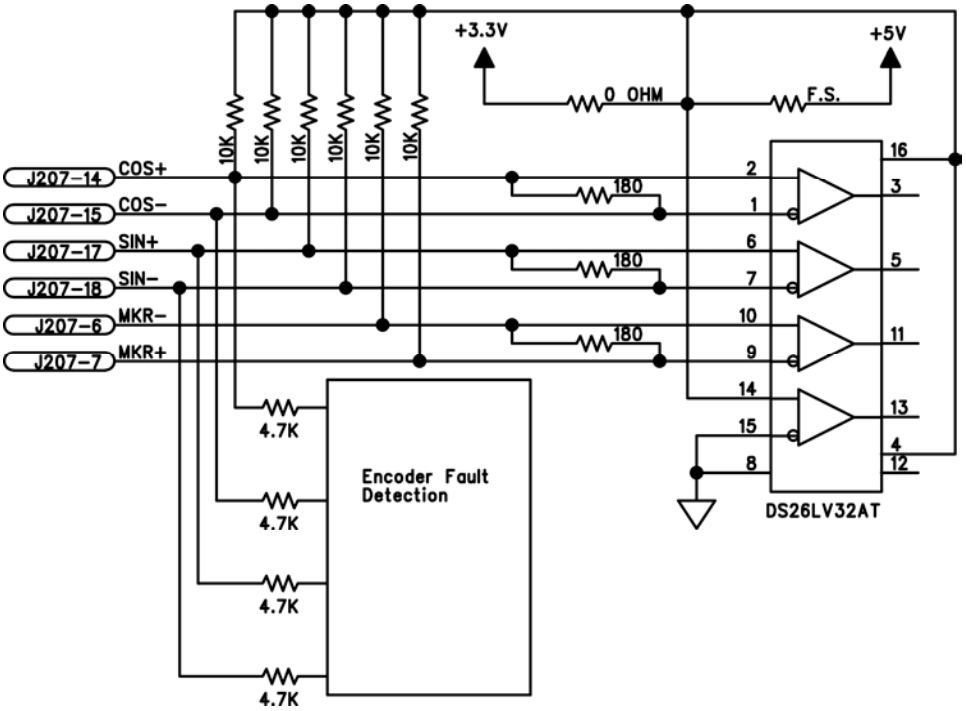




*Figure 3-9. Line Driver Encoder Interface – Standard (J207)*

NOTE

The Ndrive HP is factory configured for either a square wave differential encoder (default), OR an analog encoder (MXH option).



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### 3.3.4.2. MXH Option

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, or less if the encoder signals are to be output via the SSI Net, see Table 3-17. The MXH multiplies the resolution up to 512 times, in addition to the controller's x4 multiplication, providing a maximum of x 2048 multiplication (8.388607 GHz effective data rate), as shown in the first two columns of Table 3-17.

MXH Erase Cycle




The MXH multiplication factor is determined by the CfgFbkEncMultFactorMXH axis parameter, which is then multiplied x4 additionally by the controller. Each time this axis parameter is changed, the controller will internally re-program its logic. This re-programming cycle will take about 3.5 minutes. The LED's will indicate that the internal MXH option is being internally erased and then re-programmed, and that the axis may not be enabled during this time. While the -MXH option is being erased, the LED's will indicate the pattern shown to the upper right. When the -MXH option is being re-programmed, the LEDs will alternate between the two patterns shown to the lower right.

MXH Programming Cycle




(alternate flashing pattern)




The Ndrive contains digital potentiometers to adjust the gain, offset and phase balance of the analog Sine and Cosine inputs. The digital potentiometer settings are controlled by the CfgFbkEncCosGain, CfgFbkEncCosOffset, CfgFbkEncPhase, CfgFbkEncSineGain, CfgFbkEncSineOffset axis parameters. The –MXH option is compatible with the –DUALPSO and –TRIPLEPSO options. A differential line driver encoder may be used also, see Figure 3-9 for more information.

The specifications for the -MXH multiplier option are shown in Table 3-17. The following table indicates the maximum specifications for the MXH option when the signals are output via the SSI Net. Otherwise, the only limit is the maximum input frequency of 200 kHz. See Figure 3-9 for MXH typical input circuitry. The Pin Assignment is indicated in Table 3-11.



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**Table 3-17. MXH Option Specifications**

| CfgFbkEncMult-FactorMXH Axis Parameter | Total Multiplication (1,2) | Applicable only when signals are output via the SSI Net | | | |
|---|---|---|---|---|---|
| | | 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 x4 from quadrature – i.e., MXH50 has a net interpolation of x200 (x50 from MXH and x4 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 SSI Net use; must be limited to 20 MHz for PSO tracking applications.

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 SSI Net.



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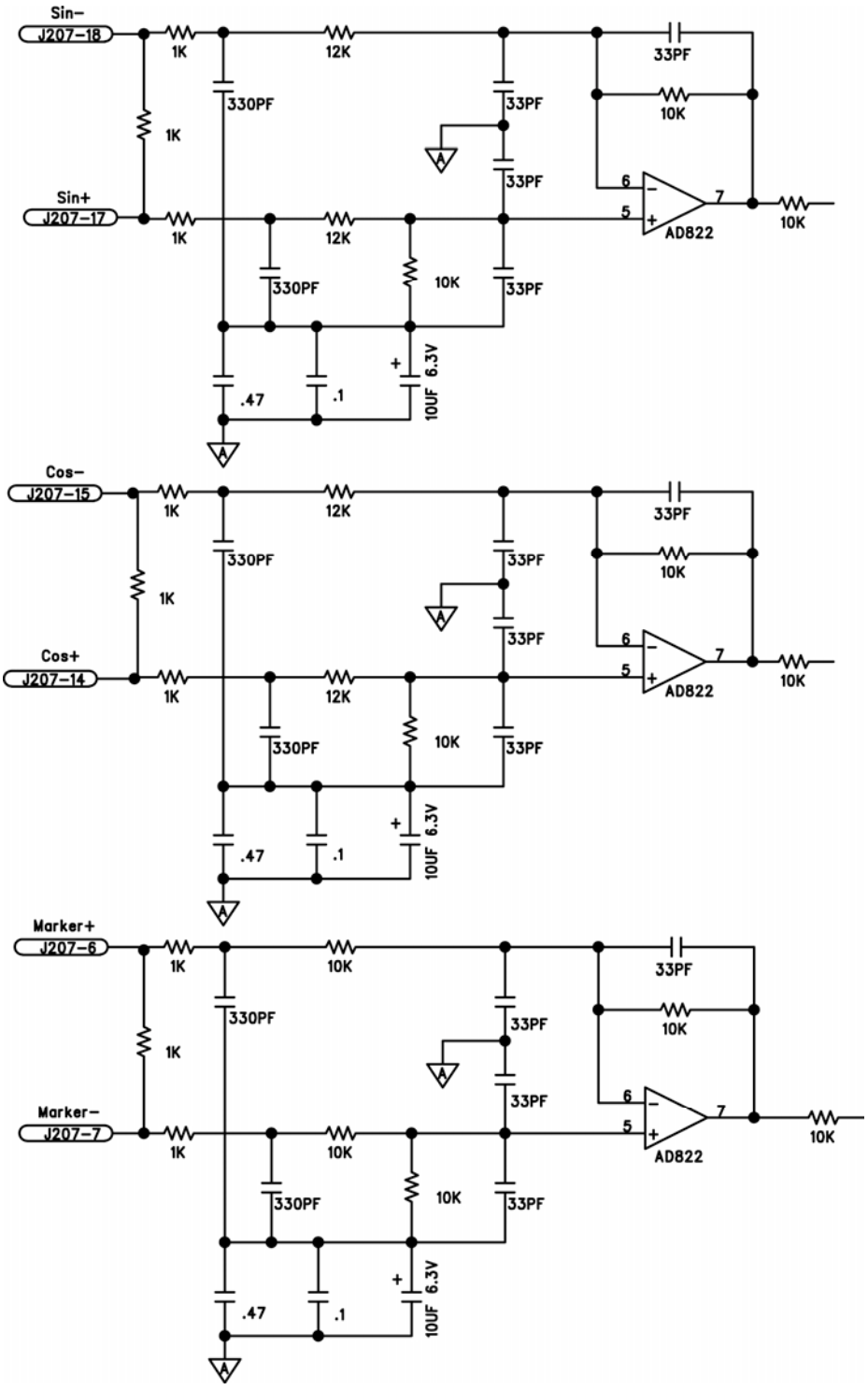



*Figure 3-10. Optional MXH Analog Encoder Interface (J207)*



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## 3.4. RS-232 / RS-422 Port (J206)




The RS-232C and RS-422 (factory option) ports may not be used simultaneously. They are one physical port, converted to each interface by the appropriate line driver/receiver, as shown in Figure 3-11. Connecting the RS-232 port to a user's PC requires only a standard 9-pin cable (not a null modem). Currently, the RS-232C port serves only a secondary means to upgrade the firmware in the Ndrive, which is done primarily through the FireWire port.

**Table 3-18. J206 RS-232 / RS-422 Connector Pin Assignment**

| 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 an internal re-settable fuse.

**Table 3-19. RS-232 / RS-422 Port Connector Mating Connector (J206)**

| 9-Pin D-style Connector | Aerotech | Third Party Source |
|---|---|---|
| Connector | ECK00137 | Cinch DE-9P |
| Back shell | ECK01021 | Amphenol 17-1724-2 |



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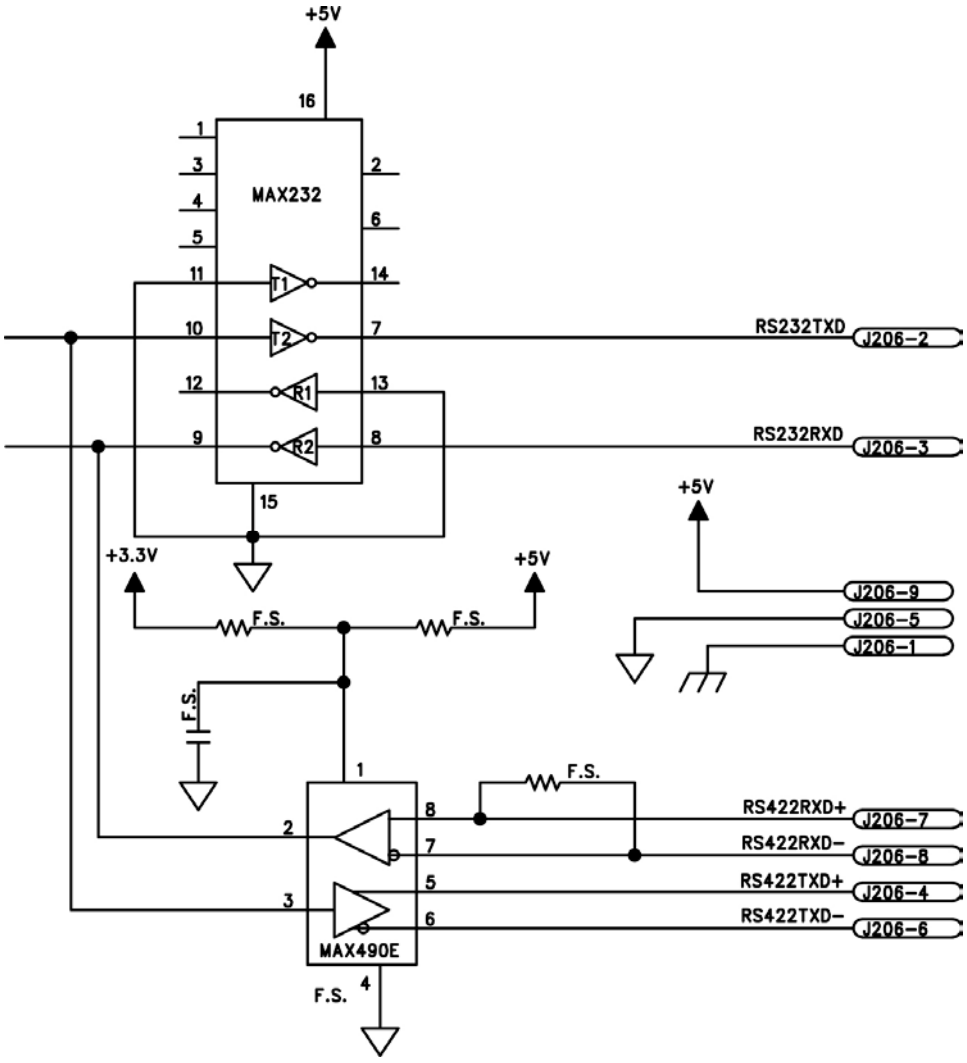



*Figure 3-11. RS-232/RS-422 Connector (J206)*



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## 3.5. FireWire Bus (J201, J202, J203)




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 HPs together or with other devices such as the Npaq (as shown in Figure 2-22). The FireWire bus power is independent of the Ndrive power, should the drive fail, communication will be maintained with the other devices.

**Table 3-20. J201, J202, J203 FireWire Connector Pin Assignment**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Bus Power | FireWire Adapter Power | In/Out |
| 2 | Physical Ground | FireWire Common<br>(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 J201-J203 have pin 1, the power pin, protected by a re-settable fuse. Should an over-current condition occur, the device will open, to protect against the overload. To reset the device, remove the overload condition.



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## 3.6. Voltage-to-Current Mode Operation

The firmware (version 2.06 and later) on the Ndrive supports a voltage-to-current mode. This mode allows the unit to run in a standalone mode, attached to a master position/velocity loop controller.

The standard operating mode of the Ndrive uses an OHCI IEEE-1394 connection from a host PC running the Nmotion SMC (software motion controller) to control servos. This connection is required for proper operation in this mode, since the fire wire connection provides positioning and synchronization information to the drive.

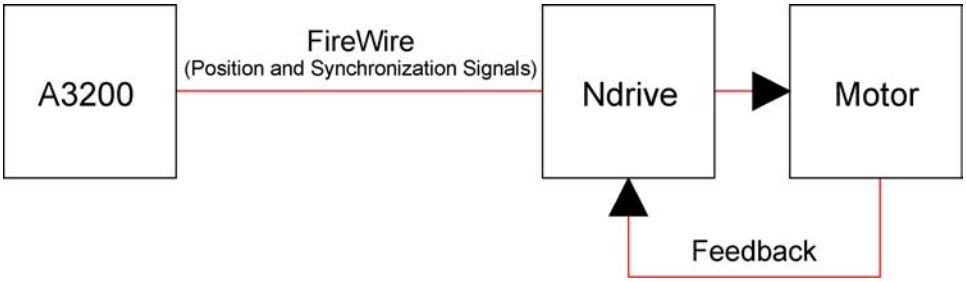



*Figure 3-12. Normal Operation*

The Voltage-to-Current mode of the Ndrive allows for a connection to a host controller that outputs +/- 10V DC as a torque (current) command. In this mode, a connection to the fire wire is not required (synchronization is performed internally), except for parameter configuration.

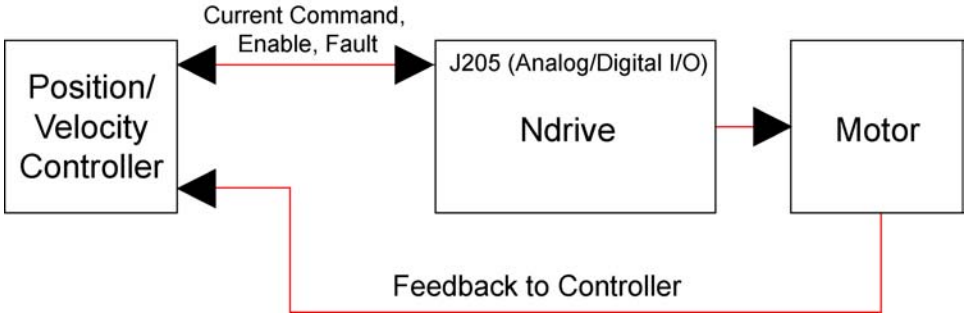



*Figure 3-13. Stand-Alone Configuration*

This mode allows the drive to be used in a general-purpose current-control mode with older existing control hardware.



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### 3.6.1. Parameter Setup and Hardware Configuration

Setup for the Voltage-to-Current mode should be performed using the Automation 3200 SMC. This software interface should be used to configure the parameters on the drive. The parameters of principal concern are:

- Current Loop Parameters (gains, offsets, etc.)
- Feedback configurations (feedback types, channels, etc.)
- Commutation Information (pole pairs, counts per cycle, etc)
- Current Clamp/RMS Current Trap

These are the parameters that will need to be saved to the flash memory within the Ndrive, before the standalone mode is activated. To enter the normal, A3200 operating mode, power down the drive and set DIP switches #6 and #7 to the ON position.

Once the parameters are correctly configured to run the motor with the A3200 (and verified) they can then be saved to the flash memory.




This initial setup should only need to be performed once for a given system type. If the parameter settings for a given axis in the system have already been verified, then on all future systems the A3200 software can be used to load the parameters for that axis into the Ndrive so that they can be saved to the flash memory on that drive. Re-configuration should only need to be done for a different system, or if it is expected that some other system parameter may have changed.

### 3.6.2. Saving Parameters to the flash memory on the drive

Open the Ndebug.exe utility and select the axis (by typing AX n, where n is the 1-based axis number, of the axis you wish to select). Save the parameters to flash memory by typing:

```
FLASHWRITE 1 0 0
```

This will save the current system configuration into the flash memory on the Ndrive.

To enter the voltage-to-current mode, power down the Ndrive and set DIP switches #6 and #7 to the OFF position. When the unit is powered on again, it will auto-boot into the voltage-to-current mode.



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### 3.6.3. Operation

In the Voltage-to-Current mode, the Ndrive acts as a simple voltage-to-current controller. Analog Input 0 provides the current/torque command. Analog input 0 is accessible through either the -IOPSO option board or the J205 connector.

To emulate a standalone drive, the Ndrive also uses Input #8 (least-significant input bit on the J205 connector) as a drive enable input, and Output #8 (least-significant output bit on the J205 connector) as a fault output indicator. These I/O points utilize a default polarity that makes them fail-safe. Both are optically isolated. See Figure 3-2 and Figure 3-3 for I/O connection information. Also, note that the fault output requires a pull-up resistor to an external power supply.

The analog input is configured to accept input voltages from -10V to +10V. In this mode, +10V is equivalent to peak amplifier current command in the negative (CCW) direction, while –10V is equivalent to peak amplifier current command in the positive (CW) direction. The drives peak current is defined by the drive part number (i.e. Ndrive HL 20 indicates that the peak output current will be 20 amps.)

The analog input is differential, utilizing pins J205-13 (Analog input 0+) and J205-14 (Analog input 0-). See Figure 4-8 for more information.




The diagrams above indicate that current flow through pins 17 and 24 will enable the axis to drive current through the motor (failsafe; by default, no motor current will be present). Also, they indicate that a fault condition will be indicated by no current flow from pin 7 to pin 15 through the fault output (failsafe; by default, no current flow indicates a drive fault. When the drive is powered up and no fault condition exists, the opto-isolator will conduct current).

### 3.6.4. Faults

A Drive Fault in the standalone mode can be caused by any of the following issues:

- Drive Over-Current (Peak current commanded for 1 second)
- Motor Over-Current (RMS threshold)
- Thermistor Over-Temperature Fault (Motor)
- Amplifier Temperature Fault
- Loss of Bus Power

∇ ∇ ∇



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# CHAPTER 4: OPTIONS

## 4.1. –IOPSO and –IOPSOH Option Boards

See the following sections for details on the connector Pin Assignment and technical information for the –IOPSO and –IOPSOH options.

The –IOPSO expansion board has 8 opto-isolated inputs (sinking or sourcing) and 8 outputs (sinking or sourcing ), two 18-bit analog outputs, two 16-bit differential analog inputs, SSI Net, absolute encoder interface and brake relay, and includes a HCPL2601 opto-isolator.

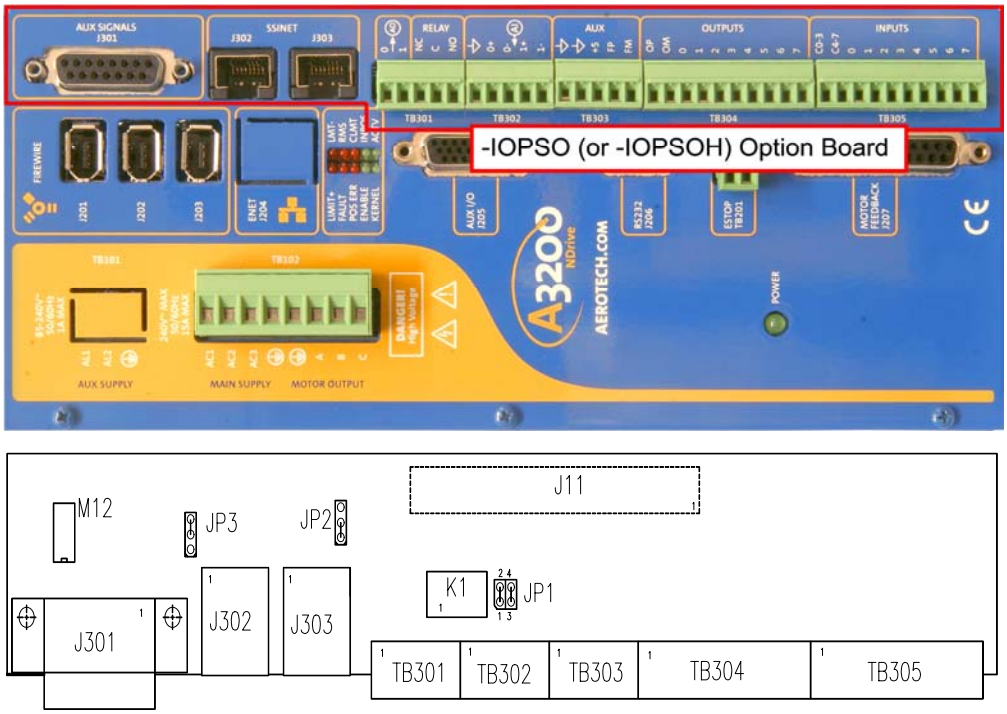



*Figure 4-1. –IOPSO Option Board (690D1579 Rev. A)*

**Table 4-1. –IOPSO Option Board Jumpers**

| Jumper | Setting | Description |
|---|---|---|
| JP1 | 1-2, 3-4 * | Brake Option at J207 |
| | 1-3 | Auxiliary relay Output Option at TB301 (Remove 1-2, 3-4 and 2-4) |
| JP2 | 1-2 * | Input 0 at TB305-3 is input 0 |
| | 2-3 | Input 0 at TB305-3 drives the external Reset Input |
| JP3 | 1-2 | PSO (Laser Firing) Output is Active High |
| | 2-3 * | PSO (Laser Firing) Output is Active Low |

* factory default setting



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The -IOPSOH expansion board has 8 opto-isolated inputs (sinking or sourcing) and 8 outputs (sinking or sourcing ) rated at 1 A per channel, two 18-bit analog outputs, two 16-bit differential analog inputs, SSI Net, absolute encoder interface and brake relay, and includes a HCPL2601 opto-isolator.

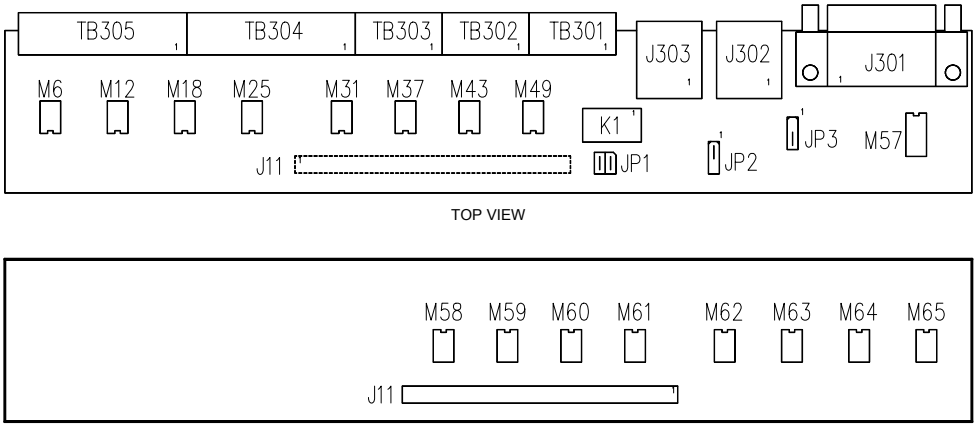



*Figure 4-2. –IOPSOH Option Board (690D1623 Rev. 0)*

**Table 4-2. –IOPSOH Output Device Numbers**

| Output | Desinator | Description | Aerotech P/N | 3d Party P/N |
|---|---|---|---|---|
| Bit 0 | M49 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M58 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 1 | M43 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M59 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 2 | M37 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M60 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 3 | M31 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M60 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 4 | M25 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M62 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 5 | M18 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M63 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 6 | M12 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M64 | Sinking Driver | ECS01079 | NEC PS710E-1A |
| Bit 7 | M6 | Sourcing Driver | ECS01079 | NEC PS710E-1A |
| | M65 | Sinking Driver | ECS01079 | NEC PS710E-1A |

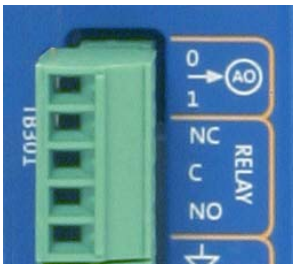
### 4.1.1. Brake Configuration Jumpers

Setting JP1 to 1-2, 3-4 allows connection of the brake relay to pins 13 and 25 of the motor feedback connector (J207). See Figure 4-4 in section 4.1.2 for more information.



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### 4.1.2. Analog Outputs (TB301)




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. This produces a resolution of 76.3 uVolts per bit of the D/A. The output current is limited to less than 50 mA. Note that the analog outputs are referenced to TB302-1 (as shown in Figure 4-3). Analog output 0 is also available at J205, see Section 3.1.6. The analog outputs will be zero volts during reset.

**Table 4-3. Analog Output Connector Pin Assignment (TB301)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Analog 0 Out | Analog Output 0 | Output |
| 2 | Analog 1 Out | Analog Output 1 | Output |

NOTE

The analog output common may be found at J205 pin 23 or TB302 pin 1.

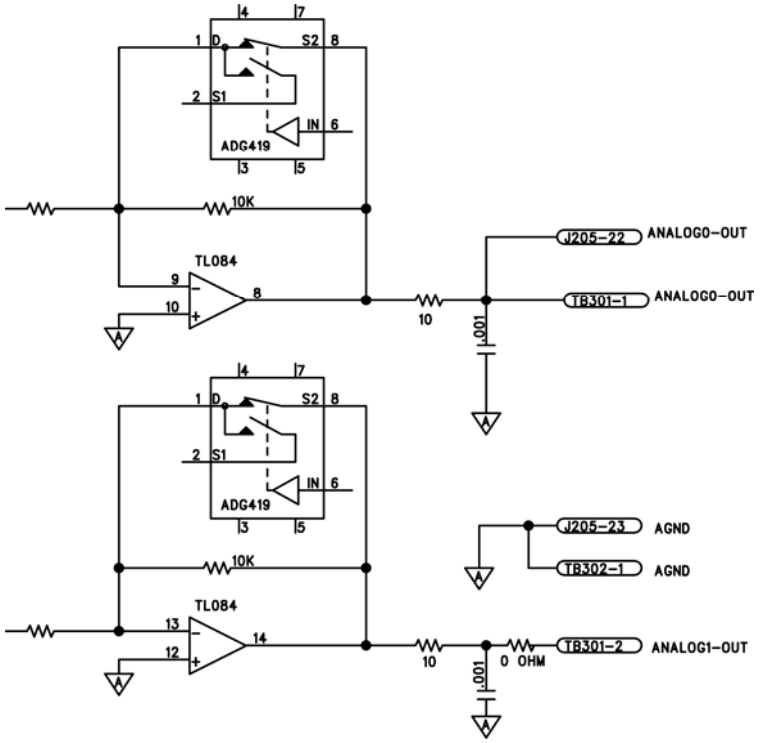
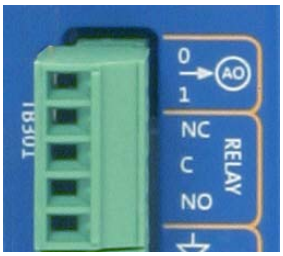



*Figure 4-3. Analog Output Connector (TB301)*



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### 4.1.3. Brake / Relay (TB301)

The relay output is typically used to automatically drive a fail-safe brake on a vertical axis, however, it may also be used as a general purpose relay. See the BrakeOnDriveDisable axis parameter for information on activating the brake output automatically, or the BRAKE command for manually toggling the output, both in the Nview HMI help. In order to help the user to interface to the brake relay the remainder of this section will be presented as a step-by-step procedure.

#### Step #1 Brake Relay Specifications

The user must verify that the application will be within the specifications of the Brake Relay contacts. These specifications are provided below in Table 4-4.

**Table 4-4. Voltage and Current Specifications (TB301)**

| **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: The maximum power that may be switched is voltage dependent.** | |
| Initial Contact Resistance | 50 milliohms max. @ 10 mA, 6 VDC |




The user must not exceed the Maximum Current or Maximum Power specifications.

#### Step #2 Select Brake Interface Connector

The Normally Open (N/O) contacts of the Brake Relay are accessible through TB301 and the Motor Feedback connector (J207). The Normally Closed (N/C) contact of the Brake Relay is only accessible through TB301 (Figure 4-4). The Motor Feedback connector (J207) allows the brake wires to be included in the motor feedback cable and eliminate the need for a separate brake cable.

**Table 4-5. Brake / Relay Connector Pin Assignment (TB301)**

| Pin # | Label | Description | In/Out |
|---|---|---|---|
| 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 |

**Table 4-6. Brake / Relay Connector Pin Assignment (J207)**

| Pin # | Label | Description | In/Out |
|---|---|---|---|
| 13 | Brake - | (Brake-) Relay Output Normally Open Contact (See JP1-A, JP1-B) | Output |
| 25 | Brake + | (Brake+) Power connection (See JP1-A, JP1-B) | Output |



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Figure 4-4 is an example of a 24 VDC Brake connected to TB301. In this example, JP1-A and JP1-B must be configured. If JP1-A and JP1-B are configured to 1-3 then J207 pins 13 and 25 will be unused. If JP1-A is set 1-2 and JP1-B is set 3-4, a connection between pins 13 and 25 of J207 is required. In this case, J207 functions as an interlock to prevent the Brake from releasing if the Motor Feedback connector is not connected.

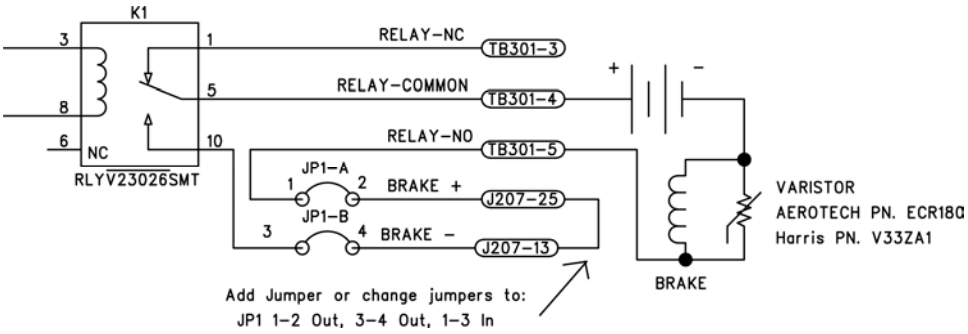



*Figure 4-4. Brake Connected to TB301*




The user is responsible for providing fuse protection for the Brake circuit.

Figure 4-5 is an example of a 24 VDC Brake connected to the Motor Feedback connector (J207). In this example, the external 24 VDC power source is connected to TB301. Also note that JP1-A is set 1-2 and JP1-B is set 3-4.

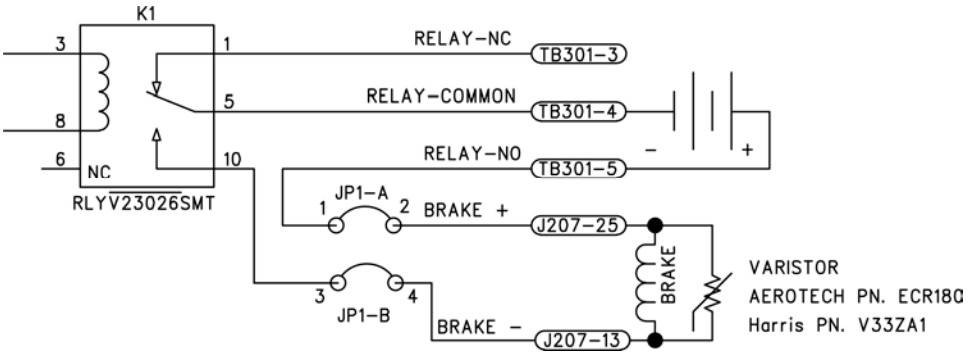



*Figure 4-5. Brake Connected to J207*




The user may reconfigure the connections for the brake, such that the positive supply lead is switched by the relay instead of the supply common.



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### Step #3 Suppression and Snubber requirements

Due to the inductive effects of the brake, suppression and/or snubber, components are needed to reduce arcing and prevent damage to the Brake Relay contacts. Suppression can also reduce the electrical noise that is emitted when the circuit is switched off. Following are three suppression circuit examples.

**Example #1:** Figure 4-4 is an example of a typical 24 VDC brake circuit. In this example, the Varistor, is the suppression device, connected across the brake. This method of suppression is used in circuits operating at voltages up to 25 VDC and AC circuits operating at voltages up to 18 VAC. If the voltage is greater than 25 VDC or 18 VAC, one of the other suppression methods should be used.

**Example #2:** Figure 4-6 is an example of a suppression circuit that can be used for systems using a DC supply. In this example, the diode is the suppression component, which is connected across the brake. It is important that the diode be installed, so that it is normally reversed biased. This diode must have a reverse voltage rating greater than the users DC power supply and a maximum current rating of at least 1 Ampere. Due to the time needed for this suppression device to dissipate the energy released by the load inductance there may be a slight delay (less than 1 second) before the brake responds to its power being switched off. If this delay is unacceptable, Example #3 should be used.

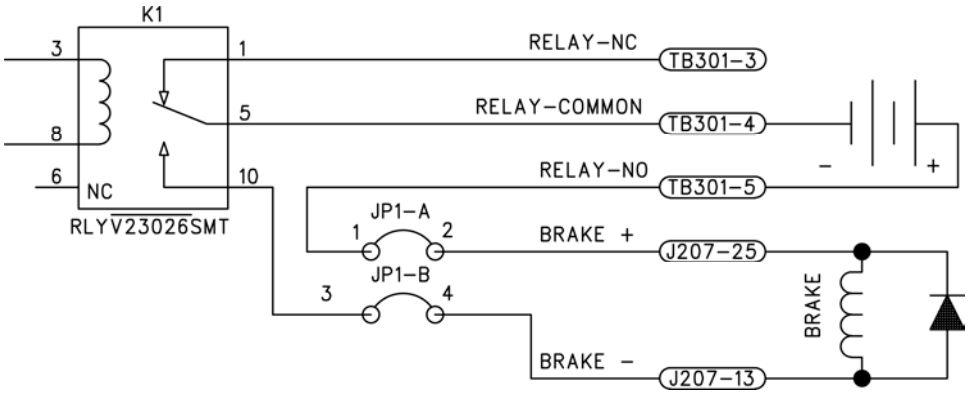



*Figure 4-6. Suppression for DC Brake Systems*

NOTE

The user may reconfigure the connections for the brake, such that the positive supply lead is switched by the relay instead of the supply common.



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**Example #3:** Figure 4-7 is a suppression circuit that can be used for both AC and DC circuits. In this method, a resistor, capacitor and a varistor are used across the load (see Figure 4-7). In some cases, better results are obtained by installing the suppression devices across the relay contacts. The ratings and values for these components are described below.

**Resistor (R)**: is calculated by the following formula, Power rating = ½ Watt.

Resistor (ohms) = Voltage / Load current

If the resistance of the Resistor is too low the relay contacts may fuse together, so if the Resistor is less than 24 ohms use a 24 ohm resistor.

If the resistance of the Resistor is too high, the contacts may be damaged due to excessive arcing, so if the Resistor is greater than 240 ohms use a 240 ohm resistor.

**Capacitor (C)**: .1 uF, rated for AC circuits, and a voltage rating of not less than 250 Volts. If the voltage rating of the capacitor is too low, the Varistor may not be able to protect it and it may fail.

**Varistor (V)**: Rated for the maximum voltage of the users power supply, Typically, a varistor rated for a standard 120 VAC line should work well. Verify that the capacitor voltage rating is greater than the clamp voltage of the varistor. If the voltage rating of the varistor is too low, it may conduct during normal operation and overheat. If the voltage rating of the varistor is too high, it may not protect the capacitor (C) against over-voltage conditions.

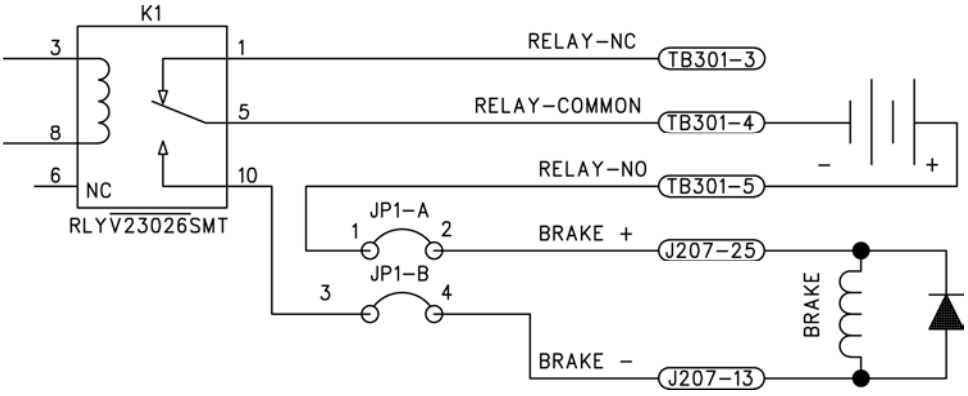


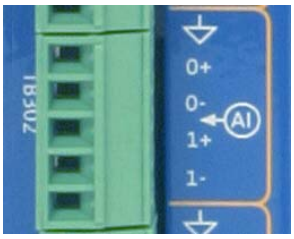

*Figure 4-7. Suppression for AC and DC Brake Systems*

NOTE

The user may reconfigure the connections for the brake, such that the positive supply lead is switched by the relay instead of the supply common.



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### 4.1.4. Analog Inputs (TB302)

Both analog inputs are differential, buffered by a precision unity gain differential INA105 amplifier and converted to digital by a 16-bit ADS8320 analog to digital converter allowing an input voltage in the range of ±10 volts. This produces a resolution of 305 uVolts per bit of the A/D. Refer to Figure 4-8. To interface to a single-ended (non-differential) voltage, ground the negative (-) input and connect your signal to the positive (+) input. Analog input 0 is also available at J205, see Section 3.1.5. The analog inputs have a 25k Ohm input, impedance and should be driven by a low impedance source such as an op-amp output.

**Table 4-7. Optional Analog Input Connector Pin Assignment (TB302)**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | A Ground | Analog Common | N/A |
| 2 | Analog0 In + | Non-Inverting Analog Input 0 | Input |
| 3 | Analog0 In - | Inverting Analog Input 0 | Input |
| 4 | Analog1 In + | Non-Inverting Analog Input 1 | Input |
| 5 | Analog1 In - | Inverting Analog Input 1 | Input |

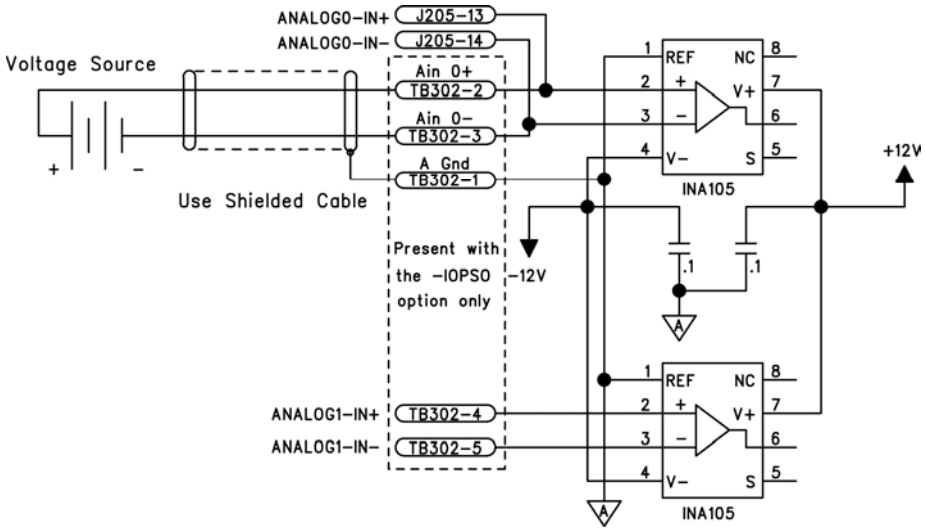



*Figure 4-8. Optional Analog Input Connector (TB302)*



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### 4.1.5. User Power Connector (TB303)



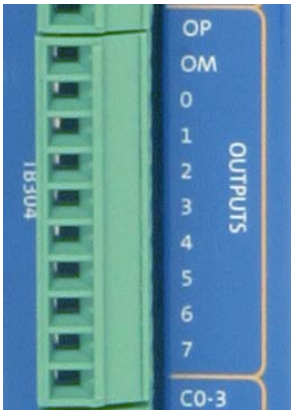

This connector provides access to the Ndrive HPs internal power supply, which may be used to power external devices (500 mAmps maximum). It also provides a connection to power the opto-isolated PSO (Laser Firing) output (see Figure 4-14).

**Table 4-8. User Power Connector Pin Assignment (TB303)**

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

* Total user +5V power from all outputs is limited to 500 mA by an internal re-settable fuse.

### 4.1.6. Opto-Isolated Outputs (TB304)




The outputs are software configurable via the DriveIOConfig axis parameter as sourcing or sinking, and are driven by a PS2802-4 opto-isolator that is rated for 40 volts maximum and up to 80 mA/channel, not to exceed 90 mW per channel. Figure 4-9 and Figure 4-10 illustrate how to connect to an output in current sinking and current sourcing modes.




The connection must always be made to both the Output Common Plus and Output Common Minus to prevent glitches on the outputs (see Figure 4-9 and Figure 4-10).

**Table 4-9. Opto-Isolated Output Connector Pin Assignment (TB304)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | OP | Output Common Plus | Input |
| 2 | OM | Output Common Minus | Input |
| 3 | Output 0 | Output 0 (Optically-Isolated) | Output |
| 4 | Output 1 | Output 1 (Optically-Isolated) | Output |
| 5 | Output 2 | Output 2 (Optically-Isolated) | Output |
| 6 | Output 3 | Output 3 (Optically-Isolated) | Output |
| 7 | Output 4 | Output 4 (Optically-Isolated) | Output |
| 8 | Output 5 | Output 5 (Optically-Isolated) | Output |
| 9 | Output 6 | Output 6 (Optically-Isolated) | Output |
| 10 | Output 7 | Output 7 (Optically-Isolated) | Output |

**Table 4-10. -IOPSO Output Device Specifications (TB304)**

| Specification | -IOPSO Value | -IOPSOH Value |
|---|---|---|
| Maximum Power Dissipation | 90 mWatts / Channel | 600 mWatts / Channel |
| Maximum Voltage | 40 Volt Maximum | 24 Volt Maximum |
| Maximum Sink/Source Current | 80 mAmps / Channel | 1 Amperes / Channel |
| Output Saturation Voltage | ~ 0.7 – 0.9 Volts | ~ 0.32 Volts |
| Rise / Fall Time | 250 usec (typical) | 1 msec (typical) |
| Maximum Output Frequency | 1 kHz | 100 Hz |



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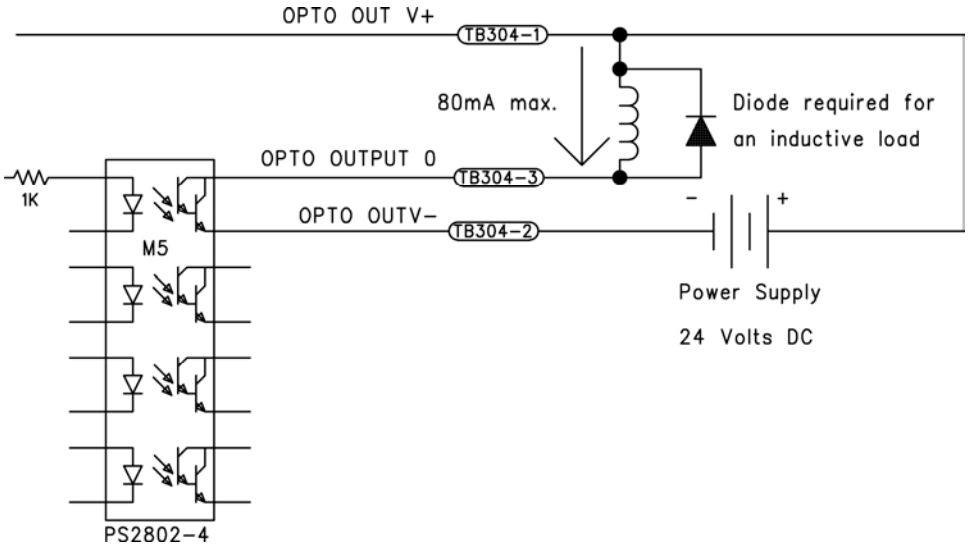



*Figure 4-9. Connecting Outputs in Current Sinking Mode*

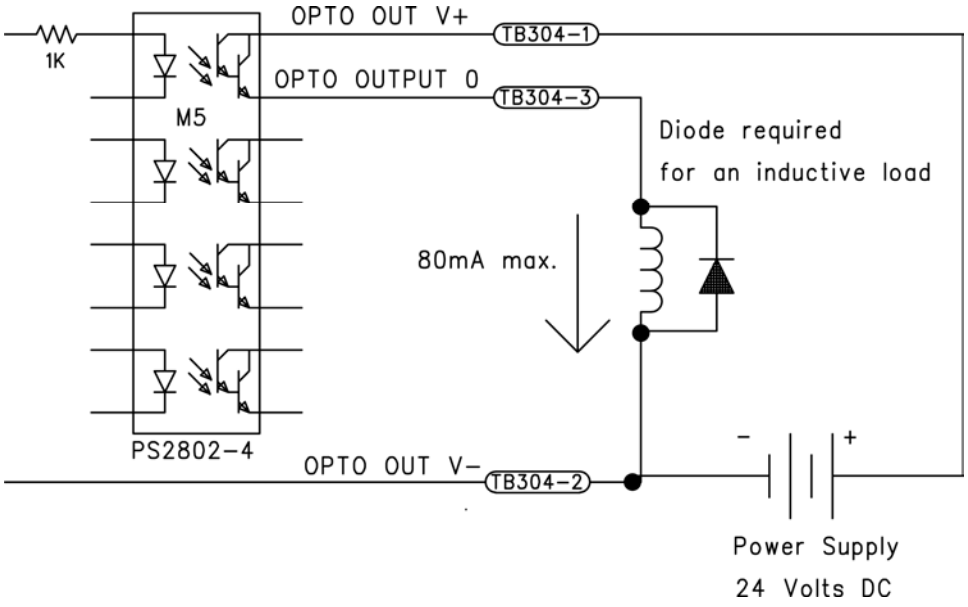


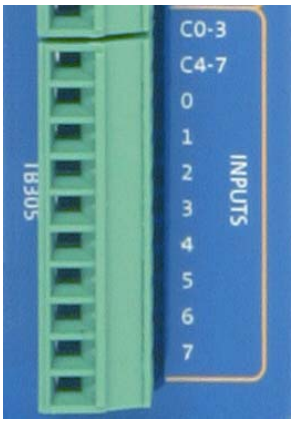

*Figure 4-10. Connecting Outputs in Current Sourcing Mode*

Suppression diodes must be installed on outputs that are used to drive relays or other inductive devices to protect the output devices from being damaged by the inductive spikes that occur when the device is turned off. Suppressor diodes can be installed on all outputs to provide greater protection. The 1N914 diode is recommended for this application. It is important that the diode be installed correctly (normally reversed biased). See Figure 4-9 for an example of a current sinking output with diode suppression and Figure 4-10 for an example of a current sourcing output with diode suppression.



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### 4.1.7. Opto-Isolated Inputs (TB305)




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 device. The inputs may be connected to current sourcing or current sinking devices, as shown in Figure 4-11 and Figure 4-12. Each 4-bit bank of inputs (0-3 or 4-7) must be connected to either all current sourcing or all current sinking devices. Also, note in the table below, that inputs 0-3 and inputs 4-7 have two different common inputs, pin 1 and pin 2, respectively. See Section 3.3.1 for opto-isolated EOT limit inputs.

**Table 4-11. Opto-Isolated Input Connector Pin Assignment (TB305)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | C0-3 | Input Common for inputs 0 - 3 | Input |
| 2 | C4-7 | Input Common for inputs 4 - 7 | Input |
| 3 | Input 0 | Input 0 (Optically-Isolated) – See pin 1 | Input |
| 4 | Input 1 | Input 1 (Optically-Isolated) – See pin 1 | Input |
| 5 | Input 2 | Input 2 (Optically-Isolated) – See pin 1 | Input |
| 6 | Input 3 | Input 3 (Optically-Isolated) – See pin 1 | Input |
| 7 | Input 4 | Input 4 (Optically-Isolated) – See pin 2 | Input |
| 8 | Input 5 | Input 5 (Optically-Isolated) – See pin 2 | Input |
| 9 | Input 6 | Input 6 (Optically-Isolated) – See pin 2 | Input |
| 10 | Input 7 | Input 7 (Optically-Isolated) – See pin 2 | Input |

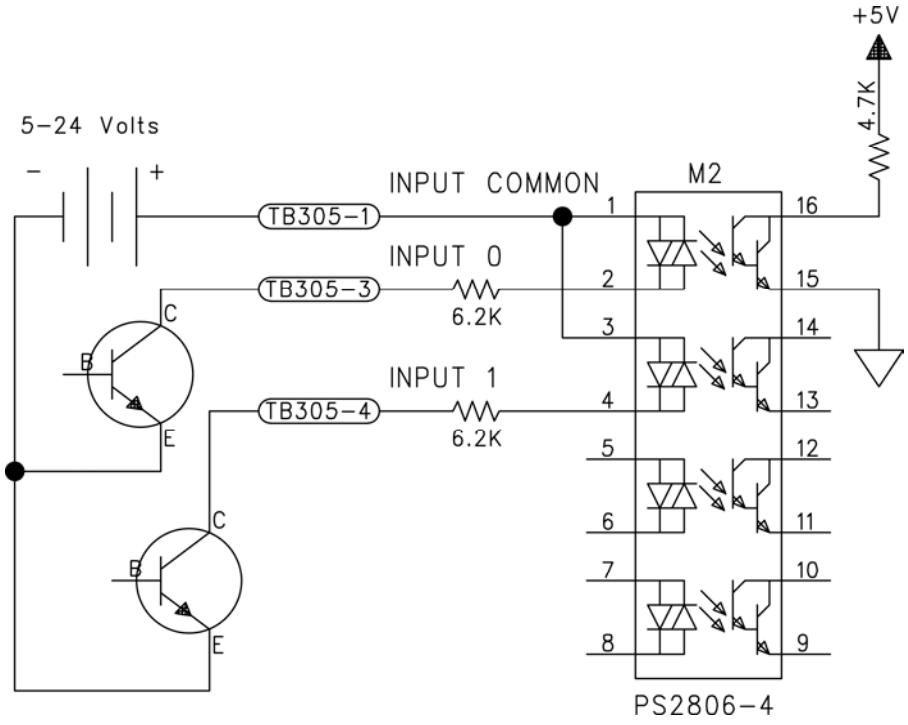



*Figure 4-11. Inputs Connected in Current Sinking Mode*



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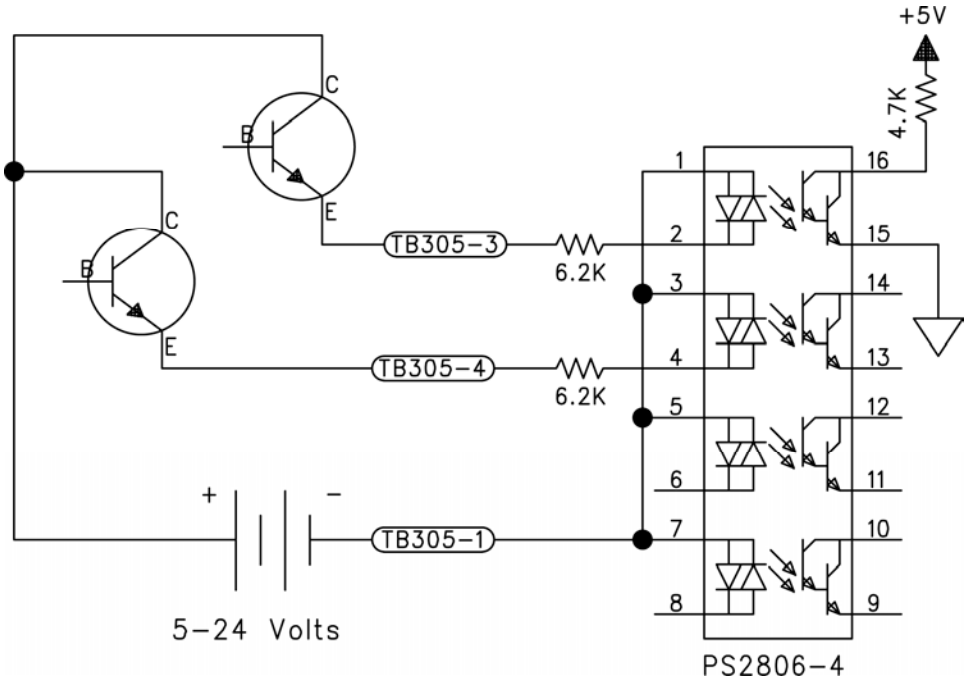



*Figure 4-12. Inputs Connected in Current Sourcing Mode*



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### 4.1.8. PSO / Absolute Encoder Interface (J301)




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 Volt P-P signal varying about a 2.5 Volt reference. The two RS-422 channels provide buffered and/or multiplied MXH encoder signals to the user, for laser firing or other purposes. Additionally, the –IOPSO option provides a RS-422 output and an open-collector laser-firing signal to the user. Only one of these signals may be used, as illustrated in Figure 4-14. Jumper JP3 defines the active state of the open-collector output, which has three options, as defined in Table 4-12. See Section 3.2 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 J302 and J303 connectors. For information on the RS-422 ports, see Figure 4-16 in Section 4.1.9.

See Figure 4-14 for the firing output.

**Table 4-12. PSO / Absolute Encoder Interface Connector Pin Assignment (J301)**

| Pin # | Label | Description | In/Out/Bi |
|---|---|---|---|
| 1 | Chassis Frame Ground | Chassis Frame Ground | N/A |
| 2 | Sin-N | SSI Net #1 Sin-N | Bi-directional |
| 3 | Sin | SSI Net #1 Sin | Bi-directional |
| 4 | Cosine-N | SSI Net #1 Cosine-N / Marker-N | Bi-directional |
| 5 | Cosine | SSI Net #1 Cosine / Marker | Bi-directional |
| 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 | 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 | Bi-directional |
| 15 | RS-485-P | RS-485 + for Abs. Encoder | Bi-directional |

**Table 4-13. PSO / Absolute Encoder Mating Connector (J301)**

| 15-pin D-Style | Aerotech | Third Party Source |
|---|---|---|
| Connector | ECK00100 | Keltron P/N DN-15PYSH-G |
| Back shell | ECK01022 | Amphenol P/N 17-1725-2 |




We recommend using the opto-isolated output, where possible, to maintain the isolation between the Ndrive HP and the 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 TB303 (see Section 4.1.5. for more information).



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

| M12 Device (Option#) See Figure 4-14 | Nominal Frequency | Propagation Delay (Typ.) | Power Supply Voltage ($V_{Laser}$) | Output Current Sink |
|---|---|---|---|---|
| * **HCPL-2601** (-PSOOPTO1 option, std) | 5 MHz | .05 us. | 5 VDC | 10 mA |
| **6N136** (-PSOOPTO2 option) | 750 KHz | .45 us. | 5-15 VDC | 2 mA |
| **4N33** (-PSOOPTO3 option) | 10 KHz | 3 us. | 5-25 VDC | 50 mA |
| **TIL117-M** (-PSOOPTO4 option) | 40 KHz | 2 us. | 5-25 VDC | 50 mA |

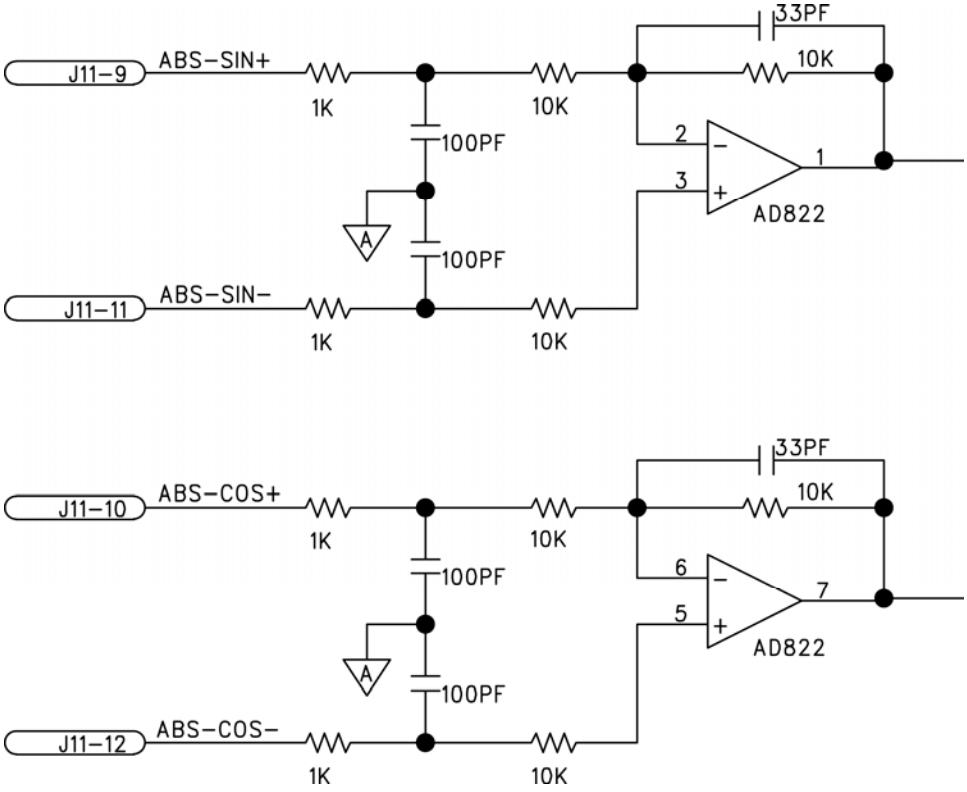



*Figure 4-13. Absolute Encoder Interface (J301)*



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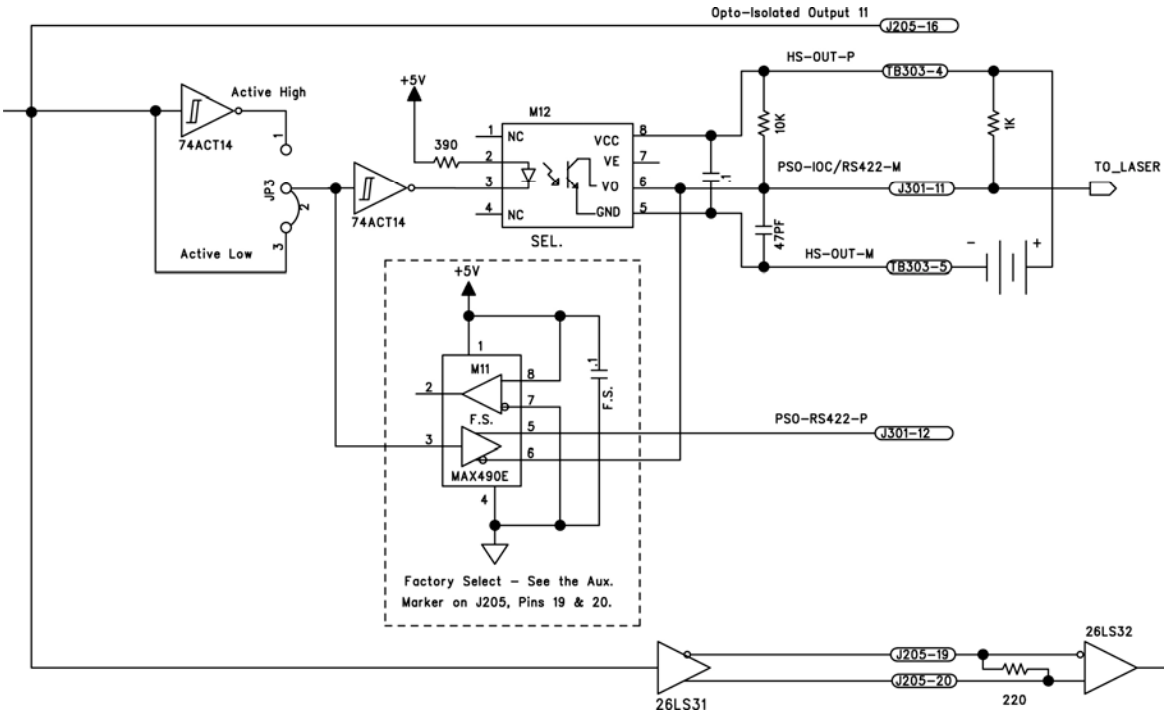



*Figure 4-14. PSO Interface*

Output 11 and the Auxiliary Marker on J205 (pins 19 and 20) may also be defined as the PSO Laser Firing output via the PSOCONTROL command. See Section 3.2 for connection and other information.

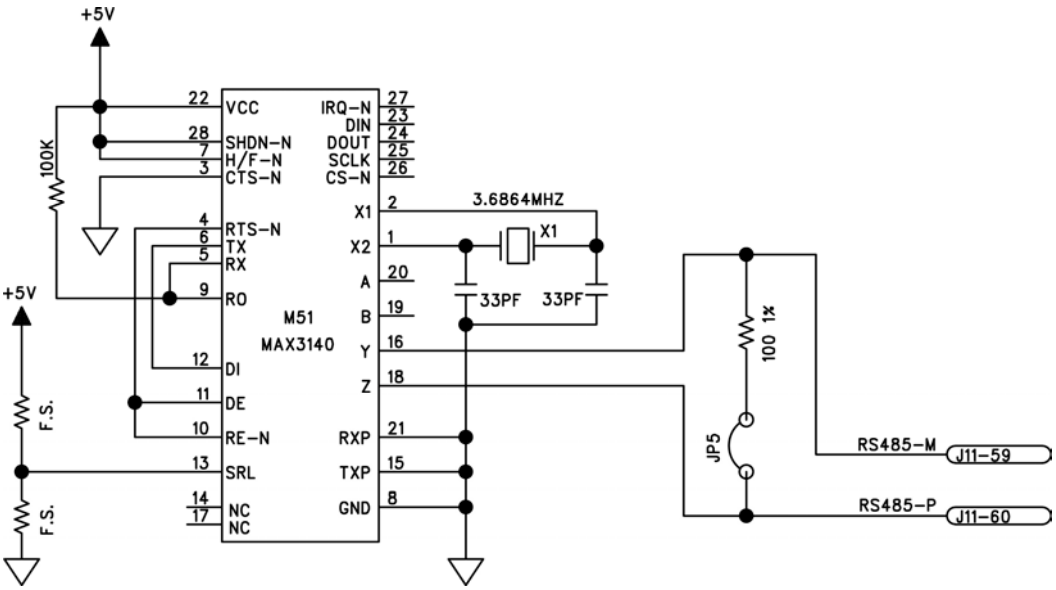



*Figure 4-15. (RS-485) Absolute Encoder Interface (J301)*



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### 4.1.9. SSI Net (2 channels) (J302, J303)

Each of the two SSI Net interfaces is a two-channel bidirectional RS-422 interface, most typically for quadrature encoders. This allows one channel for the sine signal and one channel for the cosine signal. Alternatively, one of the SSI Net interfaces may be used to provide an encoder marker signal to another SSI Net interface if used. Each of these two SSI Net interfaces are both available on the J302 and J303 connectors, as illustrated in the following table. Note that the J205 encoder channel may also be used as an input/output for multi-axis PSO firing.

The SSI Net is designed for daisy-chaining encoder signals from one Ndrive to another for two/three-axis PSO (laser firing). This allows one Ndrive containing the –DUALPSO or –TRIPLEPSO options to track the vectorial position change of two/three axes in real-time. These encoder signals may also be used for user-defined purposes. Refer to Figure 4-16 and Figure 4-17. These four channels are bi-directional and configured via the PsoSsi1Config and PsoSsi2Config axis parameters; see the Nview help for more information. Note that SSI Net #1 is also available on the J301 connector (see Section 4.1.8.). 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 Table 3-17.




The SSI Net #1 and #2 interfaces are both physically hardwired to the J302 *and* J303 connectors. If SSI Net #1 is configured as an input, a signal driven into the SSI Net #1 connections on J302 will also be present on the SSI Net #1 connections of J303, effectively making SSI Net #1 on J303 an (un-buffered) output of this same signal. Likewise, this would also be true for the SSI Net #2 interface.

**Table 4-15. J302, J303 2-Channel SSI Net Connector Pin Assignment**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Sin-N | SSI Net #1 Sin-N | Bi-directional |
| 2 | Sin | SSI Net #1 Sin | Bi-directional |
| 3 | Cosine-N | SSI Net #2 Cosine-N / Marker-N | Bi-directional |
| 4 | Sin-N | SSI Net #2 Sin-N | Bi-directional |
| 5 | Sin | SSI Net #2 Sin | Bi-directional |
| 6 | Cosine | SSI Net #2 Cosine / Marker | Bi-directional |
| 7 | Cosine-N | SSI Net #1 Cosine-N / Marker-N | Bi-directional |
| 8 | Cosine | SSI Net #1 Cosine / Marker | Bi-directional |



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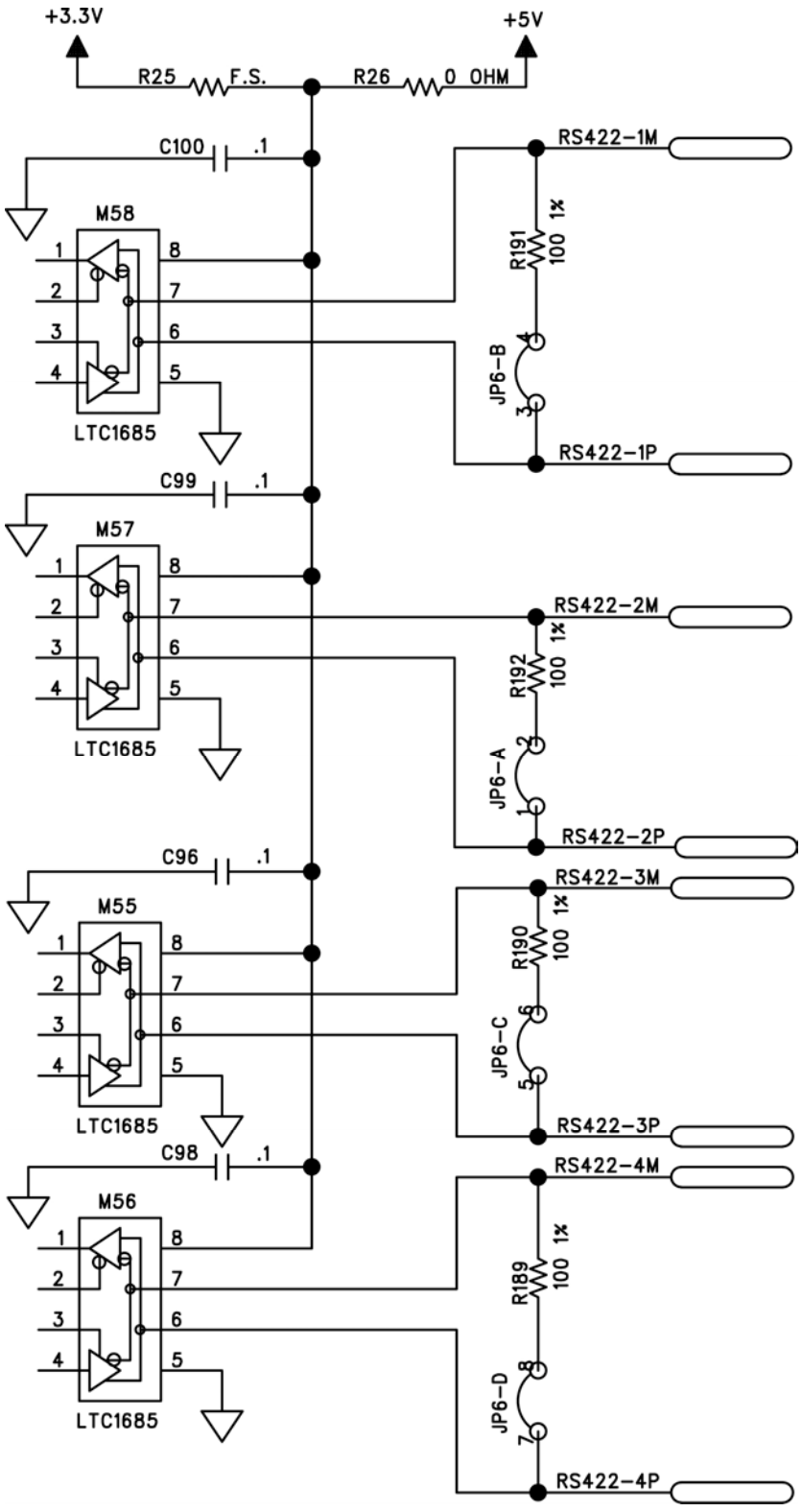



*Figure 4-16. J301/J302/J303*



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## 4.2. –DUALPSO and –TRIPLEPSO Laser Firing Options

The Ndrive HP allows two and three-axis laser firing via its -DUALPSO and -TRIPLEPSO options. To accomplish this, the encoder signals from a second/third Ndrive must be jumpered (or daisy-chained) from that Ndrive to the Ndrive with the -DUALPSO or -TRIPLEPSO options. This requires an encoder signal from another axis via the J205 connector (Section 3.1.1) or via one of the two SSI Net connectors. If the J205 connector is used, it must be configured as an output via the EncoderDivider axis parameter. If the SSI Net is used it requires a cable (see Table 4-16 and Figure 4-17) from J302 to J302 of each Ndrive (J302 to J302 or J303 to J303 of the other Ndrive, both connectors have two bi-directional 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 -DUALPSO or TRIPLEPSO options. Additionally, the CfgEncMxhSetup axis parameter must be configured for a 20 MHz. clock or less, so as not to exceed the 31 nsec. minimum edge separation specification. Also, the PSO pre-scalars may be required to limit each encoder being tracked to a 5 MHz. data rate (which does not affect the servo feedback loop data rate). The figure below also shows two/three-axis firing, which are very similar. See the Nview HMI help for more information on parameter configurations.

Note that the J205 encoder channel may be configured as an output via the EncoderDivider axis parameter, allowing other multi-axis PSO firing configurations.

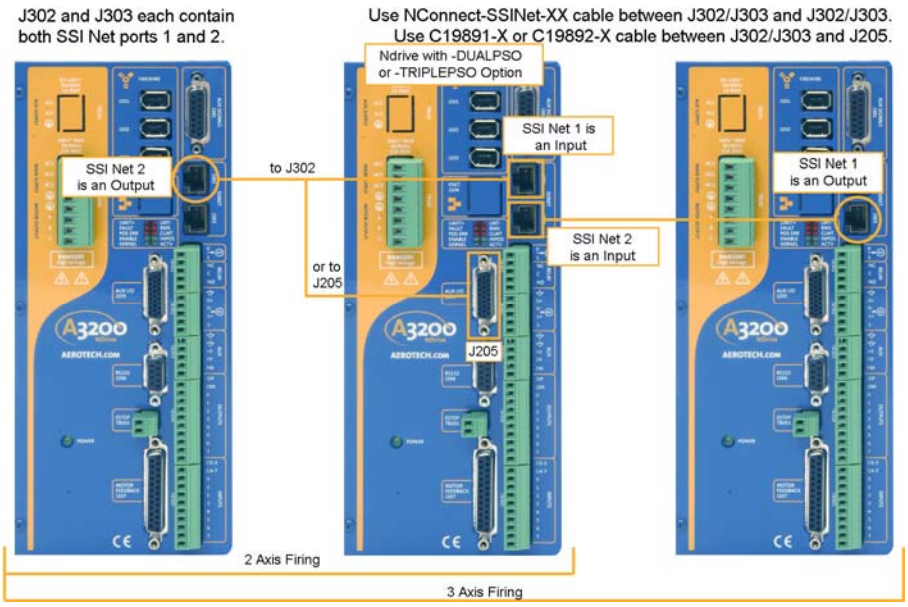



*Figure 4-17. Two/Three Axis Laser Firing Interconnection*

**Table 4-16. SSI Net Cable Part Numbers**

| Part # | Description |
|---|---|
| NConnect-SSINet-4500 | 4.5 M (15 FT) SSI Net Cable |
| NConnect-SSINet-3000 | 3.0 M (10 FT) SSI Net Cable |
| NConnect-SSINet-1500 | 1.5 M (5 FT) SSI Net Cable |
| NConnect-SSINet-900 | 0.9 M (3 FT) SSI Net Cable |



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### 4.2.1. PSO Tracking Rate Configuration

NOTE

PSO Track Rate Configuration applies to an Ndrive with either the -DUALPSO or -TRIPLEPSO options, and the MXH option, with high encoder data rates.

**A)** The maximum clock frequency of the MXH multiplier should be limited to 20 MHz. when using the -DUALPSO or -TRIPLEPSO options. This is due to a maximum encoder date rate of approximately 32 MHz. on the Ndrive's encoder input ports. The 20 MHz. clock rate is achieved by setting the "Clock Select 1" field of the CfgFbkEncMxhSetup axis parameter (value of 0x1 as shown below). This must be done when using -DUALPSO or -TRIPLEPSO options in order to ensure that encoder count information is not lost.

The 20 MHz. data rate limitation effectively limits the maximum speed of the axis (see **B** below). In addition, the -DUALPSO or -TRIPLEPSO options have a maximum tracking rate of 5 MHz. due to hardware limitations. The PSO data rate can be reduced to 5 MHz. while allowing the servo loop to operate at 20 MHz. by using the following **PSOTRACK <*axis*> SCALE 4 4 4** command. This command divides the encoder signals before the PSO counters by a factor of 4 and therefore limits the frequency seen by the PSO tracking counters to 5 MHz. However, the servo loop is still able to run at the full 20 MHz. rate.

The effective PSO programming resolution is now 1/4 that of the servo loop (full) resolution. PSODISTANCE commands should be entered 4 times lower than the full resolution in this case.

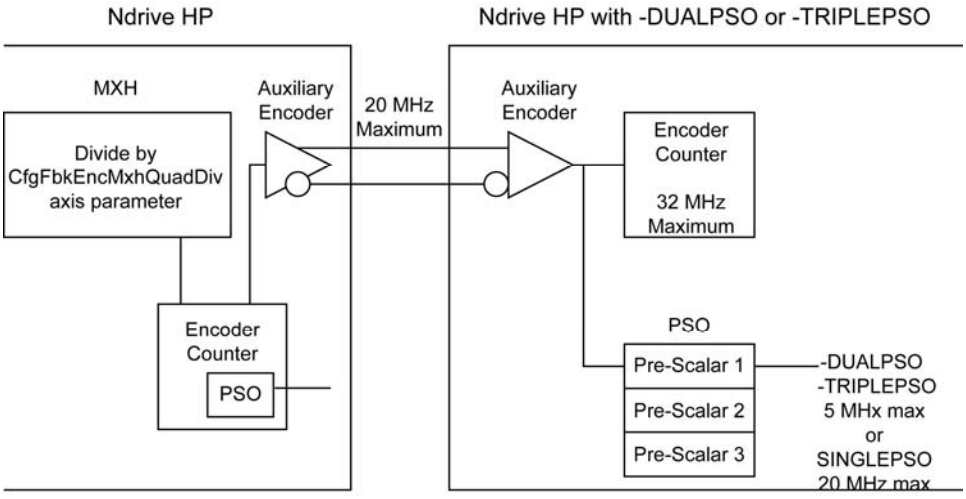



*Figure 4-18. PSO Tracking Rate Block Diagram*



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**Example**:

It is desired to generate a pulse output every 1,000 encoder counts in -DUALPSO or -TRIPLEPSO mode. The individual axis speeds approach 20 MHz. during the motion and therefore exceed the 5 MHz. -DUALPSO or -TRIPLEPSO tracking limitation. The PSOTRACK <axis> SCALE 4 4 command must be used and the PSODISTANCE values reduced by a factor of 4 as follows…

```
PSODISTANCE X FIXED 250 STEPS ; distance specified with ¼
                              ; actual resolution
```

**B)** In order to run the servo loop at full encoder resolution and data rates above 20 MHz., Ndrive software versions 2.02 and above contain the CfgFbkEncMxhQuadDiv axis parameter which acts as an MXH output divider. This parameter allows you to specify a lower resolution for the MXH quadrature output signal only (used by -DUALPSO or -TRIPLEPSO options on other drives). The effective resolution is the full resolution, as derived using CfgFbkEncMultFactorMXH axis parameter, divided by the CfgFbkEncMxhQuadDiv axis parameter.




The servo loop always runs at the full resolution as determined by the CfgFbkEncMultFactorMXH axis parameter. The CfgFbkEncMxhQuadDiv axis parameter does not affect servo loop resolution.

**Example**:

An application uses a 4um linear encoder with an MXH option on an Ndrive. It is desired to move the motor at a maximum speed of 200mm/second and track using the -DUALPSO or -TRIPLEPSO option.

```
CfgFbkEncMultFactorMXH = 500  ; value for 2nm servo loop
                              ; resolution
```

Encoder resolution = 250 lines /mm * 500 * 4 = 500,000 counts / mm (2nm)

Encoder data rate at 200mm/sec = 500,000 * 200 = 100Mhz

This exceeds the -DUALPSO or -TRIPLEPSO maximum encoder tracking rate of 5 MHz. and must be reduced by 100/5 = 20. Set the CfgFbkEncMxhQuadDiv axis parameter to 20 to achieve this. The user must now program the PSODISTANCE command in units of 40nm instead of 2 nm.



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## 4.3. –ENET (Ethernet) Option J204




The optional Ethernet port provides connectivity to a 10/100Base-T ModBus TCP network. This is typically used for adding analog and digital I/O to the controller. See the Ethernet I/O help on the Window's Start bar on the Automation 3200 menu.

**Table 4-17. Ethernet Connector Pin Assignment (J204)**

| 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 |

Additionally, the -IOPSO options provide analog and digital inputs and outputs, see Section 4.1. for more information.

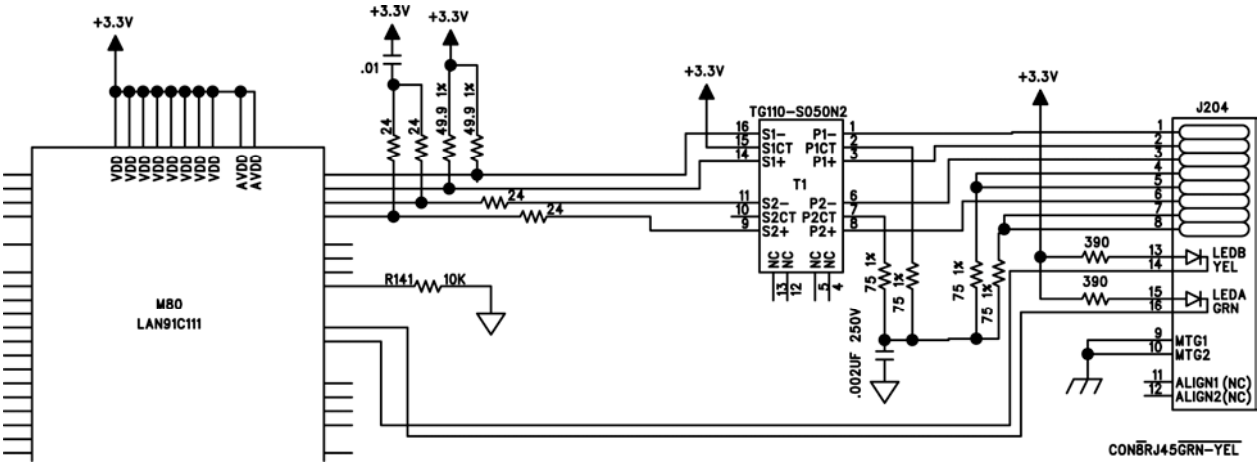



*Figure 4-19. Ethernet Interface (J204)*

**Table 4-18. NConnect I/O Cable part Numbers**

| Part Number | Description |
|---|---|
| NConnect-IO-900 | Ethernet crossover cable 900mm (3 ft.) |
| NConnect-IO-1500 | Ethernet crossover cable 1500mm (5 ft.) |
| NConnect-IO-3000 | Ethernet crossover cable 3000mm (10 ft.) |
| NConnect-IO-4500 | Ethernet crossover cable 4500mm (15 ft.) |



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## 4.4. –RDP Resolver Input



The optional resolver input provides two industry standard resolver or Inductosyn channels, which may each be used as a feedback device. Each may be separately configured for resolver or inductosyn input, as shown in Table 4-21. The standard reference output frequency is 10 kHz., optionally it may be configured as 5 or 7.5 kHz., at the factory.

The Sine and Cosine feedback signals should be adjusted for 2 volts RMS (2.8 volts Peak) via the CfgFbkRDGain axis parameter. The resolver can be physically aligned to the motor, by using the MSET CNC programming command. This physical relationship may also be defined via the CfgMotOffsetAng axis parameter. All of which is described in Section 4.4.1. See the Nview help for information on configuring the axis parameters for an axis with resolver feedback.

**Table 4-19. Resolver Connector Pin Assignment (J401, J402)**

| Pin # | Label | Description | In/Out/Bidir. |
|---|---|---|---|
| Shell | Shield | Connector shell for cable shield termination | Input |
| 1 | Enc Cos + | Optional Encoder Cosine + output | Output |
| 2 | Enc Mrk + | Optional Encoder Marker + output | Output |
| 3 | Common | Resolver Common input | Input |
| 4 | Sin + | Resolver Sine + input | Input |
| 5 | Sin - | Resolver Sine - input | Input |
| 6 | Enc Cos - | Optional Encoder Cosine - output | Output |
| 7 | Enc Sin + | Optional Encoder Sine + output | Output |
| 8 | | Reserved | N.A. |
| 9 | Common | Resolver Reference Common input | Input |
| 10 | Reference | Resolver Reference output | Output |
| 11 | Enc Sin - | Optional Encoder Sine - output | Output |
| 12 | Enc Mrk - | Optional Encoder Marker - output | Output |
| 13 | Common | Resolver Common input | Input |
| 14 | Cos + | Resolver Cosine + input | Input |
| 15 | Cos - | Resolver Cosine - input | Input |

Note that the following mating connector is always provided with the resolver option, which may be ordered separately as part number, MCK-15HDD.

**Table 4-20. Resolver Mating Connector**

| 15-Pin male D-style con. | Aerotech | Third Party Source |
|---|---|---|
| Connector | ECK01287 | Amphenol 17HD-015P-AA000 |
| Back shell | ECK01021 | Amphenol 17-1724-2 |

**Table 4-21. Resolver Jumper Configuration**

| JP # | Resolver | Inductosyn |
|---|---|---|
| JP1 | 1-2 (Channel 1) - Default | 2-3 (Channel 1) |
| JP2 | 1-2 (Channel 2) - Default | 2-3 (Channel 2) |



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**Table 4-22. Resolver Test Points**

| Test Point Number | Description |
|---|---|
| TP4 | Signal Common |
| TP10 | Sine input Channel 1 |
| TP11 | Cosine input Channel 1 |
| TP12 | Reference signal Channel 1 |
| TP20 | Sine input Channel 2 |
| TP21 | Cosine input Channel 2 |
| TP22 | Reference signal Channel 2 |

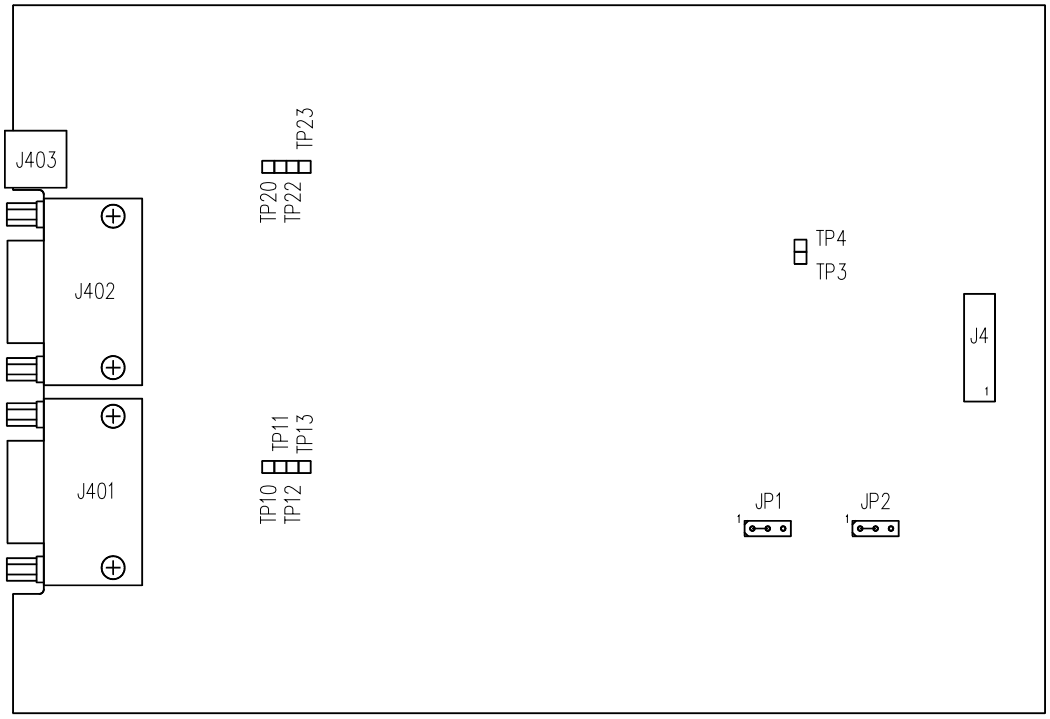



*Figure 4-20. Resolver Option Assembly (690D1599 Rev. 0)*

**Table 4-23. External Power Pin Assignment (J403)**

| Pin # | Label | Description | In/Out |
|---|---|---|---|
| 1 | +12 VDC | +12 Volts DC | Input |
| 2 | -12 VDC | -2 Volts DC | Input |
| 3 | Common | Signal Common | N.A |



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### 4.4.1. Resolver/Inductosyn Setup

There are three fundamental steps of configuring the RDP option board:

- Configuring the Resolver Hardware
- Configuring the Resolver's Analog Feedback Signals
- Configuring the Commutation Parameters

#### 4.4.1.1. Configuring the Hardware

There is a limited amount of hardware configuration capability on the RDP option board. Most of which is configured at the factory (i.e., must be ordered as a factory option). These features include carrier frequency and the number of R/D converter channels, one or two.




There are two jumpers located on the RDP board. These are used to select the reference signal for the converter chip (i.e. SIN vs. COS). Jumper JP1 selects the reference for channel 1 and jumper JP2 selects the reference for channel 2. **NOTE**: Typically these jumpers only require being changed when inductosyns are used.

The SIN reference is a fixed-phase signal, which is in phase with the reference signal used by the resolver. The COS reference is a variable-phase signal which may be phased shifted with respect to the reference of the resolver/inductosyn to optimize the alignment of the feedback (required for inductosyns, which nominally provide a 90 degree phase shift on feedback; optional for resolvers with significant phase loss). The default phase offset is 90 degrees. For most inductosyns, this value will need to be varied from system to system to optimize performance. See Figure 4-22 below for example phasing.




Note that some Aerotech systems may have an optional pre-amplifier board. This may be installed within the mechanics itself, as is the case with an Aerotech AOM360D optical mount. If so, the first step is to adjust the P1 potentiometer on the pre-amplifier board to equalize the Sine and Cosine feedback signals to the same amplitude.



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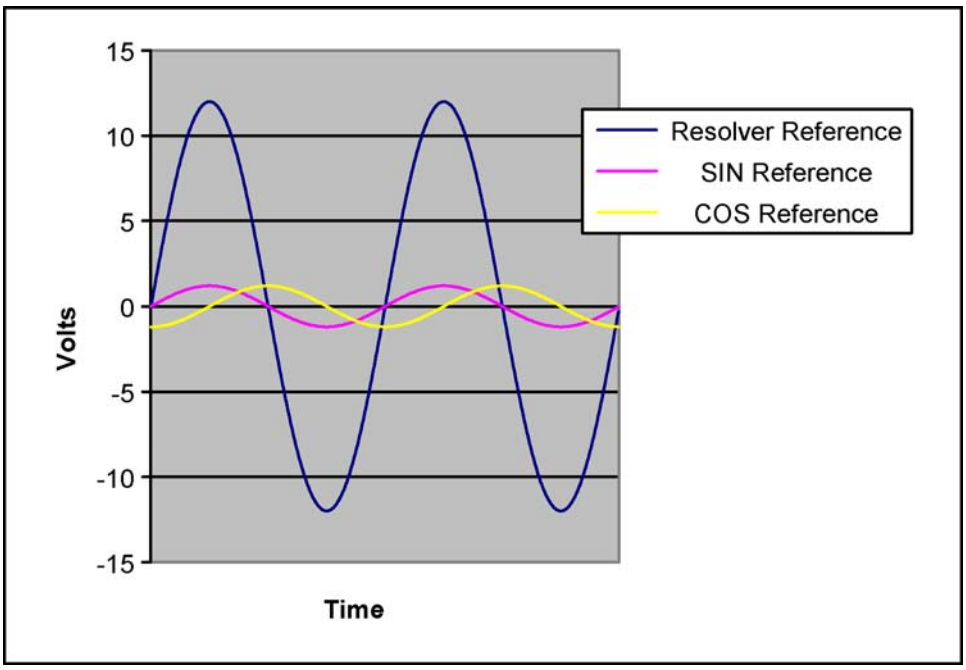



*Figure 4-21. Analog Output Connector (TB301)*

#### 4.4.1.2. Configuring the Analog Feedback Signals

**Using the Encoder Feedback Configuration Utility to set up a resolver / inductosyn**

The RDP option of the Ndrive can be optimally aligned quickly, using the Encoder Feedback Configuration utility within the Nscope.exe utility.

When the Ndrive is configured for Resolver Feedback (via the CfgFbkPosType axis parameter), then the currently selected channel (1 or 2, defined via the CfgFbkPosChan axis parameter) of the RDP board will output its analog inputs for SIN/COS into the analog input channels of the Encoder Configuration Feedback utility (a utility also used to configure the -MXH option). The values sampled by the analog inputs reflect the peak value of the carrier-frequency sine waves used by the Resolver to Digital converter.

NOTE

The Position feedback type, at present, dictates which analog channels are sampled.

There are two axis parameters, which are used to configure the analog feedback from a resolver or inductosyn for optimum performance:

- CfgFbkRDGain defines the peak amplitude of the reference sine wave to the resolver.
- CfgFbkRDCosPhase defines the phase delay on the Cosine phase of the dual-phase oscillator.



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**When to use the CfgFbkRDCosPhase axis Parameter:**

The Cosine reference signal can be adjusted from approximately 0 degrees (i.e. in phase with the SINE reference signal) to 180 degrees, with a nominal value of 90 degrees. This axis parameter is primarily for use with inductosyns, which have a nominal phase shift from the reference signal of 90 degrees. This value may vary from system to system, and therefore can be adjusted to ensure that the alignment of the feedback signals to the reference signal is at its optimum, for better performance.

This signal can also be used to adjust for resolvers that have a large amount of phase lag. Typically, less than 5 degrees of phase lag is acceptable and does not require use of the COS reference.




Use of this axis parameter requires that the jumper on the RDP board for this channel (JP1 for channel 1 or JP2 for channel 2) be set from 2-3 instead of from 1-2. Also, in order for the A/D's to sample properly, the appropriate bit in the CfgFbkRDConfig axis parameter should be set to 1 (bit 0 for channel 1 or bit 1 for channel 2).

For most resolvers, use of the CfgFbkRDCosPhase axis parameter is not required. If this axis parameter is not being used, the jumpers should be set to 1-2 and the bits in the CfgFbkRDConfig axis parameter should be set to 0. Skip to the section on adjusting the R/D Gain.

**Adjusting the CfgFbkRDCosPhase axis Parameter:**

After starting the Encoder Feedback Configuration utility, make sure the proper axis is selected and then start collecting data continuously. Set the CfgFbkRDGain axis parameter to 0 to minimize the gain. This can be done through the Ndebug.exe utility. Rotate the resolver or inductosyn until the analog signals are at one of the vertical or horizontal lines; this will ease location of a maximum. See Figure 4-22 below for an example. Adjust the CfgFbkRDCosPhase axis parameter until you locate a local maximum. This can be done through the Ndebug.exe utility. When the maximum has been found, rotate the motor in a complete circle to ensure you see a circle. If not, the P1 amplitude potentiometer on the pre-amplifier board (if present) may need adjusted.



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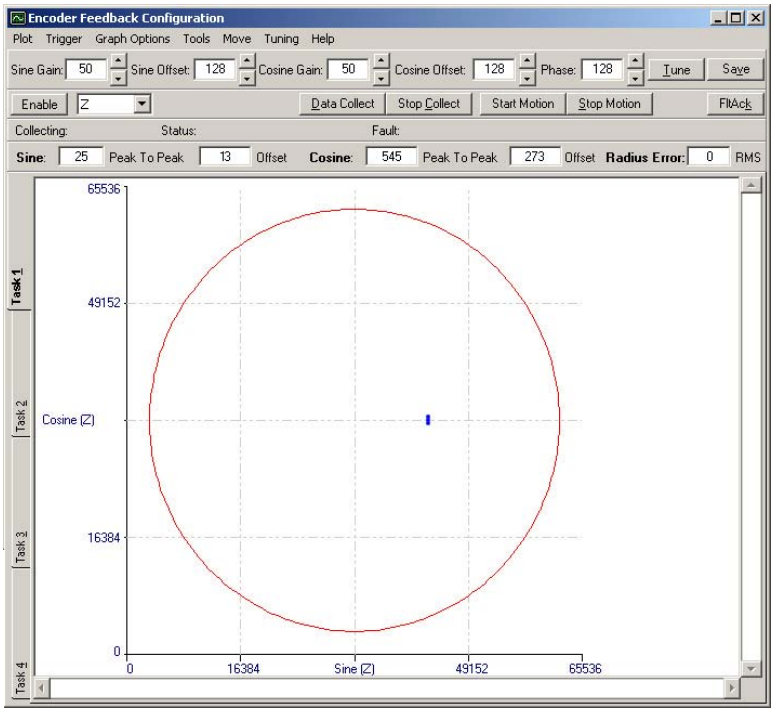



*Figure 4-22. Resolver Located at Maximum of SIN Signal*

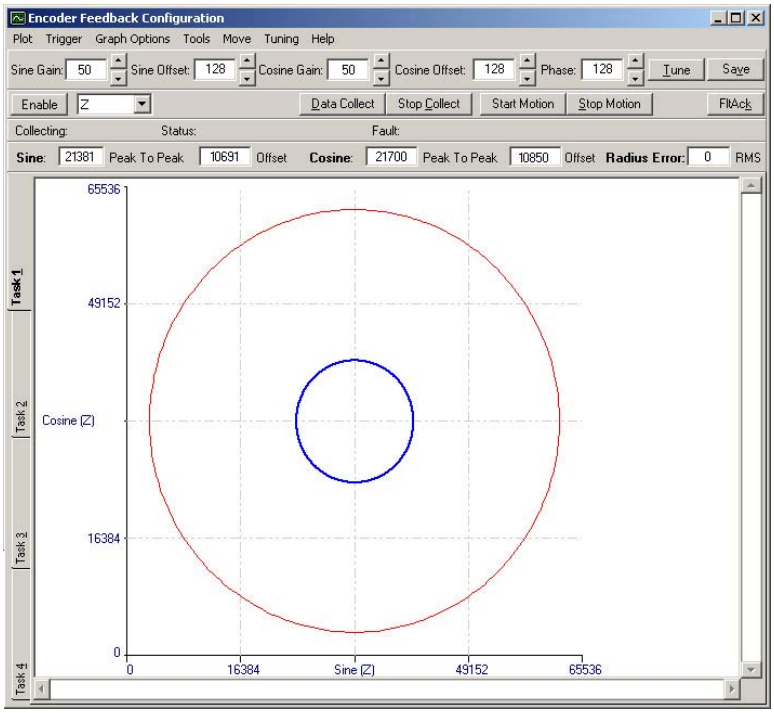



*Figure 4-23. Rotating the Resolver (to see a circle)*



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NOTE

For this to function, you MUST have the proper jumper set to 2-3 for this channel and the bit in the CfgFbkRDConfig axis parameter set to 1. Otherwise, erratic results may occur.

### Adjusting the gain of the R/D converter

Once the phase is adjusted for optimum conversion for inductosyns, adjust the CfgFbkRDGain axis parameter until you see the analog signals peaking between approximately 5,000 (on the low end) and 60,500 (on the high end) counts. This axis parameter can be adjusted via the Ndebug.exe utility. These numbers equate to approximately 0.38 to 4.62 volts on a zero- to 5-volt scale, or ± 8.48 volts on a ± 10V scale (i.e. via the Nstat.exe utility), depending upon where you measure the signals. This nominally provides 2V RMS (2.83 volts peak) to the converter chip on the RDP option board, which is required for optimum operation. See Figure 4-24 below, for an example of an optimum circle.

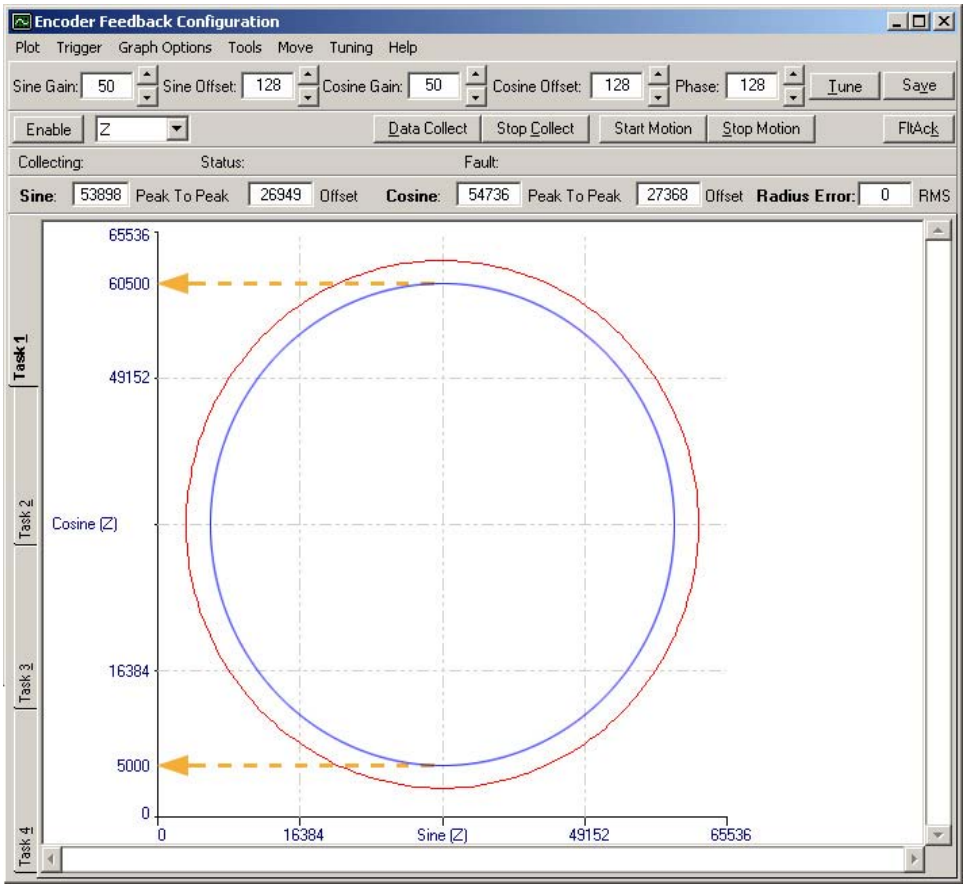



*Figure 4-24. Optimized Resolver Feedback Configuration*



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#### 4.4.1.3. Configuring the Commutation Initialization

The commutation of brushless motors with resolver feedback may be initialized two ways. The first method uses the number of motor pole pairs combined with the maximum resolution of the R/D board to determine an initial commutation position. The second method initializes the motor normally using the Hall-effect feedback signals.




Setting the CfgMotType axis parameter to auto-MSET can be used if the R/D auto-configuration or Hall-effect signals cannot be used.




R/D auto-configuration typically CAN'T be used with inductosyns as they have multiple electrical cycles per revolution of the motor. R/D auto-configuration will ONLY work if you have EXACTLY 1 cycle of the Sine and Cosine signals per revolution of the motor.

The Commutation Initialization method of the R/D is specified through bit 8 of the CfgFbkRDConfig axis parameter.

Setting this bit to 1, utilizes Hall-effect commutation initialization (i.e. commutation is initialized similar to encoder feedback). Note that this requires proper Hall effect to back-EMF configuration and/or proper commutation phase shift axis parameter setting; see brushless motor setup information for more details.

Setting this bit to 0 uses the R/D auto-Configuration, when the axis is enabled.




The position feedback type dictates which channel is used for commutation initialization. Typical configuration of the R/D has the CfgFbkPosType axis parameter set to 6 and CfgFbkVelType axis parameter set to 0 (use position). If two resolvers or inductosyns are used in a dual-loop mode, the position source will generate the commutation initialization, but the velocity source will maintain commutation position after enable. Dual-Loop with resolvers and other feedback sources is not advisable.



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### Finding the Proper Commutation Offset in R/D Auto-Configuration Mode

The R/D Auto-Configuration mode assumes that the zero crossing of the R/D Converter is aligned with the 0 angle of commutation on the Ndrive. Therefore, to determine the commutation offset angle, perform the following steps:




The resolver absolute counter may be read in the Ndebug utility via the command sequence: "DSPMEMREAD 2 0xEB0006" for channel 1, or 0xEB0007 for channel 2.

1. Open the Nstat.exe utility.
2. Select the tab, which displays the absolute resolver feedback register.
3. Rotate the resolver until you have an approximate zero value on the feedback register (note that this value will roll over at 65,535).
4. Begin with an MSET value of 0 degrees, execute MSET commands with an increasing angle until you see a value of 0 indicated for the absolute resolver angle. This MSET angle is the desired commutation offset.
5. Enter the value from step 4 into the CfgMotOffsetAng axis parameter. Note that for negative values, you must add 360 degrees (valid parameter range is 0-360 degrees).

∇ ∇ ∇



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# CHAPTER 5: ACCESSORIES

## 5.1. Standard Interconnection Cables

The following three tables show a summary of the standard cables used for interconnecting various items to the Ndrive. The "-xx", in the tables below is used to specify the length in decimeters and the "-yy," specifies the length in feet.

To identify your cable or for a drawing, see your documentation CD or software CD ROM.

**Table 5-1. Standard Interconnection Cables**

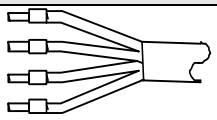
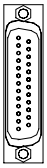
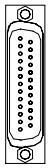
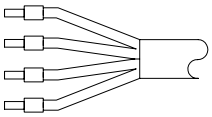
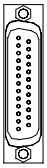
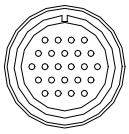
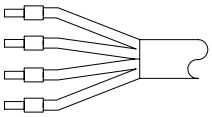
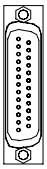
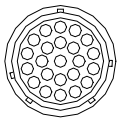
| Cable Part Number | Description |
|---|---|
| C13803-xx* | DC Brush Motor Cable<br>(DC MTR & FB-25DU FL-24MS-MAX107DM) |
| C15291-xx* | Encoder Feedback Cable<br>(BL FB-25DU-17MS 9DU-MAX120DM) |
| C15805-xx* | Motor Cable<br>(BL MTR FL 4MS) |
| C1650X | Encoder Feedback Cable<br>(BL FB-25DU-25DU-MAX120DM) |
| C1839X | Encoder Feedback Cable<br>(BL FB-25DU-25DU 9DU-MAX120DM) |
| C18982 | Motor and Encoder Feedback Cable<br>(BL MTR&FB-FL-25DU-25DU-107DM MAX) |
| C19360-xx* | Motor Cable<br>(BL MTR-FL-4DU-MAX450DM) |
| C19791 | Joystick Extension Cable with Flying Leads<br>(JSXT-FLY-XX) |
| C19792 | Joystick Extension Cable with D Style Connectors<br>(JSXT-26HD-XX) |
| C19793 | Two-Axis Joystick Adapter Cable (J205 on two Ndrive HPs) |
| C19794 | Two-Axis Joystick Adapter Cable with Flying Leads (J205 and –IO option) |
| C19851 | Hi-Flex Motor Cable<br>(BL MTR-FL-4DU-HF-46DM) |
| C19891-xx* | Auxiliary I/O to SSI Net 1 Cable |
| C19892-xx* | Auxiliary I/O to SSI Net 2 Cable |
| C20251-xx* | Stepper Motor Cable |
| ECZ01231 | BBA32 Interconnect Cable |

* The "-xx" indicates length in decimeters "-yy" would indicate length in feet.



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**Table 5-2. Combined Motor & Feedback Cables**

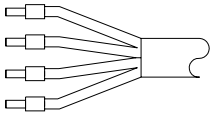
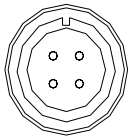
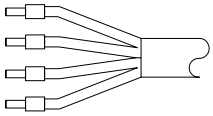
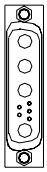
| Ndrive | Part Number (s) / Used On | Description | Stage/Motor |
|---|---|---|---|
|  Motor Output  Motor Feedback | C18982-xx* BFMCDNT-yy* | BL MTR & FB-25DU FL-25DU-MAX107DM Obsolete |  Motor/Encoder / Limits / Halls |
| | Any brushless motor stage having a single 25 pin "D" style connector for motor power, encoder, limits and halls.<br>ABL1000 series<br>ALS130 & ALS135 series (Single connector version)<br>ANT series, AVL125, & ADR175<br>ASR1000, 1100, & 2000 series (with –25D option) | | |
|  Motor Output  Motor Feedback | C13803-xx* | DC MTR & FB-25DU FL-24MS-MAX107DM |  Motor/Encoder / Limits / Brake |
| | Any stage having a DC brush motor with a single 24 pin "MS" style connector for motor power, encoder, limits and brake. | | |
|  Motor Output  Motor Feedback | C20251-xx* | SM MTR & FB-25DU FL-23B-MAX107DM |  Motor/Encoder / Limits / Brake |
| | Any stage having a stepper motor with a single 23 pin Burndy style connector for motor power, encoder, limits and brake. | | |

* The "-xx" indicates length measured in decimeters "-yy" indicates length measured in feet.



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**Table 5-3. Individual Motor Cables**

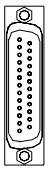
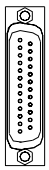
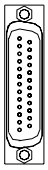
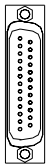
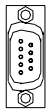
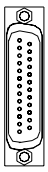
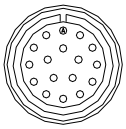
| Ndrive | Part Number (s) | Description | Stage/Motor |
|---|---|---|---|
| | **Used On** | | |
|  Motor Output | C15805-xx*<br>PMCNT-yy* | BL MTR-FL-4MS-MAX450DM<br>Obsolete |  Motor |
| | Any brushless motor stage having a 4 pin "MS"style connector for motor power.<br>BM/BMS motors (with -MS option)<br>BMxxxE motors | | |
|  Motor Output | C19360-xx*<br>PMCHPDNT-yy* | BL MTR-FL-4DU-MAX450DM<br>Obsolete |  Motor |
| | Any brushless motor stage having a 4 pin "D" style connector for motor power.<br>BM/BMS motors (with -D25 option)<br>ABL2000 & 8000 series<br>ABR1000 Series<br>ADR160 - 240 series<br>ADRT series<br>ALA1000 series<br>ALS130, 135, 2200, 3600, 5000, 5000WB, 20000, & 25000 series<br>ARA125 series<br>ASR1000, 1100, & 2000 series (with –HPD option)<br>ATS1100-H series<br>LMA & LMAC series | | |

* The "-xx" indicates length measured in decimeters "-yy" indicates length measured in feet.



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**Table 5-4. Individual Feedback Cables**

<table>
<tr><th rowspan="2">Ndrive</th><th>Part Number (s)</th><th>Description</th><th rowspan="2">Stage/Motor</th></tr>
<tr><th colspan="2">Used On</th></tr>
<tr><td rowspan="2"><br>Motor Feedback</td><td>C16501-xx*<br>C16505-xx*<br>BFCMX-yy *</td><td>BL FB-25DU-25DU-MAX120DM<br>BL FB-25DU-25DU-MAX240DM<br>Obsolete</td><td rowspan="2"><br>Encoder/Limits / Halls / Brake</td></tr>
<tr><td colspan="2">Any brushless motor stage having a 25 pin "D" style connector for encoder, limits, halls and brake.<br>BM/BMS motors (with -D25 option)<br>ABL2000 & 8000 series<br>ABR1000 Series<br>ADR160 - 240 series<br>ADRT series<br>ALA1000 series<br>ALS130, 135, 2200, 3600, 5000, 5000WB, 20000, & 25000 series<br>ARA125 series<br>ASR1000, 1100, & 2000 series (with –HPD option)<br>ATS1100-H series<br>LMA & LMAC series</td></tr>
<tr><td rowspan="2"><br>Motor Feedback</td><td>C18391-xx*<br>C18393-xx*<br>BFCD-yy*</td><td>BL FB-25DU-25DU 9DU-MAX120DM<br>BL FB-25DU-25DU 9DU-MAX240DM<br>Obsolete</td><td rowspan="2"><br>Encoder / Halls / Brake<br><br>Limits</td></tr>
<tr><td colspan="2">Any Brushless motor stage having a 25 pin "D" style connector for encoder, halls, & brake and a 9 pin "D" connector for limits.<br>BM/BMS motors (with –D25 option)</td></tr>
<tr><td rowspan="2"><br>Motor Feedback</td><td>C15291-xx*<br>C15297-xx*<br>BFC-yy*</td><td>BL FB-25DU-17MS 9DU-MAX120DM<br>BL FB-25DU-17MS 9DU-MAX240DM<br>Obsolete</td><td rowspan="2"><br>Encoder / Halls / Brake<br><br>Limits</td></tr>
<tr><td colspan="2">Any stage having a BM/BMS motor with a 17 pin "MS" style connector for encoder, halls, & brake and a 9 pin "D" connector for limits.</td></tr>
</table>

* The "-xx" indicates length measured in decimeters "-yy" indicates length measured in feet.



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## 5.2. Joystick Interface

The user may connect an Aerotech JI (not JBV, or JP4) joystick or their own joystick and switches to the Ndrive (Refer to Figure 5-1). The joystick interlock input must be set to the logic low state to indicate the joystick is connected. The zero velocity null-point for each joystick is approximately 2.5 volts. Be sure to set the JoyStickMinVoltage and JoyStickMaxVoltage task parameters. Also, the two potentiometers may be connected to analog inputs on two different Ndrives since each Ndrive standardly has one analog input.

Subsequent drawings illustrate how to connect a single axis and a two-axis joystick (both single- and two-axis) to the Ndrive in various ways, and the cables required to so do. A two-axis joystick requires 2 analog inputs (provided by the –IOPSO option).

When using an external potentiometer (such as a joystick) to drive the Ndrive analog inputs, it must be manually calibrated.

1) Set the joystick potentiometer at mid point (detent position) and record the voltage from the Nstat window.

2) Record the voltage at the maximum and minimum deflections of the potentiometer. Subtract the two voltages.

3) Set the **JoyStickMaxVoltage** task parameter to the mid point voltage from step 1 plus 1/2 the voltage difference from step 2.

4) Set the **JoyStickMinVoltage** task parameter to the mid point voltage from step 1 minus 1/2 the voltage difference from step 2.

If two different Ndrives are being used to read the joystick, only one Ndrive should be used to provide 5V power to the potentiometers. The second Ndrive should connect differentially to the second joystick potentiometer by connecting the Analog Input- to common and the Analog Input+ to the potentiometers wiper.

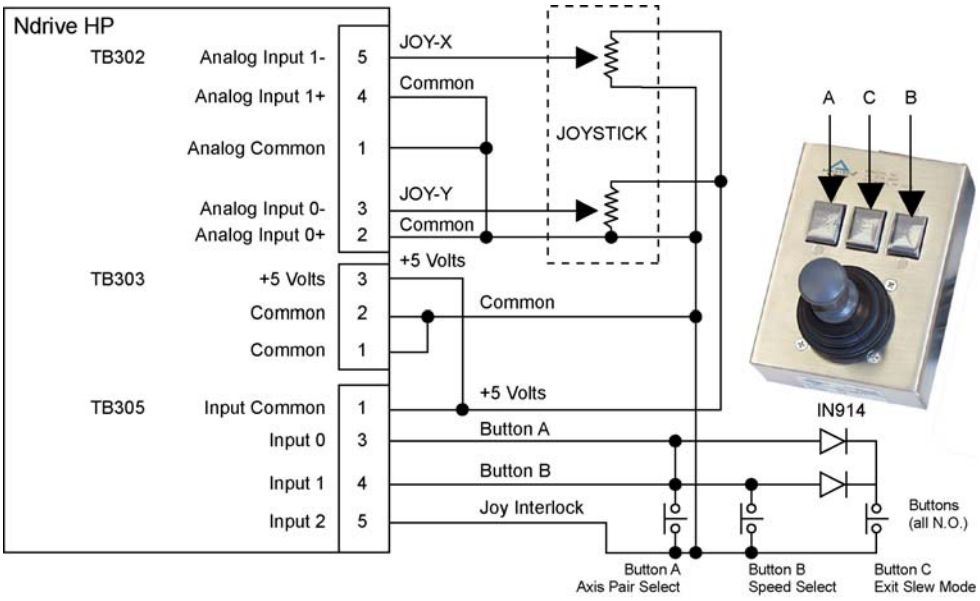



*Figure 5-1. Joystick Interface*



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A standard Aerotech JI joystick may be connected to J205 of the Ndrive as a single axis joystick via the following cable, shown below (Figure 5-2 and Figure 5-3). Figure 5-2 indicates the required cable and Figure 5-3 indicates the interconnection of the joystick to the Ndrive.

Be sure to set only one of the JoyStickAnalogHorizInput or the JoyStickAnalogVertInput task parameters. Also, define only one axis each of the SlewPair1 through SlewPair8 task parameters.

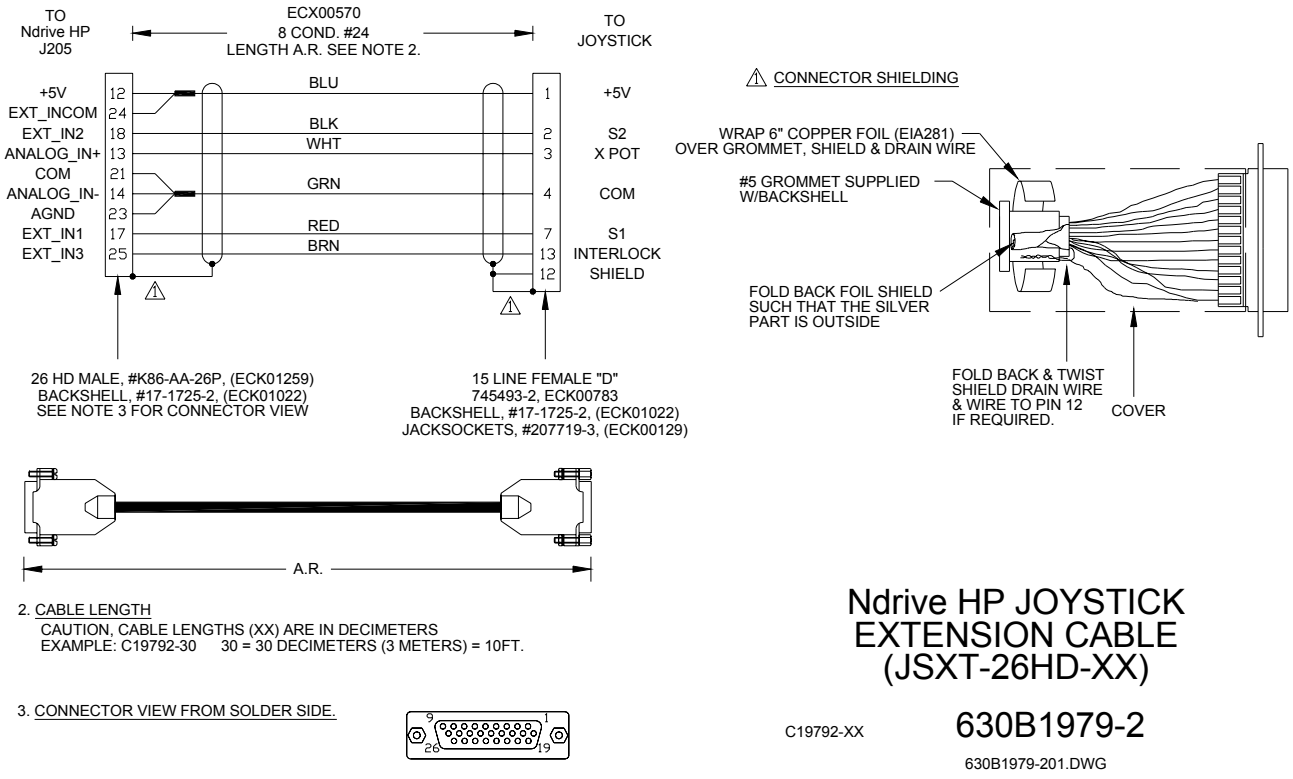



*Figure 5-2. Single Axis Joystick Interface to J205 of the Ndrive*



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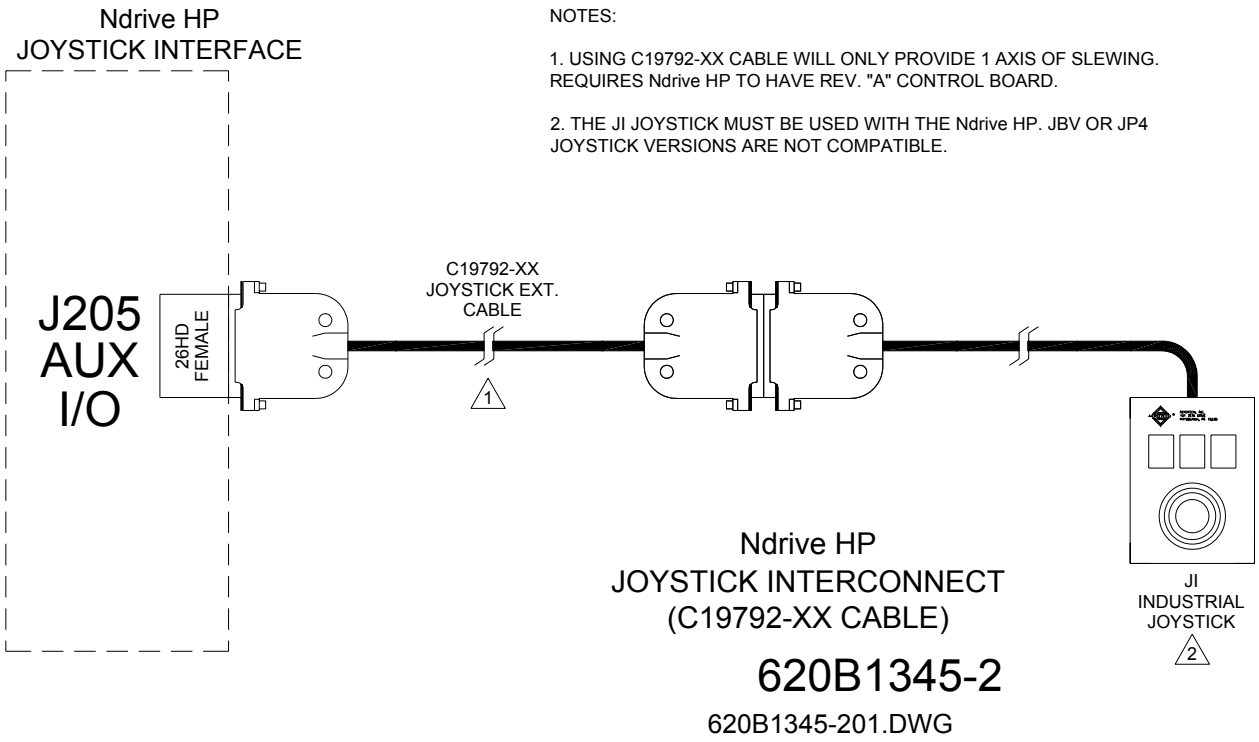



*Figure 5-3. Single Axis Joystick Interconnect to J205 of the Ndrive*



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A standard Aerotech JI joystick may be connected to the I/O on the –IOPSO option via the following cable for a two-axis joystick. Figure 5-4 indicates the required cable and the Figure 5-5 indicates the interconnection of the joystick to the Ndrive.

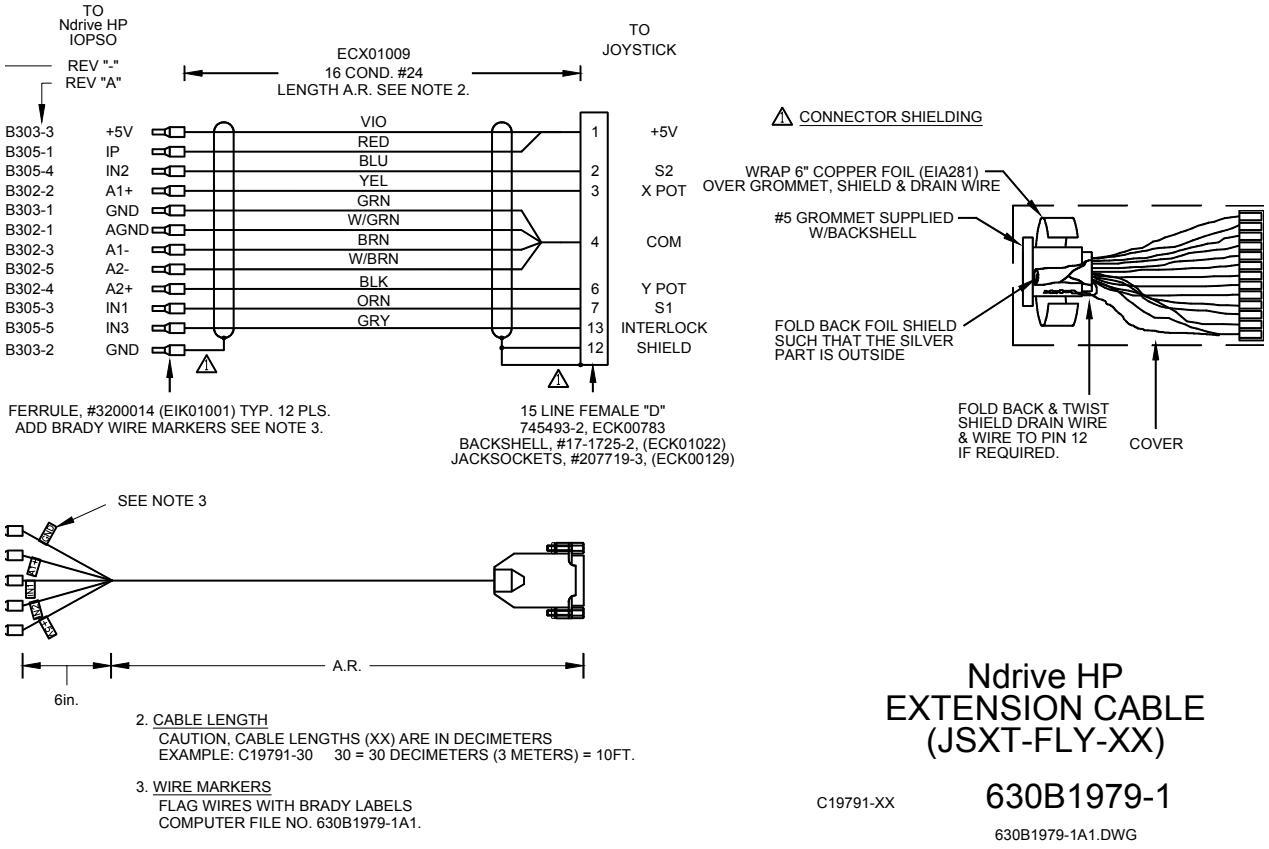



*Figure 5-4. Two-Axis Joystick Interface to the I/O on the –IOPSO Option*



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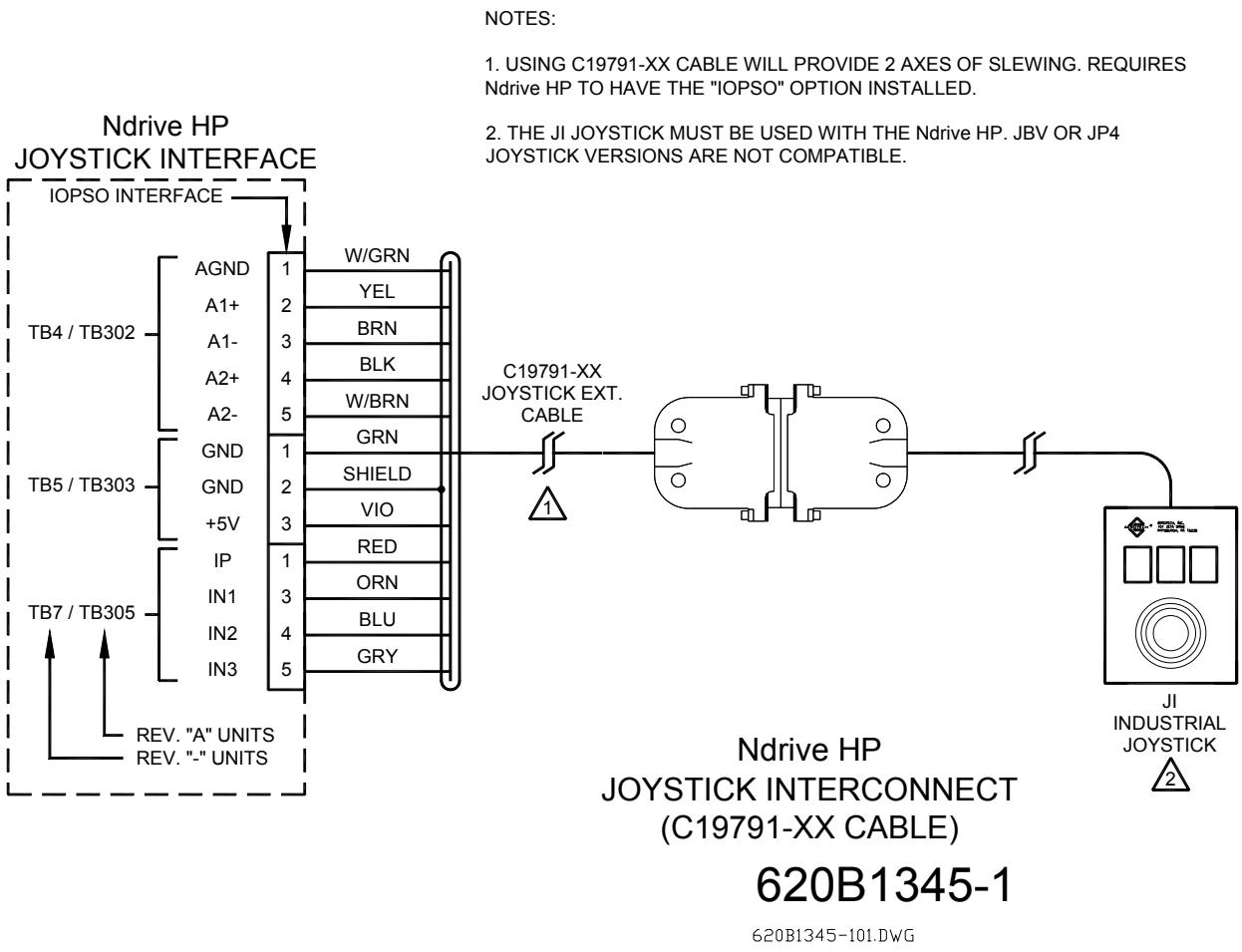



*Figure 5-5. Two-Axis Joystick Connection to the I/O on the –IOPSO Option*



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## 5.3. Handwheel Interface

The user may connect a handwheel or any device producing differential quadrature signals, for manual positioning of the axes. See the Nview HMI help for information on enabling the handwheel via software commands. The handwheel may be connected to J205 of the Ndrive as shown in Figure 5-6 below, or the I/O available on the –IOPSO option, shown in subsequent Figures.

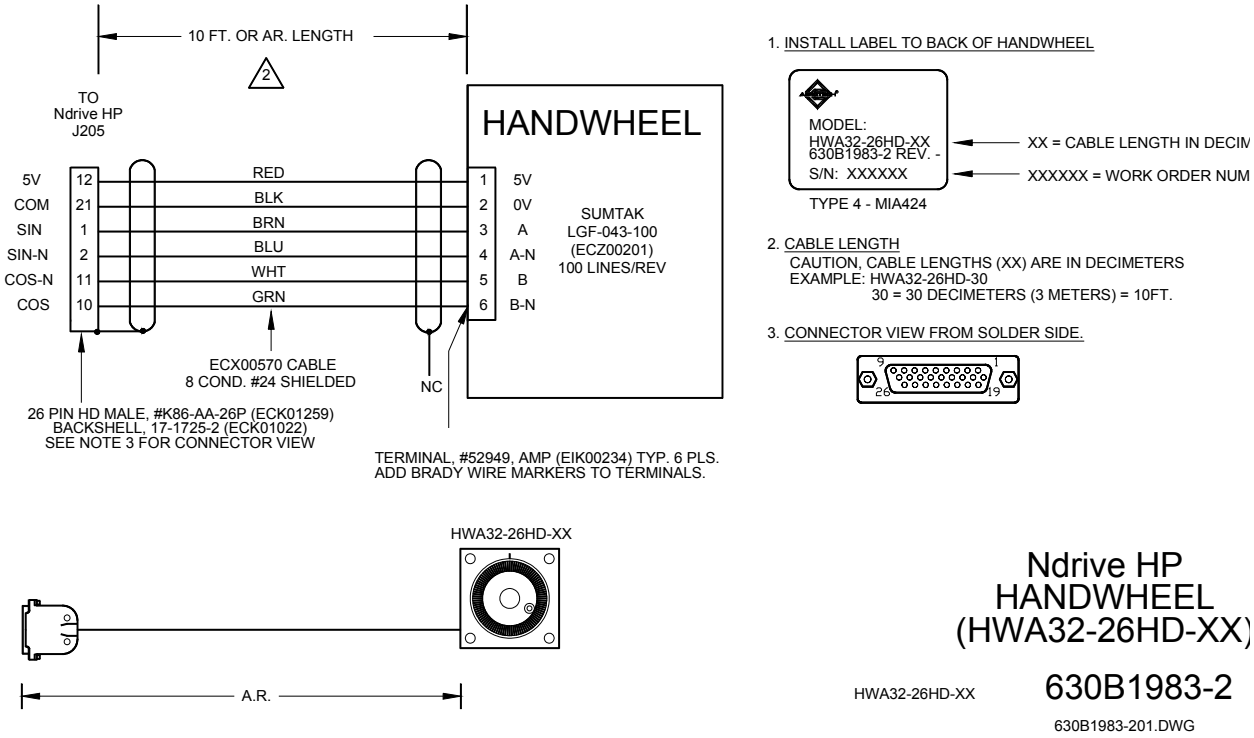



*Figure 5-6. Handwheel Interconnection to J205 of the Ndrive*

A handwheel with flying leads (no connector) may also be connected to the Ndrive via the Aerotech BBA32 to J205, per the next two drawings.



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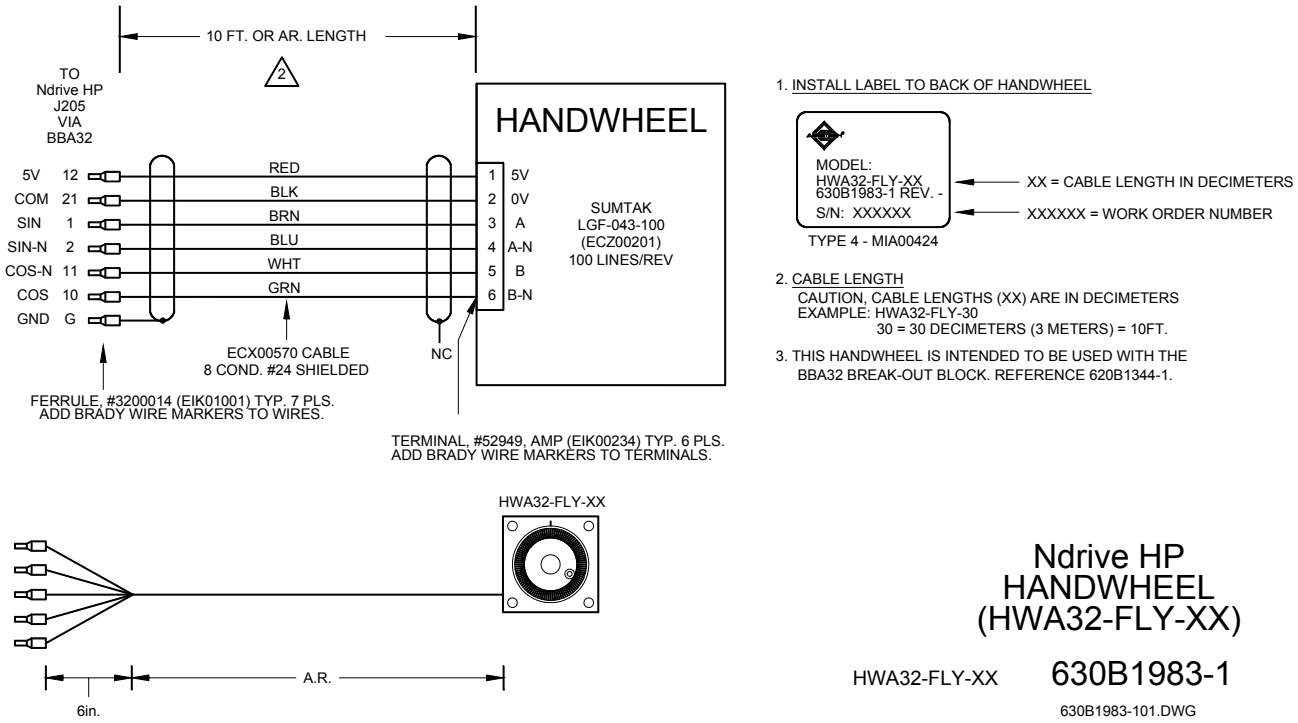



*Figure 5-7. Handwheel with flying leads (no connector)*



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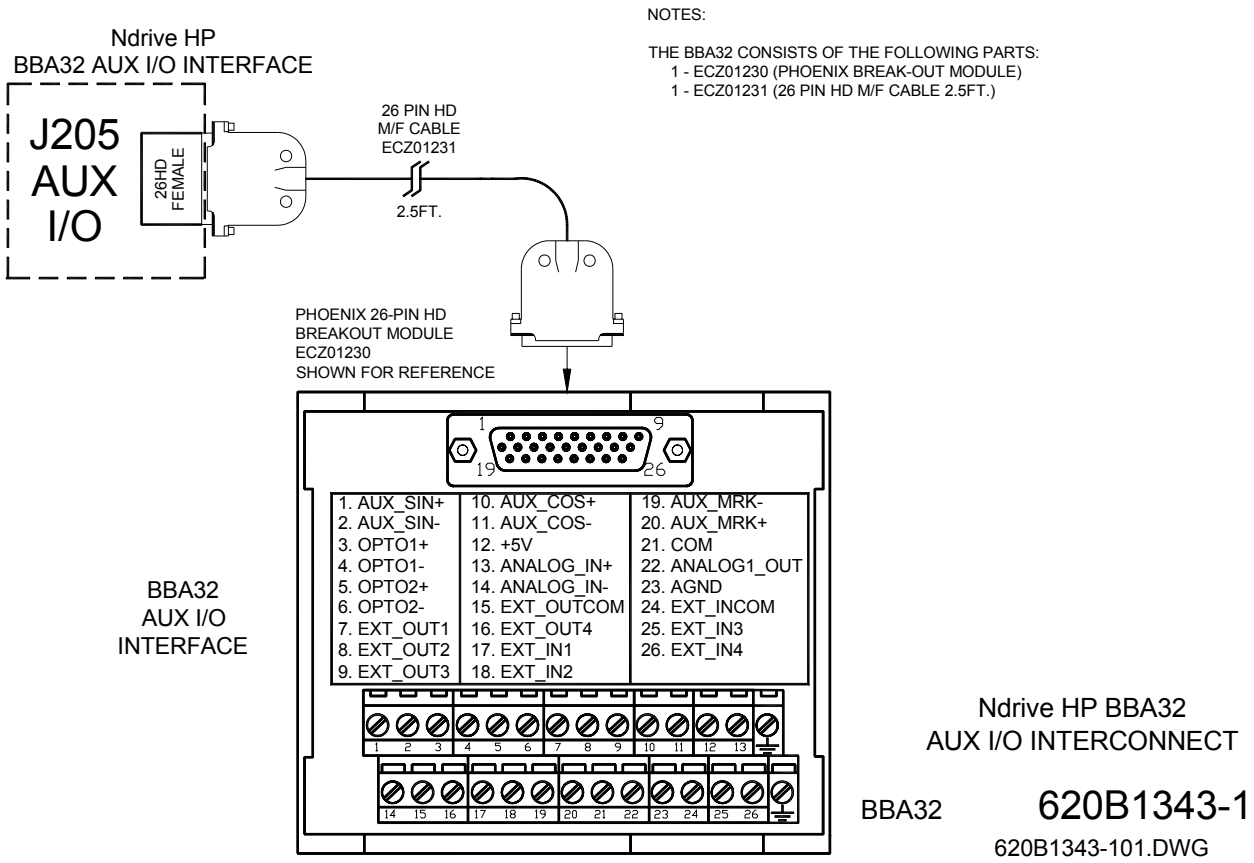



*Figure 5-8. BBA32 interface used to connect a Handwheel with flying leads (no connector)*

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# CHAPTER 6: TROUBLESHOOTING

## 6.1. Problems, Causes, and Solutions

This section covers symptoms, probable causes, and solutions related to Ndrive HP operation. Table 6-1 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 HMI help file.




Before performing the tests described in Table 6-1, 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.




No user serviceable parts inside.




Motor/Ndrive HP chassis may exceed 50°C.




Disconnect power to Ndrive HP main supply and optional supply before servicing.




Hazardous voltages may be present at Mains inlet and motor connectors.




Voltages must be mechanically secured before applying power.




Motors must be mechanically secured before applying power.



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Risk of electric shock.




Residual voltages inside the Ndrive HP controller may exceed 60 Volts after AC power has been disconnected for 10 seconds.

**Table 6-1. 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 Hall A, Hall B, and Hall C inputs. See Section 2.5. for motor phasing information. |
| Amplifier faults (“ENABLE” LED de-energizes) when motor decelerates. | Bus over voltage detected (Ndrive HP 10/20). This condition indicates an excessive regeneration condition. The Ndrive HP 10/20 requires that a shunt regulator be added to the unit. |
| Amplifier Faults ("ENABLE " LED de-energizes). | 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. |

## 6.2. Ndrive HP Control Board Test Points

The following test point is available on the control board internal to the Ndrive HP. The internal power board has no test points.

**Table 6-2. Ndrive HP Control Board Test Points**

| Test Point | Function |
|---|---|
| TP4 | Signal Common (Analog and Digital) |



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## 6.3. Ndrive HP Control Board Assembly

Figure 6-1 highlights the important components located on the control board assembly. The Ndrive HP is jumper selectable, providing the user with quick reconfiguration capability of operating modes. Table 6-3 list the jumpers and the default configurations for the Ndrive HP Control board (the -IOPSO option board and jumper configurations are listed in Chapter 3).

S2 defines the Ndrive HP communication channel number and is the only user-configurable switch/jumper on the control board (see Section 2.8).

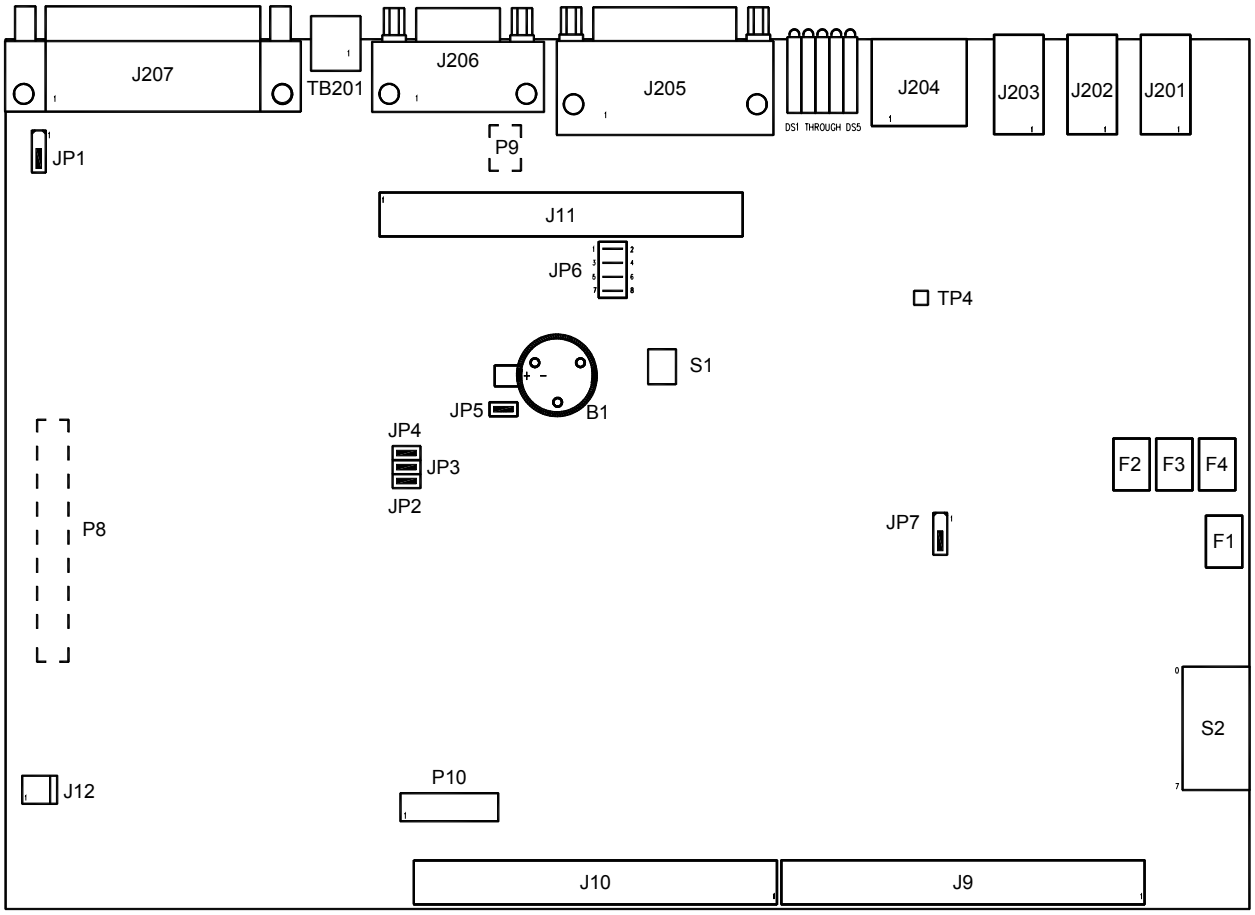



*Figure 6-1. Ndrive HP Control Board Assembly (690D1577 Rev. A)*



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**Table 6-3. Ndrive HP Control Board Jumper Selections**

| Jumpers | Position | Function |
|---|---|---|
| JP1 | 1-2 | Signal Common isolated from Frame Ground (Chassis) |
| | 2-3 * | Signal Common connected to Frame Ground (Chassis) |
| JP2<br>JP3<br>JP4 | All in * | Auxiliary Encoder Channel 2 is an input |
| | All out | Auxiliary Encoder Channel 2 is an output |
| JP5 | In * | 100 Ohm Terminator present for RS-485 port on J301 |
| | Out | 100 Ohm Terminator not present for RS-485 port on J301 |
| JP6A | 1-2 * | In for 100 Terminator on RS-422 Port 2 (J301, J302, J303) |
| JP6B | 3-4 * | In for 100 Terminator on RS-422 Port 1 (J301, J302, J303) |
| JP6C | 5-6 * | In for 100 Terminator on RS-422 Port 3 (J302, J303) |
| JP6D | 7-8 * | In for 100 Terminator on RS-422 Port 4 (J302, J303) |
| JP7 | 1-2 | Watch Dog Timer Enabled |
| | 2-3 * | Watch Dog Timer Disabled |

* indicates factory default setting




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



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## 6.4. Ndrive HP Power Board Assembly

Figure 6-2 highlights the important components located on the power board assembly. Table 6-4 lists the jumpers and their default configurations for the Ndrive HP Power board.

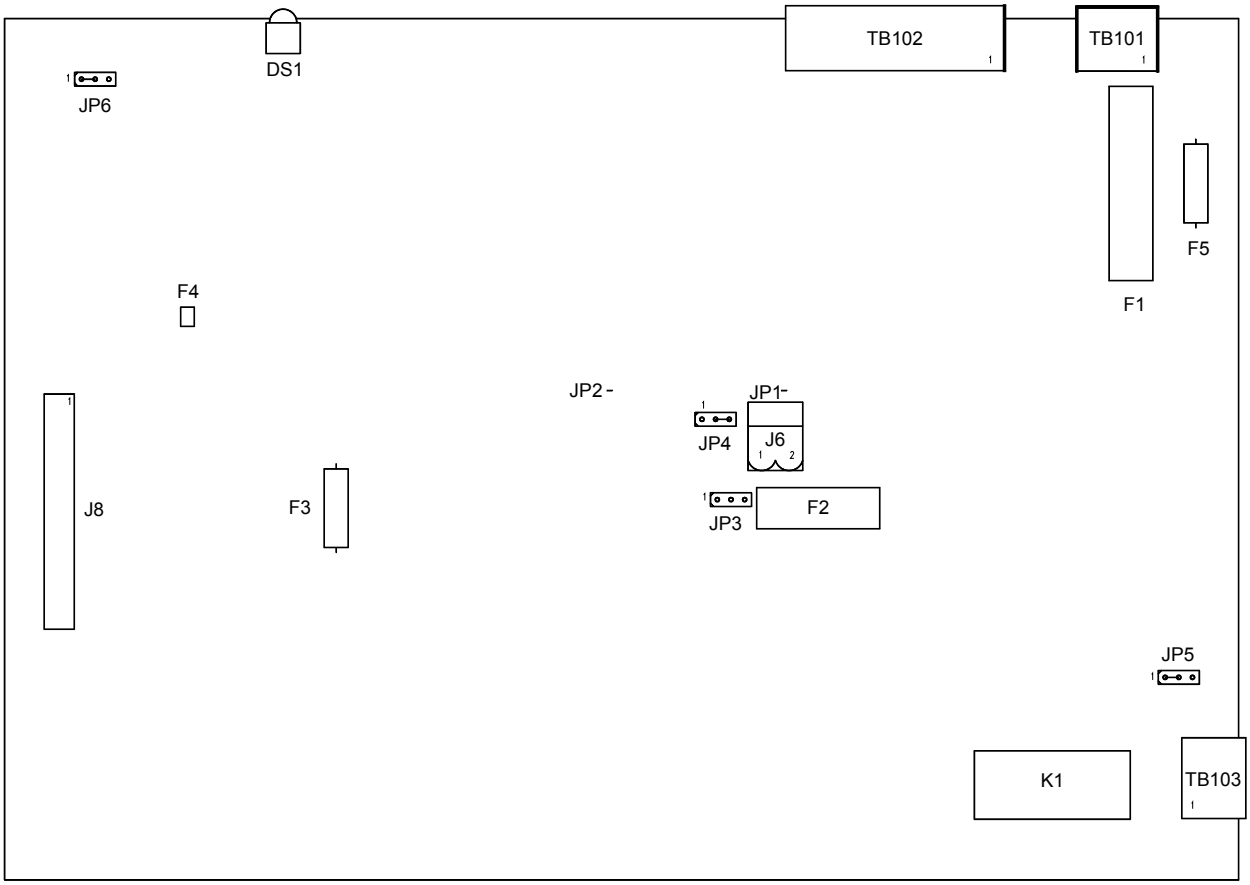



*Figure 6-2. Ndrive HP Power Board Assembly (690D1576 Rev. A)*



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**Table 6-4. Ndrive HP Power Board Jumper Selections**

| Jumpers | Positions | Function |
|---|---|---|
| JP1 | In * | 85 – 240 VAC Input Power Applied at TB102 |
| | Out | Less than 850 VAC Applied at TB102 |
| JP2 | In * | 85 – 240 VAC Input Power Applied at TB102 |
| | Out | Less than 85 VAC Applied at TB102 |
| JP3 | 1-2 | Shunt Option not Present (std. On Ndrive HP 10, 20) |
| | 2-3 | Shunt Option Present (std. On Ndrive HP 30) |
| JP4 | 1-2 | 115 VAC Shunt Option (165VDC Bus) |
| | 2-3* | 230 VAC Shunt Option (330VDC Bus) |
| JP5 | 1-2* | Bus under-voltage detection enabled |
| | 2-3 | Bus under-voltage detection disabled |
| JP6 | 1-2* | FireWire Bus power source |
| | 2-3 | Disable FireWire Bus power source |

* Factory Default




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

**Table 6-5. Ndrive HP Power Board Fuse Information**

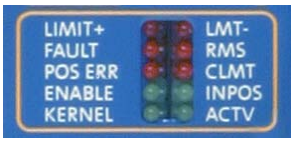
| Fuse | Description | Size |
|---|---|---|
| F1 | Supply Main Fusing for L1 VAC Bus Input | Ndrive 10: 5A S.B., 3AG |
| | | Ndrive 20: 10A S.B., 3AG |
| | | Ndrive 30: 10A S.B., 3AG |
| F2 | Shunt Option (-S) | 2 A S.B. (5 mm) |
| F3 | Control Power Fuse | .5 A S.B. |
| F4 | Encoder 5 Volt Power | .9A Auto. Reset-able |
| F5 | Optional 115/230 VAC Control Power Supply Input | 3 A S.B. |

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



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## 6.5. LED Indicators




The following LEDs are available on each Ndrive HP. Full Ndrive HP status is available via the Nmotion SMC and its utilities.

These LED's may also flash, to indicate that the internal MXH option is being re-programmed internally, see Section 3.3.4.2 for more information on the LED-flashing pattern which indicates the re-programming cycle is occurring.

**Table 6-6. LED Indicator Description**

| Label | Description |
|---|---|
| ACTV | Reset indicator |
| CLMT | Current is clamped at the value determined by the ThresholdClampIAmp axis parameter |
| ENB | Axis is enabled |
| FLT | An axis fault has occurred, see Fault axis parameter |
| INPOS | Axis is in position |
| KRNL | Nmotion SMC controller is running |
| LMT+ | Positive end of travel limit input active |
| LMT- | Negative end of travel limit input active |
| PERR | Position Error has exceeded the ThresholdPosError axis parameter |
| RMS | RMS motor current has exceeded the ThresholdAvgIAmp axis parameter |



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## 6.6. JTAG Programming Connector

The JTAG connector is for Aerotech use only.

**Table 6-7. 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 |



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## 6.7. Fuse / Battery Replacement

Table 6-9 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 6-8. Fuse Replacement Part Numbers (Ndrive Control Board)**

| Fuse | Description | Third Party P/N | Aerotech P/N | Size |
|---|---|---|---|---|
| F1 | Control Power Fuse | RAYCHEM SMD250 | EIF00002 | 5A |
| F2-4 | FireWire 5 Volt Power Fuse | RAYCHEM SMD250 | EIF00002 | 5A |

F1-F4 are reset-able semiconductor fuses, soldered to the circuit board.

**Table 6-9. Fuse Replacement Part Numbers (Ndrive Power Board)**

| Fuse | Description | | Third Party P/N | Aerotech P/N | Size |
|---|---|---|---|---|---|
| F1 | Supply Main Fusing for AC1 VAC Bus Input | Ndrive HP 10 | Littlefuse 313005 | EIF00105 | 5 A S.B. (3AG) |
| | | Ndrive HP 20 | Littlefuse 326010 | EIF00117 | 10 A S.B. (3AG) |
| | | Ndrive HP 30 | Littlefuse 326010 | EIF00117 | 10 A S.B. (3AG) |
| F2 | Shunt Option (-S) | | Littlefuse 235002 | EIF00195 | 2 A S.B. (5 mm) |
| F3 | Control Power Fuse | | Littlefuse 230.500S | EIF01010 | .5 A S.B. |
| F4 | Encoder 5 Volt Power | | Raychem RUSB090 | EIF01003 | .9A |
| F5 | Optional (Aux) 85/240 VAC Control Power Supply Input AC1 | | Littlefuse 230003S | EIF01013 | 3 A S.B. |

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




Disconnect power to Ndrive HP main supply and optional supply before servicing.

**Table 6-10. Battery Replacement Part Number (Ndrive HP Control Board)**

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



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## 6.8. Preventative Maintenance

The Ndrive HP 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 6-11 lists the recommended checks that should be made during these inspections.




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

**Table 6-11. 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. |

### 6.8.1. Cleaning

The Ndrive HP chassis can be wiped with a clean, dry, soft cloth. The cloth may be slightly moistened if required with water or isopropyl alcohol to aid in cleaning if necessary. In this case, be careful not to allow moisture to enter the Ndrive HP or onto exposed connectors / components. 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 HP while cleaning. Do not allow cleaning substances or other fluids to enter the Ndrive HP or to get on to any of the connectors. Cleaning labels should be avoided to prevent erasing label information.

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# APPENDIX A: GLOSSARY OF TERMS

| | |
|---|---|
| **Abbe Error** | The positioning error resulting from angular motion and an offset between the measuring device and the point of interest. |
| **Abbe Offset** | The value of the offset between the measuring device and the point of interest. |
| **Absolute Move** | A move referenced to a known point or datum. |
| **Absolute Programming** | A positioning coordinate reference where all positions are specified relative to a reference or “home” position. |
| **AC Brushless Servo** | A servomotor with stationary windings in the stator assembly and permanent magnet rotor. AC brushless generally refers to a sinusoidally wound motor (such as BM series) to be commutated via sinusoidal current waveform. (see DC brushless servo) |
| **Acceleration** | The change in velocity as a function of time. |
| **Accuracy** | An absolute measurement defining the difference between actual and commanded position. |
| **Accuracy Grade** | In reference to an encoder grating, accuracy grade is the tolerance of the placement of the graduations on the encoder scale. |
| **ASCII** | American Standard Code for Information Interchange. This code assigns a number to each numeral and letter of the alphabet. Information can then be transmitted between machines as a series of binary numbers. |
| **Axial Run-Out** | Positioning error of the rotary stage in the vertical direction when the tabletop is oriented in the horizontal plane. Axial run-out is defined as the total indicator reading on a spherical ball positioned 50 mm above the tabletop and centered on the axis of rotation. |
| **Axis of Rotation** | A centerline about which rotation occurs. |
| **Back EMF, Kemf** | The voltage generated when a permanent magnet motor is rotated. This voltage is proportional to motor speed and is present whether or not the motor windings are energized. |
| **Backlash** | A component of bidirectional repeatability, it is the non-responsiveness of the system load to reversal of input command. |
| **Ball Screw** | A precision device for translating rotary motion into linear motion. A lead screw is a low-cost lower performance device performing the same function. Unit consists of an externally threaded screw and an internally threaded ball nut. |
| **Ball Screw Lead** | The linear distance a carriage will travel for one revolution of the ball screw (lead screw). |
| **Bandwidth** | A measurement, expressed in frequency (hertz), of the range which an amplifier or motor can respond to an input command from DC to -3dB on a frequency sweep. |
| **Baud Rate** | The number of bits transmitted per second on a serial communication channel such as RS-232 or a modem. |



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|---|---|
| **BCD** | Binary Coded Decimal - A number system using four bits to represent 0-F (15). |
| **Bearing** | A support mechanism allowing relative motion between two surfaces loaded against each other. This can be a rotary ball bearing, linear slide bearing, or air bearing (zero friction). |
| **Bidirectional Repeatability** | See Repeatability. |
| **CAM Profile** | A technique used to perform nonlinear motion that is electronically similar to the motion achieved with mechanical cams. |
| **Cantilevered Load** | A load not symmetrically mounted on a stage. |
| **Closed Loop** | A broad term relating to any system where the output is measured and compared to the input. Output is adjusted to reach the desired condition. |
| **CNC** | Computer Numerical Control. A computer-based motion control device programmable in numerical word address format. |
| **Coefficient of Friction** | Defined as the ratio of the force required to move a given load to the magnitude of that load. |
| **Cogging** | Non-uniform angular/linear velocity. Cogging appears as a jerkiness, especially at low speeds, and is due to magnetic poles attracting to steel laminations. |
| **Commutation** | The action of steering currents to the proper motor phases to produce optimum motor torque/force. In brush-type motors, commutation is done electromechanically via the brushes and commutator. A brushless motor is electronically commutated using a position feedback device such as an encoder or Hall effect devices. Stepping motors are electronically commutated without feedback in an open-loop fashion. |
| **Commutation, 6-Step** | Also referred to as trapezoidal commutation. The process of switching motor phase current based on three Hall effect signals spaced 120 electrical degrees beginning 30 degrees into the electrical cycle. This method is the easiest for commutation of brushless motors. |
| **Commutation, Modified 6-Step** | Also referred to as modified sine commutation. The process of switching motor phase current based on three Hall effect signals spaced 120 electrical degrees beginning at 0 electrical degrees. This method is slightly more difficult to implement than standard 6-step, but more closely approximates the motor's back EMF. The result is smoother control and less ripple. Aerotech's BA series self-commutate using this method. |
| **Commutation, Sinusoidal** | The process of switching motor phase current based on motor position information, usually from an encoder. In this method, the three phase currents are switched in very small increments that closely resemble the motor's back emf. Sinusoidal commutation requires digital signal processing to convert position information into three-phase current values and, consequently, is most expensive to implement. The result, however, is the best possible control. All Aerotech controllers, as well as the BAS series amplifiers, commutate using this method. |



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| **Coordinated Motion** | Multi-axis motion where the position of each axis is dependent on the other axis, such that the path and velocity of a move can be accurately controlled. Drawing a circle requires coordinated motion. |
| **Critical Speed** | A term used in the specification of a lead screw or ball screw indicating the maximum rotation speed before resonance occurs. This speed limit is a function of the screw diameter, distance between support bearings, and bearing rigidity. |
| **Current Command** | Motor driver or amplifier configuration where the input signal is commanding motor current directly, which translates to motor torque/force at the motor output. Brushless motors can be commutated directly from a controller that can output current phase A and B commands. |
| **Current, Peak** | An allowable current to run a motor above its rated load, usually during starting conditions. Peak current listed on a data sheet is usually the highest current safely allowed to the motor. |
| **Current, RMS** | Root Mean Square. Average of effective currents over an amount of time. This current is calculated based on the load and duty cycle of the application. |
| **Cycle** | When motion is repeated (move and dwell) such as repetitive back-and-forth motion. |
| **DC Brushless Servo** | A servomotor with stationary windings in the stator assembly and permanent magnet rotor. (See AC Brushless Servo) |
| **Deceleration** | The change in velocity as a function of time. |
| **Duty Cycle** | For a repetitive cycle, the ratio of on-time to total cycle time used to determine a motor's RMS current and torque/force. |
| **Dwell Time** | Time in a cycle at which no motion occurs. Used in the calculation of RMS power. |
| **Efficiency** | Ratio of input power vs. output power. |
| **Electronic Gearing** | Technique used to electrically simulate mechanical gearing. Causes one closed loop axis to be slaved to another open or closed loop axis with a variable ratio. |
| **Encoder Marker** | Once-per-revolution signal provided by some incremental encoders to accurately specify a reference point within that revolution. Also known as Zero Reference Signal or Index Pulse. |
| **Encoder Resolution** | Measure of the smallest positional change, which can be detected by the encoder. A 1000-line encoder with a quadrature output will produce 4000 counts per revolution. |
| **Encoder, Incremental** | Position encoding device in which the output is a series of pulses relative to the amount of movement. |
| **Feedback** | Signal that provides process or loop information such as speed, torque, and position back to the controller to produce a closed-loop system. |
| **Flatness (of travel)** | Measure of the vertical deviation of a stage as it travels in a horizontal plane. |



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| | |
|---|---|
| **Force, Continuous** | The value of force that a particular motor can produce in a continuous stall or running (as calculated by the RMS values) condition. |
| **Force, Peak** | The maximum value of force that a particular motor can produce. When sizing for a specific application, the peak force is usually that required during acceleration and deceleration of the move profile. The peak force is used in conjunction with the continuous force and duty cycle to calculate the RMS force required by the application. |
| **Friction** | The resistance to motion between two surfaces in contact with each other. |
| **G.P.I.B.** | A standard protocol, analogous to RS-232, for transmitting digital information. The G.P.I.B. interface (IEEE-488) transmits data in parallel instead of serial format. (See IEEE-488) |
| **Gain** | Comparison or ratio of the output signal and the input signal. In general, the higher the system gain, the higher the response. |
| **Grating Period** | Actual distance between graduations on an encoder. |
| **Hall Effect Sensors** | Feedback device (HED) used in a brushless servo system to provide information for the amplifier to electronically commutate the motor. |
| **HED** | Hall Effect Device. (See Hall Effect Sensors) |
| **HMI** | Human Machine Interface. Used as a means of getting operator data into the system. (See MMI) |
| **Home** | Reference position for all absolute positioning movements. Usually defined by a home limit switch and/or encoder marker. |
| **Home Switch** | A sensor used to determine an accurate starting position for the home cycle. |
| **Hysteresis** | A component of bidirectional repeatability. Hysteresis is the deviation between actual and commanded position and is created by the elastic forces in the drive systems. |
| **I/O** | Input / Output. The reception and transmission of information between control devices using discrete connection points. |
| **IEEE-488** | A set of codes and formats to be used by devices connected via a parallel bus system. This standard also defines communication protocols that are necessary for message exchanges, and further defines common commands and characteristics. (See G.P.I.B.) |
| **Incremental Move** | A move referenced from its starting point (relative move). |
| **Inertia** | The physical property of an object to resist changes in velocity when acted upon by an outside force. Inertia is dependent upon the mass and shape of an object. |
| **Lead Error** | The deviation of a lead screw or ball screw from its nominal pitch. |
| **Lead Screw** | A device for translating rotary motion into linear motion. Unit consists of an externally threaded screw and an internally threaded carriage (nut). (See Ball Screw) |



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| | |
|---|---|
| **Life** | The minimum rated lifetime of a stage at maximum payload while maintaining positioning specifications. |
| **Limit Switch** | A sensor used to determine the end of travel on a linear motion assembly. |
| **Limits** | Sensors called limits that alert the control electronics that the physical end of travel is being approached and motion should stop. |
| **Linear Motor** | A motor consisting of 2 parts, typically a moving coil and stationary magnet track. When driven with a standard servo amplifier, it creates a thrust force along the longitudinal axis of the magnet track. |
| **Load Carrying Capability** | The maximum recommended payload that does not degrade the listed specifications for a mechanical stage. |
| **Master-Slave** | Type of coordinated motion control where the master axis position is used to generate one or more slave axis position commands. |
| **MMI** | Man Machine Interface used as a means of getting operator data into the system. (See HMI) |
| **Motion Profile** | A method of describing a process in terms of velocity, time, and position. |
| **Motor Brush** | The conductive element in a DC brush-type motor used to transfer current to the internal windings. |
| **Motor, Brushless** | Type of direct current motor that utilizes electronic commutation rather than brushes to transfer current. |
| **Motor, Stepping** | Specialized motor that allows discrete positioning without feedback. Used for non-critical, low power applications, since positional information is easily lost if acceleration or velocity limits are exceeded. |
| **NC** | Numerical Control. Automated equipment or process used for contouring or positioning. (See CNC). Also, a Normally-Closed switch. |
| **NO** | A Normally-Open switch. |
| **NEMA** | National Electrical Manufacturer's Association. Sets standards for motors and other industrial electrical equipment. |
| **Non-Volatile Memory** | Memory in a system that maintains information when power is removed. |
| **Open Collector** | A signal output that is performed with a transistor. Open collector output acts like a switch closure with one end of the switch at circuit common potential and the other end of the switch accessible. |
| **Open Loop** | Control circuit that has an input signal only, and thus cannot make any corrections based on external influences. |
| **Operator Interface** | Device that allows the operator to communicate with a machine. A keyboard or thumbwheel is used to enter instructions into a machine. (See HMI or MMI) |



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| | |
|---|---|
| **Optical Encoder** | A linear or angular position feedback device using light fringes to develop position information. |
| **Opto-Isolated** | System or circuit that transmits signal with no direct electrical connections, using photoelectric coupling between elements. |
| **Orthogonality** | The condition of a surface or axis perpendicular (offset 90°) to a second surface or axis. Orthogonality specification refers to the error from 90° from which two surfaces of axes are aligned. |
| **Overshoot** | In a servo system, referred to the amount of velocity and/or position overrun from the input command. Overshoot is a result of many factors including mechanical structure, tuning gains, servo controller capability, and inertial mismatch. |
| **PID** | A group of gain terms in classical control theory (Proportional Integral Derivative) used in compensation of a closed-loop system. The terms are optimally adjusted to have the output response equal the input command. Aerotech controllers utilize the more sophisticated PID FvFa loop which incorporates additional terms for greater system performance. |
| **Pitch (of travel)** | Angular motion of a carriage around an axis perpendicular to the motion direction and perpendicular to the yaw axis. |
| **Pitch Error** | Positioning error resulting from a pitching motion. |
| **PLC** | Programmable Logic Controller. A programmable device that utilizes “ladder logic” to control a number of input and output discrete devices. |
| **PWM** | Pulse Width Modulation. Switch-mode technique used in amplifiers and drivers to control motor current. The output voltage is constant and switched at the bus value (160 VDC with a 115 VAC input line). |
| **Quadrature** | Refers to the property of position transducers that allows them to detect direction of motion using the phase relationship of two signal channels. A 1000-line encoder will yield 4000 counts via quadrature. |
| **Radial Run-Out** | Positioning error of the rotary stage in the horizontal direction when the tabletop is oriented in the horizontal plane. Radial run-out is defined as the total indicator reading on a spherical ball positioned 50 mm above the tabletop and centered on the axis of rotation. |
| **Ramp Time** | Time it takes to accelerate from one velocity to another. |
| **Range** | The maximum allowable travel of a positioning stage. |
| **RDC** | Resolver to Digital Converter. Electronic component that converts the analog signals from a resolver (transmitter type) into a digital word representing angular position. |
| **Repeatability** | The maximum deviation from the mean (each side) when repeatedly approaching a position. Unidirectional repeatability refers to the value established by moving toward a position in the same direction. Bidirectional repeatability refers to the value established by moving toward a position in the same or opposite direction. |
| **Resolution** | The smallest change in distance that a device can measure. |



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|---|---|
| **Retro-reflector** | An optical element with the property that an input light beam is reflected and returns along the same angle as the input beam. Used with laser interferometers. |
| **Roll (of travel)** | Angular motion of a carriage around an axis parallel to the motion direction and perpendicular to the yaw axis. |
| **Roll Error** | Positioning error resulting from a roll motion. |
| **Rotor** | The rotating part of a magnetic structure. In a motor, the rotor is connected to the motor shaft. |
| **RS-232C** | Industry standard for sending signals utilizing a single-ended driver/receiver circuit. As such, the maximum distance is limited based on the baud rate setting but is typically 50-100 feet. This standard defines pin assignments, handshaking, and signal levels for receiving and sending devices. |
| **RS-274** | Industry standard programming language. Also referred to as G-code machine programming. A command set specific for the machine tool industry that defines geometric moves. |
| **RS-422** | Industry communication standard for sending signals over distances up to 4000 feet. Standard line driver encoder interfaces utilize RS-422 because of the noise immunity. |
| **Run-Out** | The deviation from the desired form of a surface during full rotation (360 degrees) about an axis. Run-out is measured as total indicated reading (TIR). For a rotary stage, axis run-out refers to the deviation of the axis of rotation from the theoretical axis of rotation. |
| **Servo System** | Refers to a closed loop control system where a command is issued for a change in position and the change is then verified via a feedback system. |
| **Settling Time** | Time required for a motion system to cease motion once the command for motion has ended. |
| **Shaft Radial Load** | Maximum radial load that can be applied to the end of the motor shaft at maximum motor speed. |
| **Shaft Run-Out** | Deviation from straight-line travel. |
| **Slot-less** | Describes the type of laminations used in a motor that eliminates cogging torque due to magnetic attraction of the rotor to the stator slots. |
| **Stator** | Non-rotating part of a magnetic structure. In a motor, the stator usually contains the mounting surface, bearings, and non-rotating windings. |
| **Stiction** | Friction encountered when accelerating an object from a stationary position. Static friction is always greater than moving friction, and limits the smallest possible increment of movement. |
| **Straightness of Travel** | Measure of the side-to-side deviation of a stage as it travels in a horizontal plane. |
| **Torque** | Rotary equivalent to force. Equal to the product of the force perpendicular to the radius of motion and distance from the center of rotation to the point where the force is applied. |



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| | |
|---|---|
| **Torque, Continuous** | Torque needed to drive a load over a continuous time. |
| **Torque, Peak** | Maximum amount of torque a motor can deliver when the highest allowable peak currents are applied. |
| **Torque, RMS** | Root Mean Square is a mathematical method to determine a steadfast or average torque for a motor. |
| **Torque, Stall** | The maximum torque without burning out the motor. |
| **Total Indicated Reading (TIR)** | The full indicator reading observed when a dial indicator is in contact with the part surface during one full revolution of the part about its axis of rotation. |
| **Tuning** | In a servo system, the process of optimizing loop gains (usually PID terms) to achieve the desired response from a stage or mechanism from an input command. |
| **Unidirectional Repeatability** | See Repeatability |
| **Velocity Command** | Motor driver or amplifier configuration where the input signal is commanding motor velocity. Motors with analog tachometers are normally driven by this driver configuration. |
| **Wobble** | An irregular, non-repeatable rocking or staggering motion of the table top of a rotary stage. Wobble is defined as an angular error between the actual axis of rotation and the theoretical axis of rotation. |
| **Yaw (of travel)** | Rotation about the vertical axis, perpendicular to the axis of travel. Angular movement (error) that affects straightness and positioning accuracy. |
| **Yaw Error** | Positioning error resulting from a yaw motion. |

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# APPENDIX B: WARRANTY and FIELD SERVICE

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 airfreight 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.



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***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

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

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# APPENDIX C: TECHNICAL CHANGES

**Table C-1. Current Technical Changes**

| Version | Section(s) Affected | Description |
|---|---|---|
| 1.14 | All | Removed MXU option<br>For Aerotech Use: update per Issue Tracker ID 536 |
| | Figure 1-5 | Corrected dimensions without I/O Board. |
| | Section 4.1.8. | Corrected pin numbers in PSO interface schematic. |
| | Page xii, Declaration of Conformity | Updated CE declaration |
| | Chapter 4 | Added high current I/O Board option<br>For Aerotech Use: update per Issue Tracker ID 461 |
| | Figure 2-9, Figure 2-10, Figure 2-11, Figure 2-15 | Updated cable wire color combinations<br>For Aerotech Use: update per Issue Tracker ID 727 |
| | Figure 4-14 | Updated schematic to show a transistor output device in M12. |
| | Table 5-1 | Cable interconnection information updated |



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**Table C-2. Technical Change Archive**

| Version | Section(s) Affected | Description |
|---|---|---|
| 1.13 | Fig. 4-3 | Corrected typo. in Brake circuit. |
| | Section 4.1.3. | Added notes to Brake section. |
| 1.12 | 3.1.1. | Changed pictures to new product colors. |
| 1.11 | 3.1.1. | Swapped AC1 And AC3 in Figure 2.6 |
| 1.10 | Chapter 4 | No Technically Relevant Changes |
| 1.09 | Chapter 4 | Corrected Power Board Fuse F1 |

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# APPENDIX D: REV. 0 to REV A COMPARISON

The figure below shows the connector and LED changes between Rev. 0 and the Rev. A.

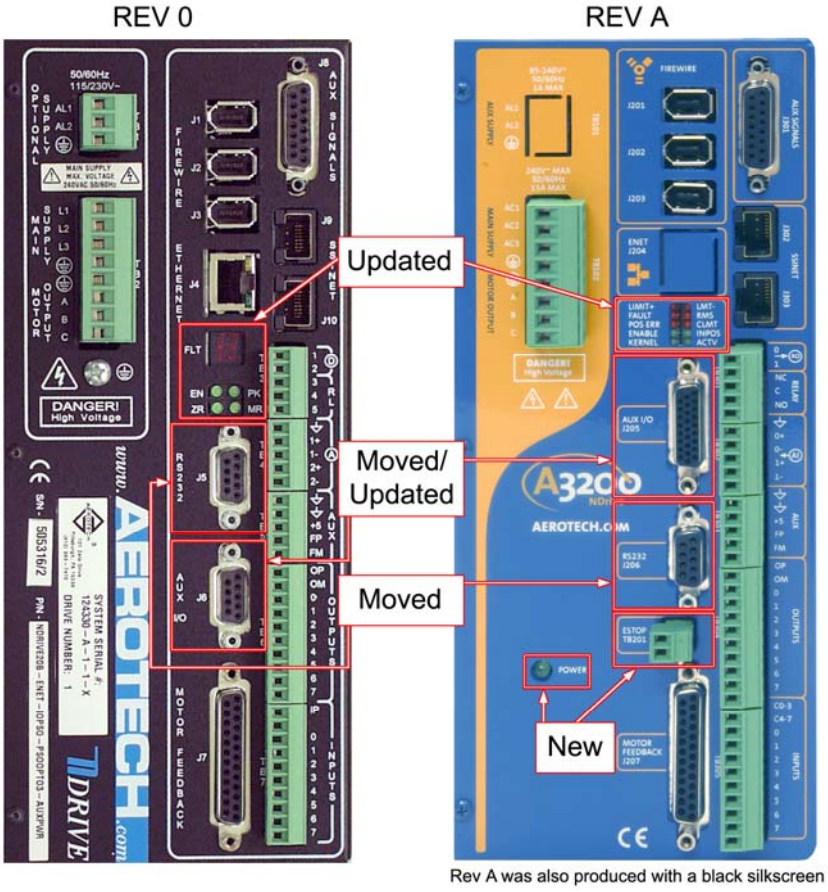



*Figure D-1. Connector/LED Comparison*

### UPDATED

The four LEDS and the seven segment LED have been replaced by 10 individual LEDs. Green LED's indicate active conditions and red LED's indicate faults and errors.

The auxiliary connector (J6 in Rev 0 and called J206 in Rev A) is now a 26-pin, high-density "D" style connector. See Table D-1 for the complete pin-out of J205 the Auxiliary connector.

### MOVED

The RS-232 and Auxiliary connectors had their physical locations swapped.

### NEW

A Power LED and a dedicated optically isolated emergency stop sense input have been added.



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## D.1. Connector Renumbering

All connectors and terminal blocks have been renumbered. Each is a 100, 200 or 300 series number within a column. The first column is 100 series, comprising the AC and motor terminal blocks, TB101 and TB102. The second column comprises the FireWire connectors down through the motor feedback connector, sequentially numbered from J201 through J207, respectively, with the ESTOP connector being TB201. The third column being the connectors on the -IOPSO option, numbered J301-J303 and TB301 through TB305, top to bottom.



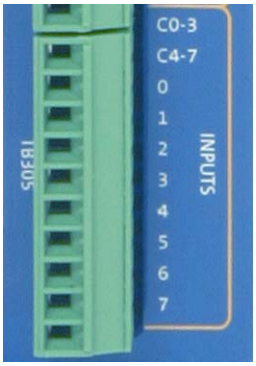
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## D.2. Option Changes

The -IOPSO3 and -IOPSO4 options are obsolete now that the -IOPSO outputs may be software configured as either sourcing or sinking.

New Features

- The pin-out of J205 has changed due to a larger connector being added. Summaries of the changes follow, see Table D-1 for the complete pin-out.
- There are now 4 optically isolated user current sinking outputs standard, on J205. They are set as $OUT8 through $OUT11. This implies that they are outputs 8 through 11. Outputs 0-7 are on the -IOPSO option.
- There are now 6 optically isolated user inputs standard, 2 of which are high speed, user configurable as sourcing or sinking, on J205. They are read as $IN8-13. This implies that they are inputs 8 through 13. Inputs 0-7 are on the -IOPSO option.
- A motor over-temperature thermistor input was added at J207 pin 2.
- One of the two analog outputs is now available standard on J205, as well as TB301 of the -IOPSO option.
- One of the two analog inputs is now available standard on J205, as well as TB302 of the -IOPSO option.
- User digital inputs on the -IOPSO options now have two input commons, one for each set of four inputs at TB305. They are pins 1 and 2 as shown in the margin.




- The auxiliary encoder (secondary feedback) may now be configured as an output, to prevent the user from having to purchase an -IOPSO option for two-axis laser firing, jumper selectable via JP2-4. This allows it to drive another axis auxiliary encoder channel for dual axis firing, on J206.
- A dedicated optically-isolated emergency stop sense input on TB201.
- Joystick, handwheel and typical ESTOP usage now supported and documented in the manual for Rev. A Ndrives. These will eventually be added to the ROM's in .dwg format also.
- Single and dual axis PSO (Laser Firing) users may now use optically isolated Output 11 as the firing output, so the -IOPSO option is not required.
- Manual for Rev. 0 Ndrives have been renamed with "Rev. 0" in filename and is still distributed with all other Aerotech product manuals.



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**Table D-1. J205 Auxiliary I/O Connector Pin Assignments**

| Pin # | Label | Description | In/Out/Bi. |
|---|---|---|---|
| 1 | Auxiliary Sine + | Secondary Encoder Channel | Input |
| 2 | Auxiliary Sine - | Secondary Encoder Channel | Input |
| 3 | **In 12 +** | **Input 12 High Speed Opto. +** | **Input** |
| 4 | **In 12 -** | **Input 12 High Speed Opto. -** | **Input** |
| 5 | **In 13 +** | **Input 13 High Speed Opto. +** | **Input** |
| 6 | **In 13 -** | **Input 13 High Speed Opto. -** | **Input** |
| 7 | **Out 8** | **Output 8** | **Output** |
| 8 | **Out 9** | **Output 9** | **Output** |
| 9 | **Out 10** | **Output 10** | **Output** |
| 10 | Auxiliary Cosine + | Secondary Encoder Channel | Input |
| 11 | Auxiliary Cosine - | Secondary Encoder Channel | Input |
| 12 | +5 Volt | +5 Volt (500mA. max.) | Output |
| 13 | Analog 0 In+ | Analog Input 0 + (Differential) | Input |
| 14 | Analog 0 In- | Analog Input 0 - (Differential) | Input |
| 15 | **Out Com** | **Output Common** | **-** |
| 16 | **Out 11** | **Output 11 (Opt. PSO Output)** | **Output** |
| 17 | **In 8** | **Input 8** | **Input** |
| 18 | **In 9** | **Input 9** | **Input** |
| 19 | Auxiliary Marker - | Secondary Encoder Channel | Input |
| 20 | Auxiliary Marker + | Secondary Encoder Channel | Input |
| 21 | +5 Volt External | +5 Volt External * | Output |
| 22 | Analog 0 Out | Analog Output 0 | Output |
| 23 | A Gnd | Analog Common | - |
| 24 | **In Com** | **Input Common** | **-** |
| 25 | **In 10** | **Input 10** | **Input** |
| 26 | **In 11** | **Input 11** | **Input** |

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



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## D.3. E-Stop Interface for Rev. 0

Refer to Chapter 2, Section 2.10.1 for Rev. A Ndrive HP.

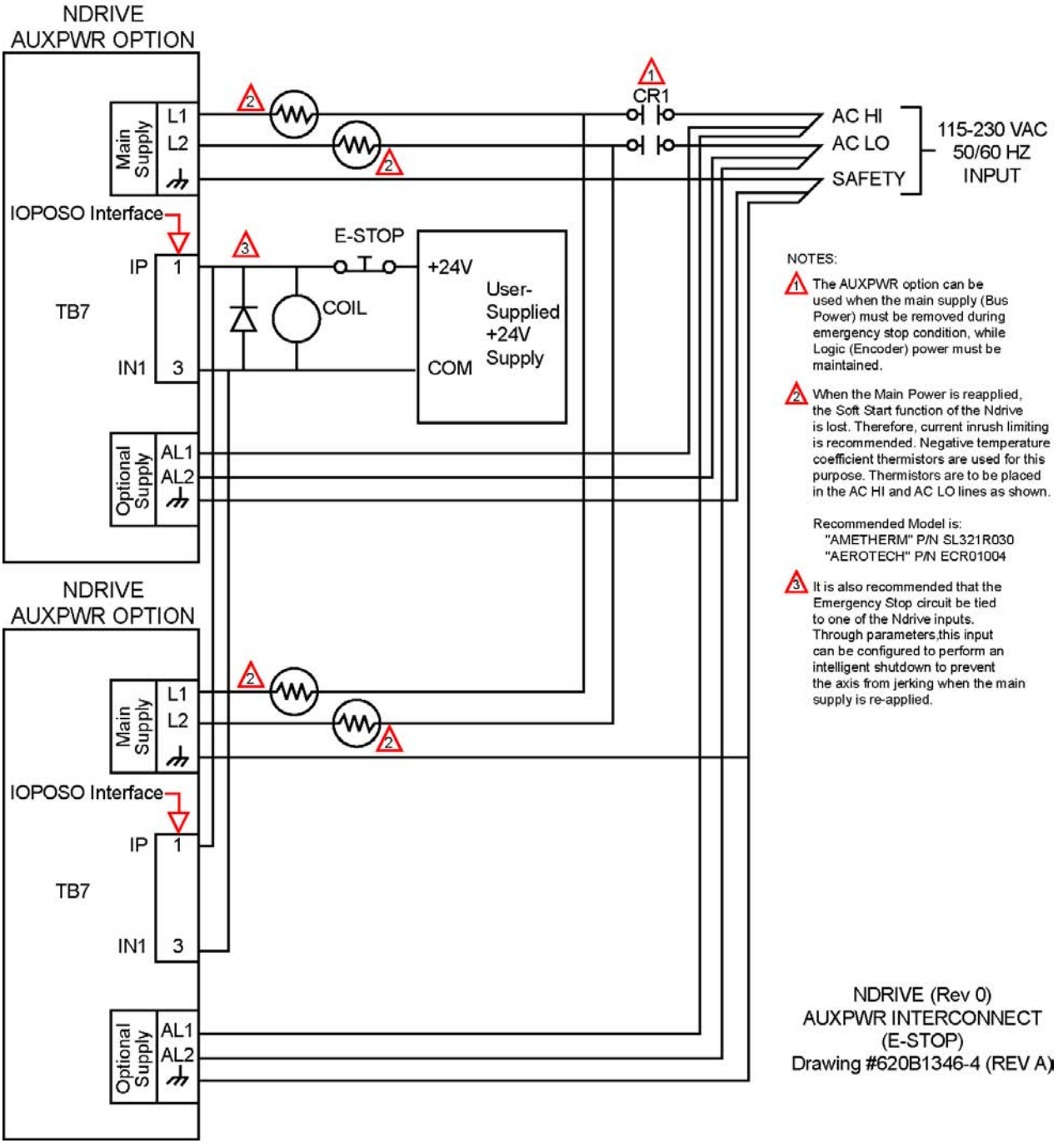



*Figure D-2. Typical Emergency Stop Circuit (Rev. 0)*



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