Stepnet Plus 2-Axis Panel EtherCAT TE2

DIGITAL STEPPER DRIVE FOR STEPPER MOTORS

CONTROL MODES
- Stepper mode: Cyclic Synchronous Position (CSP)
- Servo mode: Cyclic Synchronous Position/Velocity/Torque (CSP, CSV, CST)
- Profile Position-Velocity-Torque, Interpolated Position, Homing
- Camming, Gearing
- Indexer

COMMAND INTERFACE
- CANopen application protocol over EtherCAT (CoE)
- ASCII and discrete I/O
- Master encoder (Gearing/Camming)
- Stepper mode position commands:
  Digital: Pulse/Dir, CW/CCW, Quad A/B
  Analog: ±10V position
- Servo mode commands:
  Digital: Pulse/Dir, CW/CCW, Quad A/B
  PWM Velocity/Torque command
  Analog: ±10V Position/Velocity/Torque

COMMUNICATIONS
- EtherCAT
- RS-232

FEEDBACK

Incremental Encoders
- Digital quad A/B/X
- Panasonic Incremental A Format
- Aux. quad A/B encoder / encoder out

Absolute Encoders
- EnDat, BiSS, SSI, Absolute A

I/O DIGITAL
- 16 non-isolated, 8 isolated inputs
- 5 isolated outputs, 2 non-isolated outputs

ANALOG
- 2 Reference Inputs, 12-bit

SAFE TORQUE OFF (STO)
- SIL 3, Category 3, PL d

DIMENSIONS: IN [MM]
- 6.78 x 4.70 x 1.99 [172.1 x 119.3 x 50.4] no heatsink
- 6.78 x 4.70 x 3.14 [172.1 x 119.3 x 79.9] with heatsink

EtherCAT Conformance tested

Model	Ip	Ic	Vdc
TE2-090-07	7	5	90
TE2-090-10	10	10	90

Current ratings are for each axis

DESCRIPTION

Stepnet Plus TE2 is a 2-axis, high-performance DC powered microstepping drive for control of hybrid stepping motors via EtherCAT using the CAN Application Layer for EtherCAT (CoE). Microstepping modes are Profile Position, Interpolated Position Mode (PVT), and Homing. With encoder feedback, the TE2 can operate a stepper as a brushless servo motor, enabling Cyclic Sync Position/Velocity/Torque operation, too.

As well as operating on EtherCAT networks, the TE2 also operates in the following traditional control modes: step/direction, RS-232 ASCII, master encoder for gearing and camming, digital input commands to initiate predetermined motion sequences.

There are sixteen non-isolated inputs and eight opto-isolated digital inputs that are bipolar types, sourcing or sinking current into a common connection that can be tied to ground or +24V. [IN1&10] default to the drive Enable function for axes A & B, and are programmable to other functions. The other inputs are programmable. All inputs have programmable active levels. Five opto-isolated outputs [OUT1~5] have individual collector/emitter connections. Two MOSFET outputs [OUT6~7] are programmable to drive motor brakes or other functions and have internal flyback diodes for driving inductive loads.

Drive power is transformer-isolated DC from regulated or unregulated power supplies. An AuxHV input is provided for "keep-alive" operation permitting the drive power stage to be completely powered down without losing position information, or communications with the control system.

GENERAL SPECIFICATIONS

Test conditions: Load = Wye connected load: 2 mH + 2 Ω line-line. Ambient temperature = 25°C, +HV = HV_{max}

MODEL	TE2-090-07	TE2-090-10	
OUTPUT POWER (EACH AXIS)			
Peak Current	7 (5)	10 (7.1)	Adc (Arms-sine), ±5%
Peak time	1	1	Sec
Continuous current (Note 1)	5 (3.5)	10 (7.1)	Adc (Arms-sine) per phase
INPUT POWER			
HVmin~HVmax	+14 to +90	+14 to +90	Vdc Transformer-isolated
Ipeak	14	20	Adc (1 sec) peak
Icont	10	20	Adc continuous
Aux HV	+14 to +90 Vdc	+14 to +90 Vdc	Optional, not required for operation
4 W (Typ no load on encoder +5V outputs), 11 W, (Max, both encoder +5V @ 500 mA)			

DIGITAL CONTROL		
Digital Control Loops	Current, velocity, position. 100% digital loop control	
Sampling rate (time)	Current loop: 16 kHz (62.5 µs), Velocity & position loops: 4 kHz (250 µs)	
Bus voltage compensation	Changes in bus or mains voltage do not affect bandwidth	
Minimum load inductance	200 µH line-line	
COMMAND INPUTS (NOTE: DIGITAL INPUT FUNCTIONS ARE PROGRAMMABLE)		
Distributed Control Modes		
CANopen application protocol over EtherCAT (CoE)	Cyclic Synchronous Position (CSP), Cyclic-sync Velocity/Torque (CSV, CST, servo mode), Profile Position, Profile Velocity-torque (servo mode), Interpolated Position, Homing	
Stand-alone mode		
Analog position, velocity/torque(servo mode)	±10 Vdc, 12-bit resolution	Dedicated differential analog input
Digital position reference	Pulse/Direction, CW/CCW	Stepper commands (2 MHz maximum rate)
	Quad A/B Encoder	2 M line/sec, 8 Mcount/sec (after quadrature)
Digital torque & velocity reference (servo mode)	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, DTE, 9600~115,200 Baud, 3-wire, RJ-11 connector	

DIGITAL INPUTS	
Number 24	
[IN1,2,10,11]	Digital, non-isolated, Schmitt trigger, 1.5 µs RC filter, 24 Vdc compatible, programmable 15kΩ pull-up/down to +5 Vdc/ground, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc
[IN19~21,22~24]	Digital, non-isolated, Schmitt trigger, 1.5 µs RC filter, 24 Vdc compatible, 15kΩ pull-up to +5 Vdc/ground, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc
[IN3,4,12,13]	Digital, non-isolated, programmable as single-ended or differential pairs, 100 ns RC filter, 12 Vdc max, programmable pull-up/down per input to +5 Vdc/ground, SE: Vin-LO ≤ 2.3 Vdc, Vin-HI ≥ 2.7 Vdc, VH = 45 mV typ, DIFF: Vin-LO ≤ 200 mVdc, Vin-HI ≥ 200 mVdc, VH = 45 mV typ
[IN5~8,14~17]	Digital, opto-isolated, single-ended, ±15~30 Vdc compatible, bi-polar, 2 groups of 4, each with a common terminal Rated impulse ≥ 800 V, Vin-LO ≤ 6.0 Vdc, Vin-HI ≥ 10.0 Vdc, Input current ±3.6 mA @ ±24 Vdc, typical
[IN9,18]	Default as motor overtemp inputs on feedback connectors, 12 Vdc max, programmable to other functions Other digital inputs are also programmable for the Motemp function 330 µs RC filter, 4.99k pullup to +5 Vdc, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc
Functions	All inputs are programmable, [IN1 & IN10] default to drive axes A & B Enable function and are programmable
ANALOG INPUTS	
Number	2
[AIN1~2]	Differential, ±10 Vdc, 5 kΩ input impedance, 12-bit resolution
SAFE TORQUE OFF (STO)	
Function	PWM outputs active and current to the motor will not be possible when the STO function is asserted
Standard	Designed to IEC-61508-1, IEC-61508-2, IEC-61800-5-2, ISO-13849-1
Safety Integrity Level	SIL 3, Category 3, Performance level d
Inputs	2 two-terminal: STO_IN1+,STO_IN1-, STO_IN2+, STO_IN2-
Type	Opto-isolators, 24V compatible, Vin-LO ≤ 6.0 Vdc or open, Vin-HI ≥ 15.0 Vdc,
Input current (typical)	STO_IN1: 9.0 mA, STO_IN2: 4.5 mA
Response time	2 ms (IN1, IN2) from Vin ≤6.0 Vdc to interruption of energy supplied to motor
Reference	***Complete information and specifications are in the Accelnet & Stepnet Plus Panels STO Manual***
DIGITAL OUTPUTS	
Number	7
[OUT1~5]	Opto-isolated SSR, two-terminal, 300 mA max, 24 V tolerant, Rated impulse ≥ 800 V, series 1 Ω resistor
[OUT6~7]	Opto-isolated MOSFET, default as motor brake control, current-sinking, 1 Adc max, flyback diodes to +24 V external power supply for driving inductive loads Programmable for other functions if not used for brake
RS-232 PORT	
Signals	RxD, TxD, Gnd in 6-position, 4-contact RJ-11 style modular connector, non-isolated, common to Signal Ground
Mode	Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 115,200 Baud
Protocol	Binary and ASCII formats
ETHERCAT PORTS	
Format	Dual RJ-45 receptacles, 100BASE-TX
Protocol	EtherCAT, CANopen application protocol over EtherCAT (CoE), CiA-402 for motion control devices

NOTES:
1) Heatsink or forced-air required for continuous current rating

GENERAL SPECIFICATIONS

DC POWER OUTPUTS

Number: Ratings	2: +5 Vdc, 500 mA max each output, thermal and short-circuit protected
Connections	Axis A: J1-17, J1-32, J7-6, J7-17; combined current from these pins cannot exceed 500 mA Axis B: J1-23, J1-38, J8-6, J8-17; combined current from these pins cannot exceed 500 mA

INDICATORS

AMP	Bicolor LED, drive state indicated by color, and blinking or non-blinking condition
RUN	Green LED, status of EtherCAT state-machine (ESM)
ERR	Red LED, shows errors due to time-outs, unsolicited state changes, or local errors
L/A	Green LED, Link/Act, shows the state of the physical link and activity on the link (EtherCAT connection) RUN, ERR, and L/A LED colors and blink codes conform to ETG.1300 S(R) V1.1.0

PROTECTIONS

HV Overvoltage	+HV > +90 Vdc	Drive outputs turn off until +HV < +90 Vdc
HV Undervoltage	+HV < +14 Vdc	Drive outputs turn off until +HV > +14 Vdc
Drive over temperature	Heat plate > 70°C.	Drive outputs turn off
Short circuits	Output to output, output to ground, internal PWM bridge faults	
I^2T Current limiting	Programmable: continuous current, peak current, peak time	
Motor over temperature	Digital inputs programmable to detect motor temperature switch	

MECHANICAL & ENVIRONMENTAL

Size IN [MM]	6.78 x 4.70 x 1.99 [172.1 x 119.3 x 50.4] without heatsink 6.78 x 4.70 x 3.14 [172.1 x 119.3 x 79.9] with heatsink
Weight LB[KG]	1.5 [0.68] without heatsink, 2.75 [1.25] with heatsink
Ambient temperature	0 to +45C operating, -40 to +85C storage
Humidity	0 to 95%, non-condensing
Vibration	2 *g* peak, 10~500 Hz (sine), IEC60068-2-6
Shock	10 *g*, 10 ms, half-sine pulse, IEC60068-2-27
Contaminants	Pollution degree 2
Environment	IEC 60068-2
Cooling	Heat sink and/or forced air cooling required for continuous power output

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

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, 1st Ed.

TÜV SÜD Functional Safety to:

IEC 61508-1, IEC 61508-2, IEC 61508-3, IEC 61508-4 (SIL 3)
ISO 13849-1/Cor. 1:2009 (Cat 3, PL d)

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

GENERAL SPECIFICATIONS

FEEDBACK	
Incremental:	
Digital Incremental Encoder	Quadrature signals, (A, /A, B, /B, X, /X), differential (X, /X Index signals not required) 5 MHz maximum line frequency (20 M counts/sec) MAX3094 differential line receiver with 121 Ω terminating resistor between A & /A, B & /B inputs X & /X inputs have 130 Ω terminating resistor, S & /S inputs have 221 Ω terminating resistor X & S inputs have 1 kΩ pull-ups to +5V, /X & /S inputs have 1 kΩ pull-downs to ground
Absolute:	
EnDat	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential, 121 Ω inputs
Absolute A	Tamagawa Absolute A, Panasonic Absolute A Format, Sanyo Denki Absolute A SD+, SD- (S, /S) signals, 2.5 or 4 MHz, 2-wire half-duplex communication Status data for encoder operating conditions and errors
MULTI-MODE ENCODER PORT	
As Input	Digital quadrature encoder (A, /A, B, /B, X, /X), 5 MHz maximum line frequency (20 M counts/sec), MAX3094 line receiver, 1.5 kΩ pull-ups to +5V on X & S inputs, 1.5 kΩ pull-downs to Sgnd on /X & /S inputs Digital absolute encoder (Clk, /Clk, Dat, /Dat) half or full-duplex operation, S & X inputs are used for absolute encoder interface
As Emulated Output	Quadrature encoder emulation with programmable resolution to 4096 lines (65,536 counts) per rev from absolute encoders A, /A, B, /B, from MAX3032 differential line driver, X, /X, S, /S from MAX3362 differential line driver
As Buffered Output	Digital A/B/X encoder feedback signals from primary quad encoder are buffered (see line drives above)

ETHERCAT COMMUNICATIONS

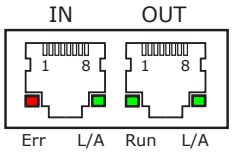
EtherCAT is the open, real-time Ethernet network developed by Beckhoff based on the widely used 100BASE-TX cabling system. EtherCAT enables high-speed control of multiple axes while maintaining tight synchronization of clocks in the nodes.

Data protocol is CANopen application protocol over EtherCAT (CoE) based on DSP-402 for motion control devices. More information on EtherCAT can be found on this web-site: http://ethercat.org/default.htm

ETHERCAT CONNECTIONS

Dual RJ-45 sockets accept standard Ethernet cables. The IN port connects to a master, or to the OUT port of a device that is 'upstream', between the Stepnet and the master.

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



J4: EtherCAT PORTS

RJ-45 receptacles,
8 position, 4 signals

PIN	SIGNAL
6	RX-
3	RX+
2	TX-
1	TX+

ETHERCAT LEDS (ON RJ-45 CONNECTORS)

RUN Green: Shows the state of the ESM (EtherCAT State Machine)

Off	=	Init
Blinking	=	Pre-operational
Single-flash	=	Safe-operational
On	=	Operational

ERR Red: Shows errors such as watchdog timeouts and unsolicited state changes in the TE2 due to local errors.

Off	=	EtherCAT communications are working correctly
Blinking	=	Invalid configuration, general configuration error
Single Flash	=	Local error, slave has changed EtherCAT state autonomously
Double Flash	=	PDO or EtherCAT watchdog timeout,or an application watchdog timeout has occurred

L/A Green: Shows the state of the physical link and activity on the link.
A green LED 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 (STATION ALIAS)

In an EtherCAT network, slaves are automatically assigned consecutive addresses based on their position on the network. But when the device must have a positive identification that is independent of cabling, a Device ID is used. In the TE2, this is provided by two 16-position rotary switches with hexadecimal encoding. These can set the Device ID of the drive from 0x00~0xFF (0~255 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 in the x10 column that is less than 107 and set x10 to the hex value in the same row:
   96 < 107 and 112 > 107, so x10 = 96 = Hex 6
2) Subtract 96 from the desired Device ID to get the decimal value for the switch x1 and set it to the Hex value in the same row:
   x1 = (107 - 96) = 11 = Hex B
3) Result: X10 = 6, X1 = B, Alias = 0x6B (107)

EtherCAT Device ID Switch Decimal values

Set	x10	x1
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

Set	x10	x1
Hex	Dec	
8	128	8
9	144	9
A	160	10
B	176	11
C	192	12
D	208	13
E	224	14
F	240	15

INDICATORS: DRIVE STATE

Two bi-color LEDs give the state of the TE2 drive. Colors do not alternate, and can be solid ON or blinking. When multiple conditions occur, only the top-most condition will be displayed. When that condition is cleared the next one TE2ow will shown.

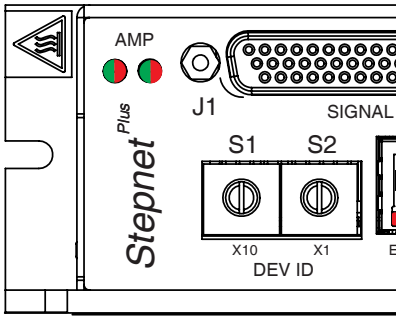
1) Red/Blinking	=	Latching fault. Operation will not resume until drive is Reset.
2) Red/Solid	=	Transient fault condition. Drive will resume operation when the condition causing the fault is removed.
3) Green/Double-Blinking	=	STO circuit active, drive outputs are Safe-Torque-Off
4) Green/Slow-Blinking	=	Drive OK but NOT-enabled. Will run when enabled.
5) Green/Fast-Blinking	=	Positive or Negative limit switch active. Drive will only move in direction not inhibited by limit switch.
6) Green/Solid	=	Drive OK and enabled. Will run in response to reference inputs or EtherCAT commands.

Latching Faults

Defaults
- Short circuit (Internal or external)
- Drive over-temperature
- Motor over-temperature
- Feedback Error
- Following Error

Optional (programmable)
- Over-voltage
- Under-voltage
- Motor Phasing Error
- Command Input Fault

AMP LEDS & DEVICE ID SWITCHES



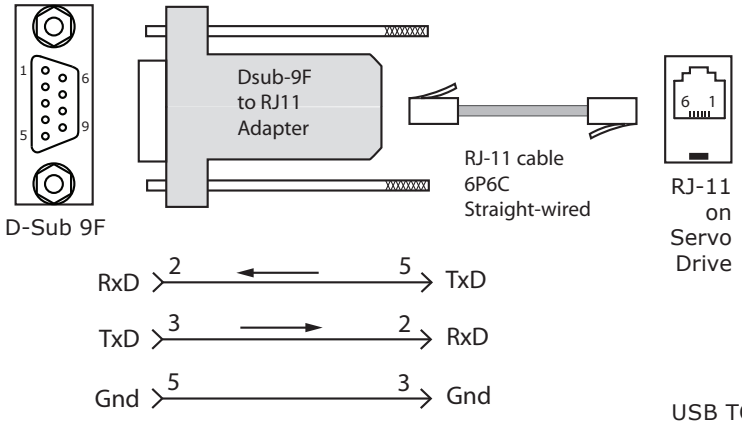
COMMUNICATIONS: RS-232 SERIAL

TE2 is configured via a three-wire, full-duplex DTE RS-232 port that operates from 9600 to 115,200 Baud, 8 bits, no parity, and one stop bit. Signal format is full-duplex, 3-wire, DTE using RxD, TxD, and Gnd. Connections to the *TE2* RS-232 port are through J4, an RJ-11 connector. The *TE2* Serial Cable Kit (SER-CK) contains a modular cable, and an adapter that connects to a 9-pin, Sub-D serial port connector (COM1, COM2, etc.) on PC's and compatibles.

After power-on, reset, or transmission of a Break character, the Baud rate will be 9,600. Once communication has been established at this speed, the Baud rate can be changed to a higher rate (19,200, 57,600, 115,200).

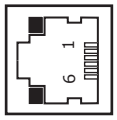
SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector on the TE2. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses common modular cable to connect to the TE2. The connections are shown in the diagram below.



J5: RS-232 PORT

RJ-11 receptacle,
6 position, 4 contact



PIN	SIGNAL
2	RxD
3,4	Gnd
5	Txd

Don't forget to order a Serial Cable Kit SER-CK when placing your order for a TE2!

USB TO RS-232 ADAPTERS

These may or may not have the speed to work at the 115,200 Baud rate which gives the best results with CME. Users have reported that adapters using the FTDI chipset work well with CME.
Recommend: Copley SER-USB-RJ11

ASCII COMMUNICATIONS

The Copley ASCII Interface is a set of ASCII format commands that can be used to operate and monitor Copley Controls Accelnet, Stepnet, and TE2 series drives over an RS-232 serial connection. For instance, after basic drive configuration values have been programmed using CME, a control program can use the ASCII Interface to:

- Enable the drive in Programmed Position mode.
- Home the axis.
- Issue a series of move commands while monitoring position, velocity, and other run-time variables.

The Baud rate defaults to 9,600 after power-on or reset and is programmable up to 115,200 thereafter.
After power-on, reset, or transmission of a Break character, the Baud rate will be 9,600. Once communication has been established at this speed, the Baud rate can be changed to a higher rate (19,200, 57,600, 115,200).
ASCII parameter 0x90 holds the Baud rate data. To set the rate to 115,200 enter this line from a terminal:

```
s r0x90 115200 <enter>
```

Then, change the Baud rate in the computer/controller to the new number and communicate at that rate.

Additional information can be found in the ASCII Programmers Guide on the Copley website:
https://www.copleycontrols.com/en/support/ > Manuals > Manuals

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 being operated by the digital control core.

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.

INSTALLATION

DANGER	***Refer to the Accelnet & Stepnet Plus Panels STO Manual***
	The information provided in the *Accelnet & Stepnet Plus Panels STO Manual* must be considered for any application using the TE2 drive's STO feature. ***FAILURE TO HEED THIS WARNING CAN CAUSE EQUIPMENT DAMAGE, INJURY, OR DEATH.***

STO BYPASS (MUTING)

In order for the PWM outputs of the TE2 to be activated, current must be flowing through all of the opto-couplers that are connected to the STO-IN1 and STO-IN2 terminals of J6, and the drive must be in an ENABLED state. When 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 all of the opto-couplers from an internal current-source. When this is done the STO feature is overridden 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 TE2 to be enabled.

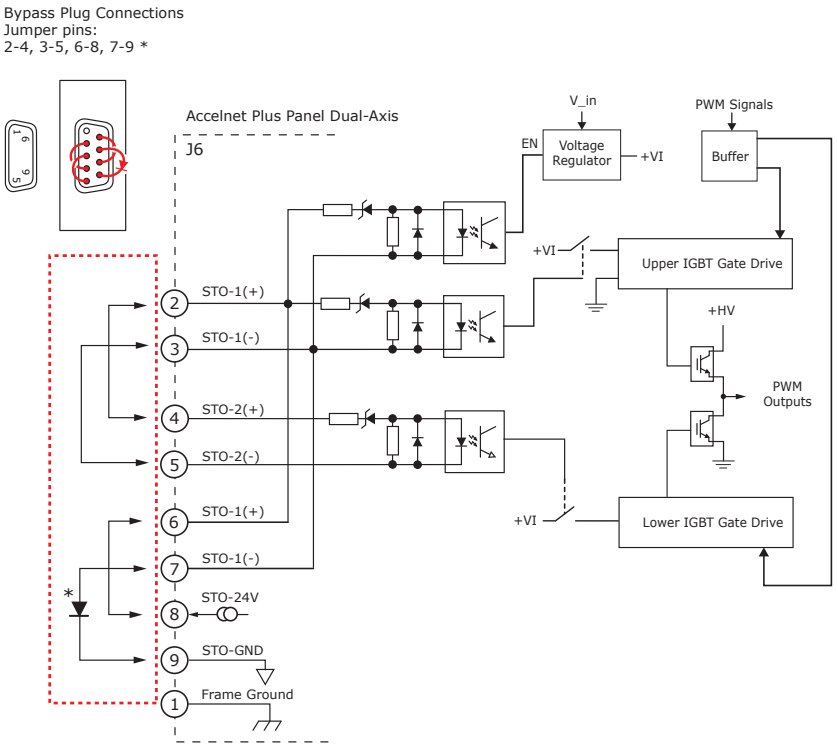
FUNCTIONAL DIAGRAM

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

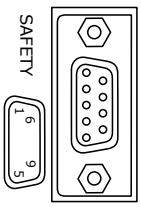
* STO bypass connections on the TE2 and Xenus XEL-XPL models are different. If both drives are installed in the same cabinet, the diode should be wired as shown to prevent damage that could occur if the STO bypass connectors are installed on the wrong drive. The diode is not required for STO bypass on the TE2 and can be replaced by a wire between pins 7 and 9.

See page 30 for STO-CK-02
It is a plug with the bypass connections built-in

STO BYPASS CONNECTIONS



SAFETY CONNECTOR J6



CONNECTIONS

PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	6	STO-1(+)
2	STO-1(+)	7	STO-1(-)
3	STO-1(-)	8	STO-24V
4	STO-2(+)	9	STO-GND
5	STO-2(-)		

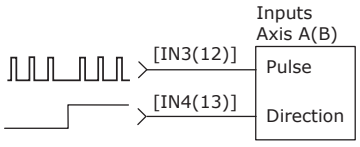
DIGITAL COMMAND INPUTS: POSITION

POSITION COMMAND INPUTS

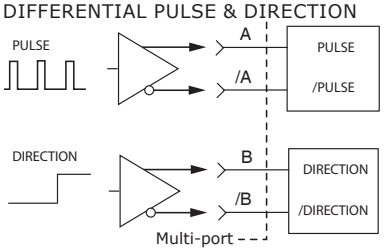
Single-ended digital position commands must be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs.

For differential commands, the A & B channels of the multi-mode encoder ports are used.

SINGLE-ENDED PULSE & DIRECTION



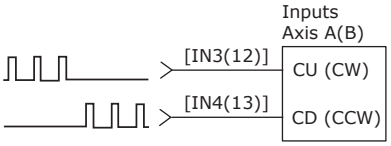
DIFFERENTIAL PULSE & DIRECTION



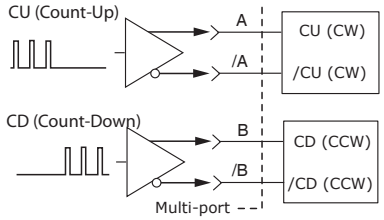
SINGLE-ENDED: IN3, 4, 12, 13

Signal	Axis A	Axis B
[IN3(12)] Pls, CU, Enc A	J1-9	J1-14
[IN4(13)] Dir, CD, Enc B	J1-10	J1-15
Signal Ground	J1-6,16,22,31, 37,44	
Frame Ground	J1-1	

SINGLE-ENDED CU/CD



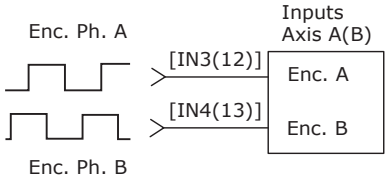
DIFFERENTIAL CU/CD



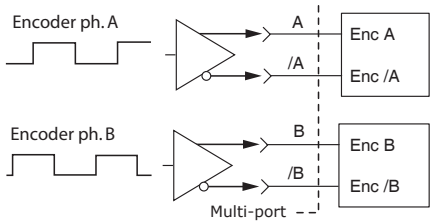
DIFFERENTIAL: MULTI-PORT A, /A, B, /B

Signal	Axis A	Axis B
[Enc A] Pls, CU, Enc A	J1-36	J1-42
[Enc /A] /Pls, /CU, Enc /A	J1-21	J1-27
[Enc B] Dir, CD, Enc B	J1-35	J1-41
[Enc /B] /Dir, /CD, Enc /B	J1-20	J1-26
Signal Ground	J1-6,16,22,31, 37,44	
Frame Ground	J1-1	

QUAD A/B ENCODER SINGLE-ENDED



QUAD A/B ENCODER DIFFERENTIAL

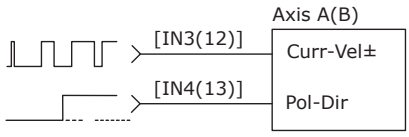


DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

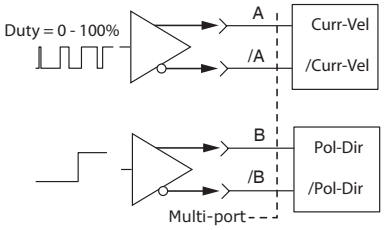
Single-ended digital torque or velocity commands must be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs.

For differential commands, the A & B channels of the multi-mode encoder ports are used.

SINGLE-ENDED PWM & DIRECTION



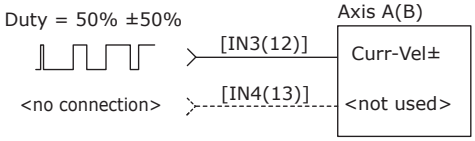
DIFFERENTIAL PWM & DIRECTION



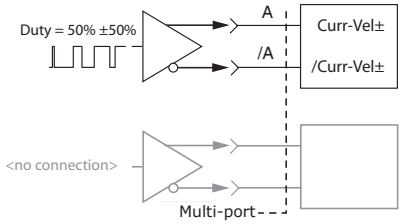
SINGLE-ENDED: IN3, 4, 12, 13

Signal	Axis A	Axis B
[IN3(12)] Curr-Vel±	J1-9	J1-14
[IN4(13)] / Curr-Vel±	J1-10	J1-15
Signal Ground	J1-6,16,22,31, 37,44	
Frame Ground	J1-1	

SINGLE-ENDED 50% PWM



DIFFERENTIAL 50% PWM



DIFFERENTIAL: MULTI-PORT A, /A, B, /B

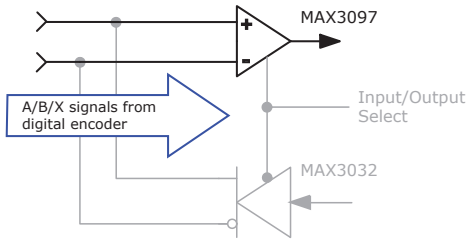
Signal	Axis A	Axis B
[Enc A] Curr-Vel±	J1-36	J1-42
[Enc /A] /Curr-Vel±	J1-21	J1-27
[Enc B] Pol-Dir	J1-35	J1-41
[Enc /B] /Pol-Dir	J1-20	J1-26
Signal Ground	J1-6,16,22,31, 37,44	
Frame Ground	J1-1	

MULTI-MODE PORT AS AN INPUT

INPUT TYPES

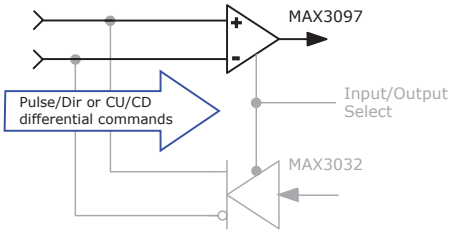
POSITION COMMAND INPUTS: DIFFERENTIAL

- Pulse & Direction
- CW & CCW (Clockwise & Counter-Clockwise)
- Encoder Quad A & B
- Camming Encoder A & B input



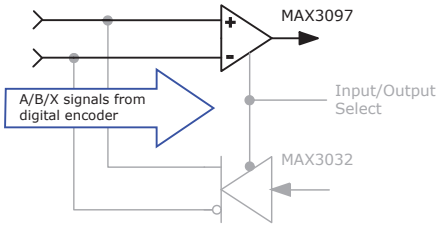
CURRENT or VELOCITY COMMAND INPUTS: DIFFERENTIAL

- Current or Velocity & Direction
- Current or Velocity (+) & Current or Velocity (-)



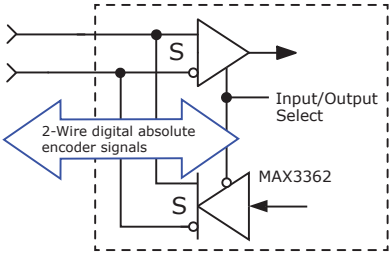
SECONDARY FEEDBACK: INCREMENTAL

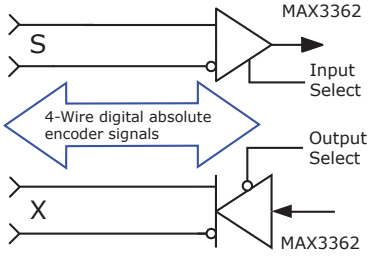
- Quad A/B/X incremental encoder



SECONDARY FEEDBACK: ABSOLUTE

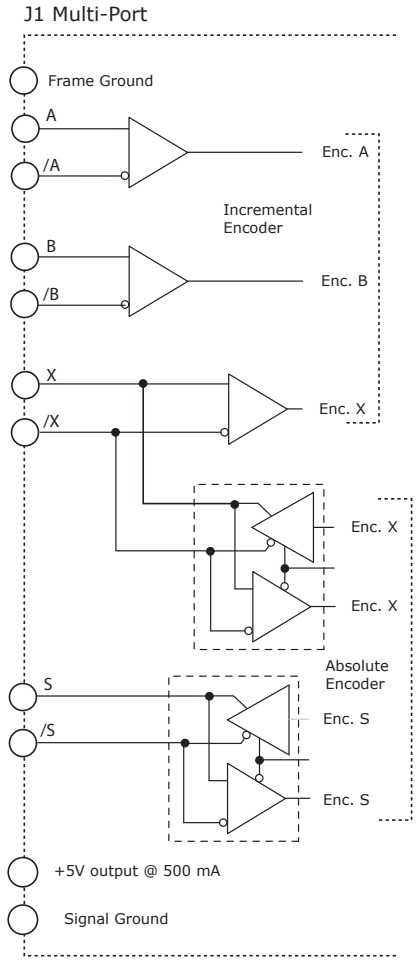
- S channel: Absolute A encoders (2-wire)
  The S channel first sends a Clock signal and then receives Data from the encoder in half-duplex mode.
- S & X channels: SSI, BiSS, EnDat encoders (4-wire)
  The X channel sends the Clock signal to the encoder, which initiates data transmission from the encoder on the S-channel in full-duplex mode





SIGNALS & PINS

Signal	Axis A J1	Axis B J1
Pulse, CW, Encoder A	36	42
/Pulse, /CW, Encoder /A	21	27
Direction, CCW, Encoder B	35	41
/Direction, /CCW, Encoder /B	20	26
Quad Enc X, Absolute Clock	34	40
Quad Enc /X, /Absolute Clock	19	25
Enc S, Absolute (Clock) Data	33	39
Enc /S, / Absolute (Clock) Data	18	24
Signal Ground	6, 16, 22, 31, 37, 44	
Frame Ground	1	



MULTI-MODE PORT AS AN OUTPUT

OUTPUT TYPES

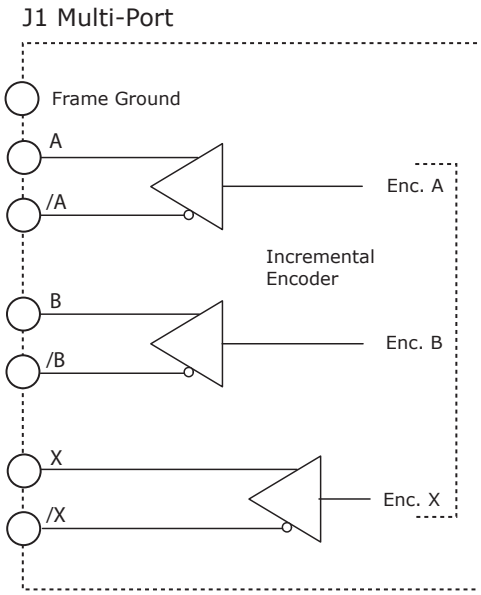
BUFFERED FEEDBACK OUTPUTS: DIFFERENTIAL

- Encoder Quad A, B, X channels
- Direct hardware connection between quad A/B/X encoder feedback and differential line drivers for A/B/X outputs

EMULATED FEEDBACK OUTPUTS: DIFFERENTIAL

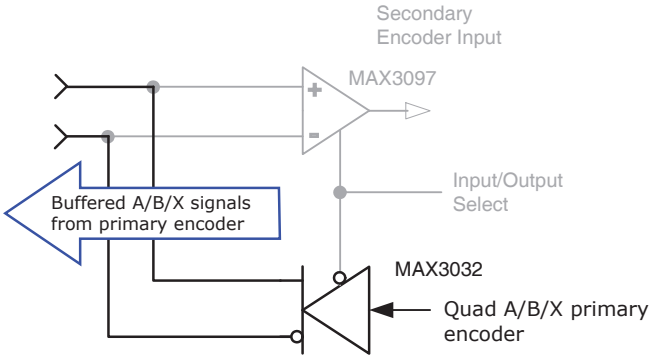
Firmware produces emulated quad A/B signals from feedback data from the following device:

- Absolute encoders



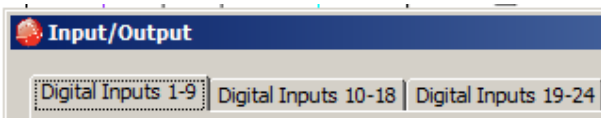
SIGNALS & PINS

Signal	Axis A J1	Axis B J1
Encoder A	36	42
Encoder /A	21	27
Encoder B	35	41
Encoder /B	20	26
Encoder X	34	40
Encoder /X	19	25
Encoder S	33	39
Encoder /S	18	24
Signal Ground	6, 16, 22, 31, 37, 44	
Frame Ground	1	



CME DEFAULTS

These tables show the CME default settings. They are user-programmable and the settings can be saved to non-volatile flash memory.

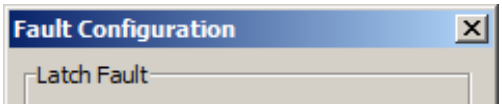


Axis A	Config	PU/PD
IN1	Enable-LO	+5V or Sgnd
IN2	Not Configured	
IN3		
IN4		
IN5	Opto Not Configured	
IN6		
IN7		
IN8		
IN9	Motemp	+5V
IN19	J7-2	
IN20	J7-3	
IN21	J7-4	

Axis B	Config	PU/PD
*IN10	Enable-LO	+5V or Sgnd
*IN11	Not Configured	
*IN12		
*IN13		
IN14	Opto Not Configured	
IN15		
IN16		
IN17		
IN18	Motemp	+5V
IN22	J8-2	
IN23	J8-3	
IN24	J8-4	

Axis A	Axis B	Notes
OUT1	OUT2	Fault Active-OFF
OUT3	Not Configured	
OUT4		
OUT5		
OUT6	OUT7	Brake Active-HI

Axes A, B	Notes
Analog: Reference Filter	Disabled
Vloop: Input Filter	Disabled
Vloop: Output Filter 1	Low Pass, Butterworth, 2-pole, 200 Hz
Vloop: Output Filter 2	Disabled
Vloop: Output Filter 3	Disabled
Iloop: Input Filter 1	Disabled
Iloop: Input Filter 2	Disabled
Input Shaping	Disabled



Axis A	Axis B	Notes
√	√	Short Circuit
√	√	Amp Over Temp
√	√	Motor Over Temp
		Over Voltage
		Under Voltage
		Motor Wiring Disconnected
		STO Active

OPTIONAL FAULTS

		Over Current (Latched)

Axes A, B	Notes
Method	Set Current Position as Home

HIGH SPEED INPUTS: IN1, IN2, IN10, IN11, IN19, IN20, IN21, IN22, IN23, IN24

- Digital, non-isolated, high-speed
- Programmable pull-up/pull-down: IN1, IN2, IN10, IN11
  Fixed pull-up to +5V: IN19, IN20, IN21, IN22, IN23, IN24
- 24V Compatible
- Programmable functions

SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	VT+ = 2.5~3.5 Vdc
	LO	VT- = 1.3~2.2 Vdc
	VH[1]	VH = ±0.7~1.5 Vdc
	Max	+30 Vdc
	Min	0 Vdc
Pull-up/down	R1	15 kΩ
Low pass filter	R2	15 kΩ
	C1	100 pF
Input Current	24V	1.3 mAdc
	0V	-0.33 mAdc
Time constant	RC[2]	1.5 µs

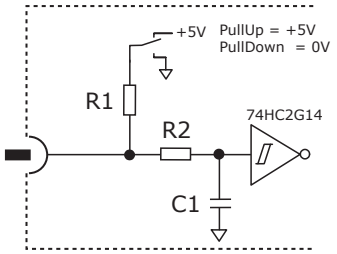
CONNECTIONS

Input	Pin
IN1	J1-7
IN2	J1-8
IN10	J1-12
IN11	J1-13
Sgnd	J1: 6, 16, 22, 31, 37, 44

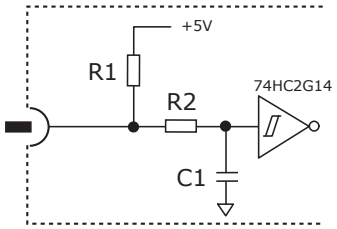
Input	Pin
IN19	J7-2
IN20	J7-3
IN21	J7-4
IN22	J8-2
IN23	J8-3
IN24	J8-4
Sgnd	J7, J8: 5, 16, 25, 26

Notes:
1) VH is hysteresis voltage
   (VT+) - (VT-)
2) The R2*C2 time constant applies when input is driven by active HI/LO devices

PulUP-PulDown



Fixed-PullUp



SINGLE-ENDED/DIFFERENTIAL INPUTS: IN3, IN4, IN12, IN13

- Digital, non-isolated, high-speed
- Progammable pull-up/pull-down
- 12V Compatible
- Single-ended or Differential
- Programmable functions

SPECIFICATIONS

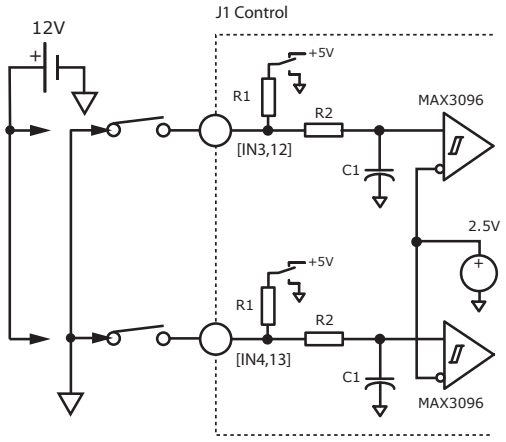
Input	Data	Notes
Input Voltages Single-ended	HI	Vin ≥ 2.7 Vdc
	LO	Vin ≤ 2.3 Vdc
	VH[1]	45 mVdc typ
Input Voltages Differential[3]	HI	Vdiff ≥ +200 mVdc
	LO	Vdiff ≤ -200 mVdc
	VH	±45 mVdc typ
Common mode	Vcm	0 to +12 Vdc
Pull-up/down	R1	10 kΩ
Low pass filter	R2	1 kΩ
	C1	100 pF
Time constant	RC[2]	100 ns

Notes:
1) VH is hysteresis voltage
   IN2 - IN3 or IN12 - IN13
2) The R2*C2 time constant applies when input is driven by active HI/LO devices)
3) Vdiff = AINn(+) - AINn(-)
   n = 1 for Axis A, 2 for Axis B

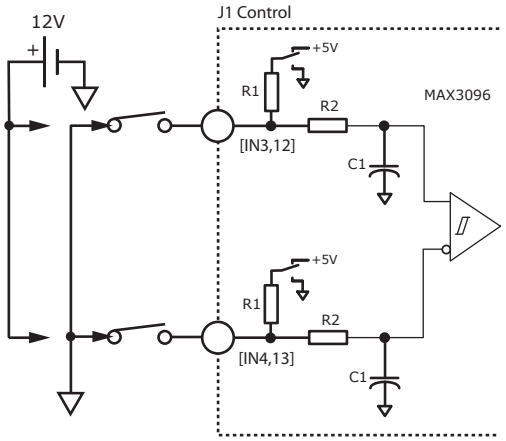
CONNECTIONS

S.E.	DIFF	Pin
IN3	IN3+	J1-9
IN4	IN3-	J1-10
IN12	IN12+	J1-14
IN13	IN12-	J1-15
Sgnd		J1-6, 16, 22, 31, 37 , 44

SINGLE-ENDED



DIFFERENTIAL



MOTOR OVERTEMP INPUTS: IN9, IN18

- Digital, non-isolated
- Motor overtemp inputs
- 12V Compatible
- Programmable functions

SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	Vin ≥ 3.5 Vdc
	LO	Vin ≤ 0.7 Vdc
	Max	+12 Vdc
	Min	0 Vdc
Pull-up/down	R1	4.99 kΩ
Input Current	12V	1.4 mAdc
	0V	-1.0 mAdc
Low pass filter	R2	10 kΩ
	C1	33 nF
Time constant	Te	330 µs *

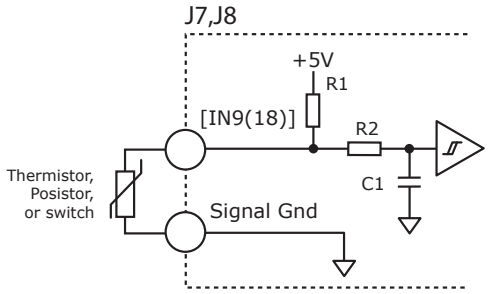
* RC time constant applies when inputs are driven by active high/low devices

CONNECTIONS

Input	Pin
IN9	J7-7
IN18	J8-7
Sgnd	J7,8-5, 16, 25, 26

MOTOR OVER TEMP INPUT

The 4.99kΩ pull-up resistor works with PTC (positive temperature coefficient) thermistors that conform to BS 4999:Part 111:1987, or switches that open/close indicating a motor over-temperature condition. The active level is programmable.



BS 4999:PART 111:1987

Property	Ohms
Resistance in the temperature range 20°C to +70°C	60~750
Resistance at 85°C	≤1650
Resistance at 95°C	≥3990
Resistance at 105°C	≥12000

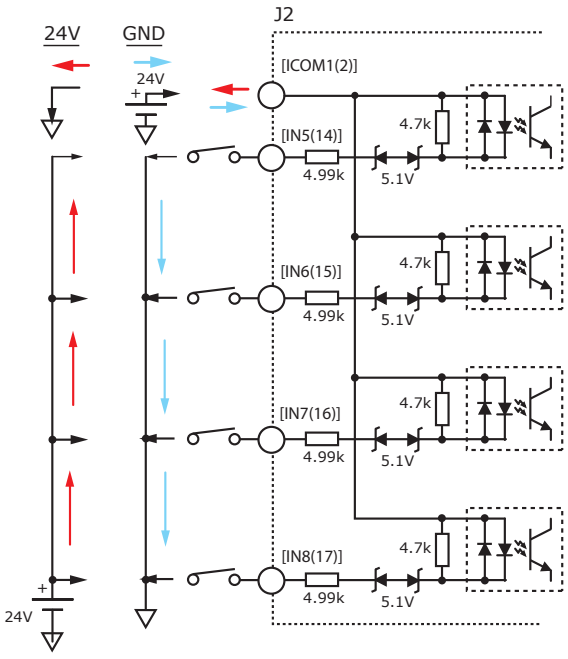
OPTO-ISOLATED INPUTS: IN5, IN6, IN7, IN8, IN14, IN15, IN16, IN17

- Digital, opto-isolated
- 2 Groups of four, each with own Common terminal
- Works with current sourcing or sinking drivers
- 24V Compatible
- Programmable functions

SPECIFICATIONS		
Input	Data	Notes
Input Voltages	HI	Vin ≥ ±10.0 Vdc *
	LO	Vin ≤ ±6 Vdc *
	Max	±30 Vdc *
Input Current	±24V	±3.6 mAdc
	0V	0 mAdc

* Vdc Referenced to ICOM terminals.

CONNECTIONS			
Signal	Pins	Signal	Pins
IN5	J2-2	IN14	J2-7
IN6	J2-3	IN15	J2-8
IN7	J2-4	IN16	J2-9
IN8	J2-5	IN17	J2-18
ICOM1	J2-6	ICOM2	J2-17



ANALOG INPUTS: AIN1, AIN2

- ±10 Vdc, differential
- 12-bit resolution
- Programmable functions

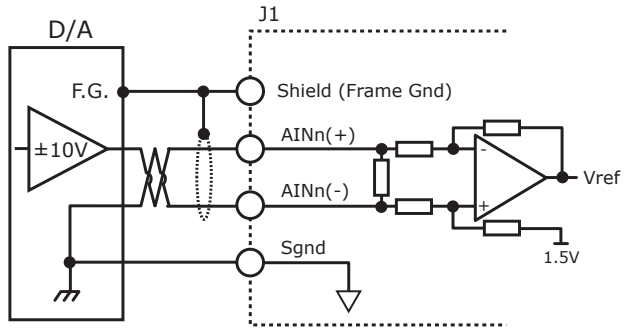
The analog inputs have a ±10 Vdc range at 12-bit resolution As reference inputs they can take position/velocity/torque commands from a controller. If not used as command inputs, they can be used as general-purpose analog inputs.

SPECIFICATIONS

Spec	Data	Notes
Input Voltage	Vref	±10 Vdc
Input Resistance	Rin	5.05 kΩ

CONNECTIONS

Signal	Pins	
	Axis A	Axis B
AIN(+)	J1-3	J1-5
AIN(-)	J1-2	J1-4
Sgnd	J1-6, 16, 22, 31, 37, 44	

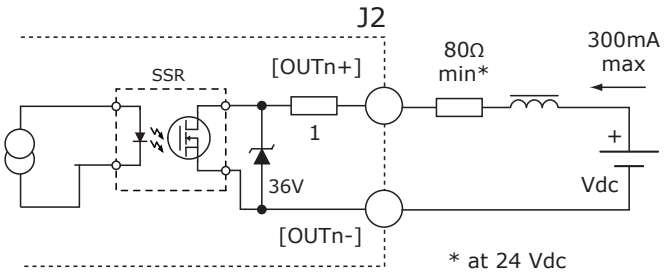


OPTO-ISOLATED OUTPUTS: OUT1, OUT2, OUT3, OUT4, OUT5

- Digital, opto-isolated
- MOSFET output SSR, 2-terminal
- Flyback diodes for inductive loads
- 24V Compatible
- Programmable functions

SPECIFICATIONS

Output	Data	Notes
ON Voltage OUT(+) - OUT(-)	Vdc	0.85V @ 300 mAdc
Output Current	Iout	300 mAdc max



HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT1~5	HI	Output SSR is ON, current flows
	LO	Output SSR is OFF, no current flows

CONNECTIONS

Signal	(+)	(-)
OUT1	J2-19	J2-10
OUT2	J2-20	J2-11
OUT3	J2-21	J2-12
OUT4	J2-22	J2-13
OUT5	J2-23	J2-14

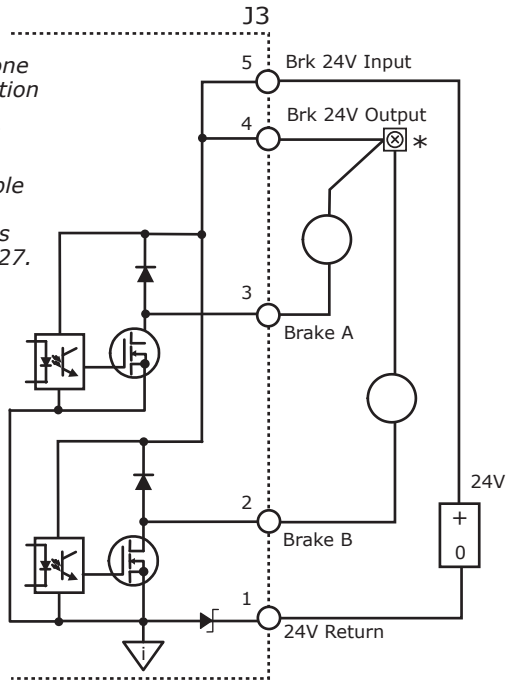
OPTO-ISOLATED MOTOR BRAKE OUTPUTS: OUT6, OUT7

- Brake outputs
- Opto-isolated
- Flyback diodes for inductive loads
- 24V Compatible
- Connection for external 24V power supply
- Programmable functions

SPECIFICATIONS

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

* *There should be only one conductor in each position of the J3 connector. If brakes are to be wired directly to J3 for their 24V power, use a double wire ferrule for J3-4. Information for ferrules can be found on page 27.*



HI/LO DEFINITIONS: OUTPUTS

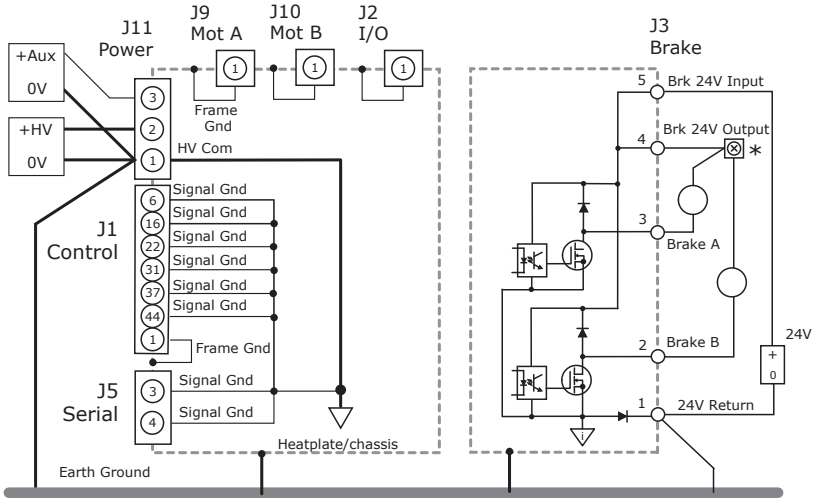
Input	State	Condition
BRK-A,B OUT6,7	HI	Output transistor is OFF Brake is un-powered and locks motor Motor cannot move Brake state is Active
	LO	Output transistor is ON Brake is powered, releasing motor Motor is free to move Brake state is NOT-Active

CME Default Setting for Brake Outputs [OUT6,7] is "Brake - Active HI"
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 Output 6 or 7 as HI
BRK Output voltage is HI (24V), MOSFET is OFF
Stepper drive output current is zero
Stepper 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 Output 6 or 7 as LO
BRK output voltage is LO (~0V), MOSFET is ON
Stepper drive is enabled, PWM outputs are on
Stepper drive output current is flowing

The brake circuits are optically isolated from all drive circuits and frame ground.

CONNECTIONS

Pin	Signal
5	Brk 24V Input
4	Brk 24V Output
3	Brake A [OUT6]
2	Brake B [OUT7]
1	24V Return



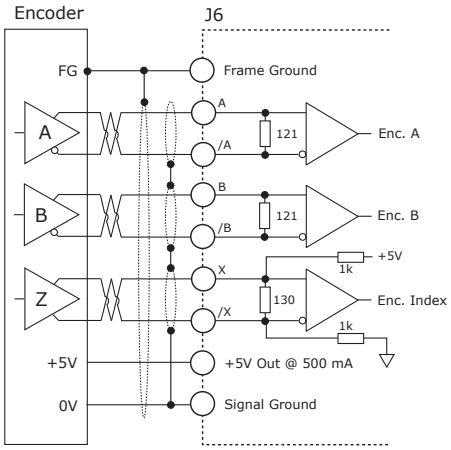
Earthing connections for power supplies should be as close as possible to elimimate potential differences between power supply 0V terminals.

This diagram shows the connections to the drive that share a common ground in the driver. If the brake 24V power supply is separate from the DC supply powering the drive, it is important that it connects to an earth or common grounding point with the HV power supply.

FEEDBACK CONNECTIONS

QUAD A/B/X INCREMENTAL ENCODER

Encoders with differential line-driver outputs are required (single-ended encoders are not supported) and provide incremental position feedback via the A/B signals and the optional index signal (X) gives a once per revolution position mark.



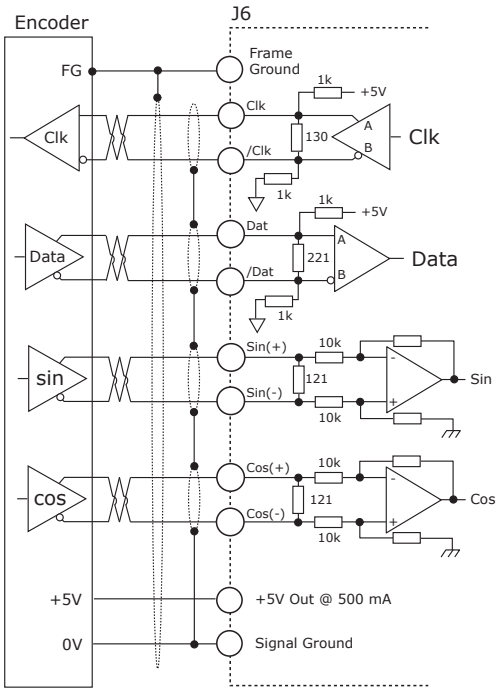
A/B/X SIGNALS

Signal	J6 Pins
Enc A	13
Enc /A	12
Enc B	11
Enc /B	10
Enc X	9
Enc /X	8
+5V	6, 17
Sgnd	5, 16, 25, 26
F.G.	1

Sgnd = Signal Ground
F.G. = Frame Gnd

ENDAT ABSOLUTE ENCODER

The EnDat interface is a Heidenhain interface that is similar to SSI in the use of clock and data signals, but which also supports analog Sin/Cos channels from the same encoder. The number of position data bits is programmable as is the use of Sin/Cos channels. Use of Sin/Cos incremental signals is optional in the EnDat specification.

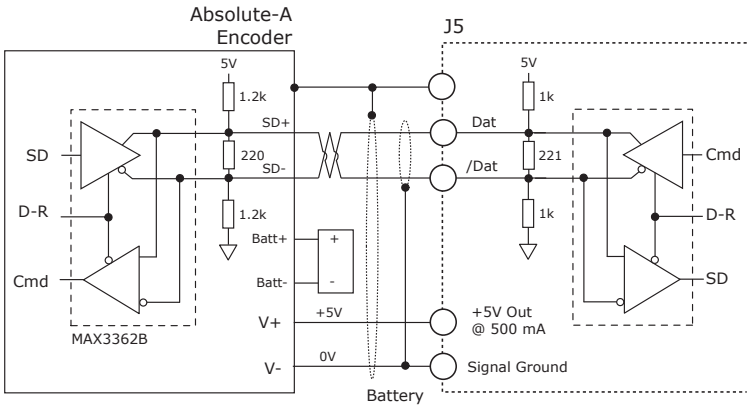


ENDAT SIGNALS

Signal	J6 Pins
Clk	9
/Clk	8
Data	15
/Data	14
Sin(+)	19
Sin(-)	18
Cos(+)	21
Cos(-)	20
+5V	6, 17
Sgnd	5, 16, 25, 26
F.G.	1

SANYO DENKI ABSOLUTE-A ENCODER

The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485. Note the battery which must be connected. Without it, the encoder will produce a fault condition.



ABSOLUTE-A SIGNALS

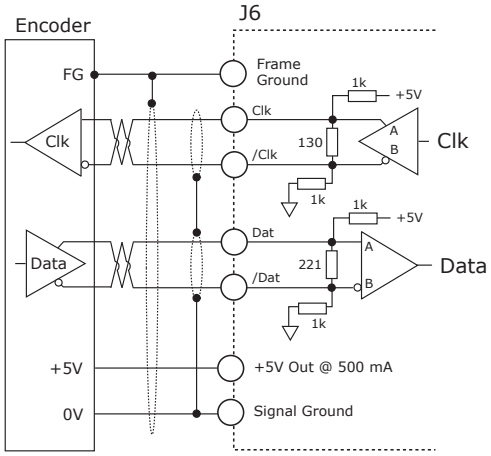
Signal	J6 Pins
Data	15
/Data	14
+5V	6, 17
Sgnd	5, 16, 25, 26
F.G.	1

FEEDBACK CONNECTIONS

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 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 polling of the encoder data occurs at the current loop frequency (16 kHz). The number of encoder data bits and counts per motor revolution are programmable.
The hardware bus consists of two signals: SCLK and SDATA. Data is sent in 8 bit bytes, LSB first. The SCLK signal is only active during transfers. Data is clocked out on the falling edge and clock in on the rising edge of the Master.

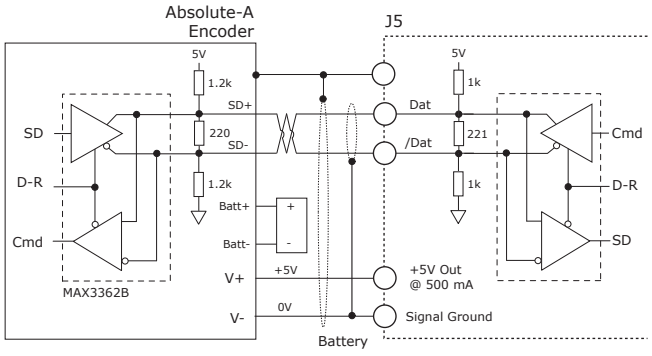
SSI	BiSS	J6 Pins
Clk	MA+	9
/Clk	MA-	8
Data	SL+	15
/Data	SL-	14
+5V		6, 17
Signal Ground		5, 16, 25, 26
Frame Gnd		1



Note: Single (outer) shields should be connected at both ends (motor and drive frame grounds). Inner shields should only be connected to Signal Ground on the drive.

ABSOLUTE-A ENCODER

The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485. Note the battery which must be connected. Without it, the encoder will produce a fault condition.



ABSOLUTE-A SIGNALS

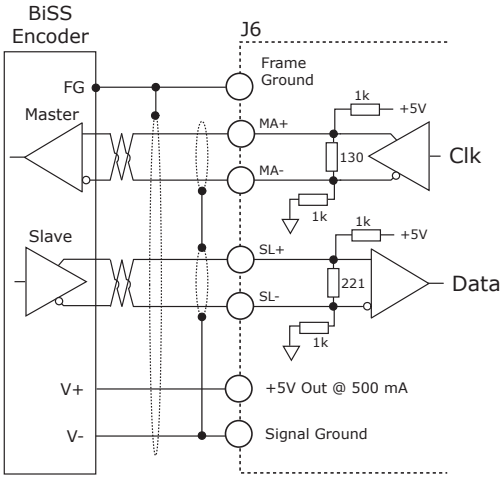
Signal	J7,J8 Pin
Data	15
/Data	14
+5V	6, 17
Sgnd	5, 16, 25, 26
F.G.	1

Sgnd = Signal Ground
F.G. = Frame Gnd

BiSS ABSOLUTE ENCODER

BiSS is an - Open Source - digital interface for sensors and actuators. BiSS 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 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 incl. actuators
- Bidirectional
  - BiSS B-protocol: Mode choice at each cycle start
  - BiSS C-protocol: Continuous mode

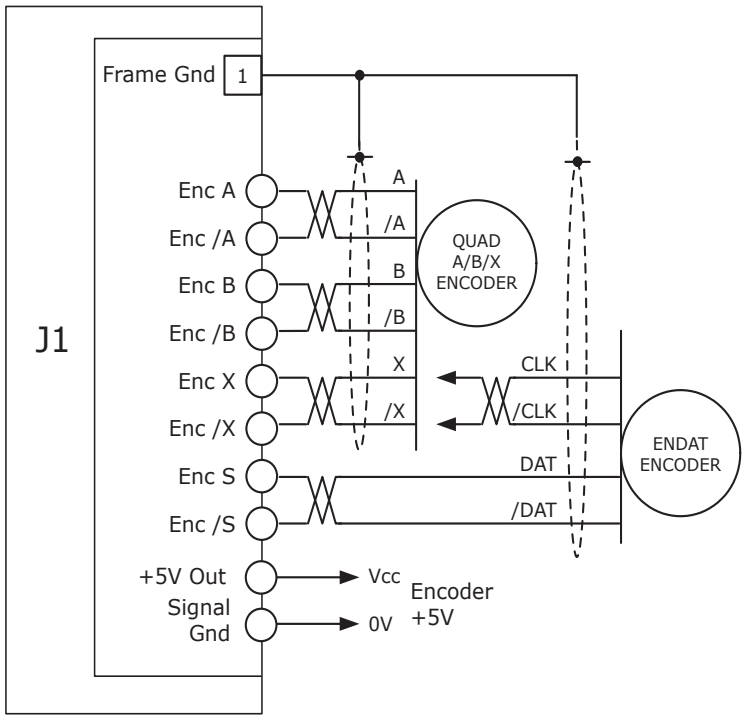


MULTI-PORT FEEDBACK CONNECTIONS

DUAL-LOOP FEEDBACK

Incremental or absolute encoders can connect to the Multi-port to function as secondary feedback for dual-loop operation. Typically, the primary encoder (J7,J8) is mounted on the motor, and the secondary encoder (J1) mounts to the load. The primary encoder is used for velocity feedback and the secondary one us used for the actual load position. The graphic shows both incremental and absolute connections. Only one encoder per axis can connect to the multi-port for dual-loop opertion.

Stepnet Plus Panel 2-Axis



MULTI-PORT J1 SIGNALS

Signal	Axis A	Axis B
Enc A	36	42
Enc /A	21	27
Enc B	35	41
Enc /B	20	26
Enc X	34	40
Enc /X	19	25
Enc S	33	39
Enc /S	18	24
+5V	32	23
Sgnd	31	22
F.G.	1	

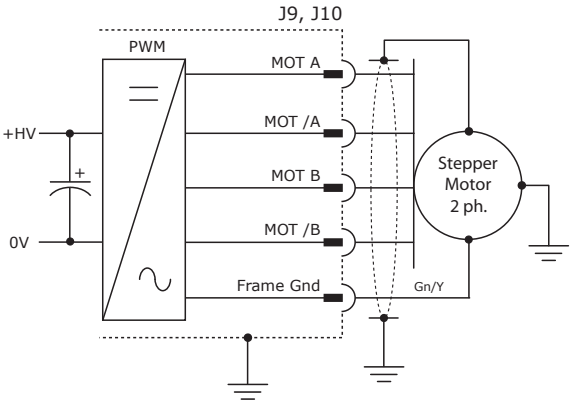
MOTOR CONNECTIONS

MOTOR PHASE CONNECTIONS

The drive outputs are two H-bridge PWM inverters that convert the DC buss voltage (+HV) into sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the drive. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. Further details on motor connections can be found on page 22.

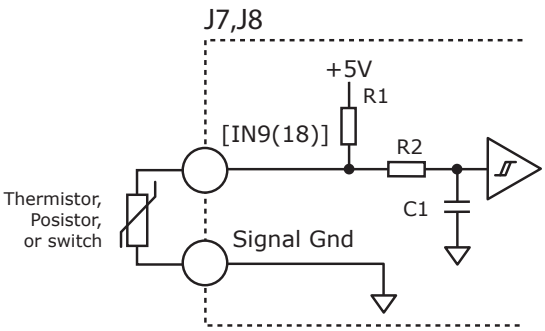
MOTOR SIGNALS

Signal	J9,J10 Pin
Mot A	5
Mot /A	4
Mot B	3
Mot /B	2
Frame Gnd	1



MOTOR OVER TEMP INPUT

The 4.99kΩ pull-up resistor works with PTC (positive temperature coefficient) thermistors that conform to BS 4999:Part 111:1987 (table below), or switches that open/close indicating a motor over-temperature condition. The active level is programmable. These inputs are programmable for other functions if not used as Motemp inputs. And, other inputs are programmable for the Motemp function.



MOTEMP SIGNALS

Signal	Pin
Motemp A	J7-7
Motemp B	J8-7
J7,J8 Signal Ground	5,10
Frame Gnd	12

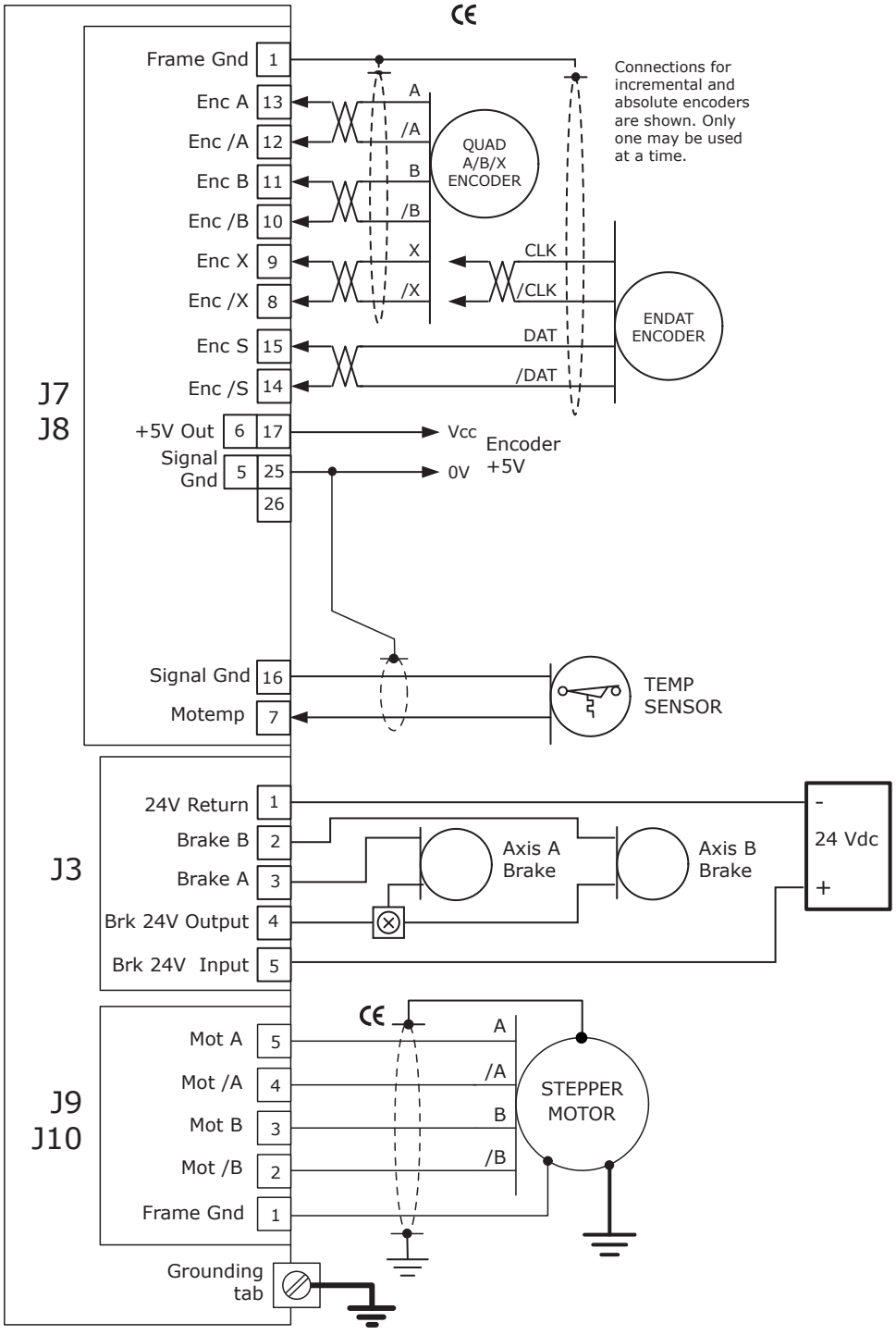
BS 4999 SENSOR

Property	Ohms
Resistance in the temperature range 20°C to +70°C	60~750
Resistance at 85°C	≤1650
Resistance at 95°C	≥3990
Resistance at 105°C	≥12000

MOTOR CONNECTIONS: ENCODER

The connections shown may not be used in all installations

Stepnet Plus Panel 2-Axis

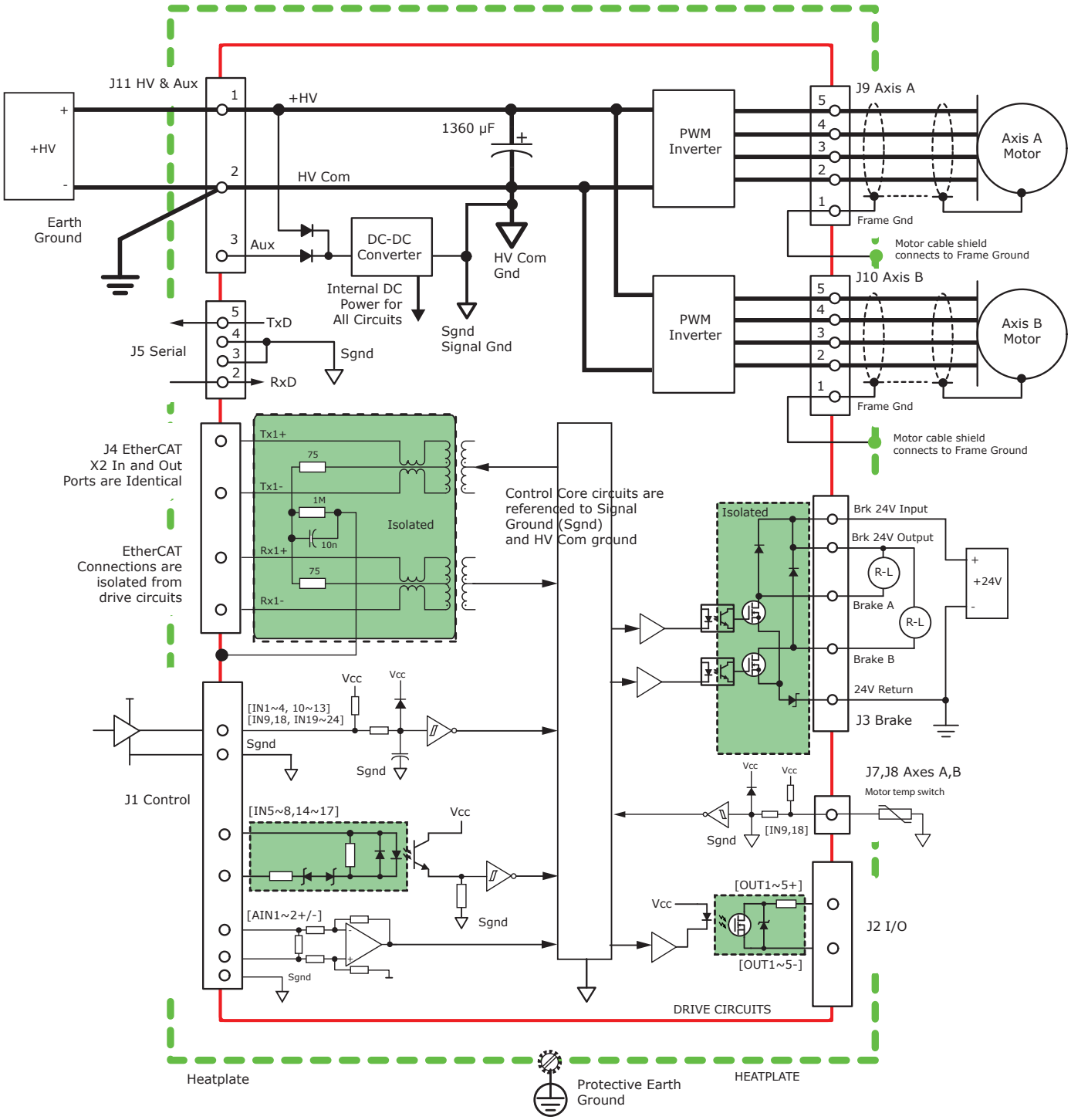


NOTES:

1) The +5VOut1 on J1-17,32 and J7-6, 17 is rated for 500 mA
   The +5VOut2 on J1-23,38 and J8-6, 17 is rated for 500 mA
   These are two independent power supplies, each with a 500 mA max output from all pins
2) CE symbols indicate connections required for CE compliance.

DEVICE STRUCTURE & ISOLATION

This graphic shows the electrical structure of the drive, detailing the elements that share a common circuit common (Signal Ground, HV Com) and circuits that are isolated and have no connection to internal circuits. Note that there is no connection between the heatplate (Chassis, Frame Ground) and any drive circuits.



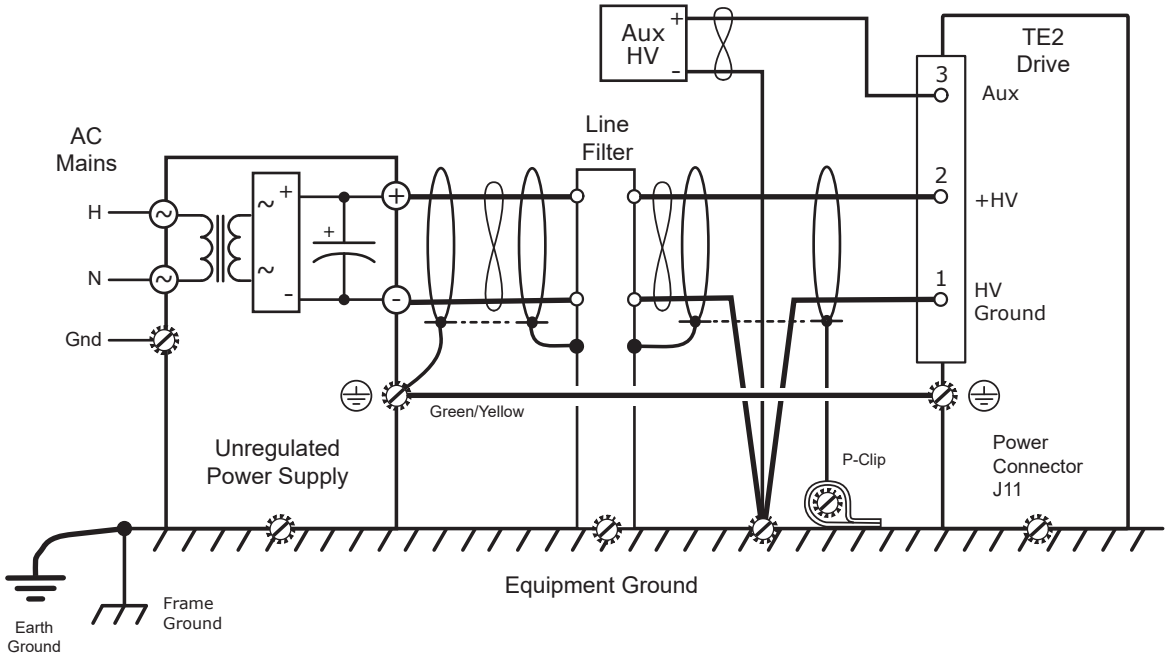
POWER & GROUNDING CONNECTIONS

DC POWER CONNECTIONS

- DC power must be provided by transformers that are galvanically isolated and provide reinforced insulation from the mains. *Auto-transformers cannot be used*.
- The (-) terminal of the power supply is not grounded at the power supply. It is grounded near each drive.
- Cabling to multiple drives for the +HV and 0V is best done in a "star" configuration, and not a "daisy-chain".
- The 0V, or return terminal of the DC power should be connected to frame ground near the drive power connector. From that point, a short wire can connect to the drive HV Ground.
- Cabling to the drive +HV and 0V terminals must be sized to carry the expected continuous current of the drive in the user's installation.
- DC power cabling should be shielded, twisted-pair for best EMI reduction. The shield should connect to the power supply frame ground on one end, and to the drive frame ground on the other. Adding a pigtail and ring-lug, as short as possible will provide a good connection of the shield at the drive.
- Motor cabling typically includes a green/yellow conductor for protective bonding of the motor frame. Connect as shown in the Motor Connections diagram on the following page.
- Motor cable conductors should be twisted and shielded for best EMI suppression.
- If a green/yellow grounding wire connects the motor to the drive's PE terminal, the shield pigtail and ring-lug may connect to one of the screws that mount the drive to the panel. A P-clip to ground the shield as near as possible to the drive will increase the EMI suppression of the shield. On the motor-end, the shield frequently connects to the connector shell. If the motor cable is a flying-lead from the motor, the shield may be connected to the motor frame internally.
- Braided cable shields are more effective for EMI reduction than foil shields. Double-shielded cables typically have a braided outer shield and foil shields for the internal twisted pairs. This combination is effective for both EMI reduction and signal quality of the feedback signals from analog encoders.
- Motor cable shielding is not intended to be a protective bonding conductor unless otherwise specified by the motor manufacturer.
- In double-shielded cables, the internal shielding should connect to the drive's Signal Ground on one end, and should be unconnected on the motor end.
- Single-shield feedback cables connect to the drive frame on one end, and to the motor frame on the other. Depending on the construction of the motor, leaving the feedback cable shield disconnected on the motor but connected on the drive end may give better results.
- The drive should be secured to the equipment frame or panels using the mounting slots. This ensures a good electrical connection for optimal EMI performance. The drive chassis is electrically conductive.

DC POWER WIRING

P-clips secure cables to a panel and provide full contact to the cable shields after the insulation has been stripped. This should be done as close to the drive as possible for best EMI attenuation.

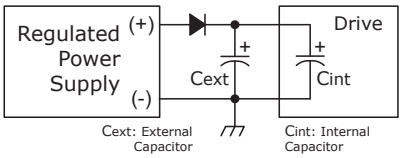


POWER SUPPLIES, SHIELDING, REGENERATION

+HV POWER SUPPLY REQUIREMENTS

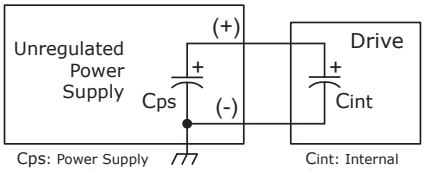
Regulated Power Supplies

- Must be over-voltage protected to 100 Vdc max when the STO (Safe Torque Off) feature of the drive is used.
- Require a diode and external capacitor to absorb regenerative energy.
- The VA rating should be greater than the actual continuous output power of the drives connected to the power supply, and adequate for the transient output power due to acceleration of motor loads.
- Must handle the internal capacitance of the drives on startup.



Unregulated Power Supplies

- No-load, high-line output voltage must not exceed 90 Vdc.
- Power supply internal capacitance adds to the drive's internal capacitance for absorption of regenerative energy.
- The VA (Volts & Amps) rating at the power supply's AC input is typically 30~40% greater than the total output power of the drives.



AUXILIARY HV POWER

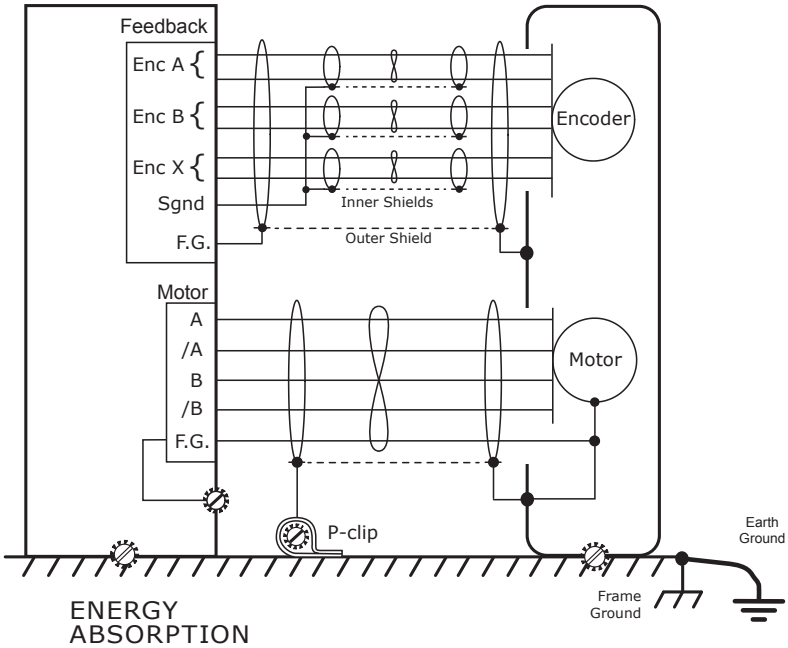
- Aux HV is power that can keep the drive communications and feedback circuits active when the PWM output stage has been disabled by removing the main +HV supply.
- Useful during EMO (Emergency Off) conditions where the +HV supply must be removed from the drive and powered-down to ensure operator safety.
- Voltage range is the same as +HV.
- Powers the DC/DC converter that supplies operating voltages to the drive DSP and control circuits.
- Aux HV draws no current when the +HV voltage is greater than the Aux HV voltage.

MOTOR CONNECTIONS

- Motor cable shield connects to motor frame, is grounded with a P-clip near the drive and terminates in a ring-lug that is screwed to the drive chassis by a mounting screw to the panel
- If provided, a green/yellow grounding wire from the motor connects to the F.G. terminal of the motor connector.

FEEDBACK CONNECTIONS

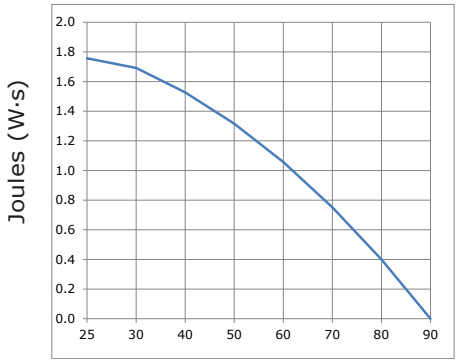
- Cable shield connects to motor frame and to the F.G. terminal of the feedback connector.
- When double-shielding is used, the inner shields connect to the Signal Ground at the drive, and is not connected at the motor end.
- If not provided by the motor manufacturer, feedback cables rated for RS-422 communications are recommended for digital encoders.



ENERGY ABSORPTION

REGENERATION

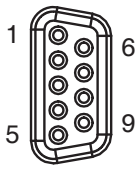
This chart shows the energy absorption in W·s for the drive operating at some typical DC voltages. It is based on the internal 470 uF capacitor and would be increased by the capacitance of the external DC power supply. When the load mechanical energy is greater than these values an external regenerative energy dissipater is required, or the DC power supply capacitance can be increased to absorb the regen energy.



CONNECTORS & SIGNALS: FRONT PANEL

J6 SAFETY (SAFETORQUE OFF)

PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	6	STO-1(+)
2	STO-1(+)	7	STO-1(-)
3	STO-1(-)	8	STO-24V
4	STO-2(+)	9	STO-GND
5	STO-2(-)		



J6 TE2 CONNECTOR:
Dsub DE-09F, 9 position female receptacle

J6 CABLE CONNECTOR:
Dsub DE-09M, 9 position

Details on J1, J2, J6, J7, and J8 cable connectors can be found in the TE2-CK listing under the Accessories section of the last page

J2: ISOLATED CONTROL

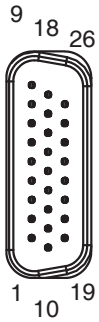
PIN	SIGNAL
9	[IN16] GPI
8	[IN15] GPI
7	[IN14] GPI
6	COM1 [IN5~8]
5	[IN8] GPI
4	[IN7] GPI
3	[IN6] GPI
2	[IN5] GPI
1	Frame Ground

PIN	SIGNAL
18	[IN17] GPI
17	COM2 [IN14~17]
16	N/C
15	N/C
14	[OUT5-] GPI
13	[OUT4-] GPI
12	[OUT3-] GPI
11	[OUT2-] GPI
10	[OUT1-] GPI

PIN	SIGNAL
26	n.c.
25	n.c.
24	n.c.
23	[OUT5+] GPI
22	[OUT4+] GPI
21	[OUT3+] GPI
20	[OUT2+] GPI
19	[OUT1+] GPI

J2: TE2 CONNECTOR
High-Density Dsub DB-26M, male plug, 26 Position

J2: CABLE CONNECTOR
High-Density Dsub DB-26F, female receptacle, 26 Position



J1: CONTROL SIGNALS

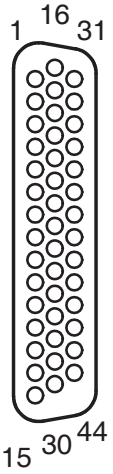
PIN	SIGNAL
1	Frame Gnd
2	[AIN1-]
3	[AIN1+]
4	[AIN2-]
5	[AIN2+]
6	Signal Gnd
7	[IN1]
8	[IN2]
9	[IN3] Diff1(+)
10	[IN4] Diff1(-)
11	N/C
12	[IN10]
13	[IN11]
14	[IN12] Diff2(+)
15	[IN13] Diff2(-)

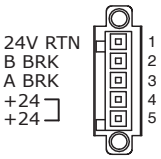
PIN	SIGNAL
16	Signal Gnd
17	A +5Vdc Out1
18	A-MultiEnc /S
19	A-MultiEnc /X
20	A-MultiEnc /B
21	A-MultiEnc /A
22	Signal Gnd
23	B +5Vdc Out2
24	B-MultiEnc /S
25	B-MultiEnc /X
26	B-MultiEnc /B
27	B-MultiEnc /A
28	N/C
29	N/C
30	N/C

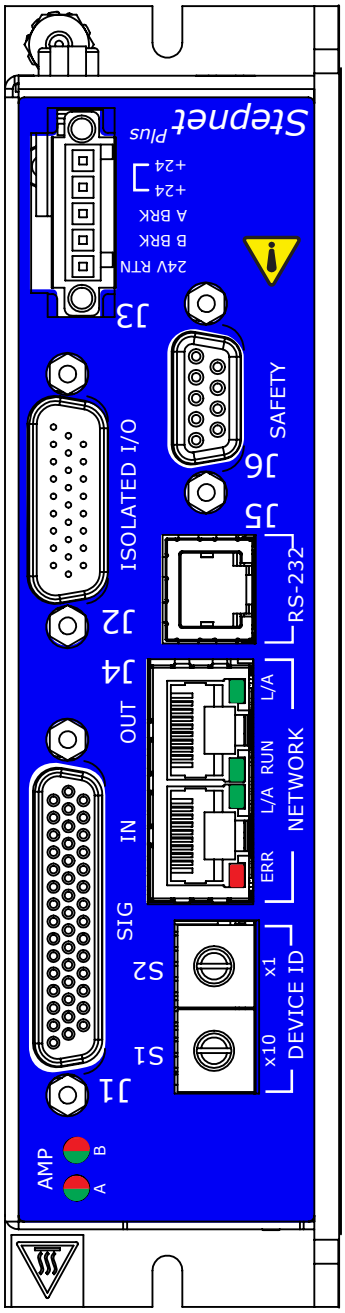
PIN	SIGNAL
31	Signal Gnd
32	A +5Vdc Out1
33	A-MultiEnc S
34	A-MultiEnc X
35	A-MultiEnc B
36	A-MultiEnc A
37	Signal Gnd
38	B +5Vdc Out2
39	B-MultiEnc S
40	B-MultiEnc X
41	B-MultiEnc B
42	B-MultiEnc A
43	N/C
44	Signal Gnd

J1: TE2 CONNECTOR
High-Density Dsub DB-44F, female receptacle, 44 Position

J1: CABLE CONNECTOR
High-Density Dsub DB-44M, male plug, 44 Position



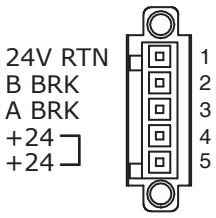




CONNECTORS & SIGNALS: FRONT PANEL

J3: BRAKE

Pin	Signal
1	24V Return
2	Brake B [OUT7]
3	Brake A [OUT6]
4	Brk 24V Output
5	Brk 24V Input



J3: DRIVE CONNECTOR
Euro-style 3.5 mm male receptacle, 5-position
Wago: MCS-MINI, 734-165/108-000

J3: CABLE CONNECTOR
Wago MCS-MINI 734-105/107-000
or 734-105/107-000

WAGO CONNECTOR TOOL
Contact opener: 734-231 operating tool

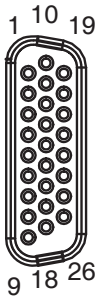
CONNECTORS & SIGNALS: END PANEL

J7, J8: AXIS A, B FEEDBACK

PIN	SIGNAL
1	Frame Gnd
2	[IN19(22)] A(B)
3	[IN20(23)] A(B)
4	[IN21(24)] A(B)
5	Signal Gnd
6	A(B) +5VOut1(2)
7	[IN9(18)] A(B) Motemp
8	A(B) Enc /X
9	A(B) Enc X

PIN	SIGNAL
10	A(B) Enc /B
11	A(B) Enc B
12	A(B) Enc /A
13	A(B) Enc A
14	A(B) Enc /S
15	A(B) Enc S
16	Signal Gnd
17	A(B) +5VOut1(2)
18	N/C

PIN	SIGNAL
19	N/C
20	N/C
21	N/C
22	N/C
23	N/C
24	N/C
25	Signal Gnd
26	Signal Gnd



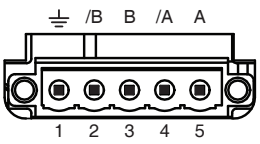
J7, J8

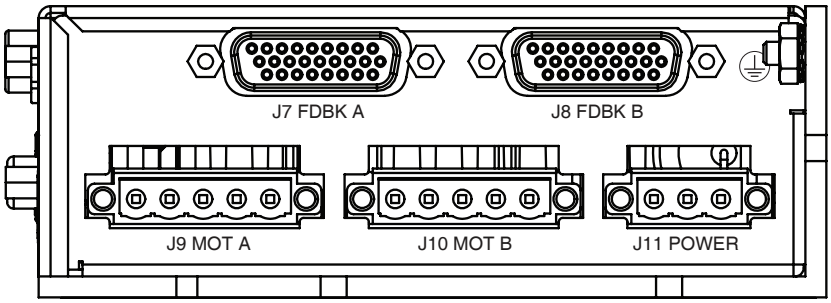
J7, J8: FEEDBACK

J7, J8: TE2 CONNECTOR
High-Density Dsub DB-26F,
female receptacle, 26 Position

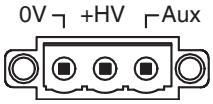
J7, J8: CABLE CONNECTOR
High-Density Dsub DB-26M,
male plug, 26 Position

J9, J10





J11



J9, J10: MOTOR OUTPUTS

Signal	Pin
Motor Phase A	5
Motor Phase /A	4
Motor Phase B	3
Motor Phase /B	2
Frame Ground	1

J9, J10: DRIVE CONNECTORS
Euro-style 5.08 mm male receptacle, 5-position
Wago: MCS-MIDI, 231-565/108-000

J9, J10 CABLE CONNECTORS
Wago MCS-MIDI Classic 231-305/107-000

WAGO CONNECTOR TOOL
Contact opener: 231-159 operating tool

J11:+HV & AUX POWER

Signal	**Pin**
Aux HV	3
HV	2
HV Ground	1

J11: DRIVE CONNECTOR
Euro-style 5.08 mm male receptacle, 3-position
Wago: MCS-MIDI, 231-563/108-000

J11: CABLE CONNECTOR
Wago MCS-MIDI, 231-303/107-000

WAGO CONNECTOR TOOL
Contact opener: 231-159 operating tool

24V & BRAKE: J3

Wago MCS-MINI: 734-105/031-000, female connector; with screw flange, 5-pole; pin spacing 3.5 mm / 0.138 in

Conductor capacity
Bare stranded: AWG 28~16 [0.08~1.5 mm2]
Insulated ferrule: AWG 24~16 [0.25~1.5 mm2]
Stripping length: 0.24~0.28 in[6~7 mm]
Operating tool: Wago MCS-MINI: 734-231

J3

Tool

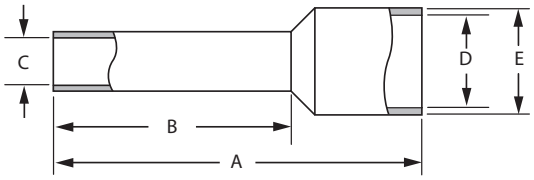
FERRULE PART NUMBERS: SINGLE WIRE INSULATED

AWG	mm²	Color	Mfgr	PNUM	A	B	C	D	E	SL
18	1.0	Red	Wago	216-223	12.0 (.47)	6.0 (.24)	1.4 (.06)	3.0 (.12)	3.5 (.14)	8 (.31)
20	0.75	Gray	Wago	216-222	12.0 (.47)	6.0 (.24)	1.2 (.05)	2.8 (.11)	3.3 (.13)	8 (.31)
22	0.5	White	Wago	216-221	12.0 (.47)	6.0 (.24)	1.0 (.04)	2.6 (.10)	3.1 (.12)	7.5 (.30)

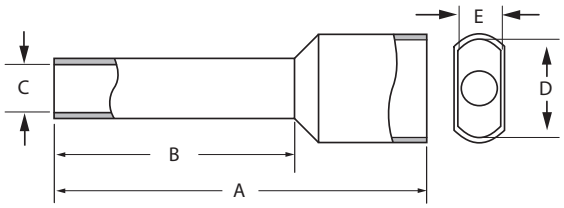
FERRULE PART NUMBERS: DOUBLE WIRE INSULATED

AWG	mm²	Color	Mfgr	PNUM	A	B	C	D	E	SL
2 x 18	2 x 1.0	Red	Altech	2776.0	15.4 (.61)	8.2 [.32]	2.4 (.09)	3.2 (.13)	5.8 (.23)	11.0 (.43)
2 x 18	2 x 1.0	Gray	Altech	2775.0	14.6 (.57)	8.2 (.32)	2.0 (.08)	3.0 (.12)	5.5 (.22)	11.0 (.43)
2 x 20	2 x 0.75	White	Altech	2794.0	14.6 (.57)	8.2 (.32)	1.7 (.07)	3.0 (.12)	5.0 (.20)	11.0 (.43)
2 x 20	2 x 0.75	Gray	TE	966144-2	15.0 (.59)	8.0 (.31)	1.70 (.07)	2.8 (.11)	5.0 (.20)	10 (.39)
2 x 22	2 x 0.50	White	TE	966144-1	15.0 (.59)	8.0 (.31)	1.40 (.06)	2.5 (.10)	4.7 (.19)	10 (.39)

SINGLE WIRE



DOUBLE WIRE



MOTOR OUTPUTS AND HV/AUX POWER: J9, J10 & J11

Wago MCS-MIDI Classic: 231-305/107-000 (J9, J10), 231-303/107-000 (J11), female connector; with screw flange; pin spacing 5.08 mm / 0.2 in

Conductor capacity
Bare stranded: AWG 28~14 [0.08~2.5 mm2]
Insulated ferrule: AWG 24~16 [0.25~1.5 mm2]
Stripping length: 8~9 mm
Operating Tool: Wago MCS-MIDI Classic: 231-159

J9, J10

J11

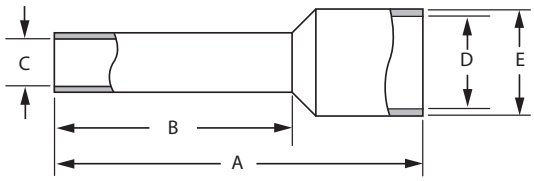
Tool

FERRULE PART NUMBERS: SINGLE WIRE INSULATED

AWG	mm²	Color	Mfgr	PNUM	A	B	C	D	E	SL
14	2.5	Blue	Wago	216-206	15.0 (0.59)	8.0 (0.31)	2.05 (.08)	4.2 (0.17)	4.8 (0.19)	10 (0.39)
16	1.5	Black	Wago	216-204	14.0 (0.59	8.0 (0.31)	1.7 (.07)	3.5 (0.14)	4.0 (0.16)	10 (0.39)
18	1.0	Red	Wago	216-223	12.0 (.47)	6.0 (.24)	1.4 (.055)	3.0 (.12)	3.5 (.14)	8 (.31)
20	0.75	Gray	Wago	216-222	12.0 (.47)	6.0 (.24)	1.2 (.047)	2.8 (.11)	3.3 (.13)	8 (.31)
22	0.5	White	Wago	216-221	12.0 (.47)	6.0 (.24)	1.0 (.039)	2.6 (.10)	3.1 (.12)	7.5 (.30)

NOTES

PNUM = Part Number
SL = Stripping length
Dimensions: mm (in)



THERMALS: POWER DISSIPATION

The top chart on this page shows the internal power dissipation for one axis of the TE2 under differing power supply and output current conditions. The +HV values are for the average DC voltage of the drive power supply. The lower chart shows the temperature rise vs. power dissipation under differing mounting and cooling conditions.

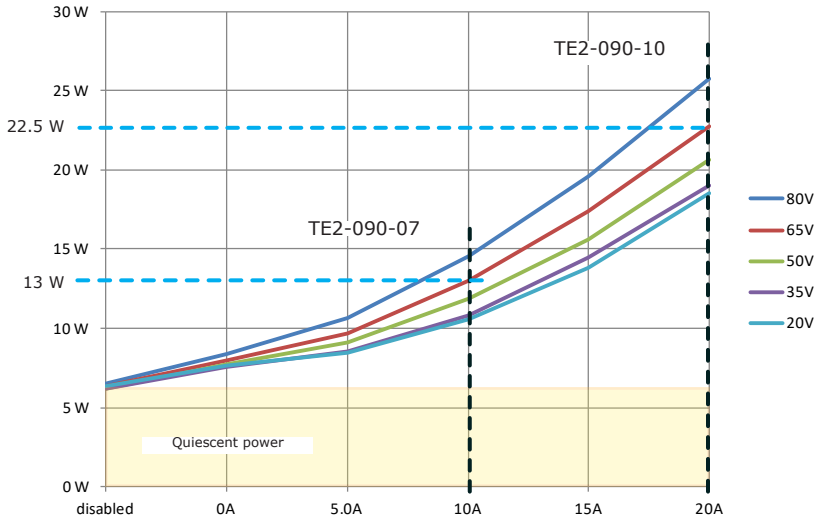
TOTAL POWER DISSIPATION

Use this chart to find the total power dissipation for both axes.

Examples

TE2-090-07:
Power supply HV = 65 Vdc
Axis 1,2 currents = 5 A
Total current = 10 A
Total dissipation = 13 Watts

TE2-090-10:
Power supply HV = 65 Vdc
Axis 1,2 currents = 10 A
Total current = 20 A
Total dissipation = 22.5 Watts



Total continuous output current of both axes

THERMALS: MAXIMUM OPERATING TEMPERATURE VS. DISSIPATION

Use this chart to find the maximum operating temperature of the drive under differing mounting and cooling conditions.

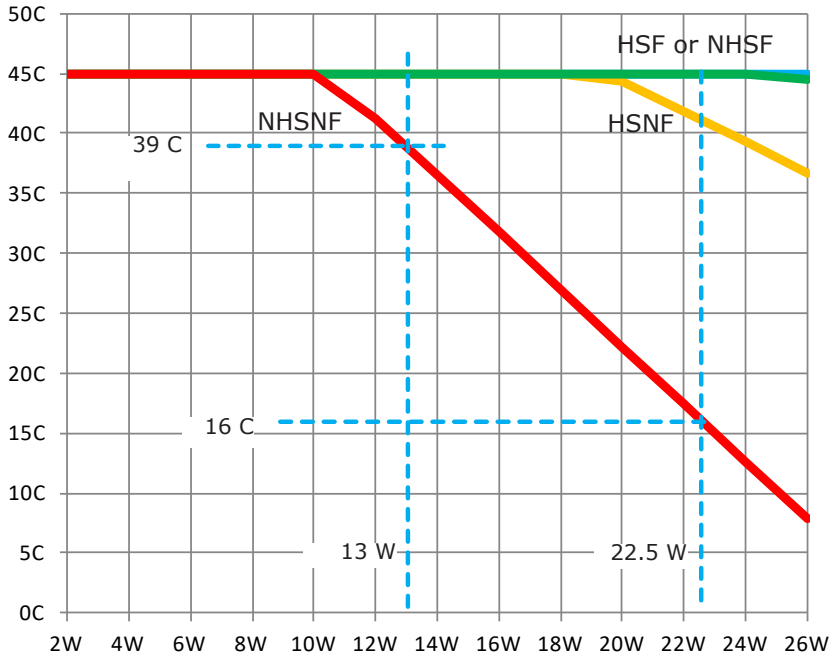
Examples

TE2-090-07:

Using the 13 W value from the calculation above, draw a vertical line. This shows that 39 C is the maximum operating temperature for NHSNF, and that any of the other mounting/cooling options will be sufficient for operation up to the maximum ambient temperature of 45 C.

TE2-090-10:
Using the 22.5 W value from the calculation above, draw a vertical line. This shows that 16 C is the maximum operating temperature for NHSNF. Heat sink with no fan is sufficient to 41 C, and the other mounting/cooling options will be sufficient for operation up to the maximum ambient temperature of 45 C.

HSF = Heat Sink (with) Fan
NHSF = No Heat Sink (with) Fan
HSNF = Heat Sink No Fan
NHSNF = No Heat Sink No Fan



Internal power dissipation (Watts)

THERMALS: MOUNTING & THERMAL RESISTANCE

MOUNTING

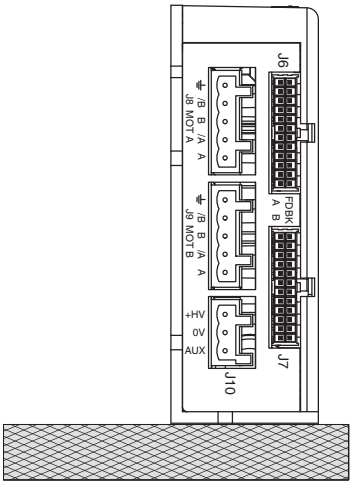
Thermal data for convection-cooling with a heatsink assumes a vertical mounting of the drive on a thermally non-conducting surface. Heatsink fins run parallel to the long axis of the drive. When fan-cooling is used vertical mounting is not necessary to guarantee thermal performance of the heatsink.

THERMAL RESISTANCE

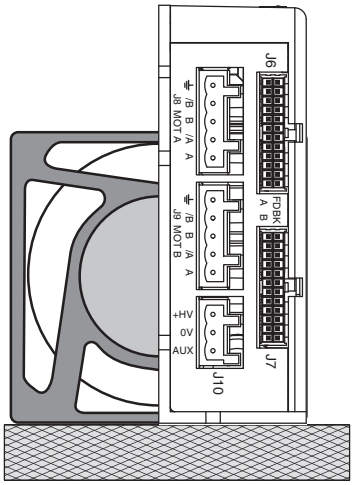
Thermal resistance is a measure of the temperature rise of the drive heatplate due to power dissipation in the drive. It is expressed in units of °C/W where the degrees are the temperature rise above ambient.

E.g., an drive dissipating 16 W mounted with no heatsink or fan would see a temperature rise of 38.2C above ambient based on the thermal resistance of 2.39C/W. Using the drive maximum heatplate temperature of 70C and subtracting 38.2C from that would give 31.7C as the maximum ambient temperature the drive in which the drive could operate before going into thermal shutdown. To operate at higher ambient temperatures a heatsink or forced-air would be required.

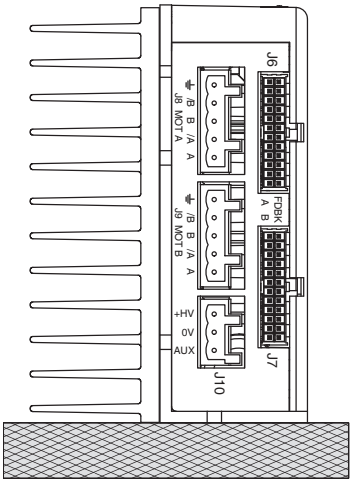
TOP VIEWS VERTICAL MOUNTING



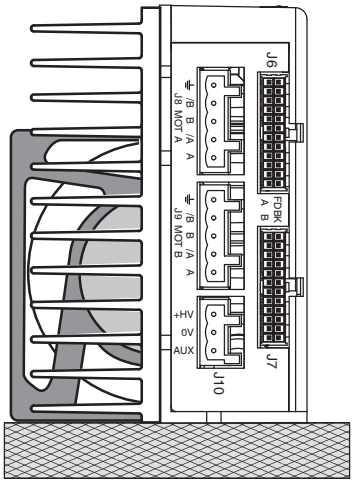
NO HEATSINK, NO FAN	°C/W
CONVECTION	2.32



NO HEATSINK + FAN	°C/W
FORCED-AIR, 300 LFM	0.98



HEATSINK, NO FAN	°C/W
CONVECTION	1.28



HEATSINK + FAN	°C/W
FORCED-AIR, 300 LFM	0.61

HEATSINK KIT INSTALLATION

- Standard heatsink for Stepnet Plus Panel TE2
- Complete kit for user installation of the heatsink

DESCRIPTION

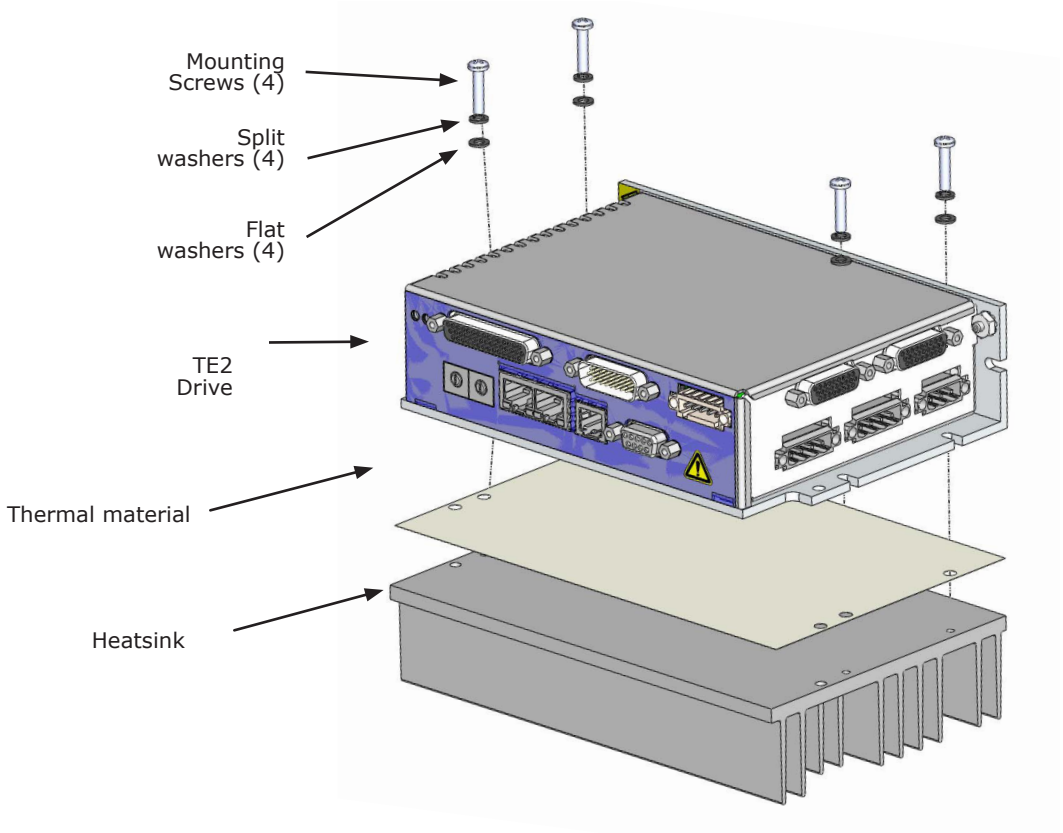
The TE2-HK is a kit containing a heatsink and mounting hardware for field installation of a standard heatsink onto a TE2 model stepper drive.

TE2-HK HEATSINK KIT PART LIST

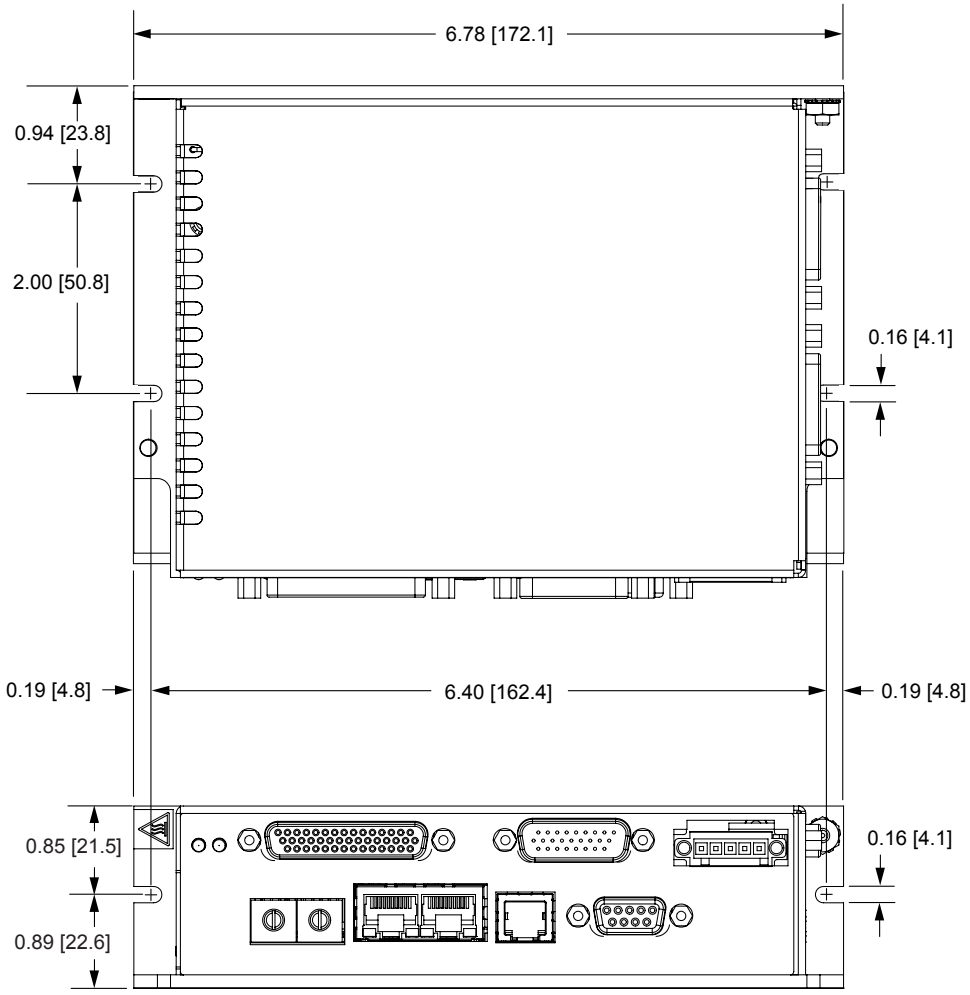
Qty	Description	
1	Heatsink, standard, TE2-HS	
1	Thermal material, 4.4 x 6.8 in.	
1	Kit, Heatsink Hardware, TE2	
	4	Washer, flat, #6
	4	Washer, split, #6
	4	Screw, PAN, #6-32 x 5/8 in

INSTALLATION

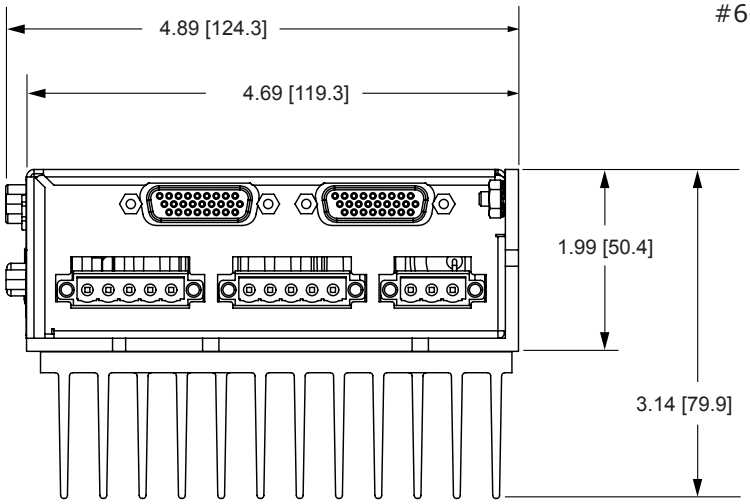
1) Place the heatsink fins-down on a work surface. Orient the heatsink so that the edge with part number is away from you. The hole for the TE2 grounding lug should be to your left.
2) Remove the clear protective film from the thermal material and discard it. Place the thermal material onto the heatsink in the placement area which is marked with four white "L".
   Apply light pressure to ensure that the thermal material is flat.
3) Peel the white protective layer away from the thermal material. Do this slowly from one corner so as not to lift the thermal material from the heatsink.
4) Align the TE2 as shown and lower onto the heatsink. If needed to adjust the position, lift it away from the thermal material and lower onto the heatsink again.
5) Install the four mounting screws with split and flat washers then tighten evenly. Torque to 17.8 lb-in (2.0 Nm) maximum.



DIMENSIONS: IN (MM)



Mounting screws:
#6-32, or 3.5 mm



ORDERING GUIDE

TE2-090-07	Stepnet Plus 2-Axis Panel EtherCAT stepper drive, 5/7 A, 90 Vdc
TE2-090-10	Stepnet Plus 2-Axis Panel EtherCAT stepper drive, 10/10 A, 90 Vdc

EtherCAT Conformance tested

Example: Order one *Stepnet Plus TE2* drive, 10/10 A, with connector kit, serial cable kit:

Qty	Item	Remarks
1	TE2-090-10	*Stepnet Plus TE2* 2-axis servo drive
1	TE2-CK	*TE2* Connector Kit
1	SER-CK	Serial Cable Kit

ACCESSORIES

	Qty	Ref	Name	Description	Manufacturer P/N
TE2-CK Connector Kit	1	J11	DC HV	Plug, 3 position, 5.08 mm, female	Wago: 231-303/107-000 (Note 1)
	1			Strain relief, snap-on, 5.08 mm, 3 position, orange	Wago: 232-633
	2	J9, J10	Motor	Plug, 5 position, 5.08 mm, female	Wago: 231-305/107-000 (Note 1)
	2			Strain relief, snap-on, 5.08 mm, 4 position, orange	Wago: 232-635
	1	J9~J11	Tool	Tool, wire insertion & extraction, 231 series	Wago: 231-159
	1	J3	Brake	Plug, 5 position, 3.5 mm, female	Wago: 734-105/107-000 (Note 1)
	1			Strain relief, snap-on, 3.5 mm, 5 position, grey	Wago: 734-605
	1		Tool	Tool, wire insertion & extraction, 734 series	Wago: 734-231
	1	J6 Note 2	Safety	Connector, DB-9M, 9-position, standard, male	TE/AMP: 205204-4
	9			AMPLIMITE HD-20 Crimp-Snap contacts, 24-20AWG, AU flash	TE/AMP: 66506-9
	1			Metal Backshell, DB-9, RoHS	3M: 3357-9209
	4			Jumper, with pins crimped on both ends	Copley: 10-75177-01
	1	J1	Control	Connector, high-density DB-44M, 44 position, male, solder cup	Norcomp: 180-044-103L001
	1			Metal Backshell, DB-25, RoHS	3M: 3357-9225
	1	J2	I/O	Connector, high-density DB-26F, 26 position, female, solder cup	Norcomp: 180-026-203L001
	2	J7, J8	Feed-back	Connector, high-density DB-26M, 26 position, male, solder cup	Norcomp: 180-026-103L001
	3	J2, J7, J8		Metal Backshell, DB-15, RoHS	3M: 3357-9215
SER-CK	1	J5	RS-232	Serial Cable Kit	
TE2-NC-10	1	J8	Network	EtherCAT® network cable, 10 ft (3 m)	
TE2-NC-01	1			EtherCAT® network cable, 1 ft (0.3 m)	

Note 1: For RoHS compliance, append "/RN01-0000" to the Wago part numbers listed above

Note 2: Insertion/extraction tool for J6 contacts is AMP/Tyco 91067-2 (not included in TE2-CK)

16-01443 Document Revision History

Revision	Date	Remarks
00	March 27, 2017	Preliminary version
02	April 19, 2017	Initial released version
03	July 10, 2019	Removed references to encoder loss protection which is not supported
04	August 21, 2019	Removed reference to emulated feedback in Multi-Port from Sin/Cos encoders
05	November 5, 2020	Correction to pin numbering on brake connector J3
06	August 24, 2021	Update with new front panel label to show brake signals
07	March 21, 2022	Updated feedback, add BiSS and SSI

Note: Specifications subject to change without notice