Evaluating the AD9835 200 mW Power, 5 V, 50 MHz CMOS Complete DDS

FEATURES
Full featured evaluation board for the AD9835 evaluation board
Graphic user interface software for board control and data analysis
Connector to the EVAL-SDP-CB1Z system demonstration platform (SDP) board
Various power supply and reference link options

APPLICATIONS
DDS tuning
Digital demodulation

GENERAL DESCRIPTION
The AD9835 is a numerically controlled oscillator employing a phase accumulator, a sine lookup table and a 10-bit digital-to-analog converter integrated on a single CMOS chip. Modulation capabilities are provided for phase modulation and frequency modulation.

The EVAL-AD9835SDZ board is used in conjunction with a EVAL-SDP-CB1Z board available from Analog Devices, Inc. The USB-to-SPI communication to the AD9835 is completed using this Blackfin®-based development board.

A high performance, on-board 50 MHz trimmed general oscillator is available to use as the master clock for the AD9835 system. Various links and SMB connectors are also available on the EVAL-AD9835SDZ board to maximize the usability.

Complete specifications for the AD9835 are provided in the AD9835 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.
## TABLE OF CONTENTS

Features ........................................................................................................... 1  
Applications ..................................................................................................... 1  
General Description ....................................................................................... 1  
Functional Block Diagram ............................................................................ 1  
Revision History ............................................................................................. 2  
Evaluation Board Software ........................................................................... 3  
  Installing the Software .................................................................................. 3  
  Running the Software .................................................................................... 4  
  Setting up the Digital Interface ................................................................... 5  
  Select External MCLK Frequency .............................................................. 5  
  Select Frequency and Phase Registers ....................................................... 6  
  Loading Frequency and Phase Registers ................................................... 6  
  Power Options ............................................................................................ 6  
  Initialize, Reset, SYNC, Clear, and Sweep ............................................... 6  
Example of Operation .................................................................................... 7  
Evaluation Board Schematics and Layout .................................................... 8  
Ordering Information ...................................................................................... 11  
  Bill of Materials ......................................................................................... 11  

## REVISION HISTORY

9/11—Rev. A to Rev. B  
Document Title Changed from EVAL-AD9835EB to UG-319 ................................................. Universal  
Updated Format ................................................................................................ Universal  
Changes to Features Section ........................................................................... 1  
Replaced Figure 1 ............................................................................................ 1  
Deleted Introduction Section and Operating the AD9835 Evaluation Board Section ...................................................... 1  
Added Applications Section and General Description Section .................... 1  
Deleted Link and Switch Options Section and Set-Up Conditions Section ............... 2  
Deleted Evaluation Board Interfacing Section, Sockets Section, Connectors Section, and Switches Section ................................................................. 3  
Replaced Software Description Section with Evaluation Board Software Section ......................................................... 3  
Replaced Figure 2 ............................................................................................ 3  
Deleted Table 2, Table 3, and Table 4; Renumbered Sequentially .......................... 3  
Added Figure 3; Renumbered Sequentially ..................................................... 4  
Changes to Table 1 .......................................................................................... 4  
Changes to Figure 4 ........................................................................................ 5  
Added Figure 5 and Figure 6 ........................................................................... 5  
Added Figure 7 to Figure 10 ......................................................................... 6  
Added Figure 11 and Figure 12 ..................................................................... 7  
Added Evaluation Board Schematics and Layout Section .............................. 8  
Changes to Figure 13 .................................................................................... 8  
Added Figure 14 ............................................................................................ 9  
Changes to Figure 15 .................................................................................... 9  
Changes to Figure 16 and Figure 17 ............................................................ 10  
Added Ordering Information Section ............................................................ 11  
Changes to Table 2 ........................................................................................ 11
EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The EVAL-AD9835SDZ 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-AD9835SDZ evaluation kit CD.
3. Download the EVAL-AD9835SDZ LabVIEW™ software. The correct driver for the SDP board, SDPDriversNET, should download automatically after LabVIEW is downloaded, supporting both 32-bit 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 SDPDriverNet Version 1.3.6.0.
4. After installation of the software and drivers is complete, plug the EVAL-AD9835SDZ into the SDP board and the SDP board into the PC using the USB cable included in the kit.
5. When the software detects the evaluation board, proceed through any dialog boxes that appear to finalize the installation (for example, Found New Hardware Wizard and Install the Software Automatically).

![Figure 2. Hardware Device Manager Window with SDP Board Plugged In](image)
RUNNING THE SOFTWARE

To run the evaluation board program, do the following:

1. Click Start/All Programs/Analog Devices/AD9835/AD9835 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 AD9835 evaluation software then opens, as shown in Figure 4.

Table 1. Default Setup for Link Positions

<table>
<thead>
<tr>
<th>Link No.</th>
<th>Position</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK1</td>
<td>Connected</td>
<td>REFOUT is used as the reference to the DAC by connecting REFOUT to REFIN.</td>
</tr>
<tr>
<td>LK3</td>
<td>B</td>
<td>3.3 V digital supply for the AD9835 supplied from the EVAL-SDP-CB1Z board.</td>
</tr>
<tr>
<td>LK5</td>
<td>B</td>
<td>3.3 V analog supply for the AD9835 supplied from the EVAL-SDP-CB1Z board.</td>
</tr>
<tr>
<td>LK6</td>
<td>A</td>
<td>On-board linear regulator selected to supply power to the general oscillator.</td>
</tr>
</tbody>
</table>

Figure 3. Pop-Up Window Error
SETTING UP THE DIGITAL INTERFACE

The first step in setting up the AD9835 to take measurements is to set the DIGITAL INTERFACE in the software window (see Figure 4).

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 upon, leave the default values as shown in Figure 5.

SELECT EXTERNAL MCLK FREQUENCY

Having selected the digital interface specifics, next use the EXTERNAL MCLK box to select the frequency to use. The boards are supplied with a 50 MHz general oscillator. If a different clock source is required, the CLK SMB connector can be used to supply a different MCLK value.

The general oscillator includes the AEL301 oscillators from AEL Crystals.
SELECT FREQUENCY AND PHASE REGISTERS

Frequency and phase registers can be selected using either software or hardware. Figure 7 shows how to select the source of control for the registers. To control the frequency and phase registers using the hardware pins, use SELSRC = 0. To control the frequency and phase registers using the software bits, use SELSRC = 1.

LOADING FREQUENCY AND PHASE REGISTERS

The desired output frequency and output phase can be loaded using the inputs shown in Figure 8. Either the FREQ0 register or the FREQ1 register can be loaded with frequency data. The frequency data is loaded in megahertz, and the equivalent hexadecimal code is shown to the right after data is entered. After data is loaded, the output appears on the IOUT pin. Similarly, the PHASE0 register, the PHASE1 register, the PHASE2 register, or the PHASE3 register can be selected, and the phase data is loaded in degrees.

The analog output frequency from the AD9835 is defined by 
\[ f_{MCLK}/2^{32} \times FREQ \]
where \( FREQ \) is the value loaded into the selected frequency register in decimals. This signal is phase shifted by 
\[ 2\pi/4096 \times PHASEx \]
where \( PHASEx \) is the value contained in the selected phase register in decimals.

POWER OPTIONS

When Sleep is selected, the sleep bit is set to 1. When this bit equals 1, the AD9835 is powered down, internal clocks are disabled, and the current sources and REFOUT of the DAC are turned off.

When Normal is selected, the sleep bit is set to 0 and the AD9835 is powered up.

INITIALIZE, RESET, SYNC, CLEAR, AND SWEEP

The initialize, reset, SYNC, and clear commands are set using the buttons shown in Figure 10. To set up a DDS sweep, click Sweep.
**Initialise** sets the frequency registers and the phase registers to the values chosen by users. It also sets SELSRC to 0. It is used in three different cases: when starting the program, after using reset, and after switching from sleep to normal.

When the reset bit = 1, the phase accumulator is set to zero phase, which corresponds to an analog output of midscale. Setting reset to 1 sets the FSELECT, PSEL0, and PSEL1 pins to 0.

Selection of the frequency/phase registers using the FSELECT and PSELx pins is synchronized with the MCLK rising edge when SYNC = 1. When SYNC = 0, the loading of the data and the sampling of FSELECT and PSELx occurs asynchronously.

When CLR = 1, SYNC and SELSRC are set to zero so that the pins are the default source. CLR resets to zero automatically.

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. When using the sweep function, SELSRC must be set to 1.

---

**EXAMPLE OF OPERATION**

An example of configuring the **AD9835** to output 1 MHz follows:

1. Plug the EVAL-SDP-CB1Z board into the EVAL-AD9835SDZ board and connect to the USB port.
2. Start up the software located at **Start/All Programs/Analog Devices/AD9835/AD9835 Eval Board**. Users should see the SDP board communicating with the PC.
3. Define MCLK; the default is an on-board 50 MHz oscillator.
4. Ensure that all links are in the correct locations (see Table 1).
5. Select the FREQ1 register.
6. Load a 1 MHz excitation frequency and press the **ENTER** key.

The output should appear on the IOUT output on the evaluation board.

For the FREQ0 register,

1. Select the FREQ0 register, and load the FREQ0 register with 2 MHz.
2. Press the **ENTER** key.

For the FREQ1 register,

1. Select the FREQ1 register to load the 1 MHz associated with this register.
2. Press the **ENTER** key.
Figure 13. AD9835 Schematic Part A
Figure 14. AD9835 Schematic Part B

Figure 15. Component Side View Layer 1
Figure 16. Component Side View Silkscreen

Figure 17. Component Side View Layer 2, Solder Side
### ORDERING INFORMATION

#### BILL OF MATERIALS

<table>
<thead>
<tr>
<th>Reference Designator</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C3, C5, C6, C11&lt;sup&gt;1&lt;/sup&gt;, C12, C13&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.1 μF, ±10%, 50 V, X7R, ceramic capacitor</td>
<td>Murata</td>
<td>GRM188R71H104KA93D</td>
</tr>
<tr>
<td>C7</td>
<td>0.01 μF, ±10%, 10 V, 0603, X5R, capacitor</td>
<td>Kemet</td>
<td>C0603C103KSRACTU</td>
</tr>
<tr>
<td>C2, C4</td>
<td>10 μF, ±10%,10 V, SMD tantalum capacitor</td>
<td>AVX</td>
<td>TAJA106K010R</td>
</tr>
<tr>
<td>C8, C9</td>
<td>1 μF, ±10%,10 V,Y5V, 0603, ceramic capacitor</td>
<td>Yageo</td>
<td>CC0603ZRY5V6BB105</td>
</tr>
<tr>
<td>C10</td>
<td>0.1 μF, ±10%, 16 V, X7R, 0603, capacitor</td>
<td>Multicomp</td>
<td>B0603R104KCT</td>
</tr>
<tr>
<td>CLK&lt;sup&gt;1&lt;/sup&gt;, FSEL&lt;sup&gt;1&lt;/sup&gt;, IOUT, PSEL&lt;sup&gt;1&lt;/sup&gt;, REFIN, PSEL&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Straight PCB mount SMB jack, 50 Ω</td>
<td>Tyco</td>
<td>1-1337482-0</td>
</tr>
<tr>
<td>FSYNC, IOUT, MCLK, SCLK, SDATA</td>
<td>Red test point</td>
<td>Vero</td>
<td>20-313137</td>
</tr>
<tr>
<td>G2</td>
<td>Copper short</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>J1</td>
<td>120-way connector, 0.6 mm pitch receptacle</td>
<td>HRS (Hirose)</td>
<td>FX8-120S-SV(21)</td>
</tr>
<tr>
<td>J2, J3</td>
<td>2-pin terminal block (5 mm pitch)</td>
<td>Campden</td>
<td>CTB5000/2</td>
</tr>
<tr>
<td>LK3, LK5, LK6</td>
<td>3-pin SIL header and shorting link</td>
<td>Harwin</td>
<td>M20-9990345 and M7567-05</td>
</tr>
<tr>
<td>LK1</td>
<td>2-pin SIL header and shorting link</td>
<td>Harwin</td>
<td>M20-9990246</td>
</tr>
<tr>
<td>R7&lt;sup&gt;1&lt;/sup&gt;, R8&lt;sup&gt;1&lt;/sup&gt;, R9&lt;sup&gt;1&lt;/sup&gt;</td>
<td>10 kΩ, ±1%, 0603, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W060310K</td>
</tr>
<tr>
<td>R12&lt;sup&gt;1&lt;/sup&gt;</td>
<td>50 Ω, ±1%, 0603, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W060350r</td>
</tr>
<tr>
<td>R14</td>
<td>3.9 kΩ, ±1%, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W06036K8</td>
</tr>
<tr>
<td>R15</td>
<td>300 Ω, ±1%, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W0603200r</td>
</tr>
<tr>
<td>R17, R18</td>
<td>100 kΩ, ±1%, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W06031%100K</td>
</tr>
<tr>
<td>R1, R2&lt;sup&gt;1&lt;/sup&gt;, R3, R4&lt;sup&gt;1&lt;/sup&gt;, R6&lt;sup&gt;1&lt;/sup&gt;, R5, R11&lt;sup&gt;1&lt;/sup&gt;, R10, R16&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0 Ω, ±1%, 0603, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W06030r</td>
</tr>
<tr>
<td>R13</td>
<td>330 kΩ, ±5%, SMD resistor</td>
<td>Multicomp</td>
<td>MC063W0603330KR</td>
</tr>
<tr>
<td>U4</td>
<td>200 mW power 5 V, 50 MHz complete DDS</td>
<td>Analog Devices</td>
<td>AD9835BRUZ</td>
</tr>
<tr>
<td>U1</td>
<td>32k i2C serial EEPROM 8-lead MSOP</td>
<td>Micro Chip</td>
<td>24LC32A-I/M5</td>
</tr>
<tr>
<td>U5</td>
<td>3.3 V linear regulator</td>
<td>Analog Devices</td>
<td>ADP3301ARZ-3.3</td>
</tr>
<tr>
<td>Y2</td>
<td>50 MHz, 3 mm × 2 mm SMD clock oscillator</td>
<td>AEL Crystals</td>
<td>AEL301series</td>
</tr>
</tbody>
</table>

<sup>1</sup> Do not install.

<sup>2</sup> DNP.
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.

Legal Terms and Conditions
By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the “Evaluation Board”), you are agreeing to be bound by the terms and conditions set forth below (“Agreement”) unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. Do not use the Evaluation Board before you have read and agreed to the Agreement. By using the Evaluation Board, you agree to be bound by all of the terms and conditions of this Agreement.

Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term “Third Party” includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED “AS IS” AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, WARRANTIES, OR WARRANTIES. EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER’S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI’S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS ($100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

©2011 Analog Devices, Inc. All rights reserved. Trademarks and registered trademarks are the property of their respective owners.