

Evaluating TxVGAs for Use with RF DACs and Transceivers

FEATURES

Full featured evaluation board for the or [ADL6316](#)
 SPI control via [SDP-S](#) board
 5.0 V single-supply operation

EVALUATION KIT CONTENTS

ADL6316-EVALZ evaluation board

ADDITIONAL HARDWARE REQUIRED

Analog signal generator
 Analog signal analyzer
 Power supplies (6 V, 5 A)
 PC with Windows® XP, Windows 7, or Windows 10 operating system
 USB 2.0 port, recommended (USB 1.1-compatible)
[EVAL-SDP-CS1Z \(SDP-S\)](#) controller board

ADDITIONAL SOFTWARE REQUIRED

[Analysis | Control | Evaluation \(ACE\)](#) software

GENERAL DESCRIPTION

The [ADL6316](#) transmit variable gain amplifier (TxVGA) provides an interface for radio frequency (RF) digital-to-analog converters (DACs), transceivers, and systems on a chip (SoC) to power amplifiers (PAs). Integrated balun and hybrid couplers allow high performance RF capability over a frequency range of 0.5 GHz to 1.0 GHz.

To optimize performance vs. power level, the [ADL6316](#) includes a voltage variable attenuator (VVA), high linearity amplifiers, and a digital step attenuator (DSA). The devices integrated into the [ADL6316](#) are programmable via a 4-wire serial port interface (SPI).

This user guide describes the evaluation board and software for the [ADL6316](#). For full details, see the [ADL6316](#) data sheet, which must be consulted when using the evaluation board. The ADL6316-EVALZ evaluation board is fabricated with FR-370HR, Rogers 4350B in four layers.

EVALUATION BOARD PHOTOGRAPH

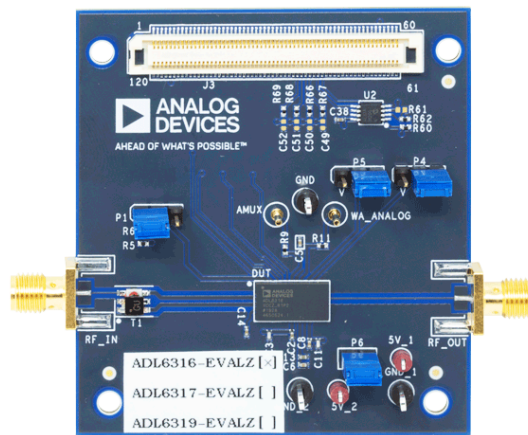


Figure 1. ADL6316-EVALZ

21832-101

TABLE OF CONTENTS

| | | | |
|------------------------------------|---|--|---|
| Features | 1 | RF Input..... | 3 |
| Evaluation Kit Contents..... | 1 | RF Outputs | 3 |
| Additional Hardware Required | 1 | Signal Path Modes Selection | 3 |
| Additional Software Required | 1 | Evaluation Board Software..... | 4 |
| General Description | 1 | Software Requirements and Installation | 4 |
| Evaluation Board Photograph..... | 1 | Installing ADL6316 ACE Plugins | 4 |
| Revision History | 2 | ACE Software Suite | 4 |
| Evaluation Board Hardware..... | 3 | Configuration and Programming Sequence..... | 5 |
| Power Supply..... | 3 | Evaluation Board Schematic | 7 |

REVISION HISTORY

10/2019—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

The ADL6316-EVALZ evaluation board provides the support circuitry required to operate the ADL6316 in various modes and configurations. Figure 2 shows the typical bench setup to evaluate the performance of the ADL6316.

POWER SUPPLY

The ADL6316-EVALZ evaluation board requires a single, 5.0 V power supply.

RF INPUT

The on-board balun enables single-ended driving. The ADL6316 operates the 0.5 GHz to 1.0 GHz frequency range.

RF OUTPUTS

The RF outputs are available on the evaluation board at the RF_OUT SMA connectors, which can drive a load of 50 Ω.

SIGNAL PATH MODES SELECTION

The ADL6316 has two signal path modes. This feature allows two predefined modes of operation to be controlled by the logic level on TXEN, a real-time external pin (Pin 37), without SPI latency. Table 1 shows the hardware configuration to select the desired mode.

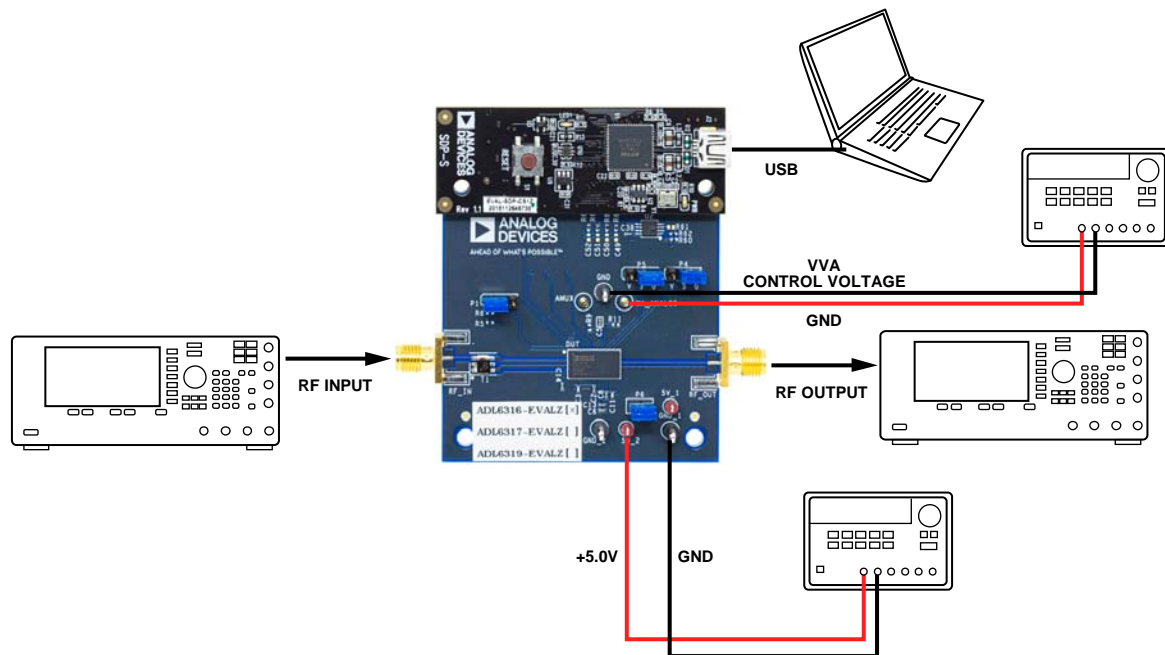


Figure 2. ADL6316 Typical Measurement Setup

21832-002

Table 1. Mode Selection and Setup Registers

| TXEN (Pin 37) Logic Level | Register | Functional Blocks | Description |
|---------------------------|----------|-------------------|------------------------------------|
| 0 | 0x0102 | DSA attenuation | 0 dB to ~14 dB range, 0.45 dB step |
| | 0x0107 | AMP1 | Amplifier 1 optimization |
| | 0x0108 | AMP1 | Amplifier 1 enable |
| | 0x0109 | AMP2 | Amplifier 2 optimization |
| | 0x010A | AMP2 | Amplifier 2 enable |
| 1 | 0x0112 | DSA attenuation | 0 dB to ~14 dB range, 0.45 dB step |
| | 0x0117 | AMP1 | Amplifier 1 optimization |
| | 0x0118 | AMP1 | Amplifier 1 enable |
| | 0x011A | AMP2 | Amplifier 2 enable |

EVALUATION BOARD SOFTWARE

The **ADL6316** on the ADL6316-EVALZ evaluation board and the **SDP-S** controller board are configured with a USB friendly interface to allow programmability of the **ADL6316** registers.

SOFTWARE REQUIREMENTS AND INSTALLATION

The **Analysis | Control | Evaluation (ACE)** software is required to program and control the **ADL6316** and the ADL6316-EVALZ evaluation board.

The ACE software suite allows bit control of the **ADL6316** register map via the SPI, and communicates to the **SDP-S** controller board via the USB connection. The **SDP-S** controller board configures the SPI lines (CS, SDI, SDO, and SCLK) accordingly to communicate to the **ADL6316**.

Installing the ACE Software Suite

To install the **ACE** software suite, take the following steps:

1. Download the software from the **ACE** product page.
2. Open the downloaded file to begin the installation process. The default installation path is **C:\Program Files (x86)\Analog Devices\ACE**.
3. If desired, the user can create a desktop icon for the **ACE** software. Otherwise, the **ACE** executable can be found by clicking **Start > Analog Devices > ACE**.

INSTALLING ADL6316 ACE PLUGINS

When the **ACE** software installations are complete, the user must install the evaluation board plugins to the hard drive of the PC.

1. Download the **ADL6316 ACE** plugins (**Board.ADL631x.1.2019.34200.acezip**) from the ADL6316-EVALZ product page.
2. Double-click the **Board.ADL631x.1.2019.34200.acezip** file to install the evaluation board plugins.
3. Ensure that the **Board.ADL631x.1.2019.34200** and **Chip.ADL631x.1.2019.34200** folders are located inside the **C:\ProgramData\Analog Devices\ACE\Plugins** folder.

ACE SOFTWARE SUITE

Power up the ADL6316-EVALZ evaluation board and connect the USB cable to the PC and to the **SDP-S** board mounted on the ADL6316-EVALZ evaluation board.

1. Double-click the **ACE** shortcut on the PC desktop of the computer (if created). The software automatically detects the ADL6316-EVALZ evaluation board. The software opens the **ACE** plugin view, as shown in Figure 3

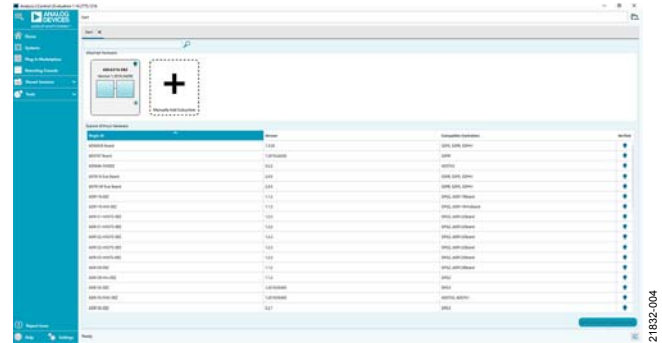


Figure 3. ACE Plugin View

2. Double-click the **ADL6316-EBZ** board icon, as shown in Figure 4.

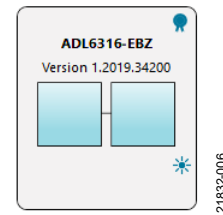


Figure 4. ADL6316-EBZ Board Icon

3. The software opens the **ACE** chip view as shown in Figure 5.

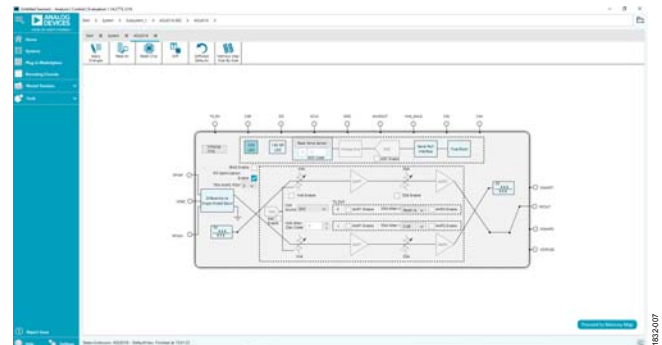


Figure 5. ACE Chip View

CONFIGURATION AND PROGRAMMING SEQUENCE

To configure and program the evaluation board, take the following steps:

1. Run the ACE software as explained in the **Error! Reference source not found.** section.
2. Click **Initialize Chip** (Label A, see Figure 6).
3. Click and adjust the block (Label B to Label H in Figure 6) if necessary.

4. After changing the block in the ACE software as directed in Step 3, click **Apply Changes** (Label K, see Figure 7) to update the ADL6316.
5. To adjust an individual register and bit, click **Proceed to Memory Map**. This button opens the ADL6316 memory map for bit control (see Figure 8). The ADL6316 can be configured by either putting data into **Data(Hex)** column (Label L, see Figure 8) or by clicking a specific bit in the **Data(Binary)** column (Label M, see Figure 8) of the register map (see Figure 8). Click **Apply Changes** (Label N, see Figure 8) to save changes and program the ADL6316.

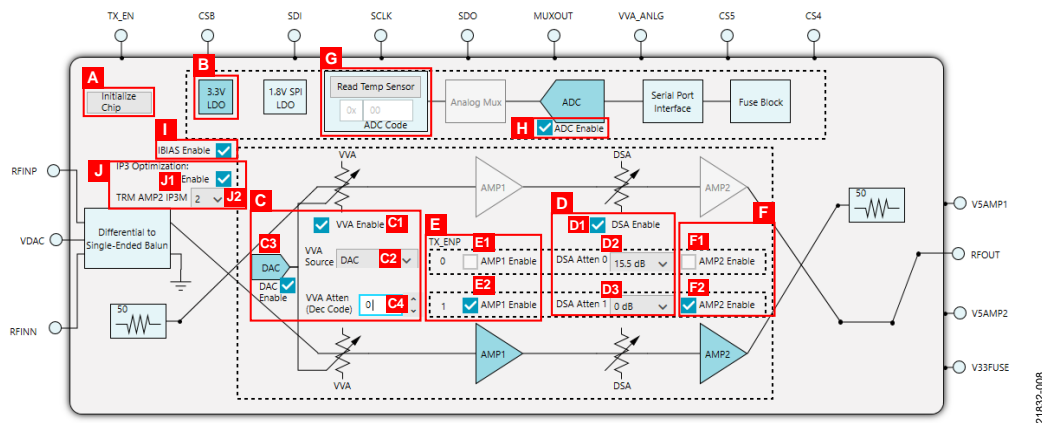


Figure 6. ADL6316 Chip Block Diagram

Table 2. Main Screen Functionality (see Figure 6)

| Label | Function |
|-------|---|
| A | Initialize chip button. |
| B | 3.3 V low dropout regulator (LDO) enable. |
| C | VVA control block. |
| C1 | VVA Enable checkbox. |
| C2 | Selects VVA voltage source: DAC = VVA attenuation set by internal 12-bit DAC, set DAC code (0 to ~4095 range) in VVA Atten (Dec Code) field. VVA_ANALOG = VVA attenuation set by analog voltage applied on ANLG pin. |
| C3 | DAC Enable checkbox for VVA attenuation when the VVA Source field is set to DAC . |
| C4 | VVA Atten (Dec Code) menu. Selects VVA DAC code in decimal (0 to ~4095 range). Higher numbers equal less attenuation. |
| D | DSA control block, DSA Atten 0 and DSA Atten 1 are selected by the logic level on TXEN (see Table 1). |
| D1 | DSA Enable checkbox. |
| D2 | Set DSA Atten 0 attenuation. |
| D3 | Set DSA Atten 1 attenuation. |
| E | AMP1 Enable checkbox. AMP1 can be set individually by the logic level on TXEN (see Table 1). |
| F | AMP2 Enable checkbox. AMP2 can be set individually by the logic level on TXEN (see Table 1). |
| G | Read Temp Sensor button and ADC Code text fields. These functions are for proportional to absolute temperature (PTAT) ADC code readback. |
| H | ADC Enable checkbox. |
| I | IBIAS Enable checkbox. This function enables the bias generator. |
| J | IP3 Optimization control block. |
| J1 | Enable checkbox for IP3 optimization. |
| J2 | TRM AMP2 IP3M dropdown menu. Set TRM_AMP2_IP3 bits value for IP3 optimization. |

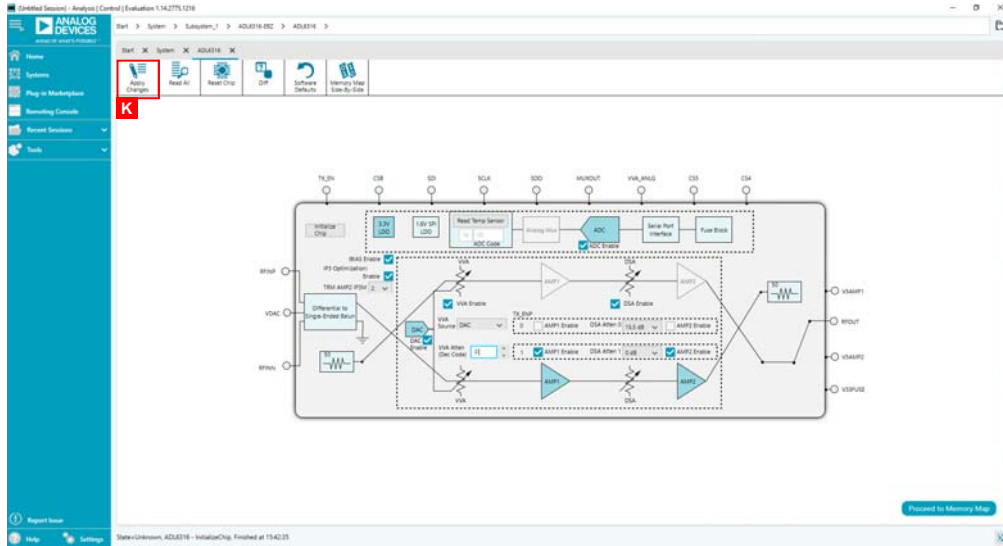


Figure 7. ADL6316-EVALZ ACE Chip View After Chip Initialization

21832-309

The screenshot shows the 'Memory Map' view in the Analog Devices IDE. The left sidebar lists various registers, and the main area displays a table of memory addresses and their corresponding data. A red box highlights a specific row in the table, which is also highlighted in the register list on the left. The highlighted row is for the register 'SGL_PNTR0_1' at address 0x0000112.

| Address (Hex) | Name | Data (Hex) | Data (Binary) |
|---------------|--------------|------------|---------------|
| 0x0000110 | SGL_PNTR0_0 | 0x00000000 | 00000000 |
| 0x0000111 | SGL_PNTR0_1 | 0x00000000 | 00000000 |
| 0x0000112 | SGL_PNTR0_2 | 0x00000000 | 00000000 |
| 0x0000113 | SGL_PNTR0_3 | 0x00000000 | 00000000 |
| 0x0000114 | SGL_PNTR0_4 | 0x00000000 | 00000000 |
| 0x0000115 | SGL_PNTR0_5 | 0x00000000 | 00000000 |
| 0x0000116 | SGL_PNTR0_6 | 0x00000000 | 00000000 |
| 0x0000117 | SGL_PNTR0_7 | 0x00000000 | 00000000 |
| 0x0000118 | SGL_PNTR0_8 | 0x00000000 | 00000000 |
| 0x0000119 | SGL_PNTR0_9 | 0x00000000 | 00000000 |
| 0x000011A | SGL_PNTR0_10 | 0x00000000 | 00000000 |
| 0x000011B | SGL_PNTR0_11 | 0x00000000 | 00000000 |
| 0x000011C | SGL_PNTR0_12 | 0x00000000 | 00000000 |
| 0x000011D | SGL_PNTR0_13 | 0x00000000 | 00000000 |
| 0x000011E | SGL_PNTR0_14 | 0x00000000 | 00000000 |
| 0x000011F | SGL_PNTR0_15 | 0x00000000 | 00000000 |
| 0x0000120 | SGL_PNTR0_16 | 0x00000000 | 00000000 |
| 0x0000121 | SGL_PNTR0_17 | 0x00000000 | 00000000 |
| 0x0000122 | SGL_PNTR0_18 | 0x00000000 | 00000000 |
| 0x0000123 | SGL_PNTR0_19 | 0x00000000 | 00000000 |
| 0x0000124 | SGL_PNTR0_20 | 0x00000000 | 00000000 |
| 0x0000125 | SGL_PNTR0_21 | 0x00000000 | 00000000 |
| 0x0000126 | SGL_PNTR0_22 | 0x00000000 | 00000000 |
| 0x0000127 | SGL_PNTR0_23 | 0x00000000 | 00000000 |
| 0x0000128 | SGL_PNTR0_24 | 0x00000000 | 00000000 |
| 0x0000129 | SGL_PNTR0_25 | 0x00000000 | 00000000 |
| 0x000012A | SGL_PNTR0_26 | 0x00000000 | 00000000 |
| 0x000012B | SGL_PNTR0_27 | 0x00000000 | 00000000 |
| 0x000012C | SGL_PNTR0_28 | 0x00000000 | 00000000 |
| 0x000012D | SGL_PNTR0_29 | 0x00000000 | 00000000 |
| 0x000012E | SGL_PNTR0_30 | 0x00000000 | 00000000 |
| 0x000012F | SGL_PNTR0_31 | 0x00000000 | 00000000 |

Figure 8. ADL6316-EVALZ ACE Memory Map View

21832-011

EVALUATION BOARD SCHEMATIC

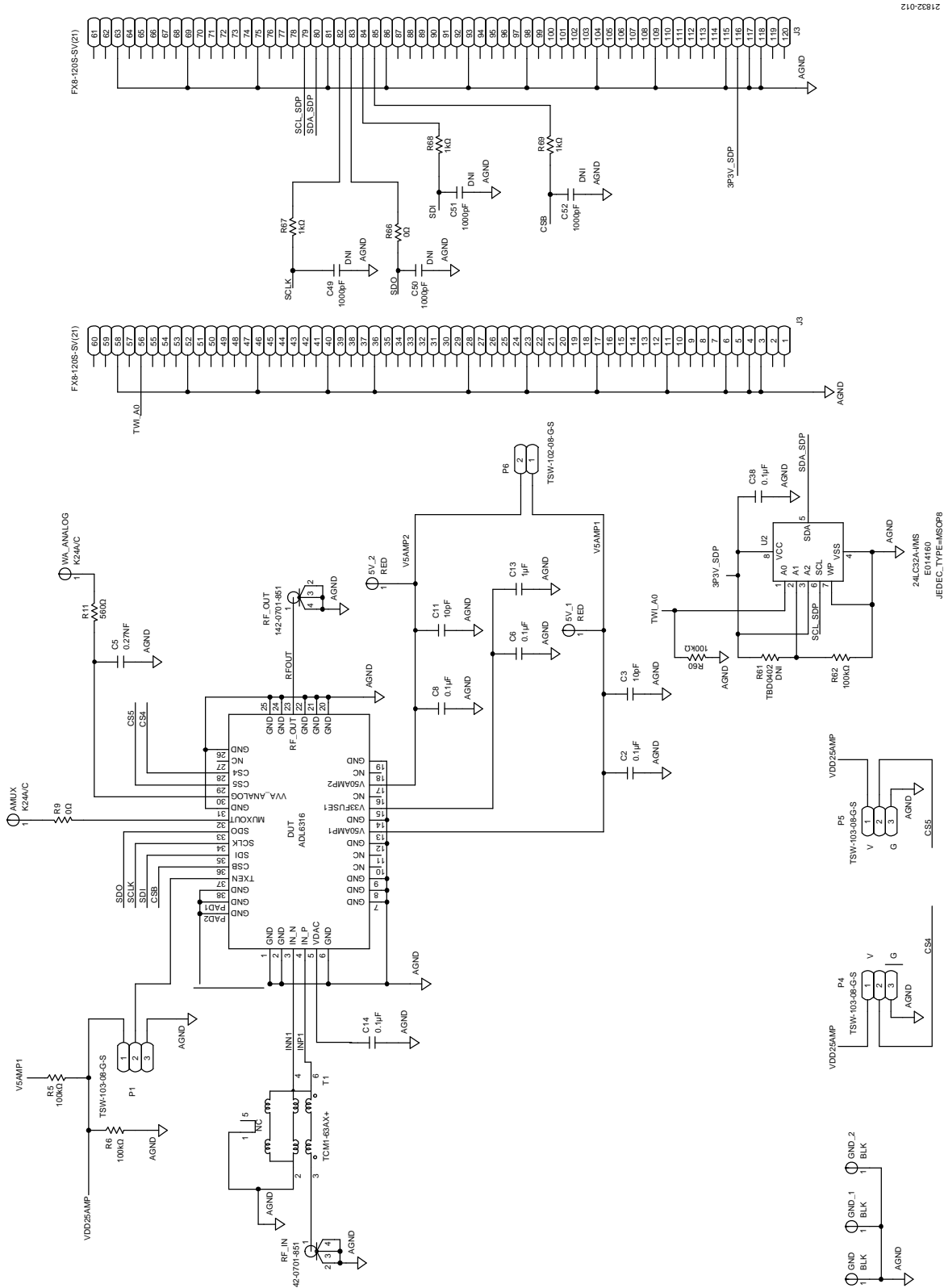


Figure 9. ADL6316-EVALZ Evaluation Board Schematic

NOTES

**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 (\$100,000). 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.