

EVM User's Guide: DRV8762-Q1EVM

DRV8762-Q1 评估模块



说明

DRV8762-Q1 是一款集成式智能栅极驱动器，适用于 48V 汽车级 H 桥有刷直流 (BDC) 应用。该器件提供低侧电流检测放大器，用于支持基于电阻器的低侧电流检测。放大器的低失调电压使系统能够实现精确的电机电流测量。

栅极驱动器支持外部 N 沟道高侧和低侧功率 MOSFET，可驱动高达 224mA 的峰值拉电流和 448mA 的峰值灌电流。自举电容器为高侧栅极驱动器生成电源电压。低侧栅极驱动器的电源电压由外部提供，标称值为 12V。

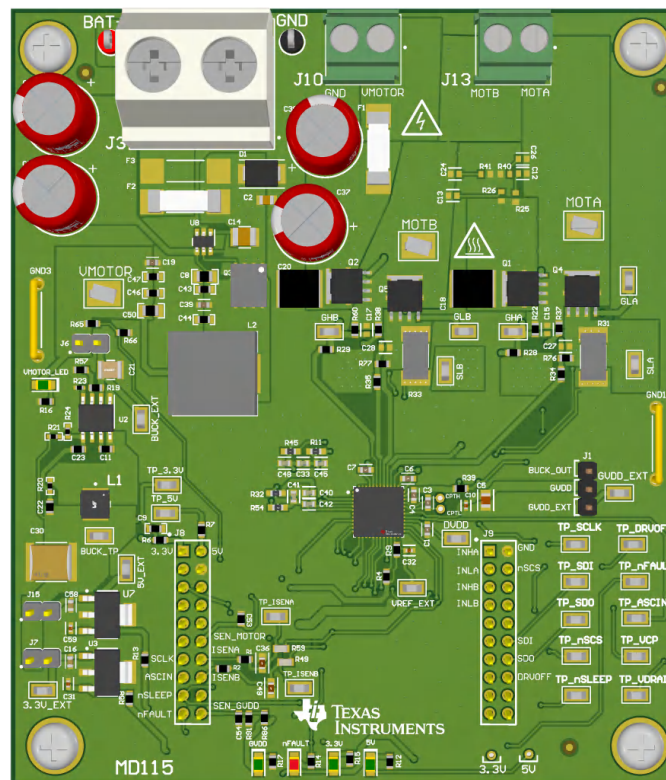
此套件需要使用 C2000™ launchpad (LAUNCHXL-F280049C) 控制 DRV8762-Q1，并监控和报告故障。

特性

- 最大工作电压 8V 至 85V，支持 12V 至 48V 的应用
- 具有 224mA/448mA 峰值栅极驱动的 100% 占空比 PWM 控制
- 32 个可配置 IDRIVE 步长，可实现精确的压摆率调优
- 集成三个具有低输入失调温漂的 CSA
- 3.3V 和 5V 板载 LDO。

应用

- 座椅位置和舒适模块
- 区域和车身域控制器
- 后备箱模块
- 有刷直流 (BDC) 电机驱动器



DRV8762-Q1EVM

1 评估模块概述

1.1 简介

本文档随 DRV8762-Q1 客户评估模块 (EVM) 提供，作为 DRV8762-Q1 数据表的补充。本用户指南详细介绍了 EVM 的硬件实现。

本文档旨在用作 DRV8762-Q1EVM 和 LAUNCHXL-F280049C 器件的入门指南。本文档适用于参与设计、实现和验证 DRV8762-Q1 + TMS320F280049C 参考软件的工程师。

本文档旨在为用户提供使用 TMS320F280049C 板评估 DRV8762-Q1 器件的指南。本文档涵盖了电路板和外部电机或电源之间所需的硬件连接。硬件连接完成后，用户可以访问必要的工具和软件，从而使用在线 GUI 旋转电机。

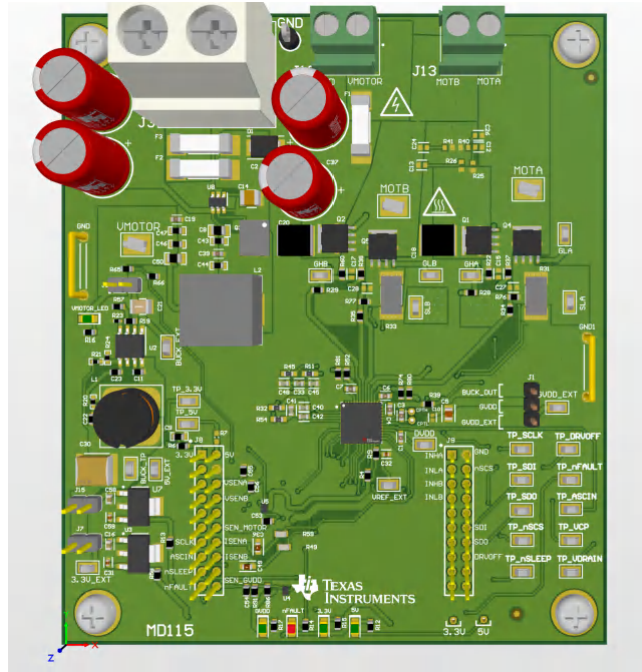


图 1-1. DRV8762-Q1EVM

小心


根据设计，DRV8762-Q1EVM 仅可使用必须单独订购的 LAUNCHXL-F280049C MCU PCB 进行评估。

警告


电压超过数据表中所指定的标准 EVM 额定值时，会导致人身伤害、电击危险、EVM 损坏等一种或几种后果。

此外，请勿在 EVM 不运行时使其连接电源。

警告

	表面高温	接触会导致烫伤。请勿触摸。
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警告

	高压	为安全起见，强烈建议使用具有过压和过流保护功能的隔离式测试设备。 将电路板连接到火线时可能会触电。电路板应由专业人员小心处理。
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1.2 套件内容

条目	说明	数量
DRV8762-Q1EVM	PCB	1
盒	纸板盒	1
标签	标准标签	1
泡沫	防静电泡沫	2
文献	EVM 免责声明	1

1.3 规格

DRV8762-Q1 是一款适用于 H 桥电机驱动应用的集成式 8V 至 85V 栅极驱动器，可帮助用户评估栅极驱动器系统内的电机性能。DRV8762-Q1 实现了增强型智能栅极驱动和扩展的器件保护功能等特性，因此非常适合电动座椅、区域控制和后备箱升降等应用。该器件支持 12V、24V 和 48V 应用，具有 85V 的 VDRAIN 绝对最大值，以支持电源瞬变。

1.4 器件信息

DRV8762-Q1EVM 在电路板上集成了多个器件以提供额外的保护功能，并提供运行评估模块所需的额外电压电平，因此仅需要 VBATT 或 VMOTOR 的电源。为防止意外反极性连接，在 VBATT 端子附近集成了一个与 LM74700-Q1 兼容的二极管控制器。DRV8762-Q1 的 GVDD 电源输入引脚需要一个 8V 至 15V 的外部电源。EVM 通过输出为 12V 的 LM5164 降压转换器提供此电压。此外，为了支持数字逻辑和接口电路，EVM 还包含两个线性稳压器：用于生成 5V 电压的 UA78M05C 和用于生成 3.3V 电压的 UA78M33C。

2 硬件

2.1 硬件连接概述 - DRV8762-Q1EVM + LAUNCHXL-F280049C

下面部分介绍了 EVM 硬件以及与外部电源、PC (通过 USB) 和电机的连接。

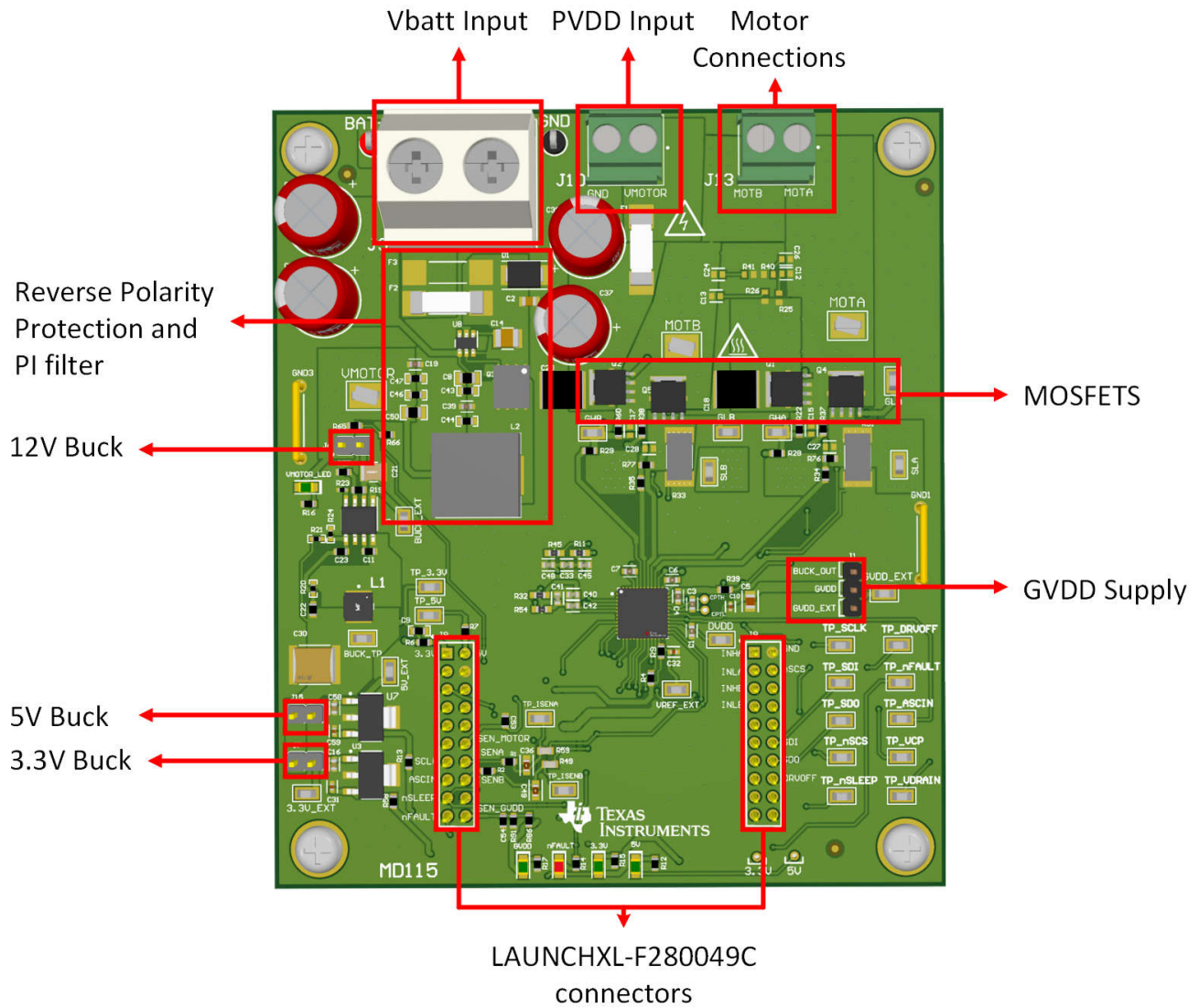
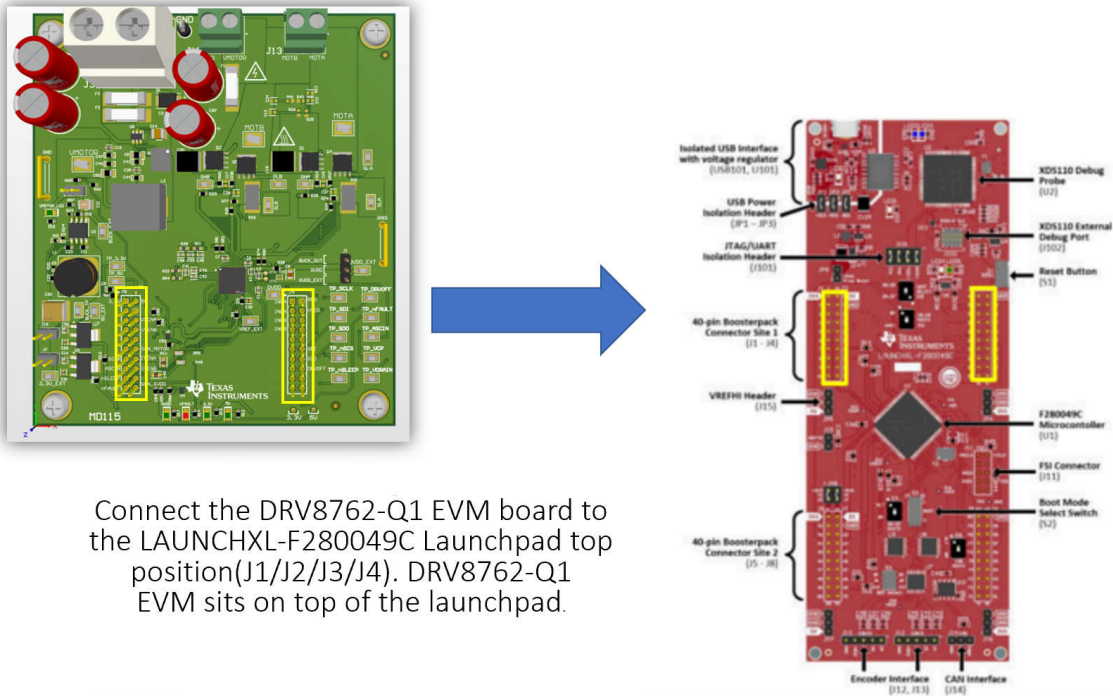


图 2-1. EVM 电路板概述



Connect the DRV8762-Q1 EVM board to the LAUNCHXL-F280049C Launchpad top position(J1/J2/J3/J4). DRV8762-Q1 EVM sits on top of the launchpad.

图 2-2. DRV8762-Q1EVM 对接 LAUNCHXL-F280049C

DRV8762-Q1EVM 必须插入离 USB 端口最近的 LAUNCHXL-F280049C Launchpad 接头，如图 2-2 所示。

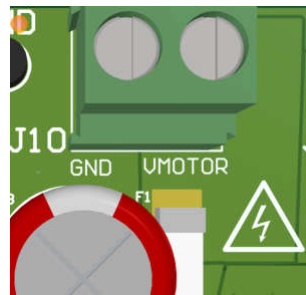


图 2-3. VMOTOR 输入 (J10)

警告

为了最大限度降低潜在的电击危险和人身伤害的风险，请在不使用 DRV8762-Q1EVM 时移除所有电源连接和接口。

DRV8762-Q1EVM 设计用于 $8V_{DC}$ 至 $48V_{DC}$ 的输入电源和高达 $30A$ 的持续驱动电流（串联保险丝受限）。输入连接到 J10，并注明极性。VMOTOR 测试点连接到同一节点，但不得用于高电流输入。VMOTOR 输入装有 $30A$ 保险丝，输入连接器的额定电流为 $30A$ 。

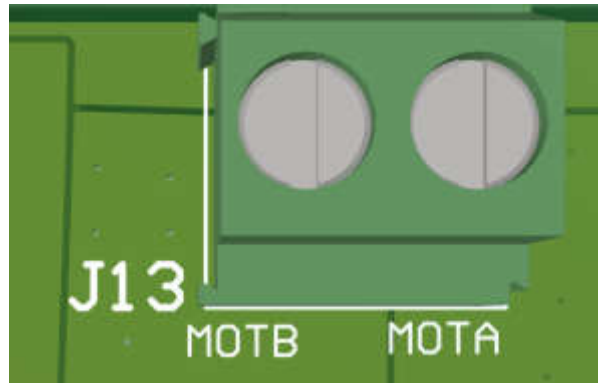


图 2-4. 电机相位连接器 (J13)

电机的两相输入通过连接器 J13 连接到 MOTA 和 MOTB。

2.2 故障、指示灯和跳线设置

DRV8762-Q1 实现了自举欠压、GVDD 欠压、VDS 和 VGS 监测，以及过热情况下的热关断。有关 DRV8762-Q1 故障支持的更多信息，请参阅 DRV8762-Q1 数据表。

这里包括 3.3V、5V、PVDD、GVDD 和 FAULT 的状态 LED，如下所示。

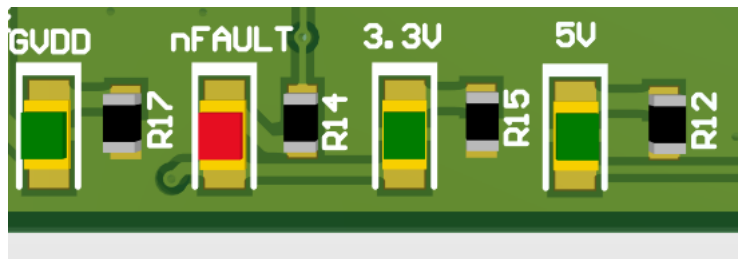


图 2-5. 状态 LED

如果 EVM 检测到故障并且 SPI 寄存器中报告了该故障，则 FAULT LED 会亮起。有关故障响应和纠正措施，请参阅完整数据表。

电路板上电后，nFAULT LED 会亮起，直到在 nSLEEP 引脚上施加逻辑高电平。

可以在 GUI 软件中使用“CLEAR FAULTS”按钮复位故障。有关 GUI 的更多详细信息，请参阅节 3。

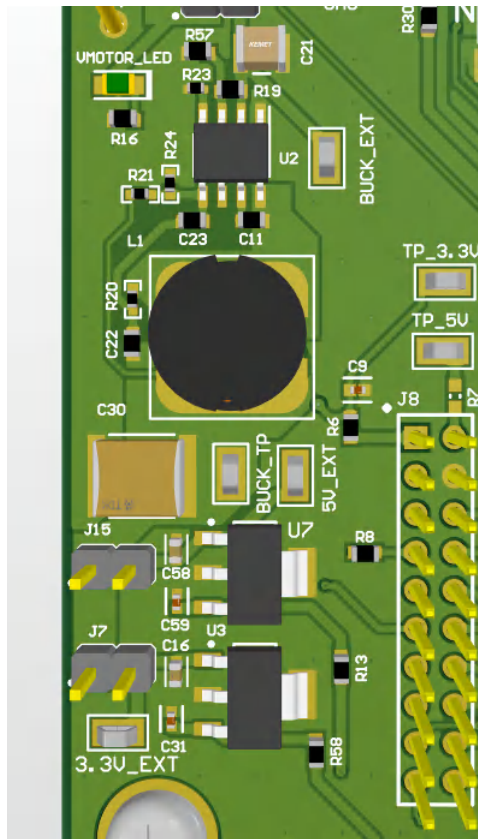


图 2-6. 板载 VMOTOR 降压、3.3V LDO 和 5V LDO

该 EVM 包括一个降压稳压器，可在需要稳压时将 VMOTOR 降低至 12V。该降压馈入 3.3V LDO 和 5V LDO，为 EVM 3.3V 和 5V 电源轨供电。

跳线 J6 将 VMOTOR 连接到降压稳压器（默认）。如果要将降压稳压器断电，请移除此跳线。

跳线 J7 将 PVDD 降压输出 (12V) 连接到 3.3V LDO（默认）。如果要关断 3.3V 电源轨，请移除此跳线。

跳线 J15 将 PVDD 降压输出 (12V) 连接到 5V LDO（默认）。如果要关断 5V 电源轨，请移除此跳线。

默认情况下，降压输出为 GVDD 供电，但可通过在引脚 1:2 上放置 J1 分流器配置为外部电源支持，如图所示。

2.3 EVM 硬件快速入门

本节介绍了为首次电机旋转准备 DRV8762-Q1EVM 的步骤。本节假定使用上面提到的默认跳线位置。

1. 将 DRV8762-Q1EVM 插入 LAUNCHXL-F280049C 板的上部位置。
2. 将电机相位连接到 J13 上相应的 MOTA/MOTB 输入。
3. 将提供的 micro-USB 电缆连接到 LAUNCHXL-F280049C。
4. 在 LAUNCHXL-F280049C 上组装 JP1 以确保 Launchpad 通过 USB 供电。
5. 将 VMOTOR 和 GND 连接到连接器 J10。首次上电时，建议在 VMOTOR 电源上设置 300mA 低电流限制，以验证 EVM 是否正确连接。如果上电时没有问题，则可以增大电流限制，以便根据您的电机规格提供电流。VMOTOR 范围为 8V 至 48V。
6. 按照下文节 3.1 中的说明启动 GUI。

3 软件

3.1 DRV8762-Q1 EVM GUI 软件

本节详细介绍 EVM GUI 软件的功能。GUI 用 GUI Composer 编写，可从 TI 的[开发软件库](#)中获取。

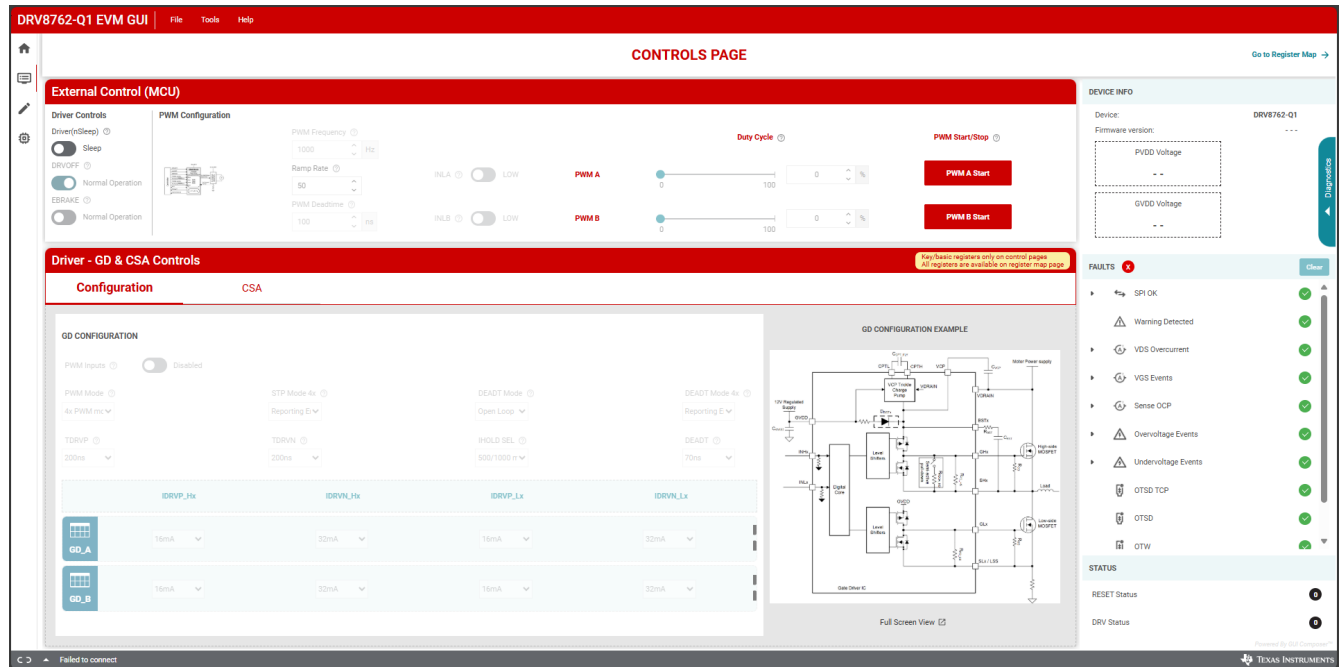


图 3-1. DRV8762-Q1EVM GUI

启动时，GUI 会连接 LAUNCHXL-F280049C 板上的 C2000 MCU 并对其进行编程，前提是该板已连接/通电。连接硬件后，FAULT 状态和电压监视器会与 EVM 匹配。如果不匹配，请切断 EVM 电源并重新检查设置。

要使电机旋转，请执行以下操作：

1. 启动位于 dev.ti.com/gallery 上的 GUI。
2. 通过将 nSLEEP 切换至 WAKE，使 DRV8762-Q1 退出睡眠模式。
3. 在弹出窗口中选择“是”以将器件配置为 2x PWM 模式
4. 验证 DRV8762-Q1 未报告任何故障（GUI 上的故障 LED 呈绿色，EVM 上无红色 nFAULT LED）。GUI 会报告 VMOTOR/GVDD 电压。
5. 使用滑块或文本输入设置占空比的斜升速率并设置 PWM 占空比。
6. 电机随即旋转。

3.2 4x PWM 模式

在 DRV8762-Q1 的 4x PWM 模式中，高侧 INHx 和低侧 INLx 输入独立运行，但同一半桥的高侧和低侧同时开启时除外，以便防止发生跨导。

如果系统设置为半桥配置，则当高侧和低侧 MOSFET 同时开启时会发生击穿。系统还会报告 STP_FLT 故障。

表 3-1. 4x PWM 模式真值

该器件会将高侧和低侧的栅极输出拉至低电平，以防止功率级发生击穿情况。

INLx	INHx	GLx	GHx	注释
0	0	L	L	
0	1	L	H	
1	0	H	L	
1	1	L	L	击穿保护

4 硬件设计文件

4.1 原理图

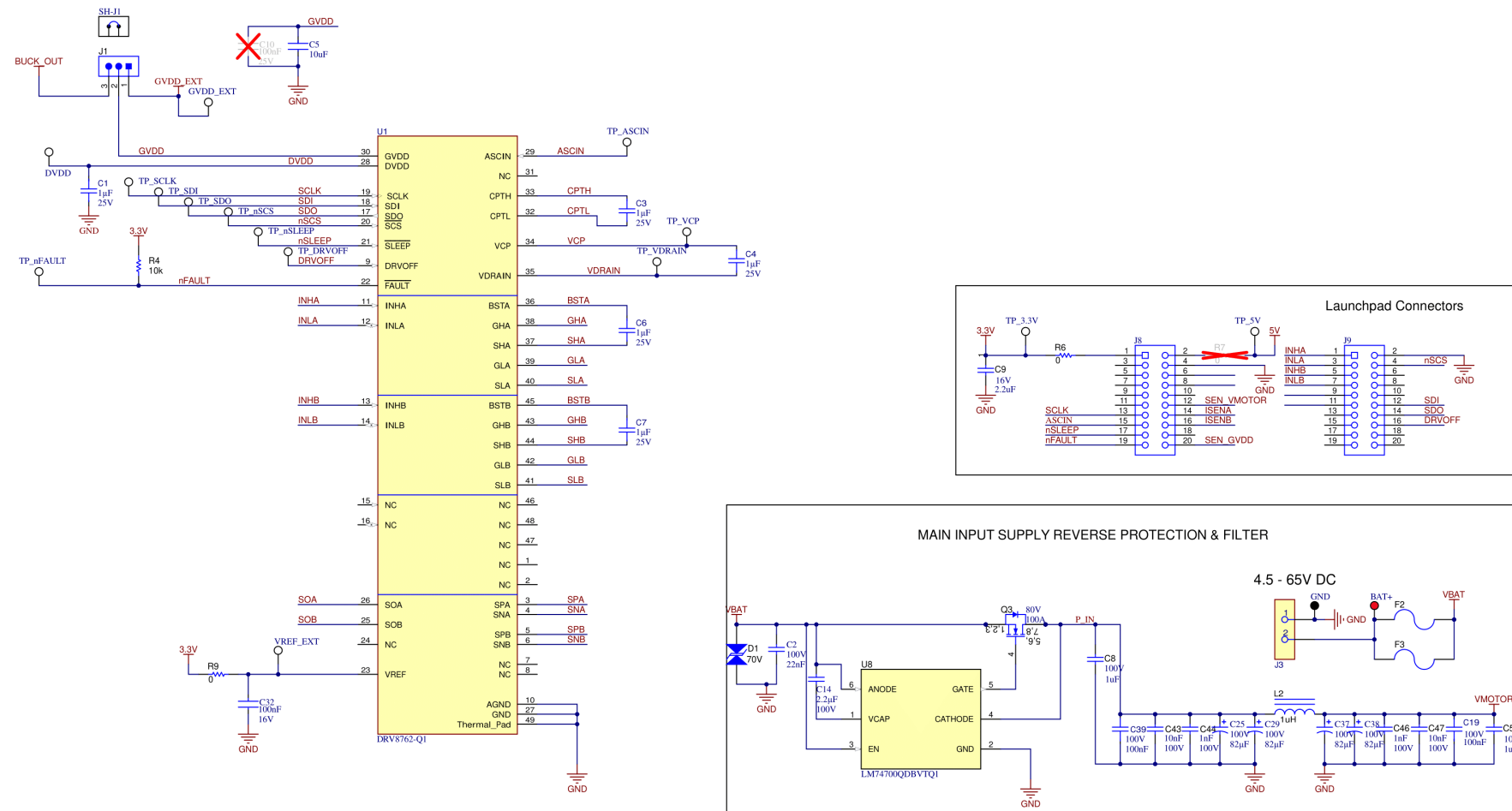


图 4-1. 原理图 1

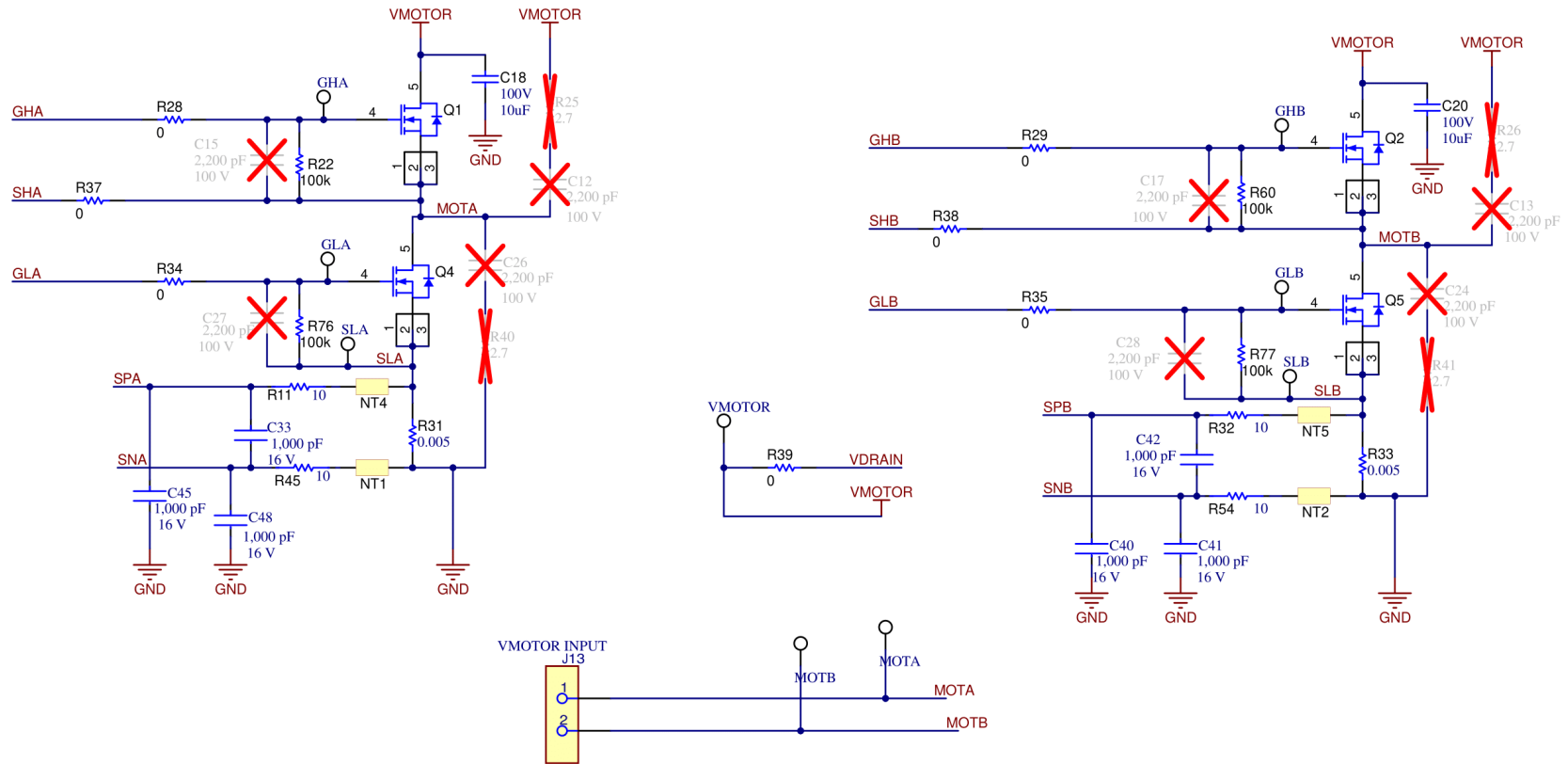


图 4-2. 原理图 2

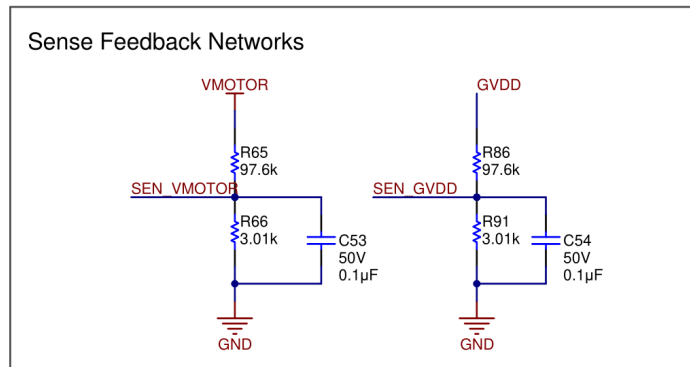
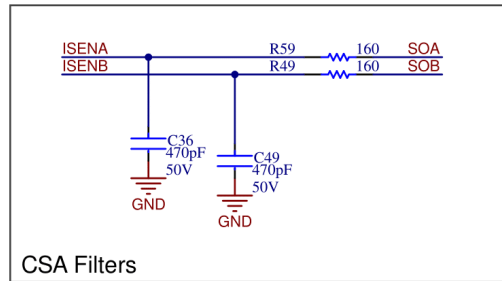


图 4-3. 原理图 3

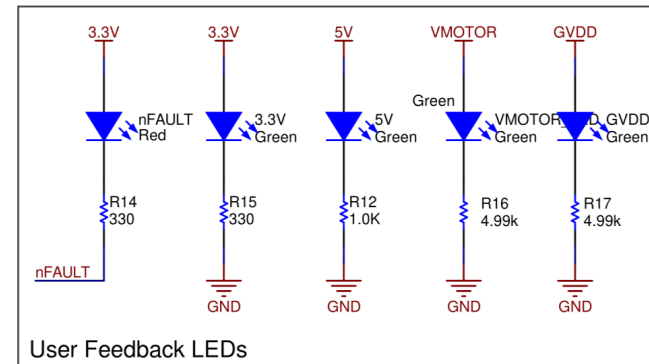
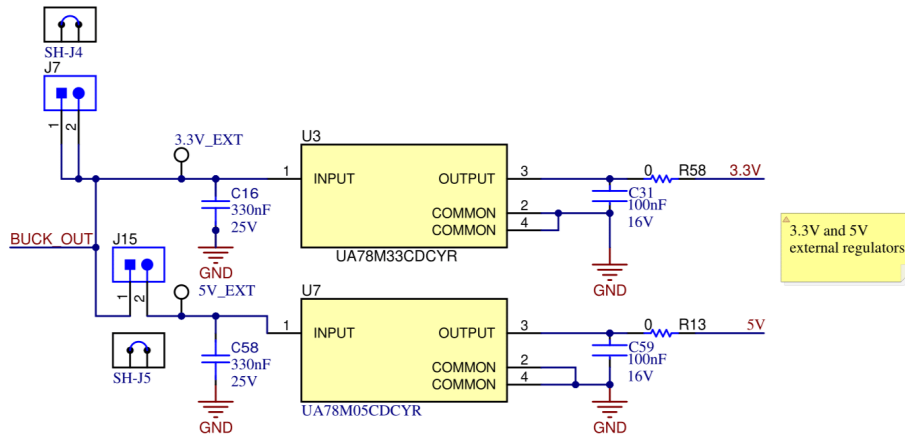
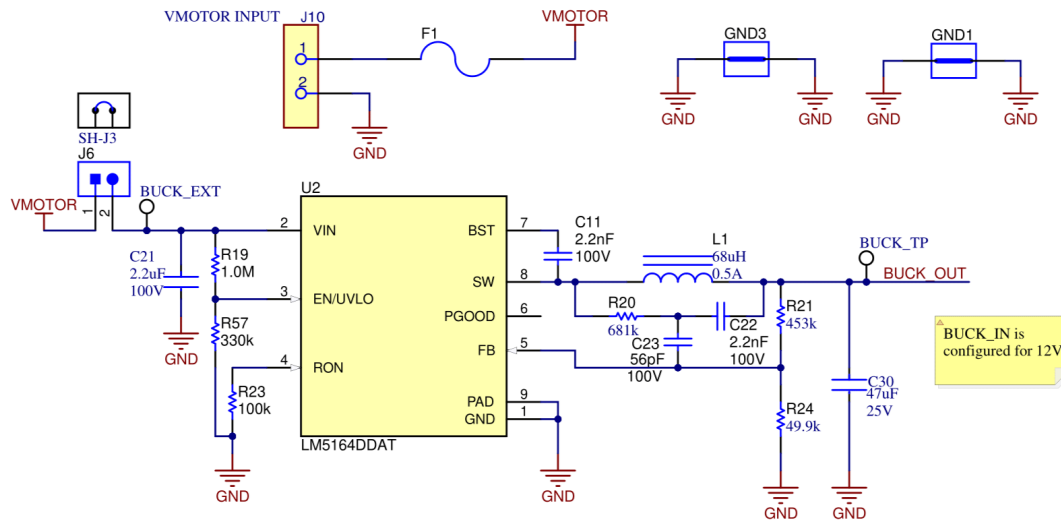


图 4-4. 原理图 4

4.2 PCB 布局

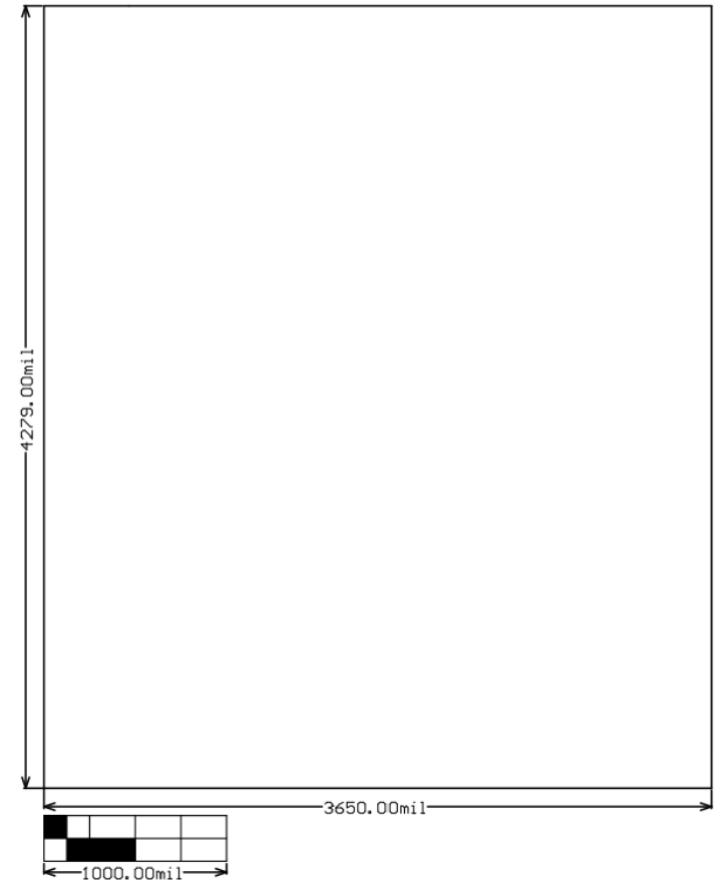


图 4-5. EVM 尺寸

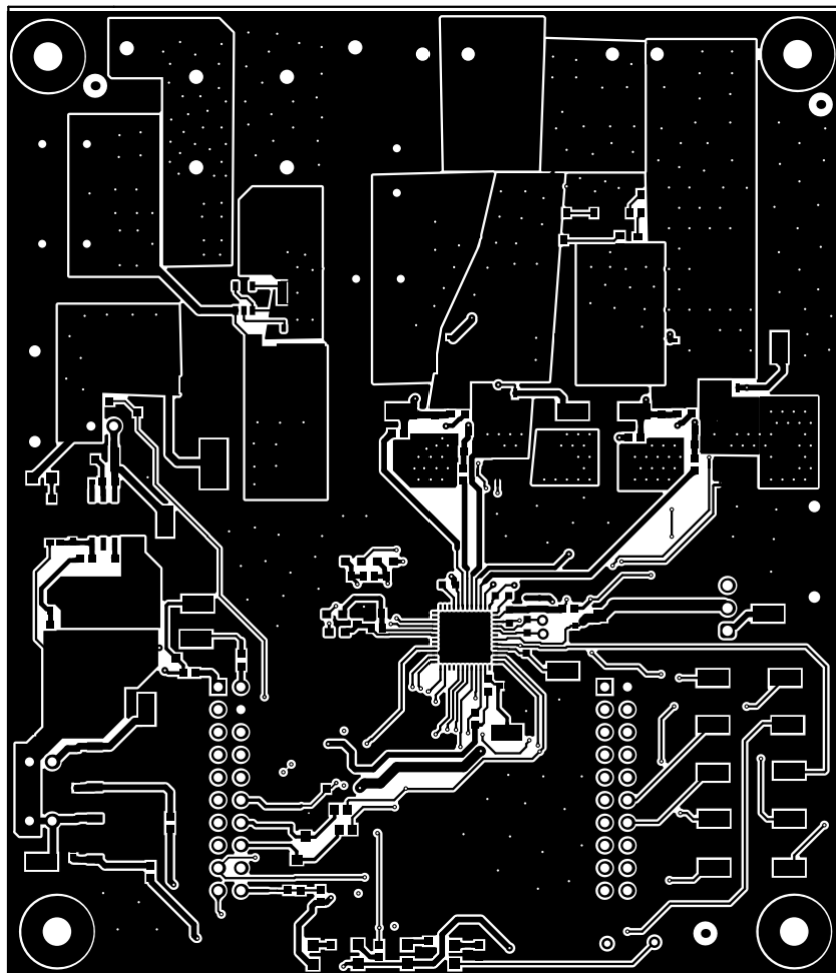


图 4-6. EVM 顶层

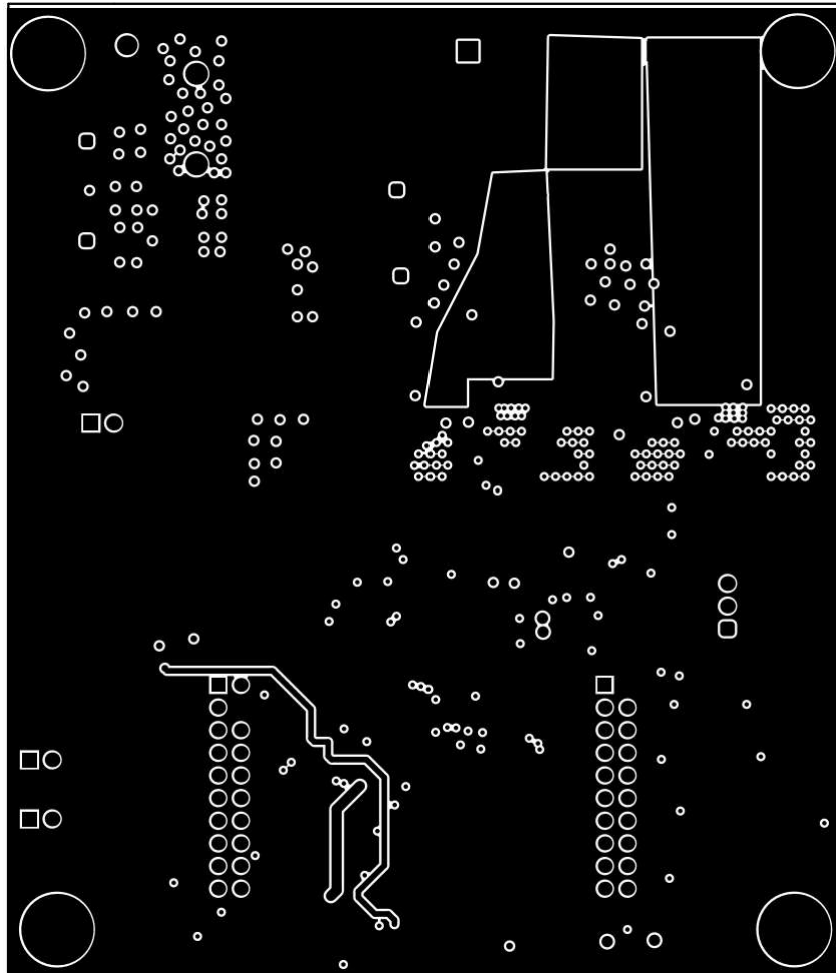


图 4-7. EVM 信号层 1

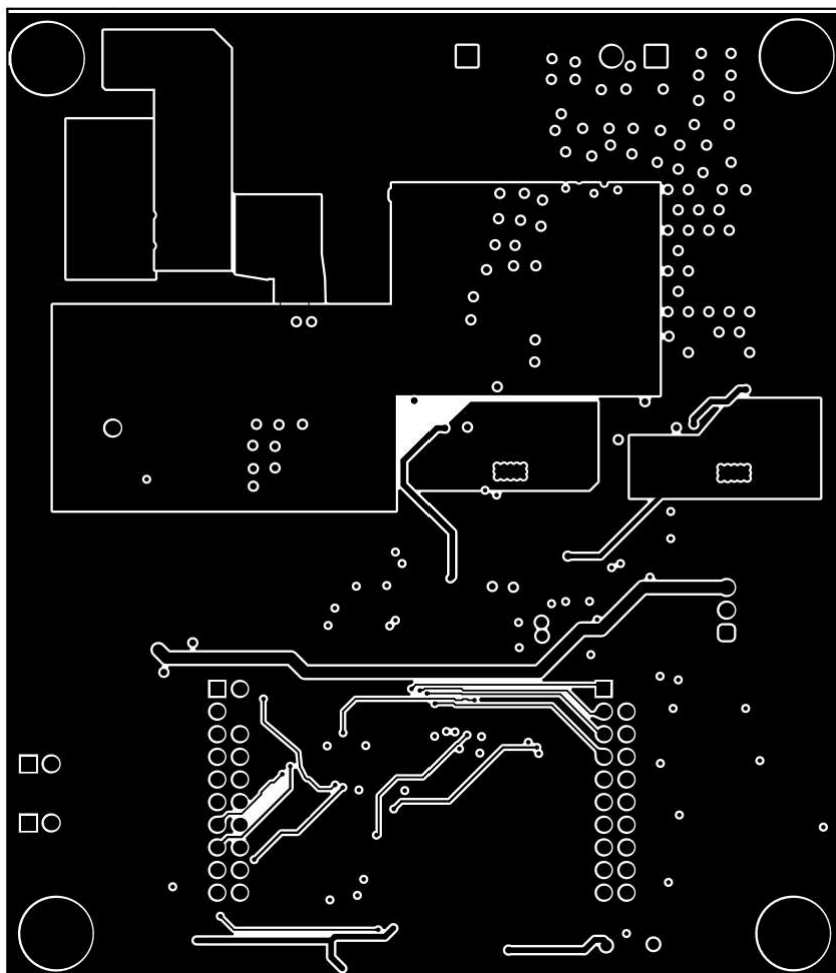


图 4-8. EVM 信号层 2

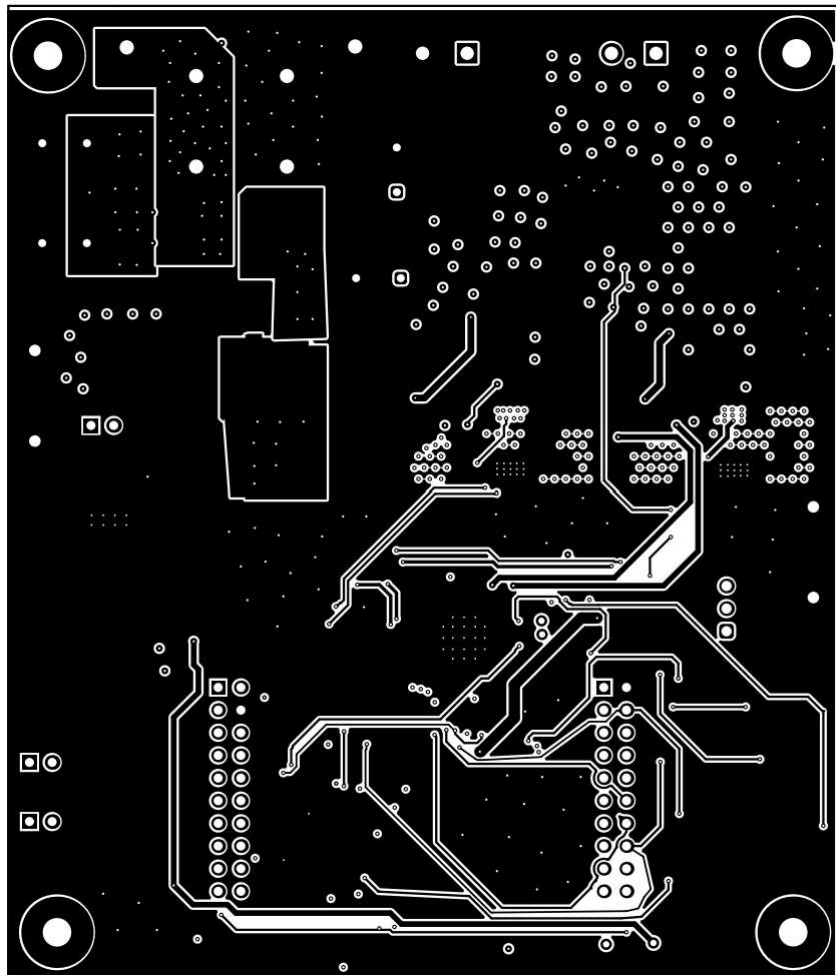


图 4-9. EVM 底层

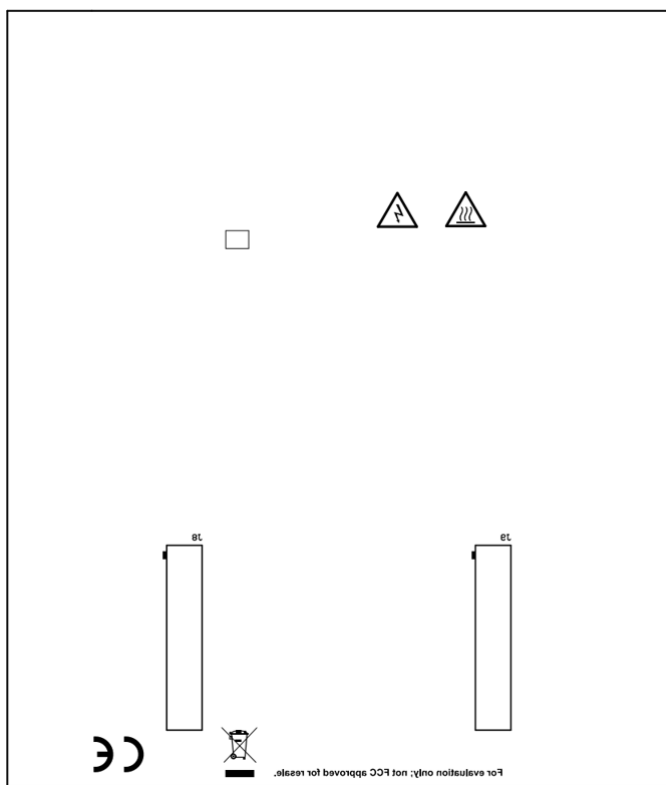


图 4-10. EVM 底部覆盖层

4.3 物料清单 (BOM)

位号	数量	值	说明	封装参考	器件型号	制造商
!PCB1	1		印刷电路板		MD115	不限
3.3V、GVDD、VMOTOR_LED	3	绿色	LED, 绿色, SMD	0805 LED	LTST-C171GKT	Lite-On™
3.3V_EXT、5V_EXT、BUCK_EXT、BUCK_TP、DVDD、GHA、GHB、GLA、GLB、GVDD_EXT、SLA、SLB、TP_3.3V、TP_5V、TP_ASCIN、TP_DRVOFF、TP_ISENA、TP_ISENB、TP_nFAULT、TP_nSCS、TP_nSLEEP、TP_SCLK、TP_SDI、TP_SDO、TP_VCP、TP_VDRAIN、VREF_EXT	27		测试点, 微型, SMT	Testpoint_Keystone_Minature	5015	Keystone Electronics
5V	1		LED, 绿色, SMD	0805 LED	LTST-C171GKT	Lite-On
BAT+	1		测试点, 多用途, 红色, TH	红色通用测试点	5010	Keystone Electronics
C1、C3、C4、C6、C7	5	1μF	1μF ±10% 25V 陶瓷电容器 X7R 0603 (公制 1608)	0603	885012206076	Würth Elektronik®
C2	1	22nF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0805, X7R, 22nF, 100VDC	0805	885012207124	Würth Elektronik
C5	1	10uF	多层陶瓷电容器 10uF 25V X7S ±10% 0805 压纹 T/R GRT21BC71E106KE13L	0805	GRT21BC71E106KE13L	
C8、C50	2	1uF	电容, 陶瓷, 1uF, 100V, ±10%, X7S, 0805	0805	C2012X7S2A105K125AB	TDK
C9	1	2.2 μ F	电容, 陶瓷, 2.2uF, 16V, ±20%, X5R, 0603	0603	885012106018	Würth Elektronik
C10	1	100nF	汽车级陶瓷电容器, 100nF, ±10%, 25VDC, X7R, 0402, 纸质 T/R	0402	GCM155R71E104KE02D	
C11、C22	2	2200pF	电容, 陶瓷, 2200pF, 100V, ±10%, X7R, AEC-Q200 1 级, 0603	0603	CGA3E2X7R2A222K080AA	TDK
C14	1	2.2 μ F	WCAP-CSST 多层陶瓷贴片电容器, 软性端子, 尺寸 1210, X7R II 类, 2.2μF, 100VDC	1210	885382209002	Würth Elektronik
C16、C58	2	330nF	电容, 陶瓷, 330nF, 25V, X7R, 10%, 焊盘 SMD, 0603, +125°C, 汽车 T/R	0603	CGA3E3X7R1E334K080AB	TDK

位号	数量	值	说明	封装参考	器件型号	制造商
C18、C20	2	10uF	电容, 陶瓷, 10uF, 100V, ±10%, X7S, AEC-Q200 1 级, 2220	2220	CGA9N3X7S2A106K230KE	TDK
C19、C39	2	100nF	0.1μF ±10% 100V 陶瓷电容器 X7R 0603 (公制 1608)	0603	885012206120	Würth Elektronik
C21	1	2.2 μ F	电容, 陶瓷, 2.2UF, 100V, X7R, 1210, AEC-Q200	1210	C1210C225K1RACAUTO	
C23	1	56pF	电容, 陶瓷, 56pF, 100V, ±5%, 0603, AEC-Q200	0603	C0603C560J1RACAUTO	MuRata™
C25、C29、C37、C38	4	82uF	WCAP-ATUL 铝电解电容器, 径向, THT, D10 × H20mm, 82μF, 100V	10mm 直径 × 20mm 高	860040875004	Würth Elektronik
C30	1	47μF	陶瓷电容 47uF 25V X7R 20% 焊盘 SMD 2220 +125°C 汽车级 T/R	2220	CGA9N3X7R1E476M230K B	
C31、C32、C59	3	100nF	汽车级陶瓷电容器, 100nF, ±10%, 16VDC, X7R, 0402, 纸质 T/R	0402	GCM155R71C104KA55J	
C33、C40、C41、C42、C45、C48	6	1000pF	电容, 陶瓷, SMD 0603 1000PF 10% X7R	0603	C0603C102K4RACAUTO	KEMET
C36、C49	2	470pF	电容, 陶瓷, 470pF, 50V, C0G, ±5%, 焊盘, SMD, 0603, +125°C, T/R	0603	CL10C471JB81PNL	
C43、C47	2	0.01uF	电容, 陶瓷, 0.01μF, 100V, +/-10%, X7R, 0603	0603	885012206114	Würth Elektronik
C44、C46	2	1000pF	电容, 陶瓷, 1000pF, 100V, ±10%, X7R, 0603	0603	06031C102KAT2A	AVX
C53、C54	2	0.1uF	电容, 陶瓷, 0.1μF, 50V, ±10%, X7R, AEC-Q200 1 级, 0603	0603	C0603C104K5RACAUTO	Kemet
D1	1	70V	二极管, TVS, 双向, 70V, SMB	SMB	SMBJ70CA-13-F	Diodes Inc.
F1、F2	2		快速熔断保险丝 60A 0.9mΩ 250V 2 引脚 3812 T/R	3812	SF-3812F6000T-2	Bourns
GND	1		测试点, 多用途, 黑色, TH	黑色通用测试点	5011	Keystone Electronics
GND1、GND3	2		1mm 非绝缘短路插头, 10.16mm 间距, TH	短路插头, 10.16mm 间距, TH	D3082-05	Harwin
H1、H2、H3、H4	4			螺柱	1902E	Keystone
H5、H6、H7、H8	4		机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头	螺钉	NY PMS 440 0025 PH	B&F Fastener Supply
J1	1		接头, 2.54mm, 3x1, 金, TH	接头, 2.54mm, 3x1, TH	61300311121	Würth Elektronik
J3	1			HDR2	691256610002	Würth
J6、J7、J15	3		接头, 100mil, 2x1, 金, TH	Sullins 100mil, 1x2, 绝缘体上方 230mil	PBC02SAAN	Sullins Connector Solutions
J8、J9	2		插座, 2.54mm, 10x2, 金, TH	插座, 2.54mm, 10x2, TH	SSQ-110-03-G-D	Samtec

位号	数量	值	说明	封装参考	器件型号	制造商
J10、J13	2		2 位，线至板，端子块，与板齐平，0.197	HDR2	691216710002	Würth Electronics
L1	1	68uH	68μH 屏蔽线绕电感器 540mA 840mΩ 非标准值	SMD2	74404042680	Würth Electronics
L2	1	1μH	电感器，屏蔽鼓芯，铁氧体，1uH，24A，0.0012Ω，SMD	12.1x9.5x11.4mm	7443320100	Würth Elektronik
MOTA、MOTB、VMOTOR	3		测试点，紧凑型，SMT	Testpoint_Keystone_Compact	5016	Keystone Electronics
nFAULT	1	红色	LED，红色，SMD	红色 0805 LED	LTST-C170KRKT	Lite-On
Q1、Q2、Q4、Q5	4	100V	MOSFET，N 沟道，100V，170A，AEC-Q101，PowerPAK_SO-8L	PowerPAK_SO-8L	SQJ456EP-T1_GE3	Vishay-Siliconix
Q3	1	80V	MOSFET，N 沟道，80V，100A，DNK0008A (VSON-CLIP-8)	DNK0008A	CSD19502Q5B	德州仪器 (TI)
R1、R2、R6、R7、R9、R28、R29、R34、R35、R37、R38、R39	12	0	电阻，0，0%，0.25W，AEC-Q200 0 级，0603	0603	RCS06030000Z0EA	Vishay-Dale
R4	1	10k	电阻，10k，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW060310K0JNEA	Vishay-Dale
R11、R32、R45、R54	4	10	10Ω ±0.1% 0.063W，1/16W 片上电阻 0603 (公制 1608)，抗硫化，汽车 AEC-Q200，防潮薄膜	0603	CPF-A-0603B10RE	TE Connectivity
R12、R14、R15	3	330	电阻，330，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW0603330RJNEA	Vishay-Dale
R13、R58	2	0	电阻，0，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06030000Z0EA	Vishay-Dale
R16、R17	2	4.99k	电阻，4.99k，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06034K99FKEA	Vishay-Dale
R19	1	1.0Meg	电阻，1.0M，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06031M00JNEA	Vishay-Dale
R20	1	681k	电阻，681k，1%，0.1W，AEC-Q200 0 级，0402	0402	ERJ-2RKF6813X	Panasonic®
R21	1	453k	电阻，453k，1%，0.1W，AEC-Q200 0 级，0402	0402	ERJ-2RKF4533X	Panasonic
R22、R60、R76、R77	4	100k	电阻，100k，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW0603100KFKEA	Vishay-Dale
R23	1	100k	电阻，100k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW0402100KFKED	Vishay-Dale
R24	1	49.9k	电阻，49.9k，1%，0.1W，AEC-Q200 0 级，0402	0402	ERJ-2RKF4992X	Panasonic

位号	数量	值	说明	封装参考	器件型号	制造商
R31、R33	2	5.000000000 0000001E-3	电阻, 0.005, 1%, 3W, AEC-Q200 0级, 2512	2512	CRE2512-FZ-R005E-3	Bourns
R49、R59	2	160	160, 0.1W, 0603, AEC-Q200 ERJ-3GEYJ161V	0603	ERJ-3GEYJ161V	Panasonic
R57	1	330k	电阻, 330k, 5%, 0.1W, AEC-Q200 0级, 0603	0603	CRCW0603330KJNEA	Vishay-Dale
R65、R86	2	97.6k	电阻, 97.6k, 1%, 0.1W, AEC-Q200 0级, 0603	0603	CRCW060397K6FKEA	Vishay-Dale
R66、R91	2	3.01k	电阻, 3.01k, 1%, 0.1W, AEC-Q200 0级, 0603	0603	CRCW06033K01FKEA	Vishay-Dale
SH-J1、SH-J3、SH-J4、SH-J5	4	1x2	分流器, 100mil, 镀金, 黑色	分流器	SNT-100-BK-G	Samtec
U1	1		具有精确电流检测和高级监测功能的 48V 电池 H 桥智能栅极驱动器	VQFN48	DRV8762-Q1	德州仪器 (TI)
U2	1		100V 低 IQ 同步降压稳压器, DDA0008E (SOIC-8)	DDA0008E	LM5164DDAT	德州仪器 (TI)
U3	1		500mA、25V 线性稳压器, DCY0004A (SOT-223-4)	DCY0004A	UA78M33CDCYR	德州仪器 (TI)
U7	1		500mA、25V 线性稳压器, DCY0004A (SOT-223-4)	DCY0004A	UA78M05CDCYR	德州仪器 (TI)
U8	1		低 Iq 常开智能二极管控制器, DBV0006A (SOT-23-6)	DBV0006A	LM74700QDBVTQ1	德州仪器 (TI)
C12、C13、C15、C17、C24、C26、C27、C28	0	2200pF	电容, 陶瓷, 2200PF, 100V, X7R, 0603			KEMET
FID1、FID2、FID3	0		基准标记。没有需要购买或安装的元件。	不适用	不适用	不适用
R25、R26、R40、R41	0		2.7, 0.125W, 0603, AEC-Q200			KOA Speer

5 其他信息

5.1 商标

C2000™ is a trademark of Texas Instruments.

Lite-On™ is a trademark of Lite-On Technology Corporation.

MuRata™ is a trademark of Murata Manufacturing Co., Ltd..

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Panasonic® is a registered trademark of Panasonic Holdings Corporation.

所有商标均为其各自所有者的财产。

6 参考资料

请参阅以下文档以获取更多参考信息：

- 德州仪器 (TI) , [DRV8762-Q1 数据表](#)
- 德州仪器 (TI) , [TMS320F280049C 产品页面](#)
- 德州仪器 (TI) , [LAUNCHXL-F280049C 产品页面](#)

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 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/lstds/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/lstds/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, 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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