Application Note

AEDR-9930E2/E2L

Three-Channel Reflective Digital Incremental Encoders

Description

The Broadcom® AEDR-9930E2/E2L is a three-channel reflective optical encoder. It provides digital signals by employing reflective technology for motion control purposes. The AEDR-9930E2/E2L digital encoder offers two-channel (AB) quadrature digital outputs and a third channel digital index output.

A selectable interpolation option is available for the three-channel digital differential A, B, and gated I outputs. Being TTL compatible, the outputs of the encoder can be interfaced with most of the signal processing circuitry. Therefore, the encoder provides easy integration and flexible design-in into existing systems.

The HEDS-9930E2EVB and HEDS-9930E2LEVB are evaluation boards to be used as reference design for the AEDR-9930 encoder ASIC. The HEDS-9930E2PRGEVB and HEDS-9930E2LPRGEVB are calibration kits to be used with the evaluation boards.

Applications

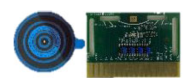
- Closed-loop stepper motors
- Small motors, actuators
- Industrial printers
- Robotics
- Card readers
- Pan-tilt-zoom (PTZ) cameras
- Portable medical equipment
- Optometric equipment
- Linear stages

Ordering Information

Table 1: AEDR-9930E2L Linear Encoder Part Numbers and Ordering Information

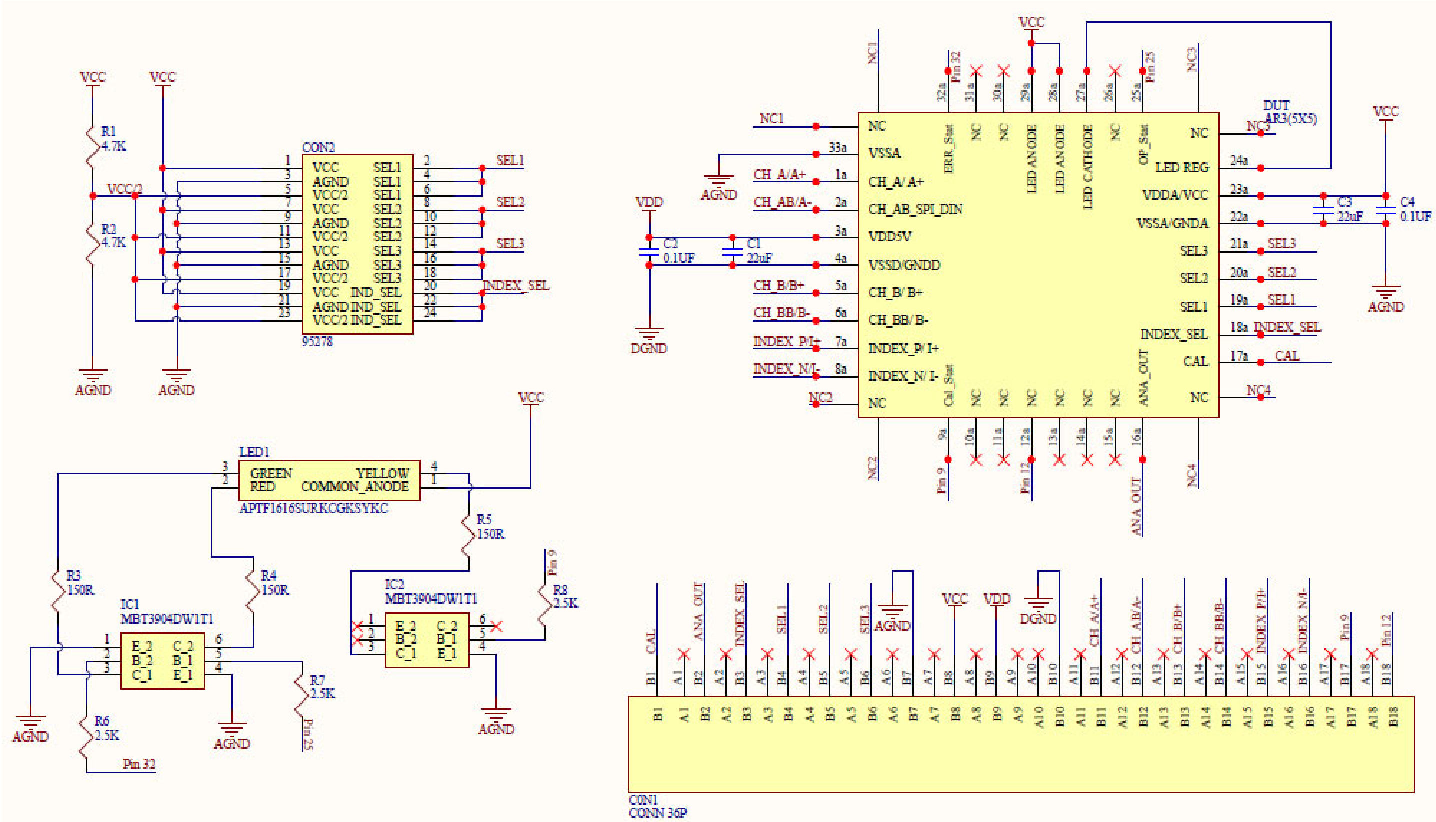
Ordering Information	Type	Notes
AEDR-9930E2L-100	AEDR-9930E2L, 397 LPI Incremental Linear Encoder, Tape and Reel, 1000 pieces	
AEDR-9930E2L-102	AEDR-9930E2L, 397 LPI Incremental Linear Encoder, Tape and Reel, 100 pieces	
HEDS-9930E2LEVB	Linear Encoder Evaluation Board with 2 Units of Code Strip Bundling	
HEDS-9930E2LPRGEVB	SPI Programming Kit with Linear Encoder Evaluation Board and 2 units of Code Strip Bundling	

Table 2: AEDR-9930E2 Rotary Encoder Part Numbers and Ordering Information

Ordering Information	Type	Notes
AEDR-9930E2-100	AEDR-9930E2, 397 LPI Incremental Rotary Encoder, Tape and Reel, 1000 pieces	
AEDR-9930E2-102	AEDR-9930E2, 397 LPI Incremental Rotary Encoder, Tape and Reel, 100 pieces	
HEDS-9930E2EVB	AEDR-9930E2 Evaluation Board with 2 Units of Code Wheel Multiple Optical Radius 256, 512, 1024,1440 CPR Base	
HEDS-9930E2PRGEVB	SPI Programming Kit with Evaluation Board, Including 2 units of Code Wheel Multiple Optical Radius 256, 512, 1024,1440 CPR Base	

Reference Schematic Design

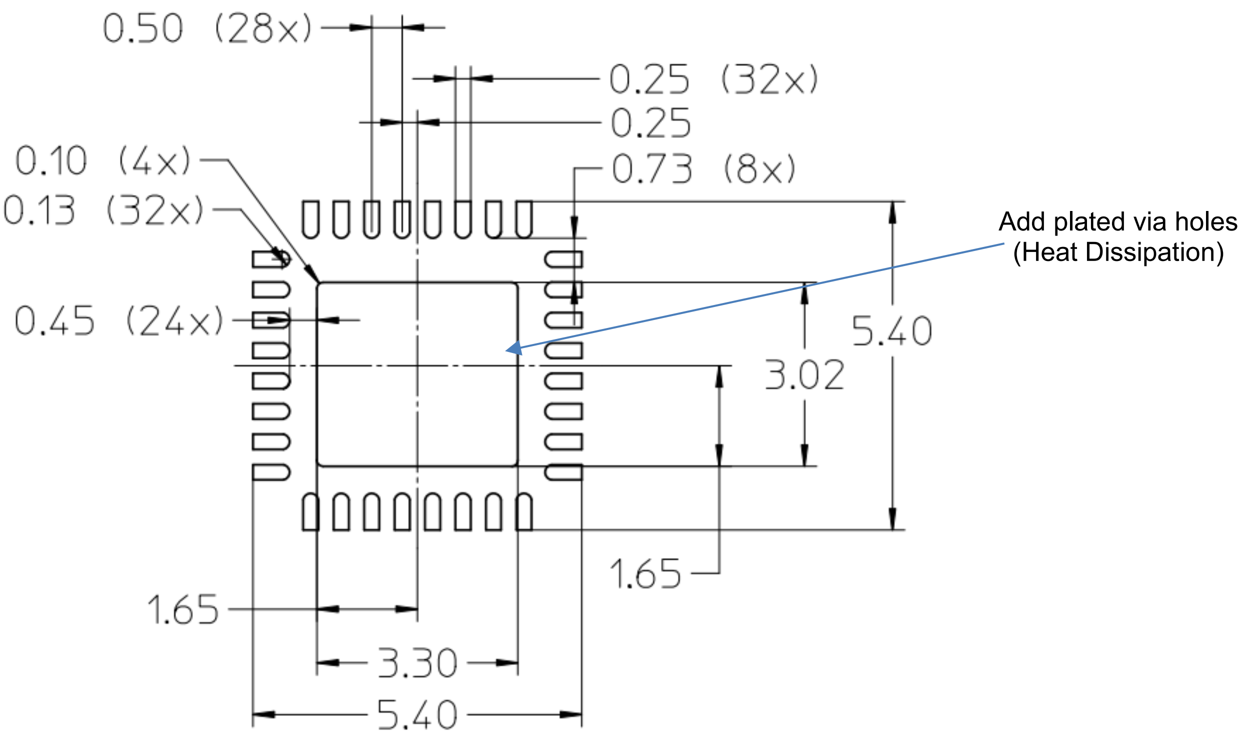
Figure 1: Schematic Diagram for HEDS-9930(E2/E2L)EVB Evaluation Board



Reference PCB Land Pattern

The recommended AEDR-9930E2/E2L 5x5 mm QFN package land pattern is shown in Figure 2.

Figure 2: AEDR-9930E2/E2L PCB Land Pattern



NOTE:

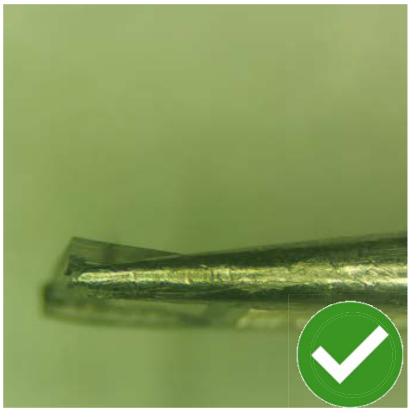
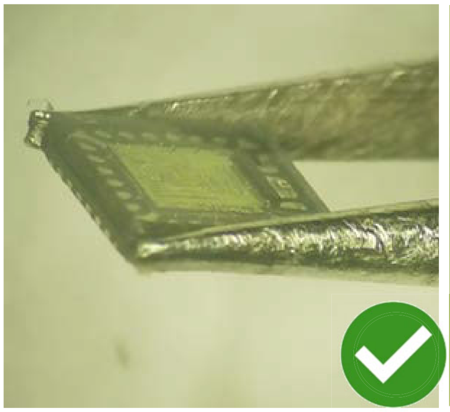
1. All dimensions are in millimeters (mm).
2. Optimize the center die paddle solder paster stencil opening to ensure adequate SMD reflow yield.
3. Unless otherwise specified, the tolerances is x.xx ± 0.05 mm.

Handling with Tweezers

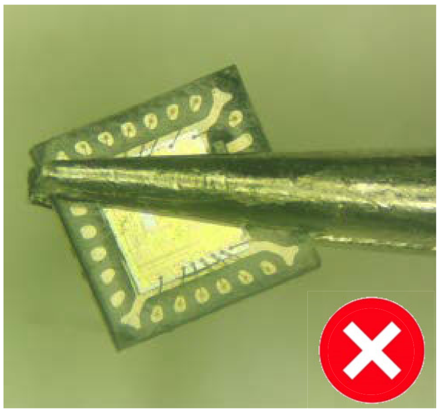
Follow these guidelines when handling the encoder with tweezers.

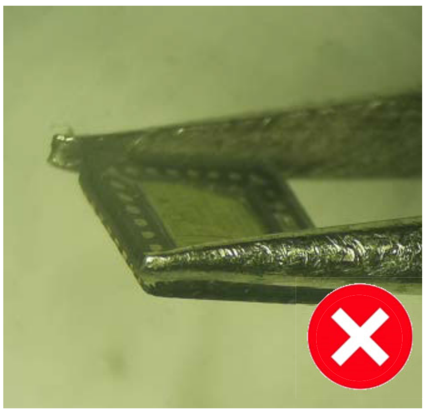
1. The following figure shows the side view of the encoder. It can be split into two zones: the clear compound and the molded lead frame (MLF).

2. Hold the encoder on the MLF side surface, or on both the MLF and clear compound side surfaces.
3. The following figures illustrate the *correct* position to use when handling the encoder. The tweezers are holding the MLF side surface and then both the MLF and the clear compound side surfaces. Use these positions when handling the encoder.


4. Do not hold the encoder by only the clear compound top surface, or by only the clear compound side surfaces.
5. The following figures illustrate *incorrect* positions to use when handling the encoder. The tweezers are holding the top surface of the clear compound and then the clear compound side surfaces only. Do ***not*** use these positions when handling the encoder.

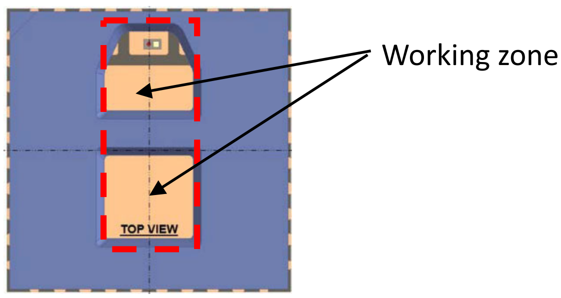




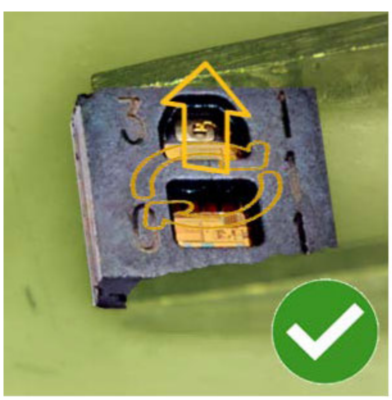
Dust and Contaminant Exposure and Sticky Surface Handling Procedures

Follow these procedures for the care and handling of the encoder.

1. Do not expose the encoder to dust and debris.



2. Do not damage or scratch the encoder.
3. Use an air-blower to blow out the dust.
4. Excessive dust and debris on the working zone can cause a drastic decrease in the performance of the encoder.
5. In the event that the surface of encoder requires cleaning, use a soft, lint-free swab and lab-grade isopropyl alcohol. Gently wipe away the contaminants. Do not press the top surface of the encoder.
6. The encoder should not come into contact with tape or sticky surfaces, regardless of whether the contact happens to the clear compound surface or the solder pad surface.
7. In the event that the encoder must be removed from a sticky surface, use the following procedure:
   a. Use tweezers to hold on the MLF side surfaces.
   b. *Do not* pull or lift the encoder vertically.
   c. Carefully rotate the encoder left and right (clockwise and counterclockwise) to break the bond between the encoder and the sticky surface before lifting up the encoder.

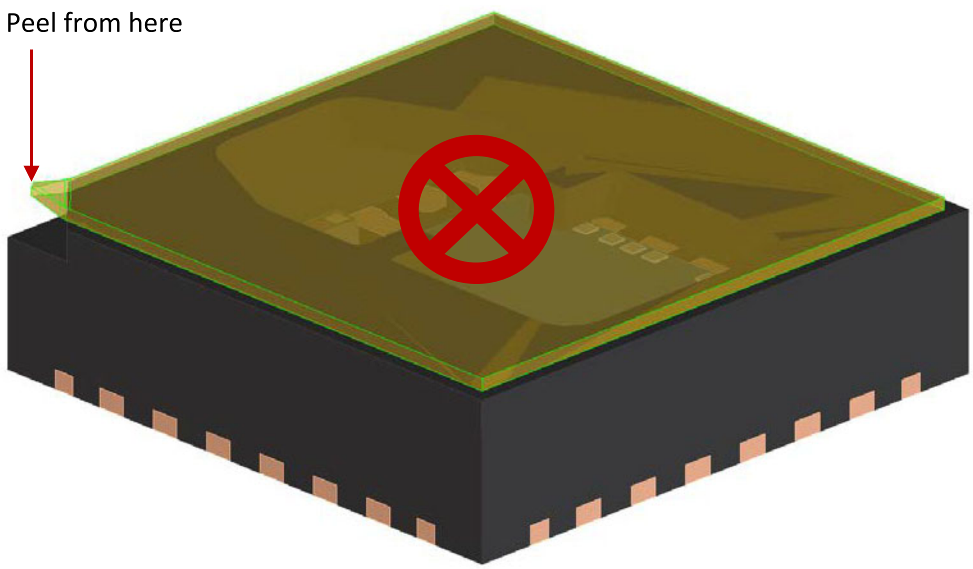


Kapton Tape Removal

The encoder has protective tape to prevent contamination. Remove the tape at the location, away from the ASIC slot, as shown in the following figure, to prevent scratches to the ASIC after the SMT reflow processes.

Do not remove the Kapton tape from the location marked with an X in the following figure.

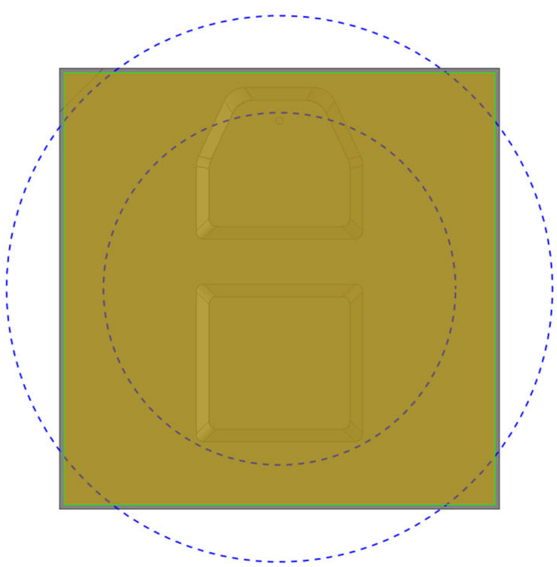
Do not press on the area marked with X in the following figure.

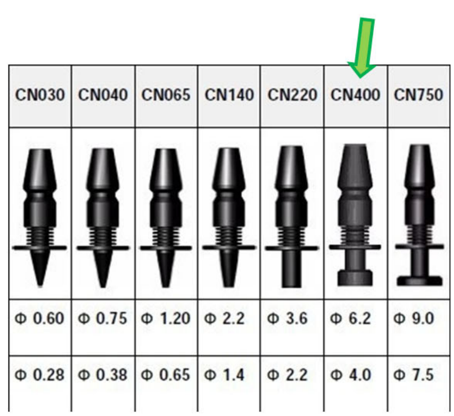


SMT Nozzle

Nozzle CN220 - Size (Inner Diameter: 4.0 mm; Outer Diameter: 6.2 mm) was used in the PCBA evaluation kit.

NOTE: This nozzle type serves as an example; each SMT house has its own controls and process capabilities.





Select Options – AEDR-9930E2/E2L Built-in Interpolation

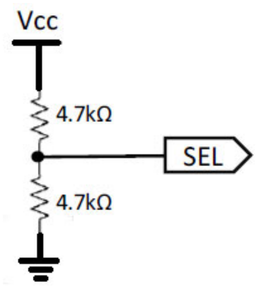
No.	SEL1	SEL2	SEL3	Interpolation Factor	IND SEL	Index
1	Low	Low	Low	1X	Low	Interpolation 1X - Index Gated 90°
					High	Interpolation 1X - Index Gated 180°
					Open	Interpolation 1X - Index Raw (Ungated)
2	High	Low	Low	2X	Low	Interpolation 2X - Index Gated 90°
					High	Interpolation 2X - Index Gated 180°
					Open	Interpolation 2X - Index Gated 360°
3	Open	Low	Low	3X	Low	Interpolation 3X - Index Gated 90°
					High	Interpolation 3X - Index Gated 180°
					Open	Interpolation 3X - Index Gated 360°
4	Low	High	Low	4X	Low	Interpolation 4X - Index Gated 90°
					High	Interpolation 4X - Index Gated 180°
					Open	Interpolation 4X - Index Gated 360°
5	High	High	Low	5X	Low	Interpolation 5X - Index Gated 90°
					High	Interpolation 5X - Index Gated 180°
					Open	Interpolation 5X - Index Gated 360°
6	Open	High	Low	6X	Low	Interpolation 6X - Index Gated 90°
					High	Interpolation 6X - Index Gated 180°
					Open	Interpolation 6X - Index Gated 360°
7	Low	Open	Low	7X	Low	Interpolation 7X - Index Gated 90°
					High	Interpolation 7X - Index Gated 180°
					Open	Interpolation 7X - Index Gated 360°
8	High	Open	Low	8X	Low	Interpolation 8X - Index Gated 90°
					High	Interpolation 8X - Index Gated 180°
					Open	Interpolation 8X - Index Gated 360°
9	Open	Open	Low	9X	Low	Interpolation 9X - Index Gated 90°
					High	Interpolation 9X - Index Gated 180°
					Open	Interpolation 9X - Index Gated 360°
10	Low	Low	High	10X	Low	Interpolation 10X - Index Gated 90°
					High	Interpolation 10X - Index Gated 180°
					Open	Interpolation 10X - Index Gated 360°
11	High	Low	High	12X	Low	Interpolation 12X - Index Gated 90°
					High	Interpolation 12X - Index Gated 180°
					Open	Interpolation 12X - Index Gated 360°
12	Open	Low	High	14X	Low	Interpolation 14X - Index Gated 90°
					High	Interpolation 14X - Index Gated 180°
					Open	Interpolation 14X - Index Gated 360°
13	Low	High	High	15X	Low	Analog SIN/COS (500 mVpp), Digital Index (Ungated)
					High	Analog SIN/COS (1 Vpp), Digital Index (Ungated)
					Open	Analog SIN/COS (1 Vpp), Analog Index

No.	SEL1	SEL2	SEL3	Interpolation Factor	IND SEL	Index
14	High	High	High	16X	Low	Interpolation 16X - Index Gated 90°
					High	Interpolation 16X - Index Gated 180°
					Open	Interpolation 16X - Index Gated 360°
15	Open	High	High	18X	Low	Interpolation 18X - Index Gated 90°
					High	Interpolation 18X - Index Gated 180°
					Open	Interpolation 18X - Index Gated 360°
16	Low	Open	High	20X	Low	Interpolation 20X - Index Gated 90°
					High	Interpolation 20X - Index Gated 180°
					Open	Interpolation 20X - Index Gated 360°
17	High	Open	High	25X	Low	Interpolation 25X - Index Gated 90°
					High	Interpolation 25X - Index Gated 180°
					Open	Interpolation 25X - Index Gated 360°
18	Open	Open	High	32X	Low	Interpolation 32X - Index Gated 90°
					High	Interpolation 32X - Index Gated 180°
					Open	Interpolation 32X - Index Gated 360°
19	Low	Low	Open	50X	Low	Interpolation 50X - Index Gated 90°
					High	Interpolation 50X - Index Gated 180°
					Open	Interpolation 50X - Index Gated 360°
20	High	Low	Open	64X	Low	Interpolation 64X - Index Gated 90°
					High	Interpolation 64X - Index Gated 180°
					Open	Interpolation 64X - Index Gated 360°
21	Open	Low	Open	80X	Low	Interpolation 80X - Index Gated 90°
					High	Interpolation 80X - Index Gated 180°
					Open	Interpolation 80X - Index Gated 360°
22	Low	High	Open	100X	Low	Interpolation 100X - Index Gated 90°
					High	Interpolation 100X - Index Gated 180°
					Open	Interpolation 100X - Index Gated 360°
23	High	High	Open	128X	Low	Interpolation 128X - Index Gated 90°
					High	Interpolation 128X - Index Gated 180°
					Open	Interpolation 128X - Index Gated 360°
24	Open	High	Open	160X	Low	Interpolation 160X - Index Gated 90°
					High	Interpolation 160X - Index Gated 180°
					Open	Interpolation 160X - Index Gated 360°
25	Low	Open	Open	256X	Low	Interpolation 256X - Index Gated 90°
					High	Interpolation 256X - Index Gated 180°
					Open	Interpolation 256X - Index Gated 360°
26	High	Open	Open	512X	Low	Interpolation 512X - Index Gated 90°
					High	Interpolation 512X - Index Gated 180°
					Open	Interpolation 512X - Index Gated 360°
27	Open	Open	Open	SPI Mode	Low	SPI Mode: Program Selection
					High	SPI Mode: Output Enabled

NOTE:

1. An open selection must be connected to the middle of a voltage divider circuit as shown in Figure 3.
2. Factory default = 512x ABI output; SPI Mode Output = AB interpolation.
3. Factory default = 90°e output; SPI Mode Output = Index width.
4. SPI Mode = Enable SPI communication.

Figure 3: Example of Voltage Divider Circuit



The digital interpolation factor above is used with the following equations to cater to various rotational speed (RPM) and count per revolution (CPR).

RPM = (Count Frequency × 60) / CPR

The CPR (at 1X interpolation) is based on the following equation, which is dependent on radius of operation (R_{OP}).

CPR = LPI × 2π × R_{OP} (in.) or CPR = LPmm × 2π × R_{OP} (mm)

NOTE: LPmm = LPI / 25.4

Autocalibration Process

The AEDR-9930E2L has a built-in autocalibration algorithm that can be triggered by moving the encoder from an off-scale condition to an on-scale condition. Alternatively, use a paper and place it in front of the encoder to start the autocalibration process. The purpose of the calibration process is to align the center of the Index signal to the center of the Channel B signal. The misalignment of the Index signal is due to potential spatial misalignment of the encoder to the code strip after assembly.

Perform the autocalibration process even if the A, B, and I signals appear normal at the first power-on after the encoder assembly. The autocalibration process helps to optimize the internal encoder ASIC settings, which enhances reliability and performance.

AEDR-9930E2L autocalibration steps are as follows:

1. Ensure the encoder is NOT positioned over the code strip (off-scale) or the window bar pattern. Power on the encoder. Alternatively, place a piece of opaque (not transparent) material in front of encoder and then remove it.
2. Move the code strip so it is positioned over the encoder and within the specified spatial tolerance (on-scale).
3. Move code strip back and forth over the encoder. Monitor the calibration status by observing the CAL_Stat signal or Ch A+/Ch B+.
4. Move the code strip continuously for at least 5 seconds to 10 seconds; the total time is dependent on both the speed of movement and the counts of the index pattern crossing the ASIC encoder. The Ch B+ state will change to high if the autocalibration process is successful. The states of both Ch A+ and Ch B+ will change to high if the autocalibration process is unsuccessful. If autocalibration is unsuccessful, verify the gap between the encoder and the code strip is correct, and repeat steps 1 through 4 as needed.
5. Perform a power cycle and the encoder ASIC will function as normal.
6. After calibration is completed, a power cycle is required for the new encoder settings to be effective.

AEDR-9930E2L autocalibration steps by pin trigger for linear encoder devices are as follows:

1. Ensure the code strip is positioned within the specified tolerance.
2. Power on the encoder and tie Pin17 to high.
3. Move the code strip back and forth over the encoder. Monitor the calibration status by observing the CAL_Stat signal or Ch A+/Ch B+.
4. Move the code strip continuously for least 5 seconds to 10 seconds; the total time is dependent on both the speed of movement and the counts of the index pattern crossing the ASIC encoder. The Ch B+ state will change to high if the autocalibration process is successful. The states of both Ch A+ and Ch B+ will change to high if the autocalibration process is unsuccessful. If autocalibration is unsuccessful, verify the gap between encoder to code strip is correct, and repeat steps 1 to 4 as needed.
5. Perform power cycle and the encoder ASIC will function as normal.
6. After calibration is completed, a power cycle is required for the new encoder settings to be effective.

AEDR-9930E2 autocalibration steps by pin trigger for rotary encoder devices are as follows:

1. Spin the motor at a rotation speed between 500 rpm to 1500 rpm.
2. Short the CAL pad to VDDA or VDD line. Use a high-value resistor such as 4.7 kΩ or 5.6 kΩ to do the shorting.
3. Turn on the power to the encoder. This will trigger the ASIC to start the autocalibration process.

4. Wait for at least 5 seconds. The Ch B+ state will change to high if the autocalibration is successful. Both the Ch A+ state and Ch B+ state will change to high if the autocalibration process is unsuccessful. If autocalibration is unsuccessful, check the spatial alignment between the encoder ASIC (PCB) and the code wheel and repeat step 1 to 4.
5. Remove the short between CAL (pin 17) to VDDA or VDD. Perform a power cycle, and the encoder ASIC will function as normal.

Table 3: Encoder Signal Status When Autocalibrating

Pad	CAL (Pin 17)	A+	B+	I+	Status
Pad State	H	L	L	L	Autocalibrating
	H	H	L	L	Incremental autocalibration complete
	H	L	H	L	Incremental and index autocalibration complete
	H	H	H	L	Autocalibration error

Table 4: Encoder Status Pad State When Autocalibrating

Pad	Op_Stat	CAL_Stat	ERR_Stat	Status
Pad State	L	Pulsing (500 ms)	L	Autocalibrating
	L	H	L	Autocalibration complete
	L	L	L	Autocalibration incomplete or error

NOTE:

1. The status pin is serves as an output signal and is NOT intended to drive or sink current.
2. The ABI signal state when LED_ERROR triggered (Off-scale/No Window Bar) is as follows:

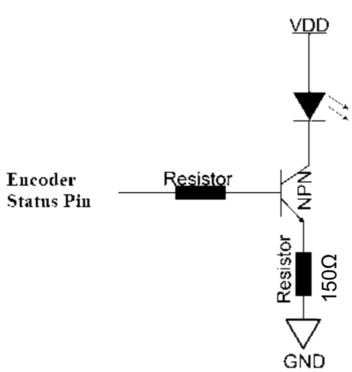
I/O	A+	A-	B+	B-	I+	I-
Pad State	H	L	H	L	L	H

Table 5: Status Pin States (LED Indicators)

Pin	Power-Up from t = 0	Encoder Ready	Autocalibrating	Autocalibration Done	Autocalibration Error	LED_ERROR[a]	LED_ERROR[b]
Op_Stat	L	H	L	L	L	L	L
Cal_Stat	L	L	Pulsing (500 ms)	H	L	L	L
Err_Stat	L	L	L	L	L	H	Pulsing (500 ms)

a. No pulsing signal indicates a maximum LED current state (Off-scale/No Window Bar).
b. Early warning on high LED current but signal is normal.

Figure 4: Status Pin Diagram



NOTE:

1. H = High (VDD)
2. L = Low (GND)

Programmable Select Options

The AEDR-9930E2/E2L digital encoder is programmable via the SPI with an interpolation factor from 1x to 1024x.

1. Configure the external selection to SPI Mode: Program Selection.
2. For signals output after configuration, set the external selection to SPI Mode: Output Enabled.

SPI Communication Pinout (for Interpolation and Index Width Selection)

Table 6: Encoder Calibration Pinout

Pin	Name	Function
7	SPI DOUT	SPI Data Output
2	SPI DIN	SPI Data Input
6	SPI CLK	SPI Clock

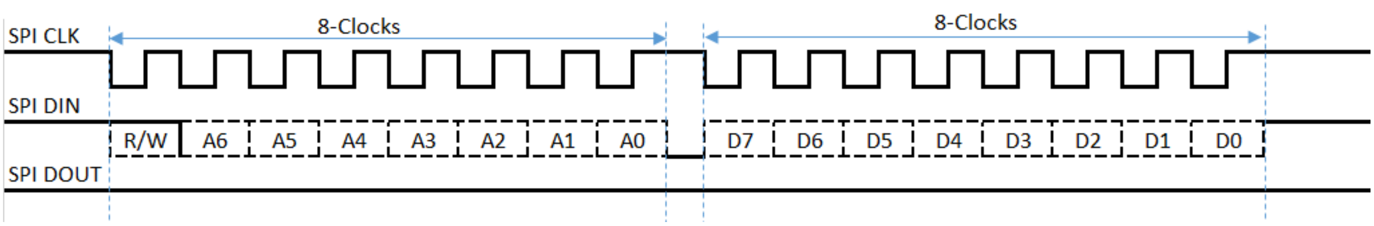
SPI Read and Write Timing Diagram (Maximum Clock Frequency 1 MHz)

Table 7: SPI Read and Write Memory Map

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Read	0	Address[6:0]							Data[7:0]							
Write	1	Address[6:0]							Data[7:0]							

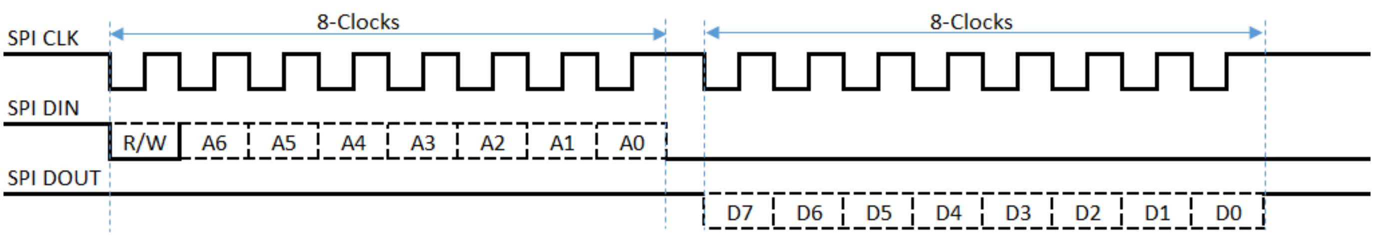
SPI Write: <Write Command = 1><7bits address><8bits data>

Figure 5: SPI Write Timing Diagram



SPI Read: <Read Command = 0><7bits address>

Figure 6: SPI Read Timing Diagram



Unlock Sequence

1. Write to SPI Address 0x10 with value AB (Hex) to unlock Level 1.
2. Write to SPI Address 0x14 with value 00 (Hex) to go to Page 0.

   When using the AEDR-99xx_Gateway.exe program to change the interpolation factor of the ASIC, the unlock sequence is automatically performed by the program.

Interpolation Settings and Programming

1. Write to SPI Address 0x0B and 0x0C with the value shown in the following tables.
2. After finalizing the CPR settings, write to SPI Address 0x11 (Hex) with a value A1 (Hex) before proceeding to program the AEDR-9930E2/E2L.

Interpolation Factor, Index (90e°, 180e°, and 360e°) Settings and Programming

1. Write to SPI Address 0x0B and 0x0C with value shown in the following tables.
2. After finalizing the INT settings, write to SPI Address 0x11 (Hex) with value A1 (Hex) to program the AEDR-9930E2/E2L.

Table 8: Interpolation Factor and Index Select Register Information

<table>
<tr><th>Byte Address</th><th rowspan="2">Page</th><th colspan="8">Bit</th><th rowspan="2">Note</th></tr>
<tr><th>[Hex]</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0x0B</td><td rowspan="2"></td><td></td><td></td><td colspan="2">Index[1:0]</td><td></td><td colspan="3">INT[10:8]</td><td rowspan="2">INT: 0-1024</td></tr>
<tr><td>0x0C</td><td colspan="8">INT[7:0]</td></tr>
</table>

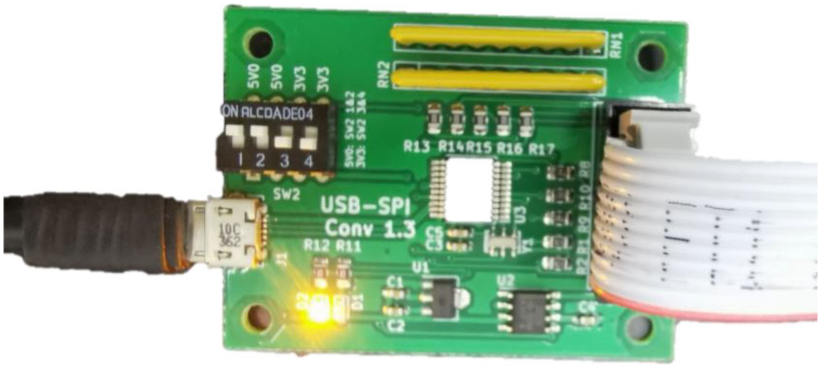
Interpolation Index, 90e°	0x0B (Hex)	0x0C (Hex)
1x	00	01
2x	00	02
.	.	.
.	.	.
10x	00	0A
11x	00	0B
.	.	.
.	.	.
256x	01	00
.	.	.
.	.	.
512x	02	00
.	.	.
.	.	.
1024x	04	00

Interpolation Index, 180e°	0x0B (Hex)	0x0C (Hex)
1x	10	01
2x	10	02
.	.	.
.	.	.
10x	10	0A
11x	10	0B
.	.	.
.	.	.
256x	11	00
.	.	.
.	.	.
512x	12	00
.	.	.
.	.	.
1024x	14	00

Interpolation Index, 360e°	0x0B (Hex)	0x0C (Hex)
1x	30	01
2x	30	02
.	.	.
.	.	.
10x	30	0A
11x	30	0B
.	.	.
.	.	.
256x	31	00
.	.	.
.	.	.
512x	32	00
.	.	.
.	.	.
1024x	34	00

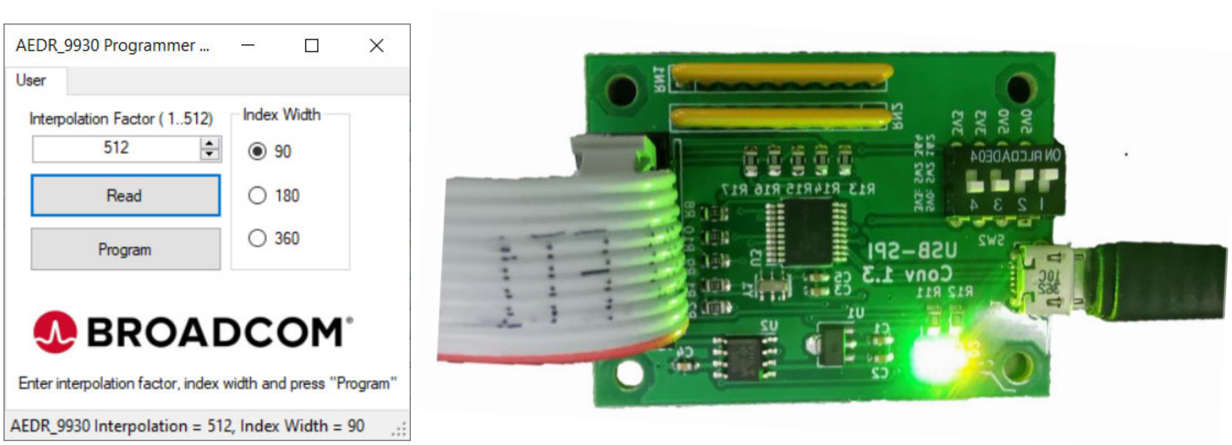
HEDR-9930EPRGEVB SPI Programmer Kit

Figure 7: HEDS-9930(E2/E2L)PRGEVB USB-SPI Programming Kit



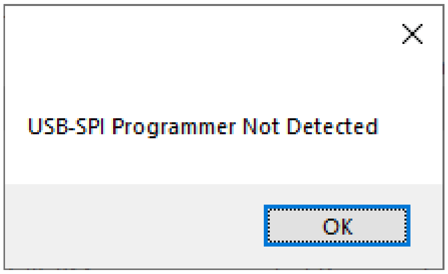
1. Download and unzip the files to local drive.
   a. Download the executable and supporting files driver from the following URL: https://broadcom.box.com/v/AEDR-9930-Programming-Software
   b. Unzip the files. Look for the folder AR3_AEDR9930_Gateway.exe and other files.
   c. Once the files are unzipped, copy the whole folder into local drive.
   d. Plug in the USB-SPI calibration kit. Connect one side into the PC's USB port, and the other side to the AEDR-9930E2/E2L device.
   e. The amber LED will light up once the USB cable is plugged into the PC's USB port.
2. Run the AEDR-9930_Gateway.exe file. The USB-SPI board and the AEDR-9930E2/E2L board with device under test should be detected immediately. The green LED will light up.

Figure 8: HEDS-9930(E2/E2L)PRGEVB USB-SPI Programming Kit Detected by the AEDR-9930_Gateway.exe Program



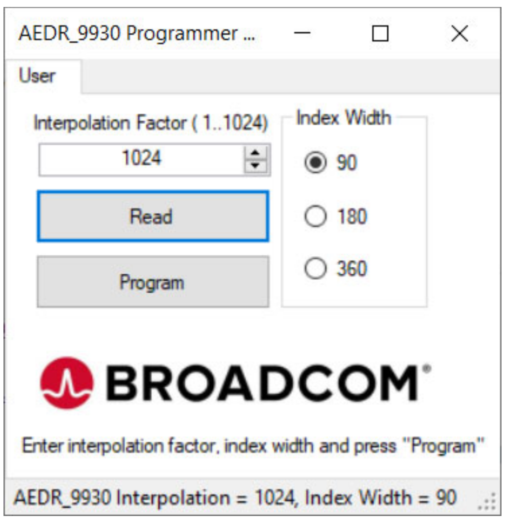
a. If the following message appears, recheck the board connection. Quit the program and run again.

Figure 9: HEDS-9930(E2/E2L)PRGEVB USB-SPI Programming Error Message



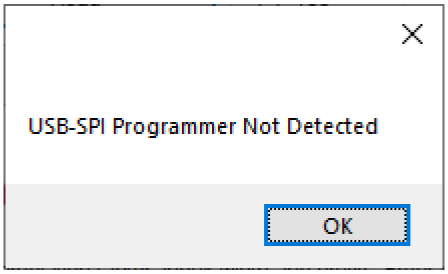
3. Click **Read** to read back the existing settings from AEDR-9930E2/E2L.
   – If the read operation is successful, it will be display the stored setting in the AEDR-9930E2/E2L as shown in Figure 10.

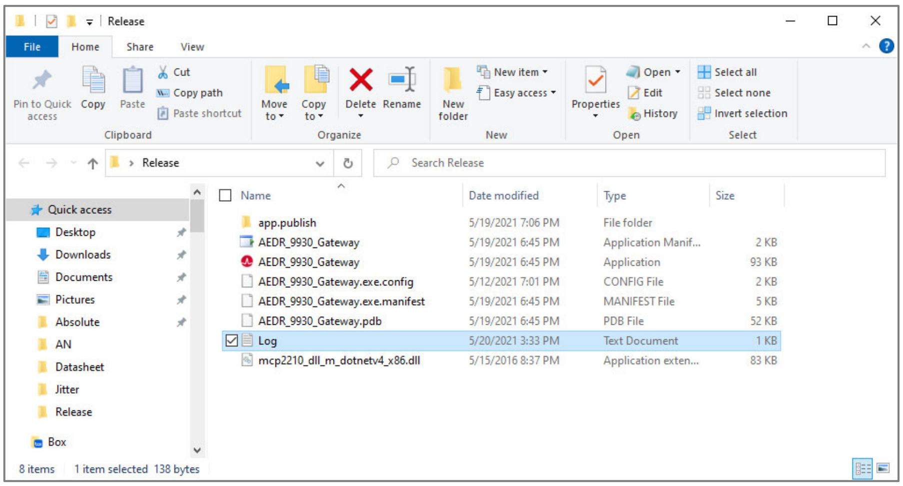
Figure 10: HEDS-9930(E2/E2L)PRGEVB USB-SPI Programming User Interface Kit

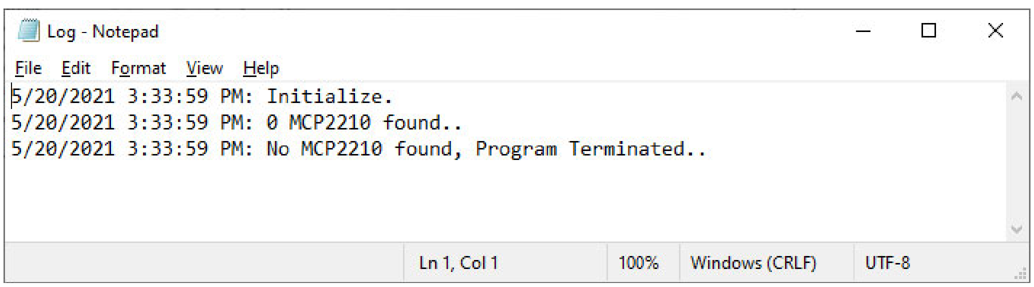


– If the AEDR-9930E2/E2L is not detected or if there is connection error, an SPI communication error message will appear.
– Please refer to the log.txt file which is found in the same folder as the AEDR-9930E2/E2L programmer file. Use the log.txt file to check the failure status, as shown in Figure 11.

Figure 11: HEDS-9930(E2/E2L)PRGEVB USB-SPI Program SPI Error Message and Sample of log.txt File Content

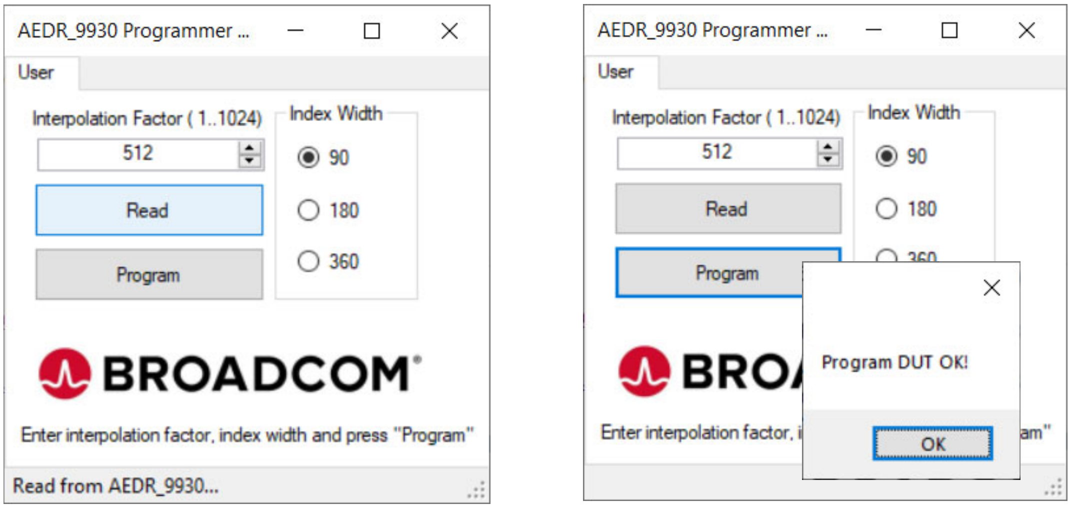






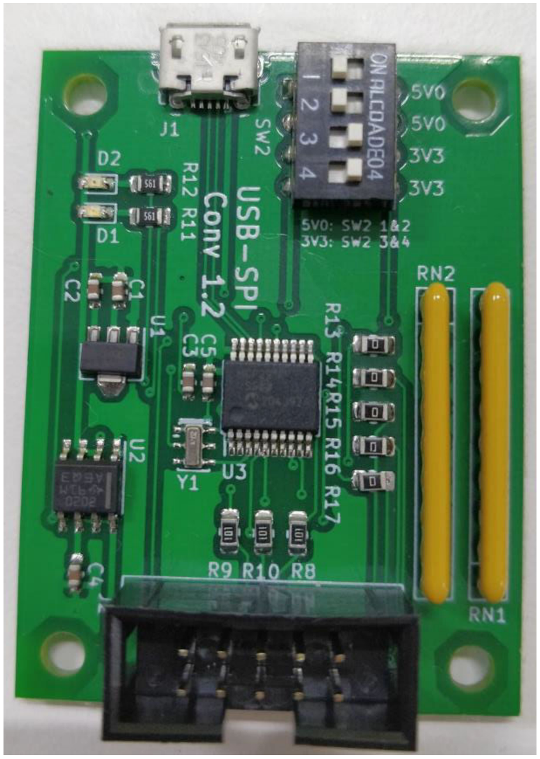
4. Enter the interpolation factor needed (1 to 1024) and Index width and press **Program** to save the settings into AEDR-9930E2/E2L.
   – If there is communication failure with AEDR-9930E2/E2L, please refer to log.txt file to check the cause.

Figure 12: Reference HEDS-9930(E2/E2L)PRGEVB Sample User Interface Program Values



HEDS-9930(E2/E2L)PRGEVB SPI Programmer Kit Pinout

Figure 13: HEDS-9930(E2/E2L)PRGEVB USB-SPI Programming Kit



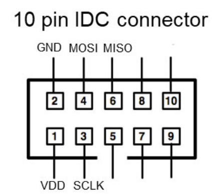


Figure 14: HEDS-9930(E2/E2L)EVB Evaluation Board

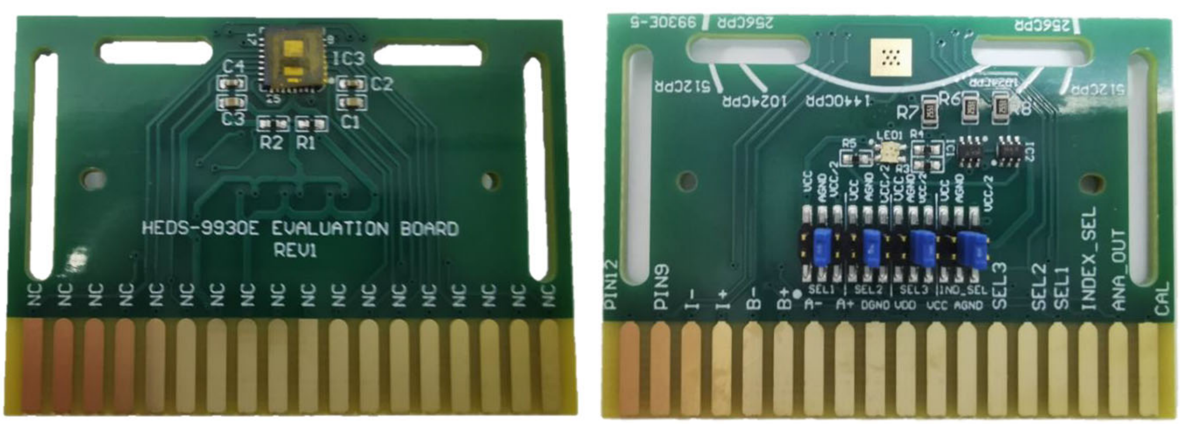
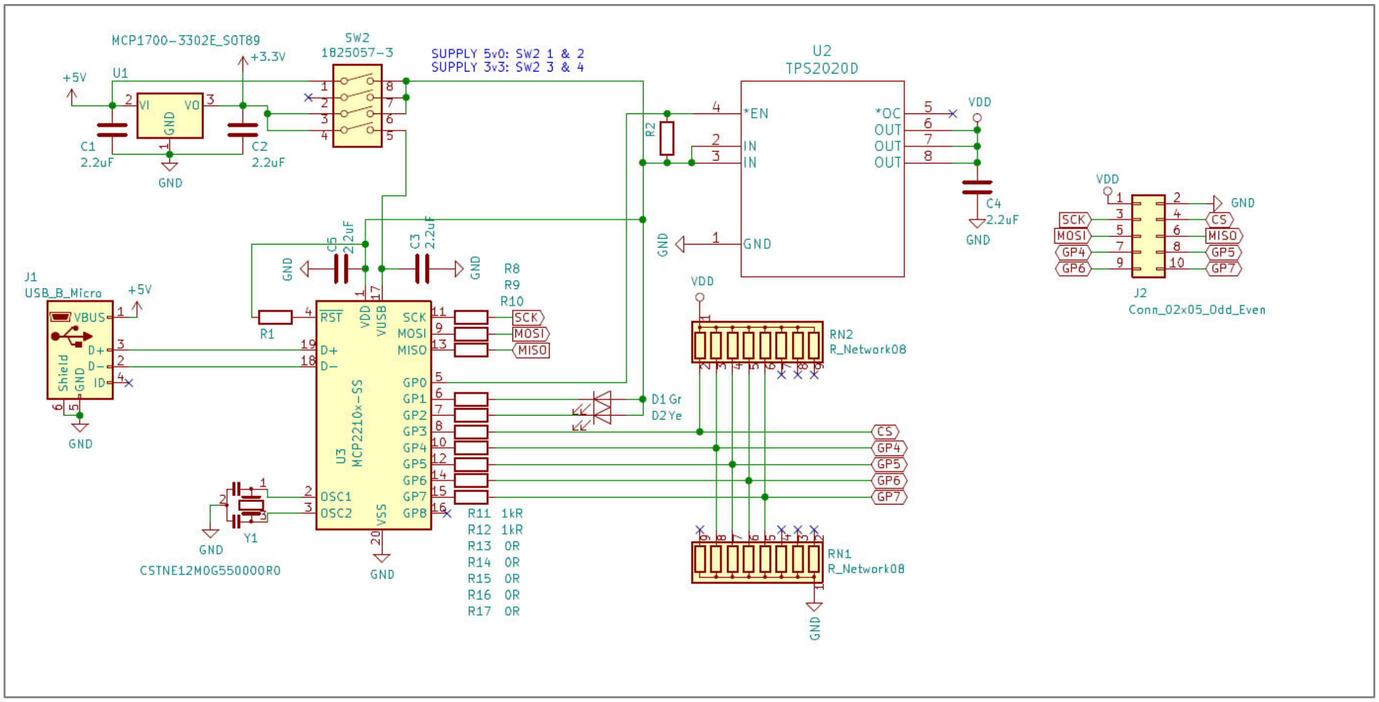
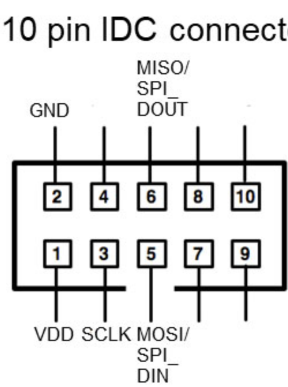


Figure 15: Reference Design for Calibration HEDS-9930(E2/E2L)PRGEVB Schematic and IDC 10 Pin Assignment





HEDS-9930(E2/E2L)EVB Evaluation Board with Reference Physical Alignment Guide Lines

1. Place the mounting plate on the motor base.
2. Place the set height jig on the motor base.
3. Install the code wheel hub assembly into the motor shaft with the aid of the set height jig between the motor base and the hub's bottom surface. Secure the hub with an M3x3 set screw. Use a 0.15-Nm tightening torque.
4. Use the guide pins to position the PCBA on the mounting plate guided by guide pins. Use the guide lines printed on the code wheel hub assembly to align the code wheel.
5. Secure the device in position with mounting screws. Use M2x6 cap screws and apply a 0.15-Nm tightening torque.

Figure 16: AEDR-9930E2 Evaluation Board Mounting Concept

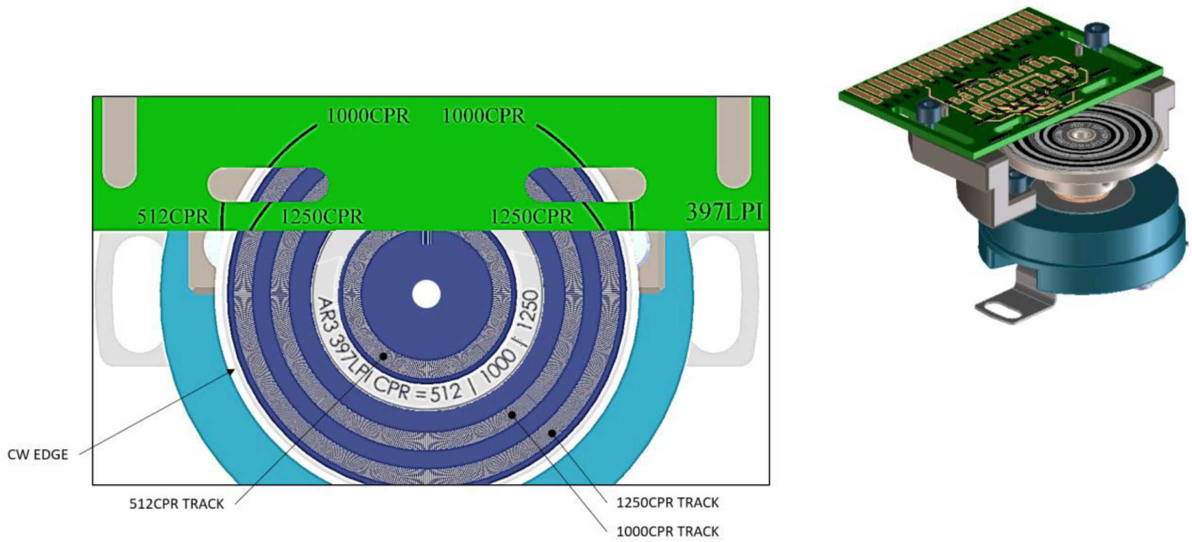
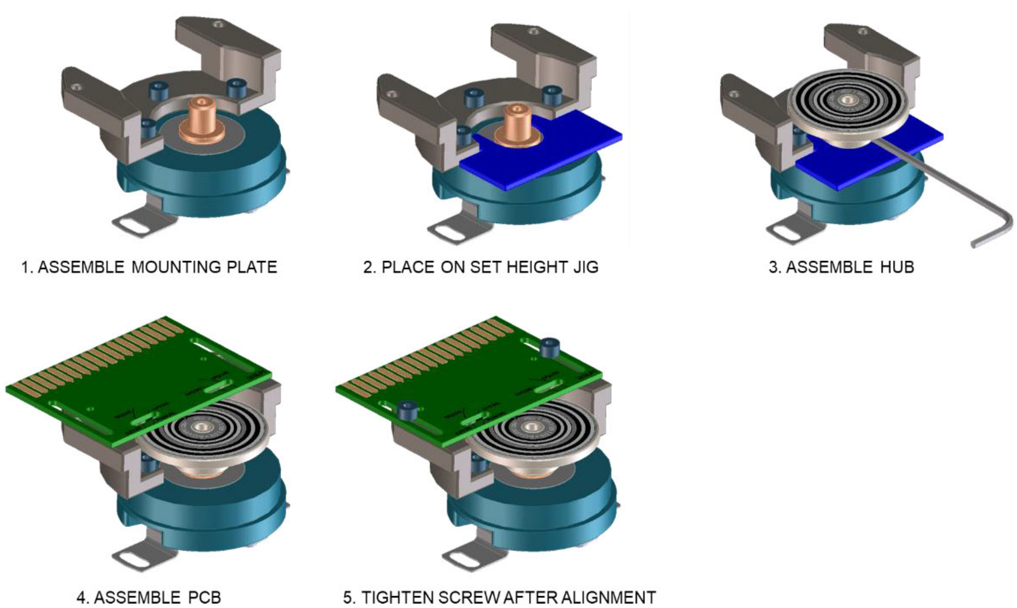


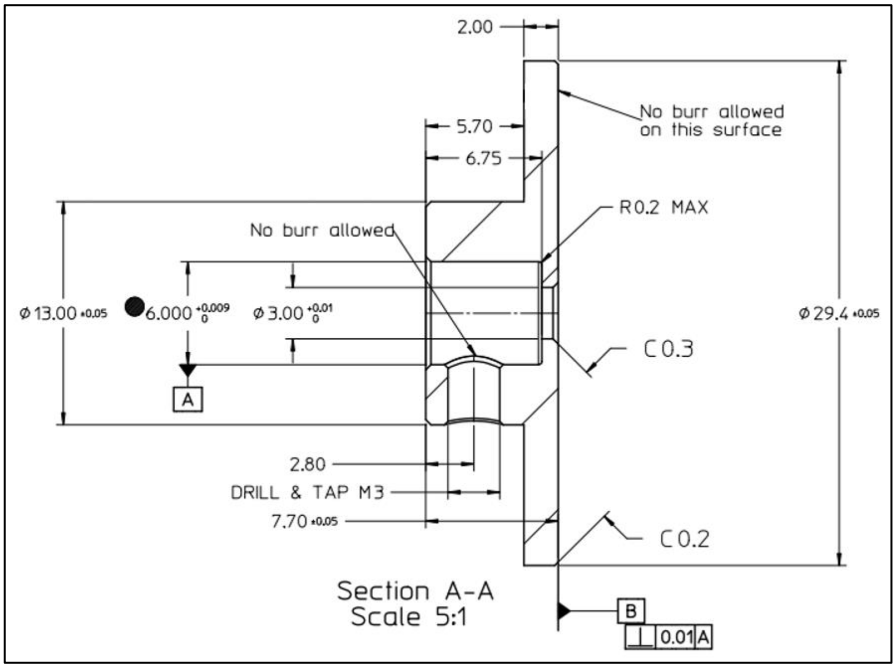
Figure 17: Reference Evaluation Board Sample Mounting Bracket and Bearing Stage



Hub Design Concept

The hub design concept for multiple track CW is shown in the following figure.

Figure 18: Reference Hub Concept



Jig Design Concept

The jig design is based on AEDR-9930E2/E2L with a 6 mm shaft mounting. Contact your Broadcom representative for jig design details.

Figure 19: Reference Mounting Jig Drawing

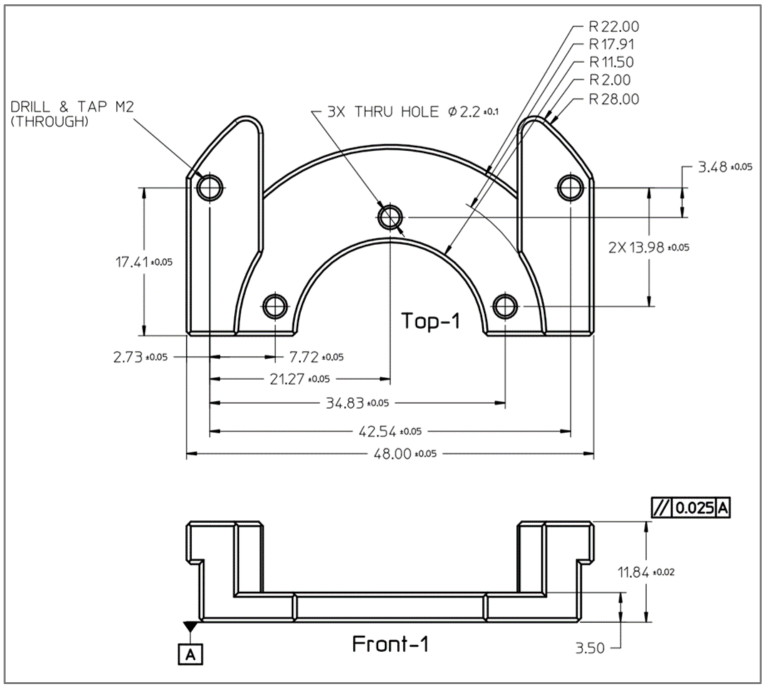
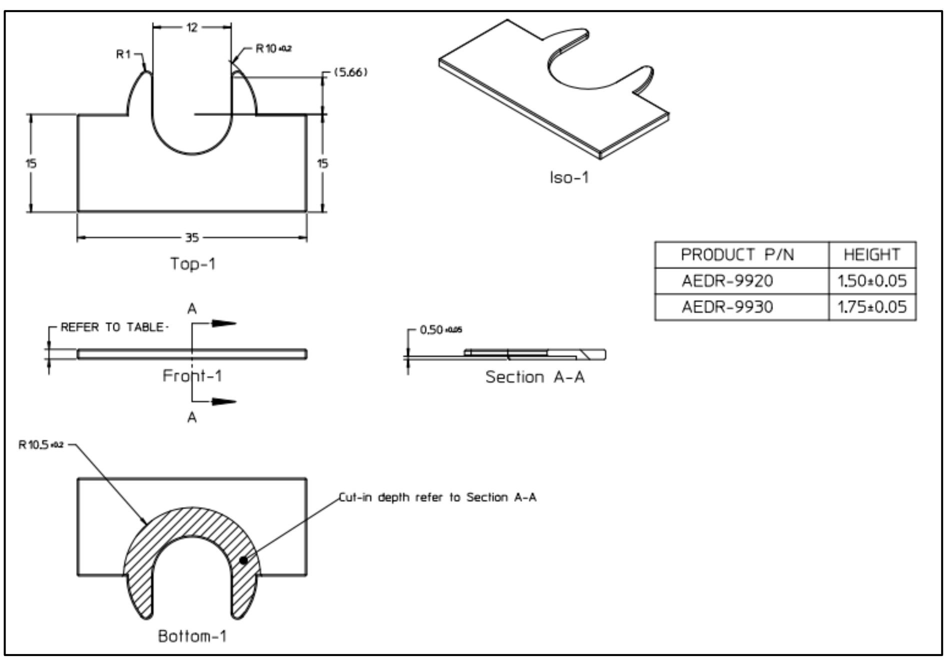


Figure 20: Reference Height Jig Drawing



Mounting Requirement

The mounting requirements ensure the encoder is set in the optimal position for encoder performance. Overall mounting requirements are applicable for:

1. AEDR-9930E2/E2L encoder to code wheel operational gap (Z-height).
2. Code wheel placement.

Figure 21: Mounting Requirement

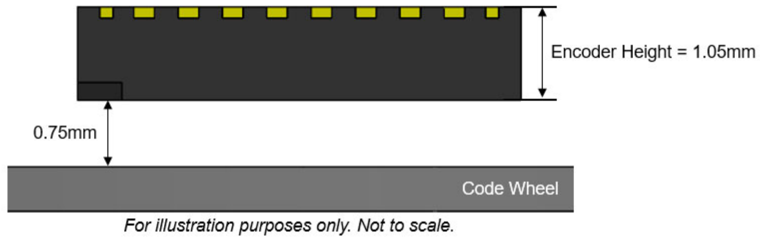
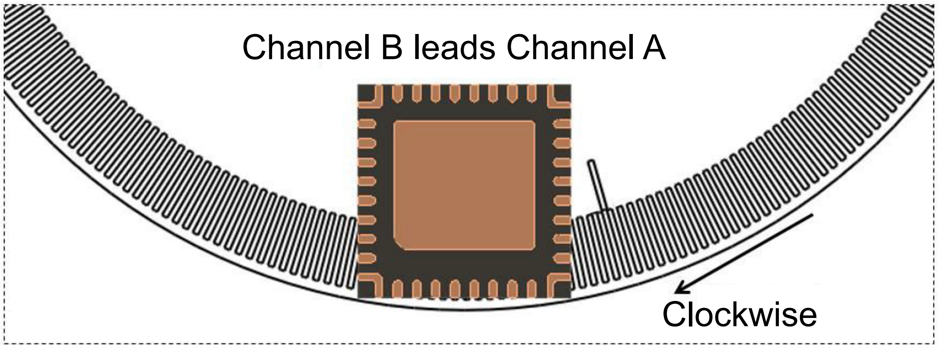
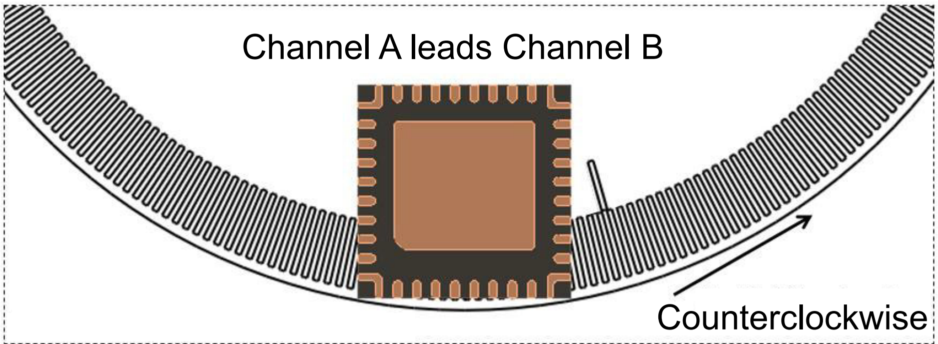
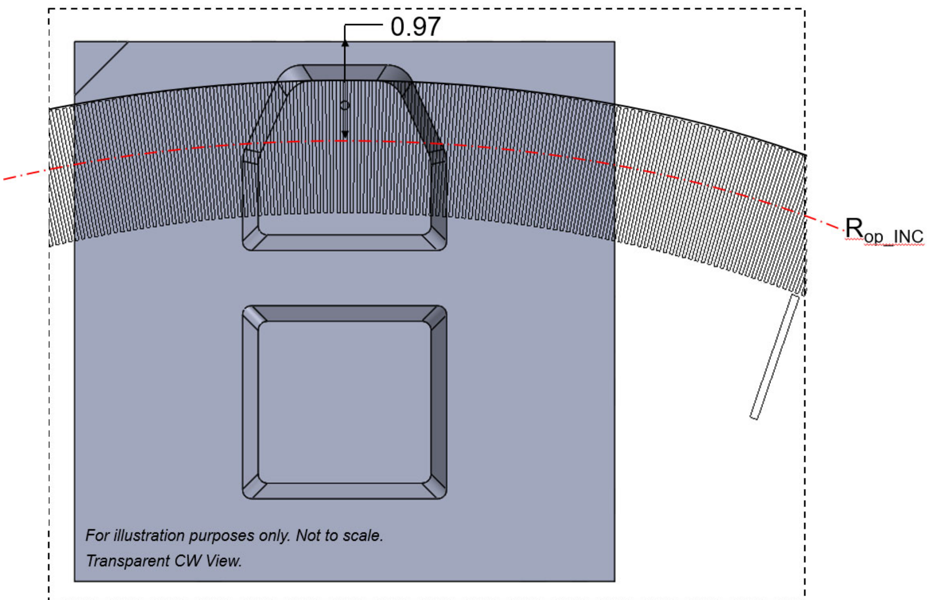


Figure 22: Channel A and Channel B Signal Orientation vs. Mounting Position



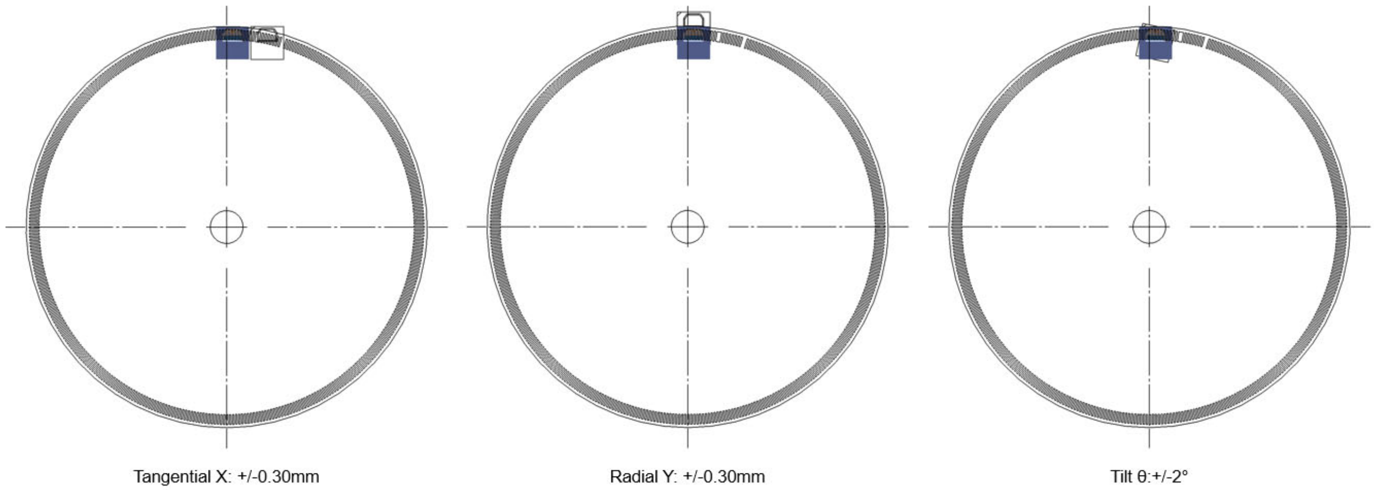




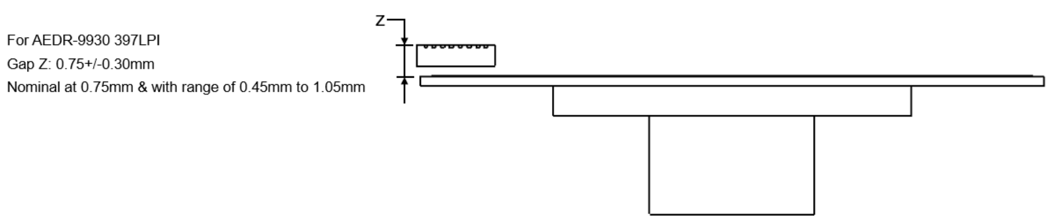
NOTE: Drawings are for illustrations purposes only and are not to scale.

Spatial Tolerances: AEDR-9930E2

Figure 23: AEDR-9930 Spatial Tolerances



Tangential Misalignment	E_T	—	—	±0.5	mm	
Radial Misalignment (R_{OP} Dependent)	E_R	—	—	±0.3	mm	Based on R_{OP} 5.21 mm 512 CPR = ±0.30 mm 256 CPR = ±0.20 mm 1000 CPR = ±0.50 mm
Code Wheel Gap	G	0.45	0.75	1.05	mm	For ≥512 CPR



NOTE:

1. Assemble the encoder in a clean room with conditions of Class 100k or better.
2. Place the encoder inside an IP50-rated enclosure.
3. The encoder is supplied with protective tape to prevent contamination. Remove the tape only after the surface-mount solder reflow process is complete.

Recommended Shaft Tolerance

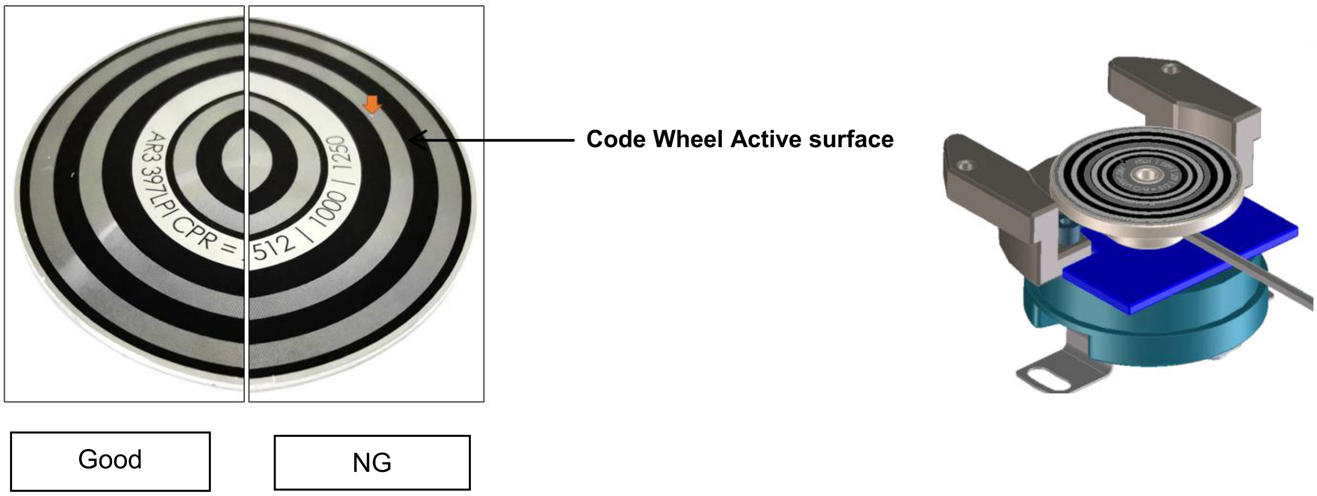
Table 9: Shaft Tolerance

Hub ID (mm)	Hole Tolerance			Set Screw SIze	Shaft OD (mm)	Shaft Tolerance		
	Lower	Upper	Hole Basis			Lower	Upper	Shaft Basis
6	0	0.008	H6	M3	6	–0.004	–0.009	g5
8	0	0.009	H6	M3	8	–0.005	–0.011	g5

Code Wheel Handling

1. Wear finger colts to prevent touching the code wheel's active area (pattern print).
2. Only use lint-free delicate task wipes with isopropyl alcohol to wipe the code wheel. Do not use a cotton bud or a cloth that is not lint-free, as these materials will contaminate the code wheel.

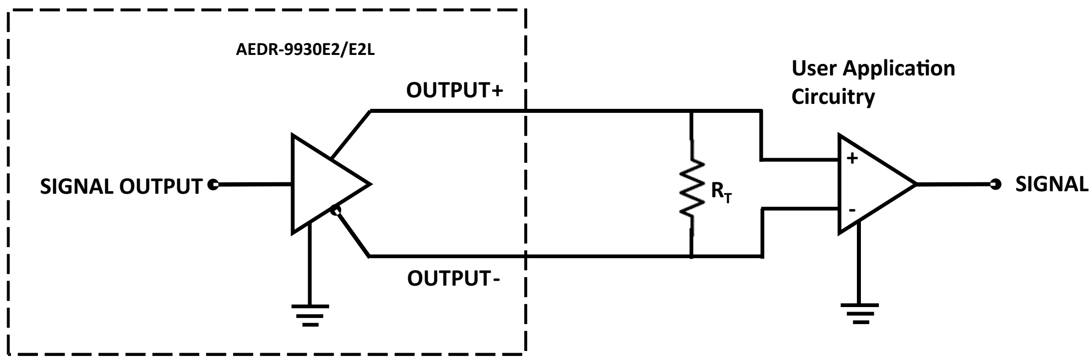
Figure 24: Code Wheel Handling



Recommended Electrical Interface

1. Use a power supply with the following characteristics:
   – A 5.0V supply with a V_{CC} within the range of 4.5V to 5.5V.
   – A 3.3V supply with a V_{CC} within the range of 3.0V to 3.6V.
2. For best noise immunity, use twisted-pair shielded cable to connect to the servo driver.
3. In order to prevent undesirable signal reflection, terminate with a suitably valued resistor.

Figure 25: Differential I/O Connection

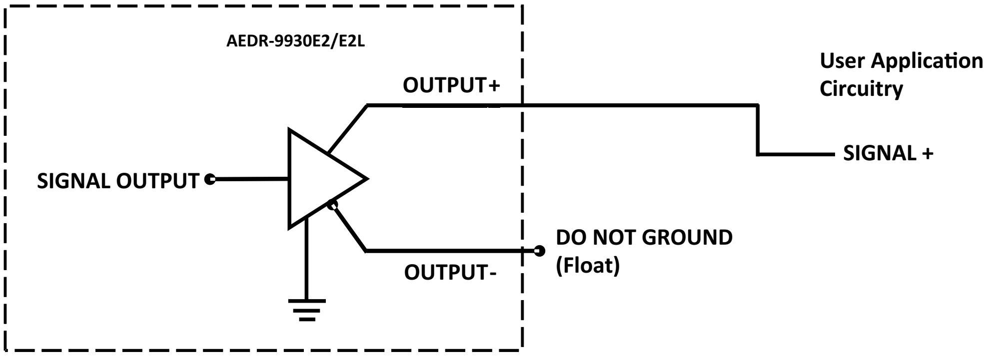


Use a Broadcom AEIC-7272-S16 Quad Differential Line Receiver or a compatible line receiver. Ground the unused pin for noise reduction. Use shielded cable for better noise immunity.

NOTE:

1. Output+ represents the A+, B+, or I+ digital output from the encoder.
2. Output– represents the A–, B–, or I- digital output from the encoder.
3. A Load resistance *R_T (1000Ω, typical) is recommended to reduce reflection.
4. The differential I/O connection is only applicable for digital output.
5. If a single-ended connection is used, leave CH A–, CH B–, and CH I- floating.

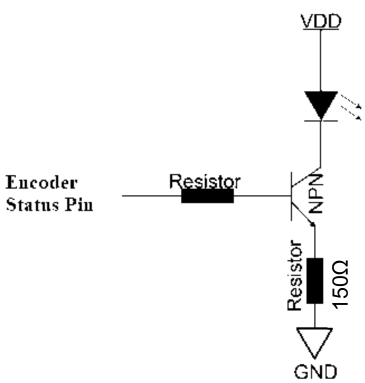
Single-Ended I/O Connection



NOTE:

1. Output+ represents the A+, B+, or I+ digital output from the encoder.
2. Output– represents the A–, B–, or I- digital output from the encoder.
3. Do not ground the Output– from the encoder. Allow the output to float.

LED, Cal, and Normal Status I/O Connection



NOTE:

1. The status pin is serves as an output signal and is NOT intended to drive or sink current.
2. The ABI signal state when LED_ERROR triggered (Off-scale/No Window Bar).