Evaluating the AD5693R Single-Channel, 16-Bit, Serial, Voltage Output DAC

FEATURES
- Full featured evaluation board for the AD5693R
- On-board reference
- Various link options
- PC control in conjunction with the Analog Devices, Inc., SDP
- PC software for control of DACs
- On-board ADC for voltage readback

EVALUATION KIT CONTENTS
- EVAL-AD5693RSDZ evaluation board
- AD5693R device

HARDWARE REQUIRED
- EVAL-SDP-CB1Z (SDP-B) board or EVAL-SDP-CS1Z (SDP-S) board, must be ordered separately

SOFTWARE REQUIRED
- ACE evaluation software, available for download from the EVAL-AD5693RSDZ product page

GENERAL DESCRIPTION
This user guide details the operation of the EVAL-AD5693RSDZ evaluation board for the AD5693R single-channel, serial, voltage output, digital-to-analog converter (DAC).

The EVAL-AD5693RSDZ is designed to help customers quickly prototype AD5693R circuits and reduce design time. The AD5693R operates from a single 2.7 V to 5.5 V supply. The AD5693R incorporates an internal 2.5 V on-board reference to give an output voltage span of 2.5 V or 5 V.

The EVAL-AD5693RSDZ evaluation board interfaces to the USB port via the SDP board. The analysis control evaluation (ACE) software is available for download from the EVAL-AD5693RSDZ product page to use with the evaluation board to allow the user to program the AD5693R. The EVAL-AD5693RSDZ evaluation board requires the purchase of the EVAL-SDP-CB1Z (SDP-B) board or the EVAL-SDP-CS1Z (SDP-S) board.

For full details, consult the AD5693R data sheet, which must be used in conjunction with this user guide when using the evaluation board.
TABLE OF CONTENTS

Features .............................................................................................. 1
Evaluation Kit Contents ................................................................. 1
Hardware Required ........................................................................ 1
Software Required ........................................................................... 1
General Description ........................................................................ 1
EVAL-AD5693RSDZ Evaluation Board Connected to the SDP-S Board .................................................................................................. 1
Revision History ............................................................................... 2
Evaluation Board Quick Start Procedures ..................................... 3
Installing the Software ....................................................................... 3

REVISION HISTORY

7/2017—Rev. 0 to Rev. A
Reorganized Layout............................................................................ Universal
Deleted Additional Equipment Needed Section .............................. 1
Added Hardware Required Section and Software Required Section .................................................................................................. 1
Changes to Title, Evaluation Kit Contents Section, General Description Section, EVAL-AD5693RSDZ Evaluation Board Connected to the SDP-S Board Section, and Figure 1 Caption . 1
Deleted Getting Started Section ......................................................... 3
Added Evaluation Board Quick Start Procedures Section,
Initial Setup Section, and Figure 2; Renumbered Sequentially .. 3
Changes to Installing the Software Section...................................... 3
Added Figure 3.................................................................................. 4
Deleted How to Use the Software Section, Running the Software Section, Figure 2, and Figure 3, and Figure 4; Renumbered Sequentially ................................................................. 5

Initial Setup ....................................................................................3
Block Diagram and Description......................................................5
Memory Map ....................................................................................6
Evaluation Board Hardware .............................................................7
Power Supplies ................................................................................7
Link Options ...................................................................................7
Evaluation Board Schematics and Artwork ....................................8
Ordering Information ......................................................................11
Bill of Materials ............................................................................ 11

Added Block Diagram and Description Section, Figure 4,
Table 1; Renumbered Sequentially................................................. 5
Deleted Software Operation Section and Figure 5......................... 6
Added Memory Map Section, Figure 5, and Figure 6....................... 6
Moved Evaluation Board Hardware Section....................................7
Changes to Power Supplies Section, Table 2, Link Options Section, and Table 4..................................................................................... 7
Changes to Figure 7 Caption............................................................ 8
Changes to Figure 8 Caption............................................................ 8
Changes to Figure 9 Caption, Figure 10 Caption, and Figure 11 Caption ............................................................................................ 10
Deleted Components List Section................................................ 10
Added Bill of Materials Section ....................................................... 11
Changes to Table 5.......................................................................... 11

3/2014—Revision 0: Initial Version

Rev. A | Page 2 of 12
EVALUATION BOARD QUICK START PROCEDURES

INSTALLING THE SOFTWARE

The EVAL-AD5693RSDZ evaluation board uses the ACE software, a desktop software application that allows the evaluation and control of multiple evaluation systems.

The ACE installer installs necessary SDP drivers and the Microsoft® .NET Framework 4 by default. The ACE software is available for download from the EVAL-AD5693RSDZ product page and must be installed before connecting the SDP board to the USB port of the PC, to ensure that the SDP board is recognized when it connects to the PC. For full instructions on how to install and use this software, see the ACE software page on the Analog Devices website.

After the installation is finished, the EVAL-AD5693RSDZ evaluation board plug in appears when the ACE software is opened.

INITIAL SETUP

To set up the evaluation board, take the following steps:

1. Connect the evaluation board to the SDP board, and then connect a USB cable between the SDP board and the PC.
2. Run the ACE application. The EVAL-AD5693RSDZ board plug ins appear in the attached hardware section of the Start tab.
3. Double click the board plug in to open the board view, shown in Figure 2.
4. Double click the AD5693R chip to access the chip block diagram. This view provides a basic representation of functionality of the board. The main function blocks of the board are labeled in Figure 3.

Figure 2. Board View of the EVAL-AD5693RSDZ
Figure 3. Chip Block Diagram View of the AD5693R
BLOCK DIAGRAM AND DESCRIPTION

The EVAL-AD5693RSDZ software is organized to appear similar to the functional block diagram shown in the AD5693R data sheet. Therefore, correlating the functions on the EVAL-AD5693RSDZ evaluation board with the description in the AD5693R data sheet is simplified.

For a full description of each block, register, and its settings, see the AD5693R data sheet.

Some of the blocks and their functions are described in this section as they pertain to the evaluation board. The block diagram is shown in Figure 4. Table 1 describes the functionality of each block.

Table 1. Block Diagram Functions (See Labels in Figure 4)

<table>
<thead>
<tr>
<th>Label</th>
<th>Button/Function Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CONFIGURATION Wizard</td>
<td>Used to set the initial configuration for the board. Select the reference gain case from the Output Gain dropdown menu. A gain of 1 is the default. After setting up the initial configuration, click Apply to apply the values. These settings can be modified at any stage while evaluating the board.</td>
</tr>
<tr>
<td>B</td>
<td>LDAC and RESET (GPIO buttons)</td>
<td>Act as external GPIO pulses to the LDAC and RESET pins. The LDAC button transfers data from the input register (D) to the DAC register (E). The RESET button clears all data from the input register and the DAC register. These buttons are live; therefore, there is no need to click Apply Changes (J).</td>
</tr>
<tr>
<td>C</td>
<td>Select a Command</td>
<td>Command option dropdown menu selects how the data being transferred to the device affects the input and DAC registers. After a data value is entered in the input register (D), this menu determines the internal DAC registers affected by updating the input register (D). After a new value is written in the input register (D), the data can be transferred to the DAC input register, or to the DAC input register and the DAC register simultaneously. If the data is transferred to both registers, the channel DAC register (E) reflects the new value.</td>
</tr>
<tr>
<td>D</td>
<td>Input register</td>
<td>16-bit data word to be transferred to the device. Click Apply Changes (J) to transfer this 16-bit data word to the device.</td>
</tr>
<tr>
<td>E</td>
<td>DAC register</td>
<td>Displays the value that is currently present in the DAC register on the device. Update the DAC register by selecting the appropriate command option or by toggling LDAC (B).</td>
</tr>
<tr>
<td>F</td>
<td>Software RESET</td>
<td>Returns the evaluation board and software to default values. This button is live; therefore, there is no need to click Apply Changes (J).</td>
</tr>
<tr>
<td>G</td>
<td>Load DAC</td>
<td>Users can individually control which channel loads the values from the input register to the DAC register. Note that the AD5693R is a single-channel DAC and only offers one channel option for the Load DAC function.</td>
</tr>
<tr>
<td>H</td>
<td>DAC</td>
<td>DAC configuration options provide access to individual channel configuration options such as power-down options and hardware LDAC mask enable/disable settings.</td>
</tr>
<tr>
<td>I</td>
<td>Internal Reference</td>
<td>Select Enable from this setting to enable the on-chip reference for the evaluation board. If Disable is selected, an external reference must be applied. This control is only available on the AD5693R.</td>
</tr>
<tr>
<td>J</td>
<td>Apply Changes</td>
<td>Applies all modified values to the device. Note that if an evaluation board is not connected, values entered into the input register are not transferred to the DAC register.</td>
</tr>
</tbody>
</table>
MEMORY MAP

All registers are fully accessible from the AD5693R Memory Map tab, shown in Figure 5. To navigate to this tab, click the Proceed to Memory Map button, shown in Figure 4. This tab allows registers to be edited at the bit level. The bits shaded in dark gray are read-only bits and cannot be accessed from the ACE software. All other bits are toggled.

Clicking the Apply Changes button transfers data to the device. All changes made in the memory map tab correspond to the block diagram. For example, if the internal register bit is enabled, it displays as enabled on the block diagram. Any bits or registers that are in bold in the memory map tab are modified values that have not been transferred to the evaluation board (see Figure 6). Click Apply Changes to transfer the data to the evaluation board.

Figure 5. AD5693R Memory Map Tab

Figure 6. AD5693R Memory Map with Unapplied Changes in the DAC0_INPUT Register
EVALUATION BOARD HARDWARE

POWER SUPPLIES

The AD5693R evaluation board can be powered through the SDP board or externally by the VPOS_EXT and AGND connectors.

Both AGND and DGND inputs are provided on the board. The AGND and DGND planes are connected at one location close to the AD5693R. To avoid ground loop problems, it is recommended not to connect AGND and DGND elsewhere in the system.

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

Table 2. Power Supply Connectors

<table>
<thead>
<tr>
<th>Connector No.</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>J2, Pin 1</td>
<td>Analog positive power supply, V_EXT</td>
</tr>
<tr>
<td>J2, Pin 2</td>
<td>AGND</td>
</tr>
</tbody>
</table>

LINK OPTIONS

Various link and switch options are incorporated on the EVAL-AD5693RSDZ evaluation board and must be set for the required operating conditions before using the board. The functions of these link options are described in detail in Table 4.

Table 3 describes the positions of the different links controlled by the PC via the USB port. An SDP board operating in single-supply mode is required.

Table 3. Link Options Setup for SDP Control (Default)

<table>
<thead>
<tr>
<th>Link No.</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>A11</td>
<td>A</td>
</tr>
<tr>
<td>LINK</td>
<td>Disconnected</td>
</tr>
<tr>
<td>A1</td>
<td>A</td>
</tr>
</tbody>
</table>

Table 4. Link Functions

<table>
<thead>
<tr>
<th>Link No.</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>This link selects the DAC digital voltage source.</td>
</tr>
<tr>
<td></td>
<td>Position A selects an external reference source via the SMB input, EXTREFER.</td>
</tr>
<tr>
<td></td>
<td>Position B selects the REF192 external reference.</td>
</tr>
<tr>
<td></td>
<td>Position C selects the ADR431 external reference.</td>
</tr>
<tr>
<td>LINK</td>
<td>Connect only if the EVAL-AD5693RSDZ board of the AD5693R is controlled through the PMOD connector and the SDP board is not connected.</td>
</tr>
<tr>
<td>A11</td>
<td>This link selects the DAC analog voltage source.</td>
</tr>
<tr>
<td></td>
<td>Position A VPOS is powered at 3.3 V.</td>
</tr>
<tr>
<td></td>
<td>Position B VPOS is powered from an unregulated USB supply.</td>
</tr>
<tr>
<td></td>
<td>Position C VPOS is powered from an external supply voltage (V_EXT).</td>
</tr>
</tbody>
</table>
EVALUATION BOARD SCHEMATICS AND ARTWORK

Figure 7. EVAL-AD5693RSDZ Schematic—Power Supply and Signal Routes
VIN: USE THIS PIN TO POWER THE SDP REQUIRES 5V 200mA

VIO: USE TO SET IO VOLTAGE MAX DRAW 20mA

BOARD ID EEPROM (24LC32)
MUST BE ON I2C BUS 0

BMODE1: PULL UP WITH A 10kΩ RESISTOR TO SET SDP TO BOOT FROM A SPI FLASH ON THE DAUGHTER BOARD.

MAIN I2C BUS (CONNECTED TO BLACKFIN TWI; PULL UP RESISTORS NOT REQUIRED)

AD5683R -> AD5693R

CONNECTOR
STANDARD
SDP
PARALLEL
PORT
SPI
I2C
GENERAL
INPUT/OUTPUT
TIMERS

**NC ON BLACKFIN SDP**

120NC
119NC
118GND
117GND
116VIO(+3.3V)
115GND
114*PAR_D22
113*PAR_D20
112*PAR_D18
111*PAR_D16
110PAR_D15
109GND
108PAR_D12
107PAR_D10
106PAR_D8
105PAR_D6
104GND
103PAR_D4
102PAR_D2
101PAR_D0
100PAR_WR
99PAR_INT
98GND
97PAR_A2
96PAR_A0
95PAR_FS2
94PAR_CLK
93GND
92SPORT_RSCLK
91SPORT_DR0
90SPORT_RFS
89SPORT_TFS
88SPORT_DT0
87SPORT_TSCLK
86GND
85SPI_SEL_A
84SPI_MOSI
83SPI_MISO
82SPI_CLK
81GND
80SDA_0
79SCL_0
78GPIO1
77GPIO3
76GPIO5
75GND
74GPIO7
73TMR_B
72TMR_D
71NC
70NC
69GND
68NC
67NC
66NC
65NC
64NC
63GND
62UART_TX
61BMODE160 RESET_IN
59 UART_RX58 GND57 NC56 EEPROM_A055 NC54 NC53 NC52 GND51 NC50 NC49 TMR_C*48 TMR_A47 GPIO646 GND45 GPIO444 GPIO243 GPIO042 ... SPORT_DT2*32 SPORT_DT131 SPORT_DR130 SPORT_DR2*28 GND27 PAR_FS126 PAR_FS325 PAR_A124 PAR_A323 GND22 PAR_CS21 PAR_RD20 PAR_D119 PAR_D318 PAR_D517 GND16 PAR_D715 PAR_D914 PAR_D1113 PAR_D1312 PAR_D1411 GND10 PAR_D17*9 PAR_D19*8 PAR_D21**7 PAR_D236 GND5 USB_VBUS4 GND3 GND2 NC1 VIN

Figure 8. EVAL-AD5693RSDZ Schematic—SDP Connector
Figure 9. EVAL-AD5693RSDZ Component Placement Drawing

Figure 10. EVAL-AD5693RSDZ Component Side Printed Circuit Board (PCB) Drawing

Figure 11. EVAL-AD5693RSDZ Solder Side PCB Drawing
## ORDERING INFORMATION

### BILL OF MATERIALS

Table 5.

<table>
<thead>
<tr>
<th>Qty</th>
<th>Reference</th>
<th>Description</th>
<th>Supplier/Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U1</td>
<td>AD5693R</td>
<td>Analog Devices/AD5693R</td>
</tr>
<tr>
<td>1</td>
<td>U3</td>
<td>2.5 V reference</td>
<td>Analog Devices/REF192</td>
</tr>
<tr>
<td>1</td>
<td>U5</td>
<td>3.3 V regulator</td>
<td>Analog Devices/ADP121</td>
</tr>
<tr>
<td>1</td>
<td>U6</td>
<td>32 kb, I²C serial EEPROM</td>
<td>FEC/1331330</td>
</tr>
<tr>
<td>1</td>
<td>U8</td>
<td>Ultralow noise XFET voltage references</td>
<td>Analog Devices/ADR431BRZ</td>
</tr>
<tr>
<td>1</td>
<td>LINK</td>
<td>2-pin link</td>
<td>FEC/1022249</td>
</tr>
<tr>
<td>2</td>
<td>A1, A11</td>
<td>3-pin link</td>
<td>FEC/148535</td>
</tr>
<tr>
<td>2</td>
<td>VOUT, EXT_REF</td>
<td>SMB jack, 50 Ω</td>
<td>FEC/1206013</td>
</tr>
<tr>
<td>1</td>
<td>J1</td>
<td>120-way female connector</td>
<td>FEC/1324660</td>
</tr>
<tr>
<td>1</td>
<td>J2</td>
<td>2-pin terminal block</td>
<td>FEC/151789</td>
</tr>
<tr>
<td>3</td>
<td>C1, C8, C10</td>
<td>0.1 μF, 16 V, X7R, ceramic capacitor</td>
<td>FEC/1216538</td>
</tr>
<tr>
<td>1</td>
<td>C21</td>
<td>0.1 μF, 50 V, X7R, ceramic capacitor</td>
<td>FEC/1759122</td>
</tr>
<tr>
<td>2</td>
<td>C4, C5</td>
<td>1 μF, 16 V, X7R, ceramic capacitor</td>
<td>FEC/1658870</td>
</tr>
<tr>
<td>3</td>
<td>C2, C7, C9</td>
<td>10 μF, 10 V, X5R, 0603</td>
<td>FEC/1853538</td>
</tr>
<tr>
<td>1</td>
<td>C22</td>
<td>10 μF, 6.3 V, tantalum</td>
<td>FEC/1190107</td>
</tr>
<tr>
<td>1</td>
<td>L2</td>
<td>Inductor</td>
<td>FEC/9526862</td>
</tr>
<tr>
<td>7</td>
<td>TP1, TP2, TP3, TP4, TP5, TP6, TP9</td>
<td>Test point</td>
<td>FEC/8731128</td>
</tr>
<tr>
<td>4</td>
<td>R1, R2, R8, R18</td>
<td>100 kΩ, SMD, resistor</td>
<td>FEC/9330402</td>
</tr>
<tr>
<td>1</td>
<td>R21</td>
<td>1.6 Ω, SMD, resistor</td>
<td>FEC/1627674</td>
</tr>
<tr>
<td>4</td>
<td>R5, R6, R9, R13</td>
<td>0 Ω, SMD, resistor</td>
<td>FEC/9331662</td>
</tr>
</tbody>
</table>

1 FEC refers to Farnell Electronic Component Distributors.
I2C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

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, WARRANTIES, 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.