**copley controls**

DIGITAL SERVO DRIVE
FOR BRUSHLESS/BRUSH MOTORS

**CANopen**

## AFS *Advanced Feature Set*
- 32-bit floating point filters
- Multiple advanced filters
- CPL (Copley Programming Language)
- Frequency analysis tools

## Control Modes
- Fast indexer, Point-to-Point, PVT, CSP
- Camming, Gearing, Position, Velocity, Torque

## Command Interface
- CANopen
- ASCII, serial binary and discrete I/O
- Stepper commands
- ±10V position/velocity/torque command
- PWM velocity/torque command
- Master encoder (Gearing/Camming)

## Communications
- CANopen
- RS-232

## Feedback
- Digital Quad A/B encoder
- Secondary encoder
- Digital Halls

## I/O - Digital
- 10 inputs, 3 outputs

## Dimensions: mm [in]
- 63.5 x 40.6 x 21.1 [2.50 x 1.60 x 0.83]
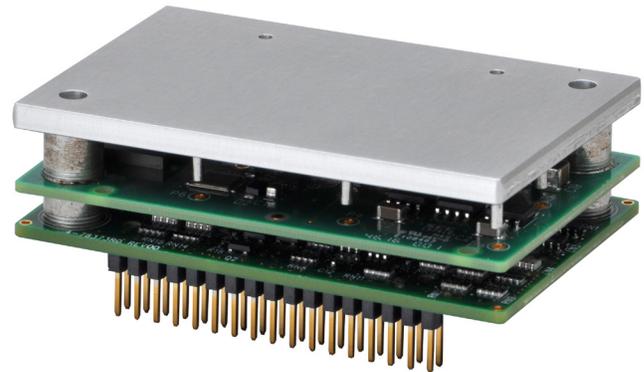


| MODEL | Ic | Ip | VDC |
|---|---|---|---|
| ACK-090-20 | 10 | 20 | 14~90 |
| ACK-090-30 | 15 | 30 | 14~90 |

## DESCRIPTION

*Accelnet Micro Module* with advanced feature set is a digital servodrive that combines CANopen networking with 100% digital control of brush or brushless motors in a PC board mounting package with power options to 15 Adc continuous and 30 Adc peak from 14 to 90 Vdc power supplies.

*Accelnet Micro Module* operates as a Motion Control Device using the CiA 402 protocol under the CANopen DS-301 V4.01 (EN 50325-4) application layer. CiA 402 modes supported include Interpolated Position (PVT), Profile Position, Profile Velocity, Profile Torque, and Homing.

There are ten logic inputs. One is dedicated to the Amp Enable function, the other nine are programmable. There are three logic outputs rated to +30 Vdc.

Used as a stand-alone drive, *Accelnet Micro Module* can operate using incremental position commands from step-motor controllers in Pulse/Direction or CU/CD format, as well as A/B quadrature commands from a master-encoder. Torque or velocity control can be from digital PWM signals, or analog ±10 V.

Drive commissioning is facilitated by *CME* software operating under Windows® communicating with *Accelnet Micro Module* via CAN or an RS-232 link.

Auto-tuning algorithms in *CME* slash set up times for fast system commissioning by automating motor phasing, and current-loop tuning.

A powerful oscilloscope and waveform generator displays drive performance for fine tuning. Drive configurations are saved in non-volatile flash memory.

Space-vector modulation delivers higher motor speeds and lower motor power dissipation than conventional sine-PWM modulation. Current-loop sampling is at 15 kHz, position and velocity loops at 3 kHz and PWM ripple at 30 kHz.

All drive circuits are DC coupled and operate from unregulated transformer-isolated linear DC power supplies, or regulated switching power supplies.

The PC-board mounting package is suitable for high-density, multi-axis installations in equipment where space is at a premium, and wiring must be minimized.

## GENERAL SPECIFICATIONS

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

| MODEL | ACK-090-20 | ACK-090-30 | |
|---|---|---|---|
| **OUTPUT POWER** | | | |
| Peak Current | 20 (14.1) | 30 (21.2) | Adc (Arms, sinusoidal) |
| Peak time | 1 | 1 | Sec |
| Continuous current | 10 (7.07) | 15 (10.6) | Adc (Arms, sinusoidal) |
| Peak Output Power | 1.8 | 2.7 | kW |
| Continuous Output Power | 0.9 | 1.35 | kW |
| **INPUT POWER** | | | |
| HVmin to HVmax | +14 to +90 | +14 to +90 | Vdc,transformer-isolated |
| Ipeak | 22 | 33 | Adc (1 sec) peak |
| Icont | 11 | 16.5 | Adc continuous |
| Aux HV | +14 to HVmax | 2.5 W | Optional keep-alive power input when +HV is removed |

**PWM OUTPUTS**

| | |
|---|---|
| Type | MOSFET 3-phase inverter, 15 kHz center-weighted PWM carrier, space-vector modulation |
| PWM ripple frequency | 30 kHz |

**BANDWIDTH**

| | |
|---|---|
| Current loop, small signal | 2.5 kHz typical, bandwidth will vary with tuning & load inductance |
| HV Compensation | Changes in HV do not affect bandwidth |
| Current loop update rate | 15 kHz (66.7 µs) |
| Position & Velocity loop update rate | 3 kHz (333 µs) |

**REFERENCE INPUTS**

| | | |
|---|---|---|
| CANopen bus | Homing, Profile Position, Profile Velocity, Profile Torque and Interpolated Position modes | |
| Digital position reference | Pls/Dir, CW/CCW | Stepper commands (2 MHz maximum rate) |
| | Quad A/B Encoder | 2 Mline/sec, (8 Mcount/sec after quadrature) |
| Analog torque, velocity & position reference | ±10 Vdc, 5 kΩ differential input impedance | |
| Digital torque & velocity reference (Note 1) | PWM , Polarity | PWM = 0~100%, Polarity = 1/0 |
| | PWM | PWM = 50% +/-50%, no polarity signal required |
| | PWM frequency range | 1 kHz minimum, 100 kHz maximum |
| | PWM minimum pulse width | 220 ns |

**DIGITAL INPUTS (NOTE 1)**

| | |
|---|---|
| Number | 10 |
| All inputs | 74HC14 Schmitt trigger with RC filter on input, 10 kΩ pull-up to +5 Vdc |
| | RC time-constants assume active drive on inputs and do not include 10 kΩ pull-ups. |
| Logic levels | Vcc = 5.0 Vdc, $V_T$+ = 1.83~3.5 Vdc, $V_T$- = 1.00~2.2 Vdc, $V_H$ = 0.53~1.53, Maximum input voltage = +10 Vdc |
| Enable [IN1] | 1 dedicated input for drive enable, active level programmable, 33 µs RC filter |
| GP [IN2,3,4,5] | 4 General Purpose inputs with 33 µs ( 22 µs for [IN5] ) RC filter, programmable functions |
| HS [IN6,7,8,9,10] | 5 High-Speed inputs with 100 ns RC filter, programmable functions |

**DIGITAL OUTPUTS**

| | |
|---|---|
| Number | 3 |
| Type | Current-sinking MOSFET open-drain output with 1 kΩ pullup to +5 Vdc through diode |
| | 300 mAdc sink max, +30 Vdc max |
| Functions | Programmable with *CME* |
| Active Level | Programmable to either HI (off, pull-up to +5 Vdc) or LO (on, current-sinking) when output is active |

**RS-232 COMMUNICATION PORT**

| | |
|---|---|
| Signals | RxD, TxD, Gnd |
| Mode | Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 115,200 baud |
| Protocol | ASCII or Binary format |
| Multi-drop | ASCII interface from single RS-232 port to control multiple drives (Xenus, Accelnet, Stepnet) |
| | Drive with serial connection acts as master for bi-directional data flow to other drives |
| | using CAN connections in daisy-chain from drive to drive |

**CANOPEN COMMUNICATION PORT**

| | |
|---|---|
| Signals | CANH, CANL, CAN_GND; 1Mbit/sec maximum. |
| Protocol | CANopen Application Layer DS-301 V4.01 |
| Device | CiA 402 Device Profile for Drives and Motion Control |

**FEEDBACK**

| | |
|---|---|
| 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 |
| Encoder power | +5 Vdc @ 250 mAdc max (L-C filter required between Accelnet and encoder) |

## NOTES

1. [IN1] is not programmable and always works as drive Enable. Other digital inputs are programmable.

## DC POWER OUTPUT

| | |
|---|---|
| +5 Vdc | 250 mA maximum. Directly connects to drive internal circuits. L-C filter required to isolate drive and external circuits |

## MOTOR CONNECTIONS

| | |
|---|---|
| Motor U,V,W | Drive outputs to 3-phase brushless motor, Wye or delta connected |
| | For DC brush motor use outputs U & V |
| Encoder (primary) | Quadrature, differential (A, /A, B, /B, X, /X), 5 Mlines/sec (20 Mcount/sec after quadrature) |
| Encoder (secondary) | Quadrature, active single-ended (A, B, X), |
| | 2 MHz maximum line frequency (8 Mcounts/sec after quadrature) |
| Halls | Hall signals (U,V,W) |
| Motemp | Motor temperature sensor or switch |

## PROTECTIONS

| | | |
|---|---|---|
| HV Overvoltage | +HV > +91 Vdc | Drive outputs turn off until +HV is < 91 Vdc |
| HV Undervoltage | +HV < +14 Vdc | Drive outputs turn off until  +HV >=  +14 Vdc |
| Drive over temperature | PC Board > 90 °C. | Programmable as latching or temporary fault |
| Short circuits | | Output to output, output to ground, internal PWM bridge faults |
| $I^2T$ Current limiting | | Programmable: continuous current, peak current, peak time |
| Latching / Non-Latching | | Programmable response to errors |

## MECHANICAL & ENVIRONMENTAL

| | |
|---|---|
| Size | 2.50 in (63.5 mm) X 1.60 in (40.6 mm) X 0.81 in (20.6 mm) |
| Weight | 2.5 oz (70 g) for ACK-090-30 & ACK-090-20 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 | IEC 680068-2 |
| Cooling | Forced air cooling required for continuous power output |

## AGENCY STANDARDS CONFORMANCE

*In accordance with EC Directive 2014/30/EU (EMC Directive)*

| | |
|---|---|
| EN 55011 | 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 | Electromagnetic Compatibility (EMC) – Part 6-1: Generic Standards – Immunity for residential, Commercial and Light-industrial Environments |

*Restriction of the Use of Certain Hazardous Substances (RoHS)*
Directive 2011/65/EU (RoHS II)

*In accordance with EC Directive 2014/35/EU (Low Voltage Directive)*

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

*Underwriters Laboratory Standards*

| | |
|---|---|
| UL 61010-1, 3rd Ed. | Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use |
| *UL File Number E168959* | |

## FIRMWARE

File name: ARM_x.xx.cff

The latest version of the firmware can be downloaded from www.copleycontrols.com.

## CME SOFTWARE

Drive setup is fast and easy using *CME* software. All of the operations needed to configure the drive are accessible through this powerful and intuitive program which communicates with the drive over CAN or an RS-232 link. Motor data can be saved as .ccm files. Drive data is saved as .ccx files that contain all drive settings plus motor data. This eases system management as files can be cross-referenced to drives. Once a drive configuration has been completed systems can be replicated easily with the same setup and performance.
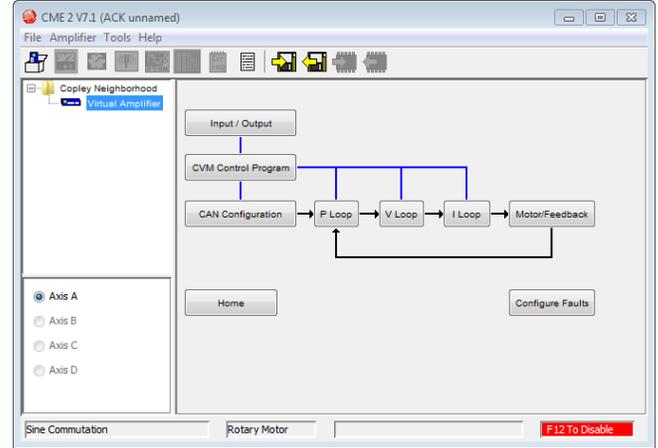
## RS-232 COMMUNICATION

The serial port is a full-duplex, three-wire (RxD, TxD, Gnd) RS-232 type that operates from 9,600 to 115,200 Baud. It can be used by CME for drive configuration and setup or by external equipment sending ASCII commands.
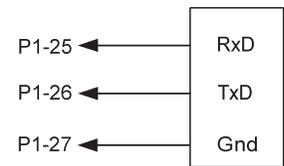
ICL3221
RS-232 Transceiver

## CANOPEN COMMUNICATION

*Accelnet Micro Module* uses the CAN physical layer signals CANH, CANL, and GND for connection, and CANopen protocol for communication. The electrical interface is a TJA1050 high-speed CAN transceiver.

Before connecting *Accelnet Micro Module* to the CAN network, it must be assigned a CAN address. This can be done via the RS-232 port, or by using logic inputs for the CAN address bits. The CAN address is a combination of an internal address stored in flash memory, and an address derived from the logic inputs. A maximum of 127 CAN devices are allowed on a CAN bus network, so this limits the input pins used for this purpose to a maximum of seven, leaving three inputs available for other purposes. Most installations will use less than the maximum number of CAN devices, in which case the number of inputs used for a CAN address can be less than seven, leaving more inputs available for other functions.

When inputs are used for the CAN address bits, the internal address is added to the binary value that results from the inputs. If all the inputs are used as logic inputs, then the CAN address in flash memory is the drive CAN address.
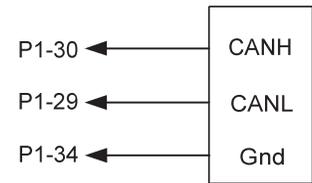
TJA1050
CAN Transceiver

## STAND-ALONE OPERATION

*Accelnet Micro Module* can operate with external motion controllers in torque, velocity, or position mode.

Torque (current, force) and velocity modes accept command inputs in either analog ±10V format, or as digital PWM & Direction signals. When operating as a position controller command signals are digital in either Pulse/Direction or CU/CD (Count-UP/Count-Down) format, or analog as ±10V. Quadrature encoder signals can also be used. In all cases, the ratio of input position commands to motor encoder feedback is programmable to match controller position units to actual motor travel. If using an encoder as position input this feature also enables electronic gearing.

## DIGITAL TORQUE & VELOCITY INPUTS

The PWM signal duty-cycle controls magnitude, and the DC signal controls polarity.
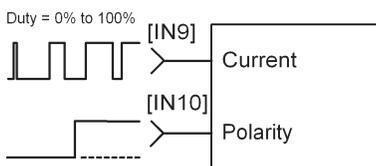
## ANALOG TORQUE, VELOCITY OR POSITION INPUTS
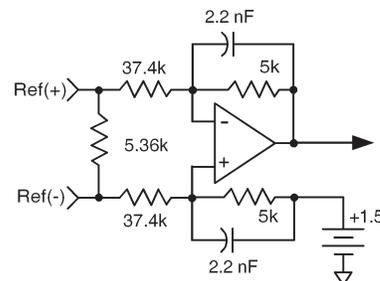
## STAND-ALONE MODE DIGITAL POSITION-CONTROL INPUTS

*Accelnet Micro Module* works with motion controllers that output pulses to command position.
These formats are supported:

    Step/Direction
    CU/CD
    A/B Quadrature Encoder

In Step/Direction mode, a pulse-train controls motor position, and the direction is controlled by a DC level at the Direction input.
CU/CD (Count-Up/Count-Down) signals command the motor to move CW or CCW depending on which input the pulse-train is directed to. The motor can also be operated in an electronic gearing mode by connecting the inputs to a quadrature encoder on another motor. In all cases the ratio between input pulses and motor revolutions is programmable.

### STEP/DIRECTION INPUTS
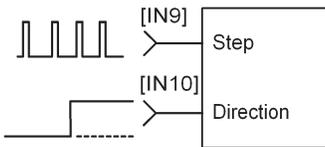


### COUNT-UP/COUNT-DOWN INPUTS
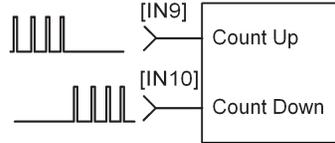


### QUAD A/B ENCODER INPUTS
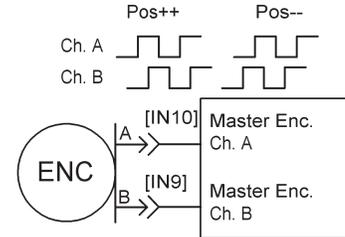


## MOTOR CONNECTIONS

Motor connections are of four types: phase, Halls, temperature sensor, and encoder. 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. A temperature sensor can shut down the drive to protect the motor from over-heating. The encoder signals give incremental position feedback and are used for velocity and position modes, as well as sinusoidal commutation.

### MOTOR PHASE CONNECTIONS

The drive output is a dual H-bridge that converts the DC buss voltage (+HV) into sinusoidal voltage waveforms that drive the motor phases. 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.
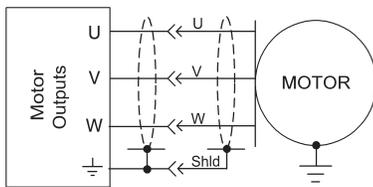


### MOTOR ENCODER

Six dedicated inputs accept the encoder A, B, and X (index) signals. Encoders with differential outputs must be used.
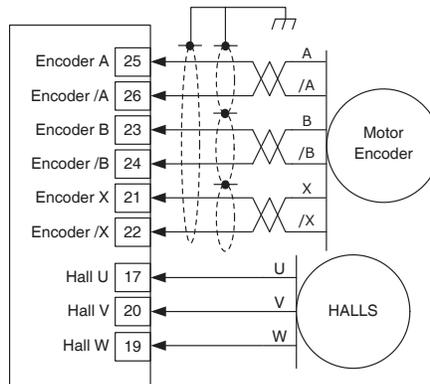


### SECONDARY ENCODER

Inputs [IN7] & [IN8] accept the encoder A and B signals. Encoders with single-ended active outputs must be used.
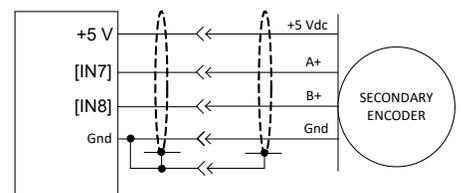


### MOTOR BRAKE

Digital outputs [OUT1,2,3] can be programmed to power a motor-mounted brake. These brake the motor when they are in an unpowered state and must have power applied to release. This provides a fail-safe function that prevents motor motion if the system is in an unpowered (uncontrolled) state. Because brakes are inductive loads, an external flyback diode must be used to control the coil voltage when power is removed. The timing of the brake is programmable.
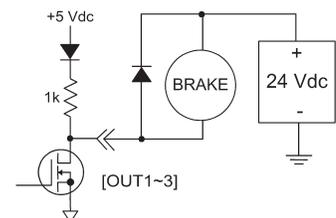
### MOTOR TEMPERATURE SENSOR

Digital input [IN5] is programmable for use with a motor overtemperature switch. The input should be programmed as a pull-up to +5 Vdc if the motor switch is grounded.
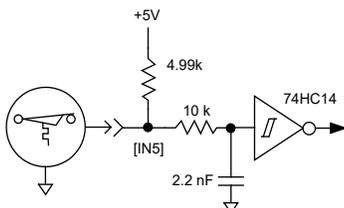
## DIGITAL INPUTS

There are ten digital inputs to *Accelnet Micro Module*, nine of which can be programmed to a selection of functions. The Enable input which controls the on/off state of the PWM outputs is fixed to [IN1] as a safety measure so that a drive cannot be programmed in such a way that, once installed, it could not be shut down by the controller. Two types of RC filters are used: GP (General-purpose) and HS (High Speed). The input time-constants apply when driven by active sources (CMOS, TTL, etc). All inputs except [IN5] have 10 kΩ pull-up resistors to +5 Vdc. The pull-up for [IN5] is 4.99 k for compatibility with Copley linear motors. Input functions such as Step/Direction, CountUp/CountDown, Quad A/B must be wired to inputs having the HS filters, and inputs with the GP filters can be used for general purpose logic functions, limit switches, and the motor temperature sensor. In addition to the selection of functions, the active level for each input is individually programmable.

### GP INPUT FUNCTIONS

- Drive enable
- CAN address
- Positive Limit switch
- Negative Limit switch
- Home switch
- Drive Reset
- Motor temperature sensor input
- Motion abort

### HS INPUT FUNCTIONS

- Step/Direction, or CountUp/CountDown step motor control commands
- Quad A/B master encoder position commands
- Motor-mounted feedback encoder

Drive reset is programmable to take place on transitions of the input and is programmable to 1/0 or 0/1. The motor temp sensor function will disable the drive if a switch in the motor opens or closes when the motor overheats.

### GP INPUTS 1,2,3,4,5
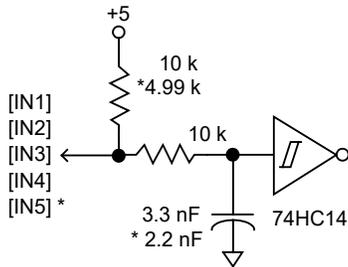


### HS INPUTS 6,7,8,9,10
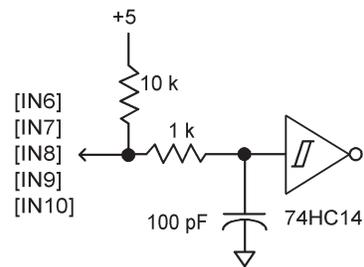


## DIGITAL OUTPUTS

Digital outputs [OUT1~3] are open-drain MOSFETs with 1 kΩ pull-up resistors in series with a diode to +5 Vdc. They can sink up to 300 mAdc from external loads operating from power supplies to +30 Vdc. The outputs are typically configured as drive fault and motor brake. Additional functions are programmable. As a drive fault output, the active level is programmable to be HI or LO when a fault occurs. As a brake output, it is programmable to be either HI or LO to release a motor brake when the drive is enabled. When driving inductive loads such as a relay, an external fly-back diode is required. A diode in the output is for driving PLC inputs that are opto-isolated and connected to +24 Vdc. The diode prevents conduction from +24 Vdc through the 1 kΩ resistor to +5 Vdc in the drive. This could turn the PLC input on, giving a false indication of the drive output state.
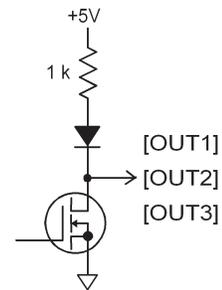


## +5 VDC OUTPUT

The drive internal +5 Vdc power is made available at P1-28. The output current is 250 mA maximum. This power should be used with care as there is no linear regulator between the drive internal power supply and the external circuits as in other Copley drives with +5 Vdc outputs. When using this power an L-C filter is required. This consists typically of a ferrite-core inductor and an electrolytic capacitor. A typical value for the capacitor would be 4.7 μF. The inductor can be 50~150 μH and should be rated for DC current of 250 mA minimum. The capacitor should have a return path to drive power ground (J1-13,14).
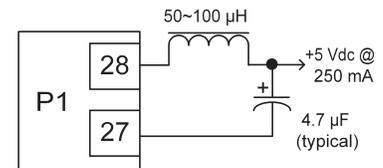
## POWER SUPPLIES

*Accelnet Micro Module* 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 drive maximum voltage rating. Power supply rating depends on the power delivered to the load by the drive.

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. The minimum value required is 330 μF per drive mounted no more than 12 inches from the drive.
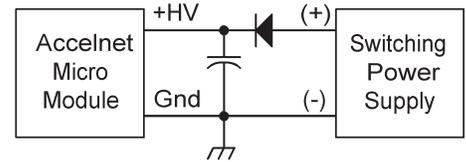


## AUX HV (OPTIONAL)

CANopen communications can be maintained when +HV is turned off by using the Aux HV input. The voltage has the same range as +HV, and can be greater or less than +HV.

In operation, the Aux HV keeps the drive logic and control circuits active so it is always visible as a node on a CAN bus. The current-position data is maintained making 'homing' unnecessary after system power is re-enabled. If Accelnet Micro Module is operating as a stand-alone drive, Aux HV is not necessary but can be useful if the controller is monitoring drive digital outputs.

## GROUNDING CONSIDERATIONS

Power and control circuits share a common circuit-ground (P1-3, 4, 27, 33, 34, and J1-13, 14). Input logic circuits are referenced to Signal Ground, as are power GND, digital outputs, and encoder. For this reason, drive Gnd terminals should connect to the users' common 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".

Because current flow through conductors produces voltage-drops across them, it is best to connect the drive HV GND 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.

For CE compliance drive cables should be shielded. Motor phase currents are balanced, but currents can flow between the PWM outputs, and the motor cable shield.

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 Gnd pins on J1. Second, the drive outputs current into and out of the motor phases, and motor shield currents circulating between the U, V, and W outputs and HV common. And, lastly, logic and signal currents connected to the drive control inputs and outputs. For CE compliance drive cables should be shielded. Motor phase currents are balanced, but currents can flow between the PWM outputs, and the motor cable shield.
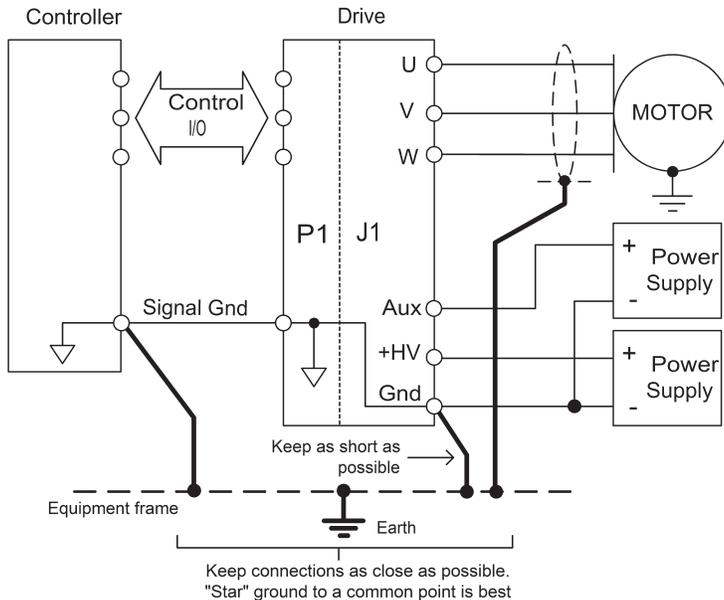
## TYPICAL DRIVE CONNECTIONS
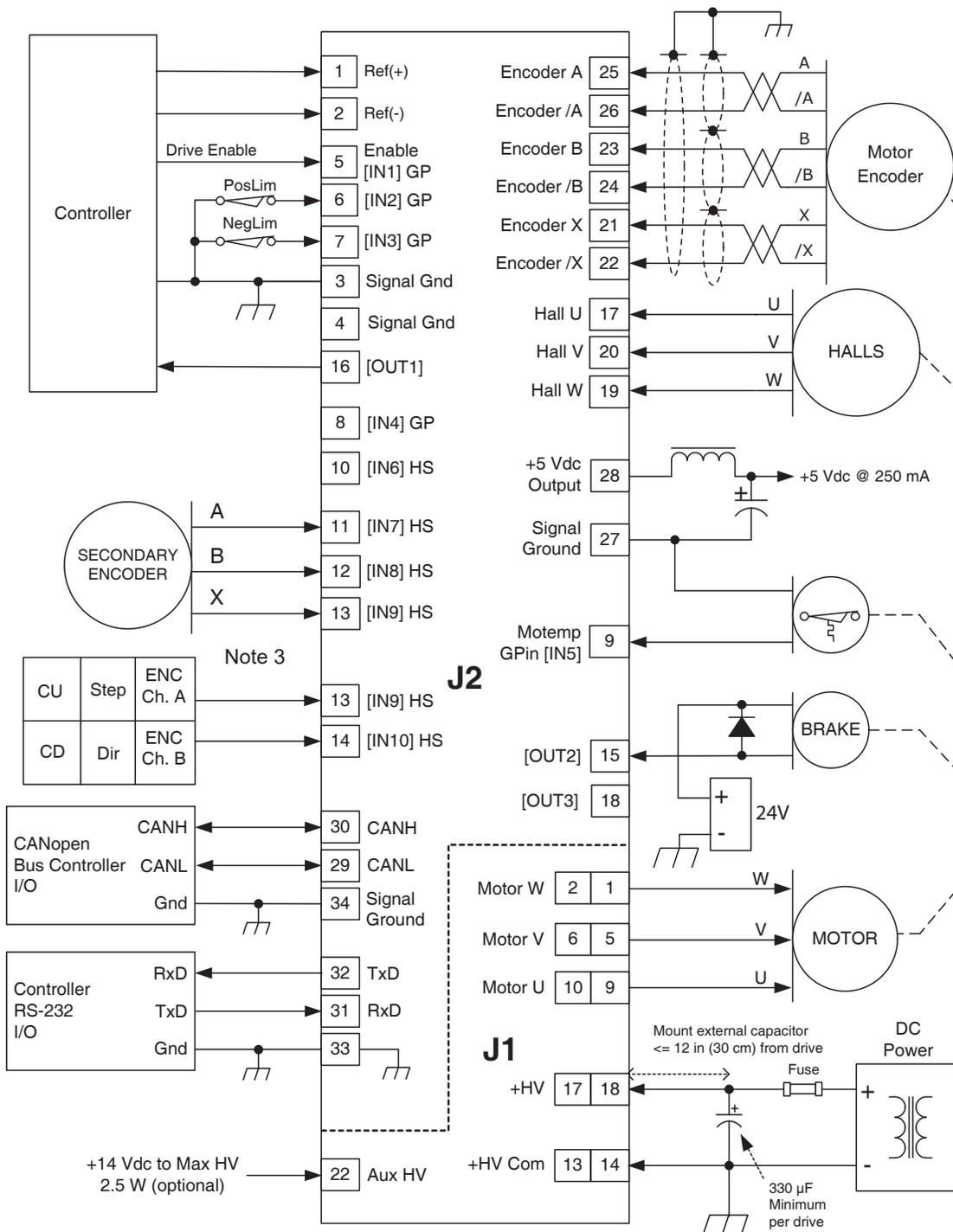


## NOTES

1. [IN1] always functions as Drive Enable with programmable active level
   [IN2]~[IN10] have programmable functions and active level

2. HS inputs [IN6,7,8,9,10] are for high-speed signals and have 100 ns RC filters.
   GP inputs [IN1,2,3, & 4] have 33 µs filters, [IN5] has a 22 µs filter.
   RC filter time constants apply when inputs are driven by active sources and do not include the 10 kΩ pull-up resistors.

3. [IN9] is programmable as an encoder index (X) input if it is not used as an input for digital commands.

DRIVE PC BOARD CONNECTORS

## Top View

**Pin 1**

*Drive viewed from above looking down on the pc board on which it is mounted.*
Pins shown in grey are unused locations in PC board socket

**J1: +HV, Gnd, & Motor Outputs**
Dual row, 0.1" centers
22 position female header
Samtec: SSW-111-01-S-D

**P1: Signal**
Dual row, 0.1" centers
34 position female header
Samtec: SSW-117-01-S-D

J1    P1

**Pin 22**

**Pin 34**
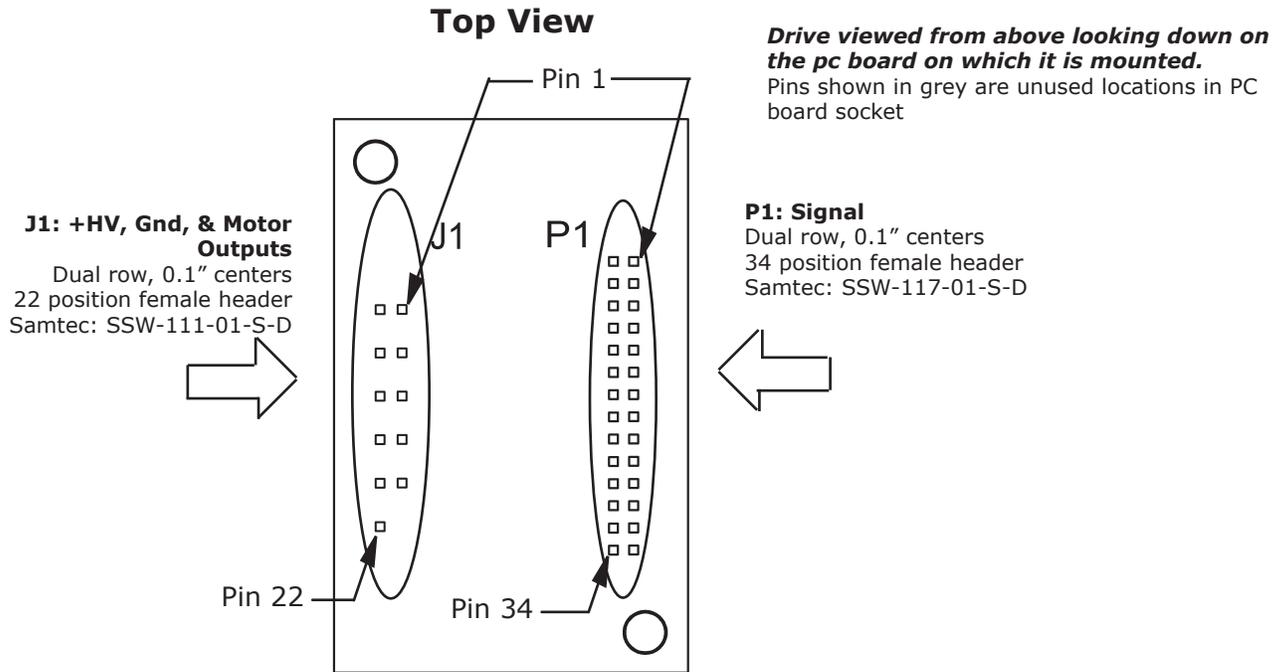
| Signal | J1 Pin | | Signal |
|---|---|---|---|
| Motor W | 2 | 1 | Motor W |
| | 4 | 3 | |
| Motor V | 6 | 5 | Motor V |
| | 8 | 7 | |
| Motor U | 10 | 9 | Motor U |
| | 12 | 11 | |
| HV common | 14 | 13 | HV common |
| | 16 | 15 | |
| +HV | 18 | 17 | +HV |
| | 20 | 19 | |

| SIGNALS | P1 Pin | | SIGNALS |
|---|---|---|---|
| Ref (-) | 2 | 1 | Ref (+) |
| Signal ground | 4 | 3 | Signal ground |
| [IN2] | 6 | 5 | [IN1] |
| [IN4] | 8 | 7 | [IN3] |
| [IN6] | 10 | 9 | [IN5] |
| [IN8] | 12 | 11 | [IN7] |
| [IN10] | 14 | 13 | [IN9] |
| [OUT1] | 16 | 15 | [OUT2] |
| [OUT3] | 18 | 17 | Hall U |
| Hall V | 20 | 19 | Hall W |
| Encoder /X | 22 | 21 | Encoder X |
| Encoder /B | 24 | 23 | Encoder B |
| Encoder /A | 26 | 25 | Encoder A |
| +5 Vdc @ 250 mA | 28 | 27 | Signal Ground |
| CANH | 30 | 29 | CANL |
| TxD | 32 | 31 | RxD |
| Signal ground | 34 | 33 | Signal Ground |

NOTES

1. Grey-shaded signal are N.C. (No Connection)

2. Signals are grouped for current-sharing on the power connector. When laying out pc board art-works, all pins in groups having the same signal name must be connected.

## PC BOARD MOUNTING FOOTPRINT

### MOUNTING AND COOLING

*Accelnet Micro Module* mounts on PC boards using two, dual-row, 0.1" female headers. These permit easy installation and removal of the drive without soldering. Threaded standoffs swaged into the PC board provide positive retention of the drive and permit mounting in any orientation. Cooling is by convection, or external fan-supplied forced air.

### NOTES

1. J1 pins with the same signal name must be connected for current-sharing.
2. To determine copper width and thickness for J1 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.

## Top View
### Dimensions in inches (mm)

1.40 (35.56)  
0.20 (5.08)  
1.183 (30.05)  
0.233 (5.92)  
0.45 (11.43)  
1.125 (28.58)  

2  1  J1  P1  

56X Ø.040 ±.003 (Ø.001 ±.076) THRU AFTER PLATING

22  21  

0.35 (8.89)  
2.05 (52.07)  
0.100 (2.54) (TYP)  
1.833 (46.56)  

34  33  

0.100 (2.54) (TYP)  

2X Ø.166 +.005/-.001 (Ø4.22 +.127/-.0254) THRU AFTER PLATING

0.017 (0.43)

### Mounting Hardware:

| Qty | Description | Mfgr | Part Number | Remarks |
|---|---|---|---|---|
| 1 | Socket Strip | Samtec | SSW-111-01-S-D | J1 |
| 1 | Socket Strip | Samtec | SSW-117-01-S-D | P1 |
| 2 | Standoff 4-40 X 3/8" | PEM | KFE-440-12-ET | |

### PC BOARD DESIGN

The peak voltage between adjacent traces will be equal to +HV. Trace width and copper plating thickness should support the drive peak and continuous output current ratings.

Printed circuit board layouts for *Accelnet Micro Module* drives should follow some simple rules:

1. Install a low-ESR electrolytic capacitor not more than 12 inches from the drive. PWM drives produce ripple currents in their DC supply conductors. *Accelnet Micro Module* drives do not use internal electrolytic capacitors as these can be easily supplied by the printed circuit board. In order to provide a good, low-impedance path for these currents a low-ESR capacitor should be mounted as close to the drive as possible. 330 µF is a minimum value, with a voltage rating appropriate to the drive model and power supply.

2. Connect J1 signals (U, V, & W outputs, +HV, and +HV Common) in pin-groups for current-sharing. The signals on J1 are all higher-current types. To carry these currents (up to 6 Adc peak) the pins of J1 must be used in multiples to divide the current and keep the current carrying capacity of the connectors within specification. The diagram on page 9 shows the pin groups that must be inter-connected to act as a single connection point for pc board traces.

3. Minimum trace width, and copper plating thickness should follow industry-standards (IPC-2221). The width and plating should depend on the model of drive used, the maximum voltage, and maximum current expected to be used for that model. Power supply traces (+HV, +HV Common) should be routed close to each other to minimize the area of the loop enclosed by the drive DC power. Noise emission or effects on nearby circuitry are proportional to the area of this loop, so minimizing it is good layout practice. Motor signals should also be routed close together. Phase outputs (U, V, & W) should be routed as closely as possible to form a balanced transmission path. Keeping these traces as closely placed as possible will again minimize noise radiation due to motor phase currents. *Accelnet Micro Module* circuit grounds are electrically common, and connect internally. However, the J1 signals carry high currents while the grounds on P1 (signal ground) carry low currents. So, P1 signals should be routed away from, and never parallel to the signals on J1.
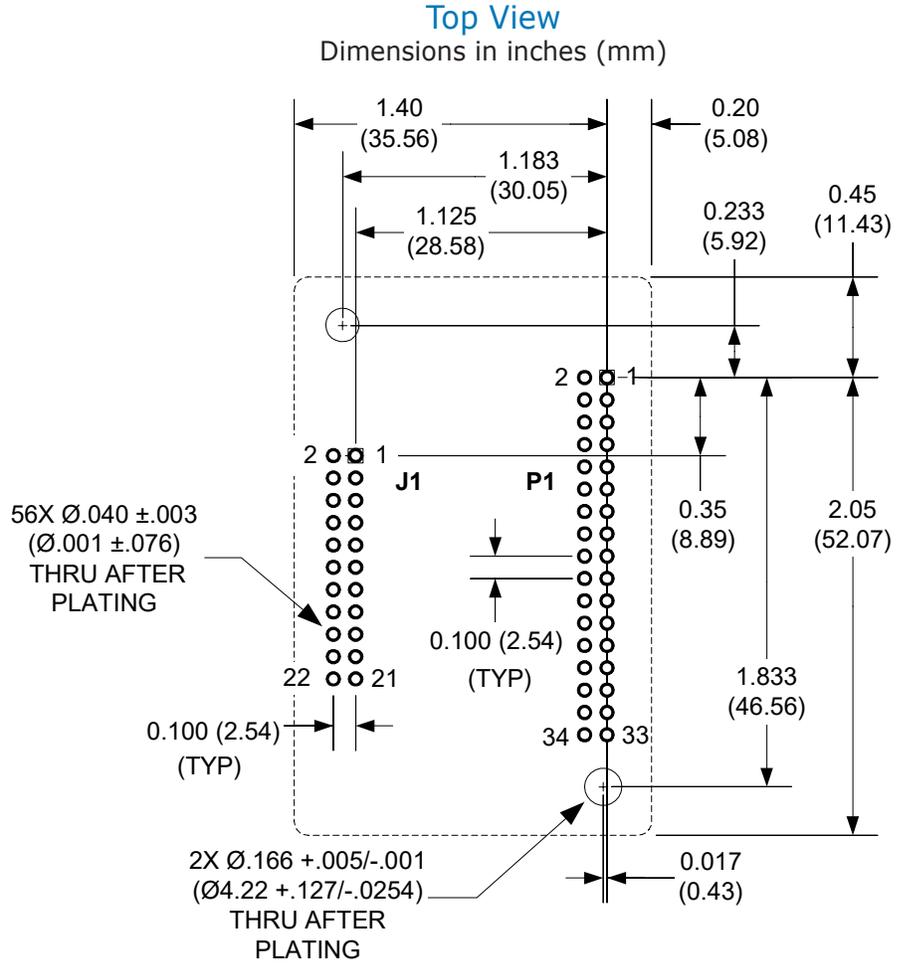
copley controls

DIMENSIONS
ACK-090-20
ACK-090-30

2.500[63.5]

.217[5.51]

.233[5.92]

.217[5.51]

.017[0.43]

1.166[29.62]

1.108[28.14]

1.600[40.64]

.483[12.27]

2.066[52.48]

.808[20.53]

.768[19.5]

1.500[38.10]
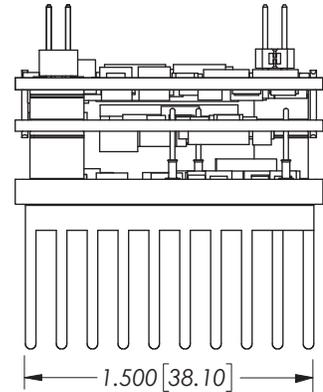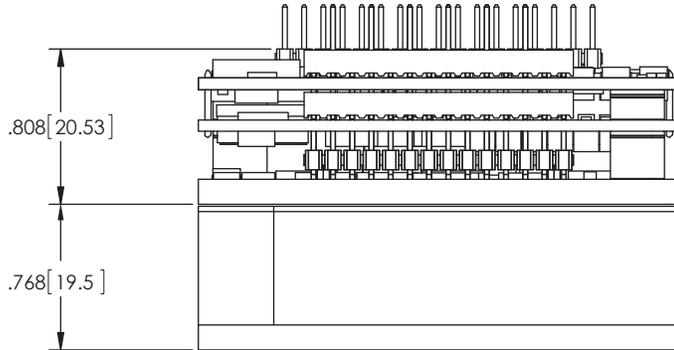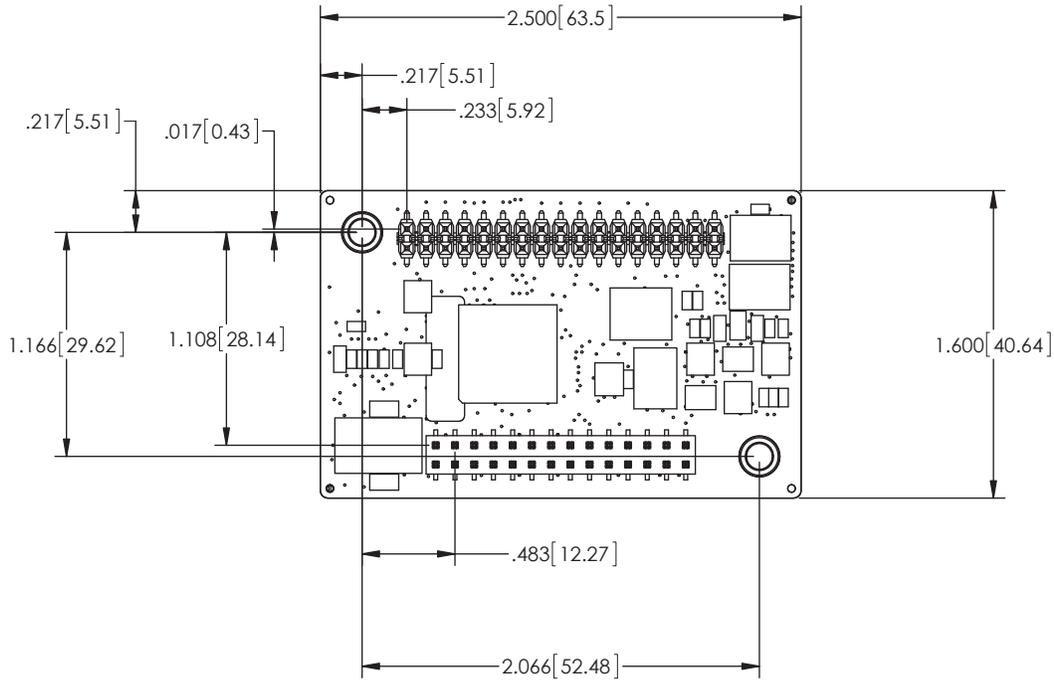
## NOTES

1. DIMENSIONS ARE IN INCHES, WITH MILLIMETERS IN BRACKETS FOR REFERENCE ONLY.
   TOLERANCES ARE: .XX= ±.01; .XXX= ±.005; ANGLES= ±1.0°.

## COOLING REQUIREMENTS:

From charts below, find power dissipation based on drive model, HV, and output current. With ambient temperature known, calculate required thermal resistance. Select cooling method that gives a thermal resistance that is equal to, or lower than the calculated value.

Example:
ACK-090-30, HV = 80 Vdc, Iout = 12A
Power dissipation is 16.2 W
Drive thermal shutdown is at 90 °C, ambient is 40 °C
Thermal resistance required = (90 - 40) / 16.2 = 3.1 C/W

There are three configurations with Rth < 3.1.
Choose the one that works best in the installation.
Fan cooling in an enclosure would provide more consistent cooling than convection and the effect of other equipment near the drive.

| Thermal Resistance (°C/W) | |
|---|---|
| No Heatsink, No Fan | 4.17 |
| Heatsink, No Fan | 2.75 |
| No Heatsink, Fan 300 LFM | 1.57 |
| Heatsink, Fan 300 LFM | 1.06 |

| ACK-090-20 Dissipation (W) | | | | |
|---|---|---|---|---|
| Iout (Adc) | HV (Vdc) | | | |
| | 20 | 40 | 60 | 80 |
| 0 | 3.4 | 3.2 | 5.2 | 6.6 |
| 2 | 3.7 | 4.5 | 5.6 | 7.1 |
| 4 | 4.4 | 5.3 | 6.6 | 8.1 |
| 6 | 5.6 | 6.5 | 8.0 | 9.6 |
| 8 | 7.2 | 8.3 | 9.8 | 11.6 |
| 10 | 9.3 | 10.3 | 12.0 | 14.0 |

| ACK-090-30 Dissipation (W) | | | | |
|---|---|---|---|---|
| Iout (Adc) | HV (Vdc) | | | |
| | 20 | 40 | 60 | 80 |
| 0 | 3.0 | 4.2 | 5.2 | 6.9 |
| 3 | 4.1 | 4.9 | 6.1 | 7.7 |
| 6 | 5.5 | 6.5 | 7.8 | 9.7 |
| 9 | 8.1 | 9.0 | 10.5 | 12.4 |
| 12 | 11.4 | 12.6 | 14.3 | 16.2 |
| 15 | 16.2 | 17.2 | 18.9 | 21 |

## DESCRIPTION

The Development Kit provides mounting and connectivity for a Accelnet Micro Module drive. Solderless jumpers ease configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~4,6 so that these can be toggled to simulate equipment operation. Three LED's provide status indication for the digital outputs. To simplify cabling to external controllers, the encoder signals from the motor are connected to pins on the signal connector J3. Dual CAN bus connectors make daisy-chain connections possible so that other CANopen devices such as Copley's Stepnet or Xenus drives can easily be connected to build mixed stepper and servo multi-axis systems.

## 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 a CANopen network. CME software communicates with the drive over this link and is then used for complete drive setup. The CAN address that is set by the rotary switch can be monitored, and an address offset programmed as well. This will add to the switch address to produce a working CAN address that can be from 1 to 127.

The RS-232 connector, J4, is a modular 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.
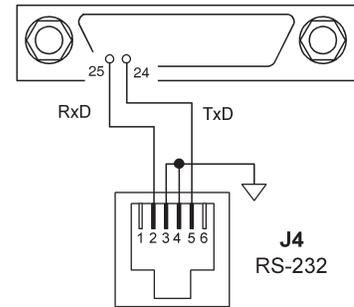
## CAN CONNECTIONS

Connectors J6 & J7 are Sub-D male and female 9-position types that conform to the CAN DS-102 Physical Layer specification. The male-female configuration supports a single cable type with male and female connectors that can be daisy-chained from device to device along a CANopen network.

Only the CAN_H, CAN_L, and CAN_GND signals are used. The CAN_GND is connected to the circuit ground on the development kit. This ground is also shared by the drive power supply, accessory +5V (for encoders), and the RS-232 link. Other DS-102 signals are wired-through for use by products that support them.

The table below lists the signals and pins on J6 & J7. Signals in ( ) are those that have no connection on the development kit and which are connected pin-to-pin between J6 & J7.

### CAN Bus Connector Signals

∗ These signals connect through from J6 to J7 with no connection to Development Kit PC board.

| PIN | SIGNALS |
|-----|---------|
| ∗ 1 | (Reserved) |
| 2 | CAN_L |
| 3 | CAN_GND |
| ∗ 4 | (Reserved) |
| 5 | (CAN_SHLD) |
| 6 | Signal ground |
| 7 | CAN_H |
| ∗ 8 | (Reserved) |
| 9 | (Reserved) |
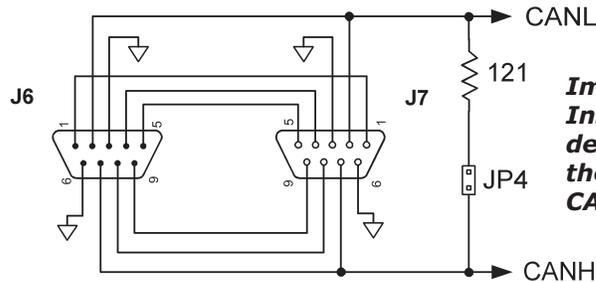
***Important! Install JP4 ONLY if development kit is the LAST node on a CAN bus***

## CAN ADDRESS SELECTION

Rotary switch SW6, labeled "CAN ADDR" connects to IN7, IN8, IN9, and IN10 of the drive. These are programmable inputs which default to CAN address bits. The switch will select CAN addresses 0x01~0x0F (dec 1~15) . Address 0 is reserved for network management devices. The CAN standard permits up to 127 devices, so if the drive must have a address beyond 0x0F(dec 15), this is done by programming an address offset into the drive before it is installed into a CAN environment or by programming logic inputs as CAN address bits.



SW6

JP6

CAN Address Switch

1 → B → [IN7]
2 → C → [IN8]
4 → D → [IN9]
8 → E → [IN10]
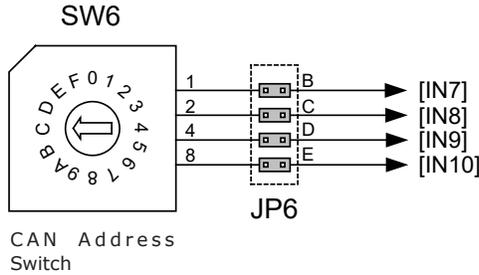
Note: To use inputs 7,8,9, or 10 as logic inputs remove jumpers shown at left to disconnect SW6 from logic inputs.

## LOGIC INPUTS

There are 10 logic inputs. [IN1] is dedicated to the drive enable function, the other inputs are programmable.

The development kit is equipped with switches that can be used to control logic inputs 1~4,6. To use these switches jumpers JP2-A, B, C, D, and E must be installed.

If connecting these logic inputs to external equipment, the same jumpers must be removed so that the switches cannot short input signals to ground.



JP3

[IN1]
[IN2]
[IN3]
[IN4]
[IN6]

Logic Inputs

JP2

J3

SWITCH POLARITY
LO   HI

SW1   SW2   SW3   SW4   SW5

IN1   IN2   IN3   IN4   IN6
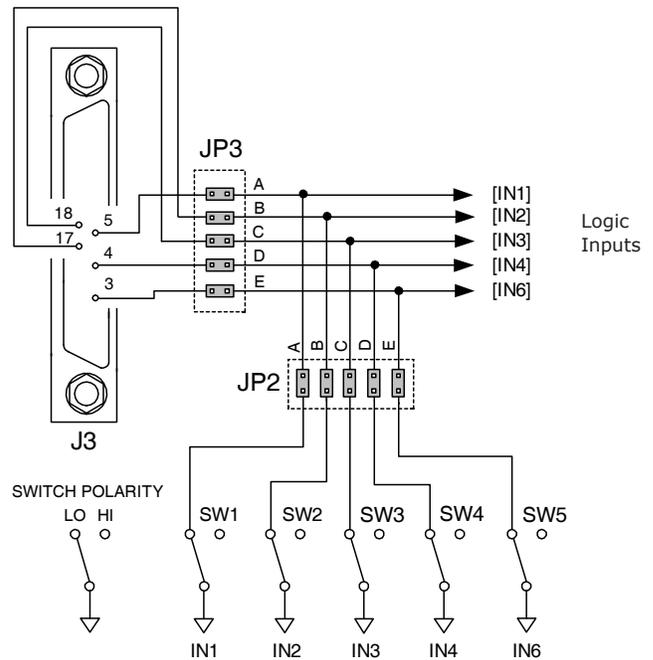
## LOGIC OUTPUTS

There are three 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.

As delivered, these outputs drive three LED's. Jumpers JP6-A, and JP1-D, & E connect these LED's to logic outputs. These are N-channel MOSFET's which sink current from loads connected to positive voltages. When the outputs are ON (Active Low), they ground the cathode of the led's which then turn on as they are connected to the +5Vdc supply via current-limiting resistors.

The logic outputs also connect to signal connector J3. If they are used to drive external loads >+5Vdc, the LED jumpers must be removed.



J3

+5   499   DS3   JP6-A
+5   499   DS2   JP1-D
+5   499   DS1   JP1-E

[OUT2]
[OUT1]
[OUT3]
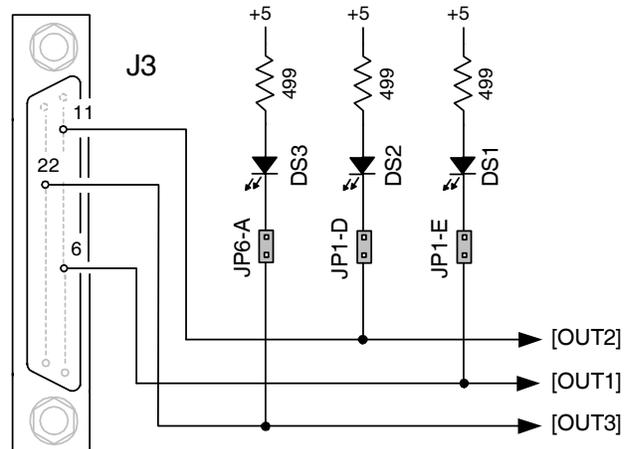
## ENCODER CONNECTIONS

The development kit has a 26C32 differential line receiver for the motor encoder inputs. Differential-output encoders are preferred for best signal quality and noise rejection. Wiring should be twisted-pairs, preferably with a shield for each pair. To eliminate noise on the encoder signals caused by reflections on the cables, it is good practice to terminate signal-pairs with a resistor that matches the characteristic impedance of the cable. On the development kit, 121Ω resistors are provided for this purpose. Jumpers at JP9-A, B, and C connect these termination resistors across the differential signals when installed.

If single-ended encoders are used, they must have active (not open-collector) outputs. They should be connected to the A, B, and X pins leaving the /A, /B, and /X pins open. Jumpers at JP1-A, B, and C must be removed.
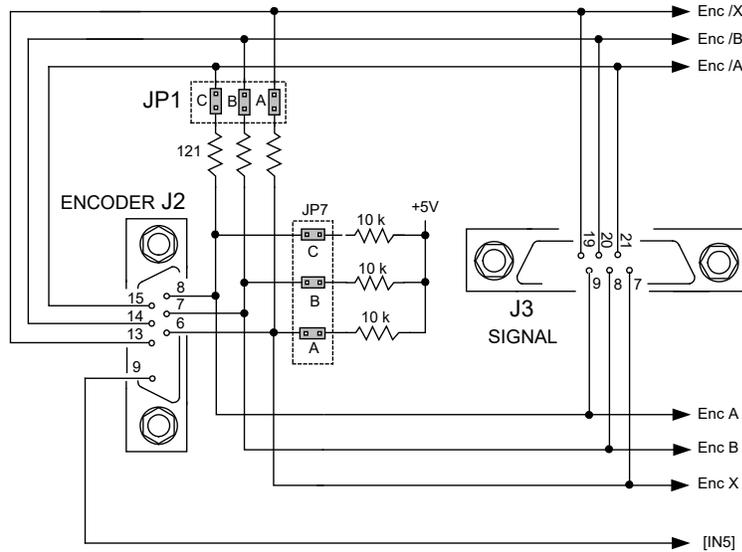
## POWER SUPPLIES

The drive main power, +HV, is typically supplied by unregulated DC power supplies. These must be isolated from the mains, and all circuits should be grounded to earth at some point. The +HV supply connects to J1. For good wiring practice, the +HV wires should be twisted together for noise suppression, and the power supply should not be grounded. Doing this ensures that the higher currents flowing in these conductors will not flow through any circuit grounds where they might induce noise. During deceleration, mechanical energy in the motor and load is converted back into electrical energy that must be dissipated as the motor comes to a stop. While some of this is converted to heat in the motor windings, the rest of it will flow through the drive into the power supply. An external storage capacitor should be used if the load has appreciable inertia, and this should be sized such that adding the undissipated energy from the motor will not raise the voltage beyond the point at which the drive shuts down. When this is not possible, an external 'dumper', or regenerative energy dissipater must be used which acts as a shunt regulator across the +HV and Gnd terminals.
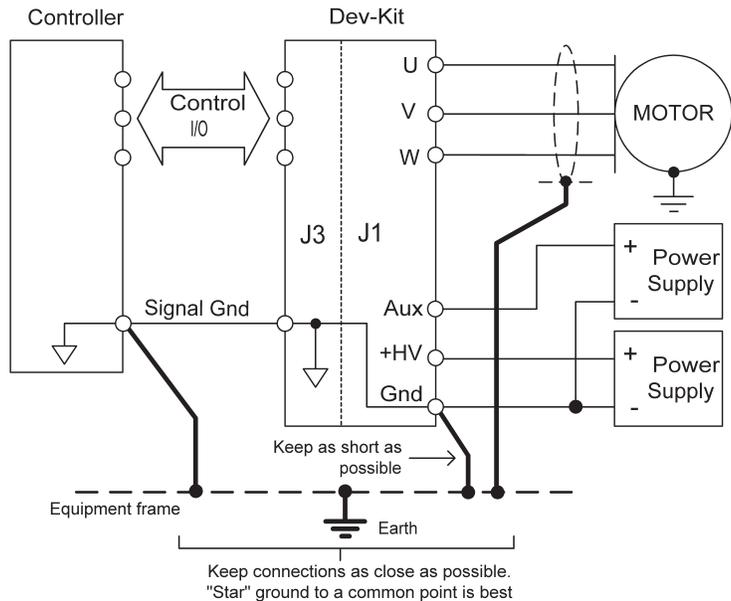
## GROUNDING

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



## SWITCHING POWER SUPPLIES

Switching power supplies can also be used for +HV power. Unlike unregulated supplies, these cannot accept reverse energy flow, so an isolating diode must be placed between the power supply and J1-1 to block current flow back into the power supply. When this is done, an external storage capacitor must be used across J1-1 & J1-2 because the capacitor on the Development Kit board is only for ripple-current control, and cannot store enough energy to handle regeneration.
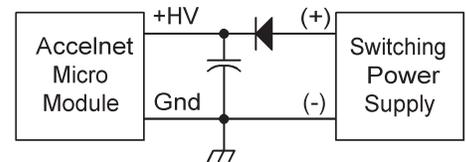


## AUX HV

Not required for stand-alone operation, an Aux HV power supply provides power for the drive control circuits so that CAN bus communications with the drive can be maintained when the +HV supply is turned off. This might occur as a result of an Emergency Off condition, or for machine operator intervention. The Aux HV supply does not power the PWM stage that drives the motor, but keeps the drive controller enabled as well as inputs and outputs. The Aux HV supply must be less than the +HV supply voltage and greater than the drive minimum +HV ( > 14 Vdc).

## ENCODER +5 VDC

Encoder power can be supplied from an external +5 Vdc supply or from the drive. To use drive +5 Vdc @ 250 mA maximum, install jumper JP8. If more than 250 mA is required then this must come from an external +5V source and JP8 must be removed when this is done.

***IMPORTANT: REMOVE JP8 BEFORE CONNECTING EXTERNAL +5V POWER TO J8-1. FAILURE TO DO SO WILL DAMAGE DRIVE!!***

copley controls

## DEVELOPMENT KIT CONNECTIONS

ACK-090-20
ACK-090-30
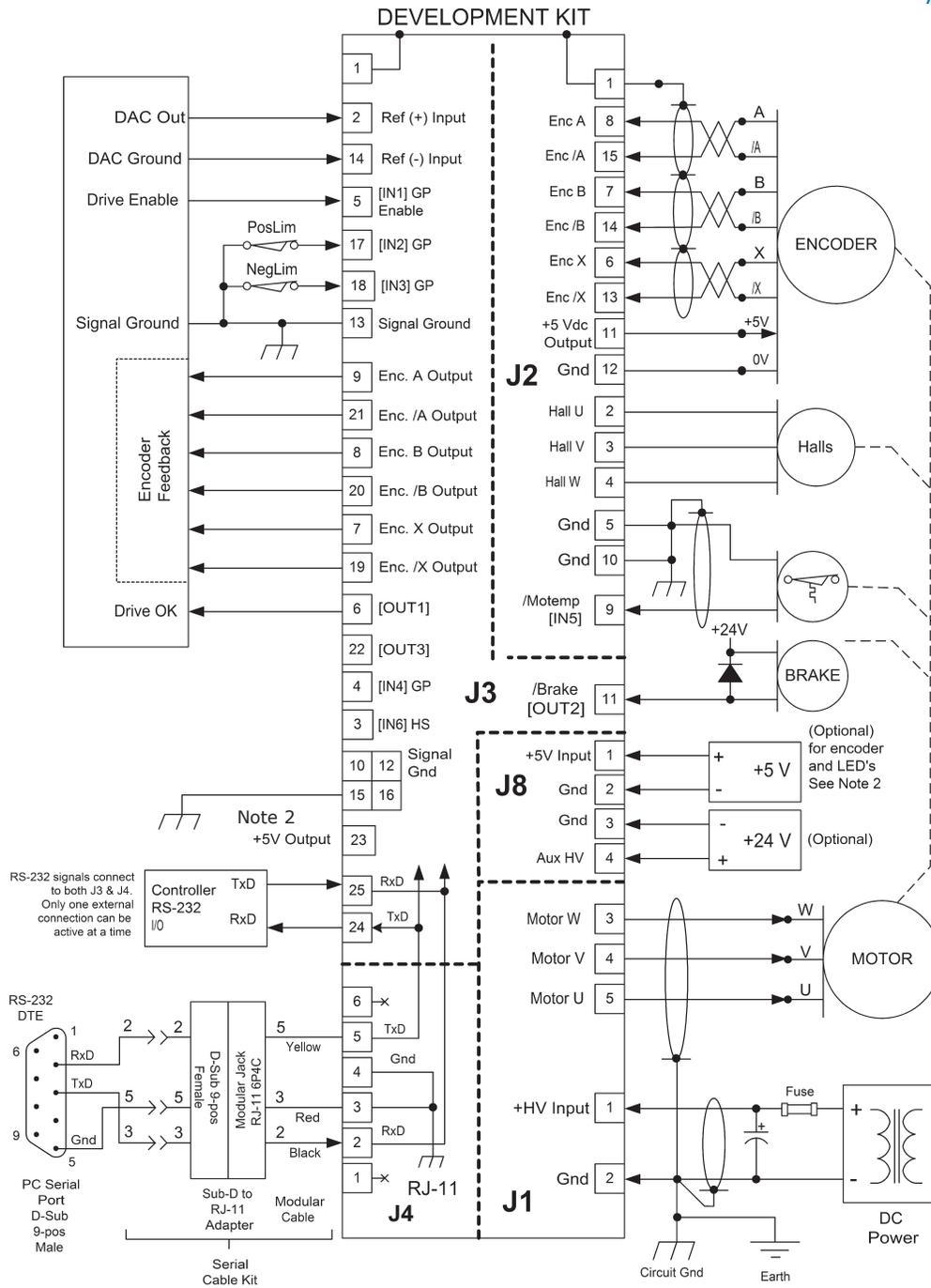


Notes:
1. CAN connectors J6 & J7 are not shown here. For details see pp. 3,6, & 10.
2. JP8 installed: +5 Vdc @ 250 mA from drive available at J3-23
   JP8 removed: +5 Vdc must be supplied from an external power supply connected to J8-1 & 2.
   **WHEN USING EXTERNAL 5 VDC POWER SUPPLY, JP8 MUST BE REMOVED OR DAMAGE TO DRIVE WILL OCCUR**

copley controls

DEVELOPMENT KIT CONNECTIONS

ACK-090-20
ACK-090-30

| CANopen SIGNALS | PIN |
|---|---|
| (Reserved) | 1 |
| CAN_L | 2 |
| CAN_GND | 3 |
| (Reserved) | 4 |
| (CAN_SHLD) | 5 |
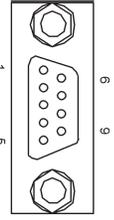
**J7**

*IMPORTANT:*
*REMOVE JUMPER JP8 BEFORE CONNECTING EXTERNAL +5 Vdc POWER*
*TO J8-1. FAILURE TO DO SO WILL DAMAGE DRIVE!!*

| J8 SIGNALS | PIN |
|---|---|
| +5V Input | 1 |
| Gnd | 2 |
| Gnd | 3 |
| Aux HV Input | 4 |
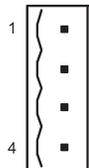
**J8**

| J1 SIGNALS | PIN |
|---|---|
| +HV Input | 1 |
| GND | 2 |
| Motor W Output | 3 |
| Motor V Output | 4 |
| Motor U Output | 5 |

**J1**

**J2**
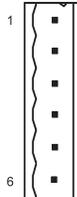
| J2 SIGNALS | PIN |
|---|---|
| Encoder /A Input | 15 |
| Encoder /B Input | 14 |
| Encoder /X Input | 13 |
| Signal Ground | 12 |
| +5V Output | 11 |
| Signal Ground | 10 |
| [IN5] | 9 |

| PIN | J2 SIGNALS |
|---|---|
| 8 | Encoder A Input |
| 7 | Encoder B Input |
| 6 | Encoder X Input |
| 5 | Signal Ground |
| 4 | Hall W |
| 3 | Hall V |
| 2 | Hall U |
| 1 | Chassis Ground |
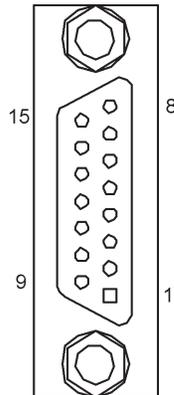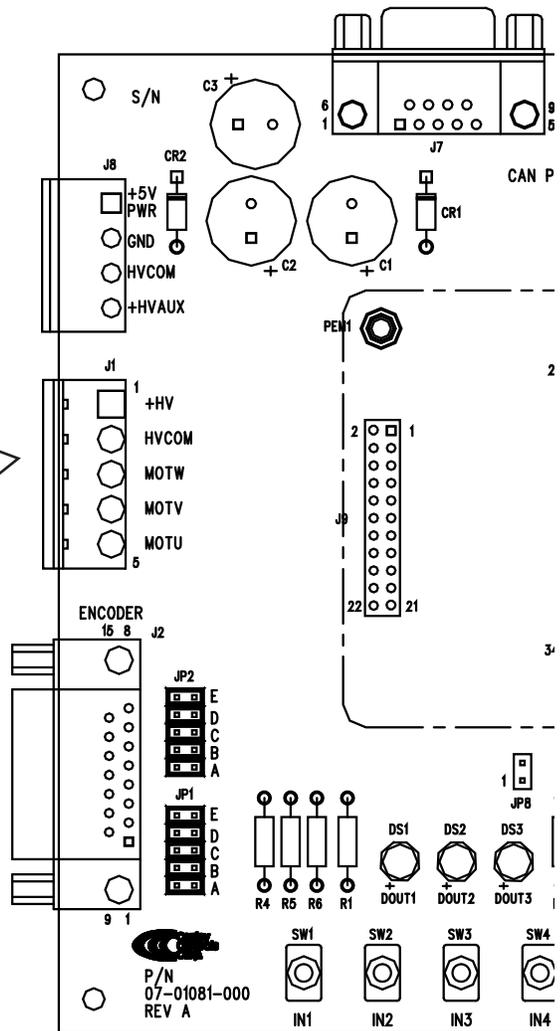
## DEVELOPMENT KIT CONNECTIONS
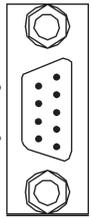
| PIN | CANopen SIGNALS |
|-----|-----------------|
| 6 | CAN_GND |
| 7 | CAN_H |
| 8 | (Reserved) |
| 9 | (CAN_V+) |

**J6**

**CANopen Notes:**

1. Connector pinouts for J6 & J7 follow CAN standard DS-102.
2. Signals in ( ) are wired-through from J7 to J6 and have no other connections on the pc board.
3. CAN_GND is connected to Gnd on pc board (Accelnet signal and power ground)

**J5**
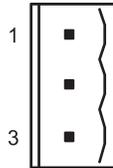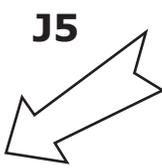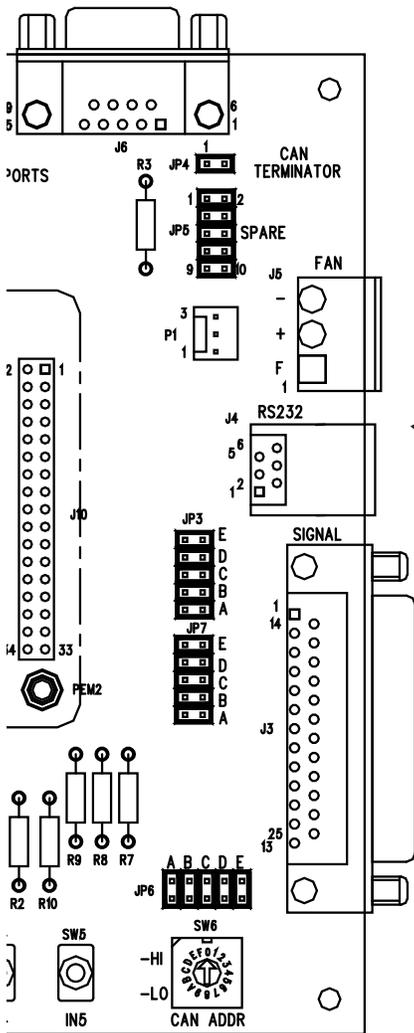
| PIN | J5 SIGNALS |
|-----|-----------|
| 1 | P1-1 |
| 2 | P1-2 |
| 3 | P1-3 |

**J4**
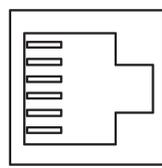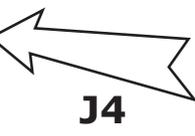
| PIN | J4 SIGNALS |
|-----|-----------|
| 6 | No Connection |
| 5 | TxD Output |
| 4 | Signal Ground |
| 3 | Signal Ground |
| 2 | RxD Input |
| 1 | No Connection |

**J3**
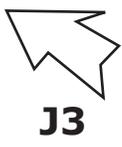
| J3 SIGNALS | PIN |
|-----------|-----|
| Chassis Ground | 1 |
| Analog Ref(+) | 2 |
| GP Input [IN6] | 3 |
| GP Input [IN4] | 4 |
| Enable Input [IN1] | 5 |
| Output [OUT1] | 6 |
| Encoder output X | 7 |
| Encoder output B | 8 |
| Encoder output A | 9 |
| Signal Ground | 10 |
| Output [OUT2] | 11 |
| Signal Ground | 12 |
| Signal Ground | 13 |

| PIN | J3 SIGNALS |
|-----|-----------|
| 14 | Analog Ref (-) |
| 15 | Signal Ground |
| 16 | Signal Ground |
| 17 | [IN2] POS Limit Switch |
| 18 | [IN3] NEG Limit Switch |
| 19 | Encoder /X output |
| 20 | Encoder /B output |
| 21 | Encoder /A output |
| 22 | [OUT3] Output |
| 23 | +5V Output |
| 24 | RS-232 TxD Output |
| 25 | RS-232 RxD Input |
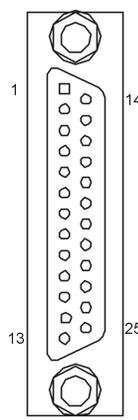
## ORDERING GUIDE

| PART NUMBER | DESCRIPTION |
|---|---|
| ACK-090-20 | *Accelnet Micro Module* 10/20 Adc @ 90 Vdc |
| ACK-090-30 | *Accelnet Micro Module* 15/30 Adc @ 90 Vdc |
| KDK-090-01 | *Accelnet Micro Module* Development Kit |
| KDK-CK | *Accelnet Micro Module* Development Kit Connector Kit |
| SER-CK | Serial cable for Development Kit |

## ORDERING INSTRUCTIONS

Example: Order 1 ACK-090-30 drive with Development Kit, Development Kit Connector Kit and Serial Cable Kit:

| Qty | Item | Remarks |
|---|---|---|
| 1 | ACK-090-30 | *Accelnet Micro Module* drive |
| 1 | KDK-090-01 | *Accelnet Micro Module Development Kit* |
| 1 | KDK-CK | Connector Kit for Development Kit |
| 1 | SER-CK | Serial Cable Kit |

## ACCESSORIES

| | QTY | REF | DESCRIPTION | MANUFACTURER/PART NUMBER |
|---|---|---|---|---|
| Connector Kit for Development Kit KDK-CK | 1 | J1 | Plug, Euro, 5 Terminal, 0.2 in (5.08 mm) | Tyco: 796635-5 |
| | 1 | J8 | Plug, Euro, 4 Terminal, 0.2 in (5.08 mm) | Tyco: 796635-4 |
| | 1 | J5 | Plug, Euro, 3 Terminal, 0.2 in (5.08 mm) | Tyco: 796635-3 |
| | 1 | J3 | 25 Pin Connector, D-Sub, Male, Solder Cup | Norcomp: 171-025-103L001 |
| | 1 | | 25 Pin Connector Backshell | Norcomp: 979-025-020R121 |
| | 1 | J2 | 15 Pin Connector, D-Sub, Male, Solder Cup | Norcomp: 171-015-103L001 |
| | 2 | | 15 Pin Connector Backshell | Norcomp: 979-015-020R121 |
| | 1 | J6 | 9 Pin Connector, D-Sub, Female, Solder Cup | Norcomp: 171-009-203L001 |
| | 2 | J7 | 9 Pin Connector, D-Sub, Male, Solder Cup | Norcomp: 171-009-103L001 |
| | 2 | J6,7 | 15 Pin Connector Backshell | Norcomp: 979-009-020R121 |
| SER-CK | | | Serial Cable Kit: 9-Pin Dsub receptacle to 6-pin modular adapter, plus modular cable | |

## 16-119445 Document Revision History

| Revision | Date | Remarks |
|---|---|---|
| 00 | June 29, 2018 | Initial release |
| 01 | August 23, 2018 | Added AFS details |
| 02 | October 23, 2018 | Removed BiSS C from AFS (ACK High Current does not support BiSS C) |
| 03 | May 9, 2019 | Minor issues fixed |
| | | |

Note: Specifications subject to change without notice