

## CONTROL MODES

- Cyclic Synchronous Position-Velocity-Torque (CSP, CSV, CST)
- Profile Position-Velocity-Torque, Interpolated Position, Homing
- Camming, Gearing
- Indexer

## COMMAND INTERFACE

- CAN application layer over EtherCAT (CoE)
- ASCII and discrete I/O
- Stepper commands
- $\pm 10V$  position/velocity/torque
- PWM velocity/torque command
- Master encoder (Gearing/Camming)

## COMMUNICATIONS

- EtherCAT
- RS-232

## FEEDBACK

### Incremental Encoders

- Digital quad A/B
- Analog Sin/Cos
- Panasonic Incremental A Format
- Aux. quad A/B encoder / encoder out

### Absolute Encoders

- SSI, EnDat, Absolute A,
- Tamagawa & Panasonic Absolute A
- Sanyo Denki Absolute A, BiSS (B & C)

### Resolver (-R option)

- Brushless Resolver

### Other

- Digital Halls

## I/O DIGITAL

- 10 non-isolated, 8 isolated inputs,
- 5 isolated outputs, 2 non-isolated outputs

## ANALOG

- 2, 12-bit inputs

## SAFE TORQUE OFF (STO)

- SIL 3, Category 3, PL d

## DIMENSIONS: MM [IN]

- 167 x 115.2 x 40.6 [6.58 x 4.54 x 1.60]

## DESCRIPTION

The BE2 is a high-performance, DC powered drive for position, velocity, and torque control of brushless and brush motors via EtherCAT, an Ethernet-based fieldbus. Drive commissioning is fast and simple using CME 2™ software operating under Windows® and communicating with the BE2 via RS-232.

The BE2 operates as an EtherCAT slave using the CAN Application Layer over EtherCAT (CoE) protocol of DSP-402 for motion control devices. Supported modes include: Profile Position-Velocity-Torque, Cyclic Synchronous Position-Velocity-Torque, Interpolated Position Mode (PVT), and Homing.

Feedback from both incremental and absolute encoders is supported. A multi-mode encoder port functions as an input or output depending on the drive's basic setup. As an input it takes feedback from a secondary encoder to create a dual-loop position control system or as a master encoder for driving a cam table. As an output, it buffers the digital encoder signals from the motor's digital encoder and eliminates split cables that would be needed to send the signals to both drive and control system.

DIGITAL SERVO DRIVE  
FOR BRUSHLESS/BRUSH MOTORS

EtherCAT®  
Conformance tested



Model	I <sub>p</sub>	I <sub>c</sub>	V <sub>dc</sub>
BE2-090-06	6	3	90
BE2-090-14	14	7	90
BE2-090-20	20	10	90

Current ratings are for each axis  
Add -R for resolver feedback option

There are ten non-isolated inputs. Eight opto-isolated digital inputs are bipolar types that source or sink 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.

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  $\Omega$  line-line. Ambient temperature = 25°C, +HV = HV<sub>max</sub>

MODEL	BE2-090-06	BE2-090-14	BE2-090-20	
OUTPUT POWER (EACH AXIS)				
Peak Current	6 (4.24)	14 (9.9)	20 (14.4)	Adc (Arms-sine), $\pm 5\%$
Peak time	1			Sec
Continuous current (Note 1)	3 (2.1)	7 (5)	10 (7.1)	Adc (Arms-sine) per phase
INPUT POWER				
HVmin~HVmax	+14 to +90	+14 to +90	+14 to +90	Vdc Transformer-isolated
Ipeak	12	28	40	Adc (1 sec) peak
Icont	6	14	20	Adc continuous
Aux HV	+14 to +HV Vdc @ 500 mAdc maximum, 2.5 W			Optional, not required for operation
DIGITAL CONTROL				
Digital Control Loops	Current, velocity, position. 100% digital loop control			
Sampling rate (time)	Current loop: 16 kHz (62.5 $\mu$ s), Velocity & position loops: 4 kHz (250 $\mu$ s)			
Bus voltage compensation	Changes in bus or mains voltage do not affect bandwidth			
Minimum load inductance	200 $\mu$ H line-line			
COMMAND INPUTS (NOTE: DIGITAL INPUT FUNCTIONS ARE PROGRAMMABLE)				
Distributed Control Modes				
CAN Application protocol over EtherCAT (CoE)	Cyclic Synchronous Position-Velocity-Torque, Profile Position-Velocity-Torque, Interpolated Position, Homing			
Stand-alone mode				
Analog torque, velocity, position reference	$\pm 10$ 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	PWM, Polarity		PWM = 0% - 100%, Polarity = 1/0	
	PWM 50%		PWM = 50% $\pm 50\%$ , 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-12 connector			
DIGITAL INPUTS				
Number 18				
[IN1,2,10,11]	Digital, non-isolated, Schmitt trigger, 1 $\mu$ s RC filter, 24 Vdc compatible, programmable 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			
[IN3,4,12,13]	Digital, non-isolated, programmable as single-ended or differential pairs, 100 ns RC filter, 12 Vdc max, 10 k $\Omega$ programmable pull-up/down per input to +5 Vdc/ground, SE: Vin-LO $\leq$ 2.3 Vdc, Vin-HI $\geq$ 2.7 Vdc, VH = 45 mV typ, DIFF: Vin-LO $\leq$ 200 mVdc, Vin-HI $\geq$ 200 mVdc, VH = 45 mV typ, Rated impulse $\geq$ 800 V, Vin-LO $\leq$ 6.0 Vdc, Vin-HI $\geq$ 10.0 Vdc, Input current $\pm 3.6$ mA @ $\pm 24$ Vdc, typical			
[IN5~8,14~17]	Digital, opto-isolated, single-ended, $\pm 15 \sim 30$ Vdc compatible, bi-polar, 2 groups of 4 with 1 common return			
[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			
Functions	330 $\mu$ s 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			
	[IN3~18] are programmable, [IN1~2] default to drive axes A & B Enable function and are programmable			
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 $\leq$ 6.0 Vdc or open, Vin-HI $\geq$ 15.0 Vdc,			
Input current (typical)	STO_IN1: 9.0 mA, STO_IN2: 4.5 mA			
Response time	2 ms (IN1, IN2) from Vin $\leq$ 6.0 Vdc to interruption of energy supplied to motor			
Reference	Complete information and specifications are in the Accelnet & Stepnet Plus Panels STO Manual			
ANALOG INPUTS				
Number	2			
[AIN1~2]	Differential, $\pm 10$ Vdc, 5 kW input impedance, 12-bit resolution			
DIGITAL OUTPUTS				
Number	7			
[OUT1~5]	Opto-isolated Darlington, 20 mA max, 24 V tolerant, Rated impulse $\geq$ 800 V, series 20 ohm resistor			
	collector & emitter connections on each output, Vce = 1.2 Vdc @ 20 mAdc, typical, output ON, Vce-max 32 Vdc, output OFF, Td-ON = 500 $\mu$ s max @ 20 mA, Td-OFF = 500 $\mu$ s max @ 20 mA, times include rise/fall times			
[OUT6~7]	Default as motor brake control: current-sinking, 1 Adc max, internal flyback diodes 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-12 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, CAN Application protocol over EtherCAT (CoE)			

### NOTES:

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



## 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) MAX3097 differential line receiver with 121 $\Omega$ terminating resistor between complementary inputs
Analog Incremental Encoder	Sin/cos format (sin+, sin-, cos+, cos-), differential, 1 Vpeak-peak, ServoTube motor compatible, BW > 300 kHz, 121 $\Omega$ terminating resistor between complementary inputs
Analog Index signal	Differential, 121 $\Omega$ terminating resistor between complementary inputs, 1 Vpeak-peak zero-crossing detect

### Absolute:

SSI	Clock (X, /X), Data (S, /S) signals, 4-wire, clock output from BE2, data returned from encoder
EnDat	Clock (X, /X), Data (S, /S), sin/cos (sin+, sin-, cos+, cos-) signals
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
BiSS (B&C)	MA+, MA- (X, /X), SL+, SL- (S, /S) signals, 4-wire, clock output from BE2, data returned from encoder

## DIGITAL HALLS

Type	Digital, single-ended, 120° electrical phase difference between U-V-W signals, Schmitt trigger, 1 $\mu$ s RC filter, 24 Vdc compatible, programmable 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
Inputs	10 k $\Omega$ pullups to +5 Vdc, 1 $\mu$ s RC filter to Schmitt trigger inverters

## MULTI-MODE ENCODER PORT

As Input	Digital quadrature encoder (A, /A, B, /B, X, /X), 121 $\Omega$ terminating resistors on X & S inputs only 5 MHz maximum line frequency (20 M counts/sec), MAX3097 line receiver Digital absolute encoder (Clk, /Clk, Dat, /Dat) half or full-duplex operation, S & X inputs with 121 $\Omega$ terminating resistors are used for absolute encoder interface
As Emulated Output	Quadrature encoder emulation with programmable resolution to 4096 lines (65,536 counts) per rev from analog sin/cos encoders or resolvers.
As Buffered Output	A, /A, B, /B, X, /X, from ISL32179 differential line driver Digital encoder feedback signals from primary digital encoder are buffered by ISL32179 line driver

## RESOLVER (-R OPTION)

Type	Brushless, single-speed, 1:1 to 2:1 programmable transformation ratio
Resolution	14 bits (equivalent to a 4096 line quadrature encoder)
Reference frequency	8.0 kHz
Reference voltage	2.8 Vrms, auto-adjustable by the drive to maximize feedback
Reference maximum current	100 mA
Maximum RPM	10,000 typical
Sin/Cos inputs	Differential, 54k $\pm$ 1% differential impedance, 2.0 Vrms, BW $\geq$ 300 kHz

## DC POWER OUTPUTS

Number	2
Ratings	+5 Vdc, 500 mA max each output, thermal and short-circuit protected
Connections	Axis A +5V Output: J1-25, J6-17, J6-22; combined current from these pins cannot exceed 500 mA Axis B +5V Output: J1-30, J7-17, J7-22; combined current from these pins cannot exceed 500 mA

## RS-232 PORT

Signals	RxD, TxD, Gnd in 6-position, 4-contact RJ-11 style modular connector, referenced to Signal Ground
Mode	Full-duplex, DTE serial port for drive setup and control, 9,600 to 115,200 Baud Baud rate defaults to 9,600 after power-on or reset and is programmable up to 115,200 thereafter
Protocol	ASCII or Binary format

## MOTOR CONNECTIONS

Phase U, V, W	PWM outputs to 3-phase ungrounded Wye or delta connected brushless motors, or DC brush motors
Hall U, V, W	Digital Hall signals, single-ended
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) MAX3097 differential line receiver, 121 ohm inputs
Analog Incremental Encoder	Sin/cos format (sin+, sin-, cos+, cos-), differential, 1 Vpeak-peak, 121 ohm inputs X or S input may be firmware configured to latch position or time
SSI	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential, 121 ohm inputs
EnDat 2.1,2.2	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential, 121 ohm inputs Sin/cos signals (Sin+, Sin-, Cos+, Cos-)
Absolute A	Tamagawa Absolute A, Panasonic Absolute A Format, SD+, SD- (S, /S) signals, 121 ohm inputs
BiSS (B&C)	MA+, MA-, SL+, SL-, 121 ohm inputs
Hall & encoder power	(See DC POWER OUTPUTS section)
Brake	[OUT6-7] Default to brake function, programmable for other functions.

## 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



## SPECIFICATIONS (CONT'D)

### PROTECTIONS

HV Overvoltage	+HV > HV <sub>max</sub>	Drive outputs turn off until +HV < HV <sub>max</sub> (See Input Power for HV <sub>max</sub> )
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 <sup>2</sup> T Current limiting		Programmable: continuous current, peak current, peak time
Motor over temperature		Digital inputs programmable to detect motor temperature switch
Feedback Loss		Inadequate analog encoder amplitude or missing incremental encoder signals

### MECHANICAL & ENVIRONMENTAL

Size	6.58 x 4.54 x 1.60 [167 x 115.2 x 40.6]
Weight	1.27 lb [0.58 kg], add 1.22 lb [0.55 kg] with heatsink
Ambient temperature	0 to +45°C operating, -40 to +85°C 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	IEC68-2: 1990
Cooling	Heat sink and/or forced air cooling required for continuous power output

### AGENCY STANDARDS CONFORMANCE

#### Approvals

Underwriters Laboratory (UL) recognized component to UL 61010-1, 2nd Ed.: 2004  
Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use  
UL File Number E249894  
TUV Functional Safety to IEC 61508

#### Functional Safety

IEC 61508-1, IEC 61508-2, EN(ISO) 13849-1, EN(ISO) 13849-2  
**(See the Accelnet & Stepnet Plus Panels STO Manual for further details)**



#### Electrical Safety

In accordance with EC Directive 2006/95/EC (Low Voltage Directive)  
IEC/UL/CSA 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use  
IEC 61800-5-1:2007

#### EMC

IEC 61326-1:2005 (Industrial locations)  
IEC 61326-3-1:2008  
IEC 55011:2009/A1:2010, Group 1, Class A  
IEC 61800-3:2004

#### Hazardous Substances

Lead-free and RoHS compliant

## 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 CAN Application Layer 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 Accelnet and the master. The OUT port connects to 'downstream' nodes. If Accelnet is the last node on a network, only the IN port is used. No terminator is required on the OUT port.

## ETHERCAT LEDS (ON RJ-45 CONNECTORS)

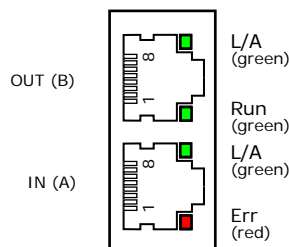
**L/A** Green: Shows the state of the physical link and activity on the link. A green LED indicates the state of the EtherCAT network:

LED	Link	Activity	Condition
ON	Yes	No	Port Open
Flickering	Yes	Yes	Port Open with activity
Off	No	(N/A)	Port Closed

**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 BE2 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



## J3: EtherCAT PORTS

RJ-45 receptacles, 8 position, 4 contact

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

## EtherCAT DEVICE ID

In an EtherCAT network, slaves are automatically assigned fixed addresses based on their position on the bus. But when the device must have a positive identification that is independent of cabling, a Device ID is needed. In the BE2, 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:

- Find the highest number under S1 that is less than 107 and set S1 to the hex value in the same row:  
96 < 107 and 112 > 107, so S1 = 96 = Hex 6
- Subtract 96 from the desired Device ID to get the decimal value of switch S2 and set S2 to the Hex value in the same row:  
S2 = (107 - 96) = 11 = Hex B

## EtherCAT Device ID Switch Decimal values

Set	S1	S2	Set	S1	S2
Hex	Dec		Hex	Dec	
0	0	0	8	128	8
1	16	1	9	144	9
2	32	2	A	160	10
3	48	3	B	176	11
4	64	4	C	192	12
5	80	5	D	208	13
6	96	6	E	224	14
7	112	7	F	240	15

## AMP LED

Two bi-color LEDs give the state of the BE2 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 below 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/Slow-Blinking = Drive OK but NOT-enabled. Will run when enabled.
- 4) Green/Fast-Blinking = Positive or Negative limit switch active. Drive will only move in direction not inhibited by limit switch.
- 5) Green/Solid = Drive OK and enabled. Will run in response to reference inputs or EtherCAT commands.

### Latching Faults

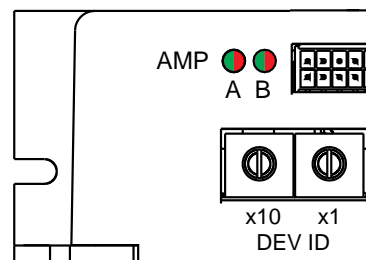
#### Defaults

- 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 & ADDRESS SWITCHES



## COMMUNICATIONS

### RS-232 COMMUNICATIONS

BE2 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 BE2 RS-232 port are through J4, an RJ-11 connector. The BE2 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.

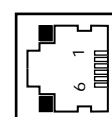
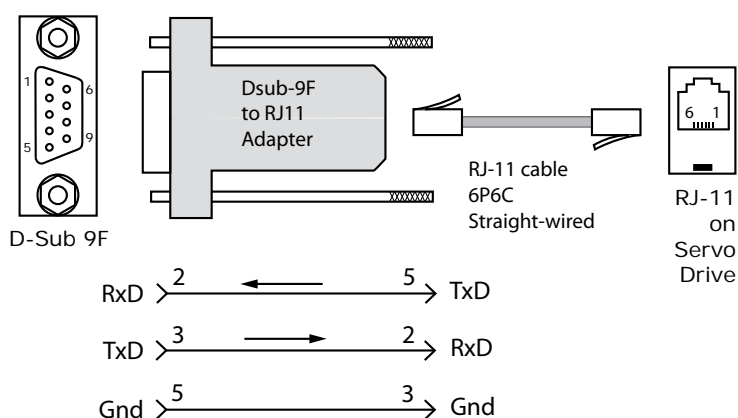
After power-on, reset, or transmission of a Break character, the Baud rate will be 9,600. Once communication has been established at this speed, the Baud rate can be changed to a higher rate (19,200, 57,600, 115,200).

### SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector on the BE2. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses common modular cable to connect to the BE2. The connections are shown in the diagram below.

### J4: 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 an BE2!

### 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 BE2 series amplifiers over an RS-232 serial connection. For instance, after basic amplifier configuration values have been programmed using CME 2, a control program can use the ASCII Interface to:

- Enable the amplifier 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:

[http://www.copleycontrols.com/Motion/pdf/ASCII\\_ProgrammersGuide.pdf](http://www.copleycontrols.com/Motion/pdf/ASCII_ProgrammersGuide.pdf)




## SAFE TORQUE OFF (STO)

### DESCRIPTION

The BE2 provides the Safe Torque Off (STO) function as defined in IEC 61800-5-2. Three opto-couplers 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 activated (current is flowing in the input diodes), the control core will be able to control the on/off state of the PWM outputs.

### INSTALLATION

 <b>DANGER</b>	<b>Refer to the Accelnet &amp; Stepnet Plus Panels STO Manual</b>
	The information provided in the <i>Accelnet &amp; Stepnet Plus Panels STO Manual</i> must be considered for any application using the BE2 drive's STO feature. <b>Failure to heed this warning can cause equipment damage, injury, or death.</b>



### STO BYPASS (MUTING)

In order for the PWM outputs of the BE2 to be activated, current must be flowing through all of the opto-couplers that are connected to the STO-1 and STO-2 terminals of J5, 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.

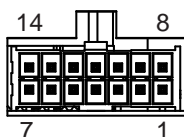
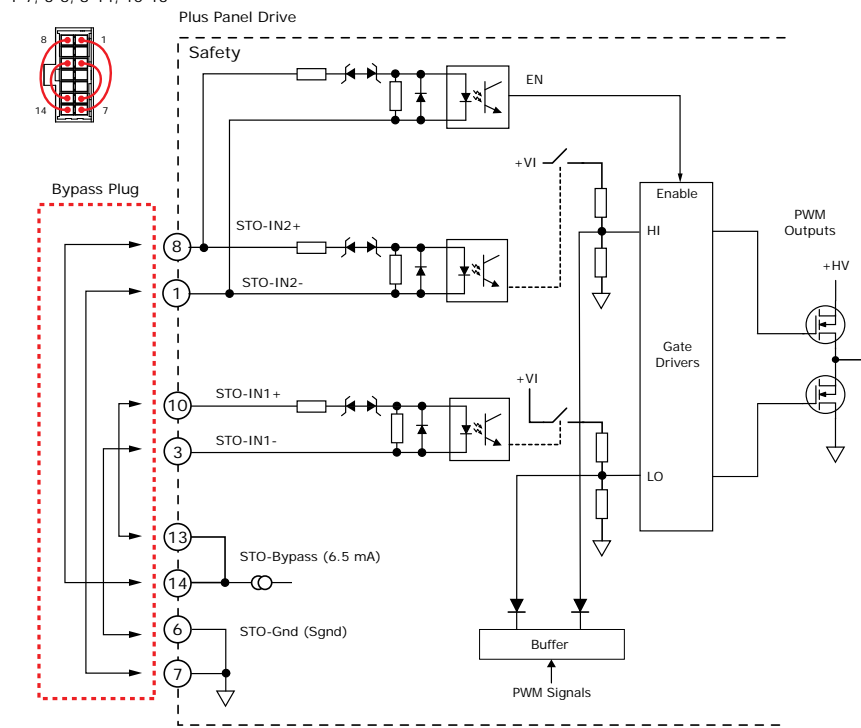
**If not using the STO feature, these connections must be made in order for the BE2 to be enabled.**

### FUNCTIONAL DIAGRAM



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

Bypass Plug Connections  
Jumper pins:  
1-7, 3-6, 8-14, 10-13



### J5 SIGNALS

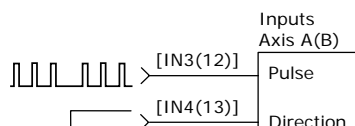
SIGNAL	PIN		SIGNAL
STO_IN2+	8	1	STO_IN2-
n.c.	9	2	n.c.
STO_IN1+	10	3	STO_IN1-
n.c.	11	4	n.c.
n.c.	12	5	n.c.
STO_BYP	13	6	Sgnd
	14	7	Sgnd

## COMMAND INPUTS

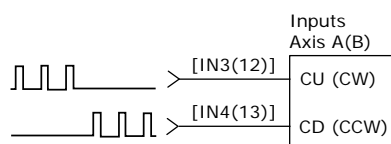
### DIGITAL POSITION

Single-ended digital position commands should 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.

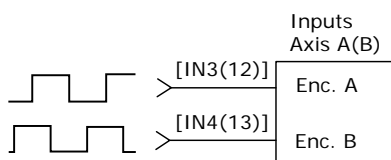
#### SINGLE-ENDED PULSE & DIRECTION



#### SINGLE-ENDED CU/CD



#### QUAD A/B ENCODER SINGLE-ENDED



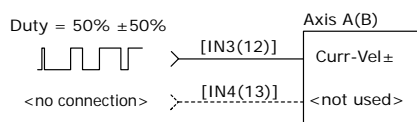
### DIGITAL TORQUE, VELOCITY

Digital torque or velocity commands are in single-ended format and must be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs.

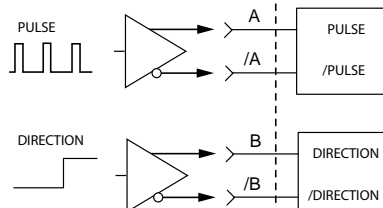
#### SINGLE-ENDED PWM & DIRECTION



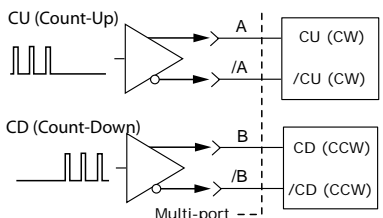
#### SINGLE-ENDED 50% PWM



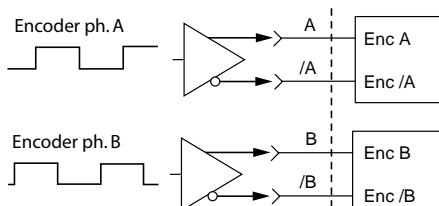
#### DIFFERENTIAL PULSE & DIRECTION



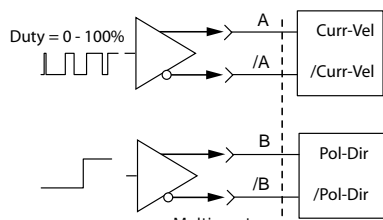
#### DIFFERENTIAL CU/CD



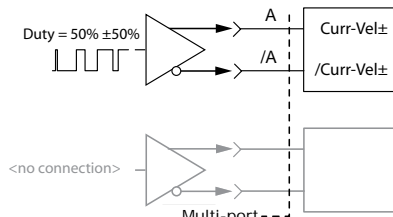
#### QUAD A/B ENCODER DIFFERENTIAL



#### DIFFERENTIAL PWM & DIRECTION



#### DIFFERENTIAL 50% PWM



#### SINGLE-ENDED

Signal	Axis A J1	Axis B J1
Pls, Enc A	23	24
Dir, Enc B	5	6
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd

#### DIFFERENTIAL

Signal	Axis A J1	Axis B J1
Pls, Enc A	26	31
/Pls, Enc /A	8	13
Dir, Enc B	27	32
/Dir, Enc /B	9	14
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd

#### SINGLE-ENDED

Signal	Axis A J1	Axis B J1
PWM	23	24
Dir	5	6
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd

#### DIFFERENTIAL

Signal	Axis A J1	Axis B J1
PWM	26	31
/PWM	8	13
Dir	27	32
/Dir	9	14
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd



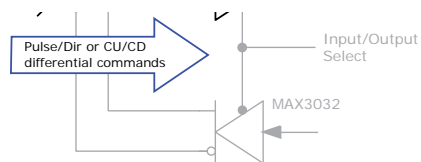
## MULTI-MODE ENCODER PORT

This port consists of three differential input/output channels that take their functions from the Basic Setup of the drive. With quad A/B encoder feedback, the port works as an output, buffering the signals from the encoder. With resolver or sin/cos encoder versions, the feedback is converted to "emulated" quad A/B/X signals with programmable resolution. These signals can then be fed back to an external motion controller that closes the position or velocity loops. As an input, the port can take quad A/B signals to produce a dual-loop position control system or use the signals as master-encoder commands in camming mode. In addition, the port can take stepper command signals (CU/CD or Pulse/Direction) in differential format.

### AS COMMAND INPUTS

#### AS DIGITAL COMMAND INPUTS IN PULSE/DIRECTION, PULSE-UP/PULSE-DOWN, OR DIGITAL QUADRATURE ENCODER FORMAT

The multi-mode port can also be used when digital command signals are in a differential format. These are the signals that typically go to single-ended inputs. But, at higher frequencies these are likely to be differential signals in which case the multi-mode port can be used.



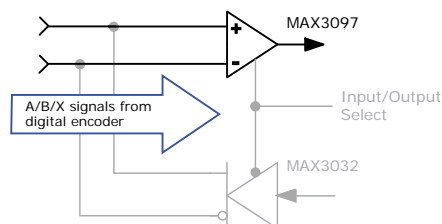
#### COMMAND INPUT MULTI-PORT

Signal	Axis A J1	Axis B J1
Pls, Enc A	26	31
/Pls, Enc /A	8	13
Dir, Enc B	27	32
/Dir, Enc /B	9	14
Enc X	28	33
Enc /X	10	15
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd

#### AS A MASTER OR CAMMING ENCODER INPUT FROM A DIGITAL QUADRATURE ENCODER

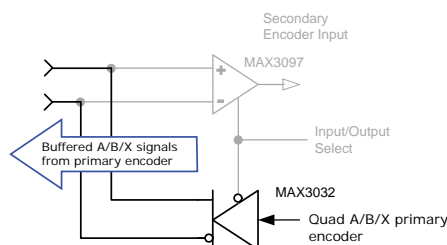
When operating in position mode the multi-mode port can accept digital command signals from external encoders. These can be used to drive cam tables, or as master-encoder signals when operating in a master/slave configuration.



### AS AN OUTPUT FOR FEEDBACK SIGNALS TO AN EXTERNAL CONTROLLER

#### AS BUFFERED OUTPUTS FROM A DIGITAL QUADRATURE PRIMARY ENCODER

When using a digital quadrature feedback encoder, the A/B/X signals drive the multi-mode port output buffers directly. This is useful in systems that use external controllers that also need the motor feedback encoder signals because these now come from J8, the Control connector. In addition to eliminating "Y" cabling where the motor feedback cable has to split to connect to both controller and motor, the buffered outputs reduce loading on the feedback cable that could occur if the motor encoder had to drive two differential inputs in parallel, each with it's own 121 ohm terminating resistor.



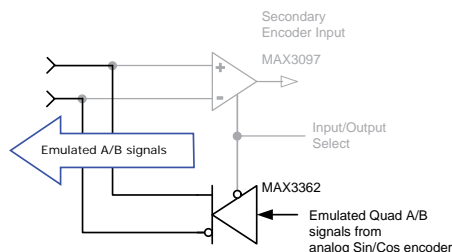
#### EMULATED QUAD A/B/X MULTI-PORT

Signal	Axis A J1	Axis B J1
Enc A	26	31
Enc /A	8	13
Enc B	27	32
Enc /B	9	14
Enc X	28	33
Enc /X	10	15
Sgnd	7,12,20	
F.G.	17	

F.G. = Frame Gnd

#### AS EMULATED QUAD A/B/X ENCODER OUTPUTS FROM AN ANALOG SIN/COS FEEDBACK ENCODER

Analog sin/cos signals are interpolated in the drive with programmable resolution. The incremental position data is then converted back into digital quadrature format which drives the multi-mode port output buffers. Some analog encoders also produce a digital index pulse which is connected directly to the port's output buffer. The result is digital quadrature A/B/X signals that can be used as feedback to an external control system.



## PROGRAMMABLE DIGITAL INPUTS

Use this chart shows as a quick reference to the inputs and their characteristic R/C combinations.

### HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN1,2,10,11 IN9,18	HI	$V_{in} \geq 3.5 \text{ Vdc}$
	LO	$V_{in} \leq 0.7 \text{ Vdc}$
IN3,4,12,13	HI	$V_{in} \geq 2.7 \text{ Vdc}$
	LO	$V_{in} \leq 2.3 \text{ Vdc}$
IN5,6,7,8 IN14,15,16,17	HI	$V_{in} \geq 10.0 \text{ Vdc}$
	LO	$V_{in} \leq 6.0 \text{ Vdc}$

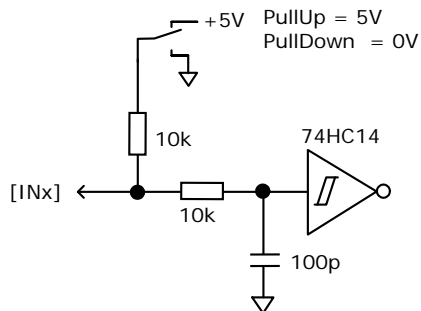
### [IN1~18] SIGNALS

Input	Pin	R1	R2	C1	Input	Pin	R1	R2	C1	
*IN1	J1-21	10k	10k	100p	*IN10	J1-22	10k	10k	100p	
*IN2	J1-3									
*IN3	J1-23		1k							
*IN4	J1-5									
IN5	J2-11	Opto ±Common is J2-20			IN14	J2-13	Opto ±Common is J2-20			
IN6	J2-1									
IN7	J2-12									
IN8	J2-2									
IN9	J6-7	4.99k	10k	33n	IN18	J7-7	4.99k	10k	33n	

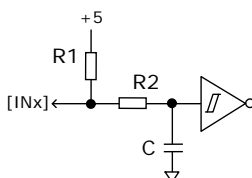
### \* PROGRAMMABLE PULL UP/DOWN

The input resistor of these inputs is programmable to pull-up to +5V or pull-down to 0V. Pull-up is the default and works with current-sinking outputs from a controller. Pull-down works with current-sourcing outputs, typically PLC's that drive grounded loads.

Six of the inputs have individually settable PU/PD. The other four have PU/PD control for pairs of inputs.



### INPUT CONFIGURATIONS



Vmax

+24V
+12V

### INPUTS WITH PROGRAMMABLE PULL UP/DOWN

Input	Pin	PU/PD	Input	Pin	PU/PD
IN1	J1-21	1	IN10	J1-22	3
IN2	J1-3	2	IN11	J1-4	4
IN3	J1-23	5	IN12	J1-24	7
IN4	J1-5	6	IN13	J1-6	8

## SINGLE-ENDED/DIFFERENTIAL DIGITAL INPUTS [IN2~3,12~13]

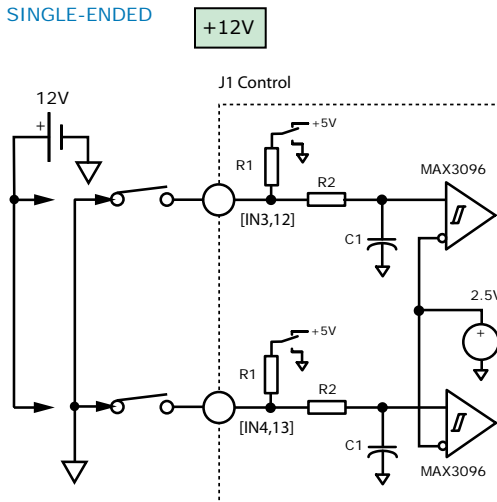
These inputs have all the programmable functions of the GP inputs plus these additional functions which can be configured as single-ended (SE) or differential (DIFF):

- PWM 50%, PWM & Direction for Velocity or Current modes
- Pulse/Direction, CU/CD, or A/B Quad encoder inputs for Position or Camming modes

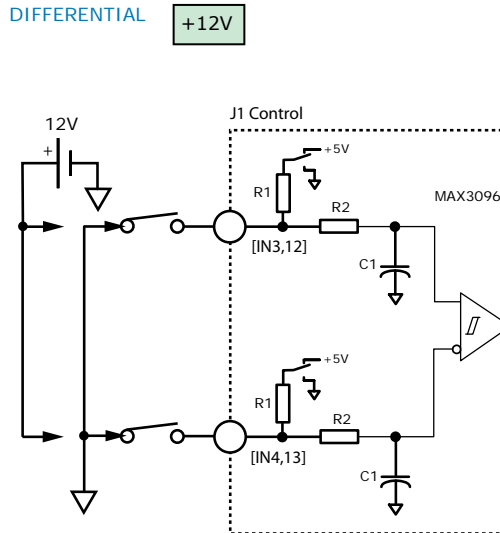
## [IN2~3,12~13] SIGNALS

S.E. Input	Diff Input	Pin	S.E. Input	Diff Input	Pin
IN2	IN2+	J1-23	IN12	IN12+	J1-24
IN3	IN2-	J1-5	IN13	IN12-	J1-6

12 Vdc max  
SINGLE-ENDED



12 Vdc max  
DIFFERENTIAL



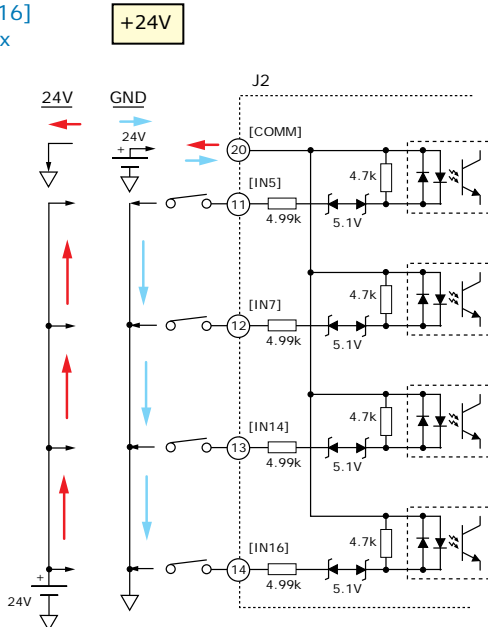
PLC outputs are frequently current-sourcing from 24V for driving grounded loads. PC based digital controllers commonly use NPN or current-sinking outputs. Set the Accelnet inputs to pull-down to ground for current-sourcing connections, and to pull-up to 5V for current-sinking connections.

## OPTO-ISOLATED DIGITAL INPUTS

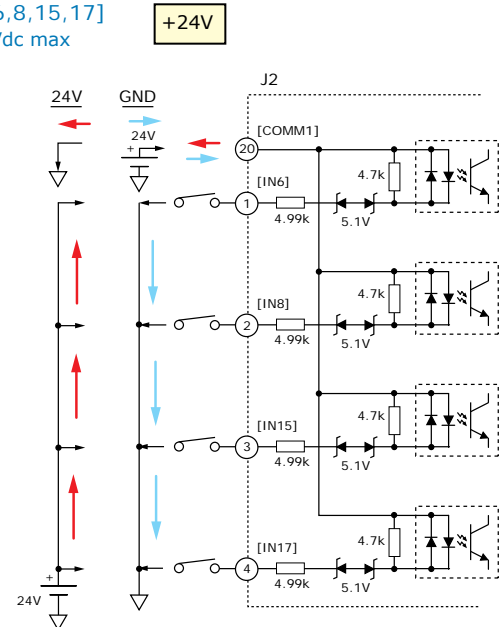
These inputs have all the programmable functions of the GP inputs plus opto-isolation. There are two groups of four inputs, which share a common terminal. Grounding the common terminal configures the inputs to work with current-sourcing outputs from controllers like PLC's. When the common terminal is connected to +24V, then the inputs will be activated by current-sinking devices such as NPN transistors or N-channel MOSFETs. The minimum ON threshold of the inputs is  $\pm 15$  Vdc.

**IN THE GRAPHICS BELOW, "24V" IS FOR CONNECTIONS TO CURRENT-SOURCING OUTPUTS AND "GND" IS FOR CURRENT-SINKING OUTPUTS ON THE CONTROL SYSTEM**

[IN5,7,13,16]  
 $\pm 30$  Vdc max



[IN16,8,15,17]  
 $\pm 30$  Vdc max



These inputs work with current-sourcing OR current-sinking connections. Connect the COMM to controller ground/common for current-sourcing connections and to 15~24V from the controller for current-sinking connections.

Vmax

+24V

[IN5~8,14~17] SIGNALS

Signal	Pins	Signal	Pins
IN5	J2-11	IN6	J2-1
IN7	J2-12	IN8	J2-2
IN14	J2-13	IN15	J2-3
IN16	J2-14	IN17	J2-4
COMM	J2-20	F.G.	J2-10

F.G. = Frame Gnd

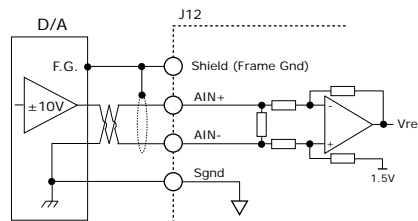
## ANALOG INPUTS

The analog inputs have a  $\pm 10$  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.

[AIN A,B] SIGNALS

Signal	J1 Pins	
	Axis A	Axis B
AIN(+)	18	19
AIN(-)	1	2
Sgnd	7, 12, 20	
F.G.	17	

F.G. = Frame Gnd



CME2 -> Basic Setup -> Operating Mode Options

Command Source: Analog Command

## OUTPUTS

### OPTO-ISOLATED OUTPUTS [OUT1~5]

30 Vdc max

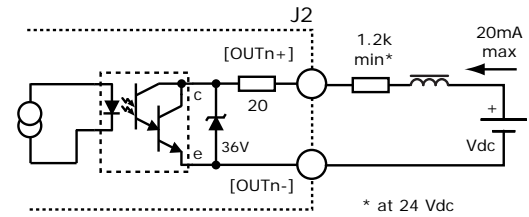
Zener clamping diodes across outputs allow driving of resistive-inductive (R-L) loads without external flyback diodes.

#### [OUT1~5] SIGNALS

Signal	Pins	Signal	Pins
[OUT1+]	J2-15	[OUT1-]	J2-5
[OUT2+]	J2-16	[OUT2-]	J2-6
[OUT3+]	J2-17	[OUT3-]	J2-7
[OUT4+]	J2-18	[OUT4-]	J2-8
[OUT5+]	J2-19	[OUT5-]	J2-9
[COMM]	J2-20	F.G.	J2-10

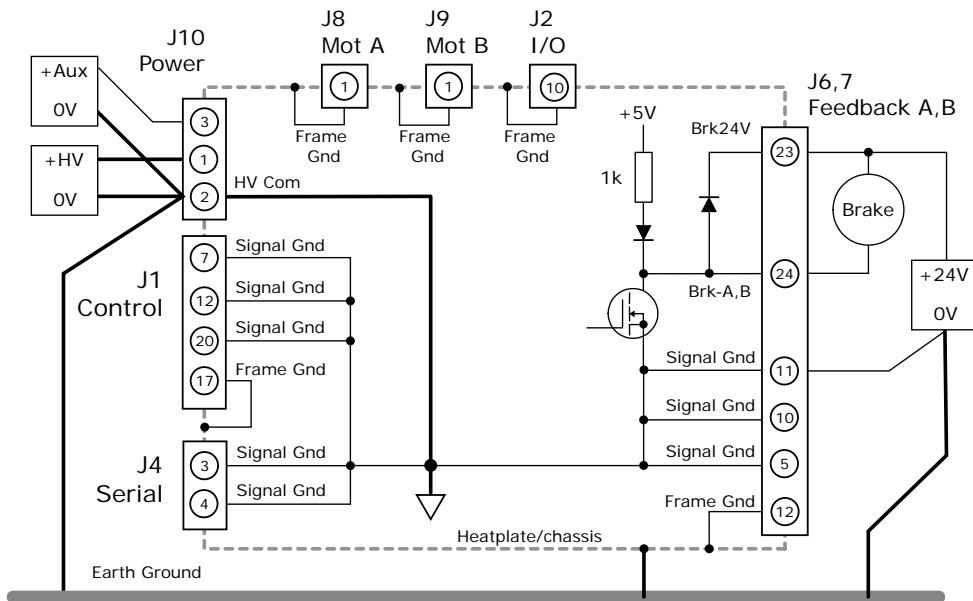
F.G. = Frame Gnd

#### [OUT1~5]



### BRAKE OUTPUTS [OUT6,7]

These outputs are open-drain MOSFETs with internal flyback diodes for driving inductive loads. Each can sink up to 1A from a motor brake connected to the +24 Vdc supply. The operation of the brake is programmable with CME 2. They can also be programmed as a general-purpose digital outputs.



Earthing connections for power supplies should be as close as possible to eliminate 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.**

#### BRAKE SIGNALS

Signal	Axis A	Axis B
Brk24V	J6-23	J7-23
BRK-A,B	J6-24	J7-24
Signal Gnd	J6-11,10,5	J7-11,10,5

### HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT1~5	HI	Output transistor is ON, current flows
	LO	Output transistor is OFF, no current flows
BRK-A,B OUT6,7	HI	Output transistor is OFF Brake is un-powered and locks motor shaft Motor cannot move Brake state is Active
	LO	Output transistor is ON Brake is powered, releasing motor shaft Motor is free to move Brake state is NOT-Active

CME2 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

CME2 I/O Line States shows Output 6 or 7 as HI

BRK Output voltage is HI (24V), MOSFET 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

CME2 I/O Line States shows Output 6 or 7 as LO

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

Servo drive is enabled, PWM outputs are on

Servo drive output current is flowing

## QUAD A/B/X ENCODER WITH SIGNAL LOSS DETECTION

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. The MAX3097 receiver has differential inputs with fault protections for the following conditions:

### Condition

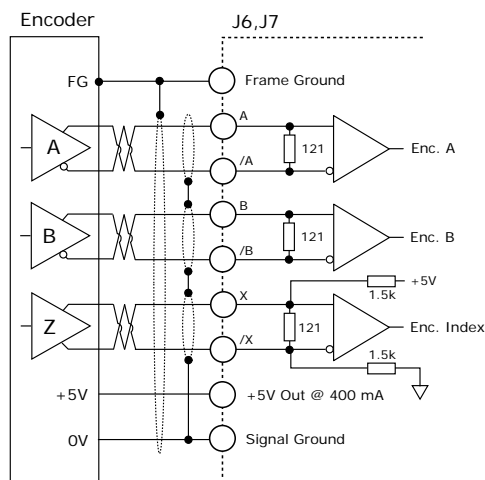
Line-line shorts  
Open-circuits:

Low-voltage

### Example

A shorted to /A  
A disconnected, /A connected. Terminator resistor pulls A & /A together for a short-circuit fault  
 $V_a - V_b \leq 200 \text{ mV}$ , or  $\geq -200 \text{ mV}$   
Encoder power loss, cabling, etc.

## QUAD ENCODER WITH INDEX

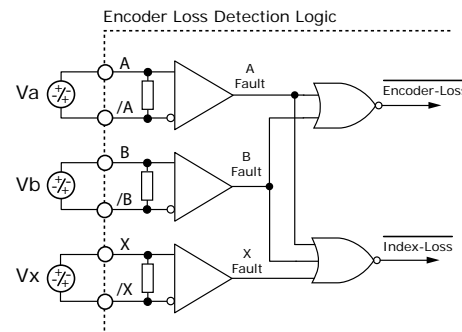


### A/B/X SIGNALS

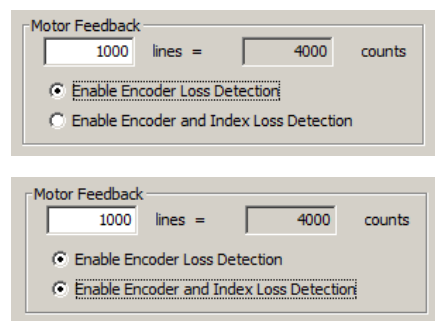
Signal	J6, J7 Pin
Enc A	13
Enc /A	1
Enc B	14
Enc /B	2
Enc X	15
Enc /X	3
+5V	17, 22
Sgnd	5, 10
F.G.	12

Sgnd = Signal Ground  
F.G. = Frame Gnd

### SIGNAL LOSS DETECTION LOGIC

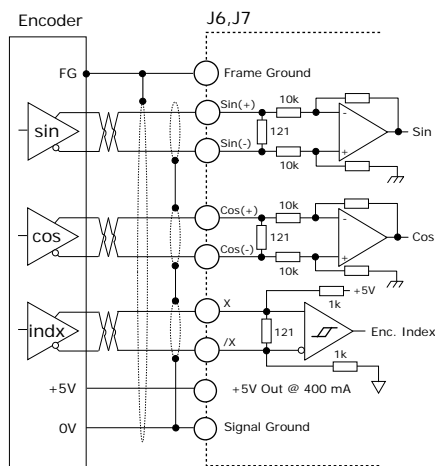


### CME2 FEEDBACK OPTIONS



## ANALOG SIN/COS INCREMENTAL ENCODER

The sin/cos/index inputs are differential with 121  $\Omega$  terminating resistors and accept 1 Vp-p signals in the format used by incremental encoders with analog outputs, or with ServoTube motors.



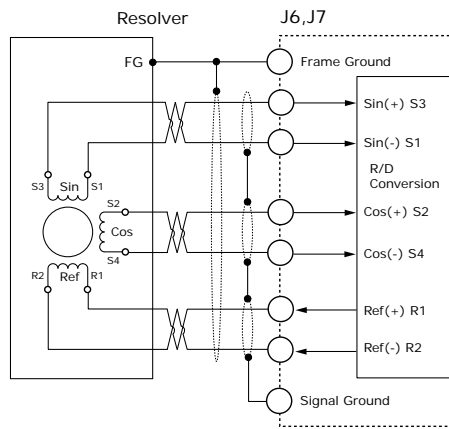
### SIN/COS SIGNALS

Signal	J6, J7 Pin
Sin(+)	20
Sin(-)	8
Cos(+)	21
Cos(-)	9
X	15
/X	3
+5V	17, 22
Sgnd	5, 10
F.G.	12

F.G. = Frame Gnd

## RESOLVER (-R MODELS)

Connections to the resolver should be made with shielded cable that uses three twisted-pairs. Once connected, resolver set up, motor phasing, and other commissioning adjustments are made with CME 2 software. There are no hardware adjustments.



### RESOLVER SIGNALS

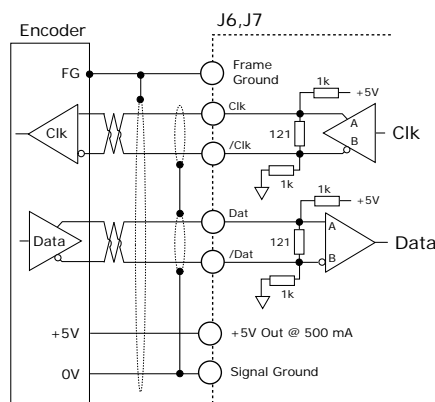
Signal	J6, J7 Pin
Sin(+)	20
Sin(-)	8
Cos(+)	21
Cos(-)	9
Ref(+)	15
Ref(-)	3
F.G.	12

F.G. = Frame Gnd

## MOTOR CONNECTIONS (CONT'D)

### 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 XEL 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 SIGNALS

SSI	BiSS	J6, J7 Pin
Clk	MA+	15
/Clk	MA-	3
Data	SL+	16
/Data	SL-	4
+5V		17, 22
Sgnd		5, 10
Frame Gnd		12

### 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

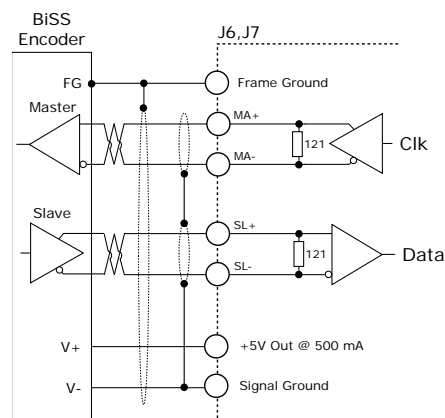
Safety capable: CRC, Errors, Warnings

Bus capability incl. actuators

Bidirectional

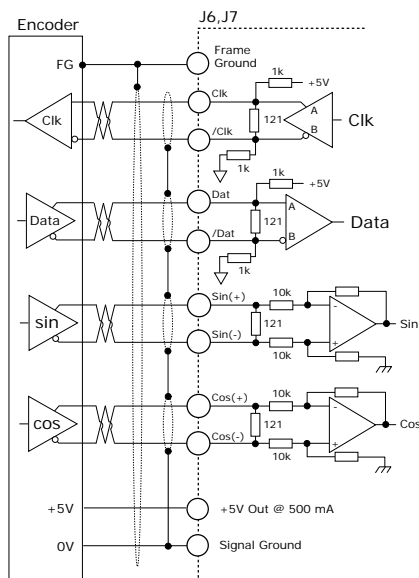
BiSS B-protocol: Mode choice at each cycle start

BiSS C-protocol: Continuous mode



### 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.



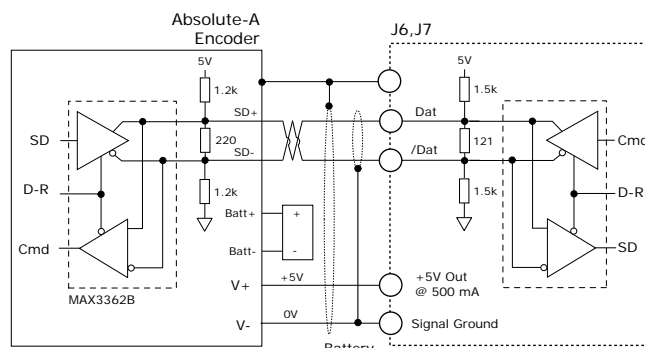
#### ENDAT SIGNALS

Signal	J6, J7 Pin
Clk	15
/Clk	3
Data	16
/Data	4
Sin(+)	20
Sin(-)	8
Cos(+)	21
Cos(-)	9
+5V	17, 22
Sgnd	5, 10
F.G.	12

F.G. = Frame Gnd

### ABSOLUTE-A ENCODER

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



#### ABSOLUTE-A SIGNALS

Signal	J6, J7 Pin
Data	16
/Data	4
+5V	17, 22
Sgnd	5, 10
F.G.	12

F.G. = Frame Gnd



## MOTOR CONNECTIONS (CONT'D)

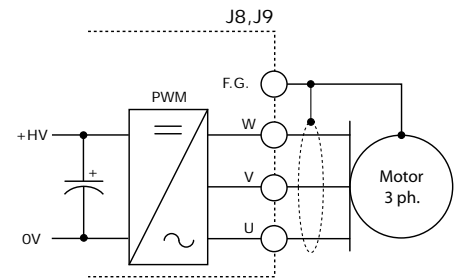
### MOTOR PHASE CONNECTIONS

The drive outputs are three-phase PWM inverters that convert the DC buss voltage (+HV) into three sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the motor. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. The motor cable shield should connect to motor frame and the drive frame ground terminal (J8,J9-1) for best results.

#### MOTOR SIGNALS

Signal	J8,J9 Pin
Mot U	4
Mot V	3
Mot W	2
Frame Gnd	1

F.G. = Frame Gnd



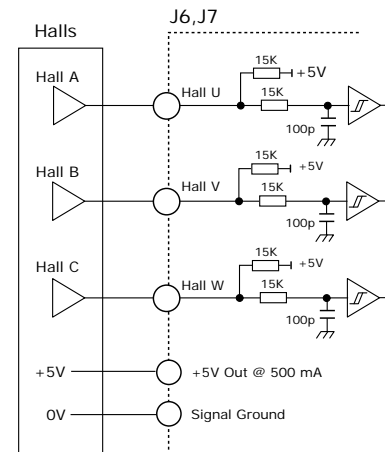
### DIGITAL HALL SIGNALS

Hall signals are single-ended signals that provide absolute feedback within one electrical cycle of the motor. There are three of them (U, V, & W) and they may be sourced by magnetic sensors in the motor, or by encoders that have Hall tracks as part of the encoder disc. They typically operate at much lower frequencies than the motor encoder signals, and are used for commutation-initialization after startup, and for checking the motor phasing after the amplifier has switched to sinusoidal commutation.

#### HALL SIGNALS

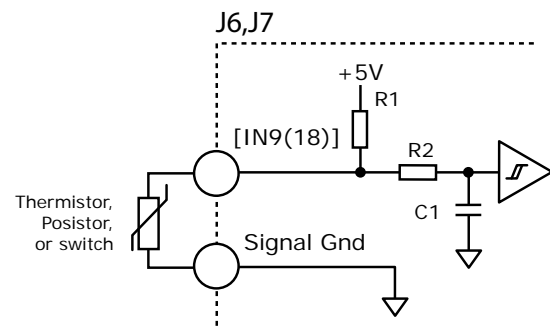
Signal	J6,J7 Pin
Hall U	18
Hall V	6
Hall W	19
+5V	17,22
Sgnd	5,10
Frame Gnd	12

F.G. = Frame Gnd



### MOTOR OVER TEMP INPUT

The 4.99k 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	J6-7
Motemp B	J7-7
J6,J7 Sgnd	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

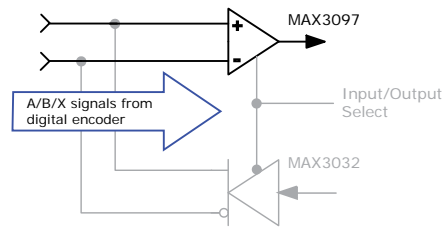
## MOTOR CONNECTIONS (CONT'D)

### MULTI-MODE ENCODER PORT

The multi-mode port can operate as primary or secondary feedback from digital quad A/B/X or absolute encoders.

#### FEEDBACK FROM DIGITAL QUADRATURE ENCODER

When operating in position mode the multi-mode port can accept digital command signals from external encoders. These can be used to drive cam tables, or as master-encoder signals when operating in a master/slave configuration.

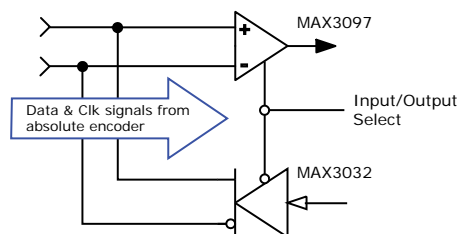


#### QUAD A/B/X SIGNALS

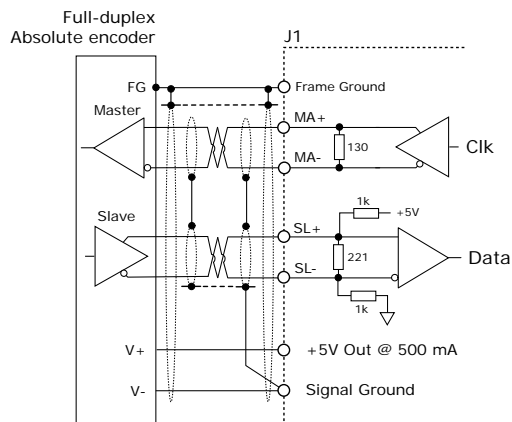
Signal J1	Axis A	Axis B
Enc A	26	31
Enc /A	8	13
Enc B	27	32
Enc /B	9	14
Enc X	28	33
Enc /X	10	15
+5V Output	25	30
Sgnd	7,12,20	
Frame Gnd	17	

#### FEEDBACK FROM ABSOLUTE ENCODERS

Digital absolute encoder feedback as motor or load encoder can come from absolute encoders, too. Analog sin/cos signals are not supported by the multi-port. The graphic to the right shows half-duplex format but both full and half-duplex operation are supported by the multi-port (see below)



#### ABSOLUTE ENCODER, FULL-DUPLEX MODE



#### FULL-DUPLEX ENCODERS

SSI  
BiSS  
EnDat

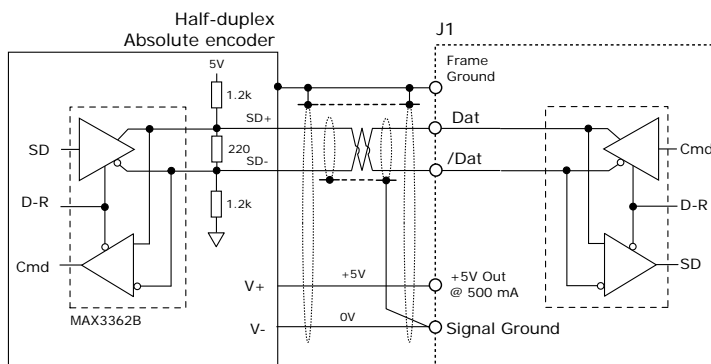
#### HALF-DUPLEX ENCODERS

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

#### FULL-DUPLEX SIGNALS

Signal J1	Axis A	Axis B
Clk	28	33
/Clk	10	15
Dat	29	34
/Dat	11	16
+5V Output	25	30
Sgnd	7,12,20	
Frame Gnd	17	

#### ABSOLUTE ENCODER, HALF-DUPLEX MODE



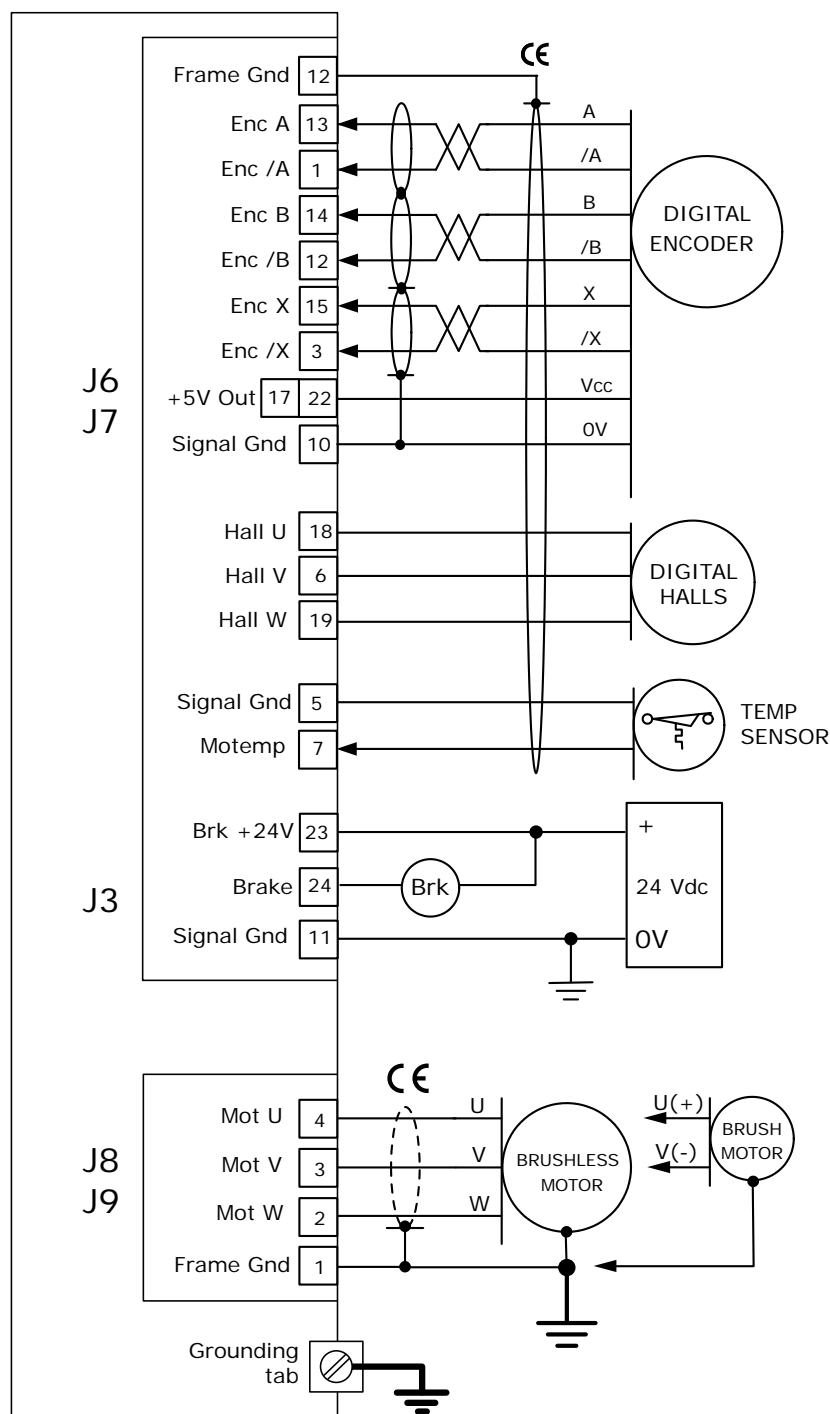
#### HALF-DUPLEX SIGNALS

Signal J1	Axis A	Axis B
Dat	29	34
/Dat	11	16
+5V Output	25	30
Sgnd	7,12,20	
Frame Gnd	17	

## MOTOR CONNECTIONS FOR INCREMENTAL DIGITAL ENCODERS

The connections shown may not be used in all installations

### Accelnet Plus Panel 2-Axis



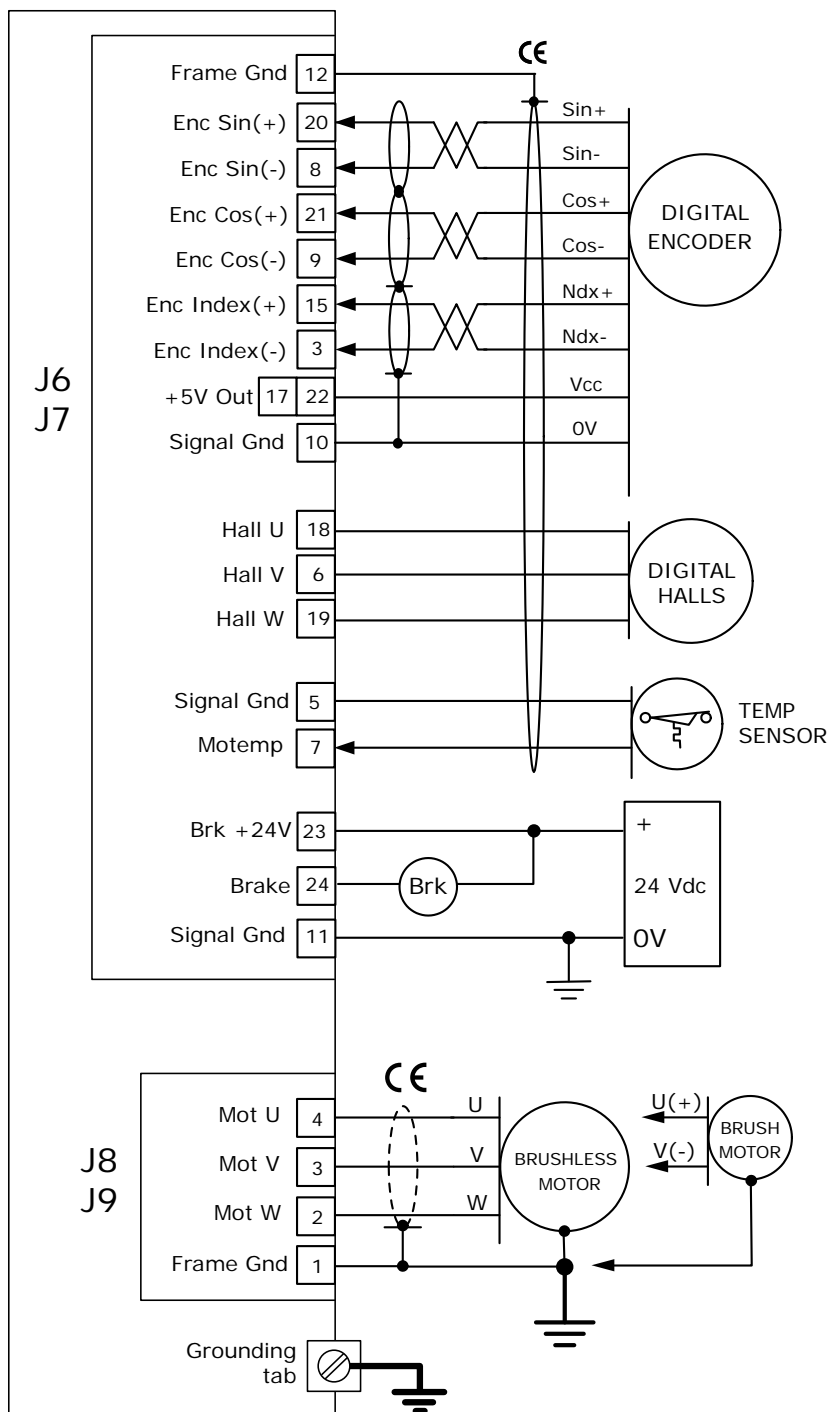
#### NOTES:

- 1) +5V Out on J6 & J7 are independent power supplies and each is rated for 400 mA
- 2) CE symbols indicate connections required for CE compliance.

## MOTOR CONNECTIONS FOR INCREMENTAL ANALOG (SIN/COS) ENCODERS

The connections shown may not be used in all installations

### Accelnet Plus Panel 2-Axis



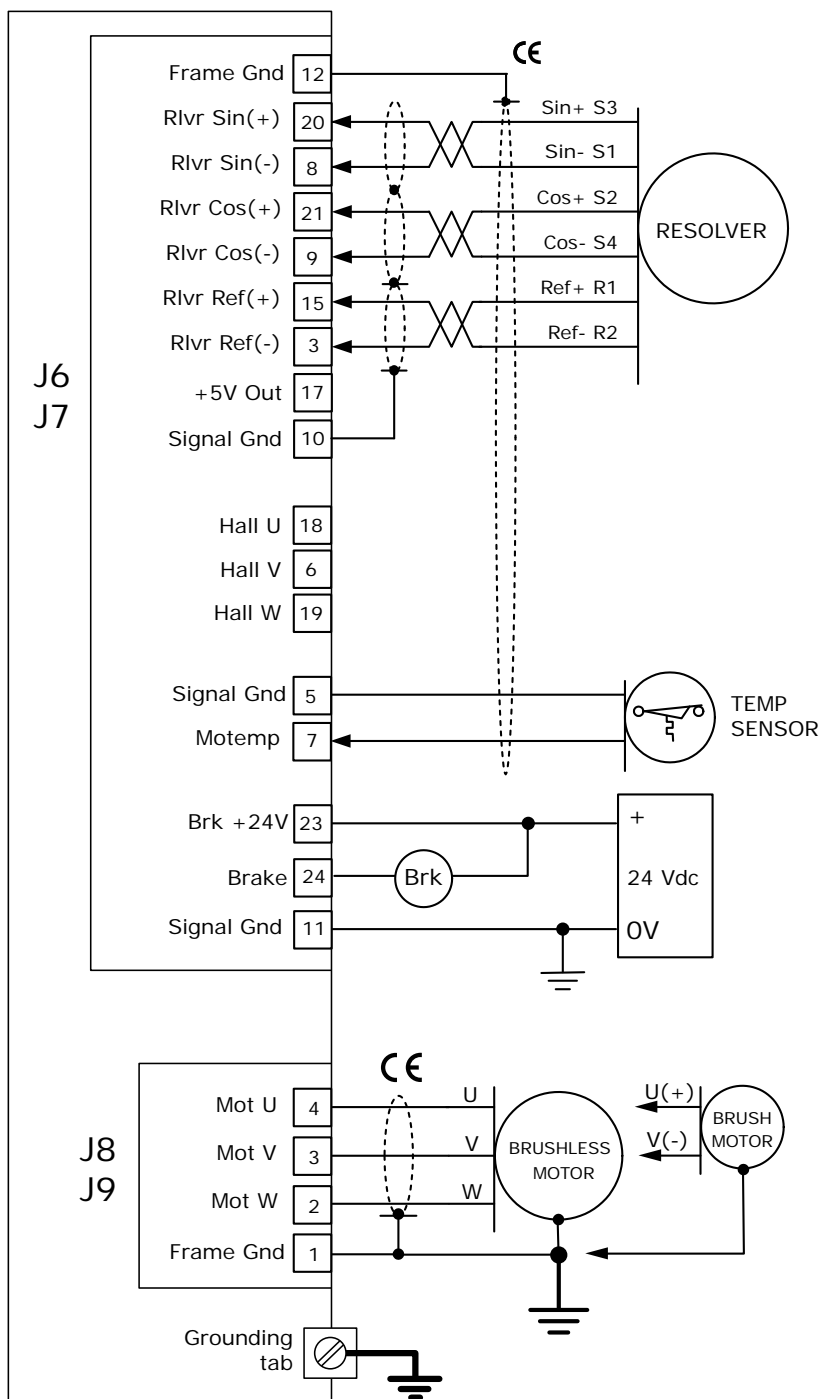
#### NOTES:

- 1) +5V Out on J6 & J7 are independent power supplies and each is rated for 400 mA
- 2) CE symbols indicate connections required for CE compliance.

## MOTOR CONNECTIONS FOR RESOLVERS

The connections shown may not be used in all installations.

### Accelnet Plus Panel 2-Axis



#### NOTES:

- 1) +5V Out on J6 & J7 are independent power supplies and each is rated for 400 mA
- 2) CE symbols indicate connections required for CE compliance.

## CONNECTORS & SIGNALS

### J2: I/O

Signal	Pin		Signal
ISO Input [IN5]	11	1	ISO Input [IN6]
ISO Input [IN7]	12	2	ISO Input [IN8]
ISO Input [IN14]	13	3	ISO Input [IN15]
ISO Input [IN16]	14	4	ISO Input [IN17]
ISO Output [OUT1+]	15	5	ISO Output [OUT1-]
ISO Output [OUT2+]	16	6	ISO Output [OUT2-]
ISO Output [OUT3+]	17	7	ISO Output [OUT3-]
ISO Output [OUT4+]	18	8	ISO Output [OUT4-]
ISO Output [OUT5+]	19	9	ISO Output [OUT5-]
ISO COMM [ICOM]	20	10	Frame Ground

#### J2 I/O Connector:

20-position shrouded cable header, keyed polarization  
Samtec IPL1-110-01-L-D-RA-K

#### J2 Cable Connector:

Samtec IPD1-10-D-K  
Contacts: CC79L-2024-L (AWG 20~24)

### J1: CONTROL

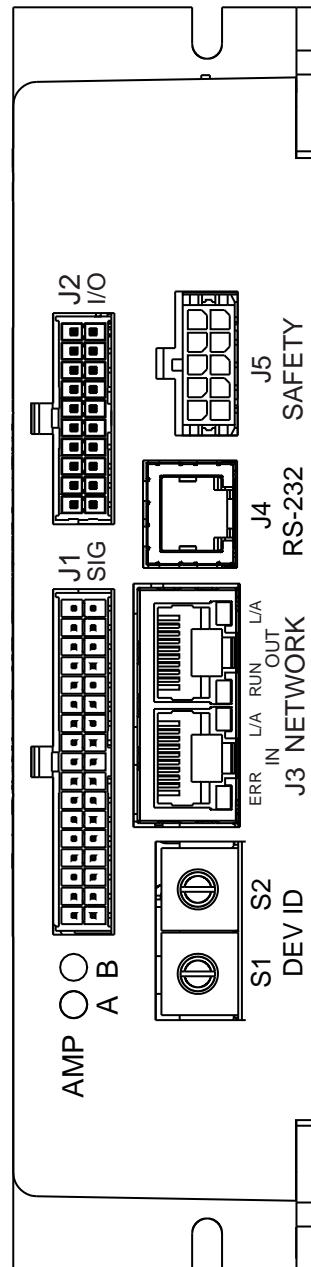
Signal	Pin		Signal
Axis A Analog Ref(+)	18	1	Axis A Analog Ref(-)
Axis B Analog Ref(+)	19	2	Axis B Analog Ref(-)
Signal Ground	20	3	GP Input [IN2]
GP Enable Input [IN1]	21	4	GP Input [IN11]
GP Input [IN10]	22	5	HS Input [IN4]
HS Input [IN3]	23	6	HS Input [IN13]
HS Input [IN12]	24	7	Signal Ground
Axis A +5 Vdc Output	25	8	Axis A Multi-Mode Enc /A
Axis A Multi-Mode Enc A	26	9	Axis A Multi-Mode Enc /B
Axis A Multi-Mode Enc B	27	10	Axis A Multi-Mode Enc /X
Axis A Multi-Mode Enc X	28	11	Axis A Multi-Mode Enc /S
Axis A Multi-Mode Enc S	29	12	Signal Ground
Axis B +5 Vdc Output	30	13	Axis B Multi-Mode Enc /A
Axis B Multi-Mode Enc A	31	14	Axis B Multi-Mode Enc /B
Axis B Multi-Mode Enc B	32	15	Axis B Multi-Mode Enc /X
Axis B Multi-Mode Enc X	33	16	Axis B Multi-Mode Enc /S
Axis B Multi-Mode Enc S	34	17	Frame Ground

#### J1 Control Connector:

34-position shrouded cable header, keyed polarization  
Samtec: IPL1-117-01-L-D-RA-K

#### J1 Cable Connector:

34-position connector housing, keyed polarization  
Samtec IPD1-17-D-K  
Contacts: CC79L-2024-L (AWG 20~24)



#### J5 Safety Connector:

14-position shrouded cable header, keyed polarization  
Samtec IPL1-107-01-L-D-RA-K

#### J5 Cable Connector:

Samtec IPD1-07-D-K  
Contacts: CC79L-2024-L (AWG 20~24)

### J5: SAFETY (STO)

Signal	Pin		Signal
STO_IN2+	8	1	STO_IN2-
n.c.	9	2	n.c.
STO_IN1+	10	3	STO_IN1-
n.c.	11	4	n.c.
n.c.	12	5	n.c.
STO_BYP	13	6	Sgnd
	14	7	Sgnd

### J4: SERIAL

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

#### J4 RS-232 Connector:

RJ-11 modular receptacle  
6-position, 4 used

### J3: ETHERCAT

Pin	Signal
8	TX1 Term
7	TX1 Term
6	RX1-
5	RX1 Term
4	RX1 Term
3	RX1+
2	TX1-
1	TX1+

#### J3 EtherCAT Connector:

RJ-45 dual receptacle

#### Samtec Connector Tools:

Crimping tool: CAT-HT-179-2024-11  
Contact Extractor: CAT-EX-179-01  
Contact lance reset tool: CAT-RE-169-01

#### Notes on Tools:

Connector tools are available from manufacturers and are not sold by Copley Controls.

## CONNECTORS & SIGNALS

### J7: AXIS B FEEDBACK

Signal	Pin	Signal
Axis B Enc A	13	1 Axis B Enc /A
Axis B Enc B	14	2 Axis B Enc /B
Axis B Enc X	15	3 Axis B Enc /X
Axis B Enc S	16	4 Axis B Enc /S
Axis B +5 Vdc Output	17	5 Signal Ground
Axis B Hall U	18	6 Axis B Hall V
Axis B Hall W	19	7 Axis B Motemp [IN18]
Axis B Sin(+)	20	8 Axis B Sin(-)
Axis B Cos(+)	21	9 Axis B Cos(-)
Axis B +5 Vdc Output	22	10 Signal Ground
Axis B Brake +24V	23	11 Signal Ground
Axis B Brake [OUT7]	24	12 Frame Ground

### J6: AXIS A FEEDBACK

Signal	Pin	Signal
Axis A Enc A	13	1 Axis A Enc /A
Axis A Enc B	14	2 Axis A Enc /B
Axis A Enc X	15	3 Axis A Enc /X
Axis A Enc S	16	4 Axis A Enc /S
Axis A +5 Vdc Output	17	5 Signal Ground
Axis A Hall U	18	6 Axis A Hall V
Axis A Hall W	19	7 Axis A Motemp [IN9]
Axis A Sin(+)	20	8 Axis A Sin(-)
Axis A Cos(+)	21	9 Axis A Cos(-)
Axis A +5 Vdc Output	22	10 Signal Ground
Axis A Brake +24V	23	11 Signal Ground
Axis A Brake [OUT6]	24	12 Frame Ground

#### J6,J7 Feedback Connectors:

24-position shrouded cable headers, keyed polarization  
Samtec IPL1-112-01-L-D-RA-K

#### J6,J7 Cable Connectors:

24-position connector housing, keyed polarization  
Samtec IPD1-12-D-K  
Contacts: CC79L-2024-L (AWG 20~24)

#### Samtec Connector Tools:

Crimping tool: CAT-HT-179-2024-11  
Contact Extractor: CAT-EX-179-01  
Contact lance reset tool: CAT-RE-169-01

#### Notes on Tools:

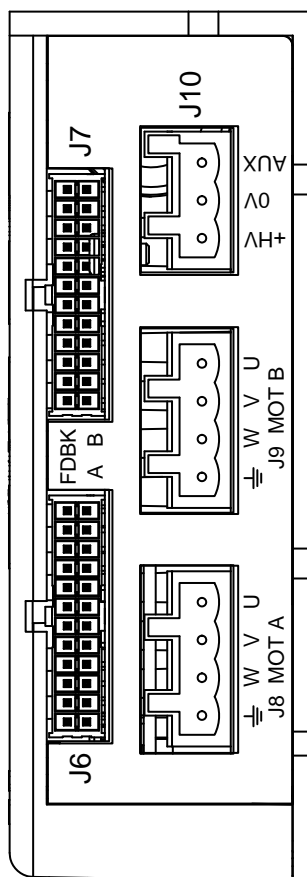
Connector tools are available from manufacturers and are not sold by Copley Controls.

#### J10: Power Connector:

Euro-style 5,0 mm receptacle, 3-position  
Wago: 721-463/001-040  
Insert/extract lever: Wago: 231-131

#### J10 Cable Connector:

Wago 721-103/026-047/RN01-0000  
Insert/extract lever: Wago: 231-131



### J10: HV & AUX POWER

Pin	Signal
3	Aux HV
2	HV Com (Gnd)
1	+HV

### J9: AXIS B MOTOR

Pin	Signal
4	Axis B Mot U
3	Axis B Mot V
2	Axis B Mot W
1	Frame Ground

### J8: AXIS A MOTOR

Pin	Signal
4	Axis A Mot U
3	Axis A Mot V
2	Axis A Mot W
1	Frame Ground

#### J8,J9: Motor Connectors:

Euro-style 5,0 mm receptacles, 4-position  
Wago: 721-464/001-000

#### J8,J9 Cable Connectors:

Wago 721-104/026-047/RN01-0000  
Insert/extract lever: Wago: 231-131

#### Wago Connector Tool:

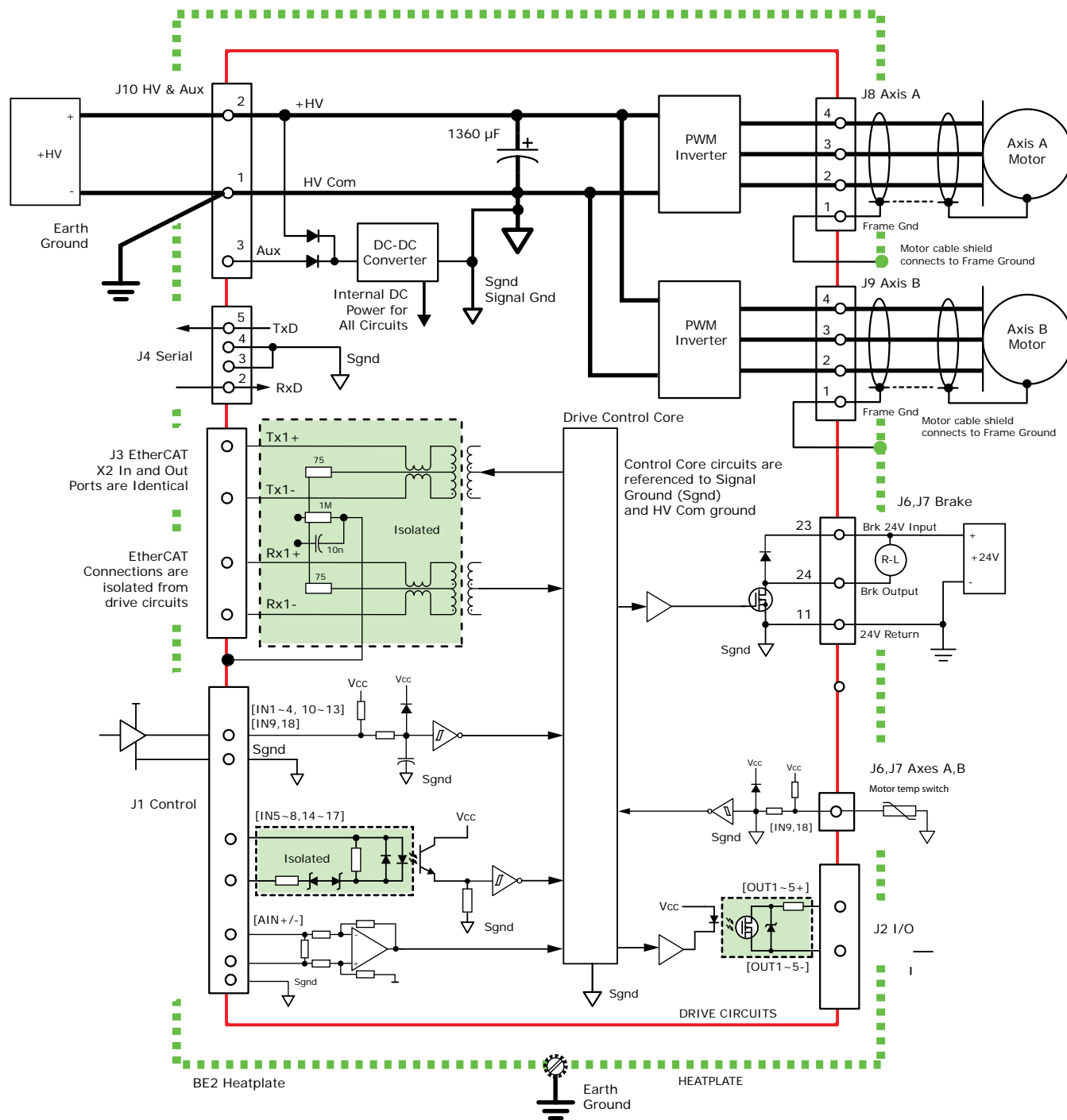
Contact opener: 231-131  
(included in BE2-CK)



## DEVICE STRUCTURE

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.

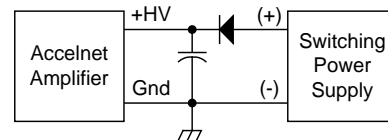
Note that there is no connection between the heatplate (Chassis, Frame Ground) and any drive circuits.



## POWER SUPPLIES

Accelnet BE2 operates typically from transformer-isolated, unregulated DC power supplies. These should be sized such that the maximum output voltage under high-line and no-load conditions does not exceed the drives maximum voltage rating. Power supply rating depends on the power delivered to the load by the drive. In many cases, the continuous power output of the drive is considerably higher than the actual power required by an incremental motion application.

Operation from regulated switching power supplies is possible if a diode is placed between the power supply and drive to prevent regenerative energy from reaching the output of the supply. If this is done, there must be external capacitance between the diode and drive.



## AUXILIARY HV POWER

Accelnet BE2 has an input for AUX-HV. This is a voltage that can keep the drive communications and feedback circuits active when the PWM output stage has been disabled by removing the main +HV supply. This can occur during EMO (Emergency Off) conditions where the +HV supply must be removed from the drive and powered-down to ensure operator safety. The AUX-HV input operates from any DC voltage that is within the operating voltage range of the drive and powers the DC/DC converter that supplies operating voltages to the drive DSP and control circuits.

When the drive +HV voltage is greater than the AUX-HV voltage it will power the DC/DC converter. Under these conditions the AUX-HV input will draw no current.

## GROUNDING CONSIDERATIONS

Power and control circuits in Accelnet BE2 share a common circuit-ground (HV\_COM on J10-2, and Signal Ground on J1-7,12,20 and J6-7-5,10,11,12,23). Circuits that are referenced to Signal Ground are the analog Reference input, non-isolated digital inputs, buffered encoder outputs, motor encoder and Hall signals, PWM outputs and the RS-232 port. For this reason, drive Signal Gnd terminals should connect to the users' control ground system so that signals between drive and controller are at the same common potential, and to minimize noise. The system ground should, in turn, connect to an earthing conductor at some point so that the whole system is referenced to "earth". The EtherCAT ports are transformer-isolated from the drive circuits.

Because current flow through conductors produces voltage-drops across them, it is best to connect the drive HV Return to system earth, or circuit-common through the shortest path, and to leave the power-supply floating. In this way, the power supply (-) terminal connects to ground at the drive HV Return terminals, but the voltage drops across the cables will not appear at the drive ground, but at the power supply negative terminal where they will have less effect.

Motor phase currents are balanced, but currents can flow between the PWM outputs, and the motor cable shield. To minimize the effects of these currents on nearby circuits, the cable shields should connect to Frame Gnd (J8-9-1).

The drive heatplate (Frame Gnd) does not connect to any drive circuits. Connections to the heatplate are provided on connectors J1-17, J2-10, and J7-8-12. Cables to these connectors must be shielded for CE compliance, and the shields should connect to these terminals. When installed, the drive heatplate should connect to the system chassis. This provides a path to ground for noise currents that may occur in the cable shields.

Signals from controller to drive are referenced to +5 Vdc, and other power supplies in user equipment. These power supplies should also connect to system ground and earth at some point so that they are at same potential as the drive circuits.

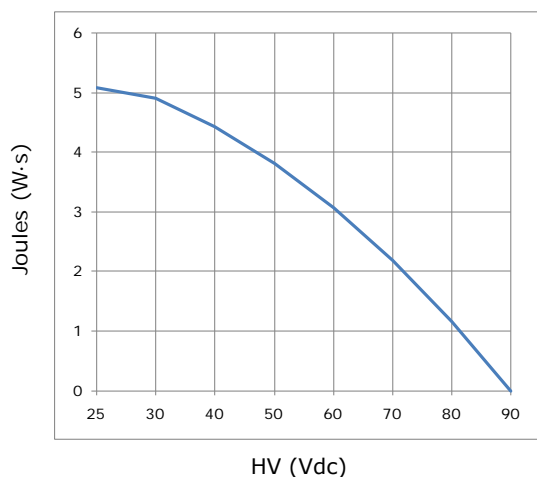
The final configuration should embody three current-carrying loops. First, the power supply currents flowing into and out of the drive at the +HV and HV\_COM pins on J10. Second the drive outputs driving currents into and out of the motor phases on J8~9, and motor shield currents circulating between the U, V, and W outputs and Gnd. And, lastly, logic and signal currents connected to the drive control inputs and outputs.

For CE compliance and operator safety, the drive heatplate should be earthed by using external tooth lock washers under the mounting screws. These will make contact with the aluminum chassis through the anodized finish to connect the chassis to the equipment frame ground.

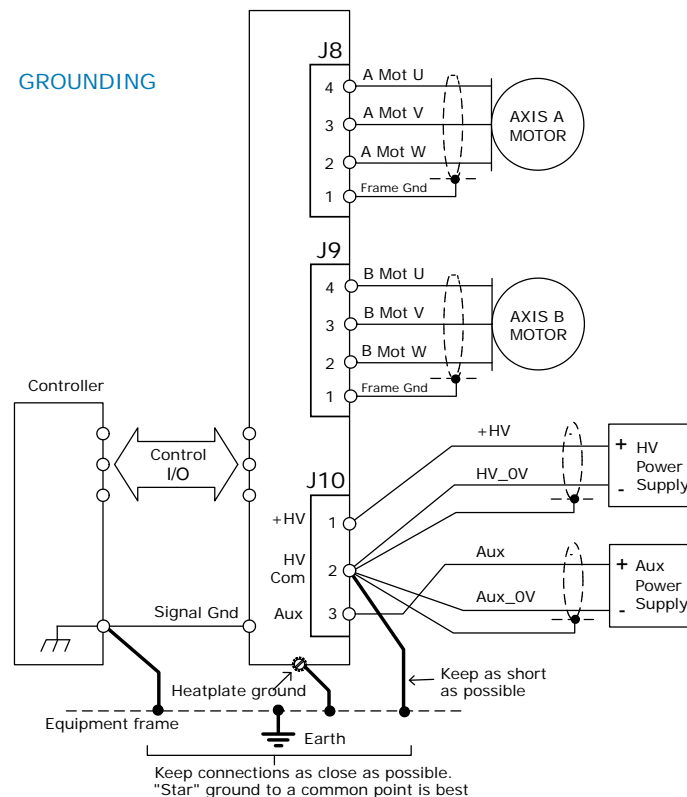
## REGENERATION

The chart Below shows the energy absorption in W·s for a BE2 drive operating at some typical DC voltages. When the load mechanical energy is greater than these values an external regenerative energy dissipater is required. The internal capacitor bank is 1360 uF and the energy absorption is shared with both axes.

ENERGY ABSORPTION



## GROUNDING



## POWER DISSIPATION

The top chart on this page shows the internal power dissipation for one axis of the BE2 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.

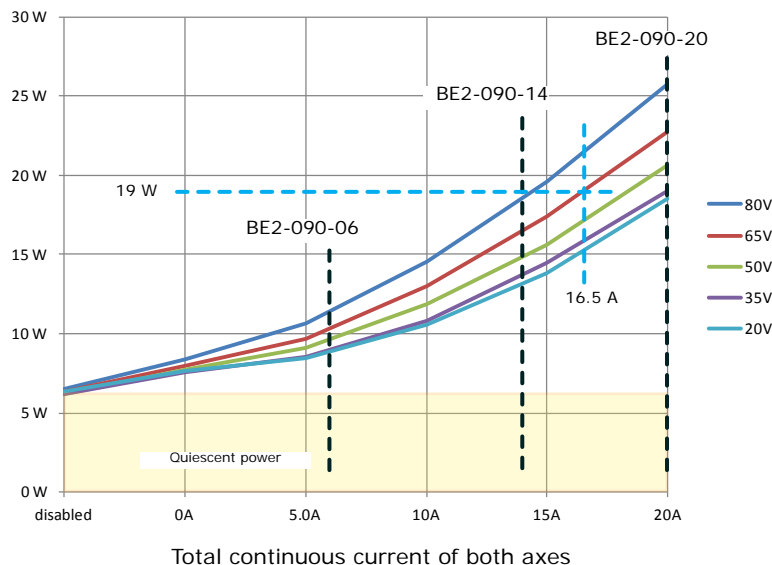
Example:

Power supply HV = 65 Vdc

Axis 1 current = 7.5 A, axis 2 = 9.0 A

Total current = 16.5 A

Total dissipation = 19 Watts



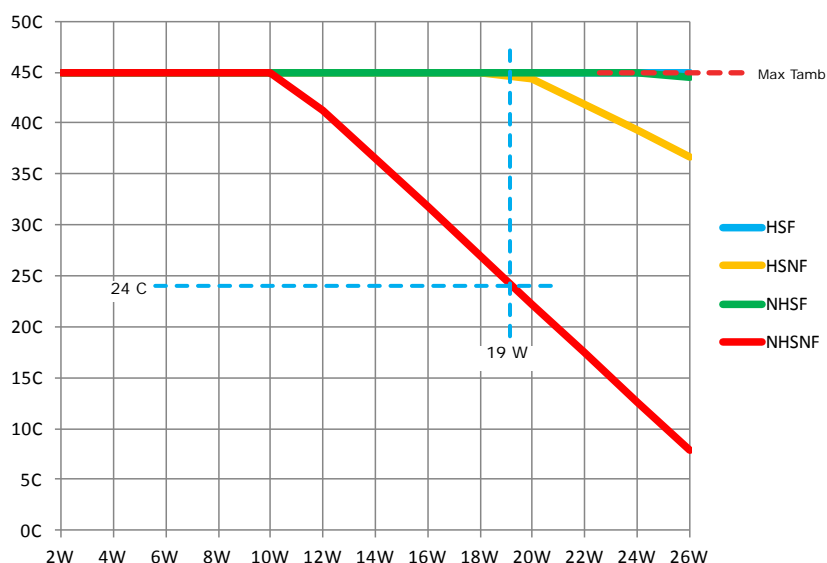
### MAXIMUM OPERATING TEMPERATURE RISE VS. TOTAL DISSIPATION

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

Example:

Using the 19 W value from the calculations above, draw a vertical line. This shows that 24 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.

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



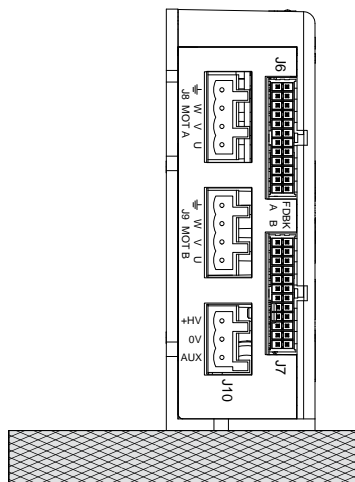
## MOUNTING

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.

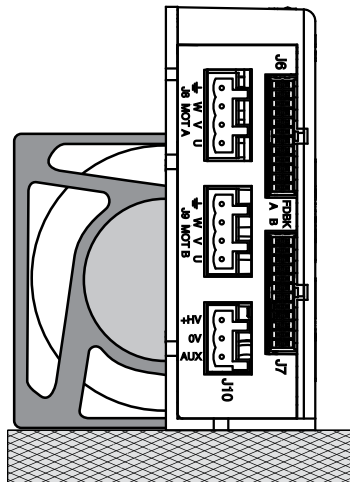
## THERMAL RESISTANCE

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.

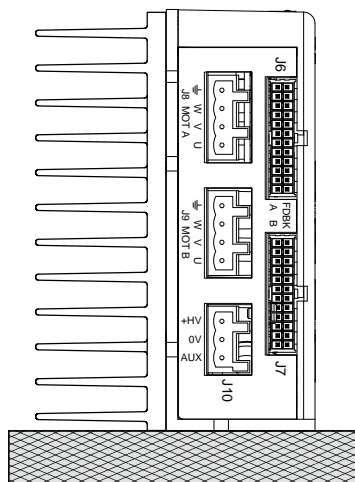


END VIEWS  
VERTICAL MOUNTING

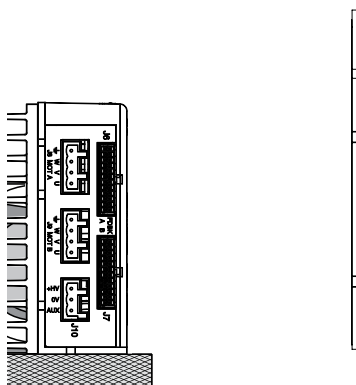


NO HEATSINK, NO FAN	°C/W
CONVECTION	2.32

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



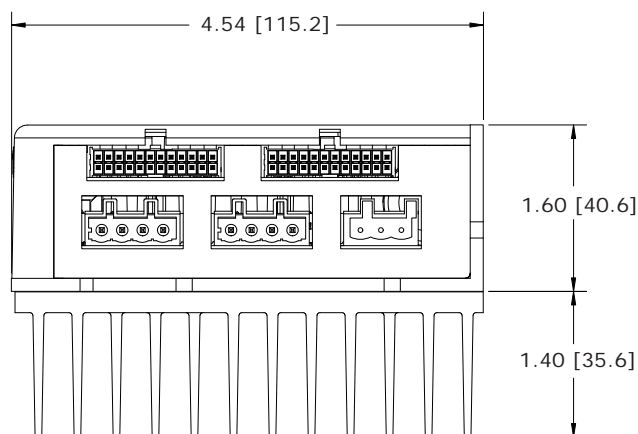
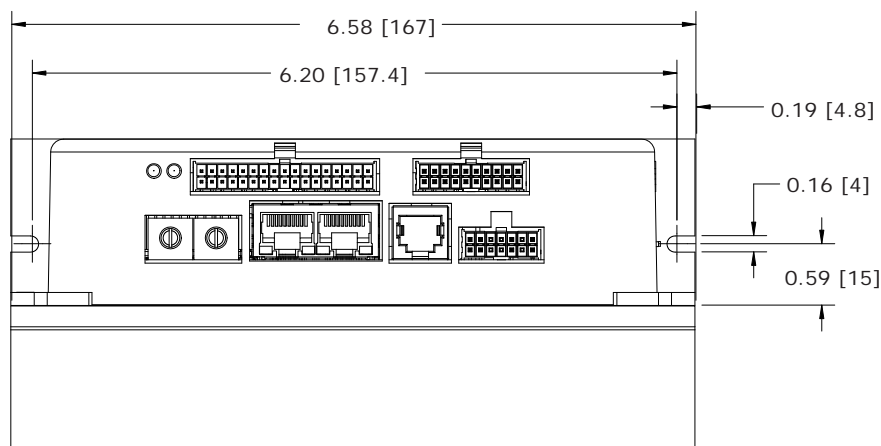
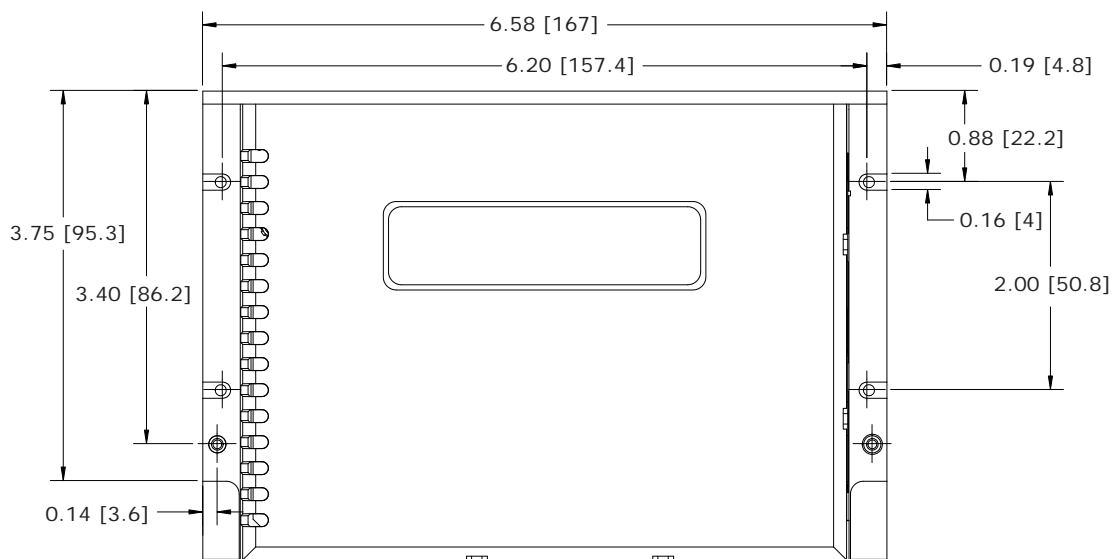
HEATSINK, NO FAN	°C/W
CONVECTION	1.28



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

## DIMENSIONS

Units: in [mm]



## MASTER ORDERING GUIDE

BE2-090-06	Accelnet Plus 2-Axis Panel EtherCAT servo drive, 3/6 A, 90 Vdc
BE2-090-14	Accelnet Plus 2-Axis Panel EtherCAT servo drive, 7/14 A, 90 Vdc
BE2-090-20	Accelnet Plus 2-Axis Panel EtherCAT servo drive, 10/20 A, 90 Vdc



Add -R to model number for resolver feedback option (Example: BE2-090-14-R)

Add -H to model number for factory-installed heatsink

Example: Order one Accelnet Plus BE2 drive, 7/14 A, resolver version, with connector kit, serial cable kit, heatsink fitted at the factory:

Qty	Item	Remarks
1	BE2-090-14-R-H	Accelnet Plus BE2 2-axis servo drive with resolver, safety option, and factory-mounted heatsink
1	BE2-CK	BE2 Connector Kit
1	SER-CK	Serial Cable Kit

## ACCESSORIES

	QTY	REF	DESCRIPTION	MANUFACTURERS PART NUMBER
BE2-CK Connector Kit	1	J1	Connector housing, 34 position, keyed polarization	Samtec: IPD1-17-D-K
	1	J2	Connector housing, 20 position, keyed polarization	Samtec: IPD1-10-D-K
	4	J5	Connector housing, 14 position	Samtec: IPD1-07-D-K
	2	J6,J7	Connector housing, 24 position, keyed polarization	Samtec: IPD1-12-D-K
	2	J8,J9	Plug, 4 position, 5.0 mm, female	Wago: 721-104/026-047/RN01-0000
	1	J10	Plug, 3 position, 5.0 mm, female	Wago: 721-103/026-047/RN01-0000
	110	->	Contacts for J1, J2, J5, J6, J7	Samtec: CC79L-2024-L
	1	->	Tool, wire insertion & extraction for J8, J9, J10	Wago: 231-131
CME 2			CME 2 Drive Configuration Software (CD-ROM)	
SER-CK		J4	RS-232 Cable Kit: Includes Dsub9 adapter and modular cable	
BE2-NC-10	1	J3	EtherCAT® network cable, 10 ft (3 m)	
BE2-NC-01	1		EtherCAT® network cable, 1 ft (0.3 m)	

### Heatsink Kits for Field Installation (Optional)

BE2-HK Heatsink Kit	1	BE2 Heatsink
	1	Heatsink thermal material
	4	Heatsink hardware

Note: The heatsink can be fitted at the factory by adding an "-H" to the drive part number.

The BE2-HK is for field installation by the user. The kit contains the heatsink, mounting hardware, and thermal interface material.

## ACCESSORIES (NOT SOLD BY COPLEY)

Hand crimping tool	J1,J2, J5,J6, J7	Samtec: CAT-HT-179-2024-11 (for CC79L-2024 contacts)
Contact extraction tool		Samtec: CAT-EX-179-01
Contact lance reset tool		Samtec: CAT-RE-169-01

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Note: Specifications subject to change without notice

Rev 12.03-we 04/15/2015