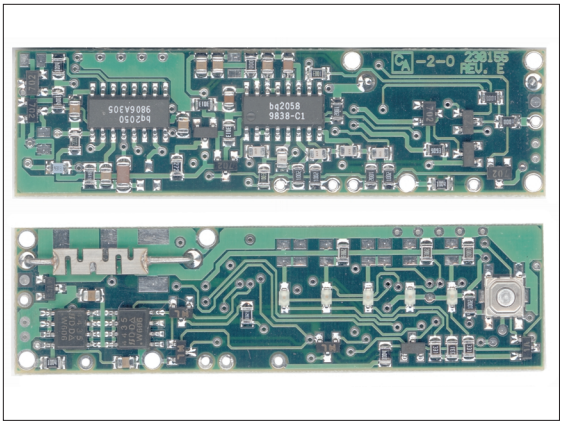
UNITRODE

# bq2167

## Li-Ion Power Gauge™ Module with Pack Supervisor

## Features

- Complete and compact lithium ion gas gauge and protection solution for three or four series cells
- Accurate measurement of available battery capacity
- Provides overvoltage, undervoltage, and overcurrent protection
- Designed for battery pack integration
  - Small size
  - Includes bq2050 and bq2058 ICs
  - On-board charge and discharge control FETs
  - Low operating current for minimal battery drain
- High side FET control
- Battery capacity available through single-wire serial port
- "L" version includes 5 push-button activated LEDs to display state-of-charge information



## General Description

The bq2167 Power Gauge Module provides a complete and compact battery management solution for Li-Ion battery packs. Designed for battery pack integration, the bq2167 combines the bq2050 Power Gauge IC with the bq2058 Supervisor IC on a small printed circuit board. The board includes all the necessary components to accurately monitor battery capacity and protect the cells from overvoltage, undervoltage, and overcurrent conditions. The board works with three or four Li-Ion series cells.

The Power Gauge IC uses the on-board sense resistor to track charge and discharge activity of the battery pack. Critical battery information can be accessed through the serial communications port at DQ. The supervisor circuit consists of the bq2058 and two FETs. The bq2058 controls the FETs to protect the batteries during charge/discharge cycles and short circuit conditions. The bq2167 provides contacts for the positive and negative terminals of each battery in the stack. Please refer to the bq2050 and bq2058 data sheets for the specifics on the operation of the power gauge and supervisor ICs.

Unitrode configures the bq2167 based on the information requested in Table 1. The configuration defines the number of series cells, the nominal battery pack capacity, the self-discharge rate, the Li-Ion battery type (coke or graphite anode), and the threshold limits. Figure 1 shows how the module connects to the cells.

The bq2167L includes five LEDs to display remaining capacity in 20% increments of the learned capacity. The LEDs are activated with the onboard push-button switch.

A module development kit is also available for the bq2167. The bq2167B-KT or the bq2167LB-KT includes one configured module and the following:

1) An interface board that allows connection to the serial port of any AT-compatible computer.
2) Menu driven software to display charge/discharge activity and to allow user interface to the bq2050 from any standard DOS PC.

## Pin Descriptions

| | |
|---|---|
| **POS** | **Pack positive** |
| **B1P** | **$BAT_{1P}$/Battery 1 positive input** |
| **B1N** | **$BAT_{1N}$/Battery 1 negative input** |
| **B2N** | **$BAT_{2N}$/Battery 2 negative input** |
| **B3N** | **$BAT_{3N}$/Battery 3 negative input** |
| **B4N** | **$BAT_{4N}$/Battery 4 negative input** |
| **ITEST** | **Overcurrent test input** |
| **DQ** | **Serial communications port** |
| **NEG** | **Pack negative** |

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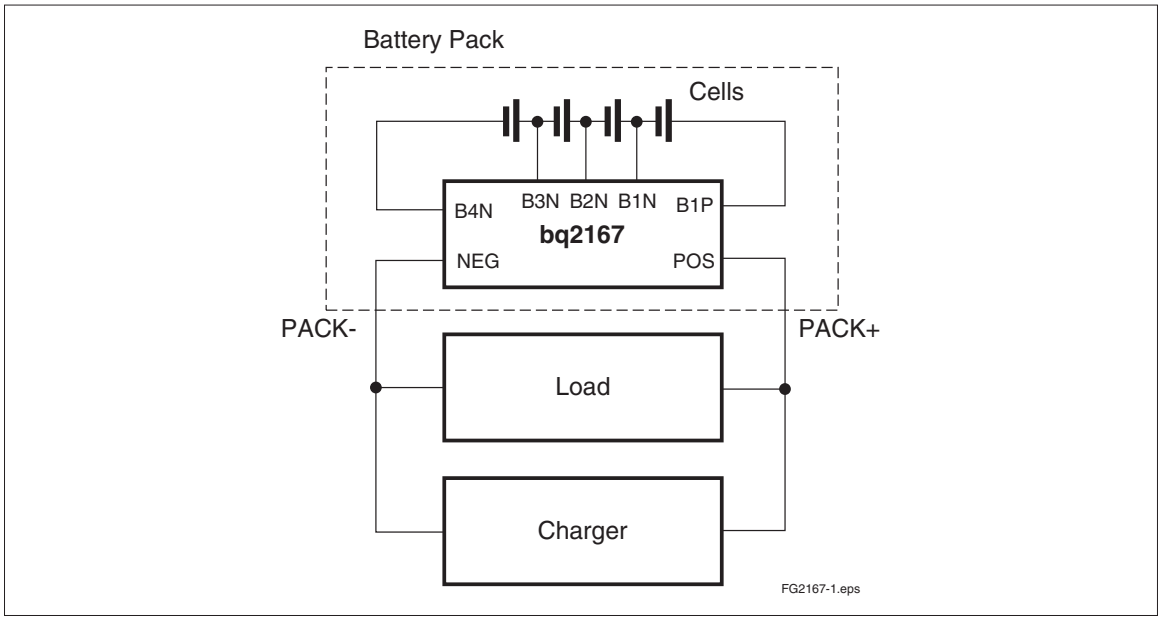



**Figure 1. Module Connection Diagram**

**Table 1. bq2167 Module Configuration**

Customer Name: _____

Contact: _____ Phone: _____

Address: _____

_____

Sales Contact: _____ Phone: _____

| | |
|---|---|
| Number of series cells (3 or 4) | _____ |
| Coke or graphite cell anode | _____ |
| Battery pack capacity (mAh) | _____ |
| Discharge current into load (3.9A max.) | Min. _____ Avg. _____ Max. _____ |
| Charge current (3.9A max) | _____ |
| Self-discharge compensation (Y/N) | _____ |
| Overvoltage threshold (4.25, 4.30, or 4.35V) | _____ |
| LEDs and switch (Y/N) | _____ |

FAE approval: _____ Date: _____

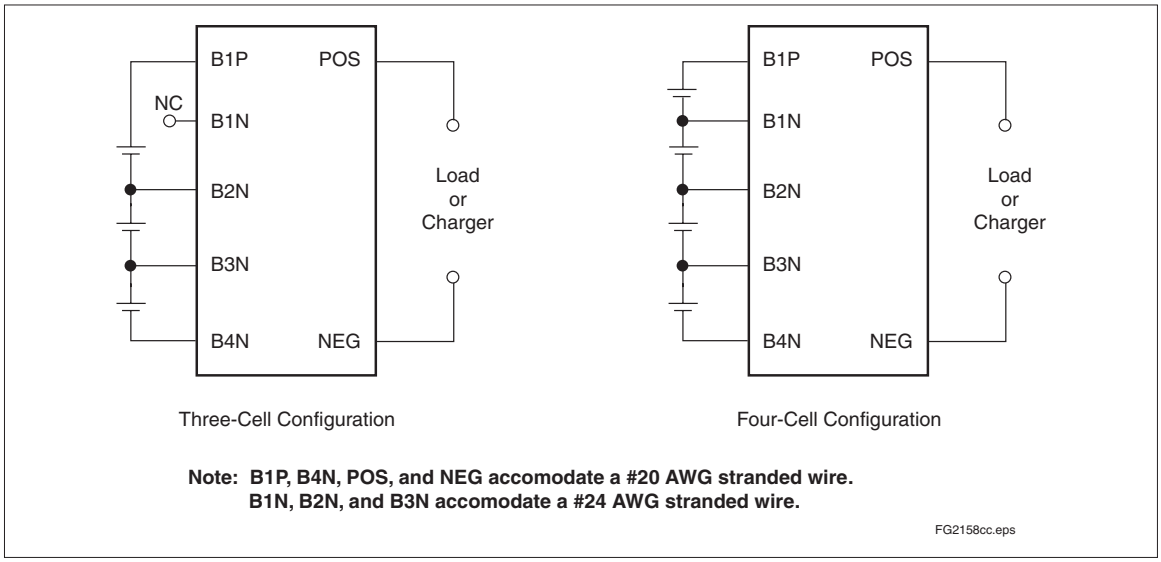
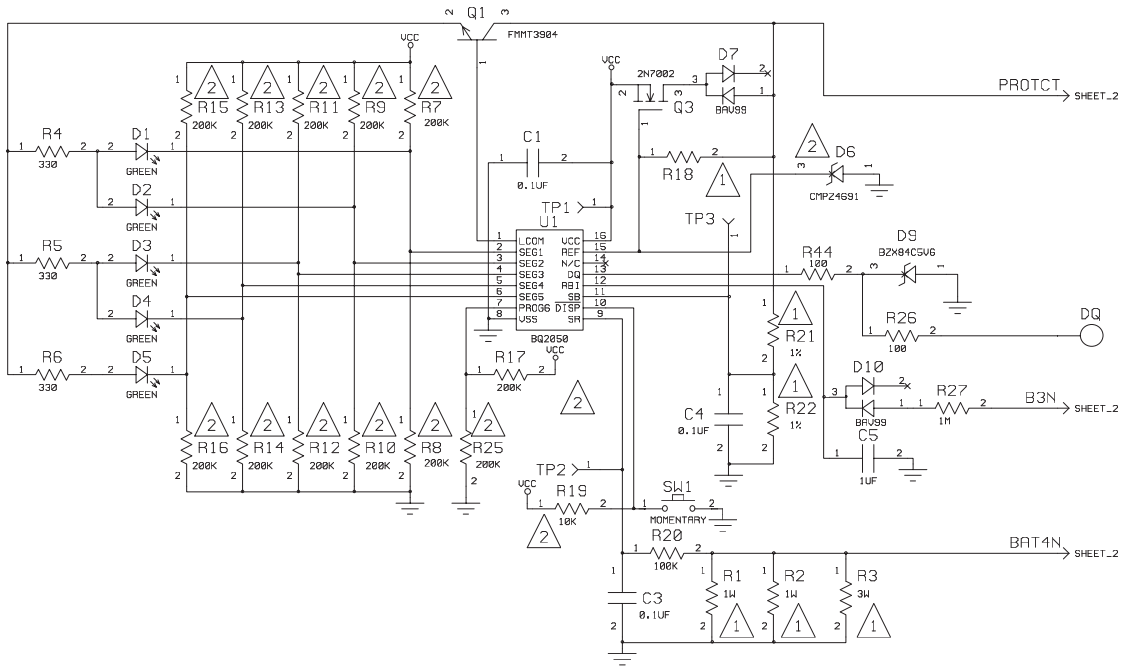


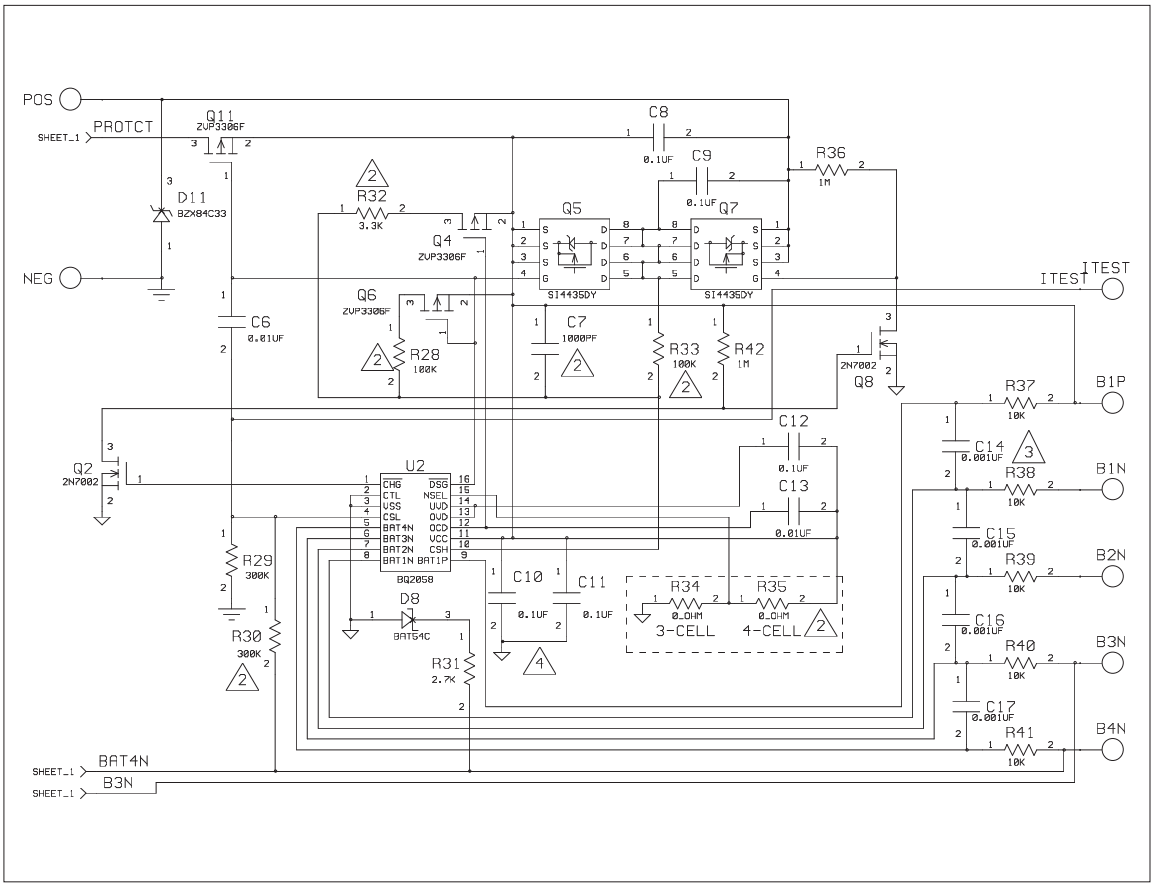

**Figure 1. Module Connection Diagram**

## bq2167 Schematic

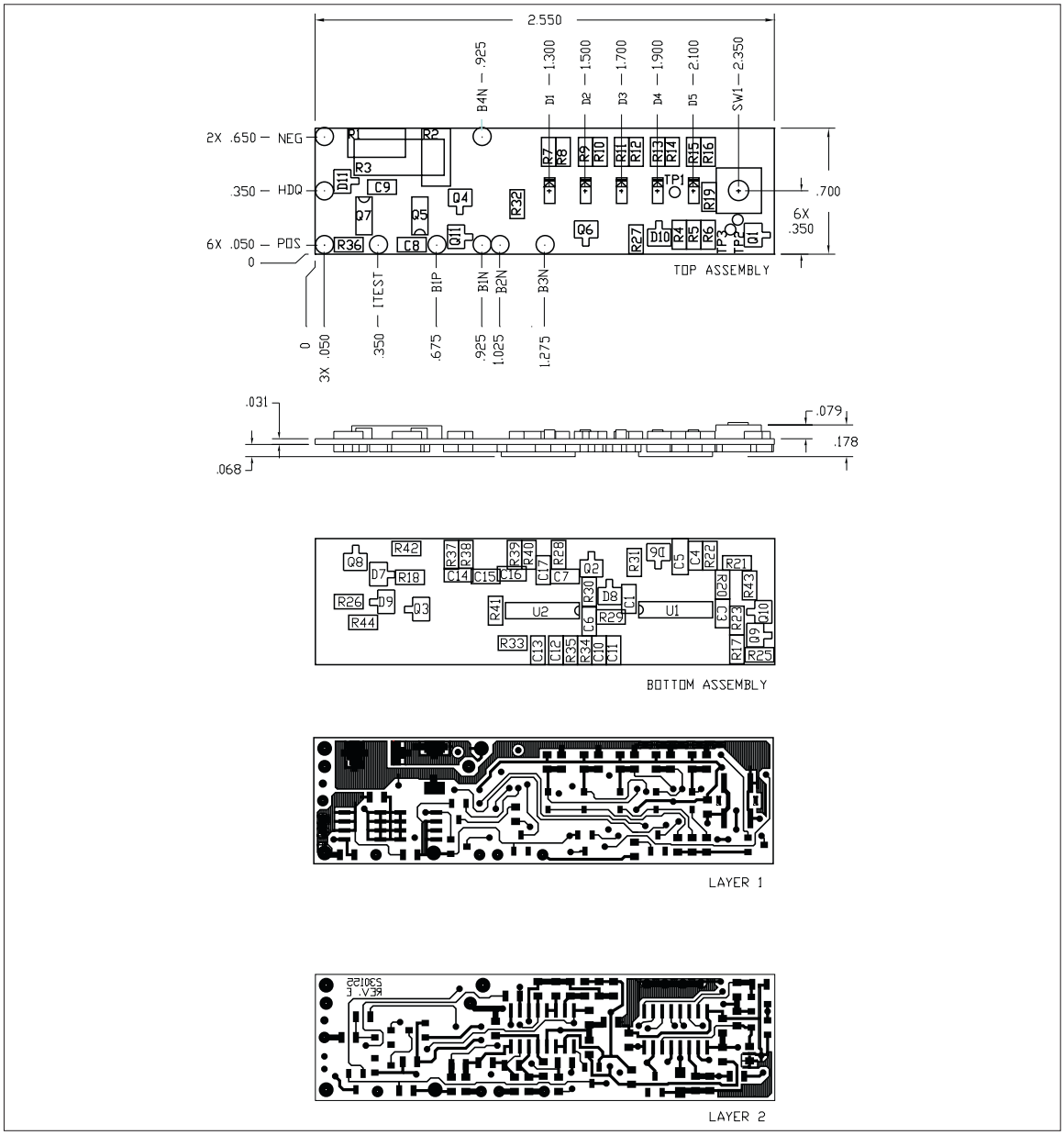



1 2 3 4 Component values depend on user-provided information in Table 1.

## bq2167 Schematic (Continued)



## bq2167 Board



## Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit | Conditions |
|---|---|---|---|---|
| $V_{OP}$ | Supply voltage (B1P to B4N) | 18 | V | DC |
| $V_{TR}$ | Maximum transient voltage (B1P to B4N) | 32 | V | Maximum duration = 1.5µs |
| $V_{CHG}$ | Charging voltage (POS to NEG) | 18 | V | |
| $I_{CHG}$ | Continuous charge/discharge current | 3.9 | A | $V_{OP}$ > 6V<br>$T_A$ = 25°C |
| $T_{OPR}$ | Operating temperature | 0 to +70 | °C | |
| $T_{STG}$ | Storage temperature | -55 to +125 | °C | |

**Note:** Permanent device damage may occur if **Absolute Maximum Ratings** are exceeded. Functional operation should be limited to the Recommended DC Operating Conditions detailed in this data sheet. Exposure to conditions beyond the operational limits for extended periods of time may affect device reliability.

## DC Electrical Characteristics ($T_A = T_{OPR}$)

| Symbol | Parameter | Minimum | Typical | Maximum | Unit | Conditions/Notes |
|---|---|---|---|---|---|---|
| $V_{OP}$ | Operating voltage, B1P to B4N | 4.0 | - | 18 | V | |
| $I_{CCA}$ | Operating current | - | - | 350 | µA | |
| $R_{ON}$ | On resistance, B1P to POS | - | - | 50 | mΩ | $T_A$ = 25°C<br>$V_{OP}$ = 10V |

## DC Thresholds ($T_A = T_{OPR}$)

| Symbol | Parameter | Value | Tolerance | Unit | Notes |
|---|---|---|---|---|---|
| $V_{OV}$ | Overvoltage threshold | 4.25 | ± 50mV | V | |
| $V_{CE}$ | Charge enable voltage | $V_{OV}$ - 100mV | ± 50mV | V | |
| $V_{UV}$ | Undervoltage limit | 2.25 | ± 100mV | V | |
| $I_{OC}$ | Overcurrent limit | 3.4 | | A | $T_A$ = 25°C |
| | | 3.8 | | A | $T_A$ = 60°C |
| $t_{UVD}$ | Undervoltage delay | 950 | ±50% | ms | $T_A$ = 30°C |
| $V_{CD}$ | Charge detect threshold | 70 | -60, +80 | mV | |
| $t_{OVD}$ | Overvoltage delay | 950 | ±50% | ms | $T_A$ = 30°C |
| $t_{OCD}$ | Overcurrent delay | 12 | ±60% | ms | $T_A$ = 30°C |

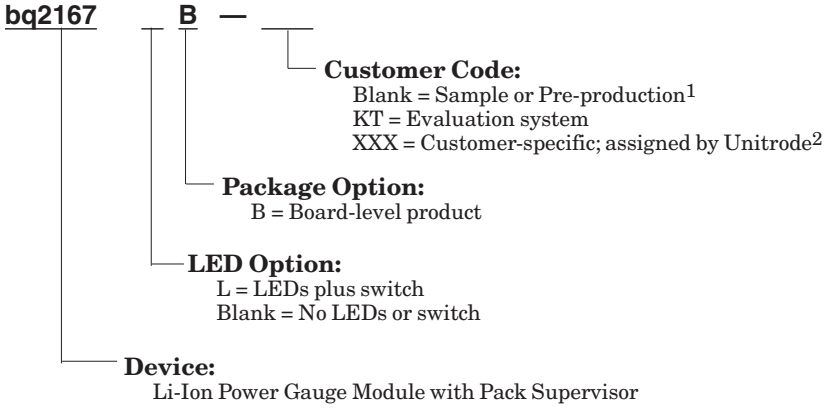
**Note:** The thresholds above reflect the operation of a bq2158 using the standard bq2058 IC ($V_{OV}$ = 4.25V). Specify other versions of the bq2058 by indicating the appropriate $V_{OV}$ threshold in Table 1.

## Data Sheet Revision History

| Change No. | Page No. | Description | Nature of Change |
|---|---|---|---|
| 1 | All | From Preliminary to Final | |

**Note:** Change 1 = May 1999 B changes from Apr. 1999.

## Ordering Information




**Notes**: 1. Requires configuration sheet (Table 1)

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