EVM User's Guide: AMC43xxDVVEVM

AMC43xxDVV Evaluation Module

Description

The AMC43xxDVVEVM, in conjunction with one of the AMC43xxDVV devices, demonstrates an isolated high-precision, high-voltage sensing design with integrated DC/DC converter. The evaluation module is capable of supporting any AMC43xxDVV device with a flexible output filtering design. The EVM includes both terminal blocks and test points for easy application of input signals and measurement of output signals.

Get Started

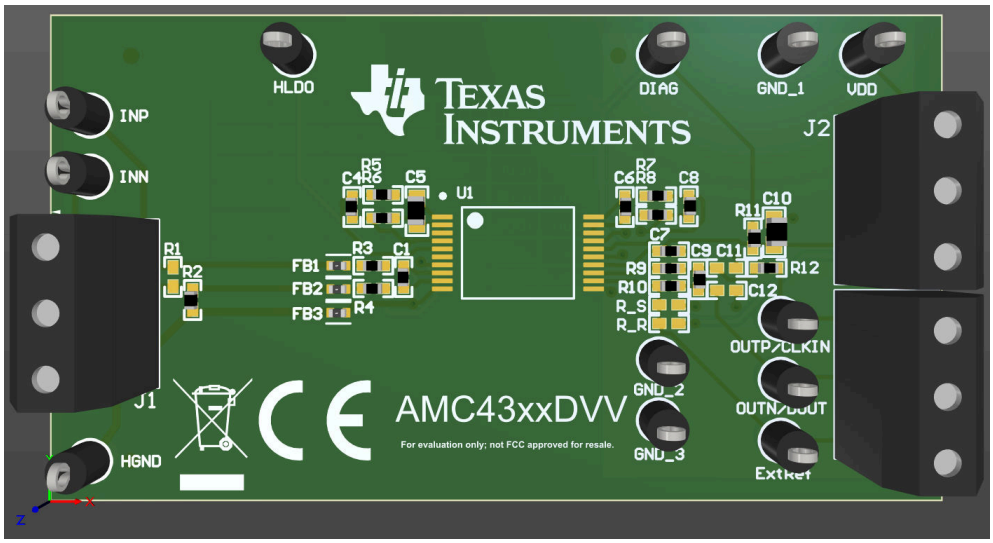
1. Order the AMC43xxDVVEVM.
2. Order the AMC43xxDVV device needed to evaluate on ti.com.
3. Evaluate performance on the bench.

Features

- Full-featured evaluation board for the AMC43xxDVV devices
- Configurable output filtering to support any AMC43xxDVV device
- Screw terminals and test points for easy access to inputs and outputs

Applications

- Rack Power
- Server Power Supply Unit
- Onboard Chargers (OBCs)
- Traction inverter
- DC/DC converter
- Energy Storage System (ESS)
- EV charging
- Solar inverters
- Motor drives
- Frequency inverters
- Protection relays



AMC43xxDVVEVM

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and use of the AMC43xxDVVEVM. This evaluation module (EVM) is an evaluation and development kit for evaluating the precision, isolated amplifiers and modulators with an integrated, isolated DC/DC converter to power the high voltage side. The low voltage side features a flexible filtering structure that supports multiple device output options such as differential, single-ended ratiometric (configurable gain), single-ended output (fixed gain) and modulator with internal or external clock. A silkscreen table on the backside of the EVM offers recommended filtering components and the installation locations.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the AMC43xxDVVEVM. This document includes how to set up the EVM, the printed circuit board (PCB) layout, schematics, and bill of materials (BOM).

The following pin and net names are synonymous or interconnected:

- INP = J1.1
- INN = J1.2
- AGND = GND1 = HGND = J1.3
- VDD = VDD = J2.1
- GND = GND_1 = GND_2 = GND_3 = J2.2 = J2.3
- VOUTP = OUTP = VOUT = CLKIN = J3.3
- VOUTN = OUTN = REFIN = DOUT = J3.2

1.2 Kit Contents

Table 1-1 details the contents included in the AMC43xxDVVEVM kit.

Table 1-1. AMC43xxDVVEVM Kit Contents

Item	Description	Quantity
AMC43xxDVVEVM	PCB	1

1.3 Specification

The AMC43xxDVVEVM provides the ability to evaluate various AMC43xxDVV isolated data converter devices. The EVM includes component placeholders on the output that are configurable based on the device being tested. This provides a convenient method of evaluating a range of devices from one board that is able to be repurposed. Refer to the datasheet of the installed device for detailed device specifications.

1.4 Device Information

The AMC43xxDVVEVM is compatible with a variety of devices. To determine the board configuration for the chosen device, refer to Section 2.1.2.

For a list of available devices that can be evaluated, see Table 5-1.

2 Hardware

Configuration of the output components requires determining the output type of the installed device.

2.1 Interfaces

The AMC43xxDVVEVM features one input design and 6 output configurations. The analog input to EVM is routed from terminal block J1 and test points INP, INN, and HGND. The output is accessible through terminal block J3 and test point OUTP/CLKIN, OUTN/DOUT, and ExtRef. Low side power is accessible through terminal block J2 and test point VDD, GND_1, GND_2, and GND_3. VDDA2 and DIAG are accessible through the test points.

2.1.1 Analog Input

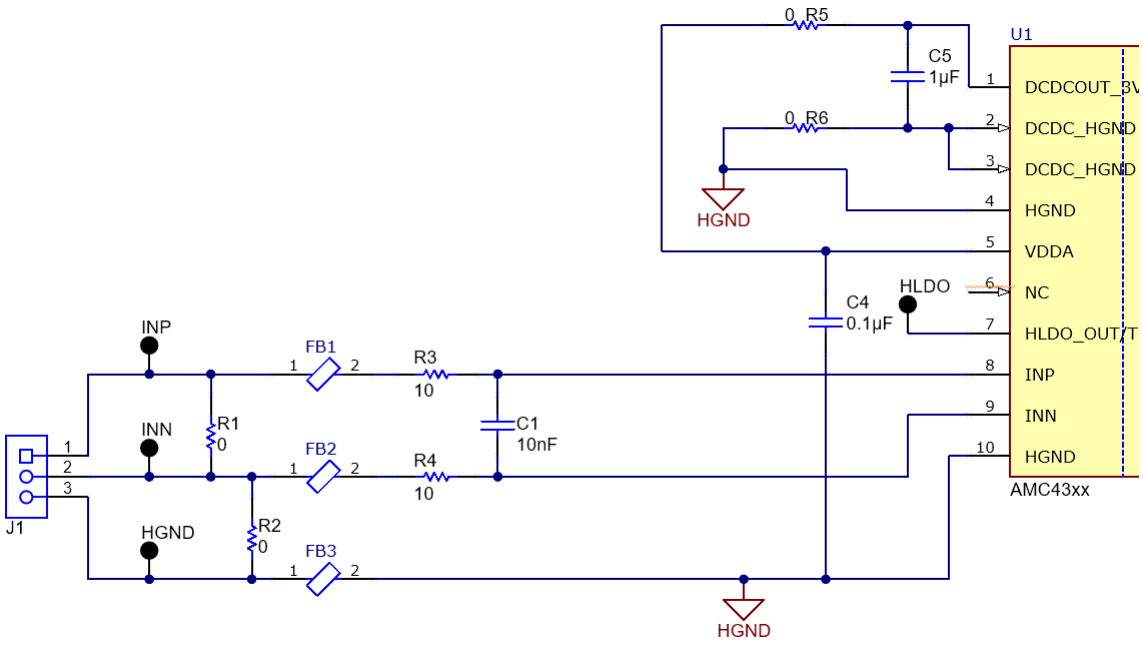


Figure 2-1. Analog Input Circuit Schematic

The analog input circuit for the AMC43xxDVVEVM is shown in Figure 2-1.

The analog input to EVM is routed from terminal block J1 and test points INP, INN, and HGND. The passive components R3, R4 and C1 create a standard RC anti-aliasing filter with a cutoff frequency of 796kHz. By default, R2 ties INN to HGND to verify that the input signal remains within the input common-mode voltage range specification of the AMC43xxDVV while R1 is not populated. FB1, FB2 and FB3 are installed by default for EMC compliance but is not necessary for all applications. Depending on the exact application of the AMC43xxDVV in the application, the ferrite bead selection can need adjustment. Please refer to the respective device datasheet for additional information.

Using a signal generator or other voltage source, the user can apply an input signal directly to INP with respect to INN and HGND. The linear input voltage range of the EVM depends on the installed device. Reference the device datasheet for more information.

2.1.2 EVM Output Configurations and Descriptions

The output schematic and the components that require modification based on the ordered output of the device and Table 2-1 matches the output type to the corresponding circuit configuration is shown in Figure 2-2.

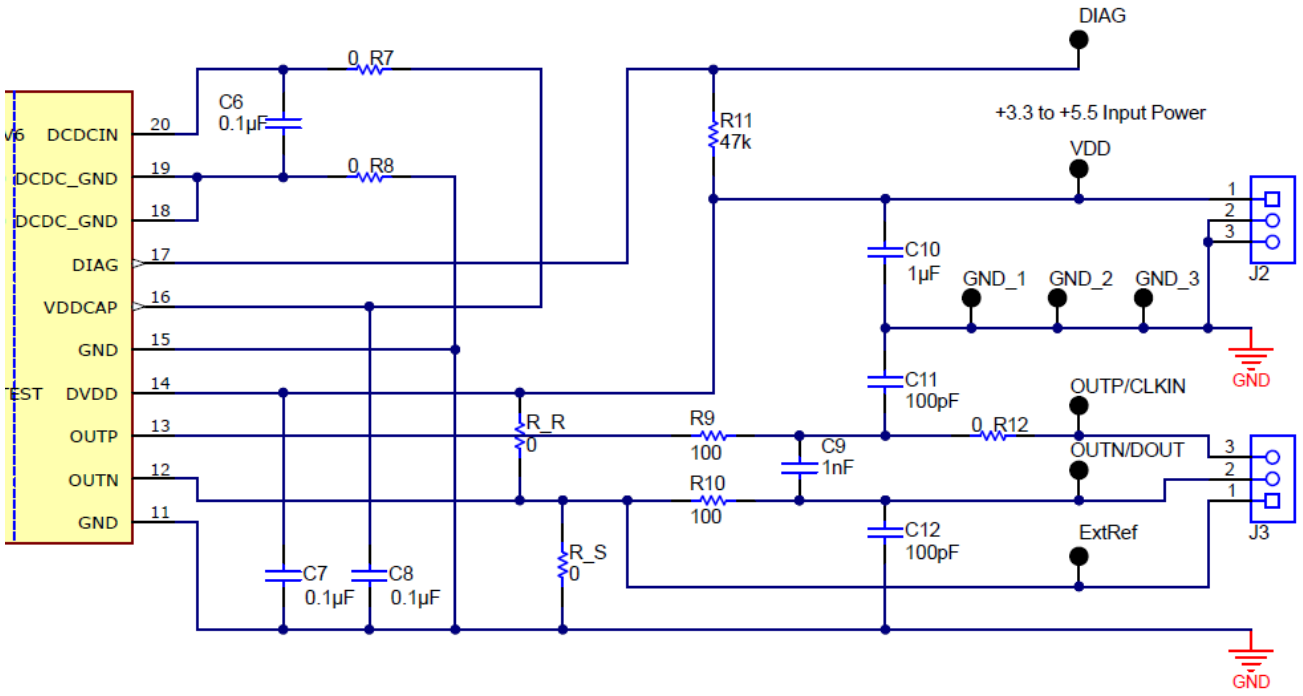


Figure 2-2. Output Circuit Schematic

Table 2-1. Output Type and Circuit Configuration Legend

Device Output Type	R_R	R_S	R9	R10	C9	C11	C12	R12
Differential Output (Diff.)	Not populated	Not populated	100Ω	100Ω	1nF	100pF	100pF	0Ω
Fixed Gain Single-Ended Output with Internal Reference (SE Int)	Not populated	0Ω	100Ω	Not populated	Not populated	100pF	Not populated	0Ω
Fixed Gain Ratiometric Output with VDD Reference (R Int)	0Ω	100nF	100Ω	Not populated	Not populated	100pF	Not populated	0Ω
Single-ended and Ratiometric Output with External Reference (SE/R Ext)	Not populated	100nF	100Ω	Not populated	Not populated	100pF	Not populated	0Ω
Internal Clock Modulator (Mod. Int.)	Not populated	Not populated	100Ω	100Ω	Not populated	100pF	100pF	0Ω
External Clock Modulator (Mod. Ext.)	Not populated	Not populated	0Ω	100Ω	Not populated	100pF	100pF	100Ω

2.1.3 Amplifier Output

2.1.3.1 Differential Output (Diff.)

The passive components of R9, R10, and C9 are populated as a low-pass differential filter to attenuate high frequency noise components. C11 and C12 can be populated to help with the filtering of any common-mode noise.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (OUTP) and J3.2 (OUTN) with respect to J2.3 (GND).

2.1.3.2 Fixed Gain Single-Ended Output With Internal Reference (SE Int)

When R_S is populated REFIN is directly tied to GND and sets the offset for the output voltage with a fixed gain. The passive components of R9 and C11 are populated as a low-pass filter to attenuate high frequency noise components.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (OUTP) with respect to J2.3 (GND).

2.1.3.3 Fixed Gain Ratiometric Output With VDD Reference (R Int)

When R_R is populated with a 0Ω resistor and R_S is populated with an external decoupling capacitor, REFIN is connected to VDD and accessible from J3.2. The ratiometric output gain is set by the applied VDD voltage. The passive components of R9 and C11 are populated as a low-pass filter to attenuate high frequency noise components.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (OUTP) with respect to J2.3 (GND).

2.1.3.4 Single-ended and Ratiometric Output With External Reference (SE/R Ext)

When R_R is not populated and R_S is populated with an external decoupling capacitor, REFIN is accessible from J3.2 and the ExtRef test point. The ratiometric output gain is set by the applied ExtRef voltage. The passive components of R9 and C11 are populated as a low-pass filter to attenuate high frequency noise components.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (OUTP) with respect to J2.3 (GND).

2.1.4 Modulator Output

2.1.4.1 Internal Clock Modulator (Mod. Int.)

When using a device with a modulator output and internal clock, the J3 connector provides access to the DOUT and CLKOUT pins of the device. The passive components of R9 and C11 are populated as a low-pass input filter for the clock coming out of the device. R10 and C12 are populated as a low pass filter on DOUT. These filters must have a high cut-off frequency, typically at least 10x the clocking frequency and are mainly to stabilize the digital signals and reduce overshoot and high frequency ripple.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (CLKOUT) and J3.2 (DOUT) with respect to J2.3 (GND).

2.1.4.2 External Clock Modulator (Mod. Ext.)

When using a device with a modulator output and external clock, the J3 connector provides access to the DOUT and CLKIN pins of the device. The passive components of R12 and C11 are populated as a low-pass input filter for the clock coming into the device. R10 and C12 are populated as a low pass filter on DOUT. These filters must have a high cut-off frequency, typically at least 10x the clocking frequency and are mainly to stabilize the digital signals and reduce overshoot and high frequency ripple.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

Using an oscilloscope, the user can observe the differential output signal on J3.3 (CLKIN) and J3.2 (DOUT) with respect to J2.3 (GND).

2.2 VDD Power Supply

The EVM requires a single power rail, VDD and GND.

VDD and GND are accessible through the J2 terminal block. C7, C8 and C10 serve as decoupling capacitors for VDD and help keep the supply stable.

The internal, isolated DC/DC converter generates the high side supply. C6, C5 and C4 all act as decoupling capacitors to improve the stability of the isolated DC/DC converter. R5, R6, R7 and R8 are all 0Ω placeholders for ferrite beads in the primary and secondary feedback loops of the isolated DC/DC. These are not necessary in typical applications, but placed to allow for testing purposes. The supply applied to the delta-sigma modulator is accessible using the VDDA2 test point.

2.3 EVM Operation

The following section describes how to verify correct soldering of your devices and components as well as general operation of the EVM.

2.3.1 Analog Input

The analog input to EVM is routed from terminal block J1 and test points INP, INN, and HGND.

The input voltage range is dependent on the device selected and installed; refer to the device datasheet for the maximum input voltages allowed.

The details of an input connection are listed in Table 2-2.

CAUTION

Carefully review the selected device data sheet for limitations of the analog input range and make sure the appropriate analog and digital voltages are applied prior to connecting any analog input to the EVM.

Table 2-2. Analog Input

Pin Number	Signal	Description
J1.1	INP	Connection to INP of the installed the device.
J1.2	INN	Connection to INN of the installed the device.
J1.3	HGND	Connection to HGND of the installed the device.

2.3.2 Outputs and VDD Power

The outputs can be observed at J3.3 and J3.2 and are dependent on the device selected and installed.

Table 2-3. Differential Output (Diff.)

Pin Number	Signal	Description
J2.1	VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.2, J2.3	GND	Connection to the installed GND terminal of the device.
J3.3	OUTP	Positive analog output from the installed device.

Table 2-3. Differential Output (Diff.) (continued)

Pin Number	Signal	Description
J3.2/J3.1	OUTN	Negative analog output from the installed device.

Table 2-4. Fixed Gain Single-Ended Output With Internal Reference (SE Int)

Pin Number	Signal	Description
J2.1	VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.2, J2.3	GND	Connection to the installed GND terminal of the device.
J3.3	OUT	SE analog output from the installed device.
J3.2/J3.1	REFIN	REFIN analog input to the installed device. GND with R_S installed.

Table 2-5. Fixed Gain Ratiometric Output With VDD Reference (R Int)

Pin Number	Signal	Description
J2.1	VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.2, J2.3	GND	Connection to the installed GND terminal of the device.
J3.3	OUT	SE analog output from the installed device.
J3.2/J3.1	REFIN	REFIN analog input to the installed device. VDD with R_R installed.

Table 2-6. Single-ended and Ratiometric Output With External Reference (SE/R Ext)

Pin Number	Signal	Description
J2.2	VDD2/VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.1	GND	Connection to the installed GND terminal of the device.
J3.2	OUT	SE analog output from the installed device.
J3.2/J3.1	REFIN	REFIN analog input to the installed device.

Table 2-7. Internal Clock Modulator (Mod. Int.)

Pin Number	Signal	Description
J2.1	VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.2, J2.3	GND	Connection to the installed GND terminal of the device.
J3.3	CLKOUT	Output clock from the installed device.
J3.2/J3.1	DOUT	Modulator data output from the installed device.

Table 2-8. External Clock Modulator (Mod. Ext.)

Pin Number	Signal	Description
J2.1	VDD	Connection to the installed VDD2/VDD terminal of the device.
J2.2, J2.3	GND	Connection to the installed GND terminal of the device.
J3.3	CLKIN	Input clock to the installed device.
J3.2/J3.1	DOUT	Modulator data output from the installed device.

2.3.3 Test Procedure

To verify the connections of the assembled EVM, TI recommends to run a test procedure.

2.3.3.1 Equipment Setup

1. One 5Vsource for low-side power supply, VDD.
2. The 5V source must be limited to 100mA.
3. Oscilloscope *or* digital multimeter (DMM) with at least 6.5 digits of resolution.
4. A signal generator for the input.

2.3.3.2 Procedure

1. Set the 5V (±10%) source and limit the current to 100mA as noted above. Connect the EVM voltage source to the connectors VDD pin referenced to GND. Turn on the power source and make sure there is no more than the specified current limit in the device data sheet drawn.
2. Tie input to ground either externally with J1, soldering short R1, or tying INP = INN = HGND.
3. Use the oscilloscope or the DMM to verify that isolated power is present on both VDD and VDDA2 supplies. Measure the output of the device referenced to GND and verify:
   a. For amplifiers: the isolated voltage is within the common-mode output voltage (typical 1.44V for differential output, REFIN/2 for single-ended output).
   b. For modulators using the oscilloscope: the digital output is a stream of ones and zeros that are high 50% of the time and low 50% of the time.
   c. For modulators using the DMM: the DMM is about 50% magnitude of VDD.
4.

CAUTION

The board can heat up under high power or improper use conditions. Contact can cause burns. Do not touch. Take the proper precautions when operating.

CAUTION

Electric shocks are possible when connecting the board to high voltage inputs. The board must be handled with care by a professional. For safety, use of isolated test equipment with overvoltage or overcurrent protection is highly recommended.

After removing the input short connection and depending on the mounted device, apply the appropriate DC full-scale linear input signal to INP or J1.1 with respect to INN = HGND.

5. Measure the output with the oscilloscope or the DMM.
   a. For amplifiers using either the oscilloscope or the DMM: Verify that the output voltage reaches the full-scale output for the installed device.
      i. 2V FSR for differential amplifiers.
      ii. REFIN FSR for single-ended amplifiers.
   b. For modulators using the oscilloscope: Verify that the digital output is proportional to the expected conversion.
      i. For a positive full scale linear input, the digital output must be high approximately 90% of the time.
   c. For modulators using the DMM: Verify that the digital output is proportional to the expected conversion. Apply a DC input signal.
      i. For a positive full scale linear input, the DMM reading needs to be approximately 90% magnitude of VDD.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the full schematic

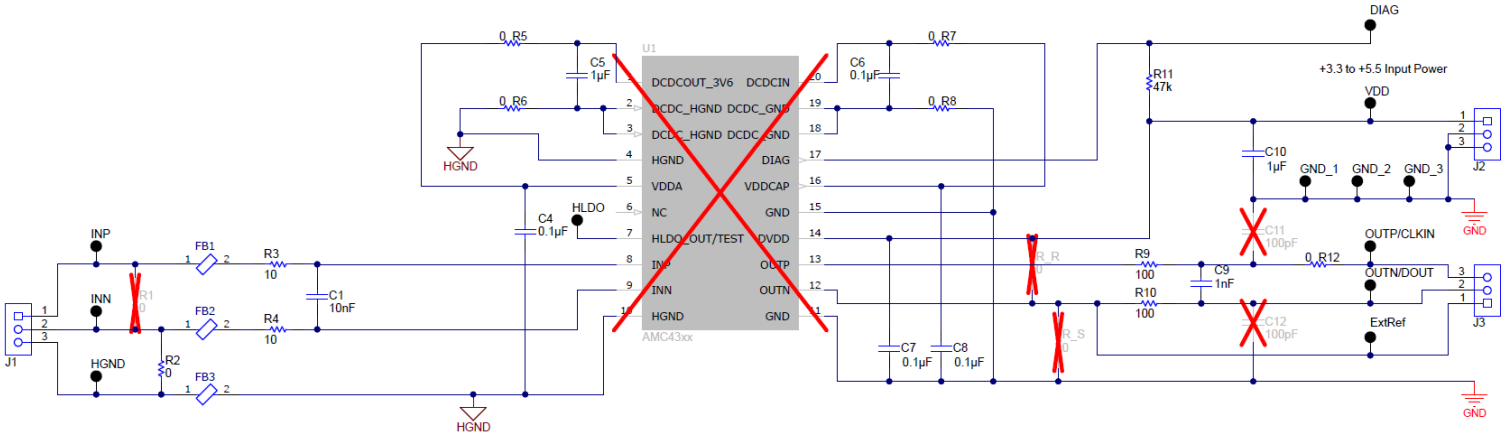


Figure 3-1. Full Schematic

3.2 PCB Layout

Figure 3-2 and Figure 3-5 show the top and bottom printed circuit board (PCB) drawings of the AMC43xxDVVEVM, respectively.

Note

Board layouts are not to scale. These layouts are intended to show how the board is laid out, and are not intended to be used for manufacturing the AMC43xxDVVEVM PCB.

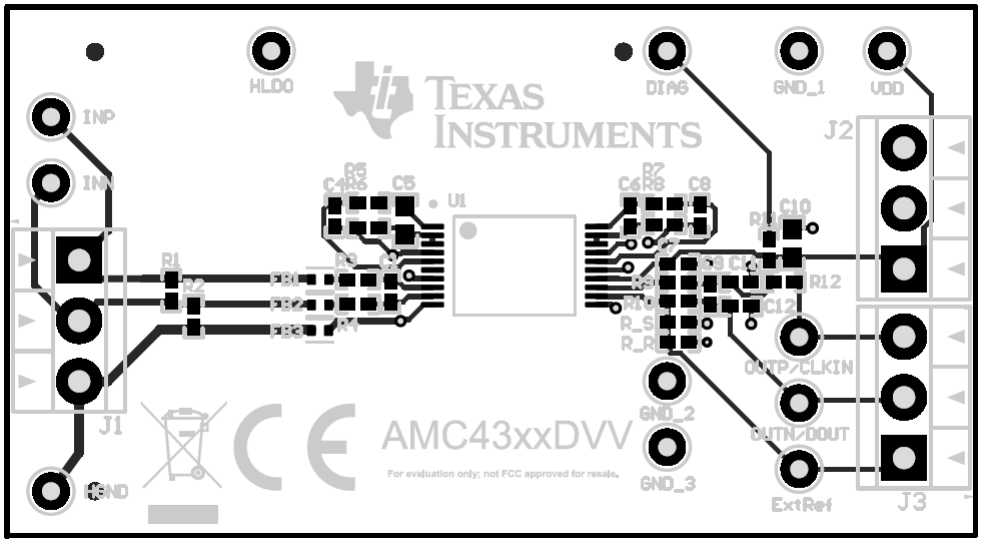


Figure 3-2. AMC43xxDVVEVM Top PCB Drawing

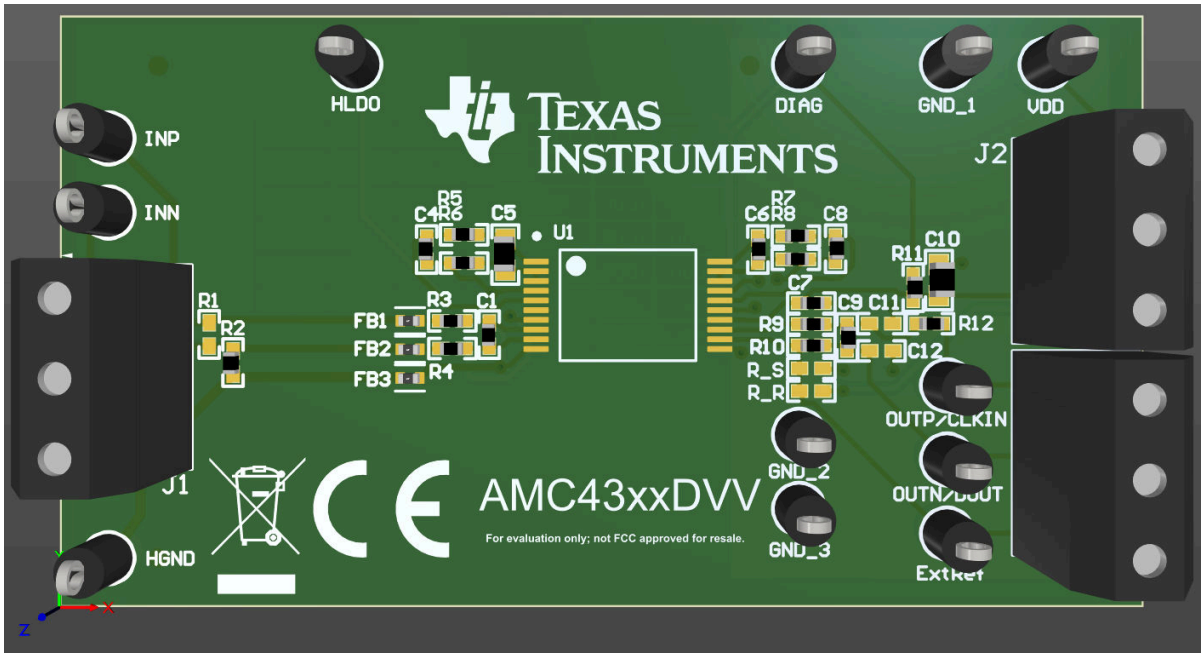


Figure 3-3. AMC43xxDVVEVM Top 3D PCB Drawing

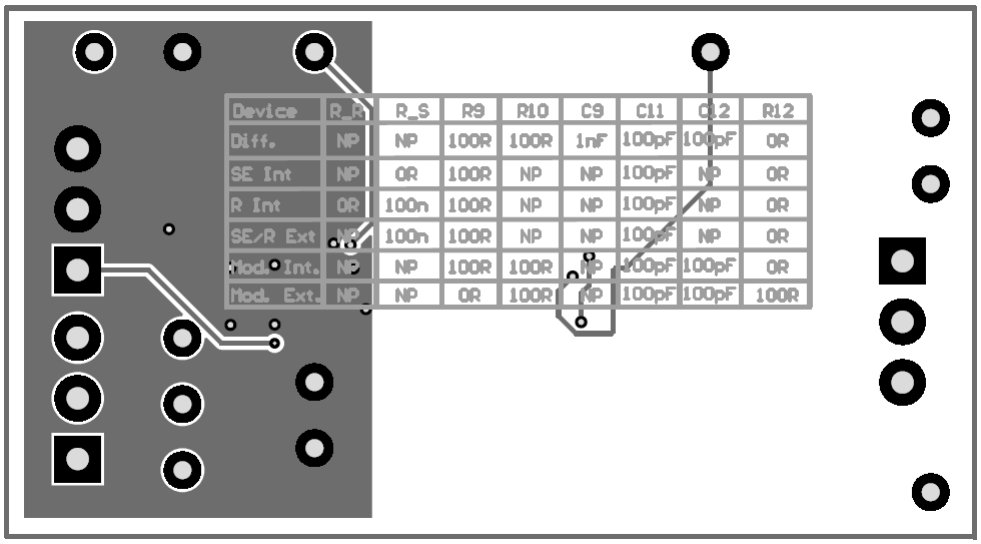


Figure 3-4. AMC43xxDVVEVM Top PCB Drawing

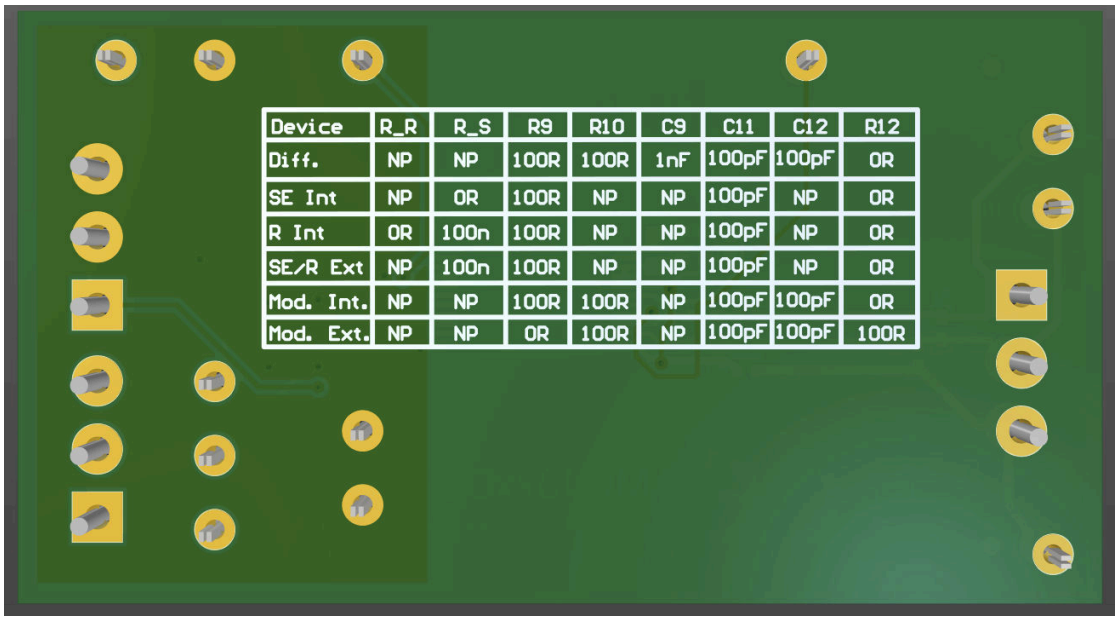


Figure 3-5. AMC43xxDVVEVM Bottom 3D PCB Drawing

3.3 Bill of Materials

The AMC43xxDVVEVM bill of materials (BOM) is shown in Table 3-1.

Table 3-1. Bill of Materials

Designator	Description	Manufacturer
C1	CAP, CERM, 0.01uF, 16V, +/- 10%, X7R, 0402	Wurth Elektronik
C4, C6, C7, C8	CAP, CERM, 0.1 µF, 16V,+/- 5%, X7R, AEC-Q200 Grade 1, 0402	MuRata
C5, C10	CAP, CERM, 1 µF, 16V,+/- 10%, X5R, 0603	AVX
C9	CAP, CERM, 1000pF, 16V,+/- 10%, X7R, AEC-Q200 Grade 1, 0402	Yageo
DIAG, ExtRef, GND_1, GND_2, GND_3, HGND, VDDA2, INN, INP, OUTN/DOUT, OUTP/CLKIN, VDD	Test Point, Miniature, Black, TH	Keystone Electronics
FB1, FB2, FB3	1.8 kOhms @ 100MHz 1 Power, Signal Line Ferrite Bead 0402 (1005 Metric) 210mA 2.1Ohm	Wurth Electronics
J1, J2, J3	Terminal Block, 3.5mm Pitch, 3x1, TH	On-Shore Technology
R2, R5, R6, R7, R8, R12	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	Vishay-Dale
R3, R4	RES, 10, 5%, 0.063W, AEC-Q200 Grade 0, 0402	Vishay-Dale
R9, R10	RES, 100, 1%, 0.063W, AEC-Q200 Grade 0, 0402	Stackpole Electronics Inc
R11	RES, 47k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	Vishay-Dale

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 Related Documentation

To obtain a copy of any of the following TI documents, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, please identify this document by the title and literature number. Updated documents can also be obtained through our website at www.ti.com.

- An Engineer's Guide to Isolated Signal Chain Solutions ebook
- Comparing Isolated Amplifiers and Isolated Modulators application note
- Isolated Amplifiers page
- Isolated ADCspage

Table 5-1. Related Devices

Devices	Input Type	Output Type	Documentation
AMC4330D	Bipolar (AC)	Differential	SLVSLH4
AMC4330R	Bipolar (AC)	Ratiometric	SLVSLH5
AMC4311D	Unipolar (DC)	Differential	SBASB87
AMC4311R	Unipolar (DC)	Ratiometric	SLVSLG2
AMC4336	Bipolar (DC)	Modulator	SLVSJL8

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 DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 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/lsds/ti_ja/general/eStore/notice_02.page

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

3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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

6. *Disclaimers:*

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

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

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

8. *Limitations on Damages and Liability:*

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

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

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

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

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