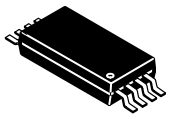


SLUS556 – FEBRUARY 2003

# SINGLE-CELL LI-ION AND LI-POL BATTERY GAS GAUGE IC FOR PORTABLE APPLICATIONS (bqJUNIOR™)

## FEATURES

- **Reports Accurate *Time-to-Empty* in Li-Ion and Li-Pol Cells, No System Processor Calculations Needed**
- **Reports Cell Temperature, Voltage and Average Current**
- **High-Accuracy Coulometric Charge and Discharge Current Integration with Automatic Offset Cancellation**
- **Requires No Offset Calibration**
- **Programmable Input/Output Port**
- **Internal Time-Base Eliminates External Crystal Oscillator**
- **Four Automatic Low-Power Operating Modes**
  - **Active: < 100 μA**
  - **Sleep: < 5 μA**
  - **Ship: < 2 μA**
  - **Hibernate: < 500 nA**
- **Small 8-Pin TSSOP Package**

## APPLICATIONS

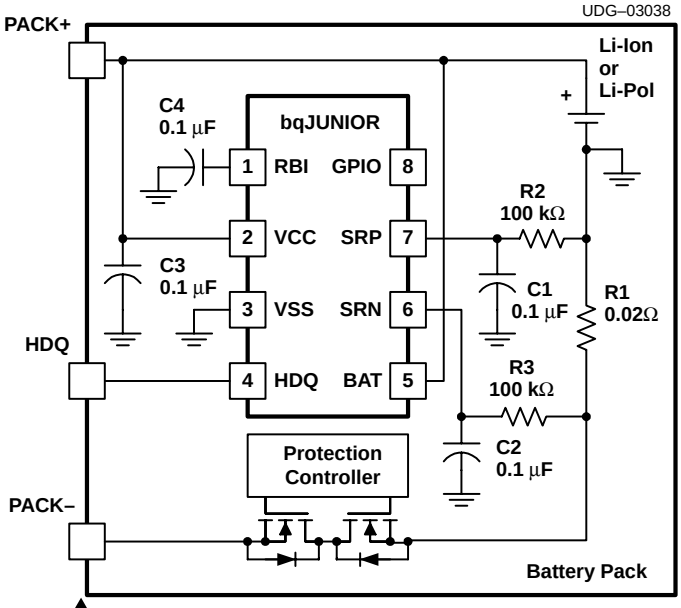
- **PDAs**
- **Smart Phones**
- **MP3 Players**
- **Digital Cameras**
- **Internet Appliances**
- **Handheld Devices**

## DESCRIPTION

The bqJUNIOR series are highly accurate standalone single-cell Li-Ion and Li-Pol battery capacity monitoring and reporting devices targeted at space limited portable applications. The device monitors a voltage drop across a small current sense resistor connected in series with the battery to determine charge and discharge activity of the battery. Compensations for battery temperature, self–discharge, and rate of discharge are applied to the charge counter to provide available *time-to-empty* and *time-to-full* information across a wide range of operating conditions. Battery capacity is automatically recalibrated, or *learned*, in the course of a discharge cycle from full to empty. Internal registers include available time-to-empty, cell temperature and voltage, average current, and other status and control registers.

The bqJUNIOR can operate directly from single-cell Li-Ion and Li-Pol batteries and communicates to the system over a simple one-wire bi-directional serial interface. The 5-kbits/s HDQ bus interfaces reduces communications overhead in the external microcontroller.

## TYPICAL APPLICATION




PRODUCT PREVIEW

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted(1) (2)

| | | bq27000<br>bq27010 |
|---|---|---|
| Supply voltage range, $V_{CC}$ (all with respect to $V_{SS}$) | | –0.3 V to 7.0 V |
| Input voltage range at SRP, SRN, RBI, and BAT (all with respect to $V_{SS}$) | | –0.3 V to $V_{CC}$ + 0.3 V |
| Input voltage | HDQ, GPIO (with respect to $V_{SS}$) | –0.3 V to 7.0 V |
| | GPIO (with respect to $V_{SS}$) during EEPROM programming only | –0.3 V to 22.0 V |
| Output sink current at GPIO, HDQ | | 5 mA |
| Operating free-air temperature range, $T_A$ | | –20°C to 70°C |
| Storage temperature range, $T_{stg}$ | | –65°C to 150°C |
| Junction temperature range, $T_J$ | | –40°C to 125°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | | 300°C |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability

PRODUCT PREVIEW

## RECOMMENDED OPERATING CONDITIONS

| | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ | 2.6 | | 4.5 | V |
| Operating free-air temperature, $T_J$ | –20 | | 70 | °C |

## ELECTRICAL CHARACTERISTICS

$T_J$ = –20°C to 70°C, $T_J = T_A$, 2.6 V ≤ $V_{CC}$ ≤ 4.5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **INPUT CURRENTS** | | | | | | |
| $I_{CC(VCC)}$ | Input current, $V_{CC}$ | $V_{CC} > V_{CC(min)}$ | | | 100 | µA |
| $I_{CC(SLP)}$ | Sleep current | | | | 5 | |
| $I_{CC(SHP)}$ | Ship current | | | | 2 | |
| $I_{CC(POR)}$ | Hibernate current | $0 V < V_{CC} < V_{(POR)}$ | | | 500 | nA |
| | EEPROM programming current | $V_{PROGRAM}$ = 21 V | | | 15 | mA |
| | RBI current | RBI pin only, $V_{CC} < V_{(POR)}$ | | | 20 | nA |
| $V_{(POR)}$ | POR threshold | | 2.0 | | 2.5 | V |
| | RBI data retention voltage | | 1.2 | | | |
| | Input impedance on BAT pin | | 10 | | | MΩ |
| | Input impedance on SRR, SRN pins | | 10 | | | |
| **VOLTAGE MEASUREMENT** | | | | | | |
| | Measurement range | $V_{CC} = V_{I(BAT)}$ | 2.6 | | 4.5 | V |
| | Reported voltage resolution | | | 2.7 | | mV |
| | Reported accuracy | | –25 | | 25 | |
| | Voltage update time | | | 2 | | s |
| **VOLTAGE MEASUREMENT** | | | | | | |
| | Reported temperature resolution | | | 0.25 | | °K |
| | Reported temperature accuracy | | –3 | | 3 | |
| | Temperature update time | | | 2 | | s |

## ELECTRICAL CHARACTERISTICS (continued)

$T_J$ = –20°C to 70°C, $T_J = T_A$, 2.6 V ≤ $V_{CC}$ ≤ 4.5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **EEPROM PROGRAMMING VOLTAGE** | | | | | | |
| $t_{RISE}$ | Programming voltage rise time | | 0.5 | | 1.5 | ms |
| | Programming voltage high time | | 10 | | 100 | |
| $t_{FALL}$ | Programming voltage fall time | | 0.5 | | 1.5 | |
| | Programming voltage | Applied to GPIO pin | 20 | | 22 | V |
| **IO PORT (GPIO) AND SERIAL INTERFACE (HDQ)** | | | | | | |
| $V_{IH}$ | High-level input voltage | $V_{CC}$ < 4.2 V | 1.7 | | | V |
| | | $V_{CC}$ > 4.2 V | 1.9 | | | |
| $V_{IL}$ | Low-level input voltage | | | | 0.7 | |
| $I_{OL}$ | Low-level output current | $V_{OL}$ > 0.4 V | | | 1 | mA |
| **STANDARD SERIAL COMMUNICATION (HDQ) TIMING**(1) | | | | | | |
| $T_{(B)}$ | Break timing | | 190 | | | µs |
| $T_{(BR)}$ | Break recovery time | | 40 | | | |
| $T_{(CYCH)}$ | Host bit window timing | | 190 | | | |
| $T_{(HW1)}$ | Host sends 1 time | | 5 | | 50 | |
| $T_{(HW0)}$ | Host sends 0 time | | 100 | | 145 | |
| $T_{(RSPS)}$ | bq27000 to host response time | | 190 | | 320 | |
| $T_{(CYCB)}$ | bq27000 bit window timing | | 190 | | 250 | |
| $T_{(DW1)}$ | bq27000 sends 1 time | | 32 | | 50 | |
| $T_{(DW0)}$ | bq27000 sends 0 time | | 80 | | 145 | |

(1) See Figure 1.

The following timing diagrams describe break and break recovery timing (a), host transmitted bit timing (b), bqJUNIOR transmitted bit timing (c), and bqJUNIOR to host response timing (d).

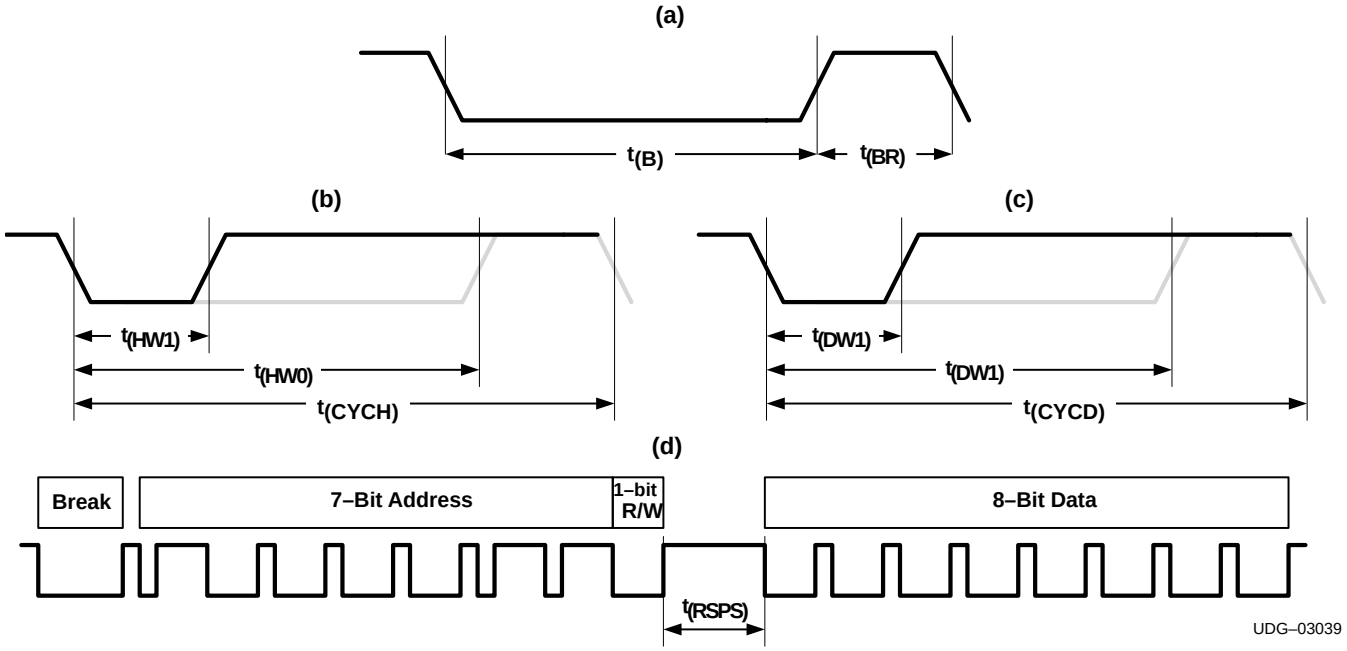


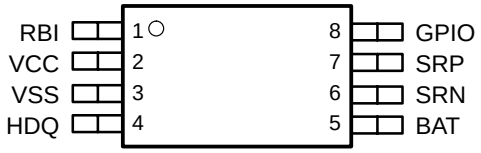

**Figure 1. HDQ Bit Timing Diagrams**

PRODUCT PREVIEW

## PIN ASSIGNMENTS

| TERMINAL NAME | TERMINAL NO. | I/O | DESCRIPTION |
|---|---|---|---|
| BAT | 5 | I | Battery voltage sense input |
| GPIO | 8 | I/O | General-purpose input/output port |
| HDQ | 4 | I/O | Single-wire HDQ serial interface |
| RBI | 1 | I | Register back-up input |
| SRN | 6 | I | Current sense input (positive) |
| SRP | 7 | I | Current sense input (negative) |
| VCC | 2 | I | $V_{CC}$ supply input |
| VSS | 3 | I | Ground input |

**PW PACKAGE**
**(TOP VIEW)**




## AVAILABLE OPTIONS

| $T_A$ | ADDITIONAL FUNCTIONS | PACKAGED DEVICES | MARKINGS |
|---|---|---|---|
| –20°C to 70°C | TTECP, AP, SAE, MLTTE, MLI, STTE, SI, ARTTE, and AR | bq27000PW | |
| | | bq27010PW | |

† The PW package is available taped and reeled. Add R suffix to device type (e.g. bq27000PWR) to order quantities of 2,000 devices per reel.

PRODUCT PREVIEW

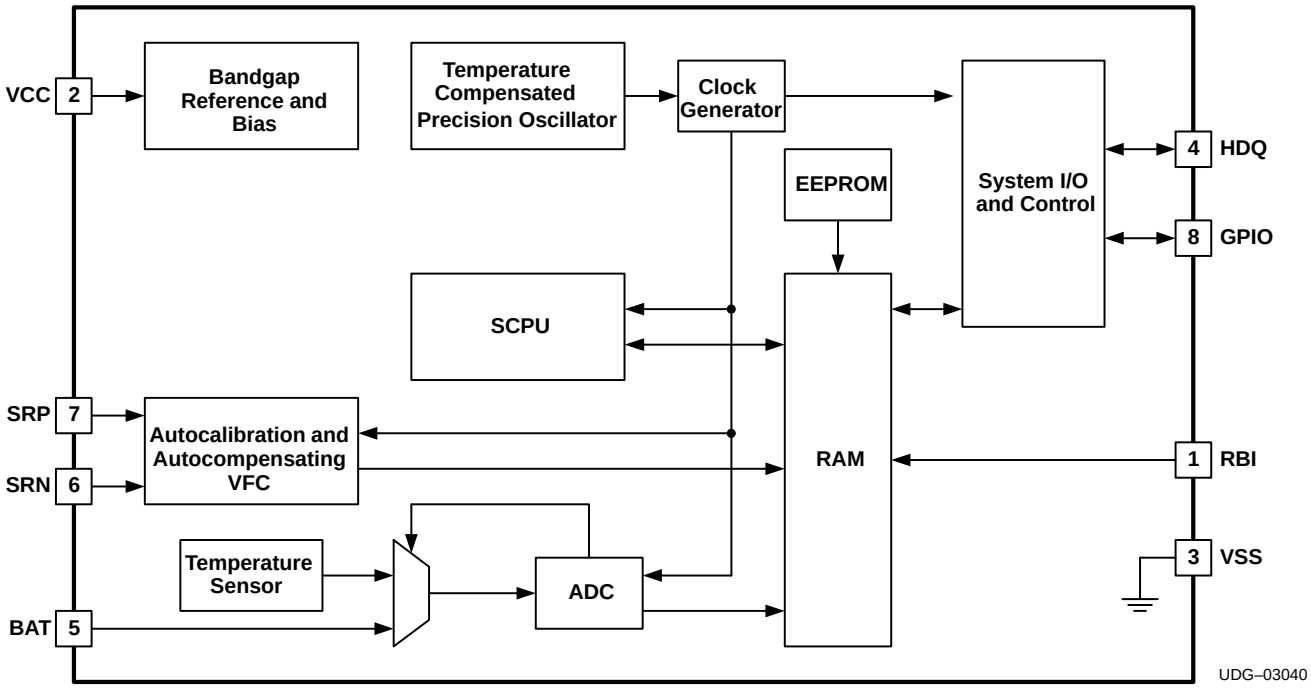
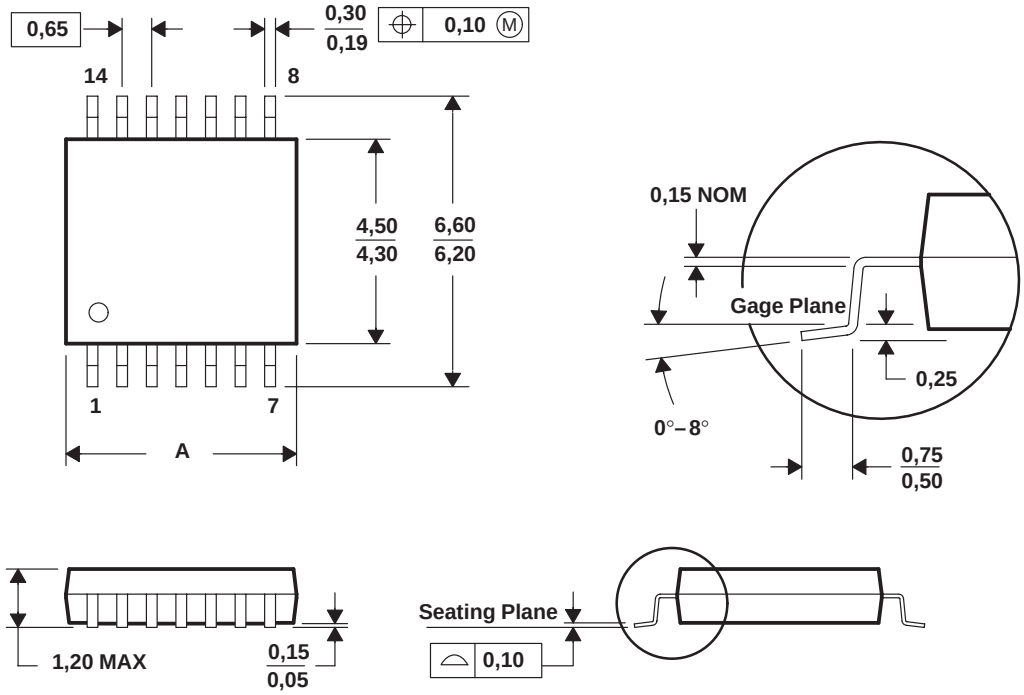



**Figure 2. Functional Block Diagram**

**PW (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**4040064/F 01/97**

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

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