

EVM User's Guide: DAC80516EVM

DAC80516 Evaluation Module



Description

The [DAC80516EVM](#) is an easy-to-use platform to evaluate the functionality and performance of the [DAC80516](#) device. The DAC80516EVM has optional circuits and jumpers to configure the device for different applications. The DAC80516 is installed on the EVM.

The DAC80516 offers 16 low power, 16-bit, buffered voltage-output DACs with a full-scale output of 2.5V or 5V. The devices include a 2.5V internal reference. The DAC output range is programmable to 2.5V or 5V.

Getting Started

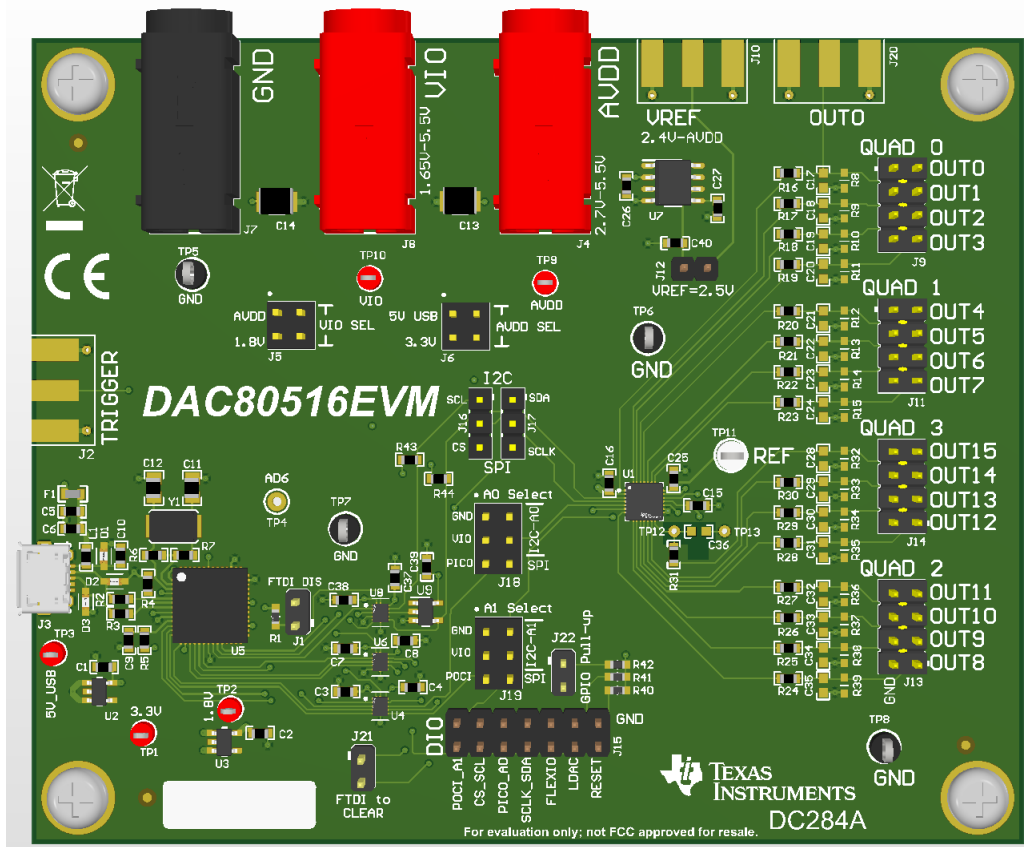
1. Order the [EVM](#).
2. Configure EVM jumpers.
3. Install the DAC805xxEVM GUI from [ti.com](#).
4. Connect USB and external power supplies.
5. Launch the DAC805xxEVM GUI.

Features

- Configurable circuit to evaluate the DAC80516
- Onboard AVDD (5V or 3.3V) and VIO (1.8V, 3.3V, or 5V) support via USB and on-board voltage regulators
- Option for external reference voltage or on-board 2.5V reference voltage
- Trigger output is available for synchronous measurement
- On-board FT4232 used to easily write to DAC using the DAC805xxEVM GUI
- External SPI and I²C connections available

Applications

- [Optical networking](#)
- [Wireless infrastructure](#)
- [Industrial automation](#)
- [Data acquisition systems](#)



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and recommended use cases of the DAC80516EVM. This document provides examples and instructions on how to use the DAC80516EVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the DAC80516EVM. 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. DAC80516EVM Kit Contents

Item	Quantity
DAC80516EVM Board	1
USB-A to Micro-USB 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 DAC80516 installed.

1.4 Device Information

The 16-bit DAC80516 and 12-bit DAC60516 are a pin-compatible family of low power, 16-channel, buffered voltage-output, digital-to-analog converters (DACs). The DAC80516 includes a 2.5V internal reference, eliminating the need for an external precision reference in most applications. A user-selectable gain configuration provides full-scale output voltages of 2.5V (gain = 1), or 5V (gain = 2). The device operates from a single 2.7V to 5.5V supply.

Communication to the DAC80516 is performed through a serial interface that supports SPI and I²C communication (using a shared interface with auto-detect) and operates at clock rates of up to 50MHz for SPI, and 1Mhz for I2C (Fast Mode Plus). The VIO pin enables serial interface operation from 1.65V to 5.5V. The DAC80516 flexible interface enables operation with a wide range of industry-standard microprocessors and microcontrollers.

2 Hardware

2.1 Hardware Setup

This section describes the overall system setup for the EVM. A computer runs software that communicates with the on-board FT4232 controller using SPI or I²C protocols.

2.1.1 Hardware Theory of Operation

The DAC80516EVM 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, digital pins, and supplies. [Figure 2-1](#) shows a block diagram of the DAC80516EVM.

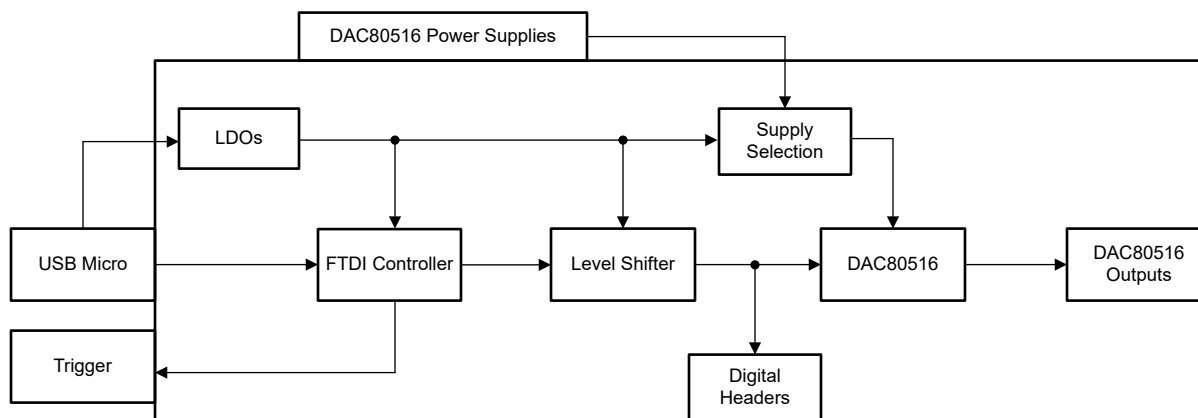


Figure 2-1. DAC80516EVM Theory of Operation Block Diagram

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 DAC80516 AVDD supply can use the on-board 5V or 3.3V supplies depending on the jumper J6 setting. By default, AVDD is connected to the on-board 5V supply. Alternatively, AVDD can be supplied externally through banana jack J4. Remove the jumper connector on J6 before connecting external supplies to AVDD.

The DAC80516 VIO supply can use the on-board 1.8V or use the same voltage as AVDD depending on the jumper J5 setting. By default, VIO is connected to AVDD. Alternatively, VIO can be supplied externally through banana jack J8. Remove the jumper connector on J5 before connecting external supplies to VIO.

The device reference voltage can be supplied via an on-board 2.5V voltage regulator by shorting jumper J12, or from an external supply with SMA J10. Make sure that the DAC80516 internal reference is powered off before connecting any other voltage supply to the REF pin.

Each of the DAC outputs have optional capacitive and resistive loads that are not populated by default. In addition, C36 is a dedicated capacitor footprint that is isolated from the ground and power planes of the EVM. This capacitor can be used for precise glitch measurements.

2.1.2 Jumper Definitions

The jumpers must be connected properly to operate the DAC80516EVM. [Table 2-1](#) provides the details of the configurable jumper settings of the DAC80516EVM. [Figure 2-2](#) shows the default jumper connections on the board.

Table 2-1. DAC80516EVM Jumper Definitions

Designator	Name	Positions
J1	FTDI_DIS	SHORT 1-2 – FT4232 communication is disabled OPEN – FT4232 communication is enabled (default)
J5	VIO_SEL	SHORT 1-2 – VIO is connected to AVDD (default) SHORT 3-4 – VIO is connected to the on-board 1.8V voltage regulator OPEN – VIO is not powered by on-board supplies
J6	AVDD_SEL	SHORT 1-2 – AVDD is connected to the 5V USB power (default) SHORT 3-4 – AVDD is connected to the on-board 3.3V voltage regulator OPEN – AVDD is not powered by on-board supplies.
J12	VREF = 2.5V	SHORT 1-2 – Connects the DAC80516 REF pin to the on-board 2.5V reference Make sure the internal reference is powered off before closing this jumper OPEN – Open if the internal reference or external reference via J10 is used (default) If an external reference is used, turn off the internal reference
J16	CS_SCL	SHORT 1-2 – Connects the DAC80516 CS/SCL pin to the FT4232 SCL pin for I ² C mode SHORT 2-3 – Connects the DAC80516 CS/SCL pin to the FT4232 CS pin for SPI mode (default)
J17	SCLK_SDA	SHORT 1-2 – Connects the DAC80516 SCLK/SDA pin to the FT4232 SDA pin for I ² C mode SHORT 2-3 – Connects the DAC80516 SCLK/SDA pin to the FT4232 SCLK pin for SPI mode (default)
J18	A0 Select	SHORT 5-6 – SPI configuration (default) SHORT all else – DAC80516 I ² C configuration, see Table 2-7 for jumper configurations
J19	A1 Select	SHORT 5-6 – SPI configuration (default) SHORT all else – DAC80516 I ² C configuration, see Table 2-7 for jumper configurations
J21	FTDI to CLEAR	SHORT 1-2 – Connects the FT4232 to the GPIO (CLEAR) pin. OPEN – Leave open if the FLEXIO pin is used as a GPIO (default)
J22	GPIO Pull-up	SHORT 1-2 – The GPIO (FLEXIO) pin is pulled up to VIO (default)

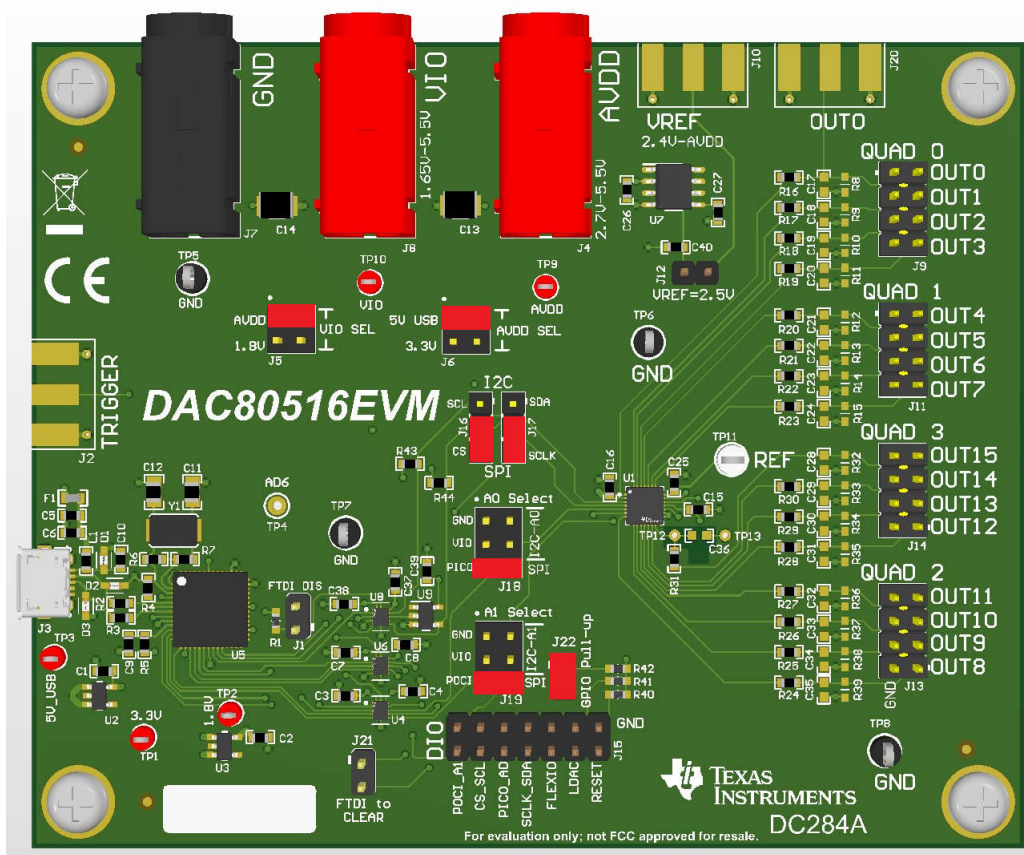


Figure 2-2. DAC80516EVM Default Jumper Settings

2.1.3 Connector Definitions

Table 2-2 shows the power connector definitions of the DAC80516EVM.

Table 2-2. Power Connector Definitions

Designator	Definition
J3	USB connector
J4	DAC80516 AVDD supply (2.7V to 5.5V)
J7	Ground
J8	DAC80516 VIO supply (1.65V to 5.5V)
J10	SMA connector for DAC80516 external reference voltage (unpopulated)

Table 2-3 shows output connector definitions for the DAC80516EVM.

Table 2-3. Output Connector Definitions

Designator	Definition
J2	SMA connector for FT4232 trigger input (unpopulated)
J20	SMA connector for DAC80516 OUT0 (unpopulated)

Table 2-4 shows output header J9, J11, J13, and J14 definitions for the DAC80516EVM.

Table 2-4. Output Headers J9, J11, J13, and J14 Definitions

Header	Pin	Definition
J9	2	DAC80516 OUT0
	4	DAC80516 OUT1
	6	DAC80516 OUT2
	8	DAC80516 OUT3
	1, 3, 5, 7	Ground
J11	2	DAC80516 OUT4
	4	DAC80516 OUT5
	6	DAC80516 OUT6
	8	DAC80516 OUT7
	1, 3, 5, 7	Ground
J13	1	DAC80516 OUT8
	3	DAC80516 OUT9
	5	DAC80516 OUT10
	7	DAC80516 OUT11
	2, 4, 6, 8	Ground
J14	1	DAC80516 OUT12
	3	DAC80516 OUT13
	5	DAC80516 OUT14
	7	DAC80516 OUT15
	2, 4, 6, 8	Ground

2.1.4 Test Points

The DAC80516EVM has test points available for measuring and debugging purposes. [Table 2-5](#) lists the description of each test point.

Table 2-5. DAC80516EVM Test Points

Test Point	Net	Description
TP1	3p3V	On-board 3.3V supply
TP2	1p8V	On-board 1.8V supply
TP3	5V_USB	USB 5V supply
TP4	AD6	Trigger (unpopulated)
TP5, TP6, TP7, TP8	GND	Ground connection
TP9	AVDD	DAC80516 AVDD
TP10	VIO	DAC80516 VIO
TP11	VREF	DAC80516 REF
TP12	OUT15	Dedicated OUT15 test point for measuring DAC glitch
TP13	GND	Dedicated ground test point for measuring DAC glitch

2.2 Hardware Overview

This section details how to configure the EVM for voltage outputs using I²C and SPI. The following subsections provide detailed information on the EVM hardware and jumper positions for the two communication modes (see also [Section 2.1.2](#)).

2.2.1 Connecting the FT4232 Digital Controller

To connect the FT4232 digital controller on the EVM board to the computer, align and firmly connect the USB connector to the J3 connector. Verify the connection is snug; a loose connection can cause intermittent operation. A 100 mil header (J15) is available for external communication. [Table 2-6](#) lists the J15 pin definitions. To use external communication, close jumper J1 to disable the connection to the FT4232 controller. When using external I²C, TI recommends to close the J16 and J17 jumpers in the I²C positions, as the jumpers connect the pull-up resistors R43 and R44 to the communication lines.

Table 2-6. Digital Header J15 Pin Definitions

Pin Number	Description
2	DAC80516 RESET input
4	DAC80516 DAC synchronization signal \overline{LDAC}
6	DAC80516 FLEXIO/CLEAR pin
8	DAC80516 SCLK/SDA pin
10	DAC80516 PICO/A0 pin
12	DAC80516 CS/SCL pin
14	DAC80516 POCI/A1 pin
1,3,5,7,9,11,13	Ground

2.2.2 SPI Configuration

[Figure 2-3](#) shows the DAC80516EVM configured for SPI communication.

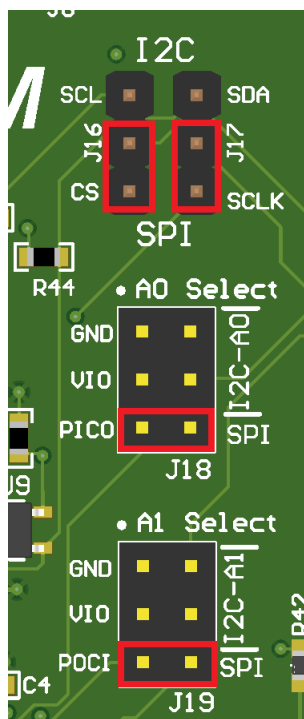


Figure 2-3. DAC80516EVM SPI Configuration

2.2.3 I²C Configuration

Figure 2-4 shows the DAC80516EVM configured for I²C communication.

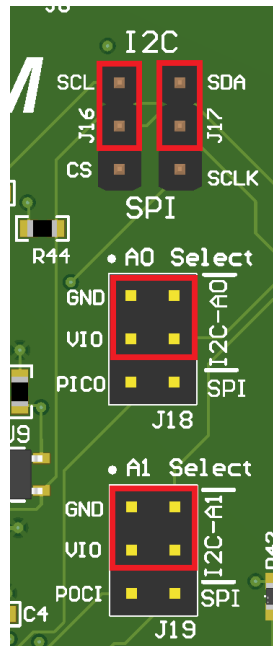


Figure 2-4. DAC80516EVM I²C Configuration

The jumper connections on J18 and J19 determine the device address of the DAC80516. The following table shows the required configuration of the A0 and A1 jumpers for specific device addresses.

Table 2-7. I²C Address Configuration

A1	A0	[A6:A0]
GND	GND	101 0000
GND	VIO	101 0001
VIO	GND	101 0100
VIO	VIO	101 0101

2.2.4 Glitch Testing

The DAC80516EVM has dedicated test points for measuring glitch on the OUT15 pin. Test point TP12 and capacitor C36 are isolated from the ground and power plane on the EVM. To best measure glitch, remove R31 to isolate the OUT15 pin from the rest of the EVM circuitry and populate C36 with the desired capacitive load. A probe can be placed across TP12 and TP13. [Figure 2-5](#) shows a glitch measurement taken with the DAC80516EVM. In this example, C36 was populated with a 10pF capacitor and the glitch was captured on the rising edge between codes 0x7FFF to 0x8000.

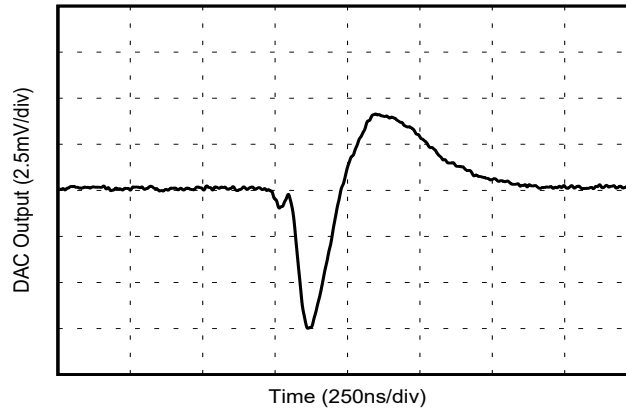


Figure 2-5. Glitch Testing

3 Software

3.1 Software Setup

This section provides the procedure for EVM software installation.

3.1.1 Software Installation

Download the latest version of the EVM graphical user interface (GUI) installer from the *Order and start development* subsection of the [DAC80516EVM tool folder](#) on TI.com. Run the GUI installer to install the DAC805xxEVM GUI software on your computer. The software installation automatically copies the required LabVIEW™ software files and drivers to the computer.

When the DAC805xxEVM 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\DAC805xxEVM*.

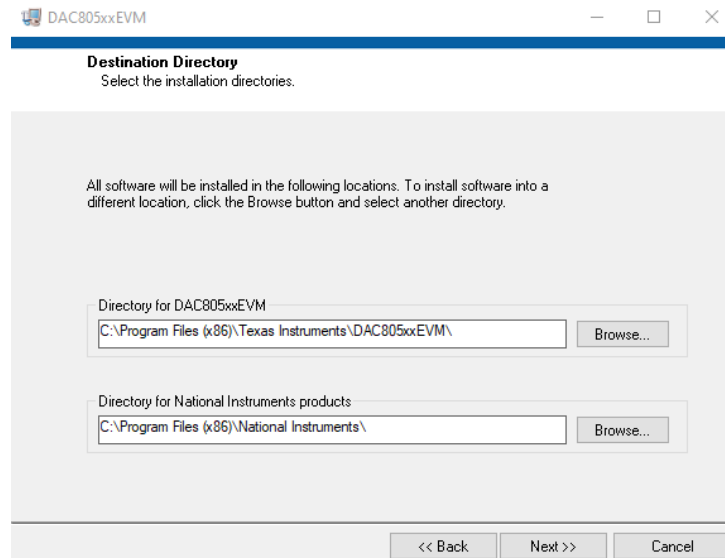


Figure 3-1. Software Installation Path

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 DAC805xxEVM software installation is complete.

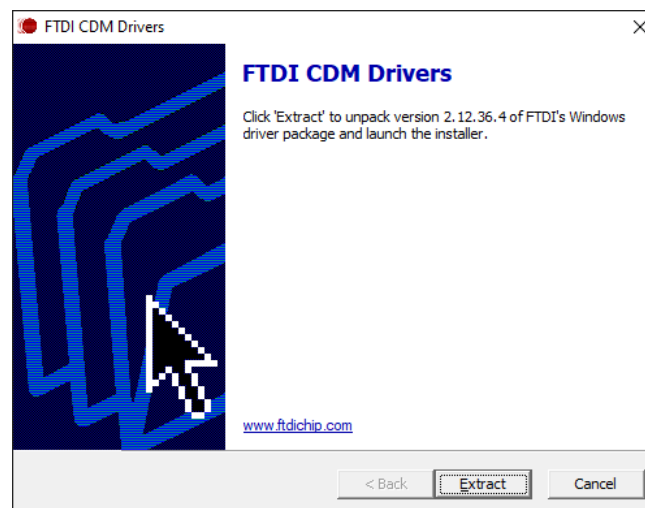


Figure 3-2. FTDI USB Drivers

3.2 Software Overview

This section discusses how to use the DAC8050xxEVM software.

3.2.1 Launching the Software

Launch the DAC8050xxEVM software by searching for *DAC805xxEVM* in the Windows® *Start* menu.

Figure 3-3 shows the Device Setting configuration menu that is present when the GUI is launched. Select the DAC80516 device from the drop down menu and click *CONFIG*.

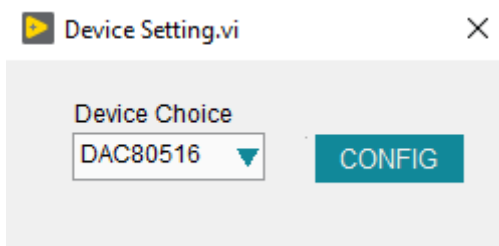


Figure 3-3. DAC805xxEVM GUI Device Settings

After a device is selected, the Interface Settings menu pops up. This menu is shown in Figure 3-4. From this menu, select the interface protocol, as well as the I²C address and I²C speed if I²C has been selected as the protocol. Select the *CONFIG* button to save the current settings and launch the main GUI.

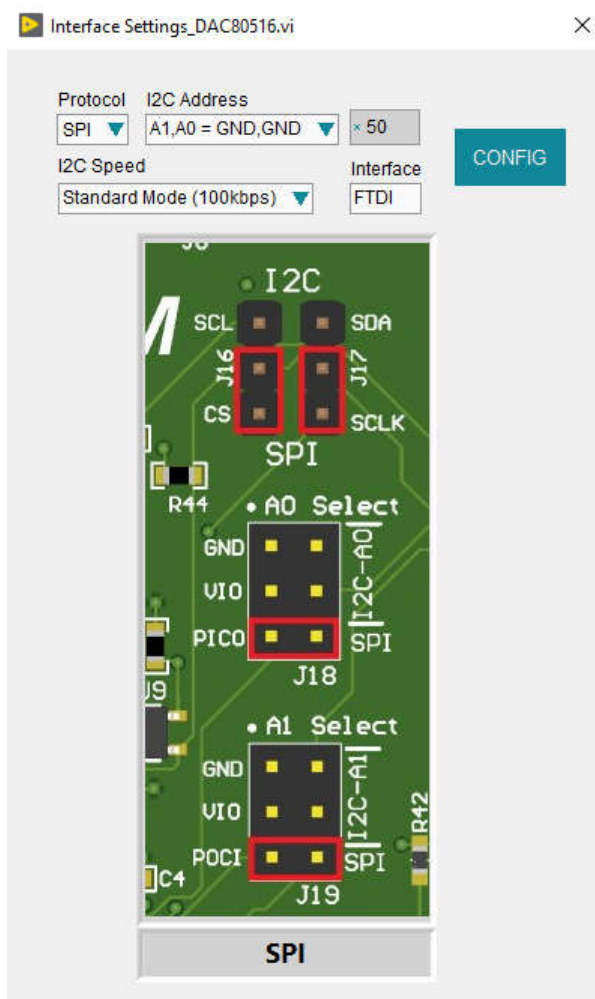


Figure 3-4. DAC805xxEVM Interface Settings Menu

Figure 3-5 shows the GUI after launch with the DAC80516 register map loaded.

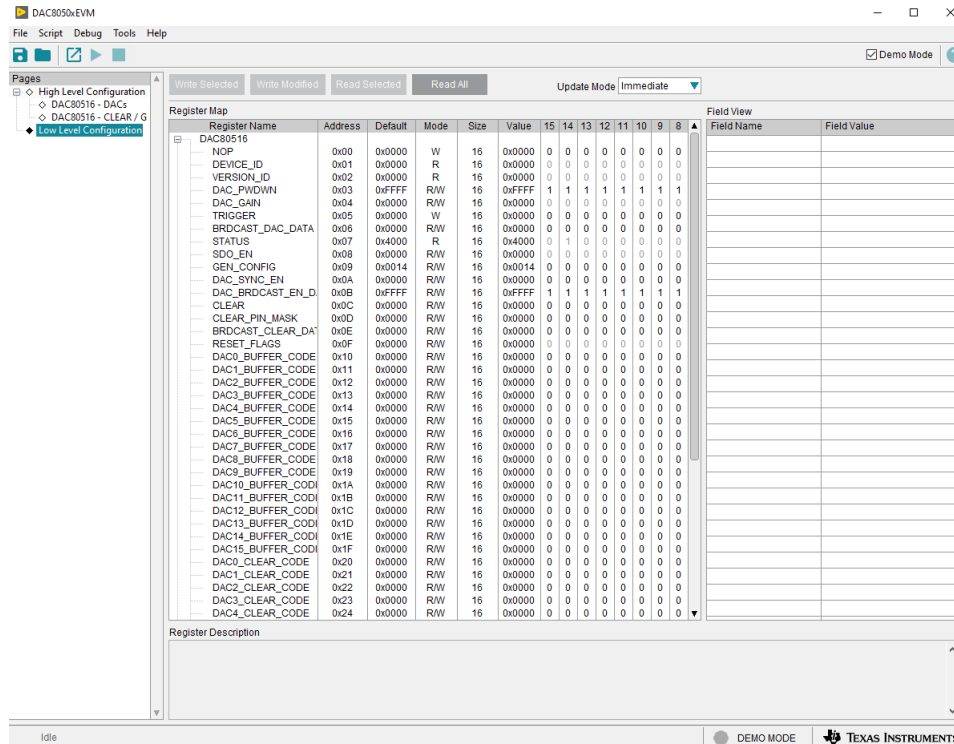


Figure 3-5. DAC805xxEVM GUI DAC80516 Selection at Launch

If the FT4232 controller is not connected to the computer when the software is launched, then the GUI defaults to *demo mode*. Figure 3-6 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 computer, click the *Demo Mode* box in the upper right to initialize the EVM.

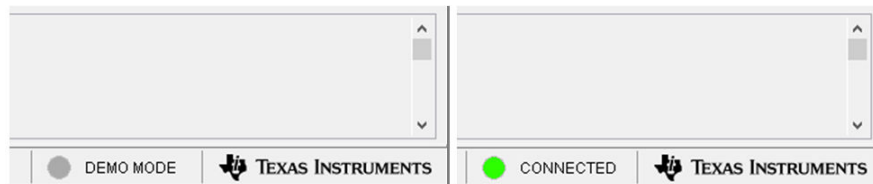


Figure 3-6. FT4232 Digital Controller Connection Status

3.3 Software Features

The DAC805xxEVM GUI allows for I²C or SPI communication to the DAC80516. 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.

3.3.1 Low Level Configuration Page

Figure 3-7 shows the *Low Level Configuration* page of the DAC805xxEVM GUI. This page allows direct access to all registers on the DAC80516.

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.

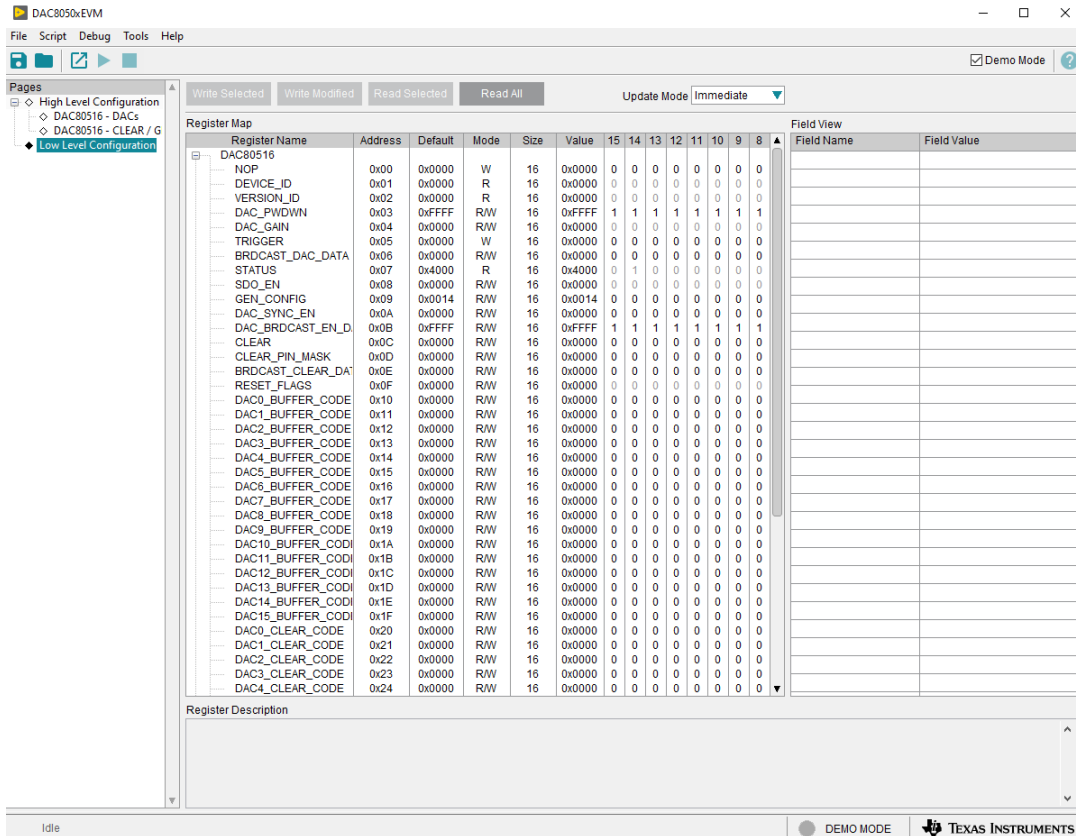


Figure 3-7. DAC80516 Low Level Configuration Page

3.3.2 High Level Configuration Page

The *High Level Configuration* page is used to set the configuration of the DAC805xxEVM GUI. The page is comprised of two tabs: *DAC80516 - DACs* and *DAC80516 - CLEAR/GPIO*. These two tabs act as shortcuts to configure the DAC80516 for basic functionality and testing.

Figure 3-8 shows the *DAC80516 - DACs* tab of the *High Level Configuration* page. This tab is used to set the gain and output of the DACs. The internal reference can also be powered on and off here.

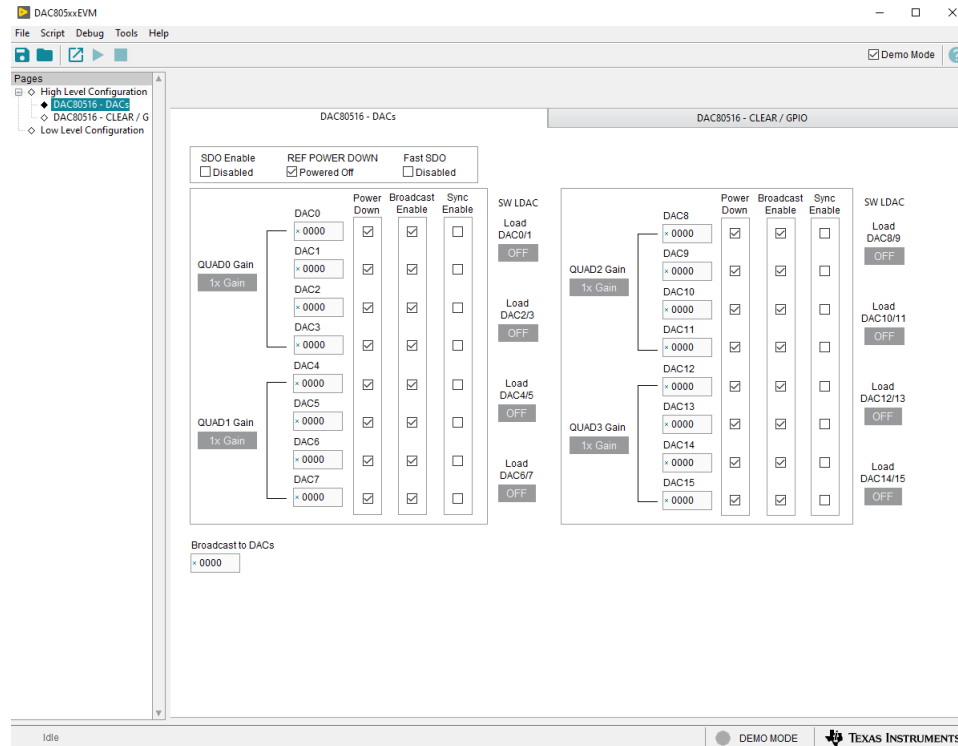


Figure 3-8. DAC80516 DACs Tab of the High Level Configuration Page

Figure 3-9 shows the *DAC80516 - CLEAR/GPIO* tab from the *High Level Configuration* page. This tab is used to set the clear values of the DACs, along with setting the configuration for the GPIO pin.

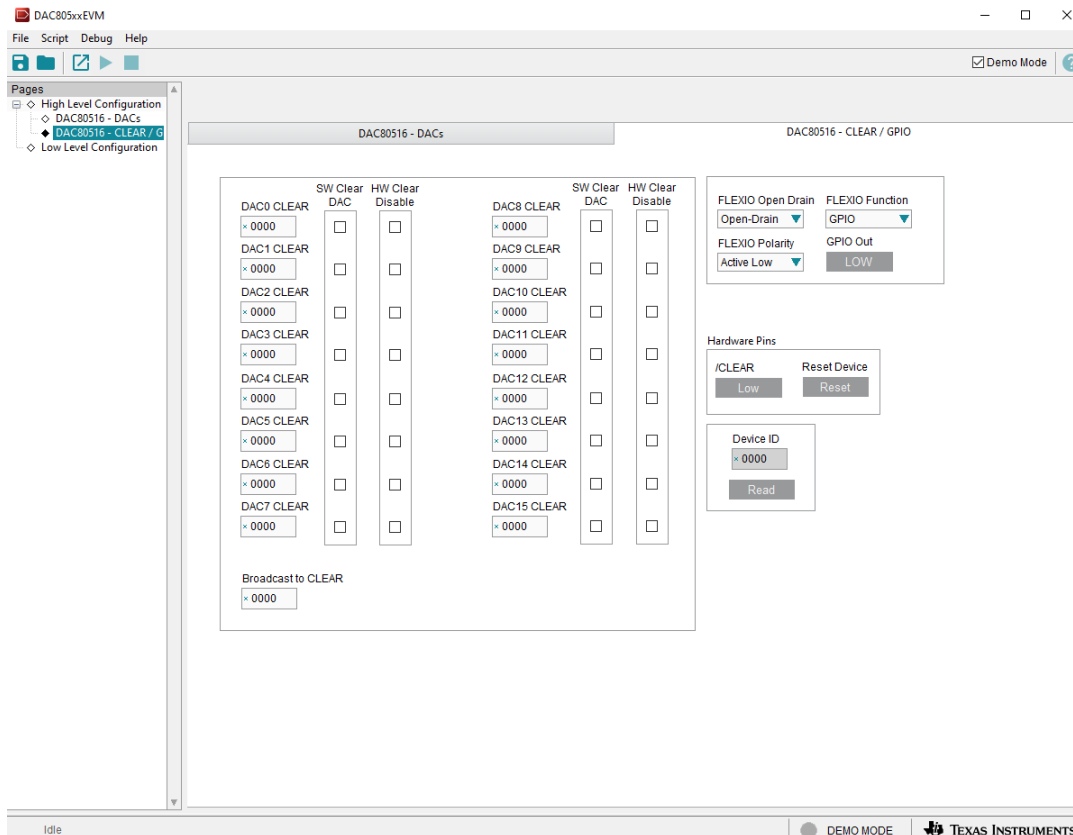


Figure 3-9. DAC80516 CLEAR/GPIO Tab of the High Level Configuration Page

4 Hardware Design Files

4.1 Schematics

Figure 4-1 and Figure 4-2 shows the DAC80516EVM schematics.

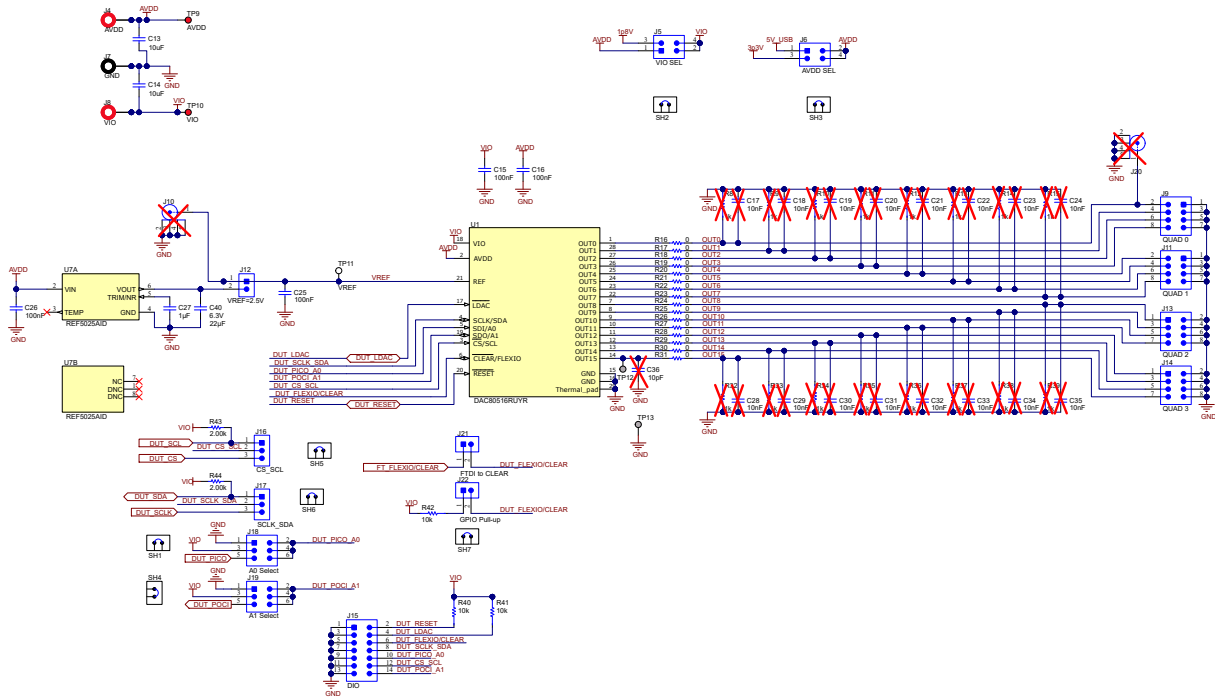


Figure 4-1. DAC80516EVM Schematic: DAC80516 Interface

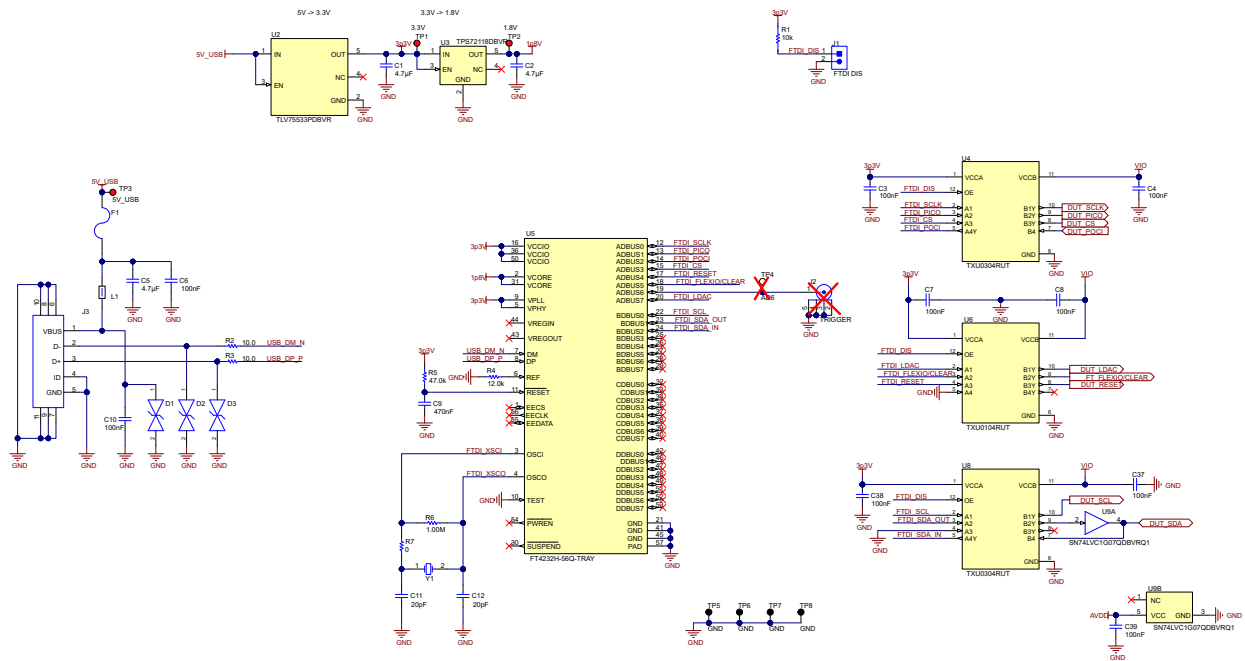


Figure 4-2. DAC80516EVM Schematic: FTDI Controller Interface

4.2 PCB Layouts

Figure 4-3 through Figure 4-6 show the board layout for the DAC80516EVM.

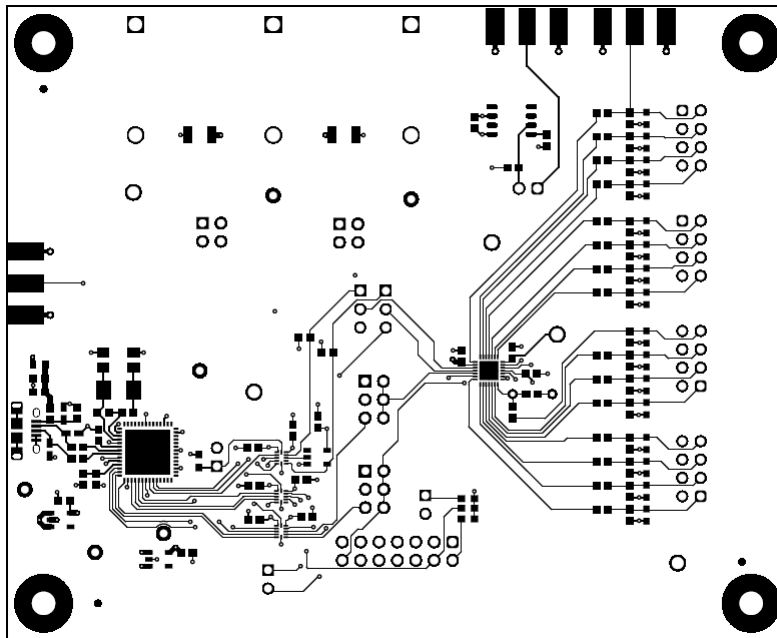


Figure 4-3. DAC80516EVM PCB Top Layer Layout

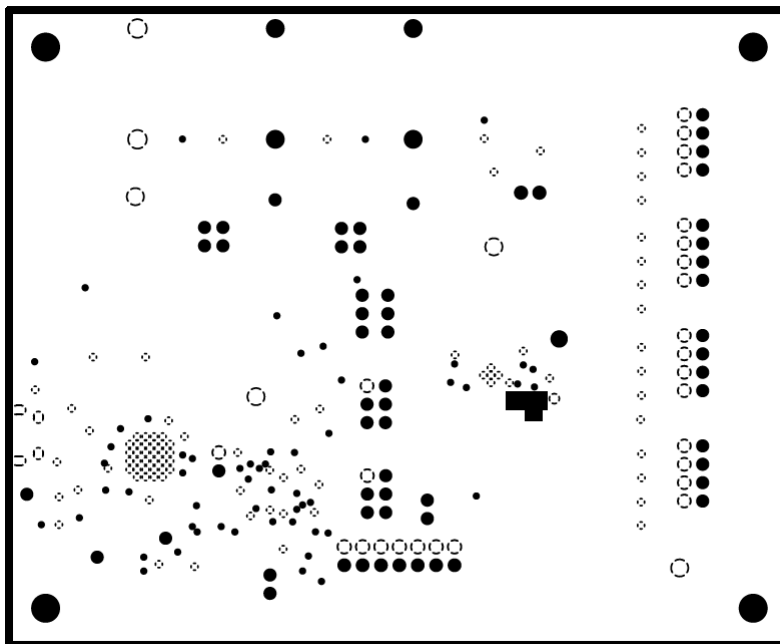


Figure 4-4. DAC80516EVM PCB Ground Plane Layout

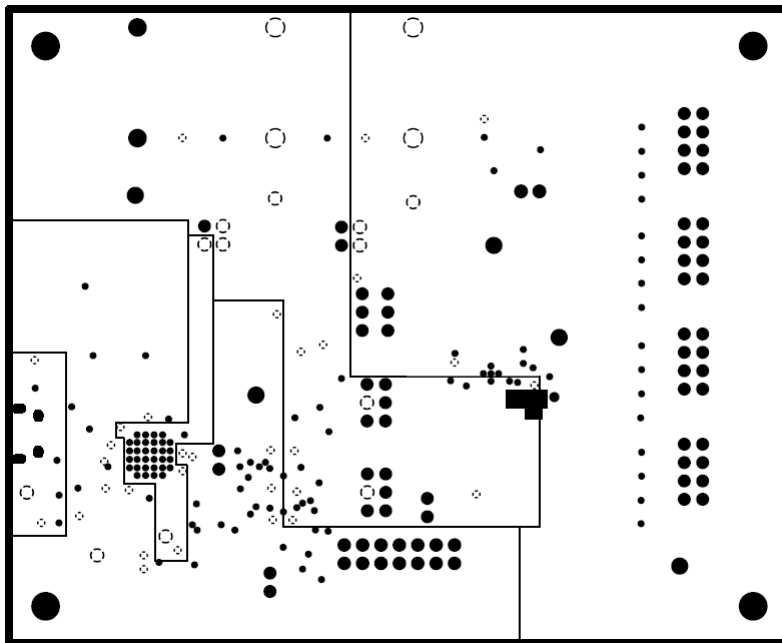


Figure 4-5. DAC80516EVM PCB Power Plane Layout

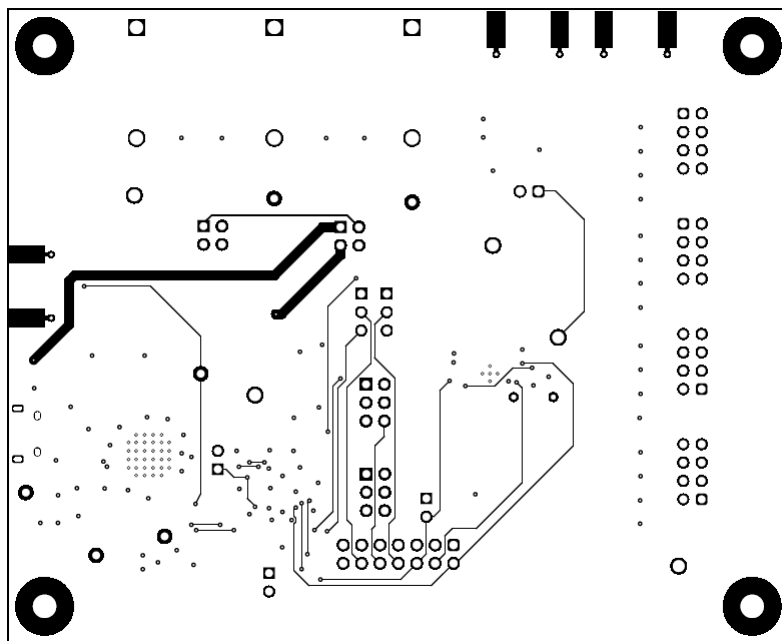


Figure 4-6. DAC80516EVM PCB Bottom Layer Layout

4.3 Bill of Materials

Table 4-1 lists the DAC80516EVM bill of materials.

Table 4-1. Bill of Materials for the DAC80516EVM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2, C5	3	4.7 μ F	CAP, CERM, 4.7 μ F, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
C3, C4, C6, C7, C8, C10, C15, C16, C25, C26, C37, C38, C39	13	0.1 μ F	CAP, CERM, 0.1 μ F, 50V,+/- 10%, X7R, AEC-Q200 Grade 0, 0603	0603	06035C104K4Z4A	AVX
C9	1	0.47 μ F	CAP, CERM, 0.47 μ F, 25V, +/- 10%, X7R, 0603	0603	GRM188R71E474KA12D	MuRata
C11, C12	2	20pF	CAP, CERM, 20pF, 100V, +/- 5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
C13, C14	2	10 μ F	CAP, CERM, 10 μ F, 25V, +/- 10%, X7R, 1210	1210	C1210C106K3RACTU	Kemet
C27	1	1 μ F	CAP, CERM, 1 μ F, 25V,+/- 20%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1E105M080AC	TDK
C40	1	22 μ F	CAP, CERM, 22 μ F, 6.3V,+/- 20%, X6S, 0603	0603	GRM188C80J226ME15D	MuRata
D1, D2, D3	3		150V (Typ) Clamp Ipp Tvs Diode Surface Mount 0603 (1608 Metric)	0603	PGB1010603MRHF	Littelfuse Inc
F1	1		Fuse, 0.5A, 50 VDC, SMD	0603	SF-0603F050-2	Bourns
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, J21, J22	3		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	HB3902U	Foxconn
J2, J10, J20	3		Connector, End launch SMA, 50 Ω , SMT	End Launch SMA	142-0701-801	Cinch Connectivity
J3	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
J4, J8	2		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J5, J6	2		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
J7	1		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing

Table 4-1. Bill of Materials for the DAC80516EVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
J9, J11, J13, J14	4		Header, 2.54mm, 4x2, Gold, TH	Header, 2.54mm, 4x2, TH	TSW-104-08-L-D	Samtec
J12	1		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Würth Elektronik
J15	1		Header, 2.54mm, 7x2, Gold, TH	Header, 2.54mm, 7x2, TH	61301421121	Würth Elektronik
J16, J17	2		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Würth Elektronik
J18, J19	2		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec
L1	1	600Ω	Ferrite Bead, 600Ω at 100MHz, 1A, 0603	0603	782633601	Würth 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, R40, R41, R42	4	10kΩ	10kΩ ±0.1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Current Sense Thin Film	0603	CRT0603-BY-1002ELF	Bourns Inc.
R2, R3	2	10Ω	RES, 10.0Ω, 1%, 0.1 W, 0603	0603	RC0603FR-0710RL	Yageo
R4	1	12.0kΩ	RES, 12.0kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0712KL	Yageo
R5	1	47.0kΩ	RES, 47.0kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0747KL	Yageo
R6	1	1.00MΩ	RES, 1.00MΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FG1M00	Stackpole Electronics Inc
R7, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31	17	0Ω	RES, 0Ω, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R43, R44	2	2kΩ	RES, 2.00kΩ, 0.1%, 0.1 W, 0603	0603	RG1608P-202-B-T5	Susumu Co Ltd
SH1, SH2, SH3, SH4, SH4, SH6	6		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP9, TP10	5		Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone, Keystone Electronics
TP5, TP6, TP7, TP8	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics

Table 4-1. Bill of Materials for the DAC80516EVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
TP11	1		Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone Electronics
TP12	1		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone
U1	1		16 channel, 16-Bit, Voltage Output DAC With Internal Reference	WQFN28	DAC80516RUYR	Texas Instruments
U2	1		500mA, Low IQ, Small Size, Low Dropout Regulator, DBV0005A (SOT-23-5)	DBV0005A	TLV75533PDBVR	Texas Instruments
U3	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°C to 125°C, Green (RoHS & no Sb/Br)	DBV0005A	TPS72118DBVR	Texas Instruments
U4, U8	2		Automotive 4-Bit Fixed Direction Voltage-Level Translator with Schmitt-Trigger Inputs, and Tri-State Outputs	UQFN12	TXU0304RUT	Texas Instruments
U5	1		Future Technology Devices International Ltd FT4232H Quad High Speed USB to Multipurpose UART/MPSSE IC, VQFN-56	VQFN-56	FT4232H-56Q-TRAY	FTDI
U6	1		4-Bit Fixed Direction Voltage-Level Translator with SchmittTrigger Inputs, and Tri-State Outputs	UQFN12	TXU0104RUT	Texas Instruments
U7	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
Y1	1		Crystal, 12MHz, 18pF, SMD	ABM3	ABM3-12.000MHZ-B2-T	Abracon Corporation
C17, C18, C19, C20, C21, C22, C23, C24, C28, C29, C30, C31, C32, C33, C34, C35	0			0603		
C36	0			0603		

Table 4-1. Bill of Materials for the DAC80516EVM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R8, R9, R10, R11, R12, R13, R14, R15, R32, R33, R34, R35, R36, R37, R38, R39	0			0603		
TP4	0			5002		

5 Additional Information

5.1 Trademarks

LabVIEW™ is a trademark of National Instruments Corporation.
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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 DAC80516EVM. This user's guide is available from the TI web site under literature number SLAU916. 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
DAC80516 product data sheet	SLASF62

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
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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 DEGRADATION 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/lstds/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.

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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。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/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.
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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.

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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.

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