Evaluating the AD5675R (I^2C) or the AD5676R (SPI) Octal, 16-Bit nanoDAC+ with 2 ppm/°C Reference

FEATURES

- Full featured evaluation board for the AD5675R (I^2C) and AD5676R (SPI)
- Various link options
- PC control in conjunction with the Analog Devices, Inc., EVAL-SDP-CK1Z (SDP-K1) controller board

EVALUATION KIT CONTENTS

- EVAL-AD5675RARDZ (I^2C) or EVAL-AD5676R2ARDZ (SPI) evaluation board
- AD5675R (I^2C) or AD5676R (SPI) device

HARDWARE REQUIRED

- EVAL-SDP-CK1Z (SDP-K1) controller board, which must be purchased separately

SOFTWARE REQUIRED

- Analysis | Control | Evaluation (ACE) Software, which is available for download from the EVAL-AD5675RARDZ (I^2C) or EVAL-AD5676R2ARDZ (SPI) product page

TYPICAL EVALUATION BOARD SETUP

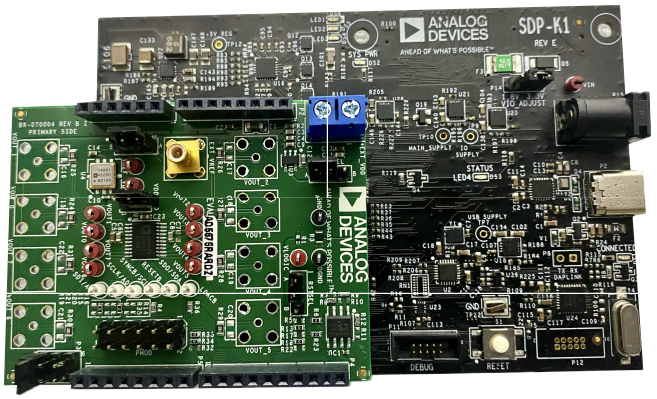

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Figure 1. Evaluation Board Connected to the SDP-K1 Controller Board (EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ)

GENERAL DESCRIPTION

This user guide details the operation of the EVAL-AD5675RARDZ (I^2C) evaluation board and the EVAL-AD5676R2ARDZ (serial peripheral interface (SPI)) evaluation board for the AD5675R (TSSOP, I^2C) and AD5676R (TSSOP, SPI), respectively, which are both octal channel, voltage output digital-to-analog converters (DACs).

The EVAL-AD5675RARDZ and the EVAL-AD5676R2ARDZ evaluation boards are designed to facilitate quick prototyping of the AD5675R or AD5676R circuits, thereby reducing design time. Both devices operate from a single 2.7 V to 5.5 V supply. Additionally, these devices both have an internal 2.5 V reference. A different reference voltage (V_{REF}) can be applied via the EXT_REF SMB connector, if required. While sharing common features, the two DACs differ in their digital interface protocols. The AD5676R employs SPI, while the AD5675R employs I^2C.

The EVAL-AD5675RARDZ and the EVAL-AD5676R2ARDZ evaluation boards interface to the USB port of a PC via a System Demonstration Platform (SDP) controller board (EVAL-SDP-CK1Z (SDP-K1)). The Analysis | Control | Evaluation (ACE) software is available for download from both the EVAL-AD5675RARDZ product page and the EVAL-AD5676R2ARDZ product page. This software can be used with the evaluation board to allow the user to program the AD5675R and AD5676R, respectively. A PMOD connection is also available to allow the connection of microcontrollers to either evaluation board. Note that when a microcontroller is used through the PMOD connection, the EVAL-SDP-CK1Z (SDP-K1) must be disconnected, and the user cannot use the ACE software.

The EVAL-AD5675RARDZ and the EVAL-AD5676R2ARDZ both require the EVAL-SDP-CK1Z (SDP-K1) controller board, which are available for purchase from Analog Devices.

For full details on the AD5675R and the AD5676R, see the AD5675R and AD5676R data sheets, which must be consulted in conjunction with this user guide when using the EVAL-AD5675RARDZ or the EVAL-AD5676R2ARDZ evaluation boards.

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REVISION HISTORY

1/2024—Revision 0: Initial Version

GETTING STARTED

INSTALLING THE SOFTWARE

The EVAL-AD5675RARDZ (I^2C) or EVAL-AD5676R2ARDZ (SPI) evaluation boards use the Analog Devices the **Analysis | Control | Evaluation (ACE)** software, a desktop software application that allows the evaluation and control of multiple evaluation systems.

The ACE software is available for download from the EVAL-AD5675RARDZ evaluation board page or EVAL-AD5676R2ARDZ evaluation board page and must be installed before connecting the EVAL-SDP-CK1Z (SDP-K1) controller board to the USB port of the PC to ensure that the EVAL-SDP-CK1Z (SDP-K1) is recognized when it connects to the PC. The ACE installer installs the necessary SDP drivers and the Microsoft® .NET Framework 4 by default. For full instructions on how to install and use this software, see the ACE software page on the Analog Devices website.

After the ACE software installation completes and the software is opened, the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ evaluation board plugin appears.

INITIAL SETUP

To set up the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ evaluation board, take the following steps:

1. Connect the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ to the EVAL-SDP-CK1Z (SDP-K1) controller board and then connect a USB cable between the SDP-K1 and the PC.
2. Run the ACE software, and the main window appears as shown in Figure 2. The EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ board plugins appear in the **Attached Hardware** section of the **Start** tab.
3. Double-click the board plugin to open the board view shown in Figure 3.
4. Double-click the **AD5675R** or **AD5676R** chip to access the chip view as shown in Figure 4. This view provides a basic representation of functionality of the board. See Figure 5 and Table 1 for the details on the main function blocks of the board.

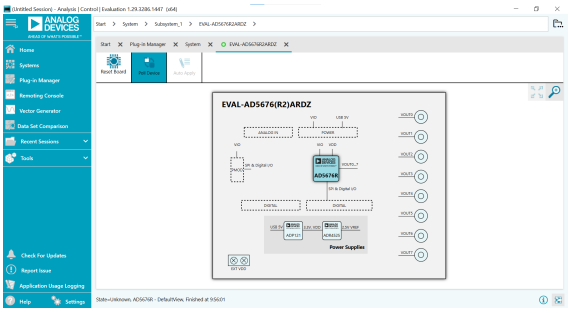

Figure 2. ACE Software Main Window

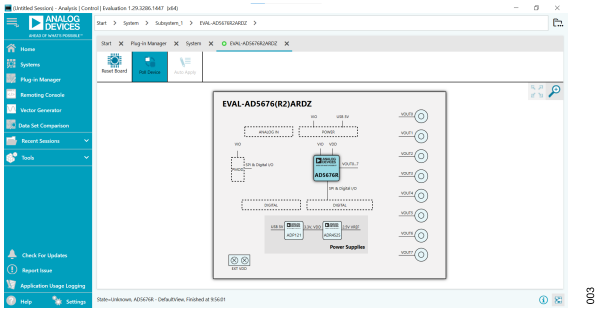

Figure 3. Board View of the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ

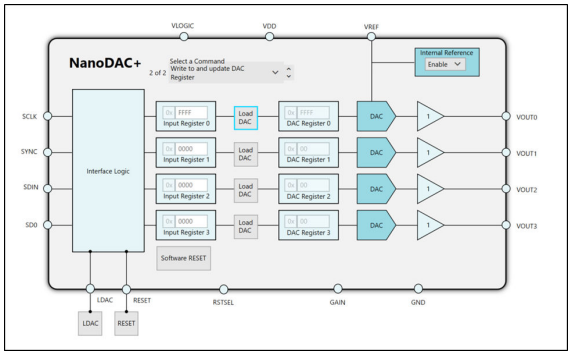

Figure 4. Chip Block Diagram View of the AD5675R or AD5676R

BLOCK DIAGRAM AND DESCRIPTION

The EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ software is organized so that it appears similar to the functional block diagram shown in the data sheets. In this way, it is easy to correlate the functions on the board with the descriptions in the data sheets. A full description of each block, register, and its settings is given in the AD5675R or AD5676R data sheets.

Some of the blocks and their functions are described in this section as they pertain to the EVAL-AD5675RARDZ and EVAL-AD5676R2ARDZ. The block diagram is shown in Figure 5, and Table 1 describes the functionality of each block.

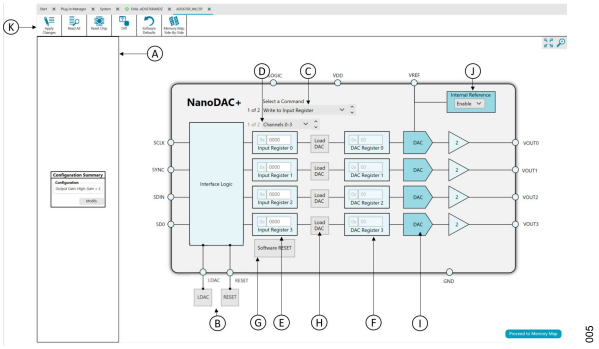

Figure 5. Block Diagram with Labels

Table 1. Block Diagram Functions

Label	Button/Function Name	Function
A	**Configuration Summary**	This function is used to set up the initial configuration for the evaluation board. Select the reference gain from the **Configuration** dropdown menu. A gain of 1 is the default. For a gain of 2, an external supply is needed (V_{DD} = V_{REF} + 1.5 V). After setting up the initial configuration, click **Apply Changes** (K) to apply the values. These settings can be modified at any stage while evaluating the board.
B	LDAC and RESET (GPIO buttons)	The **LDAC** and **RESET** buttons act as external GPIO pulses to the $\overline{\text{LDAC}}$ and $\overline{\text{RESET}}$ pins. The **LDAC** button transfers data from the input registers (E) to the DAC registers (F). The **RESET** button clears all data from the input registers and DAC registers. These buttons are live; therefore, there is no need to click **Apply Changes** (K).
C	**Select a Command**	The **Select a Command** dropdown menu controls how the data transfer to the device affects the input and DAC registers. When a data value is entered in an input register (E), this menu determines if the data is transferred to the input register only, or to the channel input register (E) and channel DAC register (F).
D	Channel page selection	Use the change page display dropdown menu to select which page of the four DAC channel settings displays.
E	Input register	The function is used to select the 16-bit data-word to transfer to the device. Then, click **Apply Changes** (K) to transfer the 16-bit data-word to the device.
F	DAC register	This box displays the value that is currently present in the DAC register on the device. Select the appropriate command option or toggle **LDAC** (B) to update the DAC register.
G	**Software RESET**	Click **Software RESET to** return the evaluation board and software to their default values. This button is live; therefore, there is no need to click **Apply Changes** (K).
H	**Load DAC**	Click **Load LDAC** to individually control which channel loads the values from the input register to the DAC register.
I	**DAC**	The DAC configuration options provide access to individual channel configuration options, such as power-down options and hardware $\overline{\text{LDAC}}$ mask enable and disable settings.
J	**Internal Reference**	In the Internal Reference area, select Enable from the dropdown menu to enable the on-chip reference for the evaluation board. If **Disable** is selected, an external reference must be applied.
K	**Apply Changes**	Click **Apply Changes** to update the device with all the modified values. However, if there is no evaluation board connected, the input register value is not transferred to the DAC register.

BLOCK DIAGRAM AND DESCRIPTION

MEMORY MAP

All registers are fully accessible from the memory map tab. The memory map allows registers to be edited at a bit level. The bits shaded in dark gray are read only bits and cannot be accessed from ACE. All other bits are toggled. Click **Apply Changes** to transfer data to the device. All changes here correspond to the block diagram; for example, if the internal register bit is enabled, it shows as enabled on the block diagram. Any bits or registers that are in bold are modified values that have not been transferred to the evaluation board. After clicking **Apply Changes**, data is transferred to the evaluation board.

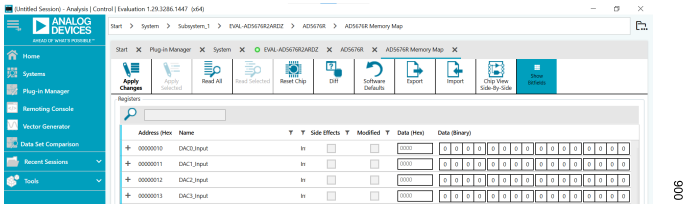

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Figure 6. AD5675R or AD5676R Memory Map

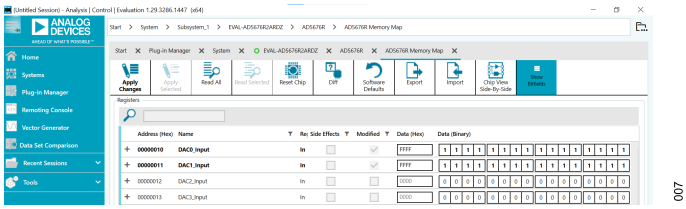

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Figure 7. AD5675R or AD5676R Memory Map with Pending Changes in DAC0_Input_Register

EVALUATION BOARD HARDWARE

Before applying power and signals to the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ, ensure that all link positions are as required by the operating mode. The two modes available for operating the evaluation board are SDP control mode, which must be used with the EVAL-SDP-CK1Z (SDP-K1), or standalone mode where an external supply must be provided.

POWER SUPPLIES

The EVAL-AD5675RARDZ and EVAL-AD5676R2ARDZ evaluation boards provide an on-board, 3.3 V regulator powered through the USB supply. If the evaluation board is controlled through a PMOD, or a gain of 2 is required, an external supply must be provided via the EXT_VDD connectors. See Table 2 and the power requirements specifications in the AD5675R or AD5676R data sheets for additional details.

Both the AGND and DGND inputs are provided on the board. The AGND and DGND planes are connected at one location close to the AD5675R or AD5676R. To avoid ground loop problems, it is recommended that AGND and DGND not be connected elsewhere in the system.

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

Table 2. Power Supply Connectors

Connector	Label	External Voltage Supplies Description
EXT_VDD, Pin 1	EXT_VDD	External analog power supply from 2.7 V to 5.5 V, V_{DD}.
EXT_VDD, Pin 2	AGND	Analog ground.
EXT_VREF, SMB Connector	EXT_VREF	External voltage reference.

EVALUATION BOARD HARDWARE

LINK OPTIONS

A number of link options are incorporated in the EVAL-AD5675RARDZ or EVAL-AD5676R2ARDZ evaluation board and must be set for the required operating conditions before using the board. The link function options are described in Table 4.

Table 3 lists the positions of the different links controlled by the PC via the USB port, and an SDP controller board operating in single-supply mode is required.

Table 3. Link Options Setup for SDP-K1 Control (Default)

Link	Option
VDD_SEL	Position A (1-2)
REF_SEL	Position A (1-2)
VDD_VIO	Disconnected
RSTSEL	Position A (1-2)
GAIN	Position 1-2

Table 4. Link Functions

Link	Description
VDD_SEL	This link selects the DAC analog voltage source. There are two options, as follows. Position A (1-2): This option selects the on-board voltage source (SDP-K1, ADP121). Position B (2-3): This option selects an external supply voltage (EXT_VDD connector).
REF_SEL	This link selects the DAC voltage reference source: Position A (1-2): This option selects an external reference source (EXT_VREF connector). If no external supply present, it defaults to the internal on-chip reference. Position B (2-3): This option selects the on-board reference from the ADR4525
VDD_VIO	This link selects the DAC digital voltage source. There are two options, as follows. Connected: shorts VDD and VLOGIC. Only use this option when the SDP-K1 controller board is not connected. Disconnected: opens the connection of VDD and VLOGIC. Use this option when using the SDP board.
RSTSEL	The RSTSEL (reset select) link selects the power-on reset state of the device. Position A (1-2): This option ties this pin to DAC_VLOGIC and powers up all DACs to midscale. Position B (2-3): This option ties this pin to DGND and powers up all DACs to zero scale.
GAIN	This link sets the internal gain setting of the device. Position 1-2: This link is the default option, and it selects the control (GAIN_IO) option, in which, the gain is controlled by the ACE software using the EVAL-SDP-CK1Z (SDP-K1). Position 3-4: This option ties the GAIN pin to DAC_VLOGIC and results in all DAC outputs having a 0 V to 2 × V_{REF} span. Position 5-6: This option ties the GAIN pin to DGND and results in all DAC outputs having a 0 V to V_{REF} span.

EVALUATION BOARD SCHEMATICS

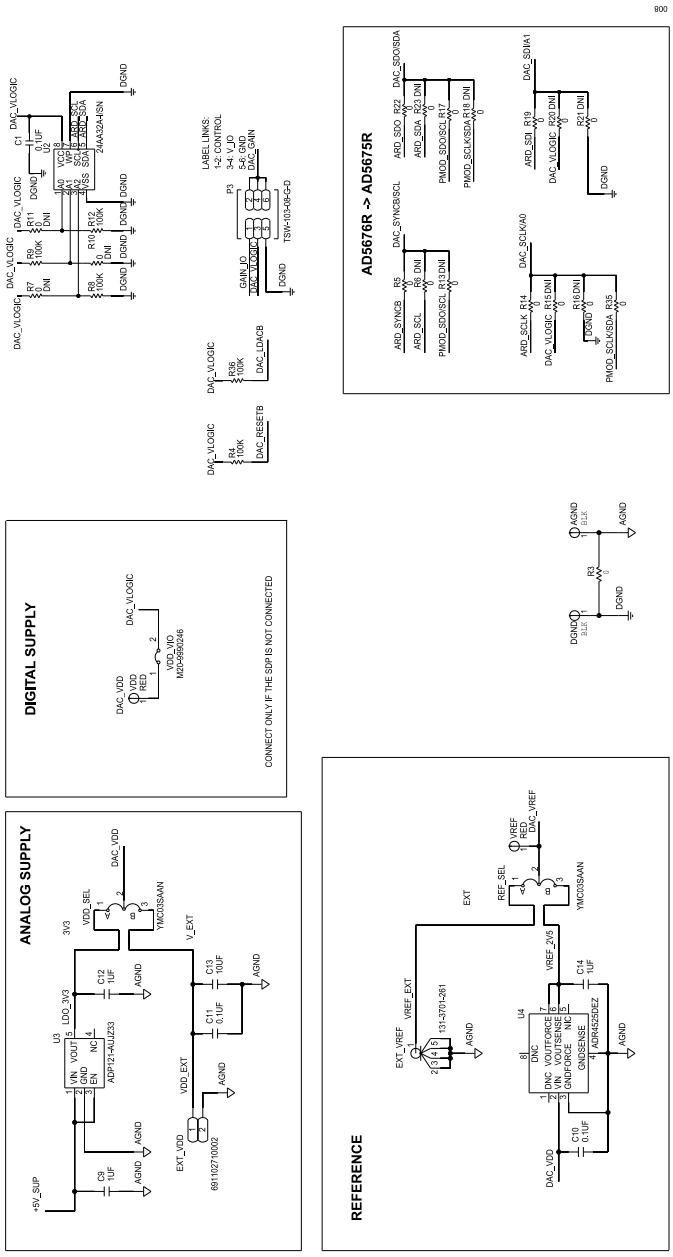

Figure 8. NanoDAC+ Evaluation Board Schematic Diagram, Power Supply and Signal Routes, Page 1

EVALUATION BOARD SCHEMATICS

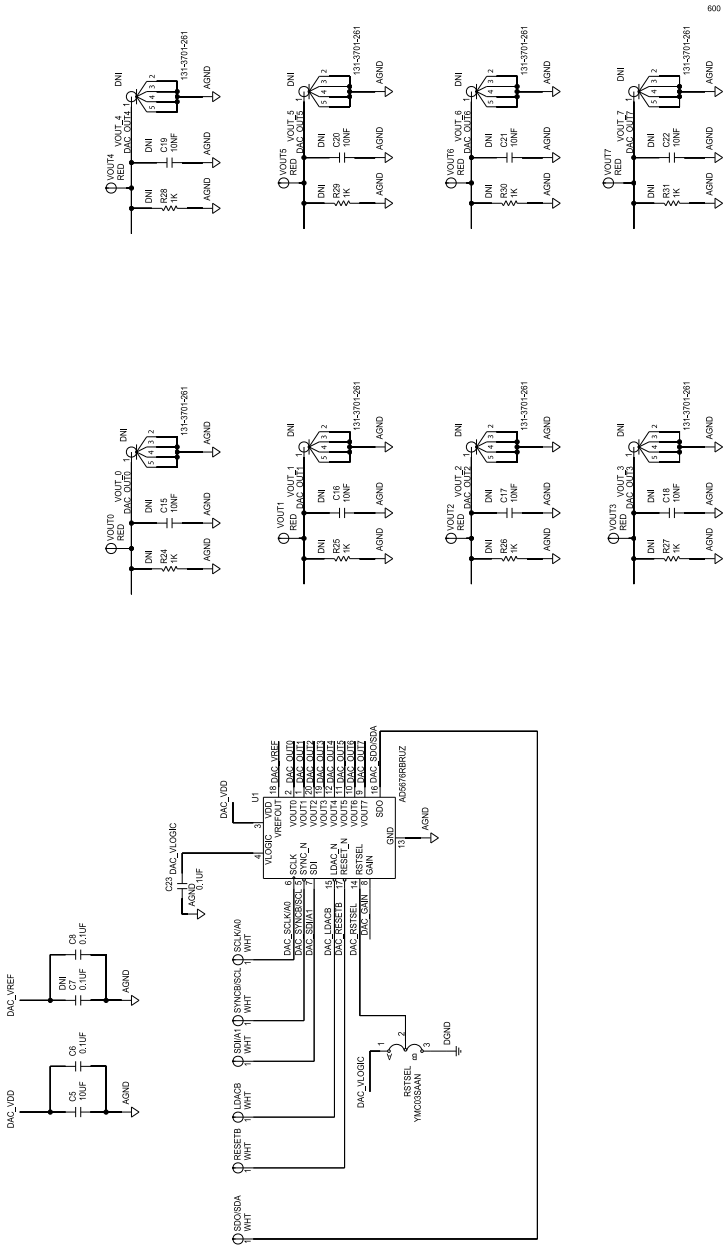

Figure 9. NanoDAC+ Evaluation Board Schematic Diagram, Power Supply and Signal Routes, Page 2

EVALUATION BOARD SCHEMATICS

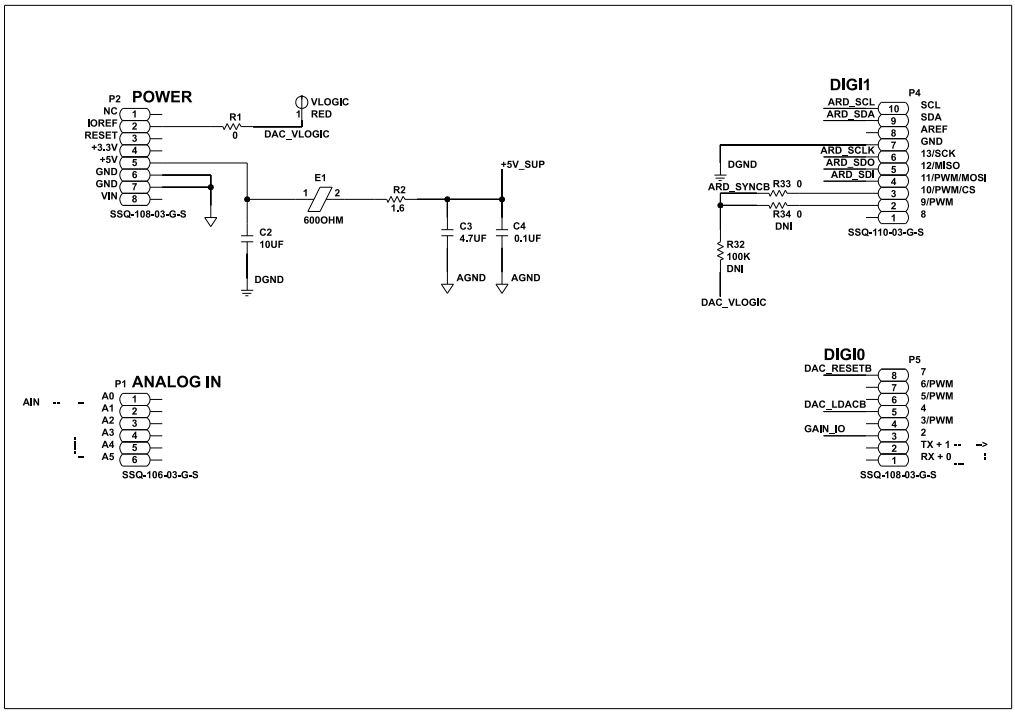

Figure 10. NanoDAC+ Evaluation Board Schematic Diagram, SDP Connector

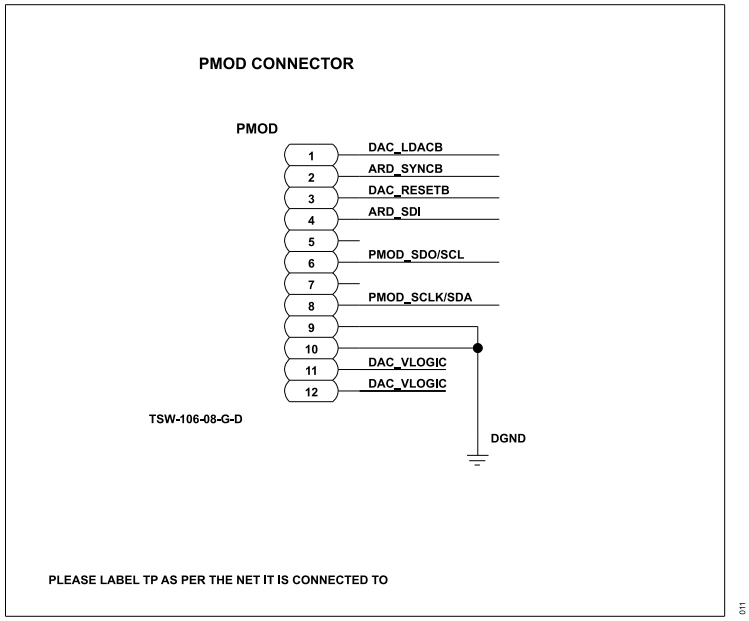

Figure 11. NanoDAC+ Evaluation Board Schematic Diagram, PMOD Connection

EVALUATION BOARD SCHEMATICS

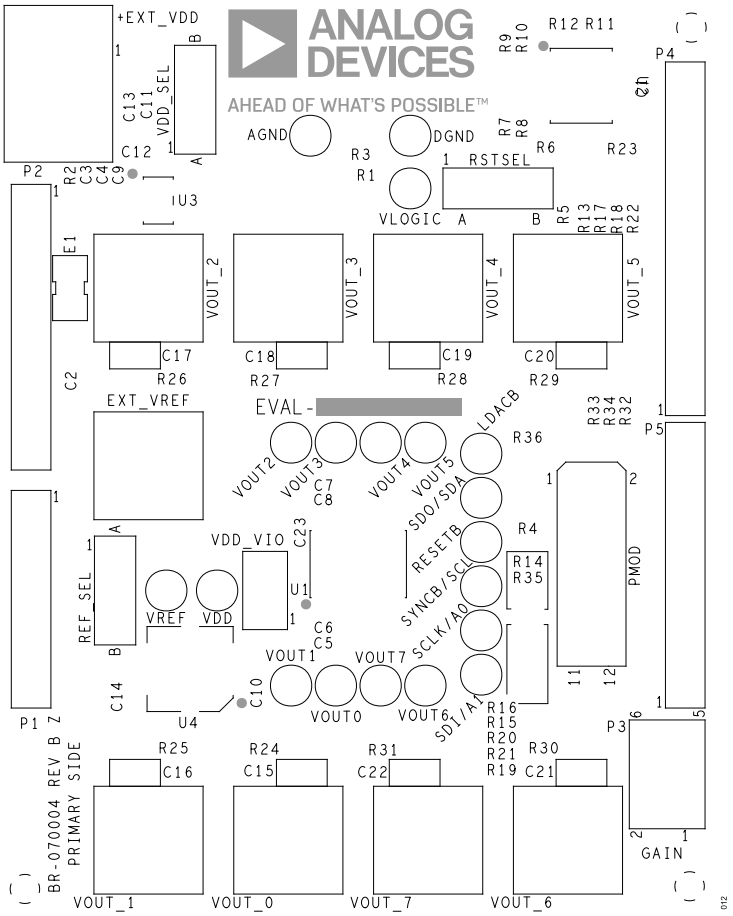

Figure 12. NanoDAC+ Evaluation Board, Component Placement

EVALUATION BOARD SCHEMATICS

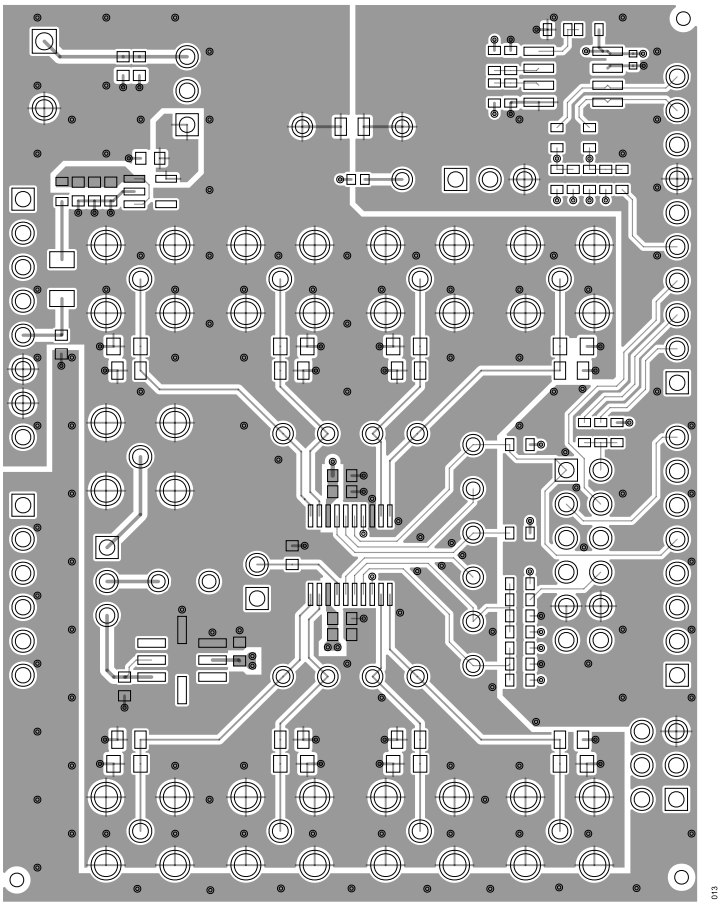

Figure 13. NanoDAC+ Evaluation Board, Top Side Routing

EVALUATION BOARD SCHEMATICS

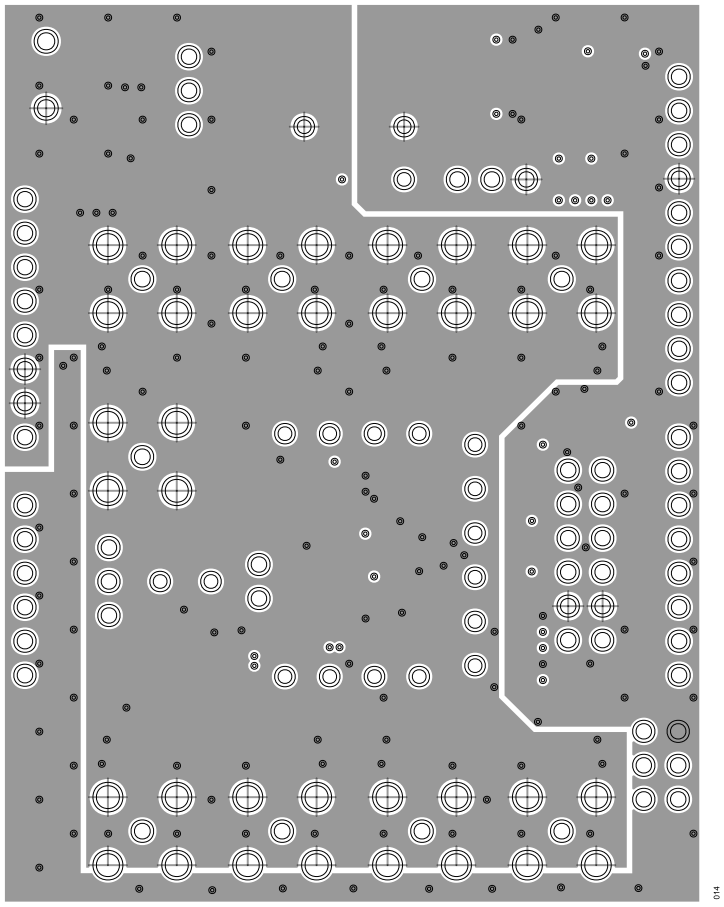

Figure 14. NanoDAC+ Evaluation Board, Bottom Side Routing

ORDERING INFORMATION

BILL OF MATERIALS

Table 5. Bill of Materials

Quantity	Reference Designator	Description	Supplier/Part Number[1]
1	U1	Octal, 16-bit nanoDAC+ with 2 ppm/°C reference	Analog Devices, AD5676RBRUZ or AD5675RBRUZ
1	U2	IC, 32 KBIT serial, electrically erasable programmable read-only memory (EEPROM)	Generic
1	U3	150 mA, low quiescent current, complementary metal-oxide semiconductor (CMOS) linear regulator in 5-lead TSOT or 4-ball WLCSP	Analog Devices, ADP121-AUJZ33
1	U4	Ultra-low noise, high-accuracy 2.5 V voltage reference	Analog Devices, ADR4525DEZ
2	AGND, DGND	Connector, printed circuit board (PCB), black test points	Generic
1	C1	0.1 µF ceramic capacitor, 16 V, 10%, X7R, 0402, AEC-Q200	Generic
2	C4, C10	0.1 µF ceramic capacitors, 50 V, 10%, X7R, 0603	Generic
4	C6, C8, C11, C23	0.1 µF ceramic capacitors, 16 V, 10%, X7R, 0603	Generic
3	C9, C12, C14	1 µF ceramic capacitors, 16 V, 10%, X7R, 0603	Generic
2	C5, C13	10 µF ceramic capacitors, 10 V, 20%, X5R, 0603	Generic
1	C2	10 µF ceramic capacitor, 6.3 V, 20%, X5R, 0603	Generic
1	C3	4.7 µF ceramic capacitor, 10 V, 20%, X5R, 0603	Generic
1	E1	Inductor, ferrite bead, 600 Ω, 25%, 100 MHz, 2.9 A, 0.038 Ω, 1206, AEC-Q200	Generic
1	EXT_VDD	Connector, PCB, 2-position terminal block side entry 5 mm pitch	Generic
1	EXT_VREF	Connector, PCB coax Subminiature Version B (SMB) jack RF vertical PC mount gold	Generic
6	LDACB, RESETB, SCLK/A0, SDI/A1, SDO/SDA, SYNCB/SCL	Connector, PCB white test points	Generic
1	P1	Connector, PCB receptacle 25 mil square post, 2.54 mm pitch	Generic
2	P2, P5	Connector, PCB receptacles 25 mil square post, 2.54 mm pitch	Generic
1	P3	Connector, PCB BERG header, double straight male, 6-position	Generic
1	P4	Connector, PCB receptacles 25 mil square post, 2.54 mm pitch	Generic
1	R1	0 Ω resistor, surface-mounted device (SMD), jumper, 1/16 W, 0402	Generic
3	R8, R9, R12	100 kΩ resistors, SMD, 1%, 1/16 W, 0603	Generic
8	R33	0 Ω resistors, SMD, jumper, 1/10 W, 0603	Generic
1	R2	1.6 Ω resistor, SMD, 1%, 1/5 W, 0603, AEC-Q200	Generic
1	R3	0 Ω resistor, SMD, jumper, ½ W, 0805, AEC-Q200, pulse proof	Generic
2	R4, R36	100 kΩ resistors, SMD, 1%, 1/10 W, 0603	Generic
3	REF_SEL, RSTSEL, VDD_SEL	Connector-PCB, high temperature, 3-position, male headers, unshrouded, single row straight, 2.54 mm pitch, 3.05 mm solder tail	Generic
11	VDD, VLOGIC, VOUT0, VOUT1, VOUT2, VOUT3, VOUT4, VOUT5, VOUT6, VOUT7, VREF	Connector-PCB red test points	Generic
1	VDD_VIO	Connector-PCB, header, 1 row, 2 way	Generic
6	R5, R14, R17, R19, R22, R35	0 Ω resistors, SMD, jumper, 1/10 W, 0603	Generic, install for EVAL-AD5676R2ARDZ
6	R6, R13, R16, R18, R21, R23	0 Ω resistors, SMD, jumper, 1/10 W, 0603	Generic, install for EVAL-AD5675RARDZ
8	R6, R13, R15, R16, R18, R20, R21, R23	0 Ω resistors, SMD, jumper, 1/10 W, 0603, do not insert (DNI) or do not populate (DNP) for EVAL-AD5676R2ARDZ	Not applicable
8	R5, R14, R15, R17, R19, R20, R22, R35	0 Ω resistors, SMD, jumper, 1/10 W, 0603, DNI or DNP for EVAL-AD5675RARDZ	Not applicable
1	R34	0 Ω resistor, SMD, jumper, 1/10 W, 0603, DNI or DNP for both boards	Not applicable

ORDERING INFORMATION

Table 5. Bill of Materials (Continued)

Quantity	Reference Designator	Description	Supplier/Part Number[1]
1	R32	100 kΩ resistor, SMD, 1%, 1/10 W, 0603, AEC-Q200, DNI or DNP for both boards	Not applicable
8	C15 C16, C17, C18, C19, C20, C21, C22	10 nF ceramic capacitors, 200 V, 10%, X7R, 0805, FLEXITERM®, DNI or DNP for both boards	Not applicable
1	C7	0.1 µF ceramic capacitor, 16 V, 10%, X7R, 0603, DNI or DNP for both boards	Not applicable
1	PMOD	Connector, PCB BERG header, straight male, 12-position, DNI or DNP for both boards	Not applicable
3	R7, R10, R11	0 Ω resistors, SMD, jumper, 1/10 W, 0603, AEC-Q200, precision power, DNI or DNP for both boards	Not applicable
8	R24, R25, R26, R27, R28, R29, R30, R31	1 kΩ resistors, SMD, 1%, 1/8 W, 0805, AEC-Q200, DNI or DNP for both boards	Not applicable
8	VOUT_0, VOUT_1, VOUT_2, VOUT_3, VOUT_4, VOUT_5, VOUT_6, VOUT_7	Connector-PCB, coax SMB, jack, RF vertical, PC mount gold, DNI or DNP for both boards	Not applicable

[1] Generic indicates that any part with the specified value, size, and rating can be used.

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.