

Overvoltage Protection for 2-Series to 4-Series Cell Li-Ion Batteries with External Delay Capacitor

Check for Samples: [bq294700](#), [bq294701](#), [bq294702](#), [bq294703](#), [bq294704](#), [bq294705](#)

FEATURES

- 2-, 3-, and 4-Series Cell Overvoltage Protection
- External Capacitor-Programmed Delay Timer
- Factory Programmed OVP Threshold (Threshold Range 3.85 V to 4.6 V)
- Output Options: Active High or Open Drain Active Low
- High-Accuracy Overvoltage Protection: ± 10 mV
- Low Power Consumption $I_{CC} \approx 1 \mu\text{A}$ ($V_{\text{CELL(ALL)}} < V_{\text{PROTECT}}$)
- Low Leakage Current Per Cell Input < 100 nA
- Small Package Footprint
 - 8-Pin SON (2 mm x 2 mm)

APPLICATIONS

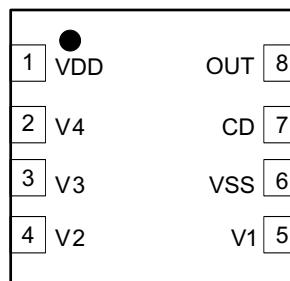
- Notebook
- UPS Battery Backup

DESCRIPTION

The bq2947xy family of products is an overvoltage monitor and protector for Li-Ion battery pack systems. Each cell is monitored independently for an overvoltage condition.

In the bq2947xy device, an external delay timer is initiated upon detection of an overvoltage condition on any cell. Upon expiration of the delay timer, the output is triggered into its active state (either high or low, depending on the configuration). The external delay timer feature also includes the ability to detect an open or shorted delay capacitor on the CD pin, which will similarly trigger the output driver in an overvoltage condition.

For quicker production-line testing, the bq2947xy device provides a Customer Test Mode with reduced delay time.



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.



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.

ORDERING INFORMATION

| T _A | Part Number | Package | Package Designator | OVP (V) | OV Hysteresis (V) | Output Drive | Tape and Reel (Large) |
|----------------|-------------------------|-----------|--------------------|-------------|-------------------|---|-----------------------|
| -40°C to 110°C | bq294700 | 8-pin SON | DSG | 4.350 | 0.300 | CMOS Active High | bq294700DSGR |
| | bq294701 | | | 4.250 | 0.300 | CMOS Active High | bq294701DSGR |
| | bq294702 | | | 4.300 | 0.300 | CMOS Active High | bq294702DSGR |
| | bq294703 | | | 4.325 | 0.300 | CMOS Active High | bq294703DSGR |
| | bq294704 | | | 4.400 | 0.300 | CMOS Active High | bq294704DSGR |
| | bq294705 | | | 4.450 | 0.300 | CMOS Active High | bq294705DSGR |
| | bq2947xy ⁽¹⁾ | | | 3.850–4.600 | 0–0.300 | CMOS Active High or Open Drain Active Low | bq2947xyTBD |

(1) Future option, contact TI.

THERMAL INFORMATION

| THERMAL METRIC ⁽¹⁾ | | bq2947xy | UNITS |
|-------------------------------|--|----------|-------|
| | | SON | |
| | | 8 PINS | |
| θ_{JA} | Junction-to-ambient thermal resistance | 62 | °C/W |
| $\theta_{JC(top)}$ | Junction-to-case(top) thermal resistance | 72 | |
| θ_{JB} | Junction-to-board thermal resistance | 32.5 | |
| Ψ_{JT} | Junction-to-top characterization parameter | 1.6 | |
| Ψ_{JB} | Junction-to-board characterization parameter | 33 | |
| $\theta_{JC(bottom)}$ | Junction-to-case(bottom) thermal resistance | 10 | |

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

PIN FUNCTIONS

| bq2947xy | Pin Name | Type I/O | Description |
|----------|----------|----------|---|
| 1 | VDD | P | Power supply input |
| 2 | V4 | IA | Sense input for positive voltage of the fourth cell from the bottom of the stack |
| 3 | V3 | IA | Sense input for positive voltage of the third cell from the bottom of the stack |
| 4 | V2 | IA | Sense input for positive voltage of the second cell from the bottom of the stack |
| 5 | V1 | IA | Sense input for positive voltage of the lowest cell in the stack |
| 6 | VSS | P | Electrically connected to IC ground and negative terminal of the lowest cell in the stack |
| 7 | CD | OA | External capacitor connection for delay timer |
| 8 | OUT | OA | Analog Output drive for overvoltage fault signal. Active High or Open Drain Active Low |
| 9 | PWPD | P | TI recommends connecting the exposed pad to VSS on PCB. |

PIN DETAILS

In the bq2947xy device, each cell is monitored independently. Overvoltage is detected by comparing the actual cell voltage to a protection voltage reference, V_{OV} . If any cell voltage exceeds the programmed OV value, a timer circuit is activated. This timer circuit charges the CD pin to a nominal value, then slowly discharges it with a fixed current back down to VSS. When the CD pin falls below a nominal threshold near VSS, the OUT terminal goes from inactive to active state. Additionally, a timeout detection circuit checks to ensure that the CD pin successfully begins charging to above VSS and subsequently drops back down to VSS, and if a timeout error is detected in either direction, it will similarly trigger the OUT pin to become active. See Figure 2 for details on CD and OUT pin behavior during an overvoltage event.

For an NCH Open Drain Active Low configuration, the OUT pin pulls down to VSS when active (OV present) and is high impedance when inactive (no OV).

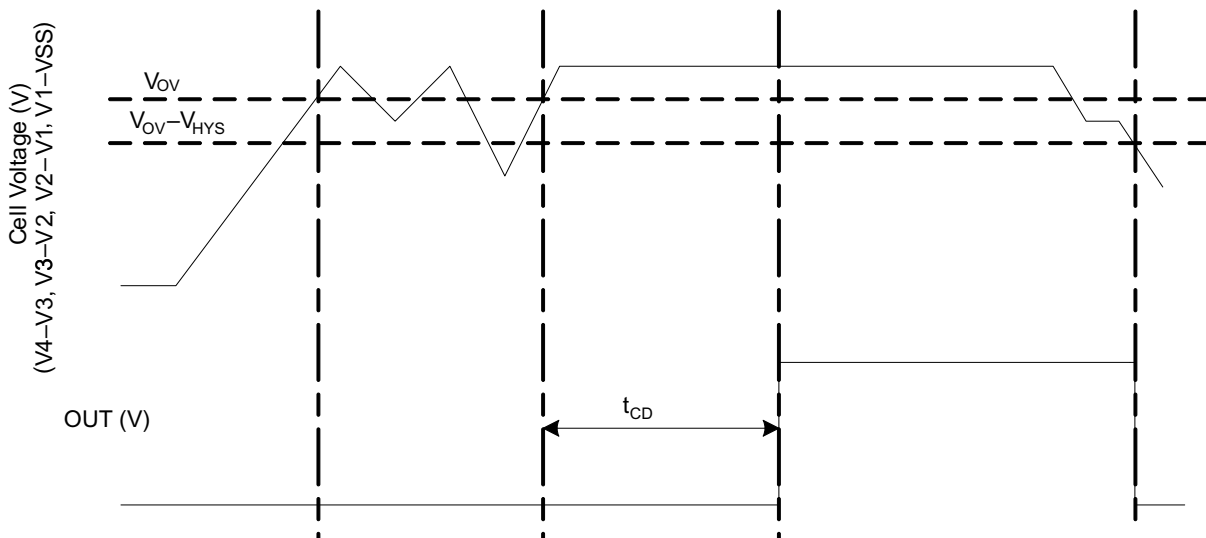


Figure 1. Timing for Overvoltage Sensing

Figure 2 shows the behavior of CD pin during an OV sequence.

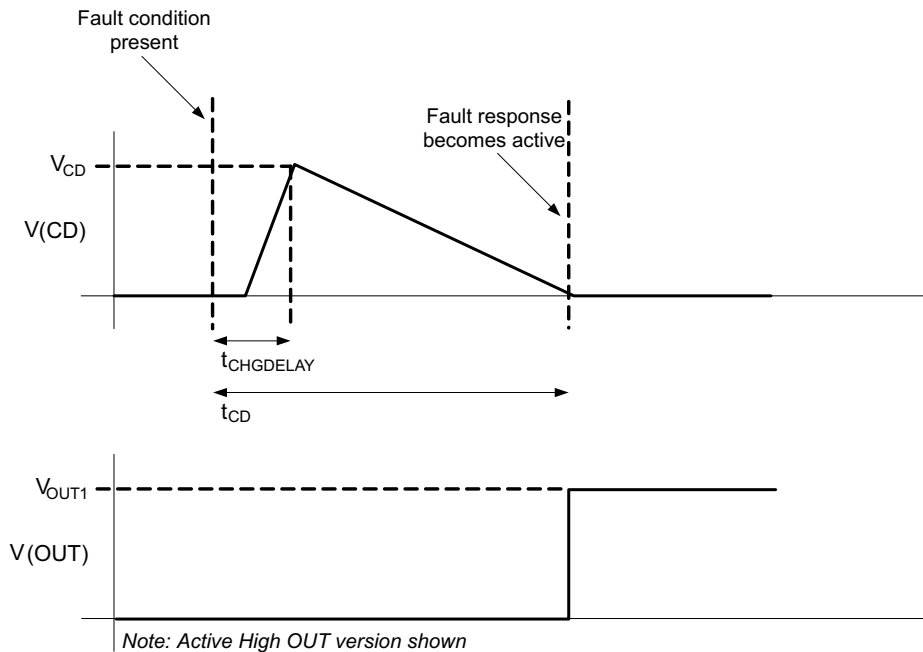


Figure 2. CD Pin Mechanism

NOTE

In the case of an Open Drain Active Low version, the V_{OUT} signal will be high and transition to low state when the voltage on the V_{CD} capacitor discharges to the set level based on the t_{CD} timer.

Input Sense Voltage, Vx

These inputs sense each battery cell voltage. A series resistor and a capacitor across the cell for each input is required for noise filtering and stable voltage monitoring.

Output Drive, OUT

This terminal serves as the fault signal output, and may be ordered in either Active High or Open Drain Active Low options.

Supply Input, VDD

This terminal is the unregulated input power source for the IC. A series resistor is connected to limit the current, and a capacitor is connected to ground for noise filtering.

External Delay Capacitor, CD

This terminal is connected to an external capacitor that sets the delay timer during an overvoltage fault event.

The CD pin includes a timeout detection circuit to ensure that the output drives active even with a shorted or open capacitor during an overvoltage event.

The capacitor connected on the CD pin rapidly charges to a voltage if any one of the cell inputs exceeds the OV threshold. Then the delay circuit gradually discharges the capacitor on the CD pin. Once this capacitor discharges below a set voltage, the OUT transitions from an inactive to active state.

To calculate the delay, use the following equation:

$$t_{CD} \text{ (sec)} = K * C_{CD} \text{ (}\mu\text{F)}, \text{ where } K = 10 \text{ to } 20 \text{ range.} \tag{1}$$

Example: If $C_{CD} = 0.1 \mu\text{F}$ (typical), then the delay timer range is

$$t_{CD} \text{ (sec)} = 10 * 0.1 = 1 \text{ s (Minimum)}$$

$$t_{CD} \text{ (sec)} = 20 * 0.1 = 2 \text{ s (Maximum)}$$

NOTE

The tolerance on the capacitor used for C_{CD} increases the range of the t_{CD} timer.

FUNCTIONAL BLOCK DIAGRAM

Figure 3 shows a CMOS Active High configuration.

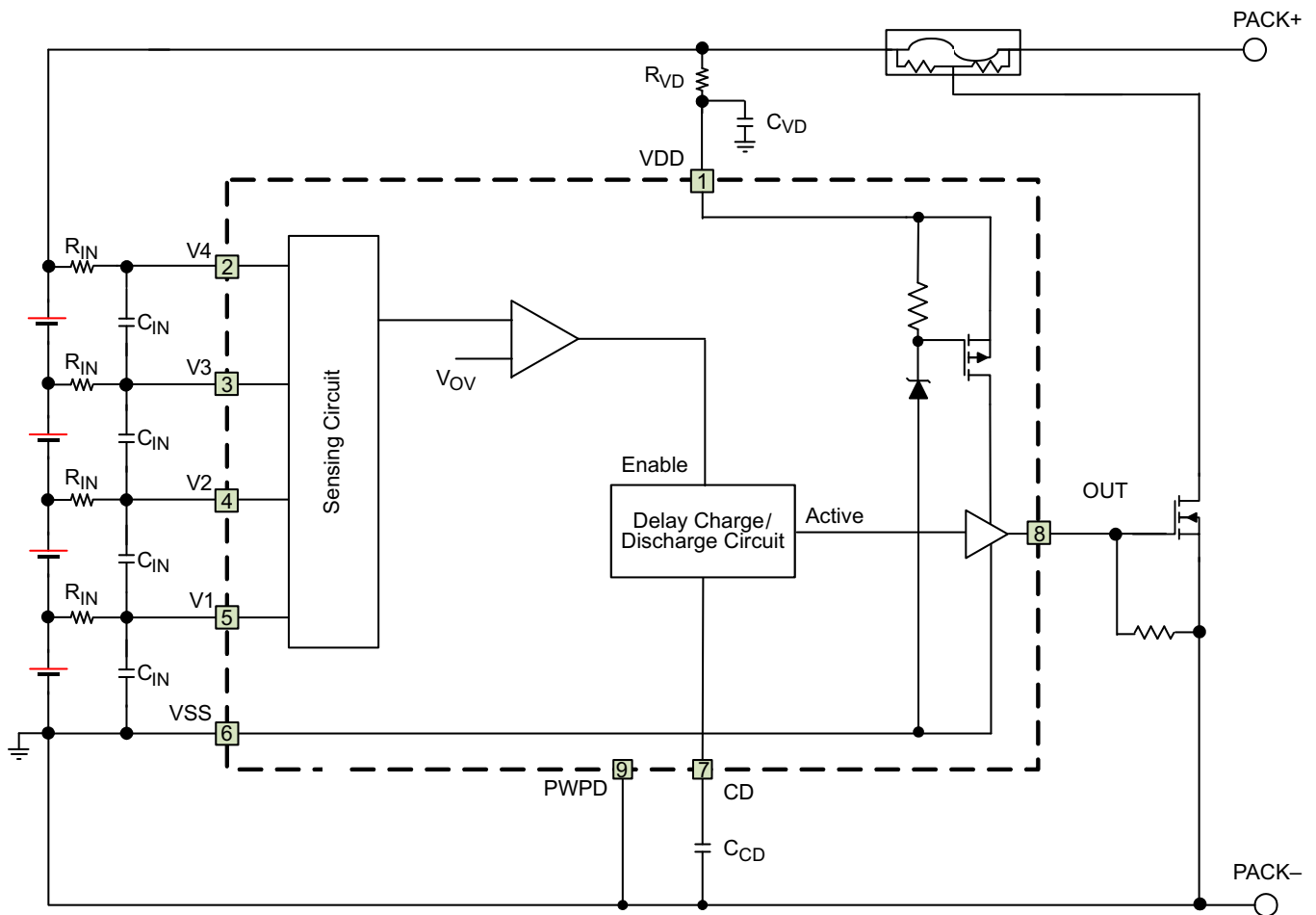


Figure 3. Block Diagram

NOTE

In the case of an Open Drain Active Low configuration, an external pull-up resistor is required on the OUT terminal.

ABSOLUTE MAXIMUM RATINGS

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

| PARAMETER | CONDITION | VALUE/UNIT |
|---|--|---------------------------------|
| Supply voltage range | VDD–VSS | –0.3 to 30 V |
| Input voltage range | V4–V3, V3–V2, V2–V1, V1–VSS, or CD–VSS | –0.3 to 30 V |
| Output voltage range | OUT–VSS | –0.3 to 30 V |
| Continuous total power dissipation, P _{TOT} | | See package dissipation rating. |
| Storage temperature range, T _{STG} | | –65 to 150°C |
| Lead temperature (soldering, 10 s), T _{SOLDER} | | 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.

RECOMMENDED OPERATING CONDITIONS

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

| PARAMETER | | MIN | NOM | MAX | UNIT |
|---|--|-----|-----|-----|------|
| Supply voltage, V _{DD} ⁽¹⁾ | | 3 | | 20 | V |
| Input voltage range | V4–V3, V3–V2, V2–V1, V1–VSS, or CD–VSS | 0 | | 5 | V |
| Operating ambient temperature range, T _A | | –40 | | 110 | °C |

(1) See [APPLICATION SCHEMATIC](#).

DC CHARACTERISTICS

Typical values stated where T_A = 25°C and V_{DD} = 14.4 V, MIN/MAX values stated where T_A = –40°C to 110°C and V_{DD} = 3 V to 20 V (unless otherwise noted).

| SYMBOL | PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|--|---|---|------|-------|-----|------|
| Voltage Protection Thresholds | | | | | | |
| V _{OV} | V _(PROTECT) Overvoltage Detection | bq294700, R _{IN} = 1 kΩ | | 4.350 | | V |
| | | bq294701, R _{IN} = 1 kΩ | | 4.250 | | V |
| | | bq294702, R _{IN} = 1 kΩ | | 4.300 | | V |
| | | bq294703, R _{IN} = 1 kΩ | | 4.325 | | V |
| | | bq294704, R _{IN} = 1 kΩ | | 4.400 | | V |
| | | bq294705, R _{IN} = 1 kΩ | | 4.450 | | V |
| V _{HYS} | OV Detection Hysteresis | bq2947xy ⁽¹⁾ | 250 | 300 | 400 | mV |
| V _{OA} | OV Detection Accuracy | T _A = 25°C | –10 | | 10 | mV |
| V _{OADRIFT} | OV Detection Accuracy Across Temperature | T _A = –40°C | –40 | | 40 | mV |
| | | T _A = 0°C | –20 | | 20 | mV |
| | | T _A = 60°C | –24 | | 24 | mV |
| | | T _A = 110°C | –54 | | 54 | mV |
| Supply and Leakage Current | | | | | | |
| I _{DD} | Supply Current | (V4–V3) = (V3–V2) = (V2–V1) = (V1–VSS) = 4.0 V at T _A = 25°C (See Figure 14.) | | 1 | 2 | μA |
| I _{IN} | Input Current at V _x Pins | (V4–V3) = (V3–V2) = (V2–V1) = (V1–VSS) = 4.0 V at T _A = 25°C (See Figure 14.) | –0.1 | | 0.1 | μA |
| I _{CELL} | Input Current (ALL V _x and V _{DD} Input Pins) | Current Consumption at Power down, (V4–V3) = (V3–V2) = (V2–V1) = (V1–VSS) = 2.30 V at T _A = 25°C | | 1.1 | | μA |
| Output Drive OUT, CMOS Active High Versions Only | | | | | | |

(1) Future option, contact TI.

DC CHARACTERISTICS (continued)

Typical values stated where $T_A = 25^\circ\text{C}$ and $V_{DD} = 14.4\text{ V}$, MIN/MAX values stated where $T_A = -40^\circ\text{C}$ to 110°C and $V_{DD} = 3\text{ V}$ to 20 V (unless otherwise noted).

| SYMBOL | PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|--|-----------------------------------|---|-----|----------------|-----|------|
| V_{OUT} | Output Drive Voltage, Active High | $(V4-V3), (V3-V2), (V2-V1),$ or $(V1-VSS) > V_{OV},$ $V_{DD} = 14.4\text{ V}, I_{OH} = 100\text{ }\mu\text{A}$ | 6 | | | V |
| | | If three of four cells are short circuited, only one cell remains powered and $> V_{OV},$ $V_{DD} = V_x$ (cell voltage), $I_{OH} = 100\text{ }\mu\text{A}$ | | $V_{DD} - 0.3$ | | V |
| | | $(V4-V3), (V3-V2), (V2-V1),$ and $(V1-VSS) < V_{OV},$ $V_{DD} = 14.4\text{ V}, I_{OL} = 100\text{ }\mu\text{A}$ measured into OUT pin. | | 250 | 400 | mV |
| I_{OUTH} | OUT Source Current (during OV) | $(V4-V3), (V3-V2), (V2-V1),$ or $(V1-VSS) > V_{OV},$ $V_{DD} = 14.4\text{ V},$ OUT = 0 V, measured out of OUT pin. | | | 4.5 | mA |
| I_{OUTL} | OUT Sink Current (no OV) | $(V4-V3), (V3-V2), (V2-V1),$ and $(V1-VSS) < V_{OV},$ $V_{DD} = 14.4\text{ V},$ OUT = VDD, measured into OUT pin. Pull resistor $R_{PU} = 5\text{ k}\Omega$ to VDD = 14.4 V | 0.5 | | 14 | mA |
| Output Drive OUT, CMOS Open Drain Active Low Versions Only | | | | | | |
| V_{OUT} | Output Drive Voltage, Active High | $(V4-V3), (V3-V2), (V2-V1),$ and $(V1-VSS) < V_{OV},$ $V_{DD} = 14.4\text{ V}, I_{OL} = 100\text{ }\mu\text{A}$ measured into OUT pin. | | 250 | 400 | mV |
| I_{OUTL} | OUT Sink Current (no OV) | $(V4-V3), (V3-V2), (V2-V1),$ and $(V1-VSS) < V_{OV},$ $V_{DD} = 14.4\text{ V},$ OUT = VDD, measured into OUT pin. Pull resistor $R_{PU} = 5\text{ k}\Omega$ to VDD = 14.4 V | 0.5 | | 14 | mA |
| I_{OUTLK} | OUT pin leakage | $(V4-V3), (V3-V2), (V2-V1),$ and $(V1-VSS) < V_{OV},$ $V_{DD} = 14.4\text{ V},$ OUT = VDD, measured into OUT pin. | | | 100 | nA |
| Delay Timer | | | | | | |
| t_{CD} | OV Delay Time | $C_{CD} = 0.1\text{ }\mu\text{F}$ (see Equation 1) | 1 | 1.5 | 2 | s |
| t_{CD_GND} | OV Delay Time with CD pin = 0 V | Delay due to C_{CD} capacitor shorted to ground for Customer Test Mode | 20 | | 170 | ms |

TYPICAL CHARACTERISTICS

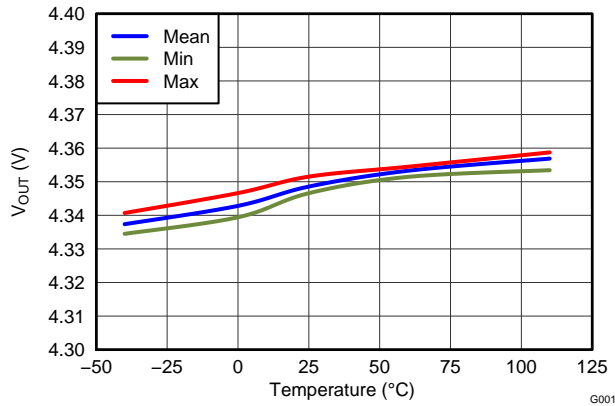


Figure 4. Overtolerance Threshold (OVT) vs. Temperature

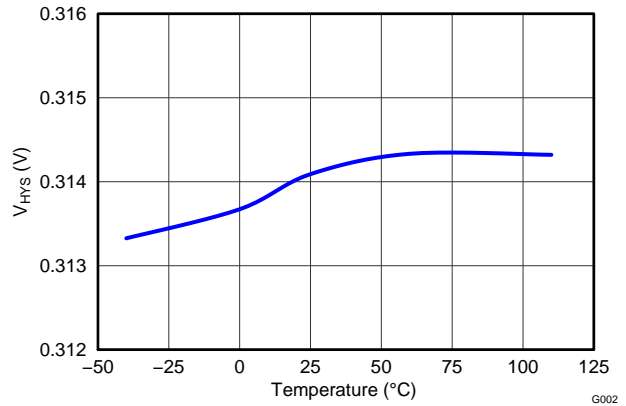


Figure 5. Hysteresis V_{HYS} vs. Temperature

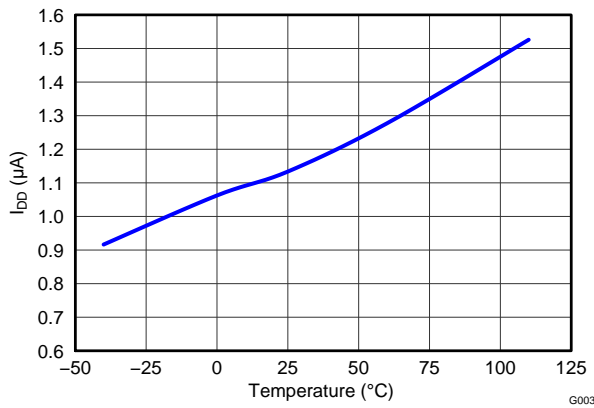


Figure 6. I_{DD} Current Consumption vs. Temperature at V_{DD} = 16 V

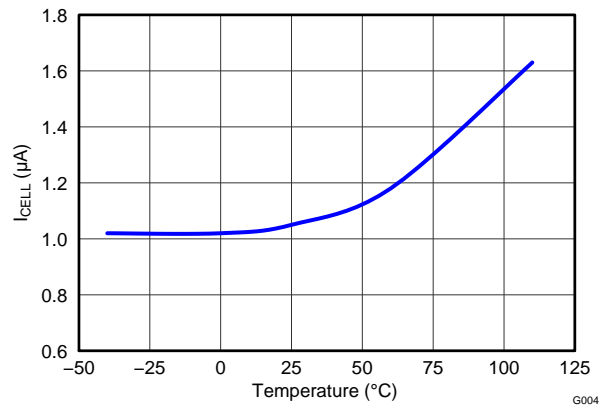


Figure 7. I_{CELL} vs. Temperature at V_{CELL} = 9.2 V

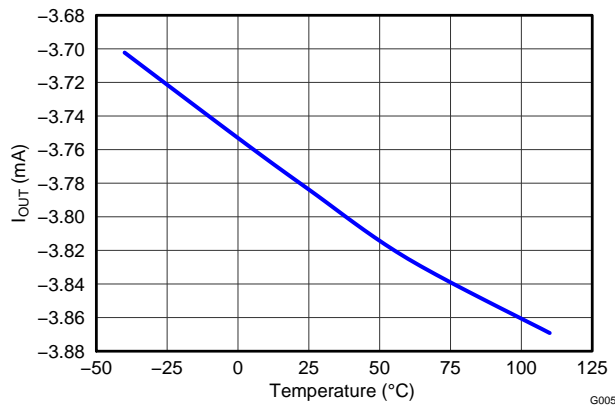


Figure 8. Output Current I_{OUT} vs. Temperature

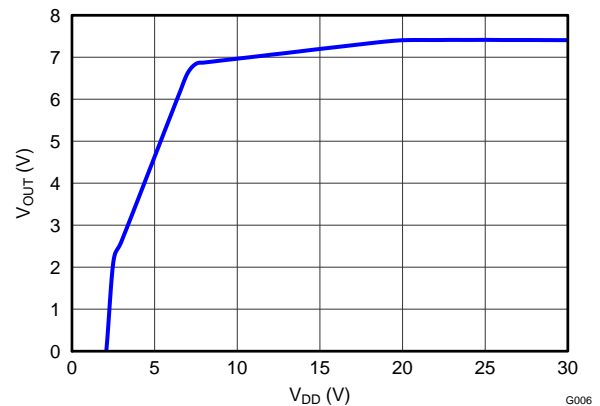


Figure 9. V_{OUT} vs. V_{DD}

APPLICATION INFORMATION

Figure 10 shows the recommended reference design components.

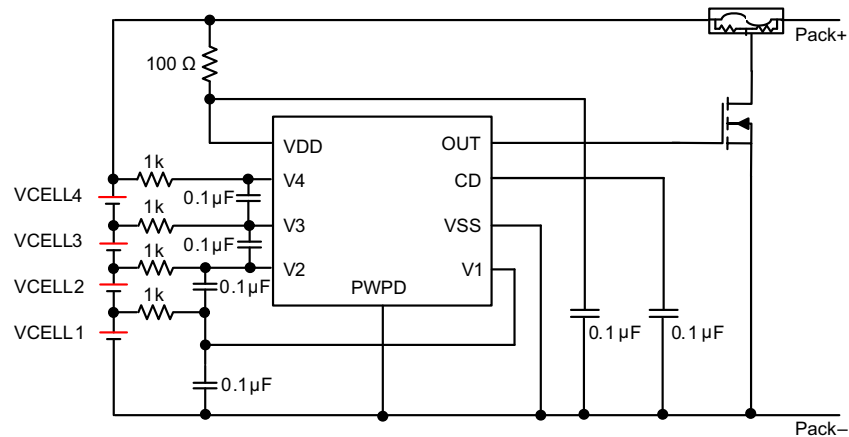


Figure 10. Application Configuration for Active High

NOTE

In the case of an Open Drain Active Low configuration, an external pull-up resistor is required on the OUT terminal.

Changes to the ranges stated in Table 1 will impact the accuracy of the cell measurements.

Table 1. Parameters

| PARAMETER | EXTERNAL COMPONENT | MIN | NOM | MAX | UNIT |
|------------------------------------|--------------------|------|------|------|-----------|
| Voltage monitor filter resistance | R_{IN} | 900 | 1000 | 4700 | Ω |
| Voltage monitor filter capacitance | C_{IN} | 0.01 | 0.1 | 1.0 | μF |
| Supply voltage filter resistance | R_{VD} | 100 | | 1 | $K\Omega$ |
| Supply voltage filter capacitance | C_{VD} | | 0.1 | 1.0 | μF |
| CD external delay capacitance | C_{CD} | | 0.1 | 1.0 | μF |

NOTE

The device is calibrated using an R_{IN} value = 1 k Ω . Using a value other than this recommended value changes the accuracy of the cell voltage measurements and V_{OV} trigger level.

APPLICATION SCHEMATIC

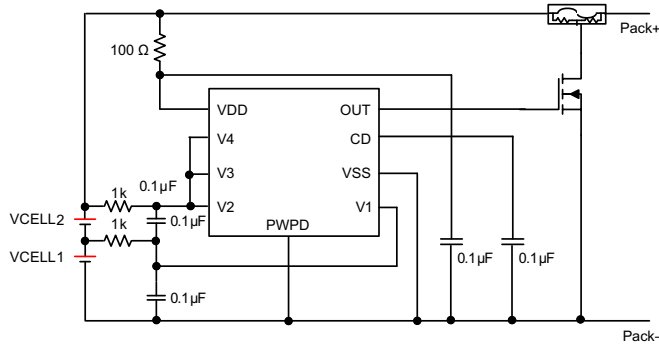


Figure 11. 2-Series Cell Configuration Active High with Capacitor-Programmed Delay

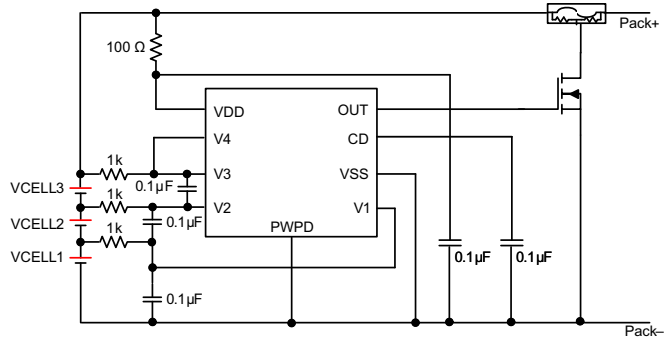


Figure 12. 3-Series Cell Configuration Active High with Capacitor-Programmed Delay

NOTE

In these application examples of 2s and 3s, an external pull-up resistor is required on the OUT terminal to configure for an Open Drain Active Low operation.

CUSTOMER TEST MODE

It is possible to reduce test time for checking the overvoltage function by simply shorting the external CD capacitor to VSS. In this case, the OV delay would be reduced to the $t_{(CD_GND)}$ value, which has a maximum of 170 ms.

Figure 13 shows the timing for the Customer Test Mode.

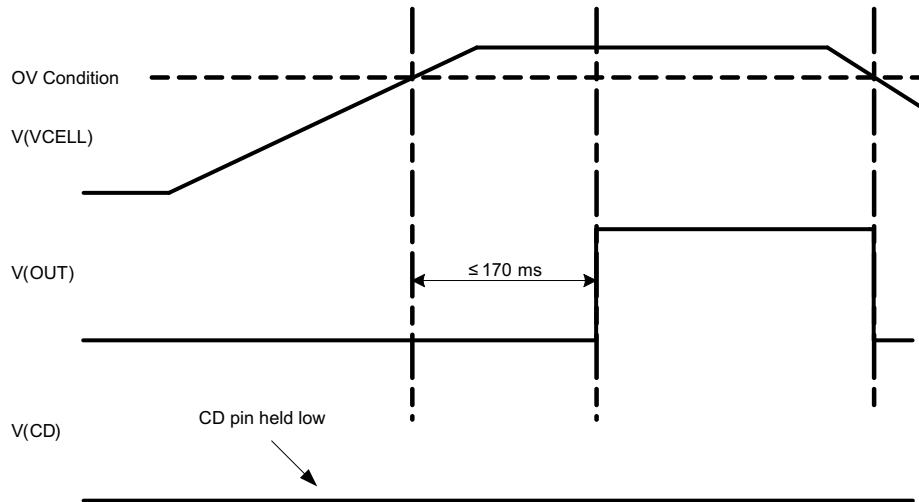


Figure 13. Timing for Customer Test Mode

Figure 14 shows the measurement for current consumption of the product for both VDD and Vx.

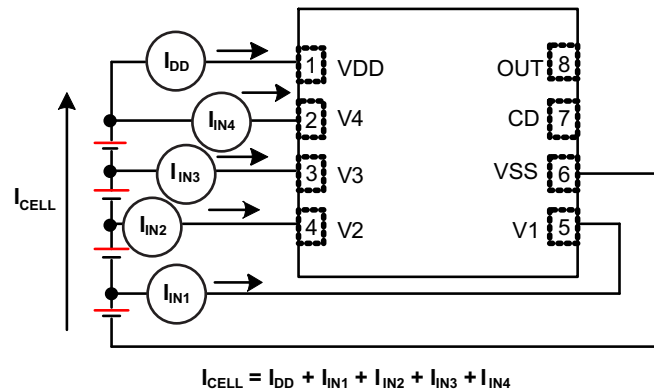


Figure 14. Configuration for IC Current Consumption Test

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| BQ294700DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 700 | Samples |
| BQ294700DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 700 | Samples |
| BQ294701DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 701 | Samples |
| BQ294701DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 701 | Samples |
| BQ294702DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 702 | Samples |
| BQ294702DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 702 | Samples |
| BQ294703DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 703 | Samples |
| BQ294703DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 703 | Samples |
| BQ294704DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 704 | Samples |
| BQ294704DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 704 | Samples |
| BQ294705DSGR | ACTIVE | WSON | DSG | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 705 | Samples |
| BQ294705DSGT | ACTIVE | WSON | DSG | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | 705 | Samples |

(1) 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.

(2) 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/productcontent> for the latest availability 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 6 substances, including the requirement that 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 use in specified lead-free processes.

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, or 2) lead-based die adhesive used between 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 (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

⁽⁴⁾ Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| BQ294700DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294700DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294701DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294701DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294702DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294702DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294703DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294703DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294704DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294704DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294705DSGR | WSON | DSG | 8 | 3000 | 330.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |
| BQ294705DSGT | WSON | DSG | 8 | 250 | 180.0 | 8.4 | 2.3 | 2.3 | 1.15 | 4.0 | 8.0 | Q2 |

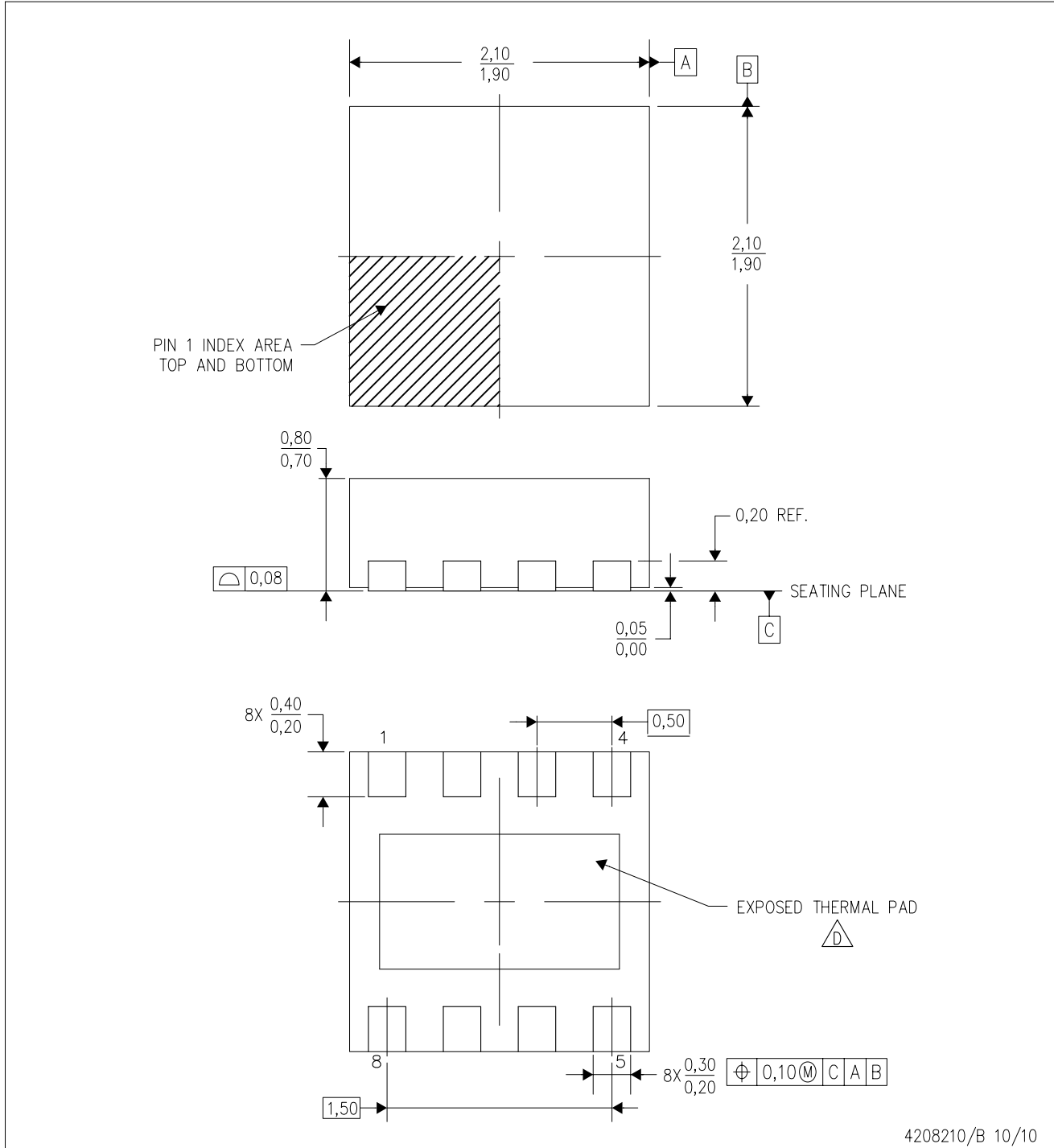
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal


| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| BQ294700DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294700DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |
| BQ294701DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294701DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |
| BQ294702DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294702DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |
| BQ294703DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294703DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |
| BQ294704DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294704DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |
| BQ294705DSGR | WSON | DSG | 8 | 3000 | 367.0 | 367.0 | 35.0 |
| BQ294705DSGT | WSON | DSG | 8 | 250 | 210.0 | 185.0 | 35.0 |

DSG (S-PWSON-N8)

PLASTIC SMALL OUTLINE NO-LEAD



4208210/B 10/10

- 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. Quad Flatpack, No-Leads (QFN) 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 dimensions.
 - E. Falls within JEDEC MO-229.

THERMAL PAD MECHANICAL DATA

DSG (S-PWSON-N8)

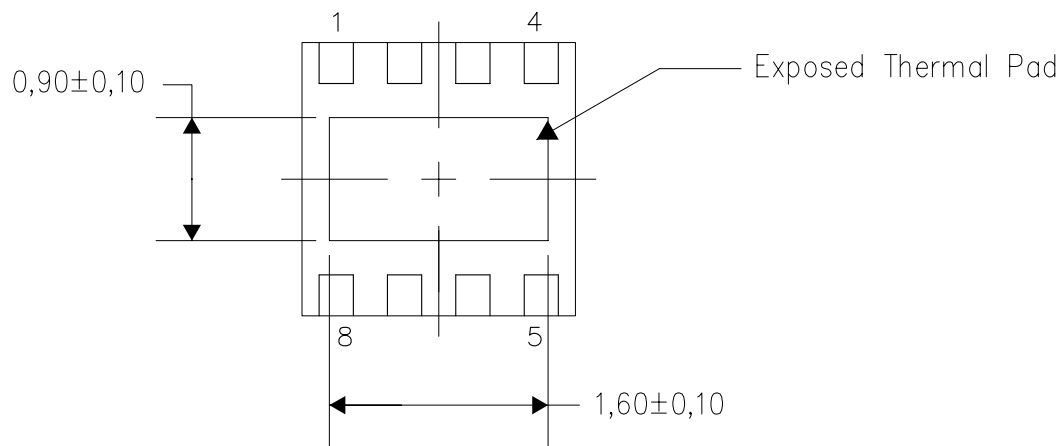
PLASTIC SMALL OUTLINE NO-LEAD

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.

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

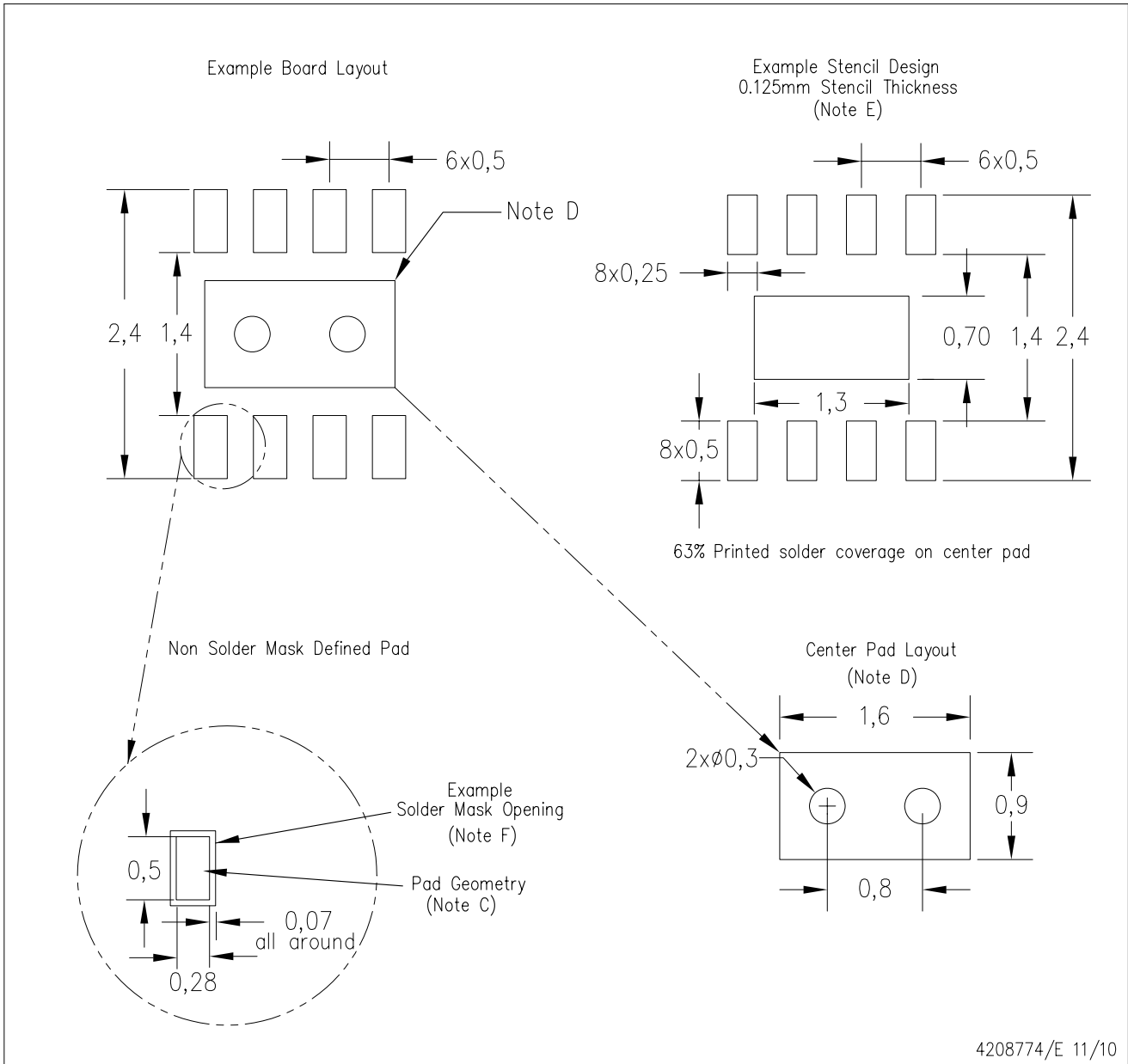


Bottom View

Exposed Thermal Pad Dimensions

4208347/E 11/10

NOTE: A. All linear dimensions are in millimeters



- 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/SON PCB Attachment, 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>>.
 - 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.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

| | |
|------------------------------|--|
| Audio | www.ti.com/audio |
| Amplifiers | amplifier.ti.com |
| Data Converters | dataconverter.ti.com |
| DLP® Products | www.dlp.com |
| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
| Interface | interface.ti.com |
| Logic | logic.ti.com |
| Power Mgmt | power.ti.com |
| Microcontrollers | microcontroller.ti.com |
| RFID | www.ti-rfid.com |
| OMAP Applications Processors | www.ti.com/omap |
| Wireless Connectivity | www.ti.com/wirelessconnectivity |

Applications

| | |
|-------------------------------|--|
| Automotive and Transportation | www.ti.com/automotive |
| Communications and Telecom | www.ti.com/communications |
| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
| Medical | www.ti.com/medical |
| Security | www.ti.com/security |
| Space, Avionics and Defense | www.ti.com/space-avionics-defense |
| Video and Imaging | www.ti.com/video |

TI E2E Community

e2e.ti.com