Evaluating the AD5780 System Ready, 18-Bit, ±1 LSB INL, Voltage Output DAC

FEATURES

- Full featured evaluation board for the AD5780
- ADP5070 power solution generated from single 5 V supply
- Applicable evaluation board for the AD5760 and AD5790
- PC control in conjunction with the Analog Devices Inc., EVAL-SDP-CK1Z (SDP-K1) controller board
- Various link options

EVALUATION KIT CONTENTS

- EVAL-AD5780ARDZ evaluation board
- EV-ADR445-REFZ reference board

HARDWARE REQUIRED

- EVAL-SDP-CK1Z (SDP-K1) controller board, which must be purchased separately
- PC running on Windows® 10 (32 bit or 64 bit) or later

SOFTWARE REQUIRED

- **Analysis | Control | Evaluation (ACE) Software**, which is also available for download from the EVAL-AD5780ARDZ product page

GENERAL DESCRIPTION

The operation of the EVAL-AD5780ARDZ for evaluating the AD5780 (18-bit), bipolar voltage output, digital-to-analog converter (DAC) is detailed in this user guide.

The EVAL-AD5780ARDZ facilitates fast prototyping of the AD5780 circuit, thereby reducing design time. The EVAL-AD5780ARDZ provides an on-board −14 V and +14 V dual power supply. This evaluation board also utilizes external reference boards with an output voltage of +10 V and −10 V.

The EVAL-AD5780ARDZ interfaces with the USB port of a PC via a system demonstration platform (SDP-K1) controller board. The ACE software is available for download on the EVAL-AD5780ARDZ product page. This software enables the user to program the AD5780. A peripheral module interface (PMOD) connection is also available that allows the connection of different microcontrollers to the EVAL-AD5780ARDZ without the SDP-K1 controller board. Note that when a microcontroller is used through the PMOD connection, the SDP-K1 board must be disconnected, and the user cannot use the ACE software.

For full details on the AD5780, see the AD5780 data sheet, which must be used in conjunction with this user guide when using the EVAL-AD5780ARDZ evaluation board.

For added flexibility, the AD5780 can be substituted with either the AD5760 or AD5790, which must be ordered separately.

TYPICAL EVALUATION SETUP

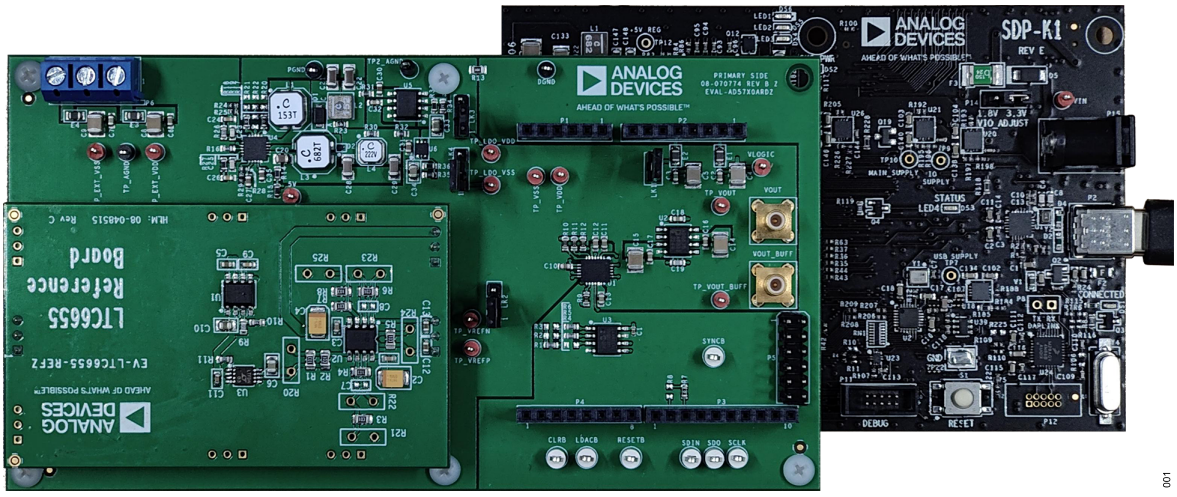

Figure 1. The EVAL-AD5780ARDZ Connected to the SDP-K1 Controller Board

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REVISION HISTORY

5/2024—Revision 0: Initial Version

GETTING STARTED

INSTALLING THE SOFTWARE

The EVAL-AD5780ARDZ uses the **ACE Software**, a software application that allows the evaluation and control of multiple evaluation systems.

The **ACE Software** is available for download from the EVAL-AD5780ARDZ product page or from the **ACE Software** web page. The **ACE Software** installer installs the necessary SDP drivers and the Microsoft® .NET Framework 4 by default. The **ACE Software** must be installed before connecting the SDP-K1 controller board to the USB port of the PC to ensure that the SDP-K1 controller board is recognized when connected to the PC. For full instructions on how to install and use this software, see the **ACE Software** web page on the Analog Devices, Inc., website.

After the installation is complete, run the **ACE Software** and the EVAL-AD5780ARDZ plug-in appears automatically.

INITIAL SETUP

To set up the EVAL-AD5780ARDZ, take the following steps:

1. Connect the evaluation board to the SDP-K1 controller board and then connect the USB cable between the SDP-K1 controller board and the PC.
2. Run the **ACE Software** application. The EVAL-AD5780ARDZ plug-in appears in the **Attached Hardware** section of the **Start** tab, as shown in Figure 2.
3. Double-click the board plug-in to open the **Board View** seen in Figure 3.
4. Choose the corresponding LK2 jumper settings based on the connection of LK2 on the board. Position 1 operates with a bipolar reference, while Position 2 operates with a unipolar reference. Note that, when using Position 2, access is granted to the gain of 2 attribute.
5. Double-click the AD5780 chip to access the chip block diagram shown in Figure 4. This view provides a basic representation of the functionality of the board, together with the **INITIAL CONFIGURATION** view. See Figure 5 and Table 1 for details on the registers of the board.

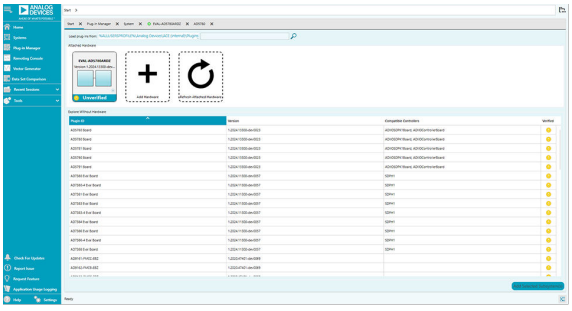

Figure 2. ACE Software Main Window

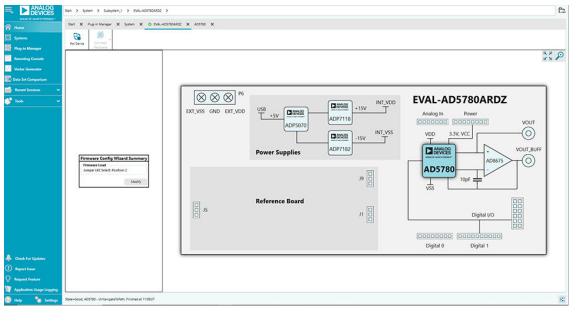

Figure 3. Board View of the EVAL-AD5780ARDZ

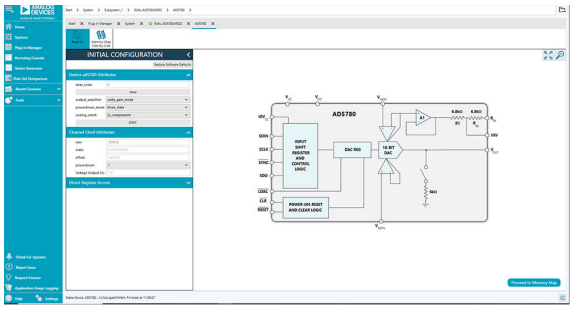

Figure 4. Chip View of the EVAL-AD5780ARDZ

EVALUATION SOFTWARE

INITIAL CONFIGURATION TAB AND DESCRIPTION

The EVAL-AD5780ARDZ software has an **INITIAL CONFIGURATION** tab. This tab provides access to the software attributes that align to the registers of the AD5780, as outlined in the AD5780 data sheet. This access simplifies the process of understanding how the attributes of the software directly relate to the registers found in the AD5780 data sheet. For a full description of each register and its settings, see the AD5780 data sheet.

Some of these functions are described in this section as these functions pertain to the EVAL-AD5780ARDZ. Changes made in the registers of the **INITIAL CONFIGURATION** tab are automatically reflected in the EVAL-AD5780ARDZ.

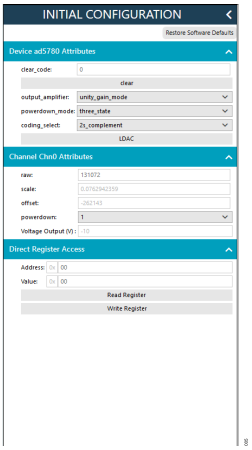

Figure 5. AD5780 Block Diagram with the INITIAL CONFIGURATION Window

Table 1. Register Functions

Button/Function Name	Function
INITIAL CONFIGURATION Tab	Users can initially set the default configuration for the device within this tab. These settings can be modified at any stage while evaluating the EVAL-AD5780ARDZ. The registers reflected in this window depend on the loaded firmware.
clear_code	The clear_code register sets the value of the DAC register when the **clear** button is asserted. The input range is from 0 to 262143 (0x0 to 0x3FFFF).
clear	Click this button for external GPIO pulses to be sent to the $\overline{\text{CLR}}$ pin.
output_amplifier	This attribute can only be accessed if using a unipolar reference. Selecting **unity_gain_mode** provides a gain of 1 to the DAC output. Selecting **gain_of_two** provides a gain of 2 to the DAC output.
powerdown_mode	This attribute relates to the **powerdown** attribute. This selects the type of power down when **powerdown** is 1. Selecting **three_state** sets the DAC output to tristate mode. Selecting **6kohm_to_gnd** sets the DAC output to be clamped to ground through a 6 kΩ resistance and is placed in tristate mode.
coding_select	Use this pulldown menu to set the coding scheme of the DAC register.
LDAC	Click this button for external GPIO pulses to be sent to the $\overline{\text{LDAC}}$ pin. The **LDAC** button pushes data from the input register to the DAC register. In the software, this button is only required if the **Direct Register Access** section is used.
raw	This field allows users to sets the value of the DAC register. The input is decimal by default; however, the hexidecimal value can also be used by inserting **0x** as the prefix. The input range is from 0 to 262143 (0x0 to 0x3FFFF)
scale	This field allows users to represent the value of the DAC LSB in mV. This field is a read-only attribute. Note that this field is only applicable if a reference board is used.
offset	This field allows users to sets the position of the zero-scale. The unit is in code. This field is a read-only attribute. Note that this field is only applicable if a reference board is used.
powerdown	This pulldown menu allows users to power down the output stage of the device based on the setting of the **powerdown_mode** attribute.
Voltage Output (V)	This field represents the calculated value across the output of the DAC. This value can be computed by (**raw** + **offset**) × **scale**. This field is a read-only attribute. Note that this is only applicable if a reference board is used.
Direct Register Access	This section can be used to manually write to or read from a register in the AD5780. It is recommended to use this tab for debugging purposes only, which may cause inconsistency between the value of the attributes and the DAC registers.

EVALUATION SOFTWARE

MEMORY MAP

All registers are fully accessible from the **AD780 Memory Map** tab shown in Figure 6. 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.

Click **Apply Changes** to transfer data to the device. All changes or configurations made in the **AD5780 Memory Map** tab are not reflected to the INITIAL CONFIGURATION tab. Any bits or registers that are shown in bold in the **AD5780 Memory Map** tab are modified values that have not been transferred to the evaluation board (see Figure 7). Click **Apply Changes** to transfer the data to the evaluation boardEVAL-AD5780ARDZ.

The **AD5780 Memory Map** and bit field tabs serve as tools for debugging purposes only. These tabs can cause glitches in the **INITIAL CONFIGURATION** tab functions in the user interface. The **INITIAL CONFIGURATION** tab is still the recommended tab for use for quick evaluation of the EVAL-AD5780ARDZ.

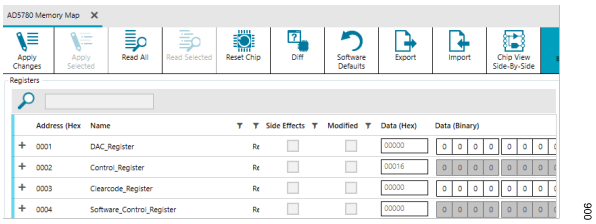

Figure 6. AD5780 Memory Map Tab

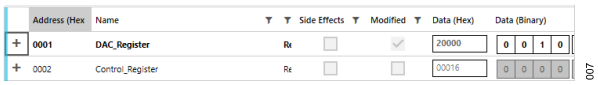

Figure 7. AD5780 Memory Map with Unapplied Changes in the DAC_Register

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The EVAL-AD5780ARDZ provides −14 V and +14 V supplies using the on-board ADP5070 from a single 5 V supply sourced from the SDP-K1 controller board. If a different supply is required or if the evaluation board is controlled through the PMOD connector, an external supply must be provided by the external supply voltage (EXT_VDD and EXT_VSS) connector. See Table 2 for additional details.

Every supply is decoupled to ground with 10 µF and 0.1 µF capacitors.

Note that when supplying more than the 14 V to 16 V range across EXT_VDD, it is recommended to use an external voltage reference.

Table 2. Power Supply Connectors

Connector Label	External Voltage Supplies Description
EXT_VDD	External analog positive power supply. Recommended supply is +15 V.
AGND	Analog ground.
EXT_VSS	External analog negative power supply. Recommended supply is −15 V.

LINK OPTIONS

A number of link options are incorporated on the EVAL-AD5780ARDZ and must be set for the required operating conditions before using the evaluation board. The functions of these link options are described in Table 3.

Table 3. Link Functions

Link	Description
LK1	This link connects the 5 V supply from SDP-K1 to the on-board ADP5070 DC-to-DC converter supply. This link is connected by default.
LK2	This link selects the DAC reference type. Two options are available as follows: Position 1 selects the bipolar −10 V to +10 V reference (default). Position 2 selects the unipolar 0 V to 10 V reference. The **ACE Software** loads a different firmware for each position chosen by the user. Refer to the Initial Setup section, Step 4. In board view, select the corresponding LK2 jumper settings in **ACE Software** based on the LK2 connection on the EVAL-AD5780ARDZ.
LK3	This link selects the V_{DD} power supply source. Two options are available as follows: Position 1 selects the on-board power supply, LDO_VDD (default). Position 2 selects the external power supply, EXT_VDD.
LK4	This link selects the V_{SS} power supply source. Two options are available as follows: Position 1 selects the on-board power supply, LDO_VSS (default). Position 2 selects the external power supply, EXT_VSS.

EVALUATION BOARD HARDWARE

ON-BOARD CONNECTORS

Table 4 shows the connectors on the EVAL-AD5780ARDZ.

Table 4. On-Board Connectors

Connector	Function
J1 to J9	Voltage reference daughter board connectors
VOUT	DAC output
VOUT_BUFF	DAC output with amplifier

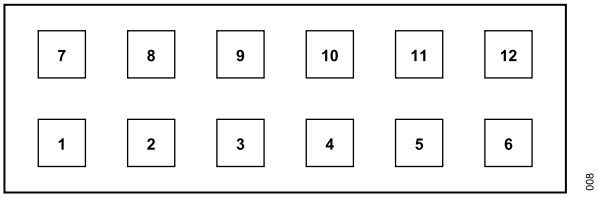

Figure 8. PMOD Pin Layout

Table 5. PMOD Connector Pin Descriptions

Pin Number	Descriptions
1	SYNCB
2	SDIN
3	SDO
4	SCLK
5, 11	DGND
6, 12	VLOGIC
7	$\overline{\text{LDAC}}$
8	$\overline{\text{RESET}}$
9	$\overline{\text{CLR}}$
10	NC

VOLTAGE REFERENCE DAUGHTER BOARDS

The daughter boards insert into the J1, J4, and J9 connectors include a voltage reference. The voltage supplied by the voltage references are gained up and inverted to provide both the positive and negative reference voltages required by the AD5780

The EVAL-AD5780ARDZ evaluation kit includes the EV-ADR445-REFZ reference board to complete the hardware required to evaluate the AD5780. The ADR445 is a 5 V low noise reference with a 3 ppm/°C maximum temperature drift and 2.25 µV p-p noise specifications across the operating temperature range.

The EV-LTC6655-REFZ and EV-LTZ1000-REFZ reference boards, which include the LTC6655 and LTZ1000 voltage references, respectively, are also available to evaluate the AD5780. These boards can be purchased separately via the EVAL-AD5780 web page.

The LTC6655 reference board offers improved noise and temperature drift performance over the ADR445 solution. The LTC6655 is a low noise, low drift precision reference with a 2 ppm/°C temperature drift and 1.25 µV p-p noise.

The LTZ1000 reference board components maintain the accuracy of the AD5780. The LTZ1000 is a 7.2 V ultraprecision reference specified with a 0.05 ppm/°C temperature drift and ultralow 1.2 µV p-p noise. The LTZ1000 voltage reference is used in conjunction with low drift amplifiers (ADA4077-2) and a low drift, thermally matched resistor for the scaling and gain circuits. In addition, place a cover over the reference board to reduce thermal errors due to air current flowing over the reference board.

EVALUATION BOARD SCHEMATICS

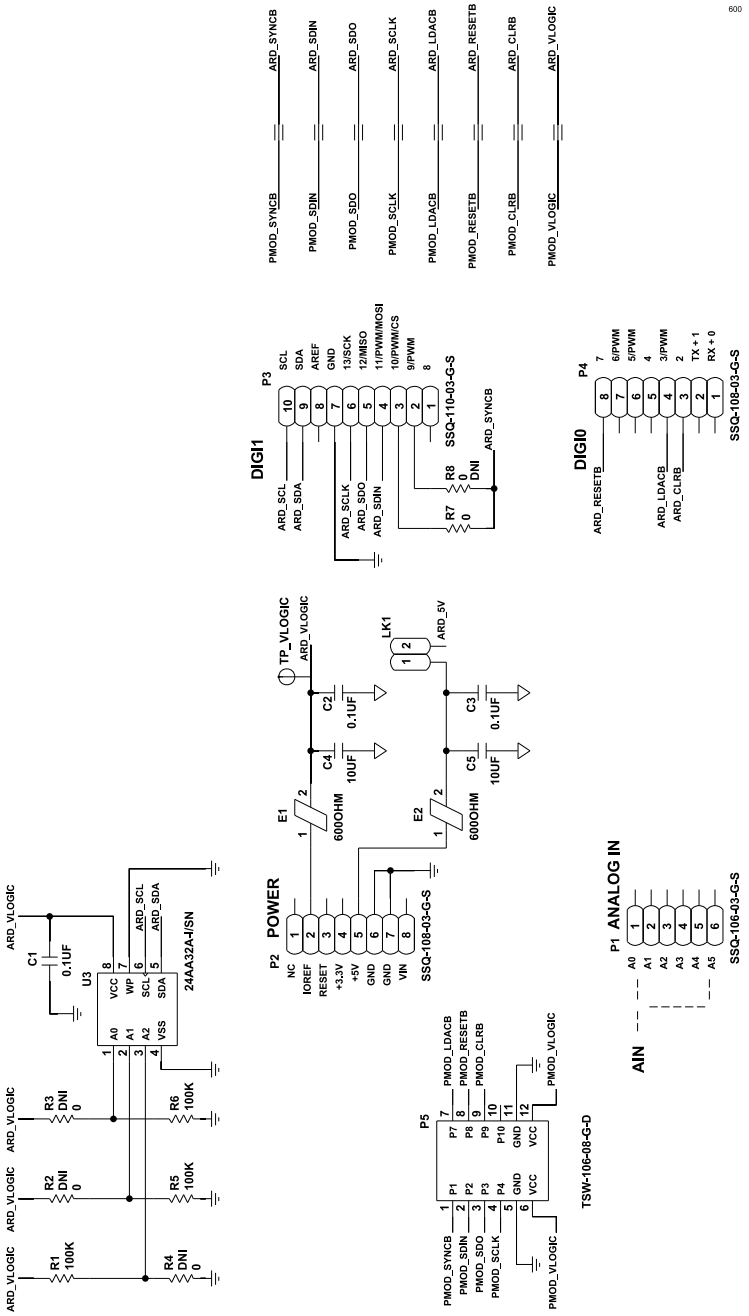

Figure 9. EVAL-AD5780ARDZ Schematic, SDP, Arduino®-Compatible, and PMOD Connectors

EVALUATION BOARD SCHEMATICS

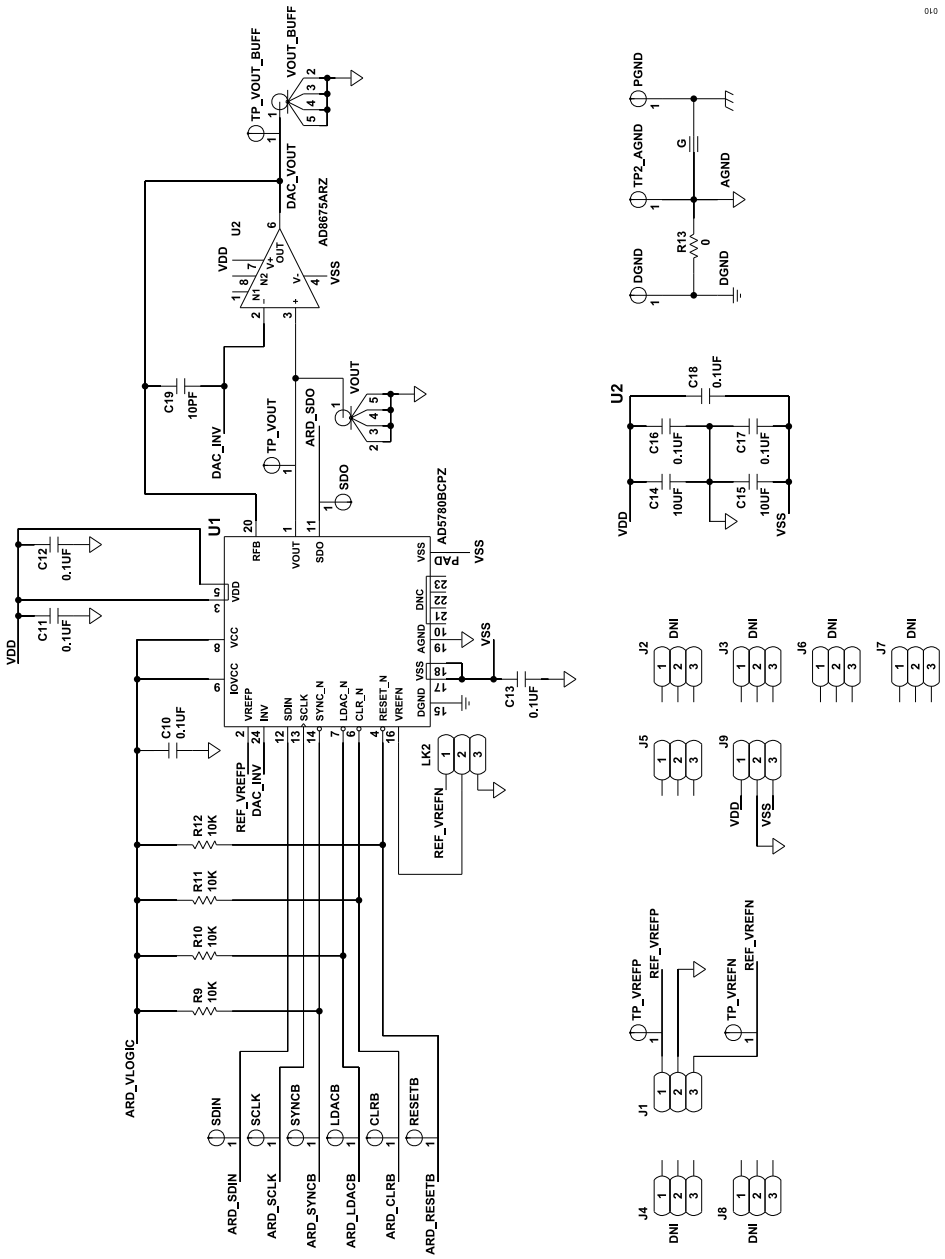

Figure 10. EVAL-AD5780ARDZ Schematic, Main Circuitry

EVALUATION BOARD SCHEMATICS

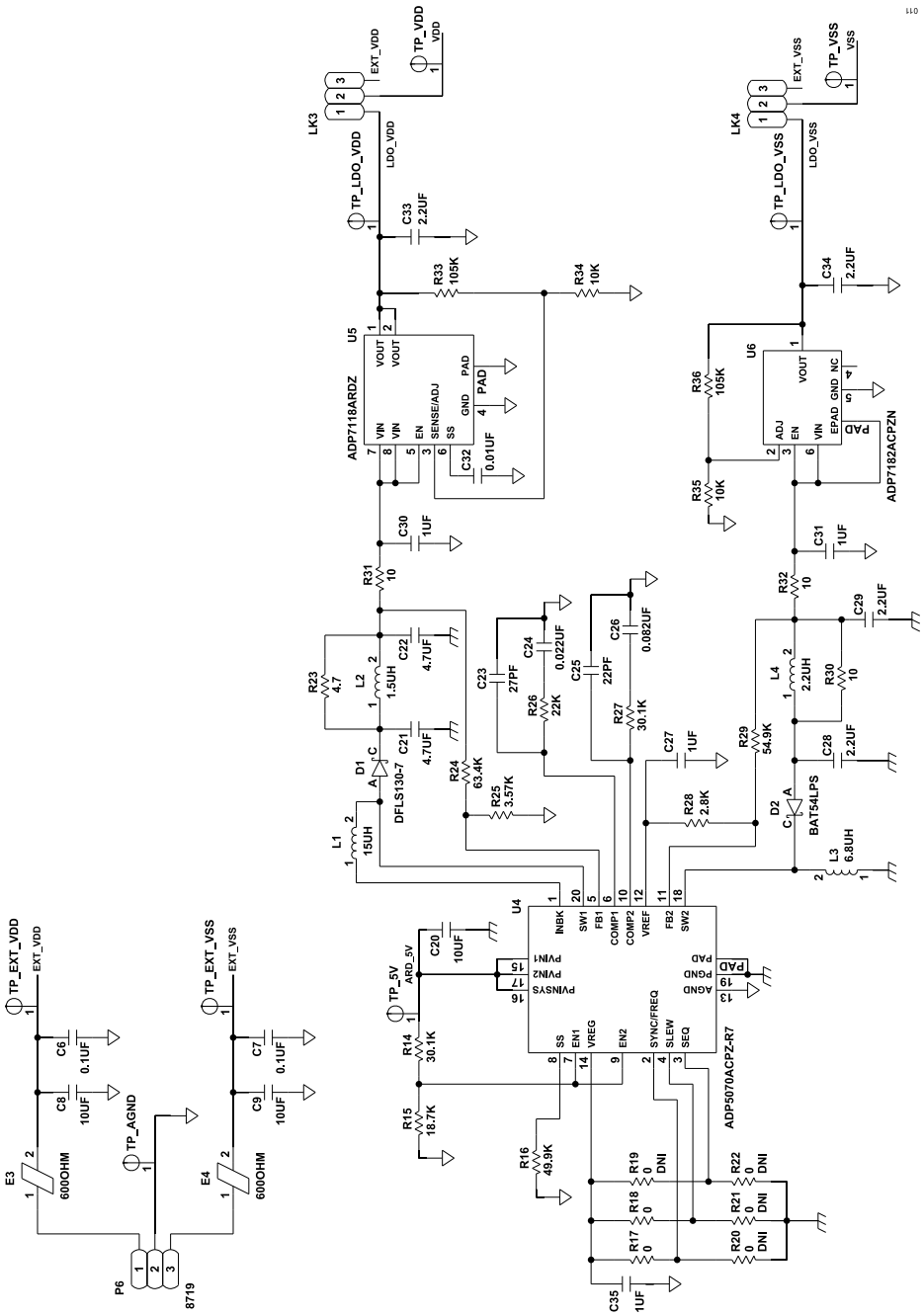

Figure 11. EVAL-AD5780ARDZ Schematic, Power Circuitry

EVALUATION BOARD SCHEMATICS

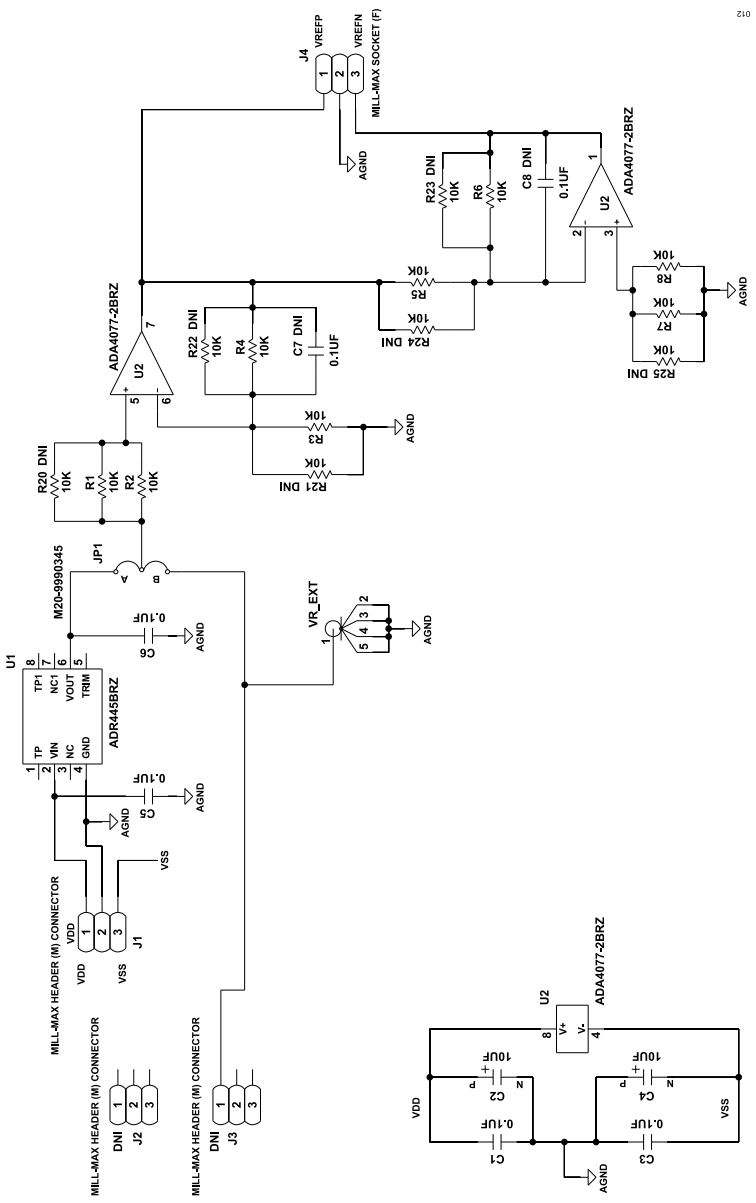

Figure 12. EV-ADR445-REFZ Schematic

EVALUATION BOARD SCHEMATICS

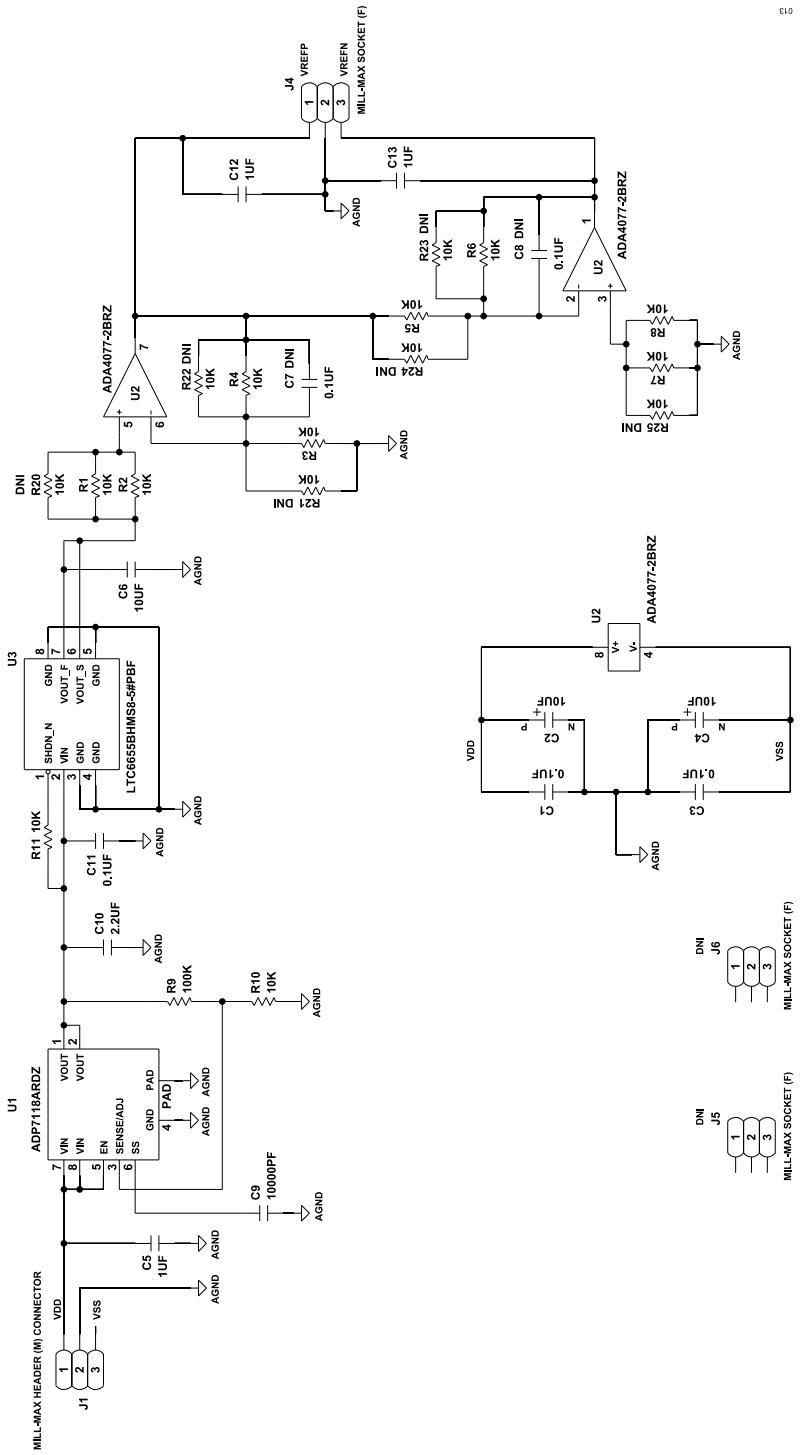

Figure 13. EV-LTC6655-REFZ Schematic

EVALUATION BOARD SCHEMATICS

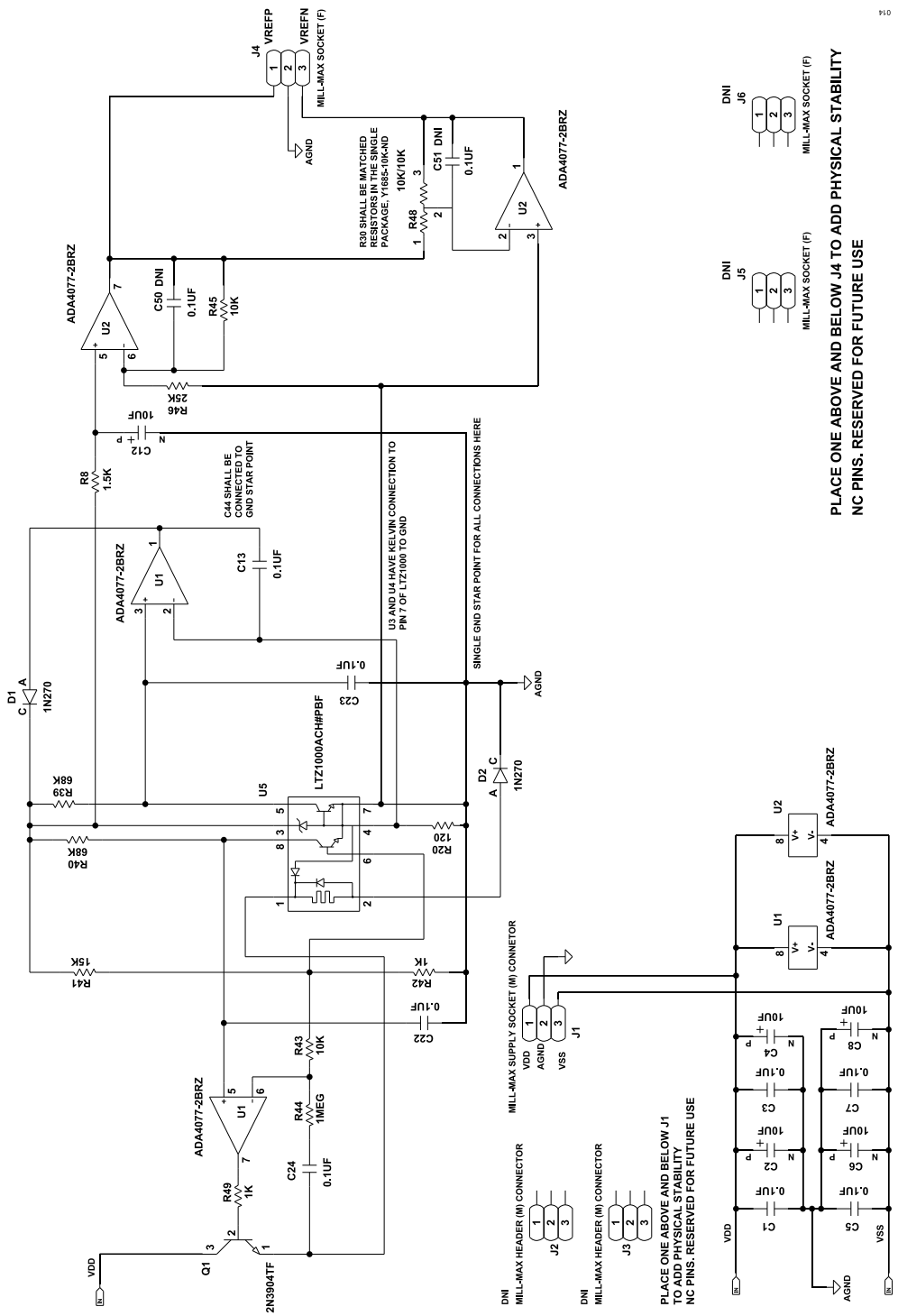

Figure 14. EV-LTZ1000-REFZ Schematic

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.

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