EVM User's Guide: BQ27427EVM

BQ27427 单节电池阻抗跟踪技术

摘要

该评估模块 (EVM) 是一个适用于 BQ27427 的完整评估系统。该 EVM 包含一个集成了电流检测电阻器的 BQ27427 电路模块。使用该 EVM 需要配备一个用于连接电量监测计的 EV2400 PC 接口板（可单独订购），一根 PC USB 电缆，以及基于 Microsoft® Windows® 的 PC 软件。该电路模块包含一个 BQ27427 集成电路，以及用于监测和预测系统侧电量监测计解决方案容量的所有其他板载组件。通过将该电路模块连接到 EV2400 接口板和软件，用户可以：

- 读取 BQ27427 数据寄存器
- 针对不同配置更新 RAM
- 记录循环数据，以便进一步评估
- 对 BQ27427 解决方案在不同充电和放电条件下的整体功能进行评估

最新的 Windows PC 软件可从德州仪器 (TI) 网站的产品文件夹下载。

内容

插图清单

表格清单

商标

1 特性

- 适用于采用 Impedance Track™ 技术的 BQ27427 电量监测计的完整评估系统
- 已组装的电路模块，便于快速设置
- 用于轻松评估的个人计算机 (PC) 软件和接口板
- 通过软件记录数据，便于进行系统分析

1.1 套件内容

- BQ27427 评估模块 (BMS037)

该 EVM 用于评估 BQ27427 电池电量监测计。可访问 www.ti.com 上的产品 Web 文件夹并下载 TRM，了解如何配置 BQ27427。

1.2 订购信息

表 1-1. 订购信息

器件型号	EVM 器件型号
BQ27427	BQ27427EVM

2 基于 BQ27427 的电路模块

基于 BQ27427 的电路模块是用于电池管理的 BQ27427 电路的一个完整且紧凑的示例解决方案。该电路模块包含 BQ27427 电池电量监测计集成电路 (IC)，其中集成了检测电阻器以及准确预测 1 节锂离子电池的容量所需的所有必要组件。

2.1 电路模块连接

电路模块上的触点提供以下连接：

- 与电池包的直接连接 (J5)：PACK+、PACK－
- 连接串行通信端口 (J10)：SDA、SCL 和 VSS
- 充电器和负载 (J6 和 J7) 之间的系统负载和充电器连接：CHARGER+/LOAD+ 和 CHARGER－/LOAD－。
- 获取信号输出（J1 和 J5）：BIN 和 GPOUT
- 通过外部连接为 IC (J4) 供电：EXT VDD 和 VSS

2.2 引脚说明

表 2-1. 引脚说明

引脚名称	说明
PACK+	电池组正极端子
PACK－	电池组负极端子
SDA	I2C 通信数据线路
EXT VDD	外部电源连接
SCL	I2C 通信时钟线路
VSS	通信线路的信号回路，与充电器和接地共用
CHARGER+/LOAD+	负载或充电器连接的高电势
CHARGER－/LOAD－	负载或充电器连接的低电势（系统 VSS）
区间	电池插入检测输入
GPOUT	通用输出

3 评估模块物理布局、物料清单和原理图

本节提供了 BQ27427 评估模块的电路板布局、物料清单和原理图。

3.1 电路板布局

本节给出了 BQ27427 模块的印刷电路板 (PCB) 层（ 图 3-1 至图 3-4 ）和装配图。

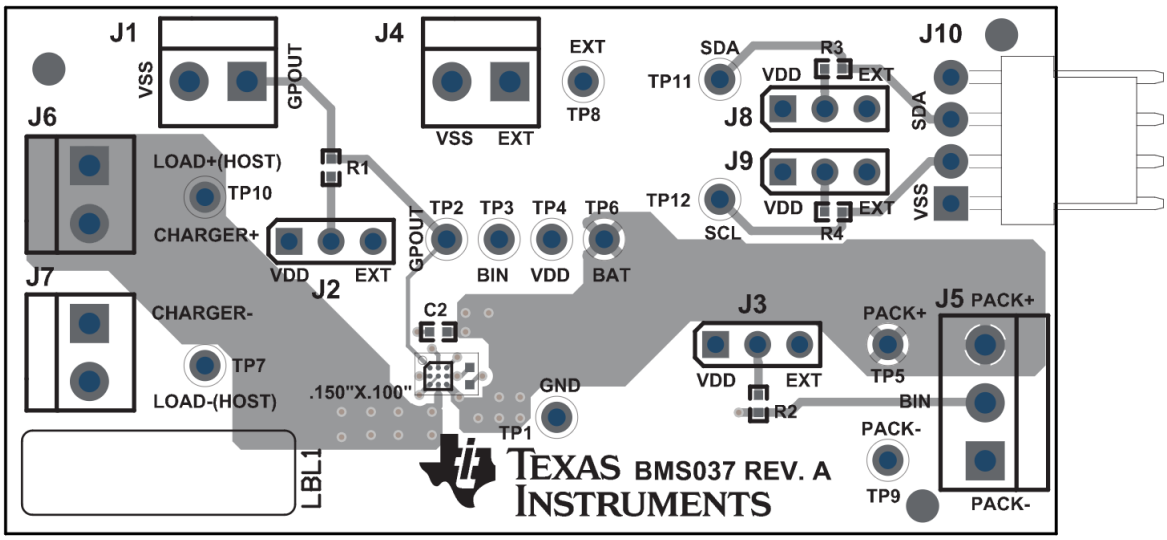

图 3-1. BQ27427EVM 布局 - 顶层丝印层

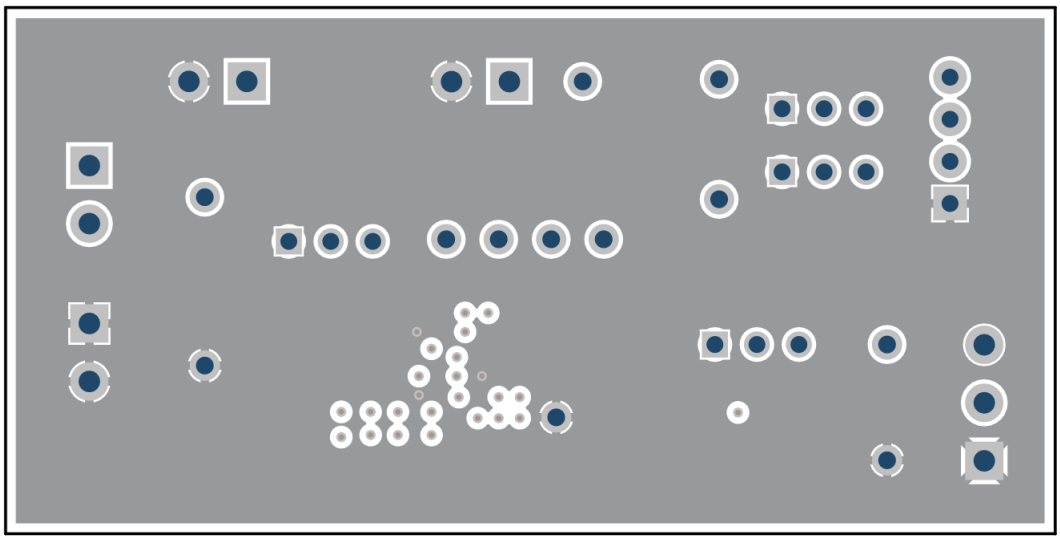

图 3-2. BQ27427EVM 布局 - 中间层 2

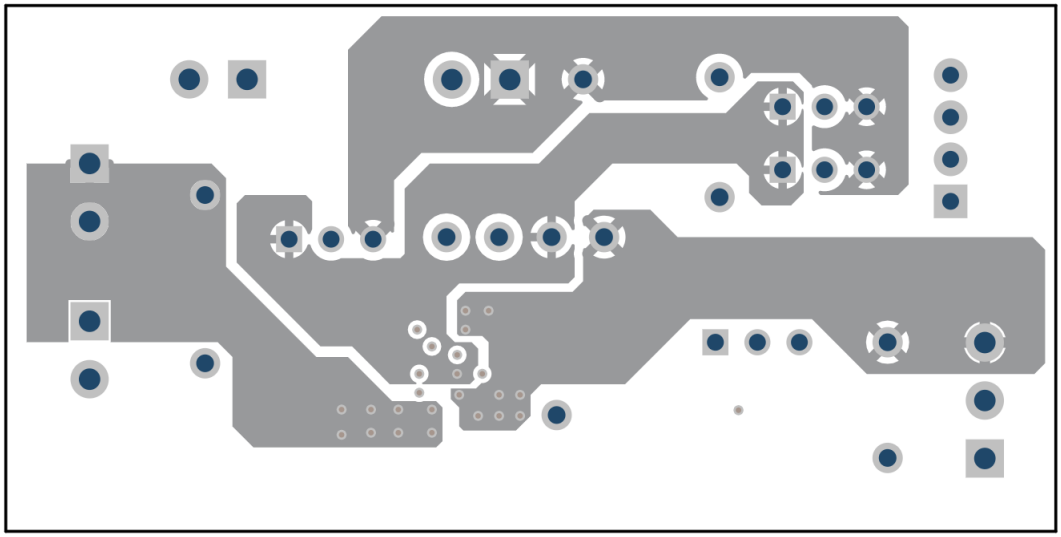

图 3-3. BQ27427EVM 布局 - 中间层 3

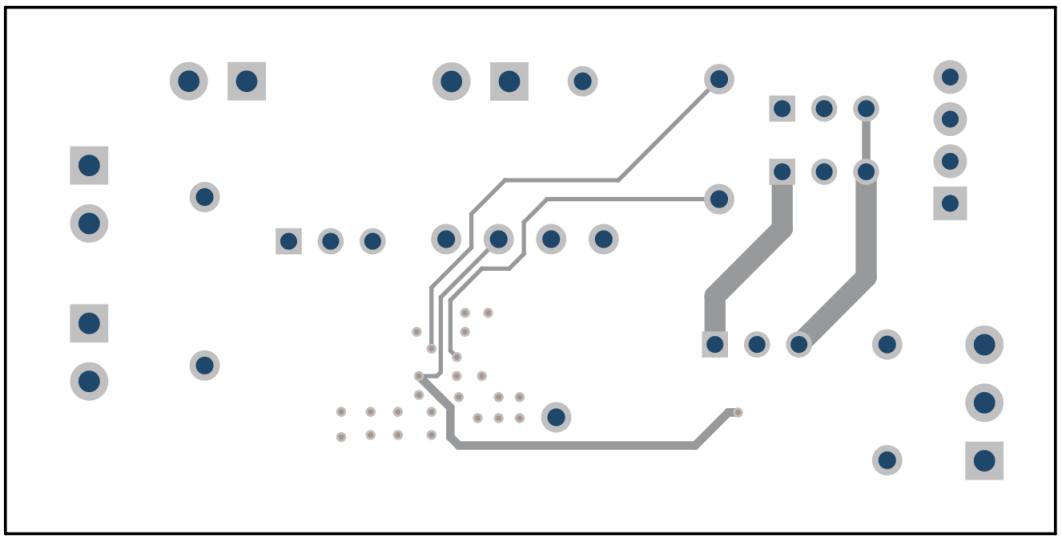

图 3-4. BQ27427EVM 布局 - 底层

3.2 物料清单

表 3-1. 物料清单

数量	参考指示符	值	说明	尺寸	器件型号	制造商
1	C1	4.7	电容，陶瓷，6.3V，X5R，20%	0402		
1	C2	1	电容，陶瓷，6.3V，X5R，10%	0402		
4	J1、J4、J6、J7	ED555/2DS	端子块，2 引脚，6A，3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
4	J2、J3、J8、J9	PEC36SAAN	接头，公头 3 引脚，100mil 间距	0.100inch x 3	PEC36SAAN	Sullins
1	J5	ED555/3DS	端子块，3 引脚，6A，3.5mm	0.41 x 0.25 inch	ED555/3DS	OST
1	J10	22-05-3041	接头，摩擦锁总成，4 引脚直角	0.400 x 0.500	22-05-3041	Molex
1	R1	14.7k	电阻，贴片，1/16W，5%	0402	Std	Std
1	R2	10k	电阻，贴片，1/16W，5%	0402	Std	Std
2	R3、R4	5.1k	电阻，贴片，1/16W，5%	0402	Std	Std
4	TP1、TP7、TP9	5001	测试点，黑色，通孔式颜色编码	0.100 × 0.100 英寸	5001	Keystone
7	TP2、TP3、TP11、TP12	5002	测试点，白色，通孔式颜色编码	0.100 × 0.100 英寸	5002	Keystone
3	TP4、TP5、T6、TP10	5000	测试点，红色，通孔式颜色编码	0.100 × 0.100 英寸	5000	Keystone
1	U1	BQ27427YZF	IC、电池电量监测计	DSBGA	BQ27427	TI

3.3 原理图

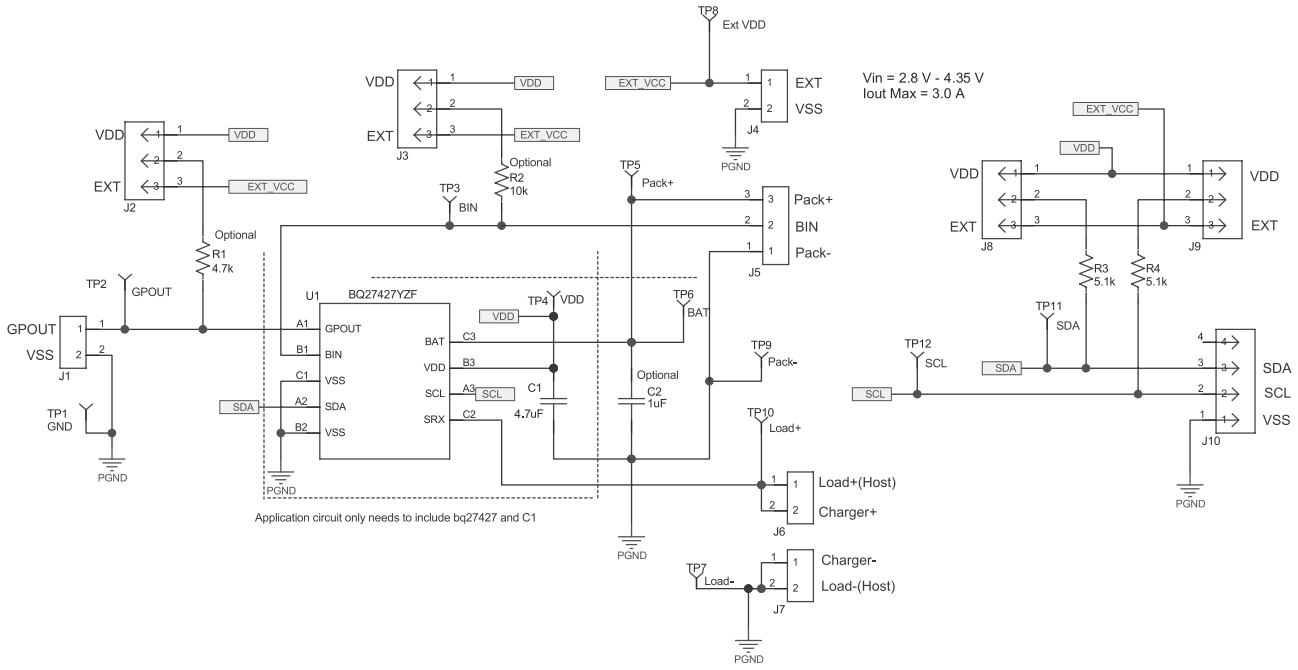

图 3-5. BQ27427EVM 原理图

3.4 BQ27427 电路模块性能规格汇总

本节总结了 BQ27427 电路模块的性能规格。

表 3-2. 性能规格汇总

规格	最小值	典型值	最大值	单元
Pack+ 至 Pack – 的输入电压	2.7	3.6	4.3	V
充电和放电电流	0	1	2.5	A

4 EVM 硬件和软件设置

本节介绍如何安装 BQ27427EVM PC 软件，以及如何连接 EVM 的不同组件。

4.1 软件安装

在 https://www.ti.com/tool/bqStudio 上查找最新的软件版本。按照以下步骤安装 Battery Management Studio 软件：

1. 开始安装之前，确保 EV2400 未通过 USB 电缆连接到 PC。
2. 在产品文件夹中选择 Tool and Software 选项卡
3. 在 Software 部分下，单击 Battery Management Studio (bqStudio) Software Suite。
4. 单击 Download 按钮下载软件。
5. 将软件下载到硬盘。
6. 双击软件的可执行文件，然后按照所有说明和提示进行操作。

5 排查意外对话框故障

下载文件的用户必须以管理员身份登录。驱动程序未签名，因此管理员必须允许在操作系统中安装未签名的驱动程序。

6 硬件连接

BQ27427 评估系统包含三个硬件组件：BQ27427 评估模块、EV2300 或 EV2400 PC 接口板以及 PC。

6.1 将 BQ27427 电路模块连接到电池包

图 6-1 展示了如何将 BQ27427 电路模块连接到电池和系统负载/充电器。

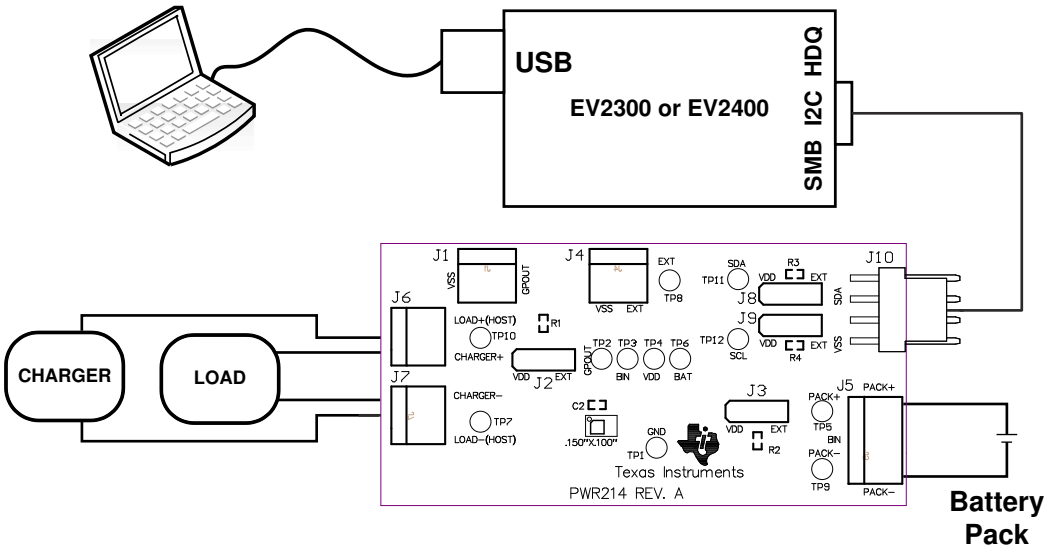

图 6-1. BQ27427 电路模块与电池组和系统负载/充电器的连接

6.2 PC 接口连接

以下步骤用于配置与 PC 的硬件连接。

1. 使用导线将基于 BQ27427 的 EVM 连接到 EV2400，如表 6-1 所示。
2. 将 PC USB 电缆连接到 EV2400 和 PC USB 端口。

表 6-1. 电路模块与 EV2400 的连接

BQ27427EVM	EV2400
SDA	SDA
SCL	SCL
VSS	GND/VSS

BQ27427EVM 现已设置完毕，可以运行。

7 运行

本节详细介绍 bqStudio 软件的操作。

7.1 启动程序

依次选择 Start | All Programs | Texas Instruments | Battery Management Studio 来运行 bqStudio。此时将显示主屏幕（图 7-1）。如果没有显示图 7-1，而显示了图 7-2，可能意味着 EVM 未正确连接到计算机。确保 USB 接口 (EV2400) 和 BQ27427 已连接，然后重新启动 bqStudio。如果这样仍然无法解决问题，请检查是否连接了 I2C 上拉电阻器。单击 <Refresh>（单次扫描）或 Scan 按钮便会开始显示数据。要禁用扫描功能，只需再次单击 Scan 按钮。

可依次打开 Window | Preferences | Register 部分来设置连续扫描周期。此间隔的范围为 0ms 至 65,535ms。在此期间仅扫描选定的待扫描项目。

Battery Management Studio 提供了记录功能，可记录上次扫描的值。要启用此功能，请选择 Start Log 按钮，此时会按下 Scan 按钮。记录停止后，Scan 按钮仍处于选中状态，需要再次手动单击。

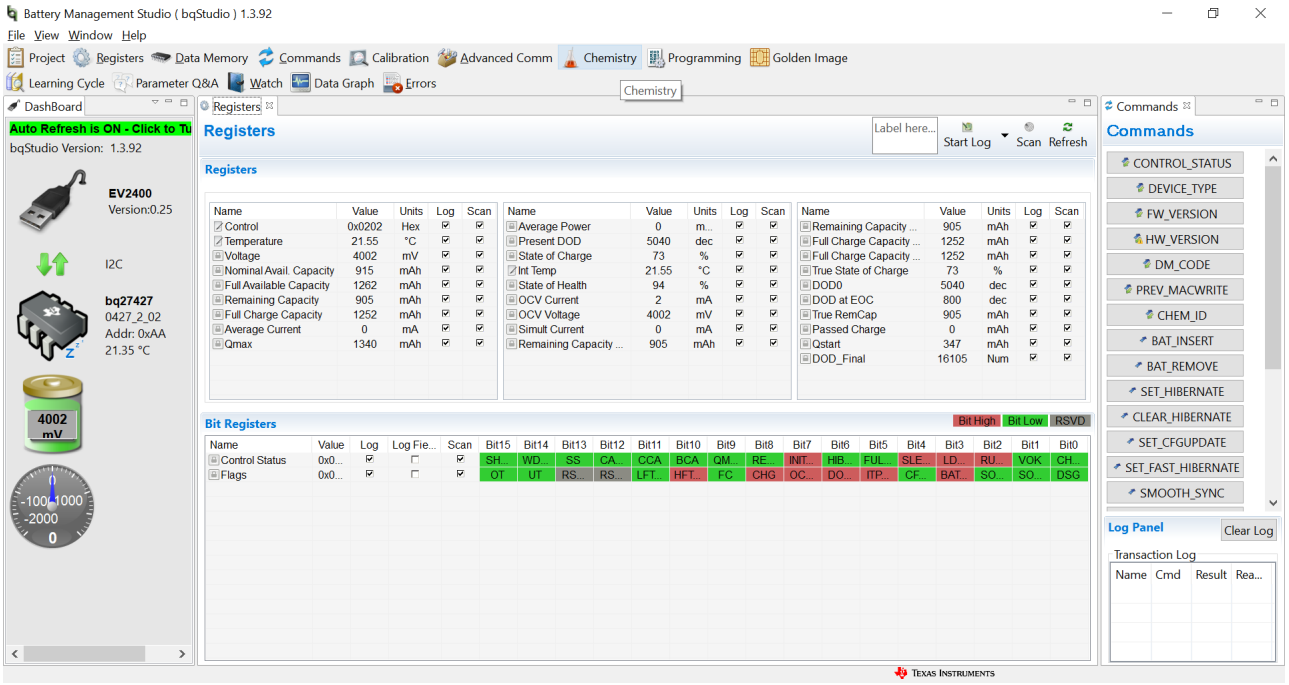

图 7-1. 寄存器屏幕

图 7-1 展示了 bqStudio 主窗口。可以在 Registers 窗口底部查看其他标志和状态数据。

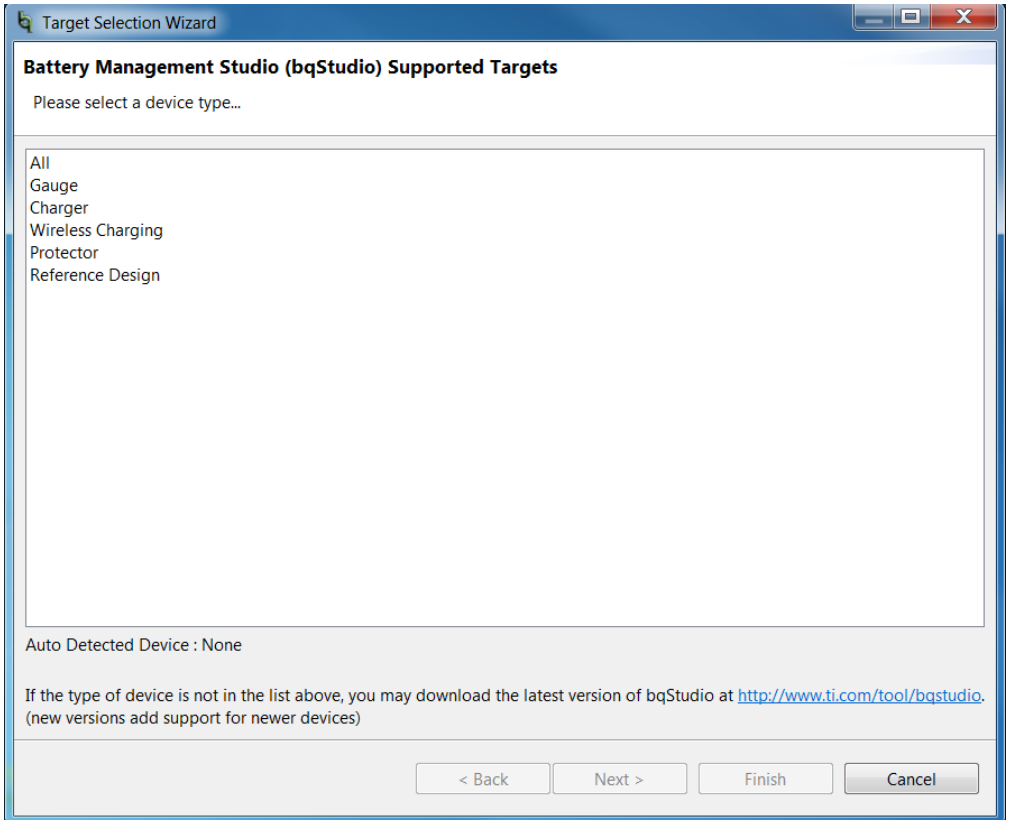

图 7-2. bqStudio 默认页面

7.2 设置可编程 BQ27427 选项

BQ27427 数据存储器按照 BQ27427 技术参考手册 (SLUUAC5) 中详细说明的默认设置进行配置。确保根据评估的 BQ27427 解决方案的电池包和应用，正确修改相应设置。

重要提示：正确设置这些选项对于获得最佳性能至关重要。可以在 Data Memory 屏幕（图 7-3）中配置这些设置。

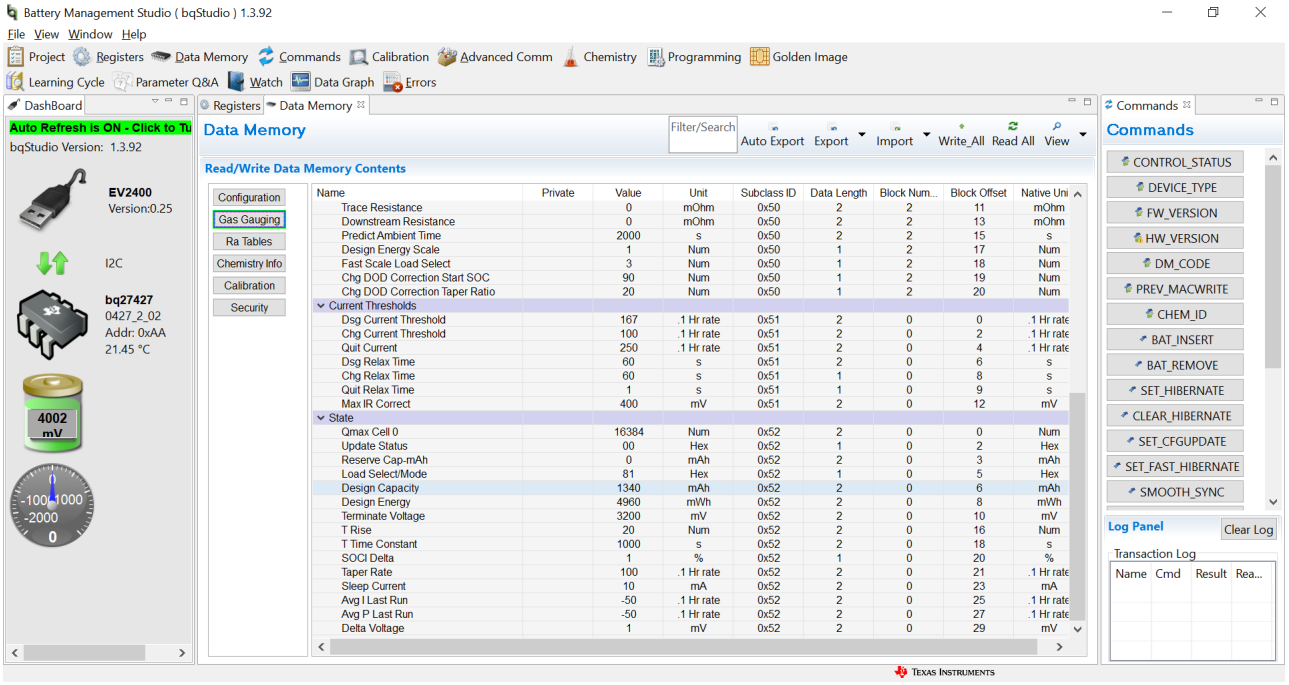

图 7-3. 数据存储器屏幕

存储器窗口。确保器件未处于密封状态，并且完全具备对数据存储器的读写访问权限。要更新参数，请单击所需的参数，此时会弹出一个窗口，提供所选参数的详细信息。接下来，在数值文本框中输入值，然后按 Enter 键。按 Enter 键后，bqStudio 将更新所选参数。可以单击 Data Memory 窗口中的 Import 按钮，从指定的 *.gg.csv 文件导入整个配置。

要将配置保存到文件，可以单击 Data Memory 窗口中的 Export 按钮并输入文件名。配置会保存为 *.gg.csv 文件。模块校准数据也保存在 BQ27427 的数据存储器中。如果 Gauge Dashboard 未显示任何信息，则使用的 bqStudio 版本可能不支持 BQ27427，可能需要升级 bqStudio。

8 校准

必须校准 BQ27427EVM，才能确保报告准确的值。这是使用 bqStudio 中的 Calibration 窗口来完成的（图 8-1）。

8.1 校准 BQ27427

1. 选择要执行的校准类型（请参阅图 8-1）。
2. 输入选定类型的测量值。
3. 按下按钮进行校准。

8.2 电压校准

通常不需要进行电压校准。如果需要，请按照以下步骤操作：

1. 测量 Pack+ 和 Pack－ 之间的电压。
2. 在 Enter measured value 中键入电压值（以 mV 为单位）。
3. 按 Calibrate 按钮。

8.3 电路板失调校准

这会对电路板的电流偏移执行偏移校准。

执行该校准步骤时，预计没有电流流过检测电阻器。

1. 移除负载并将 PACK- 短接至 LOAD－。
2. 按下 Calibrate 按钮

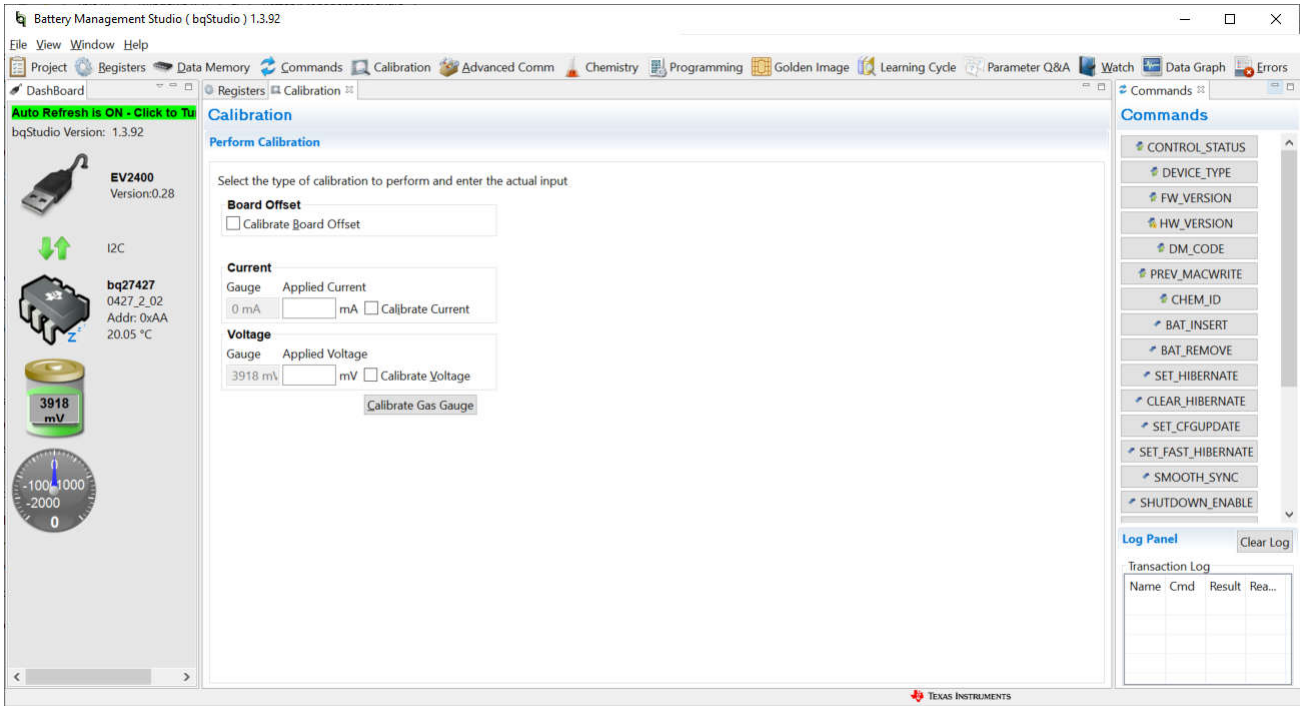

图 8-1. 校准屏幕

9 高级通信 I²C

9.1 I²C 通信

I²C 读/写操作可用作通用通信工具（图 9-1）。

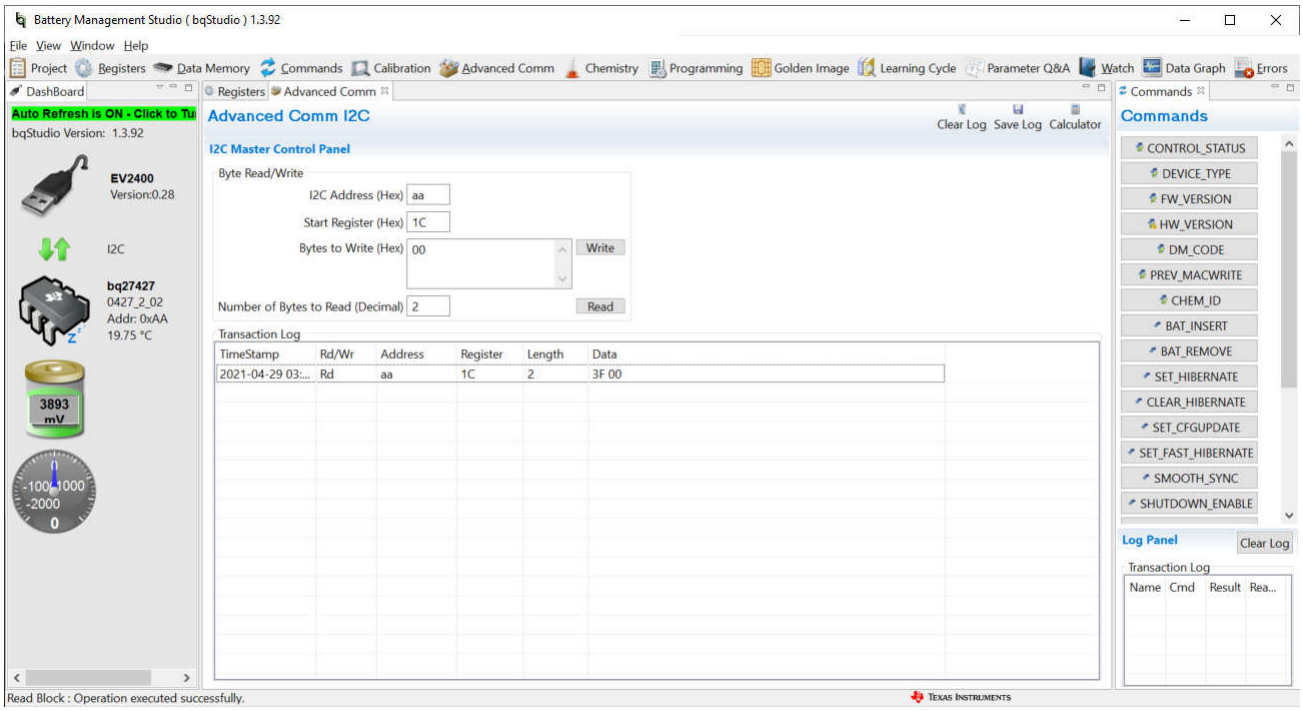

图 9-1. 高级通信 I²C

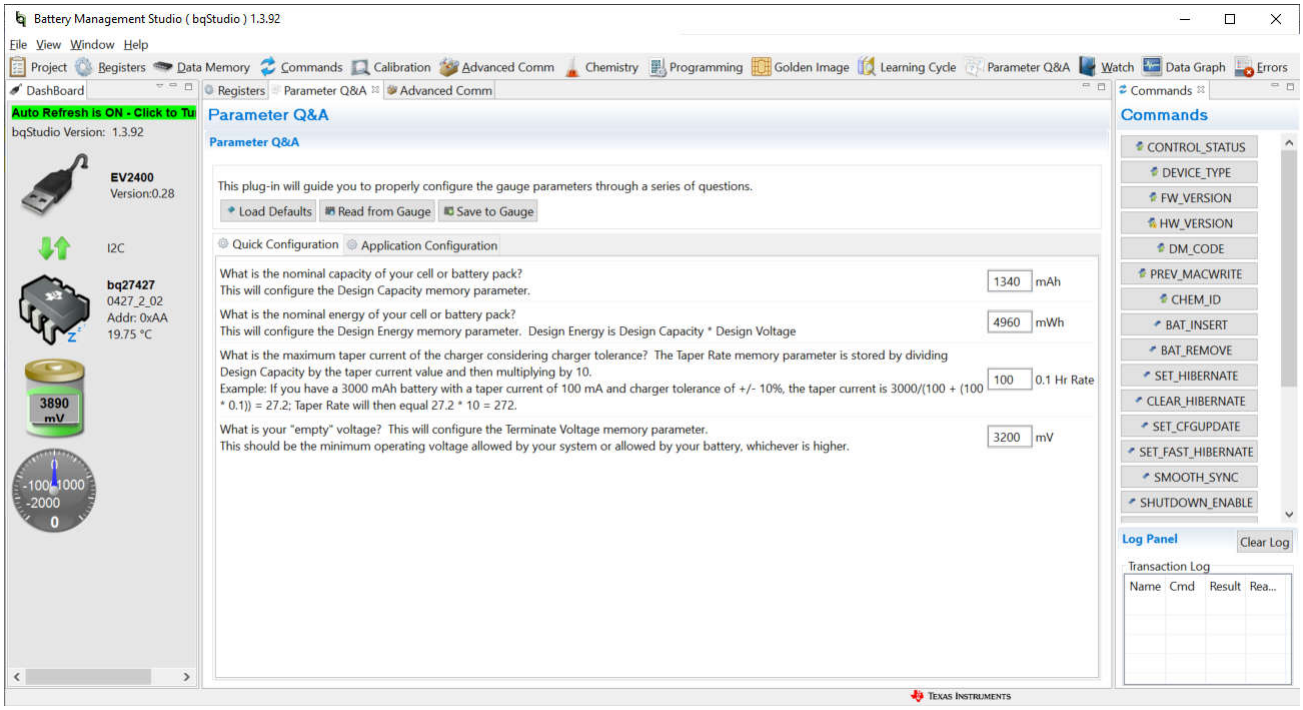

图 9-2. Parameter Q&A 屏幕

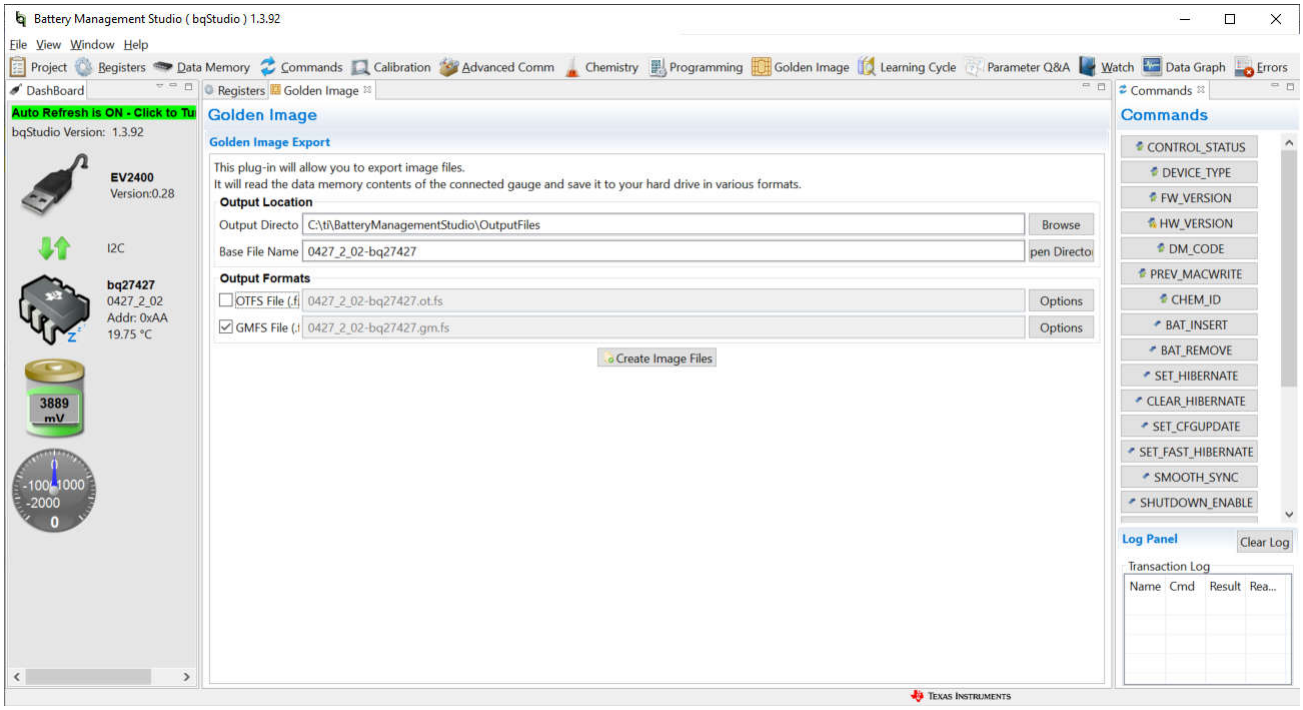

图 9-3. Golden Image Output 屏幕

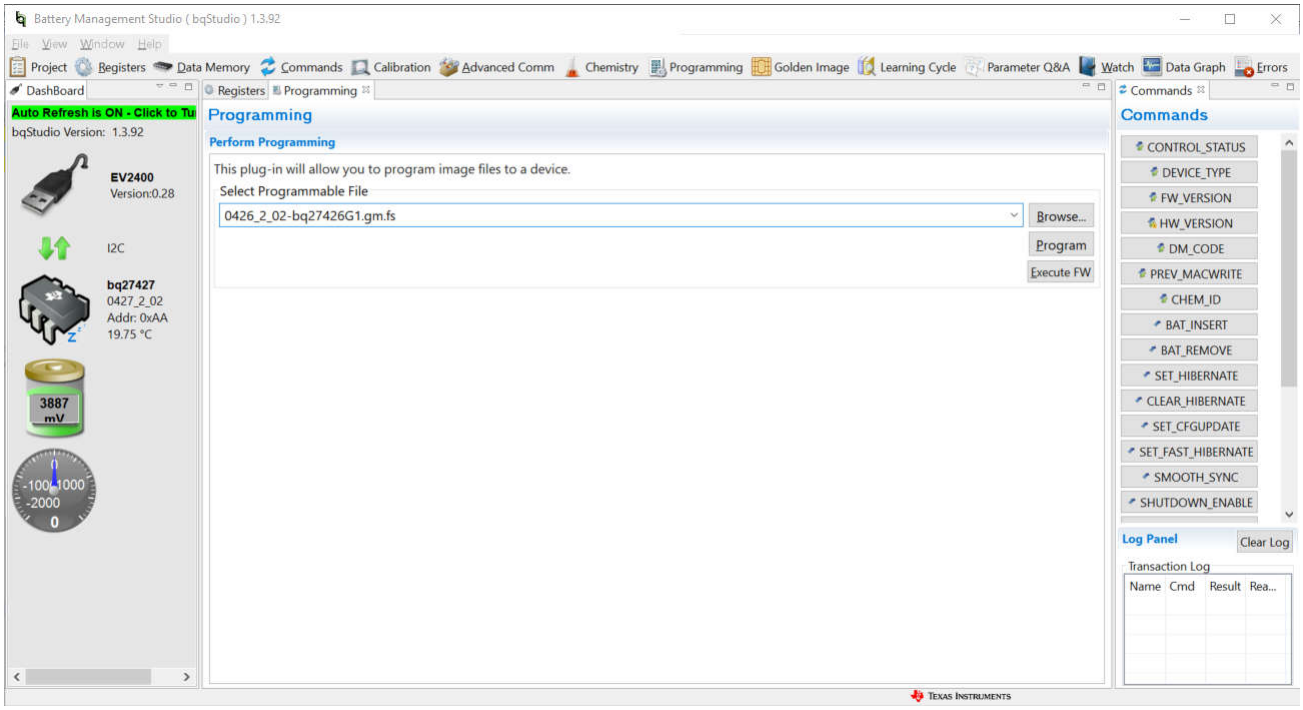

图 9-4. Gauge Programming 屏幕

10 相关文档

- 德州仪器 (TI)，BQ27427 具有集成检测电阻器的系统侧 Impedance Track™ 电量监测计数据表

11 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 2021) to Revision A (May 2026)	Page
• 将物料清单中的 C1 值从 0.47 更新为 4.7 µ F	7
• 将原理图中的 C1 值从 2.2 µ F 更新为 4.7 µ F	8

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.

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最后更新日期：2025 年 10 月