EVM User's Guide: TPS7H3xx4EVM-CVAL

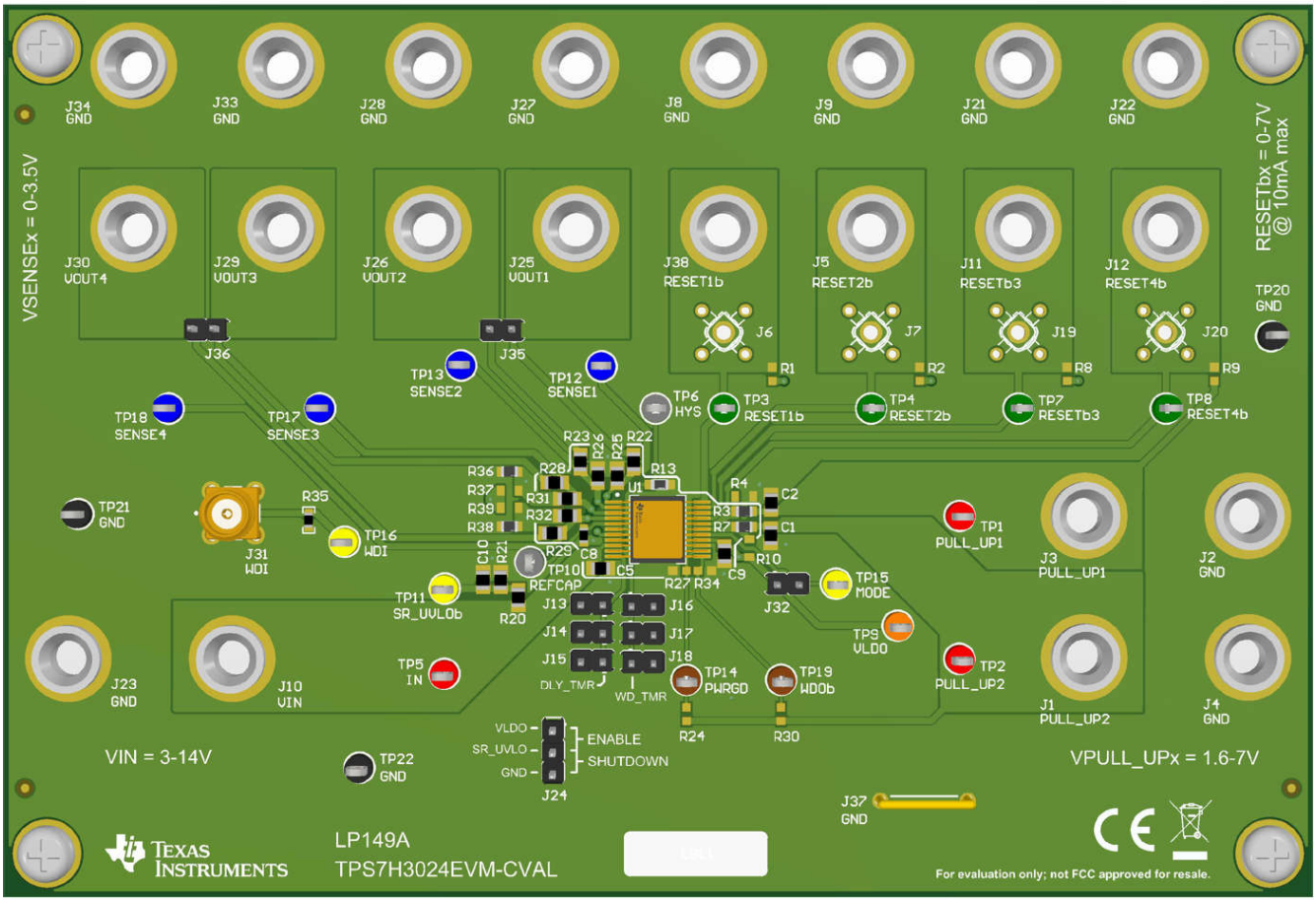
TPS7H3xx4EVM-CVAL 评估模块 (EVM)

说明

TPS7H3024EVM-CVAL、TPS7H3124EVM-CVAL、TPS7H3034EVM-CVAL 和 TPS7H3134EVM-CVAL 演示了单个 TPS7H3024-SP、TPS7H3124-SP、TPS7H3034-SP 或 TPS7H3134-SP 监控器（陶瓷封装）的运行情况。这些电路板布局完全相同，但 BOM 略有差异，只要更新了已组装的 IC 的配置，就可以互换使用。这些电路板统称为 TPS7H3xx4EVM-CVAL。

特性

- 灵活的配置选项，包括检测负电源轨的功能
- 可定制计时器、感应阈值、感应迟滞、感应模式选择以及导通/关断阈值



EVM 板

1 评估模块概述

1.1 简介

TPS7H3xx4EVM-CVAL 是适用于 TPS7H3xx4 监控器陶瓷封装选项的评估模块 (EVM)，提供了一个对其特性进行电气评估的平台。本用户指南提供了有关 EVM 的详细信息，其中包括配置、原理图 和 BOM。

该 EVM 旨在通过用于外部元件的封装以及用于受监控外部电源轨和 RESETb 信号输出的多种连接选项，让您能够在不同条件下灵活配置器件。默认情况下，EVM 中的器件配置如 TPS7H3xx4EVM-CVAL 默认配置和默认 EVM 原理图所示。若要在一个不同的配置下配置器件，请参阅 TPS7H3xx4 数据表来计算器件周围需要更改的无源器件的值。

1.2 套件内容

- EVM 电路板 (1)
- EVM 套件用户指南 (1)

1.3 规格

下面的简化原理图假定为 TPS7H30x4（推挽输出型号）。对于 TPS7H31x4（开漏型号），PULL_UPx 引脚将改为 GND 或 VLDO，且 6 个输出均通过外部 10k 上拉电阻器连接至 PULL_UPx 电源轨。

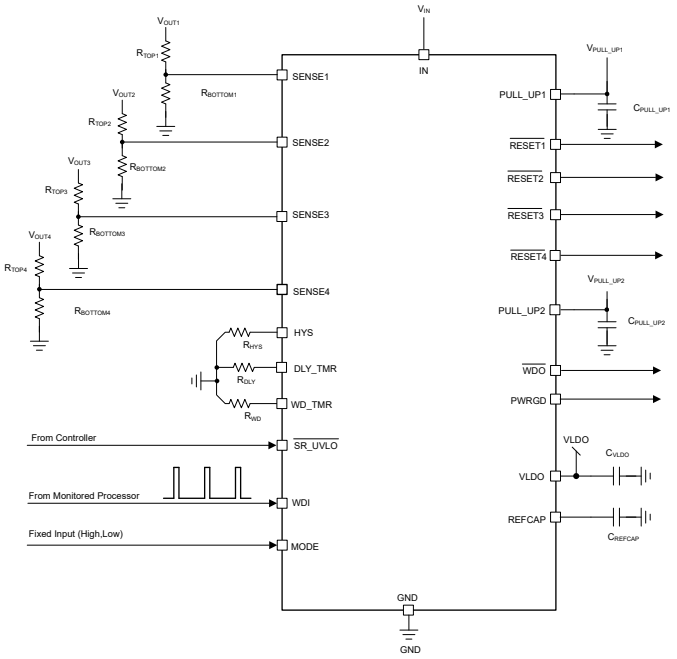


图 1-1. 默认配置简化原理图

表 1-1. 默认 EVM 配置

规格	值	说明
输入电压 VIN	12V	处于建议的器件输入电压范围 3V 至 14V 内。
导通阈值	10.3V	用于导通/关断器件的 VIN 上升/下降值。 设置方式： R20 = 10kΩ R21 = 620Ω
关断阈值	8.5V	
PULL_UP1 电压	1.8V	所有 RESETb 输出使用的电压。处于建议的器件 PULL_UPx 电压范围 1.6V 至 7V 内。

表 1-1. 默认 EVM 配置（续）

规格	值	说明
PULL_UP2 电压	1.8V	WDOb 和 PWRGD 输出使用的电压。处于建议的器件 PULL_UPx 电压范围 1.6V 至 7V 内。
VOUT1 VRISE 阈值	2.20V（2.5V 的 88%）	受监控的 VOUT 电源轨分别被视为导通或关断的上升和下降电压阈值。 设置方式： R22 = 5.17kΩ（或 R22 = 5.10kΩ） R25 = 1.91kΩ
VOUT1 VFALL 阈值	2.08V（2.5V 的 83%）	
VOUT2 VRISE 阈值	3.46V（3.3V 的 105%）	受监控的 VOUT 电源轨分别被视为导通或关断的上升和下降电压阈值。 设置方式： R23 = 5.49kΩ R26 = 1.15kΩ
VOUT2 VFALL 阈值	3.33V（3.3V 的 101%）	
VOUT3 VRISE 阈值	0.79V（0.8V 的 99%）	受监控的 VOUT 电源轨分别被视为导通或关断的上升和下降电压阈值。 设置方式： R28 = 1.33kΩ R31 = 4.12kΩ
VOUT3 VFALL 阈值	0.76V（0.8V 的 95%）	
VOUT4 VRISE 阈值	1.99V（1.8V 的 111%）	受监控的 VOUT 电源轨分别被视为导通或关断的上升和下降电压阈值。 设置方式： R29 = 3.74kΩ R32 = 1.62kΩ
VOUT4 VFALL 阈值	1.90V（1.8V 的 106%）	
RESETb 延迟时间 tDLY_TMR	12.5ms	从满足 RESETb 信号达到高电平的条件到信号实际转换之间的可编程延时时间。 设置方式： R15 = 619kΩ J14 分流
看门狗计时器 tWD_TMR	1s	可编程计时器，用于设置 WDI 引脚上检测到的上升沿之间允许的时间量，以使 WDOb 保持高电平。如果计时器到期，WDOb 输出将变为低电平，直到在 WDI 处检测到下一个上升沿。 设置方式： R18 = 118kΩ J17 分流

1.3.1 负电源轨检测

借助 TPS7H3xx4EVM-CVAL 电路板，您可以通过配置通道 3 和 4 来检测负电源轨。为此，可以移除从 SENSEx 电阻分压器连接到 GND 的 0 欧姆电阻器，并用 0 欧姆电阻器替换它，而无需将 VLDO 设置为基准。数据表包含有关在使用此配置时如何选择适当电阻器值的更详细信息和公式。

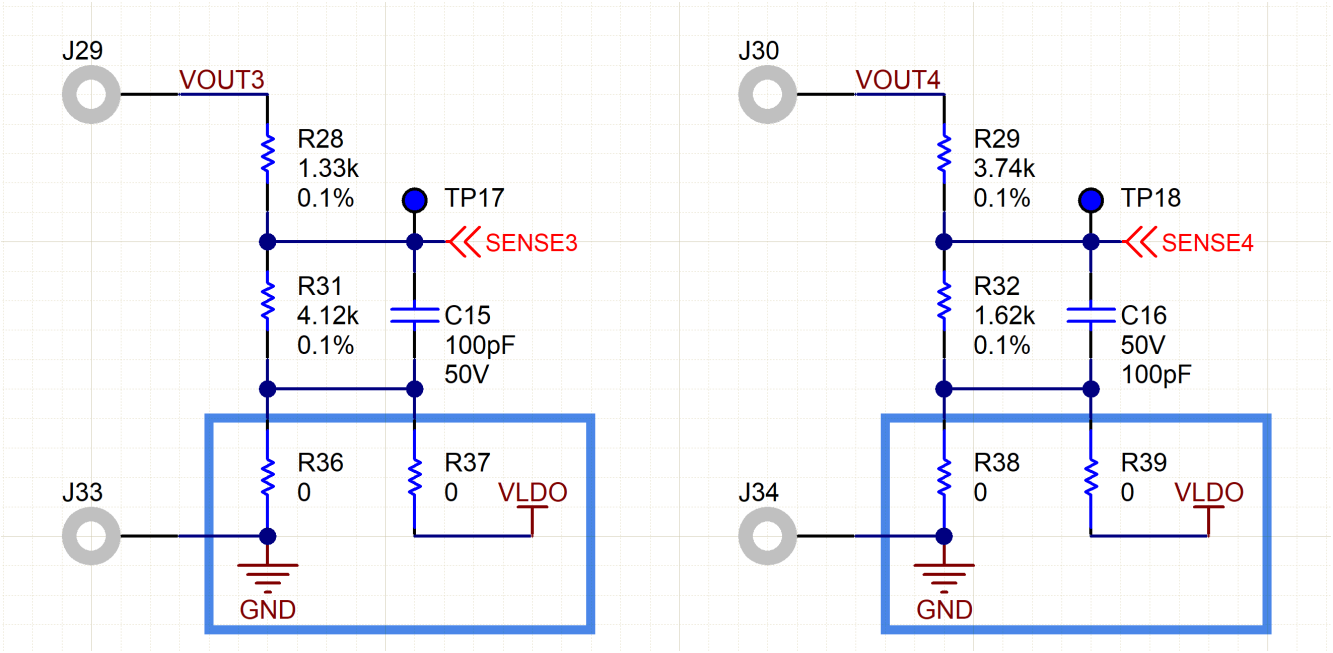


图 1-2. 负电源轨检测电路

1.3.2 推挽与开漏的配置

默认情况下，TPS7H3xx4EVM-CVAL 板针对其搭载的特定 IC 进行配置。这些配置有微小的 BOM 差异，下面列出了这些差异，同时在 EVM 原理图中突出显示了这些差异。如果需要，用户可以重新配置电路板以测试其他 IC 型号。电路板布局布线相同。

1. 引脚配置
   - TPS7H30x4-SP（推挽型号）使用 0Ω 电阻器将 PULL_UPx 引脚（引脚 17 和引脚 18）连接到 PULL_UPx 电源轨
   - TPS7H31x4-SP（开漏型号）根据数据表的要求，使用 0Ω 电阻器将引脚 17 和引脚 18 连接到 GND 和 VLDO
2. 外部上拉电阻器
   - TPS7H30x4-SP（推挽型号）未贴装用于 RESETxb、PWRGD 和 WDOb 输出的 6 个外部上拉电阻器
   - TPS7H31x4-SP（开漏型号）贴装用于 RESETxb、PWRGD 和 WDOb 输出的 6 个外部上拉电阻器。该电路板默认使用 10k 电阻器。

1.4 器件信息

TPS7H3xx4 是一款带看门狗计时器的、集成式 3V 至 14V 四通道耐辐射加固保障电源监控器。精确的 599.7mV ± 1% 阈值电压和 599.7mV ± 3% 迟滞电流能够提供可编程监控电压。通过单个电阻器对全局可编程延迟计时器进行编程。此外，还提供 PWRGD 输出来监控全局电源树状态。该器件还包含一个正边缘检测看门狗计时器，可通过监控外部处理器来确保执行一致性。可以使用 SR_UVLO 输入将外部故障传播到系统。提供 QMLV 级器件的标准微电路图 (SMD)。

2 硬件

2.1 电源要求

TPS7H3xx4EVM-CVAL 电路板需要由电源从外部提供 3 个电源轨（VIN、VPULL_UP1 和 VPULL_UP2）。这些电源轨可以单独使用，也可以共用，只要遵守各自的电压范围即可。本用户指南中显示的测试结果是在 VIN 使用一个电源，VPULL_UP1 和 VPULL_UP2 共享一个电源的情况下得出的。

- 3V ≤ VIN ≤ 14V
- 1.6V ≤ VPULL_UPx ≤ 7V

2.2 重要使用说明

由于迟滞电流会增加 SENSEx 节点的电压，因此计算添加 SENSEx 迟滞电流之前和之后的预期最大 SENSEx 电压非常重要。

2.3 连接器说明

主器件		
位号	**功能**	
J10	VIN	VIN 的电源输入连接器。
TP5		测试点
J3	PULL_UP1	PULL_UP1 的电源输入连接器。
TP1		测试点
J1	PULL_UP2	PULL_UP2 的电源输入连接器。
TP2		测试点
J2、J4、J23	GND	GND 的电源输入连接器。
TP20、TP21、TP22、J37		测试点
J25	VOUT1	将由 SENSE1 监控的外部 VOUT 电源轨的输入连接器。
J27	GND	
TP12	SENSE1	测试点
J26	VOUT2	将由 SENSE2 监控的外部 VOUT 电源轨的输入连接器。
J28	GND	
TP13	SENSE2	测试点
J29	VOUT3	将由 SENSE3 监控的外部 VOUT 电源轨的输入连接器。
J33	GND	
TP17	SENSE3	测试点
J30	VOUT4	将由 SENSE4 监控的外部 VOUT 电源轨的输入连接器。
J34	GND	
TP18	SENSE4	测试点
J35	VOUT1 和 VOUT2	通过分流连接 VOUT1 和 VOUT2 节点，以实现共享检测。
J36	VOUT3 和 VOUT4	通过分流连接 VOUT3 和 VOUT4 节点，以实现共享检测。
TP3	RESET1b	测试点
J6		探头测试点
J38		用于 RESET1b 的输出连接器。
J8	GND	

主器件		
位号	功能	
TP4	RESET2b	测试点
J7		探头测试点
J5		用于 RESET2b 的输出连接器。
J9	GND	
TP7	RESET3b	测试点
J19		探头测试点
J11		用于 RESET3b 的输出连接器。
J21	GND	
TP8	RESET4b	测试点
J20		探头测试点
J12		用于 RESET4b 的输出连接器。
J22	GND	
J13、J14、J15	DLY_TMR	用于 DLY_TMR 电阻器配置的分流器。
J16、J17、J18	WD_TMR	用于 REG_TMR 电阻器配置的分流器。
TP16	WDI	测试点
J31		探头测试点
TP15	模式	测试点
J32		用于模式选择的分流器。
TP6	HYS	测试点
TP11	SR_UVLOb	测试点
J24		用于启用/禁用的分流器。
TP19	WDOb	测试点
TP14	PWRGD	测试点
TP9	VLDO	测试点
TP10	REFCAP	测试点

3 实现结果

TPS7H3024-SP 针对以下特性的测试结果如下图所示：

1. 启用和禁用
2. 欠压和过压检测 (MODE=0)
3. 窗口和过压检测 (MODE=1)
4. WDOb 行为

请注意，TPS7H30x4-SP（推挽型号）和 TPS7H31x4-SP（开漏型号）之间的输出时序会略有不同，部分原因是推挽输出与外部上拉电阻器之间的电阻差异，以及外部可能存在的电容或其他负载。

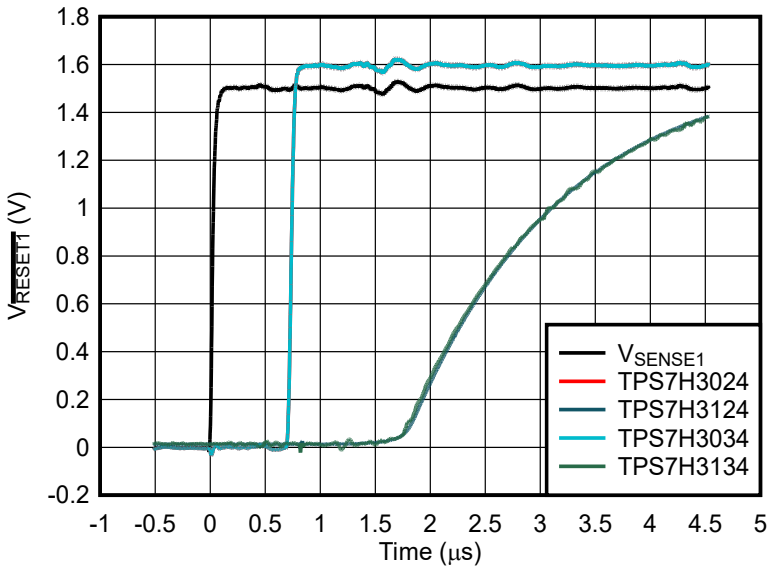


图 3-1.

3.1 默认配置结果

使用 TPS7H3024EVM-CVAL 在默认配置下执行了以下测试，其中 VIN=12V，PULL_UP1=PULL_UP2=1.8V。

3.2 启用和禁用

VIN≥10.3V 会将 SR_UVLOb 置于 $V_{TH\_SR\_UVLOb\_RISING}$ 阈值以上以启用器件。当启用时，受监控电源轨上的电压已处于调节状态。

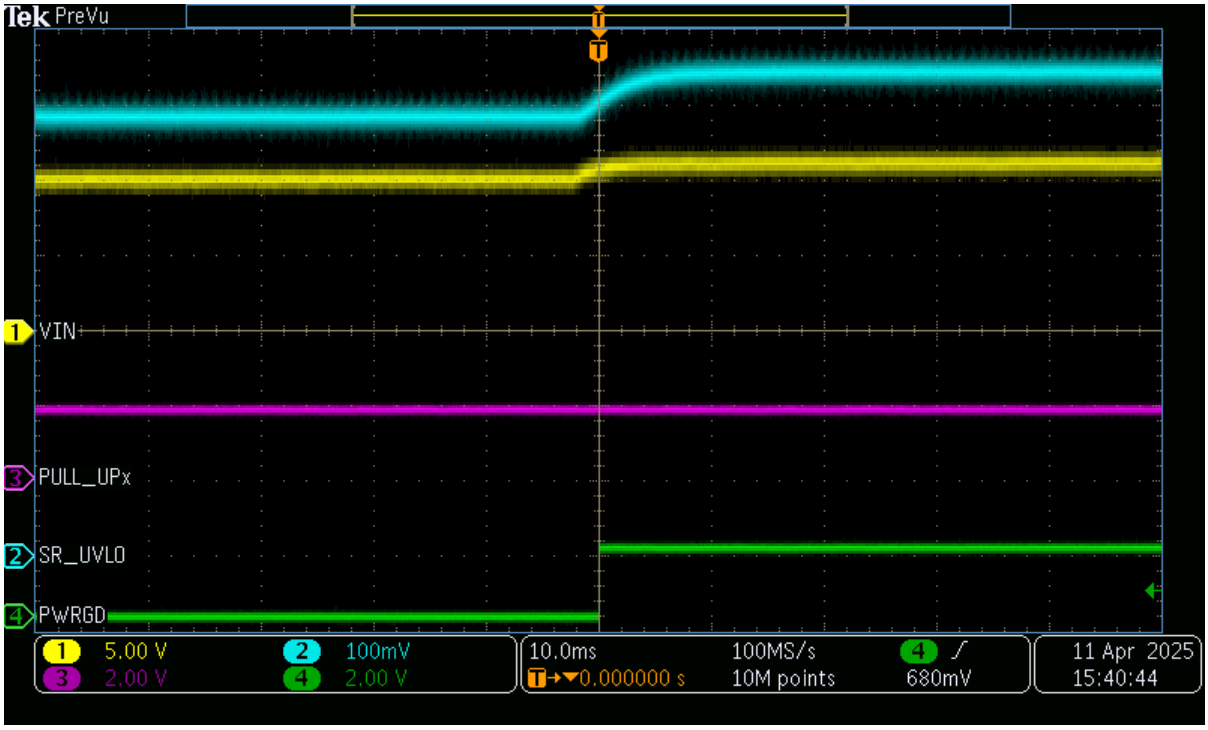


图 3-2. 启用使用 VIN 电阻网络连接至 SR_UVLOb

VIN≤8.5V 将 SR_UVLOb 置于 $V_{TH\_SR\_UVLOb\_FALLING}$ 阈值以下以禁用器件。在此测试期间，受监控电源轨上的电压处于调节状态。

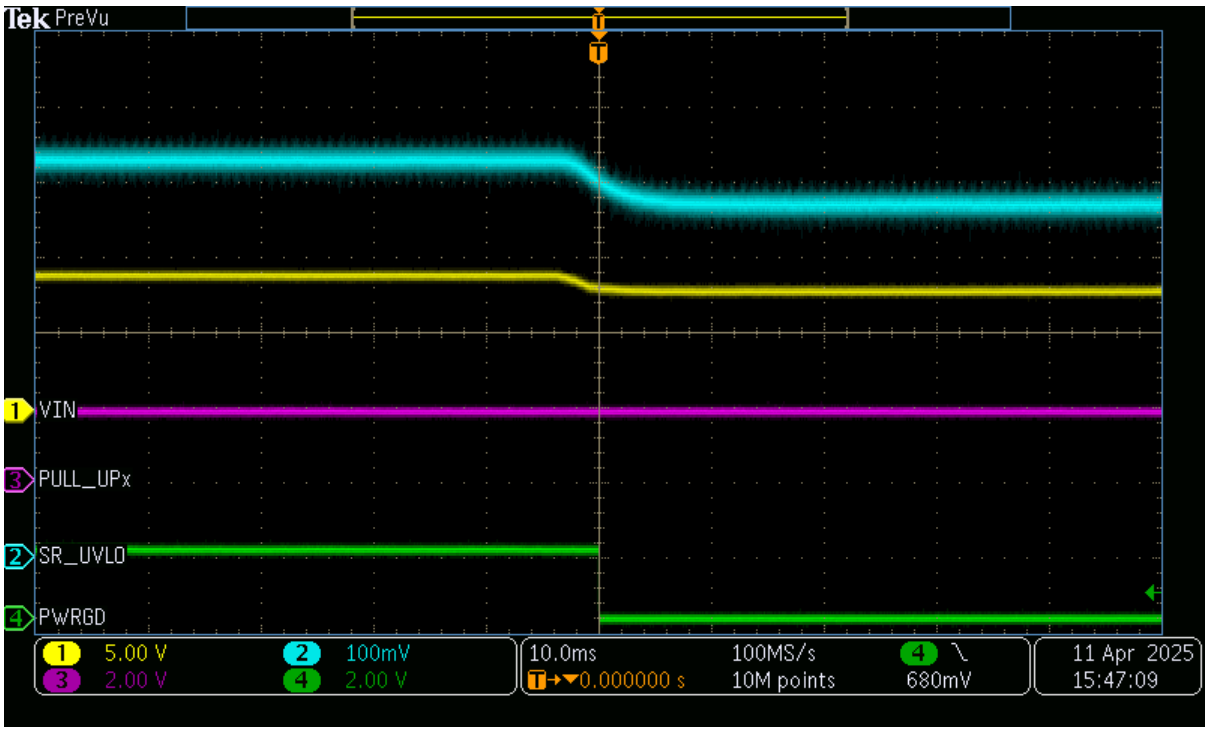


图 3-3. 禁用使用 VIN 电阻网络连接至 SR_UVLOb

3.3 欠压和过压监控 (MODE=0)

在以下测试中，J32 保持开路以将 MODE 引脚接地，从而选择 2 倍欠压 + 2 倍过压监控模式。对于示波器屏幕截图中未显示的通道对，电压保持稳定。显示了不同的 DLY_TMR 设置。

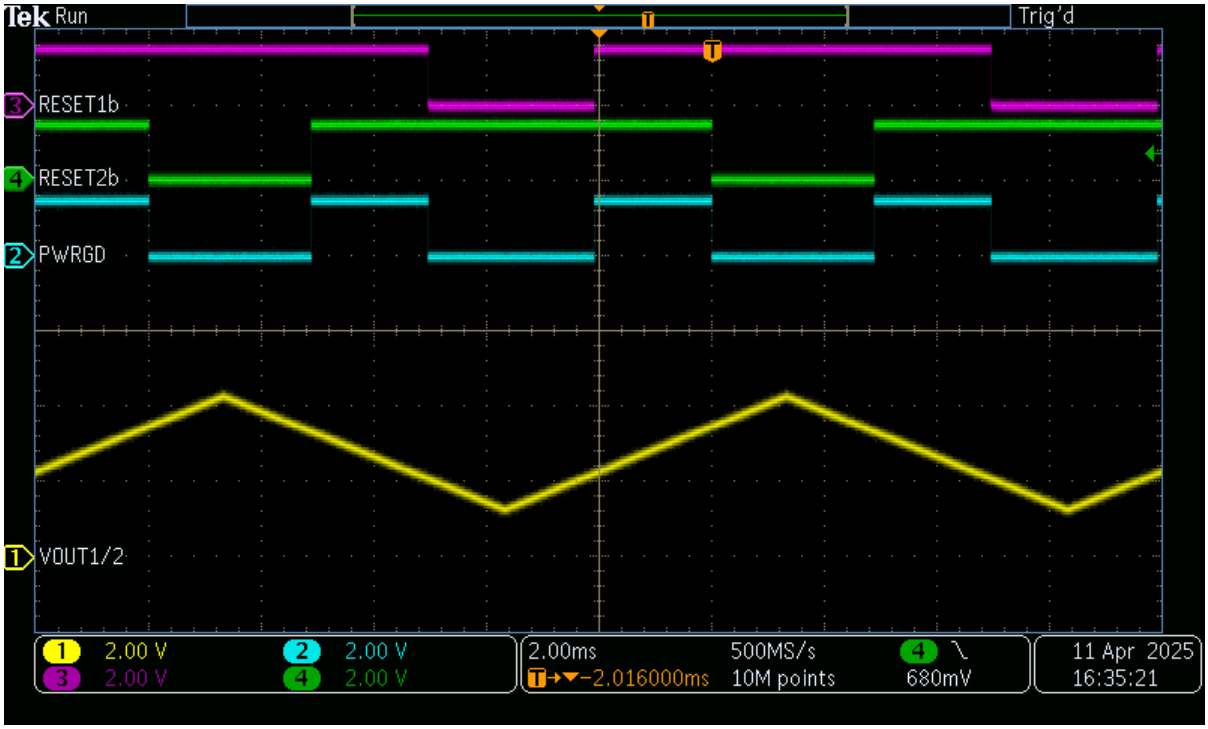


图 3-4. DLY_TMR 悬空时的通道 1/2 调节监控

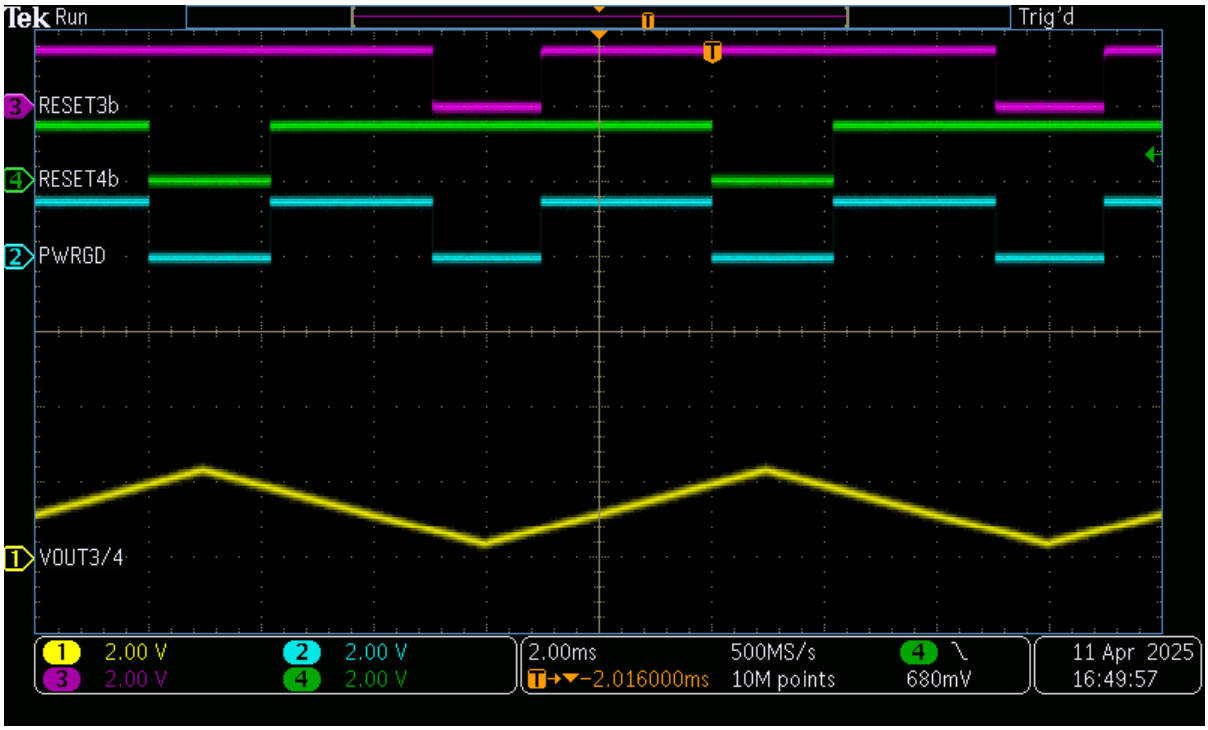


图 3-5. DLY_TMR 悬空时的通道 3/4 调节监控

图 3-6. 通道 3/4 在 DLY_TMR=619kOhms 时进入调节状态

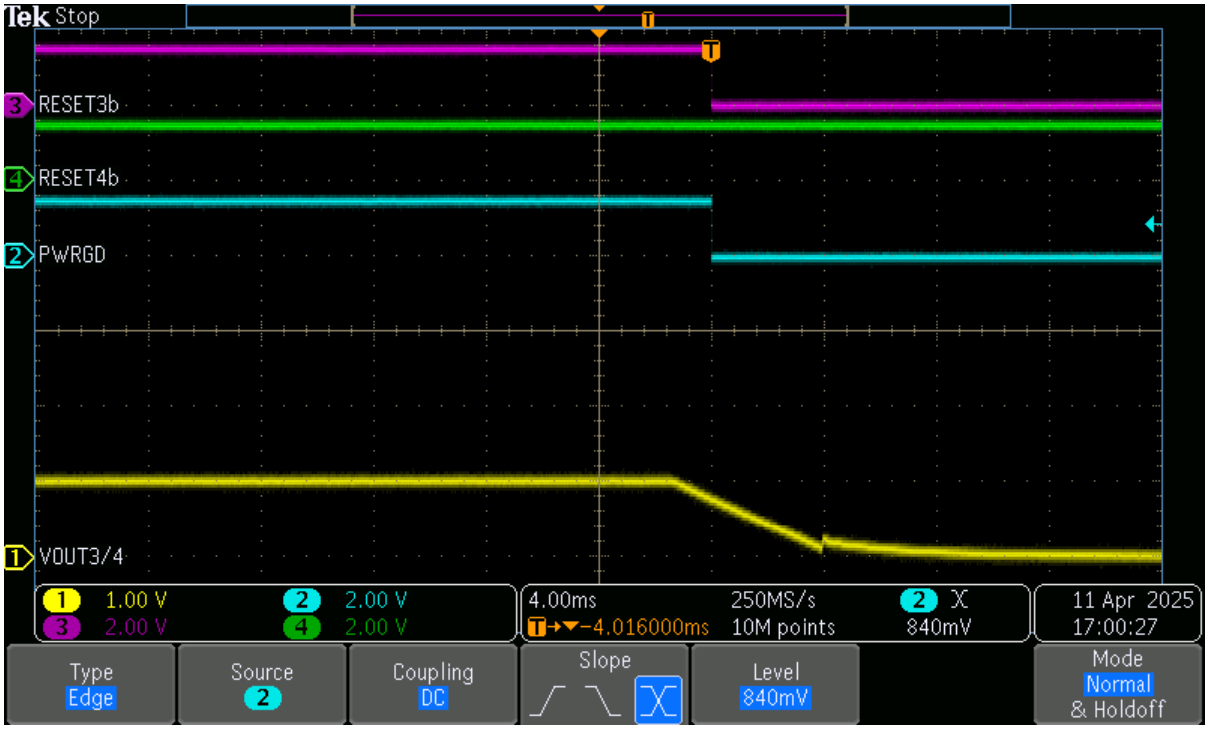


图 3-7. 通道 3/4 在 DLY_TMR=619kOhms 时脱离调节状态

3.4 窗口和过压监控 (MODE=1)

在以下测试中，J32 分流以使 MODE 引脚保持高电平，从而选择 2 倍窗口 + 2 倍过压监控模式。对于示波器屏幕截图中未显示的通道对，电压保持稳定。

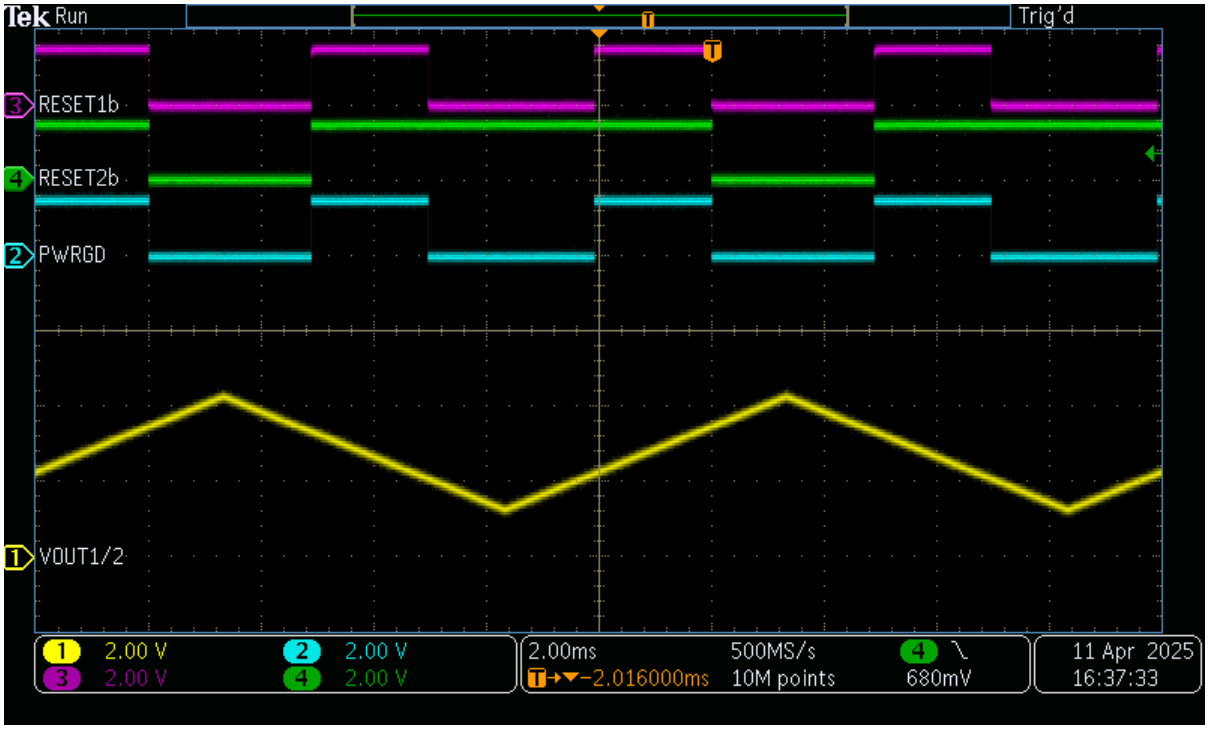


图 3-8. DLY_TMR 悬空时的通道 1/2 调节监控

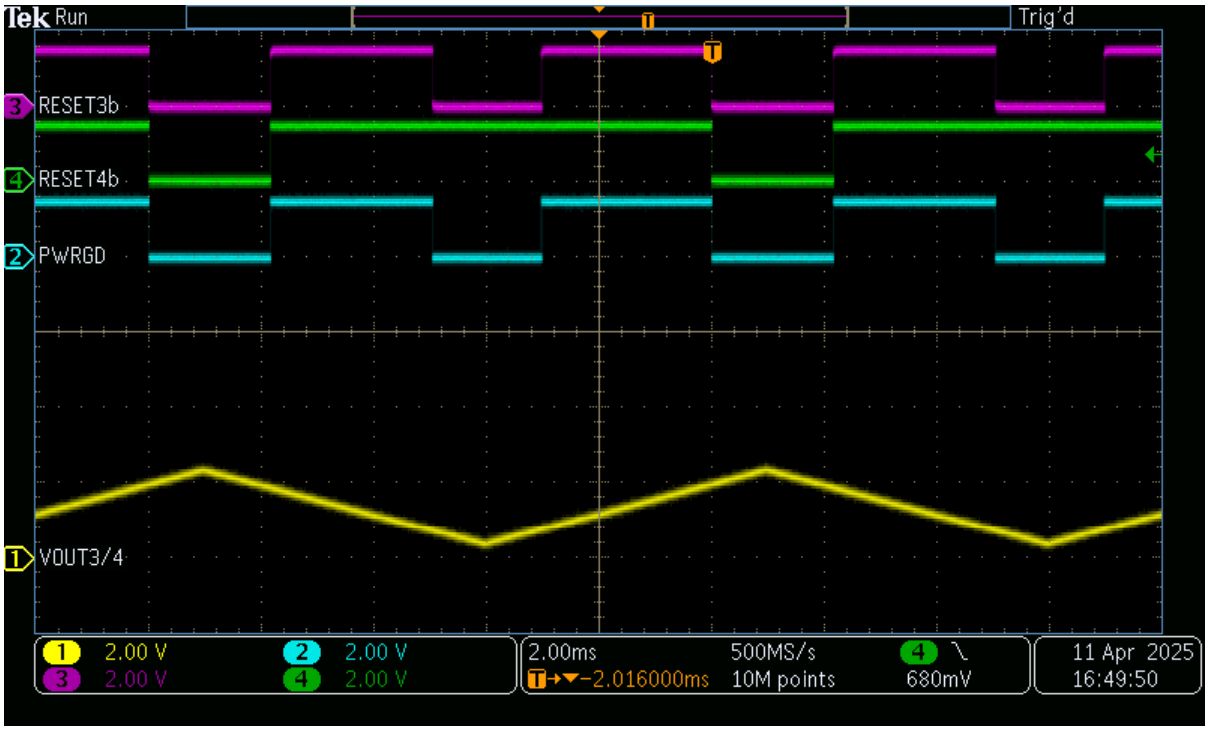


图 3-9. DLY_TMR 悬空时的通道 3/4 调节监控

3.5 WDOb

除非另有说明，否则以下测试是在稳压条件下使用所有受监控的电源轨进行的。显示了多个 WD_TMR 设置，以及至少一个受监控电源轨未处于调节状态（由 PWRGD 指示）的情况。

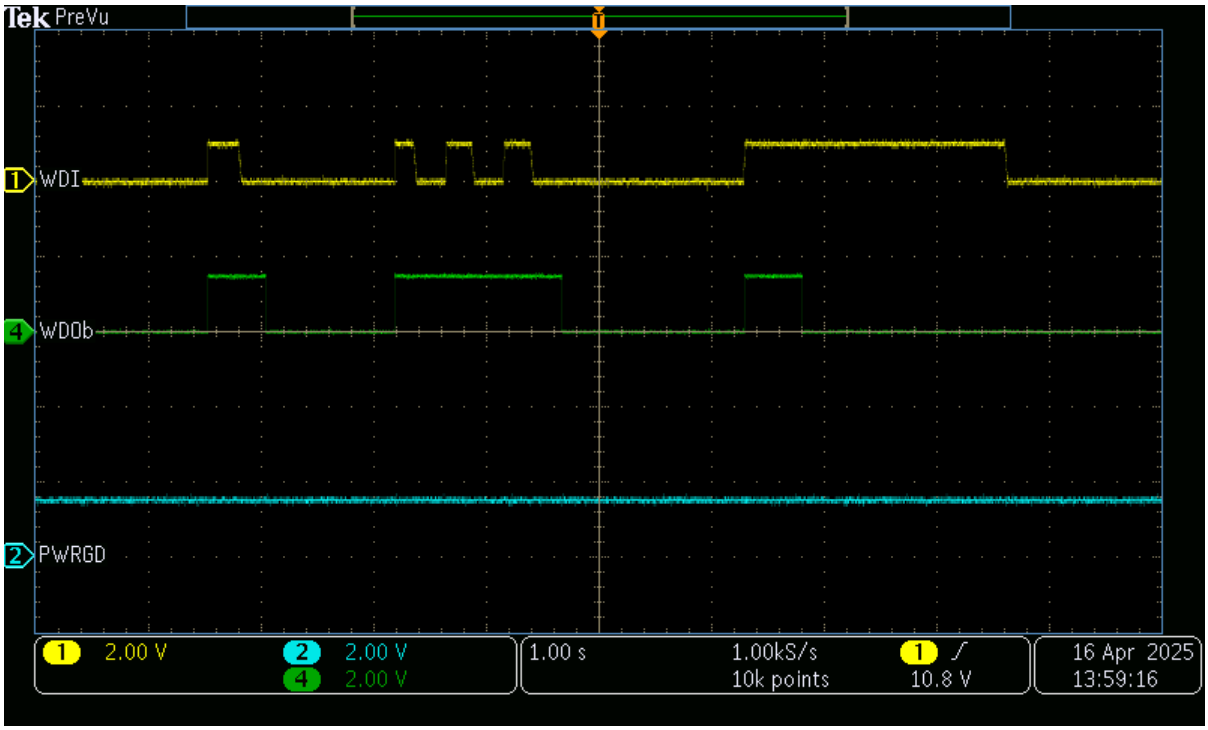


图 3-10. WD_TMR = 56.2kOhms

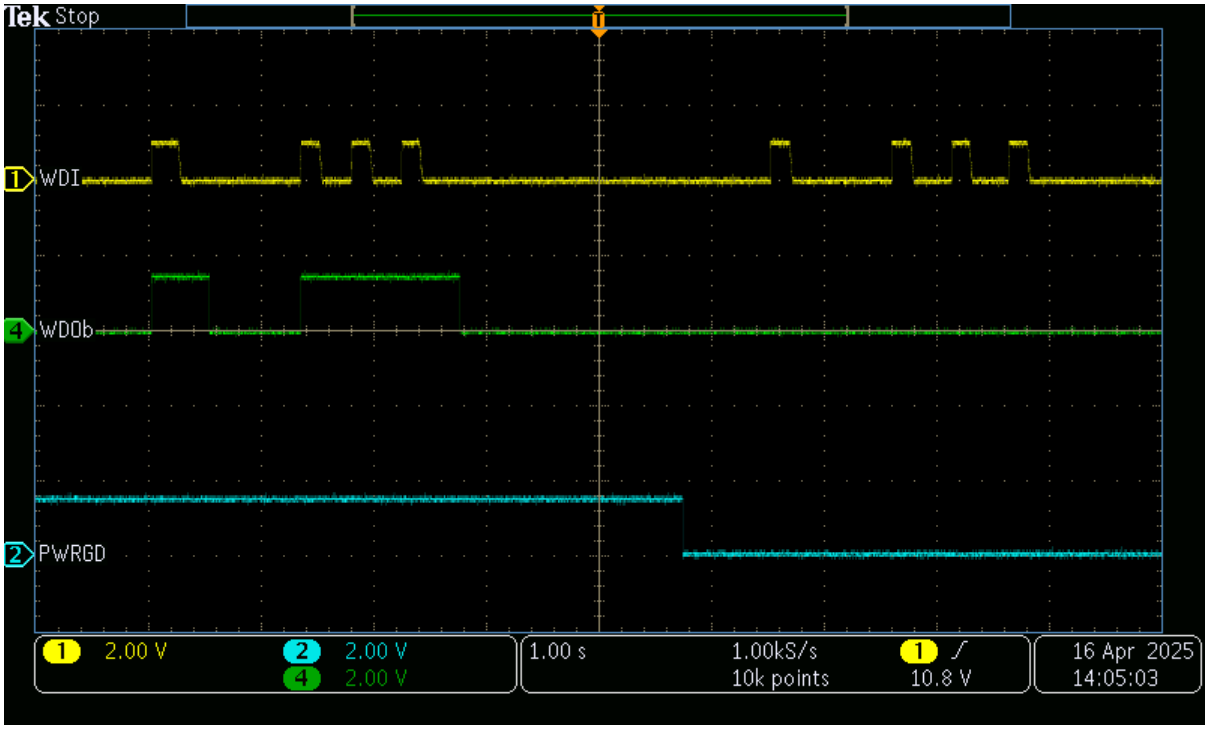


图 3-11. 当 PWRGD 指示通道 1/2 不再处于调节状态时，WD_TMR = 56.2kOhms

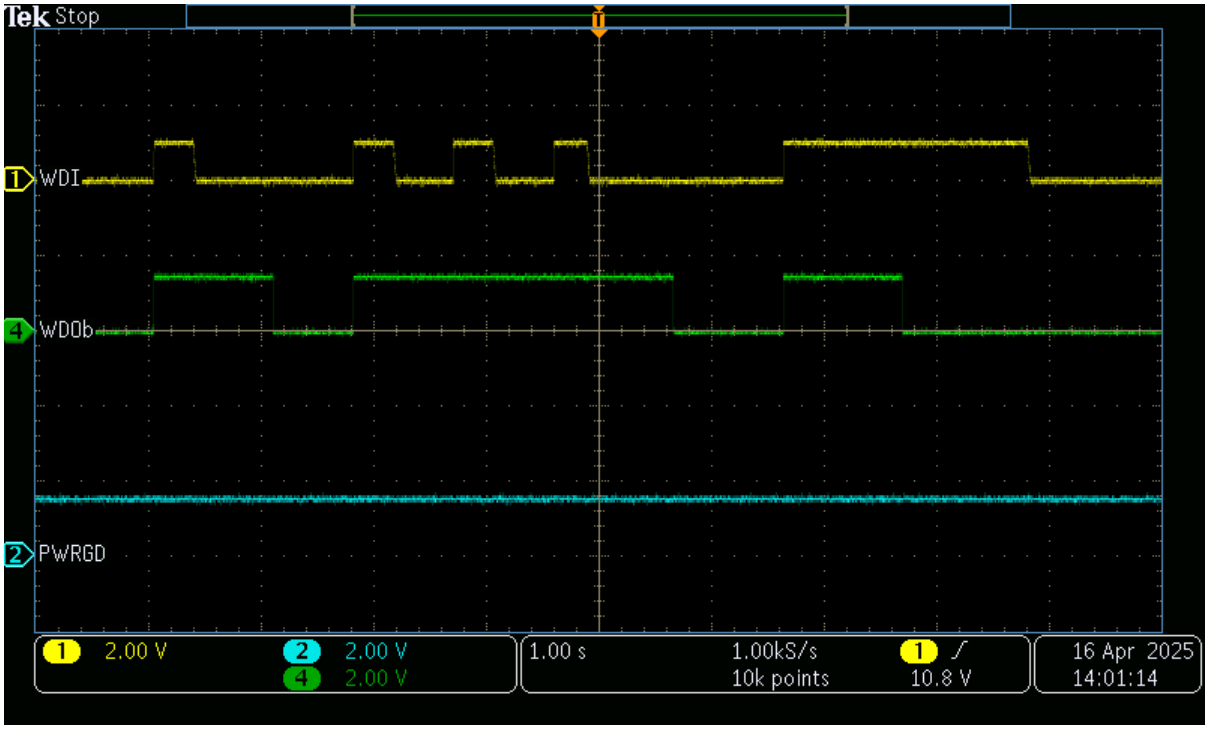


图 3-12. WD_TMR = 118kOhms

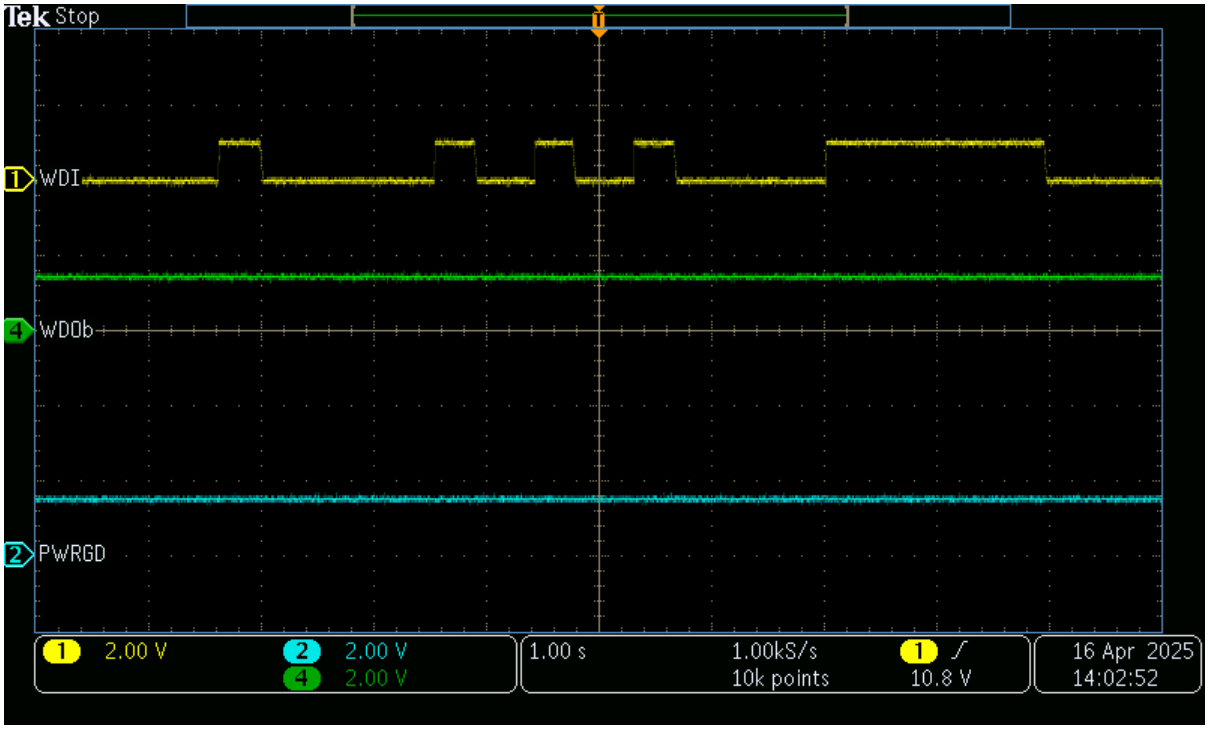


图 3-13. WD_TMR 悬空

4 硬件设计文件

4.1 原理图

TPS7H30x4EVM-CVAL 和 TPS7H31x4EVM-CVAL 的原理图

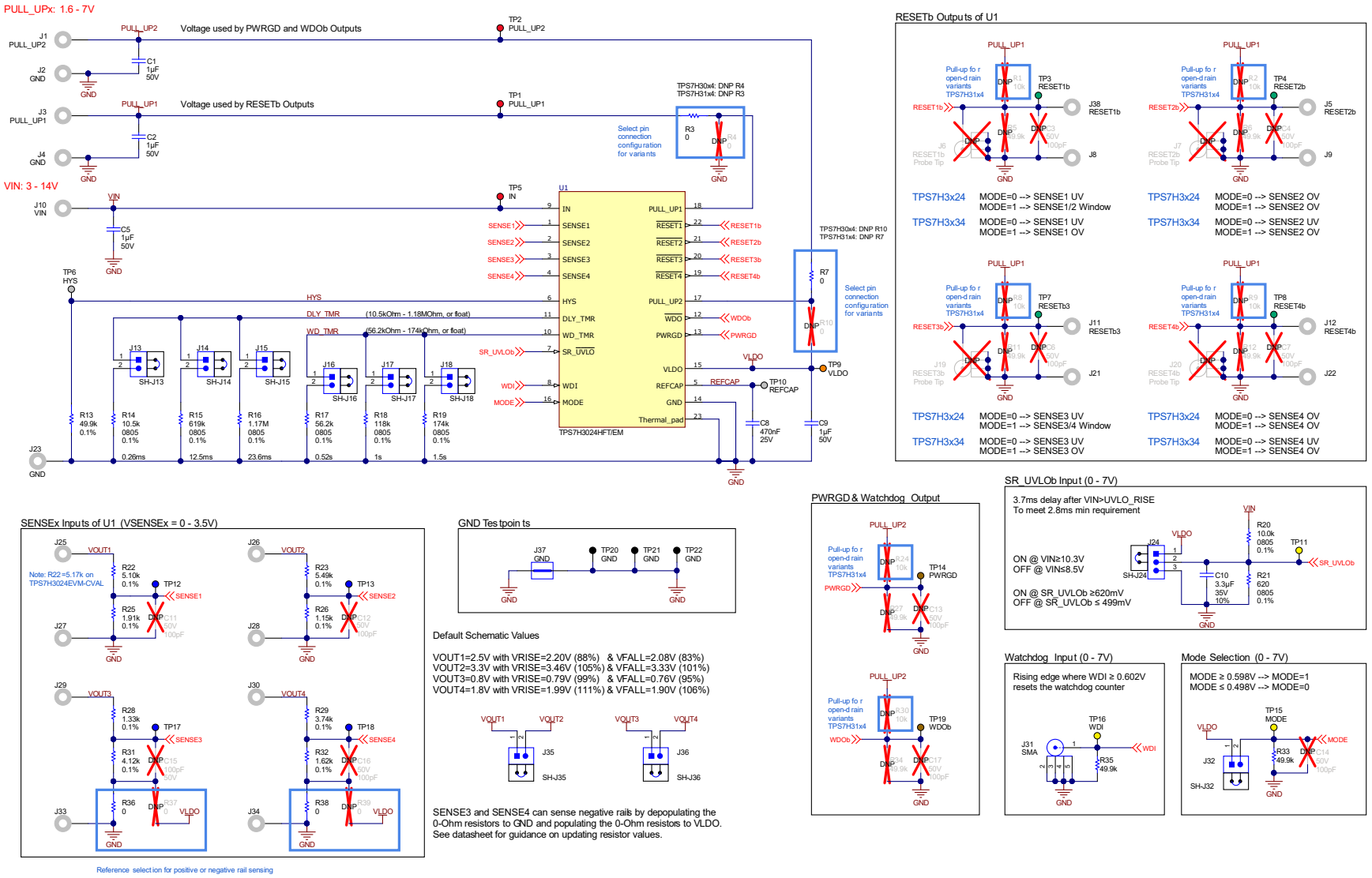


图 4-1. 默认 EVM 原理图（TPS7H3024EVM-CVAL 和 TPS7H3034EVM-CVAL）

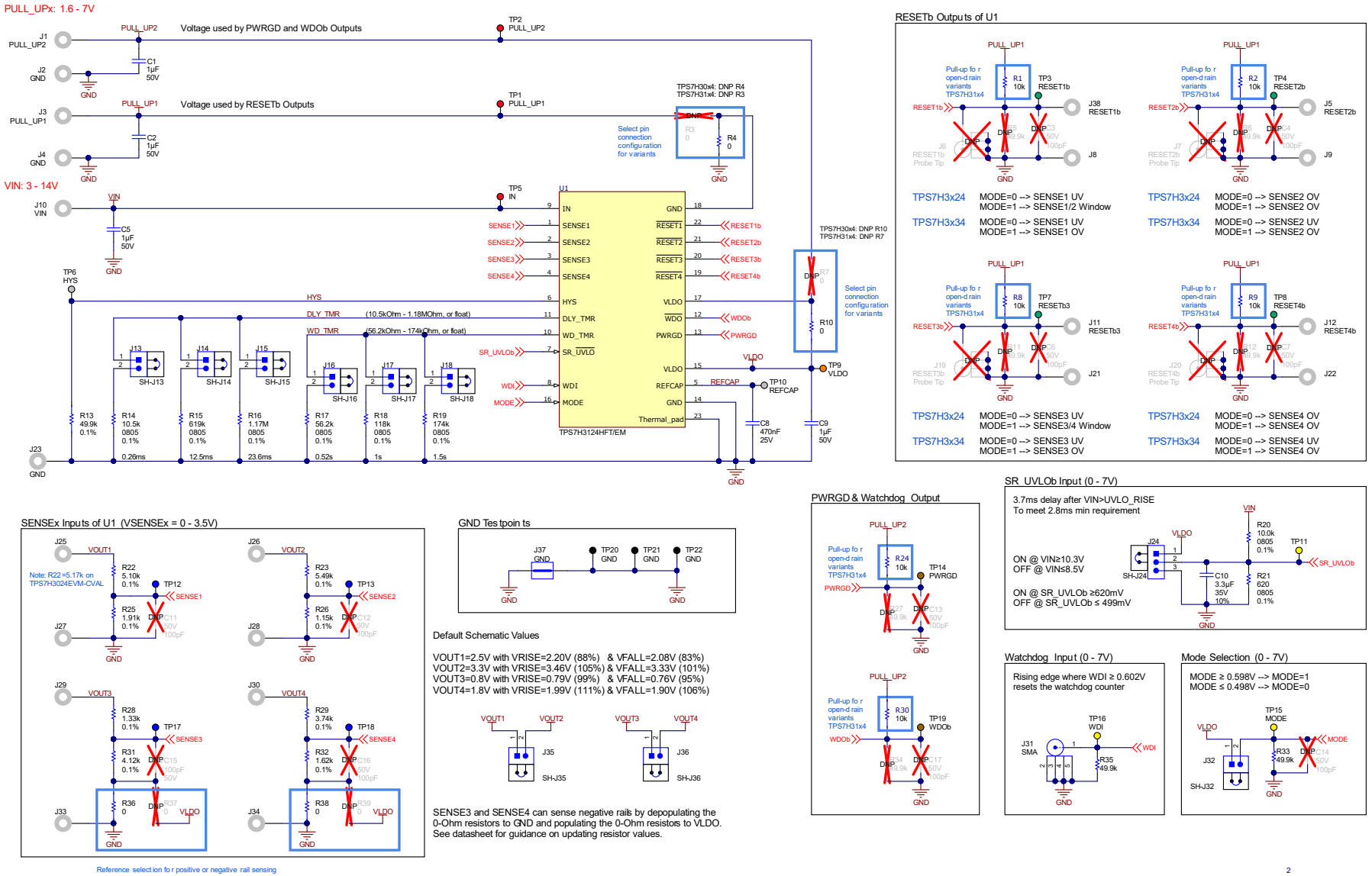


图 4-2. 默认 EVM 原理图（TPS7H3124EVM-CVAL 和 TPS7H3134EVM-CVAL）

4.2 物料清单 (BOM)

表 4-1. 用于 TPS7H3024EVM-CVAL 和 TPS7H3034EVM-CVAL 的 BOM

位号	数量	值	说明	封装参考	器件型号	制造商
C1、C2、C5、C9	4	1uF	电容，陶瓷，1µF，50V，+/-10%，X7R，0805	0805	08055C105KAT2A	AVX
C8	1	0.47uF	电容，陶瓷，0.47µF，25V，+/-10%，X7R，AEC-Q200 1 级，0603	0603	GCM188R71E474KA64D	MuRata
C10	1	3.3uF	电容，陶瓷，3.3µF，35V，+/-10%，X7R，AEC-Q200 1 级，0805	0805	CGA4J1X7R1V335K125AC	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	螺钉	NY PMS 440 0025 PH	B&F Fastener Supply
H5、H6、H7、H8	4		六角螺柱，0.5"L #4-40，尼龙	螺柱	1902C	Keystone
J1、J2、J3、J4、J5、J8、J9、J10、J11、J12、J21、J22、J23、J25、J26、J27、J28、J29、J30、J33、J34、J38	22		标准香蕉插头，非绝缘，5.5mm	Keystone_575-4	575-4	Keystone
J13、J14、J15、J16、J17、J18、J32、J35、J36	9		接头，2.54mm，2x1，锡，TH	接头，2.54mm，2x1，TH	22284023	Molex
J24	1		接头，2.54mm，3x1，锡，TH	接头，2.54mm，3x1，锡，TH	22284030	Molex
J31	1		SMA 连接器插座，母插座，50Ohm，穿孔焊接	PTH_RF_CONN	733910060	Molex
J37	1		1mm 非绝缘短路插头，10.16mm 间距，TH	短路插头，10.16mm 间距，TH	D3082-05	Harwin
R3、R7、R36、R38	4	0	电阻，SMD，0Ω，跳线，1/8W，0805	0805	RC0805FR-070RL	Yageo
R13	1	49.9k		0805	ERA-6AEB4992V	Panasonic
R14	1	10.5k		0805	RG2012P-1052-B-T5	Susumu Co Ltd
R15	1	619k		0805	RT0805BRD07619KL	Yageo
R16	1	1.17Meg		0805	RT0805BRD071M17L	Yageo
R17	1	56.2k		0805	RG2012P-5622-B-T5	Susumu Co Ltd
R18	1	118k		0805	RT0805BRD07118KL	Yageo
R19	1	174k		0805	RT0805BRD07174KL	Yageo
R20	1	10.0k		0805	MCU0805MD1002BP100	Vishay/Beyschlag
R21	1	620		0805	RG2012P-621-B-T5	Susumu Co Ltd
R22	1	5.10k (5.17k)	仅在 TPS7H3024EVM-CVAL 上使用 5.17k 电阻器	0805	RT0805BRD075K1L (RT0805BRD075K17L)	Yageo

表 4-1. 用于 TPS7H3024EVM-CVAL 和 TPS7H3034EVM-CVAL 的 BOM（续）

位号	数量	值	说明	封装参考	器件型号	制造商
R23	1	5.49k		0805	RT0805BRD075K49L	Yageo
R25	1	1.91k		0805	RT0805BRD071K91L	Yageo
R26	1	1.15k		0805	RT0805BRD071K15L	Yageo
R28	1	1.33k		0805	RT0805BRD071K33L	Yageo
R29	1	3.74k		0805	RT0805BRD073K74L	Yageo
R31	1	4.12k		0805	RT0805BRD074K12L	Yageo
R32	1	1.62k		0805	RT0805BRD071K62L	Yageo
R33、R35	2	49.9k		0603	RC0603FR-0749K9L	Yageo
SH-J13、SH-J14、SH-J15、SH-J16、SH-J17、SH-J18、SH-J24、SH-J32、SH-J35、SH-J36	10		连接器跳线 S2 (1 x 2) 位置分流连接器黑色开孔顶部 0.100"(2.54mm) GoldHORTING .100" 金	跳线	QPC02SXGN-RC	Sullins
TP1、TP2、TP5	3		测试点，多用途，红色，TH	红色通用测试点	5010	Keystone
TP3、TP4、TP7、TP8	4		测试点，通用，绿色，TH	绿色通用测试点	5126	Keystone
TP6、TP10	2		测试点，通用，灰色，TH	灰色通用测试点	5128	Keystone
TP9	1		测试点，通用，橙色，TH	橙色通用测试点	5013	Keystone
TP11、TP15、TP16	3		测试点，通用，黄色，TH	黄色通用测试点	5014	Keystone
TP12、TP13、TP17、TP18	4		测试点，通用，蓝色，TH	蓝色多用途测试点	5127	Keystone
TP14、TP19	2		测试点，通用，棕色，TH	棕色通用测试点	5125	Keystone
TP20、TP21、TP22	3		测试点，多用途，黑色，TH	黑色通用测试点	5011	Keystone
U1	1		带看门狗计时器的 14V 四通道耐辐射加固保障监控器	CFP22	TPS7H3024HFT/EM	德州仪器 (TI)
C3、C4、C6、C7、C11、C12、C13、C14、C15、C16、C17	0	100pF	电容，陶瓷，100pF，50V，+/-1%，C0G/NP0，0603	0603	C0603C101F5GACTU	Kemet
J6、J7、J19、J20	0		紧凑型探头尖端电路板测试点，TH，25 件装	TH 示波器探头	131-5031-00	Tektronix
R1、R2、R8、R9、R24、R30	0	10k	电阻，10k，1%，0.1W，0603	0603	CRCW060310K0FKEAC	Vishay
R4、R10、R37、R39	0	0	电阻，SMD，0Ω，跳线，1/8W，0805	0805	RC0805FR-070RL	Yageo
R5、R6、R11、R12、R27、R34	0	49.9k	电阻，49.9k，1%，0.1W，0603	0603	RC0603FR-0749K9L	Yageo

表 4-2. 用于 TPS7H3124EVM-CVAL 和 TPS7H3134EVM-CVAL 的 BOM

位号	数量	值	说明	封装参考	器件型号	制造商
C1、C2、C5、C9	4	1uF	电容，陶瓷，1uF，50V，+/-10%，X7R，0805	0805	08055C105KAT2A	AVX
C8	1	0.47uF	电容，陶瓷，0.47µF，25V，+/-10%，X7R，AEC-Q200 1 级，0603	0603	GCM188R71E474KA64D	MuRata
C10	1	3.3uF	电容，陶瓷，3.3µF，35V，+/-10%，X7R，AEC-Q200 1 级，0805	0805	CGA4J1X7R1V335K125AC	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	螺钉	NY PMS 440 0025 PH	B&F Fastener Supply
H5、H6、H7、H8	4		六角螺柱，0.5"L #4-40，尼龙	螺柱	1902C	Keystone
J1、J2、J3、J4、J5、J8、J9、J10、J11、J12、J21、J22、J23、J25、J26、J27、J28、J29、J30、J33、J34、J38	22		标准香蕉插头，非绝缘，5.5mm	Keystone_575-4	575-4	Keystone
J13、J14、J15、J16、J17、J18、J32、J35、J36	9		接头，2.54mm，2x1，锡，TH	接头，2.54mm，2x1，TH	22284023	Molex
J24	1		接头，2.54mm，3x1，锡，TH	接头，2.54mm，3x1，锡，TH	22284030	Molex
J31	1		SMA 连接器插座，母插座，50Ohm，穿孔焊接	PTH_RF_CONN	733910060	Molex
J37	1		1mm 非绝缘短路插头，10.16mm 间距，TH	短路插头，10.16mm 间距，TH	D3082-05	Harwin
R1、R2、R8、R9、R24、R30	6	10k	电阻，10k，1%，0.1W，0603	0603	CRCW060310K0FKEAC	Vishay
R4、R10、R36、R38	4	0	电阻，SMD，0Ω，跳线，1/8W，0805	0805	RC0805FR-070RL	Yageo
R13	1	49.9k		0805	ERA-6AEB4992V	Panasonic
R14	1	10.5k		0805	RG2012P-1052-B-T5	Susumu Co Ltd
R15	1	619k		0805	RT0805BRD07619KL	Yageo
R16	1	1.17Meg		0805	RT0805BRD071M17L	Yageo
R17	1	56.2k		0805	RG2012P-5622-B-T5	Susumu Co Ltd
R18	1	118k		0805	RT0805BRD07118KL	Yageo
R19	1	174k		0805	RT0805BRD07174KL	Yageo
R20	1	10.0k		0805	MCU0805MD1002BP100	Vishay/Beyschlag
R21	1	620		0805	RG2012P-621-B-T5	Susumu Co Ltd
R22	1	5.10k		0805	RT0805BRD075K1L	Yageo
R23	1	5.49k		0805	RT0805BRD075K49L	Yageo
R25	1	1.91k		0805	RT0805BRD071K91L	Yageo
R26	1	1.15k		0805	RT0805BRD071K15L	Yageo

表 4-2. 用于 TPS7H3124EVM-CVAL 和 TPS7H3134EVM-CVAL 的 BOM（续）

位号	数量	值	说明	封装参考	器件型号	制造商
R28	1	1.33k		0805	RT0805BRD071K33L	Yageo
R29	1	3.74k		0805	RT0805BRD073K74L	Yageo
R31	1	4.12k		0805	RT0805BRD074K12L	Yageo
R32	1	1.62k		0805	RT0805BRD071K62L	Yageo
R33、R35	2	49.9k		0603	RC0603FR-0749K9L	Yageo
SH-J13、SH-J14、SH-J15、SH-J16、SH-J17、SH-J18、SH-J24、SH-J32、SH-J35、SH-J36	10		连接器跳线 S2 (1 x 2) 位置分流连接器黑色开孔顶部 0.100"(2.54mm) GoldHORTING .100" 金	跳线	QPC02SXGN-RC	Sullins
TP1、TP2、TP5	3		测试点，多用途，红色，TH	红色通用测试点	5010	Keystone
TP3、TP4、TP7、TP8	4		测试点，通用，绿色，TH	绿色通用测试点	5126	Keystone
TP6、TP10	2		测试点，通用，灰色，TH	灰色通用测试点	5128	Keystone
TP9	1		测试点，通用，橙色，TH	橙色通用测试点	5013	Keystone
TP11、TP15、TP16	3		测试点，通用，黄色，TH	黄色通用测试点	5014	Keystone
TP12、TP13、TP17、TP18	4		测试点，通用，蓝色，TH	蓝色多用途测试点	5127	Keystone
TP14、TP19	2		测试点，通用，棕色，TH	棕色通用测试点	5125	Keystone
TP20、TP21、TP22	3		测试点，多用途，黑色，TH	黑色通用测试点	5011	Keystone
U1	1		带看门狗计时器的 14V 四通道耐辐射加固保障监控器	CFP22	TPS7H3024HFT/EM 或 TPS7H3034HFT/EM	德州仪器 (TI)
C3、C4、C6、C7、C11、C12、C13、C14、C15、C16、C17	0	100pF	电容，陶瓷，100pF，50V，+/-1%，C0G/NP0，0603	0603	C0603C101F5GACTU	Kemet
J6、J7、J19、J20	0		紧凑型探头尖端电路板测试点，TH，25 件装	TH 示波器探头	131-5031-00	Tektronix
R3、R7、R37、R39	0	0	电阻，SMD，0Ω，跳线，1/8W，0805	0805	RC0805FR-070RL	Yageo
R5、R6、R11、R12、R27、R34	0	49.9k	电阻，49.9k，1%，0.1W，0603	0603	RC0603FR-0749K9L	Yageo

4.3 PCB 布局

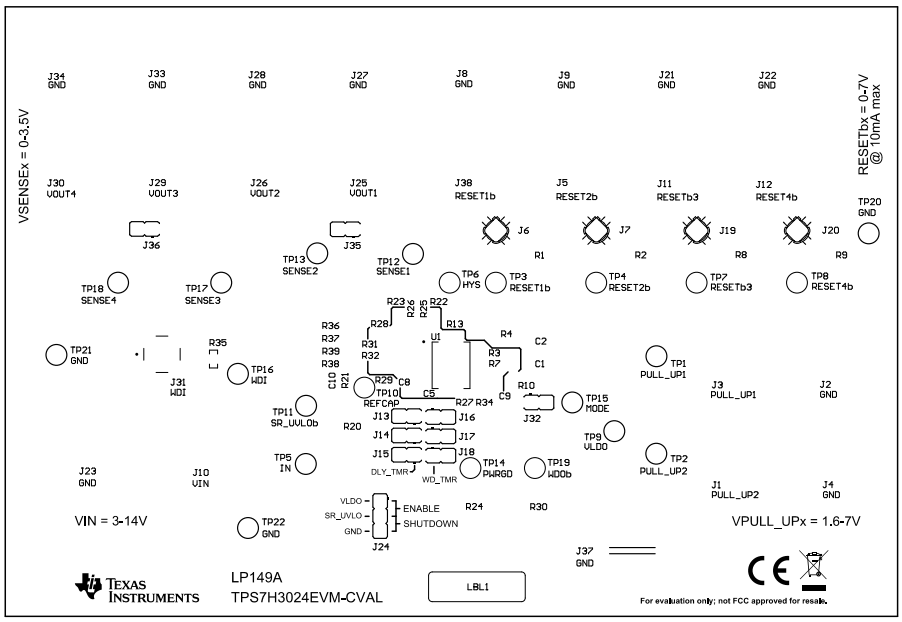


图 4-3. 顶层丝印层

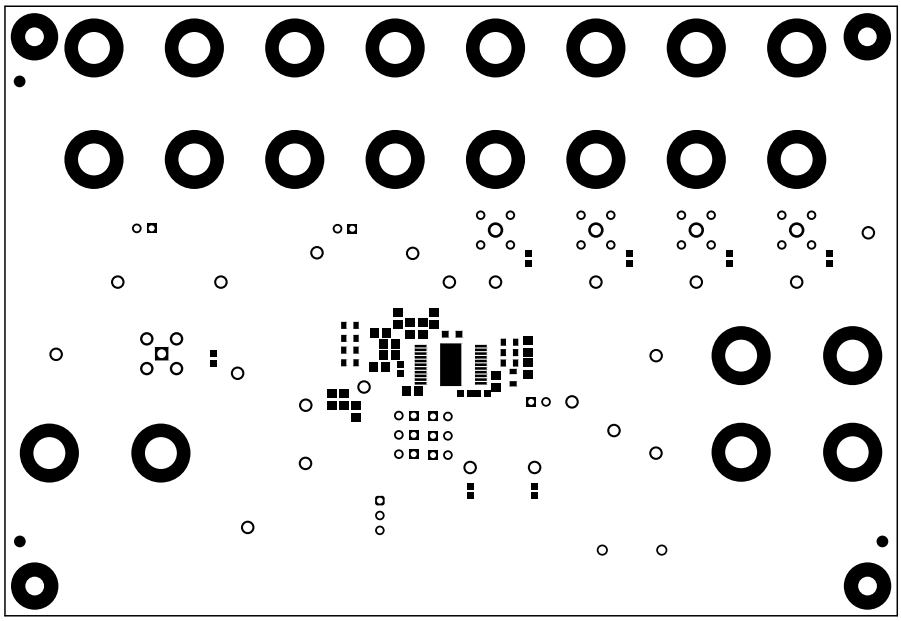


图 4-4. 顶部阻焊层

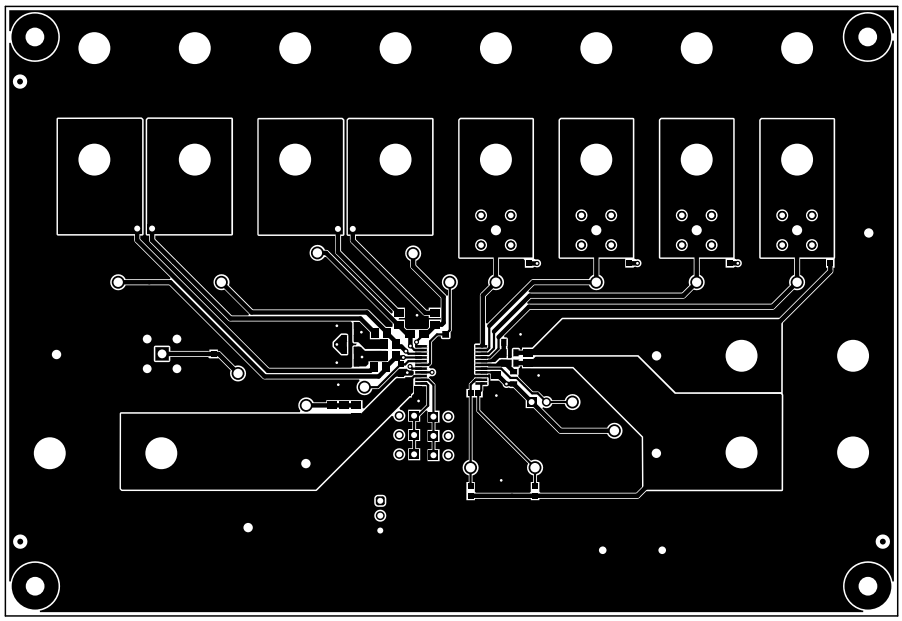


图 4-5. 第 1 层 (顶部)

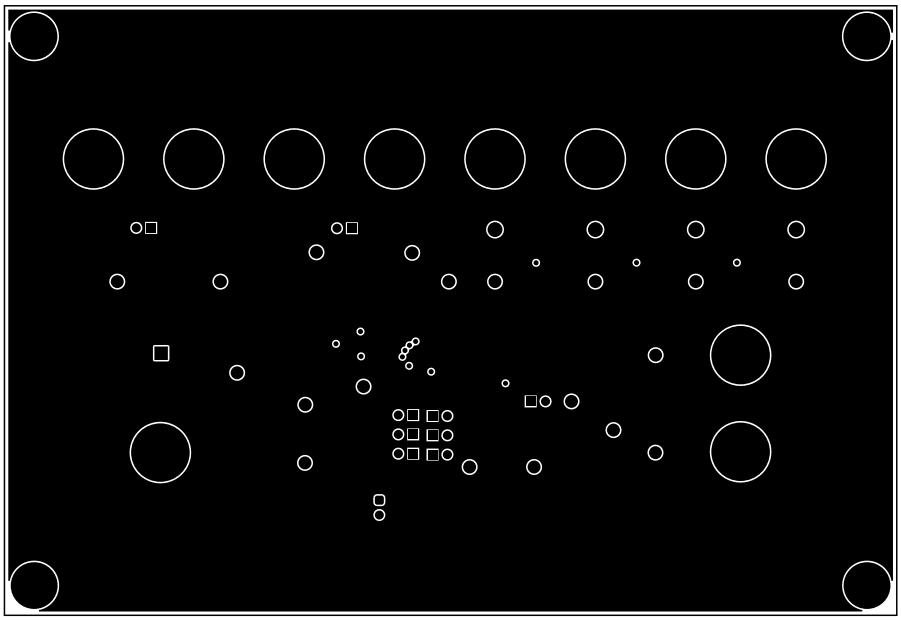


图 4-6. 第 2 层

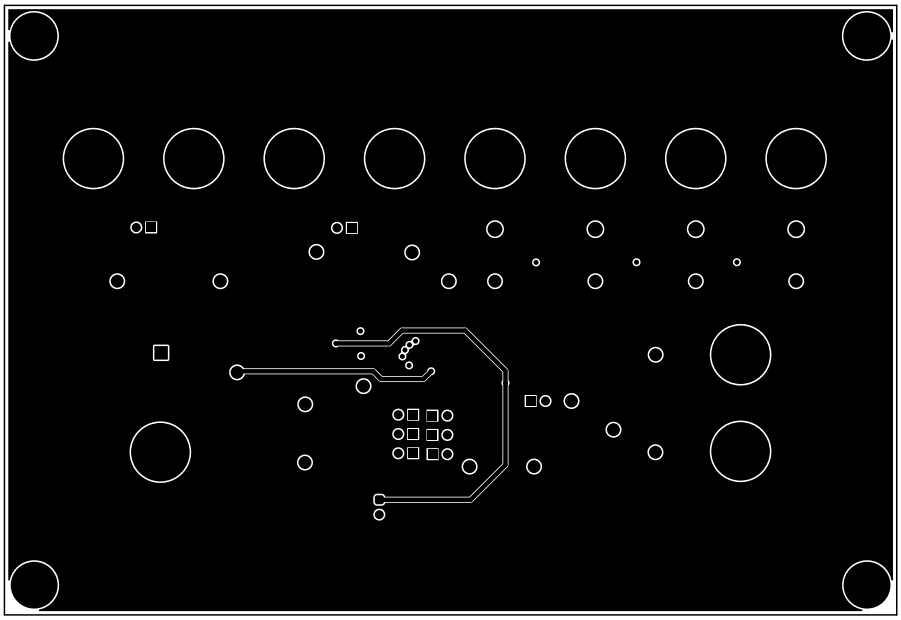


图 4-7. 第 3 层

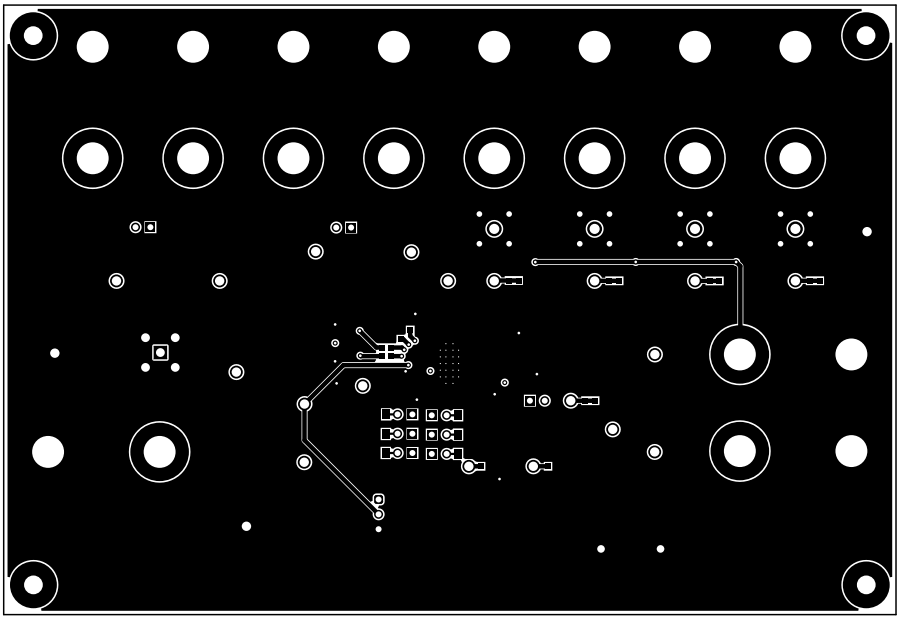


图 4-8. 第 4 层 (底部)

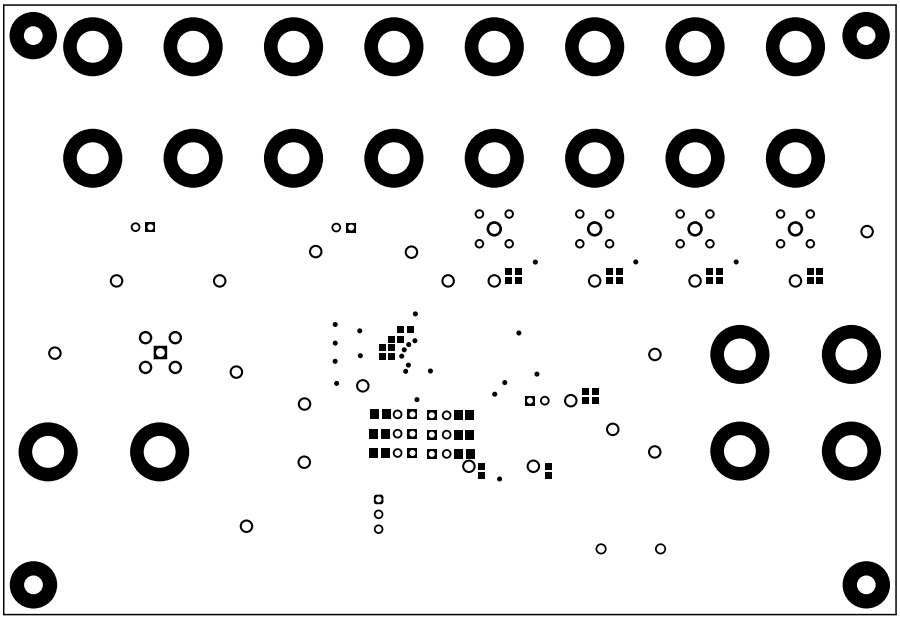


图 4-9. 底部阻焊层

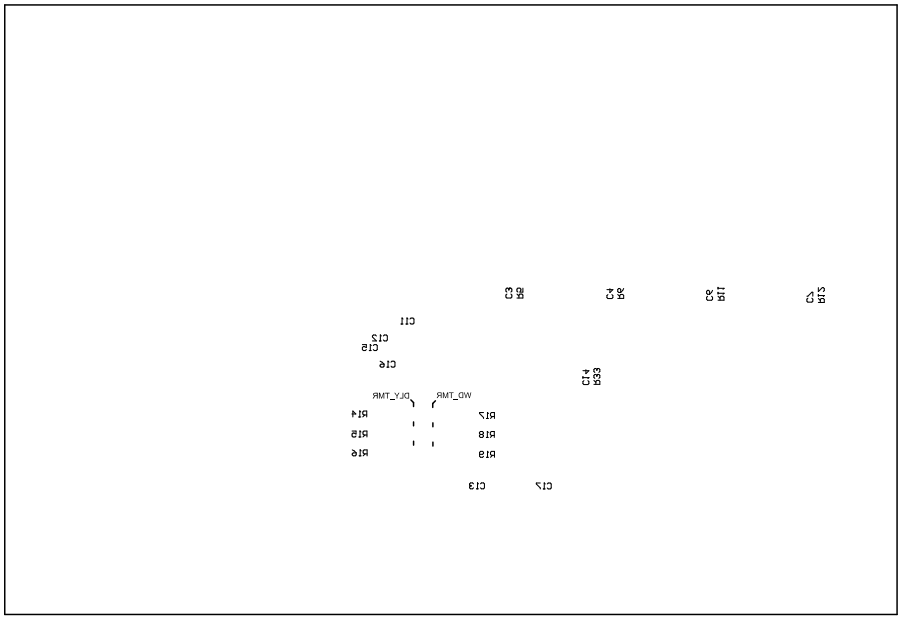


图 4-10. 底层丝印层

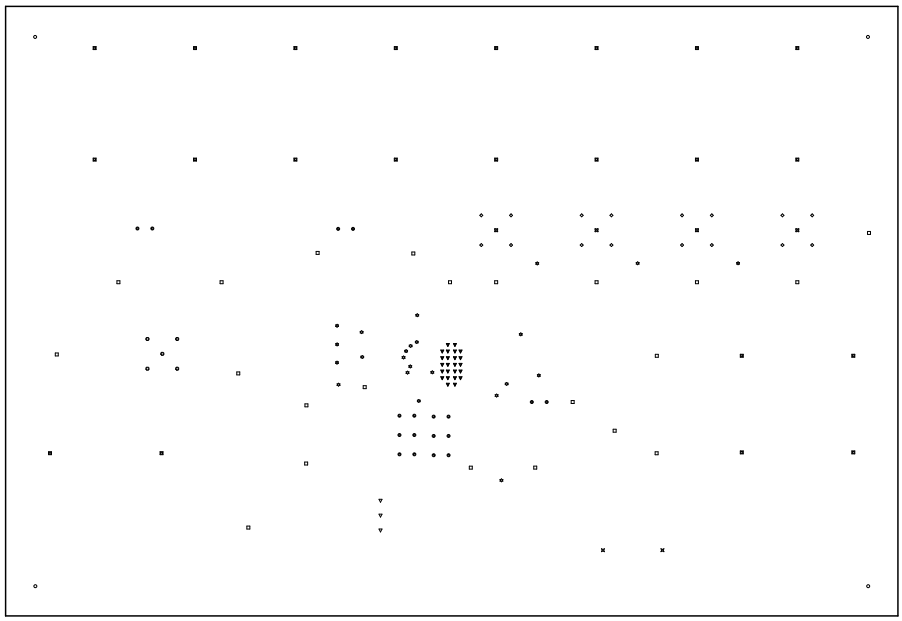


图 4-11. 钻孔图

5 合规信息

5.1 合规性和认证

- 德州仪器 (TI)，TPS7H3024EVM-CVAL EU RoHS 符合性声明 (DoC)

6 相关文档

- 德州仪器 (TI)，标准评估模块条款

7 修订历史记录

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (April 2025) to Revision A (May 2026)	Page
• 除了原来提及的 TPS7H3024 以外，新增了新的器件型号	1
• 更新了图 1-1	2
• 更新了计算得出的配置值，以匹配新增的原理图	2
• 新增有关推挽输出与开漏输出电路板配置差异的说明	4
• 删除了对 5962R2420601VXC 的引用	4
• 添加了阐述信息	7
• 添加了图 3-1	7
• 更新了图 3-3 说明	7
• 新增对器件名称的说明	14
• 除原有的推挽配置外，新增了显示开漏配置的原理图	14
• 除原有的推挽配置外，新增了显示开漏配置的 BOM	16

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。

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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

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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.

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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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