

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辅助电源应用以及各种隔离式工业辅助电源应用。该 EVM 可供用户测试

UCC34141-Q1 的各项功能，例如：器件的启用/禁用 (EN) 引脚、隔离式输出电压的 $15V < VDD < 20V$ 和 $-5V < VEE < 0V$ 配置，以及可变负载在输出上的应用。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。测试点根据表 2-1 进行策略性放置和描述。

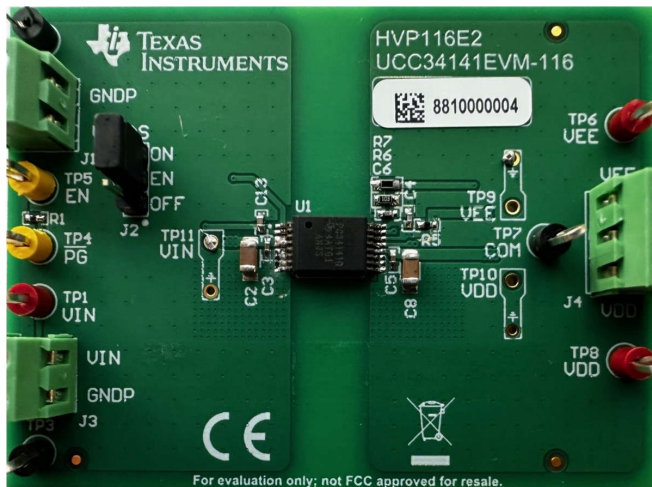
特性

- 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

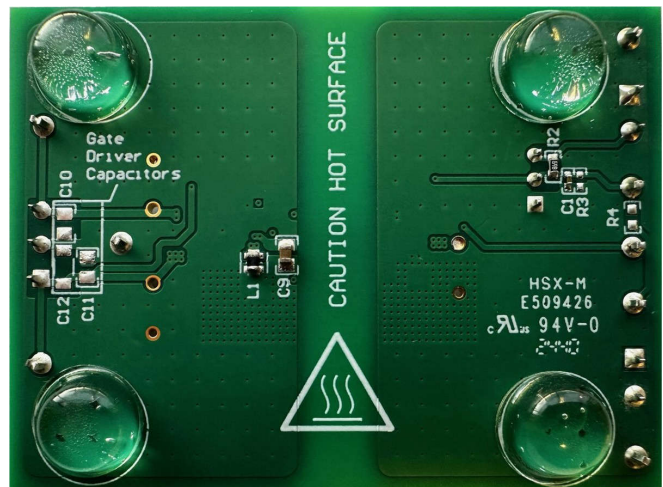
- 评估 UCC34141-Q1 集成保护特性：UVLO、OVLO、短路、OVP、UVP 和热关断
- 符合 AEC-Q100 标准，在高达 105°C 下提供满额定功率，<3pF 隔离电容，SSM 频率调制

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

本用户指南为使用 UCC34141EVM-116 型号 002 评估德州仪器 (TI) UCC34141-Q1 (具有集成变压器的高频直流/直流转换器模块) 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						
V _{DD}	直流满载设定点	8.5V<V _{IN} <20V，I _{VDD} =83mA	17.6	18.0	18.3	V
I _{VDD}	V _{DD} 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
V _{EE}	直流满载设定点	6V<V _{IN} <20V，I _{VEE} =65mA	-4.89	-5.00	-5.11	V
I _{VEE}	V _{EE} 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



图 1-1. DHA 封装，16 引脚 SSOP (顶视图)

表 1-3. 引脚配置和功能

引脚		类型 (1)	说明
名称	编号		
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。建议最大值为 5.5V。可用于通过来自 VIN 的电阻分压器对输入 UVLO 进行编程。
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。连接一个 0402 封装尺寸的去耦电容器以旁路高频噪声。它必须位于电源正常引脚旁边，且与 IC 位于 PCB 的同一侧。
VIN	3、4	P	初级输入电压。在 VIN 到 GNDP 之间连接一个 $10\mu F$ 和一个并联 $0.1\mu F$ 陶瓷电容器。 $0.1\mu F$ 陶瓷电容器用于绕过高频噪声，并且和 IC 一样必须紧挨着 PCB 同一侧的 VIN 和 GNDP 引脚。
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。
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。
COM	10、11	G	次级接地。连接到电源开关的源极。
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 $10\mu F$ 和一个并联 $0.1\mu F$ 陶瓷电容器。 $0.1\mu F$ 陶瓷电容器用于绕过高频噪声，必须靠近 VDD 和 COM 引脚。
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 $3.3\mu H$ 至 $10\mu H$ 片式电感器。
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 $2.2\mu F$ 陶瓷电容，以绕过高频开关噪声。
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 $220pF$ 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 $220pF$ 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 和 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。

(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 V_{IN} 、 V_{DD} 和 V_{EE} 。连接适当的电流表和电压表，如图 2-1 所示，以便可以进行准确的 EVM 效率测量。

连接测试设备：

1. 将分流器跳线 SH-J1 移至 J2，1-2，EN OFF 位置。这可确保在连接测试设备时 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 (V_{IN}) 处连接能够提供电压 $5V < V_{IN} < 20V$ 和电流 500mA 的 V_{IN} 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 V_{IN} 电源。
4. 在 J4:1 (V_{DD}) 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)，650 Ω （约 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 (V_{EE}) 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)，250 Ω （约 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，某些电子负载可能无法调节/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。

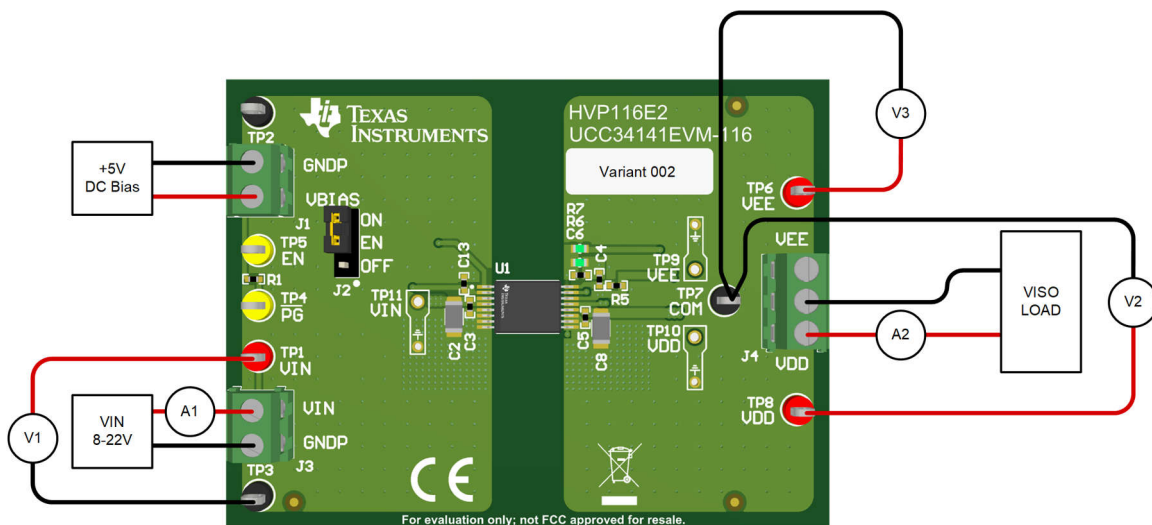


图 2-1. 典型效率测量设置

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。

启动时接通电源

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

表 2-1. 输入、输出、测试点 (I/O/TP) 说明 (续)

引脚	I/O/TP	颜色	说明	最小值	典型值	最大值	单位
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 22AWG 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。

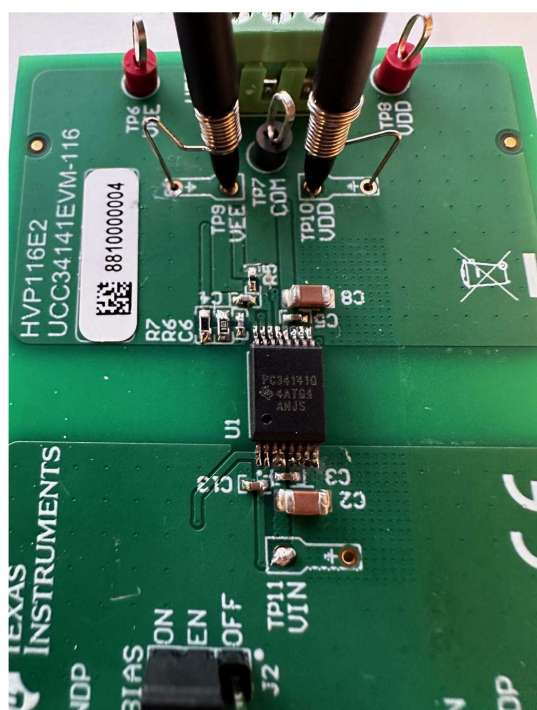


图 2-2. PCB 示波器探头测试点

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 3-1 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 硬件设计文件

3.1 原理图

图 3-1 展示了 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。

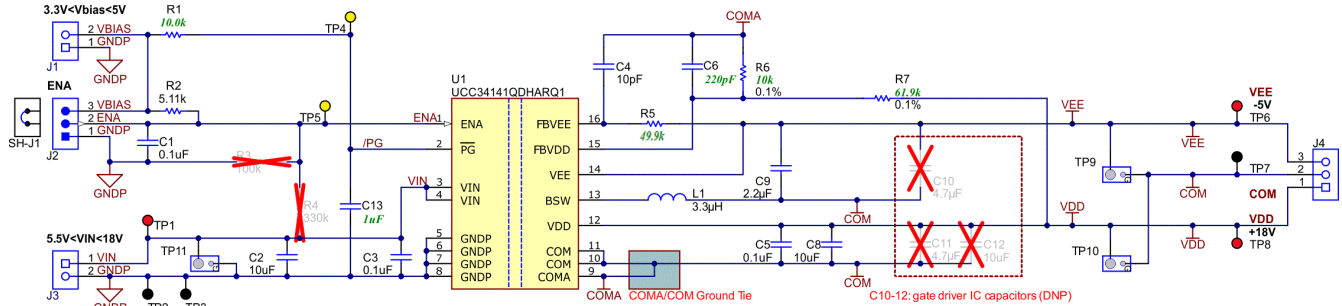


图 3-1. UCC34141EVM-116 原理图，修订版 E2，型号 002

3.2 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。

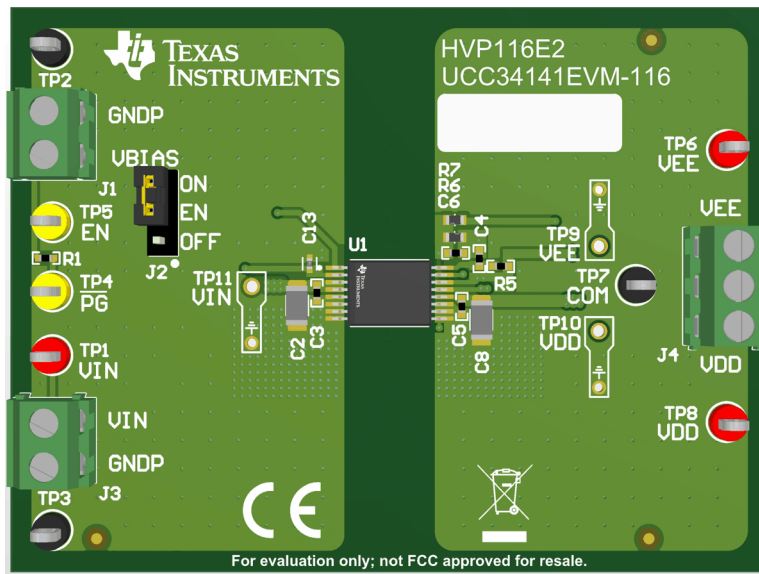


图 3-2. 经全面组装的 3D 顶视图

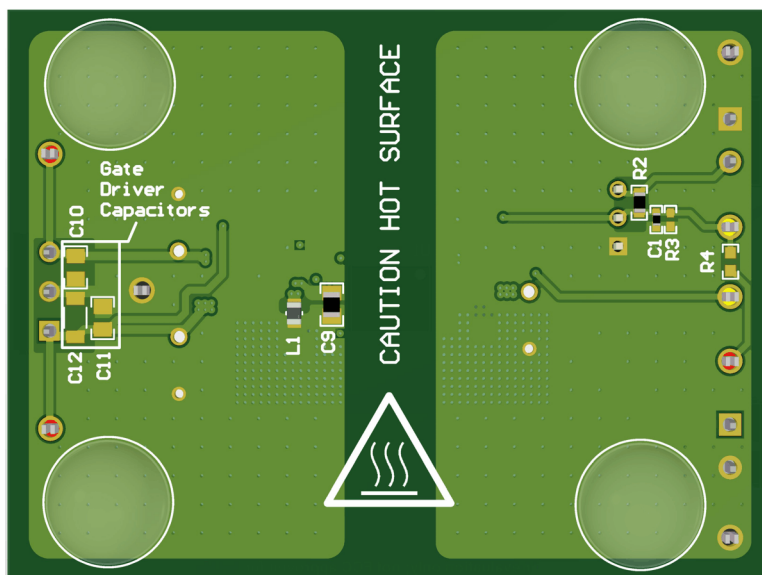


图 3-3. 经全面组装的 3D 底视图

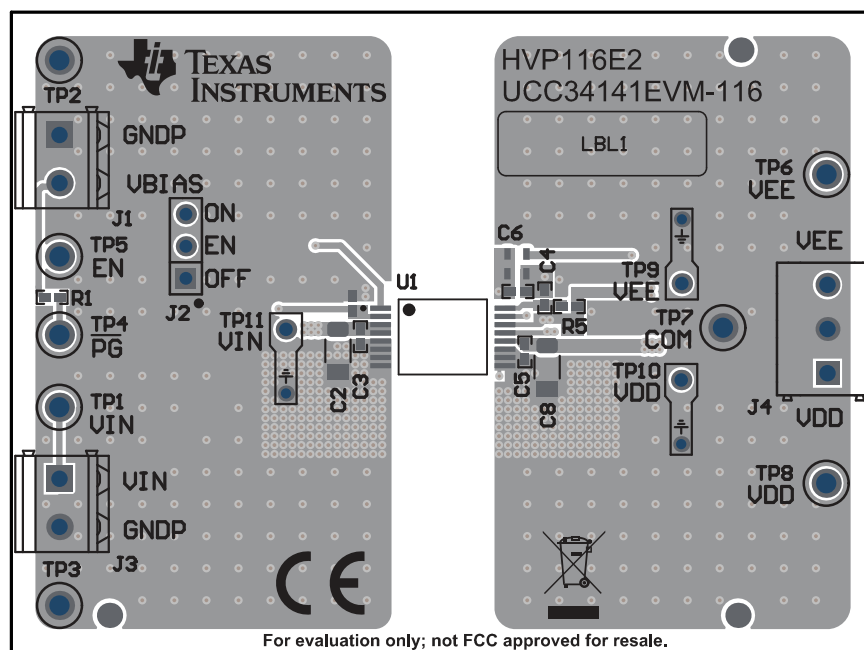


图 3-4. PCB 顶层，组装

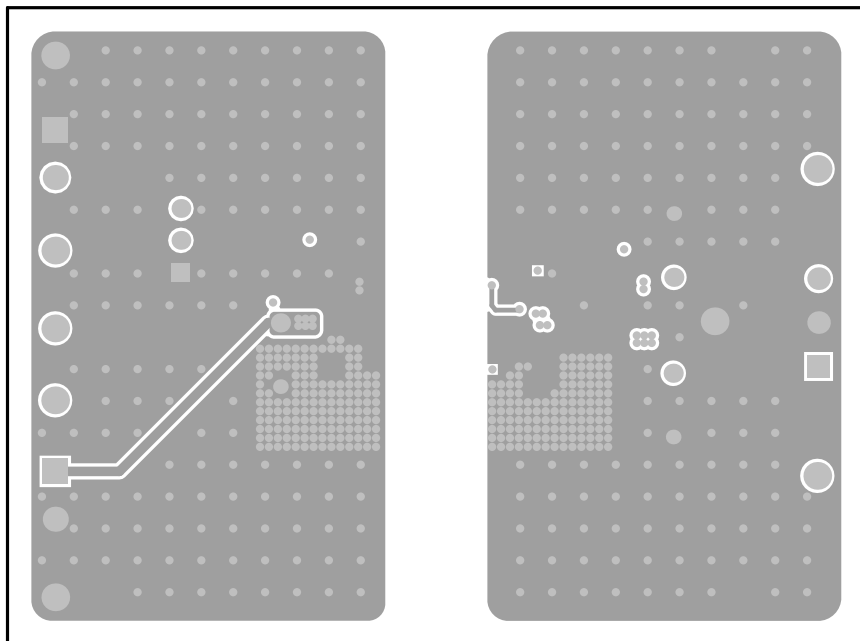


图 3-5. 接地层 2

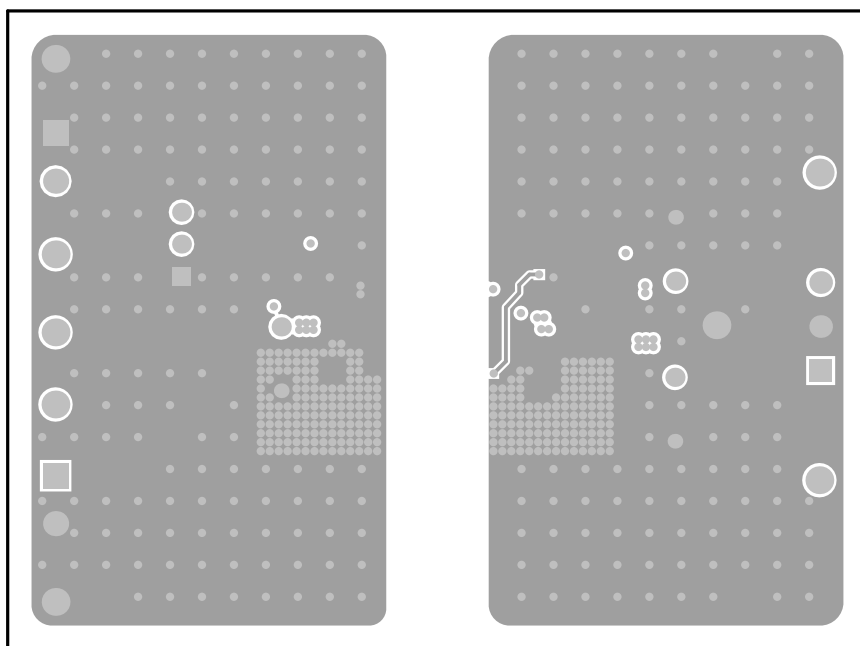


图 3-6. 接地层 3

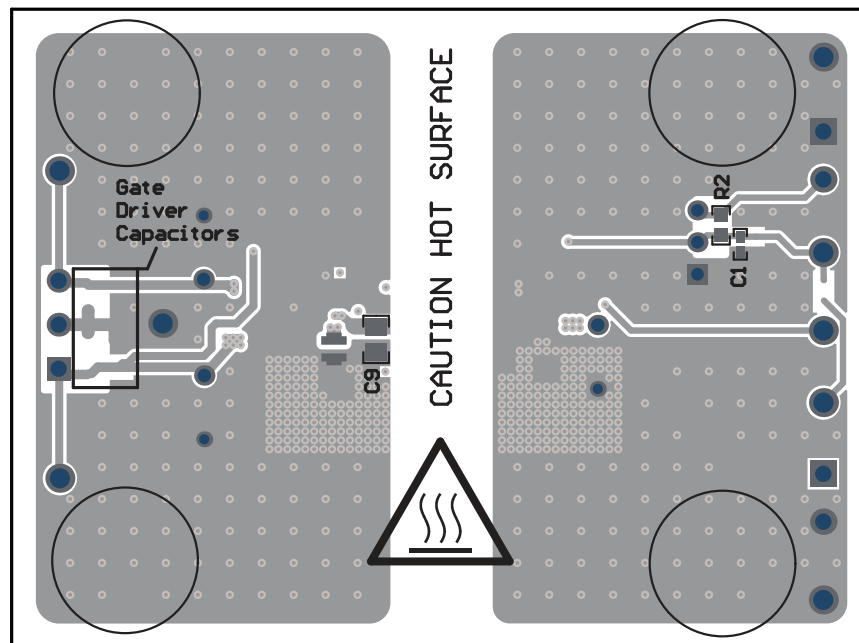


图 3-7. PCB 底层，组装（镜像视图）

3.3 物料清单 (BOM)

表 3-1. 物料清单 (BOM)

参考位号	数量	说明	器件型号	制造商
PCB1	1	印刷电路板	HVP116	不限
C1、C3、C5	3	电容，陶瓷，0.1 μ F，50V，+/-10%，X7R，AEC-Q200 1 级，0402	GCM155R71H104KE02D	MuRata
C2、C8	2	电容，陶瓷，10 μ F，35V，+/- 10%，X7R，AEC-Q200 1 级，1206_190	CGA5L1X7R1V106K160AC	TDK
C4	1	电容，陶瓷，10pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402	CGA2B2C0G1H100D050BA	TDK
C6	1	电容，陶瓷，220pF，50V，+/-5%，C0G/NP0，AEC-Q200 1 级，0402	CGA2B2C0G1H221J050BA	TDK
C9	1	电容，陶瓷，2.2 μ F，16V，+/-10%，X7R，0805	C2012X7R1C225K125AB	TDK
C13	1	1 μ F \pm 20% 10V 陶瓷电容器 X7R 0402 (公制 1005)	KAM05CR71A105MH	KYOCERA AVX
H1、H2、H3、H4	4	Bumpon，半球形，0.44 X 0.20，透明	SJ-5303 (CLEAR)	3M
J1、J3	2	接线端子，2x1，3.81mm，24-16 AWG，10A，300VAC，TH	6.91214E+11	Würth Elektronik
J2	1	接头，100mil，3x1，锡，TH	PEC03SAAN	Sullins
J4	1	端子块，3.5mm，3x1，锡，TH	6.91214E+11	Würth Elektronik
L1	1	屏蔽电感器 3.3 μ H \pm 20% 500mA 260m Ω AEC-Q200 SMD 0805	MLZ2012M3R3HTD25	TDK
R1	1	电阻，10.0k Ω ，1%，0.2W，AEC-Q200 0 级，0402	ERJPA2F1002X	Panasonic
R2	1	电阻，5.11k Ω ，1%，0.1W，AEC-Q200 0 级，0603	CRCW06035K11FKEA	Vishay-Dale
R5	1	电阻，49.9k，1%，0.1W，AEC-Q200 0 级，0402	ERJ-2RKF4992X	Panasonic

表 3-1. 物料清单 (BOM) (续)

参考位号	数量	说明	器件型号	制造商
R6	1	10kΩ, ±0.1% 0.1W, 片式电阻器 0603 汽车类 AEC-Q200 薄膜	ERA-3AEB103V	Panasonic
R7	1	61.9kΩ, ±0.1% 0.1W, 片式电阻器 0603 汽车类 AEC-Q200 薄膜	ERA-3AEB6192V	Panasonic
SH-J1	1	分流器, 100mil, 镀金, 黑色	SNT-100-BK-G	Samtec
TP1、 TP6、TP8	3	测试点, 多用途, 红色, TH	5010	Keystone Electronics
TP2、 TP3、TP7	3	测试点, 多用途, 黑色, TH	5011	Keystone Electronics
TP4、TP5	2	测试点, 通用, 黄色, TH	5014	Keystone Electronics
U1	1	汽车类 1.5W、12V-Vin、25V-Vout 高效、高密度 > 5kV _{RMS} 隔离式直流/直流模块	UCC34141QDHARQ1	德州仪器 (TI)
C10、C11	0	电容, 陶瓷, 4.7μF, 35V, +/-10%, X7R, AEC-Q200 1 级, 0805	CGA4J1X7R1V475K125AC	TDK
C12	0	电容, 陶瓷, 10μF, 35V, +/- 10%, X7R, AEC-Q200 1 级, 1206_190	CGA5L1X7R1V106K160AC	TDK
R3	0	电阻, 100kΩ, 5%, 0.1W, AEC-Q200 0 级, 0402	ERJ-2GEJ104X	Panasonic
R4	0	电阻, 330kΩ, 1%, 0.1W, AEC-Q200 0 级, 0603	ERJ-3EKF3303V	Panasonic

4 其他信息

4.1 商标

所有商标均为其各自所有者的财产。

5 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 (January 2026)	Page
• 将 RFBVEE 电阻值从 90.9k Ω 更新为 5k Ω	7

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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.
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 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance 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.

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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:*

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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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