DIGITAL SERVO DRIVE
FOR BRUSHLESS/BRUSH MOTORS

EtherCAT Conformance tested

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
- ±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

- 7 Non-isolated, 4 isolated inputs,
- 3 Isolated, 1 non-isolated output

ANALOG

- 1, 12-bit input

SAFE TORQUE OFF (STO)

- SIL 3, Category 4, PL e

DIMENSIONS: IN [MM]

- 4.89 x 3.15 x 1.57 [124.1 x 80.1 x 40]

Model	Ip	Ic	Vdc
BEL-090-06	6	3	90
BEL-090-14	14	7	90
BEL-090-30	30	15	90

Add -R for resolver feedback option

DESCRIPTION

The BEL 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 BEL via RS-232.

The BEL 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.

There are seven non-isolated inputs. Four 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] defaults to the drive Enable function and is programmable to other functions. The other inputs are programmable. All inputs have programmable active levels. Three opto-isolated outputs [OUT1~3] have individual collector/emitter connections. A MOSFET output [OUT4] is programmable to drive motor brakes or other functions and has a flyback diode to the 24V input 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	BEL-090-06	BEL-090-14	BEL-090-30	
OUTPUT POWER				
Peak Current	6 (4.24)	14 (9.9)	30 (21.2)	Adc (Arms-sine), ±5%
Peak time	1			Sec
Continuous current (Note 1)	3 (2.1)	7 (5)	15 (10.6)	Adc (Arms-sine) per phase
INPUT POWER				
HVmin~HVmax	+14 to +90	+14 to +90	+14 to +90	Vdc Transformer-isolated
Ipeak	6	14	30	Adc (1 sec) peak
Icont	3	7	15	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 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		
CAN Application Layer over EtherCAT (CoE)	Cyclic Synchronous Position-Velocity-Torque, Profile Position-Velocity-Torque, Interpolated Position, Homing	
Stand-alone mode		
Analog torque, velocity, position reference	±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% ±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	11
[IN1,2]	Digital, non-isolated, Schmitt trigger, 1 µs 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
[IN3,4,5,6]	Digital, non-isolated, programmable as single-ended or differential pairs, 100 ns RC filter, 12 Vdc max, 10 kΩ 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,
[IN7,8,9,10]	Digital, opto-isolated, single-ended, ±15~30 Vdc compatible, bi-polar, with common return Rated impulse ≥ 800 V, Vin-LO ≤ 6.0 Vdc, Vin-HI ≥ 10.0 Vdc, Input current ±3.6 mA @ ±24 Vdc, typical
[IN11]	Defaults as motor overtemp input 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] defaults to the Enable function and is programmable for other functions.

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 4, Performance level e
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

ANALOG INPUTS	
Number	1
[AIN1]	Differential, ±10 Vdc, 5 kΩ input impedance, 12-bit resolution

DIGITAL OUTPUTS	
Number	4
[OUT1~3]	Opto-isolated Darlingtons, 20 mA max, 24 V tolerant, Rated impulse ≥ 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 µs max @ 20 mA, Td-OFF = 500 µs max @ 20 mA, times include rise/fall times
[OUT4]	Defaults as motor brake control: MOSFET, current-sinking, 1 Adc max, internal flyback diode connects to Brake 24V, 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, CAN Application Layer over EtherCAT (CoE)

NOTES:

1) Heatsink or forced-air is 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 Ω 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 Ω terminating resistor between complementary inputs
Analog Index signal	Differential, 121 Ω 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 BEL, 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 BEL, data returned from encoder

DIGITAL HALLS

Number	3
Type	Digital, single-ended, 120° electrical phase difference between U-V-W signals, Schmitt trigger, 1 µs RC filter, 24 Vdc compatible, 15k pull-up to +5 Vdc, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc

MULTI-MODE ENCODER PORT

As Input	Digital quadrature encoder (A, /A, B, /B, X, /X), 121 Ω 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 Ω 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. A, /A, B, /B, X, /X, from ISL32179 differential line driver
As Buffered Output	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 ±1% differential impedance, 2.0 Vrms, BW ≥ 300 kHz

DC POWER OUTPUT

Number	1
Ratings	+5 Vdc, 500 mA max, thermal and short-circuit protected
Connections	Feedback pins 17,22, Control pin 27, combined current from these pins cannot exceed 500 mA

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, fault-detecting, 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 OUTPUT section)
Brake	[OUT4] Defaults to brake function, programmable for other functions.

INDICATORS

AMP	Bicolor LED, drive status indicated by color, and blinking or non-blinking condition
L/A, RUN, ERR	Yellow & green LED on A & B ports, status of EtherCAT bus indicated by color and blink codes based on EtherCAT Indicator Specification V0.91 Green LED: ON = Good Link, Blinking = Activity, OFF = No Link Yellow LED: ON for Full-Duplex, OFF for Half-Duplex

SPECIFICATIONS (CONT'D)

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 input programmable to detect motor temperature switch	
Feedback Loss	Inadequate analog encoder or resolver signal amplitude or missing incremental encoder signals	

MECHANICAL & ENVIRONMENTAL

Size	4.89 x 3.15 x 1.57 [124.1 x 80.1 x 40]
Weight	0.68 lb [0.31 kg], add 0.66 lb [0.30 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 61800-1
Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
UL File Number E249894

TUV Functional Safety to IEC 61508

Functional Safety

IEC 61800-5-2, IEC 61508-1, IEC 61508-2, EN(ISO) 13849-1, EN(ISO) 13849-2

Electrical Safety

In accordance with EC Directive 2006/95/EC (Low Voltage Directive)

IEC/UL/CSA, IEC 61800-5-1:2007 Adjustable speed electrical power drive systems
Parr 5-1: Safety requirements - Electrical, thermal, and energy

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.

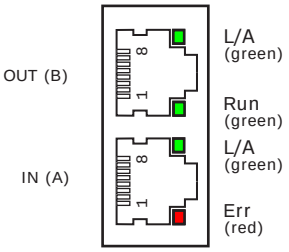
ETHERCAT LEDS (ON RJ-45 CONNECTORS)

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

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

1) Find the highest number under 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

2) Subtract 96 from the desired address 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

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

AMP LED

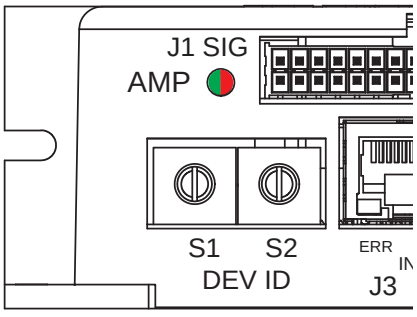
A bi-color LED gives the state of the BEL drive. Colors do not alternate, and can be solid ON or blinking. When multiple conditions occur, only the top-most condition will be displayed. When that condition is cleared the next one below will shown.

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/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.
7) 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



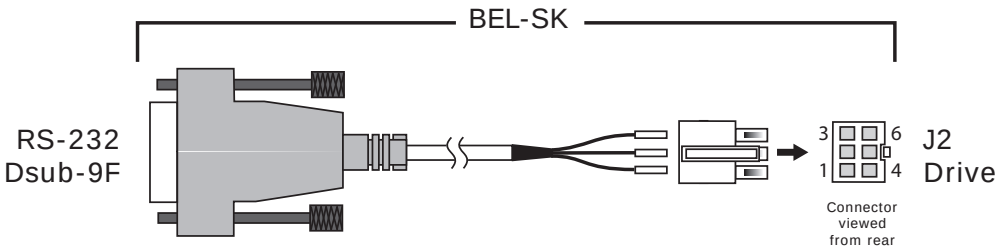
COMMUNICATIONS

RS-232 (SERIAL) COMMUNICATIONS

BEL 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 *BEL* RS-232 port are through J2, a Samtec connector. The *BEL* Serial Cable Kit (BEL-SK) contains a molded cable 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).

BEL-SK SERIAL CABLE KIT

The BEL-SK provides connectivity between a D-Sub 9 male connector and the Samtec connector on the BEL. A molded cable with a Dsub-9F connector plugs into the COM1 (or other COM) port of a PC. The connections are shown in the diagram below.



Don't forget to order a Serial Cable Kit BEL-SK when placing your order for an BEL!

J2: RS-232 PORT

Samtec receptacle, 6 position

DSUB		WIRE	DRIVE J2	
PIN	SIGNAL		PIN	SIGNAL
2	RxD	Green	5	TxD
3	Txd	Red	2	RxD
5	Gnd	Black	4	Sgnd

J2 RS-232 Connector:
6-position shrouded cable header, keyed polarization
Samtec IPL1-103-01-L-D-RA-K

J2 Cable Connector:
Samtec IPD1-03-D-K
Contacts: CC79L-2024-01-L
(AWG 20~24)

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 BEL 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

SAFE TORQUE OFF (STO)

DESCRIPTION

Three opto-couplers are provided which, when de-energized, prevent the upper and lower devices in the PWM outputs in both axes from driving current to the motor. This provides a positive OFF capability for both axes 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.

FUNCTIONAL DIAGRAM

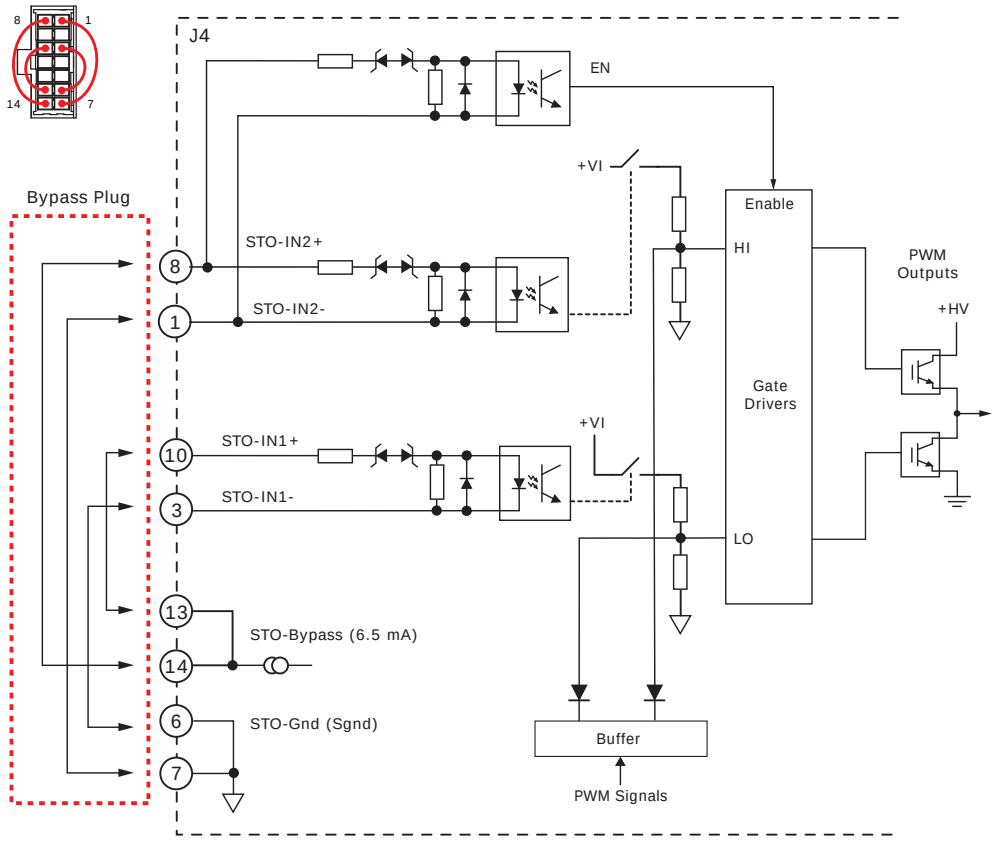
In order for the PWM outputs of the BEL Plus to be activated, current must be flowing through all opto-couplers that are connected to the STO_IN1± and STO_IN2± terminals of J5, and the drive must be in an ENABLED state. When the LED opto-couplers are de-energized, the drive is in a Safe Torque Off state and the PWM outputs cannot be activated to drive a motor.

STO OVERRIDE

The diagram below shows connections that will energize all of the opto-couplers from the internal power source.
When this is done the torque-off feature is defeated 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 as shown in order for the BEL to be enabled.

FUNCTIONAL DIAGRAM

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



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

J4 SIGNALS

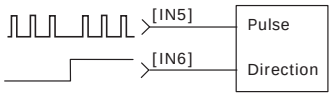
SIGNAL	PIN		SIGNAL
STO_IN2+	8	1	STO_IN2-
n.c.	9	2	n.c.
STO_IN1+	10	3	STO_IN1-
n.c.	11	4	n.c.
n.c.	12	5	n.c.
STO_BYP	13	6	Sgnd
	14	7	Sgnd

COMMAND INPUTS

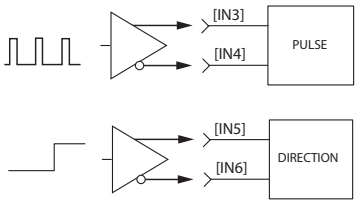
DIGITAL POSITION

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



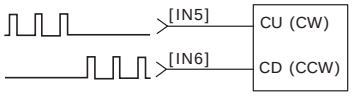
DIFFERENTIAL PULSE & DIRECTION



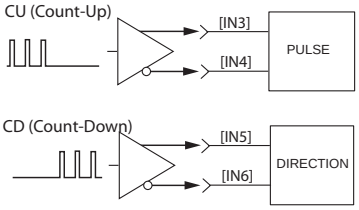
SINGLE-ENDED

Signal		J1
Pls, Enc A	[IN5]	21
Dir, Enc B	[IN6]	5
Sgnd		11,18,32
Frame Gnd		16

SINGLE-ENDED CU/CD



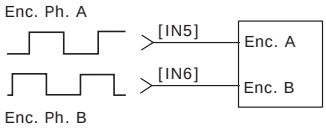
DIFFERENTIAL CU/CD



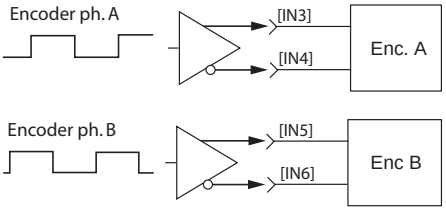
DIFFERENTIAL

Signal		J1
Pls, Enc A	[IN3]	20
/Pls, Enc /A	[IN4]	4
Dir, Enc B	[IN5]	21
/Dir, Enc /B	[IN6]	5
Sgnd		11,18,32
Frame Gnd		16

QUAD A/B ENCODER SINGLE-ENDED



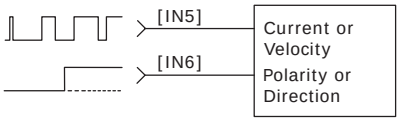
QUAD A/B ENCODER DIFFERENTIAL



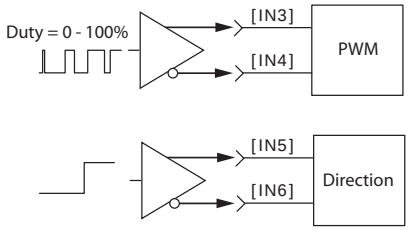
DIGITAL TORQUE, VELOCITY

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



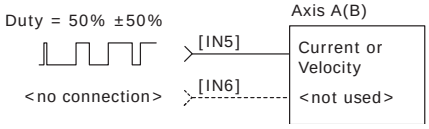
DIFFERENTIAL PWM & DIRECTION



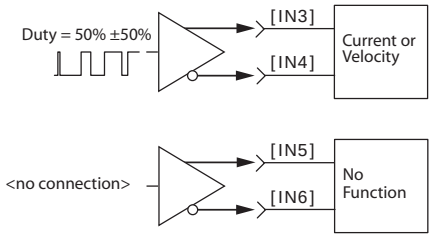
SINGLE-ENDED

Signal		J1
PWM	[IN5]	21
Dir	[IN6]	5
Sgnd		11,18,32
Frame Gnd		16

SINGLE-ENDED 50% PWM



DIFFERENTIAL 50% PWM



DIFFERENTIAL

Signal		J1
PWM	[IN3]	20
/PWM	[IN4]	4
Dir	[IN5]	21
/Dir	[IN6]	5
Sgnd		11,18,32
Frame Gnd		16

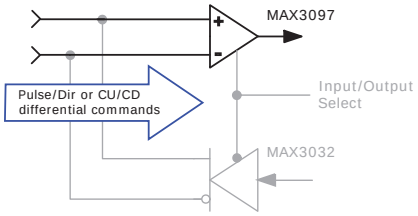
MULTI-MODE ENCODER PORT

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

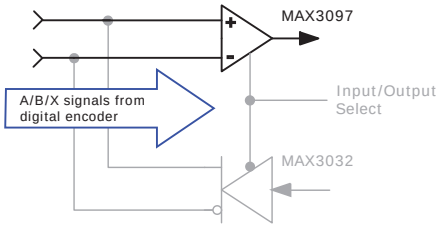
AS DIGITAL COMMAND INPUTS IN PULSE/DIRECTION, PULSE-UP/PULSE-DOWN, OR DIGITAL QUADRATURE ENCODER FORMAT

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.



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.



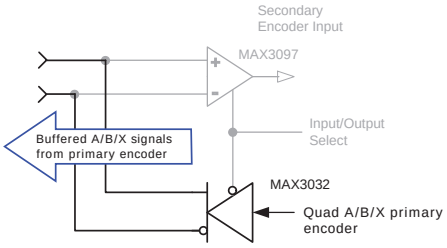
COMMAND INPUT MULTI-PORT

Signal	J1
Pls, Enc A	28
/Pls, Enc /A	12
Dir, Enc B	29
/Dir, Enc /B	13
Enc X	30
Enc /X	14
Sgnd	11,18,32
Frame Gnd	16

AS AN OUTPUT FOR FEEDBACK SIGNALS TO AN EXTERNAL CONTROLLER

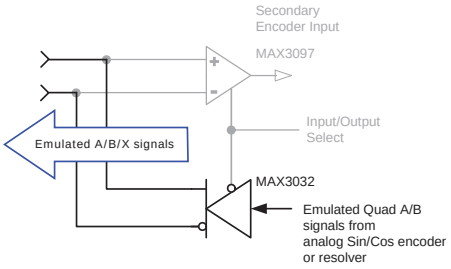
AS BUFFERED OUTPUTS FROM A DIGITAL QUADRATURE PRIMARY ENCODER

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.



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.



EMULATED QUAD A/B/X MULTI-PORT

Signal	J1
Enc A	28
Enc /A	12
Enc B	29
Enc /B	13
Enc X	30
Enc /X	14
Sgnd	11,18,32
Shld	16

PROGRAMMABLE DIGITAL INPUTS

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

[IN1~11] SIGNALS

Input	Pin	R1	R2	C1
*IN1	J1-19	15k	15k	100p
*IN2	J1-3			
*IN3	J1-20	10k	1k	
*IN4	J1-4			
*IN5	J1-21			
*IN6	J1-5			
IN7	J1-22	Opto inputs ±Common is J2-2		
IN8	J1-6			
IN9	J1-23			
IN10	J1-7			
IN11	J5-7	4.99k	10k	33n

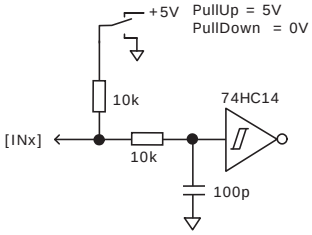
Vmax

+24V

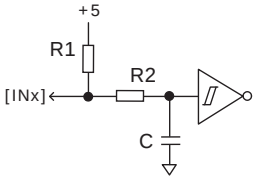
+12V

* 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



HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN1,2,11	HI	Vin >= 3.5 Vdc
	LO	Vin <= 0.7 Vdc
IN3,4,5,6	HI	Vin >= 2.7 Vdc
	LO	Vin <= 2.3 Vdc
IN7,8,9,10	HI	Vin >= 10.0 Vdc
	LO	Vin <= 6.0 Vdc

INPUTS WITH PROGRAMMABLE PULL UP/DOWN

Input	Pin	PU/PD
IN1	J1-19	1
IN2	J1-3	2
IN3	J1-20	5
IN4	J1-4	6
IN5	J1-21	7
IN6	J1-5	8

SINGLE-ENDED/DIFFERENTIAL DIGITAL INPUTS [IN3~4,5~6]

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):

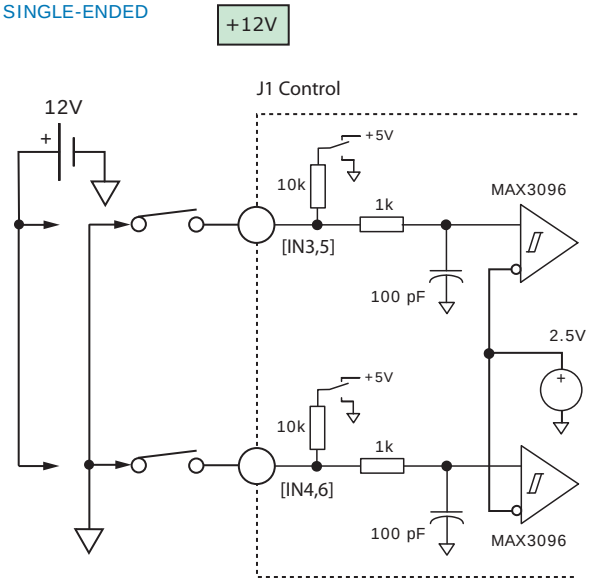
- PWM 50%, PWM & Direction for Velocity or Current modes
- Pulse/Direction, CU/CD, or A/B Quad encoder inputs for Position or Camming modes

[IN3~4,5~6] SIGNALS

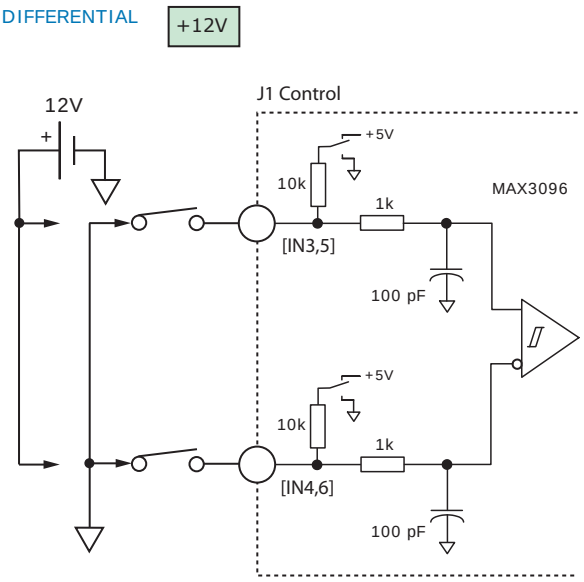
S.E. Input	Diff Input	Pin
IN3	IN3+	J1-20
IN4	IN3-	J1-4

S.E. Input	Diff Input	Pin
IN5	IN5+	J1-21
IN6	IN5-	J1-5

12 Vdc max
SINGLE-ENDED



12 Vdc max
DIFFERENTIAL



OPTO-ISOLATED DIGITAL INPUTS

These inputs have all the programmable functions of the GP inputs plus opto-isolation. There are four inputs with 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 ±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

[IN7,8,9,10]
±30 Vdc max

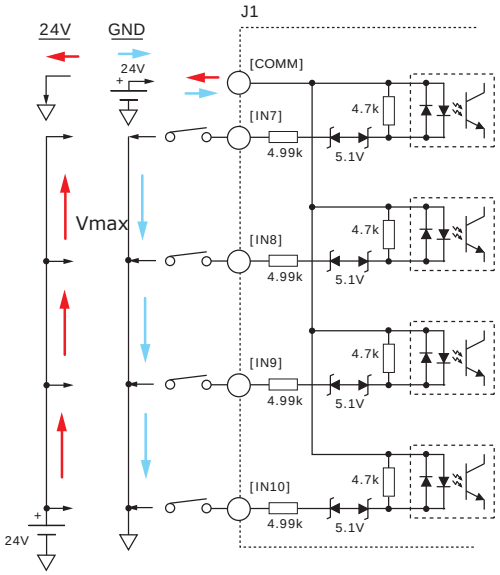
+24V

+24V

[IN7,8,9,10] SIGNALS

Signal	J1 Pins
IN7	22
IN8	6
IN9	23
IN10	7
COMM	2

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.



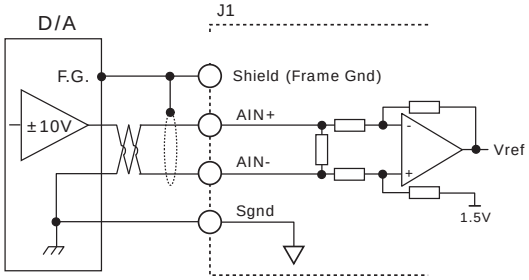
ANALOG INPUT

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

CME2 -> Basic Setup -> Operating Mode Options

[AIN A,B] SIGNALS

Signal	J1 Pins
AIN(+)	17
AIN(-)	1
Sgnd	11,18,32
Frame Gnd	16



OUTPUTS

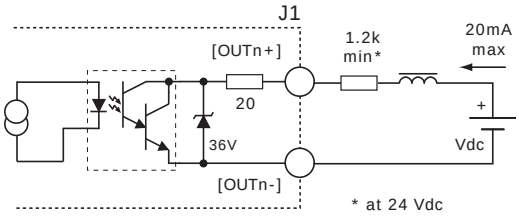
OPTO-ISOLATED OUTPUTS [OUT1~3]

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

[OUT1~3] SIGNALS

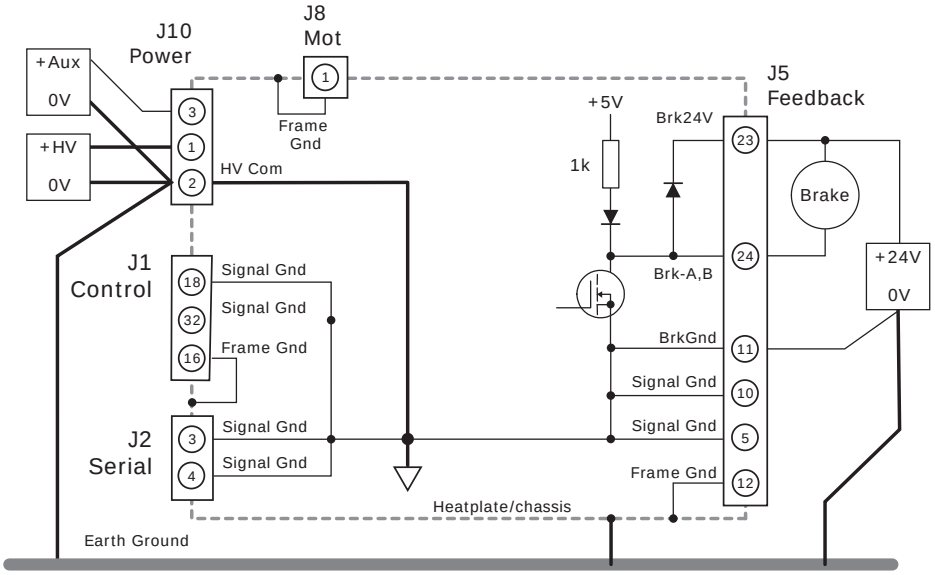
Signal	J1Pins
[OUT1+]	24
[OUT1-]	8
[OUT2+]	25
[OUT2-]	9
[OUT3+]	26
[OUT3-]	10

[OUT1~3]



BRAKE OUTPUT [OUT4]

This output is an open-drain MOSFET with an internal flyback diode for driving inductive loads. It 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 output.



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.

BRAKE SIGNALS

Signal	Pins
Brk24V	J5-23
Brk	J5-24
BrkGnd	J5-11

HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT1~3	HI	Output transistor is ON, current flows
	LO	Output transistor is OFF, no current flows
BRK OUT4	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 Output [OUT4] 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 [OUT4] 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 [OUT4] 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

MOTOR CONNECTIONS

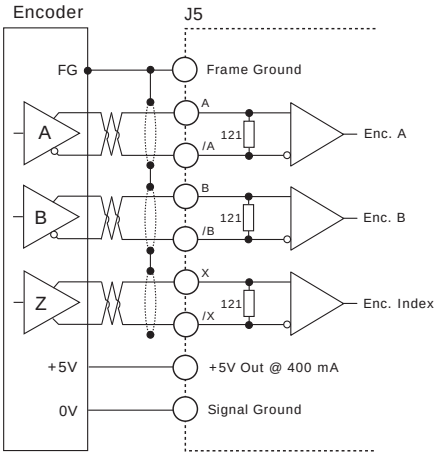
Motor connections are of three types: phase, feedback, and thermal sensor. The phase connections carry the drive output currents that drive the motor to produce motion. A thermal sensor that indicates motor overtemperature is used to shut down the drive to protect the motor. Feedback can be digital quad A/B encoder, digital absolute encoder, analog sin/cos encoder, resolver or digital Halls, depending on the version of the drive.

QUAD A/B ENCODER WITH FAULT PROTECTION

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:

Short-circuits line-line:	This produces a near-zero voltage between A & /A which is below the differential fault threshold.
Open-circuit condition:	The 121Ω terminator resistor will pull the inputs together if either side (or both) is open. This will produce the same fault condition as a short-circuit across the inputs.
Low differential voltage detection:	This is possible with very long cable runs and a fault will occur if the differential input voltage is < 200mV.
±15kV ESD protection:	The 3097E has protection against high-voltage discharges using the Human Body Model.
Extended common-mode range:	A fault occurs if the input common-mode voltage is outside of the range of -10V to +13.2V

CONNECTIONS WITH A/B/X ENCODER

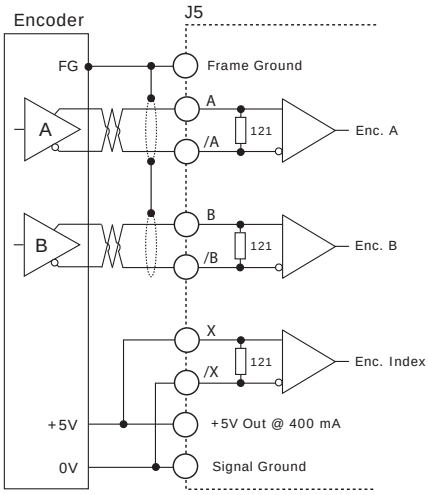


A/B/X SIGNALS

Signal	J5 Pins
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

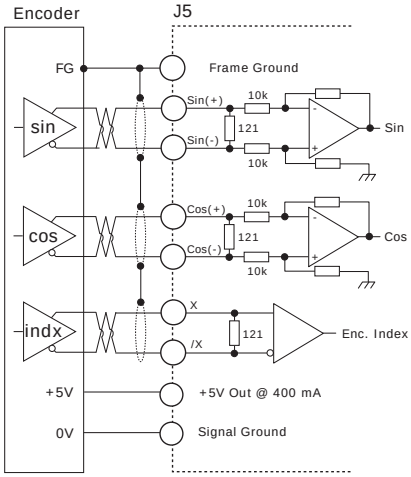
F.G. = Frame Gnd

CONNECTIONS WITH NO INDEX SIGNAL



ANALOG SIN/COS INCREMENTAL ENCODER

The sin/cos/index inputs are differential with 121 Ω 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

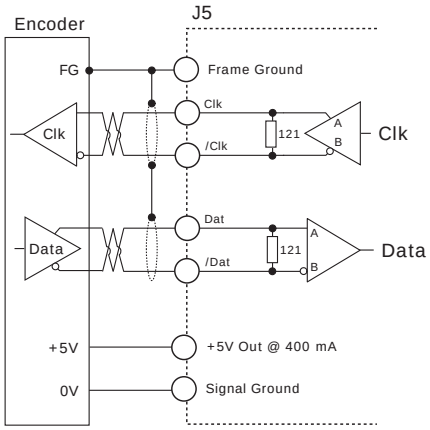
Signal	J5 Pins
Sin(+)	20
Sin(-)	8
Cos(+)	21
Cos(-)	9
X	15
/X	3
+5V	17,22
Sgnd	5,10
F.G.	12

F.G. = Frame Gnd

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 BEL 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.



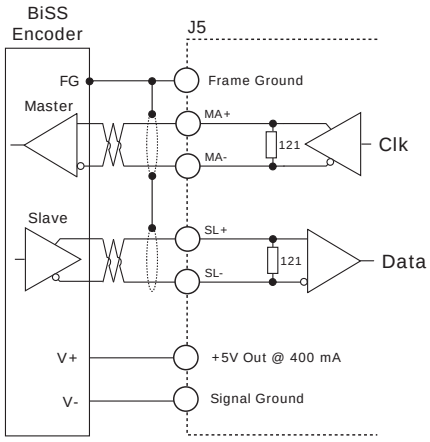
SSI,BiSS SIGNALS

SSI	BiSS	J5 Pins
Clk	MA+	15
/Clk	MA-	3
Data	SL+	16
/Data	SL-	4
+5V		17,22
Sgnd		5,10
Frame Gnd		12

BiSS ABSOLUTE ENCODER

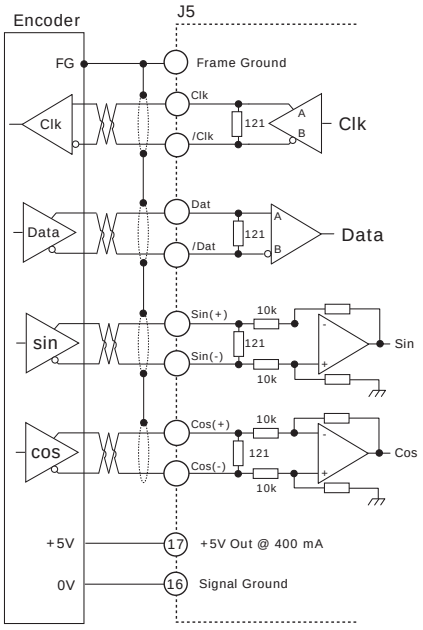
BiSS is an - Open Source - digital interface for sensors and actuators. BiSS refers to principles of well known industrial standards for Serial Synchronous Interfaces like SSI, AS-Interface® and Interbus® with additional options.

- 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.



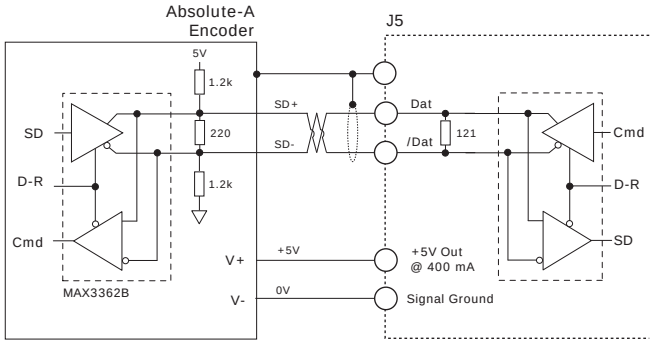
ENDAT SIGNALS

Signal	J5 Pins
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	J5 Pins
Data	16
/Data	4
+5V	17,22
Sgnd	5,10
F.G.	12

F.G. = Frame Gnd

MOTOR CONNECTIONS (CONT'D)

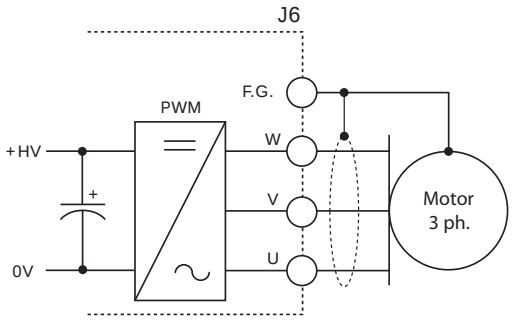
MOTOR PHASE CONNECTIONS

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	J6 Pins
Mot U	4
Mot V	3
Mot W	2
F.G.	1

F.G. = Frame Gnd



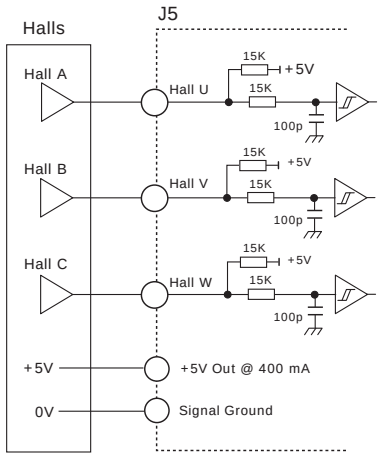
DIGITAL HALL SIGNALS

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

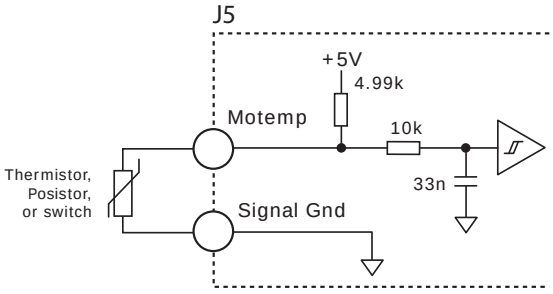
Signal	J5 Pins
Hall U	18
Hall V	6
Hall W	19
+5V	17,22
Sgnd	5,10
F.G.	12

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.
This input is programmable for other functions if not used as Motemp inputs. And, other inputs are programmable for the Motemp function.



MOTEMP SIGNALS

Signal	J5 Pins
Motemp	7
Sgnd	5,10
F.G.	12

F.G. = Frame Gnd

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

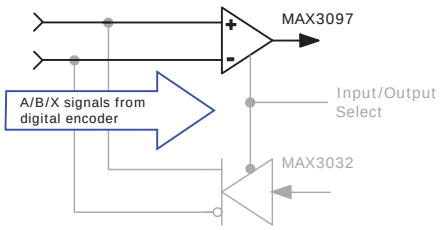
MOTOR CONNECTIONS (CONT'D)

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.

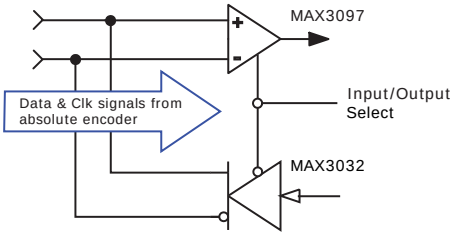


QUAD A/B/X SIGNALS

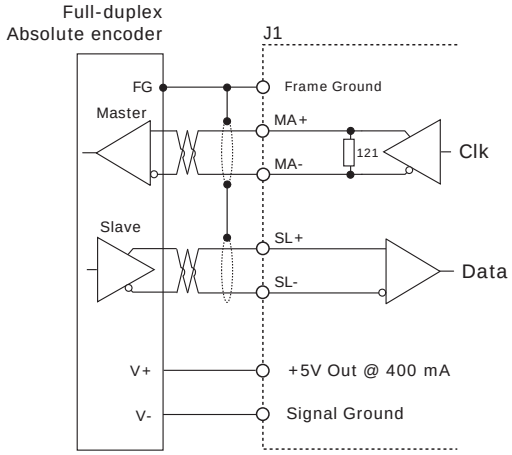
Signal	J1 Pin
Enc A	28
Enc /A	12
Enc B	29
Enc /B	13
Enc X	30
Enc /X	14
+5V Output	27
Sgnd	11,18,32
Frame Gnd	16

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

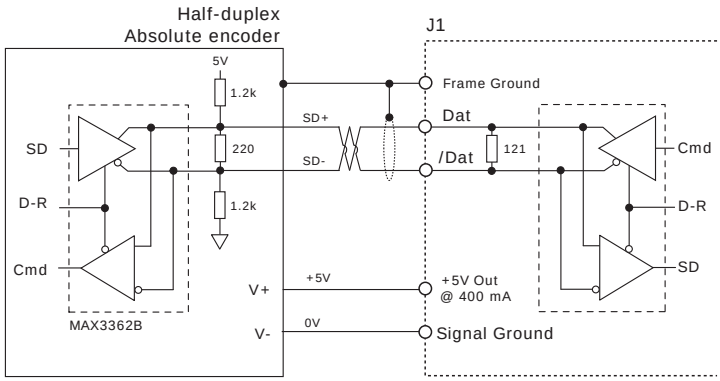
HALF-DUPLEX ENCODERS

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

FULL-DUPLEX SIGNALS

Signal	J1 Pin
Clk	30
/Clk	14
Dat	31
/Dat	15
+5V Output	27
Sgnd	11,18,32
Frame Gnd	16

ABSOLUTE ENCODER, HALF-DUPLEX MODE

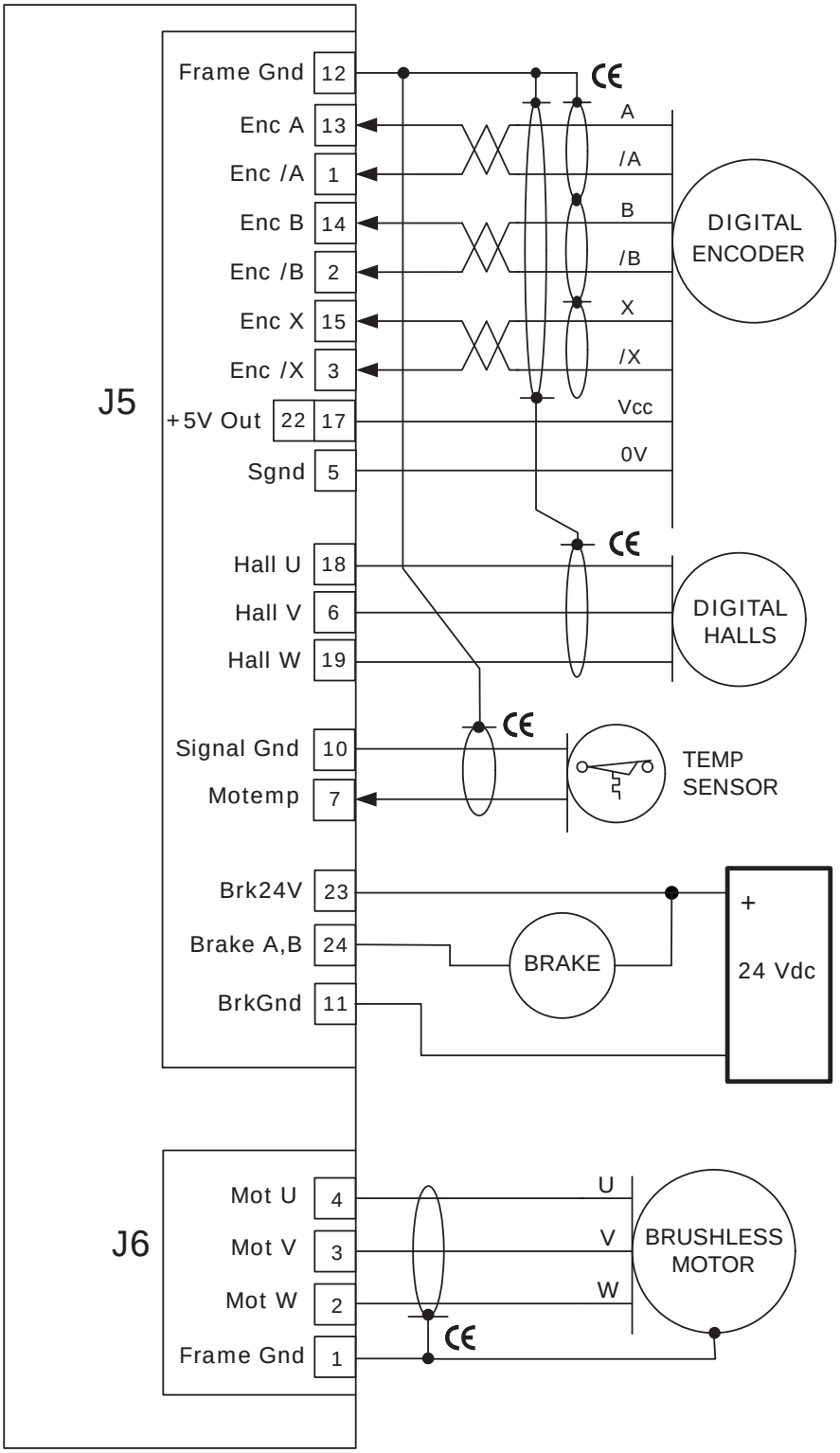


HALF-DUPLEX SIGNALS

Signal	J1 Pin
Dat	31
/Dat	15
+5V Output	27
Sgnd	11,18,32
Frame Gnd	16

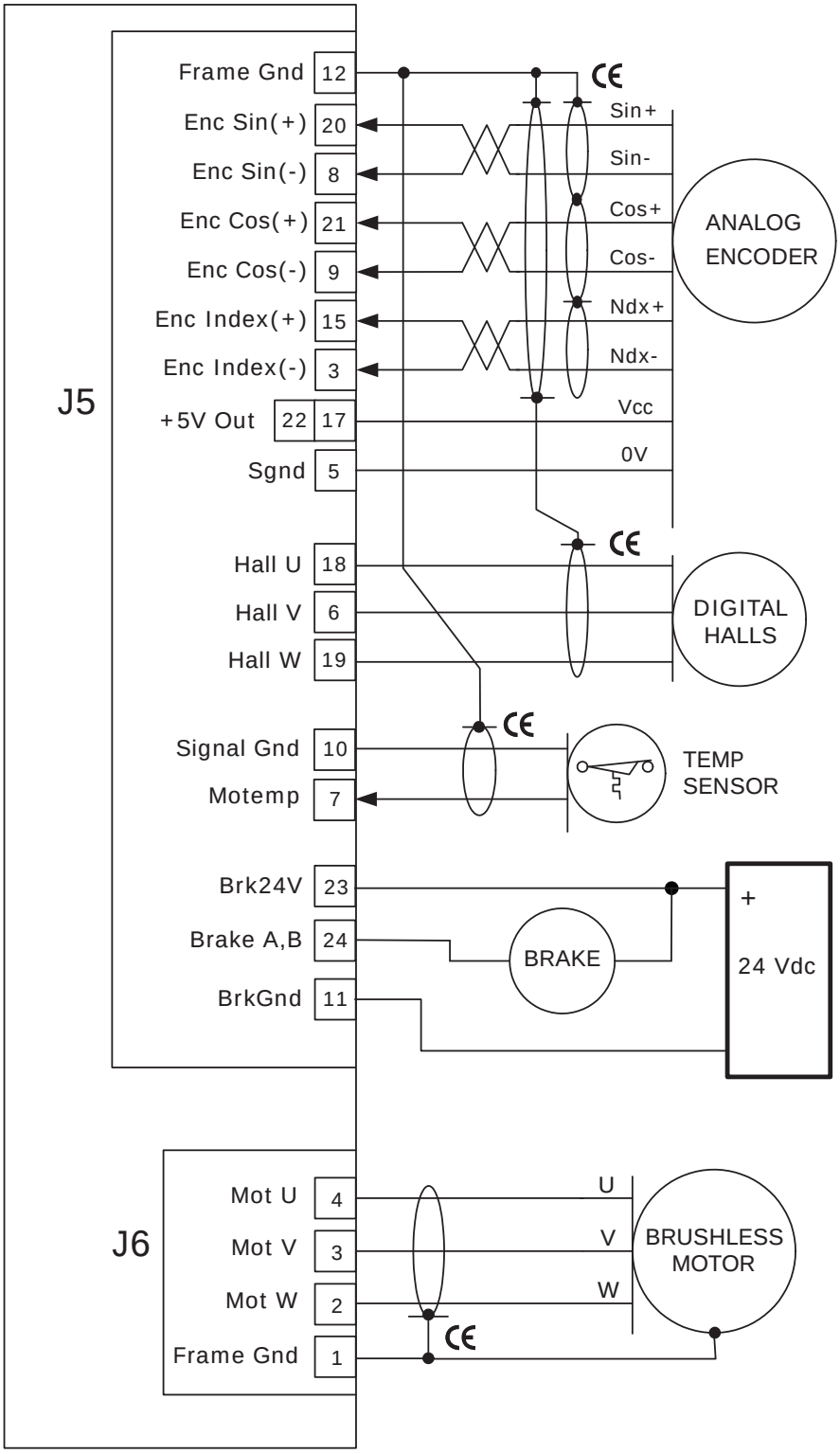
MOTOR CONNECTIONS FOR INCREMENTAL DIGITAL ENCODERS

The connections shown may not be used in all installations



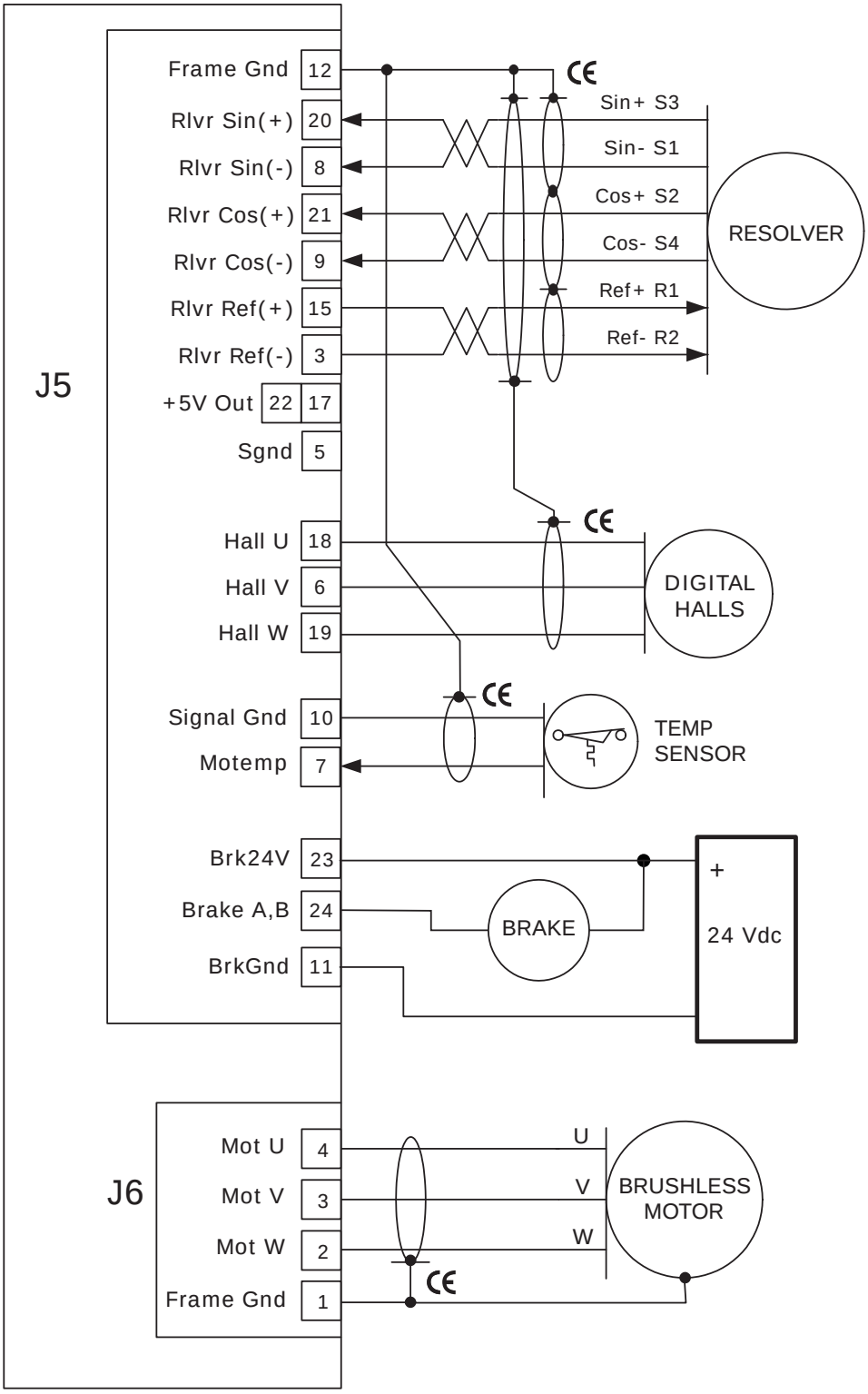
MOTOR CONNECTIONS FOR INCREMENTAL ANALOG (SIN/COS) ENCODERS

The connections shown may not be used in all installations



MOTOR CONNECTIONS FOR RESOLVERS (-R OPTION)

The connections shown may not be used in all installations.
Hall signals are not generally used with resolver feedback but are shown here because they function if needed for resolver operation.



CONNECTORS & SIGNALS

J2 Serial Connector:
6-position shrouded cable header, keyed polarization
Samtec IPL1-103-01-L-D-RA-K

J2 Cable Connector:
Samtec IPD1-03-D-K
Contacts: CC79L-2024-01-L
(AWG 20~24)

J2: SERIAL

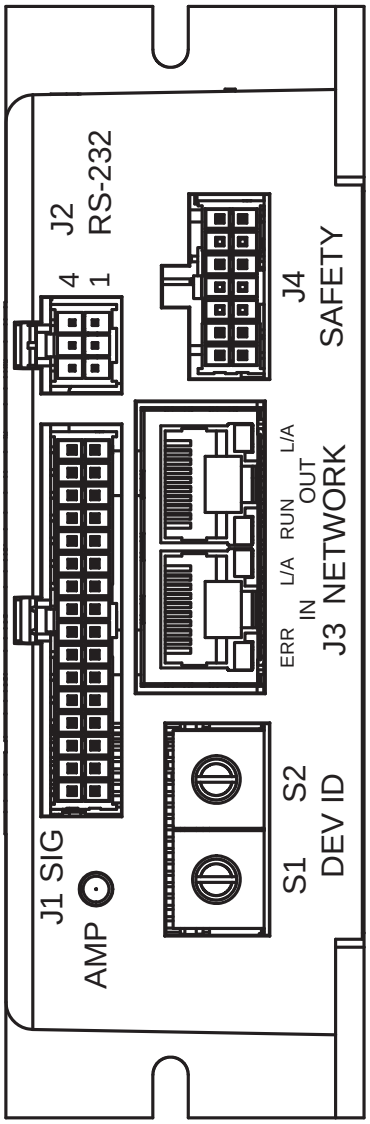
Signal	Pin		Signal
Sgnd	4	1	n.c.
TxD	5	2	RxD
n.c.	6	3	Frame Gnd

J1: SIGNAL

Signal	Pin		Signal
Analog Ref(+)	17	1	Analog Ref(-)
Signal Ground	18	2	[IN7-10COM]
HS Enable Input [IN1]	19	3	HS Input [IN2]
SED1 Input [IN3]	20	4	SED1 Input [IN4]
SED2 Input [IN5]	21	5	SED2 Input [IN6]
ISO Input [IN7]	22	6	ISO Input [IN8]
ISO Input [IN9]	23	7	ISO Input [IN10]
ISO [OUT1+]	24	8	ISO [OUT1-]
ISO [OUT2+]	25	9	ISO [OUT2-]
ISO [OUT3+]	26	10	ISO [OUT3-]
+5 Vdc Output	27	11	Signal Ground
Multi-Mode Enc A	28	12	Multi-Mode Enc /A
Multi-Mode Enc B	29	13	Multi-Mode Enc /B
Multi-Mode Enc X	30	14	Multi-Mode Enc /X
Multi-Mode Enc S	31	15	Multi-Mode Enc /S
Signal Ground	32	16	Frame Ground

J1 Signal Connector:
32-position shrouded cable header, keyed polarization
Samtec: IPL1-116-01-L-D-RA-K

J1 Cable Connector:
32-position connector housing, keyed polarization
Samtec IPD1-16-D-K
Contacts: CC79L-2024-01-L (AWG 20~24)



J4 Safety Connector:
14-position shrouded cable header, keyed polarization
Samtec IPL1-107-01-L-D-RA-K

J4 Cable Connector:
Samtec IPD1-07-D-K
Contacts: CC79L-2024-01-L
(AWG 20~24)

J4: SAFETY

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

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.

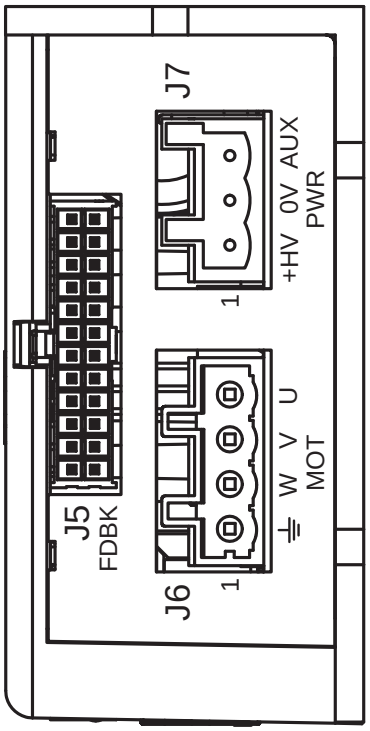
CONNECTORS & SIGNALS

J7: Power Connector:
Euro-style 5,0 mm receptacle, 3-position
Wago: 721-463/001-040
Insert/extract lever: Wago: 231-131

J7 Cable Connector:
Wago 721-103/026-047/RN01-0000
Insert/extract lever: Wago: 231-131

J5: FEEDBACK

Signal	Pin		Signal
Enc A	13	1	Enc /A
Enc B	14	2	Enc /B
Enc X	15	3	Enc /X
Enc S	16	4	Enc /S
+5 Vdc Output	17	5	Signal Ground
Hall U	18	6	B Hall V
Hall W	19	7	Motemp [IN11]
Sin(+)	20	8	Sin(-)
Cos(+)	21	9	Cos(-)
+5 Vdc Output	22	10	Signal Ground
Brake 24V	23	11	Signal Ground
Brake [OUT7]	24	12	Frame Ground



J7: HV & AUX POWER

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

J6: MOTOR

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

J5:Feedback Connectors:
24-position shrouded cable headers, keyed polarization
Samtec IPL1-112-01-L-D-RA-K

J5: Cable Connectors:
24-position connector housing, keyed polarization
Samtec IPD1-12-D-K
Contacts: CC79L-2024-01-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.

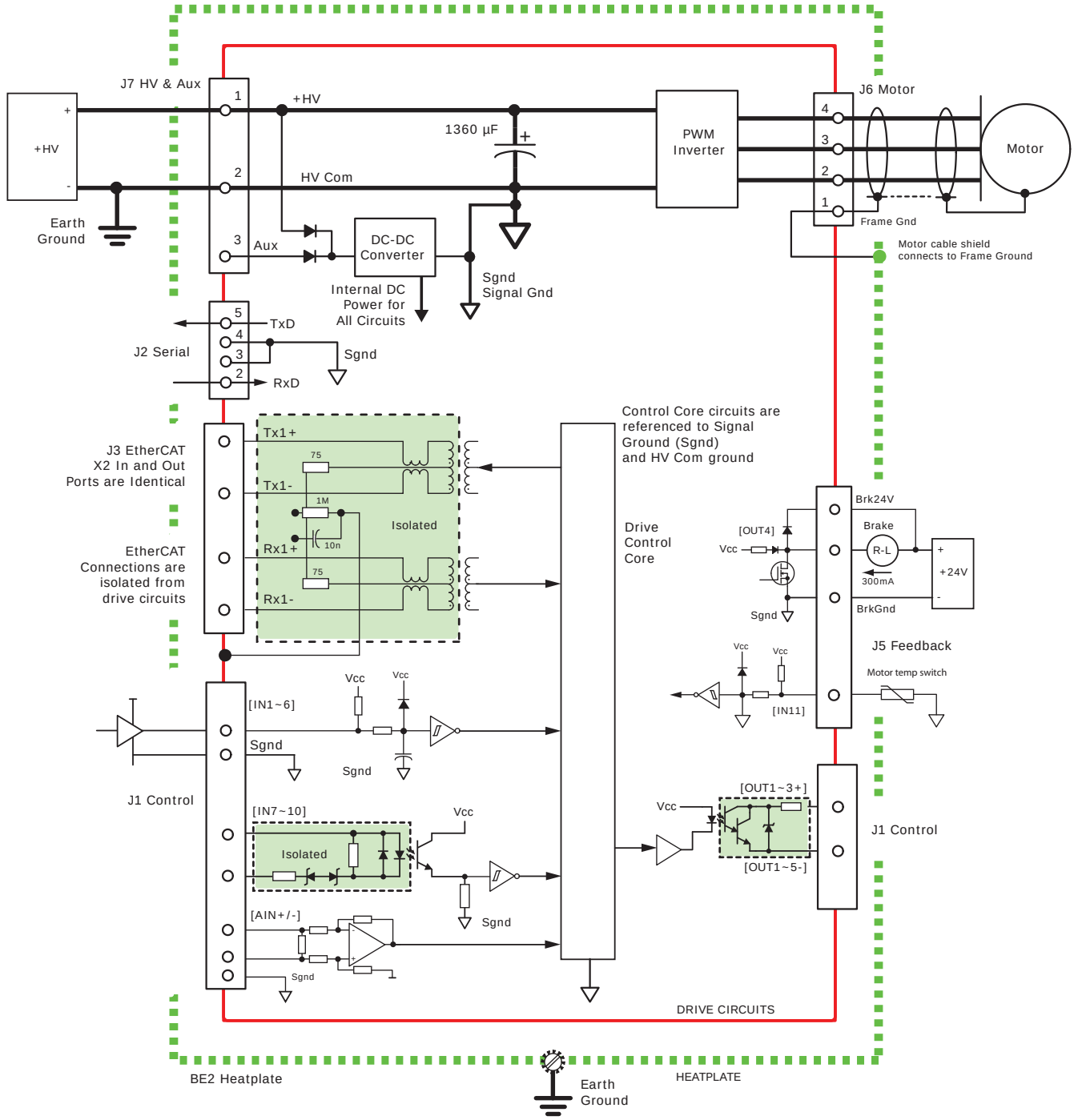
J6: Motor Connectors:
Euro-style 5,0 mm receptacles,
4-position
Wago: 721-464/001-000

J6 Cable Connectors:
Wago 721-104/026-047/RN01-0000

Wago Connector Tool:
Contact opener: 231-131
(included in BEL-SK)

DEVICE STRUCTURE

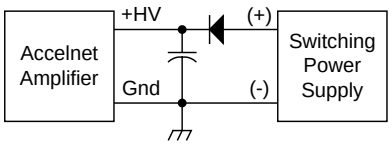
This graphic shows the electrical structure of the drive, detailing the elements that share a common circuit common (Signal Ground, HV Com) and circuits that are isolated and have no connection to internal circuits.
Note that there is no connection between the heatplate (Chassis, Frame Ground) and any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



POWER SUPPLIES

Accelnet BEL 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 BEL 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 BEL* share a common circuit-ground (HV_COM on J7-2, and Signal Ground on J1-11,18,32 and J5-5,10,11). 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 (J6-1).

The drive heatplate (Frame Gnd) does not connect to any drive circuits. Connections to the heatplate are provided on connectors J1-16, J5-12, and J6-1. 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.

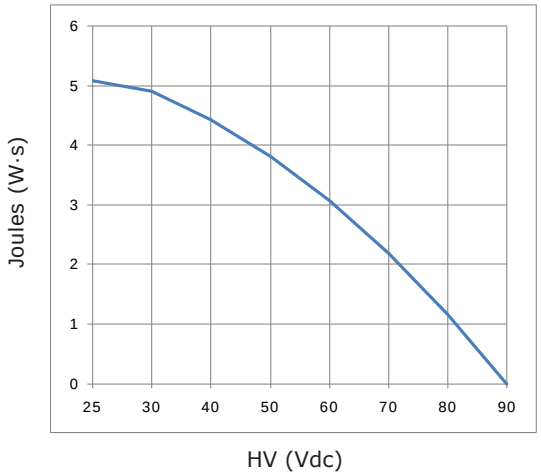
The final configuration should embody three current-carrying loops. First, the power supply currents flowing into and out of the drive at the +HV and HV_COM pins on J7. Second the drive outputs driving currents into and out of the motor phases on J6, and motor shield currents circulating between the 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.

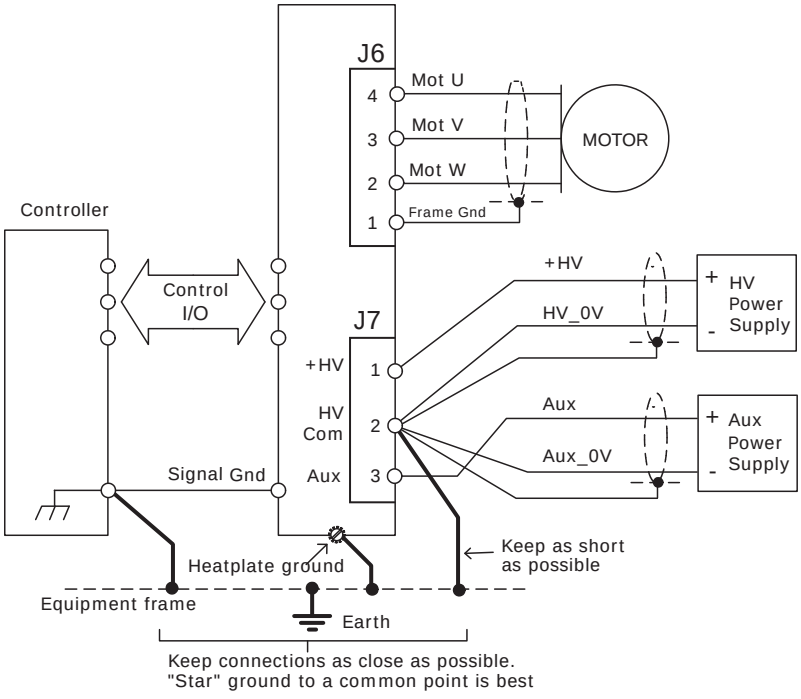
REGENERATION

The chart below shows the energy absorption in W·s for a *BEL* 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

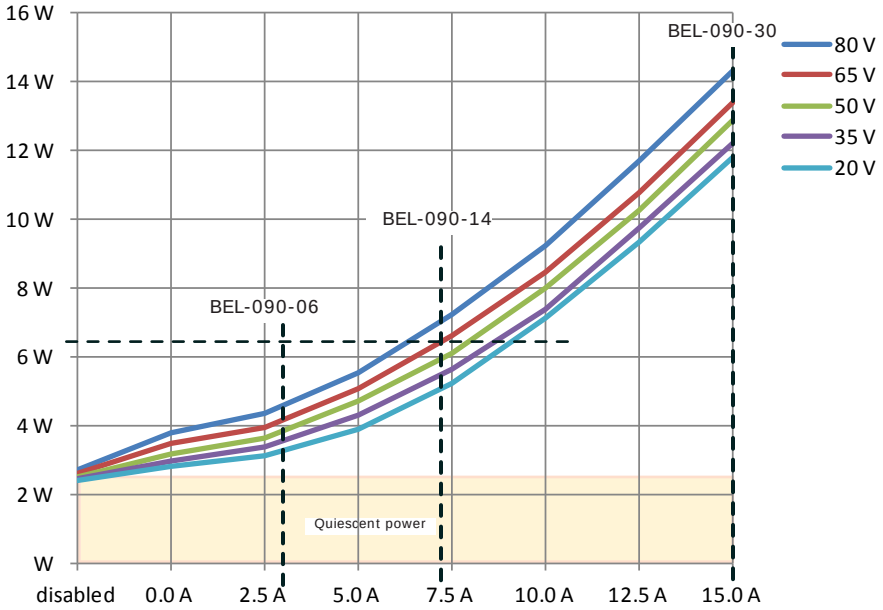
The top chart on this page shows the internal power dissipation of the BEL under differing power supply and output current conditions. The +HV values are for the average DC voltage of the drive power supply. The lower chart shows the temperature rise vs. power dissipation under differing mounting and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

POWER DISSIPATION

Use this chart to find the Watts dissipation. The vertical dashed lines show the continuous currents for the three BEL models.

Example:

Power supply HV = 65 Vdc
Current = 7.5A
Power dissipation= 6.5 W



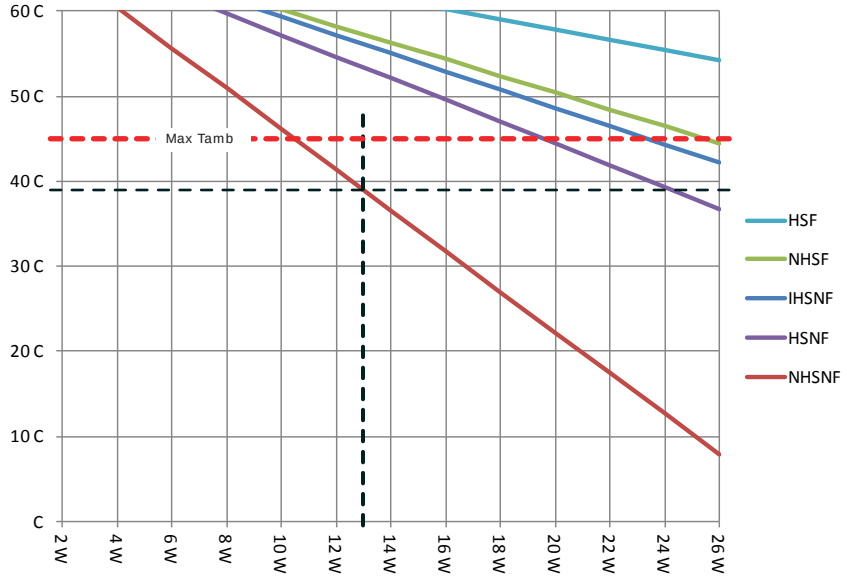
MAXIMUM OPERATING TEMPERATURE VS. DISSIPATION

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

Example:

Using the 13.2 W value from the calculations above, draw a vertical line. This shows that 39C is the maximum operating temperature for NHSNF, and that any of the other mounting/cooling options will be sufficient.

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



MOUNTING

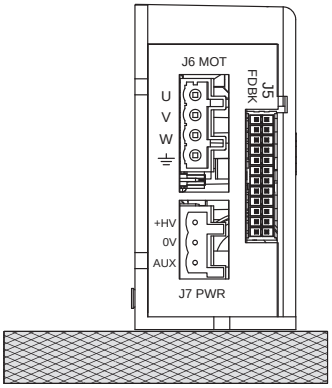
Thermal data for convection-cooling with a heatsink assumes a vertical mounting of the drive on a thermally conducting surface. Heatsink fins run parallel to the long axis of the drive. When fan-cooling is used vertical mounting is not necessary to guarantee thermal performance of the heatsink.

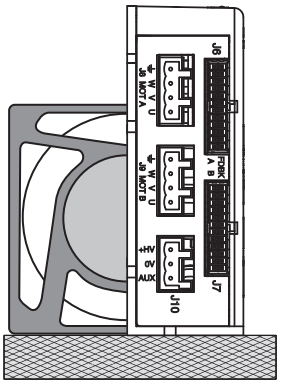
THERMAL RESISTANCE

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., a drive dissipating 13 W mounted with no heatsink or fan would see a temperature rise of 45 °C above ambient based on the thermal resistance of 3.46 °C/W. Using the drive maximum heatplate temperature of 70 °C and subtracting 46 °C from that would give 24 °C 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.

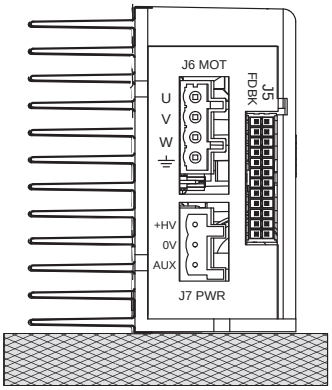
END VIEWS
VERTICAL MOUNTING

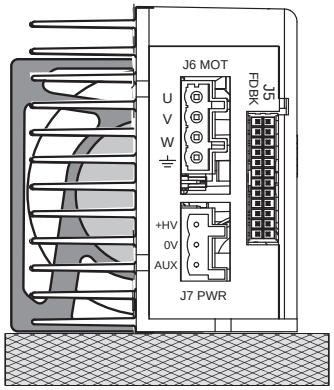




NO HEATSINK, NO FAN	°C/W
Thermally non-conductive mounting surface	3.46
Thermally conductive mounting surface	0.98

NO HEATSINK + FAN	°C/W
Forced-air, 300 LFM	1.32



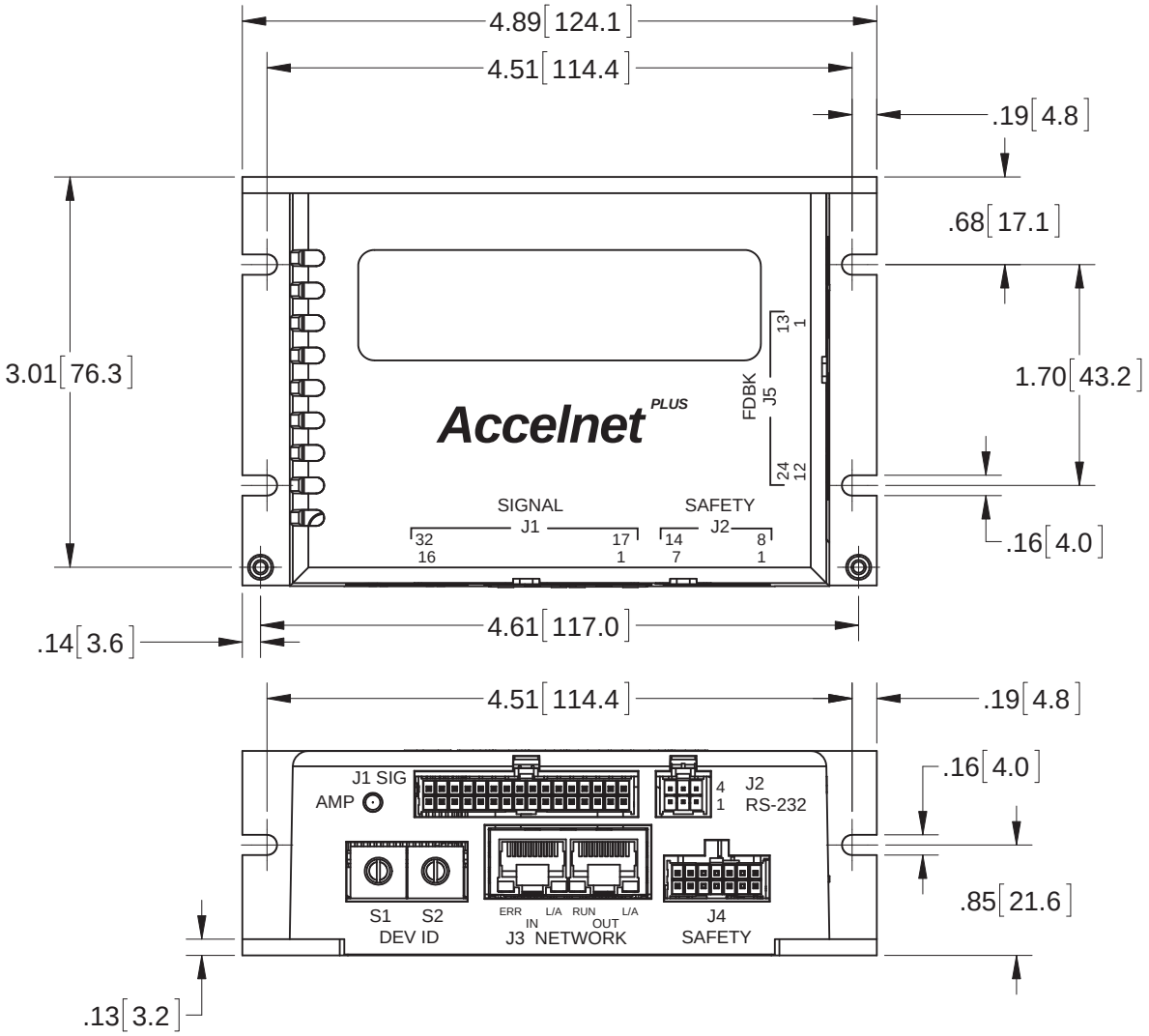


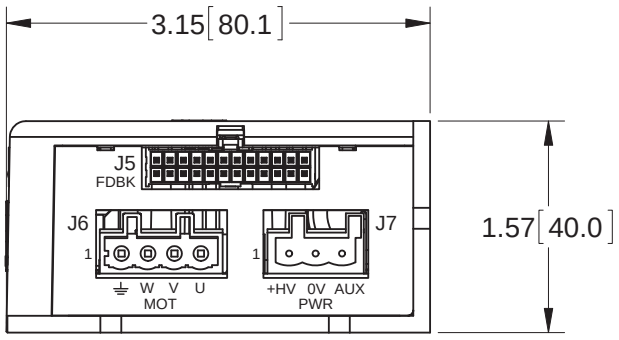
HEATSINK, NO FAN	°C/W
Convection	2.02

HEATSINK + FAN	°C/W
Forced-air, 300 LFM	0.91

DIMENSIONS

Units: in [mm]





MASTER ORDERING GUIDE

BEL-090-06	*Accelnet Plus Panel* EtherCAT servo drive, 3/6 A, 90 Vdc
BEL-090-14	*Accelnet Plus Panel* EtherCAT servo drive, 7/14 A, 90 Vdc
BEL-090-30	*Accelnet Plus Panel* EtherCAT servo drive, 15/30 A, 90 Vdc

EtherCAT® Conformance tested

Add -R to model number for resolver feedback option (Example: BEL-090-14-R)
Add -H to model number for heatsink installed at the factory (Example: BEL-090-06-H)

Example: Order one *Accelnet Plus BEL* drive, resolver version, 7/14 A, with connector Kit, *CME 2* CD, serial cable kit and heatsink fitted at the factory:

Qty	Item	Remarks
1	BEL-090-14-R-H	*Accelnet Plus BEL* servo drive with resolver, and heatsink
1	BEL-CK	*BEL* Connector Kit
1	CME 2	CME 2 CD
1	BEL-SK	Serial Cable Kit

ACCESSORIES

	QTY	REF	DESCRIPTION	MANUFACTURERS PART NUMBER
BEL-CK Connector Kit	1	J1	Connector housing, 32 position, keyed polarization	Samtec: IPD1-16-D-K
	1	J2	Connector housing, 6 position, keyed polarization	Samtec: IPD1-03-D-K
	1	J4	Connector housing, 14 position, keyed polarization	Samtec: IPD1-07-D-K
	1	J5	Connector housing, 24 position, keyed polarization	Samtec: IPD1-12-D-K
	1	J6	Plug, 4 position, 5.0 mm, female	Wago: 721-104/026-047 (Note 1)
	1	J7	Plug, 3 position, 5.0 mm, female	Wago: 721-103/026-047 (Note 1)
	80	->	Contacts for J1, J4, J5	Samtec: CC79L-2024-01-L
	2	->	Tool, wire insertion & extraction for J8, J9, J10	Wago: 231-131
CME 2			CME 2 Drive Configuration Software (CD-ROM)	
BEL-SK		J2	RS-232 Cable Kit: Dsub-9 molded cable with plug for BEL J2	
BEL-NC-10	1	J3	EtherCAT® network cable, 10 ft (3 m)	
BEL-NC-01	1		EtherCAT® network cable, 1 ft (0.3 m)	

Note 1: Add /RN01-0000 to the Wago part number for RoHS compliant parts

Heatsink Kits for Field Installation (Optional)

BEL-HK Heatsink Kit	1	BEL 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 BEL-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, 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

Note: Specifications subject to change without notice