

EVM User's Guide: LM5066H1EVM

LM5066H1 评估模块



说明

本用户指南介绍了 LM5066H1EVM。LM5066H1EVM 包含用于 LM5066H1 热插拔控制器的评估和参考电路。LM5066H1 器件将高性能热插拔控制器与 PMBus 接口相结合，可准确测量、保护和控制连接到背板电源总线的系统的电气工作条件。

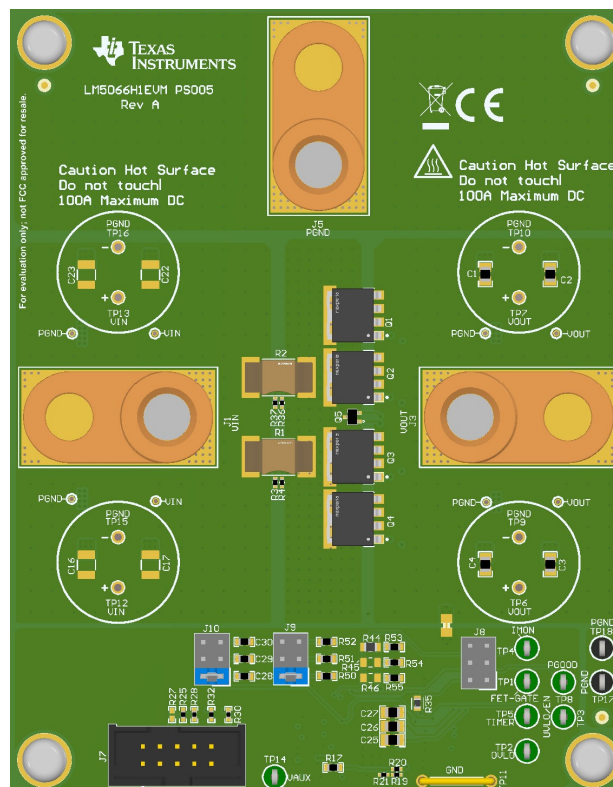
特性

- 40V 至 60V (典型值) 工作电压
- 使用 PMBus 实现 40A 至 200A 的可编程过流阈值
- 可调节输出电压压摆率控制
- 使用 PMBus 的可调节瞬态电流消隐计时器
- 用于输入瞬态保护的 TVS 二极管和用于输出瞬态保护的肖特基二极管
- 提供全面 SOA 保护的可编程电流限制和功率限制

- 可编程故障计时器可避免干扰性关机
- 可编程欠压和过压保护
- 可编程电源正常指示器
- 可编程自动重试或锁存选项
- 实时监测 VIN、VOUT、IIN、PIN、TEMP、EIN 和 VAUX

应用

- 输入热插拔
- 服务器和高性能计算
- 网络接口卡
- 显卡和硬件加速器卡
- 数据中心交换机和路由器
- 风扇托盘
- 交换机和路由器



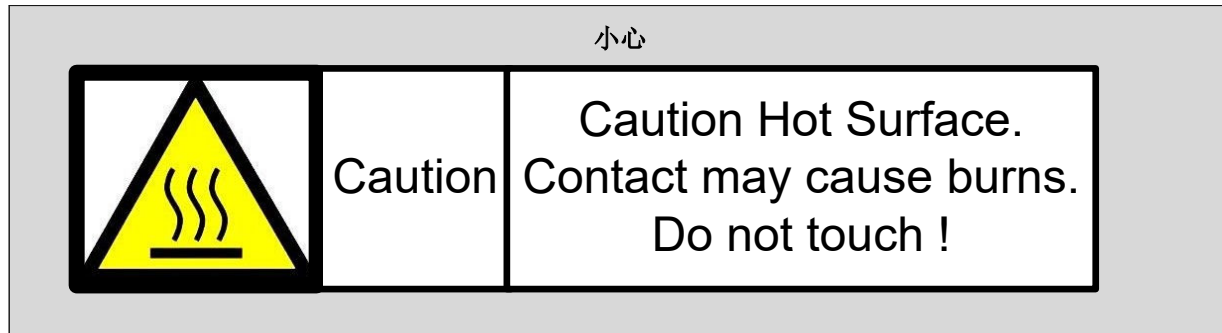
LM5066H1EVM

1 评估模块概述

1.1 简介

LM5066H1EVM 评估板为设计工程师提供了一款专为正电压系统设计的全功能智能监测和保护控制器板。本用户指南介绍了电路板的各种功能、如何测试和评估电路板，以及如何利用 GUI 设计工具来针对特定应用修改元件。为了使用该器件的先进遥测和监测功能，用户需要使用 [LM5066HxEVM-GUI](#)；但是，LM5066H1 无需安装任何软件即可用作热插拔和保护电路。此 EVM 展示了一款适用于 AI 驱动型企业数据中心的 5kW、54V 热插拔解决方案。

本用户指南介绍了 LM5066H1 热插拔控制器评估模块 (EVM)。



1.2 套件内容

表 1-1. LM5066H1EVM : 套件内容

条目	说明	数量
LM5066H1EVM	LM5066H1 热插拔控制器评估模块	1

该套件不包含 [USB 转 GPIO2](#) 适配器。需要通过以下地址单独订购：

[USB-TO-GPIO2 评估板 | TI.com.cn](#)。

1.3 规格

表 1-2 中总结了 LM5066H1EVM 规格。

表 1-2. LM5066H1EVM 设计规格

参数	值
输入电压范围 (V_{IN})	40V 至 60V
最大 RMS 负载电流 ($I_{OUT(max)}$)	100A
过流保护阈值 (I_{TRIP})	100A
最大输出电容 (C_{LOAD})	5mF
在 PG 置位之前所有负载是否都关闭？	否
最高环境温度	70°C
故障计时器	350 μ s、520 μ s 和 1ms
输出电压压摆率	0.7V/ms
是否需要承受输出端的“热短路”情况？	是
是否需要承受“加电至短路”情况？	是
是否可以热插拔电路板或对电路板进行下电上电？	是
是否需要负载电流监测？	是

表 1-2. LM5066H1EVM 设计规格 (续)

参数	值
故障响应	闭锁

1.4 器件信息

LM5066H1EVM 用于评估 LM5066Hx 系列中的 LM5066H1 热插拔控制器，并驱动四 (4) 个并联的 [PSMN2R3-100SSE](#) MOSFET。输入电源施加在连接器 J1 和 J5 之间，而 J3 和 J5 为 EVM 提供输出连接。请参阅图 4-1 中的原理图和图 3-1 中的 EVM 测试设置。TVS 二极管 D1 和 D2 提供对瞬态过压的输入保护。肖特基二极管 D3 和 D4 通过将 LM5066H1 热插拔控制器 OUT 引脚上的负电压偏移限制在最小绝对额定值内来保护输出。

连接器 J7 用于将 LM5066H1EVM 与 [USB 转 GPIO2](#) 适配器相连接，以便访问 [LM5066HxEVM-GUI](#)。TP6 和 TP9 以及 TP7 和 TP10 连接器是预留位置，用于在实验需要时连接额外的输出电容器。TP12 和 TP15 以及 TP13 和 TP16 连接器、C15 至 C18 和 C21 至 C24 电容器是预留位置，用于在需要时连接额外的输入电容器，以降低在输出热短路事件期间，由于电源和 EVM 之间输入阻抗较高导致的输入压降。

[LM5066HxEVM-GUI](#) 仅通过 [USB 转 GPIO2](#) 适配器提供对 LM5066H1 评估模块 GUI 的访问。

表 1-3. LM5066H1EVM 评估板选项和设置

EVM 功能	Vin UVLO 阈值	Vin OVLO 阈值	模拟故障计时器	输出压摆率 (dv/dt)	IMON	PLIM	ILIM
LM5066H1 的性能评估热插拔控制器	UVH = 37V UVL = 34V	OVH = 65V OVL = 63V	可选 - 350 μ s、 520 μ s 和 1ms	可选 - 0.7V/ms、 0.35V/ms 和 0.23V/ms	可选 - 每 1mV V _{SNS} 33.6mV、 66.5mV 和 167mV (VIN_K 和 SENSE 引脚 上的差分电压)	可选 - 180W、 240W 和 300W (R _{SNS} 为 250 μ Ω)	V _{CL} 为 25mV 时约 100A

小心

请勿在无人照看的情况下使该 EVM 通电

警告

信号布线、元件和元件引线位于电路模块的底部。因此，可能存在表面带电、高温或边缘锋利的情况。在操作电路板时，请勿触摸底部。

小心

EVM 上的通信接口未进行隔离。请确保计算机和 EVM 之间不存在接地电位。请注意，计算机以 EVM 的接地电位为基准。

2 硬件

2.1 一般配置

2.1.1 物理访问

表 2-1 列出了 LM5066H1EVM 评估板输入和输出连接器功能。表 2-2 和表 2-3 介绍了测试点的可用性和跳线的功能。

表 2-1. 输入和输出连接器功能

连接器	标签	说明
J1	VIN (+)	EVM 输入电源的正极端子
J3	VOOUT (+)	EVM 输出电源的正极端子
J5	PGND (-)	EVM 的负极端子 (输入和输出均为公共端子)

表 2-2. 测试点说明

测试点	标签	说明
TP1	FET GATE	MOSFET 栅极电压
TP2	OVLO	器件 OVLO 引脚处的电压
TP3	UVLO/EN	器件 UVLO/EN 引脚处的电压
TP4	IMON	稳态期间的负载电流监测器
TP5	计时器	计时器引脚电压
TP8	PGOOD	电源正常指示器
TP11	GND	器件接地
TP14	VAUX	辅助 ADC 输入
TP17 和 TP18	PGND	电源地

表 2-3. 跳线说明和默认位置

跳线	标签	说明	默认跳线位置
J8	HS-GATE	1-2 位置将输出压摆率设置为约 0.7V/ms	1-2
		3-4 位置将输出压摆率设置为约 0.35V/ms	
		5-6 位置将输出压摆率设置为约 0.23V/ms	
J9	PWR	1-2 位置将功率限制设置为约 180W, R_{SNS} 为 250 $\mu\Omega$	1-2
		3-4 位置将功率限制设置为约 240W, R_{SNS} 为 250 $\mu\Omega$	
		5-6 位置将功率限制设置为约 300W, R_{SNS} 为 250 $\mu\Omega$	
J10	计时器	1-2 位置将模拟故障计时器持续时间设置为 350 μs	1-2
		3-4 位置将模拟故障计时器持续时间设置为 520 μs	
		5-6 位置将模拟故障计时器持续时间设置为 1ms	

2.1.2 测试设备和设置

2.1.2.1 电源

一个可调电源, 具有 0V 至 80V 输出和 0A 至 200A 输出电流限制。

2.1.2.2 仪表

两个数字万用表 (DMM)。

2.1.2.3 示波器

DPO2024 或等效器件, 具有三个 10x 电压探针和一个能够测量 150A 电流的直流电流探针。

2.1.2.4 负载

一个阻性负载或等效负载，能够在 80V 电压下承受高达 200A 的直流负载。

2.1.2.5 USB 转 GPIO 接口适配器

LM5066H1EVM 和主机之间需要一个通信适配器才能使用 [LM5066HxEVM-GUI](#)。GUI 仅与德州仪器 (TI) [USB 转 GPIO2 USB 接口适配器评估模块](#)通信。可以在 [USB-TO-GPIO2 评估模块 | 德州仪器 TI.com.cn](#) 上购买该适配器。

LM5066H1EVM 套件不包含该 USB 转 GPIO2 适配器。

备注

LM5066HxEVM-GUI 不与任何其他适配器通信。

3 实现结果

3.1 测试设置和过程

本用户指南介绍了 LM5066H1 热插拔控制器的测试过程。确保评估板具有如表 3-1 所示的默认跳线设置。

表 3-1. LM5066H1EVM 电子保险丝评估板的默认跳线设置

J8	J9	J10
1-2	1-2	1-2

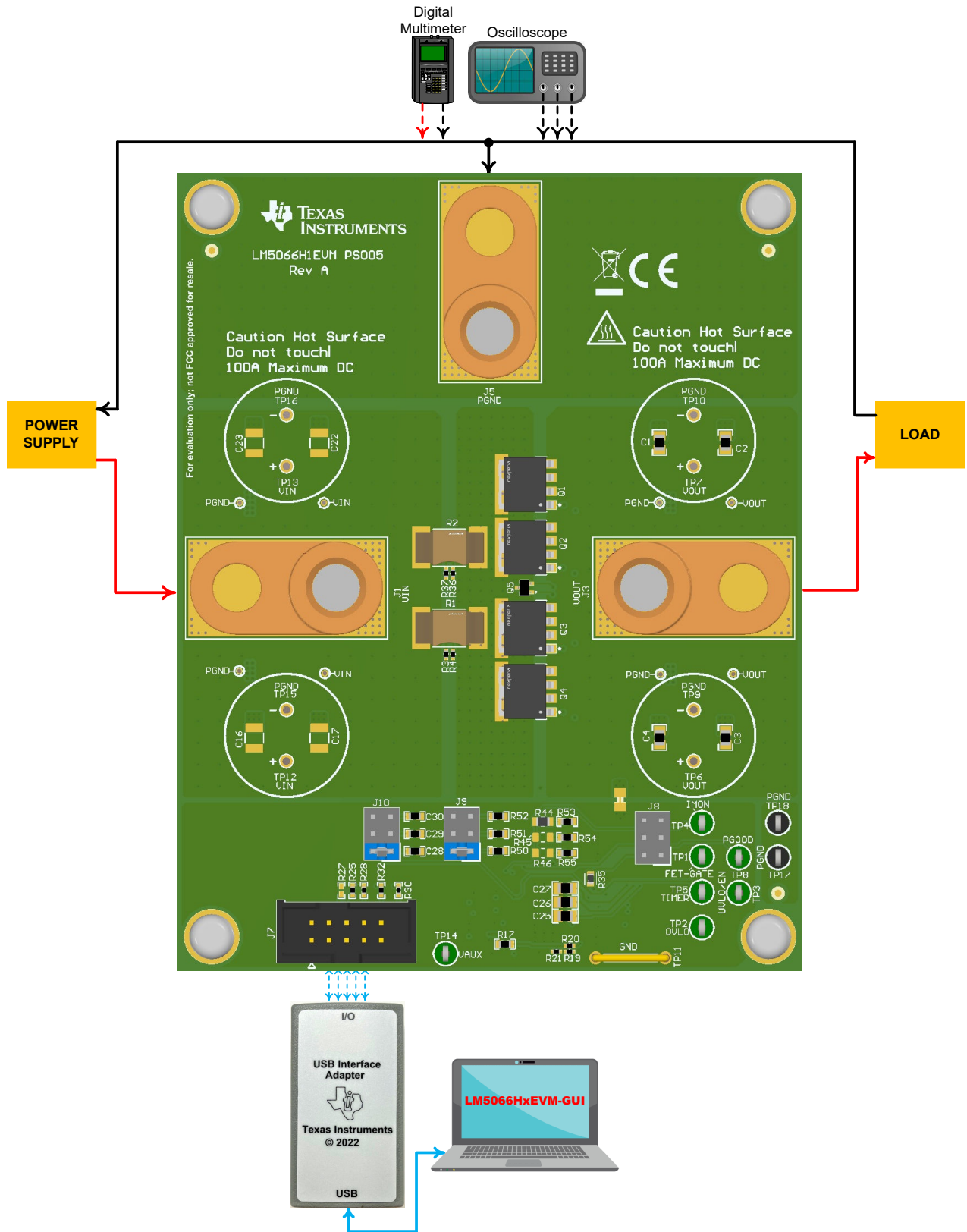


图 3-1. 带测试设备的 LM5066H1EVM 设置

在开始任何测试之前，请遵循以下说明进行操作，并在进行下一个测试之前重复这些操作：

- 将输入电源电压设置为所需的工作输入电压和电流限制
- 关闭电源

- 将电源的正电压导线连接到 J1 (VIN)
- 将电源的接地导线连接到 J5 (PGND)
- 将 EVM 上的跳线调整为默认配置，如表 3-1 所示。
- 打开电源
- 根据测试需要改变输入电压并增加负载电流
- 根据需要施加故障条件以观察故障性能

3.2 测试结果

本节提供了 LM5066H1EVM 在 $V_{IN} = 54V$ 时的典型性能波形。实际性能数据会受到测量技术和环境变量的影响；因此，这些曲线仅供参考，可能与实际获得的结果有所不同。

3.2.1 输入热插拔

测试条件： $V_{IN} = 54V$ ， $C_{IN} = 100nF$ ， $C_{OUT} = \text{约 } 1mF$ ，且 $C_{DVRT} = 33nF$

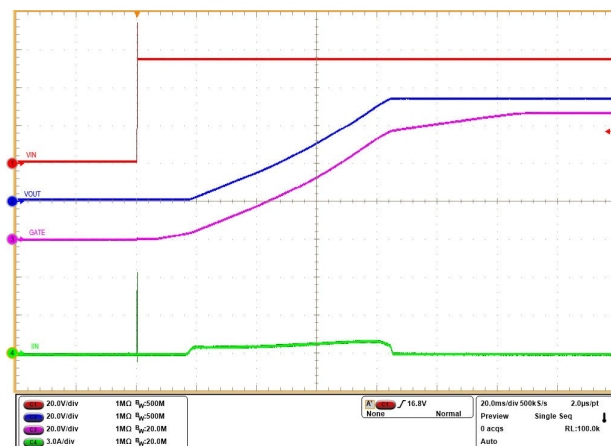


图 3-2. 输入热插拔曲线 (缩小视图) 和插入延迟

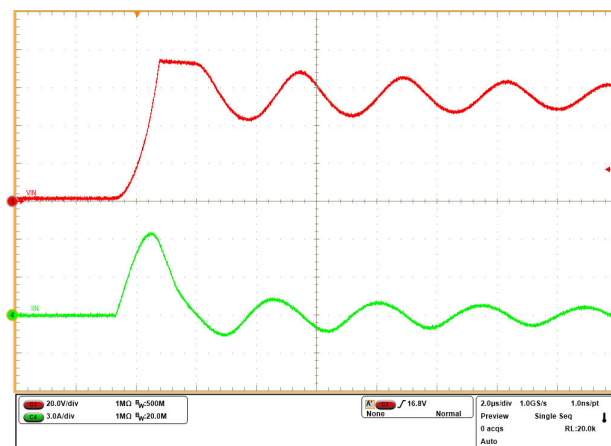


图 3-3. 输入热插拔曲线 (放大视图)

3.2.2 通过 ENABLE 启动

3.2.2.1 仅输出电容器

测试条件： $V_{IN} = 54V$ ， $C_{OUT} = \text{约 } 5mF$ ，且 $C_{DVRT} = 33nF$

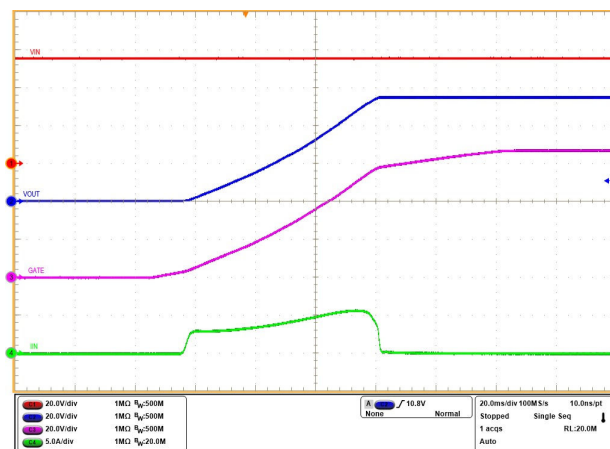


图 3-4. 仅使用输出电容器时的启动曲线

3.2.2.2 输出电容器和恒流负载

测试条件： $V_{IN} = 54V$ ， $C_{OUT} =$ 约 5mF， $I_{LOAD} = 3A$ ， $V_{TH(ON)} = 10V$ ，且 $C_{DVDT} = 33nF$

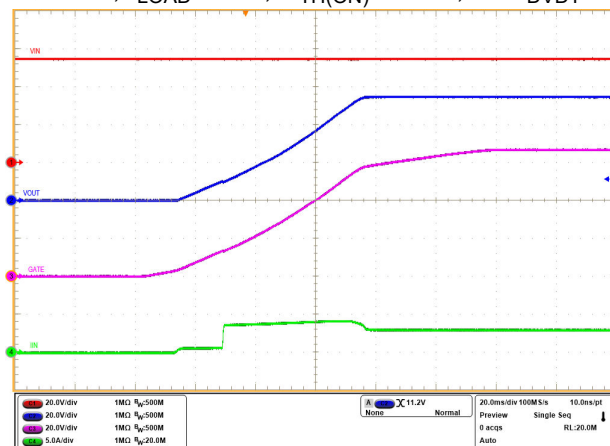


图 3-5. 使用输出电容器和恒流负载时的启动曲线

3.2.2.3 带输出电容器和恒流负载时的启动失败

测试条件： $V_{IN} = 54V$ ， $C_{OUT} =$ 约 5mF， $I_{LOAD} = 5A$ ， $V_{TH(ON)} = 10V$ ， $C_{DVDT} = 33nF$ ，并重试 8 次

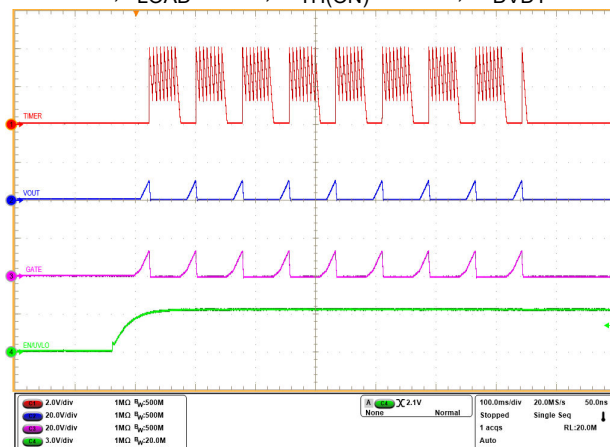


图 3-6. 带输出电容器和恒流负载时的启动失败曲线

3.2.2.4 基于折返电流限制的启动

测试条件： $V_{IN} = 54V$ ， $C_{OUT} =$ 约 $5mF$ ， $C_{DVRT} = 33nF$ ， $V_{CL} = 10mV$ ， $R_{SNS} = 250\mu\Omega$ ，且折返电流限制启用为电流限制阈值的 5%（即 $2A$ ）

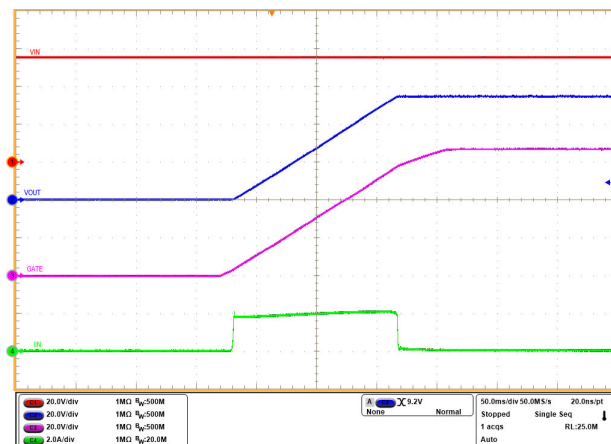


图 3-7. 具有折返电流限制的启动曲线

3.2.3 上电至短路

3.2.3.1 闭锁和较低的计时器灌电流

测试条件： $V_{IN} = 54V$ ， $C_{TMR} = 5.6nF$ ， $R_{PWR} = 6.81k$ ， $R_{SNS} = 250\mu\Omega$ ，且计时器灌电流 = $2.5\mu A$

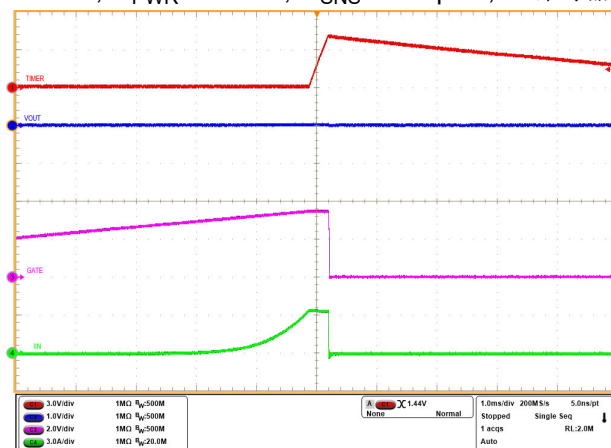


图 3-8. 上电至输出短路响应（闭锁和较低的计时器灌电流）

3.2.3.2 自动重试和较低的计时器灌电流

测试条件： $V_{IN} = 54V$ ， $C_{TMR} = 5.6nF$ ， $R_{PWR} = 6.81k$ ， $R_{SNS} = 250\mu\Omega$ ，且计时器灌电流 = $2.5\mu A$

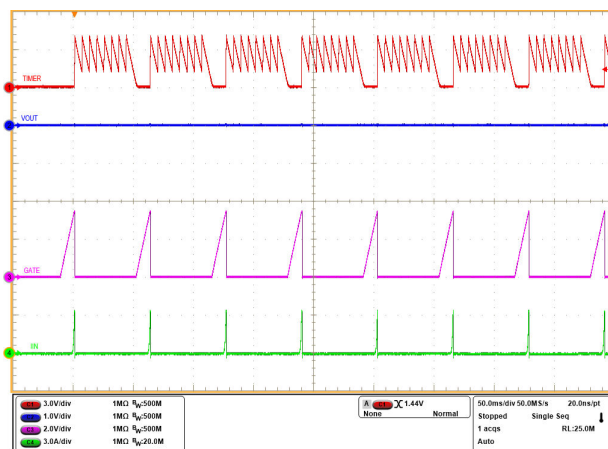


图 3-9. 上电至输出短路响应 (自动重试和较低的计时器灌电流)

3.2.3.3 闭锁和较高的计时器灌电流

测试条件： $V_{IN} = 54V$ ， $C_{TMR} = 5.6nF$ ， $R_{PWR} = 6.81k$ ， $R_{SNS} = 250\mu\Omega$ ，且计时器灌电流 = $75\mu A$

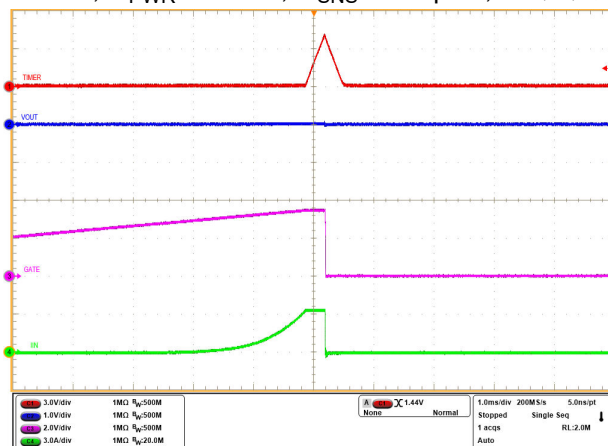


图 3-10. 上电至输出短路响应 (闭锁和较低的计时器灌电流)

3.2.3.4 自动重试和较高的计时器灌电流

测试条件： $V_{IN} = 54V$ ， $C_{TMR} = 5.6nF$ ， $R_{PWR} = 6.81k$ ， $R_{SNS} = 250\mu\Omega$ ，且计时器灌电流 = $75\mu A$

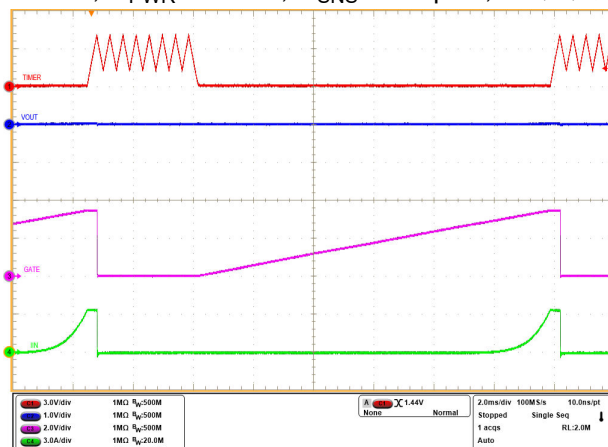


图 3-11. 上电至输出短路响应 (闭锁和较低的计时器灌电流)

3.2.4 欠压锁定

测试条件： $V_{\text{INUVLO-Rising}} = 38\text{V}$ ， $V_{\text{INUVLO-Falling}} = 35\text{V}$ ， $I_{\text{LOAD}} = 5\text{A}$ ，且 V_{IN} 从 54V 缓慢降至 30V，再缓慢升回 54V

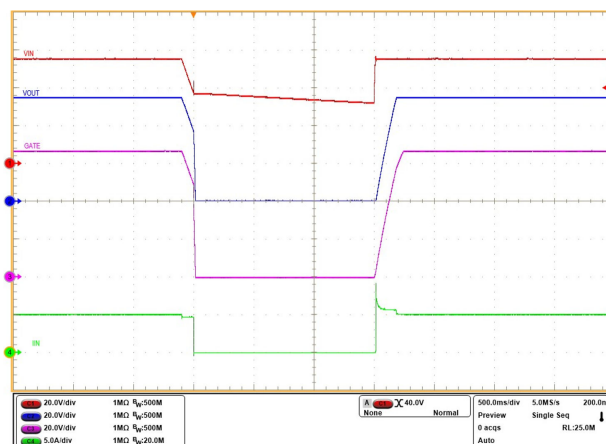


图 3-12. 欠压锁定和恢复响应 (缩小视图)

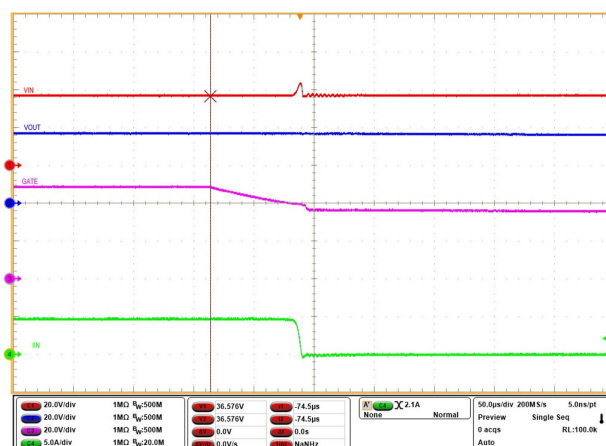


图 3-13. 欠压锁定响应 (放大视图)

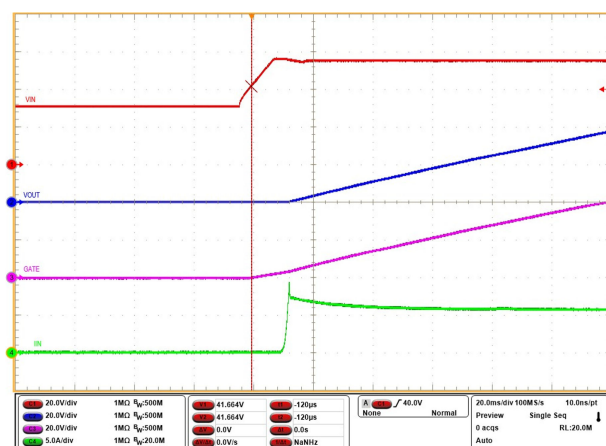


图 3-14. 从欠压锁定中恢复响应 (放大视图)

3.2.5 过压锁定

测试条件： $V_{\text{INOVLO-Rising}} = 63\text{V}$ ， $V_{\text{INOVLO-Falling}} = 60\text{V}$ ， $I_{\text{LOAD}} = 5\text{A}$ ，且 V_{IN} 从 54V 缓慢升至 65V，再缓慢降回 54V

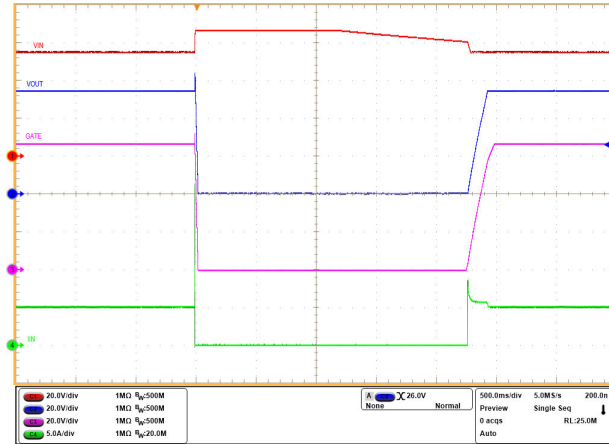


图 3-15. 过压锁定和恢复响应 (缩小视图)

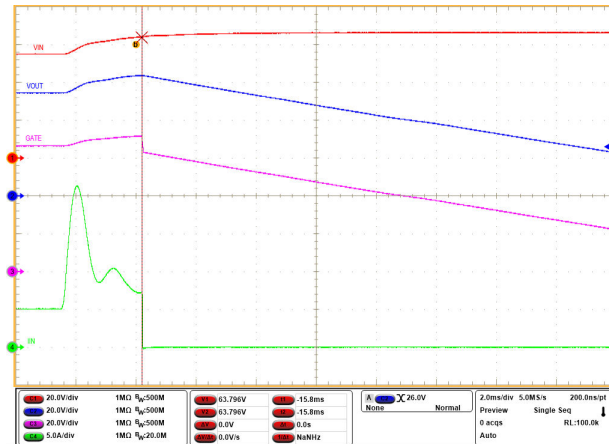


图 3-16. 过压锁定响应 (放大视图)

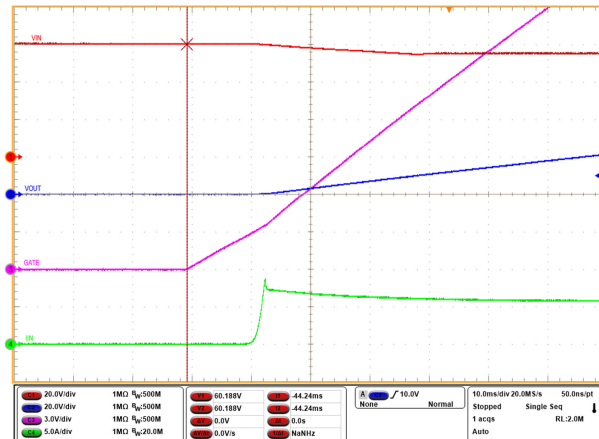


图 3-17. 从过压锁定中恢复响应 (放大视图)

3.2.6 瞬态过载性能

测试条件： $V_{IN} = 54V$ ， $I_{CL} = 85A$ ， $I_{CBL1} = 128A (1.5 \times I_{CL})$ ， $I_{CBL2} = 170A (2.0 \times I_{CL})$ ， $I_{CB} = 255A (3.0 \times I_{CL})$ ， $t_{FLT} = \text{约 } 350\mu s$ ， $t_{CBL1} = 8ms$ ，且 $t_{CBL2} = 4ms$

电流负载从 80A 升高到 120A，从而防止触发 t_{CBL2} 。但是，将会触发 t_{CBL1} 。120A 的电流脉冲如果持续时间短于 8ms 将会通过，但如果持续时间超过 8ms，则将激活硬件编程计时器 (t_{FLT})。

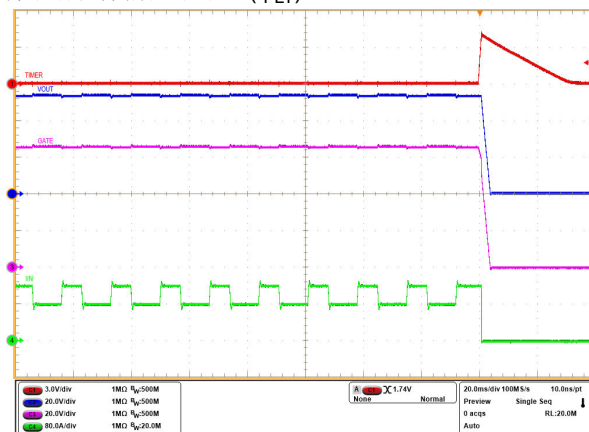


图 3-18. 瞬态过载响应 - 1

电流负载从 80A 升高到 160A，此时 t_{CBL1} 和 t_{CBL2} 将分别触发 8ms 和 4ms。160A 的电流脉冲如果持续时间短于 4ms 将会通过，但如果持续时间超过 4ms，则将激活硬件编程计时器 (t_{FLT})。

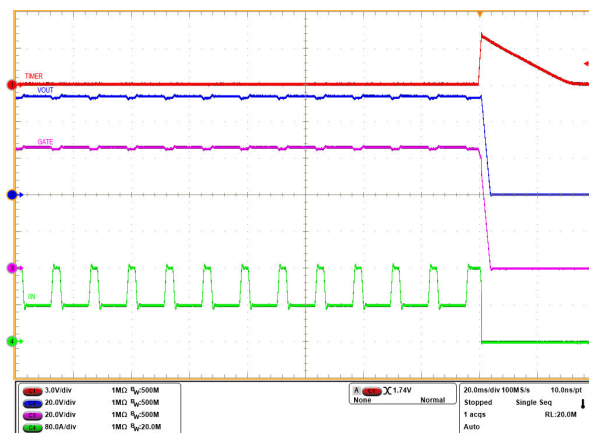


图 3-19. 瞬态过载响应 - 2

电流负载从 80A 升高到 200A。200A 电流脉冲介于 I_{CBL2} 和 I_{CB} 之间。因此，不会发生电流消隐，并且硬件编程计时器 (t_{FLT}) 将直接激活。

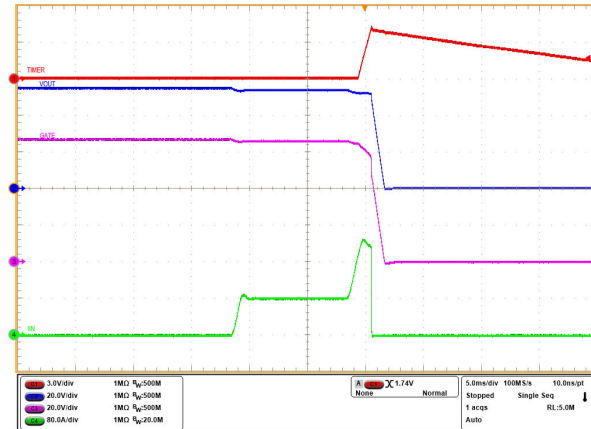


图 3-20. 瞬态过载响应 - 3

长时间施加 3ms 的 80A 负载瞬态和 3ms 的 160A 负载瞬态。

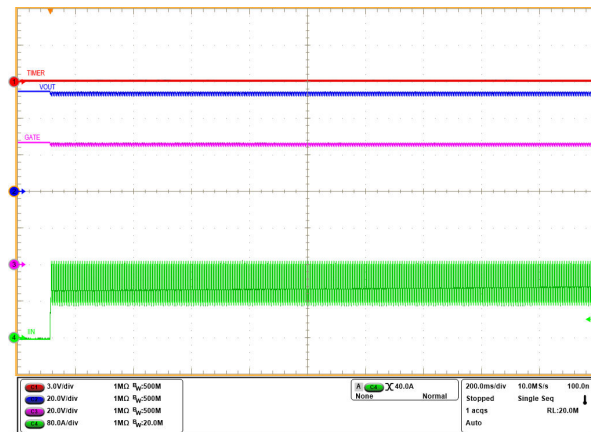


图 3-21. 瞬态过载响应 - 4

3.2.7 过流事件

测试条件： $V_{IN} = 54V$ ， $I_{CL} = 85A$ ， $I_{CBL1} = 128A (1.5 \times I_{CL})$ ， $I_{CBL2} = 170A (2.0 \times I_{CL})$ ， $I_{CB} = 255A (3.0 \times I_{CL})$ ， $t_{FLT} = \text{约 } 350\mu s$ ， $t_{CBL1} = 8ms$ ，且 $t_{CBL2} = 4ms$

施加 5ms 的 80A 负载瞬态和 5ms 的 160A 负载瞬态。

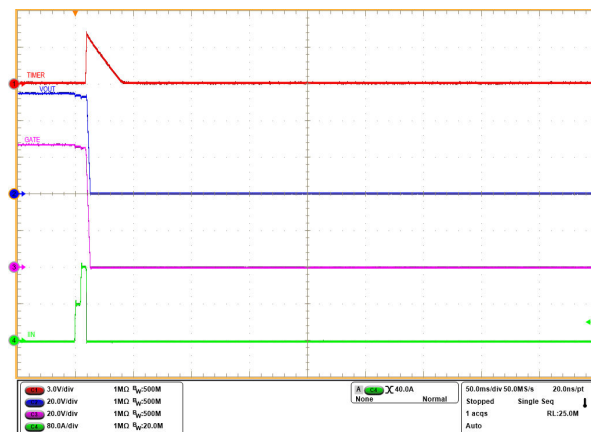


图 3-22. 持续过载响应 - 闭锁

施加 5ms 的 80A 负载瞬态和 5ms 的 160A 负载瞬态。

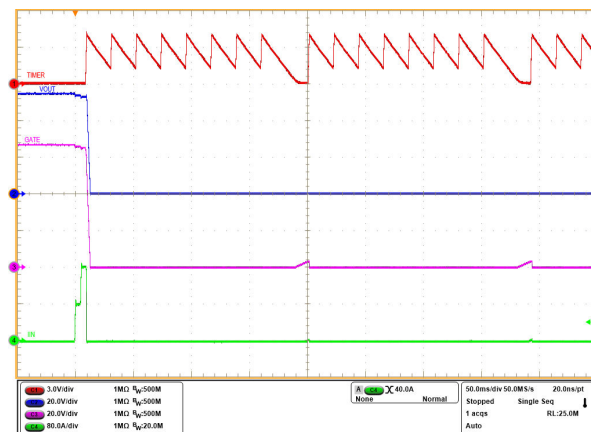


图 3-23. 持续过载响应 - 自动重试

施加 5ms 的 80A 负载瞬态和 5ms 的 160A 负载瞬态。

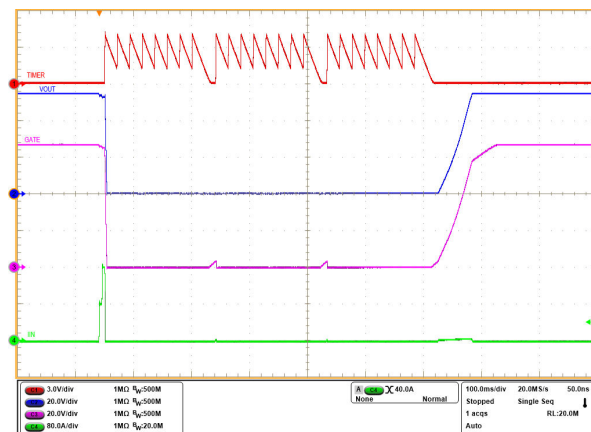


图 3-24. 持续过载响应 - 自动重试和恢复

3.2.8 负载电流监测

测试条件： $V_{IN} = 54V$ ，并施加 80A 持续 10ms 和 160A 持续 3ms 的负载瞬态。

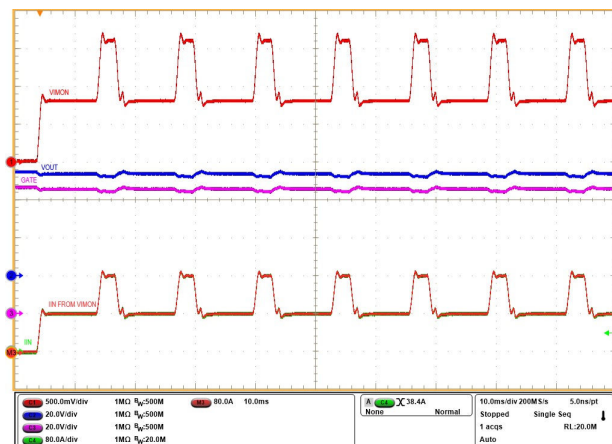


图 3-25. 负载电流监测 - 1

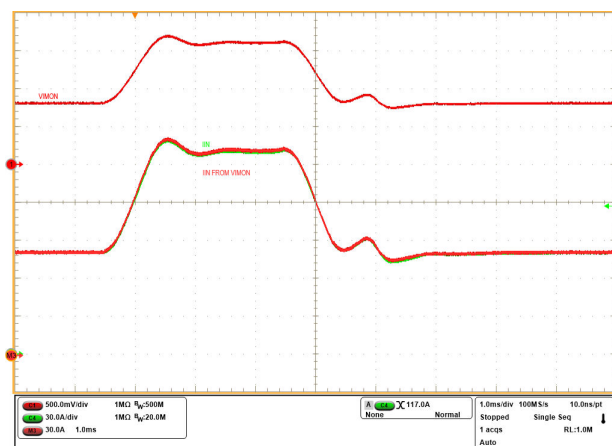


图 3-26. 负载电流监测 - 2

3.2.9 输出热短路

测试条件： $V_{IN} = 54V$ ， $I_{SCP} =$ 约 160A，且 $C_{OUT} = 1mF$

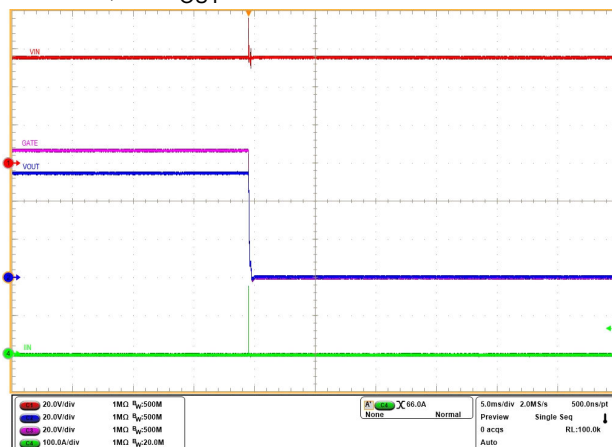


图 3-27. LM5066H1EVM 中的输出热短路响应 (缩小视图)

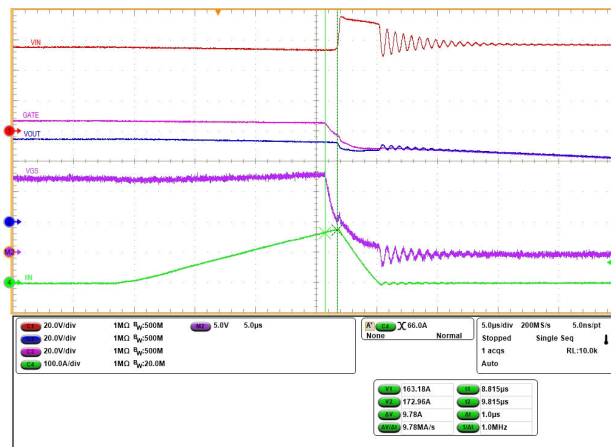


图 3-28. LM5066H1EVM 中的输出热短路响应 (放大视图)

测试条件: $V_{IN} = 54V$, $I_{SCP} = \text{约 } 100A$, $C_{OUT} = 1mF$, DEVICE_SETUP4 (CDh, 读/写字) 寄存器的位 7 默认设置为 1 (30 μs 后不立即重试)

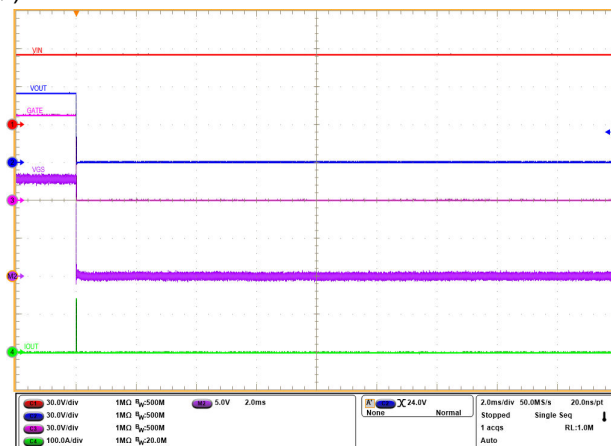


图 3-29. LM5066H1EVM 中的输出热短路响应 (30 μ s 后不立即重试)

测试条件: $V_{IN} = 54V$, $I_{SCP} = \text{约 } 100A$, $C_{OUT} = 1mF$, DEVICE_SETUP4 (CDh, 读/写字) 寄存器的位 7 设置为 0 (30 μs 后立即重试)

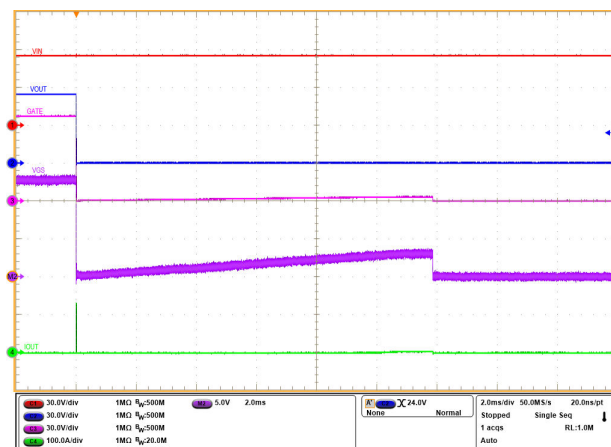


图 3-30. LM5066H1EVM 中的输出热短路响应 (30 μ s 后立即重试)

测试条件： $V_{IN} = 54V$ ， $I_{SCP} = \text{约 } 400A$ ， $I_{LOAD} = 150A$ ，且 $C_{OUT} = 1mF$

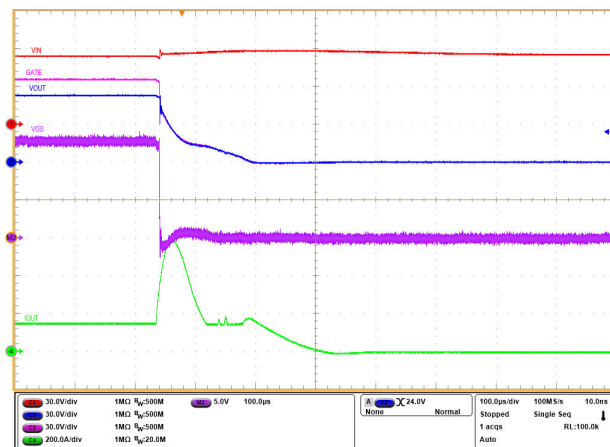


图 3-31. LM5066H1EVM 中存在直流负载电流时的输出热短路响应

备注

确保有足够的输入电容器来消除输入端的电压突降。最好结合电解电容器和陶瓷电容器。使用这些电容器，可以在短路期间在短时间内提供大电流。

获得可重复和相似的短路测试结果非常困难。以下因素会导致结果的变化：

- 源旁路
- 输入引线
- 电路板布局布线
- 组件选择
- 输出短路方法
- 短路的相对位置
- 仪表

实际短路呈现出一定程度的随机性，因为短路在微观上会弹跳和形成电弧。确保使用适当的配置和方法来获得真实的结果。因此，不要期望看到与本用户指南中的波形完全相同的波形，因为每个设置都不同。

3.2.10 热性能

测试条件： $V_{IN} = 54V$ ， $I_{LOAD} = 100A$ ， $T_A = 27^\circ C$ ，无外部气流



图 3-32. LM5066H1EVM 的热性能

4.2 PCB 图

图 4-2 和图 4-3 展示了 EVM 的元素放置方式。

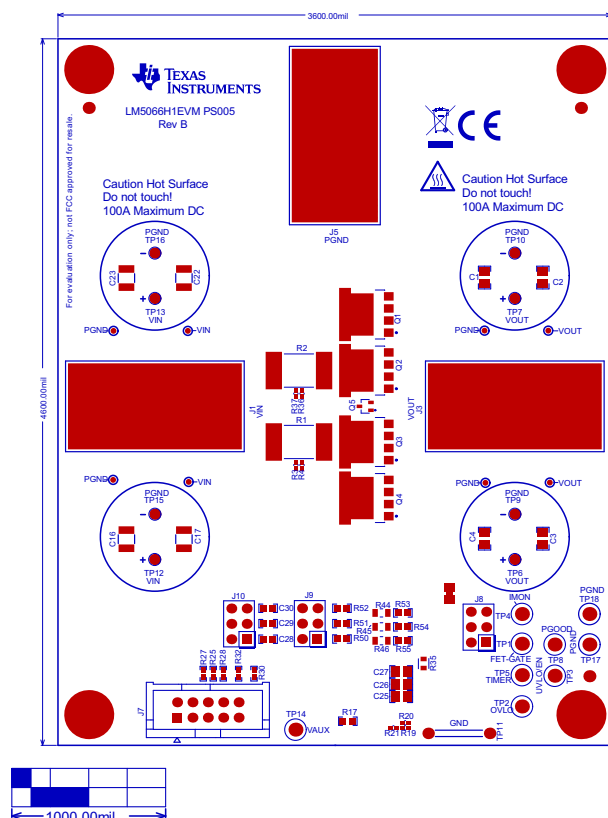


图 4-2. LM5066H1EVM 电路板：顶层装配图

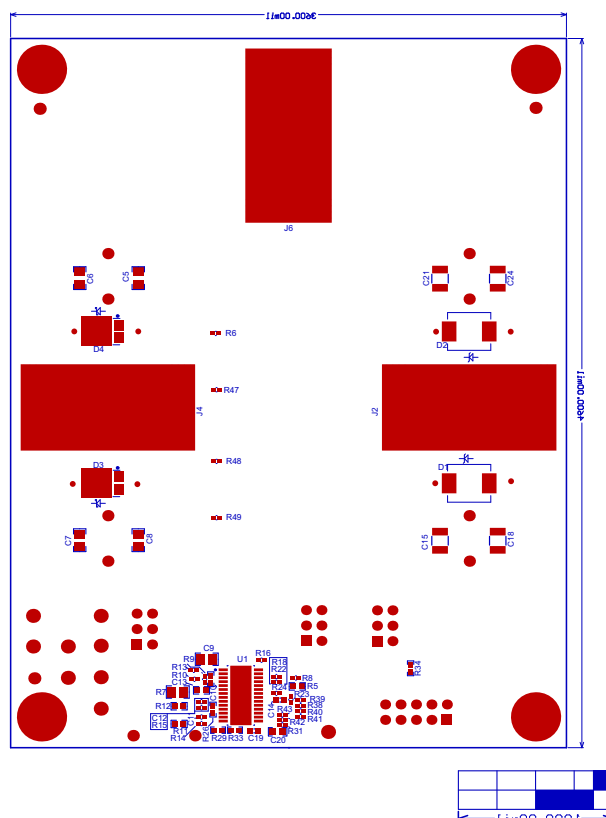


图 4-3. LM5066H1EVM 电路板：底层装配图

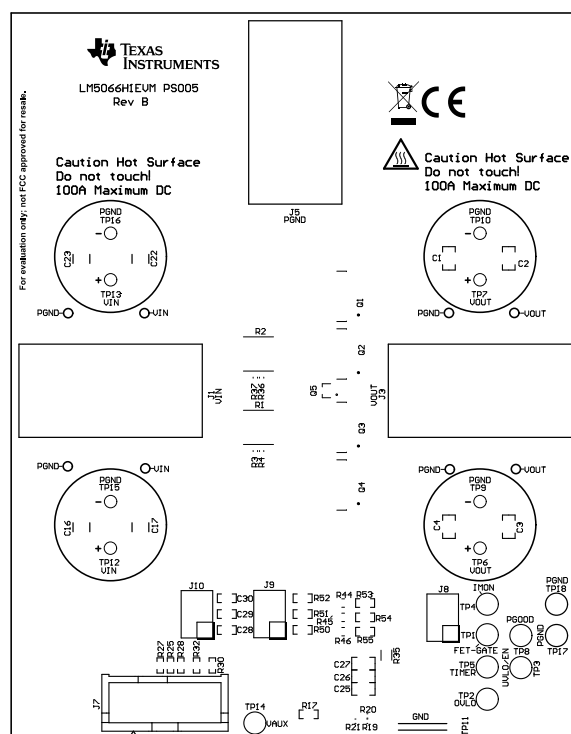


图 4-4. LM5066H1EVM 电路板：顶层丝印层

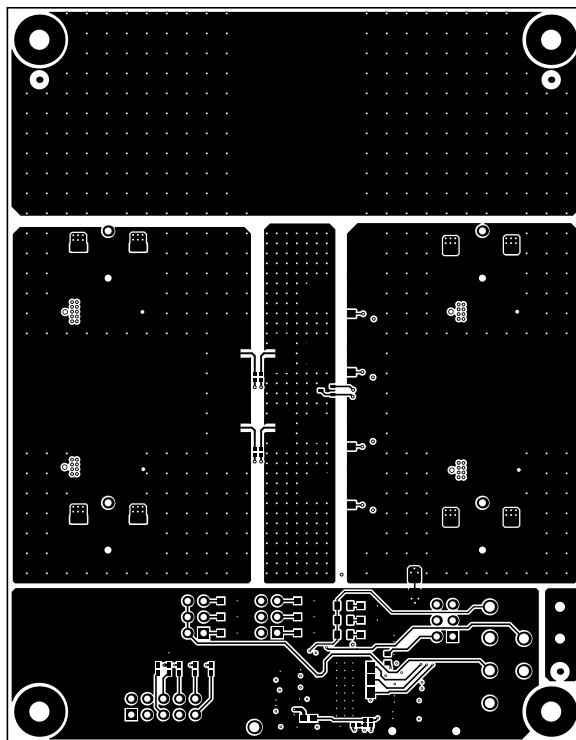


图 4-5. LM5066H1EVM 电路板：顶层

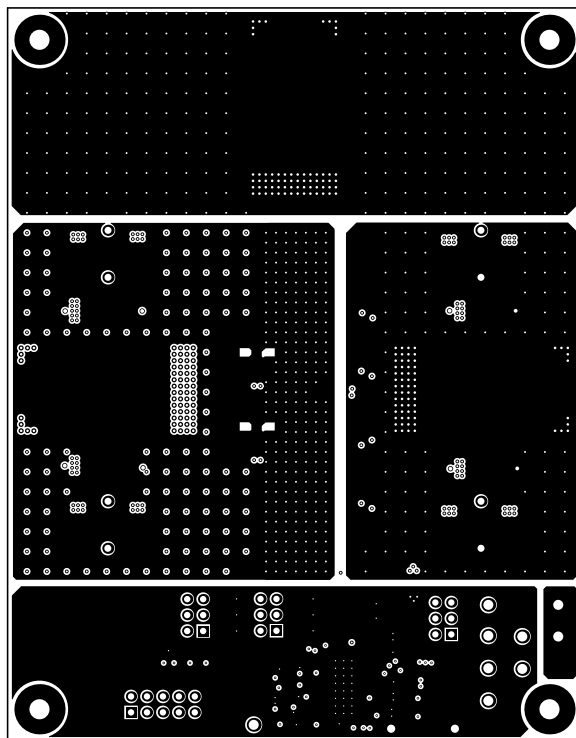


图 4-6. LM5066H1EVM 电路板：内层 - 1

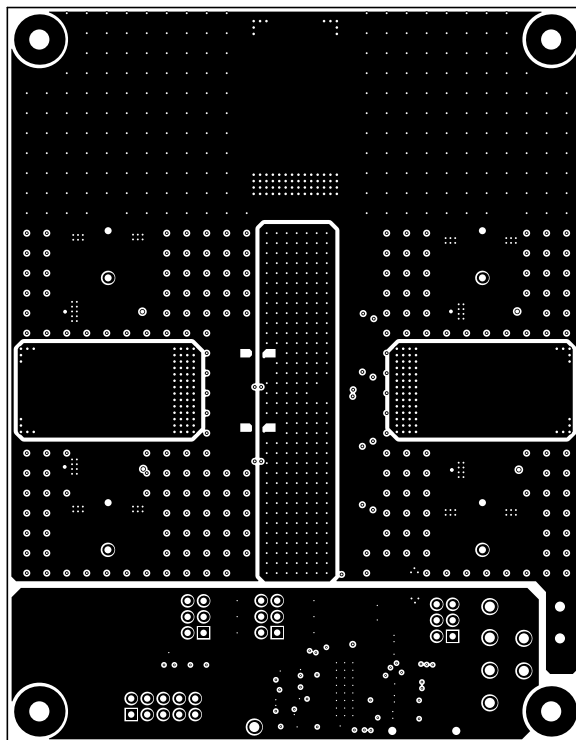


图 4-7. LM5066H1EVM 电路板：内层 - 2

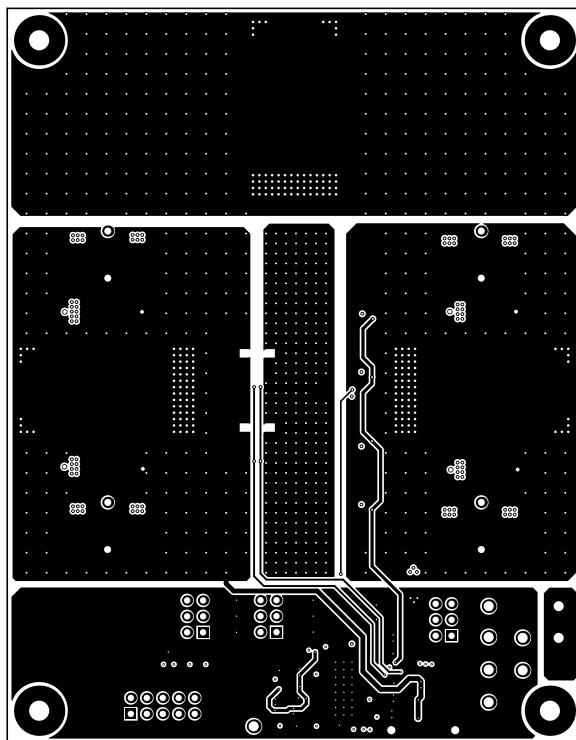


图 4-8. LM5066H1EVM 电路板：内层 - 3

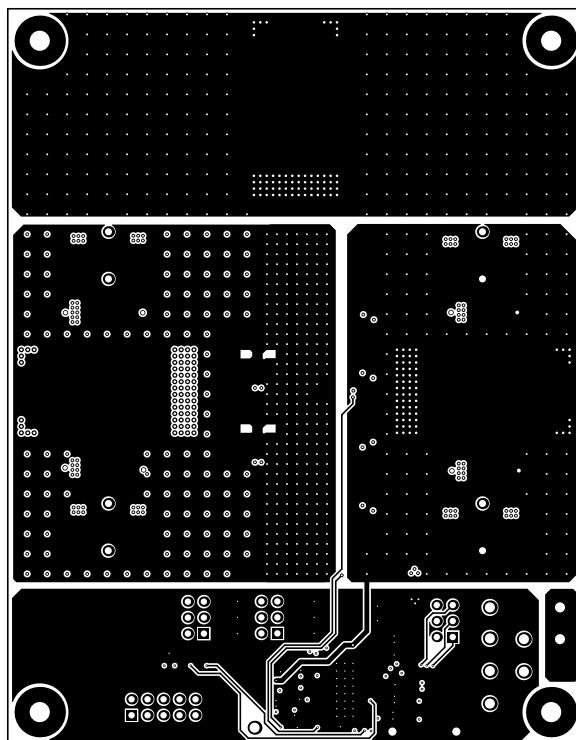


图 4-9. LM5066H1EVM 电路板：内层 - 4

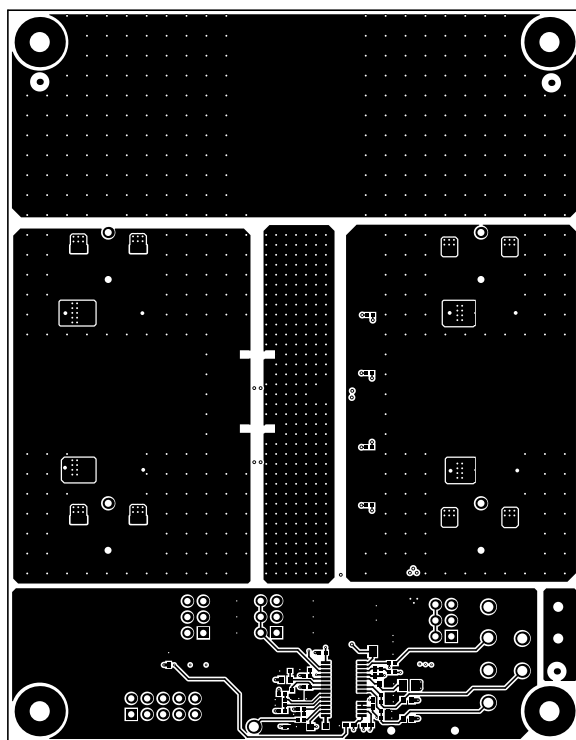


图 4-10. LM5066H1EVM 电路板：底层

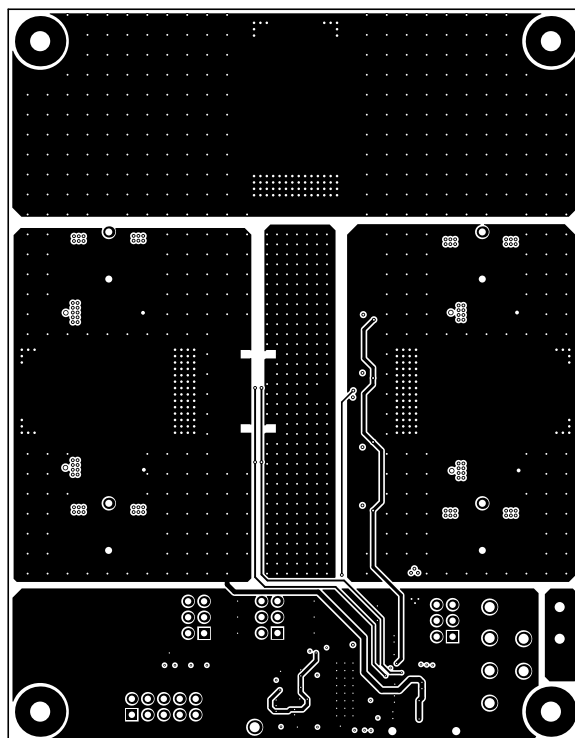


图 4-11. LM5066H1EVM 电路板：底层丝印层

4.3 物料清单 (BOM)

下表列出了该 EVM 的物料清单。

表 4-1. LM5066H1EVM 物料清单

位号	数量	值	说明	封装	器件型号	制造商
!PCB1	1		印刷电路板		PS005	不限
C1、C2、C3、C4、C9	5	1uF	电容, 陶瓷, 1μF, 100V, +/-10%, X7S, 0805	0805_HV	C2012X7S2A105K125AB	TDK
C10	1	0.1 μ F	电容, 陶瓷, 0.1μF, 16V, +/-10%, X7R, 0402	0402	GRM155R71C104KA88D	MuRata
C11、C12	2	1000pF	电容, 陶瓷, 1000pF, 50V, +/-10%, X7R, 0402	0402L	C0402C102K5RACTU	Kemet
C13	1	0.1 μ F	电容, 陶瓷, 0.1μF, 100V, +/-10%, X7R, 0603	0603_HV	GRM188R72A104KA35J	MuRata
C14、C19	2		电容, 1uF, 25V, 10%, X7R, 0603	0603L	CL10B105KA8NNNC	Samsung
C20	1	1000pF	电容, 陶瓷, 1000pF, 50V, +/-10%, X7R, 0603	0603	GRM188R71H102KA01D	MuRata
C25	1	0.033 μ F	电容, 陶瓷, 0.033uF, 100V, +/-10%, X7R, 0805	0805_HV	GRM21BR72A333KA01L	MuRata
C26	1	0.068uF	电容, 陶瓷, 0.068uF, 100V, +/-10%, X7R, 0805	0805_HV	C2012X7R2A683K085AA	TDK
C27	1	0.1 μ F	电容, 陶瓷, 0.1μF, 100V, +/-10%, X5R, 0805	0805_HV	C2012X5R2A104K125AA	TDK
C28	1	6800pF	电容, 陶瓷, 6800pF, 50V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C1H682JA01D	MuRata
C29	1	0.01uF	电容, 陶瓷, 0.01F, 50V, +/- 10%, X7R, 0603	0603	885012206089	Würth Elektronik
C30	1	0.02uF	电容, 陶瓷, 0.02F, 50V, +/- 10%, X7R, 0603	0603	CC0603KRX7R9BB203	Yageo
D1、D2	2		TVS 二极管, 8.0SMDJ 系列, 单向, 60V、125.1V, DO-214AB (SMC), 双引脚	FP-8.0SMDJ60A_DO-214 AB-MFG	8.0SMDJ60A	Littelfuse
D3、D4	2	100V	二极管, 肖特基, 100V, 20A, AEC-Q101, TO-277A	TO-277A	FSV20100V	Fairchild Semiconductor
H1、H2、H5、H6	4		机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	NY PMS 440 0025 PH	NY PMS 440 0025 PH	B&F Fastener Supply
H3、H4、H7、H8	4		六角螺柱, 0.5"L #4-40, 尼龙	Keystone_1902C	1902E	Keystone
J1、J2、J3	3		端子连接器矩形接线片, 接地 4-14 AWG 1/4 螺柱	FP-ML4-CY_TERMINAL_LUG-MFG	ML4-CY	Panduit
J7	1		接头 (有罩), 100mil, 5x2, 金, TH	CONN_5103308-1	5103308-1	TE Connectivity

表 4-1. LM5066H1EVM 物料清单 (续)

位号	数量	值	说明	封装	器件型号	制造商
J8、J9、J10	3		接头, 100mil, 3x2, 锡, TH	SULLINS_PEC03DAAN	PEC03DAAN	Sullins Connector Solutions
Q1、Q2、Q3、Q4	4		N 沟道 MOSFET, 100V, 255A (Ta), 341W (Ta), 表面贴装 LPAK88 (SOT1235)	FP-PSMN2R3-100SSEJ_LFP AK88-MFG	PSMN2R3-100SSEJ	Nexperia
Q5	1	40V	NPN 管, 40V, 0.2A, SOT-323	SOT-323	MMBT3904WT1G	ON Semiconductor
R1、R2	2	500	电阻, 金属条, 3920, 0.0005 Ω , 1%, 9W, 100ppm/C, 焊盘 SMD, 汽车 T/R	FP-CSS2H-3920R-L500F_3920-MFG	CSS2H-3920R-L500F	Bourns
R3、R4、R6、R10、R36、R37、R47、R48、R49	9	1.00	电阻, 1.00, 1%, 0.063W, AEC-Q200 0 级, 0402	0402L	CRCW04021R00FKED	Vishay-Dale
R5	1	150k	电阻, 150k, 1%, 0.1W, AEC-Q200 0 级, 0603	0603_HV	CRCW0603150KFKEA	Vishay-Dale
R7	1	0	电阻, SMD, 0 Ω , 跳线, 1/8W, 0805	0805_HV	CRCW08050000Z0EA	Vishay Dale
R8、R19、R20、R21	4	10.0k	电阻, 10.0k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402L	CRCW040210K0FKED	Vishay-Dale
R9、R13	2	10.0、0	电阻, 10.0, 1%, 0.063W, AEC-Q200 0 级, 0402, 电阻, 0, 5%, 0.063W, 0402	0402L	CRCW040210R0FKED、RC0402JR-070RL	Vishay-Dale、Yageo America
R11	1	95.3k	电阻, 95.3k, 1%, 0.1W, 0603	0603_HV	RC0603FR-0795K3L	Yageo
R12	1	178k	电阻, 178k, 1%, 0.1W, AEC-Q200 0 级, 0603	0603_HV	CRCW0603178KFKEA	Vishay-Dale
R14	1	3.74k	电阻, 3.74k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402L	CRCW04023K74FKED	Vishay-Dale
R15	1	12.7k	电阻, 12.7k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402L	CRCW040212K7FKED	Vishay-Dale
R16	1	100k	电阻, 100k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402L	CRCW0402100KFKEA	Vishay-Dale
R17	1	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	0603	RCS06030000Z0EA	Vishay-Dale
R22、R24、R31、R38、R40、R42	6	0	电阻, 0, 5%, 0.063W, 0402	0402L	RC0402JR-070RL	Yageo America
R25、R26、R28、R29、R30、R32、R33、R34	8	0	电阻, 0, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R35	1	10	10 Ω , 1%, 0.25W, 1/4W 片上电阻 0603 (公制 1608), 汽车 AEC-Q200, 耐脉冲厚膜	FP-RCS060310R0FKEA_0603-MFG	RCS060310R0FKEA	Vishay

表 4-1. LM5066H1EVM 物料清单 (续)

位号	数量	值	说明	封装	器件型号	制造商
R44	1		0Ω 跳线 0.125W, 1/8W 片上电阻 0805 (公制 2012), 汽车 AEC-Q200, 厚膜	FP-RMCF0805ZT0R00_0805-MFG	RMCF0805ZT0R00	Stackpole Electronics
R50	1	6.81k	电阻, 6.81k, 0.1%, 0.1W, 0603	0603	RT0603BRD076K81L	Yageo America
R51	1	9.09k	电阻, 9.09k, 0.1%, 0.1W, 0603	0603	RT0603BRD079K09L	Yageo America
R52	1	11.4k	电阻, 11.4k, 0.1%, 0.1W, 0603	0603	RT0603BRD0711K4L	Yageo America
R53	1	3.36k	电阻, 3.36k, 0.1%, 0.1W, 0603	0603	RT0603BRD073K36L	Yageo America
R54	1	6.65k	电阻, 6.65k, 0.1%, 0.1W, 0603	0603	RT0603BRD076K65L	Yageo America
R55	1	16.7k	电阻, 16.7k, 0.1%, 0.1W, 0603	0603	RT0603BRD0716K7L	Yageo America
SH1、SH2、SH3	3		分流器, 2.54mm, 金, 蓝色	Würth_60900213621	60900213621	Würth Elektronik
TP1	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP2	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP3	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP4	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP5	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP8	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP11	1		1mm 非绝缘短路插头, 10.16mm 间距, TH	Harwin_D3082-05	D3082-05	Harwin
TP14	1		测试点, 通用, 绿色, TH	Keystone5126	5126	Keystone
TP17、TP18	2		测试点, 多用途, 黑色, TH	Keystone5011	5011	Keystone
U1	1		LM5066H1PWPR	PWP0028V-MFG	LM5066H1PWPR	德州仪器 (TI)

5 其他信息

5.1 商标

所有商标均为其各自所有者的财产。

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 - 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 instructions, 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/sds/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。

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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/sds/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.

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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最后更新日期：2025 年 10 月