EVAL-AD5232DBZ User Guide
UG-626

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Evaluation Board for the AD5232 Digital Potentiometer

FEATURES

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

EVALUATION KIT CONTENTS

- EVAL-AD5232DBZ evaluation board
- 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 AD5232 data sheet
  - Electronic version of the EVAL-AD5232DBZ user guide

GENERAL DESCRIPTION

This user guide describes the evaluation boards for evaluating the AD5232, a single-channel, 256-position, SPI-compatible digital potentiometer.

The AD5232 supports single-supply 2.7 V to 5.5 V operation, making the device suitable for battery-powered applications and many applications requiring superior low temperature coefficient performance.

In addition, the AD5232 uses a versatile SPI-compatible serial interface that operates in fast mode, allowing speeds of up to 50 MHz. This interface can be used to read back the wiper register.

The EVAL-AD5232DBZ daughter board and the EVAL-MB-LV-SDZ motherboard can operate in single-supply mode and incorporate an internal power supply from the USB.

Complete specifications for the AD5232 can be found in the AD5232 data sheet, which is available from www.analog.com and should be consulted in conjunction with this user guide when using the evaluation board.

PHOTOGRAPH OF EVAL-AD5232DBZ WITH MOTHERBOARD AND SDP-B

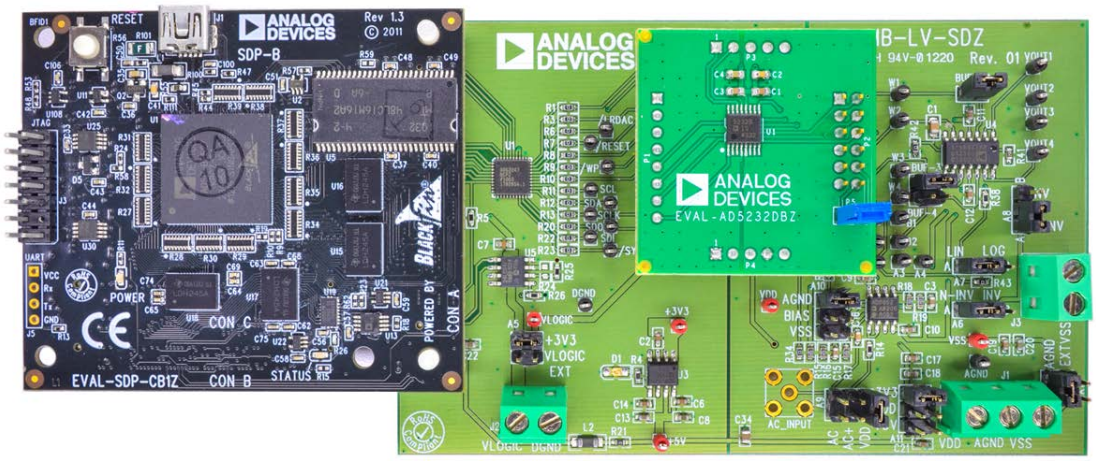

Figure 1. Digital Picture of Evaluation Board with Low Voltage DigiPOT Motherboard and System Demonstration Platform

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REVISION HISTORY

5/14—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.

LINK OPTIONS

Several link and switch options are incorporated on the EVAL-MB-LV-SDZ and EVAL-AD5232DBZ boards and must be set up before using the evaluation system. The functions of these link options are described in detail in Table 2 through Table 5. By default, the evaluation system is set up to be controlled by a PC via the SDP board.

Table 1. Connector Functions

Connector No.	Label	Description	Voltage	
			Min	Max
J1-1	VDD	Analog positive power supply, V_{DD}	2.7 V	5.5 V
J1-2	AGND	Analog ground		
J2-1	VLOGIC	Digital supply	2.7 V	V_{DD}
J2-2	DGND	Digital ground		

Table 2. Link Functions

Link No.	Power Supply	Options	Default Position
A5	V_{LOGIC}	Digital supply select options: 3.3 V (from the SDP board) VLOGIC EXT (external supply from the J2 connector)	3.3 V
A11	V_{DD}	Positive power supply select options: 5 V (from the SDP board) 3.3 V (from the SDP board) VDD (external supply from the J1 connector)	3.3 V
A12	GND	AGND	AGND

TEST CIRCUITS

The EVAL-AD5232DBZ and EVAL-MB-LV-SDZ incorporate several test circuits to evaluate the performance of the AD5232.

DAC

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

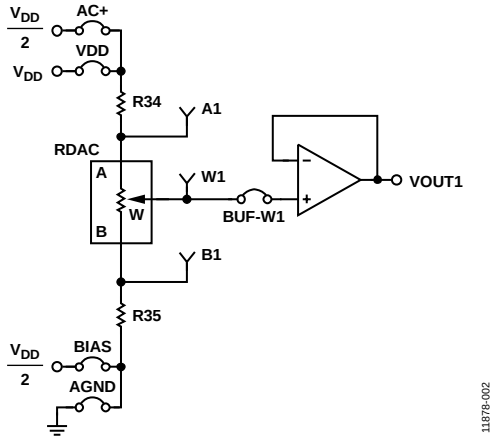

Figure 2. DAC

Table 4 shows the options available for the voltage references.

The output voltage is defined in Equation 1.

$$V_{OUT} = (V_A - V_B) \times \frac{RDAC}{256} \quad (1)$$

where:
RDAC is the code loaded in the RDAC register.
V_A is the voltage applied to the A terminal (A9 link).
V_B is the voltage applied to the B terminal (A10 link).

However, by using the R34 and R35 external resistors, you can reduce the voltage of the voltage references. In this case, use the A1 and B1 test points to measure the voltage applied to the A and B terminals and recalculate V_A and V_B in Equation 1.

AC Signal Attenuation

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

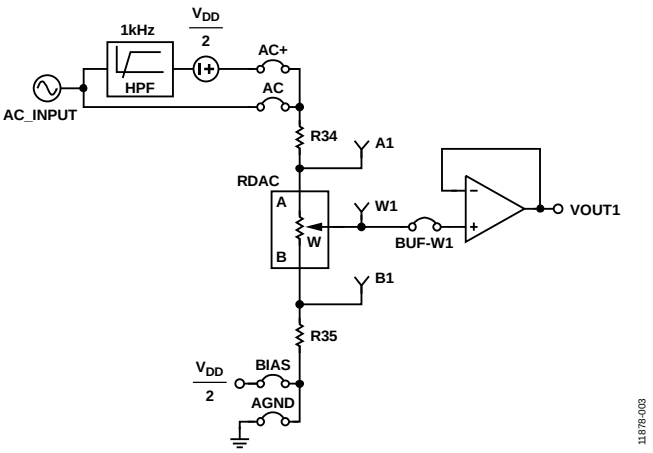

Figure 3. AC Signal Attenuator

Depending on the voltage supply rails and the dc offset voltage of the ac signal, various configurations can be used, as described in Table 3.

Table 3. 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 ≠ $V_{DD}/2$.[1]
	AC	All other conditions.
A10	BIAS	Use in conjunction with AC+ link.[1]
	AGND	All other conditions.

[1] Recommended to ensure optimal total harmonic distortion (THD) performance.

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 resistance between the W and B terminals.
R_W is the wiper resistance.
$R_{END-TO-END}$ is the end-to-end resistance value.

Table 4. DAC Voltage References

Terminal	Link Settings		Description
	Daughter Board	Motherboard	
A1	Hardwired to RDAC1 of daughter board	A9: AC+ position	Connects Terminal A1 to $V_{DD}/2$
		A9: VDD position	Connects Terminal A1 to V_{DD}
W1	Hardwired to RDAC1 of daughter board	BUF-W1: inserted	Connects Terminal W1 to an output buffer
B1	Hardwired to RDAC1 of daughter board	A10: BIAS position	Connects Terminal B1 to $V_{DD}/2$
		A10: AGND position	Connects Terminal B1 to analog ground
	P5: inserted		Closes the feedback loop of the second op amp in the AD8618

Signal Amplifier

The RDAC can be operated as an inverting or noninverting signal amplifier and can support linear or pseudologarithmic gain. Table 5 shows the available configurations.

The noninverting amplifier with linear gain is shown in Figure 4, and the gain is defined in Equation 3.

$$G = 1 + \frac{R_{WB}}{R38} \quad (3)$$

where R_{WB} is the resistance between the W and B terminals.

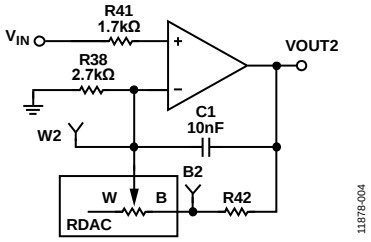

Figure 4. Noninverting Amplifier with Linear Gain

The noninverting amplifier with pseudologarithmic gain is shown in Figure 5, and the gain is defined in Equation 4.

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

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

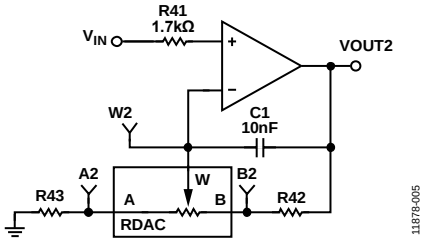

Figure 5. Noninverting Amplifier with Pseudologarithmic Gain

R43 and R42 can be used to set the maximum and minimum gain limits.

The inverting amplifier with linear gain is shown in Figure 6, and the gain is defined in Equation 5.

$$G = -\frac{R_{WB}}{R38} \quad (5)$$

where R_{WB} is the resistance between the W and B terminals.

Note that the input signal, V_{IN}, must be negative.

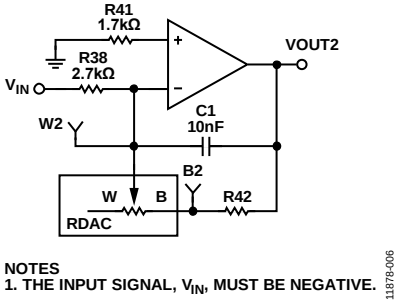

Figure 6. Inverting Amplifier with Linear Gain

Table 5. Amplifier Selection Link Settings

Amplifier	Gain	Link Settings		V_{IN} Range
		Daughter Board	Motherboard	
Noninverting	Linear	Hardwired to RDAC2 of daughter board, P5: not inserted	A7: LIN position, A6: N-INV position, A8: N-INV position	0 V to V_{DD}
	Pseudologarithmic	Hardwired to RDAC2 of daughter board, P5: not inserted	A7: LOG position, A6: N-INV position, A8: N-INV position	0 V to V_{DD}
Inverting	Linear	Hardwired to RDAC2 of daughter board, P5: not inserted	A7: LIN position, A6: INV position, A8: INV position	$-V_{DD}$ to 0 V

EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The EVAL-AD5232DBZ kit includes evaluation board software provided on a CD. The software is compatible with Windows® XP, Windows Vista, and Windows 7 (both 32-bit and 64-bit versions).

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.

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 the installation is complete, power up the evaluation board as described in the Power Supplies section.
4. Connect the EVAL-AD5232DBZ and EVAL-MB-LV-SDZ to the SDP board and the SDP board to the PC.
5. When the software detects the evaluation board, follow the instructions that appear to finalize the installation.

RUNNING THE SOFTWARE

To run the program, do the following:

1. Click **Start** > **All Programs** > **Analog Devices** > **AD5232** > **AD5232 Eval Board**. (To uninstall the program, click **Start** > **Control Panel** > **Add or Remove Programs** > **AD5232 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 7). If a connectivity error is displayed, connect the evaluation board to the USB port of the PC and wait a few seconds, and then click **Rescan** and follow the instructions that appear on-screen.

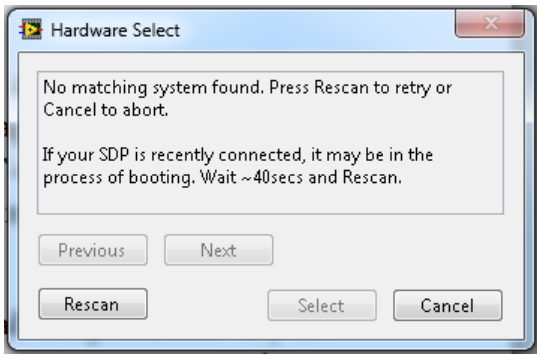

Figure 7. Pop-Up Window Error

The main window of the EVAL-AD5232DBZ software then opens, as shown in Figure 8.

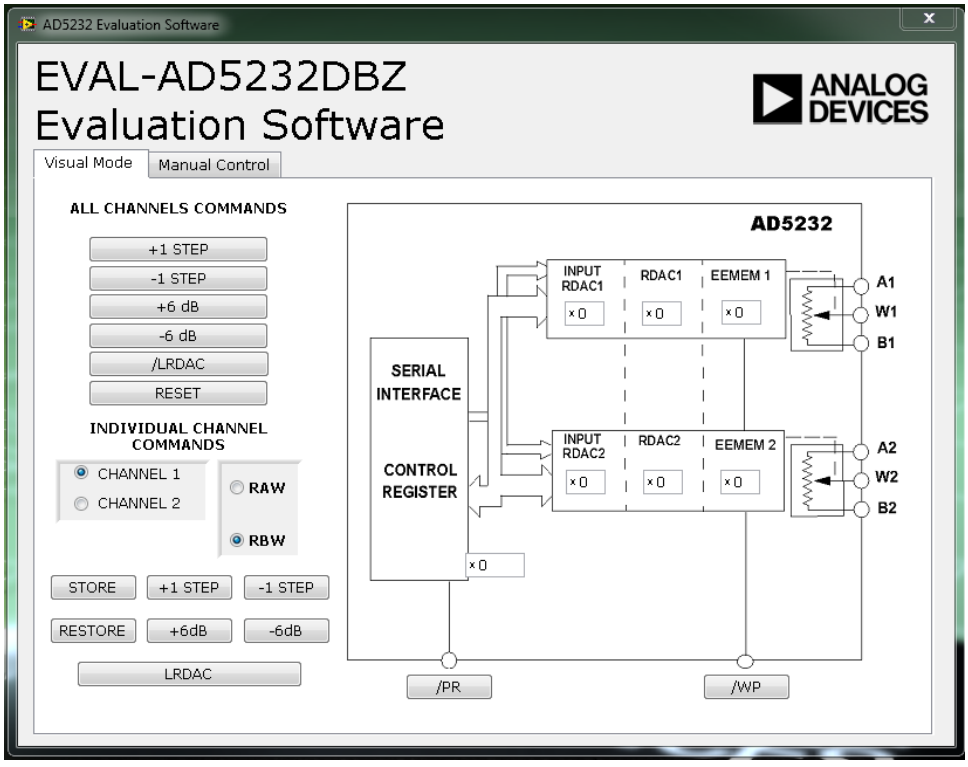

Figure 8. EVAL-AD5232DBZ Software Main Window, Visual Mode Tab

OPERATING THE SOFTWARE

The main window of the EVAL-AD5232DBZ software is divided into two tabs: **Visual Mode** and **Manual Control**.

Visual Mode Tab

The **Visual Mode** tab, as shown in Figure 8, is divided into two sections, with a block diagram on the right and command buttons on the left.

The block diagram allows updating the control register status. Each register value can easily be updated by changing the value in its respective block within the diagram.

Manual Control Tab

The **Manual Control** tab, as shown in Figure 9, allows customizing an SPI data-word by manually switching each serial data-word (D7 to D0) from 0 to 1 or from 1 to 0, as desired, and then clicking **SEND DATA**.

Exiting the window closes the program.

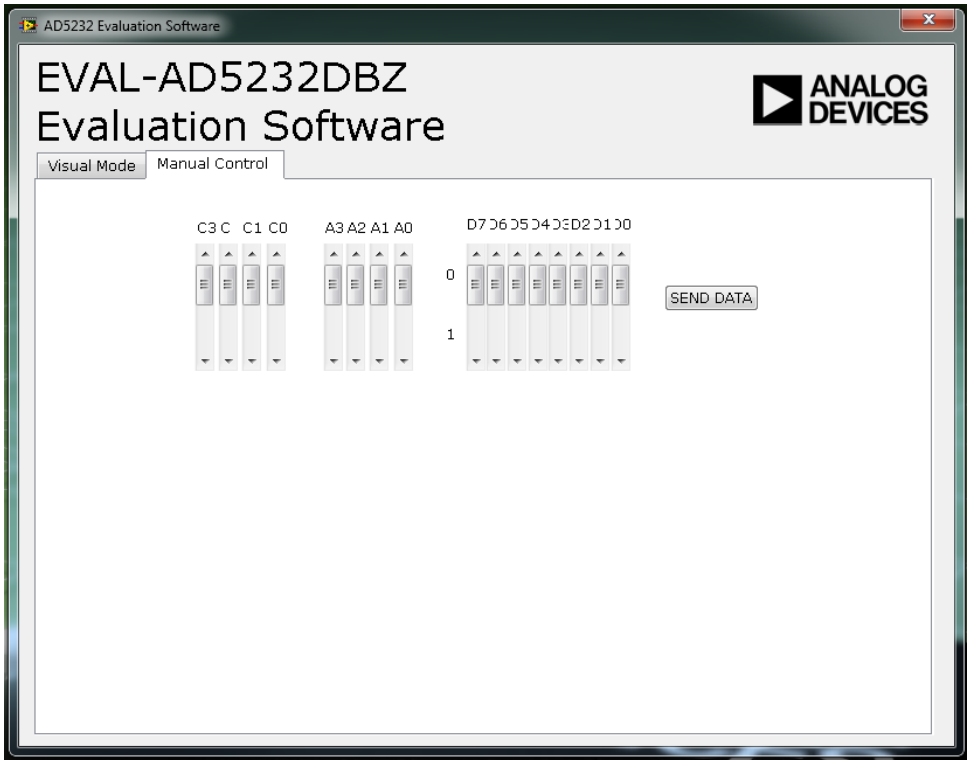

Figure 9. EVAL-AD5232DBZ Software Main Window, Manual Control Tab

EVALUATION BOARD SCHEMATICS AND ARTWORK

MOTHERBOARD

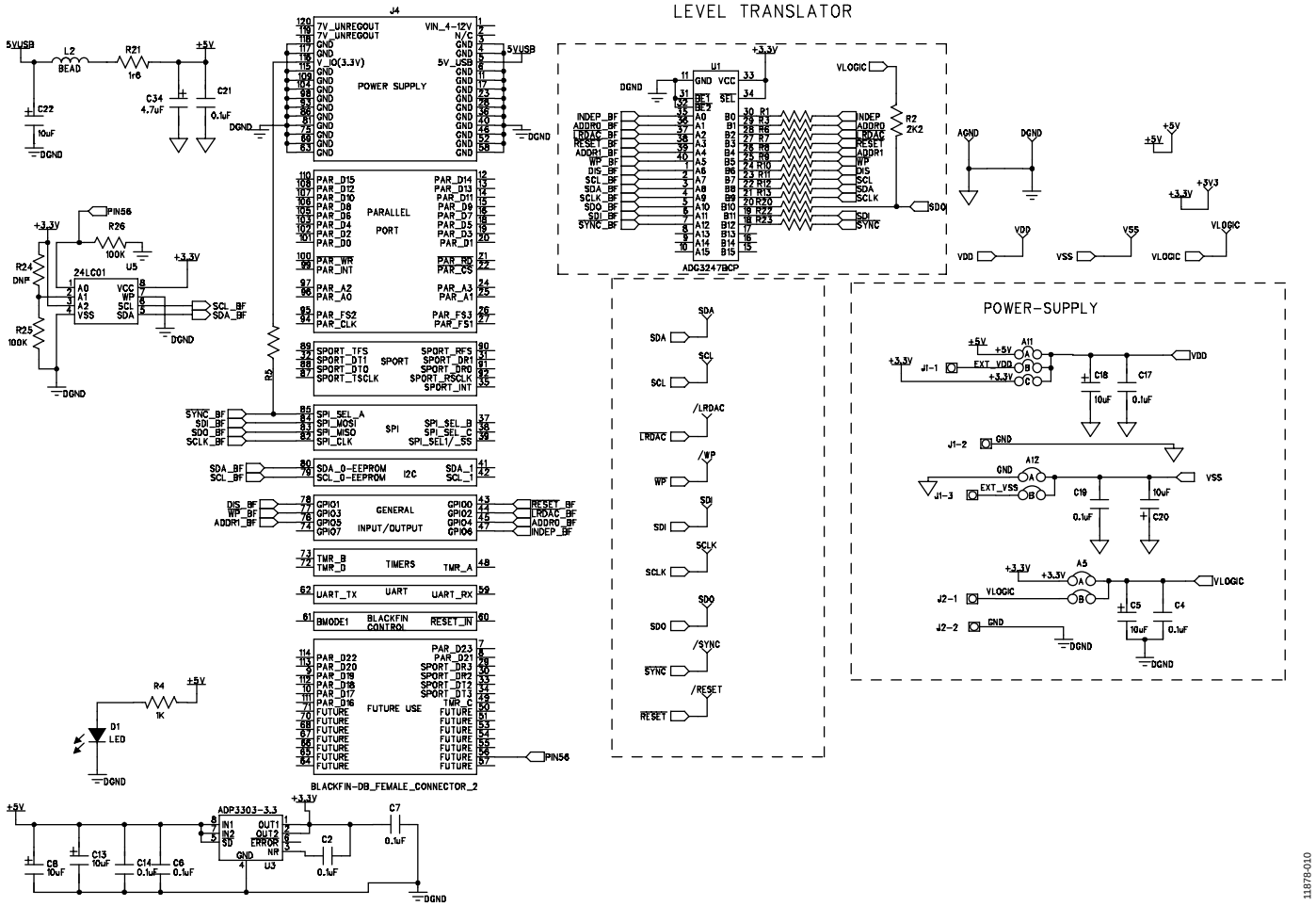

Figure 10. SDP Connector and Power Supply

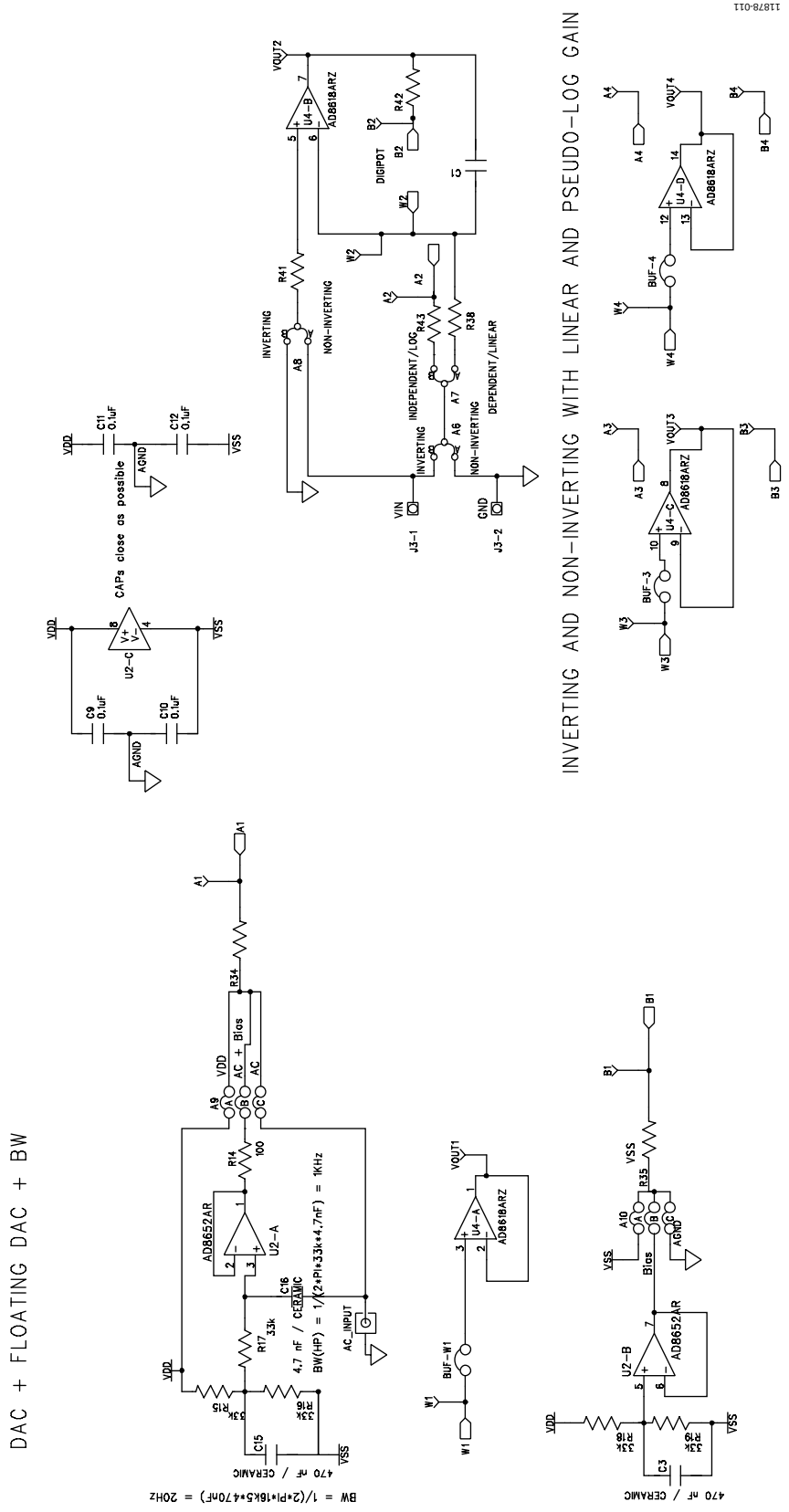

Figure 11. Schematic of Test Circuits

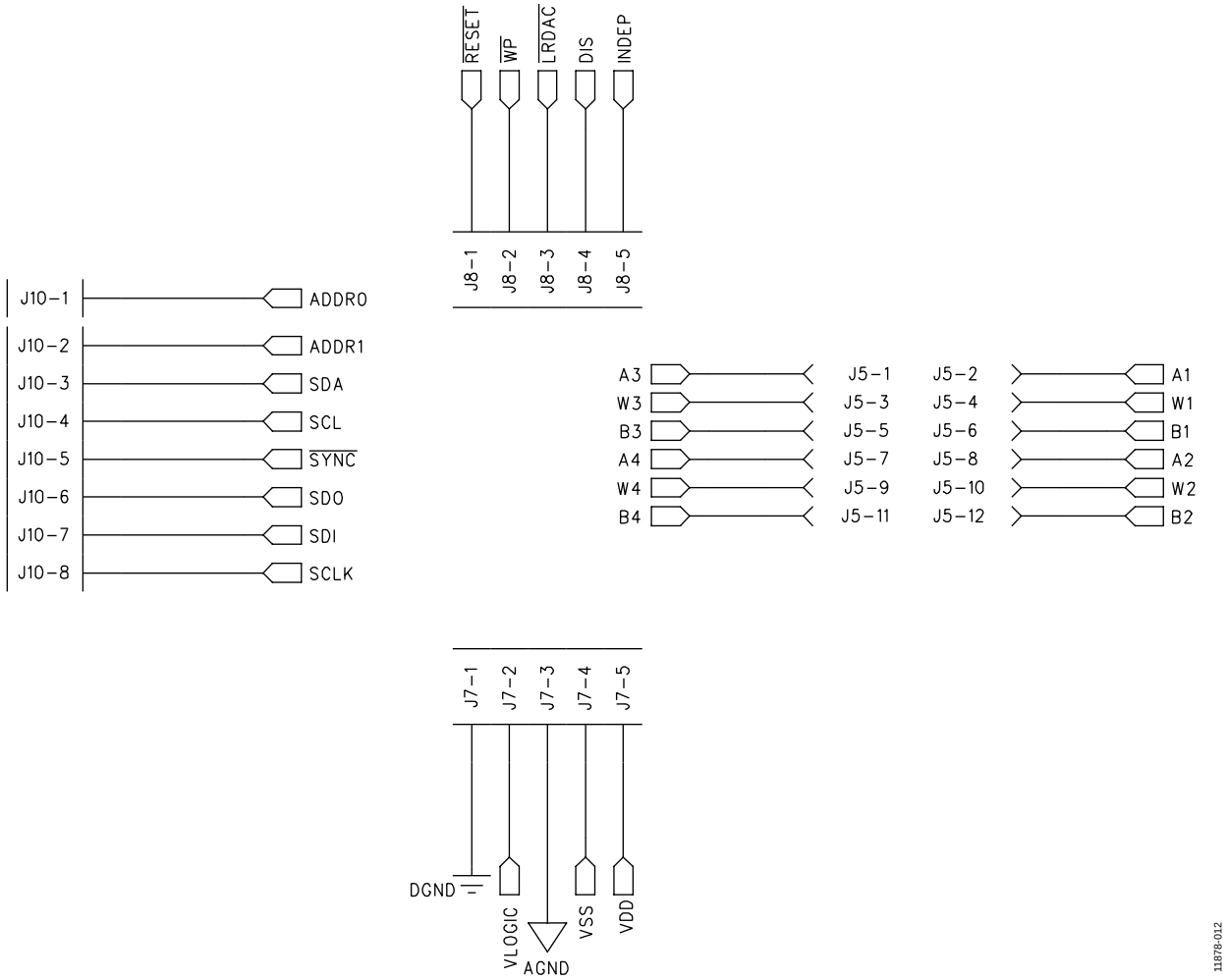

Figure 12. Schematic of Connectors to Daughter Board

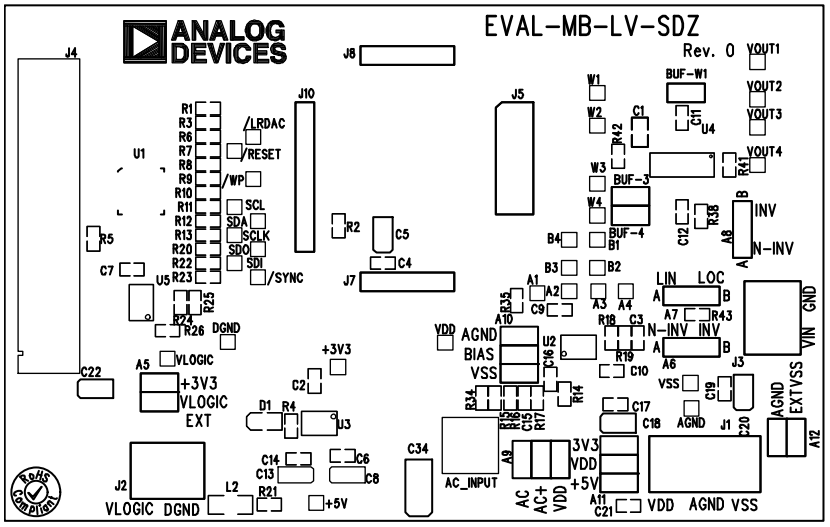

Figure 13. Component Side View

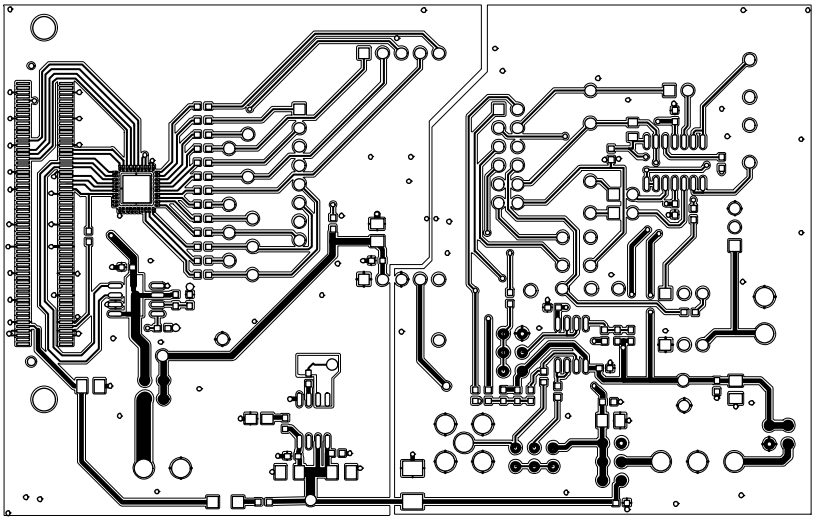

Figure 14. Component Placement Drawing

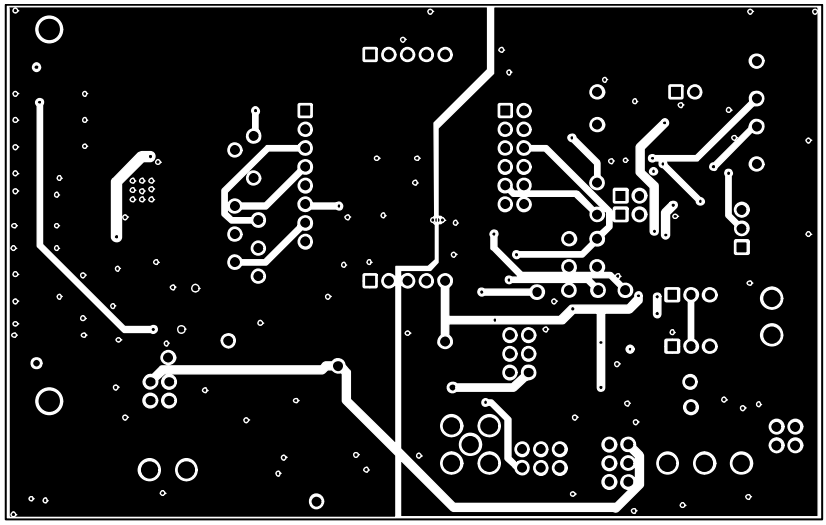

Figure 15. Layer 2 Side PCB Drawing

DAUGHTER BOARD

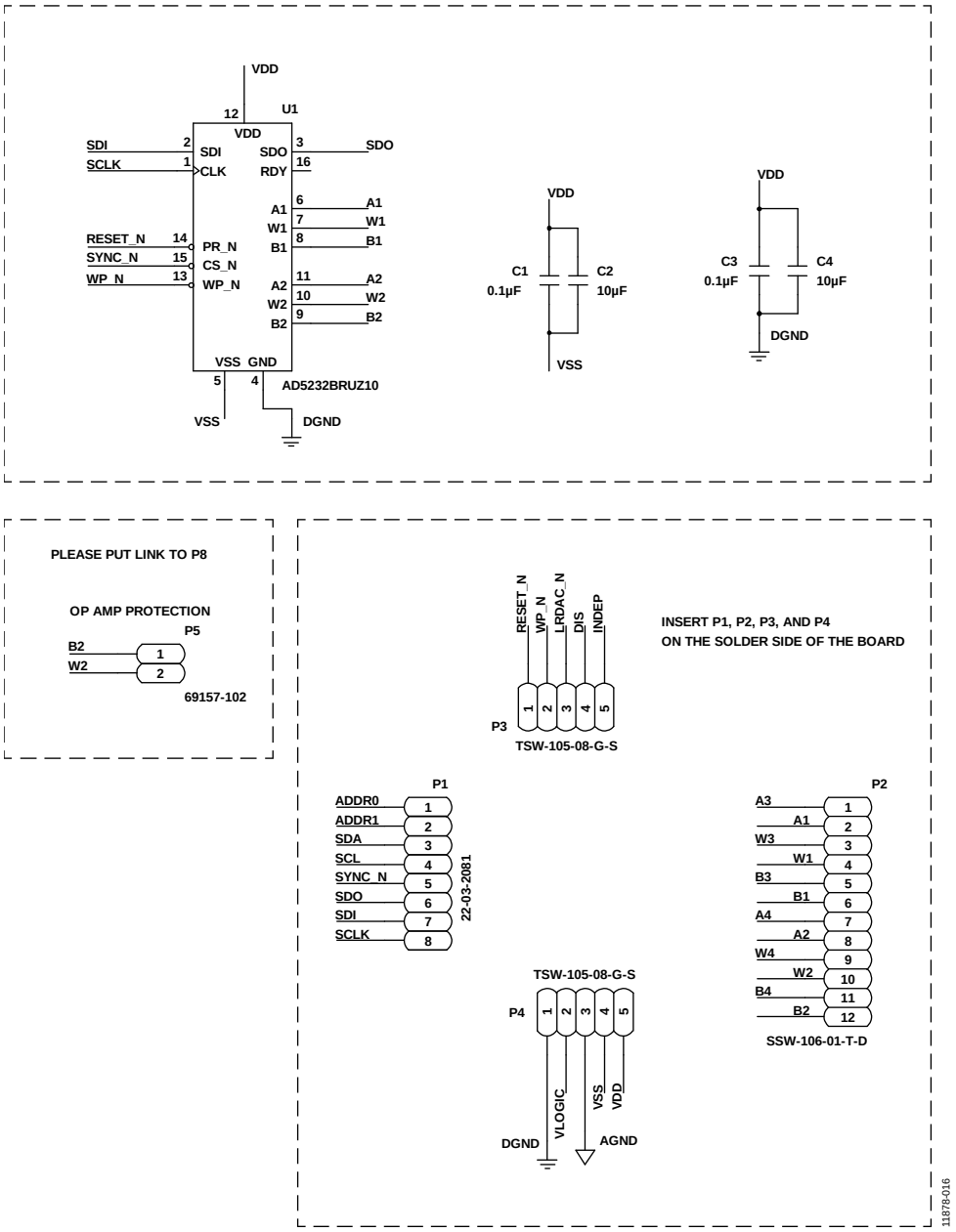

Figure 16. Schematic of Daughter Board

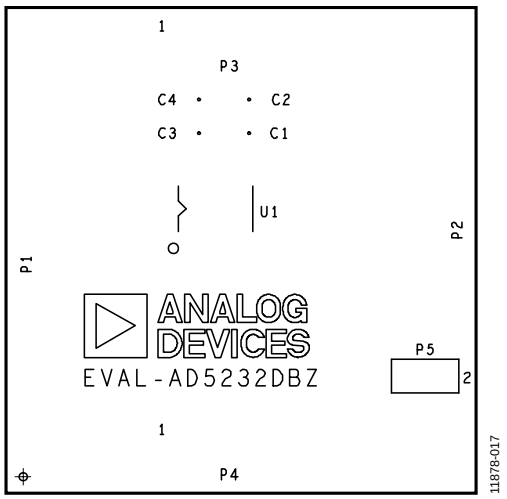

Figure 17. Component Side View

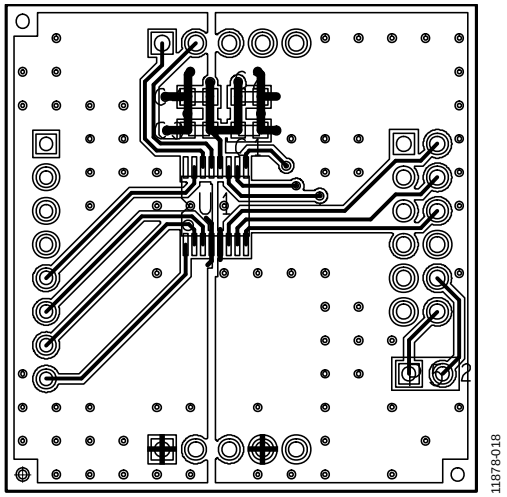

Figure 18. Component Placement Drawing

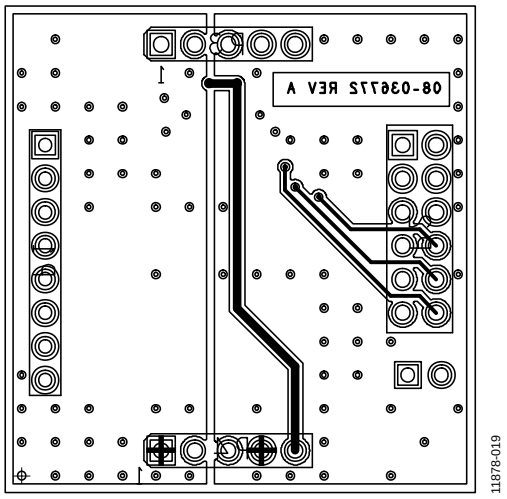

Figure 19. Layer 2 Side PCB Drawing

BILL OF MATERIALS

Table 6. Motherboard Bill of Materials

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 150411
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 148535 and FEC 150411 (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	12-pin (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 1650863
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 3019482
2	C8, C13	SMD capacitor, 10 µF, ±10%	FEC 197130
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	Two-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	$\overline{\text{LRDAC}}$, $\overline{\text{RESET}}$, $\overline{\text{SYNC}}$, $\overline{\text{WP}}$, 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	+3.3V, +5V, EXT_VDD, VLOGIC, EXT_VSS	Terminal, PCB, red, PK100	FEC 8731144

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

Table 7. Daughter Board Bill of Materials

Qty	Reference Designator	Description	Supplier[1]/Part Number
1	U1	256-position digital potentiometer	AD5232BRUZ10
1	P5	2-pin (0.1" pitch) header and shorting shunt	FEC 1022247 and FEC 150411
2	C2, C4	6.3 V, X5R, ceramic capacitor, 10 µF, ±20%	GRM188R60J106ME47D
2	C1, C3	50 V, X7R, ceramic capacitor, 0.1 µF, ±10%	GRM188R71H104KA93D
1	P1	Header, 2.54 mm, PCB, 1 × 8-way	FEC 1766172
1	P2	12-pin (2 × 6), 0.1" pitch header	FEC 1804099
2	P3, P4	5-pin SIL header	FEC 1929016

[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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