MAXSANTAFEEVSYS
User Manual

Rev 0; 5/14

Table of Contents

1 Introduction

The MAXSANTAFEEVSYS kit allows users to quickly demonstrate and evaluate the functionality of the MAXREFDES5 4-channel analog front-end (AFE) reference design without the need for a bench power supply, signal generator equipment, or Xilinx development kit. The reference design board connects to a PC through an included USB-to-SPI adaptor that provides both power and data communication to the board. To test the AFE reference design, a USB-powered signal generator board utilizing one of Maxim's digital-to-analog converters (DACs) is also included. Windows®-based graphical user interfaces (GUIs) communicate with the boards for generating various analog signal test patterns and simplified access to AFE measurement data.
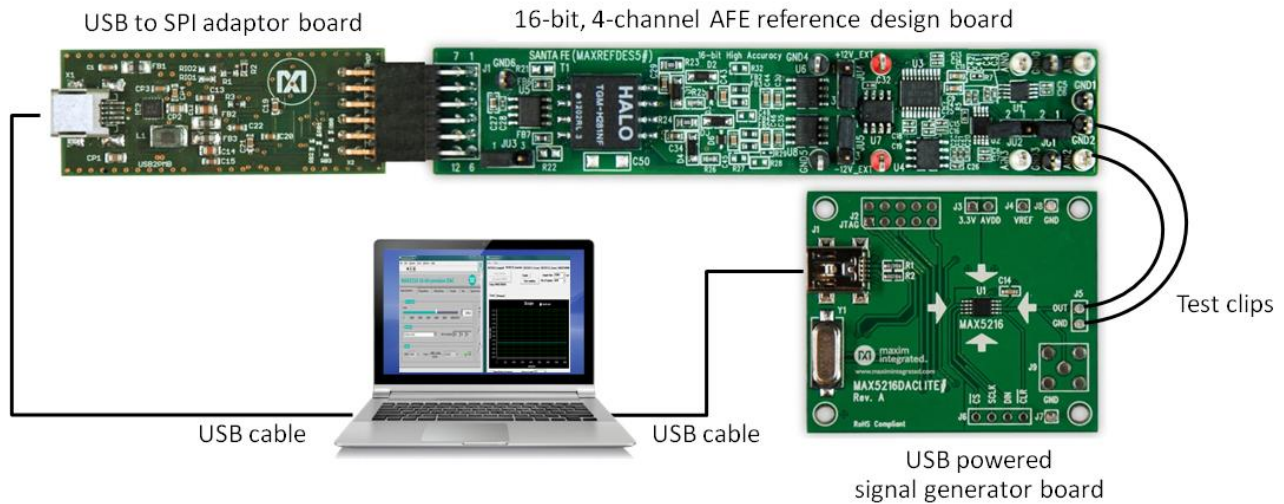
1.1 Ordering Information

PART	DESCRIPTION
MAXSANTAFEEVSYS#	Bundled kit for PC evaluation of MAXREFDES5 4-Ch AFE

#Denotes a RoHS-compliant device that may include lead that is exempt under the RoHS requirements.

1.2 Package Contents

The MAXSANTAFEEVSYS kit includes the following:

- MAXREFDES5 4-channel AFE board
- USB2PMB1 USB to Pmod™ Type 2A adaptor board
- MAX5216DACLITE signal generator board
- Two (2) wires with hook clips (1 red and 1 black)
- Two (2) USB type A male to USB type B mini cables
- USB flash drive with documentation, GUI applications, and USB Drivers
- Quick Start Guide (print copy)

1.3 System Requirements

The MAXSANTAFEEVSYS kit only requires use of a PC with the following:

- Minimum 1GHz processor and 1GB RAM
- Minimum 1024 x 768 video display resolution
- Two available USB ports
- Microsoft Windows 8, Windows 7, Windows Vista, or Windows XP®

1.4 Functional Diagram
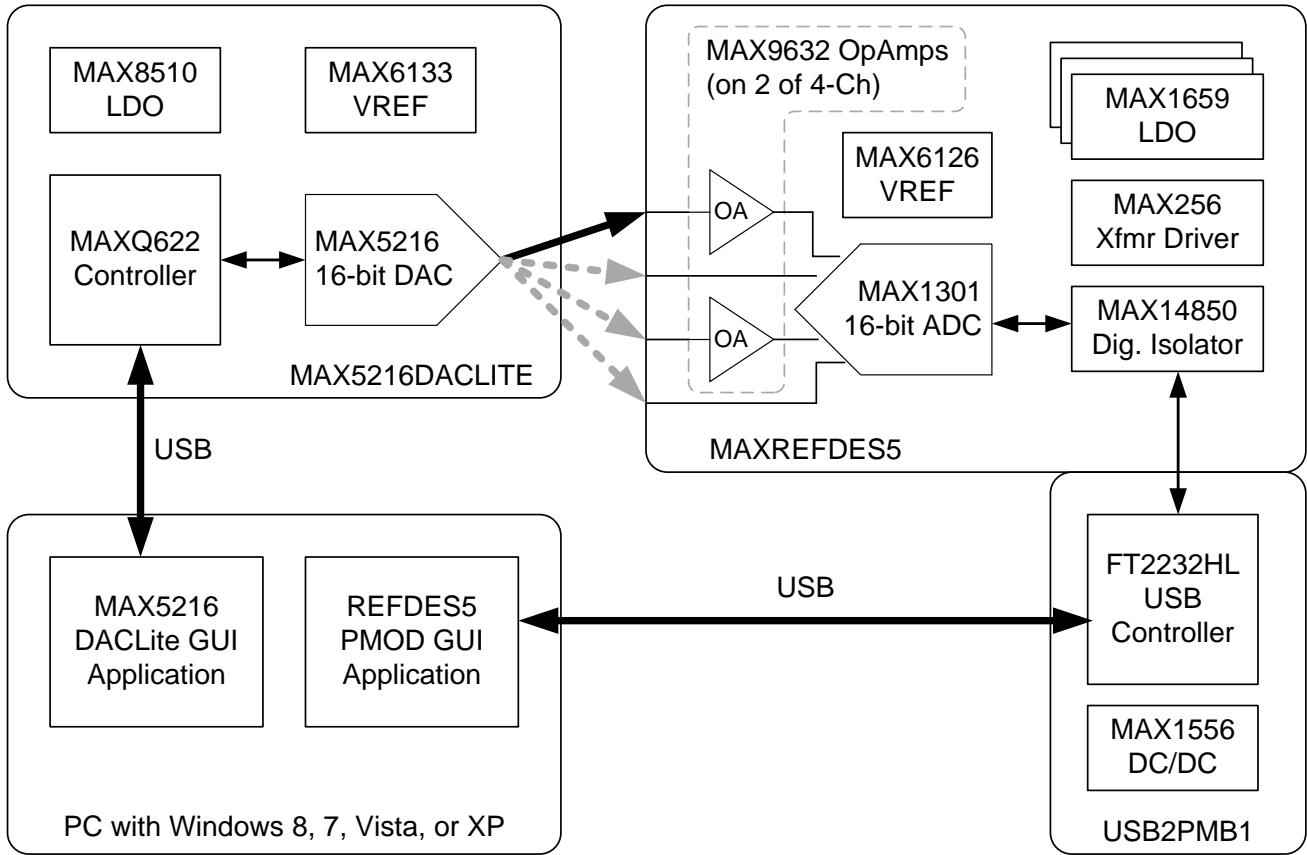
2   Software Installation

There are two Windows GUI applications included with MAXSANTAFEEVSYS used for:

- Generating analog test signals with the MAX5216DACLITE board in order to evaluate the performance of the AFE reference design. This application is created using National Instruments LabVIEW®. The NI LabVIEW Run-Time Engine (RTE) must be installed in order to install and execute the MAX5216DACLITE GUI application.

- Calibrating the offset and gain for the analog inputs of the MAXREFDES5 board and evaluating the design's measurement performance. This application created using Borland C++ does not require any installation and can be executed directly from the USB flash drive.

To begin software installation, either connect the provided USB flash drive to an available USB port on your PC, or download a zip file of the USB flash drive contents from **www.maximintegrated.com/MAXSANTAFEEVSYS** and extract to a location on your local hard drive. Administrator privileges are required for installing the provided software.

2.1   MAX5216DACLite Signal Generator Software Installation

Although the Setup.exe file located in the \DACLITE\ directory includes the LabVIEW RTE, it is recommended to follow the instructions below for best results across different Windows operating systems and user account types.

1.   Browse to the \DACLITE\ directory found on the USB flash drive or in the extracted directory from the downloaded zip file.
2.   Run **LVRTE_SETUP.exe** to install NI's 2012 (32-bit) Runtime Engine. **Do NOT restart or shut down the PC after completion of this installation.** Choose the **Restart Later** option when prompted and proceed to step #3 below.
3.   Run **DACLITE_SETUP.exe** after completion of step #2 above.
4.   Restart the PC when prompted.

3 Connections

This section describes the basic connections with the MAXSANTAFEEVSYS kit. Two available USB ports are required for operating the MAXSANTAFEEVSYS kit setup. If needed, copy the \MAXREFDES5\ and \USB2PMB1\ directories from the USB flash drive to your PC to free up a USB port.

All boards derive power from the USB ports. The USB2PMB1 board includes on-board DC-DC conversion for providing 3.3V DC to the MAXREFDES5 AFE board (or any other 3.3V Pmod Type 2A board). To provide external power to the MAXREFDES5 board, refer to Application Note 5561 included in the \MAXREFDES5\ directory and located at **www.maximintegrated.com/AN5561**. For more information on the Peripheral Module (Pmod™) form factor, refer to the Digilent Pmod^{TM} Interface Specification or visit www.DigilentInc.com.

## 3.1 MAX5216DACLITE Signal Generator Board

Connect one of the provided USB cables between the MAX5216DACLITE board and PC. The on-board controller presents itself to the PC as a USB HID class device in the Windows Device Manager as shown below and does not require any third-party drivers.

3.2 USB2PMB1 USB Adaptor Board

Connect the other provided USB cable between the USB2PMB1 board and PC. The USB2PMB1 adaptor board includes an FTDI FT2232HL USB controller IC that performs the USB functions and conversion to SPI. Upon attaching the USB2PMB1 adaptor board to the PC, the **Found New Hardware Wizard** automatically launches and installs the appropriate driver files if already located on your PC. If your PC does not find the FTDI driver files on its local hard disk drive, locate and reference the \USB2PMB1\CDM v2.10.00 WHQL Certified\ subdirectory to install FTDI's D2XX driver.

Multiple drivers will be installed before it is ready to use. To verify proper installation, one should see two USB Serial Converters (A and B) in the Device Manager as shown below.
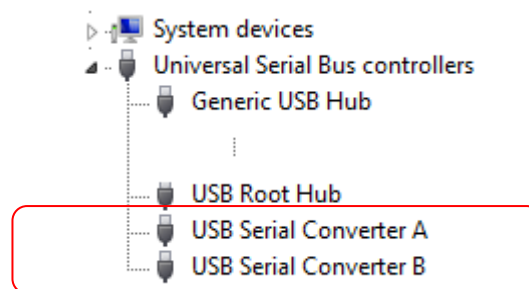
3.3   MAXREFDES5 4-Ch AFE Board

Connect the MAXREFDES5 board to the USB2PMB1 adaptor. Both connectors should be on the same side of the PCB when mated together as shown below.
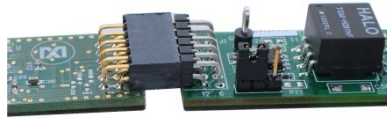
3.3.1   Analog Signal Connections

The following table summarizes the different connection options for the MAXSANTAFEEVSYS kit. Note the input range of the MAXREFDES5 analog inputs exceeds the output capabilities of the MAX5216DACLITE board included with the kit.

For testing input AIN2 with a voltage source, a jumper JU2 should be removed to disconnect the on-board sense resistor. Jumper JU1 on AIN2 is provided for optional connection to a reference ammeter.

Input AIN0
0V to +3V from DACLITE J5
(or -10V to +10V from alternate source)

Input AIN1
0V to +3V from DACLITE J5
(or -10V to +10V from alternate source)

Input AIN2
+1V to +3V from DACLITE J5 with JU2 removed
(or 4-20mA from current source with JU2 installed)

Input AIN3
0V to +3V from DACLITE J5
(or 0V to +10V from alternate source)
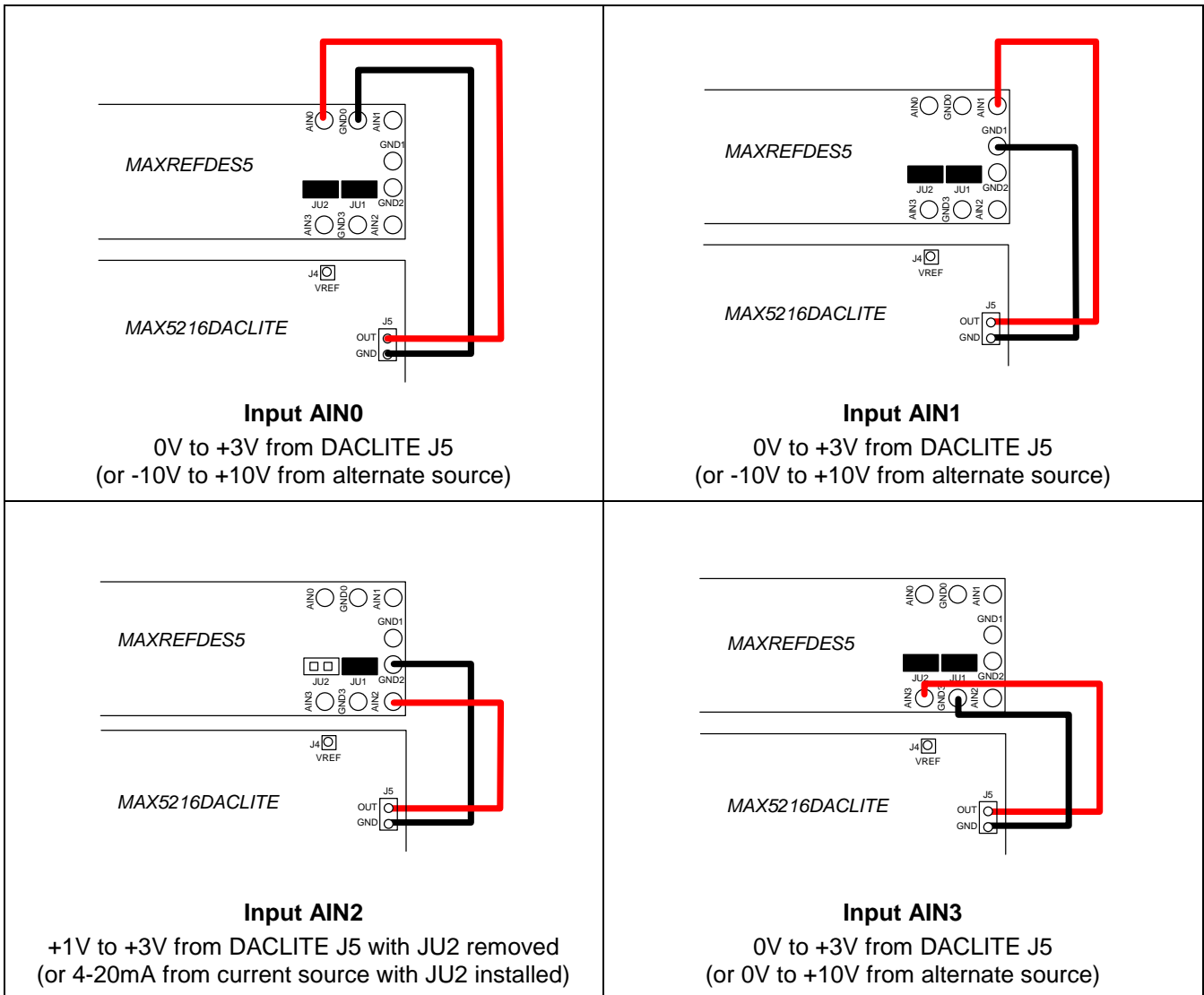
4 Graphical User Interfaces

Before launching the GUI applications, make sure the USB2PMB1 and MAX5216DACLITE boards are connected to the PC as described in the previous section.

4.1 GUI for MAXREFDES5
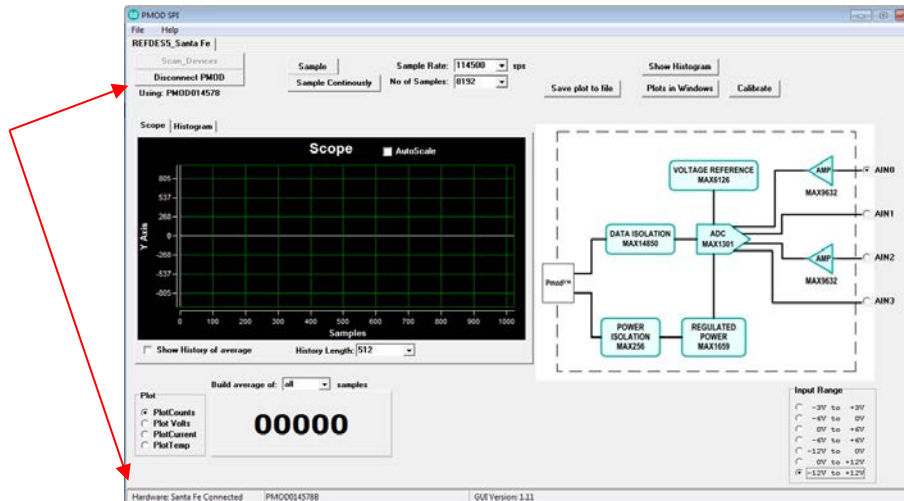
With the USB2PMB1 board connected, run (double-click) the **PMOD_SPI.exe** GUI application located in the \MAXREFDES5\ directory. Once the window below appears, press the **Connect PMOD** button and verify that the button changes its text to **Disconnect PMOD** and the status bar at the bottom indicates that the companion board is connected.

4.1.1 Input Selection and Configuration

While most of the controls in the GUI only adjust the display of information on the screen, there are two controls that both adjust the GUI display and configure the MAX1301 ADC device used in the MAXREFDES5 design. These controls send a command to the MAX1301 indicating which input to sample and the full scale range (FSR) for that input. The recommended combinations for the MAXREFDES5 hardware design are shown in the left two columns of the table below. For reference, the respective channel select bits C[2:0] and range select bits R[2:0] are also provided along with the full-scale range.

| BOARD INPUT	ADC INPUT RANGE	MAX1301 INPUT CONFIGURATION
AIN0 -10V to 10V	-12V to +12V	C[2:0] = 000 R[2:0] = 111 FSR= 6 x V_{REF}
AIN1 -10V to 10V	-12V to +12V	C[2:0] = 001 R[2:0] = 111 FSR= 6 x V_{REF}
AIN2 4mA to 20mA	0V to +6V	C[2:0] = 010 R[2:0] = 011 FSR= (3 x V_{REF}) / 2
AIN3 0V to 10V	0V to +12V	C[2:0] = 011 R[2:0] = 110 FSR= 3 x V_{REF}

4.1.2 Sampling Controls

The GUI provides the user with two options for the sampling of data from the MAXREFDES5. The **Sample** button captures a discrete number of samples as selected in the **No. of Samples** drop down menu and displays the results. To start continuously collecting and displaying measurement data, press the **Sample Continuously** button. When enabled, the button changes its text to **Stop Sampling.** In this mode, the **No. of Samples** value determines the time base for displayed results. For best GUI performance, do not set the No. of Samples above 16384.

The **Sample Rate** drop down selection allows the user to choose the sample rate or the number of conversions initiated by the GUI per second. The max allowable sample rate is determined by the MAX1301 device.

4.1.3 Results

The real-time scope on the left side of the GUI represents the measured data with **No. of Samples** used for the x-axis as described in the section above. This section describes the rest of the GUI display controls, which execute no control or command of the MAX1301 device.
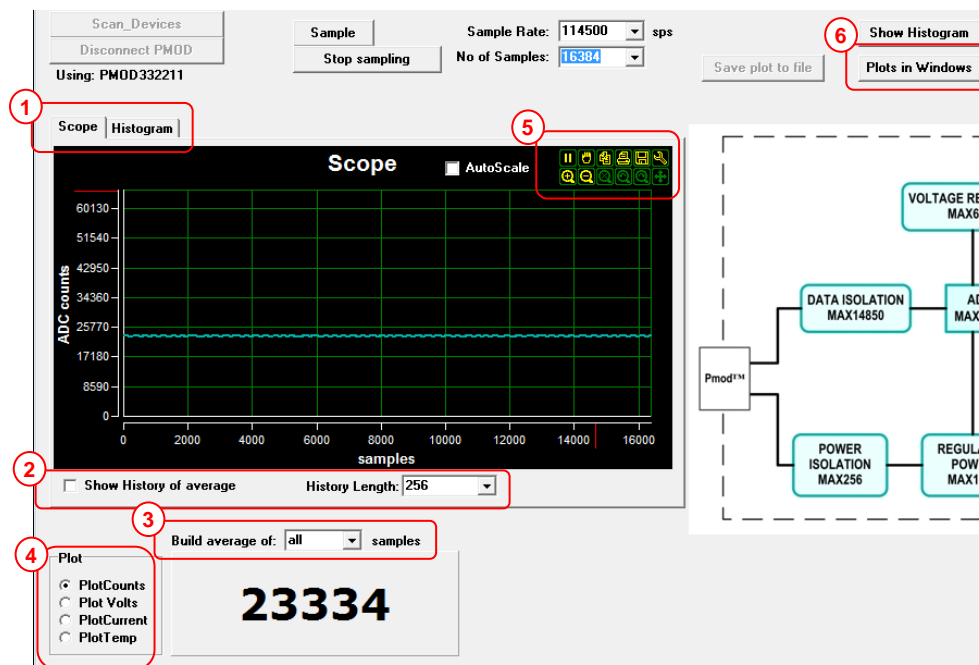
1) **Scope | Histogram:** This tab allows the user to choose between the **Scope** plot with configurable x- and y-axis or the **Histogram** plot with the ADC code on the x-axis and the number of occurrences on the y-axis.

2) **Show History of average:** Checking this option allows the user to view entire data in history up to the history length selected in the **History Length** drop-down menu.

3) **Averaging:** A **Build average of** drop-down menu is also provided for the number of discrete samples to average for each displayed data point.

4) **Plot View Options:**
    i. Plot Counts: This option plots the ADC code itself on the Y-axis with the number of samples on the x-axis.
    ii. Plot Volts: This option plots the converted Voltage value.
    iii. Plot Current: Plots the current measured across the 250Ω shunt resistance on the AIN2 input.
    iv. Plot Temp: Reserved for future use.

5) **Scope Options:** Holding the mouse cursor over the top right corner of the Scope or the Histogram plot will display the plot settings options available to the user which includes Play/Pause, Zoom in/out, Pan, Print, Save and waveform settings.


6) **Plot in Windows:** This pushbutton allows user to view the following displays in separate windows:

    I.   ADC Code of the current reading
    II.   FFT measurement
    III. Histogram Measurement
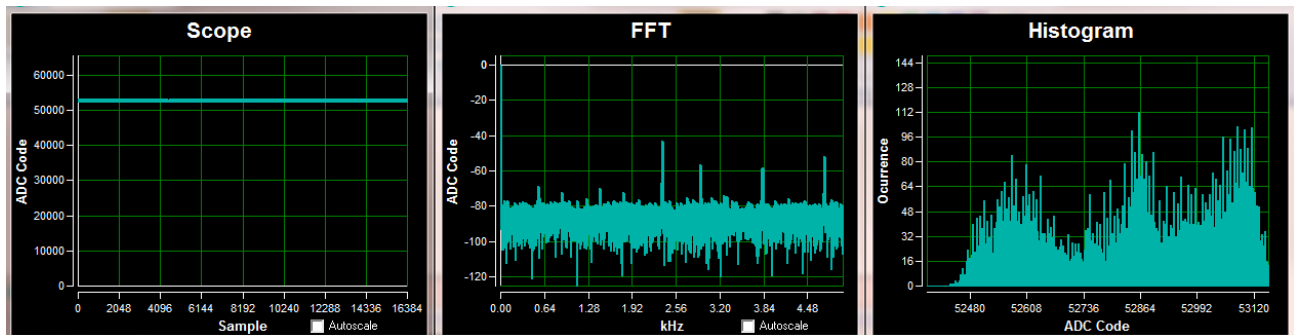
4.1.4 Calibration

For precision results, it is recommended to calibrate the MAXREFDES5 hardware using the function provided with the GUI. Calibration parameters for each combination of input channel and input range are stored in a local file in the GUI directory on the PC. Press the **Calibration** button to open a window with the calibration parameters.
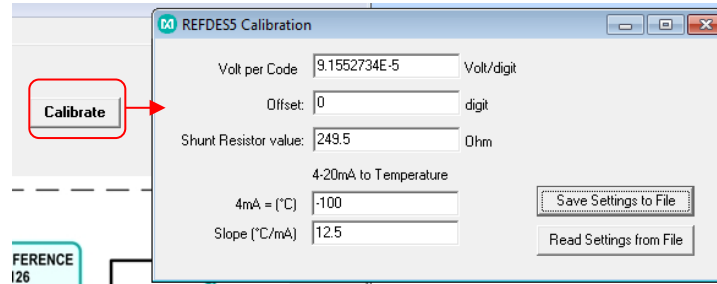
i. **Save Settings to File:** Saves the current settings to a local file on the PC. This should be done for each valid combination of input channel and range (i.e. Input AIN0 with Input Range -12V to +12V).
ii. **Offset:** Offset calibration is done by forcing a 0V input voltage or 0mA current at the physical input. The resulting plot counts value, if other than 0, should be entered in the offset digit tab of the calibration window. Hit Tab on the keyboard for the value to be applied.
iii. **Volt per Code:** This option calibrates for gain error and should be adjusted after offset calibration. The volt-per-code calibration is done by forcing a larger magnitude voltage at the input to obtain the code. With the MAX5216DACLITE generator, this is limited to +3V (for best results with the max 3V output, move the jumper wire from OUT of J5 to VREF of J4). Hit Tab on the keyboard for the value to be applied.

$$\text{Volt per code} = \frac{V_{FullScale\ Input\ Range}}{2^{16}-1}$$

iv. **Read Settings from File:** Reads the last settings that are in the file and returns the user to the input and calibration values from the last saved settings. If one wishes to reset to factory default, then the appropriate .ini file has to be deleted.
v. **Shunt Resistor value:** This option stores the exact value of shunt resistance of the board. This optional field allows the user to change the resistance and scale the current measured.

Example Calibration Sequence:

| STEP	DESCRIPTION	CONNECTIONS	DACLITE GUI	REFDES5 GUI
1	AIN0 Offset Cal	J5:OUT to AIN0 J5:GND to GND0	Single Operation: 0V	AIN0 with -12V to +12V Input Range Selected
2	AIN0 Gain Cal		Single Operation: 2.5V	
3	Save Settings	--	--	
4	AIN1 Offset Cal	J5:OUT to AIN1 J5:GND to GND1	Single Operation: 0V	AIN1 with -12V to +12V Input Range Selected
5	AIN1 Gain Cal		Single Operation: 2.5V	
6	Save Settings	--	--	
7	AIN2 Offset Cal	J5:OUT to AIN2 J5:GND to GND2	Single Operation: 0V	AIN2 with 0V to +6V Input Range Selected
8	AIN2 Gain Cal		Single Operation: 2.5V	
9	Save Settings	--	--	
10	AIN3 Offset Cal	J5:OUT to AIN3 J5:GND to GND3	Single Operation: 0V	AIN3 with 0V to +12V Input Range Selected
11	AIN3 Gain Cal		Single Operation: 2.5V	
12	Save Settings	--	--	

4.2 GUI for MAX5216DACLITE

With the MAX5216DACLITE board connected, click on the MAX5216DACLite shortcut found in the **Start** menu. The GUI will automatically connect to the MAX5216DACLITE hardware upon initialization. This section describes the basic functionality needed to generate test signals for evaluating the MAXREFDES5 design. For more information on the MAX5216DACLITE GUI, refer to the **MAX5216DACLITE data sheet**. For more information on the MAX5216 or other evaluation kits for the MAX5216, visit **www.maximintegrated.com/MAX5216**.
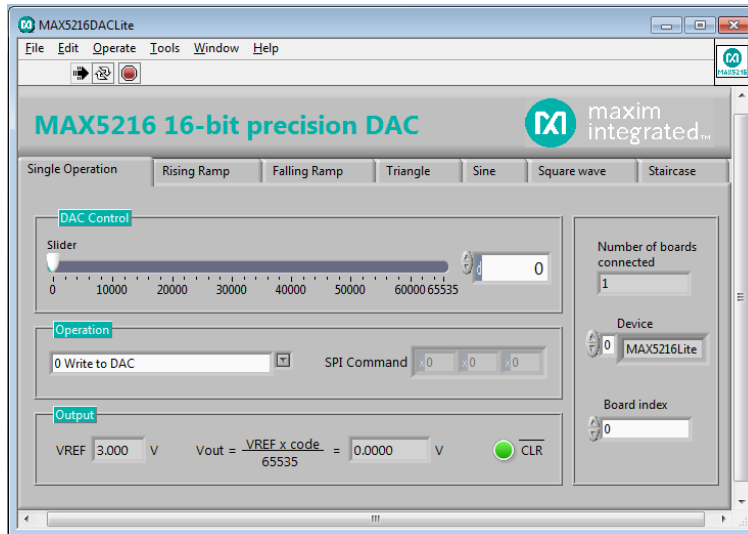
The **Single Operation** tab sheet is active by default. The application checks all the compatible boards connected to the PC and indicates them on the right side of the GUI (up to 16 boards can be connected). Any possible operation can be evaluated on the Single Operation tab sheet. For example, move the track bar slider to set the DAC output voltage. The DAC Control spin box reflects the slider position with a decimal number. The DAC output can also be set by typing in a decimal, hexadecimal, or an octal or binary value directly in the DAC Control spin box. The MAX5216 accepts codes from 0 to 65535 (216-1) decimal or from 0 to FFFF hex. The notation is displayed on the left side of the box and can be changed by clicking on the notation character.
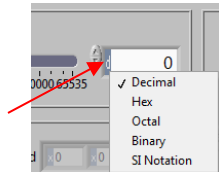
The **Rising Ramp**, **Falling Ramp**, **Triangle**, **Sine**, **Square wave**, or **Staircase** tab sheets give the DAC the ability to generate different waveforms with the selected parameters. There is a possible delay to start a new waveform until the previous one finishes a full cycle when switching between tabs. To stop or start running the signal generator application, use the toolbar at the top of the application window.
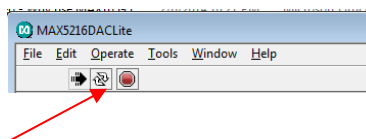
5   Hardware Description

This section provides more information on the hardware design of the three boards including schematics, bill of materials, and PCB layout files.

5.1   MAXREFDES5

The MAXREFDES5 reference design is a 4-channel analog front-end (AFE) that accepts -10V to +10V, 0 to 10V, and 4–20mA current loop signals. The design integrates a 16-bit ADC with innovative on-chip attenuation (MAX1301) plus low-noise high-impedance analog buffers (MAX9632) on two of the input channels and an ultra-high precision 4.096V voltage reference (MAX6126) to achieve maximum performance from the 16-bit system. A 600V$_{RMS}$ digital isolator (MAX14850) and 3W transformer driver (MAX256) provide the necessary isolated data and power connections to the host system. LDO regulators (MAX1659) provide regulated +12V, -12V, and 5V power rails to the analog front-end.

Application Note 5561 (REFD5561) provides more information on the design and performance results of the MAXREFDES5 reference design. Below is a summary of the other hardware design files available on the USB flash drive. Application Note 5561 contains the latest links to hardware design Files.

	USB Flash Drive
Application Note 5561	✓
Bill of Materials	✓
PCB Source Files	✓
Schematics (PDF)	✓
Layout (PDF)	✓
Layout (Gerber)	✓

5.2   MAX5216DACLITE

The MAX5216DACLite board utilizes a low power 16-bit DAC (MAX5216) with a precise 3.000V voltage reference (MAX6133) that provides a low noise and low dropout reference for the DAC. The MAX5216 receives commands from the 16-bit MAXQ622 microcontroller through a 3-wire high-speed SPI bus. The MAX5216 can run at 50MHz clock frequency, but the SPI bus speed is limited to 6MHz on this board by the microcontroller. The devices are powered by a MAX8510 low-noise voltage regulator, which gets power from the USB port and produces a fixed VDD level of 3.3V.

The above limitations are reflected by the suffix "Lite" in the name of the board. For more information on the MAX5216DACLITE (including board modifications), refer to the **MAX5216DACLITE data sheet**. For more information on the MAX5216 or other evaluation kits for the MAX5216, go to: **www.maximintegrated.com/MAX5216**.

5.3   USB2PMB1

The USB2PMB1 board uses the FT2232HL, a USB 2.0 High Speed (480Mb/s) to UART/FIFO IC, to process commands sent by a GUI application running on the PC. The design integrates a 4K MICROWIRE®-compatible serial EEPROM (93LC66BT) and a low-power, 1.2A, PWM step-down DC-DC converter (MAX1556) for generating 3.3V (VCCIO) from the 5V USB supply. VCCIO provides power to the FTDI chip, the 4k MICROWIRE EEPROM, and to the 12-pin connector for 3.3V Pmod Type 2A compatible boards.

For more information on the USB2PMB1 hardware design or other compatible boards from Maxim, go to **www.maximintegrated.com/USB2PMB1**. For more information on the Peripheral Module (Pmod™) form factor, refer to the Digilent Pmod™ Interface Specification or visit www.DigilentInc.com.

6   Contact Information

For more information about Maxim Integrated products, contact technical support at
www.maximintegrated.com/support.

7   Trademarks

LabVIEW is a registered trademark of National Instruments Corp.
MICROWIRE is a registered trademark of National Semiconductor Corp.
Pmod is a trademark Digilent Inc.
Windows is a registered trademark and registered service mark and Windows XP is a registered trademark of Microsoft Corporation.

8   Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/14	Initial release	—

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Maxim Integrated](#):
  [MAXSANTAFEEVSYS#](#)