

DIGITAL SERVO DRIVE FOR BRUSH & BRUSHLESS MOTORS

CANopen®

Control Modes

- Profile Position-Velocity-Torque, Interpolated Position (PT,PVT), Homing
- Indexer, Point-to-Point, CPL
- Camming, Gearing
- Position, Velocity, Torque

Command Interface

- CANopen
- ASCII, Serial Binary, and discrete I/O
- Stepper or Quad A/B position commands
- PWM Velocity/Torque command
- Master encoder (Gearing/Camming)

Communications

- CANopen
- RS-232

Feedback

- Dual Absolute Encoder Ports
 - SSI
 - EnDat 2.1, 2.2
 - Absolute A
 - Tamagawa Absolute A
 - Panasonic , Sanyo Denki Absolute A Format
 - BiSS
- Incremental
 - Digital quad A/B/X encoder
 - Analog Sin/Cos encoder
- Other
 - Digital Halls

I/O

- 7 High-speed digital inputs
- 6 High-speed digital outputs
- 1 Differential analog input

Safe Torque Off (STO)

- SIL 3, Category 3, PL e

Dimensions: in [mm]

- 2.5 x 1.6 x .69 [64 x 41 x 17.6] APV
- 4.4 x 2.1 x 1.85 [112 x 53.3 x 47] APZ-090-50
- 5.08 x 3.6 x 2.18 [129 x 91.4 x 55.2] APZ-090-50-C

DESCRIPTION

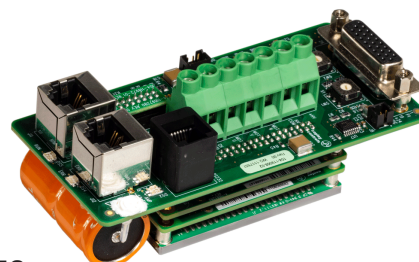
APV sets new levels of performance, connectivity, and flexibility. CANopen communication provides a widely used cost-effective industrial bus. A wide range of absolute encoders are supported.

Safe Torque Off (STO) eliminates external contactors and wiring, reducing system cost and complexity. For safety critical applications, redundant STO disable inputs can be employed.



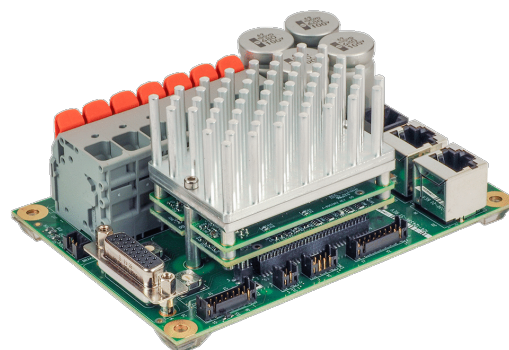
APV

MODEL	I _c	I _P	V _{DC}
APV-090-14	7	14	9~90
APV-090-30	15	30	9~90
APV-090-50	25	50	9~90
APV-090-50-C	50	50	9~90
APV-180-10	5	10	20~180
APV-180-20	10	20	20~180



APZ-50

MODEL	I _c	I _P	V _{DC}
APZ-090-50	25	50	9~90



APZ -50-C

MODEL	I _c	I _P	V _{DC}
APZ-090-50-C	50	50	9~90

GENERAL SPECIFICATIONS

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

MODEL	APV-090-14	APV-090-30	APV-090-50	APV-090-50-C	APZ-090-50	APZ-090-50-C	APV-180-10	APV-180-20	
OUTPUT POWER									
Peak Current	14 (9.9)	30 (21.2)	*50 (35.4)	*50 (35.4)	50 (35.4)	50 (35.4)	10 (7.1)	20 (14.2)	Adc (Arms)
Peak time	1	1	1	n/a	1	n/a	1	1	Sec
Continuous current	7 (5.0)	15 (10.6)	*25 (17.7)	*50 (35.4)	25 (17.7)	50 (35.4)	5 (3.5)	10 (7.1)	Adc (Arms)
Peak Output Power	1.26	2.7	4.5	4.5	4.5	4.5	1.8	3.6	kW
Continuous Output Power	0.63	1.35	2.25	4.5	2.25	4.5	0.9	1.8	kW
* APV-090-50 & APV-090-50-C must be soldered to a mounting board for these ratings.									
INPUT POWER									
HVmin to HVmax	+9~90	+9~90	+9~90	+9~90	+9~90	+9~90	+20~180	+20~180	Vdc
Ipeak	14	30	50	50	50	50	10	20	Adc
Icont	7	15	25	50	25	50	5	10	Adc
Vlogic	+9~60	+9~60	+9~60	+9~60	+9~60	+9~60	+9~60	+9~60	Vdc
Vlogic Power	Vlogic @ 9 Vdc 3.4 W, @ 24 Vdc 3.5 W, @ 60 Vdc 4.2 W with 2 encoders @ +5 V, 500 mA total								
PWM OUTPUTS									
Type	MOSFET 3-phase inverter, 16 kHz center-weighted PWM carrier, space-vector modulation								
PWM ripple frequency	32 kHz								
BANDWIDTH									
Current loop, small signal	2.5 kHz typical, bandwidth will vary with tuning & load inductance								
HV Compensation	Changes in HV do not affect bandwidth								
Current loop update rate	16 kHz (62.5 μs)								
Position & Velocity loop update rate	4 kHz (250 μs)								
COMMAND INPUTS									
CANopen:									
	Profile Position/Velocity/Torque, Interpolated Position (PVT), Homing								
Stand-alone mode									
Digital position reference	Pulse/Direction, CW/CCW				Stepper commands (4 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, 9600~230,400 Baud, 3-wire								
DIGITAL INPUTS									
Number	7								
All inputs	High-speed Schmitt trigger with 100 ns RC filter, 10 kΩ pull-up to +5 Vdc, max input voltage = +6 Vdc								
	RC time-constants assume active drive on inputs and do not include 10 kΩ pull-ups								
IN1~IN6	V _{T+} = 1.42~2.38 Vdc, V _{T-} = 0.68~1.6 Vdc, V _H = 0.44~1.26								
IN7	V _{T+} = 1.30~2.00 Vdc, V _{T-} = 0.55~1.30 Vdc, V _H = 0.40~0.79								
ANALOG INPUT									
Number	1								
Type	Differential, ±10 Vdc range, 16 bits, 14 kHz input filter bandwidth, sample-rate 16 kHz								
Function	Torque, velocity, or position command. Or, as general purpose analog input								
DIGITAL OUTPUTS									
Number	6								
OUT1~3	CMOS HCT inverters, functions programmable, +5 Vcc								
	Source -8 mA @ VOH = 2.4 Vdc, Sink 6 mA @ VOL = 0.5 Vdc								
OUT4~6	CMOS LVC inverters, functions programmable, for SLI port, +3.3 Vcc								
	Source -24 mA @ VOH = 2.3 Vdc, Sink 24 mA @ VOL = 0.55 Vdc								
RS-232 COMMUNICATION PORT									
Signals	RxD, TxD, Sgnd								
Mode	Full-duplex, DTE serial communication port for drive setup and control, 9,600 to 230,400 Baud								
Protocol	ASCII or Binary format								
Isolation	Non-isolated. Referenced to Signal Ground								
CANOPEN PORT									
Format	Galvanically isolated from drive circuits: CAN_H, CAN_L, CAN_GND, 1 mBit/sec maximum								
Protocol	CANopen, CiA 402								

GENERAL SPECIFICATIONS

DC POWER OUTPUT

+5 Vdc 500 mA maximum. Protected for overload or shorts. Shared by dual encoders.

SAFE TORQUE OFF (STO)

Function PWM outputs are inactive and current to the motor will not be possible when the STO function is asserted
 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 e
 Inputs 2 two-terminal: STO-IN1+, STO-IN1-, STO-IN2+, STO-IN2-
 Type Opto-isolators, 5 V compatible, Vin-LO ≤ 2.0 Vdc or open, Vin-HI ≥ 3.3 Vdc
 Input current (typical) STO-IN1, STO-IN2: 11 mA each
 Response time 2 ms from Vin ≤ 2.0 Vdc to interruption of energy supplied to motor
 Muting Wiring a shorting plug with jumpers (see page 7) will mute (bypass) the STO function

PROTECTIONS

HV Overvoltage +HV > +95 ±1 Vdc Drive outputs turn off until +HV is < +95 ±1 Vdc (90 V models)
 +HV > +185 ±1 Vdc Drive outputs turn off until +HV is < +185 ±1 Vdc (180 V models)
 HV Undervoltage +HV < +8.5 ±0.5 Vdc Drive outputs turn off until +HV > +8.5 Vdc ±0.5 Vdc (90 V models)
 +HV < +19.5 ±0.5 Vdc Drive outputs turn off until +HV > +19.5 Vdc ±0.5 Vdc (180 V models)
 Drive over temperature PC Board > 90 °C +3/-0 °C Programmable as latching or temporary fault
 Short circuits Output to output, output to ground, internal PWM bridge faults
 I²T Current limiting Programmable: continuous current, peak current, peak time for drive and motor
 Latching / Non-Latching Programmable response to errors

MECHANICAL & ENVIRONMENTAL

Size APV: 2.5 x 1.6 x 0.69 in [64 x 41 x 17.6 mm]
 APZ-090-50: 4.4 x 2.1 x 1.85 in [112 x 53.3 x 47 mm]
 APZ-090-50-C: 5.08 x 3.6 x 2.18 in [129 x 91.4 x 55.2 mm]
 Weight APV: ≤ 0.16 lb (0.073 kg), add 0.106 lb (0.048 kg) for pins heatsink
 APZ-090-50: 0.40 lb (0.18 kg)
 APZ-090-50-C: 0.72 lb (0.33 kg)
 Ambient temperature 0 to +45 °C operating, -40 to +85 °C storage
 Humidity 0 to 95%, non-condensing
 Altitude ≤ 2000 m (6,500 ft)
 Vibration 2 g peak, 10~500 Hz (sine)
 Shock 10 g, 10 ms, half-sine pulse
 Contaminants Pollution degree 2
 Cooling Forced air cooling required for continuous power output

AGENCY STANDARDS CONFORMANCE

Standards and Directives

Functional Safety

IEC 61508-1, IEC 61508-2, IEC 61508-3, IEC 61508-4 (SIL 3)
 Directive 2006/42/EC (Machinery)
 ISO 13849-1 (Cat 3, PL e)
 IEC 61800-5-2 (SIL3)

Product Safety

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

EMC

Directive 2014/30/EU (EMC)
 IEC 61800-3
 IEC 61800-5-2

Approvals

UL and cUL recognized component to:
 UL 61800-5-1, UL 61800-5-2
 IEC 61800-5-1, IEC 61800-5-2



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

 DANGER	Refer to the 16-01687 Accelnet Plus Micro Modules AEV/APV User Guide The information provided in the 16-01687 Accelnet Plus Micro Modules AEV & APV User Guide must be considered for any application using the APV drive STO feature. Failure to heed this warning can cause equipment damage, injury, or death.
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GENERAL SPECIFICATIONS

MOTOR CONNECTIONS

Motor U,V,W	Drive outputs to 3-phase brushless motor, Wye or delta connected For DC brush motor use outputs U & V Minimum inductance: 200 μ H line-line
Encoder	Digital encoders, incremental and absolute (see FEEDBACK below) Analog Sin/Cos incremental
Halls	see <i>Commutation</i> (below)
Motemp	Inputs are programmable to disable the drive if motor sensor drives input HI or LO

FEEDBACK

<i>Incremental encoders</i>	
Digital Incremental Encoder	Quadrature signals, (A, /A, B, /B, X, /X), differential (X, /X Index signals not required) RS-422 line receivers, 5 MHz maximum line frequency (20 M counts/sec)
Analog Incremental Encoder	Sin/Cos format (Sin+, Sin-, Cos+, Cos-), differential, 1 V _{peak-peak} $\pm$ 20% BW > 300 kHz, 16-bit resolution, with zero-crossing detection
<i>Absolute encoders</i>	
EnDat 2.1, 2.2, SSI Absolute A Format	Serial Clock (X, /X), and Data (A, /A) signals SD+, SD- (A, /A) signals, 2.5 or 4 MHz, half-duplex 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) Terminators Commutation Encoder power	MA+, MA- (X, /X), SL+, SL- (A, /A) signals, clock output from drive, data returned from encoder All encoder data inputs and clock outputs are differential and require external terminators Hall signals (U,V,W), 15 k Ω pull-up to +5V, 15 k Ω /100 pF RC to 74LVC3G14 Schmitt trigger at +5 V _{cc} +5 V _{dc} $\pm$ 2% @ 500 mAdc max, shared by dual encoders

HALLS

<i>Digital</i>	U, V, W: Single-ended, 120° electrical phase difference between U-V-W signals, Schmitt trigger, 1.5 μ s RC filter from active HI/LO sources, 24 V _{dc} compatible, 15 k Ω pull-up to +5 V _{dc} V _{t+} = 2.5~3.5 V _{dc} , V _{T-} = 1.3~2.2 V _{dc} , V _H = 0.7~1.5 V _{dc}
<i>Analog</i>	U & V: Sin/Cos format (Sin+, Sin-, Cos+, Cos-), differential, 1 V _{peak-peak} $\pm$ 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

<i>As Input</i>	See Digital Incremental Encoder above for electrical data on A, B, & X channels, or Absolute encoders using X or A channels. External terminators required as shown above
<i>As Emulated Output</i>	Quadrature A/B encoder emulation with programmable resolution to 4096 lines (65,536 counts) per rev from analog Sin/Cos encoders or resolvers
<i>As Buffered Output</i>	A, /A, B, /B, outputs from MAX3032 differential line driver, X, /X, A, /A from MAX 3362 line drivers Digital A/B/X encoder signals from primary digital encoder are buffered as shown above 5 MHz max, 20 mega count/sec

5V OUTPUT

Number	1
Ratings	+5 V _{dc} @ 500 mA thermal and overload protected

16-01682 Document Revision History

Revision	Date	Remarks
00~04	n/a	Developmental revisions
05	May 1, 2020	All models are CE certified, "All of the agency standards are pending at this time" note was removed. A page with information on panel-mounting has been added.

CME QUICK STARTS

These are some common topics with the key topics that are configured in CME with page numbers shown for quick access.

CANopen Communications: (p. 6)

CME > Settings > Operating Mode Options
Operating Mode = Position
Command Source = CAN

Serial RS-232 Setup (p. 6)

CME > Tools > Communication Wizard
Select Device = Serial Ports
Select Ports > Available Ports
Configure Ports > Select > Baud

CANopen Settings: (p. 26)

CME > Amplifier > Network Configuration
CAN Configuration > Address Configuration > Use Switch
[Input / Output] > Digital Inputs >
[x] Use Switch & LED Interface (SLI)

Position Mode from CANopen (p. 6)

CME > Settings > Operating Mode Options
Operating Mode = Position
Command Source = CAN

Pos/Vel/Curr Mode from Analog Input (p. 13)

CME > Settings > Operating Mode Options
Operating Mode = Position, Velocity, Current
Command Source = Analog Input

Digital Command Inputs: Position (p. 8)

CME > Settings > Operating Mode Options
Operating Mode = Position
Command Source = Digital Input
Digital Input Source = High Speed Inputs

Digital Command Inputs: Velocity / Current (p. 8)

CME > Settings > Operating Mode Options
Operating Mode = Velocity, Current
Command Source = PWM Command
Digital Input Source = High Speed Inputs
[PWM Command]
Input Type = 50% Duty Cycle, 100% Duty Cycle

Multi-Mode Port as Pos/Vel/Curr Command Input (p. 9)

CME > Settings > Operating Mode Options
Feedback Options
Motor Feedback > Primary
Load Feedback > None
Operating Mode Options
Operating Mode = Position, Velocity, Current
Command Source = Digital Input
Digital Input Source = Multi-mode Port

Multi-Mode Port as Secondary Encoder Input (p. 9)

CME > Settings > Feedback Options
Motor Feedback = Selections > Primary
Load Feedback = Selections > Secondary
Operating Mode Options:
Operating Mode = Position, Velocity, Current
Command Source = Digital Input, PWM Command
Digital Input Source = High Speed Inputs

Multi-Mode Port as an Output (p. 10)

CME > Settings > Operating Mode Options
Feedback Options = Motor Feedback > Primary
Load Feedback > None
Operating Mode Options
Operating Mode = Position
Command Source = CANopen
Miscellaneous Options
Multi-Mode Port = Emulated Motor Feedback

CANOPEN COMMUNICATIONS

CANOPEN

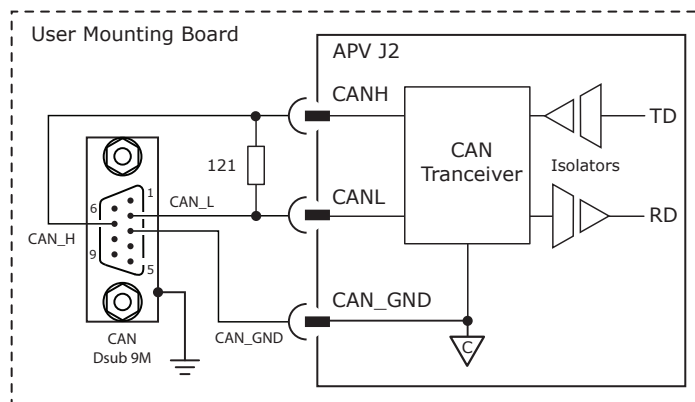
Based on the CAN V2.0b physical layer, a robust, two-wire communication bus originally designed for automotive use where low-cost and noise-immunity are essential, CANopen adds support for motion-control devices and command synchronization. The result is a highly effective combination of data-rate and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

CANOPEN COMMUNICATION

APV uses the CAN physical layer signals CANH, CANL, and CAN_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.

CANOPEN COMMAND INPUTS

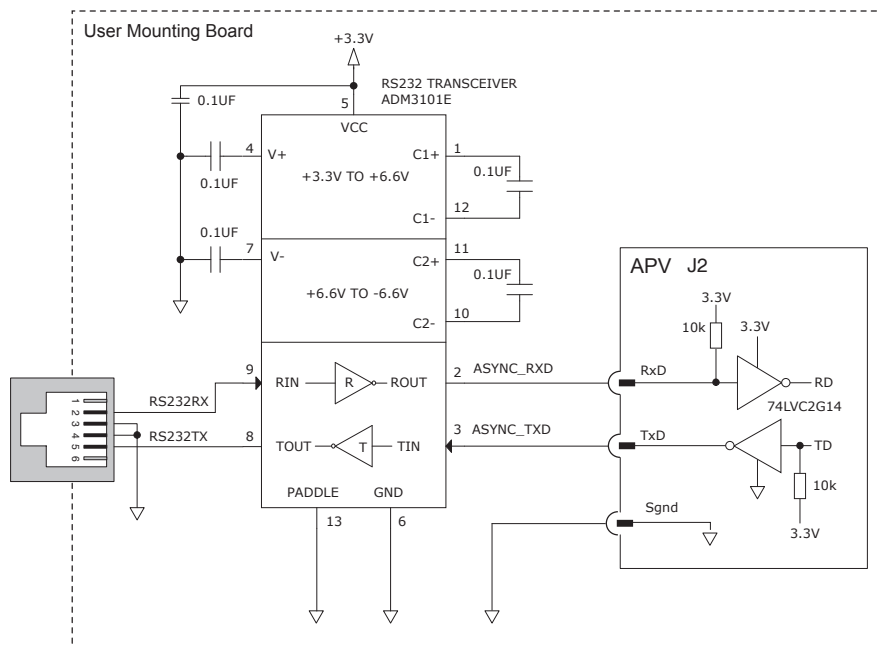
The graphic shows connections between the APV and a Dsub 9M connector on a CAN card. If the APV is the last node on a CAN bus, the internal terminator resistor can be used by adding a connection on the PC board as shown. If there are multiple APV on the mounting PCB then the terminating resistor should be near the APV that is farthest from the CAN network connection to the PCB. The node Node-ID of the APV may be set by using digital inputs, or programmed into flash memory in the drive.



Signal	J2 Pins
CANH	29
CANL	27
CAN_GND	25,26

APV RS-232 COMMUNICATIONS

RS-232 PORT



The serial port is a full-duplex, three-wire (RxD, TxD, Sgnd) type that operates from 9,600 to 230,400 Baud.

It can be used by CME for drive configuration and setup or by external equipment sending ASCII commands.

The circuit shown here is used on the EZ board and is recommended for user's PC boards. It converts the single-ended TTL signals levels in the APV into the ANSI RS-232 levels which are the standard for serial communications and computer COMM ports.

Signal	J2 Pins
RxD	28
TxD	30
Sgnd	32

SAFE TORQUE OFF (STO)

The Safe Torque Off (STO) function is defined in IEC 61800-5-2. Two channels are provided which, when de-energized, prevent the upper and lower devices in the PWM outputs from producing torque in the motor.

This provides a positive OFF capability that cannot be overridden by the control firmware, or associated hardware components. When the opto-couplers are energized (current is flowing in the input diodes), the control core will be able to control the on/off state of the PWM outputs to produce torque in the motor.

INSTALLATION



Refer to the 16-01687 Accelnet Plus Micro Modules AEV/APV User Guide

The information provided in the 16-01687 Accelnet Plus Micro Modules AEV & APV User Guide must be considered for any application using the APV drive STO feature.

FAILURE TO HEED THIS WARNING CAN CAUSE EQUIPMENT DAMAGE, INJURY, OR DEATH.



STO DISABLE

In order for the PWM outputs of the APV to be activated, current must be flowing through the opto-couplers that are connected to the STO-IN1 and STO-IN2 terminals and the drive must be in an ENABLED state. When either of 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 a +5V 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.

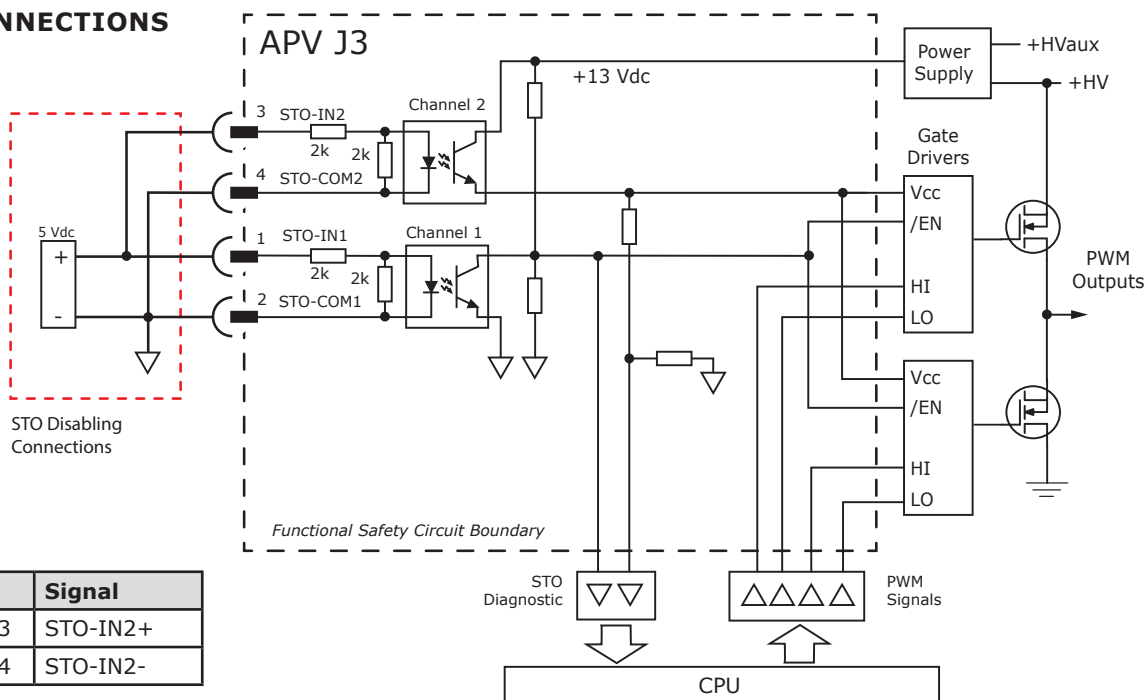
If not using the STO feature, these connections must be made in order for the drive to be enabled.

FUNCTIONAL DIAGRAM

STO DISABLE CONNECTIONS



Current must flow through all of the opto-couplers before the drive can be enabled



J3 STO

Signal	Pin	Signal
STO-IN1+	1	STO-IN2+
STO-IN1-	2	STO-IN2-

STO OPERATION

STO Input Voltage	STO State
STO-IN1 AND STO-IN2 ≥ 3.3 Vdc	STO Inactive. Drive can be enabled to produce torque
STO-IN1 OR STO-IN2 ≤ 2.0 Vdc	STO Active. Drive cannot be enabled to produce torque
STO-IN1 OR STO-IN2 Open	

Note: Voltages in the table above are referenced between an STO-INx+ and an STO-INx-.
E.g. $V(\text{STO-IN1}) = V(\text{STO-IN1+}) - V(\text{STO-IN1-})$

STO STATUS

A digital output can be programmed to be active when the drive is disabled by the STO function. The active level of the output is programmable to be HI or LO.

Note: STO Status is not part of the STO Safety Function.

DIGITAL COMMAND INPUTS: POSITION

STAND-ALONE MODE DIGITAL POSITION-CONTROL INPUTS

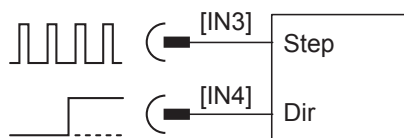
APV works with motion controllers that output pulses to command position.

These formats are supported:

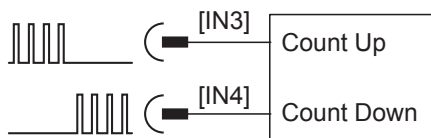
- Step/Direction
- Count-Up/Count-Down (CU/CD)
- A/B Quadrature Encoder

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

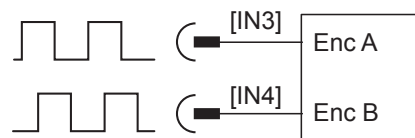
STEP/DIRECTION INPUTS



COUNT-UP/COUNT-DOWN INPUTS



QUAD A/B ENCODER INPUTS



Signal	J2 Pins
IN3	7
IN4	8

Sgnd
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60

DIGITAL COMMAND INPUTS: VELOCITY, TORQUE

STAND-ALONE MODE DIGITAL VELOCITY/TORQUE CONTROL INPUTS

APV works with motion controllers that output pulses to command velocity and torque (current).

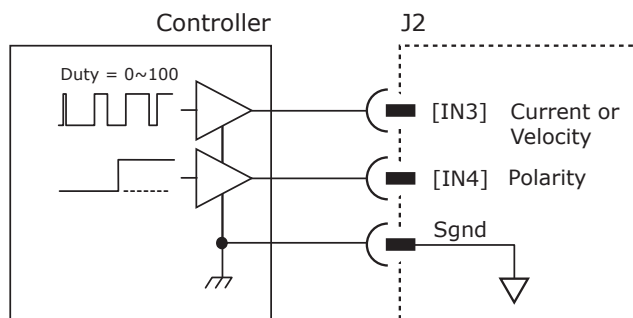
These formats are supported:

- PWM/Direction
- 50 % PWM

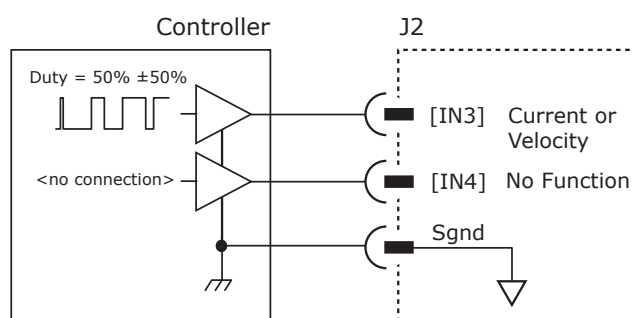
In PWM/Direction mode, a pulse-train with variable duty-cycle controls motor Vel/Trq, and the polarity or direction is controlled by HI/LO levels at the Direction input. With 50% PWM operation there is a single signal.

A 50% duty cycle produces zero output. Increasing the duty cycle to 100% produces a full-scale output in one direction and 0% duty cycle produces a full-scale output in the opposite direction.

PWM & DIRECTION



50% PWM

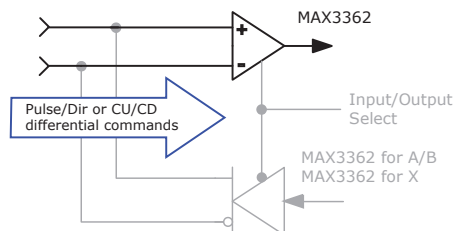


MULTI-MODE PORT AS AN INPUT

COMMAND INPUT

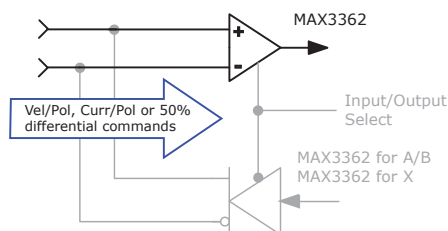
POSITION COMMANDS: DIFFERENTIAL

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



CURRENT or VELOCITY COMMANDS: DIFFERENTIAL

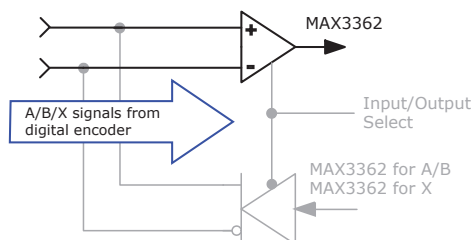
- Current/Velocity Magnitude & Direction
- Current/Velocity 50%



FEEDBACK INPUT: ENCODER 2

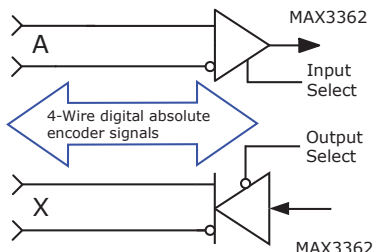
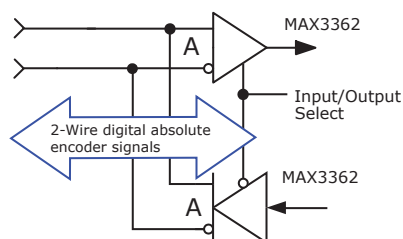
SECONDARY FEEDBACK: INCREMENTAL

- Quad A/B/X incremental encoder

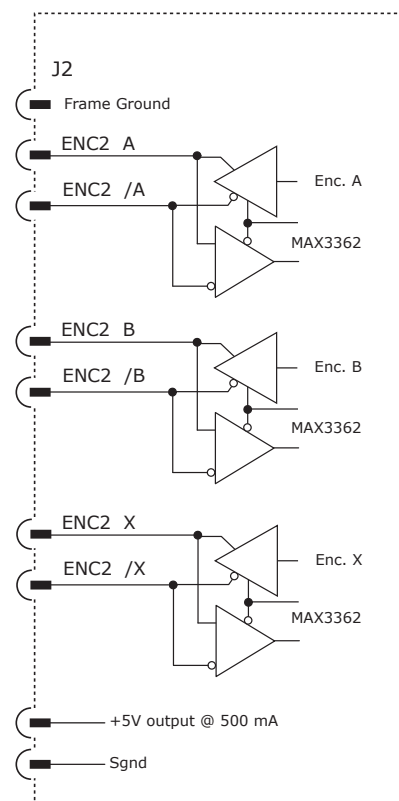


SECONDARY FEEDBACK: ABSOLUTE

- Half-Duplex: Absolute A encoders (2-wire)
The A channel first transmits a Clock signal and then switches to a receiver to receive data from the encoder.
- Full-Duplex: SSI, BiSS, EnDat encoders (4-wire)
The X channel sends the Clock signal to the encoder, which initiates data transmission to the A-channel.



Command Signals	J2 Pins
Pulse, CW, Quad Encoder A, Vel-Curr-Magnitude, Vel-Curr-50%	51
/Pulse, /CW, Quad Encoder /A, /Vel-Curr-Magnitude, /Vel-Curr-50%	52
Direction, CCW, Quad Encoder B, Vel-Curr-Direction	53
/Direction, /CCW, Quad Encoder /B, /Vel-Curr-Direction	54



Feedback Signals	J2 Pins
Quad Encoder A, Half-Duplex CLK-DATA, Full-Duplex DATA	51
Quad Encoder /A, Half-Duplex /CLK-DATA, Full-Duplex /DATA	52
Quad Encoder B	53
Quad Encoder /B	54
Quad Encoder X, Full-Duplex CLOCK	55
Quad Encoder /X, Full-Duplex /CLOCK	56

J2 Sgnd Pins
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60

MULTI-MODE PORT AS AN OUTPUT

OUTPUT TYPES

BUFFERED FEEDBACK OUTPUTS: DIFFERENTIAL

An incremental encoder connected as primary feedback from the motor is internally connected to the multi-port configured as an output.

This can then be wired to a motion controller that needs position data without the need for split-wiring cables from the encoder alone.

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

EMULATED FEEDBACK OUTPUTS: DIFFERENTIAL

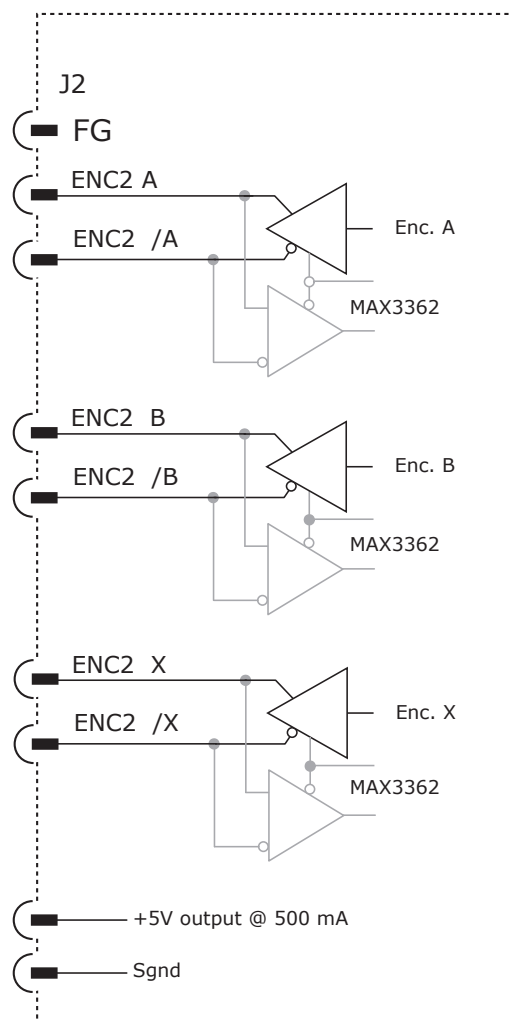
Firmware produces emulated quad A/B signals from feedback data from the following devices:

- Absolute encoders
- Analog Sin/Cos incremental encoders

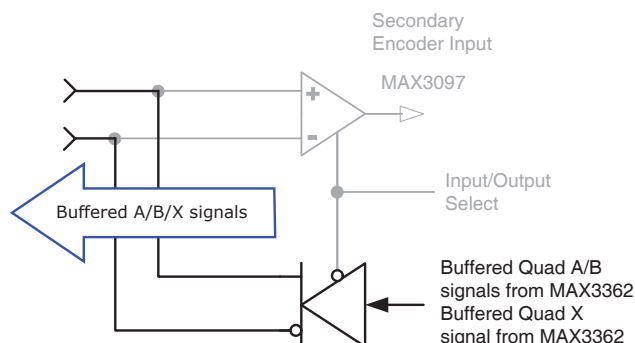
The X channel is not used in this mode

Signal	J2 Pins
Enc2 A	51
Enc2 /A	52
Enc2 B	53
Enc2 /B	54
Enc2 X	55
Enc2 /X	56

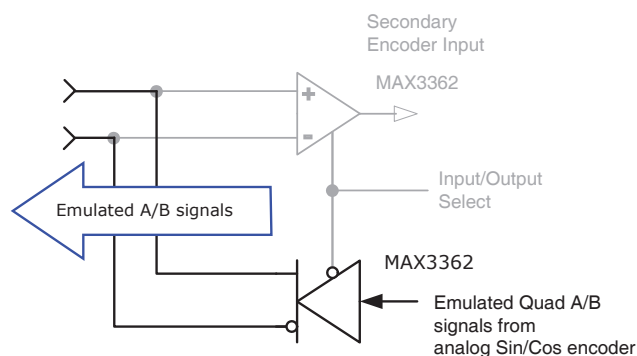
J2 Sgnd Pins
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60



BUFFERED QUAD A/B/X OUTPUTS



EMULATED QUAD A/B OUTPUTS



CME DEFAULTS

These tables show the CME default settings. They are user-programmable and the settings can be saved to non-volatile flash memory.

Input / Output > Digital Inputs

Name	Configuration
IN1	Amp Enable-LO Enables with Clear Faults
IN2	Not Configured
IN3	Not Configured
IN4	Not Configured
IN5	Motor Temp-Hi Disables
IN6	Encoder Fault-Active HI
IN7*	SLI MISO (Master Input Slave Output)

*If not used for an SLI port, this input can be programmed for other functions.

Input / Output > Digital Outputs

Name	Notes
OUT1	Fault-Active LO
OUT2	Not Configured
OUT3	Brake-Active Low
OUT4*	SLI MOSI (Master Output Slave Input)
OUT5*	SLI CLK (Clock)
OUT6*	SLI SS (Slave Select)

*If not used for an SLI port, these outputs can be programmed for other functions.

Configure Filters > Filter Settings

Name	Notes
Analog Reference	Disabled
V Loop Input	Disabled
V Loop Output 1	Low Pass, Butterworth, 2 poles, 200 Hz
V Loop Output 2	Disabled
V Loop Output 3	Disabled
I Loop Input 1	Disabled
I Loop Input 2	Disabled
Input Shaping	Disabled, 0.1 Poles

Configure Faults > Latched Faults

Active	Notes
✓	Short Circuit
✓	Amp Over Temperature
✓	Motor Over Temp
	Over Voltage
	Under Voltage
✓	Feedback Error
	Motor Phasing Error
✓	Following Error
	Command Input Fault
	Motor Wiring Disconnected
	STO Active

Configure Faults > Optional Faults

	Over Current (Latched)
--	------------------------

✓ These are the default settings for Latched Faults. Using CME, these can be checked or unchecked.

Home

Software Limits	Positive, Negative, Deceleration
Method	Set Current Position as Home
Fast Velocity	RPM
Slow Velocity	RPM
Accel / Decel	RPS
Offset	Counts
Homing Adjustment	Counts

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

The six digital inputs to the APV are programmable to a selection of functions.

All have 100 ns RC filters when driven by active sources (CMOS, TTL, etc) and all have 10 kΩ pull-up resistors to +5 Vdc.

In addition to the selection of functions, the active level for each input is individually programmable.

Input */level/* functions have programmable HI or LO to activate the function.

Input *transition* functions are programmable to activate on LO -> HI, or HI -> LO transitions.

INPUT LEVEL FUNCTIONS

- Drive Enable, Enable with Clear Faults, Enable with Reset
- PWM Sync
- Positive Limit Switch
- Negative Limit Switch
- Home Switch
- Encoder Fault
- Motor Temperature Sensor Input
- Motion Abort
- High-Resolution Analog Divide

INPUT TRANSITION FUNCTIONS

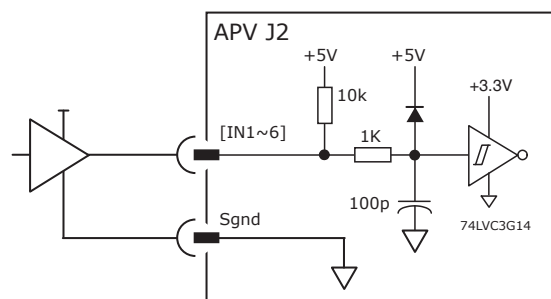
- Clear Faults and Event Latch
- Drive Reset
- PWM Sync Input
- Trajectory Update
- Count Input Edges, Save to Register
- High-Speed Position Capture
- Simulated Absolute Encoder Burst
- Abort Move if > N Counts From Destination in Register

SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	$V_T+ = 1.42 \sim 2.38$ Vdc
	LO	$V_T+ = 0.68 \sim 1.6$ Vdc
	Hys	$V_H = 0.44 \sim 1.26$
	Max	+6 Vdc
	Min	0 Vdc
Pull-up	R1	10 k Ω
Low pass filter	R2	1 k Ω
	C1	100 pF
	RC ¹	0.1 μ s

CONNECTIONS

Signal	J2 Pins
IN1	5
IN2	6
IN3	7
IN4	8
IN5	9
IN6	10



J2 Sgnd Pins

3,4,18,19,20,21,22,23,24,
31,32,33,34,42,49,50,59,60

HIGH SPEED INPUT: IN7

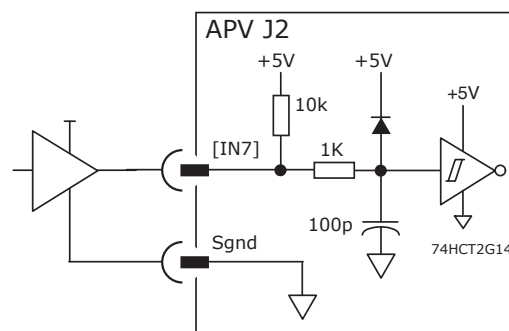
- Digital, non-isolated
- Programmable functions
- MISO Input when SLI port is in use.

SPECIFICATIONS

Input	Data	Notes
Input Voltages	HI	$VT+ \geq 1.3 \sim 2.0 \text{ Vdc}$
	LO	$VT- \leq 0.55 \sim 1.3 \text{ Vdc}$
	Hys	$VH \ 0.40 \sim 0.79 \text{ Vdc}$
	Max	+6 Vdc
	Min	0 Vdc
Pull-up	R1	10 k Ω
Low pass filter	R2	1 k Ω
	C1	100 nF
	RC ¹	0.1 μ s

CONNECTIONS

Signal	J2 Pins
IN7	11



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

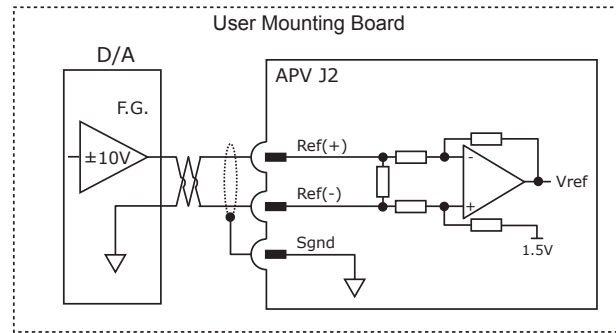
ANALOG INPUT: AIN1

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	5.09 kΩ

Signal	J2 Pins
AIN(+)	2
AIN(-)	1

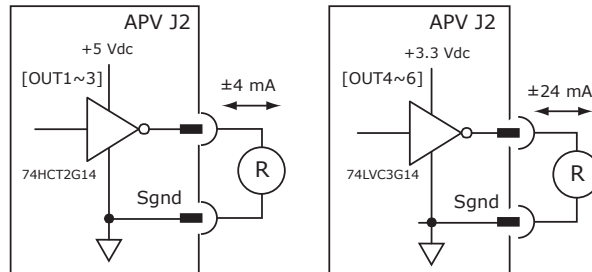


DIGITAL OUTPUTS: OUT1~OUT4

Digital outputs [OUT1~3] are HCT CMOS inverters. They operate from +5V and can source/sink 4 mAdc.
[OUT4~6] are LVC CMOS inverters. They operate from 3.3V and can source/sink 24 mA.
The output functions shown below are programmable to turn the output ON (HI) or OFF (LO) when active.

OUTPUT FUNCTIONS

- Fault
- Brake
- Custom event
- PWM Sync
- Custom Trajectory status
- Custom position-triggered output
- Program control



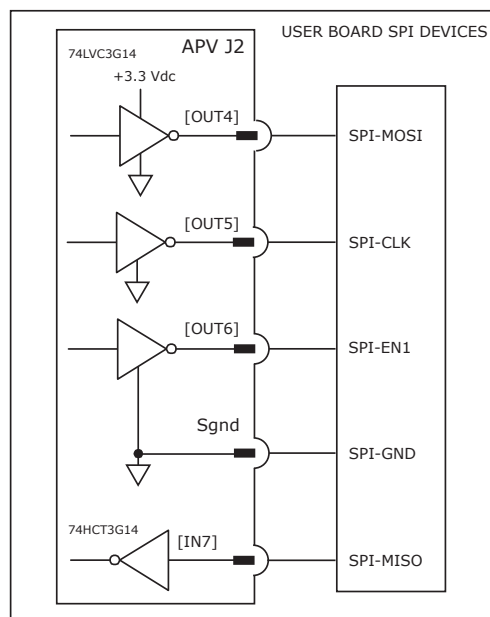
Signal	J2 Pins
OUT1	13
OUT2	12
OUT3	15
OUT4	14
OUT5	17
OUT6	16

SLI (Switch & LED Interface) PORT

These three outputs and one input operate as an SLI (Switch and LED Interface) port for controlling LEDs and reading the settings the network address switches. The graphic below shows them in SLI mode. If not used for SLI they are programmable for other functions to turn the output ON (HI) or OFF (LO) when active. [IN7] is shown here for completeness as part of the SLI function.

OUTPUT FUNCTIONS

- Fault
- Brake
- Custom event
- PWM Sync
- Custom Trajectory status
- Custom position-triggered output
- Program control



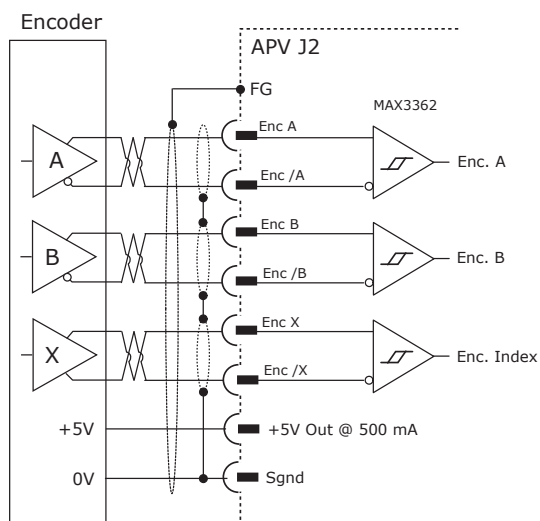
Signal	J2 Pins
SLI-MOSI	14
SLI-CLK	17
SLI-EN1	16
SLI-GND	18
SLI-MISO	11

J2 Sgnd Pins

3,4,18,19,20,21,22,23,24,
31,32,33,34,42,49,50,59,60

ENCODER 1 (PRIMARY FEEDBACK)

QUAD ENCODER WITH INDEX



A/B/X SIGNALS

Signal	J2 Pins
Enc A	43
Enc /A	44
Enc B	45
Enc /B	46
Enc X	47
Enc /X	48
+5V	57,58

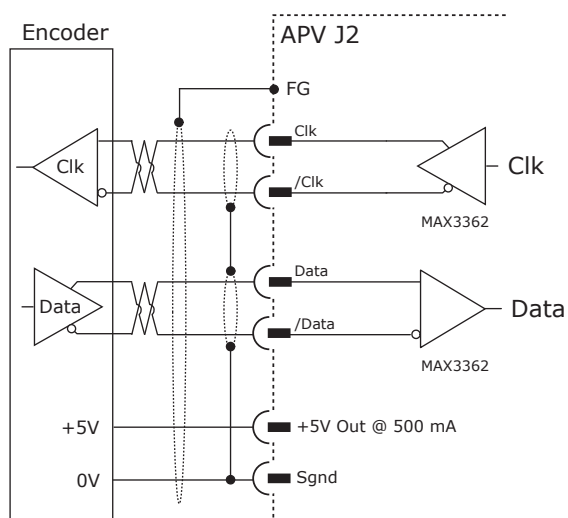
J2 Sgnd Pins

3,4,18,19,20,21,22,23,24,
31,32,33,34,42,49,50,59,60

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 APV 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+	47
/Clk	MA-	48
Data	SL+	43
/Data	SL-	44
+5V		57,58

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

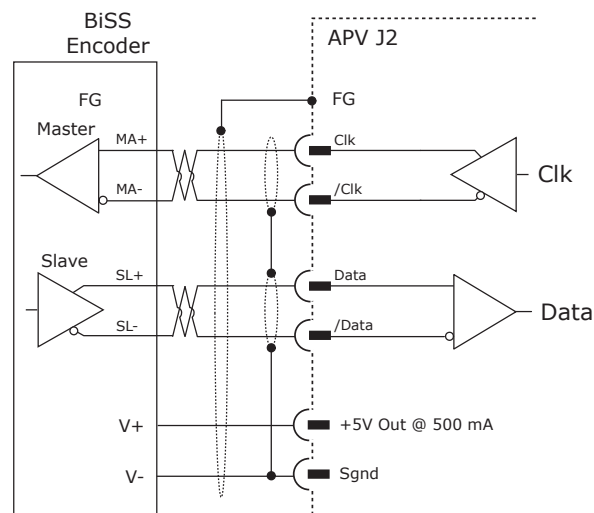
Safety capable: CRC, Errors, Warnings

Bus capability incl. actuators

Bidirectional

BiSS B-protocol: Mode choice at each cycle start

BiSS C-protocol: Continuous mode



Note: Single (outer) shields should be connected at the drive end. Inner shields are optional for digital encoders and should only be connected to Signal Ground on the drive.

ENCODER 1 (PRIMARY FEEDBACK)

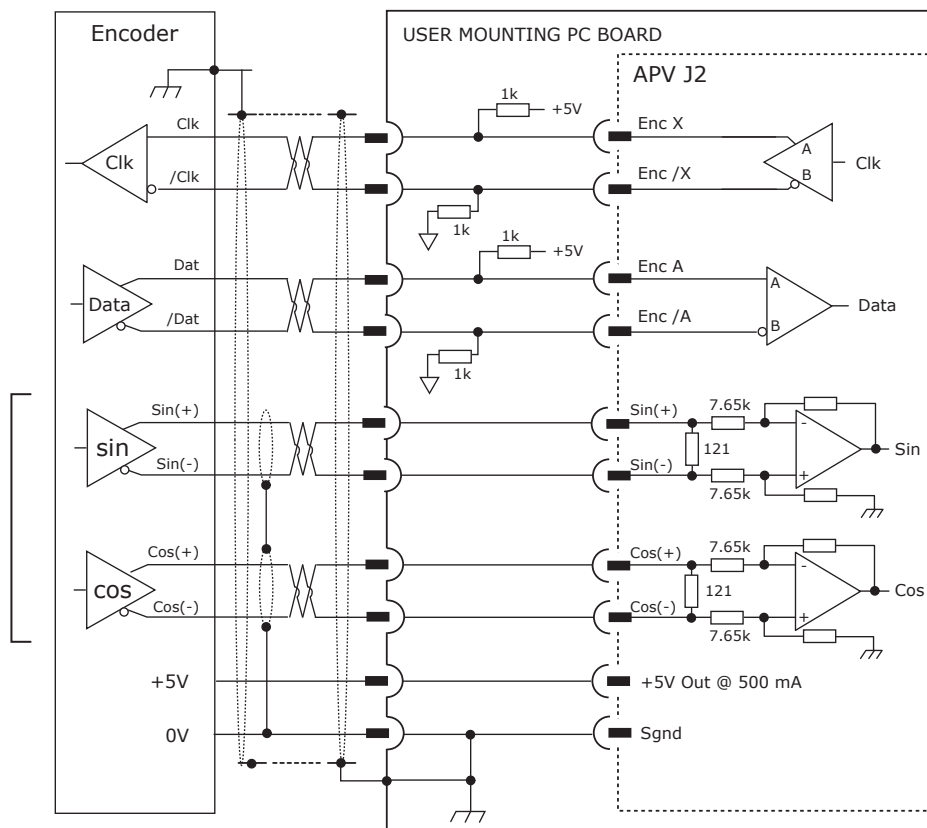
ENDAT ABSOLUTE ENCODER

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	47
/Clk	48
Data	43
/Data	44
Sin(+) *	36
Sin(-) *	35
Cos(+) *	38
Cos(-) *	37
+5V	57,58

* Sin/Cos optional with EnDat 2.2
or any 1 Mbit or faster Endat
Sin/Cos required if EnDat 2.1 < 1 Mbit



J2 Sgnd Pins

3,4,18,19,20,21,22,23,24,
31,32,33,34,42,49,50,59,60

ABSOLUTE-A ENCODER

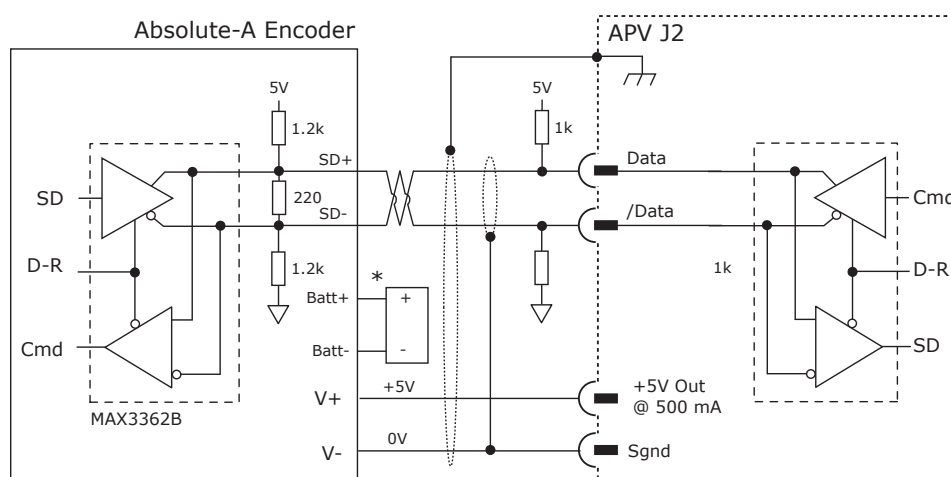
The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485. Note the battery which must be connected. Without it, the encoder will produce a fault condition.

ABSOLUTE-A SIGNALS

Signal	J2 Pins
Data	43
/Data	44
+5V	57,58

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

* Battery optional



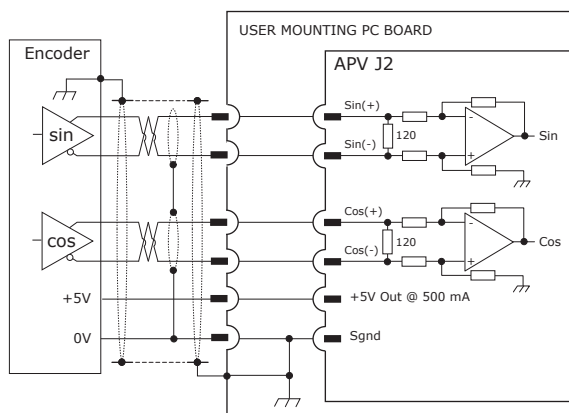
Note: Single (outer) shields should be connected at the drive end. The inner shield is optional for digital encoders and should only be connected to Signal Ground on the drive.

ANALOG ENCODER

SIN/COS ENCODERS

Sin/Cos sensors in linear brushless motors are produced from the magnetic field in the rod and provide commutation feedback as well as higher resolution position feedback by interpolating of the signals.

Incremental rotary encoders are also available with Sin/Cos outputs. Programmable interpolation enables the number of counts per revolution or linear movement to be programmable.

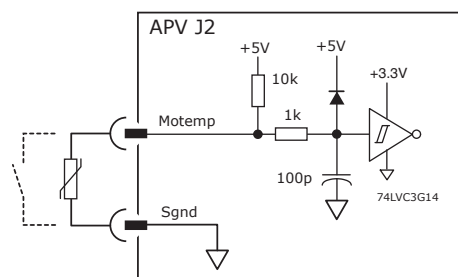


Input	J2 Pins
SIN(+)	36
SIN(-)	35
COS(+)	38
COS(-)	37
+5V	57,58

OTHER MOTOR CONNECTIONS

MOTOR TEMPERATURE SENSOR

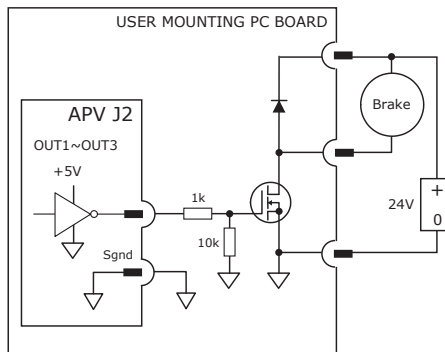
Any digital input is programmable for use with a motor overtemperature switch. Either a HI or LO input level is programmable to signal an over-temp condition.



Input	J2 Pins
Motemp IN5	9
Sgnd	3

MOTOR BRAKE

OUT1~OUT3 have +5V outputs that can control a MOSFET. When programmed for brake control with an active HI level, the output will turn on the MOSFET, releasing the brake and allowing the motor to move.

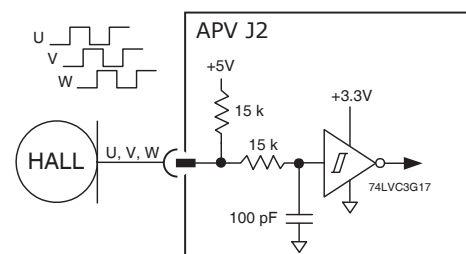


Output	J2 Pins
OUT1	13
OUT2	12
OUT3 *	15

* OUT3 is brake default

HALLS

Hall sensors in a brushless motor are produced from the magnetic field in the motor and provide commutation feedback without an encoder. When used with incremental encoders, they enable the motor to operate without a phase-finding cycle.



Input	J2 Pins
Hall U	39
Hall V	40
Hall W	41

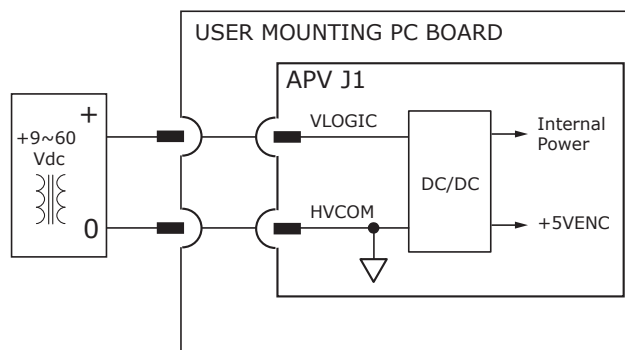
J2 Sgnd Pins
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60

VLOGIC

DESCRIPTION

Powers the internal logic and control circuits in the drive.

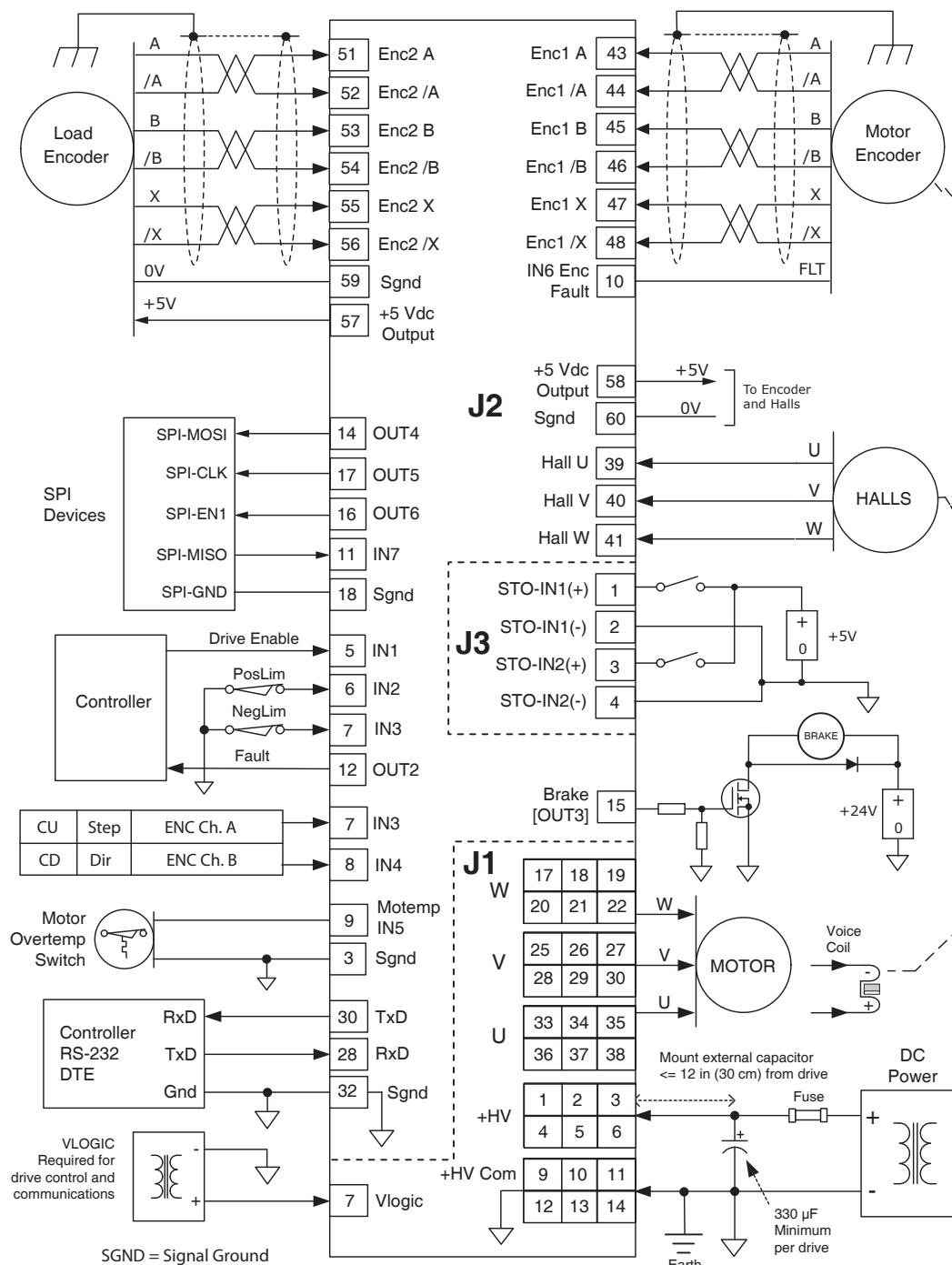
When using the STO feature, it must be produced by power supplies with transformer isolation from the mains and PELV or SELV ratings and a maximum output voltage of 60 Vdc. If the motor can operate from voltages of 60 Vdc or less, the +HV and Vlogic can be driven from a single power supply.



Signal	J1 Pins
Vlogic	7
HVcom	9,10,11, 12,13,14

TYPICAL CONNECTIONS

This graphic shows the functional connections between APV connectors and various devices. User mounting board connections are not shown.

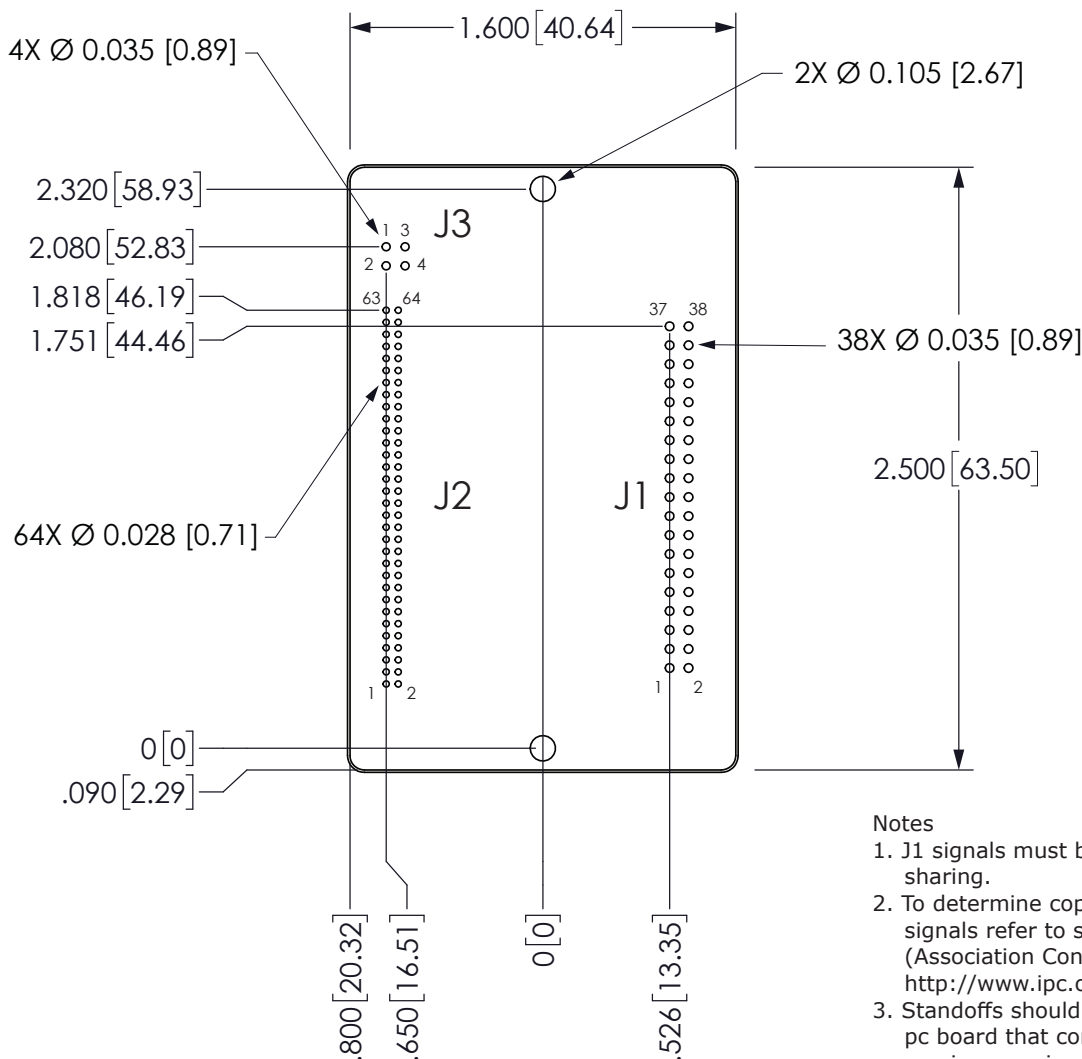


Notes

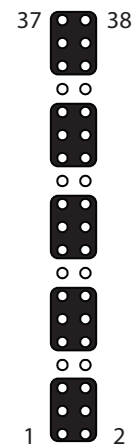
- [IN1] is shown as Drive Enable and [IN2] and [IN7] are shown with some typical functions. [IN3] and [IN4] are shown as digital command inputs. [IN3] is shown twice. If SLI function is used, it will not be available for other functions. All inputs are programmable.
- [OUT2] is shown as a Fault signal to the controller and [OUT3] is shown as control for a motor brake. All outputs are programmable.
- Encoder connections are shown for incremental types, but absolute encoders are supported on both primary and load encoder inputs.

PC BOARD MOUNTING & DRILLING DIMENSIONS

Top view looking down on mounting PC board.



J1 Signal Grouping for current-sharing



Notes

1. J1 signals must be connected for current-sharing.
2. To determine copper width and thickness for J1 signals refer to specification IPC-2221. (Association Connecting Electronic Industries, <http://www.ipc.org>)
3. Standoffs should be connected to etches on pc board that connect to frame ground for maximum noise suppression and immunity. They also provide the PE (Protective Earth) connection between the heatplate and ground.

Dimensions are in inches [mm].

For Sockets on User PC Board:

Qty	Description	Mfgr	Part Number	Ref Des	Remarks
1	Socket Strip	Samtec	SQT-119-01-G-D	J1	0.0787 in (2.00 mm) pitch
1	Socket Strip	Samtec	SFMC-132-01-L-D	J2	0.050 in (1.27 mm) pitch
1	Socket Strip	Samtec	SQT-102-01-G-D	J3	0.0787 in (2.00 mm) pitch
2	Standoff	hex, 20.5 mm long, M2,5 mm thread			

For Soldering to User PC Board:

Qty	Description	Mfgr	Part Number	Ref Des	Remarks
1	For J1, refer to this document: http://suddendocs.samtec.com/processing/through-hole-printing.pdf				
1	Socket Strip	Samtec	CLP-132-02-L-D-BE-A-K-TR	J2	0.050 in (1.27 mm) pitch
1	Socket Strip	Samtec	CLT-102-2-G-D-BE	J3	0.0787 in (2.00 mm) pitch
2	Standoff	hex, 15 mm long, M 2.5 mm thread			

PC BOARD SIGNALS

J3 SAFETY

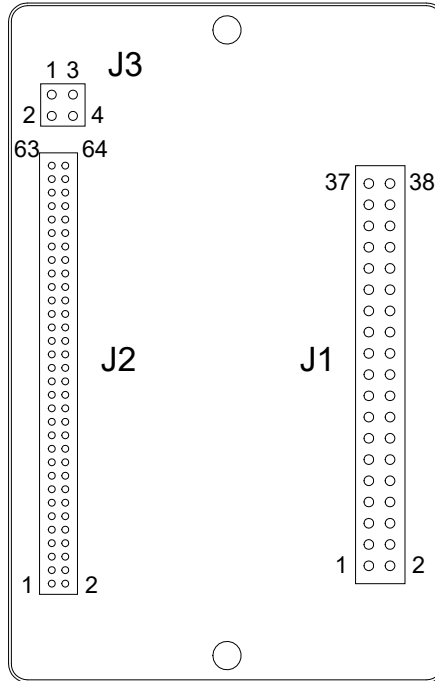
SIGNAL	PIN	PIN	SIGNAL
STO-IN1(+)	1	3	STO-IN2(+)
STO-IN1(-)	2	4	STO-IN2(-)

J2 FEEDBACK

Signal	P3 Pin	Signal
Reserved	63	64
Reserved	61	62
Sgnd	59	60
Enc +5V	57	58
Enc2 X	55	56
Enc2 B	53	54
Enc2 A	51	52
Sgnd	49	50
Enc1 X	47	48
Enc1 B	45	46
Enc1 A	43	44
Hall W	41	42
Hall U	39	40
Cos(-)	37	38
Sin(-)	35	36
Sgnd	33	34
Sgnd	31	32
CAN-H	29	30
CAN-L	27	28
CAN-Gnd	25	26
Sgnd	23	24
Sgnd	21	22
Sgnd	19	20
SLI-CLK OUT5	17	18
Brake OUT3	15	16
OUT1	13	14
SLI-MISO IN7	11	12
IN5	9	10
IN3	7	8
Enable IN1	5	6
Sgnd	3	4
Refin(-)	1	2

TOP VIEW

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



J1 POWER & MOTOR

Signal	J1 Pin	Signal
MOT U	37	38
	35	36
	33	34
	31	32
MOT V	29	30
	27	28
	25	26
	23	24
MOT W	21	22
	19	20
	17	18
	15	16
HVCOM	13	14
	11	12
	9	10
	7	8
+HV	5	6
	3	4
	1	2

J1: HV & Motor

Dual row, 2 mm centers
38 position female header
SAMTEC SQT-119-01-G-D

J2: Feedback

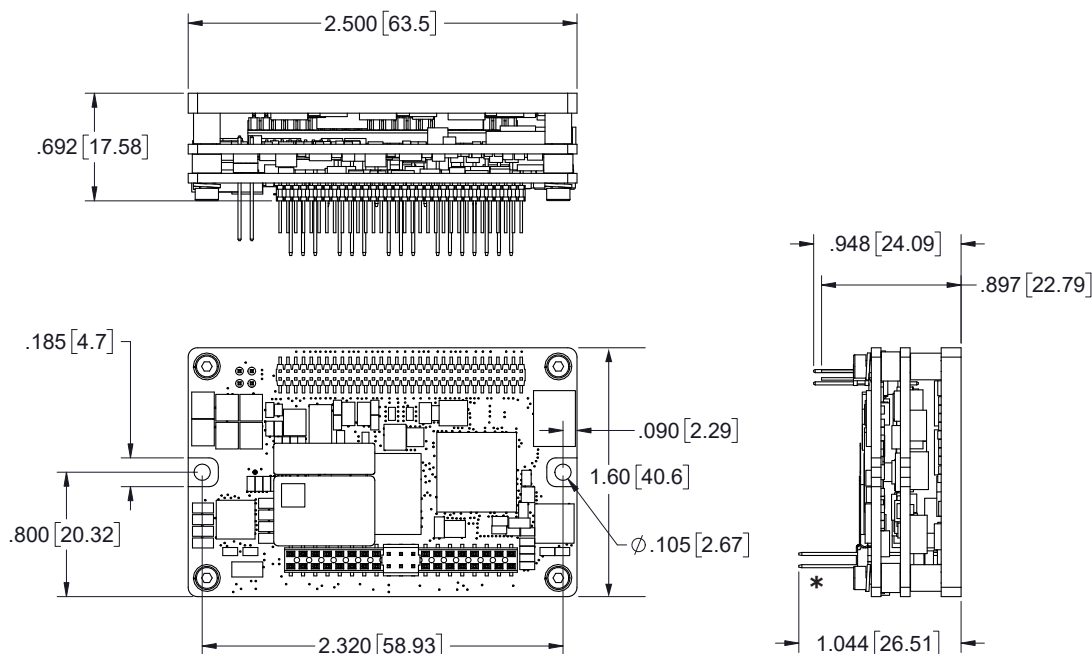
Dual row, 0.050 inch centers
64 position female header
SAMTEC FLE-132-01-G-DV-K-TR

J3: Safety

Dual row, 2 mm centers
4 position female header
SAMTEC TLE-102-01-G-DV-TR

DIMENSIONS

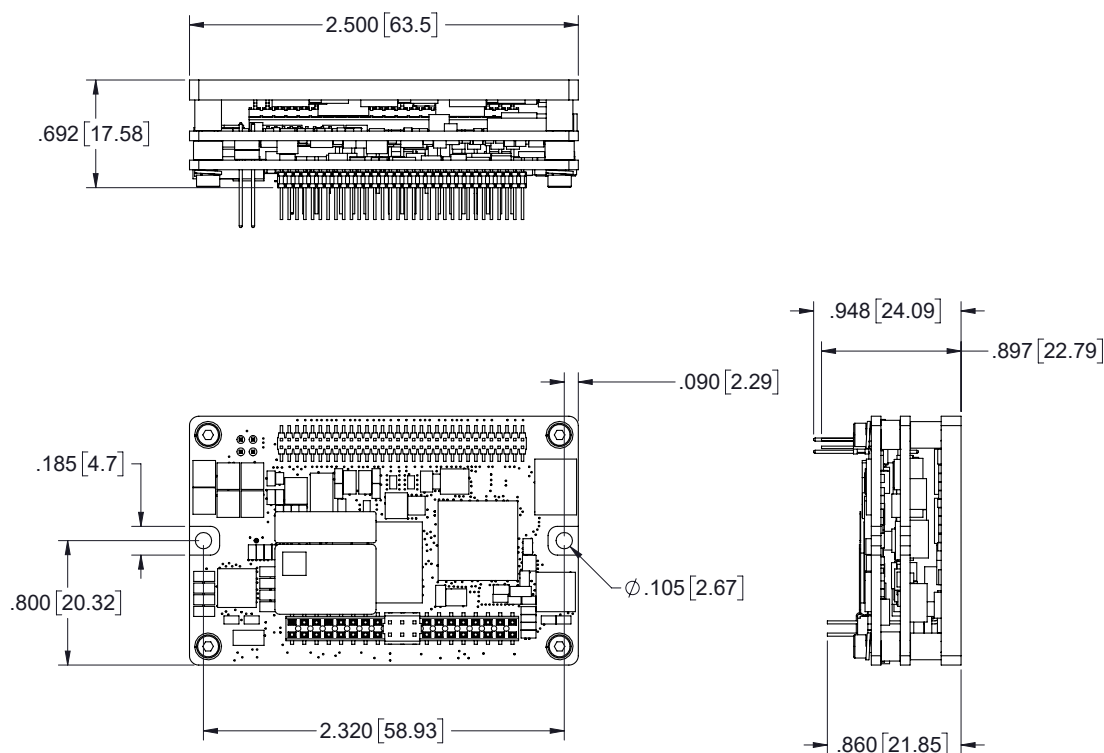
APV-090-50, APV-090-50-C



Dimensions are in inches [mm].

* These pins are longer for soldering to the user PC board.

APV-090-14, APV-090-30, APV-180-10, APV-180-20

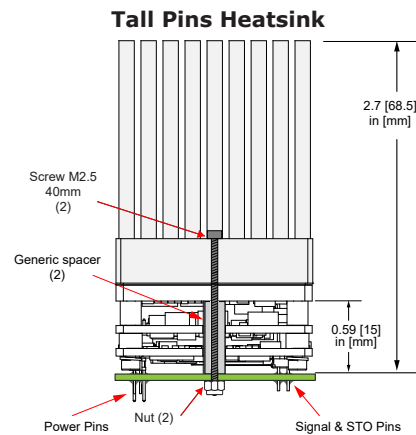
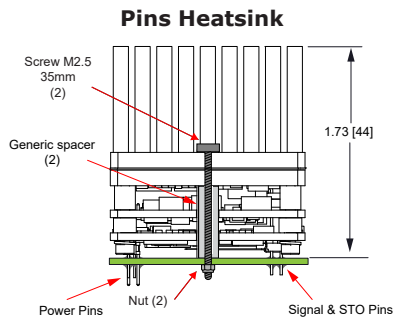


MOUNTING: SOLDERED INTO USER PC BOARD

APV-090-50, APV-090-50-C

Kits are not available for this configuration. Here are the parts required:

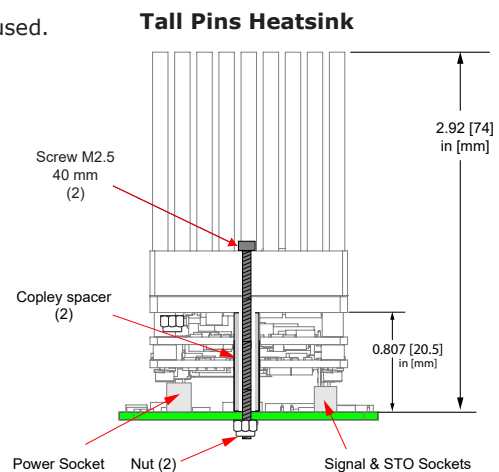
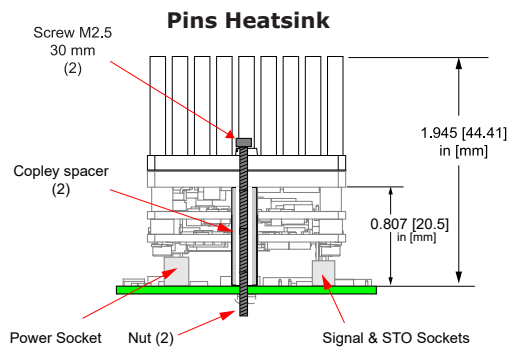
Standoffs:	15 mm, diameter 4.5 mm, hollow, aluminum, RAF M0514-25, qty 2
Thermal pad:	Copley CC 6-83985-01, qty 1
Pins Heatsink:	Copley CC 21-126260-01, qty 1
Screws:	M2.5, Length dependent on assembly, qty 2
Nuts:	M2.5, Dependent on assembly, qty 2



MOUNTING: SOCKETED INTO USER PC BOARD

APV-090-14, APV-090-30, APV-180-10, APV-180-20

All connections shown socketed. With the pins heatsink the 30 mm screws are used. With the long pins heatsink the 40 mm screws are used.



PINS HEATSINK KIT: APV-HK

Part	Part Number	Qty
Screw	M2.5-0.45 x 35 mm slotted cheese head	2
Nut	M2.5-0.45 DIN nylon lock nut	2
Thermal material	Copley	1
Spacer	Copley non-threaded spacer 20.5 mm,	2
Heatsink	Pins Heatsink, 1 inch tall	1

TALL PINS HEATSINK KIT: APV-TPK

Part	Part Number	Qty
Screw	M2.5-0.45 x 40 mm slotted cheese head	2
Nut	M2.5-0.45 DIN nylon lock nut	2
Thermal material	Copley	1
Spacer	Copley non-threaded spacer 20.5 mm,	2
Heatsink	Tall Pins Heatsink, 2 inch tall	1

CONNECTORS FOR SOCKETING

Part	Mfgr	Part Number	Qty
Signal Socket	Samtec	FLE-132-01-G-DV-K-TR	1
Power Socket	Samtec	SQT-119-01-G-D	1
STO Socket	Samtec	TLE-102-01-G-DV-TR	1

For the half-soldered configuration the dimensions, spacers, screws, and nuts are the same.

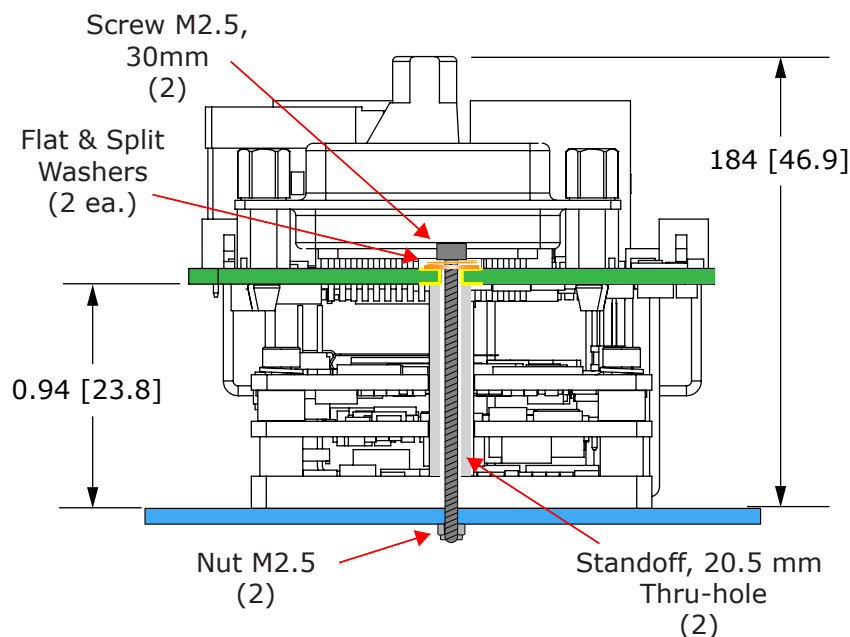
PANEL MOUNTING

APV-090-14, APV-090-30, APV-180-10, APV-180-20

These models are shown below socketed into an EZ Board. Screws pass through the EZ Board and standoffs to nuts that hold the drive to the panel. Tapping a hole in the panel to accept the M2.5-0.45 screw allows the drive to be mounted and removed from one side of the panel. User-designed mounting boards should have the same conductive etch rings around the screw holes to provide PE grounding for their circuits.

APZ-090-50

This model has the motor, +HV, and grounding pins soldered to the EZ board. The signal and STO pins are socketed. The dimensions and mounting to a panel are the same as the APV models.



IMPORTANT

The example shown here using the EZ Board to mount to a panel does not apply to panel mounting of the APV-090-50 and APV-090-50-C models. These models are incompatible with the EZ Board.

PANEL MOUNTING PARTS

Part	Part Number	Qty
Screw	M2.5-0.45 x 35 mm slotted cheese head	2
Nut	M2.5-0.45 DIN nylon lock nut	2
Thermal material	Copley	1
Spacer	Copley non-threaded spacer 20.5 mm	2
Flat Washer	Metric, M2.5, flat	2
Split Lock Washer	Metric, M2.5, lock	2

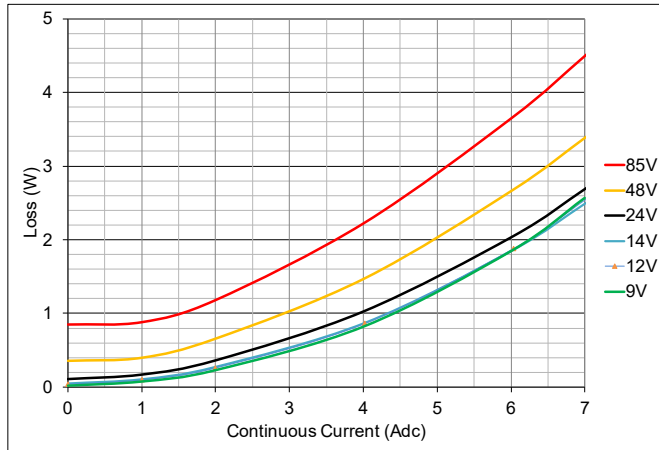
IMPORTANT

Standoffs must be metal, preferably brass. The EZ Board has conductive etch rings on each side of the screw holes which connect via etch through the holes. The screws then provide a path from the PE circuits on the drive through the standoffs and drive heatplate to the mounting panel which should be earthed. The etch on the bottom of the holes connects to the standoffs and drive heatplate, providing a PE ground for the heatplate. The thermal material between the mounting board and heatplate of the drive is non-conductive so effective grounding of the heatplate is provided by through the standoffs.

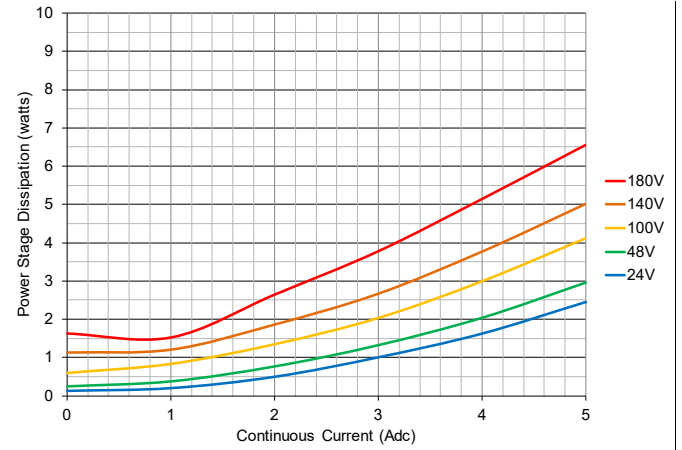
THERMALS: PWM OUTPUTS DISSIPATION

These charts show power dissipation in the drive when the PWM outputs are driving a motor. The following page shows the dissipation in the Vlogic circuits that power the drives control circuits and external encoders. Adding the PWM dissipation to the Vlogic dissipation will yield the total dissipation in Watts for the drive. The dotted lines in the APV-090-30 chart show a dissipation of 9.5 W. at a continuous current of 13 Adc and +HV = 85 Vdc.

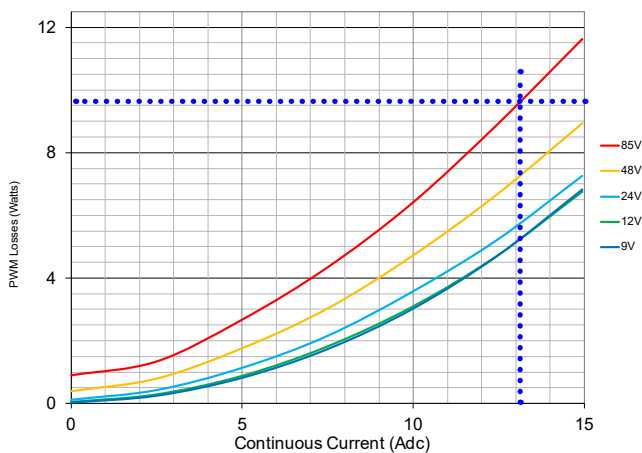
APV-090-14



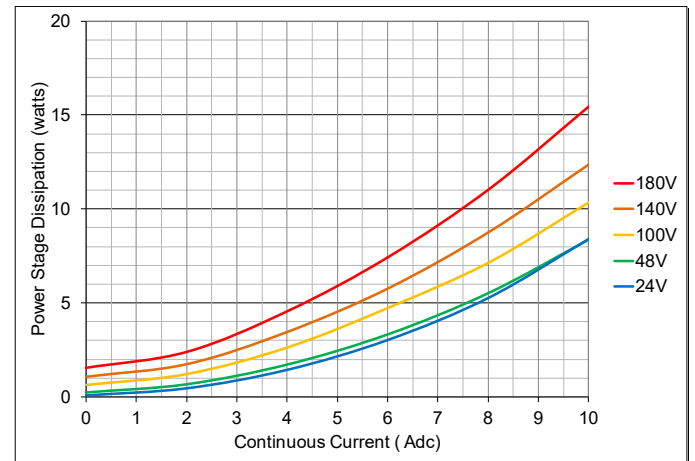
APV-180-10



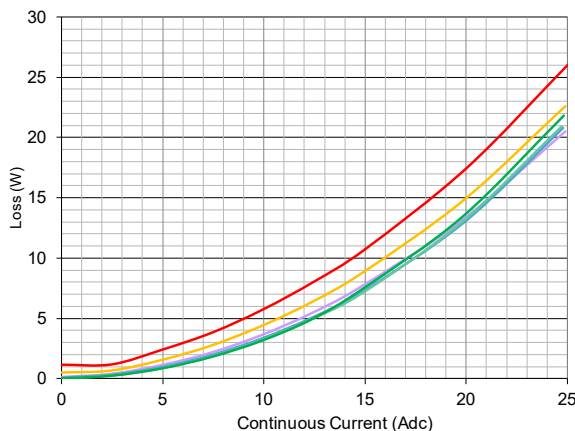
APV-090-30



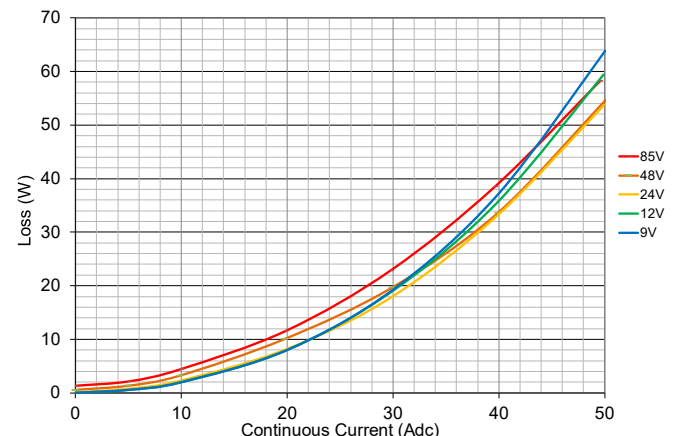
APV-180-20



APV-090-50

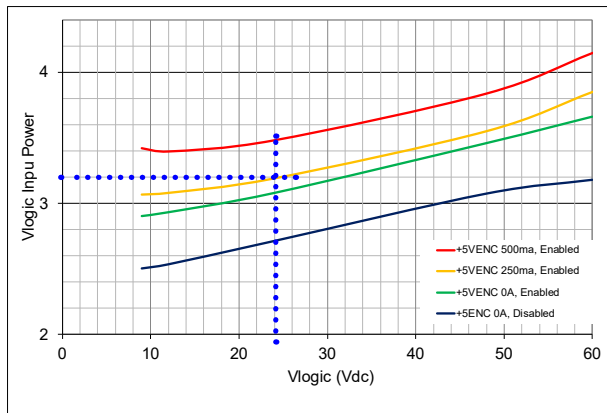


APV-090-50-C



THERMALS: VLOGIC & ENCODER +5V OUTPUT DISSIPATION

APV All Models



These charts show power dissipation in the Vlogic circuits that power the drives control circuits and external encoders. Adding the PWM dissipation to the Vlogic dissipation will yield the total dissipation in Watts for the drive.

The dotted lines in the chart show a dissipation of 3.2 W. at Vlogic = 24 Vdc when the drive is in an Enabled state and outputting 250 mA for an encoder.

THERMAL RESISTANCE

Thermal resistance Rth is a measure of the way the drive resists the flow of heat produced internally to the environment. The lower the resistance the more freely the heat can be dissipated. Thermal resistance Rth is in units of degrees-Centigrade per Watt (C/W). Lowering Rth can be done with heatsinks that increase the area that is exposed to the environment and by moving air over the surfaces with fans. The flow of fan forced air is measured in Linear-Feet-per-Minute (LFM).

No Heatsink

LFM	0	100	200	300
Rth	8.5	6.5	5.5	4.0

APV



Pins Heatsink A-Airflow

LFM	0	100	200	300
Rth	-	2.9	1.8	1.4

Pins Heatsink B-Airflow

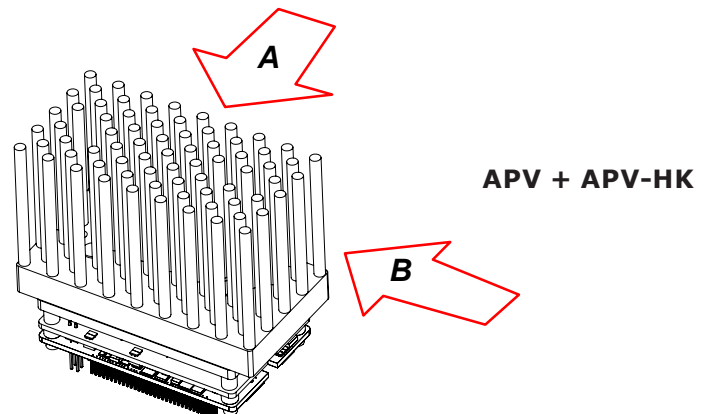
LFM	0	100	200	300
Rth	-	4.2	2.6	1.9

Tall Pins Heatsink A-Airflow

LFM	0	100	200	300
Rth	-	1.3	0.9	0.7

Tall Pins Heatsink B-Airflow

LFM	0	100	200	300
Rth	-	2.2	1.4	1.1



Note: The Tall Pins Heatsink is not shown here.

THERMAL CALCULATIONS

THERMAL CALCULATIONS EXAMPLE: APV-090-30, +HV = 85 V, IOUT = 13 A, AMBIENT TEMP 32 °C

FIND THE COOLING MEANS REQUIRED WHEN DISSIPATION AND AMBIENT TEMP ARE KNOWN

Given: Tamb = 32 °C (89.6 °F), +HV dissipation = 9.5 W, Vlogic dissipation = 3.2 W
Tmax = 90 °C (drive shut-down temperature)

Find: Thermal resistance Rth:

$$\Delta T = T_{\max} - T_{\text{amb}} = 90 - 32 = 58 \text{ }^{\circ}\text{C}$$

$$\text{Total dissipation} = 9.5 + 3.2 = 12.7 \text{ W}$$

$$R_{\text{th}} = \Delta T / \text{dissipation} = ^{\circ}\text{C} / \text{Watt} = 58 / 12.7 = 4.57 \text{ }^{\circ}\text{C/W}$$

From the tables above, there are three configurations that provide Rth less than 4.57 °C/W:

No heat sink, forced air at 300 LFM

With short pins heat sink, forced air at A or B direction, 100 LFM or greater

With long pins heat sink, convection with forced air not required

FIND THE MAX AMBIENT TEMP WHEN DRIVE CONFIGURATION IS KNOWN

Given: APV-090-30 with pins heatsink, forced-air at 200 LFM, A direction, dissipation is 12.7 W
Rth = 1.8 °C/W

$$T_{\max} = 90 \text{ }^{\circ}\text{C (drive shut-down temperature)}$$

Find: Max ambient operating temperature

$$\Delta T = 12.7 \text{ W} \times 1.8 \text{ }^{\circ}\text{C/W} = 22.9 \text{ }^{\circ}\text{C}$$

$$\text{Max } T_{\text{amb}} = T_{\max} - \Delta T = 90 - 22.9 = 67.1 \text{ }^{\circ}\text{C}$$

Max ambient operating temperature is 45 °C so it can operate up to this temperature

BEST PRACTICES FOR THERMAL MANAGEMENT

- All of the variables in an installation are usually not known.
- Calculations like those above are done with values that may be estimates, not exact values.
- Movement of air is very important. Even when enclosures have no openings, internal fans circulate the air to move heat from drives to the enclosure walls and to prevent hot-spotting.
- A heat sink cuts the APV thermal resistance significantly with forced air.
Overheating can shut down drive but over-cooling is not possible.
Measurement of the drive temperature with CME is easy and is the best indicator of the need for a heatsink. It shows the combined effect of all the variables:
Thermal dissipation, ambient temperature, cooling means, the environment, etc.

EZ BOARD

DESCRIPTION

The EZ Boards provide connectivity to these APV models so they can be mounted directly to equipment surfaces.

The APV-EZ-090 EZ Board accepts these models as plug-ins:

APV-090-14

APV-090-30

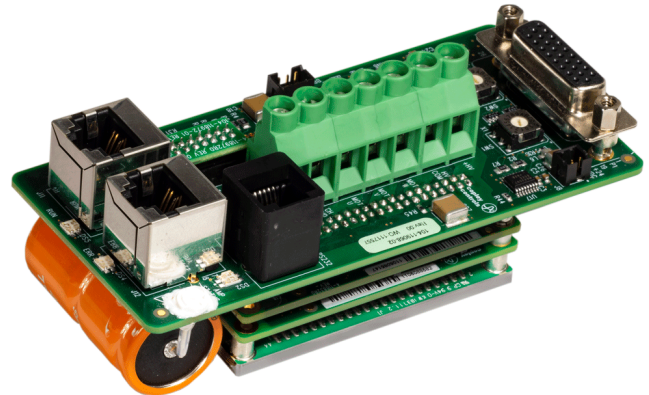
The APV-EZ-180 EZ Board accepts these models as plug-ins:

APV-180-10

APV-180-20

Important: The APV-EZ-090 EZ Board is not compatible with the APV-090-50 and APV-090-50-C models.

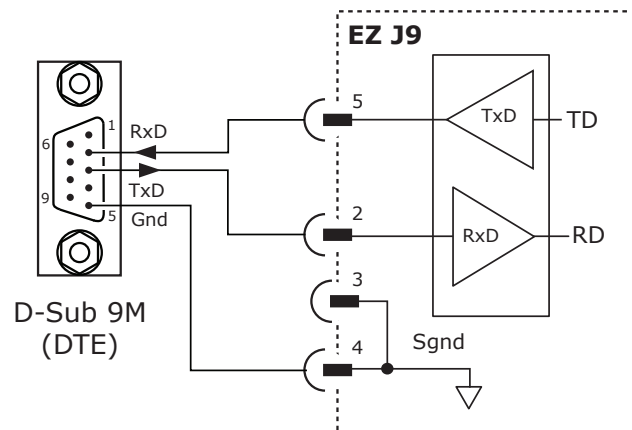
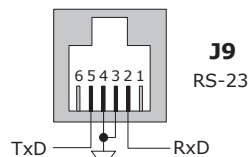
For higher current, the APZ-090-50 is an APV-090-50 soldered to the EZ Board at the factory as a single assembly.



RS-232 CONNECTION

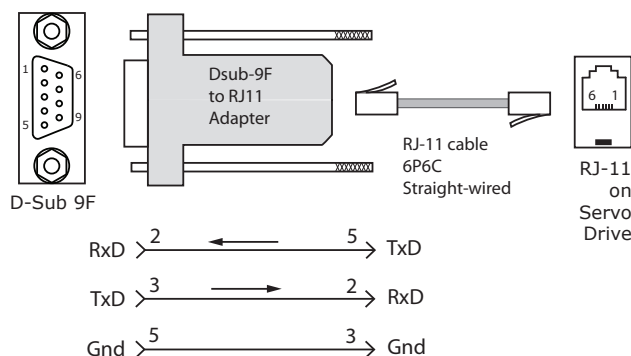
The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an CANopen network. CME software communicates with the drive over this link and is then used for complete drive setup. The CANopen Device ID that is set by the rotary switches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

The RS-232 connector, J9, is a modular RJ-11 type that uses a 6-position plug, four wires of which are used for RS-232. A connector kit is available (SER-CK) that includes the modular cable, and an adaptor to interface this cable with a 9-pin RS-232 port on a computer.



SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector J9 on the EZ board. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses a straight-through modular cable to connect to the APV. The connections are shown in the diagram below.



Don't forget to order a Serial Cable Kit SER-CK or SER-USB-RJ11 when placing your order for an APZ drive, or an EZ board.

EZ BOARD CANOPEN INDICATORS & ADDRESS SWITCHES

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 'upstream' between the APV and the master. The OUT port connects to 'downstream' nodes. If the APV is the last node on a network, only the IN port is used. A 121 Ω terminator is required on the OUT port.

CANOPEN LEDS

RUN

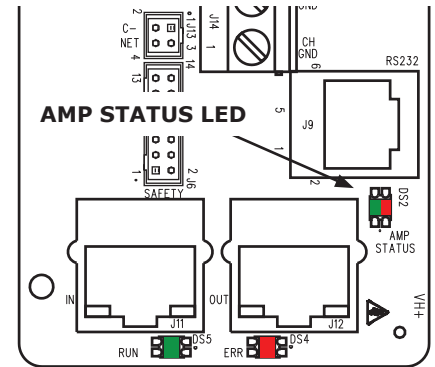
Green: Shows the state of the FSA (Finite State Automaton):

Off = INIT
Blinking = Pre-operational
Single Flash = Safe-operational
On = Operational

ERR

Red: Shows errors such as watchdog timeouts and unsolicited APV state changes due to local errors:

Off = CANopen communications are working correctly
Blinking = Invalid configuration, general configuration error
Single Flash = Local error, slave has changed CANopen state autonomously
Double Flash = PDO or CANopen watchdog timeout, or an application watchdog timeout has occurred



EZ BOARD CANOPEN CONNECTORS

CANOPEN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet CAT-5 cables are provided for CANopen connectivity.

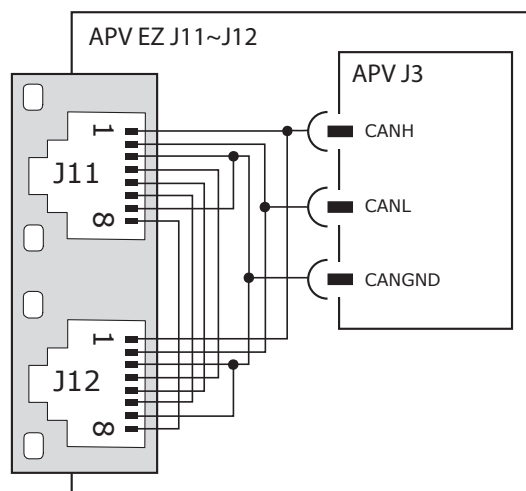
J11 CAN

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	*
5	*
6	*
7	CANGND
8	*

J12 CAN

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	*
5	*
6	*
7	CANGND
8	*

* These pins are pass-through and have no connections to the drive circuits.



EZ BOARD SAFE TORQUE OFF (STO)

DESCRIPTION

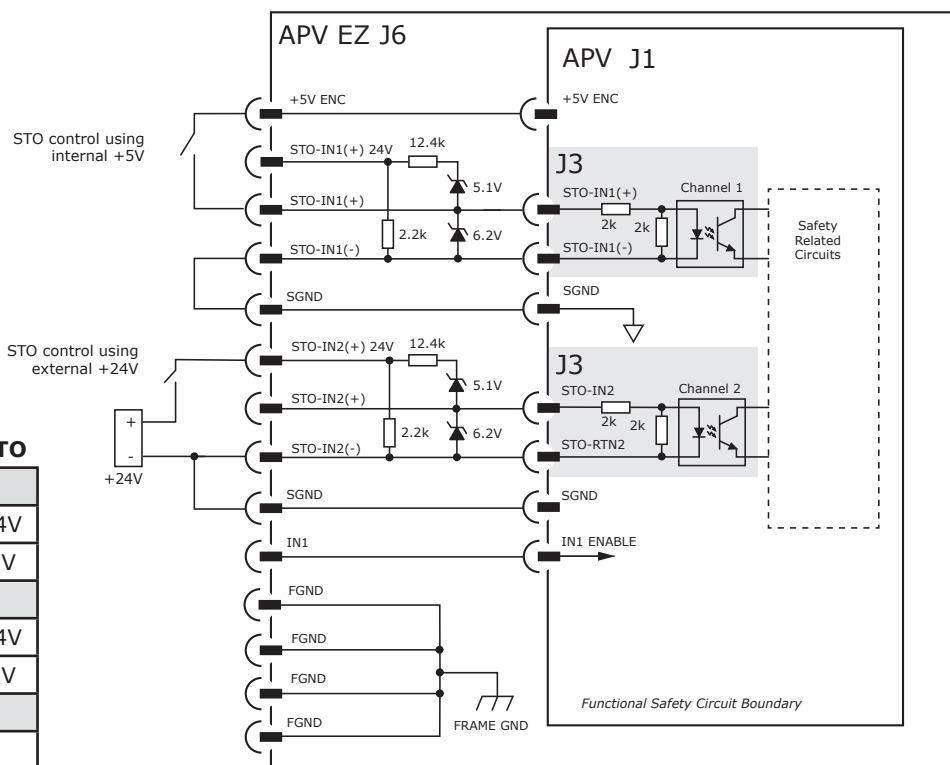
This shows the use of the internal +5V or external 24V to energize the STO inputs.

Both STO inputs must be energized in order to enable the drive. IN1, the hardware Enable input is for use with an immediate contact relay to bring the motor to a stop before a delayed contact relay de-energizes the STO inputs and prevents torque production in the motor.

J6 STO

Signal	Pin		Signal
STO-IN1(-)	1	2	STO-IN1(+) 24V
STO-IN1(-)	3	4	STO-IN1(+) 5V
n.c.	5	6	n.c.
STO-IN2(-)	7	8	STO-IN2(+) 24V
STO-IN2(-)	9	10	STO-IN2(+) 5V
n.c.	11	12	n.c.
Sgnd	13	14	FGND
IN1	15	16	+5V ENC

n.c. = No connection



EZ BOARD SLI PORT SWITCHES & LEDS

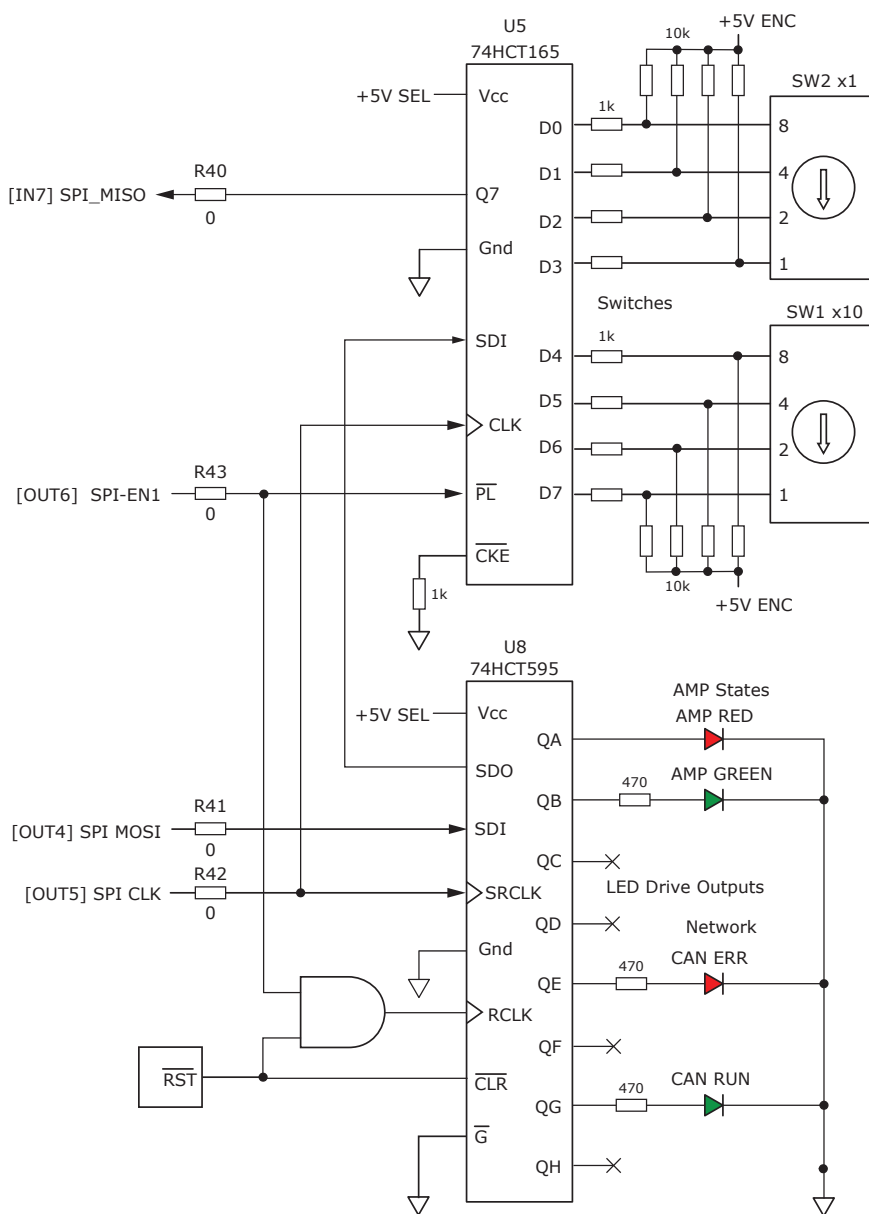
CANOPEN DEVICE ID (STATION ALIAS) SWITCH CONNECTIONS

The graphic below shows the connections to the CANopen Device ID switches and status LEDs. The switches 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 [OUT4,5,6,] and input [IN7] operate as an SLI port which reads the settings on the CANopen Device ID switches, and controls the Amp and CANopen status LEDs.

NOTE:

R40, R41, R42, R43 may be removed by the user if IN7, OUT4, OUT5, OUT6 are needed for other functions. This will disable the address switches and LEDS.



EZ BOARD VLOGIC

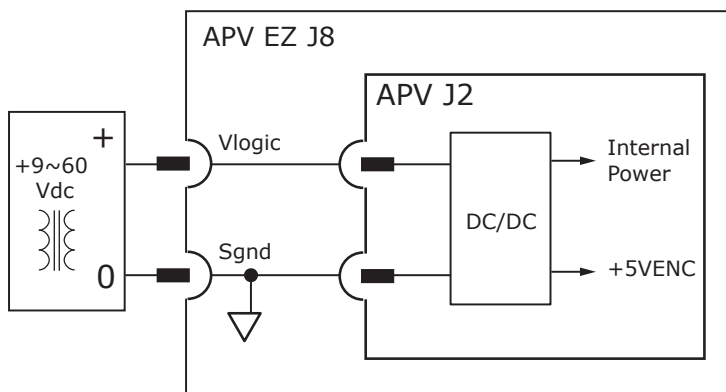
DESCRIPTION

Powers the internal logic and control circuits in the drive. When using the STO feature, it must be produced by power supplies with transformer isolation from the mains and PELV or SELV ratings and a maximum output voltage of 60 Vdc.

If the motor can operate from voltages of 60 Vdc or less, the +HV and Vlogic can be driven from a single power supply.

J8 Vlogic

Pin	Signal
1	VLOGIC
2	Sgnd



EZ BOARD +HV & MOTOR CONNECTIONS

DESCRIPTION

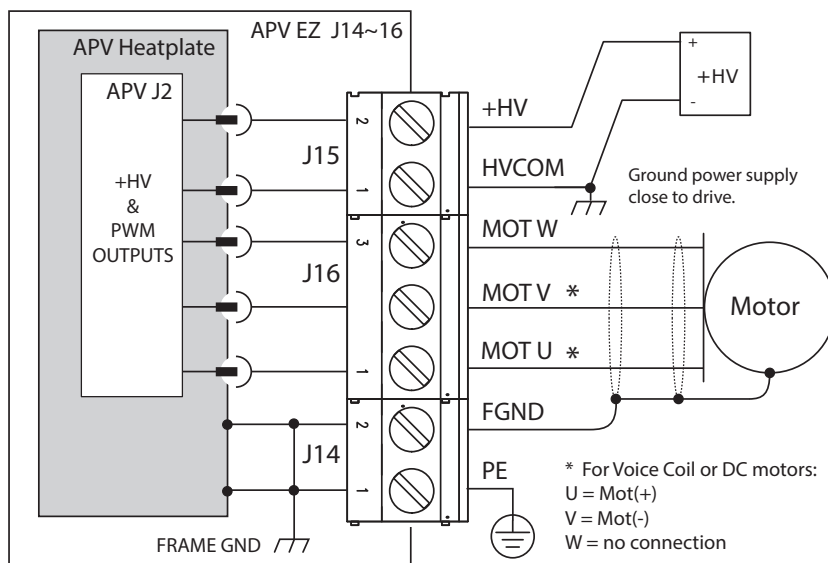
J15 provides connection to the DC power supply.

J16 carries three conductors for brushless motors.

J14-1 provides a connection for a shielded cable connecting the motor housing to chassis ground.

The PE (Protective Earth) terminal provides a single connection to earth for bonding of the APV to an earth-ground point.

J#	Pins	Signal
J15	2	+HV
	1	HVCOM
J16	3	MOT W
	2	MOT V *
	1	MOT U *
J14	2	FGND
	1	PE



EZ BOARD I/O CONNECTORS

LOGIC INPUTS

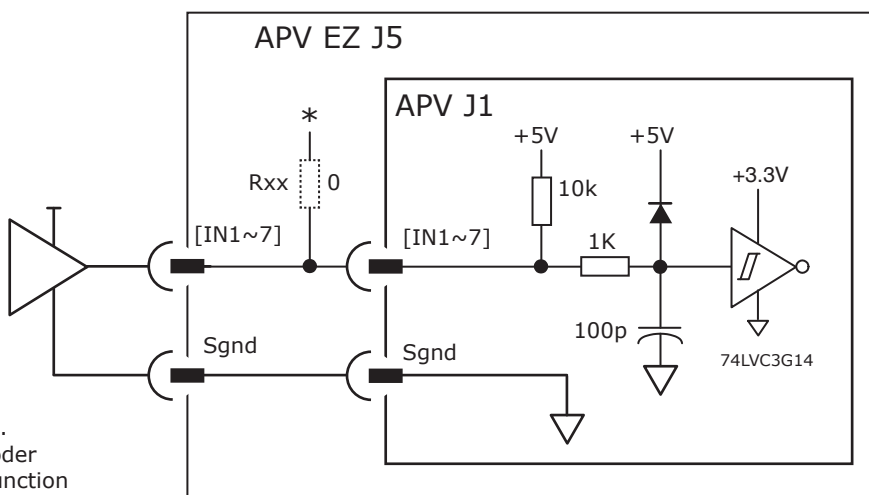
Signal	J5 Pins
IN1 Enable	4
IN2	3
IN3	6
IN4	5
IN5 Motemp	8
IN6 Encoder Fault	7
IN7 SLI MISO	10
Sgnd	5, 17, 18

Logic inputs max input voltage is +6 Vdc.
IN5 is connected to P1, the primary encoder Motemp input. If it is not used for that function then IN5 is available as a logic input.

* Rxx shows the locations of 0 Ω resistors that are in place by default as R44 and R40.

R44 connects the Encoder Fault signal to IN6.
R40 connects the SLI-MISO signal to IN7 which is used by the SLI port that controls the LEDs and reads the address switches.

If neither of these functions are needed then R40 and/or R44 can be removed making IN6 & IN7 available as logic inputs



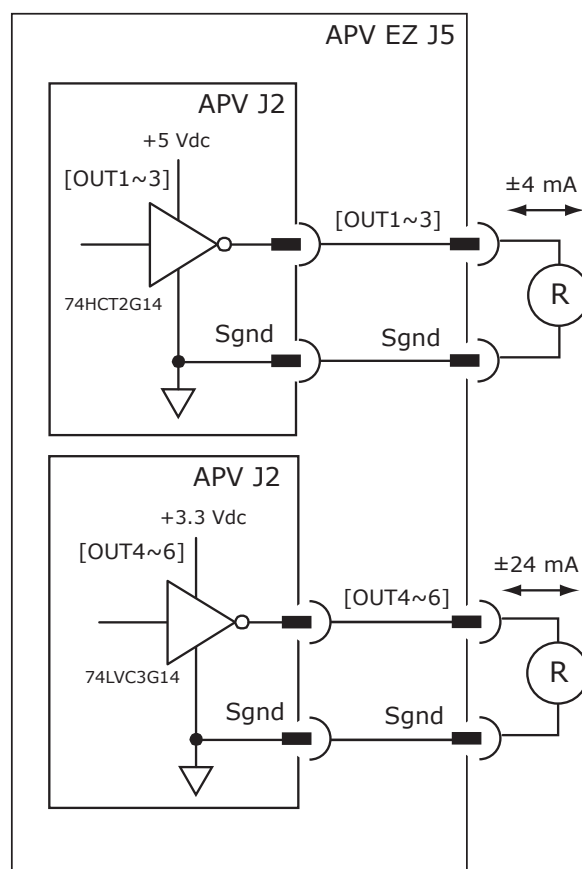
LOGIC OUTPUTS

Signal	J5 Pins
OUT1	12
OUT2	9
OUT3 Brake	14
OUT4 SLI-MOSI	11
OUT5 SLI-CLK	16
OUT6 SLI-EN1	13
Sgnd	5, 17, 18

OUT3 is connected by default to the MOSFET that is the Brake output on J10. OUT1~2 are available as logic outputs.

OUT4~6 connect to the SLI circuit that drives the displays and reads the address switches. If the SLI function is not needed then these outputs can be used as logic outputs by removing the Rxx as follows:

OUT4: R41
OUT5: R42
OUT6: R43



EZ BOARD PRIMARY FEEDBACK CONNECTOR P1

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. 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 & /A or B & /B which is below the differential fault threshold.

Open-circuit condition:

The 121Ω terminator resistor will pull the inputs 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.

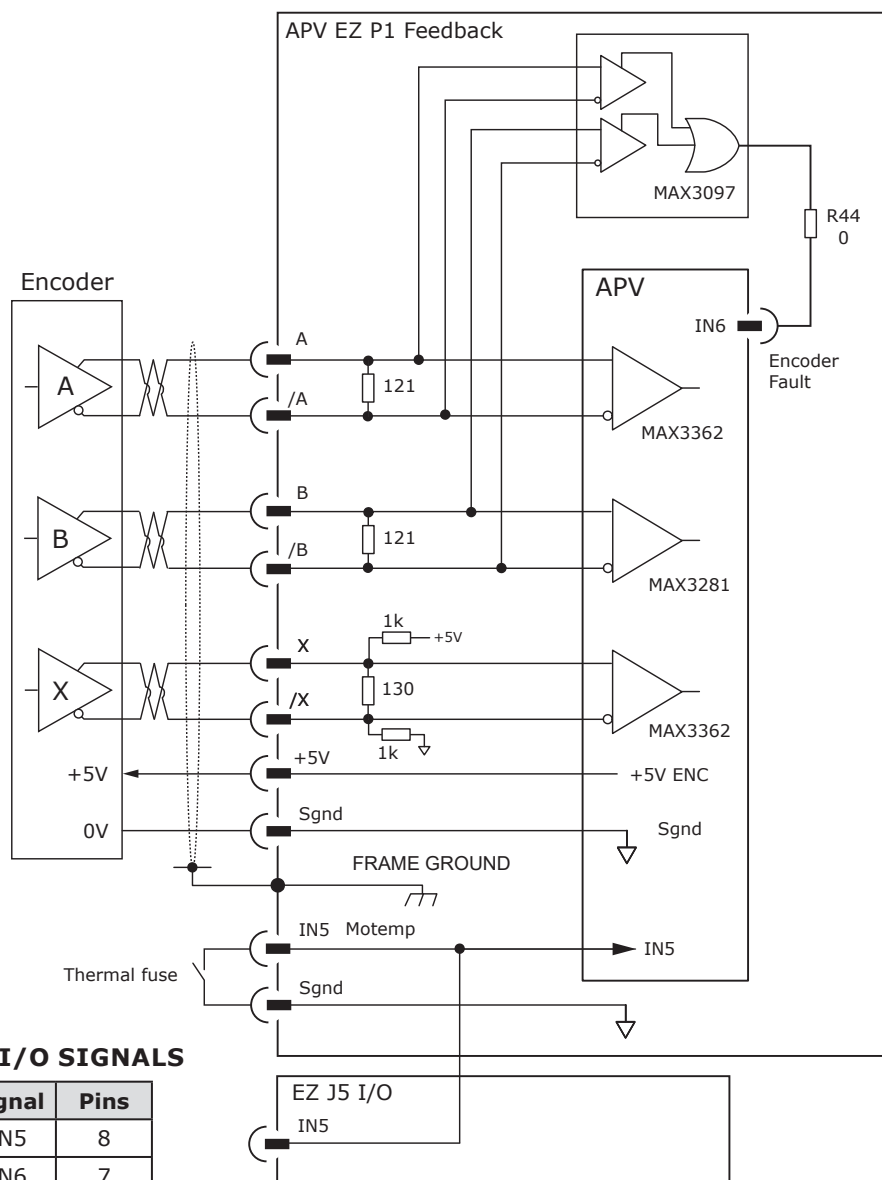
±15kV ESD protection:

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

FAULT DETECTION



J5 I/O SIGNALS

Signal	Pins
IN5	8
IN6	7
Sgnd	15, 17, 18

NOTE:

IN5 on the feedback connector is connected to the drive IN5.

P1 ENCODER 1 SIGNALS

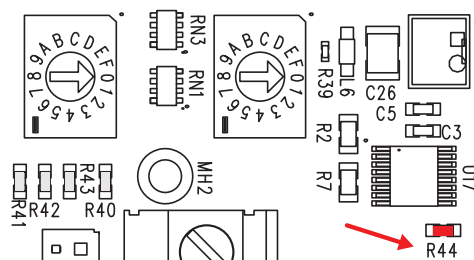
Signal	Pins
Enc A	13
Enc /A	12
Enc B	11
Enc /B	10
Enc X	9
Enc /X	8
+5V	6
IN5	7
Sgnd	5, 16, 25, 26

Sgnd = Signal Ground

IN5 MOTEMP SIGNALS

Connector	Signal	Pins
EZ P1	IN5	7
	Sgnd	5, 16, 25, 26
EZ J5	IN5	8
	Sgnd	15, 17, 18

R44 LOCATION

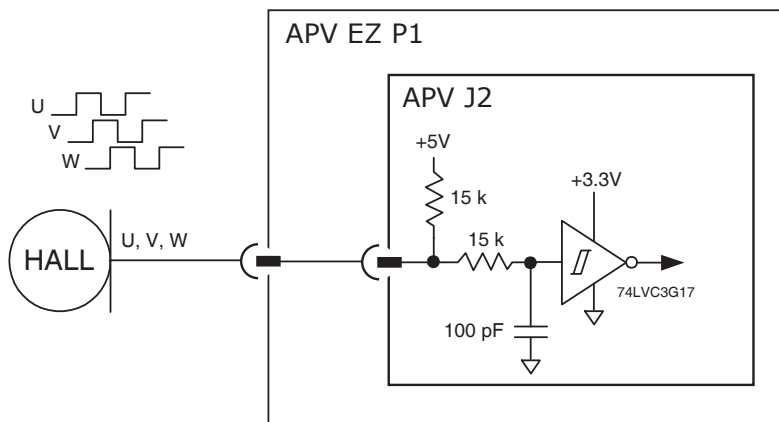


NOTE:

R44 connects IN6 to the encoder fault detection by default. If this feature is not used, then removing R44 allows IN6 to be programmed for user's function.

EZ BOARD PRIMARY FEEDBACK CONNECTOR P1

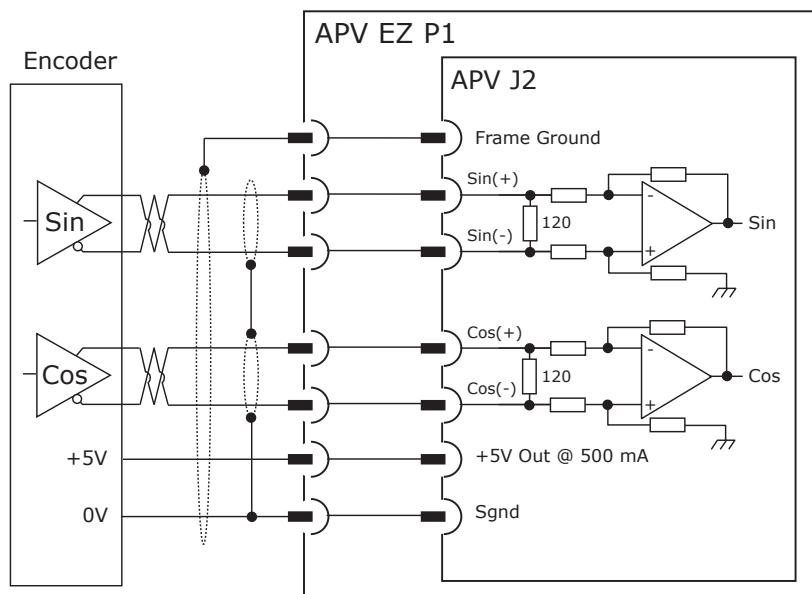
HALLS



P1 HALL SIGNALS

Signal	Pins
Hall U	2
Hall V	3
Hall W	4

SIN/COS ENCODERS



P1 SIN/COS SIGNALS

Signal	Pins
Sin(+)	19
Sin(-)	18
Cos(+)	21
Cos(-)	20

P1 +5V & SGND

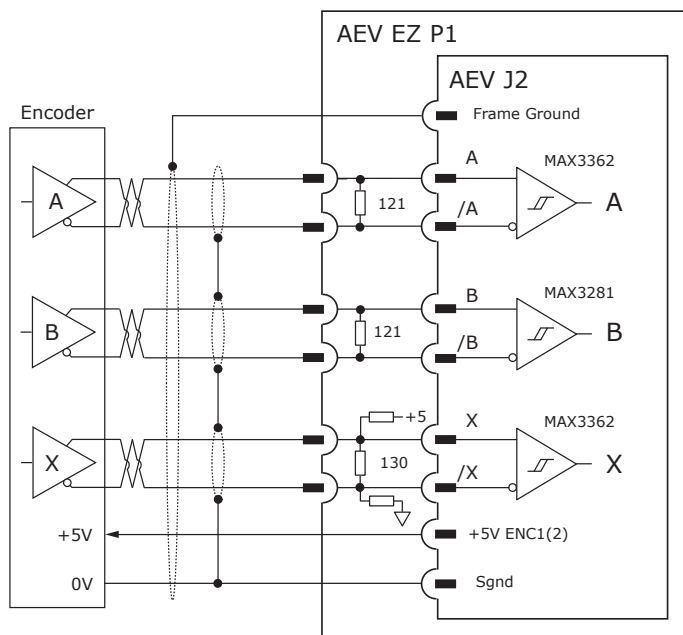
Signal	Pins
+5V	6, 17
Sgnd	5, 16, 25, 26

Note that double-shielded cable is used for the Sin/Cos signals that are analog and more susceptible to noise. Two inner shields are used providing one for each twisted-pair and these connect to Sgnd.

The outer shield connects to Frame Ground on the drive end if it not connected to the motor frame on the other. With the cable for the PWM outputs to the motor connected to Frame Ground on the drive end and the motor casing on the other there is a return path for currents produced by the capacitance between the UVW output wires and the motor cable shield.

EZ BOARD PRIMARY FEEDBACK CONNECTOR P1

QUAD ENCODER WITH INDEX



A/B/X SIGNALS

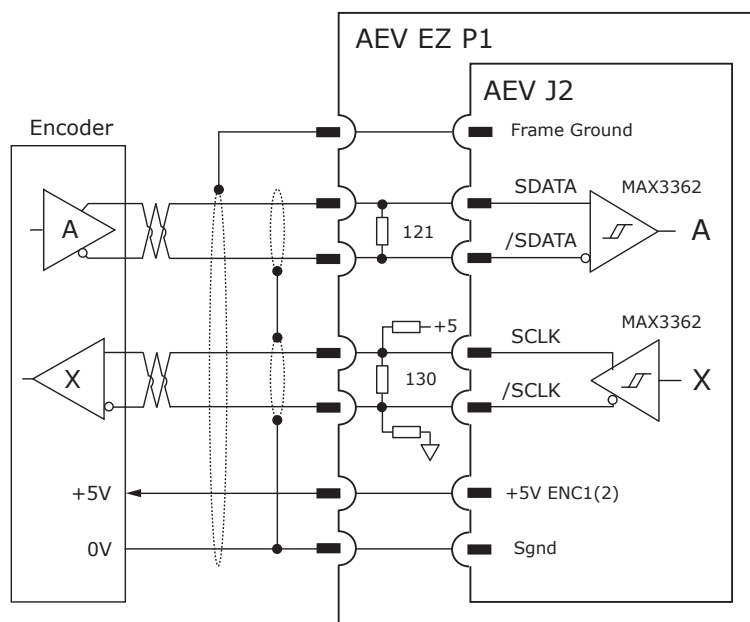
Signal	J1 Pins
Enc1 A	13
Enc1 /A	12
Enc1 B	11
Enc1 /B	10
Enc1 X	9
Enc1 /X	8
+5V	6
Sgnd	5

P1 Sgnd Pins

5,16,25,26

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 APV 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.



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

SSI, BiSS SIGNALS

SSI	BiSS	P1 Pins
Clk	MA+	9
/Clk	MA-	8
Data	SL+	13
/Data	SL-	12
+5V		6
Sgnd		5

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

EZ BOARD PRIMARY FEEDBACK CONNECTOR P1

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 incremental signals. Use of Sin/Cos incremental signals is optional in the EnDat specification.

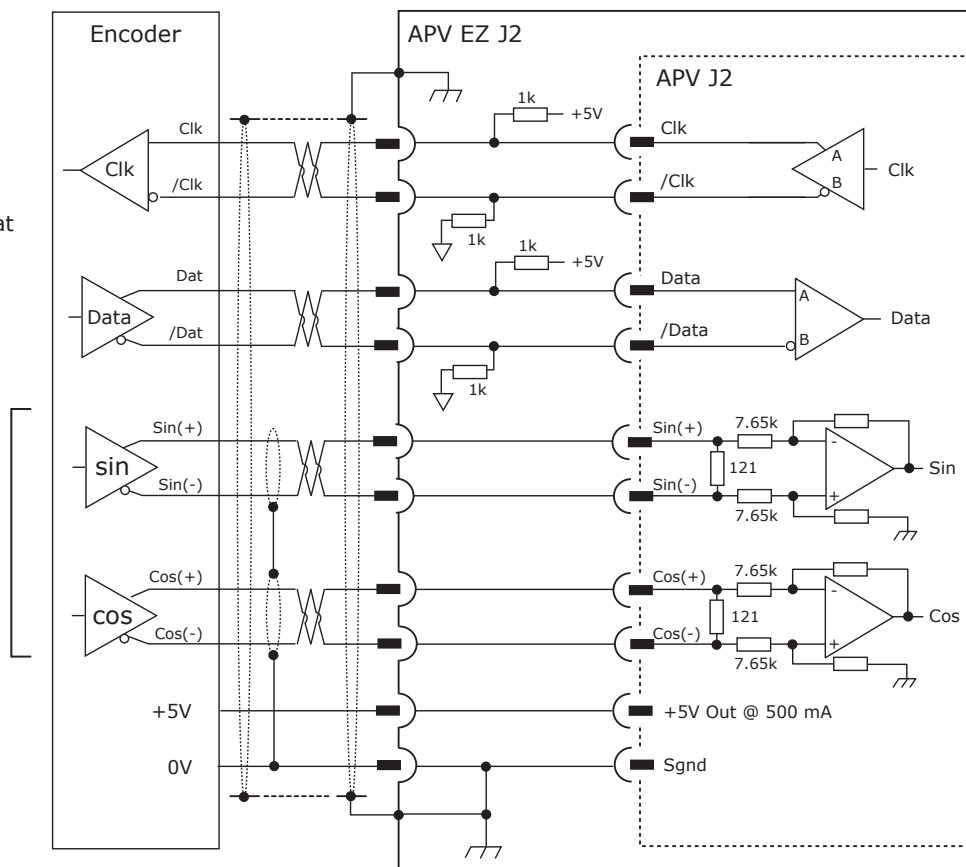
ENDAT SIGNALS

Signal	P1 Pins
Clk	9
/Clk	8
Data	13
/Data	12
Sin(+) *	19
Sin(-) *	18
Cos(+) *	21
Cos(-) *	20
+5V	6,17

* Sin/Cos optional with EnDat 2.2
or any 1 Mbit or faster Endat
Sin/Cos required if EnDat 2.1 < 1 Mbit

P1 Sgnd Pins

5,16,25,26



ABSOLUTE-A ENCODER

The Absolute A interface is a serial, half-duplex type that is electrically the same as RS-485.

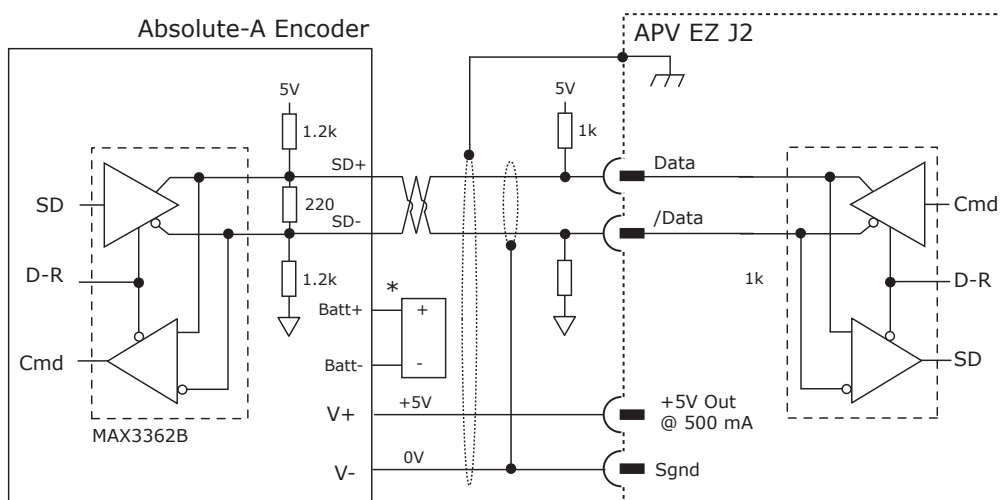
Note the battery which must be connected. Without it, the encoder will produce a fault condition.

ABSOLUTE-A SIGNALS

Signal	J2 Pins
Data	13
/Data	12
+5V	6,17

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

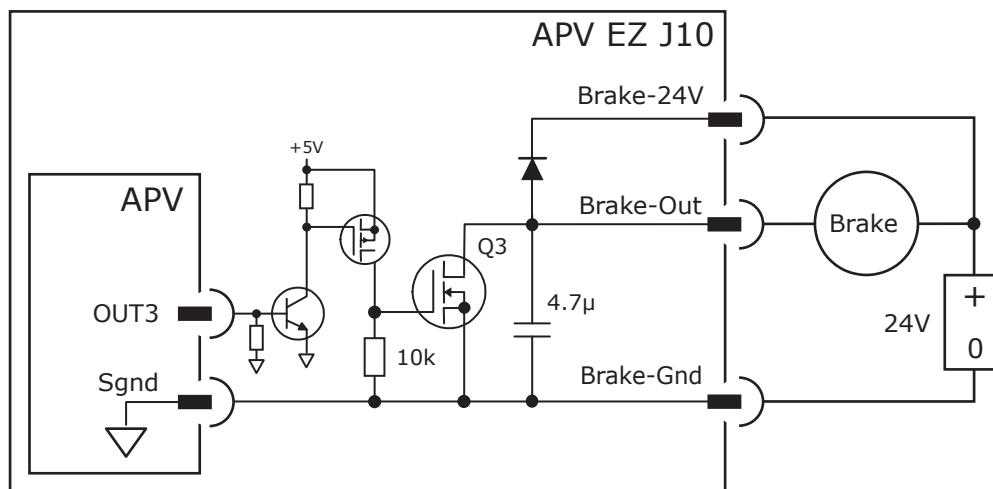
* **Battery optional**



EZ BOARD BRAKE OUTPUT

The brake circuit on the EZ board is a MOSFET driven by OUT3 of the APV.

- Brake output [OUT3]
- 24V Compatible
- Programmable functions



Specifications

Output	Data	Notes
Voltage Range	Max	+30 Vdc
Output Current	Ids	1.0 Adc

HI/LO definitions: outputs

Input	State	Condition
BRAKE [OUT3]	LO	Output MOSFET Q3 is OFF Brake is un-powered and locks motor Motor cannot move Brake state is Active
	HI	Output MOSFET Q3 is ON Brake is powered, releasing motor Motor is free to move Brake state is NOT-Active

The EZ brake circuit is referenced to Sgnd in the APV.

J10 BRAKE SIGNALS

Pin	Signal
1	Brake-24V
2	Brake-Out
3	Brake-Gnd

CME Default Setting for Brake Output [OUT3] is "Brake - Active Low"

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 [OUT3] as LO

BRK Output voltage is HI (24V), MOSFET Q3 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 [OUT3] as HI

BRK output voltage is LO (~0V), MOSFET Q3 is ON

Servo drive is enabled, PWM outputs are on

Servo drive output current is flowing

EZ BOARD CONNECTORS

P1 ENCODER 1

Pin	Signal	Pin	Signal	Pin	Signal
26	Sgnd	18	Sin(-)	9	Enc1 X
25	Sgnd	17	+5V ENC	8	Enc1 /X
24	N.C.	16	Sgnd	7	[IN5] Motemp
23	Enc1 X	15	Enc1 S	6	+5V ENC
22	Enc1 /X	14	Enc1 /S	5	Sgnd
21	Cos(+)	13	Enc1 A	4	Hall W
20	Cos(-)	12	Enc1 /A	3	Hall V
19	Sin(+)	11	Enc1 B	2	Hall U
		10	Enc1 /B	1	FGND

J10 BRAKE

Pin	Signal
3	HVCOM
2	Brake output
1	+24V Input

J8 V-LOGIC

Pin	Signal
1	VLOGIC
2	Sgnd

J15 DC-POWER

Pin	Signal
2	+HV
1	HV COM

J5 I/O

Signal	Pin	Signal
Aref(-)	2	Aref(+)
Enable IN1	4	IN2
IN3	6	IN4
Motemp IN5	8	IN6 Enc-Fault **
* SLI-MISO IN7	10	OUT2
OUT1	12	OUT4 SLI-MOSI *
* Brake OUT3	14	OUT6 SLI-EN1 *
* SLI-CLK OUT5	16	Sgnd
Sgnd	18	Sgnd

J4 ENCODER 2

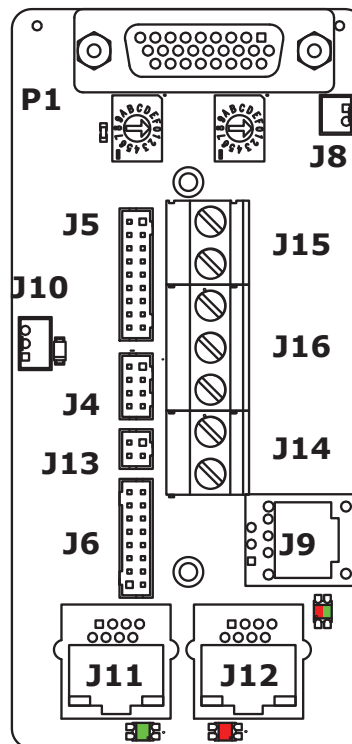
Signal	Pin	Signal
Enc2 A	2	Enc2 /A
Enc2 B	4	Enc2 /B
Enc2 X	6	Enc2 /X
Sgnd	8	+5V ENC

J13

Signal	Pin	Signal
***	2	***
***	4	***

J6 STO

Signal	Pin	Signal
IN1	15	+5V ENC
Sgnd	13	FGND
n.c.	11	n.c.
STO-IN2(-)	9	STO-IN2(+)
STO-IN2(-)	7	STO-IN2(+)
n.c.	5	n.c.
STO-IN1(-)	3	STO-IN1(+)
STO-IN1(-)	1	STO-IN1(+)



J16 MOTOR

Pin	Signal
3	Mot W
2	Mot V
1	Mot U

J14 GROUNDS

Pin	Signal
2	FGND
1	PE

J9 RS-232

Pin	Signal
1	N.C.
2	RxD
3	Sgnd
4	Sgnd
5	TxD
6	N.C.

* These signals are wired for the functions shown. They can be programmed for other functions but the default functions will no longer function.

** This input can be programmed for other functions by removing the resistor R44 that connects the input to the encoder 1 fault-detection circuit.

*** No connections

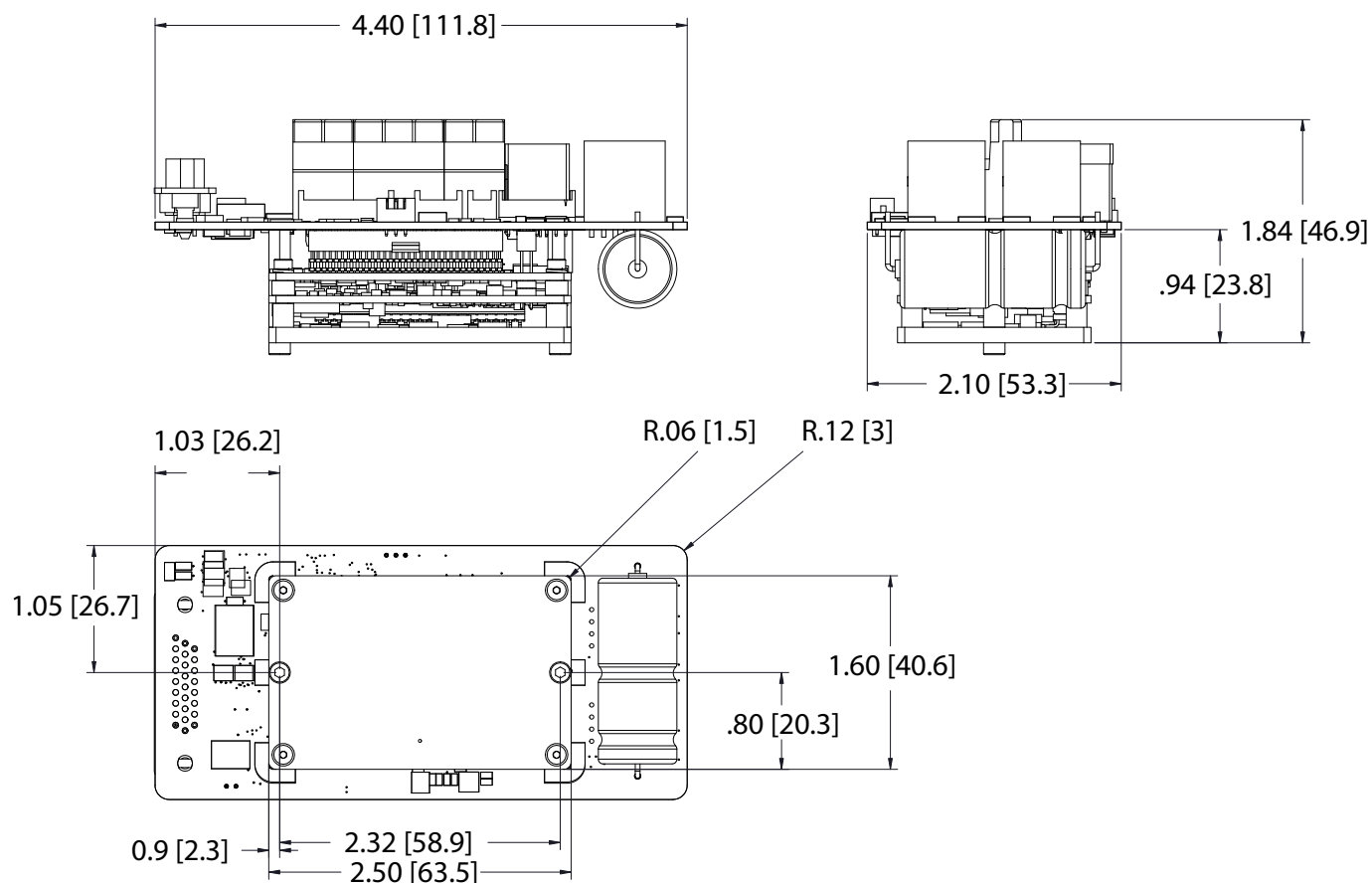
J11 CAN-IN

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	Pass-thru
5	Pass-thru
6	Pass-thru
7	CANGND
8	Pass-thru

J12 CAN-OUT

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	Pass-thru
5	Pass-thru
6	Pass-thru
7	CANGND
8	Pass-thru

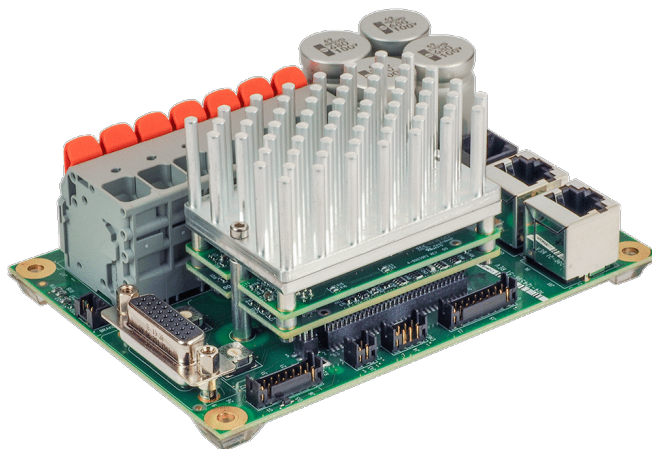
EZ BOARD DIMENSIONS



EZ DEVELOPMENT BOARD

DESCRIPTION

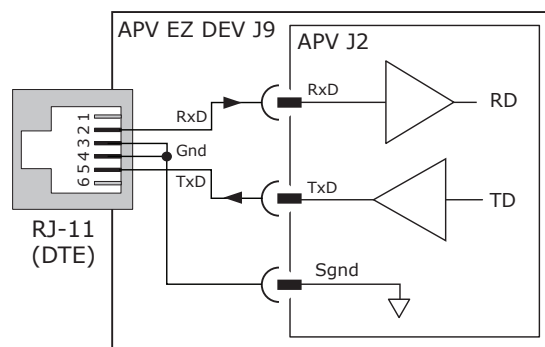
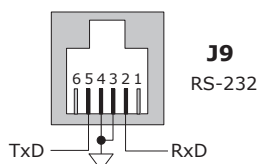
The EZ Development Board mounts an APV-090-50-C drive which has the motor and +HV pins soldered to support the 50 A dc peak and continuous current rating.



RS-232 CONNECTION

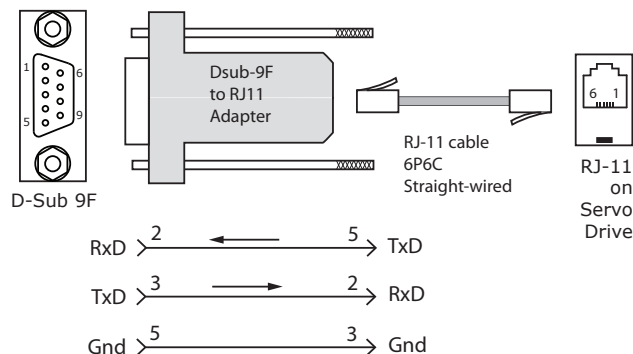
The RS-232 port is used to configure the drive for stand-alone applications, or for configuration before it is installed into an CANopen network. CME software communicates with the drive over this link and is then used for complete drive setup. The CANopen Device ID that is set by the rotary switches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

The RS-232 connector, J9, is a modular RJ-11 type that uses a 6-position plug, four wires of which are used for RS-232. A connector kit is available (SER-CK) that includes the modular cable, and an adaptor to interface this cable with a 9-pin RS-232 port on a computer.



SER-CK SERIAL CABLE KIT

The SER-CK provides connectivity between a D-Sub 9 male connector and the RJ-11 connector J9 on the EZ Development Board. It includes an adapter that plugs into the COM1 (or other) port of a PC and uses a straight-through modular cable to connect to the APV. The connections are shown in the diagram below.



Don't forget to order a Serial Cable Kit SER-CK or an SER-USB-RJ11 when placing your order for an APZ drive, or an EZ board.

EZ DEVELOPMENT BOARD CANOPEN INDICATORS & ADDRESS SWITCHES

Dual RJ-45 sockets accept standard CAN cables. If the APV is the last node on a network, only one port is used.
A 121 Ω terminator is required on the other port.

CANOPEN LEDS

RUN

Green shows the CANopen State Machine:

Off = Init state
Blinking = Pre-operational
Single Flash = Safe-operational
On = Operational

ERR

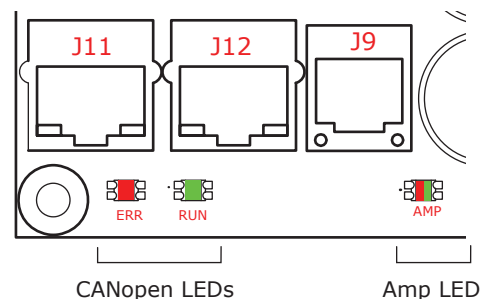
Red shows error conditions:

Blinking = Invalid configuration
Single Flash = Unsolicited state change
Double Flash = Application watchdog timeout

L/A (LINK/ACT)

Green indicates the state of the CANopen 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 bi-color LED gives the state of the drive. Colors do not alternate, and can be solid ON or blinking.

If multiple conditions occur, only the top-most condition will be displayed. When that condition is cleared the next one below will shown.

Red/Blinking = Latching fault. Operation can not resume until drive is Reset.
Red/Solid = Transient fault condition. Drive can resume operation when the condition causing the fault is removed.
Green/Slow-Blinking = Drive OK but NOT-enabled. Can run when enabled.
Green/Fast-Blinking = Positive or Negative limit switch active. Drive can only move in direction not inhibited by limit switch.
Green/Solid = Drive OK and enabled. Can run in response to reference inputs or CANopen commands.

LATCHING FAULTS

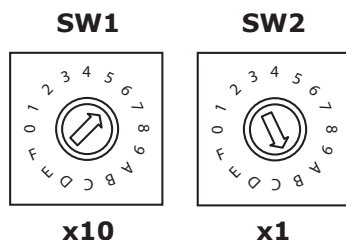
Default	Optional (programmable)
Short circuit (Internal or external)	Over-voltage
Drive over-temperature	Under-voltage
Motor over-temperature	Motor Phasing Error
Feedback Error	Command Input Lost
Following Error	Motor Wiring Disconnected
	Over Current (latched)

CANopen DEVICE ID

In an CANopen 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 EZ Development Board 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.

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

EZ DEVELOPMENT BOARD CANOPEN CONNECTORS

CANOPEN CONNECTORS

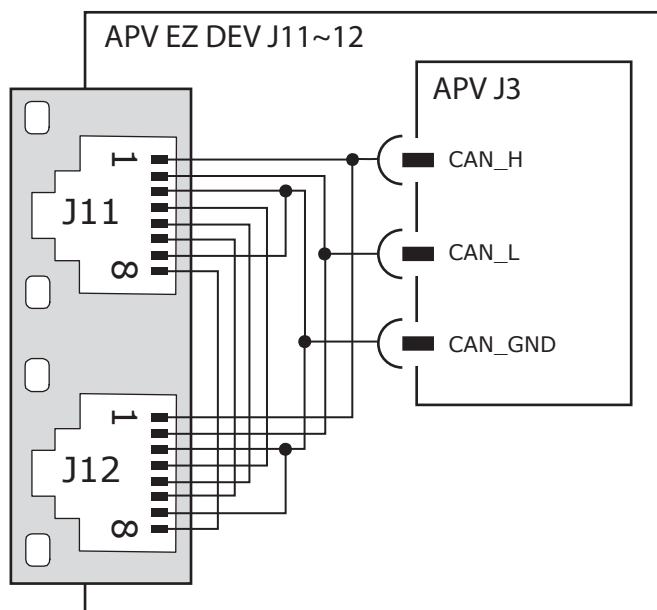
Dual RJ-45 connectors that accept standard Ethernet CAT-5 cables are provided for CANopen connectivity.

J11 ECAT-IN

Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_GND
4	AUX 1
5	AUX 2
6	AUX 3
7	CAN_GND
8	AUX 4

J12 ECAT-OUT

Pin	Signal
1	CAN_H
2	CAN_L
3	CAN_GND
4	AUX 1
5	AUX 2
6	AUX 3
7	CAN_GND
8	AUX 4



EZ DEVELOPMENT BOARD SAFE TORQUE OFF (STO)

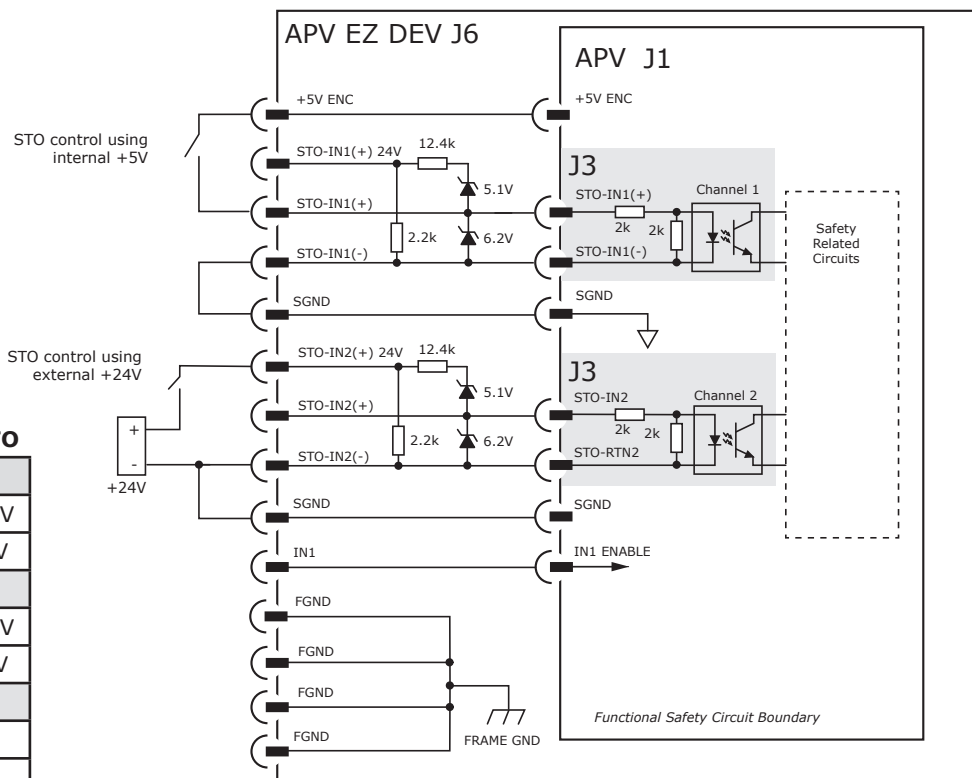
DESCRIPTION

This shows the use of the internal 5V and external 24V to energize the STO inputs.

Both STO inputs must be energized in order to enable the drive. IN1, the hardware Enable input is for use with an immediate contact relay to bring the motor to a stop before a delayed contact relay de-energizes the STO inputs and prevents torque production in the motor.

J6 STO

Signal	Pin	Signal
STO-IN1(-)	1	2
STO-IN1(-)	3	4
n.c.	5	6
STO-IN2(-)	7	8
STO-IN2(-)	9	10
n.c.	11	12
Sgnd	13	14
IN1	15	16
		+5V ENC



EZ DEVELOPMENT BOARD SLI PORT SWITCHES & LEDS

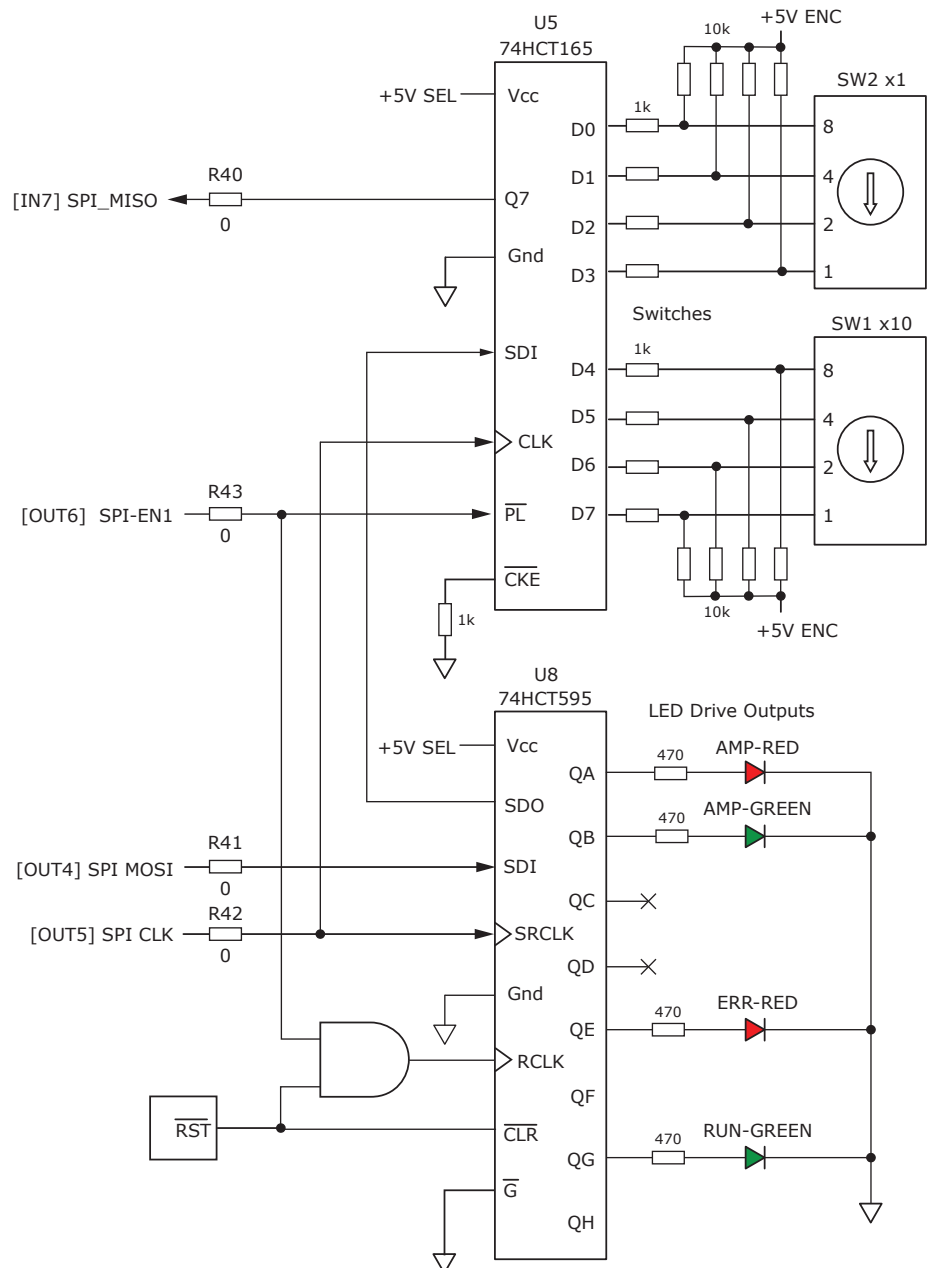
CANOPEN DEVICE ID (STATION ALIAS) SWITCH CONNECTIONS

The graphic below shows the connections to the CANopen Device ID switches and status LEDs. The switches 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 [OUT4,5,6] and input [IN7] operate as an SLI port which reads the settings on the CANopen Device ID switches, and controls the Amp and CANopen status LEDs.

NOTE:

R40, R41, R42, R43 may be removed by the user if IN7, OUT4, OUT5, OUT6 are needed for other functions. This will disable the address switches and LEDs.



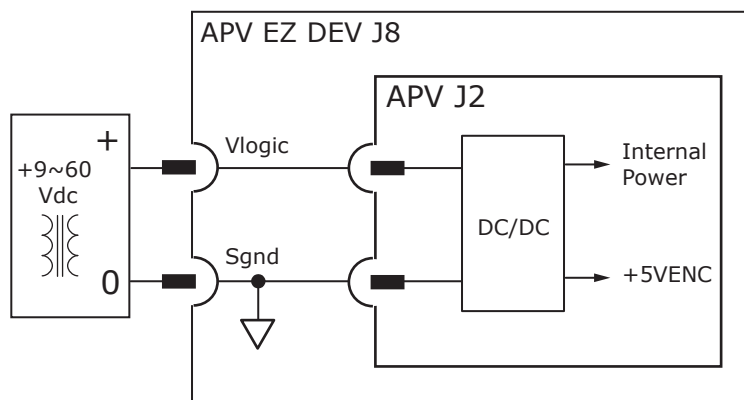
EZ DEVELOPMENT BOARD VLOGIC

DESCRIPTION

Powers the internal logic and control circuits in the drive. When using the STO feature, it must be produced by power supplies with transformer isolation from the mains and PELV or SELV ratings with a maximum output voltage of 60 Vdc. If the motor can operate from voltages of 60 Vdc or less, the +HV and Vlogic can be driven from a single power supply.

J8 Vlogic

Pin	Signal
1	Vlogic
2	Sgnd



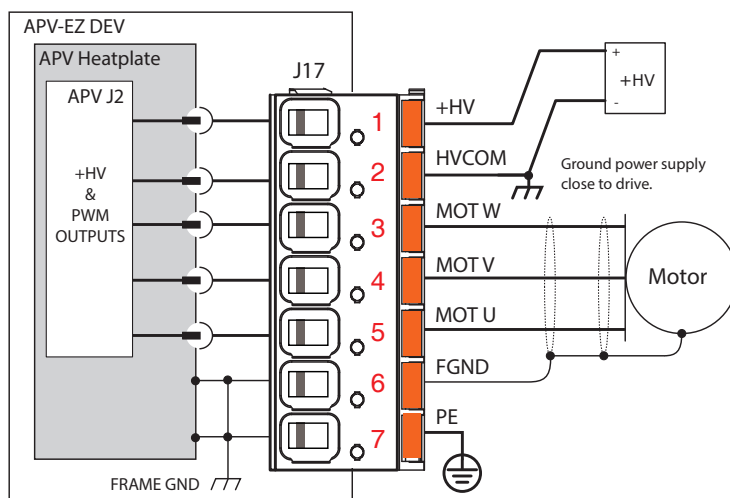
EZ DEVELOPMENT BOARD POWER, MOTOR, & GROUNDING CONNECTIONS

DESCRIPTION

J17 provides connection to the DC power supply, PWM outputs, and grounds. There are three conductors for brushless motors what provide and connection for a shielded cable connecting the motor housing to frame ground. The PE (Protective Earth) terminal provides a single connection to earth for bonding of the APV frame ground to an earth-ground point.

J17 +HV, MOTOR, GNDS

Pins	Signal
1	+HV
2	HVCOM
3	MOT W
4	MOT V
5	MOT U
6	FGND
7	PE



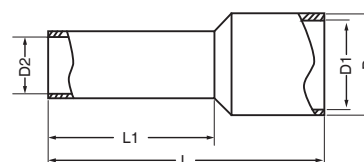
CONDUCTOR TYPE	MM ²	AWG
Solid	0.75 ~ 16	18 ~ 4
Fine stranded	0.75 ~ 25	18 ~ 4
Fine stranded with ferrule with plastic collar	0.75 ~ 16	N/A
Fine stranded with ferrule without plastic collar	0.75 ~ 16	
Fine stranded with twin ferrule	0.75 ~ 6	

INSULATION STRIPPING	MM	INCH
Strip length	18 ~ 20	0.71 ~ 0.79

Wago ferrules shown are electro-tin plated, electrolytic copper, gastight crimped, according to DIN 46228, Part 4/09.90. Wago part numbers are shown but other ferrule types with comparable specifications may be used.

216-210 Dimensions
 L = 28 mm
 L1 = 18 mm
 D = 9.6 mm
 D1 = 8.8 mm
 D2 = 5.8 mm

FERRULES		
MM ²	AWG	WAGO P/N
16	6	216-210
10	8	216-289
6	10	216-288
4	12	216-287
2.5	14	216-286
1.5	16	216-284



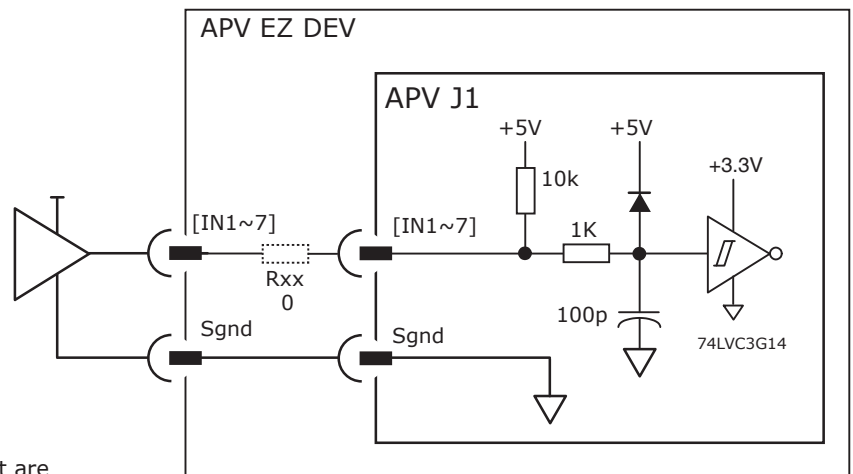
216-210

EZ DEVELOPMENT BOARD I/O CONNECTORS

LOGIC INPUTS

Signal	J5 Pins
IN1 Enable	4
IN2	3
IN3	6
IN4	5
IN5	8
IN6 Encoder Fault	7
IN7 SLI MISO	10
Sgnd	15, 17, 18

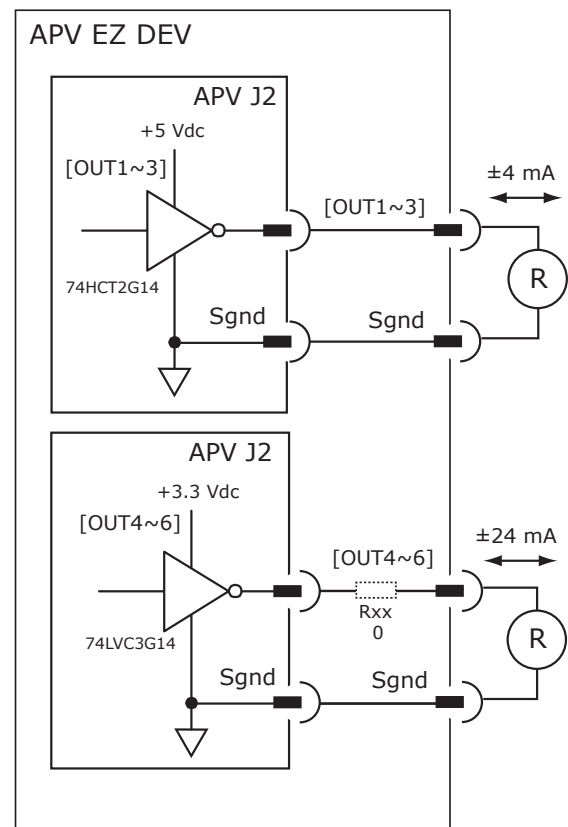
Logic inputs max input voltage is +6 Vdc.
 Rxx shows the location of 0 Ω resistors that are in place by default as R40 and R44.
 R40 connects the SLI-MISO signal to IN7 which is used by the SLI port that controls the LEDs and reads the address switches.
 R44 connects the Encoder Fault signal to IN6.
 If neither of these functions are needed then R40 and/or R44 can be removed making IN6 & IN7 available as logic inputs



LOGIC OUTPUTS

Signal	J5 Pins
OUT1	12
OUT2	9
OUT3 Brake	14
OUT4 SLI-MOSI	11
OUT5 SLI-CLK	16
OUT6 SLI-EN1	13
Sgnd	5, 17, 18

OUT3 is connected by default to the MOSFET that is the Brake output on J10. OUT1~2 are available as logic outputs.
 OUT4~6 connect to the SLI circuit that drives the displays and reads the address switches.
 If the SLI function is not needed then these outputs can be used as logic outputs by removing the Rxx as follows:
 OUT4: R41
 OUT5: R42
 OUT6: R43



EZ DEVELOPMENT BOARD PRIMARY FEEDBACK CONNECTOR P1

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. 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 & /A or B & /B which is below the differential fault threshold.

Open-circuit condition:

The 121Ω terminator resistor will pull the inputs 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.

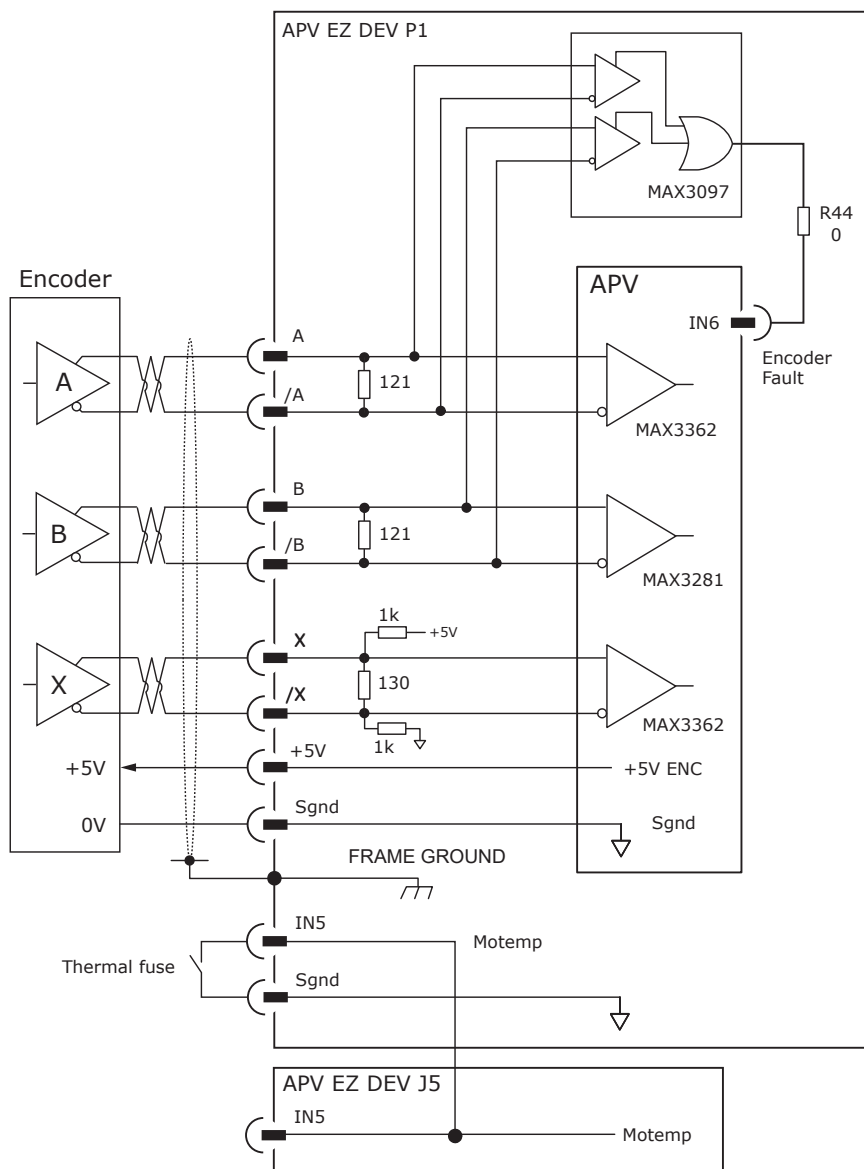
±15kV ESD protection:

The 3097 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

FAULT DETECTION



P1 ENCODER 1 SIGNALS

Signal	Pins
Enc A	13
Enc /A	12
Enc B	11
Enc /B	10
Enc X	9
Enc /X	8
+5V	6
IN5	7
Sgnd	5,16,25,26

Sgnd = Signal Ground

NOTE:

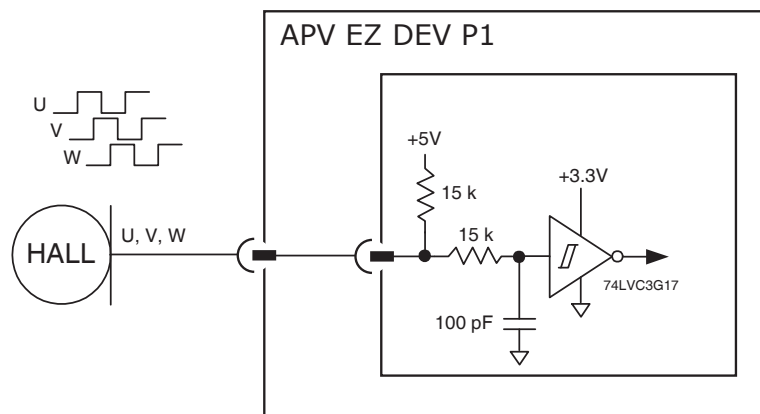
IN5 on the feedback connector is connected to the drive IN5.

IN5 MOTEMP SIGNALS

Connector	Signal	Pins
P1	IN5	7
	Sgnd	5, 16, 25, 26
J5	IN5	8
	Sgnd	15, 17, 18

EZ DEVELOPMENT BOARD PRIMARY FEEDBACK CONNECTOR P1

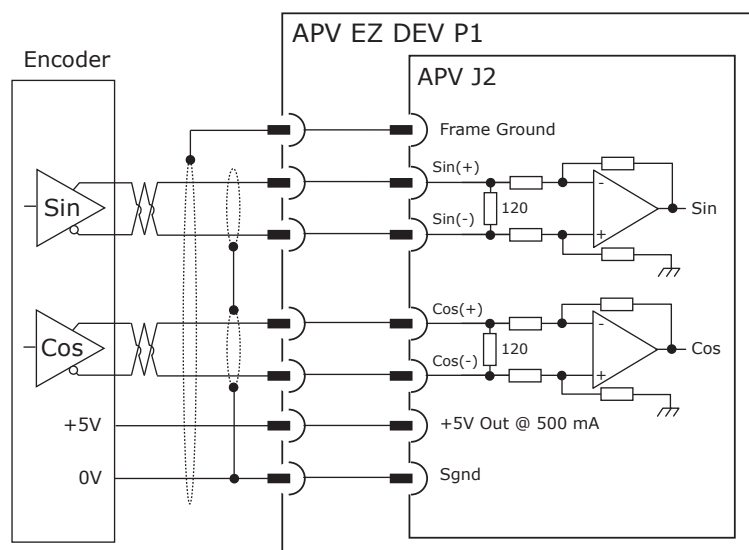
HALLS



P1 HALL SIGNALS

Signal	Pins
Hall U	2
Hall V	3
Hall W	4

SIN/COS ENCODERS



P1 SIN/COS SIGNALS

Signal	Pins
Sin(+)	19
Sin(-)	18
Cos(+)	21
Cos(-)	20

P1 +5V & SGND

Signal	Pins
+5V	6, 17
Sgnd	5, 16, 25, 26

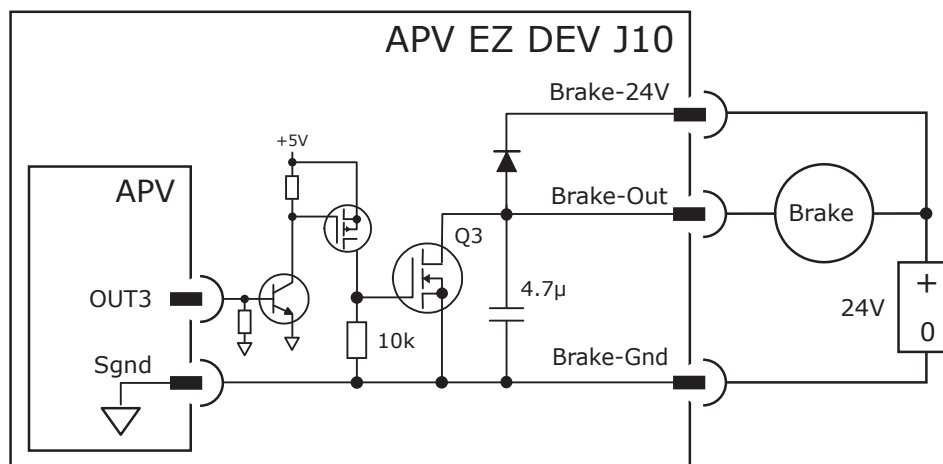
Note that double-shielded cable is used for the Sin/Cos signals that are analog and more susceptible to noise. Two inner shields are used providing one for each twisted-pair and these connect to Sgnd.

The outer shield connects to Frame Ground on the drive end is it not connected to the motor frame on the other. With the cable for the PWM outputs to the motor connected to Frame Ground on the drive end and the motor casing on the other there is a return path for currents produced by the capacitance between the UVW output wires and the motor cable shield.

EZ DEVELOPMENT BOARD BRAKE OUTPUT

The brake circuit on the EZ Development Board is a MOSFET driven by OUT3 of the APV.

- Brake output [OUT3]
- 24V Compatible
- Programmable functions



Specifications

Output	Data	Notes
Voltage Range	Max	+30 Vdc
Output Current	Ids	1.0 Adc

HI/LO definitions: outputs

Input	State	Condition
BRAKE [OUT3]	LO	Output MOSFET Q3 is OFF Brake is un-powered and locks motor Motor cannot move Brake state is Active
	HI	Output MOSFET Q3 is ON Brake is powered, releasing motor Motor is free to move Brake state is NOT-Active

The EZ brake circuit is referenced to Sgnd in the APV.

J10 BRAKE SIGNALS

Pin	Signal
1	Brake-24V
2	Brake-Out
3	Brake-Gnd

CME Default Setting for Brake Output [OUT3] is "Brake - Active Low"

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 [OUT3] as LO

BRK Output voltage is HI (24V), MOSFET Q3 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 [OUT3] as HI

BRK output voltage is LO (~0V), MOSFET Q3 is ON

Servo drive is enabled, PWM outputs are on

Servo drive output current is flowing

EZ DEVELOPMENT BOARD CONNECTORS

P1 ENCODER 1

Pin	Signal	Pin	Signal	Pin	Signal
19	Sin(+)	10	Enc1 /B	1	FGND
20	Cos(-)	11	Enc1 B	2	Hall U
21	Cos(+)	12	Enc1 /A	3	Hall V
22	Enc1 /X	13	Enc1 A	4	Hall W
23	Enc X	14	Enc1 /S	5	Sgnd
24	N.C.	15	Enc1 S	6	+5V ENC
25	Sgnd	16	Sgnd	7	IN5 Motemp
26	Sgnd	17	+5V ENC	8	Enc1 /X
		18	Sin(-)	9	Enc1 X

J10 BRAKE

Pin	Signal
1	+24V Input
2	Brake output
3	HVCOM

J6 STO

Signal	Pin	Signal
IN1	15	+5V ENC
Sgnd	13	FGND
n.c.	11	n.c.
STO-IN2(-)	9	STO-IN2(+) 5V
STO-IN2(-)	7	STO-IN2(+) 24V
n.c.	5	n.c.
STO-IN1(-)	3	STO-IN1(+) 5V
STO-IN1(-)	1	STO-IN1(+) 24V

J13

Signal	Pin	Signal
***	3	***
***	1	***

*** No connections

J4 ENCODER 2

Signal	Pin	Signal
+5V ENC	7	Sgnd
Enc2 /X	5	Enc2 X
Enc2 /B	3	Enc2 B
Enc2 /A	1	Enc2 A

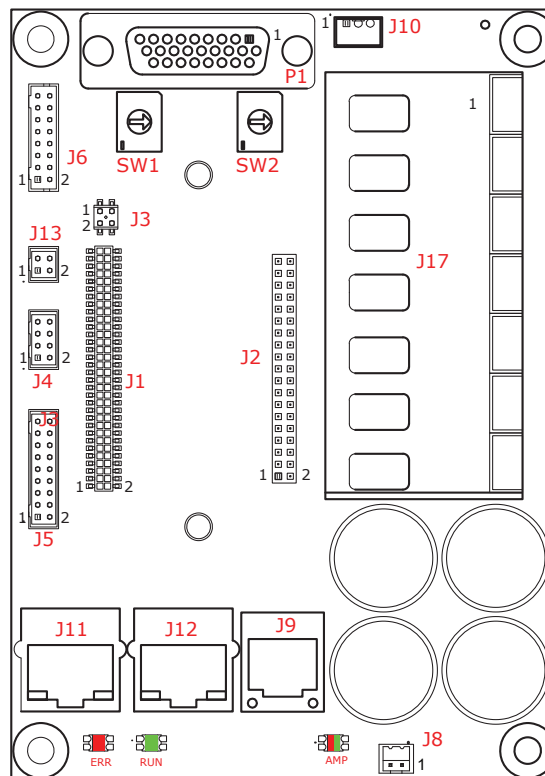
J5 I/O

Signal	Pin	Signal
Sgnd	17	Sgnd
Sgnd	15	OUT5 SLI-CLK *
* SLI-EN1 OUT6	13	OUT3 Brake *
* SLI-MOSI OUT4	11	OUT1
OUT2	9	IN7 SLI-MISO *
** Enc-Fault IN6	7	IN5 Motemp
IN4	5	IN3
IN2	3	IN1 Enable
Aref(+)	1	Aref(-)

* These signals are wired for the functions shown.

They can be programmed for other functions but the default functions will no longer function.

** This input can be programmed for other functions by removing the resistor R44 that connects the input to the encoder 1 fault-detection circuit.



J17 GROUNDS

Pin	Signal
1	PE
2	FGND

J17 MOTOR

Pin	Signal
3	Mot U
4	Mot V
5	Mot W

J17 DC-POWER

Pin	Signal
6	HVCOM
7	+HV

J8 V-LOGIC

Pin	Signal
1	Vlogic
2	Sgnd

J11 CAN-IN

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	Pass-thru
5	Pass-thru
6	Pass-thru
7	CANGND
8	Pass-thru

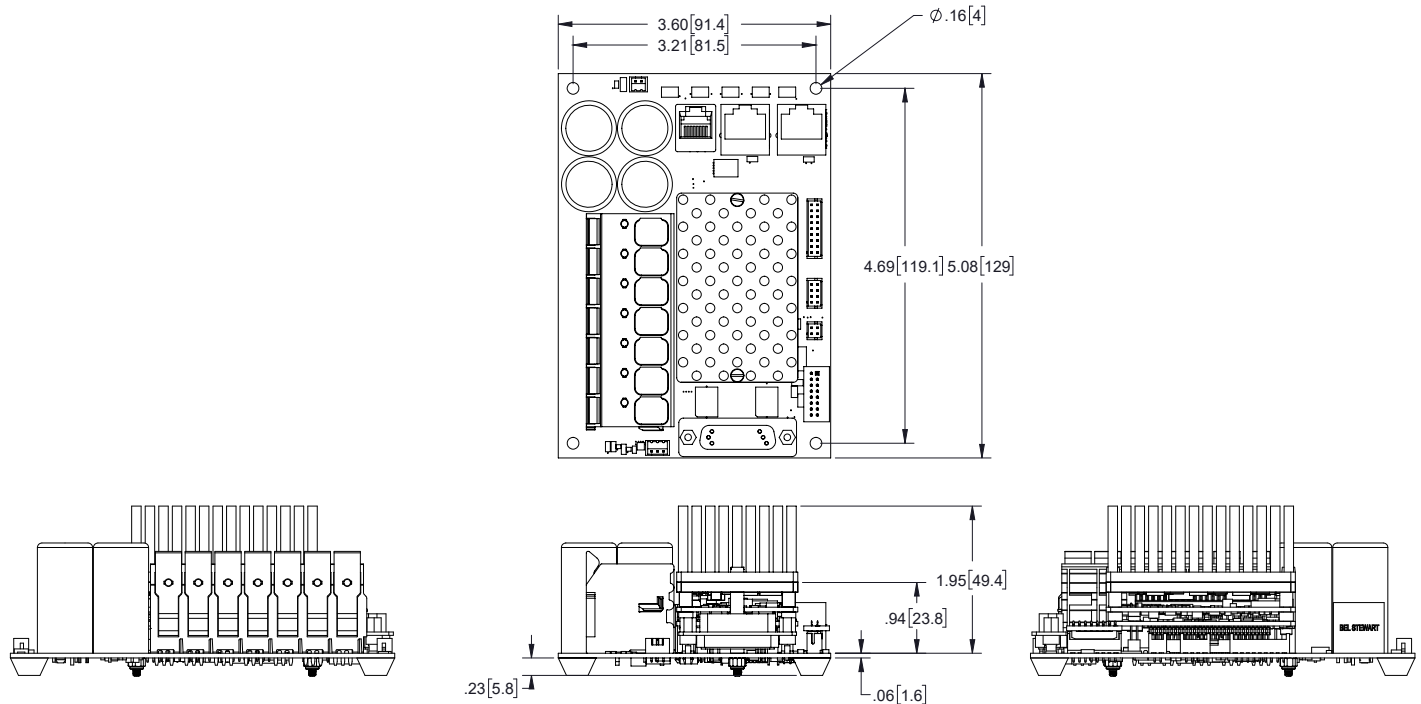
J12 CAN-OUT

Pin	Signal
1	CANH
2	CANL
3	CANGND
4	Pass-thru
5	Pass-thru
6	Pass-thru
7	CANGND
8	Pass-thru

J9 RS-232

Pin	Signal
1	N.C.
2	RxD
3	Sgnd
4	Sgnd
5	TxD
6	N.C.

EZ DEVELOPMENT BOARD DIMENSIONS



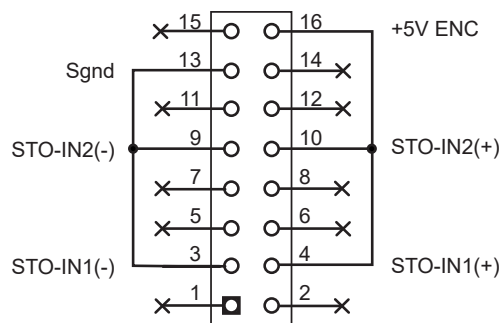
APV-EZ-STO SAFE TORQUE OFF DISABLING ACCESSORY

J6 STO

Signal	Pin	Signal
IN1	15	16 +5V ENC
Sgnd	13	14 FGND
n.c.	11	12 n.c.
STO-IN2(-)	9	10 STO-IN2(+)
STO-IN2(-)	7	8 STO-IN2(+) 24V
n.c.	5	6 n.c.
STO-IN1(-)	3	4 STO-IN1(+)
STO-IN1(-)	1	2 STO-IN1(+) 24V

The APV-EZ-STO, when inserted into J6 will disable the STO function, allowing normal operation of the APV drive when the STO function is not required. As shown below, the STO inputs are energized in parallel using the encoder +5V from the drive.

The APV-EZ-STO works on the EZ Board and the EZ Development Board.

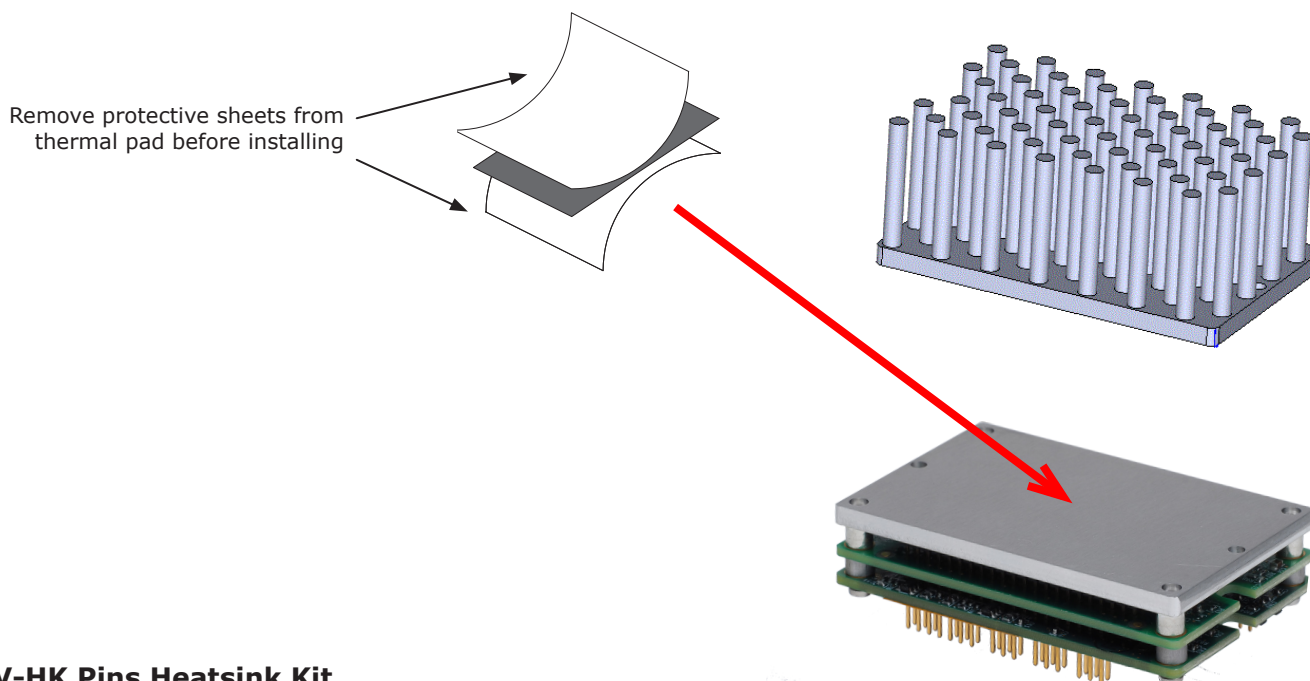
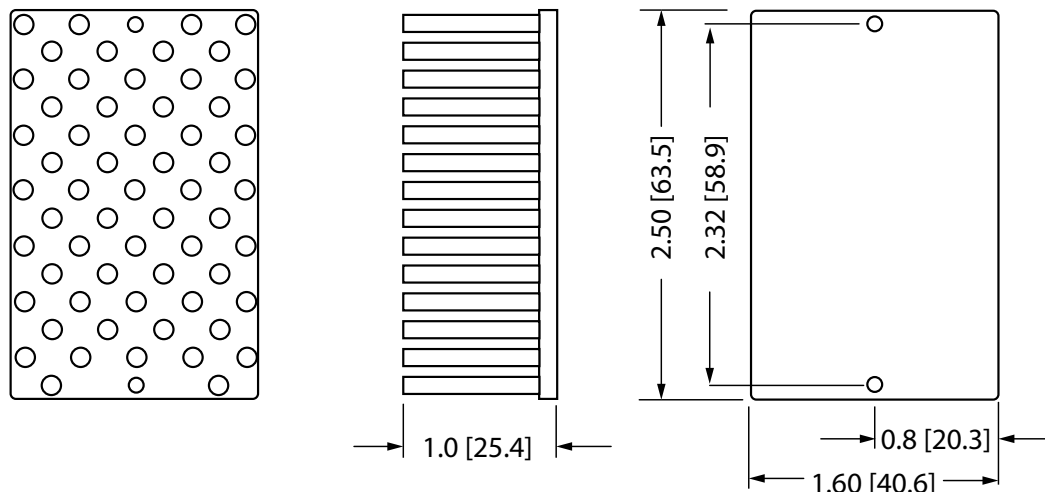


APV-EZ-STO

ORDERING CONFIGURATIONS

APV-HK HEATSINK KIT

The APV-HK kit contains a heatsink, thermal material, and hardware to mount it to the drive and PC board.



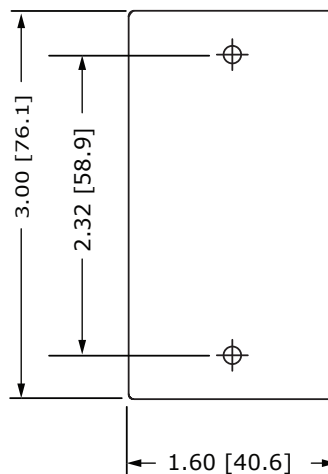
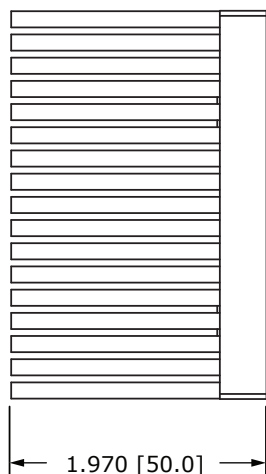
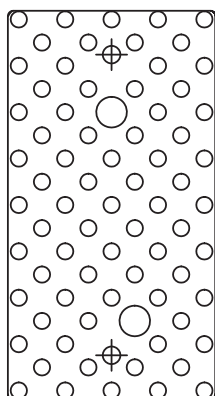
APV-HK Pins Heatsink Kit

Qty	Description
1	Pins Heatsink, 1 inch tall
1	Thermal material
2	Copley non-threaded spacer, 20.5 mm
2	Screw, M2.5-0.45 x 30 mm slotted drive cheese head
2	Nut, M2.5x0.45 DIN Zinc Plated Nylon Insert Lock

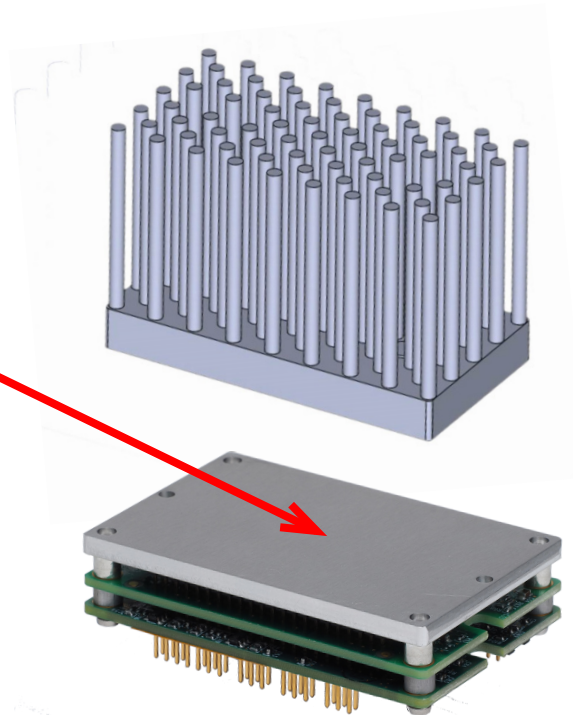
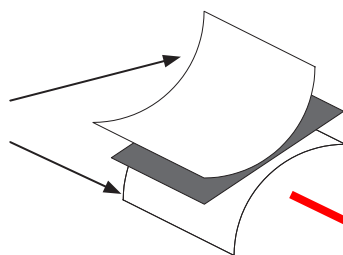
ORDERING CONFIGURATIONS

APV-THK HEATSINK KIT

The APV-THK kit contains a heatsink, thermal material, and hardware to mount it to the drive and PC board.



Remove protective sheets from thermal pad before installing



APV-THK Pins Heatsink Kit

Qty	Description
1	Tall Pins Heatsink, 1.97 inch tall
1	Thermal material
2	Copley non-threaded spacer, 20.5 mm
2	Screw, M2.5-0.45 x 40 mm slotted drive cheese head
2	Nut, M2.5x0.45 DIN Zinc Plated Nylon Insert Lock

ORDERING GUIDE

MICRO MODULES

APV-090-14	Accelnet Plus Micro Module APV servo drive, 7/14 A, 90 Vdc
APV-090-30	Accelnet Plus Micro Module APV servo drive, 15/30 A, 90 Vdc
APV-090-50 *	Accelnet Plus Micro Module APV servo drive, 25/50 A, 90 Vdc
APV-090-50-C *	Accelnet Plus Micro Module APV servo drive 50/50 A, 90 Vdc
APV-180-10	Accelnet Plus Micro Module APV servo drive, 5/10 A, 180 Vdc
APV-180-20	Accelnet Plus Micro Module APV servo drive, 10/20 A, 180 Vdc

* Not compatible with APV-EZ-090 board. Use APZ-090-50 or APZ-090-50-C if connectorized version is needed.

MICRO MODULES SOLDERED

APZ-090-50	Accelnet Plus Micro Module APV servo drive, 25/50 A, 90 Vdc, soldered to EZ Board
APZ-090-50-C	Accelnet Plus Micro Module APV servo drive 50/50 A, 90 Vdc, soldered to EZ Development Board

ACCESSORIES FOR MICRO MODULES

APV-EZ-090	EZ Board (Pluggable for 90V APV modules, <i>Not compatible with APV-090-50 or APV-090-50-C</i>)
APV-EZ-180	EZ Board (Pluggable for 180V APV modules)
APV-EZ-CK	EZ Board Connector Kit (see below)
APV-HK	Heatsink kit (Pins heatsink, thermal pad, and hardware)
APV-THK	Heatsink kit (Tall Pins heatsink, thermal pad, and hardware)
SER-CK	Serial Cable Kit: 9-Pin Dsub receptacle to 6-pin modular adapter, plus modular cable for EZ board
SER-USB-RJ11	Serial Interface Cable: USB to RJ11

ORDERING GUIDE: EZ BOARD CONNECTOR KIT WITH SHELLS & CRIMP SOCKETS

CONNECTOR KIT FOR EZ BOARD AND EZ DEVELOPMENT BOARD

	QTY	REF	NAME	DESCRIPTION	MFGR/PART NUMBER
APV-EZ-CK Connector Kit	1	J4	Encoder 2	Connector, socket, double row, 2.00 mm, 8 pos	Hirose: DF11-8DS-2C
	1	J5	I/O	Connector, socket, double row, 2.00 mm, 18 pos	Hirose: DF11-18DS-2C
	1	J6	STO	Connector, socket, double row, 2.00 mm, 16 pos	Hirose: DF11-16DS-2C
	1	J8	Vlogic	Connector, socket, single row, 2.00 mm, 2 pos	Hirose: DF3-2S-2C
	1	J10	Brake	Connector, socket, single row, 2.00 mm, 3 pos	Hirose: DF3-3S-2C
	40	J4,J5,J6	Crimp socket, 24~28 AWG, gold		Hirose: DF11-2428-SCFA
	5	J8,J10	Crimp socket, 24~28 AWG, gold		Hirose: DF3-2428-SCC
	15	J4,J5,J6	White Flying Lead with contacts at both ends, 26 AWG, gold, 12"		Hirose: H3BBG-10112-W6
	2		Red Flying Lead with socket at both ends, 26 AWG, gold, 12"		Hirose: H3BBG-10112-R6
	3		Black Flying Lead with socket at both ends, 26 AWG, gold, 12"		Hirose: H3BBG-10112-B6
	1	J8,J10	Blue Flying Lead with socket at both ends, 26 AWG, gold, 12"		Hirose: H2BBG-10112-L6
	1		Red Flying Lead with socket at both ends, 26 AWG, gold, 12"		Hirose: H2BBG-10112-R6
	1		Black Flying Lead with socket at both ends, 26 AWG, gold, 12"		Hirose: H2BBG-10112-B6
	1	P1	Encoder 1	Connector, high-density DB-26M, 26 pos, male, solder cup	Norcomp: 180-026-103L001
	1			Metal Backshell, DB-15, RoHS	3M: 3357-9215
	1	J6	APV-EZ-STO	EZ board plug-in to J6 for disabling STO function	