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Evaluation Board for the AD5222 Digital Potentiometer

FEATURES

Full featured evaluation board for the AD5222
Various test circuits
Various ac and dc input signals
PC control via a separately purchased system demonstration platform (SDP-B)
PC software for control

PACKAGE CONTENTS

EVAL-AD5222SDZ board
CD that includes
- **Self-installing software that allows users to control the board and exercise all functions of the device**
- **Electronic version of the AD5222 data sheet**
- **Electronic version of the UG-349 user guide**

GENERAL DESCRIPTION

This user guide describes the evaluation board for evaluating the AD5222—a dual-channel, 128-position, digital potentiometer

The AD5222 supports single-supply 2.7 V to 5.5 V operation, making the device suited for battery-powered applications and many other applications while offering a 0.2% channel-to-channel matching tolerance.

In addition, the AD5222 uses a high speed up/down interface, allowing speeds of up to 15 MHz.

The EVAL-AD5222SDZ can operate in single-supply mode and incorporates an internal power supply from the USB.

Complete specifications for the AD5222 part can be found in the AD5222 data sheet, which is available from Analog Devices, Inc., and should be consulted in conjunction with this user guide when using the evaluation board.

DIGITAL PICTURE OF EVALUATION BOARD WITH SYSTEM DEMONSTRATION PLATFORM

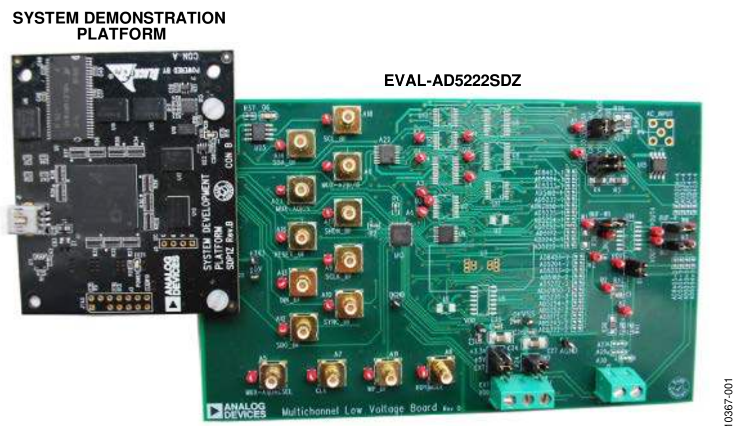

Figure 1.

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REVISION HISTORY

12/11—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The EVAL-AD5222SDZ supports using single power supplies.

The evaluation board can be powered either from the SDP port or externally by the J1-1 and J1-2 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}. For single-supply operation, it is 2.7 V to 5 V.
J1-2	GND	Analog ground.

LINK OPTIONS

Several link and switch options are incorporated in the 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-B board, using the EVAL-AD5222SDZ in single-supply mode. The functions of these link options are described in detail in Table 3 through Table 6.

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

Link No.	Option
A25	3.3 V
A24	GND

Table 3. Link Functions

Link No.	Power Supply	Options
A25	V_{DD}	This link selects one of the following as the positive power supply: 5 V (from SDP-B). 3.3 V (from SDP-B). EXT (external supply from the J1-1 connector).
A24	V_{SS}	This link should be connected to GND (analog ground).

TEST CIRCUITS

The EVAL-AD5222SDZ incorporates several test circuits to evaluate the AD5222 performance.

DAC

RDAC1 can be operated as a digital-to-analog converter (DAC), as shown in Figure 2.

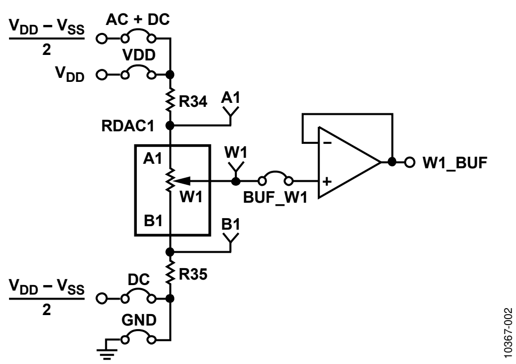

Figure 2. DAC

Table 4 shows the options available for the voltage references.

Table 4. DAC Voltage References

Terminal	Link	Options	Description
A1	A20	AC + DC	Connects Terminal A1 to $(V_{DD} - V_{SS})/2$
		VDD	Connects Terminal A1 to V_{DD}
W1	BUF_W1		Connects Terminal W1 to an output buffer
B1	A21	DC	Connects Terminal B1 to $(V_{DD} - V_{SS})/2$
		GND	Connects Terminal B1 to analog ground

The output voltage is defined in Equation 1.

$$V_{OUT} = (V_{A1} - V_{B1}) \times \frac{R_{WB1}}{128} \quad (1)$$

where:
R_{WB1} is the resistor between the W1 and B1 terminals.
V_{A1} is the voltage applied to the A1 terminal (A20 link).
V_{B1} is the voltage applied to the B1 terminal (A21 link).

However, by using the R34 and R35 external resistors, the user 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 A1 and B1 terminals and recalculate V_{A1} and V_{B1} in Equation 1.

AC Signal Attenuation

RDAC1 can be used to attenuate an ac signal, which must be provided externally using the AC_INPUT connector, as shown in Figure 3.

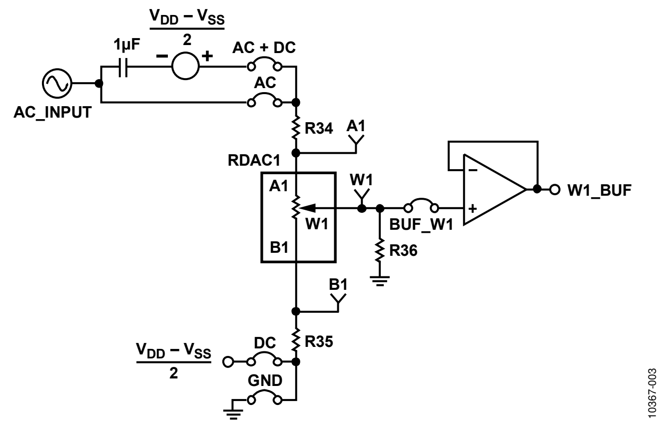

Figure 3. AC Signal Attenuator

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
A20	AC + DC	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.
A21	DC	Use in conjunction with ac + dc link.
	GND	All other conditions.

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

The signal attenuation is defined in Equation 2.

$$Attenuation\,(\text{dB}) = 20 \times \log\left(\frac{R_{WB1} + R_W}{R_{END-TO-END}}\right) \quad (2)$$

where:
R_{WB1} is the resistor between the W1 and B1 terminals.
R_W is the wiper resistance.
$R_{END\text{-}TO\text{-}END}$ is the end-to-end resistance value.

In addition, R36 can be used to achieve a pseudologarithmic attenuation. To do so, adjust the R36 resistor until a desirable transfer function is found.

Signal Amplifier

RDAC2 can be operated as an inverting or noninverting signal amplifier supporting linear or pseudologarithmic gains. Table 6 shows the available configurations.

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

$$G = 1 + \frac{R_{WB2}}{R38} \quad (3)$$

where R_{WB2} is the resistor between the W2 and B2 terminals.

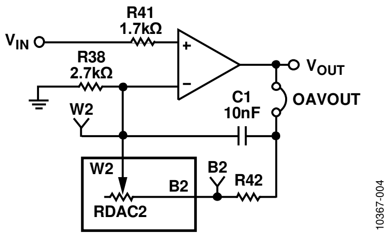

Figure 4. Linear Noninverting Amplifier

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

$$G = 1 + \frac{R_{WB2}}{R_{AW2}} \quad (4)$$

where:
R_{WB2} is the resistor between the W2 and B2 terminals.
R_{AW2} is the resistor between the A2 and W2 terminals.

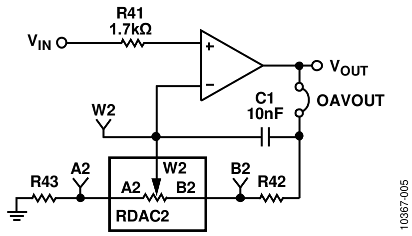

Figure 5. Pseudologarithmic Noninverting Amplifier

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.

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

$$G = -\frac{R_{WB2}}{R38} \quad (5)$$

where R_{WB2} is the resistor between the W2 and B2 terminals.

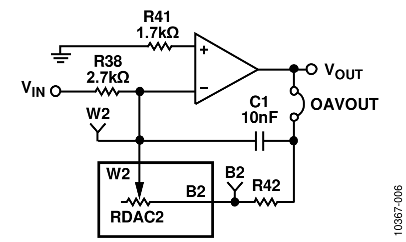

Figure 6. Linear Inverting Amplifier

Table 6. Amplifier Selection Link Options

Amplifier	Gain	Link	Label[1]	V_{IN} Range
Noninverting	Linear	A27	LINEAR	0 V to V_{DD}
		A29	NON-INVERTING	
		A30	NON-INVERTING	
	Pseudologarithmic	A27	PSEUDOLOG	0 V to V_{DD}
		A29	NON-INVERTING	
		A30	NON-INVERTING	
Inverting	Linear	A27	LINEAR	$-V_{DD}$ to 0 V
		A29	INVERTING	
		A30	INVERTING	

[1] See Figure 14.

EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The EVAL-AD5222SDZ evaluation 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).

Install the software before connecting the SDP-B board to the USB port of the PC to ensure that the SDP-B 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 installation is completed, power up the evaluation board as described in the Power Supplies section.
4. Connect the EVAL-AD5222SDZ 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, follow the instructions that appear to finalize the installation.

To uninstall the program, click **Start** > **Control Panel** > **Add or Remove Programs** > **AD5222 Eval Board.**

RUNNING THE SOFTWARE

To run the program, do the following:

1. Click **Start** > **All Programs** > **Analog Devices** > **AD5222** > **AD5222 Eval Board**.
2. If the SDP-B board is not connected to the USB port when the software is launched, a connectivity error displays (see Figure 7). Simply connect the evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.

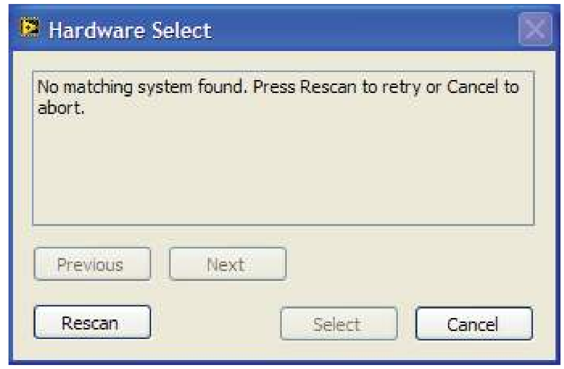

Figure 7. Pop-Up Window Error

The main window of the EVAL-AD5222SDZ software then opens, as shown in Figure 8.

SOFTWARE OPERATION

The main window of the EVAL-AD5222SDZ software is divided into the following sections: **RDAC1** and **RDAC2**. The features of the main window are as follows:

- **RDAC1** and **RDAC2** can be used to update the RDAC registers by typing the desired number of steps and clicking **UP** or **DOWN**.
- **INDEPENDENT MODE ENABLE** allows you to update each RDAC register independently.
- Clicking **EXIT** closes the program but does not reset the part.

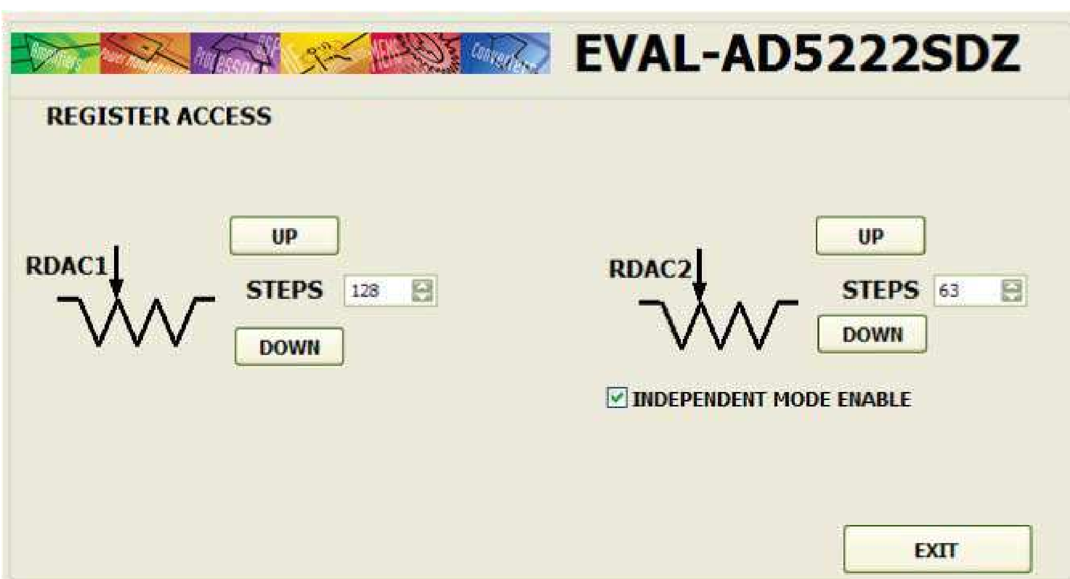

Figure 8. EVAL-AD5222SDZ Software Main Window

EVALUATION BOARD SCHEMATICS AND ARTWORK

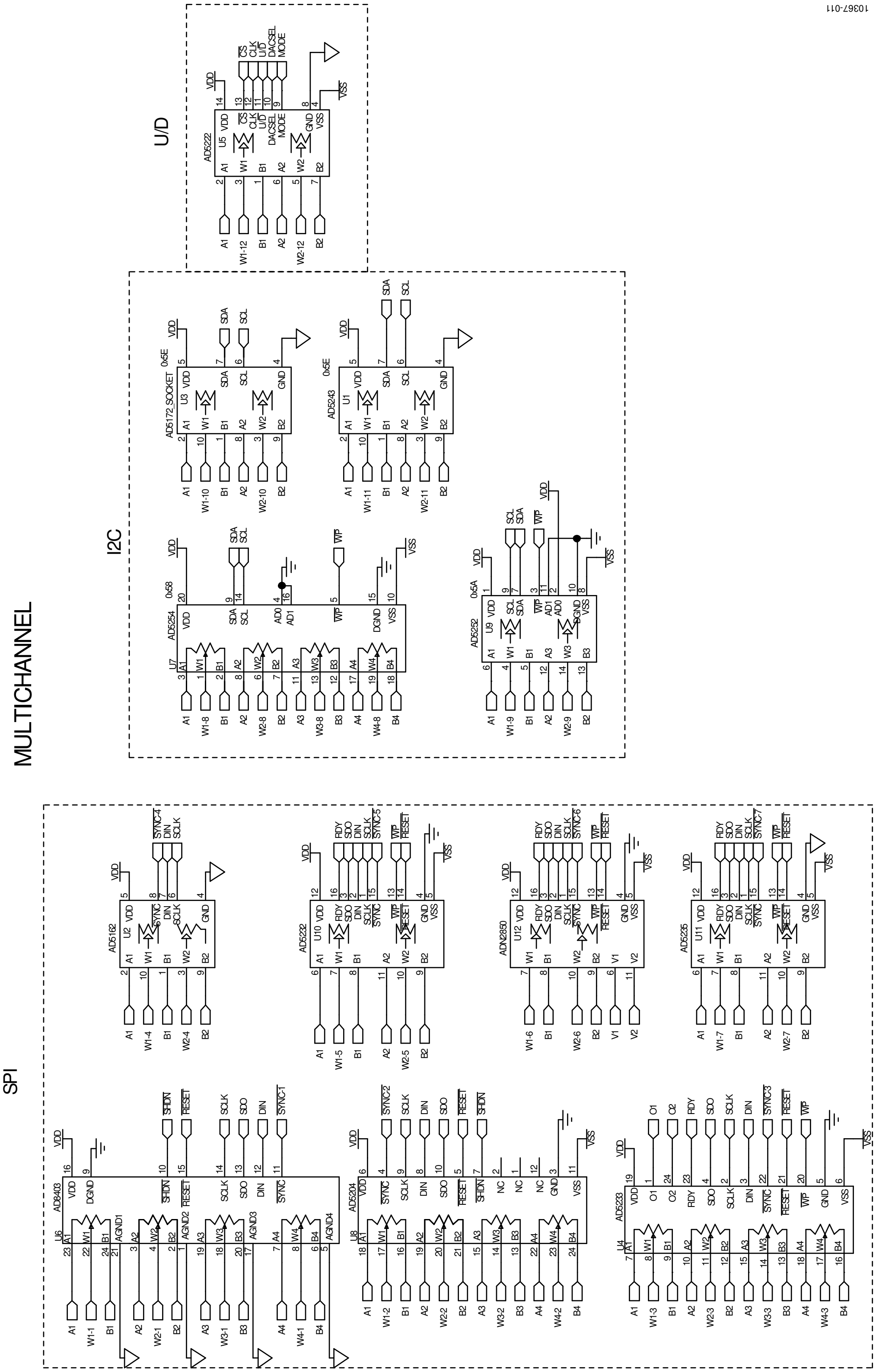

Figure 9. Schematic of Multiboard Digital Potentiometers

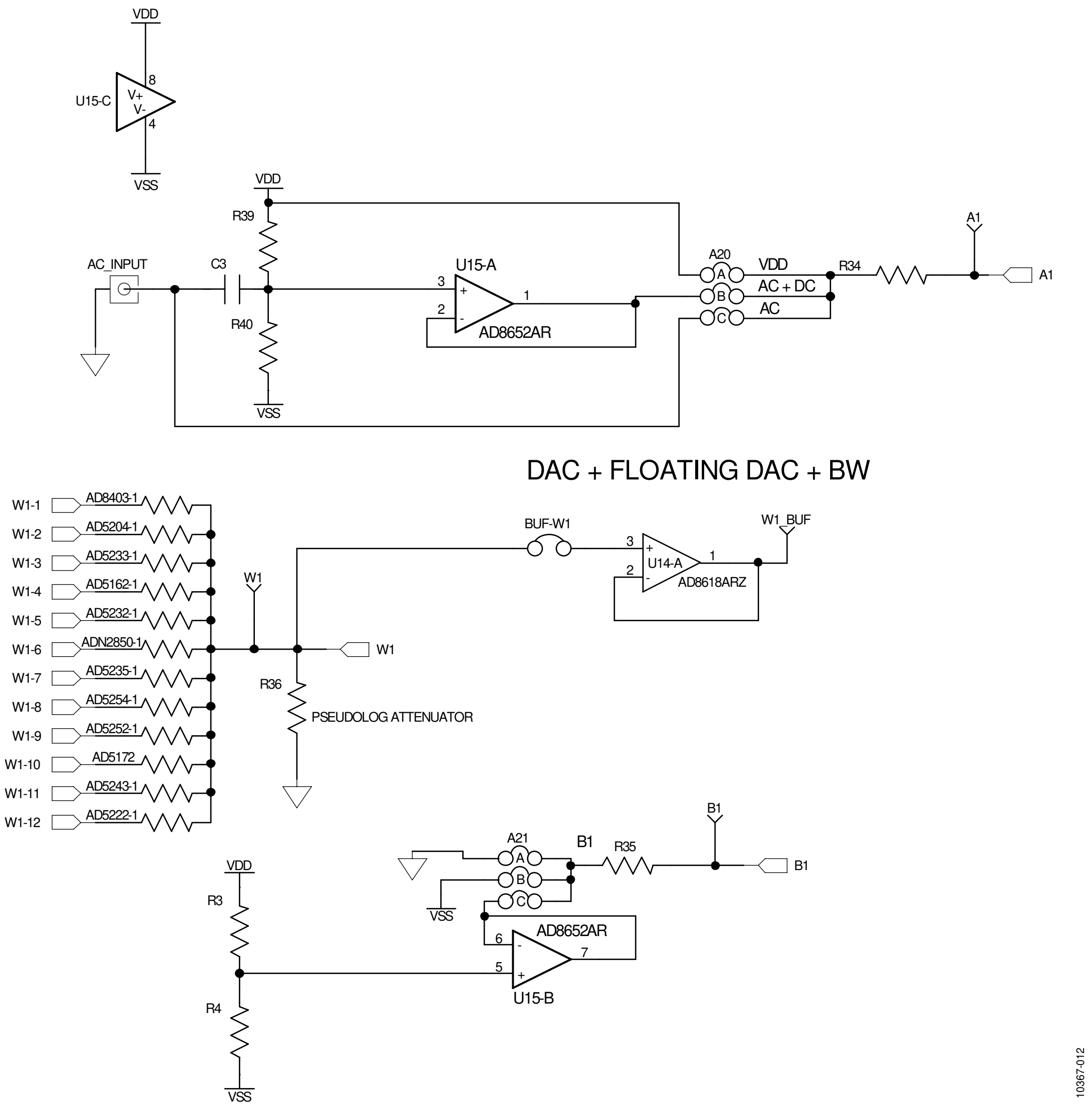

Figure 10. Schematic of Multiboard RDAC0 Circuits

INVERTING AND NON-INVERTING WITH LINEAR AND PSEUDO-LOG GAIN

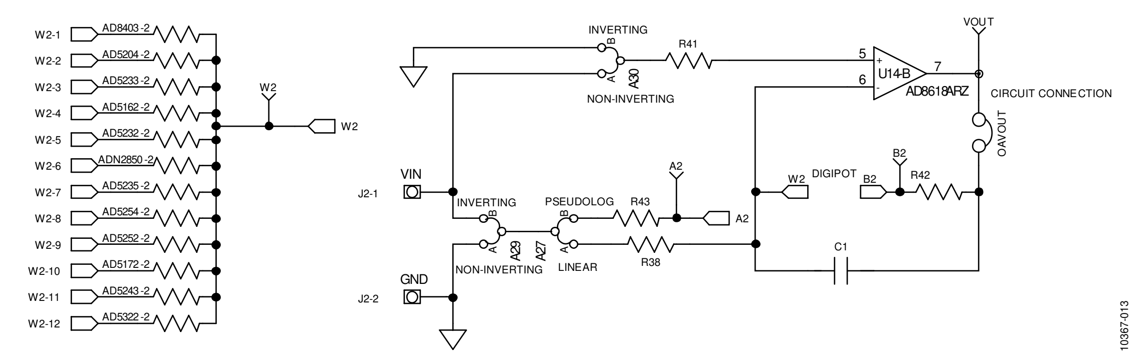

Figure 11. Schematic of Multiboard RDAC1 Circuits

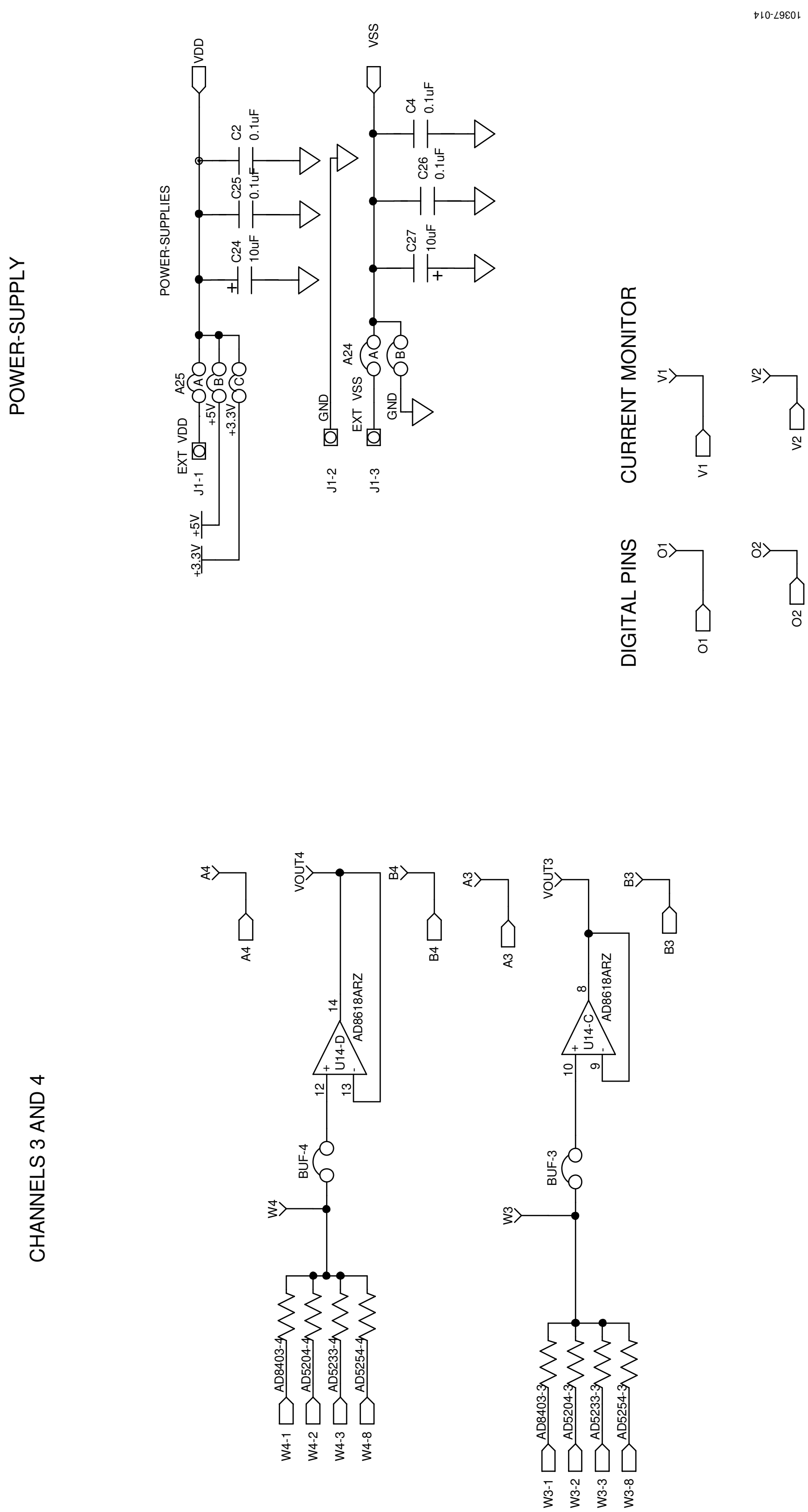

Figure 12. Schematic of AD5222 Power Supplies and Other Channels

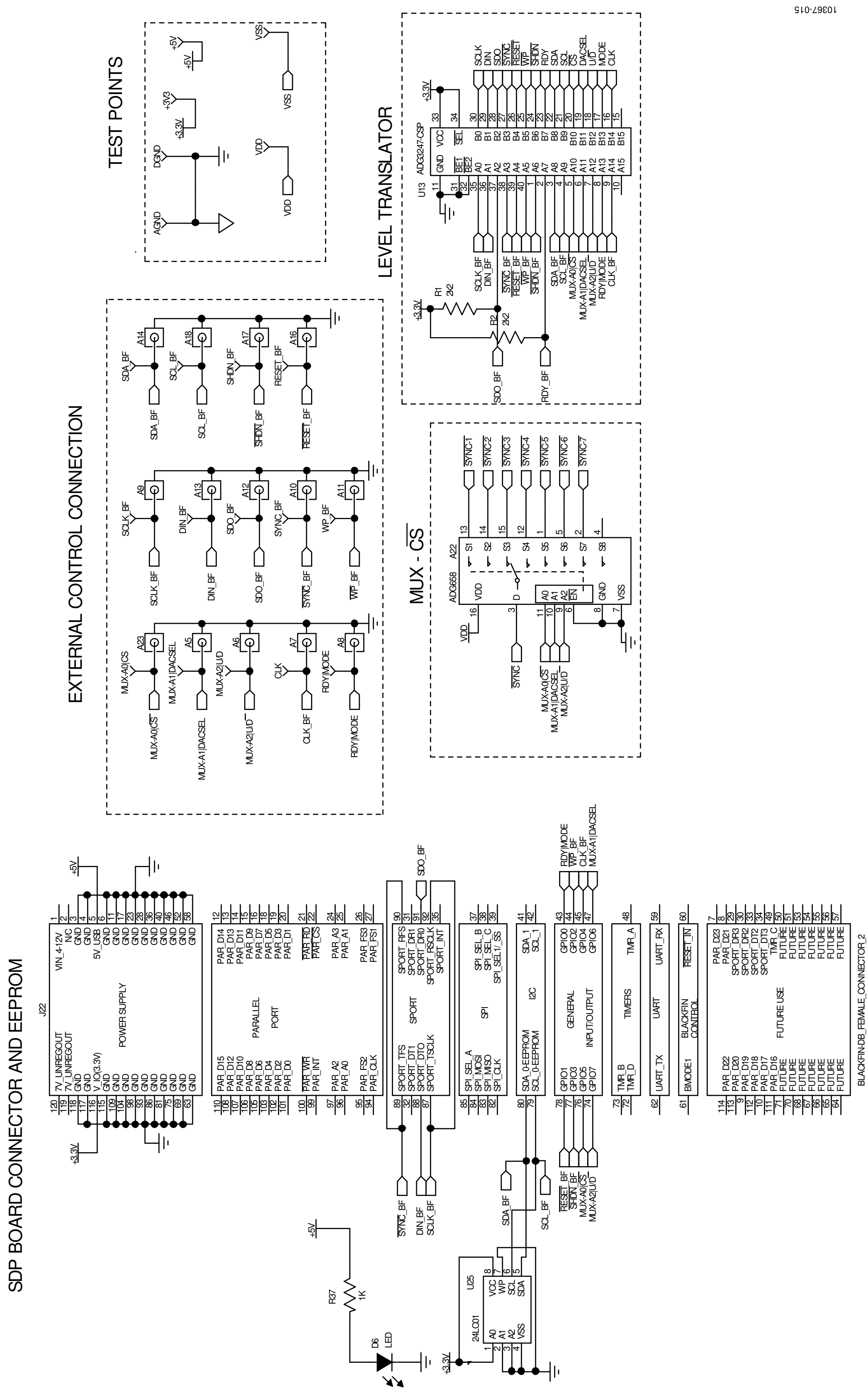

Figure 13. Schematic of SDP-B Connector

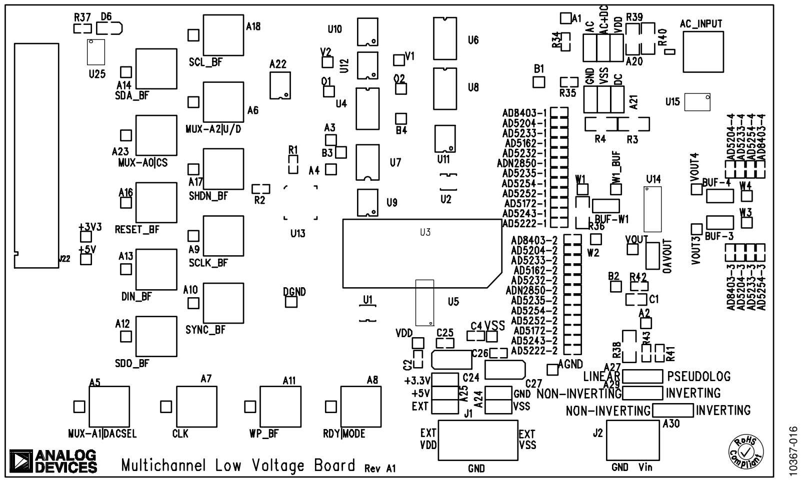

Figure 14. Component Side View

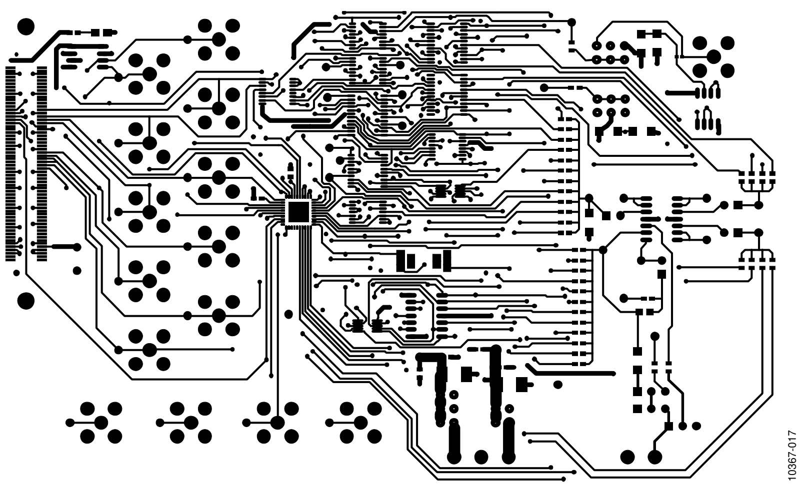

Figure 15. Component Placement Drawing

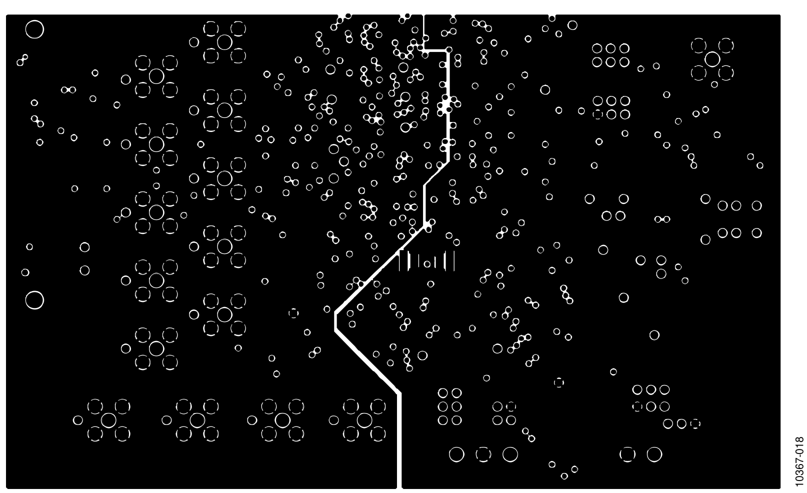

Figure 16. Layer 2 Side PCB Drawing

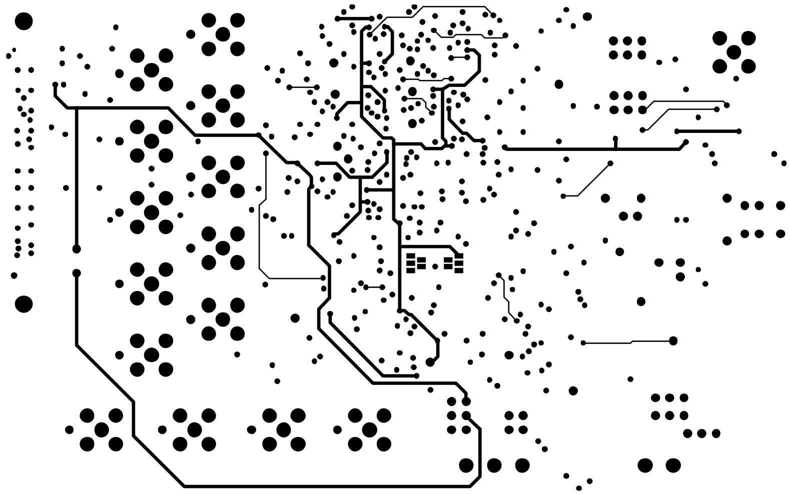

Figure 17. Layer 3 Side PCB Drawing

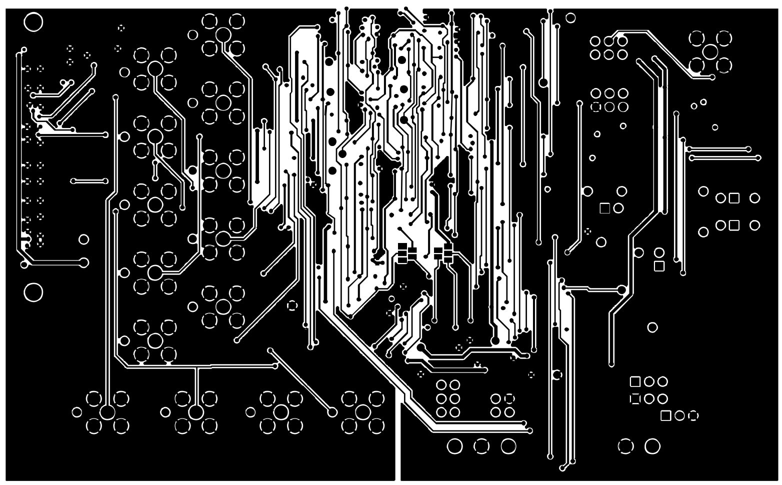

Figure 18. Solder Side PCB Drawing

ORDERING INFORMATION

BILL OF MATERIALS

Table 7.

Qty	Reference Designator	Description	Supplier[1]/Part Number
1	C1	10 nF capacitor, 0805	FEC 1692285
4	C2, C4, C25, C26	0.1 µF capacitor, 0603	FEC 138-2224
1	C3	1 µF capacitor, 0402	FEC 1288253
2	C24, C27	10 µF capacitor, 1206	FEC 1611967
1	D6	LED, green	FEC 579-0852
1	J1	3-pin connector	FEC 151790
1	J2	2-pin connector	FEC 151789
1	J22	Receptacle, 0.6 mm, 120-way	Digi-Key H1219-ND
4	A20, A21, A24, A25	Header 2-row, 36 + 36 way and jumper socket, black	FEC 148-535 and FEC 150-410
3	A27, A29, A30	Header 1-row, 3-way and jumper socket, black	FEC 102-2248 and FEC 150-410
4	BUF-W1, OAVOUT, BUF-3, BUF-4	Header 1-row, 2-way and jumper socket, black	FEC 102-2247 and FEC 150-410
1	R41	1.78 kΩ resistor, 0603, 1%	FEC 1170811
2	R1, R2	2.2 kΩ resistor, 0603, 1%	FEC 933-0810
5	R3, R4, R38, R39, R40	2.7 kΩ resistor, 1206, 1%	FEC 9337288
40	AD5162-1, AD5162-2, AD5222-1, AD5222-2, AD5204-1, AD5204-2, AD5204-3, AD5204-4, AD5222-1, AD5222-2, AD5232-1, AD5232-2, AD5233-1, AD5233-2, AD5233-3, AD5233-4, AD5235-1, AD5235-2, AD5243-1, AD5243-2, AD5252-1, AD5252-2, AD5222-1, AD5222-2, AD5222-3, AD5222-4, AD5222-1, AD5222-2, AD5222-3, AD5222-4, ADN2850-1, ADN2850-2, R34, R35, R42, R43	0 Ω resistor, 0603	FEC 9331662
1	R37	1 kΩ resistor, 0603, 1%	FEC 933-0380
6	3.3 V, 5 V, DGND, AGND, VDD, VSS	Test point, PCB, black, PK100	FEC 873-1128
34	A1, A2, A3, A4, RDY|MODE, RESET_BF, SCL_BF, SCLK_BF, SDA_BF, SDO_BF, SHDN_BF, SYNC_BF, MUX-A0|CS, MUX-A1|DACSEL MUX-A2|U/D, O1, O2, DIN_BF, CLK, B1, B2, B3, B4, V1, V2, VOUT, VOUT2, VOUT3, VOUT4, W1, W1_BUF, W2, W3, W4, WP_BUF	Test point, PCB, red, PK100	FEC 873-1144
1	U1	256-position, dual-channel, I²C-compatible digital potentiometer	Analog Devices AD5243
1	U2	256-position, dual-channel, SPI digital potentiometer	Analog Devices AD5162
1	U3	256-position, one-time programmable, dual-channel, I²C digital potentiometer	Analog Devices AD5172
1	U4	Nonvolatile, quad, 64-position digital potentiometer	Analog Devices AD5233
1	U5	Dual, increment/decrement digital potentiometer	Analog Devices AD5222
1	U6	4-channel digital potentiometer	Analog Devices AD8403
1	U7	Quad, 256-position, I²C, nonvolatile memory digital potentiometer	Analog Devices AD5254
1	U8	4-channel digital potentiometer	Analog Devices AD5204
1	U9	I²C, nonvolatile memory, dual, 256-position digital potentiometer	Analog Devices AD5252
1	U10	Nonvolatile memory, dual, 256-position digital potentiometer	Analog Devices AD5232
1	U11	Dual, 1024-position digital potentiometer with nonvolatile memory and SPI interface	Analog Devices AD5235

Qty	Reference Designator	Description	Supplier[1]/Part Number
1	U12	Dual, 1024-position digital rheostat with nonvolatile memory and SPI interface	Analog Devices ADN2850
1	U13	2.5 V/3.3 V, 16-bit (dual 8-bit), two-port level translator bus switch	Analog Devices ADG3247
1	U14	Precision, 20 MHz, CMOS, quad, rail-to-rail operational amplifier	Analog Devices AD8618
1	U15	50 MHz, precision, low distortion, low noise CMOS amplifier	Analog Devices AD8652
1	U25	24LC64 EEPROM	FEC 975-8070
1	A22	3 V/5 V, ± 5 V CMOS, 8-channel analog multiplexer	Analog Devices ADG658

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

RELATED LINKS

Resource	Description
AD5243	Product Page, 256-Position Dual-Channel I²C Compatible Digital Potentiometer
AD5162	Product Page, 256-Position Dual-Channel SPI Digital Potentiometer
AD5233	Product Page, Nonvolatile, Quad, 64-Position Digital Potentiometer
AD5222	Product Page, Dual, Increment/Decrement Digital Potentiometer
AD8403	Product Page, 4-Channel Digital Potentiometer
AD5254	Product Page, Quad 256-Position I²C Nonvolatile Memory, Digital Potentiometer
AD5204	Product Page, 4-Channel Digital Potentiometer
AD5252	Product Page, I²C, Nonvolatile Memory, Dual 256-Position Digital Potentiometer
AD5232	Product Page, Nonvolatile Memory, Dual, 256-Position Digital Potentiometer
AD5235	Product Page, Nonvolatile Memory, Dual 1024-Position Digital Potentiometer
ADN2850	Product Page, Nonvolatile Memory, Dual 1024-Position Digital Resistor
ADG3247	Product Page, 2.5 V/3.3 V, 16-Bit (Dual 8-Bit), 2-Port Level Translator, Bus Switch
ADG658	Product Page, 3 V/5 V ± 5 V CMOS 8-Channel Analog Multiplexer
AD8652	Product Page, 50 MHz, Precision, Low Distortion, Low Noise CMOS Amplifier
AD8618	Product Page, Precision 20 MHz CMOS Quad Rail-to-Rail Operational Amplifier

NOTES

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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