

Evaluating the **AD5761R** 16-Bit Serial Input, Voltage Output DAC with Single/Dual Supply

FEATURES

Fully featured evaluation board for the **AD5761R** with the **ADP5070** power solution

Power solution generated from single 3 V supply

PC control in conjunction with the Analog Devices, Inc.,

EVAL-SDP-CB1Z SDP-B

PC software for control

GENERAL DESCRIPTION

This user guide supports the EVAL-AD5761RSDZ evaluation board, Revision D. The **UG-751** user guide supports previous revisions of the evaluation board.

The EVAL-AD5761RSDZ is a fully featured evaluation board that allows the user to easily evaluate all the features of the **AD5761R** 16-bit, voltage output digital-to-analog converter (DAC). The **AD5761R** pins are accessible at on-board connectors for external connection. The evaluation board can be controlled by two means: via the on-board peripheral module (PMOD) connector (J5), or via the system demonstration platform (SDP) connector (J1).

The evaluation board also integrates a power solution utilizing the **ADP5070** switching regulator and linear regulators (**ADP7142**, **ADP7182**) to generate a bipolar supply of up to -13 V and $+23.2\text{ V}$

from a single supply as low as $+3\text{ V}$. The 3 V input voltage is supplied with a linear power supply via the on-board connector (PVIN_3V-15V), through the USB port connector (USB_POWER), or from the SDP-B controller board. The bipolar supply generated by the power solution allows the DAC to operate in any of the available eight different output ranges. Alternatively, the DAC can be supplied with a linear power supply via the on-board connector (J4).

The **EVAL-SDP-CB1Z** SDP-B board allows the EVAL-AD5761RSDZ to be controlled through the USB port of a Windows® based PC featuring Windows XP or later, using the **AD5761R** evaluation software.

The **AD5761R** is a single channel, 16-bit serial input, voltage output DAC. The device operates from single supply voltages from $+4.75\text{ V}$ up to $+30\text{ V}$, or dual supply voltages from -16.5 V to 0 V (V_{SS}) and $+4.75\text{ V}$ to $+16.5\text{ V}$ (V_{DD}). The nominal full-scale output range is software or hardware selectable. The integrated output amplifiers, reference buffers, and power-up/power-down control circuitry provide an easy to use, universal solution.

Complete specifications for the **AD5761R** are available in the **AD5761R** data sheet, which should be consulted in conjunction with this user guide when using this evaluation board.

EVALUATION BOARD PHOTOGRAPH

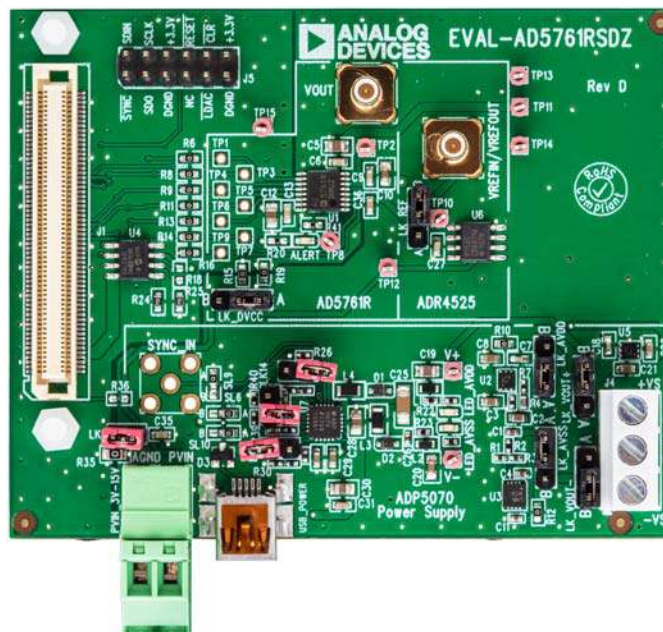


Figure 1.

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REVISION HISTORY

8/2017—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES AND DEFAULT LINK OPTIONS

The EVAL-AD5761RSDZ evaluation board can be powered using the on-board **ADP5070** from a single voltage. The voltage sources available are an external single supply via the PVIN_3V-15V connector, the USB_POWER connector, and a supply sourced from the SDP-B controller board (LK2 inserted).

Alternatively, the J4 connector can provide power to the board, instead of the **ADP5070**, and it is intended for use with well-regulated bench supplies. See Figure 2 for a functional block diagram of the evaluation board.

With any of the possible options, set the link options on the evaluation board for the required operating setup first before supplying the board.

Each supply is decoupled to the relevant ground plane with 10 μF and 0.1 μF capacitors. Each device supply pin is again decoupled with a 10 μF and 0.1 μF capacitor pair to the relevant ground plane.

The analog and digital planes are connected at one location close to the DAC. To avoid ground loop problems, do not connect AGND and DGND elsewhere in the system.

Table 1. Quick Start Jumper Configuration for On-Board **ADP5070**, Bench Supply, and USB Port

Link No.	ADP5070 with LDOs	ADP5070	Bench Supply with LDOs	Bench Supply
LK7	Removed	Inserted	Not applicable	Not applicable
LK8	Removed	Inserted	Not applicable	Not applicable
LK14	Removed	Removed	Inserted	Inserted
LK_AVDD	A	B	A	B
LK_AVSS	A	B	A	B
LK_DVCC	A	B	A	B
LK_REF	B	B	B	B
LK_VOUT+	B	B	A	A
LK_VOUT-	B	B	A	A

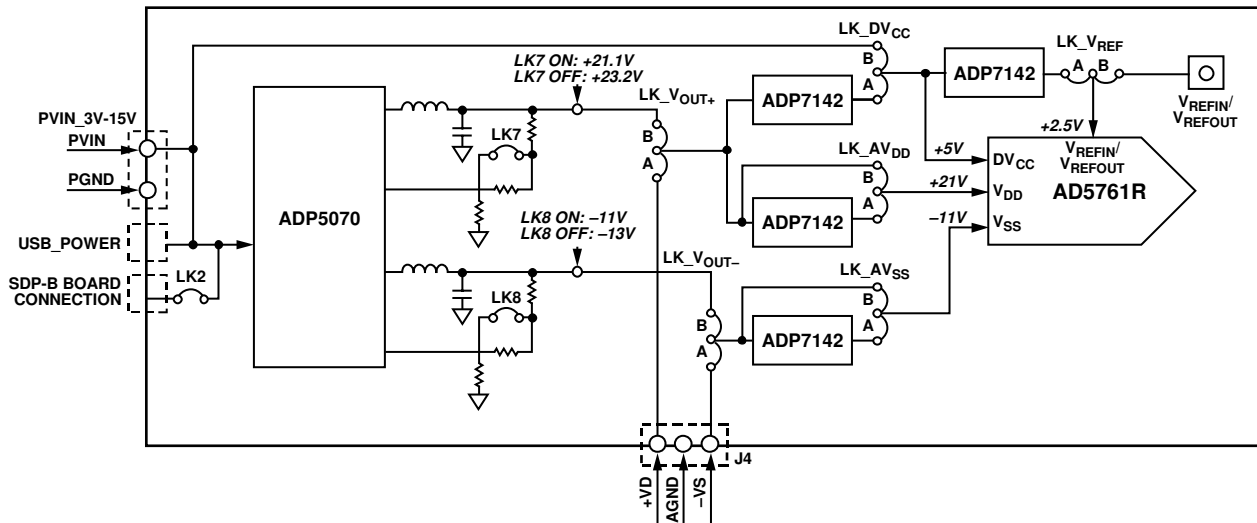


Figure 2. Powering the EVAL-AD5761RSDZ Evaluation Board

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POWER SOLUTION (ADP5070)—SINGLE-SUPPLY OPTION

The EVAL-AD5761RSDZ is populated with an [ADP5070](#) switching regulator. This regulator is preceded by voltage regulators ([ADP7142](#), [ADP7182](#)) that can be bypassed if required. The supplies generated from the [ADP5070](#) alone or with the addition of the voltage regulators are -11 V and $+21.1\text{ V}$ from a single supply as low as $+3\text{ V}$. These generated voltages allow the [AD5761R](#) to output any of the eight available ranges within the DAC. Note that Link LK7 and Link LK8 must be inserted when the voltage regulators are bypassed to avoid surpassing the absolute maximum ratings of the [AD5761R](#) DAC.

The circuit was designed using the Analog Devices® [ADIsimPower™](#) toolset, which selects the components and generates the schematic and bill of materials, and displays the performance specifications. Visit the [ADP5070](#) product page to download the design tools.

The [ADP5070](#) requires a minimum voltage supply of 3 V for correct operation. Following the jumper configuration in Table 1 for the on-board [ADP5070](#) or the [ADP5070](#) with low dropout regulators (LDOs) options, the board can be supplied in three alternative ways: external 3 V to 15 V single supply, USB port supply, and SDP-B controller board supply.

External 3 V to 15 V Single Supply

The EVAL-AD5761RSDZ board is supplied with a voltage in the range of 3 V to 15 V , via the PVIN_3V-15V connector.

Note that Link LK2 must be removed for the power supply to be driving the minimum 3 V . Also note that Link LK14 must be removed to enable both the positive and negative outputs on the [ADP5070](#). See Table 2 for full link options.

USB Port Supply

The EVAL-AD5761RSDZ is supplied through the USB_POWER connector via a USB mini-B cable. No extra voltage supplies are required for the board to operate.

Note that the LK2 link must be removed for the USB port to be the only supply source. Also note that Link LK14 must be removed to enable both the positive and negative outputs on the [ADP5070](#). Refer to Table 2 for full link options.

SDP-B Controller Board Supply

Alternatively, the EVAL-AD5761RSDZ can be supplied with 5 V coming from the Blackfin® on the SDP-B board.

Note that Link LK2 must be inserted for the 5 V supply to be available on the EVAL-AD5761RSDZ. Also note that Link LK14 must be removed to enable both positive and negative outputs on the [ADP5070](#). Refer to Table 2 for full link options.

BENCH POWER SUPPLY—DUAL-SUPPLY OPTION

The EVAL-AD5761RSDZ can be powered using a bench supply to allow all output voltage ranges of the [AD5761R](#). A headroom and footroom of at least 1 V is required on the dual supply. It is important that the voltage across V_{DD} to V_{SS} does not exceed the absolute maximum rating of 34 V . Otherwise, device reliability may be affected.

Following the jumper configuration in Table 1 for the bench supply or bench supply with LDOs options, supply the board with a dual supply of $-V_s = -11\text{ V}$ and $+V_s = +21\text{ V}$ via the J4 connector.

Note that Link LK14 must be inserted to disable both positive and negative outputs on the [ADP5070](#). This configuration avoids any possible noise to be coupled to the power solution when a supply is simultaneously applied to the [ADP5070](#) switching regulator. Refer to Table 2 for full link options.

Table 2. Link Options

Link No.	Description
LK2	This link selects the 5 V single voltage from the Blackfin on the SDP-B controller board to supply the ADP5070 switching regulator. An inserted link selects the 5 V voltage supply sourced from the SDP-B. A removed link does not select the 5 V voltage supply sourced from the SDP-B.
LK7	This link selects the voltage measured before the regulation stage (at the V+ test point). An inserted link selects a voltage of 21.1 V. A removed link selects a voltage of 23.2 V.
LK8	This link selects the voltage measured before the regulation stage (at the V- test point). An inserted link selects a voltage of -11 V. A removed link selects a voltage of -13 V.
LK14	This link selects whether the ENx pins of the ADP5070 are connected to Resistor R40. An inserted link disables the outputs of the ADP5070 switching regulator and avoids unexpected noise to be coupled to the power solution. A removed link enables the outputs of the ADP5070 switching regulator.
LK_AVDD	This link selects the voltage source for the positive analog supply, V_{DD} . Position A selects the source from the positive voltage generated by the ADP5070 and adjusted by an ADP7142 regulator. Note that Link LK7 must be inserted to avoid surpassing the absolute maximum ratings of the AD5761R DAC. Position B selects the source from the positive voltage generated by the ADP5070 when the LK_VOUT+ link is shorted to Position B. If the LK_VOUT+ link is shorted to Position A, the source comes from an externally applied voltage at +VS of J4.
LK_AVSS	This link selects the voltage source for the negative analog supply, V_{SS} . Position A selects the source from the negative voltage generated by the ADP5070 and adjusted by an ADP7182 regulator. Note that Link LK8 must be inserted to avoid surpassing the Absolute Maximum Ratings of the AD5761R DAC. Position B selects the source from the negative voltage generated by the ADP5070 when the LK_VOUT- link is shorted to Position B. If the LK_VOUT- link is shorted to Position A, the source comes from an externally applied voltage at -VS of J4.
LK_DVCC	This link selects the source of the digital power supply, DV_{CC} . Position A selects the source from the positive voltage generated by the ADP5070 and adjusted by an ADP7142 regulator. Note that Link LK7 must be inserted to avoid surpassing the Absolute Maximum Ratings of the AD5761R DAC. Position B selects the source from the USB port bus or alternatively from an externally applied voltage at the PVIN_3V-15V connector.
LK_REF	This link selects the source of the external reference voltage. Position A selects the source from the on-board ADR4525 reference. Position B selects the source from the voltage applied to the VREFIN/VREFOUT connector.
LK_VOUT+	This link selects the voltage source for the positive analog supply, V_{DD} , at the preregulation stage. Position A selects the source from the voltage externally applied at +VS of J4. Position B selects the source from the positive voltage generated by the ADP5070 .
LK_VOUT-	This link selects the voltage source for the positive analog supply, V_{SS} , at the preregulation stage. Position A selects the source from the voltage externally applied at -VS of J4. Position B selects the source from the negative voltage generated by the ADP5070 .
SL6	This link selects the ADP5070 VPOS/VNEG start-up sequence control. An open link selects a manual startup. Position A selects a sequenced startup. Position B selects a simultaneous startup.
SL9	This link selects the ADP5070 frequency setting and synchronization input. An open link and an external clock connected to SYNC_IN synchronizes the switching frequency. Position A sets the switching frequency to 1.2 MHz. Position B sets the switching frequency to 2.4 MHz.
SL10	This link selects the ADP5070 driver stage slew rate control. An open link selects the fastest slew rate. Position A selects the slowest slew rate. Position B selects a normal slew rate.

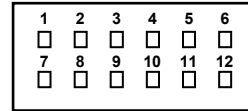
ON-BOARD CONNECTORS

There are eight connectors on the EVAL-AD5761RSDZ, as shown in Table 3.

Table 3. On-Board Connectors

Connector	Function
J1	Connection for the EVAL-SDP-CB1Z SDP-B board
J4	Supplies AV _{DD} and AV _{SS} externally
J5	Peripheral module (PMOD) connection pins
PVIN_3V-15V	Supplies a voltage in the range of 3 V to 15 V externally
SYNC_IN	Switching frequency synchronization connector
VOUT	DAC output connector
VREFIN/VREFOUT	Internal reference voltage output and external reference voltage input connector
USB_POWER	USB port connector

PMOD Connector (J5) Pin Configuration and Descriptions



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Figure 3. Jumper J5 Pin Configuration

Table 4. Connector J5 Pin Descriptions

Pin No.	Description
1	SYNC
2	SDIN/MOSI
3	SDO/MISO
4	SCLK
5	DGND
6	+3.3 V
7	NC ¹
8	$\overline{\text{RESET}}$
9	$\overline{\text{LDAC}}$
10	$\overline{\text{CLR}}$
11	DGND
12	+3.3 V

¹ NC means no connection.

EVALUATION BOARD SOFTWARE

SOFTWARE INSTALLATION

The AD5761R evaluation kit includes self installing evaluation software on a CD. The evaluation software is compatible with Windows XP or later Windows based PCs. If the setup file does not run automatically, run **setup.exe** from the CD.

Install the evaluation software before connecting the evaluation board and SDP-B board to the USB port of the PC to ensure that the evaluation system is correctly recognized when connected to the PC.

After installation from the CD is complete, power up the EVAL-AD5761RSDZ evaluation board as described in the Power Supplies and Default Link Options section. Connect the SDP-B board (Connector A) to the evaluation board and then to the USB port of your PC using the supplied cable.

When the evaluation system is detected, proceed through any dialog boxes that appear to complete the installation.

SOFTWARE OPERATION

To launch the evaluation software, complete the following steps:

1. From the **Start** menu, click **Analog Devices > AD5761R > AD5761R Evaluation Software**. The main window of the software opens (see Figure 7).
2. If the evaluation system is not connected to the USB port when the software is launched, a connectivity error displays (see Figure 4). Connect the evaluation board to the USB port of the PC, wait a few seconds, and click **Rescan**. Follow the instructions that appear.

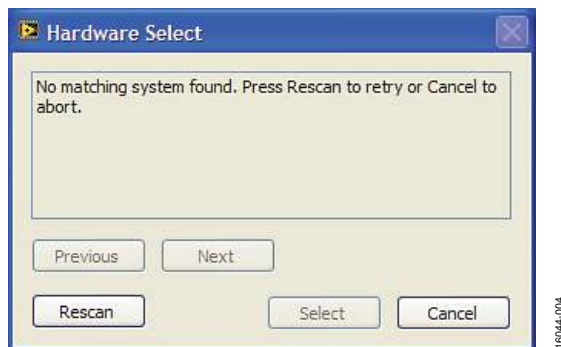


Figure 4. Connectivity Error Alert

MAIN WINDOW

The main window of the evaluation software is divided into two tabs: **Configure** and **DAC**.

Begin by choosing the device to evaluate: the AD5761R (16-bit resolution) or the AD5721R (12-bit resolution). Note that clicking the AD5721R option allows the user to evaluate the AD5761R as a 12-bit DAC; there is no separate evaluation setup for the AD5721R. A dialog box appears for this selection, as shown in Figure 5.

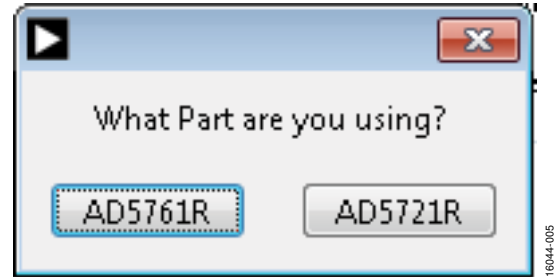


Figure 5. Device Selection

AD5761R Configuration

The **Configure** tab allows access to the control register and the mode of the daisy-chain functionality of the device. Figure 7 shows the **Configure** tab in the main window.

The AD5761R requires an initial command to write to the control register to remove the output clamp to ground. A dialog box appears as a reminder to write to the control register (see Figure 6). During the same write, configure the AD5761R as necessary to modify the default values for the power-up voltage (**Power Up Voltage**), voltage output range (**Output Range**), clear voltage (**CLEAR Voltage**), overrange (**OVR**), bipolar range coding (**B2C**), thermal shutdown alter (**ETS**), and internal reference mode (**IRO**). (See Figure 7.)

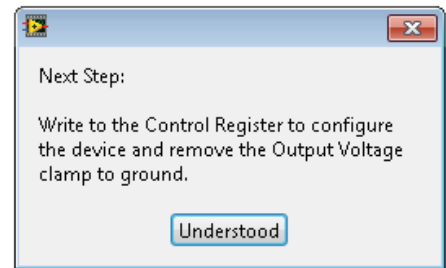


Figure 6. First Write Reminder

AD5761R DAC

The **DAC** tab programs the input and DAC registers with a hexadecimal value entered in the **Input Data 16 bit (HEX)** field (see Figure 8). Also available in this tab are the following options: **Hardware Control** to modify the **RESET PIN**, **CLR PIN**, and **LDAC PIN** values; **Software Reset** options; and **Read-back Input Register** and **Read-back DAC Register** options.

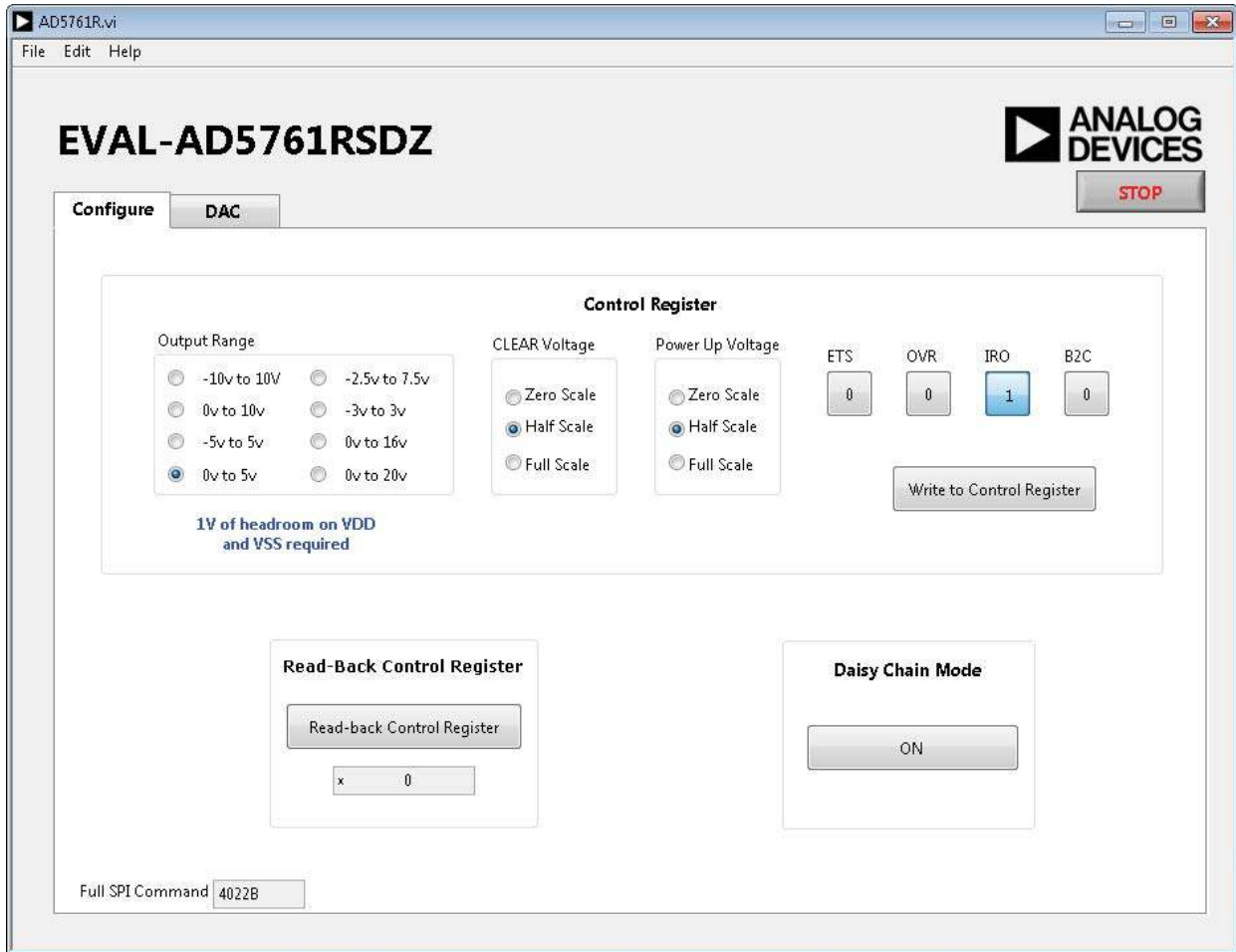


Figure 7. Evaluation Software Main Window, **Configure** Tab

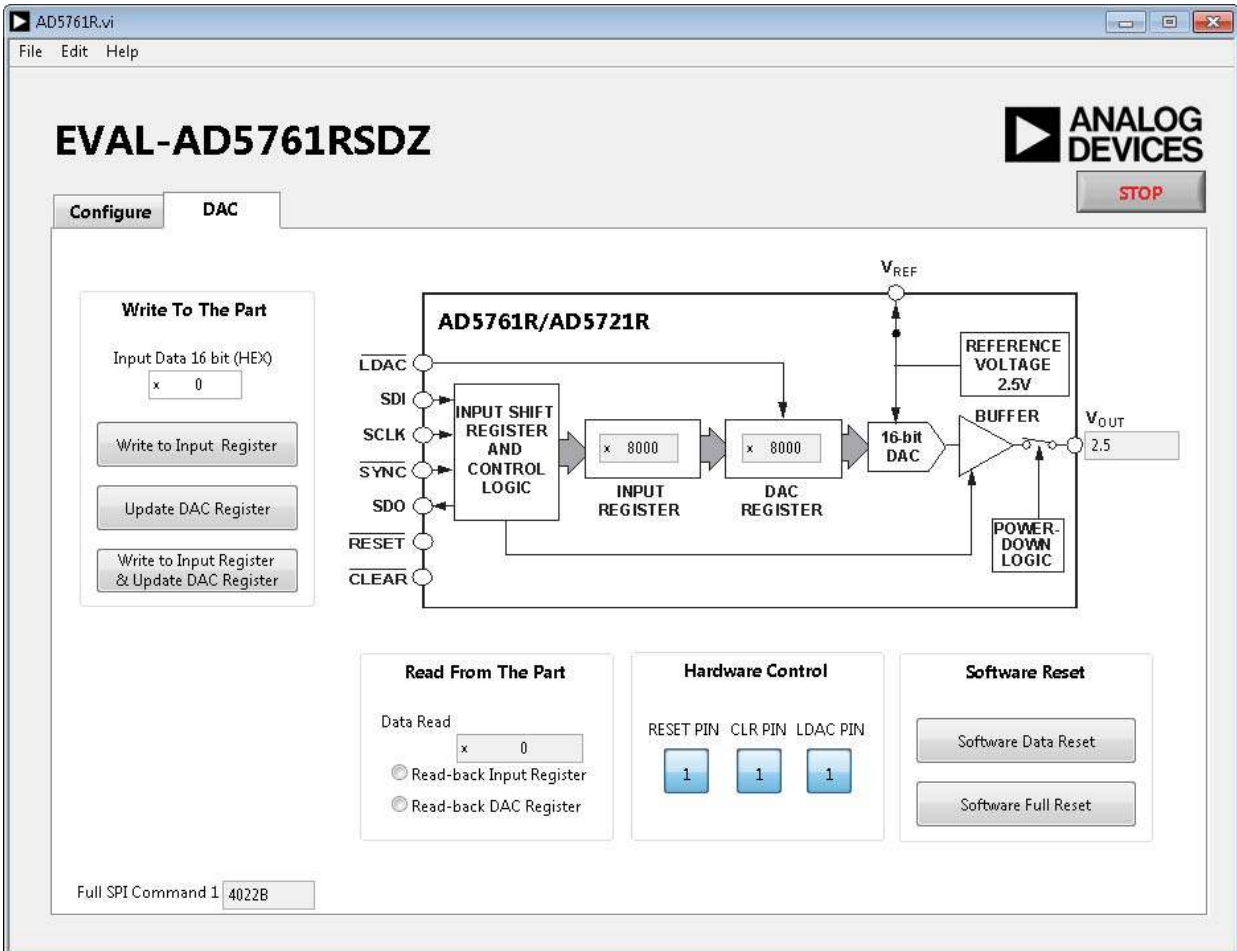


Figure 8. Evaluation Software Main Window, DAC Tab

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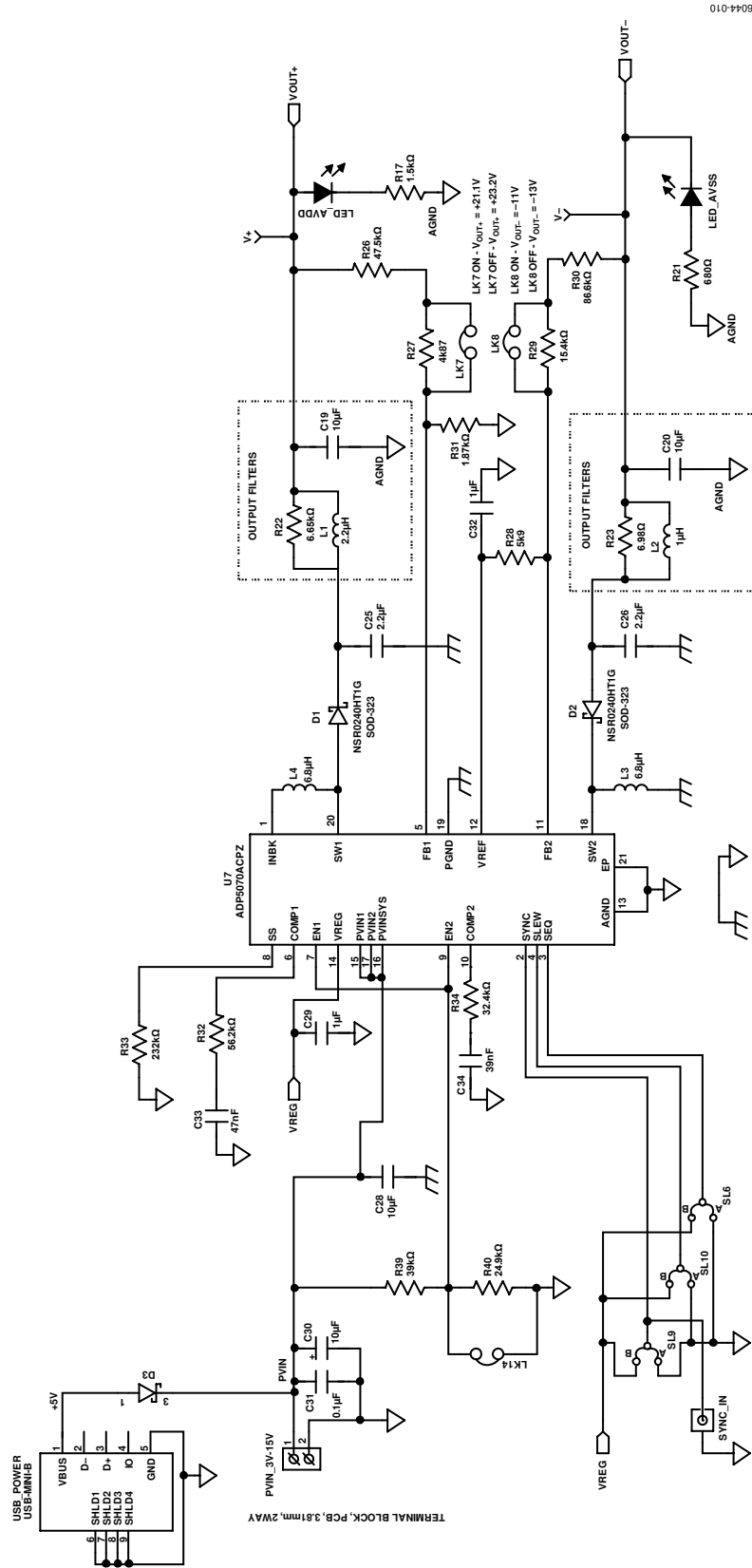


Figure 10. Schematic of the ADP5070 Circuitry

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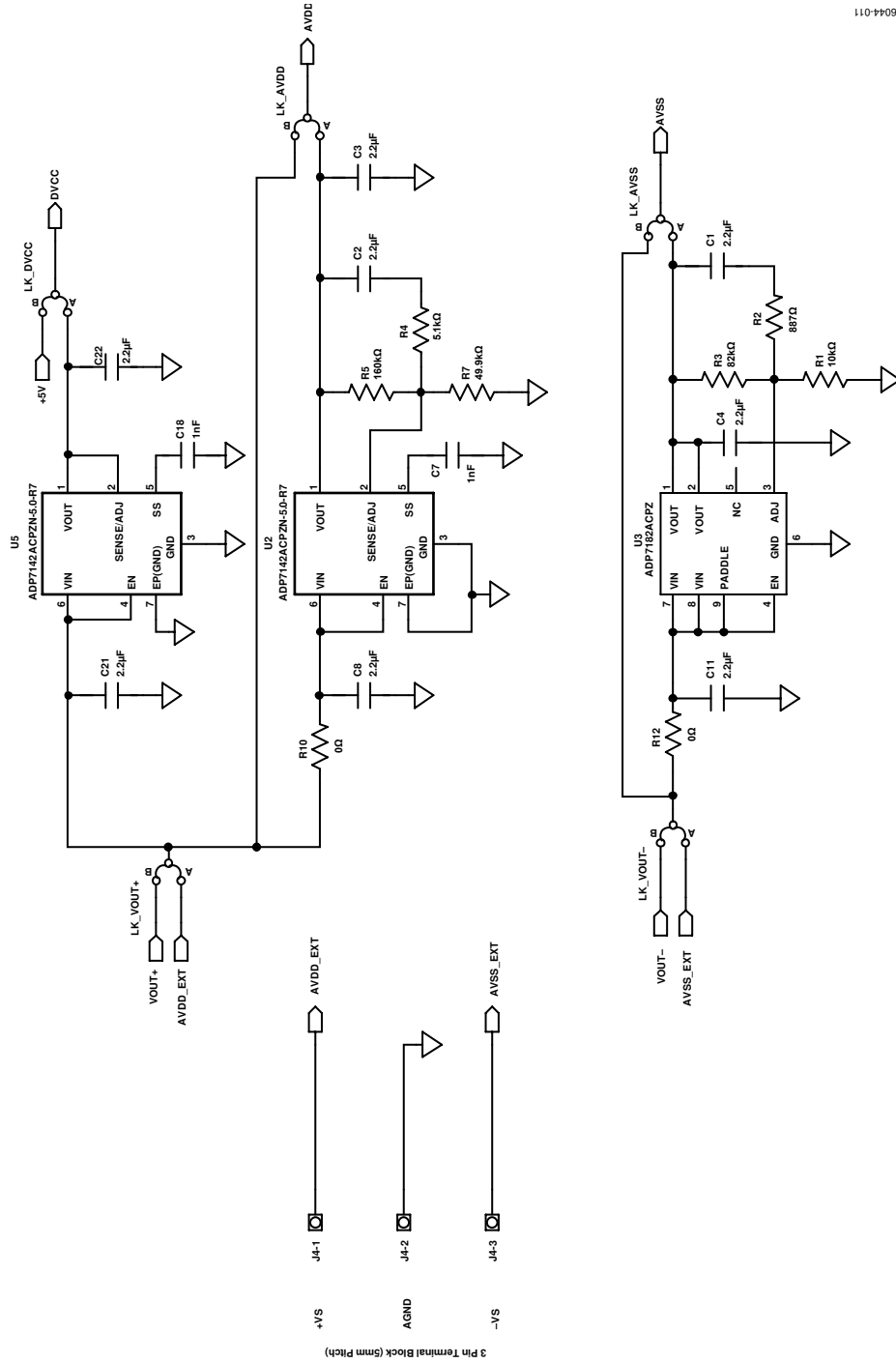


Figure 11. Schematic of the ADP7142 and ADP7182 Voltage Regulators Circuitry

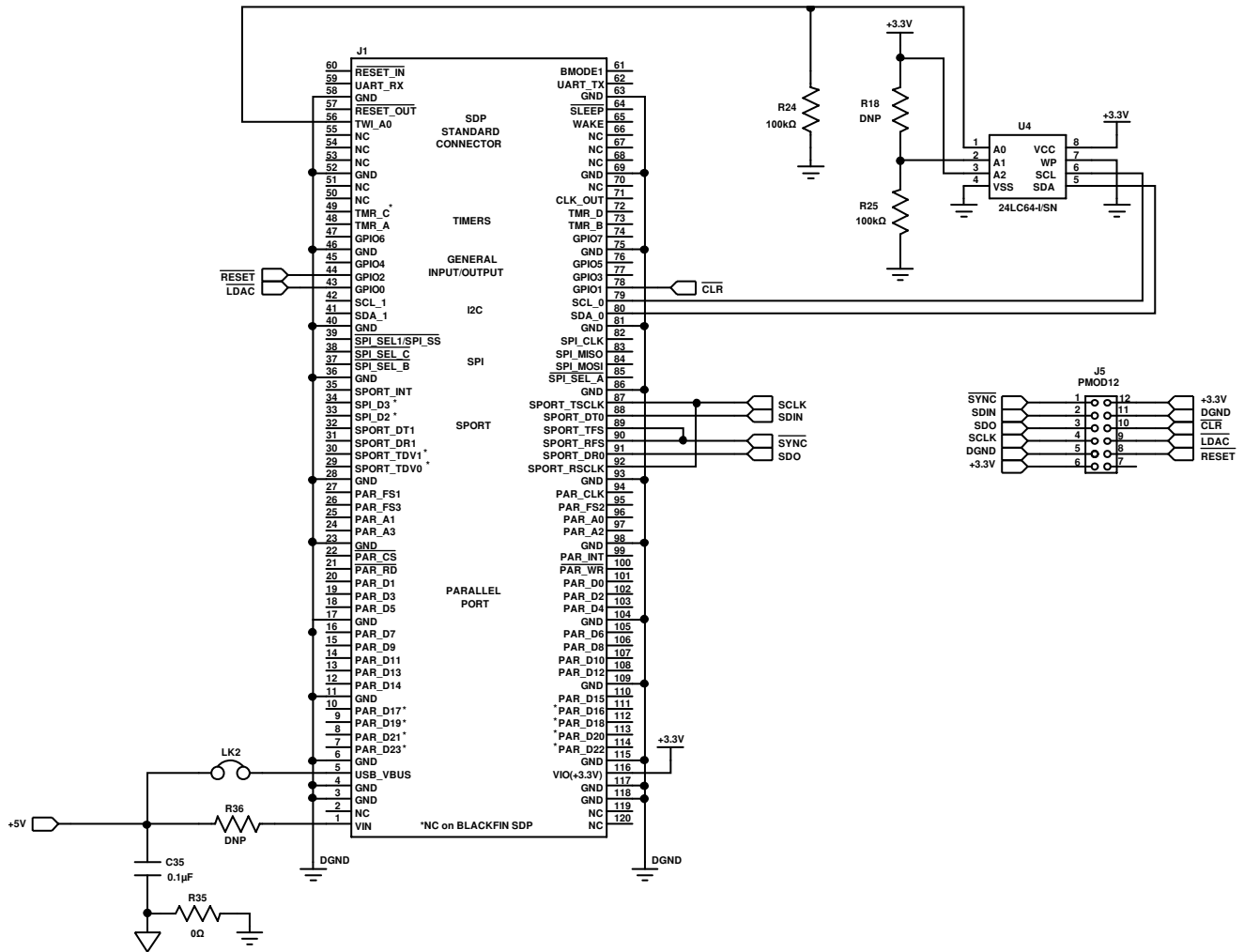


Figure 12. Schematic of the EVAL-SDP-CB1Z SDP-B Board Connector

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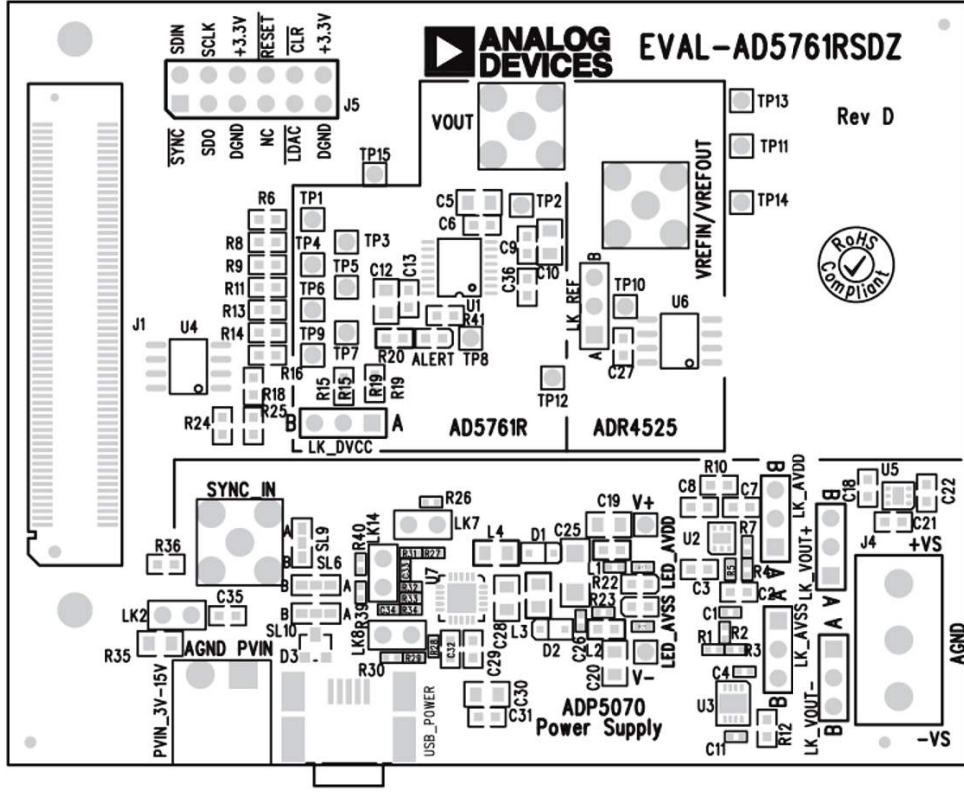


Figure 13. Component Placement Layout

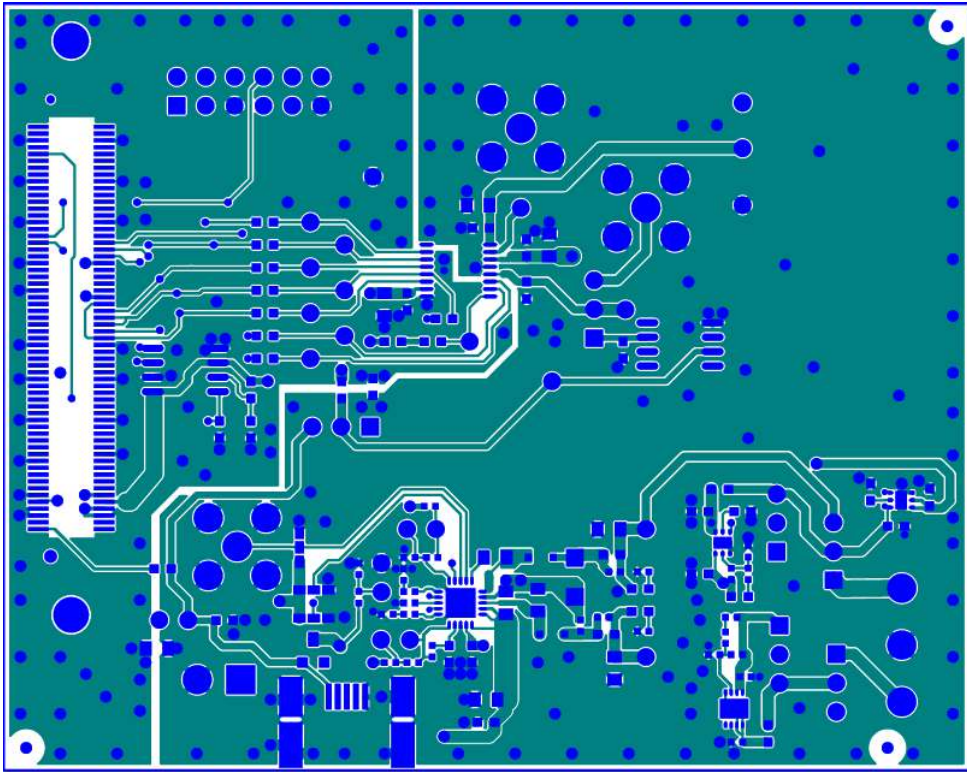
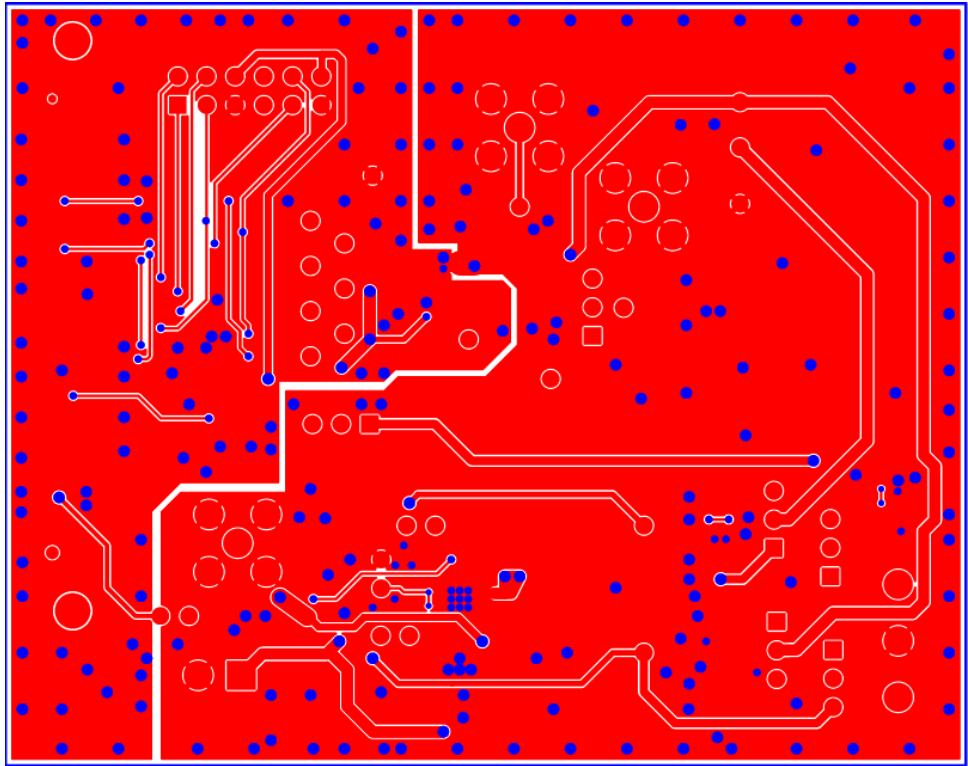


Figure 14. Top PCB Layer Layout



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Figure 15. Top Side PCB Layer Layout

ORDERING INFORMATION

BILL OF MATERIALS

Table 5.

Reference Designator	Description	Part Number	Stock Code
ALERT, LED_AVDD, LED_AVSS	LED, 0603, red	LSQ976-Z	FEC 1226390
C1, C4, C11, C26	Capacitors, 0402, 16 V, 2.2 μ F, \pm 10%	GRM155R61C225KE44	490-10455-1-ND
C2, C3, C8, C21	Capacitors, 0603, X5R, 35 V, 2.2 μ F, \pm 10%	GRM155R6YA225KE11	490-10733-1-ND
C5, C19	Capacitors, 0805, 10 μ F, \pm 10%	GRM21BR6YA106KE43	490-10514-2-ND
C6, C9, C13, C27, C31, C35	Capacitors, 0603, X7R, 50 V, 0.1 μ F, \pm 10%	GRM188R71H104KA93D	FEC 8820023
C7, C18	Capacitors, 0603, X7R, 25 V, 1 nF, \pm 10%	MC0402B102K250CT	FEC 2408538
C10, C20	Capacitors, 0805, 10 μ F, \pm 10%	GRM188R61C106KAAL	490-10728-2-ND
C12, C30	Capacitors, 0805, X7R, 10 V, 10 μ F, \pm 10%	GRM21BR71A106KE51L	FEC 1828828
C22	Capacitors, 0603, MLCC, X5R, 10 V, 2.2 μ F	MC0603X225K100CT	FEC 2310406
C25	Capacitor, 1206, MLCC, X7R, 50 V, 2.2 μ F, \pm 10%	GRM31CR71H225KA88L	FEC 1797017
C28	Capacitor, 0805, MLCC, X5R, 10 V, 10 μ F, \pm 10%	GRM21BR61A106KE19L	FEC 2368965
C29, C32	Capacitors, 0603, X5R, 6.3 V, 1 μ F, \pm 10%	GRM188R60J105KA01D	FEC 9527699
C33	Capacitor, 0402, X7R, 25 V, 47 nF, \pm 10%	GRM155R71E473KA88D	FEC 1828868
C34	Capacitor, 0402, X7R, 10 V, 39 nF, \pm 10%	0402ZC393KAT2A	FEC 2332547
C36	Capacitor, 0603, X7R, 50 V, 10 nF, \pm 10%	GRM188R71H103KA01D	FEC 2462748
D1, D2	Schottky diodes	NSR0240HT1G	Digi-Key NSR0240HT1GOSCT-ND
D3	Schottky diode	BAT750-7-F	FEC 1773479
J1	120-way connector, 0.6 mm pitch	FX8-120S-SV(21)	FEC 1324660
J4	3-pin terminal block (5 mm pitch)	CTB5000/3	FEC 151790
J5	PMOD connector	M20-9980646	FEC 1022238
L1	Surface-mount power inductor	PFL1609-222MEU	FEC 2288737
L2	Surface-mount power inductor	PFL1609-102MEW	FEC 2288736
L3, L4	Surface-mount power inductors	PFL2015-682MEB	FEC 2288749
LK2, LK7, LK8, LK14	2-pin (0.1 inch pitch) headers and shorting shunts	M20-9990246	FEC 1022247 & 150-411
LK_AVDD, LK_AVSS, LK_DVCC, LK_REF, LK_VOUT+, LK_VOUT-	3-pin SIL header and shorting links	M20-9990345 & M7567-05	FEC 1022248 & 150410
PVIN_3V-15V	2-way terminal block + pluggable terminal block	1803277 + 1827127	FEC 3704725 + FEC 3704993
R1, R41	Resistors, 10 k Ω , 0.063 W, 1%, 0402	MC00625W0402110K	FEC 1358069
R2	Resistor, 887 Ω , 0.063 W, 1%, 0402	CRCW0402887RFKED	FEC 1692516
R3	Resistor, 82 k Ω , 0.063 W, 1%, 0402	MC00625W0402182K	FEC 1358094
R4	Resistor, 5.1 k Ω , 0.063 W, 1%, 0402	MC00625W040215K1	FEC 1358061
R5	Resistor, 160 k Ω , 0.063 W, 1%, 0402	MC00625W04021160K	FEC 1358101
R6, R8 to R16, R19	Resistors, 0 Ω , 1%, 0603	MC0063W06030R	FEC 9331662
R7	Resistor, 49.9 k Ω , 0.1 W, 1%, 0402	ERJ2RKF4992X	FEC 2059172
R17	Resistor, 1.5 k Ω , 0.0625 W, 1%, 0402	RC0402FR-071K5L	FEC 2413613
R20	Resistor, 1 k Ω , 0.0625 W, 1%, 0402	RC0402FR-071KL	FEC 9239235
R21	Resistor, 680 k Ω , 0.1 W, 1%, 0402	ERJ2RKF6800X	FEC 2302619
R22	Resistor, 6.65 Ω , 0.0625 W, 1%, 0402	CRCW04026R65FKED	Digi-Key 541-6.65LLCT-ND
R23	Resistor, 6.98 Ω , 0.0625 W, 1%, 0402	CRCW04026R98FKED	Digi-Key 541-6.98LLCT-ND
R24, R25	Resistors, 100 k Ω , 0.063 W, 1%, 0603	MC0063W06031100K	FEC 9330402
R26	Resistor, 47.5 k Ω , 0.063 W, 1%, 0402	MC00625W0402147K5	FEC 2141460
R27	Resistor, 4.87 k Ω , 0.063 W, 1%, 0402	MC00625W040214K87	FEC 1803106
R28	Resistor, 5.9 k Ω , 0.063 W, 1%, 0402	MC00625W040215K9	FEC 1803114
R29	Resistor, 15.4 k Ω , 0.063 W, 1%, 0402	MC00625W0402115K4	FEC 1803152
R30	Resistor, 86.6 k Ω , 0.063 W, 1%, 0402	MC00625W0402186K6	FEC 1803744
R31	Resistor, 1.87 k Ω , 0.063 W, 1%, 0402	MC00625W040211K87	FEC 1803063

Reference Designator	Description	Part Number	Stock Code
R32	Resistor, 56.2 k Ω , 0.063 W, 1%, 0402	CRCW040256K2FKED	FEC 1652808
R33	Resistor, 232 k Ω , 0.063 W, 1%, 0402	CRCW0402232KFKED	FEC 2140961
R34	Resistor, 32.4 k Ω , 0.0625 W, 1%, 0402	MC00625W0402132K4	FEC 1803703
R35	Resistor, 0 Ω , 0.1 W, 1%, 0805	MC01W08050R	FEC 9333681
R39	Resistor, 39 k Ω , 0.063 W, 1%, 0402	MC00625W0402139K	FEC 1358085
R40	Resistor, 24.9 k Ω , 0.063 W, 1%, 0402	CRCW040224K9FKED	FEC 1469699
TP2, TP8, TP10 to TP15, V+, V–	Red test points	20-313137	FEC 8731144
U1	16-bit, bipolar DAC with internal reference and programmable output ranges	AD5761RBRUZ	AD5761RBRUZ
U2, U5	Ultralow noise linear regulators (5 V)	ADP7142ACPZN-5.0	ADP7142ACPZN-5.0-R7
U3	–200 mA, low noise linear regulator	ADP7182ACPZ	ADP7182ACPZ-R7
U4	64k I ² C serial EEPROM	24LC64-I/SN	FEC 9758070
U6	2.5 V voltage reference	ADR4525BRZ	ADR4525BRZ
U7	1 A/0.6 A dc-to-dc switching regulator with independent positive and negative outputs	ADP5070ACPZ	ADP5070ACPZ
USB_POWER	USB mini-B connector	56579-0576	Digi-Key WM17122CT-ND
VOUT, VREFIN/VREFOUT	Straight PCB mount SMB jacks, 50 Ω	1-1337482-0	FEC 1206013



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.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

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