

EVM User's Guide: INA951EVM

INA951-SEP 评估模块



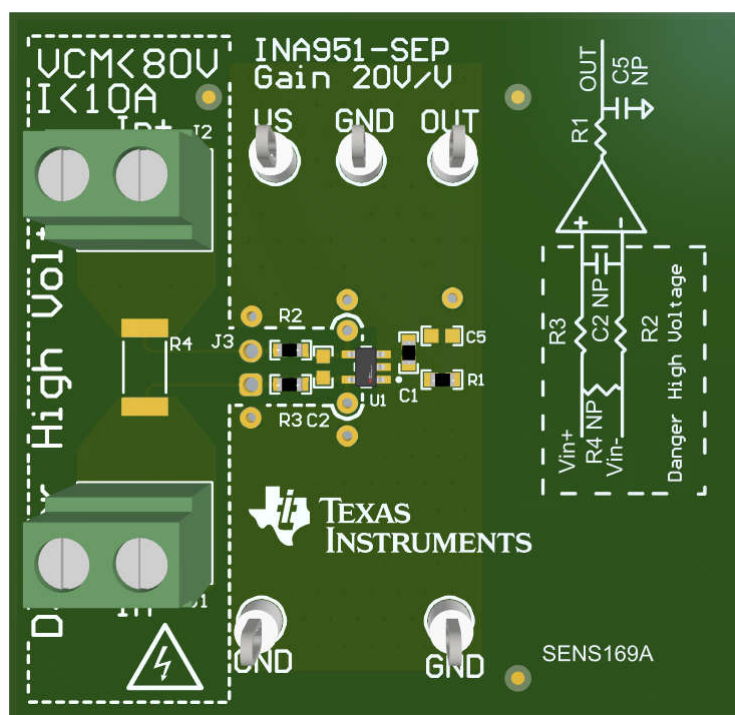
1 说明

INA951EVM 评估模块 (EVM) 是一款小型模块，其电流测量输入支持高达 80V 共模和 10A (板载分流) 输入能力。

每个电路板均设有针对 VS、GND、OUT 的测试点以及 In+ 和 In- 端子块。借助焊盘和端子连接器，可以快速实现输入和输出滤波，并采用 2512 尺寸的板载分流电阻器。

2 特性

- 对 INA951-SEP 电流传感器进行电气评估
- 通过测试点轻松连接设备引脚
- 借助焊盘和插座，在输入引脚和输出引脚处实现可选的滤波
- 提供多个输入信号选项，包括焊接分流电阻器 (2512) 和安全测量高达 10A 的电流的方法



INA951-SEP 硬件板

3 评估模块概述

3.1 简介

该 EVM 是一个易于使用的平台，用于评估 INA951-SEP 的主要特性和性能。此 EVM 支持通过 PCB 进行高达 10A 的电流测量，而 INA951-SEP 支持高达 80V 的高电压。

本 EVM 用户指南介绍了 INA951EVM 模块的特性、运行和使用情况。该 EVM 旨在评估各种配置下 INA951-SEP 电压输出、电流分流监控器的性能。本文档中的评估板、评估模块和 EVM 等术语指的是 INA951EVM。本文档还包含原理图、参考印刷电路板 (PCB) 布局和完整的物料清单 (BOM)。

3.2 套件内容

表 3-1 汇总了 INA951EVM 套件内容。如果缺少任何元件，请联系最近的德州仪器 (TI) 产品支持中心。TI 还建议查看 www.ti.com 上的器件产品文件夹，以了解有关该产品的任何更多信息。

表 3-1. INA951EVM 套件内容

条目	物品器件型号	数量
INA951EVM 测试板	INA951EVM	1

3.3 规格

INA951EVM 提供了 INA951-SEP 的基本功能评估。此治具布局并不用作目标电路的模型，也不作为针对电磁兼容性 (EMC) 测试的布局。INA951EVM 是一块 PCB，工程师可用其在最终应用中测试 INA951-SEP 器件。每个 PCB 剪裁区都有 INA951-SEP 器件、测试点和用于外部硬件连接的终端，以及用于焊接可选电路的焊盘。

3.4 器件信息

INA951-SEP 是一款高精度电流传感放大器，可不依赖于电源电压，在 -4V 至 80V 的宽共模范围内测量分流电阻器上的压降。负共模电压允许器件的工作电压低于接地电压，从而可在半桥应用中精确测量再循环电流。低失调电压、小增益误差和高直流 CMRR 的组合可实现高精度的电流测量。INA951-SEP 不仅适用于直流电流测量，还适用于高速应用（例如快速过流保护），此类应用具有 1.3MHz 的高带宽和 85dB 交流 CMRR（50kHz 时）。

INA951-SEP 由 2.7V 至 10V 的单电源供电，消耗 1.5mA 的电源电流。INA951-SEP 具有固定的 20V/V 增益。

INA951-SEP 的额定工作温度范围为 -55°C 至 +125°C，并且采用节省空间的 SOT-32 封装。

4 硬件

4.1 设置

4.1.1 快速入门设置

可以按照以下步骤来设置和使用 INA951EVM。

1. 将外部直流电源电压 (介于 2.7V 和 10V 之间) 连接到 VS 测试点。将该电源的接地基准连接到 GND 测试点。
2. 按照[测量](#)中的说明, 通过将信号引线连接到 EVM 上的 J2 和 J1, 向 Vin+ 和 Vin- 节点提供差分输入电压信号。

小心

在无人看管的情况下, 请勿让 EVM 处于通电状态。

4.1.2 测量

用户可以根据 INA951EVM 的一组给定系统条件来模拟感测电阻上产生的电压, 或者将器件输入连接到外部分流器。用户还可以将表面贴装技术 (SMT) 分流电阻器焊接在 In+ 和 In- 焊盘上, 这些输入可以与外部系统和负载串联在一起。

若要在不使用分流电阻器的情况下配置测量评估, 请执行以下步骤:

1. 将外部直流电源电压 (2.7V 至 10V) 连接到一个 VS 测试点, 并将电源接地连接到 GND 测试点
2. 在 In+ (J2) 和 In- (J1) 连接器上连接差分电压
3. 如果差分电压电源是浮动电源, 则将 -4V 至 80V 共模电压连接到输入端。将外部电压源的正极引线连接到 In- (J1) 连接器, 并将接地引线连接到 GND 测试点。此设置可有效改变输入引脚的绝对共模电压, 同时保持差分电压不变 (请参阅[图 4-1](#))
4. 测量 OUT 测试点相对于 GND 的输出电压

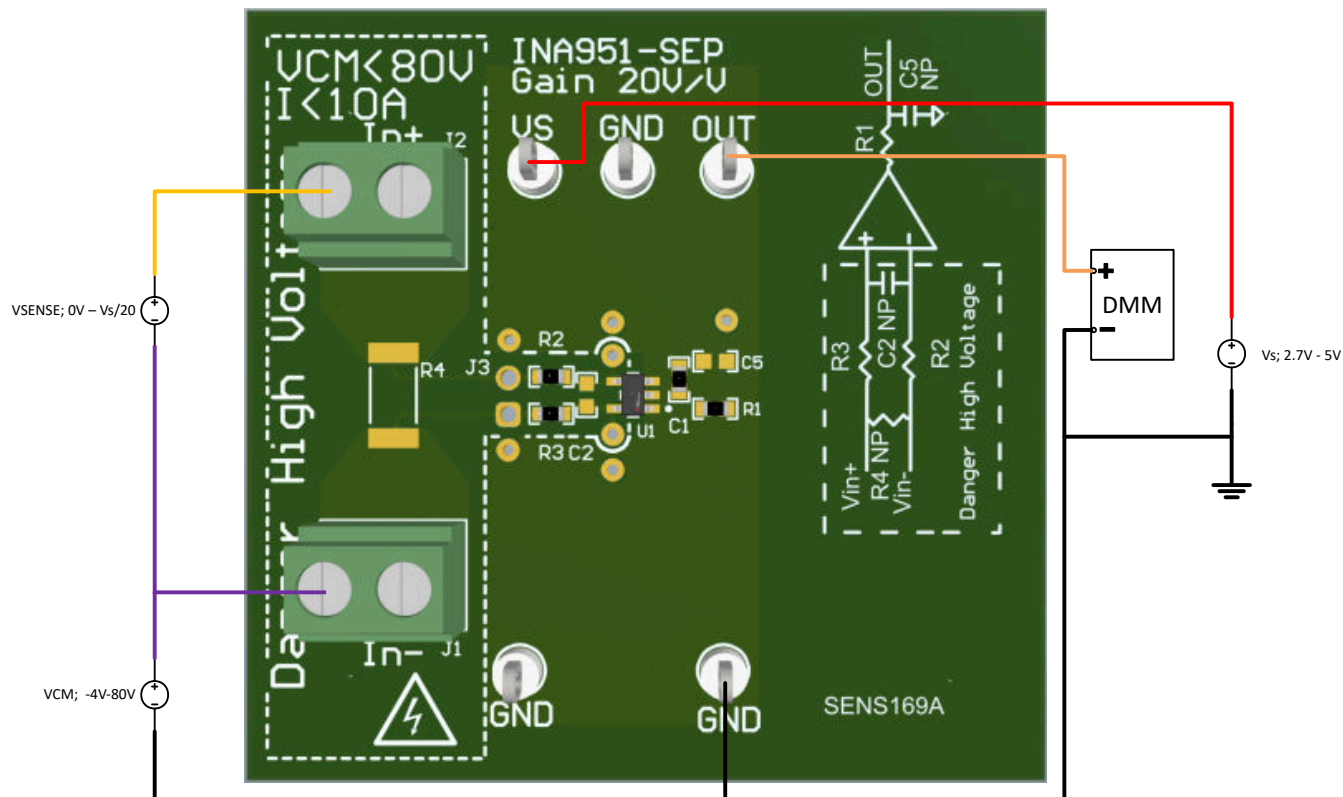


图 4-1. 无分流电阻连接

若要使用分流电阻器配置测量评估，请执行以下步骤：

1. 将一个 2512 电阻器焊接在连接 In+ (J2) 和 In- (J1) 输入端的 R4 焊盘上
2. 在断电时，将 In+ (J2) 和 In- (J1) 凸舌与负载和总线电压源串联。

警告

在测量电流之前，首先确保设备（分流电阻器、导线、连接器等）可以承受相应的电流和功率耗散。确保流经 J1 和 J2 的电流不超过 10A。否则可能会导致表面高温 (> 55°C)、EVM 损坏或人身伤害。

3. 打开系统电源并在 OUT 测试点测量输出电压。输出电压等于器件增益乘以直接在器件输入引脚上测得的差分电压。输出以 EVM 的接地输入为基准。

4.2 电路

本节总结了 INA951EVM 元件。

4.2.1 R1、R2、R3、C2、C5

R1、R2 和 R3 是出厂时已安装的 0Ω 0603 电阻器。

C2 和 C5 未填充。

总的来说，这些焊盘允许用户为 EVM 的输入引脚 (IN+ 和 IN-) 和输出引脚 (OUT) 定义滤波器。如果需要使用滤波器，请移除这些电阻器并用阻值大于 0Ω 的 SMT 电阻器替换它们，然后使用电容器填充电容器焊盘。使用输入滤波时应考虑器件的输入偏置电流。

4.2.2 C1

C1 是 0.1μF 电源旁路电容器。C1 靠近 Vs 引脚放置，以实现更好的电源滤波。

4.2.3 R4

R4 未填充，但允许用户在由 IN+ 和 IN- 输入引脚感测的 In+ 和 In- 焊盘之间焊接一个表面贴装分流电阻器。如果使用了 R4，请确保其具有适合所选电流负载的功率耗散。所选电阻器必须具有 2512 尺寸。

4.2.4 U1

表 4-1. INA951EVM

指示符	数量	值	说明	封装参考	器件型号	制造商
U1	1		-4V 至 80V、1.3MHz 电流传感放大器	DBV (SOT-23, 5)	INA951A1MDB VTSEP	德州仪器 (TI)

U1 是 INA951-SEP 测试器件的位置。

4.2.4.1 J3

J3 默认未安装，但可以安装引脚，以便更靠近器件感测器件分流输入两端的电压。尽管所有器件引脚都装有测试点，板上的未覆盖阻焊过孔可用于在更靠近器件处进行测量。

4.3 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，这样有助于加强自身和周围人员的人身安全。如需更多信息，请联系 TI 的产品信息中心，网址为 <http://support.ti.com>。

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

- 保持工作区整洁有序。
- 每次电路通电时，都必须由具有资质的观察员在场监督。
- 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，指示可能存在高压作业，以避免意外接触。
- 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。
- 使用稳定且不导电的工作台。
- 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

作为一项安全预防措施，工程规范一贯假定整个 EVM 可能存在用户可完全接触到的高电压。

- 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。
- 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。
- 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 或其电路，因为 EVM 可能存在高压，会造成电击危险。

3. 人身安全

- 穿戴人员防护装备（例如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中，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。

5 硬件设计文件

备注

电路板布局未按比例显示。这些图旨在显示电路板的布局。评估模块布局不用于 INA951EVM PCB 制造。

5.1 原理图

图 5-1 展示了 INA951EVM PCB 的原理图。

Input side capable up to 80V; Input Current <10A when using onboard R4 as shunt resistor

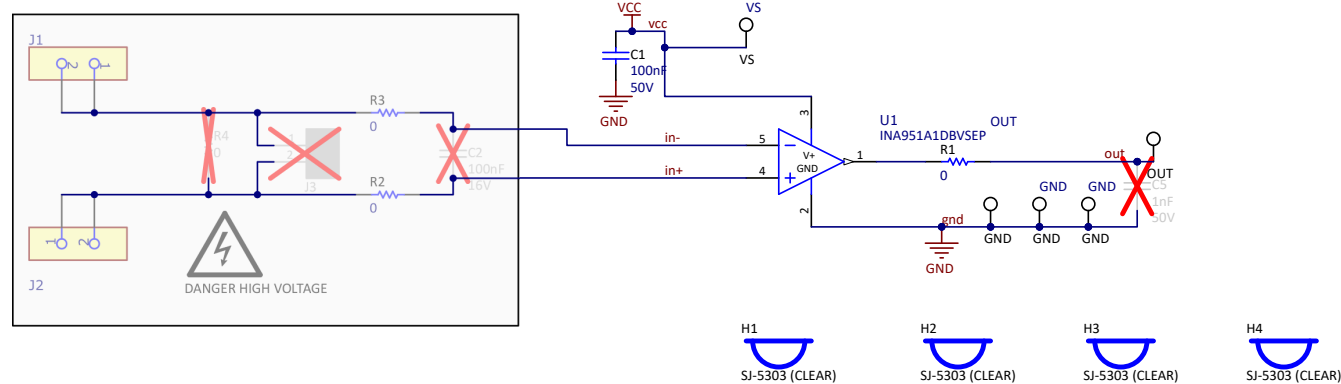


图 5-1. INA951EVM 原理图

5.2 PCB 布局

图 5-2 至图 5-5 显示了 INA951EVM 的 PCB 布局。

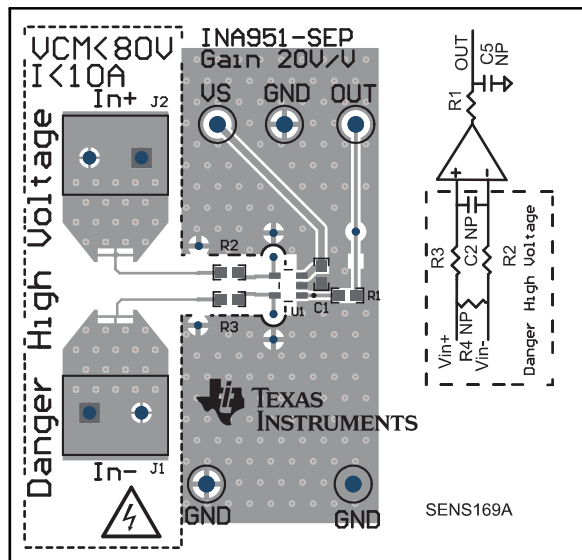


图 5-2. INA951EVM 顶层丝印层

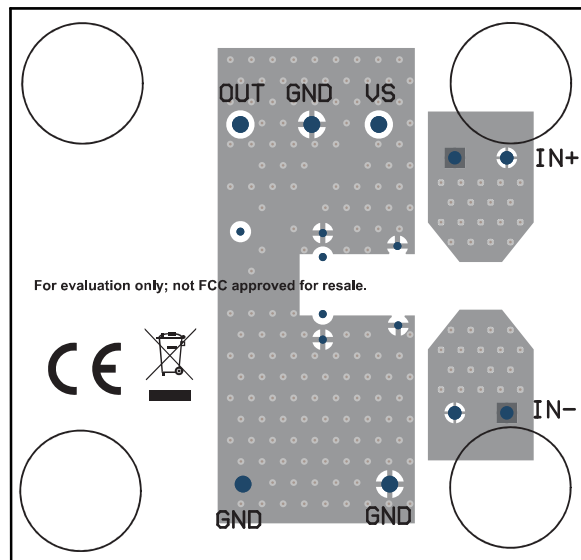


图 5-3. INA951EVM 底层丝印层

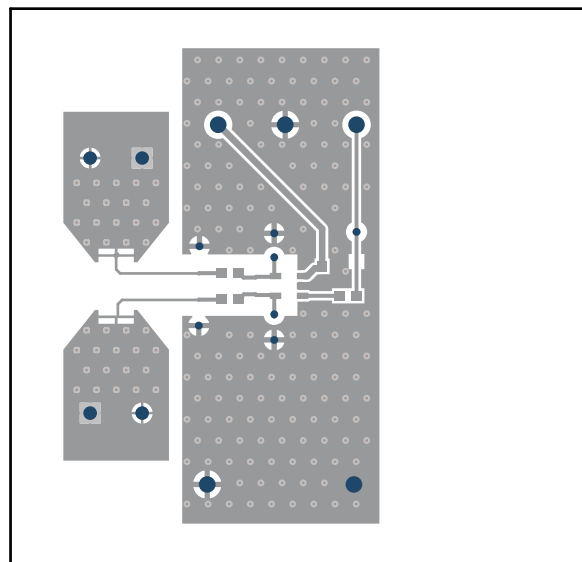


图 5-4. INA951EVM 顶层

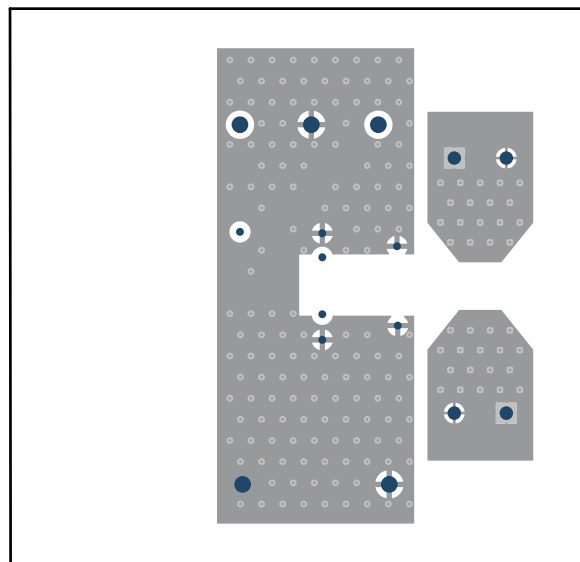


图 5-5. INA951EVM 底层

5.3 物料清单

表 5-1 提供了 INA951EVM 的器件清单。

表 5-1. 物料清单

指示符	数量	值	说明	封装参考	器件型号	制造商
C1	1	0.1 μ F	电容, 陶瓷, 0.1 μ F, 50V, +/-10%, X7R, AEC-Q200 1 级, 0603	0603	C0603C104K5RAC AUTO	Kemet
H1、H2、H3、H4	4		Bumpon, 半球形, 0.44 × 0.20, 透明	透明 Bumpon	SJ-5303 (CLEAR)	3M
J1、J2	2		端子块 2POS 侧面插入 5MM PCB	HDR2	6.91138E+11	Würth Elektronik
R1、R2、R3	3	0	电阻, 0, 5%, 0.1W, 0603	0603	RC0603JR-070RL	Yageo
TP1、TP3、TP5、 TP6、TP7	5		测试点, 通用, 白色, TH	白色通用测试点	5012	Keystone Electronics
U1	1		- 4V 至 80V、1.3MHz 电流传感放大器	SOT23-5	INA951A1MDBVTS EP ⁽¹⁾	德州仪器 (TI)
C2	0	0.1 μ F	电容, 陶瓷, 0.1 μ F, 16V, +/-5%, X7R, 0603	0603	0603YC104JAT2A	AVX
C5	0	1000pF	电容, 陶瓷, 1000pF, 50V, +/-10%, X7R, 0603	0603	C0603X102K5RAC TU	Kemet
J3	0		接头, 2.54mm, 2x1, 金, TH	接头, 2.54mm, 2x1, TH	61300211121	Würth Elektronik
R4	0	0	电阻, 0, 0.05%, 2W, AEC-Q200 0 级, 2512	2512	HCJ2512ZT0R00	Stackpole Electronics Inc

(1) INA951EVM 可能装有 INA951-SEP (U1) 器件, 该器件顶部不含正确的顶层标识。这些器件仍然是经过全面测试的 INA951-SEP 器件。

6 其他信息

6.1 商标

所有商标均为其各自所有者的财产。

7 相关文档

该文档提供了有关 INA951EVM 装配件中所用德州仪器 (TI) 集成电路的信息。

表 7-1. 相关文档

文档	文献编号
INA951-SEP 产品数据表	SLVSLJ50

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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.
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 - 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 instructions, 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/sds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

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

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

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

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

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

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

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

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/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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