

## Control Modes

- Position (Microstepping)
- Position/Velocity/Torque (Servo Mode)
- Indexer, Point-to-Point, PVT
- Camming, Gearing

## Command Interface

- CANopen
- ASCII and discrete I/O
- Stepper commands
- $\pm 10V$  or PWM velocity/torque (servo mode)
- Master encoder (Gearing/Camming)

## Communications

- CANopen
- RS-232

## Feedback

### Incremental

- Digital quad A/B encoder

## I/O

- Digital: 14 inputs, 6 outputs
- Analog: 1 input

## Dimensions: mm [in]

- 76.3 x 58.2 x 20.5 [3.01 x 2.29 x 0.81]

DIGITAL DRIVE  
FOR STEPPER MOTORS

CANopen®



| Model      | I <sub>c</sub> | I <sub>p</sub> | V <sub>dc</sub> |
|------------|----------------|----------------|-----------------|
| SPM-090-07 | 5              | 7              | 14~90           |
| SPM-090-10 | 10             | 10             | 14~90           |



DEVELOPMENT KIT

## DESCRIPTION

Stepnet SPM is a high-performance, DC powered servo drive for control of stepper motors via CANopen. The SPM operates as an CANopen node using DSP-402 for motion control devices. Supported modes include: Profile Position, Profile Velocity, Interpolated Position Mode (PVT), and Homing.

With encoder feedback a stepper can be operated as a brushless servo motor enabling  $\pm 10V$  analog or digital PWM velocity or torque control in addition to CANopen. Direct position control from pulses in CW/CCW, Pulse/Dir, or Quad A/B encoder format works in either microstepping or servo modes.

Twelve high-speed digital inputs with programmable functions are provided, and a lower-speed input for a motor temperature switch.

An SLI (Serial Peripheral 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 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 = Bipolar stepper: 2 mH + 2  $\Omega$  per phase. Ambient temperature = 25°C, +HV = HV<sub>max</sub>

| MODEL                                                                                                               | SPM-090-07                                                                                                                                                                                                         | SPM-090-10 |                            |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------------------------|
| OUTPUT POWER                                                                                                        |                                                                                                                                                                                                                    |            |                            |
| Peak Current                                                                                                        | 7 (5)                                                                                                                                                                                                              | 10 (7.1)   | Adc (Arms-sine), ±5%       |
| Peak time                                                                                                           | 1                                                                                                                                                                                                                  | 1          | Sec                        |
| Continuous current                                                                                                  | 5 (3.5)                                                                                                                                                                                                            | 10 (7.1)   | Adc (Arms-sine) per phase  |
| Maximum Output Voltage                                                                                              |                                                                                                                                                                                                                    |            | Vout = HV*0.97 - Rout*Iout |
| INPUT POWER                                                                                                         |                                                                                                                                                                                                                    |            |                            |
| HVmin~HVmax                                                                                                         | +14 to +90                                                                                                                                                                                                         | +14 to +90 | Vdc Transformer-isolated   |
| Ipeak                                                                                                               | 7.7                                                                                                                                                                                                                | 11         | Adc (1 sec) peak           |
| Icont                                                                                                               | 5.5                                                                                                                                                                                                                | 11         | Adc continuous             |
| Aux HV                                                                                                              | +14 to +HV Vdc @ 500 mAdc maximum, 2.5 W                                                                                                                                                                           |            |                            |
| PWM OUTPUTS                                                                                                         |                                                                                                                                                                                                                    |            |                            |
| Type                                                                                                                | Dual H-bridge MOSFET , 16 kHz center-weighted PWM, space-vector modulation                                                                                                                                         |            |                            |
| PWM ripple frequency                                                                                                | 32 kHz                                                                                                                                                                                                             |            |                            |
| CONTROL MODES                                                                                                       |                                                                                                                                                                                                                    |            |                            |
| CANopen:                                                                                                            |                                                                                                                                                                                                                    |            |                            |
| Microstepping: Profile Position-Velocity, Cyclic Synchronous Position-Velocity, Interpolated Position (PVT), Homing |                                                                                                                                                                                                                    |            |                            |
| Servo mode: all of the microstepping modes, plus Cyclic Synchronout Torque (CST) mode                               |                                                                                                                                                                                                                    |            |                            |
| Analog ±10 Vdc current/velocity (servo mode), camming, internal indexer and function generator                      |                                                                                                                                                                                                                    |            |                            |
| Digital PWM/Polarity current/velocity (servo mode), CW/CCW, Step/Direction, and quad A/B encoder position commands  |                                                                                                                                                                                                                    |            |                            |
| COMMAND INPUTS                                                                                                      |                                                                                                                                                                                                                    |            |                            |
| Type                                                                                                                | CANopen, galvanically isolated from drive circuits                                                                                                                                                                 |            |                            |
| Signals                                                                                                             | CAN_H, CAN_L, CAN_GND                                                                                                                                                                                              |            |                            |
| Data protocol                                                                                                       | CANopen Device Profile DSP-402                                                                                                                                                                                     |            |                            |
| Node-ID Selection                                                                                                   | Programmable, or via digital inputs                                                                                                                                                                                |            |                            |
| Analog                                                                                                              | ±10 Vdc                                                                                                                                                                                                            |            |                            |
| Digital                                                                                                             | High speed inputs for CW/CCW, Step/Direction, and quad A/B encoder                                                                                                                                                 |            |                            |
| 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                                                                                                                                                                                 |            |                            |
| Modulation                                                                                                          | Center-weighted PWM with space-vector modulation                                                                                                                                                                   |            |                            |
| Bandwidths                                                                                                          | 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                                                                                                      |                                                                                                                                                                                                                    |            |                            |
| [IN1~9]                                                                                                             | High-speed digital, 100 ns RC filter, 10 kΩ pull-up to +5 Vdc, +7 Vdc tolerant<br>74AHC14 Schmitt trigger, V <sub>T+</sub> = 3.5 Vdc max, V <sub>T-</sub> = 1.5 Vdc min, V <sub>H+</sub> = 0.45~1.50 Vdc           |            |                            |
| [IN10]                                                                                                              | SLI port MISO input, 47 ns RC filter, 10 kΩ pull-up to +5 Vdc, +7 Vdc tolerant<br>74LVC2G14 Schmitt trigger, V <sub>T+</sub> = 2.05~3.35 Vdc, V <sub>T-</sub> = 1.1~2.15 Vdc, V <sub>H+</sub> = 0.65~1.6 Vdc       |            |                            |
| [IN11]                                                                                                              | Motor temperature switch, 330 μs RC filter, 4.99 kΩ pull-up to +5 Vdc, +24V tolerant<br>74LVC2G14 Schmitt trigger, V <sub>T+</sub> = 2.05~3.35 Vdc, V <sub>T-</sub> = 1.1~2.15 Vdc, V <sub>H+</sub> = 0.65~1.6 Vdc |            |                            |
| [IN12~14]                                                                                                           | GP inputs, 1.5 μs RC filter, 15 kΩ pull-up to +5 Vdc, +24 Vdc tolerant<br>74AHC14 Schmitt trigger, V <sub>T+</sub> = 3.5 Vdc max, V <sub>T-</sub> = 1.5 Vdc min, V <sub>H+</sub> = 0.45~1.50 Vdc                   |            |                            |
| DIGITAL OUTPUTS                                                                                                     |                                                                                                                                                                                                                    |            |                            |
| [OUT1~2]                                                                                                            | Open-drain MOSFET with 1 kΩ pull-up with series diode to +5 Vdc<br>300 mAdc max, +30 Vdc max. Functions programmable                                                                                               |            |                            |
| [OUT3~6]                                                                                                            | SLI port MOSI, SCLK, SS1, & SS2 signals, 74AHCT125 line drivers; +5 Vdc tolerant                                                                                                                                   |            |                            |
| ANALOG INPUT                                                                                                        |                                                                                                                                                                                                                    |            |                            |
| Type                                                                                                                | ±10 Vdc, 12-bit resolution, differential                                                                                                                                                                           |            |                            |
| 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                                                                                                                     |            |                            |
| Encoder power                                                                                                       | +5 Vdc ±2% @ 400 mAdc max, protected against shorts and overtemperature                                                                                                                                            |            |                            |

#### 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

|                             |                                                                                                                                              |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Phases A, /A, B, /B         | PWM outputs to 2-phase, 4-wire bipolar stepper motors                                                                                        |
| Digital Incremental Encoder | Quadrature signals, (A, /A, B, /B, X, /X), differential (X, /X Index signals not required)<br>5 MHz maximum line frequency (20 M counts/sec) |
| Encoder power               | +5 Vdc $\pm$ 2% @ 400 mAdc max                                                                                                               |
| Motemp [IN11]               | Motor overtemperature switch input. Active level programmable<br>Programmable to disable drive when motor over-temperature condition occurs  |

#### PROTECTIONS

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

#### MECHANICAL & ENVIRONMENTAL

|                     |                                                                          |
|---------------------|--------------------------------------------------------------------------|
| Size 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: 2009/A1:2010 | CISPR 11:2009/A1:2010<br>Industrial, Scientific, and Medical (ISM) Radio Frequency Equipment –<br>Electromagnetic Disturbance Characteristics – Limits and Methods of Measurement<br>Group 1, Class A |
| EN 61000-6-1: 2007     | Electromagnetic Compatibility (EMC) – Part 6-1: Generic Standards –<br>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.: 2008 | Electrical Equipment for Measurement, Control and Laboratory Use;<br>Part 1: General Requirements |
|---------------------------|---------------------------------------------------------------------------------------------------|

UL File Number E249894

## COMMAND INPUTS

### CANOPEN

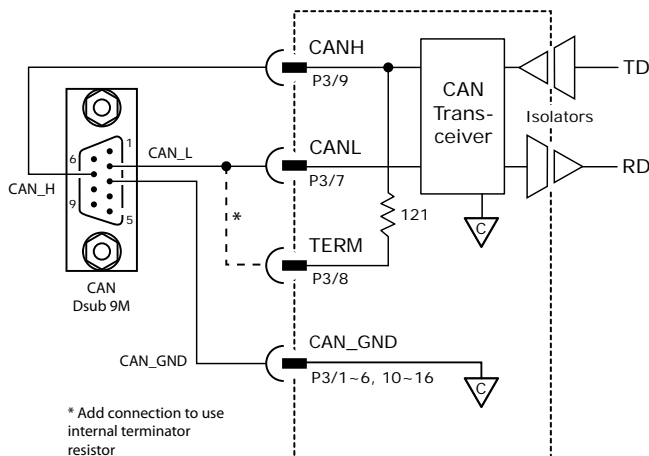
Based on the CAN V2.0b physical layer, a robust, two-wire communication bus originally designed for automotive use where low-cost and noise-immunity are essential, CANopen adds support for motion-control devices and command synchronization. The result is a highly effective combination of data-rate and low cost for multi-axis motion control systems. Device synchronization enables multiple axes to coordinate moves as if they were driven from a single control card.

### CANOPEN COMMUNICATION

Stepnet uses the CAN physical layer signals CANH, CANL, and GND for connection, and CANopen protocol for communication. Before installing the drive in a CAN system, it must be assigned a CAN Node-ID (address). A maximum of 127 CAN nodes are allowed on a single CAN bus. Up to seven digital inputs can be used to produce CAN Node-IDs from 1~127, or the Node-IDs can be saved to flash memory in the module. Node-IDs 0 is reserved for the CANopen master on the network. For more information on CANopen communications, download the CANopen Manual from the Copley web-site: CANopen Manual

### DIGITAL COMMAND INPUTS

The graphic below shows connections between the SPM and a Dsub 9M connector on a CAN card. If the SPM is the last node on a CAN bus, the internal terminator resistor can be used by adding a connection on the PC board as shown. The Node-IDs of the SPM may be set by using digital inputs, or programmed into flash memory in the drive.



CME2 -> Basic Setup -> Operating Mode Options

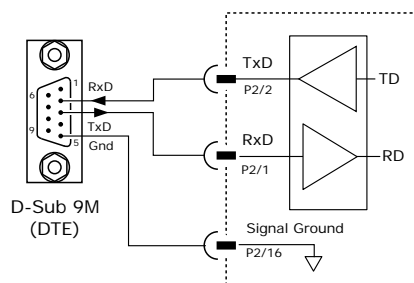
Operating Mode:

Command Source:

### RS-232 COMMUNICATIONS

SPM 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 Rx/D, Tx/D, and Gnd. Connections to the SPM RS-232 port are through P2. The graphic below shows the connections between an SPM and a computer COM port which is a DTE device.

### RS232 PORT



CME2 -> Tools -> Communications Wizard

Communications Wizard

Select device:

- ☒ Serial Ports
- ☐ CAN Network
- ☐ EtherCAT

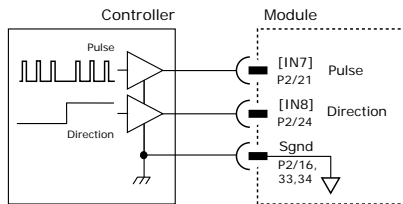
Next > Cancel

## COMMAND INPUTS

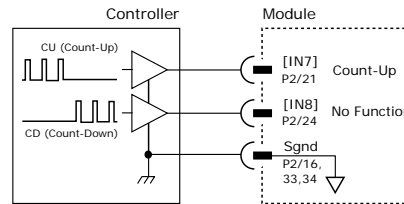
### DIGITAL POSITION

Digital position commands can be in three formats: Pulse & Direction, Count-Up/Count-Down (CU/CD), and quad A/B encoder. The active edge of the waveforms is programmable and the ratio of input pulses to motor microsteps is programmable, too. The Invert Command selection will reverse the direction of motion commanded by the inputs without changing the wiring.

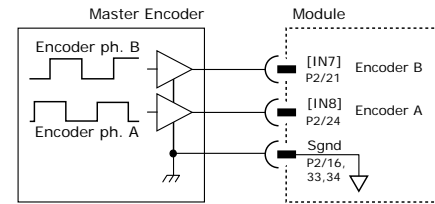
#### PULSE & DIRECTION



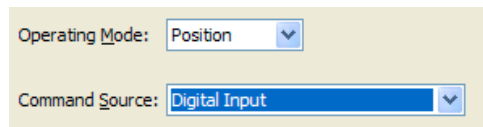
#### CU/CD



#### QUAD A/B ENCODER



CME2 -> Basic Setup -> Operating Mode Options

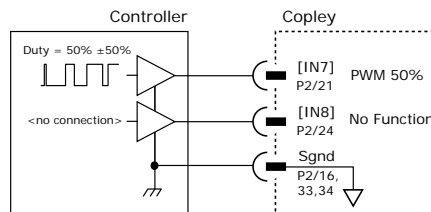


CME2 -> Basic Setup -> Operating Mode Options

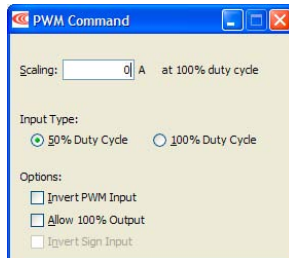
### DIGITAL VELOCITY

Digital velocity commands are PWM signals in two formats: PWM 50% is a single signal that commands 0 at 50% duty cycle, with increasing or decreasing duty cycle to command positive or negative values. PWM & Direction format uses a PWM signal that goes from 0% to 100% to command magnitude while a 0/1 at the Dir input commands direction.

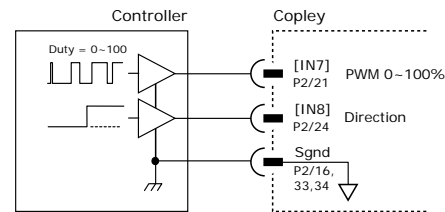
#### PWM 50%



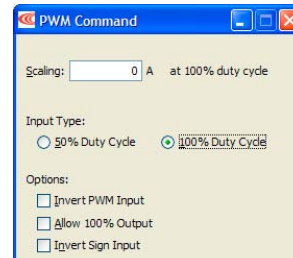
CME2 -> PWM Command block



#### PWM & DIRECTION



CME2 -> PWM Command block



### DIGITAL COMMAND FAIL-SAFE

In the position and velocity modes above, the 0% and 100% conditions can be programmed to command zero output. This is to protect against conditions that can occur with broken or disconnected cables which might produce uncontrolled motion.

## SERVO MODE

Servo mode operates a stepper like a brushless servo motor taking position feedback from an encoder and controlling position, velocity, or torque. Command inputs include all of the digital inputs and modes as well as the  $\pm 10V$  analog input which can control position, velocity, and current.

## ANALOG COMMAND INPUT

In addition to the digital position and velocity inputs on the preceding page, the analog input can be used to control position, velocity, and torque.

CME2 -> Basic Setup -> Feedback Options

Motor Encoder: Primary Incremental

☒ Differential ☐ Single Ended

☒ Run in Servo Mode

CME2 -> Basic Setup -> Operating Mode Options

Operating Mode: Position

Command Source: Analog Command

CME2 -> Basic Setup -> Operating Mode Options

Command Source: Analog Command

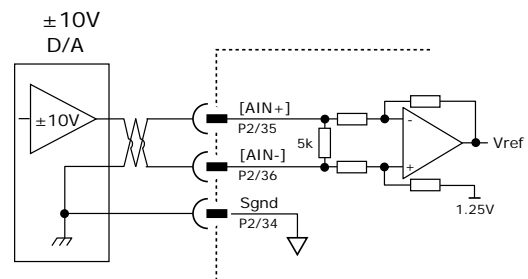
CME2 -> Main Page -> Analog Command block

Scaling: 4000 counts = 10V

Dead Band: 0 mV

☐ Invert Command

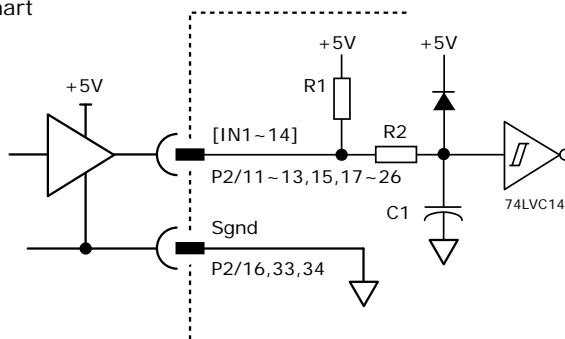
Analog Input Filter



## INPUT-OUTPUT

### HIGH SPEED DIGITAL INPUTS

Vin tolerance see chart

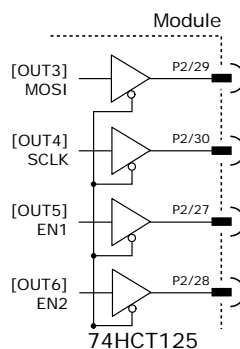
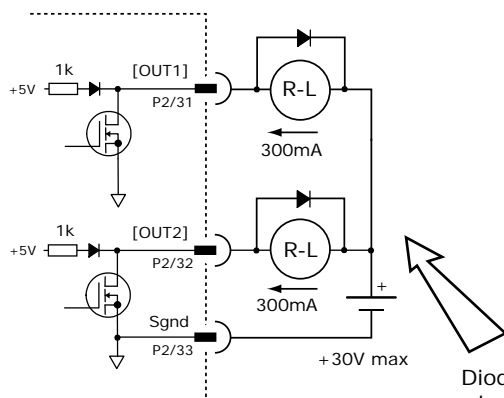


| Input | P2 Pin | R1    | R2  | C1   | Vin |
|-------|--------|-------|-----|------|-----|
| IN1   | 15     | 10k   | 1k  | 100p | 7V  |
| IN2   | 18     |       |     |      |     |
| IN3   | 17     |       |     |      |     |
| IN4   | 20     |       |     |      |     |
| IN5   | 19     |       |     |      |     |
| IN6   | 22     |       |     |      |     |
| IN7   | 21     |       |     |      |     |
| IN8   | 24     |       |     |      |     |
| IN9   | 23     |       |     |      |     |
| IN10  | 26     |       |     | 47p  |     |
| IN11  | 25     | 4.99k | 10k | 33n  | 24  |
| IN12  | 11     | 15k   | 15k | 100p |     |
| IN13  | 13     |       |     |      |     |
| IN14  | 12     |       |     |      |     |

### DIGITAL OUTPUTS

Vout max (see chart)

5V max



| Output | P2 Pin | Vout |
|--------|--------|------|
| OUT1   | 31     | 30   |
| OUT2   | 32     |      |
| OUT3   | 29     | 5    |
| OUT4   | 30     |      |
| OUT5   | 27     |      |
| OUT6   | 28     |      |

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

### CANOPEN NODE-ID (ADDRESS) SWITCHES

The SLI (Switch & LED Interface) port takes in the 8 signals from the two BCD encoded switches that set the CANopen

Node-IDs and controls the LEDs on the CANopen port connectors.

The graphic below shows the circuit for reading the CANopen Node-ID switches.

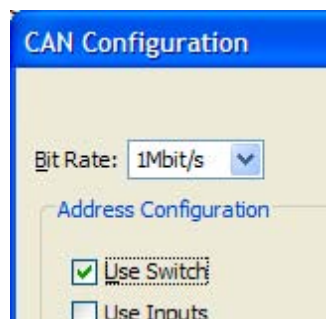
The 74HC165 works as a parallel-in/serial-out device.

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

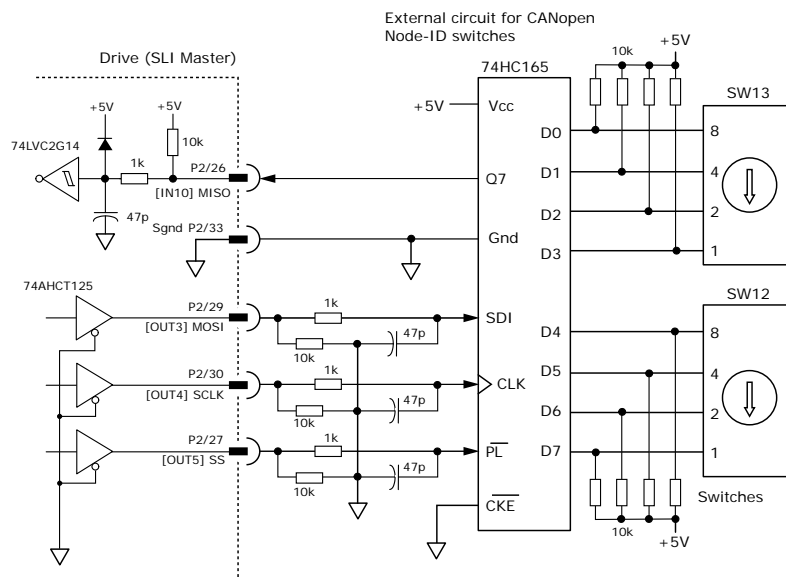
In the graphics below, switch SW13 is "S2" and SW12 is "S1". The values of S1 are 16~255 and of S2 are 0~15.

Together they provide Node-ID range of 0~255.

CME2 -> Amplifier -> Network Configuration



CME2 -> Input/Output -> Digital Outputs



## MOTOR CONNECTIONS

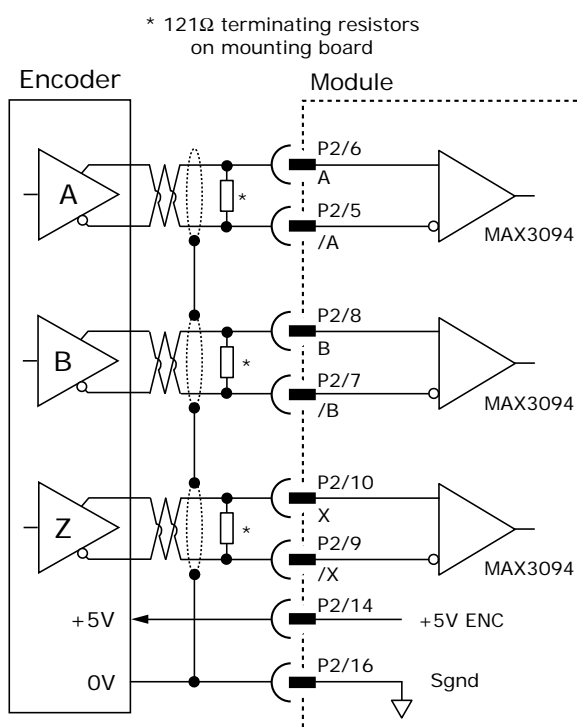
Motor connections consist of: phases, encoder, thermal sensor, and brake. The phase connections carry the drive output currents that drive the motor to produce motion. The Hall signals are three digital signals that give absolute position feedback within an electrical commutation cycle. The encoder signals give incremental 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

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.

### DIGITAL QUADRATURE ENCODER INPUT

5V



CME2 -> Motor/Feedback -> Feedback

Motor Encoder:

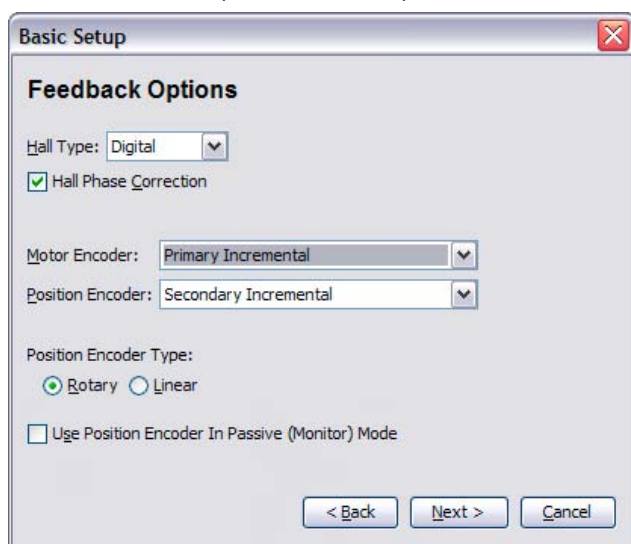


## MOTOR CONNECTIONS (CONT'D)

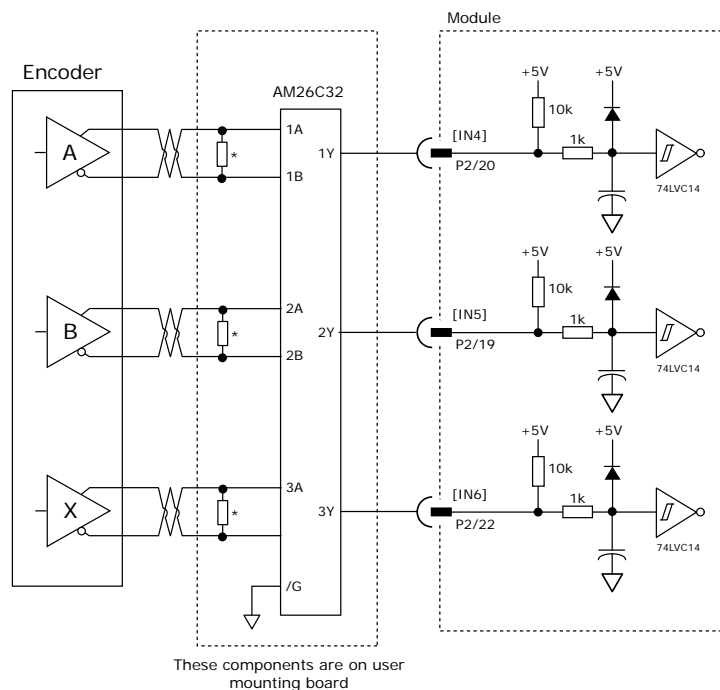
### SECONDARY QUAD A/B/X INCREMENTAL ENCODER

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 SPM.

CME2 -> Basic Setup -> Feedback Options



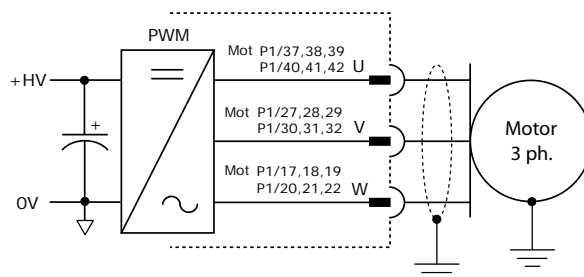
The CME2 screen above shows a Primary Incremental encoder for the motor input. Other types of encoders can be selected for this function. The secondary encoder input can be used for either motor or position feedback.



## MOTOR CONNECTIONS (CONT'D)

### 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

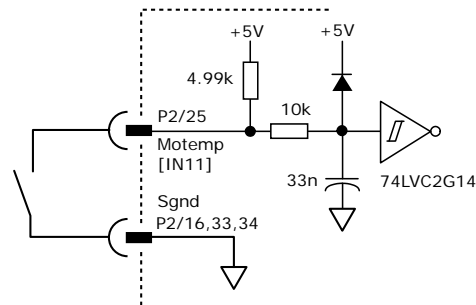
Motor Family:

☒ Brushless ☐ Brush

### 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.

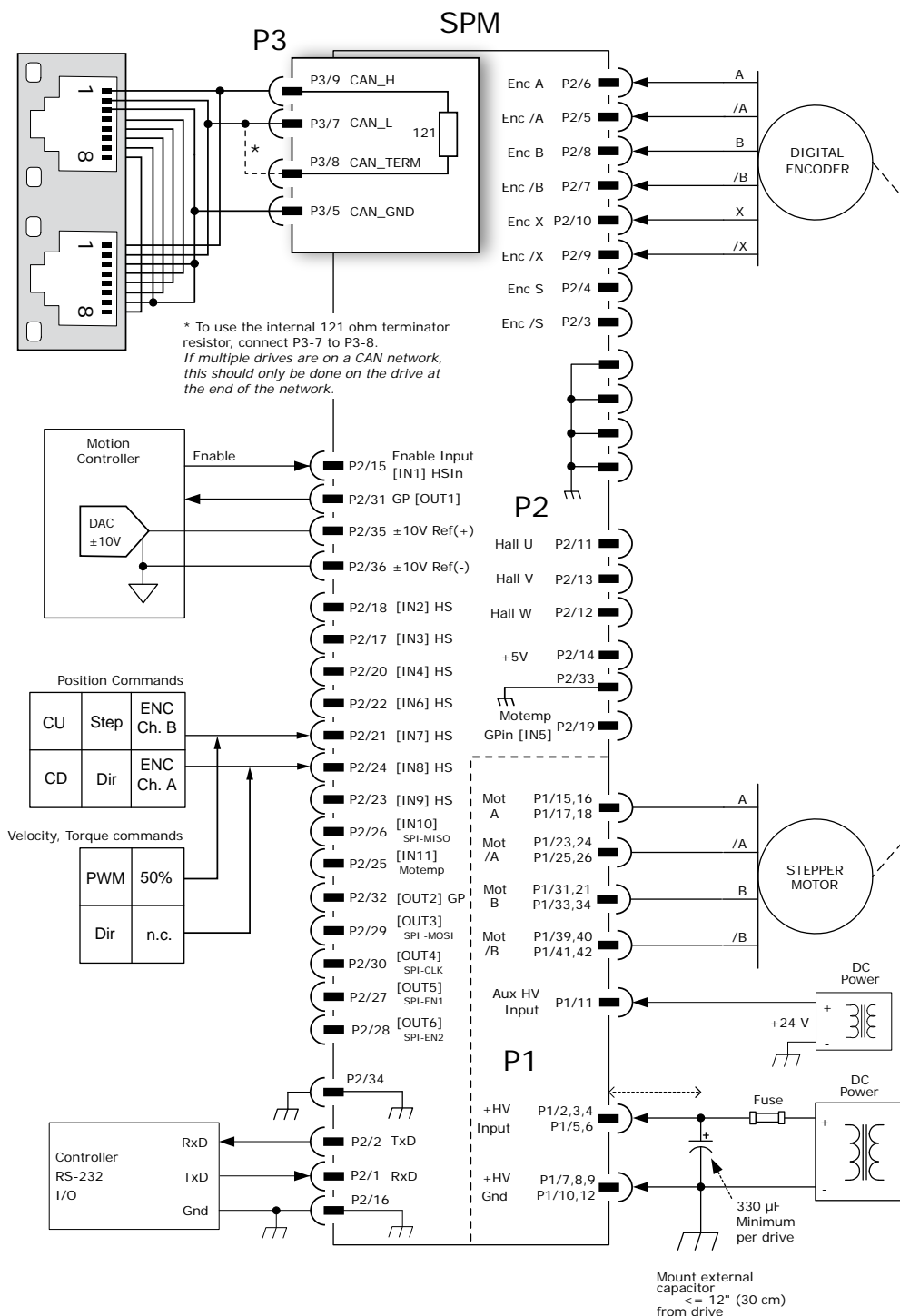
| Property                                          | Ohms   |
|---------------------------------------------------|--------|
| Resistance in the temperature range 20°C to +70°C | 60~750 |
| Resistance at 85°C                                | ≤1650  |
| Resistance at 95°C                            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



CME2 -> Input / Output

[IN5] Motor Temp-HI Disables 0 ms

# CONNECTIONS FOR INCREMENTAL DIGITAL ENCODER



## Notes:

1. P3 connections use multiple pins to share current.  
All signals of the same name must be connected on the PC board to which the SPM is mounted.
2. The CANopen connector is shown to illustrate connections between the SPM and external cabling.  
The connector is not part of the SPM and non-signal connections are not shown.

## PRINTED CIRCUIT BOARD CONNECTORS &amp; SIGNALS

## P1 POWER &amp; MOTOR

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

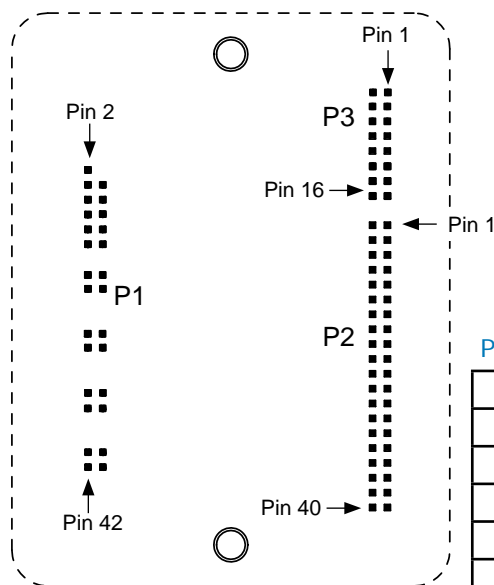
P1: Power & Motor  
Dual row, 2 mm- centers  
42 position female header  
SAMTEC SQW-121-01-L-D

## 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 SPM is mounted.
2. Cells in table above that are filled in grey are connector contacts that have no circuit connections.

## TOP VIEW

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



## P3 CANOPEN

| Signal   | Pin | Signal |
|----------|-----|--------|
| CAN_GND  | 2   | 1      |
| CAN_GND  | 4   | 3      |
| CAN_GND  | 6   | 5      |
| CAN_TERM | 8   | 7      |
| CAN_GND  | 10  | 9      |
| CAN_GND  | 12  | 11     |
| CAN_GND  | 14  | 13     |
| CAN_GND  | 16  | 15     |

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

## P2 CONTROL

| Signal      | Pin | Signal |
|-------------|-----|--------|
| RS-232 TxD  | 2   | 1      |
| Enc S       | 4   | 3      |
| Enc A       | 6   | 5      |
| Enc B       | 8   | 7      |
| Enc X       | 10  | 9      |
| Hall W      | 12  | 11     |
| Enc +5V     | 14  | 13     |
| Sgnd        | 16  | 15     |
| [IN2]       | 18  | 17     |
| [IN4]       | 20  | 19     |
| [IN6]       | 22  | 21     |
| [IN8]       | 24  | 23     |
| MISO [IN10] | 26  | 25     |
| SS2 [OUT6]  | 28  | 27     |
| SCLK [OUT4] | 30  | 29     |
| [OUT2]      | 32  | 31     |
| Sgnd        | 34  | 33     |
| Ref (-)     | 36  | 35     |
| n.c.        | 38  | 37     |
| n.c.        | 40  | 39     |

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

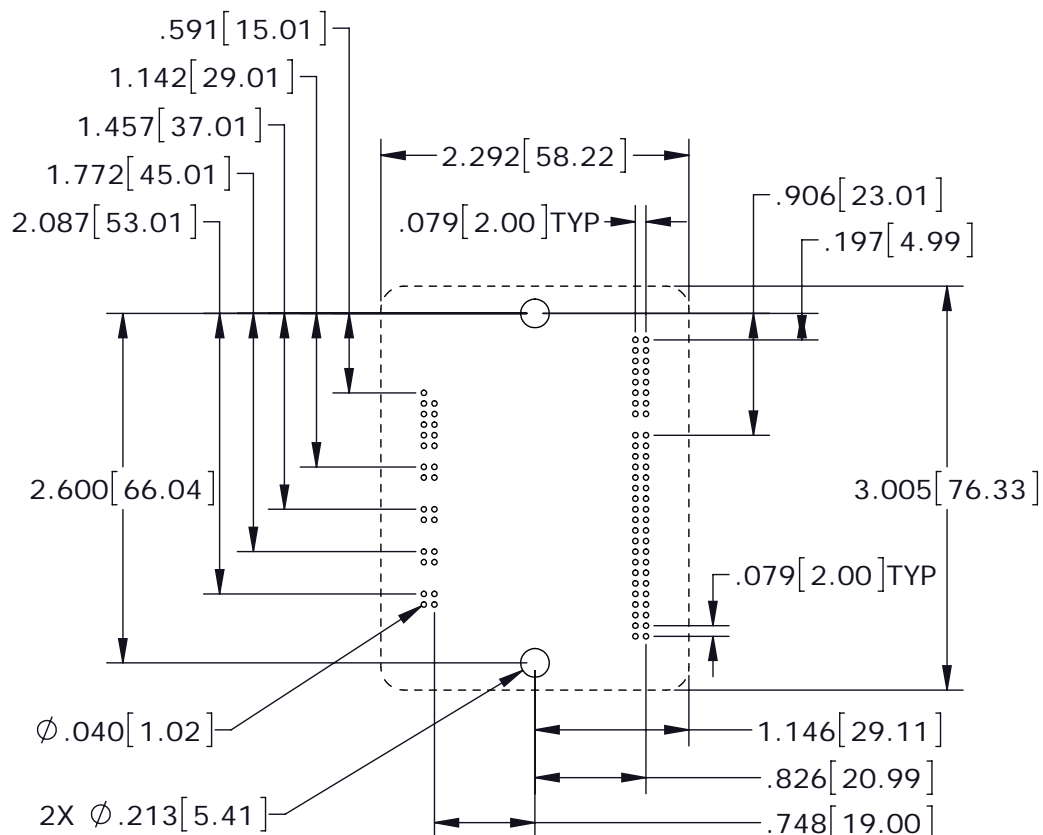
# PRINTED CIRCUIT BOARD FOOTPRINT

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



### PCB 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 CANopen    |
| 2   | Standoff     | PEM    | KFE-4/40-8ET   | #4/40 X 1/4"  |

### Additional Hardware (not shown above)

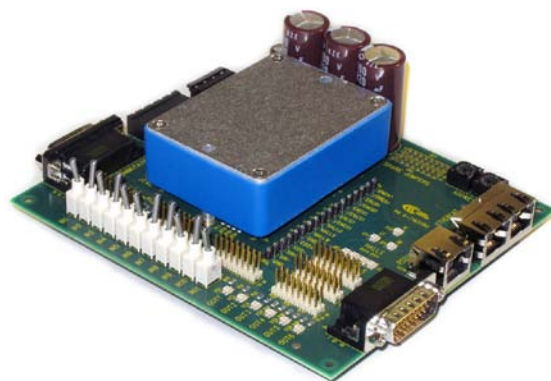
- Screw, #4-40 x 1.25" Phillips Pan Head External Tooth Lockwasher SEMS, Stainless, or steel with nickel plating, Torque to 3-5 lb-in (0.34-0.57 N·m)

### Notes

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

## DESCRIPTION

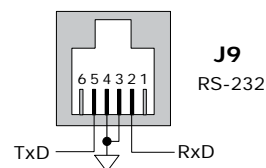
The Development Kit provides mounting and connectivity for one SPM drive. Solderless jumpers ease configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~11 so that these can be toggled to simulate equipment operation. Six LED's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



## RS-232 CONNECTION

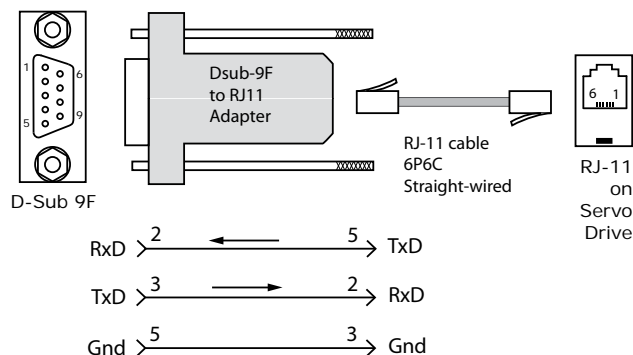
The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an CANopen network. CME 2™ software communicates with the drive over this link and is then used for complete drive setup. The CANopen Slave Node-ID that is set by the rotary switch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



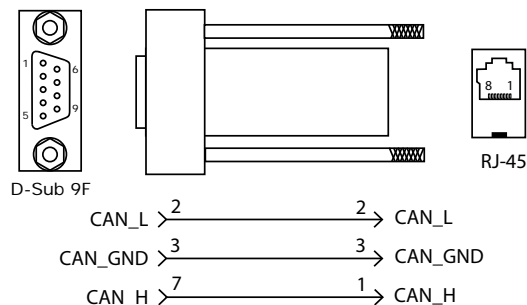
Don't forget to order a Serial Cable Kit SER-CK when placing your order for an SPM Development Kit!

## CANOPEN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet cables are provided for CAN bus connectivity. Pins are wired-through so that drives can be daisy-chained and controlled with a single connection to the user's CAN interface. A CAN terminator should be placed in the last drive in the chain. The SPM-NK connector kit provides a D-Sub adapter that plugs into a CAN controller and has an RJ-45 socket that accepts the Ethernet cable.

### SPK-NK CAN CONNECTOR KIT

The kit contains the SPK-CV adapter that converts the CAN interface D-Sub 9M connector to an RJ-45 Ethernet cable socket, plus a 10 ft (3 m) cable and terminator. Both connector pin-outs conform to the CiA DR-303-1 specification.



## INDICATORS (LEDs)

The AMP LED on J9 shows the operational state of the SPM. The STATUS LED on J9 shows the state of the CANopen NMT (Network Management) state-machine in the drive. LEDs on J10 show activity on the CANopen network. Details on the NMT state-machine can be found in the CANopen Programmers Manual, §3.1: <http://www.copleycontrols.com/Motion/pdf/CANopenProgrammersManual.pdf>

### AMP LED

A single bi-color LED gives the state of the SPM by changing color, and either blinking or remaining solid.

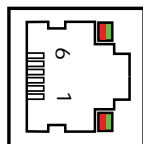
The possible color and blink combinations are:

- **Green/Solid:** Drive OK and enabled. Will run in response to reference inputs or CANopen commands.
- **Green/Slow-Blinking:** Drive OK but NOT-enabled. Will change to **Green/Solid** 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.

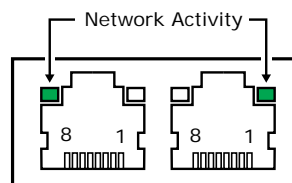
Drive Fault conditions. Faults are programmable to be either transient or latching:

- Over or under-voltage
- Motor over-temperature
- Encoder +5 Vdc fault
- Short-circuits from output to ground
- Drive over-temperature
- Internal short circuits
- Short-circuits from output to output

### J9 RS-32 SERIAL



### J10 CAN CONNECTIONS



### STATUS LED

A single bi-color LED gives the state of the NMT state-machine by changing color, and either blinking or remaining solid. The possible color and blink combinations are:

#### RUN (GREEN)

- Off: Init
- Blinking: Pre-operational
- Single-flash: Stopped
- On: Operational

#### ERROR (RED)

- Off: No error
- Blinking: Invalid configuration, general configuration error
- Single Flash: Warning limit reached
- Double Flash: Error Control Event (guard or heartbeat event) has occurred
- Triple Flash: Sync message not received within the configured period
- On: Bus Off, the CAN master is bus off

### ACT LED

- Flashing indicates the SPM is sending/receiving data via the CAN port

Note: Red & green led on-times do not overlap. LED color may be red, green, off, or flashing of either color.

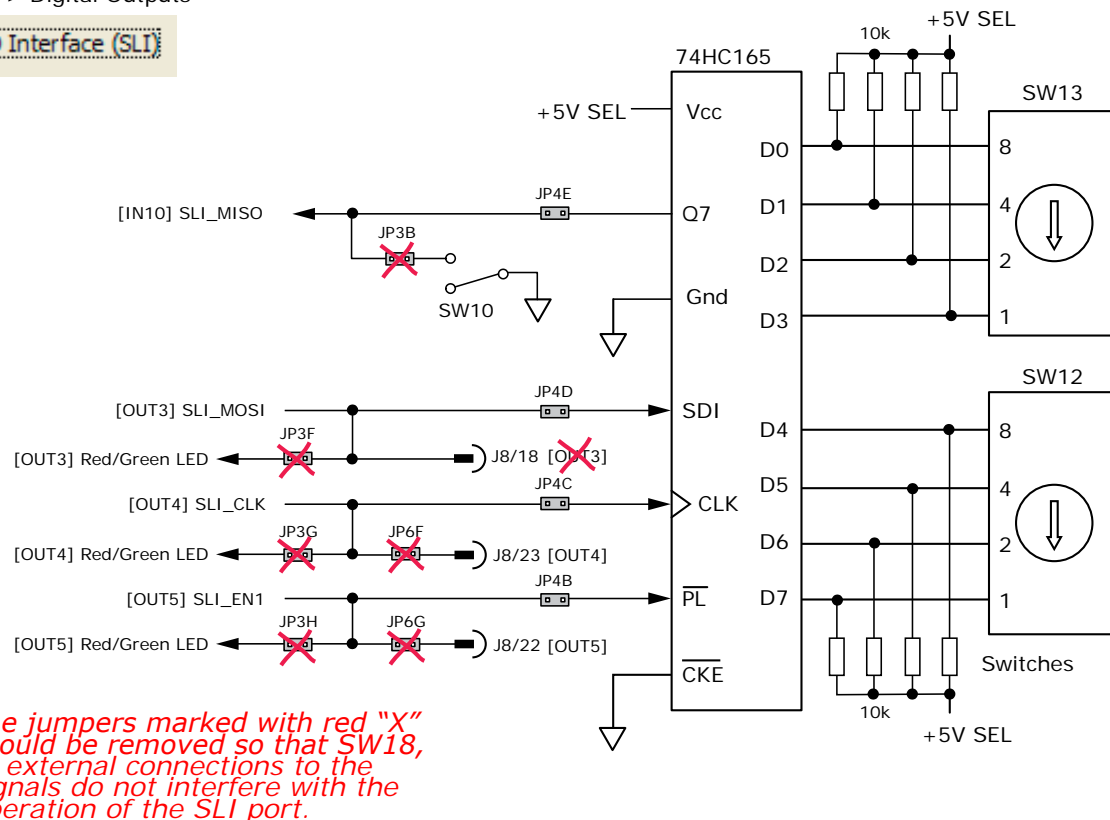
## CANOPEN NODE-ID (ADDRESS) SWITCH CONNECTIONS

The graphic below shows the connections to the CANopen Node-ID 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 CANopen Node-ID switches, and controls the LEDs on the serial and CANopen 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.

CME2 -> Input/Output -> Digital Outputs

☒ Use Switch and LED Interface (SLI)



## 5V POWER SOURCES

The feedback connector J7 has connections for two power supplies:

Pin 6 has +5V supplied by the SPM module

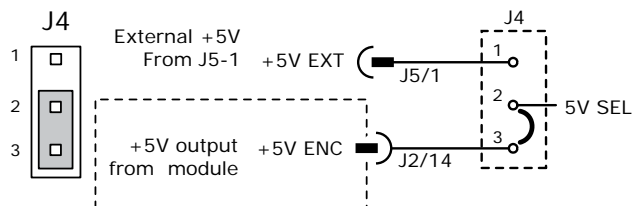
Pin 17 connects to jumper J4 for the selection of the 5V power source:

On J4, when the jumper connects pins 2 & 3, the power source is the SPM 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 SPM are labeled "5V SPM"



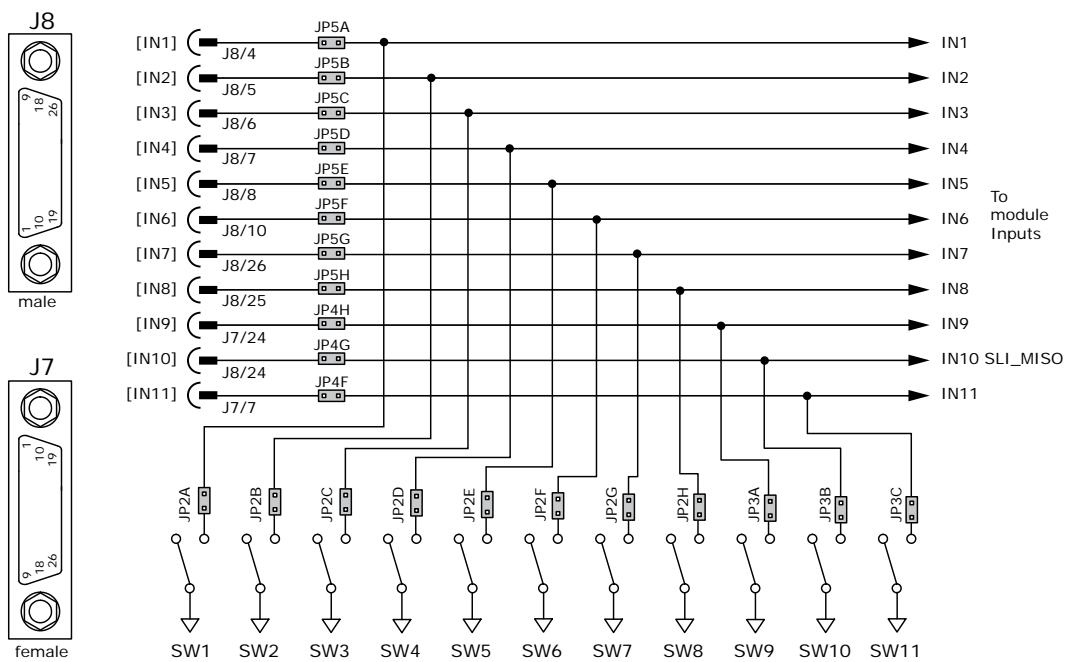


## LOGIC INPUTS & SWITCHES

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

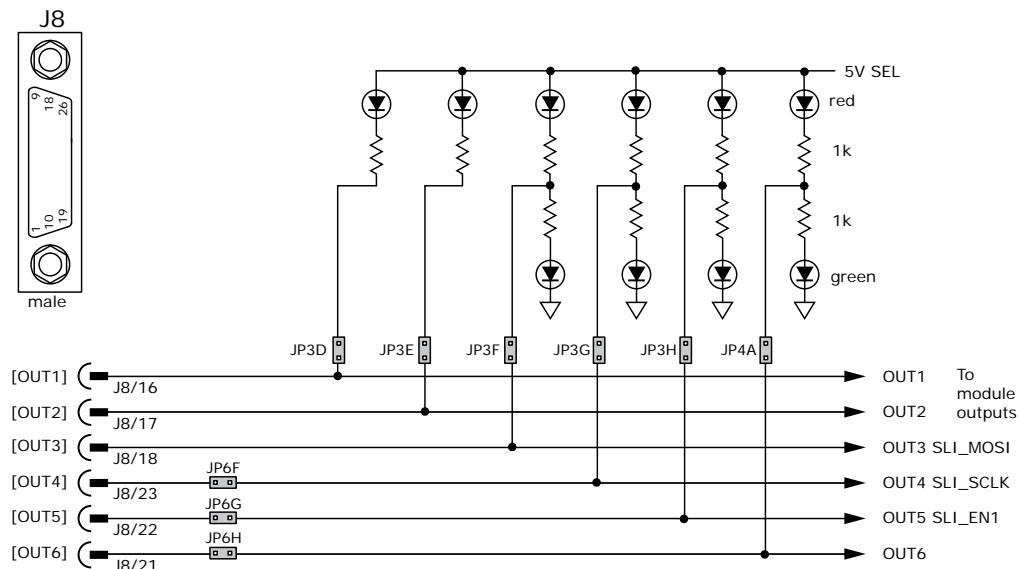
As delivered, all of these jumpers are installed as shown. If connecting to external devices that actively control the level of an input, it is desirable to disconnect the switch which could short the input to ground.

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.

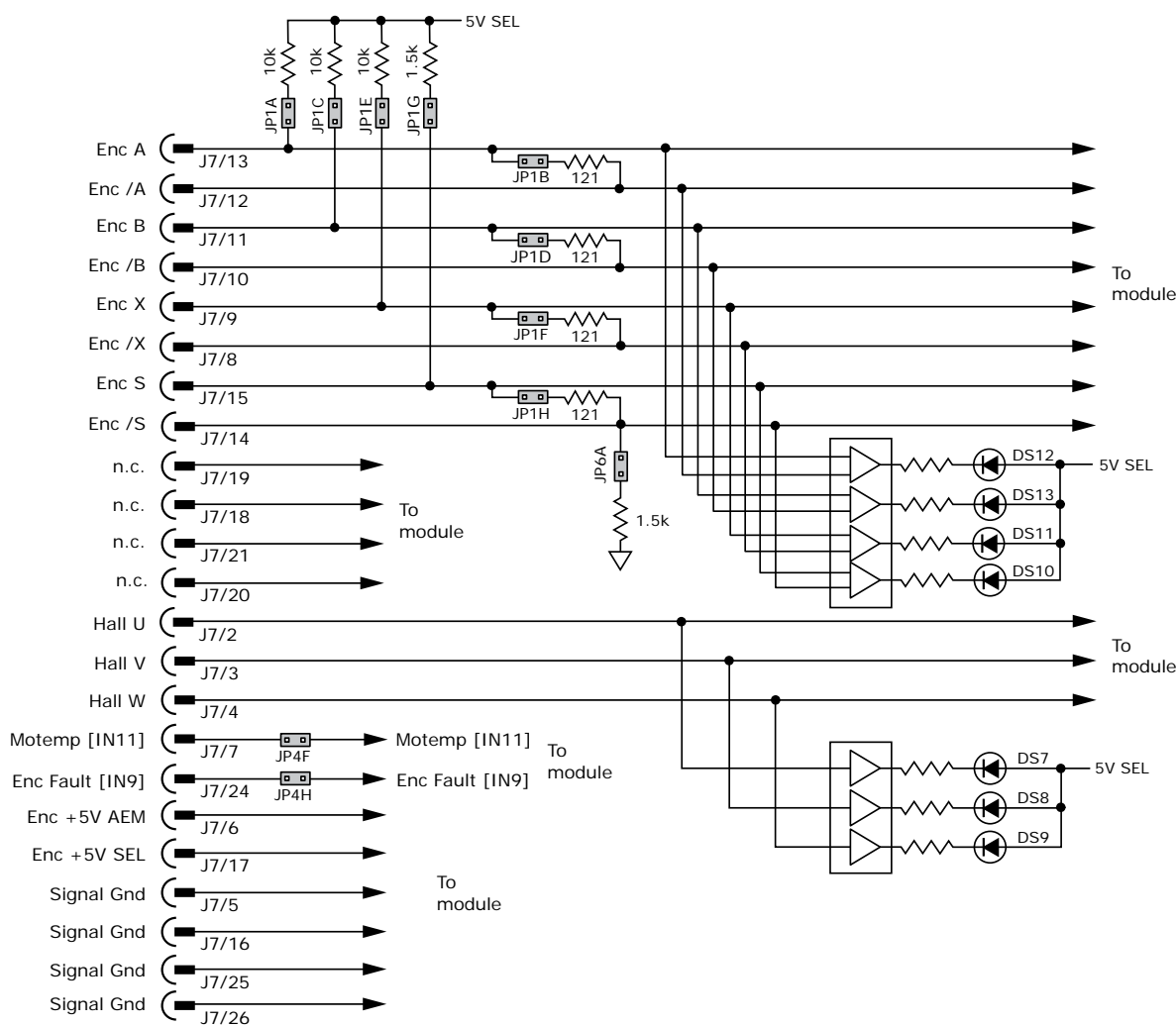
For motors with single-ended encoders: remove jumpers JP1B, JP1D, JP1F, and JP1H to disconnect 121 ohm terminators  
Install jumpers JP1A, JP1C, JP1E, and JP1G

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.

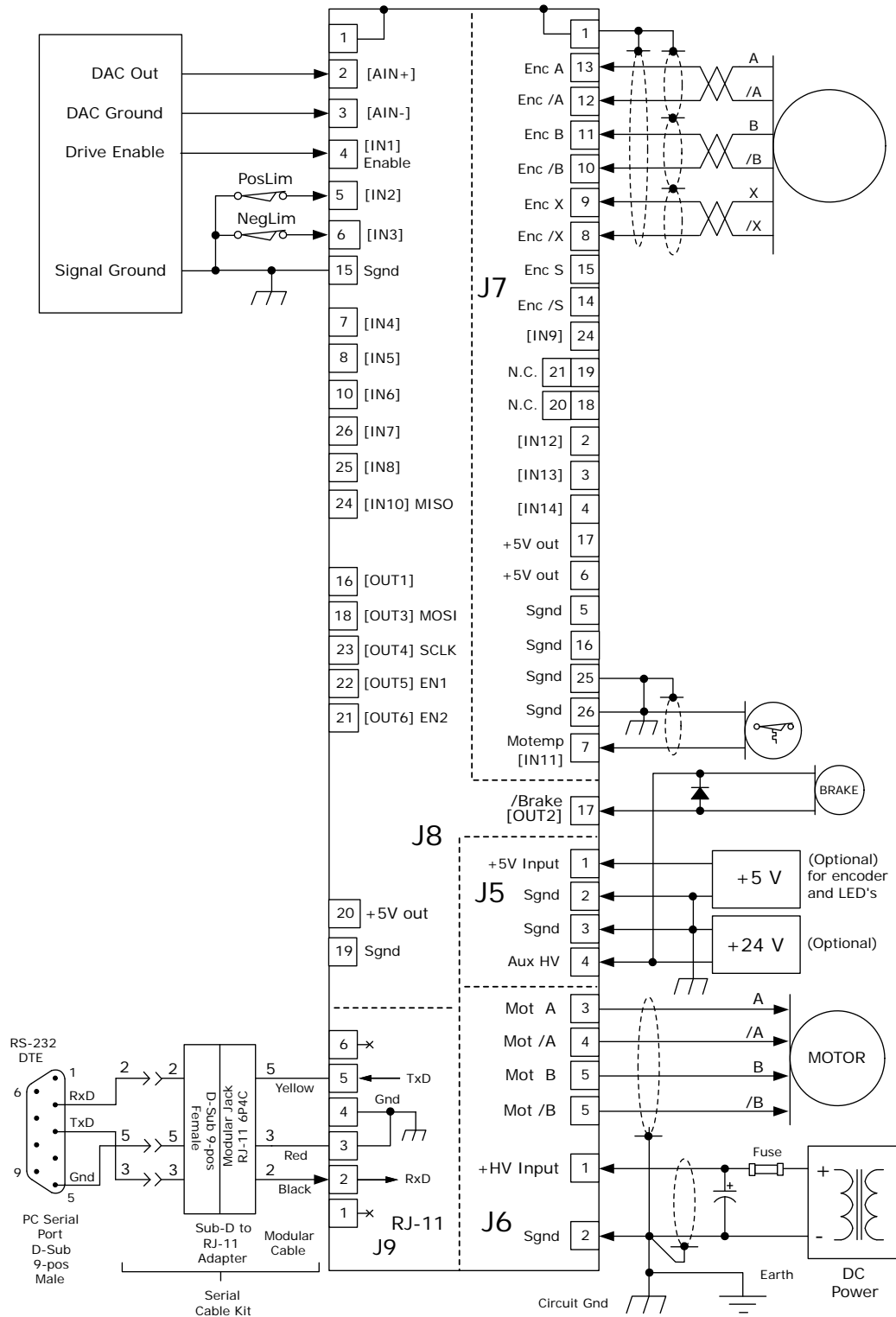
If the encoder has a fault output, then jumper JP4H must be in place and jumper JP3A must be removed to prevent switch SW9 from grounding the Enc Fault [IN9] signal.

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. CANopen connectors J10 are not shown here. For details see pp 4 & 13.



## J11 CAN NETWORK TERMINATOR

| Pins | Function       |
|------|----------------|
| 1-2  | Terminator ON  |
| 2-3  | Terminator OFF |



## J10 CANOPEN

| PIN | SIGNAL                  |
|-----|-------------------------|
| 8   | (CAN_V+) <sup>1</sup>   |
| 7   | CAN_GND                 |
| 6   | (CAN_SHLD) <sup>1</sup> |
| 5   | Reserved                |
| 4   | No Connection           |
| 3   | CAN_GND                 |
| 2   | CAN_L                   |
| 1   | CAN_H                   |

J9 RS-232

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

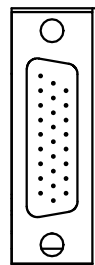
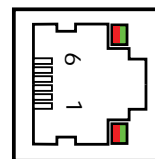
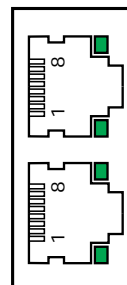
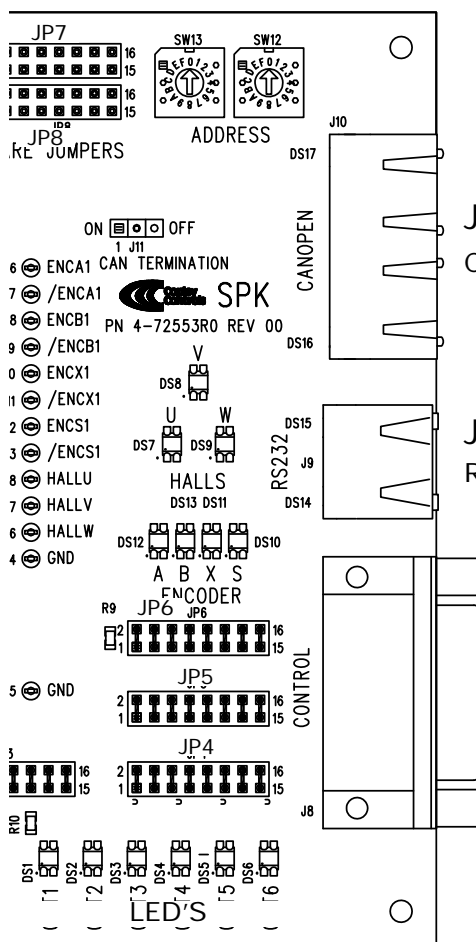
## J8 CONTROL

| PIN | SIGNAL    |
|-----|-----------|
| 9   | N.C.      |
| 8   | [IN5] HS  |
| 7   | [IN4] HS  |
| 6   | [IN3] HS  |
| 5   | [IN2] HS  |
| 4   | [IN1] HS  |
| 3   | [AIN1-]   |
| 2   | [AIN1+]   |
| 1   | Frame Gnd |

| PIN | SIGNAL      |
|-----|-------------|
| 18  | [OUT3] MOSI |
| 17  | [OUT2] GP   |
| 16  | [OUT1] GP   |
| 15  | Sgnd        |
| 14  | N.C.        |
| 13  | N.C.        |
| 12  | N.C.        |
| 11  | N.C.        |
| 10  | [IN6] HS    |

| PIN | SIGNAL      |
|-----|-------------|
| 26  | [IN7] HS    |
| 25  | [IN8] HS    |
| 24  | [IN10] MISO |
| 23  | [OUT4] CLK  |
| 22  | [OUT5] EN1  |
| 21  | [OUT6] EN2  |
| 20  | +5 Vdc Out  |
| 19  | Sqnd        |

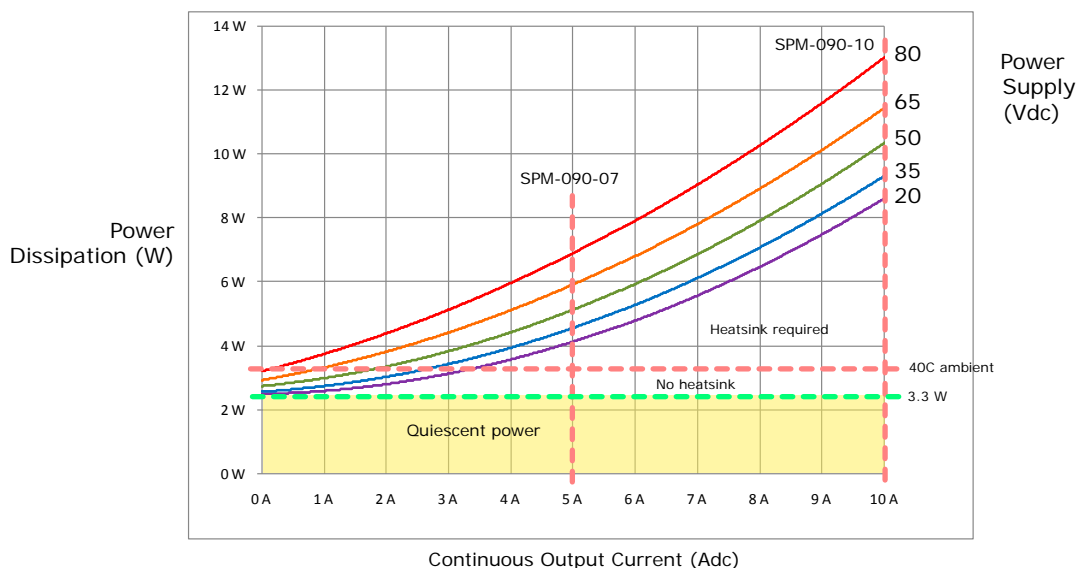
NODE-ID (ADDRESS) SWITCHES



## POWER DISSIPATION

The charts on this page show the drive's internal power dissipation for different models under differing power supply and output current conditions. Drive output current is calculated from the motion profile, motor, and load conditions. The values on the chart represent the rms (root-mean-square) 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 lines show the continuous current ratings for the drive models.

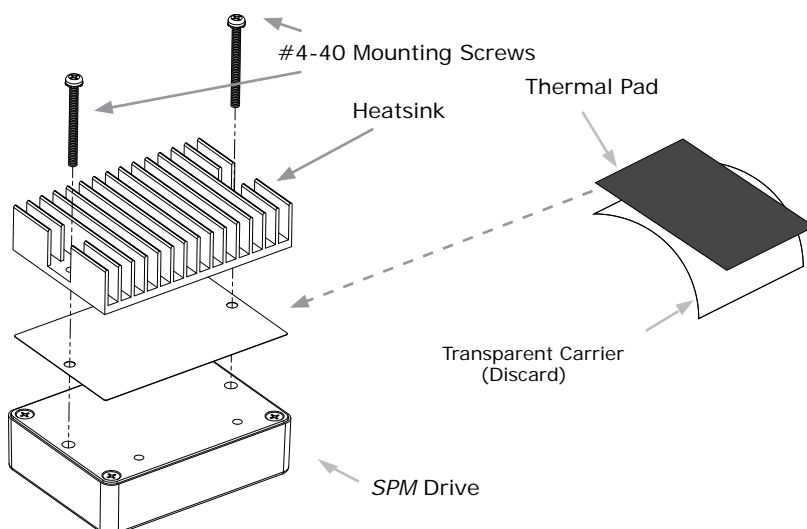


## HEATSINK INSTALLATION USING THE SPM-HK HEATSINK KIT

An AOS Micro Faze thermal pad 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 thermal pad from the clear plastic carrier.
2. Place the thermal pad on the Stepnet aluminum heatplate taking care to center the thermal pad holes over the holes in the drive body.
3. Mount the heatsink onto the thermal pad again taking care to see that the holes in the heatsink, thermal pad, 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

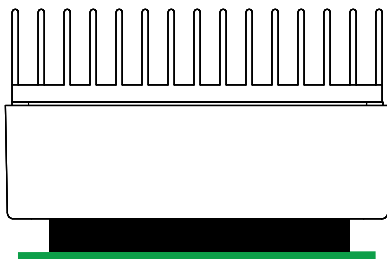
R<sub>th</sub> expresses the rise in temperature of the drive per Watt of internal power loss. The units of R<sub>th</sub> are °C/W, where the °C represent the rise above ambient in degrees Celsius. The data below show thermal resistances under convection, or fan-cooled conditions for the no-heatsink,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

### NO HEATSINK



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

### STANDARD HEATSINK (SPM-HK)



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

## MASTER ORDERING GUIDE

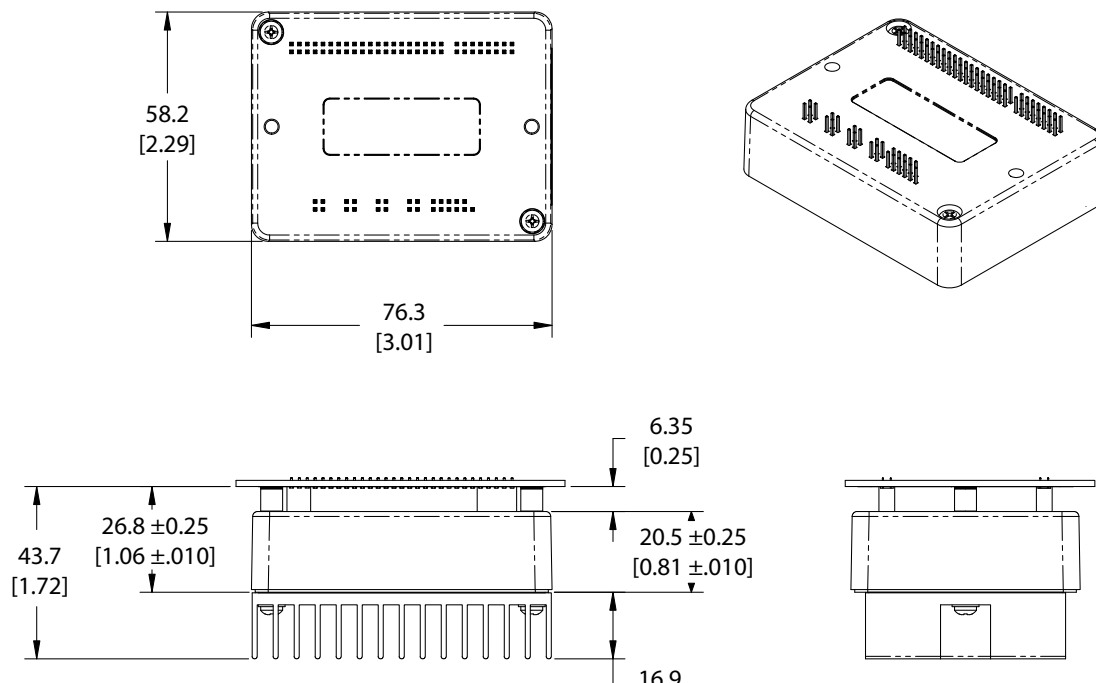
|            |                                               |
|------------|-----------------------------------------------|
| SPM-090-07 | Stepnet SPM stepper drive, 5/7 A, 20~90 Vdc   |
| SPM-090-10 | Stepnet SPM stepper drive, 10/10 A, 20~90 Vdc |
| SPK-090-01 | Development Kit for SPM stepper drive         |

## ACCESSORIES

|                                                | QTY | DESCRIPTION                                               |
|------------------------------------------------|-----|-----------------------------------------------------------|
| Connector Kit for Development Kit<br>SPK-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                                |
| CANopen Network Kit<br>SPK-NK                  | 1   | Adapter Assy, DB9 Female to RJ45 Jack (SPK-CV)            |
|                                                | 1   | CANopen Network Cable, 10 ft. (SPK-NC-10)                 |
|                                                | 1   | CANopen Network Terminator (SPK-NT)                       |
| Heatsink Kit<br>SPM-HK                         | 1   | Heatsink for SPM                                          |
|                                                | 1   | Heatsink Thermal Pad                                      |
|                                                | 2   | Screws, #4/40 x 1.25", SEMS                               |
| SPK-CV                                         |     | Adapter Assembly, DB9 Female to RJ45 Jack                 |
| SPK-NC-10                                      |     | CANopen Network Cable, 10 ft                              |
| SPK-NC-10                                      |     | CANopen network cable, 1 ft                               |
| SPK-NC-10                                      |     | CANopen Network Terminator                                |
| CME 2                                          |     | CME 2 Drive Configuration Software on CD-ROM              |
| SER-CK                                         |     | Serial Cable Kit for Development Kit                      |

## DIMENSIONS

Dimensions are mm [in]



Note: Specifications subject to change without notice

Rev 7.02-mo 03/16/2015