TEXAS INSTRUMENTS

bq2052EVM-001 Primary Lithium Gas Gauge IC Evaluation Module

User's Guide

November 2000

Advanced Analog Products

SLUU078

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Chapter 1

Introduction

The bq2052 EVM is a complete evaluation system for the bq2052 Primary Lithium Gas Gauge IC. The EVM includes a DM2052 circuit module, an EV2200 PC Interface Board for Gas Gauge Evaluation, a PC serial cable, and Windows-based PC software. The DM2052 circuit module includes one bq2052 IC, a sense resistor, five LEDs to display remaining capacity, and all other components onboard necessary to monitor capacity and other critical parameters in a primary lithium-based system. The DM2052 connects directly across the cells in a battery. With the EV2200 interface board and software, the user can read the bq2052 data registers and evaluate the functions of the bq2052 under different discharge conditions.

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1.1 Features

- ❑ Complete evaluation system for the bq2052 Gas Gauge IC
- ❑ Preprogrammed DM2052 module for quick setup
- ❑ PC software and interface board for easy evaluation
- ❑ EVM software that allows data logging for system analysis

1.2 Kit Contents

DM2052 preconfigured circuit module

1 EV2200 PC interface board

1 Set of evaluation software disks entitled EV2200-HDQ

1 PC serial cable

1 Set of support documentation

Chapter 2

DM2052—bq2052-Based Circuit Module

The DM2052 circuit module is a complete and compact example solution of a bq2052 circuit for capacity monitoring of primary lithium battery packs. The DM2052 incorporates a bq2052 gas gauge IC, a 0.1-W sense resistor, and all other components necessary to accurately monitor and display the capacity of 5 series lithium primary cells (15 V).

The DM2052 includes 5 LEDs to display remaining capacity in 20% increments of the programmed capacity. The LEDs are activated with the onboard push–button switch.

Contacts on the DM2052 provide direct connection to the battery stack (BAT+, BAT–) and the serial communications port (HDQ). The system load connects across BAT+ and PK–.

The DM2052 enters sleep mode during periods of no discharge activity. The module wakes up and returns to full operation in response to a discharge load >100 mA or by depressing the LED display switch.

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2.1 Pin Descriptions

HDQ	HDQ/Serial communications port
BAT	BAT+/Battery positive/pack positive
BAT	BAT–/Battery negative
PK–	PK–/Pack negative

2.2 Programming

The DM2052 circuit module is preconfigured for battery-pack chemistry, voltage, and pack capacity. The circuit module can be reprogrammed for chemistry, capacity, and other operating parameters via the programming resistors on the board. The resistors set the programming pins to a high (H), low (L), or float (Z) state on initialization. To set a high (H) state for a programming pin requires the pullup resistor, a low (L) state requires the pulldown resistor, and the float (Z) requires no resistors on the programming pin. The shaded area of the tables indicates the bq2052EVM-001 configuration. Please see the bq2052 data sheet for a complete description of how the bq2052 is programmed.

2.2.1 Full Capacity

Pins 2, 3, and 4 of the bq2052 determine the full capacity or programmed full count (PFC) of the DM2052. Resistors R28, R33, R39, and R46–48 set the pins to a high (H), low (L), or float (Z) state during board initialization. The shaded row indicates the current configuration.

Table 2–1. Full Capacity Programming

PFC Input Settings				
Pin 2	**Pin 3**	**Pin 4**	**Sense Resistor MΩ**	**Capacity (Ah)**
H	H	H	100	12.0
L	Z	H	100	7.2
Z	H	H	100	5.0

2.2.2 Efficiency Settings for Chemistry

Primary lithium chemistries have different discharge efficiencies. Pin 5 of the bq2052 determine the discharge efficiency factors of the DM2052. Resistors R35 and R45 set the pin to a high (H), low (L), or float (Z) state during board initialization.

Table 2–2. Discharge Efficiency Programming

Efficiency Setting	
Pin 5	**Chemistry**
H	LiSO2 (option 1)
L	LiMnO2
Z	LiSO2 (option 2)

2.2.3 LED Display

The DM2052 comes with 5 onboard LEDs and is configured for a bar-graph type display mode by setting Pin 6 to the float (Z) state on initialization. The LEDs indicate remaining battery capacity in 20% increments.

2.2.4 Initialization State

The DM2052 is configured to indicate full battery capacity on initialization. This is done by setting Pin 7 to the high (H) state on initialization using resistors R41 and R42. A low (L) or float (Z) state configures the DM2052 to come up empty. With this selection, the user must write the battery pack to full before shipping the pack or the system.

Table 2–3. Initialization Programming

Initialization Setting	
Pin 7	**Initial Capacity Indication**
H	Full
L	Empty
Z	Empty

2.2.5 Programming Hardware Changes

The following procedure changes the configuration of DM2052 to other (unshaded) options listed in the tables above:

1) Ensure that the DM2052 is disconnected from the battery.
2) Determine the resistors required to achieve the high (H), low (L), or float (Z) states on the program pin inputs.
3) Remove the 100k resistors where needed.
4) Place required 100k resistors where needed.
5) Reconnect the DM2052 to the battery pack.

The EV2200 and the PC software can be used to confirm the new settings by reading the PPU and PPD data registers and the Setup screen.

2.2.6 Pack Voltage

R18 and R19 preconfigure the DM2052 for pack voltage (number of cells), as shown in Table 2–4.

Table 2–4. Pack Voltage Programming

EVM Part Number	R18 (Ω)	R19 (Ω)	Nominal Voltage Level	End-of-Discharge Level 1	End-of-Discharge Level 2
bq2052EVM-001	1.0 M	82.5 K	15 V	10 V	8.7 V

Chapter 3

DM2052 Schematic

The DM2052 schematic shows all possible components on the board for various configurations, including all configuration resistors. Only those resistors that set the desired configuration should be installed. The schematic notes indicate where variations exist.

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3.1 Schematic

Figure 3–1 shows the DM2052 schematic diagram.

Figure 3–1. DM2052 Schematic, Part 1 of 2

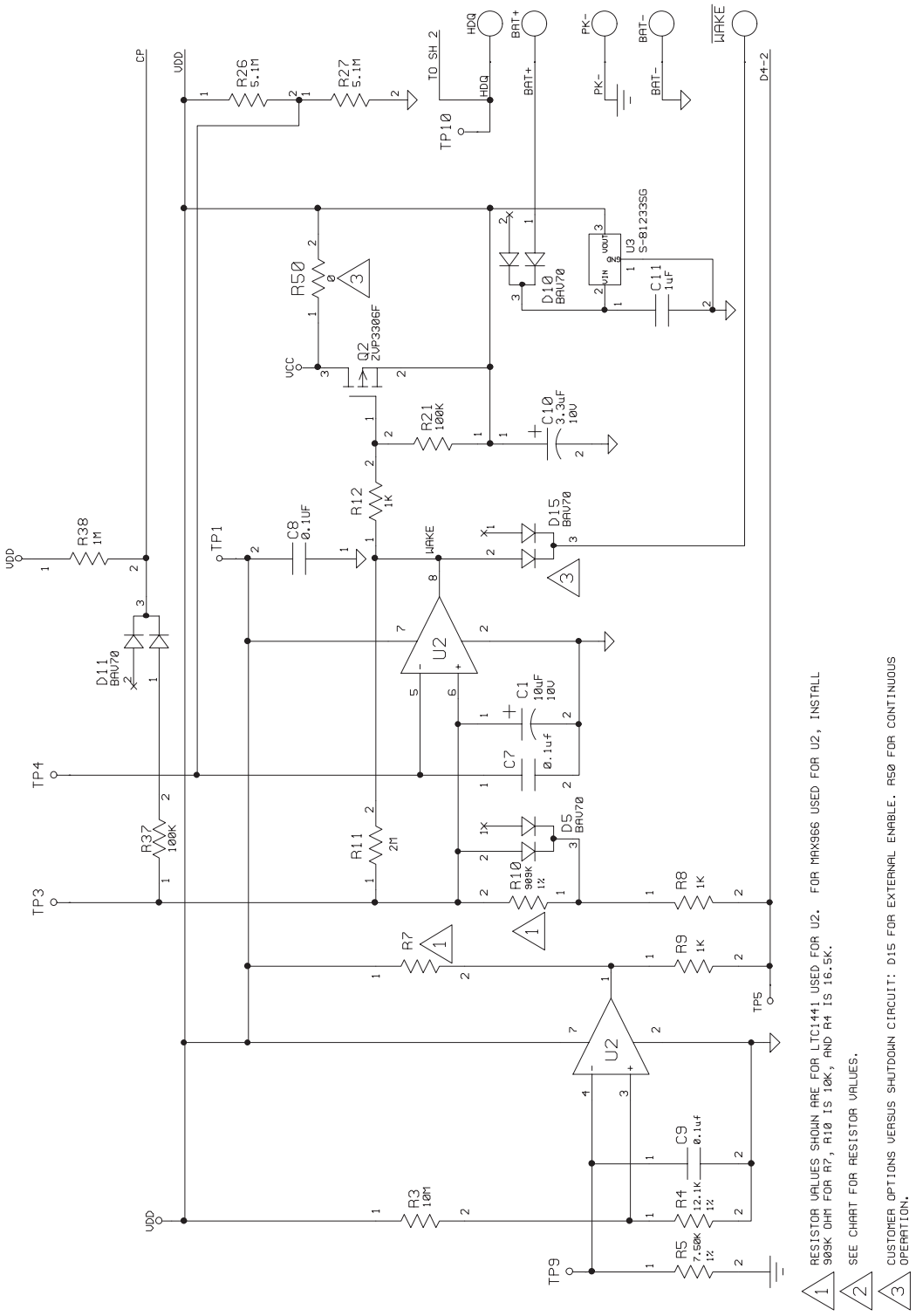
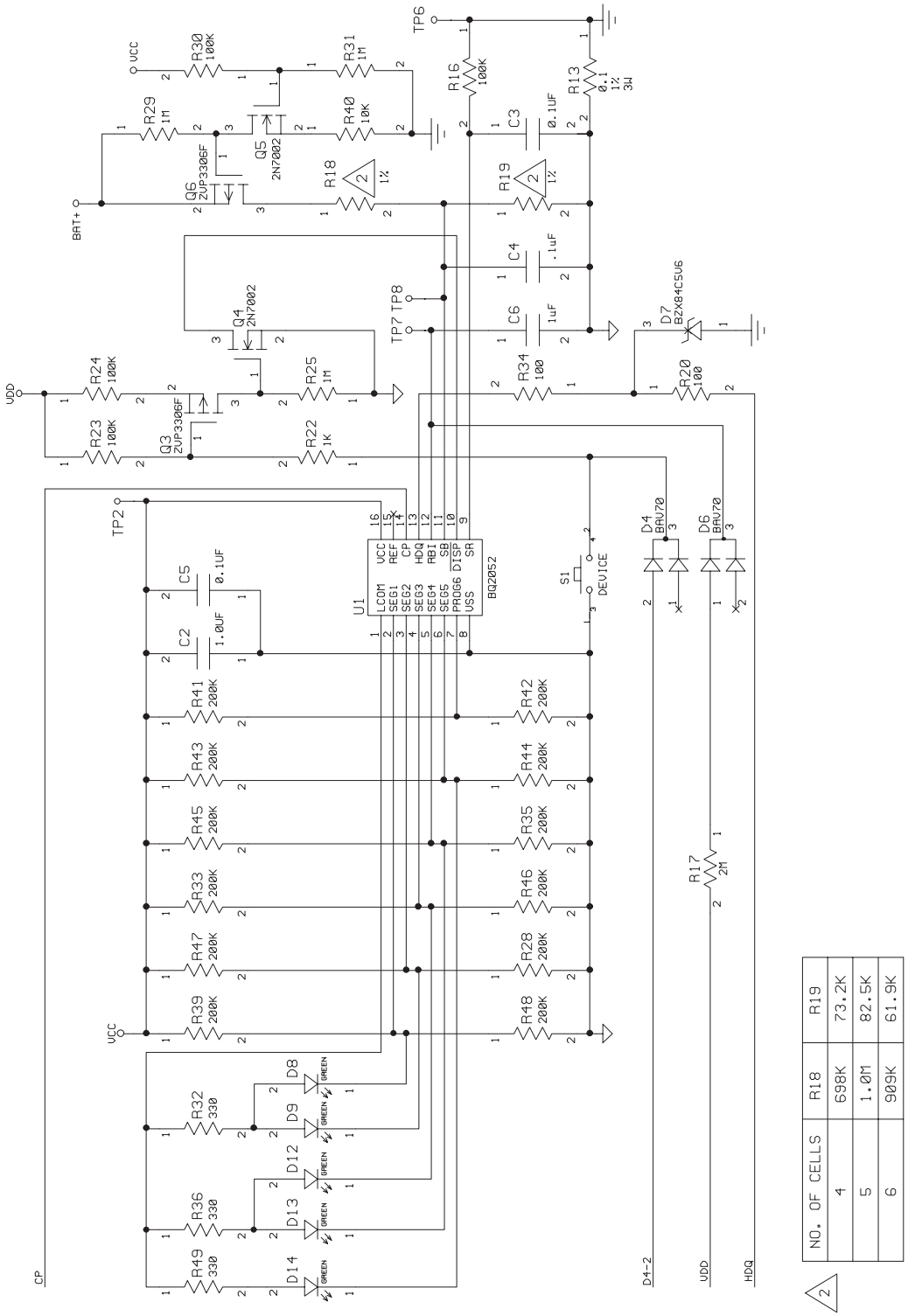


Figure 3–2. DM2052 Schematic, Part 2 of 2



Chapter 4

DM2052 Physical Layouts

This chapter contains the board layout and assembly drawings for the DM2052.

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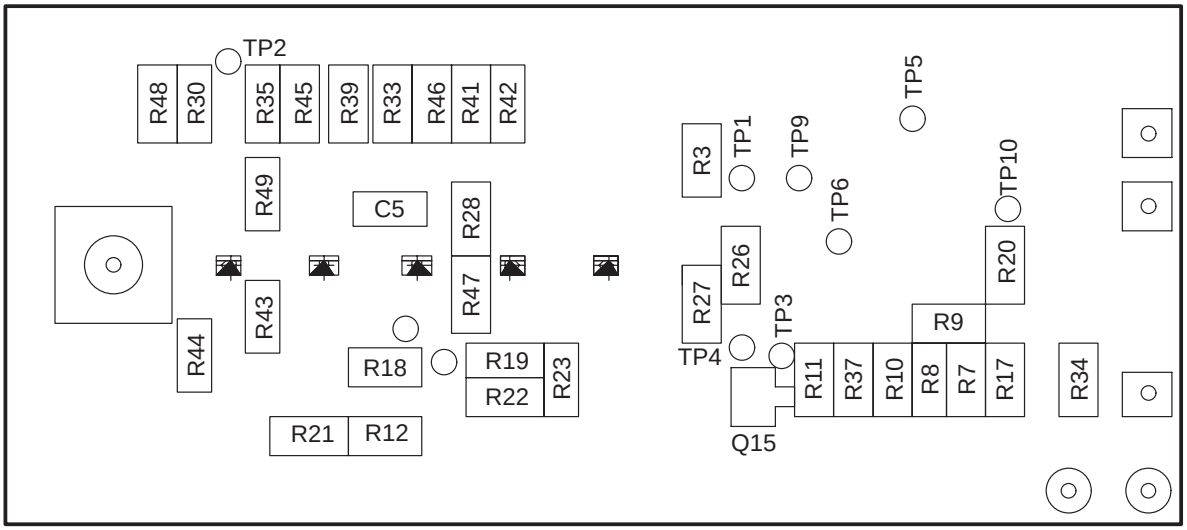
4.1 Board Layout

Figure 4–1 shows the dimensions, PCB layers, and assembly drawing for the DM2052.

Figure 4–1. DM2052 Dimensions and Layout



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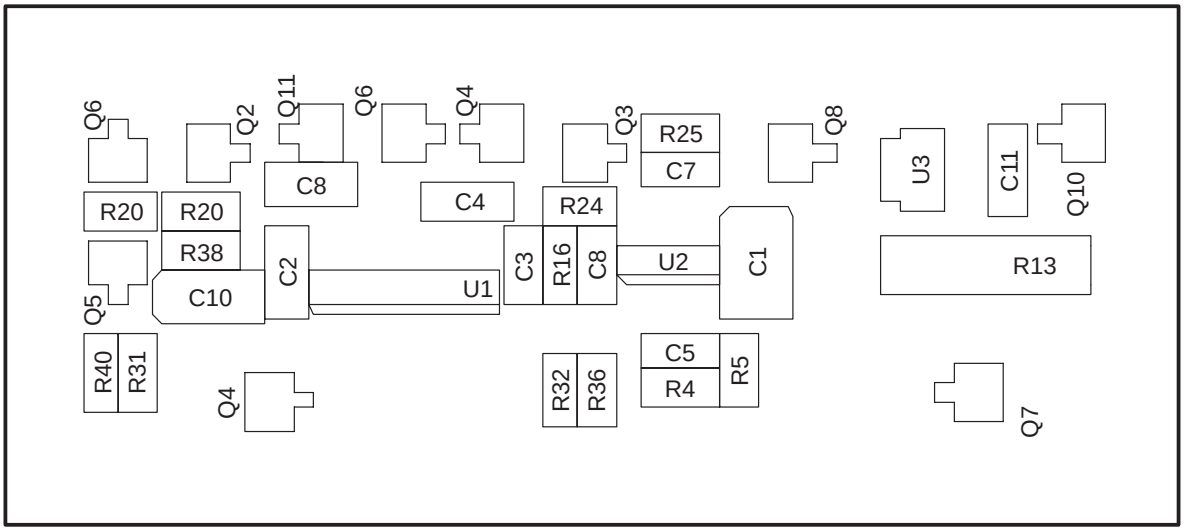

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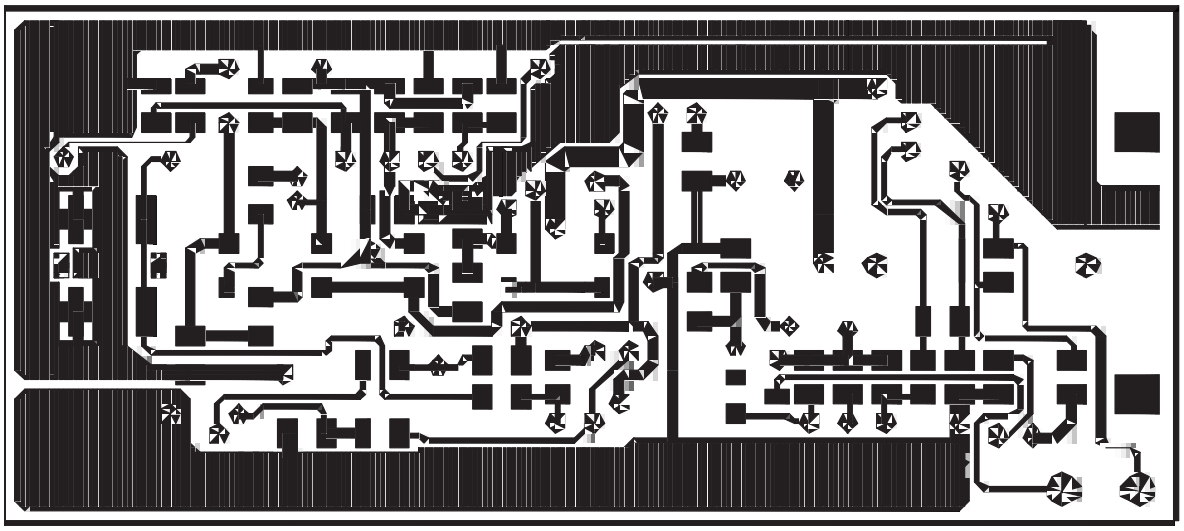
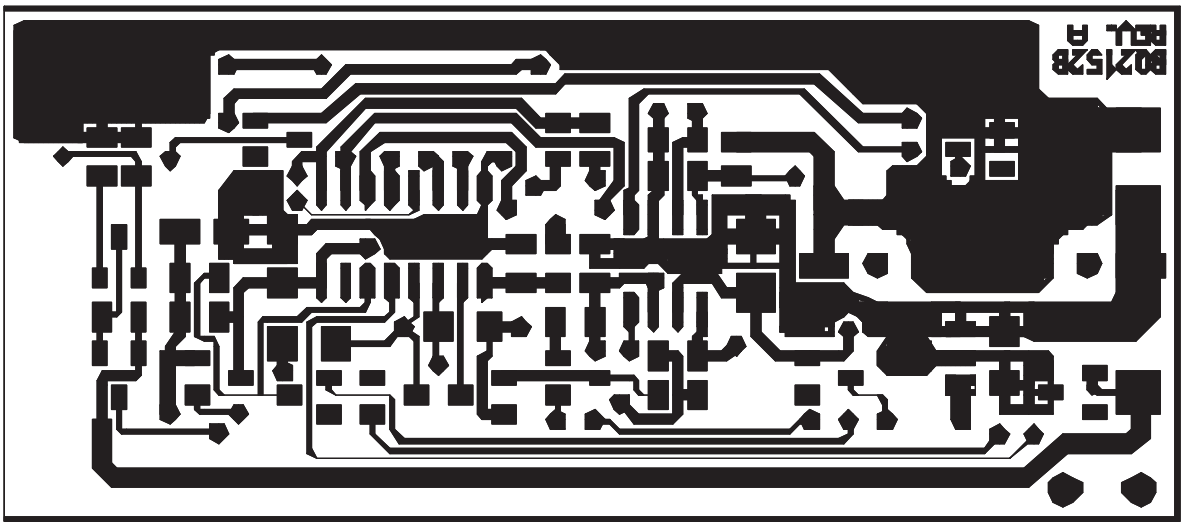
Figure 4–1. DM2052 Dimensions and Layout (Continued)



Layer_1



Layer_2

Chapter 5

DM2052 Bill of Materials

This chapter contains the bill of materials required for the DM2052. The two versions shown accommodate two different versions of the IC component U2.

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5.1 Bill of Materials

Table 5–1. Bill of Materials

REF.	#1	#2	DESCRIPTION	MFG	MFG PART#	SIZE
C1	1	1	Capacitor, tantalum, 10 µF, 10 V, 20%	Panasonic	ECS–H1AX106R	3528
C2, C6, C11	3	3	Capacitor, ceramic, 1 µF, 25 V, ±20%, X7R	Panasonic	ECJ–3YB1E105K	3216
C3, C5, C7,C8, C9	5	5	Capacitor, ceramic, 0.1 µF, 25 V, ±20%, X7R	Venkel	C0805X7R250-104MNE	2012
C4	1	1	Capacitor, ceramic, 0.1 µF, 25 V, ±20%, X7R	Panasonic	ECJ–3VBE104K	3216
C10	1	1	Capacitor, tantalum, 3.3 µF, 16 V, 20%	AVX	TAJA335M016R	3216
R3	1	1	Resistor, 10 MW, 0.1 W, 5%	Venkel	CR0805–10W106JT	805
R4	1	0	Resistor, 12.1 kKΩ, 0.1 W, 1%	Venkel	CR0805–10W1212FT	805
R4	0	1	Resistor, 16.5 kΩ, 0.1 W, 1%	Venkel	CR0805–10W1652FT	805
R5	1	1	Resistor, 7.50 kΩ, 0.1 W, 1%	Venkel	CR0805–10W7501FT	805
R7	0	1	Resistor, 909 kΩ, 0.1 W, 1%	Venkel	CR0805–10W9093FT	805
R8, R9, R12, R22	4	4	Resistor, 1 kΩ, 0.1 W, 5%	Venkel	CR0805–10W102JT	805
R10	1	0	Resistor, 909 kΩ, 0.1 W, 1%	Venkel	CR0805–10W9093FT	805
R10	0	1	Resistor, 10 kΩ, 0.1 W, 5%	Venkel	CR0805–10W103JT	805
R11, R17	2	2	Resistor, 2 MΩ, 0.1 W, 5%	Venkel	CR0805–10W1004FT	805
R13	1	1	Resistor, 0.10 W, 3W, 1%, LVR–3, Axial	Dale	LVR–3 R010 1%	3W, TH
R16, R21, R23, R24, R30, R37	6	6	Resistor, 100 kΩ, 0.1 W, 5%	Venkel	CR0805–10W104JT	805
R18	1	1	Resistor, 1 MΩ, 0.1 W, 1%	Venkel	CR0805–10W1004FT	805
R19	1	1	Resistor, 82.5 kΩ, 0.1 W, 1%	Venkel	CR0805–10W8252FT	805
R20, R34	2	2	Resistor, 100 W, 0.1 W, 5%	Venkel	CR0805–10W101JT	805
R25, R29, R31, R38	4	4	Resistor, 1 MΩ, 0.1 W, 5%	Venkel	CR0805–10W105JT	805
R26, R27	2	2	Resistor, 5.1 MΩ, 0.1 W, 5%	Venkel	CR0805–10W515JT	805
R28, R33, R35, R39, R41–R48	12	12	Resistor, 200 kΩ, 0.1 W, 5%	Venkel	CR0805–10W204JT	805
R32, R36, R49	3	3	Resistor, 330 W, 0.1 W, 5%	Venkel	CR0805–10W331JT	805
R40	1	1	Resistor, 10W KΩ, 0.1 W, 5%	Venkel	CR0805–10W103JT	805
R50	0	0	Resistor, 10W KΩ, 0.1 W, 5%	Venkel	CR0805–10W000JT	805
D4, D5, D6, D10, D11, D15	6	6	Diode, dual, switching, BAV70	Zetex	BAV70	SOT–23
D7	1	1	Diode, Zener, 5.6 V	Zetex	BZX84C5V6	SOT–23
D8, D9, D12, D13, D14	5	5	Diode, LED, green	Panasonic	LN1371G–(TR)	Gullwing
Q2, Q3, Q6	3	3	Transistor, MOSFET, P–Ch	Zetex	ZVP3306F	SOT–23
Q4, Q5	2	2	Transistor, MOSFET N–Ch	Natlional/ Samsung	2N7002	SOT–23
S1	1	1	Switch, momentary, N.O., 5 mmx1.5 mm thick	Panasonic	EVQ–PLHA15	SMD

Table 5–1. Bill of Materials (Continued)

REF.	#1	#2	DESCRIPTION	MFG	MFG PART#	SIZE
S1	1	1	Switch, momentary, N.O., 5 mmx1.5 mm thick	Panasonic	EVQ–PLHA15	SMD
U1	1	1	Integrated Circuit, Gas Gauge	Benchmarq/ TI	bq2052	SOIC16
U2	1	0	Op Amp, Dual, micropower, (LTC1441IS8)	Linear Tech	LTC1441IS8	SOIC8
U2	0	1	Op Amp, Dual, micropower, (MAX966)	MAXIM	MAX966ESA	SOIC8
U3	1	1	Voltage regulator, micropower, 3.3 V	Seiko	S81233SGUP–DQF–T1	SOT89

Chapter 6

DM2052 Performance Specification Summary

This chapter summarizes the performance specifications of the DM2052.

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6.1 Circuit Specifications

Figure 6–1. Performance Specification Summary

Specification	Min	Typ	Max	Units
Discharge current			3	A
Wake-up current		100		mA
Sleep mode current consumption		10		μA

Chapter 7

EVM Hardware and Software Setup

This section describes how to install the bq2052 EVM PC software and how to connect the different components of the EVM.

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7.1 Software Installation

The following steps install the EV2200–HDQ 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.

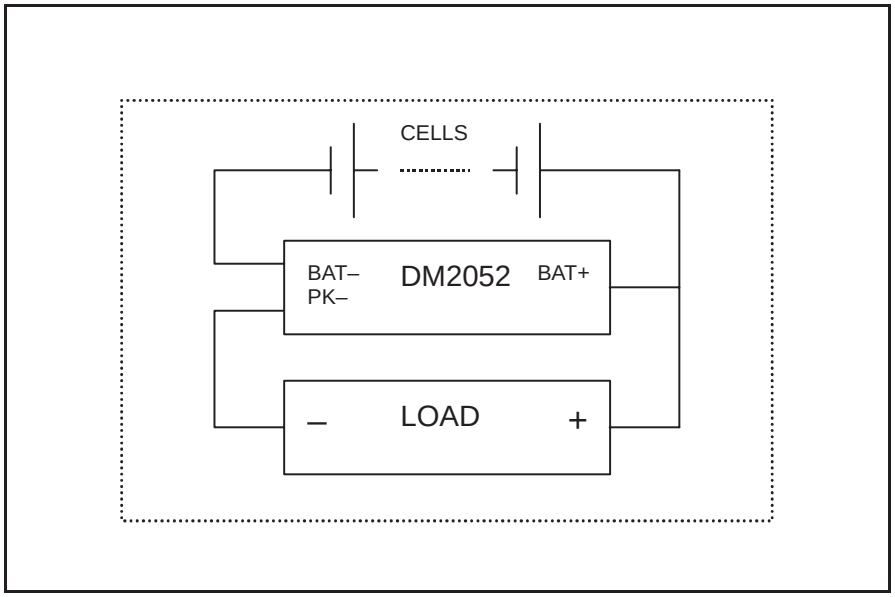
7.2 Hardware Connection

There are three hardware components to the bq2052 EVM: The DM2052 circuit module, the EV2200 PC interface board, and the PC.

7.2.1 Connecting the DM2052 to a Battery Pack

Figure 7–1 shows how to connect the DM2052 to a stack of cells and the system load.

Figure 7–1. DM2013H Connection to Cells, Sense Resistor, and System Load/Charger



7.2.2 PC Interface Connection

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

1) Connect the DM2052 based smart battery to the EV2200 using wire leads as in Table 7–1.

2) Connect the PC serial cable to the EV2200 and the PC COM port.

Table 7–1. DM2052-to-EV2200 Connection

DM2052 Based Battery	EV2200
HDQ	SMBD/HDQ1 or SMBC/HDQ2
PK–	VSS

The bq2052 EVM is now set up for operation.

Chapter 8

Operation

This chapter details the operation of the bq2052 EVM software.

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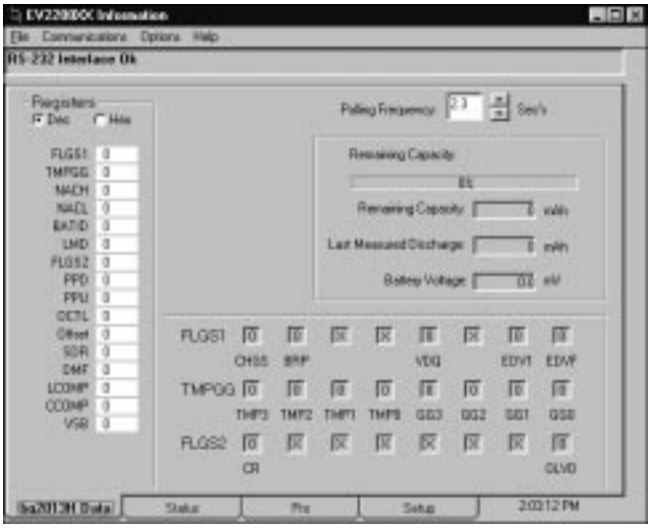
8.1 Starting the Program

Run EV2200-xxH from the Start|Programs|EV2200-xxH menu sequence. The software requests the PC communications port the first time it is run after installation. Choose the Retry Auto-detection button for automatic port configuration. After the port is detected, the software displays the bq2052 data screen.

Figure 8–1. Initial Data Screen



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

8.2 Initialization

This section describes the settingsrequired for the EVM software to properly display data.

8.2.1 Device Program Settings

Select the bq2052 option from the Options|Device Selection pulldown menu. This selection sets the software to operate with the bq2052. The program may prompt you to quit and restart the program. If so, follow the on-screen instructions and restart the program. Once restarted, the software is set up to work with the bq2052.

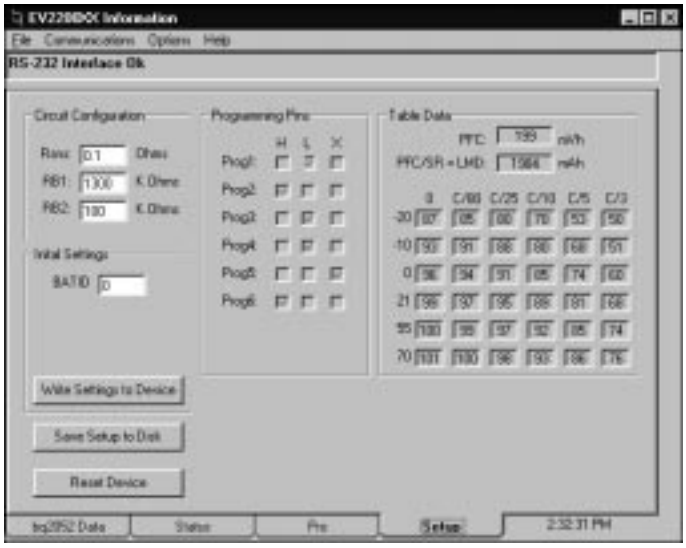
8.2.2 HDQ Port

Note whether the HDQ line from the DM2052 is connected to SMBD/HDQ1 or SMBC/HDQ2 of the EV2200. Select HDQ1 for the SMBD/HDQ1 connection or HDQ2 for the SMBC/HDQ2 connection from the Options|HDQ pulldown menu.

8.2.3 Setup Parameters

Select the Setup tab.

Figure 8–2. Setup Screen



Enter the corresponding resistor values in the Circuit Configuration box. These values are saved to disk using the Save Setup to Disk button so they are automatically called up when the program loads.

Table 8–1. Resistor Designations for Setup Screen Input

Circuit Configuration NAME	Schematic Identifier
Rsns	R13
RB1	R18
RB2	R19

The Initial Settings box programs selected registers of the bq2052. The value is entered in the selected box and written to the device by depressing the Write Settings to Device button.

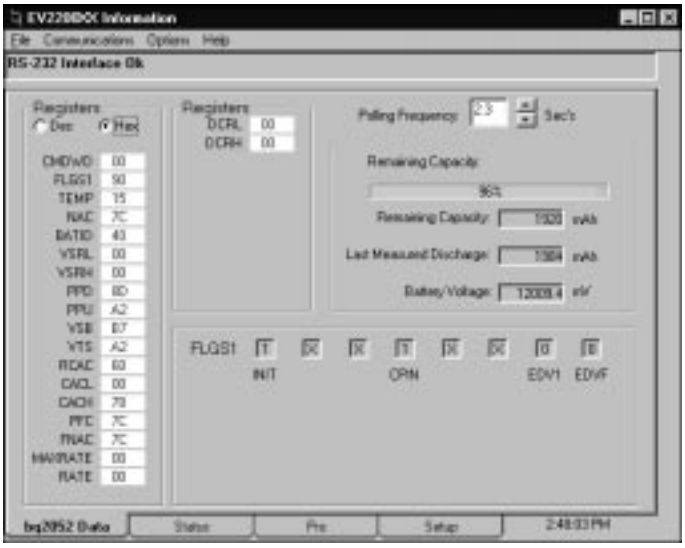
The screen also displays how pins 2 (Prog1) through 7 (Prog6) are programmed. The Reset Device button initializes the bq2052 with the programmed settings.

The Table Data box shows the discharge efficiency settings selected by the programming of pin 5. It also shows the programmed full battery capacity in terms of mVh and mAh (mAh = mVh / Rsns). The programmed full capacity or count (PFC) is set by the programming of pins 2–4.

8.3 Data Screen

After the setup parameters are entered, return to the bq2052 data screen to see the bq2052 registers. The screen displays the names and values of all the accessible registers of the bq2052. The values are displayed in hexadecimal or decimal. The Polling Frequency box sets the data polling rate of the data fields.

Figure 8–3. bq2052 Data Screen



The registers are written by selecting a data box, overwriting the present value with the desired value, and pressing ENTER. The data must be entered in the same base (decimal or hexadecimal) as the selected base.

Note:

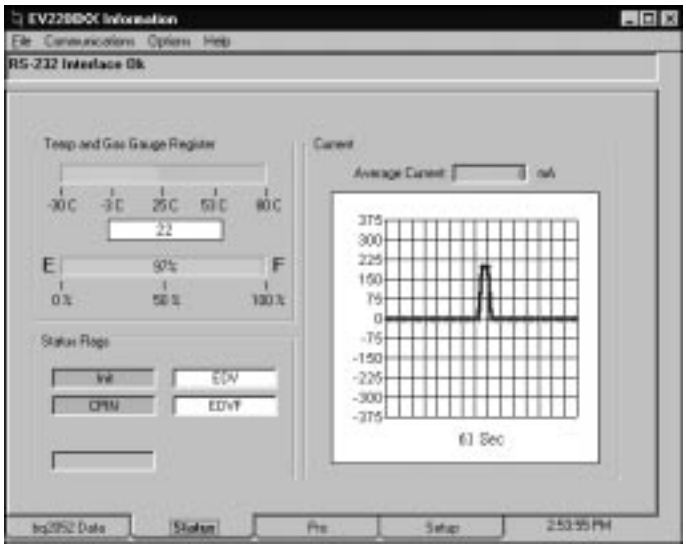
The bq2052 is active only when there is a discharge load or when the LED button is depressed. If the bq2052 is in sleep mode (inactive), the data screen will show incorrect data.

The screen also shows the bit status of the status flags register FLGS1.

8.4 Status Screen

The Status screen graphically illustrates bq2052 operation. The program shows the average current activity as well as the temperature and remaining capacity of the battery under evaluation.

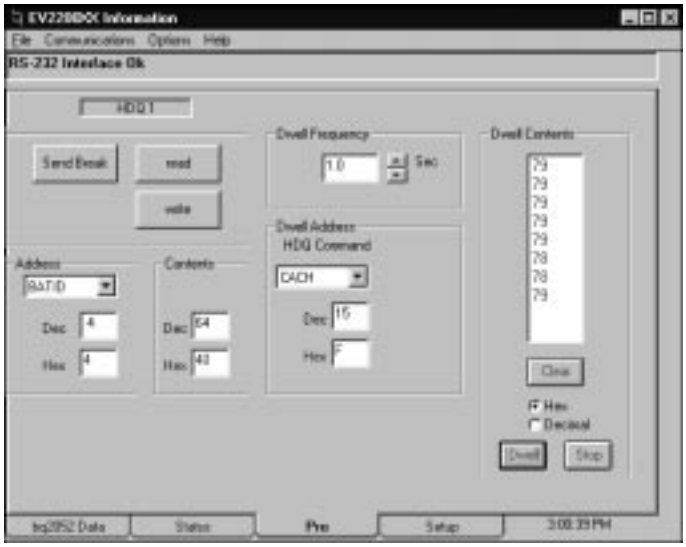
Figure 8–4. Status Screen



8.5 Pro Screen

The Pro screen allows read and write access to all the registers of the bq2052.

Figure 8–5. Pro Screen



To read or write a location:

- ❑ Enter the address location of the register in the Address box. The register and address can be selected from the pulldown menu.

- ❑ Enter the data to be written if applicable.
- ❑ Depress the Read or Write button.
- ❑ The Send Break button sends a communication timing reset signal to the bq2013H and should be depressed each time a bq2013H based batter is connected to the EV2200.

The program can continuously read a single address by using the dwell feature. To use the dwell feature:

- ❑ Enter the address to read in the Dwell Address box. This can be selected with the pulldown menu.
- ❑ Set the dwell frequency in the Dwell Frequency box.
- ❑ Click the Dwell button in the Dwell Contents box.

The contents of the register will start to scroll at the selected frequency.

8.6 Data Logging

The data log function. logs the bq2052 registers To log the data and create a log file

- ❑ Select File|Start Data Log from the pulldown menu.
- ❑ Enter a data log filename
- ❑ Press OK
- ❑ Set the data-log interval
- ❑ Press Close
- ❑ 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.