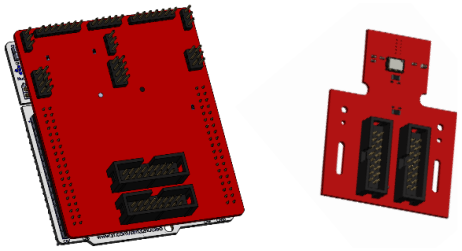
BROADCOM®

User Guide

HEDS-9988PRGEVB
HEDS-9988MEVB
HEDS-9988MBEVB

Magnetic Encoder IC Programming Kit Evaluation Board



Description

The Broadcom® AEAT-9988M is an angular magnetic rotary sensor that provides accurate angular measurement over a full 360 degrees of rotation. It is a versatile solution capable of supporting a broad range of applications with its robust architecture to measure and deliver both absolute and incremental signals.

This sophisticated system uses integrated Hall sensor elements with complex analog and digital signal processing within a single device.

A dual-track magnet generates the necessary magnetic fields by rotating perpendicularly. A wide range of selection is available for the magnet ring sizes, up to a 60-mm outer diameter.

The absolute angle measurement provides an instant indication of the magnet's angular position with a selectable and reprogrammable resolution from 16 bits to 23 bits. Once the resolution is selected, the absolute position data is represented in digital form and can be accessed via standard communication protocols such as SSI, SPI, BiSS-C, or RS-485.

The AEAT-9988M also has a built-in multi-turn counter with a battery backup power-off mode of operation. The multi-turn resolution is programmable from 10 bits to 16 bits.

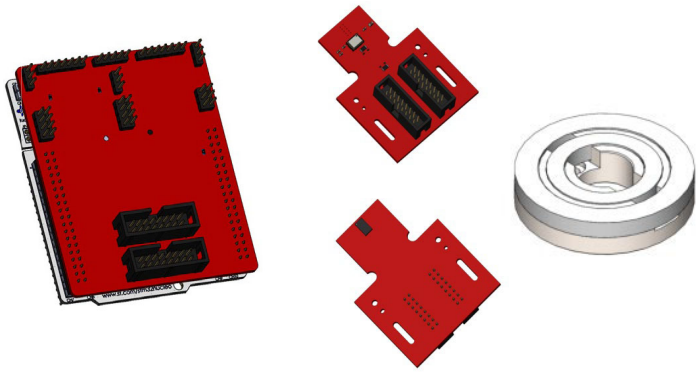
Users can choose to receive the absolute angle position in PWM-encoded output signals. The incremental positions are transmitted on ABI and UVW signals with a wide user-configurable resolution from 1 CPR to 65,536 CPR of ABI signals and pole pairs from 1 to 64 pole pairs (2 to 128 poles) for UVW commutation signals.

For ease of setup, Broadcom has made available development tools to perform the calibration process without other measurement equipment. These programming kits and evaluation board are available through the normal Broadcom sales channels.

HEDS-9988PRGEVB Programming Kit Contents

The HEDS-9988PRGEVB programming kit includes the following items:

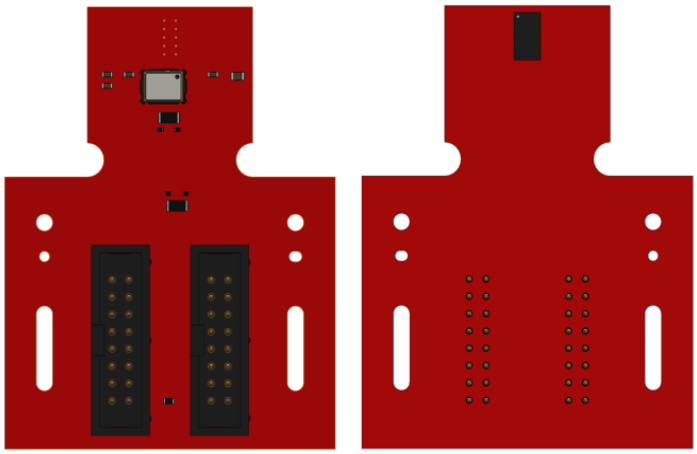
- HEDS-9988PRGEVB interface board x1
- HEDS-9988MBEVB evaluation board x2
- Dual-track ring magnet x1
- 16-pin ribbon cable x2
- Micro USB cable x1



HEDS-9988MEVB/HEDS-9988MBEVB Evaluation Board Contents

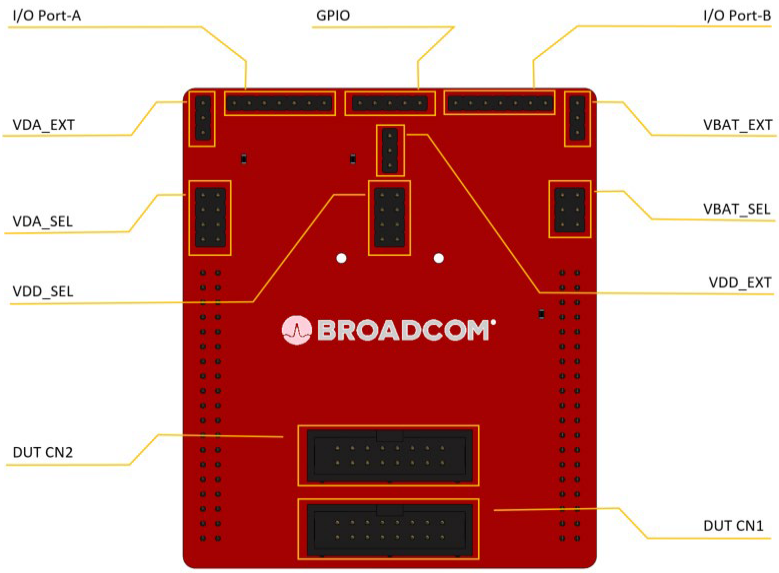
The HEDS-9988MEVB/HEDS-9988MBEVB evaluation board includes the following components:

- AEAT-9988M DFN encoder
- Crystal oscillator
- Capacitors
- Resistors



HEDS-9988PRGEVB Programming Kit Pinout

The following figure shows the pin assignment for each I/O port.



I/O Port-A	GPIO	I/O Port-B
PA0	VDD	PB0
PA1	GPIO0	PB1
PA2	GPIO1	PB2
PA3	GPIO2	PB3
PA4	GND	PB4
PA5		PB5
GND		GND

VDA_EXT	VDD_EXT	VBAT_EXT
+VE	+VE	+VE
-	-	-
GND	GND	GND

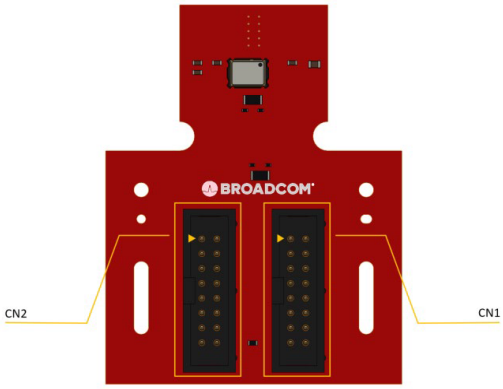
VDA_SEL	VDD_SEL	VBAT_SEL
EXT	EXT	EXT
3V3	3V3	3V3
5V0	5V0	5V0
Auto	Auto	Auto

#	DUT CN1	#	DUT CN1
1	VDD	2	GND
3	PA1	4	PA0
5	PA3	6	PA2
7	PA5	8	PA4
9	GND	10	GND
11	WKUP	12	PSEL2
13	PSEL1	14	PSEL0
15	VDA	16	GND

#	DUT CN2	#	DUT CN2
1	GND	2	GND
3	PB0	4	PB1
5	PB2	6	PB3
7	PB4	8	PB5
9	VDD	10	GND
11	GPIO1	12	GPIO2
13	GPIO0	14	ERR
15	VBAT	16	VBAT_PWR

HEDS-9988MEVB/HEDS-9988MBEVB Evaluation Board Pinout

The following figure shows the pin assignment for each I/O port.



#	DUT CN1	#	DUT CN1
1	VDD	2	GND
3	PA1	4	PA0
5	PA3	6	PA2
7	PA5	8	PA4
9	GND	10	GND
11	WKUP	12	PSEL2
13	PSEL1	14	PSEL0
15	VDA	16	GND

#	DUT CN2	#	DUT CN2
1	GND	2	GND
3	PB0	4	PB1
5	PB2	6	PB3
7	PB4	8	PB5
9	VDD	10	GND
11	GPIO1	12	GPIO2
13	GPIO0	14	ERR
15	VBAT	16	VBAT_PWR

The AEAT-9988M serial interface supports up to 10 different communication interfaces for position output and memory access. The protocol is configurable using the PSEL[2:0] pin. The output pin can be set to high-impedance mode for multi-client or bus connections.

The AEAT-9988M provides two communication ports: Port A and Port B. Port A supports both Single-Ended (SE) and Differential Line Driver (LD) modes, whereas Port B is configured for incremental output.

For more details, refer to the *AEAT-9988M Application Note*.

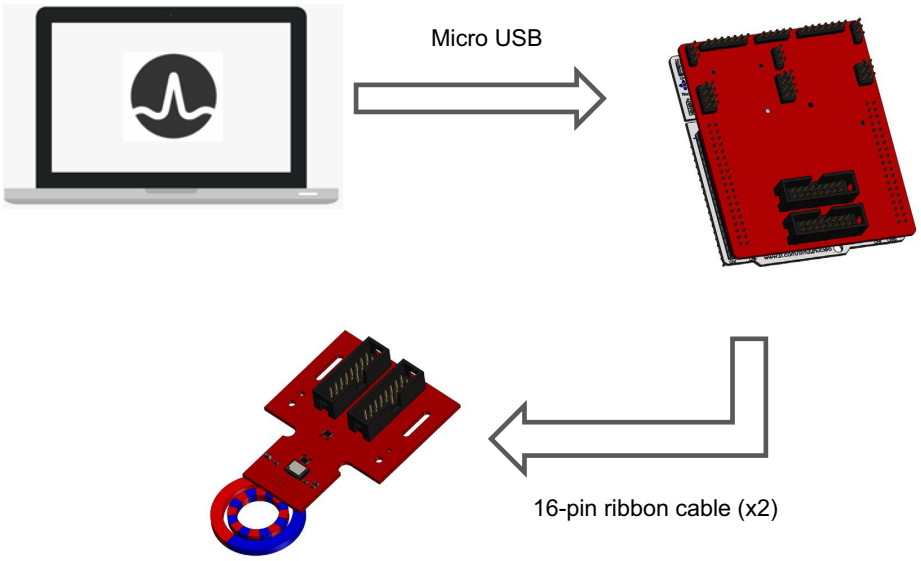
The following table shows the selectable communication interfaces.

Table 1: MATS Table

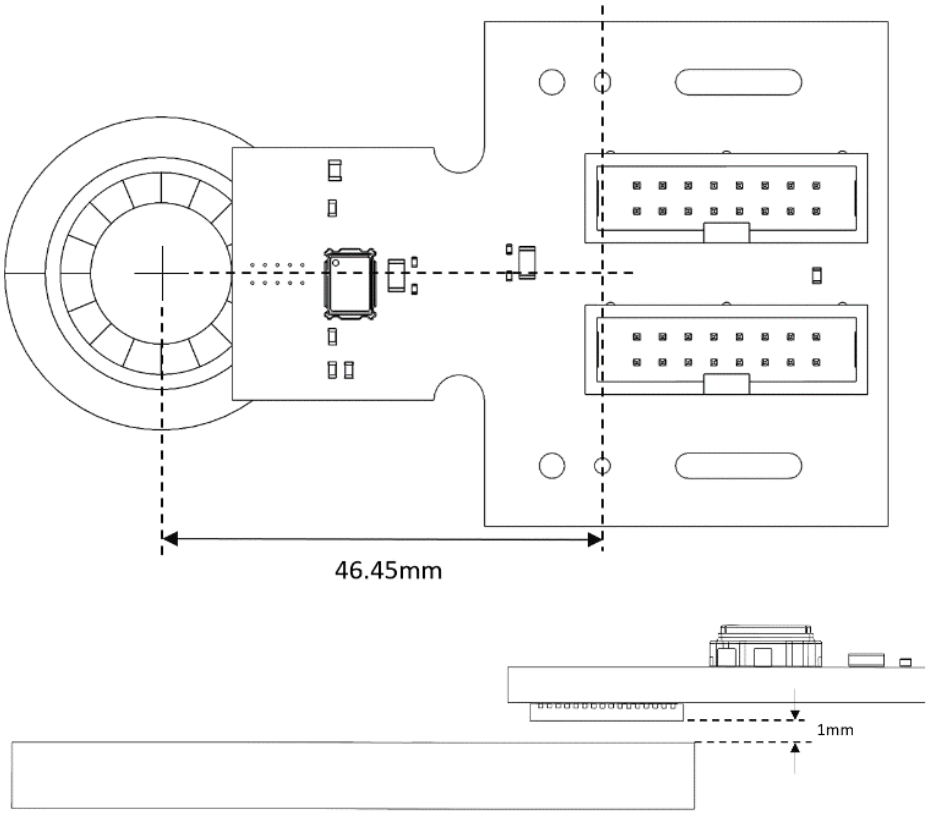
Port Configurator									
PSEL2	0	0	0	0	0	1	1	1	1
PSEL1	0	0	0	1	1	0	0	1	1
PSEL0	0	0	1	0	1	0	1	0	1
Port Assignment									
	SPI3	**SSI**	**SSI**	**BiSS-C**	**BiSS-C**	**RS-485**	**RS-485**	**SPI4**	**UVW/PWM**
	SE	**SE**	**LD**	**SE**	**LD**	**SE**	**LD**	**SE**	**LD**
PA0	MOSI	NSL	NSL+	SLI	SLI+	RX		MOSI	U+
PA1	0	1	NSL–		SLI–			NCS	U–
PA2	SCK	SCK	SCL+	MA	MA+	TX	D+	SCK	V+
PA3			SCL–		MA–		D–		V–
PA4	MISO	SOUT	SLO+	SLO	SLO+	CTS		MISO	W+
PA5	PWM	PWM	SLO–		SLO–	PWM		PWM	W–
PB0	A	A	A+	A	A+	A	A+	A	A+
PB1	U	U	A–	U	A–	U	A–	U	A–
PB2	B	B	B+	B	B+	B	B+	B	B+
PB3	V	V	B–	V	B–	V	B–	V	B–
PB4	I	I	I+	I	I+	I	I+	I	I+
PB5	W	W	I–	W	I–	W	I–	W	I–

Hardware Setup

1. Connect the HEDS-9988PRGEVB to you PC via a USB port.
2. Connect the 16-pin ribbon cables, one end to the interface board and the other end to the evaluation board.
3. Select the encoder operating voltage (VDA, VDD, VBAT) by connecting the jumper to 3.3V, 5V, or an external source.



4. Align the evaluation board over the magnet.



Program Installation

The installation software for the programming kit is available from the following link:

https://docs.broadcom.com/docs/HEDS-9988PRGEVB-Programming-Software

To install the application software, double-click the `HEDS-9988_9988 PRGEVB Programming Evaluation Kit.msi` file, and follow the on-screen instructions to finish the installation.

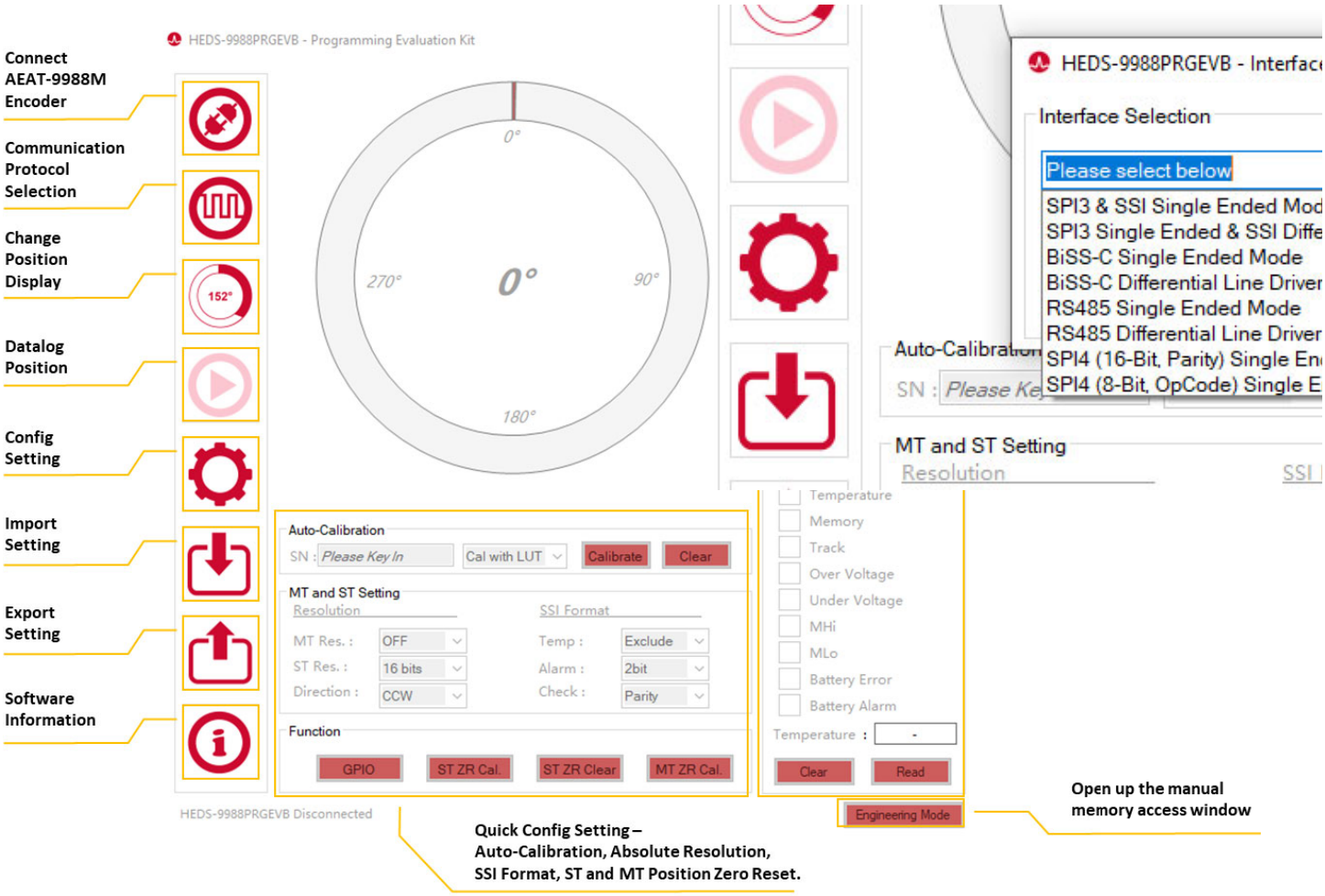
After the installation is complete, the program is available in the selected working directory.

For the latest software updates, visit the product web page.

NOTE: The software is designed for and verified with PCs running on the Windows operating system. The minimum requirement is a Windows 10 64-bit operating system.

User Interface of the Calibration Software

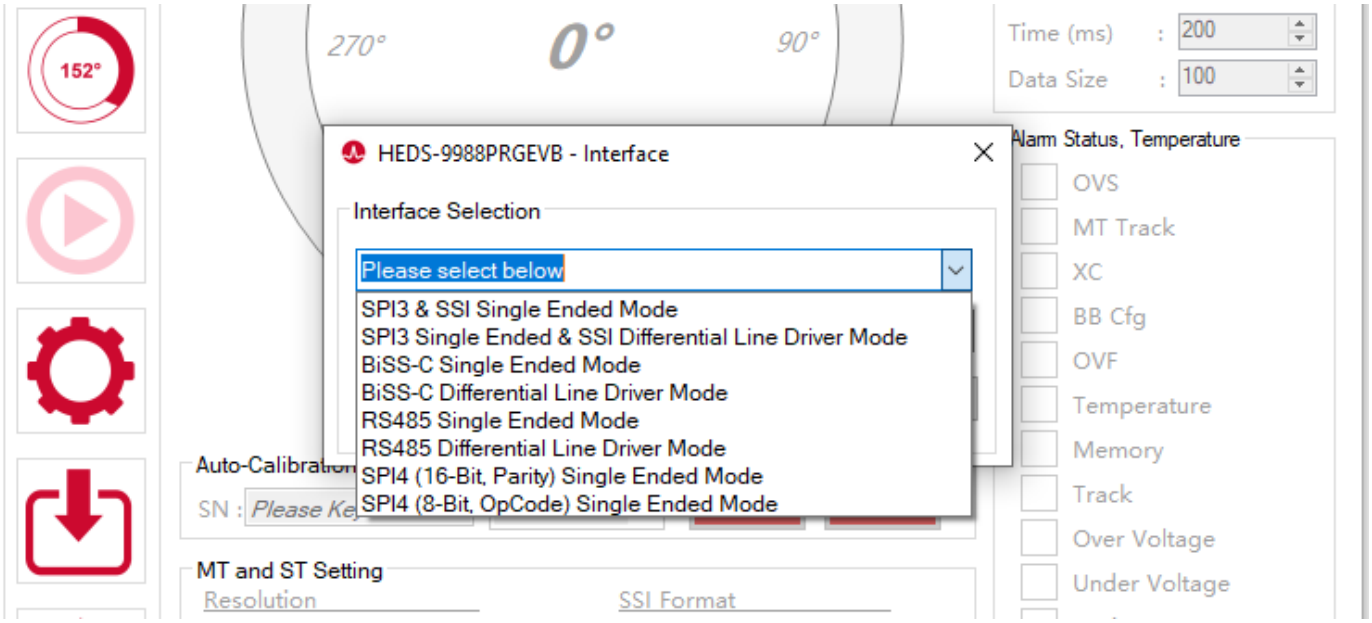
Main Window



The functional description of each button is as follows.

Function	Description
Connect AEAT-9988M Encoder	Enable software connection to hardware.
Communication Protocol Selection	Select encoder communication from SPI, SSI, BiSS, and RS-485.
Change Position Display	Select position display: (1) Chart mode (2) Plot mode.
Datalog Position	Record position data streaming during Plot mode.
Config Setting	Select encoder configuration.
Import Setting	Load encoder configuration from external file.
Export Setting	Save encoder configuration to external file.
Software Information	Software revision.
Engineering Mode	Open up the manual memory access window.

Protocol Selection

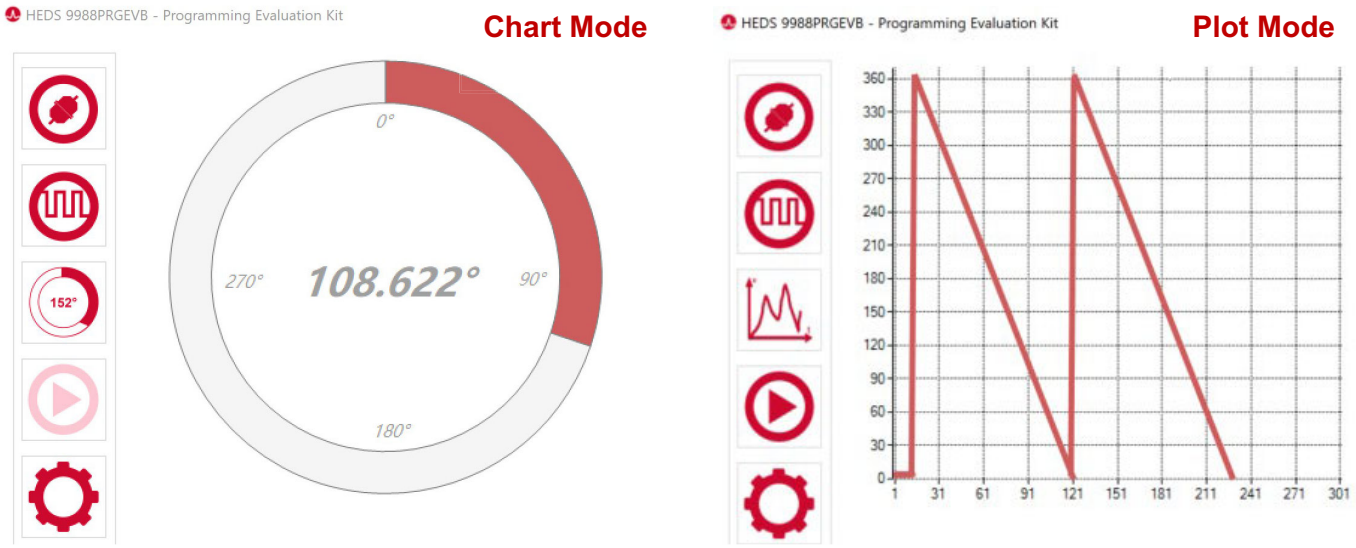


The AEAT-9988M supports eight basic protocol configurations. Further customization of the protocol behavior can be configured via the encoder register.

Once the protocol is selected, both the interface board and the evaluation board are switched together.

NOTE: In UVW Differential Line Driver mode, position and memory access via the interface is not available.

Position Display Mode



The absolute position display is available in Chart mode or Plot mode.

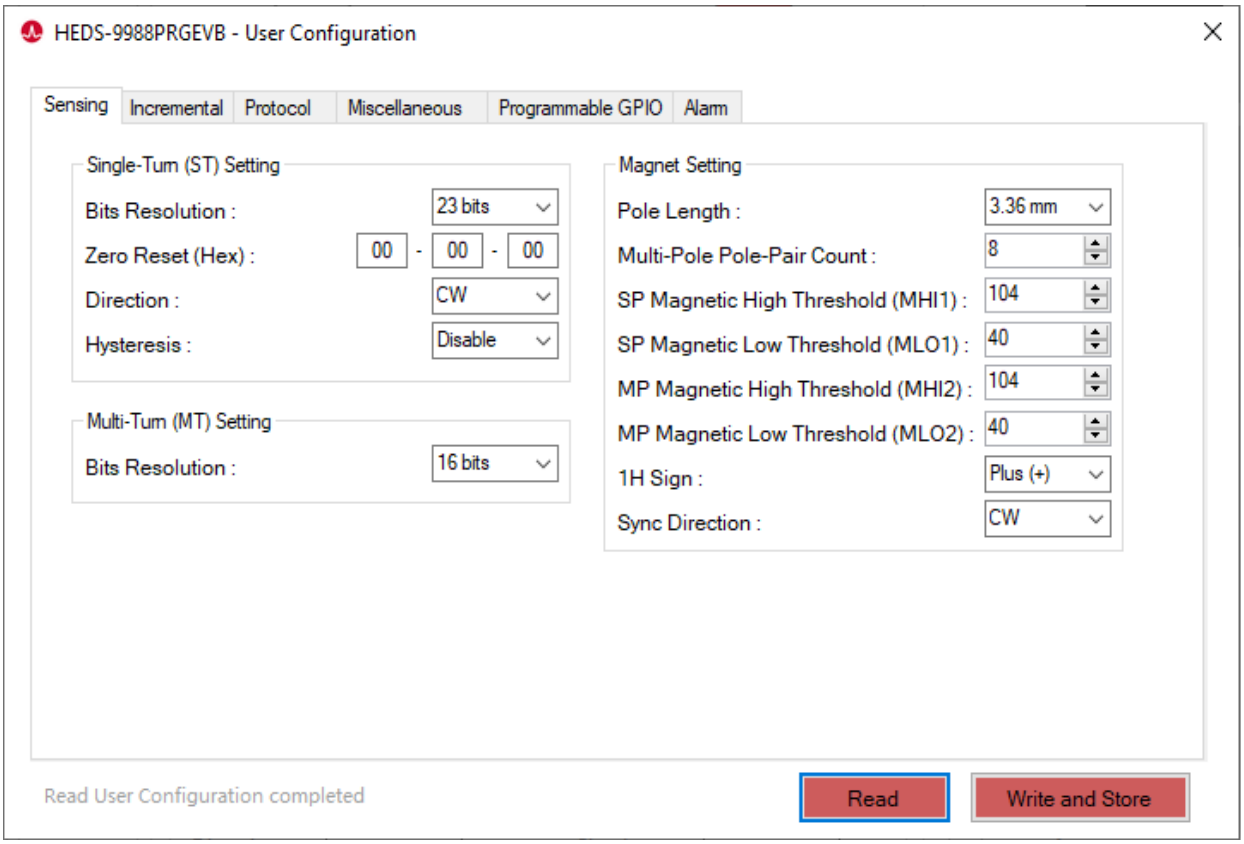
Data Logging

Record Procedure:

1. Click **User Interface selection** to switch to Plot mode.
2. Click the **Data Logging** button.
3. Enter the file name, select the file location, and click **Save**.

The position will be continuously saved to the file until **Data Logging** (stop recording) is pressed again.

User Configuration Window



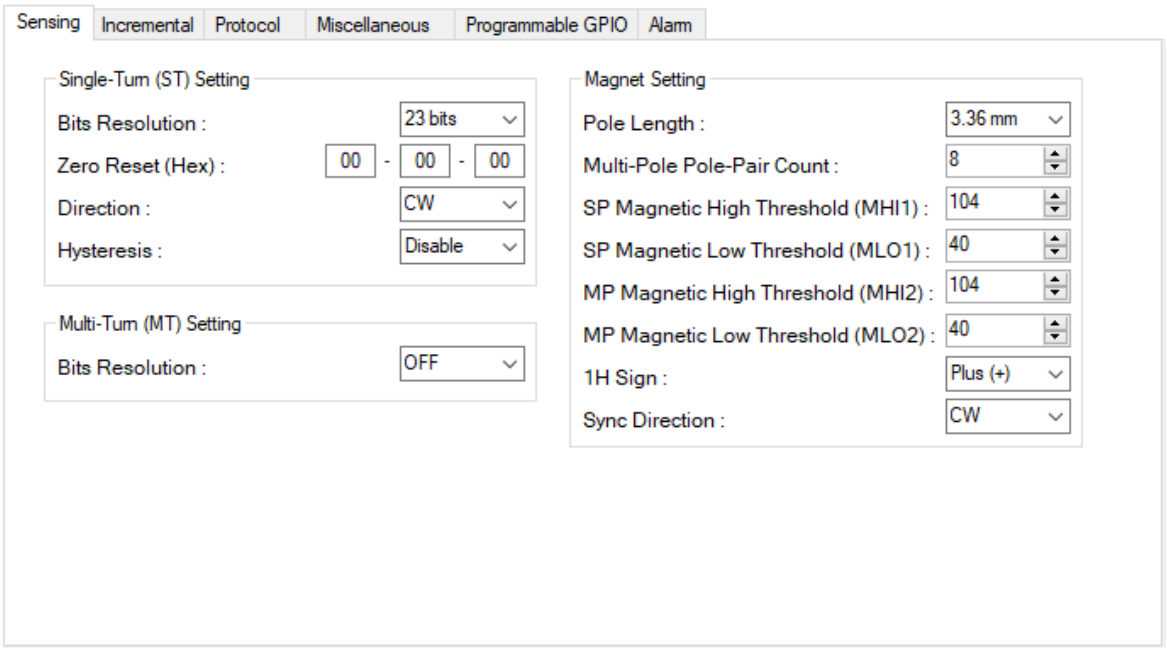
The **User Configuration** window allows users to configure the various settings available in the encoder. It is divided into six different categories:

- Sensing
- Incremental
- Protocol
- Miscellaneous
- Programmable GPIO
- Alarm

NOTE: **Read**: Update the interface with the encoder configuration from the memory.
Write and Store: Store the interface configuration into memory; it will be automatically available on the next power-up.

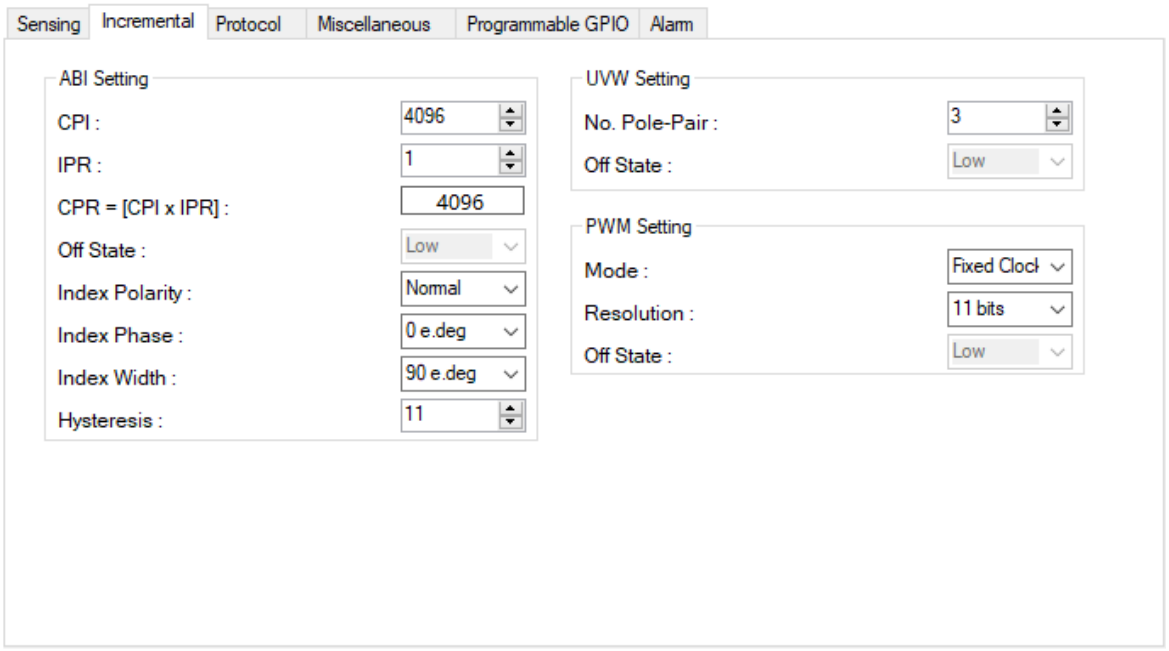
Sensing

- Single-Turn (ST) Setting: Change the ST resolution, position offset, counting direction, and noise hysteresis.
- Multi-Turn (MT) Setting: Change the MT resolution.
- Magnet Setting: Change the magnet pole count, alarm limits, and synchronization direction.



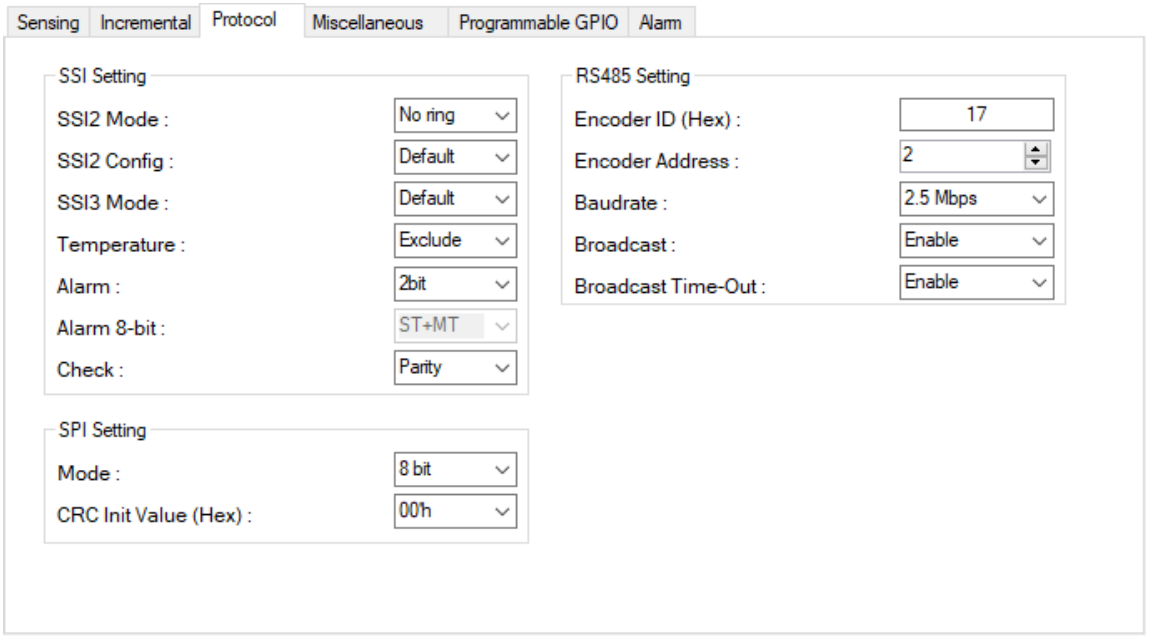
Incremental

- ABI Setting: Change the channel A, B, and I resolution, index customization, and hysteresis.
- UVW Setting: Change the commutation output pole-pair count.
- PWM Setting: Change the PWM mode and resolution.



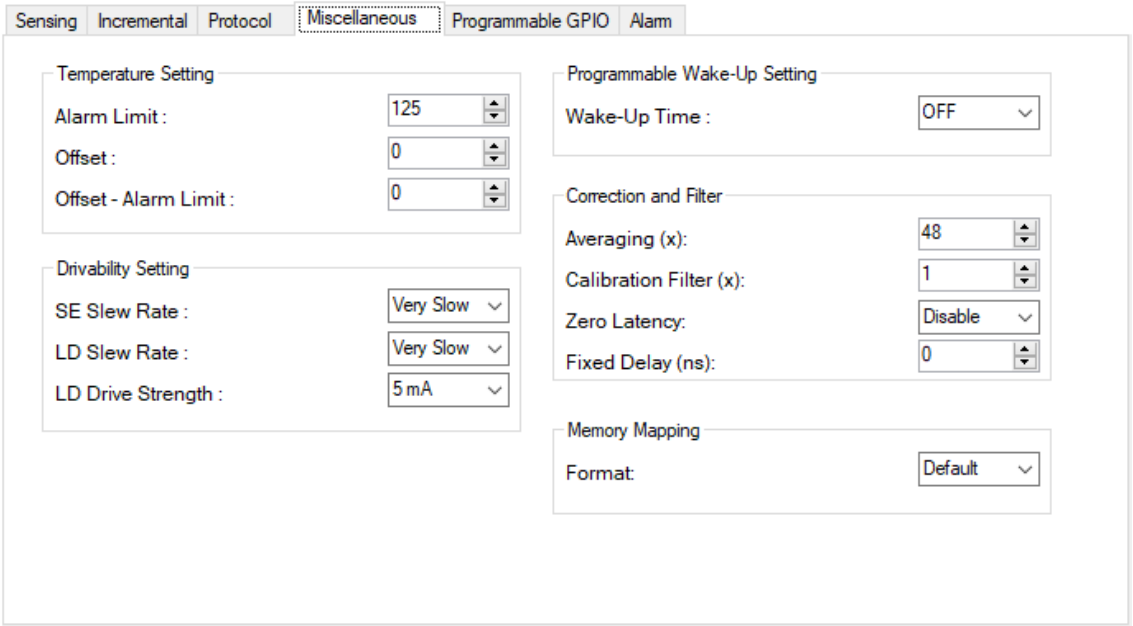
Protocol

- SSI Setting: Change the SSI protocol mode, frame format, and redundancy check.
- SPI Setting: Change the SPI4 protocol mode and redundancy check.
- RS485 Setting: Change the RS485 addressing, identification, baud rate, and broadcast timeout.



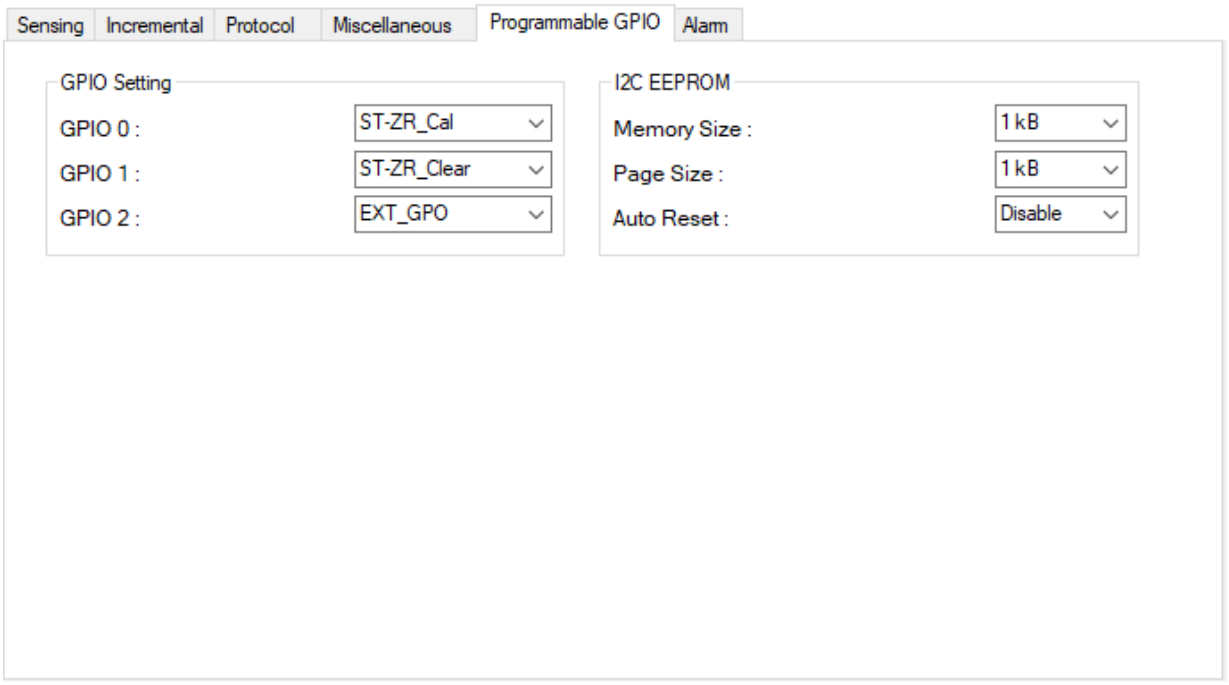
Miscellaneous

- Temperature Setting: Change the limit for the temperature alarm and the output offset.
- Drivability Setting: Change the switching timing and strength for SE (Single-Ended) or LD (Line-Driver).
- Programmable Wake-Up Setting: Change the wake-up timer.
- Correction and Filter: Change the correction and filtering setting to improve the noise level.



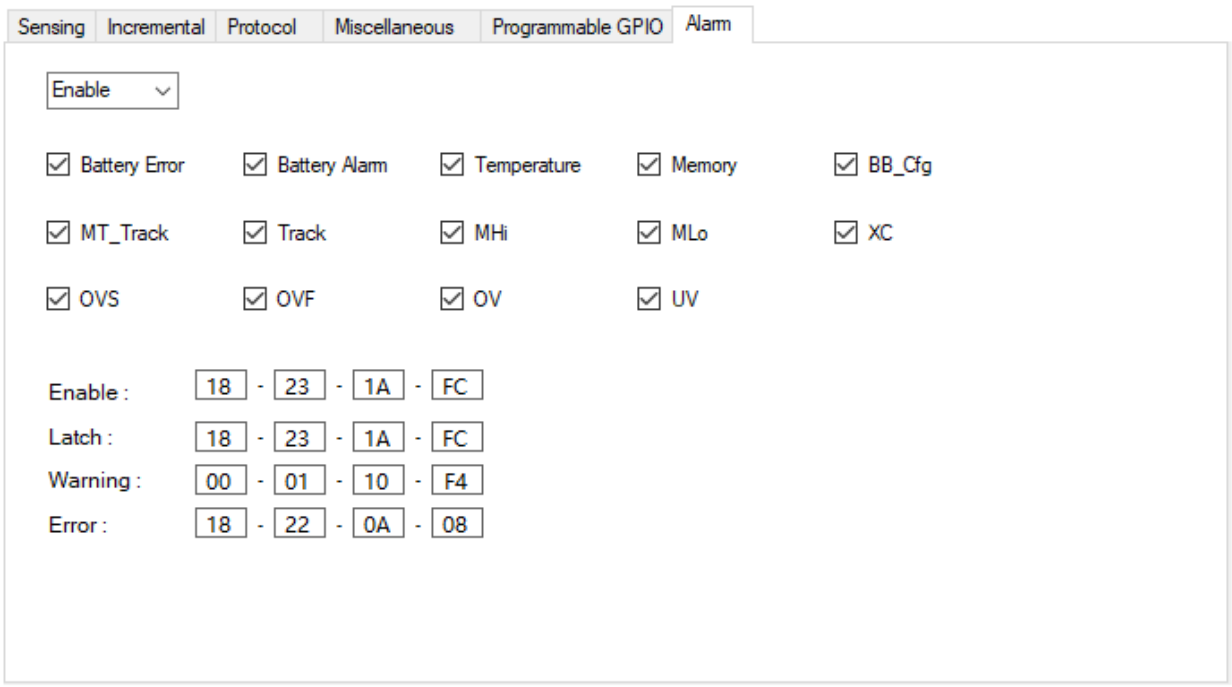
Programmable GPIO

- GPIO Setting: Assign any encoder function to the selected I/O pin.
- I2C EEPROM: Change the EERPOM memory and page size when using GPIO as I^2C.

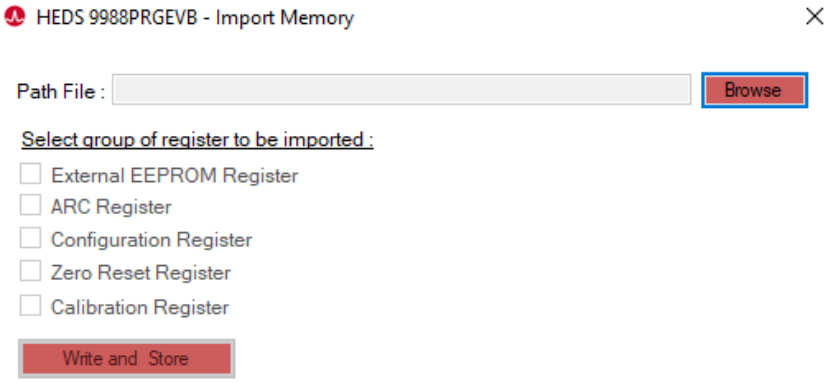


Alarm

Configure alarm behavior: Enable, Latch, Warning, or Error.



Import Encoder Configuration



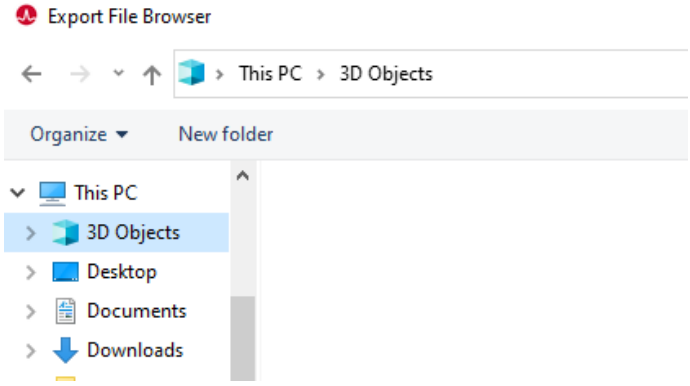
The **Import Memory** window consists of five groups of registers, which can be selected individually or in combination.

Import Encoder Configuration Procedure:

1. Click the **Import Memory** window; the preceding figure appears.
2. Click **Browse** to select the targeted file.
3. Select the checkbox for the targeted register group.
4. Click **Write and Store**.

The completion status appears below the **Write and Store** button.

Export Encoder Configuration



Export Encoder Configuration Procedure:

1. Click **Export Encoder Configuration**.
2. Enter the file name, select the file location, and click **Save**.

Calibration Process

Once the encoder is assembled (SMT) on the PCB, mount to the motor system with the magnet setup per the data sheet.

- The encoder configuration can be loaded before or after calibration.
- Perform Auto-Calibration followed by Zero Reset.

Auto-Calibration

1. Rotate the magnet at a constant speed (in any direction).
   The constant speed range is between 100 RPM to 2000 RPM.
2. Once the speed stabilizes, initiate the calibration sequence via the programming kit user interface.
   The calibration status will display once complete.

The calibration data is automatically saved in memory at the end of the sequence.

Zero Reset Calibration

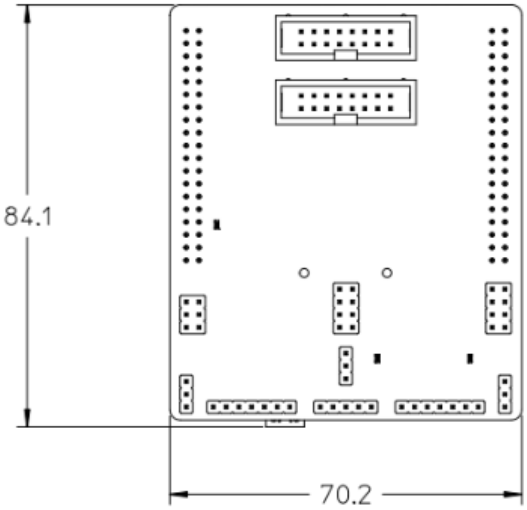
1. Stop the magnet at the reset position.
2. Initiate the reset calibration sequence via the software:
   – Commands via the PC software interface
   The calibration status will display once complete.

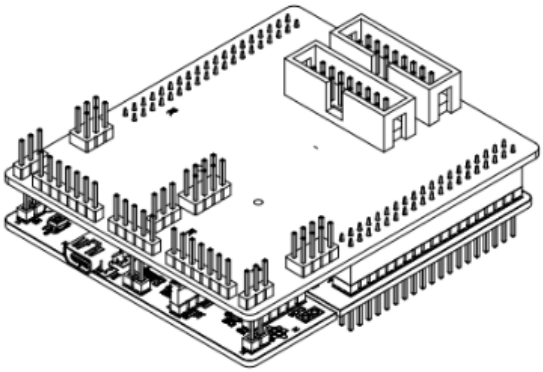
The calibration data is automatically saved in memory at the end of the sequence.

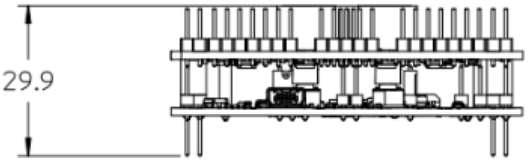
NOTE: For a detailed description of each of the parameters, refer to the data sheet and application note.

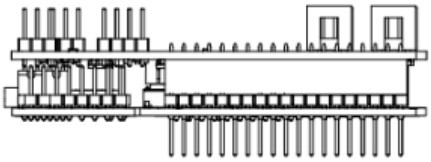
Mechanical Drawings

HEDS-9988PRGEVB



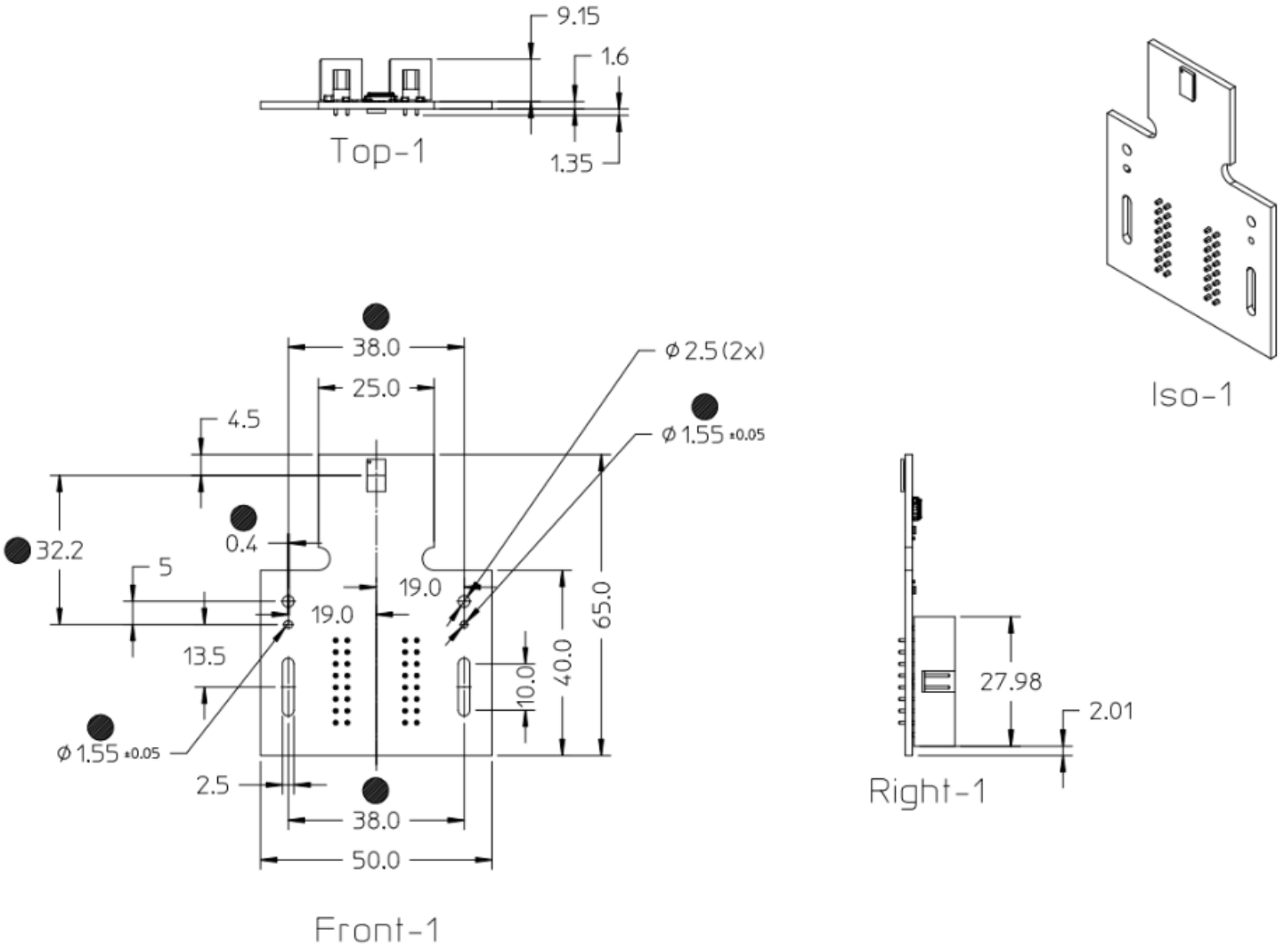






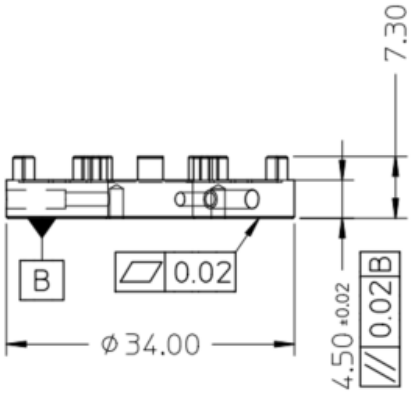
NOTE: All units are in mm.

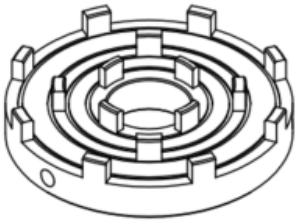
HEDS-9988MBEVB

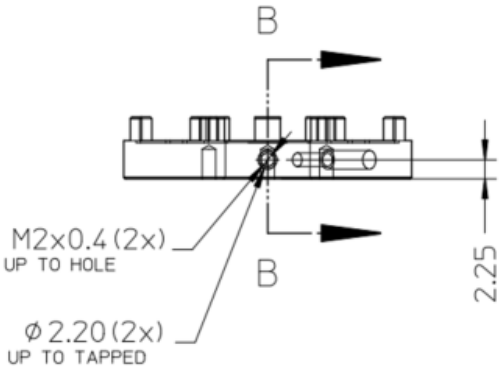


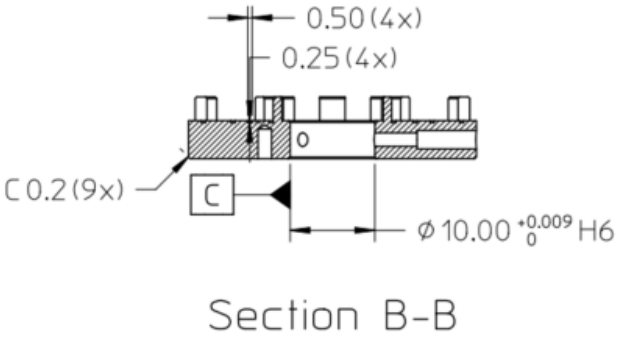
NOTE: All units are in mm.

Dual-Track Magnet Hub









Section B-B

NOTE: All units are in mm.

Ordering Information

Ordering Part Number	Product Description
HEDS-9988PRGEVB	AEAT-9988MB programming kit with 2 units of HEDS-9988MBEVB evaluation board, 1 set of hub ring magnet, and 1 set of magnet without hub.
HEDS-9988MEVB	AEAT-9988M SSI, SPI, RS-485 evaluation board.
HEDS-9988MBEVB	AEAT-9988MB SSI, SPI, RS-485, BiSS-C evaluation board.

BROADCOM®