Stepnet Plus 2-Axis Module CANopen SP2

2-AXIS DIGITAL DRIVE
FOR STEPPER MOTORS

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

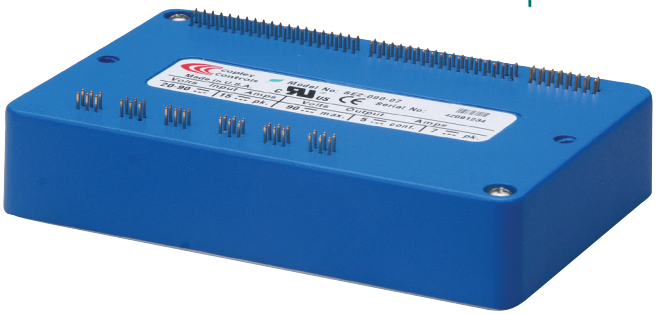
Command Interface
- CANopen
- ASCII and discrete I/O
- Stepper commands
- ±10V or PWM velocity/torque (servo mode)
- Master encoder (Gearing/Camming)

Communications
- CANopen
- RS-232

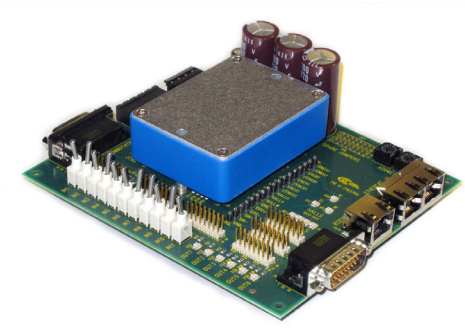
Feedback
- Digital quad A/B encoder

I/O
- Digital: 26 inputs, 7 outputs
- Analog: 2 inputs

Dimensions: mm [in]
- 114 x 73 x 21 [4.5 x 2.9 x 0.83]



Model	Ic	Ip	Vdc
SP2-090-07	5	7	14~90
SP2-090-10	10	10	14~90



DEVELOPMENT KIT

DESCRIPTION

Stepnet SP2 is a dual-axis, high-performance, DC powered drive for position, and velocity control of stepper motors via CANopen. Using advanced FPGA technology, the *SP2* provides a significant reduction in the cost per node in multi-axis CANopen systems.

Each of the two drives in the *SP2* operate as *CANopen* nodes under DSP-402 for motion control devices. Supported modes include: Profile Position-Velocity, Interpolated Position Mode (PVT), and Homing.

Servo mode allows ±10V analog position/velocity/torque, and PWM velocity/torque control. Servo mode allows ±10V analog or digital PWM control of position/velocity/torque. In microstepping mode stepper command pulses and master encoder for camming or gearing is supported.

Twenty-three high-speed digital inputs with programmable functions are provided, and two low-speed inputs for motor temperature switches.

An SLI (Switch & LED Interface) function is supported by another high-speed input and four high-speed digital outputs. If not used for SLI, the input and outputs are programmable for other functions. Three 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 Ω per phase. Ambient temperature = 25°C, +HV = HV_{max}

MODEL	SP2-090-07	SP2-090-10	
OUTPUT POWER (each axis)			
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 (Note 1)
Maximum Output Voltage	Vout = HV*0.97 - Rout*Iout		
INPUT POWER (module)			
HVmin~HVmax	+14 to +90	+14 to +90	Vdc Transformer-isolated
Ipeak	14	11	Adc (1 sec) peak
Icont	10	11	Adc continuous (Note 1)
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: Profile Position, Profile Velocity, & Profile Torque (servo mode), Interpolated Position (PVT), Homing
Position, open-loop, from stepper commands (CW/CCW, Pls/Dir, quad A/B)
Position, closed-loop, servo mode, from digital stepper commands, PWM digital, analog ±10V
Velocity/torque in servo mode, from PWM digital or analog ±10V
Discrete I/O: camming, internal indexer and function generator

COMMAND INPUTS	
Type	CANopen, galvanically isolated from drive circuits
Signals & format	CAN_H, CAN_L, CAN_GND; CAN signals and power are isolated from SP2 circuits
Data protocol	CANopen Device Profile DSP-402
Node-ID Selection	Programmable, or via digital inputs
Analog	±10 Vdc, velocity/torque control in servo mode
Digital	High speed inputs for PWM/Polarity and Step/Direction
Camming	Quad A/B digital encoder
DIGITAL CONTROL	
Digital Control Loops	Current, velocity, position. 100% digital loop control
Sampling rate (time)	Current loop: 16 kHz (62.5 µs), Velocity & position loops: 4 kHz (250 µs)
Commutation	Sinusoidal, field-oriented control for stepper motors
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
ANALOG INPUTS	
Number	2
Type	±10 Vdc, 12-bit resolution, differential
DIGITAL INPUTS	
Number, type	24, 74LVC14 Schmitt trigger, V_T+ = 1.1~2 Vdc, V_T- = 0.8~1.5 Vdc, V_H+ = 0.3~1.2 Vdc
[IN1~17, 21~26]	High-speed digital, 100 ns RC filter, 10 kΩ pull-up to +3.3 Vdc, 7 Vdc tolerant
[IN18]	SLI port MISO input, 47 ns RC filter, 1 kΩ pull-up to +3.3 Vdc, 7 Vdc tolerant 2, 74LVC2G14, V_T+ = 1.3~2.2 Vdc, V_T- = 0.6~1.5 Vdc, V_H+ = 0.4~1.2 Vdc
[IN19~20]	Motor temperature switch, 330 µs RC filter, 4.99 kΩ pull-up to +3.3 Vdc, 7 Vdc tolerant
DIGITAL OUTPUTS	
Number	7
[OUT1~3]	Open-drain MOSFET with 1 kΩ pull-up with series diode to +5 Vdc 300 mAdc max, +30 Vdc max. Functions programmable
[OUT4~7]	SLI port MOSI, SCLK, SS1, & SS2 signals, 74AHCT125 line drivers
DC POWER OUTPUTS	
Number	2
Ratings	+5 Vdc, 400 mA max each output, thermal and short-circuit protected
Connections	Axis A +5V Output: P3-17 Axis B +5V Output: P3-7
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
Commutation:	Digital Hall signals, single-ended, 1.5 µs RC filter, 15 kΩ pull-up to +5 Vdc, 74LVC14 Schmitt trigger

Notes:

1) Heatsink is required for continuous current ratings.

RS-232 PORT

Signals	RxD, TxD, Gnd for operation as a DTE device; referenced to Signal Ground in SP2 circuits
Mode	Full-duplex, DTE serial port for drive setup and control, 9,600 to 115,200 Baud
Protocol	ASCII or Binary format

MOTOR CONNECTIONS (PER AXIS)

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) 5 MHz maximum line frequency (20 M counts/sec)
Encoder power	(See DC POWER OUTPUTS section)
Motemp [IN19~20]	Motor overtemperature switch input. Active level programmable, 4.99 kΩ pull-up to +3.3 Vdc Programmable to disable drive when motor over-temperature condition occurs

PROTECTIONS

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

MECHANICAL & ENVIRONMENTAL

Size mm [in]	114 x 73 x 21 [4.5 x 2.9 x 0.83]
Weight	0.19 kg [0.42 lb] module only, no 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 2014/30/EU (EMC Directive)

EN 55011: 2009/A1:2010	CISPR 11:2009/A1:2010 Industrial, Scientific, and Medical (ISM) Radio Frequency Equipment – Electromagnetic Disturbance Characteristics – Limits and Methods of Measurement Group 1, Class A
EN 61000-6-1: 2007	Electromagnetic Compatibility (EMC) – Part 6-1: Generic Standards – Immunity for residential, Commercial and Light-industrial Environments

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

IEC 61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

Underwriters Laboratory Standards

UL 61010-1, 3rd Ed.: 2012	Electrical Equipment for Measurement, Control and Laboratory Use; Part 1: General Requirements

UL File Number E249894

CONTROL MODES AND COMMAND INPUTS

This chart shows the possible combinations of Control Modes and the Command Inputs that are available in each mode. Servo mode is the use of encoder feedback to operate the stepper as a brushless motor.

	Control Mode			
Command Source	Position	Velocity	Torque	Servo
CAN Profile Position	•			O
CAN Profile Velocity		•		O
CAN Profile Torque			•	R
CAN Homing	•			O
CAN Interpolated Position	•			O
Quad A/B Encoder	•			O
±10V		•	•	R
Digital Pls/Dir	•			O
Digital CW/CCW	•			O
Digital PWM		•	•	R

Servo Mode: O = optional, R = required

CAN = CANopen DS-402

CANOPEN

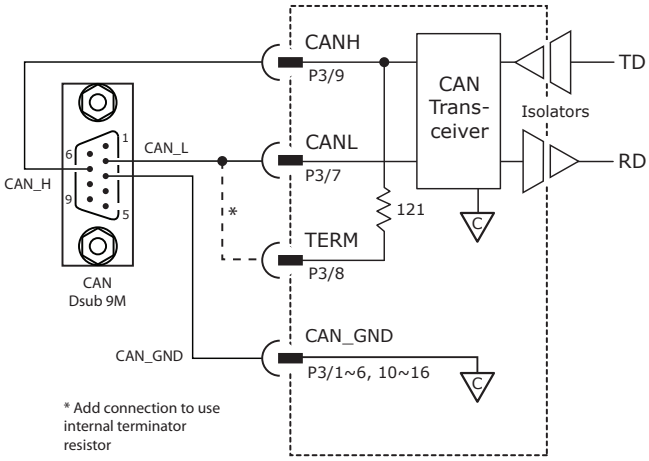
Based on the CAN V2.0b physical layer, a robust, two-wire communication bus originally designed for automotive use where low-cost and noise-immunity are essential, CANopen adds support for motion-control devices and command synchronization. The result is a highly effective combination of data-rate and 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. 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-ID can be saved to flash memory in the module. Node-ID 0 is reserved for the CANopen master on the network.

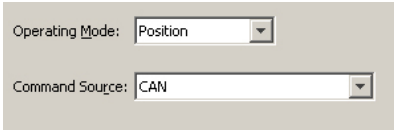
CANOPEN NETWORK CONNECTIONS

The graphic below shows connections between the SP2 and a Dsub 9M connector on a CAN card. If the SP2 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-ID (address) of the SP2 may be set by using digital inputs, or programmed into flash memory in the drive.



HOW IT LOOKS IN CME2

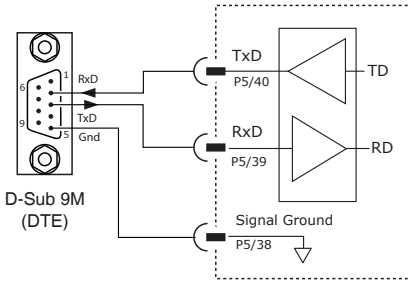
CME2 -> Basic Setup -> Operating Mode Options



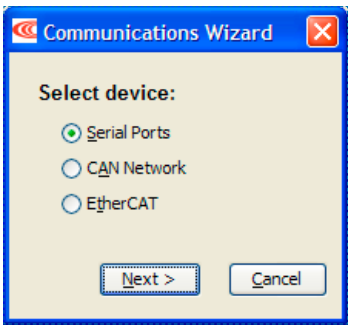
RS-232 COMMUNICATIONS

SP2 is configured via a three-wire, full-duplex DTE RS-232 port that operates from 9600 to 115,200 Baud, 8 bits, no parity, and one stop bit. Signal format is full-duplex, 3-wire, DTE using RxD, TxD, and Gnd. Connections to the *SP2* RS-232 port are through P2 The graphic below shows the connections between an *SP2* and a computer COM port which is a DTE device.

RS232 PORT



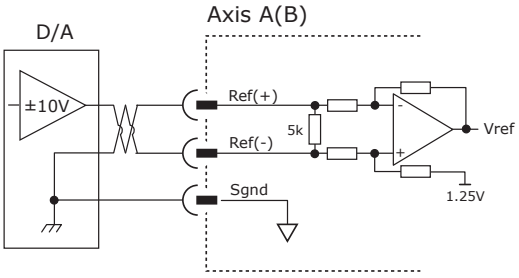
CME2 -> Tools -> Communications Wizard



COMMAND INPUTS

ANALOG COMMAND INPUT

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



SIGNALS & PINS

±10V Signal	P5 Pins	
	Axis A	Axis B
Ref(+)	3	5
Ref(-)	4	6
Sgnd	7	8

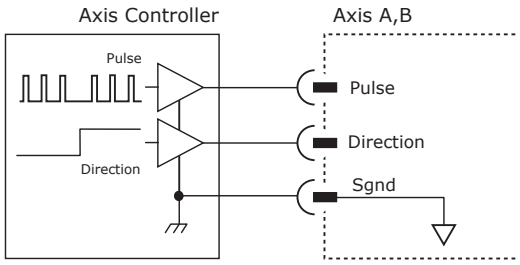
CME2 -> Basic Setup -> Operating Mode Options

DIGITAL COMMAND INPUTS

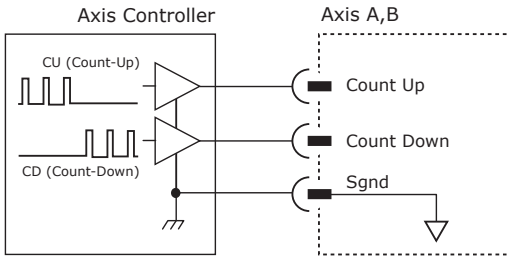
Digital commands are single-ended format and should be sourced from devices with active pull-up and pull-down to take advantage of the high-speed inputs. The active edge (rising or falling) is programmable for the Pulse/Dir and CU/CD formats.

DIGITAL POSITION

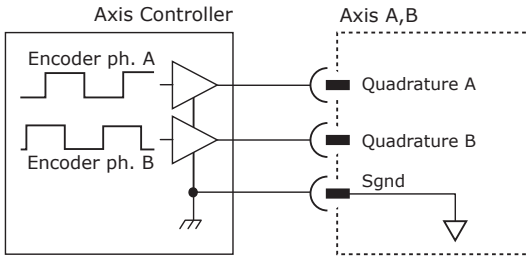
PULSE & DIRECTION



CU/CD

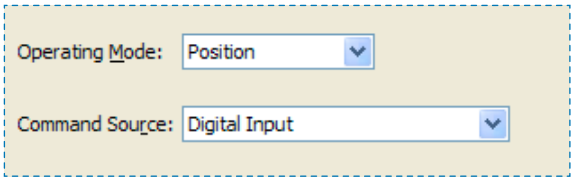


QUAD A/B ENCODER



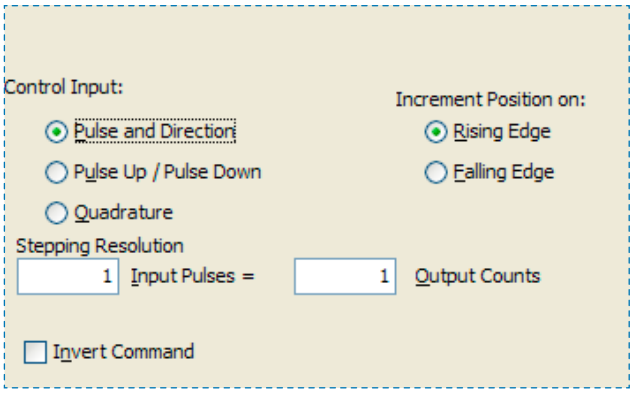
HOW IT LOOKS IN CME2

CME2 -> Basic Setup -> Operating Mode Options



HOW IT LOOKS IN CME2

CME2 -> Basic Setup -> Operating Mode Options



This screen shows the configuration screen for Pulse & Direction. CU/CD and Quad A/B encoder are selectable on this screen, too.

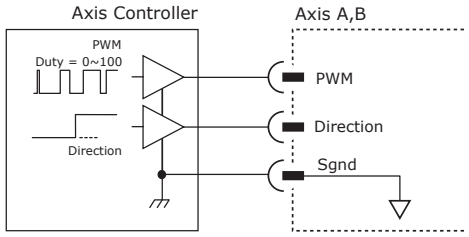
SIGNALS & PINS

Signal Types			P5 Pins		Input	
			Axis A	Axis B	Axis A	Axis B
Pulse	Count Up	Quad A	14	24	[IN6]	[IN16]
Dir	Count Down	Quad B	15	25	[IN7]	[IN17]

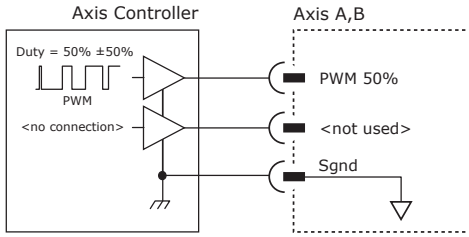
DIGITAL COMMAND INPUTS (CONT'D)

DIGITAL TORQUE, VELOCITY

PWM COMMAND (100% DUTY CYCLE)



PWM COMMAND (50% DUTY CYCLE)

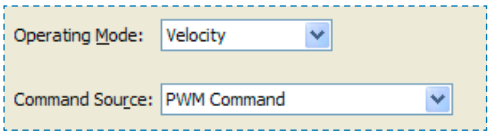


SIGNALS & PINS

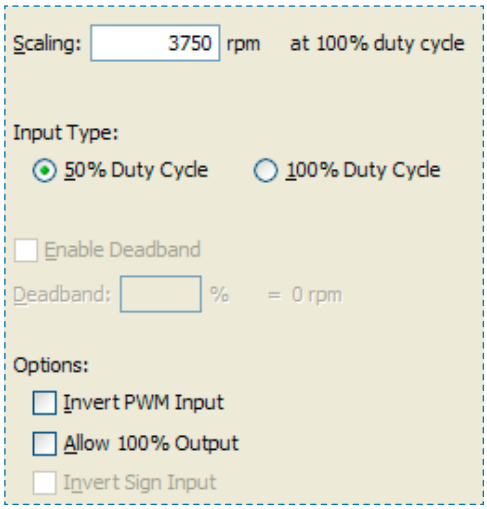
Signal Types		P5 Pins		Input	
		Axis A	Axis B	Axis A	Axis B
PWM	PWM 50%	14	24	[IN6]	[IN16]
Dir	< not used>	15	25	[IN7]	[IN17]

HOW IT LOOKS IN CME2

CME2 -> Basic Setup -> Operating Mode Options



CME2 -> Main Page-> PWM Command

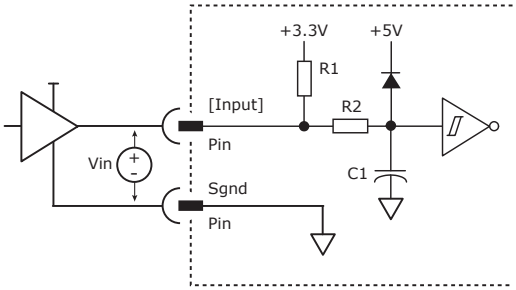


This screen shows the 50% Duty Cycle selection. Other modes are selectable via radio buttons and pull-down menus for Operating Mode and Command Source.

DIGITAL INPUTS

HIGH SPEED DIGITAL INPUTS

7V tolerant



HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN1~17 IN21~26	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.8 Vdc
IN18~19	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.8 Vdc

DIGITAL INPUT PINS AND STRUCTURE

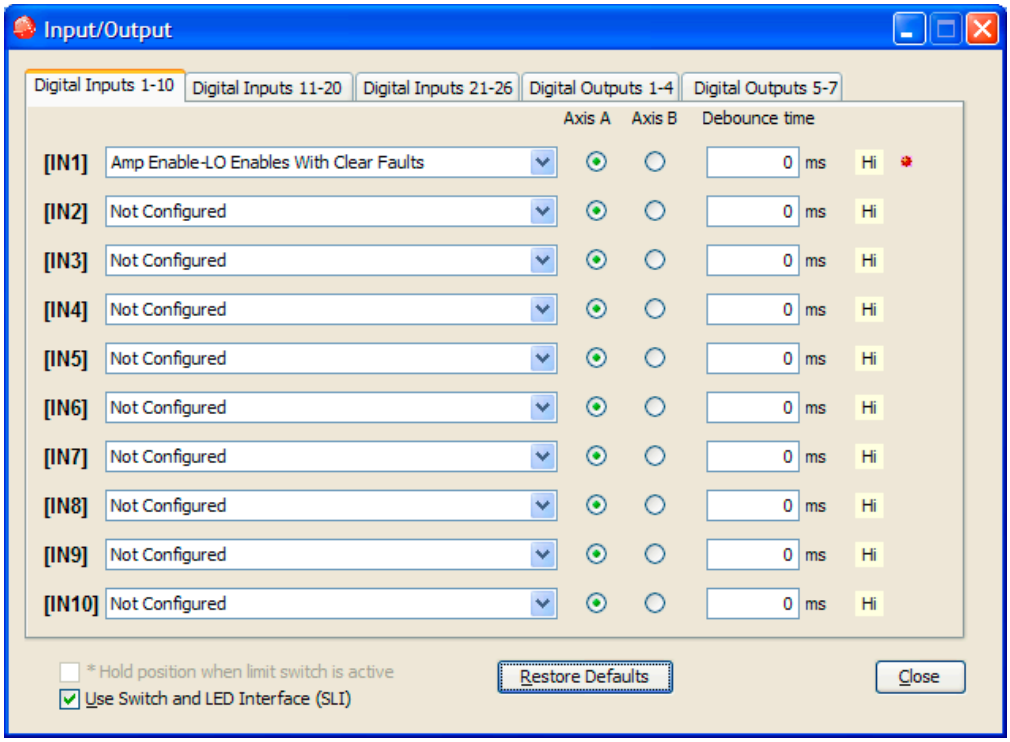
Input	P2 Pin	R1	R2	C1
IN1	9	10k	1k	100p
IN2	10			
IN3	11			
IN4	12			
IN5	13			
IN6	14			
IN7	15			
IN8	16			
IN9	17			
IN10	18			
IN11	19			
IN12	20			
IN13	21			

Input	P2 Pin	R1	R2	C1
IN14	22	10k	1k	100p
IN15	23			
IN16	24			
IN17	25			
IN18	26			47p
IN19	27	4.99k	10k	33n
IN20	28			
IN21	P3-1	10k	1k	100p
IN22	P3-3			
IN23	P3-5			
IN24	P3-2			
IN25	P3-4			
IN26	P3-6			

DIGITAL INPUT DETAILS

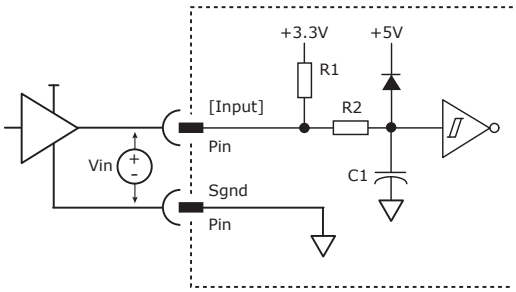
HOW IT LOOKS IN CME2

CME2 -> Main Page-> Input/Output -> Digital Inputs 1-10 (Defaults)



HIGH SPEED DIGITAL INPUTS

7V tolerant



DIGITAL INPUT PINS AND STRUCTURE

Input	P2 Pin	R1	R2	C1
IN1	9	10k	1k	100p
IN2	10			
IN3	11			
IN4	12			
IN5	13			
IN6	14			
IN7	15			
IN8	16			
IN9	17			
IN10	18			

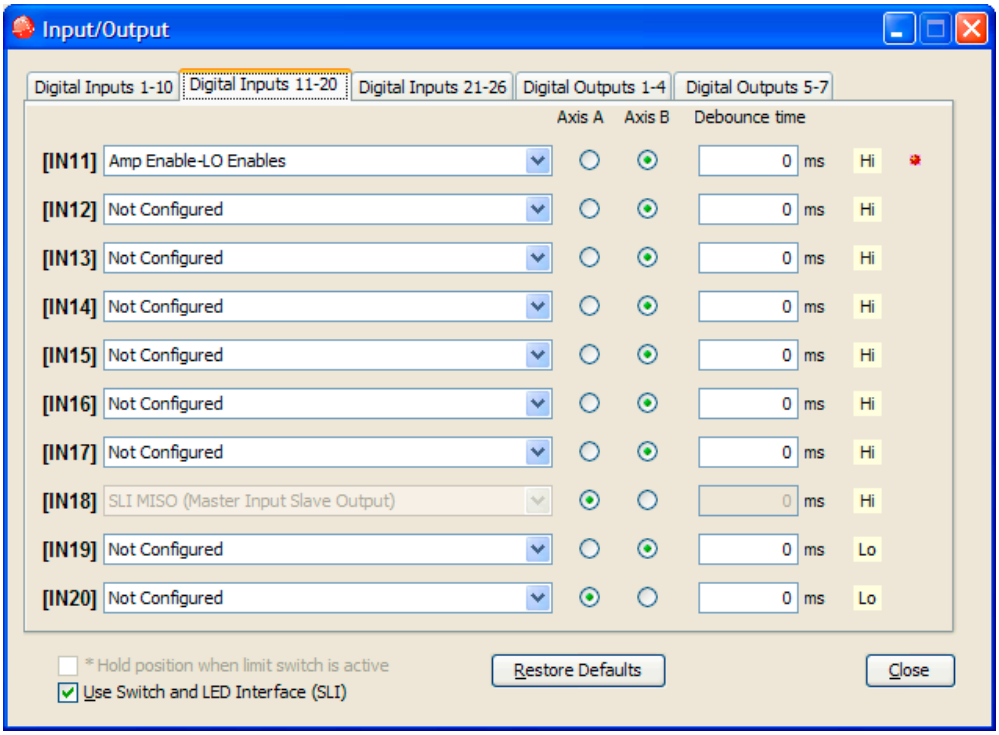
HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN1~10	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.8 Vdc

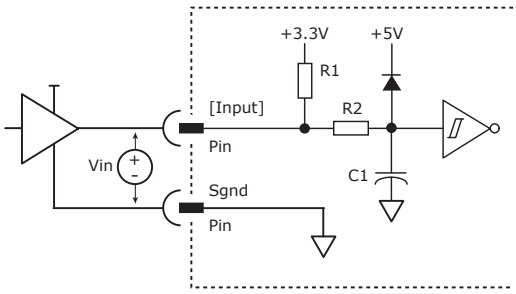
DIGITAL INPUT DETAILS

HOW IT LOOKS IN CME2

CME2 -> Main Page-> Input/Output -> Digital Inputs 11-20 (Defaults)



HIGH SPEED DIGITAL INPUTS



DIGITAL INPUT PINS AND STRUCTURE

Input	P2 Pin	R1	R2	C1
IN11	19	10k	1k	100p
IN12	20			
IN13	21			
IN14	22	10k	1k	100p
IN15	23			
IN16	24			
IN17	25			
IN18	26			47p
IN19	27	4.99k	10k	33n
IN20	28			

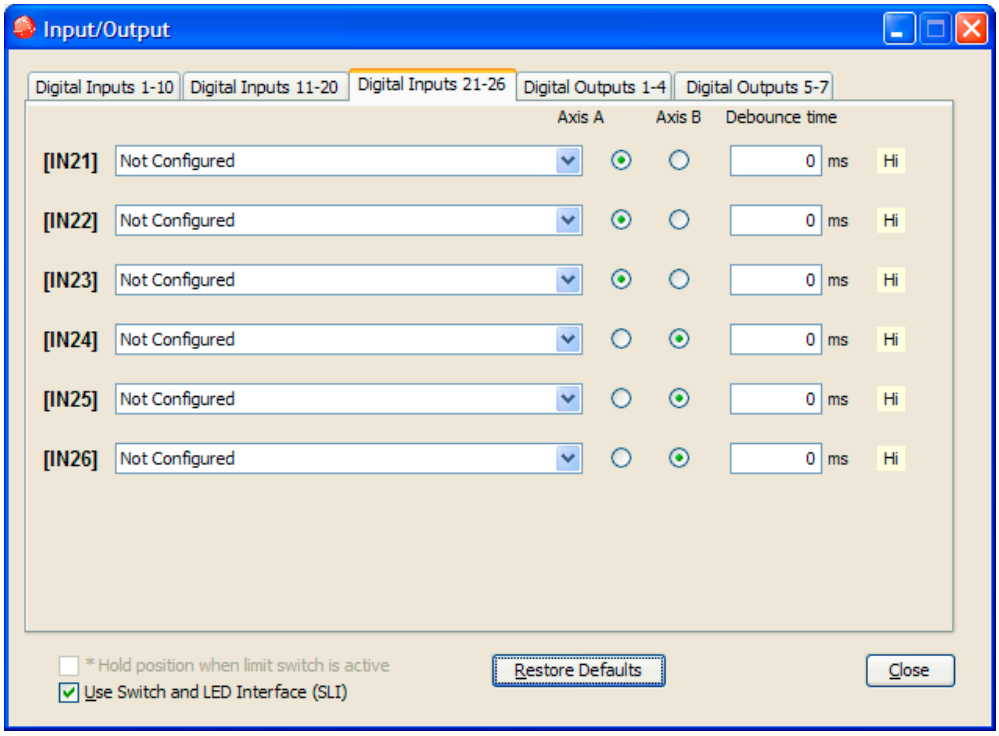
HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN11~18	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.8 Vdc
IN19~20	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.6 Vdc

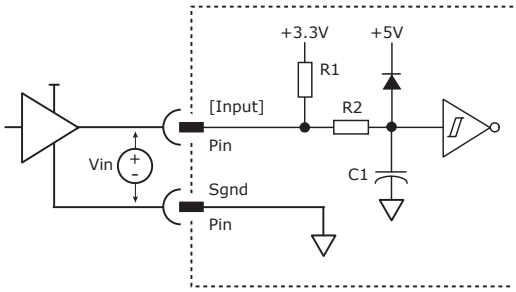
DIGITAL INPUT DETAILS

HOW IT LOOKS IN CME2

CME2 -> Main Page-> Input/Output -> Digital Inputs 21-26 (Defaults)



HIGH SPEED DIGITAL INPUTS



DIGITAL INPUT PINS AND STRUCTURE

Input	P2 Pin	R1	R2	C1
IN21	P3-1	10k	1k	100p
IN22	P3-3			
IN23	P3-5			
IN24	P3-2			
IN25	P3-4			
IN26	P3-6			

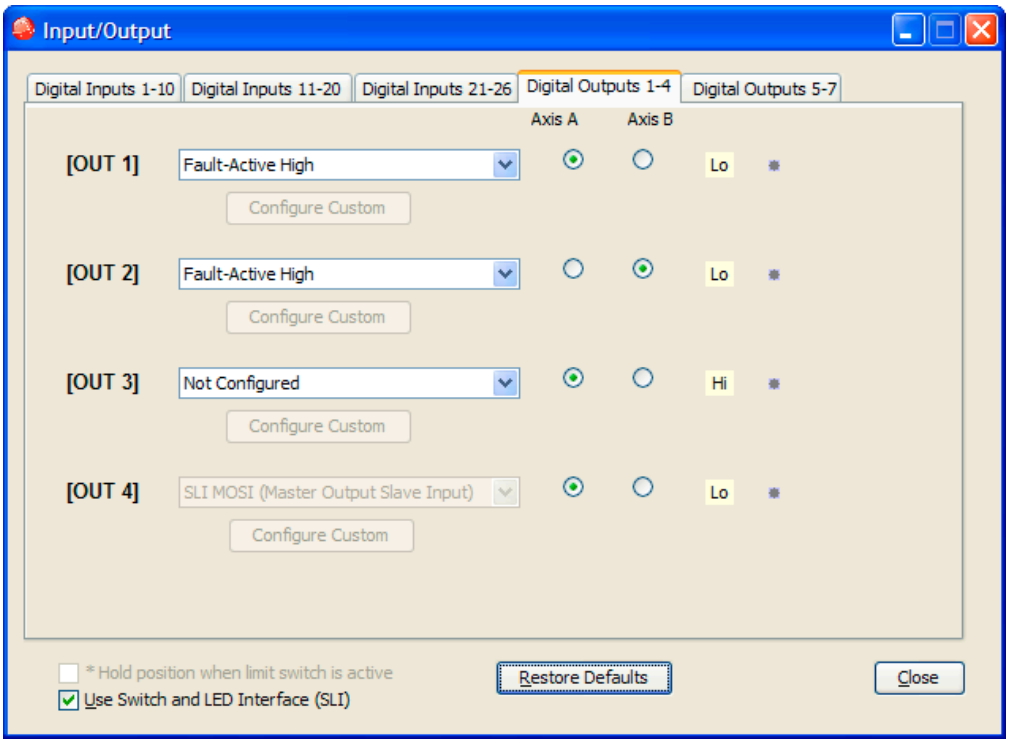
HI/LO DEFINITIONS: INPUTS

Input	State	Condition
IN21~26	HI	Vin >= 2.2 Vdc
	LO	Vin <= 0.8 Vdc

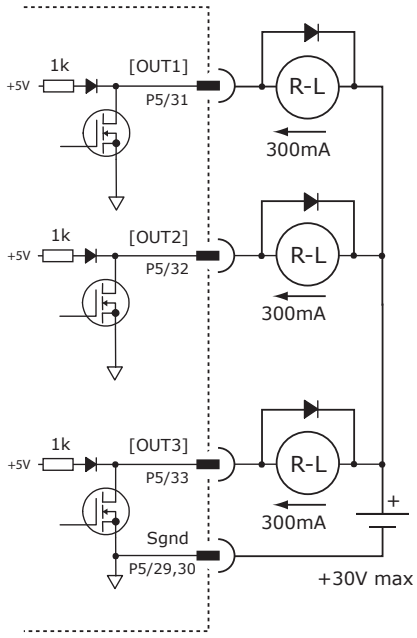
DIGITAL OUTPUT DETAILS

HOW IT LOOKS IN CME2

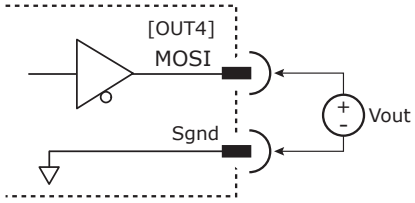
CME2 -> Main Page-> Input/Output -> Digital Outputs 1-4 (Defaults)



MOSFET DIGITAL OUTPUTS [OUT1~3]



HIGH SPEED DIGITAL [OUT4]



74HCT125
5V max

HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT1~3	HI	MOSFET OFF
	LO	MOSFET ON
OUT4	HI	Vout >= 2.2 Vdc
	LO	Vout <= 0.8 Vdc

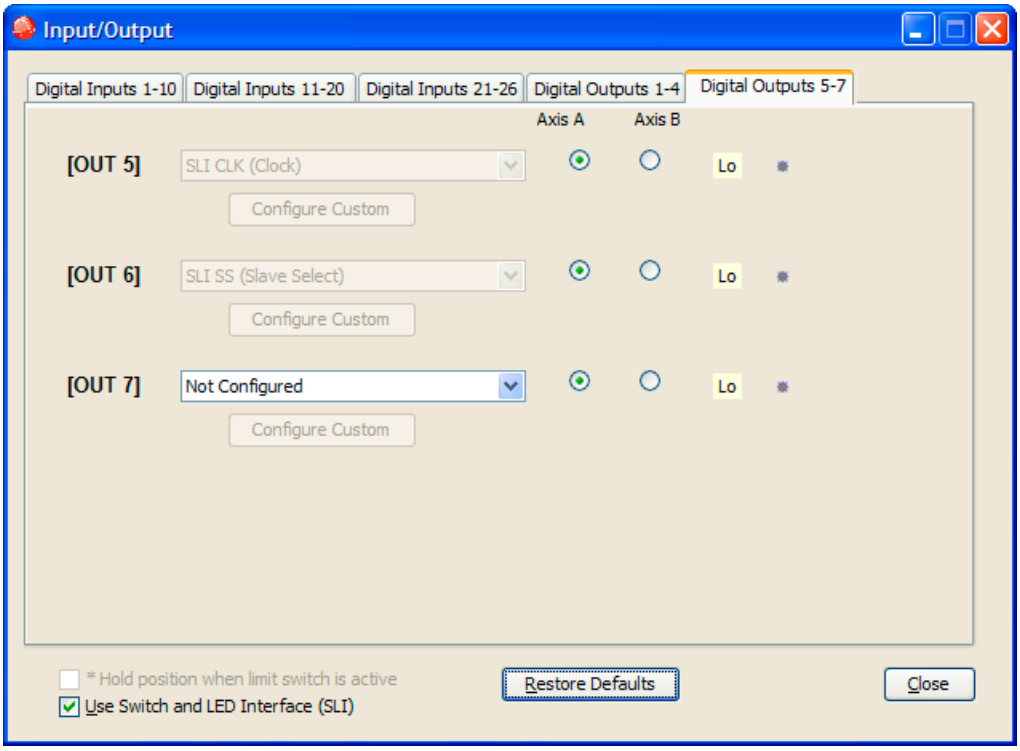
SIGNALS & PINS

Output	P5 Pin
OUT1	31
OUT2	32
OUT3	33
OUT4	34

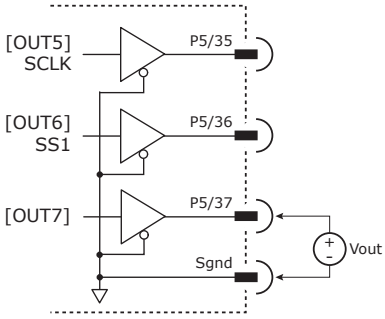
DIGITAL OUTPUT DETAILS

HOW IT LOOKS IN CME2

CME2 -> Main Page-> Input/Output -> Digital Outputs 1-4 (Defaults)



HIGH SPEED DIGITAL [OUT5~7]



74HCT125
5V max

HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT4~7	HI	Vout >= 2.2 Vdc
	LO	Vout <= 0.8 Vdc

SIGNALS & PINS

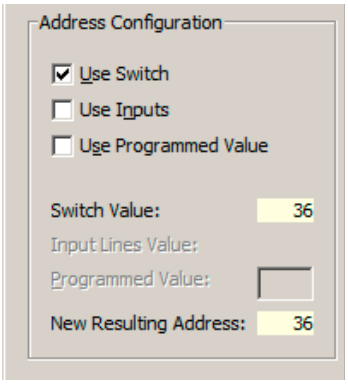
Output	P5 Pin
OUT5	35
OUT6	36
OUT7	37

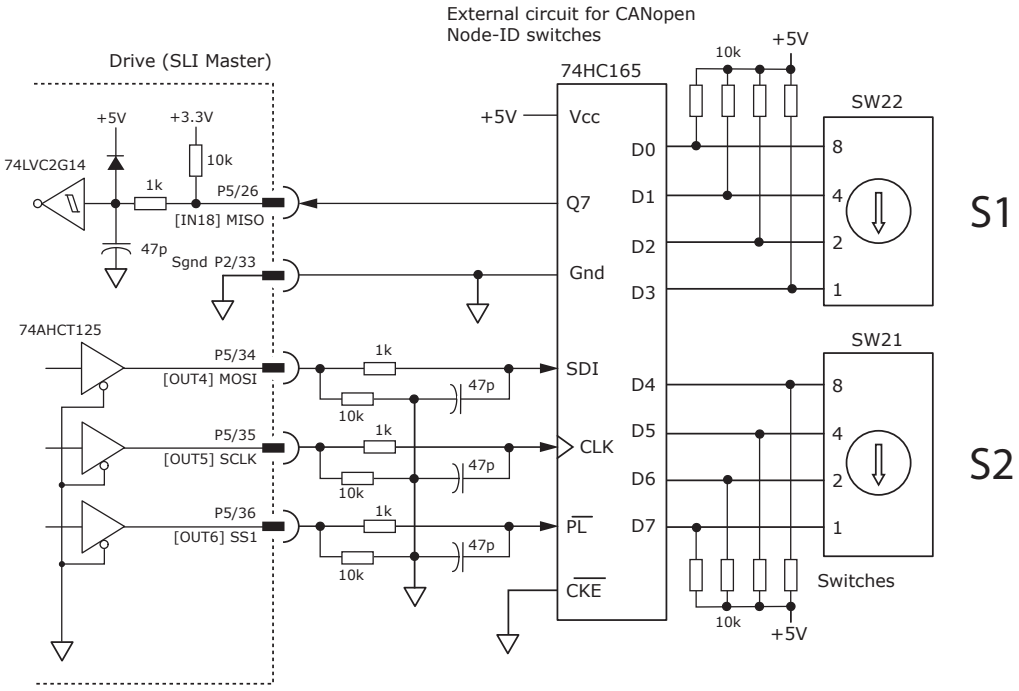
CANOPEN NODE-ID (ADDRESS) SWITCHES

The SLI (Switch & LED Interface) port takes in the 8 signals from the two BCD encoded switches that set the CANopen Node-ID 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 SP2 is initializing.
In the graphic below, the values of S1 is 2 and the value of S2 is 4.
Together they provide Node-ID of 36.

CME2 -> Input/Output -> Digital Outputs

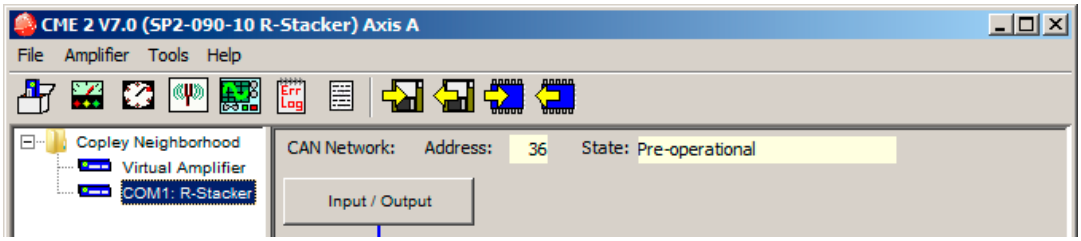
CME2 -> Amplifier -> Network Configuration

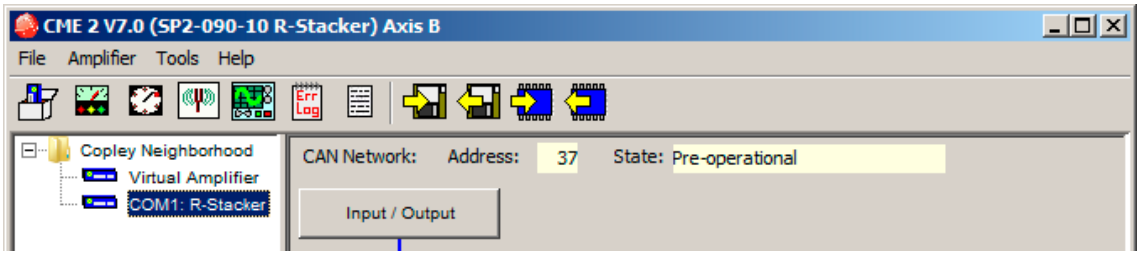




CANOPEN 2-AXIS AND THE OBJECT DICTIONARY

Single-axis CANopen devices use objects in the range of 0x6000 to 0x67FF for standardized data that are read or written via the network as defined in CAN-CiA document CiA 301 *CANopen Application Layer and Communication Profile.* The SP2 appears as two independent slave nodes on an CANopen network. Axis A is accessed by the switch or flash node address. The node address of Axis B is the Axis A address +1.



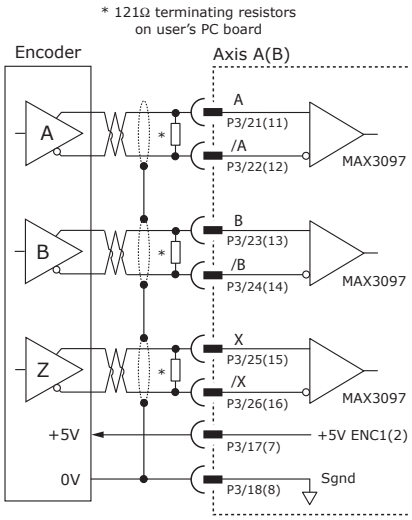


MOTOR CONNECTIONS

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

DIGITAL QUADRATURE ENCODER INPUT

5V



CME2 -> Motor/Feedback -> Feedback

Encoder Signal	P3 Pins	
	Axis A	Axis B
A	21	11
/A	22	12
B	23	13
/B	24	14
X	25	15
/X	26	16
+5V ENC	17	7
Sgnd	18	8

MOTOR CONNECTIONS (CONT'D)

MOTOR PHASE CONNECTIONS

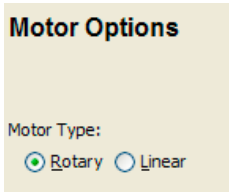
The drive outputs are two H-bridge PWM inverters that convert-sthe DC bus voltage (+HV) into sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the drive. Motor cabling should use twisted, shielded conductors for CE compliance, and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

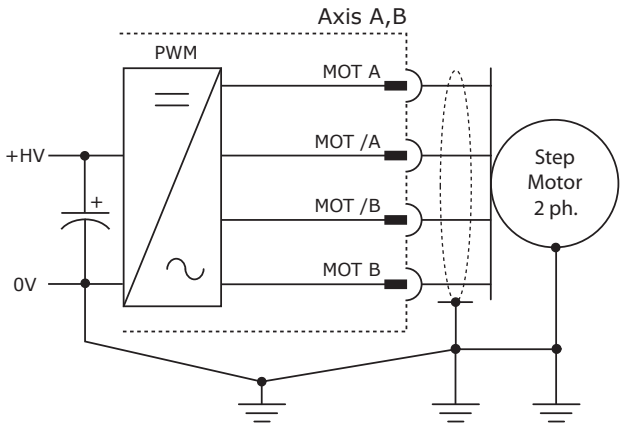
SIGNALS & PINS

Motor Signal*	Axis A	Axis B
	P4-pins	P6-pins
Phase A	1~4	
Phase /A	7~10	
Phase /B	15~18	
Phase B	21~24	
Shield	Sgnd	

HOW IT LOOKS IN CME2

CME2 -> Basic Setup -> Motor Options





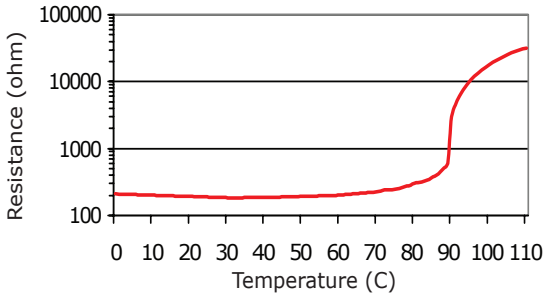
MOTOR OVER TEMP INPUT

The 4.99k pull-up resistor works with PTC (positive temperature coefficient) thermistors that conform to BS 4999:Part 111:1987 (table below), or switches that open/close indicating a motor over-temperature condition. The active level is programmable.

BS 4999 PTC THERMISTOR PROPERTIES

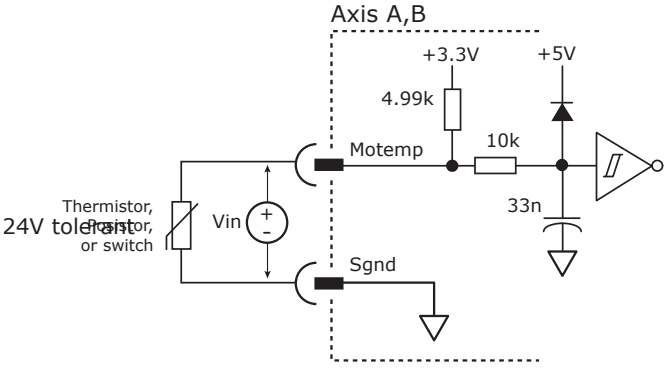
Property	Ohms
Resistance in the temperature range 20°C to +70°C	60~750
Resistance at 85°C	≤1650
Resistance at 95°C	≥3990
Resistance at 105°C	≥12000

BS 4999 TYPICAL RESISTANCE VS TEMPERATURE



HOW IT LOOKS IN CME2

CME2 -> Input / Output



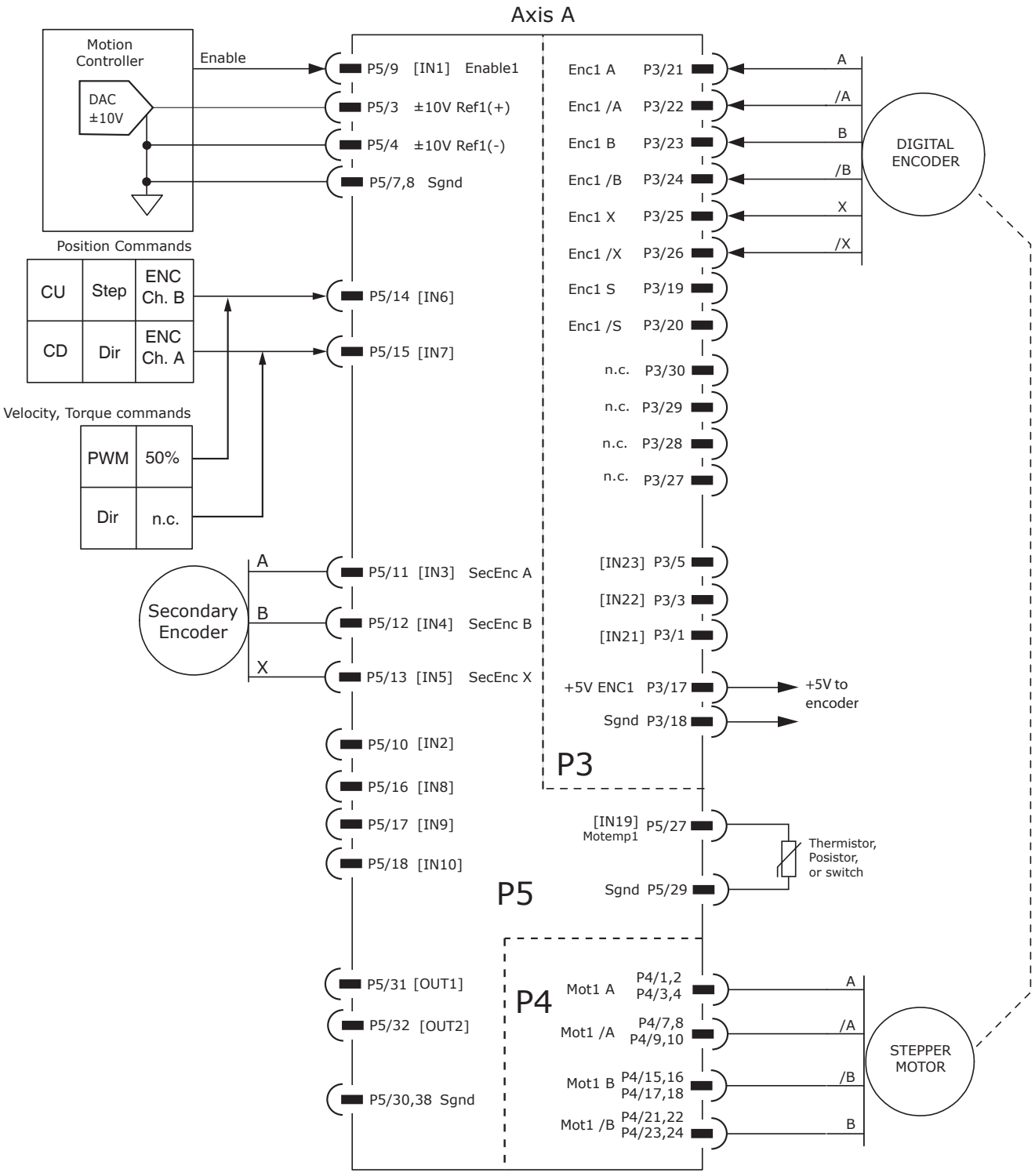
HI/LO DEFINITIONS: MOTEMP

Input	State	Condition
IN19~20	HI	Vin >= 1.2 Vdc
	LO	Vin <= 0.6 Vdc

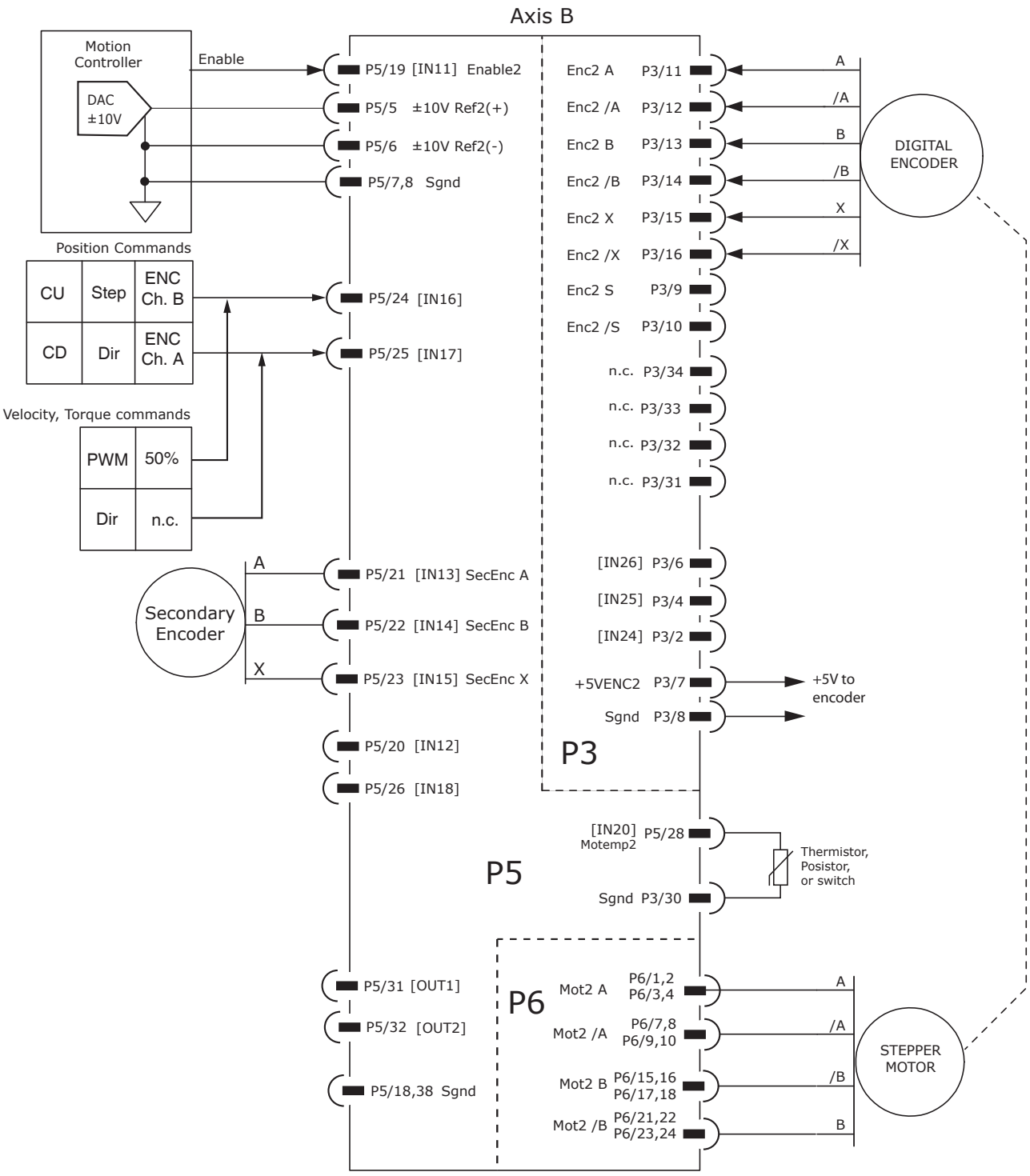
SIGNALS & PINS

Signal	Axis A	Axis B
	P5-pins	
Motemp	27	28
Input	[IN19]	[IN20]

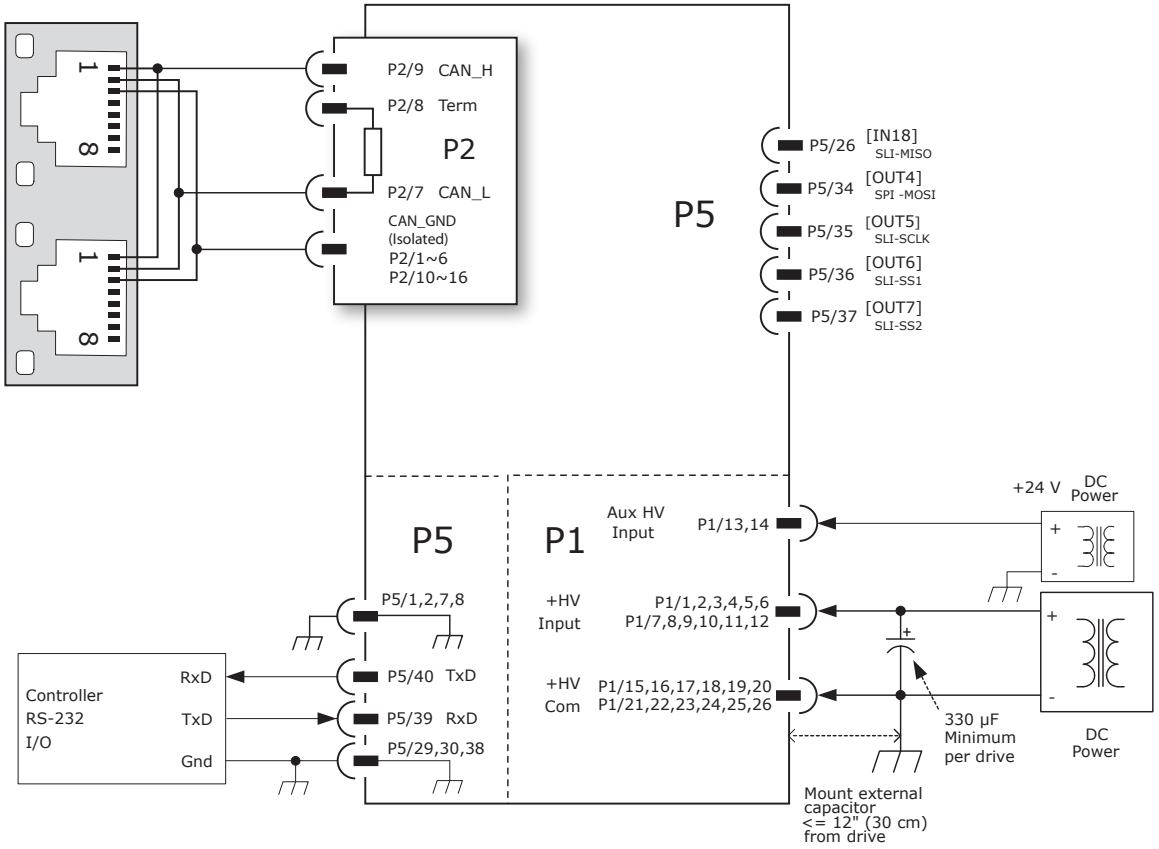
AXIS A CONNECTIONS FOR INCREMENTAL DIGITAL OR ANALOG ENCODERS



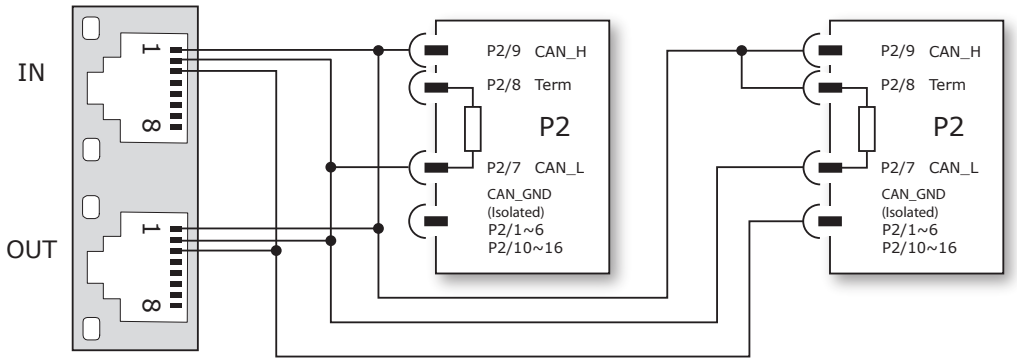
AXIS B CONNECTIONS FOR INCREMENTAL DIGITAL OR ANALOG ENCODERS



COMMON CONNECTIONS FOR AXES A,B



CANOPEN CONNECTIONS FOR MULTIPLE MODULES



PC BOARD CONNECTORS & SIGNALS

CONNECTOR NAMING (P1, P2, ETC) APPLIES TO THE SP2 MODULE AND NOT TO PC BOARD MOUNTED SOCKETS

P1 POWER

Mounting board connector:
Samtec SQW-113-01-F-D

Signal	Pin		Signal
+HV	2	1	+HV
+HV	4	3	+HV
+HV	6	5	+HV
+HV	8	7	+HV
+HV	10	9	+HV
+HV	12	11	+HV
HVaux	14	13	HVaux
HVGnd	16	15	HVGnd
HVGnd	18	17	HVGnd
HVGnd	20	19	HVGnd
HVGnd	22	21	HVGnd
HVGnd	24	23	HVGnd
HVGnd	26	25	HVGnd

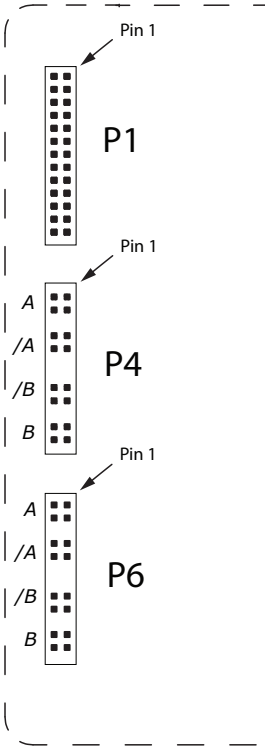
P4 AXIS A MOTOR

Mounting board connector:
Samtec SQW-113-01-F-D

Signal	Pin		Signal
MOT A	2	1	MOT A
MOT A	4	3	MOT A
n.c.	6	5	n.c.
MOT /A	8	7	MOT /A
MOT /A	10	9	MOT /A
n.c.	12	11	n.c.
n.c.	14	13	n.c.
MOT /B	16	15	MOT /B
MOT /B	18	17	MOT /B
n.c.	20	19	n.c.
MOT B	22	21	MOT B
MOT B	24	23	MOT B

TOP VIEW

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



P6 AXIS B MOTOR

Mounting board connector:
Samtec SQW-113-01-F-D

Signal	Pin		Signal
MOT A	2	1	MOT A
MOT A	4	3	MOT A
n.c.	6	5	n.c.
MOT /A	8	7	MOT /A
MOT /A	10	9	MOT /A
n.c.	12	11	n.c.
n.c.	14	13	n.c.
MOT /B	16	15	MOT /B
MOT /B	18	17	MOT /B
n.c.	20	19	n.c.
MOT B	22	21	MOT B
MOT B	24	23	MOT B

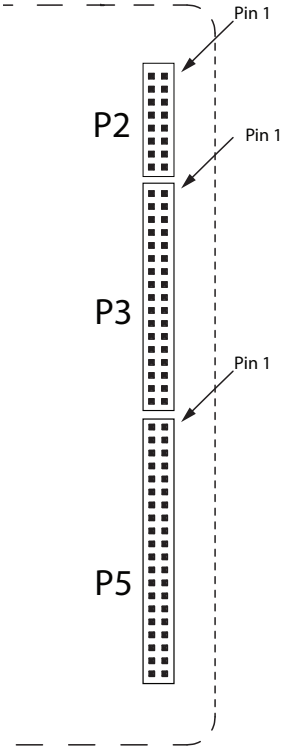
Note: The sequence of motor signals for the module is different than the sequence for Development Kit connectors!

DevKit	*Module*
A	*A*
/A	*/A*
B	*/B*
/B	*B*

P2 CANOPEN

Mounting board connector:
Samtec SQW-108-01-F-D

Signal	Pin		Signal
CAN_GND	2	1	CAN_GND
CAN_GND	4	3	CAN_GND
CAN_GND	6	5	CAN_GND
TERM	8	7	CAN_L
CAN_GND	10	9	CAN_H
CAN_GND	12	11	CAN_GND
CAN_GND	14	13	CAN_GND
CAN_GND	16	15	CAN_GND



P3 FEEDBACK

Mounting board connector:
Samtec SQW-117-01-F-D

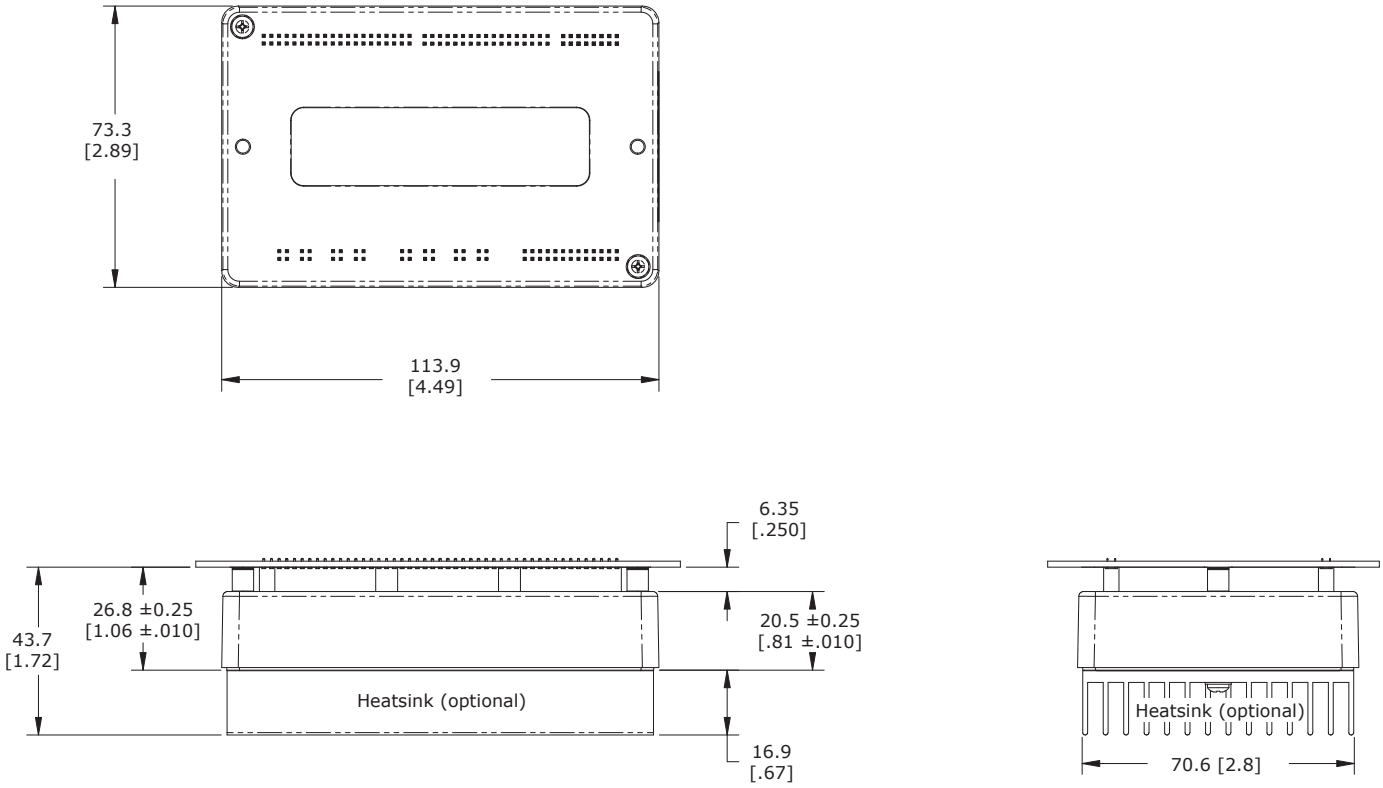
Signal	Pin		Signal
HS [IN24]	2	1	[IN21] HS
HS [IN25]	4	3	[IN22] HS
HS [IN26]	6	5	[IN23] HS
Signal Gnd	8	7	Axis B +5V Enc
Axis B Enc /S	10	9	Axis B Enc S
Axis B Enc /A	12	11	Axis B Enc A
Axis B Enc /B	14	13	Axis B Enc B
Axis B Enc /X	16	15	Axis B Enc X
Signal Gnd	18	17	Axis A +5V Enc
Axis A Enc /S	20	19	Axis A Enc S
Axis A Enc /A	22	21	Axis A Enc A
Axis A Enc /B	24	23	Axis A Enc B
Axis A Enc /X	26	25	Axis A Enc X
n.c.	28	27	n.c.
n.c.	30	29	n.c.
n.c.	32	31	n.c.
n.c.	34	33	n.c.

P5 CONTROL

Mounting board connector:
Samtec SQW-120-01-F-D

Signal	Pin		Signal
Signal Gnd	2	1	Signal Gnd
Axis A Ref(-)	4	3	Axis A Ref(+)
Axis B Ref(-)	6	5	Axis B Ref(+)
Signal Gnd	8	7	Signal Gnd
HS [IN2]	10	9	[IN1] HS
HS [IN4]	12	11	[IN3] HS
HS [IN6]	14	13	[IN5] HS
HS [IN8]	16	15	[IN7] HS
HS [IN10]	18	17	[IN9] HS
HS [IN12]	20	19	[IN11] HS
HS [IN14]	22	21	[IN13] HS
HS [IN16]	24	23	[IN15] HS
SLI-MISO [IN18]	26	25	[IN17] HS
Axis B Motemp [IN20]	28	27	[IN19] Axis A Motemp
Signal Gnd	30	29	Signal Gnd
MOSFET [OUT2]	32	31	[OUT1] MOSFET
SLI-MOSI [OUT4]	34	33	[OUT3] MOSFET
SLI-SS1 [OUT6]	36	35	[OUT5] SLI-SCLK
Signal Gnd	38	37	[OUT7] SLI-SS2
RS-232 TxD	40	39	RS-232 RxD

MODULE DIMENSIONS

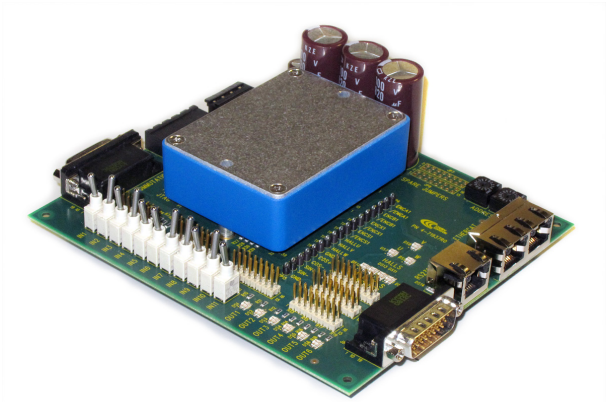


Units: mm [in]

DESCRIPTION

The Development Kit provides mounting and connectivity for one SP2 drive. Solderless jumpers ease configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~20 so that these can be toggled to simulate equipment operation. LED's provide status indication for the digital outputs, encoder A/B/X/S signals, and Hall signals. Test points are provided for these signals, too, making it easy to monitor these with an oscilloscope.

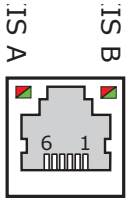
Dual CANopen connectors make daisy-chain connections possible so that other CANopen devices such as Copley's Stepnet Plus or Xenus Plus CANopen drives can easily be connected. Rotary switches are provided to set the CANopen slave Node-ID (address).



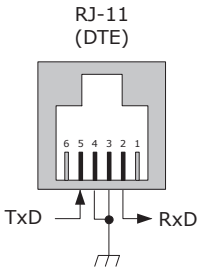
RS-232 CONNECTION

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 Node-ID that is set by the rotary switch can be monitored, and a Node-ID offset programmed as well.

The RS-232 connector, J8, 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.

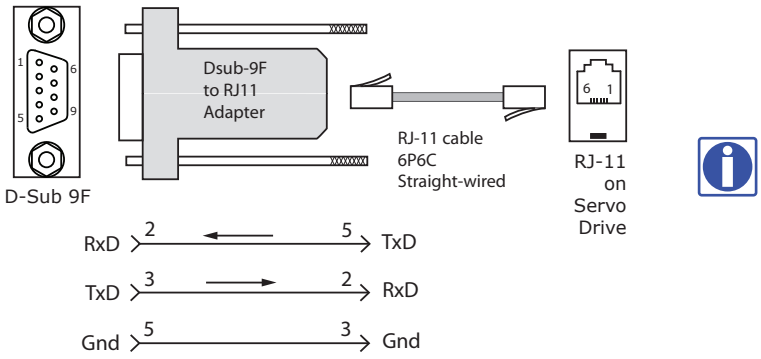


J8 SIGNALS



SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector J8 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.



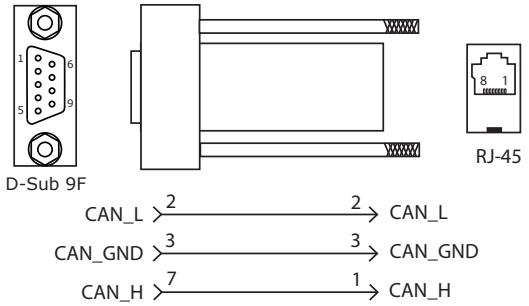
Don't forget to order a Serial Cable Kit SER-CK when placing your order for an SP2 Development Kit!

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 SP2-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 SP2-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 J8 shows the operational state of the SP2. The STATUS LED on J8 shows the state of the CANopen NMT (Network Management) state-machine in the drive. LEDs on J7 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

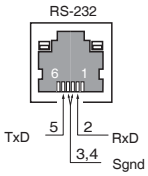
A single bi-color LED gives the state of the SP2 by changing color, and either blinking or remaining solid.
The possible color and blink combinations are:

- *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.

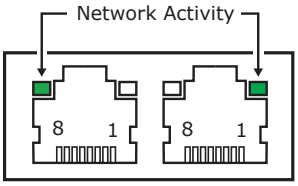
Drive Fault conditions. Faults are programmable to be either transient or latching:

- 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

J8 RS-32 SERIAL



J7 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*

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

ACT LED

- *Flashing indicates the SP2 is sending/receiving data via the CAN port*

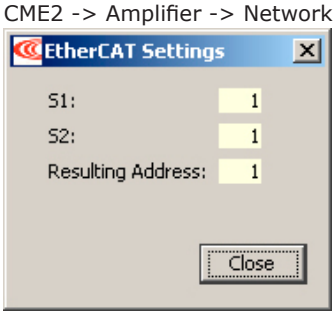
CANopen Node ID (ADDRESS)

On a CANopen network, each device must have unique, non-zero Node-ID. In the SP2 DevKit, this is provided by two 16-position rotary switches with hexadecimal encoding. These can set the Node-ID of the drive from 0x01~0xFF (1~255 decimal). The chart shows the decimal values of the hex settings of each switch.

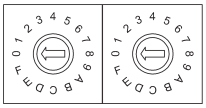
Example 1: Find the switch settings for decimal Node-ID 107:

1) Find the highest number under SW21 that is less than 107 and set SW21 to the hex value in the same row: 96 < 107 and 112 > 107, so SW21 = 96 = Hex 6
2) Subtract 96 from the desired Node-ID to get the decimal value of switch SW22 and set SW22 to the Hex value in the same row: SW22 = (107 - 96) = 11 = Hex B

CME2 -> Amplifier -> Network Configuration



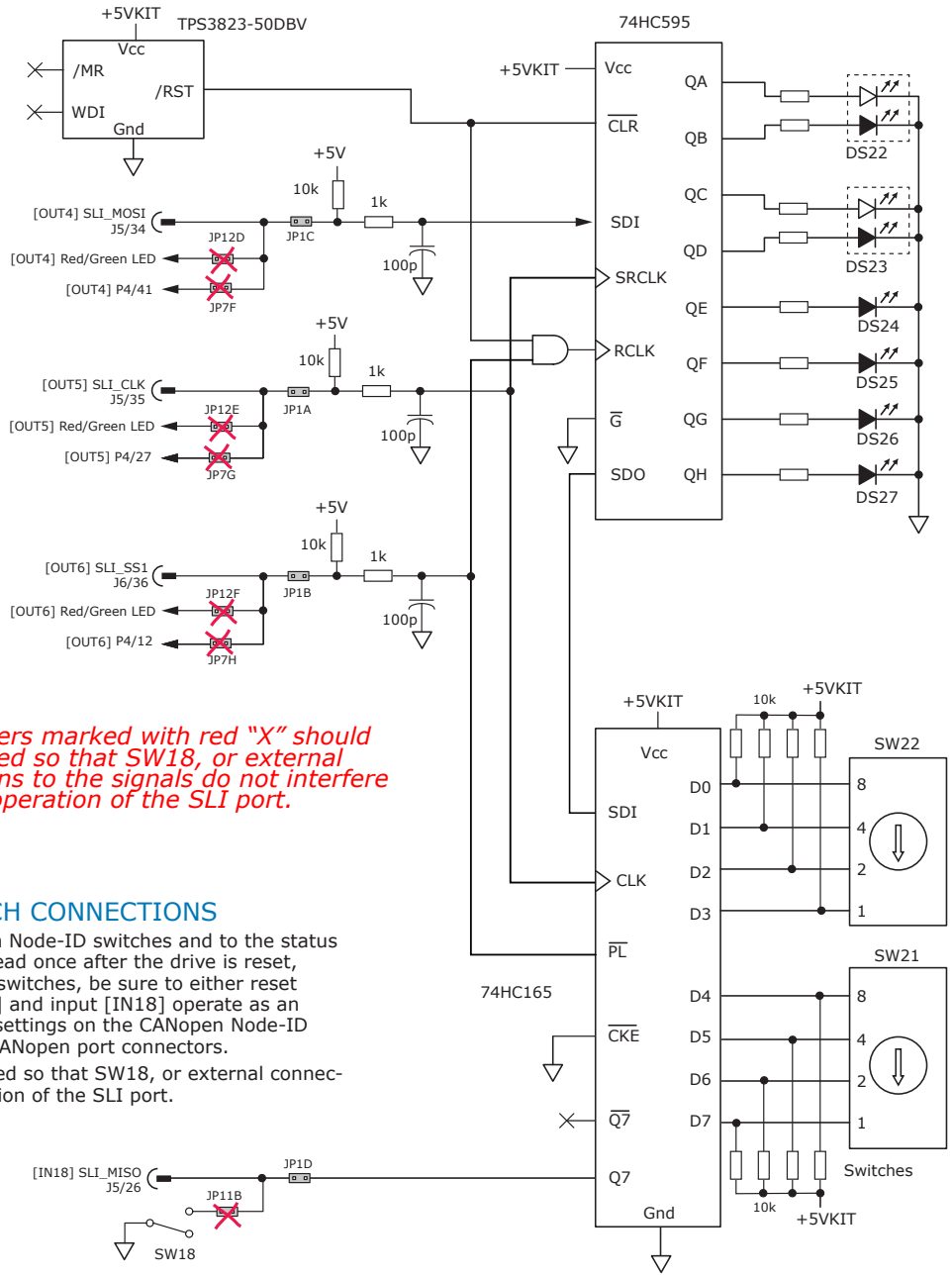
SW21 SW22



CME2 -> Input/Output -> Digital Outputs

CANopen Node-ID Switch Decimal values

	SW21	SW@2
HEX	DEC	
0	0	0
1	16	1
2	32	2
3	48	3
4	64	4
5	80	5
6	96	6
7	112	7
8	128	8
9	144	9
A	160	10
B	176	11
C	192	12
D	208	13
E	224	14
F	240	15



The jumpers marked with red "X" should be removed so that SW18, or external connections to the signals do not interfere with the operation of the SLI port.

CANopen NODE-ID (ADDRESS) SWITCH CONNECTIONS

This graphic shows the connections to the CANopen Node-ID switches and to the status LEDs for the SP2 and CANopen. The switches are read once 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 [OUT4,5,6] and input [IN18] 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 SW18, or external connections to the signals do not interfere with the operation of the SLI port.

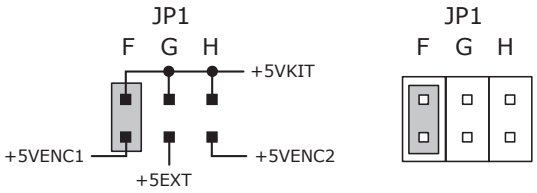
5V POWER SOURCES

The feedback connectors J9 & J10 each have a connection to a +5V power supply in the SP2.
The signal name of Axis A power is +5VENC1, and for Axis B it is +5VENC2.

The components on the DevKit that drive the LEDs and read the Node-ID (address) switches are connected to the signal +5VKIT.

Jumpers on JP1 can connect these circuits to a choice of 5V power. These include either 5V supply in the SP2, or an external 5V power supply connected to J7.

The graphic below shows the connections between +5VKIT and the other sources of 5V power.

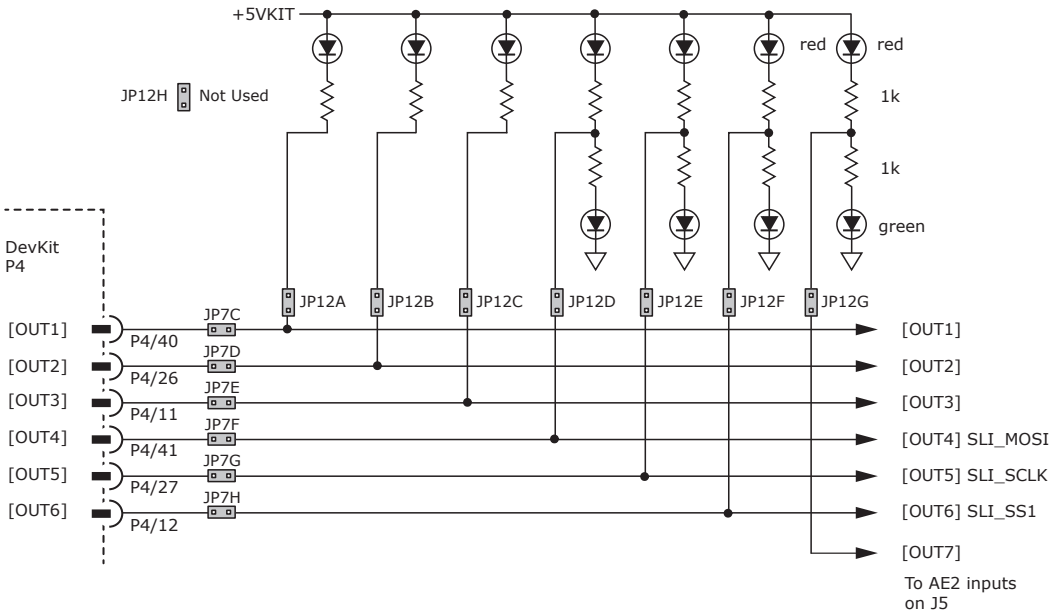


IMPORTANT: ONLY ONE SHORTING PLUG CAN BE USED ON JP1-F, G, OR H POSITIONS

USE OF MORE THAN ONE PLUG WILL DAMAGE 5V POWER SUPPLIES IN THE SP2

LOGIC OUTPUTS

There are seven 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 4,5,6 & 7 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, & 3 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.

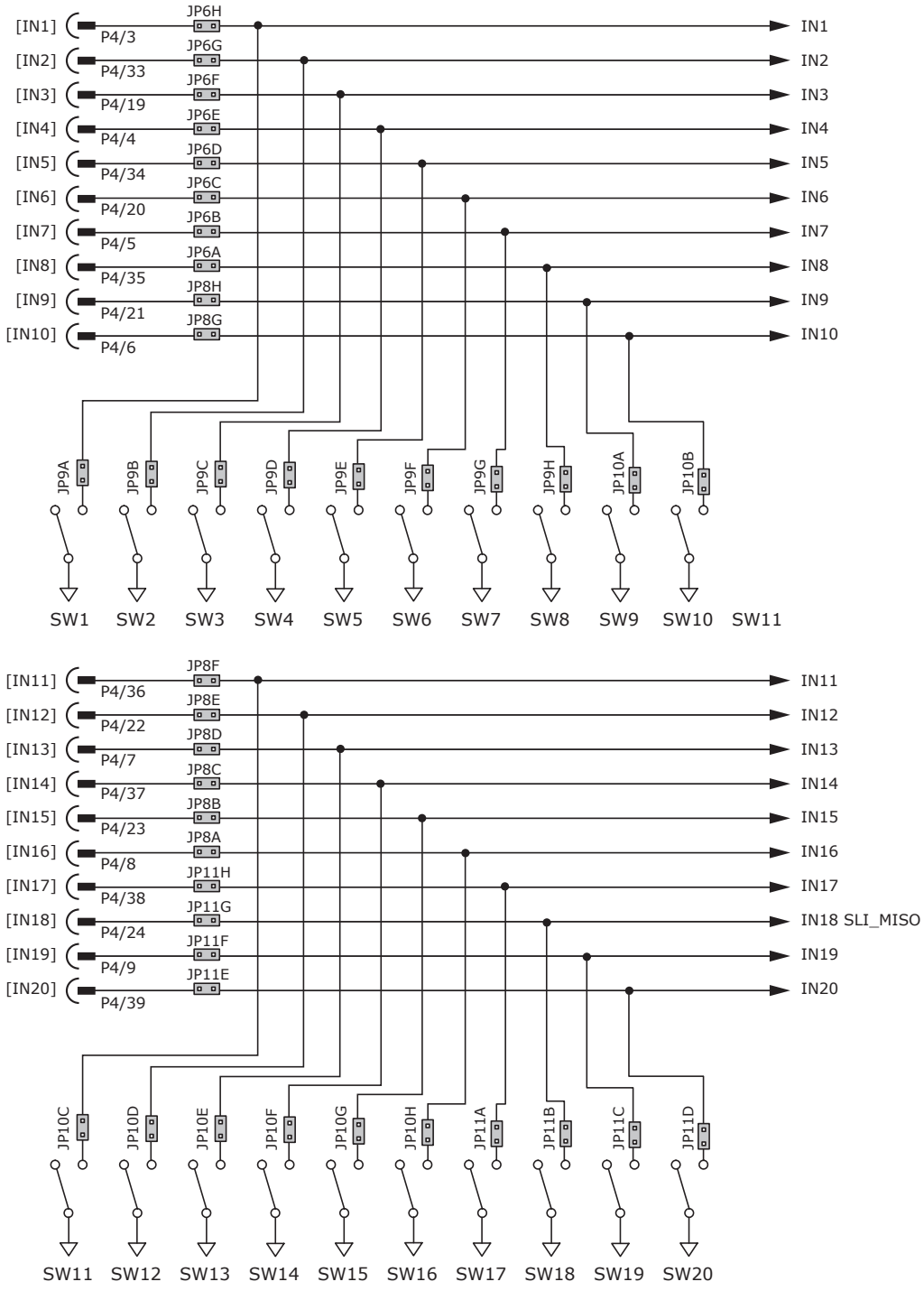


LOGIC INPUTS & SWITCHES

The Development Kit has jumpers that can connect the SP2 digital inputs to switches on the kit, or to the Signal connector J5.

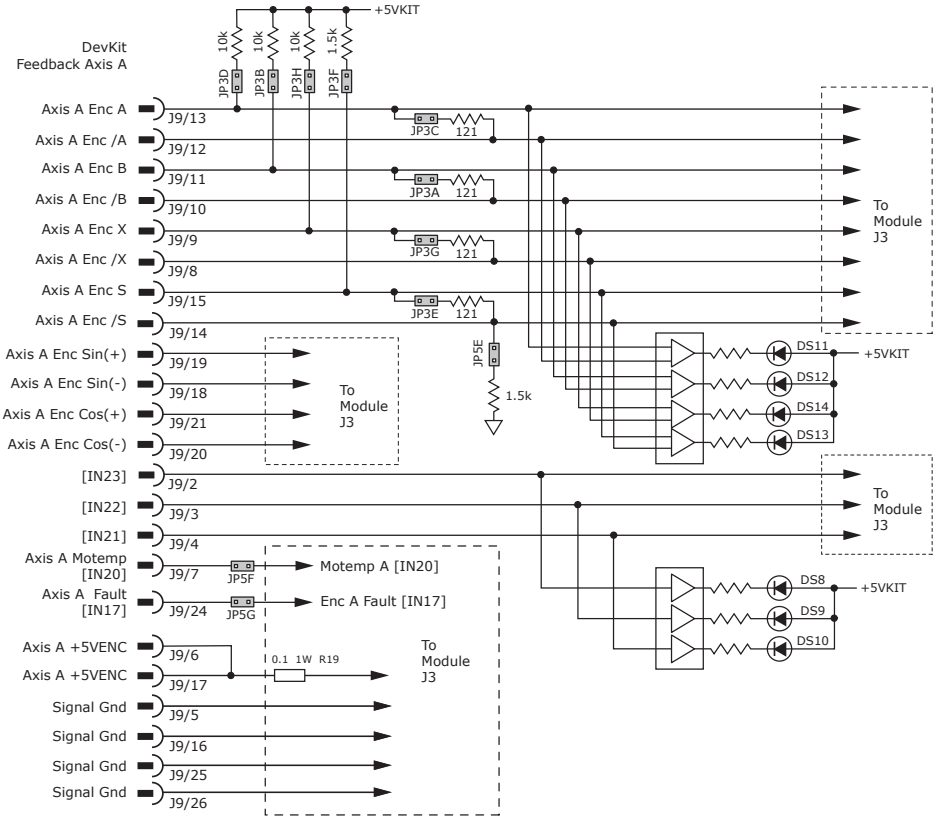
As delivered, all of these jumpers are installed as shown. If connecting to external devices that actively control the level of an input, it is desirable to disconnect the switch which could short the input to ground.

For example, if [IN1] is connected to an external device for the Enable function, then jumper JP9A should be removed to take the switch SW1 out of the circuit. The figure below shows these connections.

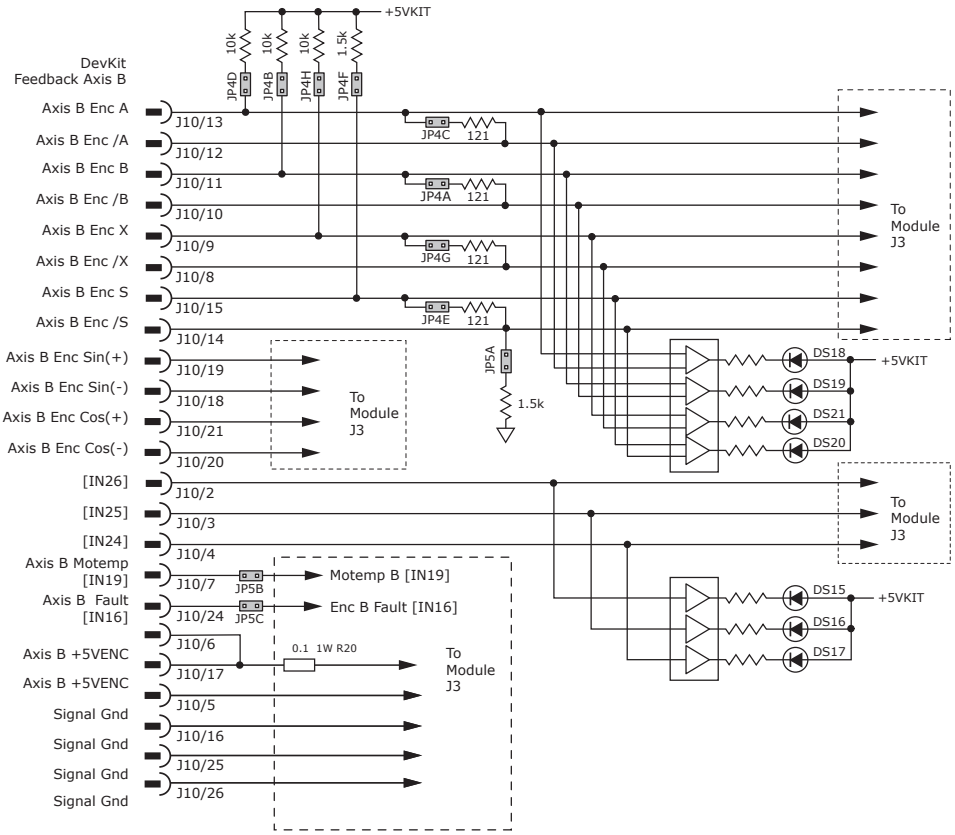


MOTOR FEEDBACK CONNECTORS J9 & J10

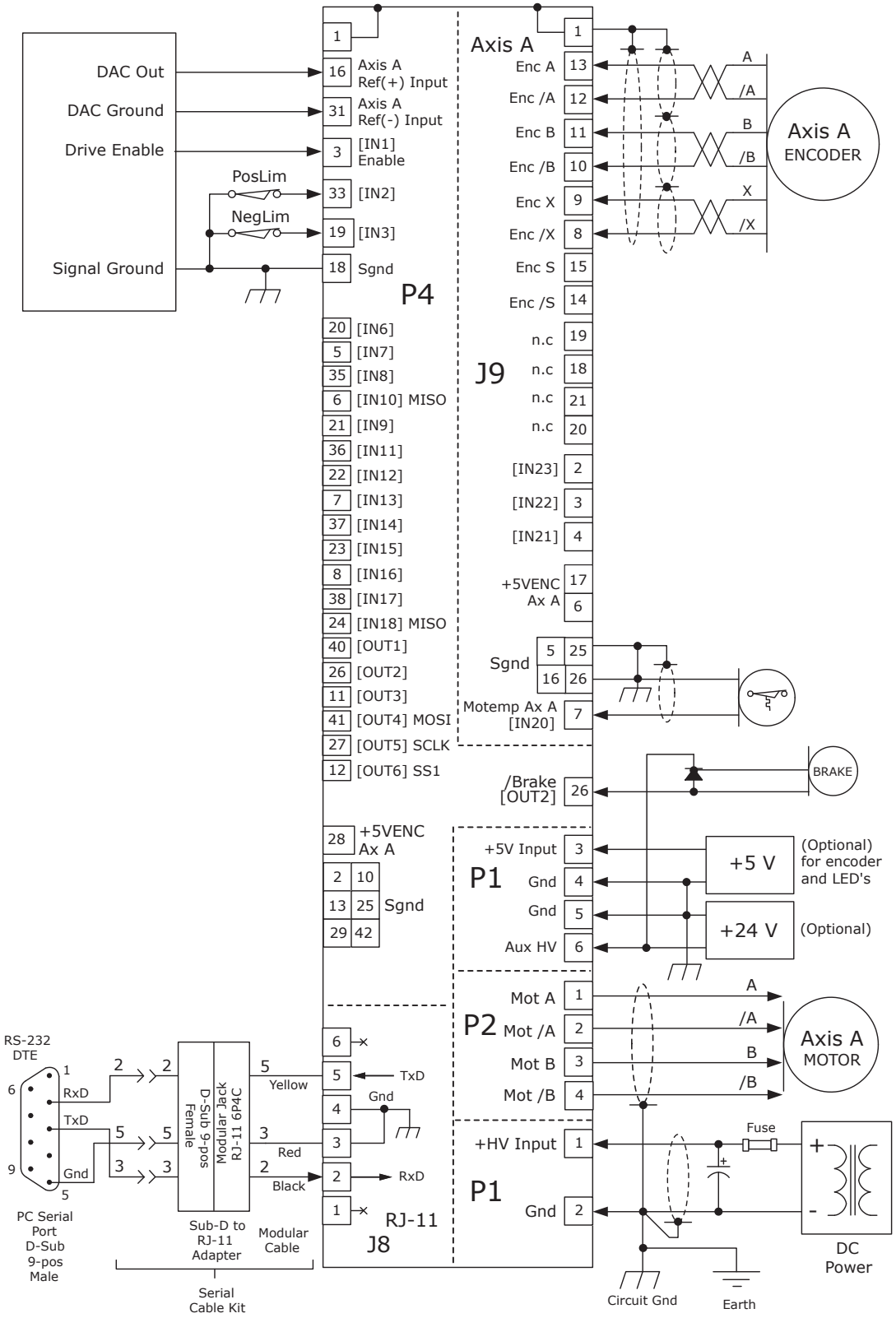
AXIS A



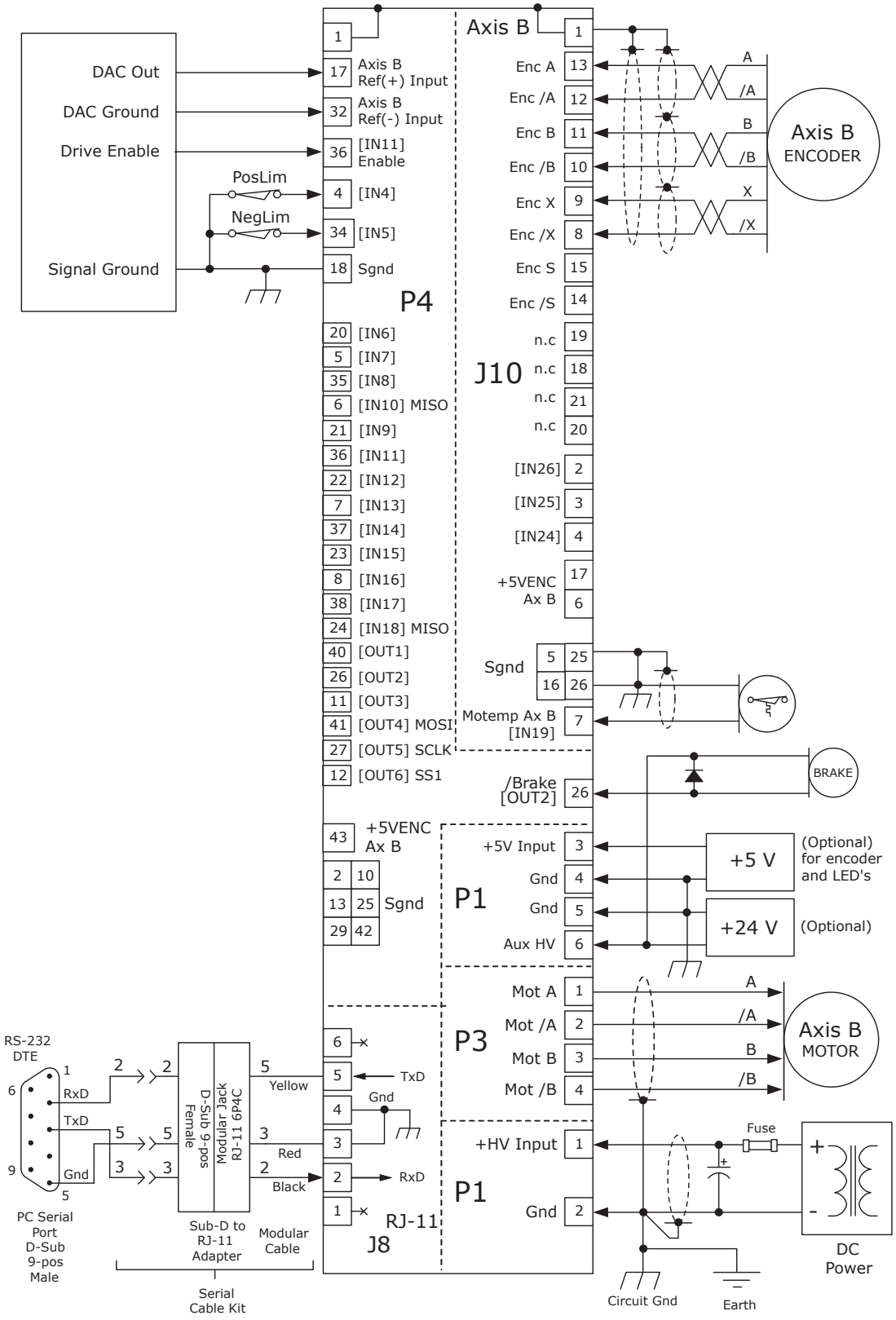
AXIS B



DEVELOPMENT KIT CONNECTIONS: AXIS A



DEVELOPMENT KIT CONNECTIONS: AXIS B



DEVELOPMENT KIT CONNECTORS

The Development Kit mounts a single SP2 module and enables the user to test and operate the SP2 before it is mounted onto a PC board in the target system.

P1: HV

Signal	Pin
+HV	1
HV Gnd	2
+5V Ext	3
Sgnd	4
HV Gnd	5
HV Aux	6

P2: AXIS A MOTOR

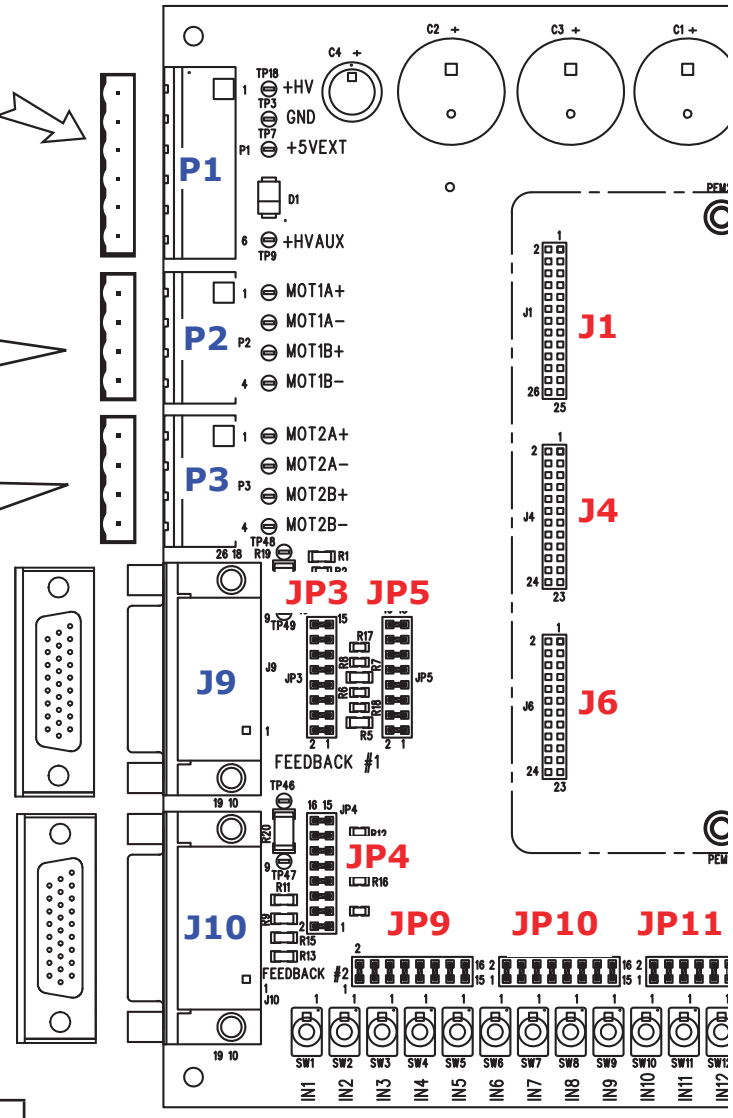
Signal	Pin
Motor A	1
Motor /A	2
Motor B	3
Motor /B	4

P3: AXIS B MOTOR

Signal	Pin
Motor A	1
Motor /A	2
Motor B	3
Motor /B	4

J9: AXIS A FEEDBACK

J10: AXIS B FEEDBACK



J9(J10): FEEDBACK A(B)

PIN	SIGNAL
26	Signal Gnd
25	Signal Gnd
24	[IN17(16)]
23	Enc X
22	Enc /X
21	n.c.
20	n.c.
19	n.c.

PIN	SIGNAL
18	n.c.
17	+5VENC*
16	Signal Gnd
15	Enc S
14	Enc /S
13	Enc A
12	Enc /A
11	Enc B
10	Enc /B

PIN	SIGNAL
9	Enc X
8	Enc /X
7	Motemp**
6	+5VENC*
5	Signal Gnd
4	[IN21(24)]
3	[IN22(25)]
2	[IN23(26)]
1	Frame Gnd

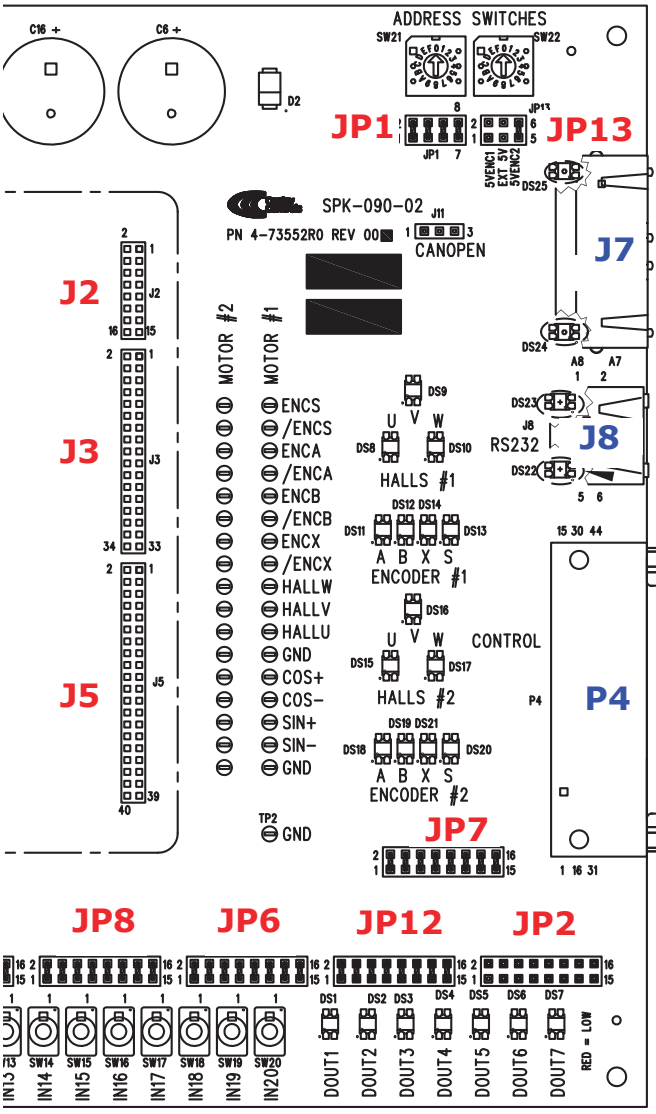
* The SP2 has two independent 5V encoder power supplies, and each is rated for 400 mA.

Axis	Supply	Connections
A	Axis A+5VENC	J9-6, J9-17, P4-28
B	Axis B +5VENC	J10-6, J10-17, P4-43

** Each axis has a motor overtemp input as shown in the chart below.

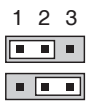
Axis	Name	Input	Connections
A	Axis A Motemp	[IN20]	J9-7, P4-39
B	Axis B Motemp	[IN19]	J10-7, P4-9

NODE ID (address) SWITCHES



J11 CAN NETWORK TERMINATOR

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



J7 CANOPEN

Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_GND
4	Pass-thru
5	Pass-thru
6	Pass-thru
7	CAN_GND
8	Pass-thru

J8: RS-232

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

P4: CONTROL A,B

PIN	SIGNAL
15	n.c.
14	n.c.
13	Sgnd
12	[OUT6] SLI-SS1
11	[OUT3]
10	Sgnd
9	[IN19] Axis A Motemp
8	[IN16] HS
7	[IN13] HS
6	[IN10] HS
5	[IN7] HS
4	[IN4] HS
3	[IN1] HS
2	Sgnd
1	Frame Gnd

PIN	SIGNAL
30	n.c.
29	Sgnd
28	Ax A +5VENC
27	[OUT5] SLI-SCLK
26	[OUT2]
25	Sgnd
24	[IN18] SLI-MISO
23	[IN15] HS
22	[IN12] HS
21	[IN9] HS
20	[IN6] HS
19	[IN3] HS
18	Sgnd
17	[REF+] Ax B
16	[REF+] Ax A

PIN	SIGNAL
44	n.c.
43	Ax B +5VENC
42	Sgnd
41	[OUT4] SLI-MOSI
40	[OUT1]
39	[IN20] Axis B Motemp
38	[IN17] HS
37	[IN14] HS
36	[IN11] HS
35	[IN8] HS
34	[IN5] HS
33	[IN2] HS
32	[REF-] Ax B
31	[REF-] Ax A

THERMAL MANAGEMENT

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

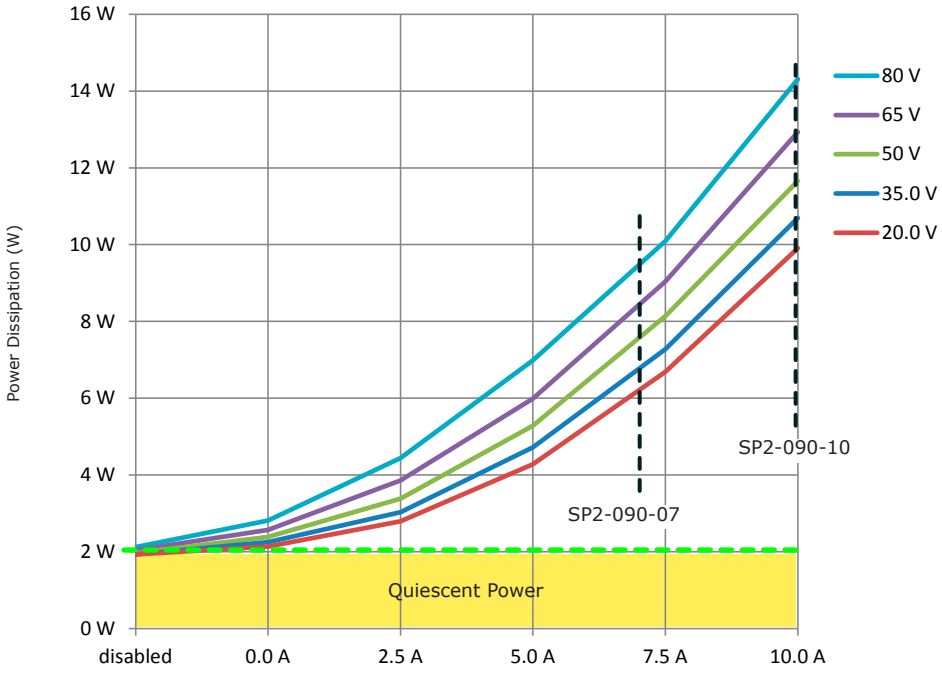
When the total power dissipation is known the maximum ambient operating temperature can be found using different mounting and cooling means from the chart in Step 2.

STEP 1: FIND THE POWER DISSIPATION FOR EACH AXIS

Using the output current for the A-axis, find the power dissipation based on the HV power supply voltage. Using the current for the B-axis, and the same HV voltage, find the dissipation for that axis.

Add the A-axis and B-axis dissipation to find the total power dissipation for Step 2.

SP2-090-07 & SP2-090-10

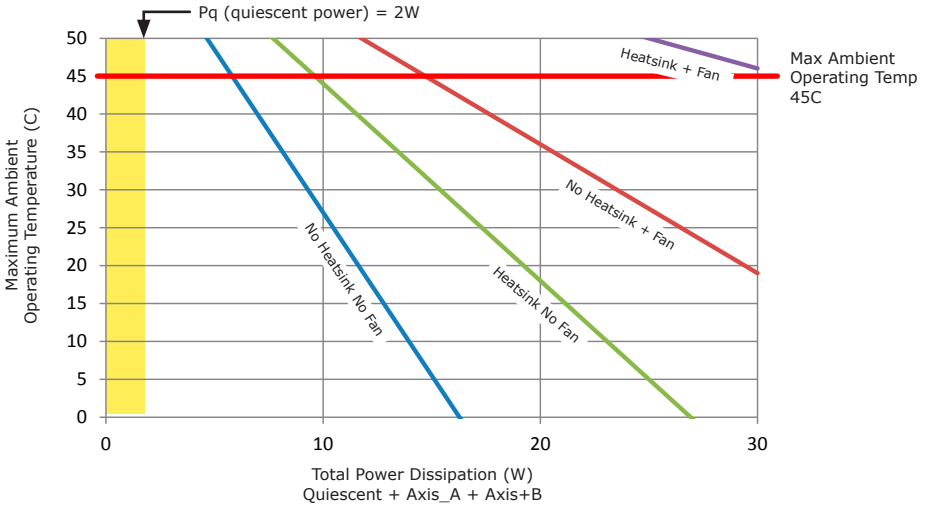


STEP 2: FIND MOUNTING AND COOLING MEANS REQUIRED FOR DIFFERENT AMBIENT TEMPERATURES

Find the total power dissipation for the SP2 using the charts on the opposite page. Add the powers for Axis A and Axis B. Find a point on the X-axis of this chart for that power and draw a vertical line from it.

Draw a horizontal line from the point where the vertical line crosses the cooling condition lines.

Read the maximum ambient operating temperature where the horizontal line meets the Y-axis.



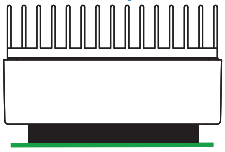
HEATSINK OPTIONS

Rth expresses the rise in temperature of the drive per Watt of internal power loss. The units of Rth are °C/W, where the °C represent the rise above ambient in degrees Celsius. The data below show thermal resistances under convection, or fan-cooled conditions for the no-heatsink, and SP2-HS heatsink.

NO HEATSINK

AIR FLOW	C/W
CONVECTION	4.3
FORCED AIR (300 LFM)	1.7

HEATSINK (SP2-HK)



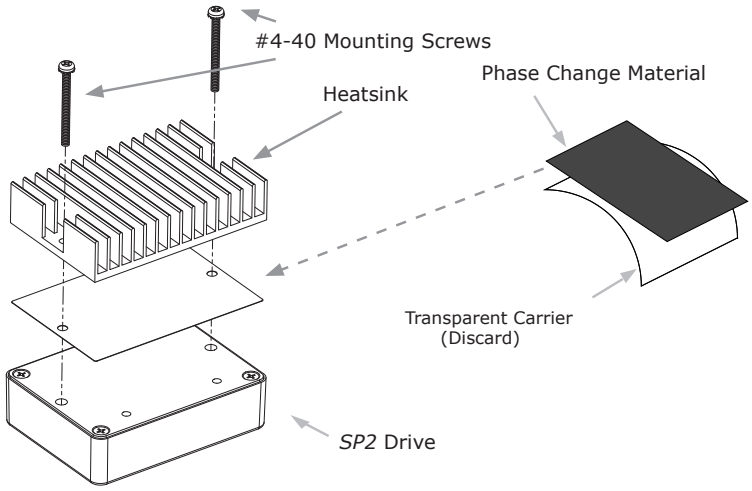
AIR FLOW	C/W
CONVECTION	2.6
FORCED AIR (300 LFM)	0.8

HEATSINK INSTALLATION

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

STEPS TO INSTALL

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



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MASTER ORDERING GUIDE

SP2-090-07	*Stepnet* SP2 stepper drive, 5/7 A, 20~90 Vdc
SP2-090-10	*Stepnet* SP2 stepper drive, 10/10 A, 20~90 Vdc
SPK-090-02	Development Kit for SP2

CANopen®

ACCESSORIES

	QTY	Connector	DESCRIPTION
Connector Kit for Development Kit SPK-CK-02	1	P1	Connector, Euro, 6 Terminal, 5.08 mm
	2	P2, P3	Connector, Euro, 4 Terminal, 5.08 mm
	1	P4	44 Pin Connector, High Density, D-Sub, Male, Solder Cup
			44 Pin Connector Backshell
	2	J9, J10	26 Pin Connector, High Density, D-Sub, Female, Solder Cup
	1		26 Pin Connector Backshell
Heatsink Kit SP2-HK	1		Heatsink for SP2
	1		Heatsink Thermal Material
	4		Heatsink Hardware
SER-CK		J8	SP2 Development Kit Serial Cable Kit
CME 2			CME 2 Drive Configuration Software on CD-ROM
CMO			CD with CMO Software
CML			CD with CML Software (Note: license fee required)

CONNECTORS & ACCESSORIES FOR CANOPEN OPERATION

	QTY	Connector	DESCRIPTION
Network Cable Kit SPK-NK	1	J7	D-Sub 9F to RJ-45 Adapter
	1		CAN bus RJ-45 terminator
	1		CAN bus network cable, 10 ft (3 m)
SPK-CV	1		D-Sub 9F to RJ-45 Adapter
SPK-NC-10	1		CAN bus Network Cable, 10 ft (3 m)
SPK-NC-01	1		CAN bus Network Cable, 1 ft (0.3 m)
SPK-NT	1		CAN bus Network Terminator

16-01589 Document Revision History

Revision	Date	Remarks
00	March 9, 2017	Initial released version

Note: Specifications subject to change without notice