Evaluating the ADAF1080 Integrated ±8 mT AMR Magnetic Field Sensor and Signal Conditioner

FEATURES

- USB interface
- Software control of the
  - Integrated amplifier gain
  - Power-down functionality
  - Synchronization with the ADC sampling
  - Offset zeroing and sensor reset
- Connector for external access
- Measurement test points

EVALUATION KIT CONTENTS

- ADAF1080 single sensor evaluation board (EVAL-ADAF1080SDZ)

ADDITIONAL HARDWARE REQUIRED

- SDP-B controller board
- USB cable (supplied with the SDP-B controller board)
- External readback electronics and 5 V supply (optional)

ADDITIONAL SOFTWARE AVAILABLE

- **EVAL-ADAF1080SDZ Evaluation Software**, which enables data visualization and control of the optional features

GENERAL DESCRIPTION

The ADAF1080 is a single-axis, high-precision, low-field magnetic sensor with integrated signal conditioning. The device incorporates a wide range anisotropic magnetoresistive (AMR) sensor with an integrated signal conditioning amplifier, a flip coil with a driver, a calibration coil with a driver, and an analog-to-digital converter (ADC) driver for measuring magnetic fields precisely. The ADAF1080 enables low-noise, high-dynamic range measurement with zero offset, high bandwidth, and low-harmonic distortions with the integrated functions.

The EVAL-ADAF1080SDZ enables the user to simply and quickly achieve precise measurement of magnetic flux density using the high performance of the ADAF1080.

The EVAL-ADAF1080SDZ, shown in Figure 1, features the ADAF1080 as a precision field sensor and a graphical user interface (GUI) is available to the user for quick evaluation.

The EVAL-ADAF1080SDZ features an on-board 5 V regulator, a precision ADC, and connectors for access to the optional features of the ADAF1080. The EVAL-ADAF1080SDZ also features test points and an unpopulated low-noise buffer to allow for user configuration.

The SDP-B controller board controls the AD4002 on the EVAL-ADAF1080SDZ, reading back the ADAF1080 output but also allows the user to change the digital inputs of the ADAF1080 to interface with the GUI and to supply power to the EVAL-ADAF1080SDZ through the USB connection.

For full details on the ADAF1080, see the ADAF1080 data sheet, which should be used in conjunction with this user guide when using the EVAL-ADAF1080SDZ.

EVAL-ADAF1080SDZ FIELD SENSOR EVALUATION SYSTEM

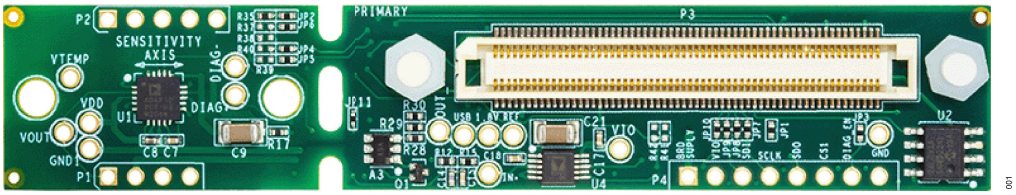

Figure 1. EVAL-ADAF1080SDZ Evaluation Board Photograph

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REVISION HISTORY

1/2023—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

The EVAL-ADAF1080SDZ comprises a printed circuit board (PCB), an on-board regulator (ADP7104), an ADC (AD4002), and the SDP-B connector.

The ADAF1080 evaluation system can be powered directly from the on-board regulator (ADP7104) through the USB connection of the SDP-B. In some cases, where the output voltage of the USB is less than the supply voltage of the ADAF1080 as outlined in the data sheet, the use of an external power supply is recommended. Low input voltage on the EVAL-ADAF1080SDZ can degrade noise performance.

To power the EVAL-ADAF1080SDZ through an external connector, supply 5 V through the P4 connector. Set the current limit of the supply to 30 mA to ensure enough current is available for the EVAL-ADAF1080SDZ.

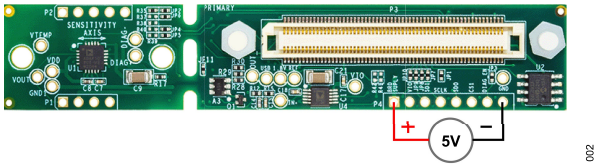

Figure 2. Optional Power-Supply Connection

DEVICE UNDER TEST (DUT) OUTPUTS

The output of the ADAF1080 can be monitored at the **VOUT** and **IN+** test points on the EVAL-ADAF1080SDZ evaluation board.

The output from the ADAF1080 is also sampled by the on-board ADC and is available through the GUI.

CONFIGURATION OF THE BOARD

The EVAL-ADAF1080SDZ was designed to provide flexibility for the user. The following configurations are available:

- SDP-B and **EVAL-ADAF1080SDZ Evaluation Software** controlled
- Use of an external digital interface
- Direct analog interface with the sensor

SDP-B and EVAL-ADAF1080SDZ Evaluation Software Controlled

The SDP-B and **EVAL-ADAF1080SDZ Evaluation Software** controlled configuration is the recommended configuration to quickly achieve high performance measurement.

This configuration uses the SDP-B to communicate with the ADC (AD4002) to sample the sensor output and makes it available to the user with the software provided. Configuration of the ADAF1080 is also available through the software. For additional details, refer to the Evaluation Board Software section and the Software Installation Procedures section.

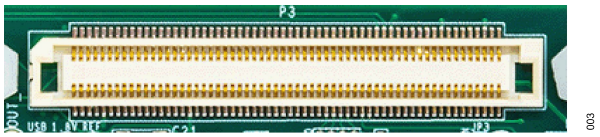

Figure 3. Connector P3 Interfaces the SDP-B to the EVAL-ADAF1080SDZ

The SDP-B controller board uses the P3 connector to connect the evaluation board to the PC. Connect P3 to **CON A** or **CON B** of the SDP-B.

Use of an External Digital Interface

Connector P4 can be used to interface with an external microcontroller or field-programmable gate array (FPGA). This connector allows the user to interface with the ADC (AD4002) directly instead of using the SDP-B controller board.

This configuration can be used to facilitate data acquisition with a higher sampling rate.

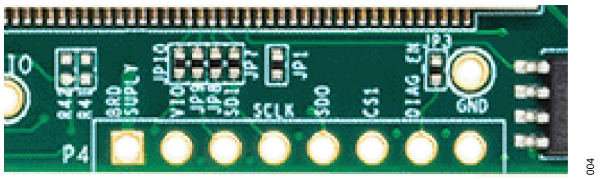

Figure 4. Access the Serial-Peripheral Interface (SPI) of the EVAL-ADAF1080SDZ with Connector P4

Table 1. Connector P4 Input Type and Descriptions

Mnemonic	Input Type	Description
BRD_SUPPLY	Supply	BRD_SUPPLY is the 5 V input supply of the EVAL-ADAF1080SDZ. This voltage is regulated down by the on-board ADP7104.
VIO	Input	VIO is the voltage level for the SPI.
SDI, SCLK, SDO, CS1	Digital input and output pins	These pins are the inputs and outputs of the SPI. A microcontroller or FPGA can use these pins to achieve a faster sampling rate.
GND	Ground	It is the ground connection of the EVAL-ADAF1080SDZ.
DIAG_EN	Digital input	This pin allows the user to enable the diagnostic feature of the ADAF1080.

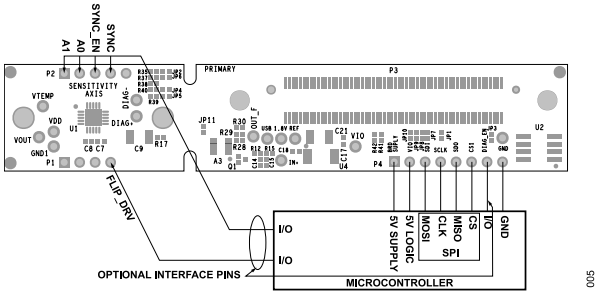

Figure 5. Typical Connection Diagram for an External Digital Interface

EVALUATION BOARD HARDWARE

For full details about the SPI and how to interface the different pins, see Figure 21, the AD4002 data sheet, and the ADAF1080 data sheet.

Direct Analog Interface with the Sensor

Direct access to the output of the sensor is possible through the **VOUT** test point.

To enable the higher level of integration while evaluating the ADAF1080, it is possible for the user to separate the sensor from other components by breaking off the sensor break-off section of the board, as shown in Figure 6. However, this separation cannot be reversed, and the sensor device cannot be reattached to the original acquisition board.

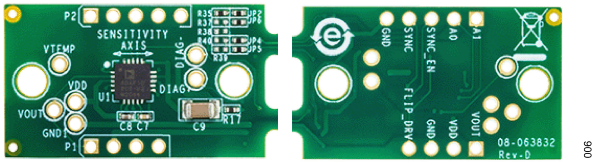

Figure 6. Sensor Break-Off Section

It is then possible to use the P1 and P4 controllers to control the ADAF1080.

Table 2. Connector P1 Input Type and Descriptions

Mnemonic	Input Type	Description
FLIP_DRV	Digital input	The ADAF1080 allows the user to control the sense field polarity of the sensor using the integrated flip coil. It is possible to flip the sensitivity of the sensor periodically, which allows the user to calculate and remove the offset of the system over life and temperature.
VDD	Supply	VDD is the 5 V input supply of the ADAF1080.
GND	Ground	GND is the ground of the EVAL-ADAF1080SDZ.
VOUT	Analog output	VOUT is the analog output of the ADAF1080. This voltage is proportional to the sensed magnetic flux density. This output sits at VDD/2 when no magnetic field is sensed.

Table 3. Connector P2 Input Type and Descriptions

Mnemonic	Input Type	Description
VDD_FLIP	Supply	VDD_FLIP is the supply pin for the flip coil driver. It must be connected to a 5 V voltage, preferably isolated from VDD.
SYNC	Digital input	Set SYNC low to disable chopping of the integrated amplifier and to enable high-bandwidth measurement. Better total harmonic distortion (THD) performance can be achieved by synchronizing the ADC sampling and the chopping of the integrated instrumentation amplifier.

Table 3. Connector P2 Input Type and Descriptions (Continued)

Mnemonic	Input Type	Description
		The conversion signal of the ADC can be provided on the SYNC pin. The SYNC_EN must also be set high.
SYNC_EN	Digital input	Set SYNC_EN high to enable the synchronization between the ADC sampling and the chopping of the integrated instrumentation amplifier. The conversion signal of the ADC must be provided on the SYNC pin.
A0 and A1	Digital inputs	These inputs are the gain control of the integrated instrumentation amplifier. These inputs can also be set with the R37 through R40, 0 Ω, resistors.

Consult the ADAF1080 data sheet for full details about the functionality.

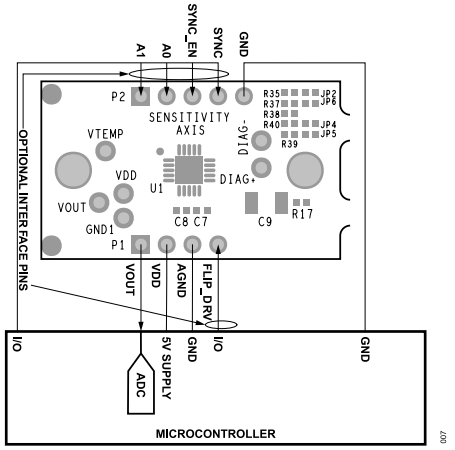

Figure 7. Typical Connection Diagram for a Sensor Only Configuration

EVALUATION BOARD QUICK START

The EVAL-ADAF1080SDZ can be controlled with the **EVAL-ADAF1080SDZ Evaluation Software**. The following sections provide instructions for installing the supporting software and an overview for connecting the hardware to the PC.

SOFTWARE INSTALLATION PROCEDURES

Installing the EVAL-ADAF1080SDZ Evaluation Software

To install the **EVAL-ADAF1080SDZ Evaluation Software**, take to the following steps:

1. Start the Windows® operating system and download the software from the EVAL-ADAF1080SDZ evaluation board product page (www.analog.com/EVAL-ADAF1080).
2. Unzip the downloaded file.
3. Run the **setup.exe** file to begin installing the **EVAL-ADAF1080SDZ Evaluation Software**. The software installation window opens as shown in Figure 8.

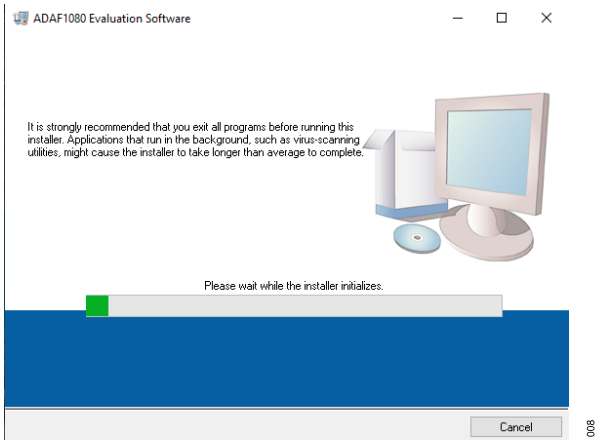

Figure 8. EVAL-ADAF1080SDZ Evaluation Software Install Window

4. Choose the installation directory and click **Next**. The default location is **C:\Program Files (x86)\Analog Devices**.

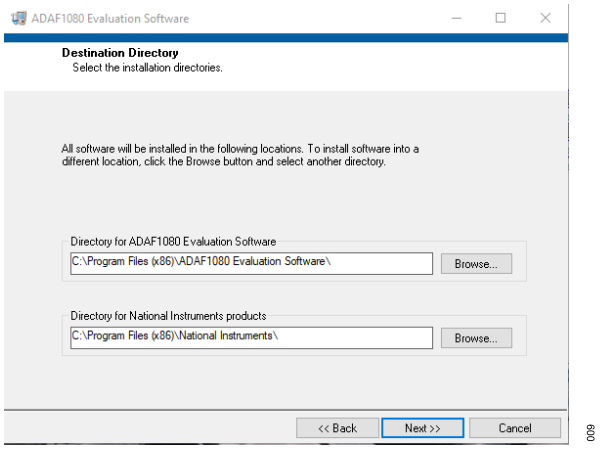

Figure 9. Destination Directory Window

5. When installing the **EVAL-ADAF1080SDZ Evaluation Software**, it is a requirement to read and accept the license agreement shown in Figure 10, and then click **Next** to proceed.

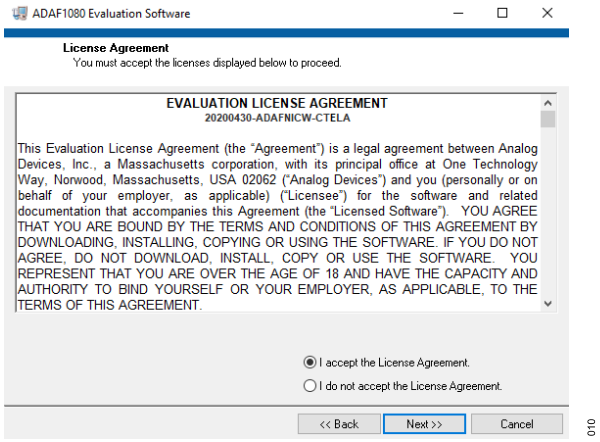

Figure 10. License Agreement Window

6. The window shown in Figure 11 provides a summary of the software installation. Click **Next** to install the software listed in the window.

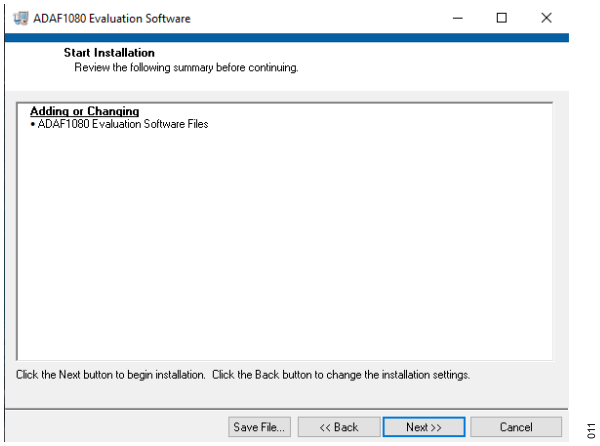

Figure 11. Start Installation Window

7. A pop-up window opens and displays a bar showing the installation progress (see Figure 12).

EVALUATION BOARD QUICK START

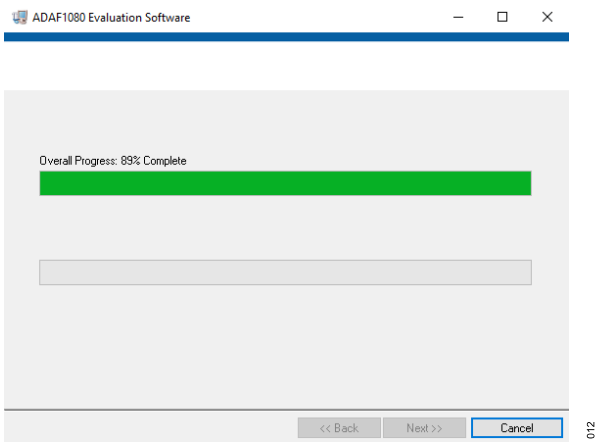

Figure 12. Overall Progress

8. Once the installation is complete, it is time to install the software demonstration platform (SDP) drivers.

SDP Drivers Installation

To install the SDP drivers, download the **SDPDrivers.exe** file from the SDP-B product page and take the following steps:

1. Run the **SDPDrivers.exe** executable file.
2. When the SDP drivers setup wizard appears, click **Next** (see Figure 13).

Figure 13. SDP Driver Installation Wizard

3. In the **Choose Install Location** window that appears (see Figure 14), click **Install**. To select a different destination folder, click **Browse...** to select a different destination, then click **Install**.

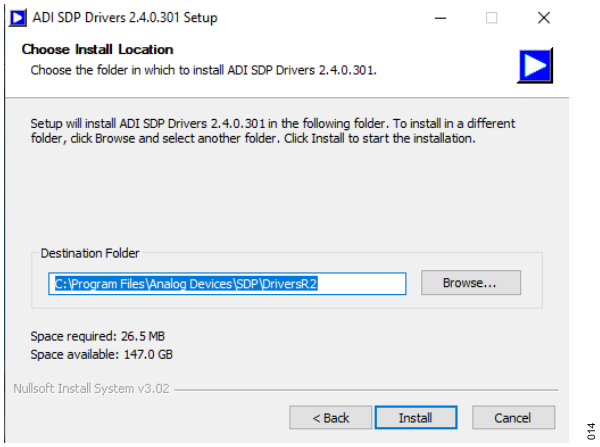

Figure 14. Choose Install Location Window

4. Click **Finish** to complete the installation of the SDP drivers.
5. When plugging in the SDP-B board with the provided USB cable, allow the **Found New Hardware Wizard** to run. Check that the drivers are installed and the SDP-B board is connected properly by checking the **Device Manager** of the PC. If the drivers and board are connected, **Analog Devices System Demonstration Platform SDP-B** appears under **ADI Development Tools** (see Figure 15).

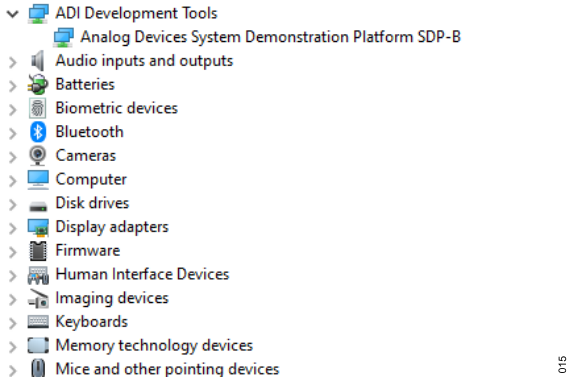

Figure 15. Device Manager Dropdown Menu

The PC now recognizes the SDP-B controller board, and the **EVAL-ADAF1080SDZ Evaluation Software** can be used.

EVALUATION BOARD QUICK START

Uninstalling the Software

To uninstall the **EVAL-ADAF1080SDZ Evaluation Software**, take the following steps:

1. Launch the uninstall wizard by navigating to **Start/Control Panel/Programs and Features/EVAL-ADAF1080SDZ** and right-click and select **Uninstall**.
2. Click **Yes** in the confirmation window that appears.

To uninstall the SDP drivers, take the following steps:

1. Launch the uninstall wizard by navigating to **Start/Control Panel/Programs and Features/ADI SDP Drivers** and right-click and select **Uninstall**.
2. Click **Yes** in the confirmation window that appears.

EVALUATION BOARD SOFTWARE

STARTING THE EVALUATION GUI

To use the EVAL-ADAF1080SDZ with the SDP-B controller board, start by connecting the two boards together on either the **CON A** or **CON B** connector of the SDP-B.

If using an external power supply, plug the positive supply for the EVAL-ADAF1080SDZ into the P4 connector (see Figure 5). The EVAL-ADAF1080SDZ requires a supply voltage between 5 V and 5.5 V. This supply is regulated down to 4.6 V with the ADP7104 and powers both the on-board ADC (AD4002) as well as the ADAF1080.

OVERVIEW OF THE GUI WINDOW

Figure 16 shows the main EVAL-ADAF1080SDZ GUI window after starting the software.

When launching the GUI, the SDP-B controller board must be recognized by the GUI before proceeding. Click **Connect** to read the electrically erasable-programmable read-only memory (EEPROM) identification of the EVAL-ADAF1080SDZ and ensure that the correct program is in use. If the SDP-B controller board is not connected, or if the drivers are not installed correctly, an error message appears. Ensure that the drivers are installed correctly, and that the PC recognizes the SDP-B controller board, if this occurs. Restart the program and attempt to connect to the SDP-B again.

When the SDP-B controller board is properly connected and **Connect** is clicked, the status bar shows **SDP Board Ready**, and the yellow LED turns green (see Figure 16).

Initially, the **Vout** plot is blank, the ADAF1080 is enabled and flipped, and the gain is set at 80. Click **Burst Read** to capture a set of samples or **Continuous Read** to get a live feedback from the ADAF1080.

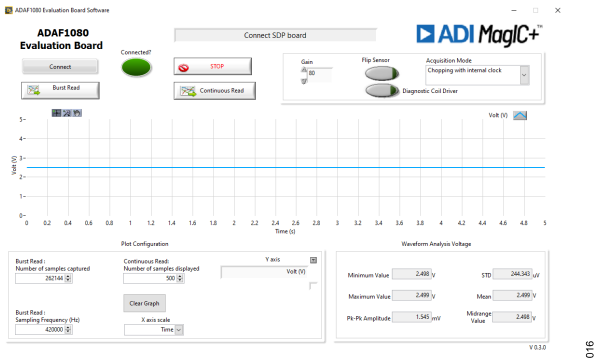

Figure 16. EVAL-ADAF1080SDZ Evaluation Board Software Main Window at Power-Up

VOUT Graph

Figure 17 shows the VOUT from the ADAF1080 magnetic field sensor waveform sampled by the ADC AD4002 when no external magnetic field is sensed.

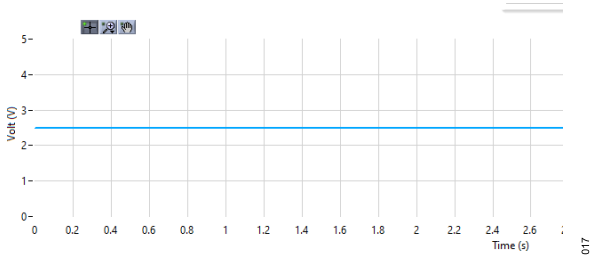

Figure 17. VOUT Output Graph

Reading and Display Options

When the EVAL-ADAF1080SDZ operates in burst read mode, it samples 2^{18} samples from the ADAF1080 with a sampling frequency of 420,000 Hz by default. The **Sampling Frequency (Hz)** and **Number of samples captured** can be adjusted within their corresponding fields, as shown in Figure 18. The number of samples must be more than 1 but not greater than 2^{18}. The sampling frequency must be faster than 1,000 Hz but cannot be greater than 420,000 Hz.

When the EVAL-ADAF1080SDZ operates in continuous read mode, it constantly samples the output of the ADAF1080. The interval between two samples is typically 10 ms, and the plot displays a maximum of 500 samples at a time by default. The **Number of samples displayed** can be modified with its corresponding field, as shown in Figure 18.

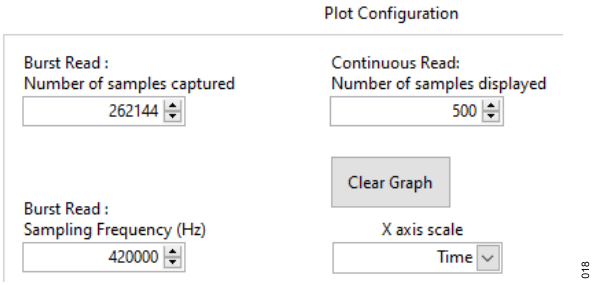

Figure 18. Reading and Display Options

Waveform Analysis

Waveform Analysis summarizes the signal displayed within the VOUT Output Graph shown in Figure 17.

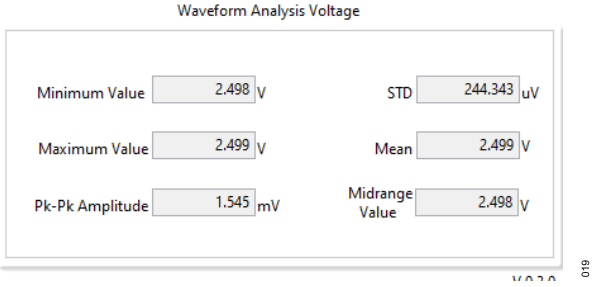

Figure 19. Waveform Analysis Pane

EVALUATION BOARD SOFTWARE

Digital Outputs and Sensor Mode

The **EVAL-ADAF1080SDZ Evaluation Board Software** enables the user to configure some of the optional features of the ADAF1080. See the ADAF1080 data sheet for full details about the available functions.

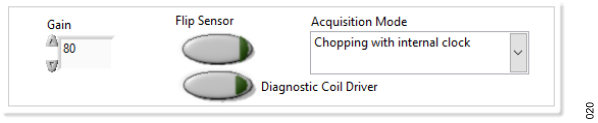

Figure 20. Access to the Optional Features of the ADAF1080

Click **Gain** to change the output sensitivity by modifying the gain of the integrated instrumentation amplifier. Three settings are available, 20, 40, and 80.

Click **Flip Sensor** to reset and reverse the sensitivity of the sensor using the integrated flip coil. It is possible to flip the sensitivity of the sensor periodically, which enables the calculation and removal of the offset of the system over life and temperature.

Click the **Acquisition Mode** dropdown menu to configure the chopping functionality of the amplifier. This field also allows the user to synchronize the ADC sampling with the chopping of the amplifier for higher total harmonic distortion (THD) performance.

Click **Diagnostic Coil Driver** to enable the diagnostic functionality. This will generate a fixed magnetic field and produce a repeatable change in the output of the sensor. This can be used to validate normal operation of the ADAF1080.

TROUBLESHOOTING

SOFTWARE

To troubleshoot the **EVAL-ADAF1080SDZ Evaluation Board Software**, take the following steps:

1. Always install the software before connecting the hardware to the PC.
2. Always allow the installation to fully complete (the software is a 2-part installation, the **EVAL-ADAF1080SDZ Evaluation Board Software** and SDP-B drivers). A restart is recommended after installation is finished.
3. When the user first plugs in the SDP-B controller board using the provided USB cable, allow the **Found New Hardware Wizard** to run, which can take several seconds. However, allow this **Found New Hardware Wizard** to run before starting the software.
4. If the EVAL-ADAF1080SDZ evaluation board and SDP-B controller board are connected to the PC by the USB port but are not being detected by the **EVAL-ADAF1080SDZ Evaluation Board Software**, ensure that the boards are being recognized in the **Device Manager**, as shown in Figure 15.
5. If connected to a slower USB port where the SDP-B cannot read as quickly as it needs to, a timeout error can result. In this case, it is advised not to read continuously, or alternatively, to lower the number of samples taken.

HARDWARE

To troubleshoot the hardware, take the following steps:

1. If the software does not display any data:
    a. Using a voltmeter, measure the voltage present at each of the test points (**USB**, **VDD**, **1.8**V, and **VIO**) and the common-mode voltages (REF/2) at **IN+** to ensure that these voltages are accurate. Note that the SDP-B controller board power LED must be illuminated.
    b. Launch the **EVAL-ADAF1080SDZ Evaluation Board Software** and read the data. If nothing happens, exit the software.
    c. Power down the EVAL-ADAF1080SDZ and relaunch the **EVAL-ADAF1080SDZ Evaluation Board Software**.
    d. If no data is read back, confirm that the EVAL-ADAF1080SDZ is connected to the SDP-B with the CON-A connector or with the CON-B connector and that the board is recognized in the **Device Manager**, as shown in Figure 15.
2. If the data is showing more noise than expected, do the following:
    a. Check the voltage at the **USB** and **VDD** test points. If **VDD** is not equal to 4.6 V, the USB voltage may be too low for the on-board low dropout (LDO) regulator.
    b. Remove the R1 resistor and connect a 5 V supply through the P4 connector, as shown in Figure 2.

EVALUATION BOARD SCHEMATIC AND SILKSCREENS

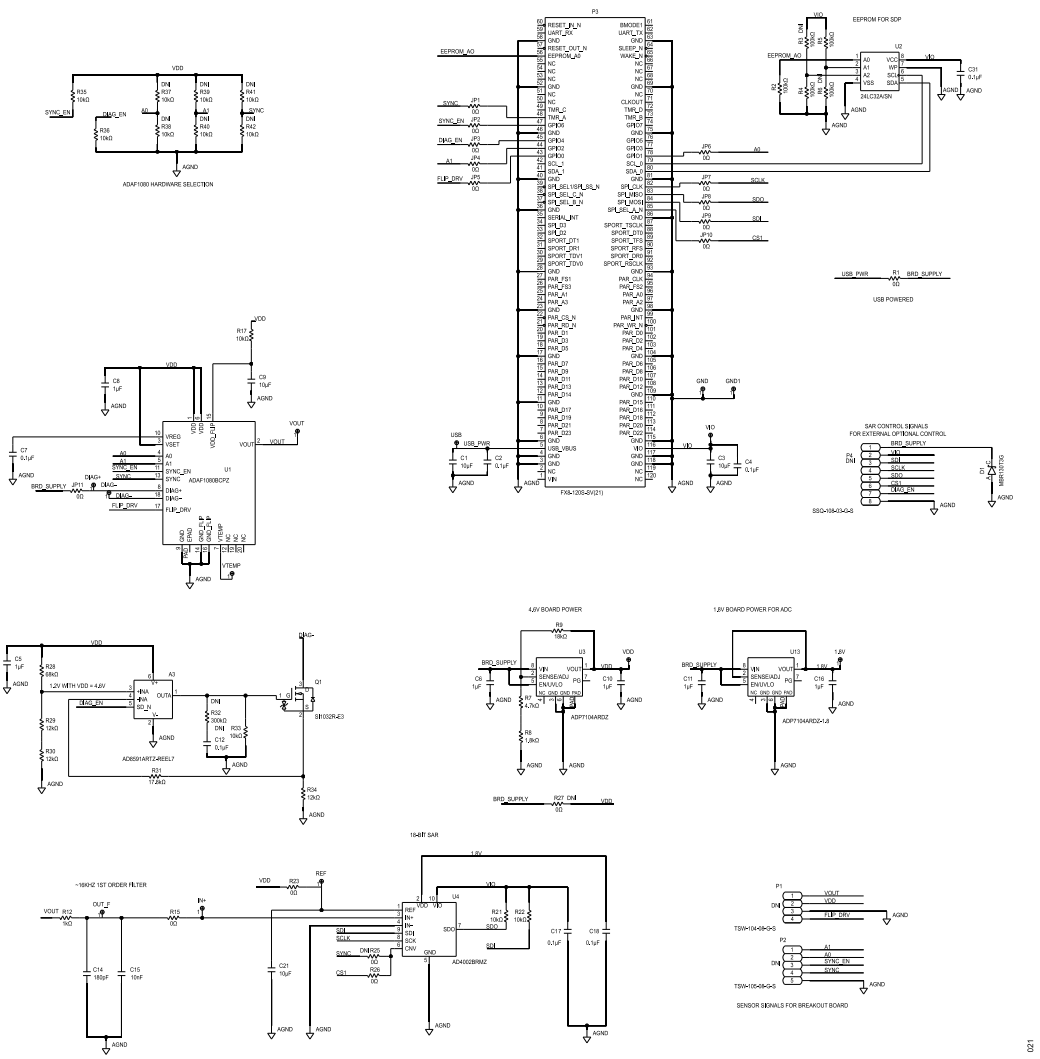

Figure 21. EVAL-ADAF1080SDZ Evaluation Board Schematic

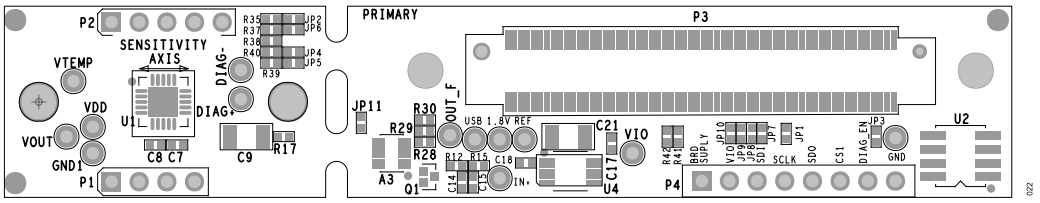

Figure 22. Top Silkscreen of the EVAL-ADAF1080SDZ Evaluation Board

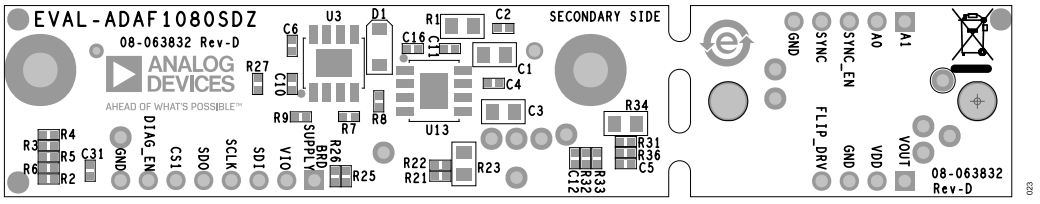

Figure 23. Bottom Silkscreen of the EVAL-ADAF1080SDZ Evaluation Board

ORDERING INFORMATION

BILL OF MATERIALS

Table 4. Bill of Materials

Reference Designator	Description	Manufacturer	Part Number
U1	Integrated 8 mT AMR magnetic field sensor and signal conditioner	Analog Devices, Inc.	ADAF1080BCPZ
U13	20 V, 500 mA, low noise, complementary metal-oxide semiconductor (CMOS) LDO, 1.8 V output	Analog Devices	ADP7104ARDZ-1.8-R7
U3	20 V, 500 mA, low noise, CMOS LDO, adjustable	Analog Devices	ADP7104ARDZ-R7
U4	18-bit, 2 MSPS/1 MSPS/500 kSPS, precision, pseudo differential, successive approximation register (SAR) ADCs	Analog Devices	AD4002BRMZ
U2	IC 32KBIT SERIAL EEPROM	Microchip Technology	24LC32A/SN
A3	CMOS single-supply, rail-to-rail, input and output, op amp with ±250 mA output current and shutdown mode	Analog Devices	AD8591ARTZ-REEL7
C1, C3	10 µF ceramic capacitors, 25 V, 10%, X5R, 0805	Murata	GRM21BR61E106KA73L
C6, C10, C11, C16	1 µF ceramic capacitors, 16 V, 10%, 0402, low equivalent series resistance (ESR)	TDK	C1005X6S1C105K050BC
C14	180 pF ceramic capacitor, 50 V, 5%, C0G, 0402, AEC-Q200, high reliability, not recommended for new designs (NRND)	TDK	CGJ2B2C0G1H181J050BA
C15	10 nF ceramic capacitor, 16 V, 5%, X7R, 0402	AVX Corporation	0402YC103JAT2A
C2, C4, C7, C17, C18, C31	0.1 µF ceramic capacitors, 35 V, 10%, X7R, 0402, AEC-Q200, low ESR	TDK	CGA2B3X7R1V104K050BB
C9, C21	10 µF ceramic capacitors, 35 V, 10%, X7R, 1206	Taiyo Yuden	GMK316AB7106KL-TR
C5, C8	1 µF ceramic capacitors, 10 V, 10%, X7S, 0402	TDK	C1005X7S1A105K
D1	Diode Schottky power rectifier surface-mount device (SMD)	On Semiconductor	MBR130T3G
JP1 to JP11	Resistors, SMD, 0 Ω jumpers, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2GE0R00X
P3	CONN-PCB, vertical type receptor for SDP breakout board, for EMC test use ALT_SYMBOLS	HRS	FX8-120S-SV(21)
Q1	N-channel 20 V (D-S) metal–oxide semiconductor, field-effect transistor (MOSFET)	Vishay	Si1032R-E3
R1, R23	0 Ω resistors, SMD, 1/10 W, 0805	Multicomp (SPC)	MC01W08050R
R12	1 kΩ resistor, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF1001X
R15, R26	0 Ω resistors, SMD, jumper, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2GE0R00X
R17	10 Ω resistor, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF10R0X
R2, R4, R5	100 kΩ resistors, SMD, 5%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2GEJ104X
R21, R22, R33, R35, R36	10 kΩ resistors, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF1002X
R28	68 kΩ resistor, SMD, 5%, 1/16 W, 0402	Yageo	RC0402JR-0768KL
R29, R30	12 kΩ resistors, SMD, 1%, 1/16 W, 0402	Multicomp (SPC)	MC 0.0625W 0402 1% 12K
R31	17.8 kΩ resistor, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF1782X
R34	12 kΩ resistor, SMD, 5%, 2/5 W, 4 W, 0805, AEC-Q200	ROHM	ESR10EZPJ120
R7	4.7 kΩ resistor, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF4701X
R8	1.8 kΩ resistor, SMD, 1%, 1/10 W, 0402, AEC-Q200	Panasonic	ERJ-2RKF1801X
R9	18 kΩ resistor, SMD, 1%, 1/16 W, 0402	Yageo	RC0402FR-0718KL
C12	0.1 µF ceramic capacitor, 35 V, 10%, X7R, 0402, AEC-Q200, low ESR, is not placed	TDK	CGA2B3X7R1V104K050BB
P1	CONN-PCB, Berg, header, straight, male, 4 position, is not placed	Samtec	TSW-104-08-G-S
P2	CONN-PCB, Berg, header, straight, male, 5 position, is not placed	Samtec	TSW-105-08-G-S
P4	CONN-PCB, receptor, 25 mil, square post, 2.54 mm pitch, are not placed	Samtec	SSQ-108-03-G-S

ORDERING INFORMATION

Table 4. Bill of Materials (Continued)

Reference Designator	Description	Manufacturer	Part Number
R25, R27	0 Ω resistors, SMD, jumper, 1/10 W, 0402, AEC-Q200, are not placed	Panasonic	ERJ-2GE0R00X
R3, R6	100 kΩ resistors, SMD, 5%, 1/10 W, 0402, AEC-Q200, are not placed	Panasonic	ERJ-2GEJ104X
R32	300 Ω resistor, SMD, 5%, 1/10 W, 0402, AEC-Q200, is not placed	Panasonic	ERJ-2GEJ301X
R37 to R42	10 kΩ resistors, SMD, 1%, 1/10 W, 0402, AEC-Q200, are not placed	Panasonic	ERJ-2RKF1002X

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.