

EVM User's Guide: DRV8218EVM

DRV8218 评估模块



说明

DRV8218EVM 支持评估 DRV8218 器件。该评估模块 (EVM) 已编程为开箱即用，可立即开始驱动负载。为简化控制与配置流程，EVM 提供了用于便捷连接电源和负载的接头，以及板载电位器，可用于 PWM 信号输入。

开始使用

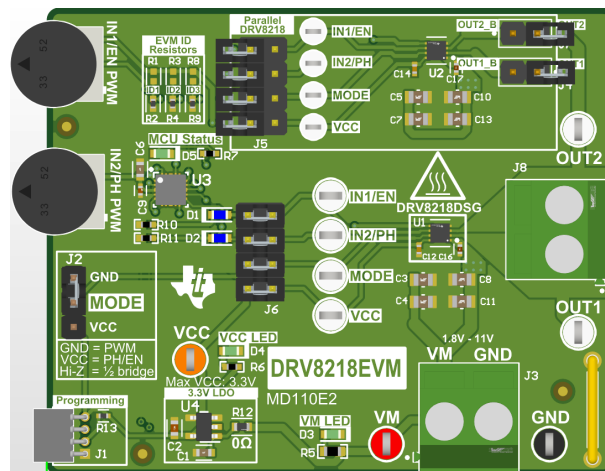
1. 订购 EVM。
 - a. DRV8218EVM
2. 连接负载和外部电源。
3. 使用板载电位器控制电机的转速和方向。

特性

- 用于数字电压电源的板载 3.3V LDO。
- 主信号接头，通过可拆卸分流器来断开板载 MCU 到 DRV8218 之间的主信号。
- 用于输入信号控制的板载电位器。

应用

- 有刷直流电机、螺线管和继电器驱动
- 电动牙刷
- 美容美发
- 电子智能锁
- 水表
- 燃气表
- 电表
- 电动玩具和机器人玩具
- IP 网络摄像机红外截止滤光器
- 可视门铃
- 血压监护仪
- 输液泵



1 评估模块概述

1.1 简介

DRV8218 是一款 H 桥电机驱动器，具备 PH/EN、PWM 和半桥控制接口以及低功耗睡眠模式。

DRV8218 是一款集成式 H 桥电机驱动器，支持 1.8V 至 11V 的电压范围和高达 8A 的峰值电流，具有四个 N 沟道功率 FET、一个电荷泵稳压器和内置保护电路。三倍电荷泵架构支持在低至 1.8V 的电压下运行，即使在电池电压较低的情况下也能保持稳定的 RDS(on)。所有电容器均已集成，从而显著减少了 PCB 占用空间并实现 100% 占空比运行。DRV8218 包括欠压锁定 (UVLO)、过流保护 (OCP) 和热关断 (TSD) 等集成的保护功能。

本文档随 DRV8218 评估模块 (EVM) 提供，作为 DRV8218 数据表的补充。本用户指南包括 EVM 硬件设置和操作说明。

1.2 套件内容

表 1-1. DRV8218EVM 套件内容

项目	数量
DRV8218EVM	1

1.3 规格

DRV8218EVM 使用板载电位器来控制电机驱动器输入。3.3V LDO 从电源生成 3.3V 电源轨。该 3.3V 电源轨用于为 MSP430 和状态 LED 供电。J6 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。如果需要，移除所有这些分流器，以便轻松将外部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源。DRV8218 支持 1.8V 至 11V 电源电压范围。

1.4 器件信息

DRV8218 是一款集成 H 桥电机驱动器，具有四个 N 沟道功率 FET、电荷泵稳压器和内置保护电路。三倍电荷泵架构支持在低至 1.8V 的电压下运行，即使在电池电压较低的情况下也能保持稳定的 RDS(on)。所有电容器均已集成，从而显著减少了 PCB 占用空间并实现 100% 占空比运行。

该器件支持三种控制接口模式：PWM (IN1/IN2)、相位/使能 (PH/EN) 和独立半桥。以及并联半桥模式。每个接口都包括低功耗睡眠模式，通过关断大多数内部电路，可将静态电流降低至 120nA 以下。

输出电流峰值高达 8A，逻辑电源电压范围为 1.8V 至 5.5V，电机电源电压范围为 1.8V 至 11V。这些内置的保护功能包括欠压锁定 (UVLO)、过流保护 (OCP) 和热关断 (TSD)。DRV8218 属于引脚对引脚兼容系列，具有可扩展的 RDS(on) 和电源电压选项。

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 SLVUDX4。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。较新的修订版可从 TI 网站 www.ti.com 获得，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)。订购时，可通过文档标题或文献编号识别文档。

表 1-2. DRV8218EVM 中使用的 TI IC 和相应的数据表

说明	数据表
主 MSP430 MCU	MSP430FR2100
板载 LDO	TPS7B6933
电机驱动器	DRV8218

2 硬件

2.1 其他图像

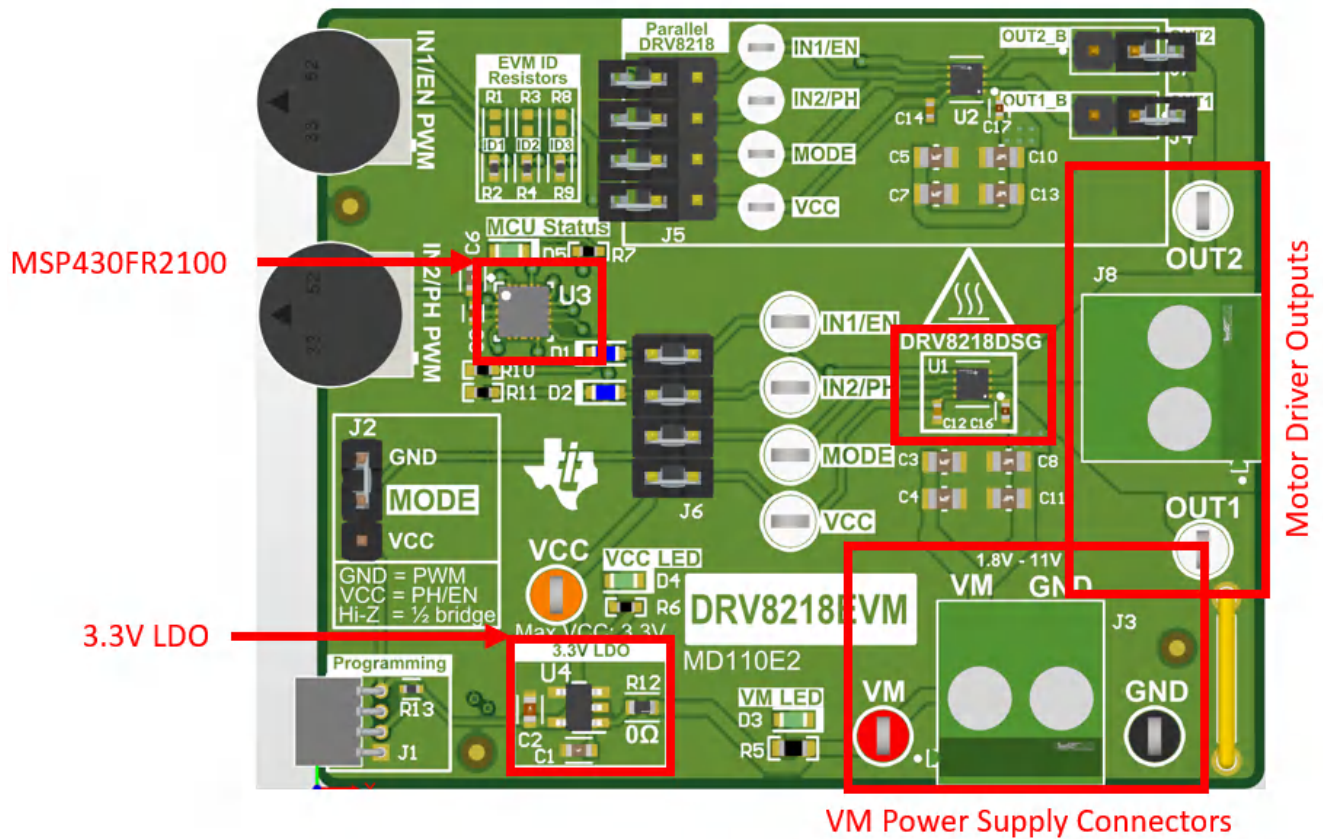


图 2-1. DRV8218EVM 顶视图

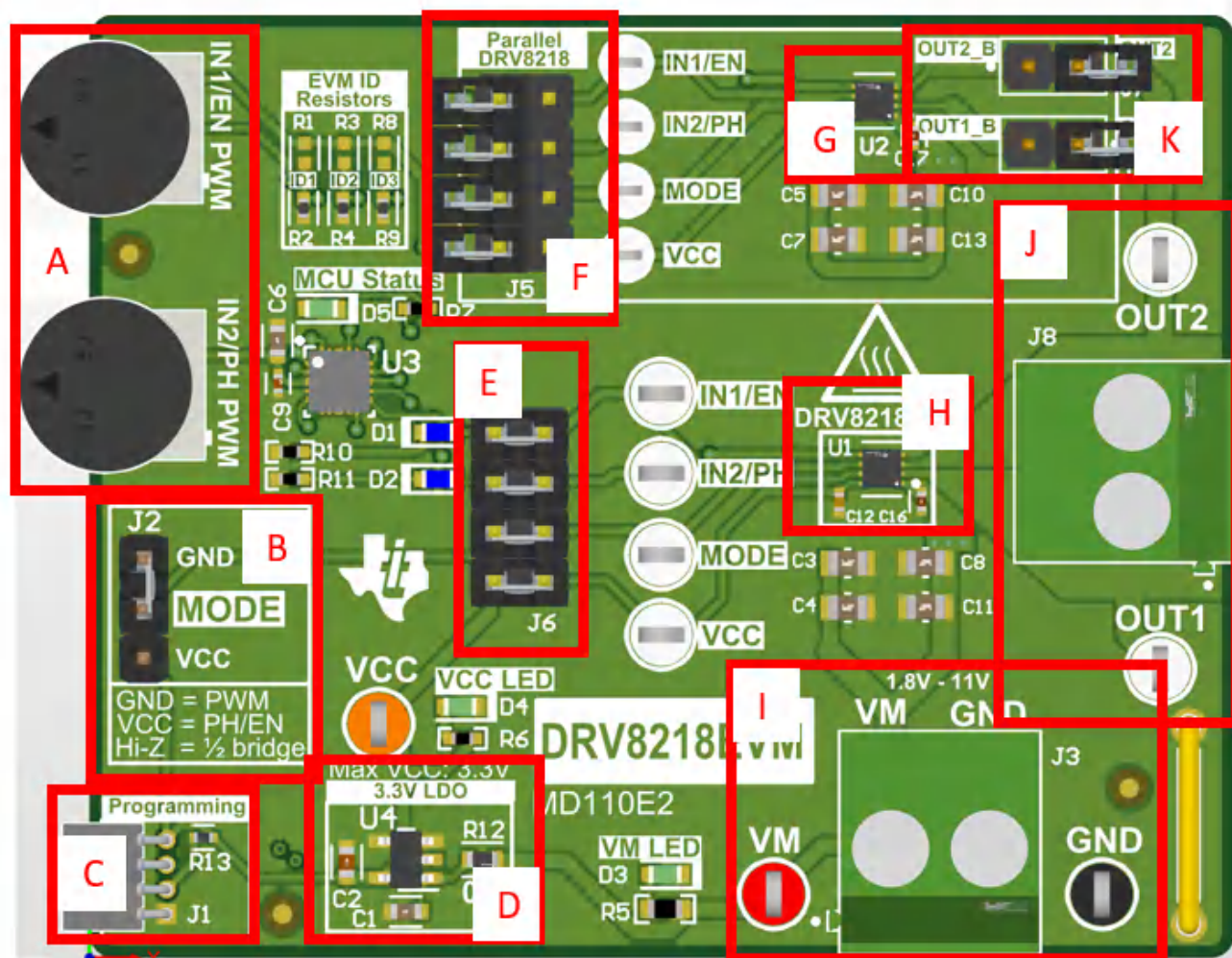


图 2-2. DRV8218EVM 接头和测试点信息

表 2-1. 接头和测试点说明

元件标签	说明
A	输入电位器，用于控制 DRV8218 输入信号的占空比。
B	输入控制选择 - MODE 至 VCC : PH/EN - MODE 至 GND : PWM - MODE 至高阻态：独立半桥
C	用于对 EVM 上 MSP430FR2100 进行编程的 4 针连接器
D	3.3V LDO
E	主信号接头 (U1 器件) - IN1/EN : 通道 1 输入 - IN2/PH : 通道 2 输入 - 模式：输入控制选择 - VCC : 来自 LDO 的 3.3V

表 2-1. 接头和测试点说明 (续)

元件标签	说明
F	主信号接头 (U2 器件) - IN1/EN : 通道 1 输入 - IN2/PH : 通道 2 输入 - 模式 : 输入控制选择 - VCC : 来自 LDO 的 3.3V <i>仅在并联器件时使用</i>
G	U2 : DRV8218 在并联运行期间使用
H	U1 : DRV8218
I	VM 电源连接器
J	电机驱动器输出连接器
K	并联运行跳线 - 单器件运行 (U1) 时未组装 - 并联运行 (U1 和 U2) 时已组装

2.2 设置

2.2.1 输入电位器和 MODE 跳线

可通过 J2 跳线将 MODE 引脚设置为相应的控制接口。通过将 MODE 引脚设置为逻辑低电平、逻辑高电平或高阻态，该引脚可选择控制接口。

表 2-2. 控制模式选择 — MODE 引脚

MODE 状态	控制模式
MODE = 逻辑低电平	PWM
MODE = 逻辑高电平	PH/EN
MODE = 高阻态	半桥

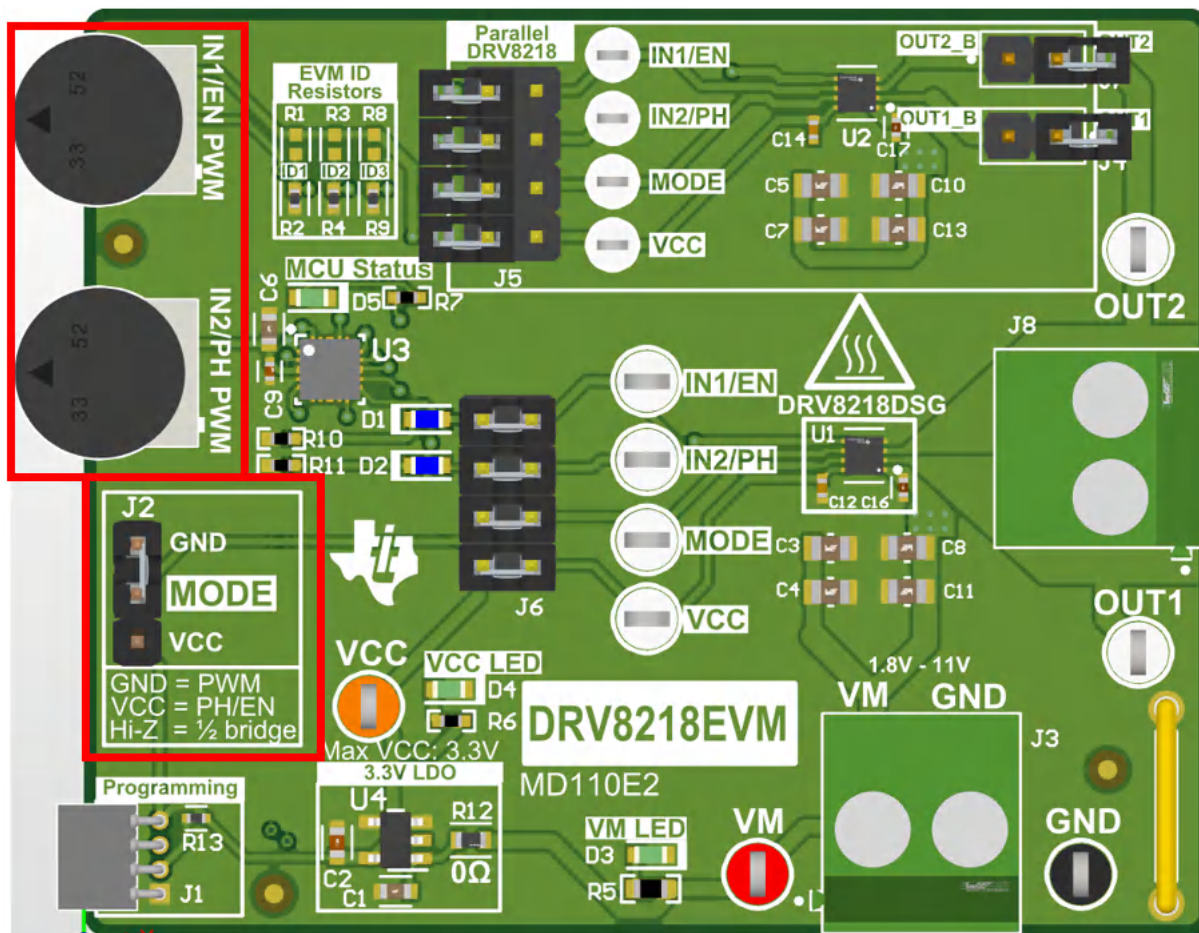


图 2-3. DRV8218EVM — MODE 引脚选择和输入电位器

2.2.2 PWM 模式 (MODE = 逻辑低电平)

当 MODE 引脚连接到 GND 或逻辑低电平时，控制接口设置为 PWM 模式。在 PWM 模式下，两个输入引脚 IN1 和 IN2 用于使用 PWM 或 100% 占空比驱动输出引脚 (OUT1 和 OUT2)。PWM 模式允许 H 桥在 PWM 关断期间通过滑行模式 (H 桥高阻态) 或制动模式 (低侧慢速衰减) 再循环电流。

表 2-3. PWM 模式控制

IN1	IN2	OUT1	OUT2	说明
低电平 — 将 IN1/EN PWM 电位器完全逆时针旋转	低电平 — 将 IN2/PH PWM 电位器完全逆时针旋转	高阻态	高阻态	滑行 (H 桥高阻态) / 低功耗自动睡眠模式
PWM — 将 IN1/EN PWM 电位器旋转至任意位置	高电平 — 将 IN2/PH PWM 电位器完全顺时针旋转	L	H	反向 (OUT2 -> OUT1)
高电平 — 将 IN1/EN PWM 电位器完全顺时针旋转	PWM — 将 IN2/PH PWM 电位器旋转至任意位置	H	L	正向 (OUT1 -> OUT2)
高电平 — 将 IN1/EN PWM 电位器完全顺时针旋转	高电平 — 将 IN2/PH PWM 电位器完全顺时针旋转	L	L	制动 (低侧慢速衰减)

2.2.3 PH/EN 模式 (MODE = 逻辑高电平)

当 MODE 引脚连接到 3.3V 或逻辑高电平时，控制接口设置为 PH/EN 模式。在 PH/EN 模式下，EN 引脚上只需要一个 PWM 信号即可控制电机的转速，且 PH 引脚上需要一个 GPIO (高电平或低电平) 信号即可控制方向。当 EN 引脚被拉至低电平时，PH/EN 模式允许 H 桥进入制动状态 (低侧慢速衰减)。

表 2-4. PH/EN 模式控制

EN	PH	OUT1	OUT2	说明
低电平 — 将 IN1/EN PWM 电位器完全逆时针旋转	X	L -> 高阻态	L -> 高阻态	制动 (低侧慢速衰减) 持续 tAUTOSLEEP 时间, 然后进入自动睡眠模式 (H 桥高阻态)
PWM — 将 IN1/EN PWM 电位器旋转至任意位置	低电平 — 将 IN2/PH PWM 电位器完全逆时针旋转	L	H	反向 (OUT2 -> OUT1)
PWM — 将 IN1/EN PWM 电位器旋转至任意位置	高电平 — 将 IN2/PH PWM 电位器完全顺时针旋转	H	L	正向 (OUT1 -> OUT2)

2.2.4 半桥 (MODE = 高阻态)

当 MODE 引脚悬空 (Hi-Z) 时, 该器件会选择半桥控制模式。此模式允许直接控制每个半桥来支持高侧慢速衰减 (或制动), 驱动两个独立的负载, 或并联输出来提高单个负载的电流能力。

表 2-5. 半桥模式控制

IN1	IN2	OUT1	OUT2	说明
0	X	L	X	OUT1 低侧导通
1	X	H	X	OUT1 高侧导通
X	0	X	L	OUT2 低侧导通
X	1	X	H	OUT2 高侧导通

2.2.5 并联多个驱动器

DRV8218EVM 支持并联两个器件以驱动一个负载, 其 RDS(on) 比单个驱动器更低。并联使用多个 DRV8218 时, 建议使用 PWM 或 PH/EN 模式, 以便器件可以自动处理死区时间。如果使用半桥模式, 则必须在关断高侧 FET 和导通低侧 FET 之间手动插入死区时间, 以避免击穿。

通过 EVM 上的跳线连接可轻松实现并联模式的连接。要将相应的输入和输出信号连接在一起, 请组装 J5 和 J7 上的所有跳线。

3 硬件设计文件

每个 EVM 的原理图、物料清单 (BOM)、PCB 布局和 3D 模型 STEP 文件可在各自产品文件夹页面的“设计文件”部分下载。

• <http://www.ti.com/tool/DRV8218EVM#design-files>

3.1 原理图

以下图片展示了 DRV8218EVM 的原理图。这些原理图可从 Design Files 部分下 EVM 工具文件夹中的硬件设计文件下载。

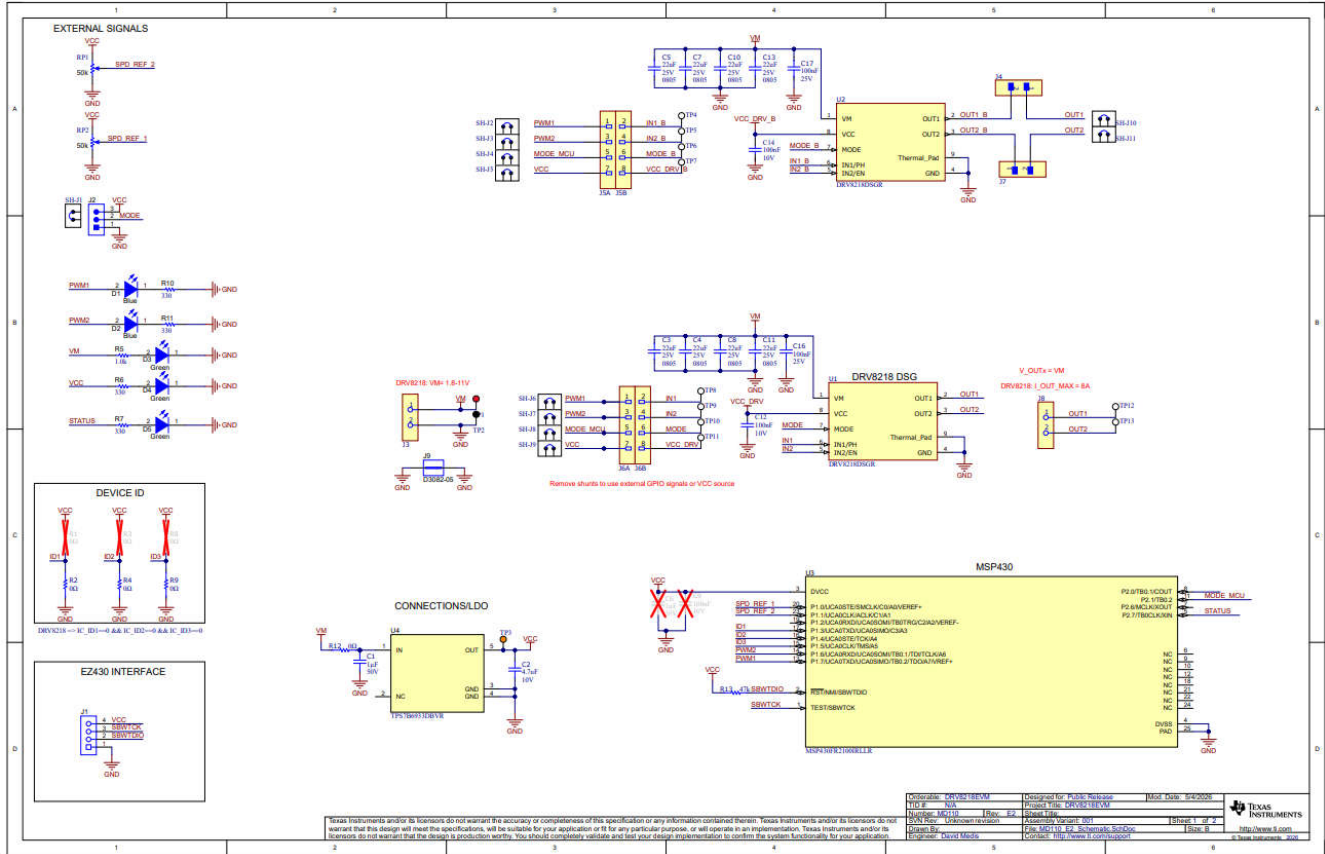


图 3-1. DRV8218EVM 原理图

3.2 PCB 布局

以下图片展示了 EVM 的 PCB 层。可以在给定 EVM 的硬件设计文件中下载 Altium 源文件。

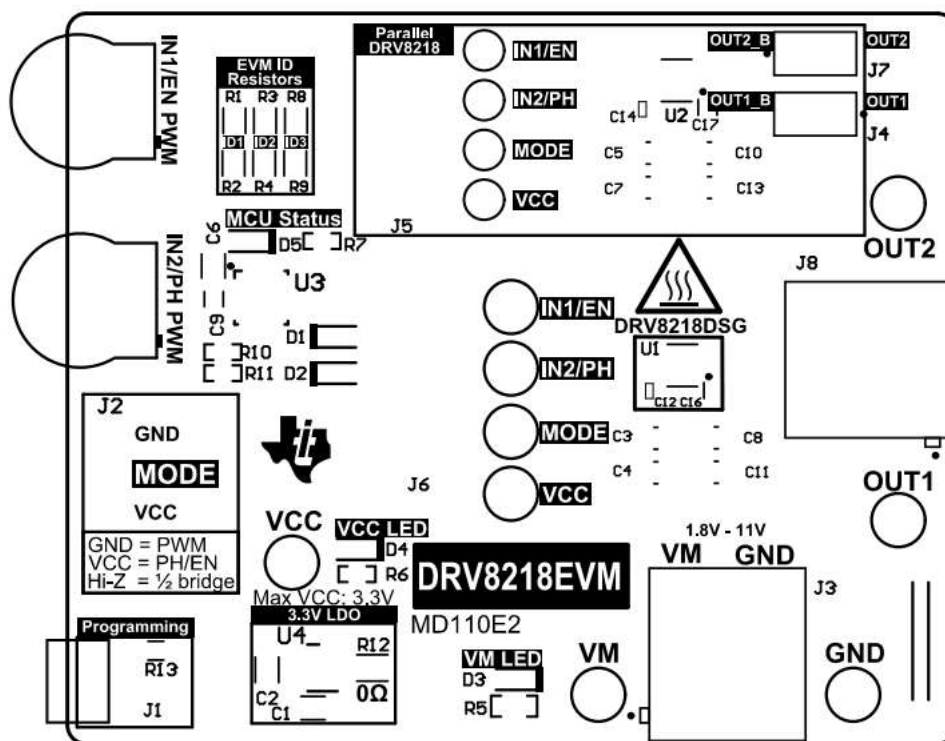


图 3-2. 顶视图

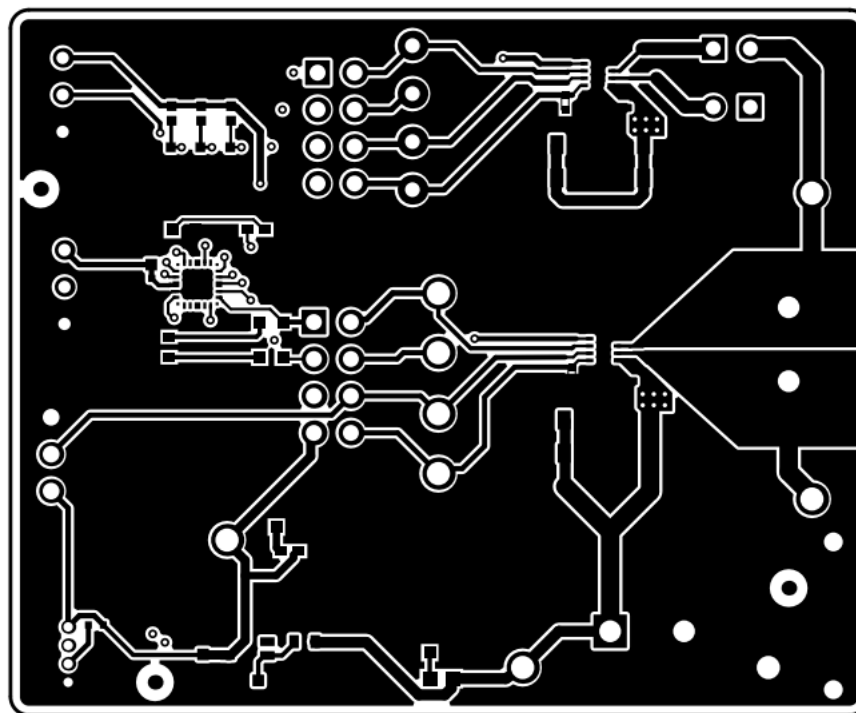


图 3-3. 顶层

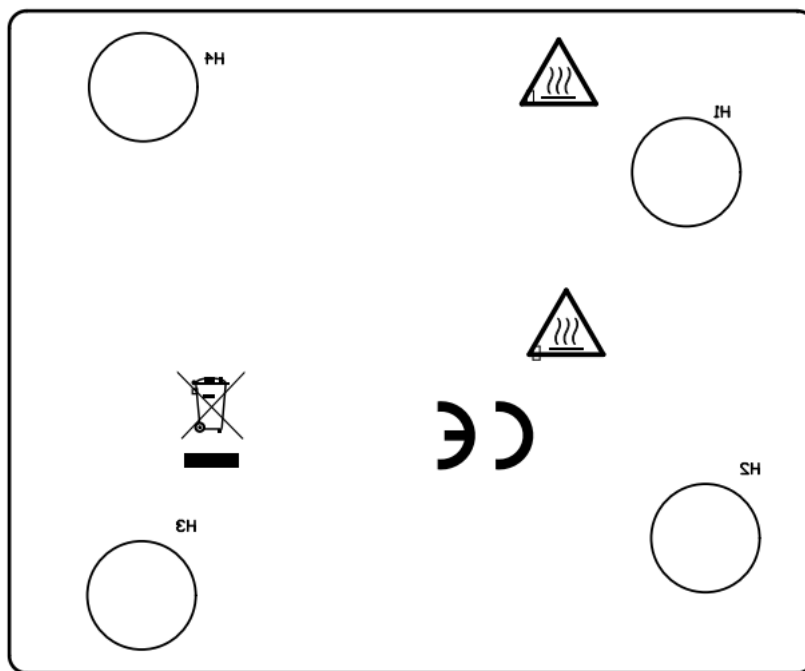


图 3-4. 底视图

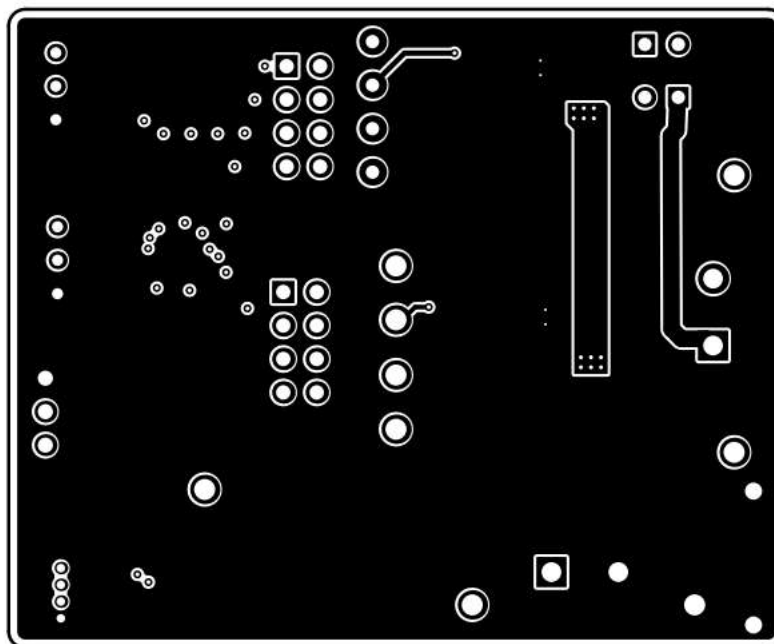


图 3-5. 底层

3.3 物料清单 (BOM)

以下提供了 DRV8218EVM 的器件清单。

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		MD110	不限

位号	数量	值	说明	封装参考	器件型号	制造商
C1, C6	2	1 μ F	1 μ F $\pm$ 10% 50V 陶瓷电容器 X7R 0603 (公制 1608)	0603	885012206126	Würth Electronics
C2	1	4.7 μ F	4.7 μ F $\pm$ 20% 10V 陶瓷电容器 X5R 0603 (公制 1608)	0603	885012106012	Würth Electronics
C3、C4、C5、C7、C8、C10、C11、C13	8	22 μ F	陶瓷电容器 0805 22 μ F $\pm$ 20% 25V X5R	0805	885012107019	Würth
C9	1	100nF	0.1 μ F $\pm$ 10% 10V 陶瓷电容器 X7R 0402 (公制 1005)	0402	885012205018	Würth Electronics
C12、C14	2		0.1 μ F $\pm$ 10% 10V 陶瓷电容器 X7R 0402 (公制 1005)	0402	885012205018	Würth Elektronik
C16、C17	2	100nF	电容, 陶瓷, 0402, X7R, 100nF, 25V, $\pm$ 15%, SMD	0402	885012205085	Würth Electronics
D1、D2	2	蓝色	LED, 蓝色, SMD	LED_0603	150060BS75000	Würth Elektronik
D3、D4、D5	3	绿色	LED, 绿色, SMD	LED_0603	150060VS75000	Würth Elektronik
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		缓冲垫, 圆柱形, 0.312 X 0.200, 黑色	黑色缓冲垫	SJ61A1	3M
J1	1		插孔 .050" GRID SIP 4 POS R/A, TH	R/A 4x1 插孔	851-43-004-20-001000	Mill-Max
J2	1		接头, 2.54mm, 3x1, 金, TH	接头, 2.54mm, 3x1, TH	61300311121	Würth Elektronik
J3、J8	2		2 位, 线至板, 端子块, 与板齐平, 0.200" (5.08mm), 穿孔	HHR2	691236510002	Würth Electronics
J4、J7	2		连接器接头穿孔 2 位 0.100" (2.54mm)	HDR2	PH1-02-UA	Adam Tech
J5、J6	2		连接器接头垂直 8 位 2.54mm	HDR8	61300821121	Würth Electronics
J9	1		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
R2、R4、R9	3	0 Ω	0 Ω 跳线 0.1W, 1/10W 片式电阻器 0402 (公制 1005) - 厚膜	0402	CR0402-10W-000T	Venkel
R5	1	1.0k	电阻, 1.0k, 5%, 0.25W, AEC-Q200 0 级, 0603	0603	ESR03EZPJ102	Rohm

位号	数量	值	说明	封装参考	器件型号	制造商
R6、R7、R10、R11	4	330	电阻, 330, 1%, 0.063W, AEC-Q200 0 级, 0402	0402	CRCW0402330RFKE D	Vishay-Dale
R12	1	0 Ω	0 Ω 跳线 0.1W, 1/10W 片式电阻器 0603 (公制 1608) 汽车类 AEC-Q200 厚膜	0603	ERJ-3GEY0R00V	Panasonic
R13	1	47k	47k Ω $\pm$ 5% 0.1W, 1/10W 片式电阻 0402 (1005 公制), 汽车类 AEC-Q200 厚膜	0402	ERJ-2GEJ473X	Panasonic
RP1、RP2	2	50k	修整电位器, 50K, 0.5W, TH	9.53mm x 8.89mm	3352T-1-503LF	Bourns
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5、SH-J6、SH-J7、SH-J8、SH-J9、SH-J10、SH-J11	11		分流器, 2.54mm, 金, 黑色	分流器, 2.54mm, 黑色	60900213421	Würth Elektronik
TP1	1		测试点, 多用途, 红色, TH	红色通用测试点	5010	Keystone Electronics
TP2	1		测试点, 多用途, 黑色, TH	黑色通用测试点	5011	Keystone Electronics
TP3	1		测试点, 通用, 橙色, TH	橙色通用测试点	5013	Keystone Electronics
TP4、TP5、TP6、TP7	4		测试点, 微型, 白色, TH	白色微型测试点	5002	Keystone Electronics
TP8、TP9、TP10、TP11、TP12、TP13	6		测试点, 通用, 白色, TH	白色通用测试点	5012	Keystone Electronics
U1、U2	2		DRV8218DSGR	WSON8	DRV8218DSGR	德州仪器 (TI)
U3	1		16MHz 超低功耗微控制器, 配备 1KB FRAM、0.5KB SRAM、12 个 IO, 8 通道 10 位 ADC, RLL0024A (VQFN-24)	RLL0024A	MSP430FR2100IRLL R	德州仪器 (TI)
U4	1		40V 低 IQ 低压降稳压器, DBV0005A (SOT-23-5)	DBV0005A	TPS7B6933DBVR	德州仪器 (TI)
R1、R3、R8	0	0 Ω	0 Ω 跳线 0.1W, 1/10W 片式电阻器 0402 (公制 1005) - 厚膜	0402	CR0402-10W-000T	Venkel

4 其他信息

商标

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 - 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 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。

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/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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