Important Notes

Restrictions in Use

IDT's ZSSC5101 SSC Evaluation Kit, consisting of the SSC Communication Board (SSC CB), the ZSSC5101 Adapter Board (SSC EB), the ZSSC5101 AMR Demo Board, and the calibration software, is designed for sensor module evaluation, laboratory setup, and module calibration development only.

IDT's Evaluation Kit hardware and software must not be used for module production or production test setups.

Disclaimer

IDT shall not be liable for any damages arising out of defects resulting from
  (i)   delivered hardware or software
  (ii) non-observance of instructions contained in this manual and in any other documentation provided to user, or
  (iii) misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT.

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1   Introduction

The ZSSC5101 Evaluation Kit enables evaluation of the ZSSC5101 xMR Sensor Signal Conditioner IC, which is designed for interfacing with magnetoresistive position sensors. The ZSSC5101 AMR Demo Board included in the kit provides a typical anisotropic magnetoresistive (AMR) position sensor for demonstrating typical calibration procedures and reading example measurement results. Alternatively, the user module can be connected in place of the AMR Demo Board (e.g., with a tunnel magnetoresistive (TMR) or giant magnetoresistive (GMR) sensor). This document describes the kit including hardware and software setup and basic operations.

Note: Reading the *ZSSC5101 Data Sheet* before using the kit is strongly recommended.

1.1.   Kit Contents

The ZSSC5101 Evaluation Kit (ZSSC5101 EVK) includes the following:

- SSC Communication Board V4.1 (SSC CB)
- ZSSC5101 Adaptor Board V1.1
- ZSSC5101 AMR Demo Board V1.0
- 3 samples of the ZSSC5101 (SSOP-14)
- Standard USB cable for connecting the kit to a PC

Note: The ZSSC5101 Evaluation Software is downloaded from the IDT product web page (see section 1.2).

Figure 1.1   ZSSC5101 Evaluation Kit Boards
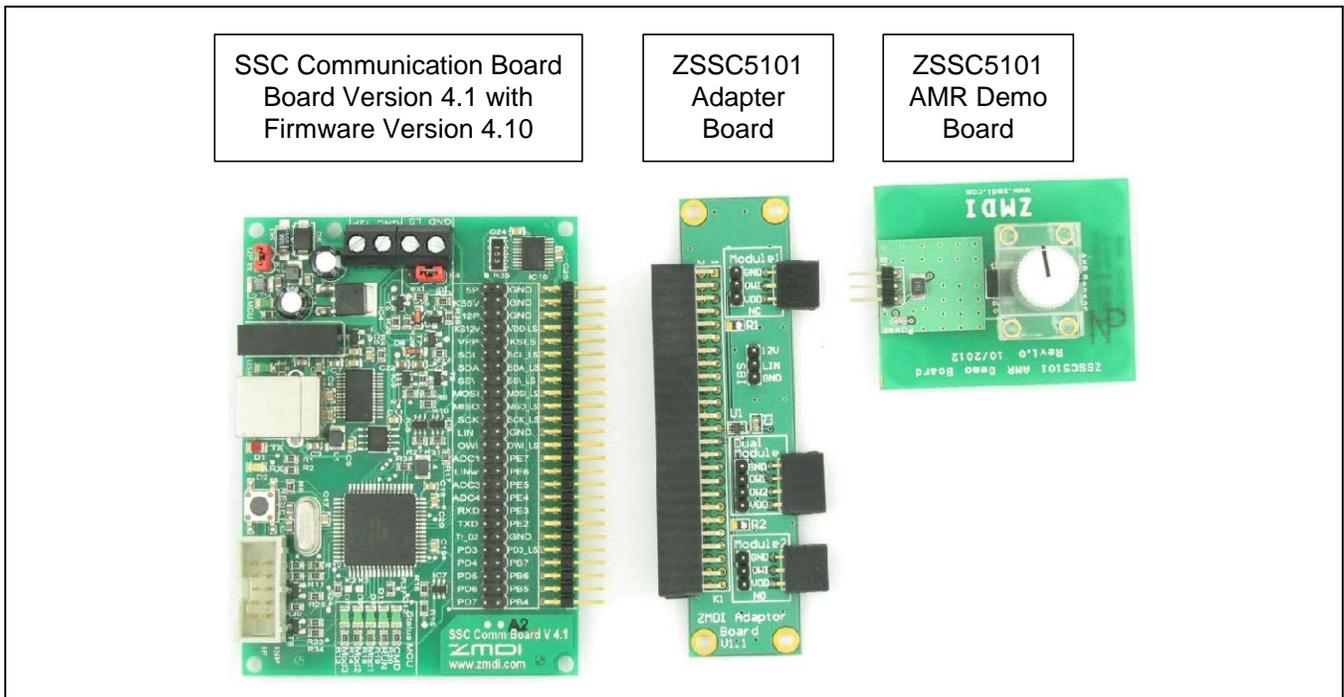
1.2. Downloading the Evaluation Kit Software

To ensure use of the latest version ZSSC5101 Evaluation Software, the software must be downloaded as a zip file from www.IDT.com/ZSSC5101KIT. Alternately, the software can be requested through the IDT application support team.

Requirements for user's computer:

- Windows®-based operating system
- An available USB port
- Administrative rights for installing the software and if needed, installing the driver for the SSC Communication Board (SSC CB)

A free customer login account is required to access the software on the product page.

Save the downloaded zip file to a user-selected location on the computer and extract the contents of the zip file.

Contents of the zip file:

- *Documentation* directory, which provides useful supporting documents
- *UsbDriver* directory, which provides the required hardware driver for the SSC Communication Board (see section 3.1 for further details)
- *ZSSC5101_GUI* directory, which contains the graphical user interface (GUI) and its associated files (see section 3.2 for further details)

2 Hardware Setup

Before proceeding with the software setup, assemble the ZSSC5101 Evaluation Kit as shown in Figure 2.1 and connect a USB cable from the connector on the SSC CB to an available USB port on the user's computer.

Note that up to two ZSSC5101 AMR Demo Boards can be connected at the same time (via the Module 1 and Module 2 connectors on the ZSSC5101 Adaptor Board). Additional AMR Demo Boards are sold separately.

Important: Before unplugging any ZSSC5101 module during operation, always click the "Power OFF" button in the software first (see section 4).

Figure 2.1   Default Hardware Set-up
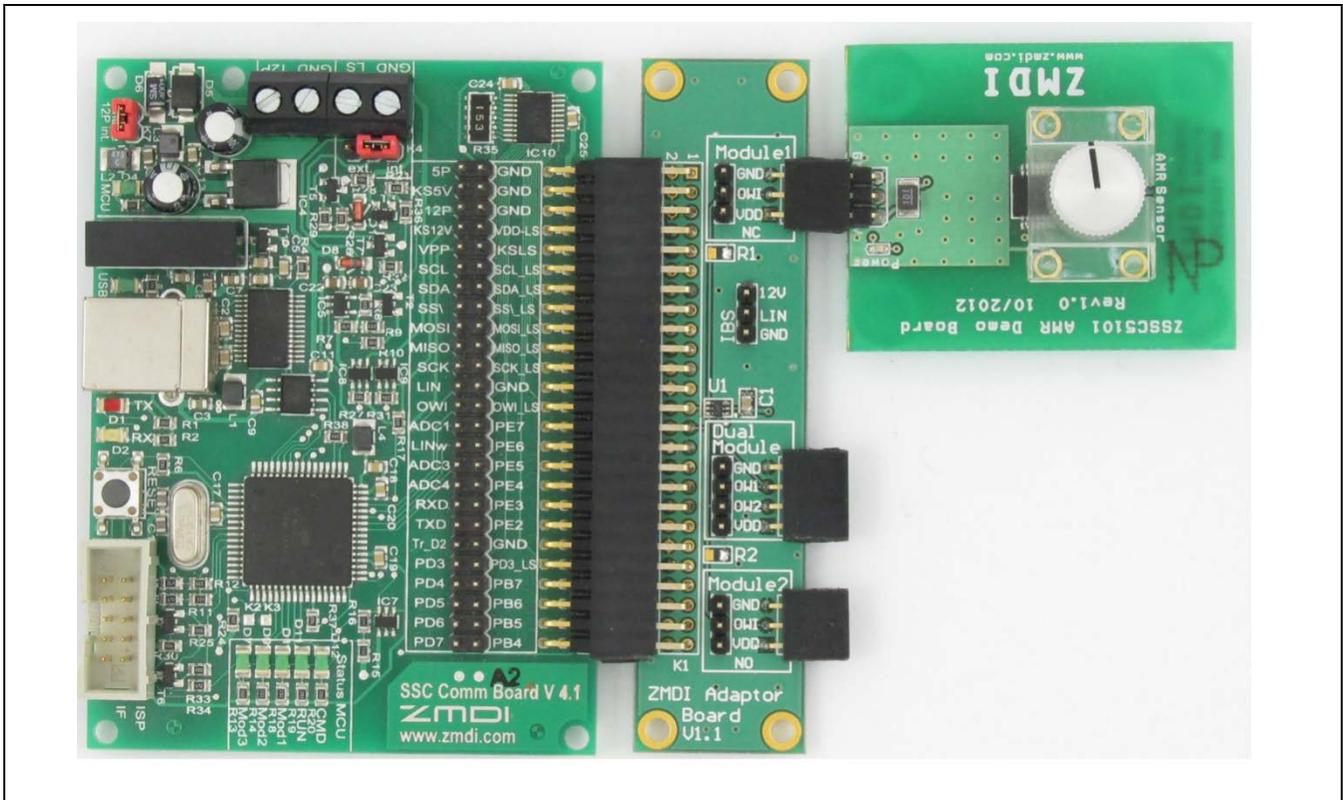
3   Software Setup

3.1.   IDT Communication Board Driver Installation

The SSC Communication Board converts the USB bus protocol to a serial data interface for communication between the user's computer and the ZSSC5101. A special driver (FTDI) must be installed.

Before continuing, ensure that the ZSSC5101 Evaluation Kit is connected via a USB cable to the user's computer as described in section 2.

3.1.1.   Compatibility Check

The following procedures are used to determine if the correct driver is already installed on the computer by checking the Device Manager in the Windows® Control panel.

1. Navigate as needed to the computer's Control Panel → System and Security → Device Manager.

2. Scroll down the device list to the "Universal Serial Bus controllers" section and check for an entry titled "USB Serial Converter." If found, right click on it and select "Properties" from the resulting drop-down menu.

3. If the "Manufacturer" is shown as "FTDI" as shown in the example in Figure 3.1, then the required driver is already installed. In this case, skip the following steps and continue at section 3.2.

Figure 3.1   Example of Properties for a USB Serial Converter under the Device Manager
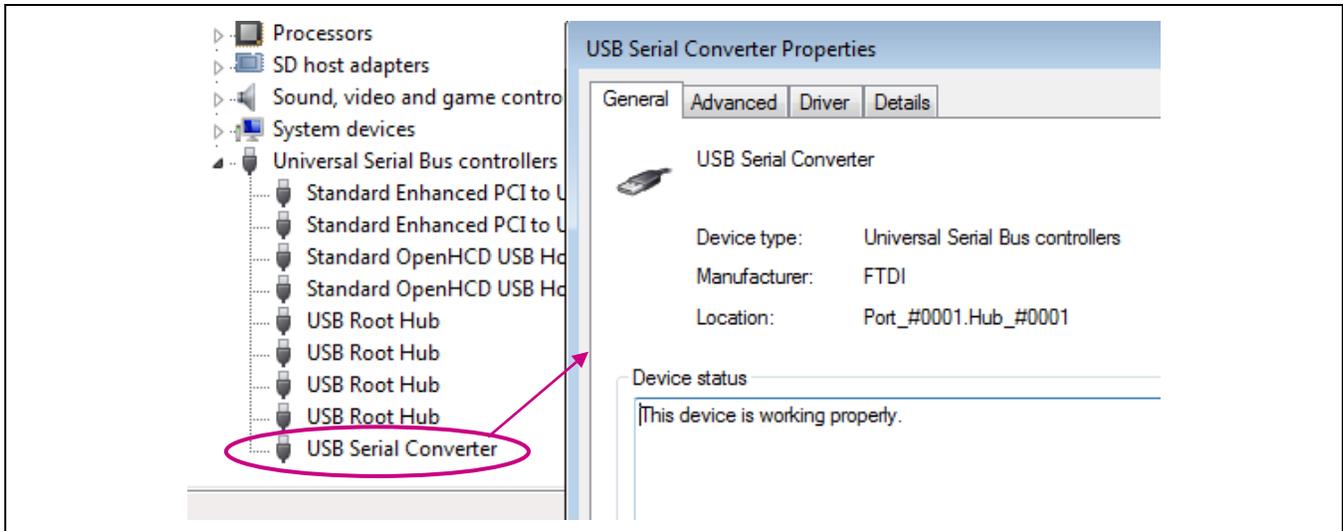
4. If the "Manufacturer" is not shown as "FTDI" or if "USB Serial Converter" does not appear in the Device Manager list, the FTDI driver must be manually installed on the SSC Communication Board microprocessor. If there is no driver installed for the SSC Communication Board, the device is likely to be listed under "Other devices" as "FT232R USB UART" in the Device Manager list as shown in Figure 3.2. Right click on the device and select "Update Driver Software."

Figure 3.2   Updating the Driver for the Communication Board (FT232R USB UART under Device Manager)
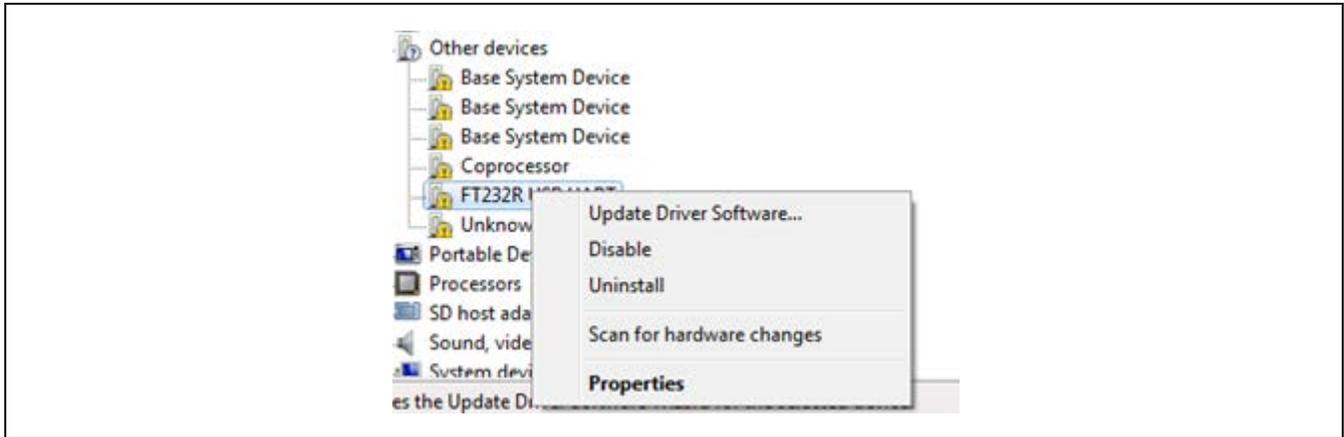
5. Next, select the option to manually browse for a driver:

➜ Browse my computer for driver software
    Locate and install driver software manually.

6. Navigate to the *UsbDriver* subdirectory under the user-selected directory for the downloaded ZSSC5101 Evaluation Software. Select the *CDM…..-Certified* subdirectory as shown in Figure 3.3. Click the "OK" button. Windows® automatically installs the FTDI driver software.

Figure 3.3   Location of the FTDI Driver in the ZSSC5101 Evaluation Software Directory
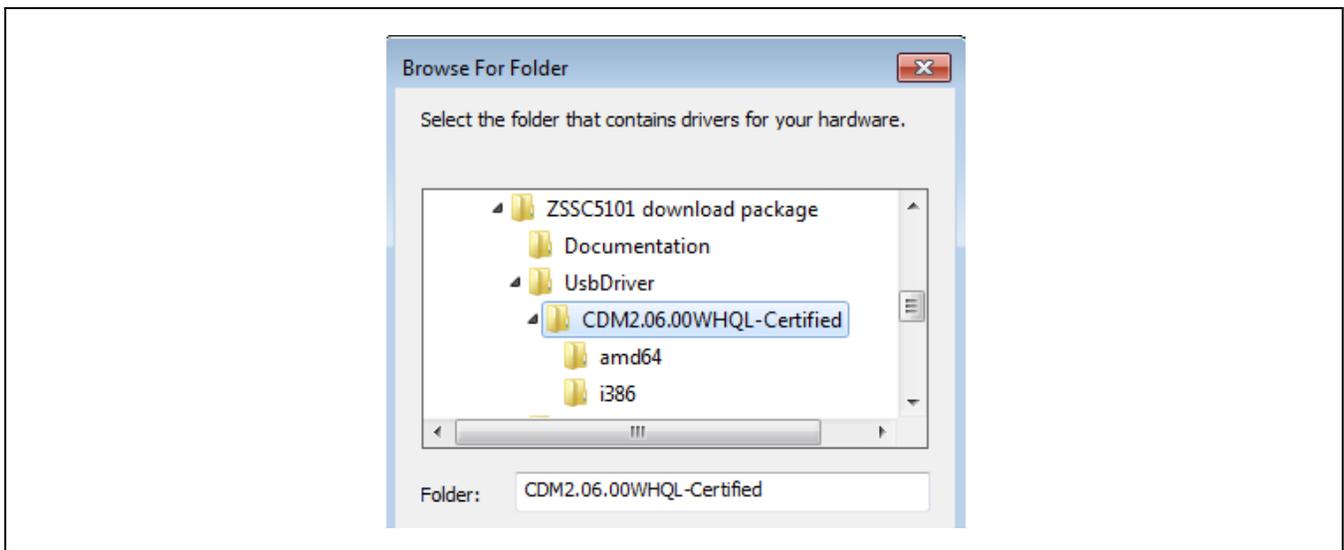
7. When the driver installation is complete, verify that message shown in Figure 3.4 is displayed and that the SSC Communication Board is now listed as "USB Serial Converter" under "Universal Serial Bus Controllers" in the Device Manager list as shown in Figure 3.1. If properly installed, proceed with the steps in section 3.2 to activate the ZSSC5101 Evaluation Software.

Figure 3.4   Confirmation Message after Installing FTDI Driver

Windows has successfully updated your driver software

Windows has finished installing the driver software for this device:

USB Serial Converter

3.2.   Starting the ZSSC5101 Evaluation Software

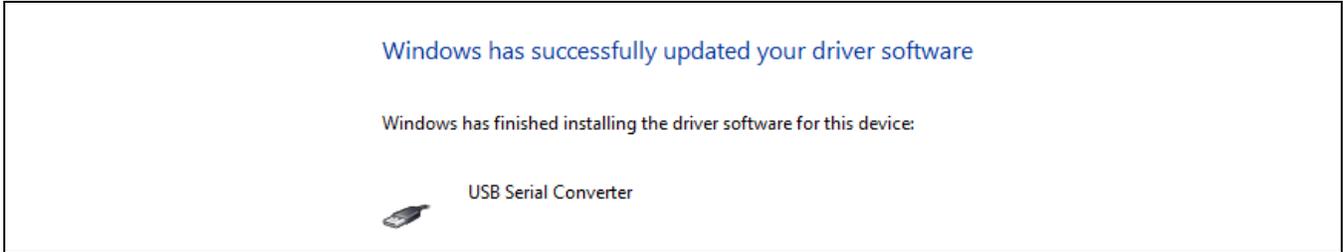After the FTDI driver is installed on the SSC Communication Board, the ZSSC5101 Evaluation Software is ready to use without any additional installation. The software provides a graphical user interface (GUI) for communication and programming of the ZSSC5101. To start the GUI, go to the *ZSSC5101_GUI* subdirectory and click on the *ZSSC5101_GUI.exe* file to run the software.

Figure 3.5   Location of the ZSSC5101 Evaluation Software

ZSSC5101 download package
Documentation
UsbDriver
ZSSC5101_GUI
ZSSC5101_GUI.exe
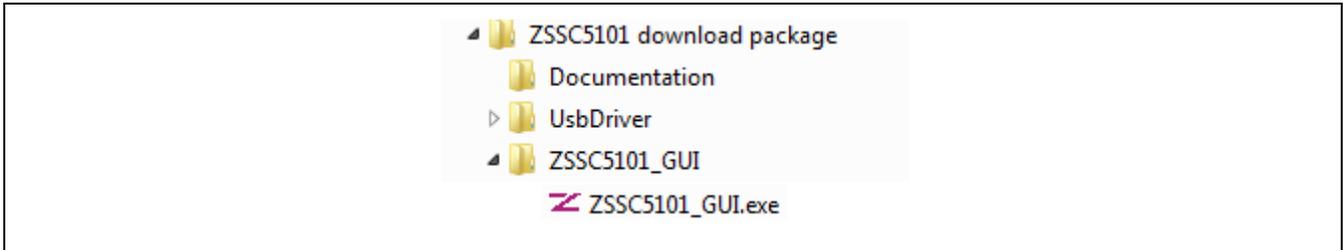
The GUI will open on the default screen shown in Figure 4.1. Typically the SSC Communication Board is detected automatically. If not, click the "Find Comm" button as needed to connect.

4 Using the ZSSC5101 Evaluation Software

Important: Before unplugging any ZSSC5101 module during operation, always click the "Power OFF" button in the software first (see Figure 4.1).

4.1. Software Revision

This kit description applies to *ZSSC5101 Evaluation Software* revision 1.2 or higher. The software revision number is given under "About" on the top main menu (see Figure 4.1).

4.2. "Setup" Tab

The initial screen for the *ZSSC5101 Evaluation Software* (i.e., the GUI) is the "Setup" tab as shown in Figure 4.1.

Figure 4.1   "Setup" Tab

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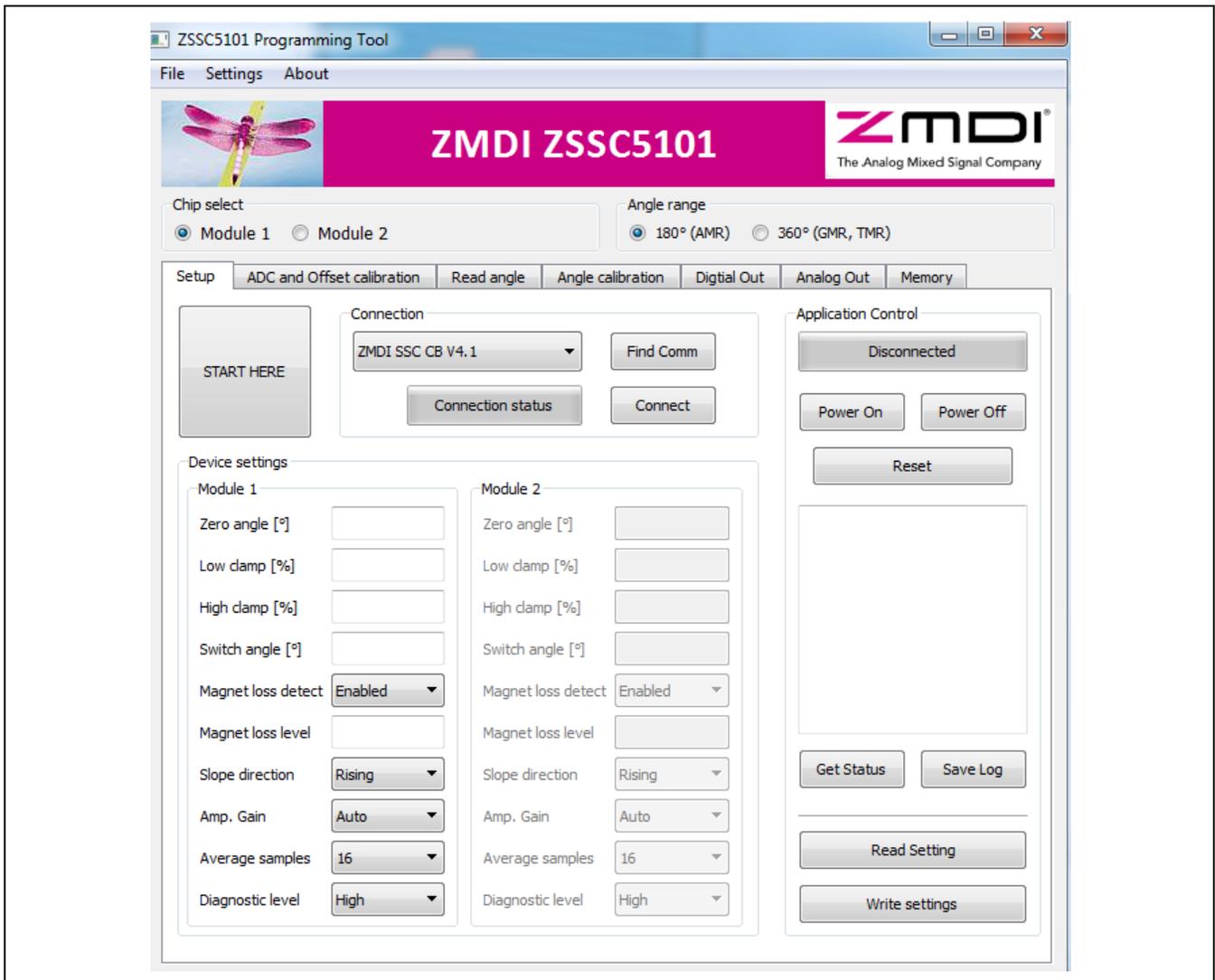
Above the tabs under "Chip select," select "Module 1" (default set-up) or "Module 2" depending on which module is connected. Under "Angle range," select whether the ZSSC5101 chip is interfacing with an AMR or GMR/TMR sensor signal. For the ZSSC5101 AMR Demo Board V1.0, which is included in the kit, choose "180° (AMR)."

Next, click the "Connect" button (see Figure 4.1). The gray "Connection status" button changes to "Connected" and turns green. This automatically turns the module on (equivalent to clicking the "Power On" button). The section for the connected module is highlighted, and the section for the non-connected module is gray to indicate that it is inactive. An example of the resulting screen for a connection to Module 1 is shown in Figure 4.2.

If two modules are connected, the user can switch between modules without cycling power by simply clicking "Module 1" or "Module 2."

The "Get Status" button can be used to check the control register and connections. Any available warnings will be displayed in the log window. The log information can be saved in a text file by clicking the "Save Log" button.
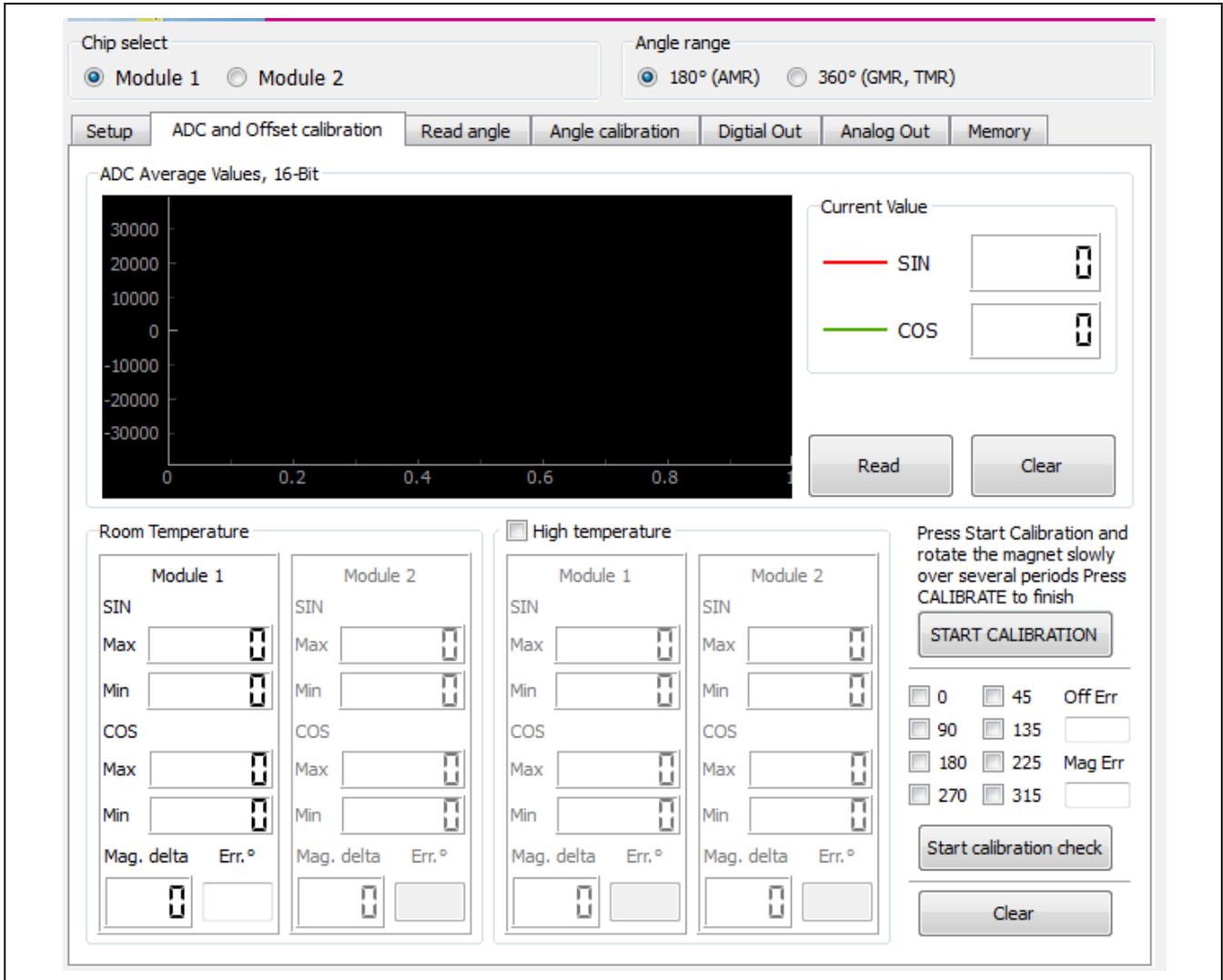
Figure 4.2   "Setup" Tab Example with Module 1 Selected
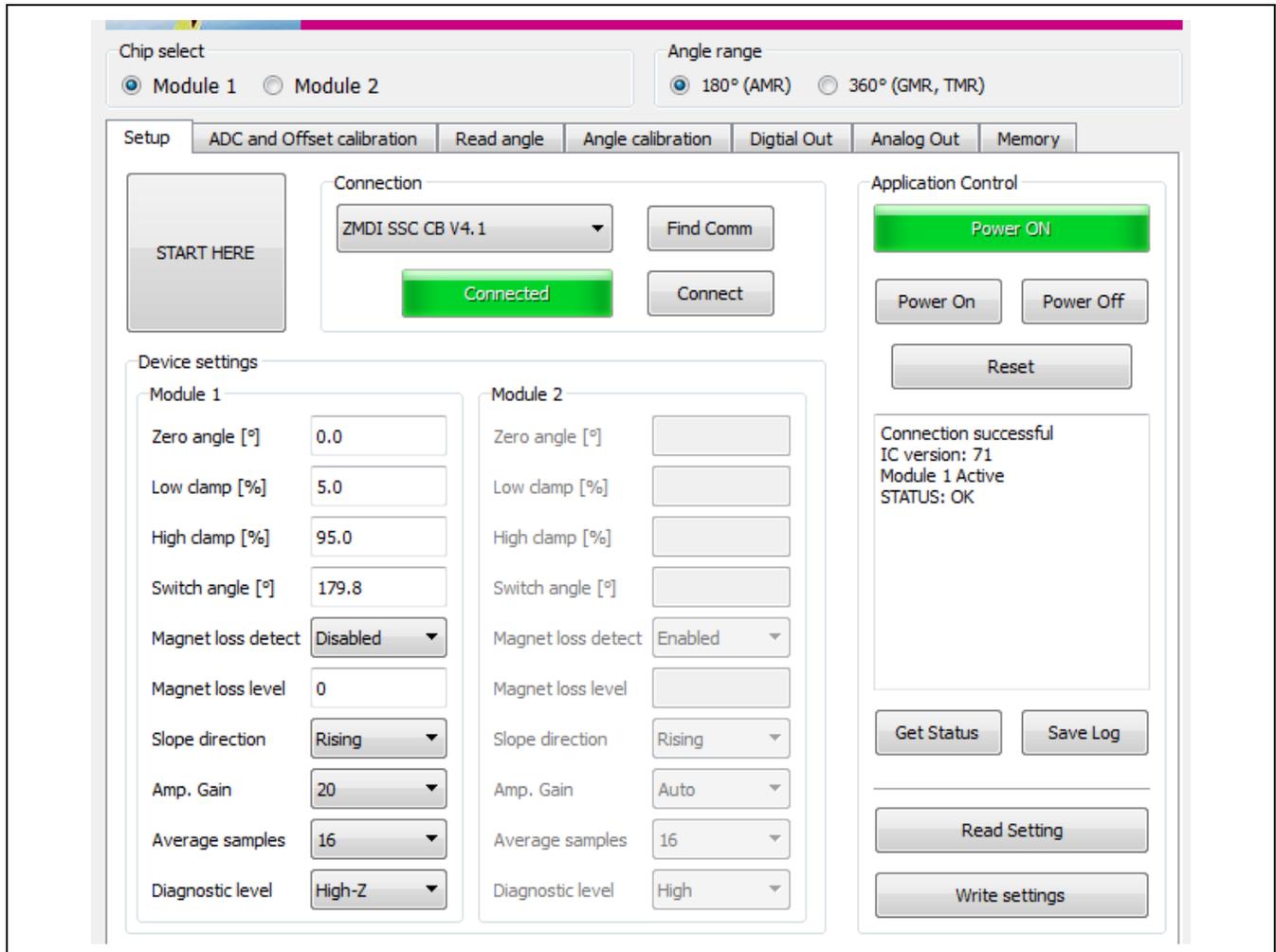
4.3.   "ADC and Offset Calibration" Tab

The "ADC and Offset calibration" tab is used to calibrate the offset of the sensor and perform an estimation of the resulting error.

*Figure 4.3   "ADC and Offset Calibration" Screen*

4.3.1. Offset Calibration

AMR sensors typically exhibit a temperature dependent offset. An offset calibration can greatly improve the accuracy of the sensor system by eliminating these errors. In addition, the offset calibration procedure also improves non-linearity caused by a misaligned (non-centered) magnet.

To start an offset calibration, ensure that a magnet is placed over the sensor and click the "START CALIBRATION" button, which is shown in Figure 4.3. The button label changes to "Calibrate Offset."

Rotate the magnet slowly until the values for SIN Min/Max and COS Min/Max that are displayed in the module's section stop changing (see Figure 4.4). Verify that the Min/Max values are in a range of approximately +/- 11000 or wider. Then click the "CALIBRATE OFFSET" button.

Figure 4.4   Example Graph and Max/Min Values for Module 1
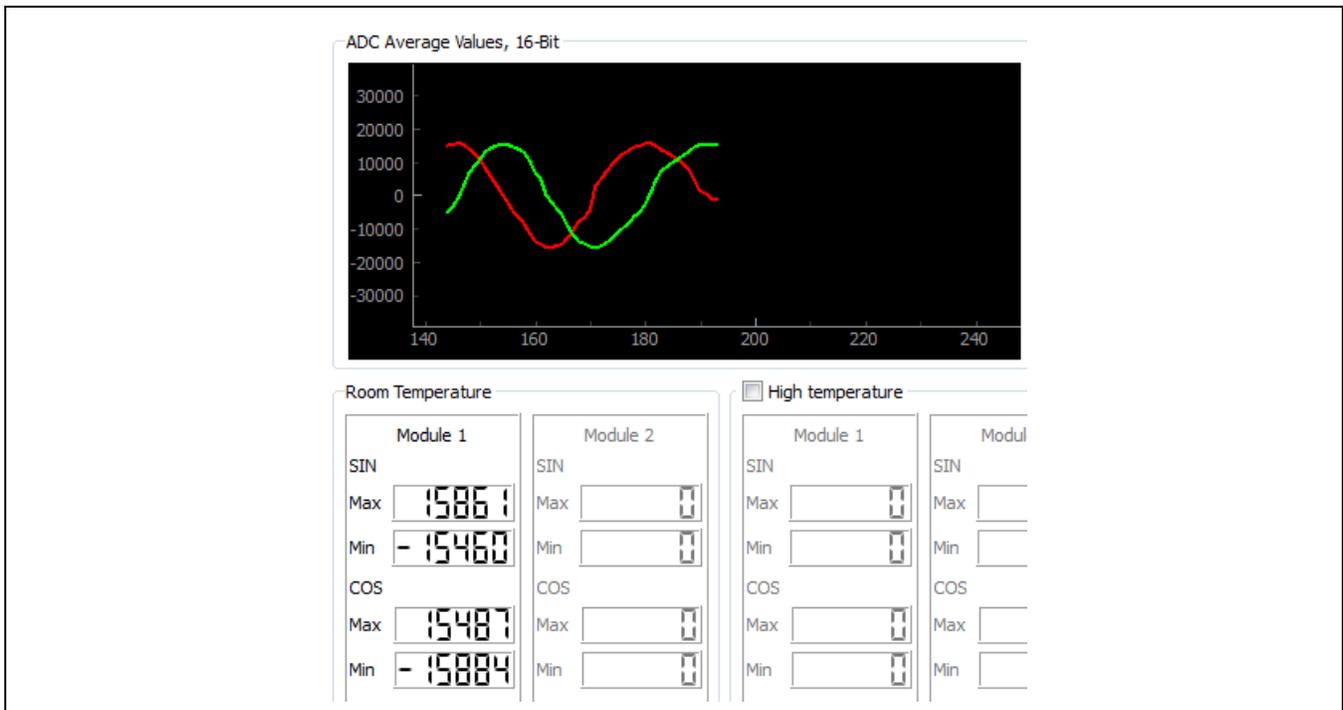
The software calculates the offset parameters and stores them in place of the default factory settings in the ZSSC5101's EEPROM. The ZSSC5101 is now calibrated for the offset of the AMR position sensor at room temperature. The same procedure can be repeated under high temperature conditions by selecting the "High temperature" checkbox. This ensures accurate output values in a range between room temperature and the high temperature; e.g., the temperature that is applied to the ZSSC5101 during high temperature calibration: 150°C. After the programming is finished, the button label changes back to "START CALIBRATION."

Note that an offset calibration can be repeated several times. Each new setting will overwrite the old setting in the EEPROM. A misalignment of the magnet also leads to an offset error. Therefore, for best performance, it is recommended that an offset calibration be repeated if the magnet is changed for any new assembly of the sensor and the magnet.

### 4.3.2.   Estimating the Resulting Angle Error

The ZSSC51201 Evaluation Kit provides a unique algorithm for estimating the resulting angle error without the need for a precision angle reference. It is only necessary to rotate the magnet after calibration and click the "Start calibration check" button, which is shown in Figure 4.5.

Important: Rotate the magnet *in one direction only*: either clockwise or counter-clockwise, not both directions.

Note that as the magnet is rotated, the eight check boxes above the button are filled in an ascending or descending sequence, depending on the rotation direction.


Figure 4.5   "Start Calibration Check"

Rotating the magnet too fast can cause check boxes to be skipped as illustrated on the left in Figure 4.6. In this case, continue rotating in the same direction until all check boxes are filled. Alternately, click the "Finish check" button, click "Start calibration check" twice, and start over. Do not rotate back and forth as this will invalidate the calculation results.

Figure 4.6   Check Boxes for Error Estimation

Example of Missed Check Boxes	Completed Calibration Check
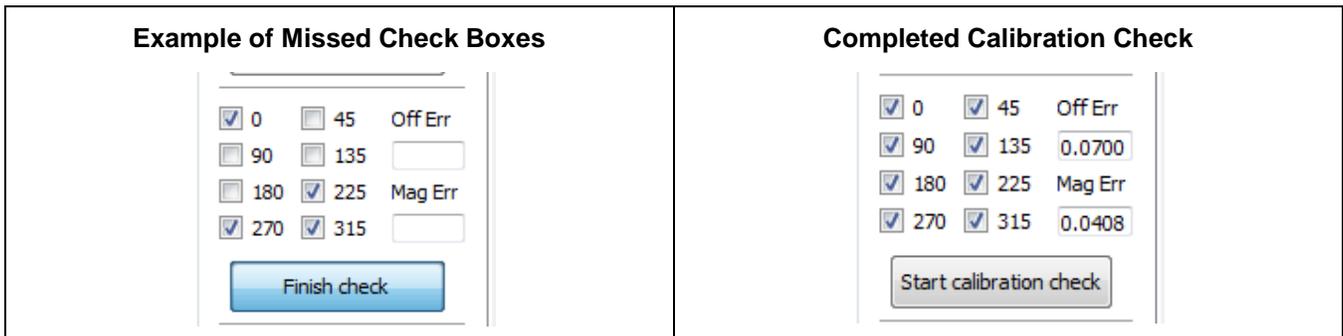
After all eight check boxes are filled, an algorithm calculates the estimated angle error and displays it in the bottom left corner. Note that the displayed error is shown as the peak angle error over one full phase (180° mechanical); e.g., in this case ±0.03°.

Note: A successful offset calibration should result in a remaining angle error of less than ±0.10°.

Figure 4.7   Estimated Error Display
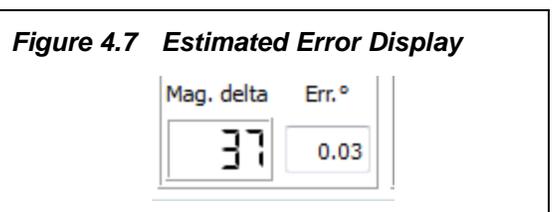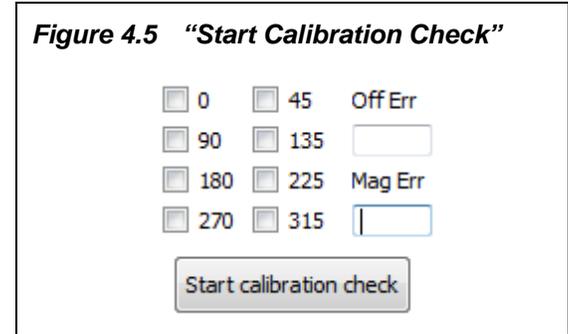
Note that there are also errors shown in the calibration window as shown on the right in Figure 4.6. These are the peak-to-peak angle errors, separated by the error resulting from remaining offset (Off Err, in this example .0.0700° pk-pk) and the error caused by magnitude mismatch (Mag Err, in this example 0.0408° pk-pk).

4.4.   "Read Angle" Tab

The "Read Angle" tab is used to display the actual angle measurement in degrees, together with the magnitude and angle value output of the CORDIC algorithm (see Figure 4.8.)

The polar plot on the right side is also a good indicator for accuracy. A perfect circle indicates a precise sensor calibration. A shift of the circle in any direction indicates an offset error, which can be eliminated through calibration (see section 4.3.1).

In order to display a circle (rather than a half circle) select "360°" under "Angle range." In the case of an AMR sensor, one circle would reflect 180° mechanical.

*Figure 4.8 "Read Angle" Screen*
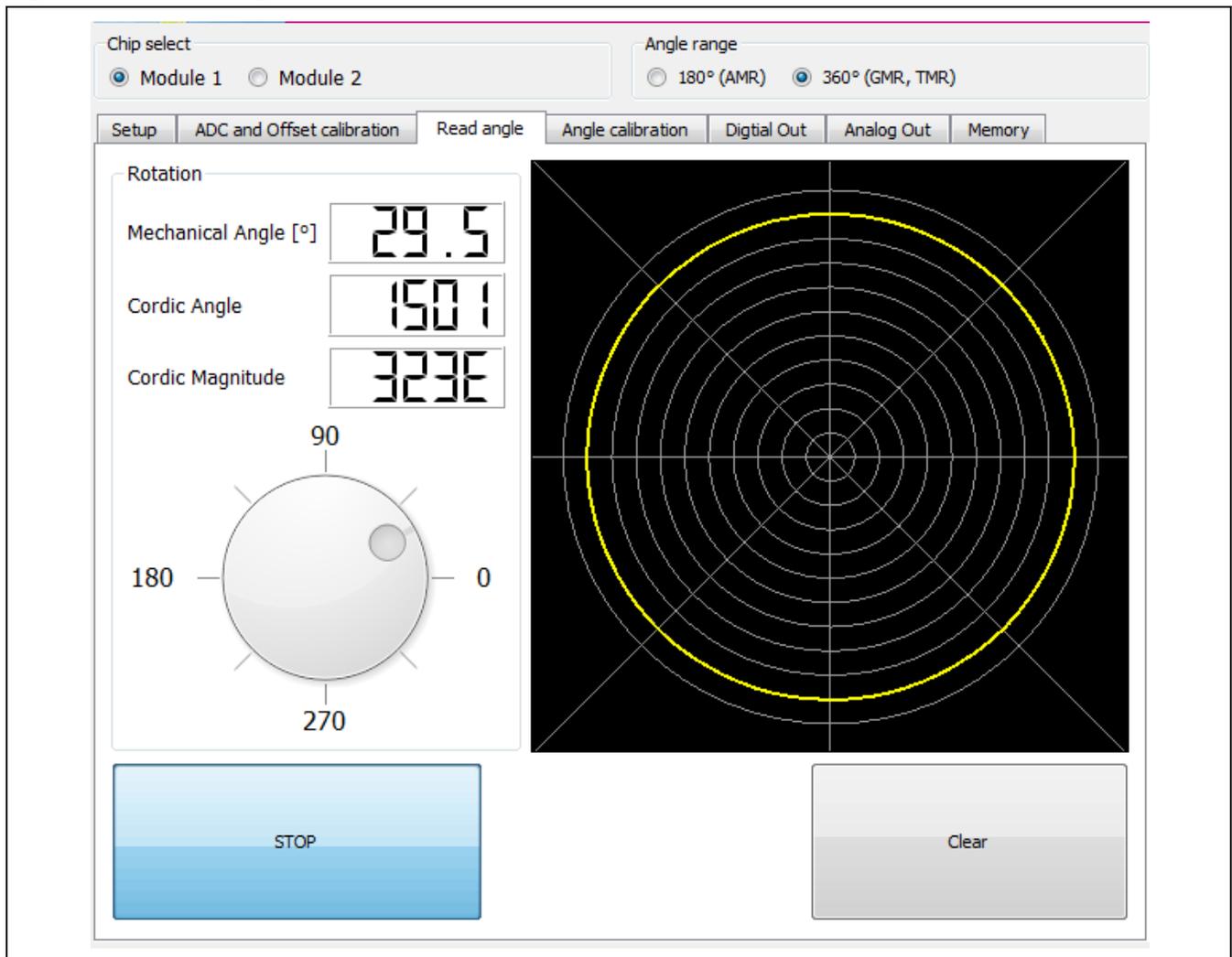
4.5. "Angle Calibration" Tab

The "Angle Calibration" tab enables setting the ZSSC5101 to match the mechanical angle limits of the application to which it is connected (e.g., a pedal).

To utilize the full angle range (e.g., 180° for AMR sensors), click the "Reset to default" button. This programs a linear ramp over the maximum angle range. To perform an angle calibration for both modules sequentially, check the "Module 1+2 angle calibration" box. The software automatically switches between module 1 and module 2, which is indicated via the radio buttons under "Chip select."

Figure 4.9 "Angle Calibration" Screen
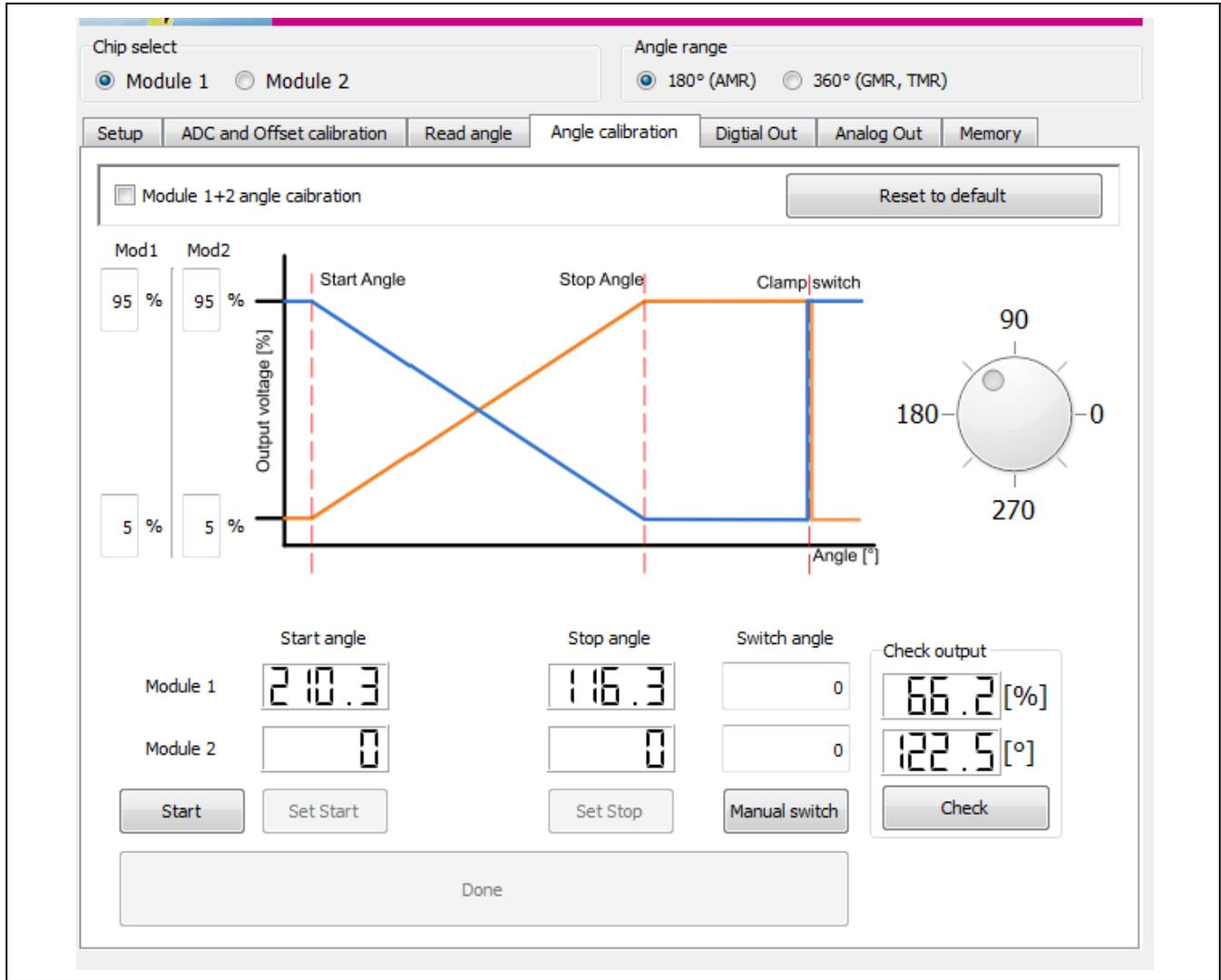

4.5.1. Setting the Angle Range Limits and Switch Angle

To match the sensor measurement range with a mechanical range (e.g., the full release and full push positions of a pedal), use the following procedure to enter the two end positions for the output voltage, which will be stored in EEPROM. The angle range between these mechanical stops will be a linear ramp.

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1. Click the "Start" button on the "Angle Calibration" tab and wait until the "Set Start" button becomes active.

2. Move the magnet to the start position (note that this is the maximum clockwise position when looking at the sensor from the top). Click "Set Start." This stores the start position, and then the "Set Stop" button becomes active.

3. Rotate the magnet to the stop position (when looking at the sensor from the top, rotate the magnet counterclockwise to the stop position) and click "Set Stop." This stores the stop position.

Figure 4.10 Setting the Angle Range with the "Angle Calibration" Tab
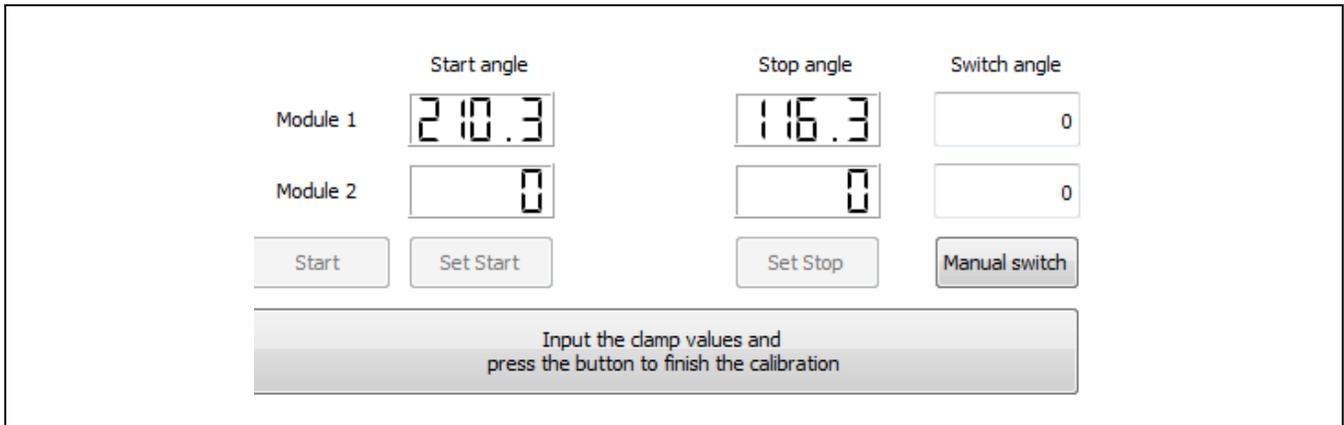
4. Optional: The switch angle, which is the angular position where the analog output returns from Vout,max to Vout, min, can be manually entered for each module in the "Switch angle" entry fields. Then click "Manual switch" to confirm the entry, which stores the value in EEPROM. If no value is entered, it will be calculated automatically.

5. Optional: Enter the minimum and maximum clamping values at the two mechanical stop positions as percentages of VDD in the entry fields adjacent to the graph in the upper left section of the tab. Alternatively, the default values that are already displayed can be used. See Figure 4.11, which illustrates the example default values Vmin = 5% VDD and Vmax = 95% VDD.

6. To complete the angle calibration, click the large button at the bottom of the tab, which has the label "Input the clamp values and press the button to finish the calibration." (See Figure 4.10.) When the angle programming is completed, this button becomes grey and its label changes to "Done."

Figure 4.11 Clamping Values
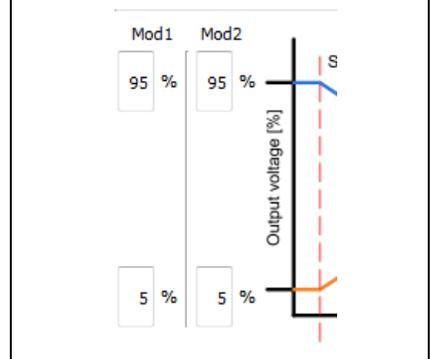
4.5.2. Checking the Calibrated Angle

Strong Recommendation: Verify the actual angle and output value by clicking the "Check" button under "Check output" on the "Angle Calibration" tab (see Figure 4.9). The two display fields under "Check output" will show the current readings for the mechanical angle and the corresponding output value as a % of VDD (see Figure 4.12).

If necessary, repeat the procedures in section 4.5.1 as needed to meet application requirements.

Figure 4.12   Angle Calibration Check Example
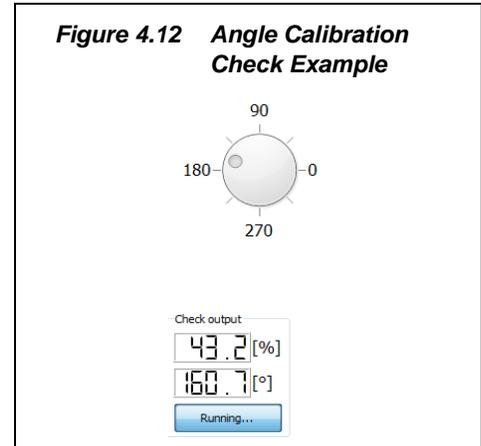
4.5.3. Indication of Possible Errors during Programming

Improper programming (e.g., start and stop angle are unintentionally programmed at the same position) is indicated by an error condition.

Error conditions are indicated on the "Angle Calibration" tab by the output being displayed as an unchanging fixed output value below the lower clamping level for all magnet positions (e.g., output voltage = 1.9%VDD over all angles as shown in Figure 4.13).

In addition, on the "Memory" tab (see section 4.9), the control register flag for "in_diag_condition" is checked if errors have been detected (see example in Figure 4.13).

In this case, repeat the programming with valid entries.

*Figure 4.13   Error Condition Indication Example*
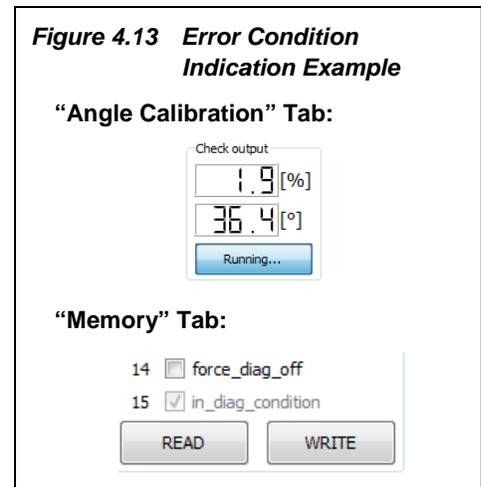
4.6. Selecting the Slope of the Angle Calibration and Writing the Settings

Note: The slope (rising or falling) of the angle calibration cannot be programmed until after programming.

After completing the steps in sections 4.3.1, 4.5.1, and 4.5.2, go to the "Setup" tab (see Figure 4.1) and select the slope setting using the "Slope direction" drop down menu as shown in Figure 4.14. Next, if all settings are final, click the "Write settings" button.

Figure 4.14 "Slope Direction" Menu and "Write settings" Button on the "Setup" Tab
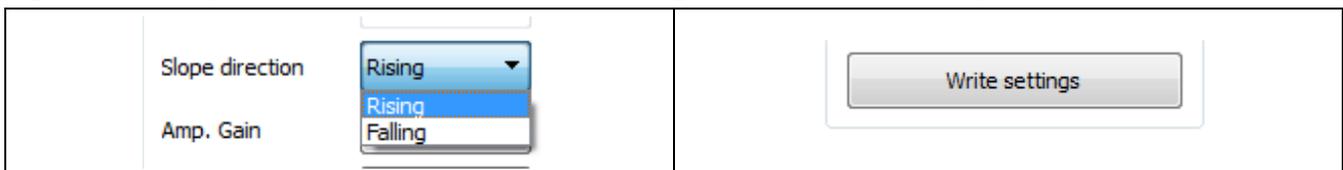
4.7.　"Digital Out" Tab

The "Digital Out" tab displays an XY plot for which the X-axis represents the angle and the Y-axis represents the output value (the ramp). To generate a graph, click the "Read" button and slowly rotate the magnet over the full angle range. The label on the button changes to "Stop."

Note that this display is cleared and refreshed automatically while in "Read" mode. To freeze the screen, click the "Stop" button.

Values shown in the display fields in the "Min/Max Values" section are determined over each period: 180° for AMR or 360° for GMR/TMR sensors.

Figure 4.15 "Digital Out" Screen

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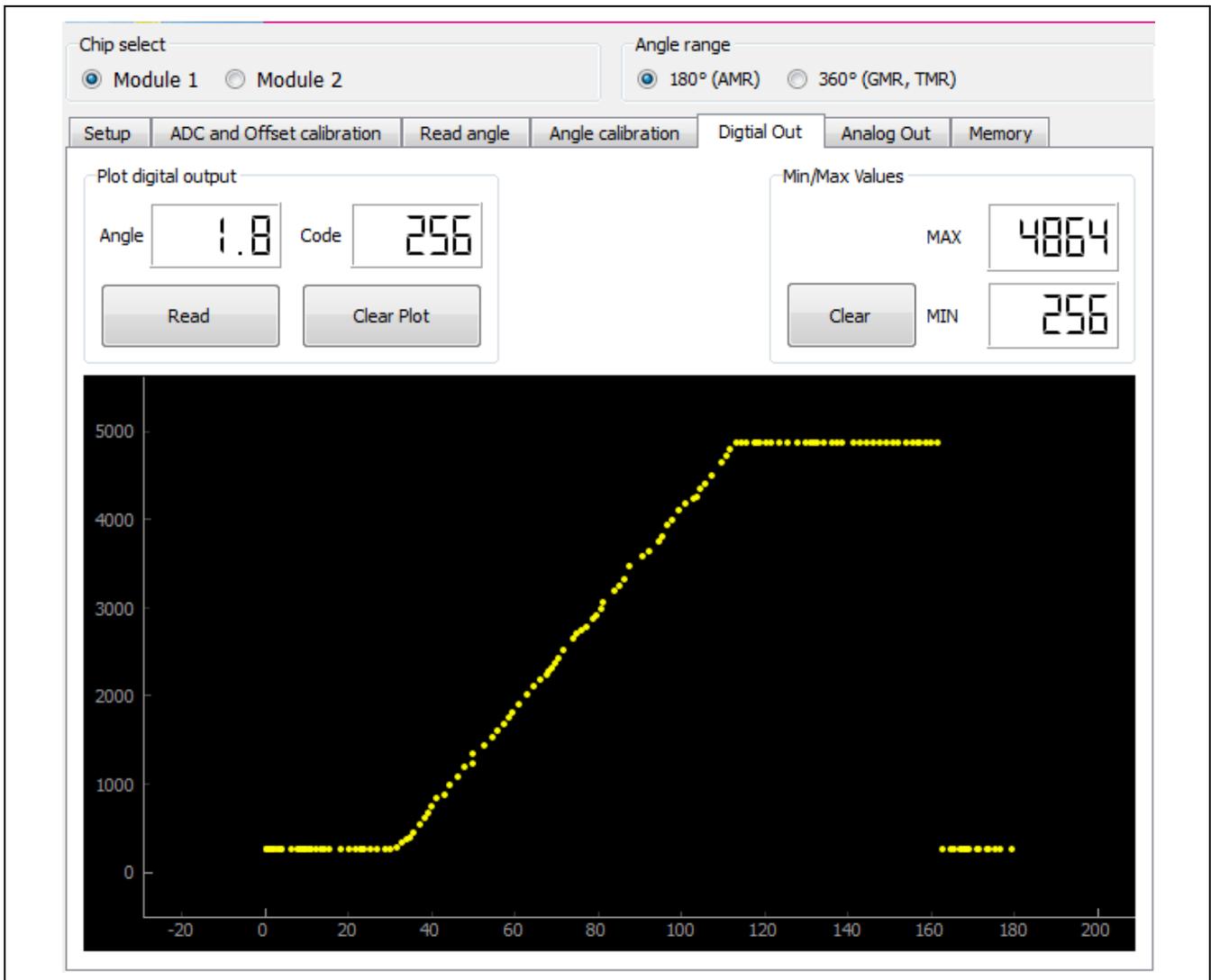
4.8. "Analog Out" Tab

The "Analog Out" tab shows the actual analog output voltage of the sensor (the voltage at the ZSSC5101's VOUT pin). The X-axis of the plot is the time, scrolling from right to left, and the Y-axis is the analog output voltage of the sensor that is measured by an ADC in the microcontroller of the SSC Communication Board. To initiate a plot, click the "Read" button. The label on the button changes to "Stop."

The values in the "Min/Max values" section are continuously calculated for the period that reading is active. The "Output difference" and "Output sum" values are calculated point-by-point and therefore updated for each reading.

The outputs of both Module 1 and Module 2 sensors can be displayed simultaneously if the "Enabled" radio button under "Dual Devices" is selected. If selected, the ADC of the SSC Communication Board measures each sensor sequentially and displays the results on the scrolling screen. The example in Figure 4.17 shows the analog outputs of two modules connected to the kit. Output 2 (falling slope) is opposite to output 1 (rising slope).
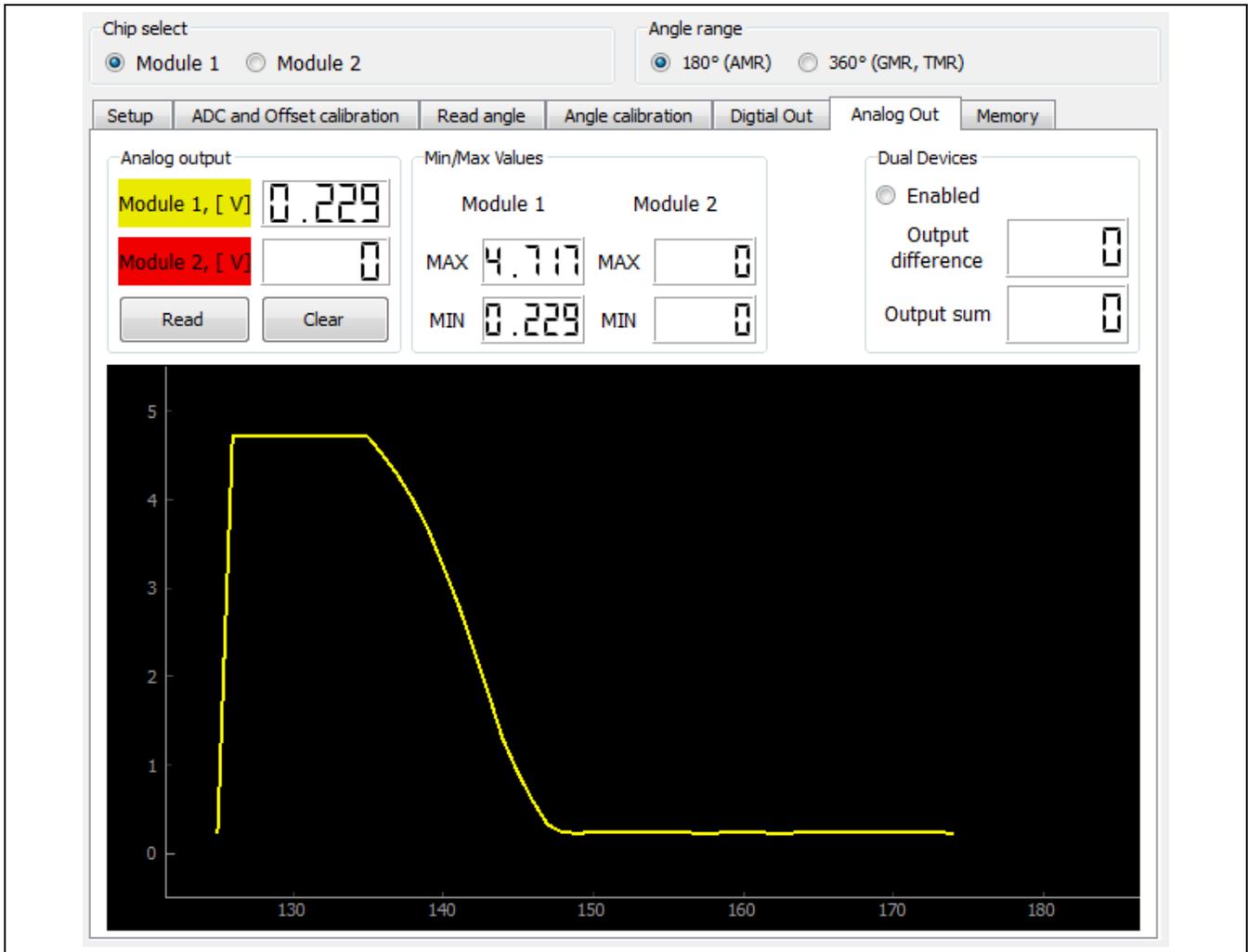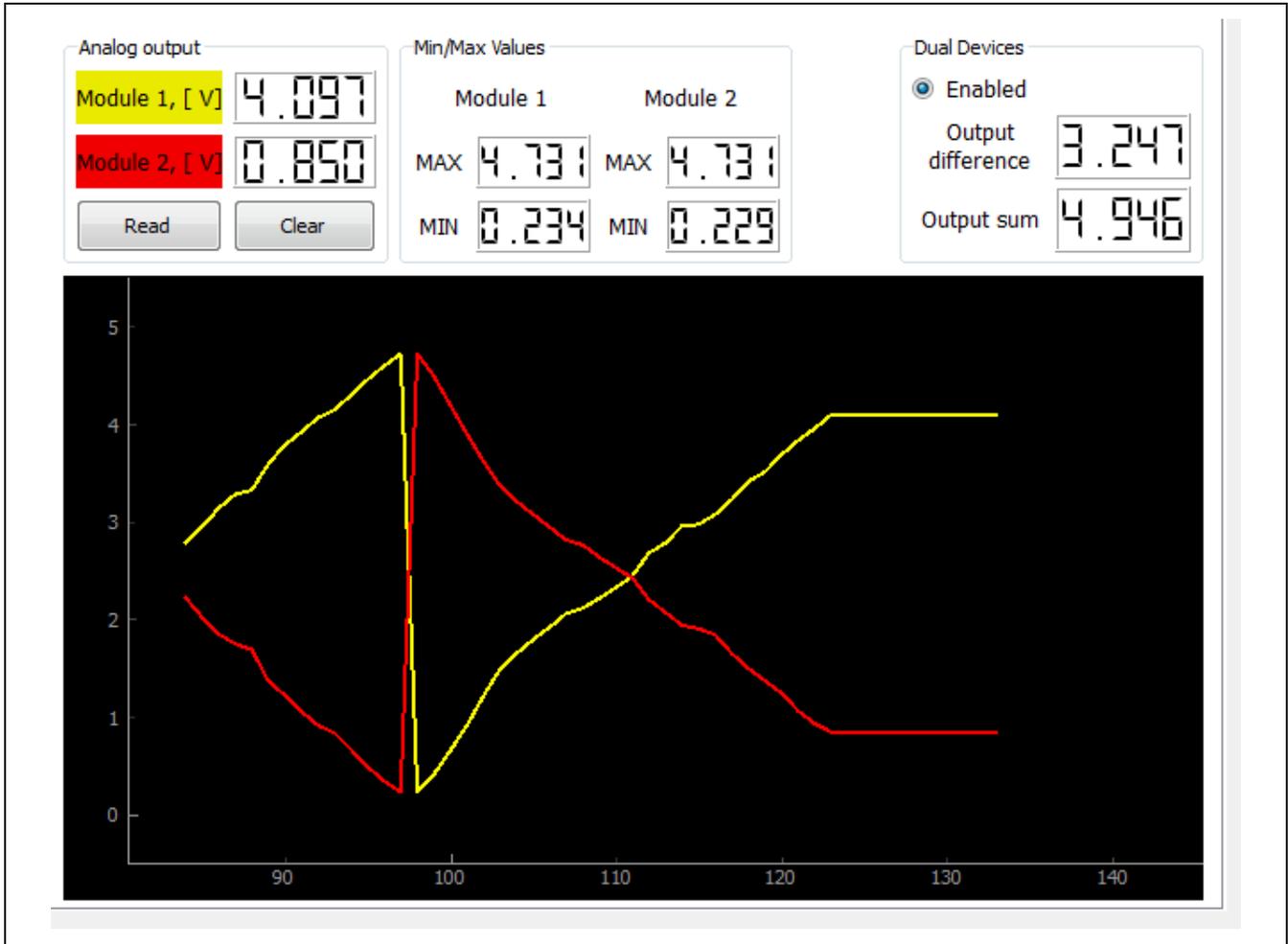
Figure 4.16 "Analog Out" Screen Example

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Figure 4.17 "Analog Out" Screen Example with Two Modules

4.9. "Memory" Tab

The "Memory" tab is used to read and modify the EEPROM contents for factory settings, user settings, and the control register. For further details about the settings refer to the *ZSSC5101 Data Sheet* and the ZSSC5101 Application Note – Programming Guidelines.

The example EEPROM contents shown in Figure 4.18 illustrate the default (uncalibrated) settings:

- Maximum angle range (180° for AMR sensors)
- Clamping levels: 5% VDD and 95% VDD
- Magnet loss detection: disabled

Under "CONTROL REGISTER," if the *digi_not_ana* bit checkbox is checked, the ZSSC5101 VOUT pin is in the digital bi-directional Command Mode instead of the default analog output mode (Normal Operation Mode).

Figure 4.18 "Memory" Screen

4.9.1. Loading and Saving EEPROM Settings

A complete set of EEPROM settings can be stored in a file on the user's computer. The stored set of settings can then be retrieved when needed and loaded into the GUI.

To store a set of EEPROM settings, go to the top main menu and click on *File → Save EEPROM*. The resulting dialog allows selection of the file name and location for storing the file.

To retrieve a set of previously saved EEPROM settings, go to the top main menu and click on *File → Load EEPROM*. The resulting dialog allows navigating to locate and load the file. Then click the "EEPROM Write" button on the "Memory" tab to load the values in the ZSSC5101.

The downloaded software provides an EEPROM configuration file containing the default settings for an AMR sensor as illustrated in Figure 4.18. It is stored in the subdirectory *user settings* with the file name *AMR default 180deg 5-95%.eep*. See Figure 4.20.

4.10. Diagnostics Conditions

If a fault condition is detected (e.g., programming error, see section 4.5.3), the output will go into the Diagnostics Mode, which is indicated by an output voltage below the lower clamping level or above the upper clamping level (see section 4.5). The diagnostics condition is also indicated by a checked box for "in_diag_condition" in the control register bit 15 as shown in Figure 4.21.

Such errors are typically resolved by either correcting the error that caused the chip to go into Diagnostics Mode (e.g., re-programming the angle range within allowed limits).

Figure 4.19   Saving or Loading Files for EEPROM Settings

Figure 4.20   Location of Default File

Figure 4.21   Diagnostics Mode Flag
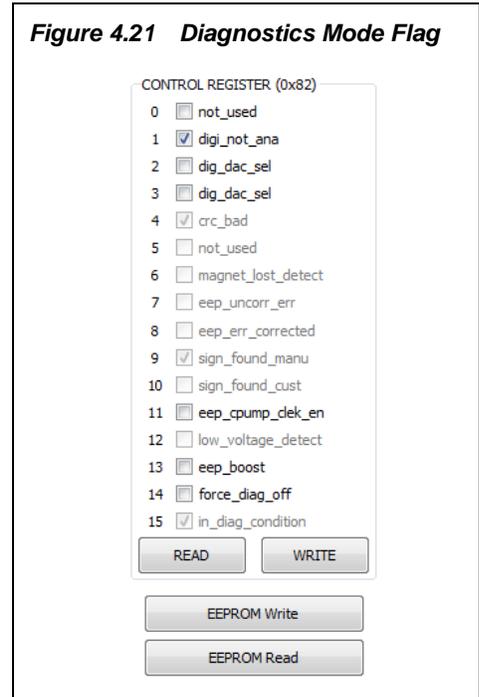
5   Related Documents

Document
ZSSC5101 Data Sheet
ZSSC5101 Application Note – Programming Guidelines*

Visit the ZSSC5101 product page www.IDT.com/ZSSC5101 or contact your nearest sales office for the latest version of these documents.

* Note: Documents marked with an asterisk (*) require a free customer login account for document access on the product page.

6   Glossary

Term	Description
AMR	Anisotropic Magnetoresistance
CORDIC	Coordinate Rotation Digital Computer
TMR	Tunnel Magnetoresistance
GMR	Giant Magnetoresistance

7   Document Revision History

Revision	Date	Description
1.00	April 17, 2015	First release.
	March 11, 2016	Changed to IDT branding.

Notice

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