

## CONTROL MODES

- Profile Position-Velocity-Torque, Interpolated Position, Homing
- Indexer, Point-to-Point, PVT
- Camming, Gearing

## COMMAND INTERFACE

- CANopen
- ASCII and discrete I/O
- Stepper commands
- ±10V Position/Velocity/Torque command
- PWM Velocity/Torque command
- Master encoder (Camming, Gearing)

## COMMUNICATIONS

- CANopen
- RS-232
- RS-422

## FEEDBACK

- *Dual Absolute Encoder Ports*
- *Absolute*
  - SSI
  - EnDat 2.1 & 2.2
  - Absolute A
  - Tamagawa
  - Panasonic
  - Sanyo Denki
  - BiSS (B&C)
- *Incremental*
  - Digital quad A/B encoder
  - Analog Sin/Cos encoder
  - Aux. encoder / encoder out
- *Other*
  - Digital Halls
  - Resolver (-R models)

## I/O DIGITAL

- 6 High-speed inputs
- 4 Opto-isolated inputs
- 1 Motor over-temp input
- 4 High-speed outputs
- 4 Opto-isolated outputs
- 1 Opto-isolated motor brake output

## I/O ANALOG

- 1 Reference input, 16-bit

## SAFE TORQUE OFF (STO)

- SIL 3, Category 3, PL d

## DIMENSIONS: IN [MM]

- 3.10 x 2.40 x 0.92 [78.7 x 60.1 x 23.4]



Model	Ic	Ip	Vdc
GPM-055-60	30	60	9~55
GPM-055-60-R	30	60	9~55
GPM-090-60	30	60	14~90
GPM-090-60-R	30	60	14~90

## DESCRIPTION

GPM sets new levels of performance, connectivity, and flexibility. The GPM operates as a CAN node using the CANopen protocol of DSP-402 for motion control devices. Supported modes include: Profile Position-Velocity-Torque, Interpolated Position Mode (PVT), and Homing. A wide range of absolute encoders are supported.

Both isolated and high-speed non-isolated I/O are provided. For safety critical applications, redundant power stage enable inputs can be employed.

## GENERAL SPECIFICATIONS

Test conditions: Wye connected load: 2 mH line-line. Ambient temperature = 25 °C. Power input = 55 Vdc

MODEL	GPM-055-60(-R)	GPM-090-60(-R)	
<b>OUTPUT CURRENT</b>			
Peak Current	60 (42.4)	60 (42.4)	Adc (Arms)
Peak time	1	1	Sec
Continuous current	30 (21.2)	30 (21.2)	Adc (Arms)
Peak Output Power	5.4	5.4	kW
Continuous Output Power	2.7	2.7	kW
<b>INPUT POWER</b>			
HVmin to HVmax	+9 to +55	+14 to +90	Vdc
Ipeak	60	60	Adc
Icont	30	30	Adc
Aux HV	+9 to +55	+14 to +90	Vdc (2.5 W max)
<b>PWM OUTPUTS</b>			
Type	MOSFET 3-phase inverter, 16 kHz center-weighted PWM carrier, space-vector modulation		
PWM ripple frequency	32 kHz		
<b>DIGITAL CONTROL</b>			
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)		
PWM frequency	16 kHz		
Bus voltage compensation	Changes in bus or mains voltage do not affect bandwidth		
Minimum load inductance	250 µH line-line		
Resolution	16-bit capture of U & V phase currents		
<b>COMMAND INPUTS</b>			
CANopen	CANopen Device Profile DSP-402 over CANopen (CoE) Galvanically isolated from drive circuits Profile Position/Velocity/Torque, Interpolated Position (PVT), Homing Isolated from Signal Ground, 32 V max working voltage vs. Signal Ground		
Stand-alone mode			
Analog Torque, Velocity, Position reference	±10 Vdc, 16 bit resolution	Dedicated differential analog input	
Digital Position reference	Pulse/Direction, CW/CCW	Stepper commands (2 MHz maximum rate)	
	Quad A/B Encoder	2 M line/sec, 8 Mcount/sec (after quadrature)	
Digital Torque & Velocity reference	PWM, Polarity	PWM = 0% - 100%, Polarity = 1/0	
	PWM 50%	PWM = 50% ±50%, no polarity signal required	
	PWM frequency range	1 kHz minimum, 100 kHz maximum	
	PWM minimum pulse width	220 ns	
Indexing	Up to 32 sequences can be launched from inputs or ASCII commands.		
Camming	Up to 10 CAM tables can be stored in flash memory		
ASCII	RS-232, 9600~115,200 Baud, 3-wire, RJ-11 connector, referenced to Signal Ground		
<b>DIGITAL INPUTS</b>			
Number	11		
[IN1,2,3,4,5,6]	Digital, non-isolated, Schmitt trigger, 0.1 µs RC filter, 12 Vdc compatible, 10kΩ pull-up to +5 Vdc Vt+ = 2.5~3.5 Vdc max, Vt- = 1.3~2.2 Vdc min, Vh = 0.7~1.5 Vdc, SLI port MISO signal		
[IN7,8,9,10]	Digital, opto-isolated, single-ended, ±15~30 Vdc compatible, bi-polar, with common return Rated impulse ≥ 800 V, Vin-LO ≤ 6.0 Vdc, Vin-HI ≥ 10.0 Vdc, Input current ±3.6 mA @ ±24 Vdc, typical Maximum working voltage with respect to ground: 32 Vdc		
[IN11]	Defaults as motor overtemp input on feedback connector, 24 Vdc max, programmable to other functions Other digital inputs are also programmable for the Motemp function		
Functions	330 µs RC filter, 4.99kΩ pull-up to +5 Vdc, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc All inputs are programmable, [IN1] defaults to the Enable function and is programmable for other functions.		
<b>ANALOG INPUT</b>			
[AIN±]	Differential, -10 to +15 Vdc, 5.36kΩ input impedance, 16-bit resolution, 16 kHz acquisition rate Bandwidth (-3 dB) of analog signal path: 14 kHz, common-mode range -10 to +15 Vdc		
<b>DIGITAL OUTPUTS</b>			
Number	9		
[OUT1~4]	Isolated, two-terminal SSR with 1 Ω series resistor and 36 V Zener diode for driving inductive loads Ton = 5 ms max, @ 300 mA, Toff = 2 ms max @ 300 mA Maximum working voltage with respect to ground: 32 Vdc, rated impulse voltage ≥ 800 Vdc		
[OUT5~8]	High speed, SLI port MOSI, SCLK, & EN1 signals, 74AHCT125 line drivers; +5 Vdc tolerant Output current: ±25 mA max @ ±5 Vdc		
[OUT9 BRAKE]	Isolated, MOSFET, 1 A max, external flyback diode required, Turn-ON & Turn-OFF delay 250 µs max GATE output can drive an external MOSFET for brakes requiring higher current Maximum working voltage with respect to ground: 32 Vdc, rated impulse voltage ≥ 800 Vdc Default functions are shown above, programmable to other functions		
<b>RS-232 PORT</b>			
Signals	RxD, TxD, Gnd in 6-position, 4-contact RJ-11 style modular connector, non-isolated		
Mode	Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 115,200 baud		
Protocol	Binary and ASCII formats, EIA/TIA-232E voltage levels, ±5.0 minimum output, ±30 V input voltage range		
<b>RS-422 PORT</b>			
Signals	A/Y(+), B/X(-), Gnd from ISL32455 transceiver, optically isolated		
Mode	Half-duplex, RS-422 slave, 9,600 bps to 230.4 kbps		
Protocol	Binary and ASCII formats		
<b>CAN PORT</b>			
Signals	CAN_H, CAN_L, CAN_GND, optically isolated, max working voltage with respect to signal ground: 32 Vdc		
Protocol	CANopen Device Profile DSP-402 over CANopen (CoE)		

### NOTES:

1. Brake output [BRAKE] is programmable as motor brake, or as general purpose digital output.
2. When STO feature is used, the 24V power supply must be a SELV or PELV type with the maximum output voltage limited to 60 Vdc or lower.

## GENERAL SPECIFICATIONS

### DC OUTPUTS

Number	1
Ratings	+5 Vdc @ 500 mA thermal and overload protected

### SAFE TORQUE OFF (STO)

Function	PWM outputs are inactive and current to the motor will not be possible when the STO function is activated
Standard	Designed to IEC-61508-1, IEC-61508-2, IEC-61800-5-2, ISO-13849-1
Safety Integrity Level	SIL 3, Category 3, Performance level d
Inputs	2 two-terminal: STO-IN1+, STO-IN1-, STO-IN2+, STO-IN2-
Type	Opto-isolators, 24V compatible, Vin-LO ≤ 6.0 Vdc or open, Vin-HI ≥ 15.0 Vdc,
Input current (typical)	STO-IN1: 11.2 mA, STO-IN2: 11.2 mA
Response time	2 ms from Vin ≤ 6.0 Vdc to interruption of energy supplied to motor
Disabling	Wiring a shorting plug with jumpers (see page 6) will disable the STO function

### PROTECTIONS

HV Overvoltage -055 models	+HV ≥ 55 Vdc	Drive outputs turn off until +HV < 55 Vdc
HV Undervoltage -055 models	+HV ≤ 9 Vdc	Drive outputs turn off until +HV > 9 Vdc
HV Overvoltage -090 models	+HV > 90 Vdc	Drive outputs turn off until +HV ≤ 90 Vdc
HV Undervoltage -090 models	+HV < 14 Vdc	Drive outputs turn off until +HV ≥ 14 Vdc
Drive over temperature	Heat plate > 80°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]	3.10 x 2.40 x 0.92 [78.7 x 60.1 x 23.4]
Weight	4.2 oz (120 g) without heatsink
Ambient temperature	0 to +45°C operating, -40 to +85°C storage
Humidity	0 to 95%, non-condensing
Vibration	2 g peak, 10~500 Hz (Sine), IEC60068-2-6
Shock	10 g, 10 ms, half-Sine pulse, IEC60068-2-27
Contaminants	Pollution degree 2
Environment	IEC 60068-2
Cooling	Heat sink and/or forced air cooling required for continuous power output
Altitude	≤ 2000 m (6560 ft) per IEC 60068-2-13

### AGENCY STANDARDS CONFORMANCE

#### Standards and Directives

##### Functional Safety

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

##### Electrical Safety

Directive 2014/35/EU – Low Voltage, UL 61800-5-1:2016

##### EMC

Directive 2014/30/EU, IEC 61800-3:2017, Category C3

##### Restriction of the Use of Certain Hazardous Substances (RoHS)

Directive 2011/65/EU (RoHS II)

#### Approvals


UL and cUL recognized component to UL 61800-5-1  
 UL Functional Safety to IEC 61800-5-2  
 EMC to IEC 61800-3

**FUNCTIONAL SAFETY**



ISO 13849-1  
 Up to PL d (Cat 3)  
 IEC 61800-5-2  
 Up to SIL 3

RoHS Directive 2011/65/EU is now part of the CE marking procedure

 <b>DANGER</b>	<b>Refer to the 16-01599 Argus Plus GEM &amp; GPM Modules User Guide</b>
	The information provided in the manual must be considered for any application using the GPM drive STO feature. <b>Failure to heed this warning can cause equipment damage, injury, or death.</b>

## GENERAL SPECIFICATIONS

### FEEDBACK

#### All Channels

MAX3097 differential line receivers for A, B, 5 MHz maximum line frequency (20 M counts/sec)  
 MAX3362 differential line transceivers for S, X, 5 MHz maximum line frequency (20 M counts/sec)  
 Fault detection for open/shorted inputs, or low signal amplitude, selectable for A/B/X or A/B  
 External terminators required for fault detection, 121 Ω for A & B channels, 130 Ω for X  
 Internal 1 kΩ biasing pull-ups to +5V: X & S, internal 1 kΩ biasing pull-downs to Sgnd: /X & /S

#### Incremental encoders:

Digital Incremental Encoder	Quadrature signals, (A, /A, B, /B, X, /X), differential (X, /X Index signals not required)
Analog Incremental Encoder	Sin/Cos, differential, internal 121 Ω terminators between ± inputs, 1.0 Vp-p typical, 1.45 Vp-p maximum Common-mode voltage 0.25 to 3.75 Vdc, ±0.25 V, centered about 2.5 Vdc Signals: Sin(+), Sin(-), Cos(+), Cos(-), Frequency: 300 kHz maximum line (cycle) frequency, interpolation 16 bits/cycle (4096 counts/cycle)

#### Absolute encoders:

Heidenhain EnDat 2.2, SSI	Serial Clock (X, /X), Data (S, /S) signals, differential 4-wire, External 121 Ω terminator required for Clock, 221 Ω for Data
Heidenhain EnDat 2.1	Clock (X, /X), Data (S, /S), Sin/Cos (Sin+, Sin-, Cos+, Cos-) signals Internal 121 Ω terminators between Sin/Cos inputs, External 121 Ω terminator required for Clock, 221 Ω for Data
Absolute A, Tamagawa Absolute A, Panasonic Absolute A Format	SD+, SD- (S, /S) signals, 2.5 or 4 MHz, 2-wire half-duplex, external 221 Ω terminator required Position feedback: 13-bit resolution per rev, 16 bit revolution counter (29 bit absolute position data) Status data for encoder operating conditions and errors
BiSS (B&C)	MA+, MA- (X, /X), SL+, SL- (S, /S) signals, 4-wire, clock output from drive, data returned from encoder External 121 Ω terminator required for MA, 221 Ω for SL

#### Resolver:

Type	Brushless, single-speed, 1:1 to 2:1 programmable transformation ratio
Resolution	14 bits (equivalent to a 4096 line quadrature encoder)
Reference frequency	8.0 kHz
Reference voltage	2.8 Vrms, auto-adjustable by the drive to maximize feedback
Reference maximum current	100 mA
Maximum RPM	10,000+

### HALLS

#### Digital:

U, V, W: Single-ended, 120° electrical phase difference between U-V-W signals,  
Schmitt trigger, 1.5 μs RC filter, 24 Vdc compatible, 15 kΩ pull-up to +5 Vdc  
Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc

#### Analog:

U & V: Sin/Cos format (Sin+, Sin-, Cos+, Cos-), differential, 1 Vpeak-peak ±20%,  
BW > 300 kHz, 121 Ω terminating resistors between Sin+ & Sin-, Cos+ & Cos- inputs  
16-bit resolution, BW ≥ 300 kHz, with zero-crossing detection

### MULTI-MODE ENCODER PORT

#### As Input:

See Digital Incremental Encoder above for electrical data on A, B, & X channels, or  
Absolute encoders using X or S channels. External terminators required as shown above  
Quadrature A/B encoder emulation with programmable resolution to 4096 lines (65,536 counts)  
per rev from analog Sin/Cos encoders or resolvers.

#### As Emulated Output:

A, /A, B, /B, outputs from MAX3032 differential line driver, X, /X, S, /S from MAX 3362 line drivers  
Digital A/B/X encoder signals from primary digital encoder are buffered as shown above, 5 MHz max

#### As Buffered Output:

### 5V OUTPUT

Number	1
Ratings	+5 Vdc @ 500 mA thermal and overload protected

### 16-01598 Document Revision History

Revision	Date	Remarks
00	March 27, 2017	Preliminary version
01	April 4, 2017	Initial released version
02	December 6, 2017	Added 90V models, change 90V model min voltage to 14 Vdc, corrected DevKit model number, added thermal data, remove large heatsink, add HS kit to accessories.
03	June 13, 2018	Corrections to STO graphic and signal namings
04	February 15, 2019	Updated photo on first page and edited the Feedback section
05	March 13, 2019	Corrected SSI encoder description
06	September 17, 2020	Update to latest data in Argus Plus GEM & GPM Modules User Guide
07	October 22, 2020	Add Functional Safety logo and ISO, IEC text
08	October 26, 2021	Updated Peak Time information from 2 seconds to 1 second. Added RoHS message to conformance.

## CANOPEN COMMUNICATIONS

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

Argus 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-ID can be saved to flash memory in the module. Node-ID 0 is reserved for the CANopen master on the network.

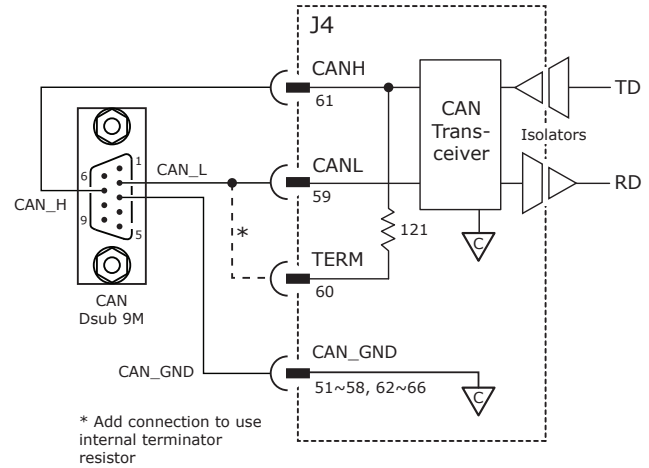
For more information on CANopen communications, download the *CANopen Programmer's Manual* from the Copley Controls web-site: <http://www.copleycontrols.com/Motion/pdf/CANopenProgrammersManual.pdf>

### CANOPEN COMMAND INPUT

This graphic shows connections between the GPM and a Dsub 9M connector on a CAN card. If the GPM 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.

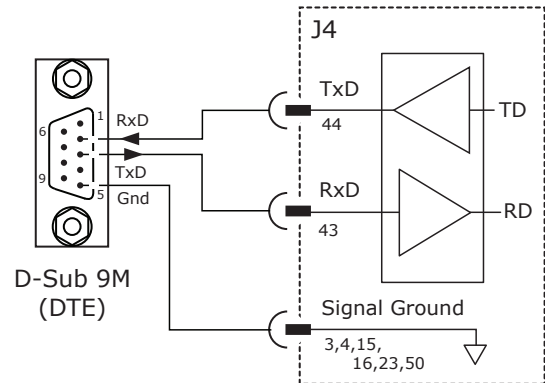
The node Node-ID of the GPM may be set by using digital inputs, or programmed into flash memory in the drive.

The C ground symbols are CAN\_GND and are only in the isolated CAN circuit. It should connect to Signal Ground on the user's PC board or other 0V electrical circuit.



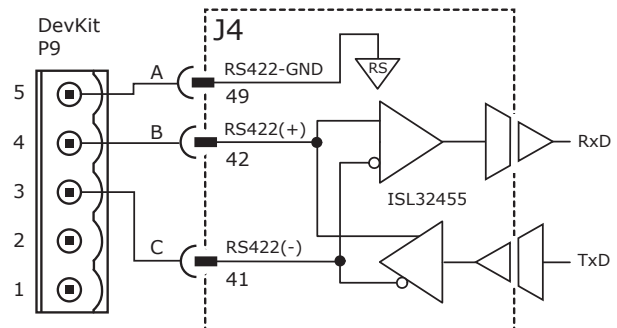
### RS-232 COMMUNICATIONS

GPM 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 Signal Gnd. Connections to the GPM RS-232 port are through J4. The graphic shows the connections between an GPM and a computer COM port which is a DTE device.



### RS-422 COMMUNICATIONS

RS-422 is a two-wire differential half-duplex port that operates from 9600 to 230.4 kbps. The graphic shows the connections between a GPM and the Development Kit RS-422 port P9. The RS ground is RS422GND and is only in the isolated RS422 circuit. It should connect to Signal Ground on the user's PC board or other 0V electrical circuit. A, B, and C are the signal labels in the RS422 specification.




## SAFE TORQUE OFF (STO)

### DESCRIPTION

The GPM provides the Safe Torque Off (STO) function as defined in IEC 61800-5-2. Three opto-couplers are provided which, when de-energized, prevent the upper and lower devices in the PWM outputs from being operated by the digital control core. This provides a positive OFF capability that cannot be overridden by the control firmware, or associated hardware components. When the opto-couplers are activated (current is flowing in the input diodes), the control core will be able to control the on/off state of the PWM outputs.

### INSTALLATION

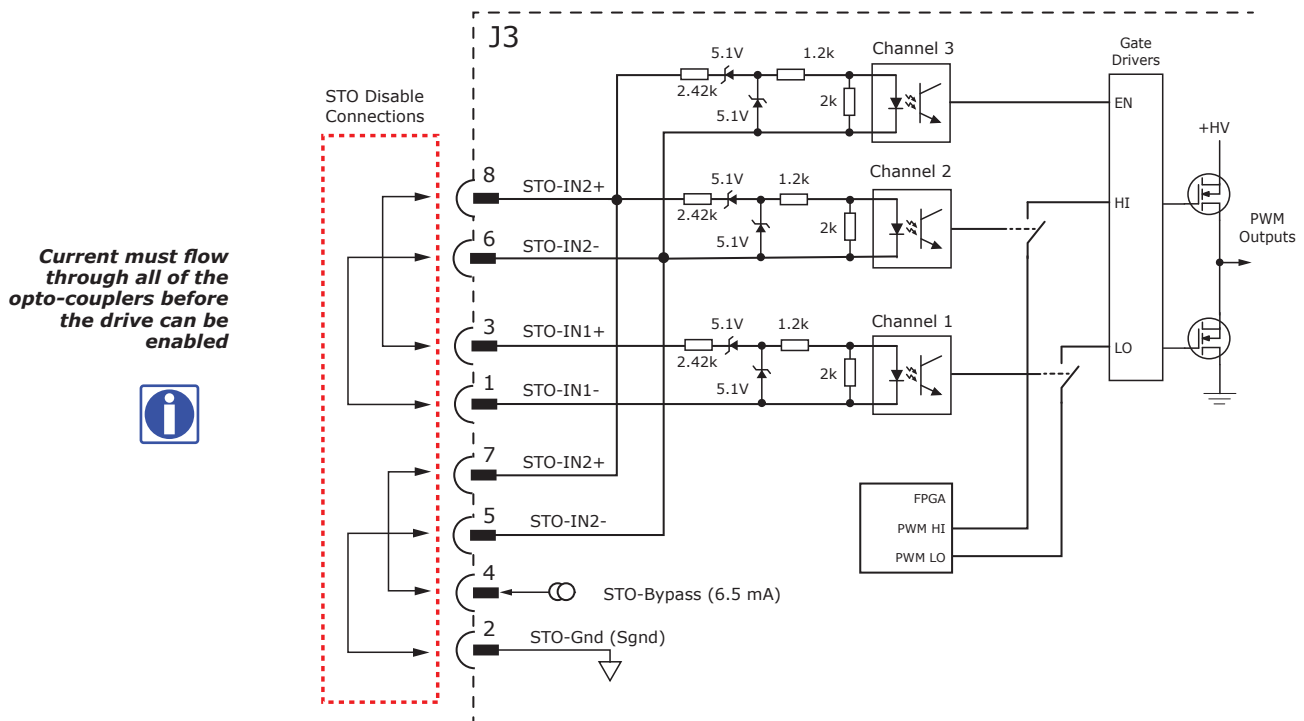
 <b>DANGER</b>	<p><b>Refer to the 16-01599 Argus Plus GEM &amp; GPM Modules User Guide</b></p>
	<p>The information provided in the manual must be considered for any application using the GPM drive STO feature.</p> <p><b>Failure to heed this warning can cause equipment damage, injury, or death.</b></p>

### STO BYPASS (DISABLING)

In order for the PWM outputs of the drive to be activated, current must be flowing through all of the opto-couplers that are connected to the STO-1 and STO-2 terminals of J3, and the drive must be in an ENABLED state. When the opto-couplers are OFF, the drive is in a Safe Torque Off (STO) state and the PWM outputs cannot be activated by the control core to drive a motor. This diagram shows connections that will energize all of the opto-couplers from an internal current-source. When this is done the STO feature is disabled and control of the output PWM stage is under control of the digital control core.

**If not using the STO feature, these connections must be made in order for the drive to be enabled.**

### STO DISABLING CONNECTIONS



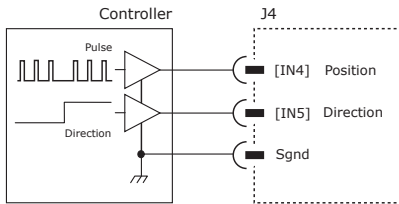
### J3 SIGNALS

SIGNAL	PIN	PIN	SIGNAL
STO-IN1(-)	1	2	STO-GND
STO-IN1(+)	3	4	STO-BYPASS
STO-IN2(-)	5	6	STO-IN2(-)
STO-IN2(+)	7	8	STO-IN2(+)



## DIGITAL COMMAND INPUTS: POSITION

### PULSE & DIRECTION

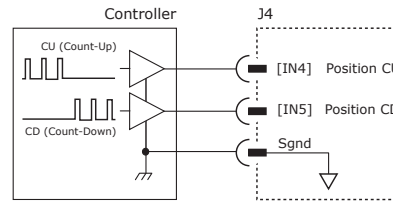


Pulses on IN4 will increment the target position. The active edge of pulses is programmable as Rising or Falling and the direction of the position change is programmable.

Also programmable is the Stepping Resolution. Two parameters, Input Pulses and Output Pulses determine the ratio of Output Pulses to Input Pulses.

If Input Pulses = 10 and Output Pulses = 2 then 5 Input Pulses will produce 1 Output Pulse.

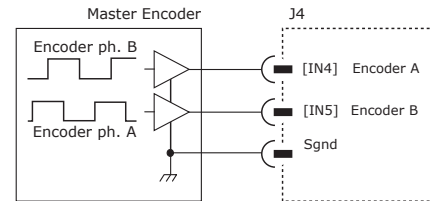
### CU/CD



Pulses on IN4 will increment the target position and pulses on IN5 will decrement the position.

The active edge, direction of the position change, and Stepping Resolution are programmable as in Pulse/Dir.

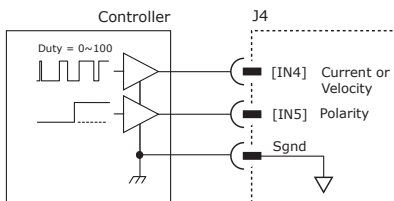
### QUAD A/B ENCODER



The Quad A/B encoder is two rising and falling pulse trains 90 degrees out of phase. The Ratio of Input Counts to Output Counts is programmable. The direction produced by the counts can be inverted.

## DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

### PWM & DIRECTION



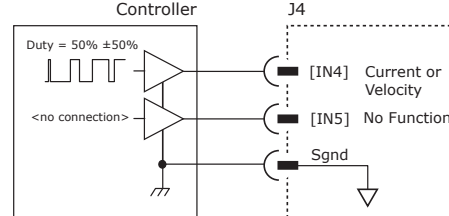
A pulse-train on IN4 with a constant frequency and variable duty-cycle will increment/decrement the target Velocity or Current. Stepping Resolution is not used.

Minimum and maximum Pulse Widths are programmable.

Also programmable is the Stepping Resolution. Two parameters, Input Pulses and Output Pulses determine the ratio of Output Pulses to Input Pulses.

If Input Pulses = 10 and Output Pulses = 2 then 5 Input Pulses will produce 1 Output Pulse.

### 50% PWM



A pulse-train on IN4 with a constant frequency and variable duty-cycle will increment/decrement the target Velocity or Current. As shown, 50% duty cycle commands 0 output, 100% duty cycle is maximum positive output, 0% duty cycle is maximum negative output.

The PWM input can be inverted to reverse the Pos/Neg output direction.

Scaling of the output current at min/max duty cycles is programmable.

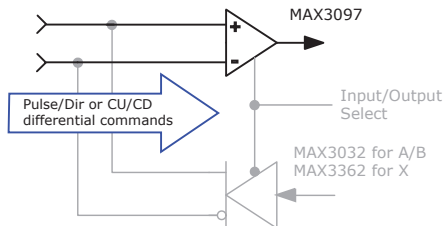
### CONNECTIONS

Input	J4 Pins
IN4	19
IN5	22
Sgnd	3,4,15,16,23,50

**MULTI-MODE ENCODER PORT AS AN INPUT**

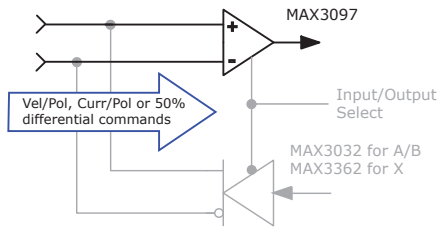
**POSITION COMMAND INPUTS: DIFFERENTIAL**

- Pulse & Direction
- CW & CCW (Clockwise & Counter-Clockwise)
- Encoder Quad A & B
- Camming Encoder A & B input



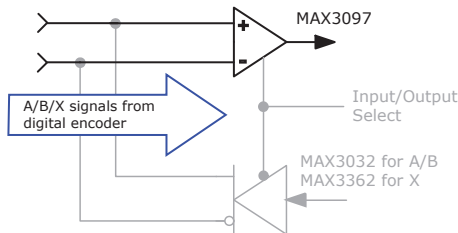
**CURRENT or VELOCITY COMMAND INPUTS: DIFFERENTIAL**

- Current/Velocity Magnitude & Direction
- Current/Velocity 50%



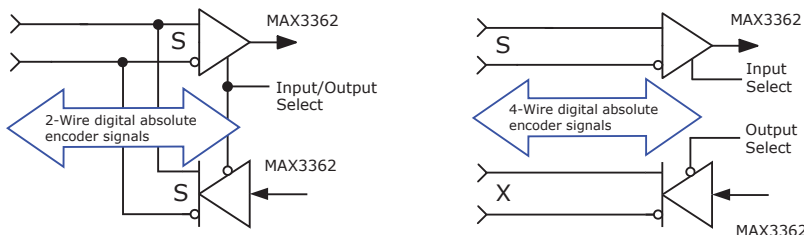
**SECONDARY FEEDBACK: INCREMENTAL**

- Quad A/B/X incremental encoder



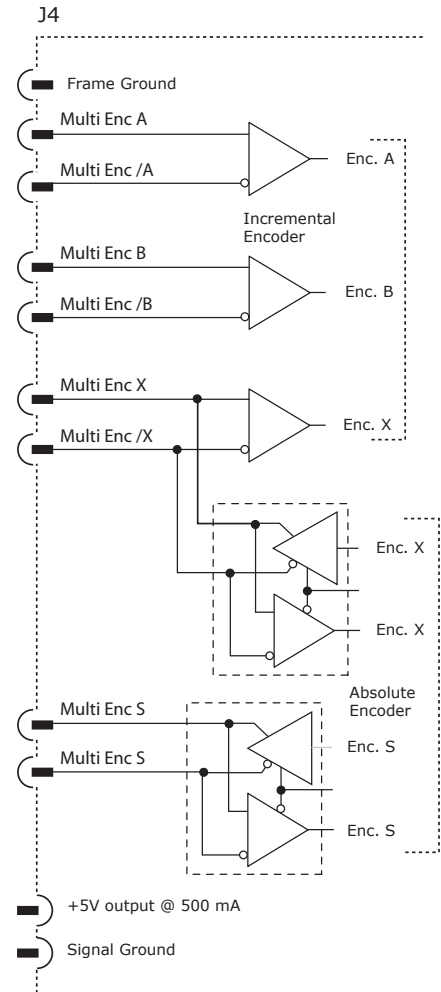
**SECONDARY FEEDBACK: ABSOLUTE**

- S channel: Absolute A encoders (2-wire)  
The S channel first sends a Clock signal and then receives Data from the encoder in half-duplex mode.
- S & X channels: SSI, BiSS, EnDat encoders (4-wire)  
The X channel sends the Clock signal to the encoder, which initiates data transmission from the encoder on the S-channel in full-duplex mode



**SIGNALS & PINS**

Signal	J4 Pins
Pulse, CW, Encoder A, Vel-Curr-Mag, Vel-Curr-50%	8
/Pulse, /CW, Encoder /A, /Vel-Curr-Mag, /Vel-Curr-50%	7
Direction, CCW, Encoder B, Vel-Curr-Pol	10
/Direction, /CCW, Encoder /B, /Vel-Curr-Pol	9
Quad Enc X, Absolute Clock	14
Quad Enc /X, /Absolute Clock	13
Enc S, Absolute (Clock) Data	12
Enc /S, / Absolute (Clock) Data	11
Signal Ground	3,4,15,16, 23,50





## MULTI-MODE PORT AS AN OUTPUT

### OUTPUT TYPES

#### BUFFERED FEEDBACK OUTPUTS: DIFFERENTIAL

- Encoder Quad A, B, X channels
- Direct hardware connection between quad A/B/X encoder feedback and differential line drivers for A/B/X outputs

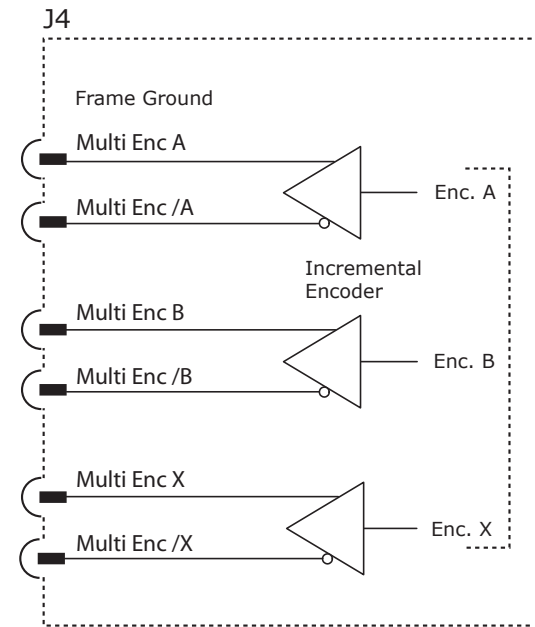
#### EMULATED FEEDBACK OUTPUTS: DIFFERENTIAL

Firmware produces emulated quad A/B signals from feedback data from the following devices:

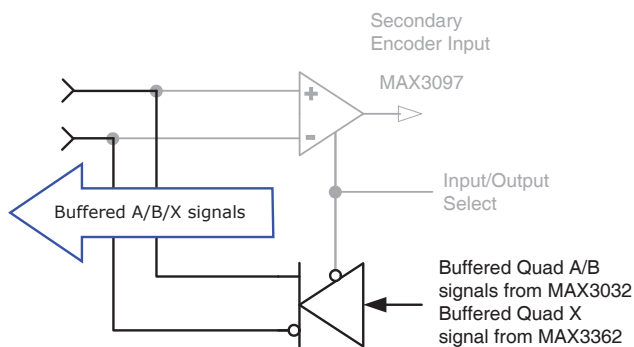
- Absolute encoders
- Analog Sin/Cos incremental encoders

#### SIGNALS & PINS

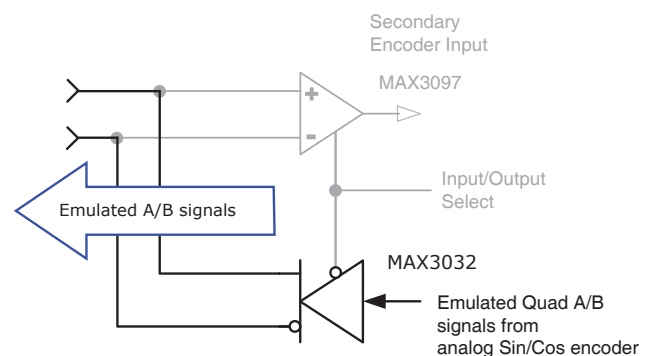
Signal	J4 Pins
Encoder A	8
Encoder /A	7
Encoder B	10
Encoder /B	9
Encoder X	14
Encoder /X	13
Signal Ground	3,4,15,16,23,50



#### BUFFERED QUAD A/B/X OUTPUTS



#### EMULATED QUAD A/B OUTPUTS



## HIGH SPEED INPUTS: IN1, IN2, IN3, IN4, IN5, IN6

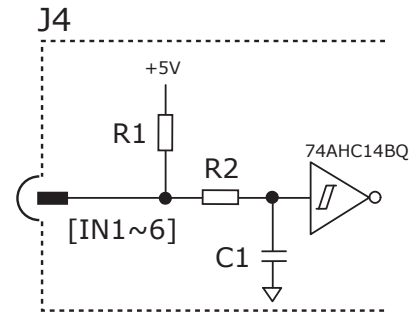
- Digital, non-isolated, high-speed
- 12V Compatible
- Programmable functions

### SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	$VT+ \geq 2.5 \sim 3.5Vdc$
	LO	$VT- \leq 1.3 \sim 2.2 Vdc$
	Hys	$VH 0.7 \sim 1.5 Vdc$
	Max	+12 Vdc
	Min	0 Vdc
Pull-up	R1	10 k $\Omega$
Low pass filter	R2	1 k $\Omega$
	C1	100 pF
	RC <sup>1</sup>	0.1 $\mu s$

### CONNECTIONS

Input	J4 Pins
IN1	18
IN2	17
IN3	20
IN4	19
IN5	22
IN6	21
Sgnd	3,4,15,16,23,50



#### Notes:

- 1) The  $R2 \cdot C1$  time constant applies when input is driven by active HI/LO devices

## MOTOR OVERTEMP INPUT: IN11

- Digital, non-isolated
- Motor overtemp input
- 24V Compatible
- Programmable functions

### MOTOR OVER TEMP INPUT

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

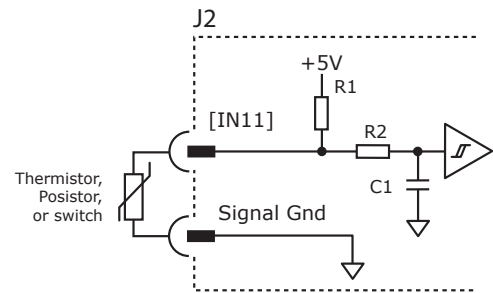
### SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	$VT+ \geq 2.5 \sim 3.5Vdc$
	LO	$VT- \leq 1.3 \sim 2.2 Vdc$
	Hys	$VH 0.7 \sim 1.5 Vdc$
	Max	+12 Vdc
	Min	0 Vdc
Pull-up	R1	4.99 k $\Omega$
Low pass filter	R2	10 k $\Omega$
	C1	33 nF
	RC <sup>1</sup>	330 $\mu s$

- \* RC time constant applies when input is driven by active high/low device

### CONNECTIONS

Input	J2 Pins
IN11	17
Sgnd	8,18,21,22



### BS 4999:Part 111:1987

Property	ohms
Resistance in the temperature range 20°C to +80°C	60~750
Resistance at 85°C	$\leq 1650$
Resistance at 95°C	$\geq 3990$
Resistance at 105°C	$\geq 12000$

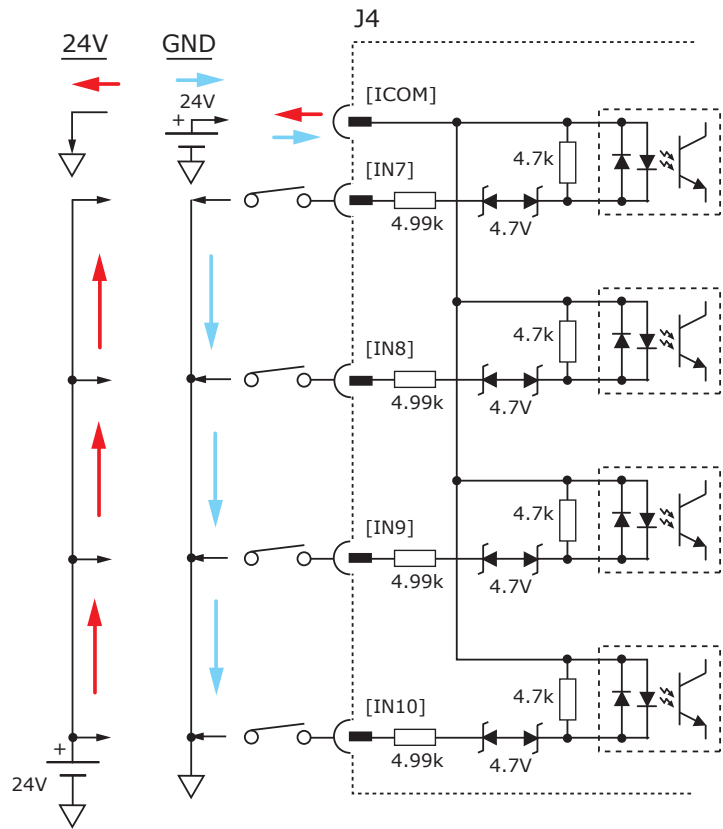
**OPTO-ISOLATED INPUTS: IN7, IN8, IN9, IN10**

- Digital, opto-isolated
- A group of four, with a common terminal
- Works with current sourcing or sinking drivers
- 24V Compatible
- Programmable functions

SPECIFICATIONS		
Input	Data	Notes
Input Voltages	HI	$V_{in} \geq \pm 10.0 \text{ Vdc} *$
	LO	$V_{in} \leq \pm 6.0 \text{ Vdc} *$
	Max	$\pm 30 \text{ Vdc} *$
Input Current	$\pm 24\text{V}$	$\pm 3.6 \text{ mAdc}$
	0V	0 mAdc

\* Vdc Referenced to ICOM terminals.

CONNECTIONS	
Signal	J4 Pins
IN7	27
IN8	25
IN9	26
IN10	24
ICOM	28



## ANALOG INPUT: AIN1

- ±10 Vdc, differential
- 16-bit resolution
- Programmable functions

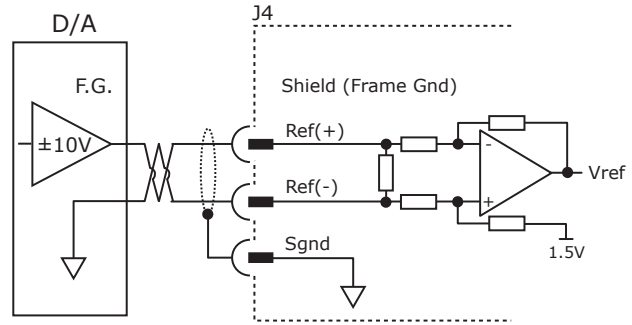
As a reference input it takes position/velocity/torque commands from a controller. If not used as a command input, it can be used as general-purpose analog input.

### SPECIFICATIONS

Spec	Data	Notes
Input Voltage	Vref	±10 Vdc
Input Resistance	Rin	5.05 kΩ

### CONNECTIONS

Signal	J4 Pins
AIN(+)	2
AIN(-)	1
Sgnd	3,4,15,16,23,50



## OPTO-ISOLATED OUTPUTS: OUT1, OUT2, OUT3, OUT4

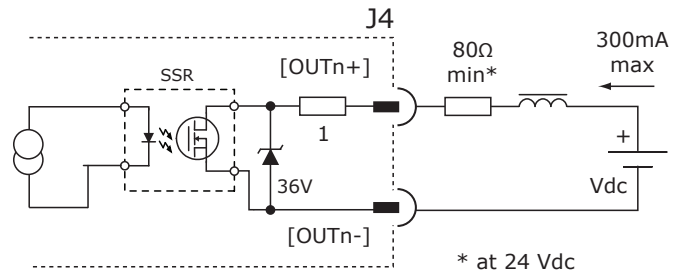
- Digital, opto-isolated
- MOSFET output SSR, 2-terminal
- Flyback diode for inductive loads
- 24V Compatible
- Programmable functions

### SPECIFICATIONS

Output	Data	Notes
ON Voltage OUT(+) - OUT(-)	Vdc	0.5V @ 300 mAdc
Output Current	Iout	300 mAdc max
Turn-on Time	Ton	5 ms max @ 300 mA
Turn-off Time	Toff	2 ms max @ 300 mA
Working Voltage	Vmax	+32 Vdc max referenced to ground, ≥800 Vdc rated impulse voltage

### CONNECTIONS: J4 PINS

Signal	(+)	(-)
OUT1	30	29
OUT2	32	31
OUT3	34	33
OUT4	36	35



### HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
OUT1~4	HI	Output SSR is ON, current flows
	LO	Output SSR is OFF, no current flows

## HIGH-SPEED OUTPUT: OUT5, OUT6, OUT7, OUT8

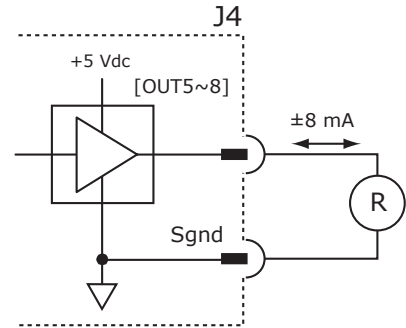
- CMOS buffer
- 74AHCT1G125
- Programmable functions

### SPECIFICATIONS

Output HI	Data	Notes
Vout HI	Voh	3.8 Vdc
Iout HI	Ioh	-8.0 mAdc
Vout LO	Vol	0.44 Vdc
Iout LO	Iol	8.0 mAdc
Vout Max	Vom	+5 Vdc

### CONNECTIONS

Signal	J4 Pins
OUT 5	38
OUT 6	37
OUT 7	40
OUT 8	39
Sgnd	3,4,15,16,23,50

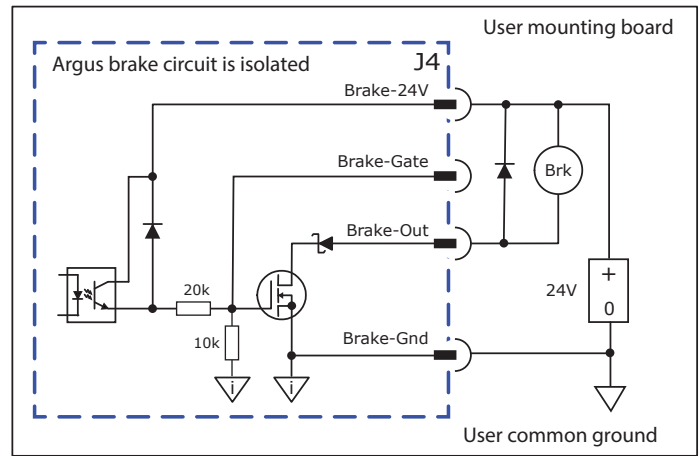


## OPTO-ISOLATED MOTOR BRAKE OUTPUT: OUT9

- Brake output [OUT9]
- Opto-isolated
- 24V Compatible
- Programmable functions
- Gate output to drive external MOSFET

### SPECIFICATIONS

Output	Data	Notes
Voltage Range	Vbrk	+24 Vdc compatible +32 Vdc max referenced to ground, ≤800 Vdc rated impulse voltage
Output Current	Ids	1.0 Adc
On-Time	Ton	250 μs max @ 200 mA



The brake circuits are optically isolated from all drive circuits and frame ground. For a flyback diode across the brake to be effective, the Brake-24V and Brake-Gnd must be connected as shown and the 24V power supply must be referenced to the user's common ground.

### HI/LO DEFINITIONS: OUTPUTS

Input	State	Condition
BRAKE [OUT9]	HI	Output transistor is OFF Brake is un-powered and locks motor Motor cannot move Brake state is Active
	LO	Output transistor is ON Brake is powered, releasing motor Motor is free to move Brake state is NOT-Active

CME Default Setting for Brake Output [OUT9] is "Brake - Active HI"

Active = Brake is holding motor shaft (i.e. the *Brake is Active*)

Motor cannot move

No current flows in coil of brake

CME I/O Line States shows [OUT9] as HI

BRK Output voltage is HI (24V), MOSFET is OFF

Servo drive output current is zero

Servo drive is disabled, PWM outputs are off

Inactive = Brake is not holding motor shaft (i.e. the *Brake is Inactive*)

Motor can move

Current flows in coil of brake

CME I/O Line States shows [OUT9] as LO

BRK output voltage is LO (~0V), MOSFET is ON

Servo drive is enabled, PWM outputs are on

Servo drive output current is flowing

### J4 CONNECTIONS

Pin	Signal
45	Brake-24V
48	Brake-Gate
47	Brake-Out
46	Brake Gnd

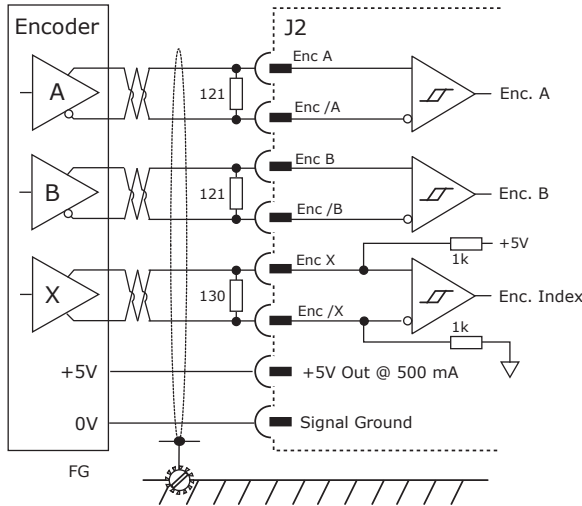
## FEEDBACK CONNECTIONS

### QUAD A/B ENCODER WITH FAULT PROTECTION

Encoders with differential line-driver outputs are required (single-ended encoders are not supported) and provide incremental position feedback via the A/B signals and the optional index signal (X) gives a once per revolution position mark. The MAX3097 receiver has differential inputs with fault protections for the following conditions:

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

### QUAD ENCODER WITH INDEX



#### A/B/X SIGNALS

Signal	J2 Pins
Enc A	10
Enc /A	9
Enc B	12
Enc /B	11
Enc X	16
Enc /X	15
+5V	19,20
Sgnd	8,18,21,22

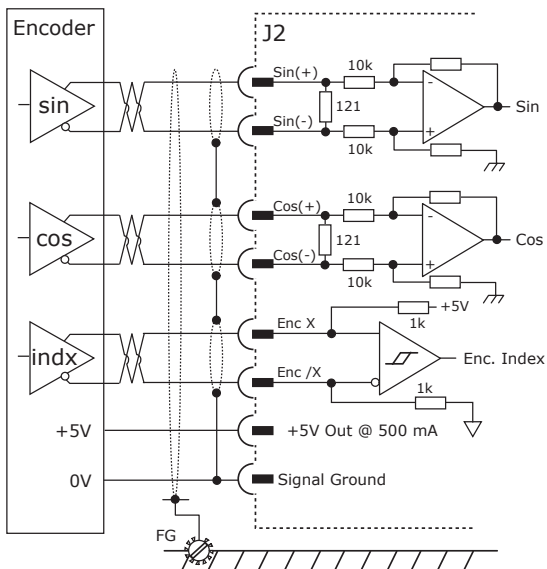
Sgnd = Signal Ground

### RESOLVER

Connections to the resolver should be made with shielded cable that uses three twisted-pairs. Once connected, resolver set up, motor phasing, and other commissioning adjustments are made with CME software. There are no hardware adjustments.

### ANALOG SIN/COS INCREMENTAL ENCODER

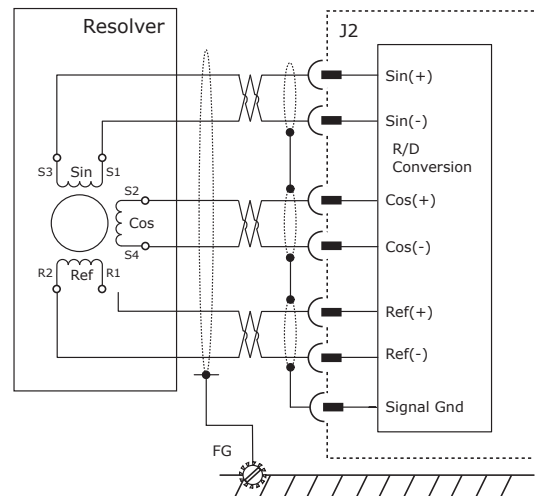
The Sin/Cos inputs are analog differential with 121 Ω terminating resistors and accept 1 Vp-p signals in the format used by incremental encoders with analog outputs. The index input is digital, differential.



#### SIN/COS SIGNALS

Signal	J2 Pins
Sin(+)	2
Sin(-)	1
Cos(+)	4
Cos(-)	3
X	16
/X	15
+5V	19,20
Sgnd	8,18,21,22

Sgnd = Signal Ground  
F.G. = Frame Gnd



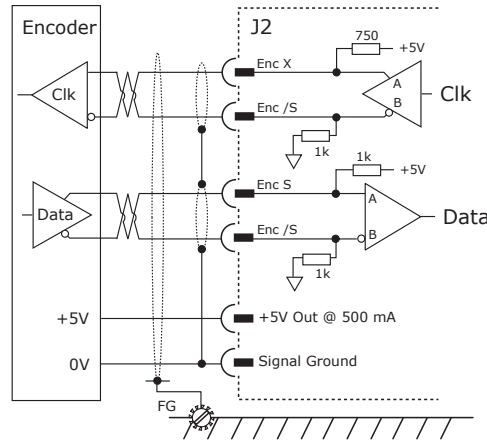
#### RESOLVER SIGNALS

Signal	J2 Pins
Sin(+)	2
Sin(-)	1
Cos(+)	4
Cos(-)	3
Ref(+)	24
Ref(-)	23
Sgnd	8,18,21,22

## FEEDBACK CONNECTIONS

### SSI ABSOLUTE ENCODER

The SSI (Synchronous Serial Interface) is an interface used to connect an absolute position encoder to a motion controller or control system. The GPM drive provides a train of clock signals in differential format to the encoder which initiates the transmission of the position data on the subsequent clock pulses. The number of encoder data bits and counts per motor revolution are programmable. The hardware bus consists of two signals: SCLK and SDATA. The SCLK signal is only active during transfers. Data is clocked in on the falling edge of the clock signal.



### SSI, BiSS SIGNALS

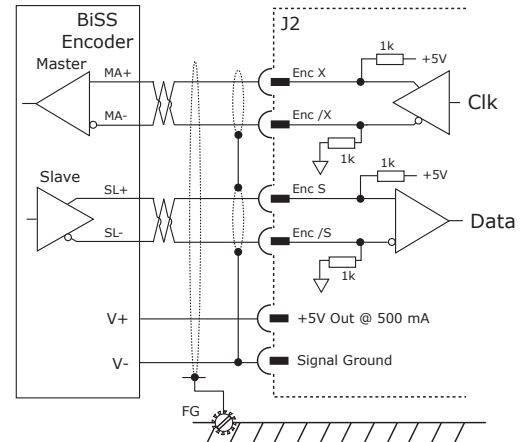
SSI	BiSS	J2 Pins
Clk	MA+	16
/Clk	MA-	15
Data	SL+	14
/Data	SL-	13
+5V		19,20
Sgnd		8,18,21,22

*Note: Single (outer) shields should be connected at the controller end. Inner shields should only be connected to Signal Ground on the drive.*

### BiSS ABSOLUTE ENCODER

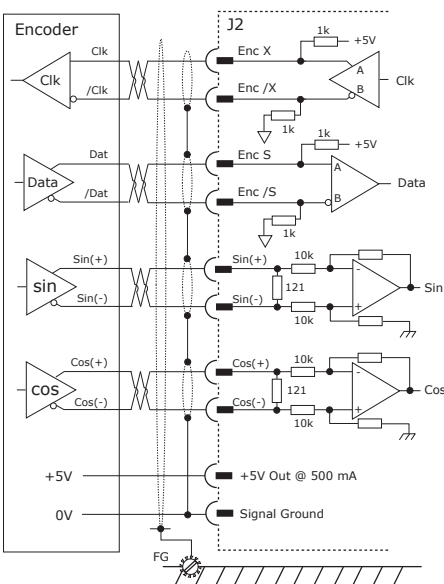
BiSS is an - Open Source - digital interface for sensors and actuators. BiSS refers to principles of well known industrial standards for Serial Synchronous Interfaces like SSI, AS-Interface® and Interbus® with additional options.

- Serial Synchronous Data Communication
- Cyclic at high speed
- 2 unidirectional lines Clock and Data
- Line delay compensation for high speed data transfer
- Request for data generation at slaves
- Safety capable: CRC, Errors, Warnings
- Bus capability incl. actuators
- Bidirectional
- BiSS B-protocol: Mode choice at each cycle start
- BiSS C-protocol: Continuous mode



### ENDAT ABSOLUTE ENCODER

The EnDat interface is a Heidenhain interface that is similar to SSI in the use of clock and data signals, but which also supports analog Sin/Cos channels from the same encoder. The number of position data bits is programmable as is the use of Sin/Cos channels. Use of Sin/Cos incremental signals is optional in the EnDat specification.



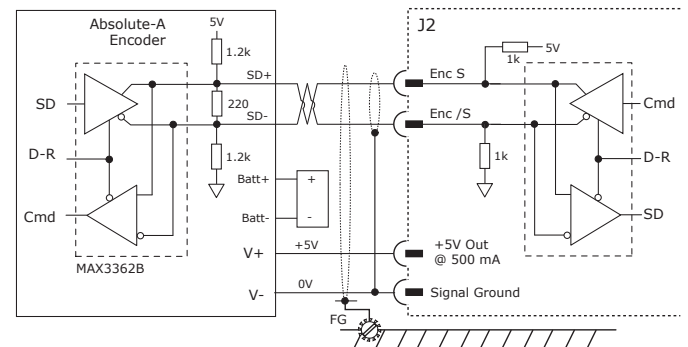
### ENDAT SIGNALS

Signal	J2 Pins
Clk	16
/Clk	15
Data	14
/Data	13
Sin(+)	2
Sin(-)	1
Cos(+)	4
Cos(-)	3
+5V	19,20
Sgnd	8,18,21,22

Sgnd = Signal Ground

### ABSOLUTE-A ENCODER

The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485. Note the battery which must be connected. Without it, the encoder will produce a fault condition.



### ABSOLUTE-A SIGNALS

Signal	J2 Pins
Data	14
/Data	13
+5V	19,20
Sgnd	8,18,21,22

Sgnd = Signal Ground

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



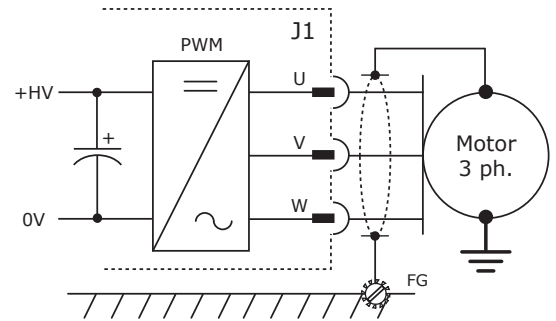
## MOTOR CONNECTIONS

### BRUSHLESS MOTOR CONNECTIONS

The drive output is a three-phase PWM inverter that converts the DC buss voltage (+HV) into three sinusoidal voltage waveforms that drive the motor phase-coils. Cable should be sized for the continuous current rating of the motor. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. The motor cable shield should connect to motor frame ground for best results.

#### MOTOR SIGNALS

Signal	J1 Pin
Mot U	41~46
Mot V	31~36
Mot W	21~26



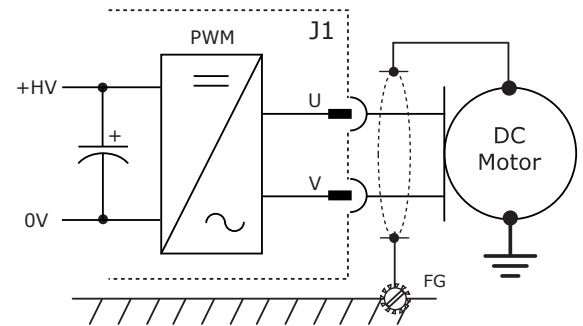
### BRUSH MOTOR CONNECTIONS

DC motors have two terminals and are commutated by internal brushes. Only two terminals are used and the polarity determines the direction of motion.

Cable should be sized for the continuous current rating of the motor. Motor cabling should use twisted, shielded conductors for CE compliance, and to minimize PWM noise coupling into other circuits. The motor cable shield should connect to motor frame ground for best results.

#### MOTOR SIGNALS

Signal	J1 Pin
Mot U	41~46
Mot V	31~36

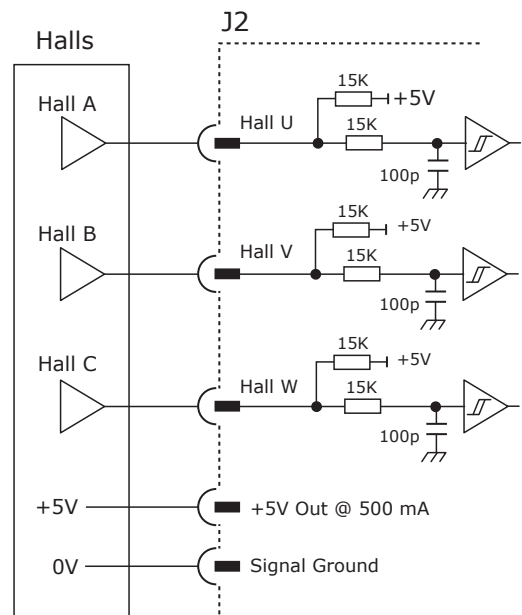


### DIGITAL HALL SIGNALS

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

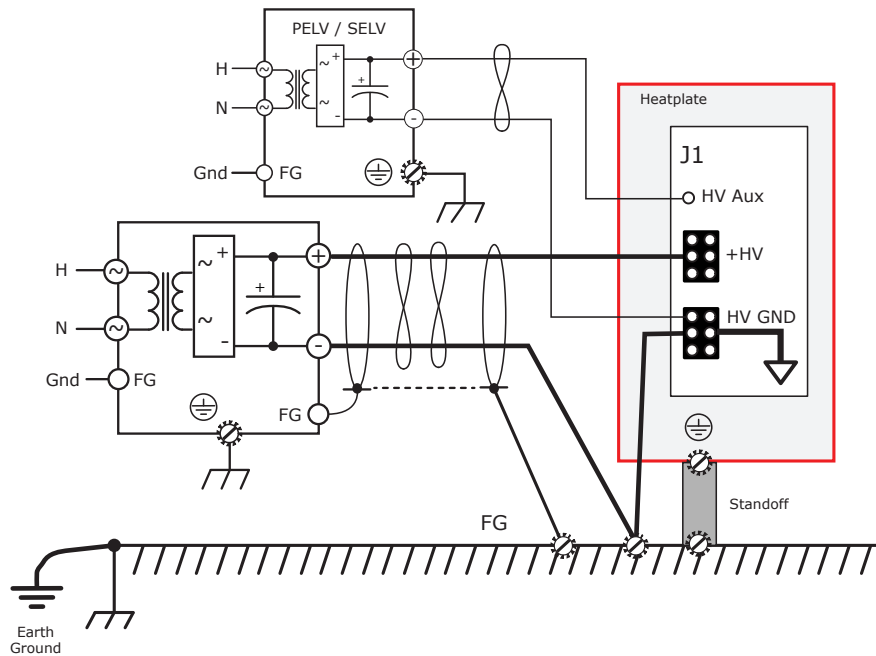
#### HALL SIGNALS

Signal	J2 Pins
Hall U	5
Hall V	6
Hall W	7
+5V	19,20
Sgnd	8,18,21,22



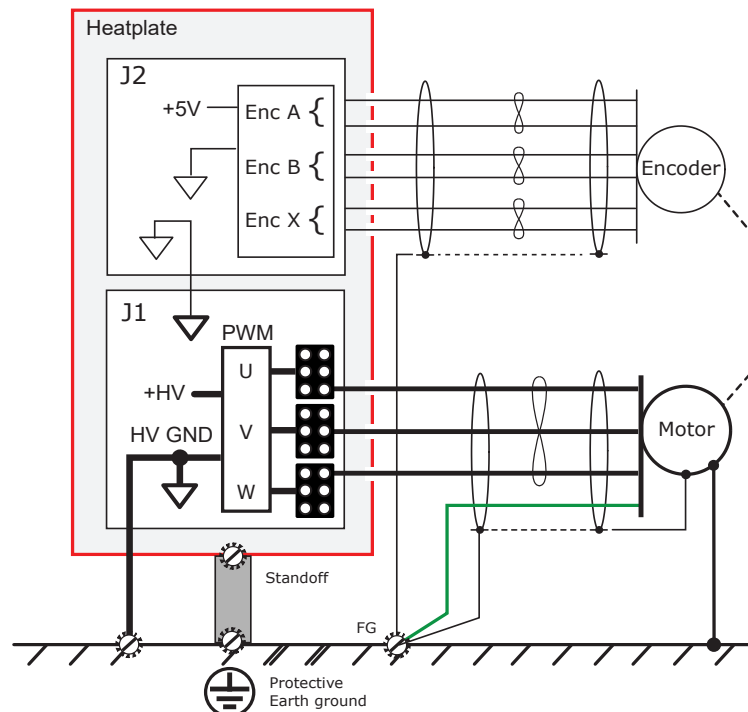
## POWER SUPPLY GROUNDING

This shows the drive HV GND connecting to Frame Ground (FG) and Earth Ground. This keeps 0V in the drive at 0V Ground. Voltage drops across the power-supply wiring will appear at the (-) terminals of the power supplies due to the cable length and current but this has no effect on the voltages of circuits and devices. The heatplate has no connection to drive circuits and standoffs provide a PE (Protective Earth) path to earth.



## MOTOR CONNECTION GROUNDING

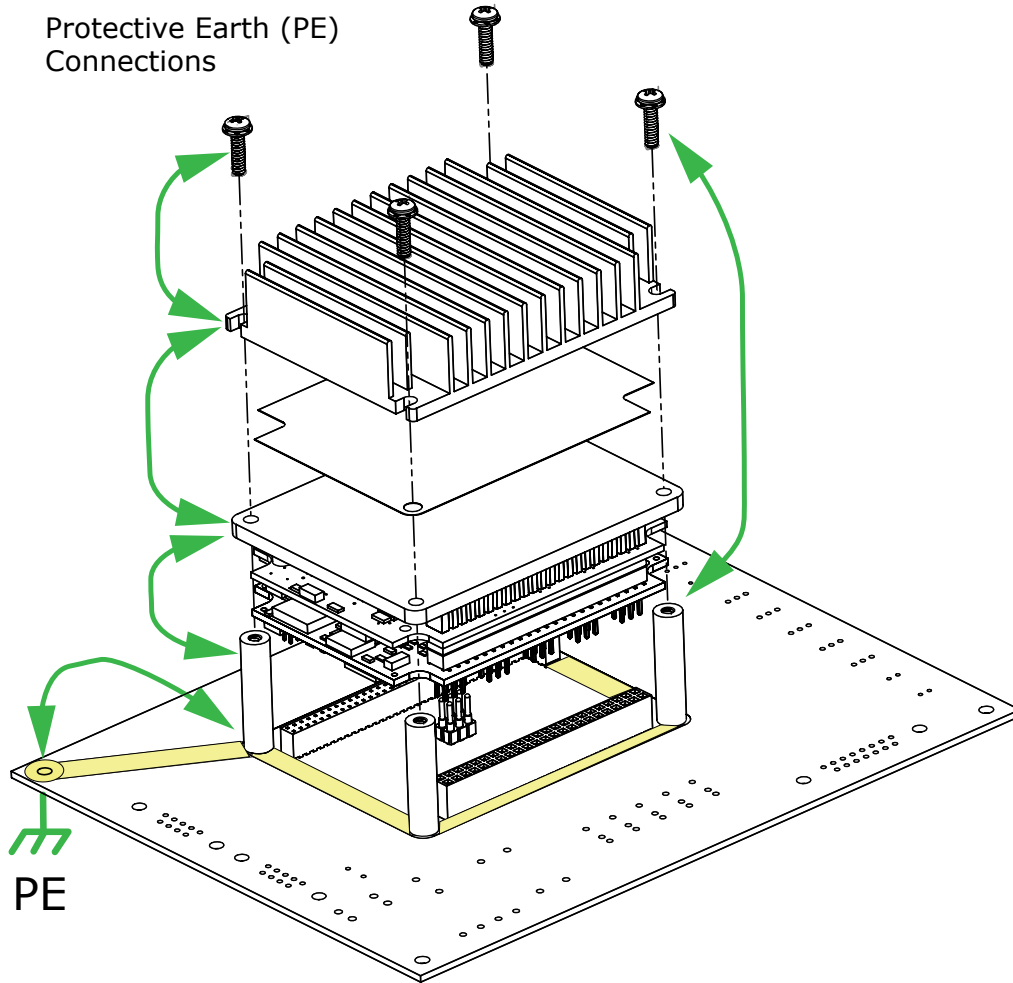
This shows the shielding on the feedback and PWM connections to the motor. Capacitive coupling between the motor windings and case plus coupling between the UVW cable and shield finds a return path via FG and HV GND. Grounding the motor feedback shield only to the FG avoids the PWM coupling in the motor shield.



**PROTECTIVE EARTH GROUNDING**

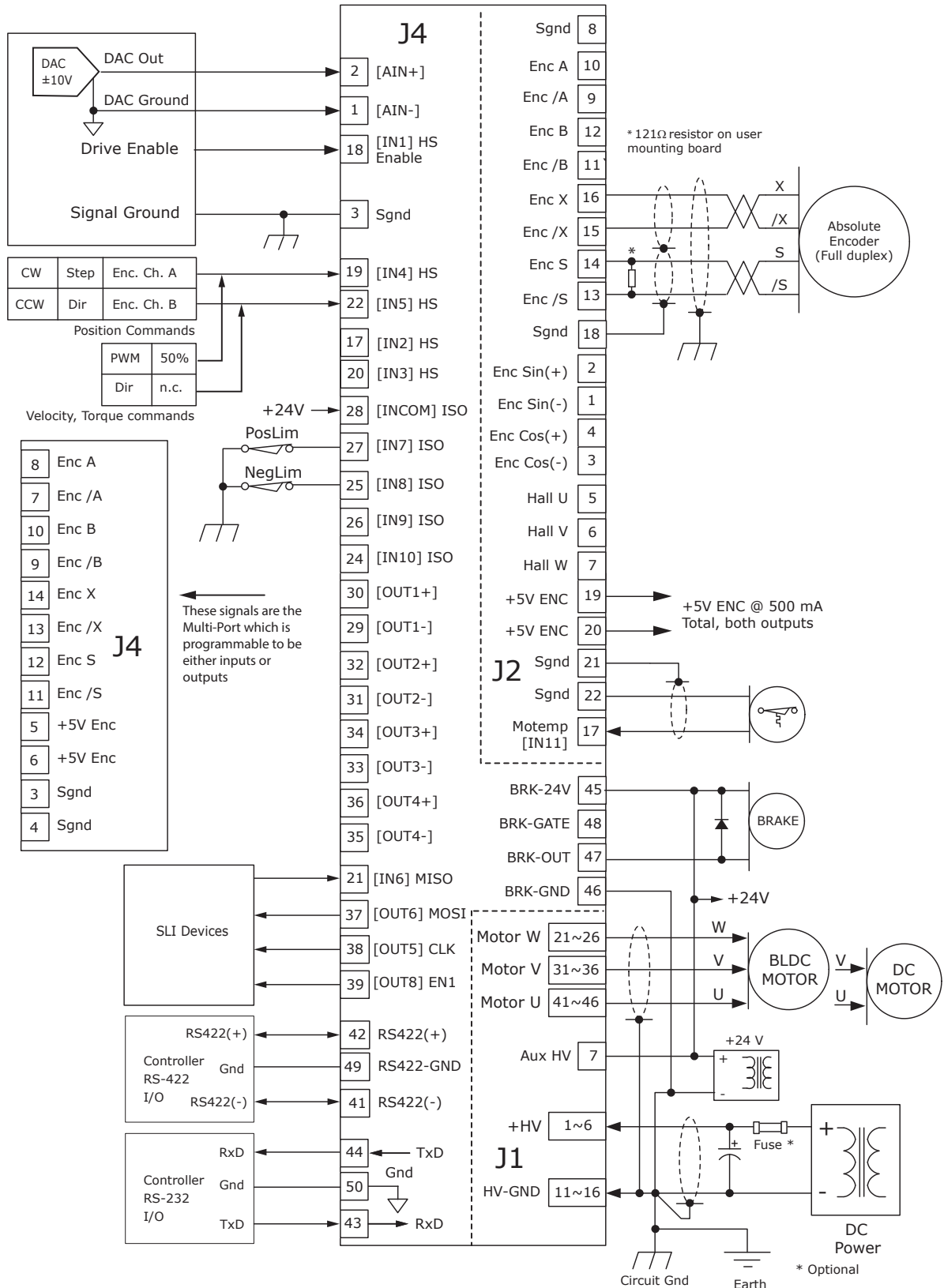
This shows how a Protective Earth (PE) connection can be made with the GPM drive.

The standoffs shown are solid with tapped holes on each end. In preparation for mounting the GPM the standoffs should be retained with four screws (not shown) inserted from the bottom of the PC board. These retain the spacers and make ohmic contact with conductive traces on the PC board. As shown all four standoffs are connected by a trace which has an extension to one of the mounting holes. This should be a plated-through hole to connect to earth either by standoff to the equipment bonded enclosure or by cable to earth ground. When the drive is placed on the standoffs the next step is to place the thermal pad taking care to align the two corner holes with the drive heatplate. Following that the heatsink can be placed, again with care to align with the drive heatplate holes. Finally install the screws to retain the heatsink. This will press two of the heatsink corners with notches in the thermal pad to make contact with the drive heatplate, providing a conductive path. From the heatplate, contact is made with the spacers and finally to the mounting board etch and to earth.



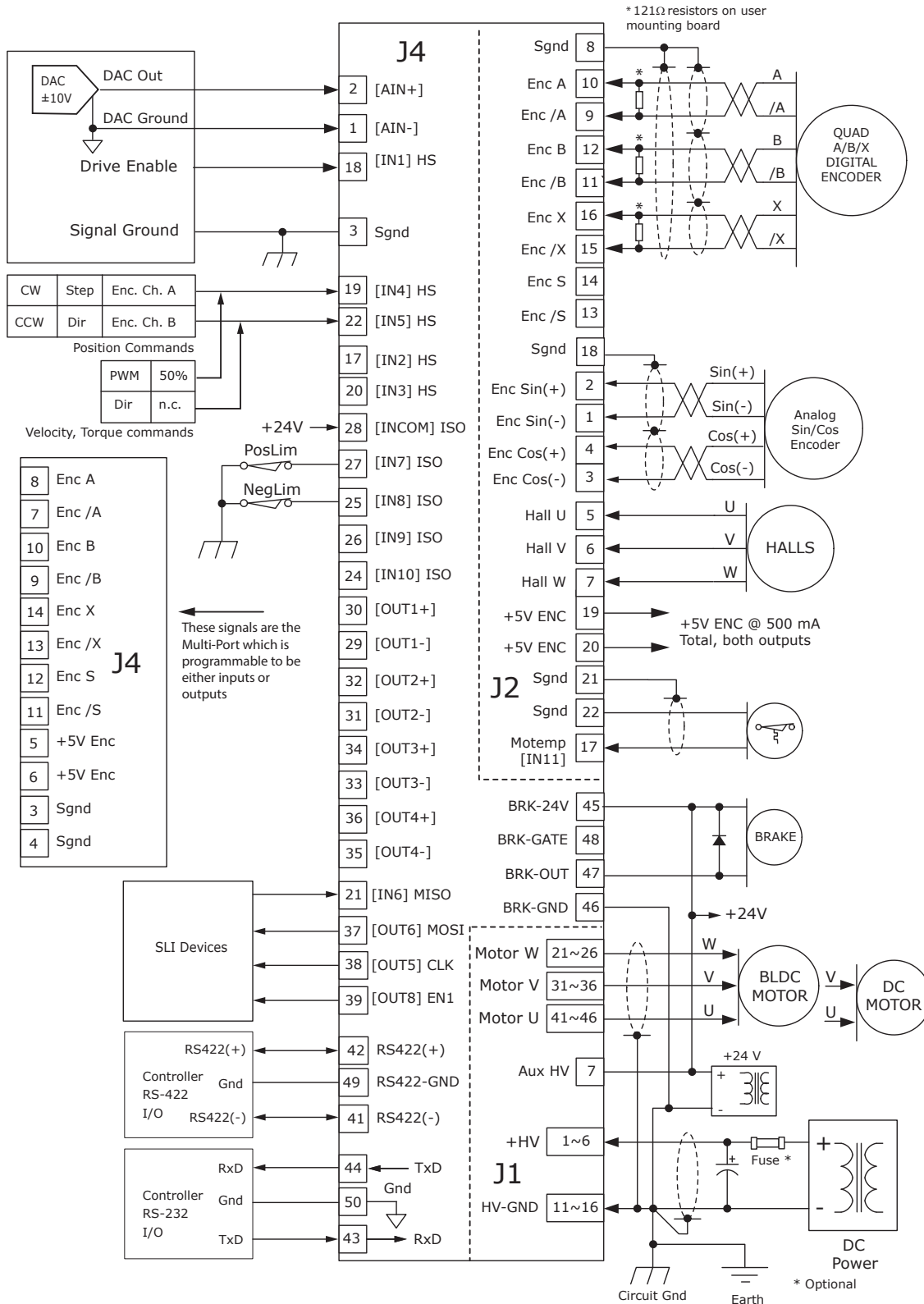
CONNECTORS & SIGNALS

CONNECTIONS FOR ABSOLUTE ENCODER WITH DUPLEX CLOCK/DATA



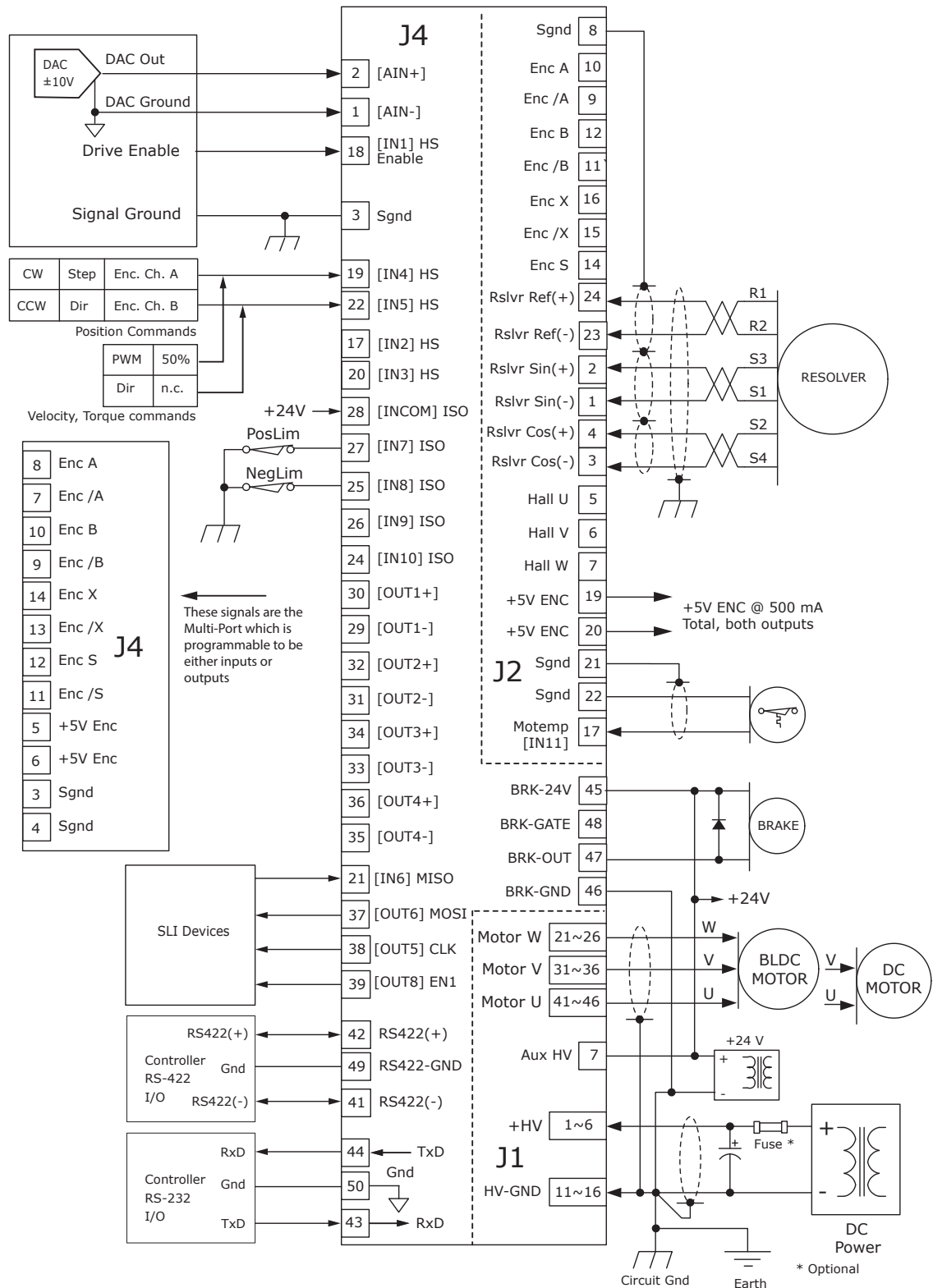
CONNECTORS & SIGNALS

CONNECTIONS FOR INCREMENTAL DIGITAL OR ANALOG ENCODERS



## CONNECTORS & SIGNALS

### CONNECTIONS FOR RESOLVERS (-R OPTION)



## DIMENSIONS IN[MM]

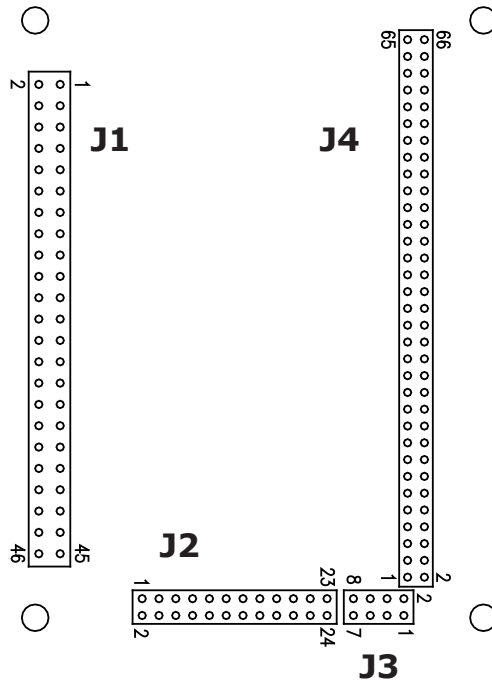
### J1 POWER & MOTOR

Signal	Pin	Signal
+HV	2	1
	4	3
	6	5
N/C	8	7
	10	9
HV Gnd	12	11
	14	13
	16	15
N/C	18	17
	20	19
Mot W	22	21
	24	23
	26	25
N/C	28	27
	30	29
Mot V	32	31
	34	33
	36	35
N/C	38	37
	40	39
Mot U	42	41
	44	43
	46	45

### J2 FEEDBACK

Signal	Pin	Signal
RES-REF-	23	RES-REF+
Sgnd	21	Sgnd
+5V ENC	19	+5V ENC
[IN11]	17	Sgnd
ENC /X	15	ENC X
ENC /S	13	ENC S
ENC /B	11	ENC B
ENC /A	9	ENC A
HALL W	7	Sgnd
HALL U	5	HALL V
COS-	3	COS+
SIN-	1	SIN+

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



**J1:** HV & Motor  
Dual row, 2 mm- centers  
46 position female header  
SAMTEC SSQ-123-01-L-D

**J2:** Feedback  
Dual row, 2 mm- centers  
24 position female header  
SAMTEC SQT-112-01-L-D

**J3:** Safety  
Dual row, 2 mm- centers  
8 position female header  
SAMTEC SQT-104-01-L-D

**J4:** Control  
Dual row, 2 mm- centers  
66 position female header  
SAMTEC SQT-133-01-L-D

### J4 CONTROL

Signal	Pin	Signal
CAN_GND	65	CAN_GND
CAN_GND	63	CAN_GND
CAN_H	61	CAN_GND
CAN_L	59	CAN_GND
CAN_GND	57	CAN_GND
CAN_GND	55	CAN_GND
CAN_GND	53	CAN_GND
CAN_GND	51	CAN_GND
RS422-GND	49	Sgnd
Brake-Out	47	Brk-Gate
Brake-24V	45	Brake-Gnd
RS232 RxD	43	RS232 TxD
RS422(-)	41	RS422(+)
HS [OUT8] SLI-EN1	39	[OUT7] HS
HS [OUT6] SLI-MOSI	37	[OUT5] HS SLI-CLK
[OUT4-] ISO	35	ISO [OUT4+]
[OUT3-] ISO	33	ISO [OUT3+]
[OUT2-] ISO	31	ISO [OUT2+]
[OUT1-] ISO	29	ISO [OUT1+]
[IN7] ISO	27	ISO [INCOM]
[IN8] ISO	25	ISO [IN9]
Sgnd	23	ISO [IN10]
[IN6] HS SLI-MISO	21	HS [IN5]
[IN4] HS	19	HS [IN3]
[IN2] HS	17	HS [IN1]
Sgnd	15	Sgnd
Enc /X	13	Enc X
Enc /S	11	Enc S
Enc /B	9	Enc B
Enc /A	7	Enc A
+5V ENC	5	+5V ENC
Sgnd	3	Sgnd
[AREF-]	1	[AREF+]

### J3 SAFETY

SIGNAL	PIN	PIN	SIGNAL
STO-IN1(-)	1	2	STO-GND
STO-IN1(+)	3	4	STO-BYPASS
STO-IN2(-)	5	6	STO-IN2(-)
STO-IN2(+)	7	8	STO-IN2(+)

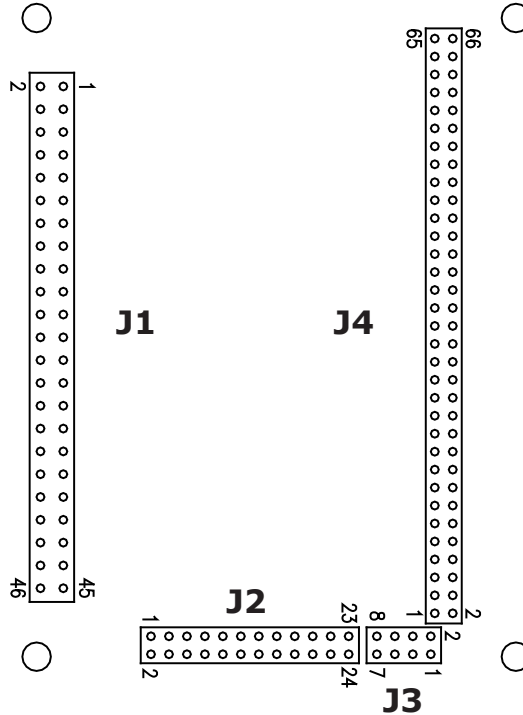
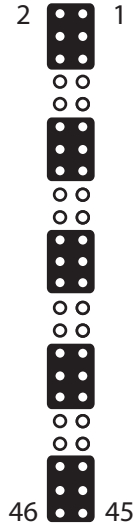


**PRINTED CIRCUIT BOARD FOOTPRINT**

**TOP VIEW**

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

J1 Signal Grouping for current-sharing See Note 1



**PCB Hardware:**

Qty	Description	Mfgr	Part Number	Remarks
1	Socket Strip	Samtec	SSQ-123-01-L-D	J1 HV & Motor
1	Socket Strip	Samtec	SQT-112-01-L-D	J2 Feedback
1	Socket Strip	Samtec	SQT-104-01-L-D	J3 Safety
1	Socket Strip	Samtec	SQT-133-01-L-D	J4 Control
2	Standoff	PEM	KFE-4/40-8ET	#4/40 X 1/4"

**Additional Hardware (not shown above)**

2	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)
---	---

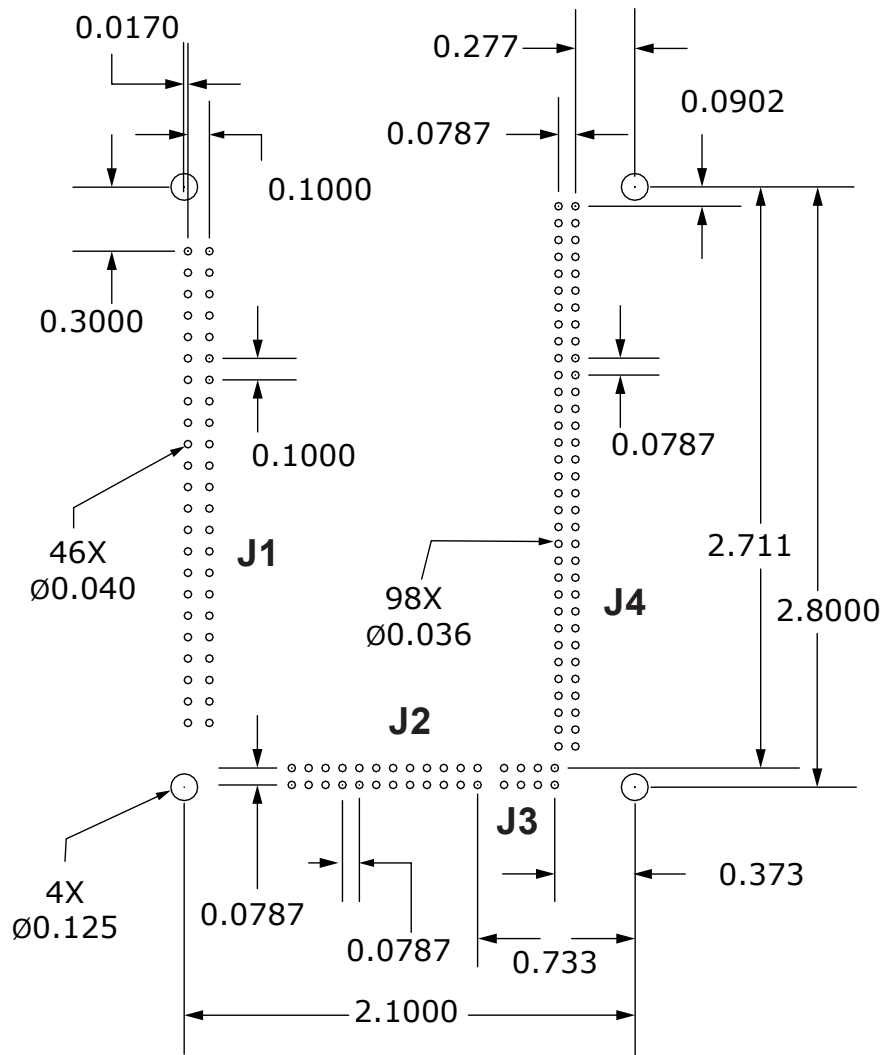
**Notes**

- J1 signals of the same name must be connected for current-sharing (see graphic above).
- To determine copper width and thickness for J1 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.

**PRINTED CIRCUIT DRILLING DIMENSIONS**

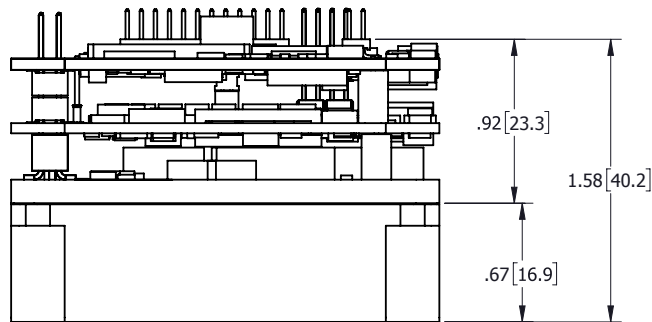
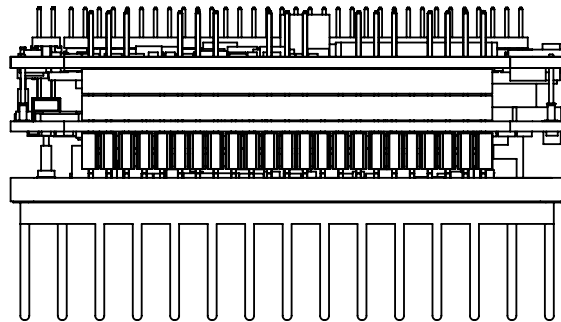
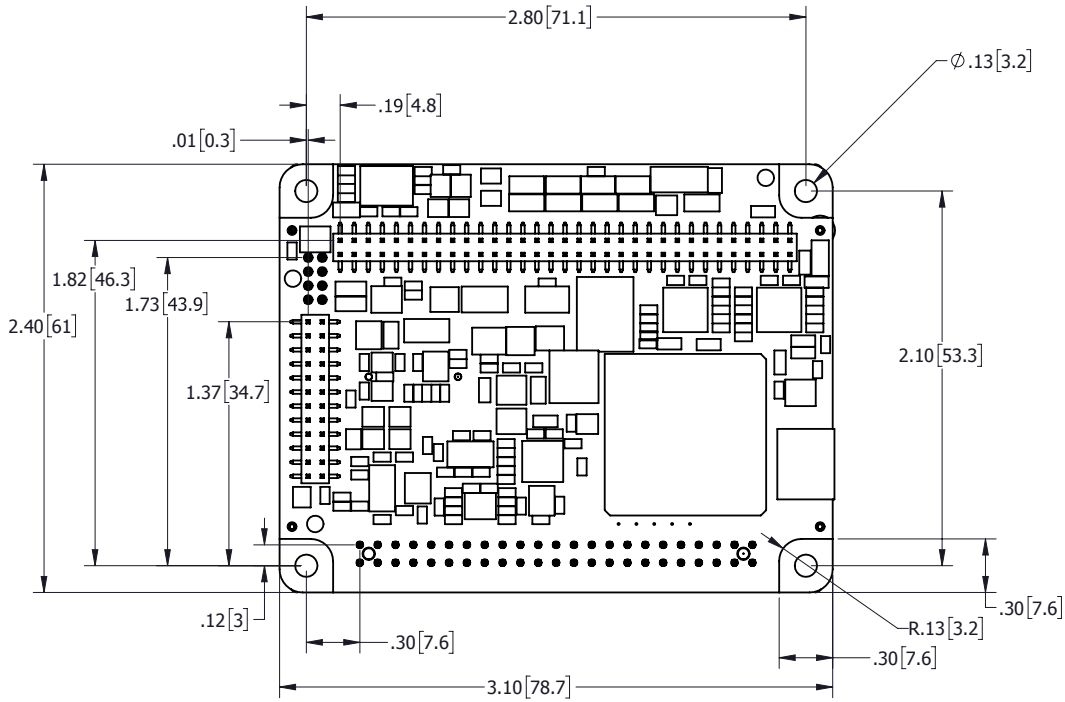
Notes:

1. This shows the drilling dimensions looking down on the mounting surface of the PC board.



Dimensions are in inches

**DIMENSIONS**



Dimensions are in inches[mm]

## MOUNTING WITH USER HARDWARE

The GPM drives can be mounted in these configurations:

**Soldered**

All drive pins are soldered. This is recommended to use the rated continuous current of the drive.

**Socketed**

All drive pins connect to sockets. The drive can be inserted and extracted from the mounting board.

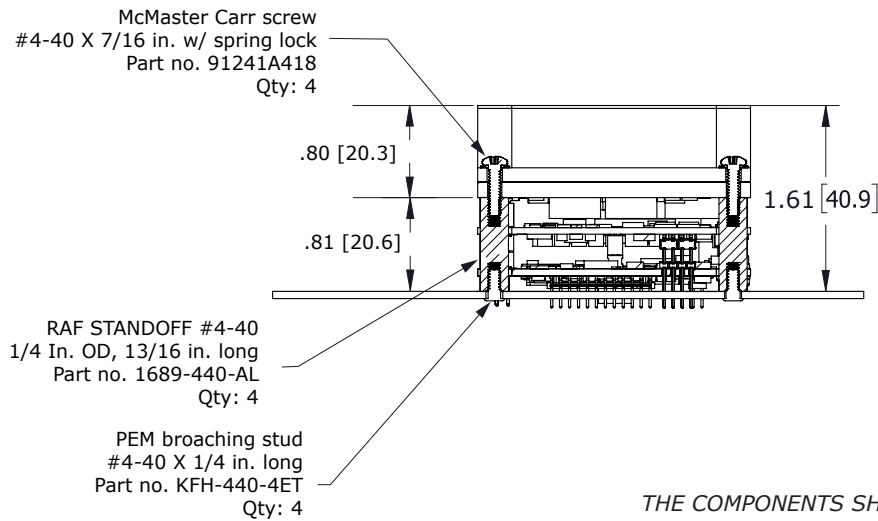
### ALL ABOUT STANDOFFS

In all configurations, the standoffs must be metal because they connect the drive heatplate to a trace on the PC board that connects to earth, providing a PE (Protective Earth) connection.

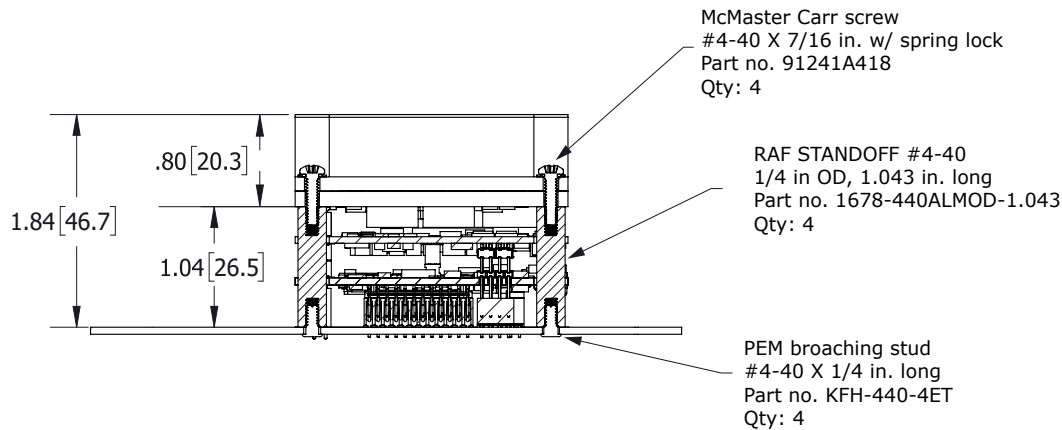
Standoffs pass through notches in the corners of the drive PC boards.

The notch width is 0.3 in [7.62 mm] and can accept 0.25 in [6.35 mm] standoffs.

### MOUNTING METHODS: SOLDERED



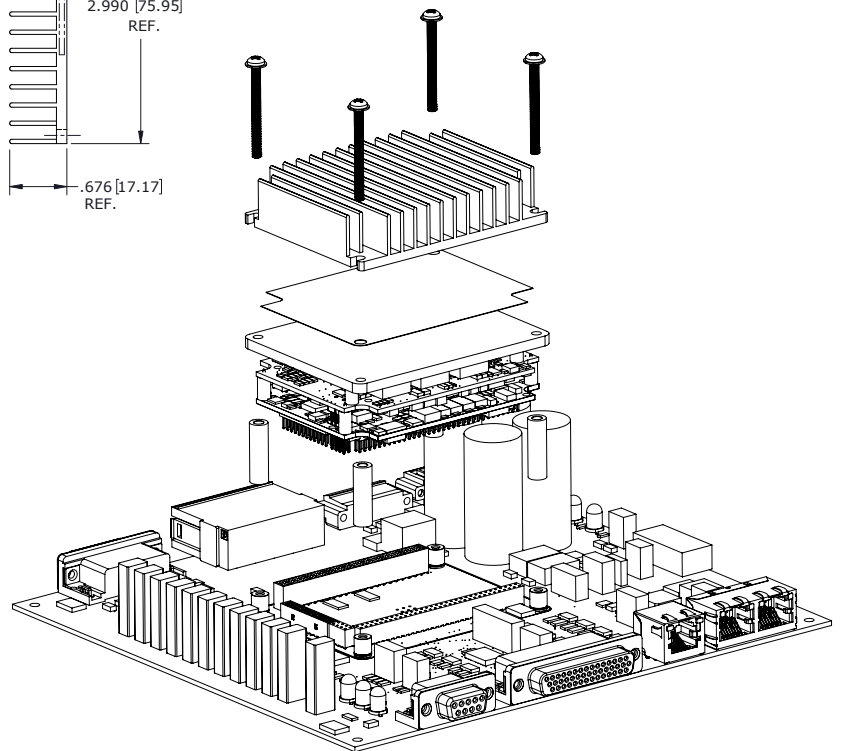
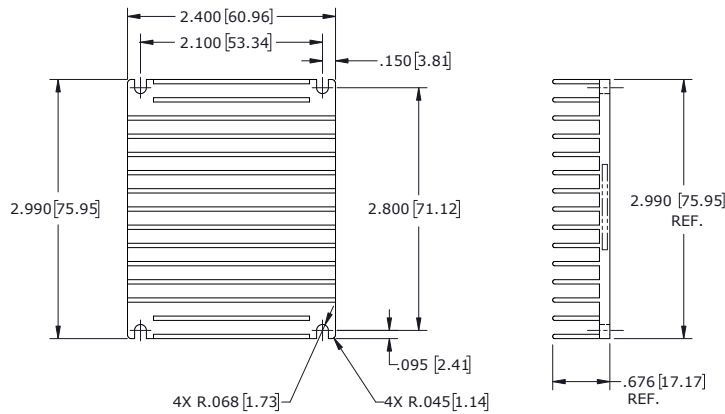
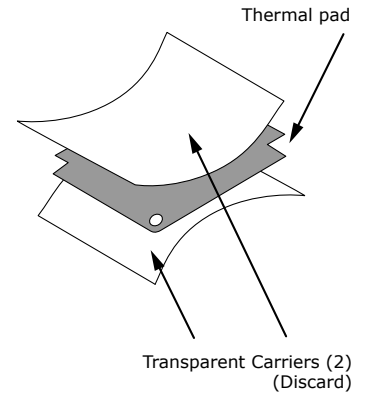
### MOUNTING METHODS: SOCKETED



**DEVELOPMENT KIT HEATSINK MOUNTING**

A thermal pad is used in place of heatsink grease. The pad is die-cut to shape and has holes for the heat sink mounting screws. There are two protective sheets, blue on one side and clear on the other. Both must be removed when the interface pad is installed.

- 1: Remove the blue protective sheet from one side of the pad.
- 2: Place the interface pad on the drive, taking care to center the pad holes over the heatplate mounting holes.
- 3: Remove the clear protective sheet from the pad.
- 4: Mount the heatsink onto the drive taking care to see that the holes in the heatsink, interface pad, and drive all line up.
- 5: Torque the 4-40 mounting screws to 5 in-lb, 80 in-oz, 0.56 Nm.



**GPM-HK HEATSINK KIT**

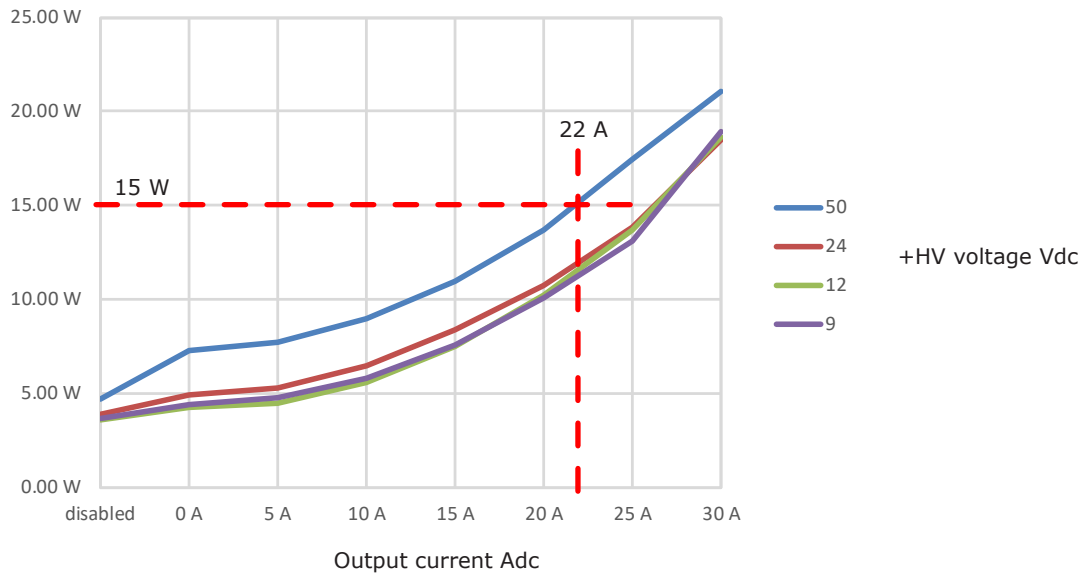
ITEM	Part	Qty
1	Heatsink Hardware Kit, contains 2 screws, 4-40, 1.25 in, Philips with locking washers	2
2	Heatsink, GPM	1
3	Thermal pad, GPM	1
4	Spacer Hardware Kit, contains 4 spacers, round, 6 mm diam, 3 mm ID, 20 mm long, AL	1

## POWER DISSIPATION

The charts on this page show the internal power dissipation for different models under differing power supply and output current conditions. The values on the chart represent the continuous current that the drive would provide during operation. The +HV values are for the average DC voltage of the drive power supply. To see if a heatsink is required or not, the next step is to determine the temperature rise the drive will experience when it's installed. For example, if the ambient temperature in the drive enclosure is 40 °C, and the heatplate temperature is to be limited to 80° C or less to avoid shutdown, the maximum rise would be 80C - 40C. or 40° C. Dividing this dissipation by the thermal resistance of 9° C/W with no heatsink gives a dissipation of 3.33W. This line is shown in the charts. For power dissipation below this line, no heatsink is required. The vertical dashed line shows the continuous current rating for the drive model.

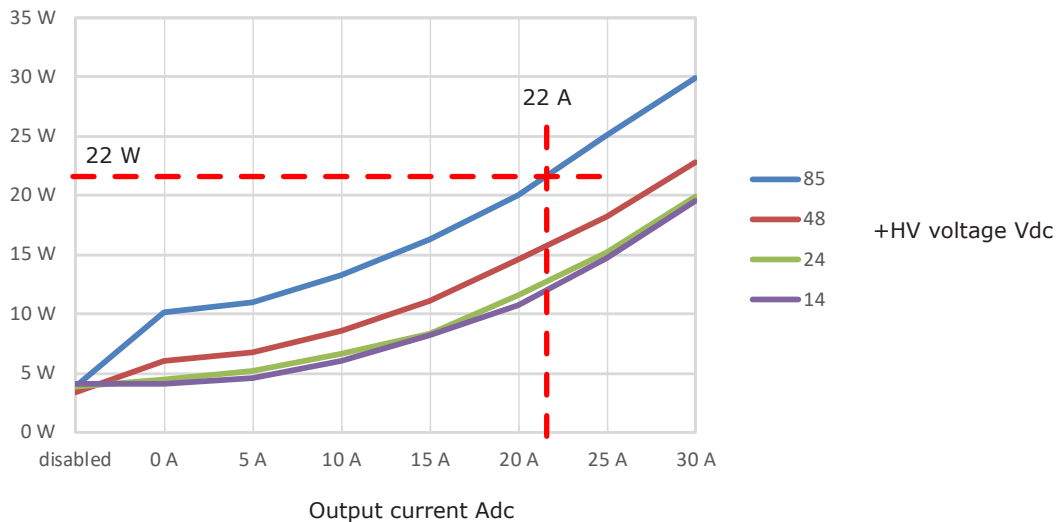
GPM-055-60, GPM-055-60-R

Dissipation vs. Output Current & +HV



GPM-090-60, GPM-090-60-R

Dissipation vs. Output Current & +HV



## THERMAL RESISTANCE VS. MOUNTING & COOLING

These tables show the thermal resistance Rth in degrees-C per Watt (C/W) for typical mounting and cooling configurations. LFM is Linear Feet per Minute, the velocity of air flow produced by a fan directed in line with the heatsink fins.

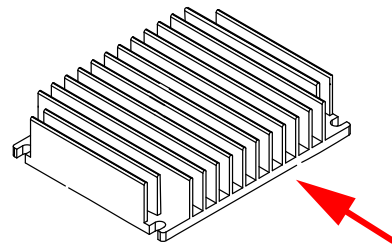
### NO HEATSINK

LFM	0	300
Rth	3.5	1.3



### HEATSINK

LFM	0	300
Rth	2.0	0.9



Airflow

### FIND COOLING MEANS WITH DISSIPATION AND AMBIENT TEMPERATURE KNOWN

Given: Tamb = 32 °C (89.6 °F), +HV dissipation = 20.5 W, Aux-HV dissipation = 6 W  
Tmax = 80 °C (drive shut-down temperature)

Find: Thermal resistance Rth:  
Delta-T = Tmax - Tamb = 80 - 32 = 48 °C  
Total dissipation = 20.5 + 6 = 26.5 W  
Rth = Delta-T / dissipation = °C / Watt = 48 / 26.5 = 1.8 °C/W

From the tables above, there are two configurations that provide Rth less than 1.8 °C/W:  
No heat sink, forced air at 300 LFM  
With heat sink, forced air at 300 LFM

### FIND MAX AMBIENT TEMP WHEN DRIVE CONFIGURATION IS KNOWN

Given: Heatsink, forced-air at 300 LFM, dissipation is 26.5 W  
Rth = 0.9 °C/W  
Tmax = 80 °C (drive shut-down temperature)

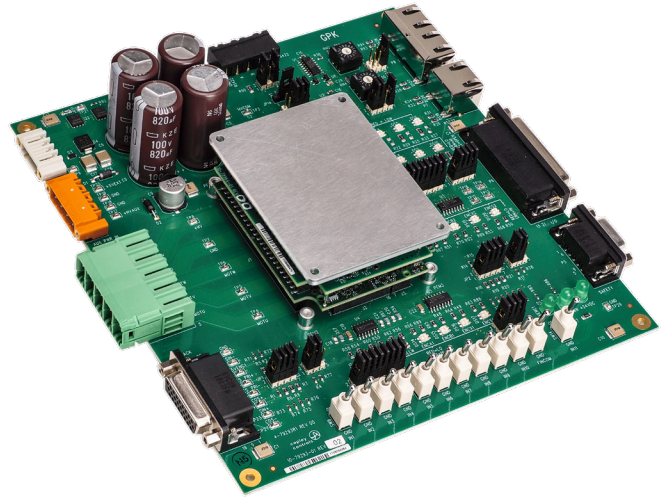
Find: Max ambient operating temperature  
Delta-T = 26.5 W x 0.9 °C/W = 23.9 °C  
Max Tamb = Tmax - Delta-T = 80 - 23.9 = 56.1 °C  
Max ambient operating temperature is 56 °C so it can operate up to this temperature



## DEVELOPMENT KIT

### DESCRIPTION

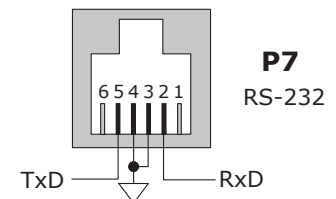
The Development Kit provides mounting and connectivity for one GPM drive. Solderless jumpers ease configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~10 so that these can be toggled to simulate equipment operation. Dual CANopen connectors make daisy-chain connections possible so that other CANopen devices such as Copley's Argus Plus or Xenus Plus CANopen drives can easily be connected.



### P7: RS-232 CONNECTION

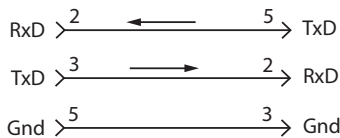
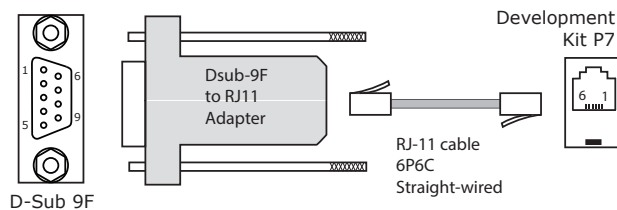
The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an CANopen network. CME software communicates with the drive over this link and is then used for complete drive setup. The CANopen Device ID that is set by the rotary switch can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

The RS-232 connector, P7, 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

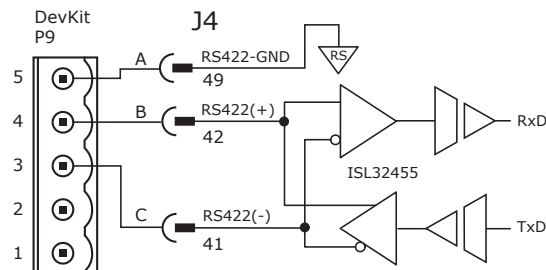
The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector P7 on the Development Kit. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses common modular cable to connect to the GPM. The connections are shown in the diagram below.



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

### P9: RS-422 COMMUNICATIONS

RS-422 is a two-wire differential half-duplex port that operates from 9600 bps to 230.4 kbps. Connections to the RS-422 port are through P9. The graphic below shows the connections between a GPM and a computer RS-422 port.



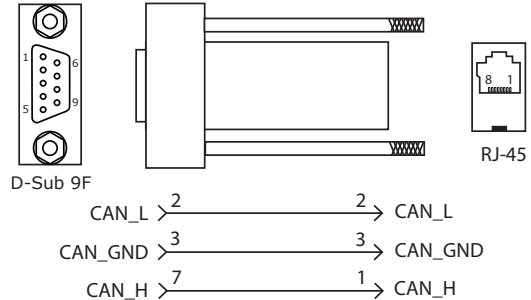
## CANOPEN

### P8: 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 GPK-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.

#### GPK-CV CAN CONNECTOR KIT

The kit contains the GPK-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 P7 shows the operational state of the GPM. The STAT LED on P7 shows the state of the CANopen NMT (Network ManaGPMent) state-machine in the drive. The ACT (Activity) LEDs on P8 show activity on the 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 GPM by changing color, and either blinking or remaining solid.

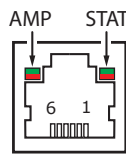
The possible color and blink combinations are:

- *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.

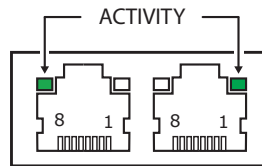
Drive Fault conditions. Faults are programmable to be either transient or latching:

- 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

#### P7 RS-32 SERIAL



#### P8 CAN CONNECTIONS



#### STAT 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:

- GREEN (RUN)**
- *Off*                      *Init*
  - *Blinking*                *Pre-operational*
  - *Single-flash*            *Stopped*
  - *On*                         *Operational*

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

**Green-Green-Red** is actually a combination of single-flash Red (Warning Limit reached) and Blinking Green (Pre-Operational) When the green-red combination is seen, it appears as a single red!

- RED (ERROR)**
- *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*

#### ACTIVITY LEDS

- *Flashing RED* indicates a network error, the GPM is trying to send data via the CAN port and getting no reply
- *Flashing GREEN* indicates the GPM is sending/receiving data via the CAN port

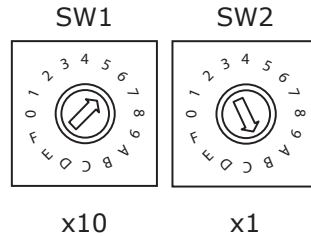
## CANOPEN

### CANopen DEVICE ID

CANopen drives need to have a Device (or Node) ID programmed into the drive, or set by switches on the device. In the Development Kit this is provided by two 16-position rotary switches with hexadecimal encoding. These can set the Device ID of the drive from 0x01~0xFF (1~255 decimal). The chart shows the decimal values of the hex settings of each switch. Device (or Node) ID 0 is reserved for the CANopen Master.

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

- 1) Find the highest number under SW1 that is less than 107 and set SW1 to the hex value in the same row: 96 < 107 and 112 > 107, so SW1 = 96 = Hex 6
- 2) Subtract 96 from the desired Device ID to get the decimal value of switch SW2 and set SW2 to the Hex value in the same row: SW2 = (107 - 96) = 11 = Hex B



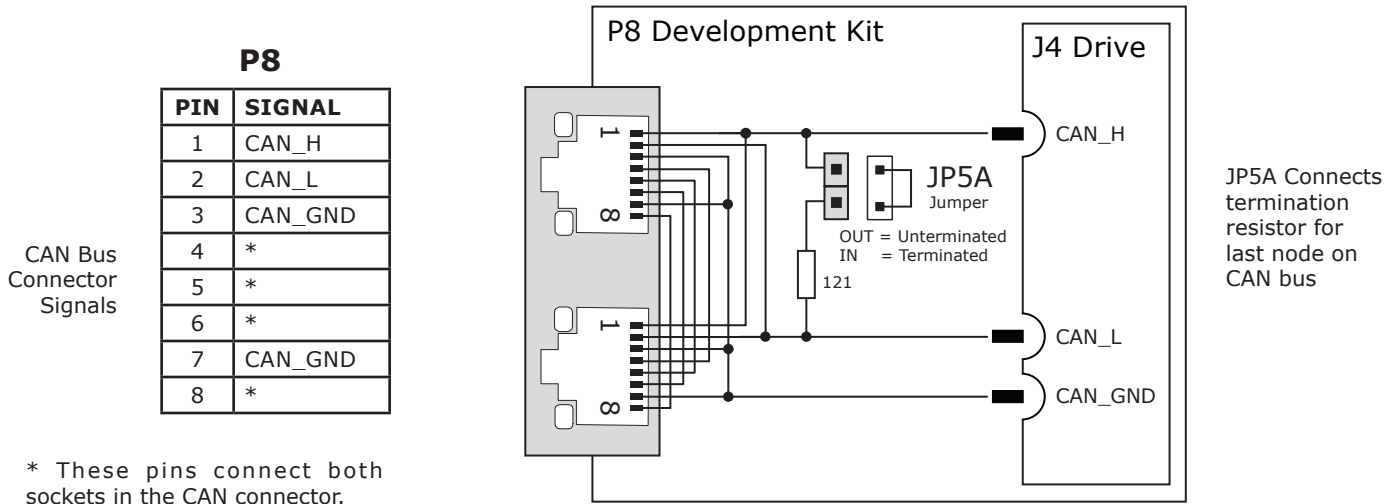
CANopen  
Device ID Switch  
Decimal values

	SW1	SW2
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

## CAN CONNECTORS

### P8: 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 GPK-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.

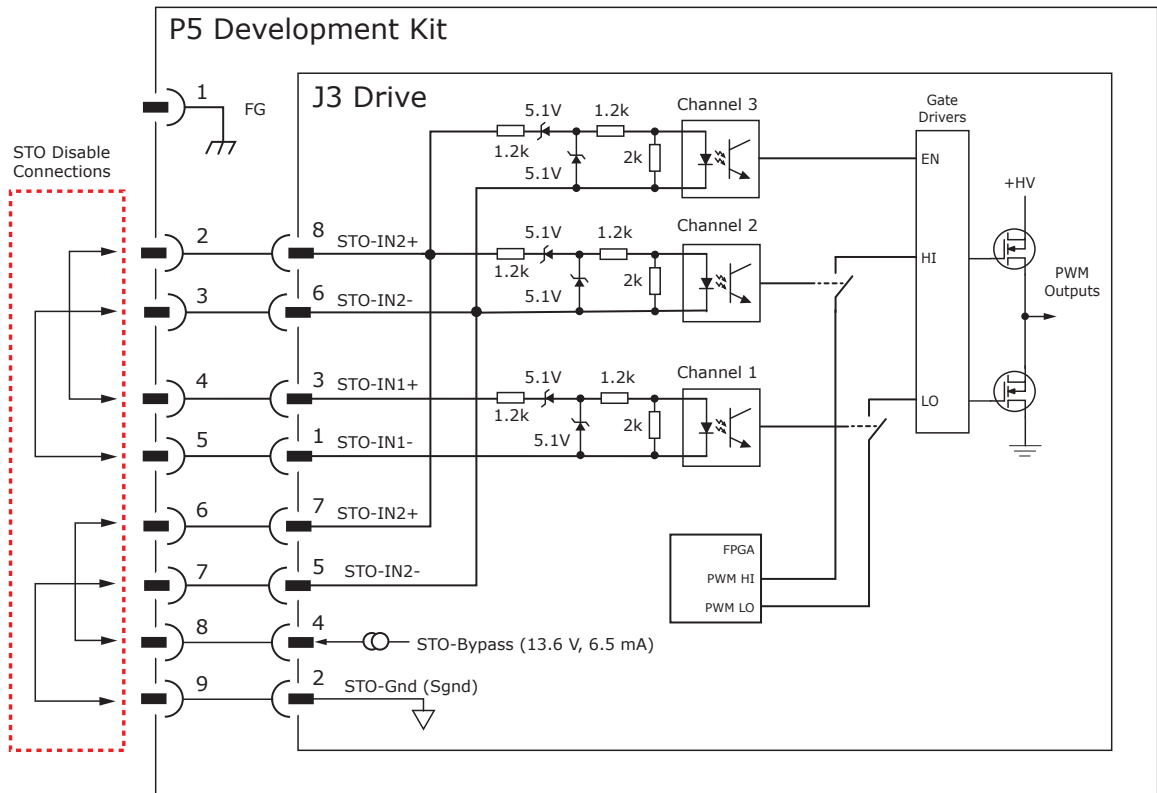


**Important!**  
Install JP5A ONLY if development kit is the LAST node on a CAN bus

## SAFE TORQUE OFF (STO)

### DESCRIPTION

If the STO feature will not be used, the STO function can be disabled by adding jumpers to a connector for P5 as shown below.

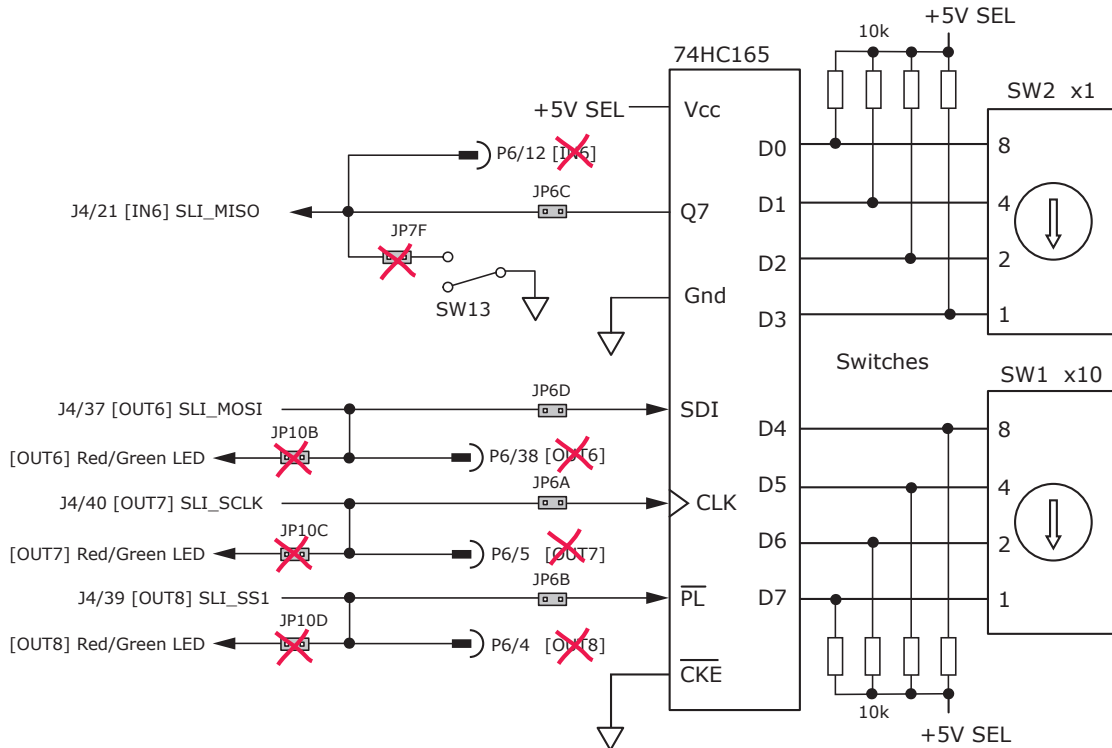


**CANOPEN DEVICE ID SWITCHES**

**CANOPEN DEVICE ID SWITCH CONNECTIONS**

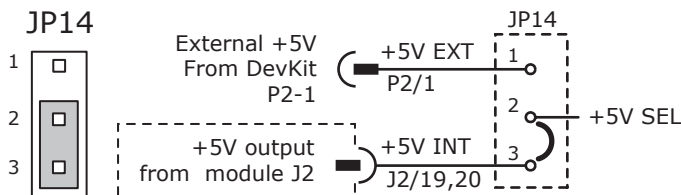
The graphic below shows the connections to the CANopen Device ID switches. These are read after the drive is reset, or powered-on. When changing the settings of the switches, be sure to either reset the drive, or to power it off-on. Outputs [OUT6,7,8] and input [IN6] operate as an SLI (Switch & LED Interface) port which reads the settings on the CANopen Device ID switches, and controls the LEDs on the serial and CAN port connectors. In addition to the SLI function, the port can operate as an SLI interface.

The jumpers marked with red "X" should be removed so that SW13, or external connections to the signals do not interfere with the operation of the SLI port. The "X" on [OUT6] shows that no connections should be made to this by the user when the SLI port is active.



**5V POWER SOURCES**

Power for circuits on the Development Kit (+5V) can be supplied either from the servo drive (INT), or from an external +5V power supply (EXT). Jumper JP14 selects the source of the +5V from either the drive or from the external source.



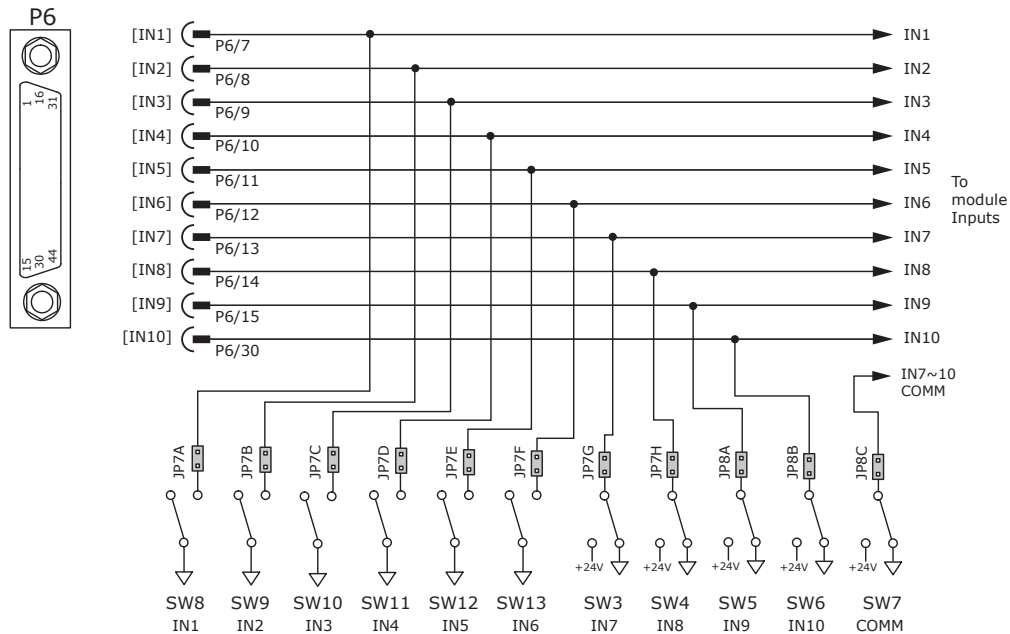
## CONNECTORS & SIGNALS

### LOGIC INPUTS & SWITCHES

The Development Kit has jumpers that can connect the GPM digital inputs to switches on the kit, or to the Signal connector 6.

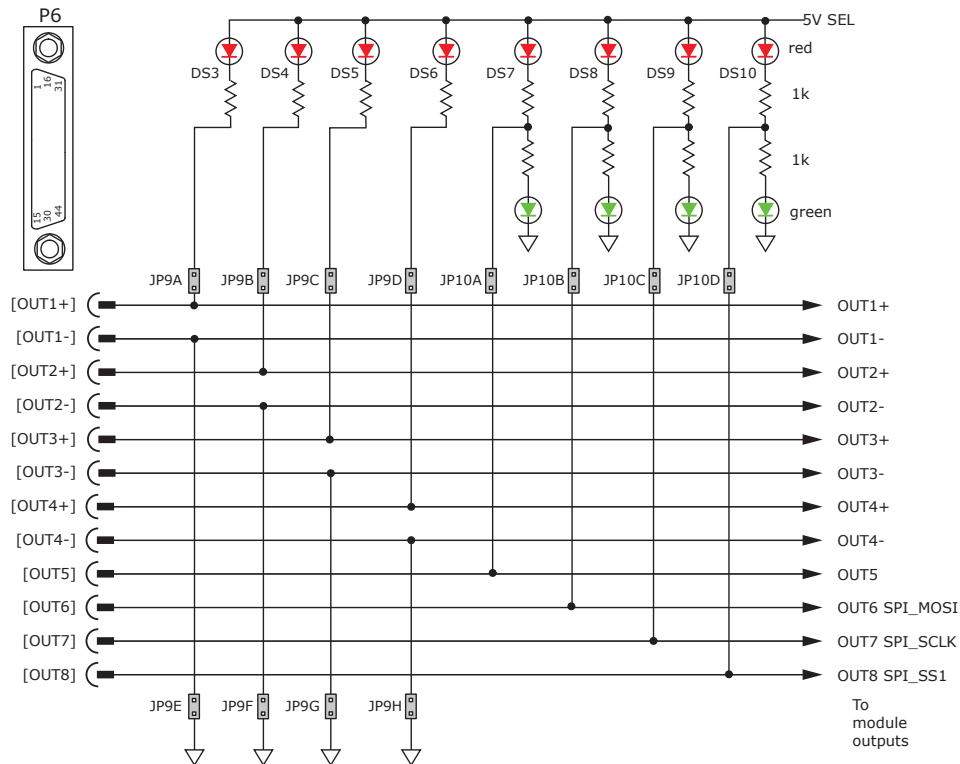
As delivered, all of these jumpers are installed as shown. If connecting to external devices that actively control the level of an input, it is desirable to disconnect the switch which could short the input to ground.

For example, if [IN1] is connected to an external device for the Enable function, then jumper JP7A should be removed to take the switch SW1 out of the circuit. The figure below shows these connections.



### LOGIC OUTPUTS

There are 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 5,6,7 & 8 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, & 4 are two-terminal opto-isolated types. With the jumpers in place as shown, when the outputs are ON they will drive current through the LEDs DS3~6.



## FEEDBACK CONNECTORS & SIGNALS

### MOTOR FEEDBACK CONNECTOR P4

For motors with differential encoders: install jumpers JP1B, JP1C, JP1A to connect terminators across A, B, and X inputs.

For motors with single-ended encoders: remove jumpers JP1B, JP1C, JP1A to disconnect the terminators.

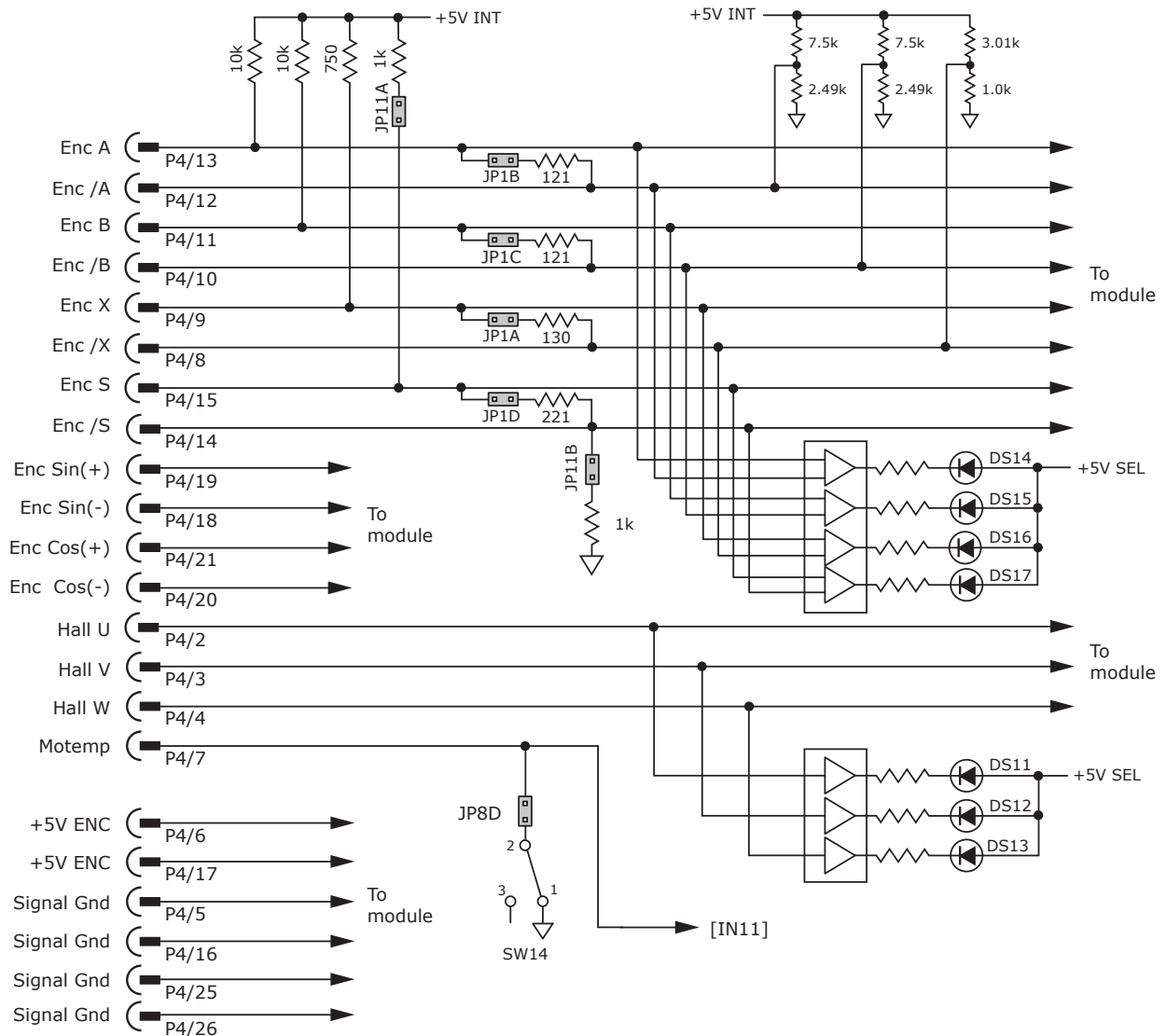
Then use the A, B, and X inputs for the encoder. The /A, /B, and /X inputs are then biased by dividers to work with the single-ended encoder signals.

A motor temperature sensor that connects to [IN11] must have jumper JP8D removed to prevent switch SW14 from grounding the Motemp[IN11] 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.

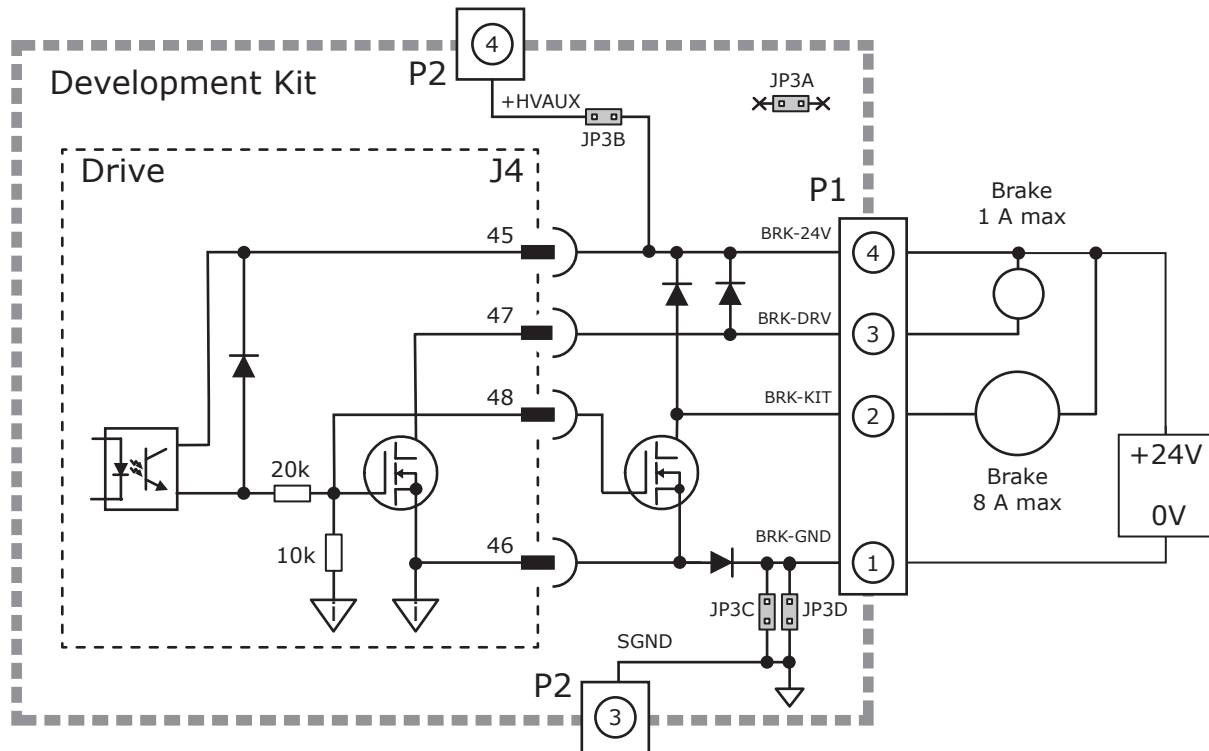
Jumpers JP11A, JP11B, and JP1D must be in place to provide line termination and biasing.

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



## BRAKE CONNECTOR & SIGNALS

The brake circuit in the GPM is optically isolated from the other drive circuits. And the brake circuit in the Development Kit is isolated from other circuits in the kit. Jumpers are provided that connect the kit brake circuits to the +24V (HVAUX) power and SGND (Signal Ground). With the jumpers in place, supplying +24V to P2-4 and ground to P2-3 will power the brake circuit. When this is done a low-current brake can be connected to P1-3 and P1-4, or a higher-current brake can be connected between P1-4 and P1-2. The +24V power supply must be able to supply the required current to energize the brake.

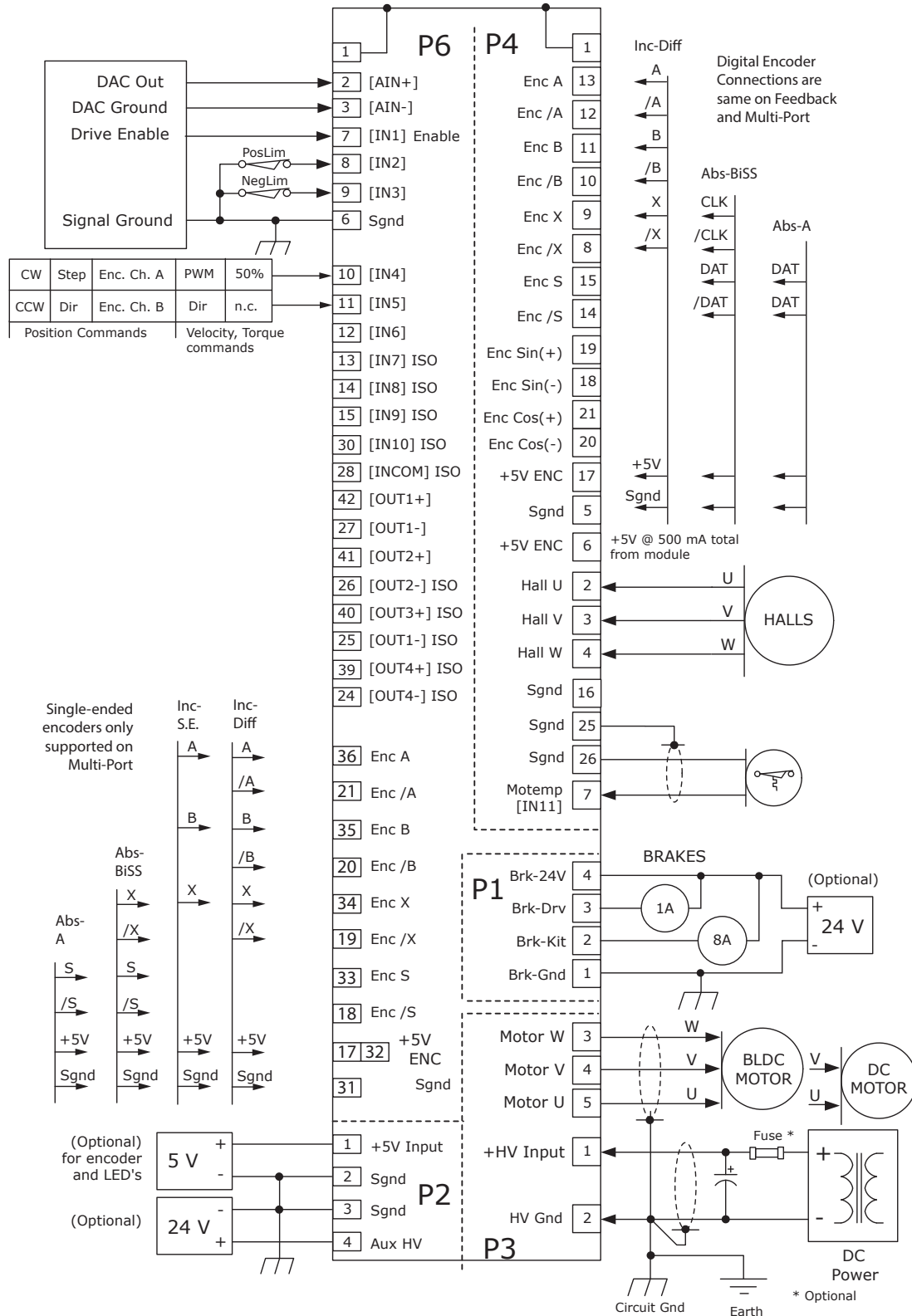


### **IMPORTANT:**

**To use the internal flyback diodes in the Development Kit the 24V power supply must be connected between P1 pins 4 and 1 as shown.**



**DEVELOPMENT KIT CONNECTIONS**



## DEVELOPMENT KIT CONNECTORS

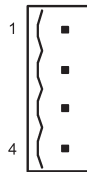
P1 BRAKE

Signal	Pin
BRK-GND	1
BRK-KIT	2
BRK-DRV	3
BRK-24V	4



P2 AUX HV & +5V

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

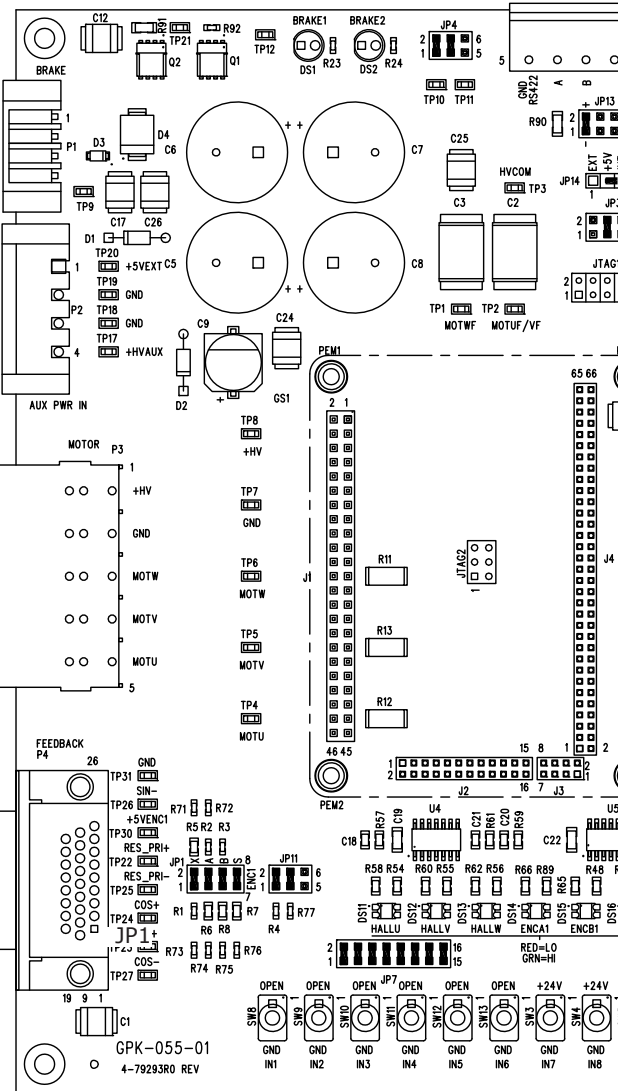


P3 MOTOR & +HV POWER

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



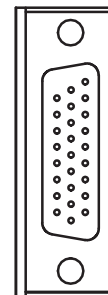
P9 (See table on page 40)



P4 FEEDBACK

INPUT SWITCHES

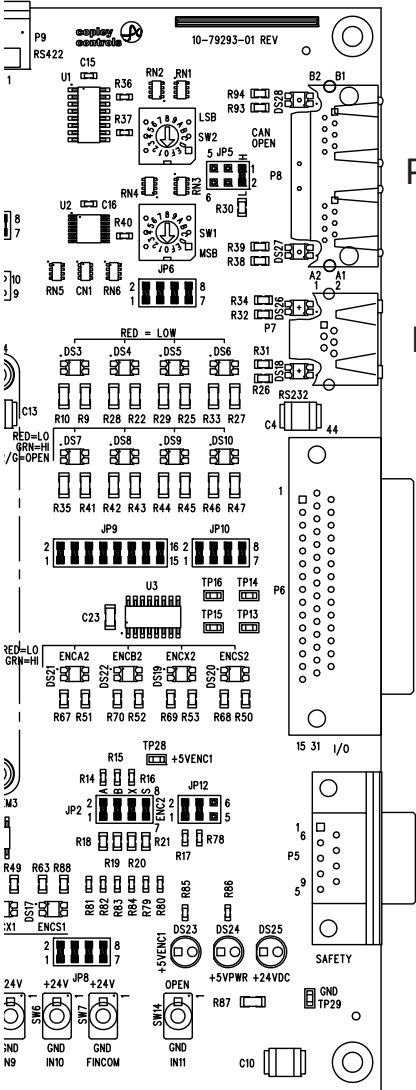
PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
26	Signal Gnd	18	Sin(-)	9	Enc X
25	Signal Gnd	17	+5V Enc	8	Enc /X
24	N.C.	16	Signal Gnd	7	[IN11] Motemp*
23	Rslvr Ref(+)	15	Enc S	6	+5V ENC
22	Rslvr Ref(-)	14	Enc /S	5	Signal Gnd
21	Cos(+)	13	Enc A	4	Hall W
20	Cos(-)	12	Enc /A	3	Hall V
19	Sin(+)	11	Enc B	2	Hall U
		10	Enc /B	1	Frame Gnd



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

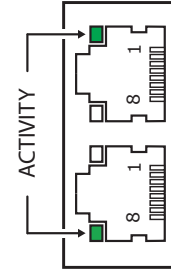
## DEVELOPMENT KIT CONNECTORS

P9 (See table below)



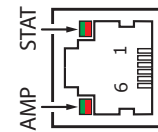
P8 CANOPEN

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



P7 RS-232

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



P6 CONTROL

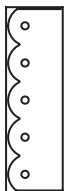
PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	16	Signal Gnd
2	[AIN-]	17	+5V ENC
3	[AIN+]	18	/S Multi-Port
4	[OUT8] SLI-EN1	19	/X Multi-Port
5	[OUT7] SLI-CLK	20	/B Multi-Port
6	Signal Gnd	21	/A Multi-Port
7	[IN1] HS	22	Signal Gnd
8	[IN2] HS	23	[OUT5] SLI-CLK
9	[IN3] HS	24	[OUT4-] ISO
10	[IN4] HS	25	[OUT3-] ISO
11	[IN5] HS	26	[OUT2-] ISO
12	[IN6] HS	27	[OUT1-] ISO
13	[IN7] ISO	28	[INCOM] ISO
14	[IN8] ISO	29	N.C.
15	[IN9] ISO	30	[IN10] ISO

PIN	SIGNAL
31	Signal Gnd
32	+5V ENC
33	S Multi-Port
34	X Multi-Port
35	B Multi-Port
36	A Multi-Port
37	Signal Gnd
38	[OUT6] SLI-MOSI
39	[OUT4+] ISO
40	[OUT3+] ISO
41	[OUT2+] ISO
42	[OUT1+] ISO
43	N.C.
44	Signal Gnd

P5 SAFETY

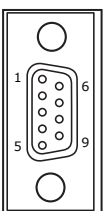
P9 RS-422

Pin	Signal
1	N.C.
2	N.C.
3	RS422(-)
4	RS422(+)
5	RS422-GND



P5 SAFETY

PIN	SIGNAL	PIN	SIGNAL
1	Frame Gnd	6	STO-IN2(+)
2	STO-IN2(+)	7	STO-IN2(-)
3	STO-IN2(-)	8	STO-BYPASS
4	STO-IN1(+)	9	STO-GND
5	STO-IN1(-)		



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## ORDERING INFORMATION

### ORDERING GUIDE

GPM-055-60	GPM Servo Drive, 30/60 Adc, 9~55 Vdc, encoder feedback
GPM-055-60-R	GPM Servo Drive, 30/60 Adc, 9~55 Vdc, resolver feedback
GPM-090-60	GPM Servo Drive, 30/60 Adc, 14~90 Vdc, encoder feedback
GPM-090-60-R	GPM Servo Drive, 30/60 Adc, 14~90 Vdc, resolver feedback



Example: Order one Argus Plus GPM drive, 30/60 Adc, 14~90 Vdc, with resolver feedback, Development Kit, Connector Kit, Serial Cable Kit, and Heatsink Kit

Qty	Item	Remarks
1	GPM-090-60-R	Argus Plus GPM servo drive with resolver feedback
1	GPK-090-01	Development Kit
1	GPK-CK	Connector Kit for Development Kit
1	SER-USB-RJ11	USB to Serial Cable Kit
1	GPM-HK	Heatsink Kit (See page 27 for instructions to mount drive and heatsink to the Development Kit)

### Accessories

GPK-090-01	Development Kit for all GPM models
GPK-CK	Connector Kit for Development Kit (see details below)
GPM-HK	Heatsink Kit (Heatsink, thermal pad, and hardware)
SER-CK	Serial Cable Kit: 9-pin Dsub receptacle to 6-pin modular adapter, plus modular cable for DevKit
SER-USB-RJ11	Serial Interface Cable: USB to RJ11 for DevKit P7, 5.9 ft (1.8 m)

### GPK-CK Connector Kit for Development Kit

Ref	Name	Qty	Description	Manufacturer P/N
P1	Brake	1	Plug, 4 position, 3.5 mm, female	Wago: 734-104/107-000
		1	Tool, wire insertion & extraction, 734 series	Wago: 734-231
P2	Aux HV	1	Plug, 4 position, 5.08 mm, female	Wago: 231-304/107-000
		1	Tool, wire insertion & extraction, 231 series	Wago: 231-159
P3	HV & Motor	1	Plug, 5 position, 7.62 mm, female	Phoenix Contact: 1778094
P4	Feedback	1	Connector, high-density DB-26M, 26 position, male, solder cup	Norcomp: 180-026-103L001
		1	Metal Backshell, DB-15, RoHS	Norcomp: 979-015-020R121
P5	Safety	1	Connector, DB-9M, 9-position, standard, male	Norcomp: 1710009-103L001
		1	Metal Backshell, DB-9, RoHS	Norcomp: 979-009-020R-121
P6	Control	1	Connector, high-density DB-44M, 44 position, male, solder cup	Norcomp: 180-044-103L001
		1	Metal Backshell, DB-25, RoHS	Norcomp: 979-025-020R121
P9	RS-422	1	Connector, terminal block, female, 0.20 in, 5-position	TE/AMP: 796635-5

### Other Connectors

P7	RS-232	Serial Cable Kit	Copley: SER-CK
P8	Network	CAN Network cable, 10 ft (3 m)	Copley: GPK-NC-10
		CAN Network cable, 1 ft (0.3 m)	Copley: GPK-NC-01
		CAN Network terminator	Copley: GPK-NT
		CAN Network Kit	Copley: GPK-NK
		CAN Network Adapter	Copley: GPK-CV

Note: Specifications subject to change without notice