Evaluation Board User Guide
UG-392

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Evaluation Board for the AD5259 Digital Potentiometer

FEATURES

Full-featured 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-AD5259DBZ 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 AD5259 data sheet**
- **Electronic version of the UG-392 user guide**

GENERAL DESCRIPTION

This user guide describes the evaluation board for evaluating the AD5259, a single-channel, 256-position, nonvolatile memory digital potentiometer in conjunction with the low voltage digiPOT motherboard.

The AD5259 supports single-supply 2.7 V to 5.5 V operation, making the device suited for battery-powered applications and many other applications with superior low temperature coefficient performance.

In addition, the AD5259 uses a versatile I^2C serial interface that operates in fast mode, allowing speeds of up to 400 kHz. This interface can be used to read back the wiper register and EEPROM content.

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

Complete specifications for the AD5259 part can be found in the AD5259 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-AD5259DBZ WITH MOTHERBOARD AND SDP-B

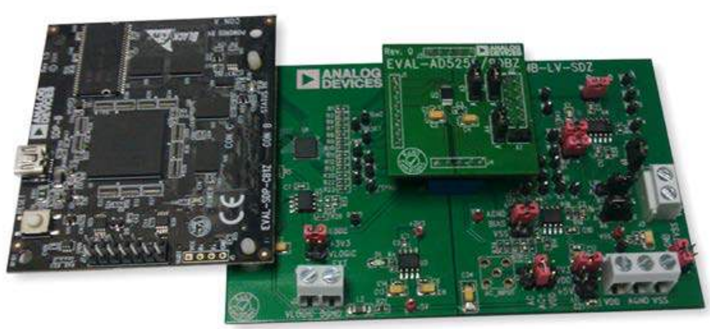

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Figure 1. Digital Picture of Evaluation Board with Low Voltage DigiPOT Motherboard and System Demonstration Platform

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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 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). EXT 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 (external supply from the J2 connector).
A12	GND	AGND.

TEST CIRCUITS

The EVAL-AD5259DBZ and EVAL-MB-LV-SDZ incorporate several test circuits to evaluate the performance of the AD5259.

DAC

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

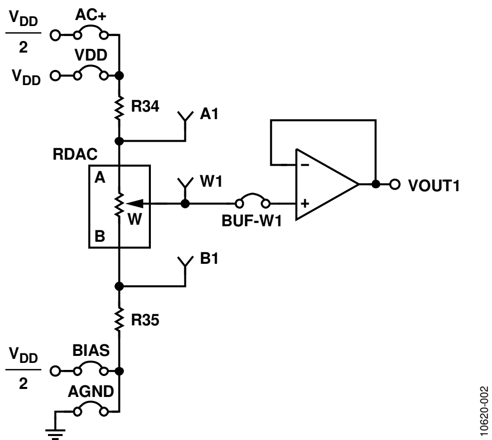

Figure 2. DAC

Table 5 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, 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 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.

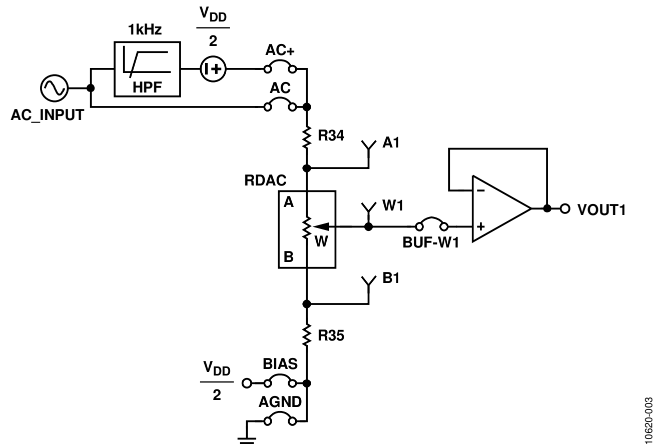

Figure 3. AC Signal Attenuator

Depending on the voltage supply rails and the dc offset voltage of the ac signal, various configurations can be used as described in Table 4.

Table 4. 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 $\neq V_{DD}/2$[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 resistor between the W and B terminals.
R_W is the wiper resistance.
$R_{END\text{-}TO\text{-}END}$ is the end-to-end resistance value.

Table 5. DAC Voltage References

Terminal	Link (Daughter Board)	Link (Motherboard)	Options	Description
A1	Switch B of A4	A9	AC+	Connects Terminal A1 to V_{DD} /2
			VDD	Connects Terminal A1 to V_{DD}
W1	Switch B of A3	BUF-W1		Connects Terminal W1 to an output buffer
B1	Switch B of A2	A10	BIAS	Connects Terminal B1 to $V_{DD}/2$
			AGND	Connects Terminal B1 to analog ground
	A1 inserted			Closes feedback loop of second op amp in the AD8618

Signal Amplifier

The RDAC 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.

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

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

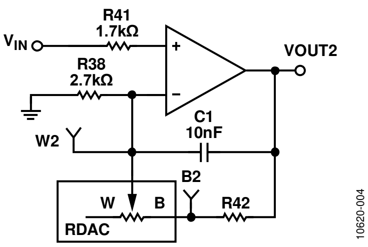

Figure 4. Linear Noninverting Amplifier

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

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

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

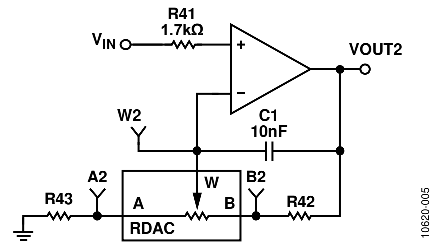

Figure 5. Pseudologarithmic Noninverting Amplifier

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.

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

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

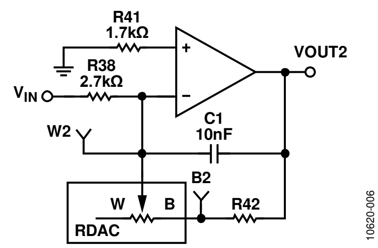

Figure 6. Linear Inverting Amplifier

Table 6. Amplifier Selection Link Options

Amplifier	Gain	Link (Daughter Board)	Link (Motherboard)	Label	V_{IN} Range
Noninverting	Linear	Switch A of A2, A3, and A4	A7	LIN	0 V to V_{DD}
			A6	N-INV	
		A1 not inserted	A8	N-INV	
	Pseudologarithmic	Switch A of A2, A3, and A4	A7	LOC	0 V to V_{DD}
			A6	N-INV	
		A1 not inserted	A8	N-INV	
Inverting	Linear	Switch A of A2, A3, and A4	A7	LIN	$-V_{DD}$ to 0 V
			A6	INV	
		A1 not inserted	A8	INV	

EVALUATION BOARD SOFTWARE

INSTALLING THE SOFTWARE

The EVAL-AD5259DBZ 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.

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-AD5259DBZ and EVAL-MB-LV-SDZ to the SDP board and the SDP 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.

RUNNING THE SOFTWARE

To run the program, do the following:

1. Click **Start** > **All Programs** > **Analog Devices** > **AD5259**> **AD5259 Eval Board**. To uninstall the program, click **Start** > **Control Panel** > **Add or Remove Programs** > **AD5259 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). Simply connect the evaluation board to the USB port of the PC, wait a few seconds, click **Rescan**, and follow the instructions.

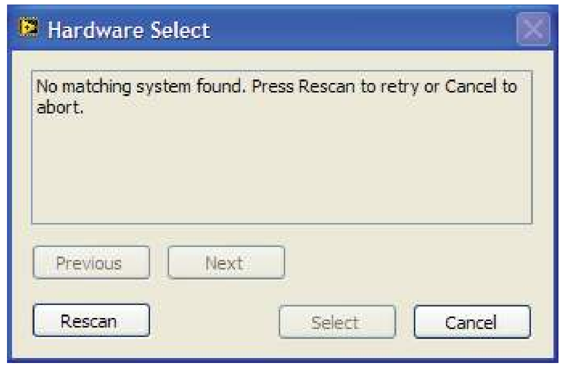

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Figure 7. Pop-Up Window Error

The main window of the EVAL-AD5259DBZ software then opens, as shown in Figure 8.

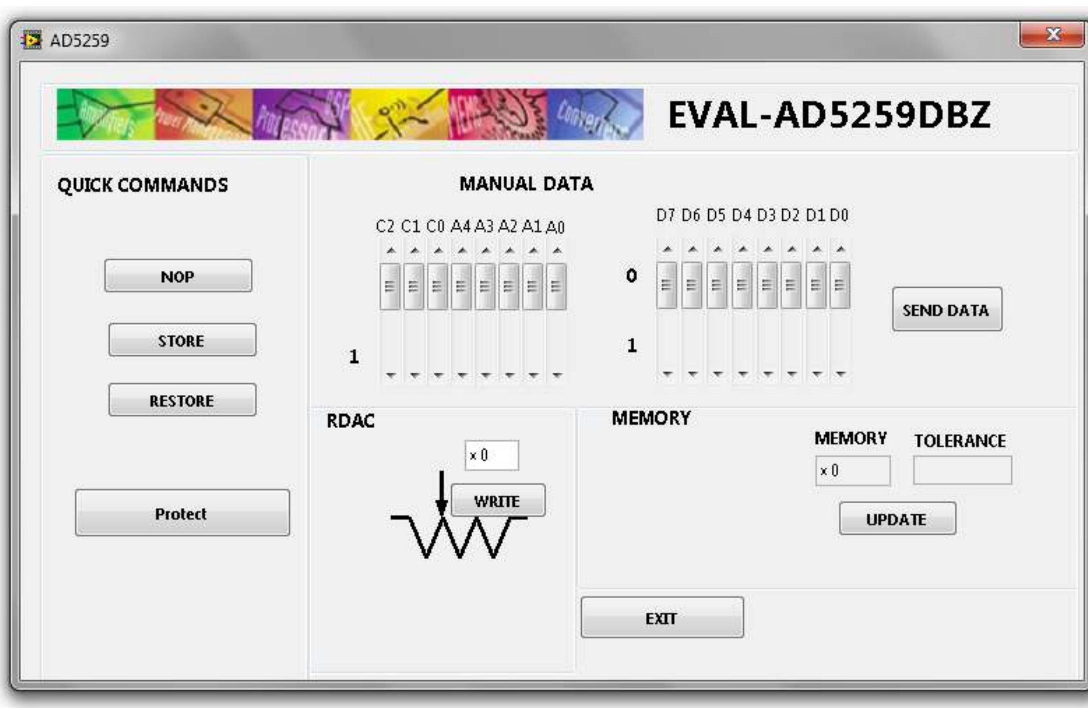

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Figure 8. EVAL-AD5259DBZ Software Main Window

SOFTWARE OPERATION

The main window of the EVAL-AD5259DBZ software is divided into the following sections: **QUICK COMMANDS, MANUAL DATA, RDAC**, and **MEMORY**.

QICK COMMANDS has the following options:

- **NOP** places the device in no operation mode, reducing the power consumption of the device.
- **STORE** saves the value of the RDAC register in the EEPROM memory.
- **RESTORE** transfers the data of the EEPROM memory into the RDAC register.
- **Protect/Unprotect** allows you to protect or unprotect the data writing.

MANUAL DATA has the following option:

- 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.

RDAC has the following option:

- Enter a desired value into the text box to update the RDAC registers and click **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.

MEMORY has the following option:

- Clicking **UPDATE** reads the content of the EEPROM memory and the tolerance of the resistance.

EXIT closes the program.

EVALUATION BOARD SCHEMATICS AND ARTWORK

MOTHERBOARD

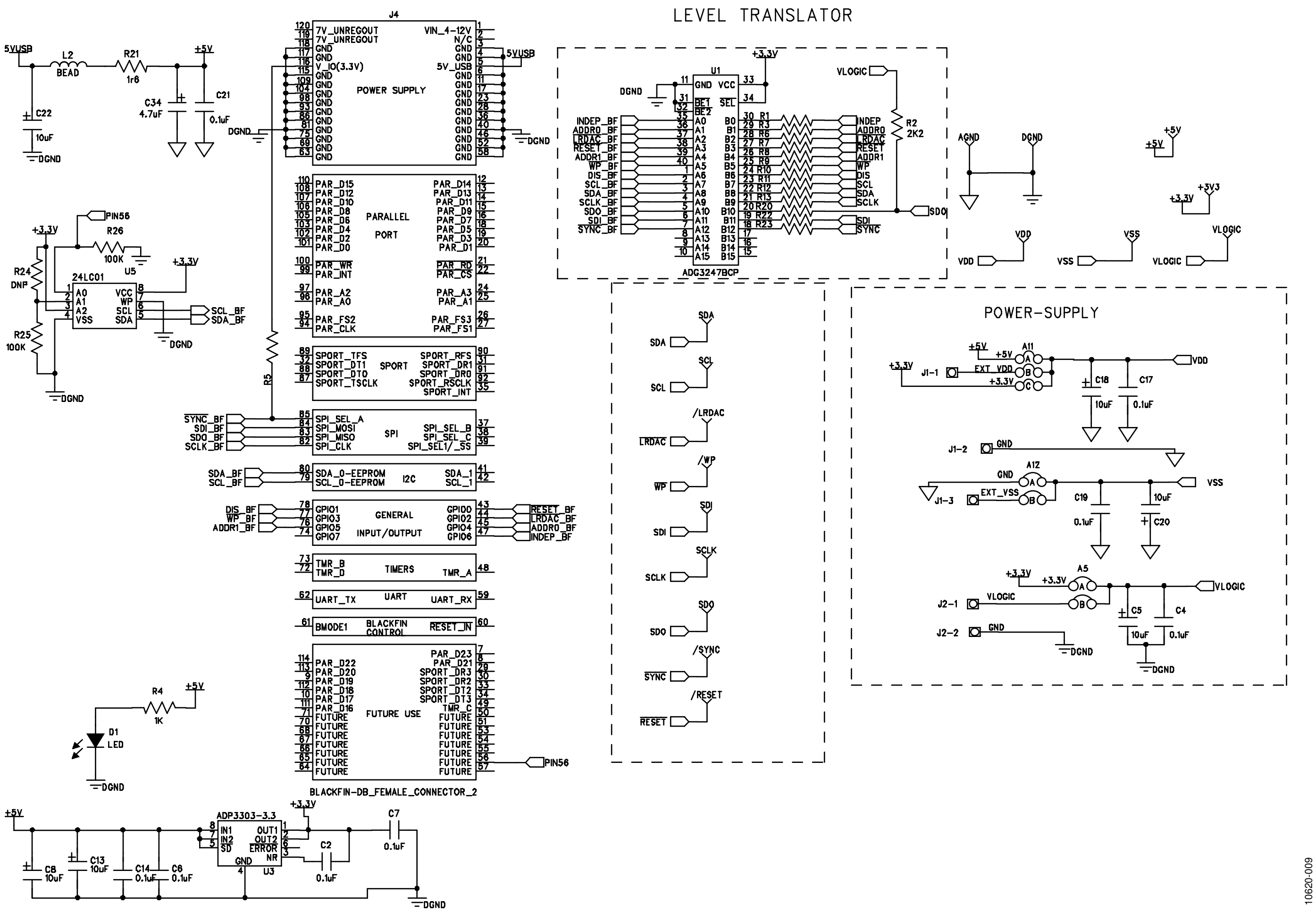

Figure 9. SDP Connector and Power Supply

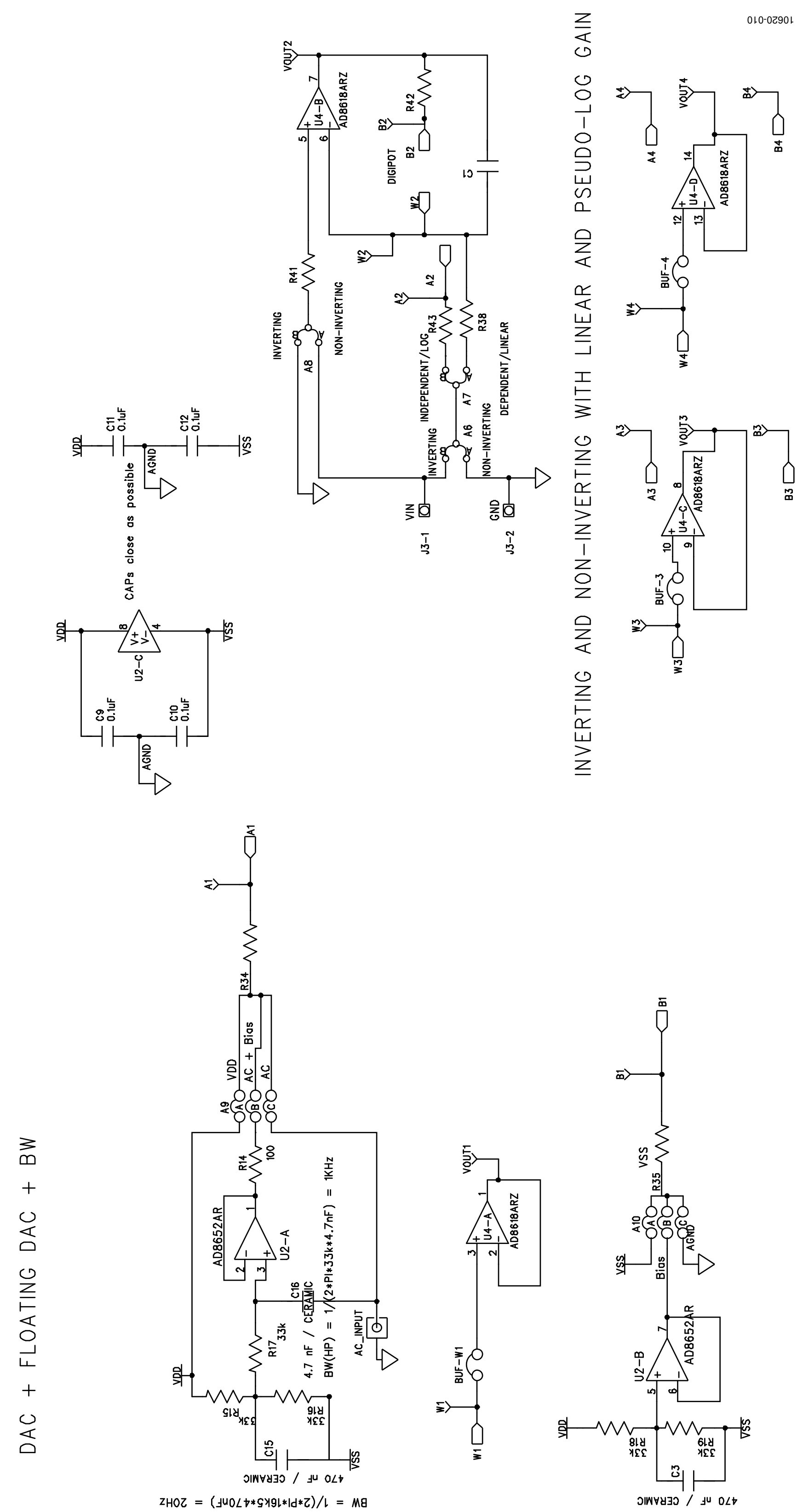

Figure 10. Schematic of Test Circuits

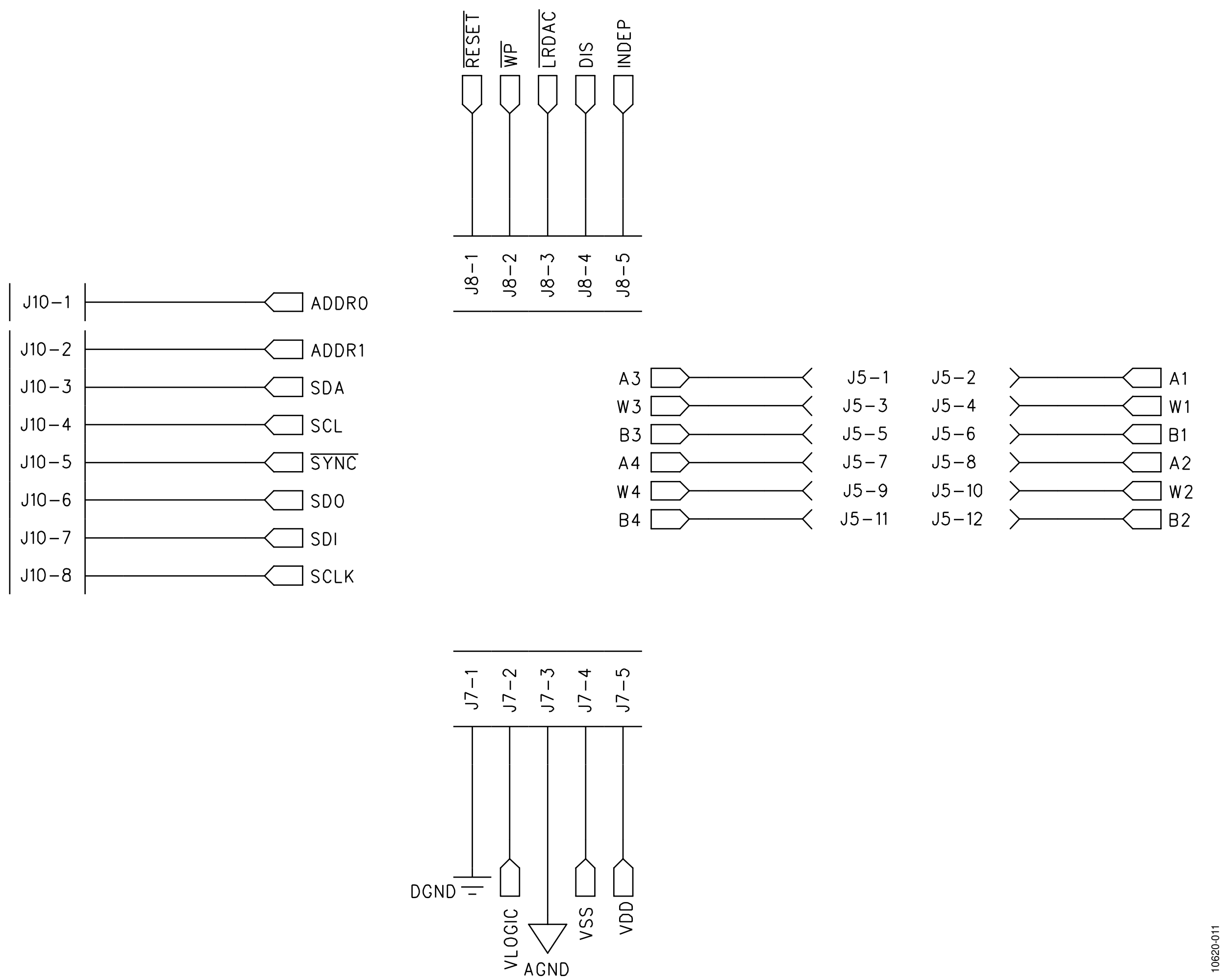

Figure 11. Schematic of Connectors to Daughter Board

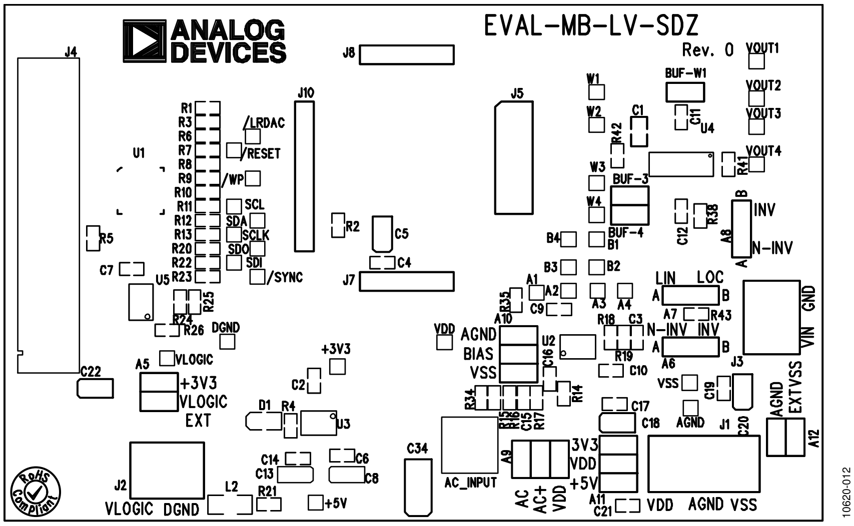

Figure 12. Component Side View

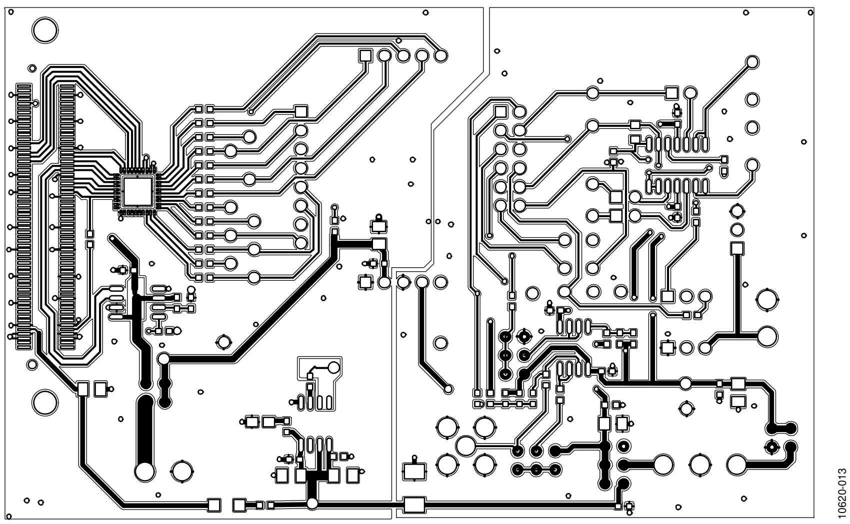

Figure 13. Component Placement Drawing

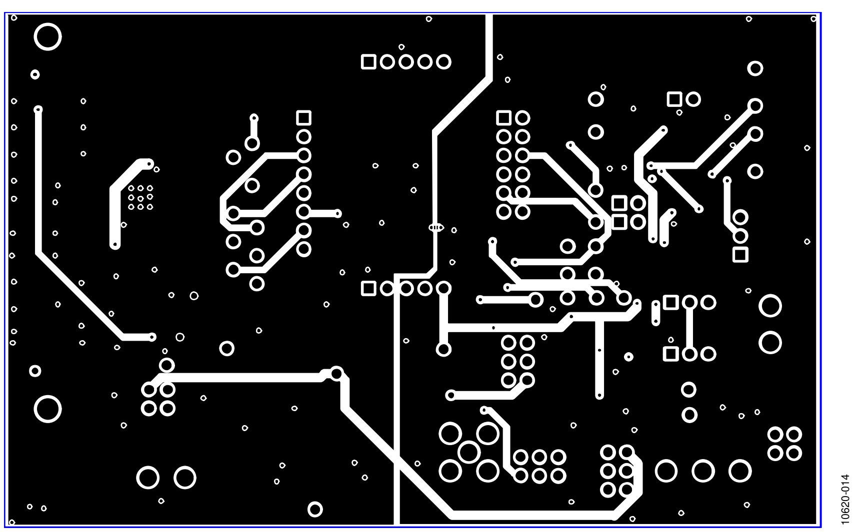

Figure 14. Layer 2 Side PCB Drawing

DAUGHTER BOARD

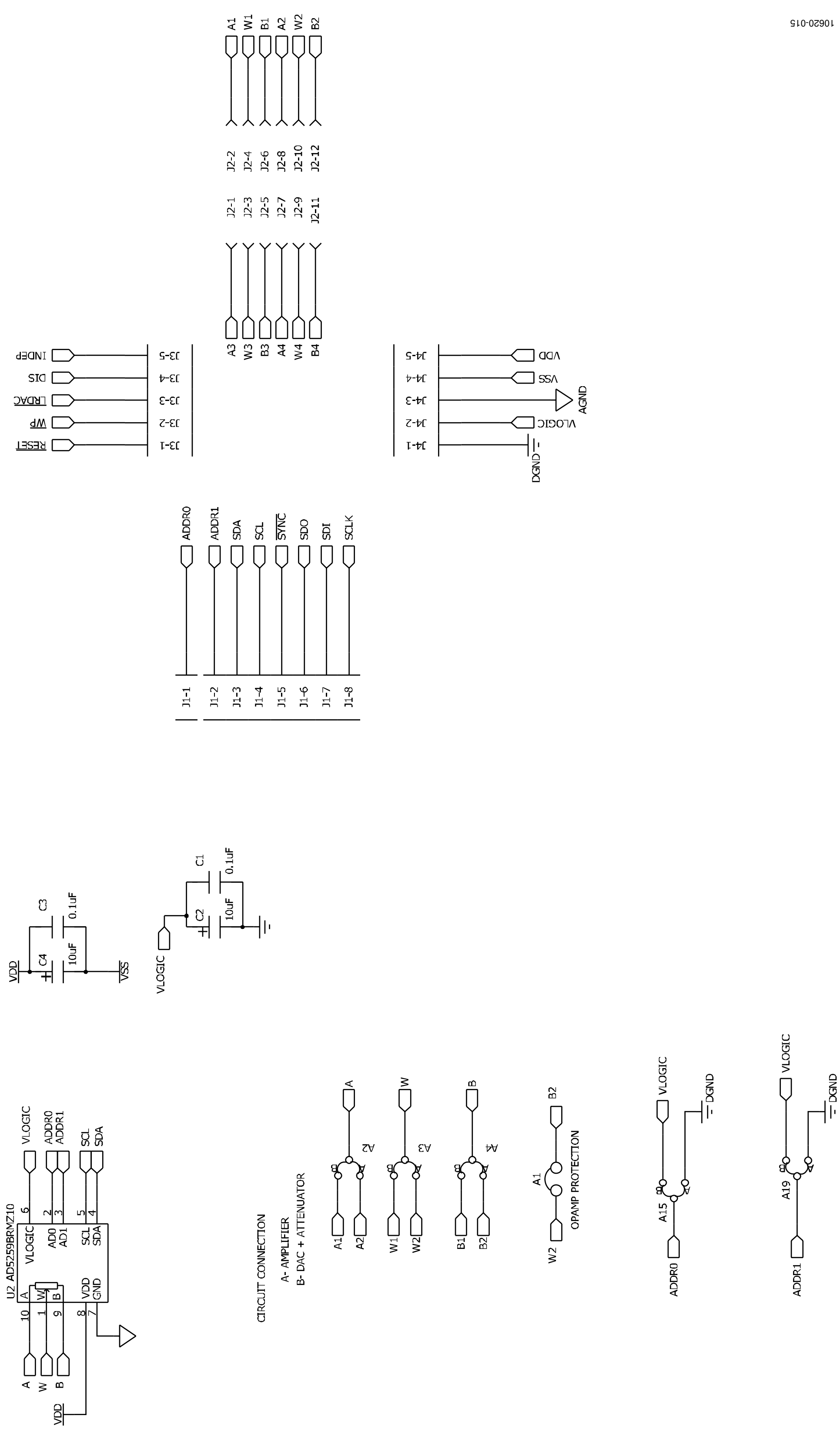

Figure 15. Schematic of Daughter Board

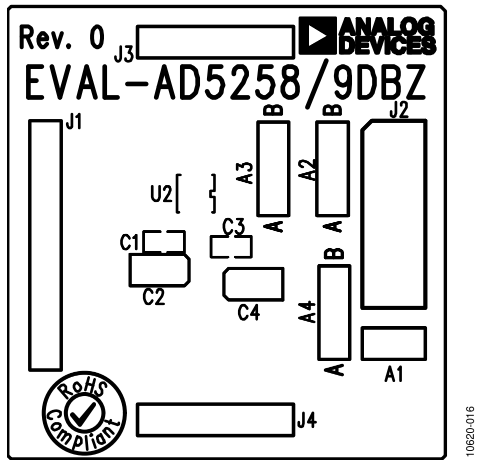

Figure 16. Component Side View

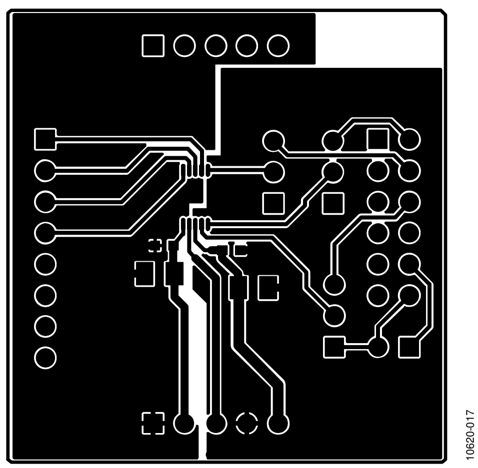

Figure 17. Component Placement Drawing

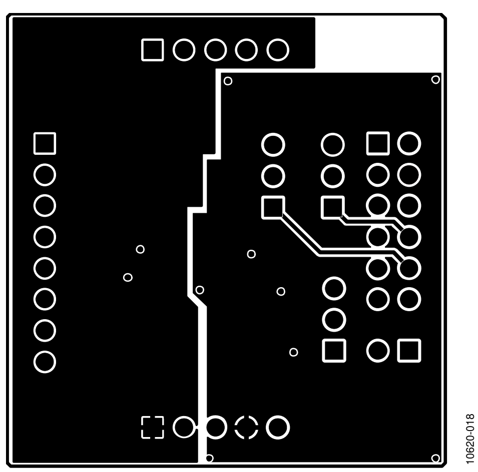

Figure 18. Layer 2 Side PCB Drawing

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 150-411
3	A6, A7, A8	3-pin SIL header and shorting link	FEC 1022248 and 150410
5	A5, A9, A10, A11, A12	6-pin (3 × 2), 0.1" header and shorting block	FEC 148-535 and 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	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 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	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^{2}C serial EEPROM 64k 2.5 V MSOP-8	FEC 1331335
27	$\overline{\text{LRDAC}}$, $\overline{\text{RESET}}$, $\overline{\text{SYNC}}$, $\overline{\text{WP}}$, 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 8. Daughter Board

Qty	Reference Designator	Description	Supplier[1]/Part Number
1	U2	256-position digital potentiometer	AD5259BRMZ10
1	A1	2-pin (0.1" pitch) header and shorting shunt	FEC 1022247 and 150-411
3	A2, A3, A4	3-pin SIL header and shorting link	FEC 1022248 and 150410
2	C2, C4	6.3 V tantalum capacitor (Case A), 10 μF, ±20%	FEC 1190107
2	C1, C3	50 V, X7R ceramic capacitor, 0.1 μF, ±10%	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.

NOTES

I^2C 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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