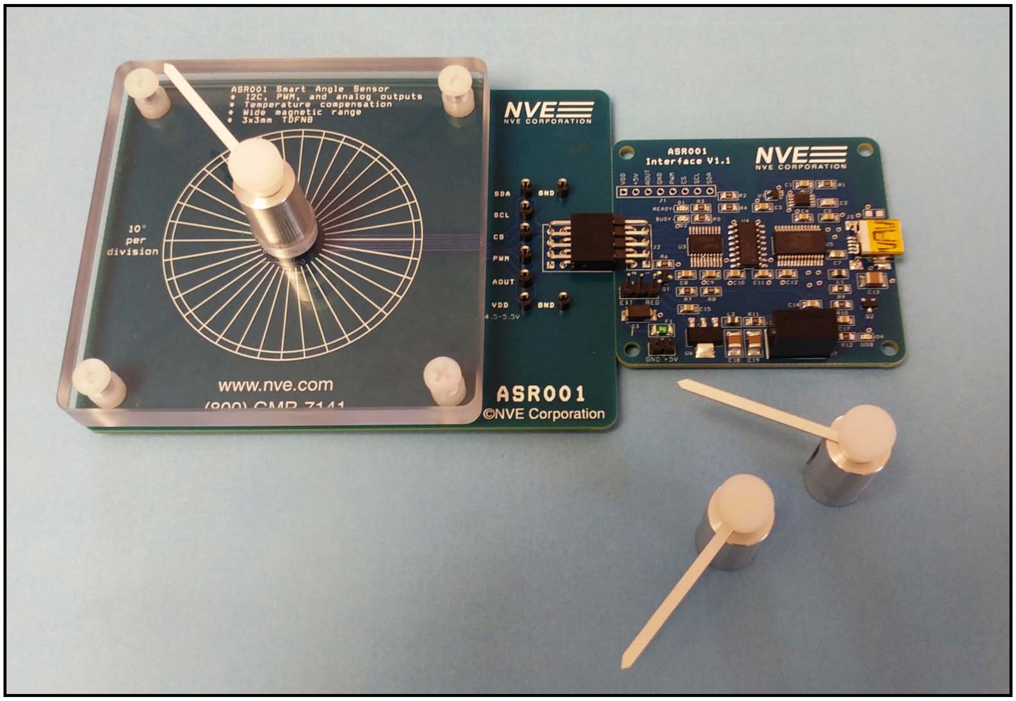
AG950: Digital Rotation Sensor Programming Module



Summary

The AG950 Evaluation Kit has everything you need to calibrate, test, and evaluate the remarkable ASR001-11E Smart Angle Sensor, including a Sensor Demonstration Board, Interface Board, Magnets, Software, and cables.

Evaluation Kit Features

- Three magnets.
- Adjustable magnet spacing.
- USB computer interface.
- Powerful, intuitive graphical user interface.
- Supports application-specific calibration.
- Flexibility to power from USB or external power supply.
- Isolated USB interface for safety and low noise.
- Simple software installation.

Contents

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1. Overview

This Evaluation Kit Includes:

- A sensor evaluation board including:
  – An ASR001-11E Smart Angle Sensor
  – A circuit board with all necessary components
  – A selection of diametrically magnetized ferrite magnets with knobs and fixturing to turn and adjust the magnets.

- Easy to install software and graphical user interface (Windows compatible)

- An interface board with:
  – A USB computer interface
  – An I²C sensor interface
  – A microcontroller
  – Isolated power supply

- USB to mini-B cable

ASR001 Features:

- Robust airgap and misalignment tolerances
- I²C, PWM, and analog outputs
- 12-bit output resolution
- 17-point piecewise curve fitting and linearization
- Programmable offset, gain, and phase compensation
- Internal temperature compensation
- 5 volt supply
- 3.3 volt or 5 volt compatible I²C interface
- Overvoltage/reverse voltage protection
- Ultraminiature 3 x 3 x 0.8 mm TDFN package

ASR001-11E Key Specifications:

- ±0.5° accuracy
- Wide 30 – 200 Oe magnetic field operating range
- Up to 6000 RPM (100 Hz)
- 2.5 kSps sample rate
- 2.6 mA typical supply current
- −40°C to +125°C operating range

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2. Quick Start

1.1. Install hardware and launch the ASR001 Interface application.

1.2. Click on MAIN tab and press *Connect* button. The software will attempt to connect to the first interface board it finds and the first I²C address that responds. A status string at the bottom of the tab indicates the connection status.

1.3 If successfully connected proceed to next step. If not, verify the connections and hardware configuration.

1.4. On MAIN tab press *Read EEPROM* button. This will read contents of sensor EEPROM and update the controls in the MAIN tab as well as the table in the EEPROM tab.

1.5. Select measurement source by pressing the *Analog*, *I2C*, or *PWM* button under the bottom display. Ensure the *Analog Enable* or *PWM Enable* buttons are set if using analog or PWM.

1.6. Press *Measure*. A single measurement will be taken and displayed in the digital displays as well as the chart or compass.

1.7. Press *Run* to put software in continuous run mode. The LED should blink green and the displays and will be updated with each measurement.

1.8. Use the EEPROM controls in bottom left of tab to alter device settings while either stopped or in continuous run mode.

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3. System Setup Details

The programming software interfaces to the ASR sensors through a USB cable to an interface board.

3.1 System Requirements

The minimum system requirements for the ASR programming software include:

- Windows 7 or later
- 100 MB of system memory
- One USB 2.0 port or powered USB hub (no self-powered hubs)
- Monitor (minimum 800 pixels vertical)

3.2 Software Installation

3.2.1. Download the software installation package from ***https://github.com/NveCorporation***

3.2.2. Unzip the download and run ***setup.exe*** to begin installation.

3.2.3. Follow prompts for installing the NVE software application as well as any supporting National Instruments files.

3.2.4. Download the FTDI VCP and D2XX drivers in either zip or executable format from ***http://www.ftdichip.com/Drivers/D2XX.htm***.

3.2.5. Install FTDI drivers as instructed.

3.3 Hardware Installation

The evaluation kit can be used in one of three configurations:

1. Standalone ASR001 sensor board only.
2. ASR001 sensor board connected to interface board powered by USB.
3. ASR001 sensor board connected to interface board powered by any external supply.

3.3.1. Stand-alone sensor board:

3.3.1.1. Connect an external 5V supply to VDD and GND test points.

3.3.1.2. The analog and PWM outputs can be measured using AOUT and PWM test points.

3.3.1.3. In addition, the SCL and SDA test points can be connected to a user-supplied I²C bus for communication with the device.

3.3.2 Sensor board with USB powered interface board:

3.3.2.1 Connect the sensor board to the interface board using the eight-pin connectors.

3.3.2.2 Place a jumper on J4 of interface board in the right position (REG) to power microcontroller and sensor using isolated 5V supply.

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3.3.2.3 Connect the interface board to PC using USB-mini to USB-A cable. The green LED labeled "*USB*" in lower-right corner of interface board should turn on after the PC configures the device. If it does not, check that the FTDI drivers were correctly installed.

3.3.2.4 The green LED labeled "*Ready*" in upper-left of interface board should turn on indicating that the microcontroller is now powered and ready. If it does not, verify that jumper on J4 is installed correctly.

3.3.3 Sensor board with externally powered interface board:

3.3.3.1 Connect the sensor board to the interface board using the eight-pin connectors.
Connect the interface board to PC using a USB-mini to USB-A cable. The green LED labeled "*USB*" in lower-right corner of interface board should turn on after the PC configures the device. If it does not, check that the FTDI drivers were correctly installed.

3.3.3.2 Place jumper on J4 of interface board in the left position (EXT) to power microcontroller and sensor from an external 5V supply.

3.3.3.3 Connect an external 5V supply to J5 with ground connected to left pin (GND) and power to right (+5V) pin. Verify voltage and polarity are correct before powering on.

3.3.3.4 Power the external supply. The green LED labeled "*Ready*" in upper-left of interface board should turn on indicating that the microcontroller is now powered and ready. If it does not verify that jumper on J4 is installed correctly.

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4. Sensor System

4.1. Sensor Evaluation Board

The sensor is mounted to a PCB with three external components, magnet fixturing, test points, and a connector to connect to an NVE interface board or the customer's own test or programming electronics:

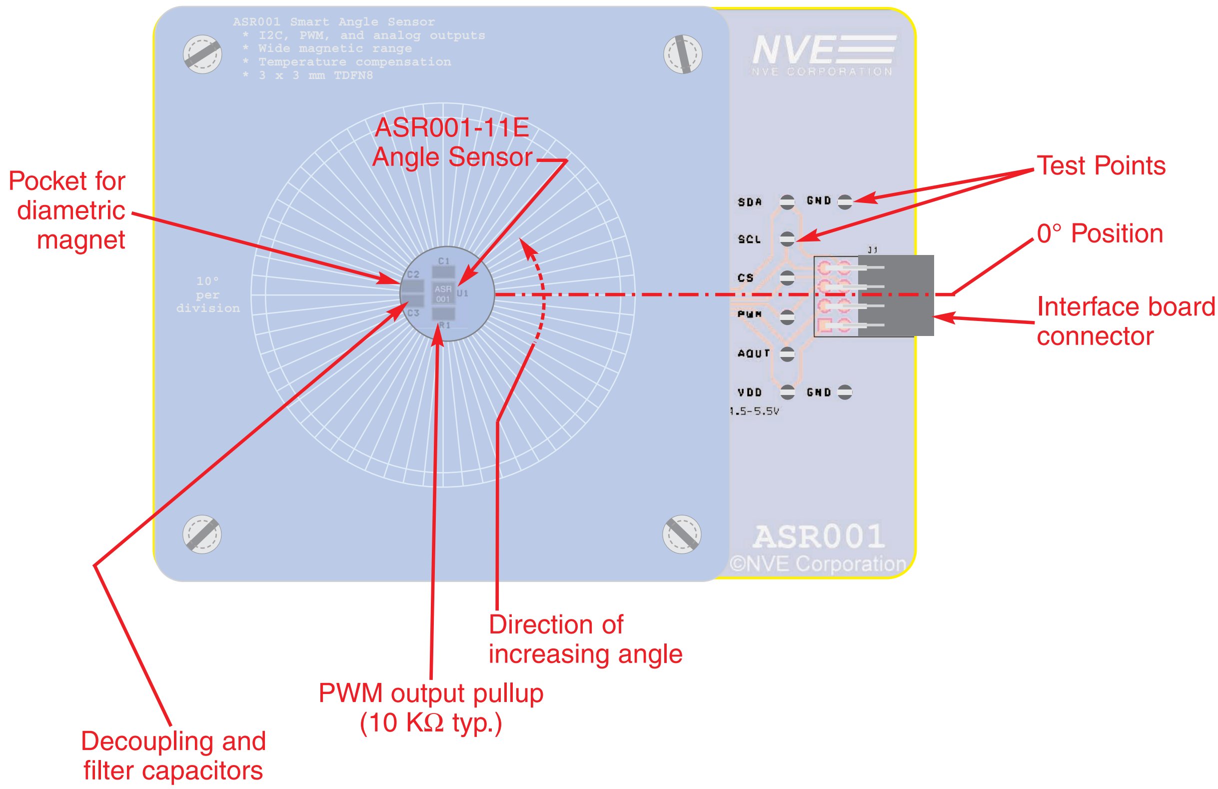

Figure 1. The ASR001 Evaluation Board (actual size).

Part Number	Designator	Manufacturer	Qty	Description
ASR001-11E	U1	NVE Corporation	1	SMART ANGLE SENSOR, TDFN8
GCM188R71C104KA37D	C1, C2	Murata Electronics NA	2	CAP CER 0.1UF 16V X7R 0603
CL10C103JA8NNNC	C3	Samsung Electro-Mechanics	1	CAP CER 10000PF 25V C0G/NP0 0603
RMCF0603FT10K0	R1	Stackpole Electronics Inc.	1	RES 10K OHM 1% 1/10W 0603
68021-208HLF	J1	Amphenol FCI	1	CONN HEADER 8POS .100 R/A 15AU
5002	N/A	Keystone Electronics	8	TEST POINT PC MINI .040"D WHITE

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4.2. Interface Board

The interface board communicates between a sensor evaluation board and a host computer:

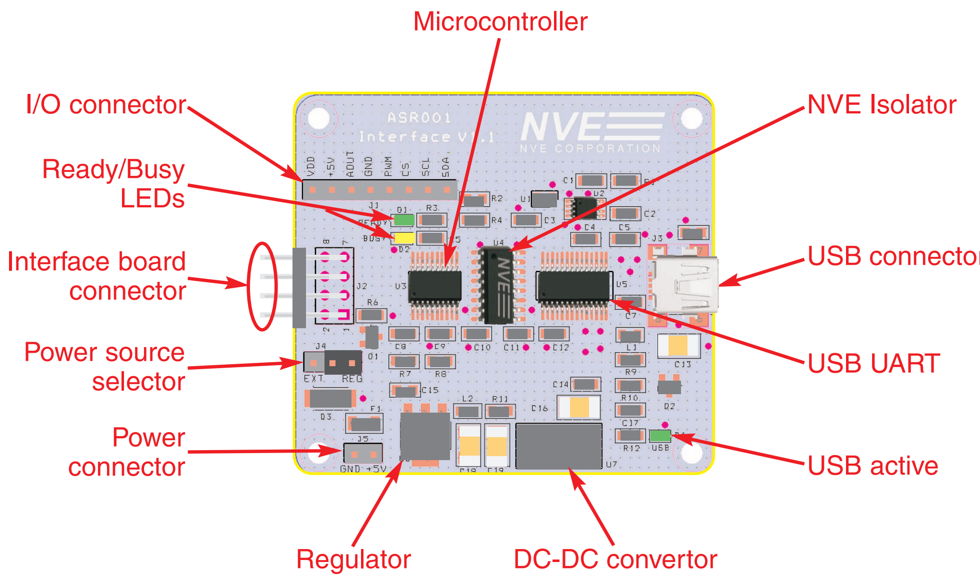

Figure 2. The Interface Board (actual size).

Part Number	Designator	Manufacturer	Qty	Description
SN74LVC1G02DCKR	U1	Texas Instruments	1	IC GATE NOR 1CH 2-INP SC-70-5
SN74LVC1G123DCTR	U2	Texas Instruments	1	IC SNGL MONO MULTIVIBTOR SM8
R5F1026AASP#V5	U3	Renesas Electronics America	1	IC MCU 16BIT 16KB FLASH 20LSSOP
IL717-3E	U4	NVE Corporation	1	4-CH (3 XMIT, 1 RCV) ISOLATOR
FT232RL	U5	FTDI, Future Technology Device	1	IC USB FS SERIAL UART 28-SSOP
UA78M05CDCYR	U6	Texas Instruments	1	IC REG LINEAR 5V 500MA SOT223-4
RO-0509S	U7	Recom Power	1	CONV DC/DC 1W 05VIN 09VOUT
LTST-C193KGKT-5A	D1, D4	Lite-On Inc.	2	LED GREEN CLEAR 0603 SMD
LTST-C193KSKT-5A	D2	Lite-On Inc.	1	LED YELLOW CLEAR 0603 SMD
DMP2100U-7	Q1, Q2	Diodes Incorporated	2	MOSFET P CH 20V 4.3A SOT23
GCM188R71C104KA37D	C1, C3-C5, C8-C12,C15,C17	Murata Electronics North Americ	11	CAP CER 0.1UF 16V X7R 0805
GRM2165C1H102FA01D	C2	Samsung Electro-Mechanics	1	CAP CER 1000PF 50V C0G/NP0 0805
CL21B103KBANNNC	C7	Samsung Electro-Mechanics	1	CAP CER 10000PF 50V X7R 0805
CL32B475KBJNFNE	C13	Samsung Electro-Mechanics	1	CAP CER 4.7UF 50V X7R 1210
CL21B102KBANNNC	C14	Samsung Electro-Mechanics	1	CAP CER 1000PF 50V X7R 0805
CL32B106KAULNNE	C16, C18, C19	Samsung Electro-Mechanics	3	CAP CER 10UF 25V X7R 1210
RMCF0805FT73K2	R1	Stackpole Electronics Inc.	1	RES 73.2K OHM 1% 1/8W 0805
RMCF0805FT4K70	R2, R4	Stackpole Electronics Inc.	2	RES 4.7K OHM 1% 1/8W 0805
RNCP0805FTD1K00	R3,R5,R7,R10-R12	Stackpole Electronics Inc.	6	RES 1K OHM 1% 1/4W 0805
RMCF0805FG100K	R6, R8	Stackpole Electronics Inc.	2	RES 100K OHM 1% 1/8W 0805
RNCP0805FTD10K0	R9	Stackpole Electronics Inc.	1	RES 10K OHM 1% 1/4W 0805
68021-208HLF	J2	Amphenol FCI	1	CONN HEADER 8POS .100 R/A 15AU
690-005-299-043	J3	EDAC Inc.	1	CONN MINI USB RCPT RA TYPE B SMD
5-146285-3	J4	TE Connectivity AMP Connector	1	CONN HEADR BRKWAY .100 3POS STR
146285-2	J5	TE Connectivity AMP Connector	1	02 MODII HDR SRST B/A .100CL
BK2125HS330-T	L1	Taiyo Yuden	1	FERRITE BEAD 33 OHM 0805 1LN
MLZ2012M100WT000	L2	TDK Corporation	1	FIXED IND 10UH 350MA 470 MOHM
SMAZ5V6-TPMSCT	D3	Micro Commercial Co	1	DIODE ZENER 5.6V 1W DO214AC
0ZCJ0025AF2E	F1	Bel Fuse Inc.	1	PTC RESET FUSE 24V 250MA 1206

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Board Schematics

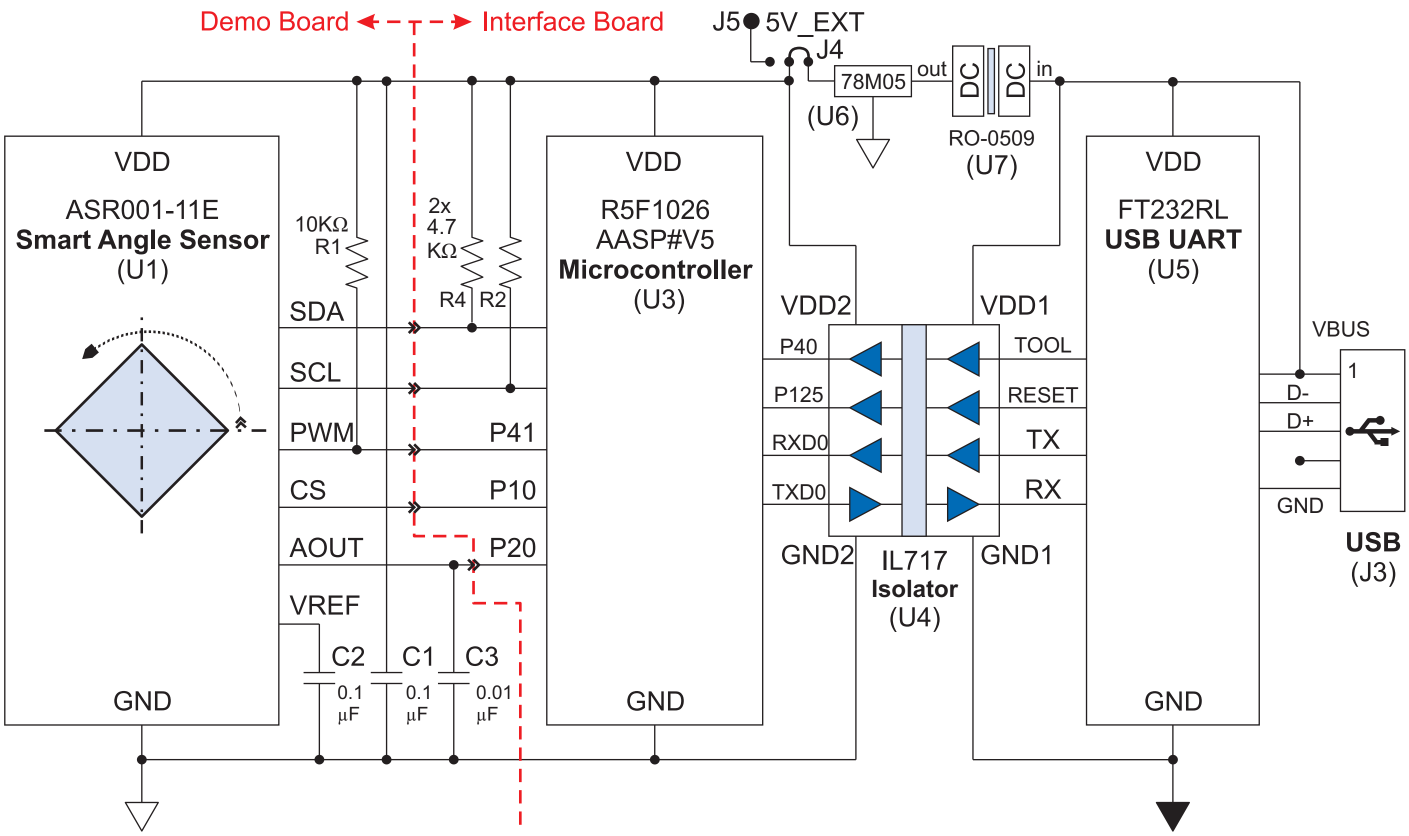

Figure 3. Board Schematics.

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4.3 Circuit Description—Sensor Evaluation Board

The Sensor

The ASR001 is an eight-pin component, all of which are available on the sensor evaluation board, with VDD and GND; I²C, PWM, and AOUT outputs; and the CS input.

ASR001 External Components

The ASR001 requires a maximum of just four external components. The Sensor Evaluation Board has 0.1 µF bypass capacitors on the V_{DD} and V_{REF} pins as recommended. There is also a 0.01 µF filter capacitor on the sensor's analog output (this is not needed if the analog output isn't used). The filter capacitor has a low temperature coefficient for consistency over temperature.

Finally, there is a 10 KΩ pullup resistor on the sensor's PWM output. The PWM output is open drain to allow interface to various power supplies. The resistor is not needed if the connected device input has its own pullup, if the PWM speed is low, if precise PWM rise-times aren't required, or if the PWM output isn't used.

4.4 Circuit Description—Interface Board

Microcontroller

The ASR001 is compatible with almost any microcontroller. This interface board uses a popular Renesas RL78/G12 16-bit microcontroller (U3).

I²C

I²C provides the main link between the sensor and the microcontroller. The ASR001 is an I²C Slave, and the microcontroller is configured as the Master. The ASR001 I²C interface is compatible with 3.3 or five-volt microcontrollers. The Interface Board in this evaluation kit uses a five-volt microcontroller.

In accordance with industry standards, the ASR001 SDA line is open-drain. The Interface Board provides 4.7 kΩ pull-up resistors (R2 and R4) on SCL and SDA for maximum flexibility. In many cases, a microcontroller's internal pull-up resistors can be activated in software to reduce parts count.

When external pull-ups are used with different power supplies, they should be connected to the lower supply voltage, which is generally the microcontroller supply.

Isolated USB Interface

A USB UART (U5) provides the computer interface. An IL717-3E isolator (U4) provides isolation from the interface board to the computer's USB. This eliminates ground-loop noise and any fear of damaging the computer. A low-cost DC-DC convertor (U7) and voltage regulator (U6) provide an isolated UART power supply.

Power Supplies

J4 on the Interface Board selects whether the microcontroller and sensor are powered by the on-board DC-DC convertor or an external supply (connected to J5).

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LEDs

Green and yellow LEDs D1 and D2 indicate the I²C interface is ready or busy. Green LED D4 shows USB bus activity.

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5. User Interface

The ASR001 Interface provides a means of measuring of all the sensor output modes (analog, PWM, and digital via I²C), reading and writing of the sensor EEPROM, and remapping of the sensor output using the piecewise linear (PWL) feature.

On starting the ASR001 Interface application, a single window with four tabbed panels is displayed. The four tabs are:

1. Main – Displays measurement results in both digital and graphical formats and allows control of data acquisition and the sensor's EEPROM measurement settings.

2. PWL – Contains a table and graphical representation of the PWL remapping along with a number of command buttons for reading and writing to the PWL section of the sensor's EEPROM. Also allows saving and loading PWL configurations to a file.

3. EEPROM – Contains a table with the contents of the sensor EEPROM. The EEPROM can be directly written to by entering values into the table. Command buttons are provided for reading or writing the contents of the table to a file.

4. COMM/I²C – Provides control of communication with the interface board (COMM section) and sensor (the I²C section), along with miscellaneous functions.

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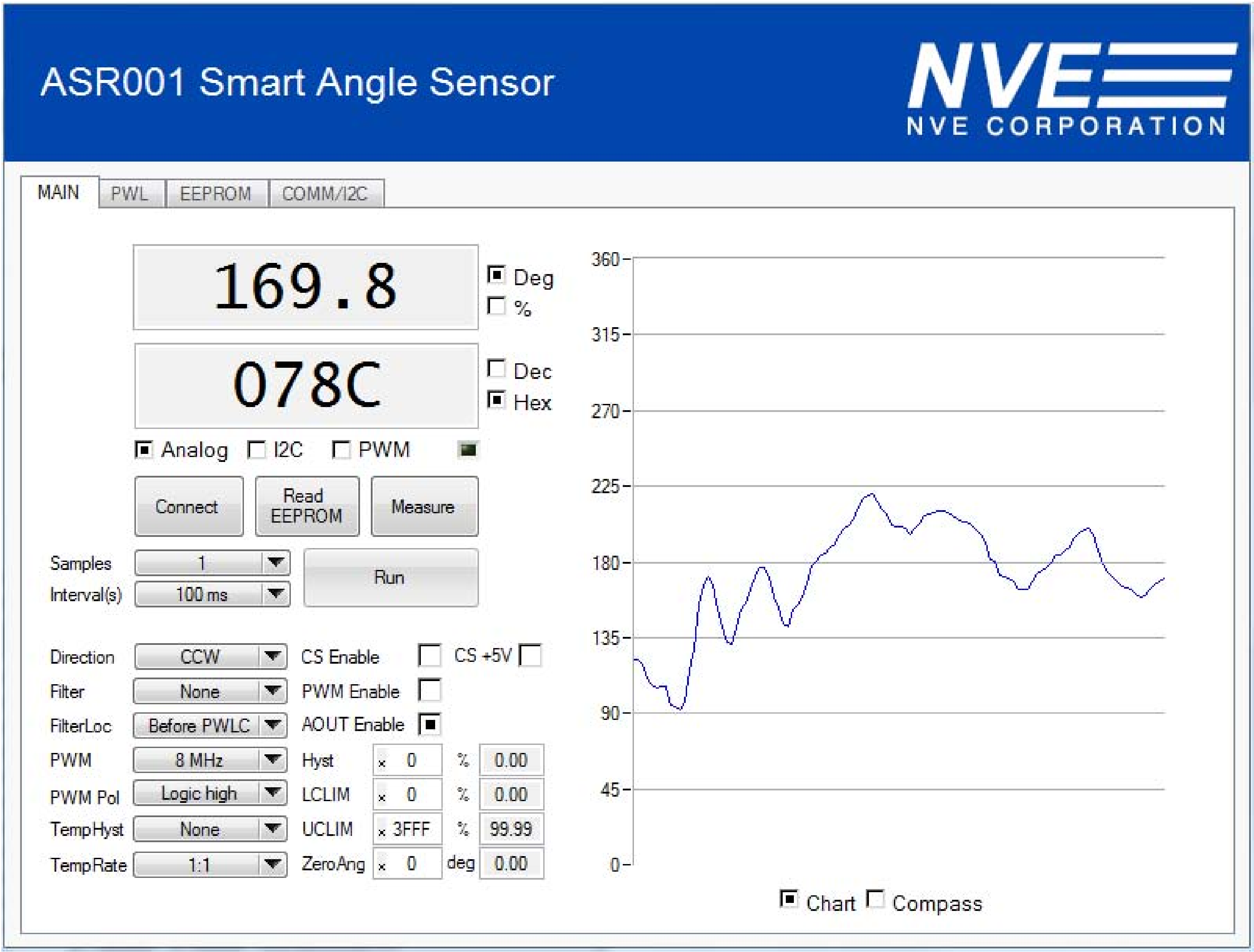
5.1. Main Tab



Main tab elements are described below:

Upper Digital Display – Displays the output of the device in units of either degrees or percent of full scale. Double right-clicking on the display changes precision.

Lower Digital Display – Displays the raw 12-bit sensor output in either decimal or hexadecimal format.

Deg – Sets upper display to degree units.

% – Sets upper display to percent of full scale output.

Dec – Sets lower display to decimal format.

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Hex – Sets lower display to hexadecimal format.

Analog – Selects analog output of the sensor (as measured by microcontroller ADC) as the display source. "*Analog output*" must be enabled in the device EEPROM to use this source. Note: The microcontroller ADC is 10 bits but is oversampled for a 12-bit output.

I²C – Selects digital output via I²C to be displayed.

PWM – Selects PWM output (as measured by microcontroller) to be displayed. PWM must be enabled in the sensor EEPROM when using this source.

LED – This indicator (located to the right of the PWM button) displays the measurement status as follows:

- Off – No activity.
- Green (blinking) – The microcontroller is continuously acquiring data.
- Red (solid) – The most recent measurement wasn't successful (device was disconnected, I²C did not ACK, etc.), and continuous run mode (if active) has been stopped.

Connect – Connects to the interface board and sensor using a quick-connect routine. The software will scan USB for the first interface board it finds and connect. Then it will scan the I²C bus for the first device that responds and set that I²C address as the default. This connection method can be used if only one interface board is connected to the PC, and there is only one sensor on the I²C bus. If more than one board or sensor are connected, manual connections should be made using COMM/I2C tab.

Read EEPROM – Reads the sensor's EEPROM and updates both the table in the EEPROM tab and the controls in the lower-left section of the MAIN tab.

Measure – Takes a single measurement of the selected source (analog, I²C, or PWM) and displays the result in the digital displays and either the chart or compass. If the measurement fails, the *LED* indicator will be set red.

Run/Stop – Pressing *Run* puts the software in continuous run mode. Measurements will be made with a time interval set by *Interval* and sample count set by *Samples*. The button text will change to *Stop* in this mode and pressing it again will exit continuous run mode. If a series of measurements fail while in continuous run-mode, the software will automatically stop and the *LED* indicator will be set to red.

Samples – Sets the number of samples the microcontroller acquires and averages for each measurement. Note: Setting high sample counts may prevent the software and microcontroller from running at the desired speed set by *Interval*.

Interval – Controls the sample interval time in continuous run mode. Note: Actual interval times may be affected by system performance, I²C data rate, and sample size.

Chart – Displays a “strip chart” on right side of the tab showing the measurement result on the y-axis and the sample number on the x-axis. The chart is updated with each measurement.

Compass – Displays a “compass” on the right side of the tab that shows the measurement.

The ***lower-left section*** of the MAIN tab contains controls that write directly to the sensor EEPROM and change setting in real time. Changes made to these controls will be reflected in the table in the EEPROM tab. Pressing *Read EEPROM* from the MAIN tab or EEPROM tab will synchronize the controls with the EEPROM’s data. These controls are as follows:

Direction – If set to “CCW,” the sensor output will increase with counterclockwise rotation direction and vice versa (the sensor default is CCW).

Filter – Sets the filter mode (see datasheet for details).

FilterLoc – Sets the filter location to either before or after the piecewise linear (“PWL”) section.

PWM – Sets the pulse-width modulation (“PWM”) output frequency. The actual waveform frequency on the PWM output in Hertz will be 1/4096 of this value.

PWM Pol – Sets the PWM polarity.

TempHyst – Sets the temperature hysteresis, which is how much internal temperature measurement has to change before its value is updated.

TempRate – Sets the ratio of the sensor temperature value to internal temperature measurement.

CS Enable – Sets the chip select bit in the sensor EEPROM. If set, the sensor will not acknowledge its I^2C address unless the CS pin is driven high. Note: Setting the *Chip Select* while the CS pin is driven low will prevent the sensor from responding to its I^2C address. In this situation, the CS pin should be driven high using *CS+5V* button to restore communication.

CS+5V – Applies 5V to the sensor CS pin when set.

PWM Enable– Enables the PWM output if set.

Analog Enable – Enables the analog output if set.

Hyst – Sets the hysteresis of angle output result. By default, the number displayed in bits, and the format can be changed using the radix on the left of the control. The “%” field to the right represents the hysteresis value as a percentage of full-scale.

LCLIM – Sets the lower clipping limit. The number displayed is in bit units, and the format can be changed using the radix on the left of the control. The “%” field to the right shows percentage of full-scale.

UCLIM – Sets the upper clipping limit. The number displayed is in bit units, and the format can be changed using the radix on the left of the control. The "%" field to the right shows percentage of full-scale.

ZeroAng– Sets the zero angle of the sensor. The default display is in bit units, and the format can be changed using the radix on the left of the control. The "deg" field to the right represents the zero angle in degrees.

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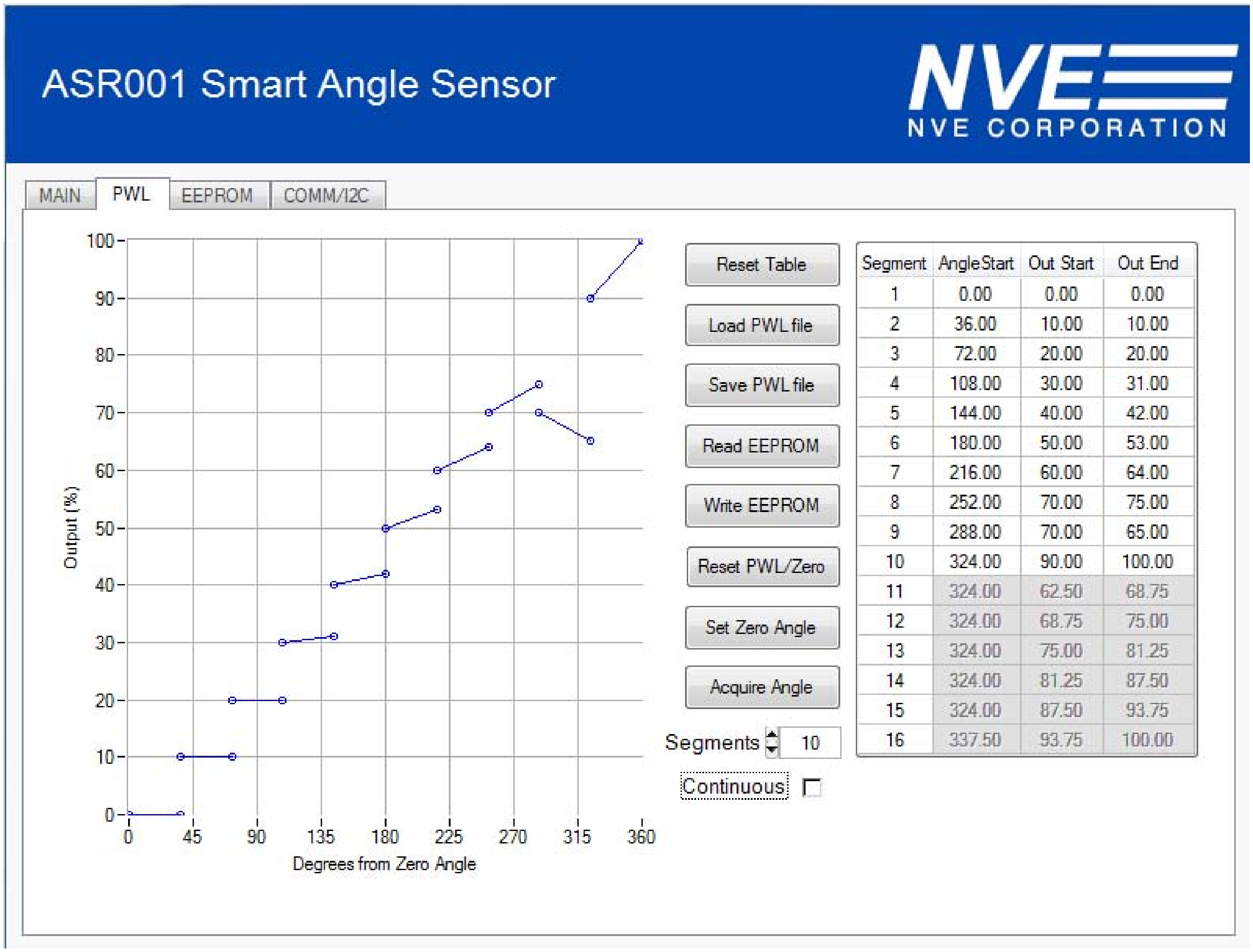
5.2. PWL Tab



Elements of the *PWL* tab are as follows:

Table – This table contains the piecewise linear (PWL) remapping of the internal sensor measurement to output using one to 16 segments. Each segment is defined by one row of the table. The *Angle Start* column contains the start angle of the segment relative to the zero position. The *Out Start* column contains the output (0 to 100%) of the segment at the start angle. The *Out Stop* column contains the output (0 to 100%) of the segment where it ends and the next segment begins. The contents of the table will be displayed on the *Graph* in real time. Inactive segments in the table will be dimmed and not displayed on the graph.

Graph – This displays the PWL parameters. The default 1:1 mapping produces a linear output of 0 to 100% over an angular input of 0 to 360 degrees.

Segments – Sets the number of active segments ranging from one to 16. Inactive segments will be dimmed in the table and not reflected in the graph.

Continuous – Forces the PWL remapping to be continuous. The *Out End* column will be dimmed and the *Out End* value of each segment will be set to the *Out Star*t value of the following segment (except for the last defined segment, which requires an end output).

Reset Table – Resets the table to a simple 16- segment linear mapping. Note: This does not update the sensor EEPROM.

Load PWL – Loads a user-selected PWL file from the PC into the *Table*. Note: This does not update the sensor EEPROM.

Save PWL – Saves the table contents to a user selected PWL file.

Read EEPROM – Reads the PWL mapping contained in the sensor EEPROM into the table.

Write EEPROM – Writes the PWL mapping in the table to the sensor EEPROM.

Reset PWL/Zero – Resets the PWL section of the sensor EEPROM to its default mapping (single segment, linear one-to-one) and resets the *ZEROANG* to zero. The table will not be updated by this operation, only the EEPROM.

Set Zero Angle – Reads the sensor output and sets the *ZEROANG* register in the EEPROM to that value. This effectively zeroes the sensor output. Note: The PWL should be reset to its default mapping using the *Reset PWL/Zero* button before setting the *ZEROANG* using this method.

Acquire Angle – Reads the sensor output and puts the value (0 to 360) in the *AngleStart* cell that is currently selected in the table. This only applies if a cell in the table is selected. If successful, the cell immediately below the active cell will be selected, allowing another point to be measured. This is useful for defining segment start points using a physical magnet or field source.

5.2.1. PWL Procedures

The following steps can be used for basic editing of the PWL remapping.

5.2.1.1 Connect to interface board and sensor using the *Connect* button on the MAIN tab.

5.2.1.2. Click on the PWL tab.

5.2.1.3. Press *Read EEPROM* to read current PWL remapping from EEPROM into table. Alternatively press *Reset Table* to reset table to default remapping or *Load PWL* to load a saved PWL into the table.

5.2.1.4. Use table to adjust segment start angles, output start values, and output end values. Use *Segments* control to select number of active segments and set *Continuous* button if a continuous remapping is desired.

Note 1: Segment angles must be in increasing order. If an angle value is entered for a segment that is smaller than the angle of the previous segment or larger than the angle of the following segment the angles will be displaced to keep them in increasing order.

Note 2: Segment 1's angle can be set larger than zero. If so, segment 1's slope will be extended backward to zero degrees.

Note 3: The last active segment will always extend to 360 degrees.

5.2.1.5. At any point the *Reset Table* button can be pressed to reset the table and graph to the default remapping.

5.2.1.6. After the desired PWL remapping is defined in the table, press *Write EEPROM* to write the new remapping to the sensor EEPROM.

5.2.1.7. Values can be saved to a user-selected file if desired by pressing the *Save PWL* button.

5.2.2. Programmed PWL while the sensor is in a fixture with a rotatable magnetic field.

5.2.2.1. Connect to interface board and sensor using the *Connect* button on the MAIN tab.

5.2.2.2. Press *Reset PWL/Zero* to reset EEPROM to default linear remapping (0 to 360 degrees, 0 to 100% output) and zero angle. This will reset EEPROM but not the table in order to preserve any changes the user may have made to the table.

5.2.2.3. Enter the number of segments to be used into the *Segments* control.

5.2.2.4. Enter the desired output start and output end values in the table for the active segments. This can also be done at the end of segment angle acquisition or any other time.

5.2.2.5. Rotate magnetic field source to the position defined as zero degrees and press *Set Zero Angle*. The present field angle will now be defined as 0 degrees.

5.2.2.6. In the table select the *Angle Start* cell of the first segment.

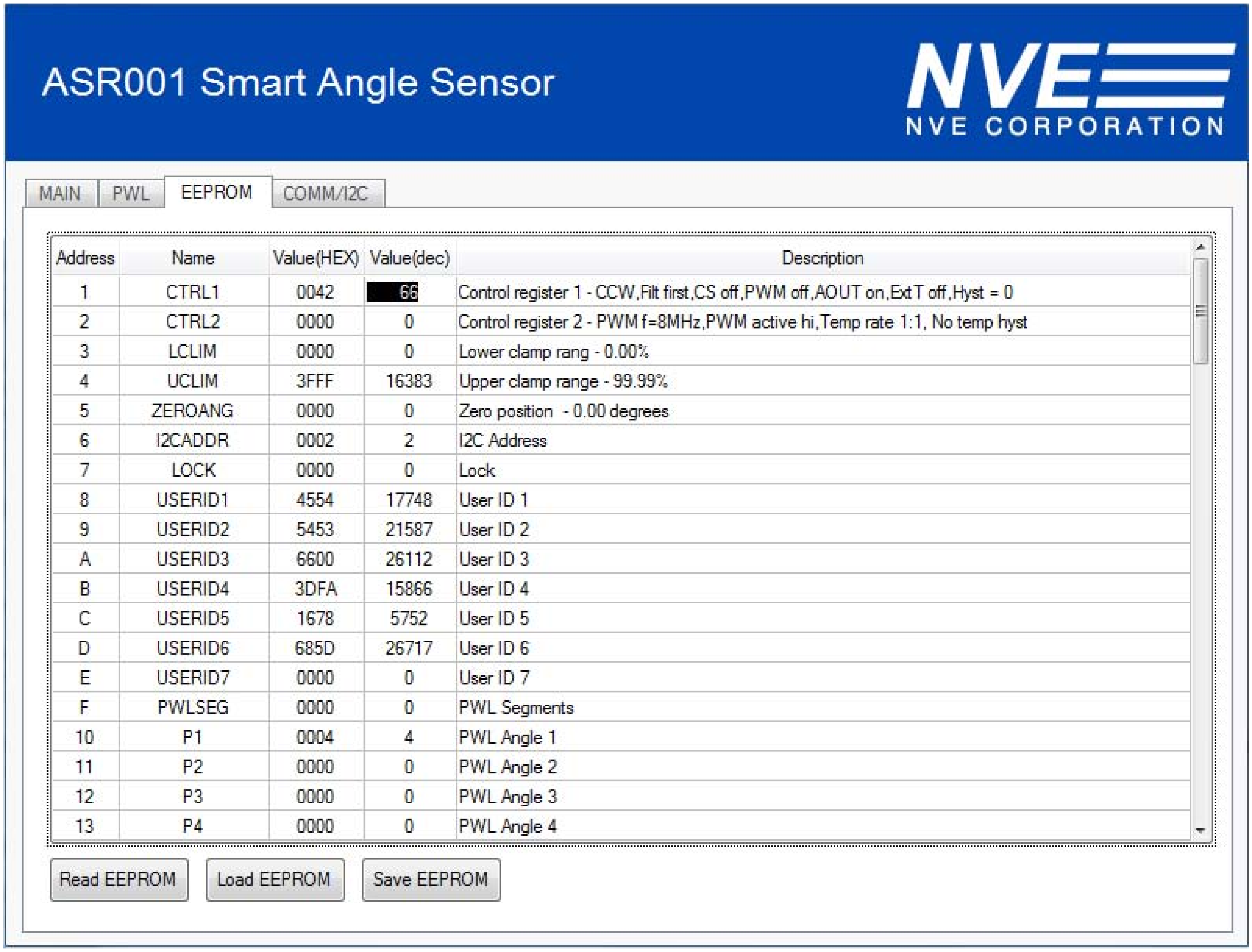
5.2.2.7. Rotate the magnetic field source to the start position of the first segment and press *Acquire Angle*. The measured angle will be placed in selected *Angle Start* cell and the next segment's *Angle Start* cell will be selected.

5.2.2.8. Rotate magnetic field source to the start position of the next segment and press *Acquire Angle*.

5.2.2.9. Repeat the previous step until the start angles of all desired segments are acquired. At any time a previous segment's *Angle Start* cell can be re-selected and re-measured. Note: An error will be generated if a segment's measured angle is less than the previous segment's angle.

5.2.2.10. When all segment start angles are measured and outputs are defined in the table, press *Write EEPROM* to write the parameters to the sensor EEPROM.

5.3. EEPROM Tab



Address	Name	Value(HEX)	Value(dec)	Description
1	CTRL1	0042	66	Control register 1 - CCW,Filt first,CS off,PWM off,AOUT on,ExtT off,Hyst = 0
2	CTRL2	0000	0	Control register 2 - PWM f=8MHz,PWM active hi,Temp rate 1:1, No temp hyst
3	LCLIM	0000	0	Lower clamp rang - 0.00%
4	UCLIM	3FFF	16383	Upper clamp range - 99.99%
5	ZEROANG	0000	0	Zero position - 0.00 degrees
6	I2CADDR	0002	2	I2C Address
7	LOCK	0000	0	Lock
8	USERID1	4554	17748	User ID 1
9	USERID2	5453	21587	User ID 2
A	USERID3	6600	26112	User ID 3
B	USERID4	3DFA	15866	User ID 4
C	USERID5	1678	5752	User ID 5
D	USERID6	685D	26717	User ID 6
E	USERID7	0000	0	User ID 7
F	PWLSEG	0000	0	PWL Segments
10	P1	0004	4	PWL Angle 1
11	P2	0000	0	PWL Angle 2
12	P3	0000	0	PWL Angle 3
13	P4	0000	0	PWL Angle 4

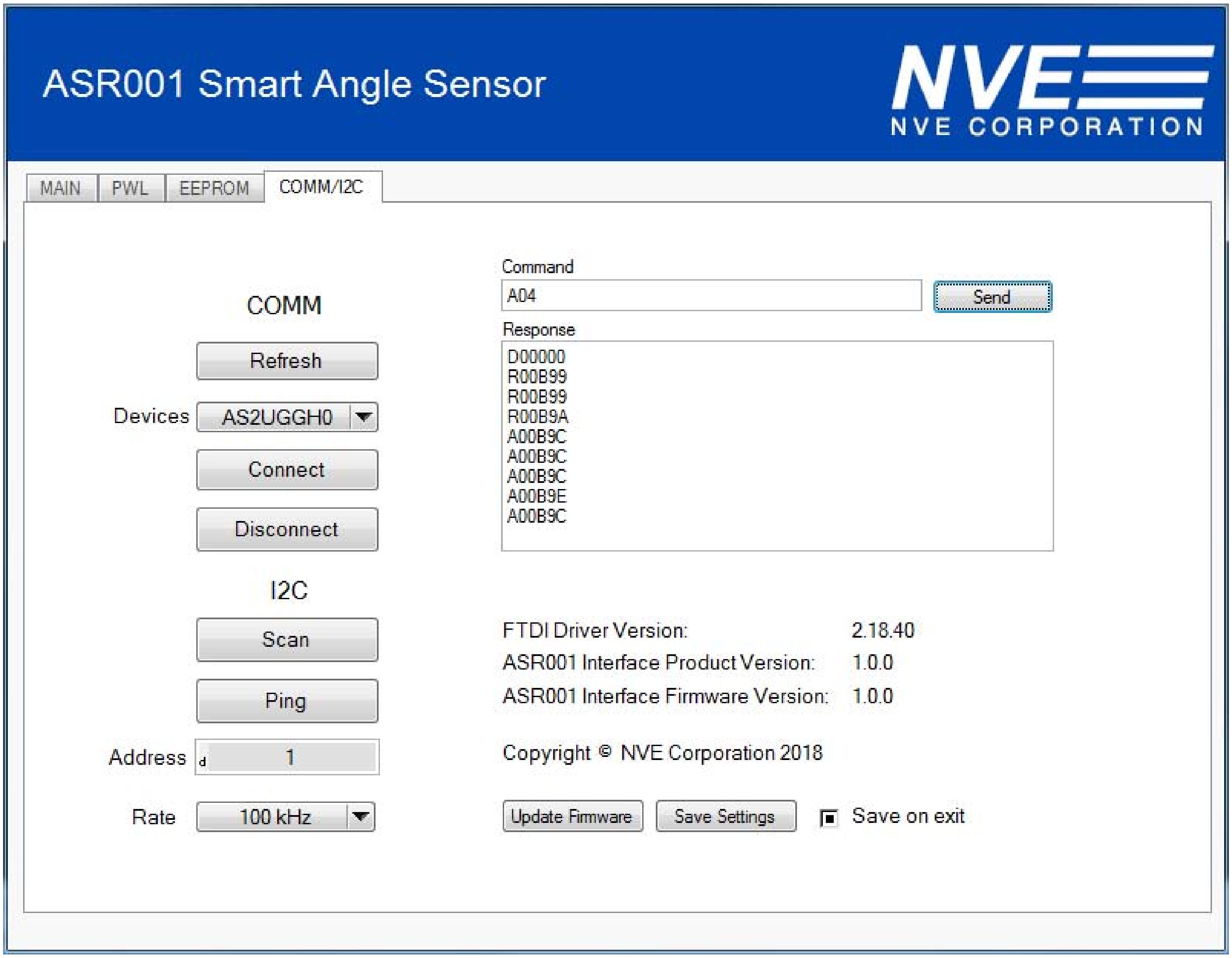
table in the PWL tab displays the contents of the sensor EEPROM. Entering a value into either the *Value(HEX)* or *Value(dec)* columns will write that value to the sensor EEPROM. If writing to CTRL1, *CTRL2, LCLIM, UCLIM*, or *ZEROPOS*, the EEPROM controls on the MAIN tab will be updated to reflect the new values. Note: When writing to the I2CADDR register, the microcontroller's I²C Master address is also changed to maintain communications.

There are three PWL tab buttons:

> *Read EEPROM* – Reads the contents of the sensor EEPROM and updates the table. The EEPROM controls on the MAIN tab will are also updated.
>
> *Load EEPROM* – Reads an EEPROM image from a user-selected file, writes it to the sensor EEPROM, and then reads back the sensor EEPROM into the table.

Save EEPROM – Saves the contents of the EEPROM table to a user-selected file. To save a connected sensor's EEPROM, it should be first read using *Read EEPROM* before saving to ensure the table matches the sensor.

5.4. I²C/COMM Tab



Elements of the I²C/COMM tab are as follows:

Refresh – Scans USB ports for connected interface boards and displays their serial number in the *Devices* list.

Devices – Displays connected interfaces boards found using *Refresh* button.

Connect – Connects to the interface board selected in the *Devices* list using the I²C address and data rate in the *Address* and *Rate* controls. The driver, firmware, and product revisions of connected devices are read and displayed.

Command – Command strings can be sent directly to the microcontroller by entering and pressing the *Send* button. Leading and terminating characters should be omitted as they will be added by software before sending. See Section 4.7 for more information on the USB serial communication protocol.

Send – Sends the command entered in the *Command* string to the microcontroller.

Response – Displays the response string for commands sent to the microcontroller using *Command*. All commands receive either a response or an error message.

Scan – Causes the microcontroller to step through all valid I²C addresses, starting with zero, until a device responds to that address. If more than one ASR device is attached to the I²C bus, the address should be set manually using the *Address* control.

Ping – Attempts a single read from the microcontroller's active I²C Master address. This can be used to verify the microcontroller (Master) I²C address matches the attached sensor's (Slave) address.

Address – Writing to this control updates the I²C Master address for the microcontroller. The value ranges from 0 to 127 and represents the upper seven bits of the device address byte written over the I²C bus.

Rate – Sets the clock rate of the I²C bus.

Update Firmware – Updates the interface board's microcontroller firmware with a user-selected SREC file (.mot). Firmware updates can be obtained from https://github.com/NveCorporation.

Save Settings – Writes software settings (I²C address and rate, formats, units, file pathnames) to an INI file (ASR001_Interface.ini) in a user-specified directory. The software will load the INI file from this directory on startup unless a new directory is selected.

Save on exit – If set the software on program exit will write the current settings to the active INI file directory (selected using *Save Settings*). If no new directory has been selected, it will save the values to the current working directory containing the executable.

5.5. Serial USB Communications

The interface board appears as a virtual COM port to the PC. This allows communications with any terminal or serial communication software. In addition, the *Command* field on the COMM/I2C tab can be used to send commands directly to the microcontroller. This section defines the COM settings and protocol for communicating with the interface board.

The virtual COM port settings are summarized in the following table:

Baud Rate	115200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Table 1. Virtual COM port settings.

The communication protocol with the interface board uses ASCII characters for ease of debugging. Commands sent to the interface board are variable in length and include a leading character STX (ASCII character 0x02) and a terminating character ETX (ASCII character 0x03). Responses from the interface board are always eight bytes long, including the leading character STX and terminating character ETX.

The first character of any command following the leading character is a command character ("W","R", etc.) followed by zero to several hexadecimal values in ASCII format (e.g. "W06001F"). The entire command string, including leading and terminating characters, for this example will then be "/02W006001F/03". Commands are listed in the following table:

	Byte										
Command	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Format**	**Example**
Read analog output	STX	"A"	n	n	ETX					Ann	"A10" Read 16 samples from AOUT
Read PWM	STX	"P"	n	n	ETX					Pnn	"P04" Read 4 samples from PWM
Read digital angle	STX	"D"	n	n	ETX					Dnn	"D08" Read 8 samples from I2C
Set sample size	STX	"N"	n	n	ETX					Nnn	"N10" Set default sample size to 16
Read analog output	STX	"A"	ETX								"A" Read default # samples from AOUT
Read PWM	STX	"P"	ETX								"P" Read default # samples from PWM
Read digital angle	STX	"D"	ETX								"D" Read default # samples from I2C
Read EEPROM	STX	"R"	a	a	ETX					Raa	"R0F" Read EEPROM address 15
Write EEPROM	STX	"W"	a	a	v	v	v	v	ETX	Raavvvv	"W06003A" Write 58 to EEPROM address
Read system version	STX	"S"	ETX								"S"
Read firmware version	STX	"X"	ETX								"X"
Drive chip select high	STX	"C"	ETX								"C"
Drive chip select low	STX	"c"	ETX								"c"
Power on VDD	STX	"V"	ETX								"V"
Power off VDD	STX	"v"	ETX								"v"

Table 2. ASR001 Interface Board serial protocol commands.

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There are always replies to commands. Replies will either echo the command character with additional data, or there will be an error message in the format "ERR_nn," where "nn" is the error value.

Command responses are listed in the following table:

Response	Byte 0	1	2	3	4	5	6	7	Format	Example
Read analog output	STX	"A"	"0"	v	v	v	v	ETX	A0vvvv	"A00800" Measurement result of 2048
Read PWM	STX	"P"	"0"	v	v	v	v	ETX	P0vvvv	"P00010" Measurement result of 32
Read digital angle	STX	"D"	"0"	v	v	v	v	ETX	D0vvvv	"D000FF" Measurement result of 255
Set sample size	STX	"N"	"0"	"0"	"0"	n	n	ETX	N000nn	"N00001" Default sample size set to 1
Read EEPROM	STX	"R"	"0"	v	v	v	v	ETX	R0vvvv	"R042AA" Read 0x42AA from EEPROM
Write EEPROM	STX	"W"	"0"	v	v	v	v	ETX	W0vvvv	"W0063A" Wrote 0x063A to EEPROM
Read system version	STX	"S"	c	c	c	c	c	ETX	Sccccc	"V1010F" Version 1.1.15
Read firmware version	STX	"X"	c	c	c	c	c	ETX	Xccccc	"V10F10" Version 1.15.32
Drive chip select high	STX	"C"	"0"	"0"	"0"	"0"	"0"	ETX	C00000	"C00000" Chip select driven high
Drive chip select low	STX	"c"	"0"	"0"	"0"	"0"	"0"	ETX	C00000	"c00000" Chip select driven low
Power on VDD	STX	"V"	"0"	"0"	"0"	"0"	"0"	ETX	V00000	"V00000" VDD powered on
Power off VDD	STX	"v"	"0"	"0"	"0"	"0"	"0"	ETX	v00000	"v00000" VDD powered off
Scan I2C address	STX	"I"	"0"	"0"	"0"	n	n	ETX	I000nn	"I00010" Device ACK to address 16
Set I2C address	STX	"I"	"0"	"0"	"0"	n	n	ETX	I000nn	"I00001" Active I2C address set to 1
Set I2C Rate	STX	"F"	n	n	n	n	n	ETX	Fnnnnn	"F00064" Set I2C rate to 100kHz

Table 3. ASR001 Interface Board command responses.

Interface Board error responses and responses codes are listed in the following table:

Error Response	Byte 0	1	2	3	4	5	6	7	Example
Error	STX	"E"	"R"	"R"	"_"	v	v	ETX	"ERR_01" Error number 1

Error Number	Interpretation
1	Syntax error - Invalid command character or improperly formatted command
2	Invalid command - Valid and properly formatted command but illegal value
3	I2C Busy - Unable to obtain free I2C bus
4	I2C TX Failed - Failed I2C transmission
5	I2C NACK - Successful I2C transmission but no ACK from target device

Table 4. ASR001 Interface Board error codes.

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6. Magnets and Magnetics

The Evaluation Kit comes with three popular diametrically-magnetized ferrite disk magnets and magnet holders that allow an adjustable air-gap between the sensor and magnet. The magnets are readily available and low cost.

The evaluation magnet holders are preset for different ASR001 operating fields. The magnetic field versus magnetic holder recess is summarized in Table 3 for each of the three magnets:

Magnetic Field (Oe)	Magnet Diameter (mm)	Magnet Length (mm)	Default Magnet Holder Recess (mm)	Magnet Material
50	4	4	1.7	Ferrite C5/Y25 or similar
110	8	8	3.3	
180	8	4	0.9	

Table 5. Three magnet holders are provided in the ASR001 evaluation kit, each with different size and position.

To simulate various mechanical configurations and evaluate sensitivity to mechanical variations, distance from the bottom of the magnet to the active sensor plane can be changed. This spacing changes the magnetic field at the sensor The distance includes the fixed stand-off distance created by the plastic fixture (which is a constant 3.0 mm), and the adjustable magnet recess in the magnet holder as shown in Fig. 4:

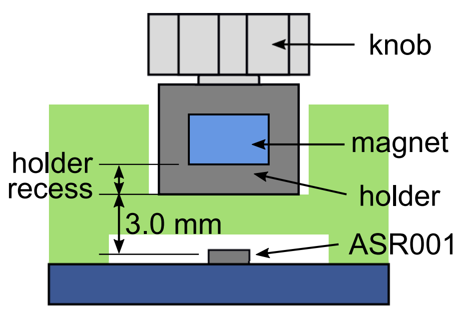

Figure 4. The magnet-to-sensor distance is set by the magnet holder recess plus 3.0 mm.

The sensor-magnet air-gap can be adjusted by loosening the set screw on the side of the 4 mm diameter magnet holder, sliding the magnet to the preferred recess, and tightening the set screws. The 8 mm magnet is not adjustable.

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The magnetic field created by each magnet at the top of the sensor is set according to the graphs in Figure 5:

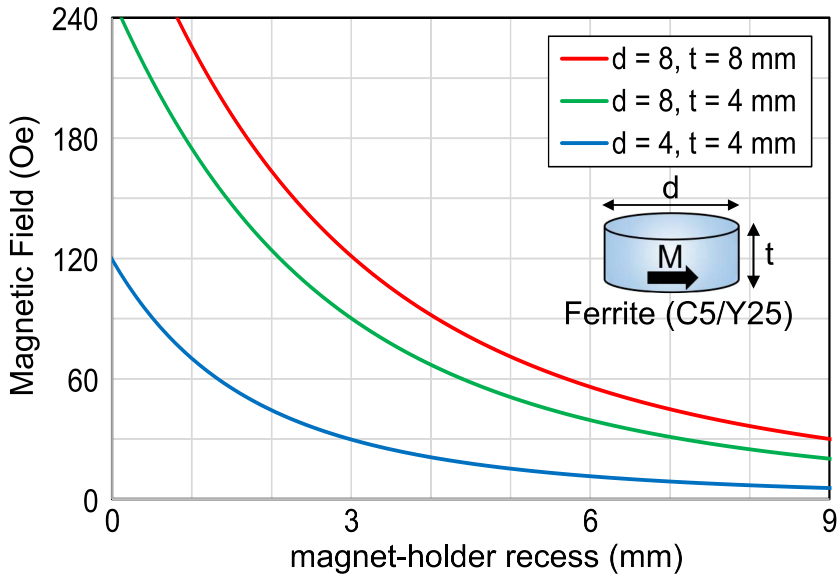

Figure 5. Magnetic fields from the evaluation magnets.

The sensor operates with as little as a 30 Oe magnetic field and is accurate up to 200 Oe. Maximizing the magnet size within the mechanical constraints of the system provides the best accuracy.

Larger or stronger magnets require more distance to avoid oversaturating the sensor; smaller or weaker magnets may require closer spacing. Refer to NVE's web apps to determine the optimum operating separations for other magnet sizes and materials at ***https://www.nve.com/spec/calculators.php***.

7. Troubleshooting

- USB inactive (green LED labeled "USB" inactive)
  - Check USB cable.
  - Reinstall the FTDI USB drivers.

- USB inactive (green LED labeled "USB" inactive)
  - Check USB cable.
  - Reinstall the FTDI USB drivers.

- Green LED not active
  - Verify jumper J4 is installed correctly.

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8. Revision History

SB-00-074-PRELIM	Change
May 2018	• Initial Release

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