EVM User's Guide: TRF0108SP-EVM TRF0108SEP-EVM

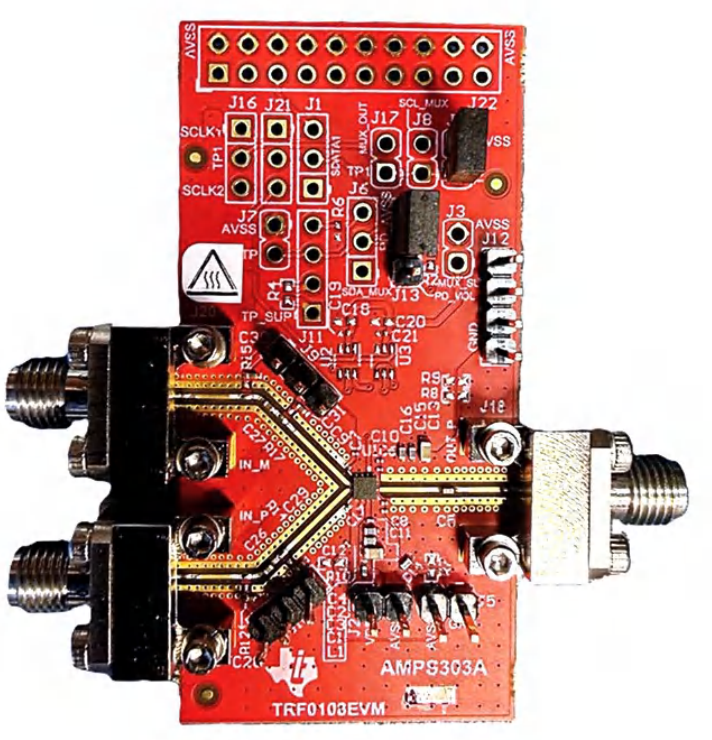
TRF0108SEP/SP 评估模块

说明

TRF0108SP 和 TRF0108SEP 评估模块 (EVM) 用于评估差分输入转单端 (D2S) 输出射频放大器 TRF0108-SP 和 TRF0108-SEP 器件。TRF0108SP-EVM 具有耐辐射加固保障 (RHA)，而 TRF0108SEP-EVM 具有耐辐射性。这些器件适用于由数模转换器 (DAC) 驱动时需要 D2S 功能的应用。

特性

- 由 +5V 单电源供电
- 交流耦合配置
- 专为 100Ω 差分输入匹配而设计
- 可通过板载 SMA 连接器轻松连接到输入端和输出端
- 借助跳线连接器，电路板可提供断电选项



TRF0108SP-EVM 和 TRF0108SEP-EVM（顶视图）

1 评估模块概述

1.1 简介

本用户指南介绍了正确运行和快速设置 TRF0108SP/SEP-EVM 所需的基本步骤和功能。本文档还包含原理图、物料清单 (BOM)、印刷电路板 (PCB) 布局和测试方框图。除非另有说明，否则本文档中的缩写词 *EVM*、*TRF0108SP/SEP-EVM* 以及术语 *评估模块*均代表 TRF0108SP-EVM 和 TRF0108SEP-EVM。

该放大器内部已匹配 100Ω 差分输入和 50Ω 单端输出，且默认 EVM 配置已针对该匹配进行设置。该 EVM 的输入和输出端具有交流耦合电容器。该 EVM 可随时连接到 +5V 电源、信号源和测试仪表，进行器件评估和测量。

小心

表面高温。接触会导致烫伤。请勿触摸。

1.2 套件内容

条目	数量
TRF0108SP-EVM 或 TRF0108SEP-EVM	1

1.3 规格

连接器	参数	值
J2	J2.1 VDD J2.2 AVSS	V_{DD} = 5V AVSS = GND
J4	J4.1 AVSS J4.2 SCL	J4.2 SCL 连接至器件的引脚 8 (GND)。为了获得出色性能，请使用用户提供的跳线短接 AVSS (J4.1) 和 SCL (J4.2)。
J5	J5.1 GND J5.2 AVSS	短接 AVSS (J5.2) 和 GND (J5.1)
J13	J13.1 PD_Voltage J13.2 PD J13.3 AVSS	短接 PD (J13.2) 和 PD_Voltage (J13.1) 可将器件断电 短接 PD (J13.2) 和 AVSS (= GND、J13.3) 可启用器件
J18	RF 输出	请参阅相关文档
J19	射频输入 INP	请参阅相关文档
J20	射频输入 INM	请参阅相关文档

1.4 器件信息

TRF0108-SP 和 TRF0108-SEP 是超高性能差分转单端 (D2S) 射频放大器。当由高性能 DAC39RF10 (-SP/-SEP) 或 AFE7950-SP 等数模转换器 (DAC) 驱动时，这些器件非常适合需要 D2S 转换的应用。

有关详细的器件信息，请参阅相关文档。

2 硬件

2.1 一般使用信息

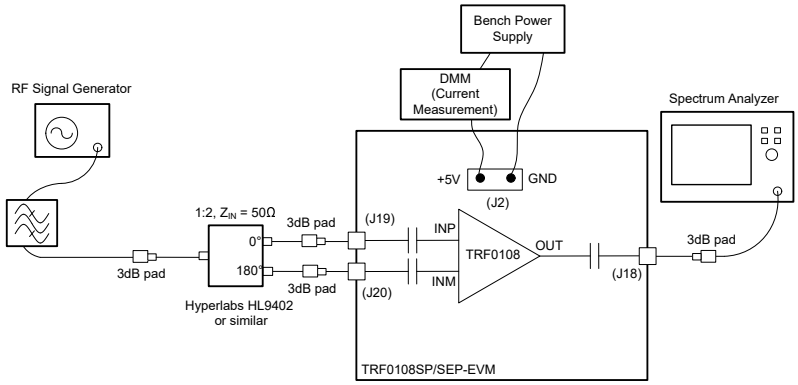


图 2-1. 增益和输出 P1dB 的单音设置

本节提供 TRF0108SP/SEP-EVM 的一般使用信息。有关作为后续说明基准点的一般 EVM 配置和单音测量设置，请参阅图 2-1（为清晰起见，省略了某些元件，如电源旁路电容器）：

1. 建议的加电序列：
   a. 在将电源电缆连接到 EVM 之前，将直流输出电源设置为 +5V
   b. 将直流输出电源的电流限制设置为 300mA
   c. 确保关闭电源，将电源电缆连接到 EVM 的 J2 连接器
   d. 现在，打开直流电源以设置 V_{DD} = +5V。从电源汲取的有源供电电流 (I_{QA}) 约为 170mA。
   e. 如果电源电流较低，请验证器件是否通过 PD 引脚配置断电
2. 断电选项：
   a. 可以通过配置 J13 跳线连接来将器件断电，如图 2-1 所述
   b. 也可以对 PD (J13.2) 施加受器件支持的逻辑高电压来将器件断电（请参阅相关文档）
3. 单音测量设置：
   a. J19 和 J20 SMA 连接器处的 EVM 输入为全差分（或 180° 异相）。必须使用外部无源平衡-非平衡变压器将来自射频信号发生器的单端信号转换为差分信号，并通过 SMA 连接器 J19、J20 连接到输入，如图 2-1 所示。测量单音失真时，在射频信号发生器和 3dB 焊盘之间使用射频带通滤波器，如图 2-1 所示。
   b. 要测试 TRF0108SP/SEP-EVM 的完整频率范围，使用的射频信号发生器必须支持最高 12GHz 的信号频率。
   c. 器件输入在通带内为 100Ω 差分输入。
      为了尽可能减少阻抗不匹配导致的信号反射，TI 建议在无源平衡-非平衡变压器的三个端子上使用约为 3dB 至 6dB 的衰减器垫。
   d. J18 SMA 连接器处的 EVM 输出为单端输出。
   e. EVM 的单端信号输出连接到频谱分析仪，如图 2-1 所示。建议在输出端使用约 3dB 至 6dB 的衰减器垫，以尽可能减少反射。
   f. 最后，TI 建议正确表征并考虑射频同轴电缆、衰减器垫和无源平衡-非平衡变压器的插入损耗，以便准确测量器件的增益和功率级别。
4. 匹配注意事项：
   a. TRF0108-SP 和 TRF0108-SEP 是宽带放大器，在工作带宽范围内需要 100Ω 差分输入匹配。驱动 EVM 输入的典型射频信号发生器或噪声源在宽带宽上具有 50Ω 阻抗，这通过 1:2 宽带平衡-非平衡变压器转换为 100Ω 差分阻抗。但是，如果 EVM 由窄带驱动器或没有 50Ω 阻抗的源驱动，则会导致放大器或测量性能下降。
   b. 在将 EVM 输出连接到频谱分析仪时，TI 建议使用衰减器垫来尽可能减少反射。

3 实现结果

3.1 测试设置图

本节包含使用该 EVM 进行 S 参数、噪声系数及双音 OIP3 测量设置的一般建议。

3.1.1 S 参数测试设置

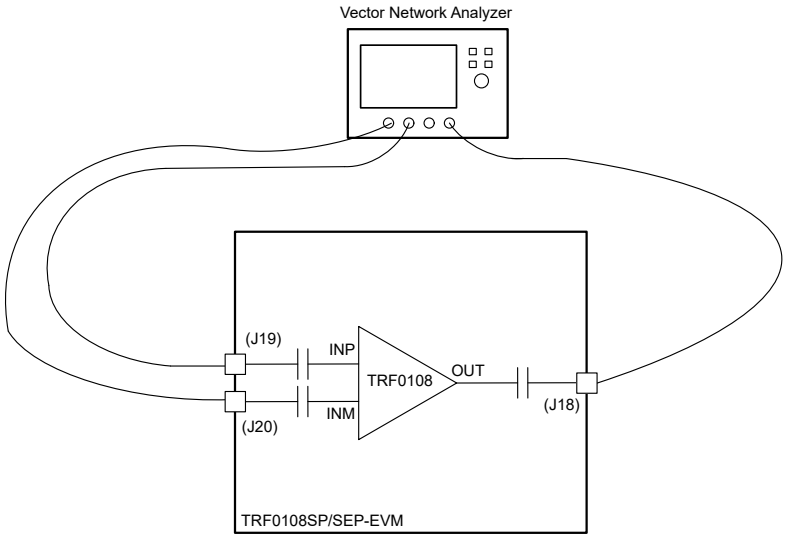


图 3-1. S 参数测试设置

请按照以下指南进行 S 参数测量：

1. 如 图 3-1 所示，通常会使用矢量网络分析器 (VNA) 进行 S 参数测量。要测量该 EVM，建议使用 3 端口 VNA，它可以分别在 EVM 的输入和输出端口产生差分信号和接收单端信号。
2. 在将射频同轴电缆连接到 EVM 之前，使用校准套件校准 VNA 和电缆
3. 确保将 VNA 的频率扫描和输出功率级别设置在 TRF0108-SP 和 TRF0108-SEP 器件的线性工作范围内。可以调整 VNA 的分辨率带宽 (RBW) 和动态范围，以便为测量提供最佳扫描时间。
4. 考虑器件输入和输出端的电路板布线损耗，以便实现准确的增益测量。图 3-2 展示了在代表性 EVM 上测得的参考输入和输出布线损耗。

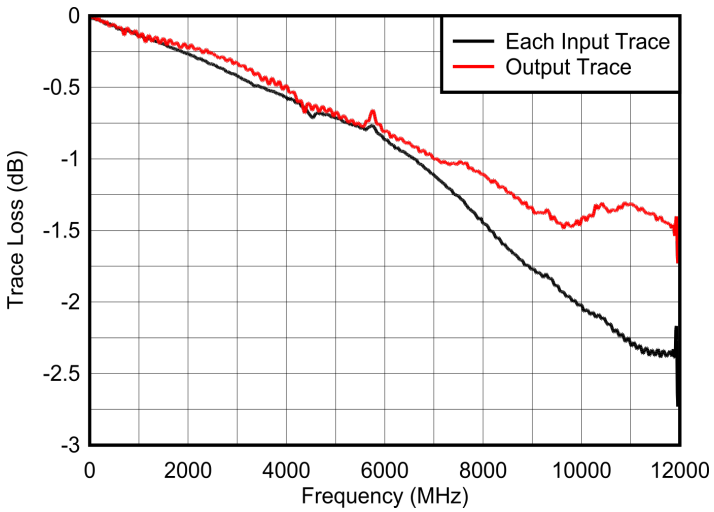


图 3-2. PCB 布线损耗与频率的关系

3.1.2 噪声系数测试设置

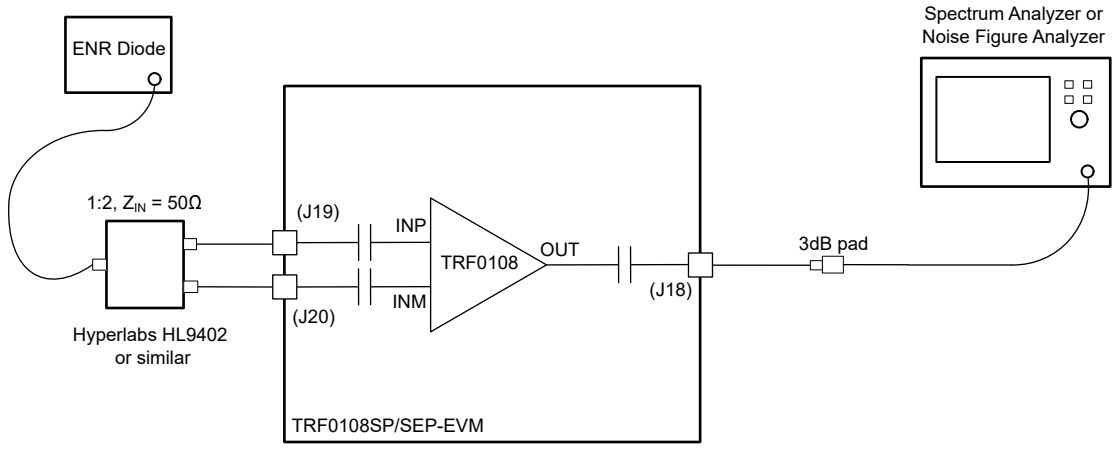


图 3-3. 噪声系数测试设置

请按照以下指南进行噪声系数 (NF) 测量：

1. 如图 3-3 所示，可以使用噪声二极管和频谱分析仪（或噪声系数分析仪），利用传统 Y 系数法进行 NF 测量。
2. 为了进行准确的 NF 测量，需要考虑 EVM 的射频电缆损耗以及设置中使用的任何外部衰减器
3. 此外，NF 测量中必须包含器件输入引脚处输入布线的板载损耗
4. 如果器件输出之后的损耗比较显著（大于 5dB），请注意将输出损耗包含到 NF 测量中。使用 *Friis* 公式，通过测量的总 NF 计算器件的噪声系数。

3.1.3 双音 OIP3 测试设置

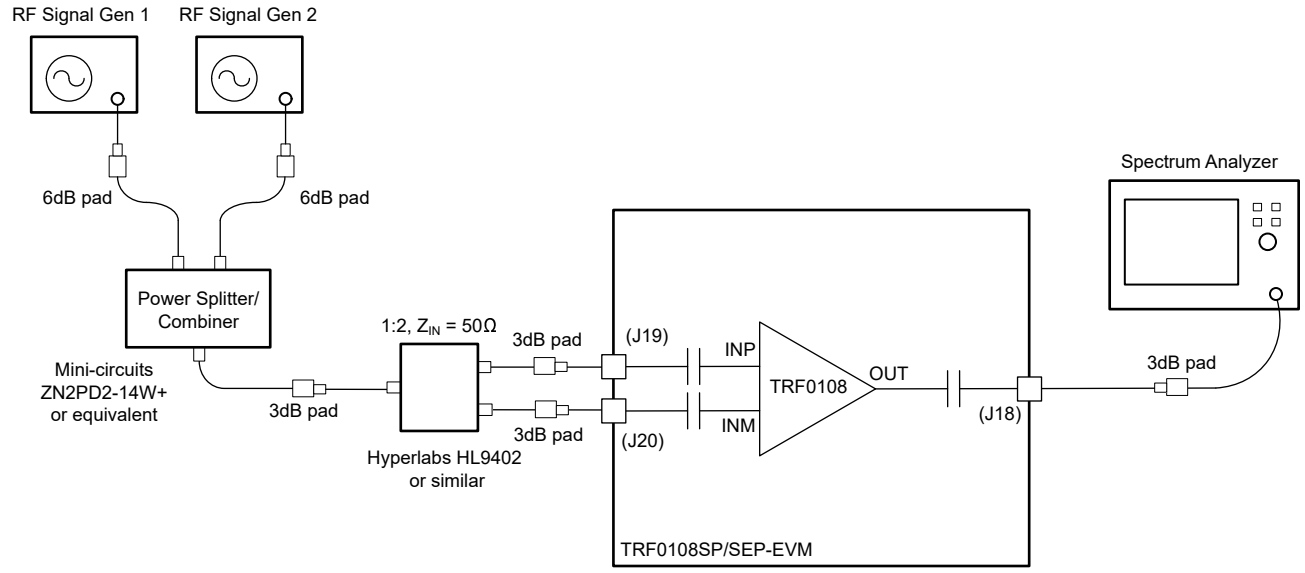


图 3-4. 双音 OIP3 测试设置

请按照以下指南进行双音 OIP3 测量：

1. 如图 3-4 所示，使用同相功率分离器/组合器合并两个信号发生器输出。建议对射频信号发生器输出使用 6dB 衰减器，以增加两个信号发生器之间的隔离并尽可能减少 IMD3 杂散。
2. 将两个射频信号发生器输出设置为适当的功率级别和频率间隔，以便信号发生器在器件上产生所需的输出功率 (P_{OUT})。

3. TI 建议输出功率级别处于 TRF0108-SP 和 TRF0108-SEP 器件的线性工作范围内。例如，设置信号发生器上的功率，使器件输出端的功率产生约 –4dBm/音调。一般情况下，TI 建议将总输出功率级别保持在比 1dB 压缩点低约 6dB 至 8dB。有关该器件支持的输出功率级别，请参阅器件数据表。
4. 根据所需的中心频率和频率间隔，设置信号发生器上的两个音调。
5. 相应地设定频谱分析仪衰减设置，使频谱分析仪非线性度不影响测量。
6. 对主音和 IM3 产物保持相同的频谱分析仪 RBW 和 VBW 设置。
7. 对于输出 IP3 计算，请考虑器件输出与频谱分析仪输入之间所需频带下的合并损耗。合并功率损耗是由于 PCB 输出布线、射频同轴电缆以及使用的任何衰减器垫导致的。计算出的 OIP3 由方程式 1 给出。

$$\text{OutputIP3} = \frac{P_{IN\_SA} - IMD3}{2} + P_{IN\_SA} + P_{LOSS} \quad (1)$$

其中，

- P_{IN_SA} = 频谱分析仪的子载波输入功率
- P_{LOSS} = 器件输出至频谱分析仪输入之间的功率损耗
- IMD3 = 在 2f1 – f2 或 2f2 – f1 处记录的两个互调失真产物的较高功率

8. 在方程式 1 中，$P_{IN\_SA} + P_{LOSS} = P_{OUT}$ 是放大器音调输出功率。

4 硬件设计文件

4.1 原理图

图 4-1 展示了 TRF0108SP/SEP-EVM 原理图。

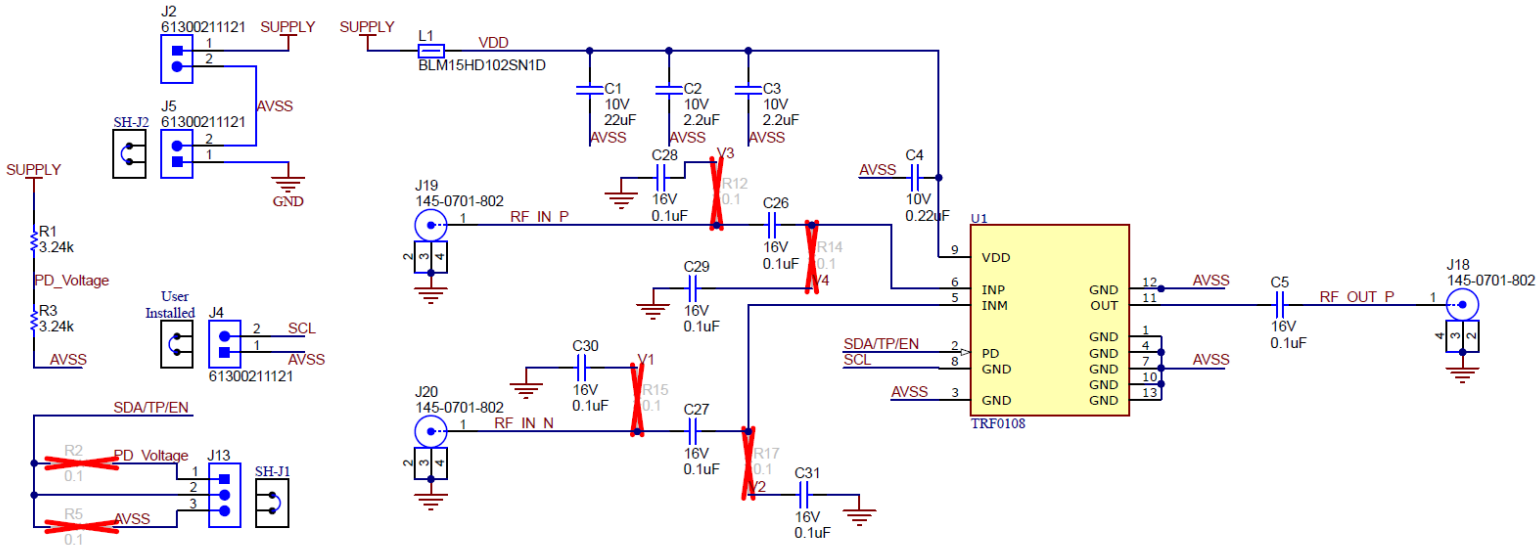


图 4-1. TRF0108SP/SEP-EVM 原理图

4.2 PCB 板层

图 4-2 至 图 4-5 显示了此 EVM 的 PCB 板层。

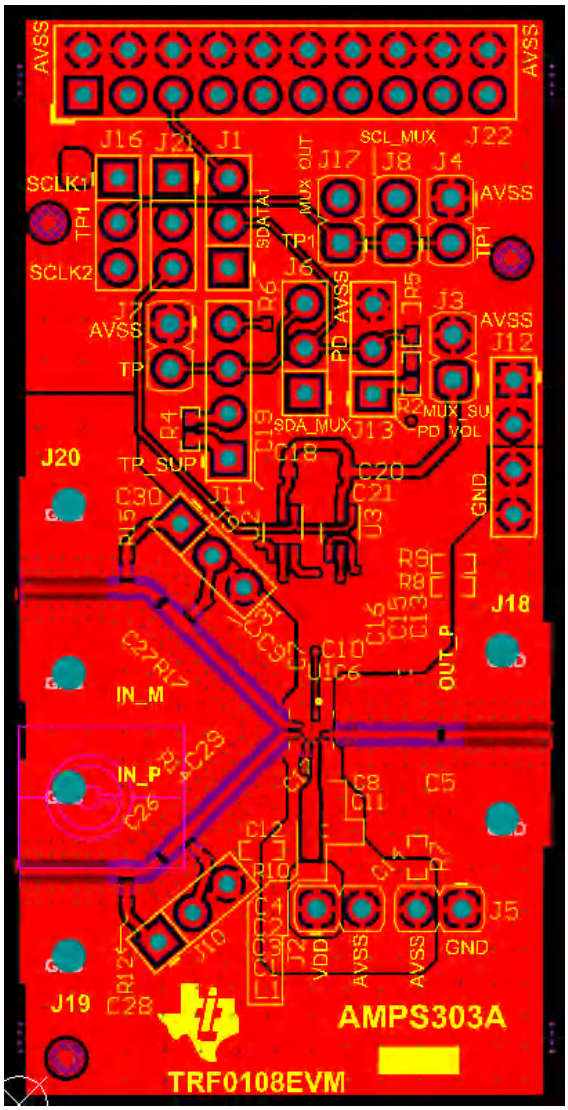


图 4-2. 顶层

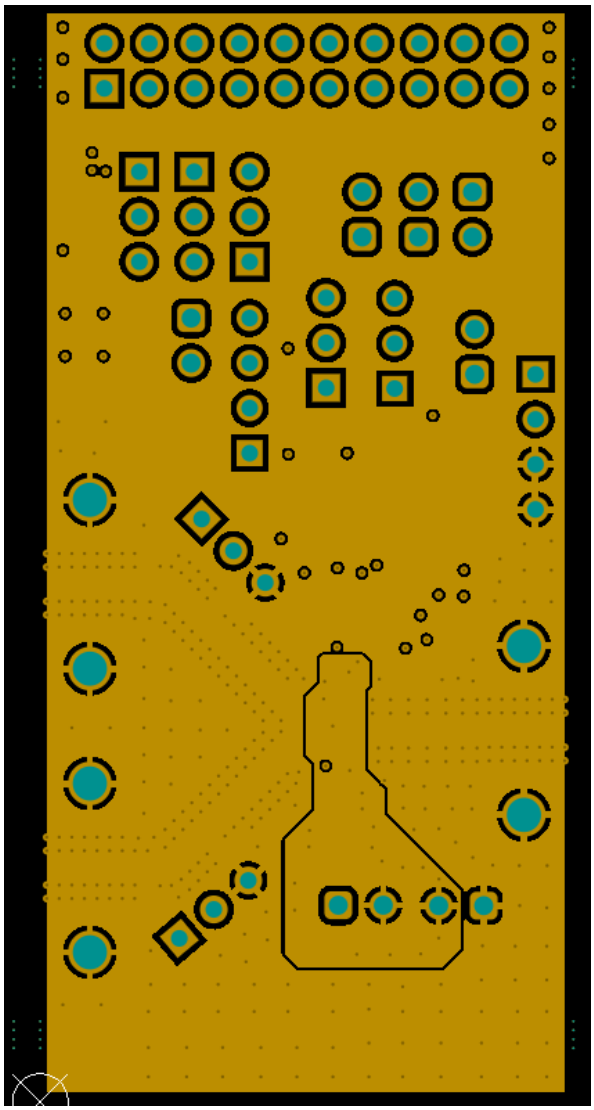


图 4-3. 第 2 层

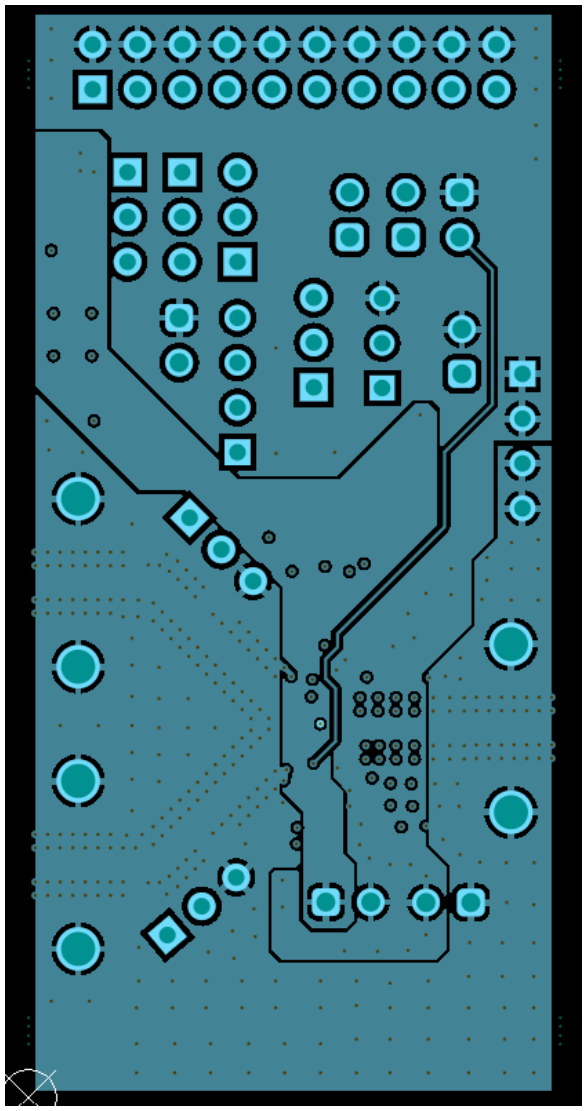


图 4-4. 第 3 层

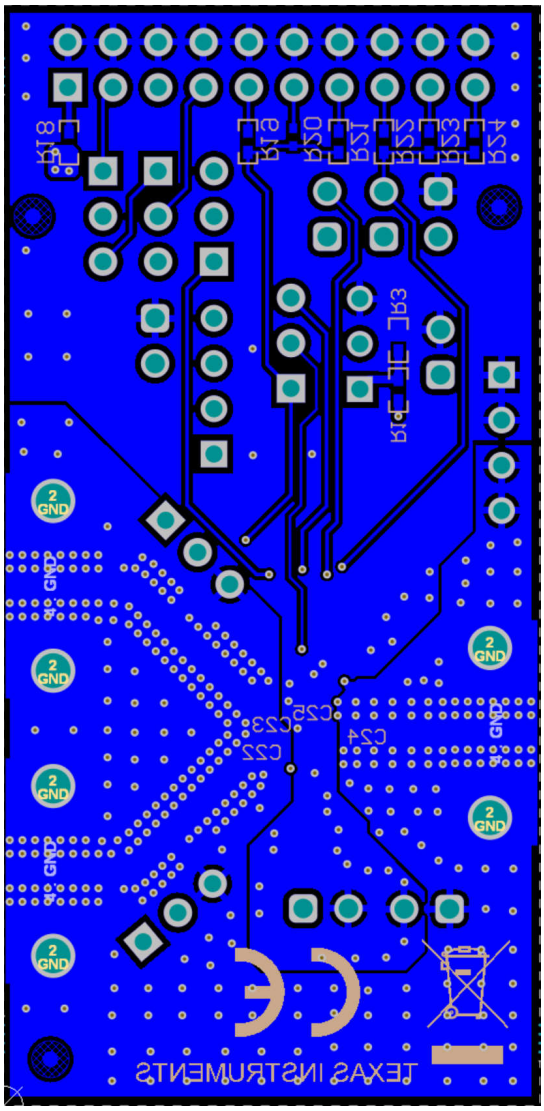


图 4-5. 底层

4.2.1 堆叠和材料

TRF0108SP/SEP-EVM 是一款 67mil 4 层电路板，材料类型为 Isola® 370HR。顶层是电源布线、接地布线以及 SMA 连接器与器件之间的信号布线。第二层是参考射频接地层。信号布线阻抗目标为 50 Ω。底部两层主要是接地层。

Layer	Stack up	Supplier	Supplier Description	Description	Base Thickness	Processed Thickness	εr
1	67.11	GOULD	COPPER FOIL	12+35 m	1.850	2.559	
		ISOLA	185HR	#2116	5.000	4.966	4.320
		ISOLA	185HR	#2116	5.000	4.966	4.320
2					1.378	1.378	
		ISOLA	185HR	1.00 1.0/1.0	39.370	39.370	4.420
3					1.378	1.378	
		ISOLA	185HR	#2116	5.000	4.966	4.320
		ISOLA	185HR	#2116	5.000	4.966	4.320
4		GOULD	COPPER FOIL	12+35 m	1.850	2.559	

图 4-6. TRF0108SP/SEP-EVM 堆叠（以 mil 为单位）

4.3 TRF0108SP/SEP-EVM 物料清单

表 4-1. TRF0108SP/SEP-EVM 物料清单

位号	数量	值	说明	器件型号	制造商	封装参考	已安装
C1, C13	2	22uF	电容，陶瓷，22 µF，10V，±20%，X5R，0603	CL10A226MP8NUNE	Samsung Electro-Mechanics	0603	已安装
C2、C3、C14、C15、C16	5	2.2 µF	电容，陶瓷，2.2uF，10V，+/-10%，X7S，0402	C1005X7S1A225K050BC	TDK	0402	已安装
C4	1	0.22uF	电容器，陶瓷，0.22 µF，10V，+/-20%，X5R，0201	LMK063BJ224MP-F	Taiyo Yuden	0201	已安装
C5、C26、C27、C28、C29、C30、C31	7	0.1uF	电容，陶瓷，0.1uF，16V，+/-10%，X7R，0402	ATC530L104KT16T	AT Ceramics	0402	已安装
C6、C7、C8、C9、C10、C11、C12、C17、C22、C23、C24、C25	12	100nF	0.1µF ±20% 16V 陶瓷电容 0201（公制 0603）	560Z104MTT	KYOCERA AVX	0201	已安装
J2、J4、J5	3		接头，2.54mm，2x1，金，TH	61300211121	Wurth Elektronik	接头，2.54mm，2x1，TH	已安装
J9、J10	2		接头，100mil，3x1，金，TH	PBC03SAAN	Sullins Connector Solutions	PBC03SAAN	已安装
J12	1		接头，2.54mm，4x1，金，TH	PBC04SAAN	Sullins Connector Solutions	接头，2.54mm，4x1，TH	已安装
J13	1		接头，100mil，3x1，锡，TH	PEC03SAAN	Sullins Connector Solutions	接头，3 引脚，100mil，锡	已安装
J18、J19、J20	3		50Ω 插孔，SMT	145-0701-802	Cinch Connectivity	50Ω 插孔，SMT	已安装
L1	1	1000ohm	铁氧体磁珠，1000ohm（在 100MHz 时），0.25A，0402	BLM15HD102SN1D	MuRata	0402	已安装
R1、R3	2	3.24k	电阻，3.24k，1%，0.063W，AEC-Q200 0 级，0402	CRCW04023K24FKED	Vishay-Dale	0402	已安装
SH-J1、SH-J2	2	1x2	分流器，100mil，镀金，黑色	SNT-100-BK-G	Samtec	分流器	已安装
U1	1		TRF0108	TRF0108RPVT/EM 或 TRF0108RPVTSP/EM	德州仪器 (TI)	WQFN-FCRLF、12	已安装
C18、C20	0	10uF	电容，陶瓷，10µF，10V，+/-20%，X5R，0402	CL05A106MP8NUB8	Samsung Electro-Mechanics	0402	未安装
C19、C21	0	0.1uF	电容，陶瓷，0.1uF，16V，+/-10%，X5R，0201	GRM033C71C104KE14D	MuRata	0201	未安装

表 4-1. TRF0108SP/SEP-EVM 物料清单（续）

位号	数量	值	说明	器件型号	制造商	封装参考	已安装
FID1、FID2、FID3、FID4、FID5、FID6	0		基准标记。没有需要购买或安装的元件。	不适用	不适用	不适用	未安装
J1、J6、J16、J21	0		接头，100mil，3x1，金，TH	PBC03SAAN	Sullins Connector Solutions	PBC03SAAN	未安装
J3、J7、J8、J17	0		接头，2.54mm，2x1，金，TH	61300211121	Wurth Elektronik	接头，2.54mm，2x1，TH	未安装
J11	0		接头，2.54mm，4x1，金，TH	PBC04SAAN	Sullins Connector Solutions	接头，2.54mm，4x1，TH	未安装
J22	0		插座，100mil，10x2，金，TH	PPPC102LFBN-RC	Sullins Connector Solutions	10x2 插座	未安装
R2、R5、R7、R8、R9、R10、R12、R14、R15、R17、R18、R19	0	0.1	电阻，0.1，1%，0.25W，0402	ERJ2BWFR100X	Panasonic	0402	未安装
R4、R6、R20	0	10.0k	电阻，10.0k，1%，0.063W，0402	RC0402FR-0710KL	Yageo America	0402	未安装
R21	0	20.0k	电阻，20.0k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040220K0FKED	Vishay-Dale	0402	未安装
R22	0	2.20k	电阻，2.20k，1%，0.063W，AEC-Q200 0 级，0402	RMCF0402FT2K20	Stackpole Electronics Inc	0402	未安装
R23	0	4.70k	电阻，4.70k，1%，0.0625W，0402	RC0402FR-074K7L	Yageo America	0402	未安装
R24	0	4.99k	电阻，4.99k，1%，0.063W，0402	RC0402FR-074K99L	Yageo America	0402	未安装

5 其他信息

5.1 商标

Isola® is a registered trademark of Isola USA Corporation.
所有商标均为其各自所有者的财产。

6 相关文档

如要查看相关文件，请参阅以下内容：

- 德州仪器 (TI)，*TRF0108-SP 耐辐射加固保障 (RHA)、直流至 12GHz 带宽、差分转单端射频放大器*数据表
- 德州仪器 (TI)，*TRF0108-SEP 耐辐射型、直流至 12GHz 带宽、差分转单端射频放大器*数据表

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

重要通知和免责声明

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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