



# **HEDS-9940PRGEVB**

## **Evaluation Board and Programming Kit**

**User Guide**

**Version 1.0**

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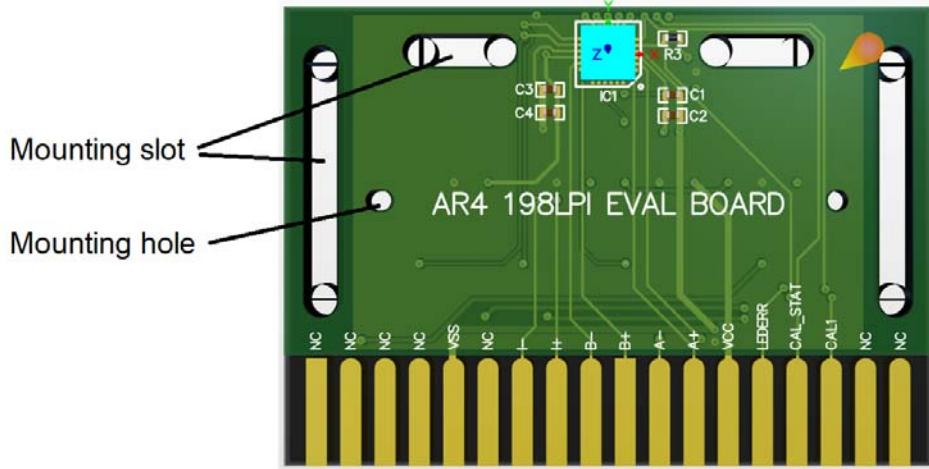
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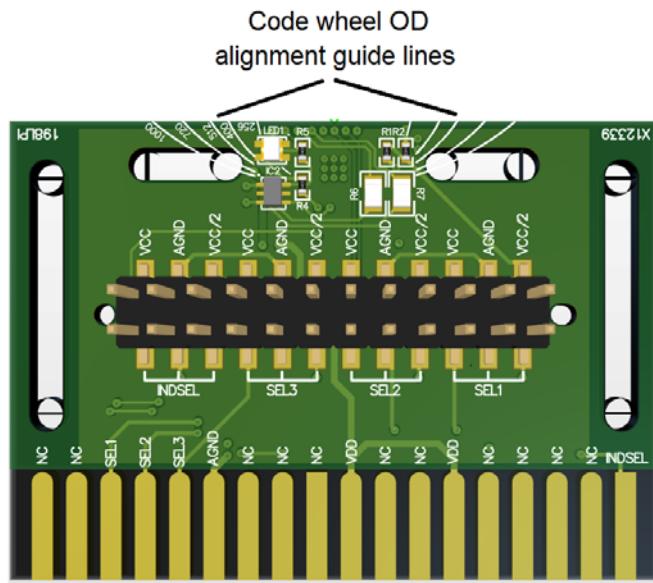
# Chapter 1: HEDS-9940EVB Evaluation Board

## 1.1 Top and Bottom Views

**Figure 1: Bottom View of the PCB**

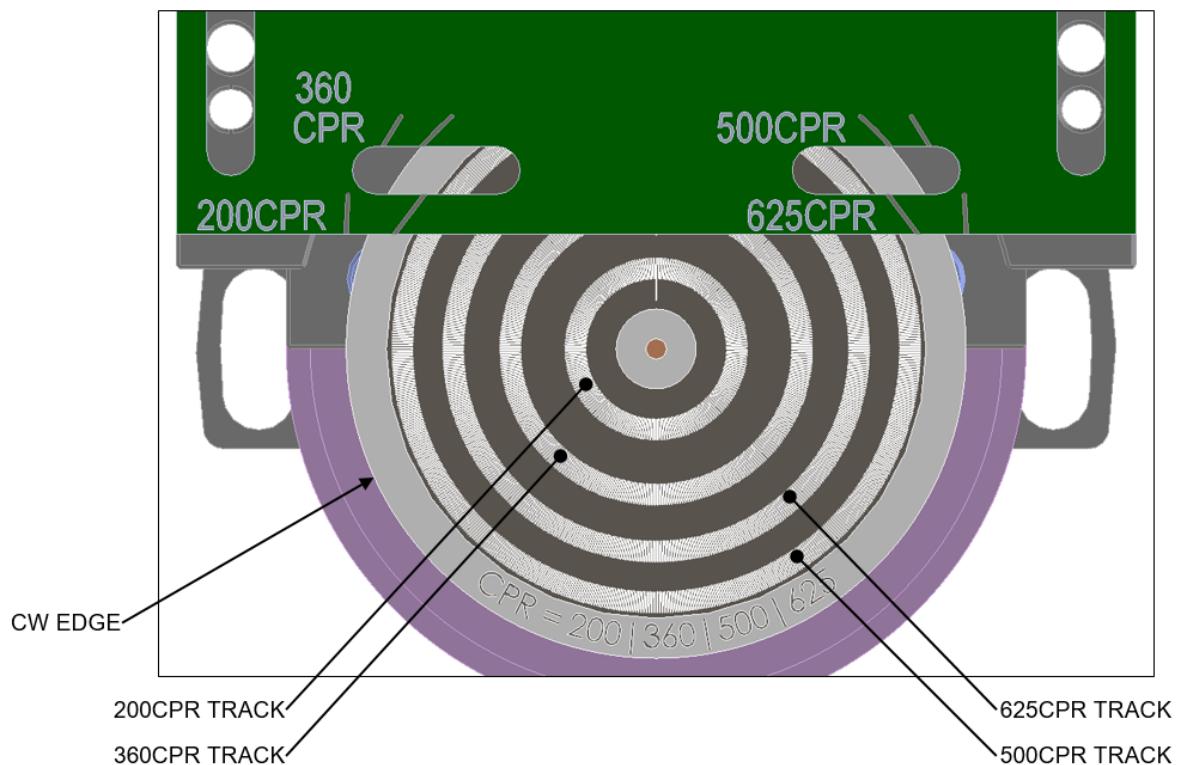


**Figure 2: Top View of the PCB**

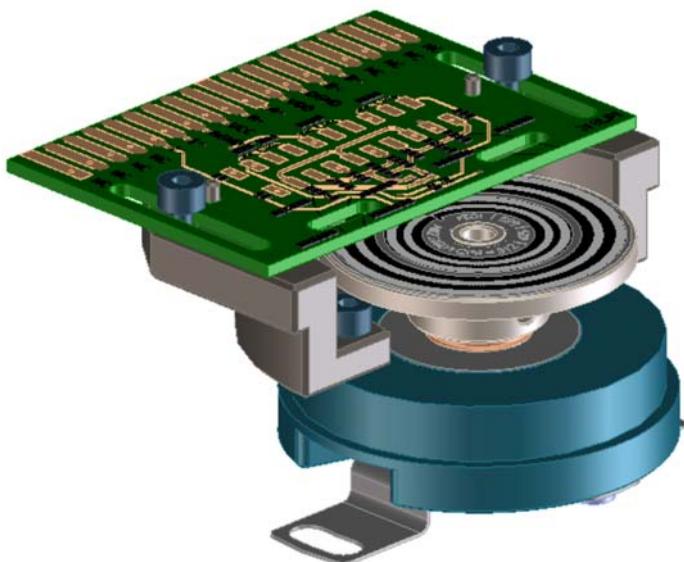


The silk screen-printed guide line on the PCB is to help in providing visual alignment of the code wheel edge (outer diameter) for each of the different ROP (CPR) tracks. A sample diagram showing the position when the encoder is aligned to the 500 CPR track is shown in [Figure 3](#).

**Figure 3: Sample Encoder Aligned to 500 CPR Track (HEDS-9940EVB1/HEDS-9940PRGEVB1)**



**Figure 4: Sample Evaluation Board Mounting with Reference to Code Wheel**



## Chapter 2: Select Options

Table 1: Selection Table for AEDR-9940 198.4375 LPI

No.	SEL1	SEL2	SEL3	Interpolation Factor	INDEXSEL	Index
1	Low	Low	Low	1X	Low	Interpolation 1X - Index Gated 90 degrees
					High	Interpolation 1X - Index Gated 180 degrees
					Open	Interpolation 1X - Index Raw (Ungated)
2	High	Low	Low	2X	Low	Interpolation 2X - Index Gated 90 degrees
					High	Interpolation 2X - Index Gated 180 degrees
					Open	Interpolation 2X - Index Gated 360 degrees
3	Open <sup>a</sup>	Low	Low	3X	Low	Interpolation 3X - Index Gated 90 degrees
					High	Interpolation 3X - Index Gated 180 degrees
					Open	Interpolation 3X - Index Gated 360 degrees
4	Low	High	Low	4X	Low	Interpolation 4X - Index Gated 90 degrees
					High	Interpolation 4X - Index Gated 180 degrees
					Open	Interpolation 4X - Index Gated 360 degrees
5	High	High	Low	5X	Low	Interpolation 5X - Index Gated 90 degrees
					High	Interpolation 5X - Index Gated 180 degrees
					Open	Interpolation 5X - Index Gated 360 degrees
6	Open <sup>a</sup>	High	Low	6X	Low	Interpolation 6X - Index Gated 90 degrees
					High	Interpolation 6X - Index Gated 180 degrees
					Open	Interpolation 6X - Index Gated 360 degrees
7	Low	Open <sup>a</sup>	Low	8X	Low	Interpolation 8X - Index Gated 90 degrees
					High	Interpolation 8X - Index Gated 180 degrees
					Open	Interpolation 8X - Index Gated 360 degrees
8	High	Open <sup>a</sup>	Low	9X	Low	Interpolation 9X - Index Gated 90 degrees
					High	Interpolation 9X - Index Gated 180 degrees
					Open	Interpolation 9X - Index Gated 360 degrees
9	Open <sup>a</sup>	Open <sup>a</sup>	Low	10X	Low	Interpolation 10X - Index Gated 90 degrees
					High	Interpolation 10X - Index Gated 180 degrees
					Open	Interpolation 10X - Index Gated 360 degrees
10	Low	Low	High	12X	Low	Interpolation 12X - Index Gated 90 degrees
					High	Interpolation 12X - Index Gated 180 degrees
					Open	Interpolation 12X - Index Gated 360 degrees
11	High	Low	High	16X	Low	Interpolation 16X - Index Gated 90 degrees
					High	Interpolation 16X - Index Gated 180 degrees
					Open	Interpolation 16X - Index Gated 360 degrees
12	Open <sup>a</sup>	Low	High	20X	Low	Interpolation 20X - Index Gated 90 degrees
					High	Interpolation 20X - Index Gated 180 degrees
					Open	Interpolation 20X - Index Gated 360 degrees

Table 1: Selection Table for AEDR-9940 198.4375 LPI (Continued)

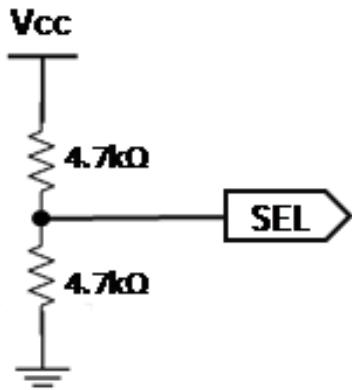
No.	SEL1	SEL2	SEL3	Interpolation Factor	INDEXSEL	Index	
13	Low	High	High	25X	Low	Interpolation 25X - Index Gated 90 degrees	
					High	Interpolation 25X - Index Gated 180 degrees	
					Open	Interpolation 25X - Index Gated 360 degrees	
14	High	High	High	32X	Low	Interpolation 32X - Index Gated 90 degrees	
					High	Interpolation 32X - Index Gated 180 degrees	
					Open	Interpolation 32X - Index Gated 360 degrees	
15	Open <sup>a</sup>	High	High	50X	Low	Interpolation 50X - Index Gated 90 degrees	
					High	Interpolation 50X - Index Gated 180 degrees	
					Open	Interpolation 50X - Index Gated 360 degrees	
16	Low	Open <sup>a</sup>	High	64X	Low	Interpolation 64X - Index Gated 90 degrees	
					High	Interpolation 64X - Index Gated 180 degrees	
					Open	Interpolation 64X - Index Gated 360 degrees	
17	High	Open <sup>a</sup>	High	80X	Low	Interpolation 80X - Index Gated 90 degrees	
					High	Interpolation 80X - Index Gated 180 degrees	
					Open	Interpolation 80X - Index Gated 360 degrees	
18	Open <sup>a</sup>	Open <sup>a</sup>	High	100X	Low	Interpolation 100X - Index Gated 90 degrees	
					High	Interpolation 100X - Index Gated 180 degrees	
					Open	Interpolation 100X - Index Gated 360 degrees	
19	Low	Low	Open <sup>a</sup>	128X	Low	Interpolation 128X - Index Gated 90 degrees	
					High	Interpolation 128X - Index Gated 180 degrees	
					Open	Interpolation 128X - Index Gated 360 degrees	
20	High	Low	Open <sup>a</sup>	160X	Low	Interpolation 160X - Index Gated 90 degrees	
					High	Interpolation 160X - Index Gated 180 degrees	
					Open	Interpolation 160X - Index Gated 360 degrees	
21	Open <sup>a</sup>	Low	Open <sup>a</sup>	256X	Low	Interpolation 256X - Index Gated 90 degrees	
					High	Interpolation 256X - Index Gated 180 degrees	
					Open	Interpolation 256X - Index Gated 360 degrees	
22	Low	High	Open <sup>a</sup>	320X	Low	Interpolation 320X - Index Gated 90 degrees	
					High	Interpolation 320X - Index Gated 180 degrees	
					Open	Interpolation 320X - Index Gated 360 degrees	
23	High	High	Open <sup>a</sup>	640X	Low	Interpolation 640X - Index Gated 90 degrees	
					High	Interpolation 640X - Index Gated 180 degrees	
					Open	Interpolation 640X - Index Gated 360 degrees	
24	Open <sup>a</sup>	High	Open <sup>a</sup>	1000X	Low	Interpolation 1000X - Index Gated 90 degrees	
					High	Interpolation 1000X - Index Gated 180 degrees	
					Open	Interpolation 1000X - Index Gated 360 degrees	
25	Low	Open <sup>a</sup>	Open <sup>a</sup>	Ungated Digital	Low	Analog SIN/COS (500 mVpp), Digital Index (Ungated)	
					High	Analog SIN/COS (500 mVpp), Digital Index (Ungated)	
					Open	Analog SIN/COS (500 mVpp), Digital Index (Ungated)	
26	High	Open <sup>a</sup>	Open <sup>a</sup>	Analog	Low	Analog SIN/COS (500 mVpp), Analog Index (1 Vpp)	
					Ungated Digital	High	Analog SIN/COS (1 Vpp), Digital Index (Ungated)
					Analog	Open	Analog SIN/COS (1 Vpp), Analog Index (1Vpp)

**Table 1: Selection Table for AEDR-9940 198.4375 LPI (Continued)**

No.	SEL1	SEL2	SEL3	Interpolation Factor	INDEXSEL	Index
27	Open <sup>a</sup>	Open <sup>a</sup>	Open <sup>a</sup>	SPI Mode	Low	SPI Mode: Program Selection
					High	SPI Mode: Output Enabled
					Open	SSI 3W Mode <sup>b</sup>

a. Open selection must be connected to the middle of a voltage divider circuit. See [Figure 5](#).

b. SSI 3W mode is for monitoring purposes only.

**Figure 5: Voltage Divider Circuit**

Use 2 x 4.7-kΩ resistors (V<sub>CC</sub> to GND).

The digital interpolation factor is based on the following equation for various rotational speeds (RPM) and count per revolution (CPR) values.

$$\text{RPM} = (\text{Count Frequency} \times 60) / \text{CPR}$$

CPR (@ 1X interpolation) is based on the following equation that is dependent on radius of operation (ROP).

$$\text{CPR} = \text{LPI} \times 2\pi \times \text{ROP} \text{ (inch)} \text{ or } \text{CPR} = \text{LP mm} \times 2\pi \times \text{ROP} \text{ (mm)}$$

**NOTE:** LP mm (lines per mm) = LPI / 25.4

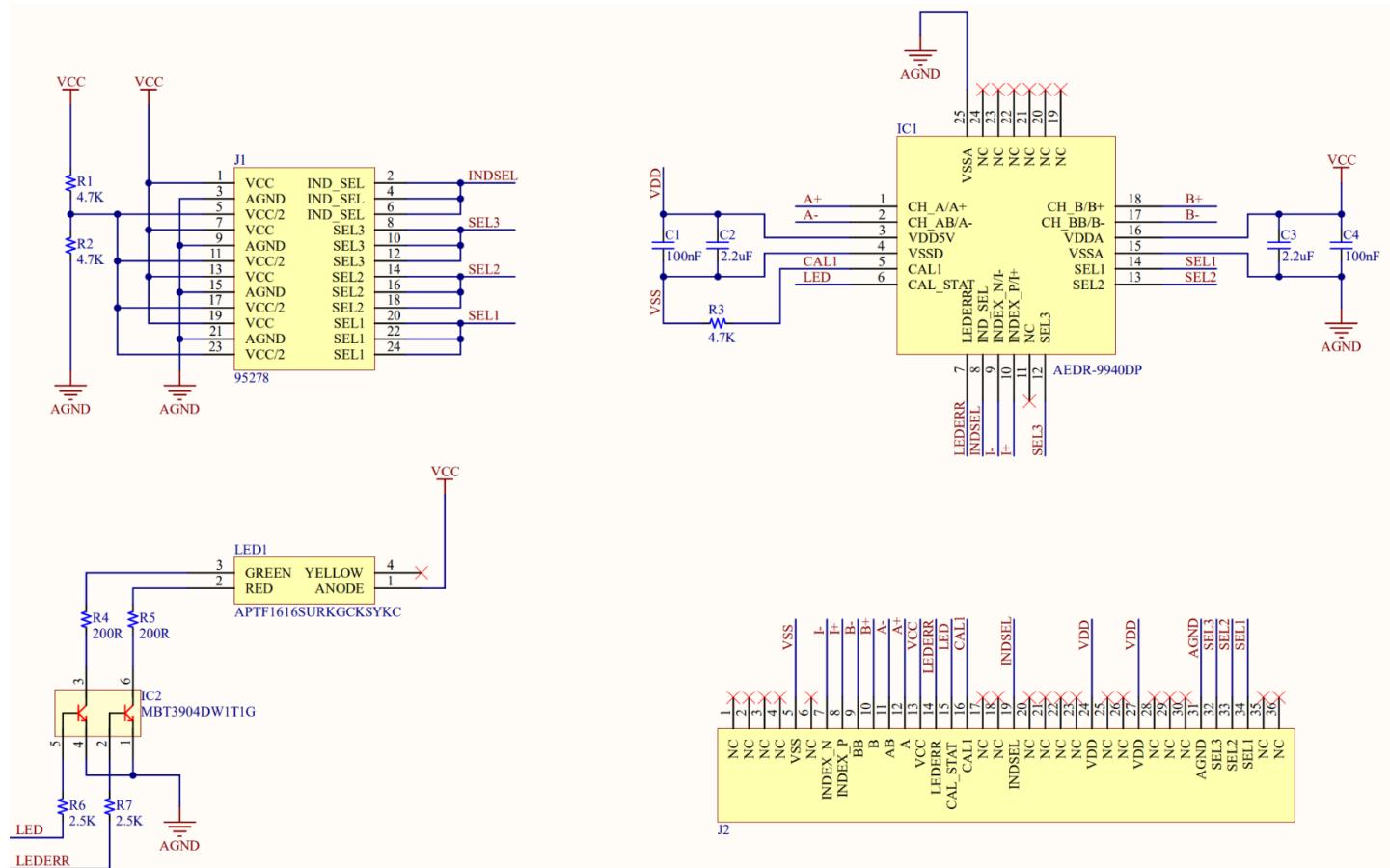
## 2.1 Programmable Select Options

SPI programmable with interpolation factor from 1X to 1024X.

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

## Chapter 3: Board Schematic and Pin Assignment

**Figure 6: HEDS-9930EVB Evaluation Board Schematic**



### 3.1 Connector Assignment

**Table 2: Connector 1 Pin Assignment**

Connector 1 (Top Side)	Label	Connector 1 (Bottom Side)	Label
1	NC	1	NC
2	NC	2	NC
3	SEL1	3	CAL1
4	SEL2	4	CAL_STAT
5	SEL3	5	LEDERR
6	AGND	6	VCC
7	NC	7	A+
8	NC	8	A-
9	NC	9	B+
10	VDD	10	B-

**Table 2: Connector 1 Pin Assignment**

Connector 1 (Top Side)	Label	Connector 1 (Bottom Side)	Label
11	NC	11	I+
12	NC	12	I-
13	VDD	13	NC
14	NC	14	VSS
15	NC	15	NC
16	NC	16	NC
17	NC	17	NC
18	INDSEL	18	NC

The finger design of Connector 1 is a match to either of the following card edge connectors:

- EDAC, CONN EDGE DUAL FEMALE 36POS 0.100, P/N# 395-036-520-202
- SULLINS, CONN EDGE DUAL FEMALE 36POS 0.100, P/N# EBC18DREH

The use of the above mentioned card edge connector is not needed if necessary connections can be made using manual soldering to the relevant card edge fingers.

**Table 3: Connector 2 Pin Assignment**

Connector 1 (Top Side)	Label	State
1	SEL1	VCC
2		AGND
3		OPEN
4	SEL2	VCC
5		AGND
6		OPEN
7	SEL3	VCC
8		AGND
9		OPEN
10	INDEX_SEL	VCC
11		AGND
12		OPEN

**NOTE:** Refer to [Table 1, Selection Table for AEDR-9940 198.4375 LPI](#) for the various interpolation selection options available by changing the SEL1, SEL2, and SEL3 jumper positions.

## Chapter 4: Code Wheel Drawing

For the AEDR-9940 evaluation board sample, the matching code wheel sample drawings are shown in the following figures. For a detailed drawing of the sample code wheel, request from your regional FAE.

**Figure 7: Code Wheel Multiple Optical Radius 200, 360, 500, 625 CPR Base**

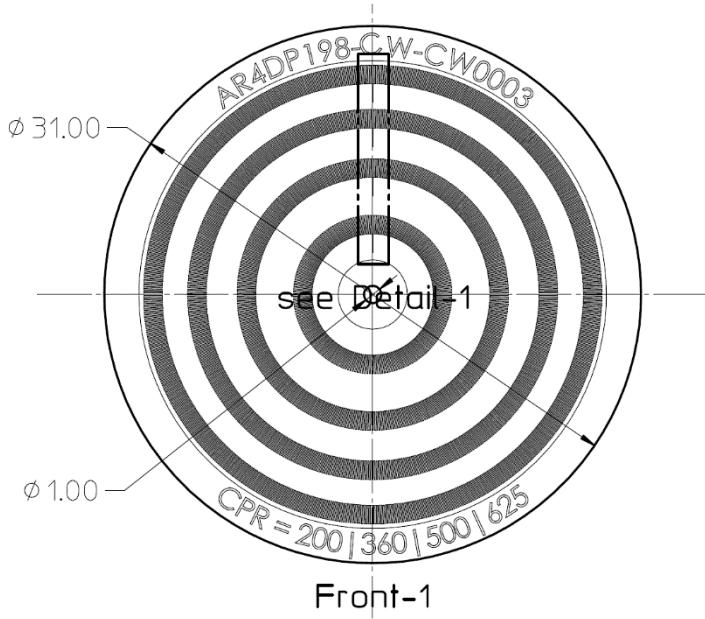


Table 1 : Data Track/Window

Signal Channel	Track	Window Width	CPR	INC Rop (mm)	INDEX Rop (mm)
INC	1	180°/200	200	4.074	2.924
INC	2	180°/360	360	7.334	6.184
INC	3	180°/500	500	10.186	9.036
INC	4	180°/625	625	12.732	11.582

**Figure 8: Code Wheel Multiple Optical Radius 256, 400, 512, 720 CPR Base**

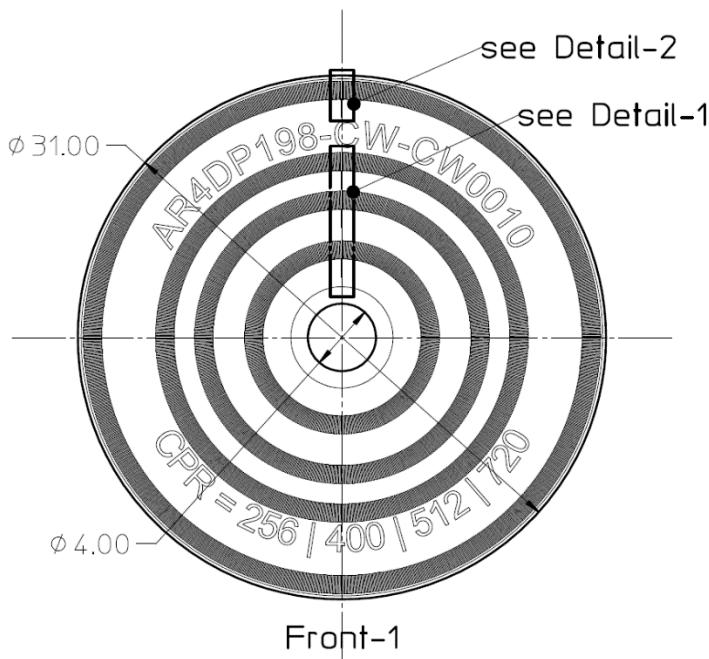


Table 1 : Data Track/Window

Signal Channel	Track	Window Width	CPR	INC Rop (mm)	INDEX Rop (mm)
INC	1	180°/256	256	5.215	4.065
INC	2	180°/400	400	8.149	6.998
INC	3	180°/512	512	10.430	9.280
INC	4	180°/720	720	14.668	13.517

## Chapter 5: HEDS-9940PRGEVB Programming USB-SPI Kit

In order to program interpolation value other than the ones offered in [Table 1, Selection Table for AEDR-9940 198.4375 LPI](#) using the SEL1, SEL2, and SEL3 option pins, you may connect to the AEDS-9940 encoder ASIC through the SPI interface.

Broadcom® offers a simple USB to SPI programming kit, together with a PC-based custom program for you to program the desired interpolation value.

**Figure 9:** The HEDS-9940PRGEVB USB to SPI Programmer Kit

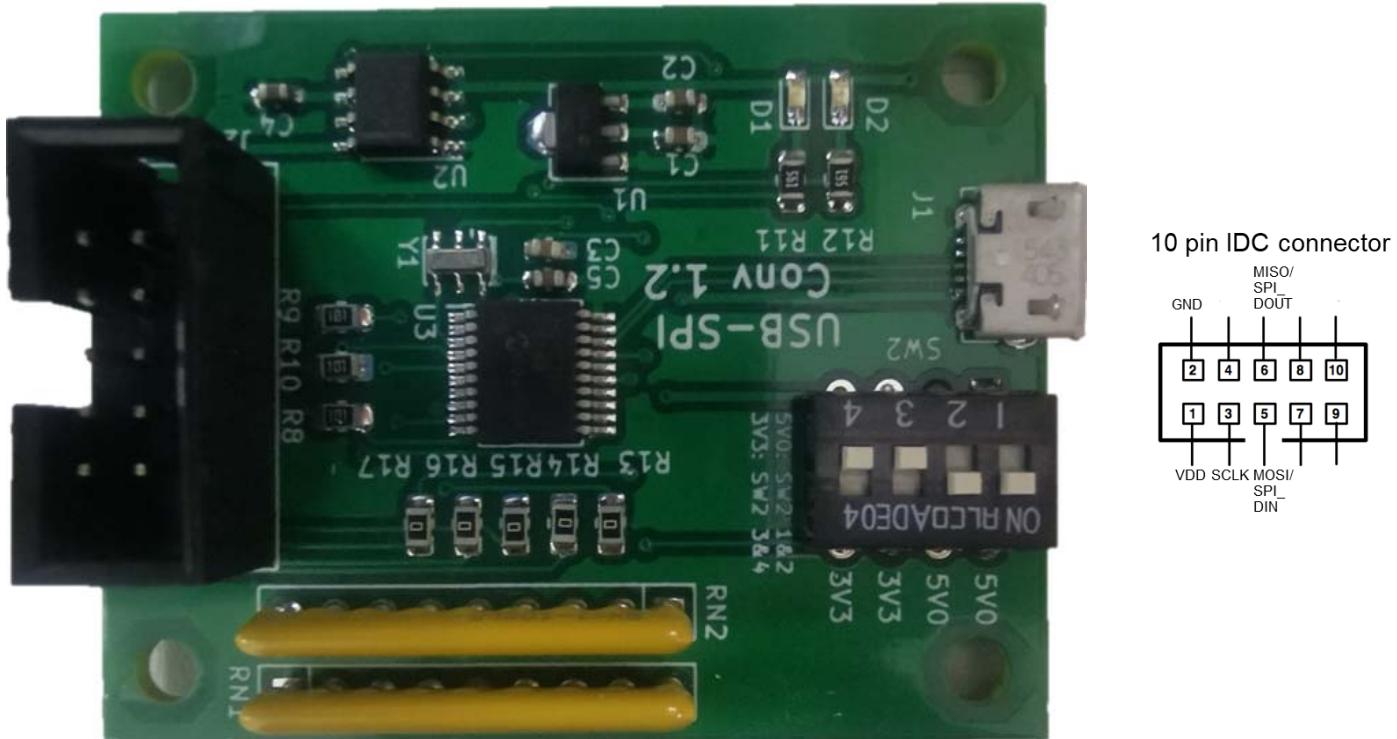
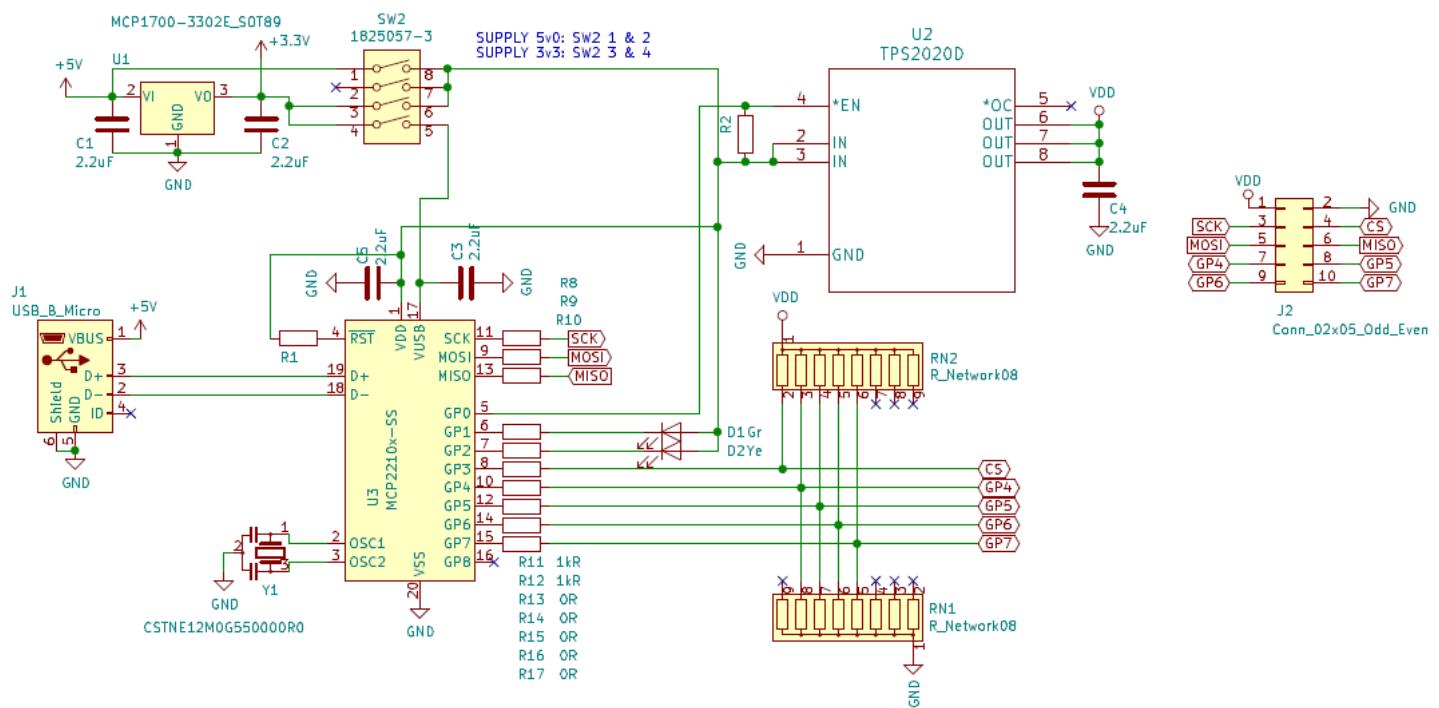


Figure 10: The HEDS-9940PRGEVB USB to SPI Programmer Kit Schematic

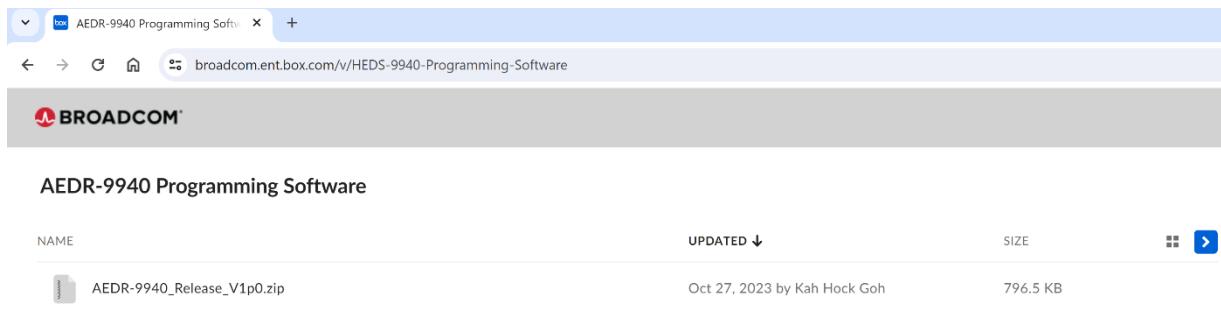


## Chapter 6: AEDR-9940 Gateway Programming GUI

The HEDS-9940PRGEVB kit is to be used together with `AEDR_9940_Gateway.exe` to program the desired interpolation factor into the encoder ASIC.

1. Download the zip file from:

<https://broadcom.box.com/v/HEDS-9940-Programming-Software>

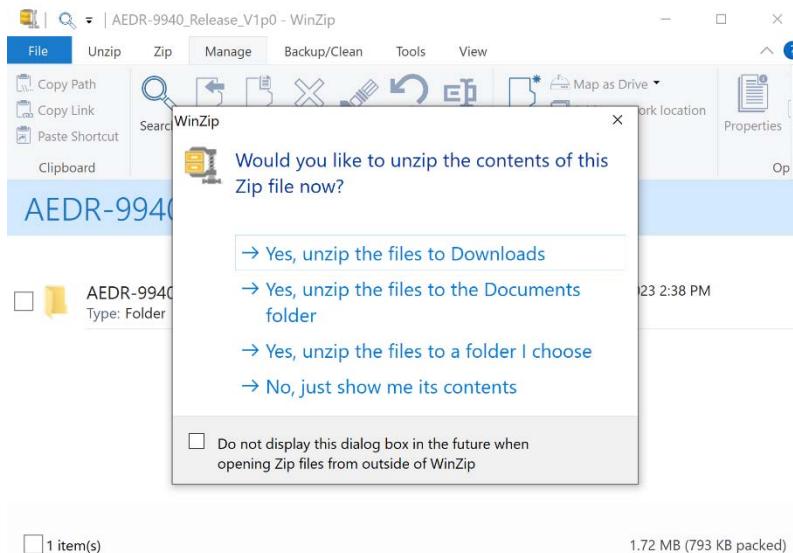


The screenshot shows a web browser window with the following details:

- Address Bar:** AEDR-9940 Programming Software > https://broadcom.ent.box.com/v/HEDS-9940-Programming-Software
- Header:** BROADCOM logo
- Section:** AEDR-9940 Programming Software
- Table:** A list of files available for download, showing columns for NAME, UPDATED, and SIZE.

NAME	UPDATED	SIZE
AEDR-9940_Release_V1p0.zip	Oct 27, 2023 by Kah Hock Goh	796.5 KB

2. Save the zip file into a local drive on your PC.
3. Unzip `AEDR-9940_Release_Vxpx.zip` to a local folder of your choice.



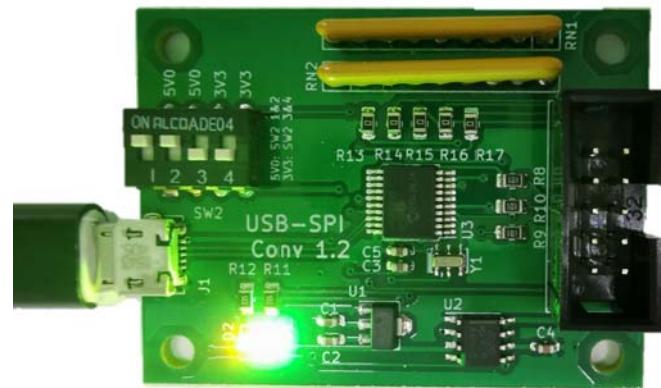
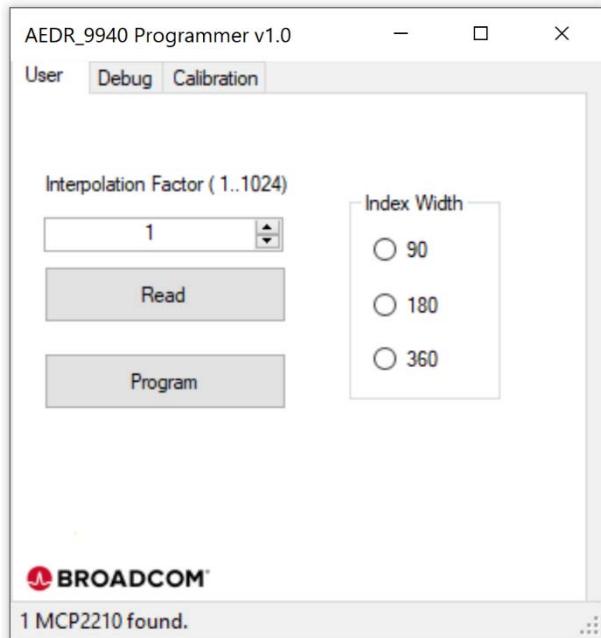
The screenshot shows a WinZip interface with the following details:

- Toolbar:** File, Unzip, Zip, Manage, Backup/Clean, Tools, View
- File List:** AEDR-9940\_Release\_V1p0 - WinZip
- Message Box:** Would you like to unzip the contents of this Zip file now?
- Options:**
  - Yes, unzip the files to Downloads
  - Yes, unzip the files to the Documents folder
  - Yes, unzip the files to a folder I choose
  - No, just show me its contents
- Checkboxes:**
  - Do not display this dialog box in the future when opening Zip files from outside of WinZip
- Bottom Status:** 1 item(s) 1.72 MB (793 KB packed)

4. Double-click `AEDR_9940_Gateway.exe`.

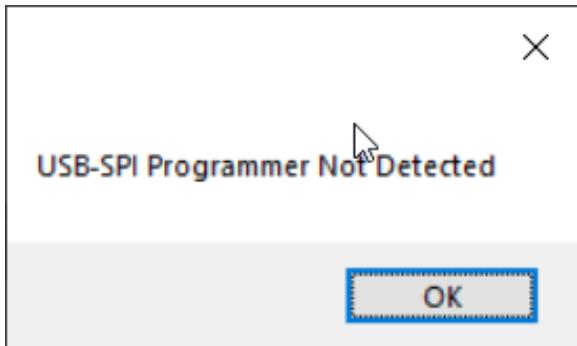
Name	Date modified	Type	Size
app.publish	1/5/2024 11:03 AM	File folder	
Resources	6/26/2023 2:21 PM	File folder	
AEDR_9940_Gateway.application	9/11/2023 2:35 PM	Application Manif...	2 KB
<input checked="" type="checkbox"/> AEDR_9940_Gateway.exe	9/11/2023 2:35 PM	Application	100 KB
AEDR_9940_Gateway.exe.config	9/5/2023 10:53 AM	XML Configuratio...	2 KB
AEDR_9940_Gateway.exe.manifest	9/11/2023 2:35 PM	MANIFEST File	5 KB
AEDR_9940_Gateway.pdb	9/11/2023 2:35 PM	VisualStudio.pdb....	56 KB
AEDR_9940_Gateway.vshost.application	9/11/2023 1:05 PM	Application Manif...	2 KB
AEDR_9940_Gateway.vshost.exe	9/11/2023 1:06 PM	Application	23 KB
AEDR_9940_Gateway.vshost.exe.config	9/5/2023 10:53 AM	XML Configuratio...	2 KB
AEDR_9940_Gateway.vshost.exe.manif...	9/11/2023 1:05 PM	MANIFEST File	5 KB
Log.txt	9/11/2023 2:37 PM	Text Document	1 KB
mcp2210_dll_m_dotnetv4_x86.dll	5/15/2016 8:37 PM	Application extens...	83 KB
msvcp120.dll	10/4/2013 11:38 AM	Application extens...	445 KB
msvcr120.dll	10/4/2013 11:38 AM	Application extens...	949 KB

5. Once the `AEDR_9940_Gateway.exe` software is running, the board should be detected.



Both amber and green LEDs are detected by the `AEDR_9940_Gateway.exe` software.

6. If the following message appears, check the board connections and try again.



7. Click **Read** to read back saved settings from the AEDR-9940 encoder ASIC.
  - a. If existing settings are read out successfully, it displays the saved Interpolation Factor and Index Width settings.

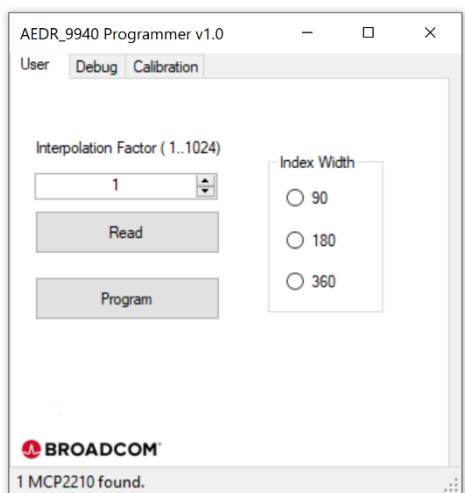
```

5/19/2021 6:22:25 PM: AEDR_9930 Interpolation = 512, Index Width = 90.
5/19/2021 6:22:30 PM: Read from AEDR_9930....
5/19/2021 6:22:31 PM: Programming AEDR_9930....
5/19/2021 6:22:32 PM: Program DUT Done, DUT Interpolation = 511, Index Width = 90.
5/19/2021 6:22:34 PM: Read from AEDR_9930....
5/19/2021 6:22:35 PM: AEDR_9930 Interpolation = 511, Index Width = 90.
5/19/2021 6:24:16 PM: Read from AEDR_9930....
5/19/2021 6:24:17 PM: Programming AEDR_9930....
5/19/2021 6:24:18 PM: Program DUT Done, DUT Interpolation = 500, Index Width = 90.

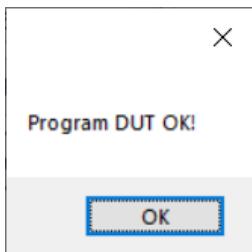
```

- b. If the AEDR-9940 is not connected or detected, the program terminates. Refer to `log.txt` in the same directory to check the failure status.
- c. If there is a communication failure with the AEDR-9940, the program exits. Refer to `log.txt` to check the error message.

8. Enter the interpolation factor required (1 to 1024) and index width setting. Click **Program** to save the settings.



9. The message `Program DUT OK!` displays when the settings are save successfully.



# Chapter 7: Using the AEDR-9940 Gateway SPI Protocol to Perform Calibration

Motor rotation with minimal speed ripple or smooth linear movement is required during calibration. This is to enable Index signals to be automatically adjusted to obtain a good crossover.

1. Turn the motor at a constant speed of 500 rpm or linear stage reciprocal movement (stroke[50 mm/s])
2. Click **Auto Calibration**.
3. Calibration in progress. Calibrating displays in **Status**.
4. The **Status** displays **Auto Cal Done** if calibration is successfully completed. Otherwise, it displays **Error**.

**NOTE:** A calibration error may be caused by wide spatial displacement or failure to obtain index signals crossover.

