One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

# Evaluating the AD9833 Low Power 12.65 mW, 2.3 V to 5.5 V, Programmable Waveform Generator

## FEATURES

- Full featured evaluation board for the AD9833 evaluation board
- Graphical user interface software for board control and data analysis
- Connector to EVAL-SDP-CB1Z system demonstration platform (SDP) board
- Various power supply and reference link options

## APPLICATIONS

- Biomedical sensors
- Bioelectrical impedance analysis
- Electrochemical analysis
- Impedance spectroscopy
- Complex impedance measurement
- Nondestructive testing

## GENERAL DESCRIPTION

The AD9833 is a 25 MHz low power DDS device capable of producing high performance sine and triangular outputs. It also has an on-board comparator that allows a square wave to be produced for clock generation. Consuming only 13 mW of power at 3 V makes the AD9833 an ideal candidate for power-sensitive applications.

The EVAL-AD9833SDZ board is used in conjunction with an EVAL-SDP-CB1Z SDP board available from Analog Devices, Inc. The USB-to-SPI communication to the AD9837 is completed using this Blackfin®-based development board.

A high performance, on-board 25 MHz trimmed general oscillator is available to use as the master clock for the AD9837 system. Various links and SMB connectors are also available on the EVAL-AD9833SDZ board to maximize usability.

Complete specifications for the AD9833 are provided in the AD9833 data sheet, available from Analog Devices, and should be consulted in conjunction with this user guide when using the evaluation board.

## FUNCTIONAL BLOCK DIAGRAM

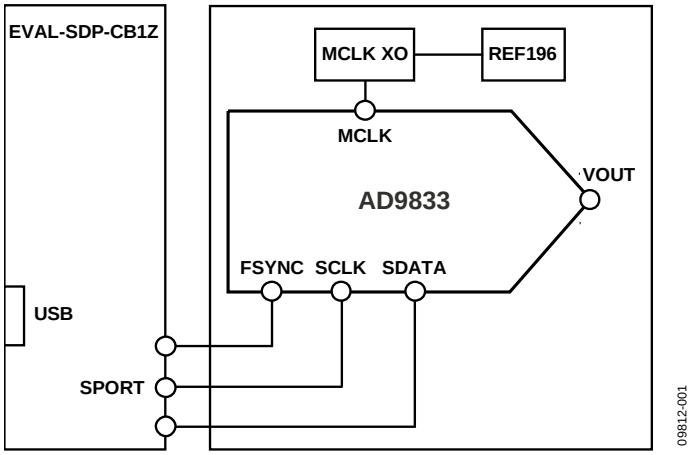


*Figure 1.*

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## REVISION HISTORY

**8/12—Rev. 0 to Rev. A**

Change to Table 1 ..... 4

**4/11—Revision 0: Initial Version**

# EVALUATION BOARD SOFTWARE

## INSTALLING THE SOFTWARE

The EVAL-AD9833SDZ evaluation kit includes the software and drivers on CD. The software is compatible with Windows® XP, Windows Vista, and Windows 7.

To install the software, follow these steps:

1. Install the software before connecting the SDP board to the USB port of the PC.
2. Start the Windows operating system and insert the EVAL-AD9833SDZ evaluation kit CD.
3. Download the AD9833SDZ LabVIEW® software. The correct driver, SDPDriversNET, for the SDP board should download automatically after LabVIEW is downloaded, supporting both 32- and 64-bit systems. However, if the drivers do not download automatically, the driver executable file can also be found in the **Program Files/Analog Devices** folder. Follow the on-screen prompts to install the SDPDriverNet Version 1.3.6.0.
4. After installation of the software and drivers is complete, plug the EVAL-AD9833SDZ into the SDP board and the SDP board into the PC using the USB cable included in the box.
5. When the software detects the evaluation board, proceed through any dialog boxes that appear to finalize the installation (**Found New Hardware Wizard/Install the Software Automatically** and so on).

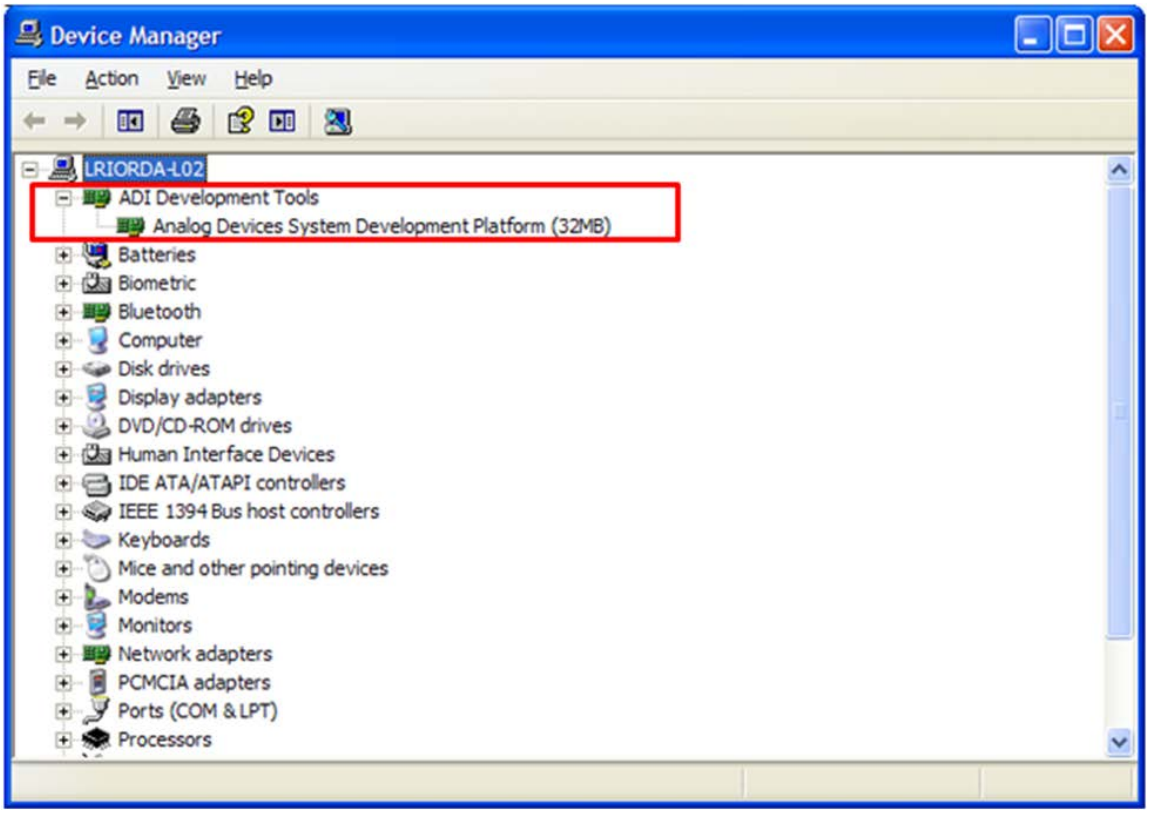



*Figure 2. Hardware Device Manager Window with SDP Board Plugged In*

## RUNNING THE SOFTWARE

To run the evaluation board program, do the following:

1. Click **Start/All Programs/Analog Devices/AD9833/ AD9833 Eval Board**.
2. If the SDP board is not connected to the USB port when the software is launched, a connectivity error displays (see Figure 3). Simply connect the evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.
3. Ensure that all links are in their correct locations (see Table 1). The main window of the AD9833DBZ evaluation software then opens, as shown in Figure 4.

**Table 1. Default Setup for Link Positions**

| Link No. | Position | Function |
|---|---|---|
| LK1 | Out | Decouple the CAP/2.5V pin to ground because $V_{DD}$ is >2.7 V. |
| LK2 | A | On-board linear regulator selected to supply power to the general oscillator. |
| LK4 | A | 3.3 V digital supply for the AD9833 supplied from the EVAL-SDP-CB1Z SDP board. |

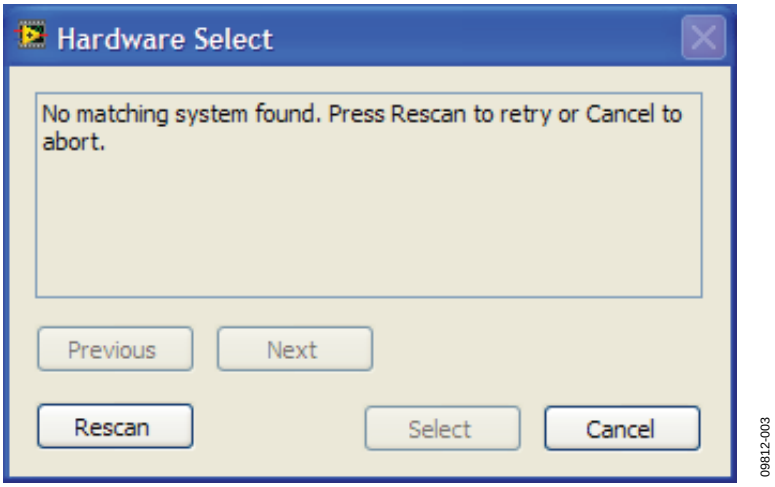



*Figure 3. Pop-Up Window Error*

# USING THE EVALUATION BOARD SOFTWARE

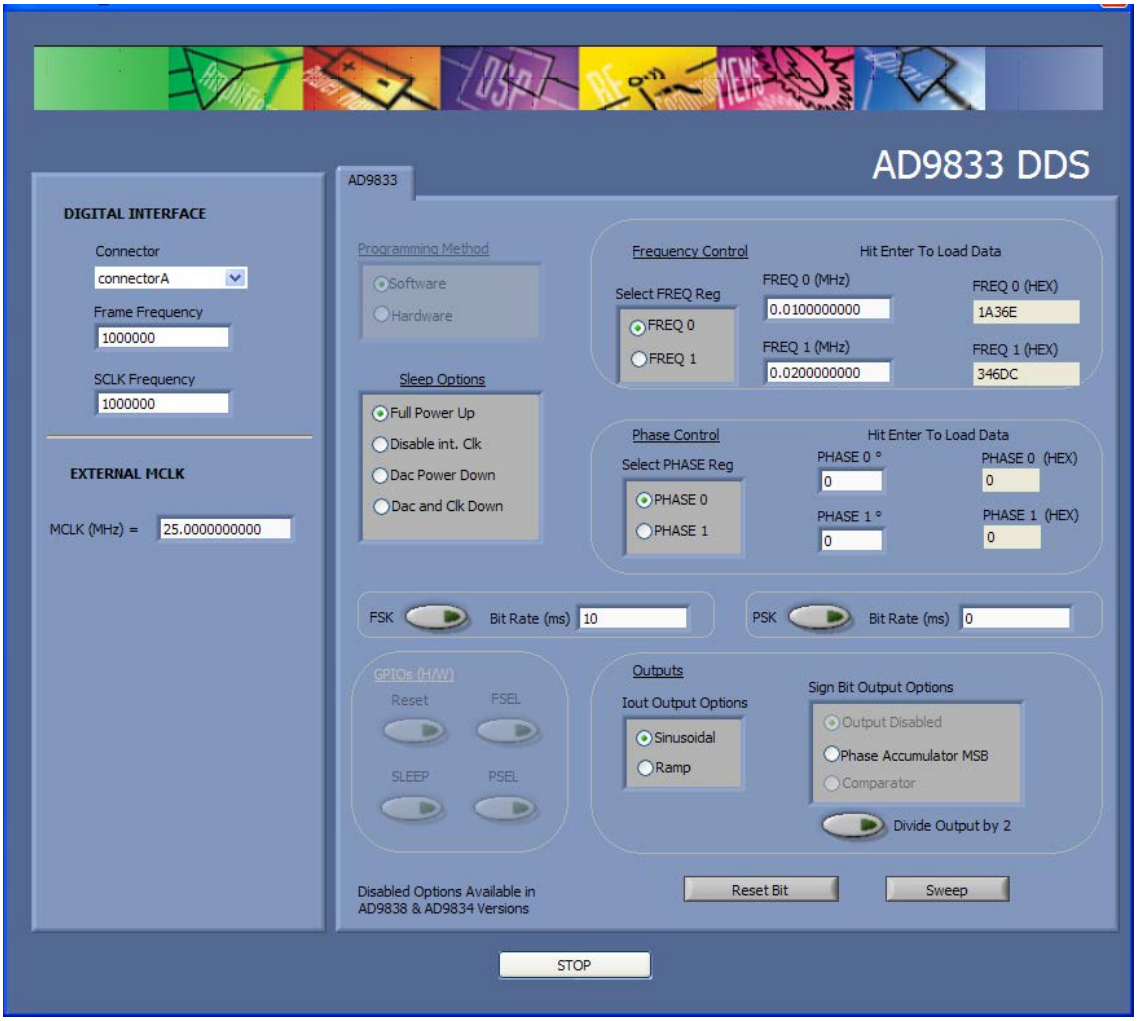



*Figure 4. AD9833 DDS Evaluation Software*

## SETTING UP THE DIGITAL INTERFACE

The first software step in setting up the AD9833 to make some measurements is to set the **DIGITAL INTERFACE** value. The EVAL-SDP-CB1Z has two connectors plugs: **connectorA** and **connectorB**. Select the connector you want to use with the AD9837 evaluation board from the drop-down box.

The SPI **Frame Frequency** (/SYNC) box and **SCLK Frequency** box can also be set in this window. If the SPI interface speed has not been decided, leave the default values shown in Figure 5.

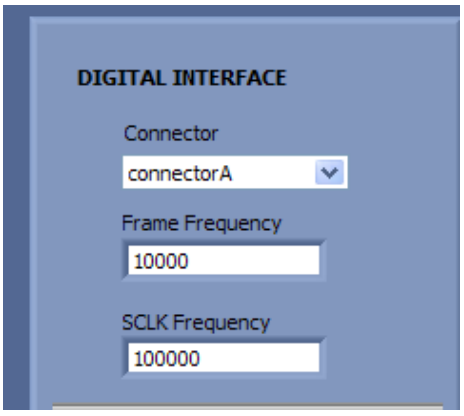



*Figure 5. Digital Interface*

## SELECT EXTERNAL MCLK FREQUENCY

Having selected the digital interface specifics, next use the **EXTERNAL MCLK** box to choose which frequency to use. The boards are supplied with a 25 MHz general oscillator. If a different clock source is required, the CLK1 SMB connector can be used to supply a different MCLK value.

Two options for the general oscillator include the AEL3013 oscillators from AEL Crystals and the SG-310SCN oscillators from Epson Electronics.

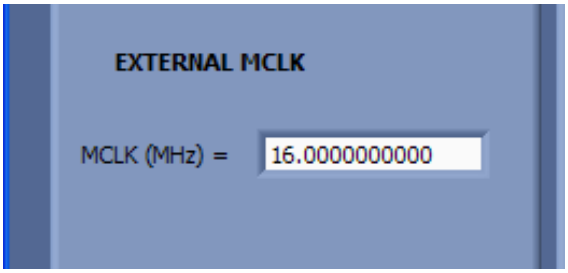



*Figure 6. EXTERNAL MCLK Input*

## LOADING FREQUENCY AND PHASE REGISTERS

The desired output frequency and output phase can be loaded using the inputs shown in Figure 7. Either the FREQ 0 register or the FREQ 1 register can be loaded with frequency data. The frequency data is loaded in megahertz, and the equivalent hex code is shown to the right once data is entered; click **Enter** to load data. Once data is loaded, the output appears on the IOUT1 and IOUT2 pins. Similarly, either the PHASE 0 register or PHASE 1 register can be selected, and the phase data is loaded in degrees.

The analog output frequency from the AD9833 is defined by

$$f_{MCLK}/2^{28} \times FREQREG$$

where *FREQREG* is the value loaded into the selected frequency register in decimals. This signal is phase shifted by

$$2\pi/4096 \times PHASEREG$$

where *PHASEREG* is the value contained in the selected phase register in decimals.

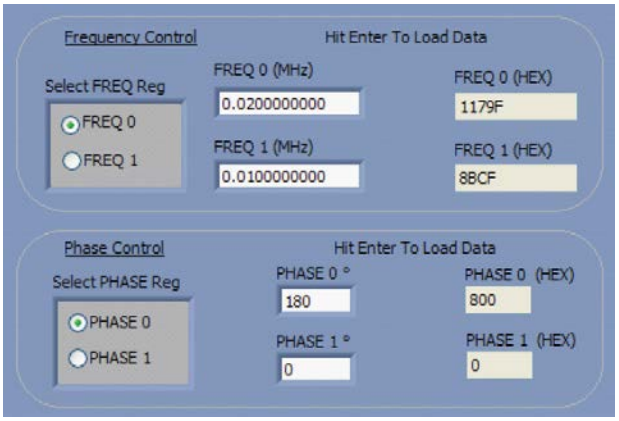



*Figure 7. Frequency and Phase Load*

## FSK AND PSK FUNCTIONALITY

In software mode, the AD9833 can be set up for FSK or PSK functionality by simply entering the bit rate in milliseconds and selecting the push-button option (see Figure 8).


*Figure 8. FSK and PSK Functionality*

## WAVEFORM OPTIONS

The output waveform can be selected as a sinusoidal waveform or a ramp waveform. The internal comparator in the AD9833 can be disabled or enabled (see Figure 9). The MSB or the MSB/2 of the phase accumulator can be selected as the output on the SIGN BIT OUT pin.

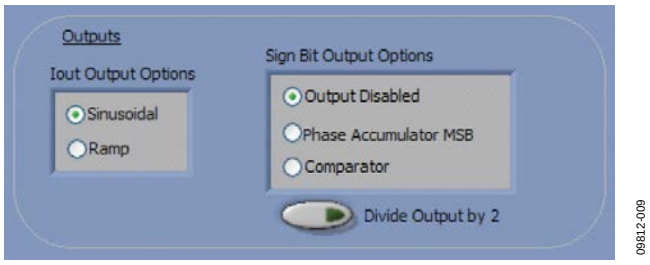



*Figure 9. Waveform Profile and SIGN BIT OUT Pin*

### *Power-Down Options*

The AD9833 has various power-down options selected through the control register. The part can disable the MCLK or disable the DAC if just the MSB output is used on the SIGN BIT OUT pin, or it can power down both sections for a lower power sleep mode (see Figure 10).

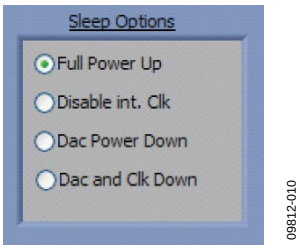



*Figure 10. Power-Down Options*

## RESET AND SWEEP

The reset software command is set using the button shown in Figure 11. To set up a DDS sweep, click **Sweep**.


*Figure 11. Software Reset and Sweep Select*

The sweep function allows users to load a start frequency, stop frequency, increment size, number of loops, and delay between each frequency increment. These commands are then loaded to the part automatically from the EVAL-SDP-CB1Z board.

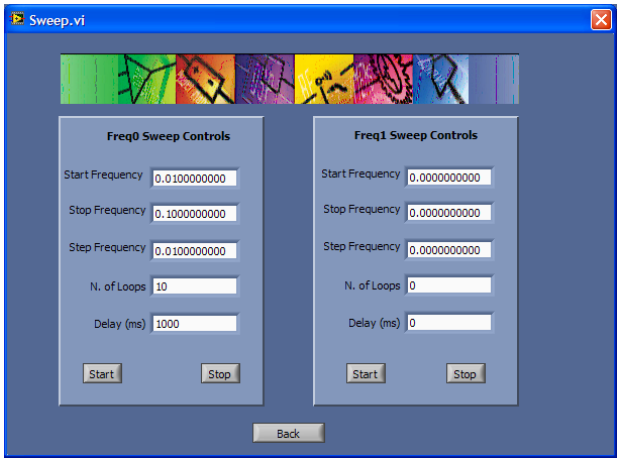



*Figure 12. Sweep Functionality*

## EXAMPLE OF OPERATION

An example of configuring the AD9833 to output 10 kHz follows:

1. Plug the EVAL-SDP-CB1Z board into the EVAL-AD9833SDZ board and connect to the USB port.
2. Start up the software located at **Start/All Programs/Analog Devices/AD9833/AD9833 Eval Board**. You should see the SDP board communicating with the PC.
3. Select **connectorA** or **connectorB**; this must match what the AD9837 test chip is connected to.
4. Define MCLK; the default is an on-board 25 MHz oscillator.
5. Ensure that all links are in the correct locations (see Table 1).
6. Select the FREQ 1 register.
7. Load a 10 kHz excitation frequency and click **Enter**.

The output should appear on the IOUT and IOUTB outputs on the evaluation board.

For the FREQ 0 register,

- Select the FREQ 0 register.
- Load the FREQ 0 register with 20 kHz and click **Enter**.

For the FREQ 1 register,

- Select the FREQ 1 register to load the 10 kHz associated with this register.

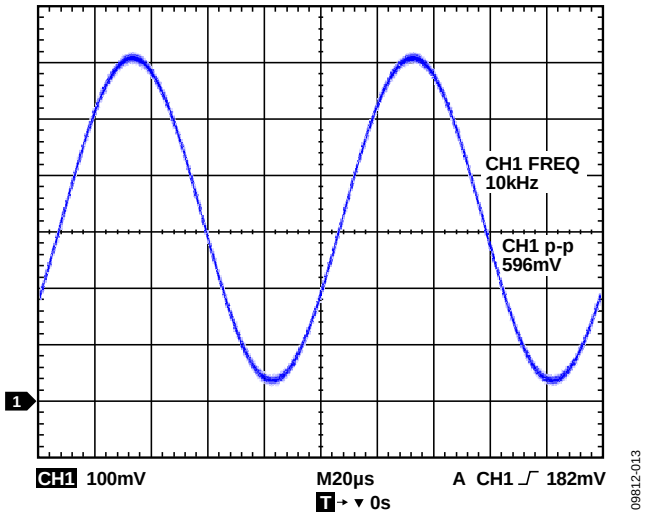



*Figure 13. 10 kHz Output Signals on an IOUT Test Point*

# EVALUATION BOARD SCHEMATICS AND LAYOUT

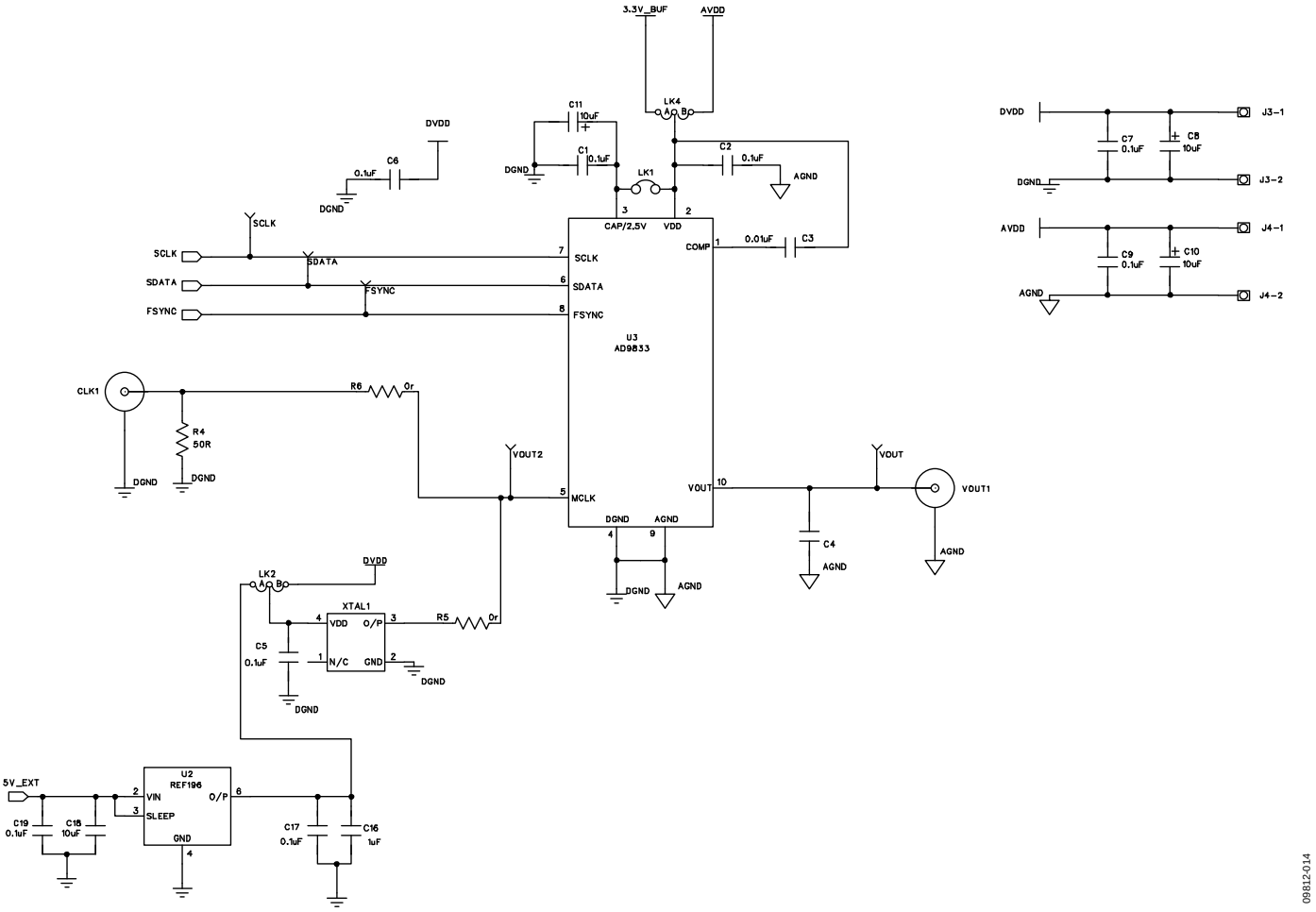



*Figure 14. AD9833 Schematic Part A*

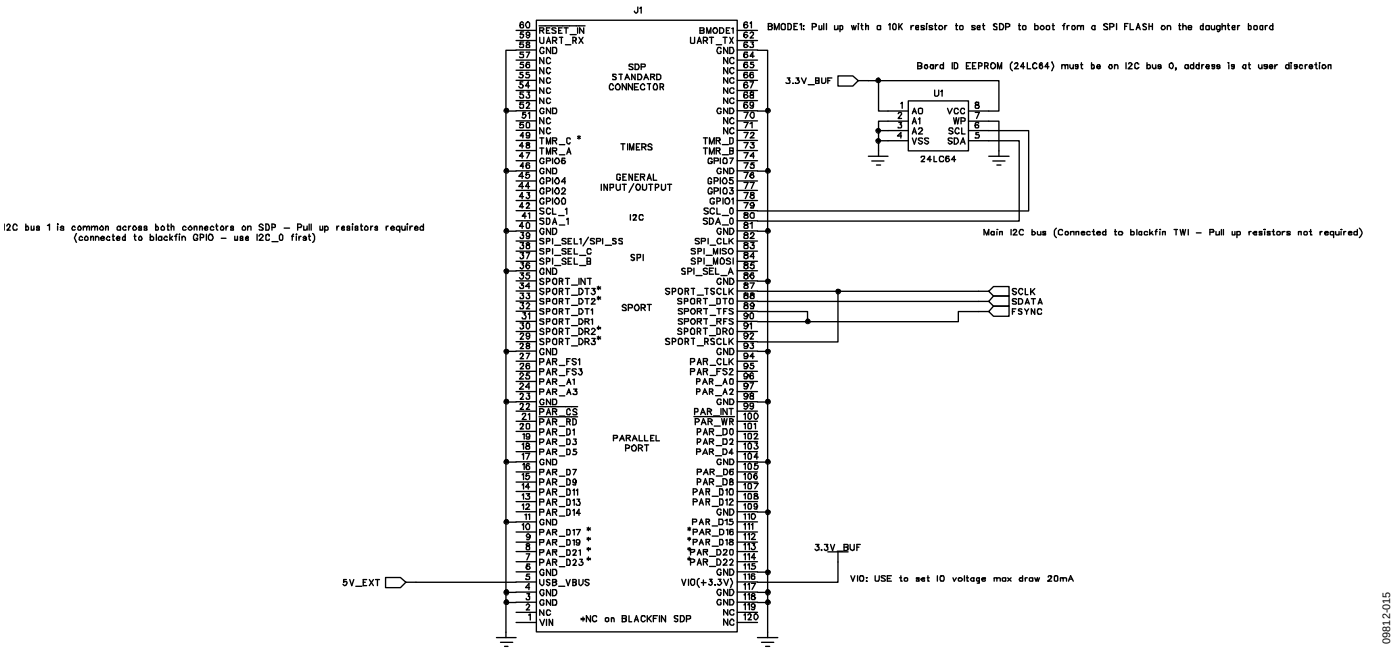
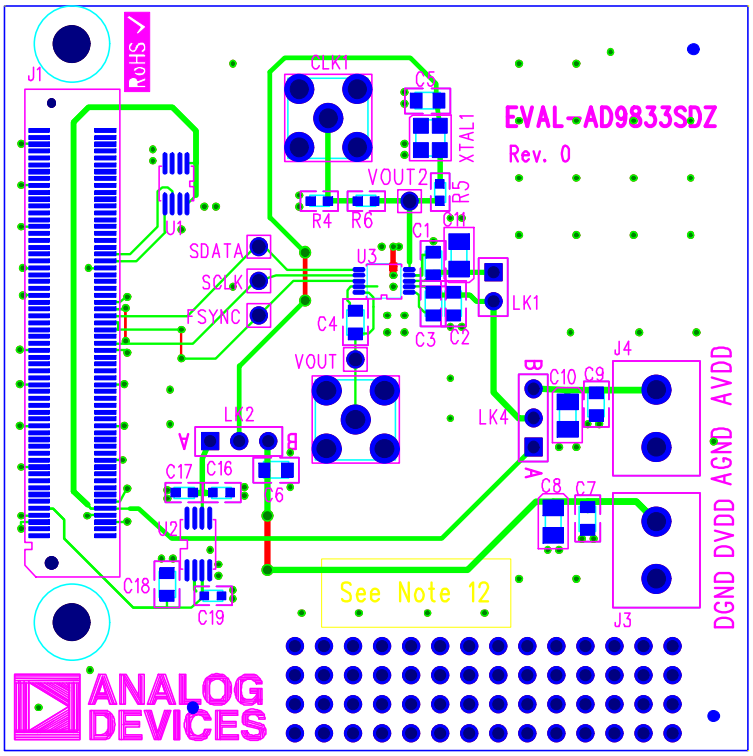



*Figure 15. AD9833 Schematic Part B*




EVAL-AD9833SDZ (Rev. 0) – Component Side View

Layer 1 – Component Side
Layer 2 – Solder Side
Silkscreen
Soldermask Top
Soldermask Bottom
Pastemask
Drill Template

*Figure 16. Evaluation Board Layout*

# ORDERING INFORMATION

## BILL OF MATERIALS

**Table 2.**

| Reference Designator | Description | Manufacturer | Part Number |
|---|---|---|---|
| C1, C2, C4 to C7, C8 | 0.1 µF, 50 V, X7R ceramic capacitor | Murata | GRM188R71H104KA93D |
| C3 | 0.01 µF ceramic capacitor, 0603, 10 V, X5R, 10% | Kemet | C0603C103K5RACTU |
| C9, C10, C11 | 10 µF SMD tantalum capacitor, 10 V, ±10%, RTAJ_A | AVX | TAJA106K010R |
| C16 | 1 µF ceramic capacitor, 10 V, 10%, Y5V, 0603 | Murata | CC0603ZRY5V6BB105 |
| C17, C19 | 0.1 µF capacitor, 0603, 16 V, X7R, ±10% | Multicomp | B0603R104KCT |
| C18 | 10 µF ceramic capacitor, 10 V, 10%, X5R, 0805 | Murata | GRM21BR61A106KE19L |
| CLK1, VOUT1 | Straight PCB mount SMB jack, 50 Ω | Tyco | 1-1337482-0 |
| FSYNC, SCLK, SDATA, VOUT, VOUT2 | Red test point | Vero | 20-313137 |
| J1 | 120-way connector, 0.6 mm pitch, receptacle | HRS (Hirose) | FX8-120S-SV(21) |
| J3, J4 | 2-pin terminal block (5 mm pitch) | Campden | CTB5000/2 |
| LK1 | Jumper block, 2-pin 0.1" spacing | Harwin | M20-9990246 |
| LK2, LK4 | 3-pin SIL header and shorting link | Harwin | M20-9990345 and M7567-05 |
| R4 | 50 Ω SMD resistor, 0603 | Multicomp | MC 0.063W 0603 50R |
| R5, R6 | 0 Ω SMD resistor, 0603 | Multicomp | MC 0.063W 0603 0R |
| U1 | 64K $I^2C$ serial EEPROM MSOP-8 | Microchip | 24LC64-I/MS |
| U2 | Precision micropower, low dropout, low voltage references, 8-lead TSSOP | Analog Devices | REF196GRUZ |
| U3 | Low power 12.65 mW, 2.3 V to 5.5 V, programmable waveform generator, 10-lead MSOP | Analog Devices | AD9833BRMZ |
| XTAL1 | 25 MHz | AEL Crystals | XTAL-AEL-301-SERIES |

## NOTES

# NOTES

**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.



**UG09812-0-8/12(A)**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