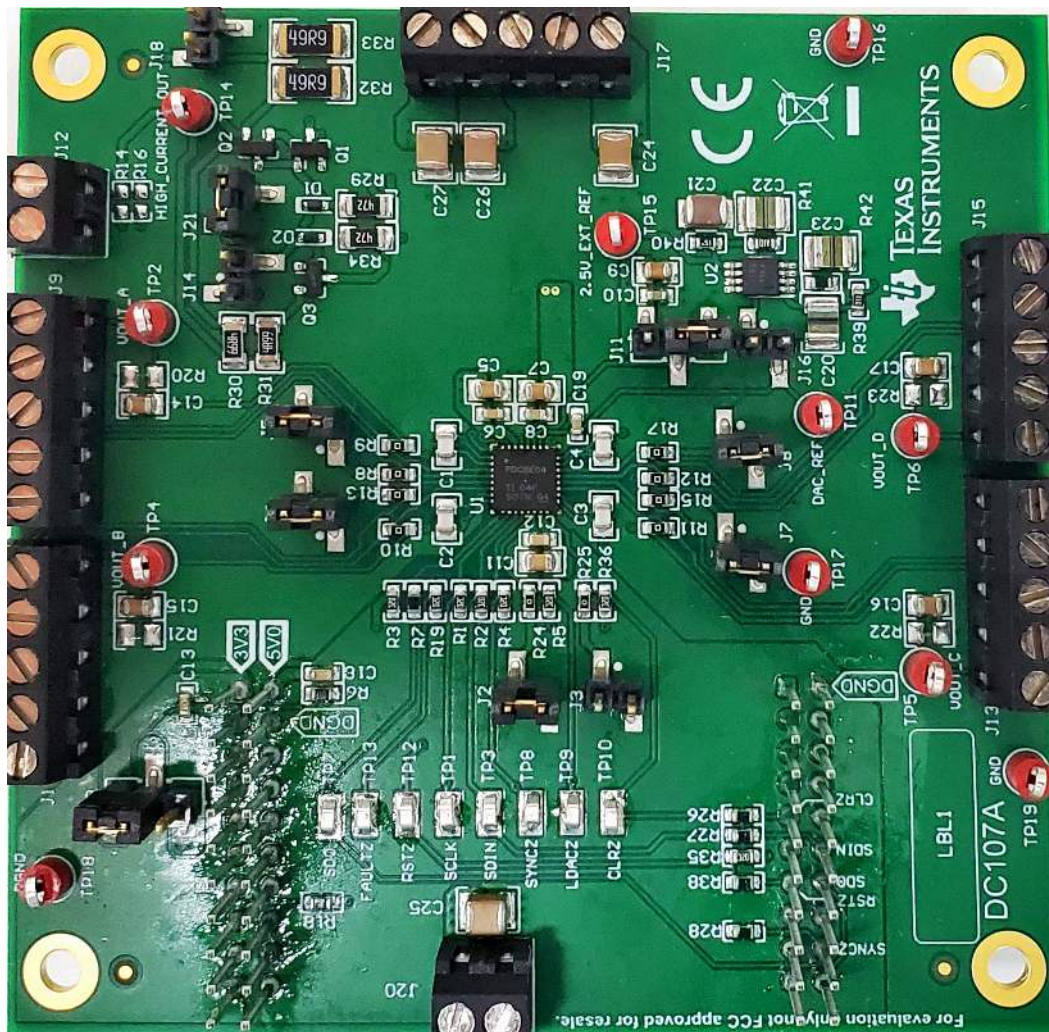


BP-DAC81404EVM, BP-DAC61402EVM



This user's guide describes the characteristics, operation, and use of the BP-DAC81404 evaluation module (EVM) and BP-DAC61402 EVM BoosterPack™ plug-in modules. This EVM is designed to evaluate the performance of the [DAC81404](#) and [DAC61402](#) buffered voltage output DACs in a variety of configurations. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the BP-DAC81404EVM and BP-DAC61402EVM. This document includes a schematic, reference printed-circuit board (PCB) layouts, and a complete bill of materials.

Contents

1	Overview	3
1.1	Kit Contents	3
1.2	Related Documentation from Texas Instruments	4
2	System Setup	5
2.1	Software Setup	5
2.2	Hardware Setup	8
3	Detailed Description.....	10
3.1	Hardware Description	10
3.2	Software Description	12
4	Schematic, PCB Layout, and Bill of Materials	18
4.1	BP-DAC81404EVM, BP-DAC61402EVM Schematic	19
4.2	PCB Layout	21
4.3	BP-DAC81404EVM, BP-DAC61402EVM Bill of Materials	23

List of Figures

1	BP-DAC81404EVM, BP-DAC61402EVM Software Setup	5
2	Software Installation Path	6
3	LaunchPad™ Setup	7
4	TI Cloud Agent Installation	7
5	Hardware Setup.....	8
6	BP-DAC81404EVM, BP-DAC61402EVM Hardware Block Diagram	10
7	LaunchPad™ Interface Pinout.....	11
8	BP-DAC81404EVM, BP-DAC61402EVM GUI Location	12
9	GUI Connection Detection	12
10	Software Home Page	13
11	Setup Page.....	14
12	DAC Quick-Start Page: Basic DAC Tab	15
13	Register Map Page	16
14	Register Page Options	16
15	Collateral Page	17
16	Schematic Page 1.....	19
17	Schematic Page 2.....	20
18	PCB Layout: Top Layer	21
19	PCB Layout: Ground Plane	21
20	PCB Layout: Power Plane	22
21	PCB Layout: Bottom Layer.....	22

List of Tables

1	DAC81404EVM Kit Contents.....	3
2	DAC61402EVM Kit Contents.....	3
3	Required Components Not Included With Kit	3
4	Related Documentation	4
5	BP-DAC81404EVM, BP-DAC61402EVM Power Supply Inputs	9
6	BP-DAC81404EVM, BP-DAC61402EVM Jumper Settings	9
7	BP-DAC81404EVM, BP-DAC61402EVM Bill of Materials	23

Trademarks

BoosterPack, LaunchPad are trademarks of Texas Instruments.
 Microsoft, Windows are registered trademarks of Microsoft Corporation.
 All other trademarks are the property of their respective owners.

1 Overview

The BP-DAC81404EVM, BP-DAC61402EVM are an easy-to-use platform to evaluate the functionality and performance of the DAC81404 device. The 16-bit DAC81404 (quad-channel) and 12-bit DAC61402 (dual-channel) (DACx140x) are a pin-compatible family of buffered output (up to ± 20 V) digital-to-analog converters (DACs) with integrated 2.5-V internal reference. These devices are specified monotonic by design and offer excellent linearity of less than 1 LSB. Additionally, the DACx140x implements per channel sense pins to eliminate IR drop and to sense up to ± 12 V of ground bounce.

The DACx140x includes reliability features such as CRC error check, short circuit protection, and thermal alarm. These devices are characterized for operation over the temperature range of -40°C to 125°C and are available in a very small 32-pin QFN package. The performance and feature set combined with a small package make the DACx140x an excellent choice for end equipment such as automated test equipment, analog output modules, servo motor drives, and precision data acquisition cards.

The DACx140x devices incorporate a power-on-reset circuit that ensures the DAC output powers in power-down mode and remains in this mode until the outputs are enabled.

The device communicates through speed 4-wire serial interface (SPI) that supports operation from 1.7 V to 5.5 V.

The EVM provides the GPIO and SPI programming interface using a PC-based graphical user interface (GUI). This EVM requires the MSP-EXP432E401Y LaunchPad™ for interfacing with the PC-based GUI.

1.1 Kit Contents

Table 1 details the contents of the EVM kit. Contact the TI Product Information Center nearest you if any component is missing. TI highly recommends that the user verify latest versions of the related software at the TI website, www.ti.com.

Table 1. DAC81404EVM Kit Contents

Item	Quantity
BP-DAC81404EVM BoosterPack	1

Table 2. DAC61402EVM Kit Contents

Item	Quantity
BP-DAC61402EVM BoosterPack	1

Table 3. Required Components Not Included With Kit

Item	Quantity
MSP-EXP432E401Y LaunchPad	1

The MSP-EXP432E401Y LaunchPad can be purchased from the [MSP432E401Y tool folder](#) on www.ti.com.

1.2 Related Documentation from Texas Instruments

The following document provides information regarding Texas Instruments integrated circuits used in the assembly of the BP-DAC81404EVM and BP-DAC61402EVM. This user's guide is available from the TI web site under literature number SLAU825. 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 may be available from the TI web site at <http://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 4. Related Documentation

Document	Literature Number
DAC81404 product data sheet	SLASEH2
DAC61402 product data sheet	SLASEH3

2 System Setup

2.1 Software Setup

This section provides the procedure for EVM software installation.

NOTE: The BP-DAC81404EVM and BP-DAC61402EVM have separate software. This document mainly describes the BP-DAC81404EVM software for brevity. This BP-DAC61402EVM software is similar to that of BP-DAC81404EVM except the changes in the number of DAC channels and the reduction of the register map.

2.1.1 Software Installation

The EVM software is compatible with the Microsoft® Windows® 7, 8, and 10 operating systems. The software is found in the [GUI Composer Gallery](#). Search for *BP-DAC81404EVM* or *BP-DAC61402EVM* in the GUI Composer Gallery. Use the down arrow symbol to download the software. There are two downloads: *BP-DAC81404EVM* or *BP-DAC61402EVM GUI* and the respective *GUI Composer Runtime*. Either download both, or just download the EVM GUI; the runtime file can be downloaded through the EVM GUI during installation. The software can also be run online; however, only after the firmware and driver are upgraded. After the software is downloaded onto the PC, navigate to the download folder, and run the BP-DAC81404EVM or BP-DAC61402EVM software executable, as [Figure 1](#) shows.

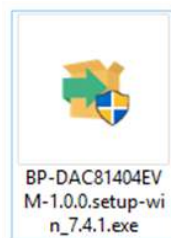


Figure 1. BP-DAC81404EVM, BP-DAC61402EVM Software Setup

When the BP-DAC81404EVM or BP-DAC61402EVM software is launched, an installation dialog window opens and prompts the user to select an installation directory. If left unchanged, the software location defaults to *C:\Program Files (x86)\Texas Instruments\BP-DAC81404 EVM*, as [Figure 2](#) shows. If there is no previous installation of the *GUI Composer Runtime* application, the installer also requests for an automatic download from the web. Select either *Install from Web* to download and install from the web, or *Install from PC* and provide the path to the local file that is already downloaded. The runtime executable also installs the USB drivers, unless the drivers are already installed.

The software installation automatically copies the required files and drivers to the local machine.

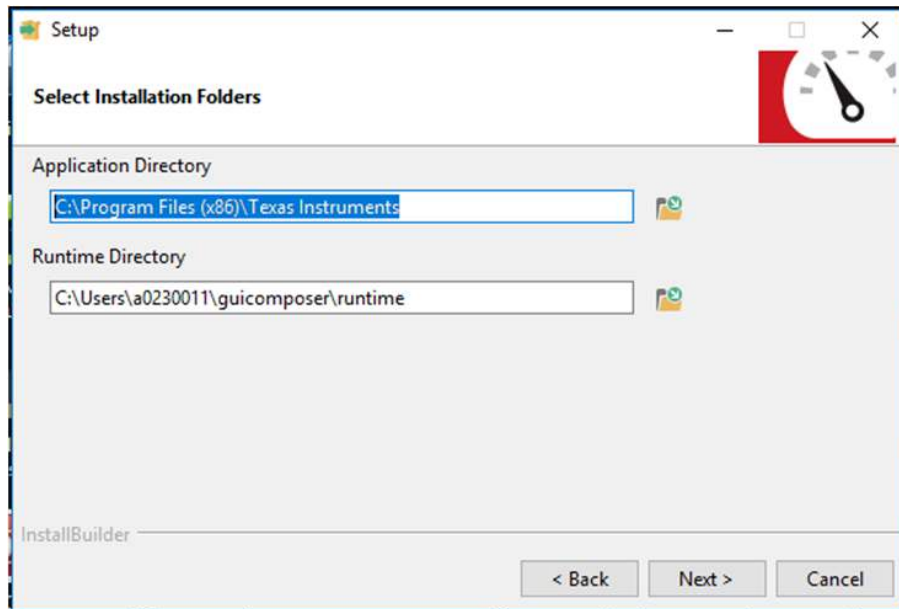


Figure 2. Software Installation Path

2.1.2 LaunchPad™ Firmware Upgrade

Before using the software for the first time, upgrade the firmware for the LaunchPad. The firmware is programmed to the LaunchPad using the online tool, [UniFlash](#). This link is also provided on the *Setup* page of the GUI. After unzipping the *install_image_BP-DAC81404EVM.zip* file, the firmware bin file is found at `<Download Directory>\BP-DAC81404EVM_1.0.1_installer_win\install_image_BP-DAC81404EVM\BP-DAC81404EVM\firmware\acctrl.bin`.

Use the following step-by-step procedure to upgrade the firmware and install the device drivers successfully:

1. Remove jumper JP6 on the LaunchPad, as shown in step 1 of [Figure 3](#).

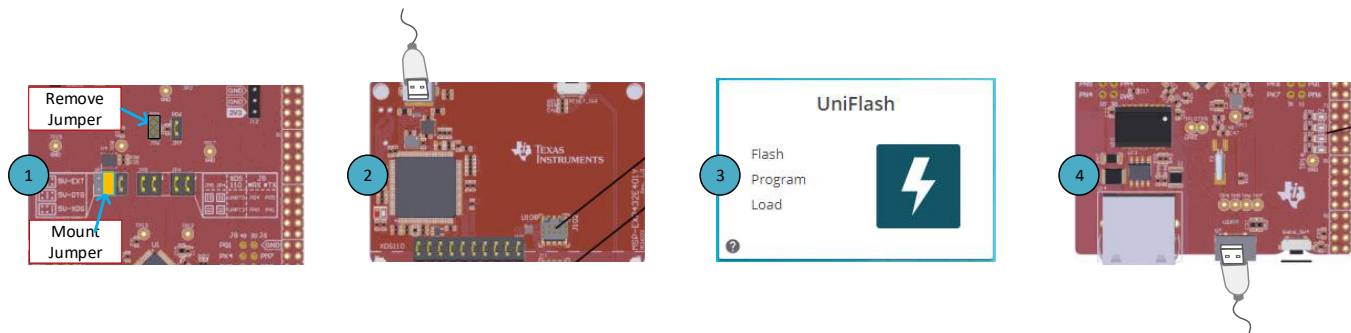


Figure 3. LaunchPad™ Setup

2. Mount the jumper on 5V-OTG. Retain the jumper on 5V-XDS, as shown in step 1 of [Figure 3](#).
3. Connect the USB cable to the port on the XDS110 side of the board, as shown in step 2 of [Figure 3](#).
4. Connect the USB cable to PC and open [UniFlash](#). Click on *Start Now* in the *Detect Device* section.
5. If the GUI Composer framework is being installed for the first time on the PC, the browser extension and the *TI Cloud Agent* must also be installed. Follow the 2-step installation flow prompted on the web page, as shown in [Figure 4](#)

TI Cloud Agent Installation

Hardware interaction requires additional one time set up. Please perform the actions listed below and try your operation again.(What's this?)

- Step 1: **INSTALL** browser extension
- Step 2: **DOWNLOAD** and install the TI Cloud Agent Application
- Help. I already did this

FINISH

Figure 4. TI Cloud Agent Installation

6. Press the *Refresh* or *Finish* button after the installation is complete. This action should detect the LaunchPad.
7. Press *Start* and browse for `<Download Directory>\BP-DAC81404EVM_1.0.1_installer_win\install_image_BP-DAC81404EVM\BP-DAC81404EVM\firmware\acctrl.bin`. Press *Load Image* followed by *Verify Image*.

2.2 Hardware Setup

This section provides the overall system setup for the EVM. The hardware setup contains the MSP-EXP432E401Y LaunchPad and the BP-DAC81404EVM or BP-DAC61402EVM. A PC runs the software that provides an interface to the BP-DAC81404EVM through the LaunchPad.

The BP-DAC81404EVM, BP-DAC61402EVM require external power supplies, as described later in this document. The 3.3-V and 5-V power supplies from the LaunchPad can be used for IOVDD and DVDD for the DAC, respectively, using jumper options. The LaunchPad generates the digital signals used to communicate with the EVM board.

Figure 5 displays the hardware setup.

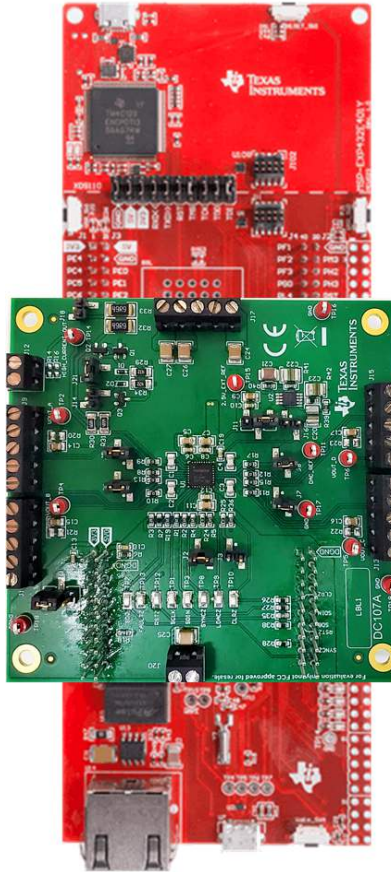


Figure 5. Hardware Setup

2.2.1 Power Configurations and Jumper Settings

The BP-DAC81404EVM, BP-DAC61402EVM provide electrical connections to the device supply pins. The connectors and optional configurations are shown in [Table 5](#), and [Table 6](#) shows the EVM jumper settings.

Table 5. BP-DAC81404EVM, BP-DAC61402EVM Power Supply Inputs

BP-DAC81404EVM, BP-DAC61402EVM Connector	Supply Name	Voltage Range (Max)
J17: Pin 1	DAC_VDD	0 to 5.5 V
J17: Pin 2	GND	-0.3 to 0.3 V
J17: Pin 3	GND	-0.3 to 0.3 V
J17: Pin 4	DAC_AVDD	41.5 V
J17: Pin 5	DAC_AVSS	-21.5 V

NOTE: $A_{VDD} - A_{VSS}$ must not exceed 42 V.

Table 6. BP-DAC81404EVM, BP-DAC61402EVM Jumper Settings

Jumper	Description	Default Position	Alternate Position
J2	LDAC Pulldown	1-2 : LDAC is LOW	None: LDAC is HIGH
J3	CLR Pulldown	None: CLR is HIGH	1-2 : CLR is LOW
J5	VSENSE_N_A	1-2: VSENSE_N_A is ground	None
J6	VSENSE_N_B	1-2: VSENSE_N_B is ground	None
J7	VSENSE_N_C	1-2: VSENSE_N_C is ground	None
J8	VSENSE_N_D	1-2: VSENSE_N_D is ground	None
J11	DAC_AVSS (Bipolar/Unipolar Selection)	2-3: DAC is in Unipolar power supply mode, AVSS to ground	1-2 : DAC is in Bipolar power supply mode, AVSS can be up to -21.5 V
J14	High Current Stage Enable/Disable	None : DAC V_{OUT} is not connected to high current Stage	1-2: DAC output Channel B is connected to High current stage
J16	External Reference	None : External Reference is not connected to REFIO	1-2: External reference of 2.5 V is connected to REFIO
J18	100 Ω load connection for high current stage	None : High current output stage is unloaded	1-2: High current output stage is loaded with 100 Ω
J19	External DAC IOVDD	2-3 : DAC IOVDD is provided by LaunchPad Interface	1-2: DAC IOVDD is provided by external connector J20
J21	Input ground for High Current Output stage	1-2: Input for high current output stage is grounded to minimize power consumption when in disabled state.	None : Input is provided by DAC V_{OUT} from channel B

2.2.2 Connecting the Hardware

After the LaunchPad firmware is upgraded as described in [Section 2.1.2](#), and power and jumper configurations done as per [Section 2.2.1](#), the BP-DAC81404EVM or BP-DAC61402EVM and the LaunchPad can be connected as [Figure 5](#) shows. Connect the USB cable from the LaunchPad OTG USB port (U7) to the PC.

2.2.3 Electrostatic Discharge Caution

Many of the components on the BP-DAC81404EVM, BP-DAC61402EVM and the LaunchPad are susceptible to damage by electrostatic discharge (ESD). Observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

3 Detailed Description

3.1 Hardware Description

The following subsections provide detailed information on the EVM hardware and jumper configuration settings.

3.1.1 Theory of Operation

Figure 6 shows the block diagram of the BP-DAC81404EVM, DAC61402EVM board. All grounds are shorted together using single-point shorts. The EVM board connects to the LaunchPad with the BoosterPack connectors. There is an onboard reference, using the REF6025, which generates a 2.5-V voltage reference, which can be used as an external reference for the DAC. Each channel outputs (named as DAC_VOUT_A, DAC_VOUT_B, DAC_VOUT_C, and DAC_VOUT_D) are available in a 5-pin connector which includes the force and sense connections for the DAC. A 470-pF capacitor is connected from the C_{COMP} pin to DAC output to compensate for the stability issues while driving large capacitive loads. DAC power supplies can be configured through jumper options to allow operation for bipolar or unipolar. The digital I/O supply of the DAC is provided by the LaunchPad interface by default; however, an external option is also present on the board.

For applications requiring high current drive capability such as motor control or programmable power supplies, an option is provided in the EVM to have up to 100-mA output current through external transistors. To enable high current option, place jumpers J14 and J18 and remove jumper from J21.

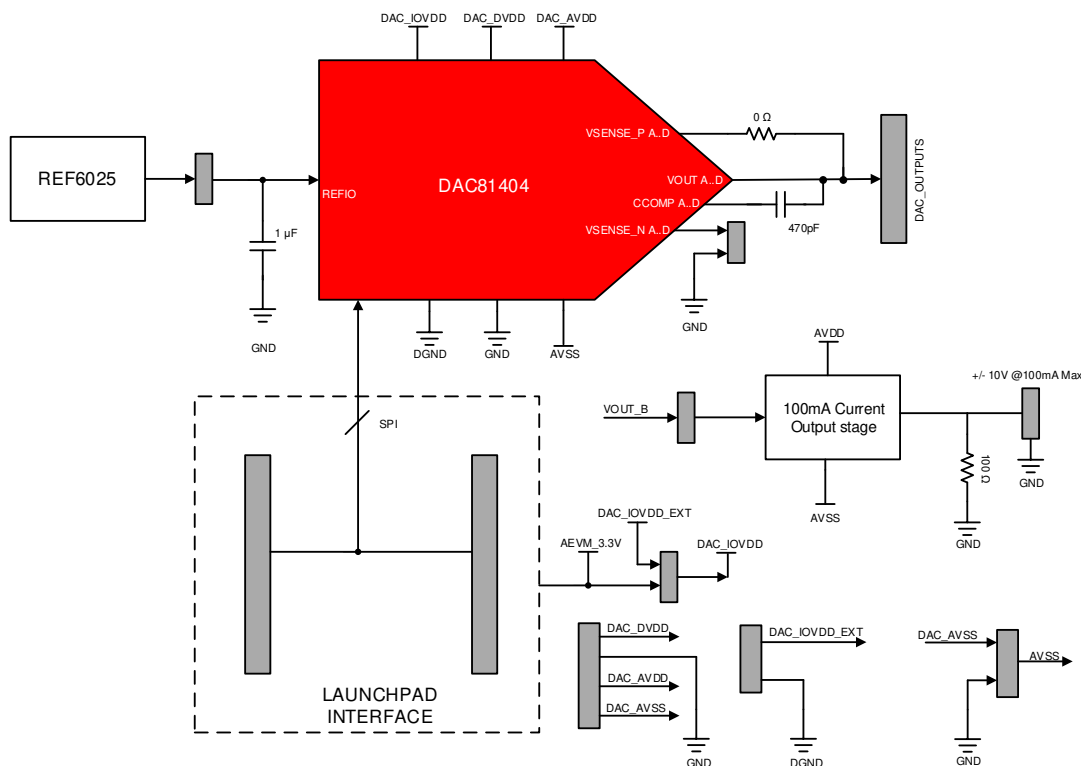


Figure 6. BP-DAC81404EVM, BP-DAC61402EVM Hardware Block Diagram

3.2 Software Description

This section describes the features of the BP-DAC81404EVM, BP-DAC61402EVM software, and discusses how to use these features. The software provides basic control of all the registers and functions of the DAC81404 / DAC61402 device.

3.2.1 Starting the Software

To launch the software, locate the Texas Instruments folder in the *All Programs* menu, and select the *BP-DAC81404EVM* or *BP-DAC61402EVM* icon, as [Figure 8](#) shows.

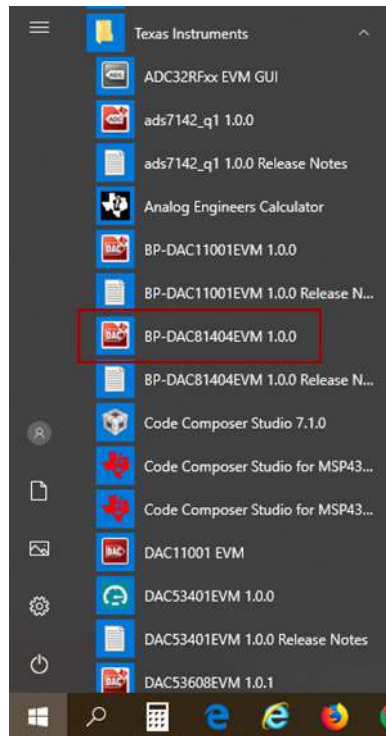


Figure 8. BP-DAC81404EVM, BP-DAC61402EVM GUI Location

[Figure 9](#) shows that if the LaunchPad connector is connected correctly, the status bar at the bottom of the screen displays *Hardware Connected*. If the LaunchPad is not properly connected or not connected at all, the status bar displays *Hardware not connected*. In case the *Hardware not connected* status persists even after the hardware is connected, go to *Options* → *Serial Port*, and change the port to the other available port with the *(Texas Instruments)* or *ACCtrl* tag. One of the two ports with these tags will connect to the hardware.

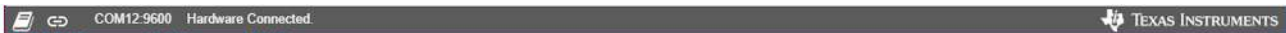


Figure 9. GUI Connection Detection

3.2.2 Software Features

The BP-DAC81404EVM, BP-DAC61402EVM GUI incorporate interactive functions that help configure the DAC81404 or DAC61402 device. These functions are built into several GUI pages, as the following sections show. The *Menu* button allows the user to switch between the pages, with each page representing a feature of the software.

3.2.2.1 Home Page

The *Home* page, shown in [Figure 10](#), provides the basic information and navigation to other pages. Click on *Learn More...* to get more information on the device.

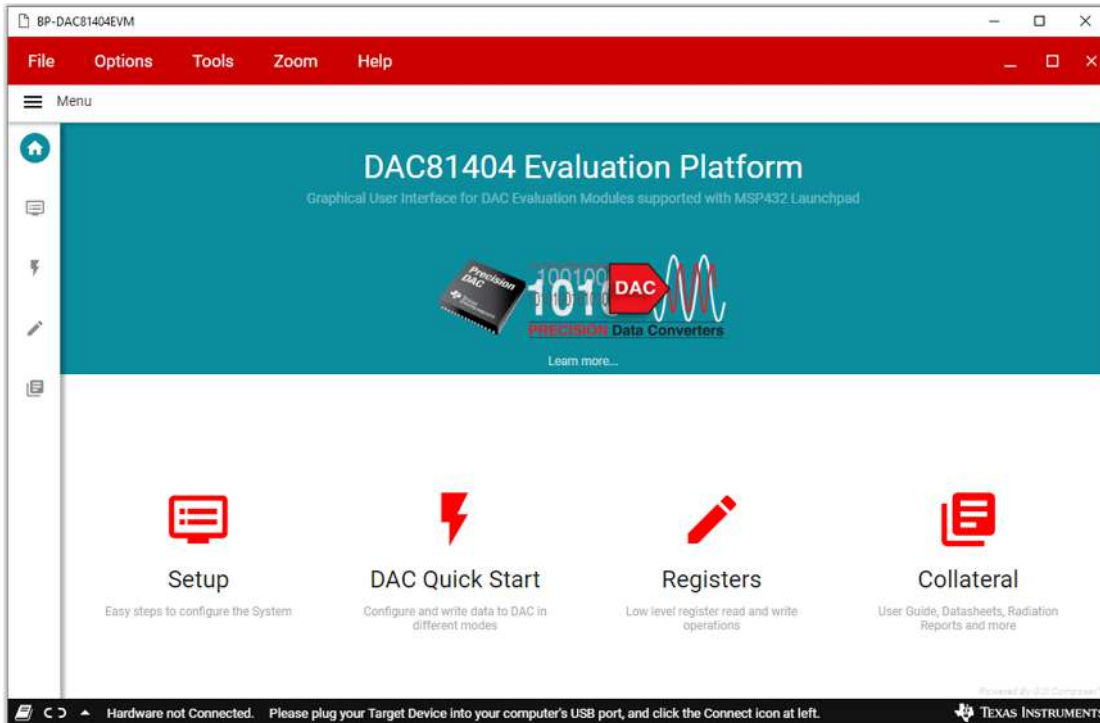


Figure 10. Software Home Page

3.2.2.2 Setup Page

The *Setup* page, shown in [Figure 11](#), guides the user to perform a one-time firmware upgrade for the LaunchPad.

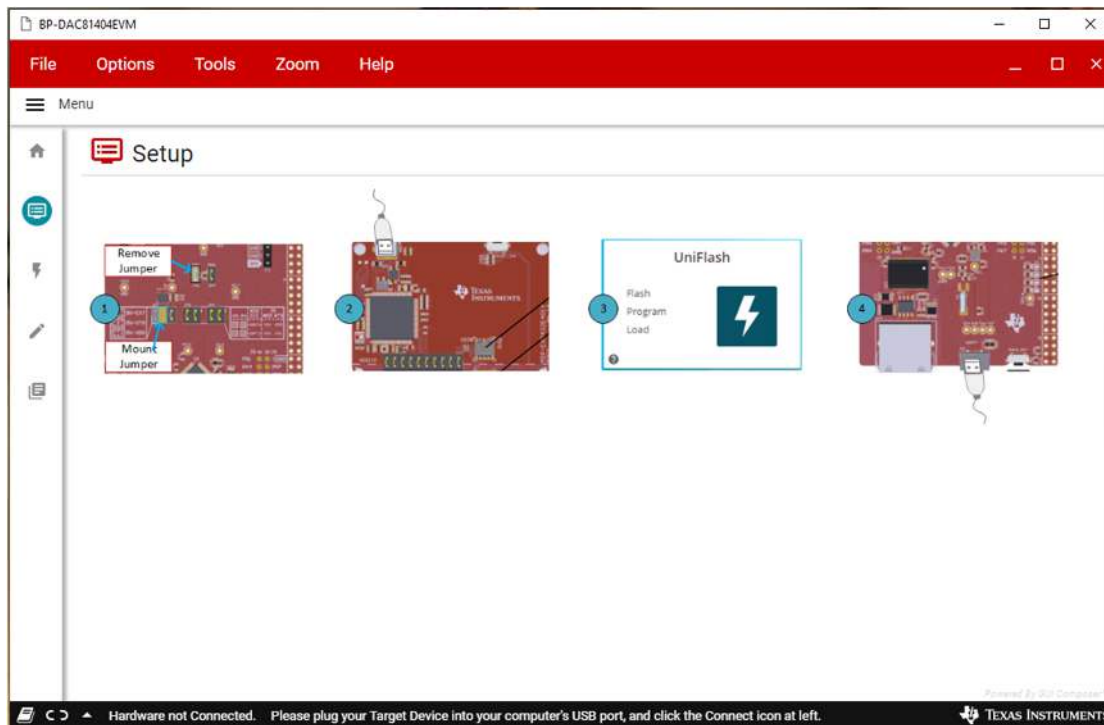


Figure 11. Setup Page

3.2.2.3 DAC Quick-Start Page

The DAC Quick-Start page provides the functions to quickly get started with the EVM. This page provides interfaces for both global and channel-specific configuration.

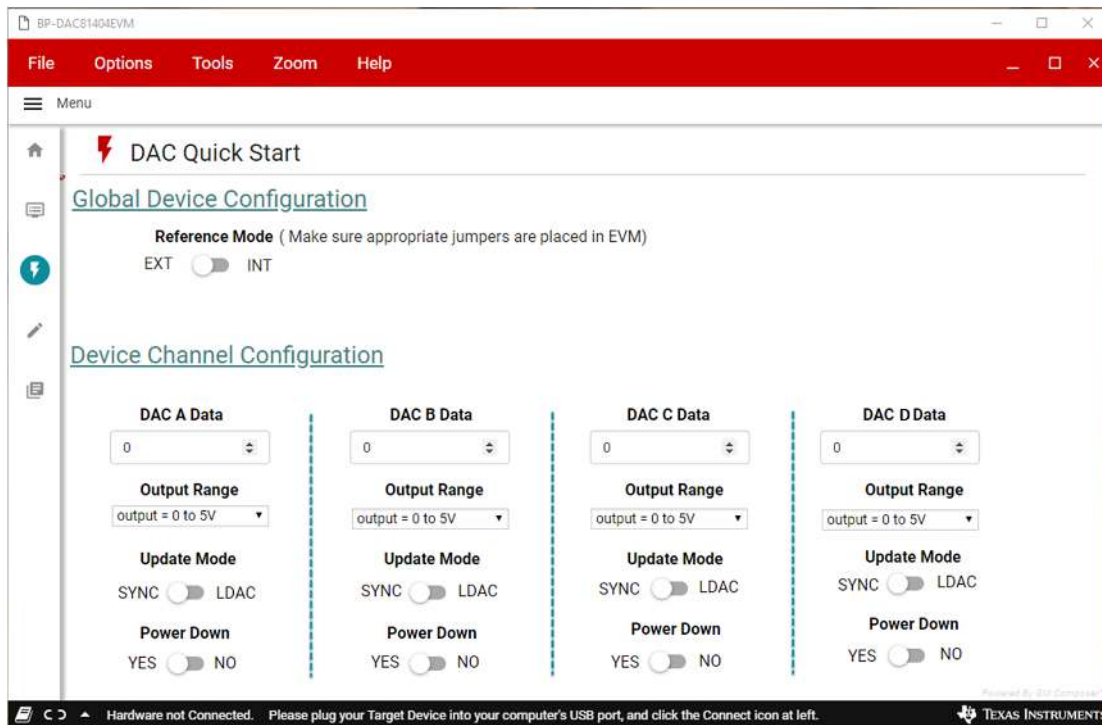


Figure 12. DAC Quick-Start Page: Basic DAC Tab

3.2.2.4 Register Map Page

The *Register Map* page, shown in [Figure 13](#), allows the user to access low-level communication directly with the DAC81404 / DAC61402 registers. Selecting a register on the *Register Map* list shows a description of the values in that register, as well as information on the register address, default value, size, and current value. Values are read from and written to the registers by writing to the *Value* or bit field of the GUI.

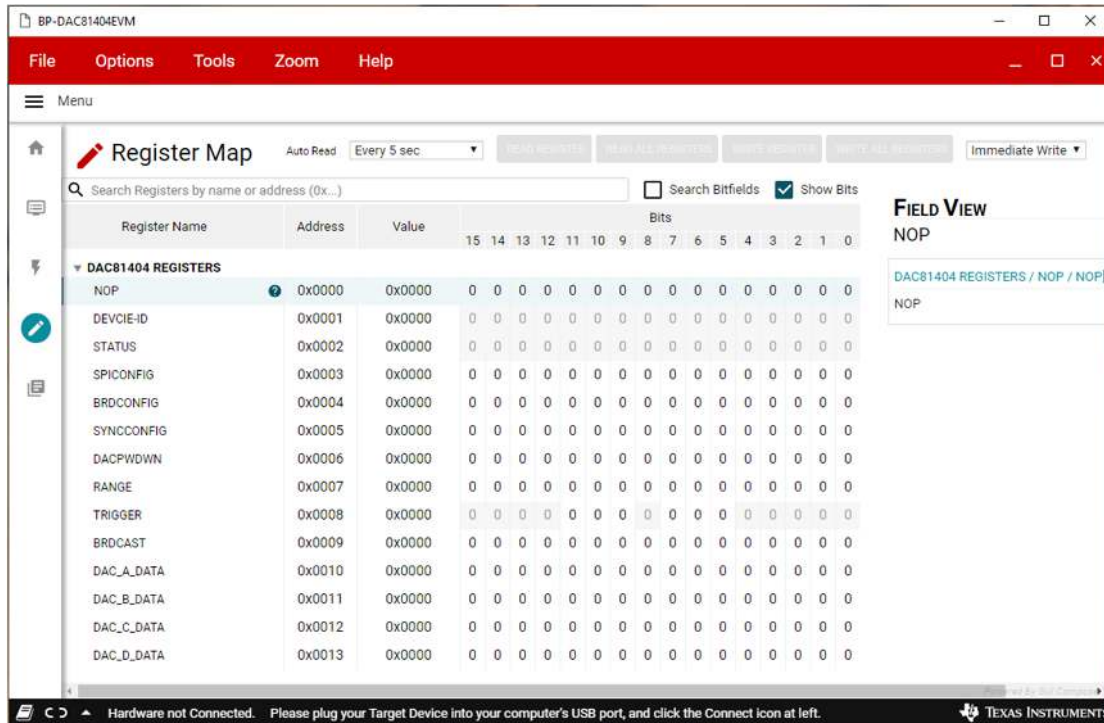


Figure 13. Register Map Page

There are some configuration lists and action buttons provided on the *Register Map* page. To store the values of the register map locally, press the *Save Registers* button under the *File* menu option. Additionally, recall and load the stored configuration files through the *Load Registers* button. Other options selectable by the user are the *Auto Read Interval*, *Read Register*, *Read All Registers*, *Write Register*, *Write All Registers*, and *Update Mode* buttons. These buttons are displayed in [Figure 14](#). The *Write Register* and *Write All Registers* buttons are enabled only with *Deferred* update mode. *Deferred* mode initiates a write operation only when the *Write Register* or the *Write All Registers* button is pressed. By default, the *Immediate* update mode is selected for the *Register Map* page write operations.



Figure 14. Register Page Options

3.2.2.5 Collateral Page

Figure 15 shows a page that provides links for all the collateral on the DAC81404 / DAC61402 device.

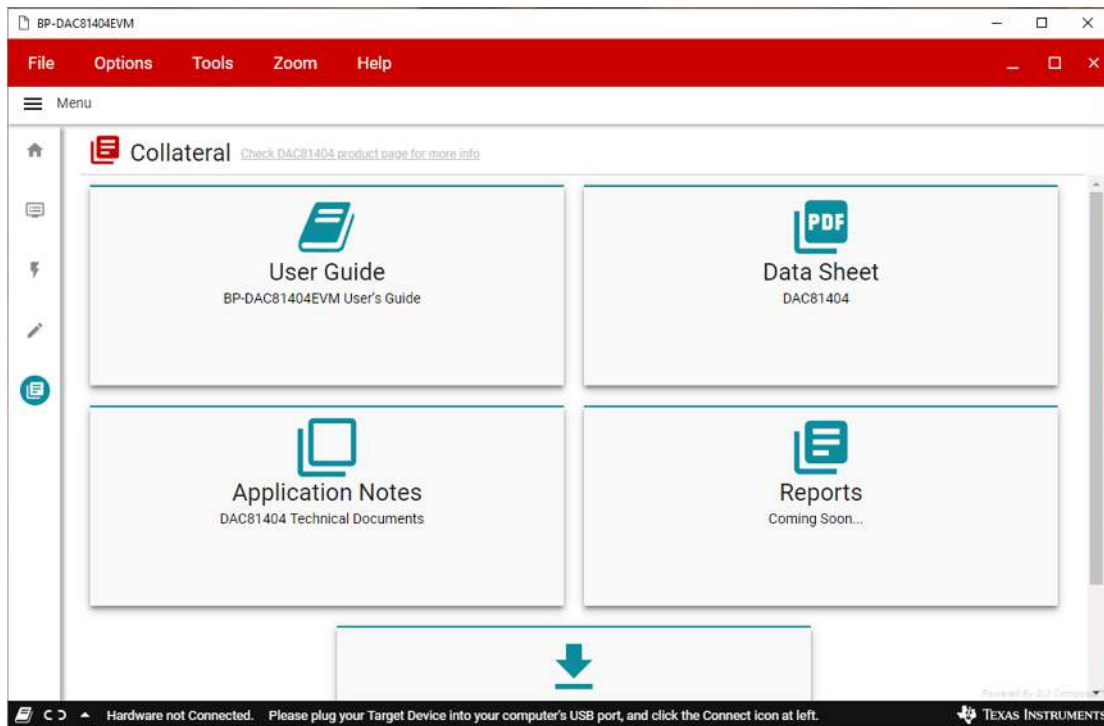


Figure 15. Collateral Page

4 Schematic, PCB Layout, and Bill of Materials

This section contains the complete bill of materials and schematic diagram for the BP-DAC81404EVM, BP-DAC61402EVM.

NOTE: The schematics and layout for both BP-DAC81404EVM and BP-DAC61402EVM are identical except the DAC part number.

4.1 BP-DAC81404EVM, BP-DAC61402EVM Schematic

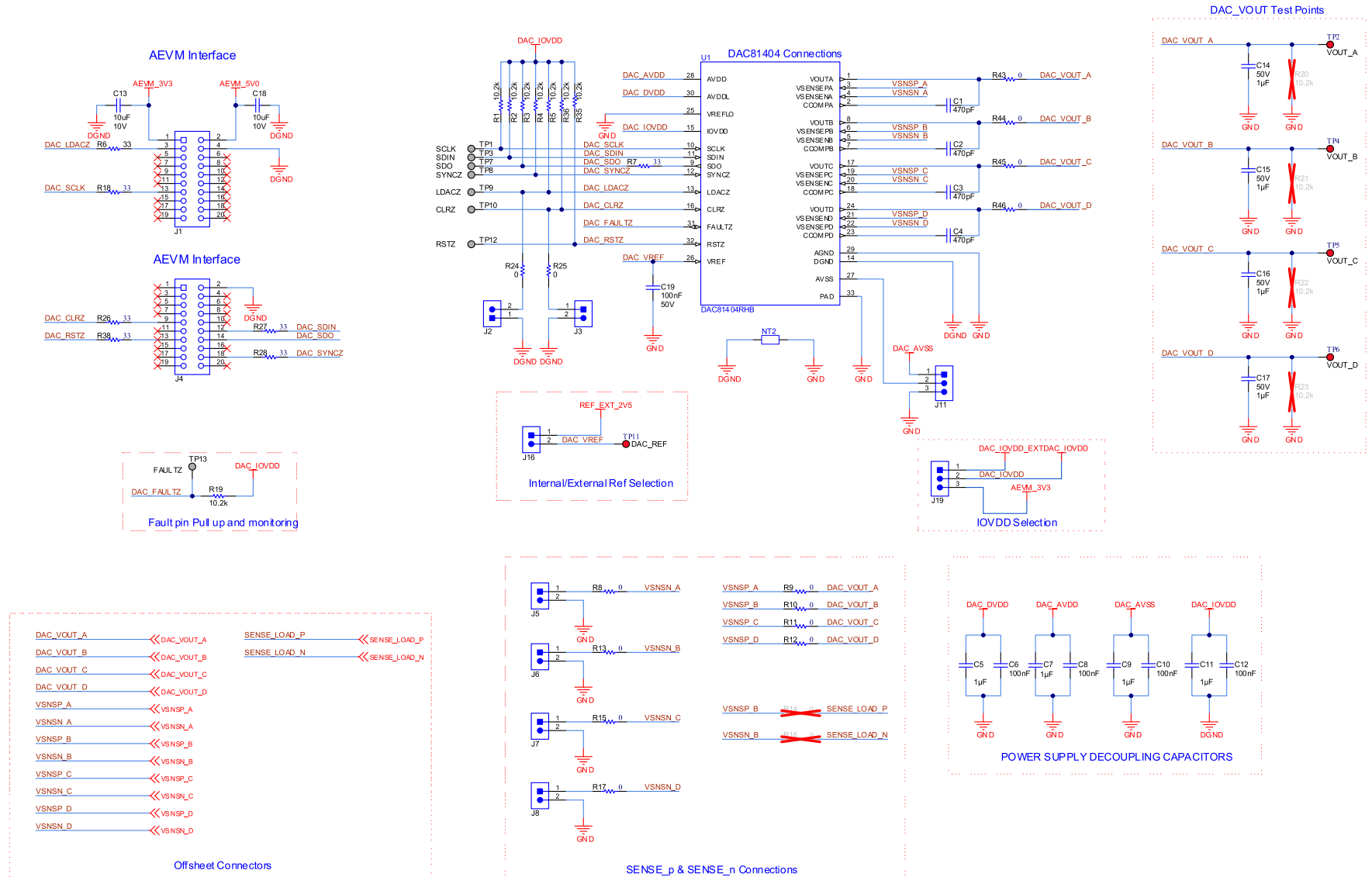


Figure 16. Schematic Page 1

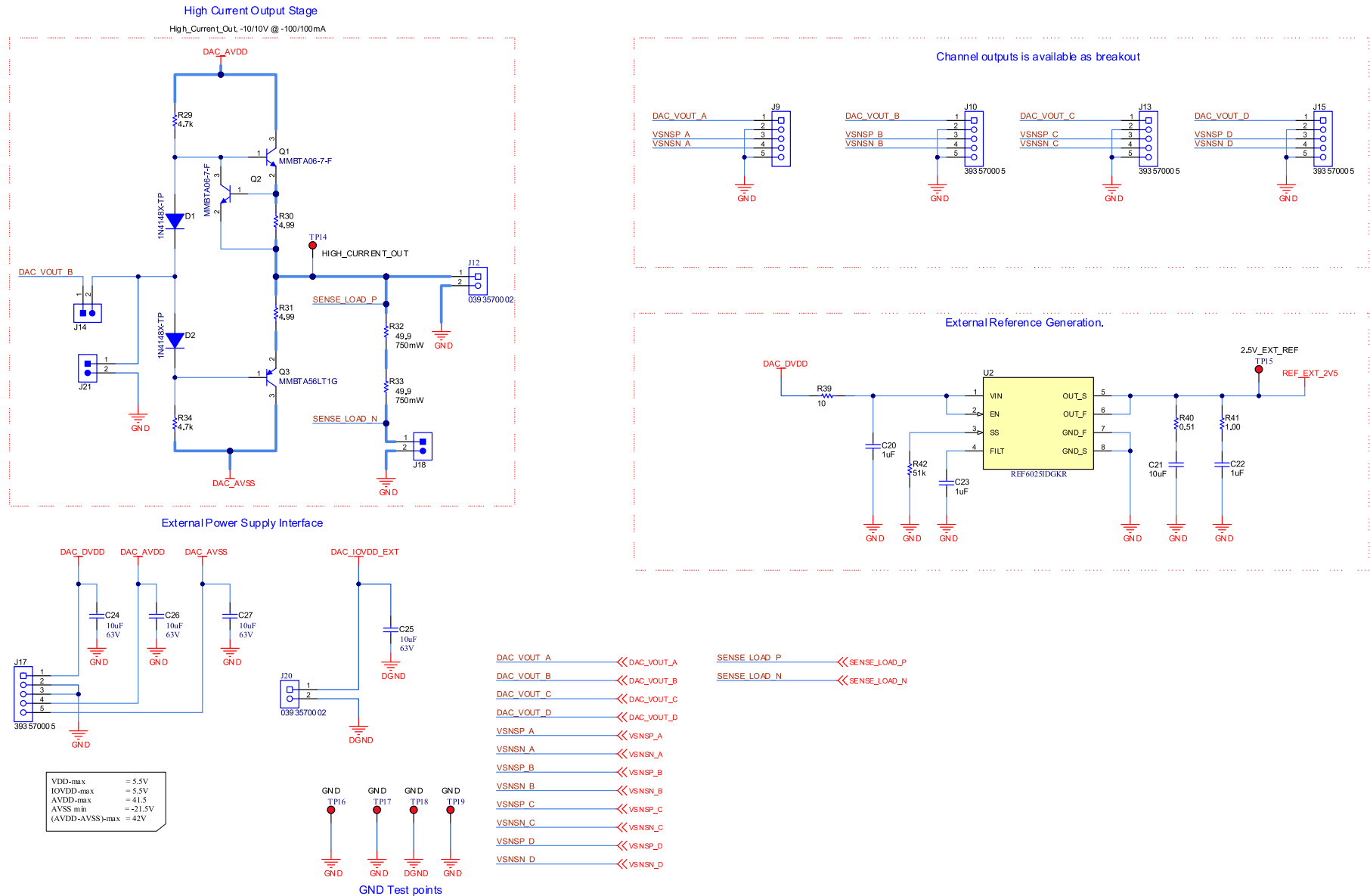


Figure 17. Schematic Page 2

4.2 PCB Layout

Figure 18 through Figure 21 show the layout details of the BP-DAC81404EVM, BP-DAC61402EVM board.

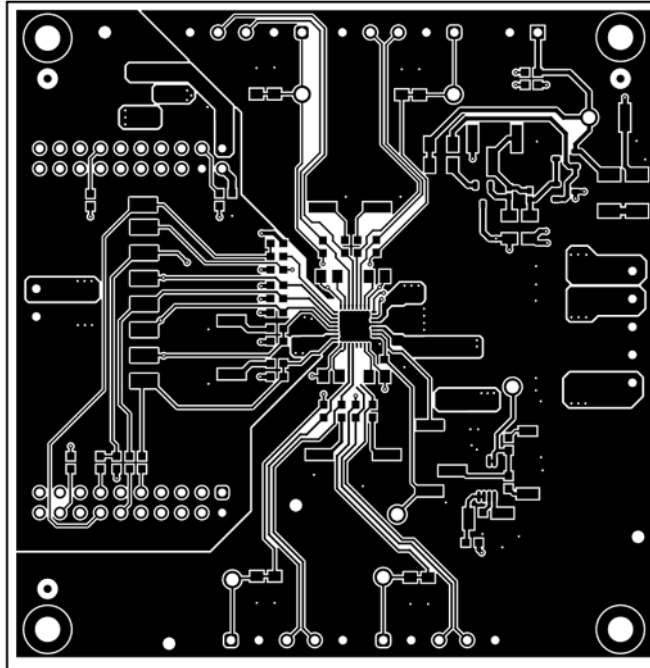


Figure 18. PCB Layout: Top Layer

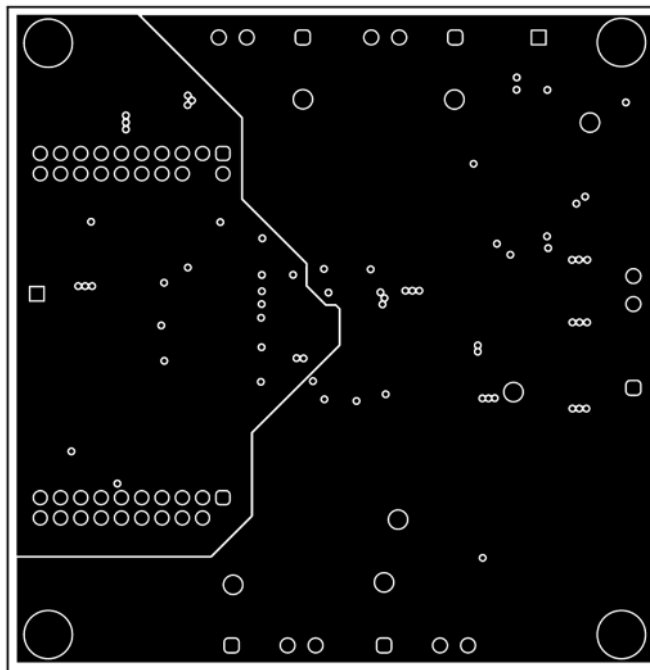


Figure 19. PCB Layout: Ground Plane

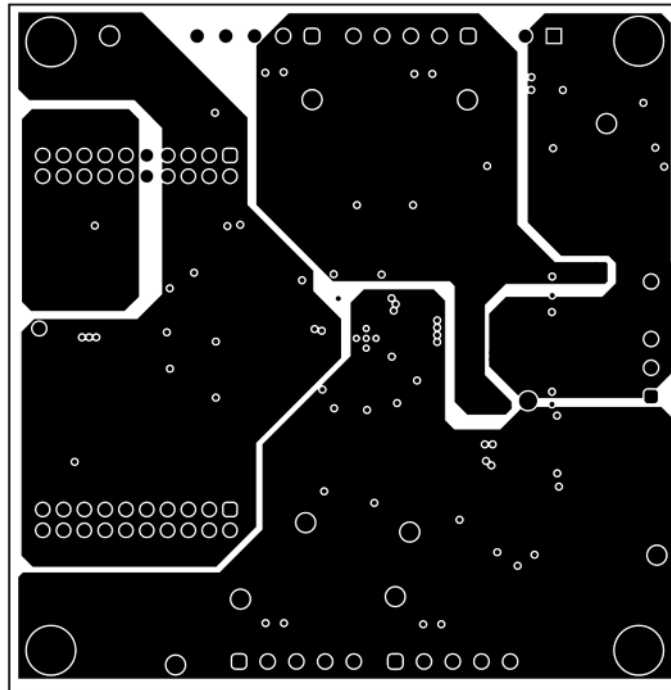


Figure 20. PCB Layout: Power Plane

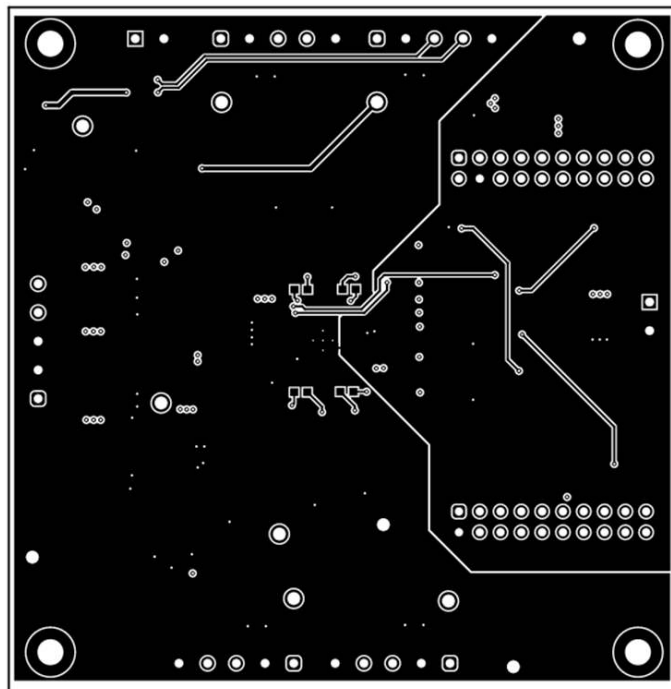


Figure 21. PCB Layout: Bottom Layer

4.3 BP-DAC81404EVM, BP-DAC61402EVM Bill of Materials

Table 7 lists the EVM bill of materials (BOM).

Table 7. BP-DAC81404EVM, BP-DAC61402EVM Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		DC107	Any
C1, C2, C3, C4	4	470pF	CAP, CERM, 470 pF, 100 V, ±5%, C0G/NP0, 0805	0805	GRM2165C2A471JA01D	MuRata
C5, C7, C9, C11, C14, C15, C16, C17	8	1uF	CAP, CERM, 1 µF, 50 V, ±10%, X7R, 0805, CAP, CERM, 1 µF, 100 V, ±10%, X7R, 0805	0805	GJ821BR71H105KA12L, GRM21BC72A105KE01L	MuRata
C6, C8, C10, C12, C19	5	0.1uF	CAP, CERM, 0.1 µF, 50 V, ±5%, X7R, 0603, CAP, CERM, 0.1 µF, 100 V, ±20%, X7R, 0603	0603	06035C104JAT2A, 490-16327-1-ND	AVX, Murata
C13, C18	2	10uF	CAP, CERM, 10 uF, 10 V, ±20%, X5R, 0603	0603	C1608X5R1A106M080AC	TDK
C20, C22, C23	3	1uF	CAP, Film, 1 uF, 16 V, ±20%, 1210 SMD	1210	ECPU1C105MA5	Panasonic
C21	1	10uF	CAP, CERM, 10 uF, 50 V, ±10%, X7S, AEC-Q200 Grade 1, 1210	1210	CGA6P3X7S1H106K250AB	TDK
C24, C25, C26, C27	4	10uF	CAP, CERM, 10 uF, 63 V, ±10%, X7R, 1210	1210	GRM32ER71J106KA12L	MuRata
D1, D2	2	75V	Diode, Switching, 75 V, 0.3 A, SOD-523	SOD-523	1N4148X-TP	Micro Commercial Components
H1, H2, H3, H4	4		MACHINE SCREW PAN PHILLIPS 4-40	Machine Screw, 4-40, 1/4 inch	PMSSS 440 0025 PH	B&F Fastener Supply
J1, J4	2		Receptacle, 2.54mm, 10x2, Tin, TH	Receptacle, 2.54mm, 10x2, TH	ESQ-110-14-T-D	Samtec
J2, J3, J5, J6, J7, J8, J14, J16, J18, J21	10		Header, 100mil, 2x1, Gold with Tin Tail, SMT	2x1 Header	TSM-102-01-L-SV	Samtec
J9, J10, J13, J15, J17	5		Terminal Block, 3.5mm, 5x1, Tin, TH	Terminal Block, 3.5mm, 5x1, TH	393570005	Molex
J11, J19	2		Header, 2.54mm, 3x1, Gold, SMT	Header, 2.54mm, 3x1, SMT	TSM-103-01-L-SV-P-TR	Samtec
J12, J20	2		Terminal Block, 3.5 mm, 2x1, Tin, TH	Terminal Block, 3.5 mm, 2x1, TH	0393570002	Molex
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
Q1, Q2	2	80 V	Transistor, NPN, 80 V, 0.5 A, SOT-23	SOT-23	MMBTA06-7-F	Diodes Inc.
Q3	1	80 V	Transistor, PNP, 80 V, 0.5 A, SOT-23	SOT-23	MMBTA56LT1G	ON Semiconductor
R1, R2, R3, R4, R5, R19, R35, R36	8	10.2k	RES, 10.2 k, 1%, 0.1 W, 0603	0603	RC0603FR-0710K2L	Yageo
R6, R7, R18, R26, R27, R28, R38	7	33	RES, 33, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333R0JNEA	Vishay-Dale
R8, R9, R10, R11, R12, R13, R15, R17, R43, R44, R45, R46	12	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo America
R24, R25	2	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZTOR00	Stackpole Electronics Inc

Table 7. BP-DAC81404EVM, BP-DAC61402EVM Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R29, R34	2	4.7k	RES, 4.7 k, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12064K70JNEA	Vishay-Dale
R30, R31	2	4.99	RES SMD 4.99 OHM 1% 3/4W 1206	1206	CRCW12064R99FKEAHP, [NoValue]	Vishay
R32, R33	2	49.9	RES, 49.9, 1%, 0.75 W, AEC-Q200 Grade 0, 2010	2010	CRCW201049R9FKEF	Vishay-Dale
R39	1	10	RES, 10, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310R0JNEA	Vishay-Dale
R40	1	0.51	RES, 0.51, 1%, 0.1 W, AEC-Q200 Grade 1, 0603	0603	ERJ-3RQFR51V	Panasonic
R41	1	1.00	RES, 1.00, 1%, 0.1 W, 0603	0603	RC0603FR-071RL	Yageo
R42	1	51k	RES, 51 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060351K0JNEA	Vishay-Dale
SH-JP5, SH-JP6, SH-JP7, SH-JP8, SH-JP11, SH-JP18, SH-JP19	7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP2, TP4, TP5, TP6, TP11, TP14, TP15, TP16, TP17, TP18, TP19	11		Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone
U1 (for BP- DAC81404EVM)	1		DAC81404RHB, RHB0032B (VQFN-32)	RHB0032B	DAC81404RHB	Texas Instruments
U1 (for BP- DAC61402EVM)	1		DAC61402RHB, RHB0032B (VQFN-32)	RHB0032B	DAC61402RHB	Texas Instruments
U2	1		5ppm/C High-Precision Voltage Reference with Integrated High-Bandwidth Buffer, DGK0008A (VSSOP-8)	DGK0008A	REF6025IDGKR	Texas Instruments
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R14, R16	0	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo America
R20, R21, R22, R23	0	10.2k	RES, 10.2 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1022V	Panasonic

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。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

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 2 4 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/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。
http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

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, INDEMNITY 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated