EVM User's Guide: TPSM65660EVM

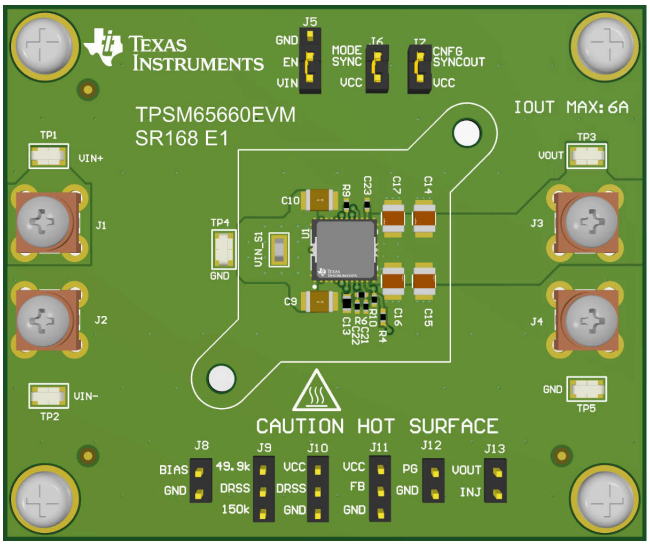
TPSM65660 评估模块

说明

TPSM65660EVM 评估模块 (EVM) 有助于设计人员评估 TPSM65660 IC 宽输入电压降压模块的运行情况和性能。

特性

- 3.5V 到 65V 的宽输入电压范围
- 3.3V、5V 固定和可调节输出电压选项
- 输出电流高达 6A
- 300kHz 至 2.2MHz 开关频率
- 超低开关节点振铃以降低电磁干扰 (EMI)
- 可将两个模块设置为以交错模式（并联输出）运行，可实现精确的电流共享，从而支持高达 12A 的输出电流



TPSM65660EVM

1 评估模块概述

1.1 简介

TPSM65660EVM 可以配置为向最高 6A 的负载提供可选的 3.3V、5V 或可调节输出。通过重新配置电路板元件，TPSM65660EVM 可用于许多不同的配置中。另请参阅节 1.4。

1.2 套件内容

此套件包含一个 TPSM65660EVM。

1.3 规格

节 3.2 介绍了 TPSM65660EVM 的性能特性。

除非另有说明：V_{IN} = 24V，V_{OUT} = 5V，T_A = 25°C。

1.4 器件信息

TPSM65660 IC 是易于使用的同步降压模块，能够通过高达 65V 的输入电压提供高达 6A 的负载电流。默认 EVM 采用 TPSM65660VCLR 器件。表 1-1 列出了可与 TPSM65660EVM 一同使用的其他器件。要在 EVM 中使用这些器件，必须进行适当的无源器件更改。

表 1-1. TPSM65660EVM 器件选项

器件 OPN	V_{IN}（最大值）	V_{OUT}（最大值）	I_{OUT}（最大值）	外部补偿，外部软启动
TPSM65660VCLR	65V	24V	6A	是

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，确保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 http://ti.com/customer support。

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。*如果不满足资格，则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. 穿戴人员防护装备（例如乳胶手套或具有侧护板的安全眼镜）或者用带有互锁机构的透明塑料箱装好 EVM，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 其他图像

图 2-1 和图 2-2 分别展示了 TPSM65660EVM 的正面和背面图像

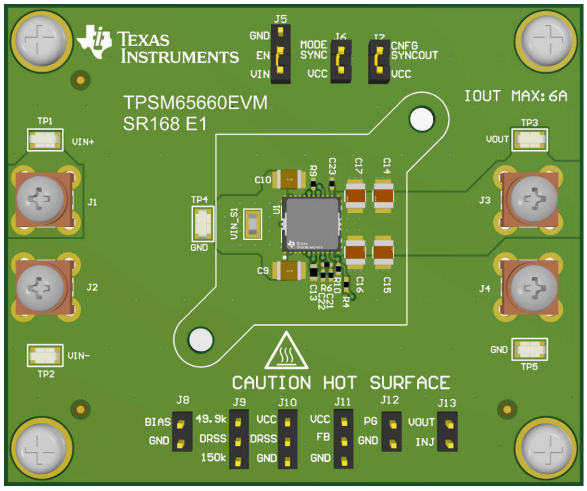


图 2-1. TPSM65660EVM 顶面

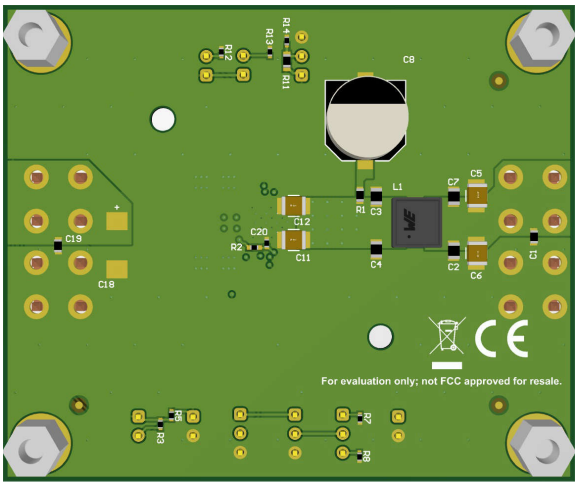


图 2-2. TPSM65660EVM 底部

2.2 电源要求

在正常条件下，3.5V 至 65V 范围内且能够提供 6A 电流的任何电源均可用于评估 TPSM65660EVM。

2.3 设置和操作

本节对 EVM 上的连接器、测试点和跳线进行了说明，并说明了如何正确地连接、设置和使用 TPSM65660EVM。要了解连接器和跳线的位置以及典型设置，请参阅 图 2-3。

信号	连接器和测试点	说明
VIN	J1、TP1、VIN_S1	端子块 J1 用作模块的输入。在 J1 和 J2 之间施加输入电压。 TP1 和 VIN_S1 可用作正 DMM 连接以进行 VIN 检测。TP2 用作 VOUT 检测的负极 DMM 连接。
VOUT	J3、TP3	端子块 J3 用作模块的输出。将输出负载连接到 J3 与 J4 之间。 TP3 (S+) 用作正极 DMM 连接以进行 VOUT 检测。TP5 (S－) 用作 VOUT 检测的负极 DMM 连接。
GND	TP2、TP4、TP5	转换器接地。TP4 可根据需要用作任何接地连接器。

信号	连接器和测试点	说明
EN	J5	EN 跳线 (J5) 用于使能或禁用 EVM。 要使用外部 UVLO 功能，请根据需要填充 R11 和 R14 并移除 EN 跳线分流器。请注意，为了准确测量关断静态电流，必须移除这些电阻器（如果使用）并将 EN 跳线分流器移至“OFF”位置。
MODE/SYNC	J6	MODE 跳线 (J6) 用于选择运行模式。移除 MODE 跳线后，MODE 引脚处于接地状态，器件在自动模式下运行。器件根据负载电流在自动 PFM/FPWM 模式下运行。安装 MODE 跳线后，MODE 引脚连接至 VCC，器件以 FPWM 模式运行，器件在所有负载情况下以固定频率运行。 MODE/SYNC 引脚也是频率同步输入。要将器件与外部时钟同步，请移除 MODE 跳线分流器，并将时钟应用于 J6 的 MODE/SYNC 引脚与 GND 之间
PGOOD	J12	PGOOD J12 用于监控电源正常状态指示器。该标志指示输出电压是否已达到调节电平。PGOOD 是一个开漏输出端，通过 EVM 上的 100kΩ 电阻器 (R5) 连接到 VCC。
FB 连接	J11	跳线 J11 用于选择 EVM 输出电压设置。在出厂默认配置中，EVM 配置为采用外部可调设置提供 12V 输出。保持跳线开路以配置可调输出电压。在 FB 引脚与 VCC 之间安装跳线以获得 5V 固定输出，并在 FB 与 GND 之间安装跳线以获得 3.3V 电压。 **注意：**为固定输出配置安装 R2，以闭合环路。
CNFG/SYNCOUT	J7	主器件配外部补偿时，电阻接地。主器件配内部补偿时，电阻短接至 VCC。若移除 R12，该引脚不得悬空。 **注意：**对于此 EVM，在使用外部补偿时，移除两个输出电容器。
BIAS	J8	BIAS 跳线 (J8) 用作内部 LDO 稳压器的辅助输入。C20 有助于绕过开关噪声。在 EVM 出厂默认配置中，BIAS 通过 R2 连接到 VOUT。 要将 LDO 输入更改为从 3.3V 到 30V 可用的外部电源，请移除 R2，并将该引脚直接连接到外部电源。 如果配置为固定 3.3V 或 5V 输出，则必须安装 R2 以闭合控制环路。 另请参阅 TPSM65660 数据表。
环路响应图	J13、TP4	在使用可调输出电压模式时，可以使用 图 2-4 中所示的连接来绘制波德图测量。必须填充 R3 才能进行此测试，并且探针必须与 TP4 具有接地连接。 在固定 3.3V 或 5V 输出电压配置下，无法获取波德图测量。TI 建议运行阶跃负载响应来评估环路稳定性。
DRSS/MCOMM	J9、J10	双随机展频 (DRSS) 选择引脚。有关可用的 DRSS 选项，另请参阅表 2-1。如果配置为双相运行，则该引脚成为主器件和辅助器件之间的模式通信引脚。对于双相运行，请将主器件和辅助器件的 MCOMM 引脚连接在一起。

表 2-1. DRSS/MCOMM 选择

DRSS/MCOMM 引脚	DRSS	压摆率控制
短接至 VCC	启用，±10%，6kHz	启用
浮点	启用，±10%，6kHz	启用
150kΩ 至 PGND	启用，±10%，6kHz	禁用
49.9kΩ 至 PGND	禁用	禁用
短接至 PGND	禁用	禁用

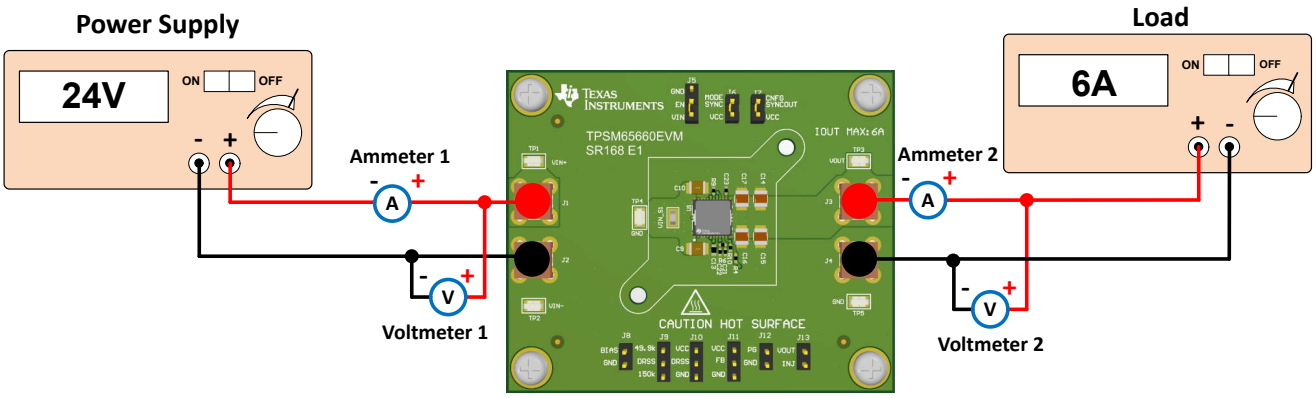


图 2-3. TPSM65660EVM 设置

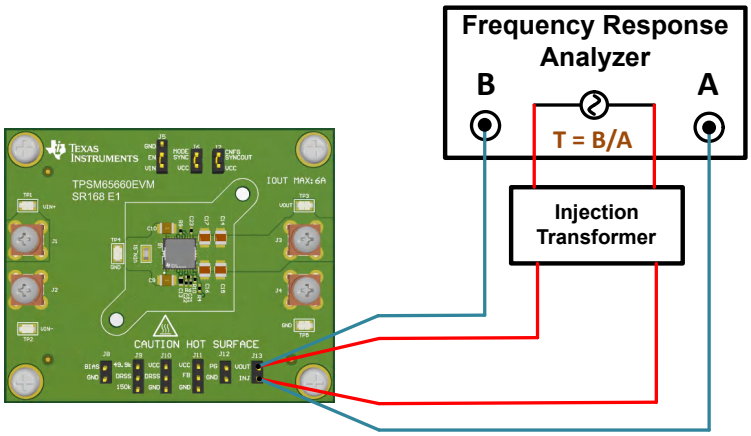


图 2-4. TPSM65660EVM 波德连接

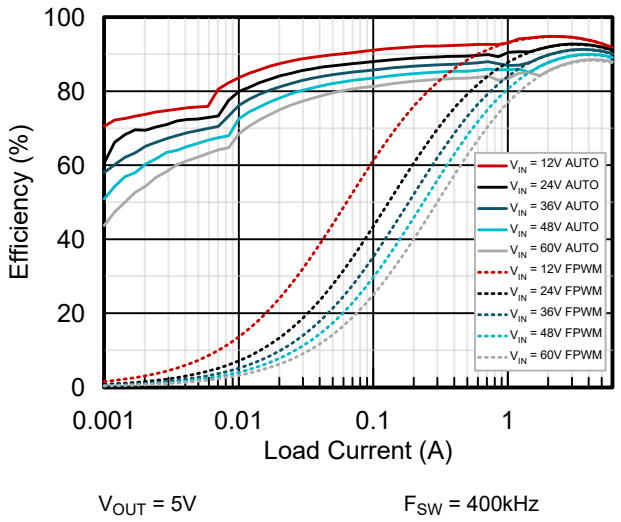
3 实现结果

3.1 评估设置

使用 TPSM65660EVM 通过图 2-3 中所示的设置获取以下数据。

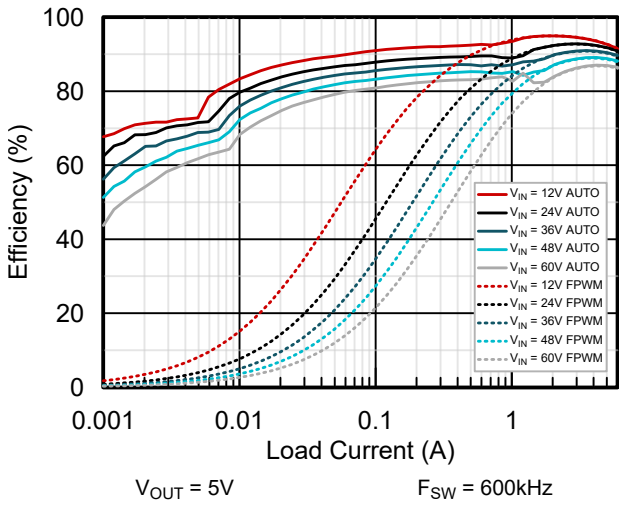
3.2 性能数据和结果

除非另有说明，否则以下条件适用：T_A = 25°C，V_{IN} = 24V，400kHz。



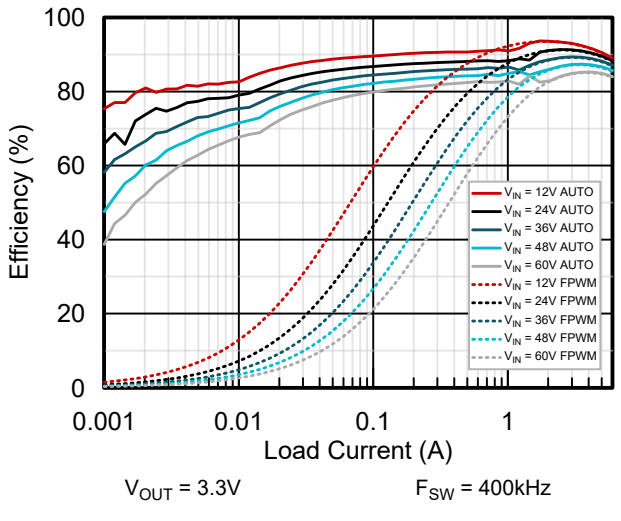
V_{OUT} = 5V　　F_{SW} = 400kHz

图 3-1. 效率



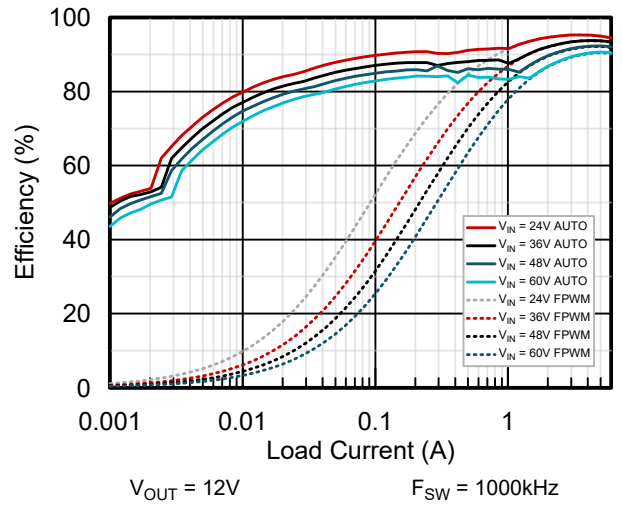
V_{OUT} = 5V　　F_{SW} = 600kHz

图 3-2. 效率



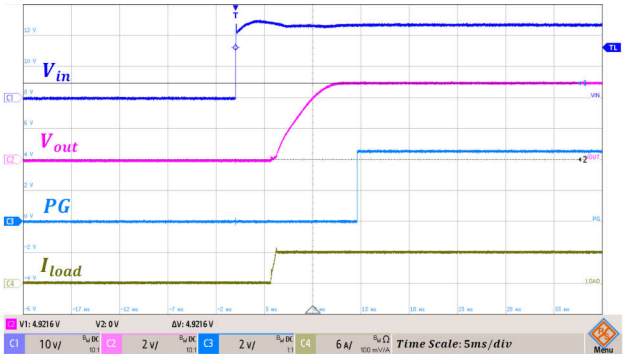
V_{OUT} = 3.3V　　F_{SW} = 400kHz

图 3-3. 效率



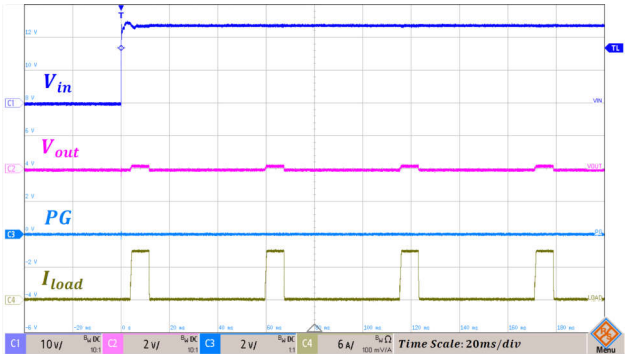
V_{OUT} = 12V　　F_{SW} = 1000kHz

图 3-4. 效率



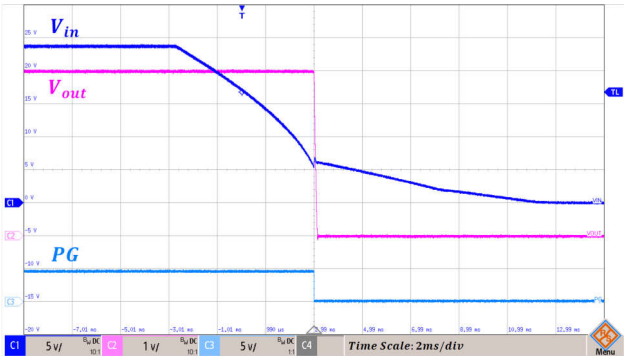
I_{OUT} = 6A　　V_{IN} = 24V　　自动　　V_{OUT} = 5V

图 3-5. 满载启动



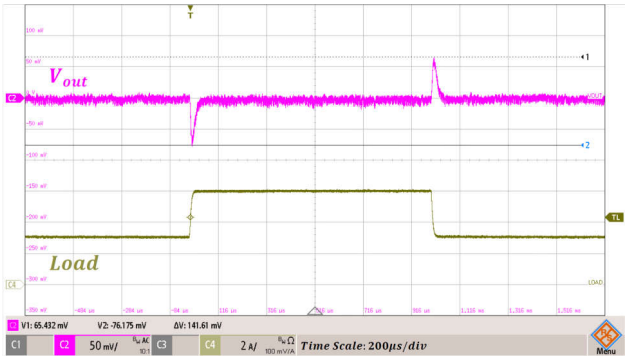
V_{IN} = 24V　　自动　　V_{OUT} = 5V

图 3-6. 输出短路时启动



I_{OUT} = 6A　　V_{IN} = 24V　　自动　　V_{OUT} = 5V

图 3-7. 关断



I_{OUT} = 3 至 6A　　V_{IN} = 24V　　自动　　V_{OUT} = 5V

图 3-8. 负载瞬态

4 硬件设计文件

4.1 原理图

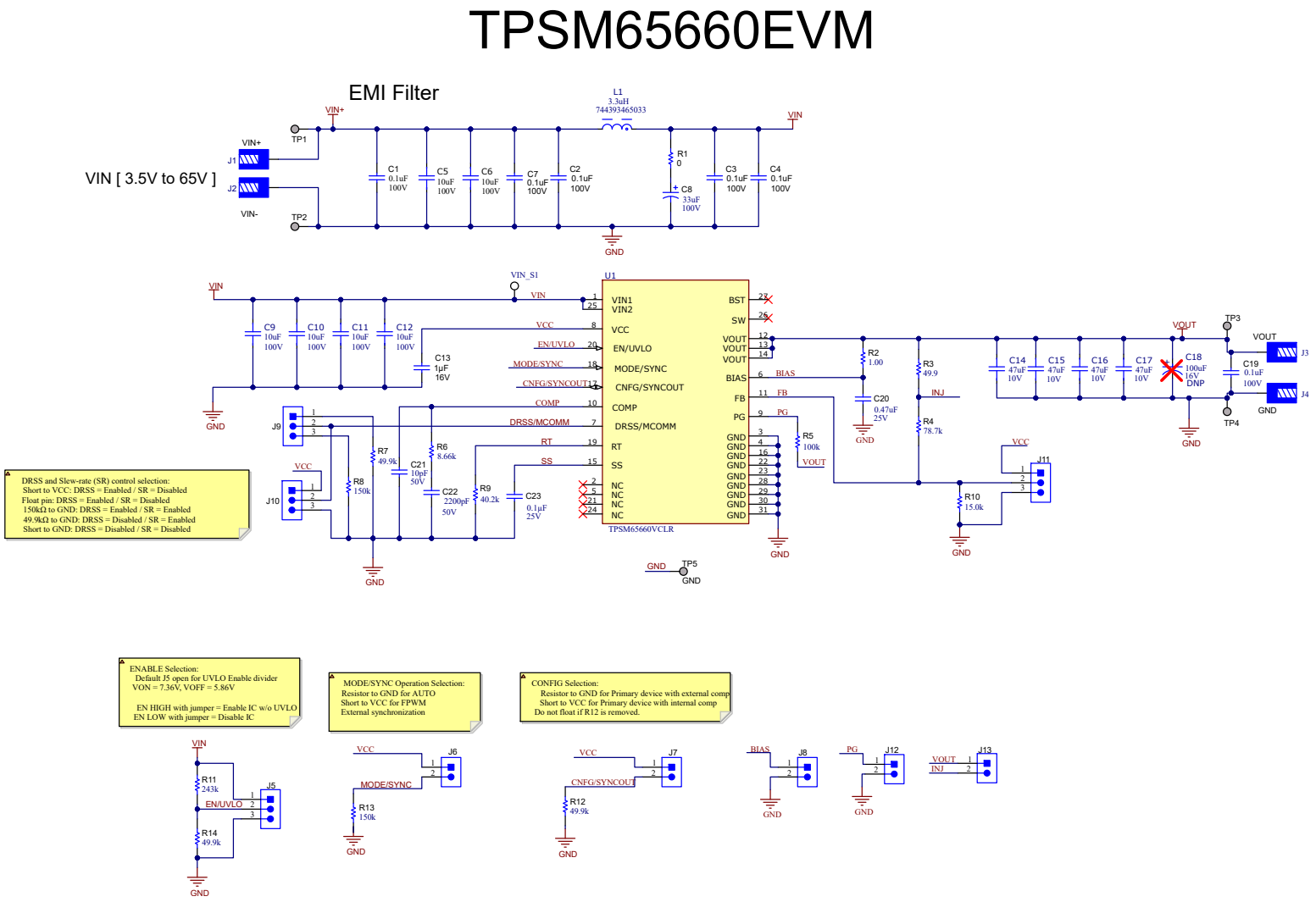


图 4-1. TPSM65660EVM 原理图

4.2 PCB 布局

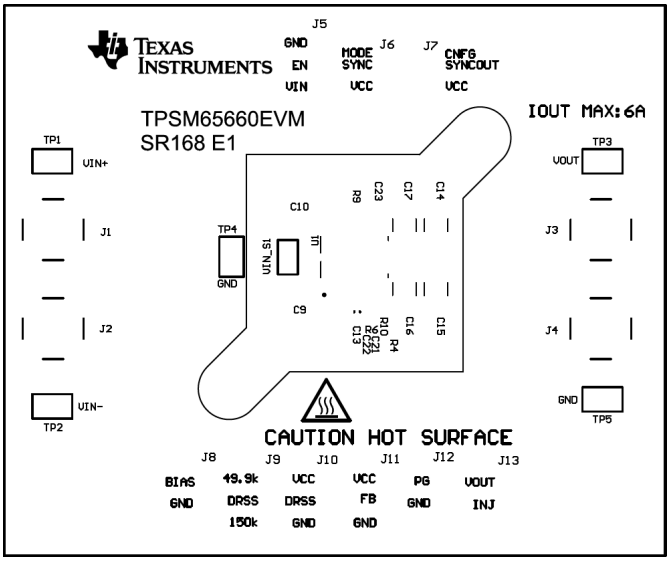


图 4-2. PCB 顶部丝印

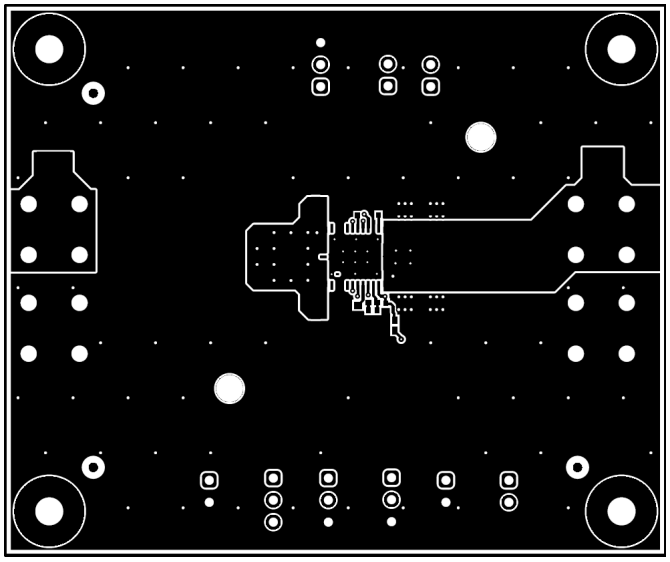


图 4-3. PCB 顶层

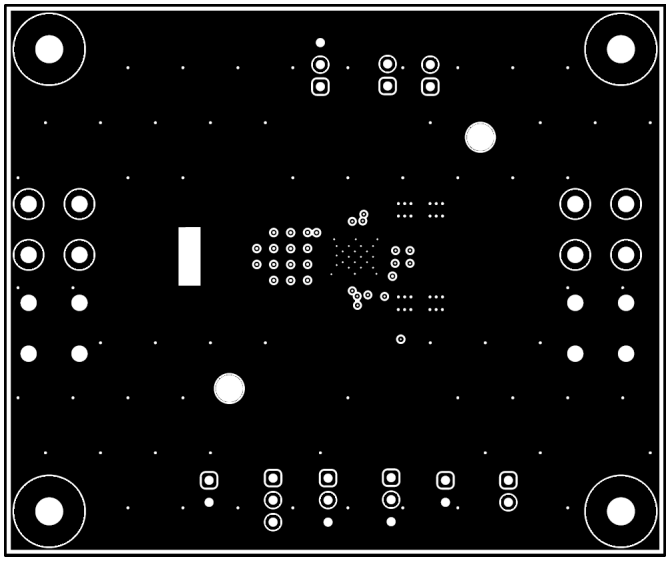


图 4-4. PCB 信号层 1

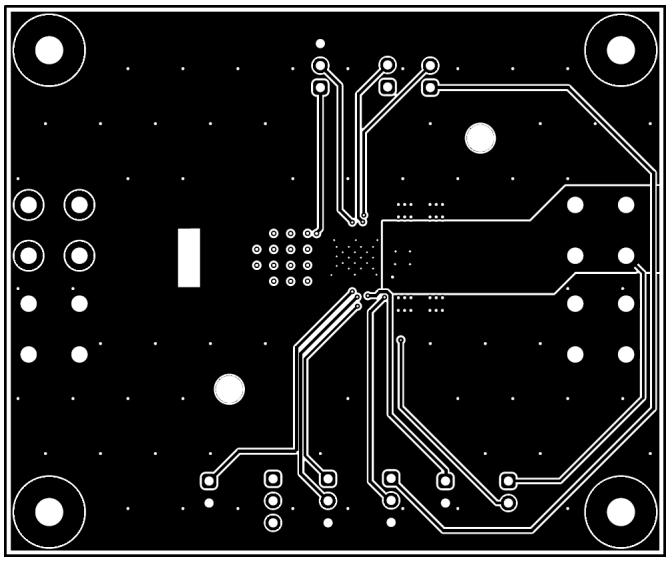


图 4-5. PCB 信号层 2

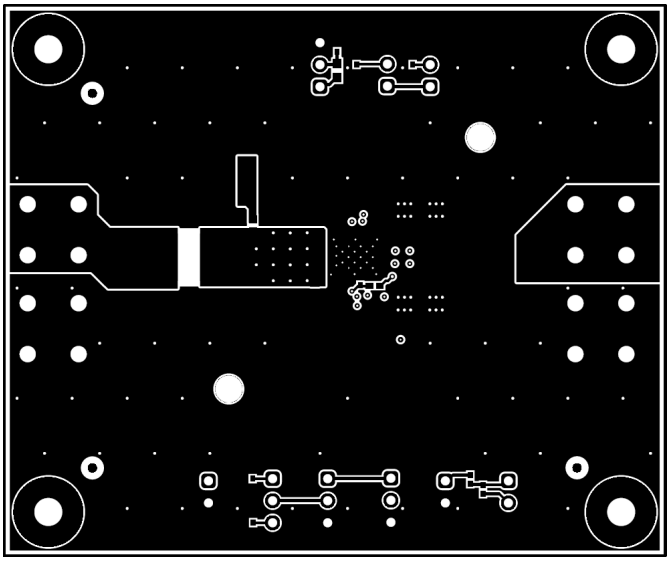


图 4-6. PCB 底层

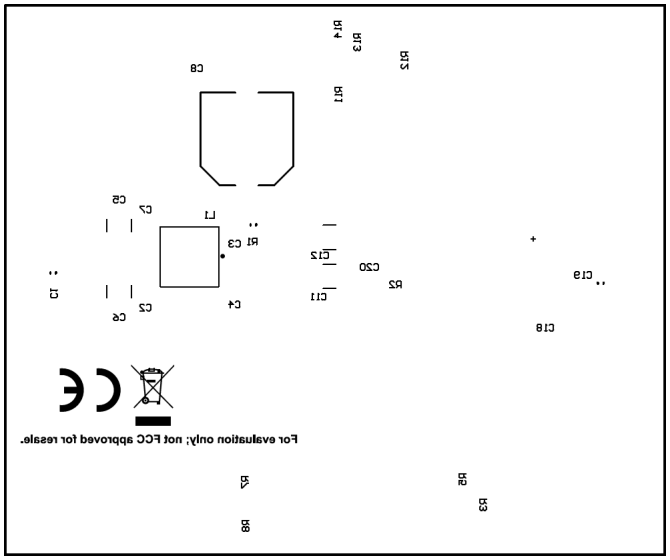


图 4-7. PCB 底部丝印

4.3 物料清单 (BOM)

表 4-1. TPSM65660EVM BOM

参考位号	数量	值	说明	器件型号	制造商
C1, C19	2	0.1µF	电容，陶瓷，0.1µF，100V，+/-10%，X7R，AEC-Q200 1 级，0603	GCJ188R72A104KA01D	MuRata
C2、C3、C4、C7	4	0.1µF	电容，陶瓷，0.1µF，100V，+/– 10%，X7R，AEC-Q200 1 级，0805	CGA4J2X7R2A104K125AA	TDK
C5、C6、C9、C10、C11、C12	6	10µF	10µF ±10% 100V 陶瓷电容器 X7R 1210（公制 3225）	CGA6P1X7R2A106K250AC	TDK
C8	1	33µF	电容，铝制，33uF，100V，+/-20%，0.7Ω，AEC-Q200 2 级，SMD	EEE-FK2A330P	Panasonic
C13	1	1µF	电容，陶瓷，1µF，16V，+/– 20%，X7R，AEC-Q200 1 级，0603	GCM188R71C105MA64D	MuRata
C14、C15、C16、C17	4	47µF	汽车用陶瓷电容器，47uF，±10%，10VDC，X7S，1210，压纹 T/R	GCM32EC71A476KE02K	Murata
C20	1	0.47µF	电容，陶瓷，0.47uF，25V，+/-10%，X5R，0402	GRM155R61E474KE01D	MuRata
C21	1	10pF	电容，陶瓷，10pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402	CGA2B2C0G1H100D050BA	TDK
C22	1	2200pF	电容，陶瓷，2200pF，50V，+/-10%，X7R，AEC-Q200 1 级，0402	GCM155R71H222KA37D	MuRata
C23	1	0.1µF	电容，陶瓷，0.1µF，25V，+/-10%，X7R，AEC-Q200 1 级，0402	CGA2B3X7R1E104K050BB	TDK
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	B&F Fastener Supply
H5、H6、H7、H8	4		六角螺柱，0.5"L #4-40，尼龙	1902C	Keystone
H9、H10、H11、H12	4		机械螺钉盘 PHILLIPS M3 5mm	MPMS 003 0005PH	B&F Fastener Supply
J1、J2、J3、J4	4		REDCUBE WP-THRBU	74650173	Würth Elektronik
J5、J9、J10、J11	4		接头，100mil，3x1，金，TH	TSW-103-07G-S	Samtec
J6、J7、J8、J12、J13	5		接头，100mil，2x1，金，TH	TSW-102-07G-S	Samtec
L1	1	3.3µH	屏蔽式功率电感器 3.3µH 20% 容差，6.5mΩ 16.6A	XGL6060-332MEC	Coilcraft
R1	1	0	电阻，0，1%，0.1W，AEC-Q200 0 级，0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R2	1	1	电阻，1.00，1%，0.063W，AEC-Q200 0 级，0402	CRCW04021R00FKED	Vishay-Dale
R3	1	49.9	电阻，49.9，1%，0.063W，AEC-Q200 0 级，0402	CRCW040249R9FKED	Vishay-Dale
R4	1	205k	电阻，205k，1%，0.063W，AEC-Q200 0 级，0402	CRCW0402205KFKED	Vishay-Dale
R5	1	100k	电阻，100k，1%，0.063W，AEC-Q200 0 级，0402	CRCW0402100KFKED	Vishay-Dale
R6	1	8.66k	电阻，8.66k，1%，0.063W，AEC-Q200 0 级，0402	CRCW04028K66FKED	Vishay-Dale
R7、R12、R14	3	49.9k	电阻，49.9k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040249K9FKED	Vishay-Dale
R8、R13	2	150k	电阻，150k，5%，0.063W，AEC-Q200 0 级，0402	CRCW0402150KJNED	Vishay-Dale
R9	1	40.2k	电阻，40.2k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040240K2FKED	Vishay-Dale
R10	1	15.0k	电阻，15.0k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040215K0FKED	Vishay-Dale
R11	1	243k	电阻，243k，1%，0.1W，0603	RC0603FR-07243KL	Yageo
SH-J1、SH-J2、SH-J3	3	1x2	分流器，100mil，镀金，黑色	SNT-100-BK-G	Samtec
TP1、TP2、TP3、TP4、TP5	5		测试点，微型，SMT	5019	Keystone
U1	1		TPSM65660VCLR	TPSM65660VCLR	德州仪器 (TI)
VIN_S1	1		测试点，微型，SMT	5015	Keystone

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 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

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/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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, INDEMITY 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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TI 反对并拒绝您可能提出的任何其他或不同的条款。

最后更新日期：2025 年 10 月