

## *EVM User's Guide: TPS1HC120Q1EVM*

## TPS1HC120-Q1 评估模块



## 说明

TPS1HC120Q1EVM 是一款硬件评估模块 (EVM)，用于评估 TPS1HC120-Q1 高侧开关的功能和性能。

TPS1HC120Q1EVM 可用作具有随附电压电源和输出负载的独立电路板。该评估模块启用了过流、对地短路和开路负载检测等功能。

## 特性

- 工作电压: 3V - 28V
- 环境工作温度: -40 至 125°C
- 可调节电流限制 (利用外部电阻器)
- 过流、接地短路、开路负载和电池短路检测
- 板载 LDO, 允许进行控制信号处理
- 输出跳线, 支持电感放电配置

应用

- ADAS 模块
- 汽车显示模块
- 车身控制模块



## TPS1HC120Q1EVM

## 1 评估模块概述

### 1.1 简介

TPS1HC120-Q1 评估模块 (EVM) 包含一个 TPS1HC120-Q1 集成电路 (IC)，支持单通道高侧开关应用。该 EVM 旨在为评估电阻、电容、电感负载下的 TPS1HC120-Q1 提供便利。本用户指南提供了连接器和测试点描述、电路板原理图和布局，以及物料清单。本文档中的评估板、评估模块和 EVM 等所有术语均指 TPS1HC120Q1EVM。

### 1.2 套件内容

表 1-1 中列出了 EVM 套件的内容。如果缺少任何元件，请与离您最近的德州仪器 (TI) 产品信息中心联系。

表 1-1. 套件内容

条目	数量
TPS1HC120Q1EVM	1

### 1.3 规格

TPS1HC120Q1EVM 与 TPS1HC120-Q1 器件兼容。表 1-2 中列出了安装在该 EVM 上的器件。有关更详细的规格，请参阅器件数据表。

表 1-2. 器件规格

器件型号	持续负载电流	通道计数	封装
TPS1HC120C-Q1	1.2A	1	DYC ( SOT , 8 )

### 1.4 器件信息

TPS1HC120-Q1 是一款受到全面保护的单通道高侧电源开关，集成了 NMOS 功率 FET 和电荷泵。

全面的诊断和高精度电流传感特性可实现对负载的智能控制。已在器件内部设定固定的热关断行为（闩锁关闭或自动重试）；请参阅下文和数据表了解更多信息。

- TPS1HC120A-Q1：自动重试
- TPS1HC120B-Q1：闩锁
- TPS1HC120C-Q1：硬短路自动闩锁

外部可编程电流限制可限制浪涌或过载电流，从而提高系统可靠性。

## 2 硬件

### 2.1 连接说明

本节对 EVM 上的连接器进行了说明，并介绍了如何正确地连接、设置和使用 TPS1HC120-Q1 EVM。

#### 2.1.1 测试点

测试点	说明
TP1	VOUT 测试点
TP2/4	EN/EN_AUX 测试点
TP3/9/10	接地测试点
TP5	电流限制测试点
TP6	IC 接地测试点
TP7/8	FLT1/FLT2 测试点
TP11	LDO 输入测试点
TP12	VS 测试点

#### 2.1.2 跳线配置

跳线	功能
J2	将上拉电阻器连接到 VS 以进行开路负载检测
J4	将 VOUT 连接到外部二极管以实现电感负载能量耗散
J5	将 ILIM 引脚短接到地
J6	绕过接地网络
J8/J10	将 EN/EN_AUX 连接到 LDO 的 5V 信号或接地
J9	将 FLT1/FLT2 连接在一起 ( 用于 GPIO 连接的全局输出 )
J11	将 LDO 的 5V 输出连接到 V_+5V 网络
J12	将 VS 连接到 LDO 的输入；为板载 LDO 供电
J13	将 LDO 的输入连接到 LDO 的使能信号；这样才能为 V_+5V 网络输出 5V

## 3 基于应用的修改

### 3.1 外部修改

#### 3.1.1 A 和 B 版本

器件的 A 和 B 版本的样片必须单独订购并焊接在 U1 上。使用该器件的 A 和 B 版本时，必须进行外部修改。

电流检测功能仅适用于该器件的 A 和 B 版本（代替 **FLT2** 引脚）。电流检测功能通过电流镜在内部实现，此实现通过 **SNS** 引脚和 **GND** 之间的外部电阻器体现。从外部将一个电阻器接地，以将检测电流转换为电压读数。拆下 **R8** 和 **R9**。添加一个串联电阻器和电容器来创建低通滤波器，以滤除噪声；有关此配置的更多信息，请参阅数据表的应用信息部分。

无需对 **DIAG\_EN** 引脚（代替 **EN\_AUX** 引脚）进行修改，因为 **DIAG\_EN** 引脚的控制方式与 **EN\_AUX** 引脚相同。

#### 3.1.2 可调节限流

电流限制将输出电流调节至设定值。该 EVM 可设计为通过 **ILIM** 引脚上的外部电阻器保持不同的电流限制值。可以基于 **RLIM** 设定 11 项设置。本应用中必须使用容差为 1% 的电阻器。将 **R4** 替换为适当的电阻器或使用电位器修改该引脚上的电阻。请移除另一个未使用的电阻器。

下表中未列出的任何电阻器设置都可能被理解为相邻电平中的一个，这不是推荐的配置。

表 3-1. 通过外部电阻器设置的电流限制

电阻值 (kΩ)	ILIM 阈值 (A)
6.75	2.0
7.5	1.8
8.4	1.6
9.6	1.4
11.3	1.2
13.5	1.0
16.9	0.8
22.9	0.6
33.75	0.4
67.5	0.2
开路、短路或超出范围 (< 7.5kΩ 或 > 75kΩ )	2

## 4 硬件设计文件

## 4.1 TPS1HC120Q1EVM 原理图

图 4-1 展示了 EVM 原理图。

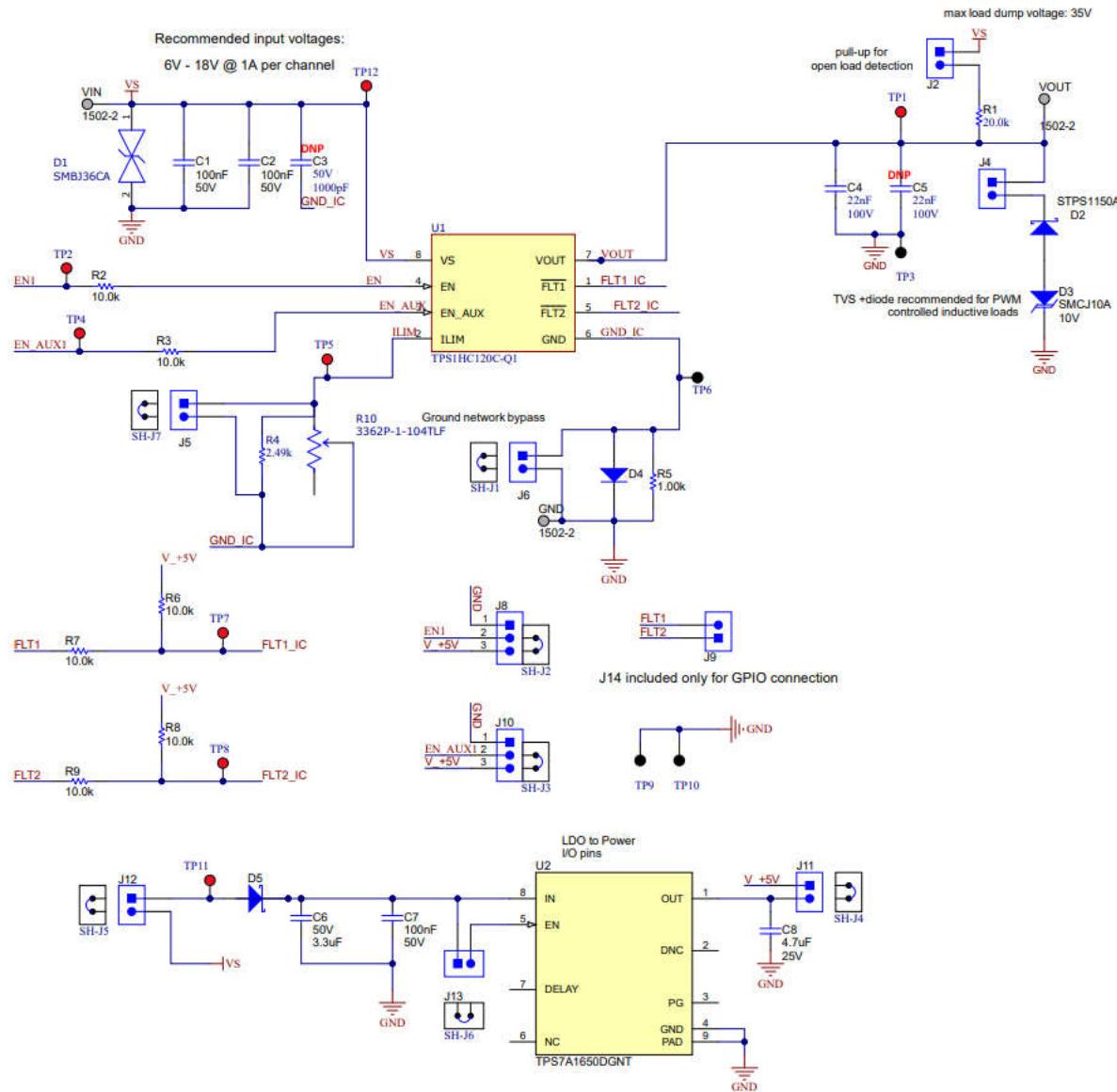


图 4-1. TPS1HC120Q1EVM 原理图

## 4.2 PCB 布局

图 4-2 至 图 4-5 展示了 TPS1HC120-Q1 印刷电路板 (PCB) 的设计。所有元件均位于顶层有源区域中，并且所有有源布线均位于顶层和底层，便于用户轻松地进行查看、探测和评估。

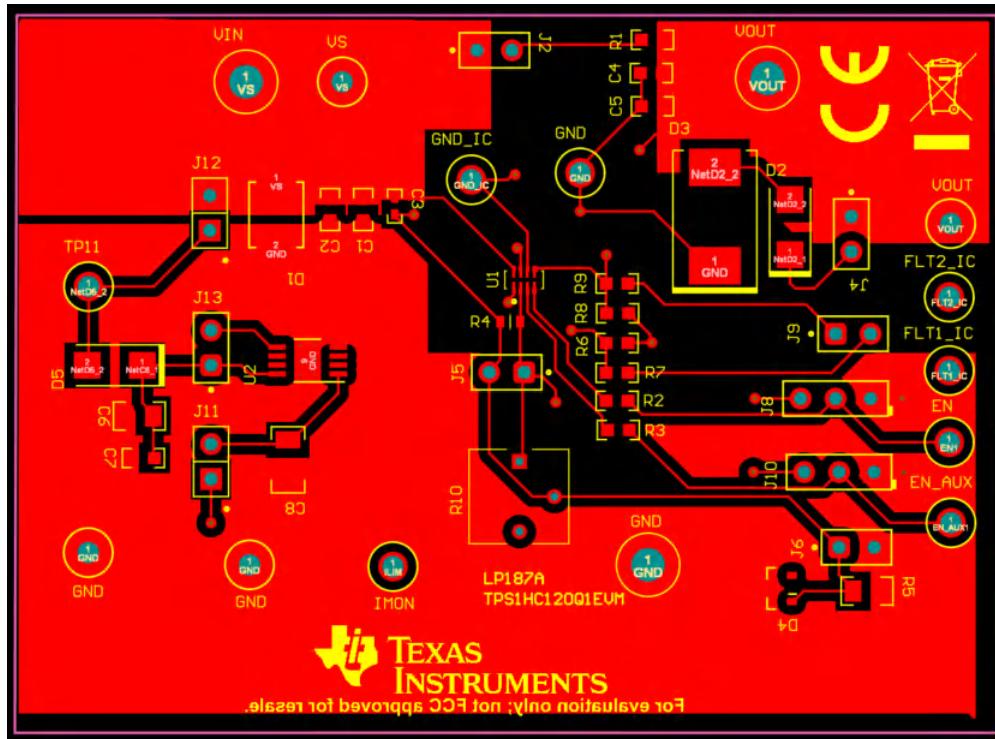


图 4-2. TPS1HC120Q1EVM 顶层

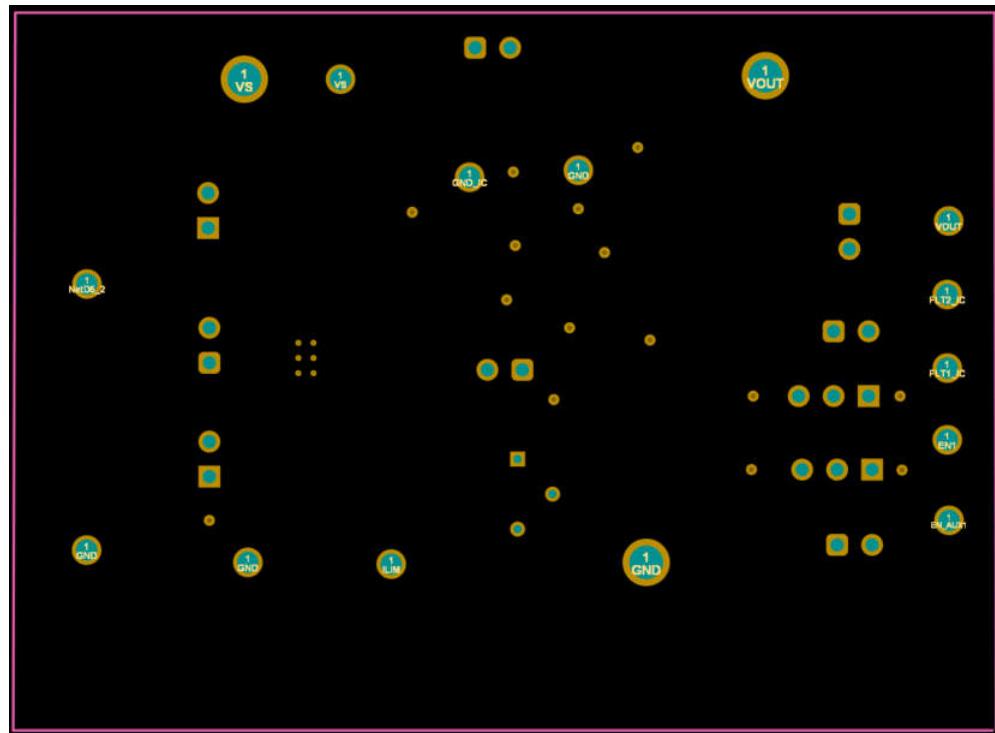


图 4-3. TPS1HC120Q1EVM 第二层

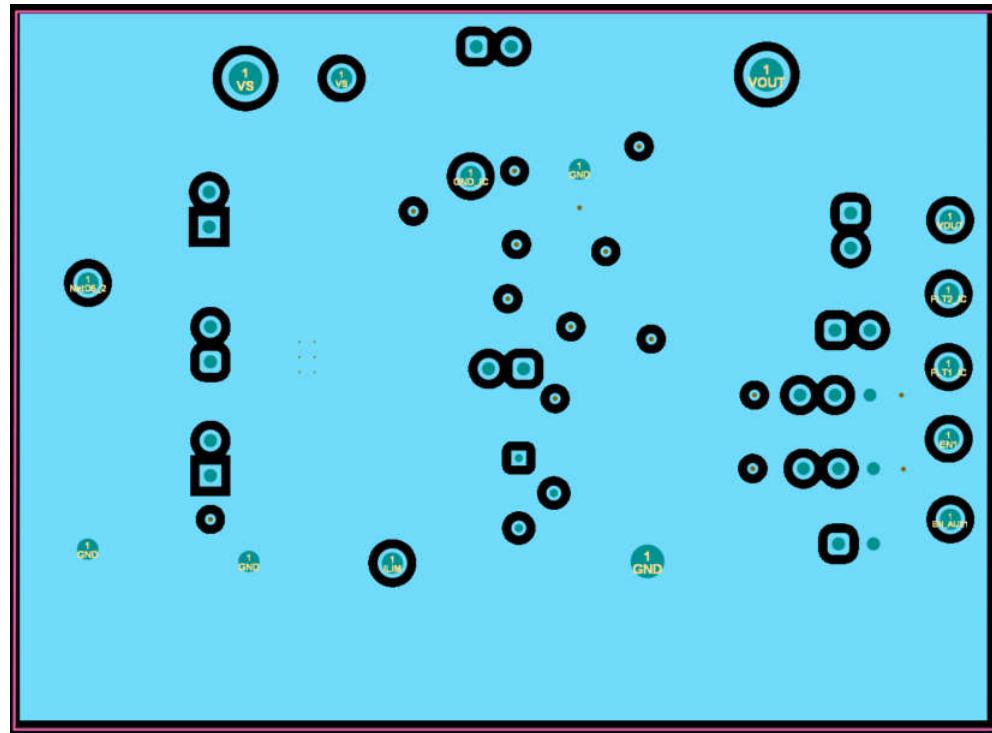


图 4-4. TPS1HC120Q1EVM 第三层 ( 接地 )

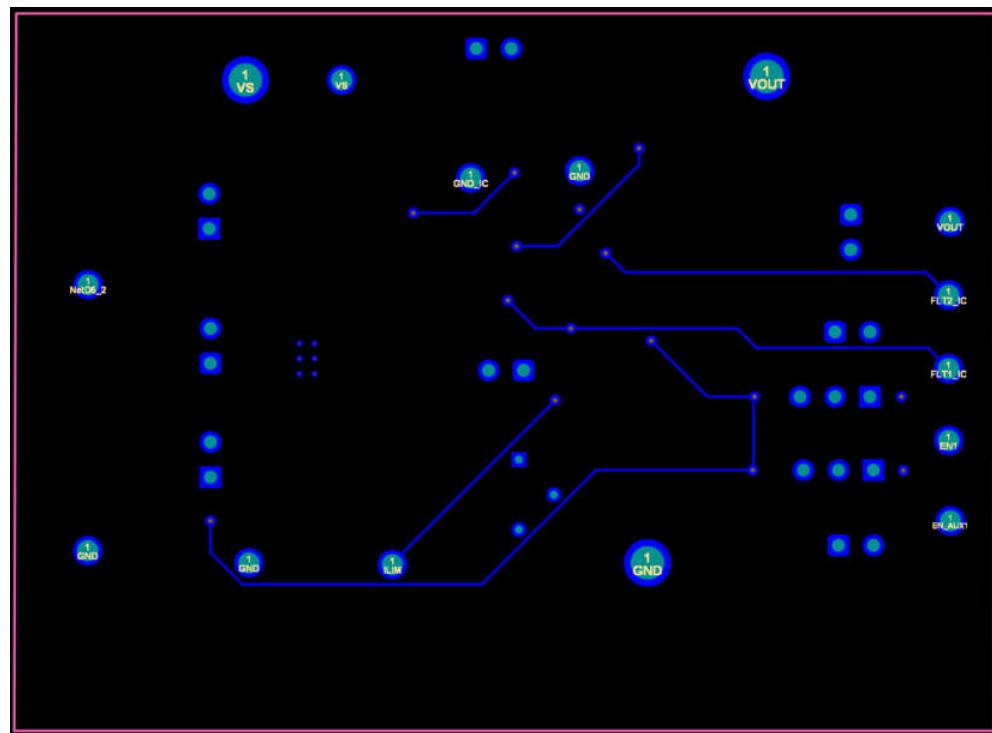


图 4-5. TPS1HC120Q1EVM 底层

## 4.3 物料清单 (BOM)

表 4-1 列出了物料清单 (BOM)。

表 4-1. 物料清单

位号	数量	值	说明	封装参考	器件型号	制造商
C1、C7	2	0.1uF	电容, 陶瓷, 0.1 $\mu$ F, 50V, +/-10%, X7R, AEC-Q200 1 级, 0603	0603	C0603C104K5RACAUTO	Kemet
C4	1	0.022uF	电容, 陶瓷, 0.022uF, 100V, +/-10%, X7R, 0603	0603	C1608X7R2A223K080AA	TDK
C6	1	3.3uF	电容, 陶瓷, 3.3uF, 50V, +/-10%, X5R, 0805	0805	C2012X5R1H335K125AB	TDK
C8	1	4.7uF	电容, 陶瓷, 4.7uF, 25V, +/-10%, X5R, 1206	1206	12063D475KAT2A	AVX
D1	1		二极管 TVS 单双向 36V 600W 2 引脚 SMB	DO-214AA	SMBJ36CA	Littelfuse
D2	1	150V	二极管, 肖特基, 150V, 1A, SMA	SMA	STPS1150A	STMicroelectronics
D3	1	10V	二极管, TVS, 单向, 10V, SMC	SMC	SMCJ10A	Bourns
D4	1	200V	二极管, 开关, 200V, 0.2A, SOT-23	SOT-23	BAS21-7F	Diodes Inc.
D5	1	50V	二极管, 肖特基, 50V, 1A, SMA	SMA	B150-13F	Diodes Inc.
GND、VIN、VOUT	3		引脚, 双转塔, TH	Keystone1502-2	1502-2	Keystone
H9、H10、H11、H12	4		Bumpon, 半球形, 0.44 × 0.20, 透明	透明 Bumpon	SJ-5303 (CLEAR)	3M
J2、J4、J5、J6、J9、J13	6		接头, 100mil, 2x1, 金, TH	2x1 接头	TSW-102-07G-S	Samtec
J8、J10	2		接头, 100mil, 3x1, 锡, TH	接头, 3x1, 100mil, TH	5-146278-3	TE Connectivity
J11、J12	2		接头, 100mil, 2x1, 锡, TH	接头 2x1	90120-0122	Molex
LBL1	1		热转印打印标签, 0.650" (宽) × 0.200" (高) - 10,000/卷	PCB 标签 0.650x 0.200 英寸	THT-14-423-10	Brady
R1	1	20.0k	电阻, 20.0k, 1%, 0.1W, 0603	0603	CRCW060320K0FKEA	Vishay-Dale
R2、R3、R6、R7、R8、R9	6	10.0k	电阻, 10.0k, 1%, 0.1W, AEC-Q200 0 级, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R4	1	2.49k	电阻, 厚膜, 0603, 2.49k $\Omega$ , 1%, 1/10W, $\pm 100\text{ppm}/^\circ\text{C}$ , 模制 SMD, 穿孔载体, T/R	0603	ERJ-3EKF2491V	Panasonic
R5	1	1.00k	电阻, 1.00k, 1%, 0.125W, AEC-Q200 0 级, 0805	0805	CRCW08051K00FKEA	Vishay-Dale
R10	1	100k $\Omega$	电阻, 金属陶瓷微调器, 100k $\Omega$ , 10%, 1/2W, 1 (电气) /1 (机械) 圈, 5mm (6.71 X 7.04 X 14.63mm) 引脚通孔管	PTH_TRIMMER_6MM60_6MM99	3362P-1-104TLF	Bourns
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5、SH-J6、SH-J7	7	1x2	分流器, 100mil, 镀金, 黑色	分流器	SNT-100-BK-G	Samtec

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
TP1、TP2、TP4、 TP5、TP7、TP8、 TP11、TP12	8		测试点，多用途，红色，TH	红色通用测试点	5010	Keystone
TP3、TP6、TP9、TP10	4		测试点，多用途，黑色，TH	黑色通用测试点	5011	Keystone
U1	1		TPS1HC120C-Q1	SOT583	TPS1HC120C-Q1	德州仪器 (TI)
U2	1		具有使能端和电源正常状态指示的 60V、5uA Iq、 100mA 低压降 (LDO) 稳压器，DGN0008C (VSSOP-8)	DGN0008C	TPS7A1650DGNT	德州仪器 (TI)

## 5 其他信息

### 5.1 商标

所有商标均为其各自所有者的财产。

## 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.

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### 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](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.

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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。

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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](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.

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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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