Argus PLUS Module EtherCAT R71

DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

CONTROL MODES
- Cyclic Synchronous Position-Velocity-Torque (CSP, CSV, CST)
- Cyclic Synchronous Torque with Commutation Angle (CSTCA)
- Profile Position-Velocity-Torque, Interpolated Position, (PT, PVT), Homing
- Indexer, Point-to-Point, CPL
- Camming, Gearing

COMMAND INTERFACE
- EtherCAT® (CoE) CANopen® over EtherCAT
- Ethernet TCP-IP, UDP, Modbus-TCP, EtherNet/IP
- ASCII, Serial Binary, and Discrete I/O
- Stepper or Quad A/B Position Commands
- PWM Position/Velocity/Torque Command
- Master Encoder (Gearing/Camming)
- ±10V Position-Velocity-Torque Command

COMMUNICATIONS
- Ethernet
- RS-232
- RS-422

FEEDBACK
- Dual Absolute Encoder Ports
  - BiSS (B&C)
  - SSI
  - CSR Resolver
  - EnDat 2.1, EnDat 2.2
  - Absolute A
  - Tamagawa™, Panasonic™, Sanyo Denki™
- Incremental
  - Digital Quad A/B/X Encoder
  - Analog Sin/Cos Encoder
  - Digital Halls
  - Resolver (-R model)

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]

R71

Model	Ic	Ip	Vdc
R71-055-60	30	60	9~55
R71-055-60-R	30	60	9~55
R71-090-60	30	60	14~90
R71-090-60-R	30	60	14~90

DESCRIPTION

The R71 sets new levels of performance, connectivity, and flexibility. The CANopen application protocol over the EtherCAT (CoE) communication provides a widely used cost-effective industrial bus. A broad range of absolute encoders are supported.

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

RUGGEDIZED STANDARDS CONFORMANCE

Ambient Temperature	Non-Operating	-50ºC to 85ºC
	Operating	-40ºC to 70ºC
Thermal Shock	Operating	-40ºC to 70ºC in 1 minute
Relative Humidity	Non-Operating	95% non-condensing at 60ºC
	Operating	95% non-condensing at 60ºC
Vibration	Operating	5 Hz to 500 Hz, up to 3.85 *g*rms
Altitude	Non-Operating	-400 m to 16,000 m
	Operating	-400 m to 5,000 m
Shock	Crash Safety	75 *g* peak acceleration
	Operating	40 *g* peak acceleration
MIL-STD Specifications	MIL-STD-	461, 704, 810, 1275, 1399
IEC Specifications	IEC-	60068, 60079

GENERAL SPECIFICATIONS

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

MODEL	R71-055-60(-R)	R71-090-60(-R)	Units
OUTPUT CURRENT			
Peak Current	60 (42.4)	60 (42.4)	ADC (Arms)
	23 (16.26) @ 70C	23 (16.26) @ 70C	ADC (Arms)
Peak Time	1	1	Sec
Continuous Current	30 (21.2)	30 (21.2)	ADC (Arms)
	11.5 (8.13) @ 70C	11.5 (8.13) @ 70C	ADC (Arms)
Peak Output Power	5.4	5.4	kW
Continuous Output Power	2.7	2.7	kW
INPUT POWER			
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.
	Optional keep-alive power input when +HV is removed.		
PWM OUTPUTS			
Type	MOSFET 3-phase inverter, 16 kHz center-weighted PWM carrier, space-vector modulation		
PWM Ripple Frequency	32 kHz		
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)		
PWM Frequency	16 kHz		
Bus Voltage Compensation	Changes in bus or mains voltage do not affect bandwidth.		
Minimum Load Inductance	200 µH line-line		
Resolution	16-bit capture of U & V phase currents		
COMMAND INPUTS			
EtherCAT	CAN application protocol over EtherCAT (CoE): Cyclic Synchronous Position/Velocity/Torque, Profile Position/Velocity/Torque, Interpolated Position (PVT), Homing Internally 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 the inputs or ASCII commands.		
Camming	Up to 10 CAM tables can be stored in the flash memory.		
ASCII	RS-232, 9600~115,200 Baud, 3-wire, RJ-11 connector, referenced to Signal Ground.		
DIGITAL INPUTS			
Number	11		
[IN1,2,3,4,5,6]	Digital, non-isolated, Schmitt trigger, 0.1 µs RC filter, 12 Vdc compatible, 10 kΩ 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 min., 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 over-temp input on feedback connector, 24 Vdc max., programmable to other functions Other digital inputs are also programmable for the Motemp function. 330 µs RC filter, 4.99 kΩ pull-up to +5 Vdc, Vt+ = 2.5~3.5 Vdc, VT- = 1.3~2.2 Vdc, VH = 0.7~1.5 Vdc		
Functions	All inputs are programmable, [IN1] defaults to the Enable function and it is programmable for other functions.		
ANALOG INPUT			
[AIN±]	Differential, ±10 Vdc, 5.36 kΩ 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		
DIGITAL OUTPUTS			
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 and 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		
Functions	Default functions are shown above, programmable to other functions.		
RS-232 PORT			
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		
RS-422 PORT			
Signals	A/Y(+), B/X(-), Gnd from ISL32455 tranceiver, optically isolated		
Mode	Half-duplex, RS-422 slave, 9,600 bps to 230.4 kbps		
Protocol	Binary and ASCII formats		

NOTES:
1. Brake output [OUT9] is programmable as a motor brake, or as a general purpose digital output.
2. When the 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 the 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.	
Muting	An internal current source wired to STO inputs will mute (bypass) 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^2T Current Limiting	Programmable: continuous current, peak current, peak time	
Motor Over Temperature	Digital inputs programmable to detect motor temperature switch.	
Feedback Loss	Inadequate analog encoder amplitude or missing incremental encoder signals.	
MECHANICAL & ENVIRONMENTAL		
Size mm [in]	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	Operating:	-40°C to 70°C
	Non-Operating:	-50°C to 85°C
Thermal Shock	Operating:	-40°C to 70°C in 1 minute
Relative Humidity	Operating:	95%, non-condensing at 60°C
	Non-Operating:	95%, non-condensing at 60°C
Vibration	Operating:	5 Hz to 500 Hz, up to 3.85 *g*rms
Altitude	Operating:	-400 m to 5,000 m
	Non-Operating:	-400 m to 16,000 m
Shock	Crash Safety:	75 *g* peak acceleration
	Operating:	40 *g* peak acceleration
MIL-STD Specifications	MIL-STD-	(461, 704, 810, 1275, 1399)
Contaminants	Pollution Degree 2	
Environment	IEC 60068-2, 60079	
Cooling	Heat sink and/or forced air cooling is required for continuous power output.	

AGENCY STANDARDS CONFORMANCE

Standards and Directives

Functional Safety

IEC 61508-1, IEC 61508-2, EN (ISO) 13849-1, IEC 61800-5-2
EN (ISO) 13849-2, Directive 2006/42/EC (Machinery)

Electrical Safety

Directive 2014/35/EU (Low Voltage), UL 61800-5-1
IEC 61800-5-1

EMC

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

Restriction of the Use of Certain Hazardous Substances (RoHS)

Directive 2011/65/EU (RoHS II)

Approvals

UL Recognized Component to UL 61800-5-1
UL Functional Safety to IEC 61800-5-2, EMC to IEC 61800-5-2

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.

DANGER	***Refer to the Argus Plus GEM & GPM User Manual, Part Number 16-01599.***
	The information provided in the *Argus Plus GEM & GPM User Manual, Part Number 16-01599* must be considered for any application using the STO feature. ***Failure to heed this warning can cause equipment damage, injury, or death.***

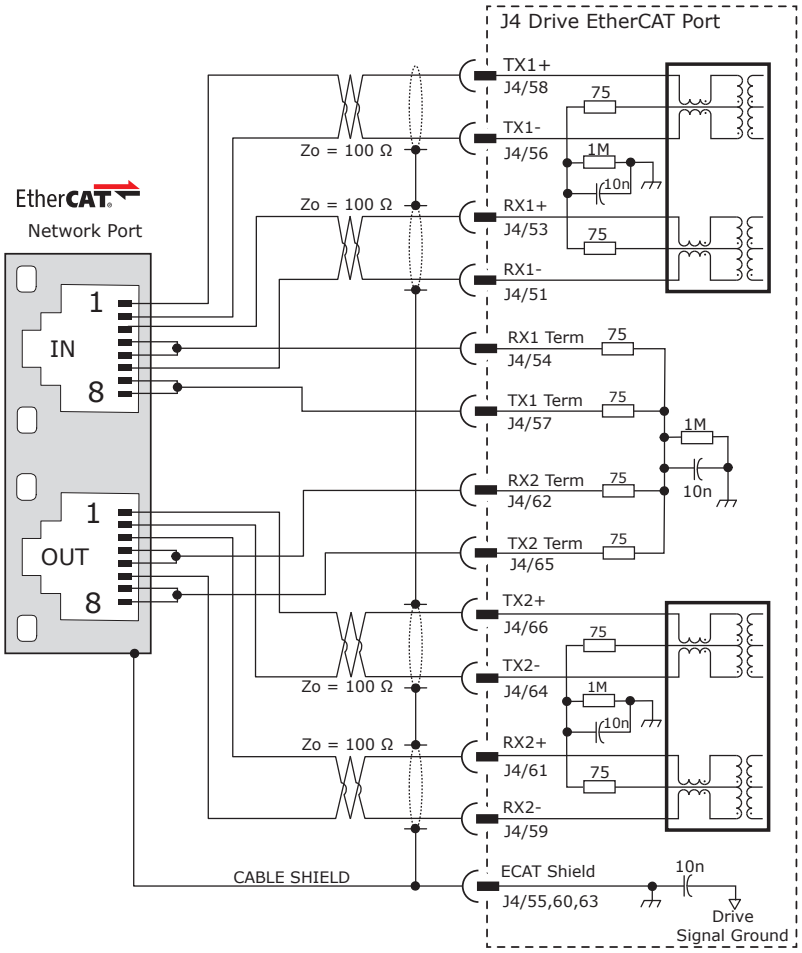
GENERAL SPECIFICATIONS

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 to 16 bits/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, > 300 kHz BW, 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.
As Emulated Output:	Quadrature A/B encoder emulation with programmable resolution, As Emulated Output: Emulates Quadrature A/B, Analog Sin/Cos, Resolver. A, /A, B, /B, outputs from MAX3032 differential line driver, X, /X, S, /S from MAX 3362 line drivers
As Buffered Output:	Digital A/B/X encoder signals from primary digital encoder are buffered as shown above, 5 MHz max.
5V OUTPUT	
Number	1
Ratings	+5 Vdc @ 500 mA thermal and overload protected.

ETHERCAT COMMUNICATIONS

EtherCAT is the open, real-time Ethernet network developed by Beckhoff based on the widely used 100BASE-TX cabling system. EtherCAT enables high-speed control of the multiple axes while maintaining tight synchronization of the clocks in the nodes. Data protocol is CAN application protocol over EtherCAT (CoE) based on DSP-402 for motion control devices. For additional information on EtherCAT, refer to the EtherCAT Technology Group web-site: https://www.ethercat.org

Ethercat Connections Diagram



ETHERCAT CONNECTIONS

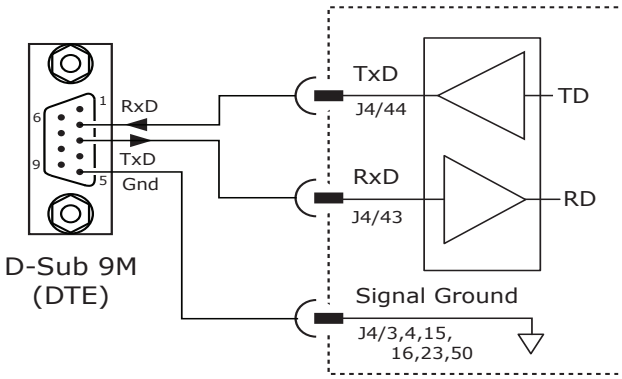
Page 23 shows the guidelines for the PC board layout and the design for the EtherCAT signals.

Page 32 shows the dual EtherCAT cable connections on the Development Kit.

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

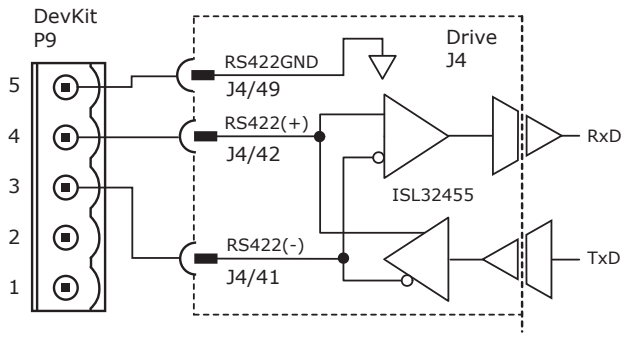
RS-232 COMMUNICATIONS

R71 is configured via a 3-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 a full-duplex, 3-wire, DTE using RxD, TxD, and Gnd. Connections to the R71 RS-232 port are made through J4. The graphic below shows the connections between an R71 and a computer COM port which is a DTE device.



RS-422 COMMUNICATIONS

RS-422 is a 2-wire differential, half-duplex port that operates from 9600 to 230.4 kbps. The following diagram shows the DevKit P9 connections between the R71 and the computer RS-422 port. It should connect to the Signal Ground on the user's PC board or it can connect to another 0V electrical circuit. A, B, and C are the signal labels in the RS-422 specification.



SAFE TORQUE OFF (STO)

DESCRIPTION

The R71 provides the Safe Torque Off (STO) function as defined in IEC 61800-5-2. Three opto-couplers are provided which, when they are de-energized, prevent the upper and lower devices in the PWM outputs from being operated by the digital control core.

This function provides a positive Off capability that cannot be overridden by the control firmware or the 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

DANGER	***Refer to the Argus^{Plus} GEM & GPM User Manual, Part Number 16-01599.***
	The information provided in the *Argus^{Plus} GEM & GPM User Manual, Part Number 16-01599* must be considered for any application using the STO feature. ***Failure to heed this warning can cause equipment damage, injury, or death.***

STO BYPASS (MUTING)

To activate the PWM outputs of the drive, the 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.

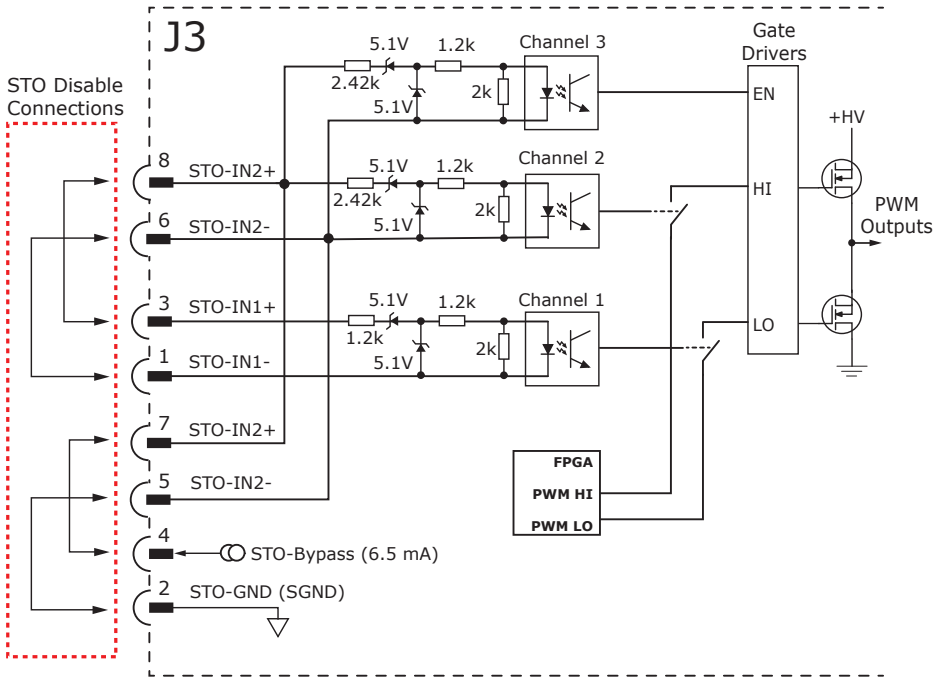
The following diagram shows the connections that will energize all of the opto-couplers from an internal current-source. When this is done, the STO feature is disabled and the control of the output PWM stage is under the control of the digital control core. If the STO feature is not used, these connections must be made in order for the drive to be enabled.

STO BYPASS CONNECTIONS

Note: The current must flow through all of the opto-couplers before the drive can be enabled.

J3 SIGNALS

Signal	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(+)



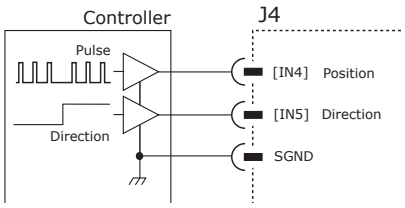
DIGITAL COMMAND INPUTS: POSITION

Pulses on IN4 will increment the target position. The active edge of the 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.

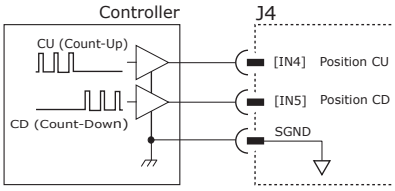
If Input Pulses = 10 and Output Pulses = 2, then 5 Input Pulses will produce 1 Output Pulse. Pulses on IN4 will increment the target position and pulses on IN5 will decrement the position. The active edge, direction of the position change and the Stepping Resolution, are programmable as in Pulse/Dir.

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.

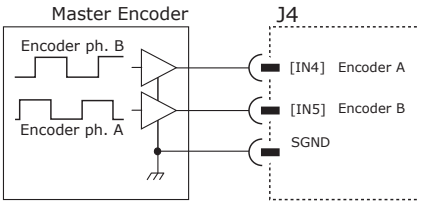
PULSE & DIRECTION



CU/CD



QUAD A/B ENCODER



DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

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.

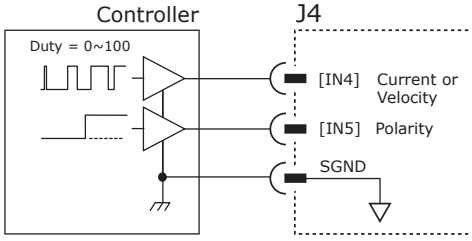
If Input Pulses = 10 and Output Pulses = 2, then 5 Input Pulses will produce 1 Output Pulse.

A pulse-train on IN4 with a constant frequency and variable duty-cycle will increment/decrement the target velocity or current, as shown in the following diagram.

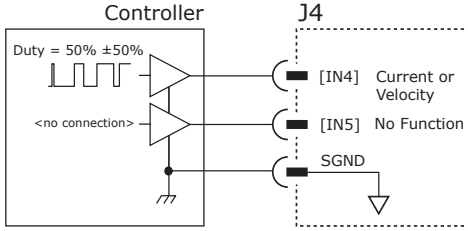
- 50% duty cycle commands 0 output.
- 100% duty cycle is the maximum positive output.
- 0% duty cycle is the maximum negative output.

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.

PWM & DIRECTION



50% PWM



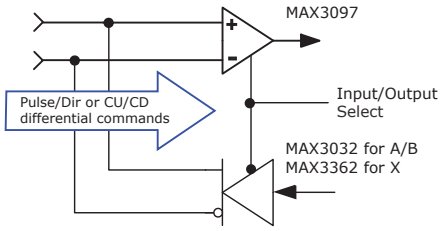
CONNECTIONS

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

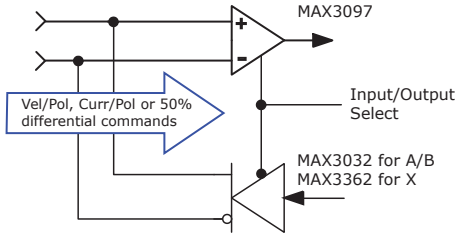


SIGNALS & PINS

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
SGND	3,4,15,16, 23,50

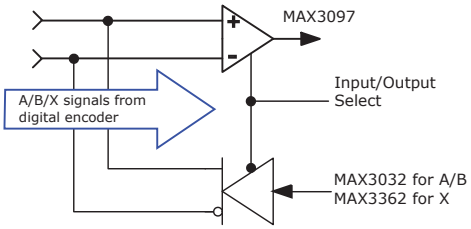
CURRENT or VELOCITY COMMAND INPUTS: DIFFERENTIAL

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



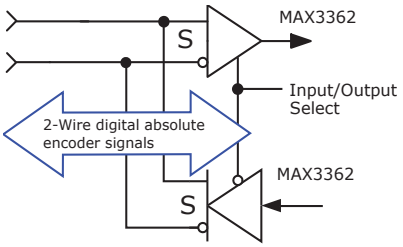
SECONDARY FEEDBACK: INCREMENTAL

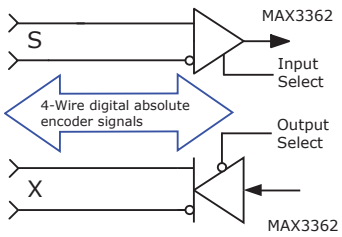
- Quad A/B/X Incremental Encoder

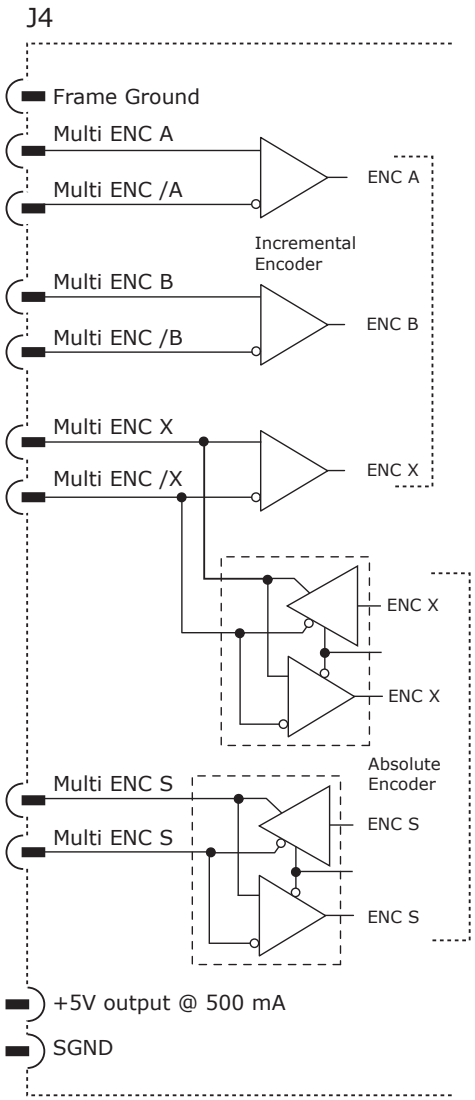


SECONDARY FEEDBACK: ABSOLUTE

- 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 the data transmission from the encoder on the S channel in full-duplex mode.







MULTI-MODE ENCODER 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 the differential line drivers for A/B/X outputs

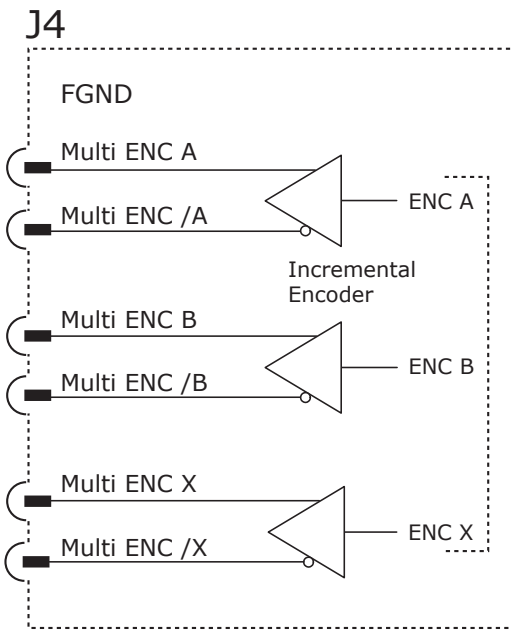
SIGNALS & PINS

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

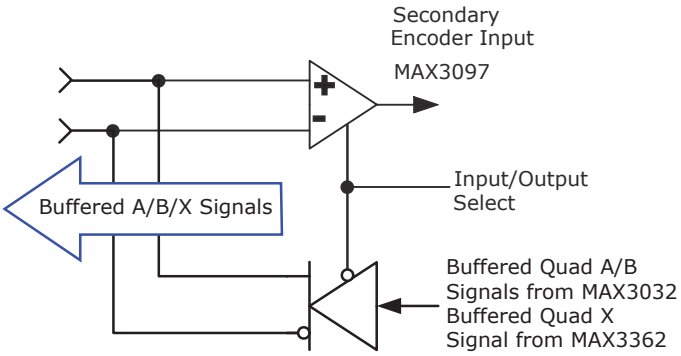
EMULATED FEEDBACK OUTPUTS: DIFFERENTIAL

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

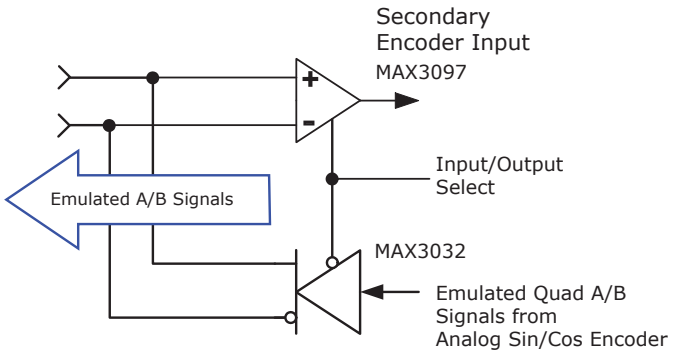
- Absolute Encoders
- Analog Sin/Cos Incremental Encoders



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
- Programmable Pull-Up/Pull-Down
- 12V Compatible
- Programmable Functions

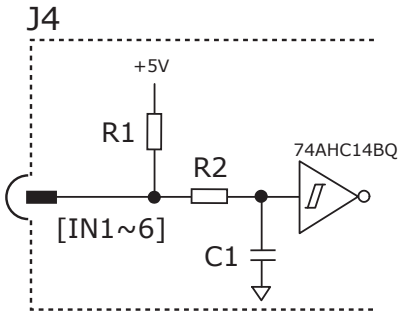
SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	VT+ ≥ 2.5~3.5Vdc
	LO	VT- ≤ 1.3~2.2 Vdc
	Hys	VH 0.7~1.5 Vdc
	Max	+12 Vdc
	Min	0 Vdc
Pull-Up/Down	R1	10 kΩ
Low Pass Filter	R2	1 kΩ
	C1	100 pF
	RC[1]	0.1 µs

[1]Note: The R2*C1 time constant applies when the input is driven by the active HI/Lo devices.

CONNECTIONS

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



MOTOR OVERTEMP INPUT: IN11

- Digital, Non-isolated
- Motor Overtemp Input
- 24V Compatible
- Programmable Functions

MOTOR OVER TEMP INPUT

The 4.99 kΩ pull-up resistor works with either of the following:

- PTC (Positive Temperature Coefficient) thermistors that conform to the BS 4999:Part 111:1987
- switches that open/close indicating a motor over-temperature condition.

The active level is programmable.

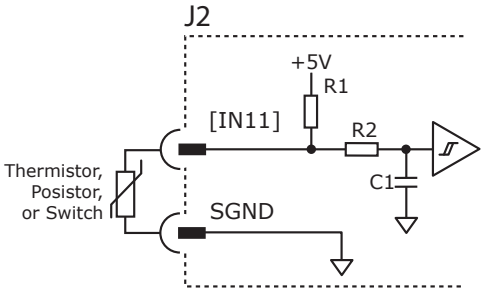
SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	VT+ ≥ 2.5~3.5Vdc
	LO	VT- ≤ 1.3~2.2 Vdc
	Hys	VH 0.7~1.5 Vdc
	Max	+12 Vdc
	Min	0 Vdc
Pull-Up	R1	4.99 kΩ
Low Pass Filter	R2	10 kΩ
	C1	33 nF
	RC[1]	330 µs

[1]Note: The RC time constant applies when the input is driven by the active HI/Lo devices.

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	≤1650
Resistance at 95°C	≥3990
Resistance at 105°C	≥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

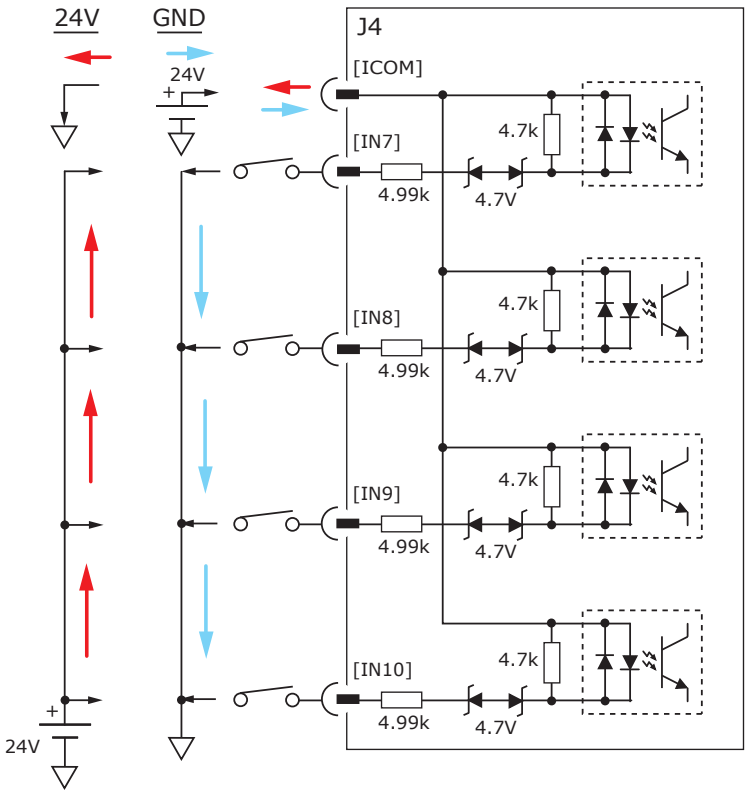
SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	Vin ≥ ±10.0 Vdc*
	LO	Vin ≤ ±6.0 Vdc*
	Max	±30 Vdc*
Input Current	±24V	±3.6 mAdc
	0V	0 mAdc

*Note: In the Notes column, Vdc refers 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

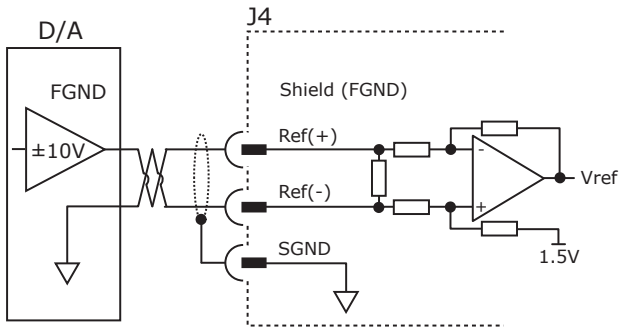
As a reference input, it takes Position/Velocity/Torque Commands from a controller. If it is not used as a command input, it can be used as a general-purpose analog input.

SPECIFICATIONS

Specification	Data	Notes
Input Voltage	Vref	±10 Vdc
Input Resistance	Rin	5.36 kΩ

CONNECTIONS

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

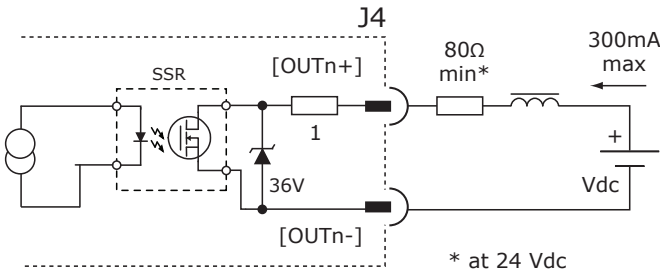


OPTO-ISOLATED OUTPUTS: OUT1, OUT2, OUT3, OUT4

- 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

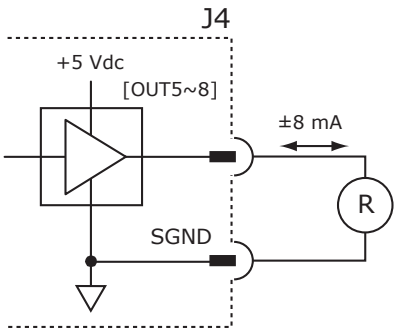
- CMOS Buffer
- 74AHCT1G125
- Programmable Functions

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

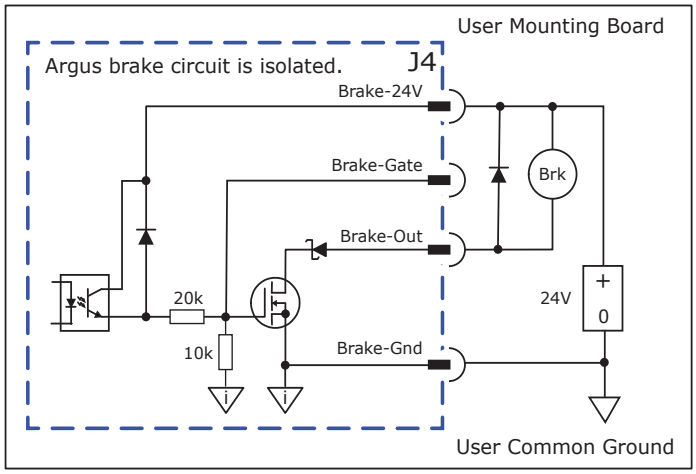
- Brake Output [OUT9]
- Opto-isolated
- 24V Compatible
- Programmable Functions
- Gate Output to drive external MOSFET

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

J4 CONNECTIONS

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



Note: The brake circuits are optically isolated from all the drive circuits and the frame ground.

For a flyback diode located across the brake to be effective, the Brake-24V and Brake-Gnd must be connected as shown in the above diagram. Also, the 24V power supply must be referenced to the user's common ground.

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.

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.

WARNING	***Refer to the AN136 Accelnet External Regen Application Note, Part Number 16-125661.***
	Vlogic +9~60. 24V power is recommended. If a 24V Brake is used, 24V is required. If common to HV, do not exceed 60V. Use REGEN protection and diode isolation from HV.

FEEDBACK CONNECTIONS

QUAD A/B ENCODER WITH FAULT PROTECTION

Encoders with differential line-driver outputs are required (single-ended encoders are not supported). They provide incremental position feedback via the A/B signals.

The optional index signal (X) gives a once per revolution position mark. The MAX3097 receiver has differential inputs with fault protections to use for the following conditions.

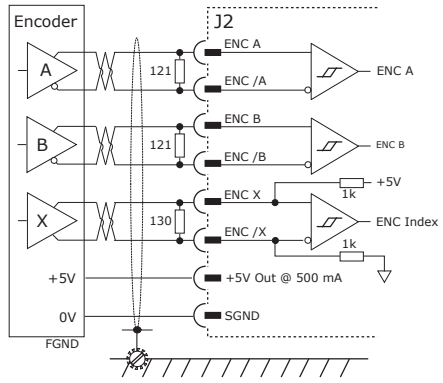
Condition	Description
Short-circuits line-line:	This condition produces a near-zero voltage between A & /A which is below the differential fault threshold.
Open-circuit condition:	The terminator resistors installed on user PC boards will pull the inputs together if either side (or both) is open. This condition will produce the same fault condition as a short-circuit across the inputs.
Low differential voltage detection:	This condition occurs if very long cable runs are used. 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.

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

QUAD ENCODER WITH INDEX

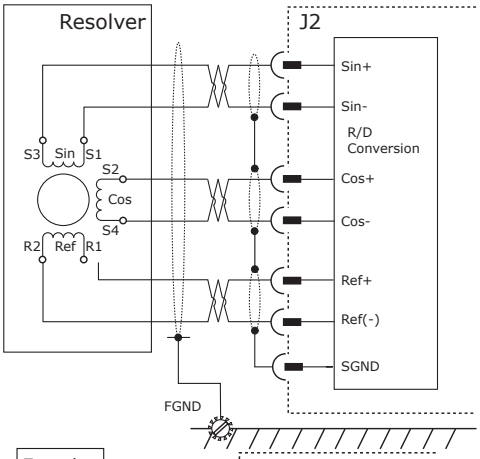


RESOLVER

For connections to the resolver, use shielded cable with three twisted-pairs. Once connected, use the CME software to configure the resolver set up, motor phasing, and other commissioning adjustments. There are no hardware adjustments required.

RESOLVER SIGNALS

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



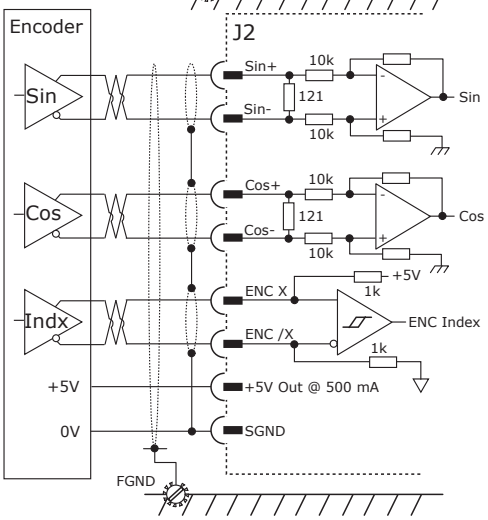
ANALOG SIN/COS INCREMENTAL ENCODER

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
FGND = Frame Ground



FEEDBACK CONNECTIONS

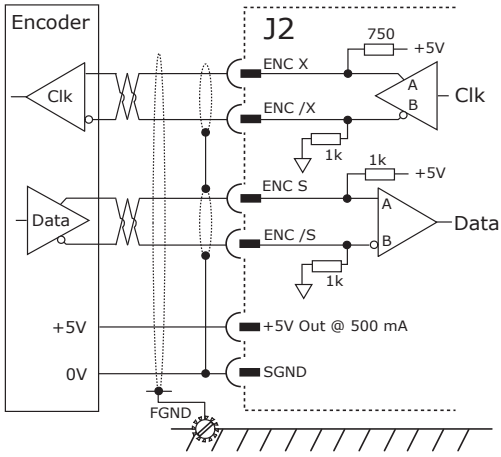
SSI ABSOLUTE ENCODER

The SSI (Synchronous Serial Interface) is an interface used to connect an absolute position encoder to a motion controller or control system. The R70 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. Data is sent in 8 bit bytes and the LSB is sent first. The SCLK signal is only active during transfers. Data is clocked-out on the falling edge and clock-in on the rising edge of the Master.

BiSS ABSOLUTE ENCODER

BiSS is an - Open Source - digital interface used 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.

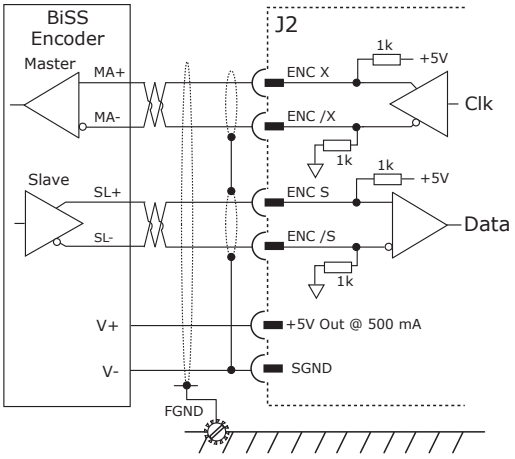
- Serial Synchronous Data Communication
- Cyclic at high speed
- Two Unidirectional Lines Clock and Data
  - -Line delay compensation for high speed data transfer
  - -Request for data generation at slaves
  - -Safety capable: CRC, Errors, Warnings
  - -Bus capability including actuators
- Bidirectional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



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

SGND = Signal Ground



Note: Connect Single (Outer) shields at the controller end. Connect Inner shields to only the Signal Ground on the drive.

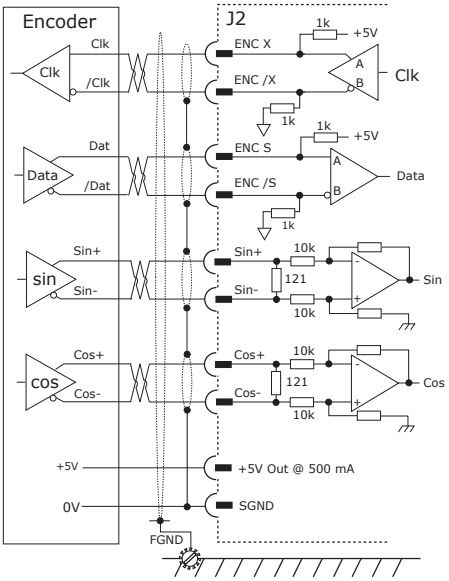
ENDAT ABSOLUTE ENCODER

The EnDat interface is a Heidenhain interface that is similar to the SSI interface that uses clock and data signals, but which also supports analog Sin/Cos channels from the same encoder. The number of position data bits and the use of Sin/Cos channels are programmable. Using 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

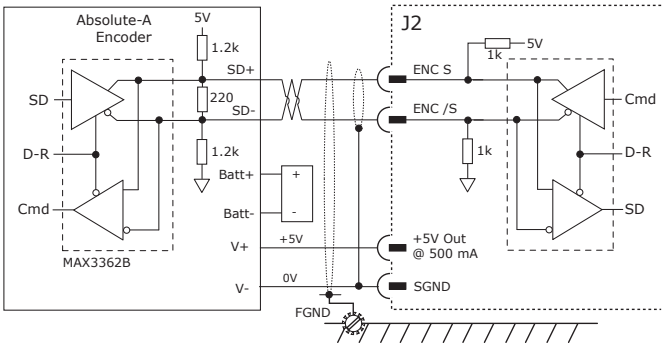
The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485. Note the battery which must be connected. Without it, the encoder will produce a fault condition.

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

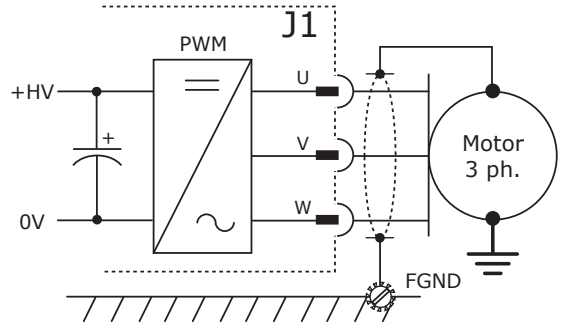
BRUSHLESS MOTOR CONNECTIONS

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 SIGNALS

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

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 the motor frame ground for the best results.



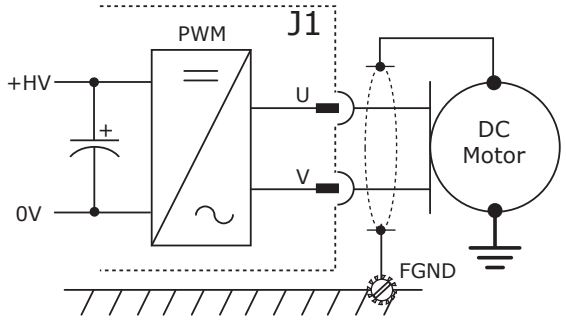
BRUSH MOTOR CONNECTIONS

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

MOTOR SIGNALS

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

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 the motor frame ground for best results.



DIGITAL HALL SIGNALS

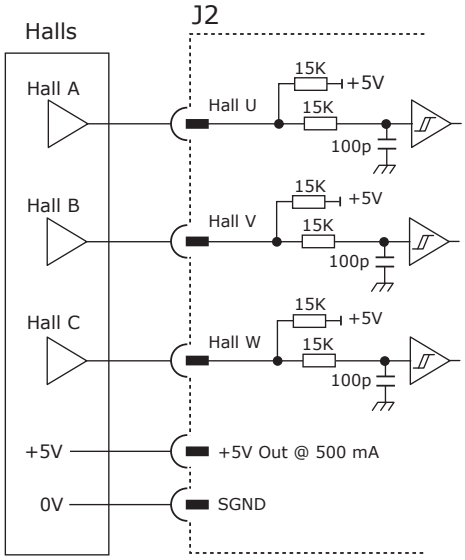
Hall signals are single-ended signals that provide absolute feedback within one electrical cycle of the motor. There are three signals (U, V, & W). The signals may be sourced by magnetic sensors in the motor or by encoders that have Hall tracks as part of the encoder disc.

HALL SIGNALS

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

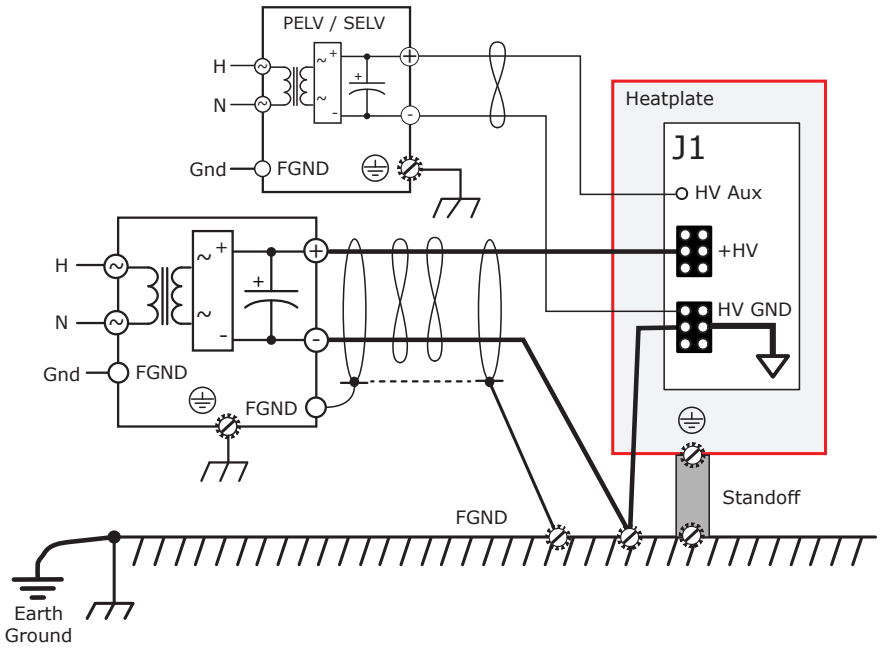
Typically, they operate at much lower frequencies than the motor encoder signals. They are used for the following functions:

- commutation-initialization after startup
- checking the motor phasing after the drive has switched to the sinusoidal commutation



POWER SUPPLY GROUNDING

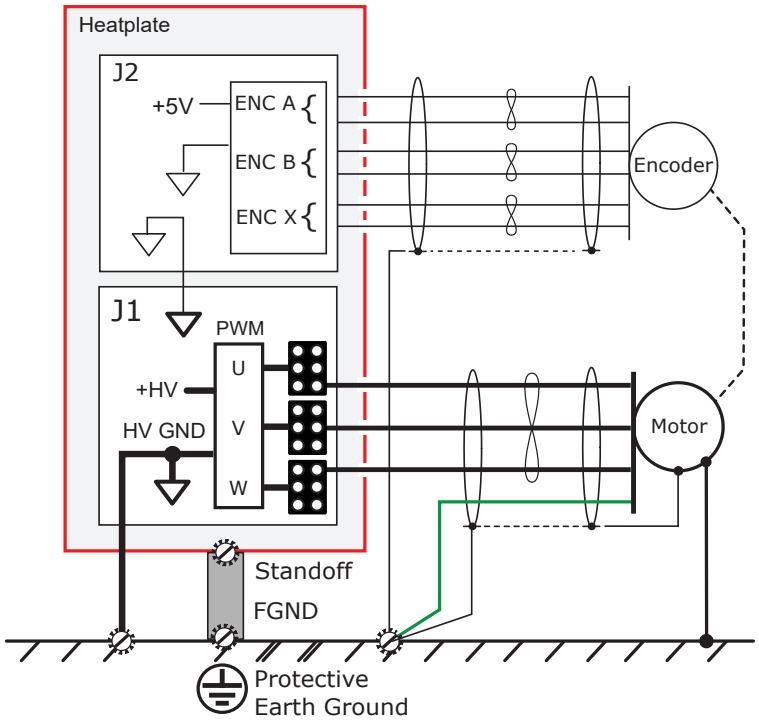
The following diagram shows the drive HV GND connecting to Frame Ground (FG) and Earth Ground. This connection keeps 0V in the drive at 0V Ground. Voltage drops that occur across the power-supply wiring will appear at the (-) terminals of the power supplies due to the cable length and the current. However,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



Power Supply Grounding Diagram

MOTOR CONNECTION GROUNDING

The following diagram 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.

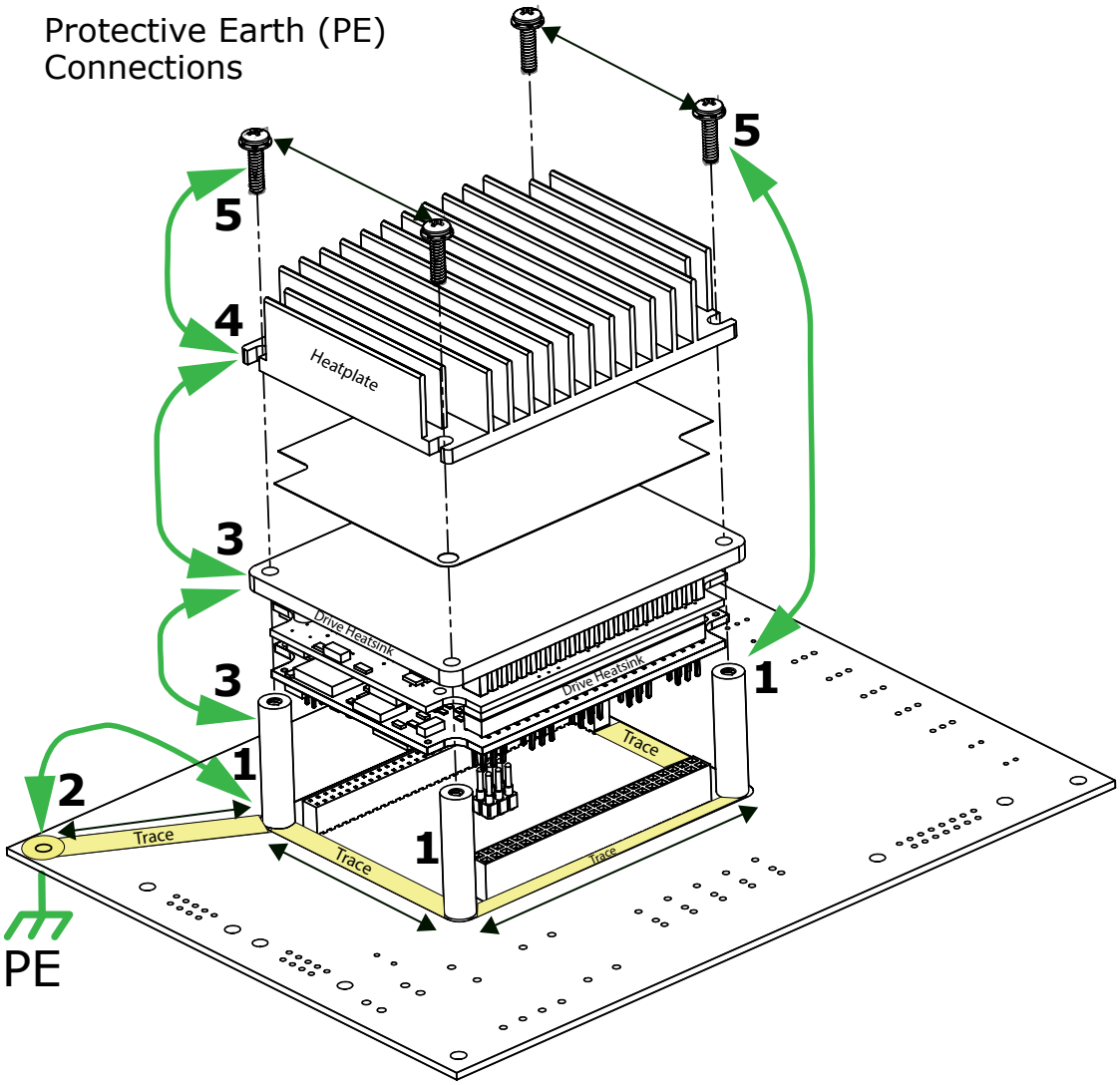


Motor Connection Grounding Diagram

PROTECTIVE EARTH GROUNDING

In the following diagram, the arrows show the sequence of a Protective Earth (PE) connection made with the R71 drive. The standoffs shown in the diagram are solid with tapped holes on each end. To prepare the R71 connection, do the following:

1. Insert the standoffs from the bottom of the PC board and secure the standoffs with four screws (not shown). The standoffs retain the spacers and make ohmic contact with conductive traces on the PC board.
2. Connect four standoffs by a trace which has an extension to one of the mounting holes as shown in the following diagram. This should be a plated through-hole to connect to earth either by connecting the standoff to the equipment bonded enclosure or by connecting the cable to earth ground.
3. When the drive is placed on the standoffs, align the two corner holes with the drive heatplate and place the thermal pad.
4. Then, align the drive heatplate to the remaining two corner holes and place the heatsink.
5. Finally, install the screws to secure the heatsink.
   This connection 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.

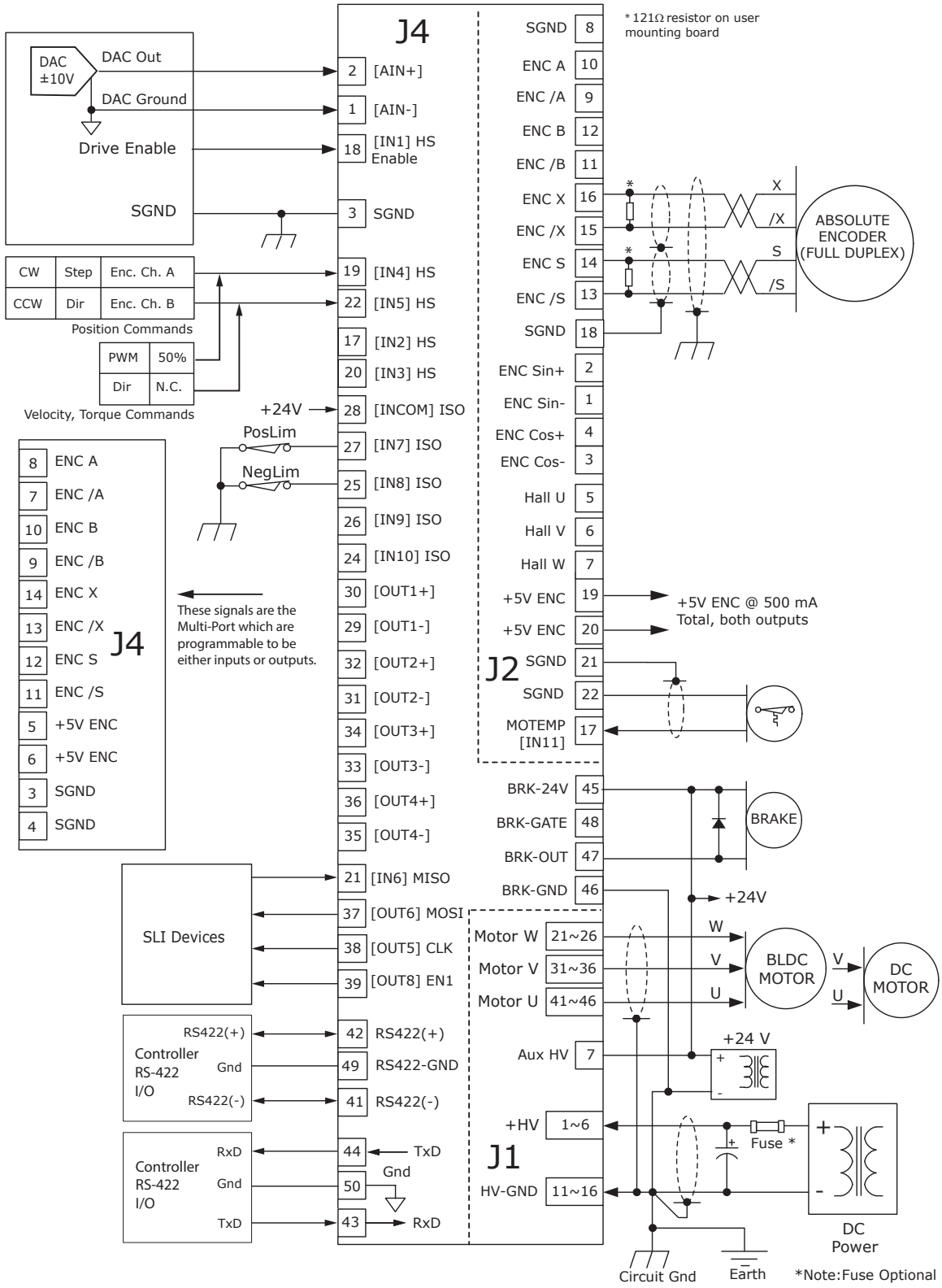


Protective Earth Grounding Diagram

CONNECTORS & SIGNALS

CONNECTIONS FOR ABSOLUTE ENCODER WITH DUPLEX CLOCK/DATA

The following diagram shows the absolute encoder with the duplex clock/data connections and signals.

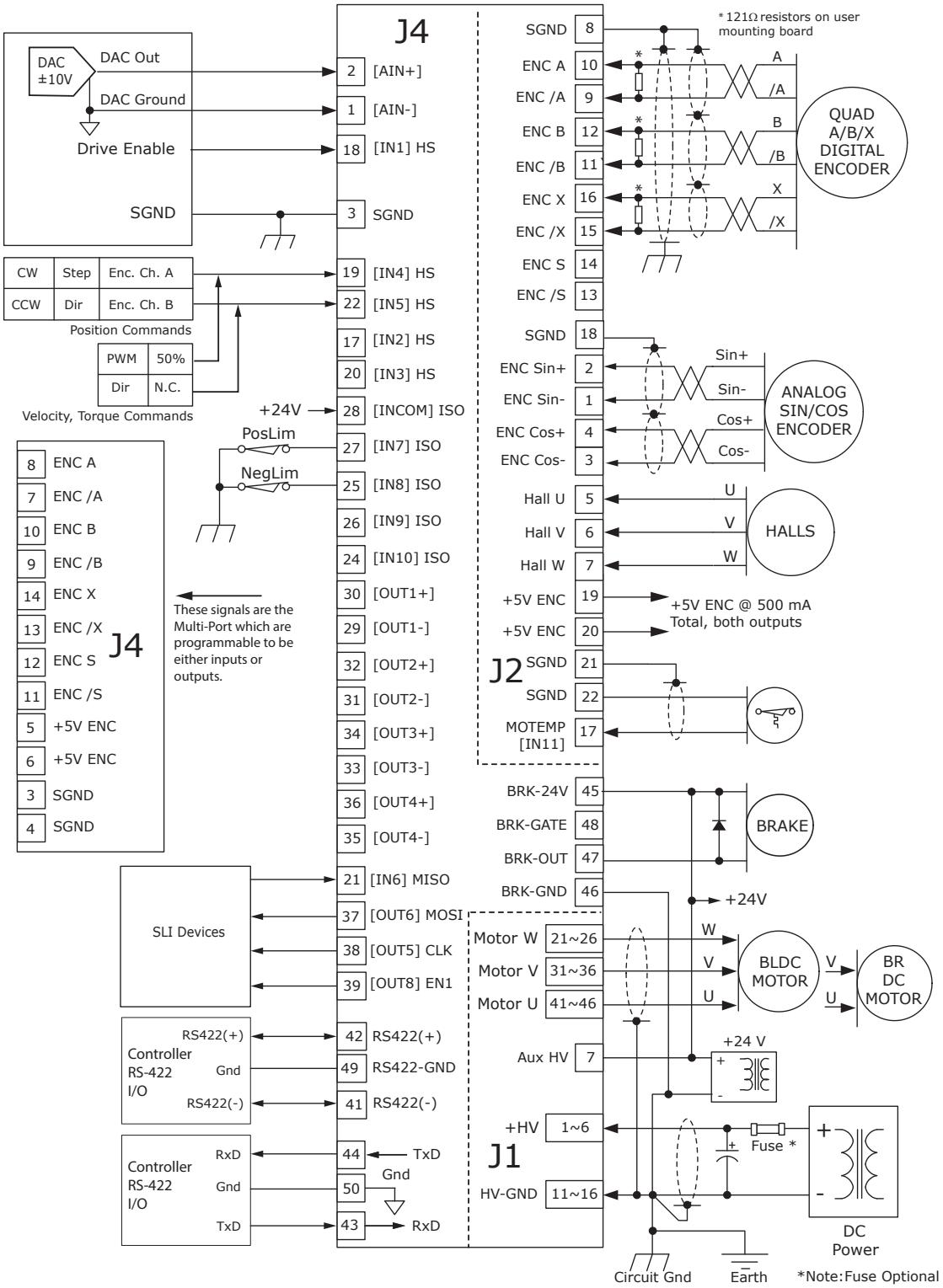


Absolute Encoder with Duplex Clock/Data Diagram

CONNECTORS & SIGNALS

CONNECTIONS FOR INCREMENTAL DIGITAL OR ANALOG ENCODERS

The following diagram shows the connections and signals for the digital and analog encoders.

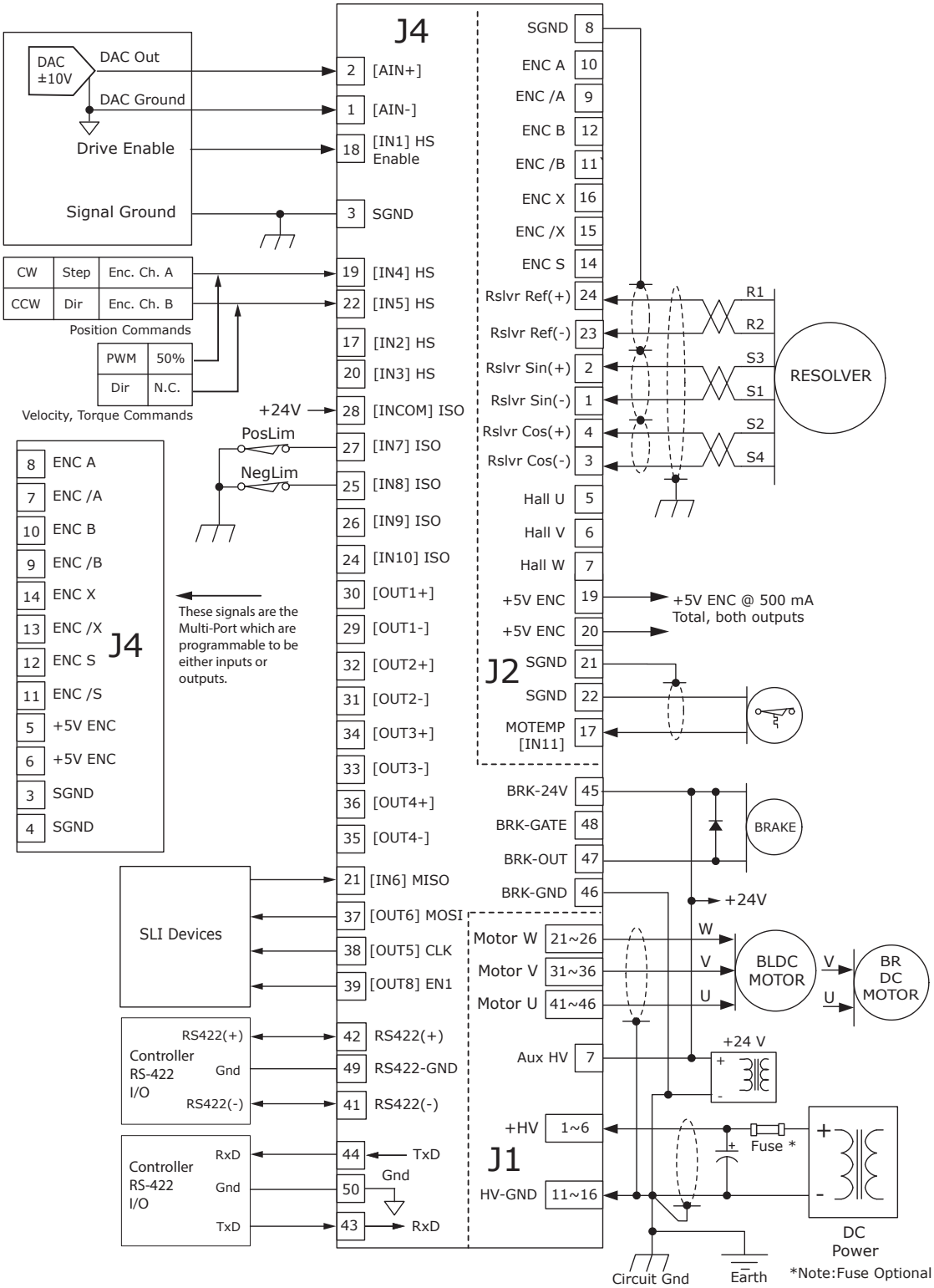


Incremental Digital/Analog Encoders Connections Diagram

CONNECTORS & SIGNALS

CONNECTIONS FOR RESOLVERS (-R OPTION)

The following diagram shows the connections and signals for the resolvers.



Resolvers (-R Option) Connections Diagram

CONNECTORS & SIGNALS

J1: HV & MOTOR

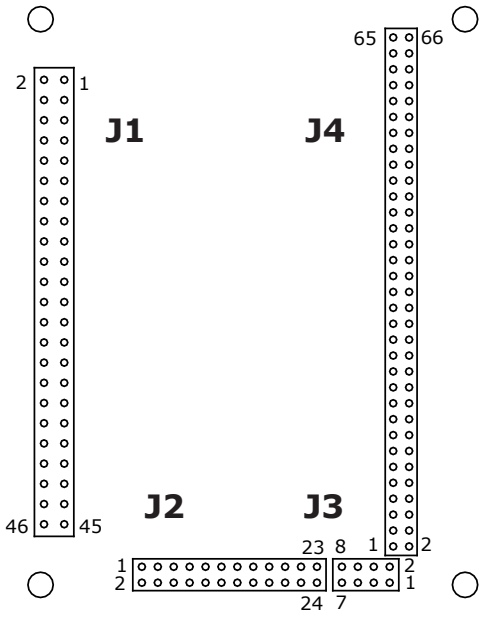
Signal	Pin		Signal
+HV	2	1	+HV
	4	3	
	6	5	
N.C.	8	7	HV Aux
	10	9	N.C.
HV Gnd	12	11	HV Gnd
	14	13	
	16	15	
N.C.	18	17	N.C.
	20	19	
Mot W	22	21	Mot W
	24	23	
	26	25	
N.C.	28	27	N.C.
	30	29	
Mot V	32	31	Mot V
	34	33	
	36	35	
N.C.	38	37	N.C.
	40	39	
Mot U	42	41	Mot U
	44	43	
	46	45	

J2: FEEDBACK

Signal	Pin		Signal
RES-REF-	23	24	RES-REF+
SGND	21	22	SGND
+5V ENC	19	20	+5V ENC
[IN11]	17	18	SGND
ENC /X	15	16	ENC X
ENC /S	13	14	ENC S
ENC /B	11	12	ENC B
ENC /A	9	10	ENC A
HALL W	7	8	SGND
HALL U	5	6	HALL V
COS-	3	4	COS+
SIN-	1	2	SIN+

Topside View

The following diagram shows the topside view of the PC board. It shows the connectors or the PC board footprint to which the module is mounted.



In the above diagram, the Jumpers are listed below:

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

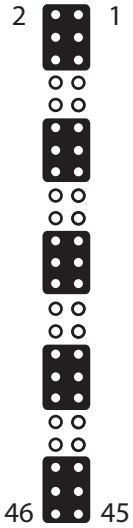
Signal	Pin		Signal
TX2TERM	65	66	TX2+
ECAT-SHLD	63	64	TX2-
RX2+	61	62	RX2TERM
RX2-	59	60	ECAT-SHLD
TX1TERM	57	58	TX1+
ECAT-SHLD	55	56	TX1-
RX1+	53	54	RX1TERM
RX1-	51	52	ECAT-SHLD
RS422-GND	49	50	SGND
Brake-Out	47	48	Brk-Gate
Brake-24V	45	46	Brake-Gnd
RS232 RxD	43	44	RS232 TxD
RS422(-)	41	42	RS422(+)
HS [OUT8] SLI-EN1	39	40	[OUT7] HS
HS [OUT6] SLI-MOSI	37	38	[OUT5] HS SLI-CLK
[OUT4-] ISO	35	36	ISO [OUT4+]
[OUT3-] ISO	33	34	ISO [OUT3+]
[OUT2-] ISO	31	32	ISO [OUT2+]
[OUT1-] ISO	29	30	ISO [OUT1+]
[IN7] ISO	27	28	ISO [INCOM]
[IN8] ISO	25	26	ISO [IN9]
SGND	23	24	ISO [IN10]
[IN6] HS SLI-MISO	21	22	HS [IN5]
[IN4] HS	19	20	HS [IN3]
[IN2] HS	17	18	HS [IN1]
SGND	15	16	SGND
ENC /X	13	14	ENC X
ENC /S	11	12	ENC S
ENC /B	9	10	ENC B
ENC /A	7	8	ENC A
+5V ENC	5	6	+5V ENC
SGND	3	4	SGND
[AREF-]	1	2	[AREF+]

J3: SAFETY

Signal	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(+)

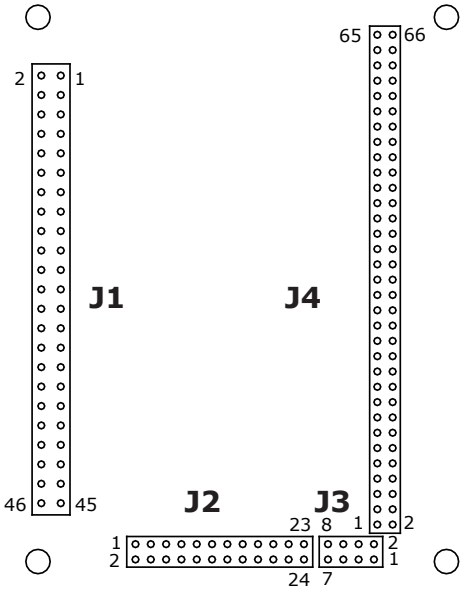
PRINTED CIRCUIT BOARD FOOTPRINT

J1 Signal Grouping for current-sharing (See Note 1).



Topside View

The following diagram shows the topside view of the PC board. It shows the connectors on the bottom surface of the PC board footprint to which the module is mounted.



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"

Note: The following includes the additional hardware (not shown above).

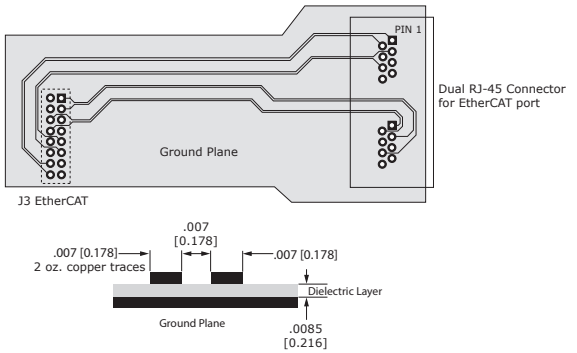
2	Screw, #4-40 x 1.25" Phillips Pan Head External Tooth Lockwasher, SEMS, Stainless, or steel with nickel plating, Torque to 3~5 lb-in (0.34~0.57 N·m)

Notes:
1. J1 signals of the same name must be connected for current-sharing (see the above diagram).
2. To determine copper width and thickness for J1 signals, refer to Specification IPC-2221. (Association Connecting Electronic Industries, http://www.ipc.org)
3. For maximum noice suppression and immunity, connect the standoffs or mounting screws to the etch on the PC board that connect to frame ground.

PRINTED CIRCUIT BOARD DESIGN FOR ETHERCAT SIGNALS

EtherCAT signal routing must produce a controlled impedance to maintain signal quality. The Ground Plane diagram shows the key principles of the PC board design that should be followed. Traces for differential signals must have controlled spacing trace-trace, trace thickness, and spacing above a ground plane. These principals and the properties of the dielectric between the ground plane and the signals affect the impedance of the traces.

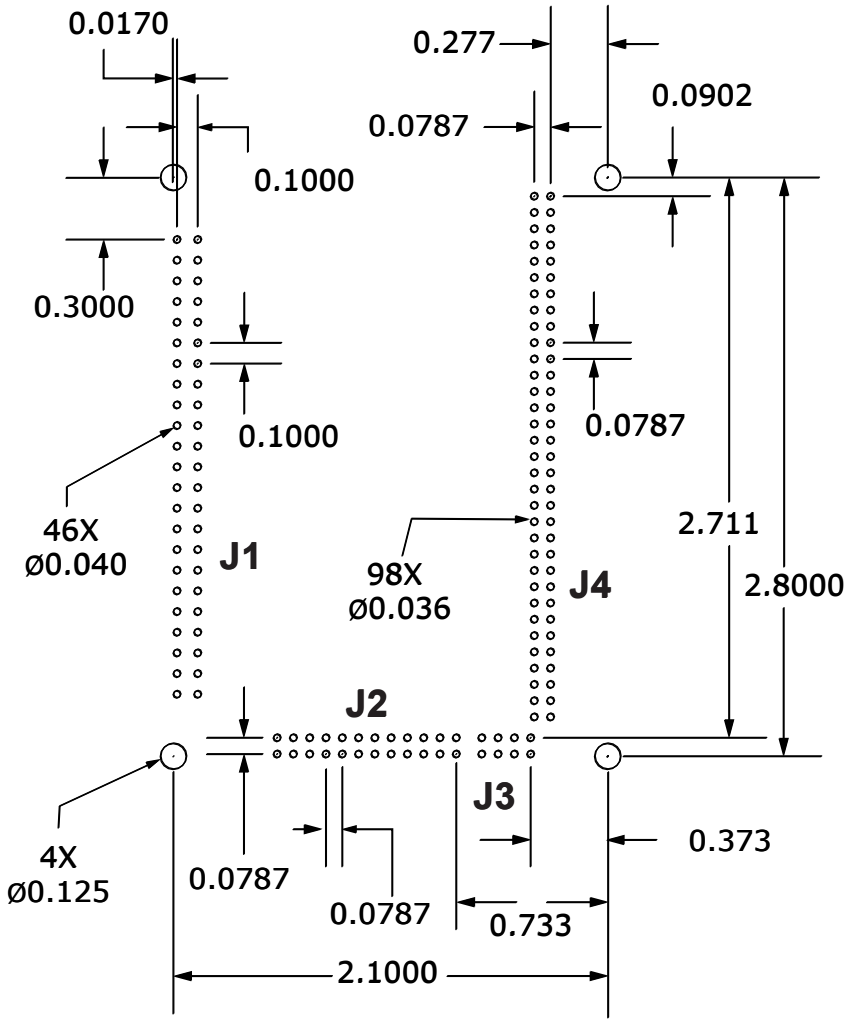
In the diagram, the dimensions shown are typical. On page 5, the EtherCAT Connections diagram shows the resistors and a capacitor in the drive for terminating the unused conductors. As an alternative to adding traces back to the drive connector J4 for these signals, the same parts can be placed on the board at the RJ-45 connector, leaving only the differential EtherCAT signals to be routed with controlled impedance.



Ground Plane Diagram

PRINTED CIRCUIT BOARD MOUNTING HOLE DIMENSIONS

The following diagram shows the mounting hole dimensions located from the topside looking down on the user PC mounting board.

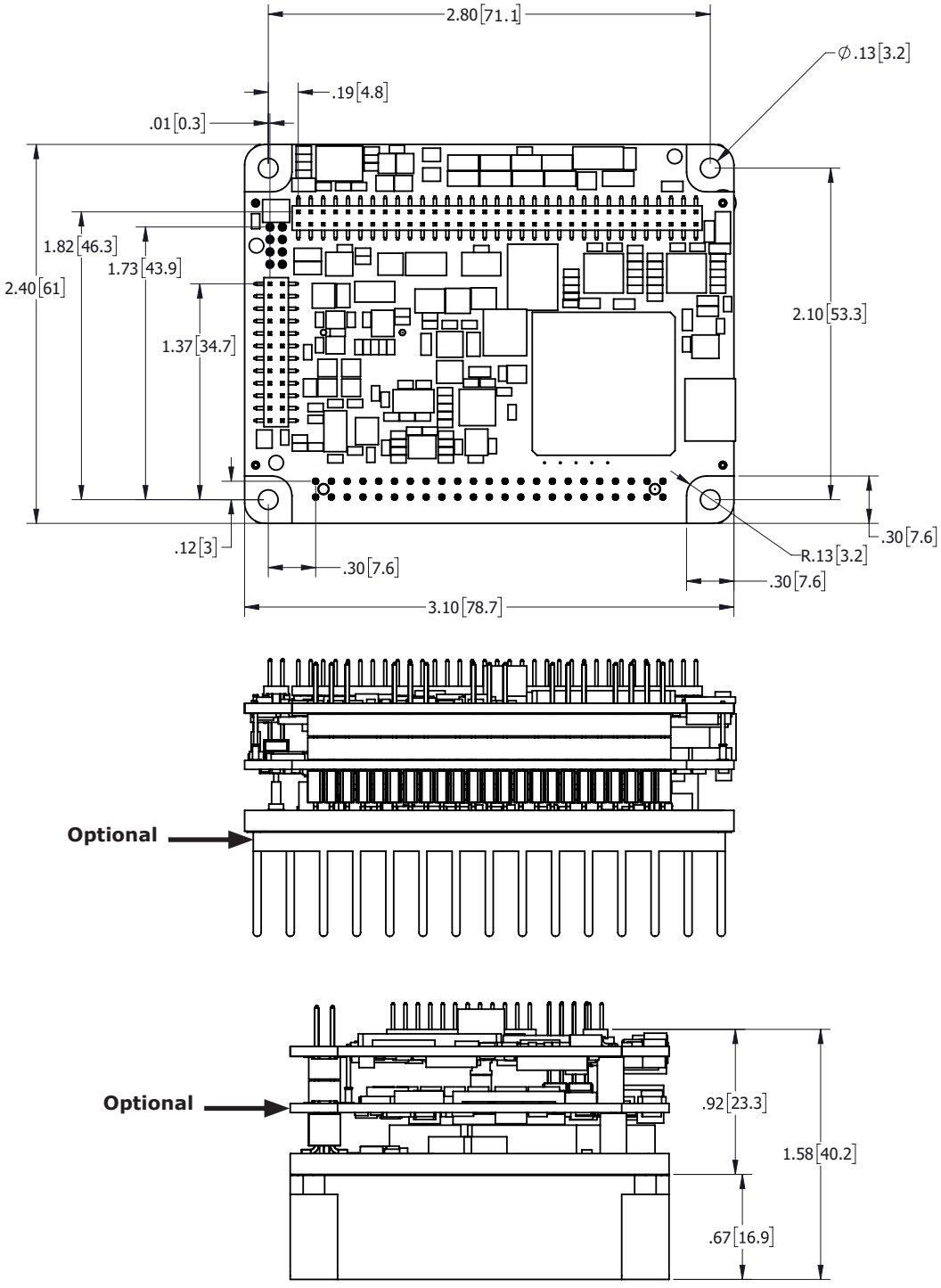


Note: Dimensions are in inches [mm].

PCB Mounting Hole Dimensions Diagram

DIMENSIONS

The following diagram shows the R71 dimensions and the optional components.



Note: Dimensions are in inches [mm].

R71 Dimensions Diagram

MOUNTING OPTIONS

The R71 drives can be mounted in the following 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.

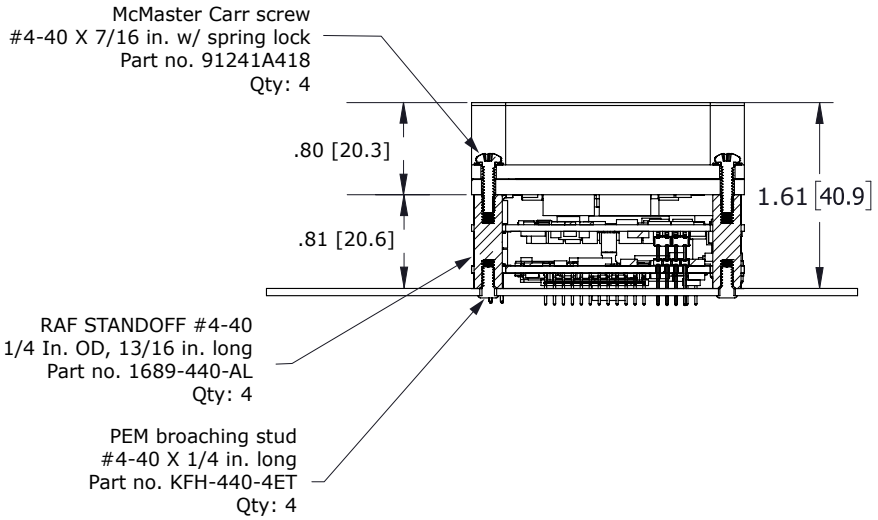
STANDOFF REQUIREMENTS:

In all configurations, the standoffs must be metal. This is required, because the standoffs 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 TO PC BOARD

In the Soldered Diagram, the hardware part numbers are listed and supplied by the user.

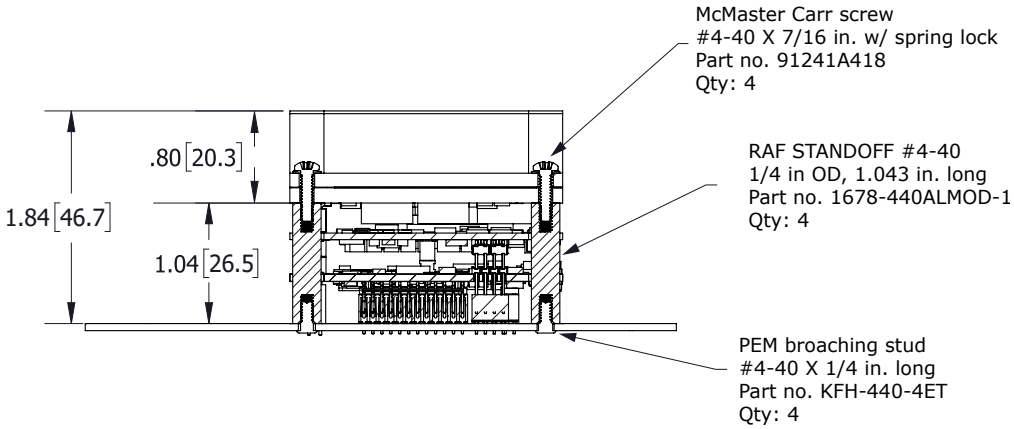


Soldered Diagram

MOUNTING METHODS: SOCKETED

In the Socketed Diagram, the hardware part numbers are listed and supplied by the user.

Refer to page 23 for PCB hardware part numbers.



Socketed Diagram

DEVELOPMENT KIT HEATSINK INSTALLATION

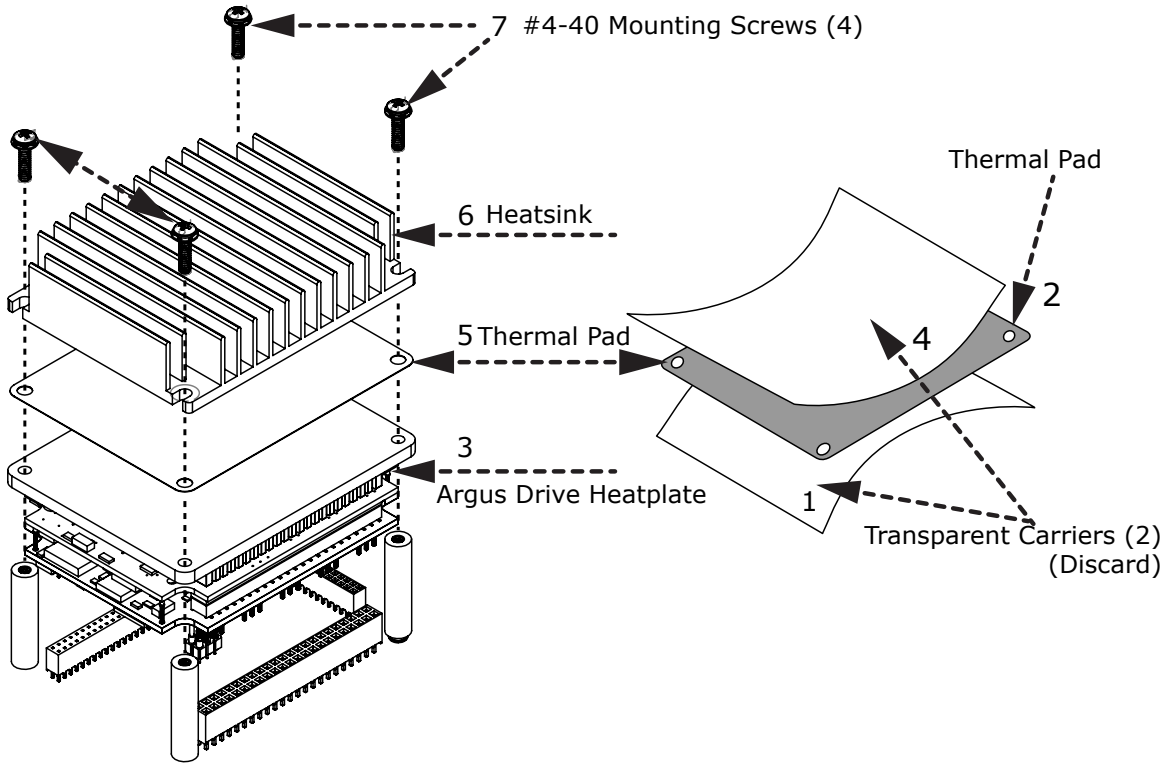
HEATSINK INSTALLATION USING THE GEM-HK HEATSINK KIT

An AOS Micro Faze thermal pad is used in place of thermal heatsink grease. This material comes in sheet form and changes from solid to liquid form as the drive warms up. The pad is die-cut to shape with mounting holes for the heatsink mounting screws.

This pad forms an excellent thermal path to transfer from the drive heatplate to the heatsink for optimum heat transfer. There are two protective sheets. Both sheets must be removed when the interface pad is installed.

INSTALLATION STEPS

1. Remove the protective sheet from one side of the pad.
2. Place the side of the thermal pad without the carrier onto the Argus aluminum heat plate. Be sure to center the thermal pad holes over the mounting holes on the drive heatplate.
3. Insert the drive into the sockets and press smoothly until the heatplate is resting on the standoffs.
4. Remove the second protective transparent plastic carrier from the thermal pad.
5. Place the heatsink onto the thermal pad. Align the holes in the heatsink, thermal pad on the drive.
6. Mount the heatsink onto the drive.
7. Insert the four #4-40 screws through the heatsink, and torque them to 3~5 lb-in, 80 in-oz, 0.56 Nm (0.34~0.57 N·m).
8. Apply a smaller torque to each screw in rotation until the final torque is reached.
   This action will ensure an even contact between the drive and the heatplate for best thermal transfer.



Heatsink Installation Diagram

GEM-HK HEATSINK KIT

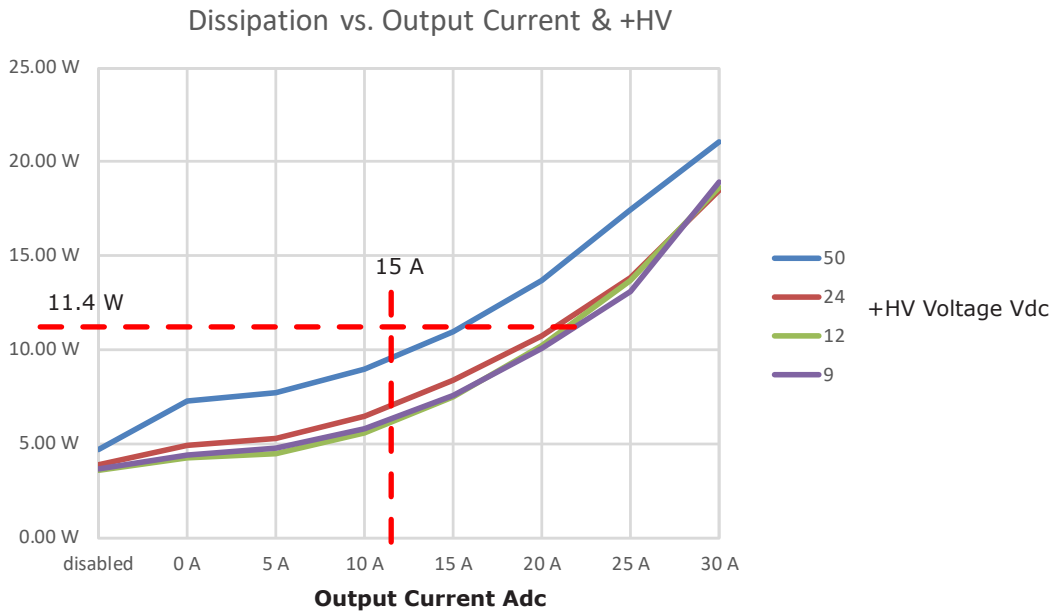
Item	Part Description	Qty
1	Heatsink Hardware Kit, contains 2 screws, 4-40, 1.25 in, Philips with locking washers	2
2	Heatsink, GEM	1
3	Thermal pad, GEM	1
4	Spacer Hardware Kit, contains 4 spacers, round, 6 mm diam, 3 mm ID, 20 mm long, AL	1

POWER DISSIPATION

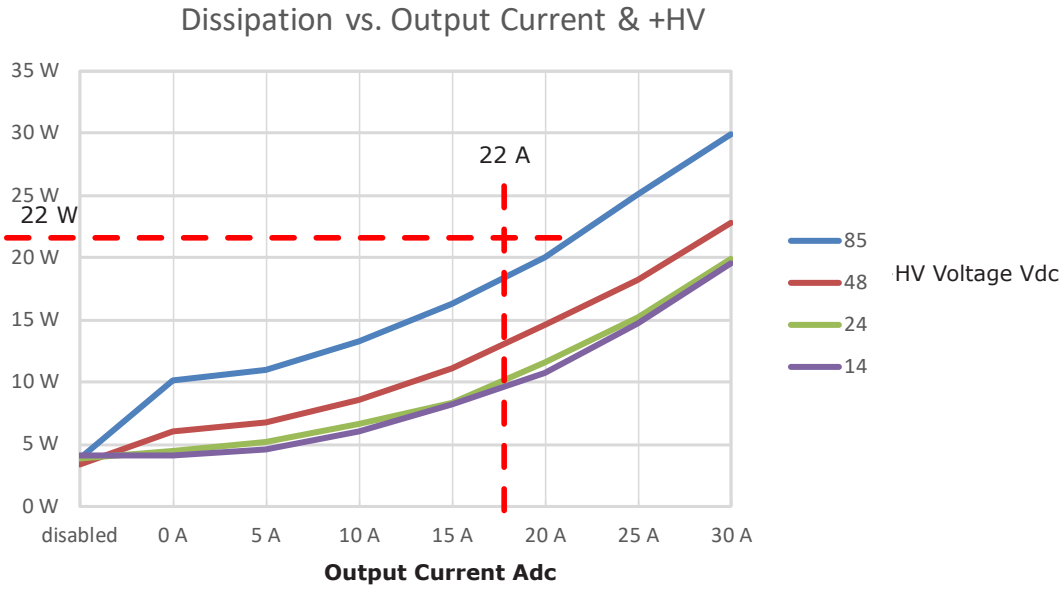
The following charts show the internal power dissipation for different models under differing power supply and output current conditions. The values on the chart represent the continuous current that the drive would provide during operation. The +HV values are used to calculate the average DC voltage of the drive power supply. To verify if a heatsink is required or not, the next step is to determine the temperature rise the drive will experience when it is 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 3.5º C/W with no heatsink, gives a dissipation of 11.4 W. This line is shown in the charts. For power dissipation below this line, no heatsink is required. The vertical dashed line shows that a heatsink is required for operation at the rated continuous current.

R71-055-60, R71-055-60-R



R71-090-60, R71-090-60-R



THERMAL RESISTANCE VS. MOUNTING & COOLING

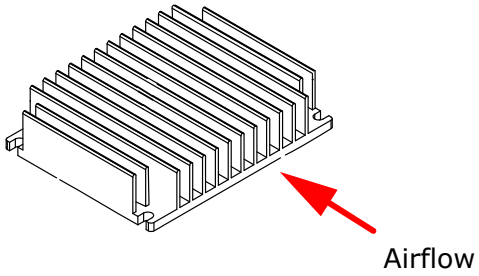
Tables 1 and 2 show the thermal resistance Rth in degrees-C per Watt (C/W) for the typical mounting and cooling configurations.

Table 1: No Heatsink		
LFM	0	300
Rth	3.5	1.3

Table 2: Heatsink		
LFM	0	300
Rth	2.0	0.9

The term, LFM, is Linear Feet per Minute. LFM is the velocity of air flow produced by a fan directed in line with the heatsink fins.

R71



EXAMPLE: FIND COOLING MEANS WITH DISSIPATION AND AMBIENT TEMPERATURE KNOWN

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

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

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

EXAMPLE: FIND MAX AMBIENT TEMP WHEN DRIVE CONFIGURATION IS KNOWN

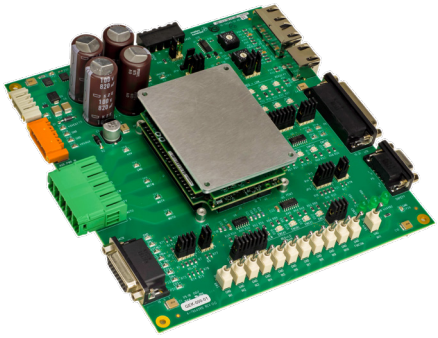
Given: Heatsink, forced-air at 300 LFV, dissipation is 26.5 W
Rth = 0.9 ºC/W
Tmax = 80 ºC (drive shut-down temperature)

Find: Max. ambient operating temperature
Delta-T = 26.5 W x 0.9 ºC/W = 23.9 ºC
Max. Tamb = Tmax - Delta-T = 90 – 23.9 = 66 ºC
Max. ambient operating temperature is 45 °C so it can operate up to this temperature.

DEVELOPMENT KIT

DESCRIPTION

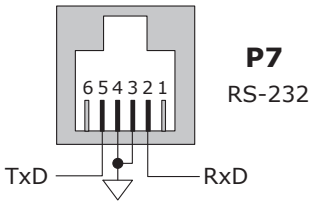
The Development Kit provides mounting and connectivity for one R71 drive. Solderless jumpers simplify the configuration of inputs and outputs to support their programmable functions. Switches can be jumpered to connect to digital inputs 1~10 so that these switches can be toggled to simulate equipment operation.
Dual EtherCAT connectors make daisy-chain connections possible so that other EtherCAT devices such as Copley's Argus Plus or Xenus Plus Ethercat drives can easily be connected.



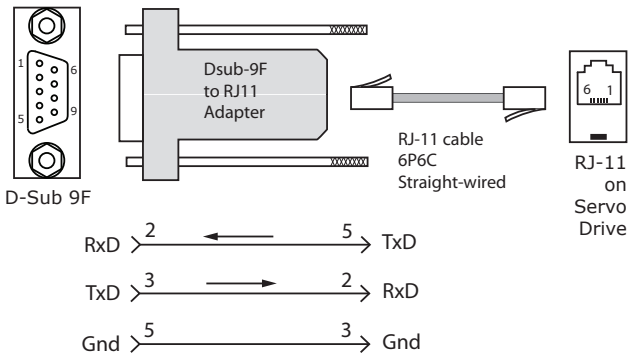
R71

RS-232 CONNECTION

The RS-232 port is used to configure the drive for stand-alone applications, or it is used for configuration before it is installed into an EtherCAT network. Use the CME software to communicate with the drive over this link. It is then used for the complete drive setup. The EtherCAT 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.



P7 Diagram



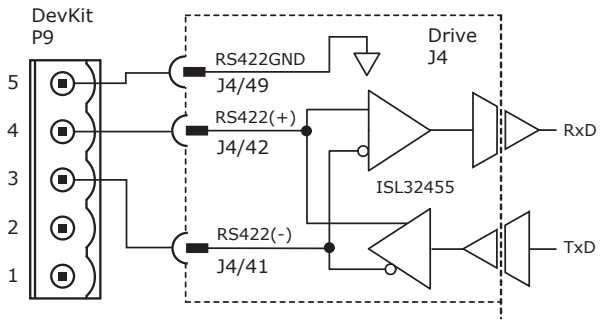
SER-USB-RJ11

This device provides connectivity between a USB connector and the RJ-11 connector J9 on the DEV board.

P9: RS-422 COMMUNICATIONS

RS-422 is a 2-wire differential half-duplex port that operates from 9600 bps to 230.4 kbps. Use P9 to connect to the RS-422 port. The DevKit P9 Diagram shows the connections between a R71 and a computer RS-422 port.

Note: Use the Serial Interface Cable USB to RJ11 (SER-USB-RJ11) to plug-in to either a customer-designed board with an RJ11 or a Copley drive. When you order either type of board, the Manufacturer recommends you order the Serial Interface Cable USB to RJ11 (SER-USB-RJ11).



DevKit P9 Diagram

ETHERCAT

P8: ETHERCAT CONNECTIONS

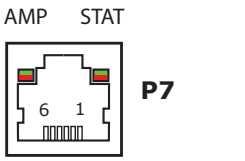
Dual RJ-45 sockets accept standard Ethernet cables. The IN port connects to a master, or to the OUT port of a device that is 'up stream', between the Argus and the master.

The OUT port connects to 'downstream' nodes. If Argus is the last node o n a network, only the IN port is used. No terminator is required on the OUT port.

STAT LED

A single bi-color STAT LED displays the state of the NMT state-machine and combines the functions of the RUN and ERR LEDs. The LED may change color, and can be either Blinking or solid On. Green, Red colors and the blink combinations are listed as follows.

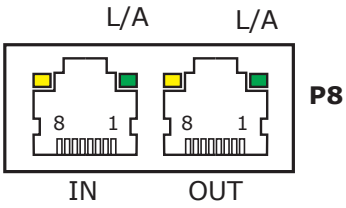
RUN (Green) Green shows the ETHECAT State Machine:		**ERR (Red)** Red shows the error conditions:	
OFF	= INIT	Blinking	= Invalid Configuration
BLINKING	= Pre-operational	Single Flash	= Unsolicited State Change
Single Flash	= Safe-Operational	Double Flash	= Application Watchdog timeout
ON	= Operational		



L/A (LINK/ACT) LED

A Green LED indicates the state of the EtherCAT network:

LED	Link	Activity	Condition
On	Yes	No	Port Open
Flickering	Yes	Yes	Port Open with activity
off	No	(N/A)	Port Closed



AMP LED

A single bi-color LED displays the state of the drive. Colors do not alternate, and can be solid On or Blinking. When multiple conditions occur, only the top-most condition will be displayed.

When that condition is cleared, the next condition in the table will be shown. The color and blink combinations are listed as follows.

LED	Condition Description
Green/Solid	Drive OK and enabled. Will run in response to reference inputs or EtherCAT commands.
Green/Slow-Blinking	Drive OK but NOT-enabled. Will 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.

Default	Optional (Programmable)
Short circuit (Internal or External)	Over-voltage
Drive over-temperature	Under-voltage
Motor over-temperature	Motor Phasing Error
Feedback Error	Command Input Lost
Following Error	

EtherCAT DEVICE ID

In an EtherCAT network, slaves are automatically assigned fixed addresses based on their position on the bus. When a device must have a positive identification that is independent of cabling, a Device ID is needed. In the R71 DevKit, this is provided by two, 16-position rotary switches with hexadecimal encoding. These switches can set the Device ID of the drive from 0x01~0xFF (1~255 decimal). In the table, the Decimel column includes the decimal values and the HEX column includes the corresponding hex settings for each switch (SW1 and SW2).

For Example: To find the switch settings for the Decimal Device ID 107, refer to the table to calculate the following:

1) In the table SW2 column, find the highest number that is less than 107, (96).
   Refer to the SW2 column and set SW2, (96) to the corresponding hex value that appears in the HEX column, (6).
   96 < 107 and 112 > 107, so SW2 = 96 = Hex 6
2) Subtract 96 from the desired Device ID (107) to get the decimal value of switch SW1, (11). Refer to the SW1 column and set SW1, (11) to the corresponding hex value that appears in the HEX column, (B).
   SW1 = (107 - 96) = 11 = Hex B

EtherCAT Device ID Switch Decimal Values

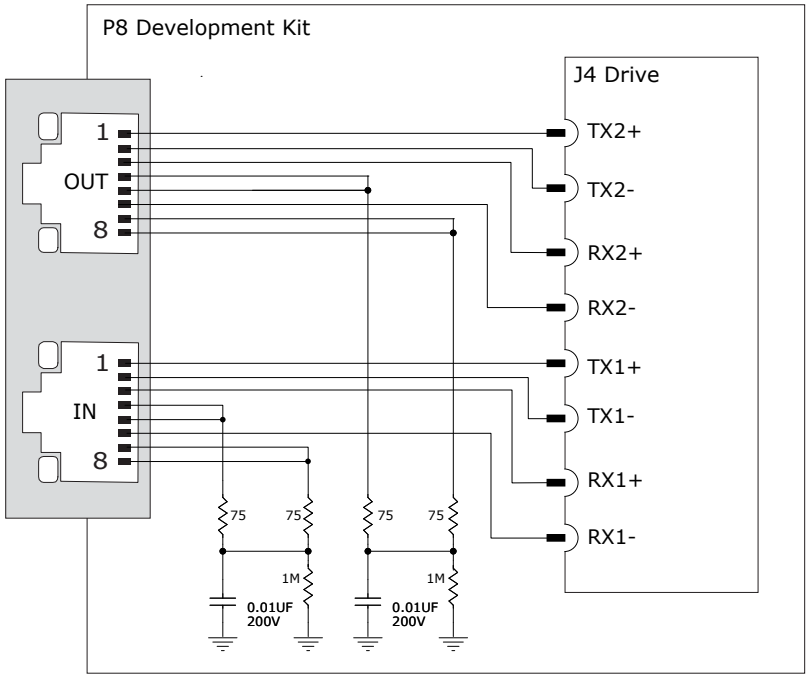
	SW2	SW1
HEX	Decimel	
0	0	0
1	16	1
2	32	2
3	48	3
4	64	4
5	80	5
6	96	6
7	112	7
8	128	8
9	144	9
A	160	10
B	176	11
C	192	12
D	208	13
E	224	14
F	240	15

ETHERCAT CONNECTORS & SIGNALS

ETHERCAT CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet cables are provided for the EtherCAT connectivity.

Pin	IN Signal	OUT Signal
1	TX1+	TX2+
2	TX1-	TX2-
3	RX1+	RX2+
4	75 Ω to 1 MΩ || 10 nF R/C	75 Ω to 1 MΩ || 10 nF R/C
5		
6	RX1-	RX2-
7	75 Ω to 1 MΩ || 10 nF R/C	75 Ω to 1 MΩ || 10 nF R/C
8		

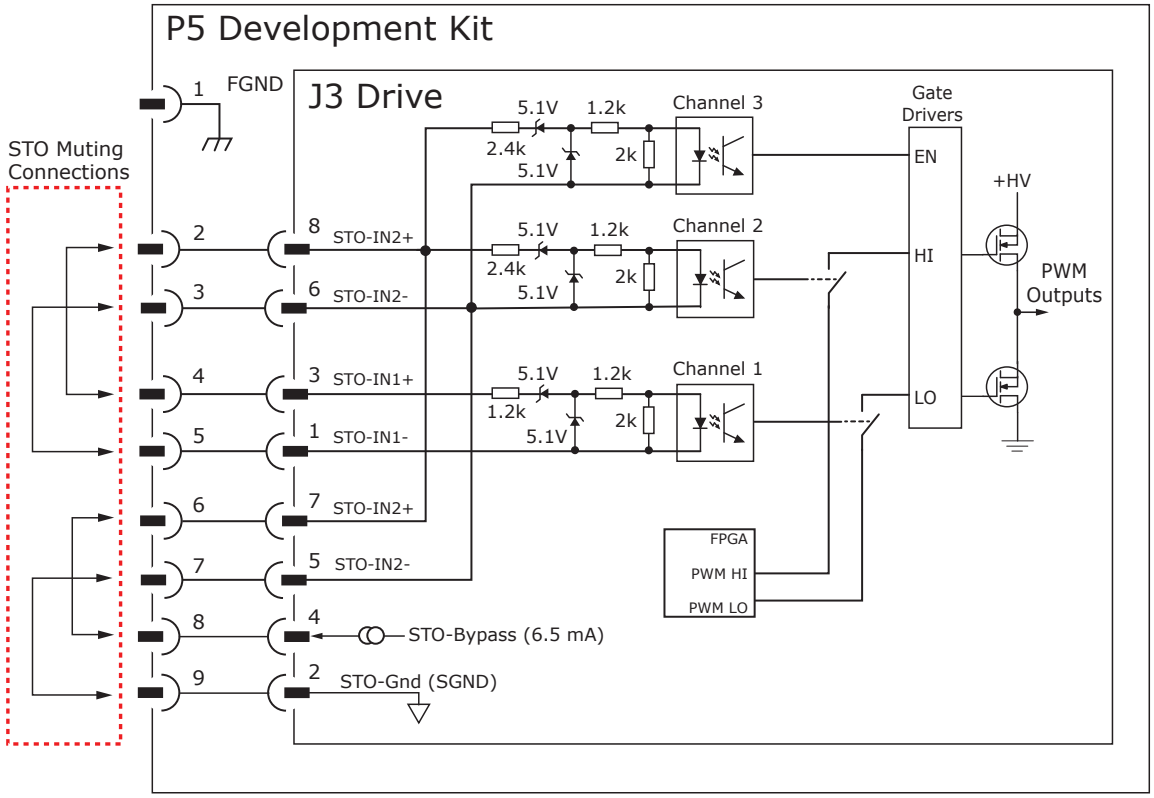


EtherCAT Connectors Diagram

SAFE TORQUE OFF (STO)

DESCRIPTION

If the STO feature is not used, the STO function can be disabled by adding jumpers to a connector for P5 as shown in the following diagram.



STO Diagram

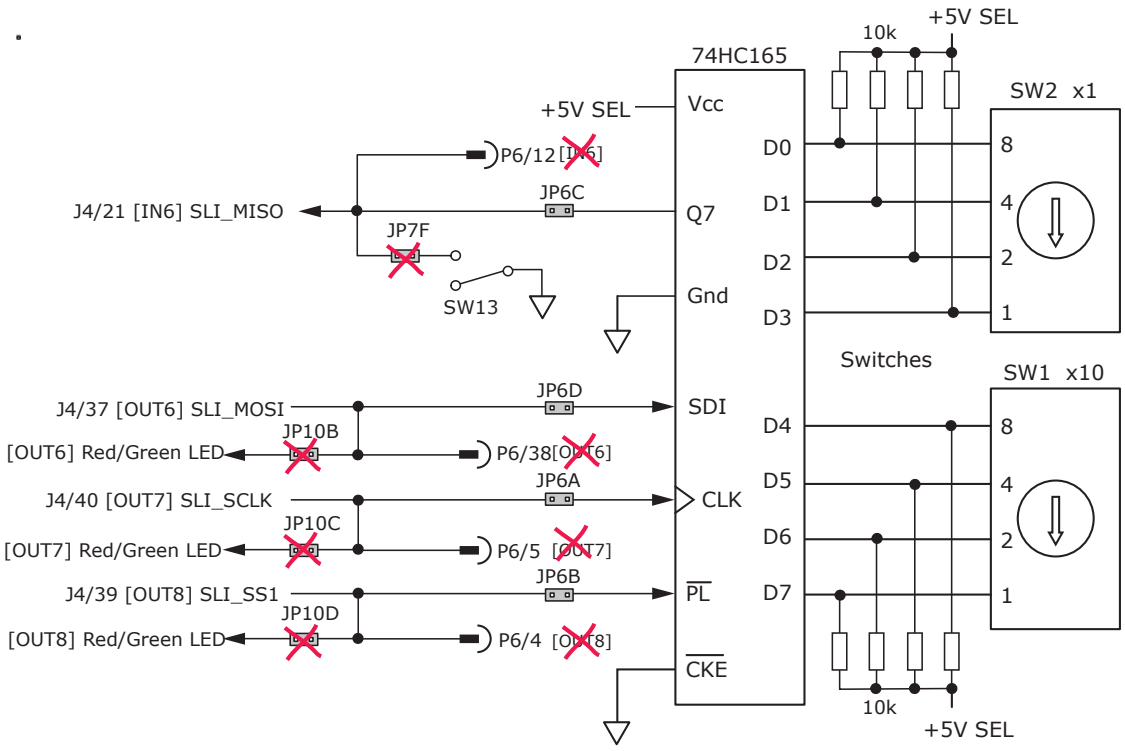
ETHERCAT DEVICE ID SWITCHES

EtherCAT Device ID (Station Alias) Switch Connections

The following diagram shows the connections to the EtherCAT Device ID switches. These switches are read after the drive is reset or powered-On. When the user changes the settings of the switches, be sure to either reset the drive or power the drive Off-On. Outputs [OUT6,7,8] and input [IN6] operate as an SLI (Switch & LED Interface) port which reads the settings on the EtherCAT 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. Remove the jumpers marked with red "X", so that SW13 or the external connections to the signals do not interfere with the operation of the SLI port. The "X" on [OUT6] indicates that the user should not make connections to this output when the SLI port is active.

CME -> Input/Output -> Digital Outputs

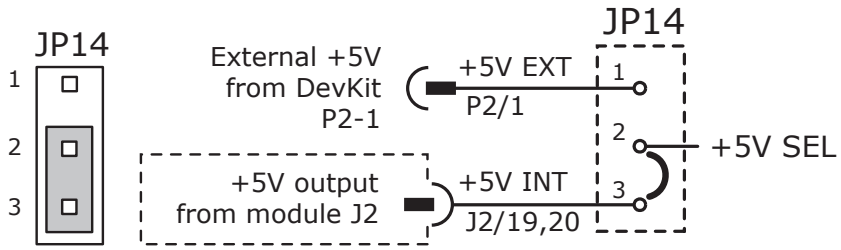


EtherCAT Device ID Switch Connections Diagram

5v Power Sources

Power for circuits on the Development Kit (+5V SEL) can be supplied from either the the servo drive (+5V INT) or from an external +5V power supply (+5 EXT).

Jumper JP14 selects the source of the +5V SEL from either the drive or from the external source.



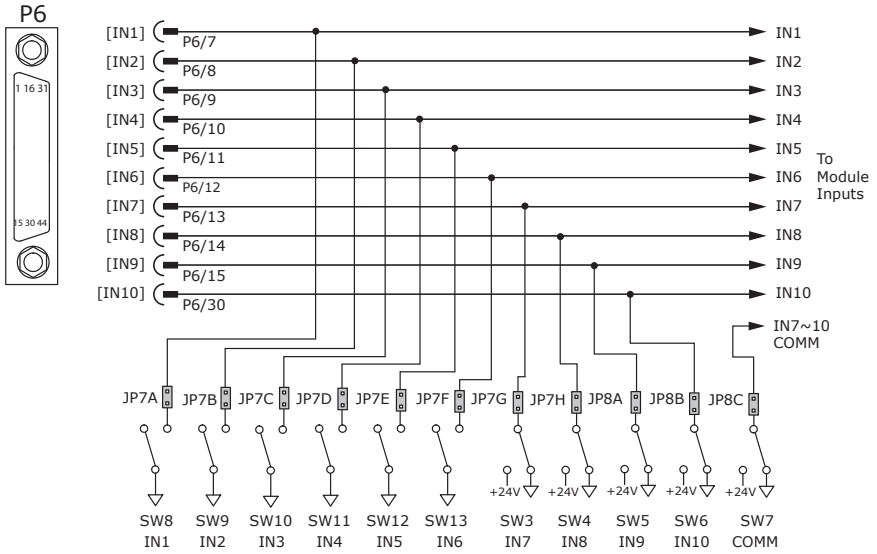
5V Power Sources Diagram

CONNECTORS & SIGNALS

LOGIC INPUTS & SWITCHES

The Development Kit includes jumpers that can connect the R71 digital inputs to switches on the kit, or connect to the Signal connector P6. As delivered, the following diagram shows all of these jumpers installed. If the user is connecting to external devices that actively control the level of an input, the manufacturer recommends to disconnect the switch which could short the input to the ground.

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

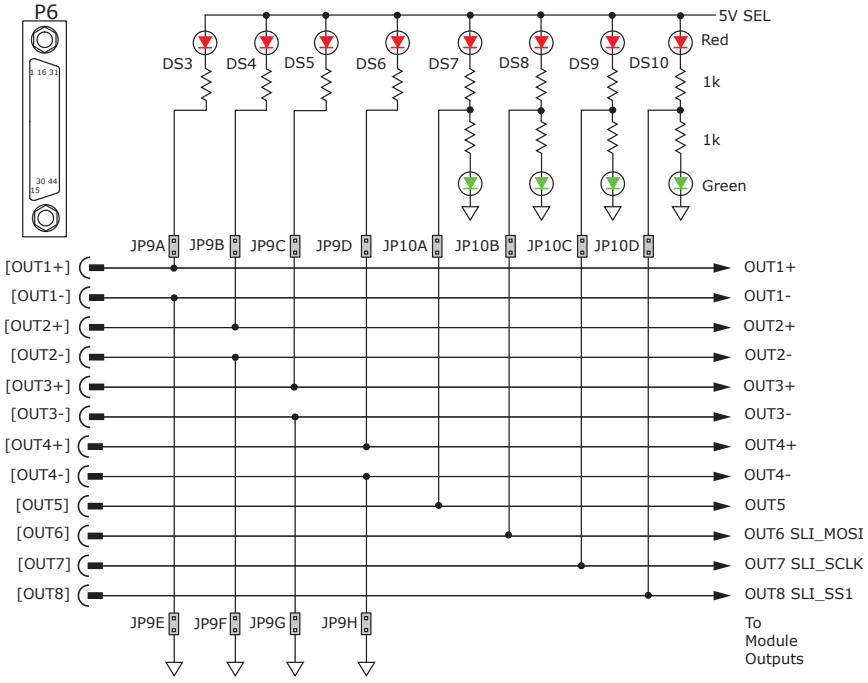


Logic Inputs Diagram

LOGIC OUTPUTS

There are logic outputs that can drive the 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 and 8 are CMOS types that pull-up to 5V or pull-down to the ground.

When these outputs go high, the Green LED turns On. When the outputs go low, the Red LED turns On. Outputs 1,2,3, & 4 are two-terminal opto-isolated types. The following diagram shows the jumpers in place when the outputs display the Green LEDs (DS7~ DS10) turned On. They will drive the current through the LEDs (DS3~DS6).



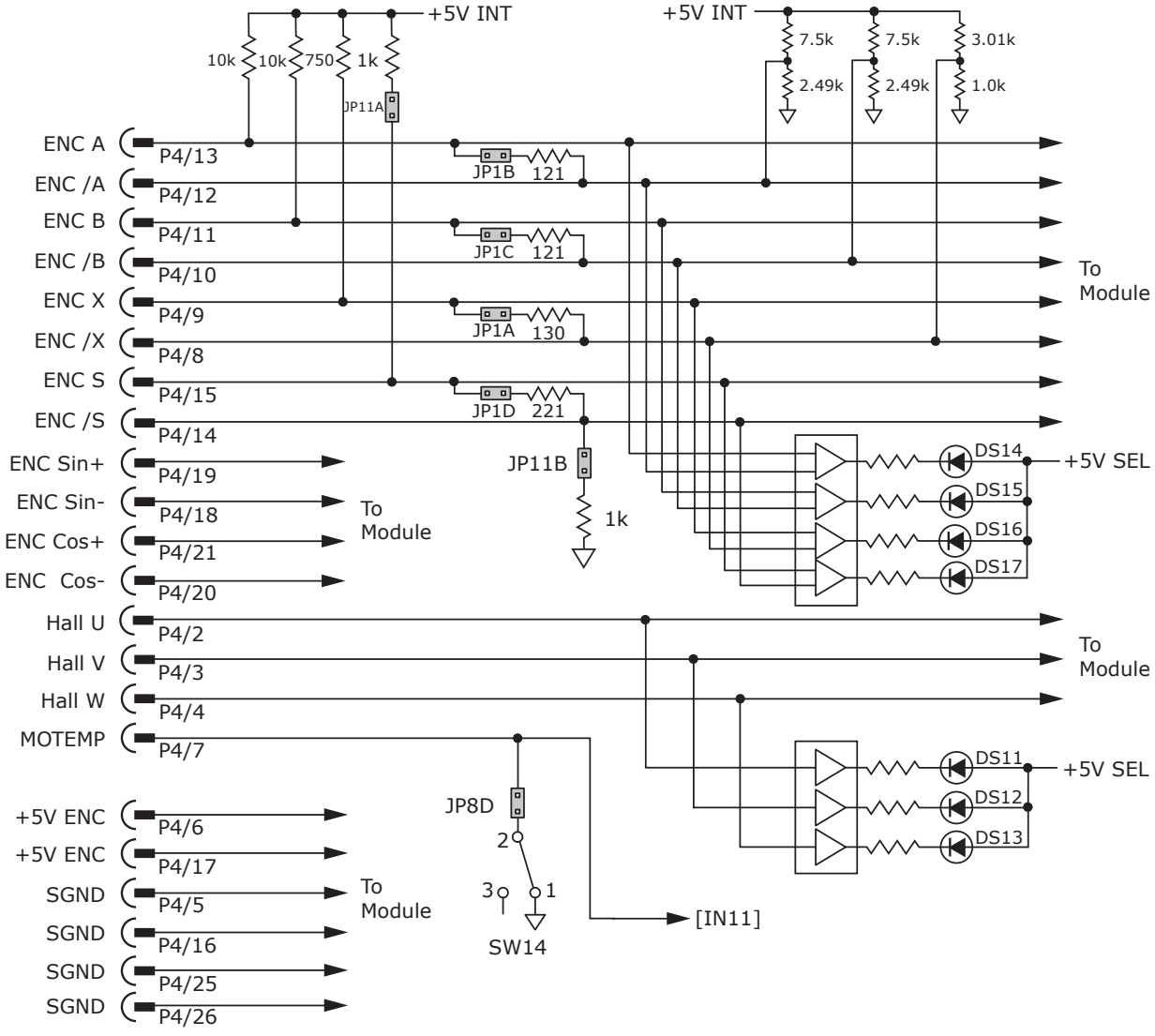
Logic Outputs Diagram

FEEDBACK CONNECTORS & SIGNALS

MOTOR FEEDBACK CONNECTOR P4

The motor feedback connector, P4 is used as follows:

- 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.
- If a motor temperature sensor connects to [IN11], the user must remove jumper JP8D 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 the line termination and biasing.
- The LEDs display the status of the encoder and the Hall signals.



Motor Feedback Connector P4 Diagram

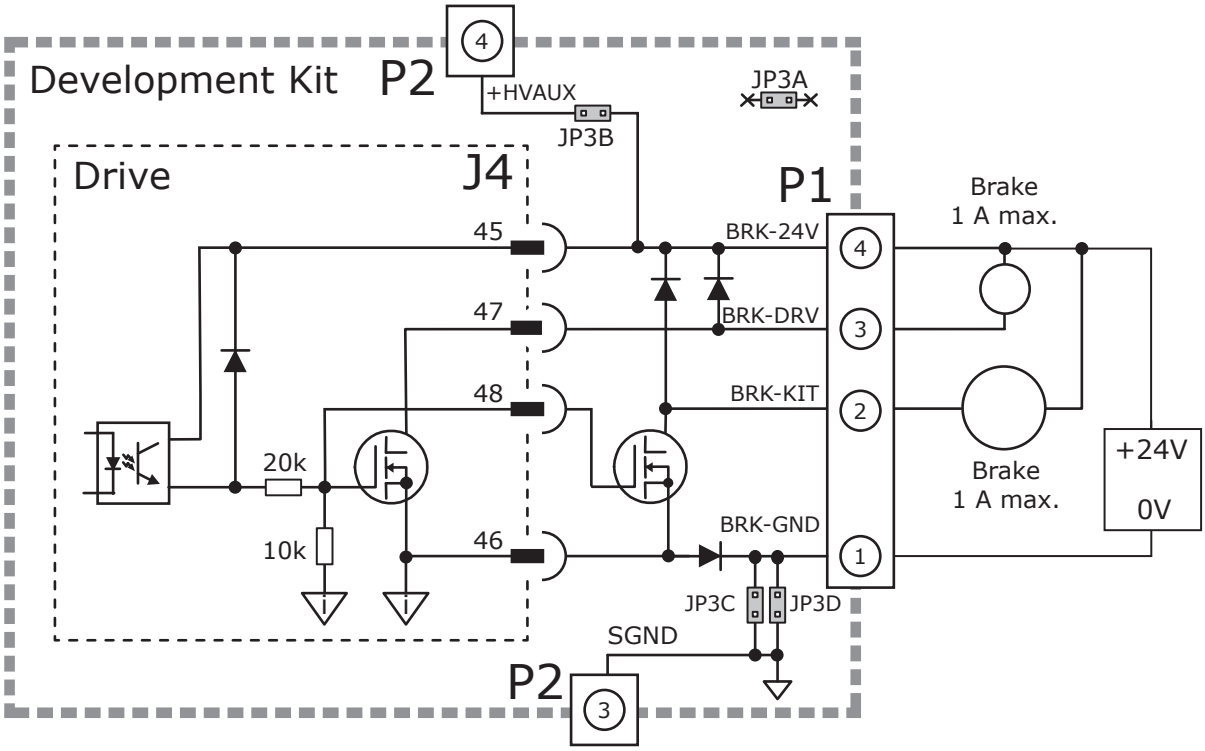
BRAKE CONNECTOR & SIGNALS

In the R71, the brake circuit is optically isolated from the other drive circuits. In addition, the brake circuit (included in the Development Kit) is isolated from the other circuits in the kit. Jumpers are provided that connect the kit brake circuits to the +24V (HVAUX) power and connect to the +HVCOM (HV Power Ground and Signal Ground).

When the jumpers are in place, by supplying +24V to P2-4 and ground to P2-3, the jumpers will power the brake circuit. When this is done, either of the following can occur:

- a low-current brake can be connected to P1-3 and P1-4.
- a higher-current brake can be connected between P1-4 and P1-2 .

The +24V power supply must supply the required current to energize the brake.



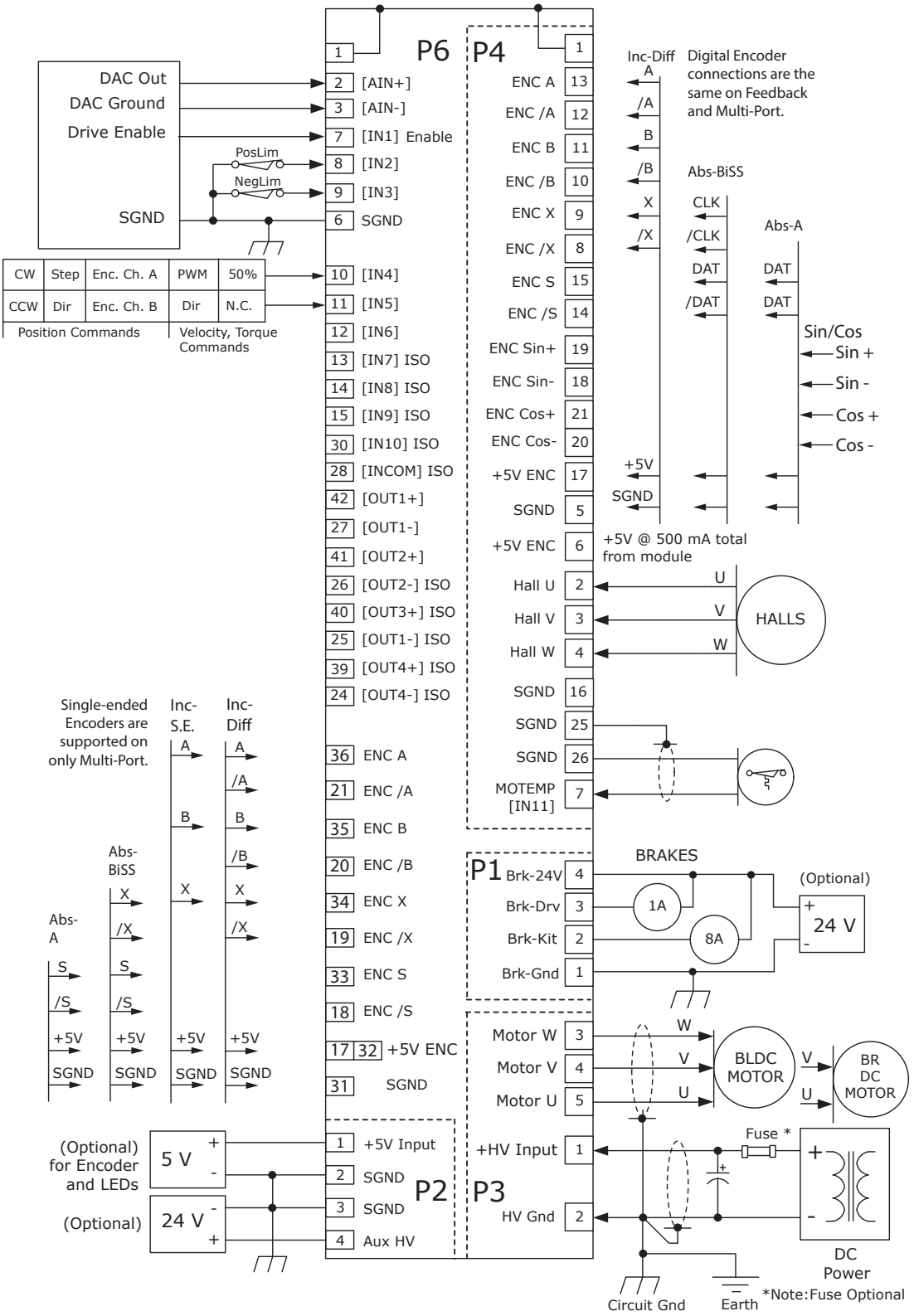
Brake Connector and Signals Diagram

Note: 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 in the above diagram.

WARNING	***Refer to the AN136 Accelnet External Regen Application Note, Part Number 16-125661.***
	Vlogic +9~60. 24V power is recommended. If a 24V Brake is used, 24V is required. If common to HV, do not exceed 60V. Use REGEN protection and diode isolation from HV.

DEVELOPMENT KIT CONNECTIONS

The following diagram shows the R71 development kit connections.



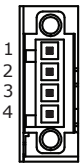
Development Kit Connections Diagram

DEVELOPMENT KIT CONNECTORS

Note: For information on P9, refer to the Table, P9-RS422 on page 39.

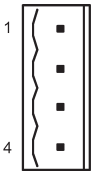
P1 BRAKE

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



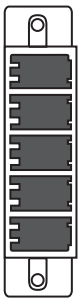
P2 AUX HV & +5V

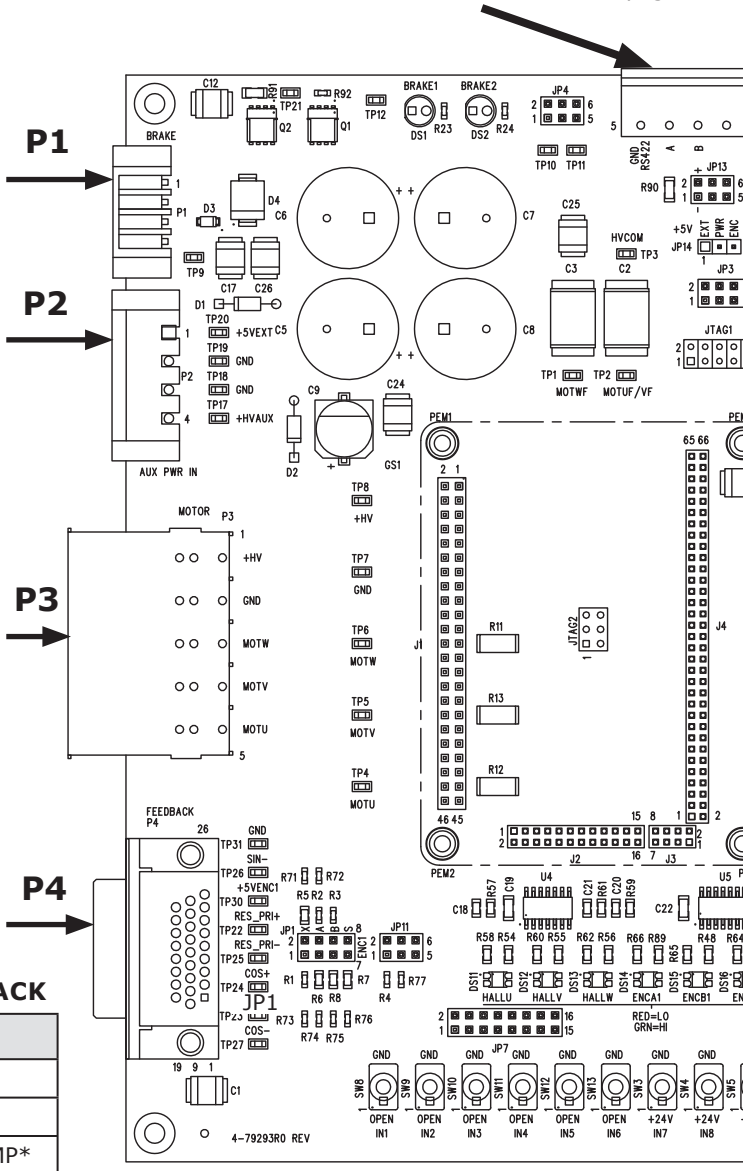
Signal	Pin
+5 Ext	1
Gnd	2
Gnd	3
Aux HV	4



P3 MOTOR & +HV POWER

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





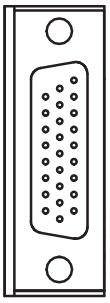
P4 FEEDBACK

Pin	Signal
26	SGND
25	SGND
24	N.C.
23	Rslvr Ref(+)
22	Rslvr Ref(-)
21	COS+
20	COS-
19	SIN+

Pin	Signal
18	Sin-
17	+5V ENC
16	SGND
15	ENC S
14	ENC /S
13	ENC A
12	ENC /A
11	ENC B
10	ENC /B

Pin	Signal
9	ENC X
8	ENC /X
7	[IN11] MOTEMP*
6	+5V ENC
5	SGND
4	Hall W
3	Hall V
2	Hall U
1	FGND

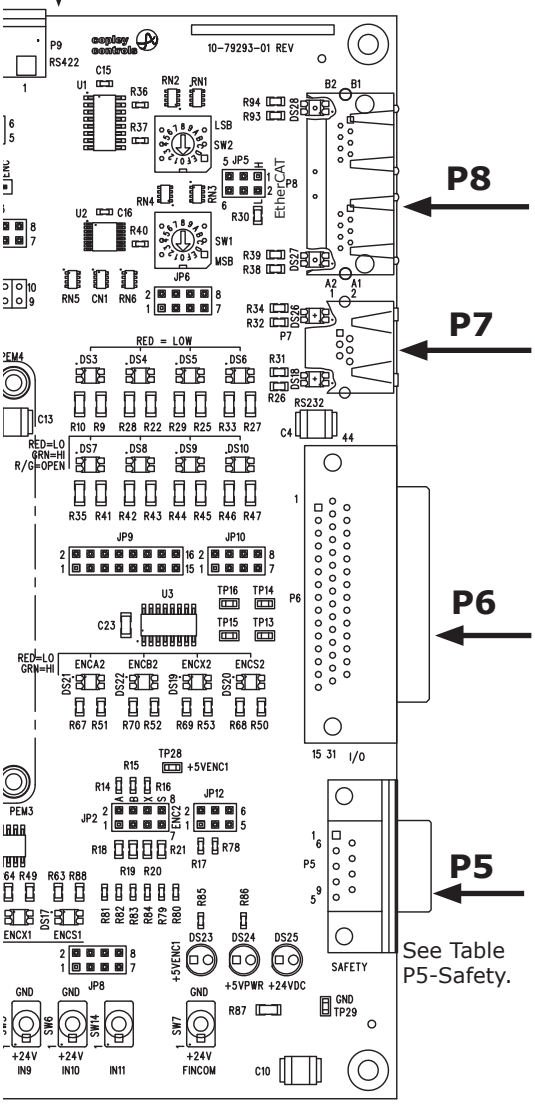
*Note: In the Signal column, the connections on the PC board are affected by the jumper placement.



Input Switches

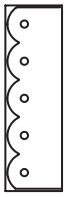
DEVELOPMENT KIT CONNECTORS

P9 (See Table-P9 RS-422).



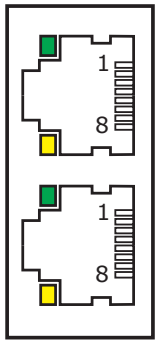
P9 RS-422

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



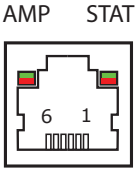
P8 EtherCAT

Pin	Signal
1	TX1+
2	TX1-
3	RX1+
4	RX1TERM
5	RX1TERM
6	RX1-
7	
8	



P7 RS-232

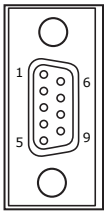
Pin	Signal
1	N.C.
2	RxD
3	SGND
4	SGND
5	Txd
6	N.C.



P6 CONTROL

Pin	Signal	Pin	Signal	Pin	Signal
1	FGND	16	SGND	31	SGND
2	[AIN-]	17	+5V ENC	32	+5V ENC
3	[AIN+]	18	/S Multi-Port	33	S Multi-Port
4	[OUT8] SLI-EN1	19	/X Multi-Port	34	X Multi-Port
5	[OUT7] SLI-CLK	20	/B Multi-Port	35	B Multi-Port
6	SGND	21	/A Multi-Port	36	A Multi-Port
7	[IN1] HS	22	SGND	37	SGND
8	[IN2] HS	23	[OUT5] SLI-CLK	38	[OUT6] SLI-MOSI
9	[IN3] HS	24	[OUT4-] ISO	39	[OUT4+] ISO
10	[IN4] HS	25	[OUT3-] ISO	40	[OUT3+] ISO
11	[IN5] HS	26	[OUT2-] ISO	41	[OUT2+] ISO
12	[IN6] HS	27	[OUT1-] ISO	42	[OUT1+] ISO
13	[IN7] ISO	28	[INCOM] ISO	43	N.C.
14	[IN8] ISO	29	N.C.	44	SGND
15	[IN9] ISO	30	[IN10] ISO		

P5 SAFETY



Pin	Signal	Pin	Signal
1	FGND	6	STO-IN2(+)
2	STO-IN2(+)	7	STO-IN2(-)
3	STO-IN2(-)	8	STO-BYPASS
4	STO-IN1(+)	9	STO-GND
5	STO-IN1(-)		

ORDERING INFORMATION

Ordering Guide

Part Number	Description
R71-055-60	R71 Servo Drive, 30/60 Adc, 9~55 Vdc, with encoder feedback
R71-055-60-R	R71 Servo Drive, 30/60 Adc, 9~55 Vdc, with resolver feedback
R71-090-60	R71 Servo Drive, 30/60 Adc, 14~90 Vdc, with encoder feedback
R71-090-60-R	R71 Servo Drive, 30/60 Adc, 14~90 Vdc, with resolver feedback

Example: Order one Argus Plus R71 drive, 30/60 Adc with Resolver Feedback, Development Kit, Connector Kit, Serial Cable, and Heatsink Kit.

Qty	Item	Description
1	R71-055-60-R	Argus Plus R71 servo drive with resolver feedback
1	GEK-090-01	Development Kit
1	GEK-CK	Connector Kit
1	SER-USB-RJ11	Serial Interface Cable
1	GEM-HK	Heatsink Kit

Accessories

Part Number	Description
GEK-090-01	Development Kit for all R71 models
GEK-CK	Connector Kit for Development Kit (see details below)
GEK-HK	Heatsink Kit (Heatsink, thermal pad and hardware)
SER-USB-RJ11	Copley USB to Serial Adapter 8.2 ft (2.5 m)

GEK-CK Connector Kit for Development Kit

Model	Ref	Name	Qty	Description	Manufacturer P/N
GEK-090-01					
GEK-CK Connector Kit for Development Kit	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-pin D-sub solder cup	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

Note: Specifications subject to change without notice.

GEM-HK: Heatsink Kits

Item	Description	Quantity
1	Heatsink Hardware Kit, has 2 screws, 4-40, 1.25 in. Phillips with locking washers	2
2	Heatsink, GEM	1
3	Thermal Pad, GEM	1
4	Spacer Hardware Kit, has 4 spacers, round, 6 mm diameter, 3 mm ID, 20 mm long. AL	1

16-136173 Document Revision History

Revision	Date	Comments
00	June 20, 2024	Initial released version.