# EVAL-AD5328DBZ User Guide
## UG-978

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# Evaluation Board for the AD5328 12-Bit, Octal Channel, Voltage Output DAC

## FEATURES

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

## PACKAGE CONTENTS

- EVAL-AD5328DBZ evaluation board
- EVAL-MBnanoDAC-SDZ motherboard

## SOFTWARE REQUIRED

- EVAL-AD5328DBZ evaluation software

## HARDWARE REQUIRED

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

## DOCUMENTS REQUIRED

- Electronic version of the AD5328 data sheet
- Electronic version of the EVAL-AD5328DBZ user guide

## GENERAL DESCRIPTION

This user guide details the operation of the evaluation board for the AD5328 octal-channel, voltage output, digital-to-analog converter (DAC).

The evaluation board is designed to help users quickly prototype new AD5328 circuits and reduce design time. The AD5328 operates from a single 2.5 V to 5.5 V supply.

For full details, see the AD5328 data sheet, which must be used in conjunction with this user guide when using the EVAL-AD5328DBZ evaluation board.

The evaluation board interfaces to the USB port of a PC via the SDP-B board. Software is available for download from the EVAL-AD5328DBZ evaluation board page to allow the user to program the AD5328.

This evaluation board requires the EVAL-SDP-CB1Z board (SDP-B controller board), which is available for order on the Analog Devices website.

## EVAL-AD5328DBZ, EVAL-MBnanoDAC-SDZ, AND SDP-B BOARDS

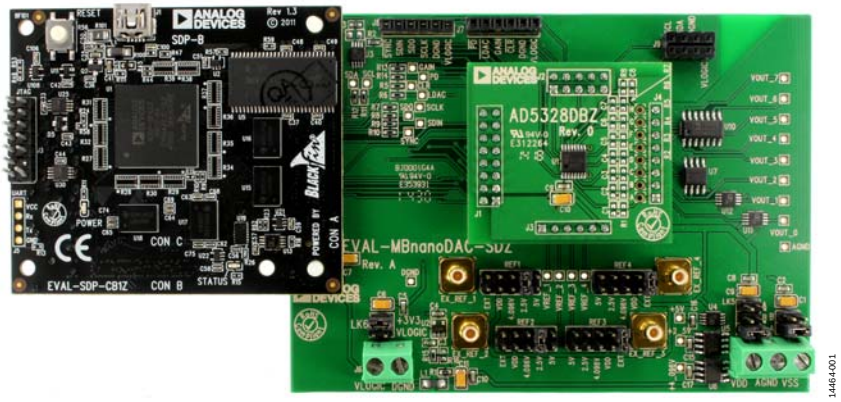


*Figure 1.*

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## REVISION HISTORY

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

# EVALUATION BOARD HARDWARE

## MOTHERBOARD POWER SUPPLIES

The EVAL-MBnanoDAC-SDZ motherboard supports single and dual power supplies.

The EVAL-AD5328DBZ 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 board. The AGND and DGND planes are connected at one location on the EVAL-MBnanoDAC-SDZ. It is recommended that AGND and DGND not be connected elsewhere in the system to avoid ground loop problems.

All supplies are decoupled to ground with 10 µF tantalum and 0.1 µF ceramic capacitors.

**Table 1. Power Supply Connectors**

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

## 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 evaluation board. Table 2 describes the positions of the links to control the evaluation board via the SDP-B 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 9).

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

| Link Number | Position |
|---|---|
| REF1 | 2.5V |
| REF2 | 2.5V |
| REF3 | EXT |
| REF4 | EXT |
| LK5 | C |
| LK6 | 3.3V |
| LK7 | B |

**Table 3. Link Functions**

| Link No. | Function |
|---|---|
| REF1 to REF4 | These links select the reference source.<br>Position EXT selects an off-board voltage reference via the appropriate EXT_REF_x connector.<br>Position VDD selects $V_{DD}$ as the reference source.<br>Position 4.096V selects the on-board 4.096 V reference as the reference source.<br>Position 2.5V selects the on-board 2.5 V reference as the reference source.<br>Position 5V selects the on-board 5 V reference as the reference source. |
| LK5 | This link selects the positive DAC analog voltage source.<br>Position A selects the internal voltage source from the SDP-B board.<br>Position B selects the internal voltage source 3.3 V from the ADP121 on the motherboard.<br>Position C selects an external supply voltage, $V_{DD}$. |
| LK6 | This link selects the VLOGIC voltage source.<br>Position 3.3V selects the digital voltage source from the SDP-B board, 3.3 V.<br>Position VLOGIC selects an external digital supply voltage, $V_{LOGIC}$. |
| LK7 | This link selects the negative DAC analog voltage source.<br>Position A selects $V_{SS}$.<br>Position B selects AGND. |

# EVALUATION BOARD SOFTWARE QUICK START PROCEDURES

## INSTALLING THE SOFTWARE

The EVAL-AD5328DBZ evaluation software is compatible with Windows® Vista (64-bit/32-bit), and Windows 7 (64-bit/32-bit).

The software must be installed before connecting the SDP-B board to the USB port of the PC to ensure that the SDP-B board is recognized when it connects to the PC.

To install the software, take the following steps:

1. Start the Windows operating system. Download the installation software from the EVAL-AD5328DBZ evaluation board page.
2. Run the setup.exe file from the installer folder if it does not open automatically.
3. After installation is completed, power up the evaluation board as described in the Motherboard Power Supplies section.
4. Connect the evaluation board to the SDP-B board and the SDP-B board to the PC using the USB cable included in the evaluation kit.
5. When the software detects the evaluation board, proceed through any dialog boxes that appear to finalize the installation.

## RUNNING THE SOFTWARE

To run the program, do the following:

1. Connect the evaluation board to the SDP-B board and connect the USB cable between the SDP-B board and the PC.
2. Power up the evaluation board as described in the Motherboard Power Supplies section.
3. From the **Start** menu, click **All Programs**, **Analog Devices**, **AD5328 Evaluation Software**.
4. If the SDP-B board is not connected to the USB port when the software is launched, a connectivity error displays (see Figure 2). Connect the evaluation board to the USB port of the PC and wait a few seconds. When the SDP-B board is detected, the display is updated (see Figure 3).

Alternatively, the software can be used without an evaluation board. The software runs in simulation mode displaying expected outputs based on the input data. The main window of the AD5328 evaluation software then opens, as shown in Figure 4.

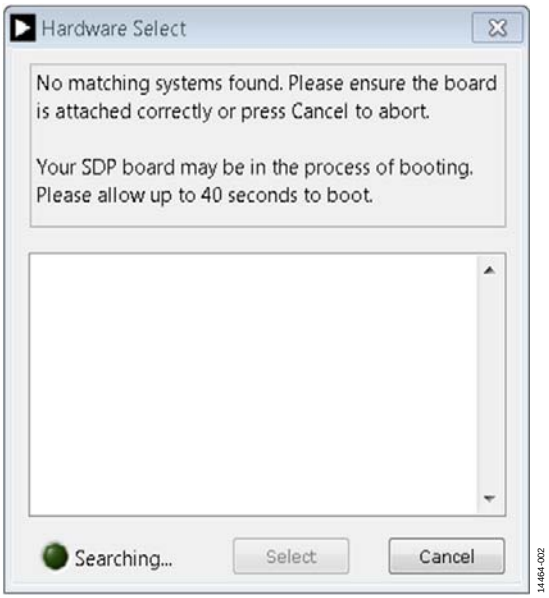


*Figure 2. Connectivity Error*

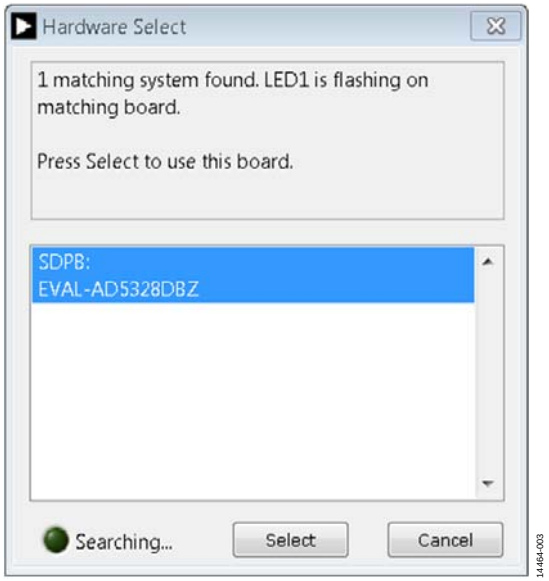


*Figure 3.* ***Hardware Select***

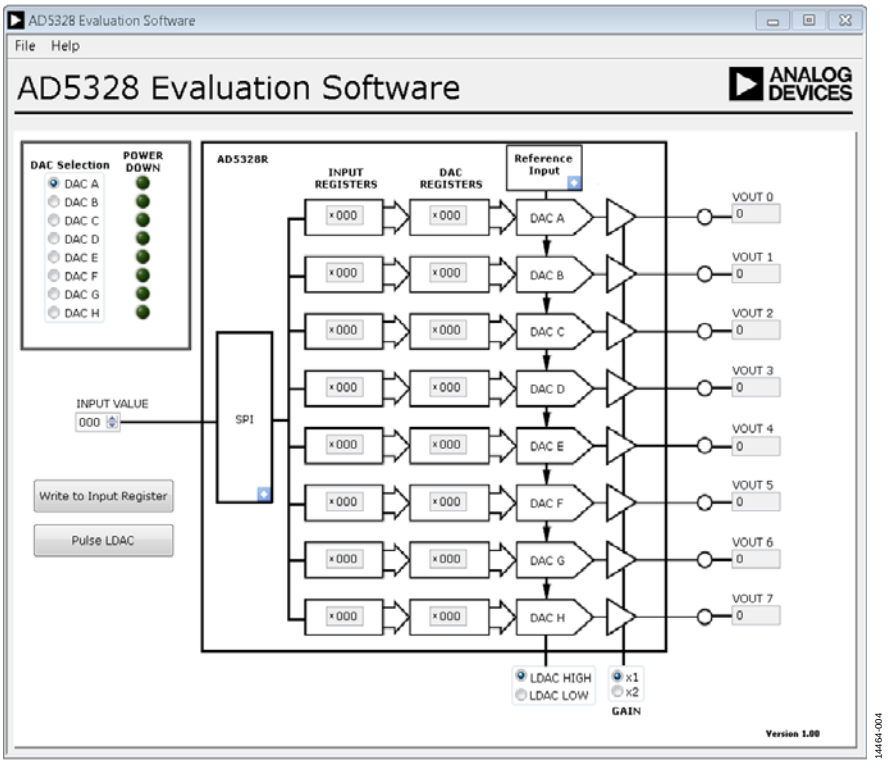


*Figure 4.* ***AD5328 Evaluation Software*** *Main Window*

## SOFTWARE OPERATION

The software for the AD5328 allows the user to program values to the input and DAC registers of each DAC individually.

### *Write to Input Register*

Click **Write to Input Register** to load the code of the input data control to the input register of the selected DAC in the **DAC Selection** box.

### *LDAC Control*

Click **Pulse LDAC** to bring the LDAC pin low and then back high. Doing this copies the data from the input registers to the DAC registers, and the outputs update accordingly.

The LDAC pin can also be set high or low by clicking the **LDAC HIGH** or **LDAC LOW** option.

### *Power-Down Control*

Each of the DACs can be powered down individually. Click the blue progressive disclosure option on the **SPI** block to access the power-down configuration window. In the window, the user can select a DAC or multiple DACs to power down or operate in normal mode. When the power-down settings for the DACs are selected, click **OK** to write the appropriate values to the AD5328. The **POWER DOWN** indicator LED lights up accordingly when a DAC is powered down.

### *GAIN Control*

The **GAIN** of all the DACs can be set simultaneously by clicking on the appropriate radio option. Select **x1** in the **GAIN** box for a full-scale output of 2.5 V or select **x2** in the **GAIN** box for a full-scale output of 5 V.

### *Buffer Control*

All of the reference buffers of the DACs can be set simultaneously. Click the blue progressive disclosure option on the **Reference Input** block and click the appropriate radio option to enable or disable the reference buffers.

### *Reference Control*

The $V_{DD}$ of the DAC can be used as a reference voltage. Click the blue progressive option on the **Reference Input** block and click the appropriate radio option to select the reference voltage to be used.

When $V_{DD}$ is used as the reference, it is always unbuffered and has an output range of 0 V to $V_{REF}$ regardless of the selected **GAIN** and **Buffer** settings.

# EVALUATION BOARD SCHEMATICS AND ARTWORK

## EVAL-MBnanoDAC-SDZ MOTHERBOARD

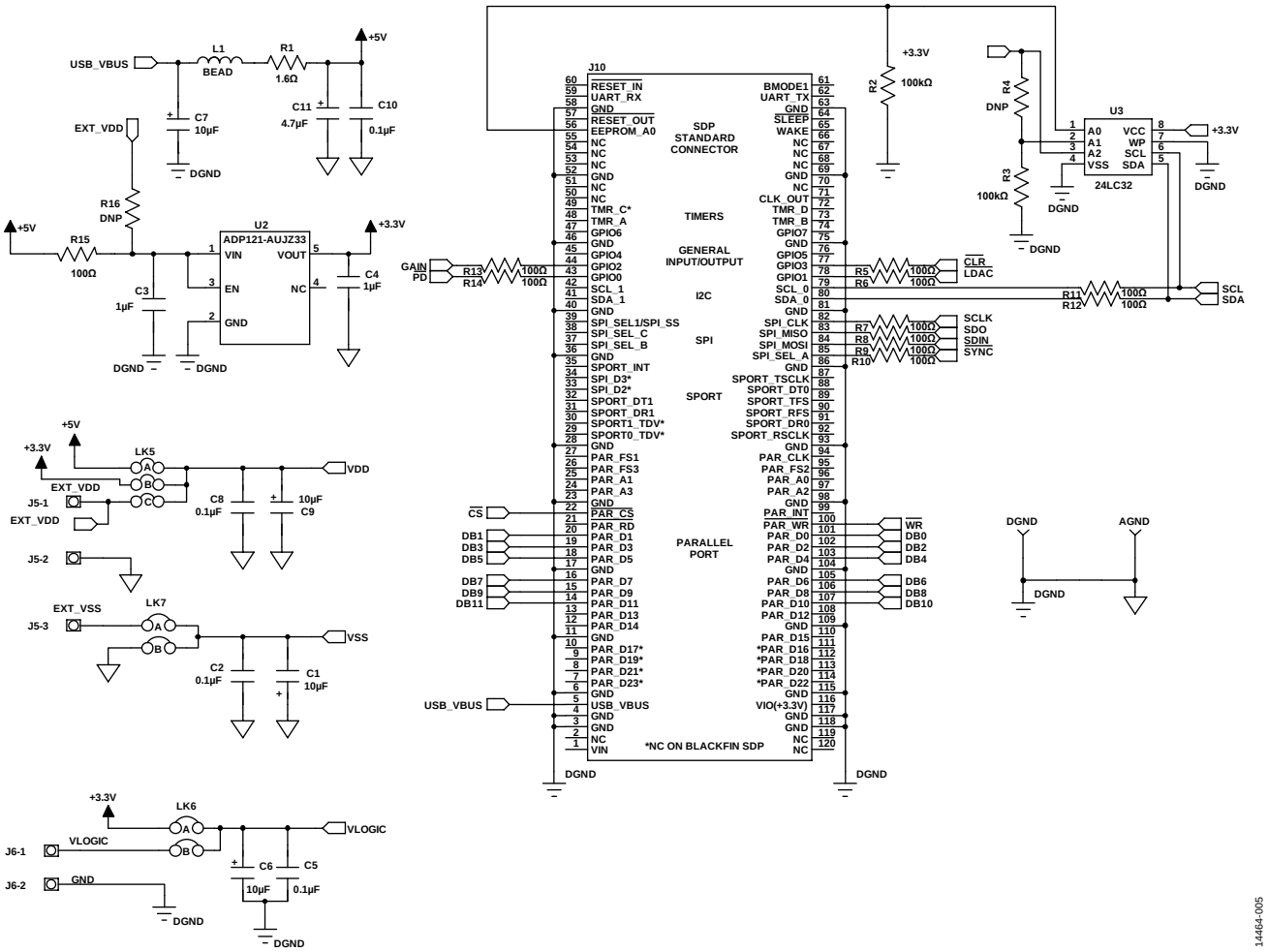


*Figure 5. EVAL-MBnanoDAC-SDZ Motherboard SDP-B Connector and Power Supply*

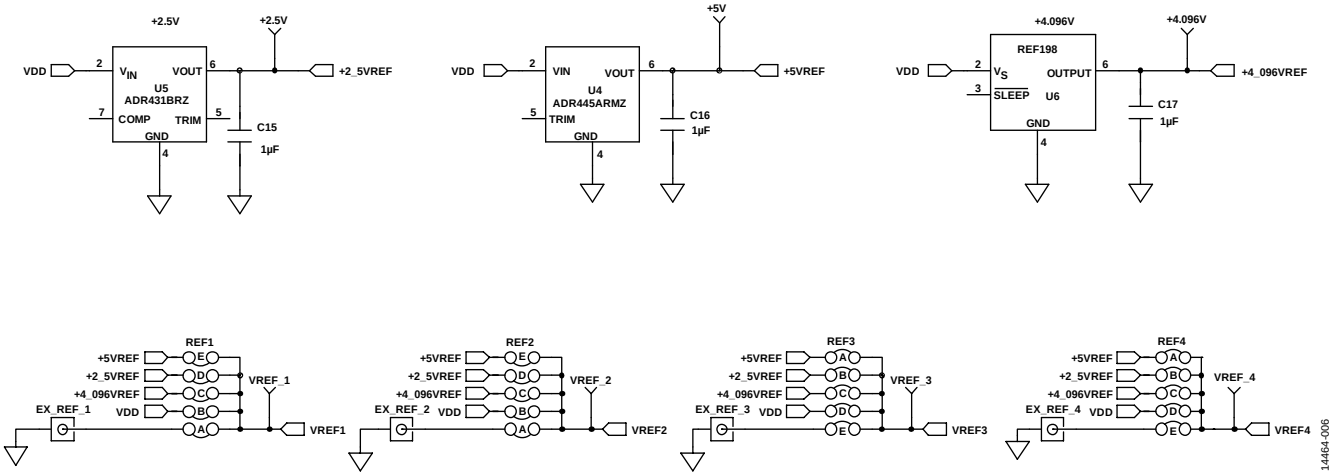


*Figure 6. EVAL-MBnanoDAC-SDZ Motherboard Reference Voltage Selector Circuit*

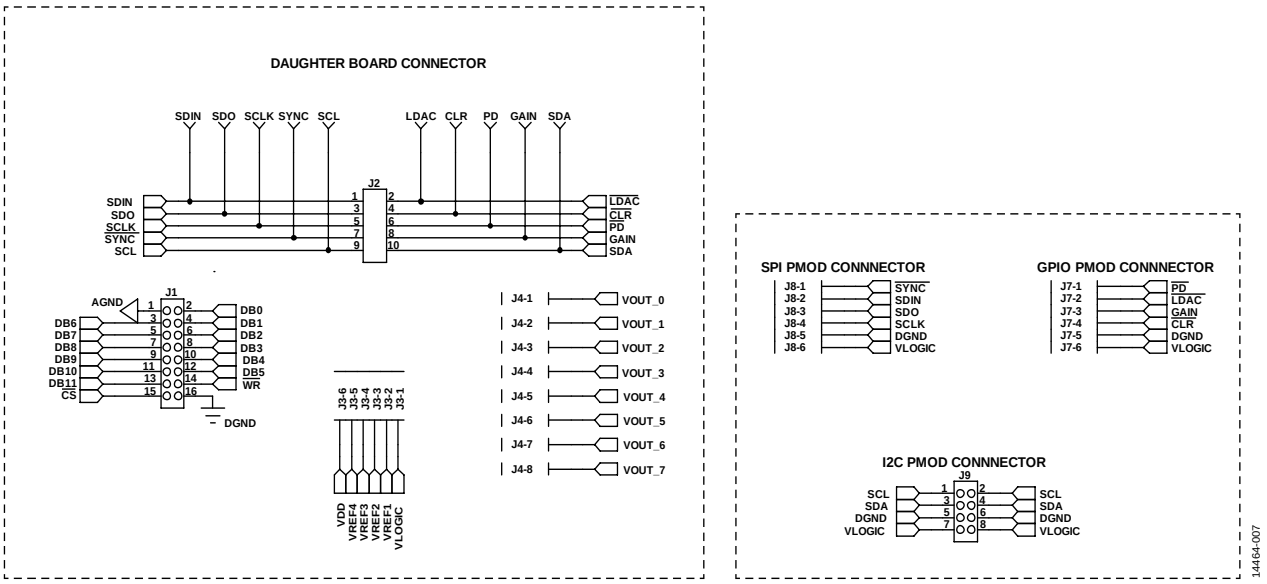


*Figure 7. EVAL-MBnanoDAC-SDZ Motherboard Connectors to Daughter Board and Serial Interface*

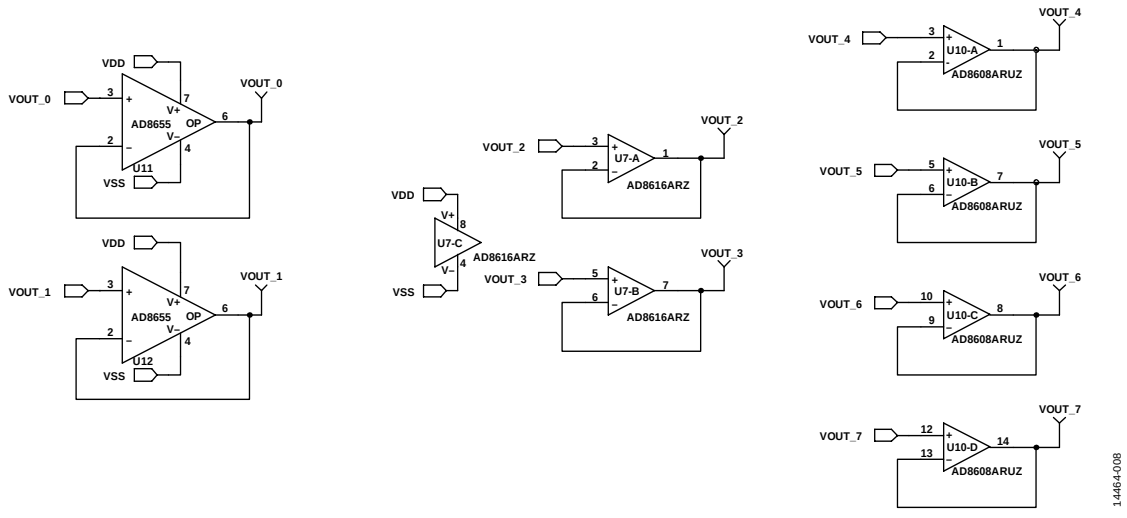


*Figure 8. EVAL-MBnanoDAC-SDZ Motherboard Output Amplifier Circuit*

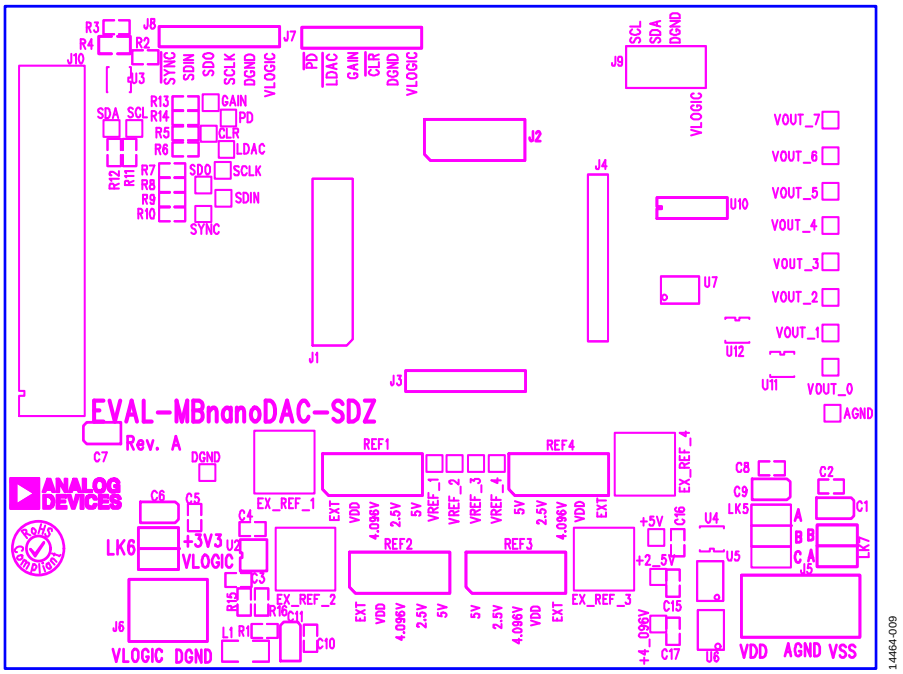


*Figure 9. EVAL-MBnanoDAC-SDZ Motherboard Component Placement*

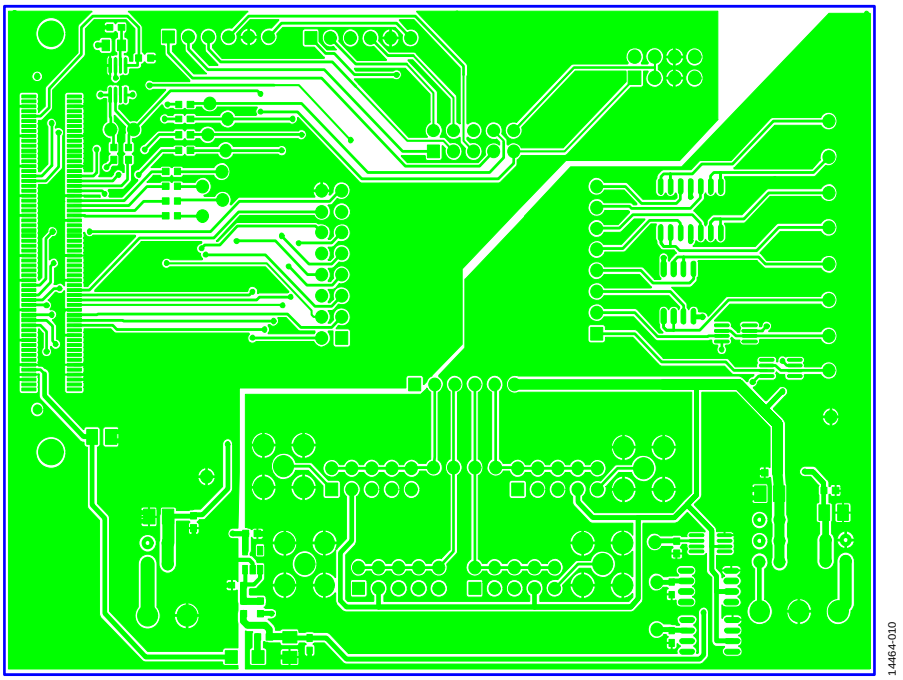


*Figure 10. EVAL-MBnanoDAC-SDZ Motherboard Top Side Routing*

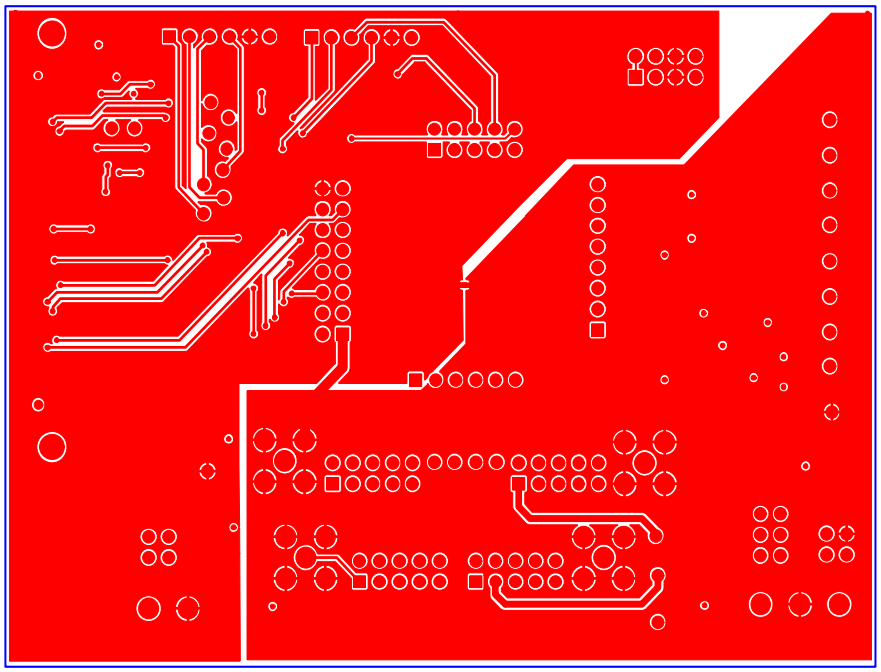


*Figure 11. EVAL-MBnanoDAC-SDZ Motherboard Bottom Side Routing*

## EVAL-AD5328DBZ DAUGHTER BOARD

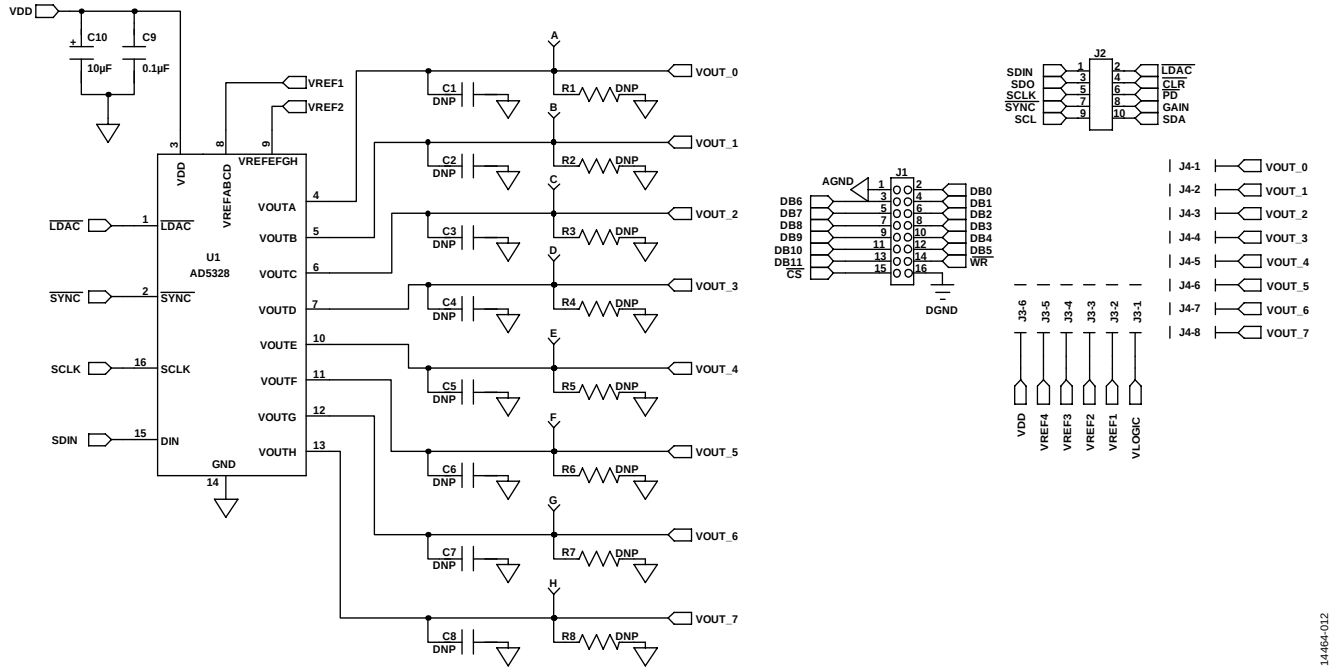


*Figure 12. EVAL-AD5328DBZ Daughter Board Schematics*

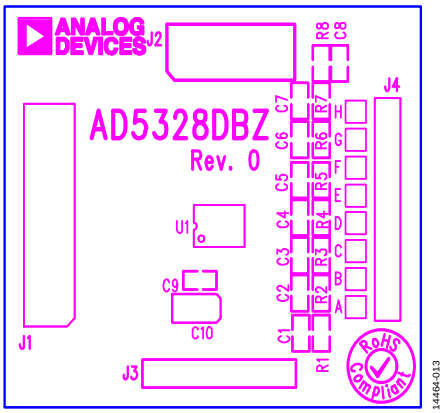


*Figure 13. EVAL-AD5328DBZ Daughter Board Component Placement*

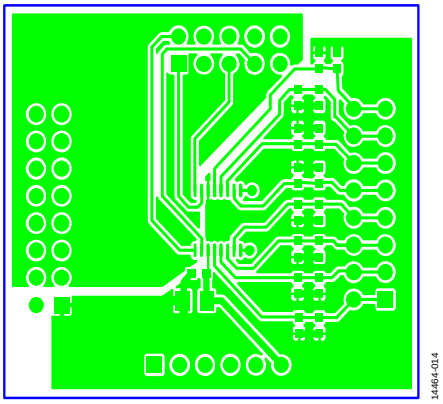


*Figure 14. EVAL-AD5328DBZ Daughter Board Top Side Routing*

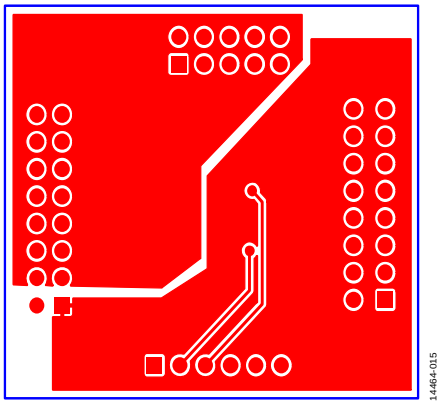


*Figure 15. EVAL-AD5328DBZ Daughter Board Bottom Side Routing*

# ORDERING INFORMATION

## BILL OF MATERIALS

**Table 4. EVAL-MBnanoDAC-SDZ Motherboard**

| Qty | Reference Designator | Description | Supplier/Part Number[1, 2] |
|---|---|---|---|
| 4 | C1, C6, C7, C9 | 6.3 V, tantalum capacitor (Case A), 10 µF, ±20% | FEC/1190107 |
| 7 | C2, C5, C8, C10, C15, C16, C17 | 50 V, X7R ceramic capacitor, 0.1 µF, ±10% | FEC/1759122 |
| 2 | C3, C4 | 10 V, X5R ceramic capacitor, 1 µF, ±10% | GRM188R61A105KA61D |
| 1 | C11 | 6.3 V, tantalum capacitor (Case A), 4.7 µF, ±20% | FEC/1432350 |
| 4 | EXT_REF_1 to EXT_REF_4 | Straight printed circuit board (PCB) mount SMB jack, 50 Ω | FEC/1206013 |
| 1 | J1 | Header, 2.54 mm, 2 × 8-way | FEC/2308428 |
| 1 | J2 | Header, 2.54 mm, 2 × 5-way | FEC/9689583 |
| 3 | J3, J7, J8 | Header, 2.54 mm, 1 × 6-way | FEC/9689508 |
| 1 | J4 | Header, 2.54 mm, 1 × 8-way | FEC/1766172 |
| 1 | J5 | 3-pin terminal block | FEC/1667472 |
| 1 | J6 | 2-pin terminal block | FEC/151789 |
| 1 | J9 | Header, 2.54 mm, 2 × 4-way | FEC/1667509 |
| 1 | J10 | 120-way connector | FEC/1324660 |
| 1 | L1 | Inductor, SMD, 600 Ω | FEC/9526862 |
| 1 | LK5 | 6-pin (3 × 2) 0.1", header and shorting block | FEC/148-535 and 150-411 (36-pin strip) |
| 2 | LK6, LK7 | 4-pin (2 × 2) 0.1", header and shorting block | FEC/148-535 and 150-411 (36-pin strip) |
| 4 | REF1 to REF4 | 10-pin (5 × 2) 0.1", header and shorting block | FEC/1022227 and 150-411 |
| 1 | R1 | Resistor, surge, 1.6 Ω, 1%, 0603 | FEC/1627674 |
| 2 | R2, R3 | SMD resistor, 100 kΩ, 1%, 0603 | FEC/9330402 |
| 11 | R5 to R15 | SMD resistor, 100 Ω, 1%, 0603 | FEC/9330364 |
| 1 | U2 | 3.3 V linear regulator | Analog Devices, Inc./ADP121-AUJZ33R7 |
| 1 | U3 | 32 kb $I^2C$ serial EEPROM | FEC/1331330 |
| 1 | U4 | 5 V, reference MSOP | Analog Devices/ADR445ARMZ |
| 1 | U5 | Ultralow noise XFET voltage reference | Analog Devices/ADR431BRZ |
| 1 | U6 | 4.096 V reference | Analog Devices/REF198ESZ |
| 1 | U7 | Dual op amp | Analog Devices/AD8616ARZ |
| 1 | U10 | Quad op amp | Analog Devices/AD8608ARMZ |
| 2 | U11, U12 | Op amp | Analog Devices/AD8655ARMZ |

[1] FEC refers to Farnell Electronic Component Distributors.
[2] GRM refers to Murata Manufacturing Company.

**Table 5. EVAL-AD5328DBZ Daughter Board**

| Qty | Reference Designator | Description | Supplier/Part Number[1] |
|---|---|---|---|
| 8 | A to H | Red test point | Do not insert |
| 8 | C1 to C8 | Not applicable | Not inserted |
| 1 | C9 | 50 V, X7R ceramic capacitor | FEC/1759122 |
| 1 | C10 | 6.3 V, tantalum capacitor (Case A) | FEC/1190107 |
| 1 | J1 | 16-pin (2 × 8) header | FEC/2308428 inserted from solder side |
| 1 | J2 | 10-pin (2 × 5) straight header, 2.54 mm pitch | FEC/9689583 inserted from solder side |
| 1 | J3 | 6-pin (1 × 6) straight header, 2.54 mm pitch | FEC/9689508 inserted from solder side |
| 1 | J4 | Header, 2.54 mm, PCB, 1 × 8-way | FEC/1766172 inserted from solder side |
| 8 | R1 to R8 | Not applicable | Not inserted |
| 1 | U1 | Octal 12-bit DAC | Analog Devices/AD5328BRUZ |

[1] FEC refers to Farnell Electronic Component Distributors.

# NOTES

I²C 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.

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