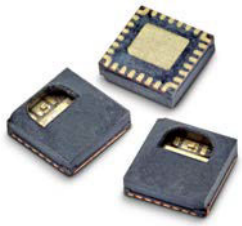
Application Note

AEDR-9920

3-Channel Reflective Digital Incremental Encoders



Introduction

The Broadcom® AEDR-9920 is a three-channel reflective optical encoder. It is configured to digital outputs employing reflective technology for motion control purposes. The selectable options available are with different interpolation three-channel digital differential A, B, and gated I outputs.

The AEDR-9920 digital encoder offers two-channel (AB) quadrature digital outputs and a third channel digital index output. 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 AEDR-9920 encoder is designed to operate over –40°C to 125°C temperature range and is suitable for commercial, industrial, and automotive end applications.

Applications

- Closed-loop stepper motor
- Small motors, actuator
- Industrial printer
- Robotic
- Card reader
- Pan-tilt-zoom (PTZ) camera
- Portable medical equipment
- Optometric equipment
- Linear stage

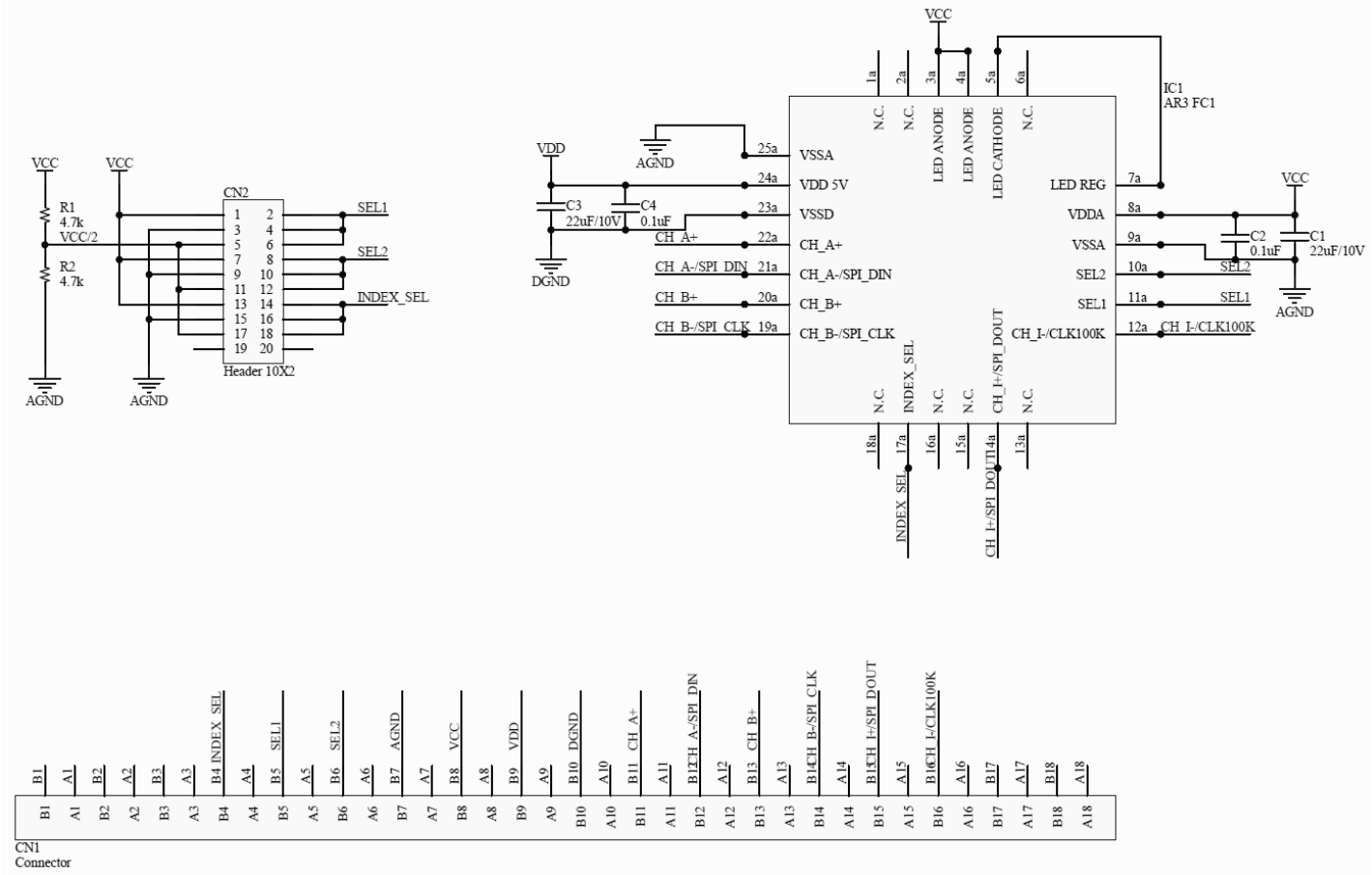
Related Part Ordering Information

Ordering Information	Type
AEDR-9920-100	AEDR-9920, 225 LPI Incremental Encoder, 1000 pieces
AEDR-9920-102	AEDR-9920, 225 LPI Incremental Encoder, 100 pieces
HEDS-9920EVB	AEDR-9920 Evaluation Board 225 LPI Evaluation Board and Code Wheel

Reference Schematic Design

Figure 1 shows an example of the schematic diagram used in the evaluation PCB example shown later in this application note.

Figure 1: Reference Schematic Diagram for AEDR-9920

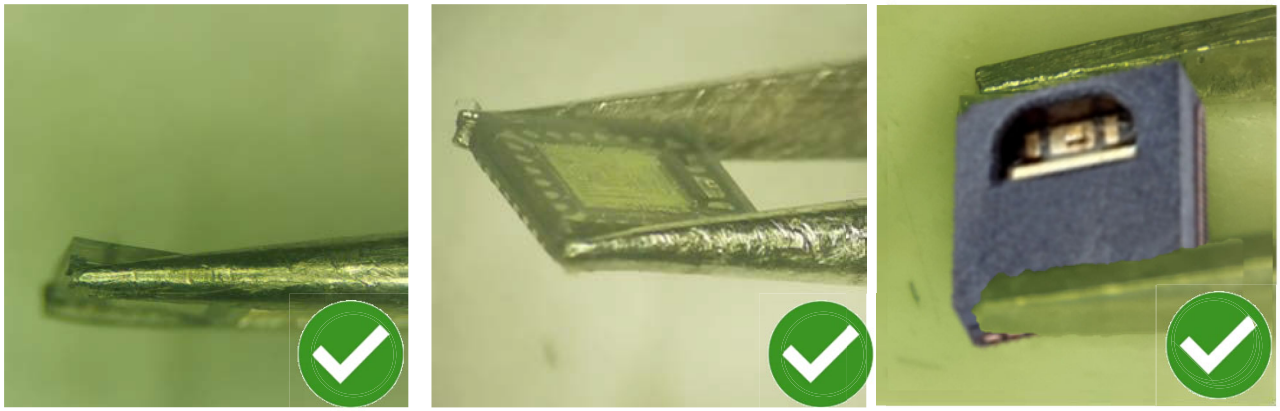


Handling with Tweezers

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.

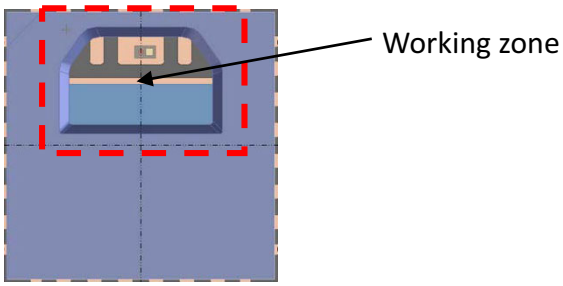


4. Do not hold the encoder by only the clear compound top surface, or by only the clear compound side surfaces.
5. The following figures illustrate *incorrect* positions to use when handling the encoder. The tweezers are holding the top surface of the clear compound and then the clear compound side surfaces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

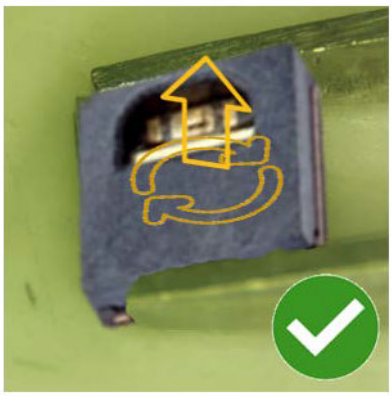
Dust and Contaminant Exposure and Sticky Surface Handling Procedures

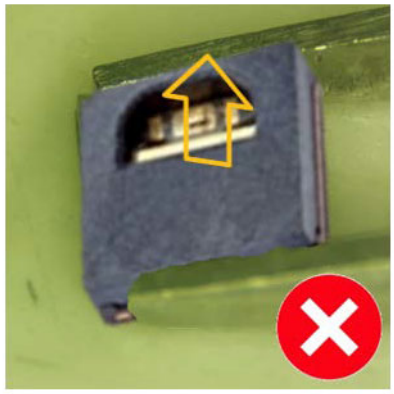
Follow these procedures for the care and handling of the encoder.

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.



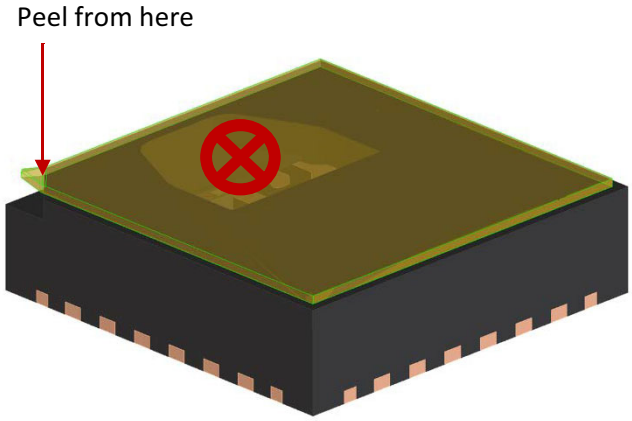


Kapton Tape Removal

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.

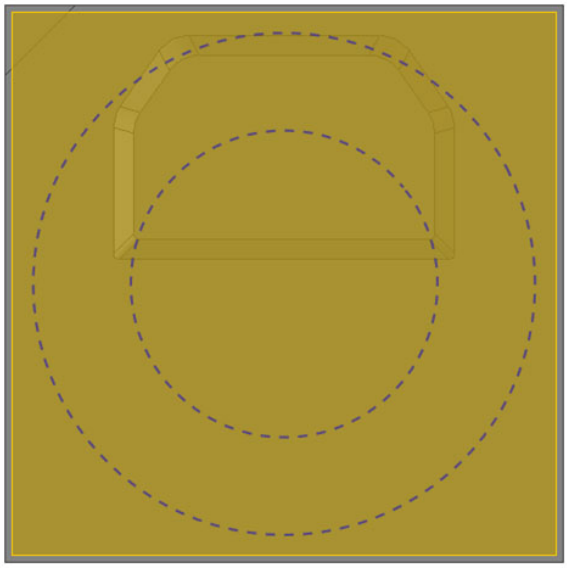
Do not press on the area marked with X in the following figure.

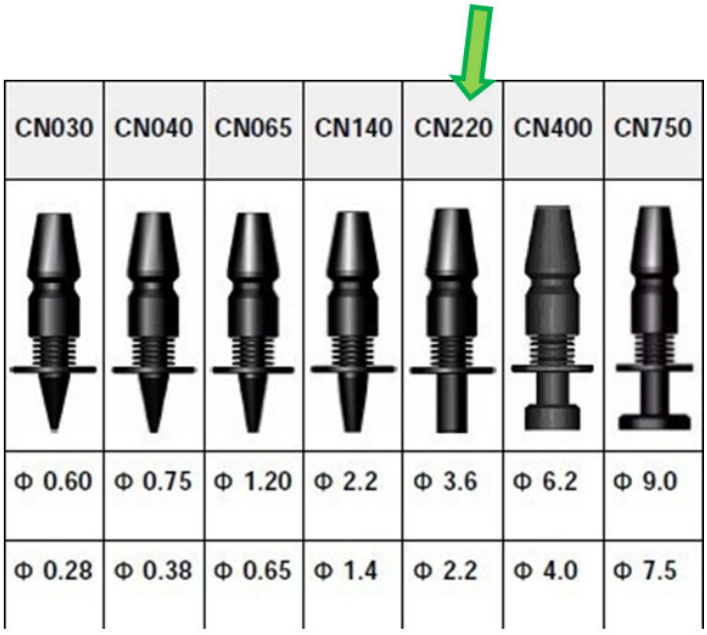


SMT Nozzle

Nozzle CN220 - Size (Inner Diameter: 2.2 mm; Outer Diameter: 3.6 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.



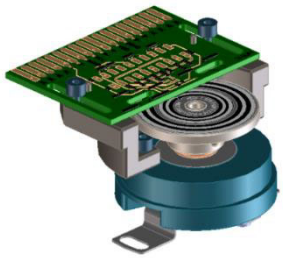


CN030	CN040	CN065	CN140	CN220	CN400	CN750
Φ 0.60	Φ 0.75	Φ 1.20	Φ 2.2	Φ 3.6	Φ 6.2	Φ 9.0
Φ 0.28	Φ 0.38	Φ 0.65	Φ 1.4	Φ 2.2	Φ 4.0	Φ 7.5

Select Options – AEDR-9920 Encoder Built-in Interpolation

SEL 1	SEL 2	IND SEL	Interpolation Factor	Index	Max Output Frequency	CPR at R_{OP} 11 mm
Open	Open	Low	1X	Gated 90°e	0.1 MHz	612
		High		Gated 180°e		
		Open		Ungated raw		
Open	Low	Low	2X	Gated 90°e	0.2 MHz	1224
		High		Gated 180°e		
		Open		Gated 360°e		
High	High	Low	4X	Gated 90°e	0.5 MHz	2448
		High		Gated 180°e		
		Open		Gated 360°e		
Low	Low	Low	8X	Gated 90°e	1.0 MHz	4896
		High		Gated 180°e		
		Open		Gated 360°e		
High	Low	Low	16X	Gated 90°e	2.0 MHz	9792
		High		Gated 180°e		
		Open		Gated 360°e		
Open	High	Low	32X	Gated 90°e	2.0 MHz	19584
		High		Gated 180°e		
		Open		Gated 360°e		
Low	High	Low	64X	Gated 90°e	2.0 MHz	39168
		High		Gated 180°e		
		Open		Gated 360°e		
High	Open	Low	128X	Gated 90°e	2.0 MHz	78336
		High		Gated 180°e		
		Open		Gated 360°e		
Low	Open	High	256X	Gated 90°e	2.0 MHz	156672
		N/A		N/A		

Evaluation Board with 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 bottom surface. Secure the hub with an M3x3 set screw. (The recommended tightening torque is 0.15 Nm for an M3x3 set screw.)
4. Position the PCBA on the mounting plate guided by the guide pins. Align to the code wheel by using the silk screen-printed guide lines to the code wheel hub assembly.
5. Secure the position with mounting screws. (The recommended tightening torque is 0.15 Nm for an M2x6 cap screw.)

Figure 2: Evaluation Board AEDR-9920 Mounting Concept

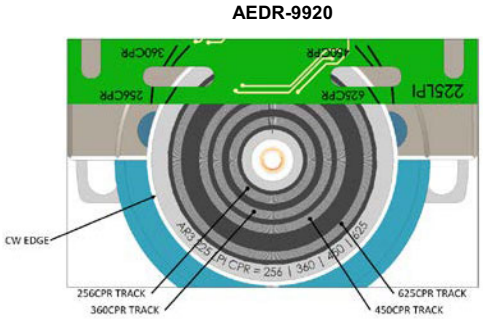
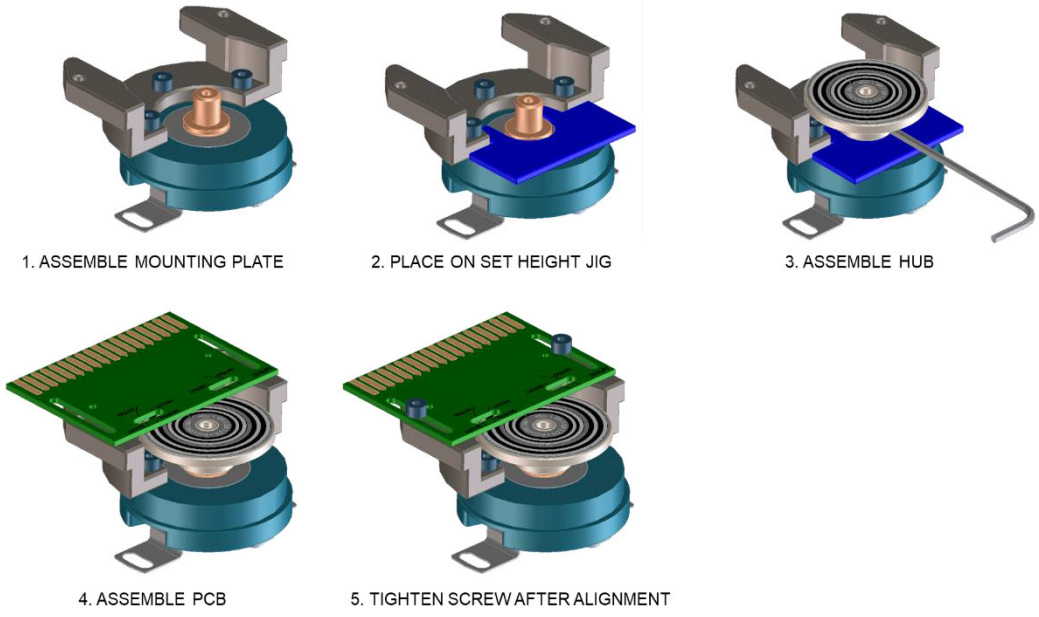


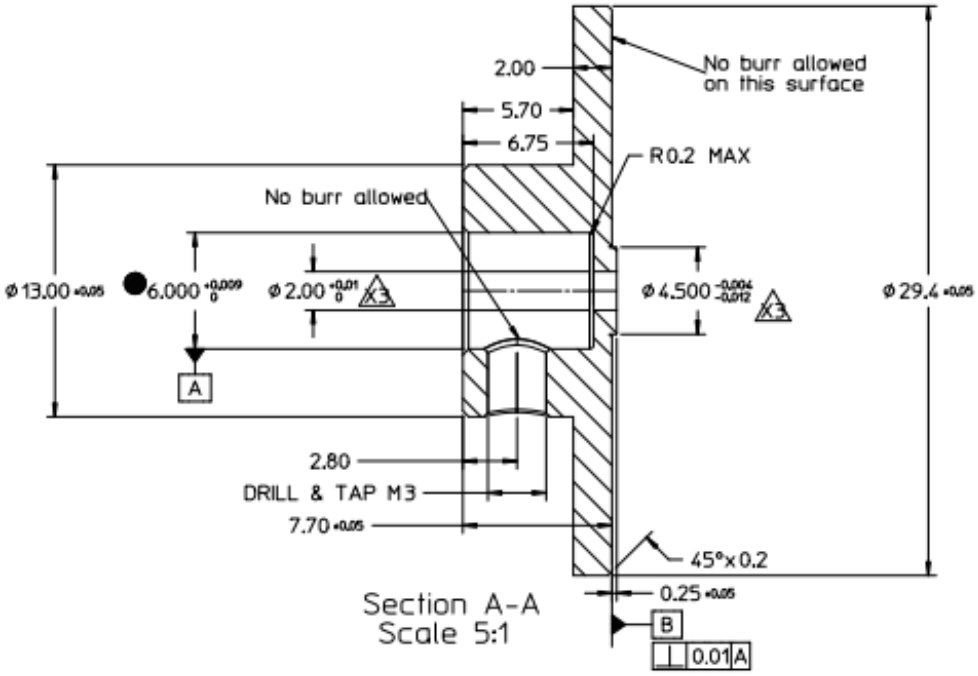
Figure 3: Evaluation Board Sample Mounting Bracket and Bearing Stage



Hub Design Concept

The hub design concept for multiple track CW is shown in Figure 4.

Figure 4: Hub Concept



Jig Design Concept

The jig design is based on the AEDR-9920 with 6-mm shaft mounting. Consult the factory for the jig design details.

Figure 5: Mounting Jig Drawing

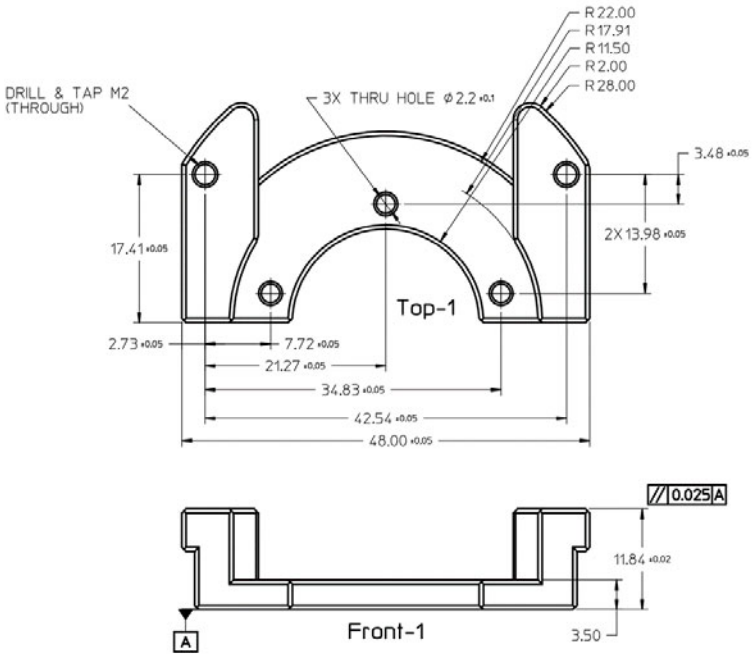
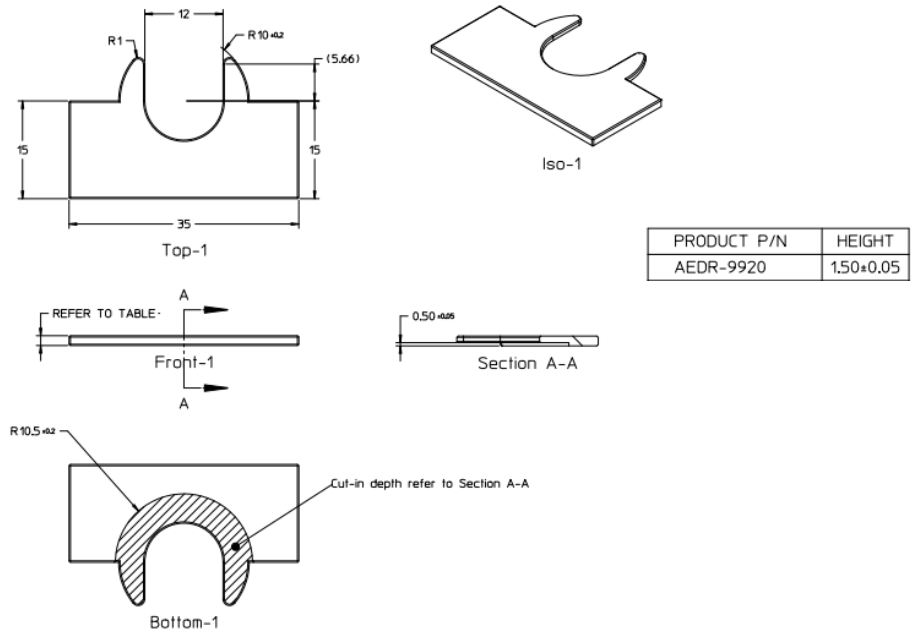


Figure 6: Height Jig Drawing



Mounting Requirement

The mounting requirement is shown in Figure 7 to set up the encoder to the optimum position for typical encoder performance. The overall mounting requirements applicable for the following:

- AEDR-9920 encoder to code wheel operational gap.
- Code wheel placement.

Figure 7: Mounting Requirement

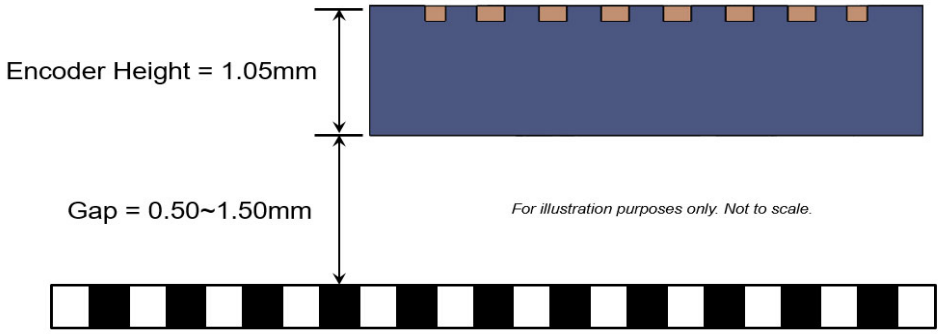
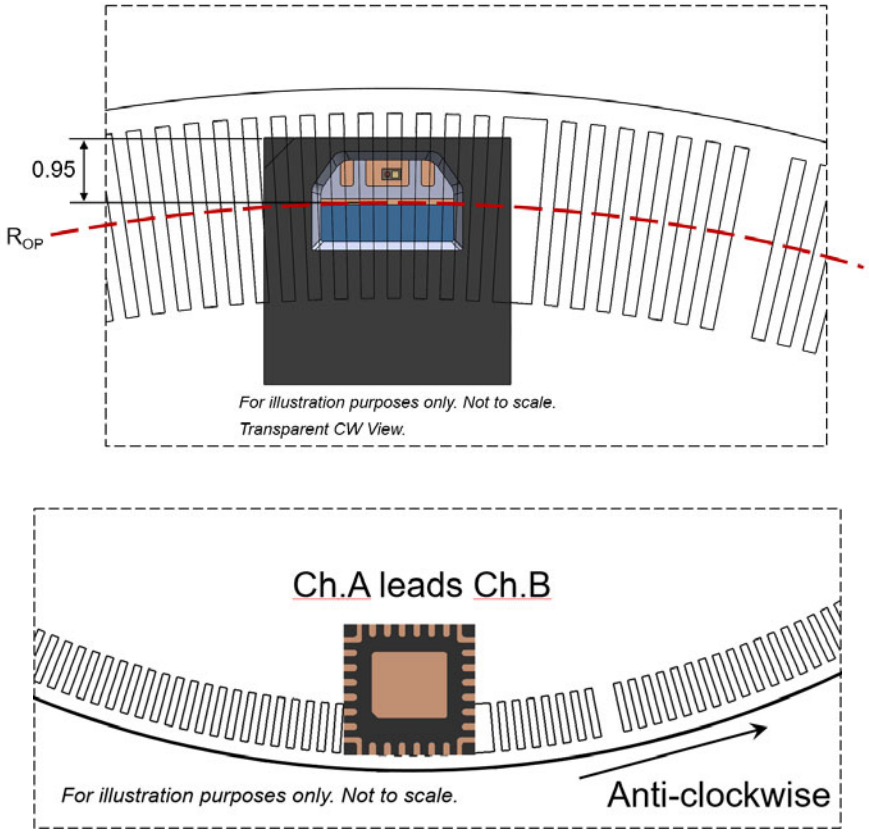
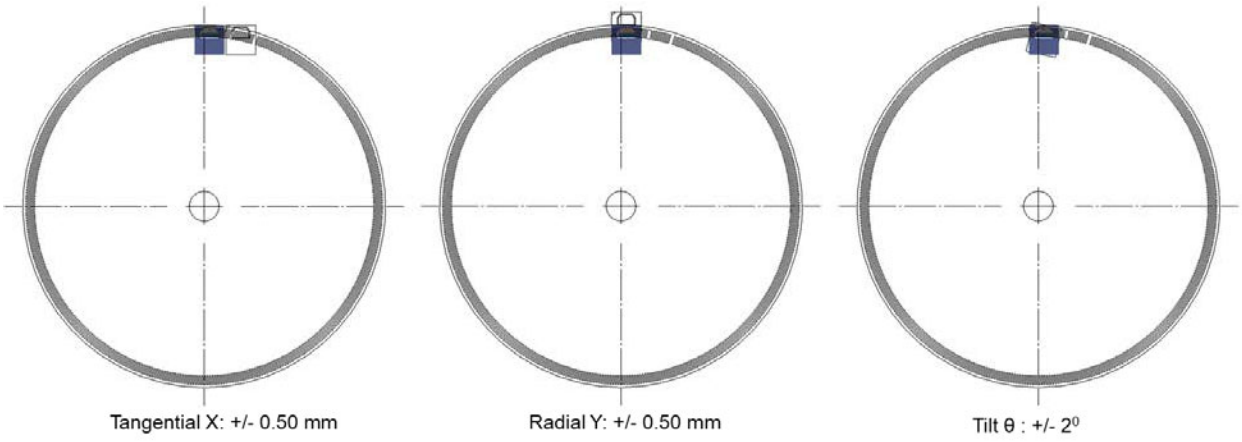


Figure 8: A and B Signal Orientation vs. Mounting Position

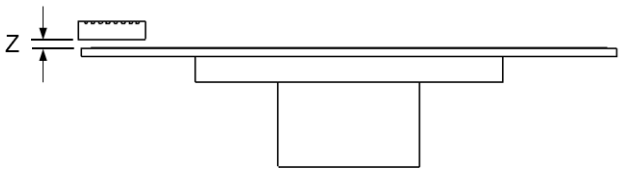


Spatial Tolerances

Figure 9: AEDR-9920 Spatial Tolerances



For AEDR-9920 225LPI
Gap Z: 1.0 +/- 0.5 mm
Nominal at 1.00 mm & with range of 0.50 mm to 1.50 mm



Notes on Assembly

1. The assembly of the encoder requires a clean room condition, Class 100k or better.
2. The encoder must be enclosed with an IP50-rated enclosure.
3. The encoder is supplied with protective tape to prevent contamination. Remove the tape only after the surface mount soldering reflow process.

Recommended Shaft Tolerance

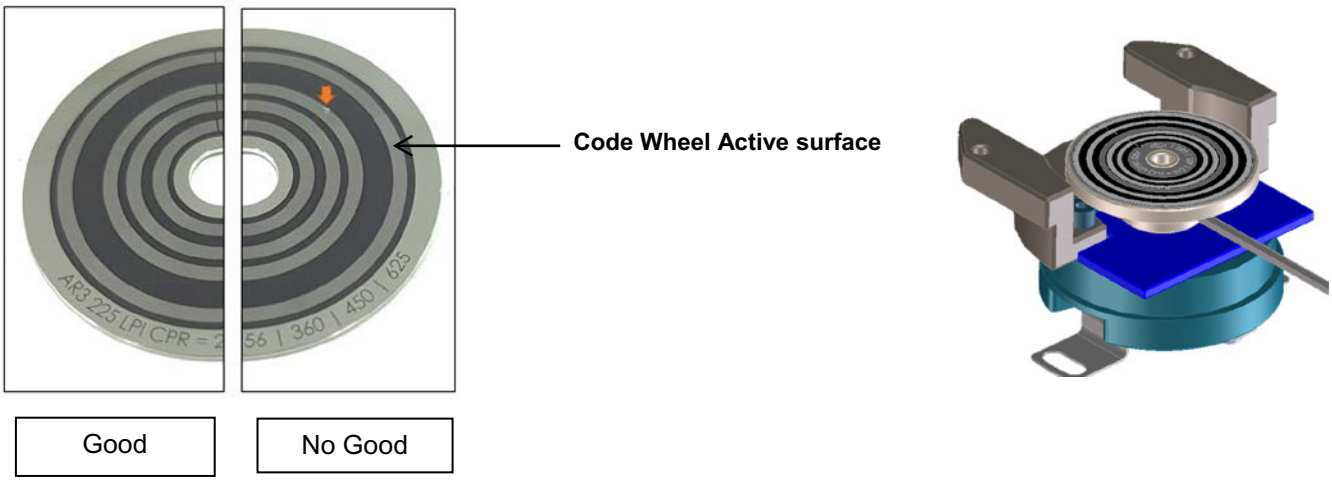
Table 1: Shaft Tolerance

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

- Prevent touching the code wheel ACTIVE AREA by wearing a finger cot.
- Use only delicate task wipers with IPA to wipe the code wheel. Do not use cotton buds (non-lint-free) because they will cause scratches and will contaminate the code wheel.

Figure 10: Code Wheel Handling



Recommended Electrical Interface

1. Provide the encoder power supply with the following values:
   – For the 5.0V supply, V_{CC} must be within the range of 4.5V ~ 5.5V.
   – For the 3.3V supply, V_{CC} must be within the range of 3.0V ~ 3.6V.
2. For best noise immunity, use a twisted-pair shielded cable for connection to the servo driver.
3. To prevent undesirable signal reflection, terminate with 1200Ω resistors.

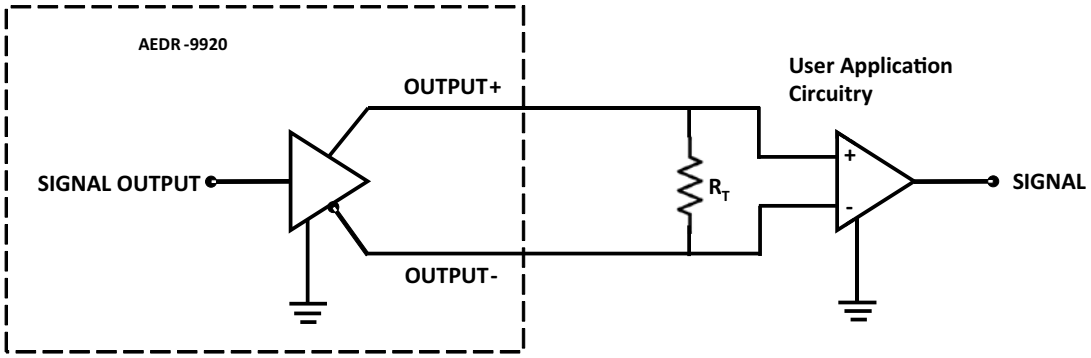
The following variations must be considered when the termination resistor is optimized:

- Cable length (impedance matching)
- PCB (impedance matching – low contribution, more on crosstalk)
- Cable type (twisted, non-twisted, parallel, non-shielded, shielded)
- Cable size, and so on

Differential I/O Connection

Use the Broadcom AEIC-7272-S16 quad differential line receiver or compatible as the line receiver. Ground unused pins for noise reduction. Use shielded cable for better noise immunity.

Figure 11: Differential I/O Connection

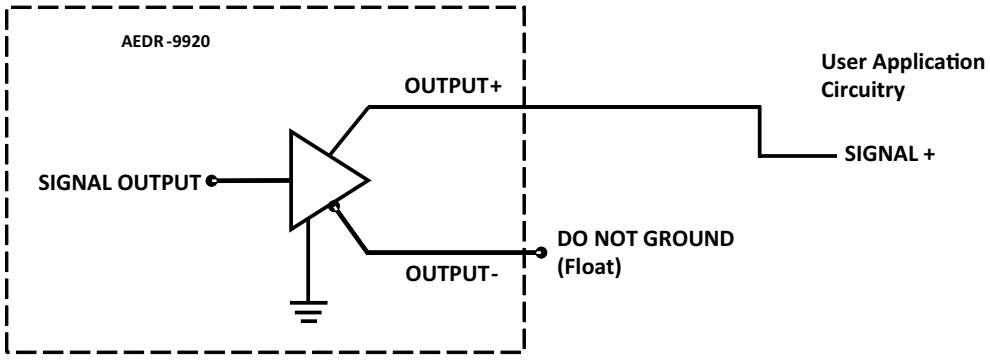


NOTE:

1. Output+ represents A+, B+, or I+ digital output from the encoder.
2. Output– represents A–, B–, or I– digital output from the encoder.
3. Load resistance, *RT, is optional although highly recommended to reduce reflection.

Single-Ended I/O Connection

Figure 12: Single-Ended Connection



NOTE:

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

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