bq2084EVM-001 SBS 1.1 Battery Management Solution Evaluation Module

User's Guide

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bq2084EVM-001 SBS 1.1 Battery Management Solution Evaluation Module

1 INTRODUCTION

This EVM is a complete evaluation system for the bq2084/bq29312/bq29401 battery management system. The EVM includes one bq2084/bq29312/ bq29401 circuit module, a current sense resistor, a thermistor and Windows®- based PC software. The circuit module includes one bq2084 IC, one bq29312 IC, one bq29401 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. An EV2300 board for gas gauge interface is required to interface this EVM with the PC and can be purchased separately. With the EV2300 interface board and software, the user can read the bq2084 data registers, program the chipset for different pack configurations, log cycling data for further evaluation and evaluate the overall functionality of the bq2084/bq29312/bq29401 solution under different charge and discharge conditions.

1.1 FEATURES

- Complete evaluation system for the bq2084 SBS 1.1-compliant advanced gas gauge, bq29312 analog front end and protection IC, and bq29401 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

1.2 KIT CONTENTS

- bq2084/bq29312/bq29401 circuit module
- Software CD with the evaluation software
- Set of support documentation

1.3 ORDERING INFORMATION

Table 1. Ordering Information

EVM PART NUMBER	CHEMISTRY	CONFIGURATION	CAPACITY
bq2084EVM-001	Li-Ion	2, 3, or 4 cell	Any

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2 bq2084/bq29312-BASED CIRCUIT MODULE

The bq2084/bq29312/bq29401-based circuit module is a complete and compact example solution of a bq2084 and bq29312 circuit for battery management and protection of Li-Ion or Li-Polymer packs. The circuit module incorporates a bq2084 battery monitor IC, bq29312 AFE and protection IC, bq29401 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)
- To the sleep pin (SLEEP)

2.2 PIN DESCRIPTIONS

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)
SLEEP	Sleep mode pin (if high, AFE enters sleep mode)
PACK-	Pack negative terminal
VSS	Pack negative terminal
PACK+	Pack positive terminal

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3 bq2084/bq29312 CIRCUIT MODULE SCHEMATIC

This chapter contains a preview schematic (thumbnail) of the circuit for the bq2084/bq29312/bq29401 implementation.

3.1 PREVIEW SCHEMATIC

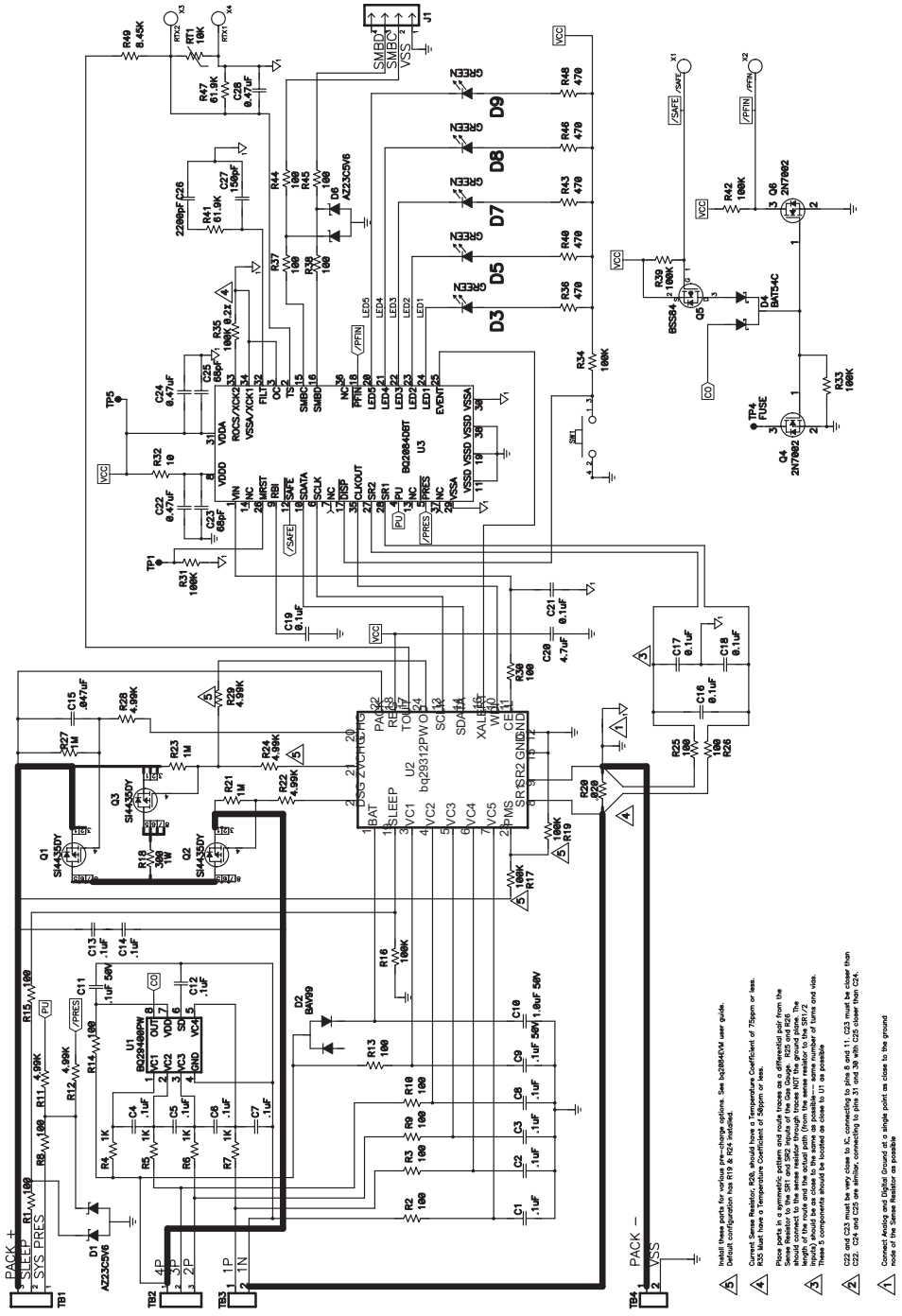

Figure 1. bq2084/bq29312/bq29401 EVM Schematic

NOTE: Refer to the back of the user's guide for the full-size schematic.

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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. There are 3 possible configurations for this function, and the bq29312 can be easily configured according to the application needs. The 3 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. The host charger is expected to provide a precharge function.
2. Common FET Mode − Does not use a dedicated precharge FET. The charge FET (CHG−FET) is set to ON state as default. The charger is expected to provide a precharge function.
3. Precharge FET Mode − Dedicates a precharge current path using an additional open drain (OD) pin drive FET (PCHG−FET) FET to sustain the PACK+ voltage level. The charger does not provide any precharge function.

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 Flash memory, Misc Configuration DF 0x2a (high) and 0x2b (low), bits PFET1, PFET0.

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

MODE	RESISTORS	FET	PFET1	FET0
1(default)	R19,R24	Q3, SI4435DY	0	0
2	R17	-	0	1
3	R19,R24	Q3, open drain FET	1	0

For more details about precharge operation and mode choices, see the bq29312 data sheet at http://www−s.ti.com/sc/ds/bq29312.pdf.

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 TP4 low if fuse blow condition occurs, so monitoring TP4 can be used to test this condition. Fuse placement on the application board is shown in the bq2084 data sheet reference-board schematic.

4 CIRCUIT MODULE PHYSICAL LAYOUTS AND BILL OF MATERIALS

This chapter contains the board layout, bill of materials, and assembly drawings for the bq2084/ bq29312/ bq29401 circuit module.

4.1 BOARD LAYOUT

Figure 2 shows the dimensions, PCB layers, and assembly drawing for the bq2084/bq29312 module.

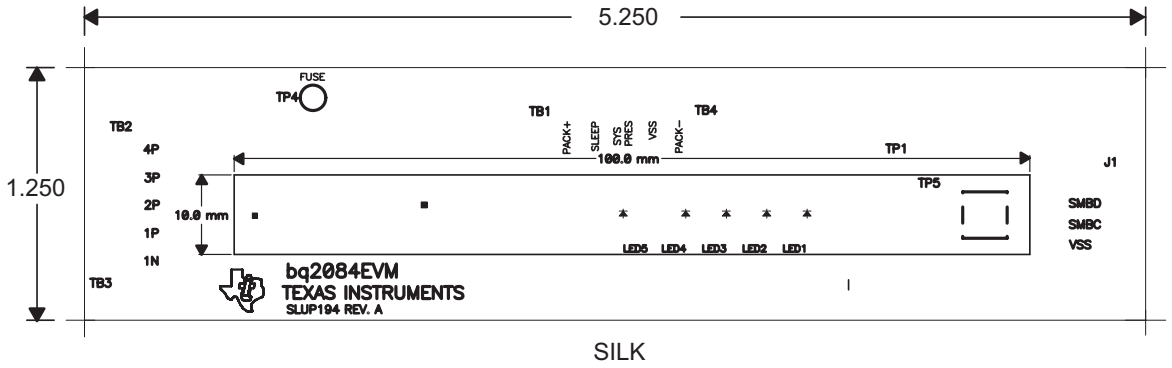

Figure 2. bq2084EVM-001 Layout

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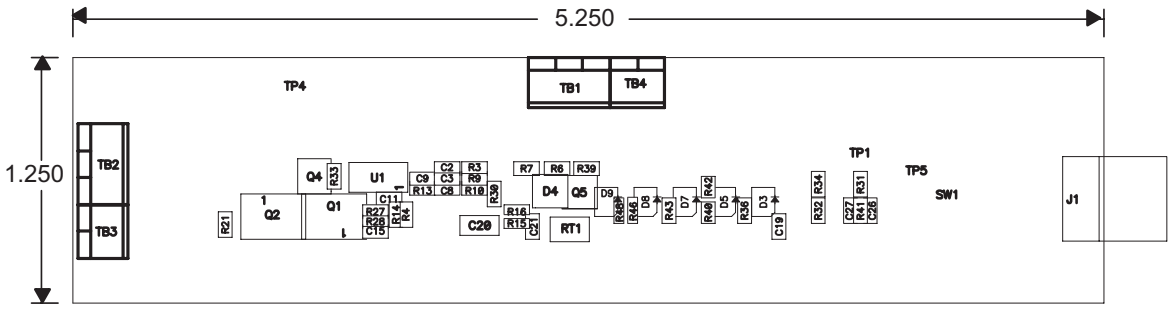
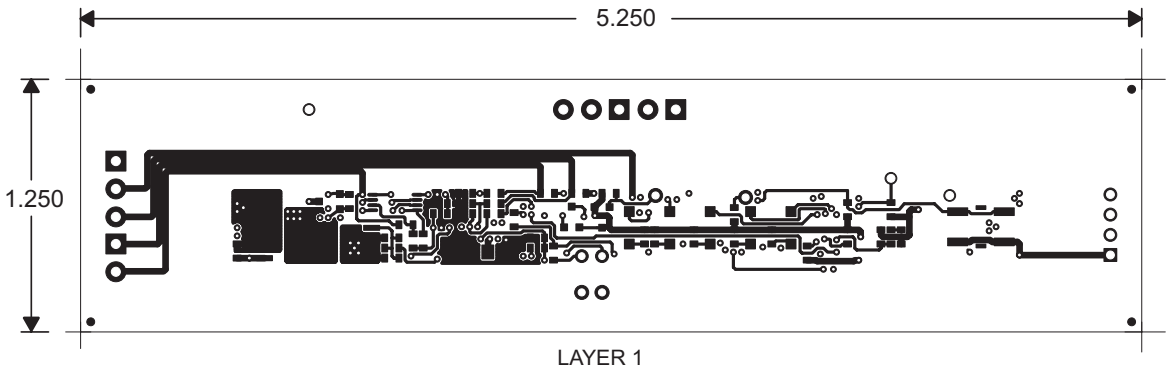


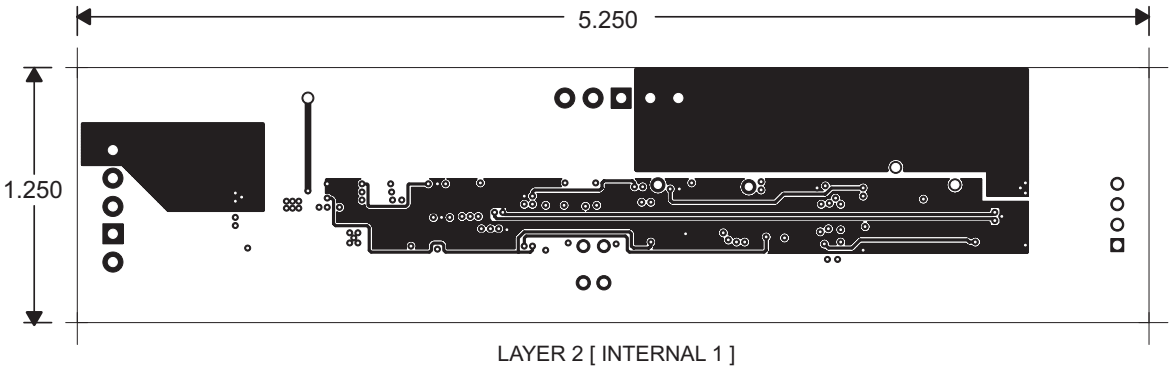
SLUP194 REV. A TOP ASSY

Figure 3. Top Assembly



LAYER 1

Figure 4. Layer 1



LAYER 2 [INTERNAL 1]

Figure 5. Layer 2 (Internal 1)

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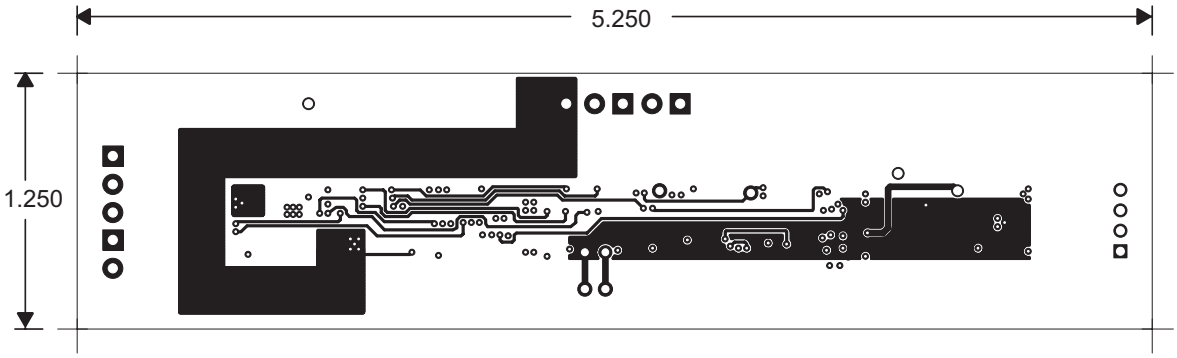
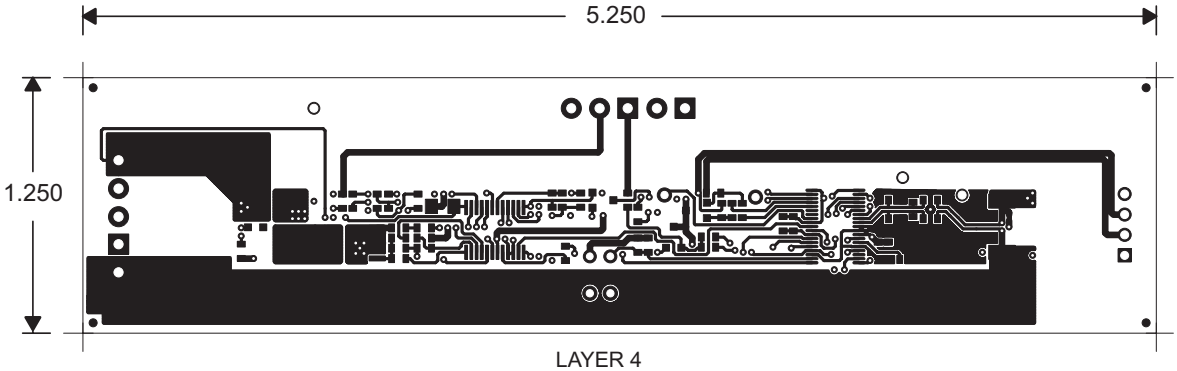


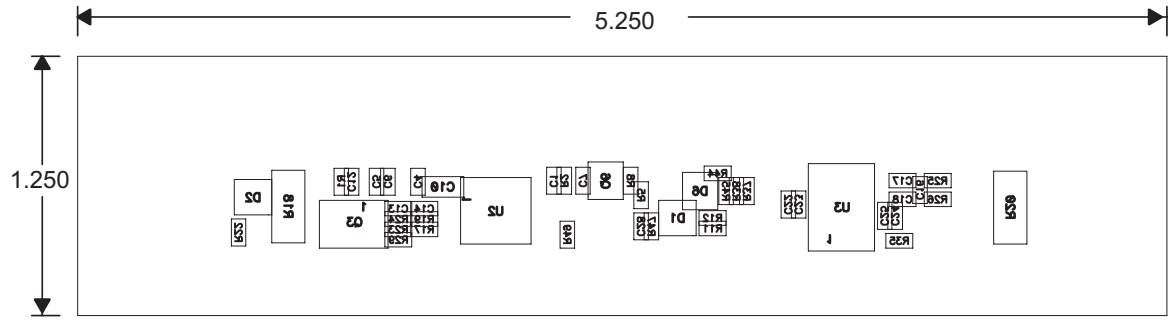
LAYER 3 [INTERNAL 2]

Figure 6. Layer 3 (Internal 2)



LAYER 4

Figure 7. Layer 4



SLUP194 REV. A BOTTOM ASSY

Figure 8. Bottom Assembly

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4.2 BILL OF MATERIALS[(1) (2) (3) (3)]

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

Table 3. Bill of Materials

COUNT	REF DES	DESCRIPTION	SIZE	VALUE	MFG PART NO.
18	C1, C2, C3, C4, C5, C6, C7, C8, C9, C11, C12, C13, C14, C16, C17, C18, C19, C21	Capacitor, ceramic, 50 V, X7R, 20%	603	0.1 µF	
1	C10	Capacitor, ceramic, 50 V, X7R, 20%	1206	1.0 µF	
1	C15	Capacitor, ceramic, 50 V, X7R, 10%	603	0.047 µF	
1	C20	Capacitor, ceramic, 16 V, X7R, 10%	1206	4.7 µF	
3	C22, C24, C28	Capacitor, ceramic, 16 V, X7R, 10%	603	0.47 µF	
2	C23, C25	Capacitor, ceramic, 16 V, COG, 10%	603	68 pF	
1	C26	Capacitor, ceramic, 16 V, COG, 10%	603	2200 pF	
1	C27	Capacitor, ceramic, 16 V, COG, 10%	603	150 pF	
2	D1, D6	Diode, dual, Zener, 5.6 V, 300 mW	SOT23		AZ23C5V6
1	D2	Diode, dual ultra fast, series, 200 mA, 70 V	SOT23		BAV99
5	D3, D5, D7, D8, D9	Diode, LED, green, Gullwing, GW type, 20 mA, 7.5 mcd Typ	Gullwing		LN1361C
1	D4	Diode, dual Schottky, 200 mA, 30 V	SOT23		BAT54C
1	J1	Header, friction lock assembly, 4-pin right angle	0.400 × 0.500		22-05-3041
3	Q1, Q2, Q3	MOSFET, P-ch, 30 V, 7.0 A, 20 mΩ	SO8		Si4435DY
2	Q4, Q6	MOSFET, N-ch, 60 V, 115 mA, 1.2 Ω	SOT23		2N7002
1	Q5	MOSFET, P-ch, 50 V, 130 mA, 10 Ω	SOT23		BSS84
16	R1, R2, R3, R8, R9, R10, R13, R14, R15, R25, R26, R30, R37, R38, R44, R45	Resistor, chip, 1/16 W, 5%	603	100 Ω	
6	R11, R12, R22, R24, R28, R29	Resistor, chip, 1/16 W, 1%	603	4.99 kΩ	
8	R16, R17, R19, R31, R33, R34, R39, R42	Resistor, chip, 1/16 W, 5%	603	100 kΩ	
1	R18	Resistor, chip, 1 W, 5%	2512	300 Ω	
1	R20	Resistor, chip, 1 W, 1%	2512	0.02 Ω	
3	R21, R23, R27	Resistor, chip, 1/16 W, 5%	603	1 MΩ	
1	R32	Resistor, chip, 1/16 W, 5%	603	10 Ω	
1	R35**	Resistor, chip, 1/16 W, 0.2%, 75 PPM	603	100 kΩ	
5	R36, R40, R43, R46, R48	Resistor, chip, 1/16 W, 5%	603	470 Ω	
4	R4, R5, R6, R7	Resistor, chip, 1/16 W, 5%	603	1 kΩ<	
2	R41, R47	Resistor, chip, 1/16 W, 1%	603	61.9 kΩ	
1	R49	Resistor, chip, 1.16 W, 1%	603	8.45 kΩ	
1	RT1	Thermistor	0.095 × 0.150	10 kΩ	
1	SW1	Switch, push button, momentary, N.O. low profile	5 mm × 5 mm		
2	TB1, TB2	Terminal block, 3 pin, 6 A, 3,5 mm	0.41 × 0.25		ED1515
2	TB3, TB4	Terminal block, 2 pin, 6 A, 3,5 mm	0.27 × 0.25		ED1514

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Table 3. Bill of Materials (continued)

COUNT	REF DES	DESCRIPTION	SIZE	VALUE	MFG PART NO.
3	TP1, TP4, TP5	Jack, test point, cir		NA	
1	U1	IC, voltage protection for 2, 3, or 4 cell Li-Ion, 2nd protection, x.xx	TSSOP-08		bq29400PW
1	U2	IC, 2, 3, or 4 cell series protection control AFE	TSSOP24		bq29312PW
1	U3	IC, advanced gas gauge	TSSOP38		bq2084DBT
1	-	PCB			

4.3 bq2084/bq29312/bq29401 CIRCUIT MODULE PERFORMANCE SPECIFICATION SUMMARY

This section summarizes the performance specifications of the bq2084/bq29312/bq29401 circuit module.

Table 4. Performance Specification Summary

SPECIFICATION	MIN	TYP	MAX	UNITS
Input Voltage Pack+ to Pack−	6.0		25	V
Charge and Discharge Current			See (1)	A

(1) Maximum currents are determined by the value of the sense resistor used and the short circuit threshold setting of the bq29312. It is important to operate this EVM within the input voltage range of 6 V and 25 V, with a maximum voltage drop across the sense resistor of ±250 mV (1-W power dissipation).

5 EVM HARDWARE AND SOFTWARE SETUP

This chapter describes how to install the bq2084EVM-001 PC software, and how to connect the different components of the EVM.

5.1 SYSTEM REQUIREMENTS

EV2300-84 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

You can find the latest software version in the bq2084 tool folder on power.ti.com. The following steps install the EV2300-84 software:

If files were delivered on floppy disks:

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. Execute setup.exe which prompts you to enter a temporary directory to extract all files. Follow the instructions of the extractor program, which prompts you to insert more disks.
3. In 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.
4. Plug the EV2300 into a USB port.
5. Wait until system prompt new hardware found appears. Chose select location manually and use the Browse button to point to subdirectory TIUSBWin2K- XP-1.
6. Answer continue to the warning that drivers are not certified with Microsoft.
7. After installation finishes, another system prompt new hardware found appears. Repeat procedure above, but point to subdirectory TIUSBWin2K-XP-2
8. Answer continue to the warning that drivers are not certified with Microsoft. Installation of drivers is

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now finished.

9. In case of Windows 98, point to directory TIUSBWin98.
10. Return to the temporary directory where you extracted files; double-click on the Setup.exe icon to install EV Software.

If files were delivered on a CD, copy all files to a temporary directory and follow the preceding steps 3−10.

1. Open the archive containing the installation package and copy its contents in a temporary directory.
2. Follow the preceding steps 3−10.

5.3 HARDWARE CONNECTION

The bq2084EVM-001 comprises three hardware components: the bq2084/bq29312/bq29401 circuit module, the EV2300 PC interface board, and the PC.

5.3.1 CONNECTING THE BQ2084/BQ29312/BQ29401 CIRCUIT MODULE TO A BATTERY PACK

Figure 9 shows how to connect the bq2084/bq29312/bq29401 circuit module to the cells and system load/charger.

The cells should be connected in the following order.

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

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

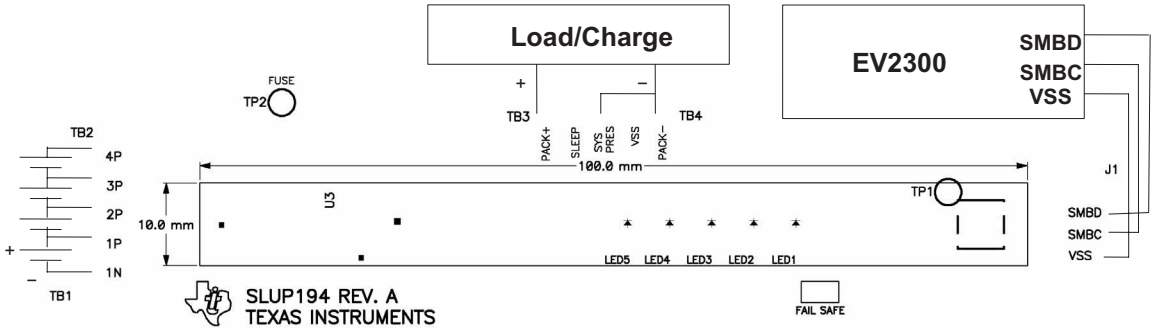

Figure 9. bq2084/bq29312 Circuit Module Connection to Cells and System Load/Charger

5.3.2 PC INTERFACE CONNECTION

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

1. Connect the bq2084/bq29312-based smart battery to the EV2300 using wire leads as shown in Table 5.

Table 5. Circuit Module to EV2300 Connections

bq2084/bq29312 BASED BATTERY	EV2300
SMBD	SMBD/HDQ1
SMBC	SMBC/HDQ2
VSS	VSS

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

The bq2084EVM-001 is now set up for operation.

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6 OPERATION

This chapter details the operation of the bq2084 EVSW software.

6.1 STARTING THE PROGRAM

Run bq2084 EVSW from the Start | Programs | Texas Instruments | bq2084 EVSW menu sequence. The SBS Data screen appears. Data begins to appear as the indicator scans down the screen, as seen in the field *Charging Current* of Figure 10. To disable the scan feature, select |Options |Scan| Off|.

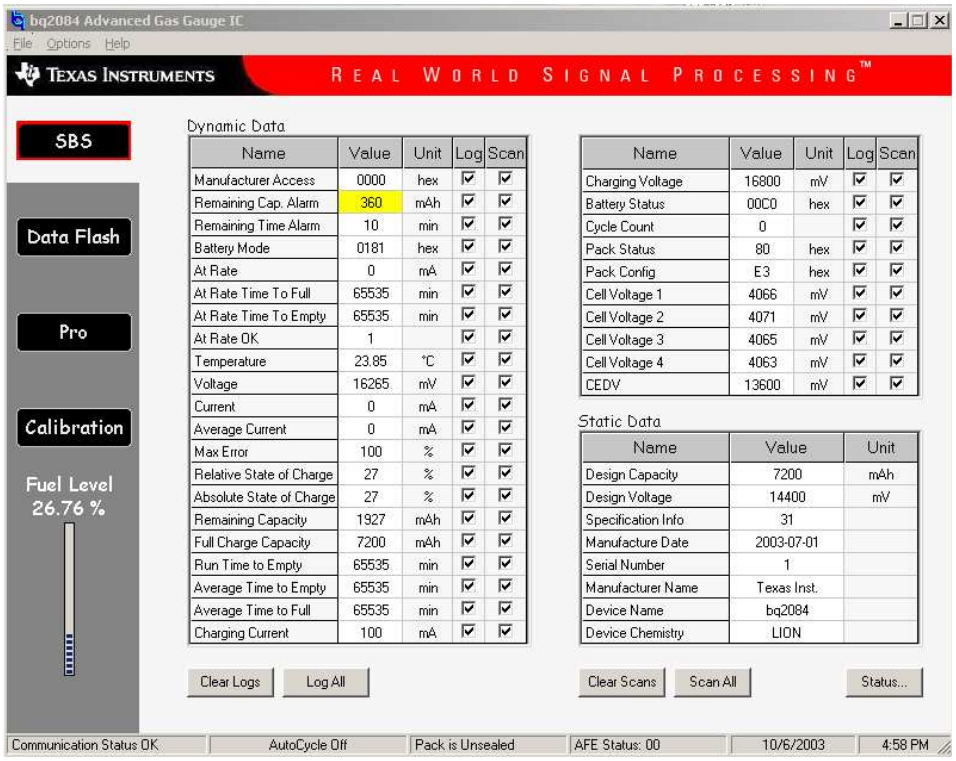

Figure 10. SBS Data Screen

This screen shows the SBS data set along with additional ManufacturersAccess() command information such as individual cell measurements. Static data is shown in a box at the bottom right which, by clicking on the Status… button, changes to show the status bits of the bq2084 and bq29312.

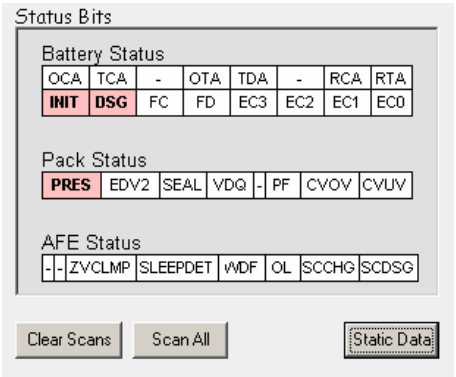

Figure 11. SBS Data Screen - Status Bit Window

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SBS Data can be logged for further evaluation by using the File | Start Data Log menu options. Then enter the desired file name and click on |OK|. An example of a data log file is shown in Table 6−1. To stop the data log, follow the same sequence. The logging period can be changed via | Options | Set Logging Options |.

Table 6. Example Log File

10/6/2003 17:01	
Design Capacity:	7200
Design Voltage:	14400
Specification Info:	31
Mfg Date (yyy−mm−dd):	2003−07−01
Serial Number:	1
Mfr Name:	Texas Instruments
Device Name:	bq2084
Device Chemistry:	LION

Table 7. Example Log File(1)

Sample	Stamp	Elapsed (s)	Mf Access	Rm Cap Aln	Rm Time Air	Batt-Mode	@Rate	@Rate-Ful	@Rate Emp	@Rate OK	Temp	Volt	Cur-rent	Avg-Curr
1	5:01:53	1	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
2	5:01:55	2	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
4	5:01:56	4	0	360	10	181	0	65535	65535	1	23.95	16267	0	0
5	5:01:57	5	0	360	10	181	0	65535	65535	1	23.95	16267	0	0
6	5:01:58	6	0	360	10	181	0	65535	65535	1	23.95	16267	0	0
7	5:01:59	7	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
8	5:02:00	8	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
9	5:02:01	9	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
10	5:02:02	10	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
11	5:02:03	11	0	360	10	181	0	65535	65535	1	23.95	16266	0	0
12	5:02:04	12	0	360	10	181	0	65535	65535	1	23.95	16266	0	0

(1) This is a reduced version of the log file; in addition to the data shown here, Max Error, RSOC, ASOC, RemCap, FCC, RT−Empty, AvTm2Emp, AvTm2Ful, ChgCurr, ChgVlt, Batstat, CyclCnt, PackStat, PackConf, Cell_V_1, Cell_V_2, Cell_V_3, Cell_V_4, CEDV, AFE Sts are also logged.

6.2 SETTING PROGRAMMABLE bq2084 and bq29312 OPTIONS

The bq2084 data flash comes configured per the default settings detailed in the bq2084 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq2084/bq29312 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.

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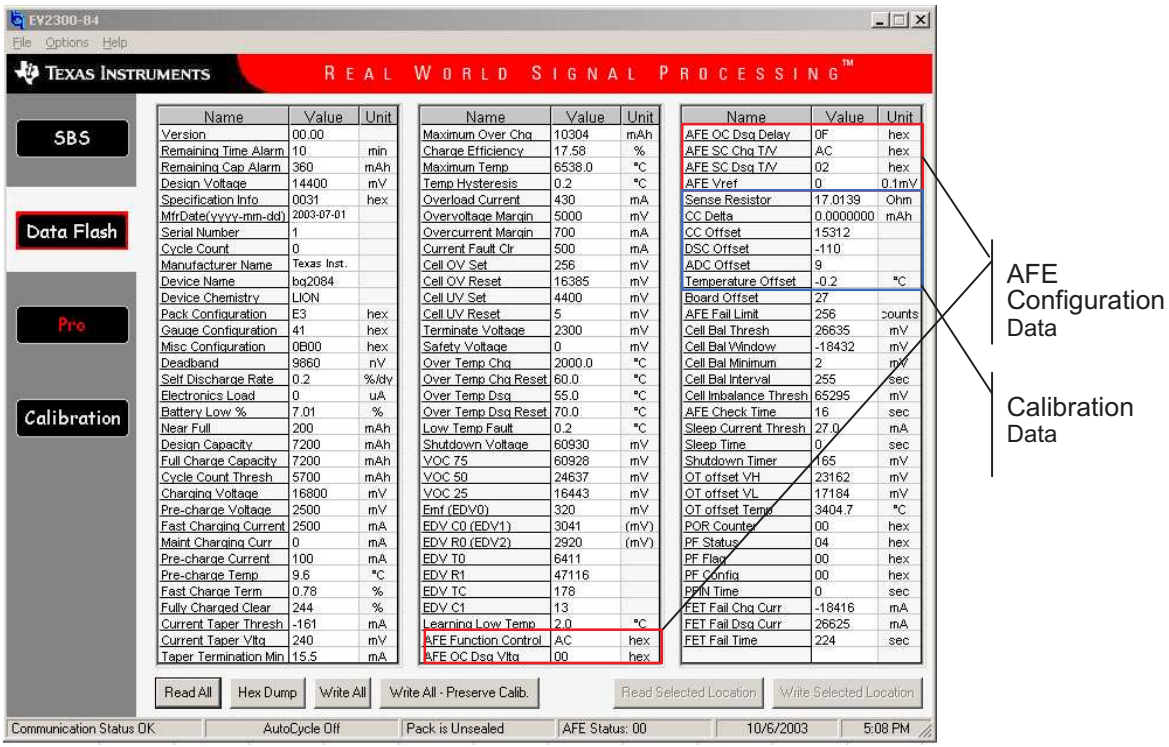

Name	Value	Unit
Version	00.00	
Remaining Time Alarm	10	min
Remaining Cap Alarm	360	mAh
Design Voltage	14400	mV
Specification Info	0031	hex
MfrDate(yyyy-mm-dd)	2003-07-01	
Serial Number	1	
Cycle Count	0	
Manufacturer Name	Texas Inst.	
Device Name	bq2084	
Device Chemistry	LION	
Pack Configuration	E3	hex
Gauge Configuration	41	hex
Misc Configuration	0B00	hex
Deadband	9860	nV
Self Discharge Rate	0.2	%/dy
Electronics Load	0	uA
Battery Low %	7.01	%
Near Full	200	mAh
Design Capacity	7200	mAh
Full Charge Capacity	7200	mAh
Cycle Count Thresh	5700	mAh
Charging Voltage	16800	mV
Pre-charge Voltage	2500	mV
Fast Charging Current	2500	mA
Maint Charging Curr	0	mA
Pre-charge Current	100	mA
Pre-charge Temp	9.6	°C
Fast Charge Term	0.78	%
Fully Charged Clear	244	%
Current Taper Thresh	-161	mA
Current Taper Vltg	240	mV
Taper Termination Min	15.5	mA

Name	Value	Unit
Maximum Over Chg	10304	mAh
Charge Efficiency	17.58	%
Maximum Temp	6538.0	°C
Temp Hysteresis	0.2	°C
Overload Current	430	mA
Overvoltage Margin	5000	mV
Overcurrent Margin	700	mA
Current Fault Clr	500	mA
Cell OV Set	256	mV
Cell OV Reset	16385	mV
Cell UV Set	4400	mV
Cell UV Reset	5	mV
Terminate Voltage	2300	mV
Safety Voltage	0	mV
Over Temp Chg	2000.0	°C
Over Temp Chg Reset	60.0	°C
Over Temp Dsg	55.0	°C
Over Temp Dsg Reset	70.0	°C
Low Temp Fault	0.2	°C
Shutdown Voltage	60930	mV
VOC 75	60928	mV
VOC 50	24637	mV
VOC 25	16443	mV
Emf (EDV0)	320	mV
EDV C0 (EDV1)	3041	(mV)
EDV R0 (EDV2)	2920	(mV)
EDV T0	6411	
EDV R1	47116	
EDV TC	178	
EDV C1	13	
Learning Low Temp	2.0	°C
AFE Function Control	AC	hex
AFE OC Dsg Vltg	00	hex

Name	Value	Unit
AFE OC Dsg Delay	0F	hex
AFE SC Chg T/V	AC	hex
AFE SC Dsg T/V	02	hex
AFE Vref	0	0.1mV
Sense Resistor	17.0139	Ohm
CC Delta	0.0000000	mAh
CC Offset	15312	
DSC Offset	-110	
ADC Offset	9	
Temperature Offset	-0.2	°C
Board Offset	27	
AFE Fail Limit	256	counts
Cell Bal Thresh	26635	mV
Cell Bal Window	-18432	mV
Cell Bal Minimum	2	mV
Cell Bal Interval	255	sec
Cell Imbalance Thresh	65295	mV
AFE Check Time	16	sec
Sleep Current Thresh	27.0	mA
Sleep Time	0	sec
Shutdown Timer	165	mV
OT offset VH	23162	mV
OT offset VL	17184	mV
OT offset Temp	3404.7	°C
POR Counter	00	hex
PF Status	04	hex
PF Flag	00	hex
PF Config	00	hex
PWN Time	0	sec
FET Fail Chg Curr	-18416	mA
FET Fail Dsg Curr	26625	mA
FET Fail Time	224	sec

Figure 12. Data Flash Screen, AFE Configuration, and Module Calibration Locations

To read all the data from the bq2084 data flash, click on the | Read All | button. To only read a selected location, click on the desired location and the | Read Selected Location | button is activated. When this button is clicked, the data is read and the screen updated.

The same procedure can be followed for writing all the data flash or just a specific location.

The data flash configuration can be saved to a file by selecting | File | Save gas gauge constants |, and entering a file name. A data flash file can also be retrieved in this way and written to the bq2084 using the | Write All | button.

If the calibration data already in the bq2084 is required to be preserved, use the | Write All – Preserve Calibration | button.

The configuration information of the bq29312 and module calibration data is also held in the bq2084 data flash as highlighted in Figure 13.

6.3 CALIBRATION OF A bq2084/bq29312/bq29401-BASED MODULE USING THE EV2300-84 SOFTWARE

Part of the calibration data is a board offset parameter. The EV2300-84 software allows the board offset to be measured. An average of several modules should be taken, and then this value entered in all like modules.

The calibration screen offers a simple-to-use interface for this procedure.

Follow the on-screen instructions as shown in Figure 13. Click |Start| to begin the test, and additional instructions appear for that particular calibration procedure until it is complete.

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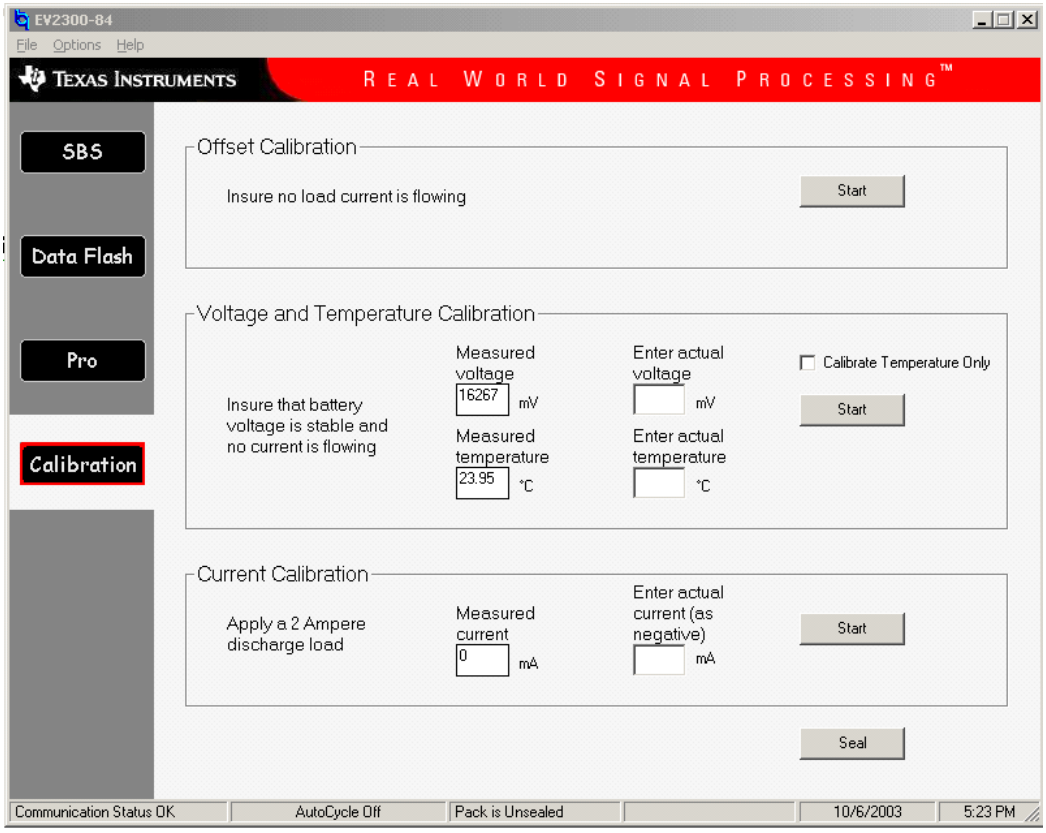

Figure 13. Calibration Screen

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6.4 DIRECT ACCESS COMMUNICATION

The bq2084 allows access to the various internal registers through the Pro Screen. Here, individual byte or block reads and block writes can be performed.

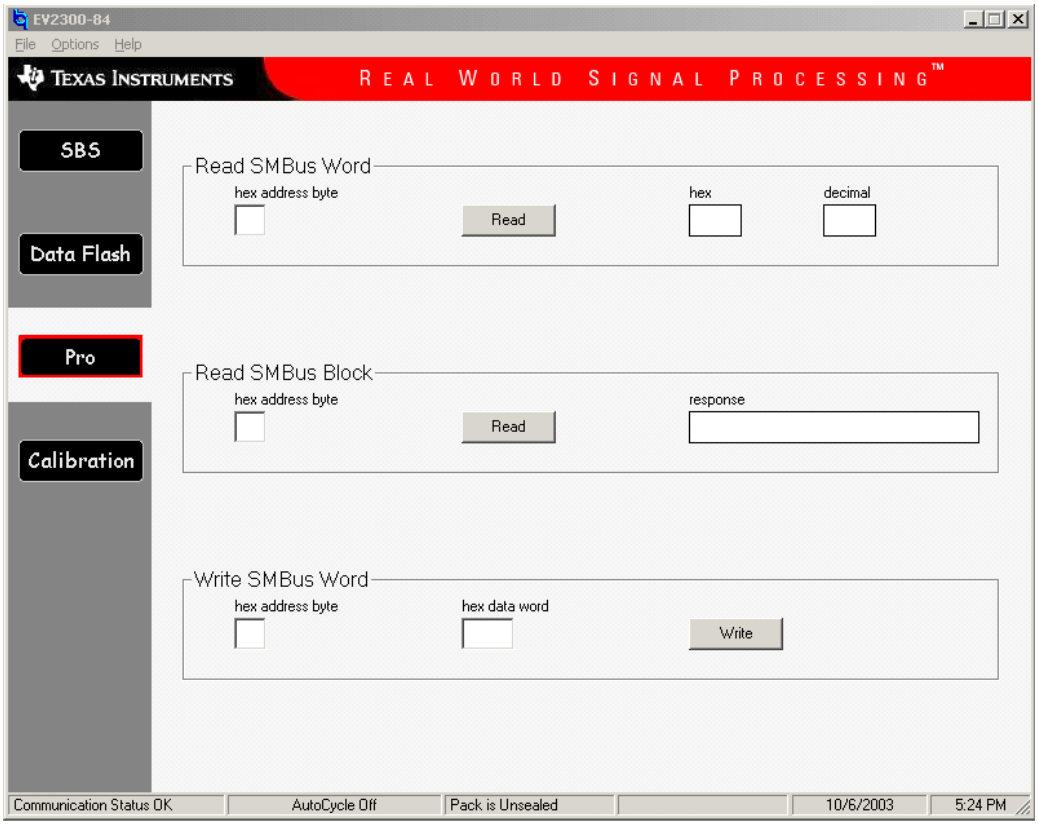

Figure 14. Pro Screen

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For EVMs **not** subject to the above rules, this evaluation board/kit/module 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 or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment 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.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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