EVM User's Guide: DAC81416-08EVM
DAC81416-08 Evaluation Module

TEXAS INSTRUMENTS

Description

The DAC81416-08EVM is an easy-to-use platform to evaluate the functionality and performance of the DAC81416 and DAC81408 devices. The board comes with the DAC81416 installed. The DAC81416-08EVM has optional circuits and jumpers to configure the device for different applications.

Get Started

1. Order the EVM.
2. Configure EVM jumpers.
3. Install the DAC81416-08EVM GUI from ti.com.
4. Download the latest libraries.
5. Connect USB and external power supplies.
6. Launch the DAC81416-08EVM GUI.

Features

- Configurable circuit to evaluate the DAC81416
- On-board VDD (5V) and VIO (3.3V or 1.8V) support via USB
- On-board FT4232 easily writes to the DAC using the DAC81416-08EVM GUI
- External SPI connections available

Applications

- Inter-DC interconnect (long-haul, submarine)
- Inter-DC interconnect (metro)
- Optical module
- Semiconductor test
- Lab and field instrumentation
- Data acquisition (DAQ)
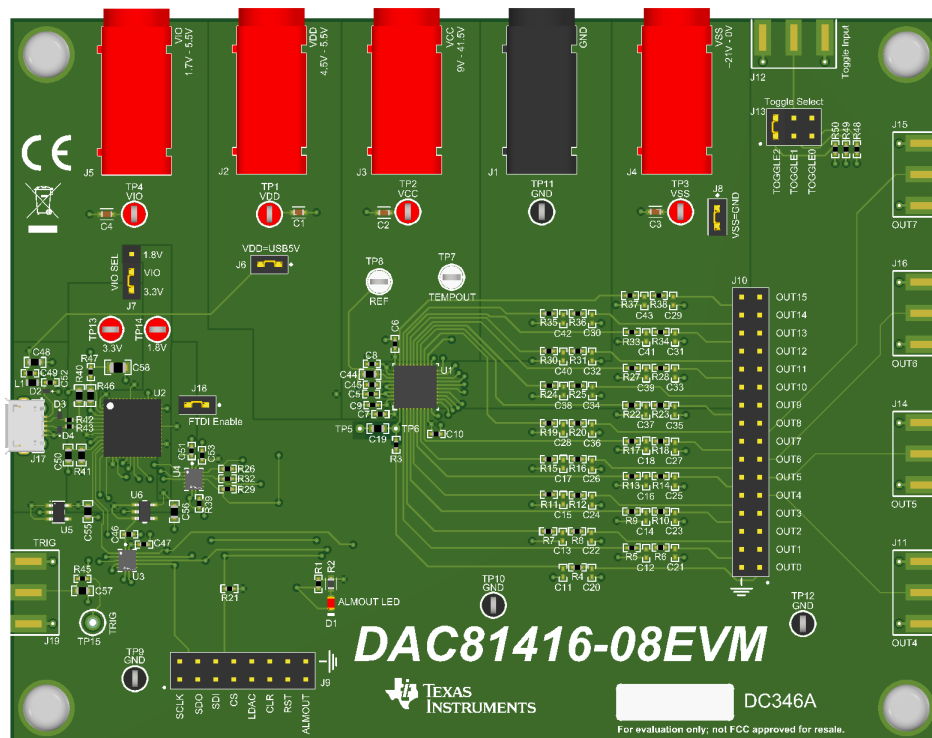
1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and recommended use cases of the DAC81416-08EVM. This document provides examples and instructions on how to use the DAC81416-08EVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the DAC81416-08EVM. This document also includes schematics, the 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. DAC81416-08EVM Kit Contents

Item	Quantity
DAC81416-08EVM board	1
USB micro-B plug to USB-A plug cable	1

1.3 Specification

The EVM is intended to provide basic functional evaluation of the device. The layout is not intended to be a model for the target circuit, nor laid out for electromagnetic compatibility (EMC) testing. The EVM consists of a printed-circuit board (PCB), which has the DAC81416 installed.

1.4 Device Information

The DAC81416, DAC71416, and DAC61416 are a pin-compatible family of 16-channel, buffered, high-voltage output digital-to-analog converters (DACs) with 16-bit, 14-bit, and 12-bit resolution. The DAC81416 includes a low-drift, 2.5V internal reference, eliminating the need for an external precision reference in most applications. These devices are specified monotonic and provide high linearity of ±1 LSB INL.

A user-selectable output configuration enables full-scale bipolar output voltages of ±20V, ±10V, ±5V or ±2.5V, and full-scale unipolar output voltages of 40V, 20V, 10V or 5V. The full-scale output range for each DAC channel is independently programmable. The integrated DAC output buffers can sink or source up to 25mA, thus limiting the need for additional operational amplifiers. Each pair of channels can be configured to provide a differential output with offset calibration. The three dedicated A-B toggle pins enable dither signal generation with up to three possible frequencies.

The DAC81416 incorporate a power-on-reset circuit that connects the DAC outputs to ground at power up. The outputs remain in this state until the device registers are properly configured for operation. Communication with the DAC81416 is performed through a 4-wire serial interface that supports operation from 1.7V to 5.5V.

2 Hardware

2.1 Hardware Setup

This section describes the overall system setup for the EVM. A computer runs software that communicates with the FT4232 controller onboard using SPI protocol. External power supplies are required for certain EVM inputs, such as the VCC and VSS supplies.

2.1.1 Hardware Theory of Operation

The DAC81416-08EVM is connected to the computer through the on-board FT4232 digital controller using the USB cable that is supplied with the EVM. The evaluation board features connectors and test points for all communication lines, DAC outputs, and supplies.Figure 2-1 shows a block diagram of the DAC81416-08EVM.
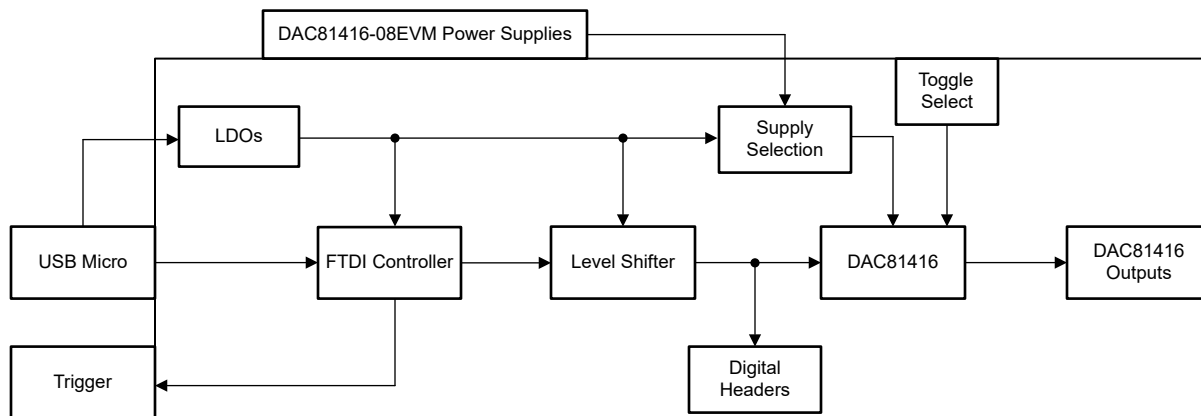

Figure 2-1. DAC81416-08EVM Theory of Operation Block Diagram

The USB connection provides the 5V supply to the EVM. Voltage regulators generate 3.3V and 1.8V from the USB 5V supply. These 3.3V and 1.8V supplies are used to power the FT4232 controller.

The DAC81416 VDD supply can use the on-board 5V supply depending on the J6 setting. By default, the VDD supply is connected to the on-board 5V supply. Alternatively, VDD can be supplied externally through banana jack J2. Remove the jumper connector on J6 before connecting external supplies to VDD.

The DAC81416 VIO supply can use the on-board 3.3V or 1.8V supply depending on the jumper J7 setting. By default, the VIO supply is connected to the on-board 3.3V supply. Alternatively, VIO can be supplied externally through banana jack J5. Remove the jumper connector on J7 before connecting external supplies to VIO.

The DAC81416 VCC supply is used to configure the DAC buffer positive output range. Power VCC externally using banana jack J3.

The DAC81416 VSS supply is used to configure the DAC buffer negative output range. Power VSS externally using banana jack J4. If the device is only used in the positive output range, the VSS supply can be grounded using jumper J8. Remove the jumper connector on J8 before connecting external supplies to VSS.

2.1.2 Jumper Definitions

Table 2-1 shows the jumper definitions of the DAC81416-08EVM.

Table 2-1. Jumper Definitions

Designator	Name	Positions
J6	VDD=USB5V	**SHORT 1-2** - VDD is connected to the USB 5V (default). **OPEN** - Open this jumper when using external power for VDD.
J7	VIO SEL	**SHORT 1-2** - VIO is connected to the on-board 3.3V (default). **SHORT 2-3** - VIO is connected to the on-board 1.8V. **OPEN** - Open this jumper when using external power for VIO.
J8	VSS=GND	**SHORT 1-2** - VSS is grounded (default). **OPEN** - Open this jumper when using external power for VSS.
J13	Toggle Select	**SHORT 1-2** - TOGGLE2 is connected to the Toggle Input SMA. **SHORT 3-4** - TOGGLE1 is connected to the Toggle Input SMA. **SHORT 5-6** - TOGGLE0 is connected to the Toggle Input SMA.
J18	FTDI Enable	**SHORT 1-2** - Connects the FT4232 controller to the DAC81416 (default). **OPEN** - Disconnects the FT4232 from the DAC81416. Open if external communication is used.

2.1.3 Connector Definitions

Table 2-2 shows the power connector definitions of the DAC81416-08EVM.

Table 2-2. Power Connector Definitions

Designator	Definition
J1	Ground
J2	DAC81416 VDD supply (4.5V to 5.5V)
J3	DAC81416 VCC supply (9V to 41.5V)
J4	DAC81416 VSS supply (−21.5V to 0V)
J5	DAC81416 VIO supply (1.7V to 5.5V)
J17	USB connector

Table 2-3 shows the output connector definitions for the DAC81416-08EVM. All of the SMAs are unpopulated by default.

Table 2-3. Output Connector Definitions

Designator	Definition
J11	OUT4 SMA
J14	OUT5 SMA
J15	OUT7 SMA
J16	OUT6 SMA
J19	SMA connector for the FT4232 trigger output

Table 2-4 shows the DAC output header J10 definitions for the DAC81416-08EVM.

Table 2-4. DAC Output Header J10 Definitions

Pin	Definition
1	OUT0
3	OUT1
5	OUT2
7	OUT3
9	OUT4
11	OUT5
13	OUT6
15	OUT7
17	OUT8
19	OUT9
21	OUT10
23	OUT11
25	OUT12
27	OUT13
29	OUT14
31	OUT15
2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32	Ground

2.1.4 Test Points

The DAC81416-08EVM has test points available for measuring and debugging purposes. Table 2-5 lists the description of each test point.

Table 2-5. DAC81416-08EVM Test Points

Test Point	Net	Description
TP1	VDD	DAC81416 VDD supply
TP2	VCC	DAC81416 VCC supply
TP3	VSS	DAC81416 VSS supply
TP4	VIO	DAC81416 VIO supply
TP5	GND	Dedicated ground test point for measuring DAC glitch
TP6	OUT0	Dedicated OUT0 test point for measuring DAC glitch
TP7	TEMPOUT	TEMPOUT test point
TP8	REF	REF test point
TP9, TP10, TP11, TP12	GND	Ground test point
TP13	3.3V	On-board 3.3V supply
TP14	1.8V	On-board 1.8V supply
TP15	TRIG	FT4232 Trigger output

2.2 Hardware Overview

This section details how to configure the EVM for and voltage outputs using SPI. The following subsections provide detailed information on the EVM hardware and jumpers (see also Section 2.1.2).

2.2.1 Electrostatic Discharge Caution

> **CAUTION**
>
> Many of the components on the DAC81416-08EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

2.2.2 Connecting the FT4232 Digital Controller

To connect the FT4232 digital controller on the EVM board to the PC, align and firmly connect the USB connector to the J17 connector. Verify the connection is snug; a loose connection can cause intermittent operation. J18 must be have a jumper to connect the FT4232 to the DAC81416. A 100 mil header (J9) is available for external communication. Table 2-6 lists the J9 pin definitions. To use external communication, disconnect jumper J18 to remove the connection to the FT4232 controller.

Table 2-6. Digital Header J9 Pin Definitions

Designator	Definition
1	DAC81416 SCLK
3	DAC81416 SDO
5	DAC81416 SDI
7	DAC81416 $\overline{CS}$
9	DAC81416 $\overline{LDAC}$
11	DAC81416 $\overline{CLR}$
13	DAC81416 $\overline{RST}$
15	DAC81416 $\overline{ALMOUT}$
2, 4, 6, 8, 10, 12, 14, 16	Ground

3 Software

3.1 Software Setup

This section provides the procedure for EVM software installation.

3.1.1 Software Installation

Note

Do not connect the EVM to the PC when the software is installing.

Download the latest version of the EVM graphical user interface (GUI) installer from the *Order and start development* subsection of the DAC81416-08EVM tool folder on TI.com. Run the GUI installer to install the DAC81416-08EVM GUI software on your PC. The software installation automatically copies the required LabVIEW™ software files and drivers to the PC.

When the DAC81416-08EVM GUI 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\DAC81416-08EVM.*
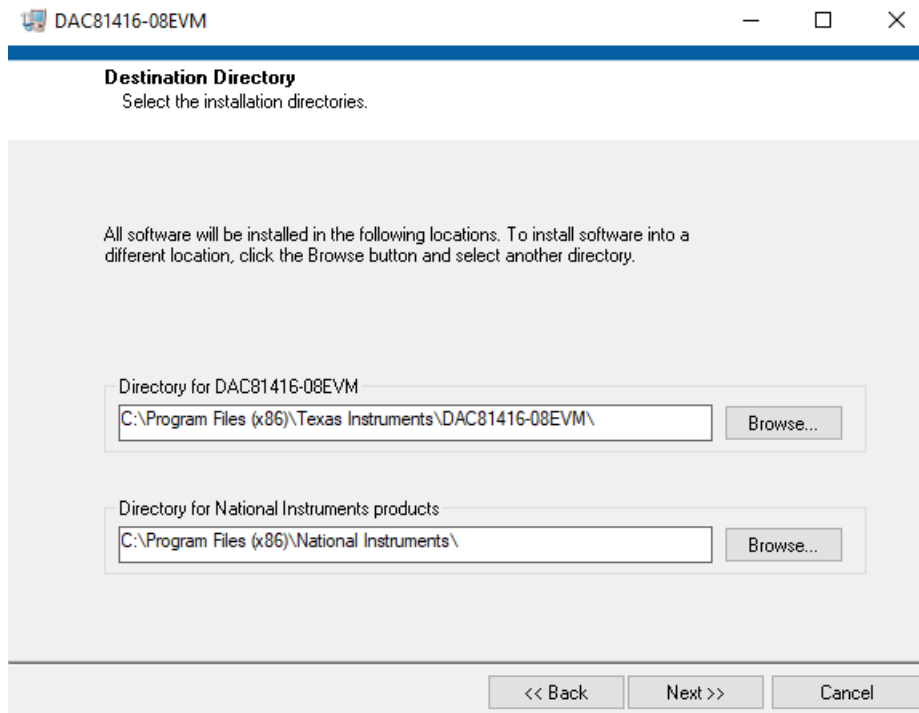
Figure 3-1. Software Installation Path

The EVM software also installs the Future Technology Devices International Limited (FTDI) USB drivers using a separate executable file. Figure 3-2 shows the FTDI USB drivers installation window that is automatically launched after the DAC81416-08EVM software installation is complete.

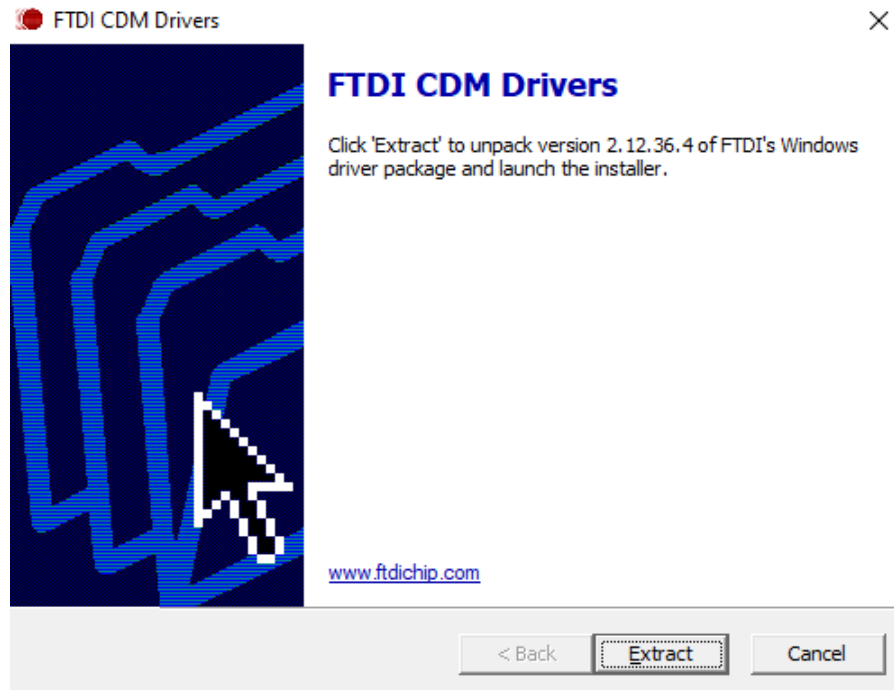**Figure 3-2. FTDI USB Drivers**

3.2 Software Overview

This section discusses how to use the DAC81416-08EVM software.

3.2.1 Launching the Software

Launch the DAC81416-08EVM software by searching for DAC81416-08EVM in the Windows® *Start* menu.

Figure 3-3 shows the GUI after launch.
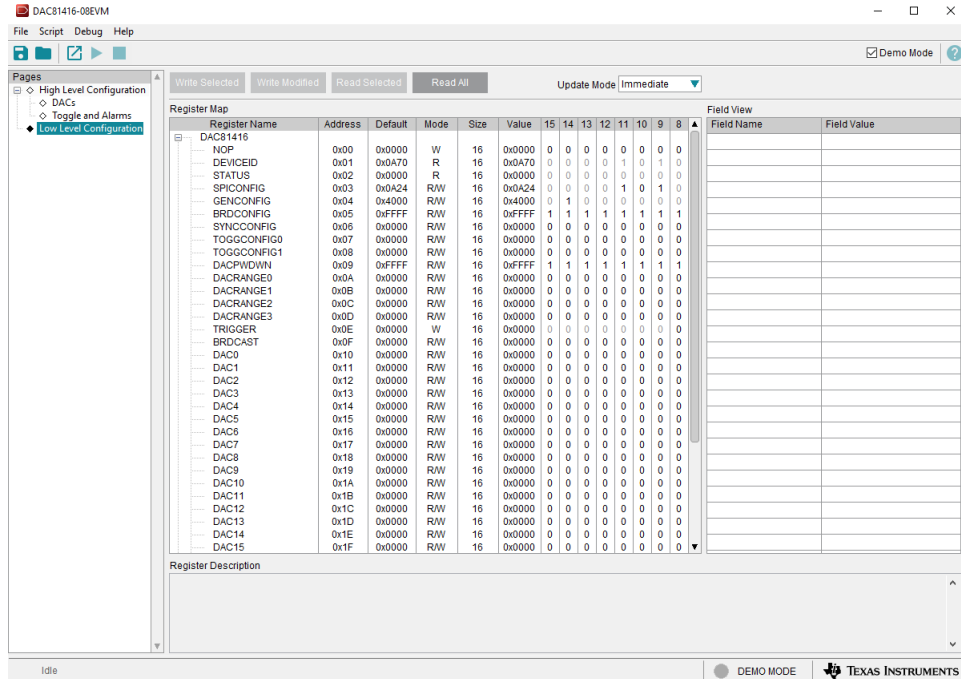
Figure 3-3. DAC81416-08EVM GUI at Launch

If the FT4232 controller is not connected to the PC when the software is launched, then the GUI defaults to *demo* mode. Figure 3-4 illustrates the bottom-left corner of the GUI that shows the hardware connection status: DEMO MODE or CONNECTED. After the FT4232 controller is properly connected to the PC, deselect the *Demo Mode* check box in the upper right corner to connect to the EVM.

Figure 3-4. FTDI Digital Controller Connection Status

3.2.2 Software Features

The DAC81416-08EVM GUI allows for SPI communication to the DAC81416 and control of the digital pins. Although the entire register map is available for use, some features have been abstracted into user controls in the *High-Level Configuration* page for easy operation.

3.2.2.1 Low Level Configuration Page

Figure 3-5 shows the DAC81416-08EVM *Low Level Configuration* page of the DAC81416-08EVM GUI. This page allows direct access to all registers on the DAC81416. The GUI handles page address management, allowing seamless access to registers.

The *Register Map* section in the center of the page lists all the registers. Directly above the *Register Map* section are four buttons that allow for read and write access to all registers.

Select a register on the Register Map list to show a description of the values in that register, as well as information on the register address, default value, size, and current value. Data are written to the registers by entering a value in the value column of the GUI.
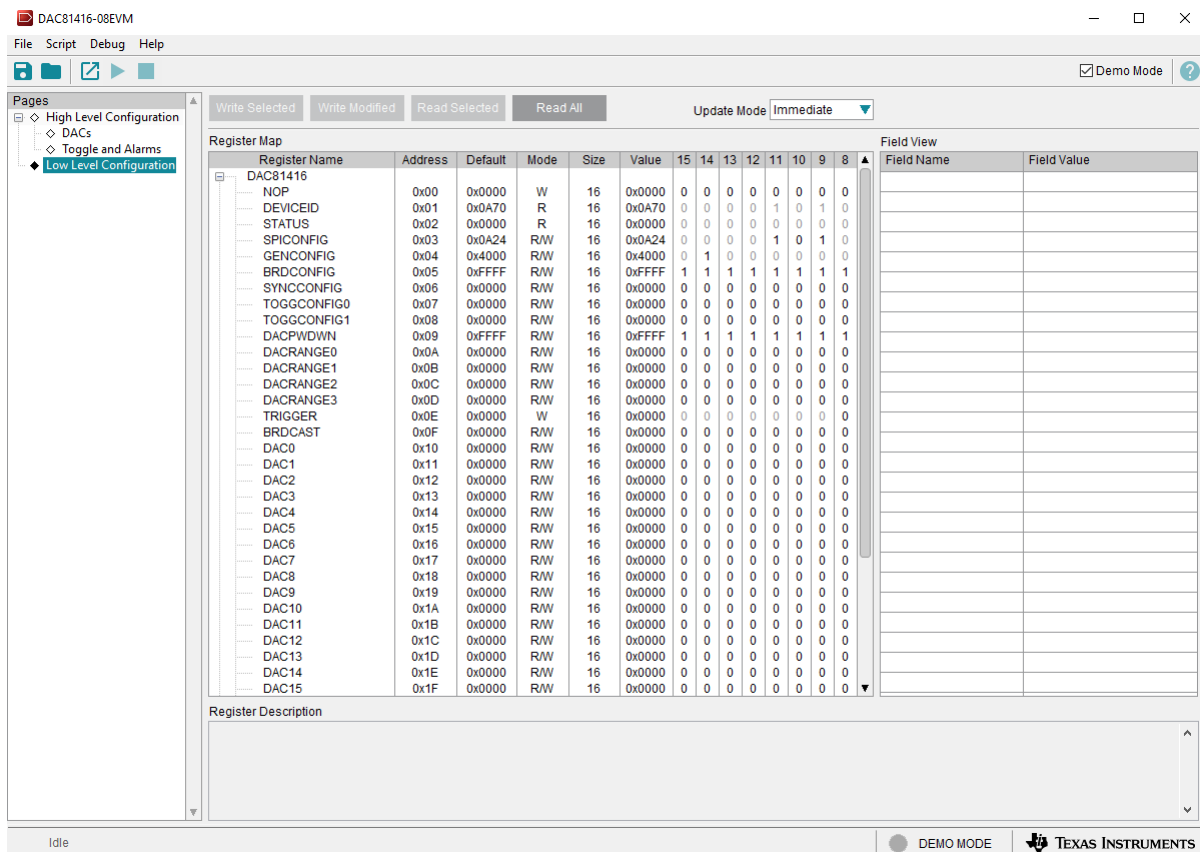

Figure 3-5. Low Level Configuration Page

3.2.2.2 High Level Configuration Page

The *High Level Configuration* page is used to set the configuration of the DAC81416-08EVM GUI. The page is comprised of two tabs: *DACs* and *Toggles and Alarms*. These two tabs act as shortcuts to configure the DAC81416 for basic functionality and testing.

Figure 3-6 shows the *DACs* tab of the *High Level Configuration* page. This tab is used to set the range and outputs for the DACs.
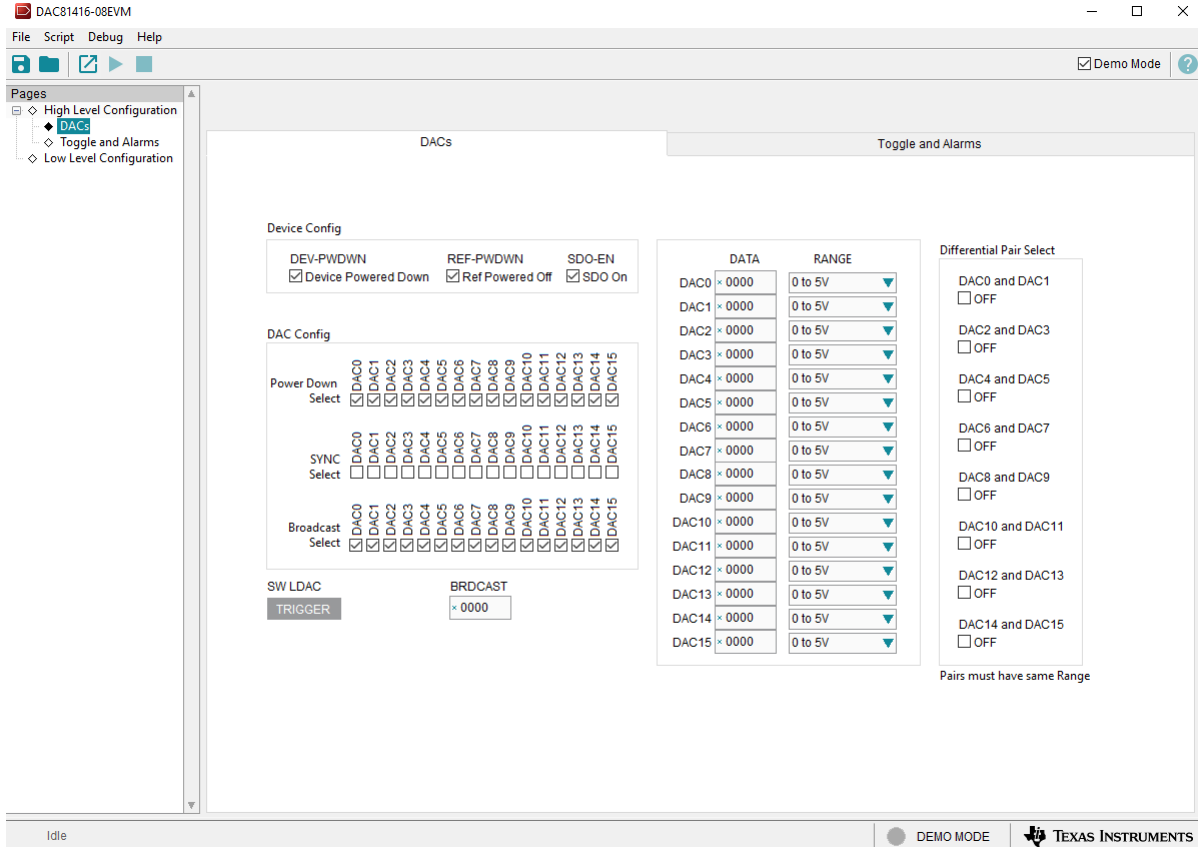

Figure 3-6. DAC Tab of the High Level Configuration Page

Figure 3-7 shows the *Toggles and Alarms* tab from the *High Level Configuration* page. This tab configures the toggle mode for the DACs and shows alarms.
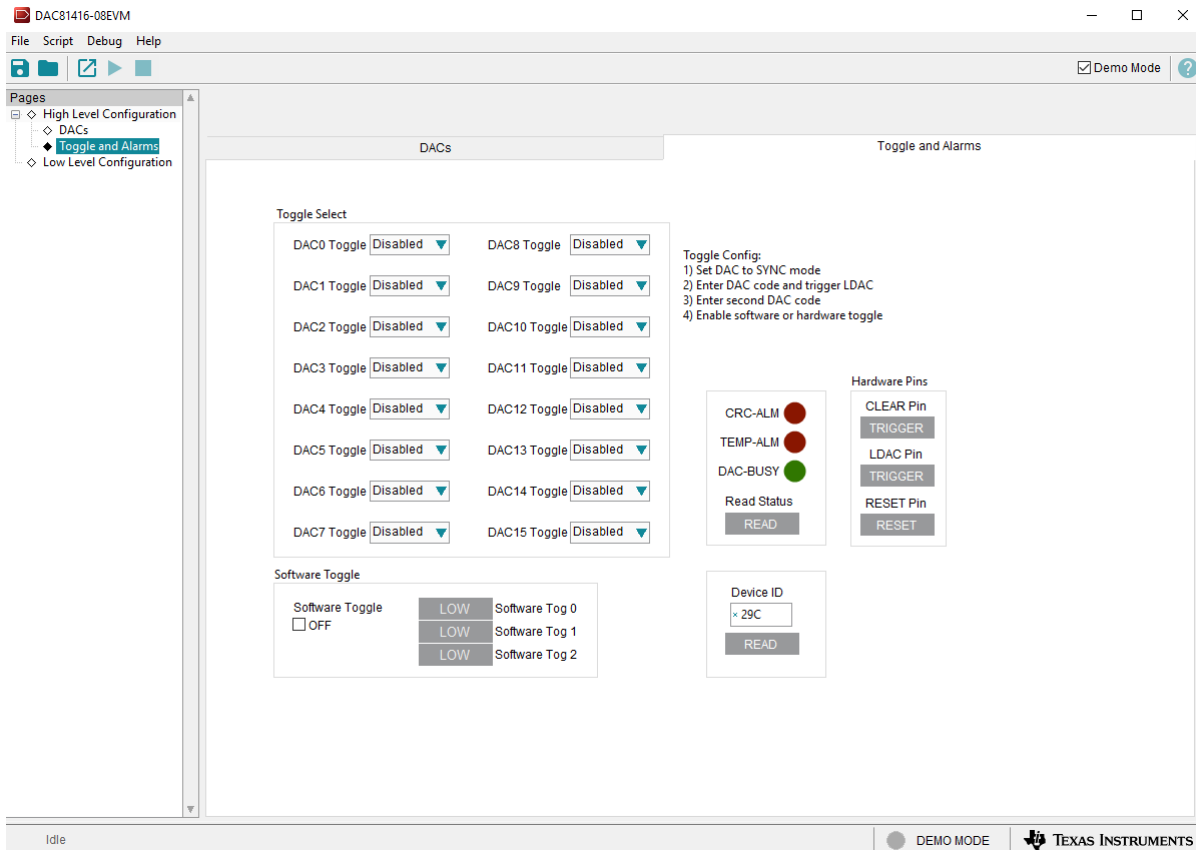
Figure 3-7. Toggle and Alarms Tab of the High Level Configuration Page

4 Hardware Design Files

4.1 Schematics

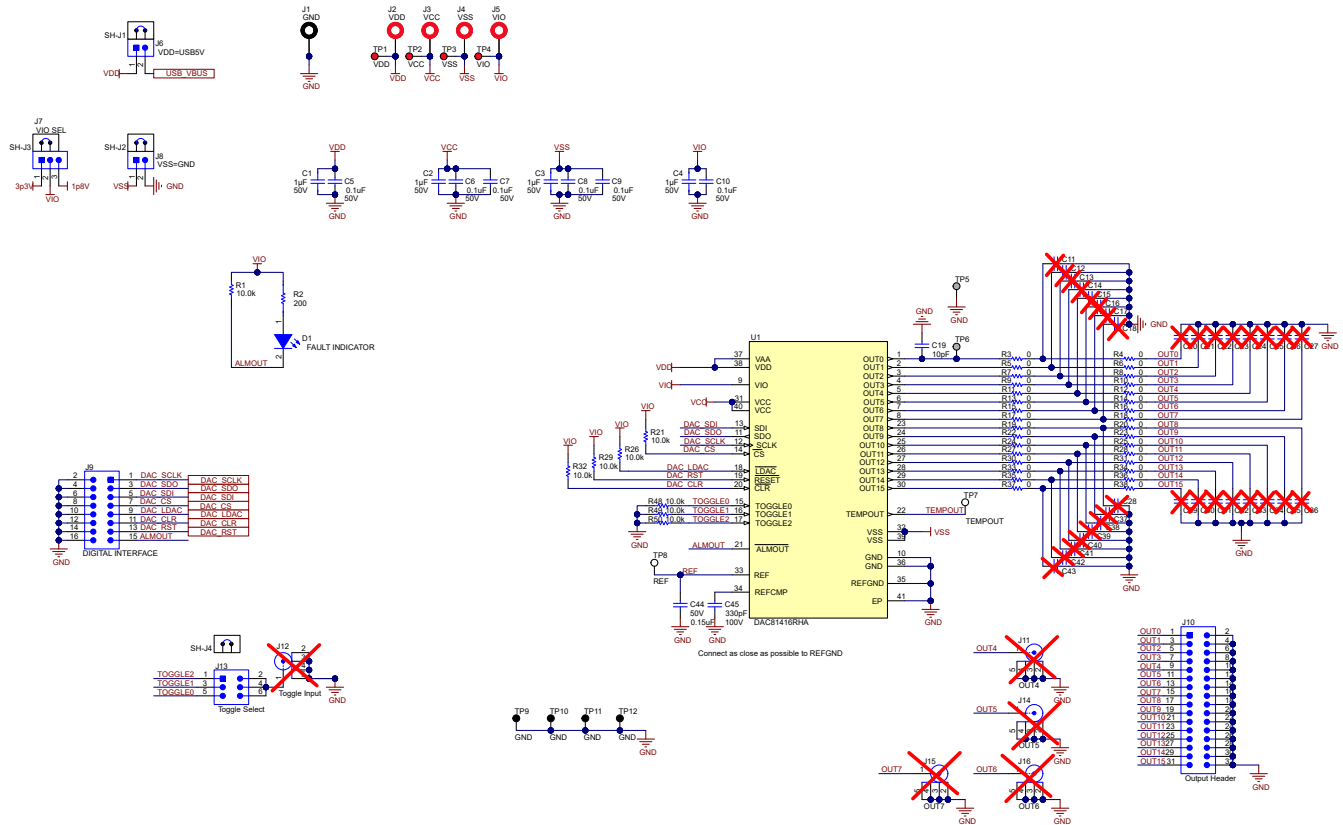The DAC81416-08EVM schematics are shown in Figure 4-1 through Figure 4-2.
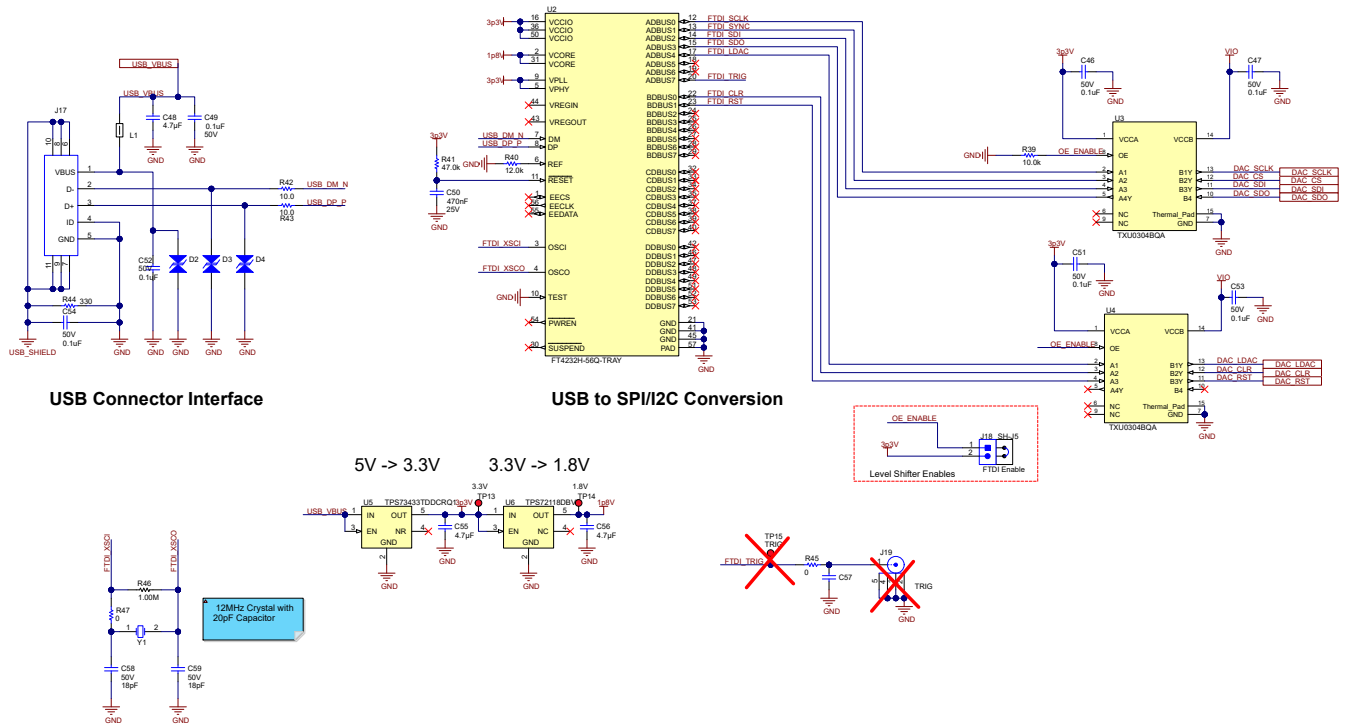

Figure 4-1. DAC81416-08EVM DUT Schematic

Figure 4-2. DAC81416-08EVM FTDI Schematic

4.2 PCB Layout

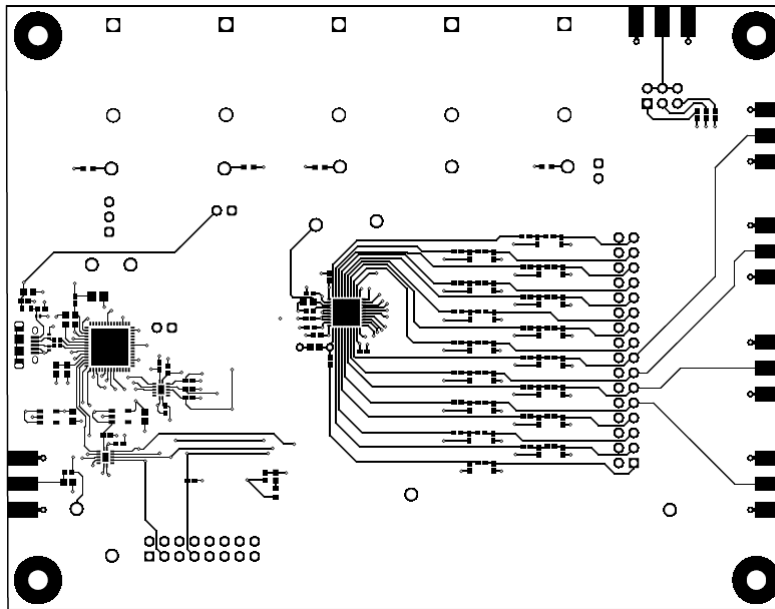Figure 4-3 through Figure 4-6 show the board layout for the DAC81416-08EVM.
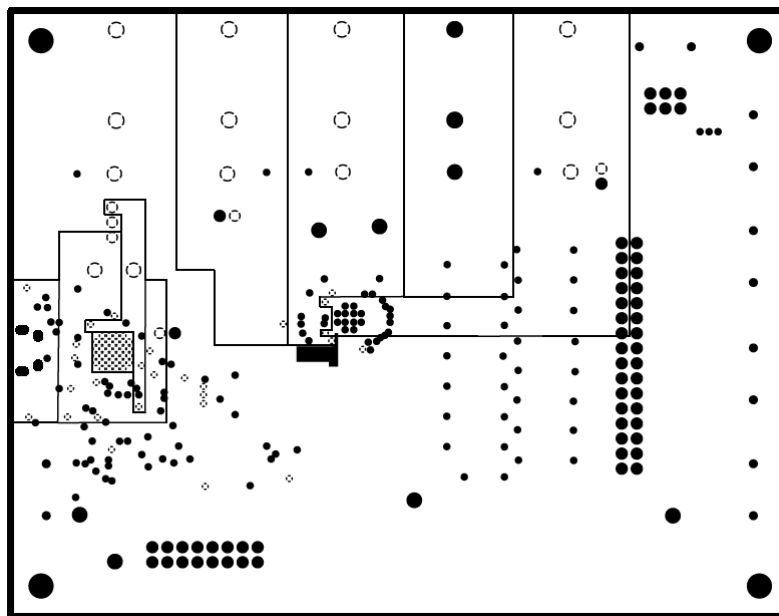

Figure 4-3. DAC81416-08EVM PCB Top Layer Layout

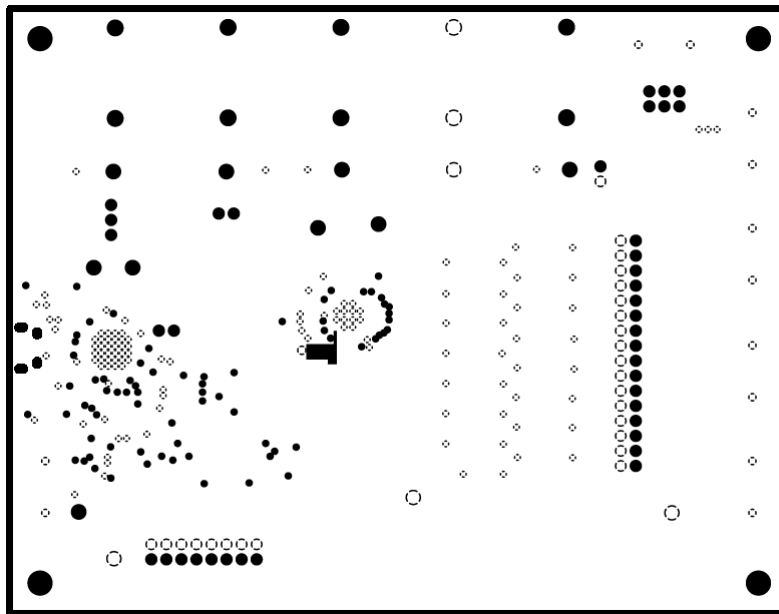**Figure 4-4. DAC81416-08EVM PCB Power Layer Layout**

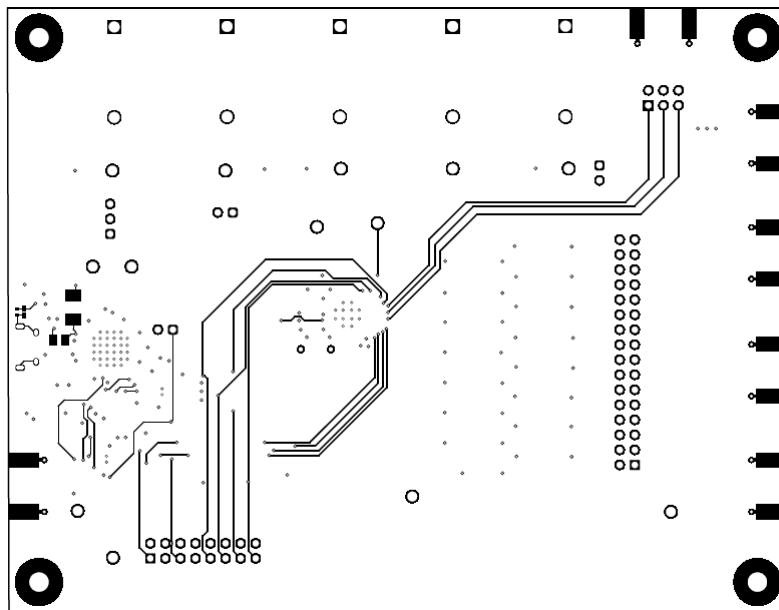**Figure 4-5. DAC81416-08EVM PCB Ground Layer Layout**

Figure 4-6. DAC81416-08EVM PCB Bottom Layer Layout

4.3 Bill of Materials

Table 4-1 lists the DAC81416-08EVM bill of materials (BOM).

Table 4-1. Bill of Materials for the DAC81416-08EVM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C3, C4	4	1µF	1µF ±10% 50V Ceramic Capacitor X7R 0603 (1608 Metric)	0603	GMC10X7R105K50NT	Cal-Chip Electronics
C5, C6, C7, C8, C9, C10, C46, C47, C49, C51, C52, C53, C54	13	0.1µF	CAP, CERM, 0.1µF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata
C19	1	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/NP0, 0603	0603	C0603C100J5GACTU	Kemet
C44	1	0.15µF	CAP, CERM, 0.15µF, 50V, +/- 10%, X5R, 0603	0603	C1608X5R1H154K080AB	TDK
C45	1	330pF	CAP, CERM, 330pF, 100V,+/- 10%, X7R, 0402	0402	HMK105B7331KV-F	Taiyo Yuden
C48, C55, C56, C57	4	4.7µF	CAP, CERM, 4.7µF, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
C50	1	0.47µF	CAP, CERM, 0.47µF, 25V, +/- 10%, X7R, 0603	0603	GRM188R71E474KA12D	MuRata
C58, C59	2	18pF	CAP, CERM, 18pF, 50V, +/- 5%, C0G/NP0, 0805	0805	CC0805JRNP09BN180	Yageo America
D1	1	Super Red	LED, Super Red, SMD	LED, 1.6x.6x.8mm	SML-LX0603SRW-TR	Lumex
D2, D3, D4	3		1-Channel ESD Protection Diode for USB Type-C and Thunderbolt 3, DPY0002A (X1SON-2)	DPY0002A	TPD1E01B04DPYR	Texas Instruments
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	1		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing
J2, J3, J4, J5	4		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J6, J8, J18	3		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J7	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J9	1		Header, 100mil, 8x2, Gold, TH	8x2 Header	TSW-108-07-G-D	Samtec
J10	1		Header, 100mil, 16x2, Gold, TH	16x2 Header	TSW-116-07-G-D	Samtec
J13	1		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec
J17	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

Table 4-1. Bill of Materials for the DAC81416-08EVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
L1	1	600Ω	Ferrite Bead, 600Ω at 100MHz, 1A, 0603	0603	782633601	Wurth Elektronik
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R21, R26, R29, R32, R39, R48, R49, R50	9	10.0kΩ	RES, 10kΩ, 1%, 0.1W, 0402	0402	ERJ-2RKF1002X	Panasonic
R2	1	200Ω	200Ω ±0.1% 0.5W, 1/2W Chip Resistor 0603 (1608 Metric) Thin Film	0603	RA73F1J200RBTD	TE Connectivity
R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R22, R23, R24, R25, R27, R28, R30, R31, R33, R34, R35, R36, R37, R38, R45, R47	34	0Ω	RES, 0Ω, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R40	1	12.0kΩ	RES, 12.0kΩ, 1%, 0.1W, 0603	0603	RC0603FR-0712KL	Yageo
R41	1	47.0kΩ	RES, 47.0kΩ, 1%, 0.1W, 0603	0603	RC0603FR-0747KL	Yageo
R42, R43	2	10Ω	RES, 10Ω 1%, 0.063 W, 0402	0402	RK73H1ETTP10R0F	KOA Speer
R44	1	330Ω	RES, 330Ω, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF3300X	Panasonic
R46	1	1.00MΩ	RES, 1.00MΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M00FKEA	Vishay-Dale
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5	5	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP13, TP14	6		Test Point, Multipurpose, Red, TH	Red Multipurpose Test point	5010	Keystone Electronics
TP7, TP8	2		Test Point, Compact, White, TH	White Compact Test point	5007	Keystone Electronics
TP9, TP10, TP11, TP12	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone Electronics
U1	1		16-Channel, 16-Bit, High-Voltage Output DAC with Precision Internal Reference, RHA0040H (VQFN-40)	RHA0040H	DAC81416RHA	Texas Instruments
U2	1		Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	VQFN-56	FT4232H-56Q-TRAY	FTDI

Table 4-1. Bill of Materials for the DAC81416-08EVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
U3, U4	2		4-Bit Fixed Direction Voltage-Level Translator with Schmitt- Trigger Inputs, and Tri-State Outputs, WQFN14	WQFN14	TXU0304BQA	Texas Instruments
U5	1		Single Output High PSRR LDO, 250mA, Fixed 3.3V Output, 2.7V to 6.5V Input, with Low IQ, 5-pin SOT (DDC), -40℃ to 105℃, Green (RoHS & no Sb/Br)	DDC0005A	TPS73433TDDCRQ1	Texas Instruments
U6	1		Single Output Low Input Voltage Requirement LDO, 150mA, Fixed 1.8V Output, 1.8V to 5.5V Input, with Low IQ, 5-pin SOT-23 (DBV), -40 to 125 degC, Green (RoHS & no Sb/Br)	DBV0005A	TPS72118DBVR	Texas Instruments
Y1	1		Crystal, 12MHz, 18pF, SMD	ABM3	ABM3-12.000MHZ-B2-T	Abracon Corporation

5 Additional Information

5.1 Trademarks

LabVIEW™ is a trademark of National Instruments Corporation.

Windows® is a registered trademark of Microsoft Corporation.

All trademarks are the property of their respective owners.

6 Related Documentation

The documents in Table 6-1 provide information regarding Texas Instruments integrated circuits used in the assembly of the DAC81416-08EVM. This user's guide is available from the TI web site under literature number SLAU942. 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 6-1. Related Device Documentation

Document	Literature Number
DAC81416 product data sheet	SLASEO0B

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

    1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

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2. *Limited Warranty and Related Remedies/Disclaimers*:

    2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

    2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

    2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:
EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3   *Regulatory Notices:*

3.1   *United States*

3.1.1   *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2   *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2   *Canada*

3.2.1   *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,

2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or

3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けて

いないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの

措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。 上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

    4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

    4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

    4.3 *Safety-Related Warnings and Restrictions:*

        4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

        4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

    4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

    6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

    6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

    8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

    8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

IMPORTANT NOTICE AND DISCLAIMER