ANALOG DEVICES

Evaluation Board User Guide
UG-397

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Evaluation Board for the AD5247 Digital Potentiometer

FEATURES

Full-featured board in conjunction with low voltage digiPOT motherboard (EVAL-MB-LV-SDZ)
Various test circuits
Various ac/dc input signals
PC control via a separately purchased system demonstration platform (SDP-B or SDP-S)
PC software for control

PACKAGE CONTENTS

EVAL-AD5247DBZ
EVAL-MB-LV-SDZ motherboard
CD that includes
- **Self-installing software that allows users to control the board and exercise all functions of the device**
- **Electronic version of the AD5247 data sheet**
- **Electronic version of the UG-397 user guide**

GENERAL DESCRIPTION

This user guide describes the evaluation board for evaluating the AD5247, a single channel, 128-position digital potentiometer.

The AD5247 supports a single-supply 2.7 V to 5.5 V operation, making the device suited for battery-powered applications and many other applications with a superior low temperature coefficient performance.

In addition, the AD5247 uses a versatile I²C serial interface that operates in fast mode, allowing speeds of up to 400 kHz.

The EVAL-AD5247DBZ and EVAL-MB-LV-SDZ can operate in single-supply mode and incorporate an internal power supply from the USB.

Complete specifications for the AD5247 part can be found in the AD5247 data sheet, which is available from Analog Devices, Inc., and should be consulted in conjunction with this user guide when using the evaluation board.

EVAL-AD5247DBZ WITH MOTHERBOARD AND SDP-B

Figure 1. Digital Picture of Evaluation Board with Low Voltage digiPOT Motherboard and System Demonstration Platform

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REVISION HISTORY

5/12—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The EVAL-MB-LV-SDZ supports using single power supplies.

The evaluation board can be powered either from the SDP port or externally by the J1 and J2 connectors as described in Table 1.

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

Table 1. Maximum and Minimum Voltages of the Connectors

Connector No.	Label	Voltage
J1-1	EXT VDD	Analog positive power supply, V_{DD}; from 2.7 V to 5.5 V.
J1-2	GND	Analog ground.
J2-1	VLOGIC	Digital supply, from 2.7 V to V_{DD}.
J2-2	DGND	Digital ground.

LINK OPTIONS

Several link and switch options are incorporated in the EVAL-MB-LV-SDZ evaluation board and should be set up before using the board. Table 2 describes the positions of the links to control the evaluation board by a PC, via the SDP board. The functions of these link options are described in detail in Table 3 through Table 6.

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

Link No.	Option
A11	3.3 V
A12	AGND
A5	3.3 V

Table 3. Link Functions

Link No.	Power Supply	Options
A11	V_{DD}	This link selects one of the following as the positive power supply: 5 V (from SDP). 3.3 V (from SDP). VDD (external supply from the J1 connector).
A5	V_{LOGIC}	This link selects one of the following as the digital supply: 3.3 V (from SDP). VLOGIC EXT (external supply from the J2 connector).
A12	GND	AGND.

TEST CIRCUITS

The EVAL-AD5247DBZ and EVAL-MB-LV-SDZ incorporate several test circuits to evaluate the AD5247 performance.

DAC

RDAC can be operated as a digital-to-analog converter (DAC), as shown in Figure 2.

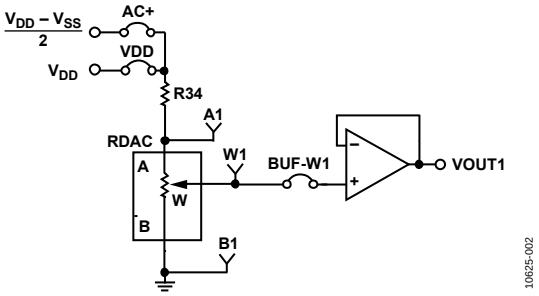

Figure 2. DAC

Table 4 shows the options available for the voltage references.

Table 4. DAC Voltage References

Terminal	Link (DB[1])	Link (MB[2])	Options	Description
A1	A2-B	A9	AC+	Connects Terminal A1 to V_{DD} /2
			VDD	Connects Terminal A1 to V_{DD}
W1	A3-B	BUF-W1		Connects Terminal W1 to an output buffer
B1		A10	AGND	
	A1 inserted			

[1] Daughter board
[2] Motherboard

The output voltage is defined in Equation 1.

$$V_{OUT} = (V_A) \times \frac{RDAC}{128} \quad (1)$$

where:
RDAC is the code loaded in the RDAC register.
V_A is the voltage applied to the A terminal (A9 link).

However, by using the R34 external resistor, the user can reduce the voltage of the voltage references. In this case, use the A1 test point to measure the voltage applied to the A terminal and recalculate V_A in Equation 1.

AC Signal Attenuation

RDAC can be used to attenuate an ac signal, which must be provided externally using the AC_INPUT connector, as shown in Figure 3.

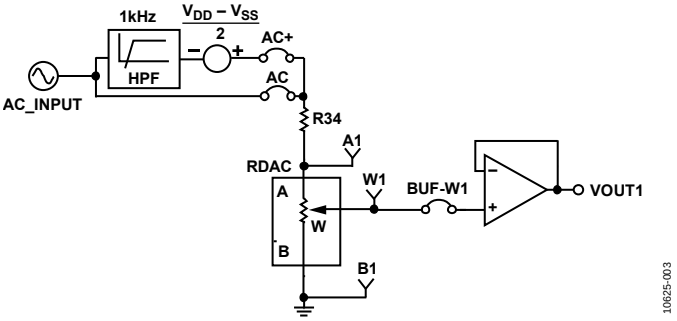

Figure 3. AC Signal Attenuator

Depending on the voltage supply rails and the dc offset voltage of the ac signal, various configurations can be used as described in Table 5.

Table 5. AC Signal Attenuation Link Options

Link	Options	Conditions
A9	AC+	No dc offset voltage.
		AC signal is outside the voltage supply rails due to the dc offset voltage.
		DC offset voltage ≠ V_{DD}/2.
	AC	All other conditions.
A10	AGND	All other conditions.

The signal attenuation is defined in Equation 2.

$$Attenuation\ (\text{dB}) = 20 \times \log\left(\frac{R_{WB} + R_W}{R_{END-TO-END}}\right) \quad (2)$$

where:
R_{WB} is the resistor between the W and ground.
R_W is the wiper resistance.
$R_{END\text{-}TO\text{-}END}$ is the end-to-end resistance value.

Signal Amplifier

RDAC can be operated as a noninverting signal amplifier supporting pseudo logarithmic gain. Table 6 shows the available configurations.

The noninverting amplifier with pseudologarithmic gain is shown in Table 6, and the gain is defined in Equation 4.

$$G = 1 + \frac{R_{AW}}{R_{WB}} \quad (4)$$

where:
R_{AW} is the resistor between the W and A terminals.
R_{WB} is the resistor between the W and B terminals.

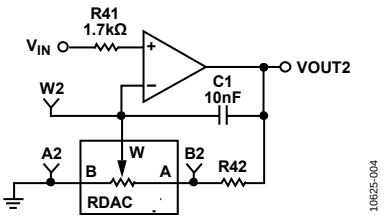

Figure 4. Pseudologarithmic Noninverting Amplifier

R42 can be used to set the maximum and minimum gain limits.

Table 6. Amplifier Selection Link Options

Amplifier	Gain	Link(DB[1])	Link (MB[2])	Label	V_{IN} Range
Noninverting	Pseudo logarithmic	A2 = A3 = A4-A	A7	LOC	0 V to V_{DD}
			A6	N-INV	
		A1 not inserted	A8	N-INV	

[1] Daughter board
[2] Motherboard

EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The EVAL-AD5247DBZ evaluation kit includes evaluation board software provided on a CD. The software is compatible with Windows® XP, Windows Vista, and Windows 7 (both 32 bits and 64 bits).

Install the software before connecting the SDP board to the USB port of the PC to ensure that the SDP board is recognized when it is connected to the PC. To install the software, use the following steps:

1. Start the Windows operating system and insert the CD.
2. The installation software opens automatically. If it does not, run the **setup.exe** file from the CD.
3. After installation is completed, power up the evaluation board as described in the Power Supplies section.
4. Connect the EVAL-AD5247DBZ and EVAL-MB-LV-SDZ into the SDP board and the SDP board into the PC using the USB cable included in the evaluation kit.
5. When the software detects the evaluation board, follow the instructions that appear to finalize the installation.

RUNNING THE SOFTWARE

To run the program, use the following steps:

1. Click **Start** > **All Programs** > **Analog Devices** > **AD5247** > **AD5247 Eval Board**. To uninstall the program, click **Start** > **Control Panel** > **Add or Remove Programs** > **AD5247 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 5). Simply connect the evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.

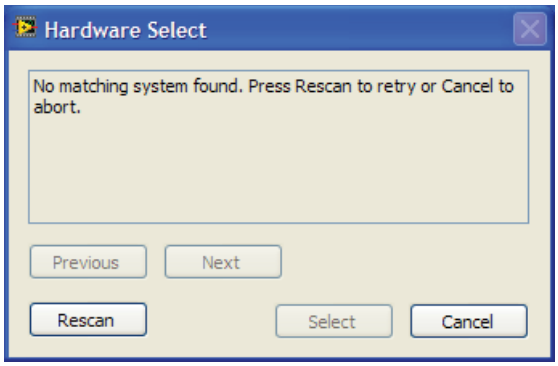

Figure 5. Pop-Up Window Error

The main window of the EVAL-AD5247DBZ evaluation software then opens, as shown in Figure 6.

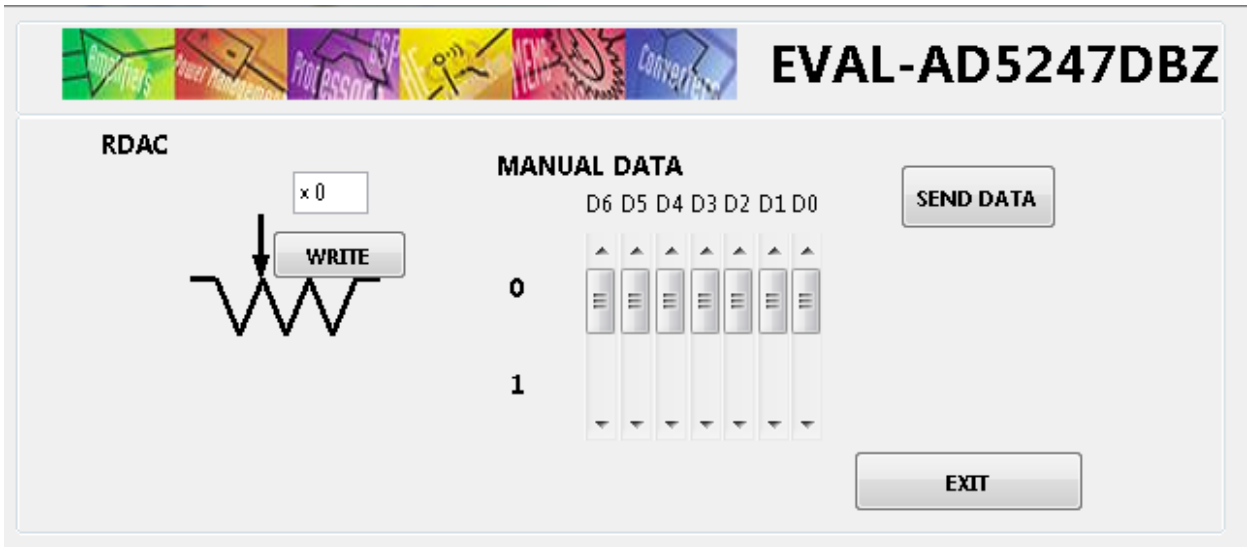

Figure 6. EVAL-AD5247DBZ Evaluation Board Software Main Window

SOFTWARE OPERATION

The main window of the EVAL-AD5247DBZ software is divided into the following sections: **RDAC** and **MANUAL DATA**.

RDAC

WRITE can be used to update the RDAC registers by entering a desirable value into the text box and clicking **WRITE**. When **WRITE** is clicked, a write/read operation is performed, and the value displayed in this section is updated with the actual RDAC register value. This function can be used to verify whether the write operation was completed successfully.

MANUAL WRITE

SEND DATA is a customized I^2C data-word can be sent by manually switching the scroll bars from 0 to 1 or from 1 to 0 as desired and then clicking SEND DATA.

In addition, the scroll bars are updated on each write transfer, showing the command sent to the part.

EXIT closes the program.

SCHEMATICS AND ARTWORK

MOTHERBOARD

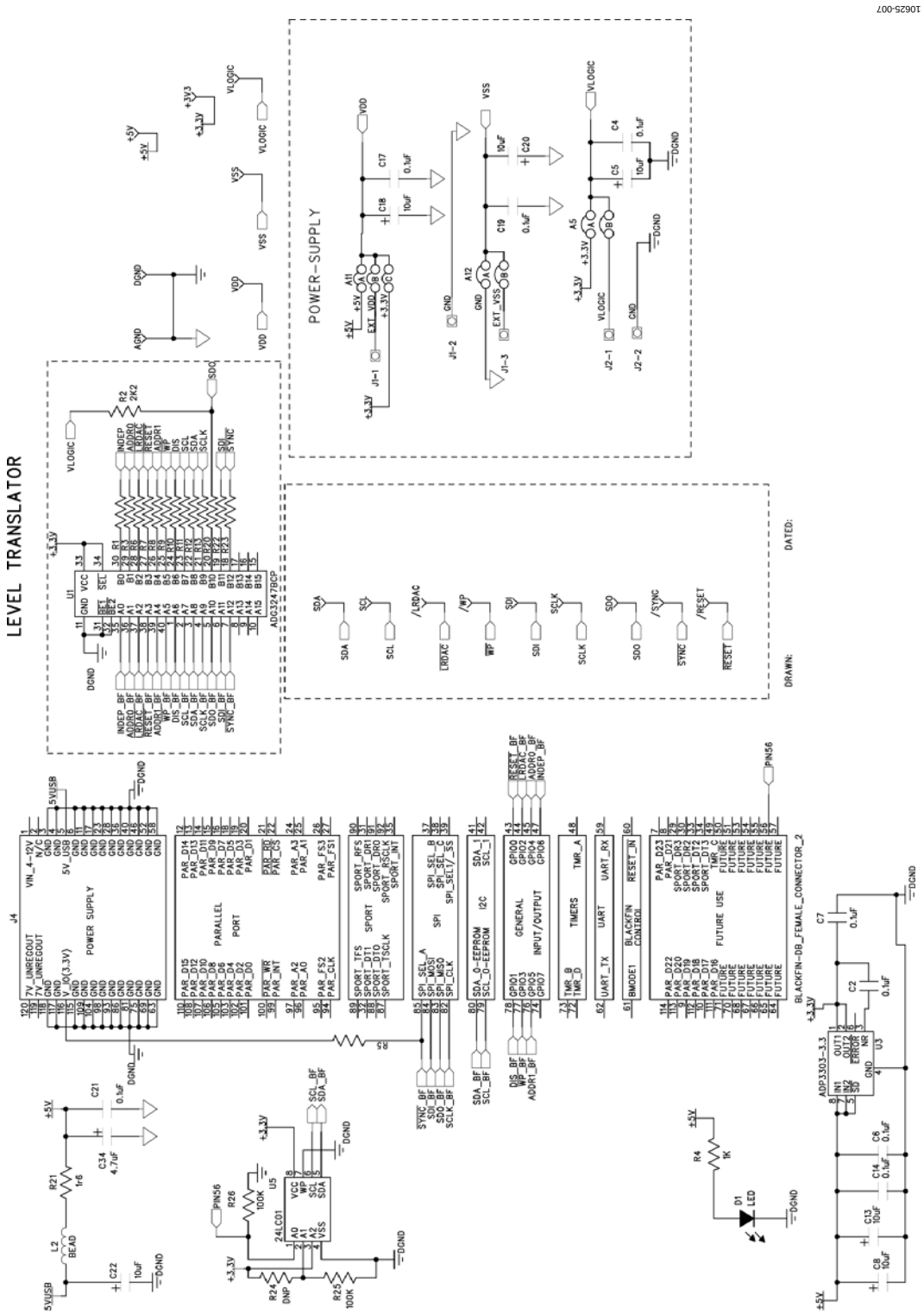

Figure 7. SDP Connector and Power Supply

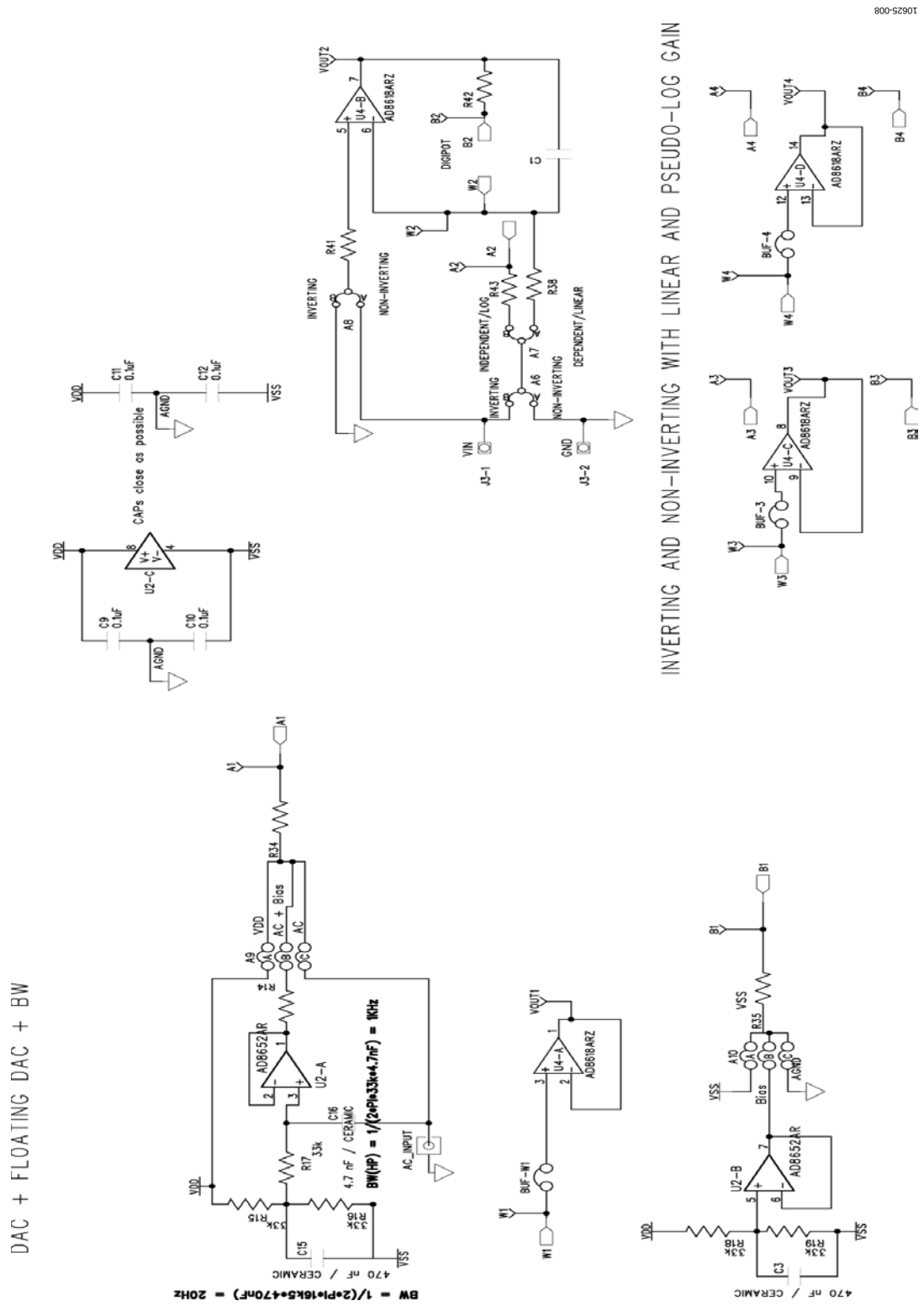

Figure 8. Schematic of Test Circuits

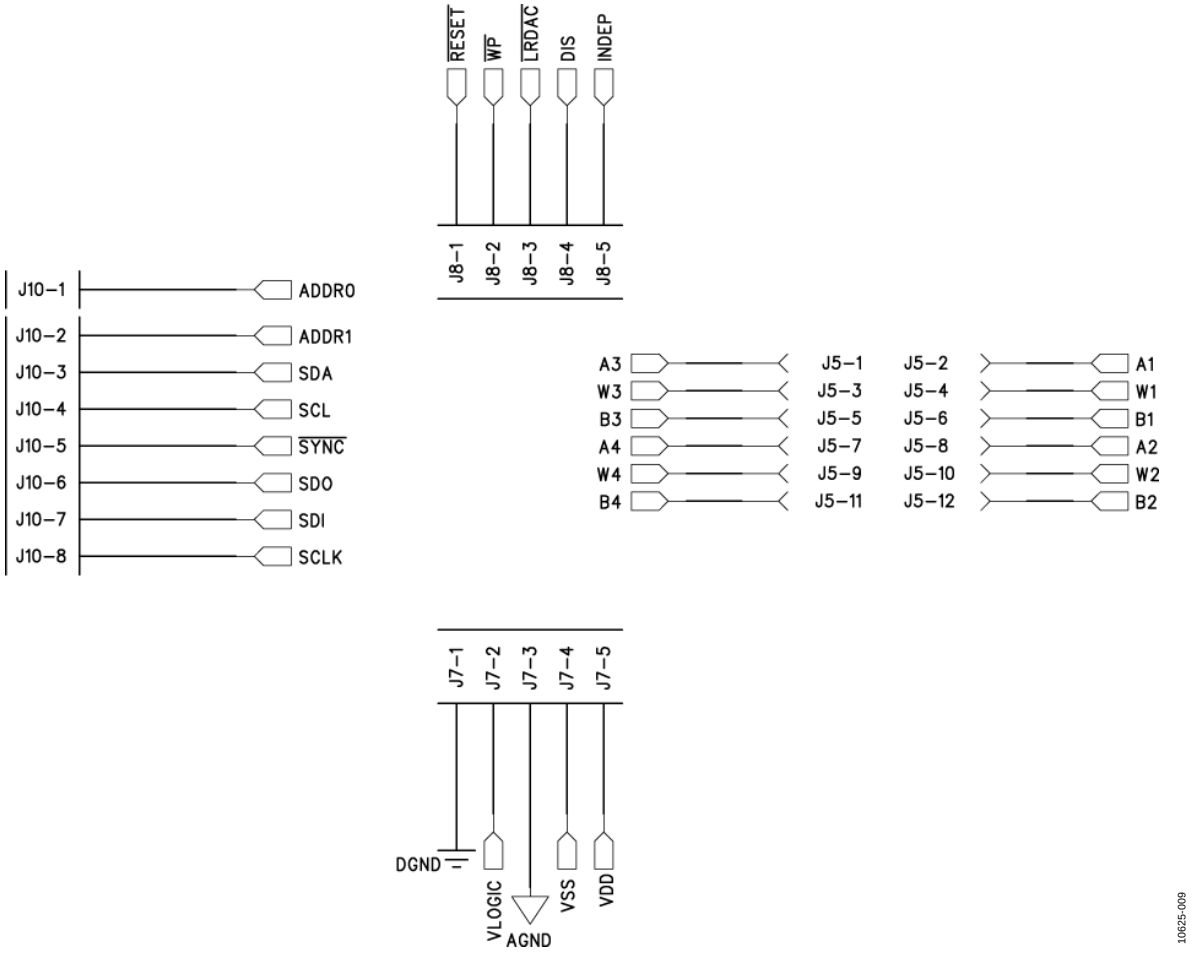

Figure 9. Schematic of Connectors to Daughter Board

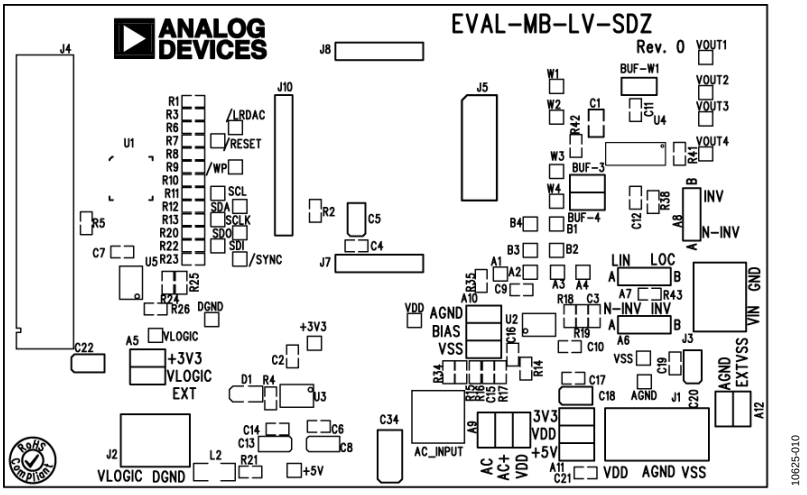

Figure 10. Component Side View

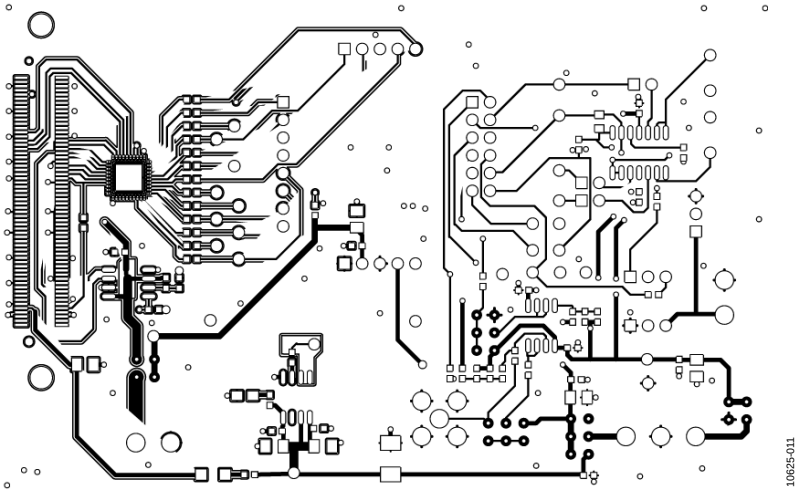

Figure 11. Component Placement Drawing

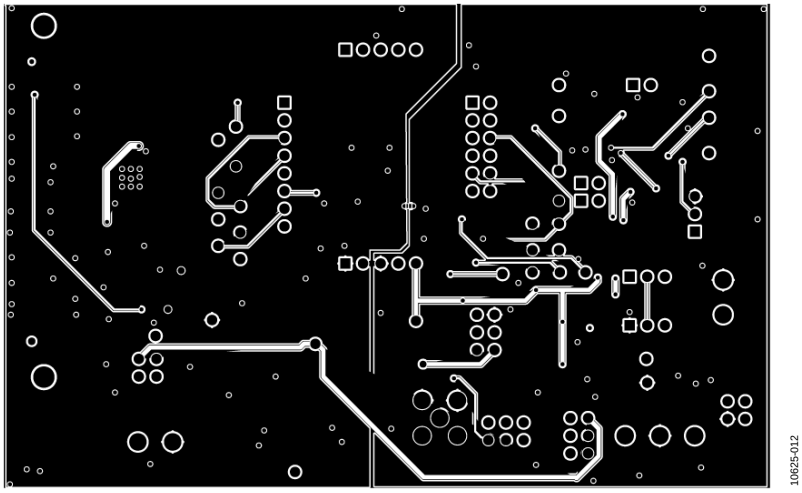

Figure 12. Layer 2 Side PCB Drawing

DAUGHTER BOARD

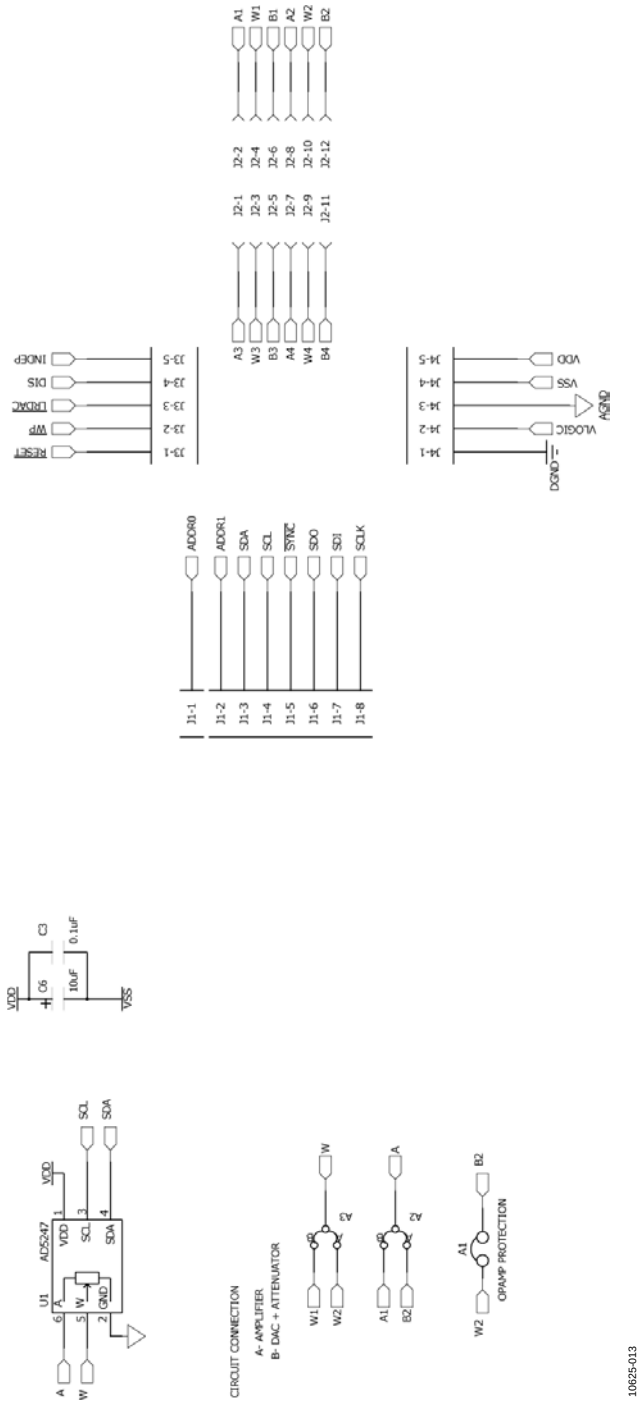

Figure 13. Schematic of Daughter Board

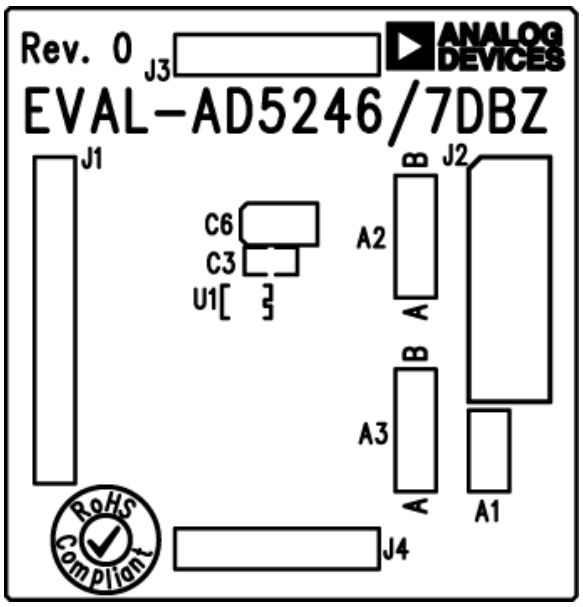

Figure 14. Component Side View

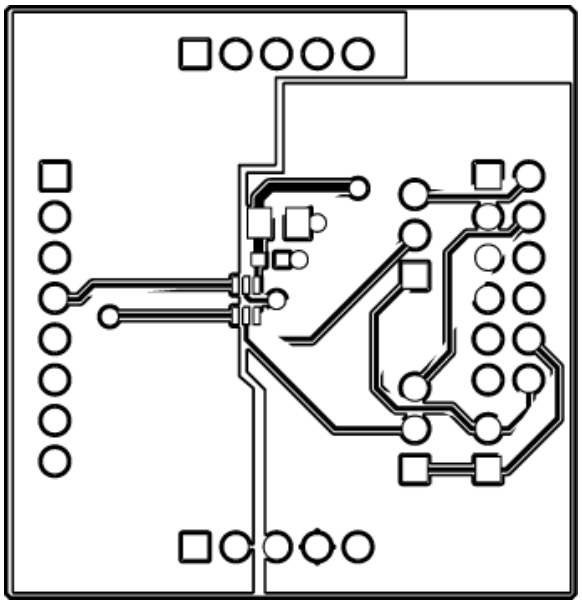

Figure 15. Component Placement Drawing

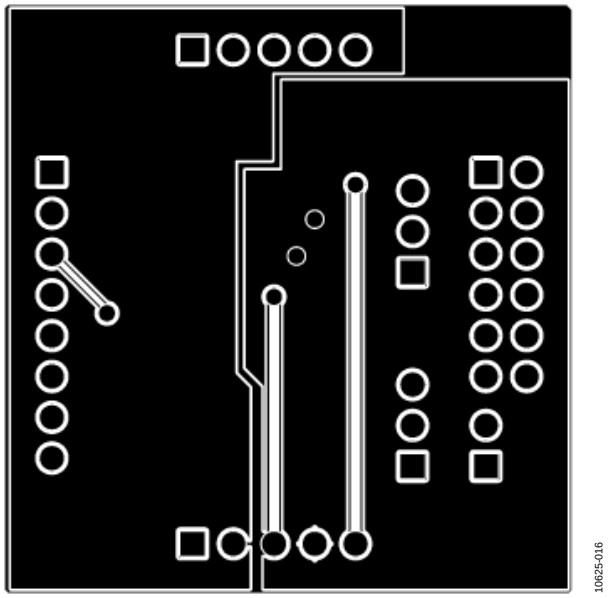

Figure 16. Layer 2 Side PCB Drawing

ORDERING INFORMATION

BILL OF MATERIALS

Table 7. Motherboard

Qty	Reference Designator	Description	Supplier[1]/Part Number
3	BUF-3, BUF-4, BUF-W1	2-pin (0.1" pitch) header and shorting shunt	FEC 1022247 and FEC 150-411
3	A6, A7, A8	3-pin SIL header and shorting link	FEC 1022248 and FEC 150410
5	A5, A9, A10, A11, A12	6-pin (3 × 2) 0.1" header and shorting block	FEC 148-535 and FEC 150-411 (36-pin strip)
1	J1	3-pin terminal block (5 mm pitch)	FEC 151790
2	J7, J8	4-pin SIL header	FEC 1098035
1	J4	Receptacle, 0.6 mm, 120-way	Digi-Key H1219-ND
1	J10	8-pin inline header; 100 mil centers	FEC 1098038
1	J5	12pin (2 × 6) 0.1" pitch header	FEC 1098051
2	J2, J3	2-pin terminal block (5 mm pitch)	FEC 151789
17	R1, R3, R6, R7, R8, R9, R10, R11, R12, R13, R20, R22, R23, R34, R35, R42, R43	SMD resistor 0 Ω, 0.01, 0603	FEC 9331662
1	R2	SMD resistor 2.2 kΩ, 0.01, 0603	FEC 1750676
1	R41	SMD resistor 1.7 kΩ, 1% ,0603	FEC 1170811
1	R21	Resistor, surge, 1.6 Ω, 1%, 0603	FEC 1627674
1	R38	SMD resistor, 2.7 kΩ, 1%, 0603	FEC 1750678
1	R14	SMD resistor 100 Ω, 1%, 0603	FEC 9330364
1	R4	SMD resistor 1 kΩ, 0.01, 0603	FEC 9330380
3	R5, R25, R26	SMD resistor 100 kΩ, 1%, 0603	FEC 9330402
5	R15, R16, R17, R18, R19	SMD resistor 33 kΩ, 1%, 0603	FEC 9331034
1	C1	SMD capacitor, 100 nF, 10%, 0805	FEC 165-0863
8	C4, C9, C10, C11, C12, C17, C19, C21	SMD capacitor, 0.1 µF, ±10%, 0603	FEC 1759122
4	C2, C6, C7, C14	SMD capacitor, 0.1 µF, ±10%, 0603	FEC 301-9482
2	C8, C13	SMD capacitor,10 µF, ±10%	FEC 197-130
4	C18, C20, C22, C5	Capacitor 10 µF, ±20%	FEC 1190107
2	C3, C15	Capacitor 470 nF, ±10%,0603	FEC 1414037
1	C16	Capacitor 4.7 nF, ±10%,0603	FEC 1414642
1	C34	Capacitor 4.7 nF, ±20%	FEC 1432350
1	L2	Inductor, SMD, 600Z	FEC 9526862
1	D1	Green SMD LED	FEC 5790852
1	U1	2 port level translating bus switch	ADG3247BCPZ
1	U2	Dual op amp	AD8652ARZ
1	U3	Precision low dropout voltage regulator	ADP3303ARZ-3.3
1	U4	Operational amplifier	AD8618ARZ
1	U5	I^2C serial EEPROM 64K 2.5 V MSOP-8	FEC 1331335
18	/LRDAC, /RESET, /SYNC, /WP, A1, A2, A3, A4, AGND, B1, VOUT_C1, VOUT_C2, VOUT3, VOUT4, W1, W2, W3, W4	Terminal, PCB, black, PK100, test point	FEC 8731128
5	+3V3, +5V, VDD, VLOGIC, VSS	Terminal, PCB, red, PK100	FEC 8731144

[1] FEC refers to Farnell Electronic Component Distributors; Digi-Key refers to Digi-Key Corporation.

Table 8. Daughter Board

Qty	Reference Designator	Description	Supplier[1]/Part Number
1	U1	256 position digital potentiometer	AD5246BKSZ10-RL7/ AD5247BKSZ10-RL7
1	A1	2-pin (0.1" pitch) header and shorting shunt	FEC 1022247 and FEC 150-411
2	A2, A3	3-pin SIL header and shorting link	FEC 1022248 and FEC 150410
1	C6	6.3 V tantalum capacitor (Case A) 10 µF, ±20%	FEC 1190107
1	C3	50 V X7R ceramic capacitor 0.1 µF, ±10%, 0603	FEC 1759122
1	J1	header, 2.54 mm, PCB, 1 × 8 way	FEC 1766172
1	J2	12-pin (2 × 6) 0.1" pitch header	FEC 1804099
2	J3, J4	5-pin SIL header	FEC 1929016

[1] FEC refers to Farnell Electronic Component Distributors; Digi-Key refers to Digi-Key Corporation.

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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