EVM User's Guide: REF53EVM

REF53-Q1 评估模块

说明

REF53EVM 是一款精密电压基准评估模块 (EVM)，可展示德州仪器 (TI) 高精度基准器件 REF53 的性能。REF53 是一系列低功耗、低噪声和低漂移串联电压基准器件。REF53 系列具有低温度漂移系数、低噪声和高精度的特点，同时消耗较低的电流。

开始使用

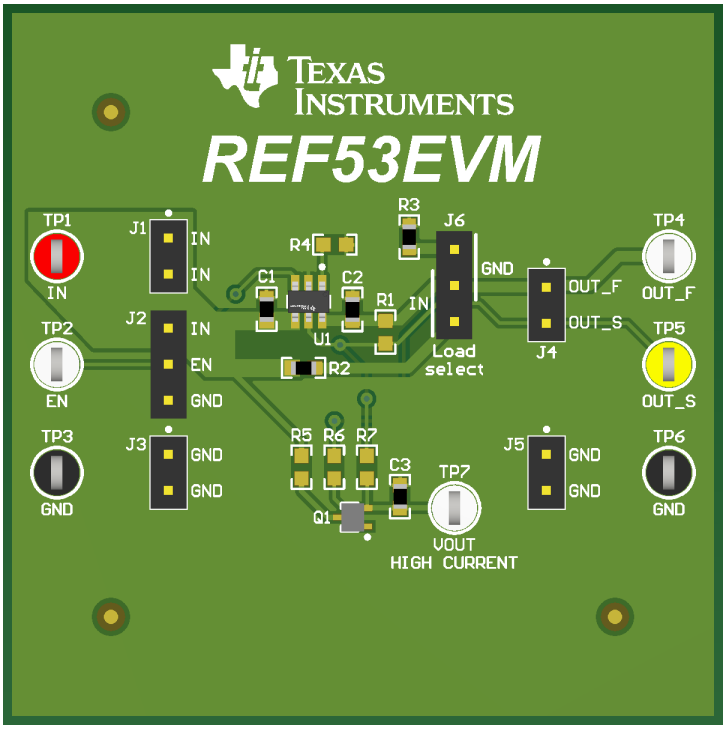
1. 从 REF53 工具页面订购 EVM。
2. 配置 EVM 上的跳线以选择负载。
3. 将 IN 连接到电源。
4. 测试输出电压。

特性

- 跳线可选择 GND 的负载或 IN 的负载，以在拉出和灌入电流时评估负载调整率。
- 用于添加晶体管以提供更高电流输出的封装

应用

- 现场发送器
- PLC 模拟 I/O 模块
- 电源监控
- 医疗成像
- 单轴和多轴伺服驱动器
- 医院患者护理
- 电表
- 电池管理系统
- 激光雷达
- 混合动力汽车/电动汽车 OBC 和直流/直流转换器



REF53EVM 电路板

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1 评估模块概述

1.1 简介

REF53EVM 是一款串联电压基准评估模块，可展示采用 6 引脚 SOT-23 封装的 REF53 的性能。REF53 具有低功耗、低噪声和低温漂，有助于满足高精度应用的严格性能要求。该器件还带有一个使能引脚 (EN)，允许通过将器件设置为关断模式来提高功效。

本 EVM 用户指南介绍了 REF53EVM 的特性、操作和推荐应用场景。本文档提供了有关如何使用 REF53EVM 电路板的示例和说明。本文档中的评估板、评估模块和 EVM 等所有术语均指 REF53EVM。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)。

1.2 套件内容

表 1-1 详细说明了 EVM 套件的内容。如果缺少任何元件，请通过 (972) 644-5580 联系 TI 产品信息中心。

表 1-1. 套件清单

条目	数量
REF53EVM	1

1.3 规格

REF53EVM 的主要功能是评估 REF53 精密串联电压基准。安装测试点以连接电源和万用表。包含跳线和电阻器，用于测试 REF53 的负载调整率。REF53EVM 还包含一个额外的晶体管，用于提供更高的输出电流。

1.4 器件信息

REF53 是一款精密串联电压基准。该器件设计为低功耗、低噪声、低温漂和高精度。这使得 REF53 可与高分辨率数据转换器和模拟前端 (AFE) 搭配使用。REF53 具有一个使能引脚 (EN)，允许通过将器件设置为关断模式来提高功效。

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2 硬件

2.1 设置

REF53EVM 设置 中所示的原理图代表 REF53EVM。

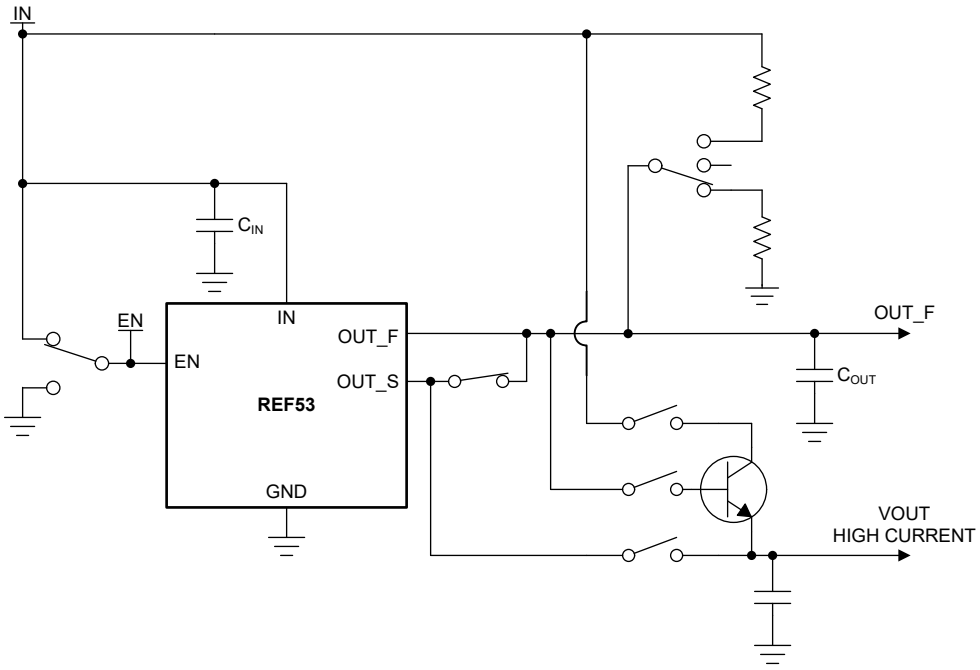

图 2-1. REF53EVM 设置

REF53EVM 的作用是帮助用户评估如 REF53EVM 设置 所示的配置。提供电阻器和跳线，用于评估 REF53 的负载调整率。还提供额外的晶体管，用于大电流输出评估。

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2.2 EVM 连接

要为 REF53EVM 供电，必须使用外部电源。为获得最佳性能，请使用低噪声电源。输入电压范围如表 2-1 所示。

表 2-1. REF53EVM 的输入电压范围

EVM 输入	器件连接	EVM 最小输入电压	EVM 最大输入电压
IN	REF53125AQDDCRQ1（IN 引脚）	1.71V	18V

默认 EVM 设置如图 2-2 所示。在默认 EVM 设置中，J6 上的跳线通过电阻器 R3 将 EVM 输出连接到 GND，从而模拟基准上的负载。要在无负载条件下测试 REF53 的输出，请移除 J6 的跳线。可以使用电路板上提供的 OUT_F 和 GND 测试点来测量输出基准电压。为获得出色的温漂性能，请使用低热 EMF 探头测量输出。

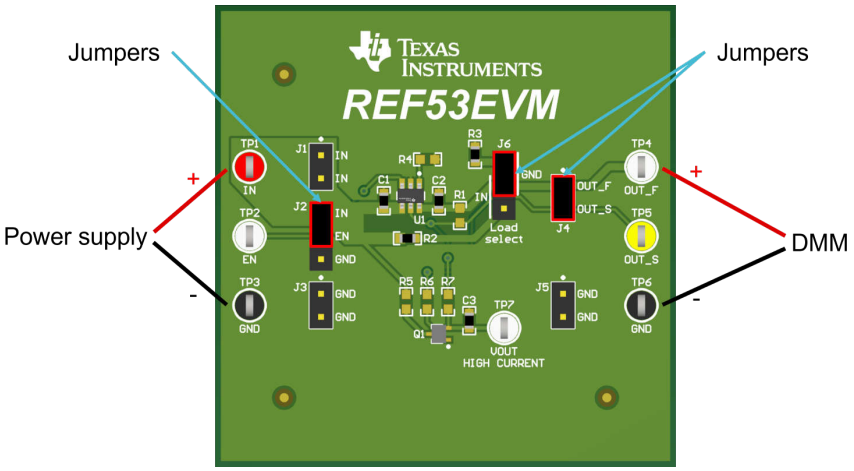

图 2-2. REF53EVM 默认设置

此外，还可以选择使用晶体管来增大 REF53 的输出电流。通过移除 C2、移除 J4 和 J6 上的跳线，并安装 R5、R6 和 R7，可以使用标记为 VOUT HIGH CURRENT 的测试点来测量输出电压。使用此配置时，该器件仅在拉出电流时调节电压，此配置无法灌入电流。

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2.3 跳线信息

REF53EVM 提供跳线来配置 EVM，从而在不同条件下测试 REF53 的功能。表 2-2 中介绍了这些跳线的功能。

表 2-2. REF53EVM 跳线信息

跳线位号	名称	跳线功能
J2	EN 选择	跳线 J2 可用于使能或禁用 REF53。将跳线连接到 IN 以使能 REF53。将跳线连接到 GND 以将 REF53 置于关断模式。移除跳线以提供外部 EN 信号
J4	OUT_F/OUT_S 短路	跳线 J4 可用于将 REF53 的 OUT_F 和 OUT_S 连接在一起。REF53 的默认配置是连接这两个引脚。
J6	负载选择	跳线 J6 可用于测试 REF53 的负载调整率。将跳线连接到 IN，以通过电阻器 R2 将 REF53 的 OUT_F 连接到 IN，从而在灌入电流时测试 REF53 负载调整率。将跳线连接到 GND，以通过电阻器 R3 将 REF53 的 OUT_F 连接到 GND，从而在拉出电流时测试 REF53 负载调整率。移除跳线以移除 REF53 的负载。

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2.4 最佳实践

- 使用具有优秀 PSRR 的电源。
- 使用高分辨率仪器（DMM、示波器）测量输出电压，以便获得出色性能。

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3 实现结果

3.1 评估设置

使用下列条件对 REF53EVM 进行测试。

IN：将 Kiethley 2420 SMU 的正输出连接到 EVM 上的 IN 测试点，并将 SMU 的负输出连接到 EVM 上最近的 GND 测试点。
OUT_F：将 3458A DMM 的正输入连接到 EVM 上的 OUT_F 测试点，并将 DMM 的负输入连接到 EVM 上最近的 GND 测试点。

3.2 性能数据和结果

REF53EVM 的输出电压是在压降条件下测量的，满足 REF53 数据表中给出的初始精度、长期漂移和温度漂移规格限制。该器件满足相关测试的线路调整率、负载调整率和关断条件规格。

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4 硬件设计文件

4.1 原理图

图 4-1 展示了 REF53EVM 的原理图。

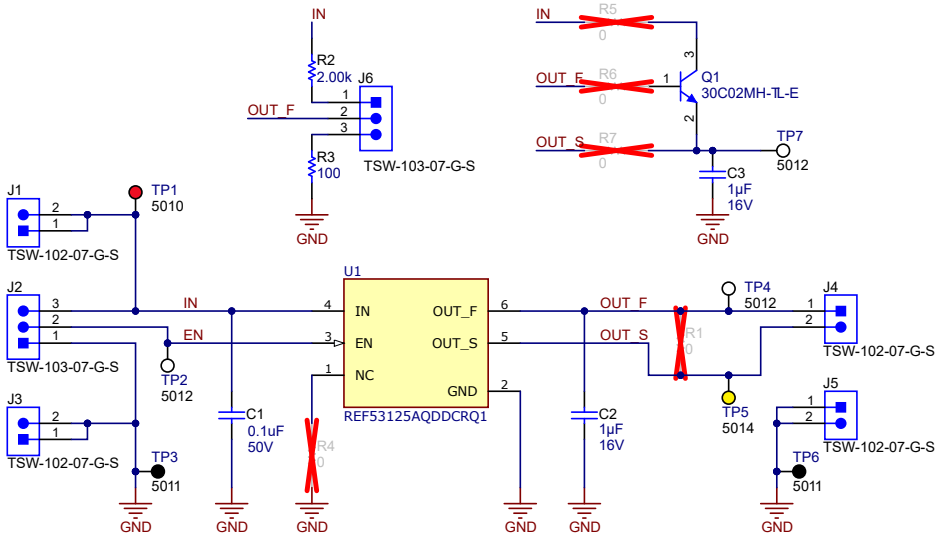

图 4-1. REF53EVM 原理图

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4.2 PCB 布局

REF53EVM 是一种两层电路板。布局如图 4-2 和图 4-3 所示。

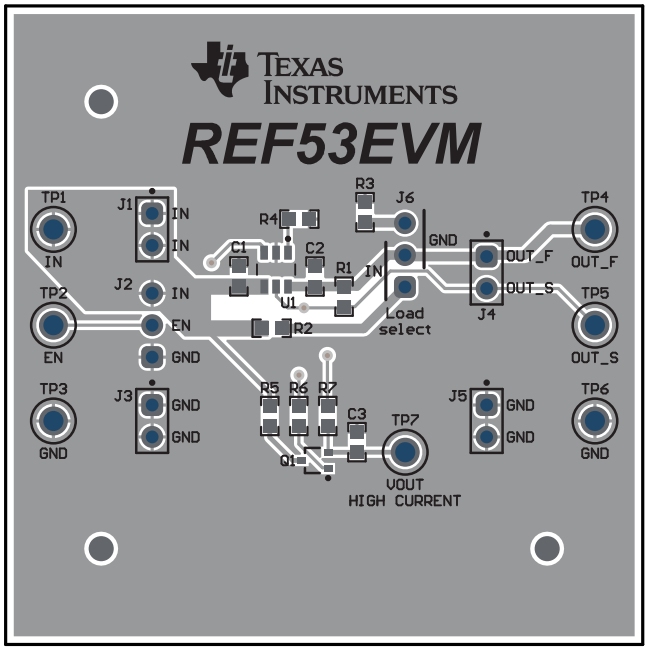

图 4-2. REF53EVM 顶层

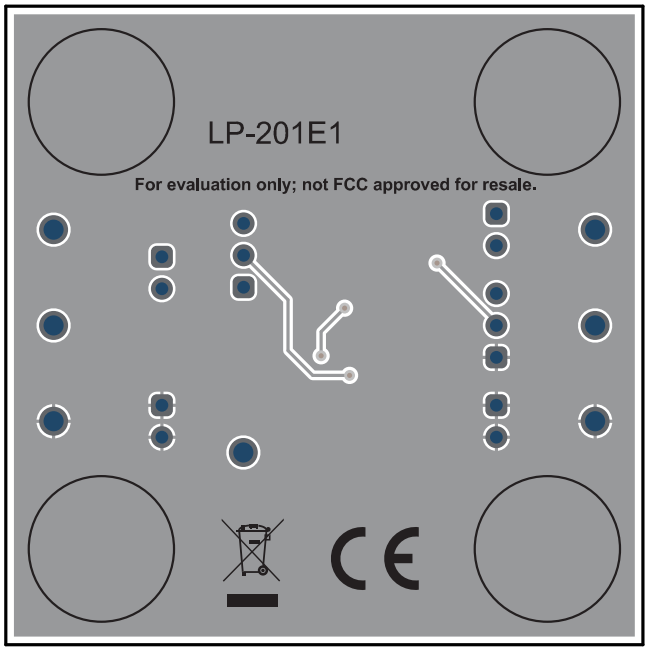

图 4-3. REF53EVM 底层

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4.3 物料清单 (BOM)

表 4-1 列出了 REF53EVM 的物料清单。

表 4-1. 物料清单

指示符	数量	说明	封装参考	器件型号	制造商
C1	1	电容，陶瓷，0.1µF，50V，+/-10%，X8R，AEC-Q200 0 级，0603	0603	CGA3E3X8R1H104K080AB	TDK
C2、C3	2	电容，陶瓷，1µF，16V，+/-10%，X7R，AEC-Q200 1 级，0603	0603	CGA3E1X7R1C105K080AC	TDK
H9、H10、H11、H12	4	Bumpon，半球形，0.44 X 0.20，透明	透明 Bumpon	SJ-5303 (CLEAR)	3M
J1、J3、J4、J5	4	接头，100mil，2x1，金，TH	2x1 接头	TSW-102-07-G-S	Samtec
J2、J6	2	接头，100mil，3x1，金，TH	3x1 接头	TSW-103-07-G-S	Samtec
Q1	1	双极晶体管，30V，0.7A，低 VCE(sat) NPN 单个，3 引脚 SC70，无铅，卷带包装	MCPH-3	30C02MH-TL-E	On Semiconductor
R2	1	电阻，2.00k，0.1%，0.1W，0603	0603	RT0603BRD072KL	Yageo America
R3	1	电阻，100，1%，0.25W，AEC-Q200 0 级，0603	0603	CRCW0603100RFKEAHP	Vishay-Dale
TP1	1	测试点，多用途，红色，TH	红色通用测试点	5010	Keystone Electronics
TP2、TP4、TP7	3	测试点，通用，白色，TH	白色通用测试点	5012	Keystone Electronics
TP3、TP6	2	测试点，多用途，黑色，TH	黑色通用测试点	5011	Keystone Electronics
TP5	1	测试点，通用，黄色，TH	黄色通用测试点	5014	Keystone Electronics
U1	1	REF53125AQDDCRQ1	SOT-23-THIN-6	REF53125AQDDCRQ1	德州仪器 (TI)
SH-J1、SH-J2、SH-J3	3	连接器跳线 S2 (1 x 2) 位置并联连接器黑色开孔顶部 0.100	跳线	QPC02SXGN-RC	Sullins
R1、R4、R5、R6、R7	0	电阻，0，0%，0.25W，AEC-Q200 0 级，0603	0603	PMR03EZPJ000	Rohm

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5 合规信息

5.1 合规性和认证

REF53EVM EU 符合性声明 (RoHS)。

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

表 7-1 中的文档提供了有关 REF53EVM 装配件中使用的德州仪器 (TI) 集成电路的信息。本用户指南可从 TI 网站上获得，文献编号为 SLVUDQ7。附加到文献编号的任何字母对应于撰写本文档时已有的最新文档修订版。较新的修订版可从 TI 网站 www.ti.com 获得，也可以致电德州仪器 (TI) 文献响应中心（电话为 (800) 477-8924）或产品信息中心（电话为 (972) 644-5580）了解评估模块。订购时，可通过文档标题或文献编号识别文档。

表 7-1. 相关器件文档

条目	文献编号
REF53125AQDDCRQ1 产品数据表	SNVSCU8

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STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

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

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

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

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

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

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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.

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