

EVM User's Guide: DRV8000-Q1EVM, DRV8001-Q1EVM, DRV8003-Q1EVM

DRV800x-Q1 评估模块



说明

DRV800x-Q1 评估模块 (EVM) 可轻松评估 DRV800x-Q1 器件。该器件有多项保护功能，例如欠压和过压监控、离线开路负载和短路诊断以及基于区域的热监控和关断保护。该器件还具有可多路复用的检测输出 (IPROPI) 并集成了电流调节 (ITRIP)。

开始使用

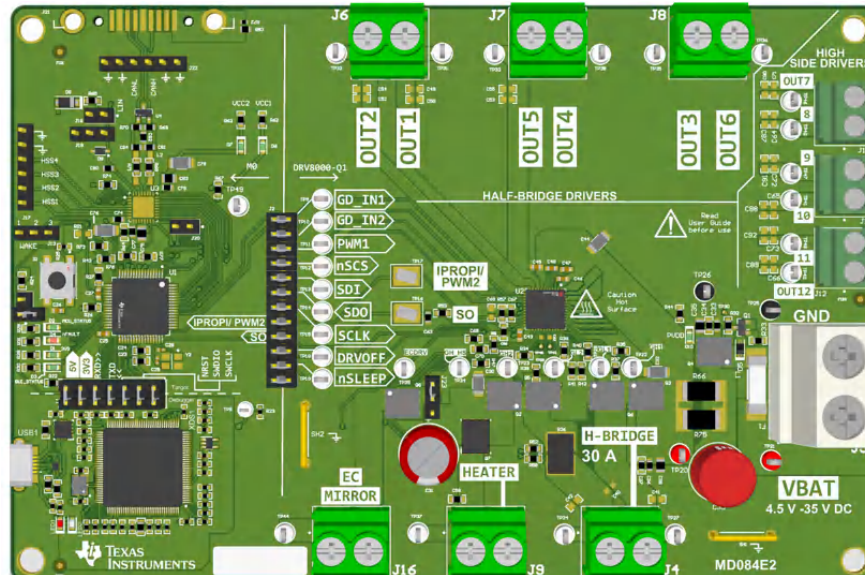
1. 通过 ti.com 工具页面订购 EVM ([DRV8000EVM](#)、[DRV8001EVM](#)、[DRV8003EVM](#))
2. 使用基于网络的 GUI : <https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/>
3. 连接 USB 和外部电源
4. 启动 DRV800x-EVM-GUI，然后在主页上选择 EVM 型号

特性

- XDS110 基于 USB 的板载仿真器，便于对 MSPM0 微控制器进行编程和调试
- 主信号接头通过可拆卸分流器来断开进入电机驱动器 IC 的主信号与 MCU 的连接
- 用于控制 EVM 和 DRV IC 的 GUI 软件
- 带 H 桥栅极驱动器的集成驱动器
- 六个集成半桥
- 六个集成高侧驱动器
- 两个外部高侧栅极驱动器：一个用于加热器，另一个用于电致变色充电
- 一个集成低侧驱动器，用于电致变色负载放电

应用

- [前门模块](#)
- [车身控制模块 \(BCM\)](#)
- [区域控制模块](#)



DRV8000-Q1EVM

1 评估模块概述

1.1 简介

DRV800x-Q1 器件集成了多种类型的驱动器以实现多种功能：驱动和诊断电机（电感）、电阻和容性负载。本文档随 DRV800x-Q1 评估模块 (EVM) 提供，作为 DRV800x-Q1 数据表的补充。本用户指南包括 EVM 硬件设置说明、GUI 安装和使用说明。

1.2 套件内容

表 1-1 列出了 EVM 套件的内含物。如果缺少任何元件，请联系最近的德州仪器 (TI) 产品支持中心。

表 1-1. 套件内容

项目	数量
DRV800x-Q1EVM	1
3 英尺白色 USB-A 转 Micro-USB 电缆	1

1.3 规格

DRV800x-Q1 EVM 通过 USB-A 转 Micro-USB 电缆连接至本地计算机 USB 端口。板载 XDS110 USB 仿真器支持对主 MSPM0 微控制器进行编程和调试，而无需外部调试器。3.3V LDO 从 USB 5V 电源生成 3.3V 电源轨。此 3.3V 电压用于为 XDS110 MCU、主 MSPM0 和电机驱动器 DVDD 引脚供电。J2 信号接头使用可拆卸分流器将信号从 MCU 传递到电机驱动器。移除所有这些分流器，以便轻松将控制信号输入到驱动器。在器件的工作范围内为 J5 螺纹接线端子提供外部电机电源。DRV800x-Q1 支持 4.5V 至 35V 的电源电压范围。

1.4 器件信息

DRV800x-Q1 器件集成了多种类型的驱动器以实现多种功能：驱动和诊断电机（电感）、电阻和容性负载。该器件具有两个半桥栅极驱动器、6 个集成半桥、6 个集成高侧驱动器、一个用于加热器的外部高侧栅极驱动器、一个用于电致变色充电的外部高侧栅极驱动器和一个用于电致变色负载放电的集成低侧驱动器。

表 1-2 中的文档提供了有关该 EVM 装配件中使用的德州仪器 (TI) 集成电路的信息。本用户指南可从 TI 网站上获得，文献编号为 SLVUCZ2。附加到文献编号的任何字母对应于撰写本文档时已有的最新文档修订版。可通过 TI 网站 www.ti.com.cn，也可以致电德州仪器 (TI) 文献响应中心（电话为 (800) 477-8924）或产品信息中心（电话为 (972) 644-5580）获取较新的修订版。订购时，可通过文档标题或文献编号识别文档

表 1-2. 相关器件文档

说明	数据表
XDS110 MCU	MSP432E401Y
主 MSPM0 MCU	MSPM0G3507
电机驱动器	DRV800x-Q1

2 硬件

2.1 接头和测试点信息

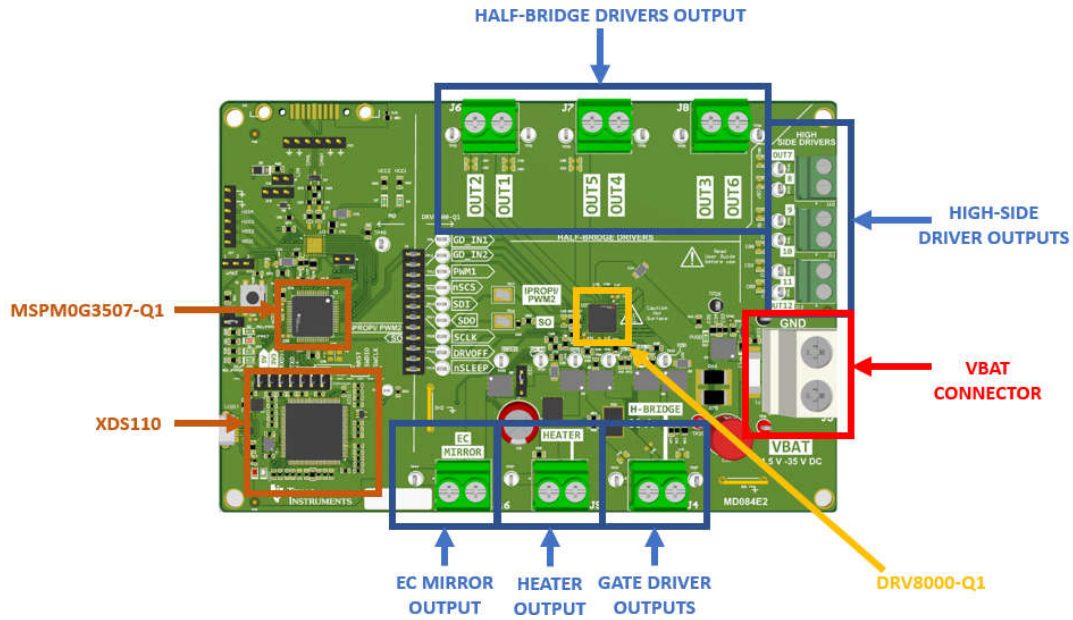


图 2-1. DRV8000-Q1EVM (MD084-001) (顶视图)

小心

表面高温。EVM 可能会用 FIRE 三角符号标记高表面温度。驱动高电流时，避免触摸标记的高温表面区域，以防止潜在的灼伤损害。

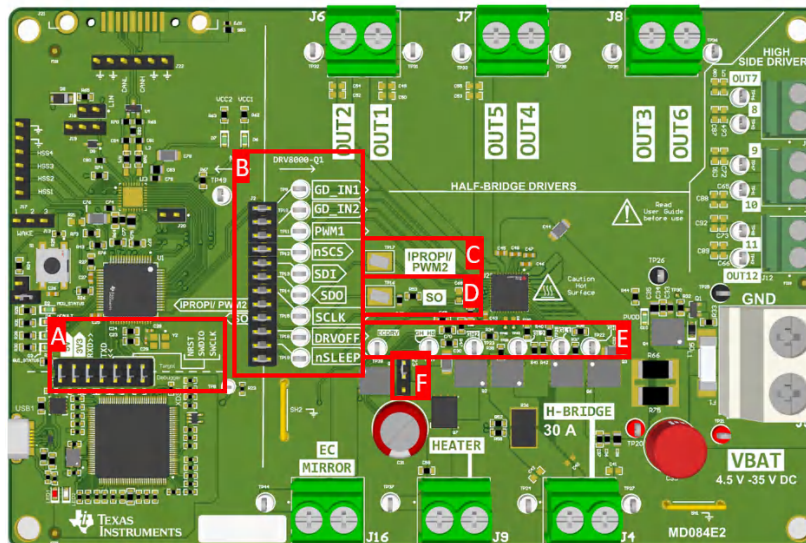


图 2-2. DRV8000-Q1EVM 接头和测试点信息

表 2-1. 接头和测试点说明 - DRV8000-Q1EVM

元件标签	说明
Aee	MSP432E401Y 和 MSPM0G3507 之间的 XDS110 接头。
B	主信号接头： • GD_IN1：半桥和 H 桥控制输入 1。 • GD_IN2：半桥和 H 桥控制输入 2。 • PWM1：用于对除电铬之外所有驱动器进行调节的 PWM 输入 1。 • nSCS：串行芯片选择。此引脚上的逻辑低电平支持串行接口通信。内部上拉电阻。 • SDI：串行数据输入。在 SCLK 引脚的下降沿捕捉数据。内部下拉电阻。 • SDO：串行数据输出。在 SCLK 引脚的上升沿移出数据。推挽式输出。 • SCLK：串行时钟输入。串行数据会移出并在此引脚上的相应上升沿和下降沿被捕捉。 • DRVOFF：栅极驱动器关断引脚。置为逻辑高电平可将高侧和低侧栅极驱动器输出拉低。内部下拉电阻。 • nSLEEP：器件使能引脚。置为逻辑低电平可关断器件并进入睡眠模式。内部下拉电阻。
C	IPROPI/PWM2 - 检测输出从任何驱动器负载电流反馈、PVDD 电压反馈或热仪表组温度反馈进行多路复用。也可针对半桥驱动器配置为第二个 PWM 引脚输入。
D	SO - 分流放大器输出。
E	栅极驱动器、EC 驱动器、加热器测试点（左至右）： • ECDRV - 对于 EC 控制，引脚控制外部 MOSFET 的栅极以进行 EC 电压调节 • GH_HS - 加热器 MOSFET 的栅极驱动器输出。连接到高侧 MOSFET 的栅极 • GH2 - 高侧栅极驱动器输出。连接到高侧 MOSFET 的栅极。 • GL2 - 低侧栅极驱动器输出。连接到低侧 MOSFET 的栅极 • GL1 - 低侧栅极驱动器输出。连接到低侧 MOSFET 的栅极 • GH1 - 高侧栅极驱动器输出。连接到高侧 MOSFET 的栅极
F	外部 EC 电压调节 FET 的漏极（从上到下）： • OUT11 - 如果跳线设置在 OUT11 和 EC FET 漏极之间，则 OUT11 是 EC FET 的漏极 • EC FET 漏极 • PVDD - 如果跳线设置在 PVDD 和 EC FET 漏极之间，则 PVDD 是 EC FET 的漏极

2.2 连接器信息

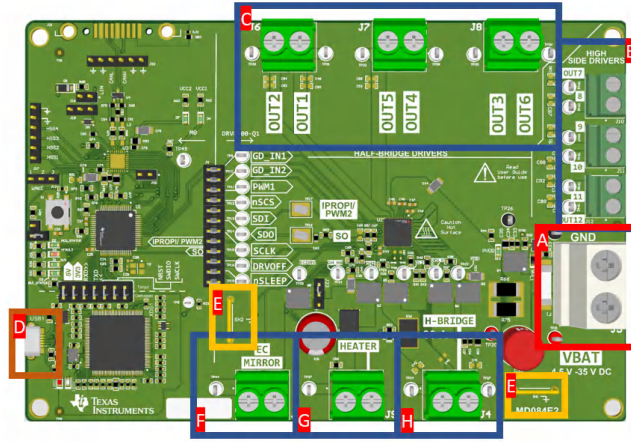


图 2-3. 连接器

表 2-2. 连接器说明

元件标签	说明
A	输入电源连接器。电源线可直接连接到螺纹接线端子，也可夹持到连接器两侧的测试点。
B	高侧驱动器输出连接器
C	半桥输出连接器
D	USB 连接器
E	接地带可用作探头和其他连接器的接地端。
F	EC 后视镜输出和接地。接地位于端子块右侧。
G	加热器输出和接地。接地位于端子块右侧。
H	H 桥输出。SH1 和 SH2 分别为端子块的右侧和左侧。

2.3 指示灯 LED

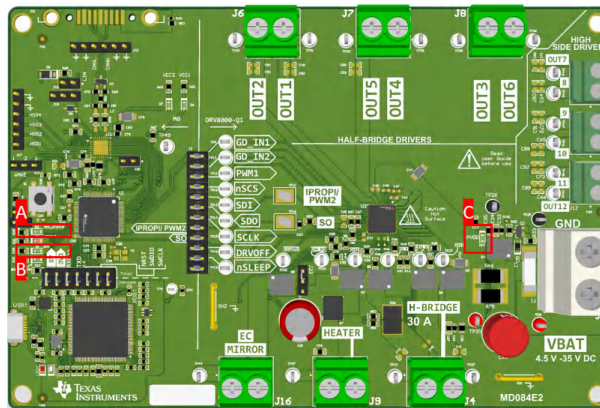


图 2-4. LED 指示灯

LED	功能
A/D2	MCU_STATUS ：当 MCU 处于活动状态时，LED 以大约 1 秒的频率闪烁。如果停止闪烁，请拔下 EVM，然后将其重新连接到计算机。
B/ D1	3V3 ：当 3.3V 未处于活动状态时 熄灭 。当 3.3V 处于活动状态时 亮起 。
C/ D10	PVDD ：当未提供 PVDD 时 熄灭 。当提供 PVDD 时 亮起

2.4 硬件设置

EVM 硬件经过专门设计和配置，可简化设置并开始启动电机。EVM 在接头的适当位置带有跳线。图 2-1 展示了跳线（也称为分流器）的位置。

备注

在使用 EVM 之前，请检查分流器位置是否与图 2-1 中所示的位置匹配。

在将 EVM 连接至 GUI 软件之前，请按照以下步骤操作：

1. 如果将 GUI 与 EVM 控制器一起使用，请确保所有跳线都安装在 J1 和 J2 上。如果用户未使用 GUI 和 TI 固件，则可以移除 J2 上的所有跳线，最底部的跳线 DVDD 除外。如果 DVDD 电压由外部而不是板载 MCU 提供，用户可以移除 DVDD 跳线。
2. 如果使用 EC 驱动器，则确保将 J23 设置到所需位置。
3. 将 micro-USB 电缆连接至 XDS110 部分中的 micro-USB 插座。LED2 亮起。
4. 通过 VBAT 连接器提供 VBAT 电压。
5. 现已完成设置。有关设置图像，请参阅图 2-5。

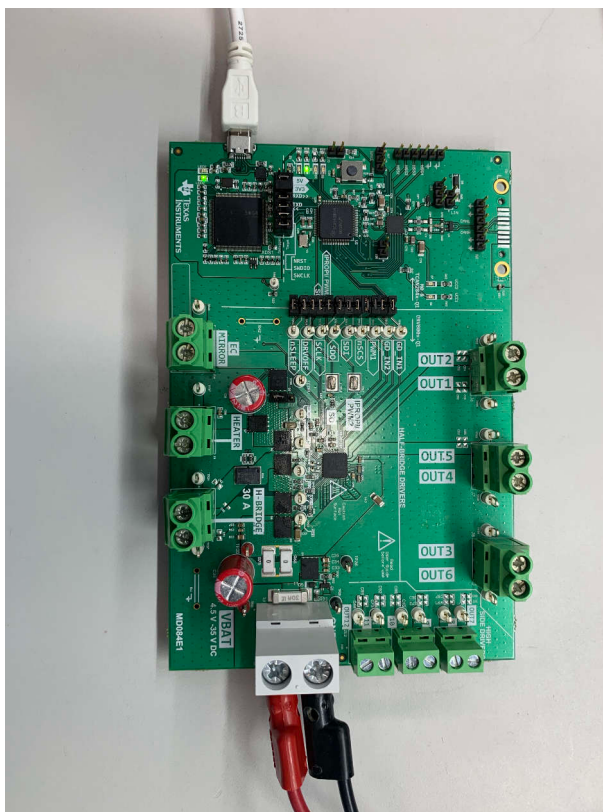


图 2-5. 硬件设置

3 软件

3.1 Web GUI 访问或本地 GUI 安装

此 EVM 通过 GUI 应用程序进行控制，可通过基于 Chrome 的浏览器访问，也可以本地安装到 PC 上。在[此处](#)下载最新的 GUI 安装程序或在[此处](#)使用基于网络的 GUI。

要使用 Web GUI (推荐)，请执行以下步骤：

1. 通过以下链接打开最新版本的 GUI：<https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/>
 - a. 或者，登录 <https://dev.ti.com/gallery/> 并按 *Recently updated* 排序来搜索 DRV800x。
 - b. 点击第一个搜索结果的标题或空白处来打开基于网络的 GUI。

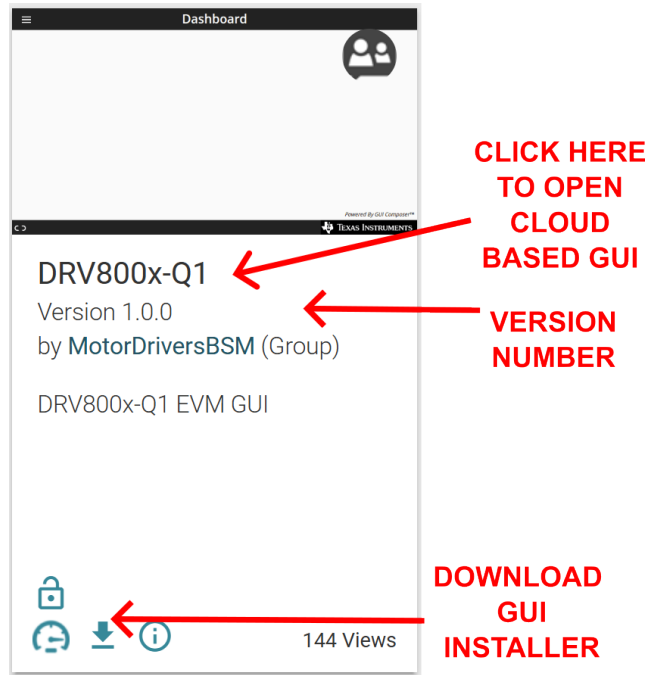


图 3-1. 启动或下载本地安装程序的 TI GUI Composer 库结果

要在本地安装 GUI，请执行以下步骤：

1. 使用 myTI 登录凭证登录 <https://dev.ti.com/gallery/>。请注意，GUI Composer 登录时会搜索非常明确的用户名匹配项，包括注册时输入的大小写。
2. 通过以下链接打开最新版本的 GUI：<https://dev.ti.com/gallery/view/MotorDriversBSM/DRV800x-Q1/>
 - a. 或者，按 *Recently updated* 排序来搜索 DRV800x。
3. 将鼠标悬停在 **Download** 图标上，然后从顶部列表中选择相关操作系统的安装程序。请参阅上一节，查看库页面的图示。
4. 使用安装程序提取 ZIP 文件夹并运行安装程序。安装程序的内容一目了然，而且每个操作系统的安装内容看上去略有不同。
5. 点击 **Next**，然后同意下一页上的条款和条件。
6. 将应用程序和运行时目录保留为默认位置。点击 **Next** 安装 GUI。
7. 如果出现提示，请选择 **Download from Web** 来下载 GUI Composer Runtime，然后点击 **Next**。
 - a. 如果网络防火墙阻止从网络下载 Runtime，则可以在[此处](#)下载 Runtime 安装程序。
8. 选中此框来创建桌面快捷方式，然后点击 **Finish** 来完成安装。
9. GUI 现已安装。

3.2 将 EVM 连接到 GUI

EVM 硬件设置和 GUI 安装已完成，现在可以将 EVM 连接到 GUI。以下步骤概述了如何将 EVM 连接到 GUI：

1. 在 EVM 连接到 PC 的情况下，打开 GUI。图 3-2 展示了主页。

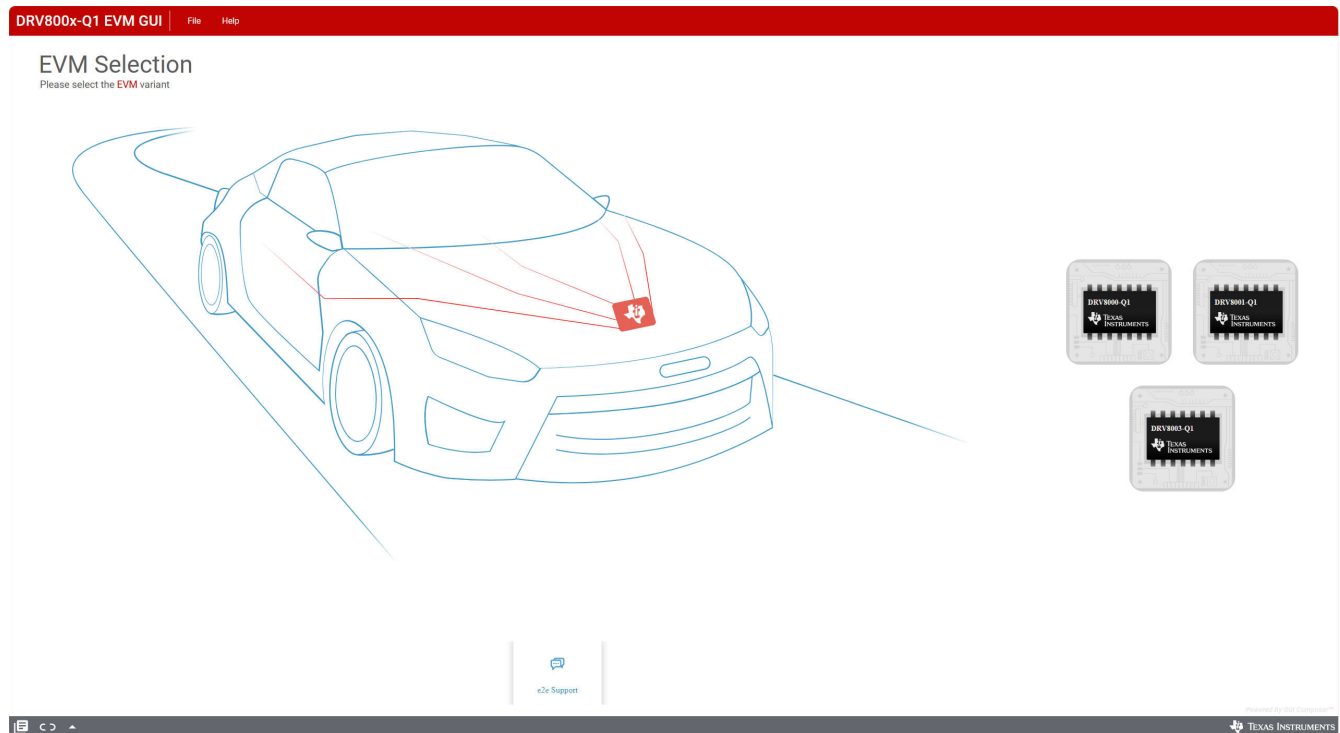


图 3-2. GUI 登录页面

2. 导航至 **File** 并选择 **Program Device**，使用最新软件对 EVM 进行编程。（请参阅图 3-3。）
用户需要在首次设置 EVM 时完成此操作，因为自 EVM 初始编程后可能已发布软件更新。



图 3-3. 编程器件

3. 从 EVM 的五个选项中选择合适的 GUI 型号（图 3-3）。

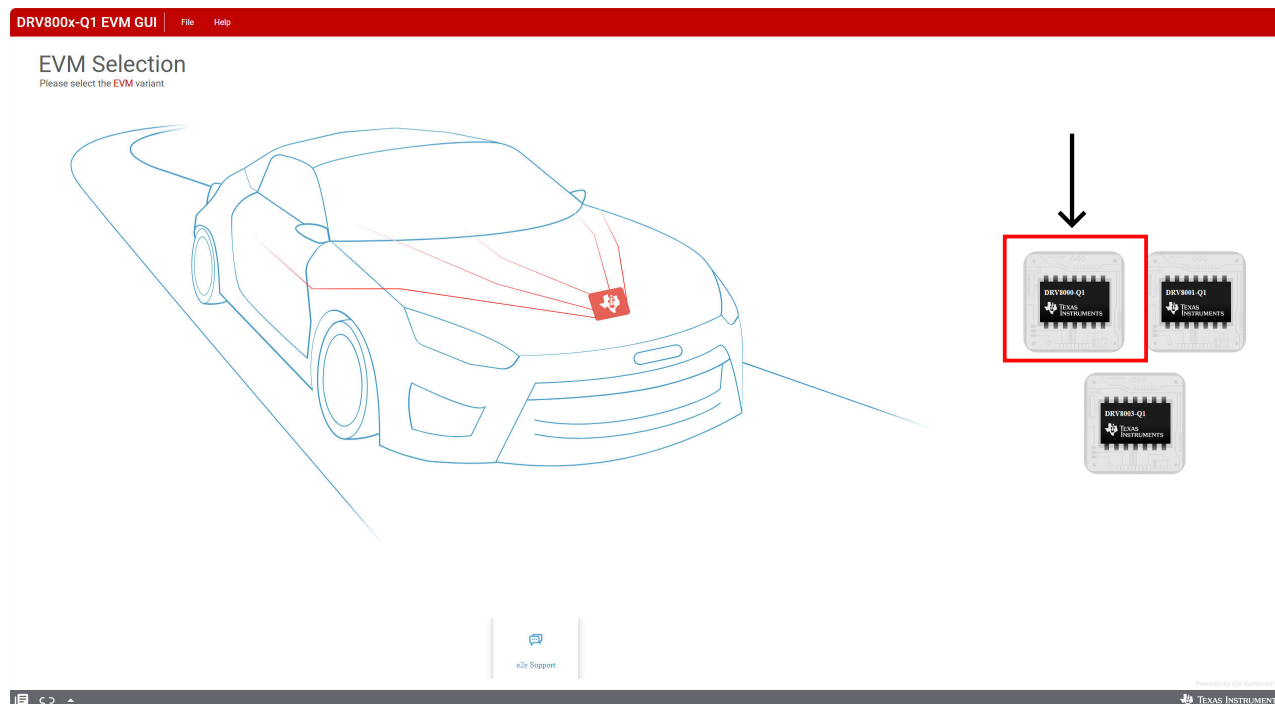


图 3-4. 选择 EVM 型号

- GUI 会尝试连接到 EVM。成功连接后，GUI 会显示以下内容。如果没有成功连接，请按照节 2.4 中的步骤再次检查硬件设置是否正确。

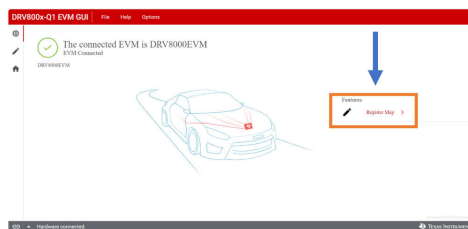


图 3-5. 成功连接 GUI

- GUI 设置现已完成。下一节概述了 GUI 以及如何使用 GUI 来控制 EVM。

3.3 GUI 概述

以下各节概述了 DRV8000-Q1EVM GUI。

3.4 DRV8000-Q1EVM

DRV8000-Q1EVM GUI 包含五个主页面：半桥控制、高侧驱动器控制、EC 和加热器控制、栅极驱动器控制和寄存器映射。每个控制页面都提供了重要的寄存器设置和硬件控制，用于配置相应的外设。每个页面不提供针对外设的所有控件；若要进行完全控制，建议在控制页面中设置基本配置后使用寄存器映射页面。还有一个 **IPROPI & Diagnostics** 面板，可以从任何 GUI 屏幕展开这个面板。

点击屏幕右侧的蓝色控件，即可随时访问 IPROPI & Diagnostics 窗格。下面的图 3-6 显示了打开后的窗格。

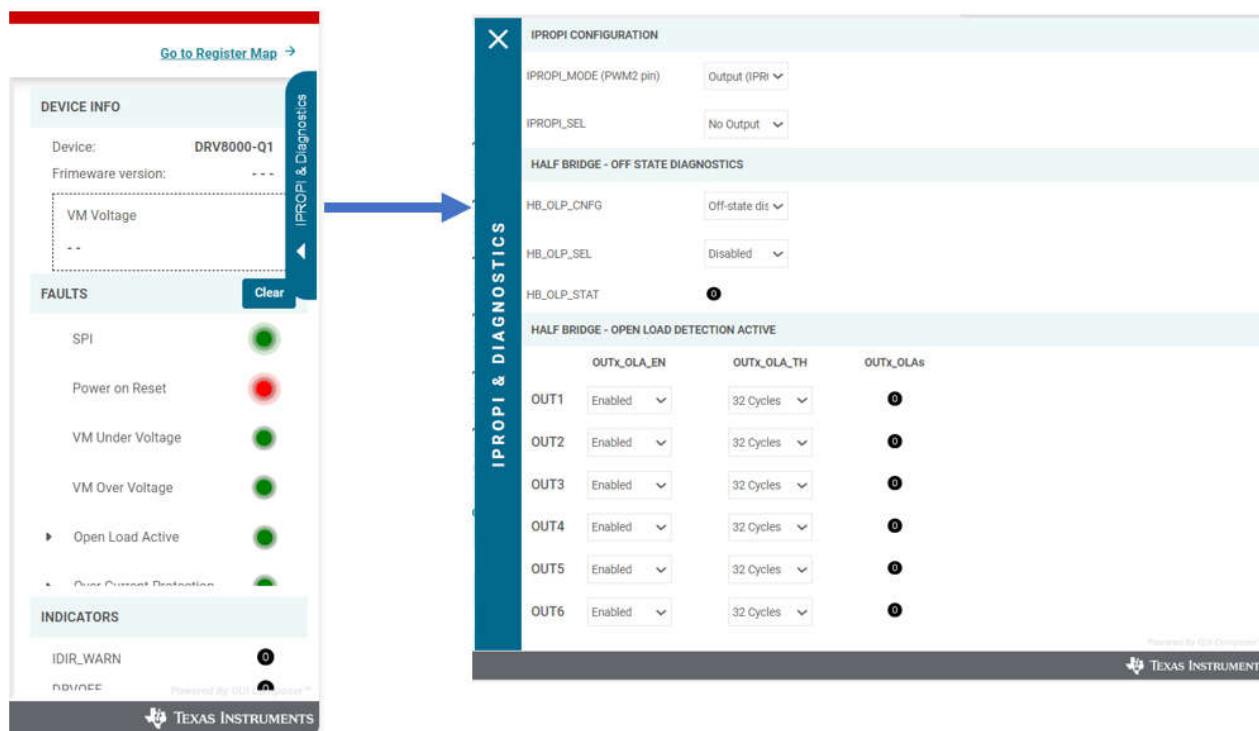


图 3-6. 驱动器控制面板

3.4.1 寄存器映射

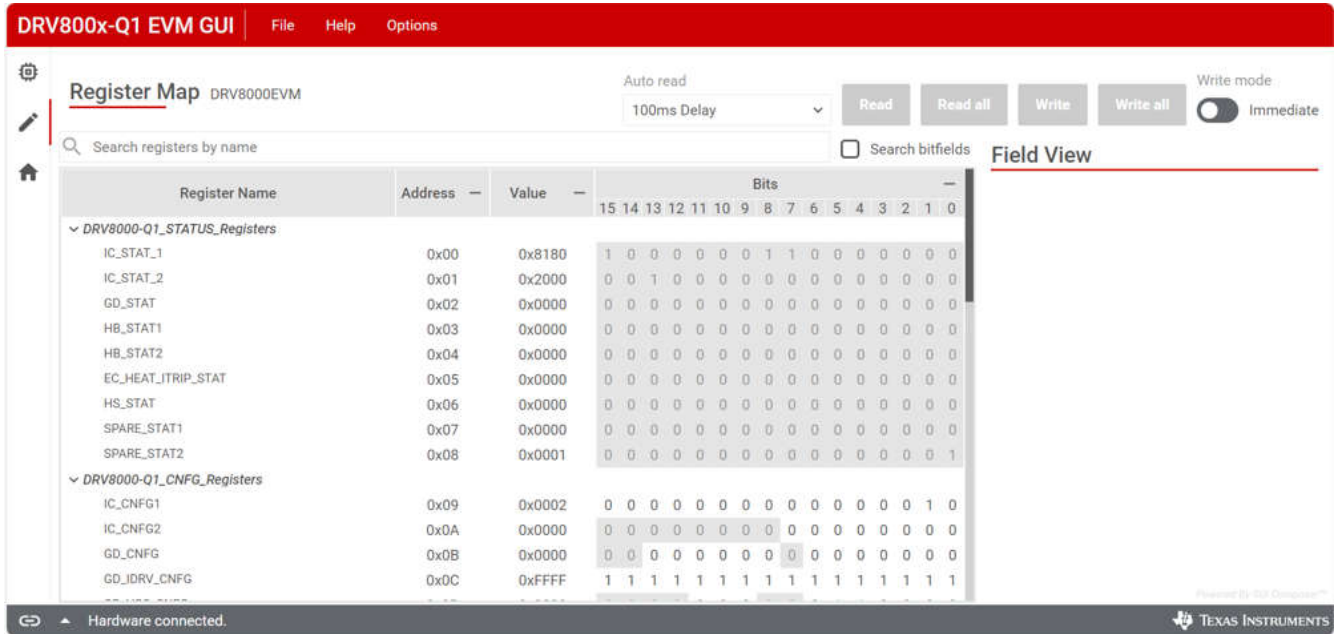


图 3-7. 寄存器映射页面

寄存器映射页面如图 3-7 所示。左侧会显示寄存器名称、地址和值。右侧是字段视图，提供了有关每个寄存器的位字段的更多信息。**Auto Read** 小工具用于设置 GUI 从电机驱动器读回寄存器的频率。最快的选项 **Fast** 为 500ms，延迟最多可以增加 1 分钟。将 **Auto Read** 设置为 **Off**，可以一次性或单个地手动读取所有寄存器。

保存和加载寄存器配置

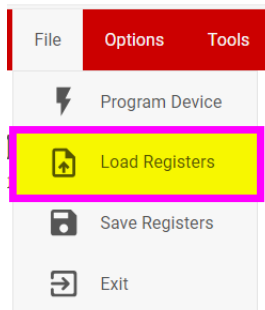


图 3-8. 加载和保存寄存器

GUI 具有内置功能，可将当前寄存器配置另存为可以加载到 GUI 中的 .json 文件。以下步骤概括了保存和加载寄存器配置的程序。

1. 写入所需的寄存器值或使用 GUI 配置器件后，点击 **File** 选项卡并点击 **Save Registers**。此时会出现保存文件弹出窗口，用户可以在这里命名和保存 .json 文件。
2. 要调用寄存器配置，请点击 **File** 选项卡，然后点击 **Load Registers**。选择已保存的 .json 文件来加载寄存器值。

4 硬件设计文件

4.1 原理图

图 4-1 展示了 DRV8000-Q1EVM 的原理图。

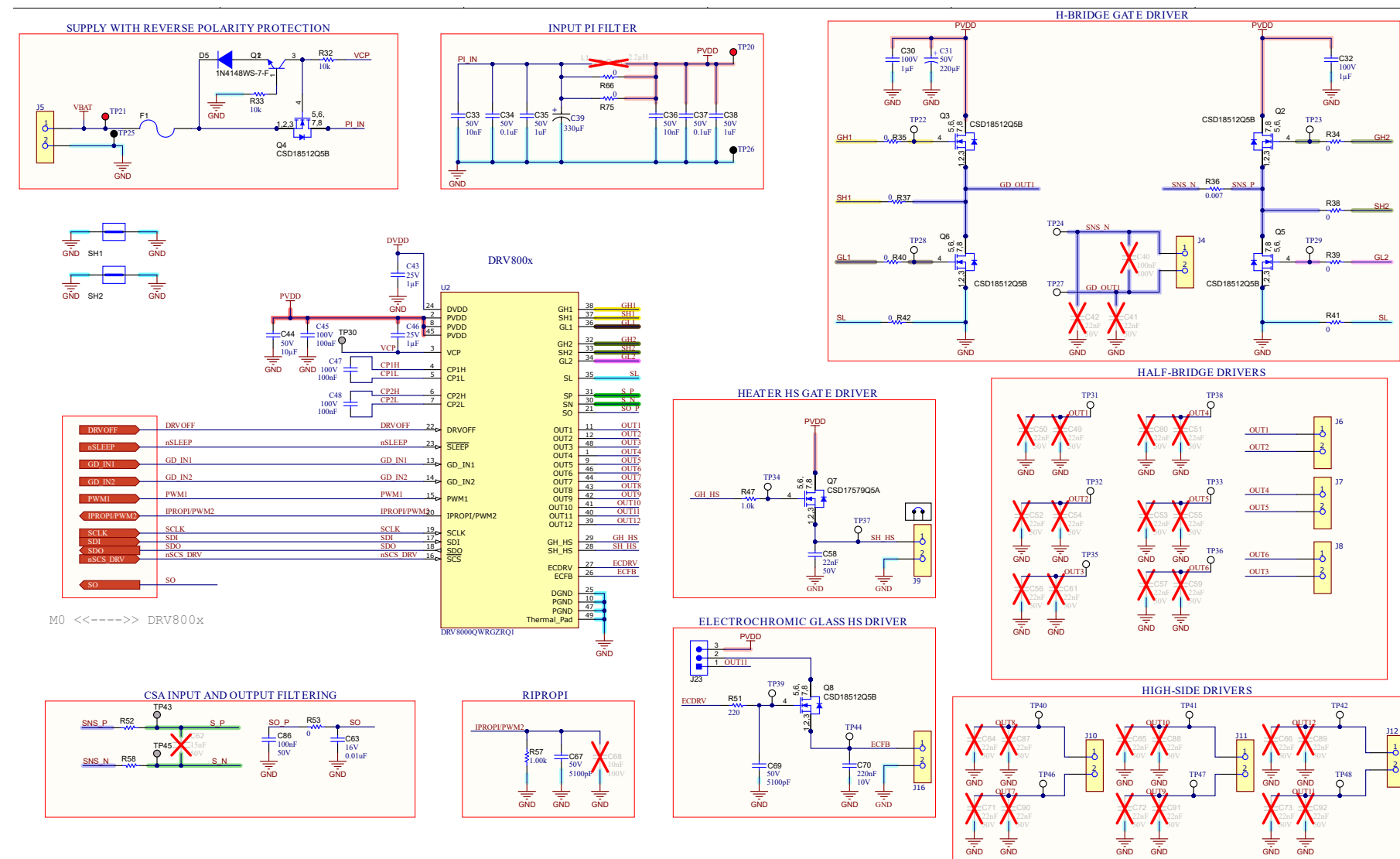


图 4-1. 电机驱动器 DRV8000-Q1

[illegible]

图 4-2. MCU MSPM0G3507-Q1

4.2 PCB 布局

图 4-3 至图 4-6 展示了 EVM 的各 PCB 层。可以在上述给定 EVM 的硬件设计文件中下载 Altium 源文件。

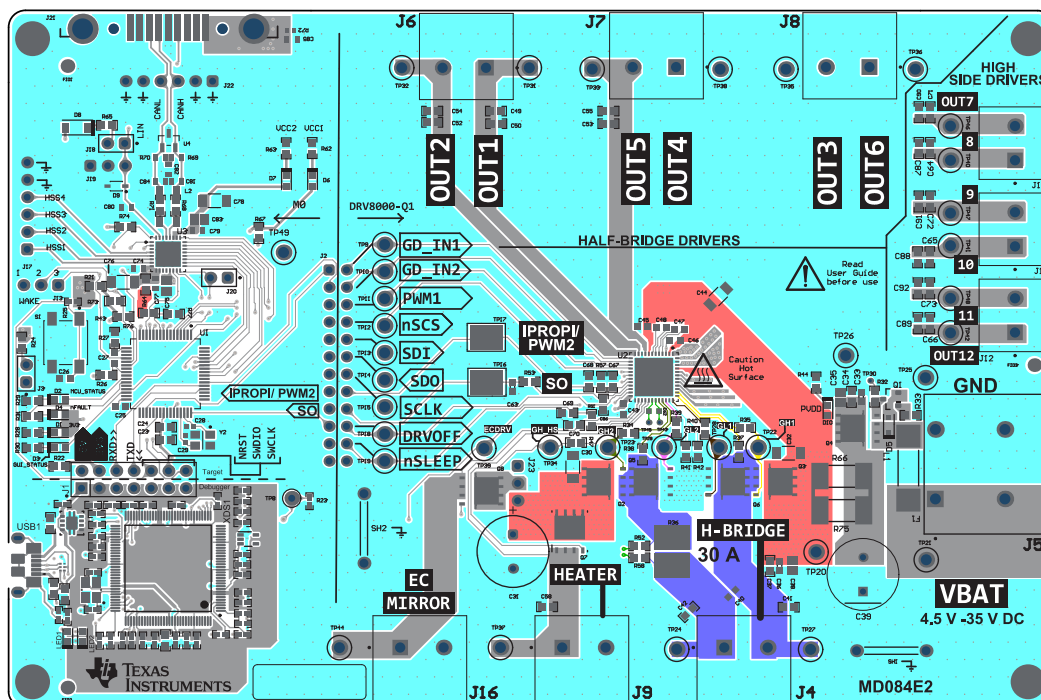


图 4-3. 顶视图

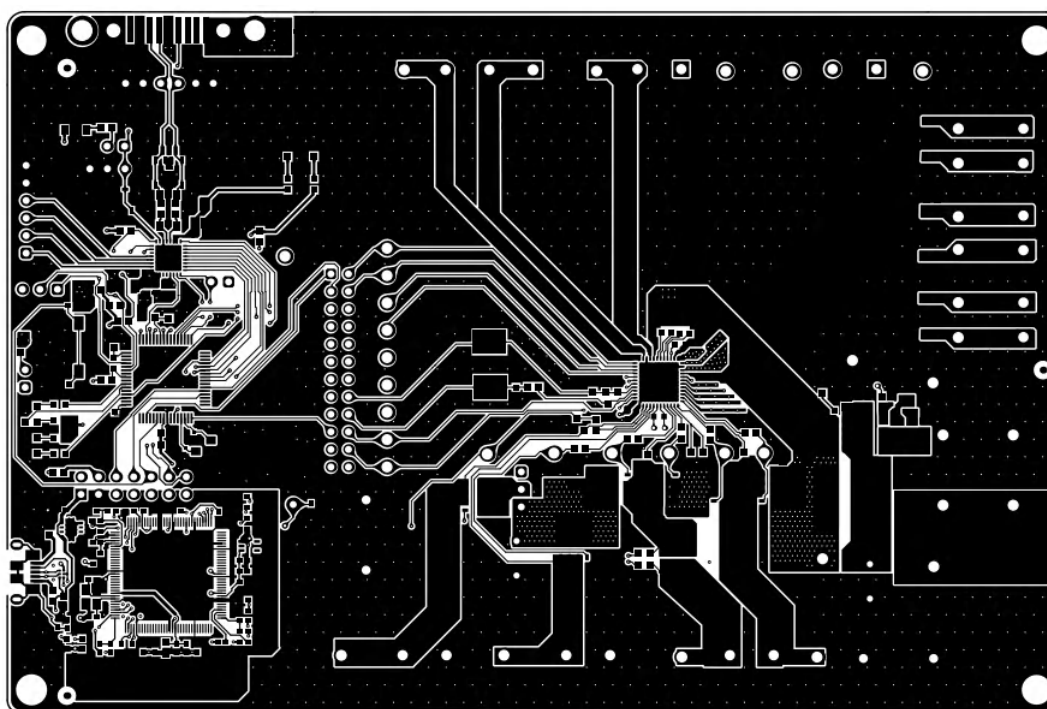


图 4-4. 顶层

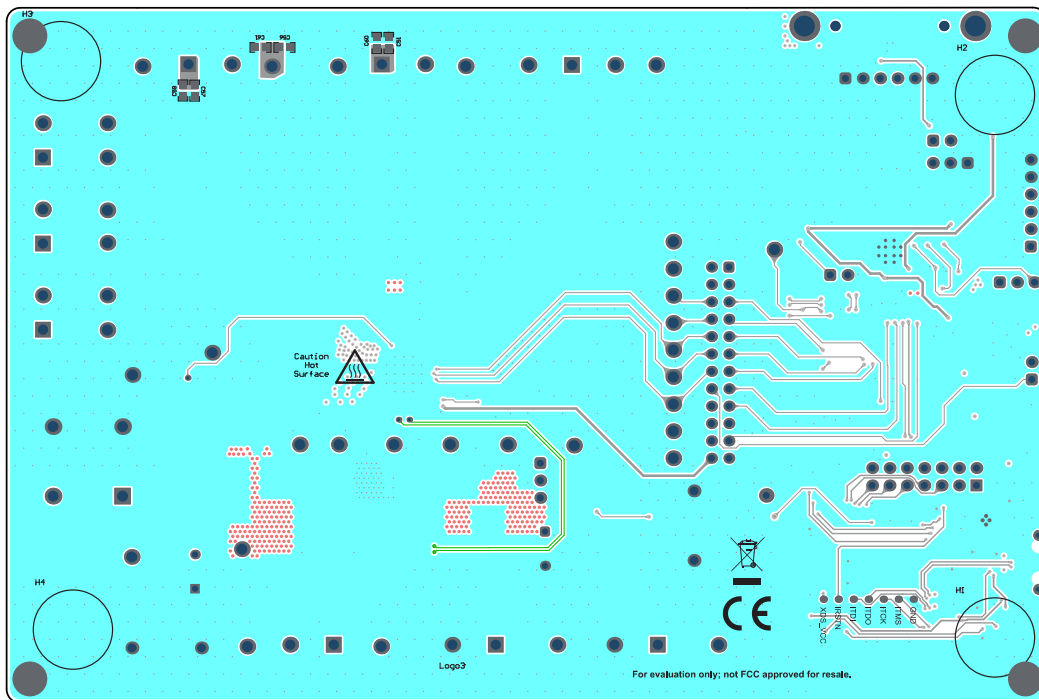


图 4-5. 底视图

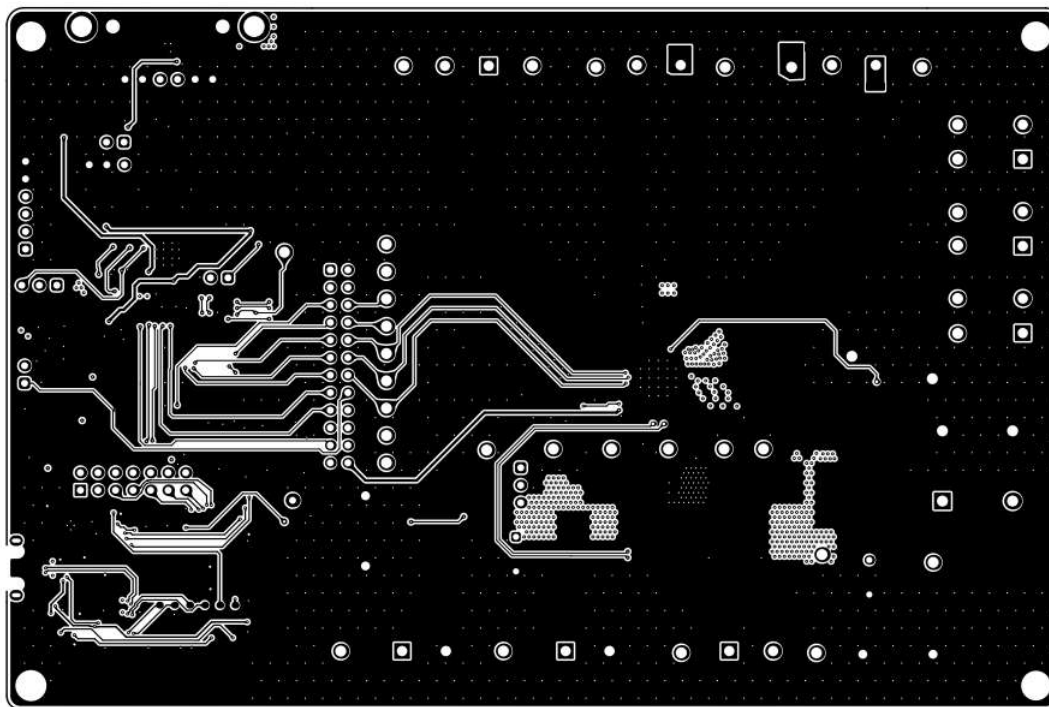


图 4-6. 底层

4.3 物料清单 (BOM)

表 4-1 提供了 DRV8000-Q1EVM 的器件清单。

表 4-1. 物料清单

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		MD084	不限
C1, C15	2	2.2 μ F	电容, 陶瓷, 2.2 μ F, 10V, $\pm$ 10%, X5R, 0603	0603	C0603C225K8PACTU	Kemet®
C2	1	3300pF	电容, 陶瓷, 3300pF, 50V, $\pm$ 10%, X7R, 0402	0402	GRM155R71H332KA01D	Murata™
C3、C10、C13、C17	4	1 μ F	电容, 陶瓷, 1 μ F, 25V, $\pm$ 10%, X5R, 0402	0402	C1005X5R1E105K050BC	TDK
C4	1	2.2 μ F	电容, 陶瓷, 2.2 μ F, 6.3V, $\pm$ 10%, X5R, 0402	0402	CL05A225KQ5NNNC	Samsung
C5、C6、C7、C14、C20	5	0.01 μ F	电容, 陶瓷, 0.01 μ F, 25V, $\pm$ 10%, X7R, 0402	0402	GRM155R71E103KA01D	MuRata
C8、C9、C11、C12、C16、C21、C22	7	0.1 μ F	电容, 陶瓷, 0.1 μ F, 6.3V, $\pm$ 10%, X7R, 0402	0402	GRM155R70J104KA01D	MuRata
C18、C19	2	12pF	电容, 陶瓷, 12pF, 50V, $\pm$ 5%, C0G/NP0, 0402	0402	GRM1555C1H120JA01D	MuRata
C23	1	10 μ F	电容, 陶瓷, 10 μ F, 25V, $\pm$ 10%, X5R, 0603	0603	GRM188R61E106KA73D	MuRata
C24、C34、C37、C86	4	0.1 μ F	电容, 陶瓷, 0.1 μ F, 50V, $\pm$ 10%, X7R, 0603	0603	8.85012 $\times$ 10 ¹¹	Würth Elektronik™
C25	1	470nF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R II 类, 470nF, 25VDC	0603	885012206075R	Würth Elektronik
C26	1	10nF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R, 10nF, 25VDC	0603	8.85012 $\times$ 10 ¹¹	Würth Elektronik
C27	1	1 μ F	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R, 1 μ F, 50VDC	0603	8.85012 $\times$ 10 ¹¹	Würth Elektronik
C28、C29	2	22pF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0402, NP0, 22pF, 50VDC	0402	8.85012 $\times$ 10 ¹¹	Würth Elektronik
C30、C32	2	1 μ F	电容, 陶瓷, 1 μ F, 100V, $\pm$ 10%, X7R, 1206	1206	CC1206KKX7R0BB105	Yageo® America
C31	1	220 μ F	WCAP-ATG5 铝电解电容器, 径向, THT, D10 $\times$ H12.5mm, 220 μ F, 50V		8.60021 $\times$ 10 ¹¹	Würth Elektronik
C33、C36	2	0.01 μ F	电容, 陶瓷, 0.01 μ F, 50V, $\pm$ 10%, X7R, 0603	0603	8.85012 $\times$ 10 ¹¹	Würth Elektronik
C35、C38	2	1 μ F	电容, 陶瓷, 1 μ F, 50V, $\pm$ 10%, X7R, 0805	0805	8.85012 $\times$ 10 ¹¹	Würth Elektronik

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
C39	1		电解电容器, 330uF, 50V, WCAP-ATG5 系列, 20%, 径向引线, 10mm	径向	8.60021 × 10 ¹¹	Würth Electronics
C43、C46	2	1μF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R, 1μF, 25VDC	0603	8.85012 × 10 ¹¹	Würth Elektronik
C44	1	10uF	电容, 陶瓷, 10μF, 50V, ±20%, X5R, 1206	1206	8.85012 × 10 ¹¹	Würth Elektronik
C45、C47、C48	3	100nF	WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R, 100nF, 100VDC	0603	8.85012 × 10 ¹¹	Würth Elektronik
C58	1	0.022uF	电容, 陶瓷, 0.022uF, 50V, ±10%, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Elektronik
C63	1	0.01uF	电容, 陶瓷, 0.01uF, 16V, ±10%, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Elektronik
C67、C69	2	5100pF	电容, 陶瓷, 5100pF, 50V, ±5%, C0G/NP0, 0603	0603	C0603C512J5GAC7867	Kemet®
C70	1	0.22uF	电容, 陶瓷, 0.22μF, 10V, ±10%, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Elektronik
C74、C77、C79	3	0.1uF	电容, 陶瓷, 0.1uF, 50V, ±10%, X7R, 0603	0603	C1608X7R1H104K080AA	TDK
C75、C83	2	4.7μF	电容, 陶瓷, 4.7μF, 16V, ±10%, X7R, AEC-Q200 1 级, 0805	0805	CGA4J3X7R1C475K125AE	TDK
C76、C78	2	10uF	电容, 陶瓷, 10uF, 50V, ±10%, X7R, 1206	1206	CL31B106KBHNNNE	Samsung
C80	1	220pF	电容, 陶瓷, 220pF, 50V, ±1%, C0G/NP0, 0603	0603	06035A221FAT2A	AVX
C81、C84	2	20pF	电容, 陶瓷, 20pF, 100V, ±5%, C0G/NP0, 0603	0603	GRM1885C2A200JA01D	MuRata
C82	1	4700pF	电容, 陶瓷, 4700pF, 100V, ±10%, X7R, 0603	0603	06031C472KAT2A	AVX
C85	1	0.01uF	电容, 陶瓷, 0.01uF, 100V, ±10%, X7R, 0603	0603	C0603X103K1RACTU	Kemet
D1、D2、D3、D6、D7、D10	6	绿色	LED, 绿色, SMD	LED_0603	150060VS75000	Würth Elektronik
D4	1	红色	LED, 红色, SMD	LED_0603	150060RS75000	Würth Elektronik
D5	1	75V	二极管, 开关, 75V, 0.15A, AEC-Q101, SOD-323	SOD-323	1N4148WS-7-F	Diodes Inc.
D8	1	100V	二极管, 开关, 100V, 0.15A, SOD-123	SOD-123	1N4148W-TP	Micro Commercial Components
D9	1		24V 单通道 ESD 保护二极管	SOD323	ESD1LIN24DYFR	德州仪器 (TI)
F1	1		保险丝, 30A, 250VAC, 100VDC, SMD	10.1 × 3.12mm	0463030.ER	Littelfuse

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
FID1、FID2、FID3	3		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
H1、H2、H3、H4	4		Bumpon, 半球形, 0.44 × 0.20, 透明	透明 Bumpon	SJ-5303 (CLEAR)	3M®
IC1	1		适用于高速数据接口的 4 通道 ESD 保护阵列, DRY0006A (USON-6)	DRY0006A	TPD4E004DRYR	德州仪器 (TI)
IC2	1		500mA、可调节、低静态电流、低噪声、高 PSRR、单路输出 LDO 稳压器、DRB0008A (VSON-8)	DRB0008A	TPS73533DRBT	德州仪器 (TI)
IC3	1		精密低功耗并联电压基准、0.5% 精度、2.5V、15ppm/°C、15mA、-40°C 至 85°C、5 引脚 SC70 (DCK)、绿色环保 (RoHS, 无镉/溴)	DCK0005A	LM4040C25IDCKR	德州仪器 (TI)
J1	1		接头, 100mil, 7x2, 金, TH	7x2 接头	TSW-107-07-G-D	Samtec®
J2	1		接头, 2.54mm, 12x2, 金, TH	接头, 2.54mm, 12x2, TH	TSW-112-08-G-D	Samtec
J3、J18、J20	3		接头, 100mil, 2x1, 金, TH	2x1 接头	TSW-102-07-G-S	Samtec
J4、J6、J7、J8、J9、J16	6		2 位, 线至板, 端子块, 与板齐平, 0.250" (6.35mm), 穿孔	CONN_TERM_BLOCK2	6.91251 × 10 ¹¹	Würth Electronics
J5	1		2 位, 线至板, 端子块, 与板齐平, 0.400" (10.16mm), 穿孔	HDR2	6.91257 × 10 ¹¹	Würth
J10、J11、J12	3		2 位, 线至板, 端子块, 与板齐平, 0.197" (5.00mm), 穿孔	HDR2	6.91217 × 10 ¹¹	Würth Electronics
J13、J19、J23	3		接头, 100mil, 3x1, 金, TH	3x1 接头	TSW-103-07-G-S	Samtec
J17、J22	2		接头, 100mil, 6x1, 金, TH	6x1 接头	TSW-106-07-G-S	Samtec
LBL1	1		热转印可打印标签, 0.650" (宽) × 0.200" (高) - 10,000/卷	PCB 标签 0.650 × 0.200 英寸	THT-14-423-10	Brady®
LED1	1	红色	LED, 红色, SMD	红色 LED, 1.6mm x 0.8mm x 0.8mm	LTST-C190KRKT	Lite-On
LED2	1	绿色	LED, 绿色, SMD	1.6 × 0.8 × 0.8mm	LTST-C190GKT	Lite-On
Q1	1	65V	晶体管, NPN, 65V, 0.1A, SOT-23	SOT-23	BC846BLT1G	ON Semiconductor
Q2、Q3、Q4、Q5、Q6、Q8	6	40V	MOSFET, N 沟道, 40V, 100A, DNK0008A (VSON-CLIP-8)	DNK0008A	CSD18512Q5B	德州仪器 (TI)
Q7	1	30V	MOSFET, N 沟道, 30V, 25A, DQJ0008A (VSONP-8)	DQJ0008A	CSD17579Q5A	德州仪器 (TI)
R1	1	330k	电阻, 330k, 1%, 0.0625W, 0402	0402	RC0402FR-07330KL	Yageo America

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
R2、R5、R22、 R26、R27、R34、 R35、R37、R38、 R39、R40、R41、 R42、R52、R53、 R58、R64、R68、 R71	19	0	电阻, 0, 5%, 0.1W, 0603	0603	RC0603JR-070RL	Yageo
R3	1	220k	电阻, 220k, 1%, 0.0625W, 0402	0402	RC0402FR-07220KL	Yageo America
R4	1	3.30k	电阻, 3.30k, 1%, 0.1W, AEC-Q200 0 级, 0402	0402	ERJ-2RKF3301X	Panasonic®
R6	1	1.00Meg	电阻, 1.00M, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04021M00FKED	Vishay®-Dale
R7、R8、R14	3	10k	电阻, 10k, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R9、R10、R11、 R12、R17	5	1.0k	电阻, 1.0k, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04021K00JNED	Vishay-Dale
R13、R16	2	100	电阻, 100, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402100RJNED	Vishay-Dale
R15	1	4.87k	电阻, 4.87k, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW04024K87FKED	Vishay-Dale
R18	1	51	电阻, 51, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040251R0JNED	Vishay-Dale
R19、R20	2	470	电阻, 470, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402470RJNED	Vishay-Dale
R23、R25	2	47k	电阻, 47k, 5%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW040247K0JNED	Vishay-Dale
R24、R43、R73、 R74	4	3.3k	电阻, 3.3k, 5%, 0.1W, 0603	0603	RC0603JR-073K3L	Yageo
R28、R29、R30、 R31、R63	5	330	电阻, 330, 5%, 0.1W, 0603	0603	RC0603JR-07330RL	Yageo
R32、R33、R67	3	10k	电阻, 10k, 5%, 0.1W, 0603	0603	RC0603JR-0710KL	Yageo
R36	1	0.007	电阻, 0.007, 1%, 7W, AEC-Q200 0 级, 7.1mm x 4.6mm	7.1 × 4.6mm	WSHM28187L000FEA	Vishay-Dale
R44	1	16k	电阻, 16k, 5%, 0.1W, 0603	0603	RC0603JR-0716KL	Yageo
R47、R65	2	1.0k	电阻, 1.0k, 5%, 0.1W, 0603	0603	RC0603JR-071KL	Yageo
R51	1	220	电阻, 220, 1%, 0.1W, 0603	0603	RC0603FR-07220RL	Yageo
R57	1	1.00k	电阻, 1.00k, 1%, 0.1W, 0603	0603	RC0603FR-071KL	Yageo
R62	1	560	电阻, 560, 5%, 0.1W, 0603	0603	RC0603JR-07560RL	Yageo

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
R66、R75	2	0	电阻, 0, 0.05%, 2W, AEC-Q200 0 级, 2512	2512	HCJ2512ZT0R00	Stackpole Electronics Inc
R69、R70	2	60.4	电阻, 60.4, 1%, 0.1W, 0603	0603	RC0603FR-0760R4L	Yageo
R72	1	1.00Meg	电阻, 1.00M, 1%, 0.1W, 0402	0402	ERJ-2RKF1004X	Panasonic
R76	1	20k	电阻, 20k, 5%, 0.1W, 0603	0603	RC0603JR-0720KL	Yageo
R77	1	1.8k	电阻, 1.8k, 5%, 0.1W, 0603	0603	RC0603JR-071K8L	Yageo
S1	1		触控开关 SPST-NO 顶部驱动表面贴装	SMT_SW_6MM2_6MM2	4.30481 × 10 ¹¹	Würth Electronics
SH1、SH2	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®
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5、SH-J6、SH-J7、SH-J8、SH-J9、SH-J10、SH-J11、SH-J12、SH-J13、SH-J14、SH-J15、SH-J16、SH-J17、SH-J18、SH-J19、SH-J20、SH-J21	21		分流器, 2.54mm, 金, 黑色	分流器, 2.54mm, 黑色	60900213421	Würth Elektronik
TP8	1		测试点, 微型, 白色, TH	白色微型测试点	5002	Keystone Electronics®
TP9、TP10、TP11、TP12、TP13、TP14、TP15、TP18、TP19、TP22、TP23、TP24、TP27、TP28、TP29、TP31、TP32、TP33、TP34、TP35、TP36、TP37、TP38、TP39、TP40、TP41、TP42、TP44、TP46、TP47、TP48、TP49	32		测试点, 通用, 白色, TH	白色通用测试点	5012	Keystone Electronics
TP16、TP17	2		测试点, 紧凑型, SMT	Test point_Keystone_Compact	5016	Keystone Electronics
TP20、TP21	2		测试点, 多用途, 红色, TH	红色通用测试点	5010	Keystone Electronics

表 4-1. 物料清单 (续)

位号	数量	值	说明	封装参考	器件型号	制造商
TP25、TP26	2		测试点, 多用途, 黑色, TH	黑色通用测试点	5011	Keystone Electronics
U1	1		具有 CAN-FD 接口 LQFP64 的混合信号微控制器	LQFP64	MSPM0G3507SPM	德州仪器 (TI)
U2	1		具有集成半桥和高侧以及电流检测和高级诊断功能的汽车级多功能驱动器	VQFN48	DRV8000QWRGZRQ1	德州仪器 (TI)
U4	1		用于车载网络的 24V、双通道 ESD 保护二极管	SOT-23-3	ESD2CAN24DBZR	德州仪器 (TI)
USB1	1		插座, USB 2.0, Micro B, 5 个位置, R/A, SMT	插座, USB 2.0, Micro B, 5 位, 0.65mm 间距, R/A, SMT	1051640001	Molex
XDS1	1		MSP432E401YTPDT、PDT0128A (TQFP-128)	PDT0128A	MSP432E401YTPDTR	德州仪器 (TI)
Y1	1		晶振, 16MHz, 8pF, SMD	3.2 × 0.75 × 2.5mm	NX3225GA-16.000M-STD-CRG-1	NDK
C40	0		WCAP-CSGP 多层陶瓷贴片电容器, 通用, 尺寸 0603, X7R, 100nF, 100VDC			Würth Elektronik
C41、C42、C49、C50、C51、C52、C53、C54、C55、C56、C57、C59、C60、C61、C64、C65、C66、C71、C72、C73、C87、C88、C89、C90、C91、C92	0	0.022uF	电容, 陶瓷, 0.022uF, 50V, ±10%, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Elektronik
C62	0		电容, 陶瓷, 0.015uF, 50V, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Electronics
C68	0	0.01uF	电容, 陶瓷, 0.01uF, 100V, ±10%, X7R, 0603	0603	8.85012 × 10 ¹¹	Würth Elektronik
J21	0		插座, D-Sub, 9 孔, R/A, SMT	30.81 × 10.28 × 10.10mm	190-009-263R001	NorComp
L1	0		固定 IND 2.2uH 16A 2.2mΩ	IND_SMT_11MM6_10MM5	74439369022	Würth Electronics
L2	0	100uH	电感, 铁氧体, 100uH, 0.15A, 2Ω, SMD	SMD, 4 引线, 封装 4.7 × 3.7mm	ACT45B-101-2P-TL003	TDK
R21	0	0	电阻, 0, 5%, 0.1W, 0603	0603	RC0603JR-070RL	Yageo
Y2	0		晶振 40MHz ±10ppm (容差) ±20ppm (稳定性) 12pF FUND 40Ω 4 引脚 Mini-CSMD T/R	TSX-3225	X1E0000210179	Seiko Epson

5 其他信息

5.1 商标

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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 * (May 2024) to Revision A (July 2026)	Page
• 添加了 DRV8001EVM 和 DRV8003EVM.....	1
• 更新了图 3-1 以显示当前 GUI.....	7
• 更新了图 3-2 以显示当前 GUI.....	8

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 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

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

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

NOTE:

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

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 Canada

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/sds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/sds/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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