# Nano Plus-HP EtherCAT

# PCF NEP-HP

## DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

### PCF Plus Common Features

- Virtual Multi-Axes with IDC
- Large CVM dRAM 64k
- Large Trace 16k
- Built-in Ethernet

### Control Modes

- Cyclic Synchronous Position-Velocity-Torque (CSP, CSV, CST)
- Cyclic Synchronous Torque with Commutation Angle (CSTCA)
- Profile Position-Velocity-Torque
- Interpolated Position (PT, PVT), Homing
- Indexer, Point-to-Point
- Camming, Gearing
- Position, Velocity, Torque

### Command Interface

- CANopen® Application Protocol over EtherCAT® (CoE)
- ASCII, Serial Binary, and Discrete I/O
- Stepper or Quad A/B Position Commands
- PWM Position-Velocity-Torque Command
- Master Encoder (Gearing/Camming)
- ±10 V Position-Velocity-Torque

### Communications

- EtherCAT
- Ethernet
- UDP, TCP-IP, Modbus-TCP, Ethernet/IP
- RS-232

### Feedback

- Dual Absolute
  BiSS, SSI, EnDat
  Absolute A
  Panasonic™, Sanyo Denki™, Tamagawa™
- Analog Sin/Cos Encoder
- Digital Quad A/B/X Encoder
- Secondary Encoder/Emulated Output
- Digital Halls

### I/O

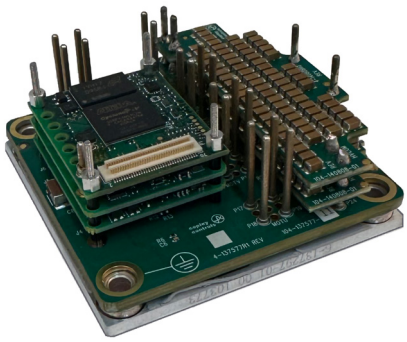
- 1 Analog Input ±10V, 16-bit
- 7 High-Speed Digital Inputs
- 6 High-Speed Digital Outputs
- High-Speed Pulse-at-Position
- SLI Support: DOUT4~6, IN7
- I/O Expansion

### Safe Torque Off (STO)

- SIL 3, Category 3, PL e

### Dimensions: in [mm]

- NEP-HP: 1.3 x 2.6 x 2.5 in [33 x 66 x 63.5 mm], 5.8 oz [164 g]
- NEP-HP-Z:1.44 x 2.6 x 2.5 in [36.5 x 66 x 63.5 mm], 7.6 oz [215 g]



**NEP-HP**

| Model | Ic | Ip | Vdc |
|---|---|---|---|
| NEP-090-80-C | 80 | 80 | 9~90 |
| NEP-090-140-C | 140 | 140 | 9~90 |

**NEP-HP-Z (Soldered to EZ Board)**

| Model | Ic | Ip | Vdc |
|---|---|---|---|
| NEP-090-80-C-Z | 80 | 80 | 9~90 |
| NEP-090-140-C-Z | 140 | 140 | 9~90 |

### Description

The Nano[Plus] High Power drive provides 100% digital control of brushless servo motors in a compact DC powered, modular package. The NEP-HP models operate as nodes used for transmitting data on an EtherCAT network. Servo drives can perform the CoE (CANopen protocol over EtherCAT) operating modes with the additional cyclic-synchronous Position, Velocity, and Torque modes. This drive complies with the requirements of the robotics, AGV, industrial machinery, medical/life-sciences and aerospace industries.

The Nano has a third party approved STO feature. Opto-isolators provide connections to user wiring and controls.

The NEP-HP drive can be mounted to any of the following:

- directly on the motor or within the robotic joints
- the user PC boards using either connectors
- soldered into the board

An optional interface board provides connectors which simplify the integration into customer applications.

## DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

### GENERAL SPECIFICATIONS

Test conditions: Load = Wye connected load: 1 mH+ 1 Ω line-line. Ambient temperature = 25 °C. +HV = HVmax.

| MODEL | NEP-090-80-C<br>NEP-090-80-C-Z | NEP-090-140-C<br>NEP-090-140-C-Z | Units |
|---|---|---|---|
| **OUTPUT POWER** | | | |
| Peak Current | 80 (56.6) | 140 (99.0) | Adc (Arms, sinusoidal) |
| Peak Time | N/A | N/A | Sec |
| Continuous Current | 80 (56.6) | 140 (99.0) | Adc (Arms, sinusoidal) |
| Peak Output Power | 4.7 | 8.3 | kW |
| Continuous Output Power | 4.7 | 8.3 | kW |
| *Note: For EZ packages, all Nano Plus HP modules are soldered into the EZ board. | | | |
| **INPUT POWER** | | | |
| HVmin to HVmax | +9 to +90 | +9 to +90 | Vdc, transformer-isolated |
| +HV Absolute Max. | +95 | +95 | Vdc, transformer-isolated |
| Ipeak | 50 | 88 | Adc |
| Icont | 50 | 88 | Adc continuous |
| VLOGIC | +9 to +60 | +9 to +60 | Vdc, transformer-isolated |
| VLOGIC Absolute Max. | +60 | +60 | Vdc, transformer-isolated |
| VLOGIC Power | 4 W with no encoder, 8 W with encoder +5V @ 500 mA, VLOGIC @ 24 VDC output. | | |
| **PWM OUTPUTS** | | | |
| Type | MOSFET 3-phase inverter, 16 kHz center-weighted PWM carrier, space-vector modulation | | |
| PWM Ripple Frequency | 32 kHz | | |
| Minimum Load Inductance | 200 µH | | |
| **BANDWIDTH** | | | |
| Current Loop, Small Signal | 2.5 kHz typical, bandwidth will vary with tuning & load inductance. | | |
| HV Compensation | Changes in HV do not affect bandwidth. | | |
| Current Loop Update Rate | 16 kHz (62.5 µs) | | |
| Position & Velocity Loop Update Rate | 4 kHz (250 µs) | | |
| **COMMAND INPUTS** | | | |
| EtherCAT | CANopen application protocol over EtherCAT (CoE): Cyclic Synchronous Position/Velocity/Torque, Profile Position/Velocity/Torque, Interpolated Position (PVT), Homing, Cyclic Synchronous Torque with Commutation Angle (CSTCA) | | |
| Stand-Alone Mode: | | | |
| Digital Position Reference | Pulse/Direction, CW/CCW | Stepper commands (4 MHz maximum rate) | |
| | Quad A/B Encoder | 10 M line/sec, 40 Mcount/sec (after quadrature) | |
| Digital Torque & Velocity Reference | PWM, Polarity | PWM = 0% - 100%, Polarity = 1/0 | |
| | PWM 50% | PWM = 50% ±50%, no polarity signal required. | |
| | PWM frequency range | 1 kHz minimum, 100 kHz maximum | |
| | PWM minimum pulse width | 220 ns | |
| Indexing | Up to 32 sequences can be launched from inputs or ASCII commands. | | |
| Camming | Up to 10 CAM tables can be stored in flash memory. | | |
| ASCII | RS-232, 9600~230,400 Baud, 3-wire | | |
| Analog | Current, Velocity, Profile Velocity, Position | | |
| **DIGITAL INPUTS NEP-HP** | | | |
| Number | 7 | | |
| IN1~4, 6 | General purpose inputs<br>High speed LVC CMOS 3.3V Schmitt trigger, 5V compatible, 100 ns RC filter, 10 kΩ pull-up to +5 Vdc, max. voltage = +6 Vdc, 1.42~2.38 Vdc positive-going threshold, 0.70~1.44 Vdc negative-going threshold<br>RC time-constant assumes active drive on inputs and does not include 10 kΩ pull-ups. | | |
| IN5 | Motor overtemperature, LV CMOS 5V Schmitt trigger, 100 µs RC filter, 1.6 kΩ pull-up to +5 Vdc, max. voltage = +6 Vdc, 2.53~3.43 Vdc positive-going threshold, 1.25~2.20 Vdc negative-going threshold<br>Also, connected to an ADC channel for continuous signal acquisition. | | |
| IN7 | High speed 5V AHCT TTL Schmitt trigger, 100 ns RC filter, 10 kΩ pull-up to +5V, max. voltage = +6 Vdc<br>2.00 Vdc min. positive-going threshold, 0.55 Vdc max. negative-going threshold<br>Programmable as SLI Function: SLI_MISO | | |
| **DIGITAL INPUTS NEP-HP-Z** | | | |
| IN1~2 | HC CMOS 5.0V Schmitt trigger, 24V compatible, 1 µs RC filter, 10 kΩ pull-up to +5 Vdc, max. voltage = +30 Vdc, 2.53~3.50 Vdc positive-going threshold, 1.25~2.20 Vdc negative-going threshold | | |
| IN3~4 | High speed LVC CMOS 3.3V Schmitt trigger, 5V compatible, 100 ns RC filter, 10 kΩ pull-up to +5 Vdc, max. voltage = +6 Vdc, 1.42~2.38 Vdc positive-going threshold, 0.70~1.44 Vdc negative-going threshold | | |
| IN5 | Motor overtemperature, LV CMOS 5V Schmitt trigger, 100 µs RC filter, 1.6 kΩ pull-up to +5 Vdc, max. voltage = +6 Vdc, 2.53~3.43 Vdc positive-going threshold, 1.25~2.20 Vdc negative-going threshold<br>Also connected to an ADC channel for continuous signal acquisition. | | |
| IN6 | Not available as an input. It is driven by an IC that checks the states of the ENCA and ENCB encoder signals. If errors are found, IN6 will go TRUE, disabling the drive. | | |
| IN7 | High speed 5V AHCT TTL Schmitt trigger, 100 ns RC filter, 10 kΩ pull-up to +5V, max. voltage = +6 Vdc | | |

## DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

| | |
|---|---|
| **DIGITAL OUTPUTS** | |
| Number | 6 |
| OUT1~3 | CMOS +5 Vdc inverters, 4.99 kΩ pull-up to 3.3 Vdc, functions programmable<br>Source -8 mA @ VOH > 3.94 Vdc, Sink 8 mA @ VOL < 0.36 Vdc |
| OUT4~6 | HS CMOS +3.3 Vdc inverters, functions programmable<br>Source -16 mA @ VOH ≥ 2.4 Vdc, Sink 16 mA @ VOL ≤ 0.4 Vdc<br>General purpose programmable or SLI functions: OUT4 = SLI_MOSI, OUT5 = SLI_CLK, OUT6 = SLI_EN1 |
| **ANALOG INPUT** | |
| Number | 1 |
| Type | Differential, ±10 Vdc range, 5.1 kΩ input impedance, 16 bits, single-pole, -3 dB @ 1450 Hz input filter |
| Function | Torque, Velocity, Position command or as general purpose analog input |
| **SERIAL COMMUNICATION PORT** | |
| Signals | RS-232: RxD, TxD, SGND |
| Mode | Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 230,400 Baud |
| Protocol | ASCII or Binary format |
| Isolation | Non-isolated. Referenced to Signal Ground. |
| **ETHERCAT PORT** | |
| Format | 100BASE-TX |
| Protocol | EtherCAT, CANopen Application Protocol over EtherCAT (CoE) |
| Isolation | External magnetics required for module. NEP-HP-Z have internal magnetics.<br>Max. voltage with respect to grounds: 32 Vdc |
| **MOTOR CONNECTIONS** | |
| Motor U,V,W | Drive outputs to 3-phase brushless motor, Wye or delta connected DC brush motors use outputs U & V.<br>Minimum inductance: 200 µH line-line |
| Encoder | Digital encoders, incremental and absolute (See FEEDBACK below).<br>Analog Sin/Cos incremental |
| Halls | Digital U/V/W, 120° |
| Motemp | Input is programmable to disable the drive if the motor sensor drives input HI or LO. |
| **FEEDBACK** | |
| Incremental Encoders: | |
| Digital Incremental Encoder | Quadrature signals, (A, /A, B, /B, X, /X), differential (X, /X Index signals not required).<br>5 MHz maximum line frequency (20 Hz counts/sec)<br>1 kΩ pull-up on (+), 1 kΩ pull-down on (-) input<br>VT+ = 1.2~2.0 Vdc min., VT- = 0.8~1.5 Vdc max., VH = 0.3 ~ 1.2 Vdc |
| Analog Incremental Encoder | Sin/Cos format (Sin+, Sin-, Cos+, Cos-), differential, 1 Vpeak-peak ±20%<br>BW > 300 kHz, 16-bit resolution, with zero-crossing detection |
| Absolute Encoders: | |
| EnDat, SSI, CSR | Serial Clock (X, /X), and Data (A, /A) signals |
| Absolute A | SD+, SD- (A, /A) signals, 2.5 or 4 MHz, half-duplex, 32 bit |
| BiSS | MA+, MA- (X, /X), SL+, SL- (A, /A) signals, clock output from drive, data returned from encoder. |
| Terminators | All encoder data inputs and clock outputs are differential and require external terminators. |
| Commutation | Hall signals (U,V,W), 15 kΩ pull-up to +5V, 15 kΩ/100 pF RC to 74LVC3G14 Schmitt trigger at +5 Vcc |
| Encoder Power | +5 Vdc ±2% @ 250 mAdc max., shared by dual encoders. |
| **HALLS** | |
| Digital U-V-W | Single-ended, 120° electrical phase difference<br>Schmitt trigger, 1.5 µs RC filter from active HI/LO sources, 5 Vdc compatible<br>15 kΩ pull-up to +5 Vdc, 74LVC, 3.3 V thresholds |
| **5V OUTPUT** | |
| Number | 2 |
| Ratings | 500 mA maximum. Protected for overload or shorts. Shared by dual encoders. |

## DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

### SAFE TORQUE OFF (STO)

| | |
|---|---|
| Function | PWM outputs are inactive and the current to the motor will not be possible when the STO function is active. |
| Safety Integrity Level | SIL 3, Category 3, Performance level e (PL e) |
| Inputs | 2 two-terminal: STO_1, STO1_RTN, STO_2, STO2_RTN |
| Type | Opto-isolators, 5V compatible |
| Disabling | Connecting both STO inputs to +5V will deactivate the STO function. |
| STO_STATUS_OUTPUT | STO status feedback, non-functional safety specified. |

### PROTECTIONS

| | | |
|---|---|---|
| HV Overvoltage | +HV > +95 ±1 Vdc | Drive outputs turn Off until +HV is < +95 ±1 Vdc (90 V models). |
| HV Undervoltage | +HV < +9.0 Vdc ±1 Vdc | Drive outputs turn Off until +HV is > +8.5 Vdc ±0.5 Vdc (90 V models). |
| Drive Over Temperature | PC Board > 90 °C +3/-0 ºC | Programmable as latching or temporary fault. |
| Short Circuits | Output to output, output to ground, internal PWM bridge faults | |
| $I^2T$ Current Limiting | Programmable: continuous current, peak current, peak time for drive and motor | |
| Latching / Non-Latching | Programmable response to errors. | |

### MECHANICAL & ENVIRONMENTAL

| | |
|---|---|
| Size, Weight | NEP-HP: 1.3 x 2.6 x 2.5 in [33 x 66 x 63.5 mm], 5.8 oz [164 g]<br>NEP-HP-Z: 1.44 x 2.6 x 2.5 in [36.5 x 66 x 63.5 mm], 7.6 oz [215 g] |
| Ambient Temperature | Operating: 0 to +45 °C, Storage: -40 to +85 °C |
| Humidity | 0 to 95%, non-condensing |
| Altitude | ≤ 2000 m (6,562 ft) |
| Vibration | 2 *g* peak, 10~500 Hz (Sine) |
| Shock | 10 *g*, 10 ms, half Sine pulse |
| Contaminants | Pollution Degree 2 |

### AGENCY STANDARDS CONFORMANCE

*Functional Safety*
- IEC 61508-1, IEC 61508-2, IEC 61508-3, (SIL 3)
- Directive 2006/42/EC (Machinery)
  - ISO 13849-1 (Cat 3, PL e)
  - IEC 61800-5-2 (SIL 3)

*Product Safety*
- Directive 2014/35/EU (Low Voltage)
  - IEC 61800-5-1

*EMC*
- Directive 2014/30/EU (EMC)
  - IEC 61800-3

*Restriction of the Use of Certain Hazardous Substances (RoHS)*
- Directive 2011/65/EU and its amendments 2015/863/EU

*Approvals*
- UL recognized component to:
  - UL 61800-5-1, UL 61800-5-2
  - IEC 61800-5-1, IEC 61800-5-2

FUNCTIONAL SAFETY

ISO 13849-1
Up to PL e (Cat.3)
IEC 61800-5-2
Up to SIL 3

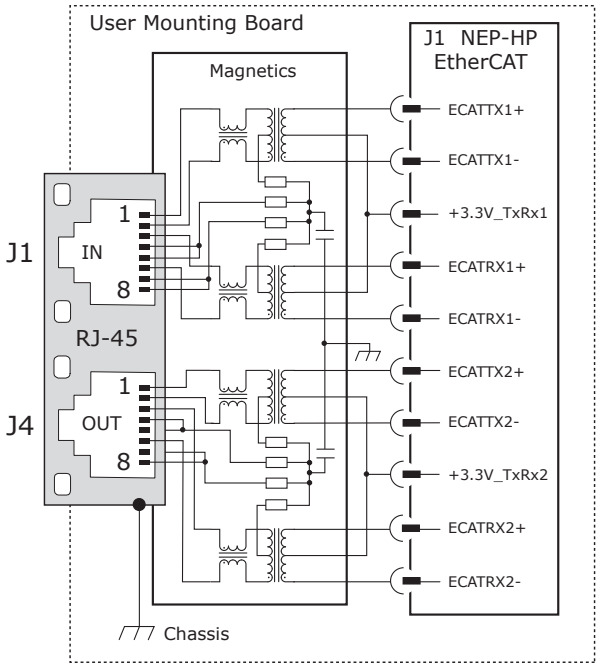
*RoHS Directive 2011/65/EU is now part of the CE marking procedure.*

| | |
|---|---|
| | ***Refer to the Copley NANO$^{Plus}$ High Power User Guide, (Part Number: 16-140881).*** |
| | For information on any application using the NANO Plus High Power drive STO feature, refer to the Copley NANO$^{Plus}$ High Power User Guide (PN: 16-140881). |
| ***DANGER*** | ***Failure to heed this warning can cause equipment damage, injury, or death.*** |

## ETHERCAT COMMUNICATIONS

EtherCAT is the open, real-time Ethernet network developed by Beckhoff based on the widely used 100BASE-TX cabling system. EtherCAT enables high-speed control of multiple axes while maintaining tight synchronization of clocks in the nodes.

Data protocol is CANopen application protocol over EtherCAT (CoE) based on CiA 402 for motion control devices. For more information on EtherCAT, refer to the web-site: https://ethercat.org.




**NETWORK RJ45**

| IN Name | Pin | OUT Name |
|---|---|---|
| ECATTX1+ | 1 | ECATTX2+ |
| ECATTX1- | 2 | ECATTX2- |
| ECATRX1+ | 3 | ECATRX2+ |
| R/C | 4 | R/C |
| | 5 | |
| ECATRX1- | 6 | ECATRX2- |
| R/C | 7 | R/C |
| | 8 | |

**DRIVE J1**

| Signal | Pin |
|---|---|
| ECATTX1+ | 27 |
| ECATTX1- | 29 |
| +3.3V_TXRX1 | 19 |
| ECATRX1+ | 24 |
| ECATRX1- | 26 |
| ECATTX2+ | 23 |
| ECATTX2- | 25 |
| +3.3V_TXRX2 | 21 |
| ECATRX2+ | 20 |
| ECATRX2- | 22 |

## RS-232 COMMUNICATIONS

The serial port is a full-duplex, three-wire (RxD, TxD, SGND) type that operates from 9,600 to 230,400 Baud. Use the Copley software to program the setup for the drive configuration or to setup the external equipment to send ASCII commands.

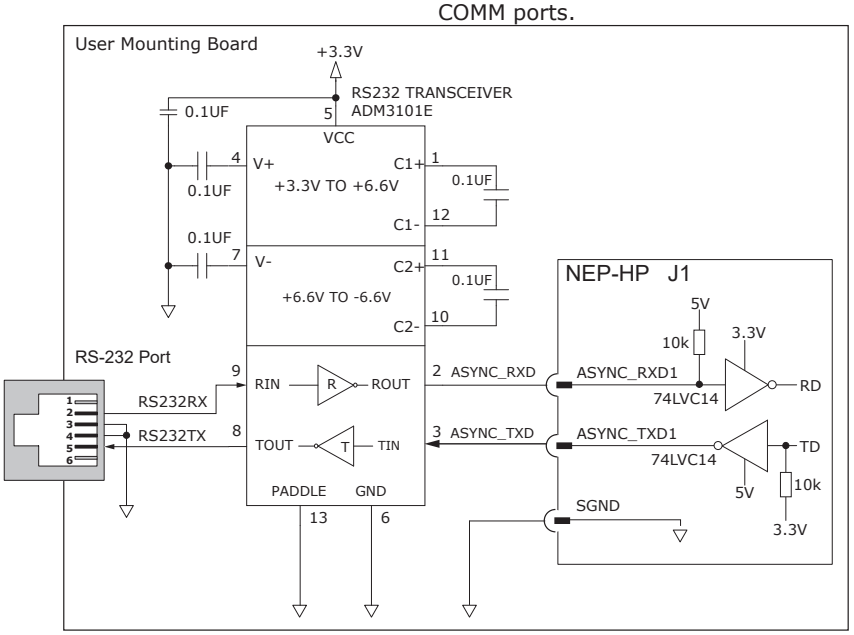
In the following diagram, the circuit shown is used on the -Z boards. It is recommended for the user's PC boards. It converts the single-ended TTL signals levels in the NEP-HP into the ANSI RS-232 levels which are the standard for serial communications and computer COMM ports.

**RS-232 PORT**

| Signal | Pins |
|---|---|
| RS232RX | 2 |
| RS232TX | 5 |
| SGND | 3,4 |

**DRIVE J1**

| Signal | Pins |
|---|---|
| ASYNC_RXD1 | 28 |
| ASYNC_TXD1 | 30 |
| SGND | 40 |




| WARNING | ***Refer to NANO NEP-HP Reference Designs & Drawings.*** |
|---|---|
| | Do not use 5V RS232 logic with module 3.3V logic RxD and TxD. Use ANSI RS232 Transceiver logic RS232RX and RS232TX. |

## SAFE TORQUE OFF (STO)

The Safe Torque Off (STO) function is defined in IEC 61800-5-2. Two channels are provided which, when de-energized, prevent the upper and lower devices in the PWM outputs from producing torque in the motor.

This provides a positive Off capability that cannot be overridden by the control firmware or associated hardware components. When the opto-couplers are energized (for example, the current is flowing in the input diodes), the control core is enabled to control the On/Off state of the PWM outputs to produce torque in the motor.

### INSTALLATION

| | |
|---|---|
| DANGER | ***Refer to the Copley NANO$^{Plus}$ High Power User Guide, (Part Number: 16-140881).*** |
| | For information on any application using the NANO Plus High Power drive STO feature, refer to the Copley NANO$^{Plus}$ High Power User Guide (PN: 16-140881). |
| | ***Failure to heed this warning can cause equipment damage, injury, or death.*** |

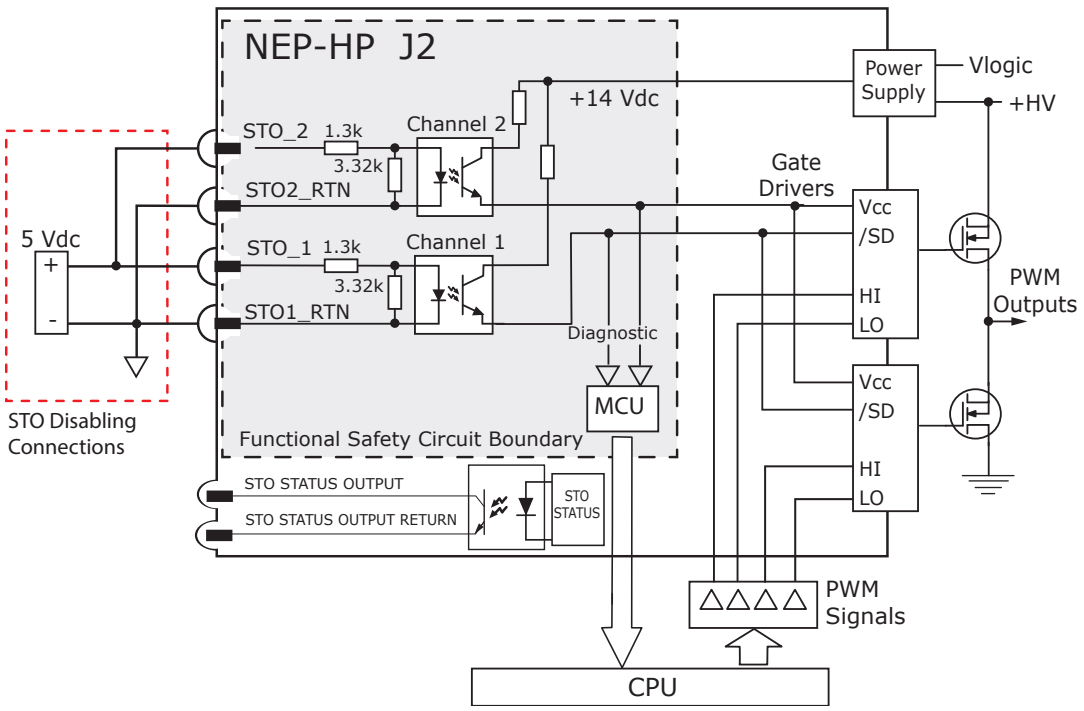
### STO DISABLE

To activate the PWM outputs of the NEP-HP, the current must be flowing through the opto-couplers that are connected to the STO_1 and STO_2 terminals and the drive must be in an ENABLED state. When either of the opto-couplers are Off, the drive is in a Safe Torque Off (STO) state and the PWM outputs cannot be activated by the control core to drive a motor.

In the diagram, it shows connections that will energize both opto-couplers from a +5V source. When this is done, the STO feature is disabled and control of the output PWM stage is under control of the digital control core. If the STO feature is not used, these connections must be made in order for the drive to be enabled.

### STO DISABLE CONNECTIONS

Current must flow through both of the opto-couplers before the drive can be enabled.




### FUNCTIONAL DIAGRAM

J2 STO

| Name | Pin | | Name |
|---|---|---|---|
| STO_1 | 1 | 2 | STO1_RTN |
| STO_2 | 3 | 4 | STO2_RTN |
| STO1_STATUS_OUTPUT | 5 | 6 | STO1_STATUS_OUTPUT_RTN |

### STO OPERATION

| STO Input Voltage | STO State |
|---|---|
| STO_1 *AND* STO_2 ≥ 3.0 Vdc | STO Inactive. Drive can be enabled to produce torque. |
| STO_1 *OR* STO_2 ≤ 0.8 Vdc | STO Active. Drive cannot be enabled to produce torque. |
| STO_1 *OR* STO_2 Open | |

Note: In the above table, the voltages are referenced between a STO_x and a STOx_RTN.
For example, V(STO1) = V(STO_1) - V(STO1_RTN)
The maximum voltage allowed for the STO inputs are 7.0 VDC.

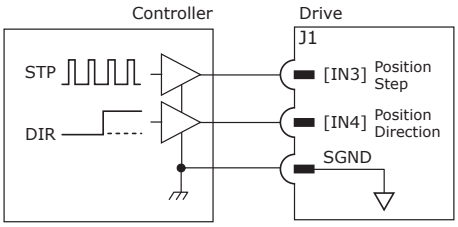
## DIGITAL COMMAND INPUTS: POSITION

### STAND-ALONE MODE DIGITAL POSITION-CONTROL INPUTS

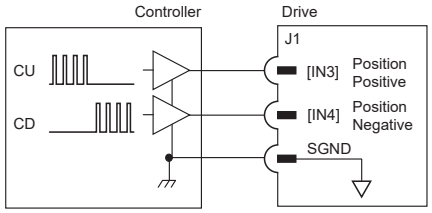
The NEP-HP works with the motion controllers to send output pulses to the command position. The following formats are supported:

- Step/Direction
  In Step/Direction mode, a pulse-train controls motor position, and the direction is controlled by a DC level at the Direction input.
- Count-Up/Count-Down (CU/CD)
  CU/CD (Count-Up/Count-Down) signals command the motor to move CW or CCW depending on to which input the pulse-train is directed.
- A/B Quadrature Encoder
  In the A/B Quadrature Encoder mode, the motor can be operated in an electronic gearing mode by connecting the inputs to a Quadrature Encoder on another motor. In all cases, the ratio between input pulses and motor revolutions is programmable.

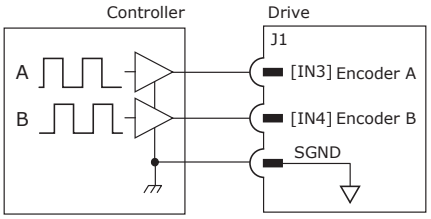
**STEP/DIRECTION INPUTS**




**COUNT-UP/COUNT-DOWN INPUTS**




**QUAD A/B ENCODER INPUTS**




| Command Options | Name | J1 Pins |
|---|---|---|
| Step, Count Up, Encoder A | IN3 | 7 |
| Direction, Count Down, Encoder B | IN4 | 8 |

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |

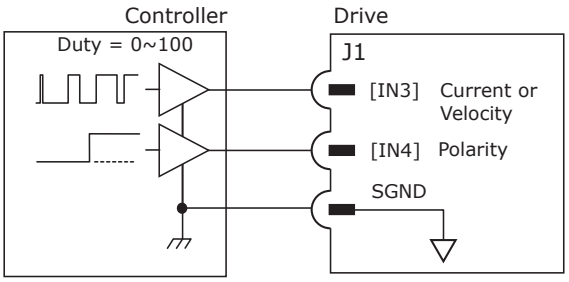
## DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

### STAND-ALONE MODE DIGITAL VELOCITY-TORQUE INPUTS

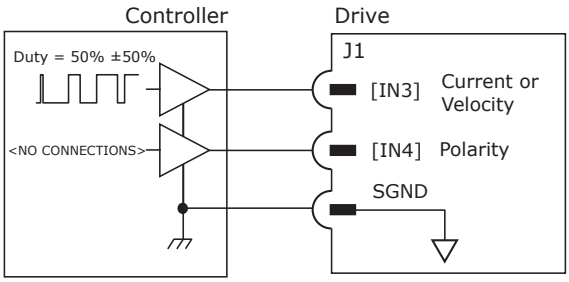
The NEP-HP works with the motion controllers to send send output pulses to the command Velocity or Torque. The following formats are supported:

- Pulse/Direction
  In Pulse/Direction mode, a pulse-train with variable duty cycle on IN3 controls Velocity or Torque from 0~100%.
  -IN4 HI or LO controls the direction of the Velocity or polarity of the Torque.
- PWM 50%
  In 50% PWM mode, a single signal of 50% duty cycle commands 0% Velocity/Torque.
  -Increasing the duty cycle to 100% commands positive Velocity/Torque.
  -Decreasing the duty cycle to 0% commands negative Velocity/Torque.

**PWM & DIRECTION**




**50% PWM**




| Command Options | Name | J1 Pins |
|---|---|---|
| PWM Vel/Trq, PWM Vel/Trq & Direction | IN3 | 7 |
| PWM/Dir Polarity, (none) | IN4 | 8 |

## HIGH SPEED INPUTS: IN1, IN2, IN3, IN4, IN6, IN7

The seven digital inputs to the NEP-HP can be programmed to a selection of functions. All inputs include the following:

- 100 ns RC filters when they are driven by the active sources (CMOS, TTL, etc.).
- 10 kΩ pull-up resistors to +5 Vdc.

In addition to the selection of functions, the active level for each input is individually programmable. Input level functions have programmable HI or LO to activate the function. Input transition functions are programmable to activate on LO -> HI, or HI -> LO transitions.

### INPUT LEVEL FUNCTIONS

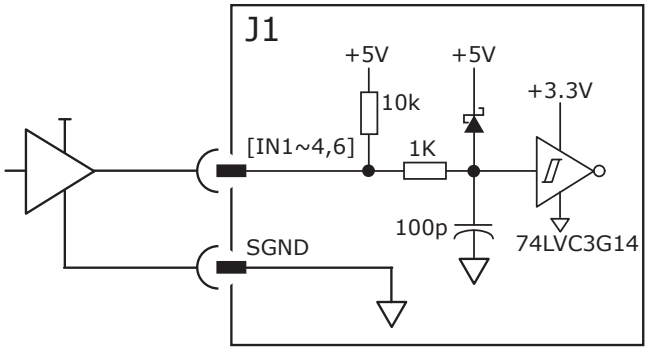
- Drive Enable, Enable with Clear Faults, Enable with Reset
- PWM Sync
- Positive Limit Switch
- Negative Limit Switch
- Home Switch
- Encoder Fault
- Motor Temperature Sensor Input
- Motion Abort
- High-Resolution Analog Divide

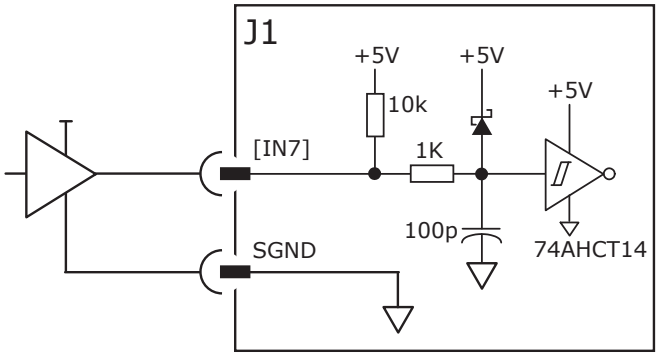
### INPUT TRANSITION FUNCTIONS

- Clear Faults and Event Latch
- Drive Reset
- PWM Sync Input
- Trajectory Update
- Count Input Edges, Save to Register
- High-Speed Position Capture
- Simulated Absolute Encoder Burst
- Abort Move if > N Counts From Destination in Register

Inputs IN1~4, and IN6 have 100 nanosecond rise time RC filters, each input with a 10 kΩ pull-up resistor to +5 VDC.

IN7 has the same input network, but the interface IC is a 74AHCT14BQ powered with 5.0 Vdc.




### SPECIFICATIONS

| Input | Data | Notes |
|---|---|---|
| Input Voltages IN1~4,6 | HI | $V_T$+ ≥ 1.42~2.38 Vdc |
| | LO | $V_T$- ≤ 0.70~1.44 Vdc |
| | Max | +6 Vdc |
| | Min | 0 Vdc |
| Input Voltage IN7 | HI | $V_T$+ ≥ 2.00 Vdc |
| | LO | $V_T$- ≤ 0.55 Vdc |
| | Max | +6 Vdc |
| | Min | 0 Vdc |
| Pull-Up | R1 | 10 kΩ |
| Low Pass Filter | R2 | 1 kΩ |
| | C1 | 100 pF |
| | RC | 100 ns |

### CONNECTIONS

| Name | J1 Pins |
|---|---|
| IN1 | 5 |
| IN2 | 6 |
| IN3 | 7 |
| IN4 | 8 |
| IN6 | 10 |
| IN7 | 11 |

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |

| | |
|---|---|
| ***WARNING*** | ***For information on Adapting 24V logic to 5V logic, consult the Factory.*** |
| | 5V logic. Do not exceed 6V. Do not connect a 24V logic to this input. Refer to page 24 that shows the circuit for 24V inputs. |

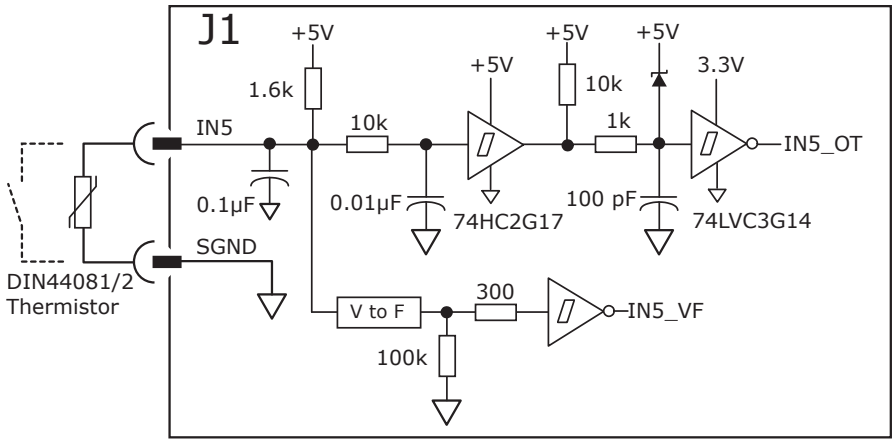
## MOTOR OVERTEMP INPUT: IN5

Input IN5 has a 100 microsecond rise time RC filter, with a 1.6 kΩ pull-up resistor to +5 VDC. If it is not used for the Motemp function, IN5 can be re-programmed for other input functions. The input network is the default used for a DIN44081/2 type PTC thermistor mounted in a motor.

IN5_VF has a voltage-to-frequency [V to F] converter. It connects to the FPGA where the frequency decodes to a voltage. By using this converter, it can be configured to work with thermistors to protect motors and/or loads. Use the Copley software to select the input to be used for the motor overtemp protection.

### CONNECTIONS

| Signal | J1 Pins |
|---|---|
| IN5 | 9 |




## ANALOG INPUT: AIN1

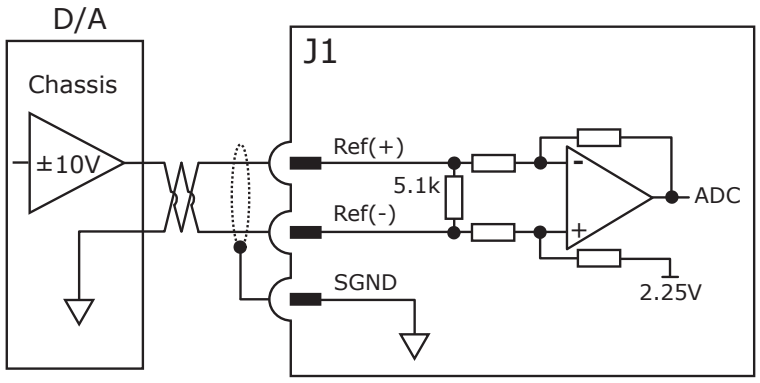
As a reference input, the AIN1 takes Position/Velocity/Torque commands from a controller.

If it is not used as a command input, it can be used as general-purpose analog input.

### SPECIFICATIONS

| Specifications | Data | Notes |
|---|---|---|
| Input Voltage | Vref | ±10 Vdc |
| Input Resistance | Rin | 5.1 kΩ |

| Signal | J1 Pins |
|---|---|
| Ref(+) | 2 |
| Ref(-) | 1 |
| AGND | 3 |



## DIGITAL OUTPUTS: OUT1~OUT3

Digital outputs [OUT1~3] are CMOS inverters. They operate from +5V and can source/sink 8 mAdc.

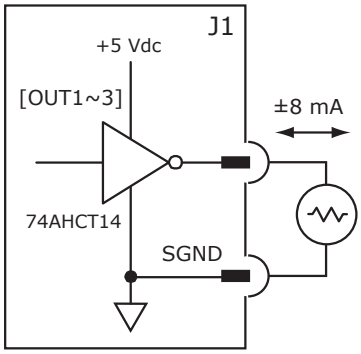
In the following diagram, the output functions shown are programmable to turn the output On (HI) or Off (LO) when they are active.

### OUTPUT FUNCTIONS

- Fault
- Custom Event
- PWM Sync
- Custom Trajectory Status
- Custom Position-Triggered Output
- Program Control
- Brake Control

| Name | J1 Pins |
|---|---|
| OUT1 | 13 |
| OUT2 | 12 |
| OUT3 | 15 |

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |




## DIGITAL OUTPUTS: OUT4~OUT6

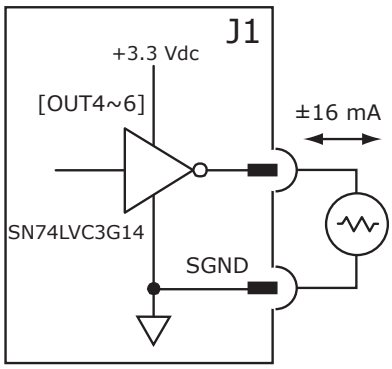
Digital outputs [OUT4~6] are CMOS inverters. They operate +3.3V and can source/sink 16 mAdc.

In the following diagram, the output functions shown are programmable to turn the output On (HI) or Off (LO) when it is active.

### OUTPUT FUNCTIONS

- Fault
- Custom Event
- PWM Sync
- Custom Trajectory Status
- Custom Position-Triggered Output
- Program Control

| Name | J1 Pins |
|---|---|
| OUT4 | 14 |
| OUT5 | 17 |
| OUT6 | 16 |




## SLI: DOUT4, DOUT5, DOUT6, IN7

The three outputs and one input operate as an SLI (Switch and LED Interface) port for controlling LEDs and reading the settings of the network address switches. In the following diagram, it shows the outputs/input in the SLI mode.

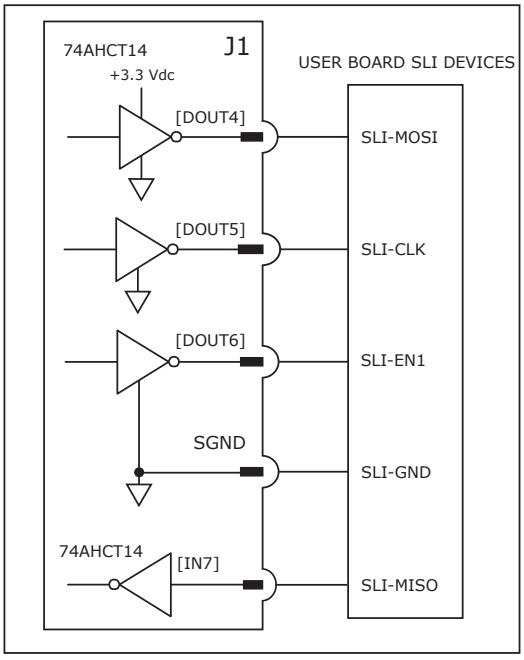
If they are not used for SLI, they are programmable for other functions to turn the output On (HI) or Off (LO) when they are active. [IN7] is shown in the diagram as part of the SLI function.

### OUTPUT FUNCTIONS

- Fault
- Brake
- Custom Event
- PWM Sync
- Custom Trajectory Status
- Custom Position-Triggered Output
- Program Control

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |

| SLI Port | Signal | J1 Pins |
|---|---|---|
| SLI-MOSI | DOUT4 | 14 |
| SLI-CLK | DOUT5 | 17 |
| SLI-EN1 | DOUT6 | 16 |
| SLI-GND | SGND | 18 |
| SLI-MISO | IN7 | 11 |



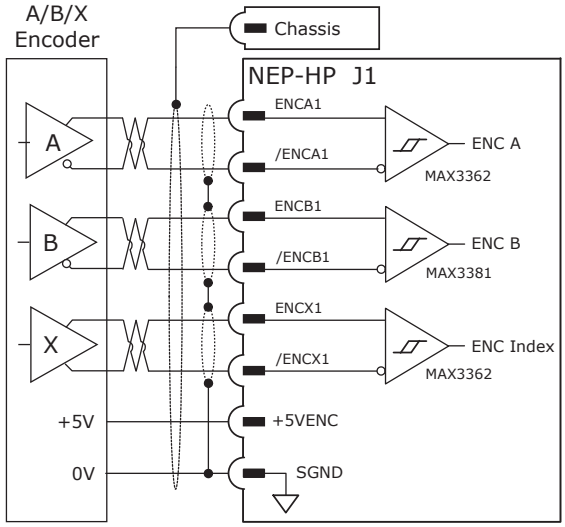
## ENCODER 1 (PRIMARY FEEDBACK)

### QUAD ENCODER WITH INDEX

#### A/B/X SIGNALS

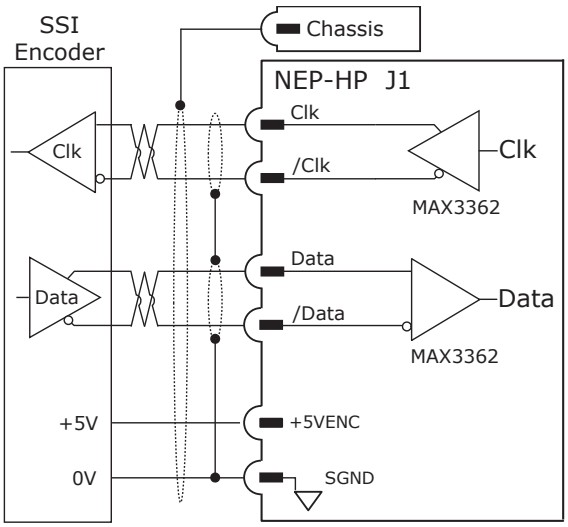
| Signal | J1 Pins |
|---|---|
| ENCA1 | 51 |
| /ENCA1 | 50 |
| ENCB1 | 53 |
| /ENCB1 | 52 |
| ENCX1 | 55 |
| /ENCX1 | 54 |
| +5VENC | 64, 66 |
| SGND | 56,57 |

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |




### SSI ABSOLUTE ENCODER

The SSI (Synchronous Serial Interface) is an interface used to connect an absolute position encoder to a motion controller or control system.
The NEP-HP drive provides a train of clock signals in differential format that are sent to the encoder which initiates the transmission of the position data on the subsequent clock pulses. The number of encoder data bits and counts per motor revolution are programmable. The hardware bus consists of two signals: SCLK and SDATA. The SCLK signal is only active during transfers. Data is clocked in on the falling edge of the clock signal.



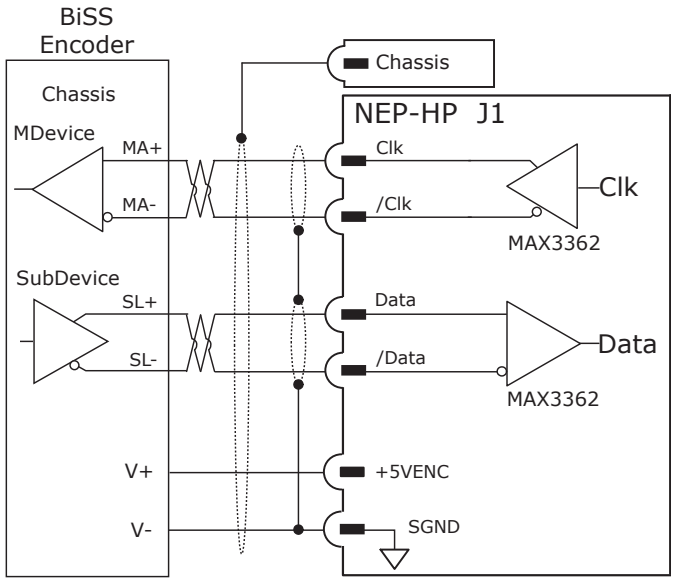

#### SSI, BiSS SIGNALS

| SSI | BiSS | Signal | J1 Pins |
|---|---|---|---|
| Clk | MA+ | ENCX1 | 55 |
| /Clk | MA- | /ENCX1 | 54 |
| Data | SL+ | ENCA1 | 51 |
| /Data | SL- | /ENCA1 | 50 |
| +5VENC | | | 64,66 |
| SGND | | | 56,57 |

### BiSS ABSOLUTE ENCODER

BiSS is an Open Source - Digital Interface used for sensors and actuators. BiSS refers to the principles of well known industrial standards for Serial Synchronous Interfaces like SSI, AS-Interface® and Interbus® with the following additional options.

- Serial Synchronous Data Communication
- Cyclic at high speed
- 2 Unidirectional Lines Clock and Data
  - -Line delay compensation for high speed data transfer
  - -Request for data generation at slaves
  - -Safety capable: CRC, Errors, Warnings
  - -Bus capability including actuators
- Bidirectional
  - -BiSS C-protocol: Continuous mode




Note: Connect single (outer) shields at the drive end. Connect inner shields to the Signal Ground on the drive.

## ENCODER 1 (PRIMARY FEEDBACK)

### ENDAT ABSOLUTE ENCODER

The EnDat interface is a Heidenhain interface that functions similar to SSI in the use of clock and data signals. In addition, it supports analog Sin/Cos channels from the same encoder.

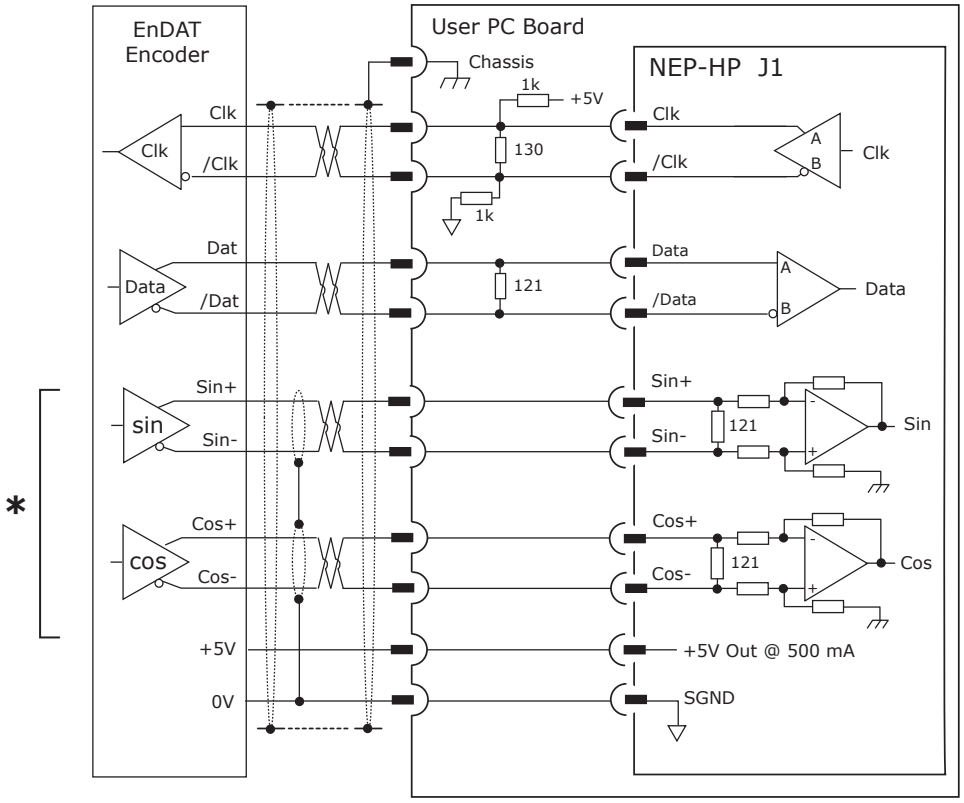
The number of position data bits are programmable and so are the use of Sin/Cos channels. In the EnDat specification, using the Sin/Cos incremental signals is optional.

#### ENDAT SIGNALS

| EnDAT | Signal | J1 Pins |
|---|---|---|
| Clk | ENCX1 | 55 |
| /Clk | /ENCX1 | 54 |
| Data | ENCA1 | 51 |
| /Data | /ENCA1 | 50 |
| Sin+* | SIN1+ | 46 |
| Sin-* | SIN1- | 47 |
| Cos+* | COS1+ | 48 |
| Cos-* | COS1- | 49 |
| +5V | +5ENC | 64,66 |

*Note: In the EnDAT column, the Sin/Cos is optional with EnDat 2.2 or any 1 Mbit or faster.
If EnDat 2.1 < 1 Mbit, EnDat Sin/Cos is required.

| J1 Signal Ground Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |




### ABSOLUTE-A ENCODER

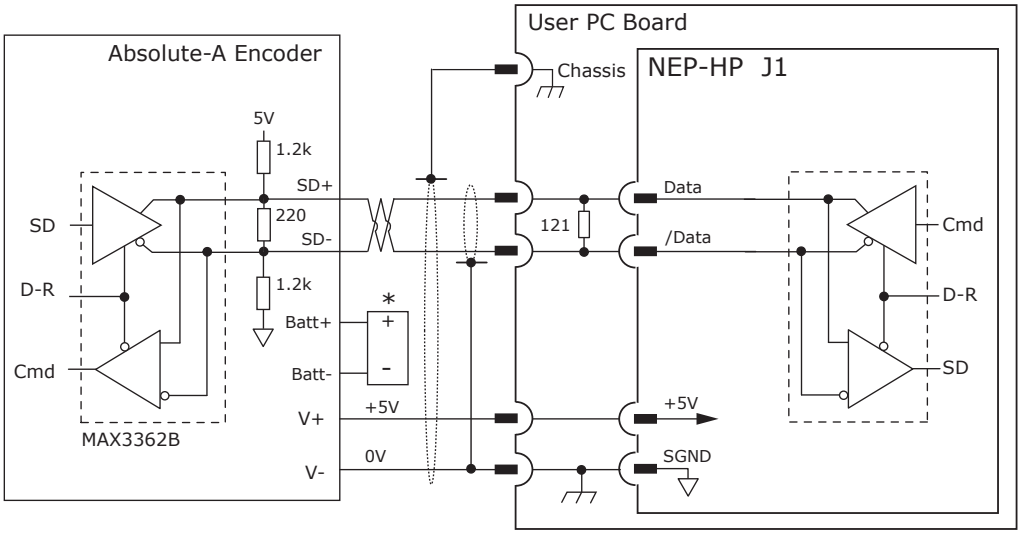
The Absolute A interface is a serial, half-duplex type that is electrically the same as the RS-485.

Note the battery which must be connected. Without the battery, the encoder will produce a fault condition.

#### ABSOLUTE-A SIGNALS

| ABS-A | Signal | J1 Pins |
|---|---|---|
| Data | ENCA1 | 51 |
| /Data | /ENCA1 | 50 |
| +5V | +5ENC | 64,66 |
| GND | SGND | 56,57 |

- Absolute A
- Tamagawa Absolute A
- Panasonic Absolute A Format
- Sanyo Denki Absolute A




Note: Signal (outer) shields should be connected at the drive end. The inner shield is optional for digital encoders and should only be connected to Signal Ground on the drive.

## ENCODER 2 (SECONDARY FEEDBACK)

### QUAD ENCODER WITH INDEX

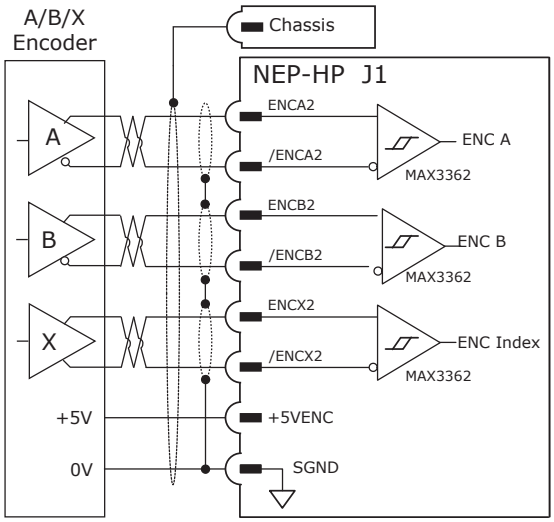
In the following diagram, it shows the secondary encoder connections.

The tables identify the signals and pins.

#### A/B/X SIGNALS

| Signal | J1 Pins |
|---|---|
| ENCA2 | 59 |
| /ENCA2 | 58 |
| ENCB2 | 61 |
| /ENCB2 | 60 |
| ENCX2 | 63 |
| /ENCX2 | 62 |
| +5VENC | 64, 66 |

| J1 SGND Pins |
|---|
| 3,4,18,39,40,44,45,56,57 |




## ABSOLUTE ENCODERS

### Secondary Feedback: Absolute

- Half-Duplex: Absolute A Encoders (2-wire)
  The A Channel first transmists a Clock signal and then switches to a receiver to receive data originating from the encoder.
- Full-Duplex: SSI, BiSS, EnDat Encoders (4-wire)
  The X Channel sends the Clock signal to the encoder which initiates the data transmission to the A-Channel.

| Feedback Options |
|---|
| Quad Encoder A, Half-Duplex CLK-DATA, Full-Duplex DATA |
| Quad Encoder /A, Half-Duplex /CLK-DATA, Full-Duplex /DATA |
| Quad Encoder B |
| Quad Encoder /B |
| Quad Encoder X, Full-Duplex CLOCK |
| Quad Encoder /X, Full-Duplex /CLOCK |

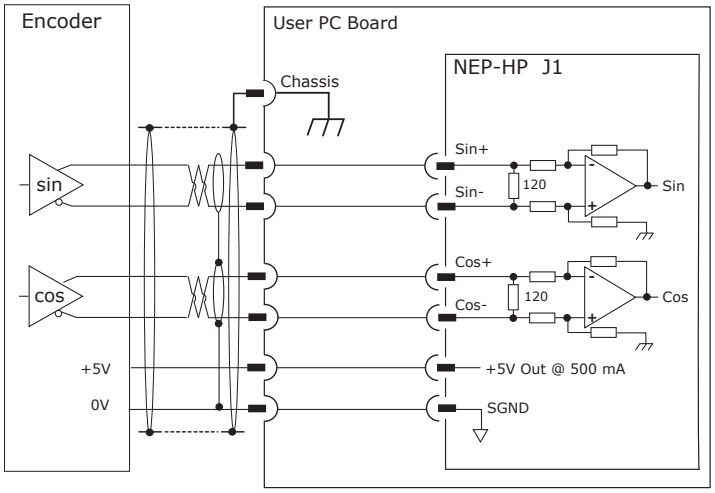
## SIN/COS ENCODER

### SIN/COS ENCODER

Sin/Cos sensors in linear brushless motors are produced from the magnetic field in the rod and provide commutation feedback as well as higher resolution position feedback by interpolating of the signals.

| Signal | J1 Pins |
|---|---|
| SIN1+ | 46 |
| SIN1- | 47 |
| COS1+ | 48 |
| COS1- | 49 |
| +5VENC | 64, 66 |
| SGND | 56, 57 |

Incremental rotary encoders are also available with Sin/Cos outputs. Programmable interpolation enables the number of counts per revolution or linear movement to be programmable.



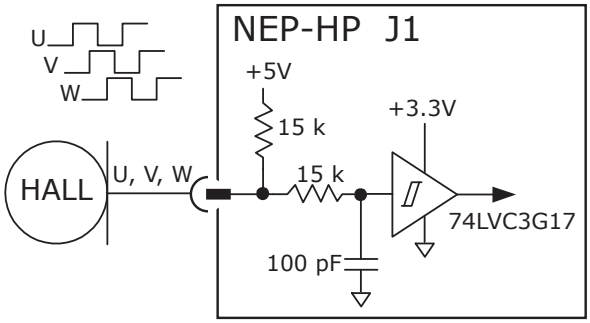

## OTHER MOTOR CONNECTIONS

### HALLS

Hall sensors in a brushless motor are driven from the magnetic field in the motor and provide commutation feedback without an encoder. When they are used with the incremental encoders, they enable the motor to operate without a phase-finding cycle.

#### HALL SIGNALS

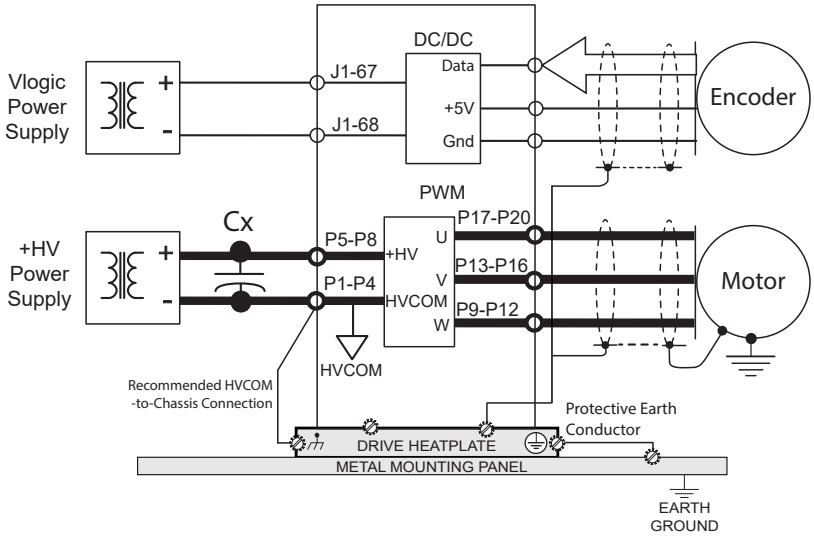
| Signal | J1 Pins |
|---|---|
| HALLU | 41 |
| HALLV | 42 |
| HALLW | 43 |



## +HV CONNECTIONS

### POWER SUPPLIES

The drive main power, +HV is typically supplied by unregulated DC power supplies. These power supplies must be isolated from the mains, and all circuits should be grounded from earth wired to HVCOM at the drive. The +HV power supply connects to P5~P8. For good wiring practice, the +HV wires should be twisted together for noise suppression, and the power supply should not be grounded. Doing this ensures that the higher currents flowing in these conductors will not flow through any circuit grounds where they might induce noise. During deceleration, mechanical energy in the motor and load is converted back into electrical energy that must be dissipated as the motor comes to a stop. While some of this is converted to heat in the motor windings, the rest of it will flow through the drive into the power supply. An external storage capacitor should be used if the load has appreciable inertia. It should be sized such that adding the undissipated energy from the motor will not raise the voltage beyond the point at which the drive shuts down. When this is not possible, an external 'dumper', or regenerative energy dissipater must be used which acts as a shunt regulator across the +HV and HVCOM terminals.



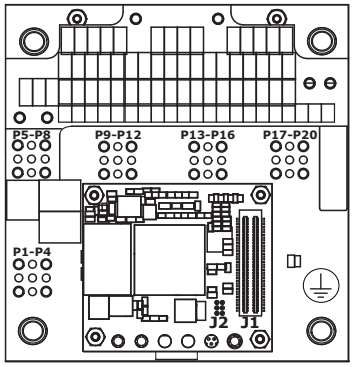

### GROUNDING

The P1~P4 connection to ground keeps the +HV power source stable at the drive while the voltage at the power supply (-) varies due to the cable resistance and the +HV current.
The labeled mounting hole provides a PE (Protective Earth) connection as well as a point to ground the motor cable shields.

**P1~P20**

| Signal | Pins |
|---|---|
| HVCOM | P1~P4 |
| +HV | P5~P8 |
| MOTW | P9~P12 |
| MOTV | P13~P16 |
| MOTU | P17~P20 |
| Chassis | * |

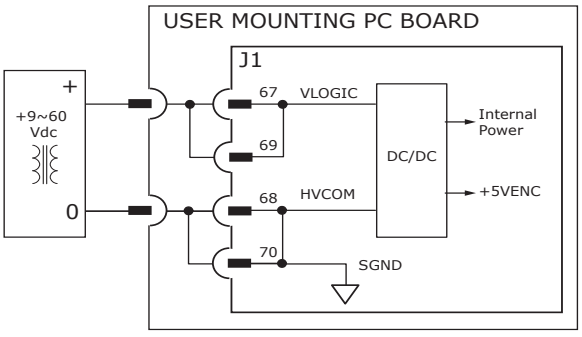
*Note: The mounting holes are connected to one another and to Chassis Ground. The mounting hole marked with the PE symbol is the connection point for the protective earth conductor.




## VLOGIC CONNECTIONS

### DESCRIPTION

VLOGIC is required for the operation of the drive. It powers the internal logic and the control circuits. Encoder +5V is derived from VLOGIC.
When the STO feature is used, VLOGIC must be produced by power supplies with transformer isolation from the mains and PELV or SELV ratings and a maximum output voltage of 60 Vdc. If the motor can operate from voltages of 60 Vdc or less, the +HV and VLOGIC can be driven from a single power supply.




**J1 VLOGIC**

| Name | Pin | | Name |
|---|---|---|---|
| VLOGIC | 67 | 68 | HVCOM |
| VLOGIC | 69 | 70 | HVCOM |

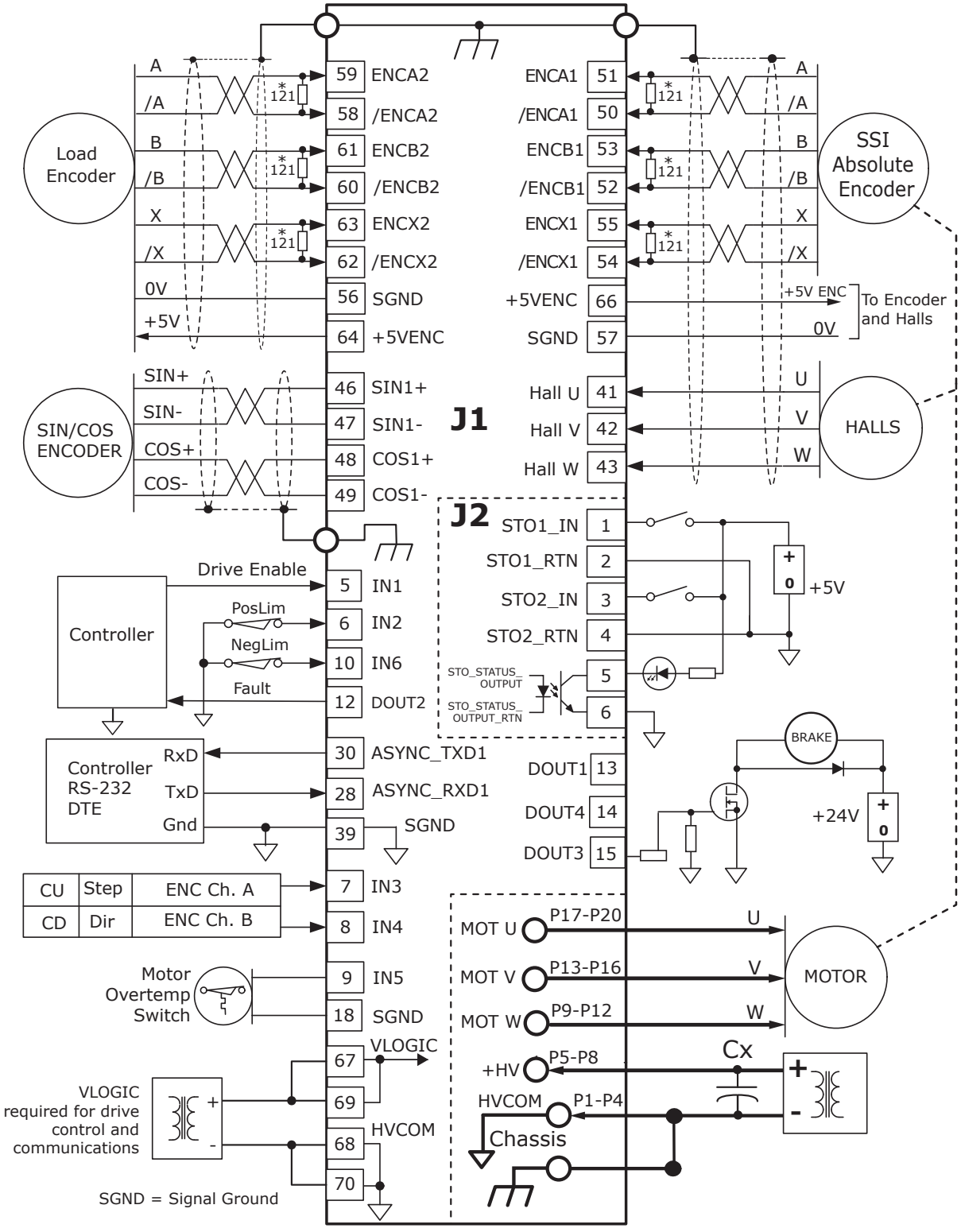
**WARNING**

***Refer to the AN136 Accelnet External Regen Application Note, Part Number 16-125661.***

VLOGIC +9~60. 24V power is recommended. If common to HV do not exceed 60V, use REGEN protection, and diode isolation from HV.

## NEP-HP TYPICAL CONNECTIONS

The following diagram shows the NEP-HP connections and identifies the pins and signals.




**NEP-HP Connections Diagram**

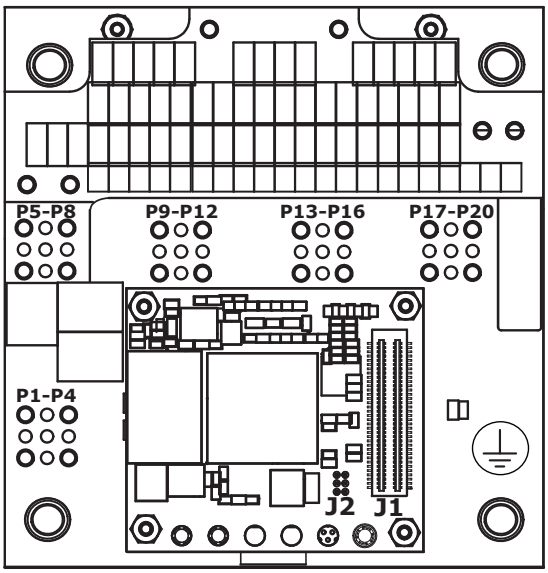
## PC BOARD CONNECTIONS

The following diagram shows the topside view of the pins and signals pointed downwards towards the PC user mounting board.

**P1~P20**

| Signal | Pins |
|---|---|
| HVCOM | P1~P4 |
| +HV | P5~P8 |
| MOTW | P9~P12 |
| MOTV | P13~P16 |
| MOTU | P17~P20 |
| Chassis | * |

*Note: The mounting holes are connected to one another and to Chassis Ground. The mounting hole marked with the PE symbol is the connection point for the protective earth conductor.




**NEP-HP Module Board Connections Diagram**

**J2 STO**

| Name | Pin | | Name |
|---|---|---|---|
| STO1_RTN | 2 | 1 | STO_1 |
| STO2_RTN | 4 | 3 | STO_2 |
| STO_STATUS_OUTPUT_RTN | 6 | 5 | STO_STATUS_OUTPUT |

**J1 SIGNAL**

| Signal | Pin | | Signal |
|---|---|---|---|
| REFIN1- | 1 | 2 | REFIN1+ |
| SGND | 3 | 4 | SGND |
| [ENABLE] IN1 | 5 | 6 | IN2 |
| IN3 | 7 | 8 | IN4 |
| IN5 | 9 | 10 | IN6 |
| IN7 | 11 | 12 | DOUT2 |
| DOUT1 | 13 | 14 | DOUT4 |
| DOUT3 | 15 | 16 | DOUT6 |
| DOUT5 | 17 | 18 | SGND |
| +3.3V_TXRX1 | 19 | 20 | ECATRX2+ |
| +3.3V_TXRX2 | 21 | 22 | ECATRX2- |
| ECATTX2+ | 23 | 24 | ECATRX1+ |
| ECATTX2- | 25 | 26 | ECATRX1- |
| ECATTX1+ | 27 | 28 | ASYNC_RXD1 |
| ECATTX1- | 29 | 30 | ASYNC_TXD1 |
| CAN_RX | 31 | 32 | ASYNC_RXD2 |
| CAN_TX | 33 | 34 | ASYNC_TXD2 |
| *HSTL_0P | 35 | 36 | HSTL_1P* |
| *HSTL_0N | 37 | 38 | HSTL_1N* |
| SGND | 39 | 40 | SGND |
| HALLU | 41 | 42 | HALLV |
| HALLW | 43 | 44 | SGND |
| SGND | 45 | 46 | SIN1+ |
| SIN1- | 47 | 48 | COS1+ |
| COS1- | 49 | 50 | /ENCA1 |
| ENCA1 | 51 | 52 | /ENCB1 |
| ENCB1 | 53 | 54 | /ENCX1 |
| ENCX1 | 55 | 56 | SGND |
| SGND | 57 | 58 | /ENCA2 |
| ENCA2 | 59 | 60 | /ENCB2 |
| ENCB2 | 61 | 62 | /ENCX2 |
| ENCX2 | 63 | 64 | +5VENC |
| N.C. | 65 | 66 | +5VENC |
| VLOGIC | 67 | 68 | HVCOM |
| VLOGIC | 69 | 70 | HVCOM |

*Note: In the Signal column, the asterisk indicates do not connect to these pins. Consult the factory for AN146: IDC Inter-Drive Communication.

| Ref Des | Label | Mfgr | Part Number * | Description | Qty |
|---|---|---|---|---|---|
| J1 | Signal | WCON | 3620-S070-022G3R02 | Header, 70 pos, 0.5 mm pitch | 1 |
| J2 | STO | WCON | 2521-203MG3CUNR1 | Header, 6 pos, 1 mm pitch | 1 |

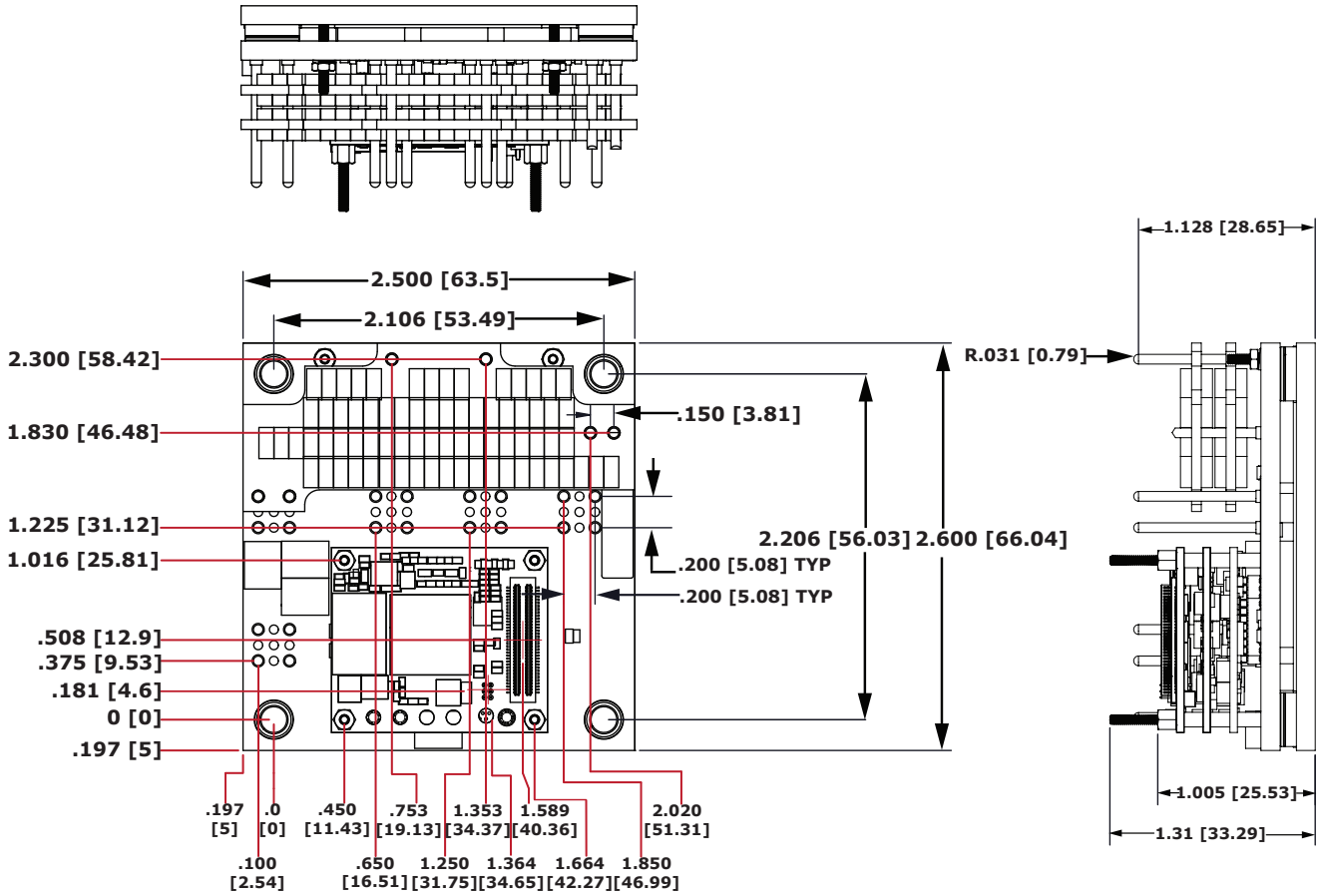
*Note: The Part Number column indicates the parts that require the purchase of reels for those components. Refer to the following vendor to contact for approved value-added partner Action Electronics.
**Action Electronics, Inc.**
**Walpole, MA 02081-2522-US**
**Phone: (508) 668-5621**

## DIMENSIONS

### NEP-HP MODULE

The following diagram shows the NEP-HP module dimensions.

The dimensions are measured in inches [in] and millimeters [mm].



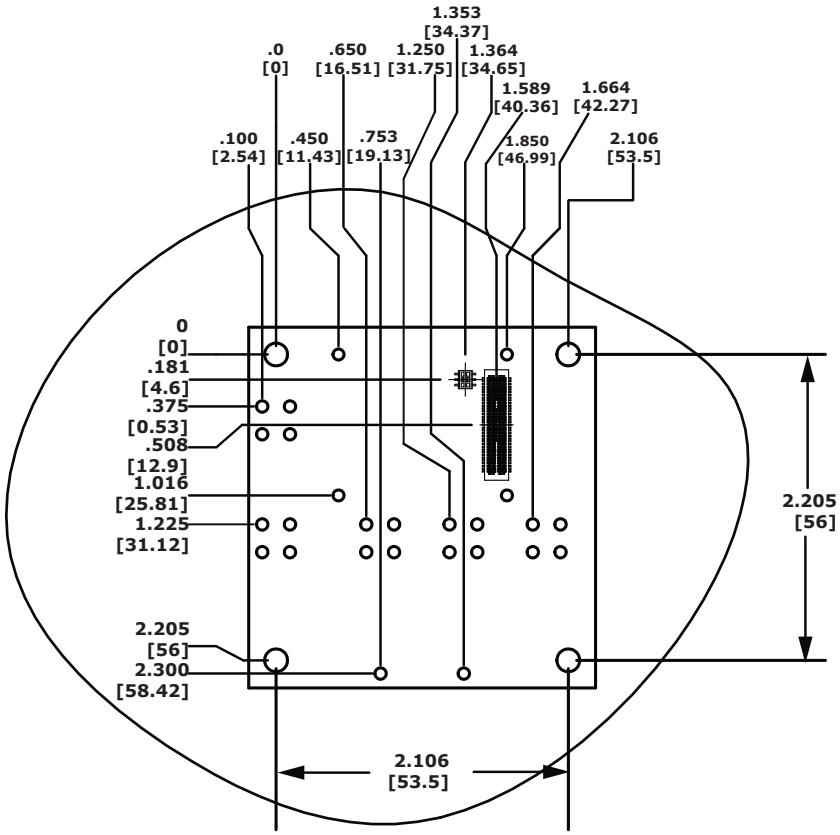

**NEP-HP Module Dimensions Diagram**

## DIMENSIONS

### PC BOARD MOUNTING DIMENSIONS

The following diagram shows the topside view of the user mounting PC board for the drive.

The STO (J2) connector is mounted on the underside of the PC board. The topside view shows the clearance holes for the STO connector mating pins.




**PC User Mounting Board Dimensions (Bottom View)**

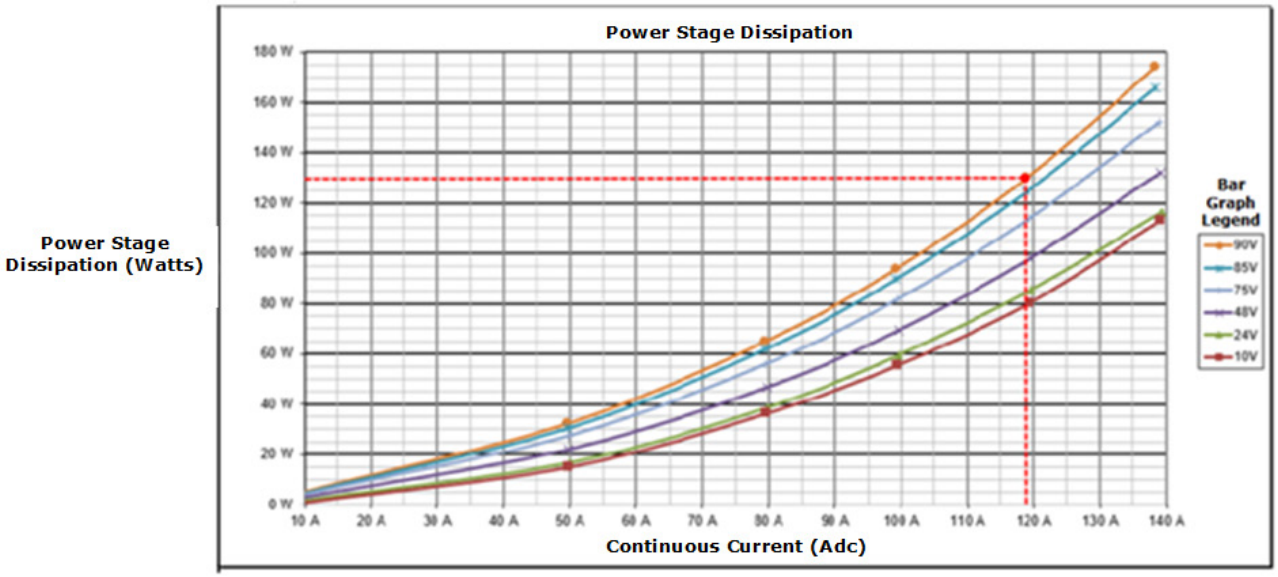
Notes:

1. The J2 Connector is not shown in the above diagram, because it is located on the far side of the PCB. The CL dimension for the connector body is shown with the 6 access holes used for the header pins so that they can pass through the customer board. Then, mate to the connector.
2. To determine the copper width and thickness for P1~P20 signals, refer to specification IPC-2221. (Association Connecting Electronic Industries, https://www.ipc.org)
3. For maximum noise suppression and immunity, connect the standoffs to etches on the PC board that connects to the chassis.
4. The Nano Plus High Power Module drives do not emit noise above 70 dB(A) when they are mounted and operating.

## THERMALS: PWM OUTPUTS DISSIPATION

The following chart shows the power dissipation in the drive when the PWM outputs are driving a motor. Adding the PWM dissipation to the VLogic dissipation will yield the total dissipation in Watts for the drive.

For example in the chart, the red dotted line show a power dissipation of 130 W at a continuous current of 119 Adc and +HV = 90 VDC.

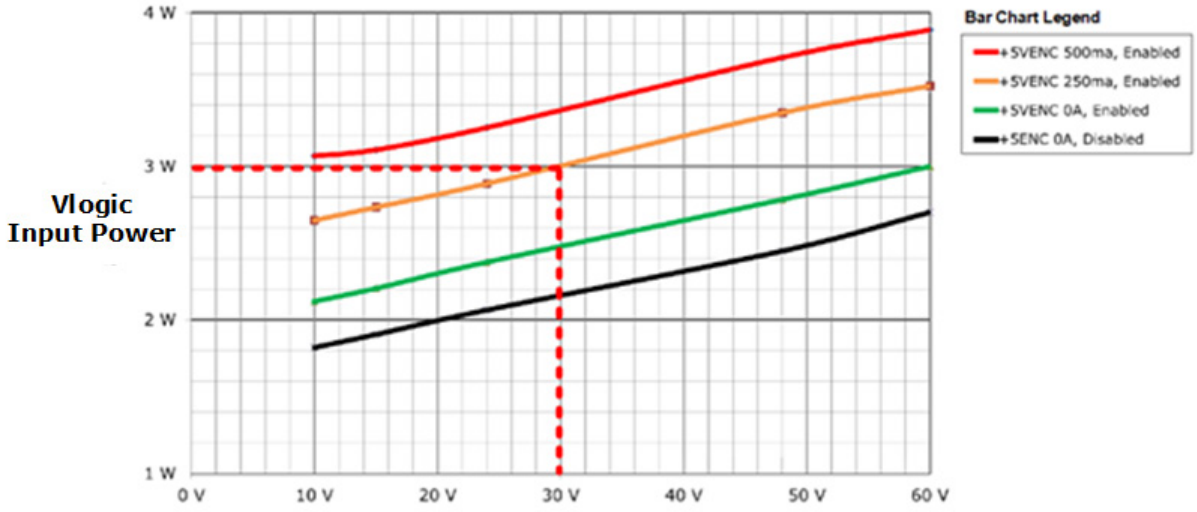



**Power Stage Dissipation Chart**

### VLOGIC/VOLTAGE

In the chart below, it shows the power dissipation in the Vlogic circuits that power the drive's control circuits and the external encoders. Adding the PWM dissipation to the Vlogic dissipation will yield the total dissipation in Watts for the drive.

In the chart, the dotted lines show a dissipation of 3.0 W. at Vlogic = 30 Vdc, when the drive is in an Enabled state and outputting 250 mA for an encoder.




**Vlogic Voltage Chart**

## NEP-HP-Z

The NEP-HP-Z Board diagram shows the connections and board layout. The tables identify the signals and pins for each connector.

### MODELS

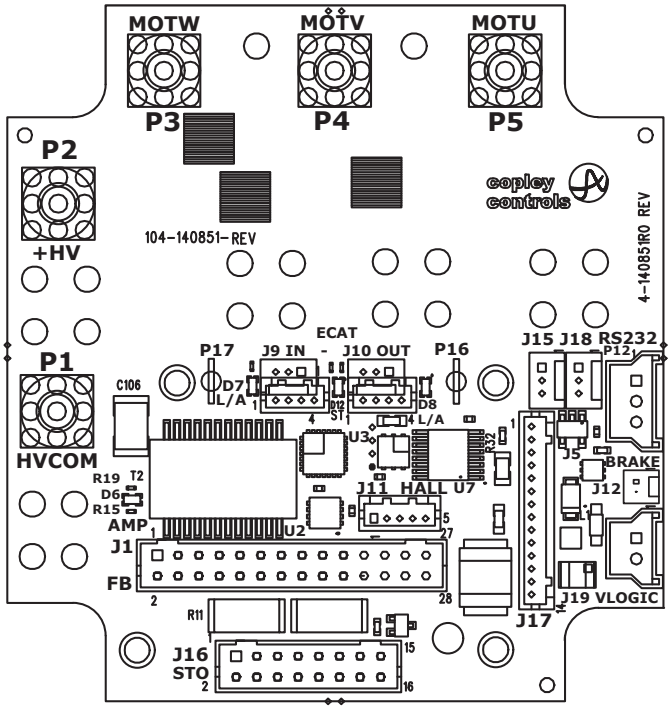
| |
|---|
| NEP-090-80-C-Z |
| NEP-090-140-C-Z |

### P1-P5

| Signal | Pin |
|---|---|
| HVCOM | P1 |
| +HV | P2 |
| MOTW | P3 |
| MOTV | P4 |
| MOTU | P5 |

### J11 HALLS

| Signal | Pin |
|---|---|
| HALLU | 5 |
| HALLV | 4 |
| HALLW | 3 |
| +5VENC | 2 |
| SGND | 1 |




NEP-HP-Z Connections Diagram

### P16 SHIELD P17 SHIELD

| Signal | Pin | Signal | Pin |
|---|---|---|---|
| SHLD | 1 | SHLD | 1 |

### J9 ECAT J10 ECAT

| IN | Pin | OUT | Pin |
|---|---|---|---|
| RX1+ | 1 | RX2+ | 1 |
| RX1- | 2 | RX2- | 2 |
| TX1+ | 3 | TX2+ | 3 |
| TX1- | 4 | TX2- | 4 |

### P12 RS-232

| Signal | Pin |
|---|---|
| RX232TX1 | 3 |
| RS232RX1 | 2 |
| SGND | 1 |

### J12 BRAKE

| Signal | Pin |
|---|---|
| VLOGIC | 2 |
| BRAKE | 1 |

### J19 VLOGIC

| Signal | Pin |
|---|---|
| VLOGIC | 2 |
| HVCOM | 1 |

### J16 STO

| Signal | Pin | | Signal |
|---|---|---|---|
| STO1_24V_IN | 2 | 1 | STO1_RTN |
| STO_1 | 4 | 3 | STO1_RTN |
| N.C. | 6 | 5 | N.C. |
| STO2_24V_IN | 8 | 7 | STO2_RTN |
| STO_2 | 10 | 9 | STO2_RTN |
| N.C. | 12 | 11 | N.C. |
| STO_STATUS_ OUTPUT_RTN | 14 | 13 | SGND |
| +5V | 16 | 15 | STO_STATUS_ OUTPUT |

### J1 I/O

| Signal | Pin | | Signal |
|---|---|---|---|
| /ENCA2 | 2 | 1 | Chassis |
| ENCA2 | 4 | 3 | SGND |
| IN1_24V | 6 | 5 | +5VENC |
| IN2_24V | 8 | 7 | +5VENC |
| IN3 | 10 | 9 | /ENCB2 |
| IN4 | 12 | 11 | ENCB2 |
| IN5 (MOTEMP) | 14 | 13 | SGND |
| IN6 (ENC_FAULT) | 16 | 15 | /ENCX2 |
| IN7 (SLI_MISO) | 18 | 17 | ENCX2 |
| SGND | 20 | 19 | REFIN1- |
| DOUT1 | 22 | 21 | REFIN1+ |
| DOUT2 | 24 | 23 | SGND |
| DOUT3 (BRAKE OFF) | 26 | 25 | DOUT6 (SLI_EN1) |
| DOUT4 (SLI_MOSI) | 28 | 27 | DOUT5 (SLI_CLK) |

### J17 ENCODER 1

| Signal | Pin |
|---|---|
| +5VENC | 1 |
| SGND | 2 |
| /ENCA1 | 3 |
| ENCA1 | 4 |
| /ENCB1 | 5 |
| ENCB1 | 6 |
| /ENCX1 | 7 |
| ENCX1 | 8 |
| IN5 | 9 |
| SGND | 10 |
| COS1+ | 11 |
| COS1- | 12 |
| SIN1+ | 13 |
| SIN1- | 14 |

## NEP-HP-Z: P12 RS-232

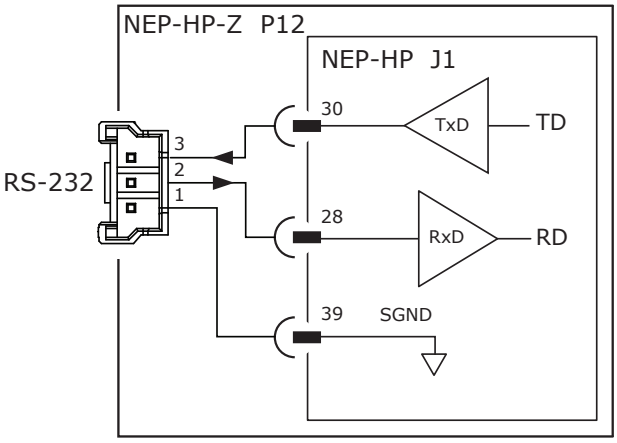
### RS-232 CONNECTION

The RS-232 port is used to configure the drive for stand-alone applications, or it is used for the configuration before it is installed into an EtherCAT network.

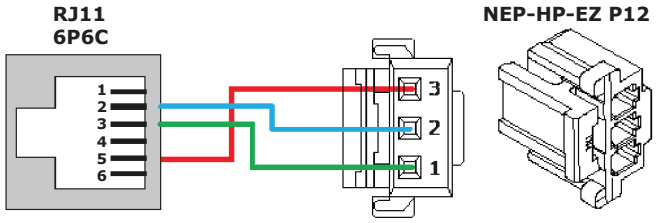
**P12 RS-232**

| Signal | Pin |
|---|---|
| RX232TX1 | 3 |
| RS232RX1 | 2 |
| SGND | 1 |

The Copley software communicates with the drive over this link. It is then used for the complete drive setup. The EtherCAT Device ID is set via RS-232 along with other operating functions.

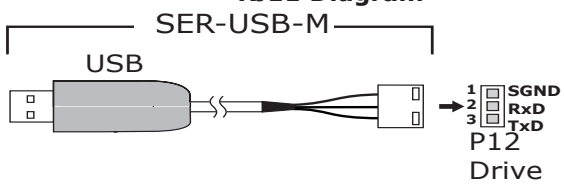



The RJ-11 socket (6P6C) is compatible with the existing serial-data cables. It can be done using an RJ-11 socket (6P6C) wired with a compatible serial-data cable as shown in the RJ11 Diagram. Molex: 42410-6170 Modular Jack, 6 terminals, size 6




**RJ11 Diagram**

Copley offers a SER-USB-M serial port adapter. This serial port is a full-duplex, three-wire (RxD, TxD, SGND) type that operates from 9,600 to 230,400. The SER-USB-M cable has output levels that are compatible with NEP-HP-Z serial port.




## NEP-HP-Z: DRIVE STATUS LED (AMP)

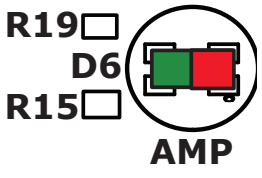
### DRIVE STATUS LED (AMP)

A bi-color LED "AMP" displays the state of the drive. Colors do not alternate and can be solid On or Blinking.
If multiple conditions occur, only the top-most condition will be displayed. When that condition is cleared, the next condition in the table is shown.

| LED | Condition Description |
|---|---|
| Red/Blinking | Latching fault. Operation can not resume until the drive is Reset. |
| Red/Solid | Transient fault condition. Drive can resume the operation when the condition causing the fault is removed. |
| Green/Slow-Blinking | Drive OK but NOT-enabled. Can run when enabled. |
| Green/Fast-Blinking | Positive or Negative limit switch active. Drive can only move in the direction not inhibited by the limit switch. |
| Green/Solid | Drive OK and enabled. Can run in response to reference inputs or EtherCAT commands. |

### LATCHING FAULTS

| Default | Optional (Programmable) |
|---|---|
| Short Circuit (Internal or External) | Over-voltage |
| Drive Over-temperature | Under-voltage |
| Motor Over-temperature | Motor Phasing Error |
| Feedback Error | Command Input Fault |
| Following Error | Motor Wiring Disconnected |
| | Over Current (Latched) |



## NEP-HP-Z: J9~J10 ETHERCAT COMMUNICATIONS

EtherCAT is the open, real-time Ethernet network developed by Beckhoff based on the widely used 100BASE-TX cabling system. EtherCAT enables high-speed control of multiple axes while maintaining tight synchronization of clocks in the nodes.

Data protocol is CANopen application protocol over EtherCAT (CoE) based on DSP-402 for motion control devices. For additional information on EtherCAT, refer to the web-site: https://ethercat.org.

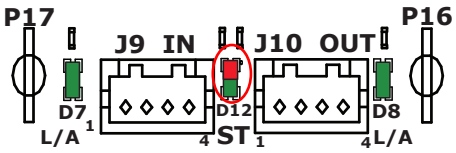
### ETHERCAT CONNECTIONS

J9 & J10 accept the Ethernet cables. The IN port connects to a master, or it connects to the OUT port of a device that is 'upstream', between the Nano and the master.

The OUT port connects to 'downstream' nodes. If the drive is the last node on a network, only the IN port is used. No terminator is required on the OUT port.

### ETHERCAT STATUS LED

| RUN<br>Green shows the state of the ESM (EtherCAT State Machine). | | ERR<br>Red shows errors such as watchdog timeouts and unsolicited state changes in the drive due to local errors. | |
|---|---|---|---|
| Off | = Init State | Off | = EtherCAT communications are working correctly. |
| Blinking | = Pre-operational | Blinking | = Invalid configuration, general configuration error |
| Single Flash | = Safe-Operational | Single Flash | = Local error, slave has changed EtherCAT state autonomously |
| On | = Operational | Double Flash | = PDO or EtherCAT watchdog timeout, or an application watchdog timeout has occurred. |




### L/A (LINK/ACT)

Green indicates the state of the EtherCAT network.

| LED | Link | Activity | Condition |
|---|---|---|---|
| On | Yes | No | = Port Open |
| Flickering | Yes | Yes | = Port Open with Activity |
| Off | No | (N/A) | = Port Closed |

### ETHERCAT DEVICE ID

In an EtherCAT network, slaves are automatically assigned fixed addresses based on their position on the bus. Stations on EtherCAT are automatically addressed by their bus location. The first drive on the network is station address -1. The second drive is station address -2, and so forth.

When a device is required to have a positive identification that is independent of cabling, a Device ID is needed. This Device ID can be set using the digital inputs or set with a programmed value. Use the Copley software to configure both of these modes.

### ETHERCAT CONNECTORS

In the following RJ45 diagram, it shows the connections to the EZ Board that use the standard RJ45 recepticals for their network connections. The tables identify the pins and signals for each connector.

**RJ45**

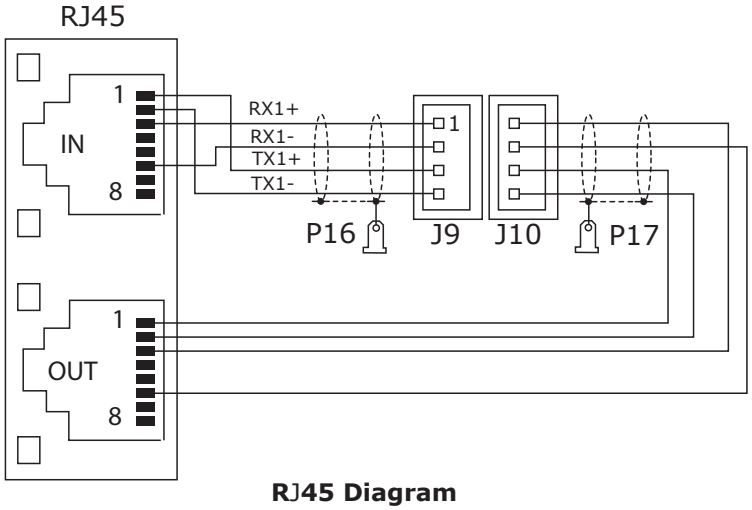
| Signal | Pins |
|---|---|
| TX1+ | 1 |
| TX1- | 2 |
| RX1+ | 3 |
| N.C. | 4 |
| N.C. | 5 |
| RX1- | 6 |
| N.C. | 7 |
| N.C. | 8 |

**J10 ECAT-OUT**

| Pin | Signal |
|---|---|
| 1 | RX2+ |
| 2 | RX2- |
| 3 | TX2+ |
| 4 | TX2- |

**J9 ECAT-IN**

| Pin | Signal |
|---|---|
| 1 | RX1+ |
| 2 | RX1- |
| 3 | TX1+ |
| 4 | TX1- |




**RJ45 Diagram**

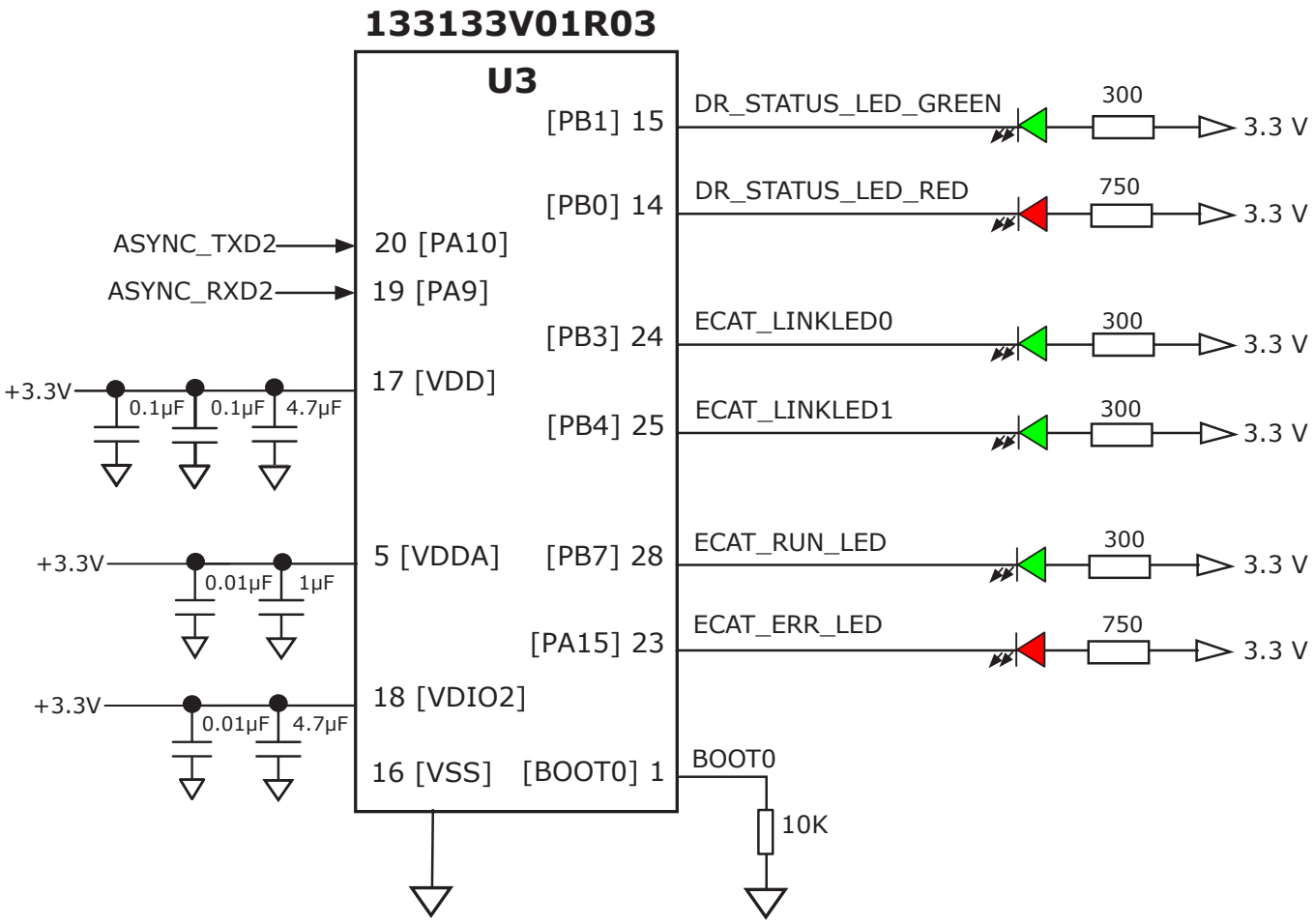
Note: Use the P16 & P17 for shields in the J9 and J10 EtherCAT cables.

## NEP-HP-Z: DRIVE AND NETWORK STATUS LEDS

The microprocessor chip uses the serial port with ASYNC_TXD2 and ASYNC_RXD2 to drive LEDs.

- DR_STATUS_LED_X signals drive the AMP STATUS LED.
- ECAT_XXX_LED shows the network status of the drive communication.
- ECAT_LINKLEDx signals show the presence of activity on the ECAT connections.

In the following diagram, it shows the NEP-HP-Z drive and the network status LEDs.




**NEP-HP-Z Drive and Network Status LEDs Diagram**

**Ordering Information: U3**

In the above diagram, U3 can be purchased through the Copley approved supplier, Arrow Electronics.

**Contact Information:**
**Arrow Electronics**
**4 Technology Drive**
**Peabody, MA 01960**
**Phone: (978) 538-8500**

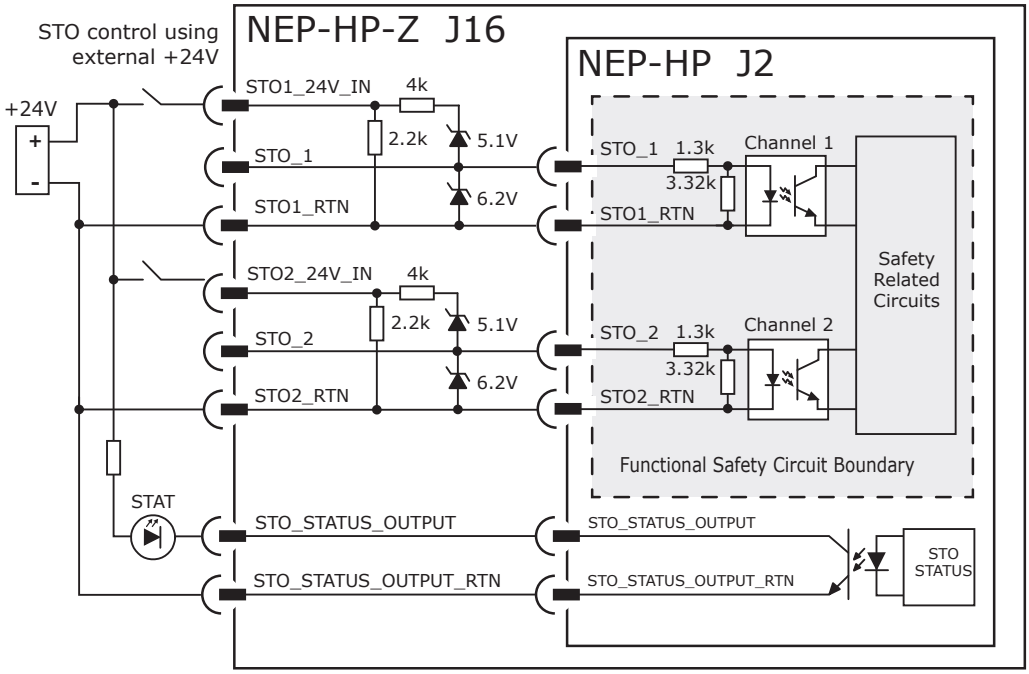
Refer to the table below for more details.

| Part Number | Supplier | Description |
|---|---|---|
| 133133V01R03 | Arrow Electronics | Pre-programmed uC for Drive and Network Status LEDs. |
| NOTE: For information on the STM32F042G4U6TR electrical, pinout and package details, refer to the product: STM32F042G4U6TR Datasheet. The datasheet is posted on the ST Microelectronics website: https://www.st.com. | | |

## NEP-HP-Z: J16 SAFE TORQUE OFF [STO]

### DESCRIPTION

In the following diagram, it shows the use of an external 24V to energize the STO inputs. Both STO inputs must be energized in order to enable the drive.




**NEP-HP-Z J16 STO Diagram**

NOTE: In the diagram, the +24V shown can be driven from the VLOGIC power supply. The STOx_24V_IN circuits can tolerate the +60V limit of the VLOGIC input. The STO_x maximum voltage limits are +7.0 Vdc.

### STO_STATUS_OUTPUT

| | | | | |
|---|---|---|---|---|
| STO1 | 0 | 1 | 0 | 1 |
| STO2 | 0 | 0 | 1 | 1 |
| STAT | 0 | 1 | 1 | 1 |

In the STAT-OUT Operation table, the following describes the values.

- STO1 & STO2 rows, 1 = 24V. It is applied between the IN-24V and RTN. 0 = open-circuit.
- In the STAT row, 1 = the optocoupler is ON, 0 = the optocoupler is OFF.
- STAT output is ON (True) when both STO1 & STO2 are energized, allowing the drive to be enabled and to produce torque.

### J16 STO

| Signal | Pin | | Signal |
|---|---|---|---|
| STO1_RTN | 1 | 2 | STO1_24V_IN |
| STO1_RTN | 3 | 4 | STO_1 |
| N.C. | 5 | 6 | N.C. |
| STO2_RTN | 7 | 8 | STO2_24V_IN |
| STO2_RTN | 9 | 10 | STO_2 |
| N.C. | 11 | 12 | N.C. |
| SGND | 13 | 14 | STO_STATUS_OUTPUT_RTN |
| STO_STATUS_OUTPUT | 15 | 16 | +5V |

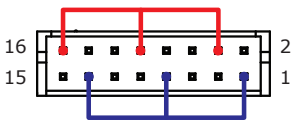
### STO OPERATION

| STO Input Voltage | STO State |
|---|---|
| STO1_24V_IN *AND* STO2_24V_IN ≥ 15 Vdc | STO Inactive. Drive can be enabled to produce torque. |
| STO_1 *AND* STO_2 ≥ 3.0 Vdc | |
| STO1_24V_IN *OR* STO2_24V_IN < 5.0 Vdc | STO Active. Drive cannot be enabled to produce torque. |
| STO_1 *OR* STO_2 ≤ 0.8 Vdc | |
| STO_1 *OR* STO_2 Open | |

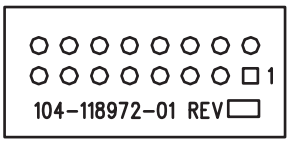
NOTE: In the above table, the voltages are referenced between a STO_x and a STOx_RTN in J16
For example, V(STO1) = V(STO1_24V_IN) - V(STO1_RTN)

## NEP-HP-Z: J16 SAFE TORQUE OFF (STO) BYPASS

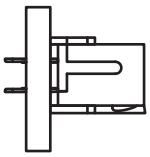
The Bypassing function is used when the user does not require the STO function. The STO-Bypass has jumpers that use the +5VENC to energize the STO inputs. This disables the STO function, allowing the drive to be enabled from hardware inputs or a network. The following diagrams show the STO-Bypass top and bottom views.

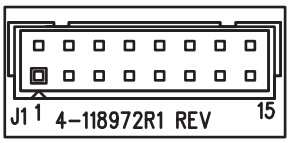



Top View




Top View






Bottom View

## NEP-HP-Z: +HV & MOTOR CONNECTIONS

**+HV**

The +HV power supply outputs connect to terminal P2. HVCOM connects to terminal P1. An overall cable shield for the +HV/HVCOM pair is necessary to meet EMC requirements. As shown, this shield connects to the chassis ground at the power supply end and to chassis ground at the drive end. To minimize electrical noise, Copley recommends that the user connect the negative (-, HVCOM) terminal of the power supply with a short, direct path to the drive chassis ground located close to the drive.

**MOTOR**

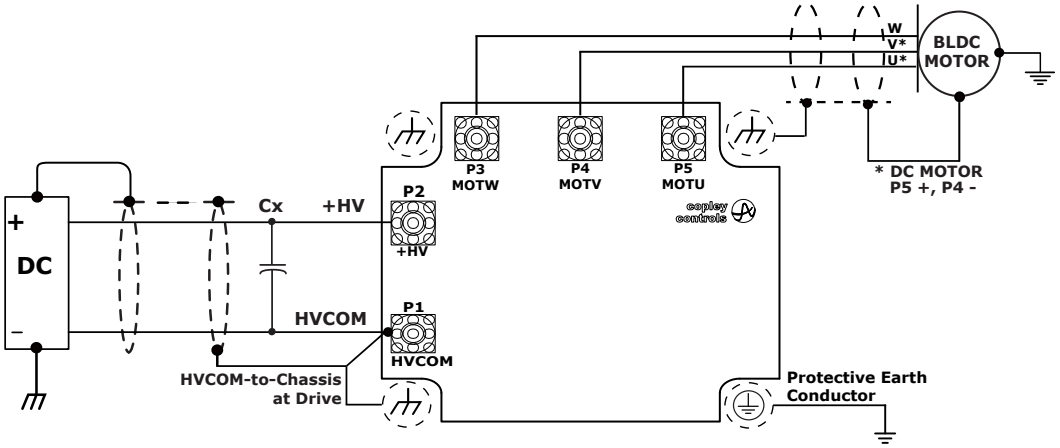
P5, P4 and P3 are used for the motor windings U, V and W respectively. Motor cables typically have one wire for each of the three phases and a fourth wire for connecting the motor housing to protective earth. The protective earth conductor wire color is commonly GREEN with a YELLOW stripe. This user must connect this protective earthing conductor to a suitable protective earth connection point which is most often found on the frame of the machine into which the drive and motor are mounted

**Protective Earth**

The Nano Plus High Power drives are Protective Class I equipment relating to protection against electric shock. Accordingly, the drives have both basic insulation between circuits and accessible conductive parts and offer a method of connecting a protective earthing conductor to prevent accessible conductive parts (the heatplate for example) from becoming 'hazardous live' in the event of a failure of the basic insulation. The PE symbol appears next to one of the four corner mounting holes on the module and identifies it as the connection point for the protective earthing conductor.

**Chassis Ground Connections**

The mounting holes other than the one specified as the Protective Earth connection point, are suitable connection points for connecting cable shields to Chassis Ground and for connecting the negative (-, HVCOM) power supply terminal to Chassis Ground.




**NEP-HP-Z +HV & Motor Connections Diagram**

| Pin | Signal |
|---|---|
| P1 | HVCOM |
| P2 | +HV |

| Pin | Signal |
|---|---|
| P3 | Motor W |
| P4 | Motor V |
| P5 | Motor U |

| Description | Data |
|---|---|
| Recommended Wire | 2~4 AWG, 600 V, shielded cable required for CE compliance. |
| Recommended | #10 Ring Terminal, 4AWG Wire, Insulated |

## NEP-HP-Z: J12 BRAKE

**J12 BRAKE:**

The EZ board has components that can actuate a brake using pulse-width modulation, controlled by DOUT3.

The behavior is based on the following parameters, which can be set using the Copley software.

| Parameter | Description |
|---|---|
| Initial Voltage (V) | Applied to the brake by duty cycling OUT3 to the brake's rated voltage. |
| Time at Inital Voltage (ms) | Sufficient time to open the brake after which, it switches to Holding Voltage. |
| Holding Voltage (V) | A lower duty-cycled voltage that is adequate to hold the brake open without overheating. |
| PWM Frequency (Hz) | 16 KHz is the default and it is programmable. |

### SPECIFICATIONS

| Input | Data | Notes |
|---|---|---|
| Voltage Range | Max | +9~60 Vdc |
| Output Current | Ids | 1.0 Adc |

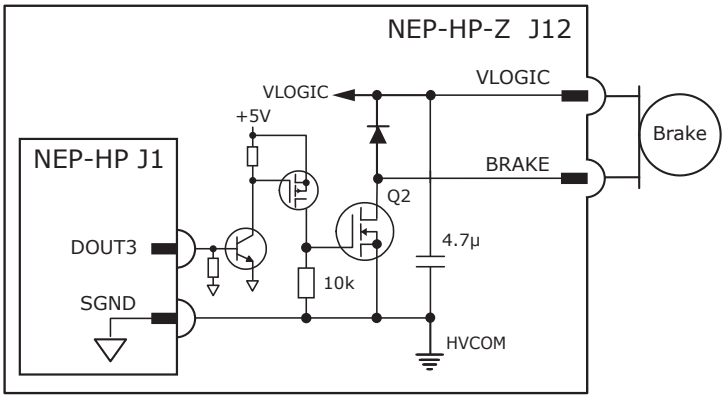
### J12 BRAKE

| Pin | Signal |
|---|---|
| 2 | VLOGIC |
| 1 | BRAKE |

Copley software default setting for Brake Output [DOUT3] is "Custom Brake Output."

"Active = Brake is holding motor shaft (i.e. the *Brake is Active*).
Motor cannot move.
No current flows in coil of brake.
Copley software I/O Line States shows [DOUT3] as LO.
BRK Output voltage is HI (24V), MOSFET Q2 is OFF.
Servo drive output current is zero.
Servo drive is disabled, PWM outputs are OFF.

Inactive=Brake is not holding motor shaft
(i.e. the *Brake is NOT-Active*).
Motor can move.
Current flows in coil of brake.
Copley software I/O Line States shows [DOUT3] as HI.
BRK output voltage is LO (~0V), MOSFET Q2 is ON.
Servo drive is enabled, PWM outputs are ON.
Servo drive output current is flowing.




## NEP-HP-Z: J19 VLOGIC

**J19 VLOGIC:**

The J19 VLogic powers the internal logic and control circuits in the drive. When the STO feature is used, it must be produced by the power supplies with the transformer isolation from the mains, PELV or SELV ratings, and provide a maximum output voltage of 60 Vdc.

If the motor can operate from voltages of 60 Vdc or less, the +HV and VLOGIC can be driven from a single power supply.

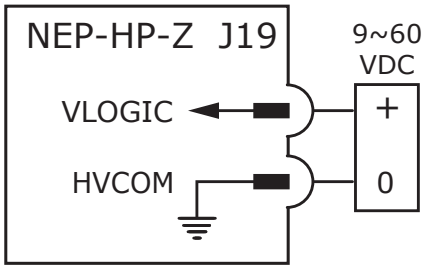
### SPECIFICATIONS

| Input | Data | Notes |
|---|---|---|
| Voltage Range | Max | +9~60 Vdc |
| Input Power | Typ | 4 W |
| | Max | 8 W |

NOTE: The following are the input power values:
- Typical input power is no load on encoder +5V.
- Maximum input power is two encoders @ 250 mA each, and +5V at maximum.

### J19 VLOGIC

| Pin | Signal |
|---|---|
| 2 | VLOGIC |
| 1 | HVCOM |




| | |
|---|---|
| ***WARNING*** | ***Refer to the AN136 Accelnet External Regen Application Note, Part Number 16-125661.*** |
| | Vlogic +9~60. 24V power is recommended. If using a 24V Brake, 24V is required. If common to HV do not exceed 60V, use REGEN protection and diode isolation from HV. |

## NEP-HP-Z: J1 INPUTS & OUTPUTS

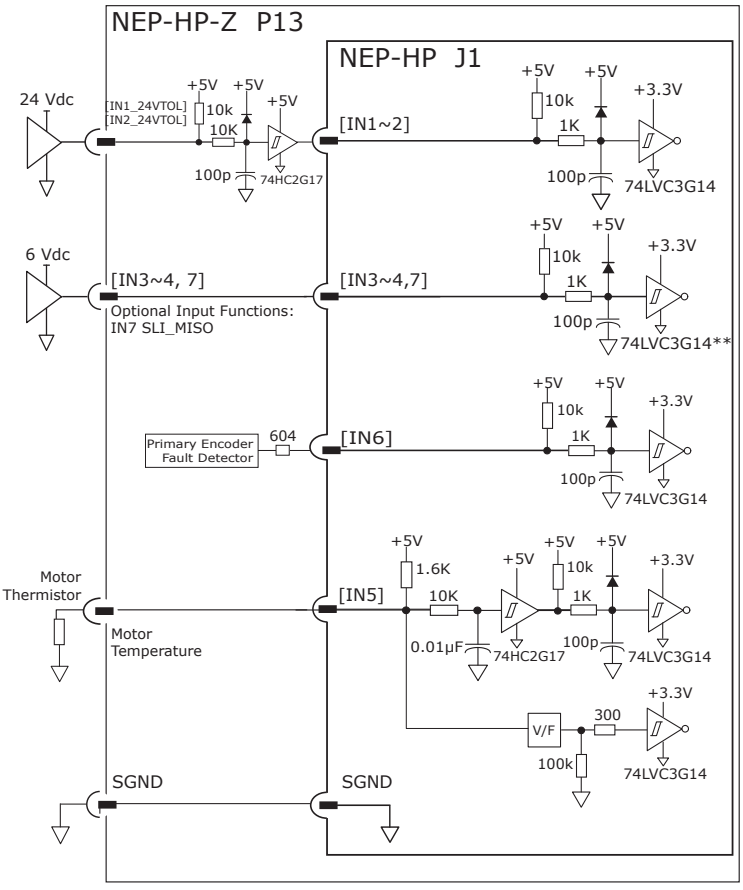
J1 has the following inputs and outputs:
- Digital Inputs 1~7
- Digital Outputs 1~6
- Analog Differential Input
- Secondary Quad A/B/X Encoder Input

The inputs and outputs are described as follows:
- IN1~2 are 24V compatible.
- IN3,4,5,7 are 6V tolerant.
- IN6 is dedicated to primary encoder fault detection.

### J1 LOGIC INPUTS

| Signal | Pins |
|---|---|
| IN1_24VTOL | 6 |
| IN2_24VTOL | 8 |
| IN3 | 10 |
| IN4 | 12 |
| IN5[1] | 14 |
| IN6 | 16 |
| IN7[2] | 18 |
| +5 V | 5,7 |
| SGND | 3,13,20,23 |

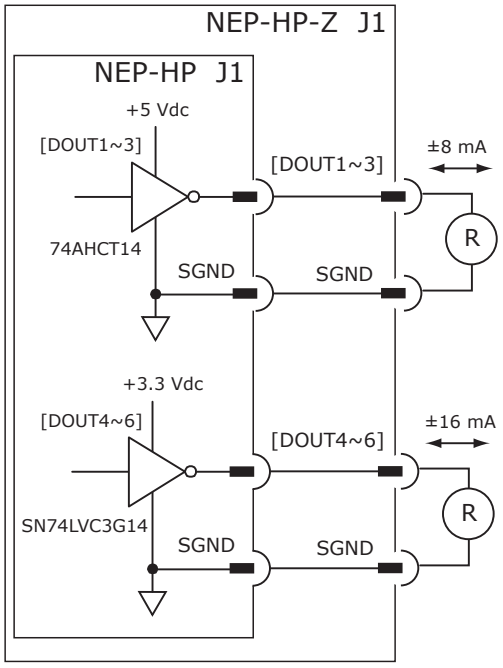
NOTES:
1) For information on IN5, refer to page 9:Motor Overtemp Input IN5.
2) The gate on IN7 is 74AHCT14BQ powered with 5.0 Vdc.




**NEP-HP-Z J1 Connections Diagram**

### J1 LOGIC OUTPUTS

| Signal | Pins |
|---|---|
| DOUT1 [OUT1] | 22 |
| DOUT2 [OUT2] | 24 |
| DOUT3 [BRAKE_OFF] | 26 |
| DOUT4 [SLI_MOSI] | 28 |
| DOUT5 [SLI_CLK] | 27 |
| DOUT6 [SLI_ENI] | 25 |
| SGND | 3,13,20,23 |



## NEP-HP-Z: J1 ANALOG INPUT

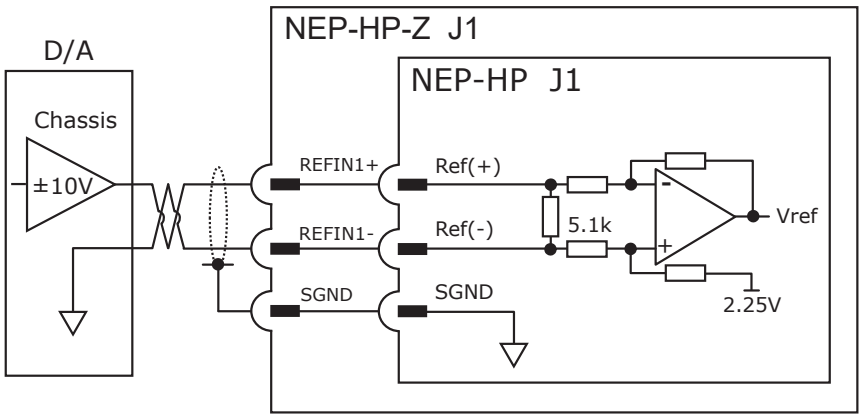
As a reference input, the J1 analog input takes Position/Velocity/Torque commands from a controller.

If it is not used as a command input, it can be used as the general-purpose analog input.

### SPECIFICATIONS

| Specifications | Data | Notes |
|---|---|---|
| Input Voltage | Vref | ±10 Vdc |
| Input Resistance | Rin | 5.1 kΩ |

| Signal | J1 Pins |
|---|---|
| Ref(+) | 21 |
| Ref(-) | 19 |



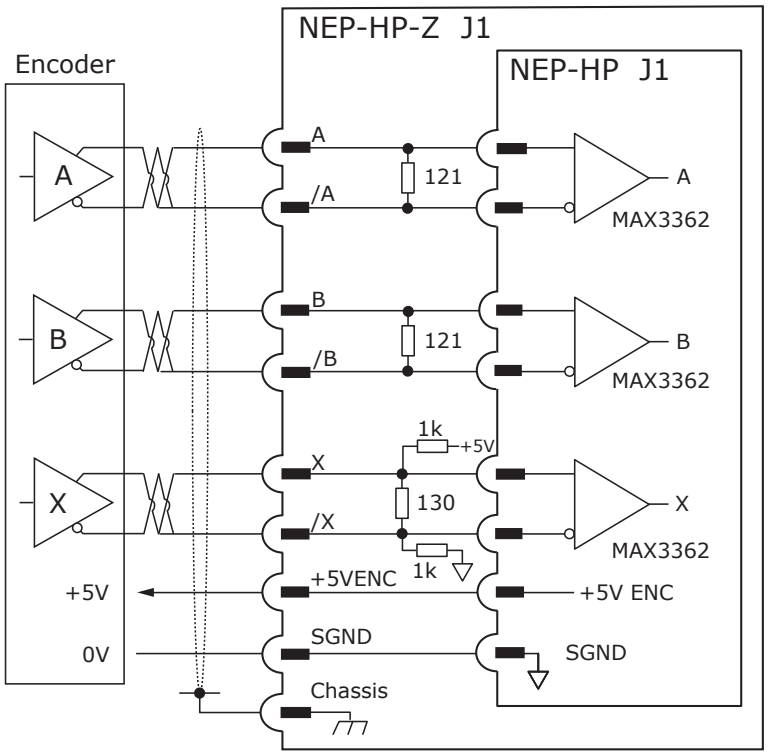

## NEP-HP-Z: J1 SECONDARY ENCODER

In the following diagram, it shows the NEP-HP-Z J1 secondary encoder connections. The table identifies the signal and pins for the J1 ENC2 inputs.

Use the secondary encoder when the load is not connected directly to the motor.

### J1 ENC2 INPUTS

| Signal | Pins |
|---|---|
| ENCA2 [A] | 4 |
| /ENCA2 [/A] | 2 |
| ENCB2 [B] | 11 |
| /ENCB2 [/B] | 9 |
| ENCX2 [X] | 17 |
| /ENCX2 [/X] | 15 |
| +5VENC | 5,7 |
| SGND | 3,13,20,23 |
| Chassis | 1 |



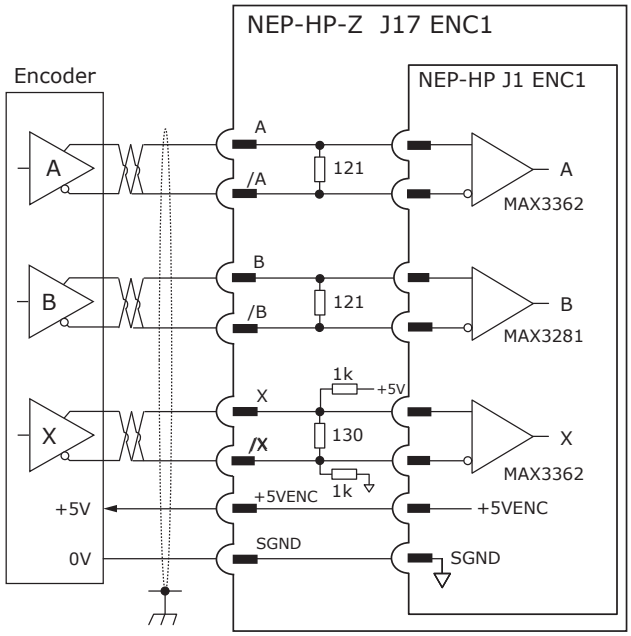
## NEP-HP-Z: J17 PRIMARY ENCODER

ENC1 is the Motor encoder. It is used in the single-encoder applications.

In the dual-encoder applications, it can be assigned as Primary or Secondary in the Copley software.

**J17 ENC1 INPUTS**

| Signal | Pins |
|---|---|
| ENCA1 [A] | 4 |
| /ENCA1 [/A] | 3 |
| ENCB1 [B] | 6 |
| /ENCB1 [/B] | 5 |
| ENCX1 [X] | 8 |
| /ENCX1 [/X] | 7 |
| OVERTEMP_IN [IN5] | 9 |
| +5VENC | 1 |
| SGND | 2,10 |



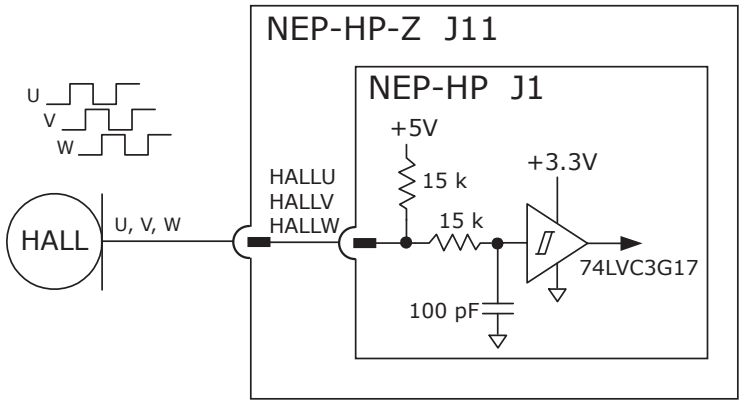

## NEP-HP-Z: J11 HALLS

In the NEP-HP-Z, J11 diagram, it shows the Halls connections.

The table identifies the signal and pins for the J11 Hall Inputs.

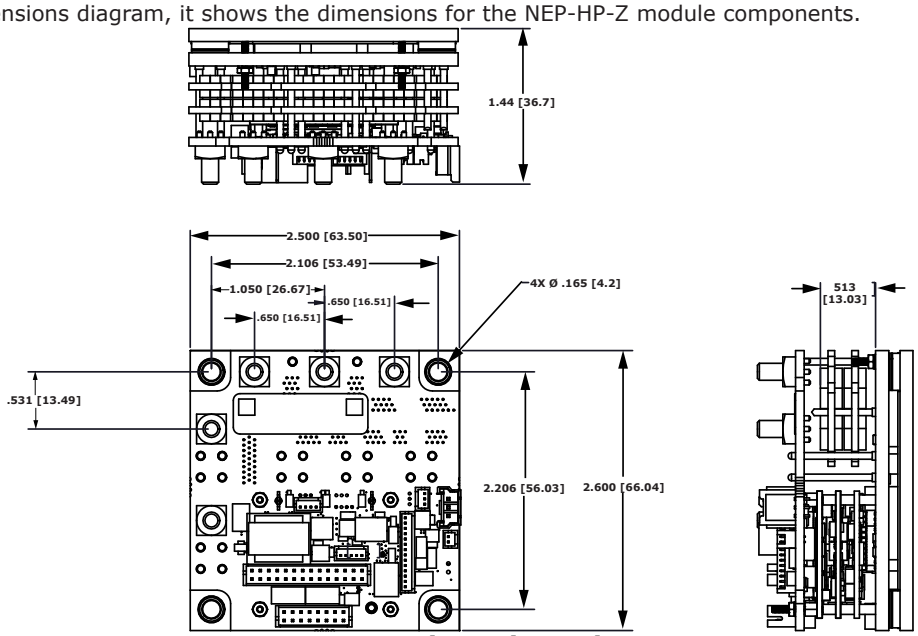
**J11 HALL INPUTS**

| Signal | Pins |
|---|---|
| Hall U | 5 |
| Hall V | 4 |
| Hall W | 3 |
| +5VENC | 2 |
| SGND | 1 |



## NEP-HP-Z: MECHANICALS

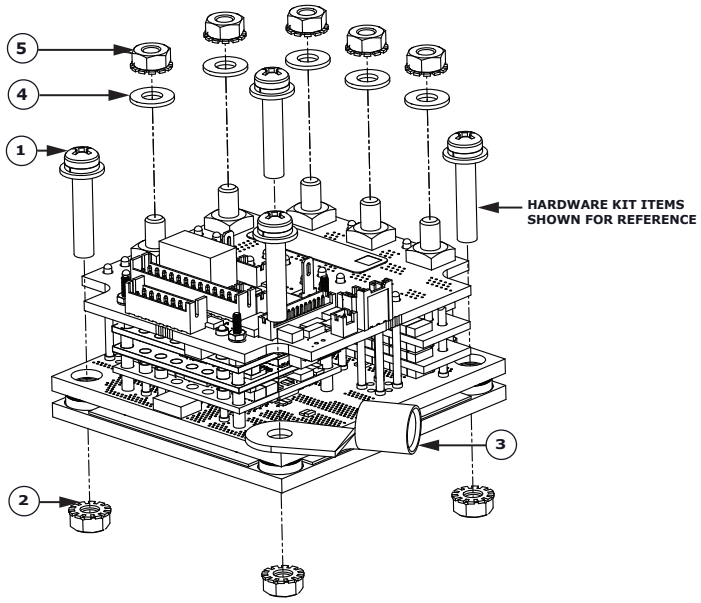
In the NEP-HP-Z Dimensions diagram, it shows the dimensions for the NEP-HP-Z module components.




**NEP-HP-Z Dimensions Diagram**

In the NEP-HP-Z Components Assembly diagram, it shows the location of the hardware parts on the drive. Use the screws to connect the nuts and washers to secure the parts together.

For information on the hardware kit components, type, size, manufacturer, part number and description, refer to the tables below.




**NEP-HP-Z Mounting Assembly Diagram**

The following table lists the item, quantity, description and manufacturing part numbers shipped with the drive.

**N-HP-Z-MK: Nano and Nano Plus HP EZ Customer Assembly Hardware Kit**

| # | Item | Qty | Mfgr | Part Number | Description |
|---|---|---|---|---|---|
| 1 | Screw | 4 | Arnold Industries | 1923NK | M4 SEMS screw, 20mm long, Phillips Pan Head |
| 2 | Nut | 4 | Arnold Industries | BN1364M4NK | M4 KEP Nut |
| 3 | Terminal Lug | 6 | Panduit Corporation | P4-10R-T | #10 Ring Terminal, 4AWG Wire, Non-Insulated |

**N-HP-Z-MK: Nano and Nano Plus HP EZ Customer Assembly Hardware Kit**

| # | Item | Qty | Mfgr | Part Number | Description |
|---|---|---|---|---|---|
| 4 | Washer | 5 | Bossard International | 1215930 | M4 Flat Washer, Brass Nickel |
| 5 | Nut | 5 | Arnold Industries | BN1364M4NK | M4 KEP Nut |
| NOTE: The items (4 & 5-nuts and washers) are assembled with the product. Use the assembly items 4 & 5 for the customer wire attachment connecting to the Power-In and Motor-Out terminals. If the customer requires additional parts, refer to the information for items 4 & 5. | | | | | |

## ORDERING GUIDE

### NEP-HP

| Part Number | Description |
|---|---|
| NEP-090-80-C* | Nano[Plus] High Power Module EtherCAT NEP-HP servo drive, 80/80 A, 90 Vdc |
| NEP-090-80-C-Z | Nano[Plus] High Power Module soldered to EZ board EtherCAT, NEP-HP-Z servo drive, 80/80 A, 90 Vdc |
| NEP-090-140-C* | Nano[Plus] High Power Module EtherCAT NEP-HP servo drive, 140/140 A, 90 Vdc |
| NEP-090-140-C-Z | Nano[Plus] High Power Module soldered to EZ board EtherCAT, NEP-HP-Z servo drive, 140/140 A, 90 Vdc |

*Note: The NEP-HP units must be soldered directly to a mounting PCBA.

### ACCESSORIES FOR NEP-HP

| Part Number | Description |
|---|---|
| N-HP-MK | Hardware Kit, Nano and Nano Plus HP MOD Customer Assembly |

### ACCESSORIES FOR NEP-HP-Z

| Part Number | Description |
|---|---|
| NP-Z-CK | Connector Kit for Nano Plus HP |
| N-HP-Z-MK | Hardware Kit, Nano and Nano Plus HP EZ Customer Assembly |
| SER-USB-M | USB to 3-Pin Molex Adapter Cable |

### CONNECTOR KIT FOR NANO PLUS HP

| | Qty | Ref | Name | Description | MFGR Part Number |
|---|---|---|---|---|---|
| NP-Z-CK Connector Kit | 1 | J12 | Brake | CONN WIRE-MT HSG SKT 1X2P 1.25MM LKG NYL BEIGE | Hirose: DF13-2S-1.25C |
| | 2 | J13, J14 | CAN | CONN WIRE-MT HSG SKT 1X3P 1.25MM LKG NYL BEIGE | Hirose: DF13-3S-1.25C |
| | 2 | J9, J10 | EtherCAT | CONN WIRE-MT HSG SKT 1X4P 1.25MM LKG NYL BEIGE | Hirose: DF13-4S-1.25C |
| | 1 | J11 | Halls | CONN WIRE-MT HSG SKT 1X5P 1.25MM LKG NYL BEIGE | Hirose: DF13-5S-1.25C |
| | 1 | J17 | Primary Feedback | CONN WIRE-MT HSG SKT 1X14P 1.25MM LKG NYL BEIGE | Hirose: DF13-14S-1.25C |
| | 29 | J9,J10,J11, J12,J13, J14,J17 | DF13 pins | CONN CONTC SKT CRMP 30-26GA 1MM MAX INSUL DIA AU | Hirose: DF13-2630SCFA |
| | 1 | J16 | STO | CONN WIRE-MT HSG RCPT 2X8P 2X2MM LKG NYL BLK | Hirose: DF11-16DS-2C |
| | 1 | J1 | Secondary Feed-back, I/O | CONN WIRE-MT HSG RCPT 2X14P 2X2MM LKG NYL BLK | Hirose: DF11-28DS-2C |
| | 44 | | DF11 pins | CONN CONTC SKT CRMP 28-24GA 1.45MM MAX INSUL DIA AU | Hirose: DF11-2428SCFA(04) |
| | 1 | J19 | Vlogic | CONN WIRE-MT HSG RCPT 1X2P 2MM LKG POLYEST NAT | Molex: 35507-0200 |
| | 1 | P12 | RS-232 | CONN WIRE-MT HSG RCPT 1X3P 2MM LKG POLYEST NAT | Molex: 35507-0300 |
| | 2 | P16, P17 | Cable Shields | FASTON RCPT .110X.020 26-22GA UNINSUL POSI-TIVE-LOCK PHBRZ/SN | TE: 353249-2 |
| | 4 | | DF13 Wires, Black | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD BLK AU 12IN | Hirose:H4BBG-10112-B6 |
| | 17 | | DF13 Wires, White | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD WHT AU 12IN | Hirose:H4BBG-10112-W6 |
| | 20 | | DF11 Wires, White | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD WHT AU 12IN | Hirose:H3BBG-10112-W6 |
| | 3 | | DF11 Wires, Red | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD RED AU 12IN | Hirose:H3BBG-10112-R6 |
| | 3 | | DF13 Wires, Red | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD RED AU 12IN | Hirose:H4BBG-10112-R6 |
| | 1 | | J19, HVCOM Wire, Black | CBL ASSY SKT CONTC TO FREE END 1COND 24GA 7STRD BLK SN 12IN | Molex:0502128000-12-B4 |
| | 1 | | J19, +VLOGIC Wire, Red | CBL ASSY SKT CONTC TO FREE END 1COND 24GA 7STRD RED SN 12IN | Molex:0502128000-12-R4 |
| | 3 | | DF11 Wires, Black | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD BLK AU 12IN | Hirose:H3BBG-10112-B6 |
| | 1 | | DF13 Brake Wire, Blue | CBL ASSY SKT CONTC TO SKT CONTC 1COND 26GA 7STRD BLU AU 12IN | Hirose:H4BBG-10112-L6 |
| | 1 | | STO-Bypass PCB | BD ASSY, STO BYPASS BOARD | Copley: 104-118972-01 |

## REVISION HISTORY

### 16-140917 Document Revision History

| Revision | Date | Remarks |
|---|---|---|
| 00 | July 15, 2025 | Initial Release for Production |
| | | |