Accelnet^Plus *Micro Module CANopen* **APV**

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

APV

Model	Ic	Ip	Vdc
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	Ic	Ip	Vdc
APZ-090-50	25	50	9~90

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.
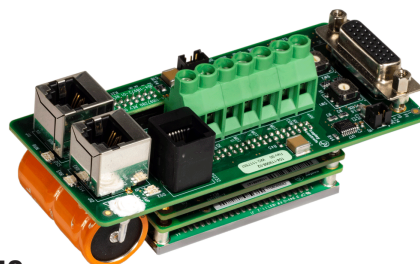Safe Torque Off (STO) eliminates external contactors and wiring, reducing system cost and complexity. For safety critical applications, redundant STO disable inputs can be employed.
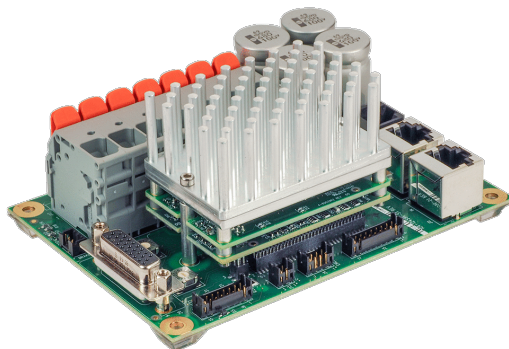
APZ -50-C

Model	Ic	Ip	Vdc
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	$V_T+ = 1.42{\sim}2.38$ Vdc, $V_T- = 0.68{\sim}1.6$ Vdc, $V_H = 0.44{\sim}1.26$
IN7	$V_T+ = 1.30{\sim}2.00$ Vdc, $V_T- = 0.55{\sim}1.30$ Vdc, $V_H = 0.40{\sim}0.79$

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 ºC	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 (E168959-20200424A)
    IEC 61800-5-1, IEC 61800-5-2

CE — FUNCTIONAL SAFETY — UL®

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.

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 µH line-line
Encoder	Digital encoders, incremental and absolute (see FEEDBACK below)
	Analog Sin/Cos incremental
Halls	see *Commutation* (below)
Motemp	Inputs are programmable to disable the drive if motor sensor drives input HI or LO

FEEDBACK

Incremental encoders

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 Vpeak-peak ±20%
	BW > 300 kHz, 16-bit resolution, with zero-crossing detection

Absolute encoders

EnDat 2.1, 2.2, SSI	Serial Clock (X, /X), and Data (A, /A) signals
Absolute A Format	
	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)	MA+, MA- (X, /X), SL+, SL- (A, /A) signals, clock output from drive, data returned from encoder
Terminators	All encoder data inputs and clock outputs are differential and require external terminators
Commutation	Hall signals (U,V,W), 15 kΩ pull-up to +5V, 15 kΩ/100 pF RC to 74LVC3G14 Schmitt trigger at +5 Vcc
Encoder power	+5 Vdc ±2% @ 500 mAdc max, shared by dual encoders

HALLS

Digital

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

Analog

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

MULTI-MODE ENCODER PORT

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

5V OUTPUT

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

NOTE:
Inputs and outputs may have more than one function. Data tables now have a Signals column that has the signal names used in the Reference Kits. Other columns show the signal names that have been used in the datasheets.

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.
06	August 31, 2020	Correction of part numbers on pp. 18~19, clarified APZ-090-50-C heatsink feature
07	September 25, 2020	Correction of VLOGIC pins on pp. 16~17, added EZ board signals to data tables
08	October 21, 2020	Data tables now have "Signals" columns that contain the labels shown in the Reference Design schematics. Other columns show the labels that have been used in the datasheets and manuals.
09	November 11, 2020	Add UL file number to Approvals in Agency Standards Conformance.

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
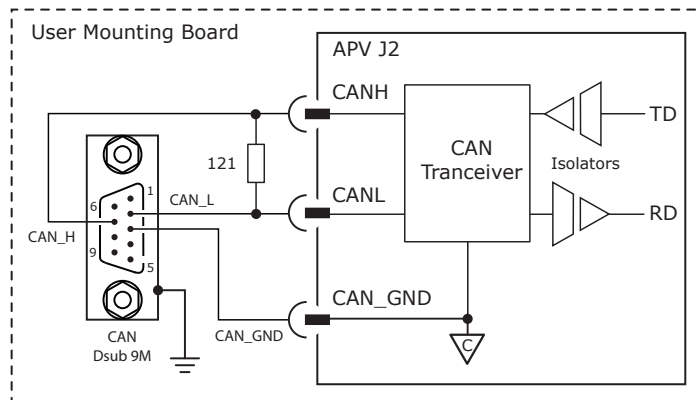
APV RS-232 COMMUNICATIONS

RS-232 PORT
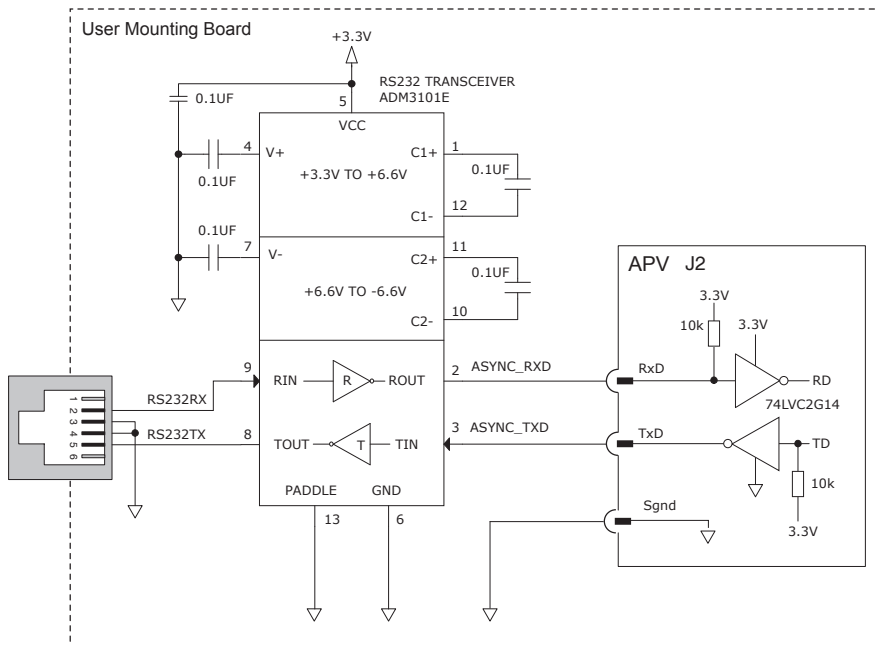
The serial port is a full-duplex, three-wire (RxD, TxD, SGND) type that operates from 9,600 to 230,400 Baud.
It can be used by CME for drive configuration and setup or by external equipment sending ASCII commands.

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.

RS-232	Signal	J2 Pins
RxD	ASYNC_RXD	28
TxD	ASYNC_TXD	30
SGND	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

⚠️ **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.***

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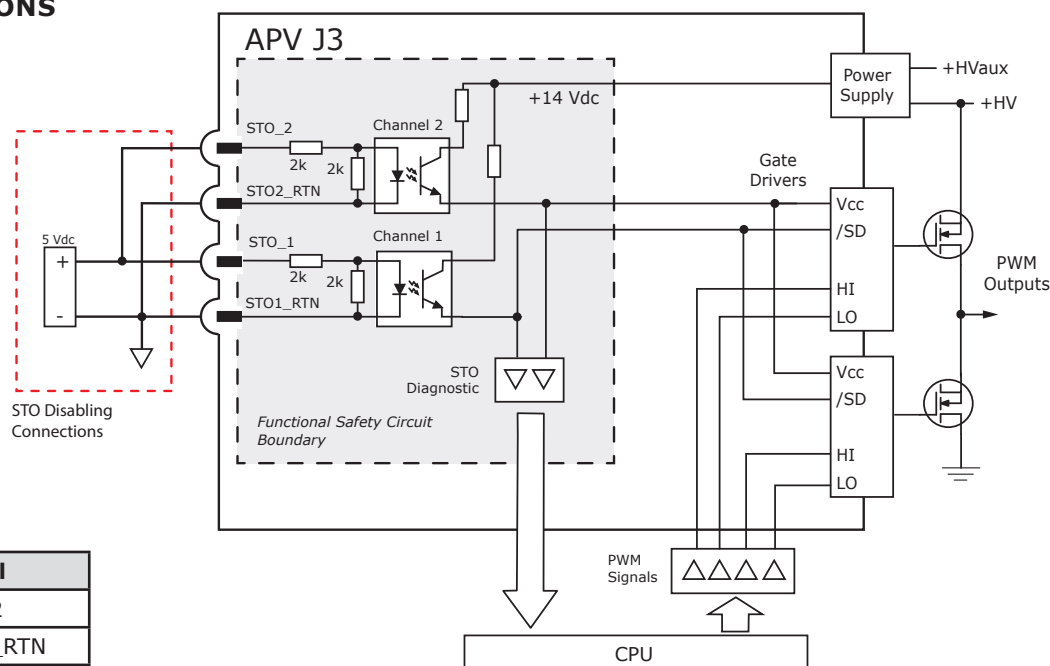***If not using the STO feature, these connections must be made in order for the drive to be enabled.***

STO DISABLE CONNECTIONS

FUNCTIONAL DIAGRAM

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

J3 STO

Signal	Pin		Signal
STO_1	1	3	STO_2
STO1_RTN	2	4	STO2_RTN

STO OPERATION

STO Input Voltage	STO State
STO_1 *AND* STO_2 ≥ 3.3 Vdc	STO Inactive. Drive can be enabled to produce torque
STO_1 *OR* STO_2 ≤ 2.0 Vdc	STO Active. Drive cannot be enabled to produce torque
STO_1 *OR* STO_2 Open	

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

Accelnet^Plus *Micro Module CANopen* **APV**

DIGITAL COMMAND INPUTS: POSITION
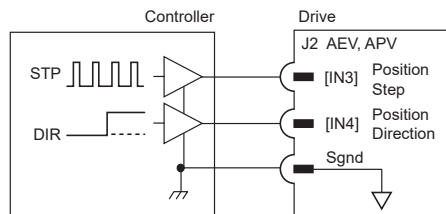
STAND-ALONE MODE DIGITAL POSITION-CONTROL INPUTS

APV works with motion controllers that output pulses to command position.
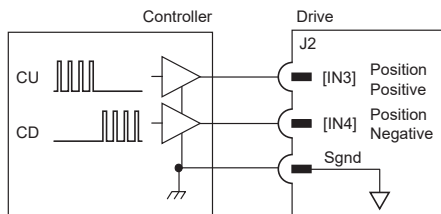These formats are supported:

  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
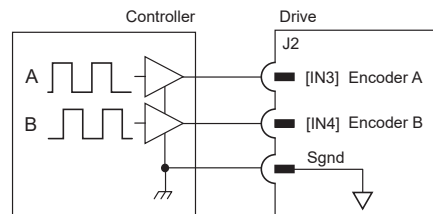
Command Options	Signal	J2 Pins
Step, Position Positive, Encoder A	IN3	7
Direction, Positioni Negative, Encoder B	IN4	8

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 cyle 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.
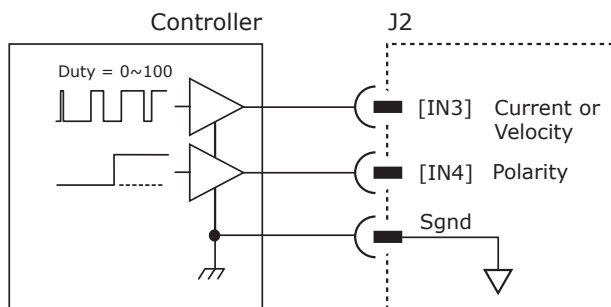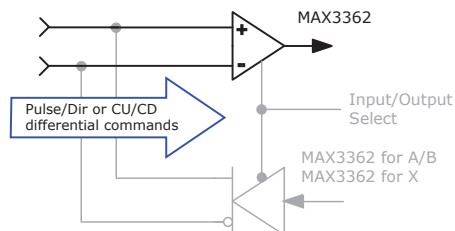
PWM & DIRECTION   50% PWM
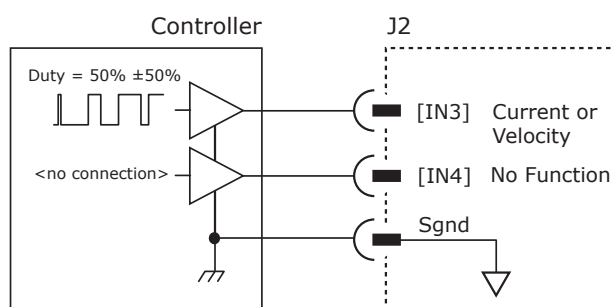
Command Options	Signal	J2 Pins
PWM/Dir Current or Velocity	IN3	7
PWM/Dir Polarity	IN4	8

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

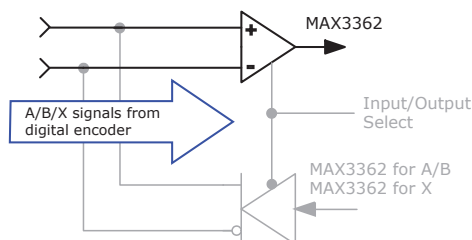| Command Options	J2 Pins
Pulse, CW, Quad Encoder A, Vel-Curr-Magnitude, Vel-Curr-50%	51
/Pulse, /CW, Quad Encoder /A, /Vel-Curr-Magnitude, /Vel-Curr-50%	52
Direction, CCW, Quad Encoder B, Vel-Curr-Direction	53
/Direction, /CCW, Quad Encoder /B, /Vel-Curr-Direction	54

CURRENT or VELOCITY COMMANDS: DIFFERENTIAL

- Current/Velocity Magnitude & Direction
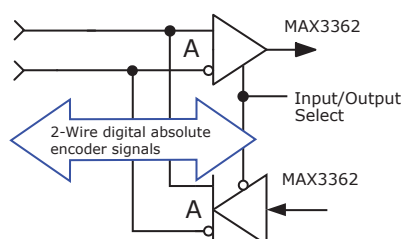- Current/Velocity 50%
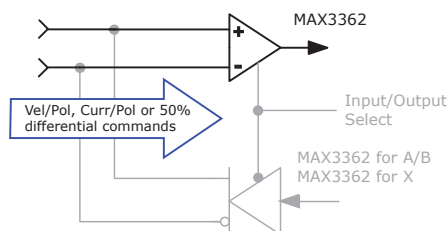
FEEDBACK INPUT: ENCODER 2

SECONDARY FEEDBACK: INCREMENTAL
- Quad A/B/X incremental encoder

J2 SIGNALS

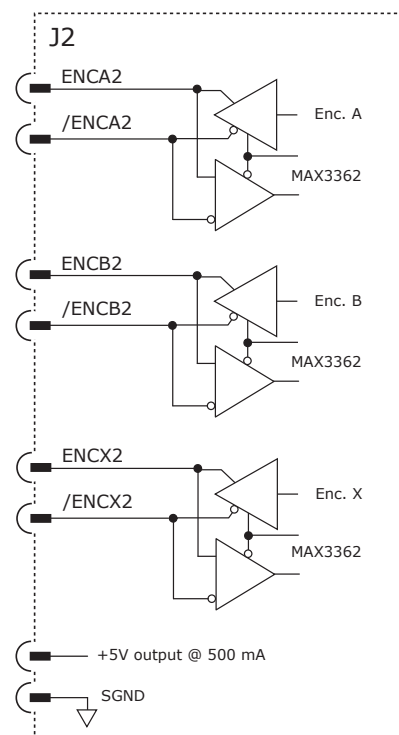| Signal	Pin
ENCA2	51
/ENCA2	52
ENCB2	53
/ENCB2	54
ENCX2	55
/ENCX2	56

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.

Feedback Options	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

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
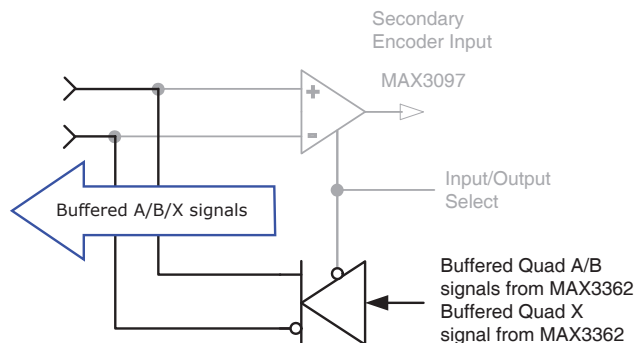 The X channel is not used in this mode

J2 SIGNALS

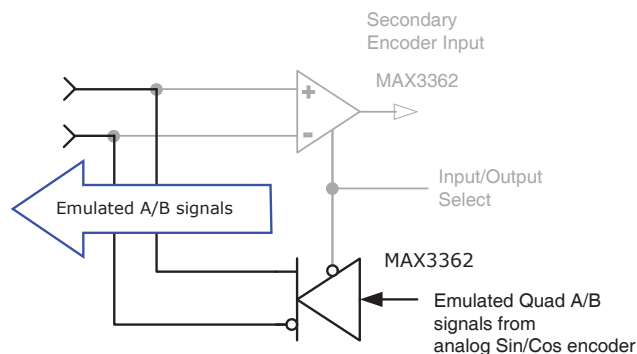| Buffered A/B/X	Emulated A/B	Signal	Pin
Buffered A	Quad A	ENCA2	51
Buffered /A	Quad /A	/ENCA2	52
Buffered B	Quad B	ENCB2	53
Buffered /B	Quad /B	/ENCB2	54
Buffered X		ENCX2	55
Buffered /X		/ENCX2	56

J2 SGND Pins
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60
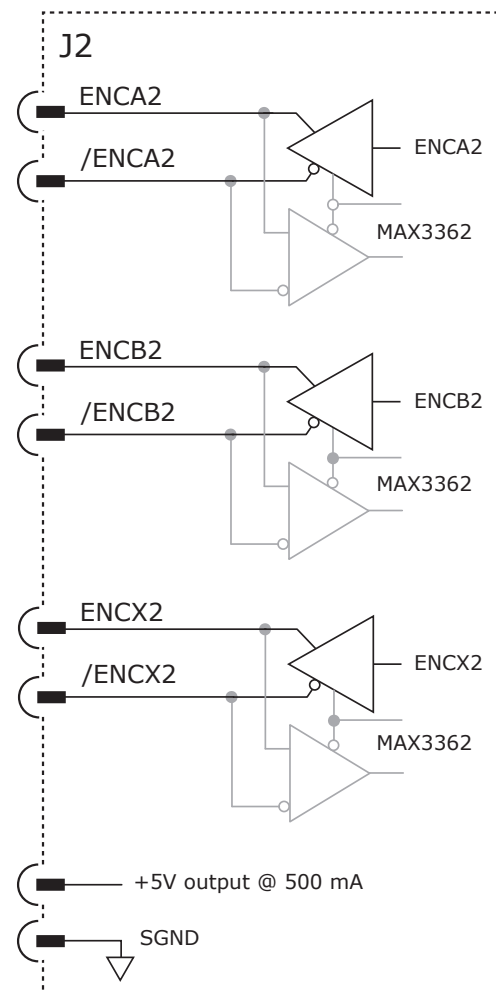
BUFFERED QUAD A/B/X OUTPUTS

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	$V_T+ = 1.42\sim2.38$ Vdc
	LO	$V_T+ = 0.68\sim1.6$ Vdc
	Hys	$V_H = 0.44\sim1.26$
	Max	+6 Vdc
	Min	0 Vdc
Pull-up	R1	10 kΩ
Low pass filter	R2	1 kΩ
	C1	100 pF
	RC[1]	0.1 µs

CONNECTIONS

Signal	J2 Pins
IN1	5
IN2	6
IN3	7
IN4	8
IN5	9
IN6	10
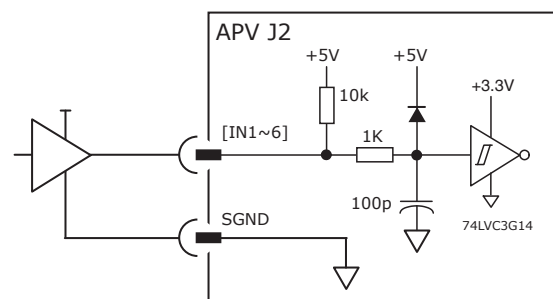
J2 SGND Pins
3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60

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+ ≥ 1.3~2.0 Vdc
	LO	VT- ≤ 0.55~1.3 Vdc
	Hys	VH 0.40~0.79 Vdc
	Max	+6 Vdc
	Min	0 Vdc
Pull-up	R1	10 kΩ
Low pass filter	R2	1 kΩ
	C1	100 nF
	RC[1]	0.1 µs

CONNECTIONS

Signal	J2 Pins
IN7	11
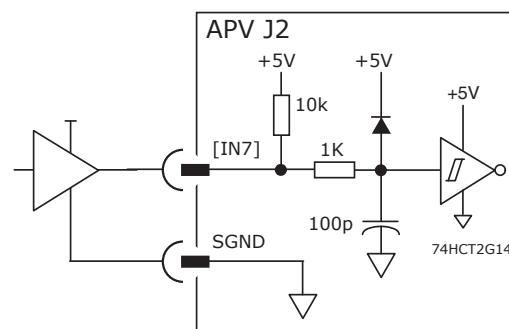
* RC time constant applies when input
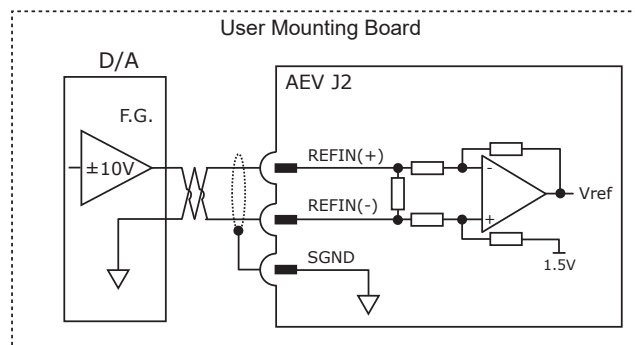 is driven by active high/low device

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

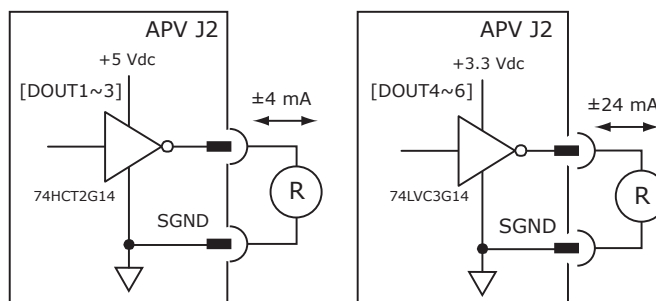| Signal	J2 Pins
AIN(+)	2
AIN(-)	1

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
DOUT1	13
DOUT2	12
DOUT3	15
DOUT4	14
DOUT5	17
DOUT6	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
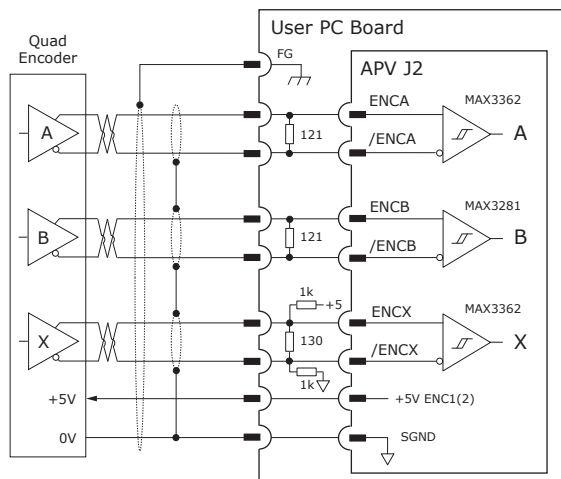• Custom position-triggered output
• Program control
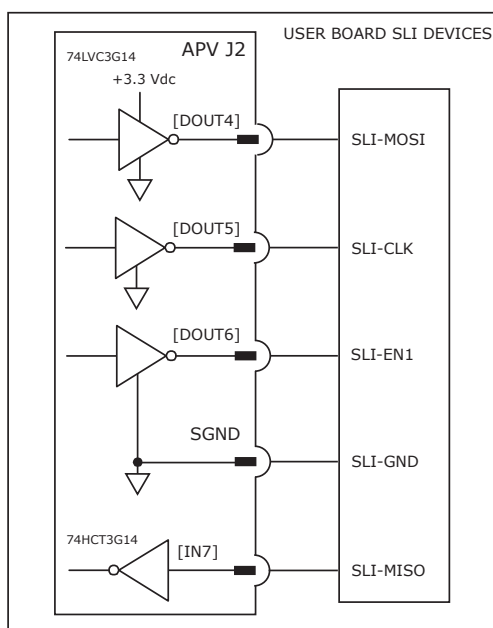
SLI PORT	Signal	J2 Pins
SLI-MOSI	DOUT4	14
SLI-CLK	DOUT5	17
SLI-EN1	DOUT6	16
SLI-GND	SGND	18
SLI-MISO	IN7	11

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

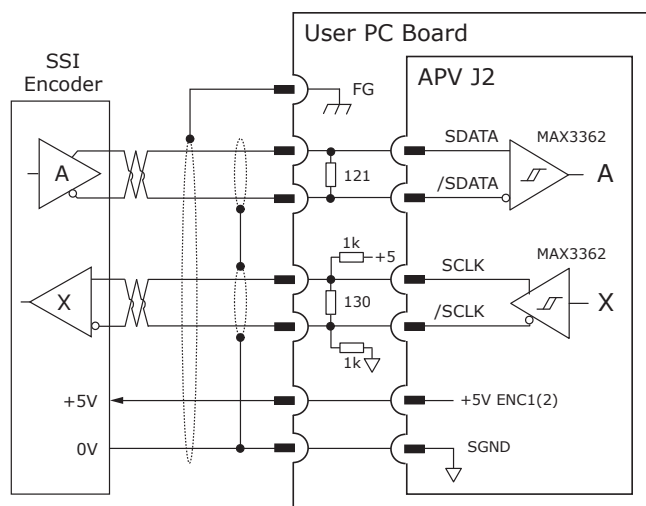| Signal	J2 Pins
ENCA1	43
/ENCA1	44
ENCB1	45
/ENCB1	46
ENCX1	47
/ENCX1	48
+5VENC	57,58

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.

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
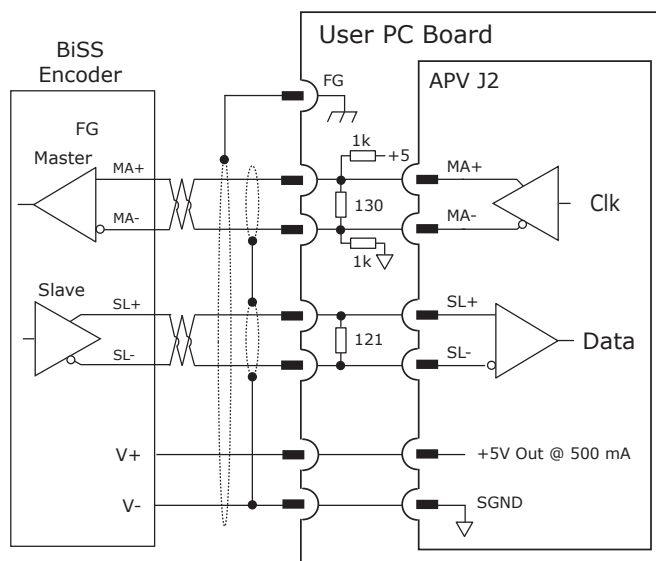   Request for data generation at slaves
    Safety capable: CRC, Errors, Warnings
    Bus capability incl. actuators
Bidirectional
    BiSS B-protocol: Mode choice at each cycle start
    BiSS C-protocol: Continuous mode

SSI,BiSS SIGNALS

SSI	BiSS	Signal	J2 Pins
SCLK	MA+	ENCX1	47
/SCLK	MA-	/ENCX1	48
SDATA	SL+	ENCA1	43
/SDATA	SL-	/ENCA1	44
+5V		+5VENC	57,58

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

EnDAT	Signal	J2 Pins
Clk	ENCX1	47
/Clk	/ENCX1	48
Data	ENCA1	43
/Data	/ENCA1	44
Sin(+) *	SIN1+	36
Sin(-) *	SIN1-	35
Cos(+) *	COS1+	38
Cos(-) *	COS1-	37
+5V	+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
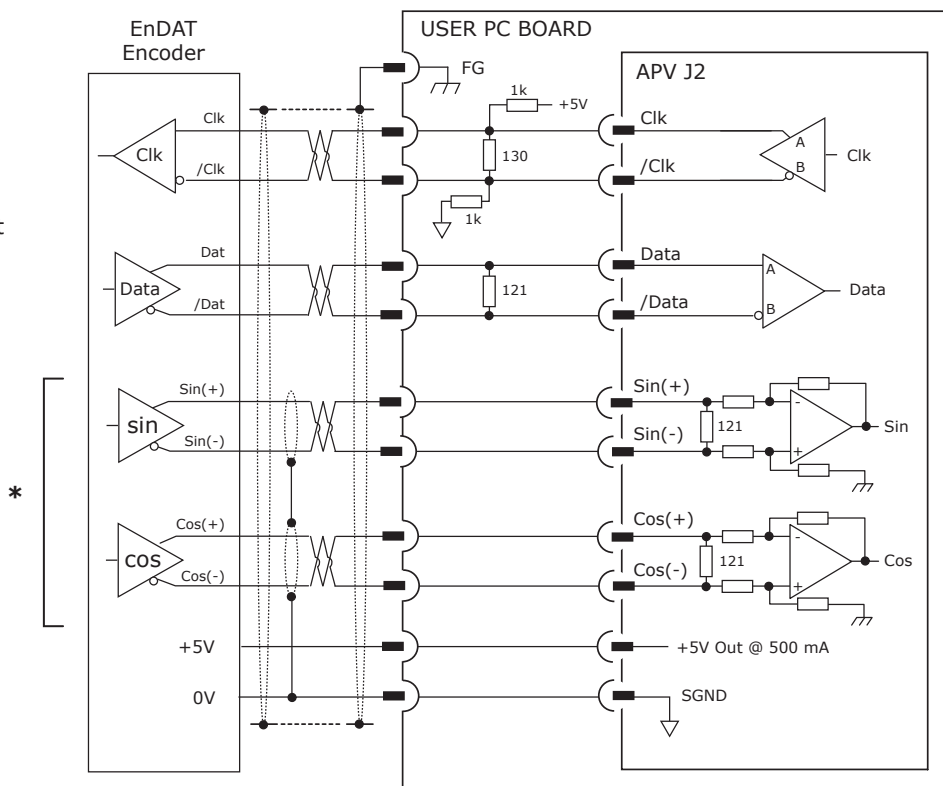
| J2 SGND Pins |
|---|
| 3,4,18,19,20,21,22,23,24, 31,32,33,34,42,49,50,59,60 |

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

ABS-A	Signal	J2 Pins
Data	ENCA1	43
/Data	/ENCA1	44
+5V	+5ENC	57,58

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


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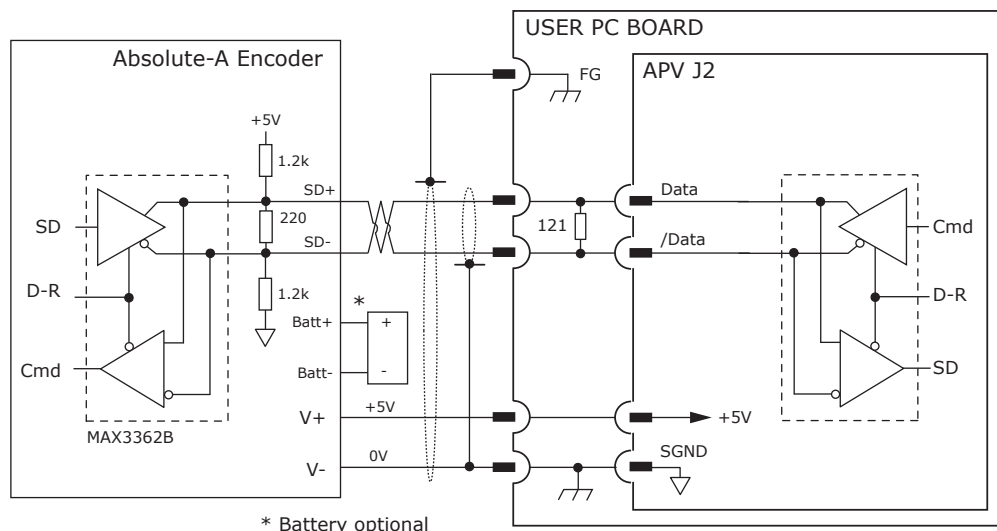
Note: Signal (outer) shields should be connected at the drive end. The inner shield is optional for digital encoders and should only be connected to Signal Ground on the drive.

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.
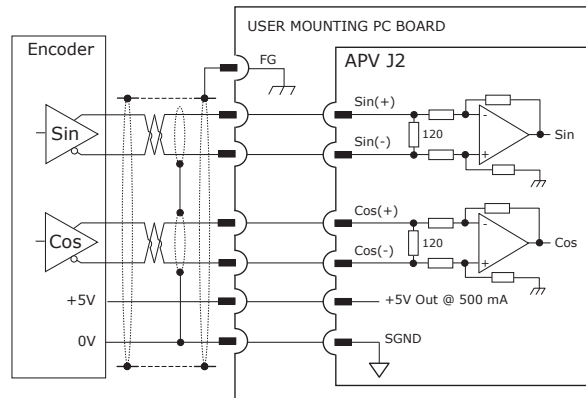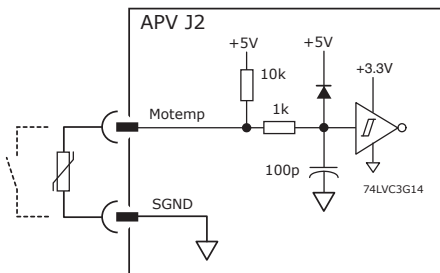

Encoder	Signal	J2 Pins
Sin(+)	SIN1+	36
Sin(-)	SIN1-	35
Cos(+)	COS1+	38
Cos(-)	C0S1-	37
+5V	+5VENC	57,58

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	Signal	J2 Pins
Motemp	IN5	9
SGND	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.
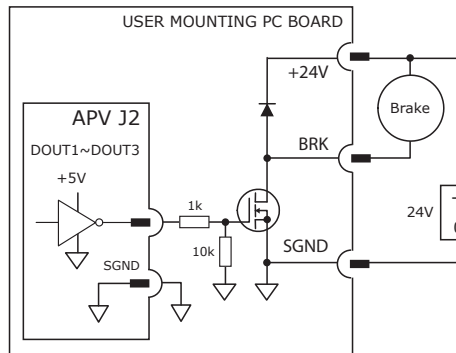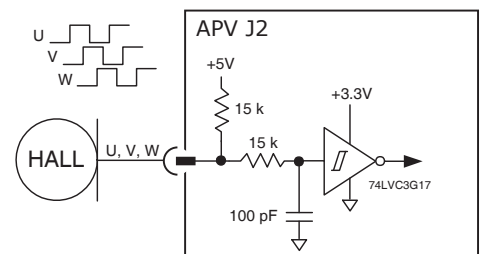

Brake	Signal	J2 Pins
OUT1	DOUT1	13
OUT2	DOUT2	12
OUT3 *	DOUT3	15

* 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	Signal	J2 Pins
Hall U	HALLU	39
Hall V	HALLV	40
Hall W	HALLW	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.
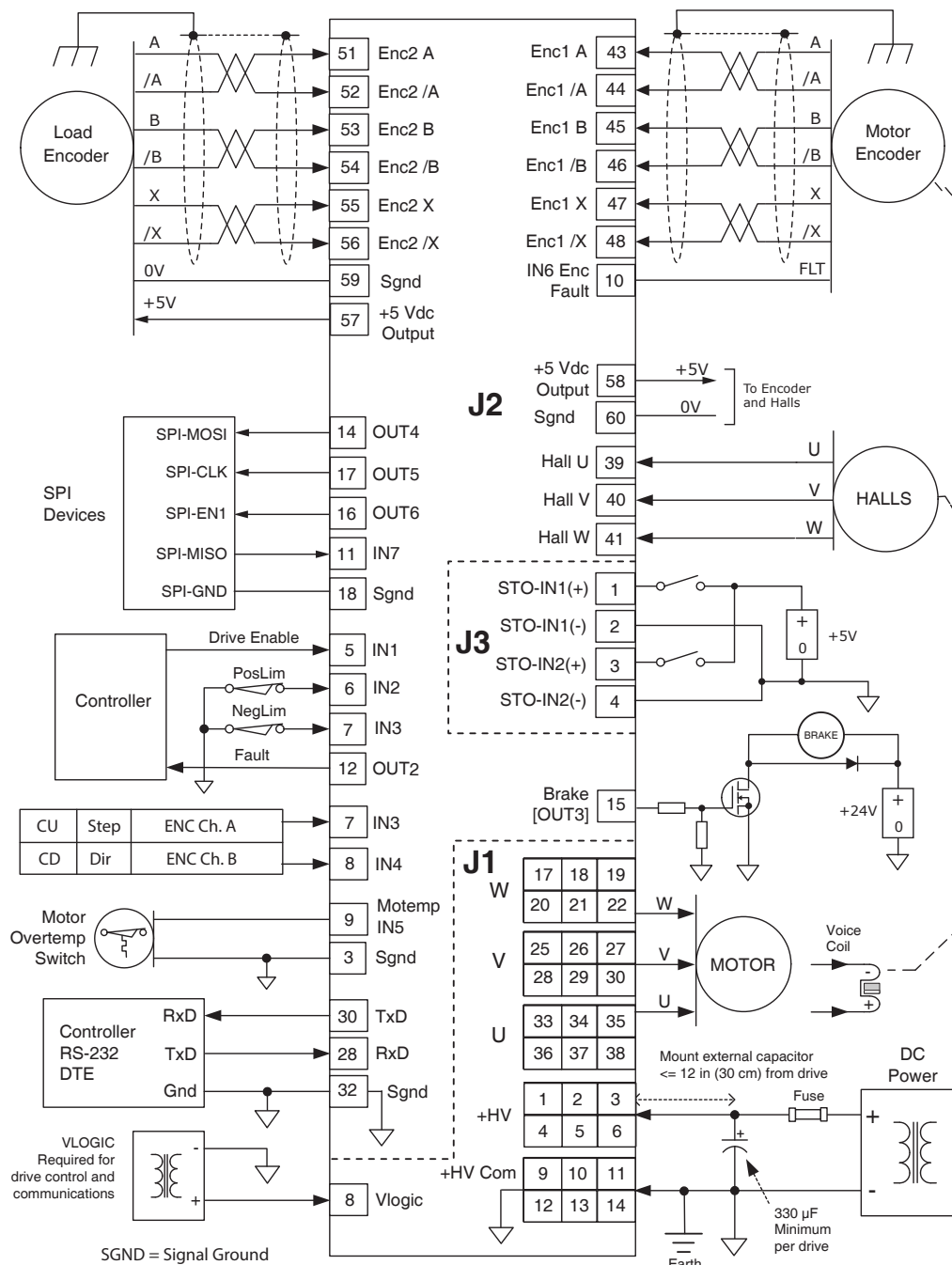
If the motor can operate from voltages of 60 Vdc or less, the +HV and VLOGIC can be driven from a single power supply.
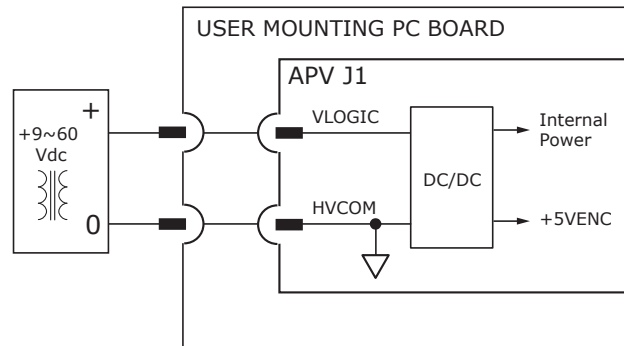
Signal	J1 Pins
VLOGIC	8
HVCOM	9,10,11, 12,13,14

TYPICAL CONNECTIONS

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

Notes
1. [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.
2. [OUT2] is shown as a Fault signal to the controller and [OUT3] is shown as control for a motor brake.
   All outputs are programmable.
3. 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

4X Ø 0.035 [0.89]

2X Ø 0.105 [2.67]

1.600 [40.64]

2.320 [58.93]

2.080 [52.83]

1.818 [46.19]

1.751 [44.46]

38X Ø 0.035 [0.89]

2.500 [63.50]

64X Ø 0.028 [0.71]

J3   J2   J1

0 [0]

.090 [2.29]

.800 [20.32]   .650 [16.51]   0 [0]   .526 [13.35]

J1 Signal Grouping for current-sharing

37   38

1   2

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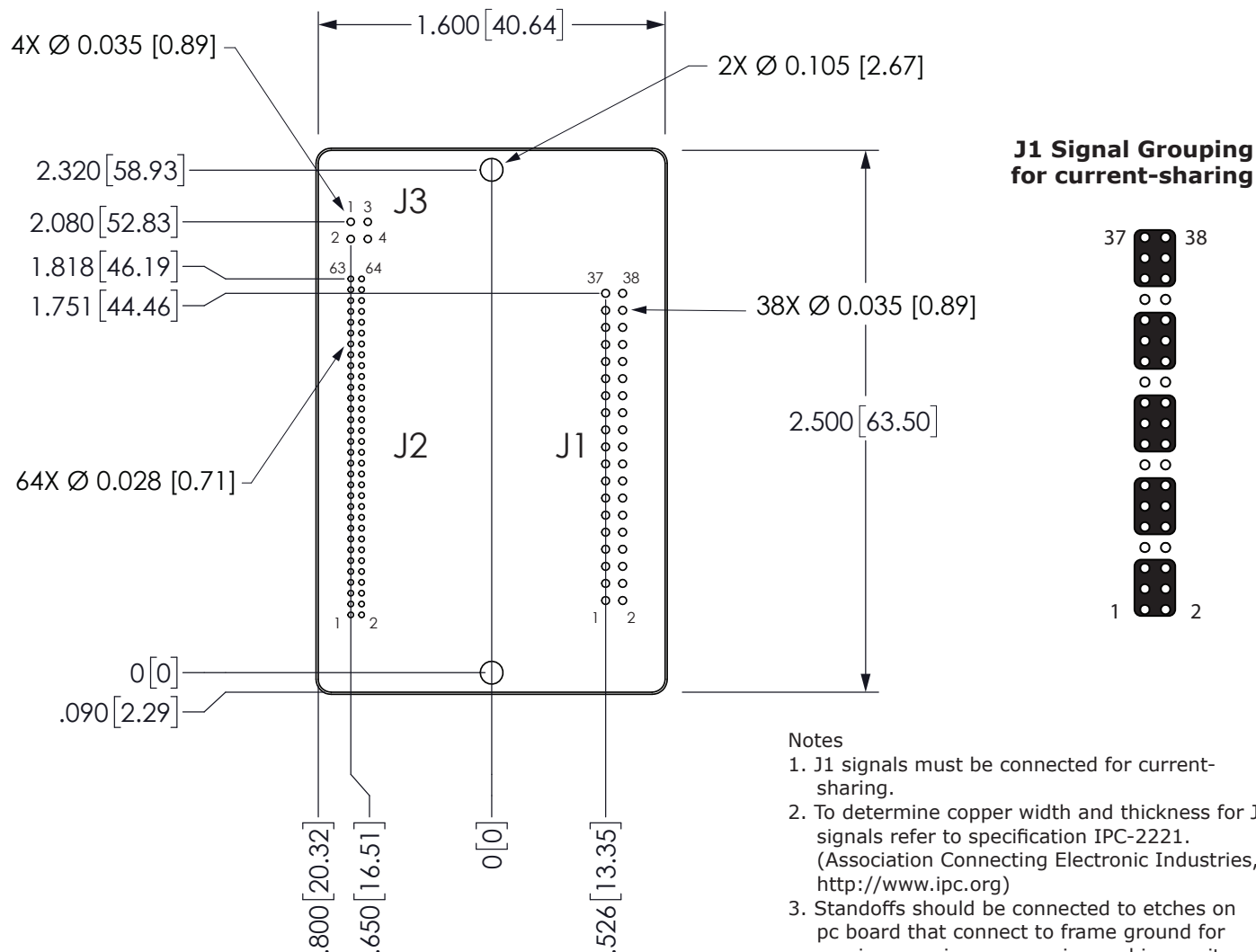
Notes
1. J1 signals must be connected for current-sharing.
2. To determine copper width and thickness for J1 signals refer to specification IPC-2221. (Association Connecting Electronic Industries, http://www.ipc.org)
3. Standoffs should be connected to etches on pc board that connect to frame ground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

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	FLE-132-01-G-DV-K-TR	J2	0.050 in (1.27 mm) pitch
1	Socket Strip	Samtec	TLE-102-01-G-DV-TR	J3	0.0787 in (2.00 mm) pitch
2	Standoff		hex, 20.5 mm long, 2.5 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				
2	Standoff		hex, 15 mm long, 2.5 mm thread		

PC BOARD SIGNALS

J3 SAFETY

SIGNAL	PIN	PIN	SIGNAL
STO_1	1	3	STO_2
STO1_RTN	2	4	STO2_RTN

J2 FEEDBACK

Signal	P3 Pin		Signal
*	63	64	*
*	61	62	*
SGND	59	60	SGND
+5VENC	57	58	+5VENC
ENCX2	55	56	/ENCX2
ENCB2	53	54	/ENCB2
ENCA2	51	52	/ENCA2
SGND	49	50	SGND
ENCX1	47	48	/ENCX1
ENCB1	45	46	/ENCB1
ENCA1	43	44	/ENCA1
HALLW	41	42	SGND
HALLU	39	40	HALLV
COS1-	37	38	COS1+
SIN1-	35	36	SIN1+
SGND	33	34	SGND
SGND	31	32	SGND
CANH	29	30	ASYNC_TXD
CANL	27	28	ASYNC_RXD
CANGND	25	26	CANGND
SGND	23	24	SGND
SGND	21	22	SGND
SGND	19	20	SGND
(SLI-CLK) DOUT5	17	18	SGND
(BRAKE) DOUT3	15	16	DOUT6 (SLI-EN1)
DOUT1	13	14	DOUT4 (SLI-MOSI)
(SLI-MISO) IN7	11	12	DOUT2
IN5	9	10	IN6
IN3	7	8	IN4
(Enable) IN1	5	6	IN2
SGND	3	4	SGND
REFIN(-)	1	2	REFIN(+)

* Do not connect to these pins

TOP VIEW

Viewed from above looking down on the connectors or PC board footprint to which the module is mounted
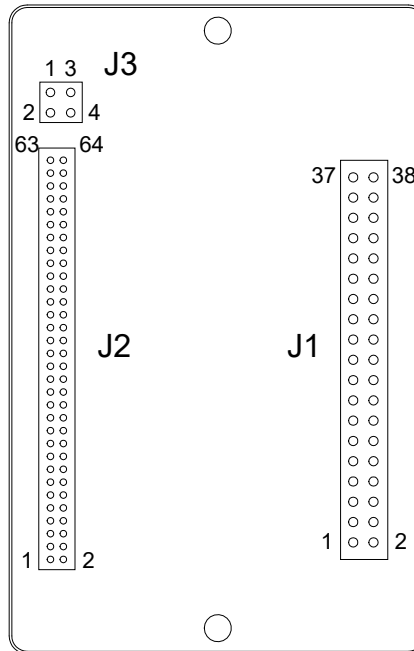
Connector part numbers for socket mounting.

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
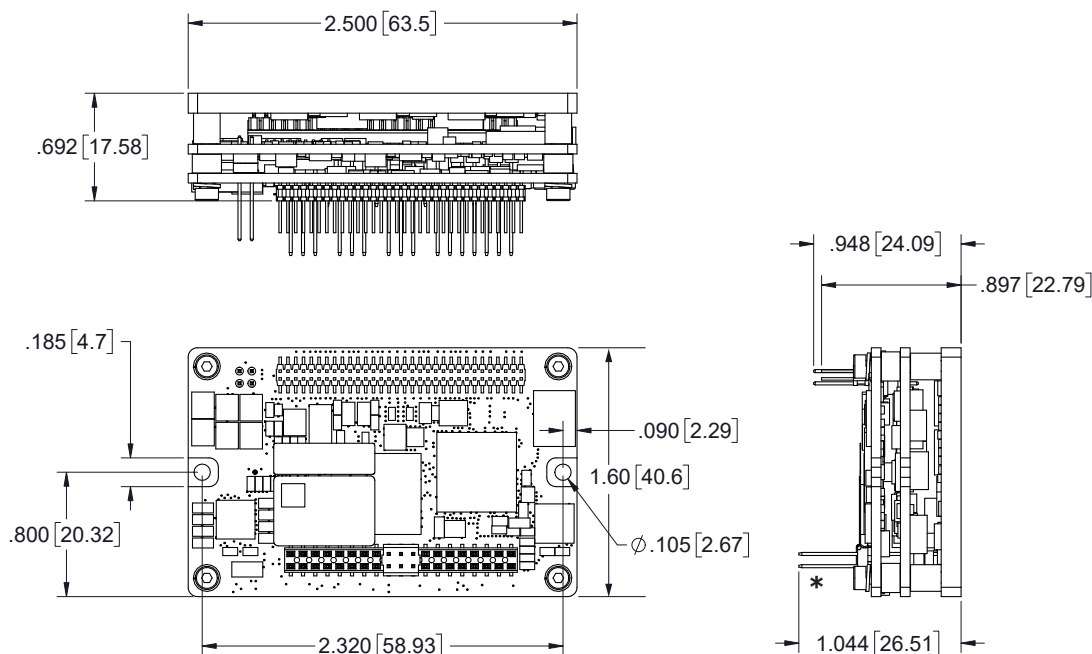   4 position female header
   Samtec: TLE-102-01-G-DV-TR

J1 POWER & MOTOR

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

* Do not connect to these pins

DIMENSIONS

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

2.500 [63.5]

.692 [17.58]

.185 [4.7]

.090 [2.29]

1.60 [40.6]

.800 [20.32]

Ø.105 [2.67]

2.320 [58.93]

.948 [24.09]

.897 [22.79]

*

1.044 [26.51]
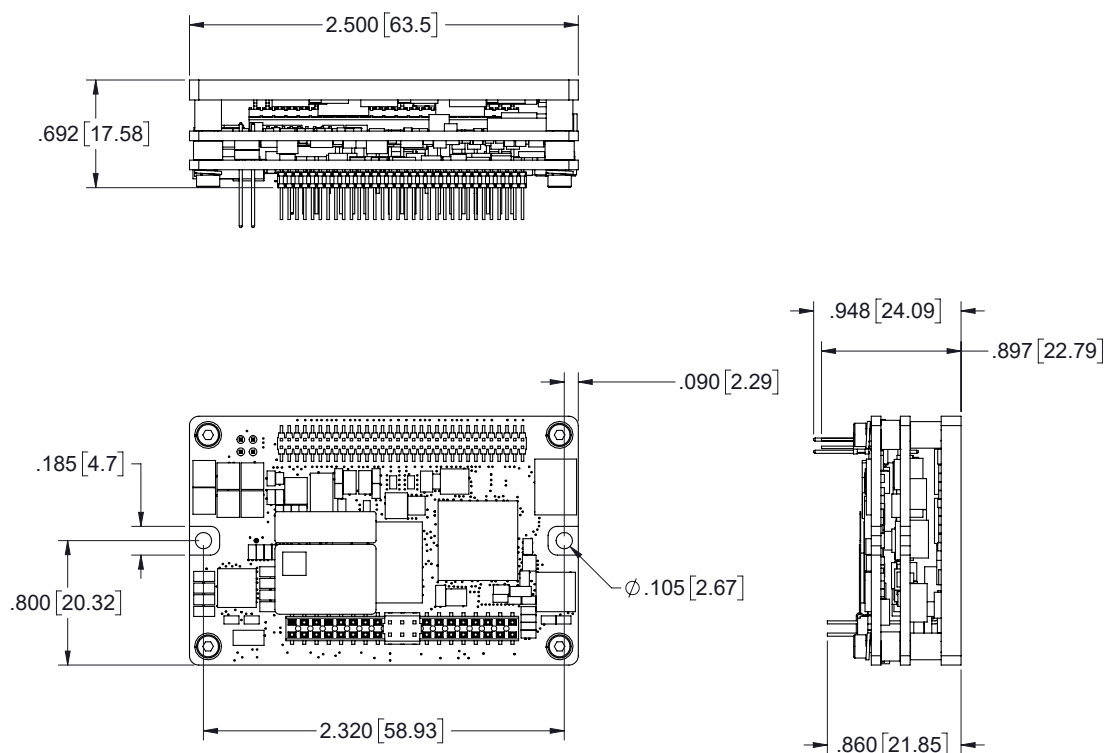
Dimensions are in inches [mm].

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

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

2.500 [63.5]

.692 [17.58]

.185 [4.7]

.090 [2.29]

.800 [20.32]

Ø.105 [2.67]

2.320 [58.93]

.948 [24.09]

.897 [22.79]

.860 [21.85]

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

Pins Heatsink
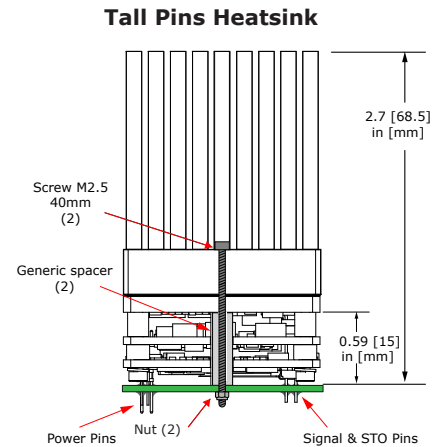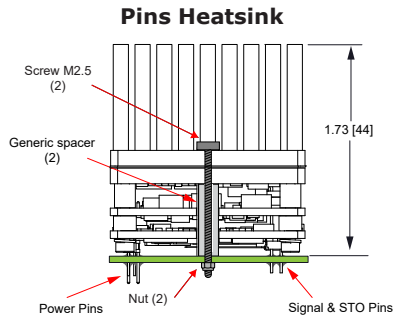
Tall Pins Heatsink

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 35 mm screws are used.
With the long pins heatsink the 40 mm screws are used.

Pins Heatsink
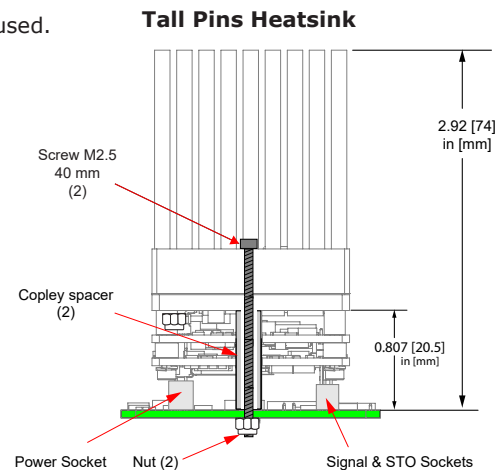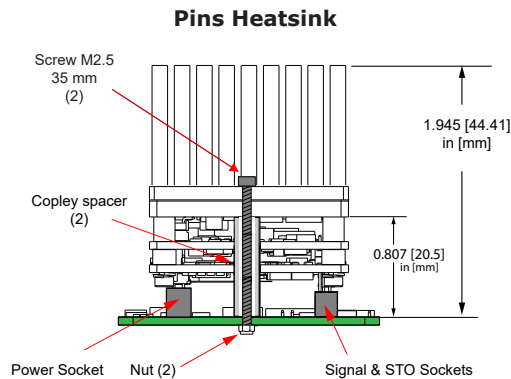
Tall Pins Heatsink

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, 1.97 inch tall	1

CONNECTORS FOR SOCKETING

Part	Mfgr	Part Number	Qty
Power Socket J1	Samtec	SQT-119-01-G-D	1
Signal Socket J2	Samtec	FLE-132-01-G-DV-K-TR	1
STO Socket J3	Samtec	TLE-102-01-G-DV-TR	1

For the half-soldered configuration the dimensions, spacers, screws, and nuts are the same.
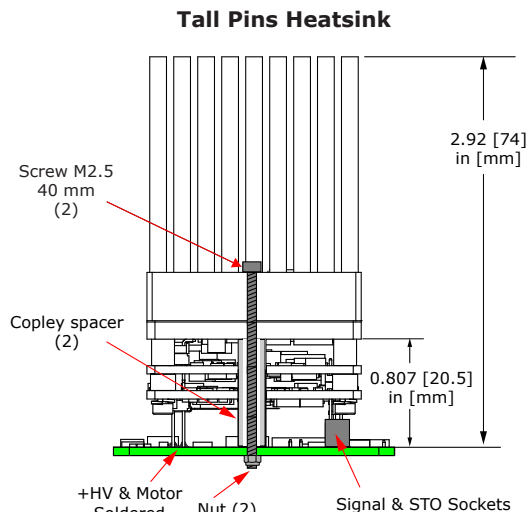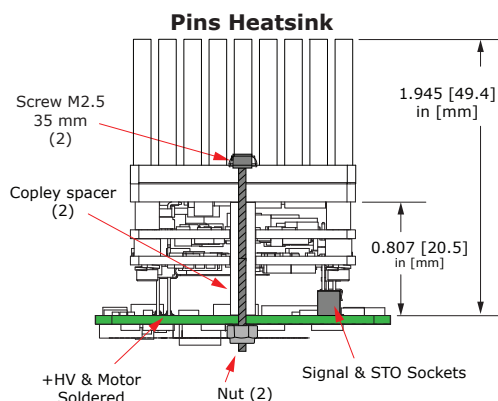
MOUNTING: HALF-SOCKETED INTO USER PC BOARD

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

Signal J2 and STO J3 are socketed. Power & motor J1 are soldered. With the pins heatsink
35 mm screws are used. With the long pins heatsink 40 mm screws are used.
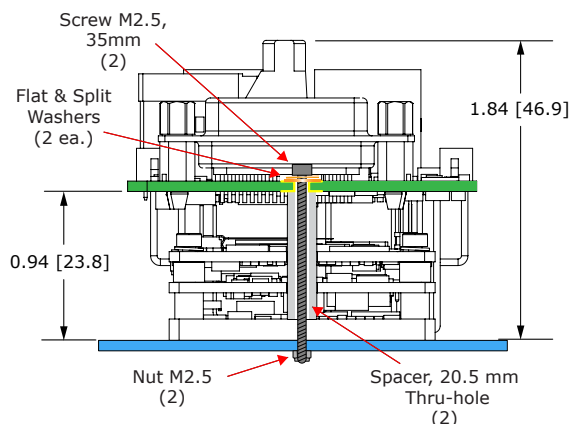
CONNECTORS FOR HALF-SOCKETING

Part	Mfgr	Part Number	Qty
Signal Socket J2	Samtec	FLE-132-01-G-DV-K-TR	1
STO Socket J3	Samtec	TLE-102-01-G-DV-TR	1

Pins Heatsink

Screw M2.5 35 mm (2)

Copley spacer (2)

1.945 [49.4] in [mm]

0.807 [20.5] in [mm]

+HV & Motor Soldered

Nut (2)

Signal & STO Sockets

Tall Pins Heatsink

2.92 [74] in [mm]

Screw M2.5 40 mm (2)

Copley spacer (2)

0.807 [20.5] in [mm]

+HV & Motor Soldered

Nut (2)

Signal & STO Sockets

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.

Screw M2.5, 35mm (2)

Flat & Split Washers (2 ea.)

1.84 [46.9]

0.94 [23.8]

Nut M2.5 (2)

Spacer, 20.5 mm Thru-hole (2)

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.
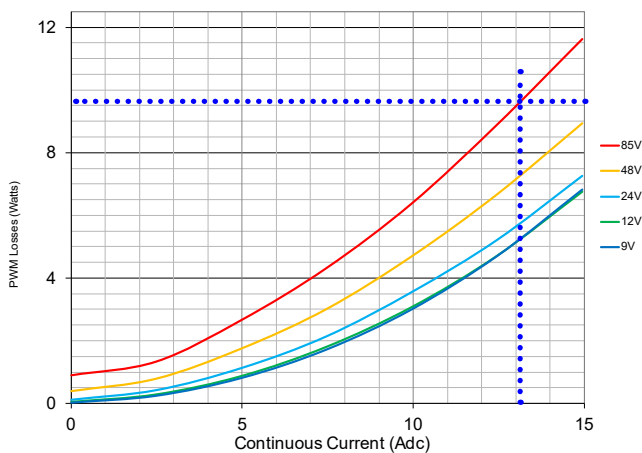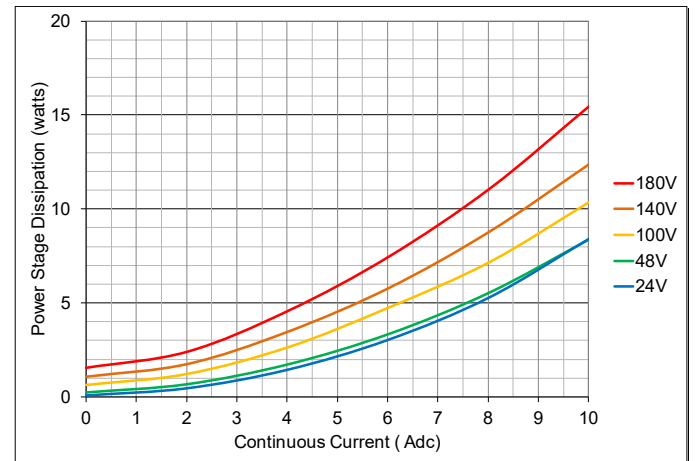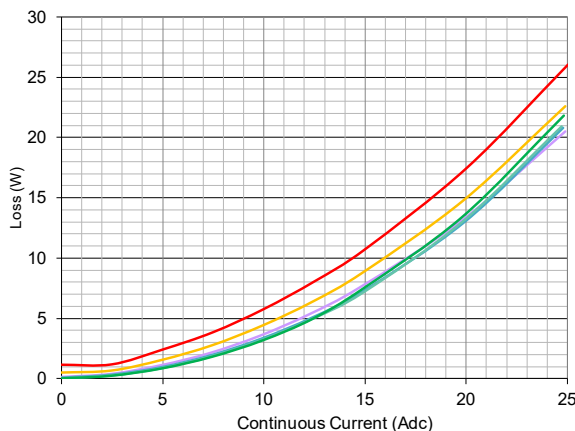
APV-090-14
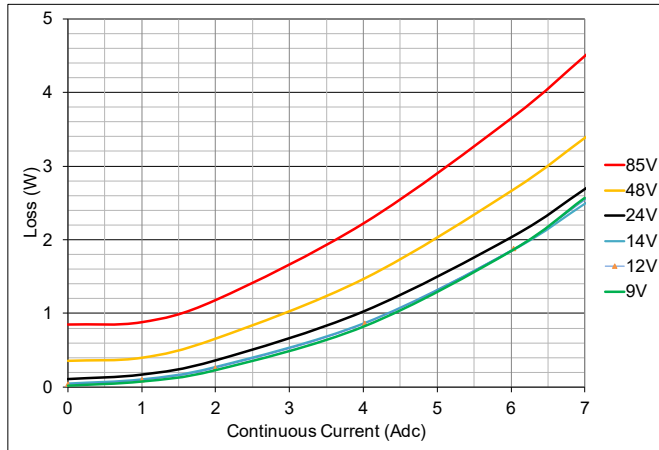
APV-180-10
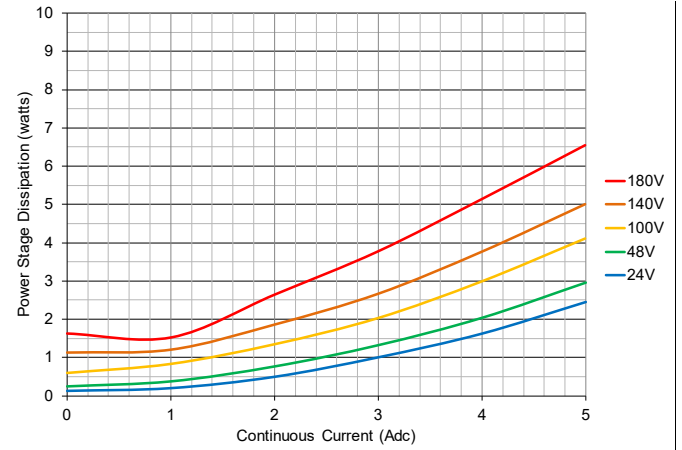
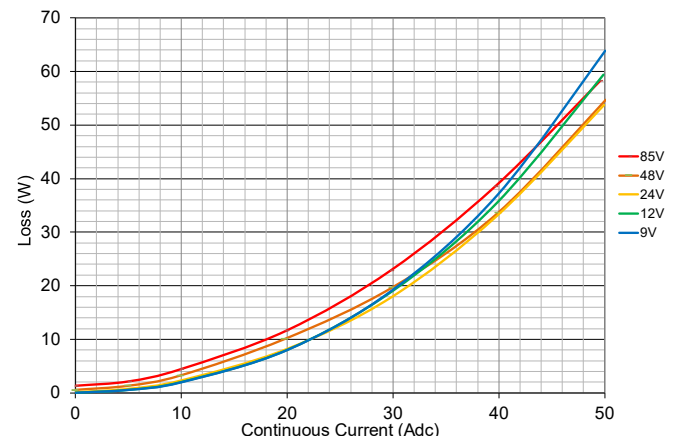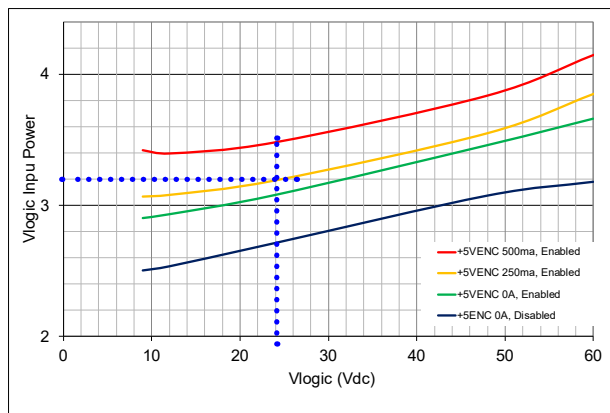### APV-090-30

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.

Chart legend:
- +5VENC 500ma, Enabled
- +5VENC 250ma, Enabled
- +5VENC 0A, Enabled
- +5ENC 0A, Disabled

X-axis: Vlogic (Vdc), Y-axis: Vlogic Input Power

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

A

APV + APV-HK

Tall Pins Heatsink A-Airflow

LFM	0	100	200	300
Rth	-	1.3	0.9	0.7

B

Tall Pins Heatsink B-Airflow

LFM	0	100	200	300
Rth	-	2.2	1.4	1.1
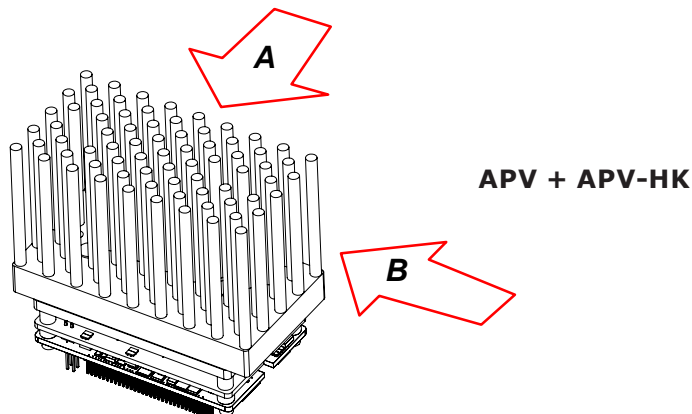
Note: The Tall Pins Heatsink is not shown here.

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 ºC (89.6 ºF), +HV dissipation = 9.5 W., VLOGIC dissipation = 3.2 W
        Tmax = 90 ºC (drive shut-down temperature)
Find: Thermal resistance Rth:
        Delta-T = Tmax - Tamb = 90 - 32 = 58 ºC
        Total dissipation = 9.5 + 3.2 = 12.7 W
        Rth = Delta-T / dissipation = ºC / Watt = 58 / 12.7 = 4.57 ºC/W
From the tables above, there are three configuations that provide Rth less than 4.57 ºC/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 ºC/W
        Tmax = 90 ºC (drive shut-down temperature)
Find: Max ambient operating temperature
        Delta-T = 12.7 W x 1.8 ºC/W = 22.9 ºC
        Max Tamb = Tmax - Delta-T = 90 - 22.9 = 67.1 ºC
        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.

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:
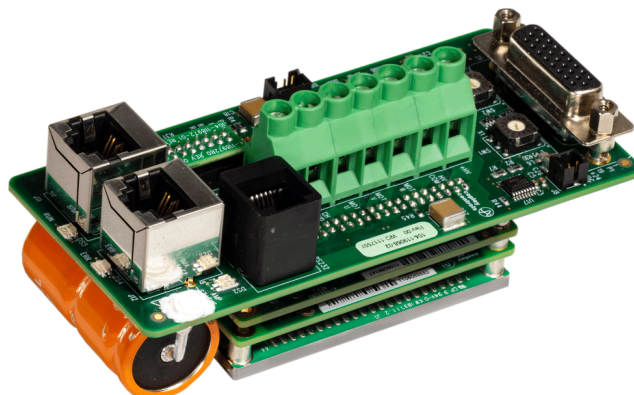   APV-090-14
    APV-090-30
The APV-EZ-180 EZ Board accepts these models as plug-ins:
    APV-180-10
    APV-180-20

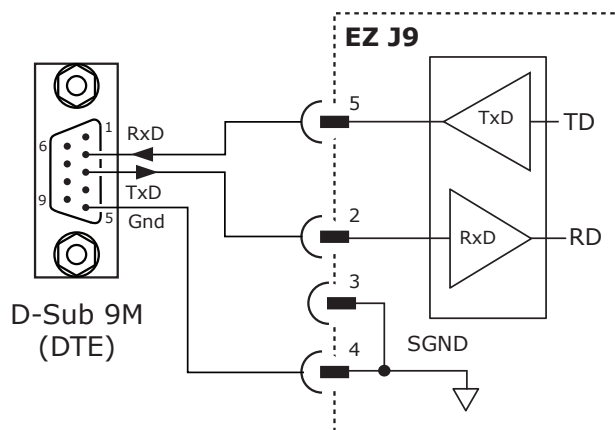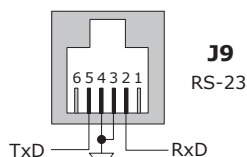*Important: The APV-EZ-090 EZ Board is not compatible with the APV-090-50 and APV-090-50-C models.*

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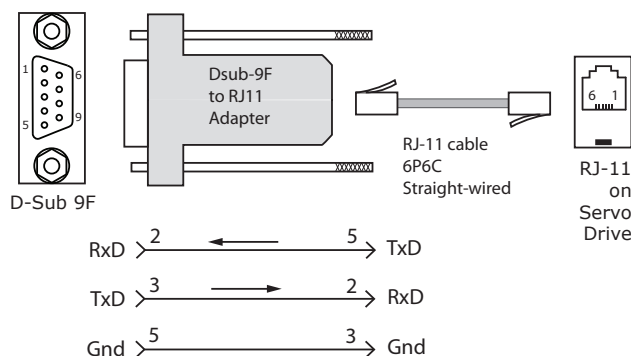
Don't forget to order a Serial Cable Kit SER-CK or SER-USB-RJ11 when placing your order for an APZ drive, or an EZ board.

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.
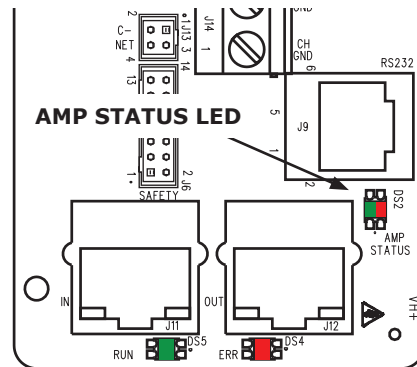
CANOPEN LEDS

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

AMP STATUS LED

CANopen LEDs

AMP STATUS 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 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
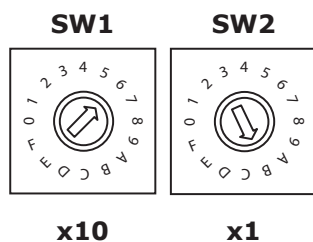
CANopen
Device ID Switch
Decimal values

SW1   **SW2**

x10   x1

	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 BOARD CANOPEN CONNECTORS

CANOPEN CONNECTORS

Dual RJ-45 connectors that accept standard Ethernet CAT-5 cables are provided for CANopen connectivity.
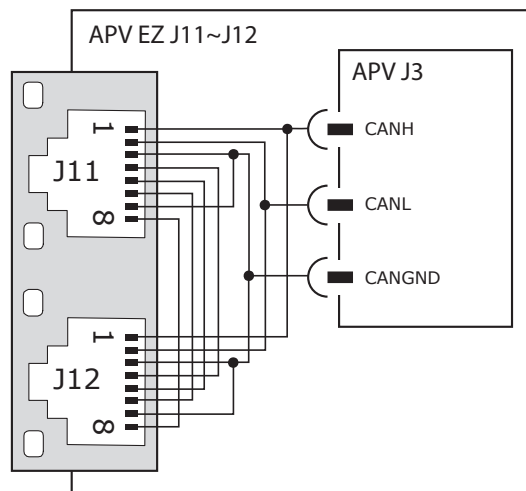
J11 CAN

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
STO1_RTN	1	2	STO1_24V_IN
STO1_RTN	3	4	STO1_IN
n.c.	5	6	n.c.
STO2_RTN	7	8	STO2_24V_IN
STO2_RTN	9	10	STO2_IN
n.c.	11	12	n.c.
SGND	13	14	FGND
IN1	15	16	+5VENC

n.c. = No connection
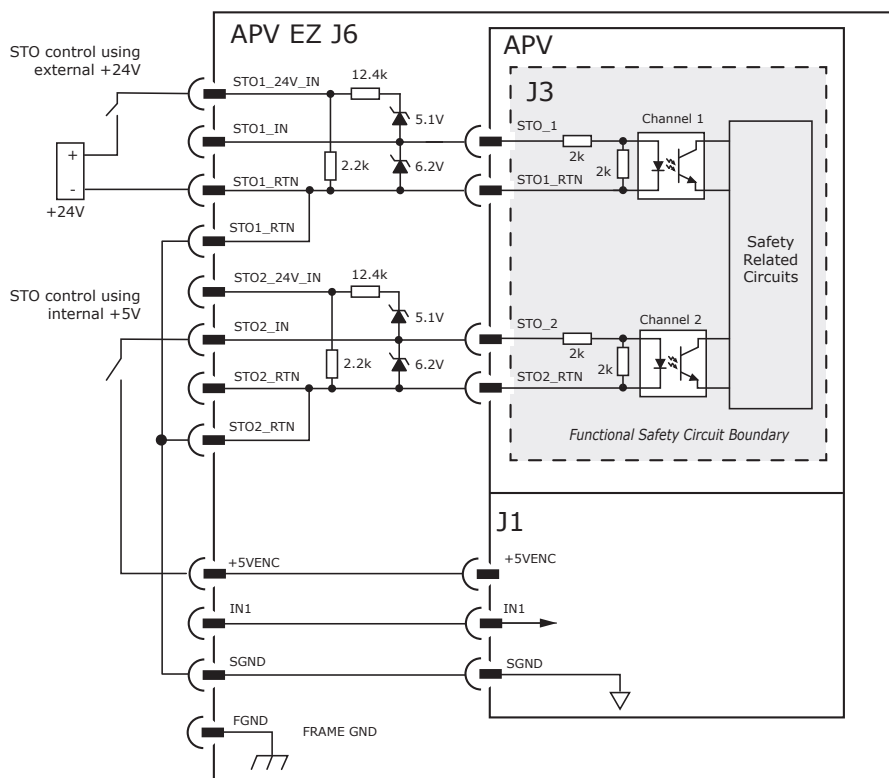
CANOPEN DEVICE ID (STATION ALIAS) SWITCH CONNECTIONS

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 ch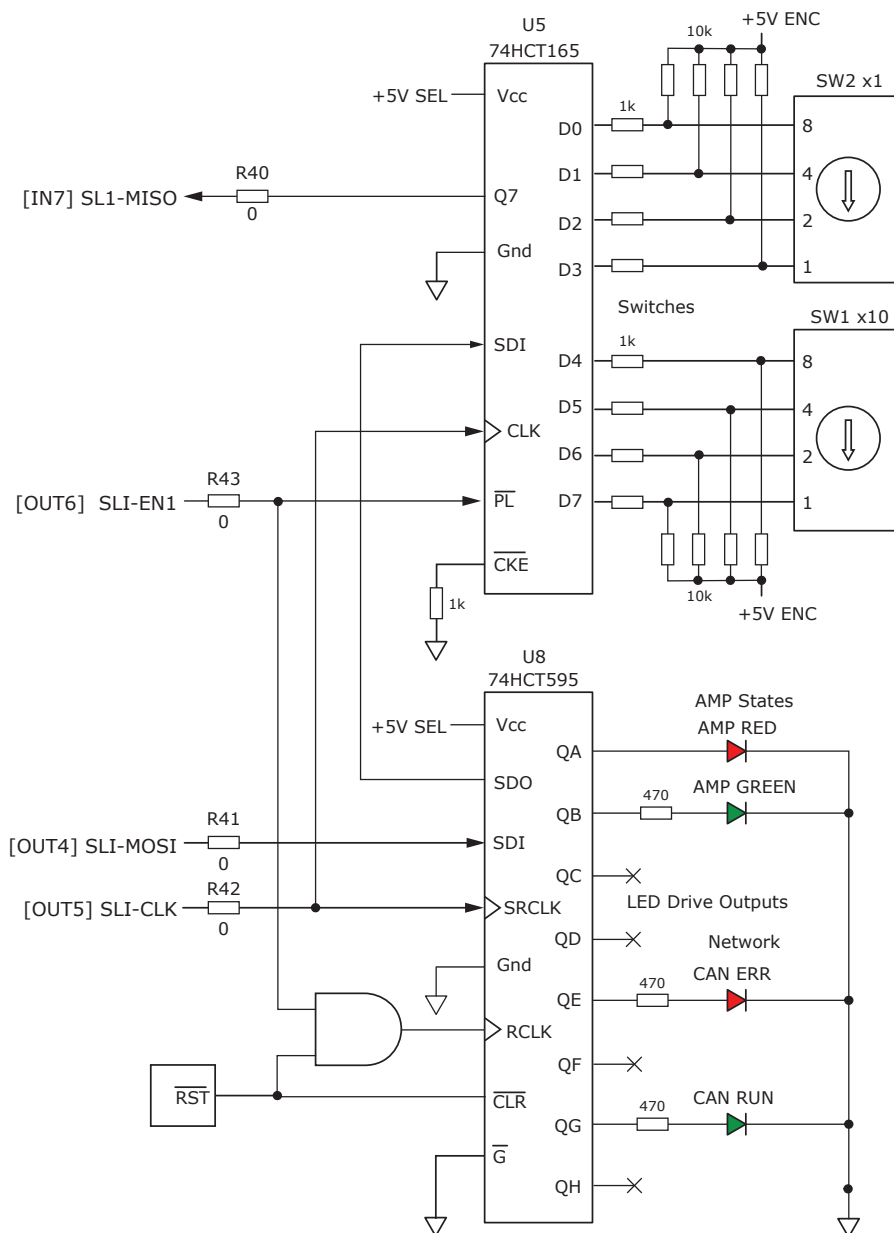anging the settings of the switches, be sure to either reset the drive, or to power it off-on. Outputs [OUT4,5,6,] and input [IN7] operate as an SLI port which reads the settings on the CANopen Device ID switches, and controls the Amp and CANopen status LEDs.

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.

SLI PORT

SLI-Port	Signal	Pin
SLI-MISO (IN7)	IN7	11
SLI-EN1 (OUT6)	DOUT6	16
SLI-MOSI (OUT4)	DOUT4	14
SLI-CLK (OUT5)	DOUT5	17

Note:
The SLI-xxxx naming appears as SPI-xxxx in the Reference Design schematic.
The SPI interface is not supported in the APV.

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	EZ-Board	Signal
1	VLOGIC	+24V_VLOGIC
2	SGND	SGND
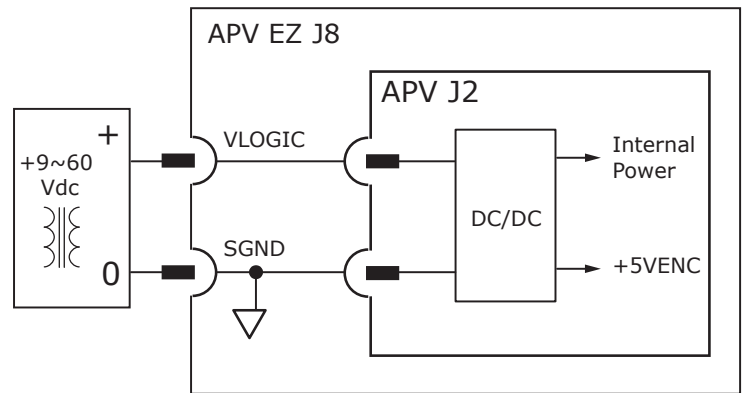
EZ BOARD +HV & MOTOR CONNECTIONS

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	EZ-Board	Signal
J15	2	+HV	+HV
	1	HVCOM	HVCOM
J16	3	MOT W	MOTW
	2	MOT V *	MOTV
	1	MOT U *	MOTU
J14	2	FGND	CHASSIS
	1	PE	PE
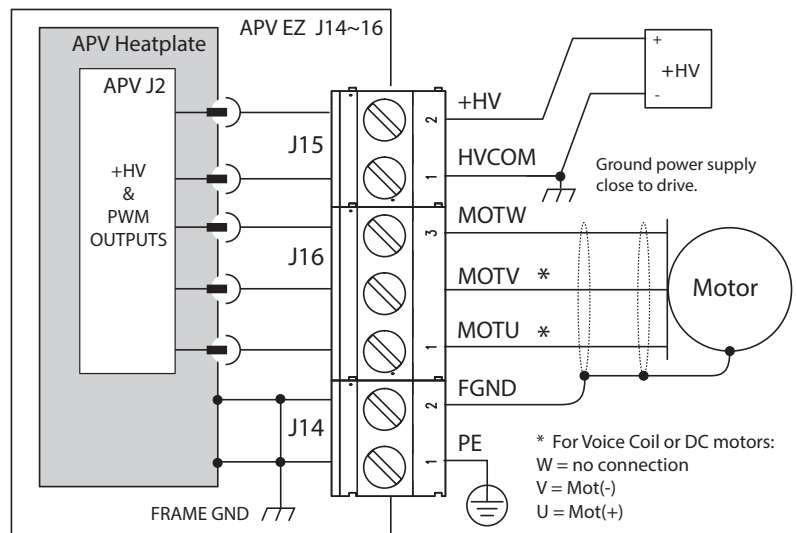
EZ BOARD I/O CONNECTORS

EZ-Board	Signal	J5 Pins
IN1 Enable	IN1	4
IN2	IN2	3
IN3	IN3	6
IN4	IN4	5
IN5	IN5	8
IN6 Encoder Fault	IN6	7
IN7 SLI MISO	IN7	10
SGND	SGND	15, 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
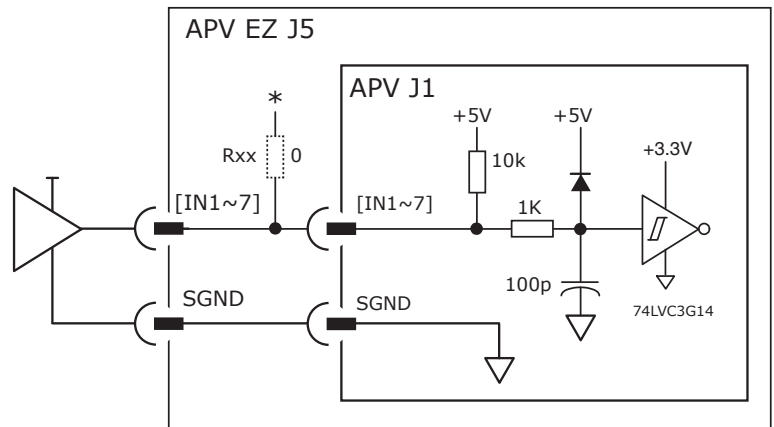
LOGIC OUTPUTS

EZ-Board	Signal	J5 Pins
DOUT1	DOUT1	12
DOUT2	DOUT2	9
DOUT3 (Brake)	DOUT3	14
DOUT4 (SLI-MOSI)	DOUT4	11
DOUT5 (SLI-CLK)	DOUT5	16
DOUT6 (SLI-EN1)	DOUT6	13
SGND	SGND	15, 17, 18

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

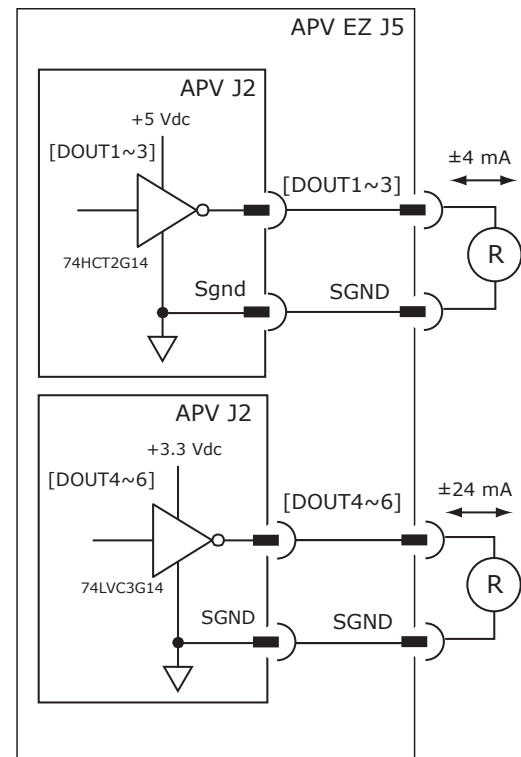## EZ BOARD PRIMARY FEEDBACK CONNECTOR P1

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 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 SIGNALS

EZ-Board	Signal	Pins
Enc1 A	ENCA1	13
Enc1 /A	/ENCA1	12
Enc1 B	ENCB1	11
Enc1 /B	/ENCB1	10
Enc1 X	ENCX1	9, 23
Enc1 /X	/ENCX1	8, 22
+5V ENC	+5VENC	6, 17
[IN5] Motemp	IN5	7
FGND	FGND	*
SGND	SGND	5,16, 25,26

* FGND on P1 is the metal shell.

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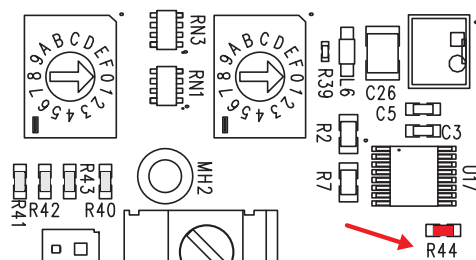
NOTE:
R44 connects IN6 to the encoder fault detection by default. If this feature is not used, then removing R44 allows IN6 to be programmed for user's function.

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.

EZ BOARD PRIMARY FEEDBACK CONNECTOR P1
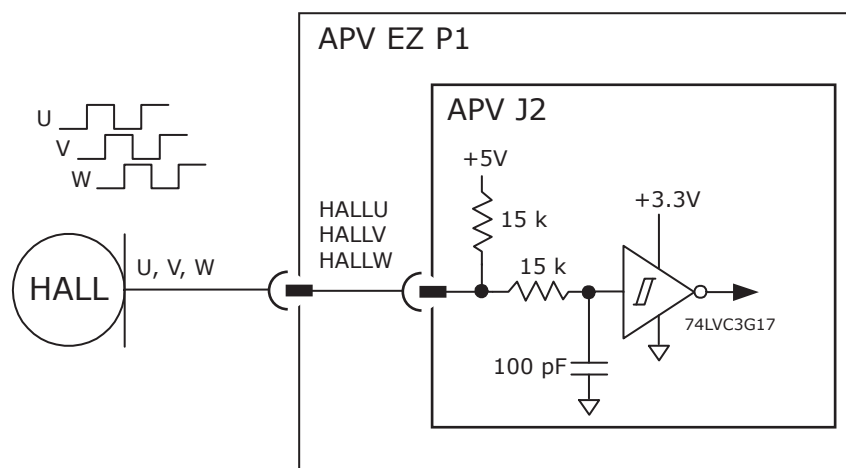
HALLS

P1 HALL SIGNALS

HALLS	Signal	Pins
Hall U	HALLU	2
Hall V	HALLV	3
Hall W	HALLW	4

SIN/COS ENCODERS
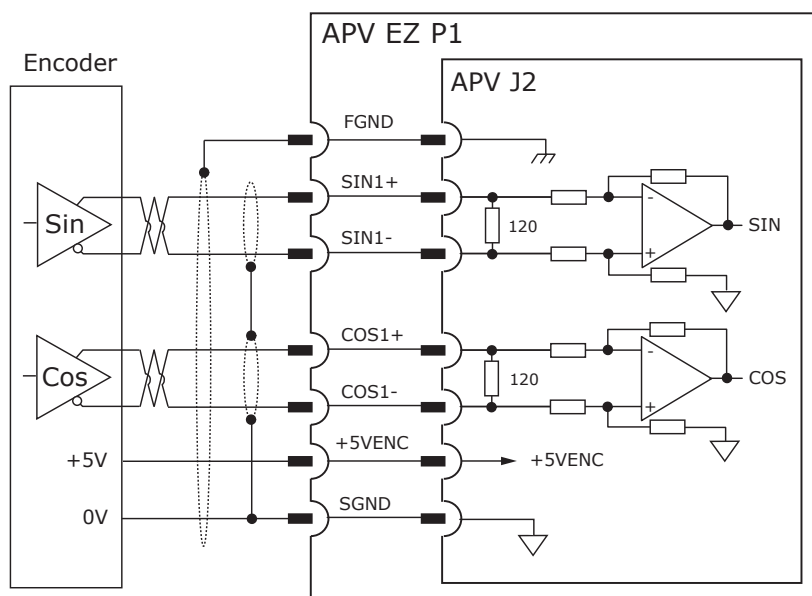
P1 SIN/COS SIGNALS

Sin/Cos	Signal	Pins
Sin(+)	SIN1+	19
Sin(-)	SIN1-	18
Cos(+)	COS1+	21
Cos(-)	COS1-	20

P1 +5V & SGND

Signal	Pins
+5VENC	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.

QUAD ENCODER WITH INDEX
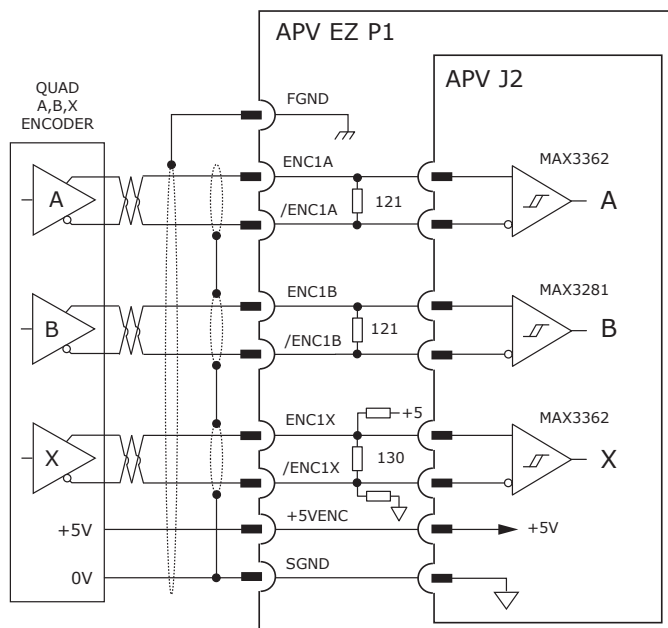
A/B/X SIGNALS

QUAD	Signal	P1 Pins
Enc1 A	ENCA1	13
Enc1 /A	/ENCA1	12
Enc1 B	ENCB1	11
Enc1 /B	/ENCB1	10
Enc1 X	ENCX1	9
Enc1 /X	/ENCX1	8
+5V ENC	+5VENC	6,17
SGND	SGND	5,16,25,26
FGND	FGND *	27, 28

* FGND on P1 is the metal shell of the connector. This makes contact with the feedback cable backshell which then makes contact with the motor feedback cable's shielding. It is shown as a pins 27 & 28 which is how it appears in the EZ board schematic.

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	Signal	P1 Pins
SDATA	MA+	ENCA1	13
/SDATA	MA-	/ENCA1	12
SCLK	SL+	ENCX1	9
/SCLK	SL-	/ENCX1	8
+5V		+5VENC	6,17

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

ENDAT SIGNALS

EnDAT	Signal	P1 Pins
Clk	ENCX1	9
/Clk	/ENCX1	8
Data	ENCA1	13
/Data	/ENCA1	12
Sin(+) *	SIN1+	19
Sin(-) *	SIN1-	18
Cos(+) *	COS1+	21
Cos(-) *	COS1-	20
+5V	+5VENC	6,17
0V	SGND	5, 16 25, 26

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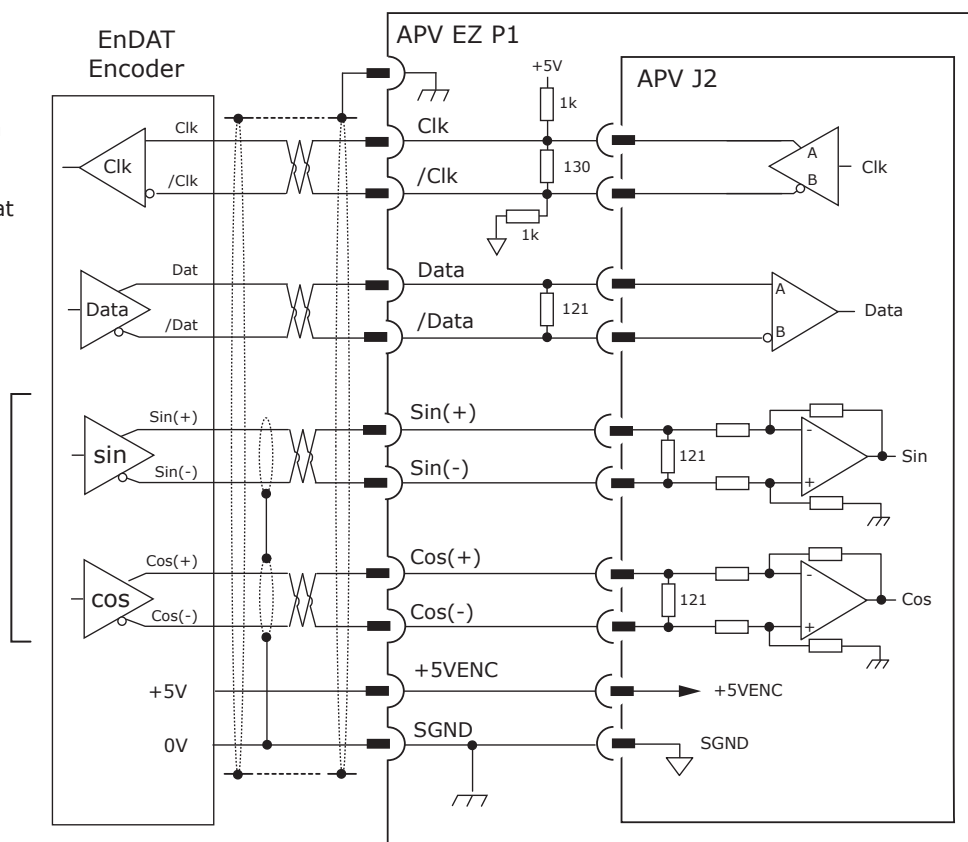
ABSOLUTE-A ENCODER

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

ABS-A	Signal	J2 Pins
Data	ENCA1	13
/Data	/ENCA1	12
+5V	+5VENC	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.
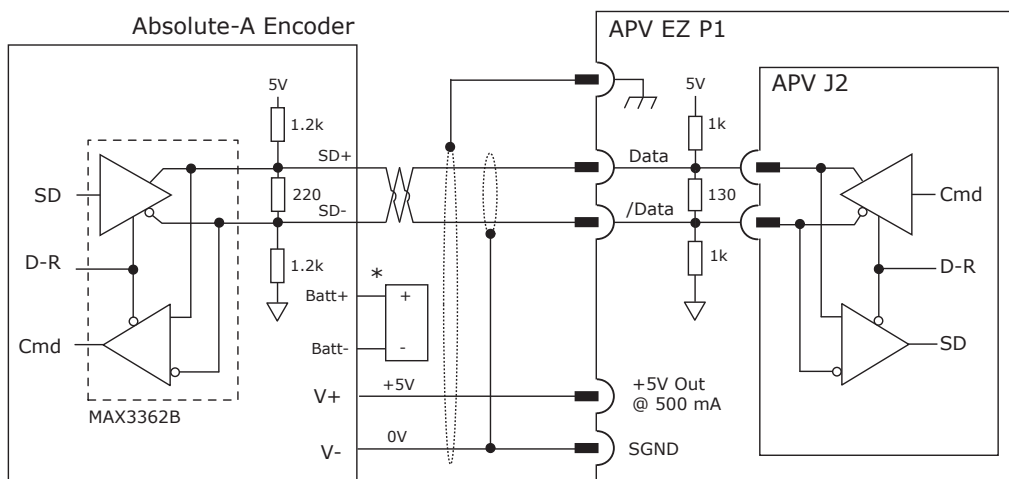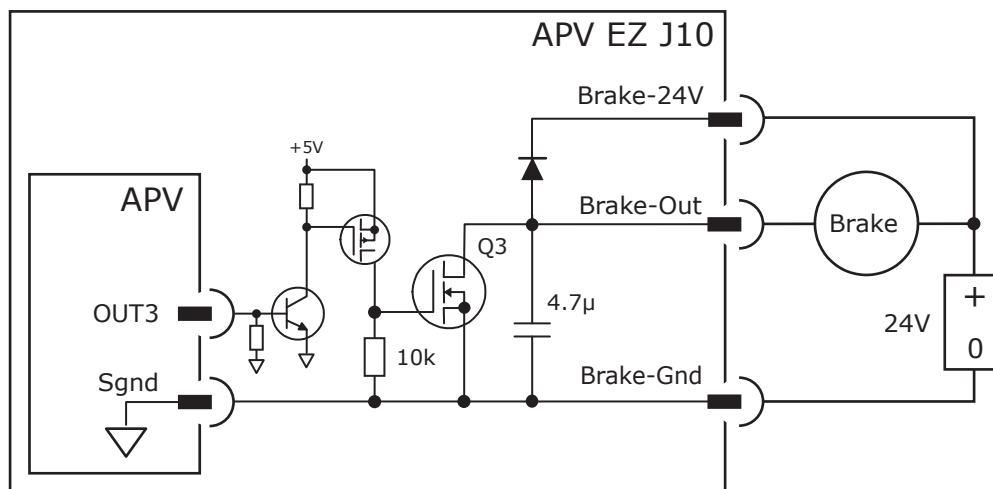
- Brake output [OUT3]

- 24V Compatible

- Programmable functions

APV EZ J10

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

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

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

J10 BRAKE SIGNALS

Pin	Brake	Signal
1	Brake-24V	+24V_IN
2	Brake-Out	BRAKE
3	Brake-Gnd	24V_GND_IN

EZ BOARD CONNECTORS

P1 ENCODER 1

Pin	EZ Board	Pin	EZ Board	Pin	EZ Board
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	EZ Board
3	HVCOM
2	Brake output
1	+24V Input

J8 V-LOGIC

Pin	EZ Board
1	VLOGIC
2	SGND

J15 DC-POWER

Pin	EZ Board
2	+HV
1	HV COM

J16 MOTOR

Pin	EZ Board
3	Mot W
2	Mot V
1	Mot U

J14 GROUNDS

Pin	EZ Board
2	FGND
1	PE

J5 I/O

EZ Board	Pin	Pin	EZ Board
Aref(-)	2	1	Aref(+)
Enable IN1	4	3	IN2
IN3	6	5	IN4
Motemp IN5	8	7	IN6 Enc-Fault **
* SLI-MISO IN7	10	9	OUT2
OUT1	12	11	OUT4 SLI-MOSI *
* Brake OUT3	14	13	OUT6 SLI-EN1 *
* SLI-CLK OUT5	16	15	SGND
SGND	18	17	SGND

J9 RS-232

Pin	EZ Board
1	N.C.
2	RxD
3	SGND
4	SGND
5	TxD
6	N.C.

J4 ENCODER 2

EZ Board	Pin	Pin	EZ Board
Enc2 A	2	1	Enc2 /A
Enc2 B	4	3	Enc2 /B
Enc2 X	6	5	Enc2 /X
SGND	8	7	+5V ENC

J13

EZ Board	Pin	Pin	EZ Board
***	2	1	***
***	4	3	***

J6 STO

EZ Board	Pin	Pin	EZ Board
IN1	15	16	+5VENC
SGND	13	14	FGND
n.c.	11	12	n.c.
STO2_RTN	9	10	STO2_IN
STO2_RTN	7	8	STO2_24V_IN
n.c.	5	6	n.c.
STO1_RTN	3	4	STO1_IN
STO1_RTN	1	2	STO1_24V_IN

P1
J8
J5
J15
J10
J16
J4
J13
J14
J6
J9
J11
J12

* 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.
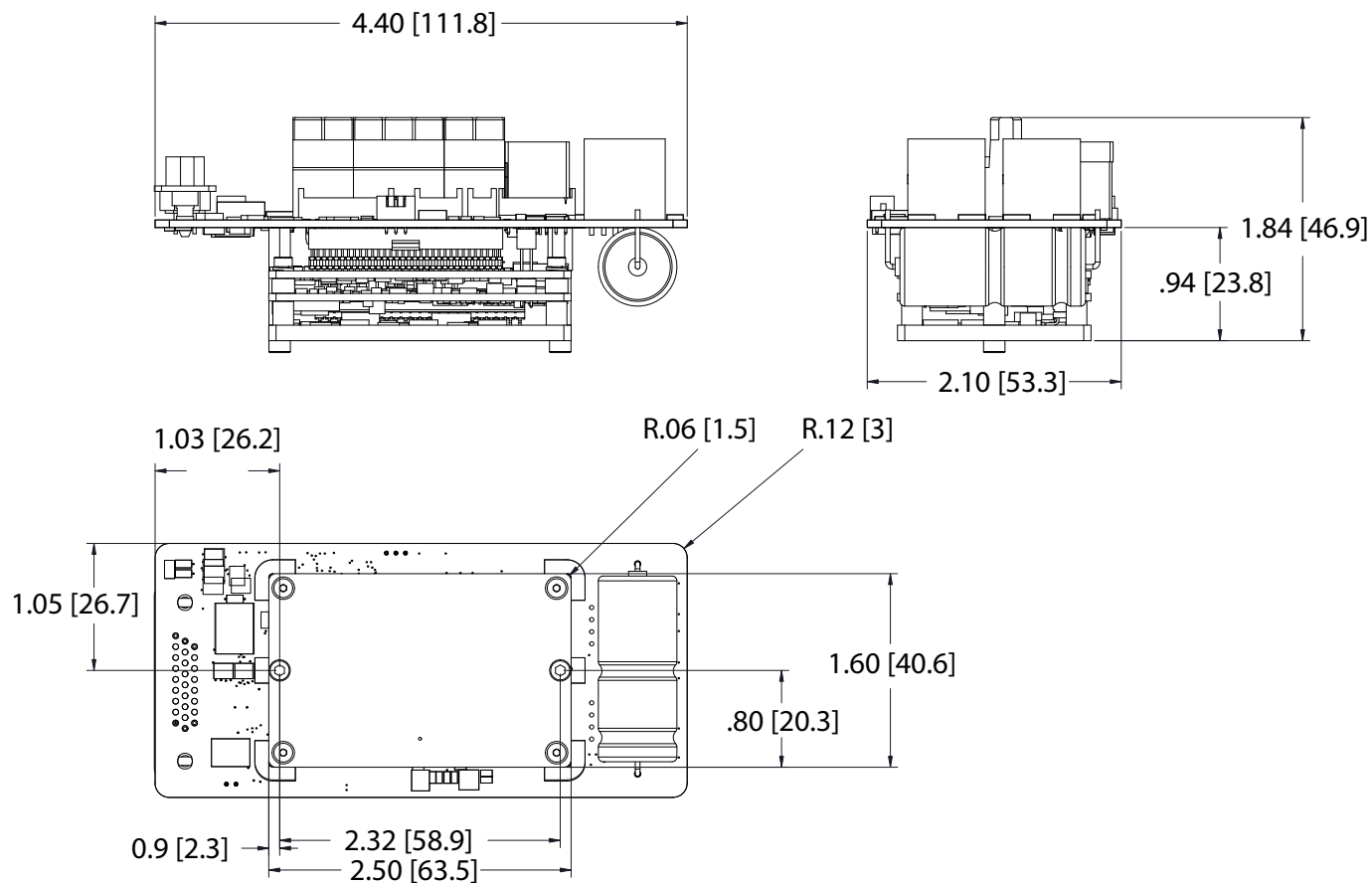
 *** No connections

J11 CAN-IN

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

J12 CAN-OUT

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

EZ BOARD DIMENSIONS

The dimensions shown here are for an APV drive socketed into an EZ Board

4.40 [111.8]

1.84 [46.9]

.94 [23.8]

2.10 [53.3]

1.03 [26.2]

R.06 [1.5]   R.12 [3]

1.05 [26.7]

1.60 [40.6]

.80 [20.3]

0.9 [2.3]

2.32 [58.9]

2.50 [63.5]

EZ DEVELOPMENT BOARD

DESCRIPTION

The APZ-090-50-C is an APV-090-50-C drive with the motor and +HV pins soldered to a Development Kit to support the 50 Adc peak and continuous current rating. The heatsink shown here is included.
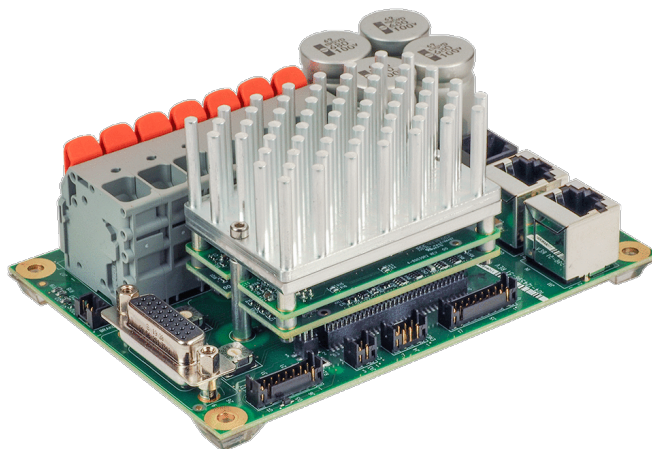
RS-232 CONNECTION

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.


J9
RS-232
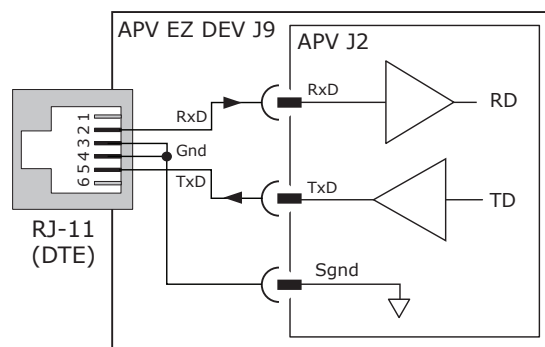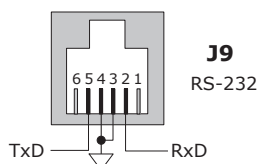
J9 RS-232

Pin	EZ Board	Signal
1	N.C.	N.C.
2	RxD	RS232RX
3	SGND	SGND
4	SGND	SGND
5	TxD	RS232TXD
6	N.C.	N.C.

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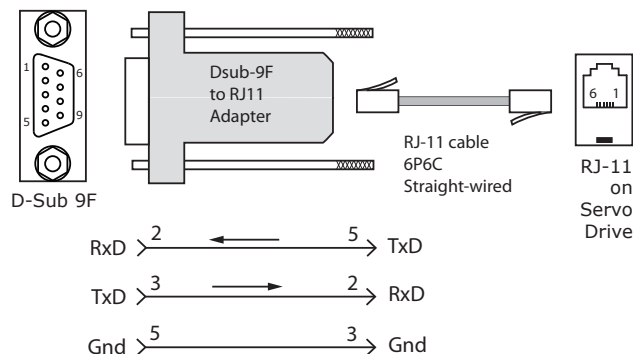
Don't forget to order a Serial Cable Kit SER-CK or an SER-USB-RJ11 when placing your order for an APZ drive, or an EZ board.

Accelnet^{Plus} Micro Module CANopen APV

EZ DEVELOPMENT BOARD CANOPEN INDICATERS & 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

CANopen LEDs   Amp LED

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.

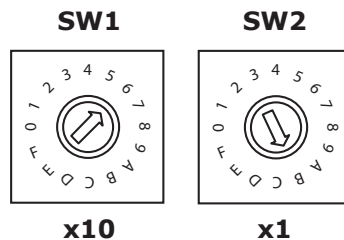|		
Red/Blinking	=	Latching fault. Operation can not resume until drive is Reset.
Red/Solid	=	Transient fault condition. Drive can resume operation when the condition causing the fault is removed.
Green/Slow-Blinking	=	Drive OK but NOT-enabled. Can run when enabled.
Green/Fast-Blinking	=	Positive or 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

HEX	SW1	SW2
	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

SW1   **SW2**

x10   x1

## 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	EZ-Dev	Signal
1	TX1+	ECATTX1+
2	TXRX1 Term	+3.3V_TXRX1
3	TX1-	ECATTX1-
4	RX1+	ECATRX1+
5	TXRX1 Term	+3.3V_TXRX1
6	RX1-	ECATRX1-
7	n.c.	n.c.
8	FGND	CHASSIS

J12 ECAT-OUT

Pin	EZ-Dev	Signal
1	TX2+	ECATTX2+
2	TXRX2 Term	+3.3V_TXRX2
3	TX2-	ECATTX2-
4	RX2+	ECATRX2+
5	TXRX2 Term	+3.3V_TXRX2
6	RX2-	ECATRX2-
7	n.c.	n.c.
8	FGND	CHASSIS
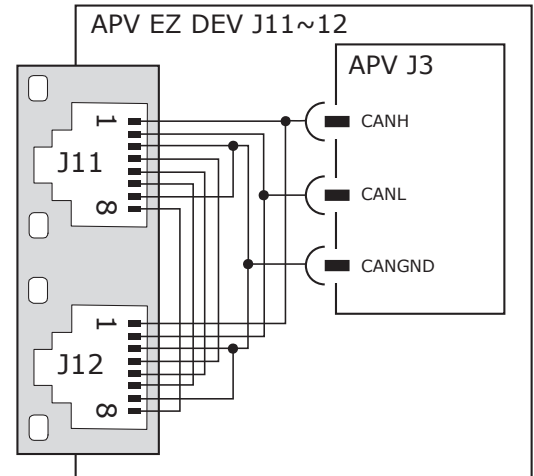
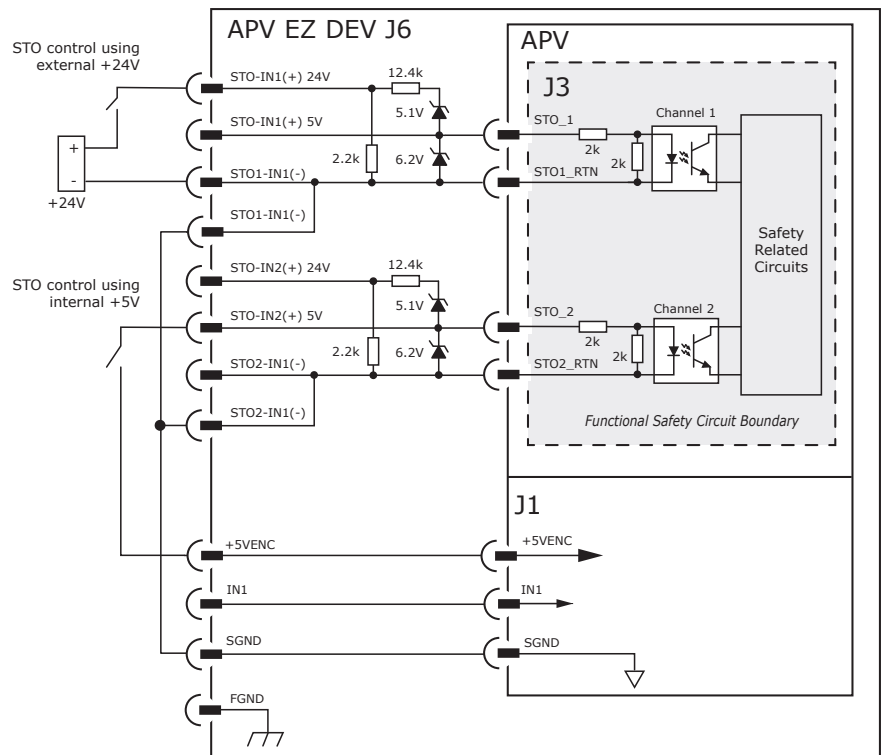## EZ DEVELOPMENT BOARD SAFE TORQUE OFF (STO)

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

EZ-Dev	Pin		Pin	EZ-Dev
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

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

| Pins	EZ-Dev	Signal
1	VLOGIC	+24V_VLOGIC
2	SGND	SGND
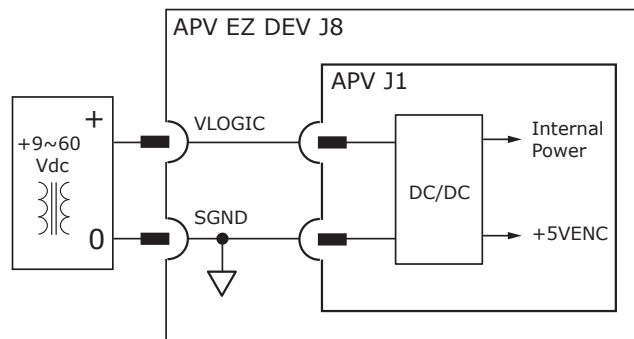
EZ DEVELOPMENT BOARD POWER, MOTOR, & GROUNDING CONNECTIONS

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	EZ-Dev	Signal
1	PE	PE
2	FGND	CHASSIS
3	MOT U	MOTU
4	MOT V	MOTV
5	MOT W	MOTW
6	HVCOM	HVCOMM
7	+HV	+HV
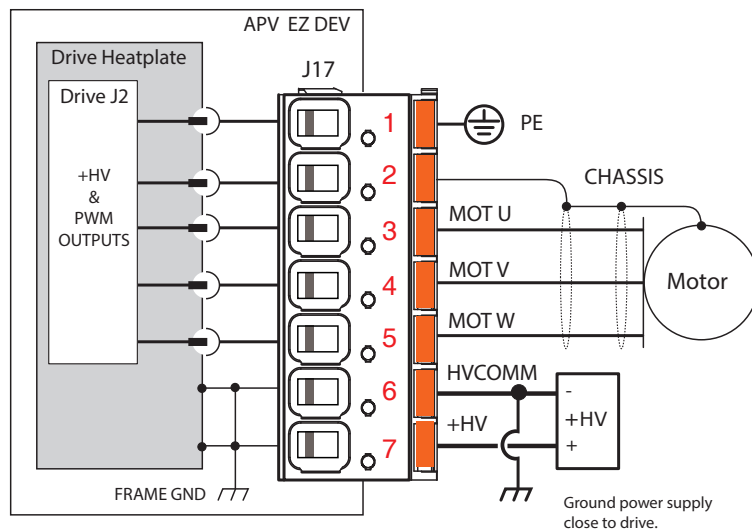
CONDUCTOR TYPE	MM²	AWG
Solid	0.75 ~ 16	18 ~ 4
Fine stranded	0.75 ~ 25	18 ~ 4
Fine stranded with ferrule with plastic collar	0.75 ~ 16	
Fine stranded with ferrule without plastic collar	0.75 ~ 16	N/A
Fine stranded with twin ferrule	0.75~ 6	

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

FERRULES		
MM²	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

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
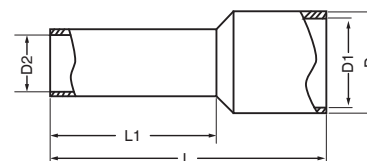
216-210

EZ DEVELOPMENT BOARD I/O CONNECTORS

LOGIC INPUTS

EZ-Dev	Signal	J5 Pins
IN1 Enable	IN1	4
IN2	IN2	3
IN3	IN3	6
IN4	IN4*	5
IN5	IN5*	8
IN6 Encoder Fault	IN6*	7
IN7 SLI MISO	IN7	10
SGND	SGND	15, 17, 18
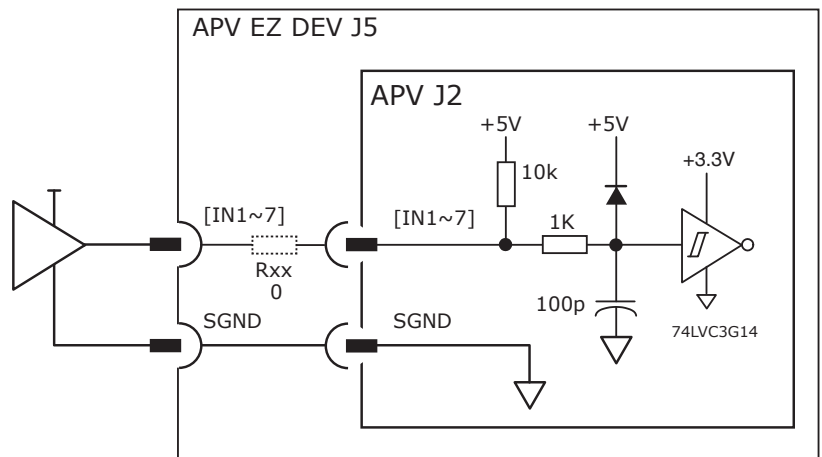
Logic inputs max input voltage is +6 Vdc.
* Rxx shows the location of the four 0 Ω resistors that are in place by default as R40~R44.
R40 connects the SLI-MISO signal to IN7 which is used by the SLI port that controls the LEDs and reads the address switches.
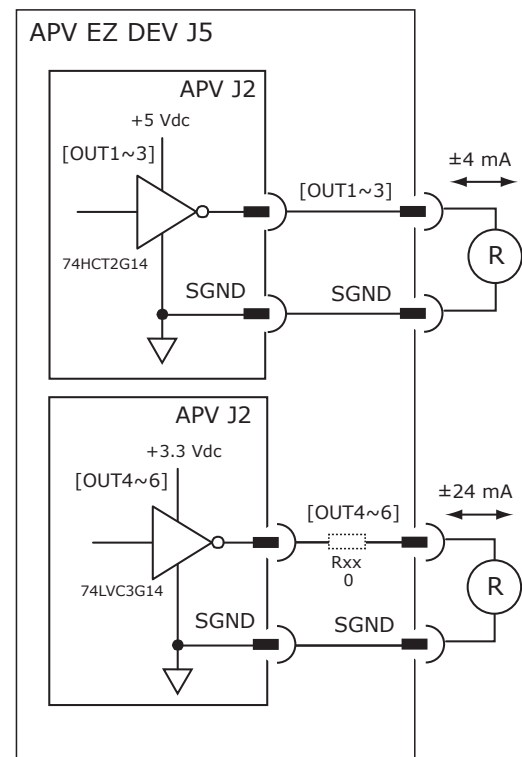R44 connects the Encoder Fault signal to IN6.
If neither of these functions are needed then R40 and/or R44 can be removed making
IN6 & IN7 available as logic inputs

LOGIC OUTPUTS

EZ-Dev	Signal	J5 Pins
OUT1	DOUT1	12
OUT2	DOUT2	9
OUT3 Brake	DOUT3	14
OUT4 SLI-MOSI*	DOUT4	11
OUT5 SLI-CLK*	DOUT5	16
OUT6 SLI-EN1*	DOUT6	13
SGND	SGND	15, 17, 18

OUT1~2 are available as logic outputs.
OUT3 is connected by default to the MOSFET that is the Brake output on J10.
* 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:
   R41 connects the SLI-MOSI signal to to DOUT4
   R42 connects SLI-CLK to DOUT5
   R43 connects SLI-EN1 to DOUT6

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.
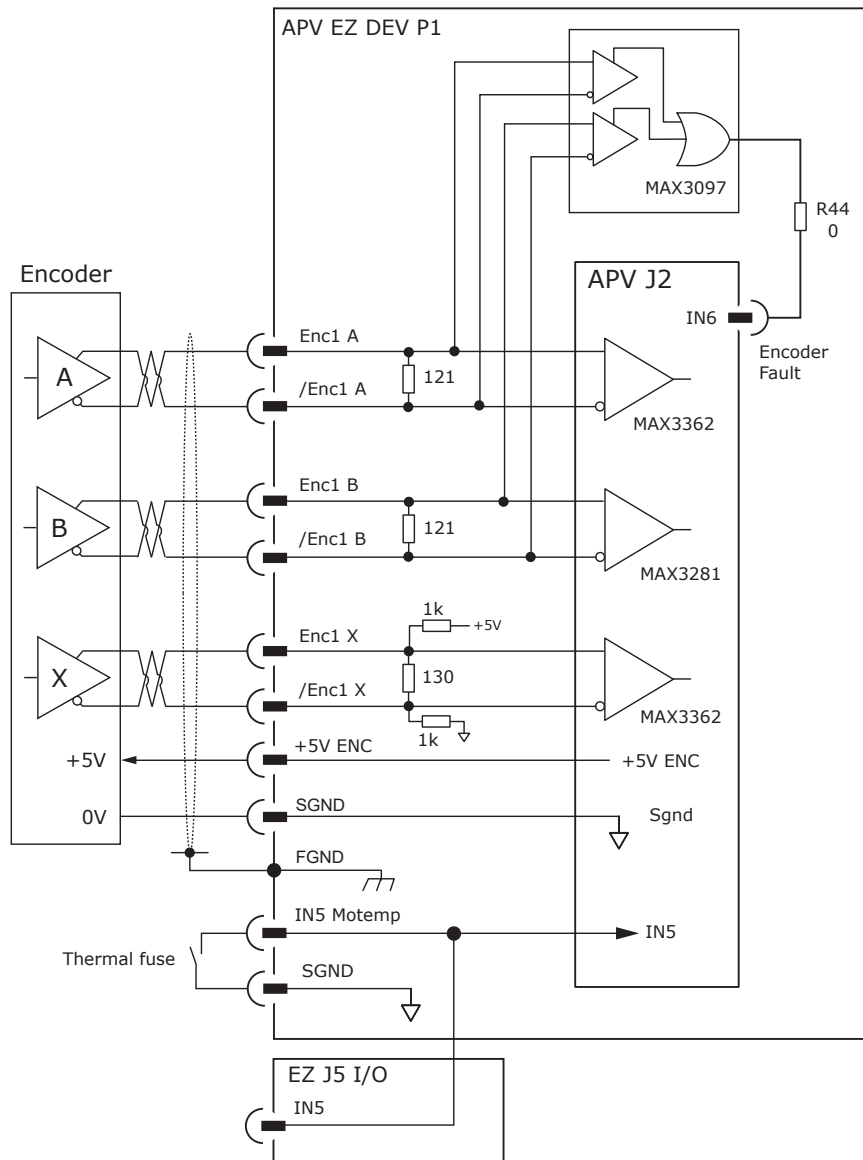
±15kV ESD protection: The 3097 has protection against high-voltage discharges using the Human Body Model.

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

EZ-Dev	Signal	Pins
Enc1 A	ENCA1	13
Enc1 /A	/ENCA1	12
Enc1 B	ENCB1	11
Enc1 /B	/ENCB1	10
Enc1 X	ENCX1	9
Enc1 /X	/ENCX1	8
+5V ENC	+5VENC	6, 17
IN5 Motemp	IN5	7
SGND	SGND	5,16, 25,26

SGND = Signal Ground

NOTE:

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

IN5 MOTEMP SIGNALS

EZ-Dev	Signal	Pins
P1	IN5	7
	SGND	5, 16, 25, 26
J5	IN5	8
	SGND	15, 17, 18

HALLS

P1 HALL SIGNALS

EZ-Dev	Signal	Pins
Hall U	HALLU	2
Hall V	HALLV	3
Hall W	HALLW	4

SIN/COS ENCODERS
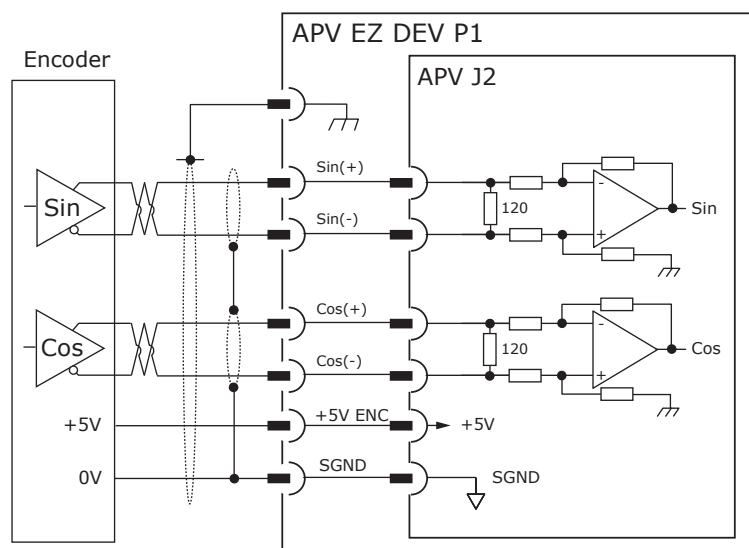
P1 SIN/COS SIGNALS

EZ-Dev	Signal	Pins
Sin(+)	SIN1+	19
Sin(-)	SIN1-	18
Cos(+)	COS1+	21
Cos(-)	COS1-	20

P1 +5V & SGND

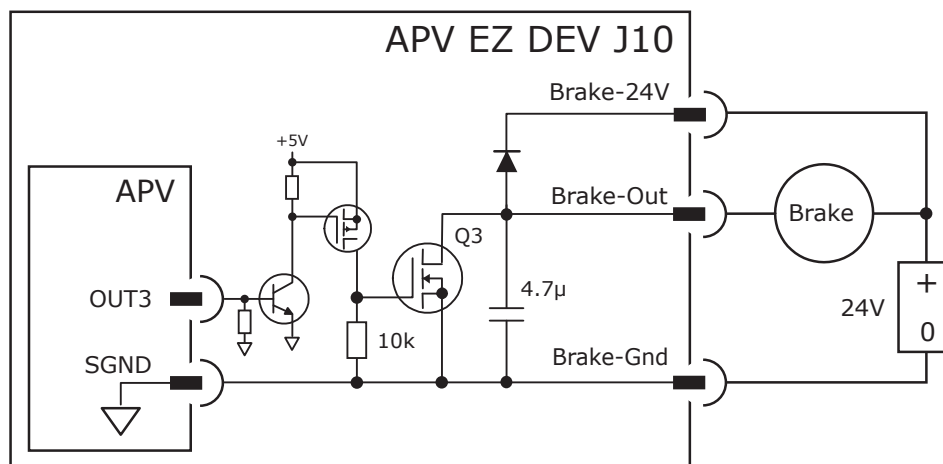| EZ-Dev	Signal	Pins
+5V	+5VENC	6, 17
SGND	SGND	5, 16, 25, 26

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 and 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.

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

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

APV EZ DEV J10

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

Specifications

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

J10 BRAKE SIGNALS

EZ-Dev	Signal	Pin
Brake-24V	+24V_IN	1
Brake-Out	BRAKE	2
Brake-Gnd	24V_GND_IN	3

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

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
              Brake-Out 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
              Brake-Out 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	Brake-24V
2	Brake-Out
3	Brake-Gnd

J6 STO

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

J13

Signal	Pin	Pin	Signal
***	3	4	***
***	1	2	***

*** No connections

J4 ENCODER 2

Signal	Pin	Pin	Signal
+5V ENC	7	8	SGND
Enc2 /X	5	6	Enc2 X
Enc2 /B	3	4	Enc2 B
Enc2 /A	1	2	Enc2 A

J5 I/O

Signal	Pin	Pin	Signal
SGND	17	18	SGND
SGND	15	16	OUT5 SLI-CLK *
* SLI-EN1 OUT6	13	14	OUT3 Brake *
* SLI-MOSI OUT4	11	12	OUT1
OUT2	9	10	IN7 SLI-MISO *
** Enc-Fault IN6	7	8	IN5 Motemp
IN4	5	6	IN3
IN2	3	4	IN1 Enable
Aref(+)	1	2	Aref(-)
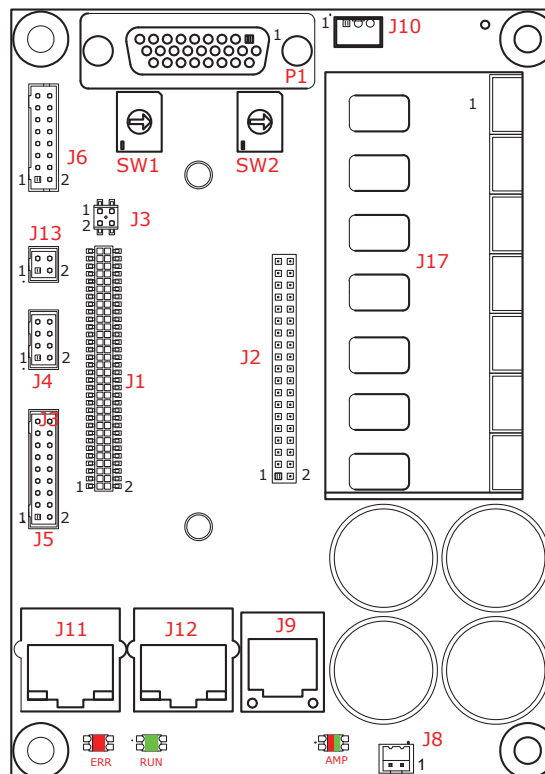
J17 GROUNDS

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.

* 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.

EZ DEVELOPMENT BOARD DIMENSIONS
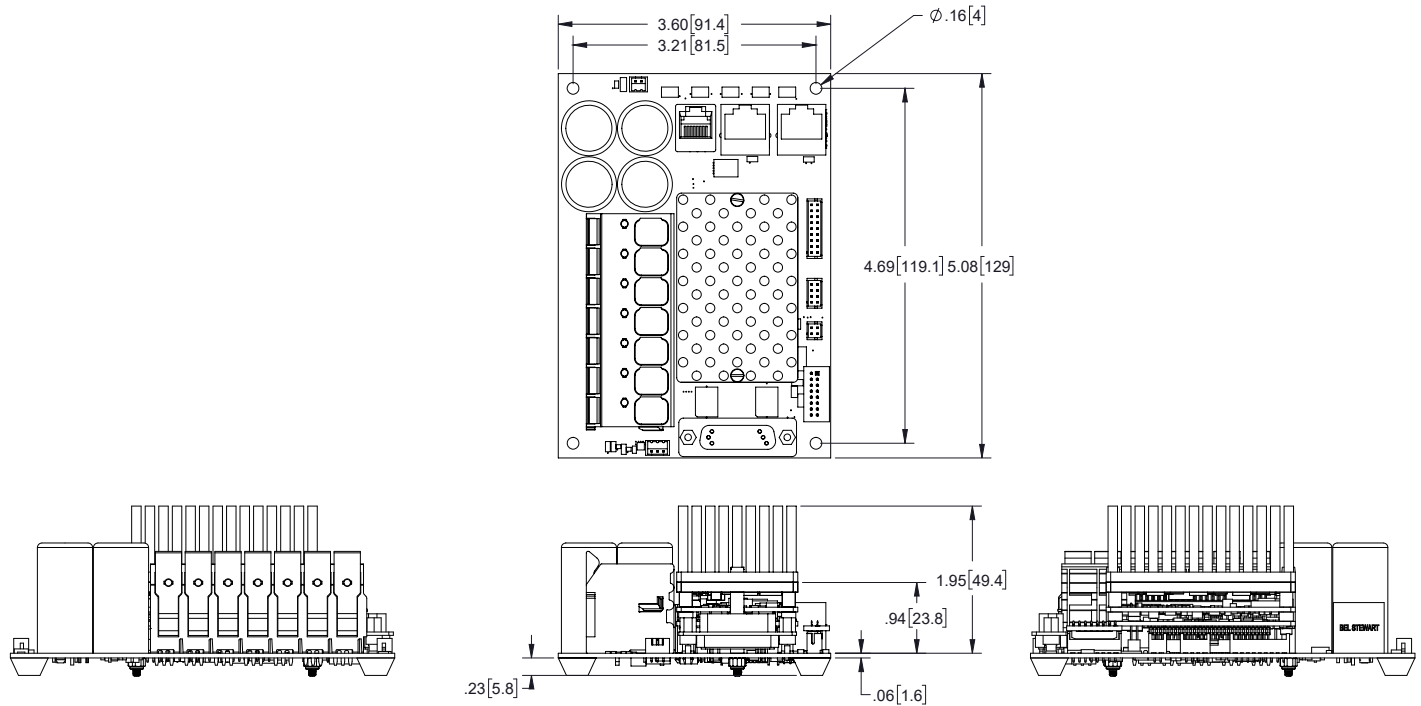
APV-EZ-STO SAFE TORQUE OFF DISABLING ACCESSORY

J6 STO EZ-Board

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.

J6 STO Signals

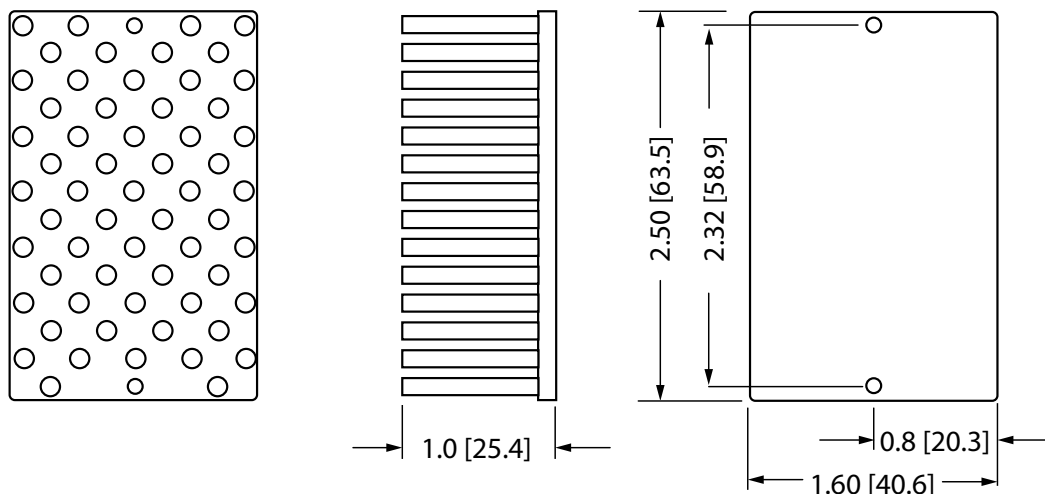| Signal	Pin		Signal
IN1	15	16	+5VENC
SGND	13	14	FGND
n.c.	11	12	n.c.
STO2_RTN	9	10	STO2_IN
STO2_RTN	7	8	STO2_24V_IN
n.c.	5	6	n.c.
STO1_RTN	3	4	STO1_IN
STO1_RTN	1	2	STO1_24V_IN
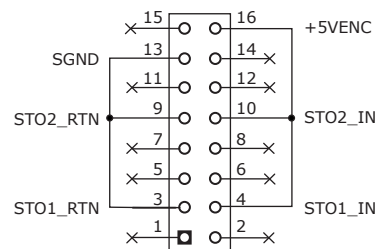
APV-EZ-STO

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.

2.50 [63.5] 2.32 [58.9] 1.0 [25.4] 0.8 [20.3] 1.60 [40.6]

Remove protective sheets from thermal pad before installing
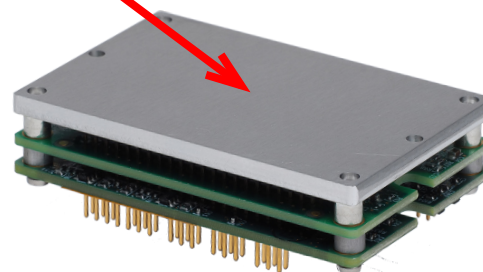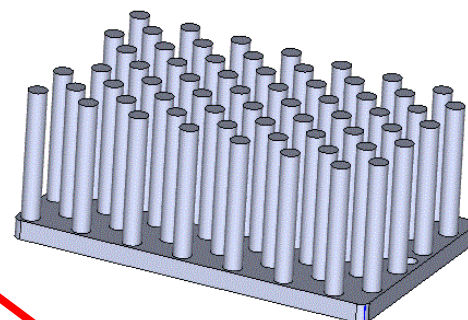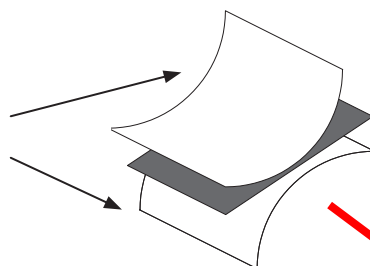
APV-HK Pins Heatsink Kit

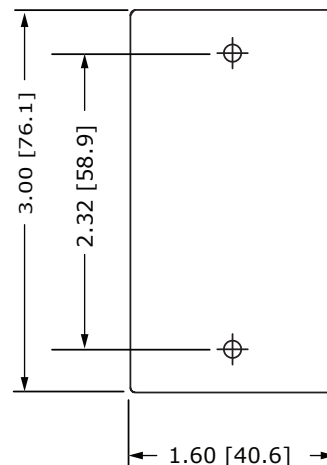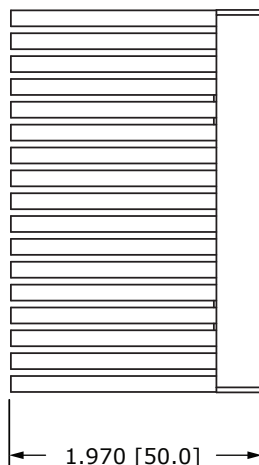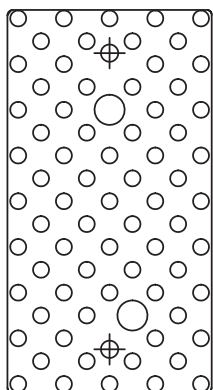| Qty	Description
1	Pins Heatsink, 1 inch tall
1	Thermal material
2	Copley non-threaded spacer, 20.5 mm
2	Screw, M2.5-0.45 x 35 mm slotted drive cheese head
2	Nut, M2.5x0.45 DIN Zinc Plated Nylon Insert Lock

NOTE: The spacers and screws in the kit are for socketed or half-socketed mounting. For a soldered mounting, a 15 mm spacer should be used and the screw length depends the mounting board. These spacers and screws are supplied by the user.

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.

3.00 [76.1]
2.32 [58.9]
1.970 [50.0]
1.60 [40.6]

Remove protective sheets from thermal pad before installing
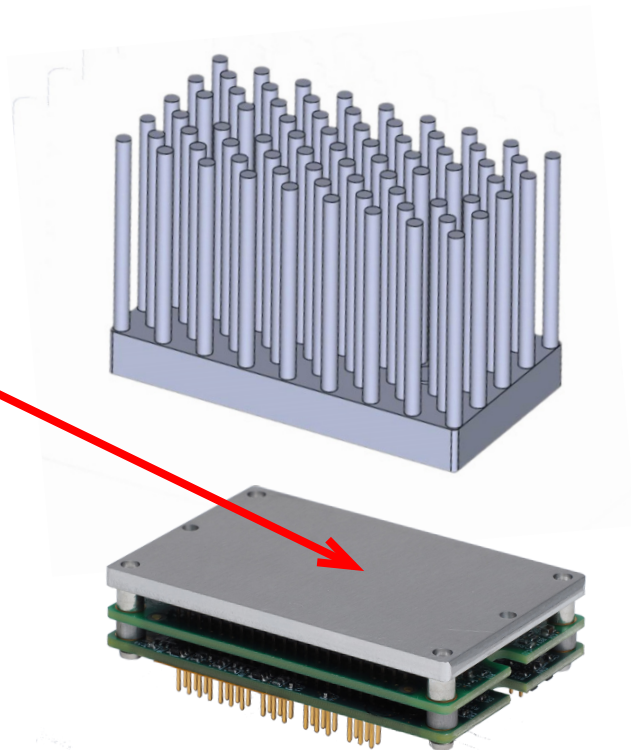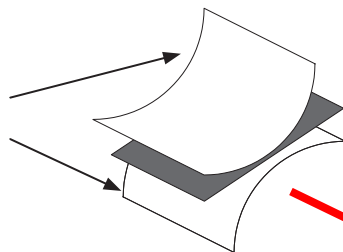
APV-THK Pins Heatsink Kit

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

NOTE: The spacers and screws in the kit are for socketed or half-socketed mounting. For a soldered mounting, a 15 mm spacer should be used and the screw length depends the mounting board. These spacers and screws are supplied by the user.

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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 with heatsink installed (see page 39)

ACCESSORIES FOR MICRO MODULES

APV-EZ-090	EZ Board (Pluggable for 90V APV modules, *Not compatible with APV-090-50 or APV-090-50-C*)
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
	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
APV-EZ-CK	5	J8,J10	Crimp socket, 24~28 AWG, gold		Hirose: DF3-2428-SCC
Connector Kit	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	