Application Report

轻松配置 BQ76942、BQ76952 电池监控器

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摘要

本应用报告包含多种信息，可帮助用户配置 BQ769x2 系列电池监控器（包括 BQ76942 和 BQ76952）。为帮助用户熟悉器件设置，此文档提供了多个常用配置示例。

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商标

1 引言

BQ769x2 电池监控器系列包括许多配置选项，可满足各种应用的需求。本文档使用 BQ76942 评估模块和 Battery Management Studio 演示了多个不同的配置示例。这些示例还可应用于 BQ769x2 系列中的所有器件。本文档还包含一个示例 .gg 文件，可使用 Battery Management Studio 将其加载到评估模块上。*BQ76942 评估模块用户指南* 包含有关设置器件的基本信息，本文档应与该指南一同使用。

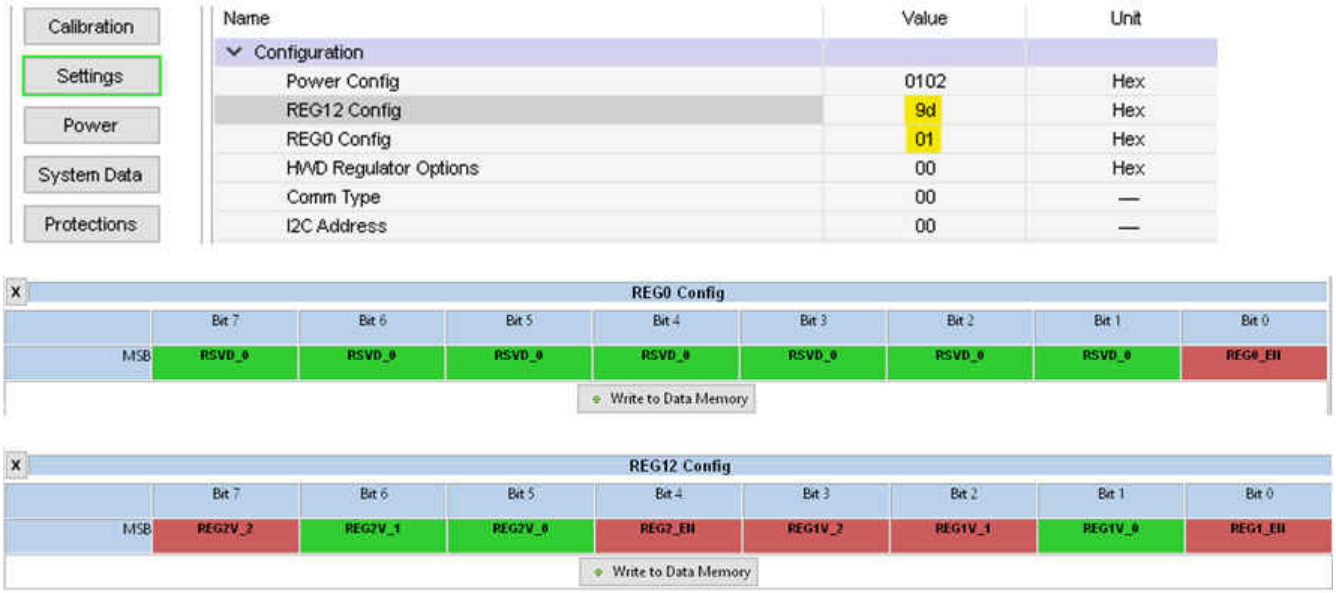
2 基本配置

浏览 *BQ76942 评估模块用户指南* 的“快速入门”部分后，请参阅以下部分，了解配置器件的后续步骤。器件数据表和 TRM（技术参考手册）中提供了有关每个特性的更多详细信息。Battery Management Studio 还包括工具提示，当鼠标指针在不同字段上移动时，这些提示会提供不同设置的详细说明。

2.1 稳压器设置

BQ769x2 包含一个 1.8V 稳压器 (REG18) 和两个具有多种电压选项的 LDO（REG1 和 REG2）。REG18 电源不可配置，仅用于内部电路，而 REG1 和 REG2 是可配置的，可用于为外部电路供电。多个器件特性可引用 REG1，因此为这些特性启用 REG1 非常重要。评估模块还使用 REG1 作为多个引脚的上拉电压，因此建议启用前置稳压器 (REG0) 和 REG1。

以下示例显示了如何启用 REG0、REG1 和 REG2。REG1 和 REG2 可设置为 1.8V、2.5V、3.0V、3.3V 或 5.0V。以下示例将 REG1 设为 3.3V，将 REG2 设为 2.5V。用于配置 REG1 和 REG2 的选项也显示在图 2-1 中。



REG1V_2–REG1V_0 (Bits 3–1)

Selects voltage level for REG1 This setting should not be changed while REG1 is enabled.

Setting	Description
0–3	1.8 V
4	2.5 V
5	3 V
6	3.3 V
7	5 V

图 2-1. 启用 REG0，将 REG1 设为 3.3V，将 REG2 设为 2.5V

2.2 电池数目

可在 ***Vcell Mode*** 寄存器中配置适用于应用的串联电池节数。评估模块包括一个电阻分压器，用于模拟所有电池输入，因此在使用评估模块时可启用所有电池。若要减少电池节数，请按照 *BQ76942 评估模块用户指南* 中的说明更新硬件，并相应地更新 ***VCell Mode***。在以下示例中，BQ76942 的电池数减少到 8 节，以便与《评估模块用户指南》中的示例一致。

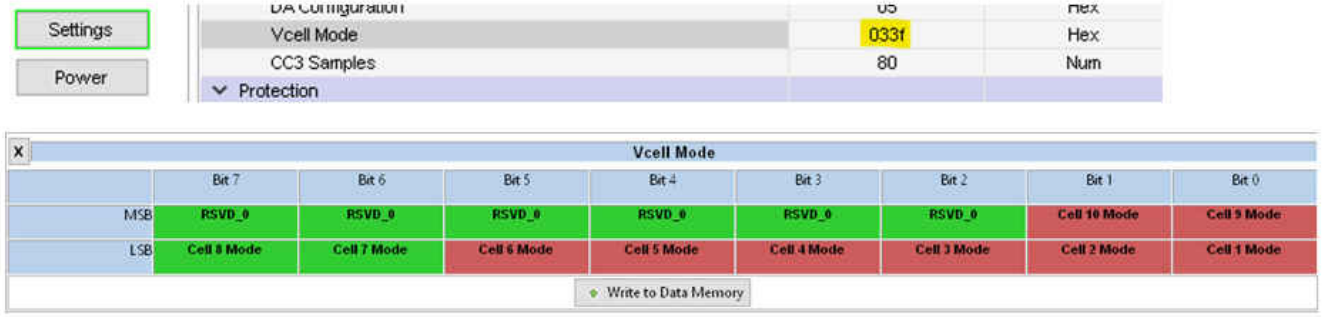


图 2-2. 为 BQ76942 配置 8 节电池

2.3 启用保护功能

可通过 ***Enabled Protections A***、***Enabled Protections B*** 和 ***Enabled Protections C*** 寄存器启用各种器件保护功能。在默认设置中，仅会启用 COV 和 SCD 故障。在图 2-3 中，所有可用的保护功能均已启用。额外的寄存器可配置 BQ76942 如何控制 CHG 和 DSG FET，以响应被触发的每个保护。***CHG FET Protections A***、***CHG FET Protections B*** 和 ***CHG FET Protections C*** 配置应以何种方式控制 CHG FET。***DSG FET Protection A***、***DSG FET Protection B*** 和 ***DSG FET Protection C*** 配置应以何种方式控制 DSG FET。

当 CHG 和 DSG FET 串联配置时（这些 FET 在评估模块上串联），***Body Diode Threshold*** 保护功能有助于防止损坏 FET。如果 CHG FET 关断且器件检测到放电电流大于此阈值，则 CHG FET 将打开以保护 CHG FET 体二极管，直到放电电流被移除。当检测到充电电流高于此阈值时，DSG FET 的情况正好相反。如果 FET 并联配置，则不使用此功能。节 2.8 详细介绍了 FET 控制的配置。

次级保护功能可对更严重的故障做出反应，以采取措施禁用电池组。永久性故障的配置与主要保护功能的配置非常相似。可通过永久性故障寄存器对其进行配置。

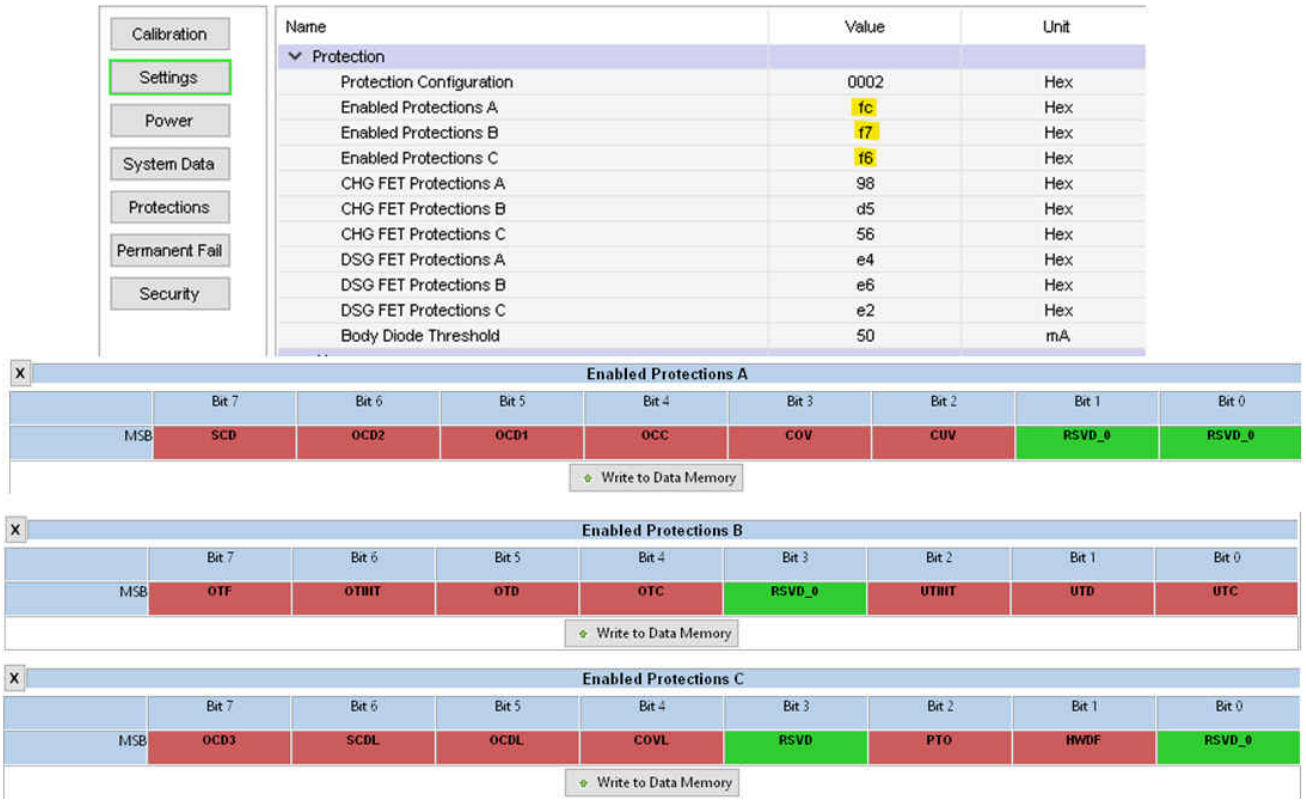
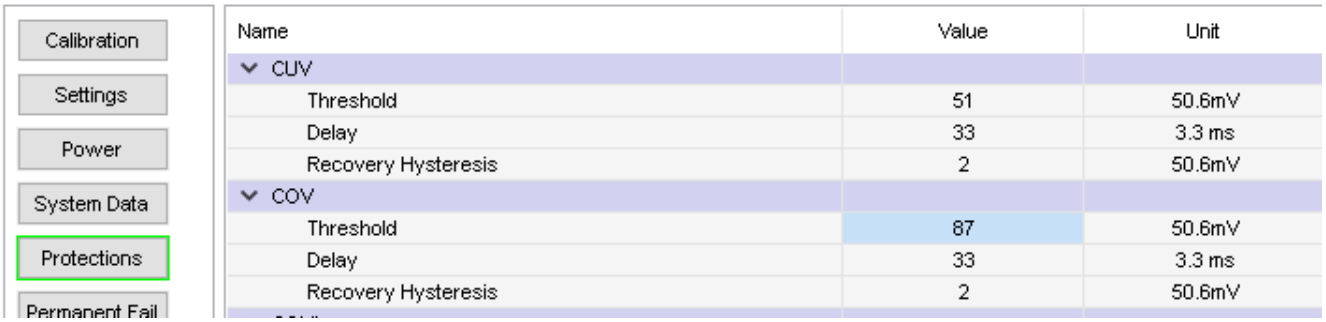


图 2-3. 启用所有保护功能

2.3.1 电压保护

可使用 ***Enabled Protections A*** 启用电压保护（过压和欠压）功能。可根据应用调整与每个保护特性关联的多个参数。在以下示例中，在“保护”设置下将 CUV（电池欠压）和 COV（电池过压）的阈值和延迟参数从默认值修改为其他值。例如，***CUV Threshold*** 只能以 50.6mV 的增量进行编程，***CUV Delay*** 只能以 3.3ms 的增量进行编程。

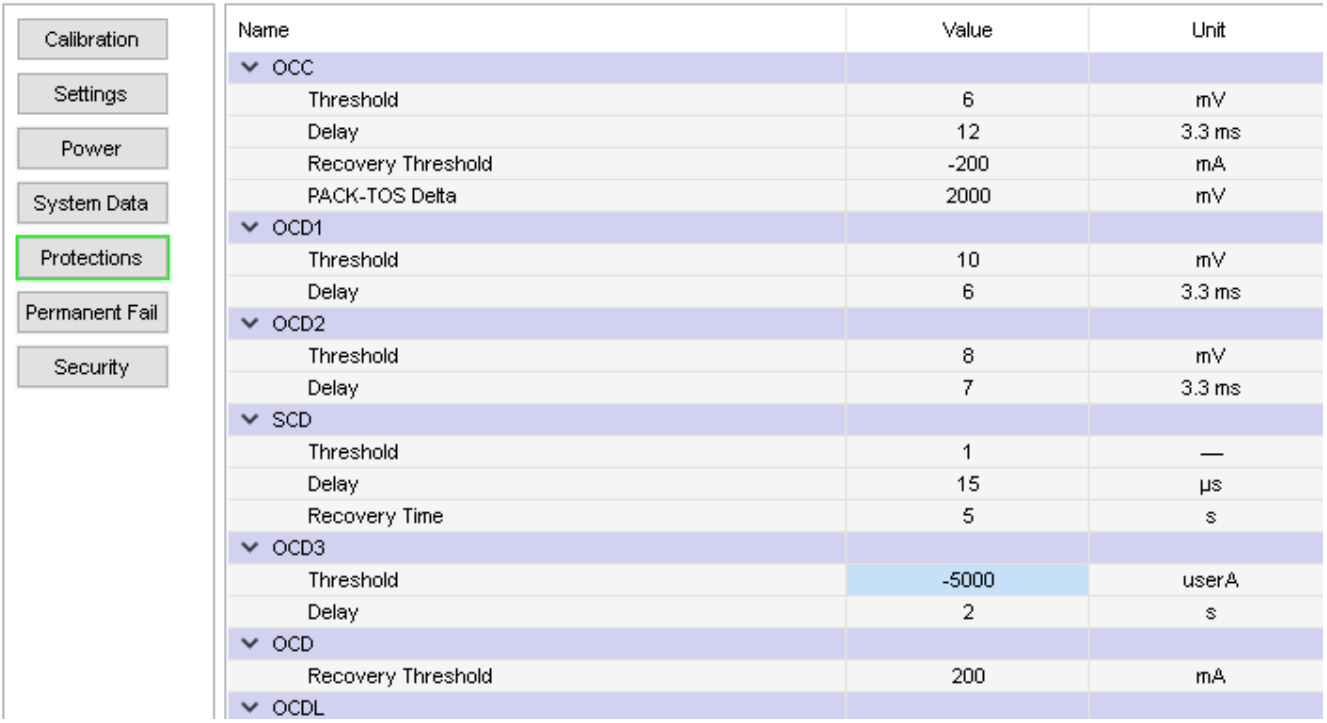


Name	Value	Unit
CUV		
Threshold	51	50.6mV
Delay	33	3.3 ms
Recovery Hysteresis	2	50.6mV
COV		
Threshold	87	50.6mV
Delay	33	3.3 ms
Recovery Hysteresis	2	50.6mV

图 2-4. 设置电压保护参数

2.3.2 电流保护

可在 ***Enabled Protections A*** 和 ***Enabled Protections C*** 下启用电流保护功能（过流和短路检测）。可在“Protections”设置下修改各项保护功能的参数。在以下示例中，一些当前采用的保护参数已从默认值修改为其他值。



Name	Value	Unit
OCC		
Threshold	6	mV
Delay	12	3.3 ms
Recovery Threshold	-200	mA
PACK-TOS Delta	2000	mV
OCD1		
Threshold	10	mV
Delay	6	3.3 ms
OCD2		
Threshold	8	mV
Delay	7	3.3 ms
SCD		
Threshold	1	—
Delay	15	µs
Recovery Time	5	s
OCD3		
Threshold	-5000	userA
Delay	2	s
OCD		
Recovery Threshold	200	mA
OCDL		

图 2-5. 设置当前保护参数

2.3.3 温度保护

可在 ***Enabled Protections B*** 下启用温度保护。可在“Protections”设置下修改各项保护的参数。在以下示例中，OTC（充电模式下的过热）阈值和 OTD（放电模式的过热）阈值已从默认值修改为其他值。

Protections
Permanent Fail
Security

Recovery Threshold	200	mA
OTC		
Threshold	50	°C
Delay	2	s
Recovery	50	°C
OTD		
Threshold	65	°C
Delay	2	s
Recovery	55	°C
OTF		
Threshold	80	°C
Delay	2	s
Recovery	65	°C
OTINT		
Threshold	85	°C
Delay	2	s
Recovery	80	°C
UTC		
Threshold	0	°C
Delay	2	s
Recovery	5	°C
UTD		
Threshold	0	°C
Delay	2	s
Recovery	5	°C
UTINT		
Threshold	-20	°C
Delay	2	s
Recovery	-15	°C

图 2-6. 设置温度保护参数

2.3.4 其他保护

可在 ***Enabled Protections C*** 下启用预充电超时和主机看门狗保护功能。在以下示例中，HWD（主机看门狗）故障延迟和 PTO（预充电超时）延迟已从默认值修改为其他值。

HWD		
Delay	65	s
Load Detect		
Active Time	0	s
Retry Delay	50	s
Timeout	1	hrs
PTO		
Charge Threshold	250	mA
Delay	2000	s
Reset	2	userAh

图 2-7. 设置 PTO 和 HWD 参数

2.4 热敏电阻

多个器件引脚具有多个功能。除了 TSx 引脚之外，一些引脚还可配置为与外部热敏电阻连接。以下示例展示了为测量电池温度的外部热敏电阻进行的 TS1 配置，TS2 未使用，为测量 FET 温度的外部热敏电阻配置了 TS3，为报告温度但不用于保护的外部热敏电阻配置了 HDQ 引脚。热敏电阻引脚设置是高度可配置的，因此如果使用不同于默认值的热敏电阻，请参阅数据表。（默认值设置为与 Semitec 103-AT 和 204AP-2 热敏电阻匹配。）

有关热敏电阻引脚的详细配置选项，请参阅 BQStudio 工具提示或器件技术参考手册。

图 2-8. 启用额外的热敏电阻

2.5 通用输出

一些器件引脚可配置为 GPO（通用输出）。将这些引脚设为 GPO 时，有多个选项可供选择。在以下示例中，CFETOFF、DFETOFF、HDQ、DCHG 和 DDSG 引脚配置为在 0V 和 3.3V（REG1 的电压）之间驱动。器件数据表的**通用数字输出子命令**表中列出了用于控制每个 GPO 引脚的完整命令。每个 ***[OPT]*** 寄存器位的说明在 BQStudio 工具提示以及器件数据表的 **ALT 或 GPO 引脚的多功能引脚选项**表中有所描述。

图 2-9. 启用多个通用输出

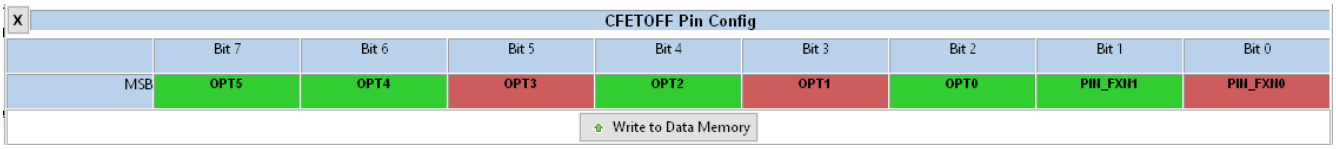


图 2-10. 使用 REG1 高驱动电平将 CFETOFF 设为具有高电平有效输出的 GPO

2.6 ADC 输入

多个器件引脚还可配置为通用 ADC 输入。以下示例演示了如何将 CFETOFF、DFETOFF、ALERT、TS1、TS2、TS3、HDQ、DCHG 和 DDSG 设为通用 ADC 输入。BQStudio 工具提示详细说明了每个 [OPT] 位。设为通用 ADC 输入时，应始终按以下示例所示设置 [OPT] 位（**OPT5**、**OPT3**、**OPT2** 设为 1，**OPT4**、**OPT1**、**OPT0** 设为 0）。

图 2-11. 启用多个 ADC 输入

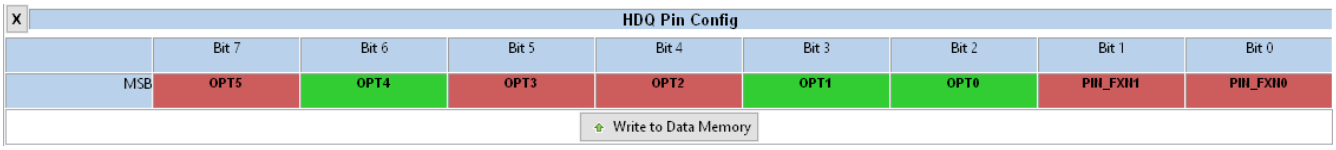


图 2-12. 将 HDQ 引脚配置为通用 ADC 输入

2.7 ALERT 引脚

ALERT 引脚可配置为在检测到故障时向主机发送中断来传达故障信息。以下示例将 ALERT 引脚设置为高电平有效输出，参考 REG1 的输出电压驱动电平。PIN_FXN 位将 ALERT 引脚配置为具备 ALERT 功能。

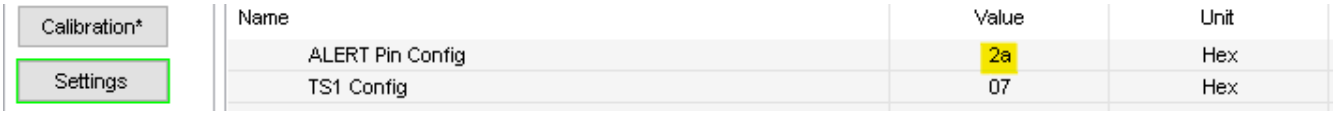


图 2-13. 配置 ALERT 引脚功能

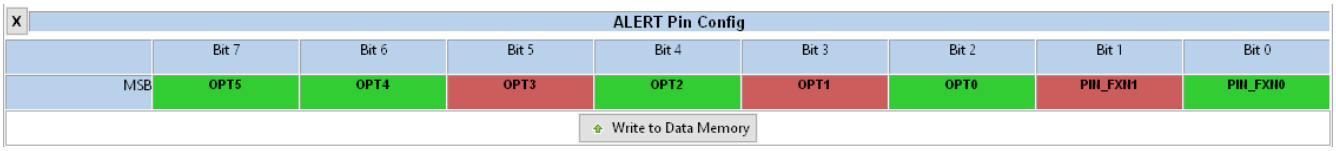


图 2-14. 使用 REG1 高驱动电平设置 ALERT 为高电平有效输出

可将很多事件映射到 ALERT 引脚以通知主机。默认警报屏蔽寄存器可配置为控制将哪些事件映射到 ALERT 引脚。SF 警报屏蔽和 PF 警报屏蔽寄存器可进一步控制将哪些安全警报和永久故障警报映射到 ALERT 引脚。

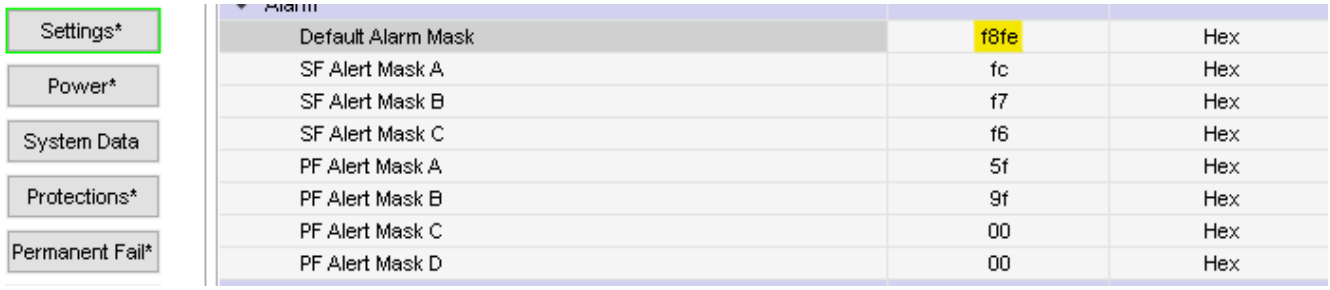


图 2-15. 警报寄存器

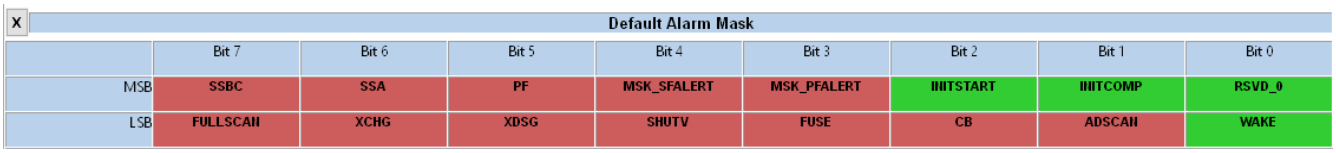


图 2-16. 使用默认警报屏蔽寄存器设置映射到 ALERT 引脚的事件

2.8 FET 控制设置

BQ769x2 器件支持多种 FET 控制方法。默认情况下，这款器件将根据故障条件和从这些故障中恢复的情况自主控制 FET。这款器件还可配置为允许主机部分或完全控制 FET。本节介绍部分基本配置。

器件初次加电启动时，FET 是默认禁用的。发送 **FET_ENABLE** 命令会导通 FET。图 2-17 所示为 ***FET Options*** 寄存器的默认设置。在此配置中，***FET_CTRL_EN*** 位允许器件启用 FET。***HOST_FET_EN*** 位会从主机启用 FET 控制命令，并允许主机在 CFETOFF 和 DFETOFF 引脚配置为控制 FET 时使用这些引脚。***SFET*** 位会针对串联配置（例如在 BQ76942 评估模块中）的 FET 启用体二极管保护功能。

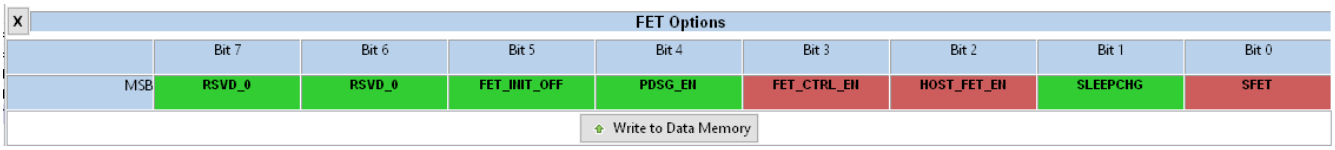


图 2-17. FET 选项默认设置

2.8.1 CFETOFF 和 DFETOFF

CFETOFF 和 DFETOFF 可设置为允许主机通过这些引脚禁用 CHG 和 DSG FET。以下示例展示了将 CFETOFF 和 DFETOFF 配置为输入，进而允许主机通过这些引脚禁用 FET。

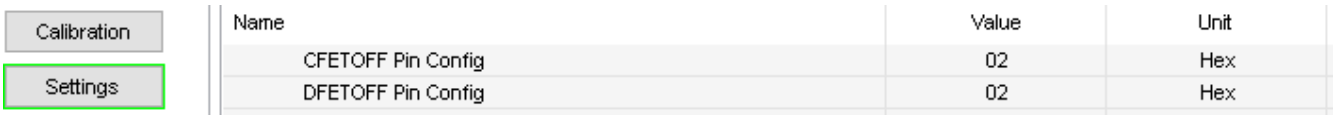


图 2-18. 配置 CFETOFF 和 DFETOFF 以进行 FET 控制

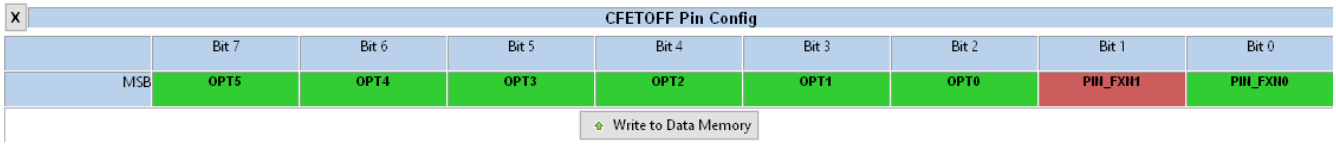


图 2-19. CFETOFF 配置寄存器

2.8.2 DCHG 和 DDSG

该器件可配置为在故障条件发出应通过 DCHG 和 DDSG 引脚禁用 CHG 和 DSG FET 的指示时，向主机处理器或外部电路发送信号。在以下示例中，这些引脚配置为高电平有效输出，具有 REG1 的高驱动电平。

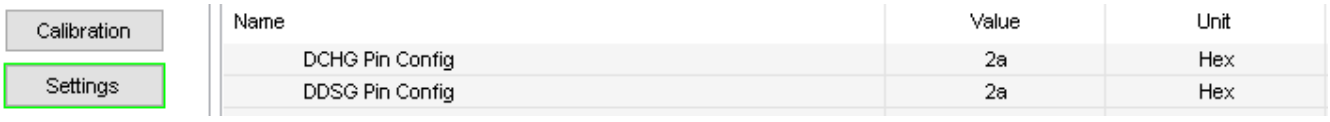


图 2-20. 将 DCHG 和 DDSG 配置为输出至 MCU

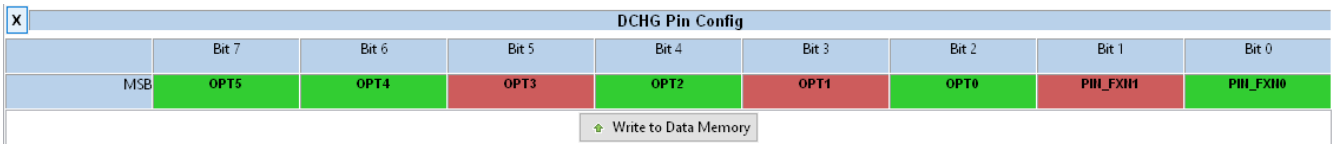


图 2-21. DCHG 配置寄存器

3 GG 文件示例

Battery Management Studio 允许用户将所有器件寄存器设置的图像导入和导出为扩展名为 .gg.csv 的文本文件。以下示例按照与默认值不同的改动（以绿色突出显示），对列出的设置进行配置。要使用以下示例，请在已连接 EVM 的 BQStudio 的“Data Memory”屏幕中点击 *Export -> Export Defaults*。依次点击 *Import -> Import from a File*，即可使用文本编辑器按照突出显示的改动来修改保存后的文件，并使用 BQStudio 将其加载到器件上。

- 已启用前置稳压器，REG1 = 3.3V，REG2 = 2.5V
- 将 CFETOFF 和 DFETOFF 配置为输入，进行 FET 控制
- 将 DCHG 和 DDSG 配置为高电平有效输出至 MCU
- 将 ALERT 配置为高电平有效输出至 MCU
- 将 TS1 配置为电池温度热敏电阻，TS3 配置为 FET 温度热敏电阻，HDQ 配置为不带保护的温度测量
- 为 ***VCell Mode*** 寄存器设置 8 节电池
- 已启用所有保护功能
- 已启用 SOV 和 SUV 永久性故障
- ***[FUSE]*** 位（在 ***Default Alarm Mask*** 寄存器中设置）
- ***[SLEEPCHG]*** 位（在 FET 选项寄存器中设置）
- ***[FET_EN]*** 位（在 ***Mfg Status Init*** 寄存器中设置）

```
* Texas Instruments Data Flash File
* File created Thu Sep 17 15:10:54 2020
*
* Device Number 7694
* Firmware Version 0.36
* Build Number 39
* Order Number 0
*
* bqz Device Number 7692
* bqz Firmware Version 0.36
* bqz Build Number 39
*
* Field Order: Class name, Subclass name, Parameter name, Parameter Value, Display Units
"Calibration","Voltage","Cell 1 Gain","12120","—"
"Calibration","Voltage","Cell 2 Gain","12120","—"
"Calibration","Voltage","Cell 3 Gain","12120","—"
"Calibration","Voltage","Cell 4 Gain","12120","—"
"Calibration","Voltage","Cell 5 Gain","12119","—"
"Calibration","Voltage","Cell 6 Gain","12119","—"
"Calibration","Voltage","Cell 7 Gain","12119","—"
"Calibration","Voltage","Cell 8 Gain","12119","—"
"Calibration","Voltage","Cell 9 Gain","12122","—"
"Calibration","Voltage","Cell 10 Gain","12122","—"
"Calibration","Voltage","Pack Gain","34067","—"
"Calibration","Voltage","TOS Gain","33961","—"
"Calibration","Voltage","LD Gain","34268","—"
"Calibration","Voltage","ADC Gain","4039","—"
"Calibration","Current","CC Gain","1.000","mΩ"
"Calibration","Current","Capacity Gain","1.000","mΩ"
"Calibration","Vcell Offset","Vcell Offset","0","mV"
"Calibration","V Divider Offset","Vdiv Offset","0","userV"
"Calibration","Current Offset","Coulomb Counter Offset Samples","64","—"
"Calibration","Current Offset","Board Offset","0","—"
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"Calibration","Temperature","DFETOFF Temp Offset","0.0","°C"
"Calibration","Temperature","ALERT Temp Offset","0.0","°C"
"Calibration","Temperature","TS1 Temp Offset","0.0","°C"
"Calibration","Temperature","TS2 Temp Offset","0.0","°C"
"Calibration","Temperature","TS3 Temp Offset","0.0","°C"
"Calibration","Temperature","HDQ Temp Offset","0.0","°C"
"Calibration","Temperature","DCHG Temp Offset","0.0","°C"
"Calibration","Temperature","DDSG Temp Offset","0.0","°C"
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"Calibration","Internal Temp Model","Int base offset","3032","—"
"Calibration","Internal Temp Model","Int Maximum AD","16383","—"
"Calibration","Internal Temp Model","Int Maximum Temp","6379","0.1K"
"Calibration","18K Temperature Model","Coeff a1","-15524","—"
"Calibration","18K Temperature Model","Coeff a2","26423","—"
"Calibration","18K Temperature Model","Coeff a3","-22664","—"
"Calibration","18K Temperature Model","Coeff a4","28834","—"
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"Calibration","18K Temperature Model","Coeff a5","672","-"
"Calibration","18K Temperature Model","Coeff b1","-371","-"
"Calibration","18K Temperature Model","Coeff b2","708","-"
"Calibration","18K Temperature Model","Coeff b3","-3498","-"
"Calibration","18K Temperature Model","Coeff b4","5051","-"
"Calibration","18K Temperature Model","Adc0","11703","-"
"Calibration","180K Temperature Model","Coeff a1","-17513","-"
"Calibration","180K Temperature Model","Coeff a2","25759","-"
"Calibration","180K Temperature Model","Coeff a3","-23593","-"
"Calibration","180K Temperature Model","Coeff a4","32175","-"
"Calibration","180K Temperature Model","Coeff a5","2090","-"
"Calibration","180K Temperature Model","Coeff b1","-2055","-"
"Calibration","180K Temperature Model","Coeff b2","2955","-"
"Calibration","180K Temperature Model","Coeff b3","-3427","-"
"Calibration","180K Temperature Model","Coeff b4","4385","-"
"Calibration","180K Temperature Model","Adc0","17246","-"
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"Calibration","Custom Temperature Model","Coeff a2","0","-"
"Calibration","Custom Temperature Model","Coeff a3","0","-"
"Calibration","Custom Temperature Model","Coeff a4","0","-"
"Calibration","Custom Temperature Model","Coeff a5","0","-"
"Calibration","Custom Temperature Model","Coeff b1","0","-"
"Calibration","Custom Temperature Model","Coeff b2","0","-"
"Calibration","Custom Temperature Model","Coeff b3","0","-"
"Calibration","Custom Temperature Model","Coeff b4","0","-"
"Calibration","Custom Temperature Model","Rc0","0","-"
"Calibration","Custom Temperature Model","Adc0","0","-"
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"Calibration","CUV","CUV Threshold Override","ffff","Hex"
"Calibration","COV","COV Threshold Override","ffff","Hex"
"Settings","Fuse","Min Blow Fuse Voltage","5000","mV"
"Settings","Fuse","Fuse Blow Timeout","30","s"
"Settings","Configuration","Power Config","2982","Hex"
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"Settings","Configuration","REG0 Config","01","Hex"
"Settings","Configuration","HWD Regulator Options","00","Hex"
"Settings","Configuration","Comm Type","00","-"
"Settings","Configuration","I2C Address","00","-"
"Settings","Configuration","SPI Configuration","20","-"
"Settings","Configuration","Comm Idle Time","0","s"
"Settings","Configuration","CFETOFF Pin Config","02","Hex"
"Settings","Configuration","DFETOFF Pin Config","02","Hex"
"Settings","Configuration","ALERT Pin Config","2a","Hex"
"Settings","Configuration","TS1 Config","07","Hex"
"Settings","Configuration","TS2 Config","00","Hex"
"Settings","Configuration","TS3 Config","0f","Hex"
"Settings","Configuration","HDQ Pin Config","0b","Hex"
"Settings","Configuration","DCHG Pin Config","2a","Hex"
"Settings","Configuration","DDSG Pin Config","2a","Hex"
"Settings","Configuration","DA Configuration","05","Hex"
"Settings","Configuration","Vcell Mode","033f","Hex"
"Settings","Configuration","CC3 Samples","80","Num"
"Settings","Protection","Protection Configuration","0002","Hex"
"Settings","Protection","Enabled Protections A","fc","Hex"
"Settings","Protection","Enabled Protections B","f7","Hex"
"Settings","Protection","Enabled Protections C","f6","Hex"
"Settings","Protection","CHG FET Protections A","98","Hex"
"Settings","Protection","CHG FET Protections B","d5","Hex"
"Settings","Protection","CHG FET Protections C","56","Hex"
"Settings","Protection","DSG FET Protections A","e4","Hex"
"Settings","Protection","DSG FET Protections B","e6","Hex"
"Settings","Protection","DSG FET Protections C","e2","Hex"
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"Settings","Alarm","SF Alert Mask C","f4","Hex"
"Settings","Alarm","PF Alert Mask A","5f","Hex"
"Settings","Alarm","PF Alert Mask B","9f","Hex"
"Settings","Alarm","PF Alert Mask C","00","Hex"
"Settings","Alarm","PF Alert Mask D","00","Hex"
"Settings","Permanent Failure","Enabled PF A","03","Hex"
"Settings","Permanent Failure","Enabled PF B","00","Hex"
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"Settings","Permanent Failure","Enabled PF D","00","Hex"
"Settings","FET","FET Options","0f","Hex"
"Settings","FET","Chg Pump Control","01","Hex"
"Settings","FET","Precharge Start Voltage","0","mV"
"Settings","FET","Precharge Stop Voltage","0","mV"
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"Settings","FET","Predischarge Timeout","5","10ms"
"Settings","FET","Predischarge Stop Delta","500","mV"
"Settings","Current Thresholds","Dsg Current Threshold","100","userA"
"Settings","Current Thresholds","Chg Current Threshold","50","userA"
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"Settings","Interconnect Resistances","Cell 1 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 2 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 3 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 4 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 5 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 6 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 7 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 8 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 9 Interconnect","0","mΩ"
"Settings","Interconnect Resistances","Cell 10 Interconnect","0","mΩ"
"Settings","Manufacturing","Mfg Status Init","0050","Hex"
"Settings","Cell Balancing Config","Balancing Configuration","00","Hex"
"Settings","Cell Balancing Config","Min Cell Temp","-20","°C"
"Settings","Cell Balancing Config","Max Cell Temp","60","°C"
"Settings","Cell Balancing Config","Max Internal Temp","70","°C"
"Settings","Cell Balancing Config","Cell Balance Interval","20","s"
"Settings","Cell Balancing Config","Cell Balance Max Cells","1","Num"
"Settings","Cell Balancing Config","Cell Balance Min Cell V (Charge)","3900","mV"
"Settings","Cell Balancing Config","Cell Balance Min Delta (Charge)","40","mV"
"Settings","Cell Balancing Config","Cell Balance Stop Delta (Charge)","20","mV"
"Settings","Cell Balancing Config","Cell Balance Min Cell V (Relax)","3900","mV"
"Settings","Cell Balancing Config","Cell Balance Min Delta (Relax)","40","mV"
"Settings","Cell Balancing Config","Cell Balance Stop Delta (Relax)","20","mV"
"Power","Shutdown","Shutdown Cell Voltage","0","mV"
"Power","Shutdown","Shutdown Stack Voltage","6000","mV"
"Power","Shutdown","Low V Shutdown Delay","1","s"
"Power","Shutdown","Shutdown Temperature","85","°C"
"Power","Shutdown","Shutdown Temperature Delay","5","s"
"Power","Shutdown","FET Off Delay","0","0.25s"
"Power","Shutdown","Shutdown Command Delay","0","0.25s"
"Power","Shutdown","Auto Shutdown Time","0","min"
"Power","Shutdown","RAM Fail Shutdown Time","5","s"
"Power","Sleep","Sleep Current","20","mA"
"Power","Sleep","Voltage Time","5","s"
"Power","Sleep","Wake Comparator Current","500","mA"
"Power","Sleep","Sleep Hysteresis Time","10","s"
"Power","Sleep","Sleep Charger Voltage Threshold","20000","mV"
"Power","Sleep","Sleep Charger PACK-TOS Delta","2000","mV"
"System Data","Integrity","Config RAM Signature","0000","Hex"
"Protections","CUV","Threshold","50","50.6mV"
"Protections","CUV","Delay","74","3.3 ms"
"Protections","CUV","Recovery Hysteresis","2","50.6mV"
"Protections","COV","Threshold","86","50.6mV"
"Protections","COV","Delay","74","3.3 ms"
"Protections","COV","Recovery Hysteresis","2","50.6mV"
"Protections","COVL","Latch Limit","0","—"
"Protections","COVL","Counter Dec Delay","10","s"
"Protections","COVL","Recovery Time","15","s"
"Protections","OCC","Threshold","4","mV"
"Protections","OCC","Delay","4","3.3 ms"
"Protections","OCC","Recovery Threshold","-200","mA"
"Protections","OCC","PACK-TOS Delta","2000","mV"
"Protections","OCD1","Threshold","8","mV"
"Protections","OCD1","Delay","1","3.3 ms"
"Protections","OCD2","Threshold","6","mV"
"Protections","OCD2","Delay","7","3.3 ms"
"Protections","SCD","Threshold","0","—"
"Protections","SCD","Delay","15","µs"
"Protections","SCD","Recovery Time","5","s"
"Protections","OCD3","Threshold","-4000","userA"
"Protections","OCD3","Delay","2","s"
"Protections","OCD","Recovery Threshold","200","mA"
"Protections","OCDL","Latch Limit","0","—"
"Protections","OCDL","Counter Dec Delay","10","s"
"Protections","OCDL","Recovery Time","15","s"
"Protections","OCDL","Recovery Threshold","200","mA"
"Protections","SCDL","Latch Limit","0","—"
"Protections","SCDL","Counter Dec Delay","10","s"
"Protections","SCDL","Recovery Time","15","s"
"Protections","SCDL","Recovery Threshold","200","mA"
"Protections","OTC","Threshold","55","°C"
"Protections","OTC","Delay","2","s"
"Protections","OTC","Recovery","50","°C"
"Protections","OTD","Threshold","60","°C"
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"Protections","OTD","Delay","2","s"
"Protections","OTD","Recovery","55","°C"
"Protections","OTF","Threshold","80","°C"
"Protections","OTF","Delay","2","s"
"Protections","OTF","Recovery","65","°C"
"Protections","OTINT","Threshold","85","°C"
"Protections","OTINT","Delay","2","s"
"Protections","OTINT","Recovery","80","°C"
"Protections","UTC","Threshold","0","°C"
"Protections","UTC","Delay","2","s"
"Protections","UTC","Recovery","5","°C"
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"Protections","UTD","Recovery","5","°C"
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"Protections","UTINT","Delay","2","s"
"Protections","UTINT","Recovery","-15","°C"
"Protections","Recovery","Time","3","s"
"Protections","HWD","Delay","60","s"
"Protections","Load Detect","Active Time","0","s"
"Protections","Load Detect","Retry Delay","50","s"
"Protections","Load Detect","Timeout","1","hrs"
"Protections","PTO","Charge Threshold","250","mA"
"Protections","PTO","Delay","1800","s"
"Protections","PTO","Reset","2","userAh"
"Permanent Fail","CUDEP","Threshold","1500","mV"
"Permanent Fail","CUDEP","Delay","2","s"
"Permanent Fail","SUV","Threshold","2200","mV"
"Permanent Fail","SUV","Delay","5","s"
"Permanent Fail","SOV","Threshold","4500","mV"
"Permanent Fail","SOV","Delay","5","s"
"Permanent Fail","TOS","Threshold","500","mV"
"Permanent Fail","TOS","Delay","5","s"
"Permanent Fail","SOCC","Threshold","10000","userA"
"Permanent Fail","SOCC","Delay","5","s"
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"Permanent Fail","SOCD","Delay","5","s"
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"Permanent Fail","SOT","Delay","5","s"
"Permanent Fail","SOTF","Threshold","85","°C"
"Permanent Fail","SOTF","Delay","5","s"
"Permanent Fail","VIMR","Check Voltage","3500","mV"
"Permanent Fail","VIMR","Max Relax Current","10","mA"
"Permanent Fail","VIMR","Threshold","500","mV"
"Permanent Fail","VIMR","Delay","5","s"
"Permanent Fail","VIMR","Relax Min Duration","100","s"
"Permanent Fail","VIMA","Check Voltage","3700","mV"
"Permanent Fail","VIMA","Min Active Current","50","mA"
"Permanent Fail","VIMA","Threshold","200","mV"
"Permanent Fail","VIMA","Delay","5","s"
"Permanent Fail","CFETF","OFF Threshold","20","mA"
"Permanent Fail","CFETF","OFF Delay","5","s"
"Permanent Fail","DFETF","OFF Threshold","-20","mA"
"Permanent Fail","DFETF","OFF Delay","5","s"
"Permanent Fail","VSSF","Fail Threshold","100","—"
"Permanent Fail","VSSF","Delay","5","s"
"Permanent Fail","2LVL","Delay","5","s"
"Permanent Fail","LFOF","Delay","5","s"
"Permanent Fail","HWMX","Delay","5","s"
"Security","Settings","Security Settings","00","Hex"
"Security","Keys","Unseal Key Step 1","0414","Hex"
"Security","Keys","Unseal Key Step 2","3672","Hex"
"Security","Keys","Full Access Key Step 1","ffff","Hex"
"Security","Keys","Full Access Key Step 2","ffff","Hex"
```

4 参考文献

- 《BQ76942 评估模块用户指南》
- 《BQ76952 评估模块用户指南》

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