

# ***bq27531EVM with bq27531 Battery Management Unit Impedance Track™ Fuel Gauge and bq24192 4.5-A, Switch-Mode Battery Charger for Single-Cell Applications***

This evaluation module (EVM) is a complete evaluation system for the Battery Management Unit (BMU) chipset consisting of the bq27531-G1 fuel gauge and bq24192 battery charger. The EVM includes one bq27531 circuit, including a current sense resistor and one thermistor. In addition, the fuel gauge controls the bq24192 battery charger's settings and monitors its status via I<sup>2</sup>C communication lines. Together, the chipset provides all necessary components to monitor and predict capacity for a system-side fuel gauge solution as well as to charge the battery from either an adapter or USB input with up to 4.5-A of charge current. The circuit module connects directly across the battery pack. With the EV2300 interface board and software, the user can read the bq27531-G1 data registers, program the chipset for different pack configurations, log cycling data for further evaluation, and evaluate the overall functionality of the battery management unit solution under different charge and discharge conditions. The latest Windows™-based PC software can be downloaded from the product folder on the Texas Instruments Web site.

## **Contents**

|   |                                                                         |    |
|---|-------------------------------------------------------------------------|----|
| 1 | Features .....                                                          | 2  |
| 2 | bq27531-Based Circuit Module .....                                      | 2  |
| 3 | Circuit Module Physical Layouts, Bill of Materials, and Schematic ..... | 5  |
| 4 | EVM Hardware and Software Setup .....                                   | 13 |
| 5 | Troubleshooting Unexpected Dialog Boxes .....                           | 16 |
| 6 | Operation .....                                                         | 17 |
| 7 | Calibrate Screen .....                                                  | 19 |
| 8 | I2C Pro Screen .....                                                    | 21 |
| 9 | Related Documentation From Texas Instruments .....                      | 21 |

## **List of Figures**

|    |                                           |    |
|----|-------------------------------------------|----|
| 1  | Schematic .....                           | 3  |
| 2  | bq27531EVM-001 Layout – Silk Screen ..... | 6  |
| 3  | Layer 1 .....                             | 7  |
| 4  | Layer 2 .....                             | 8  |
| 5  | Layer 3 .....                             | 9  |
| 6  | Layer 4 .....                             | 10 |
| 7  | BAT_Load (PR1010) Schematic .....         | 13 |
| 8  | Test Setup for bq27531EVM (PWR216) .....  | 15 |
| 9  | DataRAM Screen .....                      | 17 |
| 10 | Data Flash Screen .....                   | 18 |
| 11 | Calibration Screen .....                  | 20 |
| 12 | I2C Pro Screen .....                      | 21 |

## **List of Tables**

|   |                            |    |
|---|----------------------------|----|
| 1 | Ordering Information ..... | 2  |
| 2 | Bill of Materials .....    | 11 |

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## 1 Features

- Complete evaluation system for the Battery Management Unit chipset consisting of the bq27531-G1 Impedance Track fuel gauge and bq24192 4.5-A Battery Charger.
- Populated circuit module for quick setup
- Personal computer (PC) software and interface board (orderable on TI website) for easy evaluation
- Software that allows data logging for system analysis (available in product folder on TI website)
- Ability to upgrade to the latest firmware version by flash reprogramming

### 1.1 Kit Contents

- bq27531-G1 and bq24192 chipset circuit module (PWR216)
- NTC103AT thermistor

This EVM is used for the evaluation of the bq27531-G1 and bq24192 BMU chipset. Ensure that you visit the product Web folder at [www.ti.com](http://www.ti.com) to download the latest firmware version, evaluation software, and documentation for the associated product to be evaluated.

### 1.2 Ordering Information

**Table 1. Ordering Information**

| EVM PART NUMBER | CHEMISTRY | CONFIGURATION | CAPACITY |
|-----------------|-----------|---------------|----------|
| bq27531EVM      | Li-ion    | 1 cell        | Any      |

## 2 bq27531-Based Circuit Module

The bq27531-based circuit module is a complete and compact example solution of a bq27531 circuit for battery management. The circuit module incorporates a bq27531 battery gas gauge integrated circuit (IC) and all other components necessary to accurately predict the capacity of 1-series Li-ion cell.

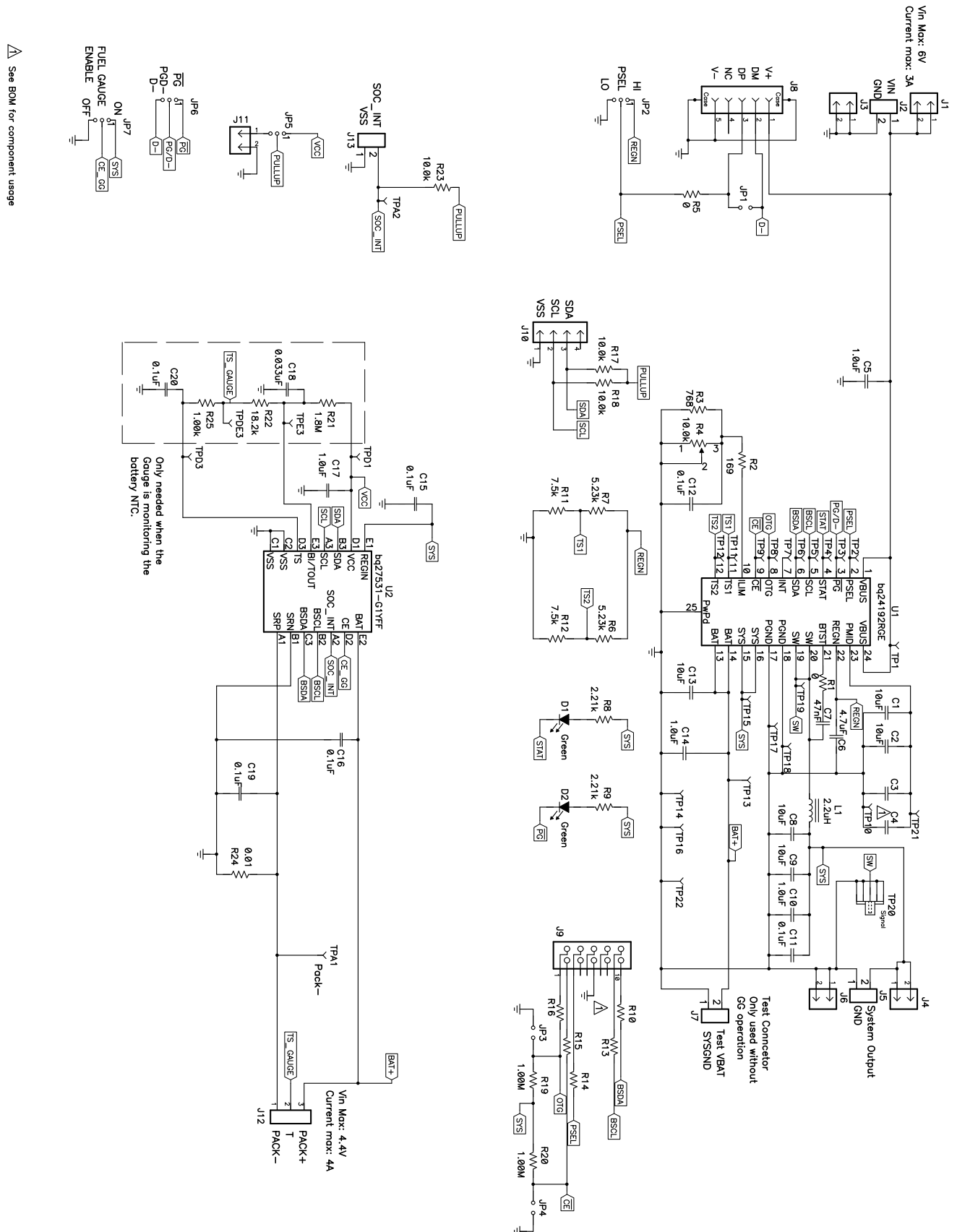


Figure 1. Schematic

## 2.1 Circuit Module Connections

Contacts on the circuit module provide the following connections:

- Direct connection to the battery pack (J12): PACK+, PACK–, and TS
- To the serial communications port (J10): SDA, SCL, and VSS
- Connection to system load (J5)
- Connection to charger (J2)
- Access to signal output (J13): SOC\_INT

## 2.2 I/O Description

| Header/Terminal Block | Description                                                                |
|-----------------------|----------------------------------------------------------------------------|
| J1–VIN                | Adapter positive terminal                                                  |
| J2–VIN                | Adapter positive terminal                                                  |
| J2–GND                | Adapter negative terminal                                                  |
| J3–GND                | Adapter negative terminal                                                  |
| J4–SYS                | System positive terminal                                                   |
| J5–SYS                | System positive terminal                                                   |
| J5–GND                | System negative terminal                                                   |
| J6–GND                | System negative terminal                                                   |
| J7–TEST               | Test terminal                                                              |
| J8                    | USB Miniconnector                                                          |
| J9                    | USBTOGPIO 10-pin connector (not installed)                                 |
| J10                   | EV2300 connector for using bq27531 software to communicate with bq27531 IC |
| J11                   | Allows SOC_INT to be tied to external pullup rather than VCC               |
| J12–PACK+             | Battery positive terminal                                                  |
| J12–T                 | Pack thermistor input that leads to IC TS pin                              |
| J12–PACK–             | Battery negative terminal                                                  |
| J12–SOC_INT           | SOC_INT output from gauge                                                  |

## 2.3 Test Points

| Test Point | Description                                               |
|------------|-----------------------------------------------------------|
| TP1        | bq24192 IN voltage                                        |
| TP2        | bq24192 PSEL pin                                          |
| TP3        | bq24192 PG/D- pin                                         |
| TP4        | bq24192 STAT pin                                          |
| TP5        | bq24192 SCL = bq27531 BSCL - I2C communication clock line |
| TP6        | bq24192 SDA = bq27531 BSDA - I2C communication data line  |
| TP7        | bq24192 INT pin                                           |
| TP8        | bq24192 OTG pin                                           |
| TP9        | bq24192 CE pin                                            |
| TP10       | PGND                                                      |
| TP11       | bq24192 TS1 pin                                           |
| TP12       | bq24192 TS2 pin                                           |
| TP13       | bq24192 BAT pin                                           |
| TP14       | PGND                                                      |
| TP15       | bq24192 SYS pin                                           |
| TP16       | PGND                                                      |
| TP17       | PGND                                                      |

| Test Point | Description                |
|------------|----------------------------|
| TP18       | PGND                       |
| TP19       | bq24192 SW pin             |
| TP20       | bq24192 SW signal          |
| TP21       | bq24192 PMID pin           |
| TP22       | PGND                       |
| TPA1       | PACK-                      |
| TPA2       | bq27531 SOC_INT pin        |
| TPD1       | bq27531 VCC pin            |
| TPD3       | bq27531 TS pin             |
| TDPE3      | External thermistor output |
| TPE3       | bq27531 BI/TOUT pin        |

## 2.4 Control and Key Parameters Setting

| Jumper                      | Description                                                                                                                                                                                                                                                    | Default Factory Setting |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| JP1<br>USB D+/D-            | Shorting jumper for USB data lines DM (D-) and DP (D+). When shorted, USB input current limit defaults to 1.5 A. Otherwise, USB100 mode is selected.                                                                                                           | INSTALLED               |
| JP2<br>PSEL                 | 2-3 (PSEL = LO): Indicates that an ac adapter is connected to the USB input and sets the USB input current limit to 1.5 A.<br>1-2 (PSEL = HI): Indicates that a USB source is connected to the USB input and sets the input current limit to 500 mA. (DEFAULT) | 1-2 (PSEL = HI)         |
| JP3<br>OTG                  | When installed, OTG feature will be disabled.                                                                                                                                                                                                                  | NOT INSTALLED           |
| JP4<br>CHARGE ENABLE        | When installed, charging is enabled.                                                                                                                                                                                                                           | INSTALLED               |
| JP5<br>SOC_INT              | 2-3: SOC_INT is tied to external pull-up<br>1-2: SOC_INT is tied to onboard VCC through pull-up (DEFAULT)                                                                                                                                                      | 1-2 VCC                 |
| JP6<br>D-/PG                | 2-3: Connect D-/PG to D-<br>1-2: Connect D-/PG to PG (DEFAULT)                                                                                                                                                                                                 | 1-2 PG                  |
| JP7<br>FUEL GAUGE<br>ENABLE | 1-2 ON: Fuel gauge enable (CE) pin high for normal operation (DEFAULT)<br>2-3 OFF: Fuel gauge enable (CE) pin low to disable gauging                                                                                                                           | 1-2 ON                  |

## 3 Circuit Module Physical Layouts, Bill of Materials, and Schematic

This section contains the board layout, bill of materials, assembly drawings, and schematic for the bq27531 circuit module.

### 3.1 Board Layout

This section shows the printed-circuit board (PCB) layers ([Figure 2](#) through [Figure 5](#)), assembly drawing, and schematic for the bq27531 module.

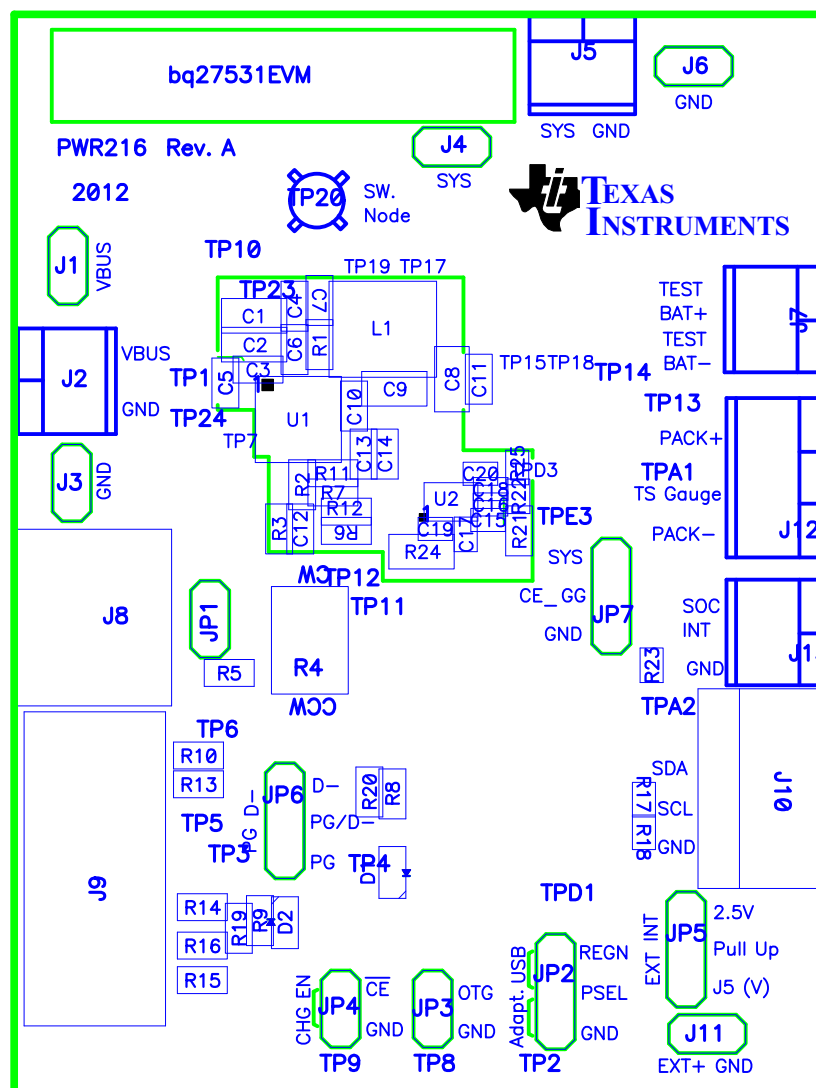
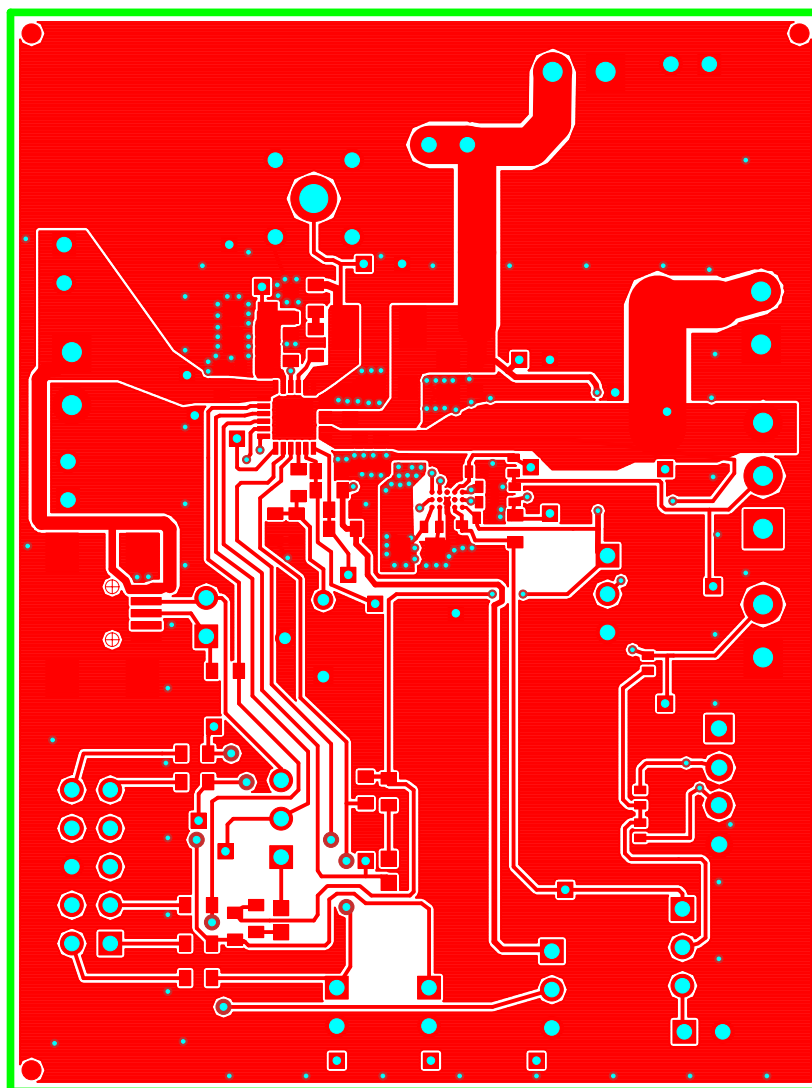


Figure 2. bq27531EVM-001 Layout – Silk Screen



**Figure 3. Layer 1**

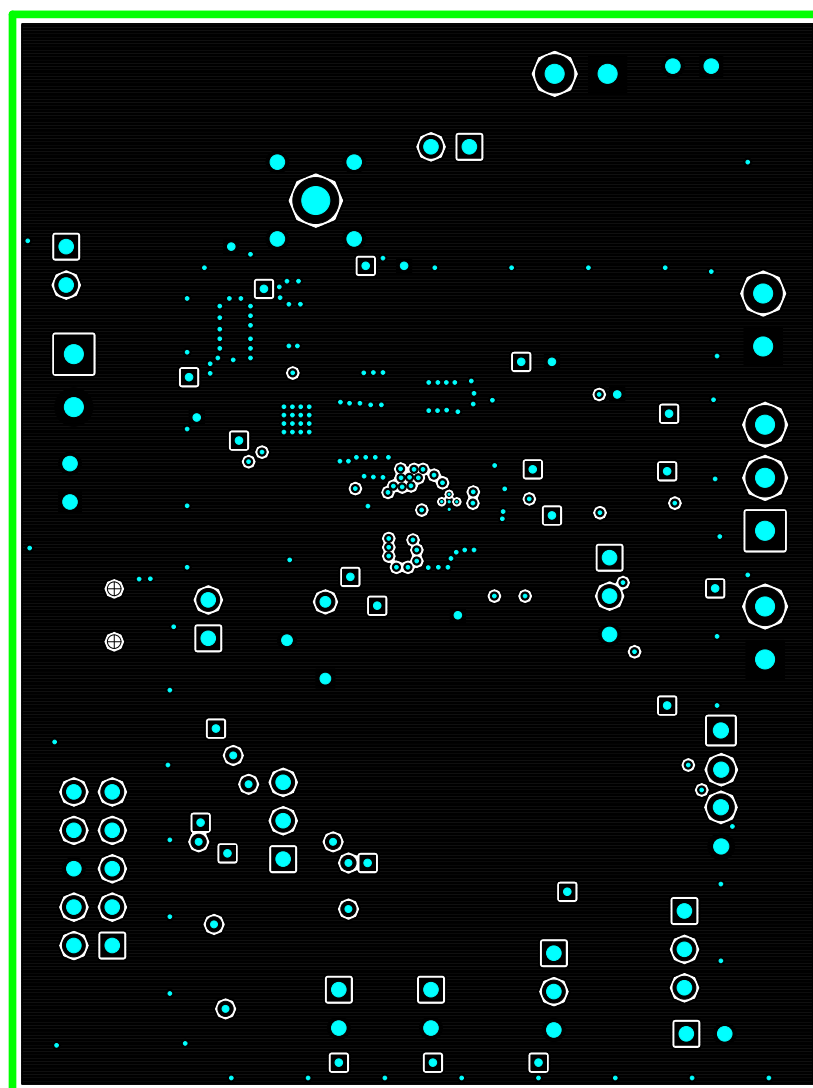


Figure 4. Layer 2

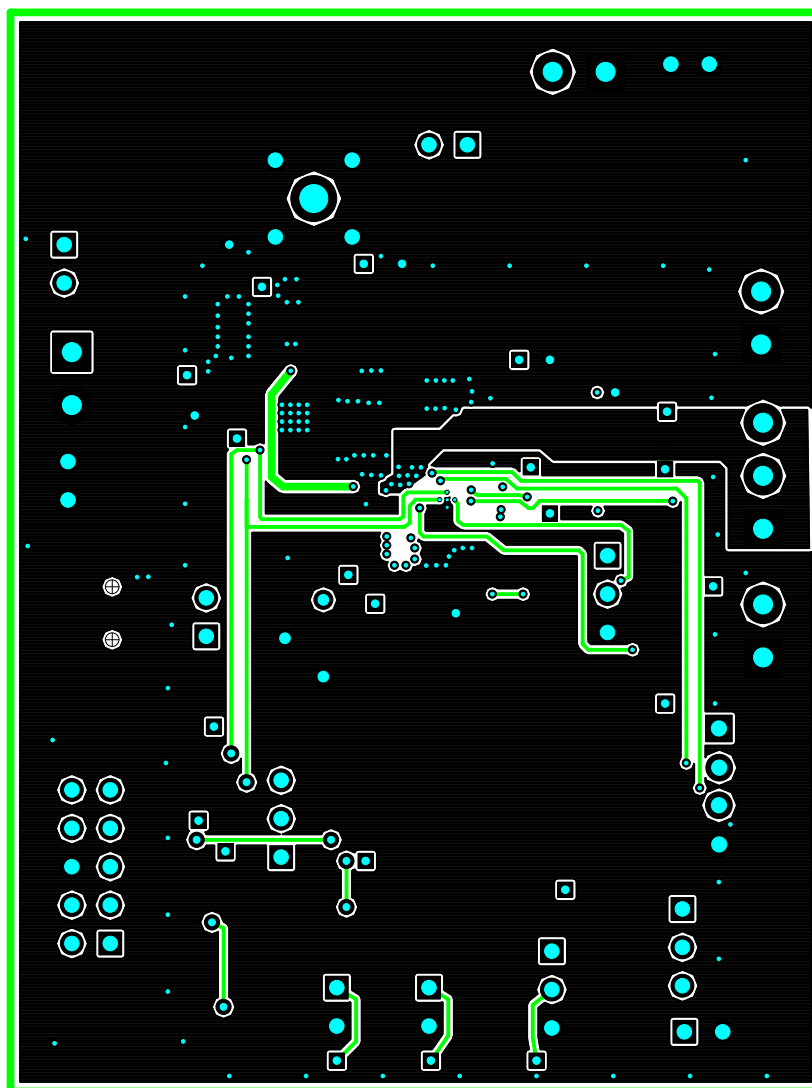
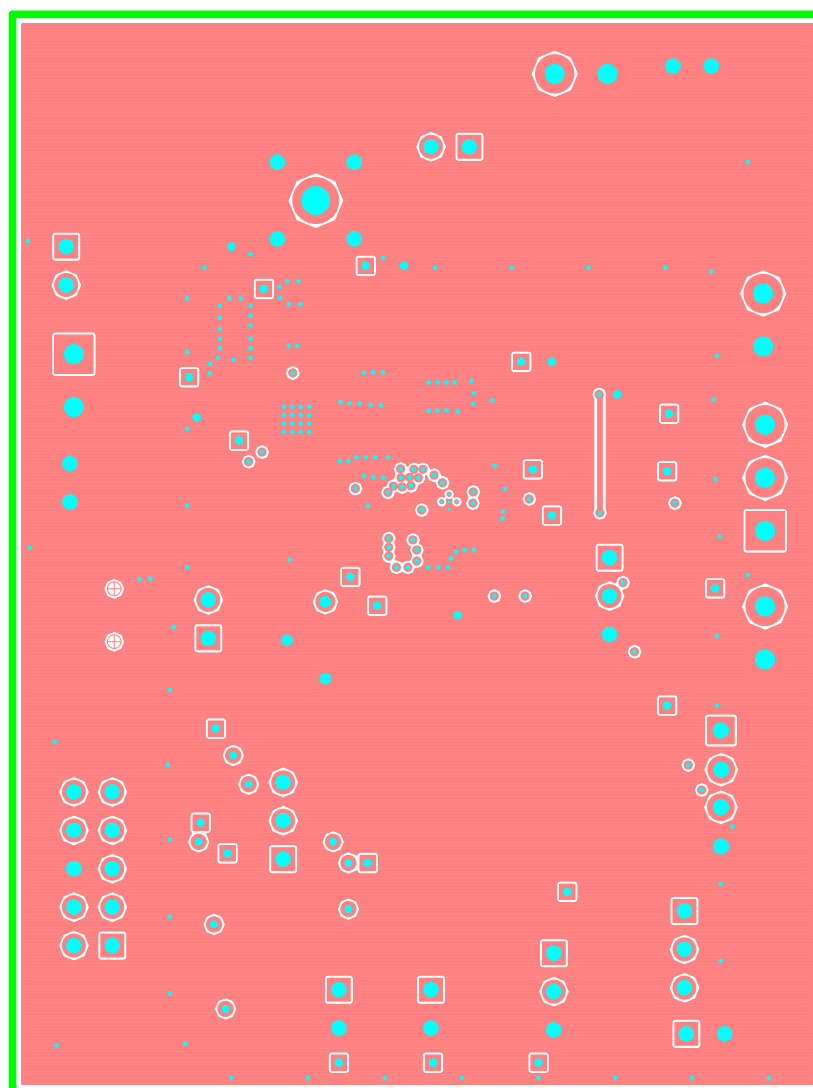


Figure 5. Layer 3



**Figure 6. Layer 4**

## 3.2 Bill of Materials and Schematic

**Table 2. Bill of Materials**

| COUNT | RefDes                  | Value       | Description                                              | Size                 | Part Number          | MFR                |
|-------|-------------------------|-------------|----------------------------------------------------------|----------------------|----------------------|--------------------|
| 1     | C18                     | 0.033uF     | Capacitor, Ceramic, 16V, X7R, 10%                        | 402                  | C1005X7R1C333K       | TDK                |
| 4     | C15, C16, C19, C20      | 0.1uF       | Capacitor, Ceramic, 6.3V, X5R, 10%                       | 402                  | C1005X5R0J104K050BA  | TDK                |
| 1     | C17                     | 1.0uF       | Capacitor, Ceramic, 6.3V, X5R, 10%                       | 402                  | C1005X5R0J105K050BB  | TDK                |
| 2     | C11, C12                | 0.1uF       | Capacitor, Ceramic, 25V, X5R, 10%                        | 603                  | C1608X5R1E104K       | TDK                |
| 2     | C10, C14                | 1.0uF       | Capacitor, Ceramic, 10V, X5R, 10%                        | 603                  | C1608X5R1A105K080AC  | TDK                |
| 1     | C5                      | 1.0uF       | Capacitor, Ceramic, 25V, X5R, 10%                        | 603                  | C1608X5R1E105K080AC  | TDK                |
| 1     | C6                      | 4.7uF       | Capacitor, Ceramic, 10V, X5R, 10%                        | 603                  | CGB3B1X5R1A475K055AC | TDK                |
| 1     | C13                     | 10uF        | Capacitor, Ceramic, 10V, X5R, 10%                        | 603                  | C1608X5R1A106K080AC  | TDK                |
| 1     | C7                      | 47nF        | Capacitor, Ceramic, 10V, X5R, 10%                        | 603                  | 06033D473KAT2A       | AVX                |
| 0     | C3, C4                  | DNP         | Capacitor, Ceramic, 10V, X5R, 10%                        | 603                  |                      |                    |
| 4     | C1, C2, C8, C9          | 10uF        | Capacitor, Ceramic, 25V, X5R, 10%                        | 805                  | C2012X5R1E106K125AB  | TDK                |
| 0     | J9                      | DNP         | Connector, Male Straight 2x5 pin, 100mil spacing, 4 Wall | 0.338 x 0.788 inch   | N2510-6002-RB        | 3M                 |
| 1     | J8                      | UX60-MB-5ST | Connector, Recpt, USB-B, Mini, 5-pins, SMT               | 0.354 X 0.303 Inches | UX60-MB-5ST          | Hirose Electric Co |
| 2     | D1, D2                  | Green       | Diode, LED, Green, 2.1-V, 10-mA, 6-mcd                   | 603                  | LTST-C190GKT         | Liteon             |
| 5     | J1, J3, J4, J6, J11     | PEC02SAAN   | Header, Male 2-pin, 100mil spacing                       | 0.100 inch x 2       | PEC02SAAN            | Sullins            |
| 1     | J10                     | 22-05-3041  | Header, Friction Lock Ass'y, 4-pin Right Angle           | 0.400 x 0.500        | 22-05-3041           | Molex              |
| 1     | L1                      | 2.2uH       | Inductor, SMT, 4.2A, 50.1milliohm                        | 0.204 x 0.216 inch   | IHLP2020BZER2R2M01   | Vishay             |
| 3     | JP1, JP3, JP4           | PEC02SAAN   | Header, Male 2-pin, 100mil spacing                       | 0.100 inch x 2       | PEC02SAAN            | Sullins            |
| 4     | JP2, JP5, JP6, JP7      | PEC03SAAN   | Header, Male 3-pin, 100mil spacing                       | 0.100 inch x 3       | PEC03SAAN            | Sullins            |
| 1     | R4                      | 10.0k       | Potentiometer, 3/8 Cermet, Single-Turn                   | 0.25x0.17 inch       | 3266W-1-103LF        | Bourns             |
| 1     | R25                     | 1.00k       | Resistor, Chip, 1/16W, 1%                                | 402                  | CRCW04021K00FKED     | Vishay             |
| 3     | R17, R18, R23           | 10.0k       | Resistor, Chip, 1/16W, 1%                                | 402                  | CRCW040210K0FKED     | Vishay             |
| 1     | R22                     | 18.2k       | Resistor, Chip, 1/16W, 1%                                | 402                  | CRCW040218K2FKED     | Vishay             |
| 2     | R1, R5                  | 0           | Resistor, Chip, 1/10W                                    | 603                  | CRCW06030000Z0EA     | Vishay             |
| 2     | R6, R7                  | 5.23k       | Resistor, Chip, 1/10W, 1%                                | 603                  | CRCW06035K23FKEA     | Vishay             |
| 2     | R19, R20                | 1.00M       | Resistor, Chip, 1/10W, 1%                                | 603                  | ERJ-3EKF1004V        | Panasonic          |
| 2     | R11, R12                | 7.5k        | Resistor, Chip, 1/10W, 1%                                | 603                  | CRCW06037K50FKEA     | Vishay             |
| 1     | R2                      | 169         | Resistor, Chip, 1/10W, 1%                                | 603                  | ERJ-3EKF1690V        | Panasonic          |
| 0     | R10, R13, R14, R15, R16 | DNP         | Resistor, Chip, 1/10W, 1%                                | 603                  |                      |                    |
| 1     | R3                      | 768         | Resistor, Chip, 1/10W, 1%                                | 603                  | ERJ-3EKF7680V        | Panasonic          |

**Table 2. Bill of Materials (continued)**

|   |                                                                                                                                                                |                |                                                                                        |                    |                   |           |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------|--------------------|-------------------|-----------|
| 1 | R21                                                                                                                                                            | 1.8M           | Resistor, Chip, 1/10W, 1%                                                              | 603                | ERJ-3EKF1804V     | Panasonic |
| 2 | R8, R9                                                                                                                                                         | 2.21k          | Resistor, Chip, 1/10W, 1%                                                              | 603                | ERJ-3EKF2211V     | Panasonic |
| 1 | R24                                                                                                                                                            | 0.01           | Resistor, Chip, 1/4W, 1%                                                               | 805                | WSL0805R0100FEA18 | Vishay    |
| 4 | J2, J5, J7, J13                                                                                                                                                | ED555/2DS      | Terminal Block, 2-pin, 6-A, 3.5mm                                                      | 0.27 x 0.25        | ED555/2DS         | OST       |
| 1 | J12                                                                                                                                                            | ED555/3DS      | Terminal Block, 3-pin, 6-A, 3.5mm                                                      | 0.41 x 0.25 inch   | ED555/3DS         | OST       |
| 0 | TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TPA1, TPA2, TPD1, TPD3, TPDE3, TPE3 | DNP            | Test Point, 0.020 Hole                                                                 | 0.100 x 0.100 inch |                   |           |
| 1 | TP20                                                                                                                                                           | 131-4244-00    | Adaptor, 3.5-mm probe clip ( or 131-5031-00)                                           | 0.200 inch         | 131-4244-00       | Tektronix |
| 1 | U1                                                                                                                                                             | bq24192RGET    | IC, I2C Controlled 4.5A Single Cell USB/Adapter Charger                                | QFN-24             | bq24192RGET       | TI        |
| 1 | U2                                                                                                                                                             | bq27531-G1YZFT | IC, Battery Management Unit Impedance Track Fuel Gauge With bq24192 Charger Controller | BGA                | bq27531-G1YZFT    | TI        |
| 1 | RT1                                                                                                                                                            | 10K            | Thermistor, NTC, 3-A                                                                   | 0.095 X 0.150 inch | 103AT-2           | Semitec   |
| 5 |                                                                                                                                                                |                | Shunt, 100-mil, Black                                                                  | 0.100              | 929950-00         | 3M        |
| 1 |                                                                                                                                                                |                | PCB                                                                                    |                    | PWR216            | Any       |

### 3.3 bq27531 Circuit Module Performance Specification Summary

This section summarizes the performance specifications of the bq27531 circuit module.

### 3.4 Recommended Operating Conditions

|                                             |                                                                                                                     | Min   | Typ | Max                   | Unit |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------|-----|-----------------------|------|
| Supply voltage, $V_{IN}$                    | Input voltage from ac adapter                                                                                       | 4.2   |     | 6                     | V    |
| System voltage, $V_{SYS}$                   | Voltage output at SYS terminal (depends on VBAT voltage and status of $V_{INDPM}$ and input current limit circuits) | 3.3   |     | VBATR<br>EG+4.17<br>% | V    |
| Battery voltage, $V_{BAT}$                  | Voltage output at VBAT terminal (registers set via bq27531 software)                                                | 3     | 4.2 | 4.44                  | V    |
| Supply current, $I_{IN(MAX)}$               | Maximum input current from ac adapter input (registers set via bq27531 software)                                    | 1.5   |     | 3                     | A    |
| Fast charge current, $I_{CHRG(MAX)}$        | Battery charge current (registers set via bq27531 software)                                                         | 0.550 |     | 3                     | A    |
| Operating junction temperature range, $T_J$ |                                                                                                                     | -40   |     | 125                   | °C   |

## 4 EVM Hardware and Software Setup

This section describes how to connect the different components of the EVM how to install the bq27531EVM PC software and.

### 4.1 Recommended Test Equipment

#### 4.1.1 Power Supplies

1. Power Supply #1 (PS #1) capable of supplying 6 V at 3 A is required.
2. If not using a battery as the load, then power supply #2 (PS #2) capable of supplying up to 5 V at 5 A is required to power the circuit shown in Figure 7.

#### 4.1.2 Load #1 Between BAT and GND

Testing with an actual battery is the best way to verify operation in the system. If a battery is not available, then a circuit similar to the one shown in Figure 7 can simulate a battery when connected to a power supply.

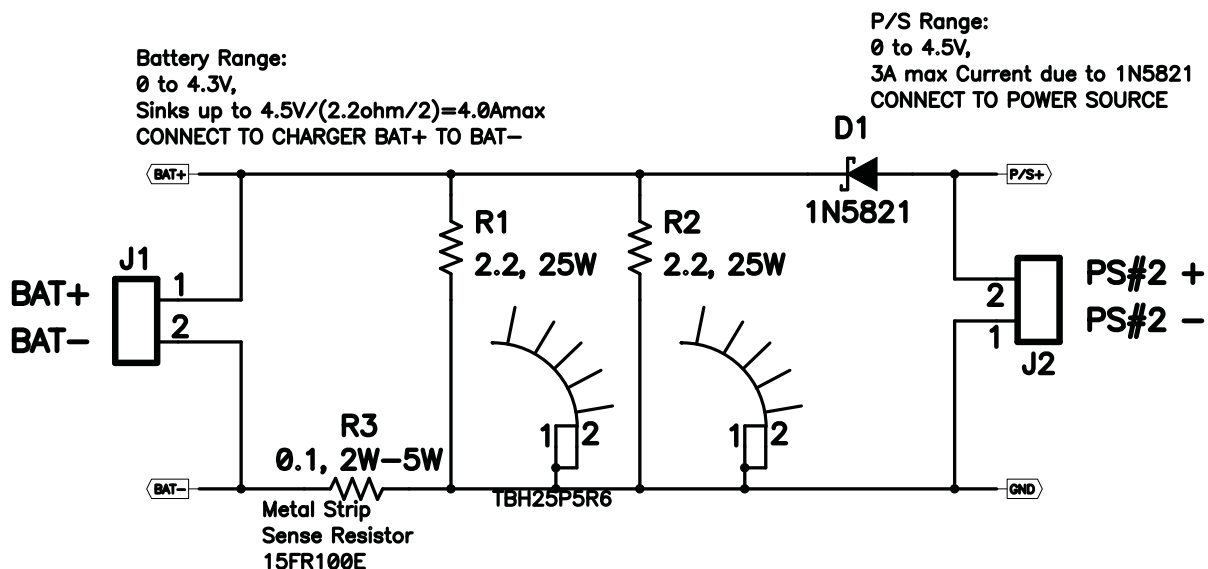


Figure 7. BAT\_Load (PR1010) Schematic

#### 4.1.3 Load #2 Between SYS and GND

Although not required, a resistive load capable of sinking up to 3 A can be used.

#### 4.1.4 Meters

Three equivalent voltage meters (VM #) and two equivalent current meters (CM #) are required. The current meters must be able to measure 3-A current.

#### 4.1.5 Test Equipment Setup

1. For all power connections, use short, twisted-pair wires of appropriate gauge wire for the amount of the current.
2. Set Power Supply #1 (PS #1) for 6-V, 3-A current limit and then turn off supply.
3. If BAT\_Load as shown in [Figure 8](#) is used, connect Power Supply #2 (PS #2) set to approximately 3.6 V to the input side (PS #2+/-) of BAT\_Load, then turn off PS #2.
4. Connect the output side of the battery or BAT\_Load in series with current meter to J12 (PACK+, PACK-). Ensure that a voltage meter is connected across J12 (PACK+,PACK-).
5. Connect VM #3 across J5 (SYS, GND).
6. Ensure jumpers are at the default factory settings per [Section 2.4](#)
7. Connect I2C port of EV2300 with J10 board using the assembled 4 colored-wire connector included with EV2300 kit (GND / BLACK at the bottom).
8. After the preceding steps have been performed, the test setup for PWR216 is configured as is shown in [Figure 8](#)

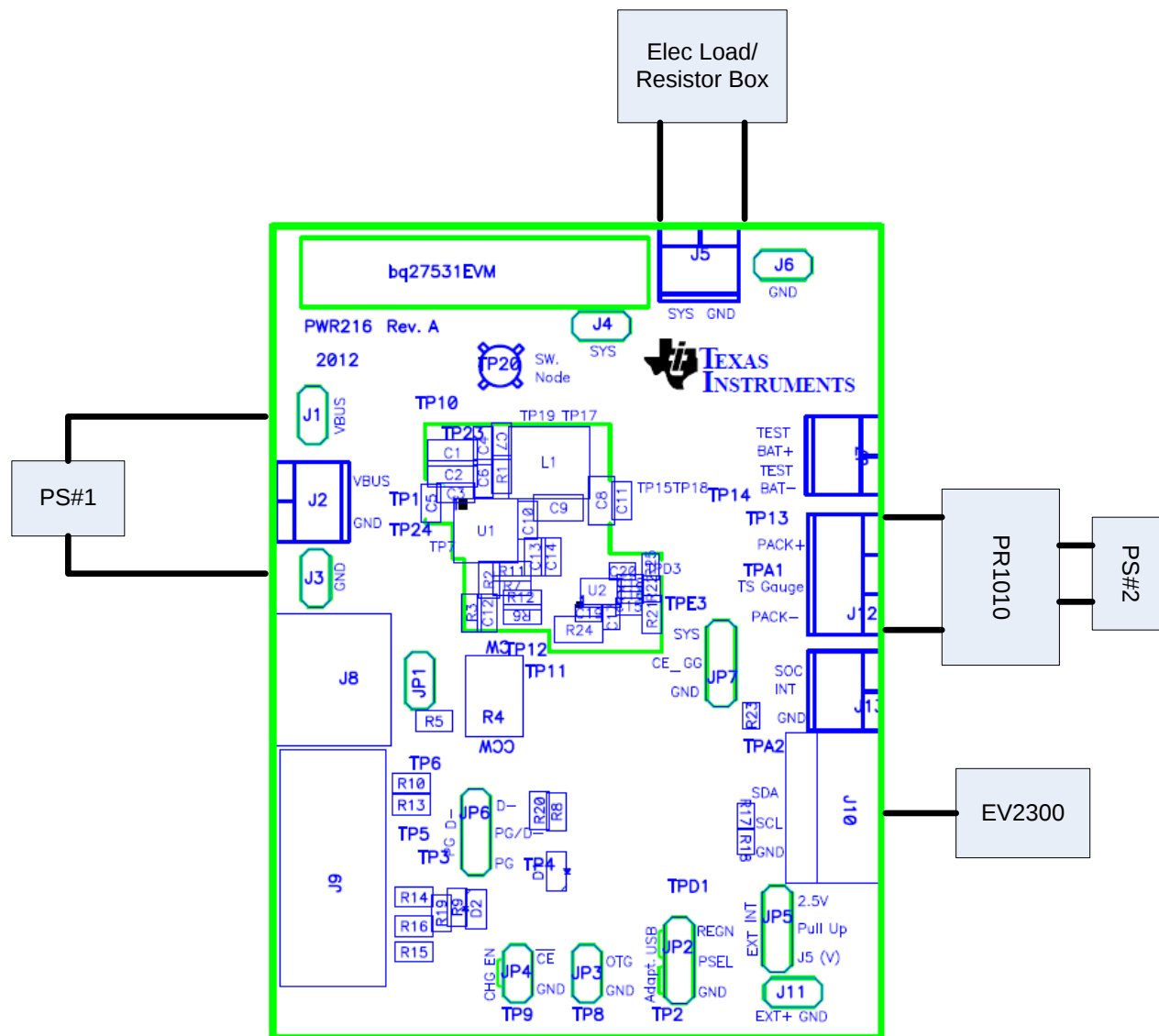


Figure 8. Test Setup for bq27531EVM (PWR216)

9. Turn on the computer. Open the bq27531 evaluation software. The main window of the software is shown in Figure 9 (DataRAM Screen).

## 4.2 Software System Requirements

The bq27531EVSW software requires 32-bit versions of Windows 2000 or Windows XP. Drivers for Windows 98SE are provided, but Microsoft™ no longer supports Windows 98; therefore, Windows 98 can have issues 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.

## 4.3 Software Installation

Find the latest software version in the bq27531 tool folder on [power.ti.com](http://power.ti.com). Make a search by part number for bq27531 to access the tool folder.

### 4.3.1 Using EV2300

Use the following steps to install the bq27531EVSW software when using EV2300:

1. Ensure that the EV2300 is not connected to the PC through a USB cable before starting this procedure.
2. Browse for the supported software link within the bq27531 TI web site product folder to find the downloadable evaluation software (EVSW) installation files.
3. Open the software file that was downloaded from the TI web site.
4. Follow the instructions on screen until the software installation is completed.
5. Before starting the EVSW, connect the EV2300 to the computer using the USB cable.
6. Wait until the system prompt "new hardware found" appears. Choose "select location manually", and use the "browse" button to point to subdirectory TIUSBWin2K-XP-1.
7. Answer "continue" to the warning that drivers are not certified with Microsoft™.
8. After installation finishes, another system prompt "new hardware found" appears. Repeat steps 6 and 7, but specify the directory as TIUSBWin2K-XP-2.
9. Answer "continue" to the warning that drivers are not certified with Microsoft. Driver installation is now finished.

### 4.3.2 Using EV2400:

1. Ensure that the EV2400 is not connected to the PC through a USB cable before starting this procedure.
2. Browse for the supported software link within the bq27531 TI web site product folder to find the downloadable EVSW installation files.
3. Open the software file that was downloaded from the TI web site.
4. Follow the instructions on screen until the software installation is completed.

## 5 Troubleshooting Unexpected Dialog Boxes

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.

## 6 Operation

This section details the operation of the bq27531 EVSW software.

### 6.1 Starting the Program

Run bq27531 EVSW from the Start | Programs | Texas Instruments | bq Evaluation Software menu sequence. The DataRAM screen (Figure 9) 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 with the | Options | and | Set Scan Interval | menu selections. The range for this interval is 0 ms to 65,535 ms. Only items that are selected for scanning are scanned within this period.

The bq27531 EVSW 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 65,535 ms. The Log interval cannot be smaller than the scan interval because this results in the same value being logged at least twice.

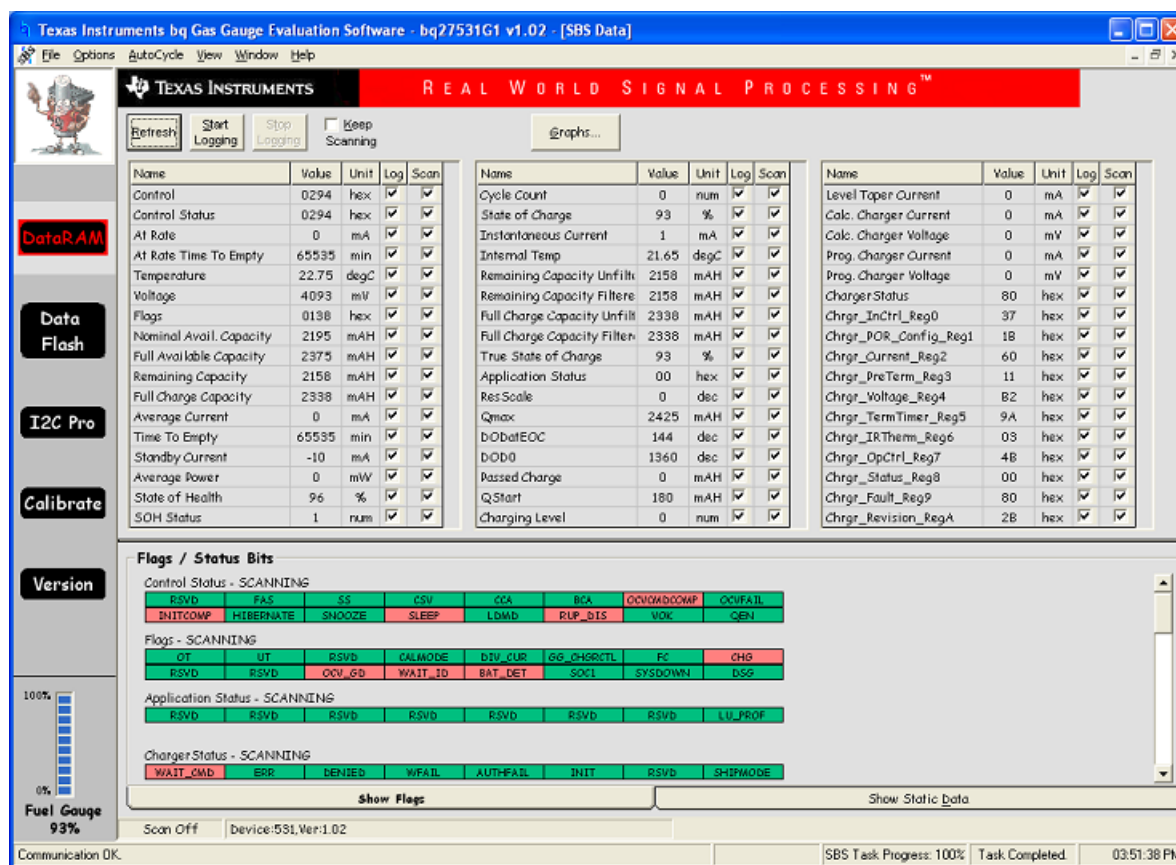


Figure 9. DataRAM Screen

This screen (Figure 9) shows the RAM data set. Additional Flag and Status data can be viewed at the bottom of the DataRAM screen.

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

## 6.2 Setting Programmable bq27531 Options

The bq27531 data flash comes configured per the default settings detailed in the bq27531 data sheet. Ensure that the settings are correctly changed to match the pack and application for the bq27531 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 10).

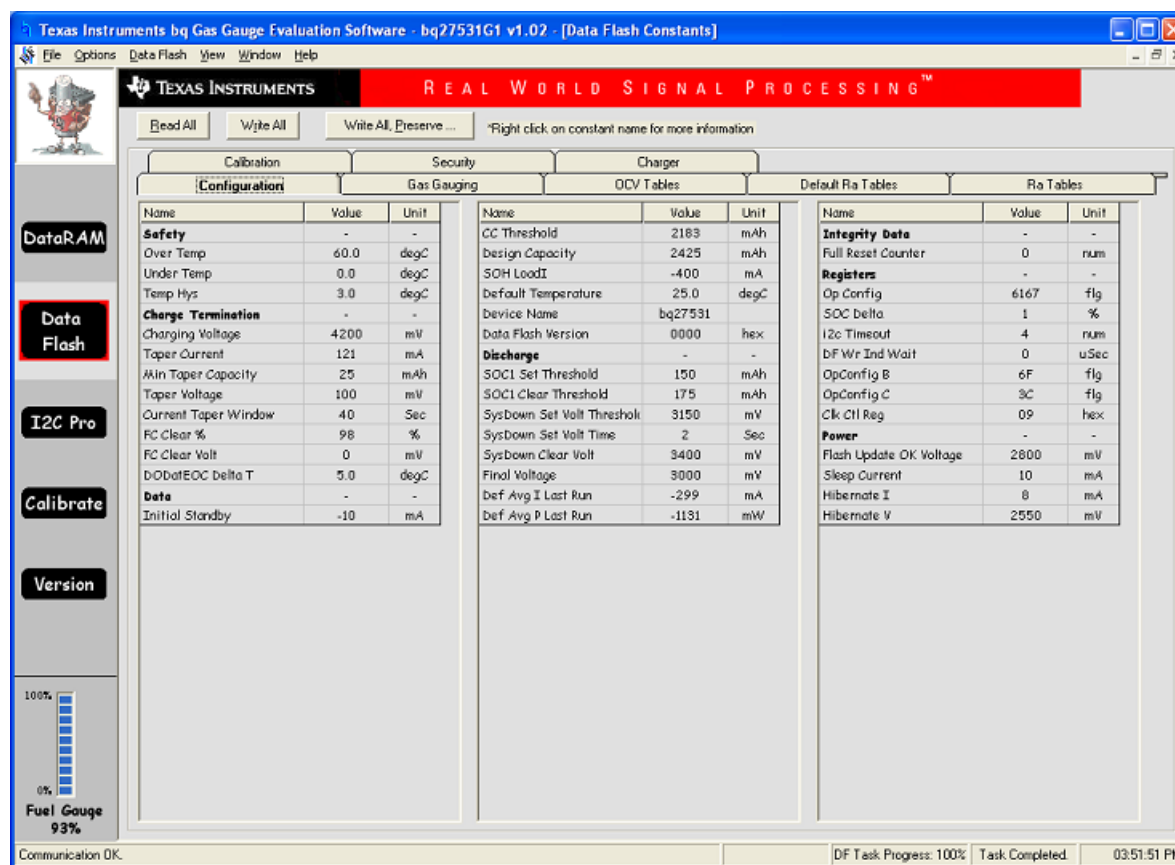


Figure 10. Data Flash Screen

To read all the data from the bq27531 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 bq27531 using the | Write All | button.

The module calibration data is also held in the bq27531 data flash.

The bq27531 allows for an automatic data-flash export function, similar to the DataRAM 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 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 bq27531 that is being used may not be supported by the bqEVSW version that is being used. An upgrade may be required. Most of the Data Flash also cannot be read if the bq27531 is in Sealed mode.

## 7 Calibrate Screen

To ensure proper calibration, perform the following steps. These steps may or may not be required, depending on the type of calibration being performed. Only one calibration item can be selected and calibrated at a time.

### 7.1 To Calibrate the bq27531

Calibrate each item one at a time in the order presented in this document. Select the types of calibration to be performed by selecting the corresponding checkbox (see [Figure 11](#)).

Enter the measured values for the types selected, if necessary.

Then press the *Calibrate Part as indicated below* button. After all calibration is complete, close the Calibrate subwindow. While the Calibrate subwindow is open, even in the background, the calibration routines are running in firmware. Close the subwindow to ensure that they are stopped before proceeding with configuration or testing.

### 7.2 CC Offset Calibration

This performs the internal calibration of the coulomb counter input offset. Press the *Calibrate Coulomb Counter* button.

### 7.3 Voltage Calibration

- Measure the voltage across Pack+ and Pack- with a calibrated meter.
- Type the voltage value in mV into *Enter Actual Voltage*.
- Measure the temperature for PACK.
- Type the temperature value into *Enter Actual Temperature*.
- Press the *Calibrate Voltage and Temperature* as indicated below button.

### 7.4 Board Offset Calibration

This performs the offset calibration for the current offset of the board. It takes approximately 35 seconds to complete.

It is expected that no current is flowing through the sense resistor while performing this calibration step. Remove load and short PACK- to GND.

Press the *Calibration Board Offset* button.

### 7.5 Pack Current Calibration

- Connect a load to GND and SYS that draws approximately 1 A, or connect a current source to GND and Pack-. Ensure that the Measured Current reported is negative, or else reverse the connections.
- Measure the current with a calibrated meter, and type the value into *Enter Actual Current* using (-) for current in discharge direction.
- Press the *Calibrate Pack Current* button.

Texas Instruments bq Gas Gauge Evaluation Software - bq27531G1 v1.02 - [Host Calibration]

File Window Help

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Version: 1.3.0.7

Please ensure that scanning/communication is off on all other open windows.

**Coulomb Counter Offset Calibration—Step 1**

Calibrate Coulomb Counter

Ensure that no load current is flowing.

**Voltage and Temperature Calibration—Step 2**

Calibrate Voltage and Temperature as indicated below

**Voltage**

☐ Voltage Cal

Measured voltage: 4093 mV

Enter actual voltage: 4000 mV

**Temperature**

☐ Temperature

Measured temperature: 22.6 °C

Enter actual temperature: 25 °C

**Board Offset Calibration—Step 3**

Calibrate Board Offset

Ensure that no load current is flowing. CC Offset is Updated with this command.

**Pack Current Calibration—Step 4**

Calibrate Pack Current

Measured current: 0 mA

Enter actual current: -1000 mA

Apply a discharge load. Discharge current is a negative value. Charge current is positive. A voltage applied between Cell ground and Pack+ will force current through sense resistor.

100%  
0%  
Fuel Gauge 93%

Communication OK.

SBS Task Progress: 100% Task Completed 03:53:00 PM

Figure 11. Calibration Screen

## 8 I2C Pro Screen

### 8.1 I<sup>2</sup>C Communication

The read/write operations of the I2C Pro function is not specific to any gas gauge. These operations serve as general-purpose communication tools (Figure 12).

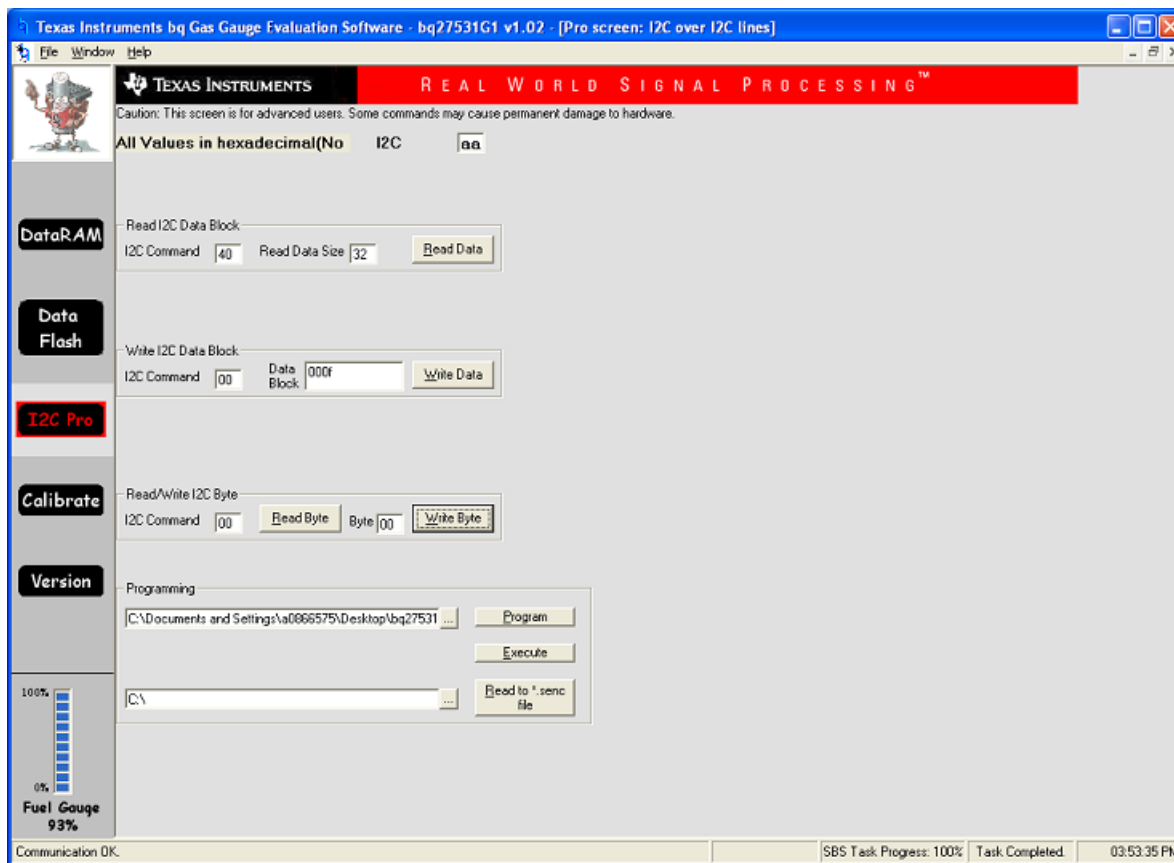


Figure 12. I2C Pro Screen

## 9 Related Documentation From Texas Instruments

To obtain a copy of any of the following TI documents, 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 also can be obtained through the TI Web site at [www.ti.com](http://www.ti.com).

- bq27531, System-Side Impedance Track™ Fuel Gauge With Integrated LDO data sheet ([SLUSBE7](#))

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### 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.

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### **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.

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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.

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

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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
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3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. 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 as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

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