TEXAS INSTRUMENTS

User's Guide
SLUU275–October 2006

bq20z95EVM-001 SBS 1.1 Impedance Track™ Technology Enabled Battery Management Solution Evaluation Module

This evaluation module (EVM) is a complete evaluation system for the bq20z95/bq29412 battery management system. The EVM includes one bq20z95/bq29412 circuit module, an EV2300 PC interface board for gas gauge interface, a PC USB cable, and Windows™-based PC software. The circuit module includes one bq20z95 integrated circuit (IC), one bq29412 IC, and all other onboard components necessary to monitor and predict capacity, perform cell balancing, monitor critical parameters, protect the cells from overcharge, over-discharge, short-circuit, and overcurrent in 2-, 3- or 4-series cell Li-ion or Li-polymer battery packs. The circuit module connects directly across the cells in a battery. With the EV2300 interface board and software, the user can read the bq20z95 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the bq20z95/bq29412 solution under different charge and discharge conditions.

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1 Features

- Complete evaluation system for the bq20z95 SBS 1.1-compliant advanced gas gauge with Impedance Track™ technology and bq29412 independent overvoltage protection IC
- Populated circuit module for quick setup
- PC software and interface board for easy evaluation
- Software that allows data logging for system analysis

1.1 Kit Contents

- bq20z95/bq29412 circuit module
- EV2300 PC interface board
- Software CD with the evaluation software
- Connection cable to interface board
- Set of support documentation
- EV2300 USB interface board

1.2 Ordering Information

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq20z95EVM-001	Li-ion	2, 3, or 4 cell	Any

2 bq20z95-Based Circuit Module

The bq20z95/bq29412-based circuit module is a complete and compact example solution of a bq20z95 circuit for battery management and protection of Li-ion or Li-polymer packs. The circuit module incorporates a bq20z95 battery monitor IC, bq29412 independent overvoltage protection IC, and all other components necessary to accurately predict the capacity of 2-, 3-, or 4-series cells.

2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the cells: 1N (BAT-), 1P, 2P, 3P, 4P (BAT+)
- To the serial communications port (SMBC, SMBD)
- The system load and charger connect across PACK+ and PACK-
- To the system-present pin (SYS PRES)

2.2 Pin Descriptions

PIN NAME	DESCRIPTION
1N	-ve connection of first (bottom) cell
1P	+ve connection of first (bottom) cell
2P	+ve connection of second cell
3P	+ve connection of third cell
4P	+ve connection of fourth (top) cell
SMBC	Serial communication port clock
SMBD	Serial communication data port
SYS PRES	System present pin (if low, system is present)
PACK-	Pack negative terminal
VSS	Pack negative terminal
PACK+	Pack positive terminal

3 bq20z95 Circuit Module Schematic

This section contains information for modifying and choosing a precharge mode for bq20z95/bq29412 implementation.

3.1 Schematic

The schematic follows the bill of materials in this user's guide.

3.2 Modifications for Choosing Particular Precharge Mode

In order to charge, the charge FET (CHG-FET) must be turned on to create a current path. When the $V_{(BAT)}$ is 0 V and CHG-FET = ON, the $V_{(PACK)}$ is as low as the battery voltage. In this case, the supply voltage for the device is too low to operate. This function has three possible configurations, and the IC can be easily configured according to the application needs. The three modes are 0-V Charge FET mode, Common FET mode, and Precharge FET mode.

1. 0-V Charge FET mode - Dedicates a precharge current path using an additional FET (ZVCHG-FET) to sustain the PACK+ voltage level.
2. Common FET mode - Does not use a dedicated precharge FET. The charge FET (CHG-FET) is set to ON state as default.
3. Precharge FET mode - Dedicates a precharge current path using an additional open-drain (OD) pin drive FET (PCHG-FET) to sustain the PACK+ voltage level.

To use a particular mode of charging with the EVM, add or remove some elements shown in Table 2, and use the given settings of DF.Configuration, ZVCHG1, 0.

Table 2. Components and Flash-Memory Settings for Different Precharge Modes

MODE	RESISTORS	PRECHG FET	ZVCHG1	ZVCHG0
1. 0-V Chg (default)	R21, R28	Q3	0	0
2. Common FET	R24	Q2	0	1
3. Precharge	R23, R28	Q3	1	0

For more details about precharge operation and mode choices, see the bq20z95 data sheet at (SLUS757).

3.3 Testing Fuse-Blowing Circuit

To prevent the loss of board functionality during the fuse-blowing test, the actual chemical fuse is not provided in the circuit. FET Q4 drives TP3 low if a fuse-blow condition occurs; so, monitoring TP3 can be used to test this condition. Fuse placement on the application board is shown in the bq20z95 data sheet reference-board schematic.

4 Circuit Module Physical Layouts and Bill of Materials

This section contains the board layout, bill of materials, and assembly drawings for the bq20z95/bq29412 circuit module.

4.1 Board Layout

This section shows the dimensions, PCB layers (Figure 1 through Figure 5), and assembly drawing for the bq20z95 module.

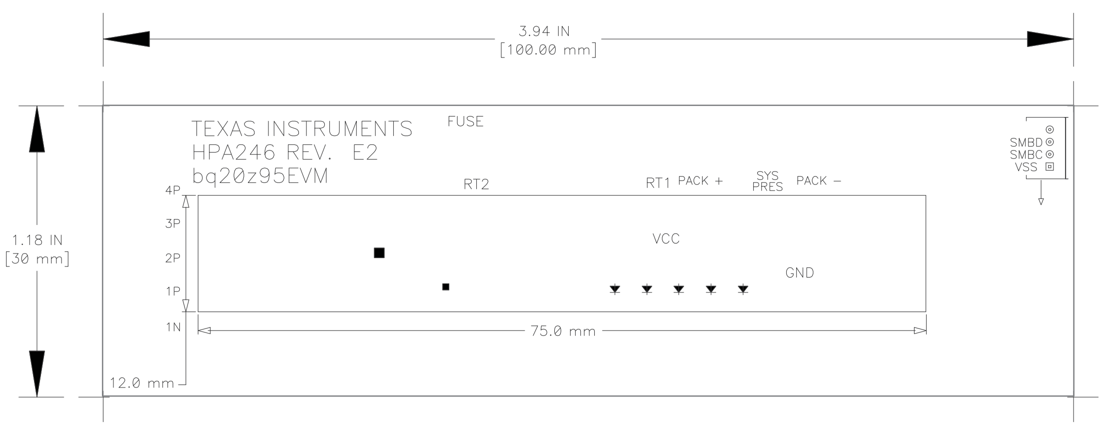

Figure 1. bq20z95EVM-001 Layout (Silk Screen)

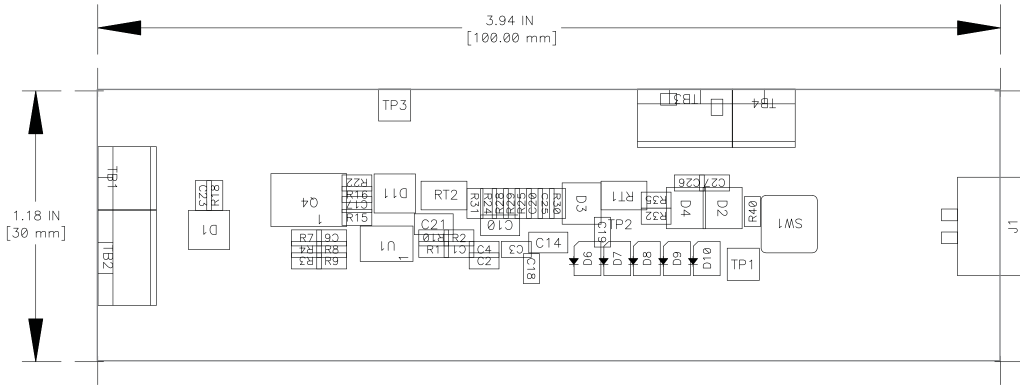

Figure 2. Top Assembly

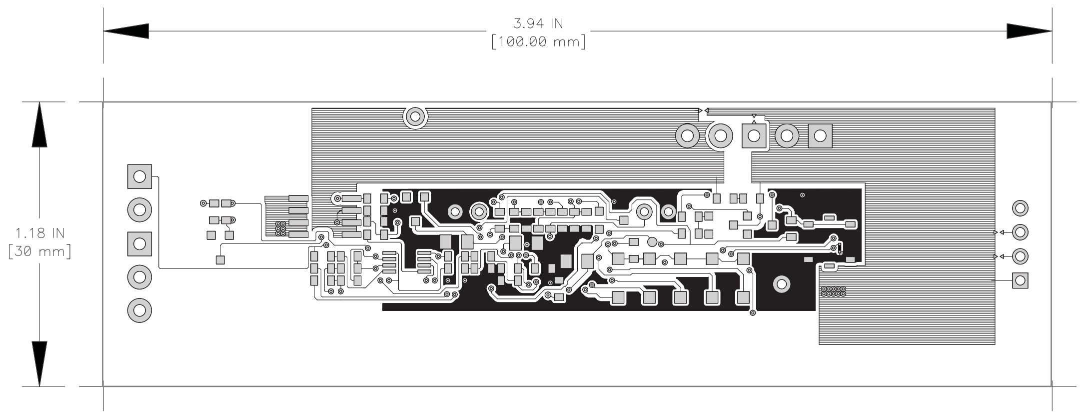

Figure 3. Top Layer

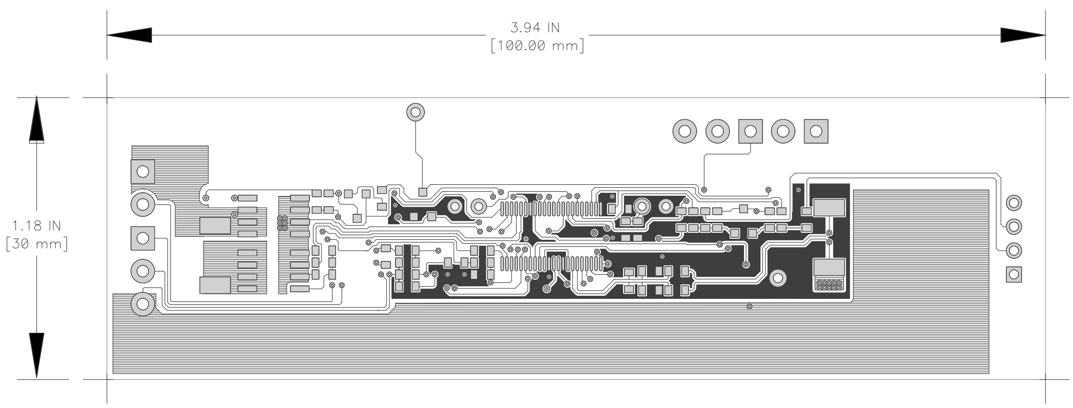

Figure 4. Bottom Layer

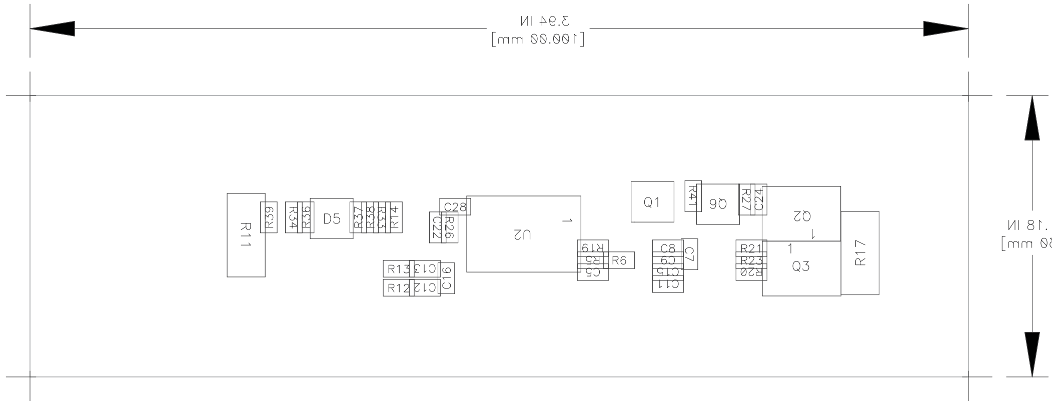

Figure 5. Bottom Assembly

4.2 Bill of Materials and Schematic

Table 3. Bill of Materials

Count	RefDes	Description	Size	Mfr	Part Number
21	C1–C9, C12, C13, C15–C18, C20, C23, C24, C26–C28	Capacitor, Ceramic, 0.1μF, 50 V, X7R, 20%	0603	Any	STD
1	C11	Capacitor, Ceramic, 0.22μF, 50 V, X7R, 20%	0603	Any	STD
1	C19	Capacitor, Ceramic, 4.7μF, 10 V, X7R, 20%	0603	Any	STD
2	C22, C25	Capacitor, Ceramic, 0.47μF, 16 V, X7R, 20%	0603	Any	STD
3	C10, C14, C21	Capacitor, Ceramic, 1.0μF, 25 V, X7R, 20%	0805	Any	STD
4	D1–D3, D11	Diode, Switching, 150-mA, 75-V, 350mW	SOT23	Vishay-Liteon	BAS16
2	D4, D5	Diode, Dual, Zener, 5.6V, 300mW	SOT23	Vishay-Telefunken	AZ23C5V6
5	D6–D10	Diode, LED, Green, Gullwing, GW Type, 20ma, 7.5 mcd typ.	0.120 × 0.087 inches	Panasonic	LN1361C
1	J1	Header, Friction Lock Ass'y, 4-pin Right Angle,	0.400 × 0.500	Molex	22-05-3041
1	Q1	MOSFET, N-ch, 20-V, 1.3A, 0.16-Ω	SOT23	Fairchild	NDS331N
2	Q2, Q4	MOSFET, N-ch Logic Level, Power Trench, 30V, 11A, 12.5 mΩ	SO8	Fairchild	FDS6690A
1	Q3	MOSFET, P-ch, 30-V, 8.0-A, 20-mΩ	SO8	Siliconix	Si4435DY
1	Q6	MOSFET, Nch, 50V, 0.22A, 6 Ω	SOT23	Fairchild	BSS138
12	R1–R5, R12, R13, R32–R34, R38, R39	Resistor, Chip, 100-Ω, 1/16-W, 5%	0603	Std	Std
1	R11	Resistor, Chip, 0.010 Ω, 1-W, xx%	2512	Vishay	WSL-2512-010 1% R86
3	R15, R16, R40	Resistor, Chip, 220 kΩ, 1/16-W, 5%	0603	Std	Std
1	R17	Resistor, Chip, 300-Ω, 1-W, 10%	2512		WSL-2512-300 1% R86
2	R18, R27	Resistor, Chip, 3.01MΩ, 1/16-W, 5%	0603	Std	Std
5	R14, R19, R21–R23	Resistor, Chip, 5.1kΩ, 1/16-W, 5%	0603	Std	Std
4	R20, R36, R37, R41	Resistor, Chip, 1MΩ, 1/16-W, 5%	0603	Std	Std
2	R24, R28	Resistor, Chip, 100kΩ, 1/16-W, 5%	0603	Std	Std
2	R25, R29	Resistor, Chip, 8.45kΩ, 1/16-W, 1%	0603	Std	Std
2	R26, R30	Resistor, Chip, 61.9kΩ, 1/16-W, 1%	0603	Std	Std
7	R6–R10, R31, R35	Resistor, Chip, 1kΩ, 1/16-W, 5%	0603	Std	Std
2	RT1, RT2	Thermistor, 10kΩ	0.095 × 0.150	Semitec	NTC103AT
1	SW1	Switch, Push button, Momentary, N.O. Low Profile	5 mm × 5 mm	Panasonic	EVQPLCxxxx
2	TB1, TB4	Terminal Block, 2-pin, 6-A, 3,5mm	0.27 × 0.25	OST	ED1514
2	TB2, TB3	Terminal Block, 3-pin, 6-A, 3,5mm	0.41 × 0.25	OST	ED1515
1	TP1	Test Point, Black, Thru Hole Color Keyed	0.100 × 0.100 inch	Keystone	5001
1	TP3	Test Point, White, Thru Hole Color Keyed	0.100 × 0.100 inch	Keystone	5002
1	U1	IC, Voltage Protection for 2, 3, 4 Cell Lion , 2nd Protection, 4.45 V OVP	SSOP-08	TI	BQ29412DCT
1	U2	IC, Cool-GG Programmable Battery Management	TSSOP30	TI	bq20z95DBT

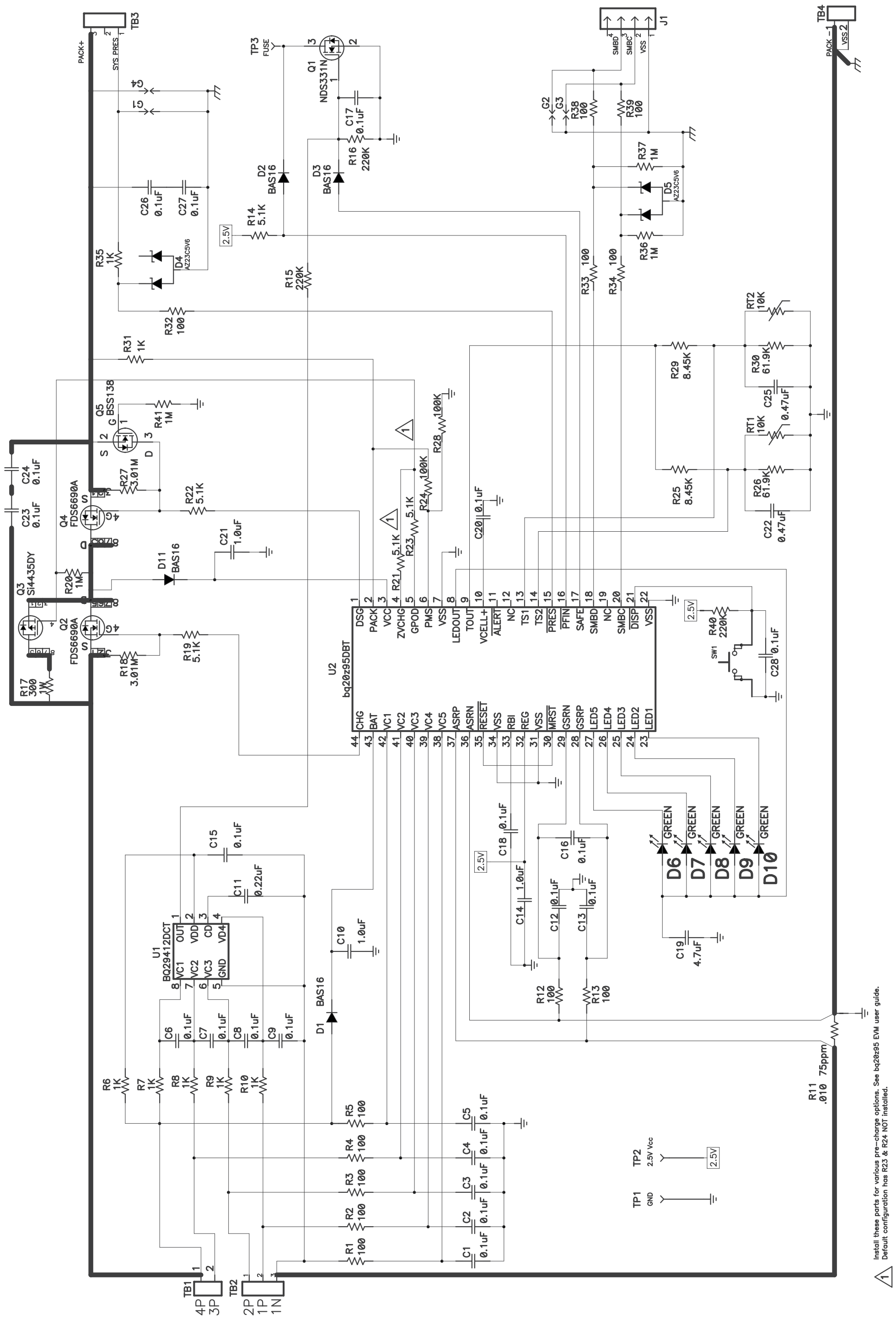

Figure 6. Schematic

4.3 bq20z95/bq29412 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq20z95/bq29412 circuit module.

Table 4. Performance Specification Summary

Specification	Minimum	Typical	Maximum	Units
Input voltage Pack+ to Pack–	6	15	25	V
Charge and discharge current	0	2	7	A

5 EVM Hardware and Software Setup

This section describes how to install the bq20z95EVM-001 PC software, and how to connect the different components of the EVM.

5.1 System Requirements

The bq20z95EVSW software requires Windows™ 2000 or Windows XP. Drivers for Windows 98SE are provided, but Microsoft™ no longer supports Windows 98; and there may be issues in Windows 98 with USB driver support. The EV2300 USB drivers have been tested for Windows 98SE, but no assurance is made for problem-free operation with specific system configurations.

5.2 Software Installation

Find the latest software version in the bq20z95 tool folder on power.ti.com. Use the following steps to install the bq20z95EVSW software:

1. Copy the files from the CD into the temporary directory you selected, open the archive TI USB DRVRS.zip, and extract its contents in a subdirectory/drivers. Choose *preserve directory structure* option when extracting. Alternatively, run *setup.exe* from the same directory.
2. Plug the EV2300 into a USB port.
3. Wait until system prompt *new hardware found* appears. Choose *select location manually*, and use the *browse* button to point to subdirectory TIUSBWin2K-XP-1.
4. Answer *continue* to the warning that drivers are not certified with Microsoft.
5. After installation finishes, another system prompt *new hardware found* appears. Repeat procedure above, but point to subdirectory TIUSBWin2K-XP-2
6. Answer *continue* to the warning that drivers are not certified with Microsoft. Installation of drivers is now finished.
7. For Windows 98, point to directory TIUSBWin98.
8. Return to the temporary directory where you extracted files; double-click on the *setup.exe* icon to install EV Software.

If files were downloaded from the Web:

1. Open the archive containing the installation package, and copy its contents in a temporary directory.
2. Follow the preceding steps 1–8.

6 Troubleshooting Unexpected Dialog Boxes

Ensure that the files were extracted from the zip file using the *Preserve Folder names* option.

Ensure that all the files were extracted from the zip file.

The user that is downloading the files must be logged in as the administrator.

The driver is not signed, so the administrator must allow installation of unsigned drivers in the operating system policy.

7 Hardware Connection

The bq20z95EVM-001 comprises three hardware components: the bq20z95/bq29412 circuit module, the EV2300 PC interface board, and the PC.

7.1 Connecting bq20z95/bq29412 Circuit Module to Battery Pack

Figure 7 shows how to connect the bq20z95/bq29412 circuit module to the cells and system load/charger.

The cells should be connected in the following order:

1. 4-Cell Pack: 1N (BAT–), 1P, 2P, 3P, and 4P (see Section 2.1 for definitions).
2. 3-Cell Pack: 1N (BAT–), 1P, 2P, and then connect 4P and 3P together.
3. 2-Cell Pack: 1N (BAT–), 1P, and then connect 4P, 3P, and 2P together

To start charge or discharge test, connect PRES pin to PACK- pin to set SYS PRES state. To test sleep mode, disconnect the PRES pin.

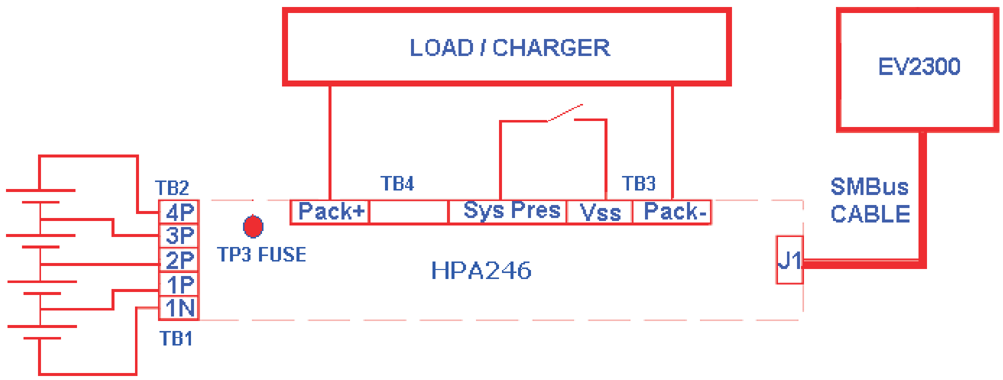

Figure 7. bq20z95 Circuit Module Connection to Cells and System Load/Charger

7.2 PC Interface Connection

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

1. Connect the bq20z95-based smart battery to the EV2300 using wire leads as shown in Table 5.

Table 5. Circuit Module to EV2300 Connections

bq20z95-Based Battery	EV2300
SMBD	SMBD
SMBC	SMBC
VSS	GND

2. Connect the PC USB cable to the EV2300 and the PC USB port.

The bq20z95EVM-001 is now set up for operation.

8 Operation

This section details the operation of the bq20z95 EVSW software.

8.1 Starting the Program

Run bq Evaluation Software from the Start | Programs | Texas Instruments | bq20z95 EVSW menu sequence. The SBS Data screen (Figure 8) appears. Data begins to appear once the <Refresh> (single time scan) button is clicked, or when the <Keep Scanning> check box is checked. To disable the scan feature, deselect <Keep Scanning>.

The continuous scanning period can be set via the | Options | and | Set Scan Interval | menu selections. The range for this interval is 0 ms to 65535 ms. Only items that are selected for scanning are scanned within this period.

The bq Evaluation Software provides a logging function which logs the values that were last scanned by EVSW. To enable this function, select the *Start Logging* button, this causes the *Keep Scanning* button to be selected. When logging is *Stopped*, the keep scanning button is still selected and has to be manually unchecked.

The logging intervals are specified under the | Options | menu with the maximum value of 65535 ms. The *Log* interval cannot be smaller than scan interval because this results in the same value being logged at least twice.

Figure 8. SBS Data Screen

This screen (Figure 8) shows the SBS data set along with additional ManufacturersAccess() command information such as individual cell measurements. Additional Flag and Static data can be viewed by selecting the appropriate tab at the bottom of the SBS screen.

Data such as SBS.ManufacturerName( ) is static and does not change. This data is viewed separately using the *Static Data* tab available at the bottom of the screen.

Dragging the splitter bar (line that separates the Flags/Static data from SBS values) changes the height of the Flags/Static Data display. Selecting | View |, then | Auto Arrange | returns the splitter bar to its original location.

8.2 Setting Programmable bq20z95 Options

The bq20z95 data flash comes configured per the default settings detailed in the bq20z95 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq20z95 solution being evaluated.

IMPORTANT: The correct setting of these options is essential to get the best performance.

The settings can be configured using the Data Flash screen (Figure 9).

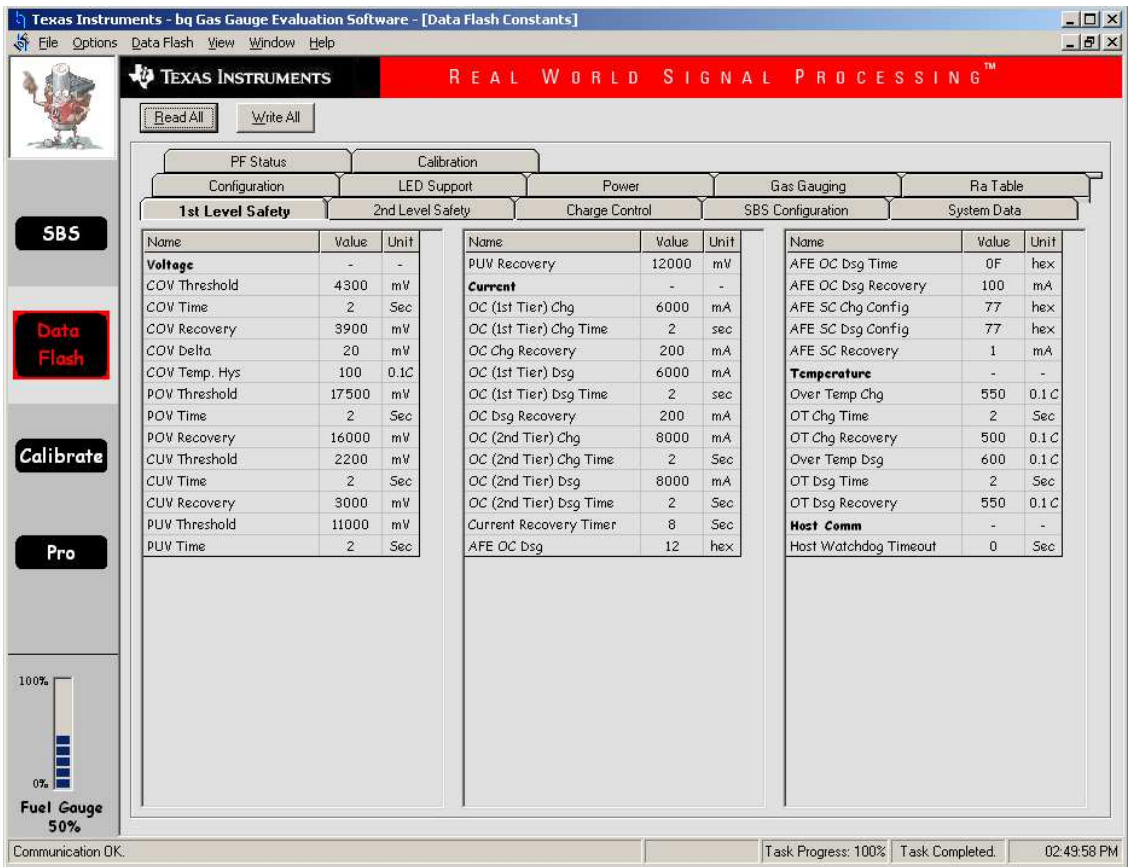

Figure 9. Data Flash Screen, 1st Level Safety Class

To read all the data from the bq20z95 data flash, click on menu option | Data Flash | Read All |.

To write to a data flash location, click on the desired location, enter the data and press <Enter>, which writes the entire tab of flash data, or select menu option | Data Flash | Write All |. The data flash must be read before any writes are performed to avoid any incorrect data being written to the device.

The | File | Special Export | menu options allows the data flash to be exported, but it configures the exported data flash to a learned state ready for mass production use.

The data flash configuration can be saved to a file by selecting | File | Export | and entering a file name. A data flash file also can be retrieved in this way, imported, and written to the bq20z95 using the | Write All | button.

The configuration information of the bq29z95 and module calibration data also is held in the bq20z95 data flash.

The bq20z95 allows for an automatic data flash export function, similar to the SBS Data logging function. This feature, when selected via | Options | Auto Export |, exports Data Flash to a sequential series of files named as *FilenameNNNNN.gg* where N = a decimal number from 0 to 9.

The AutoExport interval is set under the | Options menu | with a minimum value of 15 s. The AutoExport filename also is set under the | Options menu |.

When a check mark is next to | AutoExport |, the AutoExport is in progress. The same menu selection is used to turn on / off AutoExport.

If the data flash screen is blank, then the bq20z95 that is being used may not be supported by the bqEVSW version that is being used. An upgrade may be required.

9 Calibration Screen

9.1 How to Calibrate

Before the bq20z95 is calibrated:

- Connect a load to Pack- and Pack+ that draws approximately 2 A and measures discharge current to use the FETs.
- Connect a current source to Batt- and Pack- to calibrate without using the FETs.
- Measure the pack voltage from Batt+ to Batt- (Total of Cell voltages).
- Measure the temperature of the pack.
- These steps may not be required, depending on the type of calibration being performed.

Note that voltage calibration with cells attached requires special consideration. Cells must be in a resting state. For additional information, go to the TI Web site (www.ti.com) and access the TI Knowledge Base and search for *bq20zxx Calibration Using EV Software*.

9.2 To Calibrate the bq20z95

Select the types of calibration to be performed (see Figure 10).

Enter the measured values for the types selected.

If *Voltage Calibration* is selected, then enter the number of cells on the pack.

If *Temperature Calibration* is selected, then select the sensor that is to be calibrated.

If the load is connected between Pack+ and Pack-, then select the *Use FETs* check box.

Press the *Calibrate Part* button.

9.3 Board Offset Calibration

This performs the offset calibration for the current offset of the board.

Remove load/external voltage and short Pack- to Batt-.

Press the *CC Board Offset Calibration* button.

9.4 Pack Voltage Calibration

This calibrates the voltage at the AFE Pack pin.

Make sure *Voltage Calibration* has been performed for the pack. If *Voltage Calibration* is not performed, then *Pack Voltage Calibration* calibrates incorrectly.

Remove load/external voltage applied between Pack+ and Pack-.

Press the *Pack Voltage* button to calibrate.

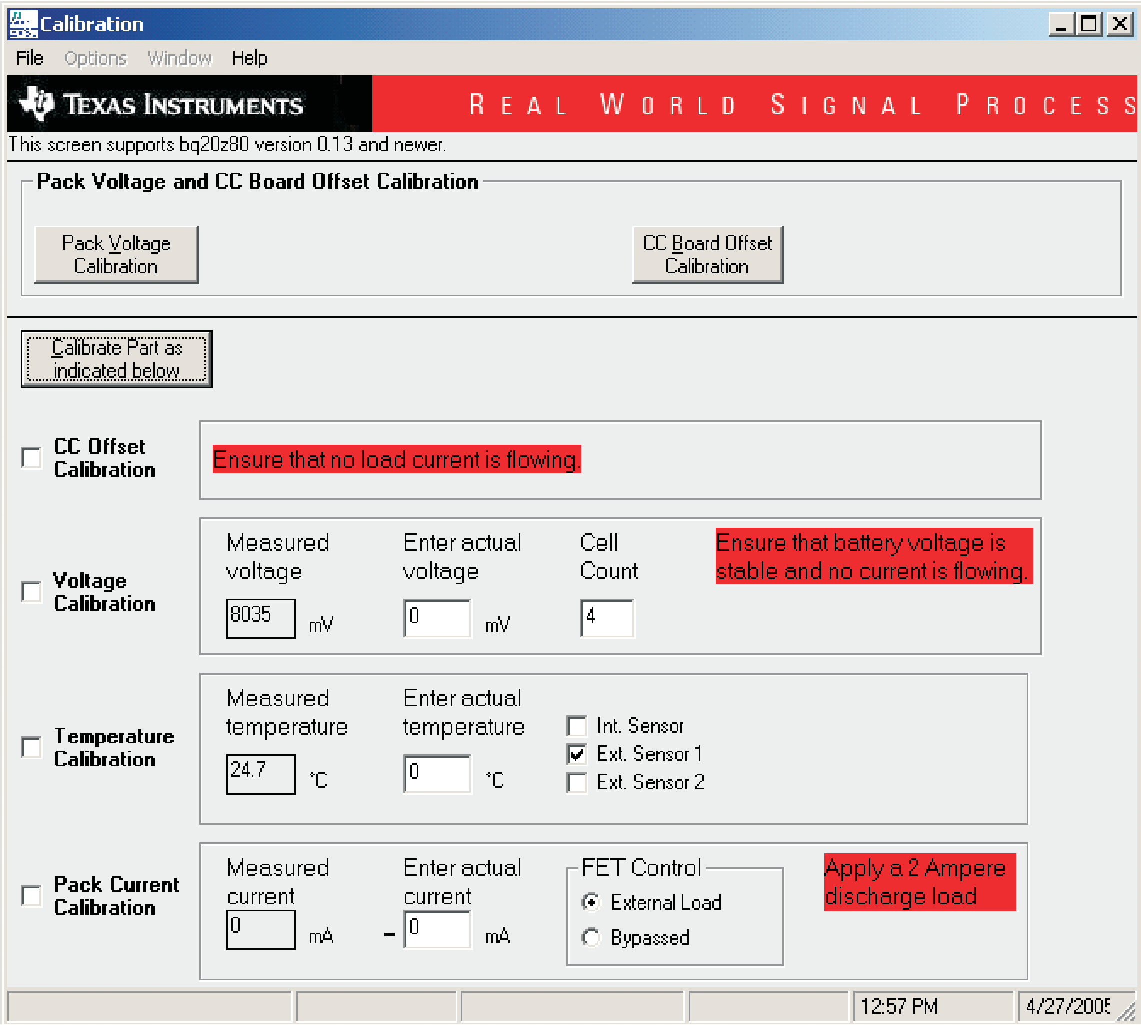

Figure 10. Calibration Screen

10 Pro (Advanced) Screen

10.1 SMB Communication

The set of read/write operations over SMBus are not specific to any gas gauge. These are provided as general-purpose communication tools (Figure 11).

10.2 Hexadecimal/Decimal Converter

These two boxes convert between hexadecimal and decimal as soon as values are typed into the boxes. Invalid values may cause erroneous results.

When scaling converted hexadecimal values to a higher number of bytes, follow these rules:

- When unsigned is selected, the left pad contains zeroes.
- When signed is selected, the left pad contains zeroes for a positive number, or the left pad contains *F* for negative numbers.

10.3 Programming

This screen allows device reprogramming from unencrypted and encrypted files.

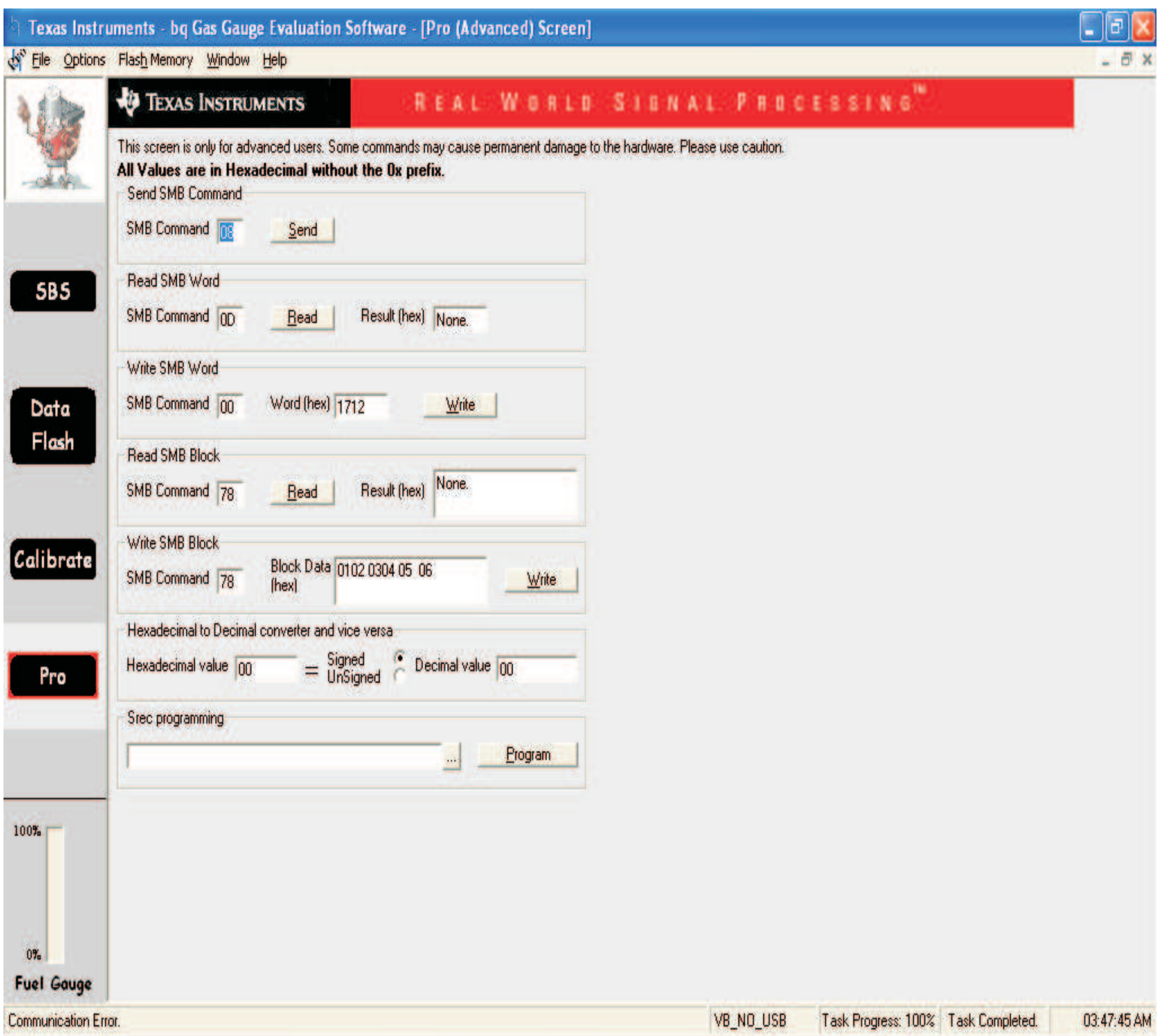

Figure 11. Pro (Advanced) Screen

11 Pack Assembly and The bq20z95

This section describes a recommended assembly sequence for a bq20z95-based battery pack. This procedure results in the most time-efficient setup of the battery pack. Following are the steps for connecting a 4-series cell battery to the bq20z95EVM board. Review the application report *bq20zxx EVM Data Flash Settings for Number of Serial Cells and Pack Capacity*, SLVA208, for further details on 2- and 3-series cell arrangements.

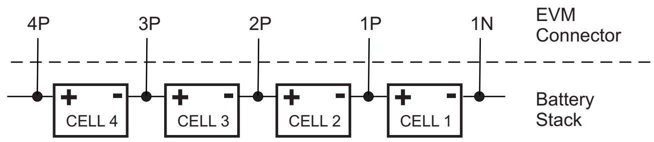

Figure 12. Connection Sequence

1. Connect the most negative terminal (– terminal of cell 1) of the serially-connected, 4-cell battery stack to the 1N PIN of the TB3–TB2 connector as shown in Figure 12.
2. Connect the positive terminal of cell 1 to 1P.
3. Connect the positive terminal of cell 2 to 2P.
4. Connect the positive terminal of cell 3 to 3P.
5. Connect the positive terminal of the battery stack (+) to 4P.
6. Connect external power (from 6 to 16.8V) to the Pack+ and Pack– terminals to wake up the EVM from shutdown mode. External power does not need to remain connected once the bq20zxx has exited Shutdown Mode.
7. Connect the SMBus connector (J1) to the EV2300 adapter and start the EV software.
8. Navigate to the *Flash Screen*. Change the flash constants that correspond to the specific parameters of your application (refer to the data sheet or other application reports). For the first evaluation, the default values may be used.
9. Navigate to the *Calibration screen*. Select the check-box for *CC Offset Calibration*. Click the *calibrate part* button. It should show OK.
10. Uncheck previously-selected boxes. Select the check-box for voltage near *Measured voltage* field. Measure the actual pack voltage between pins 1N and 4P, and enter the value into the *Enter actual voltage* field. Click the *calibrate part* button.
11. To start fuel-gauging, navigate to the *Pro screen* in the EV software. Make sure that the *Write SMB Word* section reads: "SMB Command: 00 Word (hex): 0021" as shown in Figure 13, and click the *Write* button.

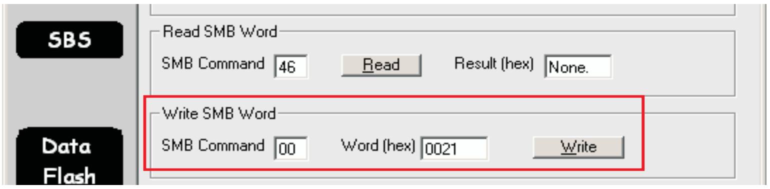

Figure 13. Fuel Gauging Command

12. Navigate to the SMB Screen and be sure that the QEN bit in Operation Status is set (red). The *Relative State of Charge* value is now updated to the correct value that corresponding to the state of charge of the attached cells.
13. Now the pack is ready. Simulate insertion into a system by shorting between the *Sys Pres* (System Present) and the *VSS* pins on the connector. At this point, the discharge and charge FETs are ON (as indicated by value of 0006 in the *FET Status* field in the SMB Screen of the EV software), and charge/discharge tests can be conducted. This step in not needed if the NR bit (nonremovable pack) is enabled in Operation Cfg B register.

12 Related Documentation from Texas Instruments

To obtain a copy of any of the following TI document, call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center (PIC) at (972) 644-5580. When ordering, identify this document by its title and literature number. Updated documents can also be obtained through the TI Web site at www.ti.com

Document:	**Literature Number:**
bq20z95, SBS-Compliant Gas Gauge Enabled With Impedance Track™ data sheet	SLUS757
bq20z90-110 + bq29330 Chipset technical reference manual	SLUU264
bq20z70 and bq20z90 application book	SLUA404
Quick-Start Guide for bq20zxx Family Gas Gauge application report	SLUA421
bqEasy user's guide	SLUU278

Trademarks

Impedance Track is a trademark of Texas Instruments.

Windows, Microsoft are trademarks of Microsoft Corporation.

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Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

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FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 6 V to 25 V and the output voltage range of 0 V to 16.4 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 60°C. The EVM is designed to operate properly with certain components above 60°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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