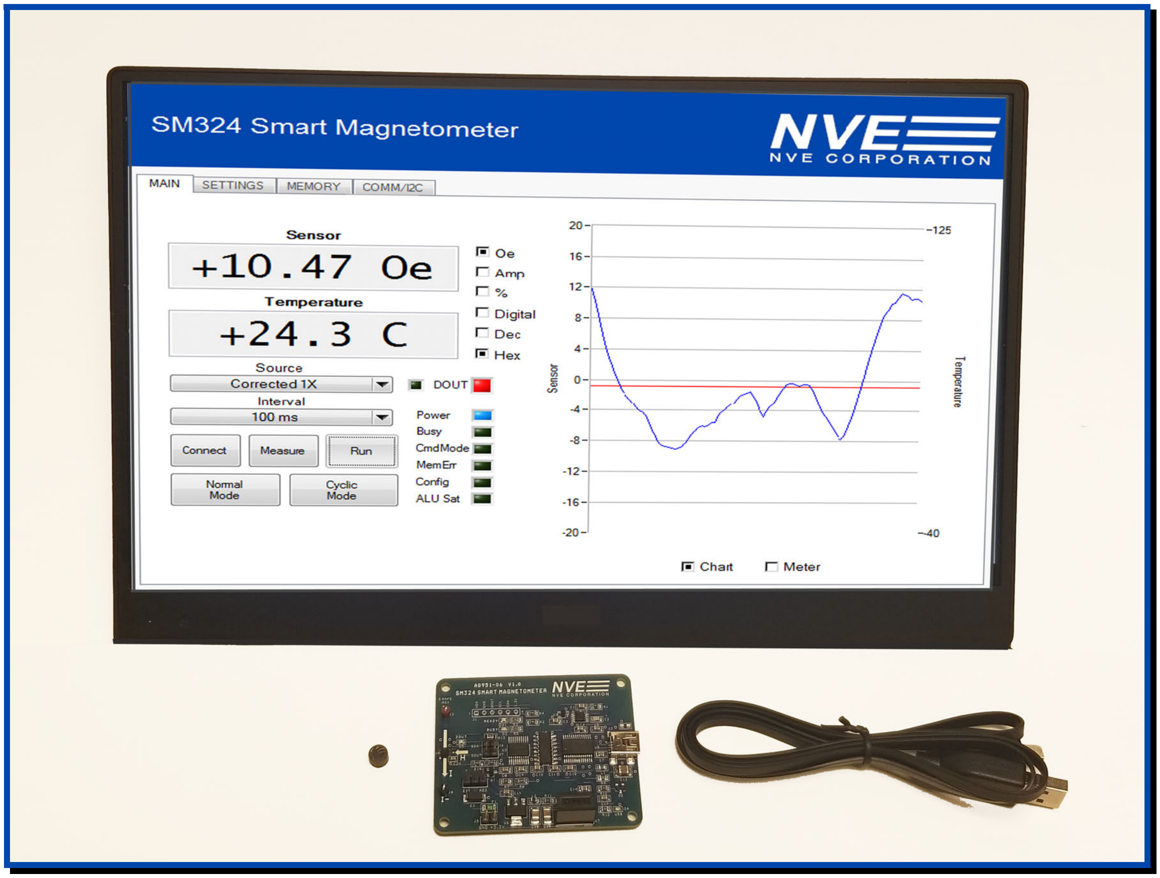
AG951: SM324 Smart TMR Magnetometer Current Sensing/Proximity Sensing Evaluation Kit



Summary

The AG951 Evaluation Kit has everything you need to calibrate, test, and evaluate the remarkable SM324-10E Smart Magnetometer. The evaluation kit includes:

- USB-powered Evaluation Board with:
  - an SM324-10E sensor
  - a microcontroller connected to the sensor via I²C
  - a current-carrying trace under the sensor for evaluating as a current sensor

- A powerful, intuitive graphical user interface.
- Simple software installation.
- Flexibility to power from USB or external power supply.
- Isolated USB interface for safety and low noise.
- USB cable to connect the Evaluation Board to a computer.
- A small ceramic magnet for evaluating as a proximity sensor.

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Contents

1. Overview

2. Quick Start

3. The Evaluation Board

4. Magnets and Magnetic Operation

5. Current Sensing

6. Hardware and Software Setup

7. User Interface Operation
   7.1. Main
   7.2. Calibration
   7.3. Calibration Memory
   7.4. I²C/USB

8. Troubleshooting / FAQs

9. Revision History

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1. Overview

This Evaluation Kit Includes:

- An evaluation board including:
  – An SM324-10E Smart Angle Sensor
  – A microcontroller
  – A USB computer interface
- Easy to install Windows-compatible software and graphical user interface
- A disk magnet
- USB to mini-B cable

SM324-10E Features:

- Can detect magnets more than 50 mm away
- I^2C and digital threshold outputs
- 24-bit output resolution
- In-plane sensitivity more usable than Hall effect sensors
- Programmable offset and gain compensation
- Internal temperature compensation
- 1.68 – 3.6 volt supply
- 1.68 – 3.6 volt compatible I^2C interface
- Ultraminiature 2.5 x 2.5 x 0.8 mm TDFN package

SM324-10E Key Specifications:

- 1.0% accuracy
- -20 to 20 Oe (2 mT) range for high sensitivity
- 300 Sps sample rate for virtually instant response
- 1.5 mA typical supply current
- −40°C to +125°C operating range

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2. Quick Start

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

2.2. Install the software and launch the application.

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

2.3. Click *Measure*. A single measurement will be taken and displayed in the digital displays as well as the chart or dial meter.

2.4. Click *Run* to put software in continuous run mode.

2.5. Apply a magnetic field with the disk magnet included in the kit and verify that the DOUT LED (D5) turns on (NOTE: north/south orientation doesn't matter with the default threshold values of −10 Oe and +10 Oe):

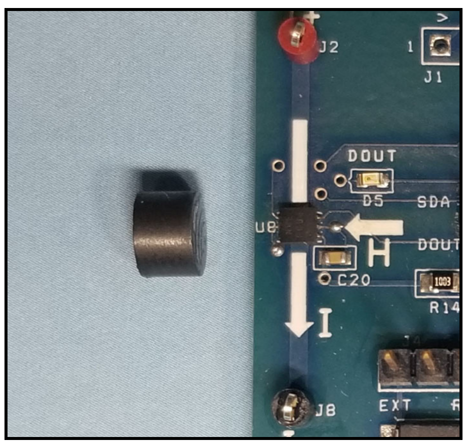

Figure 1. Activating the SM324 sensor with a disk magnet.

(NOTE: Since the sensor output only updates with each data request, the board must be connected and the software running for the threshold output to work).

2.6. Use the *Oe*, *Amp*, *%*, or *Digital* buttons to change units displayed. Click on *Dec* or *Hex* to select format when *Digital* units are selected. Use the *Source* drop-down list to select oversampling values and the *Interval* drop-down list to select measurement interval. Use the *Chart* or *Meter* buttons to select a graphic display.

3. The Evaluation Board

3.1 Board Layout

The evaluation board communicates with a host computer via USB and a Smart Magnetometer via I²C:

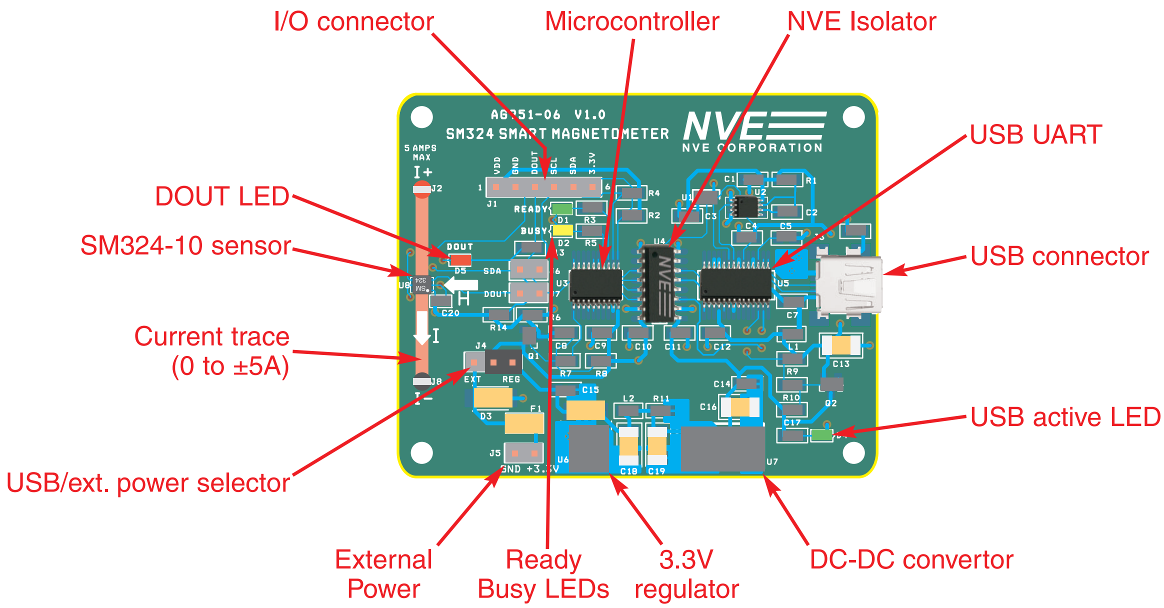

Figure 2. The Evaluation Board (actual size).

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3.2 Bill of Materials

Part Number	Designator	Manufacturer	Qty	Description
		Board-Level Components		
SM324-10E	UB	NVE Corporation	1	SMART MAGNETOMETER 3-BYTE, 20 OE
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 Devices Internatio	1	IC USB FS SERIAL UART 28-SSOP
UA78M33CDCYR	U6	Texas Instruments	1	IC REG LINEAR 3.3V 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
LTST-C193KRKT-5A	D5	Lite-On Inc.	1	LED RED CLEAR 0603 SMD
DMP2100U-7	Q1, Q2	Diodes Incorporated	2	MOSFET P CH 20V 4.3A SOT23
GCM188R71C104KA37	C1, C3-C5, C9-C12,C15,C17	Murata Electronics North America	10	CAP CER 0.1UF 16V X7R 0805
GRM2165C1H102FA01I	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	C8, C14, C20	Samsung Electro-Mechanics	3	CAP CER 1000PF 50V X7R 0805
CL32B106KAULNNE	C16, C18, C19	Samsung Electro-Mechanics	3	CAP CER 10UF 25V X7R 1210
DNP	C6			
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	R8	Stackpole Electronics Inc.	1	RES 100K OHM 1% 1/8W 0805
RNCP0805FTD10K0	R6, R9	Stackpole Electronics Inc.	2	RES 10K OHM 1% 1/4W 0805
5005	J2	Keystone Electronics	1	TEST POINT PC COMPACT .063"D RED
5006	J8	Keystone Electronics	1	TEST POINT PC COMPACT .063"D BLK
690-005-299-043	J3	EDAC Inc.	1	CONN MINI USB RCPT RA TYPE B SMD
5-146285-3	J4	TE Connectivity AMP Connectors	1	CONN HEADR BRKWAY .100 3POS STR
146285-2	J5	TE Connectivity AMP Connectors	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
		Package-Level Components		
12216	N/A	NVE Corporation	1	6 mm Dia. x 4 mm Thick Disk Magnet
	N/A	Generic	1	Mini USB Cable USB 2.0 Type A to Mini B Cable Mal

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3.3 Board Schematic

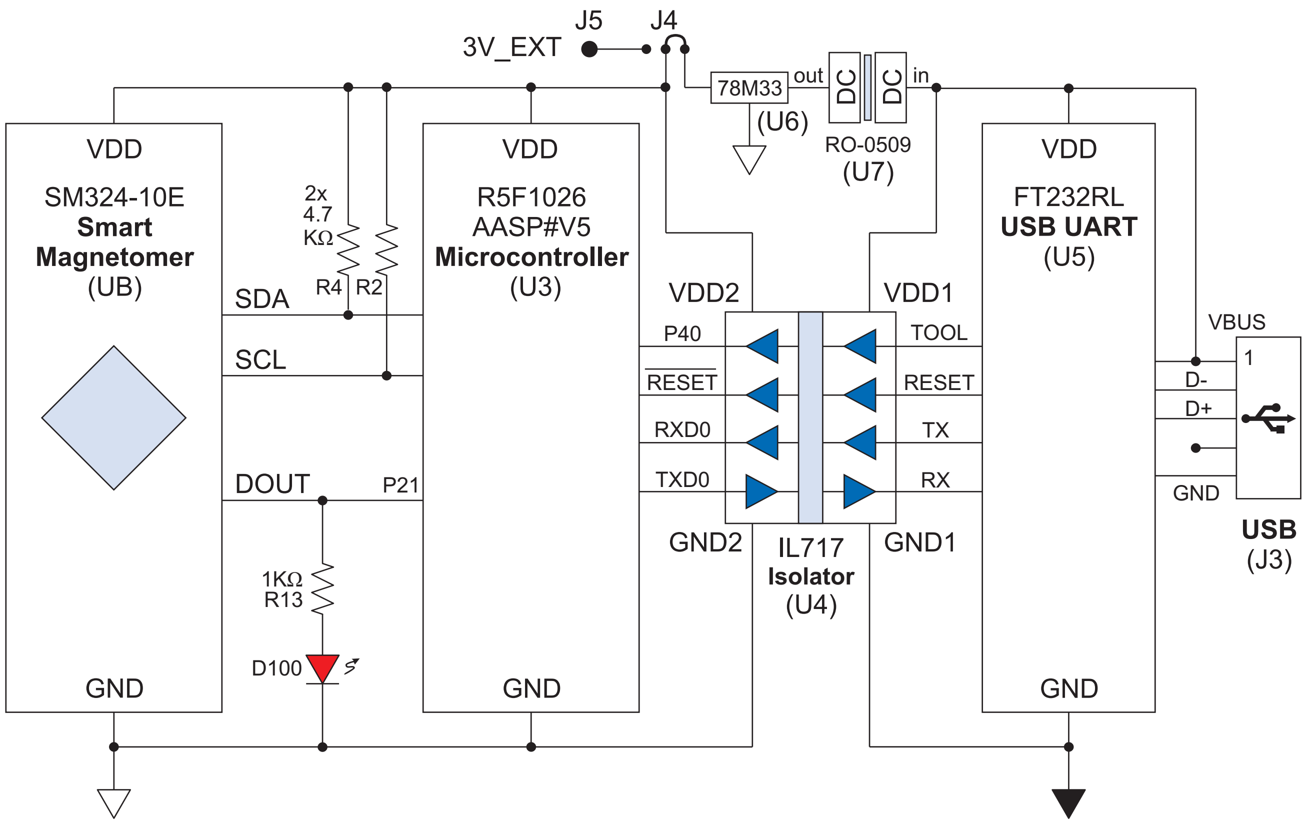

Figure 3. Evaluation Board Simplified Schematic.

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3.4 Evaluation Board Circuit Description

The Sensor
The SM324-10E has five active pins, all of which are available on the evaluation board. The active pins are for power (VDD and GND); I²C (SCL and SDA); and the digital output (DOUT).

Microcontroller
The SM324 is compatible with almost any microcontroller. This evaluation board uses a popular Renesas RL78/G12 16-bit microcontroller (U3).

Current-Sensing Trace
The evaluation board includes a current-sensing trace for evaluating the magnetometer as a current-sensor. The trace is 0.05 inches (1.3 mm) wide and one-ounce copper, it can carry up to carry up to 5 amps with a safe temperature rise.

The sensor can be sensitive to the fields generated by clip leads, so for precise measurements, the lead positioning should be fixed, and ideally at right angles to the trace to minimize their effect on the sensor.

I²C
I²C links the sensor to the microcontroller. The SM324 is an I²C Slave, and the microcontroller is configured as the Master. The SM324 I²C interface is compatible with 3.3 or five-volt microcontrollers. The evaluation board uses 3.3 volts for both the sensor and microcontroller.

In accordance with industry standards, the SM324 SDA line is open-drain. The board has 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.

The SCL and SDA test points can be connected to additional sensors, or to a user-supplied I²C bus for communication with the device.

Isolated USB Interface
A USB UART (U5) provides the computer interface. An IL717-3E isolator (U4) provides isolation from the 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.

LEDs
Red LED D5 shows when the digital output (DOUT) is activated. Green LED D1 indicates the microcontroller is active and yellow LED D2 indicates the microcontroller is running a command. Green LED D4 shows the USB bus has configured and powered the board.

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Power Supplies

The evaluation kit can be powered by an external supply or by USB via an on-board DC-DC convertor. J4 selects the power source, and the optional external supply is connected to J5. Note that although the sensor will operate down to 1.68 volts, other components on the board require a 3-volt minimum supply.

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4. Magnets and Magnetic Operation

The Evaluation Kit includes a popular ferrite disk magnet. The magnetic field from the magnet at the center of the sensor is shown in this graph:

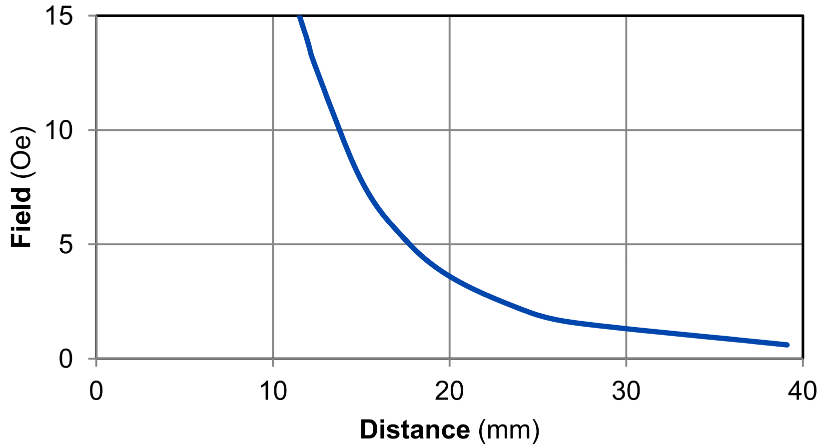

Figure 4. Magnetic field from the 6 mm dia. x 4 mm thick ferrite magnet.

Larger and stronger magnets allow farther operate and release distances. For more calculations, use our axial disc magnetic field versus distance Web application at:

www.nve.com/spec/calculators.php#tabs-Axial-Disc-Magnet-Field.

4.1 Magnetic Thresholds

The default magnetic threshold is 20 Oe, and commonly-used thresholds are 4 to 20 Oe. Thresholds even lower than 4 Oe can be programmed, although care must be taken to account for the earth's magnetic field, which is typically on the order of 0.5 Oe.

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5. Current Sensing

SM324-10E sensors can measure the current through a circuit board trace by detecting the magnetic field generated by the current through the trace this application. The digital output can be used for current threshold detection or overcurrent protection.

The evaluation board includes a current-sensing trace:

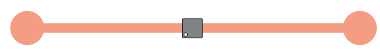

Figure 5. Current trace (top view).

The board trace is on the top side of the circuit board for high current sensitivity, but traces can also be run on the bottom side of the PCB for higher currents. The magnetic field generated in either case can be approximated by Ampere's law:

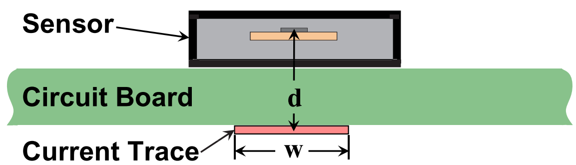

Figure 6. Current-sensing over a circuit board trace (side view).

$$H = \frac{2I}{d}$$ [“H” in oersteds, “I” in amps, and “d” in millimeters]

For the trace on the top of the circuit board, “d” is the distance from the trace to the sensor element, which is 0.7 millimeters. The field is therefore approximately 2.8 Oe/amp.

More precise calculations for different trace configurations can be made by meshing the trace into a finite element array of thin traces and calculating the field from each array element. We have a free, Web-based application with a finite-element model to estimate magnetic fields and sensor outputs in this application:

www.nve.com/spec/calculators.php#tabs-Current-Sensing

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6. Hardware and Software Setup

6.1 System Requirements

The software system requirements are:

- 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)

6.2 Software Installation

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

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

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

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

6.2.5. Install FTDI drivers as instructed.

6.3 Electrical Connections

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

6.3.2 Powering the board using USB power:

6.3.2.1 Place a jumper on J4 in the right position (REG) to power the microcontroller and sensor using the regulated, isolated 3.3V supply.

6.3.2.2 The green LED labeled "*Ready*" should turn on indicating that the microcontroller is now powered and ready. If it does not, verify that jumper on J4 is installed correctly.

6.3.3. To use an external supply:

6.3.3.1. Connect an external 3V to 3.6V supply to the 3.3V and GND test points on either J1 or J5. Verify voltage and polarity are correct before powering on. If powering using the 3.3V test point on J1, ensure the jumper on J4 is set to the left (EXT) position or removed.

6.3.3.2. Power the external supply. The green LED labeled "*Ready*" 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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6.3.4. Sensor selection:

6.3.4.1 To use the on-board SM324 sensor (U8) located over the current trace place jumpers on J6 (SDA) and J7 (DOUT).

6.3.4.2 To use an off-board sensor remove jumpers from J6 and J7. This will effectively disconnect the onboard sensor from the I2C bus and its DOUT output from the LED and microcontroller digital input. Connect an external SM324 sensor using the VDD, GND, DOUT, SCL, and SDA test points on J1.

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7. 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 four tabbed panels is displayed. The four tabs are:

1. Main – Displays measurement results in both digital and graphical formats.

2. Settings – Controls for easily setting the sensor and temperature offsets, sensor thresholds values, digital output configuration, cyclic measurement interval, and I2C address.

3. Memory – A table with the sensor's calibration constants. Also allows reading or writing the contents of the table to a file.

4. Comm/I²C – Controls communication with the evaluation board (USB) and sensor (I²C), along with miscellaneous functions.

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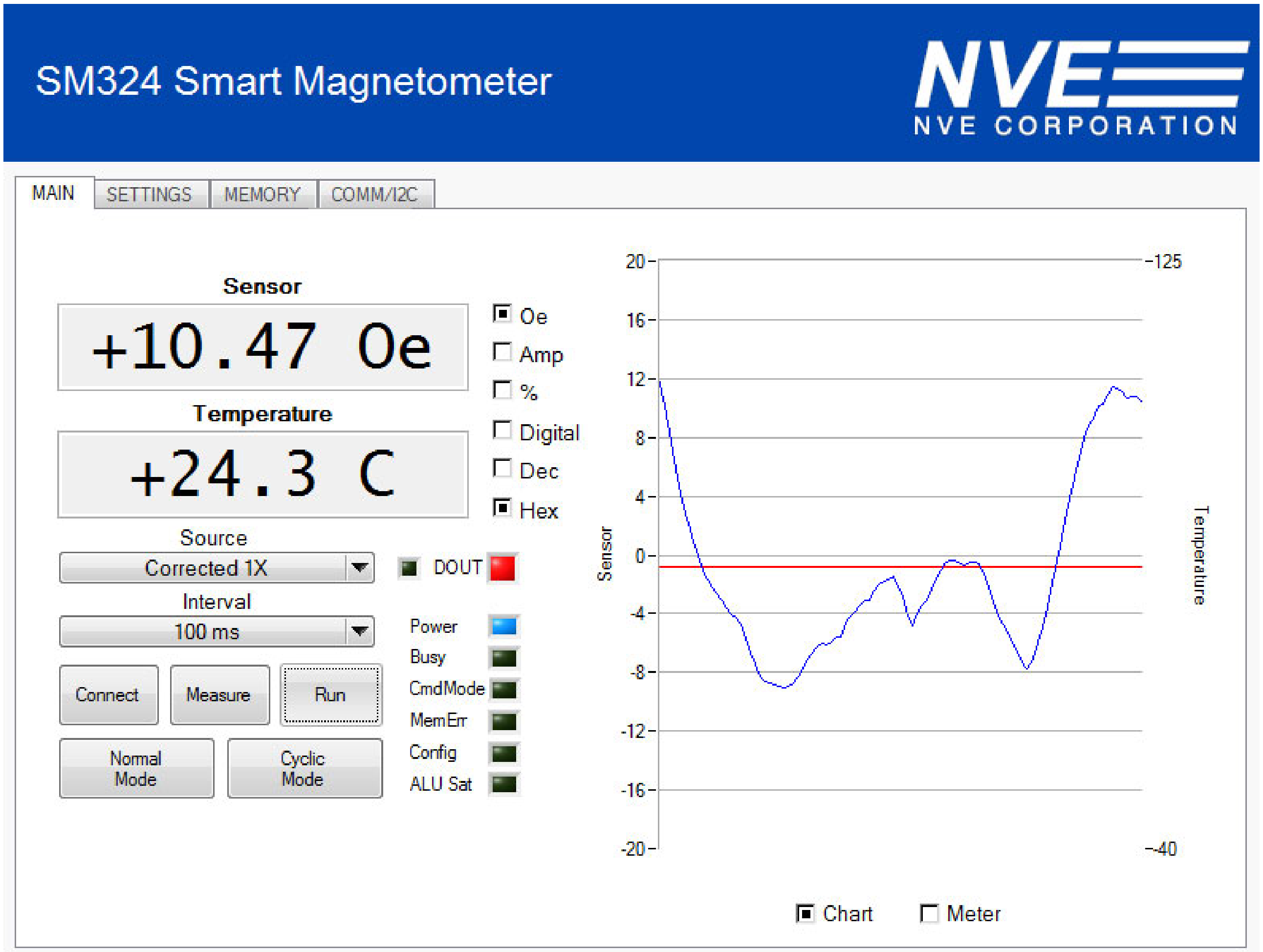
7.1. Main Tab



Main tab elements are described below:

Sensor – Displays the output of the device in either Oersteds, Amps, percent of full scale, or as a 24-bit integer. Double right-clicking on the display changes precision.

Temperature – Displays the temperature of the device's on-board thermometer in either Celsius, percent of full scale, or as a 24-bit integer. Double right-clicking on the display changes precision.

Oersteds – Sets *Sensor* display units to Oersteds and *Temperature* display units to degrees Celsius.

Amp – Sets *Sensor* display units to Amps and *Temperature* display units to degrees Celsius.

% – Sets both *Sensor* and *Temperature* displays units to percent of full scale.

Digital – Sets both *Sensor* and *Temperature* displays units to 24-bit digital value.

Dec – Sets both *Sensor* and *Temperature* displays to show decimal format when *Digital* units are selected.

Dec – Sets both *Sensor* and *Temperature* displays to show hexadecimal format when *Digital* units are selected.

Connect – Connects to the board and sensor using a quick-connect routine. The software will scan USB for the first evaluation 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 evaluation board is connected to the PC and there is only one sensor on the I²C bus. If more than one evaluation board or sensor are connected then manual connections should be made using COMM/I2C tab.

Measure – Takes a single measurement and displays the results in the *Sensor* and *Temperature* displays, the *Meter* or *Chart* graphical display, and the status of the sensor's digital output in the *DOUT* LED.

Run/Stop – Pressing *Run* puts the software in continuous run mode. Measurements will be made with a time interval set by *Interval*. 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.

Source – Sets the amount of oversampling that the sensor's digital processor will perform when making a measurement.

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

Normal Mode – Puts the sensor into normal sleep mode where it will only perform a measurement when the *Measure* button is pressed, or at the time interval specified in the *Interval* control when in continuous run mode.

Cyclic Mode – Puts the sensor into cyclic mode where it will routinely perform measurements at the interval defined in the sensor's memory and place the results in the sensor's I2C output buffer. Performing a measurement using the *Measure* button or while in continuous mode will read the latest result. To exit cyclic mode press the *Normal Mode* button.

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

Meter – Displays a meter on the right side of the tab that shows the measurement result.

DOUT – Displays the status of the sensor's digital output DOUT (Red = on).

LED – This small LED next to DOUT displays measurement status. If dark then the software is idle. If flashing green then software is in continuous run mode. If red then the latest measurement failed due to an error or connectivity issue.

Status LEDs – This column of blue LEDs display the contents of the status byte read with each measurement:

Power – Bit 6 of status byte. Normally on.

Busy – Bit 5 of status byte. Normally off except when in cyclic mode.

CmdMode – Bit 3 of status byte. Normally off and not used in this evaluation.

MemErr – Bit 2 of status byte. On when the memory checksum does not match the memory contents. This can be resolved by re-writing the checksum using the *Settings* tab.

Config – Bit 1 of status byte. Normally off and not used in this evaluation.

ALU Sat – Bit 0 of status byte. On when the latest measurement produced an internal saturation in the digital signal processing.

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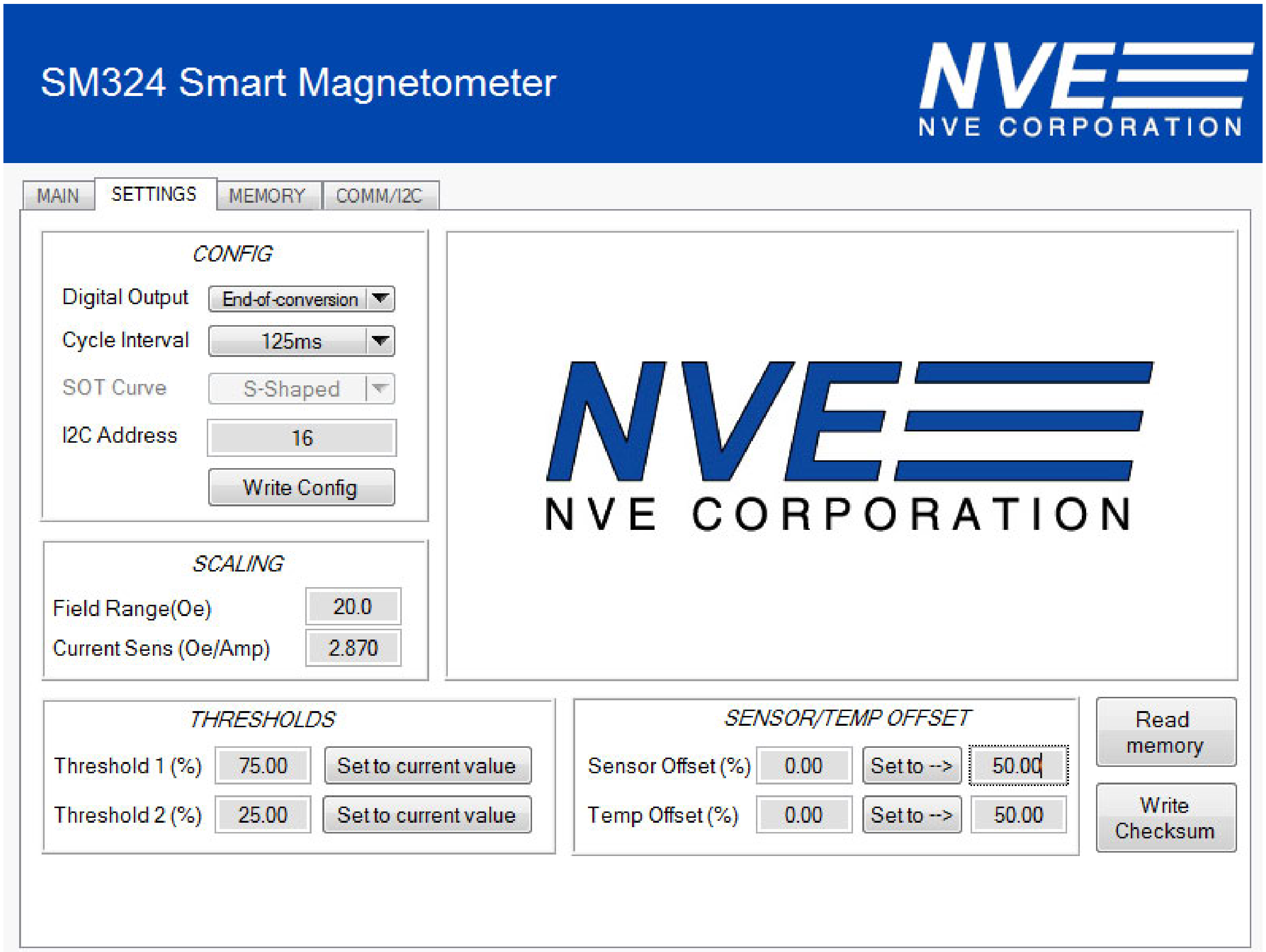
7.2. Settings Tab



Settings tab elements are described below:

Read memory – This button, located in the lower-right corner of the tab, will read the contents of the sensor memory and update the values in the *Settings* and *Memory* tabs to match. When first connecting a new sensor the memory should be read so that the controls displayed match the device contents.

Write checksum – This button, located in the lower-right corner of the tab, when pressed will send a command to the sensor to calculate and write a new checksum. This should be performed after all changes to the memory are complete.

Config – This section can be used to set contents of config memory address 0x02.

- *Digital Output* (bits 8:7) – Controls functionality of the sensor's DOUT pin.
- *Cycle Interval* (bits 14:12) – Sets measurement interval when in cyclic mode.
- *I2C Address* (bits 6:0) – Sets I2C address of sensor. Note: The sensor will respond to a newly written I²C address only after the next power-on reset (POR). Also, addresses 4 through 8 are reserved for high-speed I²C and not currently supported in this evaluation.

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- *Write Config* – Writes the values set in the *Config* section to the device memory.

Scaling - This section controls how the digital output of the sensor is converted into physical units.

- *Field Range (Oe)* – Full-scale field range in units of Oersted. If set to 20 Oe, then a digital output of 0x000000 (0%) will be interpreted as −20 Oe, a digital output of 0x800000 (50%) will be interpret as 0 Oe, and a digital output of 0xFFFFFF (100%) will be interpreted as +20 Oe.

- *Current Sens (Oe/Amp)* – When using the sensor to detect electrical current this value converts the measured field into units of Ampere. This value is dependent on the geometry and spacing of the sensor to current source and is left to the user to determine the optimum value for their application. By default this value will be set for the evaluation kit's onboard sensor.

Thresholds – This section can be used to set the threshold values at which the sensor's digital output (DOUT) turns on or off. Changing values in this section will write to memory addresses 0x13, 0x14, and 0x15.

To manually change the thresholds, enter a percent of full-scale value (0–100%) into the numeric field next to each threshold. This will calculate and write the contents to the associated memory addresses.

Alternatively, the thresholds can be set to the field level present at the sensor. To do this set the magnetic field source to the desired position or value and press *Set to current value*. The threshold will be set and the numeric field will be updated.

Note: The thresholds will only affect the digital output of the sensor if enabled in the *Digital Output* control in the *Config* section.

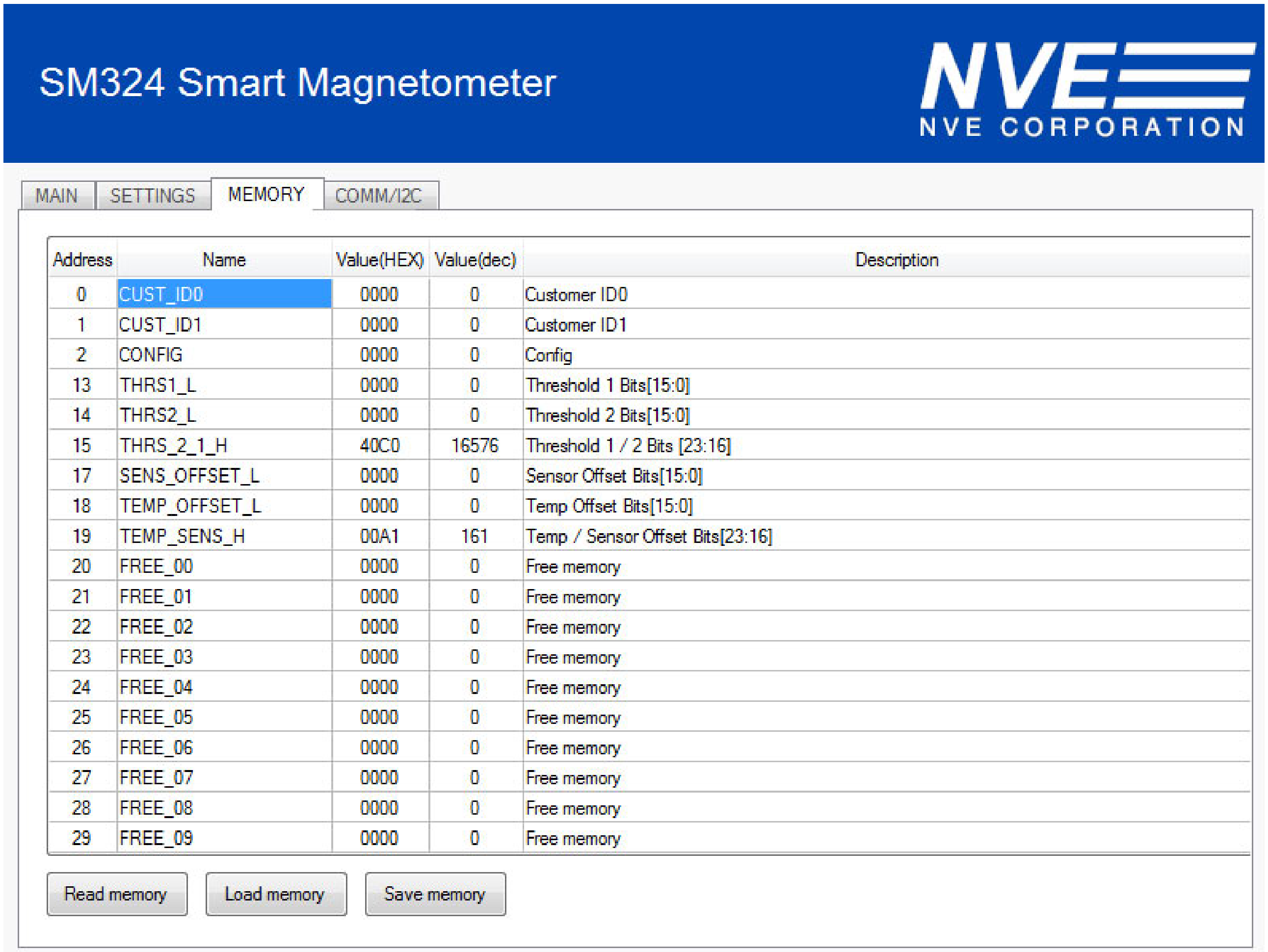
Sensor/Temp Offset – This section can be used to set the sensor and temperature offsets, useful for zeroing out background magnetic fields. Changing values in the left numeric fields will write to memory addresses 0x17, 0x18, and 0x19.

To manually set the offsets enter a percent of full-scale shift (−50% to +50%) into the numeric field next to either the *Sensor Offset (%)* or *Temp Offset (%)* labels. This will calculate and write the contents to the associated memory addresses. A positive value will shift the measured sensor or temperature positive by that percent and vice versa.

Alternatively, the offsets can be set so that the measured outputs match a predefined value, i.e., zeroing out background magnetic field. To do this set the magnetic field source to the desired position or value, enter the desired output value into the right numeric field, and press the "Set to →" button. The offset shift needed to match the desired value will then be calculated and written to the associated memory addresses as well as the left numeric field.

Example: The sensor produces an output of 52% with no field present. To zero it to 50%, enter "50.00" into the right field and press "Set to →". A −2% shift will be put into the left numeric field and written to the sensor memory, and the sensor will now output 50%.

7.3. Memory



Address	Name	Value(HEX)	Value(dec)	Description
0	CUST_ID0	0000	0	Customer ID0
1	CUST_ID1	0000	0	Customer ID1
2	CONFIG	0000	0	Config
13	THRS1_L	0000	0	Threshold 1 Bits[15:0]
14	THRS2_L	0000	0	Threshold 2 Bits[15:0]
15	THRS_2_1_H	40C0	16576	Threshold 1 / 2 Bits [23:16]
17	SENS_OFFSET_L	0000	0	Sensor Offset Bits[15:0]
18	TEMP_OFFSET_L	0000	0	Temp Offset Bits[15:0]
19	TEMP_SENS_H	00A1	161	Temp / Sensor Offset Bits[23:16]
20	FREE_00	0000	0	Free memory
21	FREE_01	0000	0	Free memory
22	FREE_02	0000	0	Free memory
23	FREE_03	0000	0	Free memory
24	FREE_04	0000	0	Free memory
25	FREE_05	0000	0	Free memory
26	FREE_06	0000	0	Free memory
27	FREE_07	0000	0	Free memory
28	FREE_08	0000	0	Free memory
29	FREE_09	0000	0	Free memory

Memory tab elements are described below:

Table – Contains a listing of user memory addresses including address in hexadecimal format, name, value in hexadecimal and decimal format, and a description. Memory addresses may be written to directly by entering a value into the table. Factory set addresses are not displayed in this evaluation.

Read memory – This will read the contents of the sensor memory and update the values in the *Settings* and *Memory* tabs to match. When first connecting a new sensor, the memory should be read so that the controls displayed match the device contents.

Load memory – This will prompt the user to select an XML formatted memory file to load and write to the sensor. After loading and writing it will read back the contents into the table.

Save memory – This will prompt the user to select a file into which it will write the contents of the memory table. A *Read memory* should be performed before saving to ensure the contents of the saved match that stored in the sensor.

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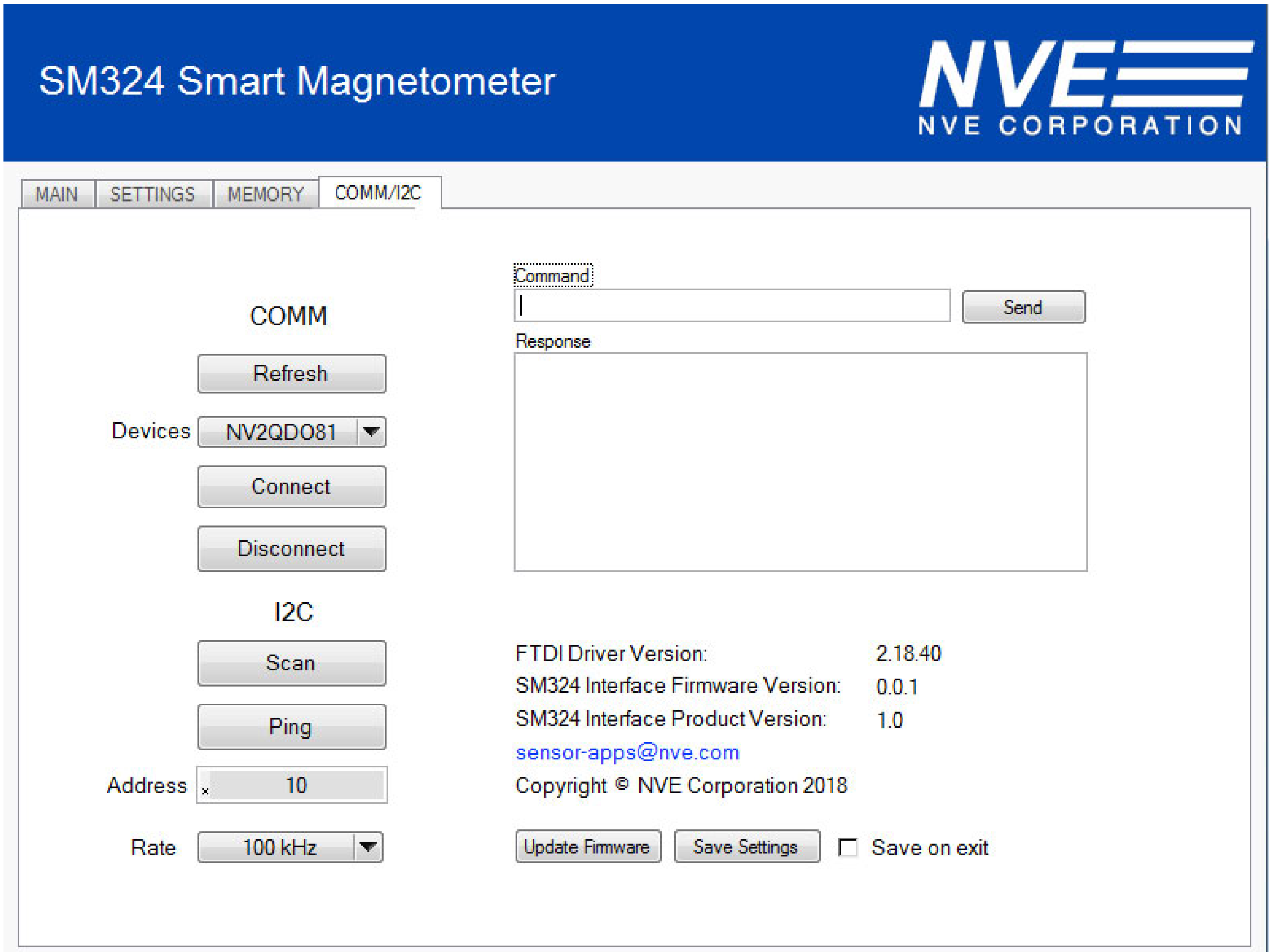
7.4. Comm/I2C Tab



Elements of the Comm/I2C tab are as follows:

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

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

Connect – Connects to the 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 – Field for entering commands to be sent to the board for microcontroller configuration and reading/writing to SM324 I²C. See Section 7.5 for more information on the USB serial communication protocol. Leading and terminating characters (0x02, 0x03) will be added by software and should be omitted.

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

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Response – Displays response for the command sent.

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 sensor is attached to the I²C bus, the address should be set manually using the *I²C Address* control.

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

Ping – Attempts a single read from the address set by the *I²C Address* control. This can be used to verify the address matches the attached sensor's slave address.

Rate – Sets the clock rate of the I²C bus.

Save Settings – Writes software settings (I²C address and rate, formats, units, file pathnames) to an INI file 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.

7.5. Serial USB Communications

The evaluation 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 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 uses ASCII characters for ease of debugging. Commands sent to the 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 board are always 16 bytes long, including the leading character STX and terminating character ETX.

The first character of any command following the leading character are one to two command characters ("W," "R," "AA," 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."

A complete listing of commands, responses, and error codes can be found in the *SM324 Interface Communication.xlsx* spreadsheet included in the *Documents* folder of the software install directory.

8. Troubleshooting

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

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

- Red "DOUT" LED doesn't turn on in the presence of a magnetic field.
  - Ensure the board is connected to the computer and the software is running (since the sensor output only updates with each data request, the software must be running for the device output to work).
  - Ensure thresholds are programmed in a reasonable range.

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9. Revision History

SB-00-078-PRELIM	Change
July 2018	• Initial Release

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