EVM User's Guide: TMP4719

TMP4719 评估模块

说明

TMP4719 是一款与 I²C 兼容的 3 通道（2 个远程和 1 个本地）温度传感器，采用 VSSOP 和 WSON 封装。TMP4719EVM 可供用户评估 TMP4719 数字温度传感器的性能。TMP4719EVM 可直接使用，也可与评估模块 GUI 一起使用。或者，可以拆下传感器，从而在用户系统中进行评估。为此，可以通过多种方法来与传感器连接，以便提供出色的用户体验。

开始使用

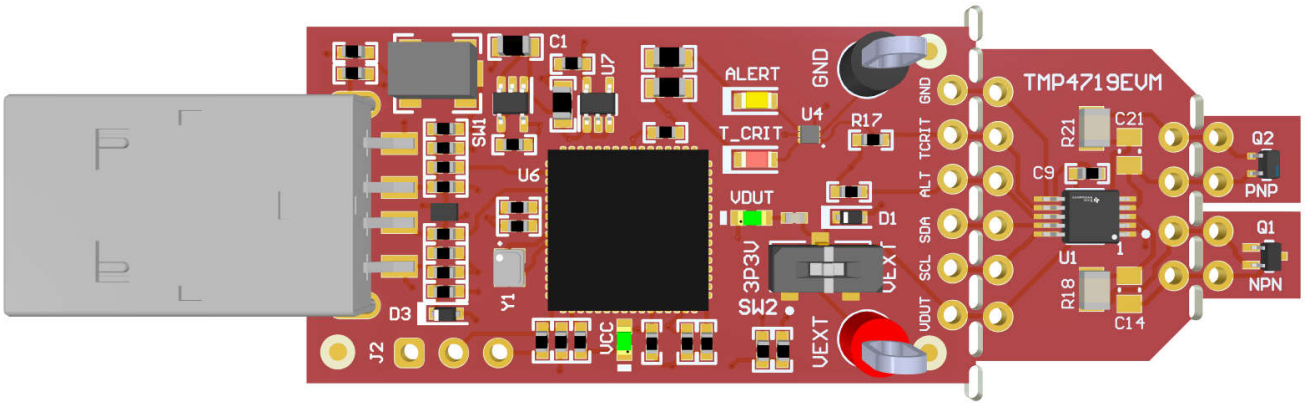
1. 订购 TMP4719EVM
2. 拆下传感器分接 PCB 部分（可选）
3. 将 EVM 连接到计算机或用户系统
4. 前往 dev.ti.com 上的 TMP4719EVM 库页面，下载 GUI 或在 Web 上运行
5. 有关 IC 详细信息，请参阅 TMP4719 数据表
6. 访问我们的 E2E 论坛寻求支持或提问

特性

- 展示了具有警报功能的高精确度 3 通道数字温度传感器
- 易于使用、基于云的 GUI 可在线使用，也可下载供离线使用
- 可拆式传感器板具有 0.1 英寸间距接头封装，可与 TMP4719 连接
- 使用 GUI 进行数据记录

应用

- 标准笔记本电脑
- 机架式服务器主板
- 智能网络接口卡 (NIC)
- 小型蜂窝基站
- 基带单元 (BBU)
- 软件定义无线电



TMP4719EVM

1 评估模块概述

1.1 简介

该 EVM 具有 USB 记忆棒大小，其板载 MSP430F5528 微控制器通过一个 I²C 接口与主机和 TMP4719 器件相连。该模块在 EVM 板上的传感器和主机控制器之间设计有穿孔。利用穿孔，用户可以灵活地进行评估：

- 用户可以将 TMP4719 传感器分接部分连接到其系统/主机。
- 用户可使用 TMP4719 器件将 EVM 主机和 GUI 软件与用户系统连接。
- 小型独立电路板允许用户将传感器放置在用户系统或温度受控环境中来评估性能。
- 孔间距与常见的 0.1 英寸原型设计试验电路板兼容。

本用户指南介绍了 TMP4719EVM 评估版的特性、操作和使用，具体来说，说明了如何设置和配置软件、介绍了硬件并探讨了软件操作的各个方面。本文档中的评估板、评估模块和 EVM 等所有术语均指 TMP4719EVM。本用户指南还提供了有关操作过程、输入和输出连接、电气原理图、印刷电路板 (PCB) 布局图和 EVM 器件列表的信息。

1.2 套件内容

表 1-1 详细说明了 EVM 套件的内容。如果缺少任何元件，请与离您最近的德州仪器 (TI) 产品信息中心联系。TI 强烈建议用户查看 TI 网站 http://www.ti.com，以验证是否已下载相关软件的最新版本。

表 1-1. EVM 套件物品

条目	数量
TMP4719EVM	1

1.3 规格

表 1-2 定义了 EVM 每个部分的绝对最大热性能条件。主要的 2 个部分是控制器部分和传感器分接部分。评估器件在极端温度下的性能时，必须考虑这些限值。在这种情况下，如果设置条件超过控制器绝对最大热性能规格，则必须分离传感器分接部分，以便在这些温度下仅评估传感器（而不是 MCU）。

表 1-2. 热性能规格

板部分	条件	温度范围
控制器板	建议的自然通风条件下的工作温度范围 (T_A)	-40°C 至 85°C
	绝对最高结温 T_J	95°C
TMP4719 分接部分	建议的自然通风条件下的工作温度范围 (T_A)	-40°C 至 125°C

1.4 器件信息

TMP4719 是一款数字输出温度传感器，具有一个本地集成传感器和两个远程温度传感器通道。该器件采用与 SMBus 和 I^2C 接口兼容的两线制环境进行通信。该器件可设置为进行连续转换或单次转换，此外还可以使用 ALERT 与 T_CRIT 引脚实现警报功能。该器件在生产过程中进行了校准，以实现高精度，并可采用 VSSOP 和 WSON 封装。EVM 包括一个 TMP4719DGSR (VSSOP) 器件。有关该 IC 的更多信息，请参阅器件数据表。表 1-3 包含了在使用该 EVM 时要考虑的有关 TMP4719 的一些参数。

表 1-3. 器件规格

器件规格	值
工作温度范围	-40°C 至 125°C
工作电源电压范围	1.62V 至 5.5V
本地温度精度（T_A = -40°C 至 125°C）	± 1°C
远程温度精度（T_D = -10°C 至 85°C，T_A = -10°C 至 85°C）	± 0.8°C
远程温度精度（T_D = -55°C 至 125°C，T_A = -10°C 至 85°C）	± 1.0°C
温度精度（T_D = -55°C 至 125°C，T_A = -40°C 至 125°C）	± 1.5°C

2 硬件

2.1 概述

该 EVM 分为两个部分：控制器部分和传感器分接部分。传感器分接部分可以分离，以便在以下情况下使用传感器：

- 若需在极端温度或其他条件下，对远离控制器和 PC 的传感器进行评估，可将传感器分接部分通过焊接电线或连接器与控制器部分相连后进行。
- 将传感器分接部分连接到用户系统，通过 I^2C 与 TMP4719 通信来使用分接部分。
- 将控制器部分与用户系统中的 TMP4719 传感器结合使用。
- 传感器分接部分的右半部分（包含 PNP 和 NPN 晶体管）也可以分离，改为连接用户的远程传感器，例如不同的二极管连接晶体管。

图 2-1 突出显示了用户必须识别的 EVM 各部分以及一些元件，以便了解其用途和使用方法。后续几节将详细说明这些元件。

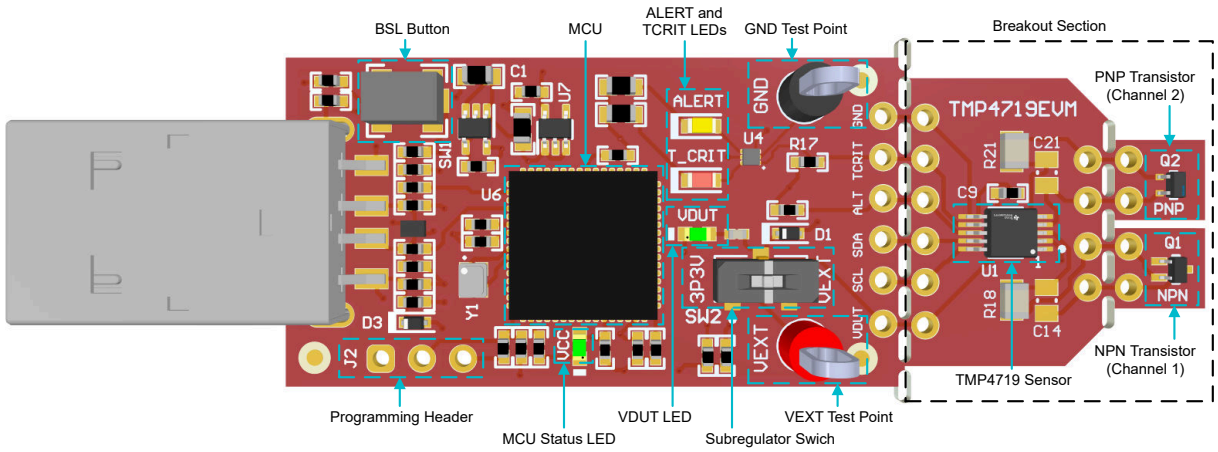


图 2-1. TMP4719EVM 电路板部分

2.2 穿孔和连接

USB 控制器和 TMP4719 传感器分接部分之间的穿孔在电路板底部两侧均进行了标记，以用于引脚连接。将传感器分接部分与控制器部分分离后，用户可以通过焊线或 0.1 英寸接头连接器来连接电路板部分。通过这种方法，用户可以访问该器件的所有 10 个引脚。

TMP4719 具有内置可编程数字滤波器来提高防噪性能。但是，在噪声特别大的环境中，可在远程通道输入端以差分方式放置一个旁路电容器，使应用能够更好地抵御不必要的耦合信号。传感器分接部分包括 0805 封装，供用户选择安装滤波电容器（默认不安装 C14 和 C21）。另外，某些应用可通过额外的串联电阻获得更好的总体精度。传感器分接部分包含 0805 封装，供用户选择安装串联电阻器（R18 和 R21 默认为 0Ω）。有关滤波电容和串联电阻值的具体建议，请参阅 TMP4719 数据表。

请注意，上拉电阻器和保护二极管位于控制器部分上。因此，当连接其他控制器板时，TI 建议验证任何控制器板上是否存在上拉电阻器和保护电路，以确保功能安全且正常。

2.3 状态 LED 和子稳压器

为 VDUT 供电后，绿色 LED D2 亮起。由于 VDUT 用于 TMP4719 器件电源，因此必须为 VDUT 供电才能确保 TMP4719EVM 正常运行。可以通过板载子稳压器 U7 或外部电源为 VDUT 供电。有关更多详细信息，请参阅 节 2.4。

当 ALERT 引脚为低电平时，黄色 LED D4 亮起。当 T_CRIT 引脚为低电平时，红色 LED D5 亮起。ALERT 和 T_CRIT 引脚的默认软件配置为低电平有效，当引脚变为有效或“跳闸”时，LED 将亮起。

绿色 LED D6 是 MSP430F5528 状态 LED。表 2-1 显示了器件如何通过 LED 状态显示不同的工作模式。

表 2-1. LED 状态与工作模式

D6 LED 状态	MSP430F5528 的工作模式
关闭	EVM 已连接到 EVM GUI
连续闪烁 4 次	EVM 已插入 PC，未连接到 EVM GUI
持续闪烁	已连接到 USB 电源

2.4 电源

VDUT 为 TMP4719 器件供电，必须设置在 1.62V 至 5.5V 之间才能确保 TMP4719EVM 正常运行。机械开关 SW2 用于将 VDUT 连接到子稳压器输出 (3P3V) 或外部电源 (VEXT)。

VDUT 默认连接到板载子稳压器 U7，该子稳压器将 USB 电源调低至 3.3V。在使用外部电源电压时，用户可以使用 VEXT 和 GND 测试点连接外部电源，或通过分接部分的焊接接头或焊线连接外部电源。当 VDUT 供电正常时，绿色 LED D2 将亮起。

2.5 编程接头

TMP4719EVM 预先加载了正常运行 USB 接口和 PC GUI 软件所必需的固件。提供了未填充的接头 J2，用于对 MSP430F5528 进行 Spy-Bi-Wire 访问。TI 不建议用户访问该接头或对器件进行重新编程。

2.6 BSL 按钮

TMP4719EVM 具有用于进入 USB BSL 模式的按钮 SW1。可将其用于固件更新。要进入 USB BSL 模式，请在按住 SW1 的同时将 EVM 连接到 PC USB 端口。

3 软件

3.1 软件下载

TMP4719EVM 的 PC GUI 软件在 TI 的 GUI Composer 框架上运行。该软件可作为在您的浏览器中运行的实时版本提供，也可以下载以供离线使用。该软件与 Windows®、Mac® 和 Linux® 操作系统兼容。

3.1.1 dev.ti.com 上的实时软件

在线软件当前可以在 Chrome、Firefox 和 Safari 中工作。不支持 Internet Explorer。用户可以通过以下操作之一访问实时版本：

- 转到 EVM 工具页面并点击“View”按钮。
- 转至 https://dev.ti.com/gallery/search/tmp4719

点击库中的应用程序图标以启动该软件。点击提示以安装 TI Cloud Agent Bridge 浏览器插件。

3.1.2 离线软件

3.1.2.1 从 dev.ti.com 下载

如上所述，用户可以通过导航到实时版本来访问最新版本的离线软件。找到下载图标 并下载适用于操作系统的应用程序和运行时，如库下载中所示。

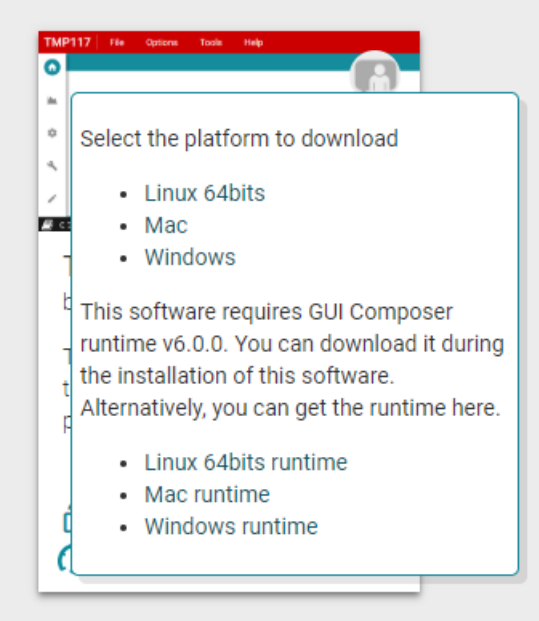


图 3-1. 下载弹出窗口

3.2 主页选项卡

“Home”选项卡会在软件启动时显示。在这里，您可以访问“Information”、“Data”、“Registers”和“Collateral”选项卡，如下详述。屏幕左侧的图标是这些选项卡的快捷方式。

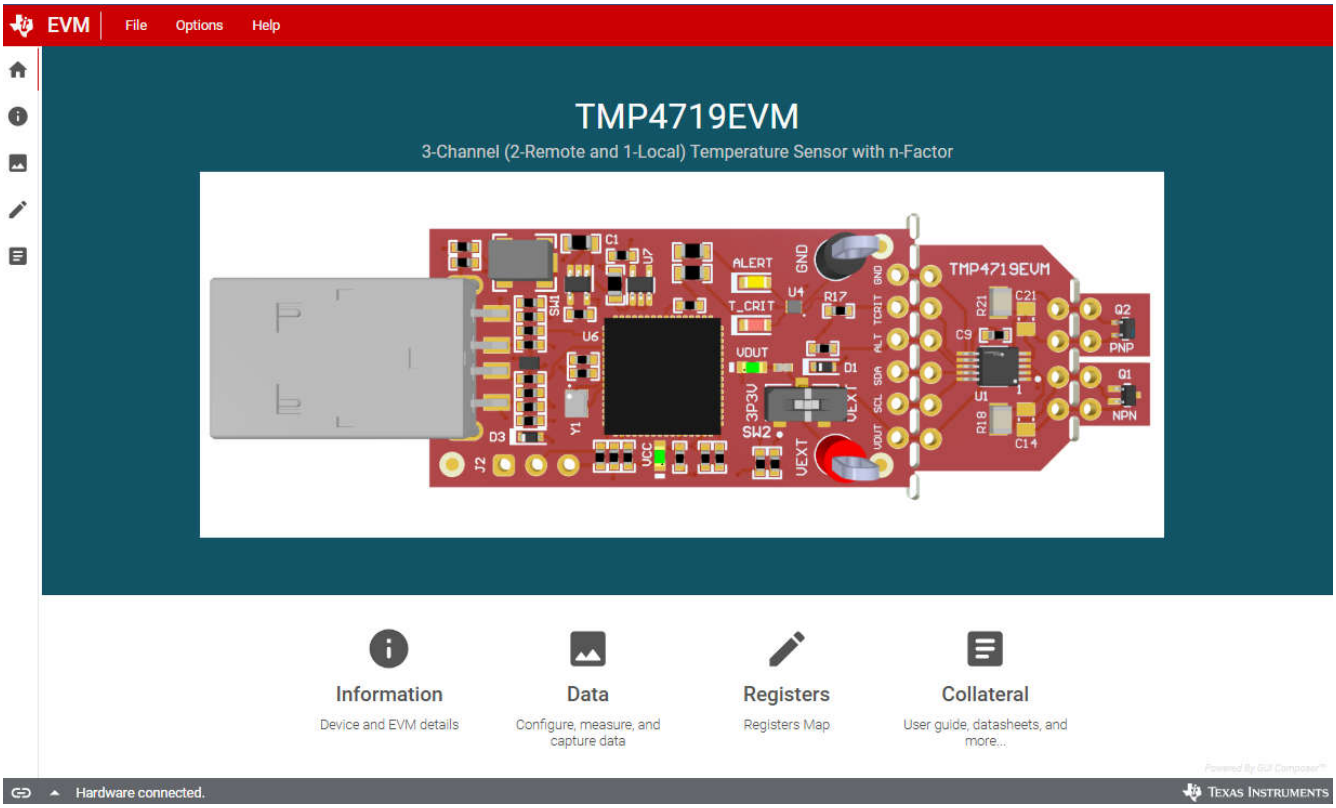


图 3-2. 主页

3.3 Information 选项卡

Information 选项卡显示 TMP4719 的器件详细信息和特性以及 EVM。Device Information & Features 子选项卡包含规格摘要、器件方框图和功能模式说明。EVM Details 子选项卡包含 EVM 原理图和图例。

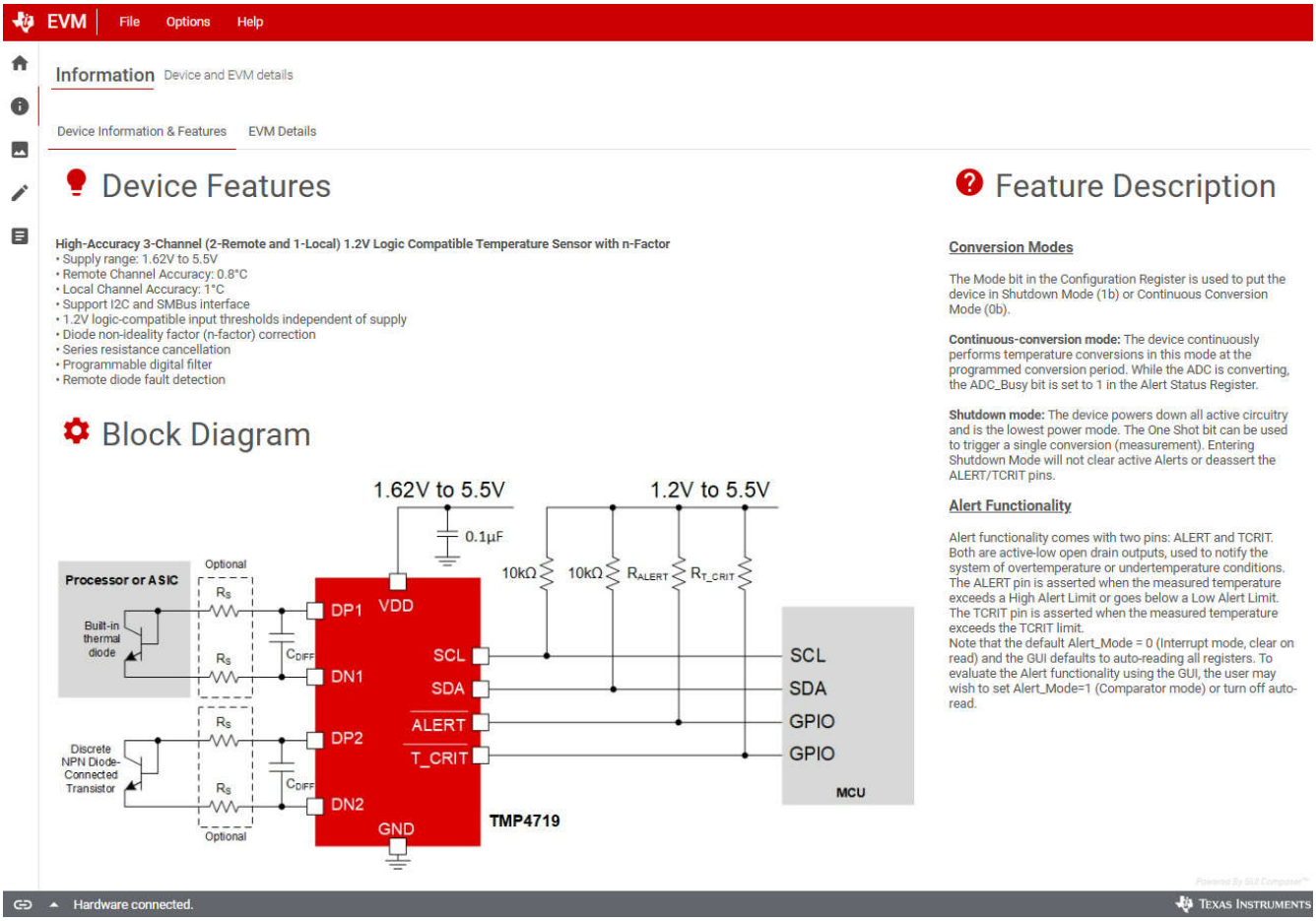


图 3-3. 信息

3.4 数据选项卡

“Data Capture”选项卡报告 TMP4719EVM 中包含的 TMP4719 器件的温度。默认情况下，连接 EVM 且 GUI 已正确加载并运行后，器件会以连续转换模式启动，并且 MCU 开始轮询器件。转换结果会自动报告并显示在“Data”选项卡图中。

在该选项卡的右侧，用户可以查看最新的温度读数值。此外，还有一个“Data Controls”框允许用户：

- 设置轮询速率。从下拉列表中选择一个值后，MCU 会自动开始以设定的轮询速率读取 TMP4719。
- 使用“Device Rate”字段写入 TMP4719 转换周期设置。从下拉列表中选择一个值后，MCU 会自动写入 TMP4719，然后开始以编程的速率转换。
- 开始和停止记录数据读取，可将数据导出为 CSV 格式，以便进行温度监测。用户必须通过点击“Start”按钮开始轮询。一旦点击“Stop”按钮，数据 (CSV) 会自动导出。

用户可通过“Alert Limit Settings”框轻松配置本地传感器和远程传感器的 Alert 和 TCRIT 限值。可以十进制格式写入限值，对应的十六进制值会自动显示在右侧，以供参考。一旦选定或更新，所有设置都由 MCU 自动写入 TMP4719。

还有一些按钮可轻松触发通用调用复位或单次触发温度测量。请注意，要触发单次触发，器件必须处于关断模式。通过写入 CONFIG 寄存器（模式[6] 位）来设置适当的器件模式。

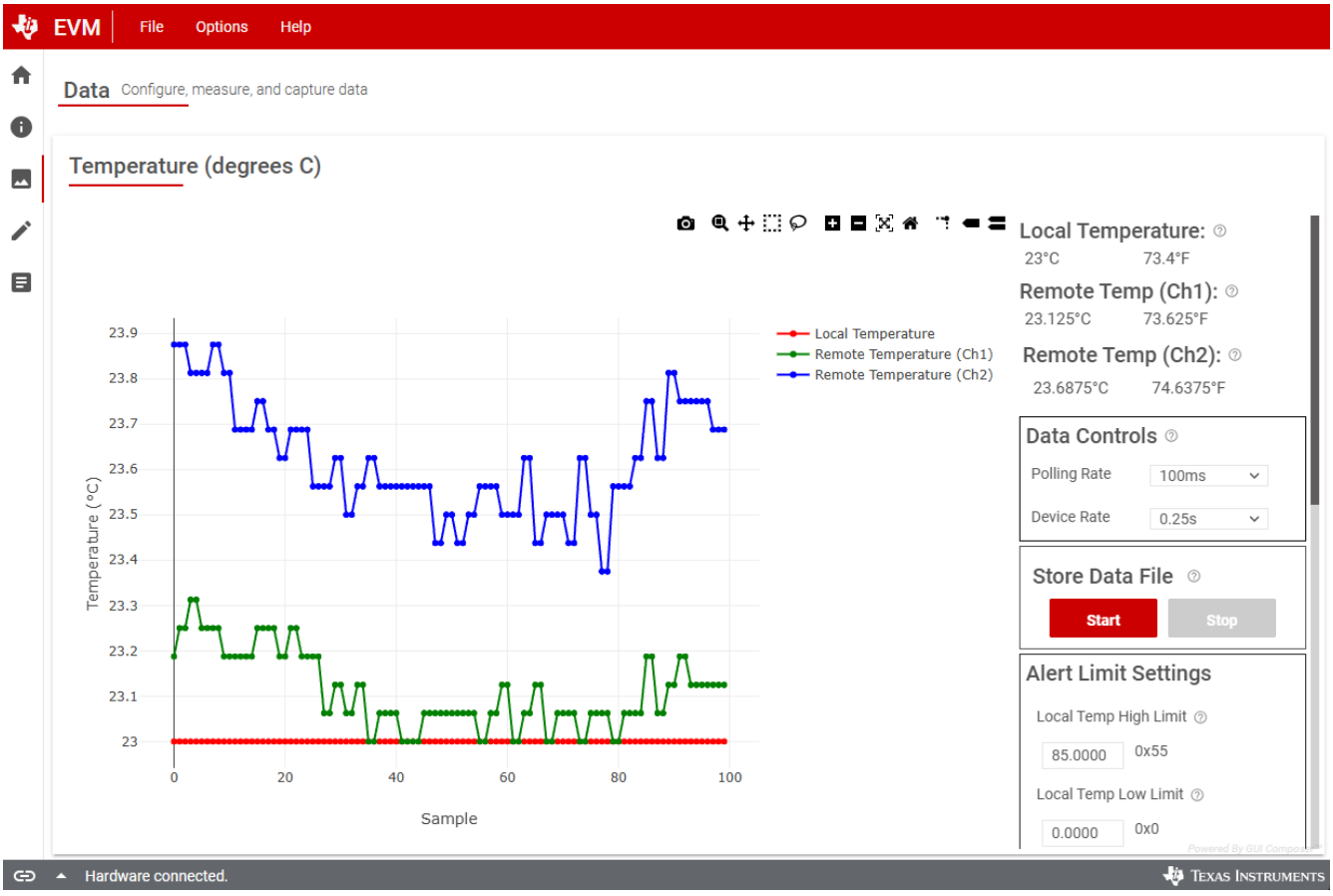


图 3-4. 数据采集

3.5 “Registers”选项卡

“Registers”选项卡提供 TMP4719 器件中寄存器和位的交互。有关每个寄存器/位的更多信息，请点击寄存器名称以查看每个位的定义。

“Auto Read”下拉框配置寄存器内容的轮询速率。默认情况下，MCU 以 100ms 的延迟轮询寄存器。当“Auto Read”关闭时，请点击“Read Register”来获取选定寄存器的内容。“Read All Registers”可用于立即获取所有寄存器的内容。

默认情况下，当“Write Mode”按钮被设置为“Immediate”时，“Write Register”按钮将显示为灰色并被禁用。每次修改寄存器时，Immediate 模式都会触发写入操作。选择“Deferred”模式时，会启用“Write Register”按钮，除非点击“Write Register”按钮，否则不会执行写入操作。

这些设置使用户可以完全控制 I²C 总线活动，并可以使用示波器、逻辑分析仪或总线监听器件轻松观察各个事务。

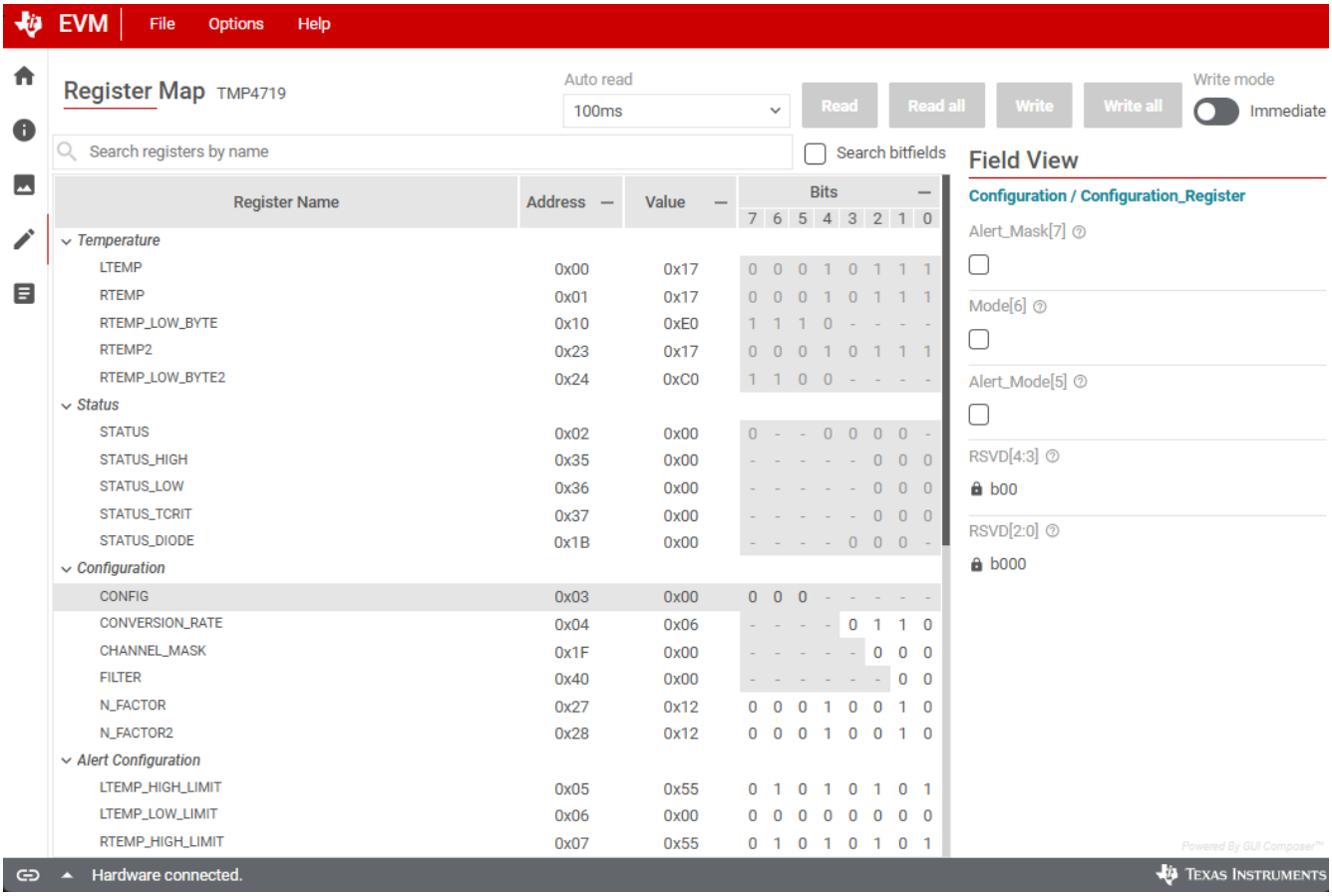


图 3-5. 寄存器

3.6 配套资料选项卡

“Collateral”选项卡包含 EVM 用户指南链接、ti.com 工具页面链接、产品数据表链接以及其他相关链接。

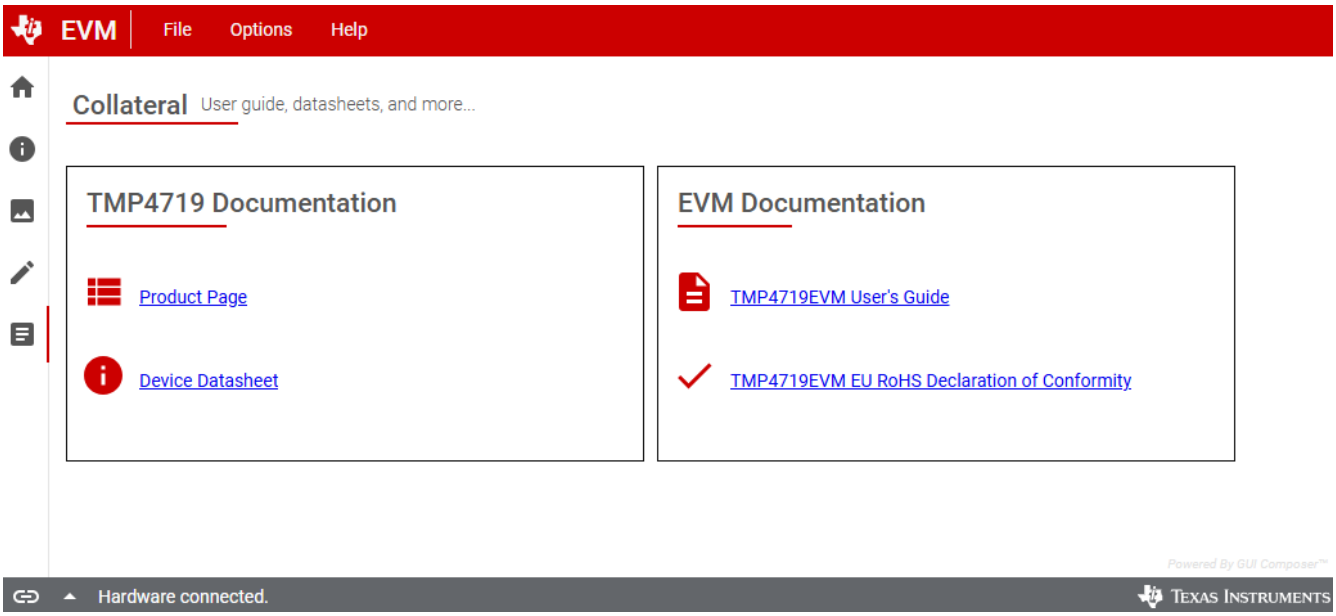


图 3-6. 配套资料

4 硬件设计文件

4.1 原理图

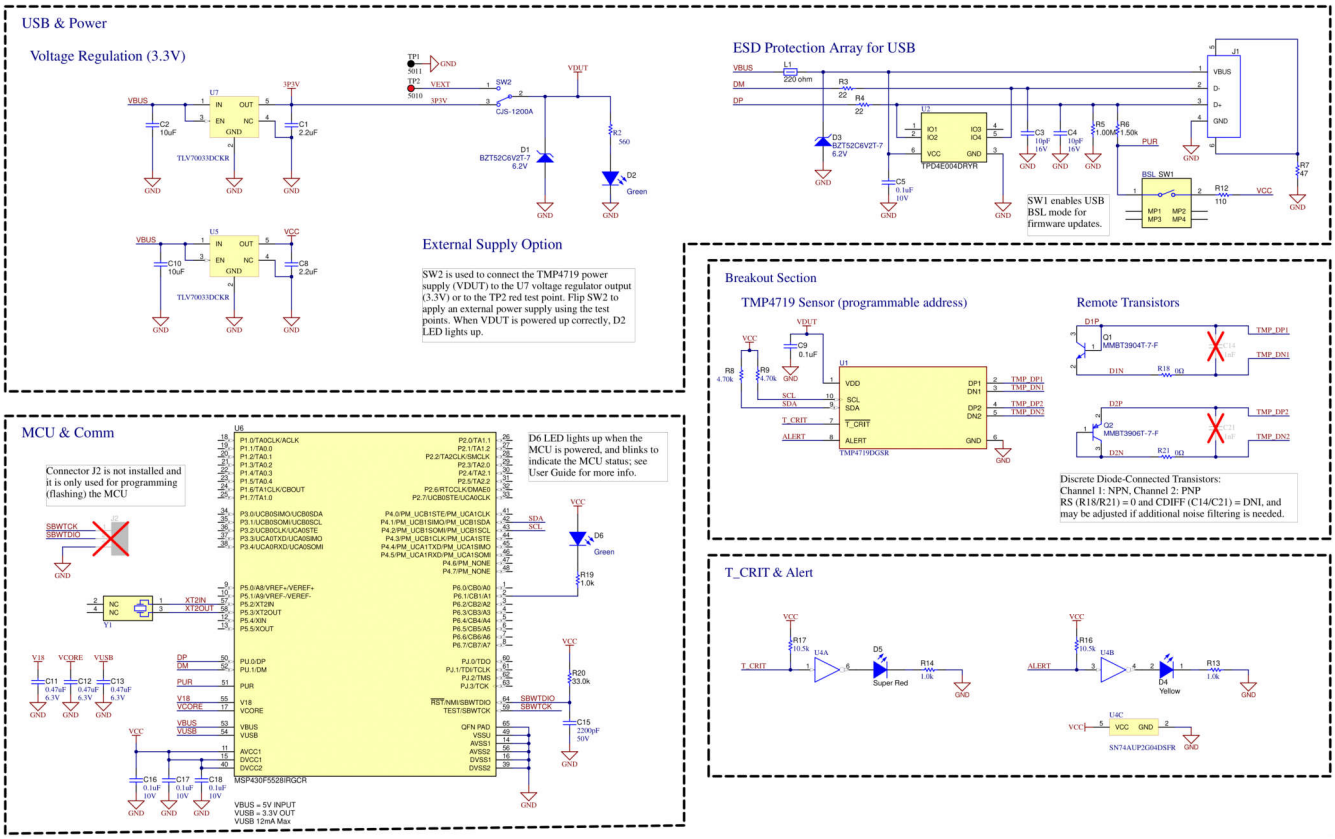


图 4-1. 原理图

4.2 PCB 布局

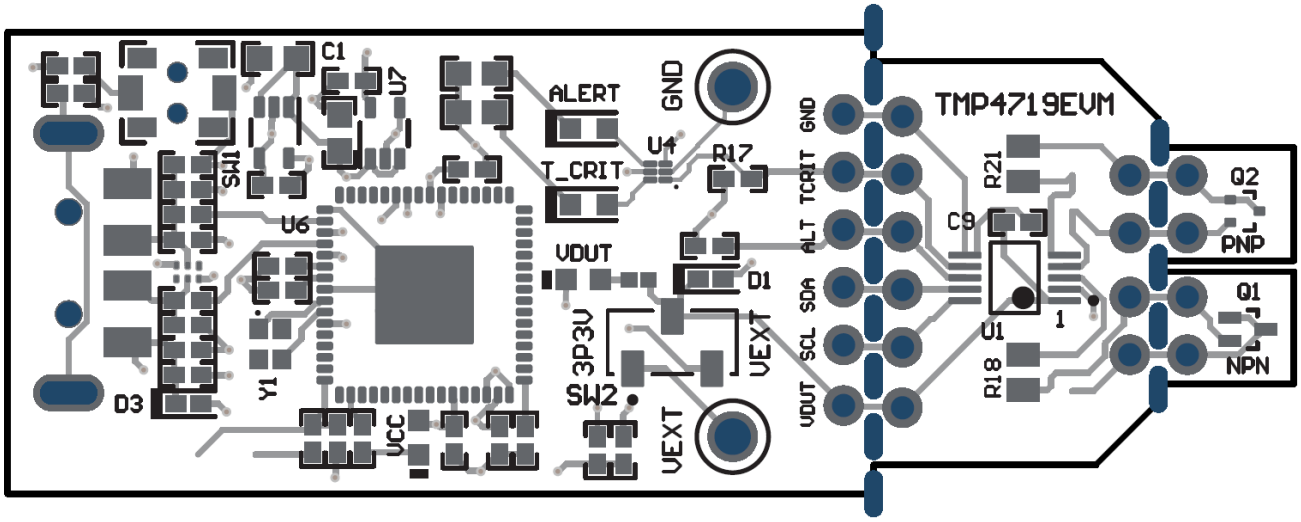


图 4-2. 顶视图

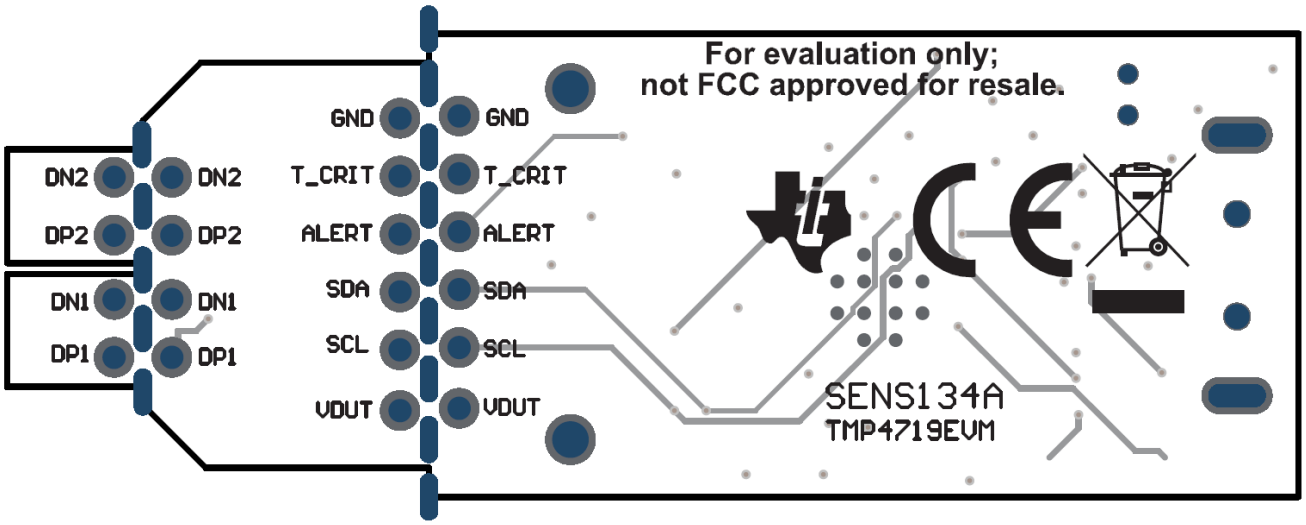


图 4-3. 底视图

4.3 物料清单

说明	指示符	器件型号	数量	制造商	封装参考	值
印刷电路板	!PCB1	SENS134	1	不限		
电容，陶瓷，2.2uF，16V，+/-10%，X5R，0402	C1, C8	GRM155R61C225KE11D	2	MuRata	0402	2.2uF
电容，陶瓷，10uF，10V，+/-20%，X5R，0603	C2、C10	C1608X5R1A106M080AC	2	TDK	0603	10uF
电容，陶瓷，10pF，16V，+/-10%，C0G，0402	C3、C4	C0402C100K4GACTU	2	Kemet	0402	10pF
电容，陶瓷，0.1uF，10V，+/-10%，X5R，0402	C5、C16、C17、C18	LMK105BJ104KV-F	4	Taiyo Yuden	0402	0.1uF
电容，陶瓷，0.1uF，16V，+/-10%，X7R，0402	C9	ATC530L104KT16T	1	AT Ceramics	0402	0.1uF
电容，陶瓷，0.47uF，6.3V，+/-10%，X7R，0402	C11、C12、C13	JMK105B7474KVHF	3	Taiyo Yuden	0402	0.47µF
电容，陶瓷，2200pF，50V，±5%，X7R，0402	C15	CL05B222JB5NNNC	1	Samsung Electro-Mechanics	0402	2200pF
二极管，齐纳，6.2V，300mW，SOD-523	D1、D3	BZT52C6V2T-7	2	Diodes Inc.	SOD-523	6.2V
LED，绿色，SMD	D2、D6	SML-LX0603GW-TR	2	Lumex	LED，绿色，0603	绿色
LED，黄色，SMD	D4	150060YS75000	1	Wurth Elektronik	LED_0603	黄色
LED，红色超高亮，SMD	D5	150060SS75000	1	Wurth Elektronik	LED_0603	红色超高亮
连接器，插头，USB Type-A，R/A，顶部安装 SMT	J1	48037-1000	1	Molex	USB Type-A 直角	
铁氧体磁珠，220ohm（在 100MHz 时），0.45A，0402	L1	BLM15AG221SN1D	1	MuRata	0402	220ohm
晶体管，NPN，40V，0.2A，SOT-523	Q1	MMBT3904T-7F	1	Diodes Inc.	SOT-523	40V
双极 (BJT) 晶体管 PNP 40V 200mA 250MHz 150mW 表面贴装 SOT-523	Q2	MMBT3906T-7F	1	二极管	SOT523	-40V
RES，560Ω，0402	R2	RC0402JR-07560RL	1	Yageo/Phycomp	0402	560ohm
电阻，22，5%，0.1W，AEC-Q200 0 级，0402	R3、R4	ERJ-2GEJ220X	2	Panasonic	0402	22
电阻，1.00M，1%，0.063W，AEC-Q200 0 级，0402	R5	RMCF0402FT1M00	1	Stackpole Electronics Inc	0402	1.00Meg
电阻，1.50k，1%，0.063W，AEC-Q200 0 级，0402	R6	RMCF0402FT1K50	1	Stackpole Electronics Inc	0402	1.50k
电阻，47，5%，0.1W，AEC-Q200 0 级，0402	R7	ERJ-2GEJ470X	1	Panasonic	0402	47
电阻，4.70k，1%，0.1W，0402	R8、R9	ERJ-2RKF4701X	2	Panasonic	0402	4.70k
电阻，110，1%，0.1W，AEC-Q200 0 级，0402	R12	ERJ-2RKF1100X	1	Panasonic	0402	110

说明	指示符	器件型号	数量	制造商	封装参考	值
电阻，1.0k，5%，0.1W，0603	R13、R14	RC0603JR-071KL	2	Yageo	0603	1.0k
电阻，10.5k，1%，0.063W，0402	R16、R17	RC0402FR-0710K5L	2	Yageo America	0402	10.5k
片式电阻器，0Ω，0.125W，-55°C 至 125°C，0805（公制 2012），RoHS，卷带包装	R18、R21	CRG0805ZR	2	TE Connectivity	0805	0ohm
电阻，1.0k，5%，0.1W，AEC-Q200 0 级，0402	R19	ERJ-2GEJ102X	1	Panasonic	0402	1.0k
电阻，33.0k，1%，0.063W，0402	R20	RC0402FR-0733KL	1	Yageo America	0402	33.0k
开关，SPST-NO，Off-Mom，0.05A，12VDC，SMD	SW1	PTS820J20M SMTR LFS	1	C&K Components	3.9x2.9mm	
滑动开关，2 位，SPDT，锁存，0.1A，6VDC，焊接端子，表面贴装-直插式	SW2	CJS-1200A	1	Nidec Copal	SMT_SW_5MM4_2MM5	
测试点，黑色，穿孔，RoHS，大容量	TP1	5011	1	Keystone	5011	
测试点，红色，穿孔，RoHS，大容量	TP2	5010	1	Keystone	5010	
具有串联电阻、η 因数和自动 Beta 补偿的高精度 3 通道（2 个远程和 1 个本地）1.2V 逻辑兼容温度传感器	U1	TMP4719DGSR	1	德州仪器 (TI)	VSSOP10	
适用于高速数据接口的 4 通道 ESD 保护阵列，DRY0006A (USON-6)	U2	TPD4E004DRYR	1	德州仪器 (TI)	DRY0006A	
低功耗双路反相器门，DSF0006A，大盘卷带包装	U4	SN74AUP2G04DSFR	1	德州仪器 (TI)	DSF0006A	
单路输出 LDO，200mA，固定 3.3V 输出，2 至 5.5V 输入，具有低 IQ，5 引脚 SC70 (DCK)，-40 至 125 摄氏度，绿色环保（RoHS，无锑/溴）	U5、U7	TLV70033DCKR	2	德州仪器 (TI)	DCK0005A	
16 位超低功耗微控制器，128KB 闪存，8KB RAM，USB，12 位 ADC，2 个 USCI，32 位硬件乘法器，RGC0064B (VQFN-64)	U6	MSP430F5528IRGCR	1	德州仪器 (TI)	RGC0064B	
晶体，24MHz，SMD	Y1	XRCGB24M000F2P00R0	1	MuRata	2x1.6mm	
电容，1nF，50V，±5%，0805（公制 2012），厚度 1.45mm SMD	C14、C21	CC0805JRX7R9BB102	0	Yageo	0805	1nF
接头，100mil，3x1，金，TH	J2	TSW-103-07G-S	0	Samtec	3x1 接头	

5 其他信息

5.1 商标

Windows® is a registered trademark of Microsoft Corporation.
Mac® is a registered trademark of Apple Inc.
Linux® is a registered trademark of Linus Torvalds.
所有商标均为其各自所有者的财产。

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

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

WARNING

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

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

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

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

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

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

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做出任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 TI 销售条款)、TI 通用质量指南 或 ti.com 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。 除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

最后更新日期：2025 年 10 月