EVM User's Guide:

Universal Difference Amplifier Evaluation Module

Description

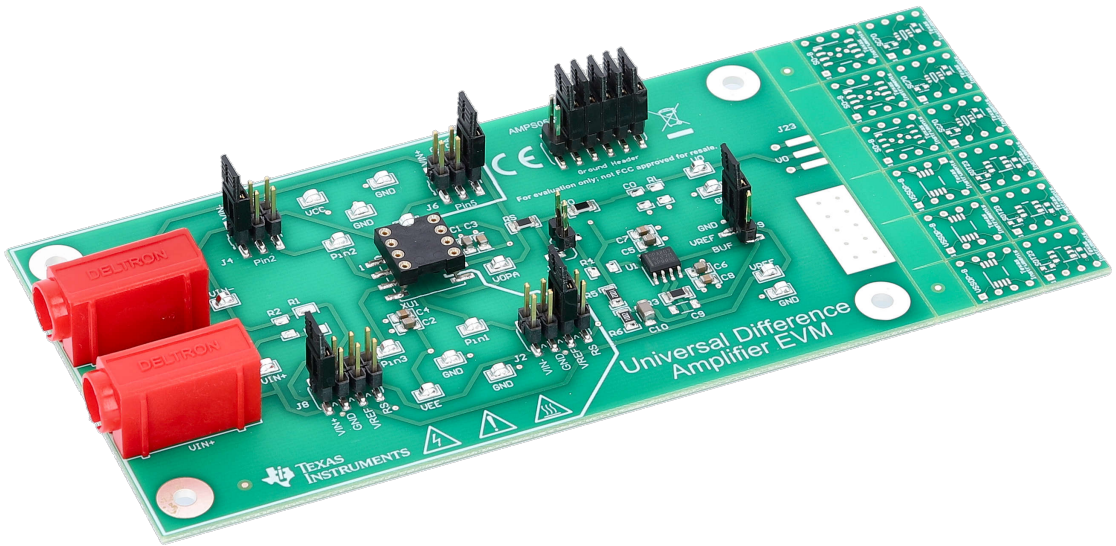
The DIFFAMP-EVM allows for the end user to quickly evaluate multiple difference amplifiers in a variety of packages. With support for a variety of configurations, this module can be tailored towards your desired application for a reliable evaluation. A DIP adapter section is provided to enable evaluation regardless of the IC package.

Get Started

1. Order the EVM.
2. Download the comprehensive reference design files.
3. Order samples of the difference amplifier you wish to evaluate.
4. Follow the instructions in the users guide for use with your difference amplifier

Features

- Intuitive jumper configuration as difference amplifier, precision gain amplifier, or current source
- Socketed IC connection for multi-package evaluation and easy comparison between devices
- 12 DIP adapter boards supporting SOIC, MSOP, SOT23-6 and SOT-SC70-6 packages
- Onboard reference buffer for single supply operation



1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics and operation of the universal difference amplifier evaluation module (EVM) that is compatible with all standard pinout difference amplifiers. The EVM is designed to evaluate the performance of these devices in a variety of common configurations and supports both single and dual-supply operation. The amplifier interfaces with the board through a DIP socket, allowing evaluation of any amplifier package with a DIP adapter board. A breakaway DIP adapter section is included to accommodate SOIC-8, VSSOP-8, SOT23-6, and SOT-SC70-6 style packages. This document includes the schematic, printed circuit board (PCB) layouts, and BOM. Throughout this document the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the Universal Diff-Amp EVM. Note this EVM is not compatible with fully differential amplifiers.

1.2 General Texas Instruments High Voltage Evaluation (TI HV EMV) User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help verify your personal safety and those working around you. Contact TI's Product Information Center http://ti.com/customer support for further information.

Save all warnings and instructions for future reference.

> **WARNING**
> Failure to follow warnings and instructions can result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitably qualified, then you need to immediately stop from further use of the HV EVM.

1. Work Area Safety:
   a. Keep work area clean and orderly.
   b. Qualified observers must be present anytime circuits are energized.
   c. Effective barriers and signage must be present in the area where the TI HV EVM and the interface electronics are energized, indicating operation of accessible high voltages can be present, for the purpose of protecting inadvertent access.
   d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
   e. Use stable and non-conductive work surface.
   f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. Electrical Safety:
   a. As a precautionary measure, a good engineering practice to assume is that the entire EVM can have fully accessible and active high voltages.
   b. De-energize the TI HV EVM and all the inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   c. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   d. Once EVM readiness is complete, energize the EVM as intended.

   > **WARNING**
   > While the EVM is energized, never touch the EVM or the electrical circuits, as the electrical circuits and EVM can be at high voltages capable of causing electrical shock hazard.
3. Personal Safety
   a. Wear personal protective equipment that is, latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

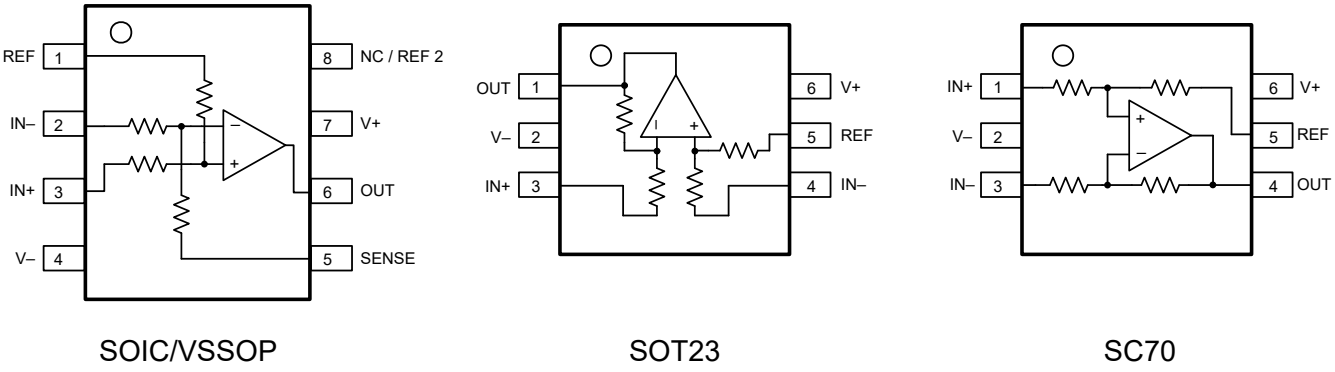
1.3 Features

This EVM is intended to provide basic functional evaluation of the amplifiers shown in Table 1-1 with the pinout shown in Figure 1-1. The EVM provides the following features:

- Breakaway DIP adapter boards for evaluation of multiple packages and easy comparison of devices
- Intuitive layout for setting jumpers
- Easy access to nodes with surface-mount test points
- Reference voltage source flexibility
- Support for a variety of configurations as a diff amp, current source, or precision inverting/non-inverting amplifier

1.4 Diff-amp Pinout

This EVM is intended to evaluate diff-amps that have the pinouts shown in Figure 1-1. Pin 8 of SOIC-8 and VSSOP-8 packages is normally a no connect pin, but some devices provide an additional reference input at this pin. Pin 8 is tied to ground on the EVM, so these devices can also be tested but an additional reference is not supported. To evaluate an amplifier with a pinout different than that in Figure 1-1 then a custom DIP adapter board is required.



SOIC/VSSOP SOT23 SC70

Figure 1-1. Supported Difference Amplifier Pinouts

1.5 Compatible Devices

Devices that are compatible with this EVMs are shown in Table 1-1.

Table 1-1. Compatible Devices

Device	Description
INA600	Small-size, high input impedance fixed-gain difference amplifier
INA500	Small-size, low voltage, high input impedance fixed-gain difference amplifier
INA592	Wide Bandwidth, e-Trim Difference Amplifiers
INA597	Wide Bandwidth, e-Trim Difference Amplifiers
INA105	Precision Unity Gain Differential Amplifier
INA106	Precision Gain = 10 Differential Amplifier
INA132	Low Power, Single-Supply Difference Amplifier
INA133	High-Speed, Precision Difference Amplifier
INA134	Audio Differential Line Receivers, 0dB (G=1)
INA137	Audio Differential Line Receivers, +-6dB (G=1/2 or 2)
INA143	High-Speed, Precision, G = 10 or G = 0.1 Difference Amplifier
INA152	Single-Supply Difference Amplifier
INA154	High-Speed, Precision Difference Amplifier (G = 1)
INA157	High-Speed, Precision Difference Amplifier
INA159	High-Speed, Precision Gain of 0.2 Level Translation Difference Amplifier

2 Hardware

2.1 Power

Power is applied to the device with test points VCC and VEE. These test points power both the socketed diff-amp and the onboard reference amplifier. The board is initially populated at U1 with an OPA207 as the reference amplifier, but if a different device is used then take care that the new device can operate with the same supply as the diff-amp.

2.2 Inputs

Inputs are applied to the device using test points VIN+ and VIN-. Alternately, inputs can be applied at the high-voltage banana jacks J3 and J5. This is recommended if high currents are expected to flow through the input, and required for use with high voltage inputs. This board was designed with clearance rules for ±125V signals on the input pins. Two footprints are provided at the input for shunt resistors R1 and R2 if the user needs to test an amplifier for a current sense application.

2.3 Output

The output of the circuit can be accessed through test point VO or by adding an SMA connector at J23.

2.3.1 Output Filtering

RO and CO provide the ability to apply a single-pole RC output filter. Take care not to overload the output with excess capacitance, as this can lead to stability issues. Use Equation 1 to calculate the cutoff frequency of the output filter:

$$f_{c\text{-}o} = \frac{1}{2\pi \times RO \times CO} \quad (1)$$

2.4 Reference

There are multiple methods of applying a reference voltage to the device. The reference voltage is set by J9, which either connects the reference to ground or ties the reference to the output of the reference buffer. The reference buffer is initially configured to generate a rail at mid-supply for single supply operation. Alternatively, this jumper can be left unconnected and the desired voltage can be applied directly to the VREF test point. It is also possible to connect J7 and configure the reference buffer as an integrator to ac couple the output as shown in Figure 2-3.

2.5 Miscellaneous

C1, C2, C3, and C4 are the supply bypass capacitors for the device and are pre-populated with 0.1 µF and 0.01µF capacitors that usually provide adequate power supply bypassing for U1. Refer to the difference amplifier data sheet for further information. Similarly, C5, C6, C7, and C8 provide supply bypassing for U2. Refer to the buffer amplifier data sheet for further information.

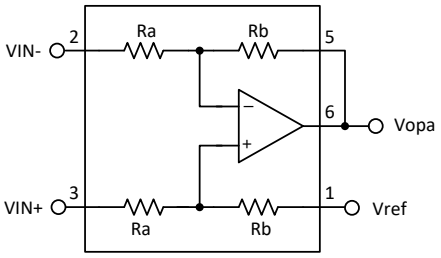
2.6 Configurations

2.6.1 Difference Amplifiers (SOIC-8 and VSSOP-8)

This EVM allows for many jumper-selectable configurations. Pins 1, 2, 3, and 5 of the amplifier are routed to headers that allow the user to define what connections are made to the internal resistors. Note it is always necessary for either pin 2 or pin 5 to route to the output to ensure closed loop operation with negative feedback. Figure 2-1 shows several ways to configure the jumpers and the associated transfer function. The exact gain depends on the ratio of resistors used in the selected difference amplifier. If the resistors in the difference amplifier are not all equal, then reciprocal gains can be achieved in each configuration as shown in the top two figures.

Precision Diff-Amp

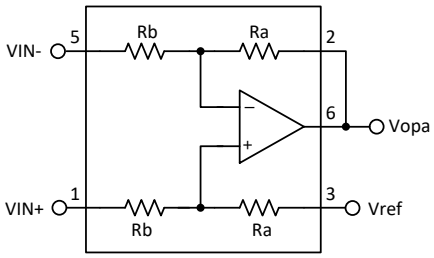
Pin1 (J2) – Vref
Pin2 (J4) – VIN-
Pin3 (J8) – VIN+
Pin5 (J6) - Vopa



$$Vopa = \left(\frac{Rb}{Ra}\right) * \left(V_{IN+} - V_{IN-}\right) + V_{REF}$$

Precision Diff-Amp
(Reciprocal Gain)

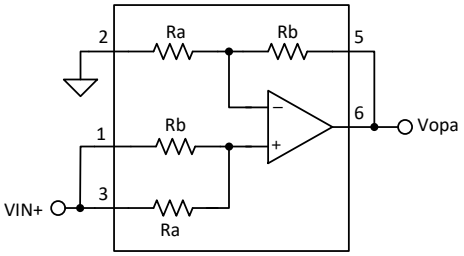
Pin1 (J2) – VIN+
Pin2 (J4) – Vopa
Pin3 (J8) – Vref
Pin5 (J6) – VIN-



$$Vopa = \left(\frac{Ra}{Rb}\right) * \left(V_{IN+} - V_{IN-}\right) + V_{REF}$$

Precision Non-inverting Amplifier

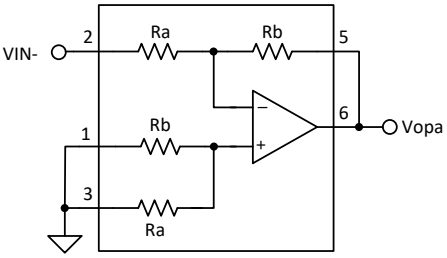
Pin1 (J2) – VIN+
Pin2 (J4) – GND
Pin3 (J8) – VIN+
Pin5 (J6) – Vopa



$$Vopa = \left(1 + \frac{Rb}{Ra}\right) * V_{IN+}$$

Precision Inverting Amplifier

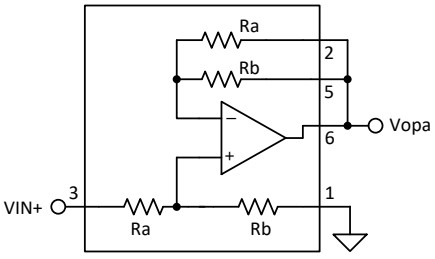
Pin1 (J2) – GND
Pin2 (J4) – VIN-
Pin3 (J8) – GND
Pin5 (J6) – Vopa



$$Vopa = \left(-\frac{Rb}{Ra}\right) * V_{IN-}$$

Precision Divider

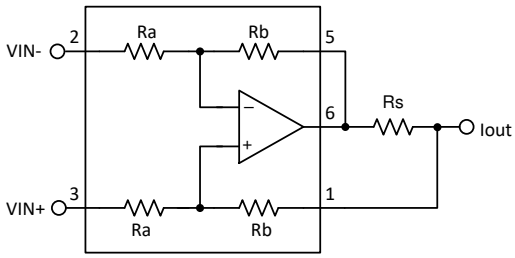
Pin1 (J2) – Vref
Pin2 (J4) – VIN-
Pin3 (J8) – VIN+
Pin5 (J6) – Vout



$$Vopa = \left(\frac{Rb}{Rb + Ra}\right) * V_{IN+}$$

Improved Howland
Current Source

Pin1 (J2) – RS
Pin2 (J4) – VIN-
Pin3 (J8) – VIN+
Pin5 (J6) – Vout



$$Iout \approx \frac{\left(\frac{Rb}{Ra}\right) * \left(V_{IN+} - V_{IN-}\right)}{Rs}$$

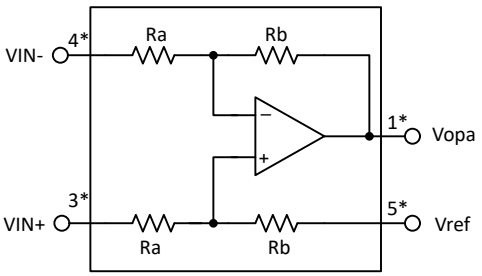
Figure 2-1. Common Difference Amplifier Configurations

2.6.2 Difference Amplifiers (SOT23 and SOT-SC70)

This board supports the usage of smaller SOT23 and SOT-SC70 package difference amplifiers with associated DIP adapter boards. "SOT23 and SOT-SC70 Difference Amplifier Configurations" Figure 2-2 shows how to configure the jumpers and the associated transfer function. The exact gain depends on the ratio of resistors used in the selected difference amplifier.

SOT23 Diff-Amp

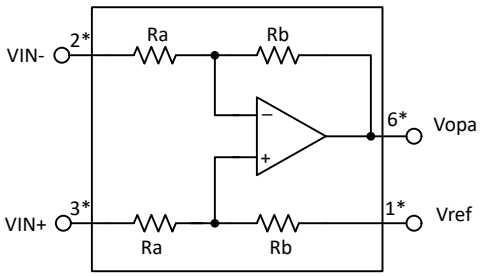
Pin1 (J2) – Vref
Pin2 (J4) – VIN-
Pin3 (J8) – VOPA
Pin5 (J6) – VIN+



$$V_{OPA} = \left(\frac{R_b}{R_a}\right) * (V_{IN+} - V_{IN-}) + V_{REF}$$

SC70 Diff-Amp

Pin1 (J2) – Vref
Pin2 (J4) – VIN-
Pin3 (J8) – VIN+
Pin5 (J6) – NC



$$V_{OPA} = \left(\frac{R_b}{R_a}\right) * (V_{IN+} - V_{IN-}) + V_{REF}$$

Figure 2-2. SOT23 and SOT-SC70 Difference Amplifier Configurations

2.6.3 Reference Amplifier

An onboard amplifier provides flexibility in reference configuration. In the default configuration the amplifier operates as a supply splitter, dividing the positive supply voltage in half and buffering the voltage for single supply operation.

2.6.3.1 Buffered Reference Voltage Connection

A buffered-reference configuration is useful when the source impedance is high (for example, a voltage divider). Buffering a high-impedance source with an operational amplifier provides a low-impedance source and preserves common-mode rejection. The reference amplifier voltage is derived from the positive power supply and can be adjusted by changing the R5 and R6.

2.6.3.2 AC Coupled Output

It is possible to generate an ac coupled output by feeding the output of the diff-amp through an integrator and back to the reference pin. The output of the integrator drives the reference such that the dc voltage at the output of the diff-amp matches the voltage applied to the non-inverting terminal of the reference amplifier. R5 can be removed if the user desires to ground the input of the amplifier in dual supply operation. The cutoff frequency is set by the RC time constant of the integrator. This is sometimes preferable to using ac coupling capacitors at the input because capacitors tend to have wide tolerance ranges and mismatch in these capacitors can degrade the common-mode rejection of the amplifier. This can be implemented by placing a jumper on J7, removing R3, and populating R4 and C9 as shown in Figure 2-3.

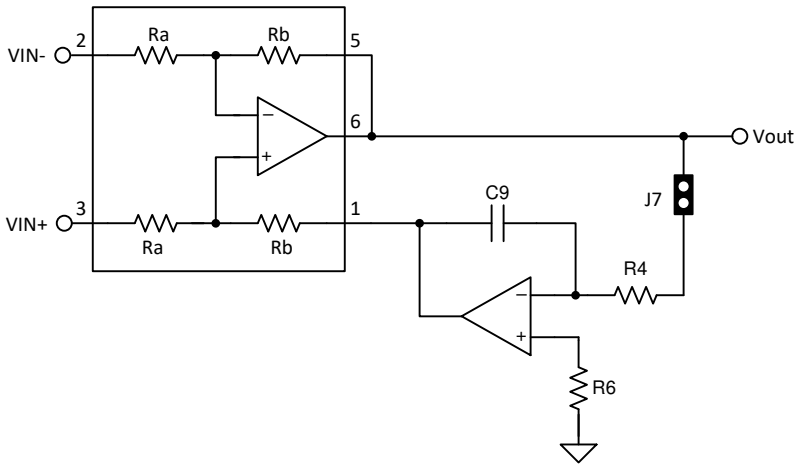


Figure 2-3. AC Coupling with Output Integrator

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the schematic for the PCB.

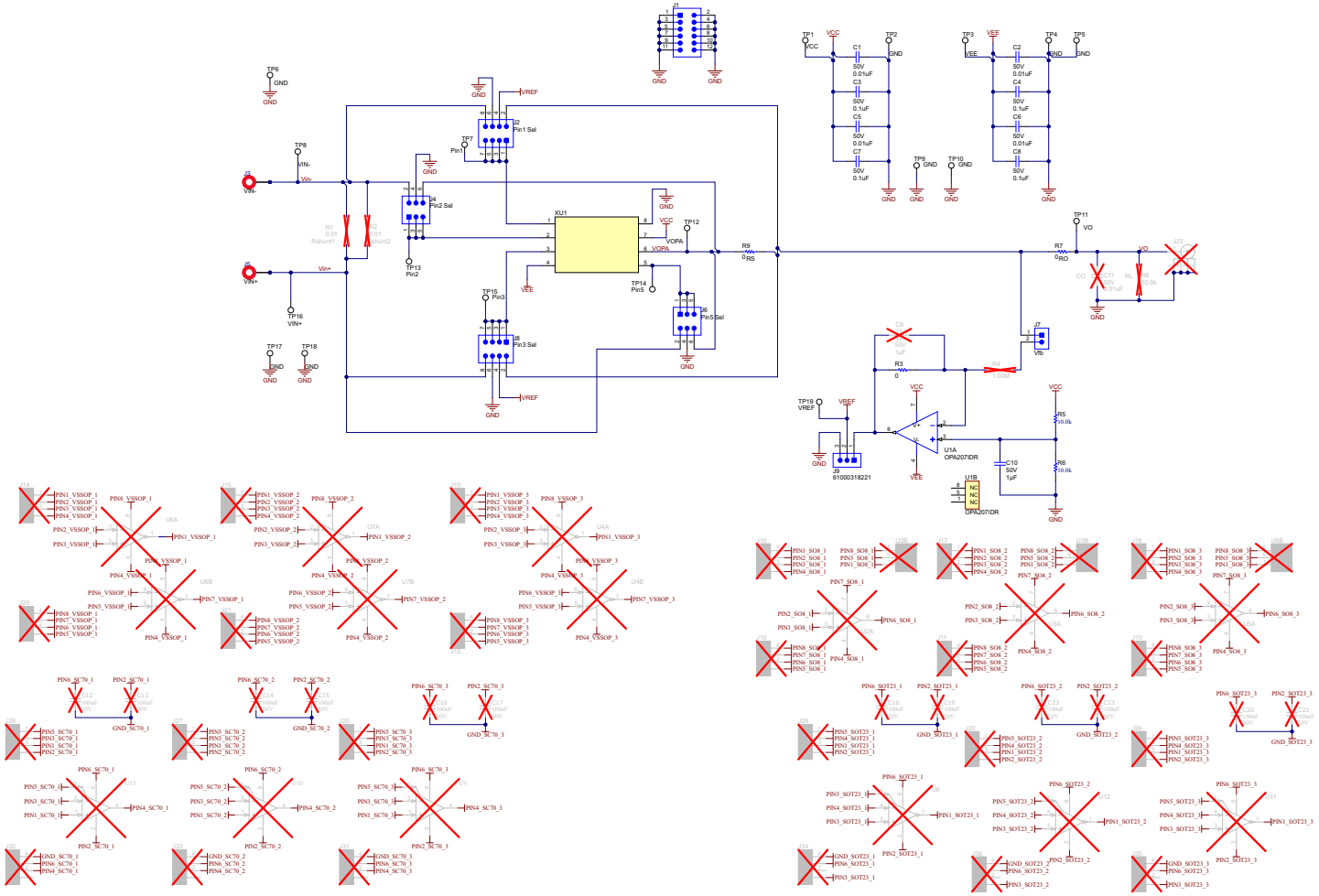


Figure 3-1. DIFFAMP-EVM Schematic

3.2 PCB Layout

The top and bottom sides of the EVM are shown in Figure 3-2 and Figure 3-3, respectively.

Note

Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing PCBs.

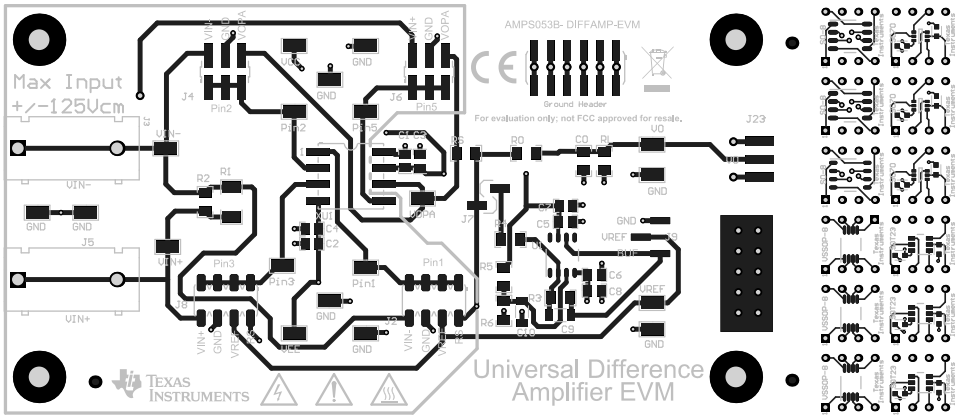


Figure 3-2. DIFFAMP-EVM Top Side

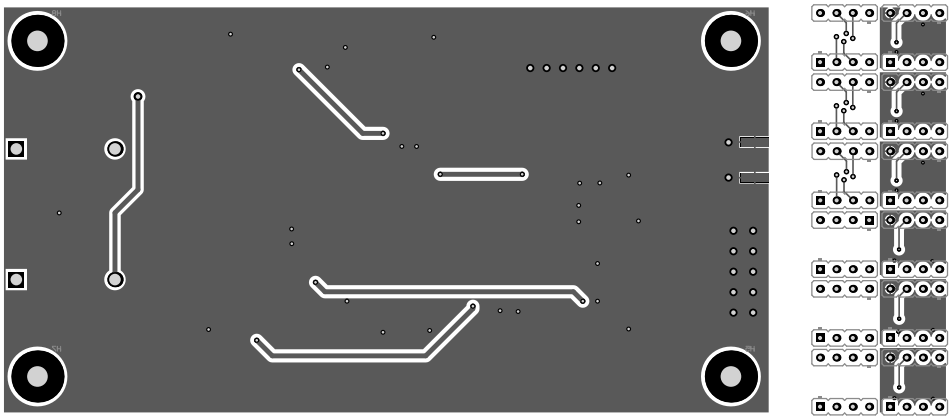


Figure 3-3. DIFFAMP-EVM Bottom Side

3.3 Bill of Materials (BOM)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C1, C2, C5, C6	4	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	805	C0805C103K5RACTU	Kemet
C3, C4, C7, C8	4	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	805	C0805C104K5RACTU	Kemet
C10	1	1uF	CAP, CERM, 1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	UMK316B7105KLHT	Taiyo Yuden
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
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, 1"L #4-40 Nylon	Standoff	1902E	Keystone
J1	1		Header, 2.54mm, 6x2, Gold, SMT	Header, 2.54mm, 6x2, Gold, TH	61031221121	Wurth Elektronik
J2, J8	2		Header, 2.54mm, 4x2, Gold, SMT	Header, 2.54mm, 4x2, SMT	95278-801A08LF	FCI
J3, J5	2		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J4, J6	2		Header, 2.54mm, 3x2, Gold, SMT	Header, 2.54mm, 3x2, SMT	TSM-103-01-L-DV	Samtec
J7	1		Header, 2.54 mm, 2x1, Gold, R/A, SMT	Header, 2.54 mm, 2x1, R/A, SMT	878980204	Molex
J9	1		Header, 2.54mm, 3x1, Gold, SMT	Header, 2.54mm, 3x1, SMT	61000318221	Wurth Elektronik
R3, R7, R9	3	0	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12060000Z0EA	Vishay-Dale
R5, R6	2	10.0k	RES, 10.0 k, 1%, 0.25 W, 1206	1206	RC1206FR-0710KL	Yageo America

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19	19		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
U1	1		High Precision, Low Noise, Low Power Operational Amplifier, D0008A (SOIC-8)	D0008A	OPA207IDR	Texas Instruments
XU1	1		Socket, DIP-8, 2.54 mm Pitch, SMT	Socket, DIP-8, 2.54 mm Pitch	110-87-308-41-105191	Preci-Dip
C9	0	1uF	CAP, CERM, 1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	UMK316B7105KLHT	Taiyo Yuden
C11	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 1206	1206	C1206C103K5RACTU	Kemet
C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23	0	100nF	0.1 µF ±10% 50V Ceramic Capacitor X7R 0603 (1608 Metric)	603	KGF15AR71H104KT	KYOCERA AVX
J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J25, J26, J27, J28, J29, J30, J31, J32, J33, J34, J35, J36	0		Header, 2.54mm, 4x1, Gold, Black, TH	Header, 2.54mm, 4x1, TH	TS-104-G-AA	Samtec
J23	0		SMA(F) Jack, 50 Ohm, SMT	SMA(F) Jack, SMT	EMPCB.SMAFSTJ.B.HT	Taoglas Antenna Solutions
R1	0	0.01	RES, 0.01, 1%, 1 W, 2010	2010	PMR50HZPFU10L0	Rohm
R2	0	0.01	RES, 0.01, 1%, 0.5 W, 1206	1206	CSR1206FK10L0	Stackpole Electronics Inc
R4	0	1.00Meg	RES, 1.00 M, 1%, 0.25 W, 1206	1206	MCR18EZHF1004	Rohm

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R8	0	10.0k	RES, 10.0 k, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8ENF1002V	Panasonic

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

4.2 Related Documentation

For related documentation, see the following:

- Texas Instruments, *OPA207 Low-Power, High-Precision, Low-Noise, Rail-to-Rail Output Operational Amplifier* data sheet

5 Revision History

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

Changes from Revision * (October 2018) to Revision A (July 2025)	Page
• Added the *Features*, *Evaluation Module Overview*, *Hardware*, *Hardware Design Files*, and *Additional Information* sections	1
• Added SOT23-6, and SOT-SC70-6 style packages to the *Introduction*	2
• Added the *High Voltage* warnings	3
• Updated the *Diff-amp Pinout* section	4
• Updated the *Inputs* section	5

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.

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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。

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。

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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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