

## Voltage Protection for 2-Series, 3-Series, or 4-Series Cell Li-Ion Batteries (Second-Level Protection)

Check for Samples: bq29440, bq2944L0, bq29441, bq29442, bq29443, bq29449, bq2944L9

### FEATURES

- 2-Series, 3-Series, or 4-Series Cell Secondary Protection
- External Capacitor-Controlled Delay Timer
- Low Power Consumption  $I_{CC} < 2 \mu A$  Typical [ $V_{CELL(ALL)} < V_{PROTECT}$ ]
- High-Accuracy Overvoltage Protection:  $\pm 25$  mV with  $T_A = 0^\circ C$  to  $60^\circ C$
- Fixed Overvoltage Protection Thresholds: 4.30 V, 4.35 V, 4.40 V, 4.45 V, 4.50 V
- Small 8L QFN Package

### APPLICATIONS

- Second-Level Protection in Li-Ion Battery Packs
  - Notebook Computers
  - Power Tools
  - Portable Equipment and Instrumentation

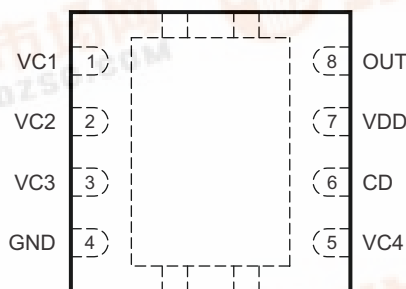
### DESCRIPTION

The bq2944x is a secondary overvoltage protection IC for 2-series, 3-series, or 4-series cell Li-Ion battery packs that incorporates a high-accuracy precision overvoltage detection circuit.

### FUNCTION

The voltage of each cell in a battery pack is compared to an internal reference voltage. If any cells reach an overvoltage condition, the bq2944x device starts a timer that provides a delay proportional to the capacitance on the CD pin. Upon expiration of the internal timer, the OUT pin changes from a low state to a high state. An optional latch configuration is available that holds the OUT pin in a high state indefinitely after an overvoltage condition has satisfied the specified delay timer period. The latch is released when the CD pin is shorted to GND.

DRB Package  
(Top View)



P0012-02



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**Table 1. ORDERING INFORMATION<sup>(1)</sup>**

| T <sub>A</sub>  | PART NUMBER | OUT PIN LATCH OPTION | PACKAGE | PACKAGE DESIGNATOR | PACKAGE MARKING | OVP    | ORDERING INFORMATION <sup>(2)</sup>  |                                      |
|-----------------|-------------|----------------------|---------|--------------------|-----------------|--------|--------------------------------------|--------------------------------------|
|                 |             |                      |         |                    |                 |        | TAPE AND REEL (LARGE) <sup>(3)</sup> | TAPE AND REEL (SMALL) <sup>(4)</sup> |
| -40°C to +110°C | BQ29440     | No                   | QFN-8   | DRB                | 440             | 4.35 V | BQ29440DRBR                          | BQ29440DRBT                          |
|                 | BQ2944L0    | Yes                  |         |                    | 44L0            | 4.35 V | BQ2944L0DRBR                         | BQ2944L0DRBT                         |
|                 | BQ29441     | No                   |         |                    | 441             | 4.40 V | BQ29441DRBR                          | BQ29441DRBT                          |
|                 | BQ29442     | No                   |         |                    | 442             | 4.45 V | BQ29442DRBR                          | BQ29442DRBT                          |
|                 | BQ29443     | No                   |         |                    | 443             | 4.50 V | BQ29443DRBR                          | BQ29443DRBT                          |
|                 | BQ29449     | No                   |         |                    | 449             | 4.30 V | BQ29449DRBR                          | BQ29449DRBT                          |
|                 | BQ2944L9    | Yes                  |         |                    | 44L9            | 4.30 V | BQ2944L9DRBR                         | BQ2944L9DRBT                         |

(1) Example: bq2944L0DRBR is a device with the OUT latch option with a V<sub>OV</sub> threshold of 4.35 V.

Contact Texas Instruments for other V<sub>OV</sub> threshold options.

(2) For the most current package and ordering information, see the Package Addendum at the end of this document, or the TI website at [www.ti.com](http://www.ti.com).

(3) Large tape and reel quantity is 3,000 units.

(4) Small tape and reel quantity is 250 units.

## THERMAL INFORMATION

| THERMAL METRIC <sup>(1)</sup> |   | bq2944x | UNITS |
|-------------------------------|---|---------|-------|
|                               |   | DRB     |       |
|                               |   | 8 PINS  |       |
| θ <sub>JA</sub>               | Junction-to-ambient thermal resistance <sup>(2)</sup>       | 50.5    | °C/W  |
| θ <sub>JC(top)</sub>          | Junction-to-case(top) thermal resistance <sup>(3)</sup>     | 25.1    |       |
| θ <sub>JB</sub>               | Junction-to-board thermal resistance <sup>(4)</sup>         | 19.3    |       |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter <sup>(5)</sup>   | 0.7     |       |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter <sup>(6)</sup> | 18.9    |       |
| θ <sub>JC(bottom)</sub>       | Junction-to-case(bottom) thermal resistance <sup>(7)</sup>  | 5.2     |       |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.

(3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.

(5) The junction-to-top characterization parameter, ψ<sub>JT</sub>, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ<sub>JA</sub>, using a procedure described in JESD51-2a (sections 6 and 7).

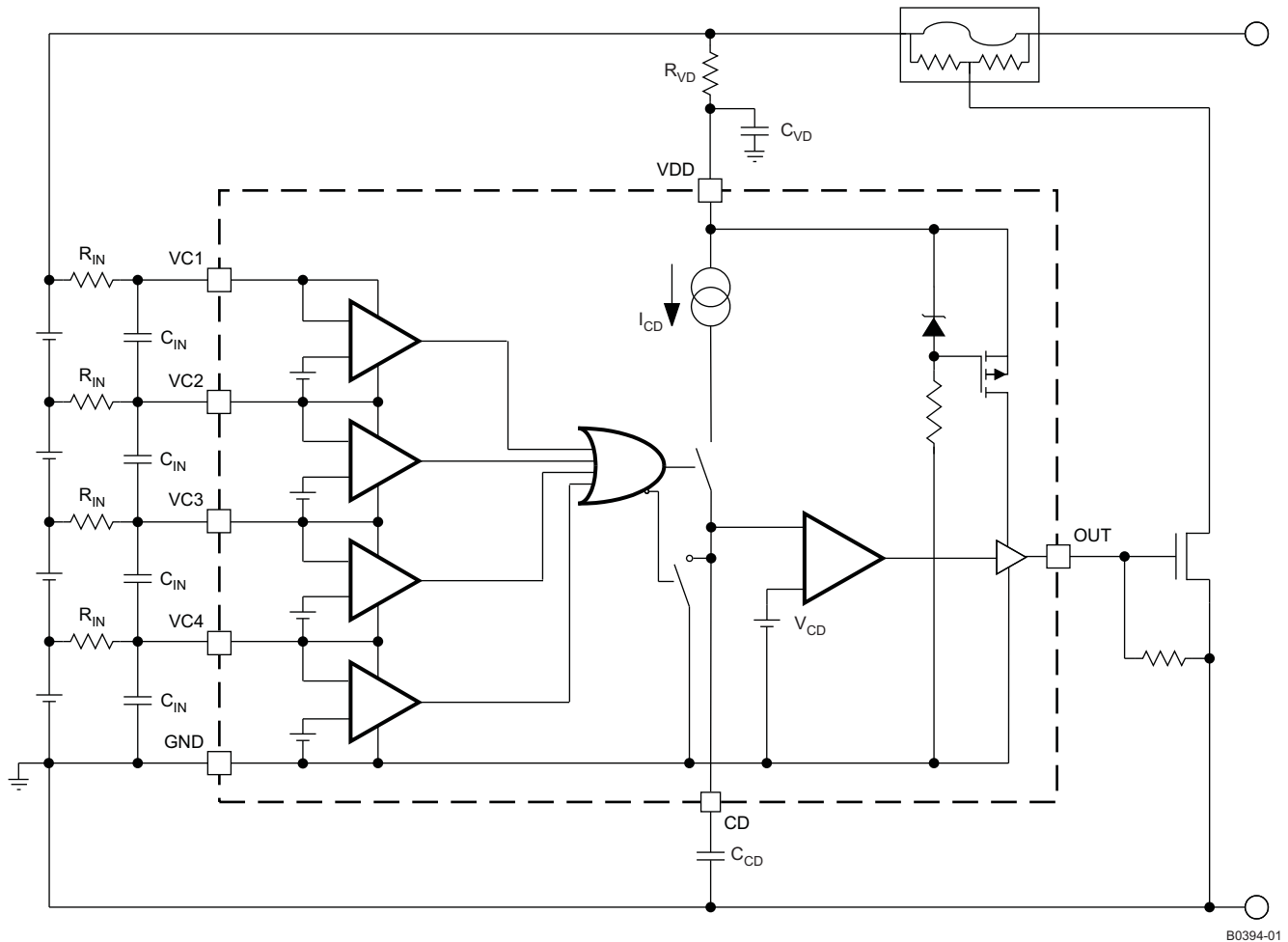
(6) The junction-to-board characterization parameter, ψ<sub>JB</sub>, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ<sub>JA</sub>, using a procedure described in JESD51-2a (sections 6 and 7).

(7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

## PIN FUNCTIONS

| PIN NAME | PIN NO. | DESCRIPTION  |
|----------|---------|--|
| CD       | 6       | Connection to external capacitor for programmable delay time |
| GND      | 4       | Ground pin   |
| OUT      | 8       | Output   |
| VC1      | 1       | Sense voltage input for top cell                             |
| VC2      | 2       | Sense voltage input for second-to-top cell                   |
| VC3      | 3       | Sense voltage input for third-to-top cell                    |
| VC4      | 5       | Sense voltage input for fourth-to-top cell (bottom cell)     |
| VDD      | 7       | Power supply   |

## FUNCTIONAL BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

|                                      |                                    | VALUE/UNIT     |
|--------------------------------------|------------------------------------|----------------|
| Supply voltage range, $V_{MAX}$      | VDD–GND                            | –0.3 to 28 V   |
| Input voltage range, $V_{IN}$        | VC1–GND, VC2–GND, VC3–GND          | –0.3 to 28 V   |
|                                      | VC1–VC2, VC2–VC3, VC3–VC4, VC4–GND | –0.3 to 8 V    |
|                                      | CD–GND                             | –0.3 to 8 V    |
| Output voltage range, $V_{OUT}$      | OUT–GND                            | –0.3 to 28 V   |
| Storage temperature range, $T_{stg}$ |                                    | –65°C to 150°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.

## RECOMMENDED OPERATING CONDITIONS

|                                    |                                    | MIN | NOM | MAX | UNIT |
|------------------------------------|------------------------------------|-----|-----|-----|------|
| Supply voltage, VDD                |                                    | 4   |     | 25  | V    |
| Input voltage range                | VC1–VC2, VC2–VC3, VC3–VC4, VC4–GND | 0   |     | 5   | V    |
| $t_{d(CD)}$ delay-time capacitance | $C_{CD}$ (See Figure 7.)           |     | 0.1 |     | μF   |
| Voltage monitor filter resistance  | $R_{IN}$ (See Figure 7.)           | 0.1 | 1   |     | kΩ   |

## RECOMMENDED OPERATING CONDITIONS (continued)

|  |                          | MIN  | NOM | MAX | UNIT        |
|--|--------------------------|------|-----|-----|-------------|
| Voltage monitor filter capacitance         | $C_{IN}$ (See Figure 7.) | 0.01 | 0.1 |     | $\mu F$     |
| Supply voltage filter resistance           | $R_{VD}$ (See Figure 7.) | 0.1  |     | 1   | $k\Omega$   |
| Supply voltage filter capacitance          | $C_{VD}$ (See Figure 7.) |      | 0.1 |     | $\mu F$     |
| Operating ambient temperature range, $T_A$ |                          | -40  |     | 110 | $^{\circ}C$ |

## ELECTRICAL CHARACTERISTICS

Typical values stated where  $T_A = 25^{\circ}C$  and  $V_{DD} = 17 V$ , MIN/MAX values stated where  $T_A = -40^{\circ}C$  to  $110^{\circ}C$  and  $V_{DD} = 4 V$  to  $25 V$  (unless otherwise noted).

| PARAMETER          |   | TEST CONDITION  | MIN  | NOM  | MAX  | UNIT            |
|--------------------|---|---|------|------|------|-----------------|
| $V_{PROTECT}$      | Overvoltage detection voltage                                 | bq29440   |      | 4.35 |      | V               |
|                    |   | bq29441   |      | 4.40 |      |                 |
|                    |   | bq29442   |      | 4.45 |      |                 |
|                    |   | bq29443   |      | 4.50 |      |                 |
|                    |   | bq29449   |      | 4.30 |      |                 |
| $V_{HYS}$          | Overvoltage detection hysteresis                              | For non-latch devices only  | 200  | 300  | 400  | mV              |
| $V_{OA}$           | Overvoltage detection accuracy                                | $T_A = 25^{\circ}C$   | -10  |      | 10   | mV              |
| $V_{OA\_DRIFT}$    | Overvoltage threshold temperature drift                       | $T_A = 0^{\circ}C$ to $60^{\circ}C$   | -0.4 |      | 0.4  | mV/ $^{\circ}C$ |
|                    |   | $T_A = -40^{\circ}C$ to $110^{\circ}C$  | -0.6 |      | 0.6  |                 |
| $X_{DELAY}$        | Overvoltage delay time scale factor                           | $T_A = 0^{\circ}C$ to $60^{\circ}C$<br>Note: Does not include external capacitor variation  | 6.0  | 9.0  | 12   | s/ $\mu F$      |
|                    |   | $T_A = -40^{\circ}C$ to $110^{\circ}C$<br>Note: Does not include external capacitor variation   | 5.5  | 9.0  | 13.5 |                 |
| $X_{DELAY\_CTM}$   | Overvoltage delay time scale factor in Customer Test Mode     | See CUSTOMER TEST MODE.   |      | 0.08 |      | s/ $\mu F$      |
| $I_{CD(CHG)}$      | Overvoltage detection charging current                        | See Figure 1.   |      | 140  |      | nA              |
| $I_{CD(DSG)}$      | Overvoltage detection discharging current                     | See Figure 2.   |      | 60   |      | $\mu A$         |
| $V_{CD}$           | Overvoltage detection external capacitor comparator threshold |   |      | 1.2  |      | V               |
| $I_{CC}$           | Supply current  | (VC1-VC2), (VC2-VC3), (VC3-VC4) and (VC4-GND) = 3.5 V<br>See Figure 3.  |      | 2    | 3.5  | $\mu A$         |
| $V_{OUT}$          | OUT pin drive voltage   | (VC1-VC2), (VC2-VC3), (VC3-VC4) or (VC4-GND) = $V_{PROTECT}$ , $V_{DD} = 20 V$ , $I_{OH} = 0$ to $-10 \mu A$                                  | 6.5  | 8.0  | 9.5  | V               |
|                    |   | (VC1-VC2), (VC2-VC3), (VC3-VC4) or (VC4-GND) = $V_{PROTECT}$ , $V_{DD} = 4.35 V$ , $I_{OL} = -10 \mu A$ , $T_A = 0^{\circ}C$ to $60^{\circ}C$ | 1.50 | 3.0  |      | V               |
|                    |   | (VC1-VC2), (VC2-VC3), (VC3-VC4) or (VC4-GND) = $V_{PROTECT}$ , $V_{DD} > 6 V$ , $I_{OH} = -10 \mu A$ , $T_A = 0^{\circ}C$ to $60^{\circ}C$    | 2.0  | 3.0  |      | V               |
|                    |   | (VC1-VC2), (VC2-VC3), (VC3-VC4) or (VC4-GND) = 4 V, $I_{OL} = 0 \mu A$  |      |      | 0.1  | V               |
| $I_{OUT(SHORT)}$   | OUT short circuit current                                     | OUT = 0 V, (VC1-VC2), (VC2-VC3), (VC3-VC4) or (VC4-GND) > $V_{PROTECT}$ , $V_{DD} = 18 V$   |      |      | 4    | mA              |
| $t_{r(OUT)}^{(1)}$ | OUT output rise time  | $C_L = 1 nF$ , $V_{DD} = 4 V$ to $25 V$ , $V_{OH(OUT)} = 0 V$ to $5 V$  |      | 5    |      | $\mu s$         |
| $Z_{O(OUT)}^{(1)}$ | OUT output impedance  |   |      | 2    |      | $k\Omega$       |

(1) Specified by design. Not 100% tested in production.

## ELECTRICAL CHARACTERISTICS (continued)

Typical values stated where  $T_A = 25^\circ\text{C}$  and  $V_{DD} = 17\text{ V}$ , MIN/MAX values stated where  $T_A = -40^\circ\text{C}$  to  $110^\circ\text{C}$  and  $V_{DD} = 4\text{ V}$  to  $25\text{ V}$  (unless otherwise noted).

| PARAMETER                          | TEST CONDITION   | MIN  | NOM | MAX | UNIT          |
|------------------------------------|--|------|-----|-----|---------------|
| $I_{IN}$ Input current at VCx pins | Measured at VC1, (VC1–VC2), (VC2–VC3), (VC3–VC4) and (VC4–GND) = 3.5 V, $T_A = 0^\circ\text{C}$ to $60^\circ\text{C}$<br>See Figure 3.             | –0.3 |     | 1.5 | $\mu\text{A}$ |
|                                    | Measured at VC2, VC3 OR VC4, (VC1–VC2), (VC2–VC3), (VC3–VC4) and (VC4–GND) = 3.5 V, $T_A = 0^\circ\text{C}$ to $60^\circ\text{C}$<br>See Figure 3. | –0.3 |     | 0.3 | $\mu\text{A}$ |

## TYPICAL CHARACTERISTICS

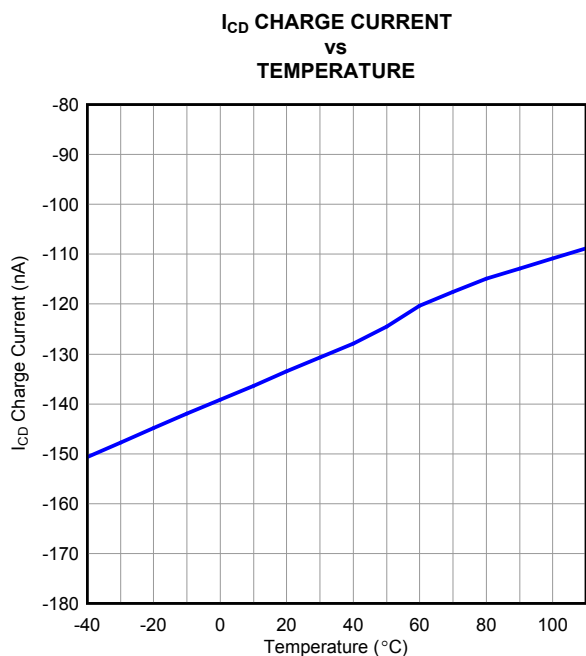


Figure 1.  $I_{CD}$  Charge Current

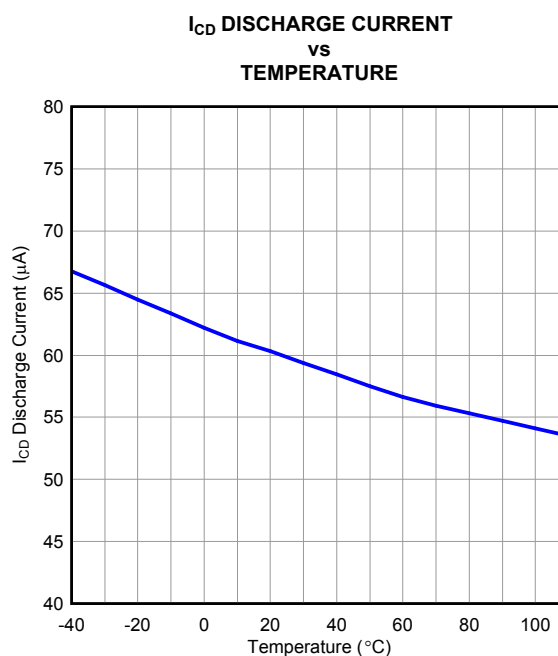


Figure 2.  $I_{CD}$  Discharge Current

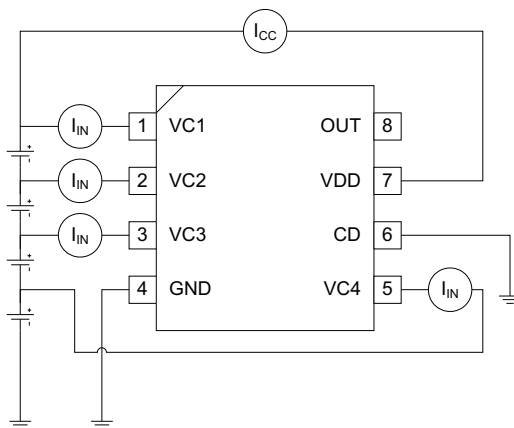
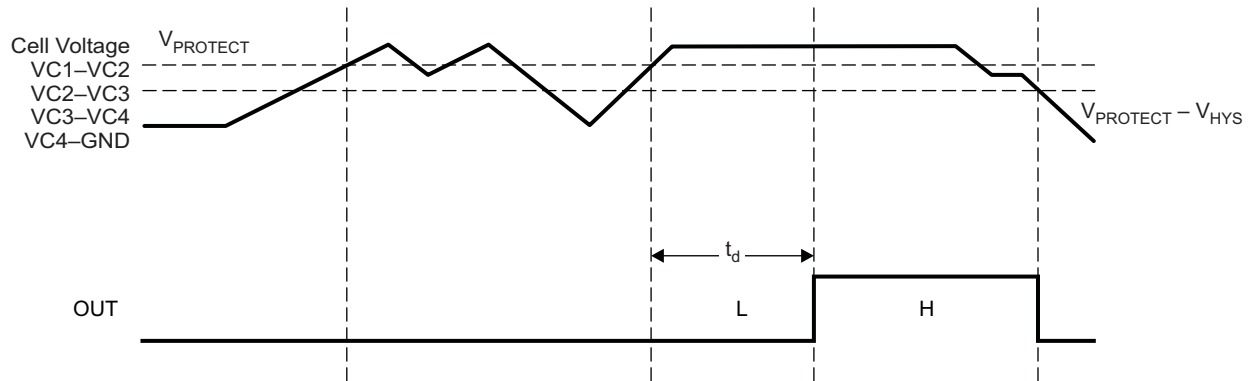


Figure 3.  $I_{CC}$ ,  $I_{IN}$  Measurement

## APPLICATIONS INFORMATION

### PROTECTION (OUT) TIMING AND DELAY TIME CAPACITOR SIZING

The bq2944x uses an external capacitor to set delay timing during an overvoltage condition. When any of the cells exceed the overvoltage threshold, the bq2944x activates an internal current source of nominally 140 nA, which charges the external capacitor. When the external capacitor charges up to a voltage of nominally 1.2 V, the OUT pin transitions from a low state to a high state, by means of an internal pull-up network, to a regulated voltage of no more than 9.5 V when  $I_{OH} = 0$  mA.



T0461-01

Figure 4. Timing for Overvoltage Sensing

Sizing the external capacitor is based on the desired delay time as follows:

$$C_{CD} = \frac{t_d}{X_{DELAY}}$$

Where  $t_d$  is the desired delay time and  $X_{DELAY}$  is the overvoltage delay time scale factor, expressed in seconds per microFarad.  $X_{DELAY}$  is nominally 9.0 s/ $\mu$ F. For example, if a nominal delay of 3 seconds is desired, the customer should use a  $C_{CD}$  capacitor that is 3 s/9.0 s/ $\mu$ F = 0.33  $\mu$ F.

The delay time is calculated as follows:

$$t_d = C_{CD} \times X_{DELAY}$$

If the cell overvoltage condition is removed before the external capacitor reaches the reference voltage, the internal current source is disabled and an internal discharge block is employed to discharge the external capacitor down to 0 V. In this instance, the OUT pin remains in a low state.

For latched versions of the bq2944x, if an overvoltage condition has caused the OUT pin to transition to a high state, the external capacitor remains charged even after the overvoltage condition has been removed. In this instance, the OUT pin remains in a high state.

For non-latched versions, the OUT pin is allowed to transition back from a high to low state when the overvoltage condition is no longer present, and the external capacitor is discharged down to 0 V.

## BATTERY CONNECTION FOR 2-SERIES, 3-SERIES, AND 4-SERIES CELL CONFIGURATIONS

Figure 5, Figure 6, and Figure 7 show the 2-series, 3-series, and 4-series cell configurations.

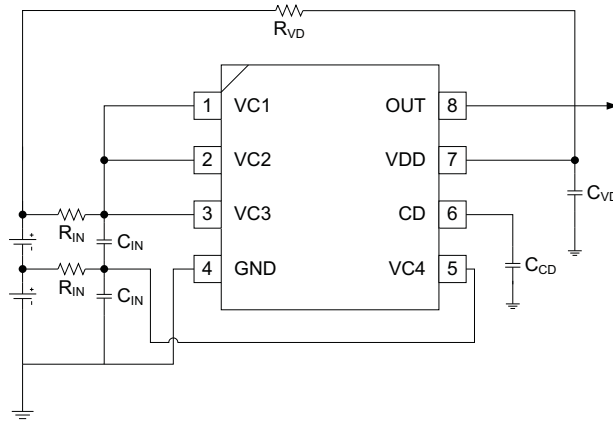


Figure 5. 2-Series Cell Configuration

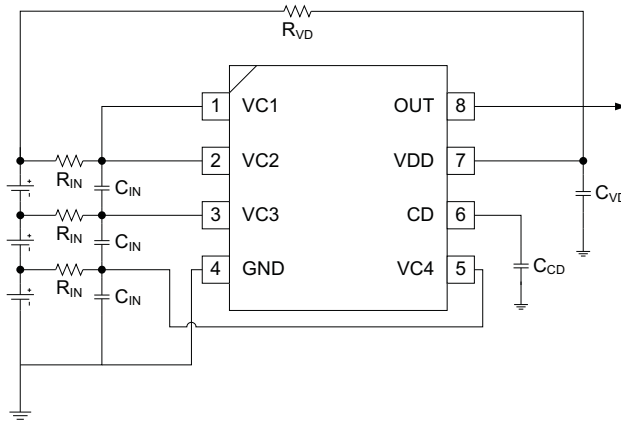


Figure 6. 3-Series Cell Configuration

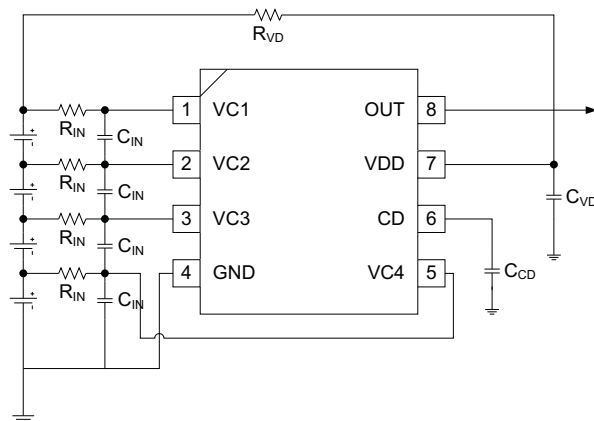


Figure 7. 4-Series Cell Configuration

## CELL CONNECTION SEQUENCE

### NOTE

Before connecting the cells, propagate the overvoltage delay timing capacitor,  $C_{CD}$ .

The recommended cell connection sequence begins from the bottom of the stack, as follows:

1. GND
2. VC4
3. VC3
4. VC2
5. VC1

While not advised, connecting the cells in a sequence other than that described above does not result in errant activity on the OUT pin. For example:

1. GND
2. VC4, VC3, VC2, or VC1
3. Remaining VCx pin
4. Remaining VCx pin
5. Remaining VCx pin

## CUSTOMER TEST MODE

Customer Test Mode (CTM) helps to greatly reduce the overvoltage detection delay time and enable quicker customer production testing. This mode is intended for quick-pass board-level verification tests, and, as such, individual cell overvoltage levels may deviate slightly from the specifications ( $V_{PROTECT}$ ,  $V_{OA}$ ). If accurate overvoltage thresholds are to be tested, use the standard delay settings that are intended for normal use.

To enter CTM, VDD should be set to approximately 9.5 V higher than VC1. When CTM is entered, the device switches from the normal overvoltage delay time scale factor,  $x_{DELAY}$ , to a significantly reduced factor,  $x_{DELAY\_CTM}$ , thereby reducing the delay time during an overvoltage condition. The CTM overvoltage delay time is similar to the equation presented in [PROTECTION \(OUT\) TIMING AND DELAY TIME CAPACITOR SIZING](#) with the substitution of  $x_{DELAY\_CTM}$  in place of  $x_{DELAY}$ :

$$t_{d\_CTM} = C_{CD} \times X_{DELAY\_CTM}$$

### CAUTION

Avoid exceeding any Absolute Maximum Voltages on any pins when placing the part into Customer Test Mode. Also, avoid exceeding Absolute Maximum Voltages for the individual cell voltages (VC1–VC2), (VC2–VC3), (VC3–VC4), and (VC4–GND). Stressing the pins beyond the rated limits may cause permanent damage to the device.

To exit CTM, power off the device and then power it back on.

For latched versions of the bq2944x, the external  $C_{CD}$  capacitor must be externally discharged if any overvoltage functionality is exercised during protection testing. This can be accomplished by shorting the CD pin to GND. If the  $C_{CD}$  capacitor is not explicitly discharged, a residual charge may cause the overvoltage delay time to be inaccurate.

## REVISION HISTORY

| Changes from Revision B (June 2010) to Revision C                                   | Page |
|---|------|
| • Added new protection thresholds .....   | 1    |
| • Changed occurrences of $V_{DD}$ to VDD throughout document .....                  | 1    |
| • Added part numbers .....  | 2    |
| • Changed the Functional Block Diagram .....  | 3    |
| • Changed the Electrical Characteristics .....                                      | 4    |
| • Deleted 3.5 from one of the maximum values from the $V_{OUT}$ specification ..... | 4    |
| • Changed nominal delay time .....  | 6    |



PACKAG

## PACKAGING INFORMATION

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/ Ball Finish | MSL Pe       |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|-------------------|--------------|
| BQ29440DRBR      | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ29440DRBT      | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ29441DRBR      | PREVIEW               | SON          | DRB             | 8    | 3000        | TBD                     | Call TI           | Call TI      |
| BQ29441DRBT      | PREVIEW               | SON          | DRB             | 8    | 250         | TBD                     | Call TI           | Call TI      |
| BQ29442DRBT      | PREVIEW               | SON          | DRB             | 8    | 250         | TBD                     | Call TI           | Call TI      |
| BQ29443DRBR      | PREVIEW               | SON          | DRB             | 8    | 3000        | TBD                     | Call TI           | Call TI      |
| BQ29443DRBT      | PREVIEW               | SON          | DRB             | 8    | 250         | TBD                     | Call TI           | Call TI      |
| BQ29449DRBR      | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ29449DRBT      | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ2944L0DRBR     | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ2944L0DRBT     | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ2944L9DRBR     | ACTIVE                | SON          | DRB             | 8    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |
| BQ2944L9DRBT     | ACTIVE                | SON          | DRB             | 8    | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU         | Level-2-2600 |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com> for more information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for



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PACKAG

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

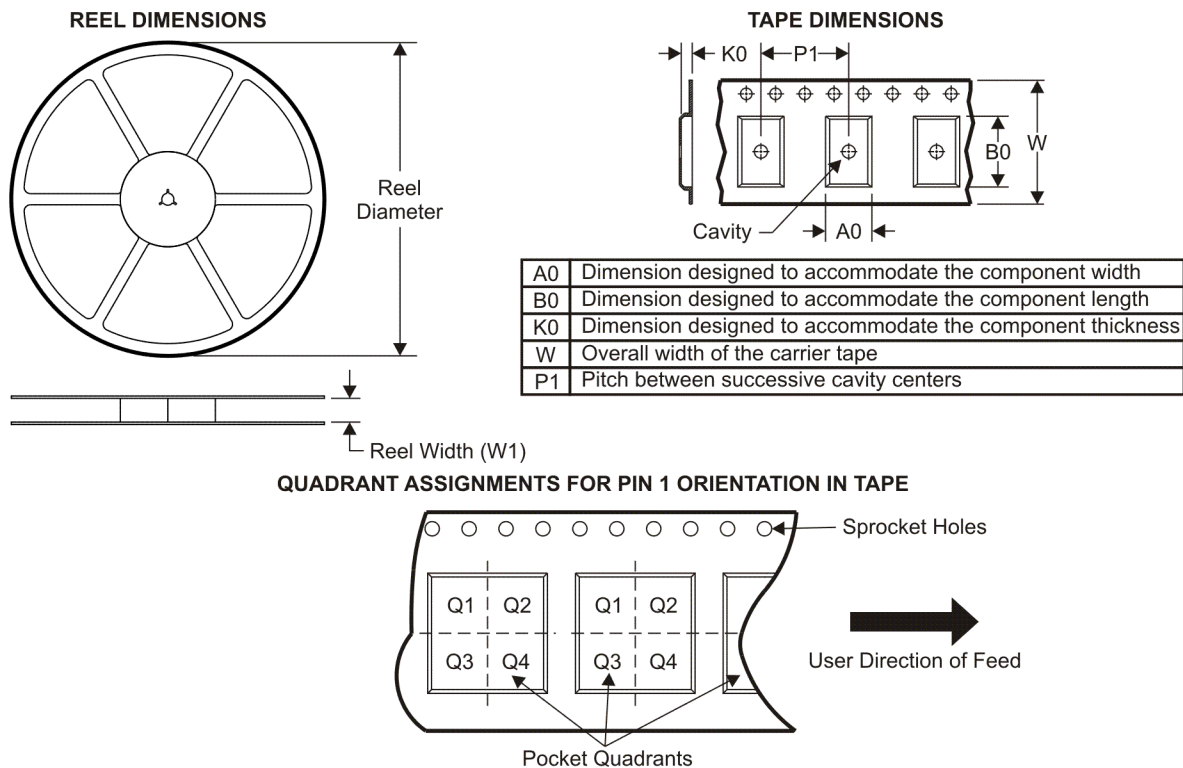
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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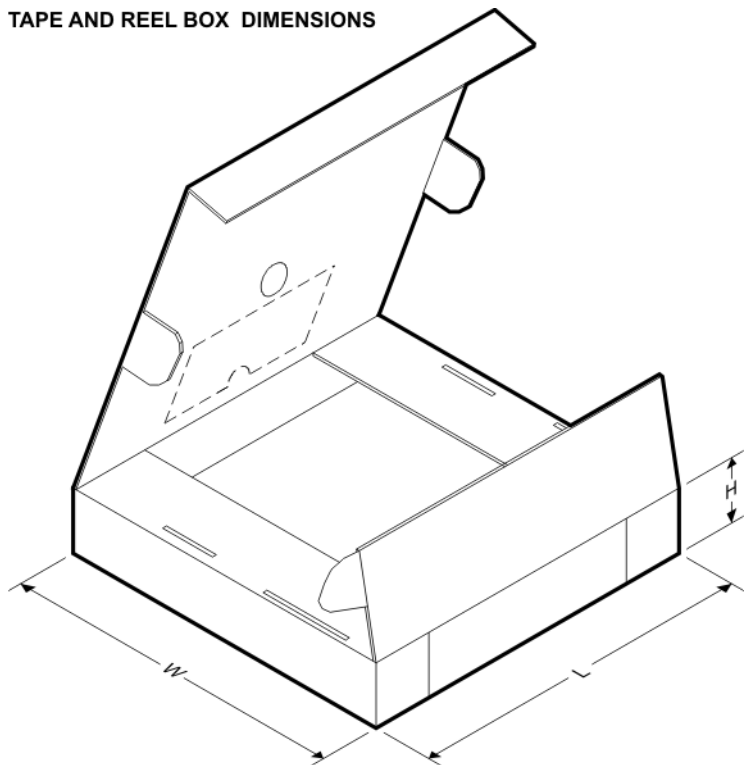
**TAPE AND REEL INFORMATION**



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ29440DRBR  | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ29440DRBT  | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ29449DRBR  | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ29449DRBT  | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ2944L0DRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ2944L0DRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ2944L9DRBR | SON          | DRB             | 8    | 3000 | 330.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |
| BQ2944L9DRBT | SON          | DRB             | 8    | 250  | 180.0              | 12.4               | 3.3     | 3.3     | 1.1     | 8.0     | 12.0   | Q2            |

## TAPE AND REEL BOX DIMENSIONS

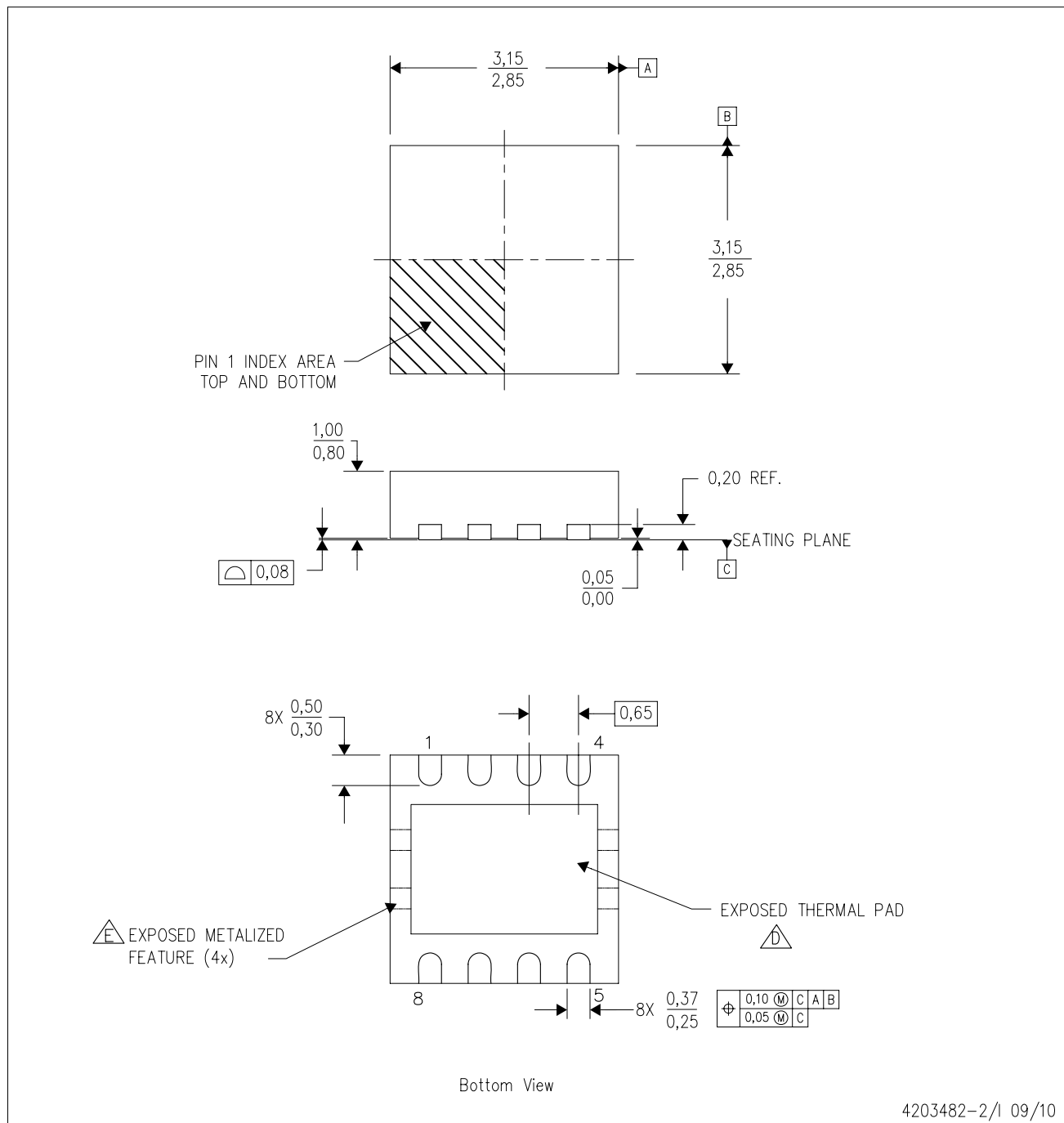


\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ29440DRBR  | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| BQ29440DRBT  | SON          | DRB             | 8    | 250  | 190.5       | 212.7      | 31.8        |
| BQ29449DRBR  | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| BQ29449DRBT  | SON          | DRB             | 8    | 250  | 190.5       | 212.7      | 31.8        |
| BQ2944L0DRBR | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| BQ2944L0DRBT | SON          | DRB             | 8    | 250  | 190.5       | 212.7      | 31.8        |
| BQ2944L9DRBR | SON          | DRB             | 8    | 3000 | 346.0       | 346.0      | 29.0        |
| BQ2944L9DRBT | SON          | DRB             | 8    | 250  | 190.5       | 212.7      | 31.8        |

DRB (S-PVSON-N8)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Small Outline No-Lead (SON) package configuration.
  - The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - See the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

DRB (S-PVSON-N8)

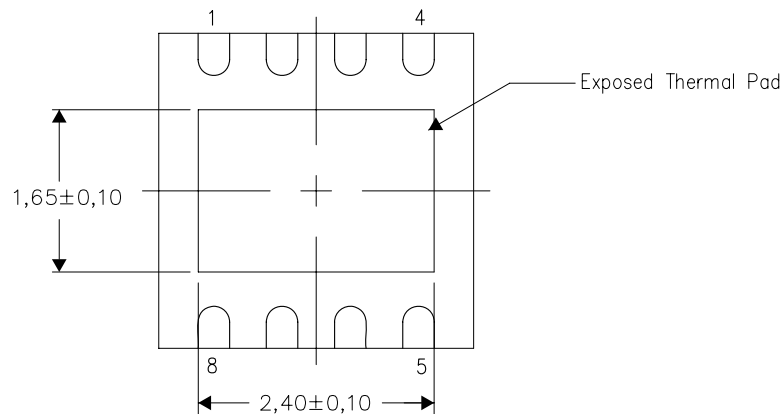
PLASTIC SMALL OUTLINE NO-LEAD

## THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

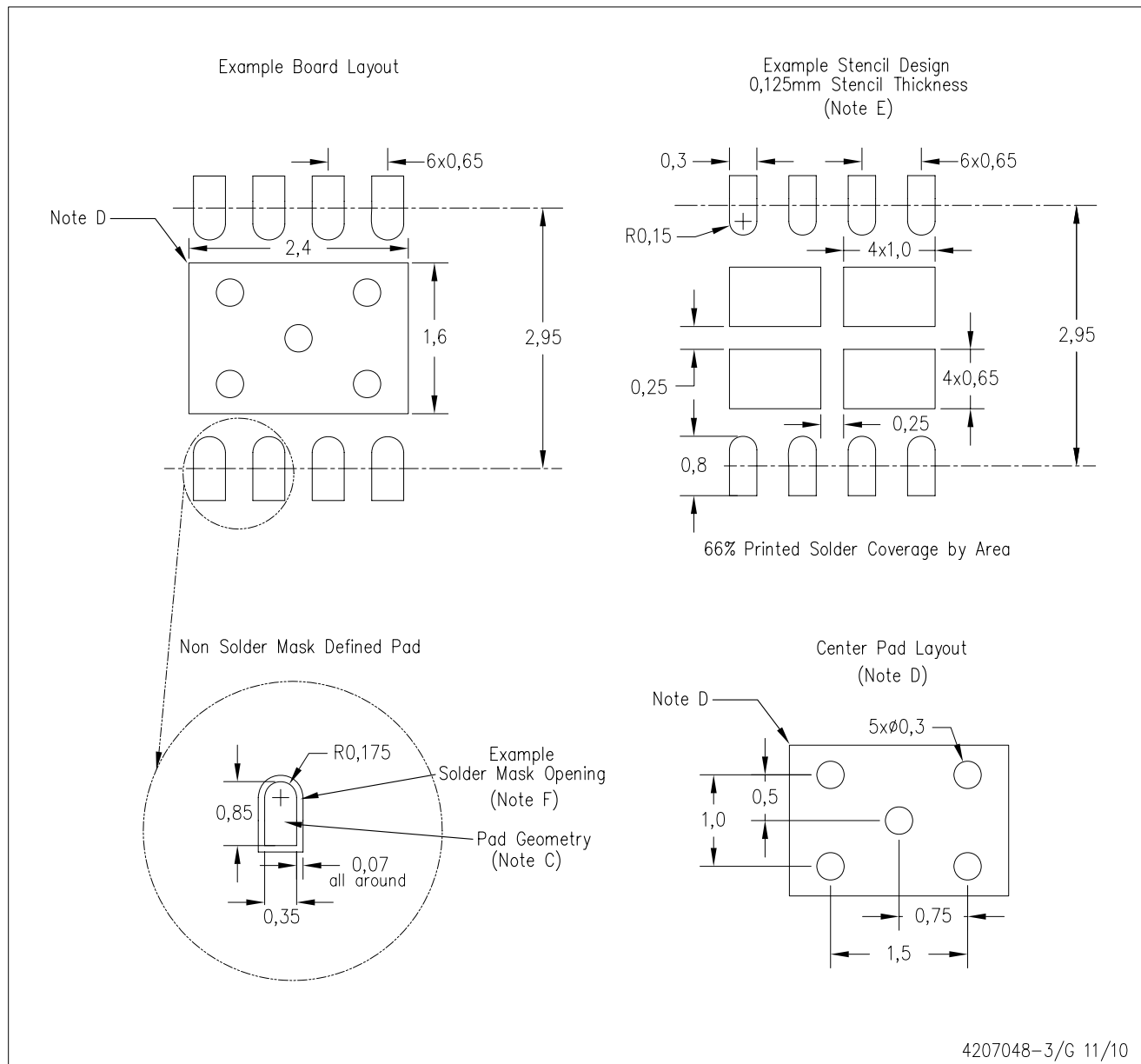
Exposed Thermal Pad Dimensions

4206340-3/K 11/10

NOTE: A. All linear dimensions are in millimeters

DRB (S-PVSON-N8)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - Customers should contact their board fabrication site for solder mask tolerances.

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