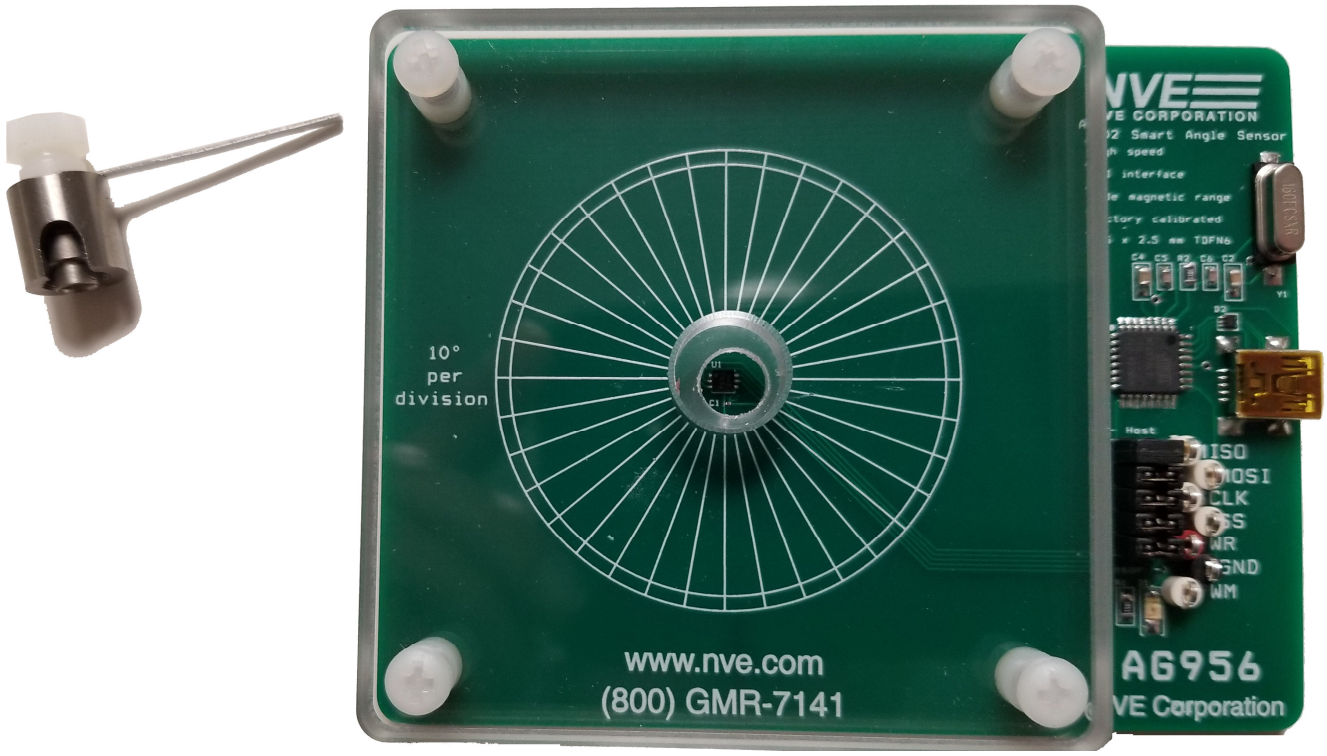
AG956-07E / AG963-07E:
ASR002 / ASR012 Smart Angle Sensor Evaluation Kit



Summary
These Evaluation Boards provide clean, efficient user interface for the ASR002-10E (SPI) or ASR012-10E (I²C) Smart Angle Sensors.

The evaluation kits include:

- A USB-powered Evaluation Board
- An ASR0x2-10E sensor
- A diametrical magnet, indicator hand, and fixturing for the magnet
- A microcontroller connected to the sensor
- A regulated 3.3-volt supply to power the Sensor
- A USB cable to connect the Evaluation Board to a computer
- A powerful, intuitive graphical user interface

Contents

1. Overview

The Evaluation Kit Includes:

- An ASR0x2-10E evaluation board
- A USB stick with single-click install Windows-compatible user interface software
- A diametrically magnetized magnet
- USB to mini-B cable

ASR0x2-10E Features:

- 60 – 200 Oe field operating range for robust airgap and misalignment tolerances
- SPI (ASR002-10E) or I²C (ASR012-10E) interface
- 0.1° resolution
- ±2° accuracy
- 12500 samples/second
- Factory calibrated
- Internal temperature compensation
- 2.2 to 3.6V supply
- 4 mA typical supply current
- –40°C to +125°C
- Ultraminiature 2.5 x 2.5 x 0.8 mm TDFN6 package

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2. Quick Start

2.1. Connect the Evaluation Board to a computer via the USB cable.

2.2. Place a magnet in the holder and the assembly in the Plexiglas pocket:

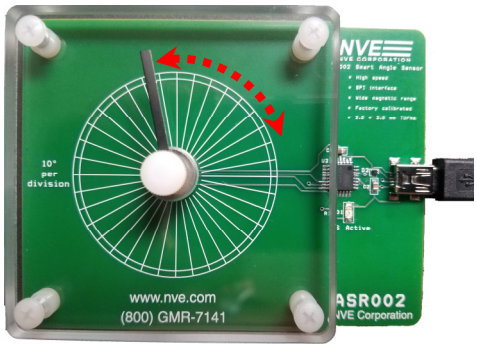


Figure 1. The ASR0x2 Evaluation Board.

2.3. Run the user interface Setup file from the USB stick if provided, or download from https://github.com/NveCorporation to install the user interface on a Windows PC.

2.4. Click on the desktop icon to launch the application.

2.6. The user interface will show the sensor output.

3. The Evaluation Board

3.1 Board Layout

The key features of the evaluation board are shown below:

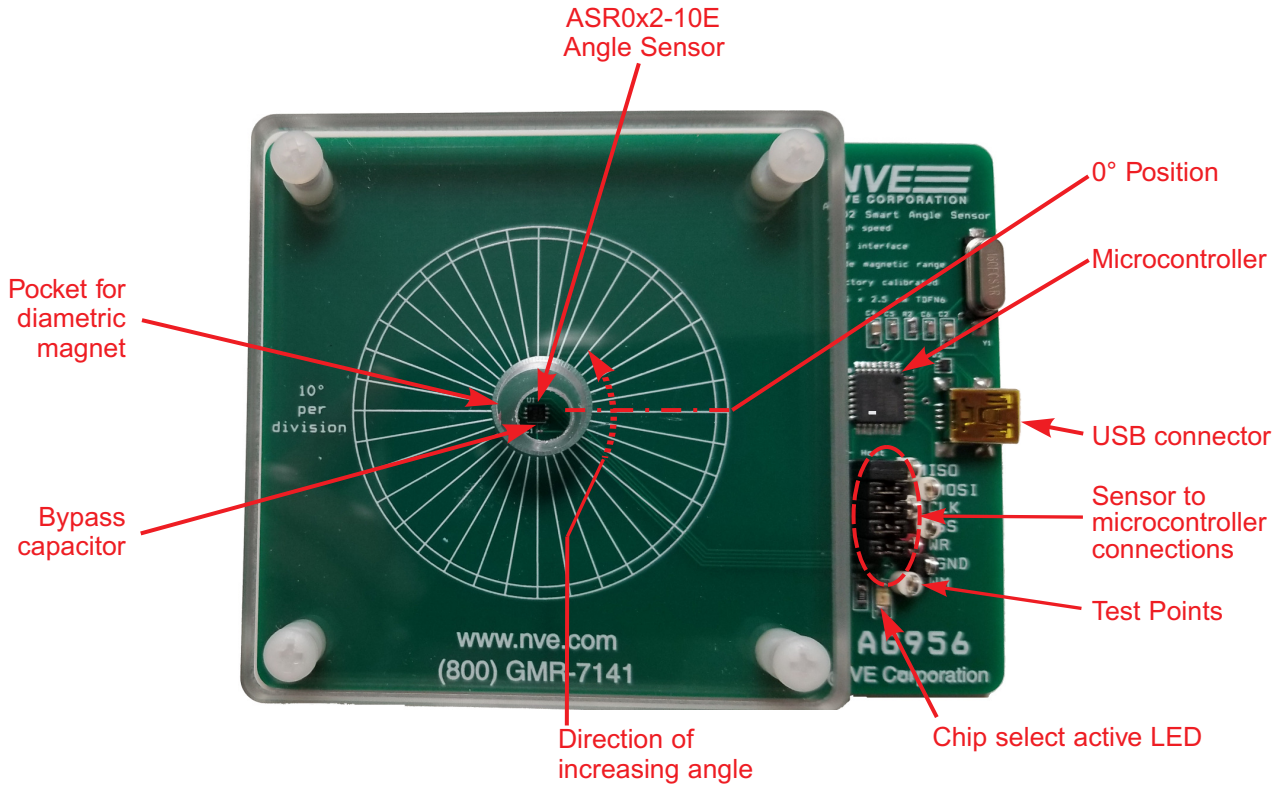


Figure 2. The Evaluation Board (actual size).

Part Number	Designator	Manufacturer	Qty	Description
		Board-Level Components		
ASR002-10E / ASR012-10E	U1	NVE	1	SMART TMR ANGLE SENSOR
ATMEGA16U2-AU	U2	Microchip Technology	1	IC MCU 8BIT 16KB FLASH 32TQFP
APT3216LSECK/J3-PRV	D1	Kingbright	1	LED RED CLEAR 1206 SMD
	R1	Generic	1	RES 1K OHM 1% 1/4W 0805
	R2	Generic	1	RES 1M OHM 1% 1/10W 0603
	R3	Generic	1	0-OHM JUMPER (DNP) 1206 (AG963-07E only)
TPD2E001DRLR	D2	Texas Instruments	1	TVS DIODE 5.5V SO T5
GRM033C71C104KE14D	C1	Murata Electronics	1	CAP CER 0.1UF 16V X7S 125C 0201
LMK212AB7106MG-T	C2, C4	Taiyo Yuden	1	CAP CER 10UF 10V X7R 125C 0805
GRM21BR71C105KA01L	C3	Murata Electronics North Am	1	CAP CER 1UF 16V X7R 0805
CL10C200JB8NNNC	C5, C6	Samsung Electro-Mechanics	2	CAP CER 20PF 50V C0G/NP0 0603
ECS-160-20-5PX-TR	Y1	ECS Inc.	1	CRYSTAL 16.0000MHZ 20 PF SMD
690-005-299-043	J1	EDAC Inc.	1	CONN MINI USB RCPT RA TY PE B SMD
TSW-10x-07-T-D	J2	Samtec Inc.	1	CONN HEADER VERT 2.54MM
500x		Keystone Electronics		TEST POINT PC MINI .040"D
	J3			Diagnostic port (DNP; AG963-07E only)
		Package-Level Components		
12426	N/A	NVE	1	Split-Pole Round Horseshoe Magnet
N/A	N/A	NVE	1	NVE-branded USB stick with PC install file
N/A	N/A	Generic	1	3ft FLAT USB 2.0 Type A Male to Mini-B/5 Male

3.2 AG956-07E Schematic

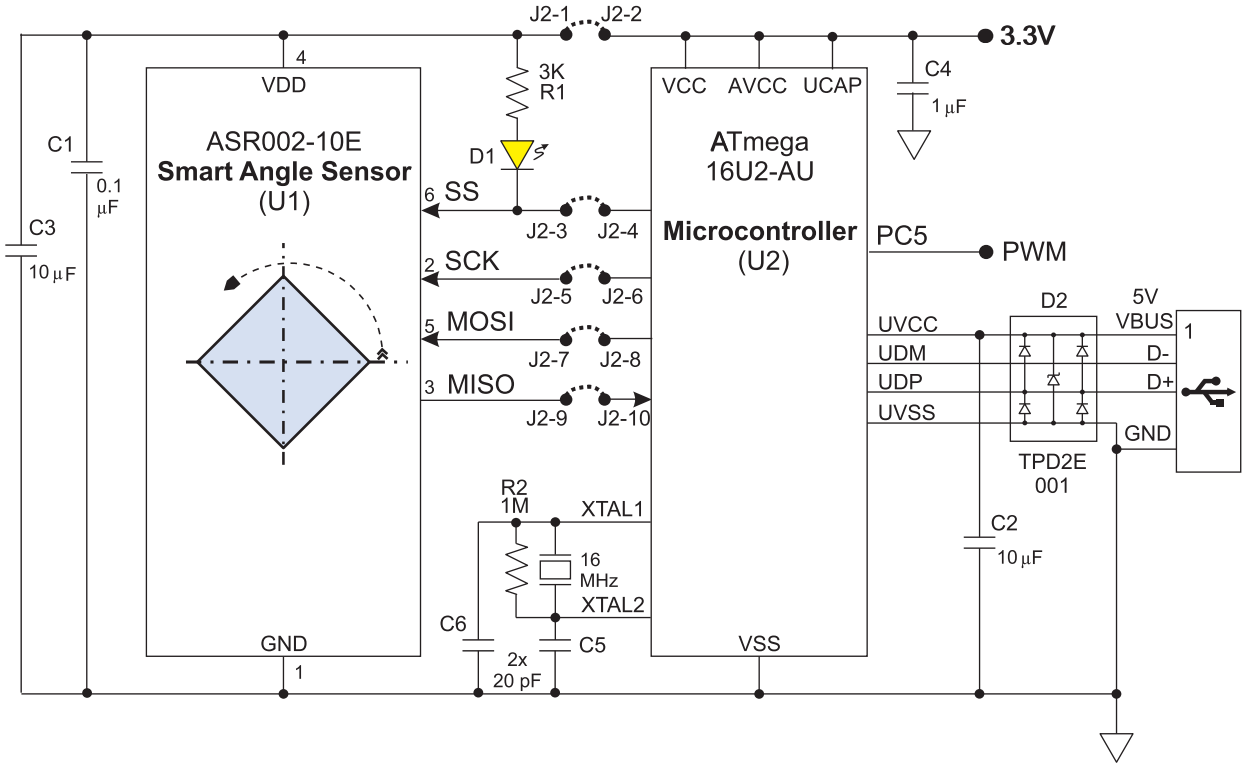


Figure 3. AG956-07E Evaluation Board Schematic.

3.2 AG963-07E Schematic

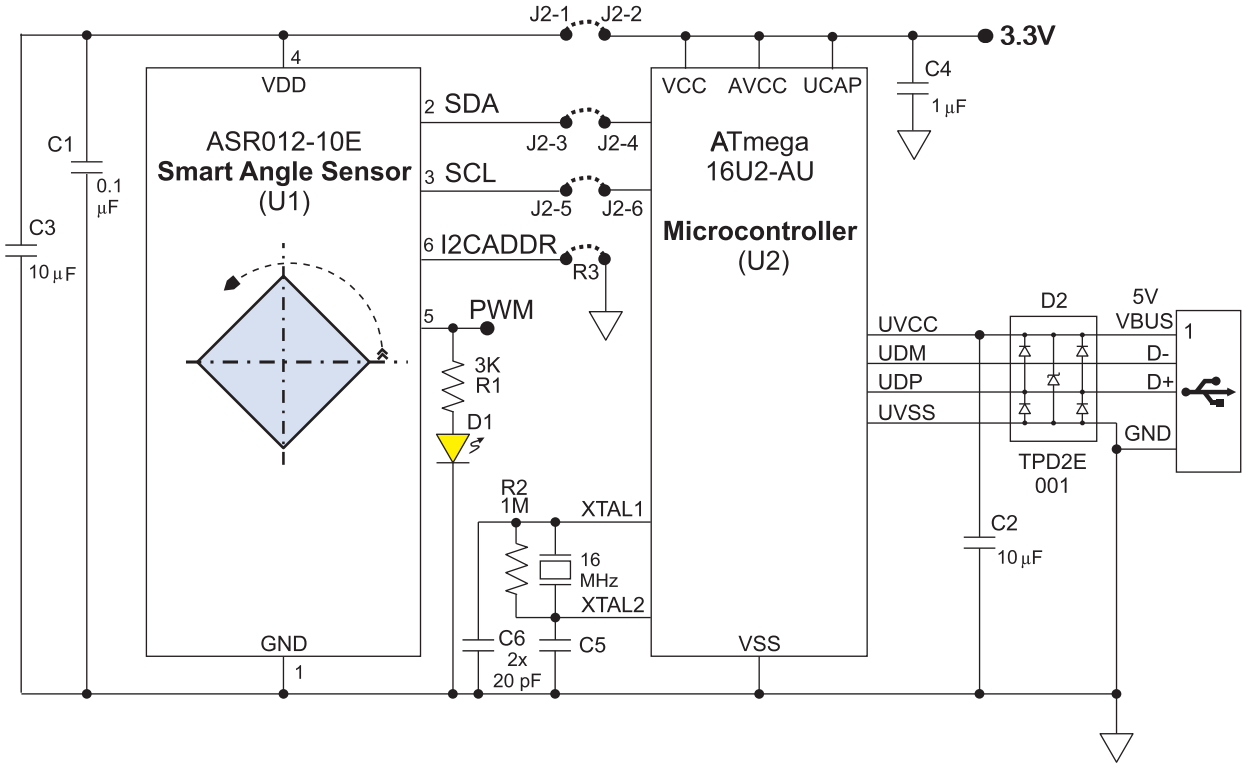


Figure 4. AG963-07E Evaluation Board Schematic.

3.3 Circuit Description

The Angle Sensor

ASR0x2 sensors (U1) are six-pin component, with power (VDD and GND); SPI or I²C interface pins. The

Microcontroller

The sensor is compatible with almost any microcontroller. This board uses a popular ATMEGA16U2 8-bit microcontroller (U2), which communicates with the Angle Sensor, has integrated USB to interface to a computer.

Power

The board is powered by the USB port. The microcontroller has an internal 3.3-volt regulator that powers the sensor.

SPI / I²C

The microcontroller is configured as the Master and communicates with the sensor via SPI or I²C.

Jumpers / Connector

Connector J2 allows normal operation by jumpering the sensor (U1) to the microcontroller (U2), or without jumpers the Connector can be used to provide direct access to the Sensor.

PWM Analog Output

A PWM output tracks the angle measured by the sensor, and can be connected to a multimeter or data acquisition system. The output is ratiometric with the 3.3 V regulated supply, for an output of 9.2 mV per degree. The ASR012 sesnor has a integrated PWM output. The ASR002 sensor does not have a PWM output, so the evaluation board PWM output is generated by the microcontroller.

USB

The microcontroller has an integrated USB UART. A Transient Voltage Suppressor (D2) protects the microcontroller.

LED

On the ASR002 board, the yellow LED D1 shows when the sensor is sending or receiving data. On the ASR012, the LED is connected to the sensor's PWM analog output, so the LED intensity varies with the angle (off at 0°; full intensity at 360°).

Crystal

A crystal (Y1) provides the microcontroller time base as required for the USB interface. The sensor SPI interface operates over an extremely wide clock frequency, so crystal control is not required for the sensor itself.

Decoupling Capacitors

The boards have a small (0201 / 0603 metric) 0.1 µF ceramic capacitor (C1) close to the sensor and a 10 µF capacitor (C3) a few millimeters away so it does not magnetically interfere with the sensor. The small capacitor is used because it contains very little ferromagnetic material.

There are also a 1 µF decoupling capacitor (C4) near the microcontroller and a 10 µF decoupling capacitor (C2) for the 5-volt USB bus supply, both as recommended by the microcontroller manufacturer.

Operating Temperature

The sensor is rated for the full −40 to 125 °C temperature range, but not all of the board components are rated for the full temperature range. Therefore the board is not recommended for environmental testing. Breakout boards are offered with the sensor and high-temperature bypass capacitors for such testing.

4. Magnets and Magnetics

The Evaluation Kit comes with a versatile and convenient Alnico round horseshoe magnet with a mounting hole. For production, most customers use lower-cost diametrically-magnetized ferrite disk magnets, and NVE stocks four popular ferrite magnets in addition to the Alnico magnet included in this kit:

NVE Part Number	**Dia.** (mm)	**Length** (mm)	**Typ. sensor distance** (mm; 120 Oe nom. field)	**Material and Configuration**
12526	4	4	3	C5/Y25 ferrite disk magnets
12249	12.5	3.5	4	
12527	8	4	5	
12528	8	8	6	
12426*	11	11	8	Alnico-5 round horseshoe

*Included with this kit.

Table 1. Popular magnets for angle sensing.

We also offer machined disk magnet holders that are compatible with this kit.

Our free Web apps can be used to determine the optimum operating separations for other magnet sizes and materials:

https://www.nve.com/spec/calculators.php.

5. User Interface Software Installation

5.1 System Requirements

The software system requirements are:

- 64-bit Windows 7 or later
- A USB 2.0 port

5.2 Software Installation

5.2.1. Run the Setup file on the USB stick if provided to begin the installation, or download the file from ***https://github.com/NveCorporation*.**

5.2.2. Run the Setup file to install the User Interface software and USB driver.

5.2.3. Click on the desktop shortcut to run the User Interface software.

5.2.4. Connect the demo board to a USB port.

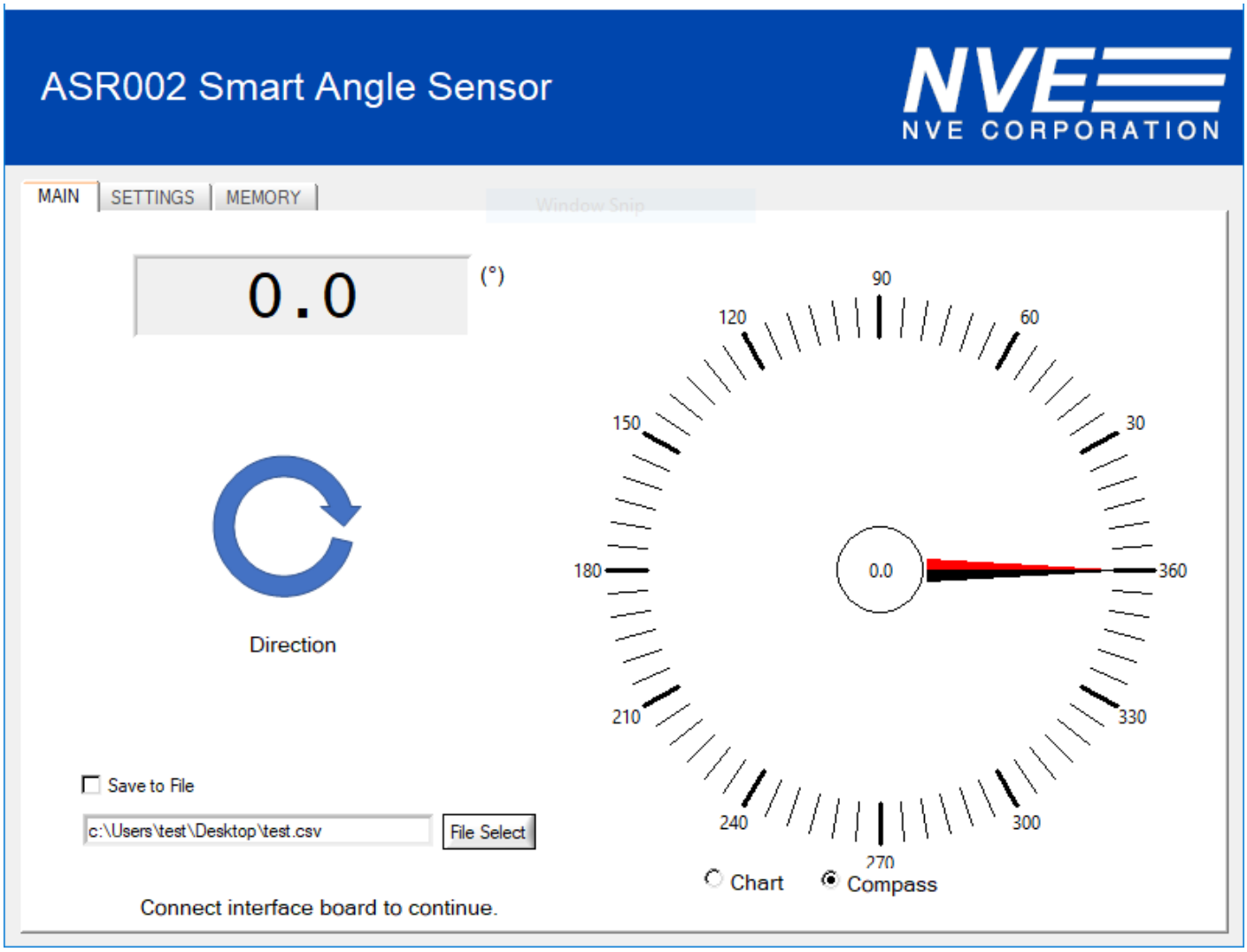
6. User Interface Operation

The User Interface allows reading sensor data, as well as reading and writing the nonvolatile sensor calibration memory.

After starting the application, a single window with three tabbed panels is displayed. The three tabs are:

1. Main – Displays the measured angle in digital and graphical format.
2. Settings – Allows changing the Sensor's Rotation Direction, Zero Angle, and Digital Filter Constant.
3. Memory – Allows reading and writing data and parameters in the Sensor's internal memory.

6.1. Main Tab



Main tab elements are described below:

Digital Display – Displays the sensor output in degrees and tenths. Double right-clicking on the digital angle display changes its precision.

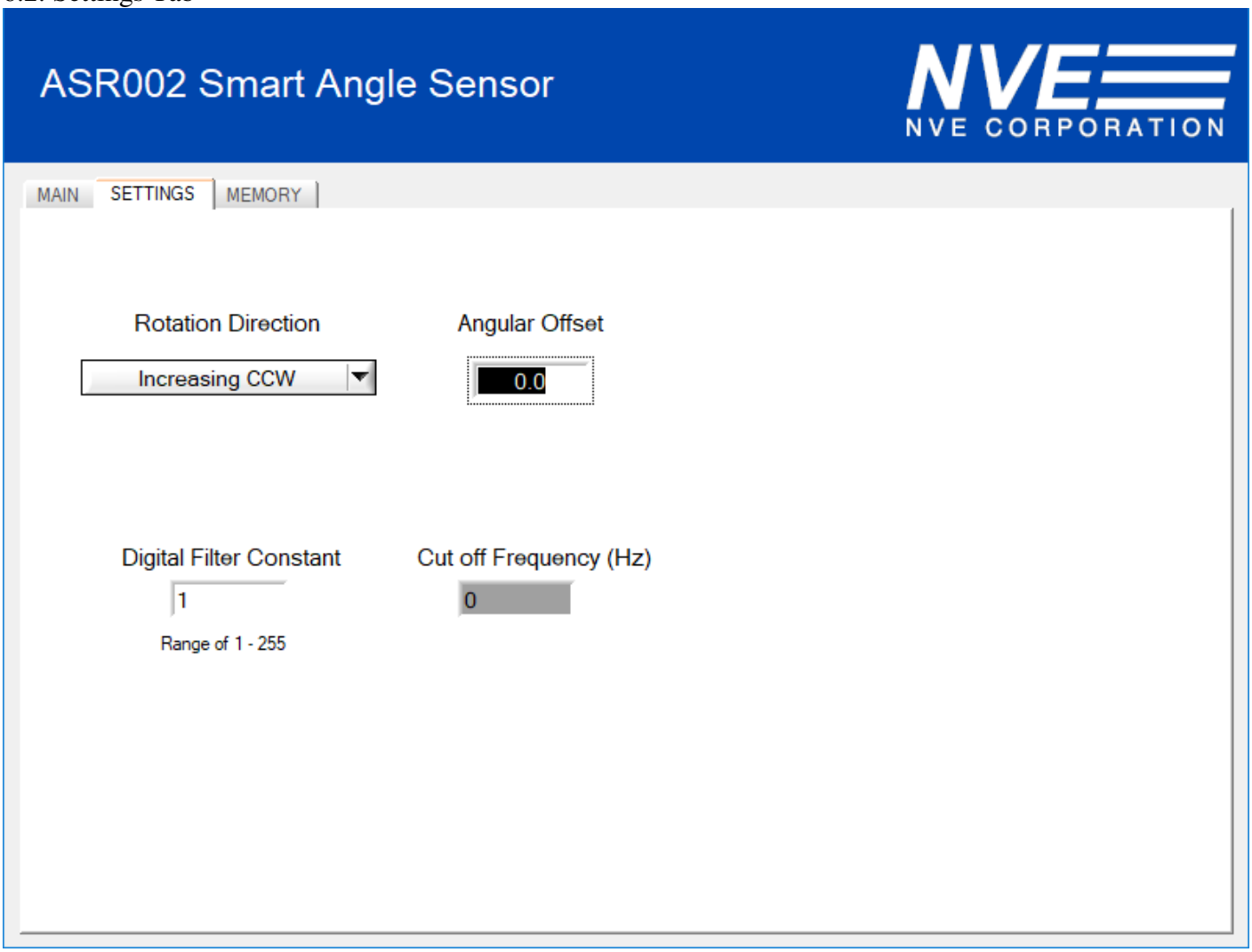
Compass – Displays the measured angle a bar chart using a compass metaphor.

Chart – Displays the measured angle using a "strip chart" metaphor of angle vs. time.

Direction – Displays the Sensor's measured rotation direction (as viewed from the top of the Sensor).

Save to File – Saves a session's measured angle history to a *.csv* file. The angle and time are recorded approximately every 0.1 seconds.

6.2. Settings Tab

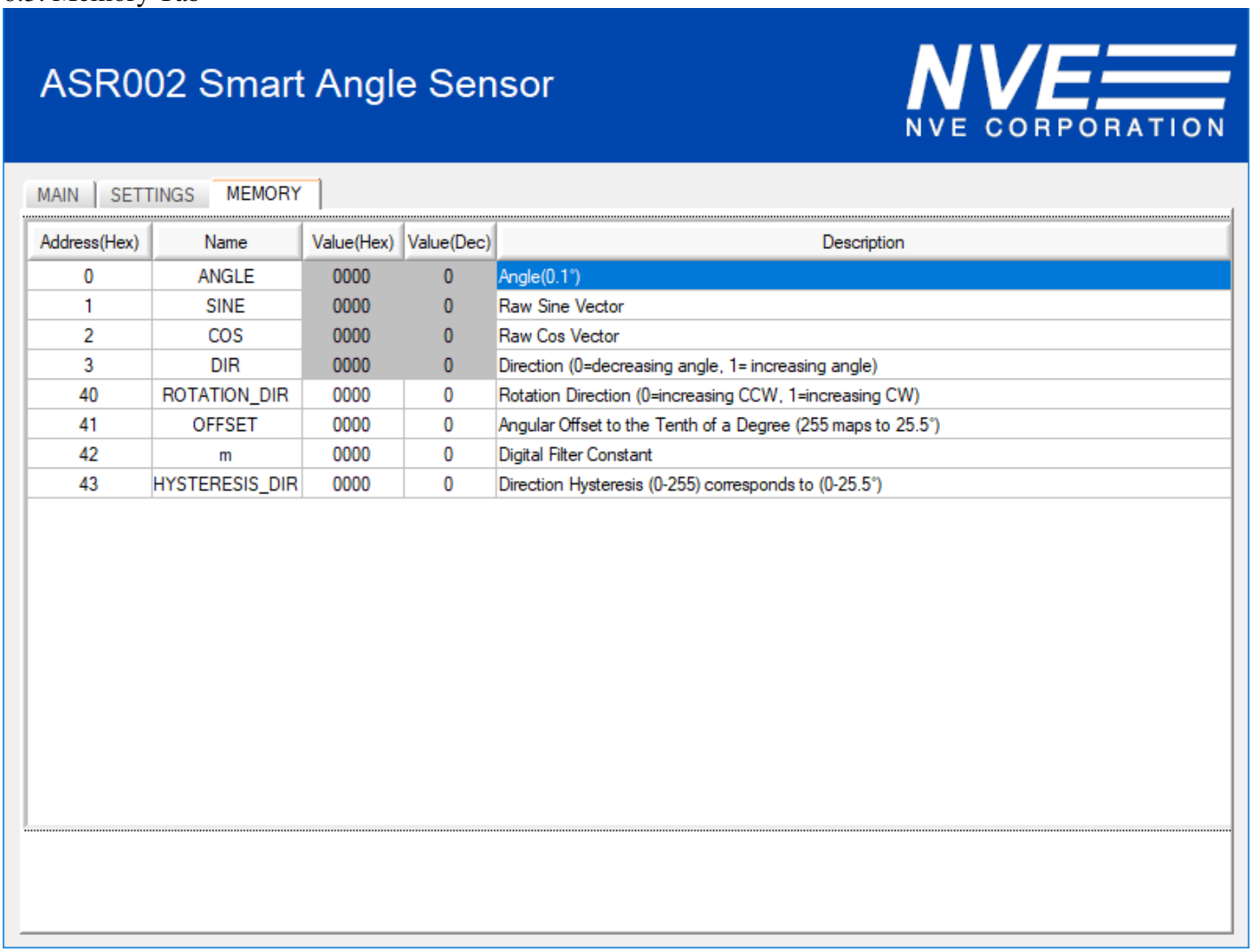


Set Rotation Direction – Sets the Sensor to output to either increasing clockwise or counterclockwise (as viewed from the top of the Sensor).

Angular Offset – A value can be entered to change point at which the sensor reads zero.

Digital Filter Constant – Allows setting the Sensor's digital filter constant within the allowable range of 1 to 255. Larger numbers provide a more heavily filtered output (i.e., a lower cutoff frequency). The calculated cutoff frequency is displayed in the adjacent box ($f_{CUTOFF} = f_{SAMPLE}/(2\pi\ m)$, where f_{SAMPLE} = approx. 12.5 kSps). The factory default for the sensors is "1," which disables the filter, however the user interface default is with the filter enabled since the evaluation board is intended for lower speeds.

6.3. Memory Tab



Address(Hex)	Name	Value(Hex)	Value(Dec)	Description
0	ANGLE	0000	0	Angle(0.1°)
1	SINE	0000	0	Raw Sine Vector
2	COS	0000	0	Raw Cos Vector
3	DIR	0000	0	Direction (0=decreasing angle, 1= increasing angle)
40	ROTATION_DIR	0000	0	Rotation Direction (0=increasing CCW, 1=increasing CW)
41	OFFSET	0000	0	Angular Offset to the Tenth of a Degree (255 maps to 25.5°)
42	m	0000	0	Digital Filter Constant
43	HYSTERESIS_DIR	0000	0	Direction Hysteresis (0-255) corresponds to (0-25.5°)

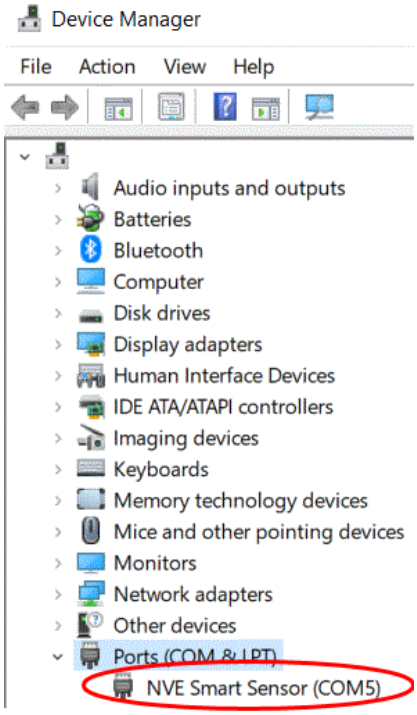
The *Memory* tab allows reading and writing the Sensor's internal memory. Addresses 0 to 3 are Sensor outputs, and can only be read, not written. These outputs are two-byte (16 bit) unsigned integers and are updated in real time. The angle (address 0) is in tenths of a degree, with a range of 0 to 3600 (dec). The raw Sine and Cosine outputs are centered at approximately 2048, with peak-to-peak amplitudes of approximately 1000.

The user-settable parameters are in addresses 0x40 to 0x43, and can be read or written. Parameters can be changed by clicking on the appropriate cell, typing a new number, and hitting "Enter." The sensor's parameter memory is nonvolatile, so the settings remain after power is removed.

7. Troubleshooting

No communications

1. Check the USB cable.
2. Verify the USB port under Windows Device Manager:



3. Reinstall the USB driver.

8. Revision History

SB-00-082-D
January 2020

Change
- Added ASR012 support via AG963-07E Evaluation Board.

SB-00-082-C
December 2019

Changes
- Added PWM output to board.
- Added crystal to schematic and BOM.
- Added sensor-to-microcontroller jumpers.
- Updated bypass capacitors.
- Single-click user interface installation software.
- Added a USB stick with the user interface installation software.

SB-00-082-B
February 2019

Changes
- Simplified “Troubleshooting” section.
- Expanded magnet options.
- Minor text changes.

SB-00-082-A
December 2018

Change
- Initial Release.

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