EVM User's Guide: UCC34141EVM-116

适用于汽车和工业偏置电源应用的 UCC34141EVM-116 评估模块

说明

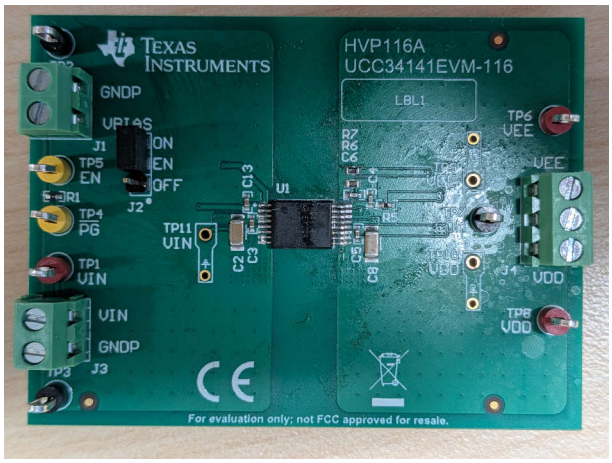
UCC34141EVM-116 旨在让设计人员能够快速、轻松地评估 UCC34141-Q1 的性能特性和功能，从而用于汽车类隔离式栅极驱动器偏置应用以及各种隔离式工业偏置电源应用。该 EVM 可供用户测试 UCC34141-Q1 的各项功能，例如：启用/禁用 (EN) 器件，配置隔离输出电压以使 15V<VDD<20V 且 -5V<VEE<0V，以及轻松向输出端施加可变负载。借助此 EVM，用户可以根据系统要求，测量输入电压范围内和不同输出负载条件下的效率。EVM 的另一个特性是易于在测试期间进行探测。测试点经过策略性布局，并按照本文档后面的“输入、输出、测试点 (I/O/TP) 说明”表进行了说明。

特性

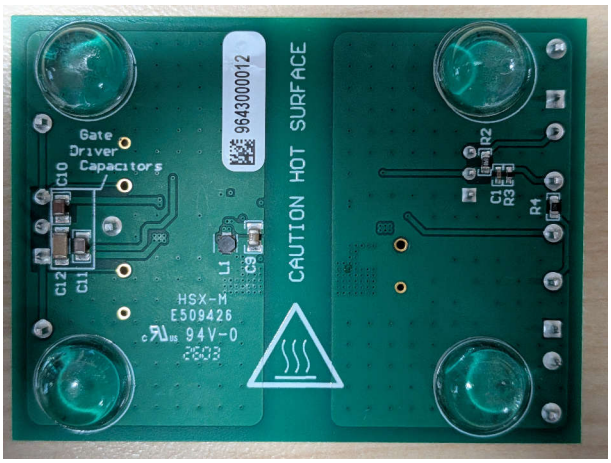
- UCC34141-Q1 1.5W DC/DC、5kV$_{RMS}$ 隔离式转换器模块，可配置为单路正输出电压、双路正输出电压或双路正/负输出电压
- 变压器、功率级和控制完全集成在一个低厚度、5.85mm × 7.5mm × 2.6mm 宽体 16 引脚 SOIC 封装中
- 评估 UCC34141-Q1 集成保护特性：UVLO、OVLO、短路、OVP、UVP 和热关断
- 符合 AEC-Q100 标准，在高达 105°C 下提供满额定功率，<3pF 隔离电容，SSM 频率调制

应用

- 混合动力、电动和动力总成系统 (EV/HEV)
  - 逆变器和电机控制
  - 车载充电器 (OBC) 和无线充电器
  - DC/DC 转换器
- 电网基础设施
  - 电动汽车充电站电源模块
  - 直流充电（桩）站
  - 串式逆变器
- 电机驱动器
  - 交流逆变器和变频驱动器、机器人伺服驱动器
- 工业运输
  - 非公路用车电力驱动



UCC34141EVM-116 硬件板（顶视图）



UCC34141EVM-116 硬件板（底视图）

1 评估模块概述

1.1 简介

本评估模板用户指南为使用 UCC34141EVM-116 型号 001 评估德州仪器 (TI) UCC34141-Q1（具有集成变压器的高频 DC/DC 转换器模块）提供了说明和指导。借助该 EVM，设计人员能够快速且高效地评估 UCC34141-Q1，从而用于需要栅极驱动器 IC 辅助电源高达 1.5W 且符合高达 5kV$_{RMS}$ 隔离要求的汽车或工业应用。

1.2 套件内容

表 1-1. UCC34141EVM-116 套件内容

位号	说明	数量
PCB1/HVP116E2	UCC34141EVM-116 EVM	1

1.3 规格

表 1-2. UCC34141EVM-116 电气特性

参数		测试条件	最小值	典型值	最大值	单位
输入特性						
V_{IN}	输入电压范围	P_{VDD}=1.5W	8.5	12	20	V
V_{IN_ON}	输入电压开启	P_{VDD}=P_{VEE}=0W			5.5	V
V_{IN_OFF}	输入电压关闭	P_{VDD}=P_{VEE}=0W		4.65		V
EN 到 /PG 延迟		I_{VDD}=I_{VEE}=0mA		5		ms
输出特性						
VDD	直流满载设定点	8.5V<V_{IN}<20V，I_{VDD}=83mA	17.6	18.0	18.3	V
I_{VDD}	VDD 负载电流范围	8.5V<V_{IN}<20V	0		83	mA
P_{MAX}	最大输出功率	I_{VDD}=83mA，I_{VEE}=0mA			1.5	W
VEE	直流满载设定点	6V<V_{IN}<20V，I_{VEE}=65mA	-4.89	-5.00	-5.11	V
I_{VEE}	VEE 负载电流	6V<V_{IN}<20V，P_{VDD}=0W	0		65	mA
系统特性						
F_{SW}	开关频率	V_{IN}=6.5V，空载		27.4		MHz
		V_{IN}=9V，空载		22.3		
		V_{IN}=17V，空载		16.3		
T_{MAX}	高于环境温度的最大温升 (T_C-T_A)，T_A=21°C	V_{IN}=10V，I_{VDD}=84mA，I_{VEE}=0mA		46.5		°C
		V_{IN}=12V，I_{VDD}=84mA，I_{VEE}=0mA		51		
		V_{IN}=20V，I_{VDD}=84mA，I_{VEE}=0mA		73.5		

1.4 器件信息

表 1-3 列出了与此 EVM 兼容的 UCC34XXX 器件以及器件正常运行所需的硬件更改。

表 1-3. 与 UCC3414EVM-116 EVM 兼容的 UCC34XXX 器件

器件型号	必要更改	兼容性
UCC34141-Q1	无	全双工
UCC34141	无	全双工
UCC34141D-Q1	无	全双工
UCC34141D	无	全双工

1.5 引脚配置和功能

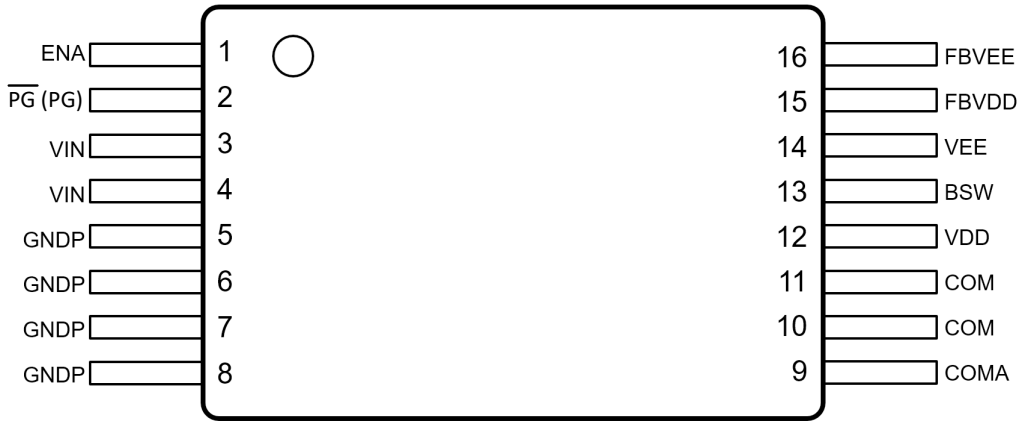


图 1-1. DHA 封装，16 引脚 SSOP（俯视图）

表 1-4. 引脚功能

引脚		类型(1)	说明
名称	编号		
BSW	13	P	内部降压/升压转换器开关管脚。在该引脚与 COM 之间连接一个电感器。建议使用 3.3μH 至 10μH 片式电感器。如果在单输出模式下使用器件，则将该引脚悬空。
BSW	13	P	内部降压/升压转换器开关管脚。在该引脚与 COM 之间连接一个电感器。建议使用 3.3μH 至 10μH 片式电感器。在 BSW 和 VEE 引脚之间连接一个低寄生电感肖特基二极管。如果在单输出模式下使用器件，则将该引脚悬空。
COM	10、11	G	次级接地。连接到电源开关的源极。
COMA	9	G	用于噪声敏感模拟反馈输入、FBVDD 和 FBVEE 的次级侧模拟检测基准连接。将低侧 FBVDD 反馈电阻和高频去耦滤波电容连接到靠近 COMA 引脚和各自的反馈引脚 FBVDD。连接到次级侧栅极驱动电压基准 COM。使用单点连接并将高频去耦陶瓷电容器靠近 COMA 引脚放置。
ENA	1	I	使能引脚。强制 ENA 为低电平会禁用器件。上拉至高电平以启用正常的器件功能。可用于通过来自 VIN 的电阻分压器对输入 UVLO 进行编程。
FBVDD	15	I	反馈 (VDD – COM) 输出电压检测引脚用于调整输出 (VDD – COM) 电压。在 VDD 至 COMA 之间连接一个电阻分压器，以使中点连接到 FBVDD。通过跨隔离的内部迟滞控制，将等效 FBVDD 电压调节为 2.5V。需要添加一个 470pF 陶瓷电容器，与低侧反馈电阻器并联实现高频去耦。用于高频旁路的 470pF 陶瓷电容器必须紧挨着顶层或背层（两层通过过孔连接）的 FBVDD 和 COMA 引脚。
FBVEE	16	I	反馈 (COM – VEE) 输出电压检测引脚用于调整输出 (COM – VEE) 电压。将一个反馈电阻器连接至 VEE 以在 2V 到 8V 之间对 (COM – VEE) 电压进行编程。在 FBVEE 和 COMA 之间连接一个 10pF 陶瓷电容，以绕过高频开关噪声。10pF 陶瓷电容器必须紧挨着顶层或背层（两层通过过孔连接）的 FBVEE 引脚。如果在单输出模式下使用器件，则将 180kΩ 电阻器连接到 VEE。
GNDP	5、6、7、8	G	VIN 的初级侧接地连接。在覆铜上放置几个过孔以进行散热。
$\overline{PG}$(PG)	2	O	电源正常开漏输出引脚。当 $V_{VIN\_UVLOP} \leq V_{VIN} \leq V_{VIN\_OVLOP}$、$V_{VDD\_UVP} \leq V_{FBVDD} \leq V_{VDD\_OVP}$、$V_{VEE\_UVP} \leq V_{FBVEE} \leq V_{VEE\_OVP}$、$T_{J\_Primary} \leq T_{SHUT\_P\_R}$ 以及 $T_{J\_secondary} \leq T_{SHUT\_S\_R}$ 时，保持有效状态。通过 4.99kΩ 电阻器上拉至 3.3V 或 5V 电源轨。在 IC 同侧的 PCB 上，靠近电源正常引脚的位置，放置一个 0402 封装尺寸的 1μF 去耦电容器，用于旁路高频噪声。对于 UCC34141-Q1，该引脚为低电平有效；但根据具体器件型号的不同，该引脚也可能为高电平有效。
VDD	12	P	来自变压器的次级侧隔离式输出电压。在 VDD 到 COM 之间连接一个 10μF 和一个并联 0.1μF 陶瓷电容器。0402 封装的 0.1μF 陶瓷电容器用于旁路高频噪声，必须靠近 VDD 和 COM 引脚。
VEE	14	P	负电源轨的次级侧隔离式输出电压。在 VEE 和 COM 之间连接一个 2.2μF 陶瓷电容，以绕过高频开关噪声。如果在单输出模式下使用该器件，则将 VEE 直接连接到 COM。
VIN	3、4	P	初级输入电压。在 VIN 到 GNDP 之间连接一个 10μF 和一个并联 0.1μF 陶瓷电容器。0402 封装的 0.1μF 陶瓷电容器用于旁路高频噪声，必须和 IC 一样置于 PCB 同一侧的 VIN 和 GNDP 引脚旁。

(1) P = 电源，G = 地，I = 输入，O = 输出

2 硬件

2.1 EVM 设置和操作

2.1.1 建议测试设备

1. V_{BIAS}：直流电源 1：5V，10mA
2. V_{IN}：直流电源 2：20V，500mA
3. I_{VDD}：电子负载（设置为恒定电阻）或固定电阻器：18V，83mA
4. I_{VEE}：电子负载（设置为恒定电阻）或固定电阻器：5V，65mA
5. 用于测量 < 30V 直流电压的 (3) 个万用表
6. (2) 个万用表在 I_{VDD}、I_{VEE} 上测量的直流电流 < 200mA，在 I_{VIN} 上测量的直流电流 <500mA
7. 示波器：4 通道，500MHz 或更高，电压探头，电流探头
8. 最小线规 20AWG 至 22AWG 或更大
9. 热像仪（可选）或热电偶测量 U1 外壳温度

2.1.2 通过外部连接轻松进行评估

UCC34141EVM-116 EVM 利用螺丝接线端快速连接至 VIN、VDD 和 VEE。连接适当的电流表和电压表，如图 2-1 所示，以便测量准确的 EVM 效率。

2.1.2.1 连接测试设备

1. 将分流器跳线 SH-J1 移至 J2，1-2，EN OFF 位置。这可确认在连接测试设备时 EVM 无法启动。
2. 连接 +5V 直流偏置电源 J1:1-2（调整至 +3.3V 至 +5V）。J1 上的 +5V 电源将用作 /PG 和 ENA 的上拉偏置。关闭/禁用 +5V 直流辅助电源。
3. 在 J3:1-2 (VIN) 处连接能够提供电压 5V<VIN<20V 和电流 500mA 的 VIN 直流电源。将电源调整为 12V，并将电流限值设置为 1A。关闭/禁用 VIN 电源。
4. 在 J4:1 (VDD) 和 J4:2 (COM) 之间连接一个可变负载。如果使用电子负载，则设置为恒定电阻 (CR)，650Ω (≅500mW)。在 EVM 通电之前，将负载保持为禁用状态。
5. 在 J4:2 (COM) 和 J4:3 (VEE) 之间连接第二个负载。如果使用电子负载，则设置为恒定电阻 (CR)，250Ω (≅10mW)。在 EVM 通电之前，将负载保持为禁用状态。由于所需的负载较小，因此可以在 J4:2-3 之间连接一个 500mW 的穿孔负载电阻器。
6. 当设置在低 mA 范围内时，某些电子负载无法调节/稳定 CC。通过插入电流表来监测输入电流和负载电流，如图 4-1 所示。电流探头可以与示波器结合使用，以验证由电子负载调节的直流电流的稳定性。

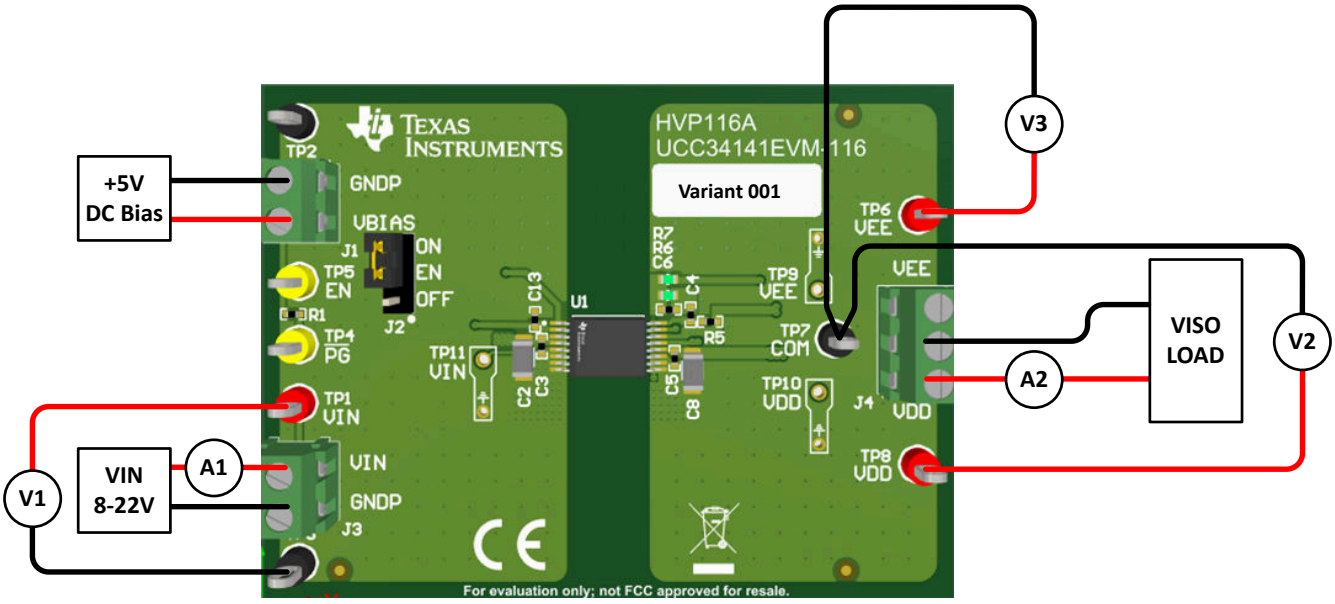


图 2-1. 典型效率测量设置

2.1.3 为 EVM 供电

警告

- 表面高温。接触会导致烫伤。U1 封装表面温度可达到环境温度以上 45°C。请勿触摸！
- 除非您受过功率电子产品安全、处理和测试方面的适当培训，否则不要测试此 EVM。

上电以便启动

1. 验证 VIN 和 +5V 直流偏置电源是否关闭/禁用，并且未向 UUT 施加电压
2. 将短接跳线 SH-J1 移至 J2，2-3，EN 开启位置。注意：移除短接跳线 SH-J1 也会导致“EN 开启”。
3. 打开 VIN 直流电源。验证 TP1 至 TP3 是否存在 12V 电压
4. 验证 VDD 和 VEE 上的负载是否已禁用
5. 打开 +5V 直流辅助电源。现在，EVM 在无负载条件下通过调节中的 VDD 和 VEE 启用。
6. 验证 VDD-COM 上是否存在 +18V 电压，VEE-COM 上是否存在 -5V 电压
7. 在 VDD 上启用负载，在 VEE 上启用负载
8. UCC34141-Q1 现在正在调节 VDD 和 VEE 并处理约 0.5W 的隔离式输出功率
9. VIN 在 5V<VIN<20V 之间变化，IVDD 在 0mA<IVDD<83mA 之间变化，IVEE 在 0mA<IVEE<6mA 之间变化
10. 将示波器探头插入 TP9、TP10 和 TP11，以测量 VEE、VDD 和 VIN 启动、稳定状态和交流纹波电压

断电以便关断

1. 将短接跳线 SH-J1 移至 J2，1-2，EN 关闭位置。
2. 关闭 +5V 直流辅助电源
3. 禁用 IVDD 负载
4. 禁用 IVEE 负载
5. 关闭 VIN 电源

2.2 测试点

表 2-1 描述了各种 EVM 测试点，便于将示波器探头、DVM 测试引线和电线连接至“建议测试设备”中概述的实验室测试设备。注意保持初级侧 GNDP 和次级侧 COM 之间的隔离。不能使初级侧测试点通过不正确的测试设备插入来以 COM 为基准。同样，也不能使次级侧测试点通过不正确的测试设备插入来以 GNDP 为基准。

表 2-1. 输入、输出、测试点 (I/O/TP) 说明

引脚	I/O/TP	颜色	说明	最小值	典型值	最大值	单位
J1	I	绿色	V_{BIAS}、EN 和 /PG 偏置	3	V_{BIAS}	5	V
SH-J1	I	黑色	J2 短接跳线		0		V
J2:1-2	I	黑色	EN，关闭		0		V
J2:2-3	I	黑色	EN，开启（移除 SH-J1 后为“EN，开启”）		V_{BIAS}		V
J3	I	绿色	V_{IN}，初级输入电压	5	12	20	V
J4:1-2	O	绿色	次级侧 VDD 至 COM	0		18	V
J4:2-3	O	绿色	次级侧 VEE 至 COM	-5		0	V
TP1	TP	红色	V_{IN}，正探测点	5	12	20	V
TP2	TP	黑色	GNDP，共享初级 GND 测试点		0		V
TP3	TP	黑色	GNDP，共享初级 GND 测试点		0		V
TP4	TP	黄色	/PG，电源正常测试点		V_{BIAS}		V
TP5	TP	黄色	EN，启用测试点		V_{BIAS}		V
TP6	TP	红色	VEE，次级 VEE 测试点	-5		0	V
TP7	TP	黑色	COM，次级侧基准		0		V
TP8	TP	红色	VDD，次级 VDD 测试点	0		18	V
TP9	TP	PCB	VEE 至 COM，次级 VDD 示波器探测点	-5		0	V
TP10	TP	PCB	VDD 至 COM，次级 VDD 示波器探测点	0		18	V
TP11	TP	PCB	V_{IN} 至 GNDP 示波器探测点	5	12	20	V

2.3 示波器探测点

使用 TP9-11 示波器探头 PCB 测试点 UCC34141-Q1 是一款高频直流/直流模块，需要通过仔细测量来准确地捕获瞬态事件和测量高频交流纹波电压。从示波器探头上拆下*尖顶帽*（探头尖端盖）和接地引线。如果未提供示波器探头接地弹簧，请将一根 22 AWG 裸线缠绕在示波器探头接地环上，或者使用合适的接地弹簧，然后将探头尖端和接地环插入 EVM，如图 2-2 所示。

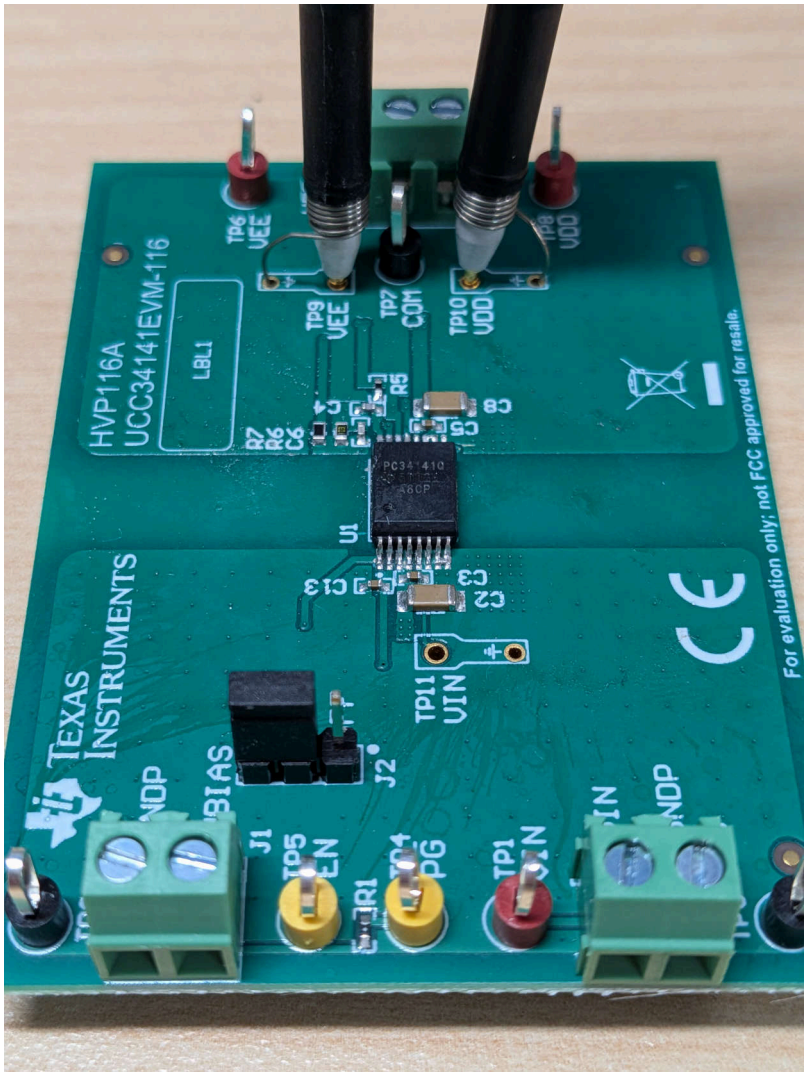


图 2-2. PCB 示波器探头测试点

EVM 输出命名规则（VDD、VEE、COM）与隔离式栅极驱动器 IC 的常用名称相对应。如图 4-1 所示，TP4 (COM) 是中点基准，用于连接到隔离式栅极驱动器 IC 的 COM 引脚。当 UCC34141-Q1 用于为栅极驱动器 IC 提供辅助电源时，VDD (VDD-COM) 和 VEE (VEE-COM) 是相对于 COM 而言的。

3 实现结果

3.1 性能数据

除非另有规定，否则所有性能数据和波形均使用电阻负载收集。

3.1.1 效率数据

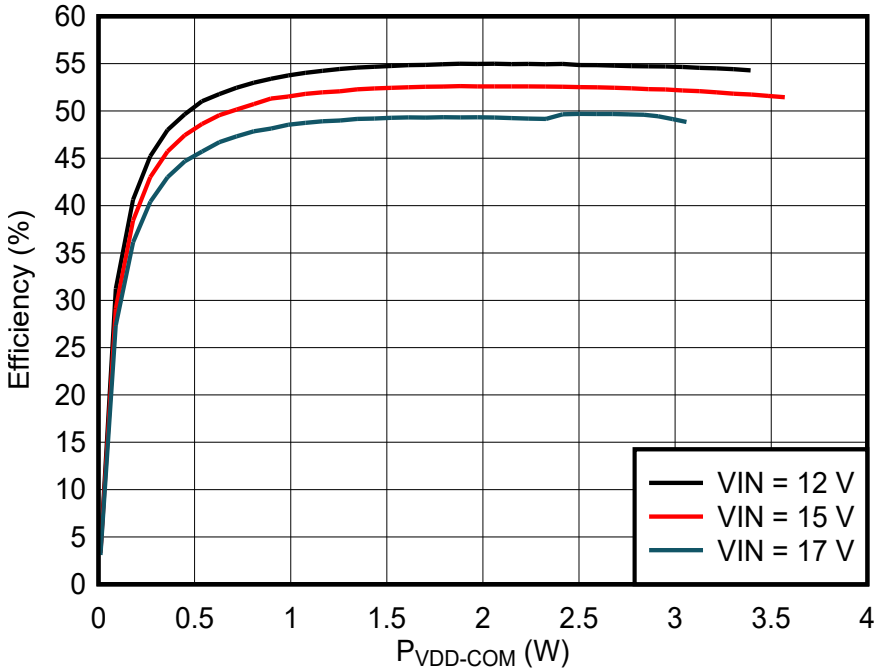


图 3-1. 测量的效率，仅限 VDD-COM 负载

表 3-1. 效率测试数据 (V_{IN} = 12V)

V_{IN} (V)	I_{IN} (mA)	VDD (V)	I_{VDD} (mA)	VEE (V)	I_{VEE} (mA)	P_{IN} (W)	$P_{VDD-VEE}$ (W)	效率 (%)
12	24.0	17.96	5.0	-5.06	0.0	0.29	0.09	31.2
12	49.6	17.96	15.0	-5.05	0.0	0.60	0.27	45.2
12	75.3	17.95	25.0	-5.05	0.0	0.90	0.45	49.6
12	101.1	17.95	35.0	-5.05	0.0	1.21	0.63	51.8
12	127.0	17.94	45.0	-5.05	0.0	1.52	0.81	53.0
12	153.0	17.94	55.0	-5.05	0.0	1.84	0.99	53.8
12	179.1	17.94	65.0	-5.05	0.0	2.15	1.17	54.2
12	205.3	17.93	75.0	-5.05	0.0	2.46	1.34	54.6
12	232.0	17.93	85.0	-5.04	0.0	2.78	1.52	54.7
12	258.5	17.92	95.0	-5.04	0.0	3.10	1.70	54.9
12	285.0	17.91	105.0	-5.04	0.0	3.42	1.88	55.0
12	312.1	17.91	115.0	-5.04	0.0	3.75	2.06	55.0
12	339.3	17.90	125.0	-5.03	0.0	4.07	2.24	55.0
12	366.3	17.90	135.0	-5.03	0.0	4.40	2.42	55.0
12	394.2	17.89	145.0	-5.02	0.0	4.73	2.59	54.8
12	422.1	17.89	155.0	-5.02	0.0	5.06	2.77	54.7
12	449.5	17.88	165.0	-5.01	0.0	5.39	2.95	54.7
12	477.9	17.88	175.0	-5.00	0.0	5.73	3.13	54.6
12	506.2	17.87	185.0	-5.00	0.0	6.07	3.31	54.4

表 3-2. 效率测试数据 (V_{IN} = 15V)

V_{IN} (V)	I_{IN} (mA)	VDD (V)	I_{VDD} (mA)	VEE (V)	I_{VEE} (mA)	P_{IN} (W)	$P_{VDD-VEE}$ (W)	效率 (%)
15	20.6	17.96	5.0	-5.05	0.0	0.31	0.09	29.1
15	41.7	17.96	15.0	-5.05	0.0	0.63	0.27	43.0
15	63.1	17.95	25.0	-5.05	0.0	0.95	0.45	47.4
15	84.5	17.95	35.0	-5.05	0.0	1.27	0.63	49.6
15	106.2	17.95	45.0	-5.05	0.0	1.59	0.81	50.7
15	127.7	17.94	55.0	-5.05	0.0	1.92	0.99	51.5
15	149.6	17.94	65.0	-5.05	0.0	2.24	1.17	52.0
15	171.6	17.93	75.0	-5.04	0.0	2.57	1.35	52.3
15	193.7	17.93	85.0	-5.04	0.0	2.91	1.52	52.4
15	216.0	17.93	95.0	-5.04	0.0	3.24	1.70	52.6
15	238.3	17.92	105.0	-5.03	0.0	3.57	1.88	52.6
15	261.1	17.91	115.0	-5.03	0.0	3.92	2.06	52.6
15	283.7	17.90	125.0	-5.02	0.0	4.26	2.24	52.6
15	306.5	17.90	135.0	-5.02	0.0	4.60	2.42	52.6
15	329.5	17.89	145.0	-5.01	0.0	4.94	2.59	52.5
15	352.8	17.89	155.0	-5.00	0.0	5.29	2.77	52.4
15	376.4	17.88	165.0	-5.00	0.0	5.65	2.95	52.3
15	400.4	17.88	175.0	-5.00	0.0	6.01	3.13	52.1
15	425.2	17.87	185.0	-4.99	0.0	6.38	3.31	51.8
15	450.2	17.86	195.0	-4.99	0.0	6.75	3.48	51.6

表 3-3. 效率测试数据 (V_{IN} = 17V)

V_{IN} (V)	I_{IN} (mA)	VDD (V)	I_{VDD} (mA)	VEE (V)	I_{VEE} (mA)	P_{IN} (W)	$P_{VDD-VEE}$ (W)	效率 (%)
17	19.3	17.97	5.0	-5.06	0.0	0.33	0.09	27.3
17	39.2	17.97	15.0	-5.05	0.0	0.67	0.27	40.4
17	59.1	17.96	25.0	-5.05	0.0	1.00	0.45	44.7
17	79.2	17.96	35.0	-5.05	0.0	1.35	0.63	46.7
17	99.3	17.95	45.0	-5.05	0.0	1.69	0.81	47.8
17	119.6	17.95	55.0	-5.05	0.0	2.03	0.99	48.5
17	140.3	17.95	65.0	-5.05	0.0	2.38	1.17	48.9
17	161.0	17.94	75.0	-5.04	0.0	2.74	1.35	49.2
17	182.0	17.94	85.0	-5.04	0.0	3.09	1.52	49.3
17	203.3	17.93	95.0	-5.03	0.0	3.46	1.70	49.3
17	224.6	17.93	105.0	-5.03	0.0	3.82	1.88	49.3
17	245.8	17.92	115.0	-5.02	0.0	4.18	2.06	49.3
17	267.8	17.92	125.0	-5.02	0.0	4.55	2.24	49.2
17	286.2	17.89	135.0	-5.01	0.0	4.86	2.41	49.6
17	306.6	17.86	145.0	-5.01	0.0	5.21	2.59	49.7
17	327.2	17.81	155.0	-5.00	0.0	5.56	2.76	49.6
17	346.4	17.64	165.0	-5.00	0.0	5.89	2.91	49.4
17	368.4	17.48	175.0	-4.99	0.0	6.26	3.06	48.8

3.1.2 调节数据

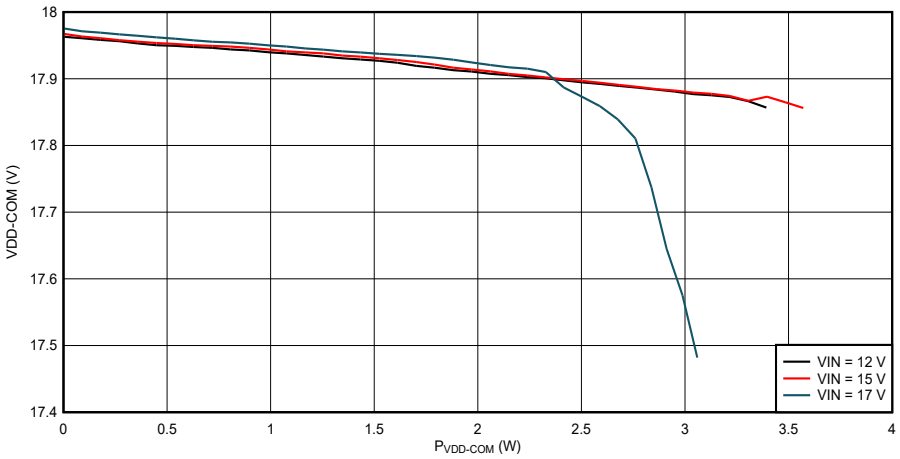


图 3-2. 调节与功率间的关系，仅 VDD-COM 负载

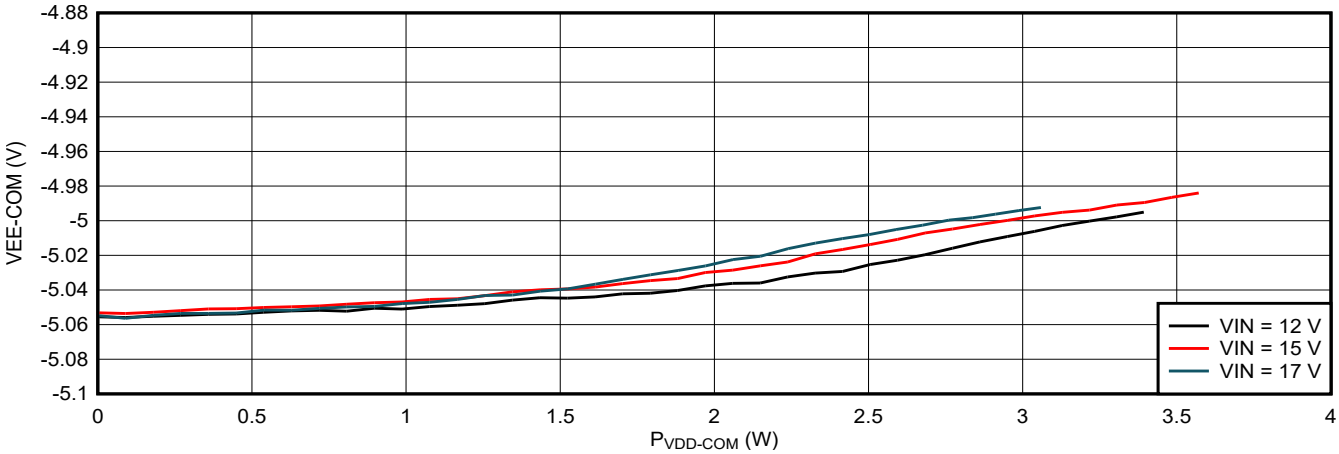


图 3-3. 调节与功率间的关系，仅 VDD-COM 负载

3.1.3 稳态输入电流

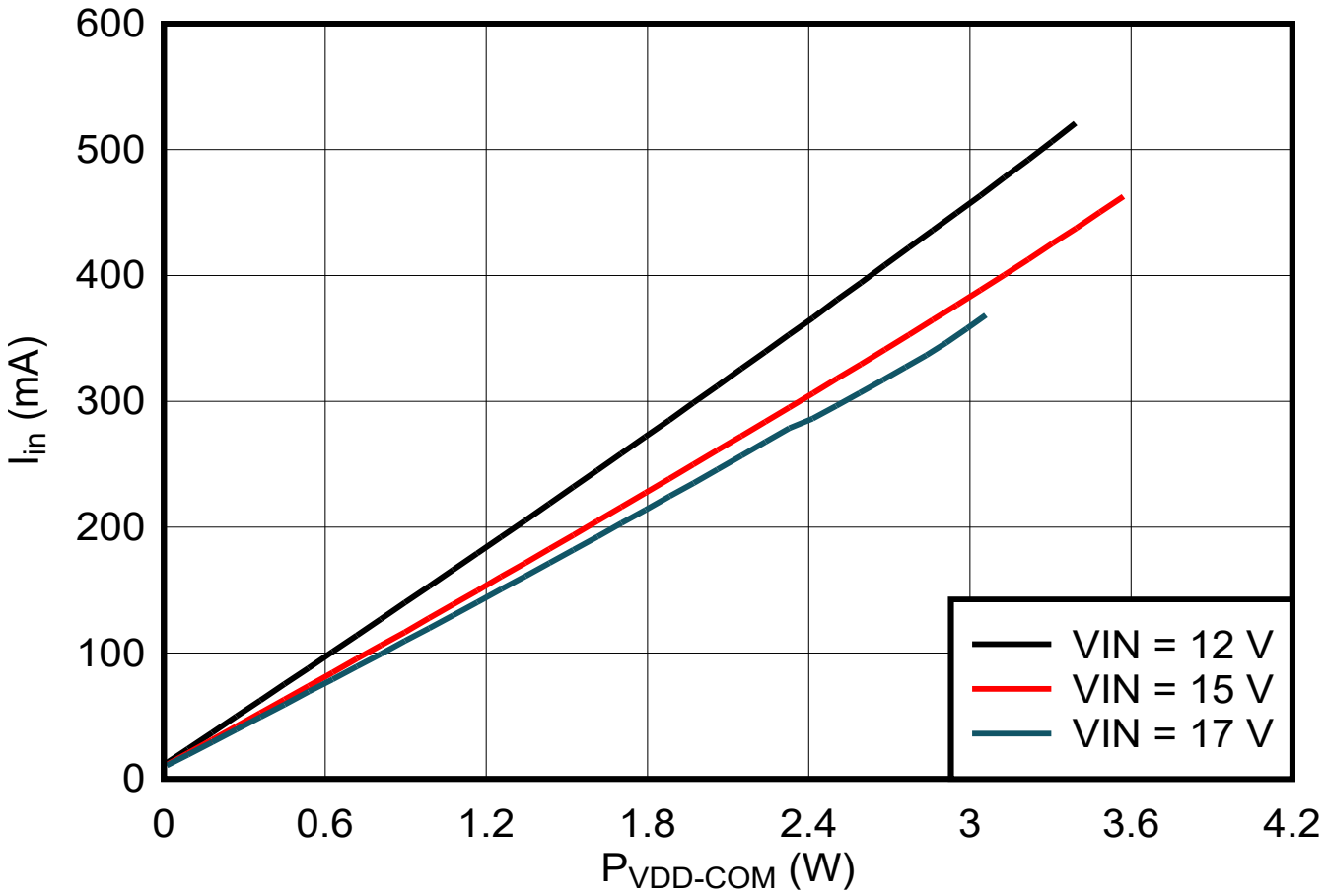


图 3-4. 输入电流与功率间的关系，仅限 VDD-COM 负载

3.1.4 启动波形

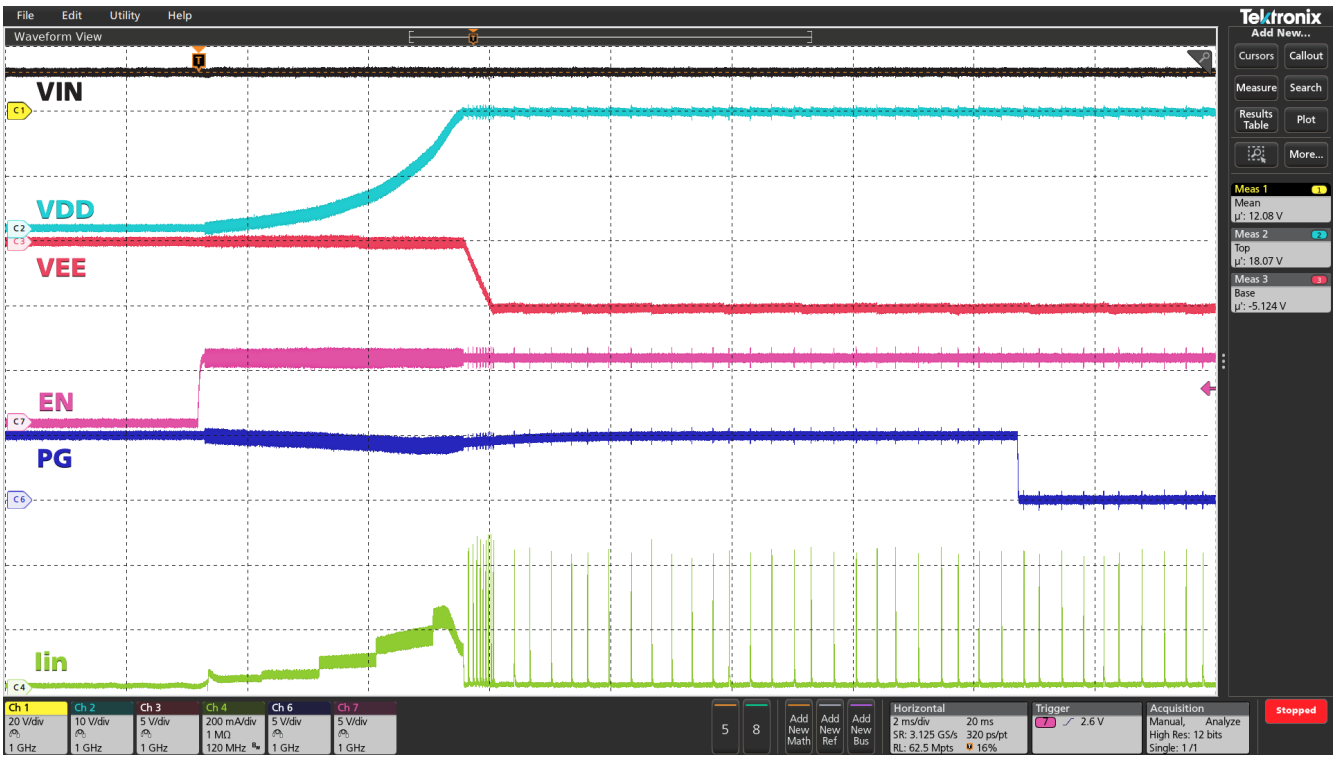


图 3-5. ENA 触发启动：V_{IN} = 12V，$I_{VDD-COM}$ = 0mA，$I_{VEE-COM}$ = 0mA

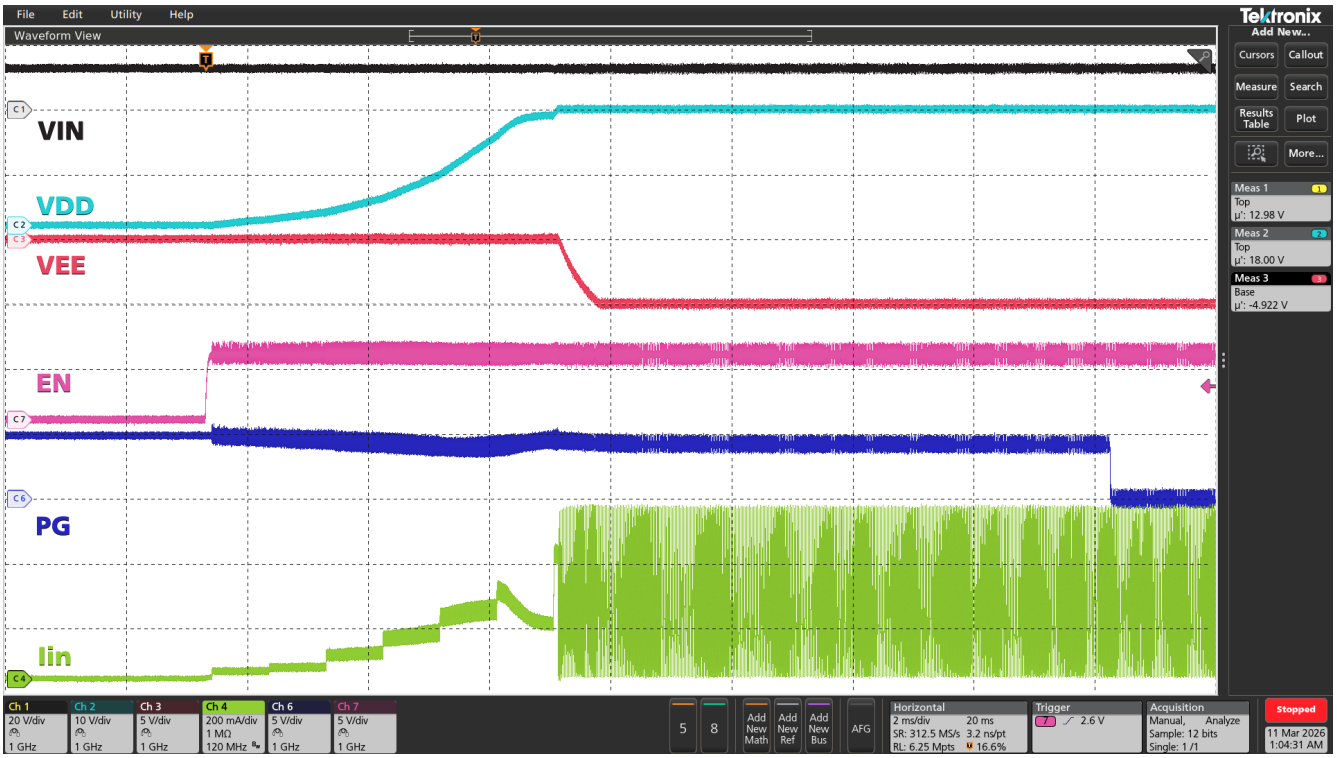


图 3-6. ENA 触发启动：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

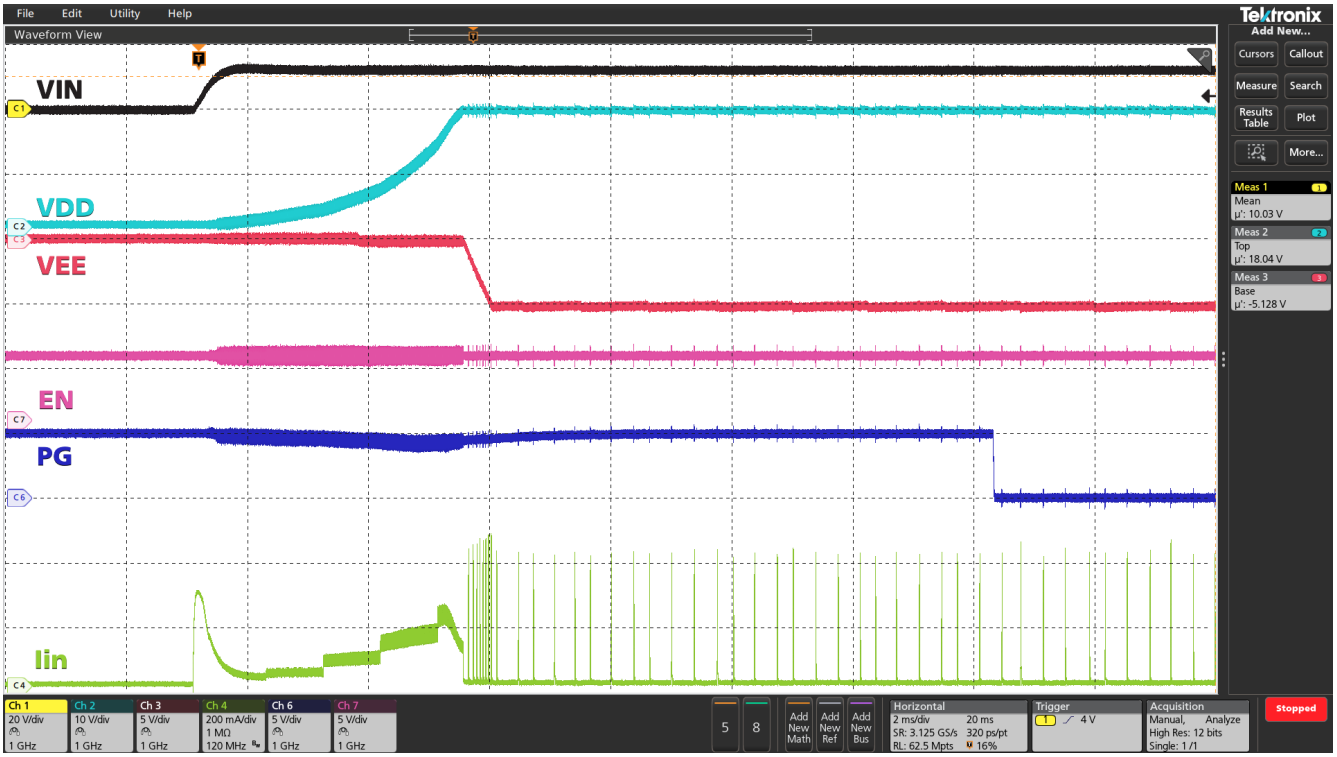


图 3-7. V_{IN} 触发启动：V_{IN} = 12V，$I_{VDD-COM}$ = 0mA，$I_{VEE-COM}$ = 0mA

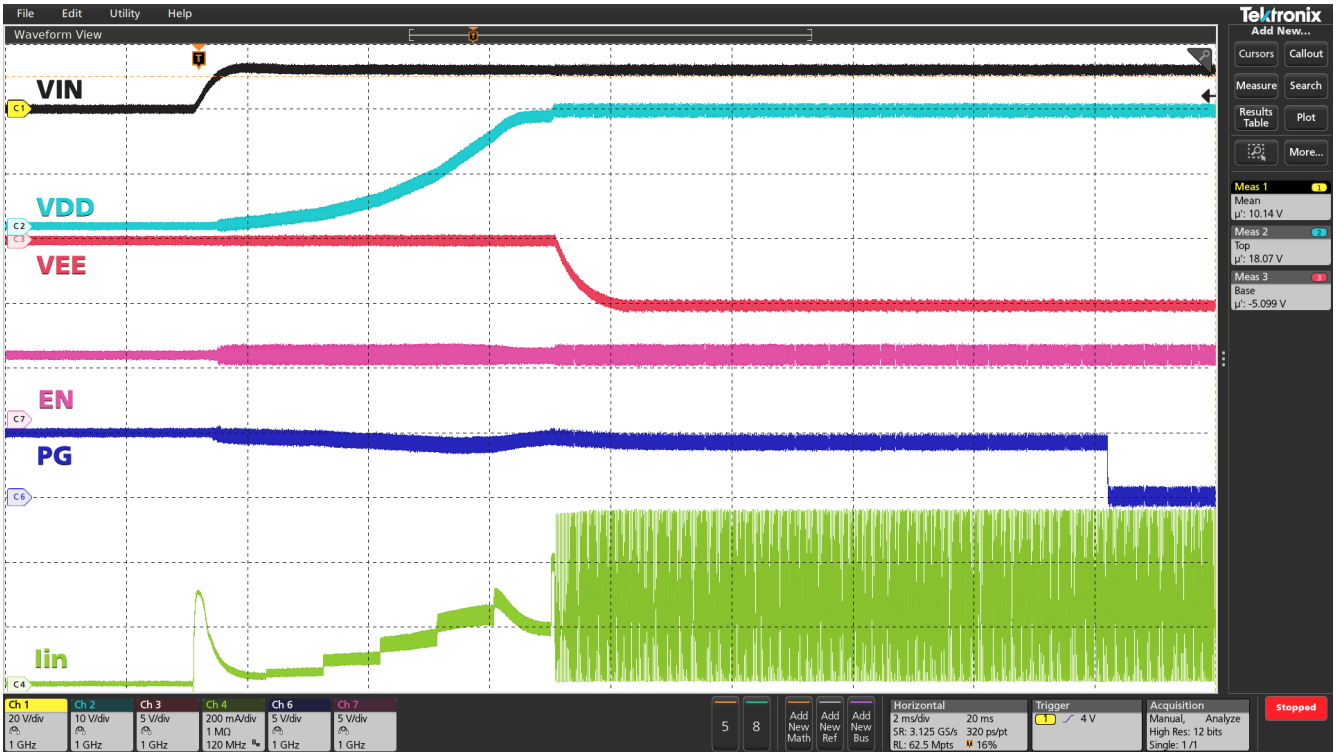


图 3-8. V_{IN} 触发启动：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

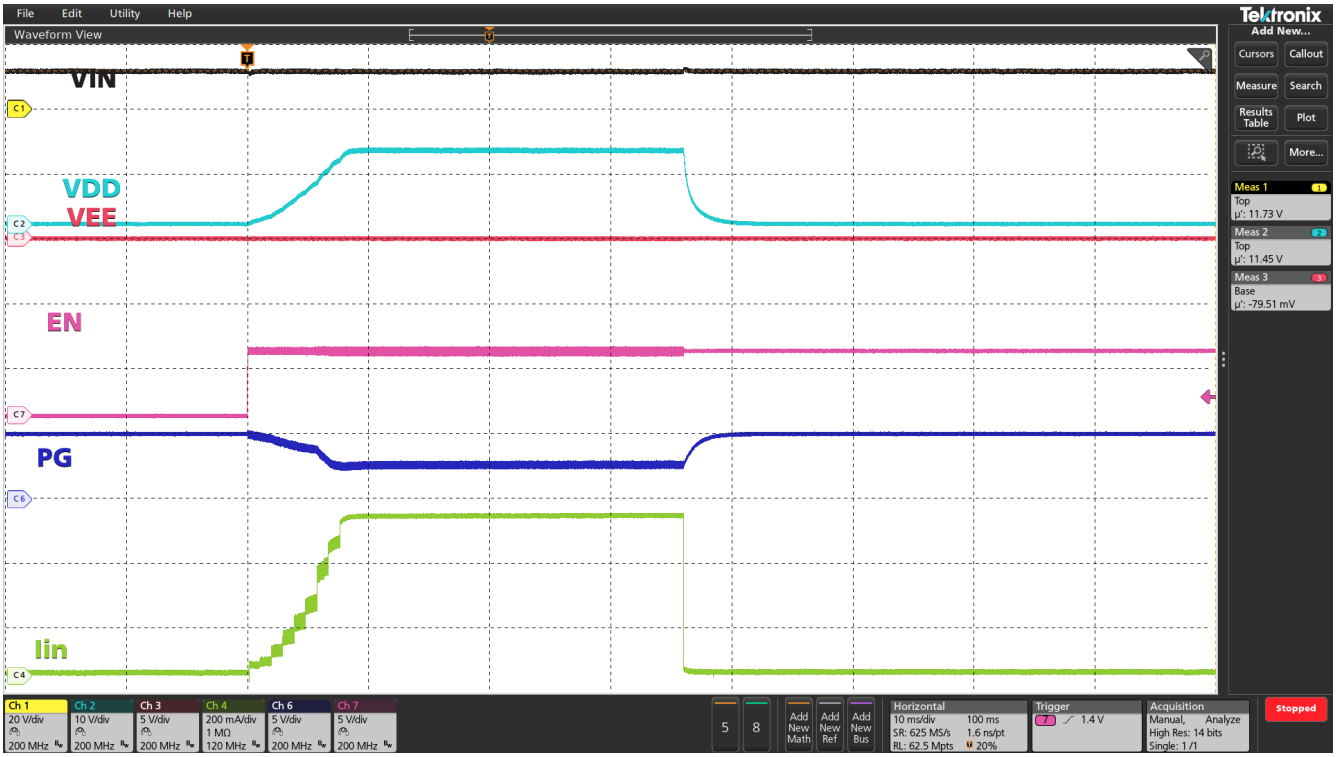


图 3-9. ENA 触发的过载启动：V_{IN} = 12V，$I_{VDD-COM}$ = 389mA，$R_{VDD-COM}$ = 46Ω，$I_{COM-VEE}$ = 0mA

3.1.5 输出纹波

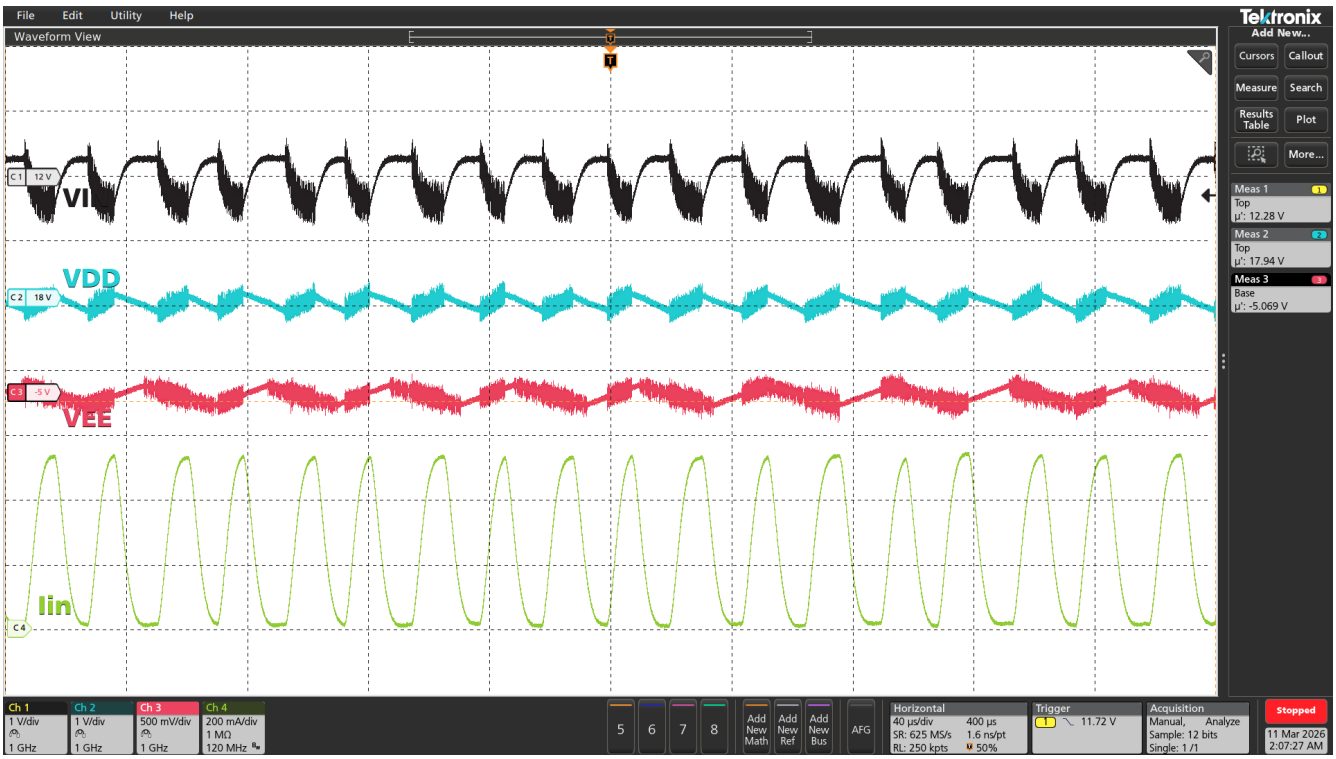


图 3-10. 稳定状态输出纹波：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

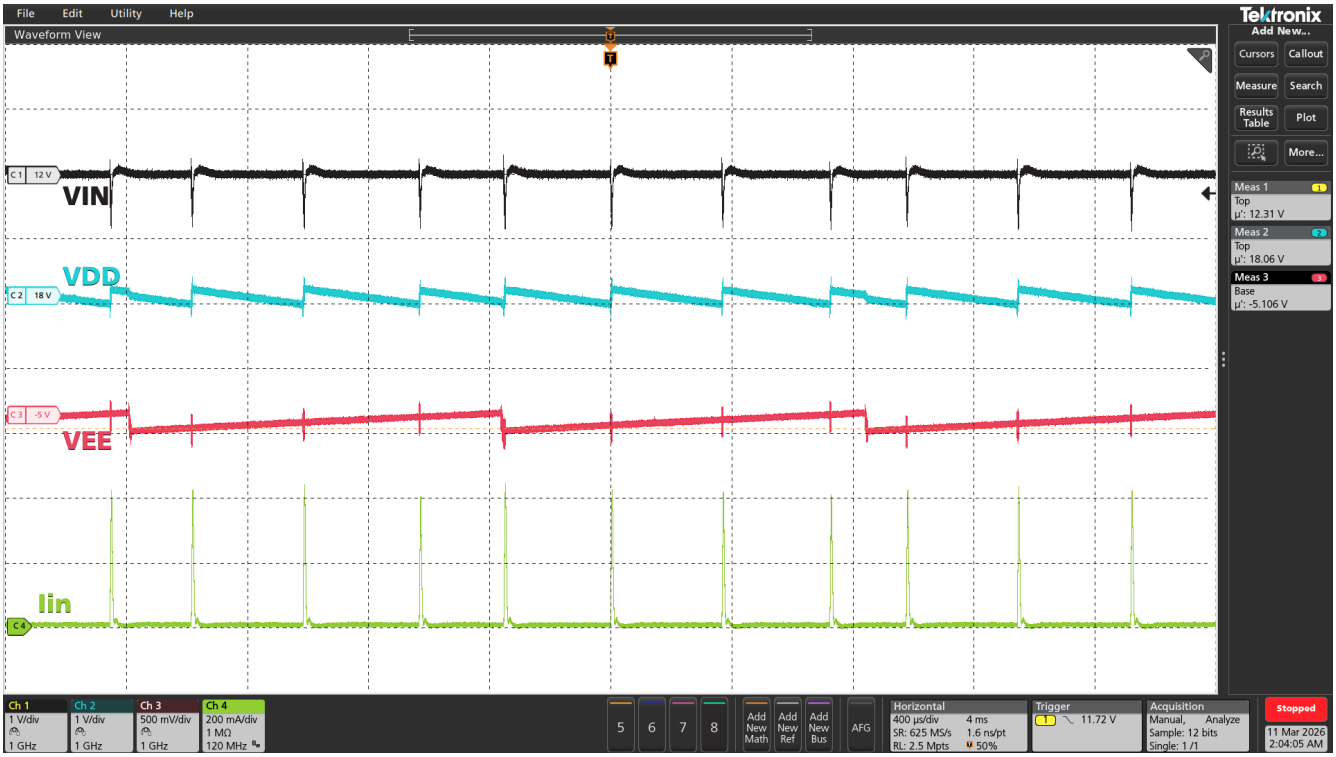


图 3-11. 稳定状态输出纹波：V_{IN} = 12V，$I_{VDD-COM}$ = 0mA，$I_{COM-VEE}$ = 0mA

3.1.6 关断

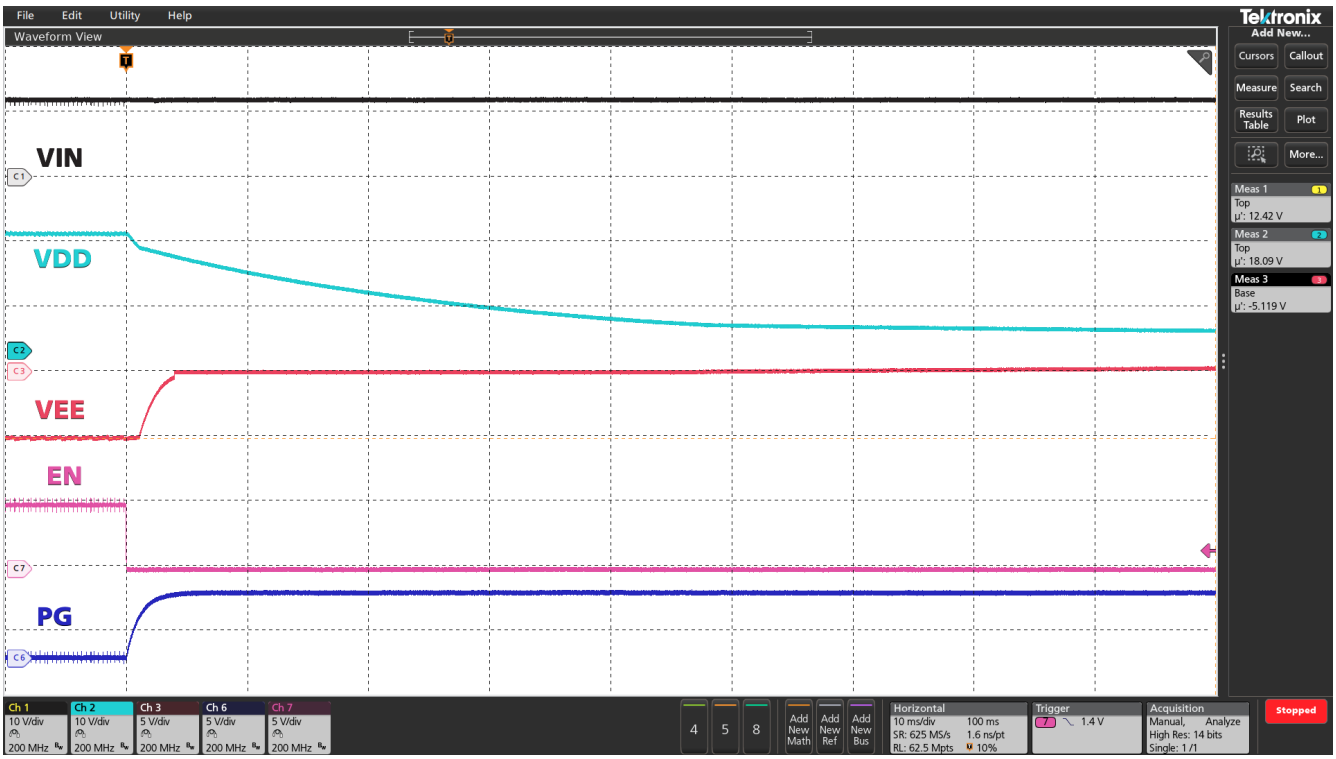


图 3-12. ENA 触发关断：V_{IN} = 12V，$I_{VDD-COM}$ = 0mA，$I_{VEE-COM}$ = 0mA

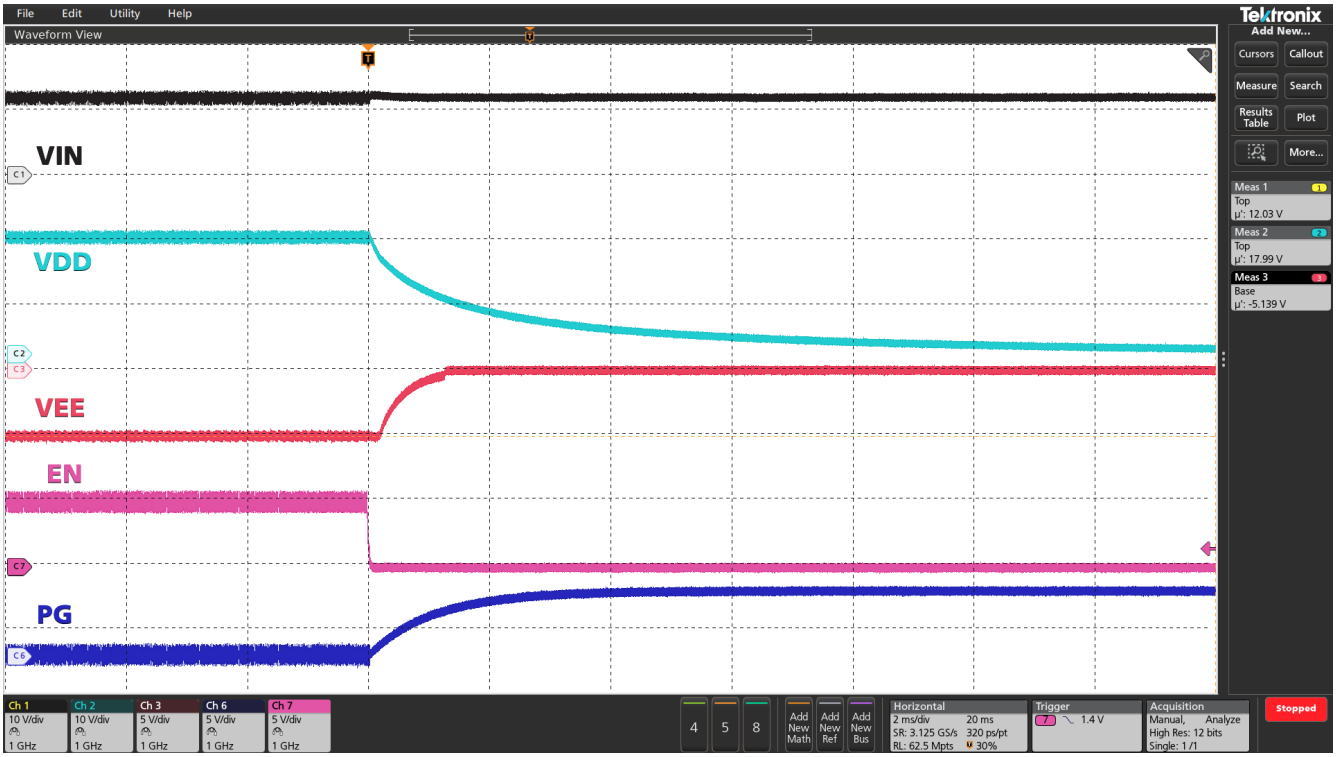


图 3-13. ENA 触发关断：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

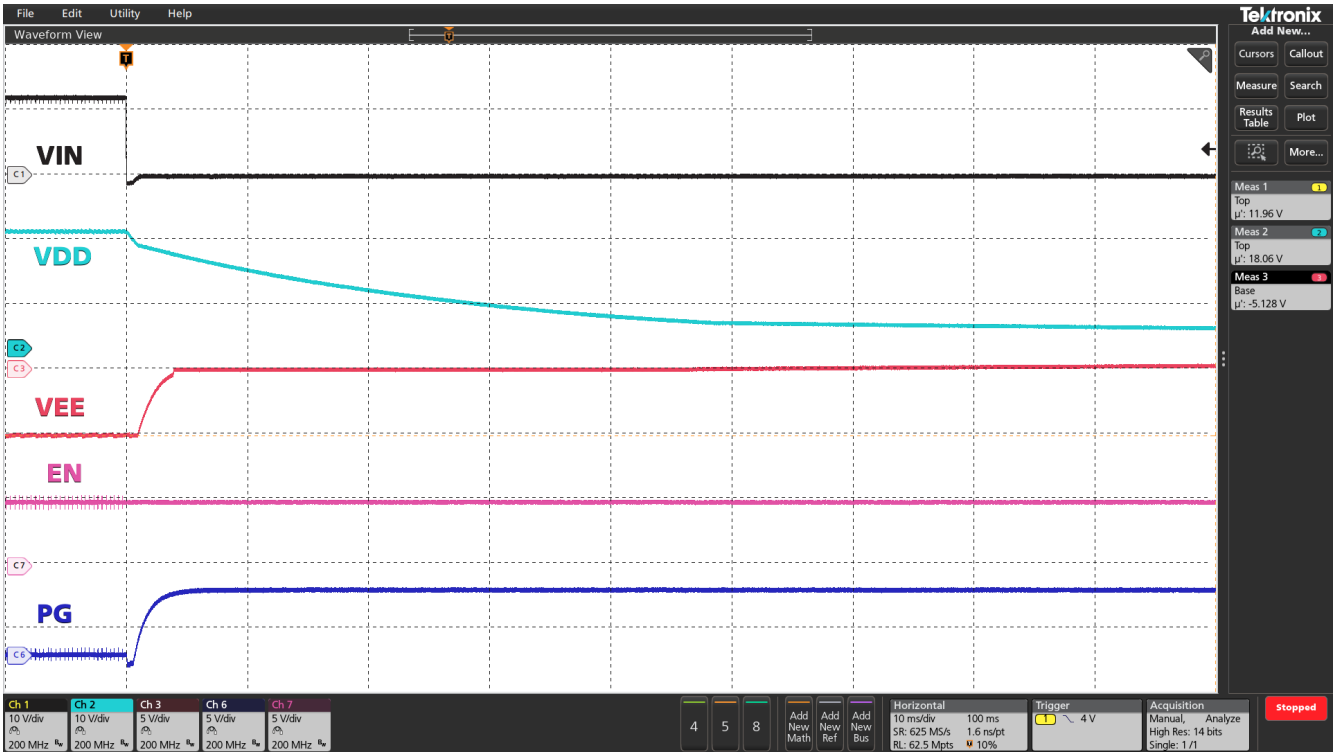


图 3-14. V_{IN} 触发关断：V_{IN} = 12V，$I_{VDD-COM}$ = 0mA，$I_{VEE-COM}$ = 0mA

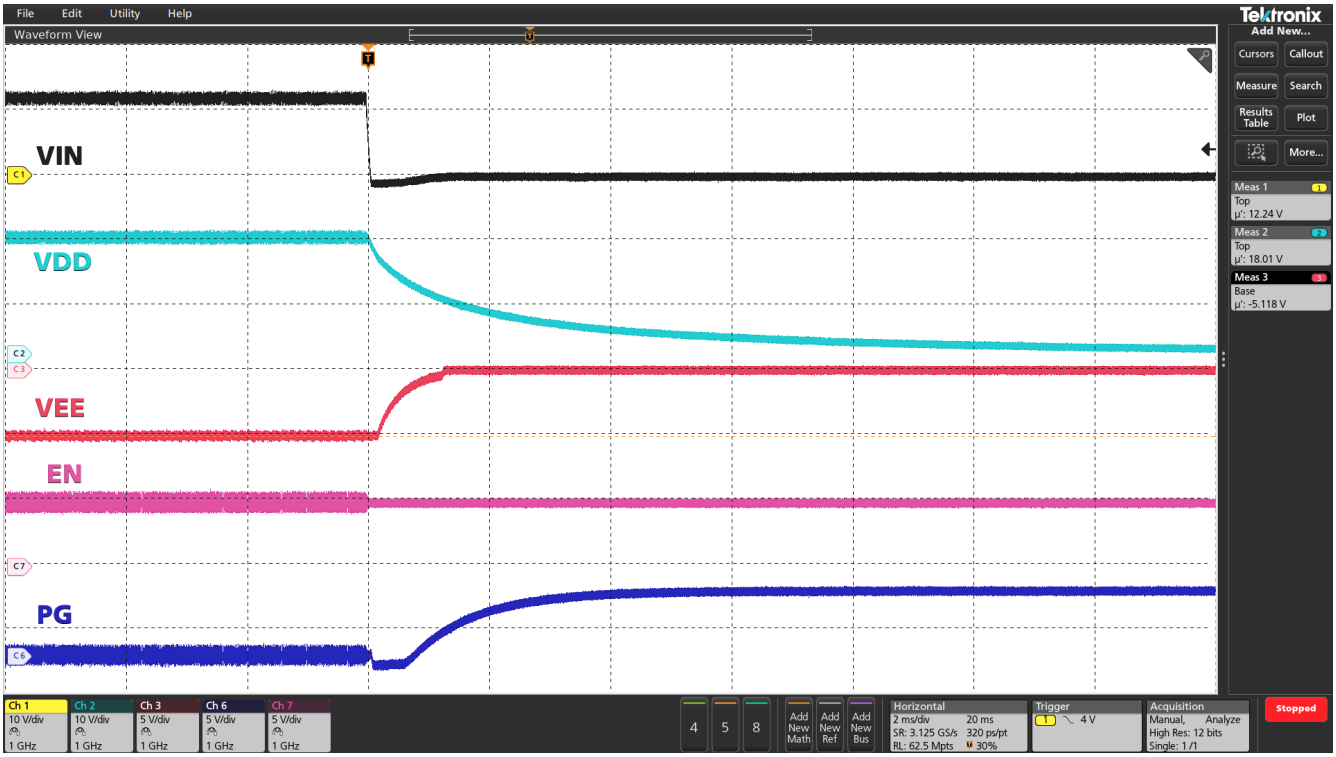


图 3-15. V_{IN} 触发关断：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

3.1.7 热性能

满载 EVM 运行可能导致 U1 封装温度非常高。在满载运行期间探测或操作 EVM 时，请小心不要触碰 U1 外壳。

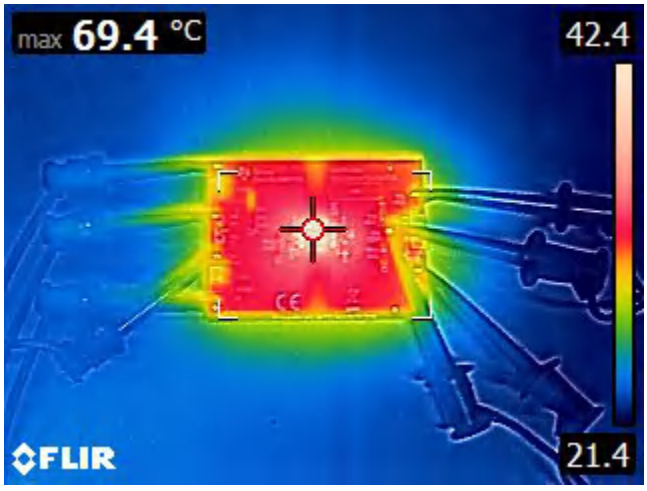


图 3-16. 热像图：V_{IN} = 12V，$I_{VDD-COM}$ = 72mA，$I_{COM-VEE}$ = 40mA

$$T_{RISE} = 69.4°C - 21.4°C = 48°C \quad (1)$$

4 硬件设计文件

4.1 原理图

图 4-1 显示了 EVM 电气原理图。R3-4 和 C10-12 特意未组装，如红色 X 所示，直接放置在元件上方。

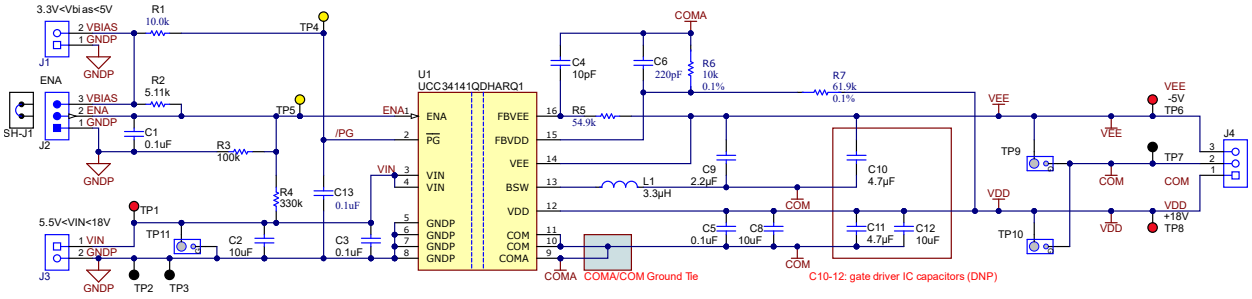


图 4-1. UCC34141EVM-116 原理图，修订版 A

4.2 组装和印刷电路板 (PCB) 布局

UCC34141EVM-116 采用四层 FR4 PCB 设计，所有四层均敷有 2 盎司铜。EVM PCB 展示了接地层和包覆拼接过孔在屏蔽和改善 EMI 性能方面的重要用途。对于汽车牵引逆变器等更高密度的 PCB，PCB 可以包含几个额外的信号层，也可以尽可能采用类似的设计方法。

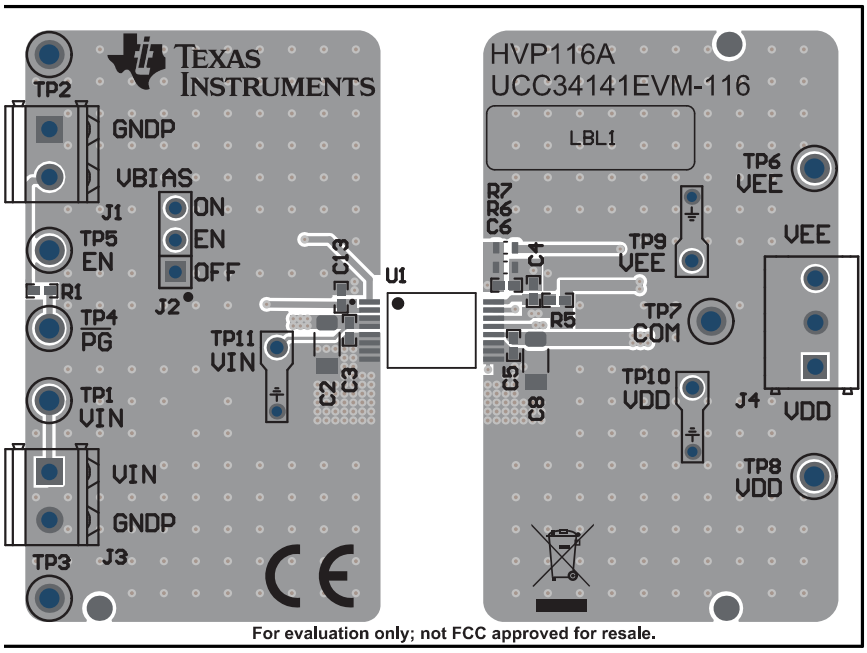


图 4-2. PCB 顶层，组装

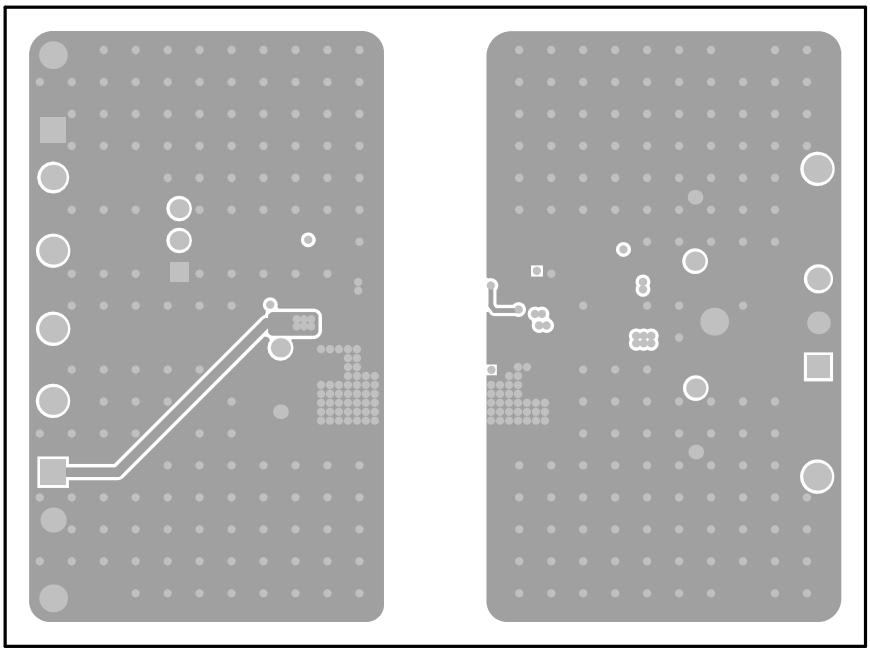


图 4-3. 接地层 2

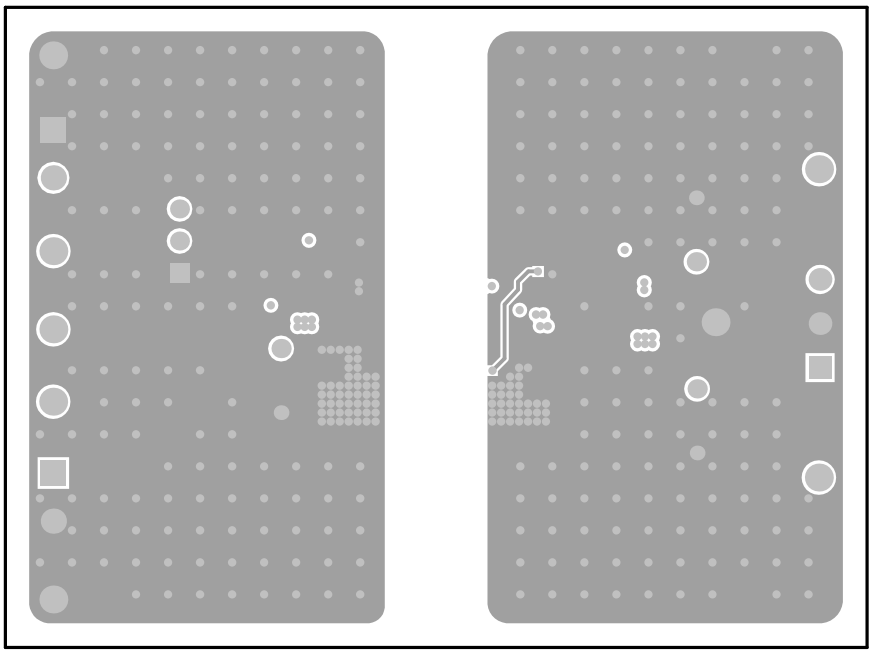


图 4-4. 接地层 3

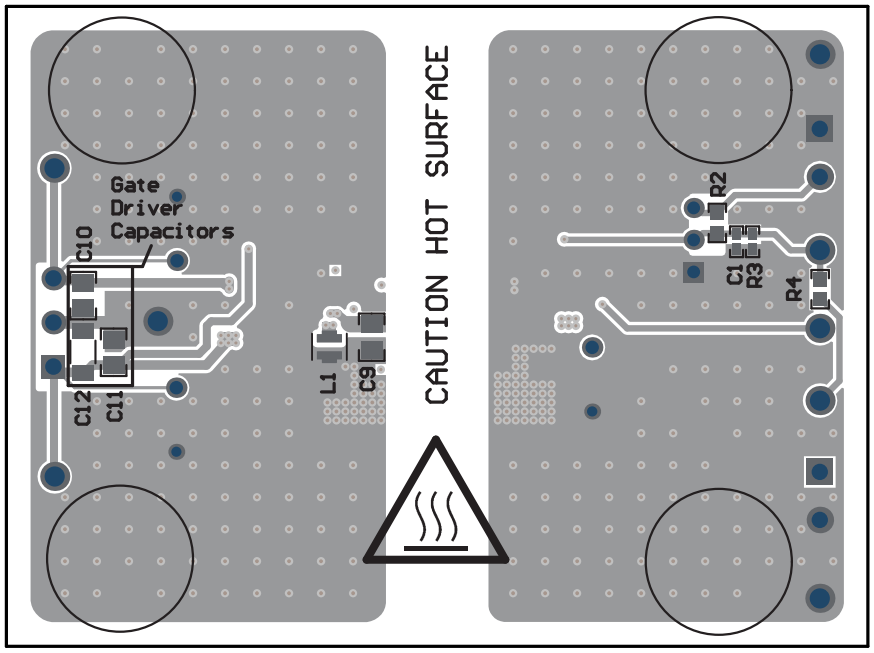


图 4-5. PCB 底层，组装（镜像视图）

4.3 物料清单 (BOM)

表 4-1. 物料清单 (BOM)

位号	数量	值	说明	器件型号	制造商
PCB1	1	不适用	印刷电路板	HVP116	不限
C1、C3、C5、C13	4	0.1uF	电容，陶瓷，0.1µF，50V，+/－ 10%，X7R，AEC-Q200 1 级，0402	GCM155R71H104KE02D	MuRata
C2、C8	2	10µF	电容，陶瓷，10uF，35V，+/- 10%，X7R，AEC-Q200 1 级，1206_190	CGA5L1X7R1V106K160AC	TDK
C4	1	10pF	电容，陶瓷，10pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402	CGA2B2C0G1H100D050BA	TDK
C6	1	220pF	电容，陶瓷，220pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402	CGA2B2C0G1H221J050BA	TDK
C9	1	2.2 µ F	电容，陶瓷，2.2uF，16V，+/-10%，X7R，0805	C2012X7R1C225K125AB	TDK
H1、H2、H3、H4	4	不适用	Bumpon，半球形，0.44 × 0.20，透明	SJ-5303 (CLEAR)	3M
J1、J3	2	不适用	接线端子，2x1，3.81mm，24-16 AWG，10A，300VAC，TH	6.91214E+11	Wurth Elektronik
J2	1	不适用	接头，100mil，3x1，锡，TH	PEC03SAAN	Sullins Connector Solutions
J4	1	不适用	端子块，3.5mm，3x1，锡，TH	6.91214E+11	Wurth Elektronik
L1	1	3.3uH	电感器功率屏蔽线绕 3.3uH 20% 100KHz 铁氧体 0.88A 0.3Ω DCR T/R	NRV2010T3R3MGF	Taiyo Yuden
LBL1	1	不适用	热转印打印标签，0.650"（宽）x 0.200"（高）- 10,000/卷	THT-14-423-10	Brady

表 4-1. 物料清单 (BOM) （续）

位号	数量	值	说明	器件型号	制造商
R1	1	10.0k	电阻，10.0k，1%，0.2W，AEC-Q200 0 级，0402	ERJPA2F1002X	Panasonic
R2	1	5.11k	电阻，5.11k，1%，0.1W，AEC-Q200 0 级，0603	CRCW06035K11FKEA	Vishay-Dale
R5	1	54.9k	电阻，54.9k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040254K9FKED	Vishay-Dale
R6	1	10k	10kΩ，±0.1%，0.1W，1/10W 片上电阻器 0603（1608 公制），汽车 AEC-Q200 薄膜	ERA-3AEB103V	Panasonic
R7	1	61.9k	61.9kΩ，±0.1%，0.1W，1/10W 片上电阻器 0603（1608 公制），汽车 AEC-Q200 薄膜	ERA-3AEB6192V	Panasonic Electronic Components
SH-J1	1	1x2	分流器，100mil，镀金，黑色	SNT-100-BK-G	Samtec
TP1、TP6、TP8	3	不适用	测试点，多用途，红色，TH	5010	Keystone Electronics
TP2、TP3、TP7	3	不适用	测试点，多用途，黑色，TH	5011	Keystone Electronics
TP4、TP5	2	不适用	测试点，通用，黄色，TH	5014	Keystone Electronics
U1	1	不适用	汽车类 1.5W，12V-Vin，25V-Vout，高效，高密度，> 5kVRMS 隔离式直流/直流模块	UCC34141QDHARQ1	德州仪器 (TI)
C10、C11	0	4.7uF	电容，陶瓷，4.7µF，35V，+/-10%，X7R，AEC-Q200 1 级，0805	CGA4J1X7R1V475K125AC	TDK
C12	0	10µF	电容，陶瓷，10uF，35V，+/- 10%，X7R，AEC-Q200 1 级，1206_190	CGA5L1X7R1V106K160AC	TDK
R3	0	100k	电阻，100k，5%，0.1W，AEC-Q200 0 级，0402	ERJ-2GEJ104X	Panasonic
R4	0	330k	电阻，330k，1%，0.1W，AEC-Q200 0 级，0603	ERJ-3EKF3303V	Panasonic

5 其他信息

5.1 商标

所有商标均为其各自所有者的财产。

6 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 A (January 2026) to Revision B (March 2026)	Page
• 将图更新为新版本	1
• 将型号 002 更新为 001	2
• 添加了“器件信息”部分	2
• 更新了图以显示最新版 PCB	4
• 将图更新为最新的 PCB 版本	6
• 添加了“实现结果”部分	8
• 将“性能数据”部分移至“实现结果”部分	8
• 将 R_{FBVEE} 电阻值从 49.9K 更新为 54.9K，将 PG 电容器更新为 0.1 µF	18
• 删除了 PCB 的 3D 图像并更新了布局照片	18
• 更新了 BOM 并添加了值列	20

Changes from Revision * (April 2025) to Revision A (March 2026)	Page
• 将 R_{FBVEE} 电阻值从 90.9kΩ 更新为 49.9kΩ	18

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