EVM User's Guide: RES60EVM

RES60 Evaluation Module

Description

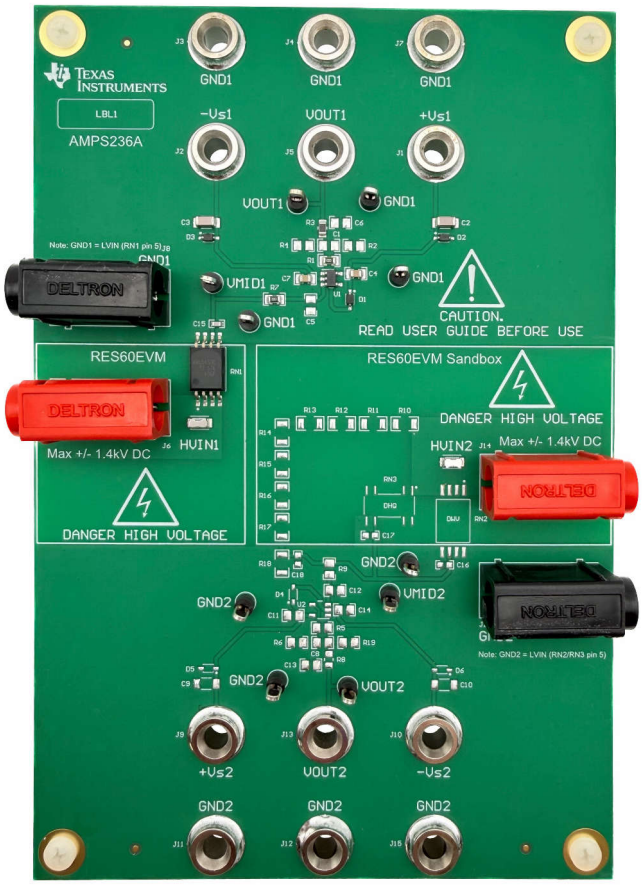
The RES60 evaluation module (EVM) is designed to help users easily evaluate and test the operation and functionality of the RES60 device. The EVM is configured as resistor divider followed by an operational amplifier buffer. The EVM operates on a split-supply from ±0.9V to ±2.75V. The default configuration of the EVM uses a resistor divider of 500:1.

Features

- Banana connections for input and output
- Convenient test points to all pertinent nodes
- Supports various RES60 ratios
- Additional blank sandbox circuit available for flexible configurations

Applications

- High-voltage bus and battery voltage monitoring
  - HEV/EV Battery Management System (BMS)
  - HEV/EV DC/DC converter
  - HEV/EV Onboard Charger (OBC)
  - HEV/EV inverter and motor control
- Non-isolated, same-ground, always-on dividers
- Discrete difference amplifiers with high CMRR



1 Evaluation Module Overview

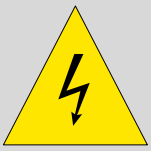
1.1 Introduction

The RES60A-Q1 is a matched resistive divider, implemented in thin-film SiCr with Texas Instruments' modern, high-performance, analog wafer process. A high quality SiO_2 insulative layer encapsulates the resistors and enables usage at extremely high voltages, up to 1400VDC for sustained operation or 4000VDC for HiPOT testing (60s). The device has a nominal high-side resistance of R_{HV} = 12.5MΩ, and is available in several nominal ratios to meet a wide array of system needs.

This user's guide describes the characteristics, operation, performance, and use of the Texas Instruments' RES60 evaluation module. This user's guide contains information and support documentation for the RES60A-Q1 evaluation module. Included are the circuit description, schematic, and bill of materials of the RES60EVM. Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the RES60EVM.

CAUTION

Do not leave EVM powered when unattended.



HIGH VOLTAGE: Electric shock is possible when connecting the board to live wire. The board must be handled with care by a professional. For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.

1.2 Kit Contents

The contents of the EVM kit are detailed in Table 1-1. Contact the nearest TI Product Information Center if any component is missing.

Table 1-1. Contents of RES60EVM Kit

Item	Quantity
RES60EVM evaluation board PCB	1

1.3 Specification

The RES60EVM operates on a total power supply voltage from 1.8V to 5.5V for a single supply configuration or ±0.9V to ±2.75V on a split-supply configuration. The power supply is limited to the OPA320-Q1 supply voltage on the RES60EVM. The banana connectors labeled $+V_{S1}$ and $–V_{S1}$ supply power to the OPA320-Q1 device.

1.4 Device Information

The RES60EVM provides a basic functional evaluation of the RES60A-Q1 device. For typical applications, see the *RES60A-Q1 Automotive, 1400V, Precision Resistive Divider* data sheet.

1.5 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within the 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 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, you should 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 is to assume 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 EVM or electrical circuits can be at high voltages capable of causing electrical shock hazard.
3. Personal Safety
   a. Wear personal protective equipment e.g. latex gloves or safety glasses with side shields or protect EVM in an adequate translucent 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.

2 Hardware

2.1 Getting Started

This section explains the connectors and test points, and details the basic EVM functionality.

2.1.1 Power Supplies

The RES60EVM operates on a total power supply voltage from 1.8V to 5.5V for a single supply configuration or ±0.9V to ±2.75V on a split supply configuration. The power supply is limited to the OPA320-Q1 supply voltage on the RES60EVM. The banana connectors labeled $+V_S$, $-V_S$ and GND supply power to the OPA320-Q1 device.

2.1.2 Input

The high voltage inputs to the RES60EVM are labeled HVIN1 (J6) and GND1 (J8).

2.1.3 Output

Monitor the EVM output by using the banana connector labeled VOUT1 (J5) or the test point labeled VOUT1. Resistor R3 is used as an isolation resistor on the OPA320-Q1 output. Resistor R3 is a 49.9 ohm resistor and can be adjusted to adhere to application design requirements.

2.2 Application Circuit

The RES60A-Q1 can be used in conjunction with an automotive precision amplifier, such as the OPA320-Q1, for single-ended voltage measurement of the high side (BAT+) of an EV battery relative to a fixed potential. For systems where BAT- and GND are equivalent, refer to Figure 2-1.

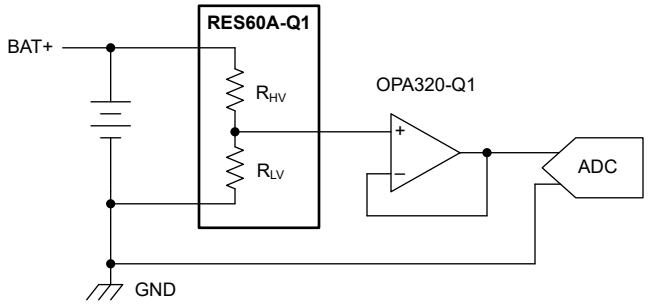


Figure 2-1. Single-ended Measurement, BAT+ to GND

2.2.1 Example Measurement

An example of a 1,000V battery measurement is shown in Figure 2-2. The EVM is populated with the RES60A500 for a nominal voltage division ratio of 501:1. Applying 1,000V across the divider results in a 1.996V potential seen at the MID pin of the RES60A-Q1, which is buffered by the OPA320-Q1, resulting in a nominal output voltage of 1.996V.

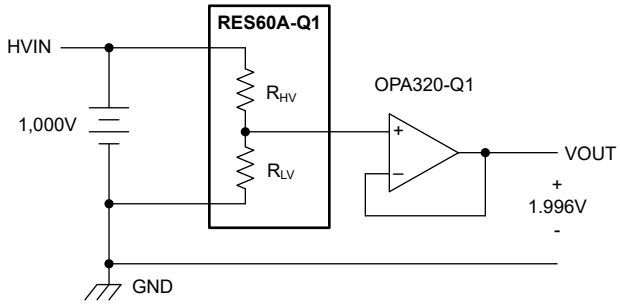


Figure 2-2. 1,000V Example Measurement

2.3 Evaluation Module Limitations

The default RES60EVM configuration operates within the specified voltage and current regions of the RES60A-Q1. User modifications can be made to the RES60EVM. Reference the respective product data sheet to maintain the specified operating conditions for the device. In addition to observing the specified current and voltage levels, use proper electrostatic discharge precautions when handling and applying the EVM.

2.4 Electrostatic Discharge Caution

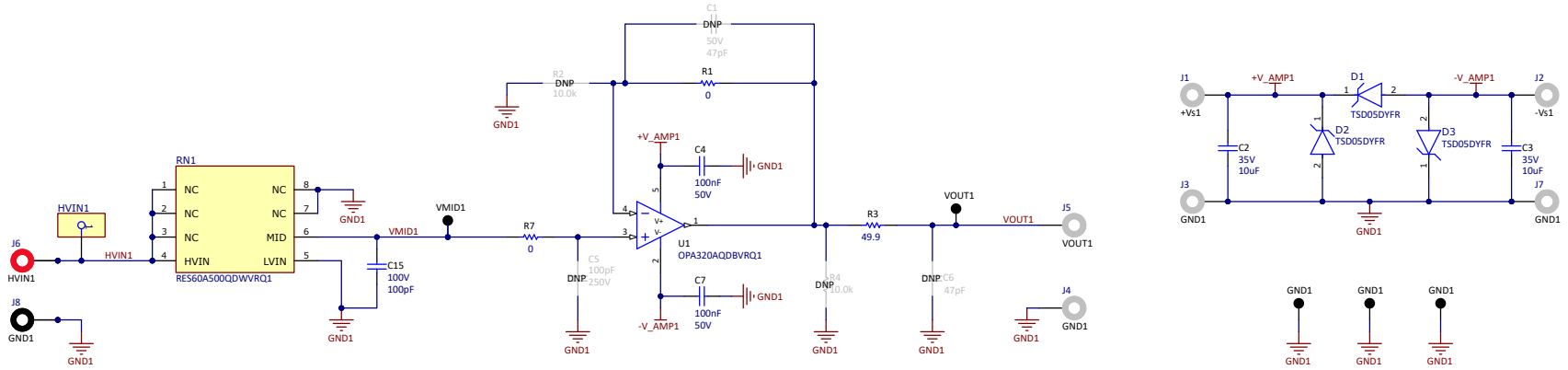
CAUTION

Many of the components on the RES60EVM are susceptible to damage by electrostatic discharge (ESD). Use proper ESD handling precautions when unpacking and handling the EVM. Failure to observe ESD handling procedures can result in damage to the EVM components.

3 Hardware Design Files

3.1 Schematics

RES60EVM



RES60EVM Sandbox

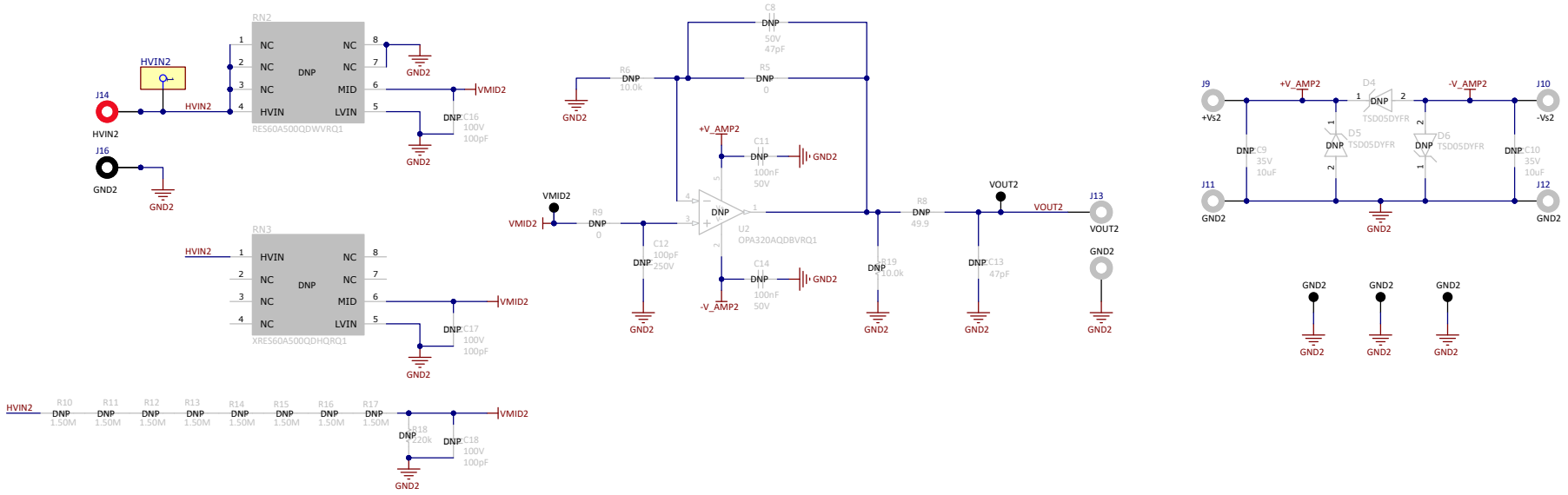


Figure 3-1. RES60EVM Schematic

3.2 PCB Layouts

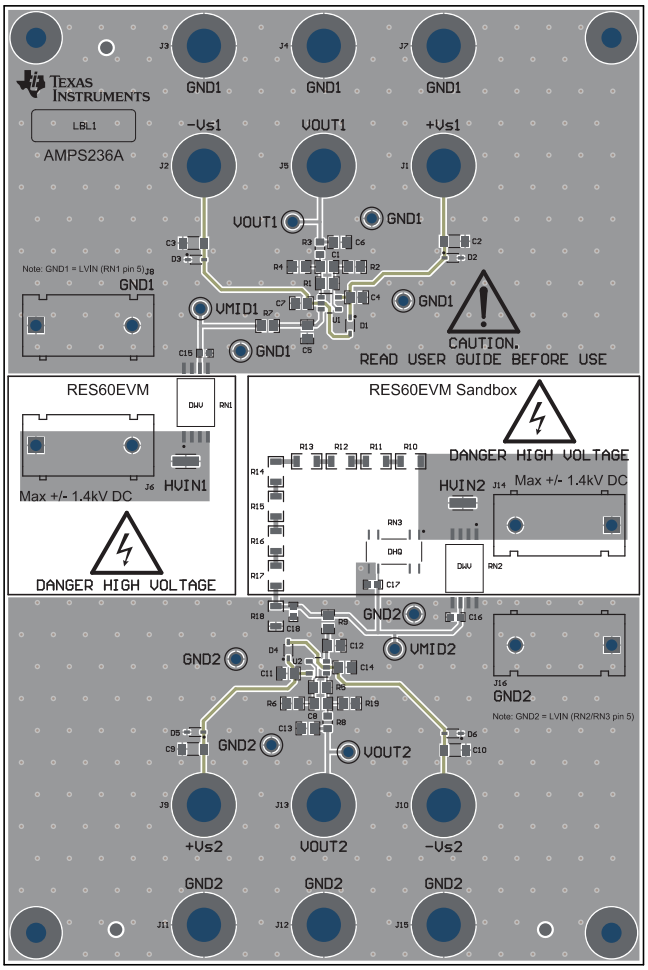


Figure 3-2. RES60EVM PCB Layout Composite (Top View)

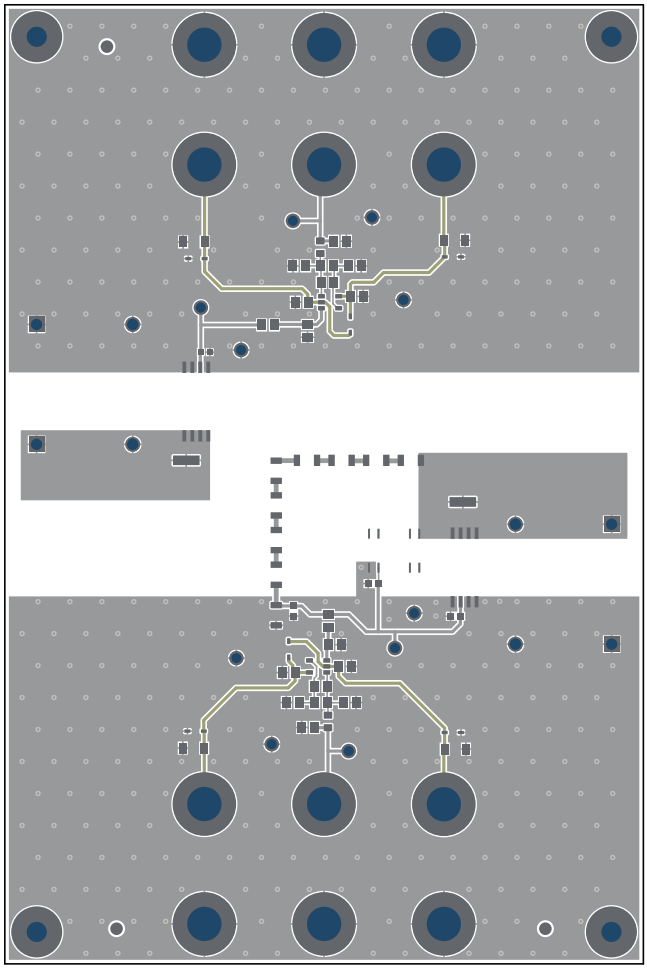


Figure 3-3. RES60EVM PCB Top Layer Mask

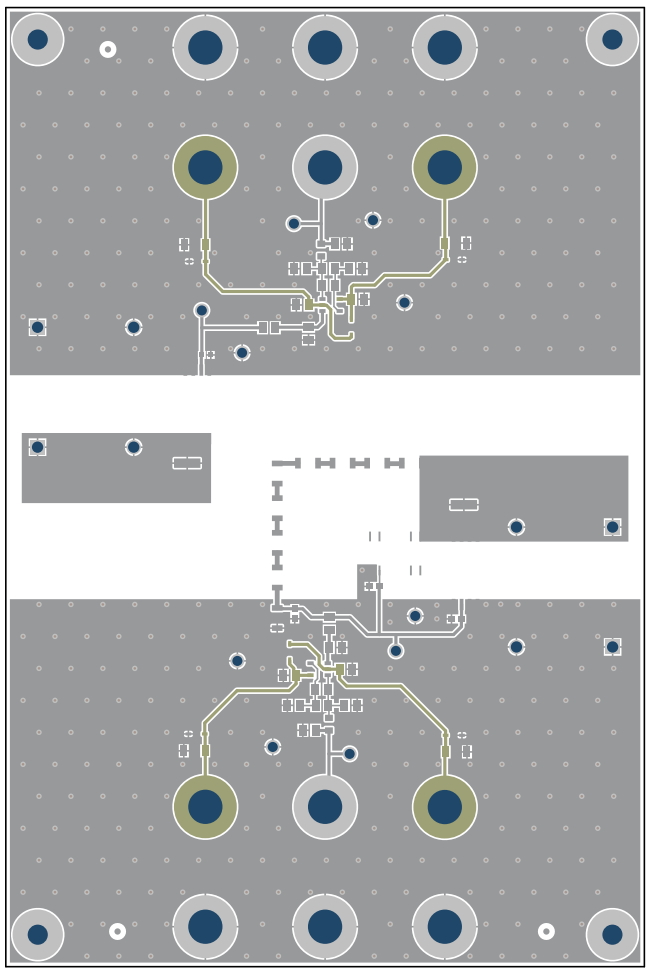


Figure 3-4. RES60EVM PCB Top Layer

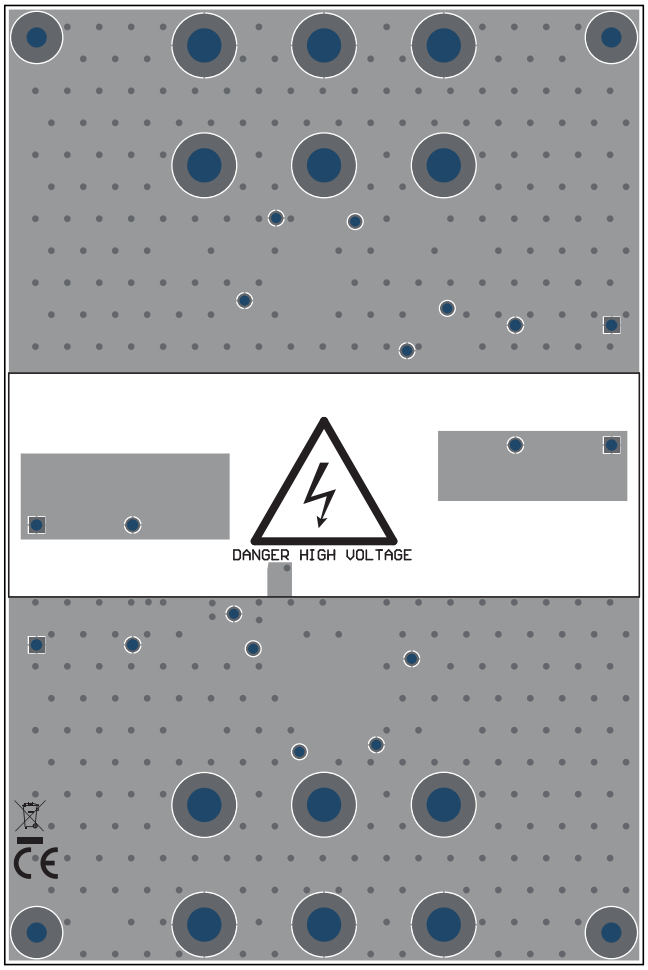


Figure 3-5. RES60EVM PCB Composite (Bottom View)

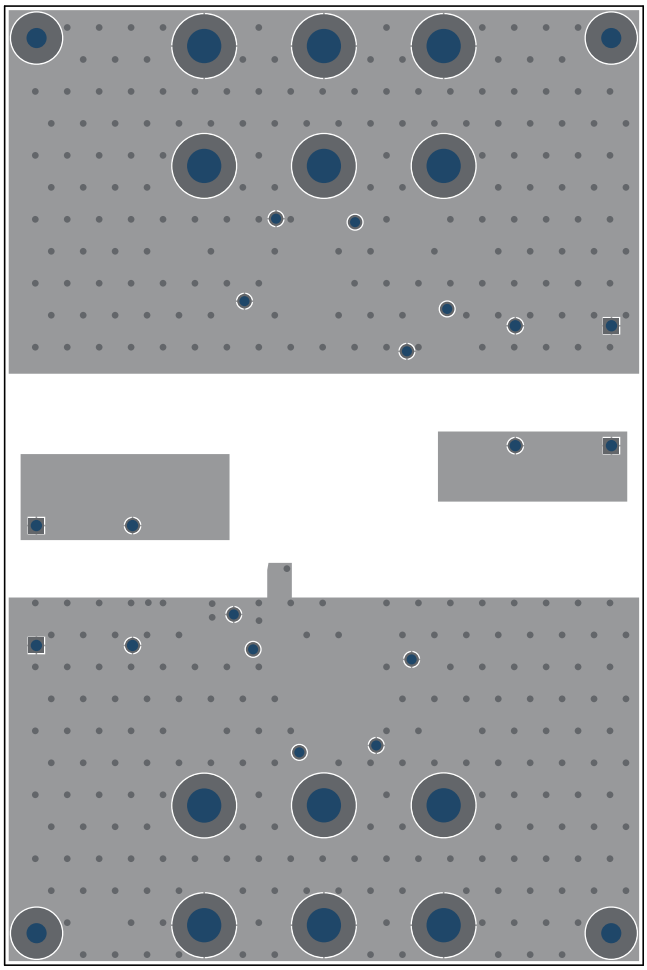


Figure 3-6. RES60EVM PCB Bottom Layer Mask

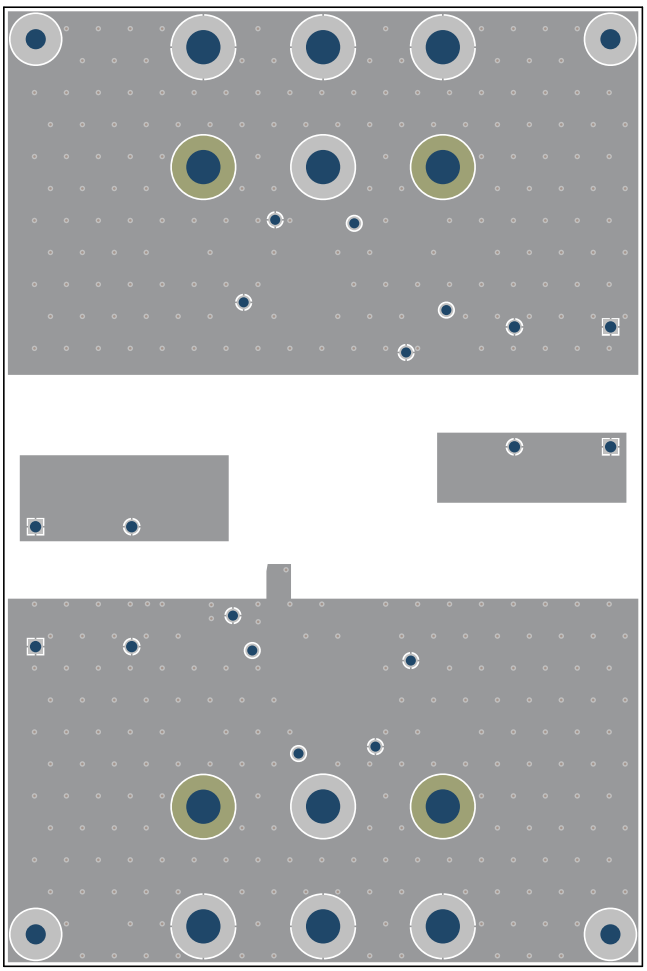


Figure 3-7. RES60EVM PCB Bottom Layer

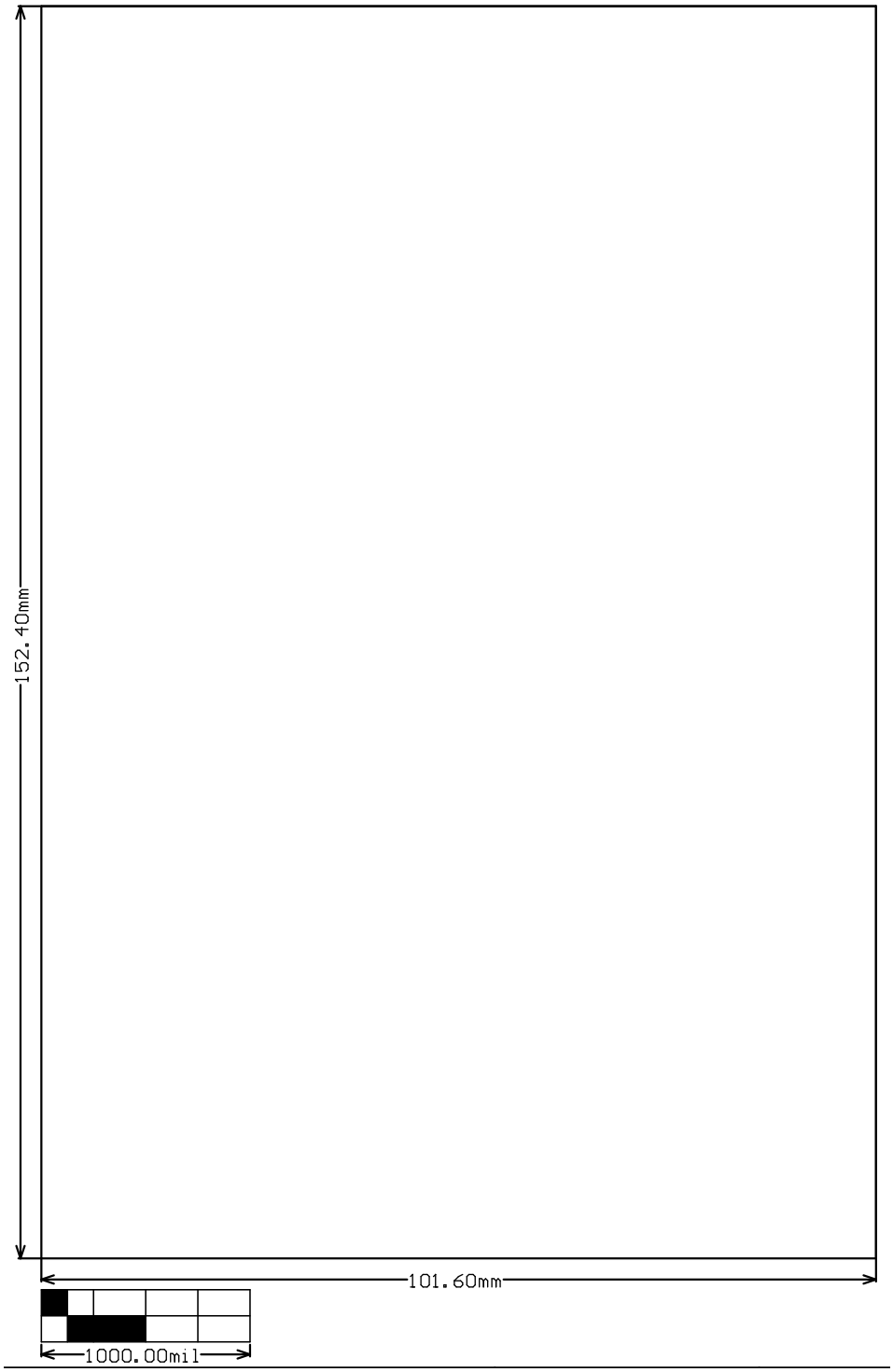


Figure 3-8. RES60EVM Board Dimensions

3.3 Bill of Materials (BOM)

Table 3-1 lists the complete bill of materials for the RES60EVM. Data for each component is available from the corresponding manufacturer website.

Table 3-1. RES60EVM BOM

Designator	Qty	Value	Description	Part Number	Package Reference	Manufacturer
C2, C3	2	10uF	CAP, CERM, 10uF, 35V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206_190	CGA5L1X7R1V106K160AC	1206_190	TDK
C4, C7	2	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0805	C0805C104K5RACTU	0805	Kemet
C15	1	100pF	CAP, CERM, 100pF, 100V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	GCM1885C2A101JA16D	0603	MuRata
D1, D2, D3	3		5V 24A surge protection device 2-SOT -40 to 125	TSD05DYFR	SOD323	Texas Instruments
H1, H2, H3, H4	4		Machine Screw, Round, #4-40x 1/4, Nylon, Philips panhead	NY PMS 440 0025PH	Screw	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Standoff	Keystone
J1, J2, J3, J4, J5, J7, J9, J10, J11, J12, J13, J15	12		Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone_575-4	Keystone
J6, J14	2		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J8, J16	2		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	PCB Label 0.650x 0.200 inch	Brady
R1, R7	2	0	RES, 0, 5%, 0.125W, AEC-Q200 Grade 0, 0805	ERJ-6GEY0R00V	0805	Panasonic
R3	1	49.9	RES, 49.9, 0.1%, 0.125W, 0805	RT0805BRD0749R9L	0805	Yageo America
RN1	1		Automotive, 1400V, Precision Resistive Divider	RES60A500QDWVRQ1	SOIC8	Texas Instruments
TP1, TP2, TP3, TP4, TP5, TP6, TP9, TP10, TP11, TP12	10		Test Point, Multipurpose, Black, TH	5011	Black Multipurpose Testpoint	Keystone Electronics
TP7, TP8	2		PC Test Point Plating Surface Mount Mounting Type	RCWCTE	SMT_TP	KOA Speer
U1	1		Automotive Qualified Precision, Zero-Crossover, 20MHz, 0.9pA Ib, RRIO, CMOS Operational Amplifier, DBV0005A (SOT-23-5)	OPA320AQDBVRQ1	DBV0005A	Texas Instruments

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 Related Documentation

Table 5-1 lists the documents that provide information about TI's integrated circuits and support tools for the RES60EVM.

Table 5-1. Related Documentation

Document	Literature Number
RES60A-Q1 product data sheet	SLPS764
OPA320-Q1 product data sheet	SLOS884

6 Revision History

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

Changes from Revision * (September 2024) to Revision A (December 2025) **Page**

- Updated existing board image with image of revised EVM (AMPS236A) 1
- Added link to the OPA320-Q1 product folder in *Specification* 2
- Changed banana connector labels from $+V_S$ and $–V_S$ to $+V_{S1}$ and $-V_{S1}$ in *Specification* 2
- Updated Product Information Center link in General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines 2
- Changed the high voltage input names from "+HV (J5) and GND (J7)" to "HVIN1 (J6) and GND1 (J8)" in *Input* 4
- Changed "Vout (J4)" to "VOUT1 (J5)" and "R1" to "R3" in *Output* to reflect PCB changes 4
- Changed nominal output voltage from 2V to 1.996V and clarified voltage division ratio in *Example Measurement* 4
- Changed 2V to 1.996V in Figure 2-2 4
- Updated EVM schematic to reflect EVM revision in Figure 3-1 6
- Updated PCB images to reflect EVM revision in Figure 3-2, Figure 3-3, Figure 3-4, Figure 3-5, Figure 3-6, Figure 3-7, and Figure 3-8 in *PCB Layouts* 7
- Updated Bill of Materials to reflect EVM revision in Table 3-1 11

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。
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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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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.

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