

DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

Advanced Feature Set

- 32-bit floating point filters
- Multiple advanced filters
- Frequency analysis tools

Control Modes

- Profile Position-Velocity-Torque
- Interpolated Position, Homing
- Indexer, Point-to-Point, PVT
- Camming, Gearing

Command Interface

- CANopen
- ASCII, Serial Binary, and discrete I/O
- Stepper or Quad A/B position commands
- PWM Velocity-Torque command
- Master encoder (Gearing, Camming)
- ± 10 V Position-Velocity-Torque

Communications

- CANopen
- RS-232

Feedback

- Primary Absolute
BiSS-C Unidirectional
SSI Absolute or Incremental
- Primary & Secondary Incremental
Digital Quad A/B/X
- Digital Halls

I/O

- 1 Analog input ± 10 V, 12-bit
- 5 High-speed digital inputs
- 1 Motor overtemp input
- 4 High-speed digital outputs

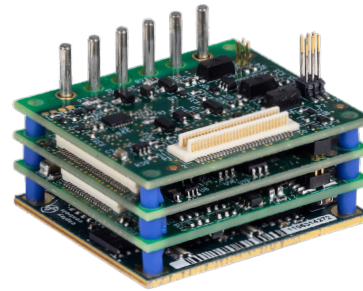
Safe Torque Off (STO)

- SIL 3, Category 3, PL d

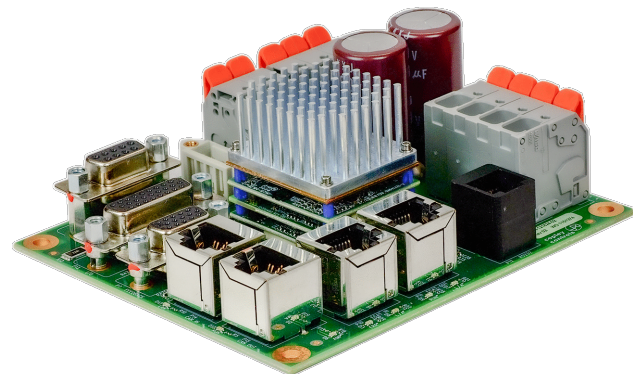
Dimensions

- 35 x 30 x 21.6 mm [1.38 x 1.18 x 0.85 in]
- 0.8 oz [0.023 kg]

CANopen®



MODEL	Ic	Ip	VDC
NPS-090-10	5	10	9~90
NPS-090-70	35	70	9~90
NPS-180-10	5	10	20~180
NPS-180-30	15	30	20~180



MODEL	Ic	Ip	VDC
NPS-090-10-D	5	10	9~90
NPS-090-70-D	35	70	9~90
NPS-180-10-D	5	10	20~180
NPS-180-30-D	15	30	20~180

Nano is the smallest servo drive that Copley offers and can be mounted directly on the motor or within robotic joints. It can satisfy requirements of the robotics, AGV, industrial machinery, medical/life-sciences and aerospace industries.

It mounts to user PC boards using connectors, or can be soldered in. An optional interface board provides connectors which facilitate easy integration into customer applications. The Nano has a third party approved STO feature. Opto-isolators provide connections to user wiring and controls.

DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

GENERAL SPECIFICATIONS

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

MODEL	NPS-090-10 NPS-090-10-D	NPS-090-70 NPS-090-70-D	NPS-180-10 NPS-180-10-D	NPS-180-30 NPS-180-30-D	
OUTPUT POWER...					
Peak Current	10 (7.07)	70 (49.5)	10 (7.07)	30 (21.2)	Adc (Arms, sinusoidal)
Peak time	1	1	1	1	Sec
Continuous current	5 (3.54)	35 (24.8)	5 (3.54)	15 (10.6)	Adc (Arms, sinusoidal)
Peak Output Power	0.9	6.3	1.8	5.4	kW
Continuous Output Power	0.45	3.15	0.9	1.8	kW

INPUT POWER					
HVmin to HVmax	+9 to +90	+9 to +90	+20 to +180	+20 to +180	Vdc, transformer-isolated
Ipeak	10	70	10	30	Adc (1 sec) peak
Icont	5	35	5	15	Adc continuous
VLOGIC	+9 to +60	+9 to +60	+9 to +60	+9 to +60	Vdc, transformer-isolated
VLOGIC Power	3 W with no encoder, 6 W with encoder +5V @ 500 mA				

PWM OUTPUTS	
Type	MOSFET 3-phase inverter, 16 kHz center-weighted PWM carrier, space-vector modulation
PWM ripple frequency	32 kHz

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	
CANopen	Galvanically isolated from drive circuits
Signals	CAN_H, CAN_L, CAN_GND, 1 mBit/sec maximum
Data protocol	CANopen Device Profile DSP-402 over CANopen (CoE)
<i>Stand-alone mode</i>	
Digital position reference	Pulse/Direction, CW/CCW Quad A/B Encoder Stepper commands (2 MHz maximum rate) 2 M line/sec, 8 Mcount/sec (after quadrature)
Digital torque & velocity reference	PWM, Polarity PWM 50% PWM frequency range PWM minimum pulse width PWM = 0% - 100%, Polarity = 1/0 PWM = 50% ±50%, no polarity signal required 1 kHz minimum, 100 kHz maximum 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

DIGITAL INPUTS	
Number	6
IN1~5	General purpose inputs LV CMOS 3.3V Schmitt trigger, 100 ns RC filter, max input voltage = +12 Vdc, 10 kΩ pull-up to +5 Vdc 2.2 Vdc min positive threshold, 0.6 Vdc max negative threshold
IN1~3 on DEV Board	RC time-constant assumes active drive on inputs and does not include 10 kΩ pull-ups HV CMOS 5.0V Schmitt trigger, no RC filter, 0~24 Vdc compatible, 10 kΩ pull-up to +5 Vdc 2.2 Vdc min positive threshold, +0.6 Vdc max negative threshold
IN6	Motor overtemperature, LV CMOS 3.3V Schmitt trigger, 33 μS RC filter, max input voltage = +12 Vdc 4.99 kΩ pull-up to +5 Vdc, 2.2 Vdc min positive threshold, 0.6 Vdc max negative threshold

ANALOG INPUT	
Number	1
Type	Differential, ±10 Vdc range, 5.5 kΩ input impedance, 12 bits, single-pole 1934 Hz input filter
Function	Torque, velocity, or position command. Or, as general purpose analog input

DIGITAL OUTPUTS	
Number	4
OUT1~4	74HCT14 5 V CMOS Schmitt trigger, functions programmable, +5 Vcc Source -4 mA @ VOH = 4.18 Vdc, Sink 4 mA @ VOL = 0.26 Vdc
OUT4	Brake control, programmable release time followed by programmable PWM duty-cycle for holding current

RS-232 COMMUNICATION PORT	
Signals	RxD, TxD, SGND RxD input is 74LV14 3.3 V Schmitt trigger with 10 kΩ pull-up to +5V TxD output is 74HCT14 5 V Schmitt trigger
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

CANOPEN PORT	
Format	CAN_H, CAN_L, CAN_GND, 1 mBit/sec maximum
Protocol	CANopen, CiA 402
Isolation	Galvanically isolated from drive circuits

DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

DC POWER OUTPUT

+5 Vdc 500 mA maximum. Protected for overload or shorts. Shared by dual encoders.

SAFE TORQUE OFF (STO)

Function	PWM outputs are inactive and current to the motor will not be possible when the STO function is active
Safety Integrity Level	SIL 3, Category 3, Performance level d
Inputs	2 two-terminal: STO-IN1, STO-COM1, STO-IN2, STO-COM2
Type	Opto-isolators, 5V compatible
Disabling	Connecting both STO inputs to +5V will deactivate the STO function

PROTECTIONS

HV Overvoltage	+HV > +95 ±1 Vdc	Drive outputs turn off until +HV is < +95 ±1 Vdc (90 V model)
	+HV > +185 ±1 Vdc	Drive outputs turn off until +HV is < +185 ±1 Vdc (180 V models)
HV Undervoltage	+HV < +8.5 ±0.5 Vdc	Drive outputs turn off until +HV > +8.5 Vdc ±0.5 Vdc (90 V models)
	+HV < +19.5 ±0.5 Vdc	Drive outputs turn off until +HV > +19.5 Vdc ±0.5 Vdc (180 V models)
Drive over temperature	PC Board > 90 °C +3/-0 °C	Programmable as latching or temporary fault
Short circuits		Output to output, output to ground, internal PWM bridge faults
I ² T Current limiting		Programmable: continuous current, peak current, peak time for drive and motor
Latching / Non-Latching		Programmable response to errors

MECHANICAL & ENVIRONMENTAL

Size	35 x 30 x 21.6 mm [1.38 x 1.18 x 0.85 in]
Weight	0.8 oz [0.023 kg]
Ambient temperature	0 to +45 °C operating, -40 to +85 °C storage
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

Standards and Directives

Functional Safety

IEC 61508-1, IEC 61508-2, IEC 61508-3, IEC 61508-4 (SIL 3)
 Directive 2006/42/EC (Machinery)
 ISO 13849-1/Cor. 1:2009 (Cat 3, PL d)
 IEC 61800-5-2 (SIL3)

Product Safety

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

EMC

Directive 2014/30/EU (EMC)
 IEC 61800-3
 IEC 61800-5-2

Restriction of the Use of Certain Hazardous Substances (RoHS)

Directive 2011/65/EU (RoHS II)

Approvals

UL and cUL 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 d (Cat.3)
 IEC 61800-5-2
 Up to SIL 3

All of the agency standards are pending at this time.

MOTOR CONNECTIONS

Motor U,V,W	Drive outputs to 3-phase brushless motor, Wye or delta connected For DC brush motor use outputs U & V Minimum inductance: 200 µH line-line
Encoder	Digital encoders, incremental and absolute (see FEEDBACK below)
Halls	Digital U/V/W
Motemp	Input is programmable to disable the drive if 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)
 RS-422 line receivers, 5 MHz maximum line frequency (20 M counts/sec), 74HCT thresholds

Absolute encoders:

BiSS-C Unidirectional, SSI 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

HALLS

U, V, W:	Single-ended, 120° electrical phase difference Schmitt trigger, 1.0 µs RC filter from active HI/LO sources, 5 Vdc compatible 15 kΩ pull-up to +5 Vdc, 74LVC, 3.3 V thresholds
----------	---

5V OUTPUT

Number	1
Rating	+5 Vdc @ 500 mA thermal and overload protected, shared by two encoders

CANOPEN COMMUNICATIONS

CANOPEN

Based on the CAN V2.0b physical layer, a robust, two-wire communication bus originally designed for automotive use where low-cost and noise-immunity are essential, CANopen adds support for motion-control devices and command synchronization. The result is a highly effective combination of data-rate and low cost for multi-axis motion control systems. Device synchronization enables multiple axes to coordinate moves as if they were driven from a single control card.

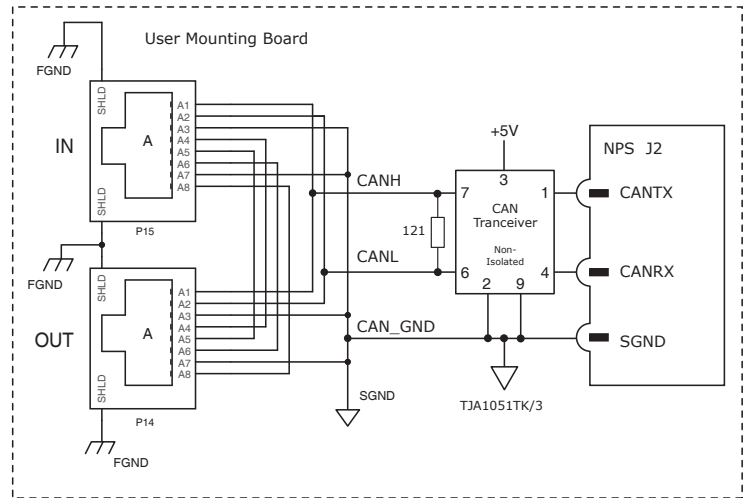
CANOPEN COMMUNICATION

NPS uses the CAN physical layer signals CANH, CANL, and CAN_GND for connection, and CANopen protocol for communication. Before installing the drive in a CAN system, it must be assigned a CAN Node-ID (address). A maximum of 127 CAN nodes are allowed on a single CAN bus. Up to seven digital inputs can be used to produce CAN Node-IDs from 1~127, or the Node-ID can be saved to flash memory in the module. Node-ID 0 is reserved for the CANopen master on the network.

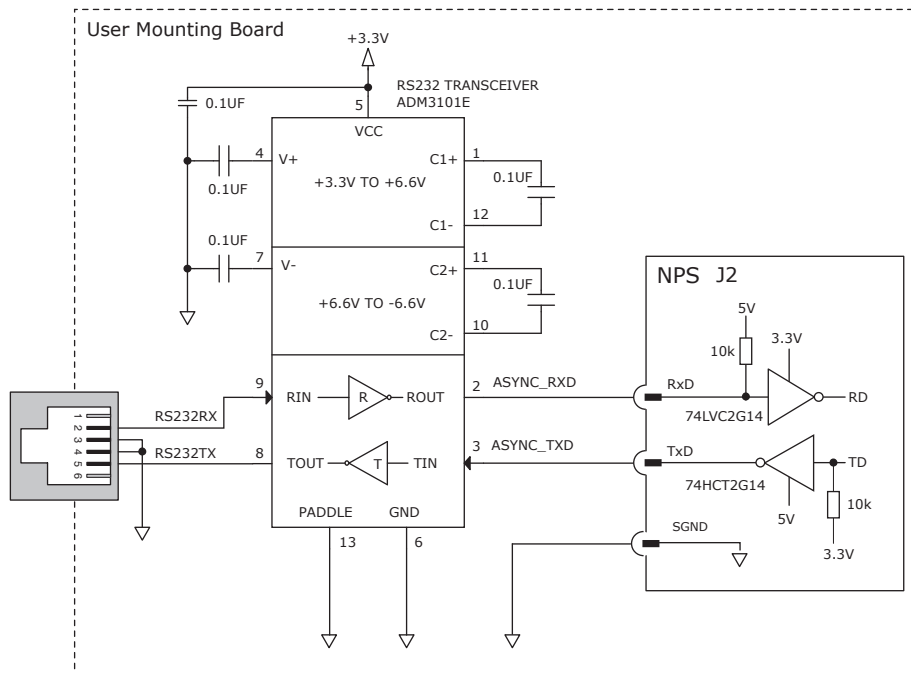
CANOPEN COMMAND INPUTS

The graphic shows connections between the NPS and RJ-45 connectors on the DEV card. If the NPS is the last node on a CAN bus, the internal terminator resistor can be used by adding a connection on the PC board as shown. If there are multiple NPS on the mounting PCB then the terminating resistor should be near the NPS that is farthest from the CAN network connection to the PCB. The node Node-ID of the NPS may be set by using digital inputs, or programmed into flash memory in the drive.

Signal	J2 Pins
CANTX	36
CANRX	38
SGND	34



RS-232 COMMUNICATIONS



The serial port is a full-duplex, three-wire (Rx/D, Tx/D, SGND) type that operates from 9,600 to 230,400 Baud. It can be used by CME for drive configuration and setup or by external equipment sending ASCII commands.

The circuit shown here is used on the DEV board and is recommended for user's PC boards. It converts the single-ended TTL signals levels in the NPS 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 J2

Signal	Pins
RxD1	30
TxD1	32
SGND	34

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 (current is flowing in the input diodes), the control core will be able to control the on/off state of the PWM outputs to produce torque in the motor.

INSTALLATION



Refer to the 16-121699 Nano Micro Modules NES & NPS USER GUIDE

The information provided in the 16-121699 Nano Micro Modules NES & NPS USER GUIDE must be considered for any application using the drive's STO feature.

FAILURE TO HEED THIS WARNING CAN CAUSE EQUIPMENT DAMAGE, INJURY, OR DEATH.



STO DISABLE

In order for the PWM outputs of the NPS to be activated, current must be flowing through the opto-couplers that are connected to the STO-IN1 and STO-IN2 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.

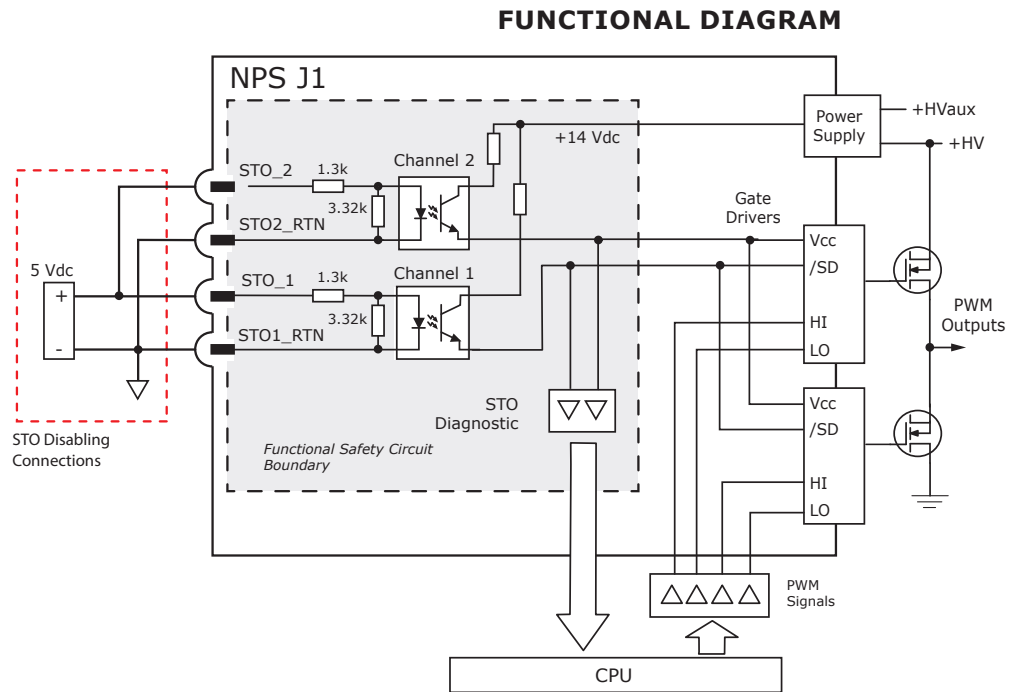
This diagram shows connections that will energize both opto-couplers from a +5V source. When this is done the STO feature is disabled and control of the output PWM stage is under control of the digital control core.

If not using the STO feature, these connections must be made in order for the drive to be enabled.

DEV BOARD STO DISABLE CONNECTIONS



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



P9 STO

Signal	Pin	Signal
STO2-RTN	5	9
STO2-IN-24V	4	8
STO1-RTN	3	7
STO1-IN-24V	2	6
FGND	1	

STO OPERATION

STO Input Voltage	STO State
STO1-IN-24V AND STO2-IN-24V \geq 16 Vdc	STO Inactive. Drive can be enabled to produce torque
STO1-IN-24V OR STO2-IN-24V $<$ 16 Vdc	STO Active. Drive cannot be enabled to produce torque
STO1-IN OR STO2-IN Open	

Note: Voltages in the table above are referenced between an STOx-IN and an STOx-RTN in P2
 E.g. $V(\text{STO1-IN}) = V(\text{STO1-IN1}) - V(\text{STO1-RTN})$

DIGITAL COMMAND INPUTS: POSITION

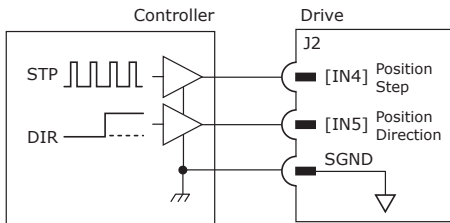
STAND-ALONE MODE DIGITAL POSITION-CONTROL INPUTS

NPS works with motion controllers that output pulses to command position. These formats are supported:

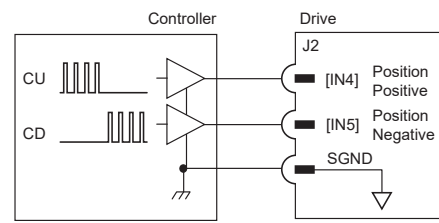
- Step/Direction
- Count-Up/Count-Down (CU/CD)
- A/B Quadrature Encoder

In Step/Direction mode, a pulse-train controls motor position, and the direction is controlled by a DC level at the Direction input. CU/CD (Count-Up/Count-Down) signals command the motor to move CW or CCW depending on which input the pulse-train is directed to. The motor can also 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.

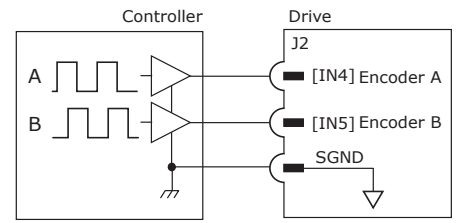
STEP/DIRECTION INPUTS



COUNT-UP/COUNT-DOWN INPUTS



QUAD A/B ENCODER INPUTS



Command Options	Name	J2 Pins
Step, Count Up, Encoder A	IN4	8
Direction, Count Down, Encoder B	IN5	9

J2 SGND Pins
3,4,11,12,33,34,49,50

DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

STAND-ALONE MODE DIGITAL VELOCITY-TORQUE INPUTS

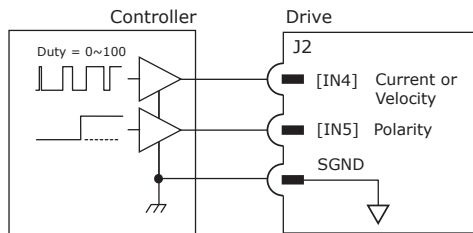
NPS works with motion controllers that output pulses to command Velocity or Torque. These formats are supported:

- Pulse/Direction
- PWM 50%

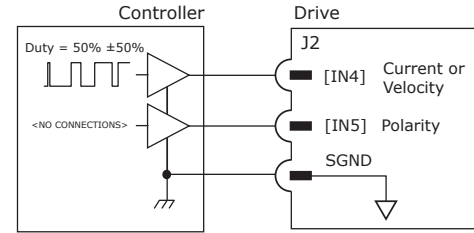
In Pulse/Direction mode, a pulse-train with variable duty cycle on IN4 controls Velocity or Torque from 0~100%. IN5 HI or LO controls the direction of the Velocity or polarity of the Torque.

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	J2 Pins
PWM Vel/Trk, PWM Vel/Trk & Direction	IN4	8
PWM/Dir Polarity, (none)	IN5	9

HIGH SPEED INPUTS: IN1, IN2, IN3, IN4, IN5

The six digital inputs to the NPS are programmable to a selection of functions. All have 100 ns RC filters when driven by active sources (CMOS, TTL, etc.) and all have 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

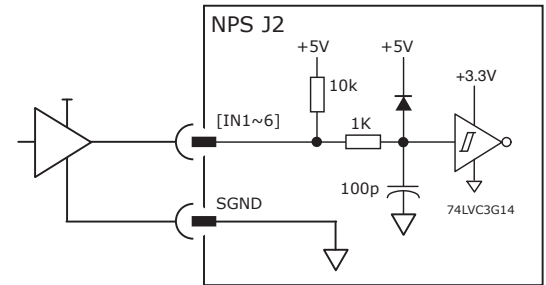
SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	$V_{T+} = 1.42 \sim 2.38$ Vdc
	LO	$V_{T-} = 0.68 \sim 1.6$ Vdc
	Hys	$V_H = 0.44 \sim 1.26$
	Max	+6 Vdc
	Min	0 Vdc
Pull-up	R1	10 kΩ
	R2	1 kΩ
Low pass filter	C1	100 pF
	RC	IN1~5: 0.1 μs
		IN6: 33 μs

CONNECTIONS

Signal	J2 Pins
IN1	5
IN2	6
IN3	7
IN4	8
IN5	9

J2 SGND Pins
3,4,11,12,17,18,28,31,33,34,49,50



* IN7 is the SLI-MISO signal when the SLI Port is in use.

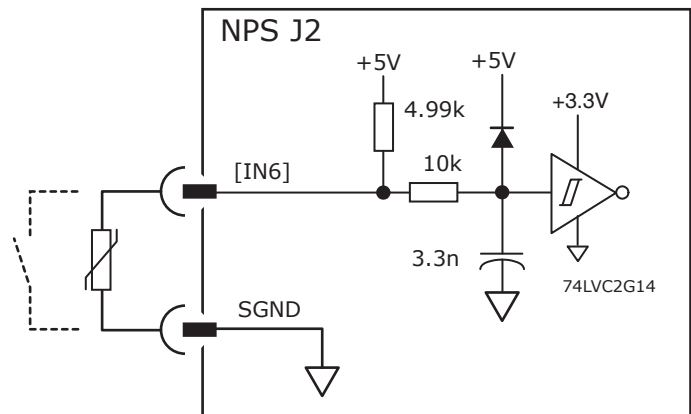
Inputs IN1~5 have 100 nanosecond rise time RC filters, each with a 10K pullup resistor to +5 VDC. 12 Vdc compatible, 2.2V minimum HI threshold voltage, 0.6V max LO threshold voltage
IN1~6 are +3.3V logic, IN7 is +5V logic.

MOTOR OVERTEMP INPUT: IN6

Input IN6 has a 76 microsecond rise time RC filter, with a 4.99 kΩ pullup resistor to +5 VDC. Input IN6 is designed to interface with an industry standard PTC thermistor IAW BS 49990111(1987) for built-in thermal protection of the motor as a default. If not used for the Motemp function, IN6 can be re-programmed for other input functions.

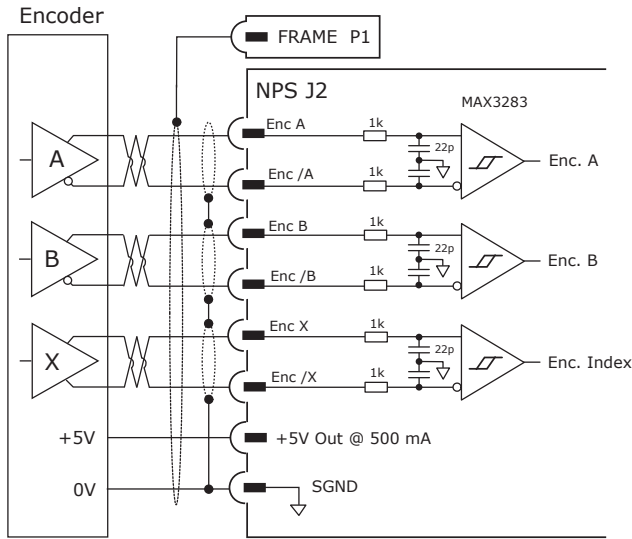
CONNECTIONS

Signal	J2 Pins
IN6	10



ENCODER 1 (PRIMARY FEEDBACK)

QUAD ENCODER WITH INDEX



A/B/X SIGNALS

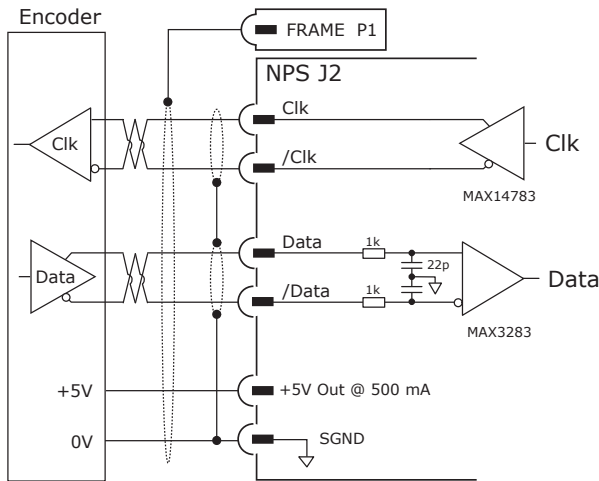
Signal	J2 Pins
Enc A	43
Enc /A	44
Enc B	45
Enc /B	46
Enc X	47
Enc /X	48
+5V	57,59

FRAME GROUND
P1

J2 SGND Pins
3,4,11,12,17,18,28,31,33,34,49,50

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 NPS drive provides a train of clock signals in differential format 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.

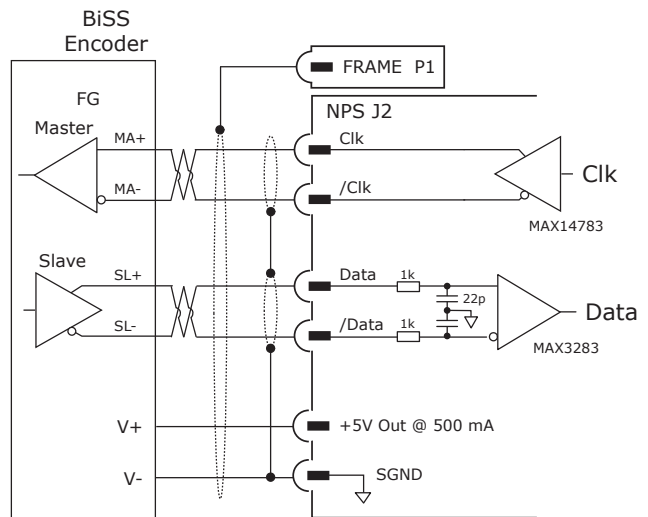


SSI, BiSS SIGNALS

SSI	BiSS	J2 Pins
Clk	MA+	47
/Clk	MA-	48
Data	SL+	43
/Data	SL-	44
+5V		57,58

BiSS-C ABSOLUTE ENCODER

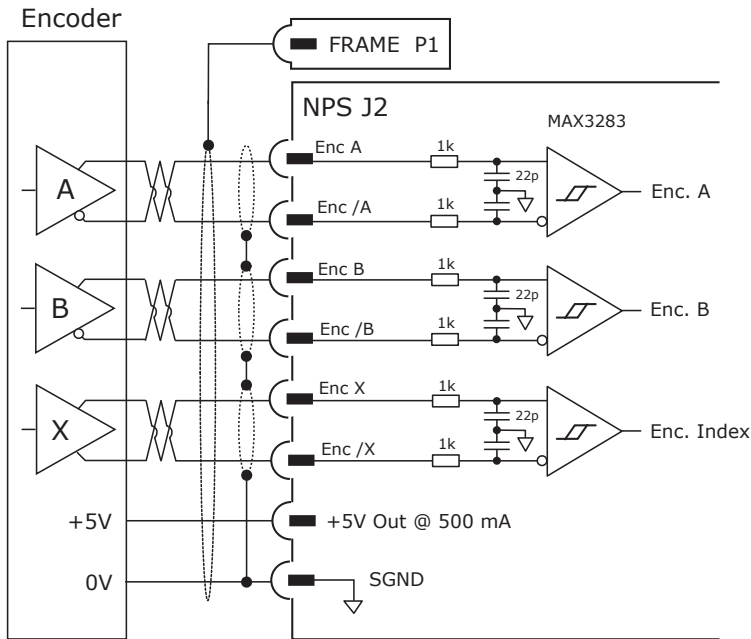
BiSS-C absolute Encoder
 BiSS-C is an - Open Source - digital interface for sensors and actuators. BiSS-C refers to principles of well known industrial standards for Serial Synchronous Interfaces like SSI, AS-Interface® and Interbus® with additional options.
 Serial Synchronous Data Communication
 Cyclic at high speed
 2 unidirectional liNPS Clock and Data
 Line delay compensation for high speed data transfer
 Request for data generation at slaves
 Safety capable: CRC, Errors, Warnings
 Bus capability incl. actuators
 Bidirectional
 BiSS C-protocol: Continuous mode



Note: Single (outer) shields should be connected at the drive end. Inner shields should only be connected to Signal Ground on the drive.

ENCODER 2: SECONDARY FEEDBACK

QUAD ENCODER WITH INDEX



A/B/X SIGNALS

Signal	J2 Pins
Enc A	51
Enc /A	52
Enc B	53
Enc /B	54
Enc X	55
Enc /X	56
+5V	57,59

FRAME GROUND

P1

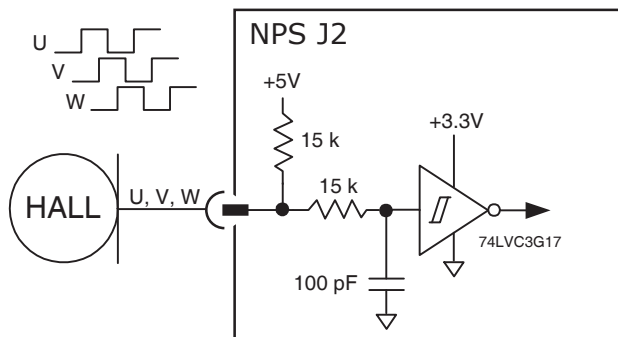
J2 SGND Pins

3,4,11,12,17,18,28,31,33,34,49,50

OTHER MOTOR CONNECTIONS

HALLS

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

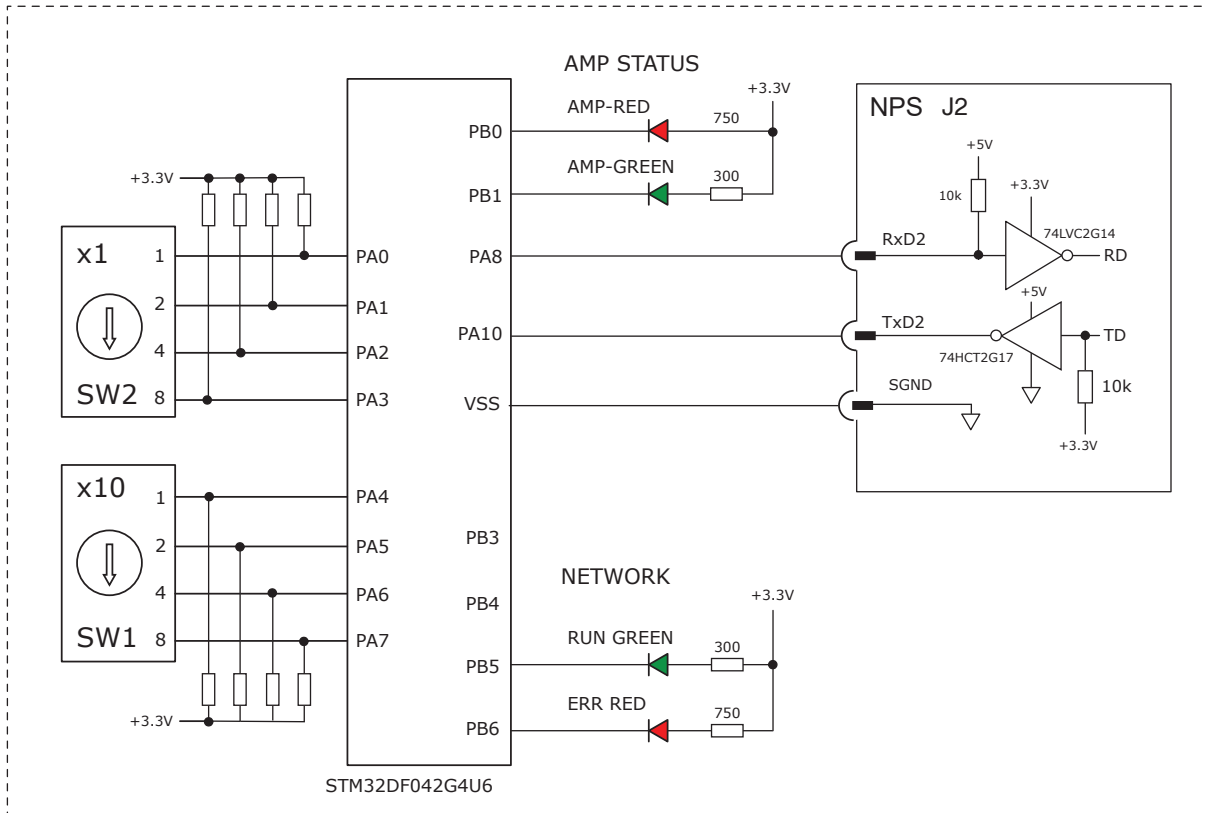


HALL SIGNALS

Input	J2 Pins
Hall U	39
Hall V	40
Hall W	41

SECONDARY SERIAL PORT

This serial port is used in combination with the DEV board driving the LEDs and reading the address switches for the CANopen device ID (Station Alias).



SERIAL SIGNALS

Signal	J1 Pins
RxD2	35
TxD2	37
SGND	33

J2 SGND Pins
3,4,11,12,17,18,28,31,33,34,49,50

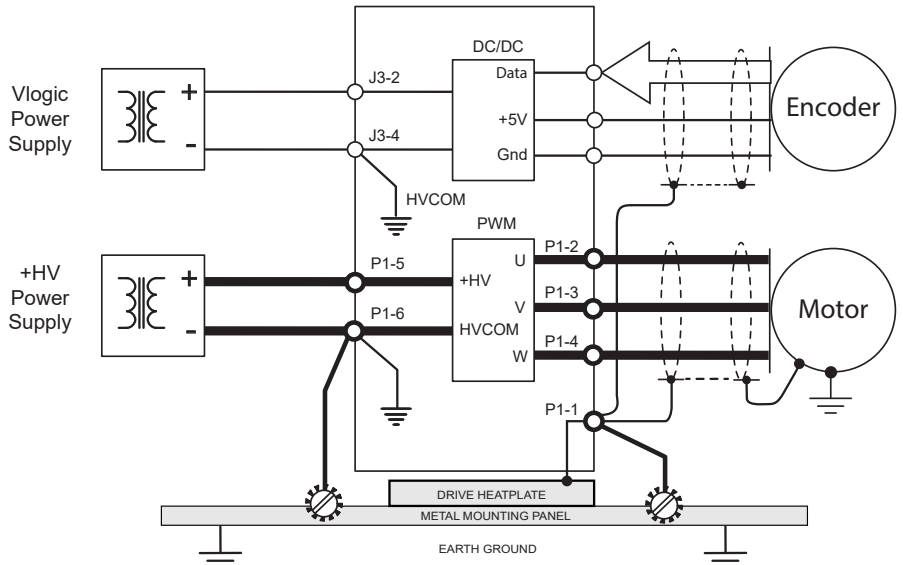
+HV CONNECTIONS

POWER SUPPLIES

The drive main power, +HV, is typically supplied by unregulated DC power supplies. These must be isolated from the mains, and all circuits should be grounded to earth at some point. The +HV supply connects to P5 and P6. 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, and this 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 Gnd terminals.

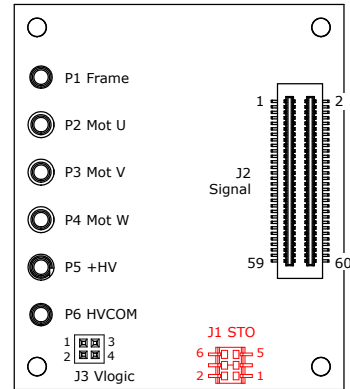
GROUNDING

An earthing ground connection can be made via a second conductor to J1-2 that connects to the equipment frame ground.



P1~P6

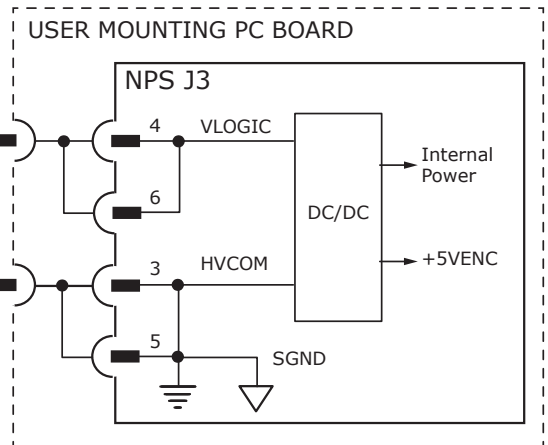
Signal	Pins
Frame Gnd	P1
Mot U	P2
Mot V	P3
Mot W	P4
+HV	P5
HVCOM	P6



VLOGIC CONNECTIONS

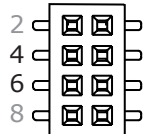
DESCRIPTION

VLOGIC is required for operation of the drive. It powers the internal logic and control circuits. Encoder +5V is derived from VLOGIC. When using the STO feature, 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.

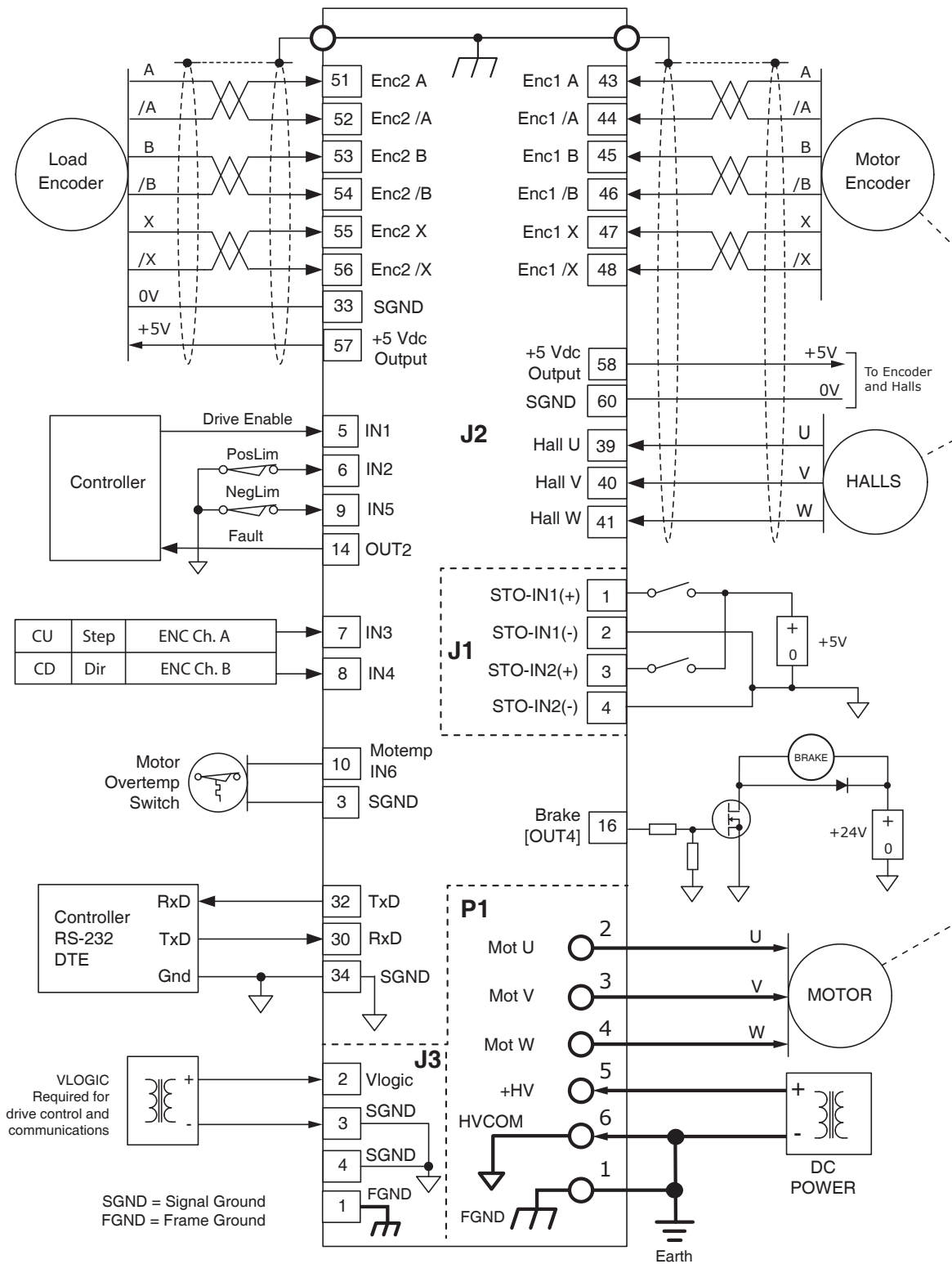


J3 VLOGIC

Name	Pin	Name
n.c.	2	1 n.c.
VLOGIC	4	3 HVCOM
VLOGIC	6	5 HVCOM
n.c.	8	7 n.c.



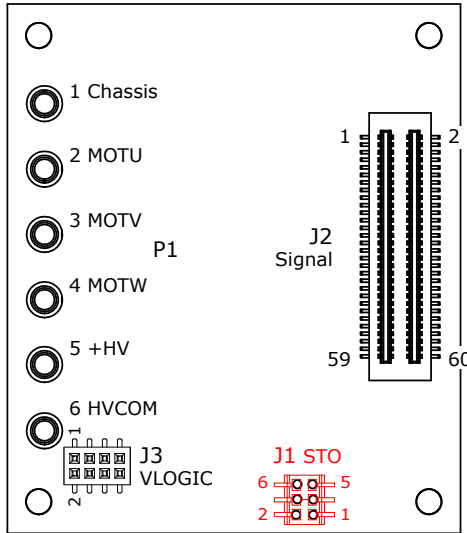
NPS TYPICAL CONNECTIONS



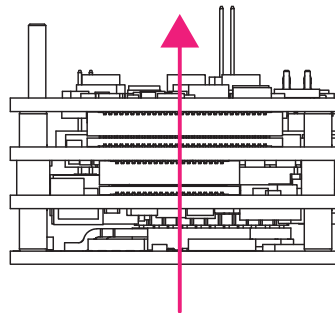
PC BOARD CONNECTIONS

P1~P6 MOTOR & +HV

Signal	Pin
FGND	P1
Motor U	P2
Motor V	P3
Motor W	P4
+HV	P5
HVCOM	P6



This page shows the pins and signals looking down on a user PC board.



J3 VLOGIC

Name	Pin	Name
N.C.	2	1
VLOGIC	4	3
	6	5
N.C.	8	7

J1 STO

Name	Pin	Name
STO_STATUS_OUTPUT_RTN	6	5
STO2_RTN	4	3
STO1_RTN	2	1

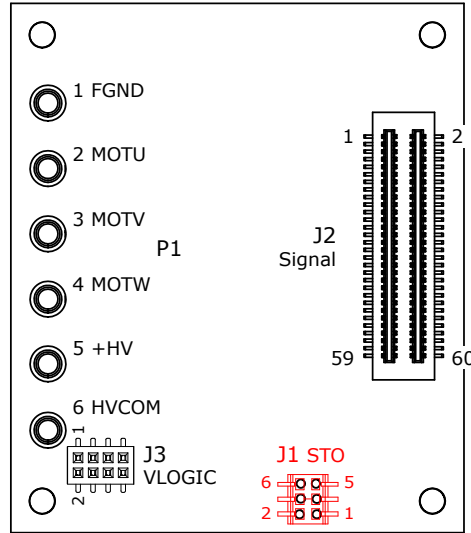
J2 SIGNAL

Signal	Pin	Signal
REFIN1-	1	2
N.C.	3	4
ENABLE IN1	5	6
IN3	7	8
IN5	9	10
SGND	11	12
DOUT1	13	14
DOUT3	15	16
SGND	17	18
VDD33TXRX1	19	20
VDD33TXRX2	21	22
(TX2-) TXNB	23	24
(TX2+) TXPB	25	26
(RX2+) RXNB	27	28
(RX2+) RXPB	29	30
SGND	31	32
SGND	33	34
ASYNC_RXD2	35	36
ASYNC_TXD2	37	38
HALL U	39	40
HALL W	41	42
ENCA1_UBC_DAT	43	44
ENCB1	45	46
ENCX1_UBC_CLK	47	48
SGND	49	50
ENCA2	51	52
ENCB2	53	54
ENXX2	55	56
+5VENC	57	58
+5VENC	59	60

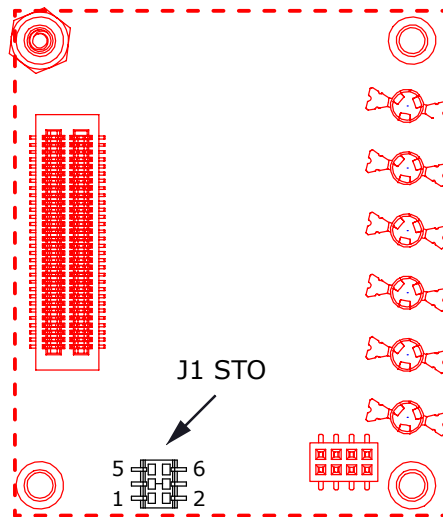
NOTE:
THE STO CONNECTOR J2
IS MOUNTED ON THE BOTTOM
SIDE OF THE PCB

PC BOARD CONNECTORS

The pin sockets P1~P6 are rated for 6 A continuous.
 For operation at higher currents the drive pins should be soldered to the PCB etched copper.



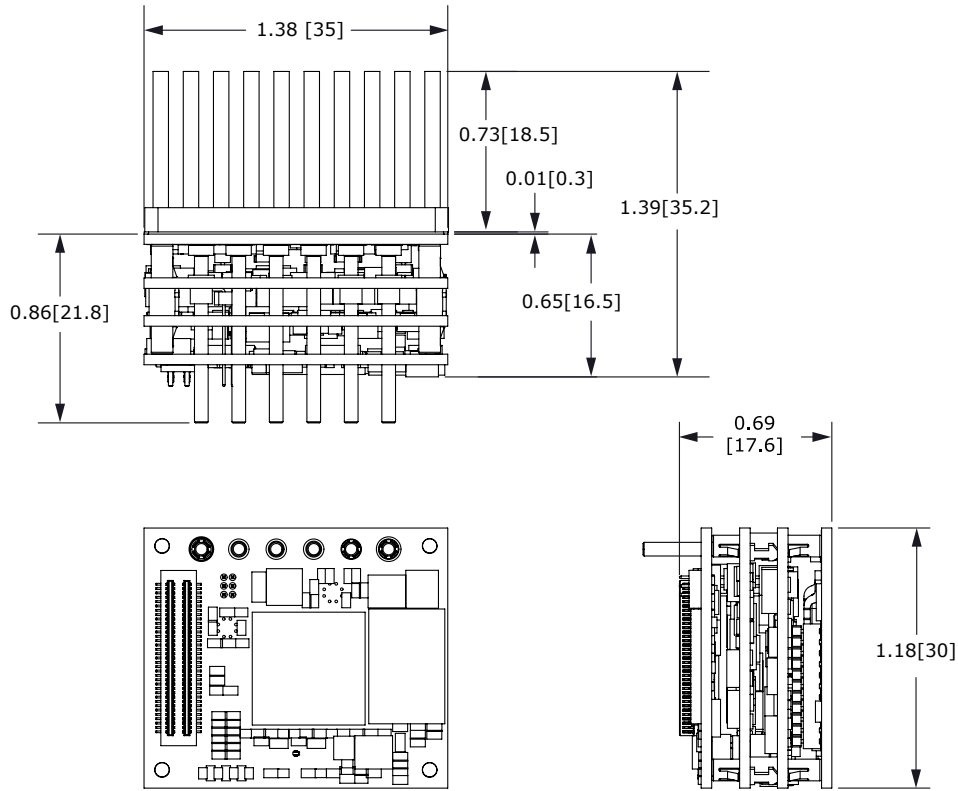
PC Board
TOP VIEW



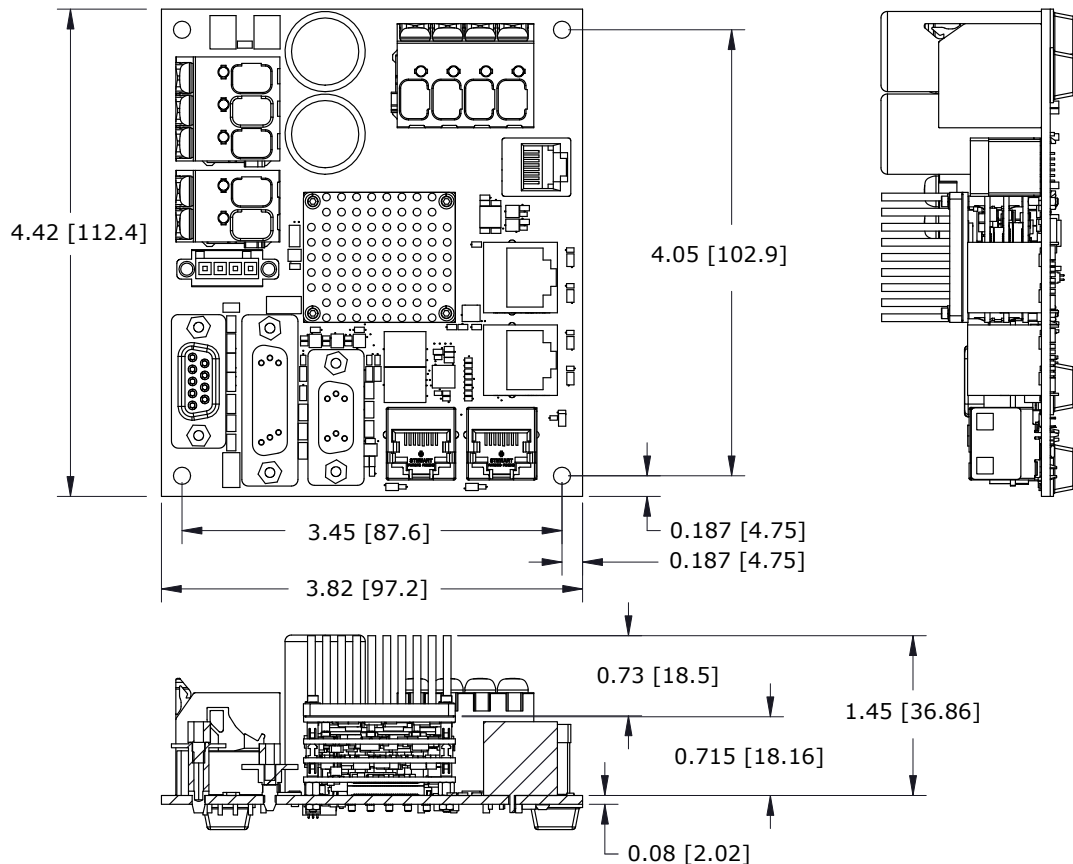
PC Board
BOTTOM VIEW

Ref Des	Label	Mfgr	Part Number	Description	Qty
J1	STO	Samtec	CLM-103-02-L-D-BE	Header, 6 pos, 1 mm pitch	1
J2	Signal	Kunshan WCON	3620-S060-022G202	Header, 60 pos, 0.5 mm pitch	1
J3	VLOGIC	WCON	2521-202MG3CUNR1	Header, 4 pos, 1 mm pitch	1
P1	+HV, Motor	Harwin	S9121-45R	Socket, 2 mm diam	6

DIMENSIONS

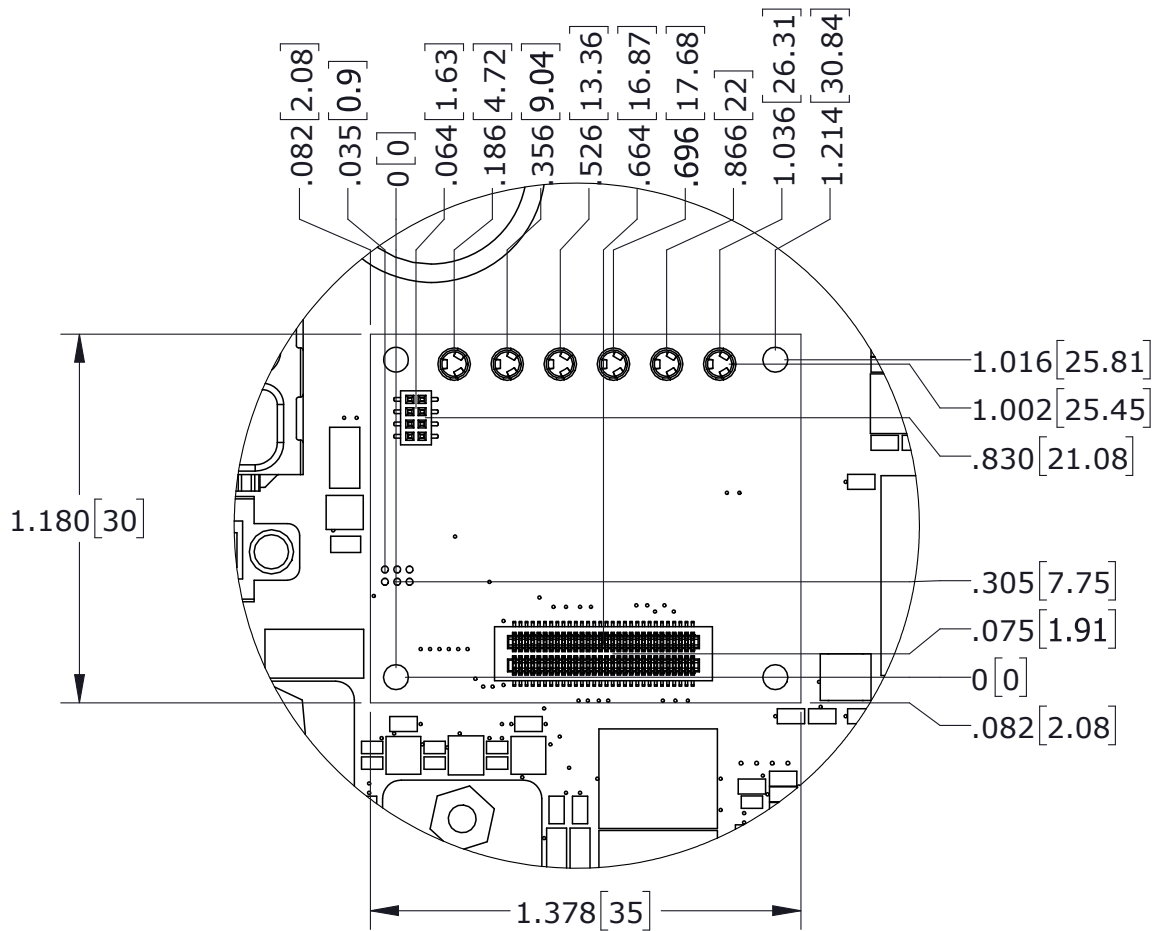


Dimensions are in inches [mm]



PC BOARD MOUNTING DIMENSIONS

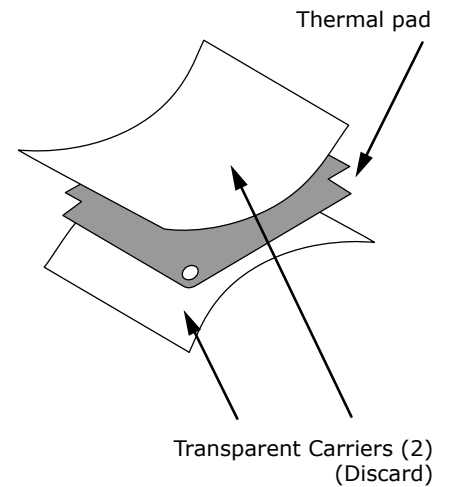
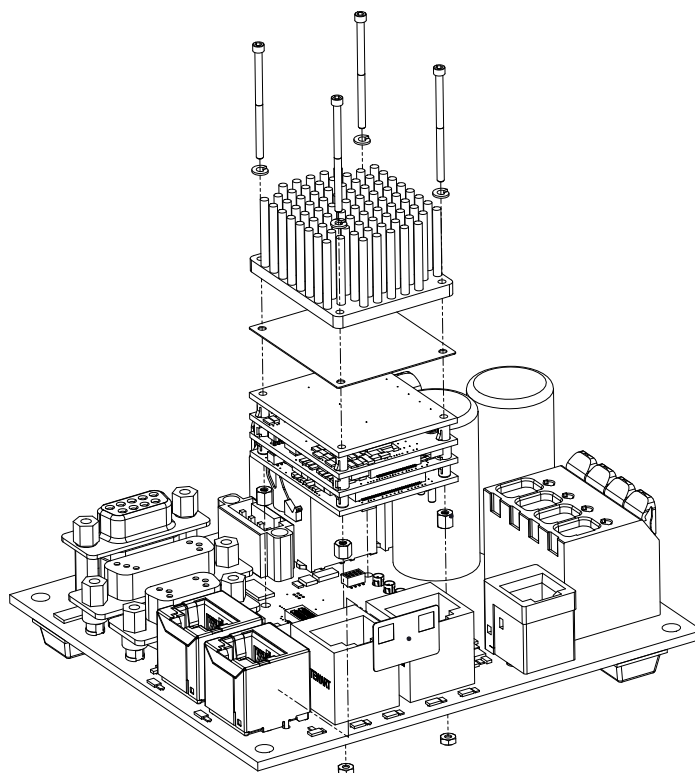
Looking down on the mounting PC board for the drive. The STO connector is mounted on the underside of the PC board.



DEV KIT HEATSINK MOUNTING

A thermal pad is used in place of heatsink grease. The pad is die-cut to shape and has notches for the heat sink mounting screws. There are two protective sheets, blue on one side and clear on the other. Both must be removed when the interface pad is installed.

- 1: Remove the blue protective sheet from one side of the pad.
- 2: Place the interface pad on the drive, taking care to center the pad holes over the heatplate mounting holes.
- 3 Remove the clear protective sheet from the pad.
- 4 Mount the heatsink onto the drive taking care to see that the holes in the heatsink, interface pad, and drive all line up.
- 5 Torque the _#0-80 mounting screws to 4 in-lb, 64 in-oz, 0.45 Nm.

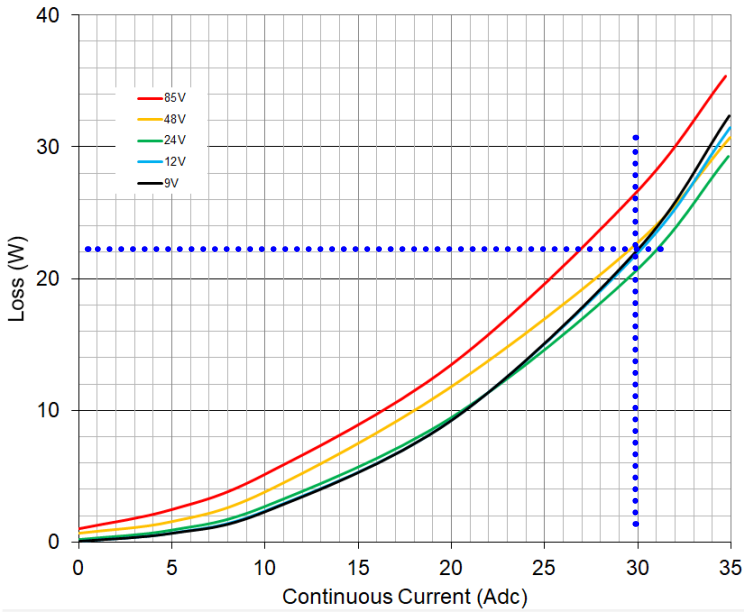


N-HK Heatsink Kit

Item	Description	Quantity
1	Screw, #0-80, hex, socket cap screw, 1 in [25.4 mm]. stainless steel	4
2	Heatsink, NES/NPS, 0.728 [18.49] tall, pins	1
3	Thermal pad, NES/NPS	1
4	Spacer, hex, 0.125 in [3.18 mm], 0-80 UNC 2B thread, 0.120 in [3.05 mm] tall, AL	4
6	Washer, medium split lock, #0, 18-8, stainless steel,	4
7	Nut, #0-80, fine thread, stainless steel	4
5	Ifixit Opening Tool	1

THERMALS: PWM OUTPUTS DISSIPATION

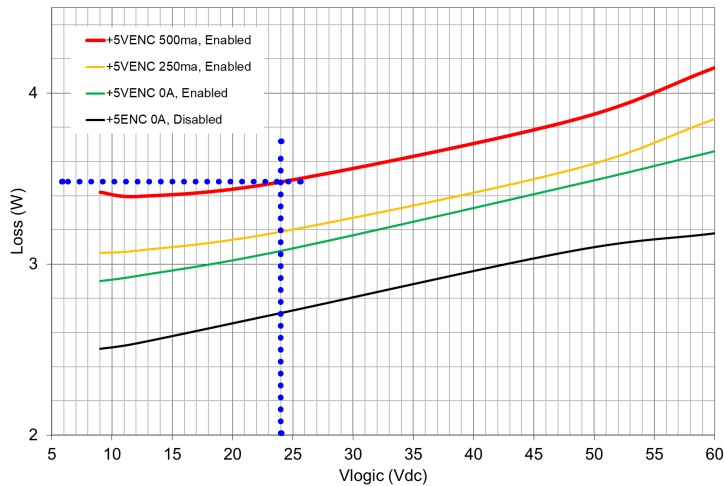
NPS-090-70



This 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. The dotted lines in the chart show a dissipation of 22 W. at a continuous current of 30 A and +HV = 48 Vdc.

THERMALS: VLOGIC & ENCODER +5V OUTPUT DISSIPATION

NPS All Models



This chart shows the power dissipation in the Vlogic circuits that power the drives control circuits and external encoders. Adding the PWM dissipation to the Vlogic dissipation will yield the total dissipation in Watts for the drive. The dotted lines in the chart show a dissipation of 3.5 W. at Vlogic = 24 Vdc when the drive is in an Enabled state and outputting 250 mA for an encoder.

THERMAL RESISTANCE

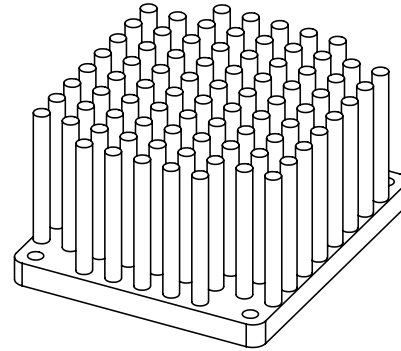
Thermal resistance R_{th} is a measure of the way the drive resists the flow of heat produced internally to the environment. The lower the resistance the more freely the heat can be dissipated. Thermal resistance R_{th} is in units of degrees-Centigrade per Watt (C/W). Lowering R_{th} can be done with heatsinks that increase the area that is exposed to the environment and by moving air over the surfaces with fans. The flow of fan forced air is measured in Linear-Feet-per-Minute (LFM).

No Heatsink

LFM	0	100	200	300
R_{th}				

Pins Heatsink Forced-Air

LFM	0	100	200	300
R_{th}	1.57			



Pins Heatsink

DEV BOARD

J4 MOTOR

Signal	Pin
+HV	3
HVCOM	2
FGND	1

J6 FGND/ HVCOM

Signal	Pin
HVCOM	2
FGND	1

P8 BRAKE

Signal	Pin
HVCOM	1
Brake	2
VLOGIC	3
VLOGIC	4

J5 MOTOR

Pin	Signal
1	Mot W
2	Mot V
3	Mot U
4	FGND

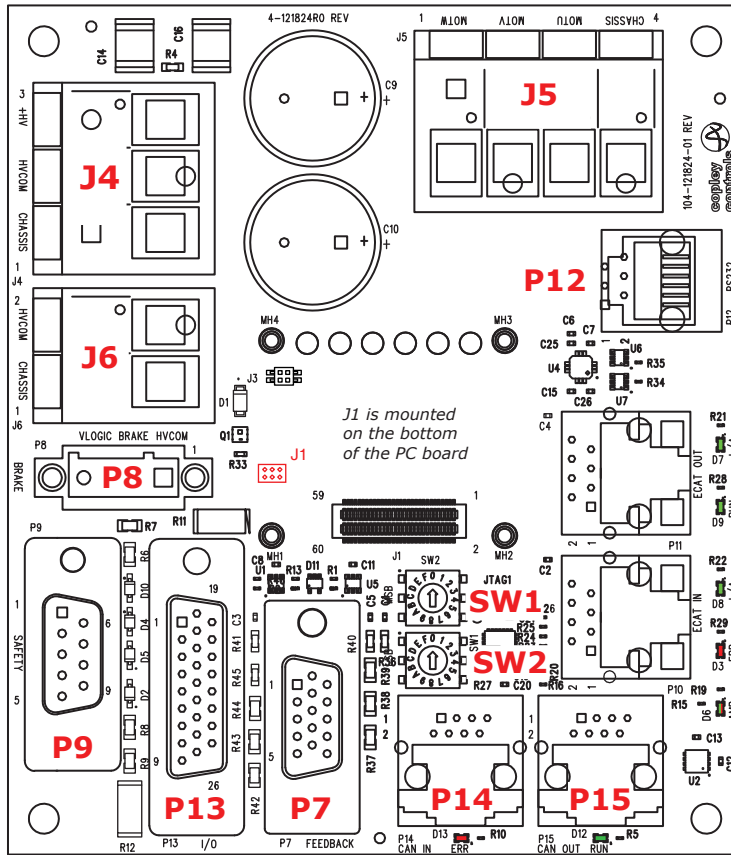
P12 RS-232

Pin	Signal
6	n.c.
5	TxD
4	SGND
3	SGND
2	RxD
1	n.c.

* These pins are feed-through between P14 & P15. They have no internal connections.

P14~15 CAN

Pin	Signal
1	CANH
2	CANL
3	SGND
4	*
5	*
6	*
7	SGND
8	*



P9 STO

Signal	Pin	Signal
FGND	1	6 STO_STATUS_OUTPUT
STO1_24V_IN	2	7 STO_STATUS_OUTPUT_RTN
STO1_RTN	3	8 SGND
STO2_24V_IN	4	9 VLOGIC +24V
STO2_RTN	5	

P7 ENCODER 1

Pin	Signal	Pin	Signal	Pin	Signal
1	FGND	6	Hall V	11	Enc1/B
2	+5 V	7	Enc1 /X	12	Enc1 B
3	Hall U	8	Enc1 X	13	Enc1/A
4	+5 V	9	Hall W	14	Enc1 A
5	SGND	10	Fault (IN6)	15	SGND

P13 I/O & ENCODER 2

Pin	Signal	Pin	Signal	Pin	Signal
1	FGND	10	IN5 12V	19	SGND
2	Aref-	11	n.c.	20	+5 V
3	Aref+	12	n.c.	21	Enc2 /X
4	IN1 24V	13	n.c.	22	Enc2 X
5	IN2 24V	14	n.c.	23	Enc2 /B
6	IN3 24V	15	SGND	24	Enc2 B
7	IN4 12V	16	OUT1	25	Enc2 /A
8	n.c.	17	OUT2	26	Enc2 A
9	n.c.	18	OUT3		

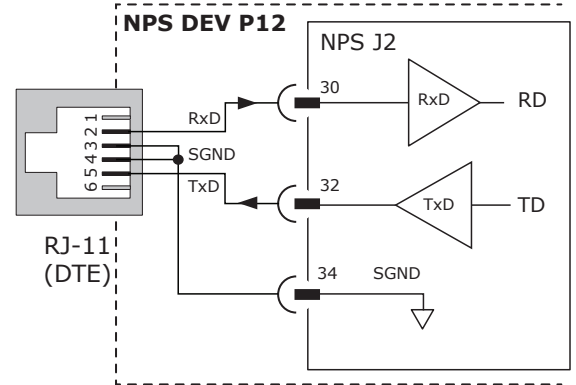
DEV BOARD

RS-232 CONNECTION

The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an CANopen network. CME software communicates with the drive over this link and is then used for complete drive setup. The CANopen Device ID that is set by the rotary switches can be monitored, and a Device ID programmed as well. The RS-232 connector, J9, is a modular RJ-11 type that uses a 6-position plug, four wires of which are used for RS-232. A connector kit is available (SER-CK) that includes the modular cable, and an adaptor to interface this cable with a 9-pin RS-232 port on a computer.

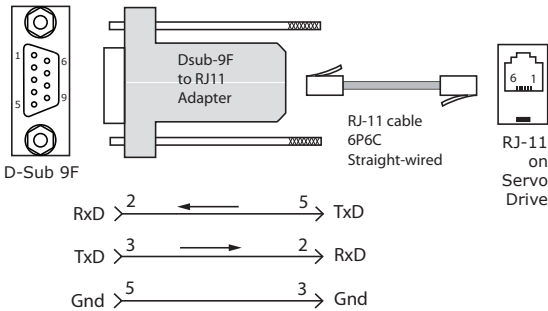
P12 DEV RS-232

Pin	Signal
2	RxD
3,4	SGND
5	TxD



SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector J9 on the DEV board. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses a straight-through modular cable to connect to the NPS. The connections are shown in the diagram below.



SER-USB-RJ11

This provides connectivity between a USB connector and the RJ-11 connector P12 on the DEV board.

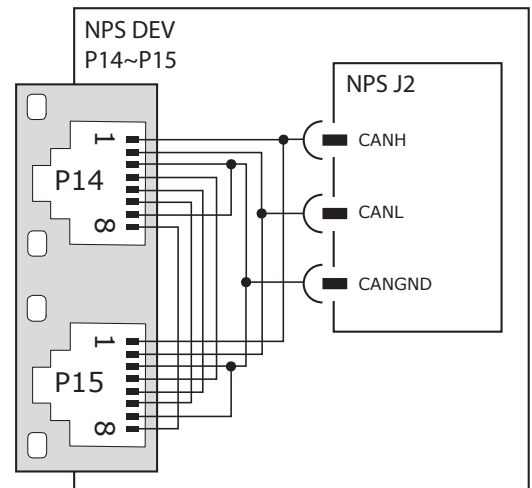
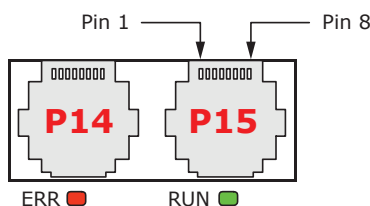


Don't forget to order a SER-USB-RJ11 when placing your order for an NPS drive with the DEV board.

CANOPEN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet cables are provided for CAN bus connectivity. Pins are wired-through so that drives can be daisy-chained and controlled with a single connection to the user's CAN interface. A 120 Ω CAN terminator should be placed in the last drive in the chain. The XTL-NK connector kit provides a D-Sub adapter that plugs into a CAN controller and has an RJ-45 socket that accepts the Ethernet cable.

P14-P15 CAN CONNECTORS

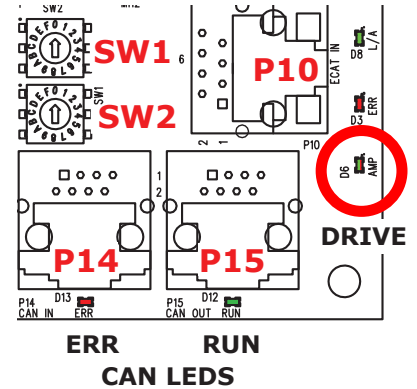


DEV BOARD

DRIVE STATUS LED

A bi-color LED "AMP" gives 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 one below will shown.

- Red/Blinking = Latching fault. Operation can not resume until drive is Reset.
- Red/Solid = Transient fault condition. Drive can resume 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 direction not inhibited by limit switch.
- Green/Solid = Drive OK and enabled. Can run in response to reference inputs or CANopen commands.

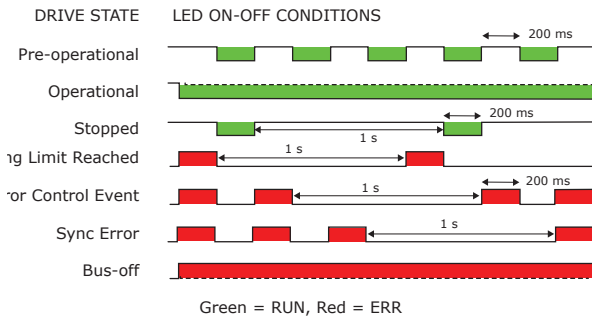


LATCHING FAULTS

<p>DEFAULT</p> <ul style="list-style-type: none"> Short circuit (Internal or external) Drive over-temperature Motor over-temperature Feedback Error Following Error 	<p>OPTIONAL (PROGRAMMABLE)</p> <ul style="list-style-type: none"> Over-voltage Under-voltage Motor Phasing Error Command Input Lost Motor Wiring Disconnected Over Current (latched)
---	---

CAN LEDS

The green LED "RUN" shows the state of the CAN state machine. The red LED "ERR" shows the status of the CAN physical layer and errors due to missing messages.

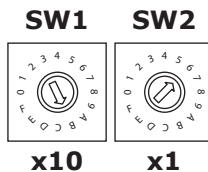


CAN DEVICE ID

When a device must have a positive identification a Device ID is needed. In the DEV board this is provided by two 16-position rotary switches with hexadecimal encoding. These can set the Device ID of the drive from 0x01~0xFF (1~255 decimal). The chart shows the decimal values of the hex settings of each switch.

Example 1: Find the switch settings for decimal Device ID 107:

- 1) Find the highest number under SW2 that is less than 107 and set SW2 to the hex value in the same row: 96 < 107 and 112 > 107, so SW2 = 96 = Hex 6
- 2) Subtract 96 from the desired Device ID to get the decimal value of switch SW1 and set SW1 to the Hex value in the same row: SW1 = (107 - 96) = 11 = Hex B



CAN Device ID Switch Decimal values

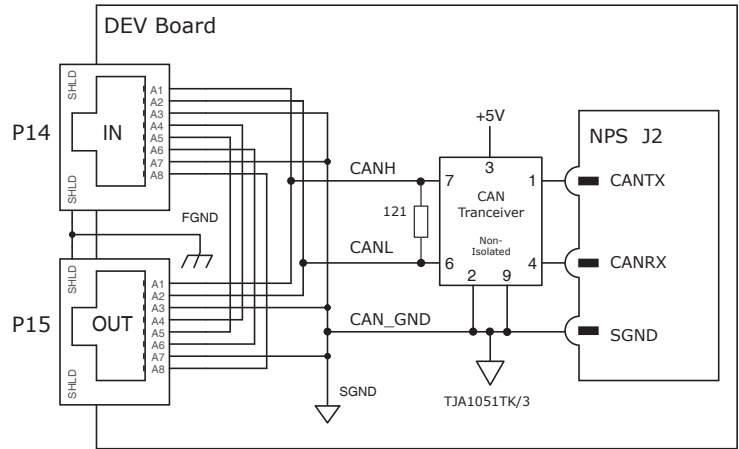
	SW1	SW2
HEX	DEC	
0	0	0
1	16	1
2	32	2
3	48	3
4	64	4
5	80	5
6	96	6
7	112	7
8	128	8
9	144	9
A	160	10
B	176	11
C	192	12
D	208	13
E	224	14
F	240	15

DEV BOARD CANOPEN CONNECTORS

CAN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet CAT-5 cables are provided for CANopen connectivity. If there are multiple NPS drives with DEV board in the system, the 121 Ω terminator shown below should only be placed on the last drive in the chain.

P14 CAN-IN		P15 CAN-OUT	
Pin	Signal	Pin	Signal
A1	CANH	A1	CANH
A2	CANL	A2	CANL
A3	SGND	A3	SGND
A4	n.c.	A4	n.c.
A5	n.c.	A5	n.c.
A6	n.c.	A6	n.c.
A7	SGND	A7	SGND
A8	n.c.	A8	n.c.



DEV BOARD SAFE TORQUE OFF (STO)

DESCRIPTION

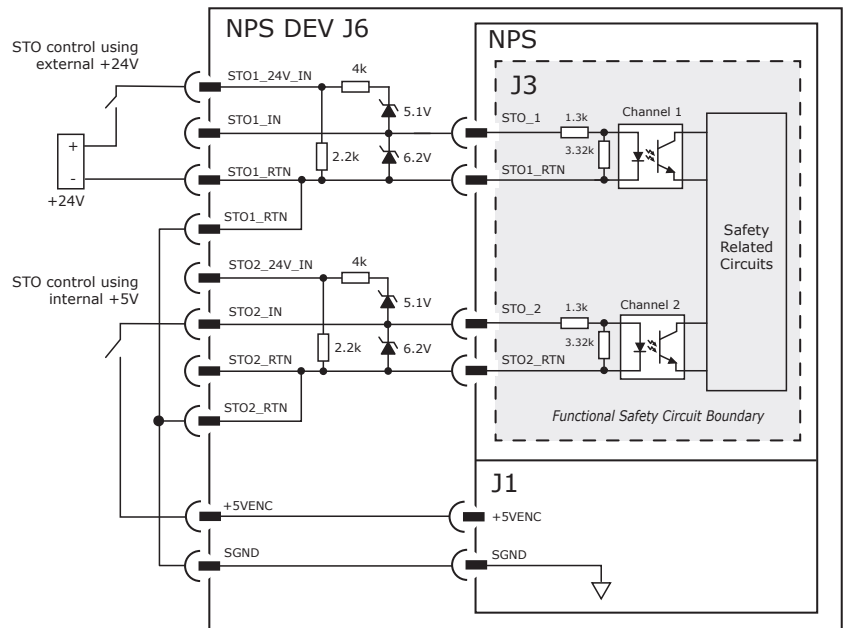
This shows the use of external 24V to energize the STO inputs. Both STO inputs must be energized in order to enable the drive. IN1, the hardware Enable input is for use with an immediate contact relay to bring the motor to a stop before a delayed contact relay de-energizes the STO inputs and prevents torque production in the motor.

P9 STO

Signal	Pin	Signal
FGND	1	6
STAT(+)	2	7
STO1-IN-24V	3	8
STO1-RTN	4	9
STO2-IN-24V	5	VLOGIC

STAT-OUT Operation

STO1	0	1	0	1
STO2	0	0	1	1
STAT	0	0	0	1



In this table, STO1 & STO2 rows, 1 = 24V has been 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.

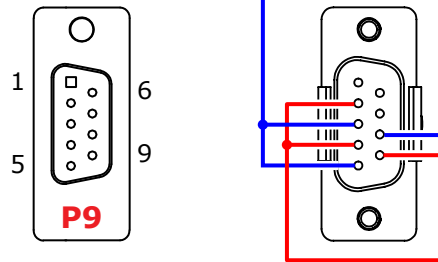
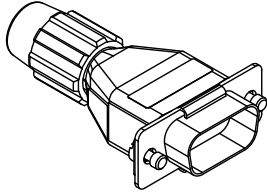
STO OPERATION

STO Input Voltage	STO State
STO1-IN-24V AND STO2-IN-24V ≥ 16 Vdc	STO Inactive. Drive can be enabled to produce torque
STO1-IN-24V OR STO2-IN-24V < 16 Vdc	STO Active. Drive cannot be enabled to produce torque
STO1-IN OR STO2-IN Open	

Note: Voltages in the table above are referenced between an STOx-IN and an STOx-RTN in P2
 E.g. $V(\text{STO1-IN}) = V(\text{STO1-24V-IN1}) - V(\text{STO1-RTN})$

DEV BOARD SAFE TORQUE OFF BYPASS JUMPER: STO-CK-04

The graphic below shows the STO Bypass plug. The switches are read after the drive is reset, or powered-on. When changing the settings of the switches, be sure to either reset the drive, or to power it off-on.



Jumper 1 carries +24V from P8 (Brake release)
 Jumper 2 connects to SGND.
 The STO bypass has no connections to any other circuits and is designed to be powered by +24V.

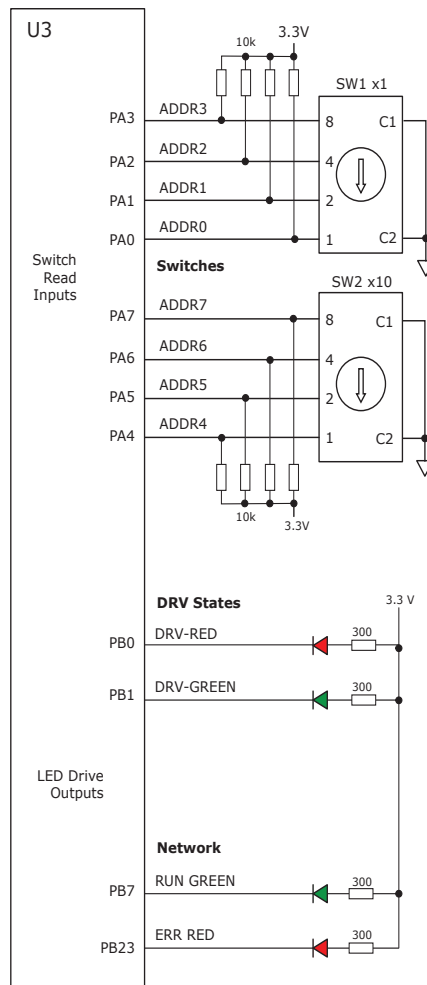
J6 STO

Signal	Pin	Signal
No connection	1	6
Jumper 1	2	7
Jumper 2	3	8
Jumper 1	4	9
Jumper 2	5	

DEV BOARD SWITCHES & LEDs

CAN DEVICE ID SWITCH CONNECTIONS & LEDs

The graphic below shows the connections to the CAN Device ID switches and status LEDs. The switches are read after the drive is reset, or powered-on. When changing the settings of the switches, be sure to either reset the drive, or to power it off-on.



DEV BOARD +HV, VLOGIC, & MOTOR CONNECTIONS

J4 +HV

The +HV power supply outputs connect to J4 pins 2 & 3. The shield shown is optional and is primarily for reduction of RF emissions from the drive. As shown it connects to the case of the power supply. Note that the minus terminal is not grounded externally. This is because currents in the cables produce voltage drops. Grounding the supply at the drive ensures that such voltage drops do not appear in the drive circuits.

J5 MOTOR

Pins 1~3 are for the motor windings. Pin 4 is for a cable shield. It connects to the drive heatplate on one end and should connect to the motor frame on the other. This provides a return path for currents produced by the PWM outputs and the capacitance between the cable conductors, motor windings, and motor frame. While the frame is commonly grounded by mounting to equipment, without the shield connections the PWM shield current could flow into external devices.

P8 VLOGIC

Powers the internal logic and control circuits in the drive. When using the STO feature, it 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. P8 also is the connection point for a motor holding brake. These connect to pins 2 & 3 and is not shown here because it is not part of the power & motor connections.

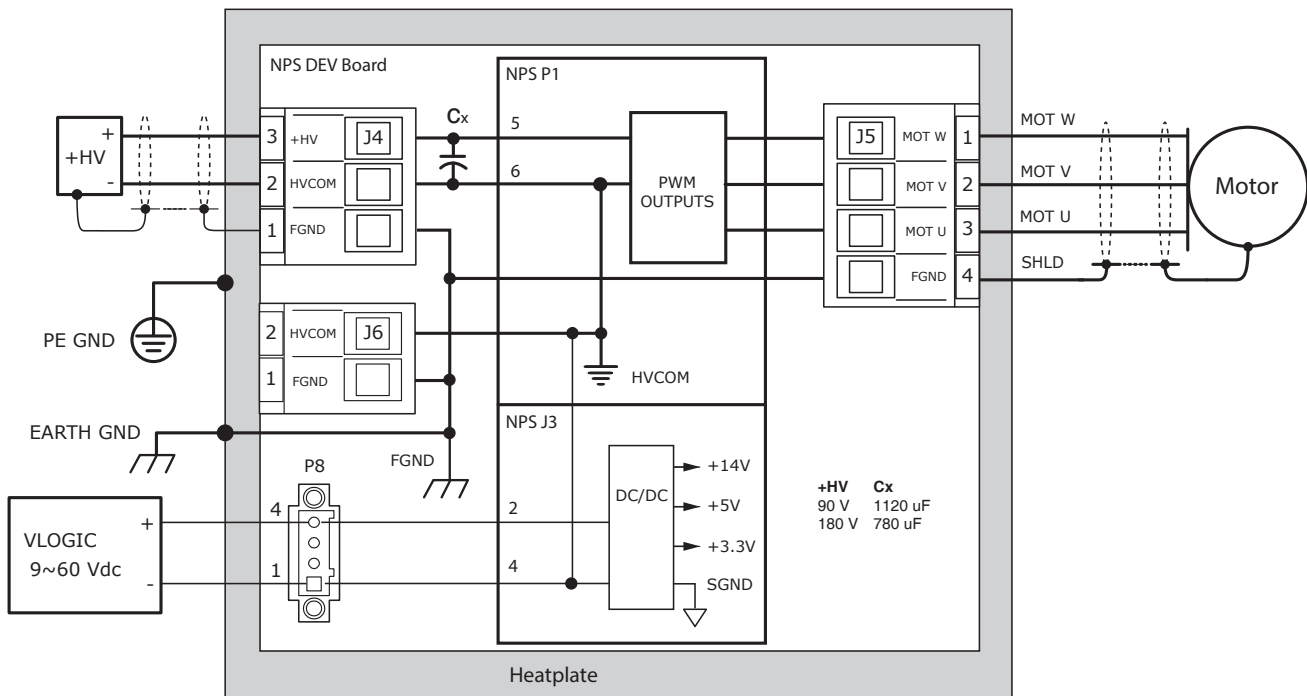
GROUNDING

PE GND is a Protective Earth ground which is the zero-volt reference for voltages used in the drive and is also the connection point for fault currents that might flow from any failures in the drive that could expose a user to an electric shock.

FGND, Frame Ground is referenced to the drive heatplate and has no connections to any circuits in the drive. Internal connections from the heatplate to J4, J5, and J6 enable cabling for grounding and shielding.

HVCOM, High-Voltage-Common is the 0V or 'ground' circuit for the high voltage circuits that drive the motor.

SGND, Signal Ground is the 0V circuit for low power control and interface circuits. It is connected to HVCOM internally so that all internal circuits have a common "0V" connection.



J4 +HV

Pin	Signal
3	+HV
2	HVCOM
1	FGND

J6 GROUNDS

Pin	Signal
2	HVCOM
1	FGND

P8 VLOGIC & BRAKE

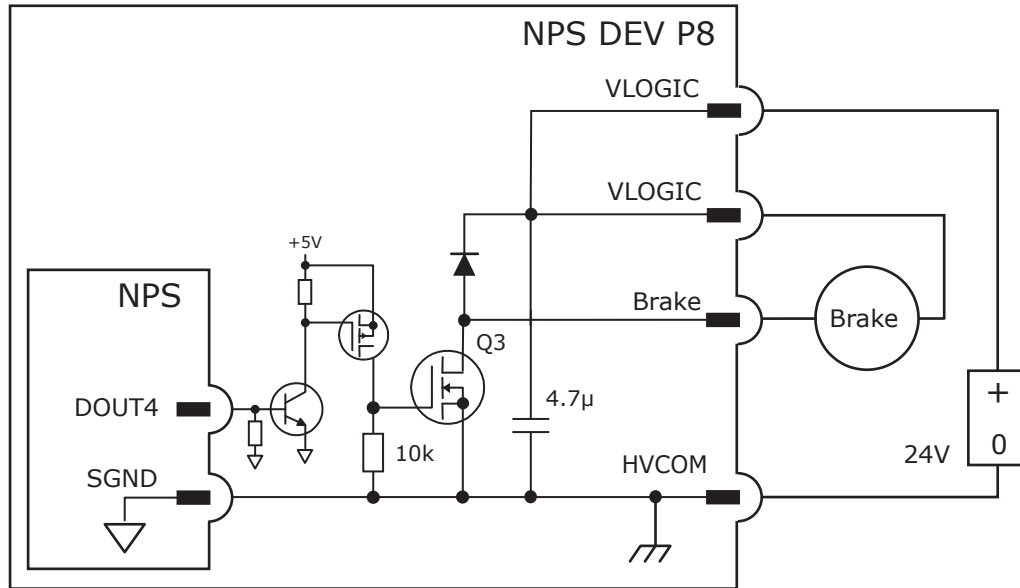
Pin	Signal
4	VLOGIC
3	VLOGIC
2	Brake
1	HVCOM

J5 MOTOR

Pin	Signal
1	MOT W
2	MOT V
3	MOT U
4	FGND

DEV BOARD BRAKE CONNECTOR & SIGNALS

The brake circuit on the DEV board is a MOSFET driven by OUT4 of the NPS



Specifications

Output	Data	Notes
Voltage Range	Max	+30 Vdc
Output Current	Ids	1.0 Adc

P8 BRAKE

Signal	Pins
VLOGIC	4
VLOGIC	3
Brake	2
HVCOM	1

HI/LO definitions: outputs

Input	State	Condition
BRAKE [OUT4]	LO	Output MOSFET Q3 is OFF Brake is un-powered and locks motor Motor cannot move Brake state is Active
	HI	Output MOSFET Q3 is ON Brake is powered, releasing motor Motor is free to move Brake state is NOT-Active

CME Default Setting for Brake Output [OUT4] is "Brake - Active Low"

Active = Brake is holding motor shaft (i.e. the Brake is Active)

Motor cannot move

No current flows in coil of brake

CME I/O Line States shows [OUT4] as LO

BRK Output voltage is HI (24V), MOSFET Q3 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 Inactive)

Motor can move

Current flows in coil of brake

CME I/O Line States shows [OUT4] as HI

BRK output voltage is LO (~0V), MOSFET Q3 is ON

Servo drive is enabled, PWM outputs are on

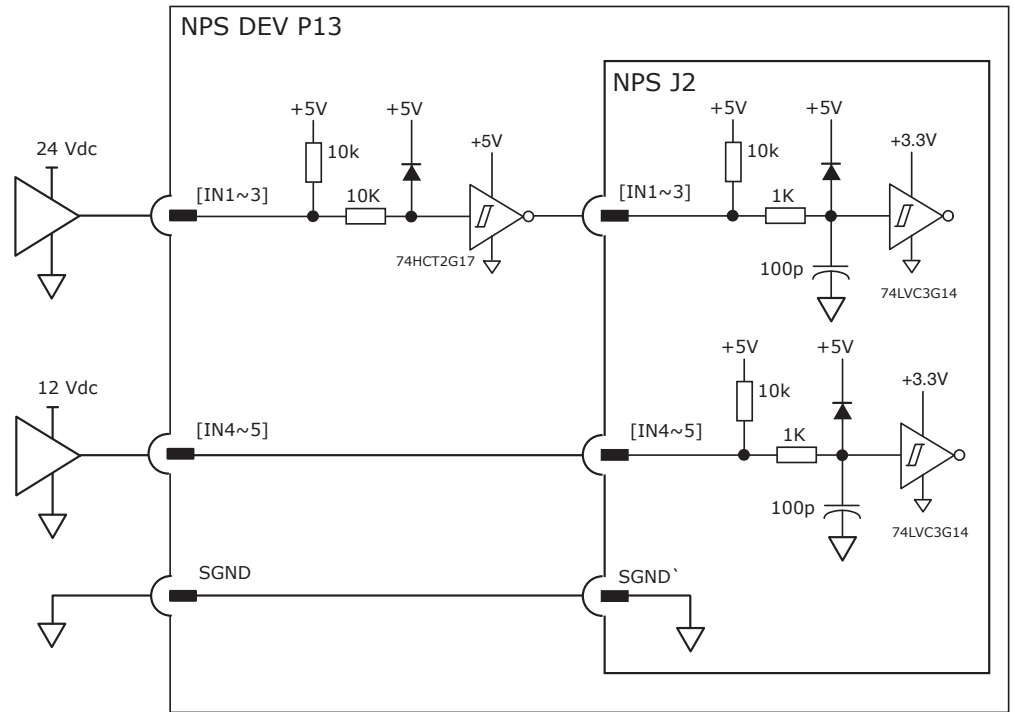
Servo drive output current is flowing

DEV BOARD INPUTS & OUTPUTS

P13 LOGIC INPUTS

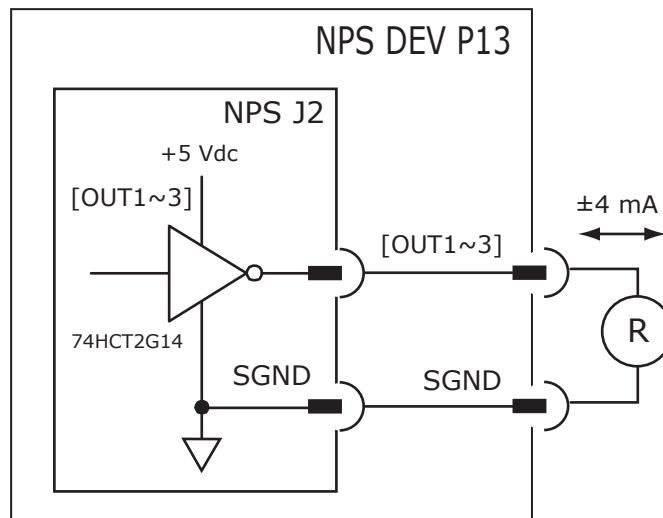
Signal	Pins
IN1 Enable 24V	4
IN2 24V	5
IN3 24V	6
IN4 12V	7
IN5 12V	10
SGND	15,19

IN1~3 on the DEV board are 24V compatible.
IN4~5 are 12V tolerant.



P13 LOGIC OUTPUTS

Signal	Pins
OUT1	16
OUT2	17
OUT3	18
SGND	15,19

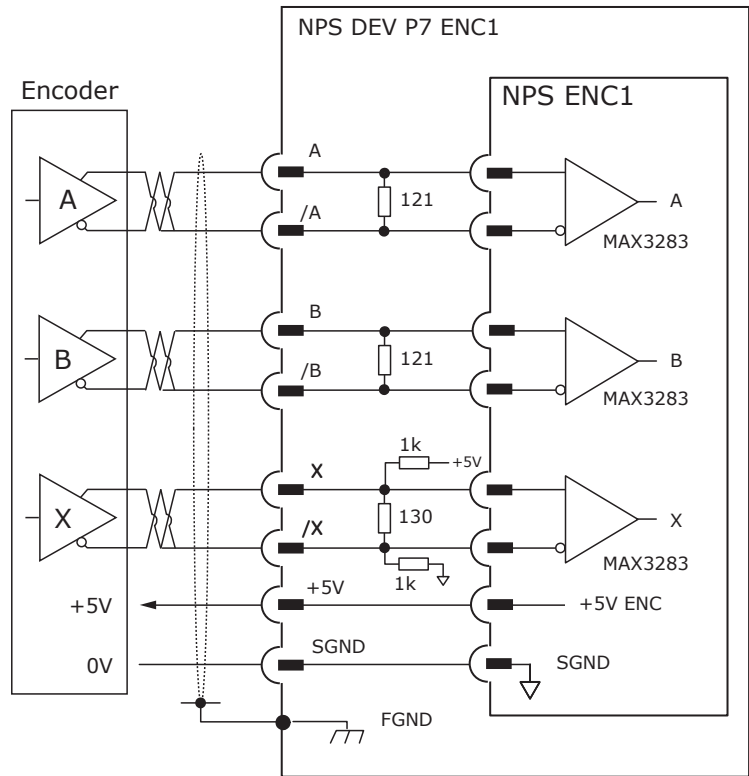


DEV BOARD PRIMARY FEEDBACK ENCODER

P7 ENC1 INPUTS

Signal	Pins
ENC1 A	14
ENC1 /A	13
ENC1 B	12
ENC1 /B	11
ENC1 X	8
ENC1 /X	7
Fault IN6	10
+5 V	2,4
SGND	5,15

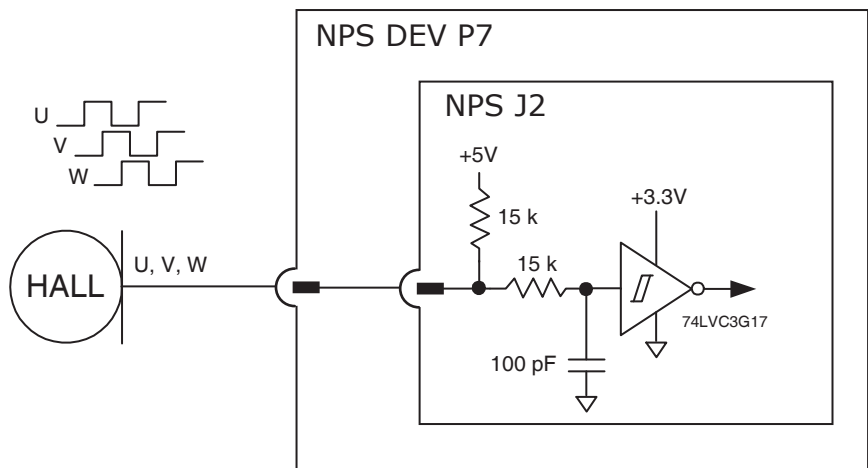
ENC1 is the Motor encoder and should be used in single-encoder applications. In dual-encoder applications, it can be assigned as Primary or Secondary using CME.



FGND connects to the connector shells which connect to the etch around the four mounting holes of the DEV board. The mounting screws and metal standoffs provide a connection to the equipment chassis which has a connection to earth.

P7 HALL INPUTS

Signal	Pins
Hall U	3
Hall V	6
Hall W	9

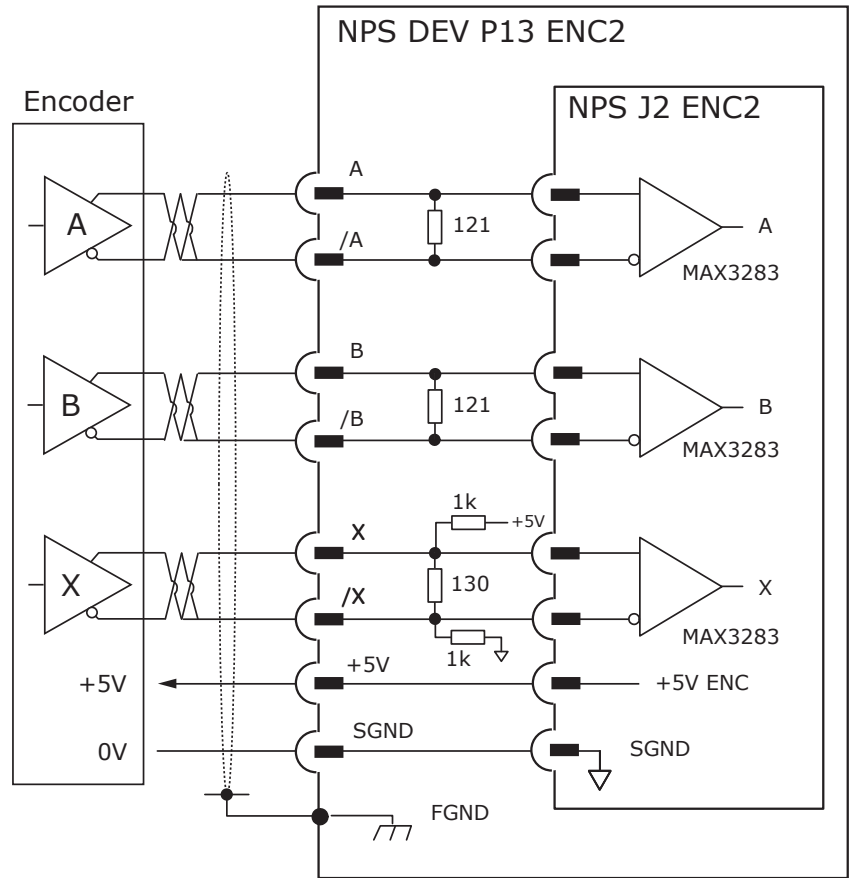


DEV BOARD SECONDARY FEEDBACK ENCODER

P13 ENC2 INPUTS

Signal	Pins
ENC2 A	26
ENC2 /A	25
ENC2 B	24
ENC2 /B	23
ENC2 X	22
ENC2 /X	21
Fault IN5	10
+5 V	20
SGND	15,19
FGND	1

ENC2 is the Load encoder and typically is feedback from a load driven by the motor and is used in dual-encoder applications. In dual-encoder applications, it can be assigned as Primary or Secondary using CME.



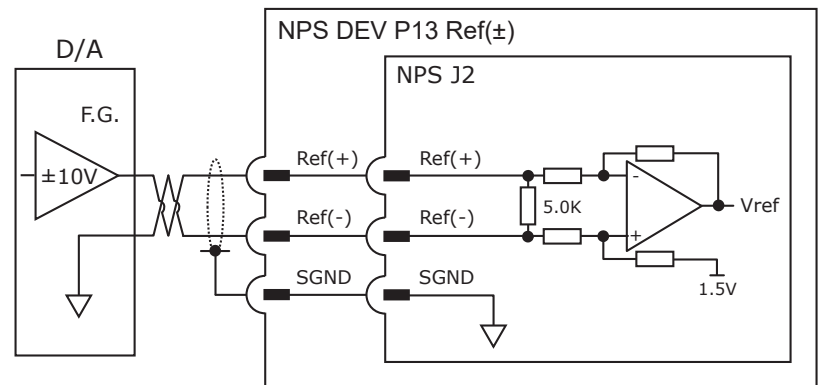
ANALOG INPUT: AIN1

As a reference input it takes Position/Velocity/Torque commands from a controller. If not used as a command input, it can be used as general-purpose analog input.

SPECIFICATIONS

Spec	Data	Notes
Input Voltage	Vref	±10 Vdc
Input Resistance	Rin	5 kΩ

Signal	J2 Pins
Ref(+)	2
Ref(-)	1
Sgnd	3



*THIS PAGE
LEFT BLANK
INTENTIONALLY*

ORDERING GUIDE

NANO

NPS-090-10	Nano Micro Module CANopen NPS servo drive, 5/10 A, 90 Vdc
NPS-090-70	Nano Micro Module CANopen NPS servo drive, 35/70 A, 90 Vdc
NPS-180-10	Nano Micro Module CANopen NPS servo drive, 5/10 A, 180 Vdc
NPS-180-30	Nano Micro Module CANopen NPS servo drive, 15/30 A, 180 Vdc
NPS-090-10-D	Nano Micro Module with DEV board, not soldered, no heat sink
NPS-090-70-D	Nano Micro Module with DEV board, soldered, with heat sink
NPS-180-10-D	Nano Micro Module with DEV board, not soldered, no heat sink
NPS-180-30-D	Nano Micro Module with DEV board, not soldered, with heat sink

ACCESSORIES FOR NANO MICRO MODULES

NS-D-CK	DEV Development Board Connector Kit
N-HK	Heat Sink Kit
SER-CK	Serial Cable Kit: 9-Pin Dsub receptacle to 6-pin modular adapter, plus modular cable for DEV board
SER-USB-RJ11	USB to 6-pin modular adapter
CAN-USB-01	CAN Interface with USB connection and DB9 Male output
NPS-CV	Adapter Assembly, DB9 Female to RJ45 Jack
NPS-NC-01	CAN network cable, 1 ft (0.3 m)
NPS-NC-10	CAN network cable, 10 ft (3 m)
NPS-NK	Network Kit, includes NPS-CV, NPS-NC-10, and NPS-NT
NPS-NT	RJ45 Terminator

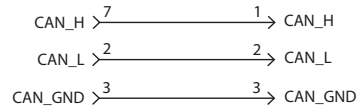
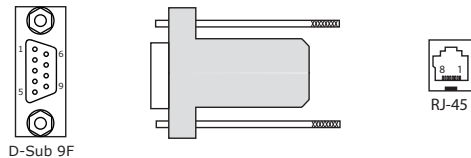
CAN-USB-01

This is a CAN interface with USB connectivity to the control computer. The Dsub male 9-pin socket connects to the NPS-NK connector kit which accepts the NPS-NC-01 or NPS-NC-10 cables.



NPS-NK CAN CONNECTOR KIT

The kit contains the adapter that converts the CAN interface D-Sub 9M connector to an RJ-45 Ethernet cable socket, plus a 10 ft (3 m) cable and terminator. Both connector pin-outs conform to the CiA DR-303-1 specification.



16-121737 Document Revision History

Revision	Date	Remarks
00	November 12, 2019	Initial released version
01	November 22, 2019	NPS-090-10 added
02	December 6, 2019	Deleted EtherCAT references, updated accessories, corrections to diagram on page 15.
03	May 20, 2020	Added thermals, added -D models to table above.
04	February 25, 2021	Deleted NPS-090-10 model, DEV board only

Note: Specifications subject to change without notice