

# ***bq2023EVM-002 Single-Cell Battery Monitor and Protector IC Evaluation Module***

## *User's Guide*

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It is important to operate this EVM within the input voltage range of 2.8-5.5 V and the output voltage range of 2.8 V and 5.5 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 70°C. The EVM is designed to operate properly with certain components above 70°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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# Introduction

The bq2023EVM-002 is a complete evaluation system for the bq2023 flash-based battery-monitoring IC and UCC3952A battery-protection IC. The EVM includes one bq2023/UCC3952A circuit module, a current sense resistor, an EV2201 PC interface board for gas-gauge evaluation, a PC serial cable, and Windows™-based PC software. The circuit module includes one bq2023, one UCC3952A IC, and all other components on board necessary to protect and monitor capacity and other critical parameters in a one-cell Li-Ion battery pack. The circuit module connects directly across the cell in the battery. With the EV2201 interface board and software, the user can read the bq2023 data registers and evaluate the functions of the bq2023 under different charge and discharge conditions.

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## 1.1 Features

- ☐ Complete evaluation system for the bq2023 battery monitor and UCC3952A protection IC
- ☐ Populated circuit module for quick setup
- ☐ PC software and interface board for easy evaluation
- ☐ Software that allows data logging for system analysis

## 1.2 Kit Contents

- ☐ bq2023/UCC3952A circuit module with sense resistor
- ☐ EV2201 PC interface board
- ☐ Set of evaluation software disks entitled EV2201–23
- ☐ PC serial cable
- ☐ Set of support documentation

## 1.3 Ordering Information

Table 1–1. Ordering Information

EVM Part Number	Additional ICs	Chemistry	Pack Voltage	Capacity
bq2023EVM–001	None	All	2.8–5.5 V	Any
bq2023EVM–002	UCC3952	Li-Ion	2.8–4.2 V	Any

# Circuit Module

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The bq2023EVM-002-based circuit module is a complete and compact example solution of a circuit for battery monitoring and protection of a single-cell Li-Ion pack. The circuit module incorporates a bq2023 battery-monitor IC, a UCC3952 protection IC, and all other components necessary to accurately protect and monitor the charge and discharge of one Li-Ion cell.

Terminal blocks on the circuit module provide direct connection to the cell (BAT+, BAT–), and the serial communications port (SDQ). The system load and charger connect across PACK+ and PACK–.

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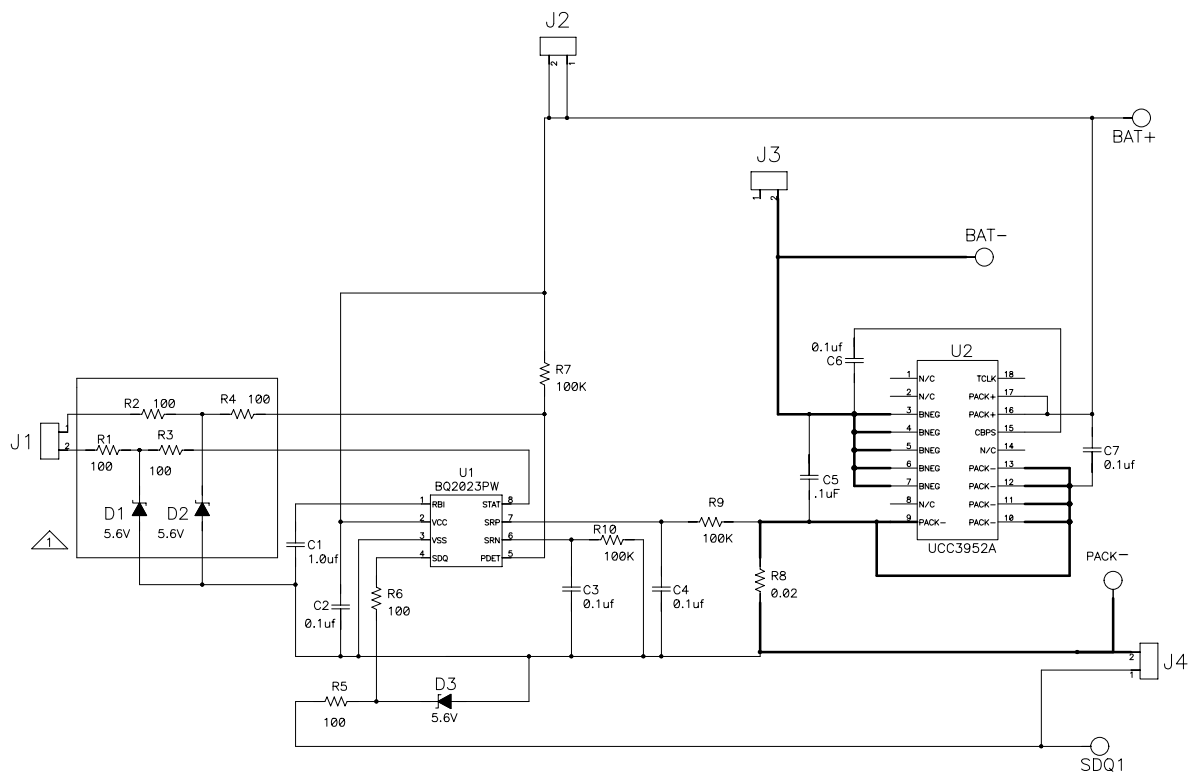
## **2.1 Pin Descriptions**

BAT+	cell positive
BAT–	cell negative
PACK+	pack positive
PACK–	pack negative
SDQ	serial communications port
PDET	pack removal detection
STAT	status output

## 2.2 Schematic

Figure 2–1 is the schematic diagram for the bq2023EVM–002 circuit module (SLUP143–001).

Figure 2–1. Schematic

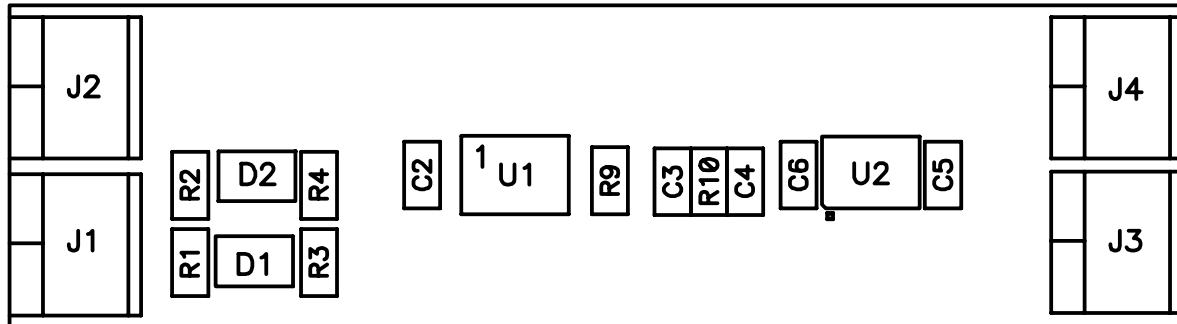


## 2.3 Board Layout

Figure 2–2 shows the PCB layers and assembly drawing for the bq2023EVM–002 circuit module (SLUP143–001).

Figure 2–2. Board Layout

Top Assy



Bottom Assy

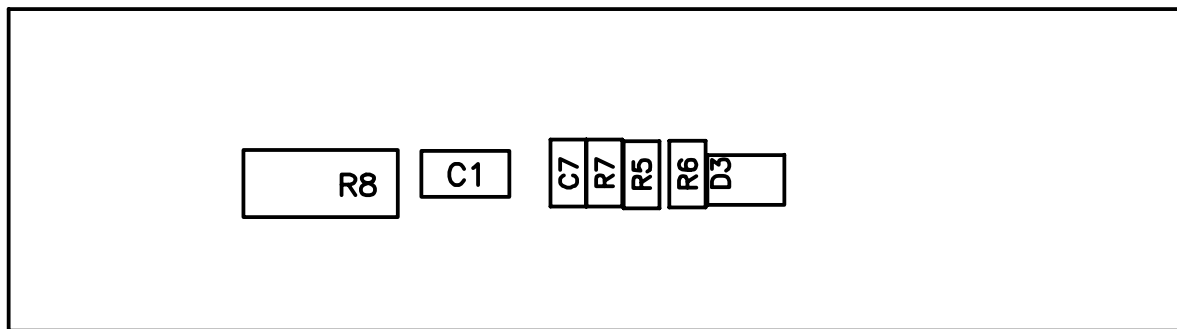
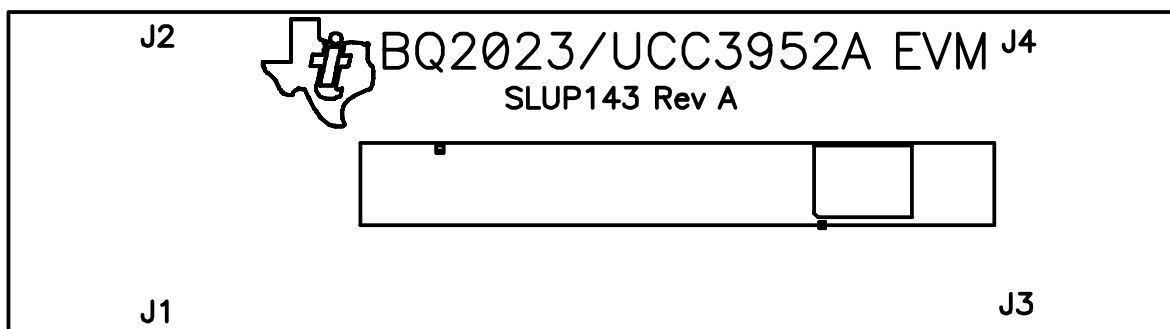
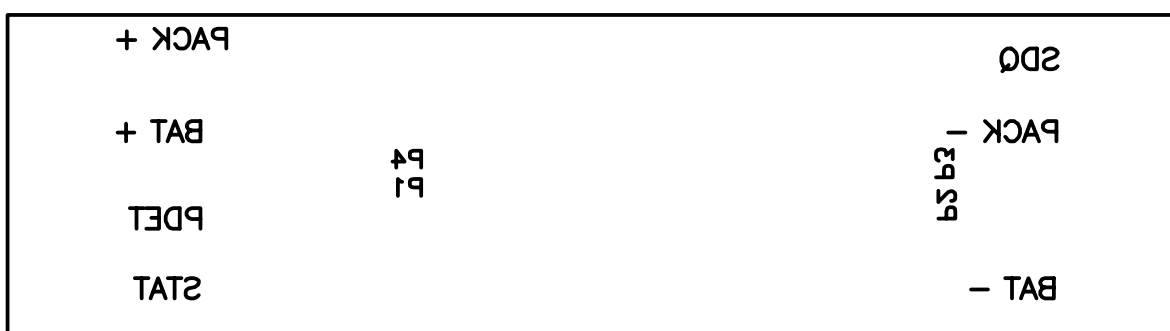


Figure 2–2. Board Layout (Continued)

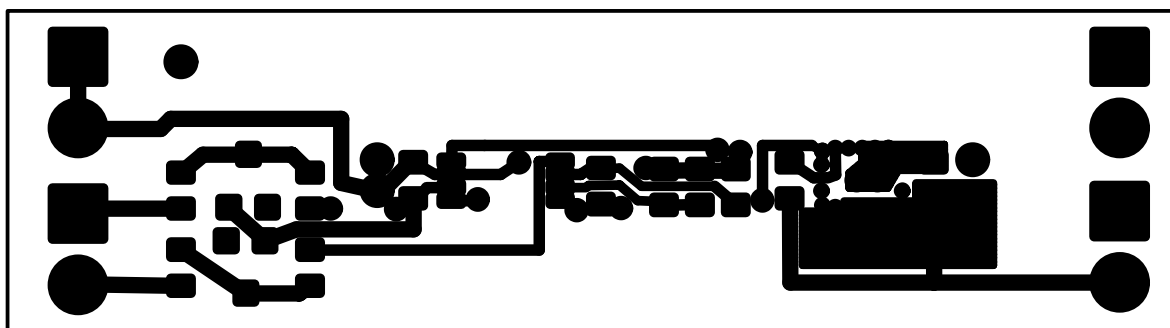
Silk 1



Silk 2



Layer 1



Layer 2

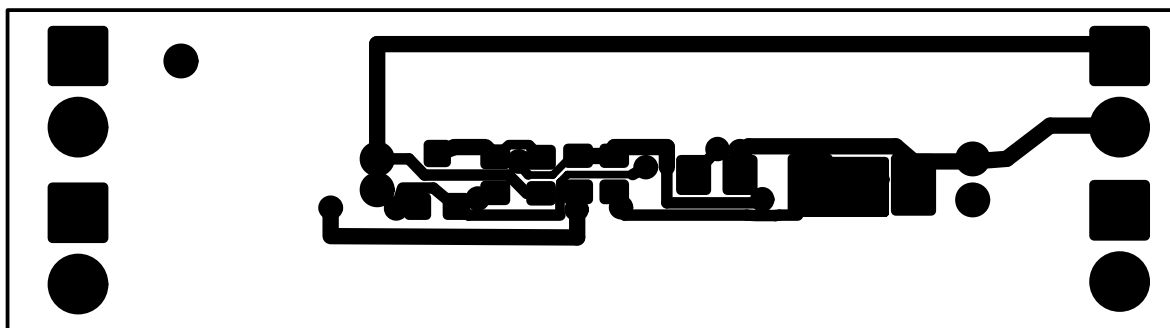
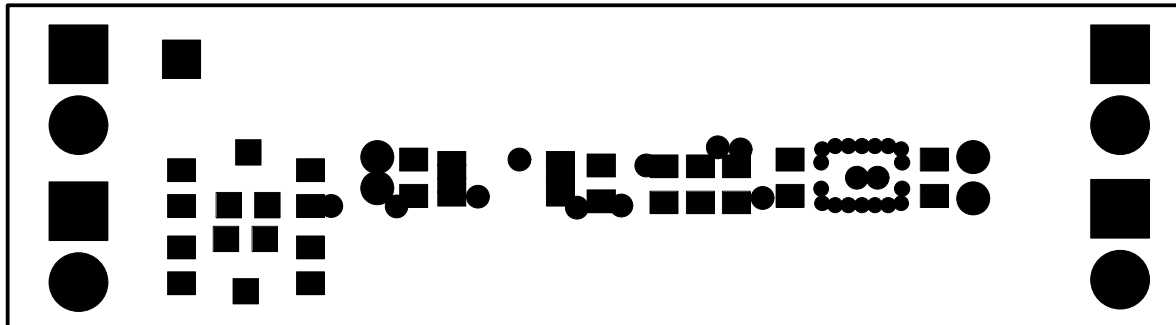
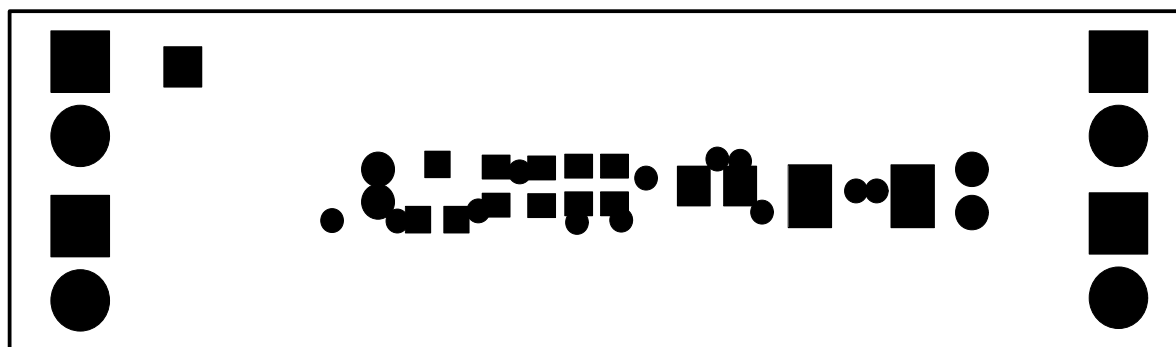


Figure 2–2. Board Layout (Continued)

Mask 1



Mask 2





## 2.4 Bill of Materials

Table 2–1 lists the materials required for the bq2023EVM–002 circuit module (SLUP143–001).

Table 2–1. Bill of Materials

Ref Des	Qty-001	Description	MFG	MFG PART#	Size
PCB	1	Printed-circuit board, .031, FR4, SMOBC, HASL	Any	SLUP143 Rev. A	See FAB DWG
Terminal	4	Terminal block 3.5 mm	On Shore Technology	ED555/2DS	3.5 mm × 2
C1	1	Capacitor, ceramic, 1.0 $\mu$ F, 16 V, $\pm$ 10%, X7R	Panasonic	ECJ–1VB1C104K	603
C2, C3, C4, C5, C6, C7	6	Capacitor, ceramic, 0.1 $\mu$ F, 16 V, $\pm$ 10%, X7R	Panasonic	ECJ–1VB1C104K	603
R8	1	Resistor, .020 $\Omega$ , 1/2 W, 1%	IRC	LR2010–01–R020–F	2010
R7, R9, R10	3	Resistor, 100 k $\Omega$ , 1/16 W, 5%	Panasonic	ERJ–3GSYJ104	603
R1, R2, R3, R4, R5, R6	6	Resistor, 100 $\Omega$ , 1/16 W, 5%	Venkel	ERJ–3GSYJ101	603
D1, D2, D3	3	Diode, Zener, 5.6 V	Zetex	BZX84C5V6	SOT–23
U1	1	Integrated circuit, battery monitor, bq2023	Benchmarq/TI	bq2023PW	TSSOP–8
U2	1	Integrated circuit, charger protection, UCC3952A –2	Unitrode/TI	UCC3952AGSH–2	BCC–18
Component count	27				

### Assembly Notes:

- 1) This assembly is ESD sensitive.
- 2) This assembly shall comply with IPC–A–610 class 2 or better.
- 3) This assembly must be free of flux residues and contaminants.
- 4) Use of no-clean flux is not acceptable.

## 2.5 Performance Specifications

Table 2–2 summarizes the performance specifications for bq2023–002 Circuit Module (SLUP143–001).

*Table 2–2. Performance Specifications Summary*

Specification	Min	Typ	Max	Units
Input voltage BAT+/BAT–	2.8		4.2	V
Charge and discharge current			3	A

**Note:** Charge and discharge maximums are limited by the PCB design and power dissipation of the 20 mΩ 0.5-W sense resistor in the kit.

# EVM Hardware and Software Setup

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This section describes how to install the bq2023EVM–002 PC software and how to connect the different components of the EVM.

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## 3.1 Software Installation

The following steps install the bq2023EVM-002 software:

- 1) Insert disk 1 into a 3 1/2 inch floppy drive.
- 2) Select the 3 1/2 inch drive using My Computer or File Manager.
- 3) Double-click the Setup.exe icon.

The setup program prompts for the remaining disks and installs a Windows application group.

## 3.2 Hardware Connection

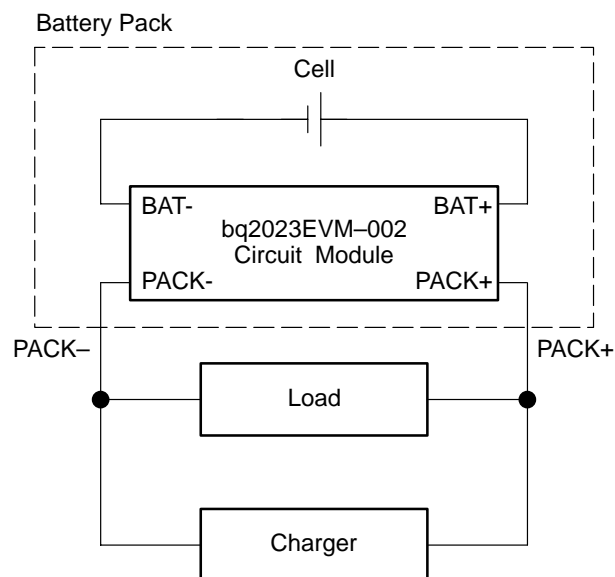
There are three hardware components to the bq2023EVM-002:

- 1) bq2023EVM-002 circuit module
- 2) EV2201 PC interface board
- 3) PC

### 3.2.1 Connecting the Circuit Module to a Battery Pack

Figure 7-1 shows how to connect the bq2023EVM-002 circuit module to a stack of cells, the sense resistor, and the system load/charger.

*Figure 3-1. Connection to Cells and System Load/Charger*



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### 3.2.2 PC Interface Connection

The following steps configure the hardware for interface to the PC:

- 1) Connect the bq2023-based smart battery to the EV2201 using wire leads as in Table 7–1.
- 2) Connect the PC serial cable to the EV2201 and the PC COM port.

*Table 3–1. Connection EV2201*

<b>bq2023-Based Battery</b>	<b>EV2201</b>
SDQ	SMBD/HDQ1
PACK–	VSS

The bq2023EVM–002 is now set up for operation.

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# Operation

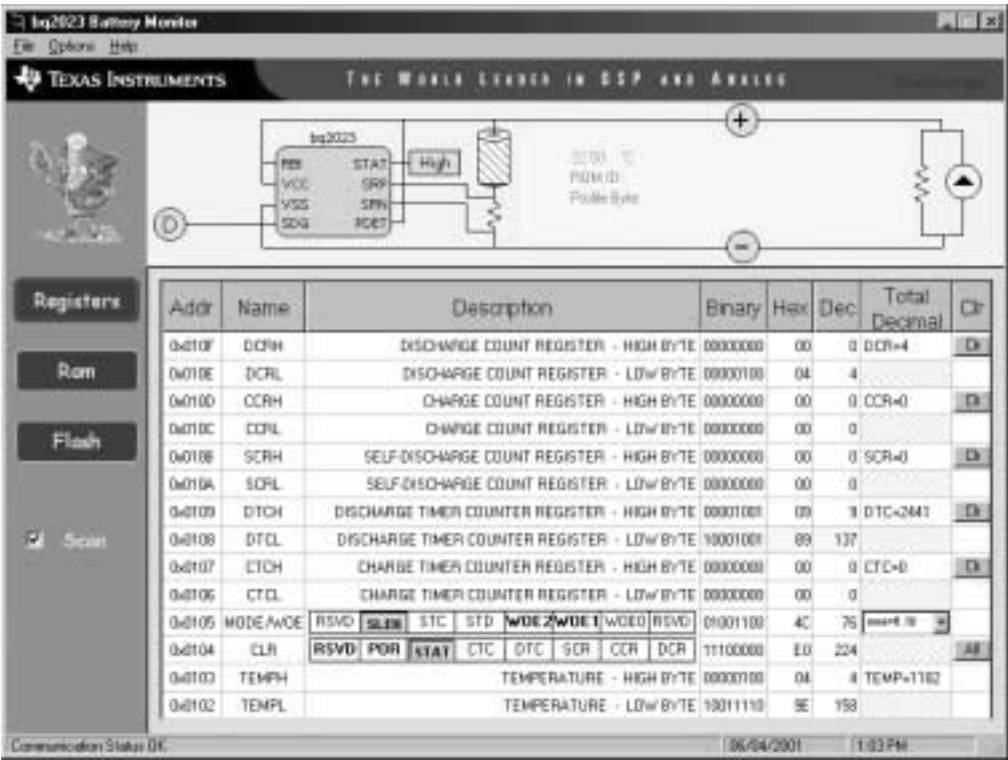
This chapter details the operation of the or bq20232EVM-002 software.

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4.1 Starting the Program

Run EV2201-23 from the Start|Programs|Texas Instruments|bq2023 Battery Monitor menu sequence. The software defaults to PC com port 1 for communication. If the EV2201 is connected to com port 1, the program loads and displays the initial data screen.

Figure 4–1. Initial Data Screen

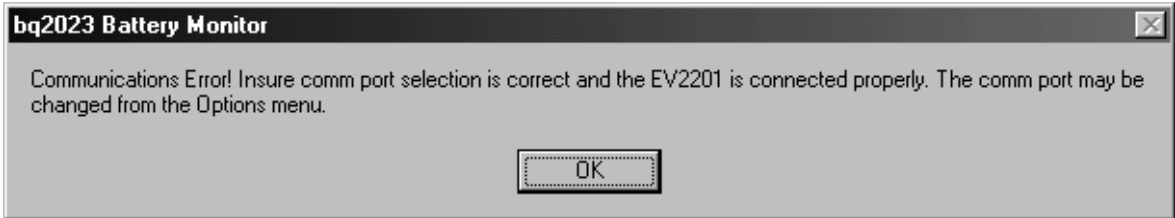


The data screen may not show correct information until parameters in the software are initialized.

If the EV2201 is connected to PC com port 2 or no port, the program will display a warning.

Once OK is clicked, the program loads the initial register screen. The com port can be changed by selecting the port under the Options menu.

Figure 4–2. Communications (Comm) Port Selection Warning Screen





## 4.2 Initialization

This section describes the settings that must be made before the bq2023 is evaluated.

### 4.2.1 Setting the Programmable bq2023 Wake-Up Threshold Option

Select the wake-up threshold with the WOE pulldown tab at location 0x0105. This designates the potential across the sense resistor below which the bq2023 goes to sleep, provided that the sleep enable (SLEN) bit is set. To set the SLEN bit check the sleep enable (SLEN) box.

### 4.2.2 Register Clearing

Each counter in the bq2023 can be cleared (set to 00) by depressing the adjacent Clr button. The All button clears all counting registers in one sequence.

## 4.3 Reading and Writing Flash Memory

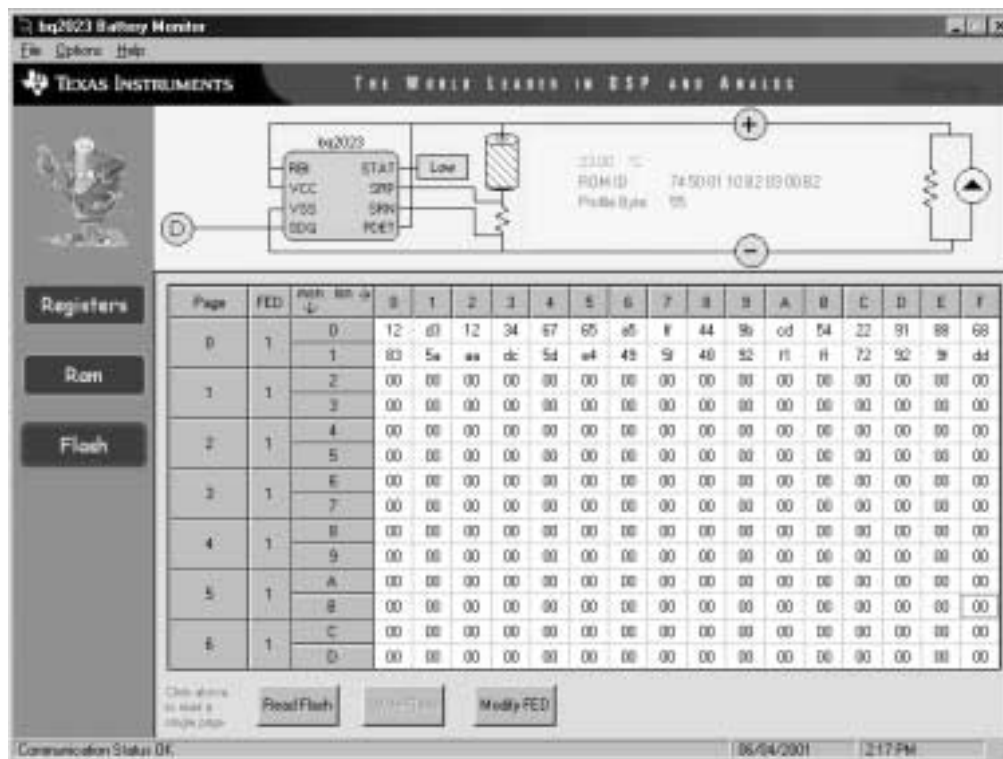
The flash memory on the bq2023 can store battery-pack-specific parameters used by the host system in its capacity monitoring algorithm.

To read the flash memory, click on the Flash button to select the flash data screen. Click the Read Flash button to read all six flash pages or click the individual page number to read the pages individually.

Each flash location can be modified by clicking on the individual location and entering the new value in hex.

The flash values can be stored to disk as one data file. To do this, select File|Save Flash File and enter the file name in the Store Flash File window. The file can subsequently be opened using the File|Open Flash File command from the pulldown menu. Once the flash file is loaded into the program the Write Flash button can be used to store the data in the bq2023.

Figure 4–3. Flash Register Screen



### 4.3.1 The FED Register

The FED register can be used to *permanently* disable erase and write access to each page of flash. Click the Modify FED button to access this register.

## 4.4 RAM Addressing

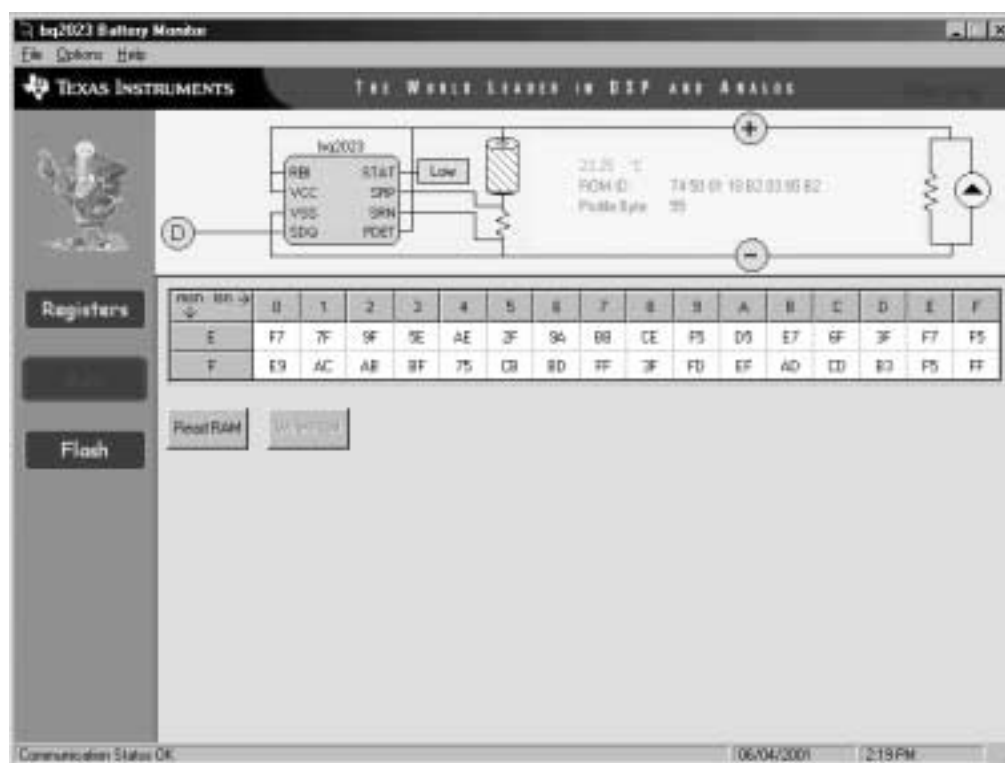
The RAM page of memory is viewed by selecting the RAM data screen.

Click the Read RAM button to read the RAM locations.

Each RAM location can be modified by clicking on the individual location and entering the new value in hex.

The RAM values can be stored to disk as one data file. To do this, select File|Save RAM File and enter the file name in the Store Ram File window. The file can subsequently be opened using the the File|Open Ram File command from the pull down menu. Once the RAM file is loaded into the program, the Write RAM button can be used to store the data in the bq2023.

Figure 4–4. RAM Register Screen



## 4.5 Data Logging

- 1) Select Options|Logging Options to select the registers to log and set the logging interval.
- 2) File|Start Data Log from the pulldown menu.
- 3) Enter the name of the data log file in the Name Datalog File box
- 4) Click on the Open button
- 5) To stop the data logging select File|Close Data Log from the pulldown menu. The file can be imported into a text editor, spreadsheet, or word processor program.

Example data log:

EV2201–23 Version: 1.0.0  
Texas Instruments bq2023 battery monitor  
06/04/2001 2:40:35 PM  
ROM ID: 74 50 01 10 B2 03 00 B

Sample	Stamp	Elapsed (s)	DCR	CCR	SCR	DTC	CTC	MODE/WOE	CLR	TEMP
1	2:40:45 PM	10	0	0	0	0	16	78	192	1186
2	2:40:55 PM	20	0	0	0	0	26	78	192	1186
3	2:41:05 PM	30	0	0	0	0	37	78	192	1187
4	2:41:15 PM	40	5	0	0	4	44	78	192	1187
5	2:41:25 PM	50	9	0	0	15	44	78	192	1187
6	2:41:35 PM	60	9	0	0	25	44	78	192	1188
7	2:41:45 PM	70	9	0	0	46	44	78	192	1188
8	2:41:55 PM	80	9	0	0	56	44	78	192	1196
9	2:42:05 PM	90	10	0	0	66	44	78	192	1194