EVM User's Guide: DAC8811EVM

DAC8811 Evaluation Module

Description

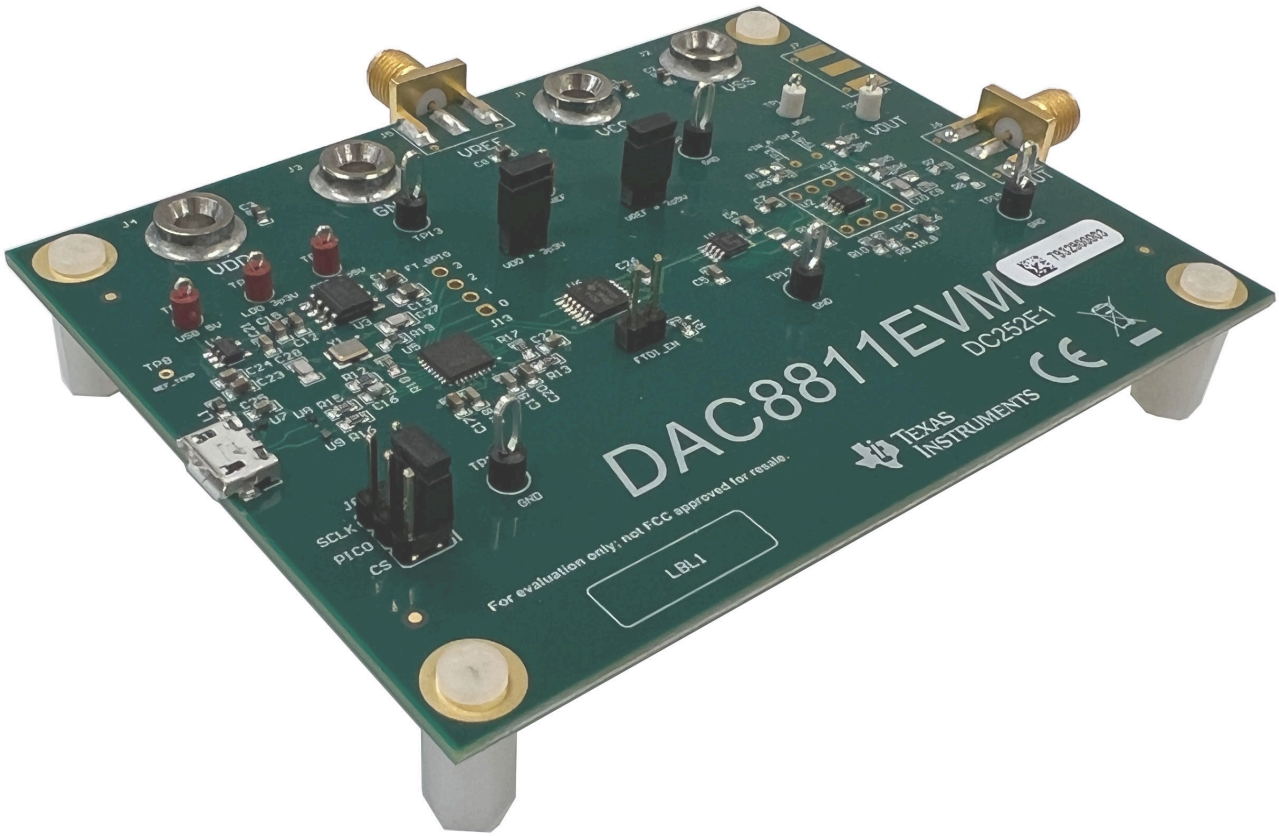
The DAC8811 16-bit multiplying digital-to-analog converter (DAC) is an accurate, low-power, easy-to-use device with a precise, unbuffered, current output. The DAC8811EVM showcases the DAC8811 and a configurable operation amplifier (op amp) circuit. By default, the EVM uses the OPA2828 in a bipolar ±10-V output configuration, but supports the addition of a DIP connection for other op amps.

Get Started

1. Order the EVM.
2. Configure EVM jumpers.
3. Install DAC8811EVM GUI on ti.com.
4. Connect USB and external power supplies.
5. Launch DAC8811EVM GUI.

Features

- Configurable circuit to evaluate DAC with operational amplifiers
- Onboard VDD and VREF support
- FT4222 used to easily write to DAC using DAC8811EVM GUI
- External SPI connections available



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and recommended use cases of the DAC8811EVM. This document provides examples and instructions on how to use the DAC8811EVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the DAC8811EVM. This document also includes a schematic, reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).

1.2 Kit Contents

Table 1-1 details the contents of the EVM kit. Contact the TI Product Information Center at (972) 644-5580 if any component is missing. Download the latest versions of the related software on the TI website, www.ti.com.

Table 1-1. DAC8811EVM Kit Contents

Item	Quantity
DAC8811EVM	1
USB-A to Micro-USB Cable	1

1.3 Specification

Figure 1-1 shows the block diagram of the DAC8811EVM board. By default, the DAC8811EVM connects to a local machine USB port through a USB-A to Micro-USB cable.

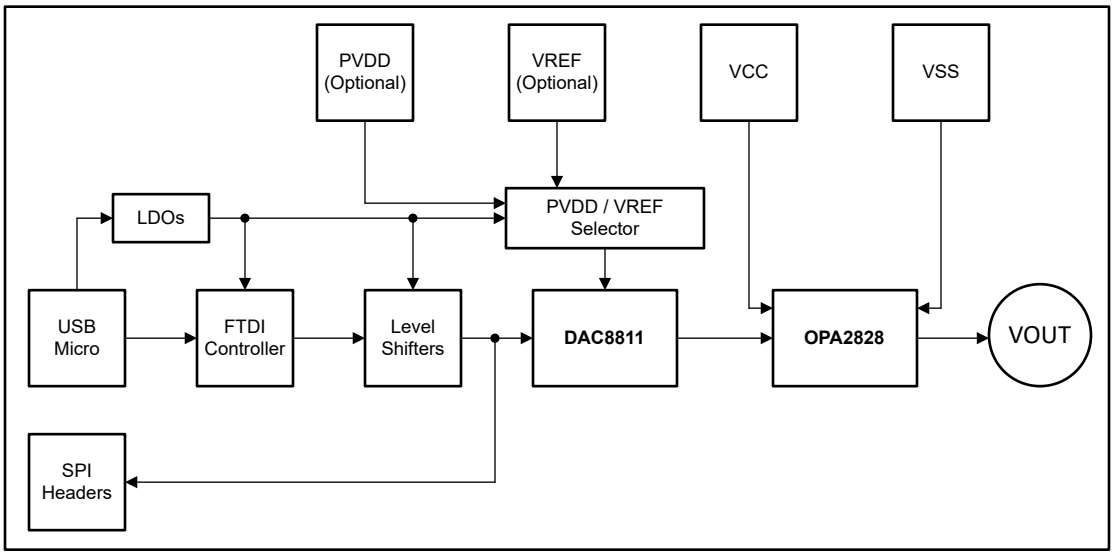


Figure 1-1. DAC8811EVM Functional Block Diagram

With the default jumper settings, the USB sources a 3.3-V supply for VDD and a 2.5-V reference for VREF through onboard low-dropout regulators (LDOs). The VDD and VREF supplies source power through J9 and J10, respectively. To use external supplies, remove the shunts connecting the jumpers, use banana jack connectors at J3 for GND, J4 for VDD, and use SMA connectors at J5 for VREF.

The OPA2828 is powered by external banana jack connectors at J1 and J2, for VCC and VSS respectively. The first amplifier converts the current output of the DAC8811 to a voltage, then the second amplifier gains the output to be a bipolar ±10-V output. The OPA2828 circuit can be configured to support other gain or shift values, and also other operational amplifiers.

1.4 Device Information

The documents in Table 1-2 provide information regarding Texas Instruments integrated circuits used in the assembly of the DAC8811EVM. This user's guide is available from the TI web site under literature number SLAU151. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from the TI web site at www.ti.com, or call

the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 1-2. Related Device Documentation

Document	Literature Number
DAC8811 product data sheet	SLAS411
OPA2828 product data sheet	SBOS671
REF5025 product data sheet	SBOS410
SN74LV4T125 product data sheet	SCLS749
TPD1E10B09 product data sheet	SLLSEB0
TPS73443-Q1 product data sheet	SBVS185

2 Hardware

2.1 Power Requirements

The USB connection at J12 provides 5 V of power to the EVM. This connection is necessary if using the DAC8811EVM-GUI, as the FT4222 is powered by one of the LDOs on the board. Two LDOs translate the USB power to 3.3-V and 2.5-V supplies used for VDD and VREF respectively. There are jumper options available to disconnect the supplies if external supplies are desired to power or regulate the DAC8811. VCC and VSS must be provided externally for proper operation of the OPA2828 or any other op amp used. As the default configuration is for a ±10 V output, TI recommends to provide between 11 V and 18 V to VCC and between –11 V and –18 V to VSS. Table 2-1 summarizes the external power connections.

Table 2-1. DAC8811EVM Power Supply Inputs

Terminal	Name	Function
J1	VCC	External +11 V to +18 V connection for OPA2828's VCC (required)
J2	VSS	External –11 V to –18 V connection for OPA2828's VSS (required)
J3	GND	Ground connection
J4	VDD	Optional external VDD power supply (disconnect J9 when using external supply)
J5	VREF	Optional external VREF power supply (disconnect J10 when using external supply)

2.2 Jumper Information

The jumper settings on the DAC8811EVM are crucial to the proper operation of the EVM. Table 2-2 provides the details of the configurable jumper settings on the EVM. Figure 2-1 shows the default jumper connections on the board.

Table 2-2. DAC8811EVM Jumper Summary

Header	Name	Function
J9	VDD = 3p3V	**Short 1-2** – VDD supplied through USB power (default) **Open** – VDD supplied through J4
J10	VREF = 2p5V	**Short 1-2** – VREF supplied through USB power (default) **Open** – VREF supplied through J5
J11	FTDI_DIS	**Short 1-2** – FTDI SPI level shifter disabled **Open** – FTDI SPI level shifter enabled (default)

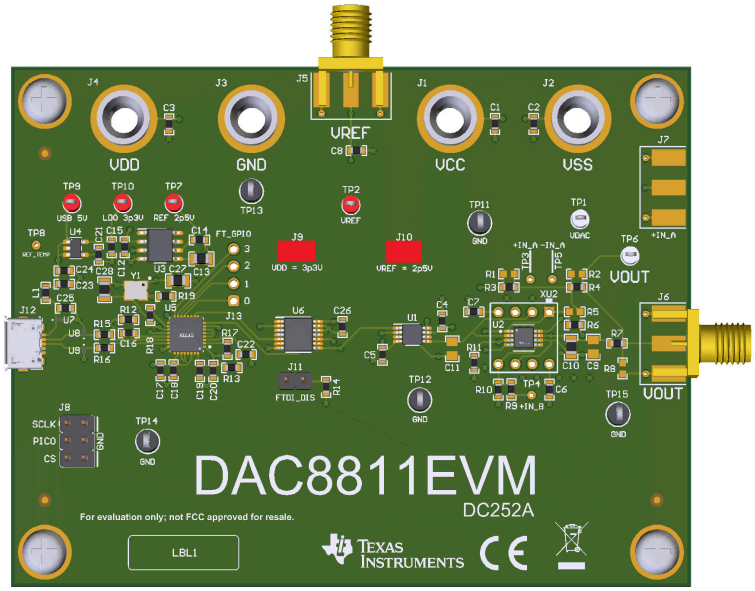


Figure 2-1. Default Header Settings for the DAC8811EVM

2.3 Setup

After the power and jumper configurations are set up per Table 2-1 and Table 2-2, and the DAC8811EVM GUI is fully installed, connect the USB cable from the DAC8811EVM USB port to the local machine. Figure 2-2 displays the system hardware setup.

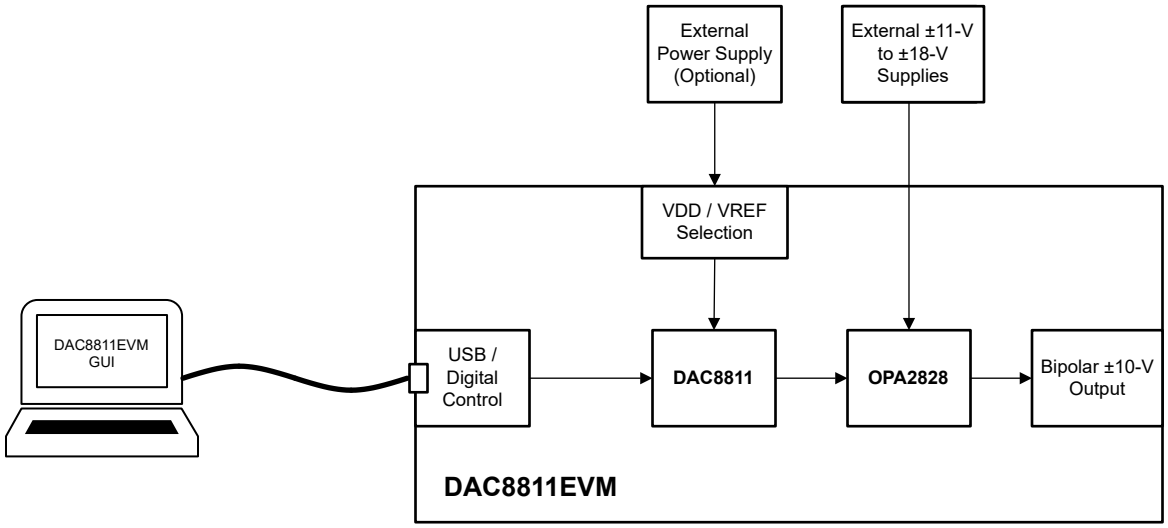


Figure 2-2. DAC8811EVM Hardware Setup

The DAC8811EVM features a configurable op amp circuit that can be modified to change the output of the EVM. Figure 2-3 shows the available resistors and capacitors in the circuit. Any components crossed out with a red "X" are not included by default with the EVM.

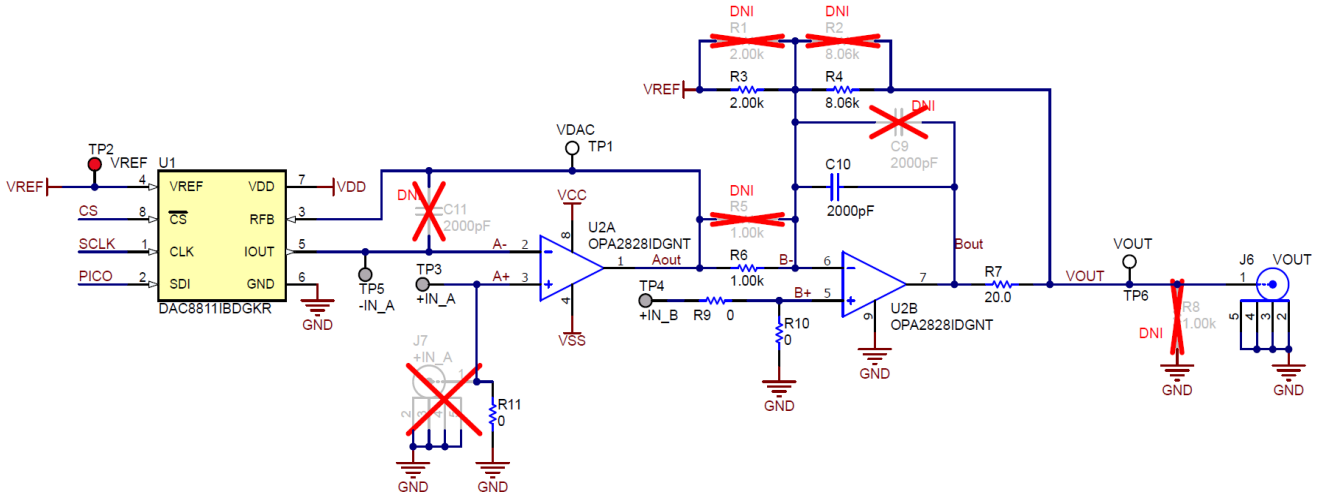


Figure 2-3. DAC8811EVM Op Amp Configuration

To change the output voltage range for the circuit, the resistance at R3, R4, or R6 can be changed. This can easily be done by swapping the entire resistor or adding another resistor in parallel to change the equivalent resistance. The below equation can be used to calculate new resistor values if desired.

$$V_{OUT} = \left(\frac{R4}{R6} \times \frac{V_{REF} \times Code}{2^{BITS}}\right) - \left(\frac{R4}{R3} \times V_{REF}\right) \quad (1)$$

If an op amp other than the OPA2828 is used, then U2 can be removed from the EVM and another op amp can be added. The new op amp must either be a HVSSOP or DIP-8 package type. Figure 2-4 shows the pin configuration of the DIP-8 adapter included on the DAC8811EVM.

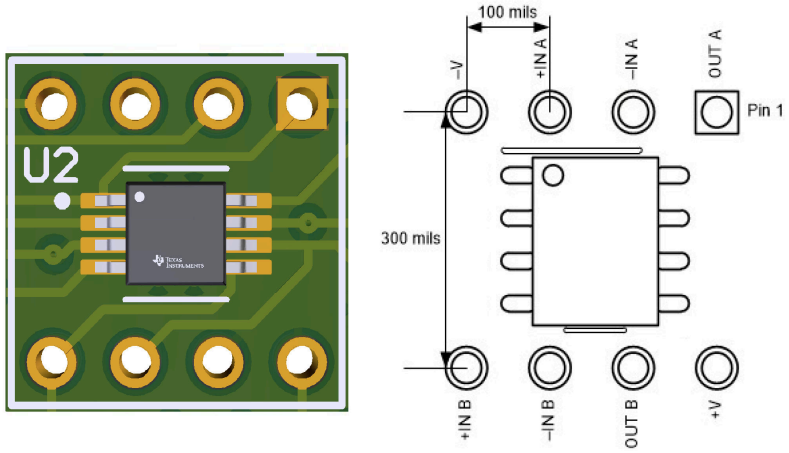


Figure 2-4. DAC8811EVM Op Amp DIP Adapter

2.4 Header Information

The EVM provides access to the digital DAC8811 pins through header J8. Table 2-3 lists the J8 pin definitions.

Table 2-3. DAC8811EVM Header J8 Pin Definitions

Pin Number	Signal	Description
1	SCLK	DAC8811 SPI serial clock input
3	PICO	DAC8811 SDI (serial data input)
5	$\overline{CS}$	DAC8811 chip select input
2, 4, 6	GND	Ground

The pins on J8 can be used to externally control the DAC8811 with SPI messages if the FTDI controller is disconnected from the DAC, by shunting the J11 jumper.

2.5 Test Points

The DAC8811EVM has a variety of test points available for measuring and debugging purposes. Table 2-4 explains the purpose of each test point.

Table 2-4. DAC8811EVM Test Points

Test Point	Net	Description
TP1	VDAC	Output of DAC8811, ranges from 0-V to negative VREF
TP2	VREF	DAC8811 reference voltage
TP3, not installed	+IN_A	Non-inverting input of the first op amp in OPA2828
TP4, not installed	+IN_B	Non-inverting input of the second op amp in OPA2828
TP5, not installed	-IN_A	Inverting input of the first op amp in OPA2828
TP6	VOUT	±10-V output of OPA2828 circuit
TP7	REF 2p5V	Onboard 2.5-V reference provided by REF5025
TP8, not installed	REF_TEMP	TEMP pin of REF5025
TP9	USB 5 V	Onboard 5-V provided by USB connection
TP10	LDO 3p3V	Onboard 3.3-V supply provided by TPS73433-Q1
TP11, TP12, TP13, TP14, TP15	GND	Ground connection

3 Software

3.1 GUI Installation

This section provides the procedure for EVM software installation.

The EVM software is compatible with the Windows® 10 operating system. Before installing the software, make sure that the DAC8811EVM is not connected to the local machine.

Download the latest version of the EVM graphical user interface (GUI) installer from the *Order and start development* subsection of the DAC8811EVM tool folder on TI.com. Run the GUI installer to install the EVM GUI software on your local machine.

When the DAC8811EVM software is launched, an installation dialog window opens and prompts the user to select an installation directory. If left unchanged, Figure 3-1 shows that the software location defaults to *C:\Program Files (x86)\Texas Instruments\DAC8811EVM.*

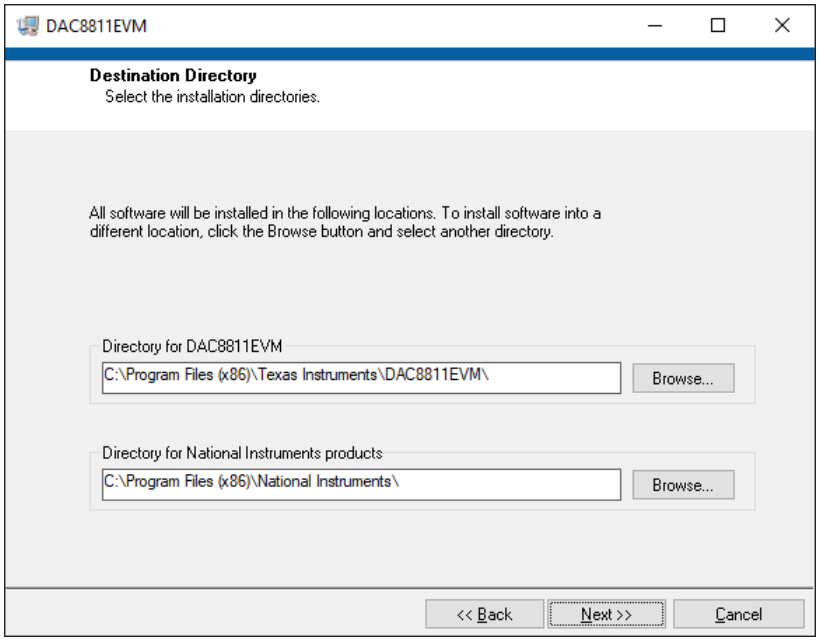


Figure 3-1. Software Installation Path

The EVM software also installs the Future Technology Devices International Limited (FTDI) USB drivers using a separate executable file, and automatically copies the required LabVIEW™ software files and drivers to the local machine. Figure 3-2 shows the FTDI USB drivers installation window that is automatically launched after the DAC8811EVM software installation is complete.

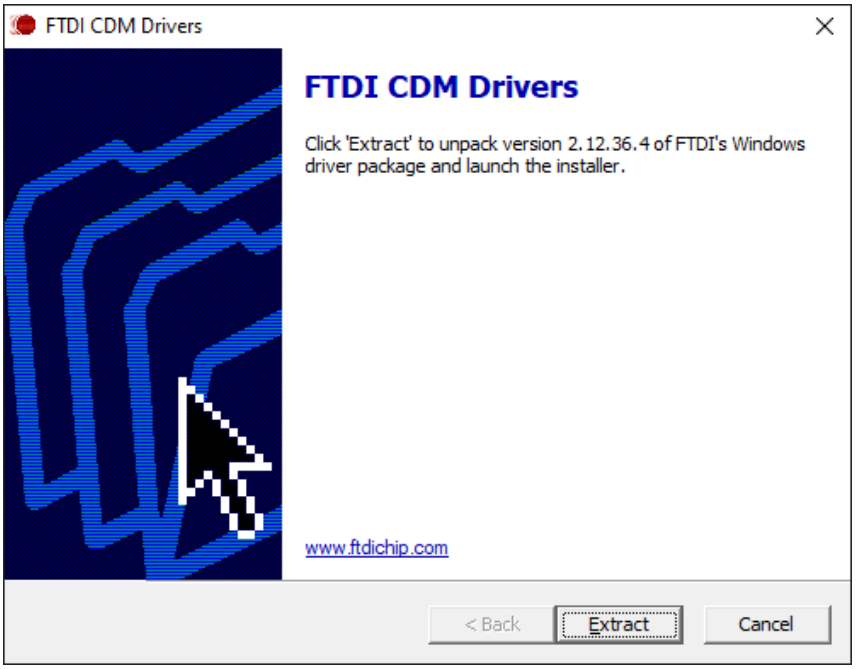


Figure 3-2. FTDI USB Drivers

3.2 Software Description

To launch the software, locate the *Texas Instruments* folder in the *Start Menu*, and select the *DAC8811EVM* icon.

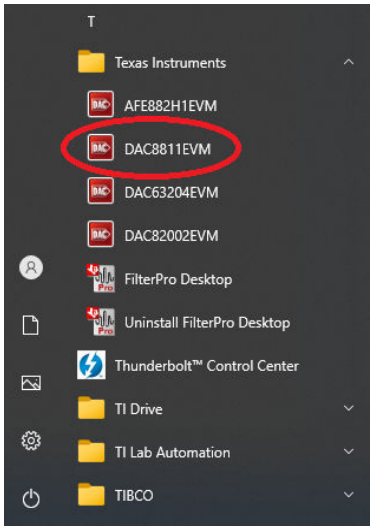


Figure 3-3. DAC8811EVM Software Installation in Start Menu

Figure 3-4 shows that if the onboard FTDI controller is connected correctly, then the status bar at the bottom of the screen displays *CONNECTED*. If the controller is not properly connected or not connected at all, then the status displays *DEMO*. If the graphical user interface (GUI) is not displaying the *CONNECTED* status while the EVM is connected, then unplug and reconnect the EVM and relaunch the GUI software.

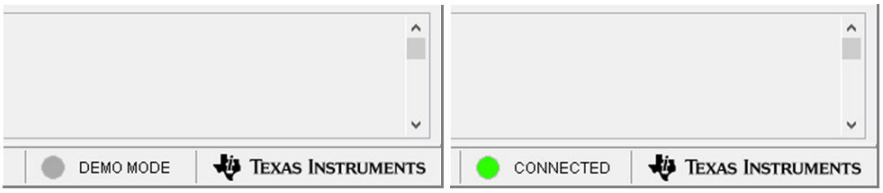


Figure 3-4. DAC8811EVM GUI Connection Detection

Figure 3-5 shows the *DAC8811 Register* page of the DAC8811EVM GUI. This page allows direct access to the data register of the DAC8811. The GUI handles page address management, allowing seamless access to the register.

The *Register Map* section in the center of the page lists the register. Directly above the *Register Map* section are four buttons that allow access to the data register.

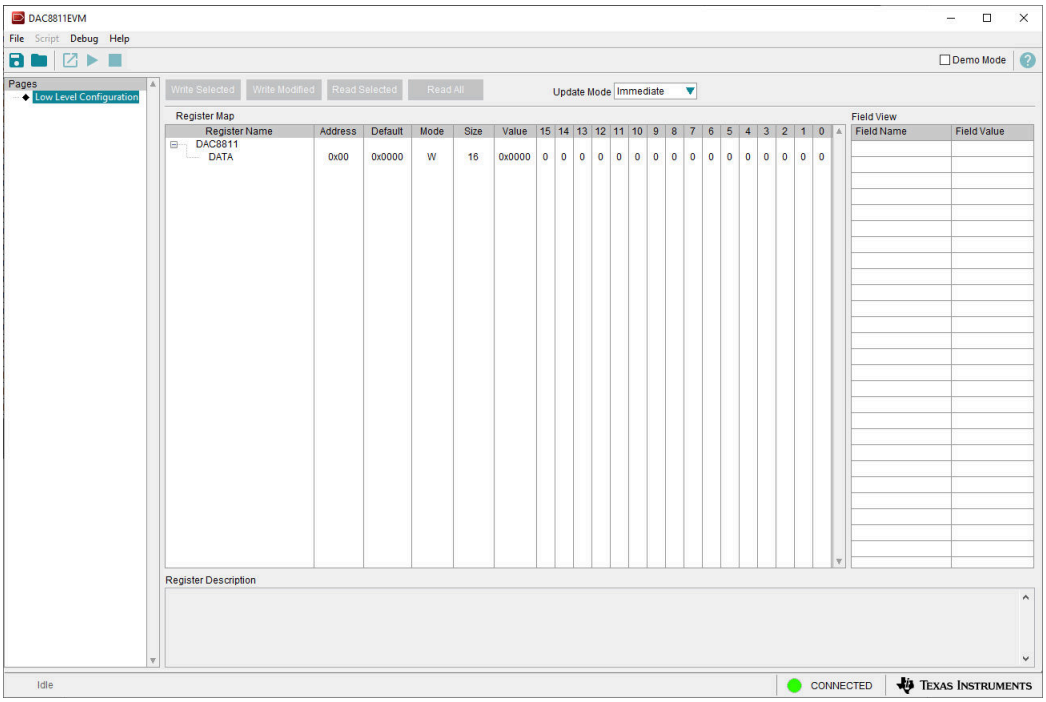


Figure 3-5. DAC8811EVM Register Page

To store the values of the register map locally, select *Save Configuration* under the *File* menu option. The stored configuration files can be recalled and loaded by selecting *Open Configuration*.

Figure 3-6 shows the single configuration button, **Write Selected**, provided on the *Register* page above the *Register Map* that allow the user to interact with the device registers:

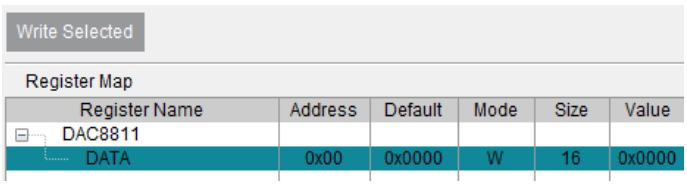


Figure 3-6. DAC8811EVM Register Page Options

4 Hardware Design Files

4.1 Schematics

The DAC8811EVM schematic is shown in Figure 4-1 and Figure 4-2.

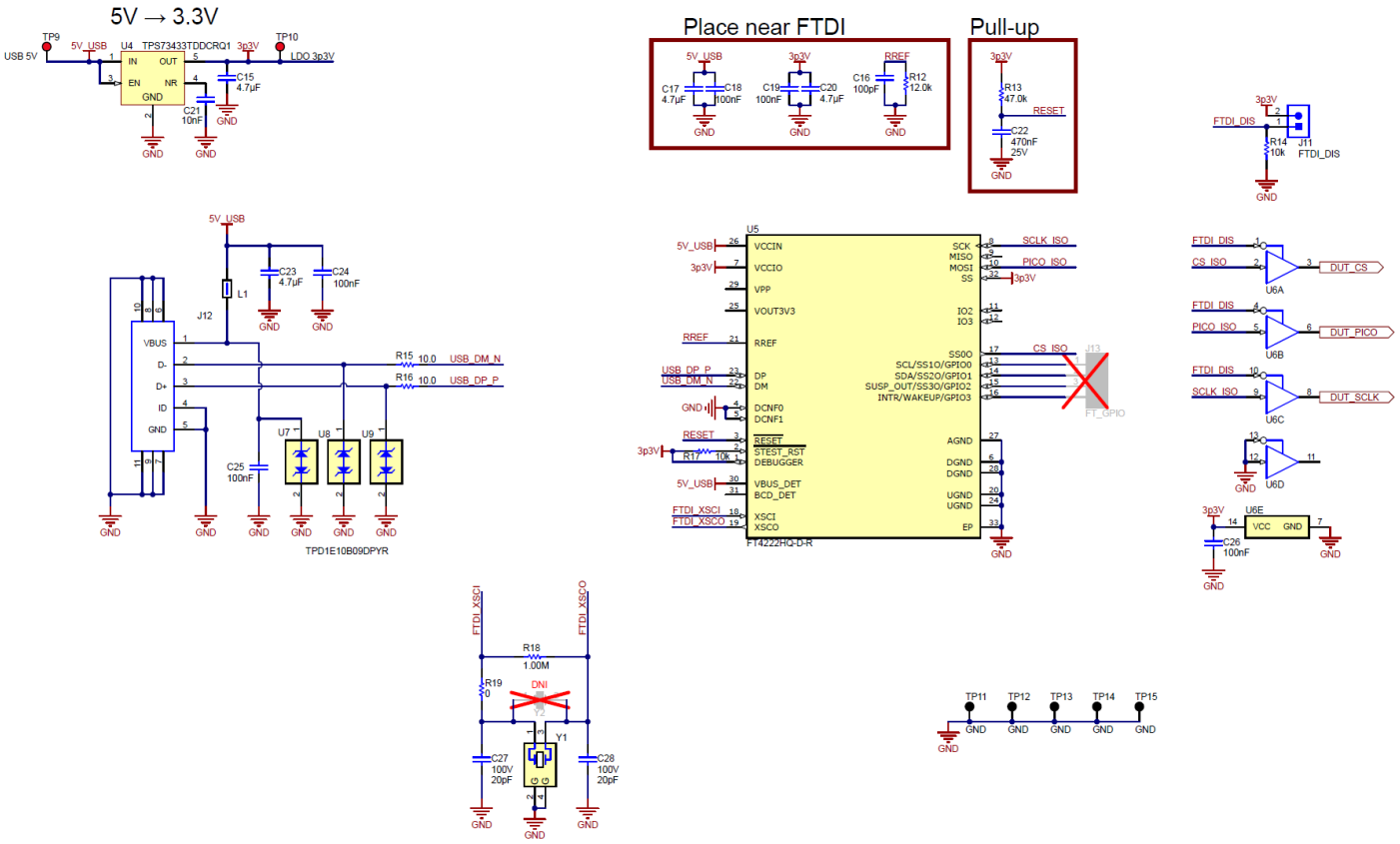


Figure 4-1. DAC8811EVM Schematic: FTDI Controller

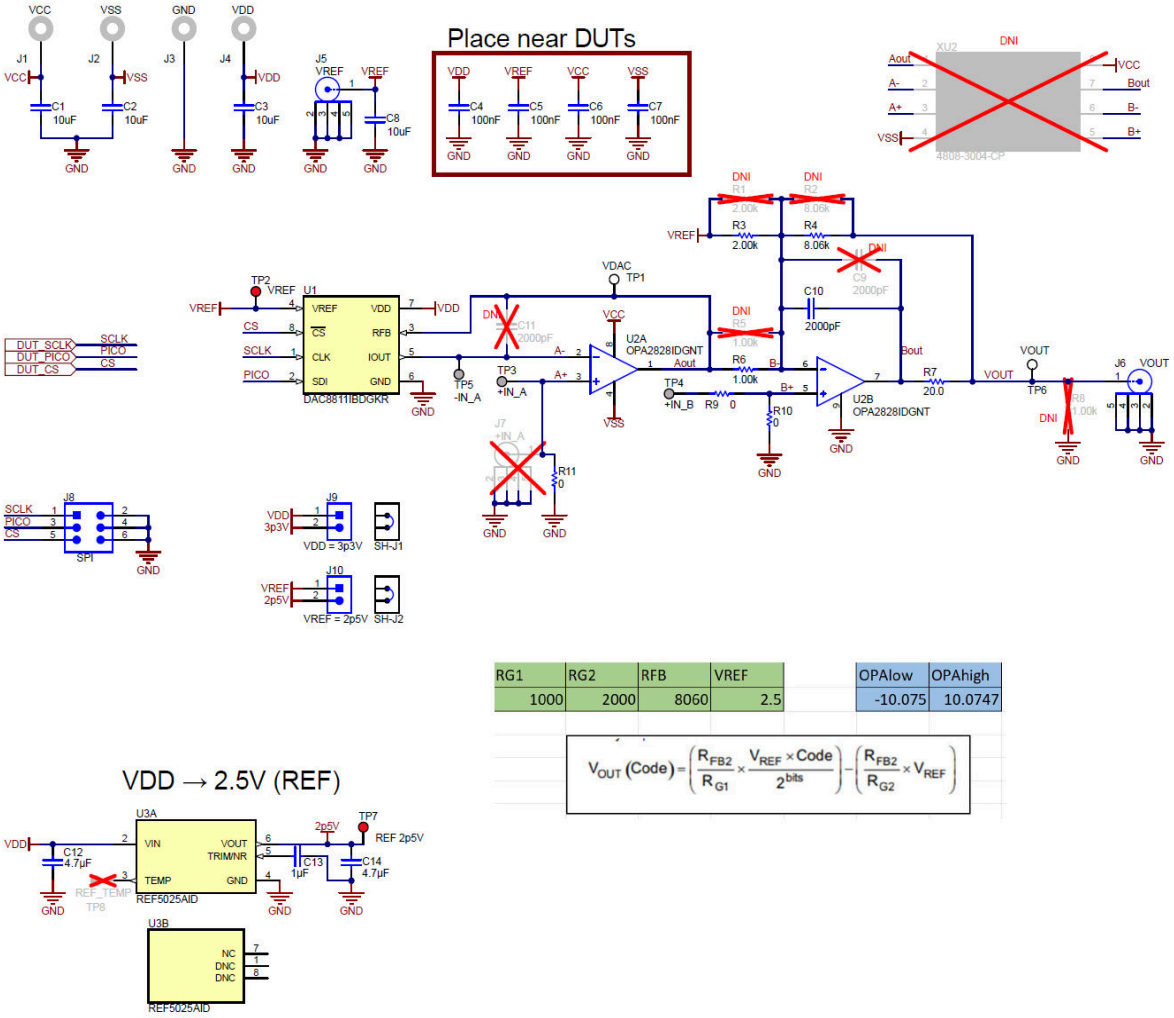


Figure 4-2. DAC8811EVM Schematic: DAC8811 and OPA2828 Bipolar Output

4.2 PCB Layouts

Figure 4-3 through Figure 4-6 show the board layout for the DAC8811EVM.

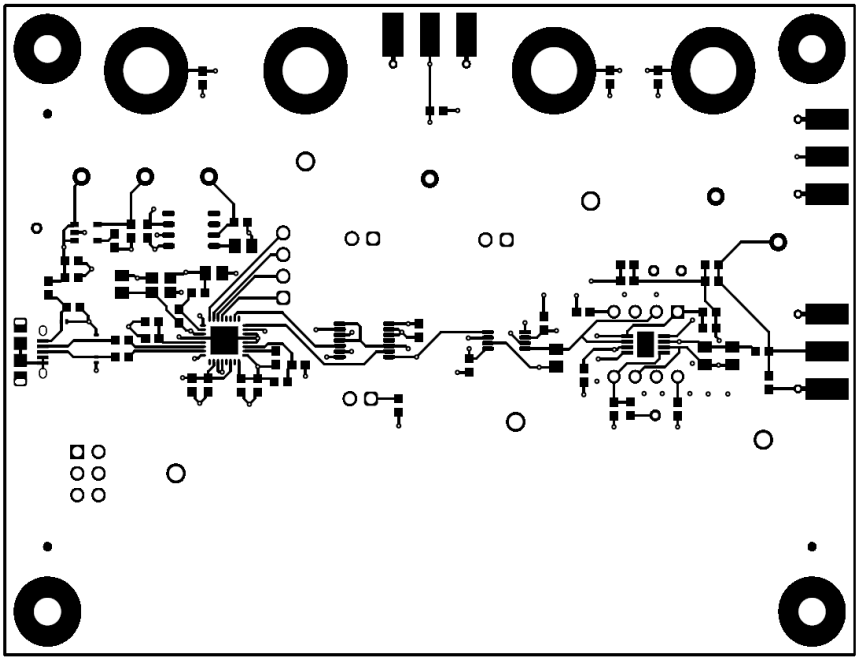


Figure 4-3. DAC8811EVM PCB Top Layer Layout

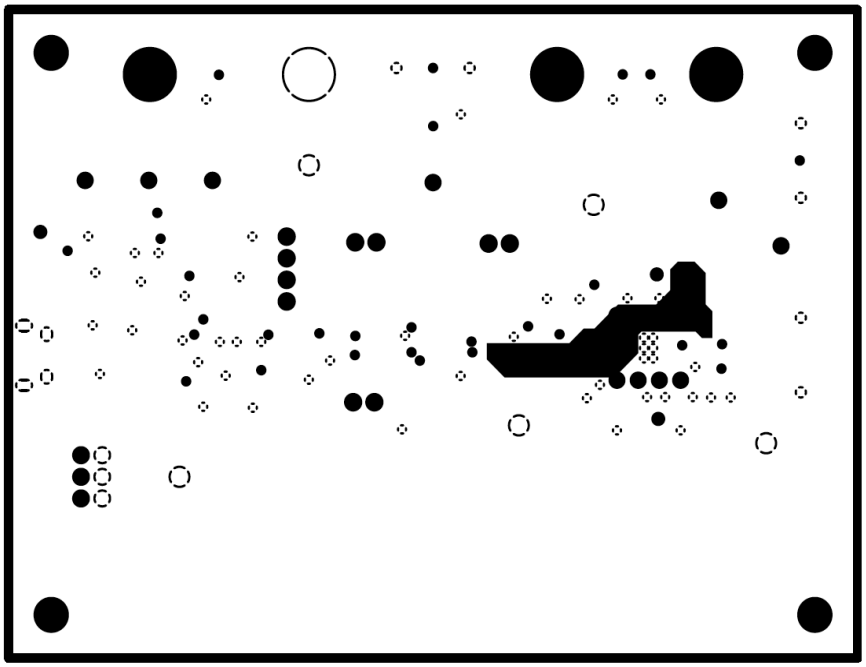


Figure 4-4. DAC8811EVM PCB Mid Layer 1 Layout

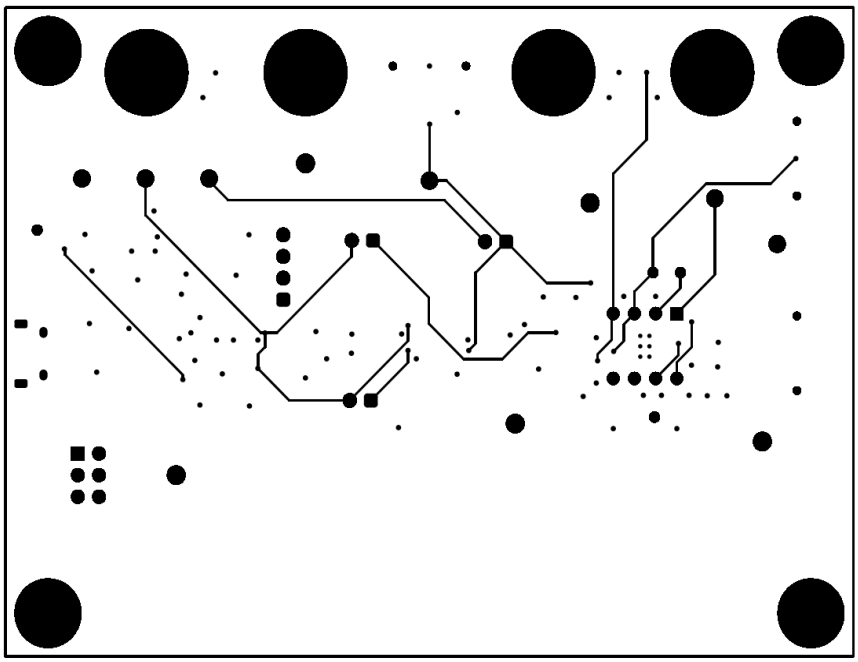


Figure 4-5. DAC8811EVM PCB Mid Layer 2 Layout

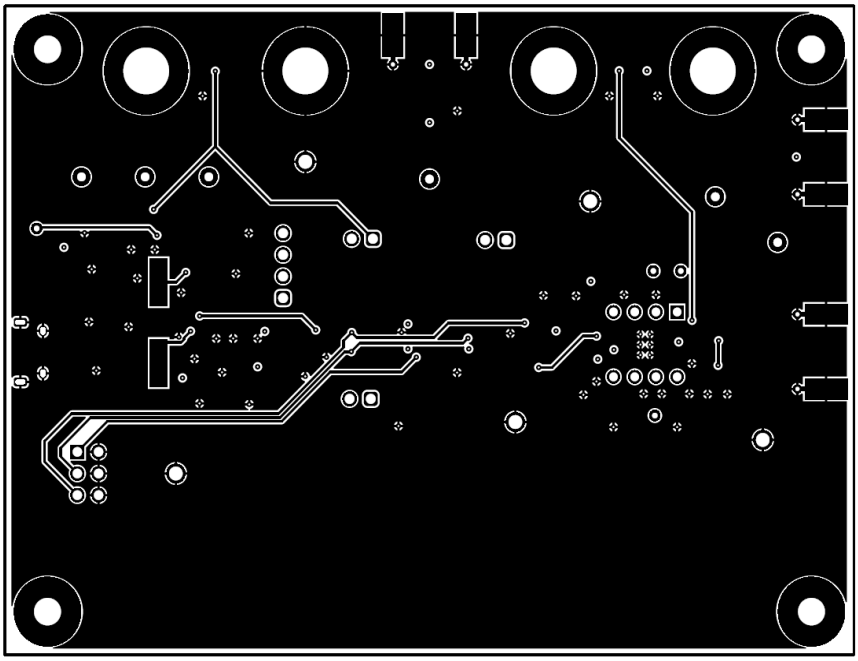


Figure 4-6. DAC8811EVM PCB Bottom Layer Layout

4.3 Bill of Materials (BOM)

Table 4-1 lists the DAC8811EVM bill of materials (BOM).

Table 4-1. Bill of Materials for the DAC8811EVM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C3, C8	4	10 µF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	0603	GRT188R61E106ME13D	MuRata
C4, C5, C6, C7, C18, C19, C24, C25, C26	9	0.1 µF	CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 0, 0603	0603	06035C104K4Z4A	AVX
C10	1	2000 pF	CAP, CERM, 2000 pF, 100 V, +/- 5%, C0G/NP0, 0805	0805	GRM2165C2A202JA01D	MuRata
C12, C14, C15, C17, C20, C23	6	4.7 µF	CAP, CERM, 4.7 uF, 16 V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
C13	1	1 µF	CAP, CERM, 1 uF, 10 V, +/- 10%, X7R, 0805	0805	C0805C105K8RACTU	Kemet
C16	1	100 pF	CAP, CERM, 100 pF, 25 V, +/- 10%, X7R, 0603	0603	06033C101KAT2A	AVX
C21	1	0.01 µF	CAP, CERM, 0.01 uF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC103KAT2A	AVX
C22	1	0.47 µF	CAP, CERM, 0.47 uF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E474KA12D	MuRata
C27, C28	2	20 pF	CAP, CERM, 20 pF, 100 V, +/- 5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J3, J4	4		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J5, J6	2		Connector, End launch SMA, 50 ohm, SMT	End Launch SMA	142-0701-801	Cinch Connectivity
J8	1		Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, TH	61300621121	Wurth Elektronik
J9, J10, J11	3		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
J12	1		Receptacle, USB 2.0, Micro-USB Type B, R/A, SMT	USB-micro B USB 2.0, 0.65mm, 5 Pos, R/A, SMT	10118194-0001LF	FCI
L1	1	600 Ω	Ferrite Bead, 600 ohm @ 100 MHz, 1 A, 0603	0603	782633601	Wurth Elektronik
R3	1	2.00k	RES, 2.00 k, 0.1%, 0.1 W, 0603	0603	RG1608P-202-B-T5	Susumu Co Ltd
R4	1	8.06k	RES, 8.06 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD078K06L	Yageo America
R6	1	1.00k	RES, 1.00 k, 0.1%, 0.1 W, 0603	0603	RT0603BRD071KL	Yageo America
R7	1	20.0	RES, 20.0, 1%, 0.1 W, 0603	0603	RC0603FR-0720RL	Yageo
R9, R10, R11, R19	4	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R12	1	12.0k	RES, 12.0 k, 0.1%, 0.1 W, 0603	0603	RG1608P-123-B-T5	Susumu Co Ltd
R13	1	47.0k	RES, 47.0 k, 1%, 0.1 W, 0603	0603	RC0603FR-0747KL	Yageo
R14, R17	2	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo
R15, R16	2	10.0	RES, 10.0, 1%, 0.1 W, 0603	0603	RC0603FR-0710RL	Yageo
R18	1	1.00Meg	RES, 1.00 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FG1M00	Stackpole Electronics Inc
SH-J1, SH-J2	2	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec

Table 4-1. Bill of Materials for the DAC8811EVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP6	2		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone Electronics
TP2, TP7, TP9, TP10	4		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone Electronics
TP11, TP12, TP13, TP14, TP15	5		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
U1	1		16-bit, single-channel, serial input multiplying DAC with 0.5us settling time, DGK0008A (VSSOP-8)	DGK0008A	DAC8811IBDGKR	Texas Instruments
U2	1		Low-Offset, Low-Drift, Low-Noise, 45-MHz, 36-V, JFET-Input Operational Amplifiers	VSSOP8	OPA2828IDGNT	Texas Instruments
U3	1		Low Noise, Very Low Drift, Precision Voltage Reference, -40 to 125 degC, 8-pin SOIC (D), Green (RoHS & no Sb/Br)	D0008A	REF5025AID	Texas Instruments
U4	1		Single Output High PSRR LDO, 250 mA, Fixed 3.3 V Output, 2.7 to 6.5 V Input, with Low IQ, 5-pin SOT (DDC), -40 to 105 degC, Green (RoHS & no Sb/Br)	DDC0005A	TPS73433TDDCRQ1	Texas Instruments
U5	1		USB Bridge, USB to I²C/SPI USB 2.0 I²C, SPI 32-VQFN (5x5)	VQFN32	FT4222HQ-D-R	FTDI
U6	1		Single Power Supply Quadruple Buffer GATE w/ 3-State Output CMOS Logic Level Shifter, PW0014A, LARGE T&R	PW0014A	SN74LV4T125PWR	Texas Instruments
U7, U8, U9	3		Single-Channel ESD Protection in 0402 Package With 10 pF Capacitance and 9 V Breakdown, DPY0002A (X1SON-2)	DPY0002A	TPD1E10B09DPYR	Texas Instruments
Y1	1		Crystal, 12 MHz, 30 ppm, SMD	3.20x0.70x2.50mm	7M-12.000MAHE-T	TXC Corporation

5 Compliance Information

5.1 Compliance and Certifications

- DAC8811EVM EU Declaration of Conformity (DoC) for Restricting the use of Hazardous Substances (RoHS)

6 Related Documentation

6.1 Supplemental Content

- Thermally-Enhanced Packages Improve Precision for Operational Amplifiers
  - Document covering the precision benefits of using operational amplifiers that utilize packages with heat sinks, testing was done using the DAC8811EVM

7 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (November 2009) to Revision B (June 2023)	Page
• The DAC8811EVM and this user's guide have been completely redesigned. This user's guide cannot be used for previous board versions	1

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