

EVM User's Guide: TPSM8287B30-2X-EVM

TPSM8287B30-2X-EVM 评估模块

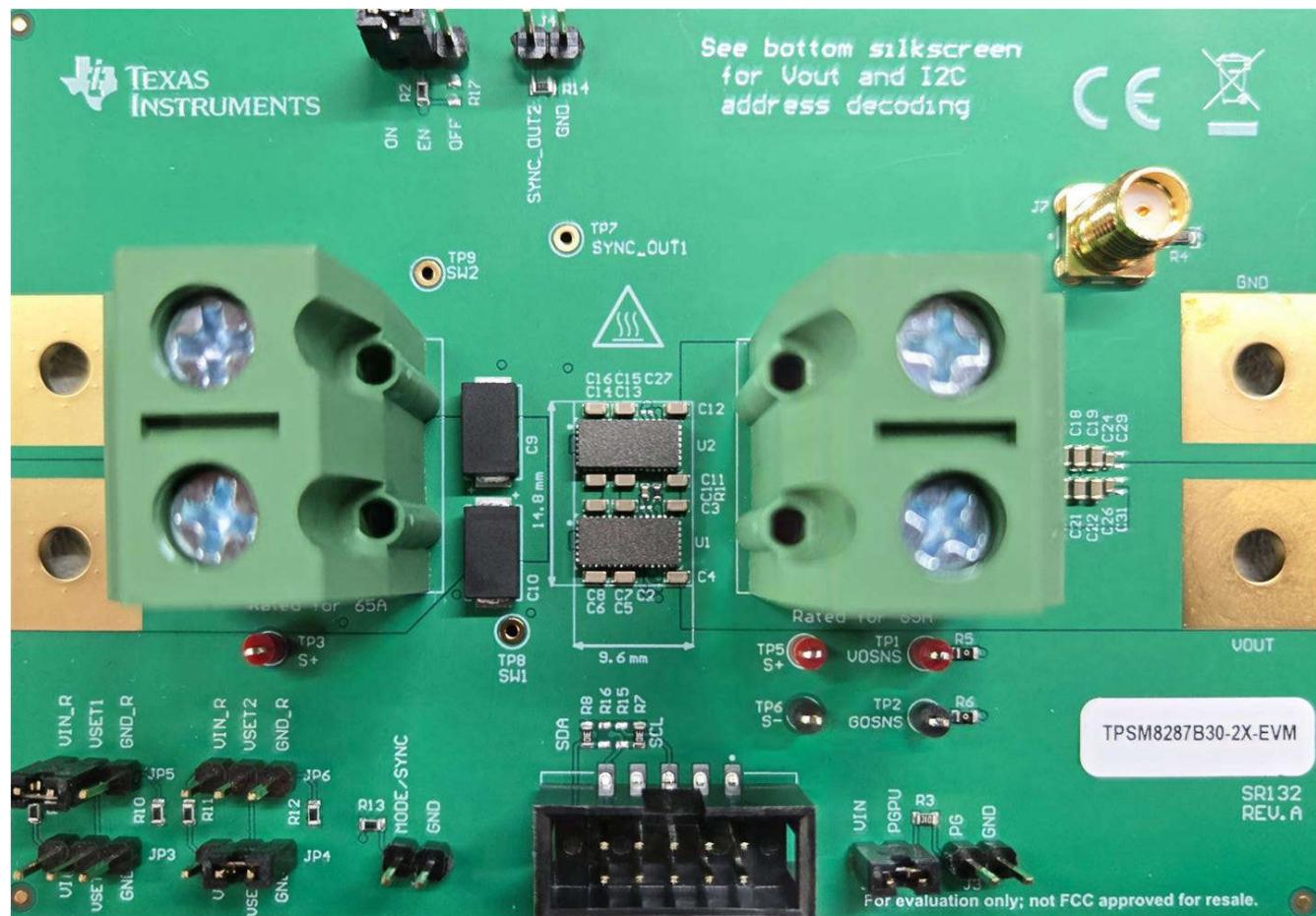


说明

TPSM8287B30-2X-EVM 评估模块 (EVM) 有助于在双堆叠配置下评估 TPSM8287B30。该器件是具有 I²C 接口、遥感和频率同步功能并采用 3.75mm × 8mm MagPack™ 封装的引脚对引脚兼容降压电源模块，支持高达 60A 的负载电流。这些 EVM 可提供 0.4V 至 1.675V 的 I²C 可调节输出电压，精度为 0.8%，输入电压范围为 2.7V 至 6V。

特性

- 具有集成电感器、输入电容器和输出电容器且采用 MagPack 封装的 60A 输出双相电源模块
- 总设计面积为 9.6mm × 14.8mm (142mm²)
- 出色的热性能 ($\theta_{JA} = 11.9^{\circ}\text{C}/\text{W}$)
- 启动输出电压可通过跳线调节为 16 个值中的一个
- 具有遥感功能和可调节控制环路补偿的高精度输出电压



1 评估模块概述

1.1 简介

TPSM8287B30-2X-EVM 支持在双堆叠降压转换器应用中评估 TPSM8287B30LAPVCHR 电源模块。

TPSM8287Bxx 是高效率、高精度、小尺寸、薄型负载点 (POL) 电源模块，适用于 FPGA、ASIC、DSP 等内核电源应用；光学模块；存储；测试和测量以及其他空间受限型应用。

1.2 套件内容

TPSM8287B30-2X-EVM 工具箱（套件）包括一个 PCB (SR132)，用于在双堆叠（并联）应用中评估 TPSM8287B30 器件。要使用 TI 的 TPSM8287B30 EVM GUI 通过 I²C 总线来评估器件，请单独订购 [USB2ANY 适配器 EVM](#)。

1.3 规格

下表提供了 TPSM8287B30-2X-EVM 性能规格的汇总。

表 1-1. 性能规格汇总

规格	测试条件	最小值	典型值	最大值	单位
输入电压		2.7	3.3 或 5	6	V
输出电压	$V_{IN} > V_{OUT} + 1.5V$	0.4	0.6	1.675	V
输出电流	TPSM8287B30-2X-EVM (SR132-001)	0	60	60	A

1.4 器件信息

TPSM8287B30 是引脚对引脚兼容的 15A、20A、25A 和 30A 电源模块系列，该系列集成了电感器以及输入和输出电容器。这些器件使用 I²C 接口微调输出电压，用于精确匹配处理器内核的需求。这些器件无需 I²C 接口即可运行，用于提供具有高电流、固定输出电压的电源。

2 硬件

2.1 安全说明

警告



表面高温。接触会导致烫伤。请勿触摸。

警告

输入和输出端可能存在高电流。

警告

外部连接：对于系统中连接的所有硬件/元件，与硬件的所有外部连接必须保持在建议的工作条件和预期用途范围内。

2.2 接头信息

J1 - VIN/GND	输入电源和 EVM 之间的输入和回路连接。 该连接器可使用高达 6 AWG 的导线。
MH1/2 - VIN/GND	输入电源和 EVM 之间的备用输入和回路连接。 这些孔的尺寸适合 M4 或 8 号螺栓。
J2 - VOUT/GND	从 EVM 到负载的输入和返回连接。 该连接器可使用高达 6 AWG 的导线。
MH3/4 - VOUT/GND	EVM 和负载之间的备用输入和回路连接。 这些孔的尺寸适合 M4 或 8 号螺栓。
J3 - PG/GND	该接头的引脚 2 为 PG 输出，引脚 1 接地。
J4 - SYNC_OUT2/GND	该接头的引脚 1 出现第二个器件的 SYNC_OUT 信号，引脚 2 接地。
J6 - MODE/SYNC 和 GND	如果需要，应在引脚 1 上施加同步信号。
J7 - VOUT/GND SMA	测量该 SMA 连接器处的输出电压波形。

2.3 跳线信息

JP1 - EN	EN 引脚输入跳线。使提供的跳线跨接 ON 和 EN 以开启模块。使用跳线跨接 OFF 和 EN，以便关断模块。在 ON 和 EN 之间安装跳线后，用户就可以用 R2 和 R17 产生精确的导通电压。保持 R2 的值高于 15k Ω 。
JP2 - PG 上拉电压	PG 引脚上拉电压跳线。将提供的跳线置于 JP2 上，从而将 PG 引脚上拉电阻连接到 VIN。或者，可移除跳线，并在引脚 1 上施加不同电压，从而将 PG 引脚上拉到不同电平。外部施加电压必须低于 6.5V。
JP3 和 JP5 - VSET1	VSET1 设置跳线。将提供的跳线置于 JP3 或 JP5 上，但不能同时置于两者上。
JP4 和 JP6 - VSET2	VSET2 设置跳线。将提供的跳线置于 JP4 或 JP6 上，但不能同时置于两者上。

要正确设置启动电压，必须在施加 VIN 之前设置 VSETx 的两个跳线。施加 VIN 后更改跳线不会有任何影响。

警告

施加 VIN 之前，确认两个跳线分别安装至 JP3 或 JP5 以及 JP4 或 JP6。

请勿将 VSETx 引脚悬空。

2.4 接口

J5 - I²C	I ² C 适配器连接。将 10 引脚带状电缆从 USB2ANY 适配器 EVM 连接到该接头，以便通过 TPSM8287B30 EVM GUI 经由 I ² C 总线与器件进行通信。该接头为键控式，可防止向后安装。TPSM8287B30-2X-EVM 无需 USB2ANY EVM 即可运行。
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2.5 测试点

TP1/2 - VOSNS/GOSNS	稳压输出电压连接。测量此处的输出电压调节。
TP3/4 - VIN/GND S+/S -	输入电压感测连接。测量此处的输入电压。
TP5/6 - VOUT/GND S+/S -	用于效率测量的输出电压检测连接。计算效率时测量此处的输出电压。
TP7 - SYNC_OUT1	此处出现第一个器件的 SYNC_OUT 信号。此测试点未安装。
TP8 - SW1	SW1 节点测试点。测量此点处的 SW1 节点。此测试点未安装。
TP9 - SW2	SW2 节点测试点。测量此点处的 SW2 节点。此测试点未安装。

3 软件

TPSM8287B30 EVM GUI 位于 [TPSM8287B30-2X-EVM](#) 工具文件夹，可通过 USB2ANY 适配器 EVM 经由 I²C 总线与器件进行通信。必须施加有效的输入电压。

GUI 将自动连接到 EVM。如果未自动连接，则点击 GUI 右上角的连接按钮或 GUI 左下角的链接符号。

4 实现结果

TPSM8287B30-2X-EVM 用于评估 [TPSM8287Bxx 具有 I²C 接口和遥感功能且采用 MagPack 封装的 2.7V 至 6V 输入、15A、20A、25A 和 30A 可并联降压电源模块](#) 数据表中的所有数据。对于此 EVM 的性能，请参阅器件数据表。

4.1 评估设置

4.1.1 纹波测量设置

SMA 连接器 J7 用于测量输出电压纹波和瞬态响应。为获得出色效果，请使用同轴电缆（而不是使用 10x 示波器探头）将 SMA 连接器直接连接到示波器。该操作允许在示波器上设置 V/div 最小值以查看纹波。该 EVM 包含一个与 SMA 连接器串联的 49.9Ω 电阻，用于阻挡同轴电缆上的反射。可以使用示波器上的高阻抗或 50Ω 端接设置。

4.1.2 环路响应测量

将 R5 替换成 10Ω 电阻并在两端施加注入信号，即可测量环路响应。图 4-2 展示了环路响应测量结果。

4.1.3 精确的导通电压

安装 JP1 上的跳线后，可以修改 R2 和 R17 以产生精确的导通电压。有关详细信息，请参阅 [使用带有精密使能引脚阈值的直流/直流转换器实现零噪声启动 模拟设计期刊](#)。保持 R2 的值高于 $15k\Omega$ 。

4.2 性能数据和结果

下图显示了 TPSM8287B30-2X-EVM 的热性能。

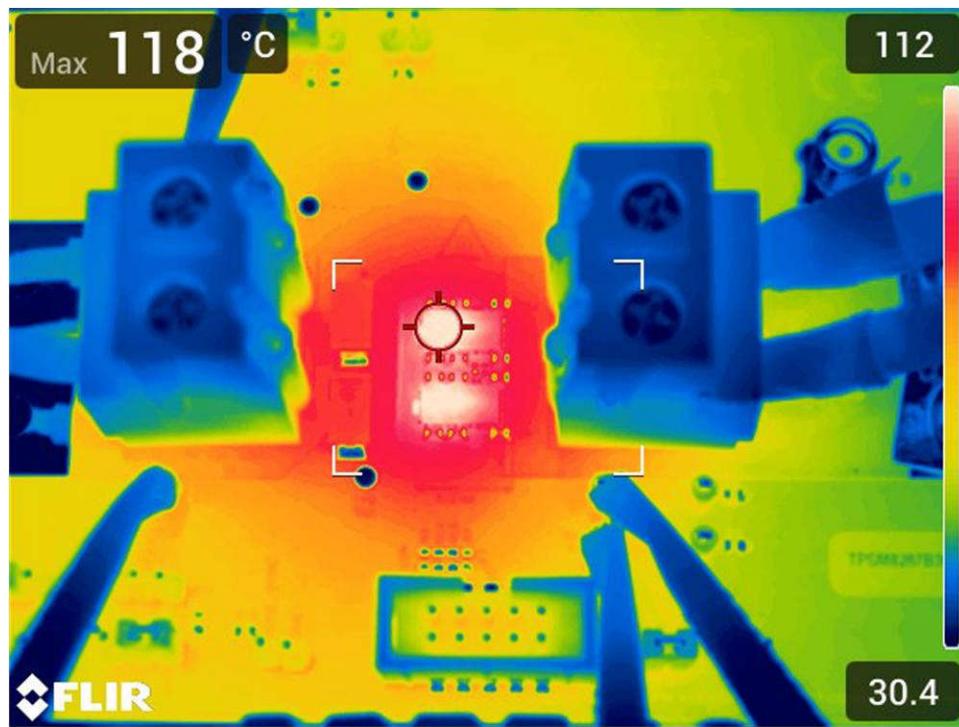


图 4-1. 热性能 (TPSM8287B30-2X-EVM , $V_{IN} = 5V$, $V_{OUT} = 0.6V$, $I_{OUT} = 60A$)

下图显示了 TPSM8287B30-2X-EVM 的环路响应测量。

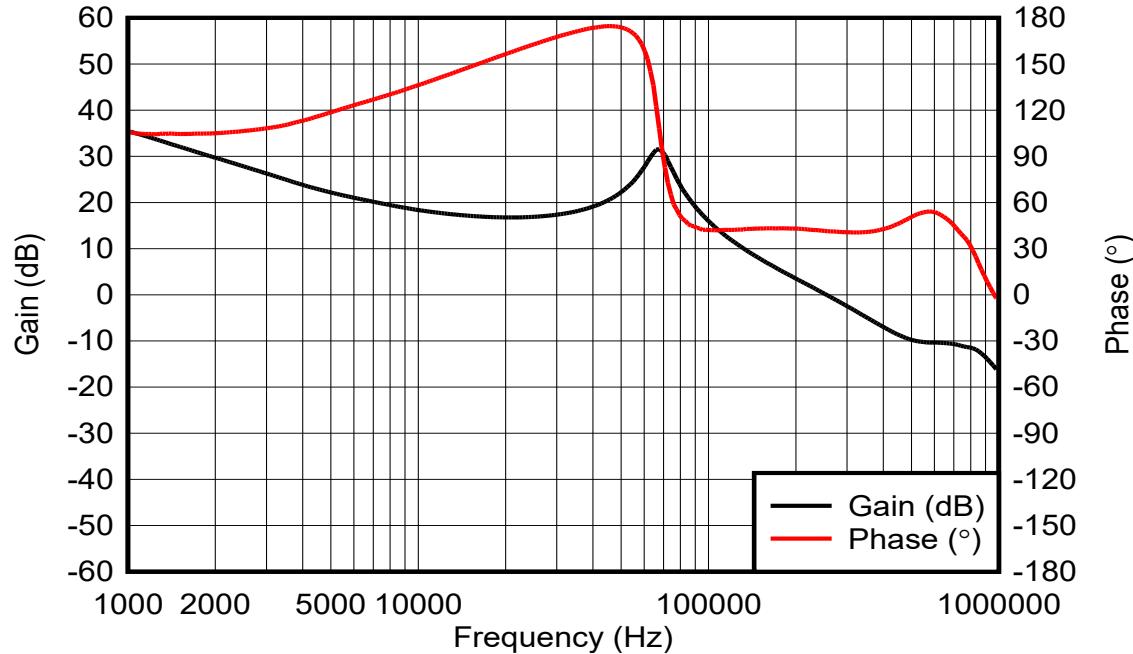


图 4-2. 环路响应测量 (TPSM8287B30-2X-EVM , $V_{IN} = 5V$, $V_{OUT} = 0.6V$, $I_{OUT} = 60A$)

5 硬件设计文件

5.1 原理图

下图展示了 EVM 原理图。

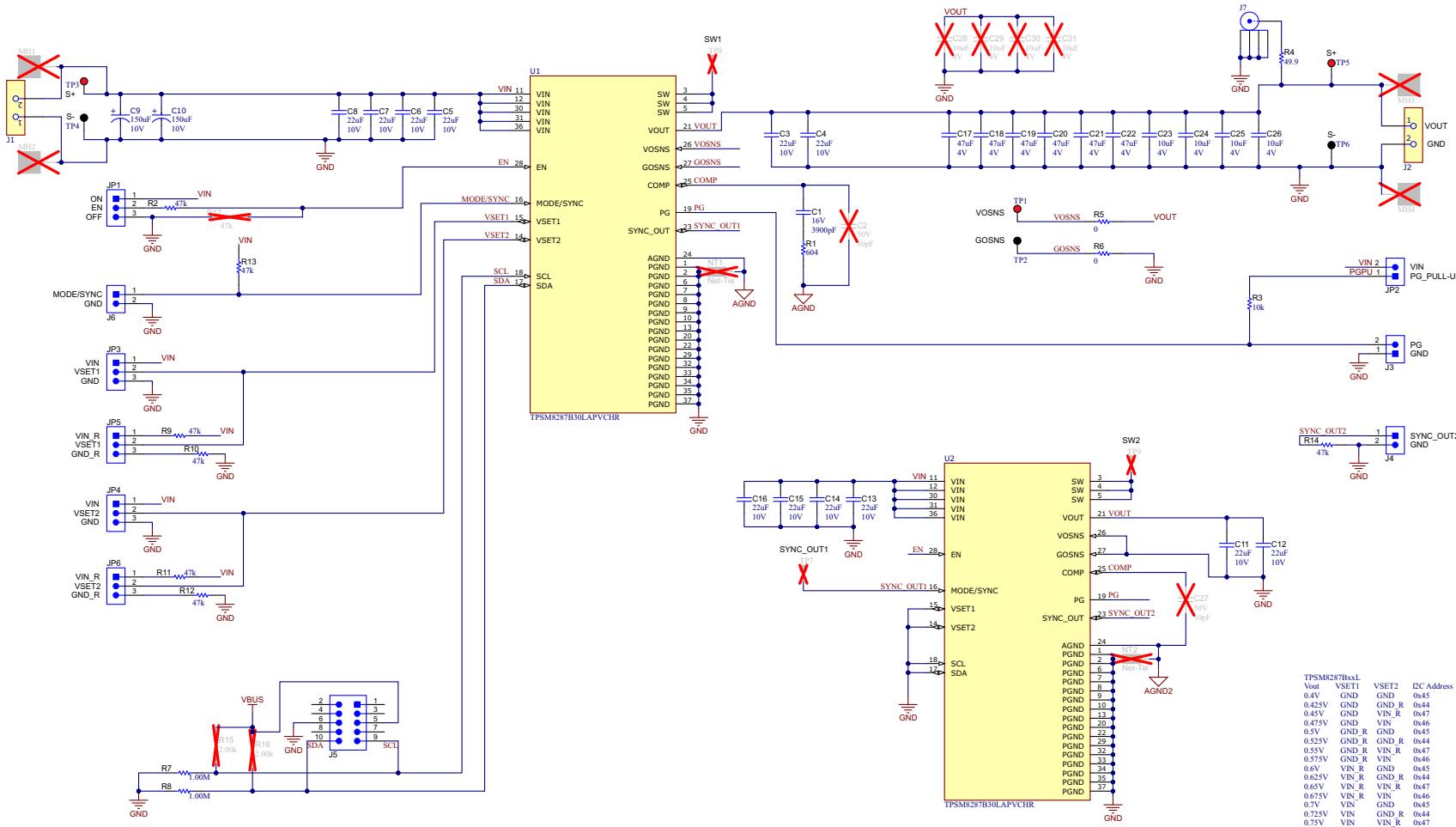


图 5-1. TPSM8287B30-2X-EVM 原理图

5.2 PCB 布局

本节介绍了 TPSM8287B30-2X-EVM 电路板布局布线 (SR132)。光绘文件位于 [TPSM8287B30-2X-EVM](#) 工具文件夹。所有八层均使用 2 盎司铜。

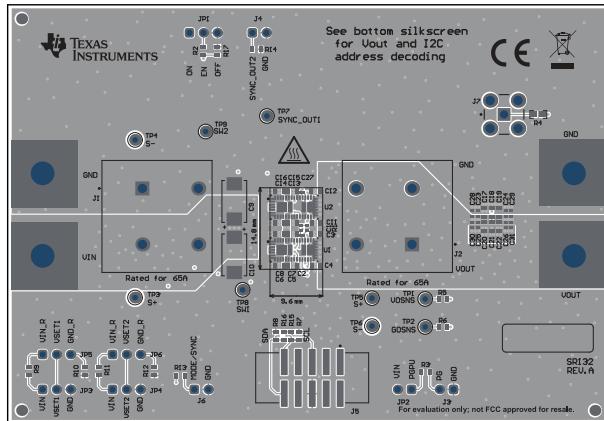


图 5-2. 顶层装配图

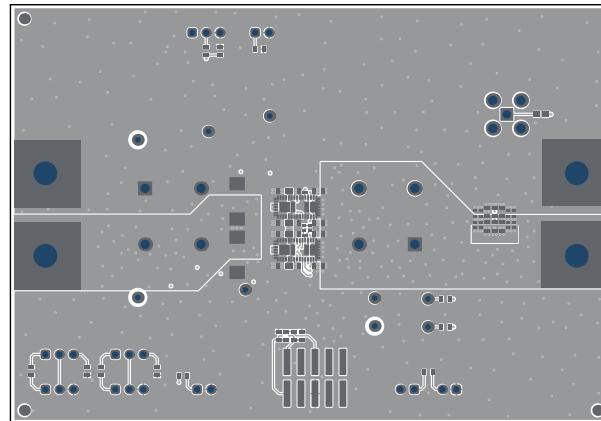


图 5-3. 顶层

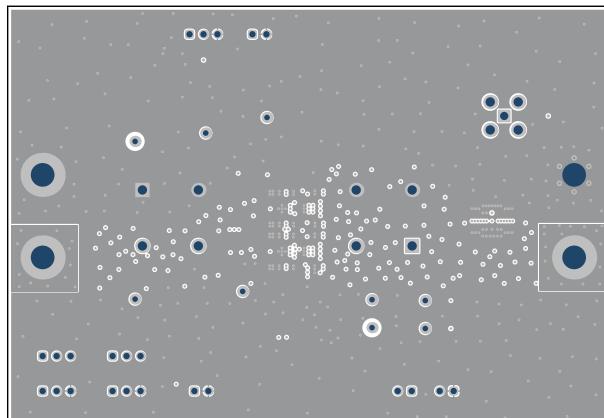


图 5-4. 内层 1

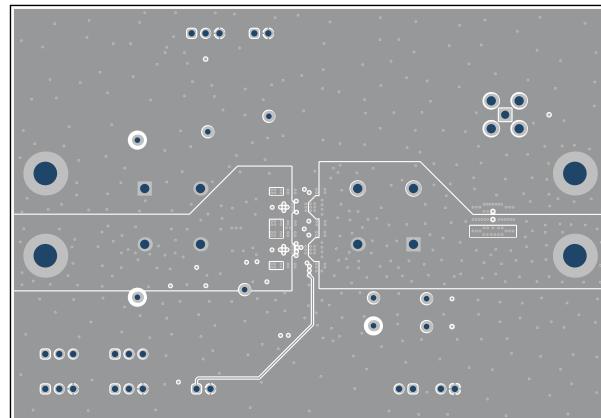


图 5-5. 内层 2

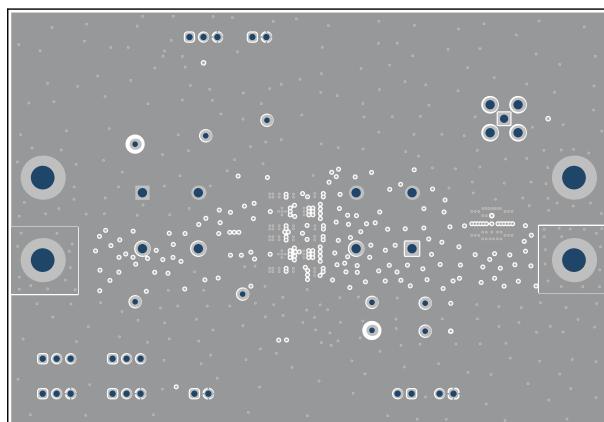


图 5-6. 内层 3

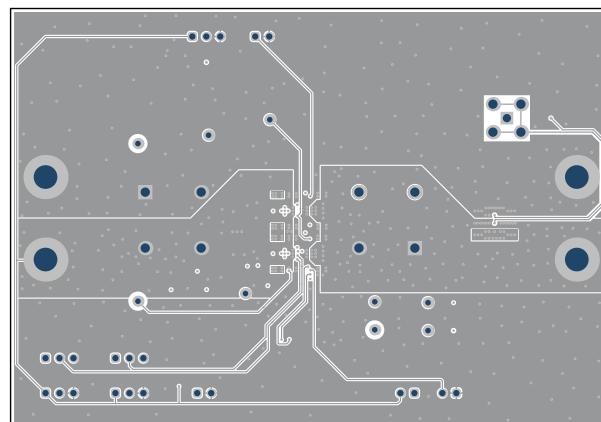


图 5-7. 内层 4

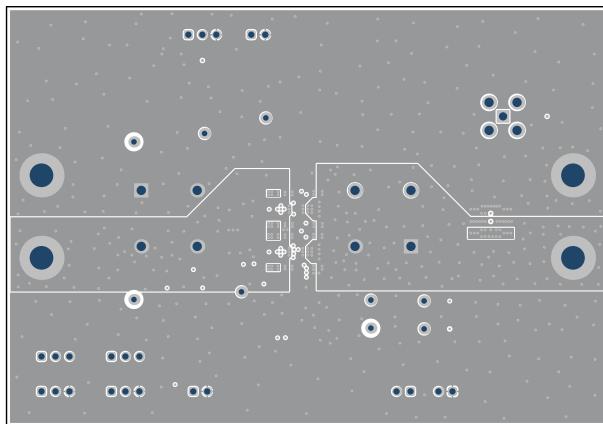


图 5-8. 内层 5

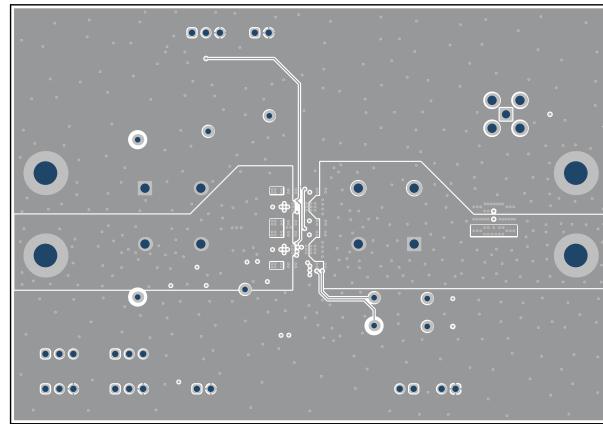


图 5-9. 内层 6

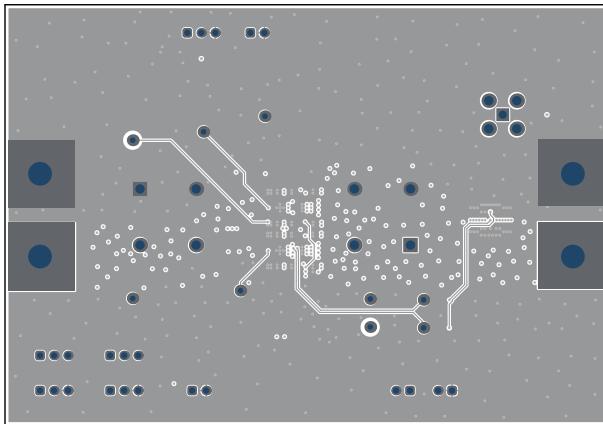


图 5-10. 底层

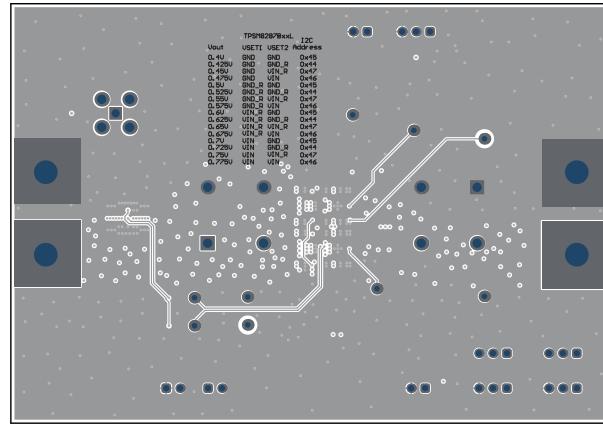


图 5-11. 底层装配 (镜像)

5.3 物料清单 (BOM)

下表列出了此 EVM 的 BOM。

表 5-1. TPSM8287B30-2X-EVM (SR132) 物料清单

数量	参考位号	值	说明	尺寸	器件型号	制造商
-001						
1	C1	3900pF	陶瓷电容器, 16V, X7R	0402	Std	Std
12	C3、C4、 C5、C6、 C7、C8、 C11、C12、 C13、C14、 C15、C16	22μF	陶瓷电容器, 10V, X6S	0603	GRM188C81A226ME01D	Murata
2	C9、C10	150μF	铝聚合物电容器, 10V, 10mΩ ESR	7343	ECASD61A157M010KA0	Murata
6	C17、C18、 C19、C20、 C21、C22	47μF	陶瓷电容器, 4V, X6S	0603	GRM188C80G476ME01D	Murata
4	C23、C24、 C25、C26	10μF	陶瓷电容器, 4V, X6S	0402	GRM155C80G106ME18D	Murata
1	R1	604Ω	电阻器 1%, 0.063W	0402	Std	Std
7	R2、R9、 R10、R11、 R12 R13、R14	47kΩ	电阻器 5%, 0.1W	0603	Std	Std
1	R3	10kΩ	电阻器 5%, 0.1W	0603	Std	Std
1	R4	49.9Ω	电阻器 1%, 0.1W	0603	Std	Std
2	R5、R6	0Ω	电阻器 5%, 0.1W	0603	Std	Std
2	R7、R8	1.0MΩ	电阻器 5%, 0.1W	0603	Std	Std
2	U1、U2 ¹		具有 I ² C 接口和遥感功能并采用 MagPack 封装的 2.7V 至 6V 输入、30A 可并联降压电源模块	3.75mm × 8mm	TPSM8287B30LAPVCHR	德州仪器 (TI)

1. 这些 U1 和 U2 器件可能包含不正确的顶部标识，但仍经过了全面测试且功能正常

6 其他信息

6.1 商标

MagPack™ is a trademark of Texas Instruments.

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.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 Japan

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

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

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

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

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

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

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

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

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

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西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsts/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSENSORS 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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