

## Evaluating the **AD5313R** 10-Bit, Dual-Channel Voltage Output Digital-to-Analog Converter (DAC)

### FEATURES

- Full featured evaluation board (**EVAL-AD5313RDBZ**) in conjunction with nanoDAC motherboard (**EVAL-MBnanoDAC-SDZ**)
- On-board references
- Various link options
- PC control in conjunction with Analog Devices, Inc., system demonstration platform (SDP)

### EVALUATION KIT CONTENTS

- EVAL-AD5313RDBZ** evaluation board
- EVAL-MBnanoDAC-SDZ** motherboard
- USB cable

### SOFTWARE REQUIRED

- EVAL-AD5313RDBZ** evaluation software

### HARDWARE REQUIRED

- EVAL-SDP-CB1Z** controller board (**SDP-B** controller board), must be purchased separately

### GENERAL DESCRIPTION

This user guide details the operation of the **EVAL-AD5313RDBZ** evaluation board for the **AD5313R** dual-channel, voltage output DAC. The **AD5313R** operates from a single 2.7 V to 5.5 V supply.

The **EVAL-AD5313RDBZ** is designed to quickly prototype **AD5313R** circuits and reduce design time. The evaluation board interfaces with the USB port of a PC via the **SDP-B** controller board. Software can be downloaded via the **EVAL-AD5313RDBZ** product page that allows users to program the **AD5313R**.

This evaluation board requires the **SDP-B** controller board, which is available for order on the Analog Devices, Inc., website.

Full data on the **AD5313R** can be found in the **AD5313R** data sheet available from Analog Devices and should be consulted in conjunction with this user guide when using the evaluation board.

### **EVAL-AD5313RDBZ, EVAL-MBnanoDAC-SDZ, AND EVAL-SDP-CB1Z** BOARDS

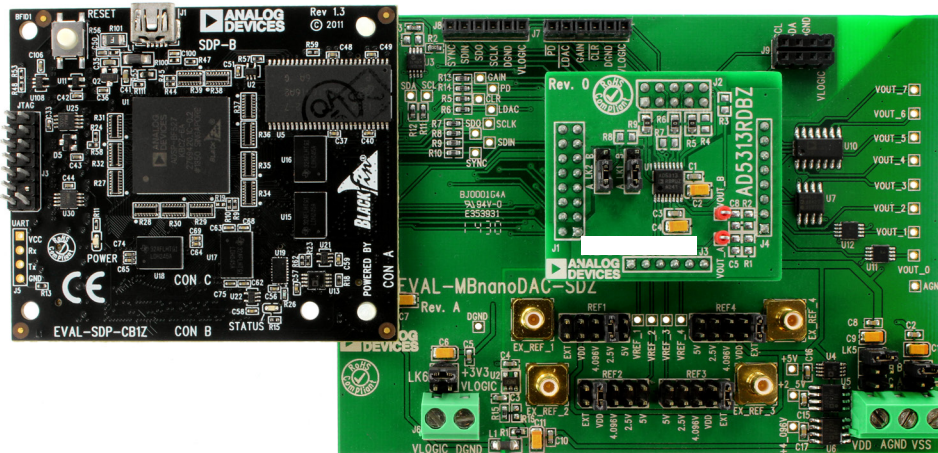


Figure 1.

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## REVISION HISTORY

### 9/2017—Rev. 0 to Rev. A

Changes to Figure 1 .....	1
Changes to Daughter Board Link Options Section and Table 3.....	3

### 3/2017—Revision 0: Initial Version

## EVALUATION BOARD HARDWARE

### POWER SUPPLIES

The nanoDAC® [EVAL-MBnanoDAC-SDZ](#) motherboard supports single and dual power supplies.

The [EVAL-AD5313RDBZ](#) evaluation board can be powered either from the [SDP-B](#) port or externally by the J5 and J6 connectors, as described in Table 1.

Both AGND and DGND inputs are provided on the [EVAL-AD5313RDBZ](#) evaluation board. The AGND and DGND planes connect at one location on the [EVAL-MBnanoDAC-SDZ](#). It is recommended that AGND and DGND do not connect elsewhere in the system to avoid ground loop problems.

All supplies are decoupled to ground with a 10  $\mu$ F tantalum capacitor and 0.1  $\mu$ F ceramic capacitor.

**Table 1. Power Supply Connectors**

Connector No.	Label	Voltage
J5, Pin 1 (J5-1)	VDD	Analog positive power supply, $V_{DD}$ ; 5.5 V single- and dual-supply
J5, Pin 2 (J5-2)	AGND	Analog ground
J5, Pin 3 (J5-3)	VSS	Analog negative power supply, $V_{SS}$ ; 5.5 V dual-supply
J6, Pin 1 (J6-1)	VLOGIC	Digital supply from 1.8 V to $V_{DD}$
J6, Pin 2 (J6-2)	DGND	Digital ground

**Table 3. Link Functions**

Link Number	Position
REF1 to REF4	These links select the reference source. Position EXT selects an off board voltage reference via the appropriate EXT_REF connector. Position VDD selects $V_{DD}$ as the reference source. Position 4.096V selects the on-board 4.096 V reference as the reference source. Position 2.5V selects the on-board 2.5 V reference as the reference source. Position 5V selects the on-board 5 V reference as the reference source.
LK5	This link selects the positive DAC analog voltage source. Position A selects the internal voltage source from the <a href="#">SDP-B</a> controller board. Only the 2.5 V on-board reference can be used with this configuration. Position B selects the internal voltage source 3.3 V from the <a href="#">ADP121</a> . Position C selects an external supply voltage, $V_{DD}$ .
LK6	This link selects the VLOGIC voltage source. Position +3.3V selects the digital voltage source from the <a href="#">SDP-B</a> controller board (+3V3). Position VLOGIC selects an external digital supply voltage ( $V_{LOGIC}$ ).
LK7	This link selects the negative DAC analog voltage source. Position A selects $V_{SS}$ . Position B selects AGND.

### LINK OPTIONS

A number of link options are incorporated in the [EVAL-MBnanoDAC-SDZ](#) and must be set for the required operating conditions before using the [EVAL-AD5313RDBZ](#). Table 2 describes the positions of the links to control the evaluation board via the [SDP-B](#) controller board using a PC and external power supplies. The functions of these link options are described in detail in Table 3. The positions listed in Table 2 and Table 3 match the evaluation board imprints (see Figure 12).

**Table 2. Link Options Setup for [SDP-B](#) Control (Default)**

Link Number	Position
REF1	2.5V
REF2	EXT
REF3	EXT
REF4	EXT
LK5	C
LK6	+3V3
LK7	B

### DAUGHTER BOARD LINK OPTIONS

The [EVAL-AD5313RDBZ](#) has two link options, LK1 and LK2, and it is recommended to remove the link from the [EVAL-AD5313RDBZ](#).

## EVALUATION SOFTWARE

### INSTALLING THE EVAL-AD5313RDBZ EVALUATION SOFTWARE

The EVAL-AD5313RDBZ evaluation software is compatible with Windows® Vista (64-bit/32-bit), and Windows 7 (64-bit/32-bit).

Install the software before connecting the SDP-B controller board to the USB port of the PC to ensure that the SDP-B controller board is recognized when it connects to the PC.

To install the EVAL-AD5313RDBZ evaluation software, take the following steps:

1. Start the Windows operating system.
2. Download the installation software from the EVAL-AD5313RDBZ evaluation board page.
3. Run the **setup.exe** file from the installer folder if it does not open automatically.
4. After the installation is complete, power up the evaluation board as described in the Power Supplies section.
5. Connect the EVAL-AD5313RDBZ to the SDP-B controller board and the SDP-B controller board to the PC using the USB cable included in the evaluation kit.
6. When the software detects the EVAL-AD5313RDBZ, proceed through any dialog boxes that appear to finalize the installation.

### RUNNING THE SOFTWARE

To run the EVAL-AD5313RDBZ evaluation software, proceed with the following steps:

1. Connect the EVAL-AD5313RDBZ to the SDP-B controller board and connect the USB cable between the board and the PC.
2. Power up the EVAL-AD5313RDBZ as described in the Power Supplies section.
3. Click **Start > All Programs > Analog Devices > AD5313R Evaluation Software** to locate the evaluation board.

If the SDP-B controller board is not connected to the USB port when the software launches, a connectivity error displays (see Figure 2).

Connect the SDP-B controller board to the USB port of the PC and wait a few seconds. When the SDP-B controller board and the EVAL-AD5313RDBZ daughter board are detected, the display updates (see Figure 3).

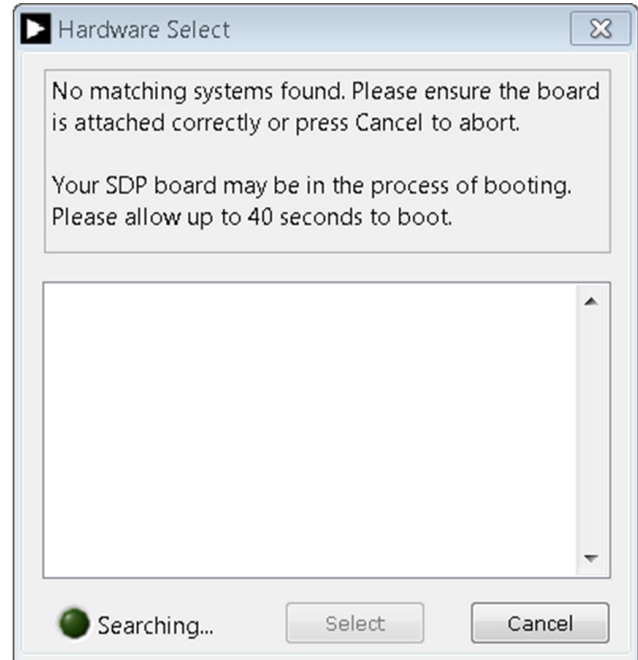


Figure 2. Connectivity Error

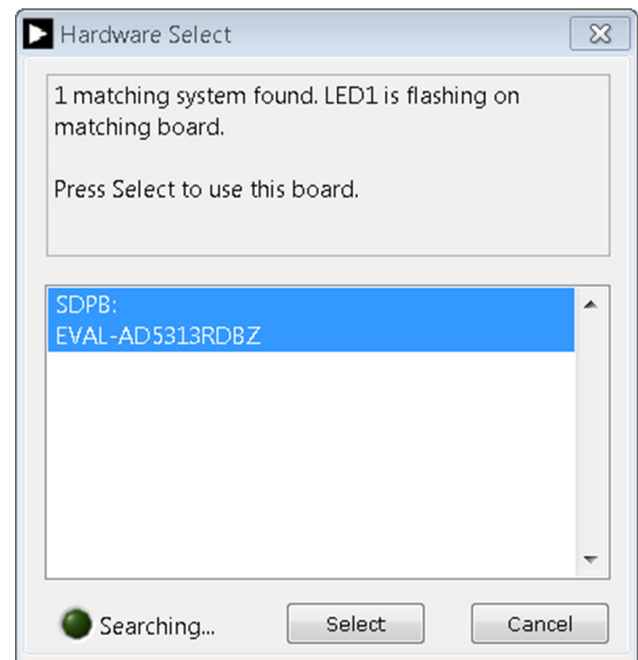


Figure 3. Hardware Select Window

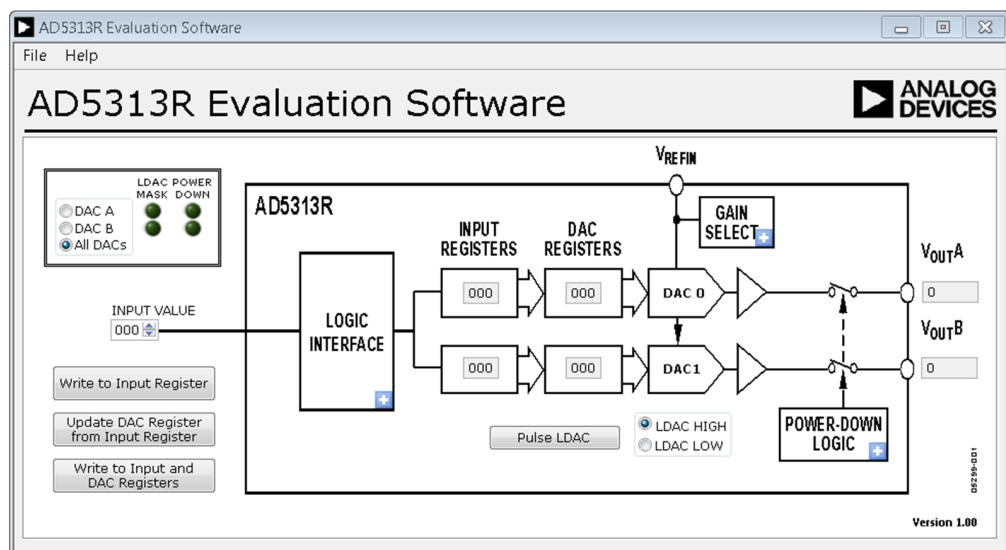


Figure 4. AD5313R Evaluation Software Main Window

Alternatively, the [EVAL-AD5313RDBZ](#) evaluation software can be used without an evaluation board. The [EVAL-AD5313RDBZ](#) evaluation software runs in simulation mode displaying expected outputs based on the input data. The main window of the [EVAL-AD5313RDBZ](#) evaluation software then opens, as shown in Figure 4.

## SOFTWARE OPERATION

The [EVAL-AD5313RDBZ](#) evaluation software allows the user to program values to the input and DAC registers of each DAC individually or collectively.

### Write to Input Register

Click the **Write to Input Register** button to load the code of the input data control to the input register of the selected DAC (DAC A, DAC B, or All DACs).

### Update DAC Register from Input Register

Click the **Update DAC Register from Input Register** button to copy the value in the input register to the corresponding DAC register. DAC outputs are automatically updated with the appropriated voltage. Ignore the **LDAC MASK** indicator LED.

### Write to Input and DAC Registers

Click the **Write to Input and DAC Registers** button to load the code of the input data control to the input register and DAC register of the selected DAC. The DAC outputs are automatically updated with the appropriated voltage. Ignore the **LDAC MASK** indicator LED.

## LDAC Control

Select the **Pulse LDAC** button to bring the  $\overline{\text{LDAC}}$  pin low and then back to high, copying the data from the input registers to the DAC registers, and the outputs update accordingly. Ignore any DAC updates disabled by the LDAC mask settings.

The  $\overline{\text{LDAC}}$  pin can also be set high or low by clicking LDAC HIGH or LDAC LOW, respectively.

## LDAC Mask Register

Each DAC can be configured to respond or ignore the  $\overline{\text{LDAC}}$  pin settings in the LDAC Control. Click the blue progressive disclosure option on the **LOGIC INTERFACE** block to access the **LDAC Configuration** window, as shown in Figure 5.

When the LDAC selections are completed, click **OK** to write the appropriate values to the **AD5313R**. The **LDAC MASK** indicator LED lights up accordingly when a DAC LDAC mask is enabled.

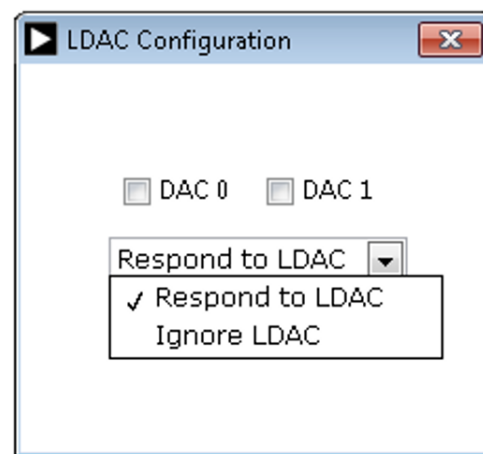


Figure 5. LDAC Configuration Window

### Power-Down Control

DAC A and DAC B in the [AD5313R](#) can be powered down individually. Each of the DACs has a selection box allowing the selected DAC to operate in normal mode or power-down mode. Click on the blue progressive disclosure button on the **POWER-DOWN LOGIC** block to access the **Powerdown Configuration** window, shown in Figure 6. When the power-down setting for the DAC is selected, click **OK** to write the appropriate values to the [AD5313R](#). The **POWER DOWN** indicator LED lights up accordingly when a DAC powers down.

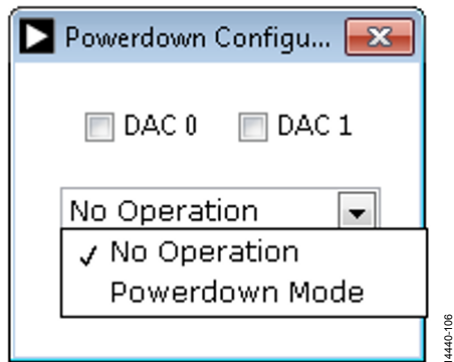


Figure 6. **Powerdown Configuration** Window

### GAIN Control

Set the GAIN pin high or low by clicking the blue progressive disclosure button on the **GAIN SELECT** block to access the **Gain Control** window, shown in Figure 7. Select **GAIN X1** to give a full-scale output of 2.5 V or select **GAIN X2** to give a full-scale output of 5 V.

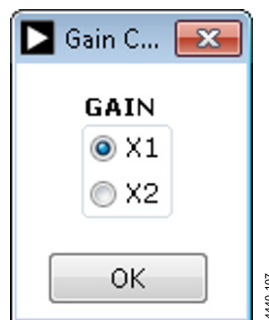


Figure 7. **Gain Control** Window

## EVAL-MBNANODAC-SDZ MOTHERBOARD



The schematic diagram illustrates a four-channel reference voltage divider circuit. The top row shows the internal structure of the four-channel reference divider circuit, including the internal structure of the four-channel reference divider circuit. The bottom row shows the external connections for the four-channel reference divider circuit, including the external connections for the four-channel reference divider circuit.

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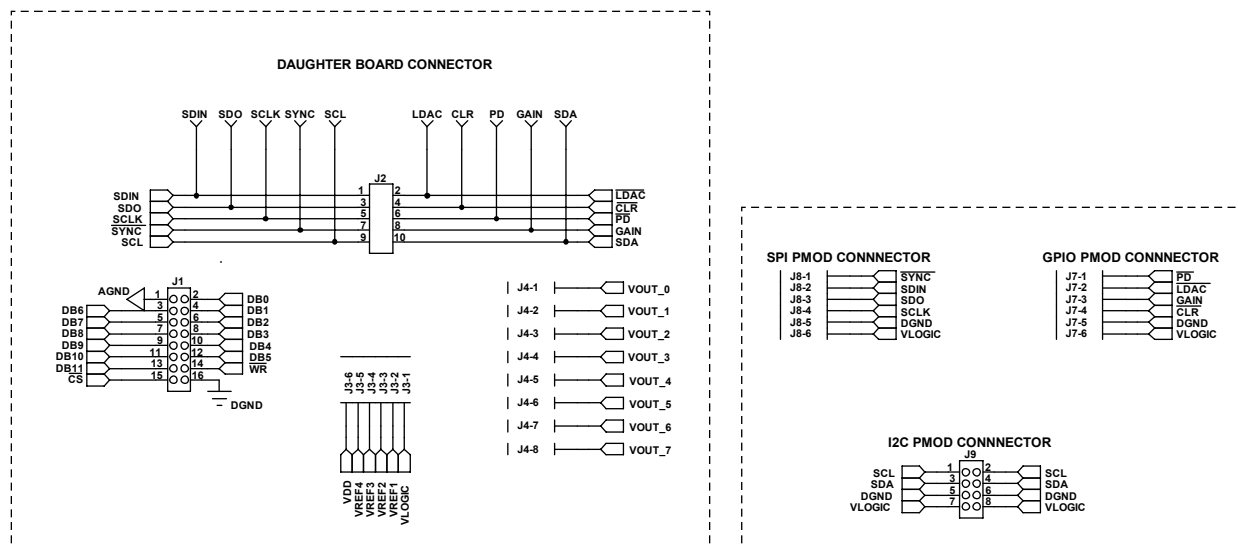


Figure 10. EVAL-MBnanoDAC-SDZ Motherboard Connectors to Daughter board and Serial Interface

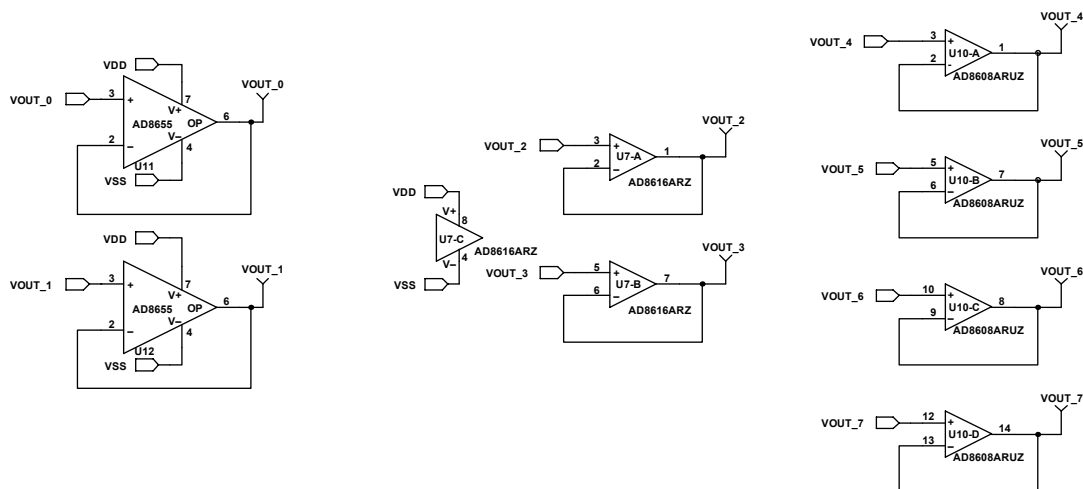


Figure 11. EVAL-MBnanoDAC-SDZ Motherboard Output Amplifier Circuit



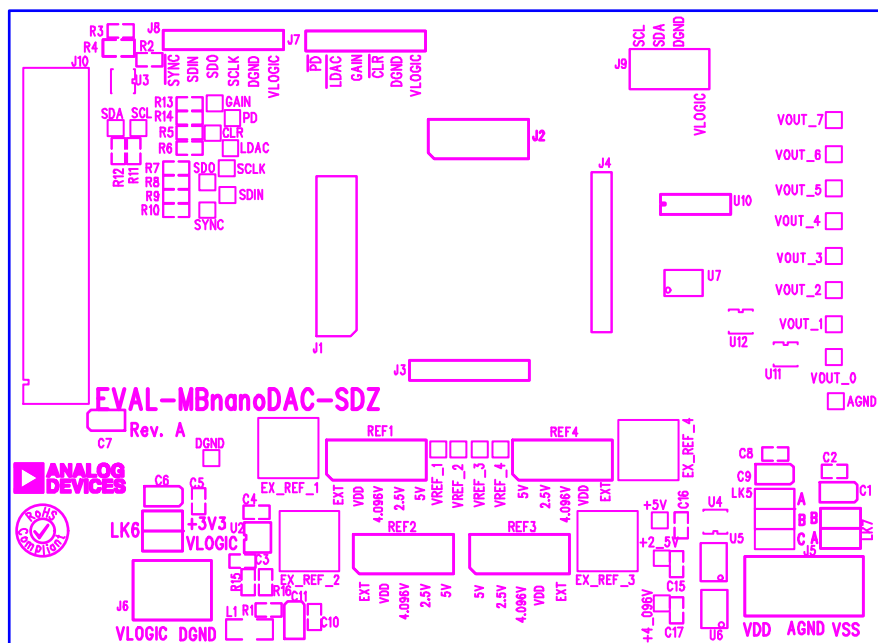


Figure 12. EVAL-MBnanoDAC-SDZ Motherboard Component Placement

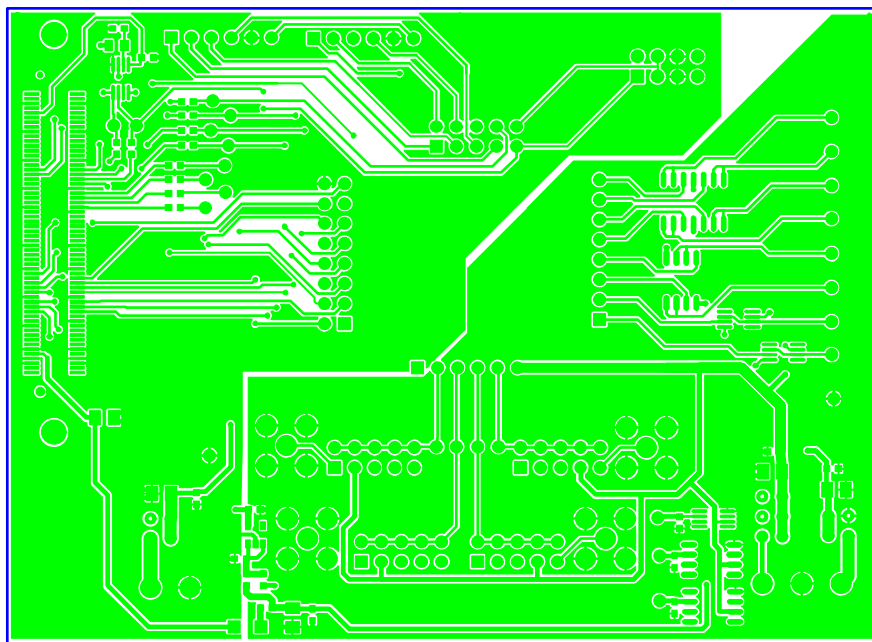
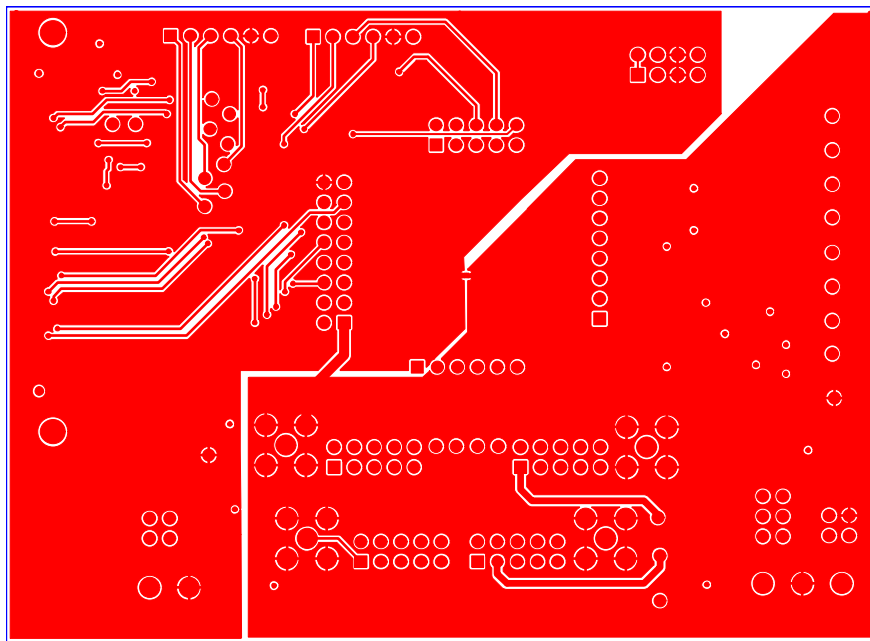


Figure 13. EVAL-MBnanoDAC-SDZ Motherboard Top Side Routing



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Figure 14. EVAL-MBnanoDAC-SDZ Motherboard Bottom Side Routing

## EVAL-AD5313RDBZ DAUGHTER BOARD

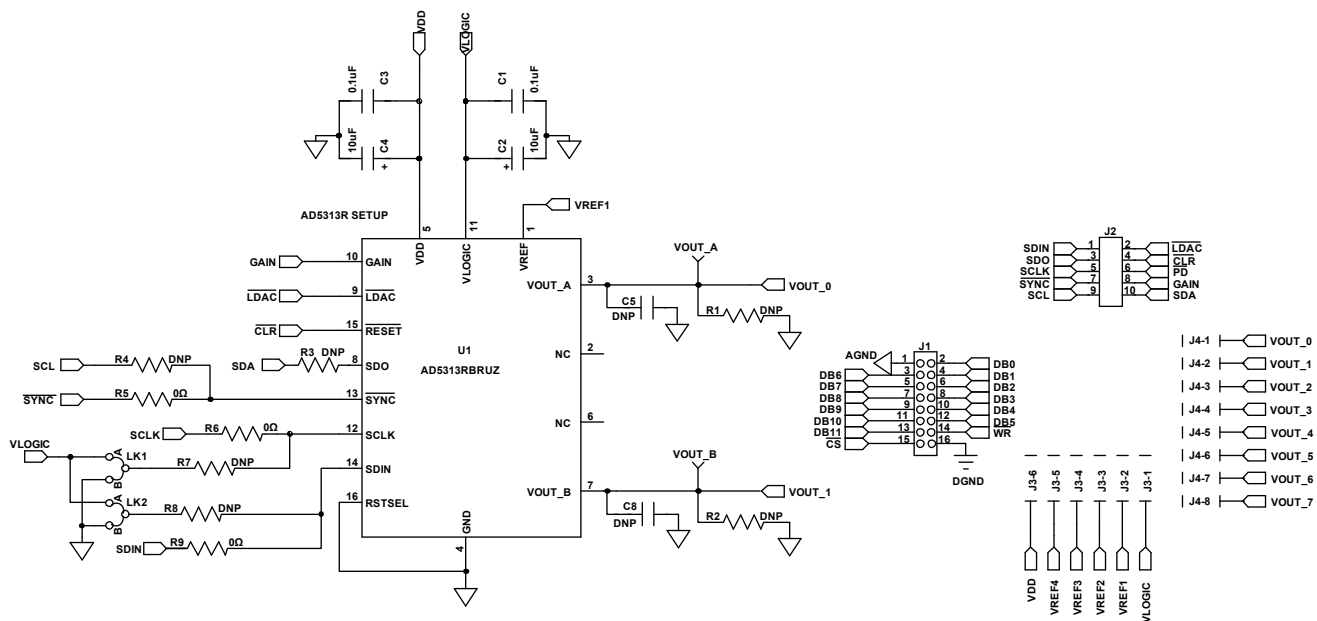


Figure 15. EVAL-AD5313RDBZ Daughter Board Schematic

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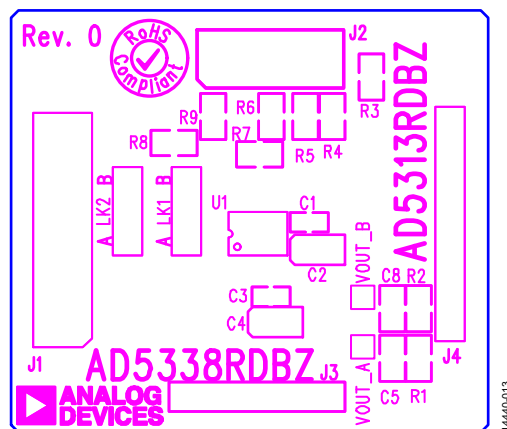


Figure 16. EVAL-AD5313RDBZ Daughter Board Component Placement

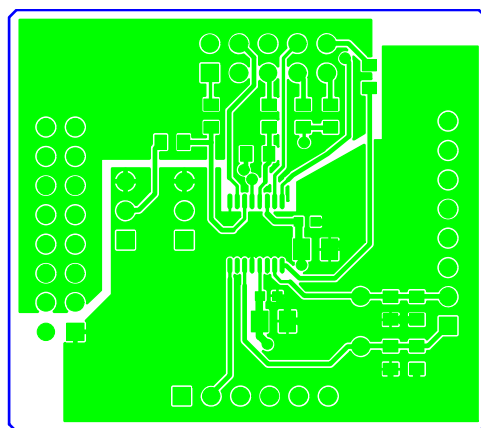


Figure 17. EVAL-AD5313RDBZ Daughter Board Top Side Routing

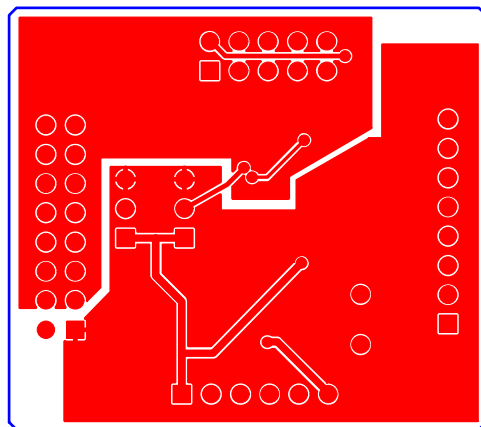


Figure 18. EVAL-AD5313RDBZ Daughter Board Bottom Side Routing

## ORDERING INFORMATION

### BILL OF MATERIALS

Table 4. EVAL-MBnanoDAC-SDZ Motherboard

Reference Designator	Description	Supplier <sup>1</sup> /Part Number
C1, C6, C7, C9	6.3 V tantalum capacitors (Case A), 10 $\mu$ F, $\pm$ 20%	FEC 1190107
C2, C5, C8, C10, C15 to C17	50 V, X7R ceramic capacitors, 0.1 $\mu$ F, $\pm$ 10%	FEC 1759122
C3, C4	10 V, X5R ceramic capacitors, 1 $\mu$ F, $\pm$ 10%	GRM188R61A105A61D <sup>2</sup>
C11	6.3 V tantalum capacitor (Case A), 4.7 $\mu$ F, $\pm$ 20%	FEC 1432350
EXT_REF_1 to EXT_REF_4	Straight PCB mount SMB jacks, 50 $\Omega$	FEC 1206013
J1	Header, 2.54 mm, 2 $\times$ 8-way	FEC 2308428
J2	Header, 2.54 mm, 2 $\times$ 5-way	FEC 9689583
J3, J7, J8	Header, 2.54 mm, 1 $\times$ 6-way	FEC 9689508
J4	Header, 2.54 mm, 1 $\times$ 8-way	FEC 1766172
J5	3-pin terminal block	FEC 1667472
J6	2-pin terminal block	FEC 151789
J9	Header, 2.54 mm, 2 $\times$ 4-way	FEC 1667509
J10	120-way connector	FEC 1324660
L1	Inductor, SMD, 600 $\Omega$	FEC 9526862
LK5	6-pin (3 $\times$ 2-way) 0.1 inch header and shorting block	FEC 148-535 and FEC 150-411 (36-pin strip)
LK6, LK7	4-pin (2 $\times$ 2-way) 0.1 inch header and shorting block	FEC 148-535 and FEC 150-411 (36-pin strip)
REF1 to REF 4	10-pin (5 $\times$ 2-way) 0.1 inch header and shorting block	FEC 1022227 and FEC 150-411
R1	Resistor, surge, 1.6 $\Omega$ , 1%, 0603	FEC 1627674
R2, R3	SMD resistors, 100 k $\Omega$ , 1%, 0603	FEC 9330402
R5 to R15	SMD resistors, 100 $\Omega$ , 1%, 0603	FEC 9330364
U2	3.3 V linear regulator	<a href="#">ADP121-AUJZ33R7</a>
U3	32 k $\Omega$ I <sup>2</sup> C serial EEPROM	FEC 1331330
U4	5 V reference MSOP	<a href="#">ADR445ARMZ</a>
U5	Ultralow noise XFET <sup>®</sup> voltage reference	<a href="#">ADR431BRZ</a>
U6	4.096 V reference	<a href="#">REF198ESZ</a>
U7	Dual-op amp	<a href="#">AD8616ARZ</a>
U10	Quad-op amp	<a href="#">AD8608ARMZ</a>
U11, U12	Op amp	<a href="#">AD8655ARMZ</a>

<sup>1</sup>FEC refers to Farnell Electronic Component Distributors.

<sup>2</sup>GRM refers to Murata Manufacturing Company.

Table 5. EVAL-AD5313RDBZ Daughter Board

Qty	Reference Designator	Description	Supplier <sup>1</sup> /Part Number
2	C1, C3	50 V, X7R ceramic capacitors	FEC 1759122
2	C2, C4	6.3 V tantalum capacitors (Case A)	FEC 1190107
2	C5, C8	Do not insert	Do not insert
1	J1	16-pin (2 $\times$ 8-way) header	FEC 2308428 inserted from solder side
1	J2	10-pin (2 $\times$ 5-way) straight header, 2.54 mm pitch	FEC 9689583 inserted from solder side
1	J3	6-pin (1 $\times$ 6-way) straight header, 2.54 mm pitch	FEC 9689508 inserted from solder side
1	J4	Header, 2.54 mm, PCB, 1 $\times$ 8-way	FEC 1766172 inserted from solder side
2	LK1, LK2	Jumper blocks using 3-pin SIP header	FEC 1022248 and FEC 150410
2	R1, R2	Do not insert	Do not insert
4	R3, R4, R7, R8	Do not insert	Do not insert
3	R5, R6, R9	Resistors, 0603, 1%, 0 $\Omega$	FEC 9331662
1	U1	10-bit DAC	<a href="#">AD5313RBRUZ</a>
1	VOUT_A	Red test point	FEC 8731144 (pack)
1	VOUT_B	Red test point	FEC 8731144 (pack)

<sup>1</sup>FEC refers to Farnell Electronic Component Distributors.

## NOTES

I<sup>2</sup>C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).



### 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. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. 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, GUARANTEES, 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 NON-INFRINGEMENT 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 LOST 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.