Accelnet Plus Module EtherCAT AEM

DIGITAL SERVO DRIVE
FOR BRUSHLESS/BRUSH MOTORS

Control Modes
- Cyclic Synchronous Position-Velocity-Torque (CSP, CSV, CST)
- Indexer, Point-to-Point, PVT
- Camming, Gearing

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

Communications
- EtherCAT
- RS-232

Feedback
- Digital quad A/B encoder
  Analog sin/cos incremental
  Panasonic Incremental A Format
- SSI, EnDat, Absolute A
  Tamagawa & Panasonic Absolute A
  Sanyo Denki Absolute A,
  BiSS,BiSS
- Aux. encoder / encoder out
- Digital Halls

I/O
- Digital: 11 inputs, 6 outputs
- Analog: 1, 12-bit input

Dimensions: mm [in]
- 76.3 x 58.2 x 20.5 [3.01 x 2.29 x 0.81]

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

DEVELOPMENT KIT

DESCRIPTION

Accelnet AEM is a high-performance, DC powered servo drive for position, velocity, and torque control of brushless and brush motors via EtherCAT, an Ethernet-based fieldbus. Using advanced FPGA technology, the *AEM* provides a significant reduction in the cost per node in multi-axis EtherCAT systems.

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

Command sources also include ±10V analog torque/velocity/position, PWM velocity/torque, and stepper command pulses.

Feedback from a number of incremental and absolute encoders is supported.

Nine high-speed digital inputs with programmable functions are provided, and a low-speed input for motor temperature switches. An SLI (Switch & LED Interface) function is supported by another high-speed input and four high-speed digital outputs. If not used for SLI, the input and outputs are programmable for other functions. Two open-drain MOSFET outputs can drive loads powered up to 24 Vdc.

An RS-232 serial port provides a connection to Copley's CME2 software for commissioning, firmware upgrading, and saving configurations to flash memory.

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	AEM-090-06	AEM-090-14	AEM-090-30	Units	
OUTPUT POWER					
Peak Current	6	14	30	A	DC, sinusoidal
	4.2	10	21	A	RMS, sinusoidal
Peak time		1	1	s	Sec
Continuous current	3	7	15	A	DC, sinusoidal
	2.1	5	10.6	A	RMS, sinusoidal
Maximum Output Voltage				V	Vout = HV*0.97 - Rout*Iout
INPUT POWER					
HVmin~HVmax	+14 to +90	+14 to +90	+14 to +90	V	DC, transformer-isolated
Ipeak	6	14	30	A	For 1 sec
Icont	3	7	15	A	Continuous
Aux HV	+14 to +HV Vdc @ 500 mAdc maximum, 2.5 W				

PWM OUTPUTS

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

CONTROL MODES

EtherCAT: CAN application layer over EtherCAT (CoE): Cyclic Synchronous Position/Velocity/Torque, Profile Position/Velocity/Torque, Interpolated Position (PVT), Homing
Analog ±10 Vdc velocity/torque
Digital PWM velocity/torque and stepper position commands
Discrete I/O: camming, internal indexer and function generator

COMMAND INPUTS

Type	EtherCAT, galvanically isolated from drive circuits
Signals & format	TX+, TX–, RX+, RX–; 100BaseTX
Data protocol	CAN application layer over EtherCAT (CoE)
Address Selection	Programmable, or via digital inputs
Analog	±10 Vdc, torque/velocity control
Digital	High speed inputs for PWM velocity/torque and stepper/encoder position commands
Camming	Quad A/B digital encoder

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)
Commutation	Sinusoidal, field-oriented control for brushless motors
Modulation	Center-weighted PWM with space-vector modulation
Bandwidth	Current loop: 2.5 kHz typical, bandwidth will vary with tuning & load inductance
HV Compensation	Changes in bus voltage do not affect bandwidth
Minimum load inductance	200 µH line-line

DIGITAL INPUTS

Number, type	11, 74LVC14 Schmitt trigger, V_T+ = 1.1~2.2 Vdc, V_T- = 0.8~1.5 Vdc, V_H+ = 0.3~0.45 Vdc
[IN1~9]	High-speed (HS) digital, 100 ns RC filter, 10 kΩ pull-up to +5 Vdc, +7 Vdc tolerant
[IN10]	SLI port MISO input, 47 ns RC filter, 15 kΩ pull-up to +5 Vdc
[IN11]	Motor temperature switch, 330 µs RC filter, 4.99 kΩ pull-up to +5 Vdc

ANALOG INPUT

Number	1
Type	Differential, ±10 Vdc, 12-bit resolution, 5 kΩ input impedance

DIGITAL OUTPUTS

Number	6
[OUT1~2]	Open-drain MOSFET with 1 kΩ pull-up with series diode to +5 Vdc 300 mAdc max, +30 Vdc max. Functions programmable
[OUT3~6]	SLI port MOSI, SCLK, SS1, & SS2 signals, 74AHCT125 line drivers; +5 Vdc tolerant Output current:-8 mA source @ V_{OH} = 2.4V, 6 mA sink at V_{OL} = 0.5V

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)
26LS32 differential line receiver with 121 Ω terminating resistor between complementary inputs

Secondary Incremental Encoder — Single-ended A/B/X signals using digital inputs [IN4,5,6] programmed as secondary encoder

Analog Incremental Encoder — Sin/cos format (sin+, sin-, cos+, cos-), differential, 1 Vpeak-peak, ServoTube motor compatible

Absolute:

SSI — Clock (X, /X), Data (S, /S) signals, 4-wire, clock output from AEP, 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
SD+, SD- (S, /S) signals, 2.5 or 4 MHz, 2-wire half-duplex communication
position feedback: 13-bit resolution per rev, 16 bit revolution counter (29 bit absolute position data)
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 AEP, data returned from encoder

Encoder power — +5 Vdc ±2% @ 400 mAdc max, current limited to 750 mAdc @ +1 Vdc if output overloaded

RS-232 PORT

Signals	RxD, TxD, Gnd for operation as a DTE device
Mode	Full-duplex, DTE serial port for drive setup and control, 9,600 to 115,200 Baud
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, 1.5 µs RC filter, 15 kΩ pull-up to +5 Vdc, 74LVC14 Schmitt trigger
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) RS-422/RS-485 line receivers with fault detection for open/shorted inputs, or low signal amplitude
Secondary Incremental Encoder	Quad A/B/X signals connect to [IN4,5,6] when inputs are programmed as secondary encoder
Analog Incremental Encoder	Sin/cos format (sin+, sin-, cos+, cos-), differential, 1 Vpeak-peak X or S input may be firmware configured to latch position or time
SSI	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential
EnDat 2.1, 2.2	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential; optionally sin/cos signals
EnDat 2.1,2.2	Serial data and clock signals (DATA, /DATA, CLK, /CLK), differential
Absolute A, Tamagawa Absolute A, Panasonic Absolute A Format	SD+, SD- (S, /S) signals
BiSS (B&C)	MA+, MA-, SL+, SL-
Hall & encoder power	+5 Vdc ±2% @ 400 mAdc max, current limited to 750 mAdc @ +1 Vdc if output overloaded
Motemp [IN11]	Motor overtemperature switch input. Active level programmable, 4.99 kΩ pull-up to +5 Vdc Programmable to disable drive when motor over-temperature condition occurs
Voltage range	All inputs shown above are +5 Vdc tolerant

PROTECTIONS

HV Overvoltage	$+HV > HV_{max}$	Drive outputs turn off until $+HV < HV_{max}$ (See Input Power for HV_{max})
HV Undervoltage	+HV < +14 Vdc	Drive outputs turn off until +HV > +14 Vdc
Drive over temperature	Heat plate > 70°C.	Drive outputs turn off
Short circuits	Output to output, output to ground, internal PWM bridge faults	
I^2T Current limiting	Programmable: continuous current, peak current, peak time	
Motor over temperature	Digital inputs programmable to detect motor temperature switch	
Feedback Loss	Inadequate analog encoder amplitude or missing incremental encoder signals	

MECHANICAL & ENVIRONMENTAL

Size mm [in]	76.3 x 58.2 x 20.5 [3.01 x 2.29 x 0.81]
Weight	0.27 lb (0.12 kg) without 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

In accordance with EC Directive 2004/108/EC (EMC Directive)

EN 55011: 2007	CISPR 11:2003/A2:2006 Industrial, Scientific, and Medical (ISM) Radio Frequency Equipment – Electromagnetic Disturbance Characteristics – Limits and Methods of Measurement Group 1, Class A
EN 61000-6-1: 2007	Electromagnetic Compatibility (EMC) – Part 6-1: Generic Standards – Immunity for residential, Commercial and Light-industrial Environments

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

IEC 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

Underwriters Laboratory Standards

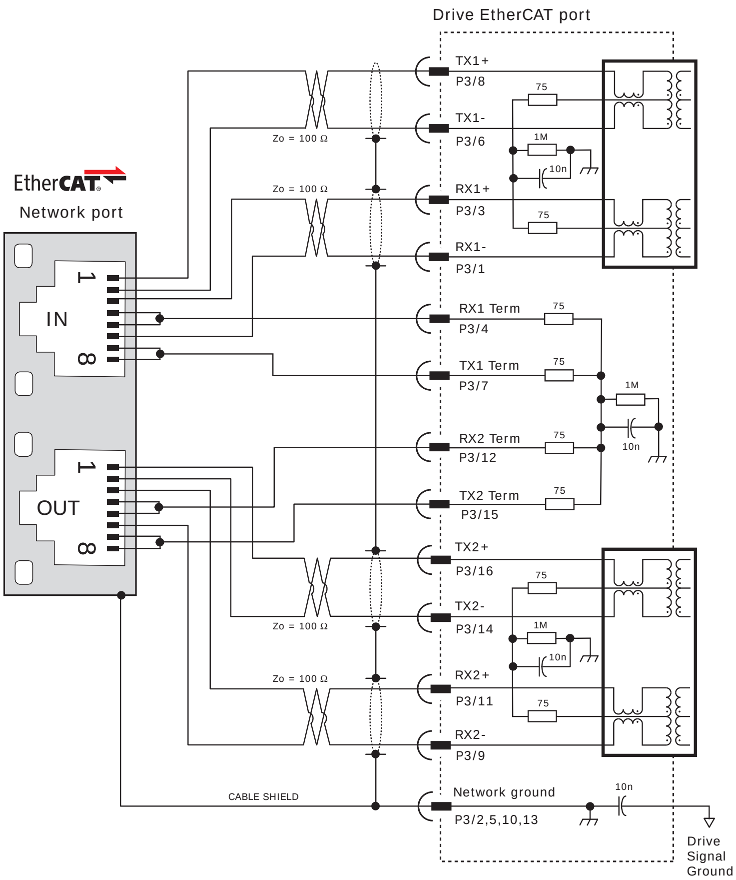
UL 61010-1, 2nd Ed.: 2004	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

UL File Number E249894

COMMAND INPUTS

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



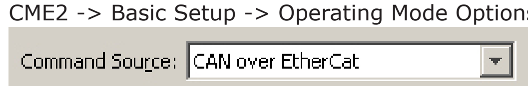
ETHERCAT CONNECTIONS

Page 11 shows guidelines for PC board layout and designing for EtherCAT signals.

Page 13 shows the dual EtherCAT cable connections on the Development Kit.

Magnetics are in the servo drive. External RJ-45 connectors do not require integrated magnetics.

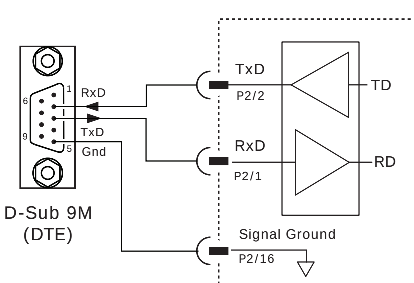
CME2 -> Basic Setup -> Operating Mode Options



RS-232 COMMUNICATIONS

AEM 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 *AEM* RS-232 port are through P2 The graphic below shows the connections between an *AEM* and a computer COM port which is a DTE device.

RS232 PORT

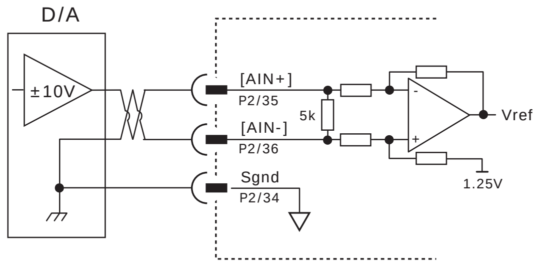


CME2 -> Tools -> Communications Wizard

COMMAND INPUTS

ANALOG COMMAND INPUT

The analog input has a ±10 Vdc range. As a reference input it can take position/velocity/torque commands from a controller.



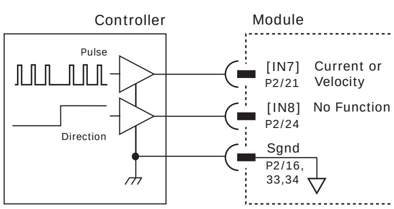
CME2 -> Basic Setup -> Operating Mode Options

DIGITAL COMMAND INPUTS

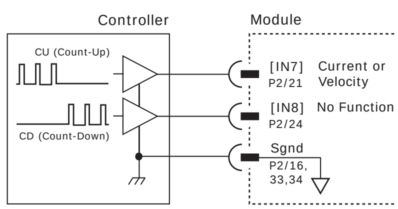
Digital commands are single-ended format and should be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs. The active edge (rising or falling) is programmable for the Pulse/Dir and CU/CD formats.

DIGITAL POSITION

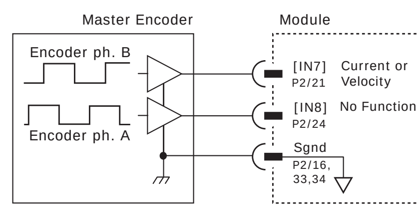
PULSE & DIRECTION



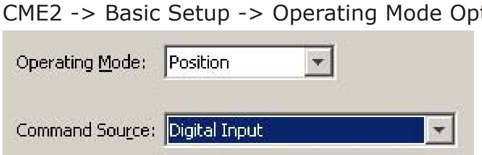
CU/CD



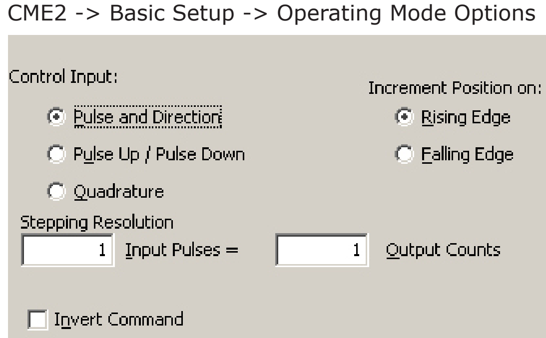
QUAD A/B ENCODER



CME2 -> Basic Setup -> Operating Mode Options

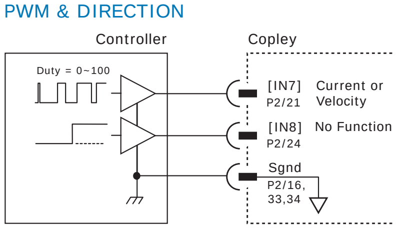


CME2 -> Basic Setup -> Operating Mode Options

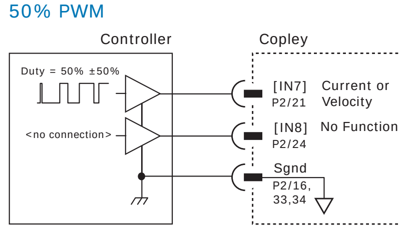


DIGITAL TORQUE, VELOCITY

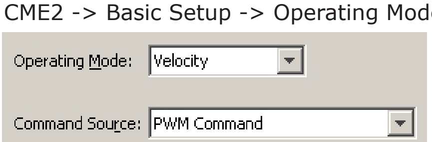
PWM & DIRECTION



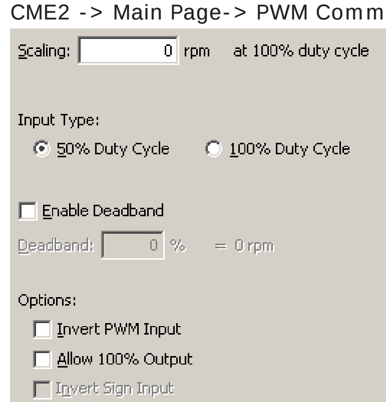
50% PWM



CME2 -> Basic Setup -> Operating Mode Options



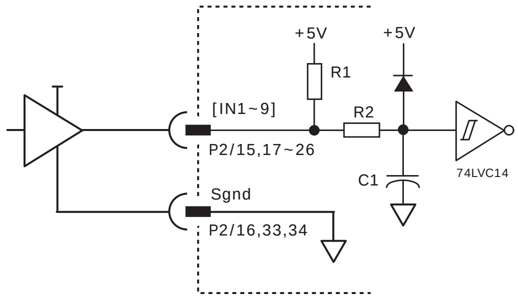
CME2 -> Main Page-> PWM Command



INPUT-OUTPUT

HIGH SPEED DIGITAL INPUTS

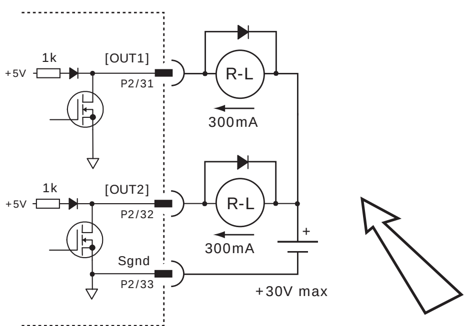
7V tolerant



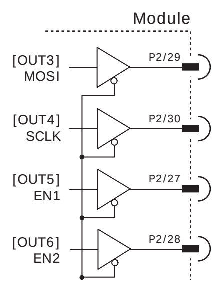
Input	P2 Pin	R1	R2	C1
IN1	15	10k	1k	100p
IN2	18			
IN3	17			
IN4	20			
IN5	19			
IN6	22			
IN7	21			
IN8	24			
IN9	23			
IN10	26			47p
IN11	25	4.99k	10k	33n

DIGITAL OUTPUTS

30V max



5V max



74HCT125

Diodes shown on outputs must be supplied when driving inductive loads.

Output	P2 Pin
OUT1	31
OUT2	32
OUT3	29
OUT4	30
OUT5	27
OUT6	28

ETHERCAT ALIAS (SLAVE ADDRESS) SWITCHES

The SLI (Switch & LED Interface) port takes in the 8 signals from the two BCD encoded switches that set the EtherCAT alias address and controls the LEDs on the EtherCAT port connectors.

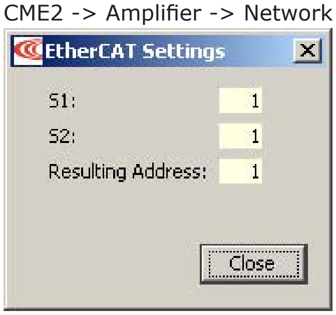
The graphic below shows the circuit for reading the EtherCAT address switches.

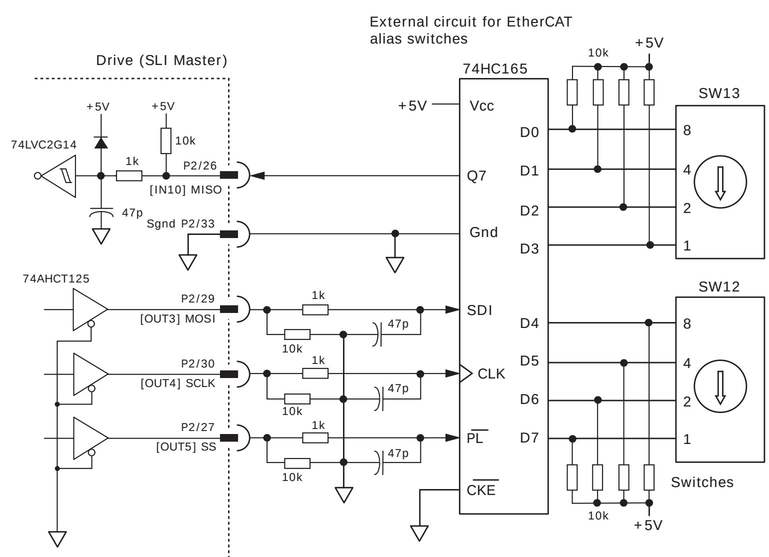
The 74HC165 works as a parallel-in/serial-out device.

The 10k pull-down resistors pull the shift register inputs to ground when the AEM is initializing.

In the graphics below, switch SW13 is “S2” and SW12 is “S1”. The values of S1 are 16~255 and of S2 are 0~15. Together they provide addressing range of 0~255.

CME2 -> Amplifier -> Network Configuration





MOTOR CONNECTIONS

Motor connections consist of: phases, Halls, encoder, thermal sensor, and brake. The phase connections carry the drive output currents that drive the motor to produce motion. The Hall signals are three digital signals that give absolute position feedback within an electrical commutation cycle. The encoder signals give position feedback and are used for velocity and position modes, as well as sinusoidal commutation. A thermal sensor that indicates motor overtemperature is used to shut down the drive to protect the motor. A brake can provide a fail-safe way to prevent movement of the motor when the drive is shut-down or disabled.

QUAD A/B INCREMENTAL ENCODER WITH FAULT PROTECTION

Encoders with differential line-driver outputs 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.

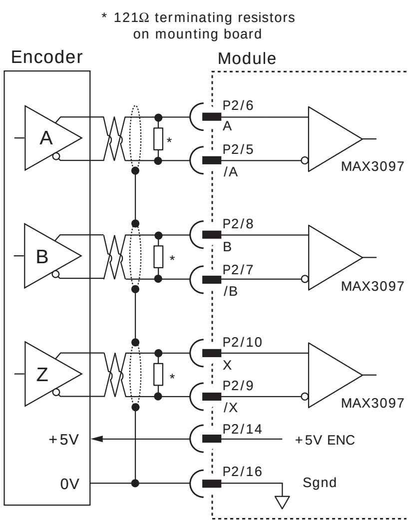
±15kV ESD protection: The 3097E has protection against high-voltage discharges using the Human Body Model.

Extended common-mode range: A fault occurs if the input common-mode voltage is outside of the range of -10V to +13.2V

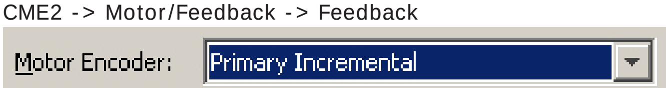
If encoder fault detection is selected (CME2 main page, Configure Faults block, Feedback Error) and an encoder with no index is used, then the X and /X inputs must be wired as shown below to prevent the unused index input from generating an error for *low differential voltage detection*.

DIGITAL QUADRATURE ENCODER INPUT

5V

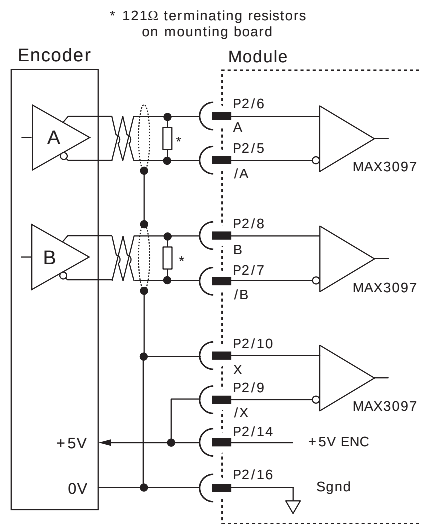


CME2 -> Motor/Feedback -> Feedback



A/B CONNECTIONS (NO INDEX)

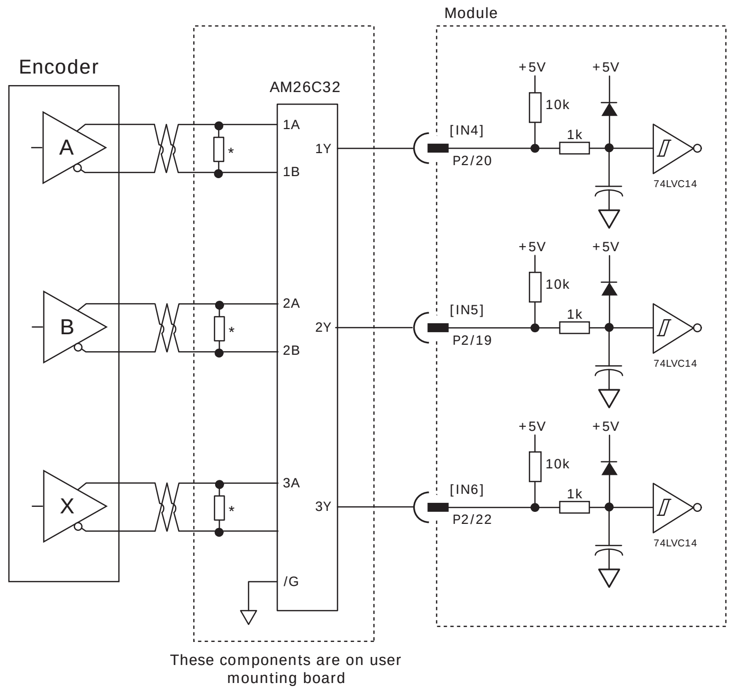
5V



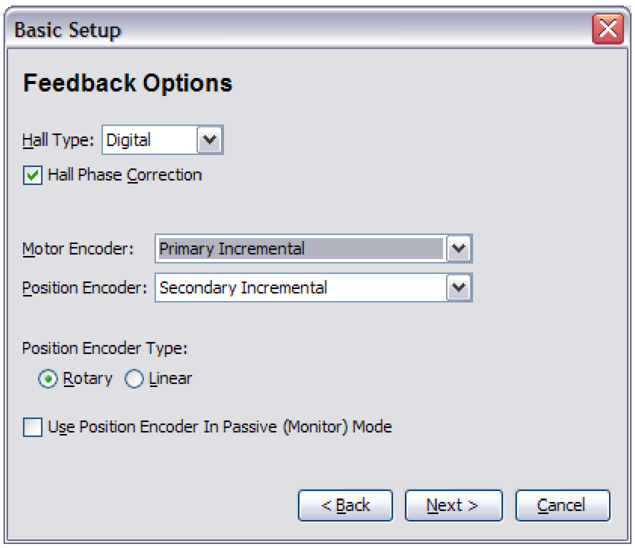
MOTOR CONNECTIONS (CONT'D)

SECONDARY QUAD A/B/X INCREMENTAL ENCODER

Digital inputs [IN4,5,6] can be programmed as secondary encoder inputs. The graphic shows a differential line receiver on the user mounting board to convert typical encoder signals into single-ended ones for the secondary inputs. Single-ended encoders would connect directly to the inputs of the AEM.



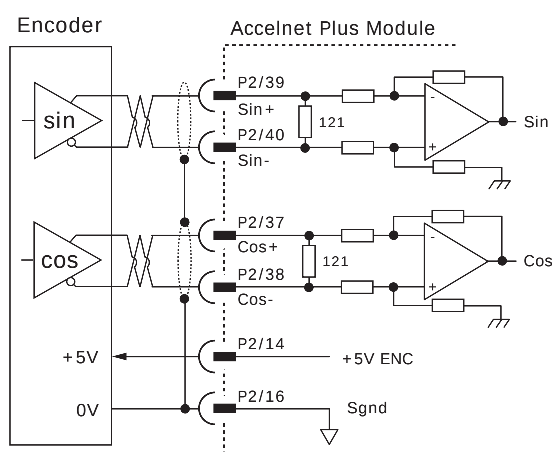
CME2 -> Basic Setup -> Feedback Options



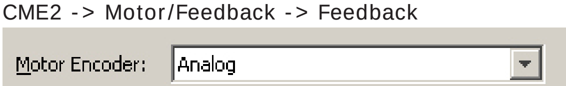
The CME2 screen above shows a Primary Incremental encoder for the motor input. Other types of encoders can be selected for this function. The secondary encoder input can be used for either motor or position feedback.

ANALOG SIN/COS INCREMENTAL ENCODER

The sin/cos 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.



CME2 -> Motor/Feedback -> Feedback

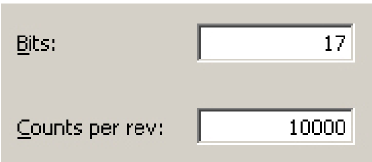


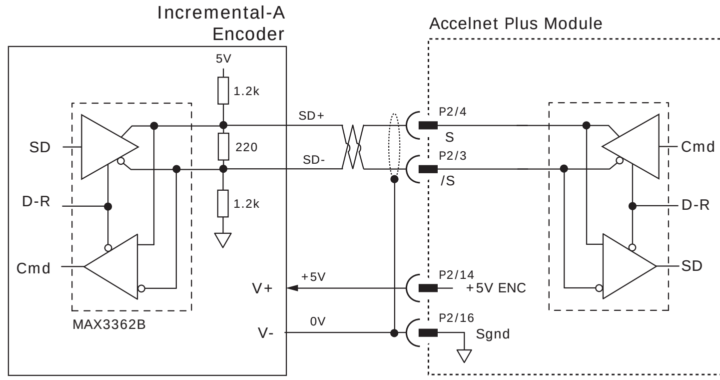
MOTOR CONNECTIONS (CONT'D)

PANASONIC INCREMENTAL A ENCODER

This is a "wire-saving" incremental encoder that sends serial data on a two-wire interface in the same fashion as an absolute encoder.

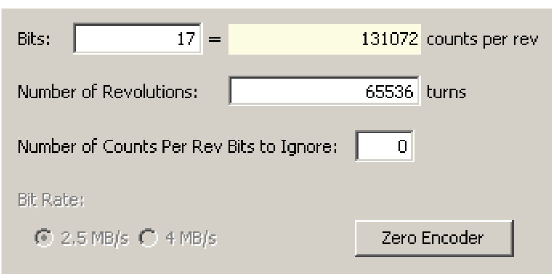
CME2 -> Basic setup -> Feedback

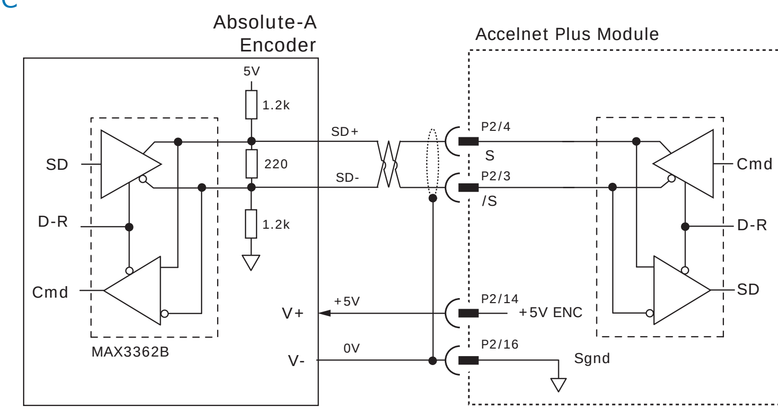




ABSOLUTE A ENCODER, TAMAGAWA, AND PANASONIC

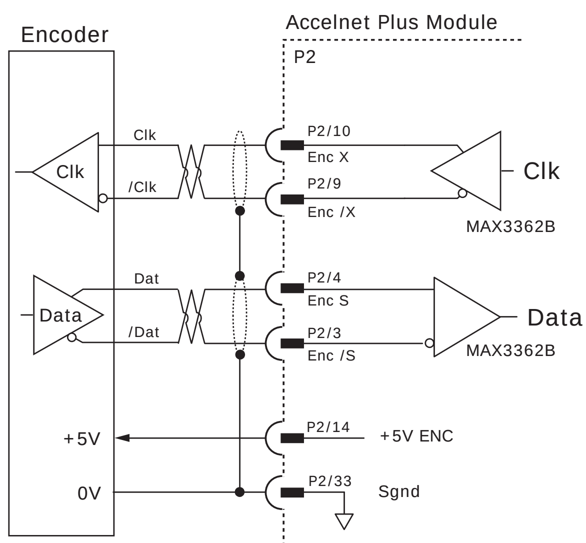
CME2 -> Motor/Feedback -> Feedback



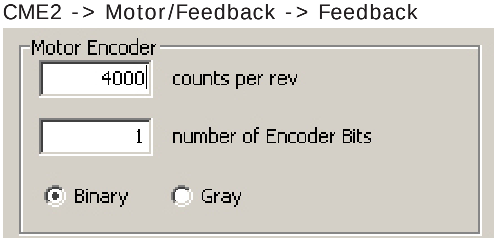


SSI ABSOLUTE ENCODER

The SSI (Synchronous Serial Interface) is an interface used to connect an absolute position encoder to a motion controller or control system. The Accelnet drive provides a train of clock signals in differential format (Clk, /Clk) 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. Data from the encoder in differential format (Dat, /Dat) MSB first. Binary or Gray encoding is selectable. When the LSB goes high and a dwell time has elapsed, data is ready to be read again.



CME2 -> Motor/Feedback -> Feedback

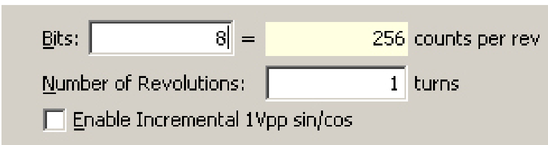


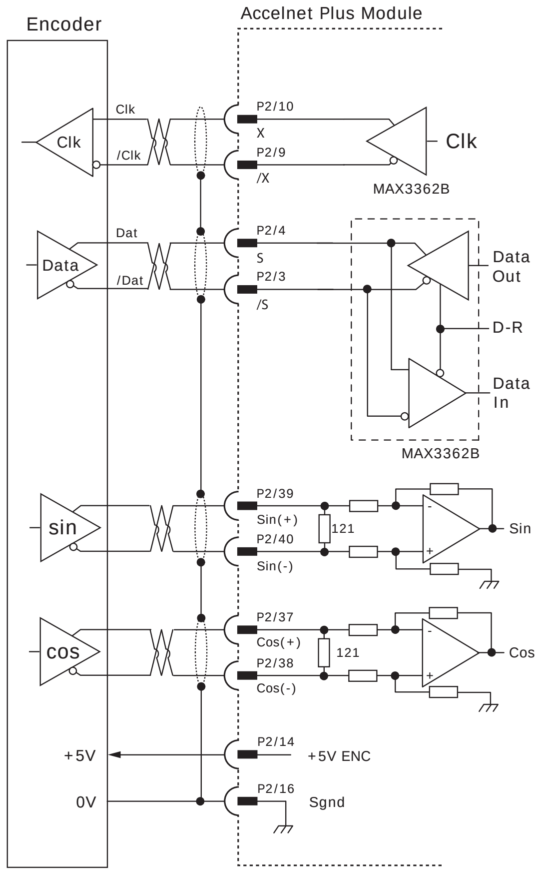
MOTOR CONNECTIONS (CONT'D)

ENDAT ABSOLUTE ENCODER

The EnDat interface is a Heidenhain interface that is similar to SSI in the use of clock and data signals for synchronous digital, bidirectional data transfer. It also supports analog sin/cos channels from the same encoder. The number of position data bits is programmable Use of sin/cos incremental signals is optional in the EnDat specification.

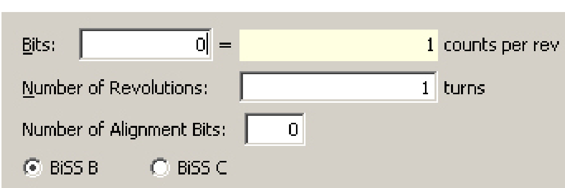
CME2 -> Motor/Feedback -> Feedback

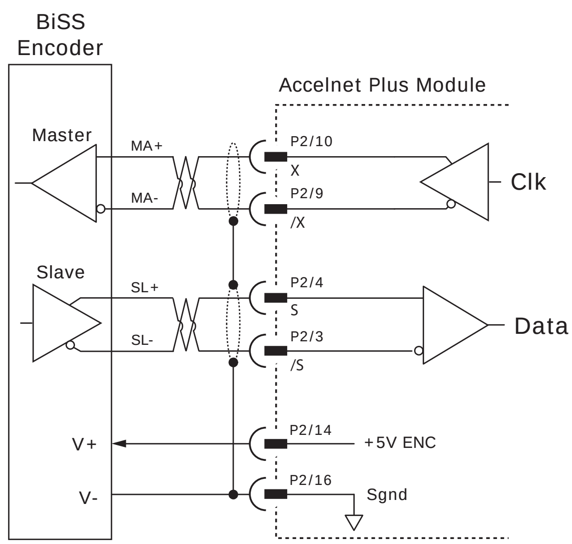




BISS (B & C) ABSOLUTE ENCODER

CME2 -> Motor/Feedback -> Feedback



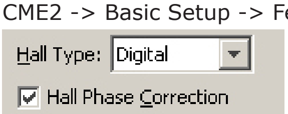


MOTOR CONNECTIONS (CONT'D)

DIGITAL HALL SIGNALS

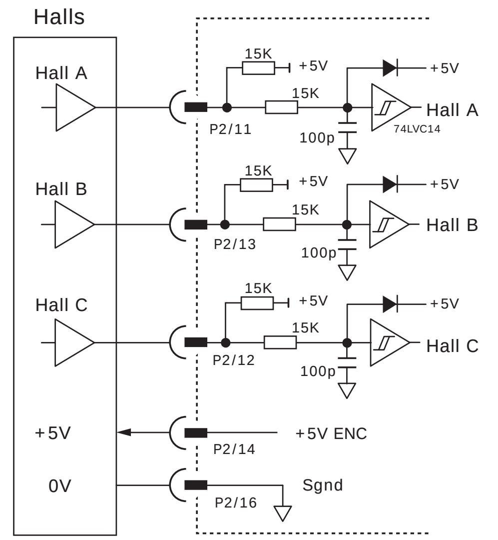
Hall signals are single-ended signals that provide absolute feedback within one electrical cycle of the motor. There are three of them (U, V, & W) and they may be sourced by magnetic sensors in the motor, or by encoders that have Hall tracks as part of the encoder disc. They typically operate at much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

CME2 -> Basic Setup -> Feedback Options



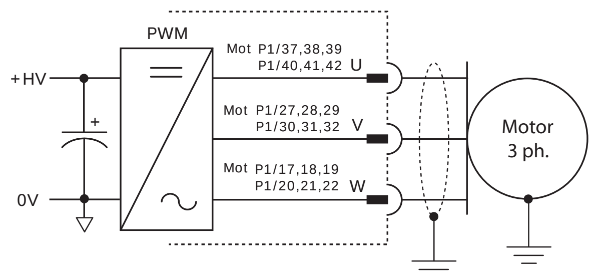
HALL INPUTS

5V

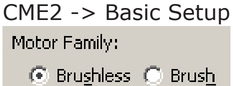


PHASE CONNECTIONS

The drive output is a three-phase PWM inverter that converts the DC bus voltage (+HV) into three sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the drive. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. The motor cable shield should connect to motor frame and the drive HV ground terminal (J2-1) for best results. When driving a DC motor, the W output is unused and the motor connects between the U & V outputs.



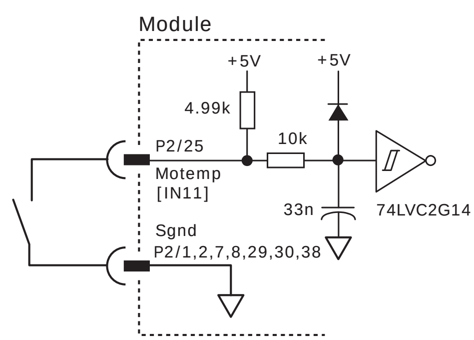
CME2 -> Basic Setup -> Motor Options



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.

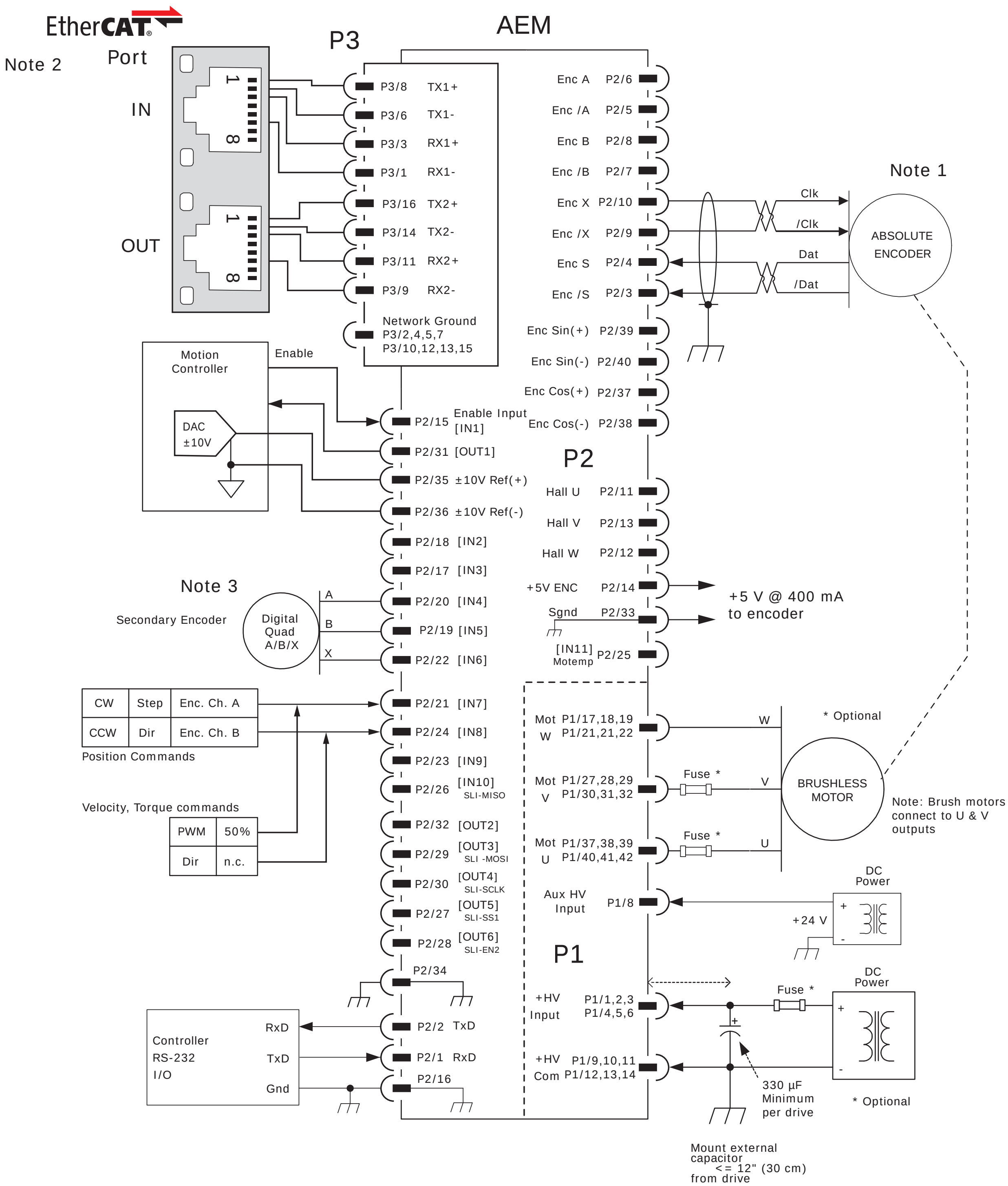
Property	Ohms
Resistance in the temperature range 20°C to +70°C	60~750
Resistance at 85°C	≤1650
Resistance at 95°C	≥3990
Resistance at 105°C	≥12000



24V tolerant

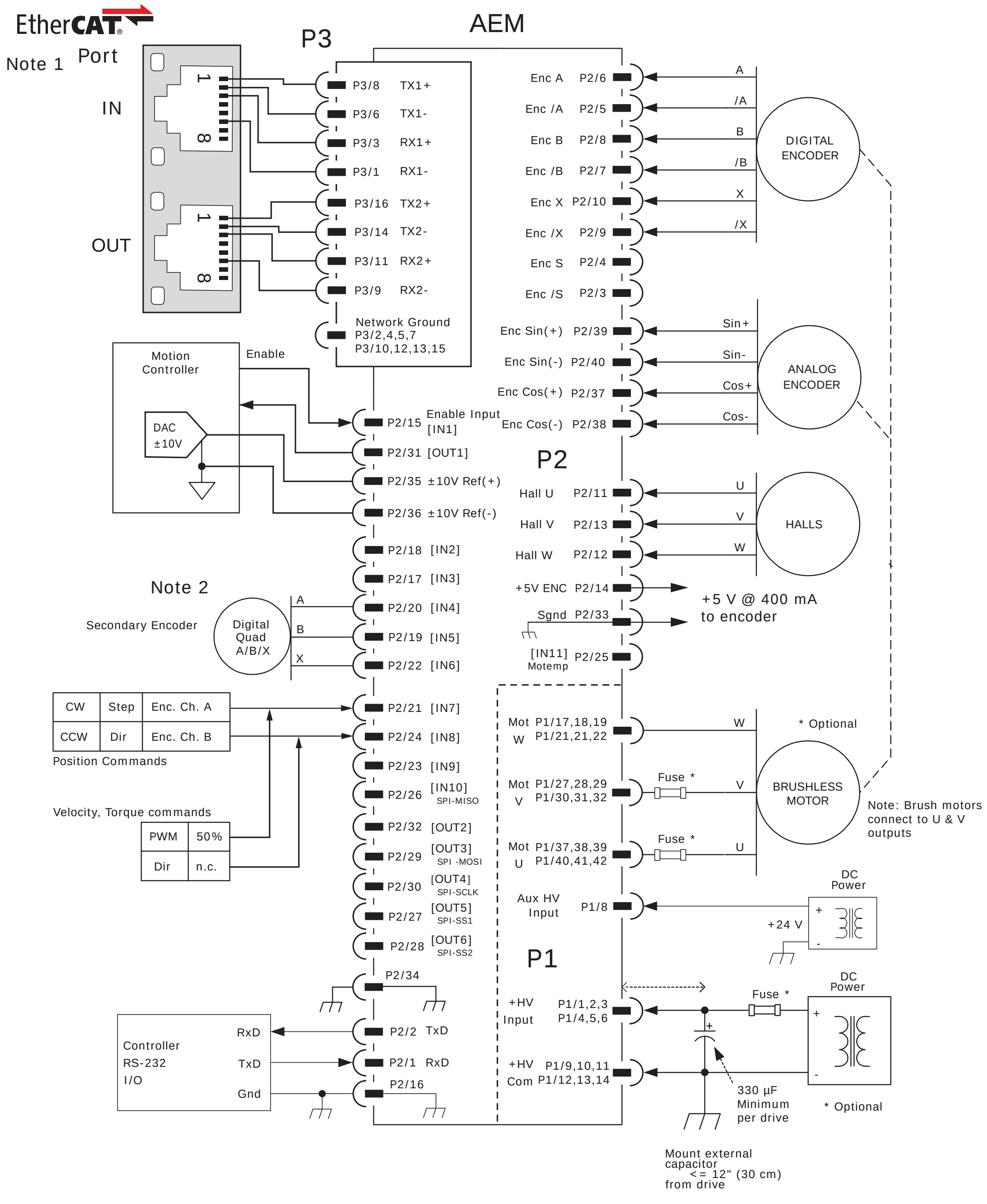
CME2 -> Input / Output

CONNECTIONS FOR ABSOLUTE ENCODER WITH DUPLEX CLOCK/DATA



Notes:
1. Connections are for BiSS and SSI encoders. Pages 9 & 10 show connections for other types of absolute encoders.
2. The EtherCAT connector is shown to illustrate connections between the AEM and external cabling. The connector is not part of the AEM and non-signal connections are not shown.
3. The secondary encoder is shown as a single-ended type. Page 8 shows connections for differential encoders which require a line receiver on the user's PC board.

CONNECTIONS FOR INCREMENTAL DIGITAL OR ANALOG ENCODERS



Notes:
1. The EtherCAT connector is shown to illustrate connections between the AEM and external cabling. The connector is not part of the AEM and non-signal connections are not shown.
2. The secondary encoder is shown as a single-ended type. Page 8 shows connections for differential encoders which require a line receiver on the user's PC board.

PRINTED CIRCUIT BOARD CONNECTORS & SIGNALS

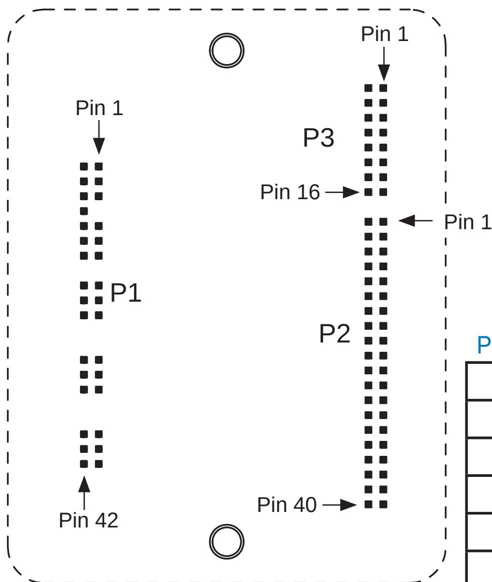
P1 POWER & MOTOR

Signal	Pin	Pin	Signal
+HV	2	1	+HV
+HV	4	3	+HV
+HV	6	5	+HV
Aux HV	8	7	
HVGnd	10	9	HVGnd
HVGnd	12	11	HVGnd
HVGnd	14	13	HVGnd
	16	15	
Mot W	18	17	Mot W
Mot W	20	19	Mot W
Mot W	22	21	Mot W
	24	23	
	26	25	
Mot V	28	27	Mot V
Mot V	30	29	Mot V
Mot V	32	31	Mot V
	34	33	
	36	35	
Mot U	38	37	Mot U
Mot U	40	39	Mot U
Mot U	42	41	Mot U

P1: Power & Motor
Dual row, 2 mm- centers
42 position female header
SAMTEC SQW-121-01-L-D

TOP VIEW

Viewed from above looking down on the connectors or PC board footprint to which the module is mounted



P3 ETHERCAT

Signal	Pin	Pin	Signal
NetGnd	2	1	RX1-
RX1 Term	4	3	RX1+
TX1-	6	5	NetGnd
TX1+	8	7	TX1 Term
NetGnd	10	9	RX2-
RX2 Term	12	11	RX2+
TX 2-	14	13	NetGnd
TX2+	16	15	TX2 Term

P3: EtherCAT
Dual row, 2 mm- centers
16 position female header
SAMTEC SQW-108-01-L-D

P2 CONTROL

Signal	Pin	Pin	Signal
RS-232 TxD	2	1	RS-232 RxD
Enc S	4	3	Enc /S
Enc A	6	5	Enc /A
Enc B	8	7	Enc /B
Enc X	10	9	Enc /X
Hall W	12	11	Hall U
+5V ENC	14	13	Hall V
Sgnd	16	15	[IN1] HS
HS [IN2]	18	17	[IN3] HS
HS [IN4]	20	19	[IN5] HS
HS [IN6]	22	21	[IN7] HS
HS [IN8]	24	23	[IN9] HS
MISO [IN10]	26	25	[IN11] Motemp
[OUT6]	28	27	[OUT5] SLI-SS1
SLI-SCLK [OUT4]	30	29	[OUT3] SLI-MOSI
MOSFET [OUT2]	32	31	[OUT1] MOSFET
Sgnd	34	33	Sgnd
Ref(-)	36	35	Ref(+)
Enc Cos(-)	38	37	Enc Cos(+)
Enc Sin (-)	40	39	Enc Sin(+)

P2: Control
Dual row, 2 mm- centers
40 position female header
SAMTEC SQW-120-01-L-D

Notes:
1. P1 connections use multiple pins to share current. *All signals of the same name must be connected* on the PC board to which the AEM is mounted.
2. Cells in table above that are filled in grey are connector contacts that have no circuit connections.

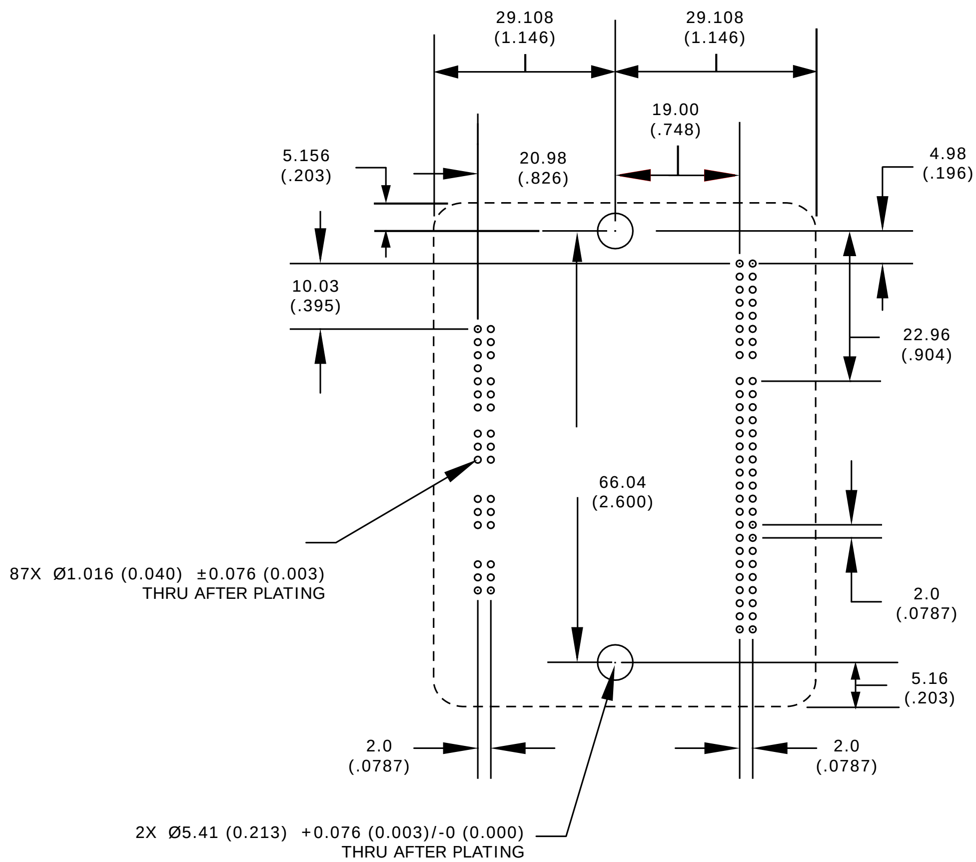
PRINTED CIRCUIT BOARD FOOTPRINT

Dimensions are in. [mm]

TOP VIEW

Viewed from above looking down on the connectors or PC board footprint to which the module is mounted

P1 Signal Grouping for current-sharing See Note 1



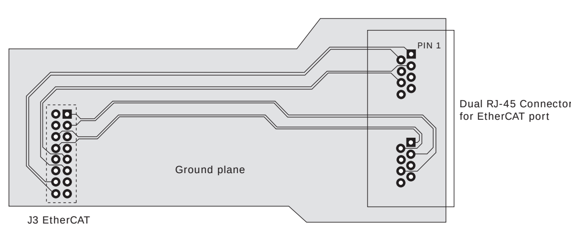
Mounting Hardware:

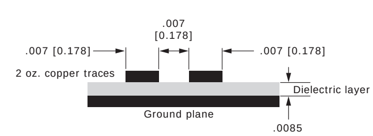
Qty	Description	Mfgr	Part Number	Remarks
1	Socket Strip	Samtec	SQW-121-01-L-D	J1 HV & Motor
1	Socket Strip	Samtec	SQW-120-01-L-D	J2 Control
1	Socket Strip	Samtec	SQW-108-01-L-D	J3 EtherCAT
2	Standoff 6-32 X 1/4"	PEM	KFE-632-8ET	

Notes
1. J1 signals of the same name must be connected for current-sharing (see graphic above).
2. To determine copper width and thickness for J3 signals refer to specification IPC-2221. (Association Connecting Electronic Industries, http://www.ipc.org)
3. Standoffs should be connected to etches on pc board that connect to frame ground for maximum noise suppression and immunity.

PRINTED CIRCUIT BOARD DESIGN FOR ETHERCAT SIGNALS

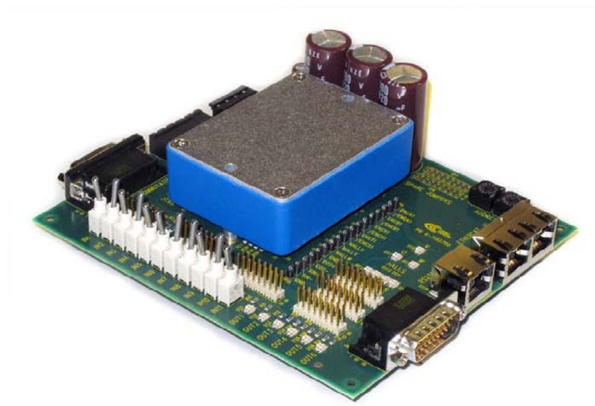
EtherCAT signal routing must produce a controlled impedance to maintain signal quality. This graphic shows some principles of PC board design that should be followed. Traces for differential signals must have controlled spacing trace-trace, trace thickness, and spacing above a ground plane. All these things and the properties of the dielectric between ground plane and signals affect the impedance of the traces. The dimensions shown here are typical.
The graphic on p. 4 detailing the EtherCAT connections shows resistors and a capacitor in the drive for terminating the unused conductors.
As an alternative to adding traces back to the drive connector J3 for these signals, the same parts can be placed on the board at the RJ-45 connector, leaving only the differential EtherCAT signals to be routed with controlled impedance.





DESCRIPTION

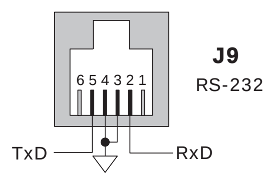
The Development Kit provides mounting and connectivity for one AEM drive. Solderless jumpers ease configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~11 so that these can be toggled to simulate equipment operation. Six LED's provide status indication for the digital outputs. Dual EtherCAT connectors make daisy-chain connections possible so that other EtherCAT devices such as Copley's Accelnet Plus or Xenus Plus Ethercat drives can easily be connected.



RS-232 CONNECTION

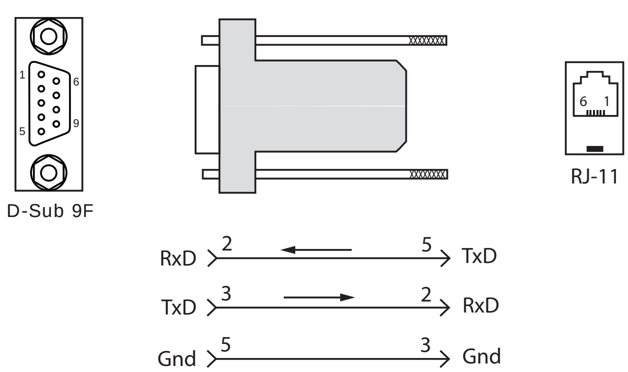
The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an EtherCAT network. CME 2™ software communicates with the drive over this link and is then used for complete drive setup. The EtherCAT Slave ID address that is set by the rotary switch can be monitored, and an address offset programmed as well.

The RS-232 connector, J9, is a modular RJ-11 type that uses a 6-position plug, four wires of which are used for RS-232. A connector kit is available (SER-CK) that includes the modular cable, and an adaptor to interface this cable with a 9-pin RS-232 port on a computer.



SER-CK SERIAL CABLE KIT

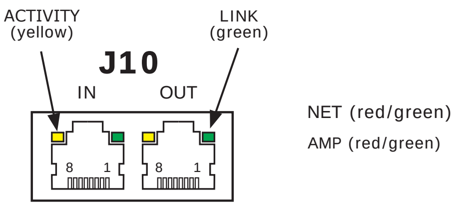
The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector J9 on the Development Kit. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses common modular cable to connect to the XEL. The connections are shown in the diagram below.



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

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 'up-stream', 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)

Green and yellow LEDs indicate the state of the EtherCAT interface:

Green is the "Link" indicator:
On = Good Link
Off = No Link

Yellow is the "Activity" indicator:
On = Activity
Blinking = No Activity

J10: EtherCAT PORTS

RJ-45 receptacles,
8 position, 4 contact

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

NET STATUS LED

A bi-color LED indicates the state of the EtherCAT bus.
Green and red colors alternate, and each color has a separate meaning:

Green is the "RUN" or EtherCAT State Machine:
Off = INIT state
Blinking = PRE-OPERATIONAL
Single Flash = SAFE-OPERATIONAL
On = OPERATIONAL

Red is the "ERR" indicator:
Blinking = Invalid configuration
Single Flash = Unsolicited state change
Double Flash = Application watchdog timeout

AMP STATUS LED

A bi-color LED gives the state of the Accelnet drive.
Colors do not alternate, and can be solid ON or blinking:

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

EtherCAT ADDRESS (STATION ALIAS)

In an EtherCAT network, slaves are automatically assigned addresses based on their position in the bus. But when the device must have a positive identification that is independent of cabling, a Station Alias is needed. In the AEM DevKit, this is provided by two 16-position rotary switches 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.

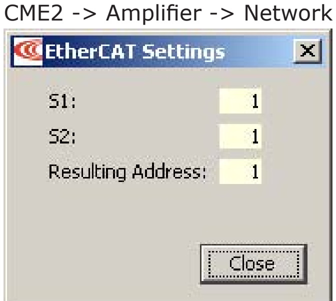
Example 1: Find the switch settings for decimal address 107:

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

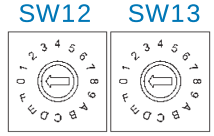
EtherCAT Address Switch Decimal values

	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

CME2 -> Amplifier -> Network Configuration



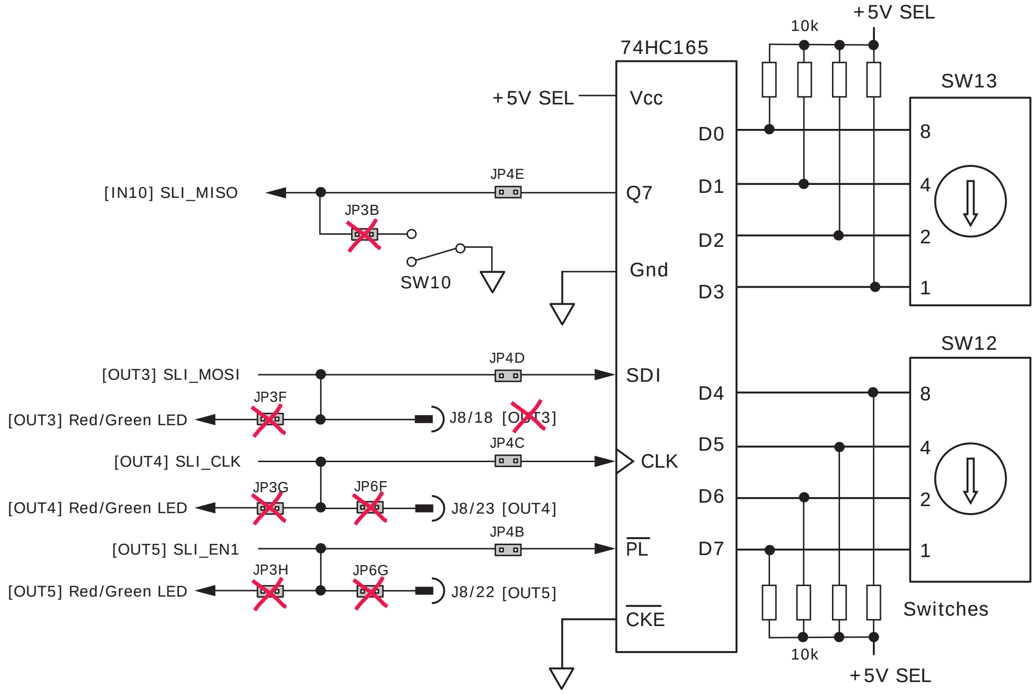
SW12 SW13



ETHERCAT SLAVE ADDRESS (STATION ALIAS) SWITCH CONNECTIONS

The graphic below shows the connections to the EtherCAT address switches. These are read after the drive is reset, or powered-on. When changing the settings of the switches, be sure to either reset the drive, or to power it off-on. Outputs [OUT3,4,5] and input [IN10] operate as an SLI (Switch & LED Interface) port which reads the settings on the EtherCAT address switches, and controls the LEDs on the serial and EtherCAT port connectors.

The jumpers marked with red "X" should be removed so that SW10, or external connections to the signals do not interfere with the operation of the SLI port. The "X" on [OUT3] shows that no connections should be made to this by the user when the SLI port is active.



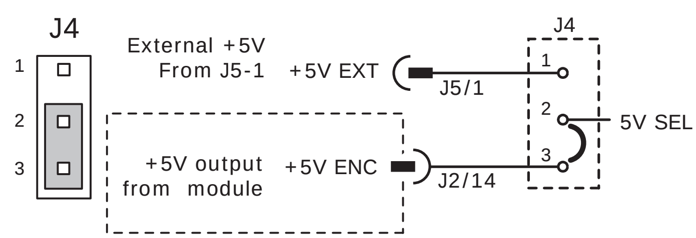
5V POWER SOURCES

The feedback connector J7 has connections for two power supplies:

Pin 6 has +5V ENC supplied by the Accelnet Plus module
Pin 17 connects to jumper J4 for the selection of the encoder +5V power source:
On J4, when the jumper connects pins 2 & 3, the power source is the Accelnet Plus module internal supply (the default setting)
When the jumper is on pins 1 & 2, the power source comes from an external power supply connecting to J5-1.

5V power on the Development Kit that comes from the selectable 5V power source on J4 is labeled "5V SEL".

Circuits powered by 5V supplied only by the Accelnet Plus module are labeled "5V ENC"

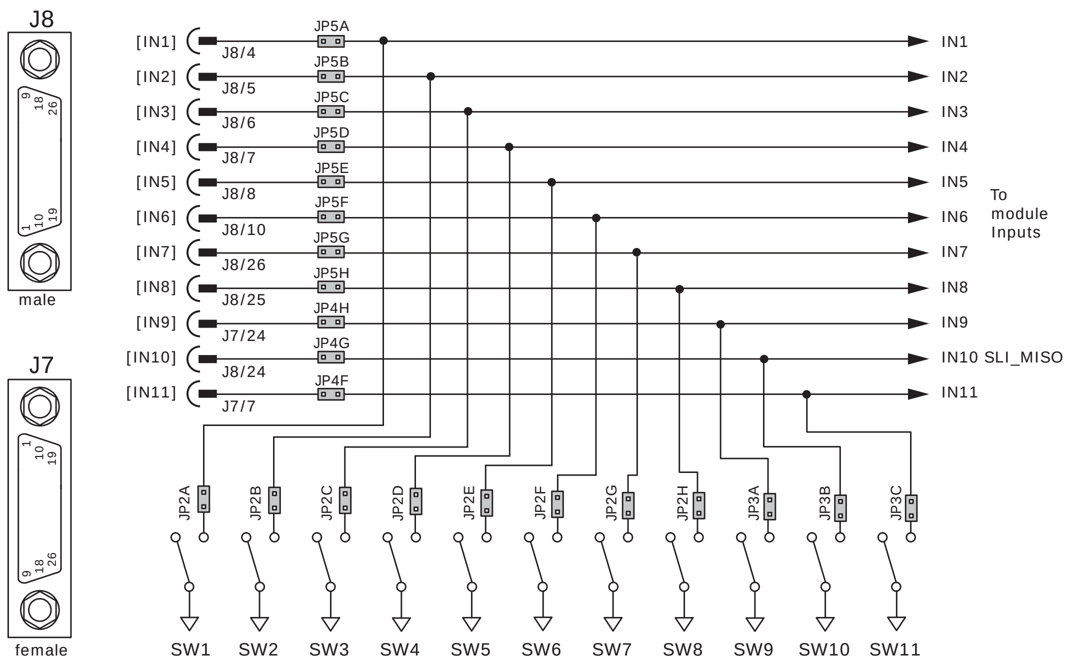


LOGIC INPUTS & SWITCHES

The Development Kit has jumpers that can connect the AEM digital inputs to switches on the kit, or to the Signal connector J8.

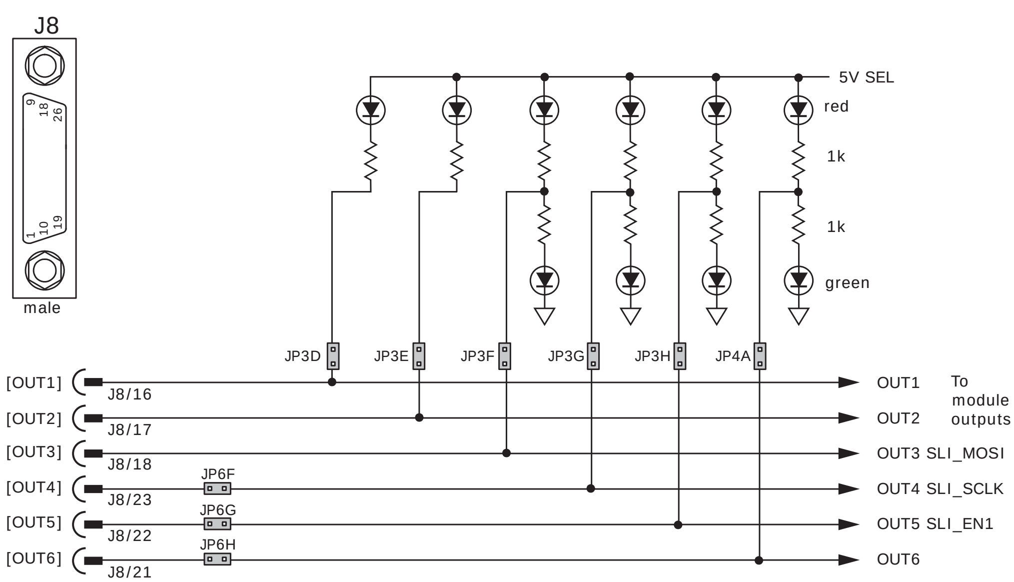
As delivered, all of these jumpers are installed as shown. If connecting to external devices that actively control the level of an input, it is desirable to disconnect the switch which could short the input to ground.

For example, if [IN1] is connected to an external device for the Enable function, then jumper JP2A should be removed to take the switch SW1 out of the circuit. The figure below shows these connections.



LOGIC OUTPUTS

There are six logic outputs that can drive controller logic inputs or relays. If relays are driven, then flyback diodes must be connected across their terminals to clamp overvoltages that occur when the inductance of the relay coil is suddenly turned off. Outputs 3,4,5 & 6 are CMOS types that pull up to 5V or down to ground. When these outputs go high it turns on the green LED. When they are low, the red LED is turned on. Outputs 1 & 2 are MOSFET types that sink current when ON, and appear as open-circuit when OFF. When these outputs are ON a red LED is turned on. When the outputs are OFF, the red LED is off. The green LED is not used on these outputs.



MOTOR FEEDBACK CONNECTOR J7

For motors with differential encoders: install jumpers JP1B, JP1D, JP1F, and JP1H to connect 121 ohm terminators across inputs Jumpers JP1A, JP1C, JP1E, and JP1G do not affect this setting and may remain in place or be removed.

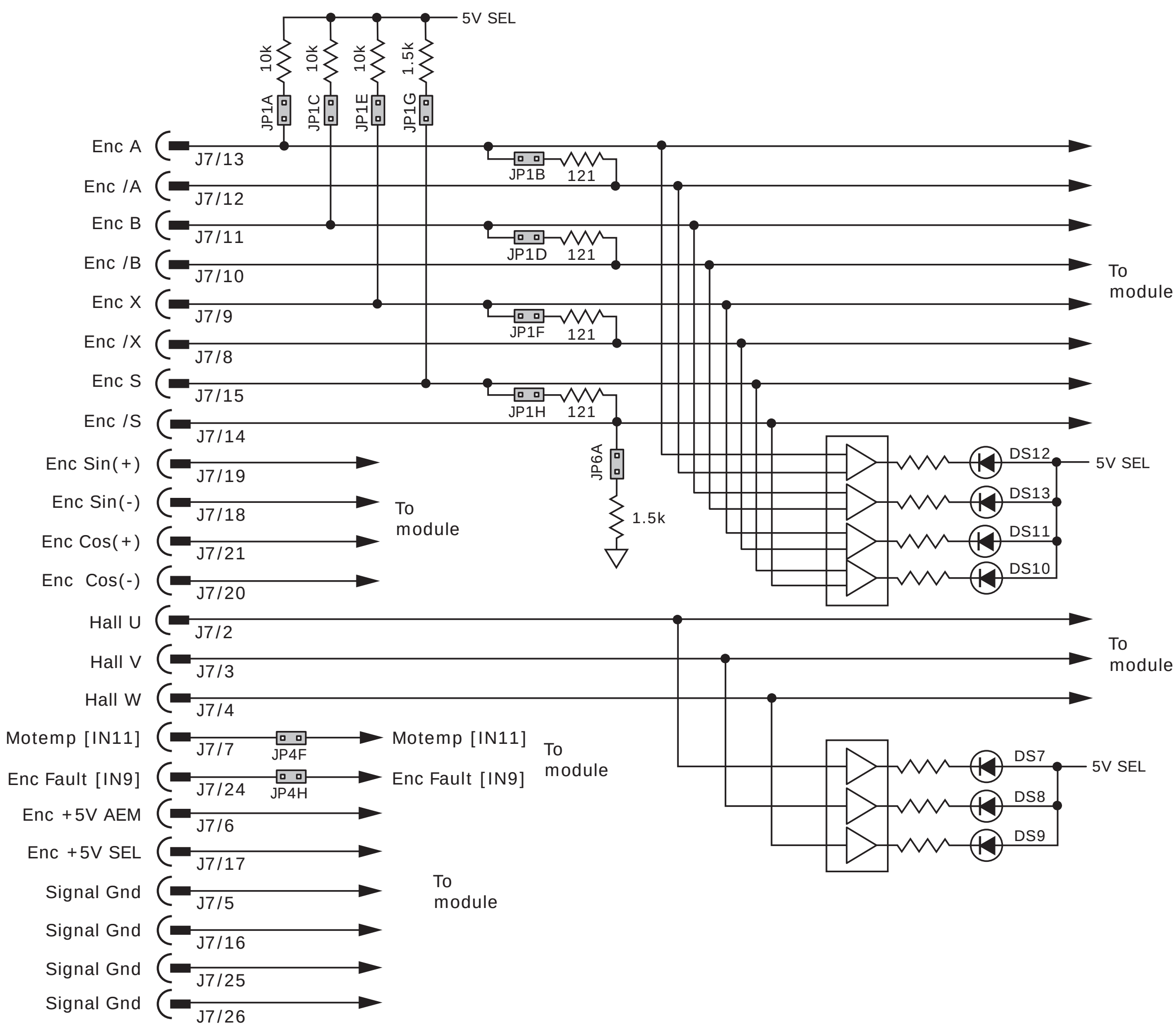
For motors with single-ended encoders: remove jumpers JP1B, JP1D, JP1F, and JP1H to disconnect 121 ohm terminators Install jumpers JP1A, JP1C, JP1E, and JP1G

A motor temperature sensor that connects to [IN11] must have jumper JP4F installed and JP3C removed to prevent switch SW11 from grounding the Motemp[IN11] signal.

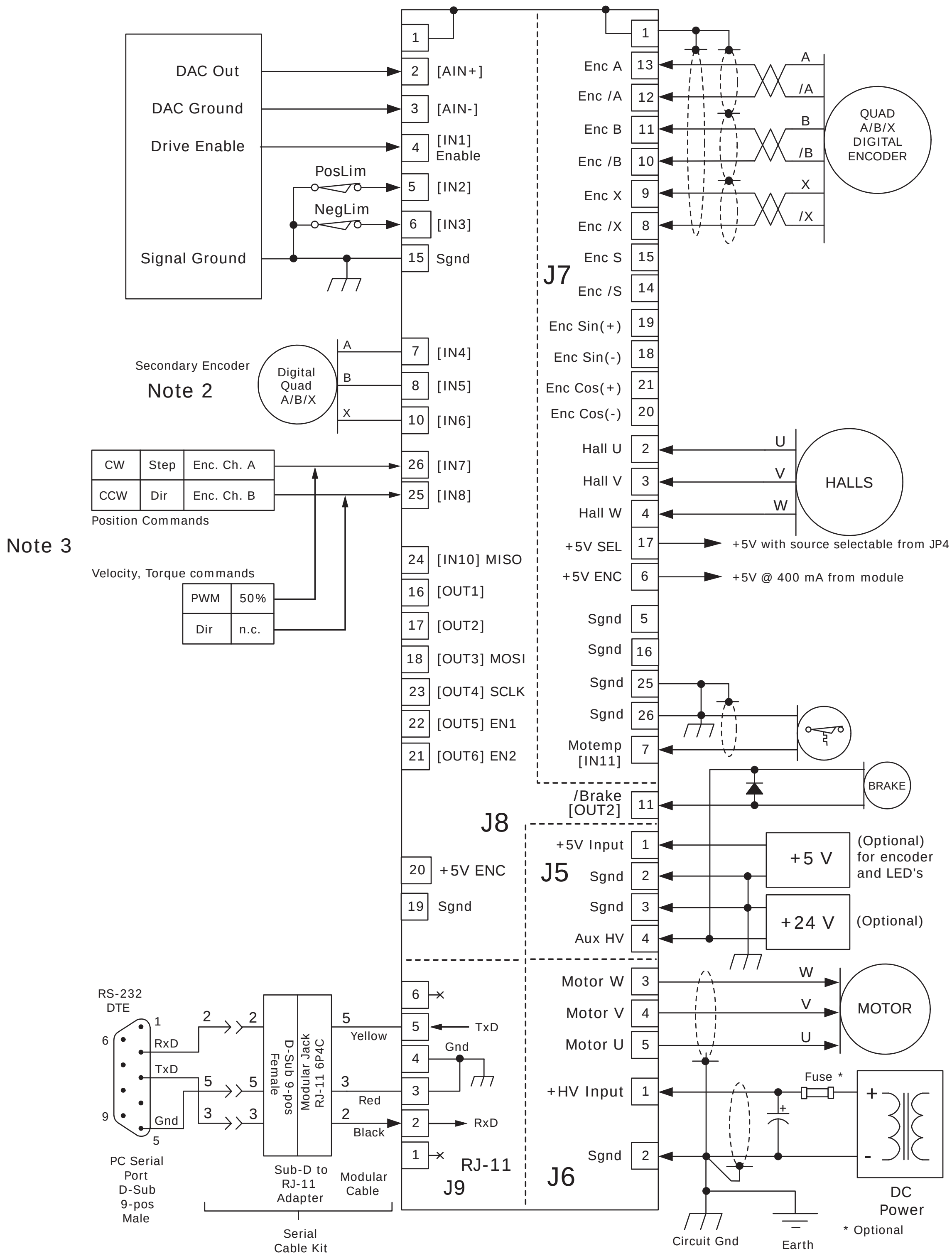
If the encoder has a fault output, then jumper JP4H must be in place and jumper JP3A must be removed to prevent switch SW9 from grounding the Enc Fault [IN9] signal.

Absolute encoders such as the Nikon A type that use 2-wire bidirectional signals require biasing the lines when they are in a quiescent state. Jumpers JP1G, JP1H, and JP6A must be in place to provide line termination and biasing.

LED's are provided to show the status of the encoder and Hall signals.



DEVELOPMENT KIT CONNECTIONS



Notes:
1. EtherCAT connectors J10 are not shown here. For details see pp 4 & 13.
2. When using a secondary encoder jumpers JP5D,E,F must be IN, and jumpers JP2D,E,F must be OUT.
3. When using digital commands, jumpers JP5G,H must be IN, and jumpers JP2G,H must be OUT

DEVELOPMENT KIT

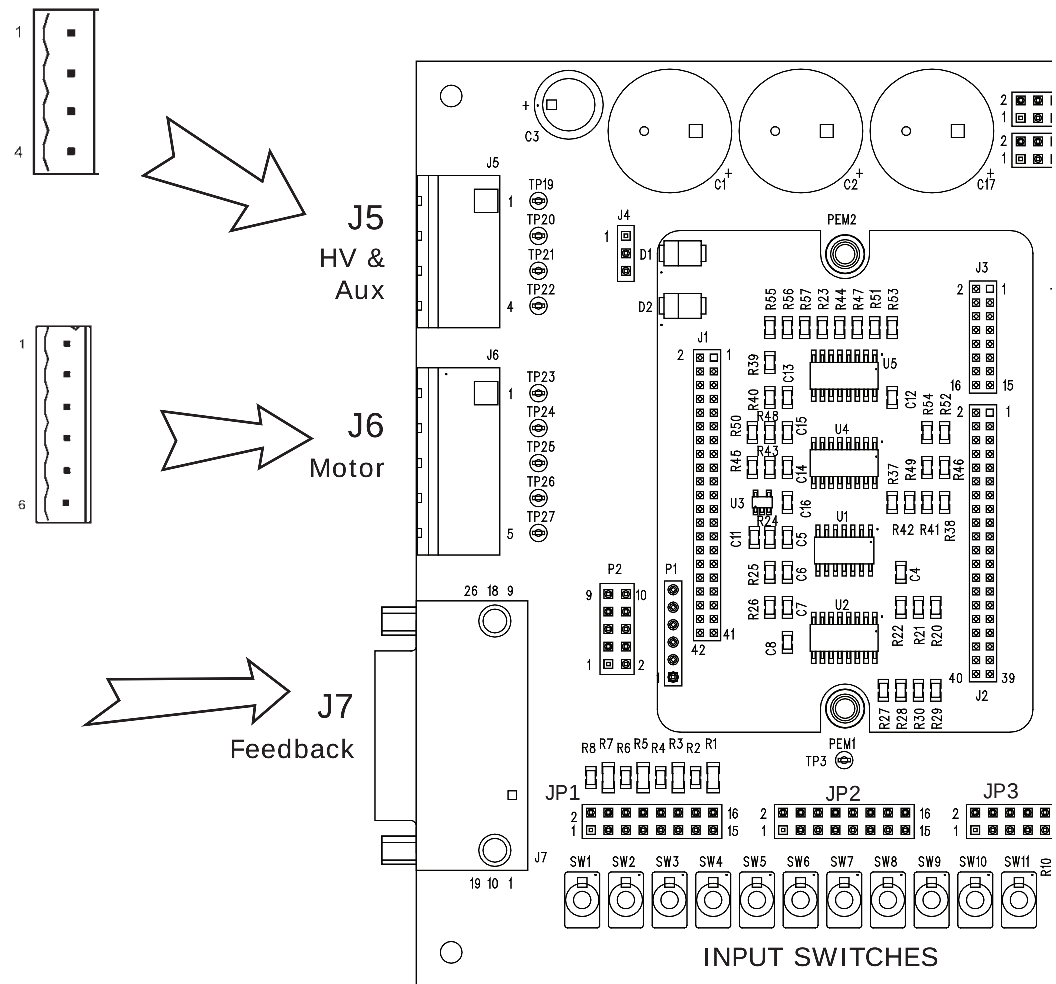
The Development Kit mounts a single AEM module and enables the user to test and operate the AEM before it is mounted onto a PC board in the target system.

J5 AUX HV & EXT 5V

Signal	Pin
+5V Ext	1
Gnd	2
Gnd	3
Aux HV Input	4

J6 MOTOR

Signal	Pin
+HV Input	1
HV Gnd	2
Motor W	3
Motor V	4
Motor U	5



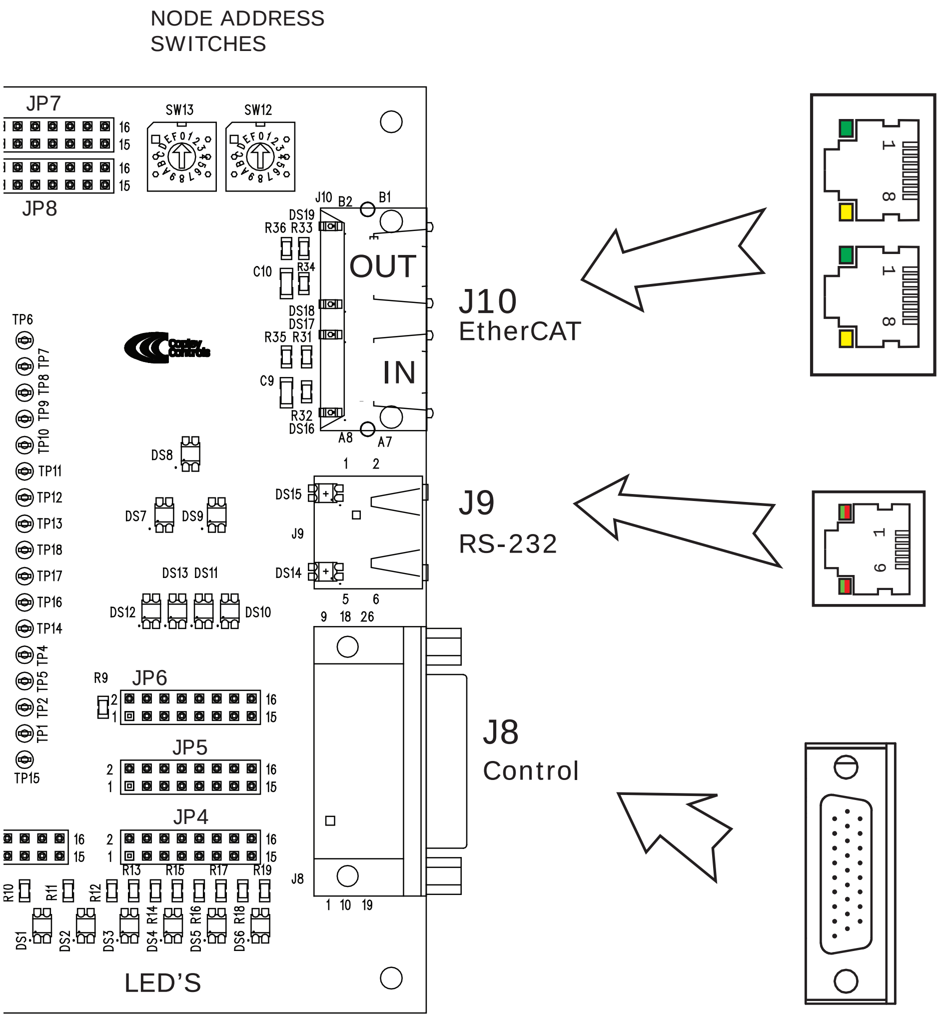
J7 FEEDBACK

PIN	SIGNAL
26	Signal Gnd
25	Signal Gnd
24	[IN9] Enc Fault*
23	n.c.
22	n.c.
21	Cos(+)
20	Cos(-)
19	Sin(+)

PIN	SIGNAL
18	Sin(-)
17	+5V SEL
16	Signal Gnd
15	Enc S
14	Enc /S
13	Enc A
12	Enc /A
11	Enc B
10	Enc /B

PIN	SIGNAL
9	Enc X
8	Enc /X
7	[IN11] Motemp*
6	+5V ENC
5	Signal Gnd
4	Hall W
3	Hall V
2	Hall U
1	Frame Gnd

* Signal connections on the PC board are affected by jumper placement



J10 ETHERCAT

Pin	Signal
1	TX+
2	TX-
3	RX+
6	RX-

J9 RS-232

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

J8 CONTROL

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
9	n.c.	18	[OUT3] SLI-MOSI*		
8	[IN5] HS*	17	[OUT2] MOSFET	26	[IN7] HS*
7	[IN4] HS*	16	[OUT1] MOSFET	25	[IN8] HS*
6	[IN3] HS*	15	Signal Gnd	24	[IN10] SLI-MISO*
5	[IN2] HS*	14	n.c.	23	[OUT4] SLI-SCLK*
4	[IN1] HS*	13	n.c.	22	[OUT5] SLI-SS1*
3	[AIN-]	12	n.c.	21	[OUT6] SLI-SS2*
2	[AIN+]	11	n.c.	20	+5V ENC
1	Frame Gnd	10	[IN6] HS*	19	Signal Gnd

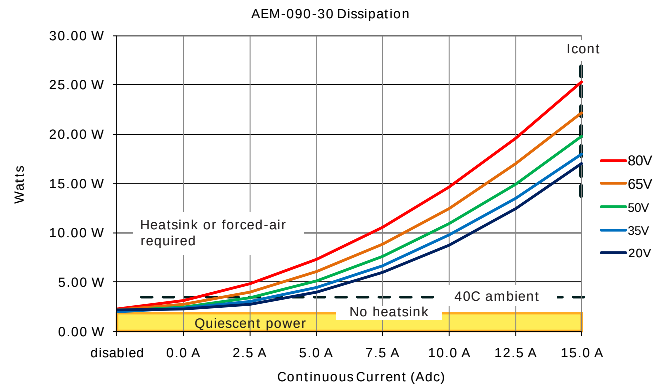
* Signal connections on the PC board are affected by jumper placement

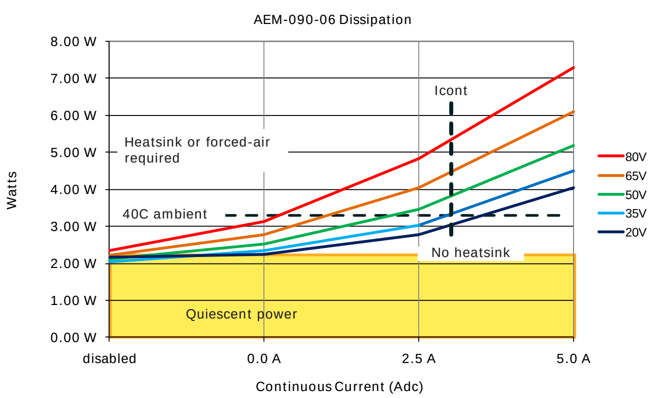
POWER DISSIPATION

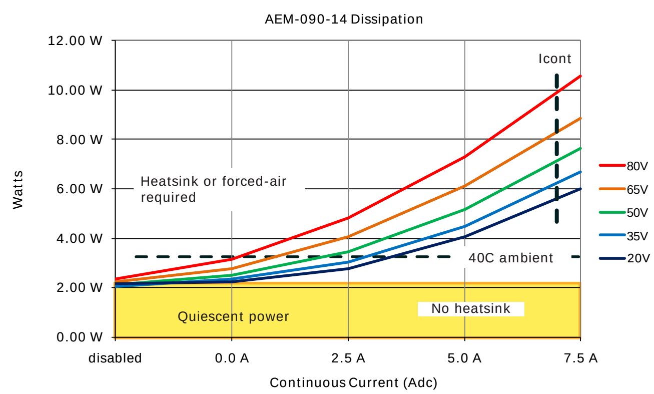
The charts on this page show the internal power dissipation for different models under differing power supply and output current conditions. The values on the chart represent the continuous current that the drive would provide during operation. The +HV values are for the average DC voltage of the drive power supply.

To see if a heatsink is required or not, the next step is to determine the temperature rise the drive will experience when it's installed. For example, if the ambient temperature in the drive enclosure is 40 °C, and the heatplate temperature is to be limited to 70° C or less to avoid shutdown, the maximum rise would be 70C - 40C. or 30° C. Dividing this dissipation by the thermal resistance of 9° C/W with no heatsink gives a dissipation of 3.33W. This line is shown in the charts. For power dissipation below this line, no heatsink is required. The vertical dashed line shows the continuous current rating for the drive model.

Note: These charts are based on the total power dissipation in the drive which includes quiescent operating power and dissipation in the PWM output section.





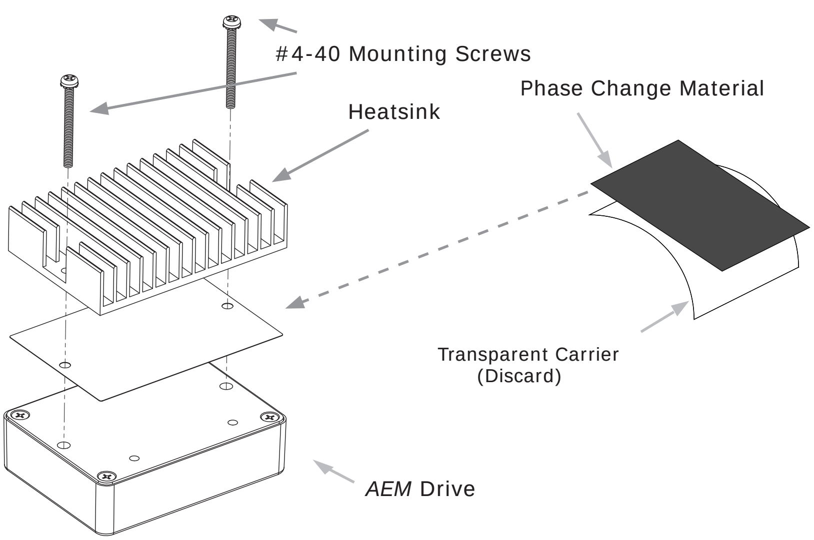


HEATSINK INSTALLATION

If a heatsink is used it is mounted using the same type of screws used to mount the drive without a heatsink but slightly longer. Phase change material (PSM) is used in place of thermal grease. This material comes in sheet form and changes from solid to liquid form as the drive warms up. This forms an excellent thermal path from drive heatplate to heatsink for optimum heat transfer.

STEPS TO INSTALL

1. Remove the PSM (Phase Change Material) from the clear plastic carrier.
2. Place the PSM on the *Accelnet* aluminum heatplate taking care to center the PSM holes over the holes in the drive body.
3. Mount the heatsink onto the PSM again taking care to see that the holes in the heatsink, PSM, and drive all line up.
4. Torque the #4-40 mounting screws to 3~5 lb-in (0.34~0.57 N·m).



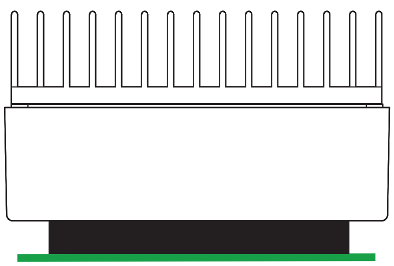
HEATSINK OPTIONS

Rth expresses the rise in temperature of the drive per Watt of internal power loss. The units of Rth are °C/W, where the °C represent the rise above ambient in degrees Celsius. The data below show thermal resistances under convection, or fan-cooled conditions for the no-heatsink, and AEM-HS heatsink.

NO HEATSINK

NO HEATSINK	C/W
CONVECTION	9.1
FORCED AIR (300 LFM)	3.3

STANDARD HEATSINK (AEM-HK)



WITH HEATSINK	C/W
CONVECTION	5.3
FORCED AIR (300 LFM)	1.1

MASTER ORDERING GUIDE

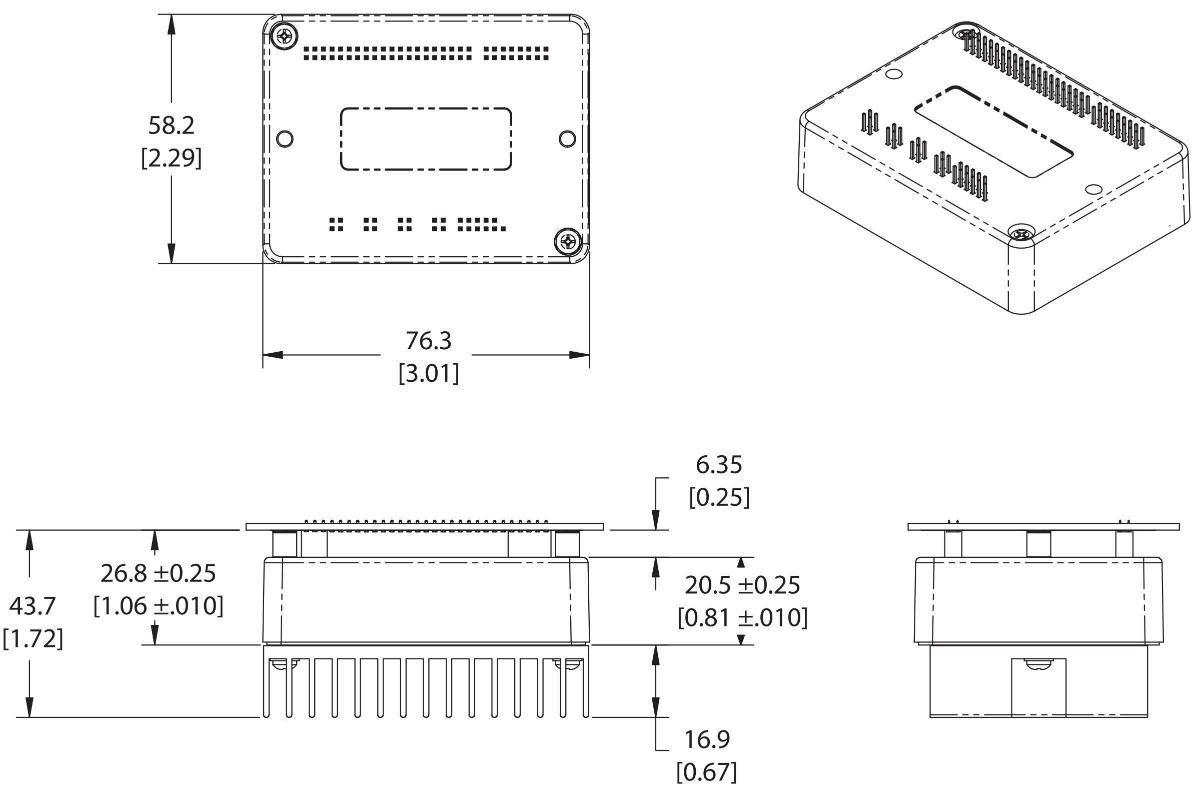
AEM-090-06	*Accelnet* AEM servo drive, 3/6 A, 90 Vdc
AEM-090-14	*Accelnet* AEM servo drive, 7/14 A, 90 Vdc
AEM-090-30	*Accelnet* AEM servo drive, 15/30 A, 90 Vdc
AEK-090-01	Development Kit for AEM servo drive

ACCESSORIES

	QTY	DESCRIPTION
Connector Kit for Develop-ment Kit AEK-CK-01	1	Connector, Euro, 5 Terminal, 5.08 mm
	1	Connector, Euro, 4 Terminal, 5.08 mm
	1	26 Pin Connector, High Density, D-Sub, Male, Solder Cup
	2	26 Pin Connector, High Density, D-Sub, Female, Solder Cup
	1	26 Pin Connector Backshell
Heatsink Kit AEM-HK	1	Heatsink for AEM
	1	Heatsink Thermal Material
	4	Heatsink Hardware
AEK-NC-10		Ethernet Network Cable, 10 ft
AEK-NC-01		Ethernet network cable, 1 ft
CME 2		CME 2 Drive Configuration Software on CD-ROM
SER-CK		Serial Cable Kit

DIMENSIONS

Units: mm [in]



Note: Specifications subject to change without notice

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