

EVM User's Guide: RES60EVM

RES60 评估模块



说明

RES60 评估模块 (EVM) 旨在帮助用户轻松评估和测试 RES60 器件的操作和功能。该 EVM 配置为电阻分压器后跟一个运算放大器缓冲器，由 $\pm 0.9V$ 至 $\pm 2.75V$ 的双电源供电，默认配置为使用 500:1 电阻分压器。

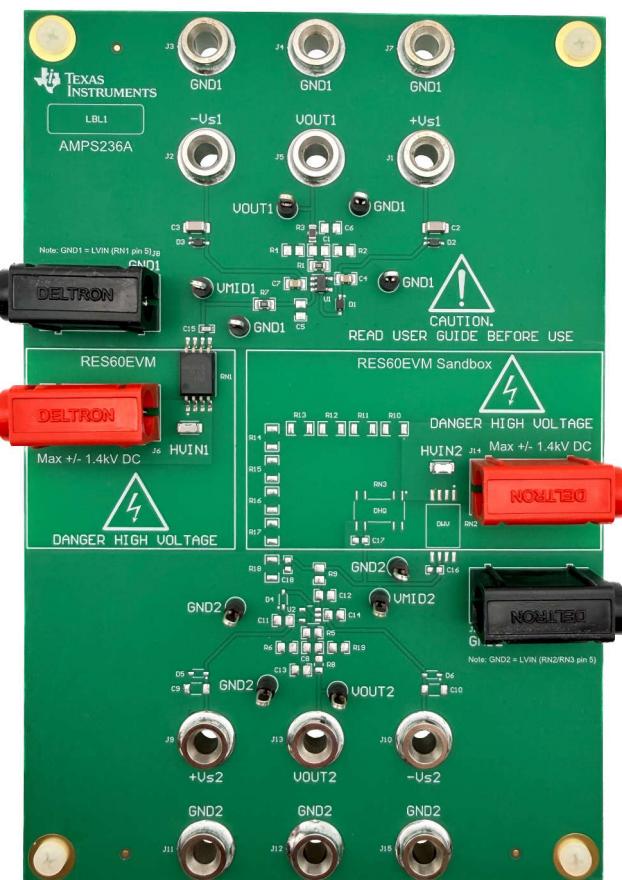
特性

- 输入和输出采用香蕉连接器
- 便捷的测试点可连接到所有相关节点
- 支持各种 RES60 比率

- 额外的空白沙盒电路可用于实现灵活配置

应用

- 高压总线和电池电压监控
 - HEV/EV 电池管理系统 (BMS)
 - HEV/EV 直流/直流转换器
 - HEV/EV 车载充电器 (OBC)
 - HEV/EV 逆变器和电机控制
- 非隔离式共地常开型分压器
- 具有高 CMRR 的分立式差分放大器

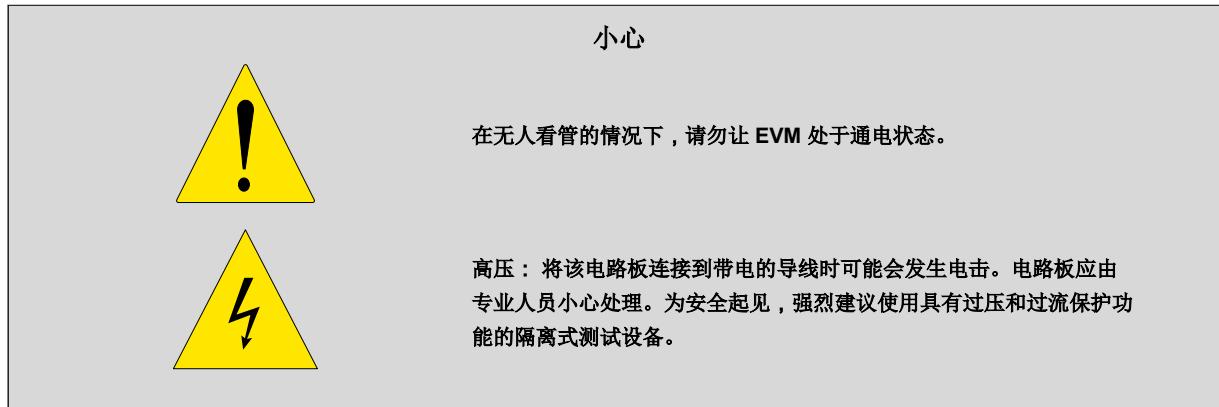


1 评估模块概述

1.1 简介

RES60A-Q1 是一款匹配电阻分压器，采用德州仪器 (TI) 的现代、高性能模拟晶圆工艺和薄膜 SiCr。高质量 SiO_2 绝缘层封装了电阻器，因此可在极高的电压下使用，持续运行时电压高达 1400VDC，HiPOT 测试 (60s) 时电压高达 4000VDC。该器件具有 $R_{HV} = 12.5\text{M}\Omega$ 的标称输入电阻，并提供多种标称比率以满足各种系统需求。

本用户指南介绍了德州仪器 (TI) RES60 评估模块的特性、操作、性能和使用情况。本用户指南包含 **RES60A-Q1** 评估模块的信息和支持文档，还包含 RES60EVM 的电路说明、原理图和物料清单。本文档中的评估板、评估模块和 *EVM* 等术语指的是 RES60EVM。



1.2 套件内容

表 1-1 中详细列出了 EVM 套件的内容。如果缺少任何元件，请与离您最近的 TI 产品信息中心联系。

表 1-1. RES60EVM 套件的内容

条目	数量
RES60EVM 评估板 PCB	1

1.3 规格

RES60EVM 在单电源配置下的总电源电压范围为 1.8V 至 5.5V，在双电源配置下为 $\pm 0.9\text{V}$ 至 $\pm 2.75\text{V}$ 。电源电压受限于 RES60EVM 上的 **OPA320-Q1** 电源电压。标有 $+V_{S1}$ 和 $-V_{S1}$ 的香蕉连接器为 OPA320-Q1 器件供电。

1.4 器件信息

RES60EVM 可以对 **RES60A-Q1** 器件的基本功能进行评估。对于典型应用，请参阅 **RES60A-Q1 汽车级 1400V 精密电阻分压器** 数据表。

1.5 通用德州仪器 (TI) 高压评估模块 (TI HV EVM) 用户安全指南



务必遵循 TI 的设置和应用说明，包括在建议的电气额定电压和功率限制范围内使用所有接口元件。务必采取电气安全防护措施，这样有助于确保自身和周围人员的人身安全。有关更多信息，请联系 TI 的产品信息中心。

保存所有警告和说明以供将来参考。

警告

务必遵循警告和说明，否则可能引发电击和灼伤危险，进而造成财产损失或人员伤亡。

TI HV EVM 一词是指通常以开放式框架、敞开式印刷电路板装配形式提供的电子器件。该器件严格用于开发实验室环境，仅供了解开发和应用高压电路相关电气安全风险且接受过专门培训、具有专业知识背景的合格专业用户使用。德州仪器 (TI) 严禁任何其他不合规的使用和/或应用。如果不满足合格要求，应立即停止进一步使用 HV EVM。

1. 工作区安全：

- a. 保持工作区整洁有序。
- b. 每次电路通电时，都必须由具有资质的观察员在场监督。
- c. TI HV EVM 及接口电子元件通电区域必须设有有效的防护栏和标识；指示可能存在高压操作，以避免意外接触。
- d. 开发环境中使用的所有接口电路、电源、评估模块、仪器、仪表、示波器和其他相关装置如果超过 50Vrms/75VDC，则必须置于紧急断电 EPO 保护电源板内。
- e. 使用稳定且不导电的工作台。
- f. 使用充分绝缘的夹钳和导线来连接测量探针和仪器。尽量不要徒手进行测试。

2. 电气安全：

- a. 作为一项预防措施，假定整个 EVM 可能存在用户可完全接触到的高电压是一种好的工程做法。
- b. 执行任何电气测量或其他诊断测量之前，需切断 TI HV EVM 及其全部输入、输出和电气负载的电源。再次确认 TI HV EVM 已安全断电。
- c. 确认 EVM 断电后，根据所需的电路配置、接线、测量设备连接和其他应用需求执行进一步操作，同时仍假定 EVM 电路和测量仪器均带电。
- d. EVM 准备就绪后，根据需要将 EVM 通电。

警告

EVM 通电后，请勿触摸 EVM 或电路，因为 EVM 或电路可能存在高压，会造成电击危险。

3. 人身安全

- a. 穿戴个人防护装备（例如佩戴乳胶手套或具有侧护板的安全眼镜），或将 EVM 放置于带有联锁装置的透明塑料箱，避免意外接触。

安全使用限制条件：

勿将 EVM 作为整体或部分生产单元使用。

2 硬件

2.1 入门

本部分将介绍连接器和测试点，并详细介绍基本的 EVM 功能。

2.1.1 电源

RES60EVM 在单电源配置下的总电源电压范围为 1.8V 至 5.5V，在双电源配置下为 $\pm 0.9V$ 至 $\pm 2.75V$ 。电源电压受限于 RES60EVM 上的 OPA320-Q1 电源电压。标记为 $+V_S$ 、 $-V_S$ 和 GND 的香蕉连接器为 OPA320-Q1 器件提供电源。

2.1.2 输入

RES60EVM 的高压输入标记为 HVIN1 (J6) 和 GND1 (J8)。

2.1.3 输出

使用标有“VOUT1 (J5)”的香蕉连接器或标有 VOUT1 的测试点监测 EVM 输出。电阻器 R3 用作 OPA320-Q1 输出端的隔离电阻器，电阻器 R3 为 49.9 欧姆，可对其进行调整以符合应用设计要求。

2.2 应用电路

RES60A-Q1 可与汽车精密放大器（如 OPA320-Q1）配合使用，能够相对于固定电势，对电动汽车电池的高侧 (BAT+) 进行单端电压测量。对于 BAT- 和 GND 等效的系统，请参见图 2-1。

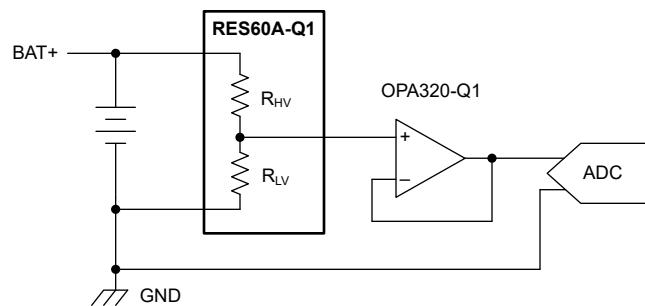


图 2-1. 单端测量，BAT+ 至 GND

2.2.1 测量示例

图 2-2 展示了一个 1,000V 电池测量的示例。该 EVM 装有 RES60A500，可提供 501:1 的分压比。在该分压器上施加 1000V 电压会导致 RES60A-Q1 的 MID 引脚上出现 1.996V 电势，该电势由 OPA320-Q1 进行缓冲，从而产生 1.996V 的标称输出电压。

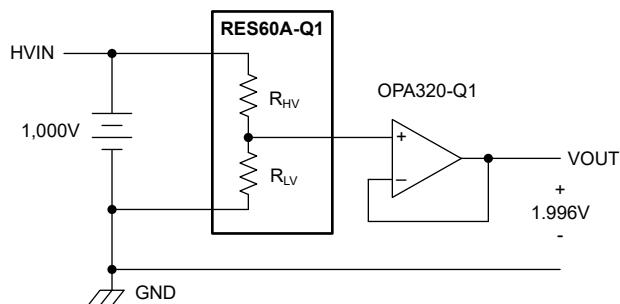


图 2-2. 1,000V 测量示例

2.3 评估模块限制

RES60EVM 默认配置为在 [RES60A-Q1](#) 的指定电压和电流范围内运行，用户可对 RES60EVM 进行修改。请参考相应的产品数据表，以便保持器件的指定工作条件。除了遵守指定的电流和电压电平外，在操作和应用 EVM 时，还要采取适当的静电放电预防措施。

2.4 静电放电警告

小心

RES60EVM 上的许多元件都容易受到静电放电 (ESD) 的损坏。取出和操作 EVM 时，应采取适当的 ESD 处理预防措施。如未遵守 ESD 处理程序，可能会导致 EVM 元件损坏。

3 硬件设计文件

3.1 原理图

RES60EVM

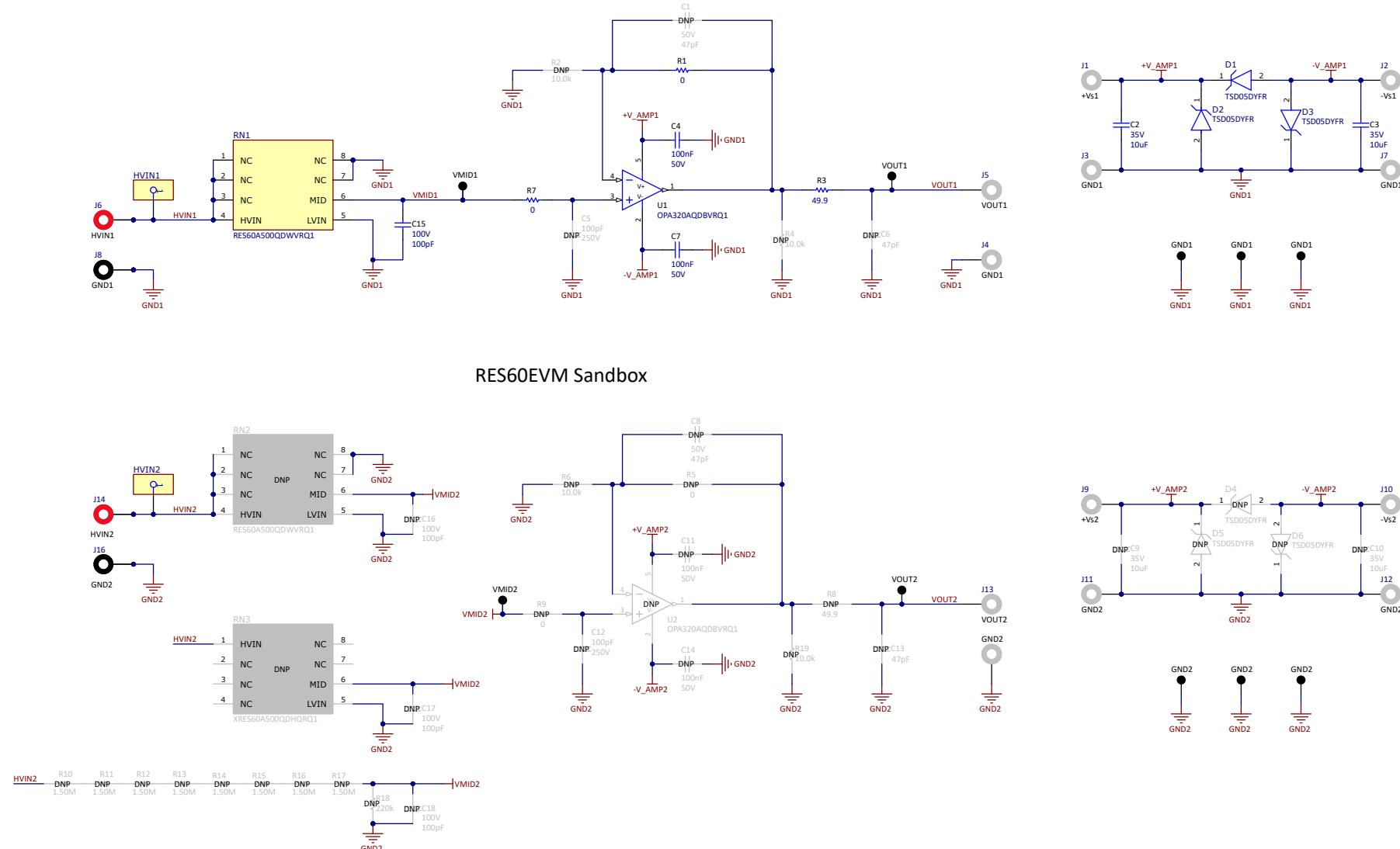


图 3-1. RES60EVM 原理图

3.2 PCB 布局

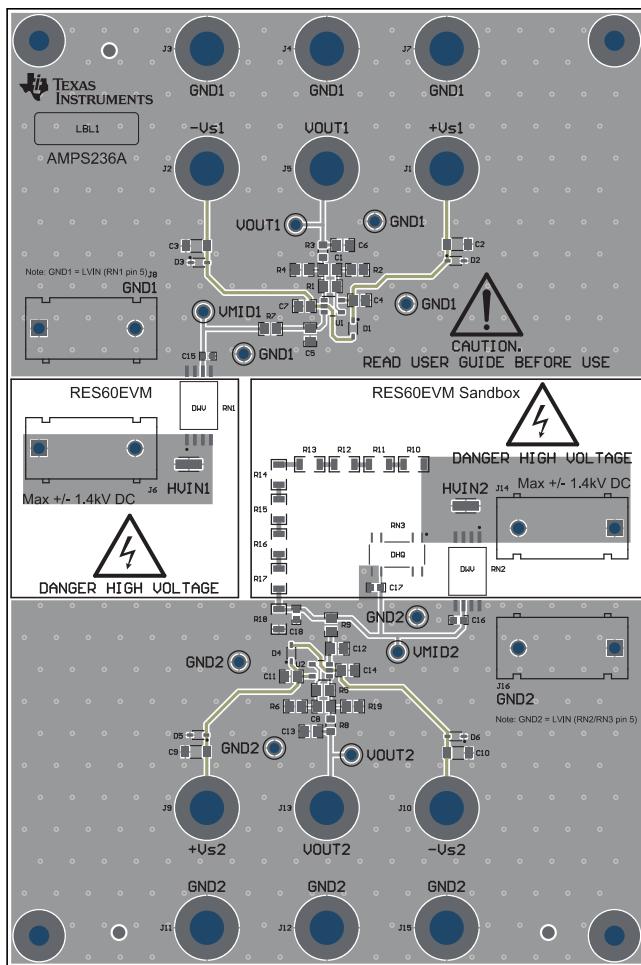


图 3-2. RES60EVM PCB 布局复合视图 (顶视图)

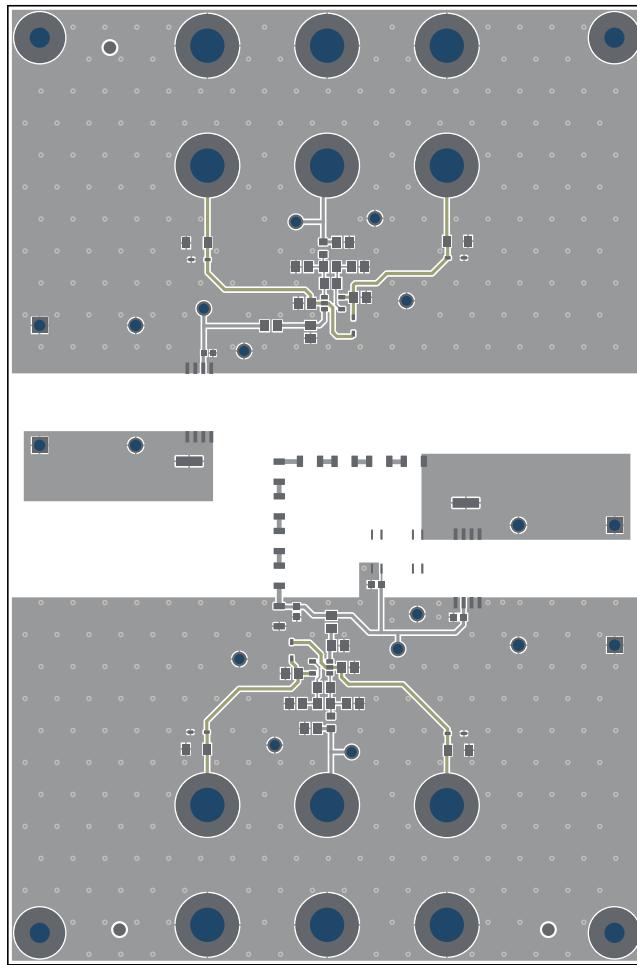


图 3-3. RES60EVM PCB 顶层掩膜

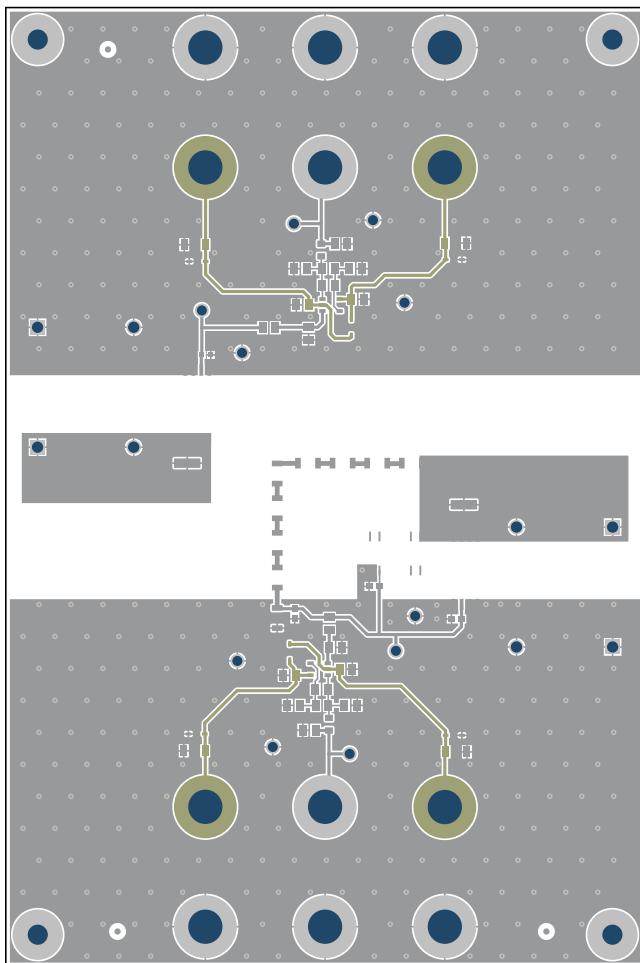


图 3-4. RES60EVM PCB 顶层

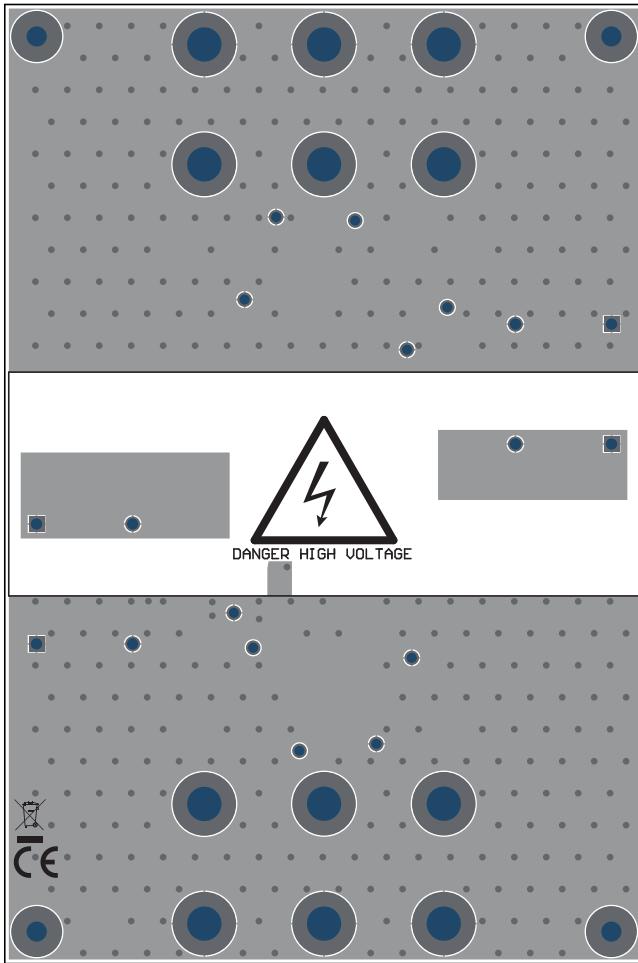


图 3-5. RES60EVM PCB 复合视图 (底视图)

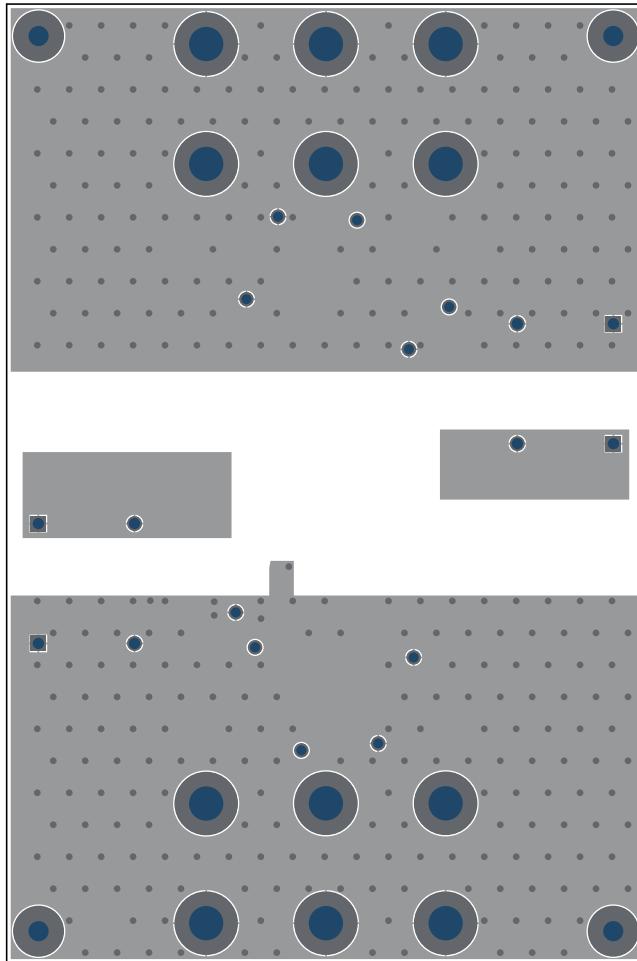


图 3-6. RES60EVM PCB 底层掩膜

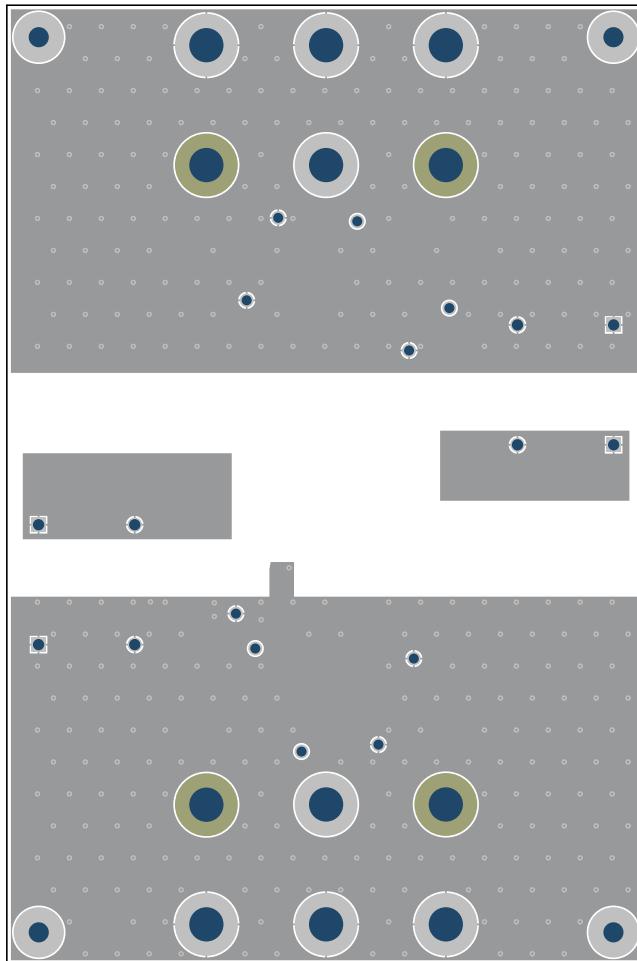


图 3-7. RES60EVM PCB 底层

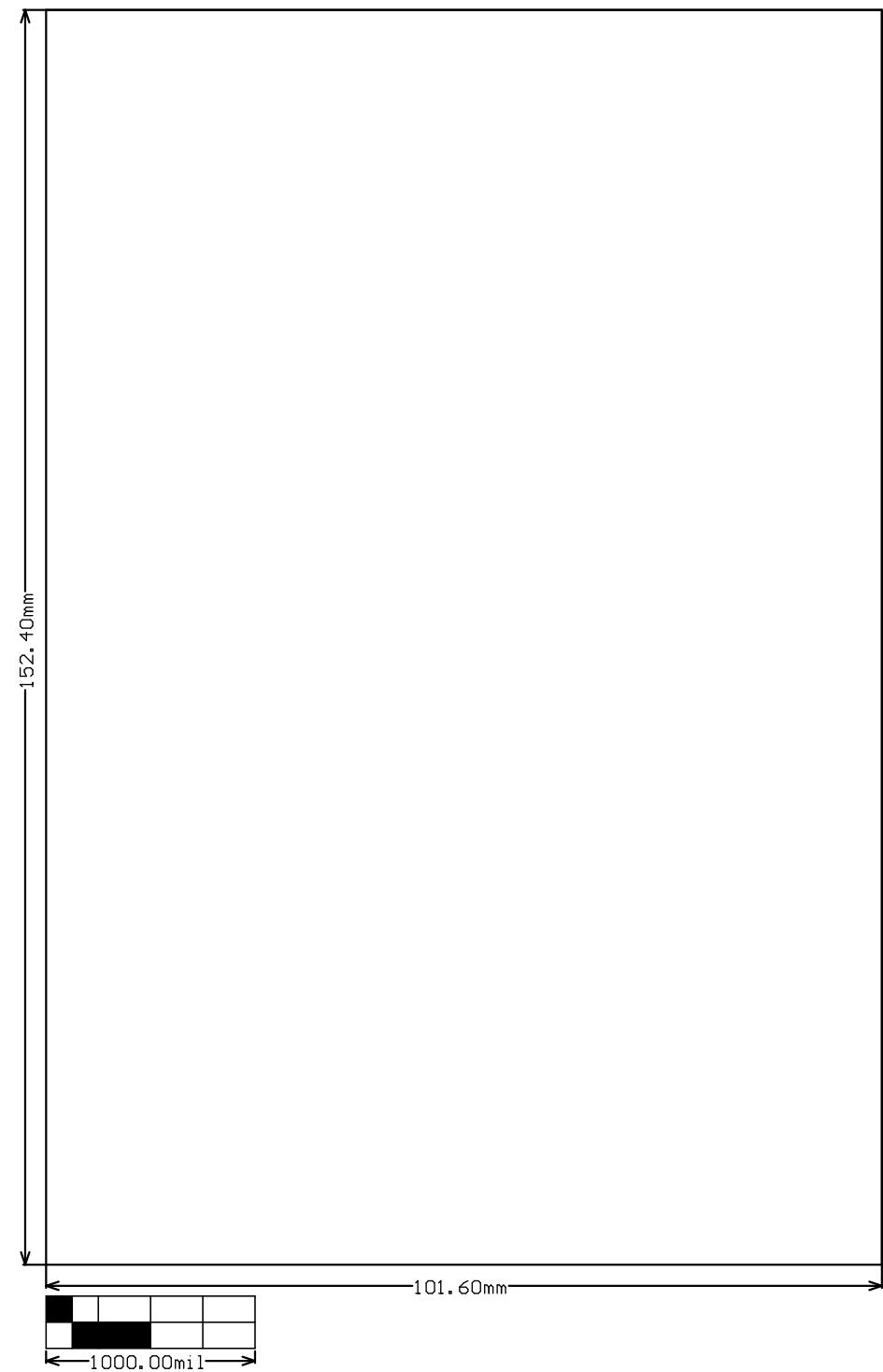


图 3-8. RES60EVM 电路板尺寸

3.3 物料清单 (BOM)

表 3-1 列出了 RES60EVM 的完整物料清单。每个元件的数据可从相应制造商的网站获取。

表 3-1. RES60EVM BOM

位号	数量	值	说明	器件型号	封装参考	制造商
C2 , C3	2	10uF	电容 , 陶瓷 , 10uF , 35V , +/- 10% , X7R , AEC-Q200 1 级 , 1206_190	CGA5L1X7R1V106K160AC	1206_190	TDK
C4 , C7	2	0.1uF	电容 , 陶瓷 , 0.1uF , 50V , +/-10% , X7R , 0805	C0805C104K5RACTU	0805	Kemet
C15	1	100pF	电容 , 陶瓷 , 100pF , 100V , +/-5% , C0G/NP0 , AEC-Q200 1 级 , 0603	GCM1885C2A101JA16D	0603	MuRata
D1、D2、D3	3		5V 24A 浪涌保护器件 , 2-SOT , -40 至 125	TSD05DYFR	SOD323	德州仪器 (TI)
H1、H2、H3、H4	4		机械螺钉 , 圆头 , #4-40 x 1/4 , 尼龙 , 飞利浦盘形头	NY PMS 440 0025PH	螺钉	B&F Fastener Supply
H5、H6、H7、H8	4		六角螺柱 , 0.5" L #4-40 , 尼龙	1902C	螺柱	Keystone
J1、J2、J3、J4、J5、J7、J9、J10、J11、J12、J13、J15	12		标准香蕉插头 , 非绝缘 , 5.5mm	575-4	Keystone_575-4	Keystone
J6 , J14	2		标准香蕉插孔 , 绝缘 , 10A , 红色	571-0500	571-0500	DEM Manufacturing
J8 , J16	2		标准香蕉插孔 , 绝缘 , 10A , 黑色	571-0100	571-0100	DEM Manufacturing
LBL1	1		热转印打印标签 , 0.650" (宽) x 0.200" (高) - 10,000/卷	THT-14-423-10	PCB 标签 0.650x 0.200 英寸	Brady
R1 , R7	2	0	电阻 , 0 , 5% , 0.125W , AEC-Q200 0 级 , 0805	ERJ-6GEY0R00V	0805	Panasonic
R3	1	49.9	电阻 , 49.9 , 0.1% , 0.125W , 0805	RT0805BRD0749R9L	0805	Yageo America
RN1	1		汽车级、1400V、精密电阻分压器	RES60A500QDWVRQ1	SOIC8	德州仪器 (TI)
TP1、TP2、TP3、TP4、TP5、TP6、TP9、TP10、TP11、TP12	10		测试点 , 多用途 , 黑色 , TH	5011	黑色通用测试点	Keystone Electronics
TP7 , TP8	2		PC 测试点镀层表面贴装安装类型	RCWCTE	SMT_TP	KOA Speer
U1	1		通过汽车级认证的精密、零交叉、20MHz、0.9pA lb、RRIO、CMOS 运算放大器 , DBV0005A (SOT-23-5)	OPA320AQDBVRQ1	DBV0005A	德州仪器 (TI)

4 其他信息

4.1 商标

所有商标均为其各自所有者的财产。

5 相关文档

表 5-1 中列出的文档提供了有关 TI RES60EVM 集成电路和支持工具的信息。

表 5-1. 相关文档

文档	文献编号
RES60A-Q1 产品数据表	SLPS764
OPA320-Q1 产品数据表	SLOS884

6 修订历史记录

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (September 2024) to Revision A (December 2025)	Page
• 使用修订版 EVM (AMPS236A) 的图像更新了现有电路板图像.....	1
• 在规格中添加了指向 OPA320-Q1 产品文件夹的链接.....	2
• 将规格中的香蕉连接器标签从 $+V_S$ 和 $-V_S$ 更改为 $+V_{S1}$ 和 $-V_{S1}$	2
• 更新了 通用德州仪器 (TI) 高压评估模块 (TI HV EVM) 用户安全指南 中的“产品信息中心”链接.....	2
• 将输入中的高压输入名称从“ $+HV$ (J5) 和 GND (J7)”更改为“ $HVIN1$ (J6) 和 $GND1$ (J8)”	4
• 将输出中的“ V_{out} (J4)”更改为“ $VOUT1$ (J5)”，并将“ $R1$ ”更改为“ $R3$ ”，以反映 PCB 变化.....	4
• 将标称输出电压从 $2V$ 更改为 $1.996V$ ，并在 测量示例 中阐明了分压比.....	4
• 在 图 2-2 中，将 $2V$ 更改为 $1.996V$	4
• 更新了 EVM 原理图，以在 图 3-1 中反映 EVM 修订.....	6
• 更新了 PCB 图像，以在 PCB 布局中的 图 3-2 、 图 3-3 、 图 3-4 、 图 3-5 、 图 3-6 、 图 3-7 和 图 3-8 中反映 EVM 修订	7
• 更新了 表 3-1 中的物料清单以反映 EVM 修订版.....	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 DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotope 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/lsts/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

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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/lsts/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, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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

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

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