bq2947 Overvoltage Protection for 2-Series to 4-Series Cell Li-Ion Batteries with External Delay Capacitor

1 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} ≈ 1 µA ($V_{CELL(ALL)}$ < $V_{PROTECT}$)
- Low Leakage Current Per Cell Input < 100 nA
- Small Package Footprint
  - 8-Pin WSON (2.00 mm x 2.00 mm)

2 Applications

- Notebook
- UPS Battery Backup

3 Description

The bq2947 family is an overvoltage monitor and protector for Li-Ion battery pack systems. Each cell is monitored independently for an overvoltage condition.

In the bq2947 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.

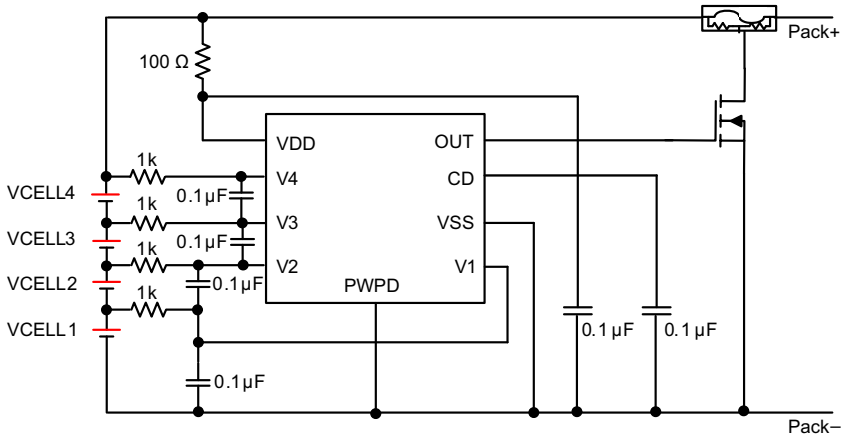
For quicker production-line testing, the bq2947 device provides a Customer Test Mode with reduced delay time.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
bq294700	WSON (8)	2.00 mm × 2.00 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (November 2015) to Revision D **Page**

- Changed the device number to bq2947 ... 1
- Deleted the *Related Links* table from the *Device and Documentation Support* section ... 16

Changes from Revision B (August 2014) to Revision C **Page**

- Added bq294708 and bq294709 to the datasheet ... 1
- Added preview footnote to *Device Options Table* ... 3
- Added bq294708 and bq294709 to *Device Options Table* ... 3

Changes from Revision A (June 2013) to Revision B **Page**

- Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

Changes from Original (September 2012) to Revision A **Page**

- Added the bq294707 device to Production Data ... 1

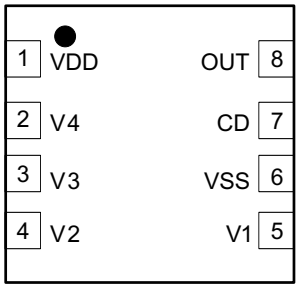
5 Device Options

PART NUMBER	OVP (V)	OV HYSTERESIS	OUTPUT DRIVE
bq294700	4.350	0.300	CMOS Active High
bq294701	4.250	0.300	CMOS Active High
bq294702	4.300	0.300	CMOS Active High
bq294703	4.325	0.300	CMOS Active High
bq294704	4.400	0.300	CMOS Active High
bq294705	4.450	0.300	CMOS Active High
bq294706(1)	4.550	0.300	CMOS Active High
bq294707	4.225	0.050	NCH Open Drain Active Low
bq294708	4.500	0.300	CMOS Active High
bq294709(1)	4.160	0.300	CMOS Active High
bq2947	3.850–4.60	0–0.300	CMOS Active High or Open Drain Active Low

(1) Product Preview only

6 Pin Configuration and Functions

DSG Package
8-Pin WSON
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
CD	7	OA	External capacitor connection for delay timer
OUT	8	OA	Analog Output drive for overvoltage fault signal. Active High or Open Drain Active Low
PWPD	9	P	TI recommends connecting the exposed pad to VSS on PCB.
V1	5	IA	Sense input for positive voltage of the lowest cell in the stack
V2	4	IA	Sense input for positive voltage of the second cell from the bottom of the stack
V3	3	IA	Sense input for positive voltage of the third cell from the bottom of the stack
V4	2	IA	Sense input for positive voltage of the fourth cell from the bottom of the stack
VDD	1	P	Power supply input
VSS	6	P	Electrically connected to IC ground and negative terminal of the lowest cell in the stack

7 Specifications

7.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage range	VDD–VSS	–0.3	30	V
Input voltage range	V4–V3, V3–V2, V2–V1, V1–VSS, or CD–VSS	–0.3	30	V
Output voltage range	OUT–VSS	–0.3	30	V
Continuous total power dissipation, P_{TOT}		See *Thermal Information*		
Lead temperature (soldering, 10 s), T_{SOLDER}			300	°C
Storage temperature, T_{stg}		–65	150	

(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.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage, V_{DD}		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

7.4 Thermal Information

THERMAL METRIC(1)		bq2947 SON 8 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	62	°C/W
$R_{\theta JC(top)}$	Junction-to-case(top) thermal resistance	72	
$R_{\theta JB}$	Junction-to-board thermal resistance	32.5	
ψ_{JT}	Junction-to-top characterization parameter	1.6	
ψ_{JB}	Junction-to-board characterization parameter	33	
$R_{\theta JC(bottom)}$	Junction-to-case(bottom) thermal resistance	10	

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

7.5 Electrical Characteristics

Typical values stated where T_A = 25°C and VDD = 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).

PARAMETER		TEST CONDITIONS	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
		bq294706 (1), R_{IN} = 1 kΩ		4.550		V
		bq294707, R_{IN} = 1 kΩ		4.225		V
		bq294708, R_{IN} = 1 kΩ		4.500		V
		bq294709 (1), R_{IN} = 1 kΩ		4.160		V
V_{HYS}	OV Detection Hysteresis	bq2947 (2)	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 11.)		1	2	µA
I_{IN}	Input Current at Vx Pins	(V4–V3) = (V3–V2) = (V2–V1) = (V1–VSS) = 4.0 V at T_A = 25°C (See Figure 11.)	–0.1		0.1	µA
I_{CELL}	Input Current (ALL Vx and VDD 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

(1) Product Preview only
(2) Future option, contact TI.

Electrical Characteristics (continued)

Typical values stated where T_A = 25°C and VDD = 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).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
OUTPUT DRIVE OUT, CMOS ACTIVE HIGH VERSIONS ONLY						
V_{OUT}	Output Drive Voltage, Active High	(V4–V3), (V3–V2), (V2–V1), or (V1–VSS) > V_{OV}, VDD = 14.4 V, I_{OH} = 100 µA	6			V
		If three of four cells are short circuited, only one cell remains powered and > V_{OV}, VDD = Vx (cell voltage), I_{OH} = 100 µA		VDD – 0.3		V
		(V4–V3), (V3–V2), (V2–V1), and (V1–VSS) < V_{OV}, VDD = 14.4 V, I_{OL} = 100 µA 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}, VDD = 14.4 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}, VDD = 14.4 V, OUT = VDD, measured into OUT pin .Pull resistor R_{PU} = 5 kΩ 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}, VDD = 14.4 V, I_{OL} = 100 µA 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}, VDD = 14.4 V, OUT = VDD, measured into OUT pin. Pull resistor R_{PU} = 5 kΩ 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}, VDD = 14.4 V, OUT = VDD, measured into OUT pin.			100	nA
DELAY TIMER						
t_{CD}	OV Delay Time	C_{CD} = 0.1 µF (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

7.6 Typical Characteristics

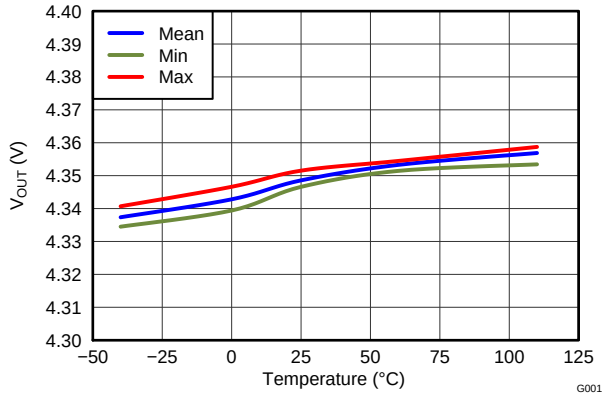


Figure 1. Overvoltage Threshold (Nominal = 4.35 V) vs. Temperature

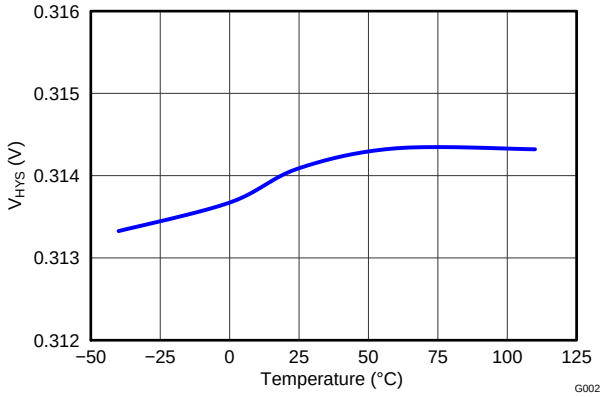


Figure 2. Hysteresis V_{HYS} vs. Temperature

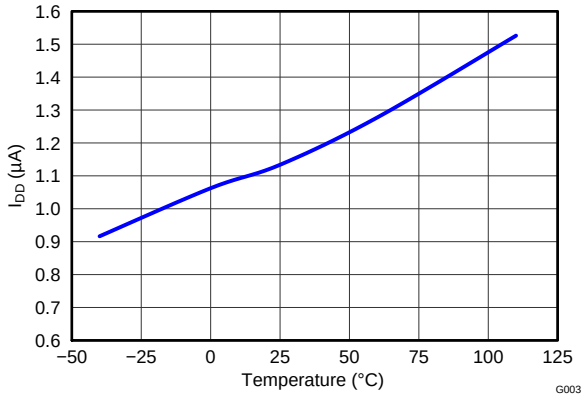


Figure 3. I_{DD} Current Consumption vs. Temperature at VDD = 16 V

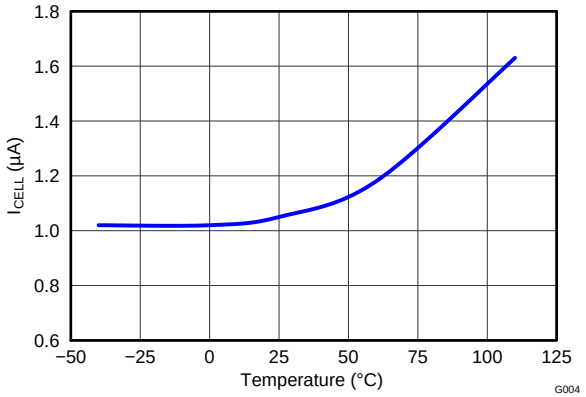


Figure 4. I_{CELL} vs. Temperature at V_{CELL}= 9.2 V

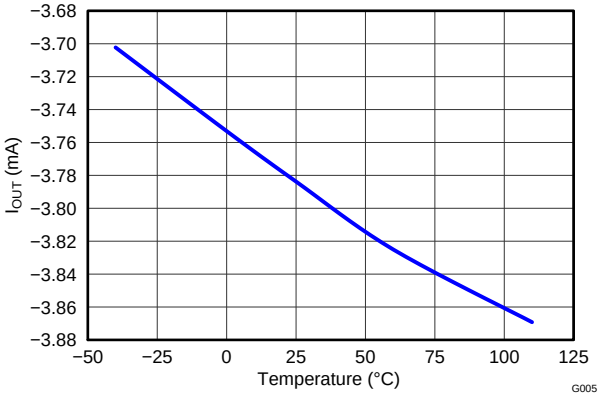


Figure 5. Output Current I_{OUT} vs. Temperature

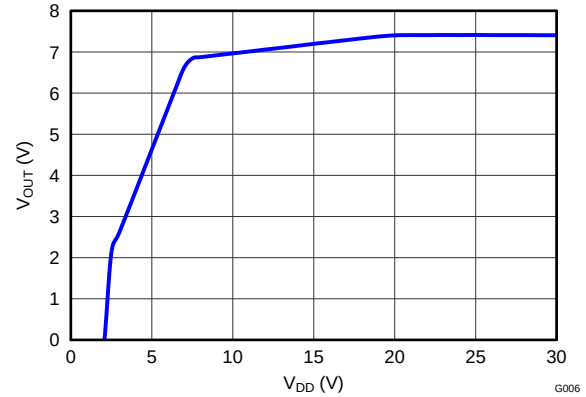


Figure 6. V_{OUT} vs. V_{DD}

8 Detailed Description

8.1 Overview

The bq2947 is a second level overvoltage (OV) protector. Each cell is monitored independently by comparing the actual cell voltage to a protection voltage threshold, V_{OV}. The protection threshold is preprogrammed at the factory with a range between 3.85 V and 4.65 V.

8.2 Functional Block Diagram

Figure 7 shows a CMOS Active High configuration.

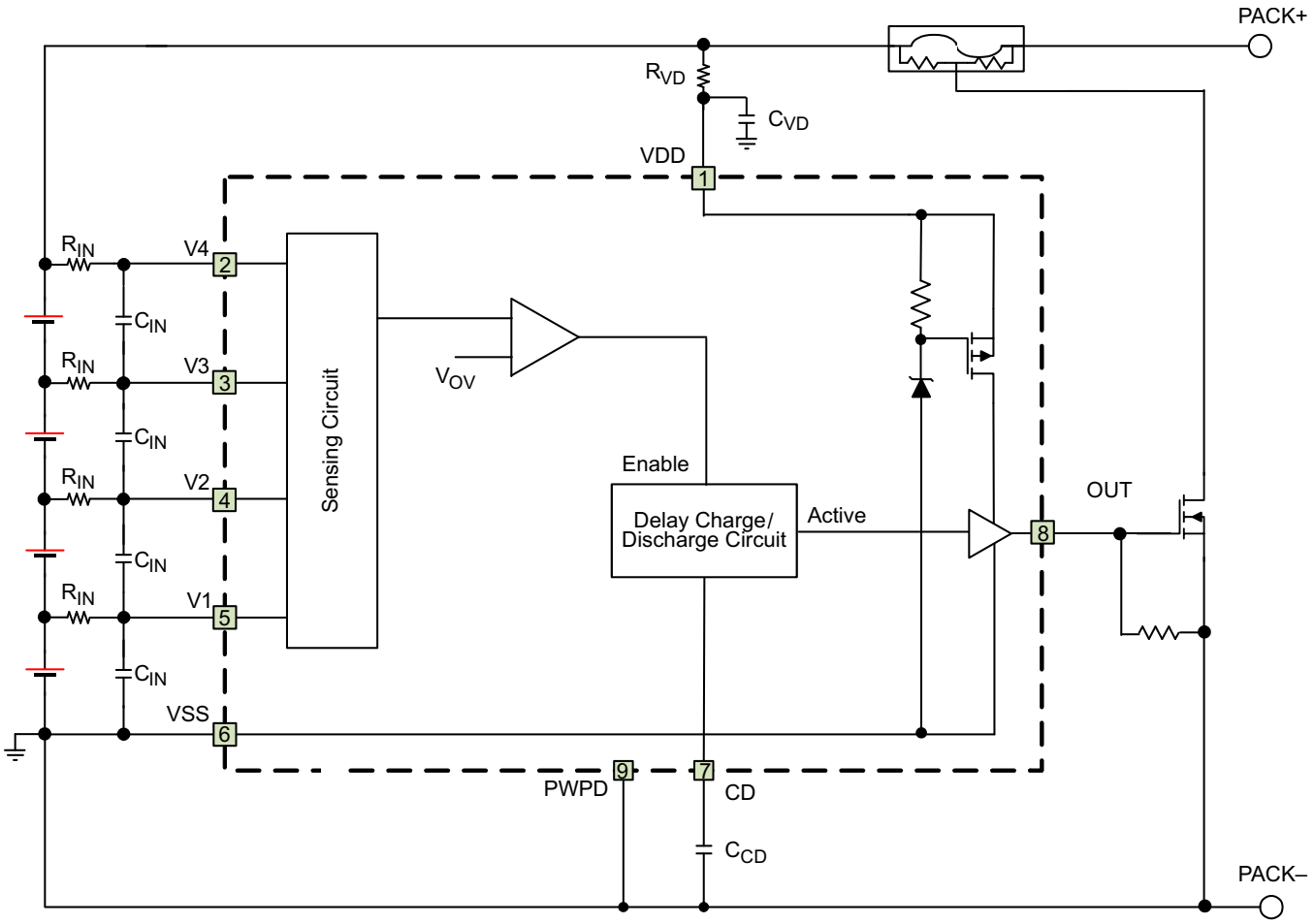


Figure 7. Block Diagram

NOTE

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

8.3 Feature Description

In the bq2947 family of devices, 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 9 for details on CD and OUT pin behavior during an overvoltage event.

Feature Description (continued)

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).

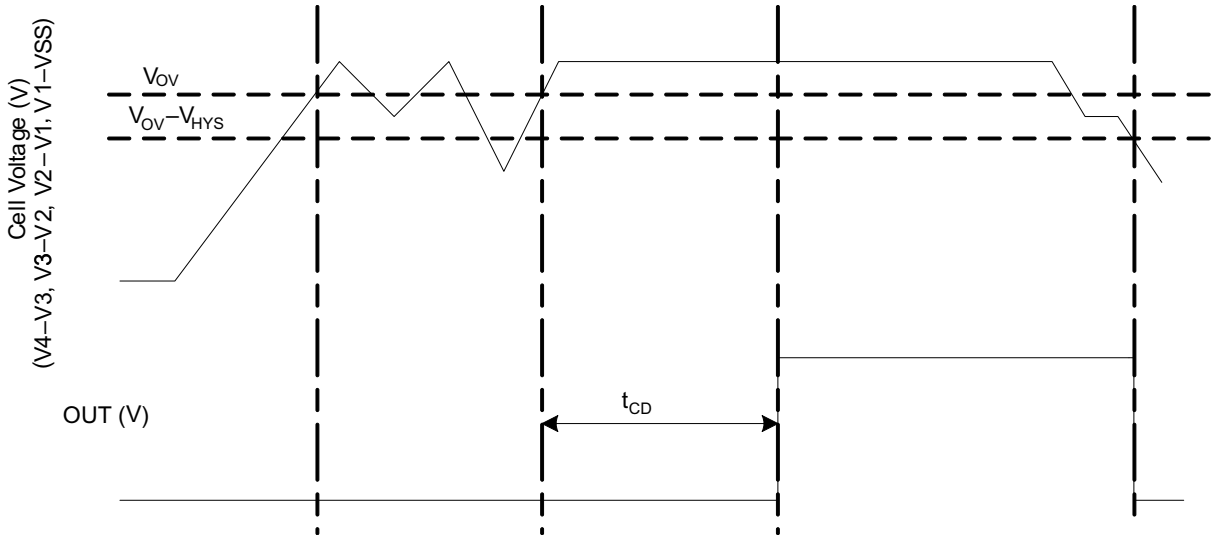


Figure 8. Timing for Overvoltage Sensing (OUT Pin Is Active High)

Figure 9 shows the behavior of CD pin during an OV sequence.

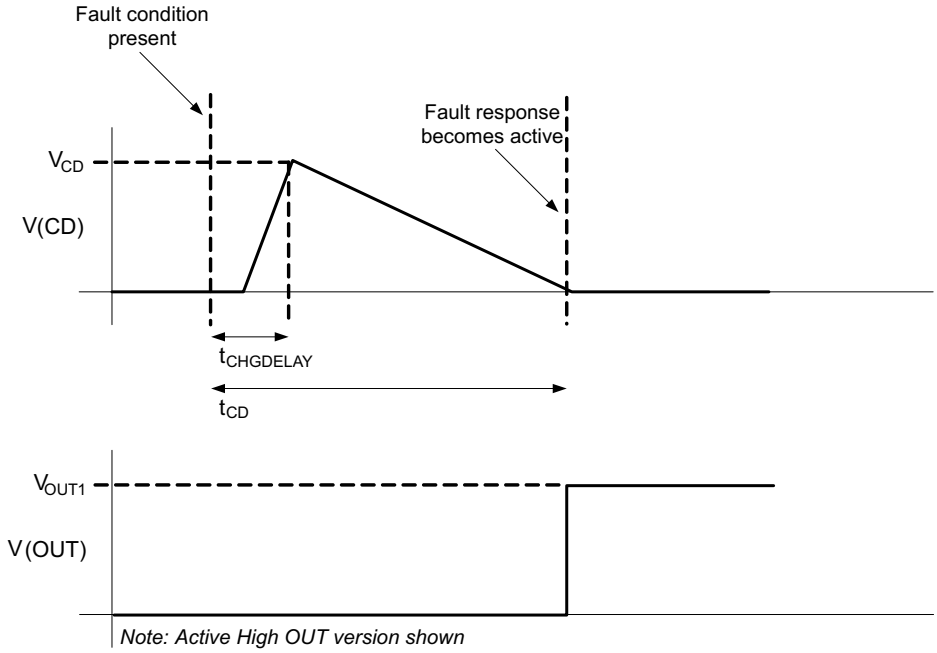


Figure 9. CD Pin Mechanism (OUT Pin Is Active High)

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.

Feature Description (continued)

8.3.1 Pin Details

8.3.1.1 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.

8.3.1.2 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.

8.3.1.3 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.

8.3.1.4 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} (sec) = K × C_{CD} (µF), where K = 10 to 20 range. (1)

Example: If C_{CD}= 0.1 µF (typical), then the delay timer range is

t_{CD} (s) = 10 × 0.1 = 1 s (Minimum)

t_{CD} (s) = 20 × 0.1 = 2 s (Maximum)

NOTE

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

8.4 Device Functional Modes

8.4.1 NORMAL Mode

When all of the cell voltages are below the overvoltage threshold, V_{OV}, the device operates in NORMAL mode. The device monitors the differential cell voltages connected across (V1–VSS), (V2–V1), (V3–V2), and (V4–V3). The OUT pin is inactive, and is low if configured active high, or, if configured active low, is an open drain being externally pulled up.

8.4.2 OVERVOLTAGE Mode

OVERVOLTAGE mode is detected if any of the cell voltage exceeds the overvoltage threshold, V_{OV} for configured OV delay time. The OUT pin is activated after a delay time set by the capacitance in the CD pin. The OUT pin will either pull high internally, if configured as active high, or will be pulled low internally if configured as active low. An external FET is then turned on, shorting the fuse to ground, which allows the battery and/or charger power to blow the fuse. When all of the cell voltages fall below the (V_{OV}–V_{HYS}), the device returns to NORMAL mode.

8.4.3 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.

Device Functional Modes (continued)

Figure 10 shows the timing for the Customer Test Mode.

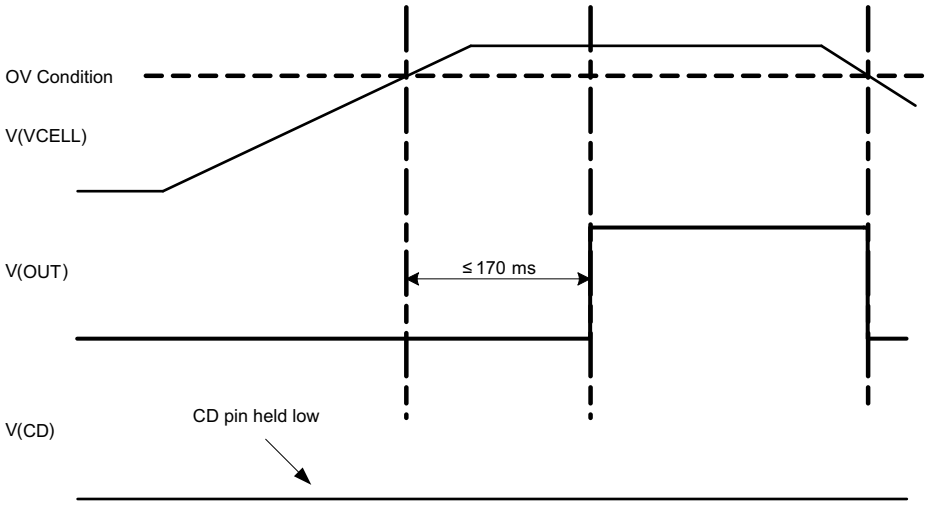
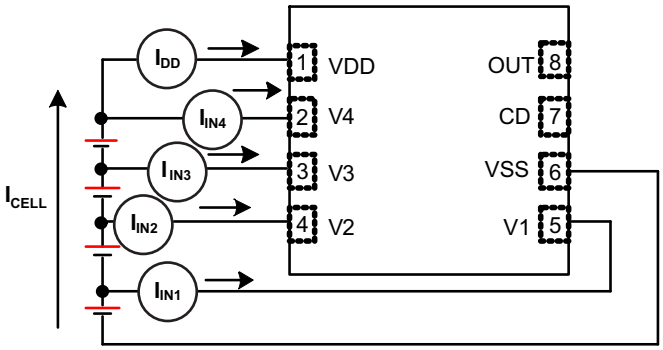


Figure 10. Timing for Customer Test Mode

Figure 11 shows the measurement for current consumption of the product for both VDD and Vx.



$$I_{CELL} = I_{DD} + I_{IN1} + I_{IN2} + I_{IN3} + I_{IN4}$$

Figure 11. Configuration for IC Current Consumption Test

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The bq2947 devices are a family of second-level protectors used for overvoltage protection of the battery pack in the application. The device, when configuring the OUT pin with active high, drives a NMOS FET that connects the fuse to ground in the event of a fault condition. This provides a shorted path to use the battery and/or charger power to blow the fuse and cut the power path. The OUT pin, when configured as active low, can be used to drive a PMOS FET to connect the fuse to ground instead.

9.2 Typical Applications

9.2.1 Application Configuration for Active High

Figure 12 shows the recommended reference design components.

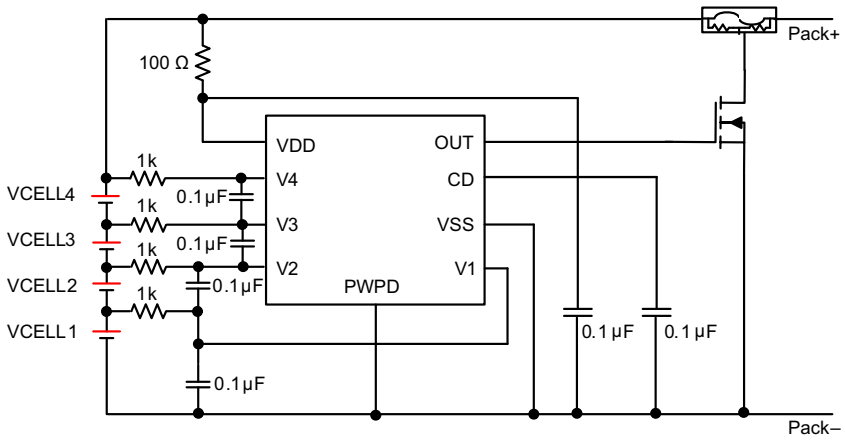


Figure 12. Application Configuration for Active High

9.2.1.1 Design Requirements

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		1000	Ω
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 kΩ. Using a value other than this recommended value changes the accuracy of the cell voltage measurements and V_{OV} trigger level.

9.2.1.2 Detailed Design Procedure

1. Determine the number of cell in series.

   The device supports 2-S to 4-S cell configuration. For 2S and 3S, the top unused pin(s) should be shorted as shown in Figure 13 and Figure 14.

2. Determine the overvoltage protection delay.

   Follow the calculation example described in CD pin description. Select the right capacitor to connect to the CD pin.

3. Follow the application schematic to connect the device. If the OUT pin is configured to open drain, an external pull up resistor should be used.

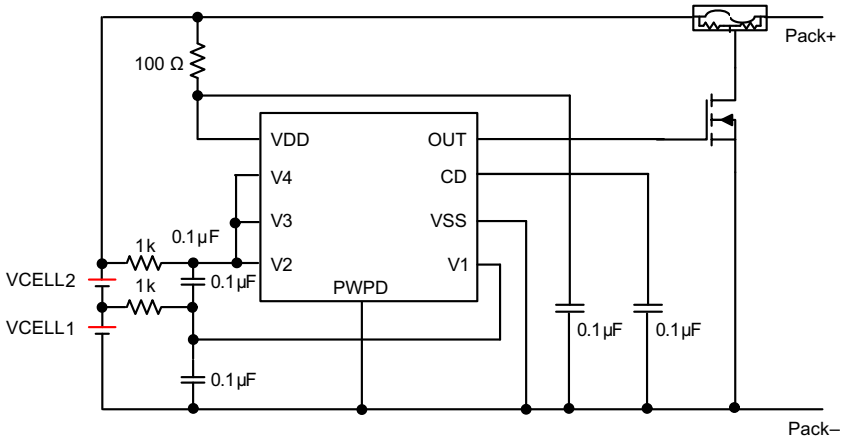


Figure 13. 2-Series Cell Configuration

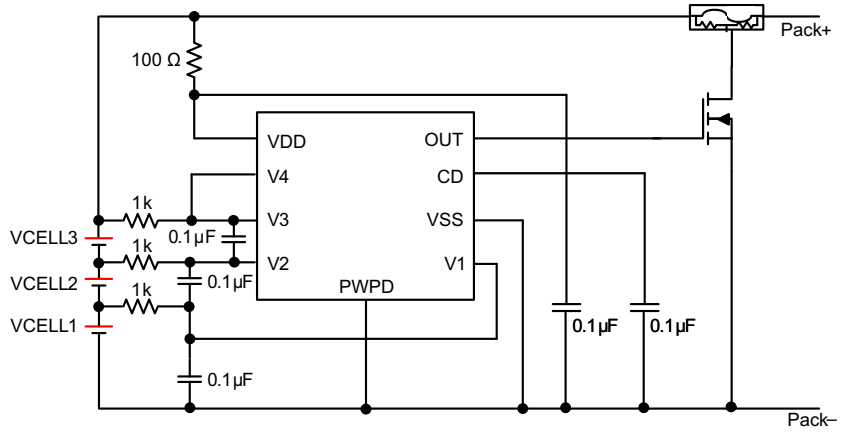


Figure 14. 3-Series Cell Configuration

9.2.1.3 Application Curves

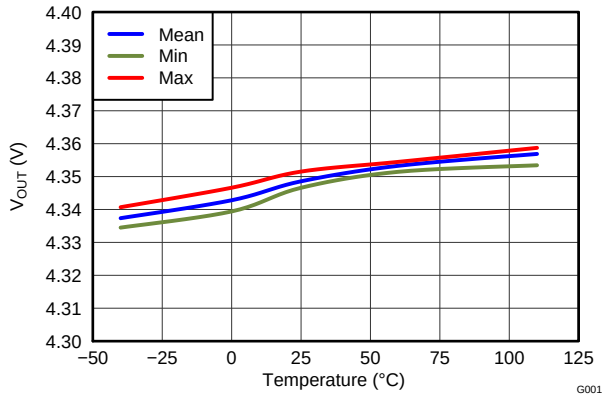


Figure 15. Overvoltage Threshold (OVT) vs. Temperature

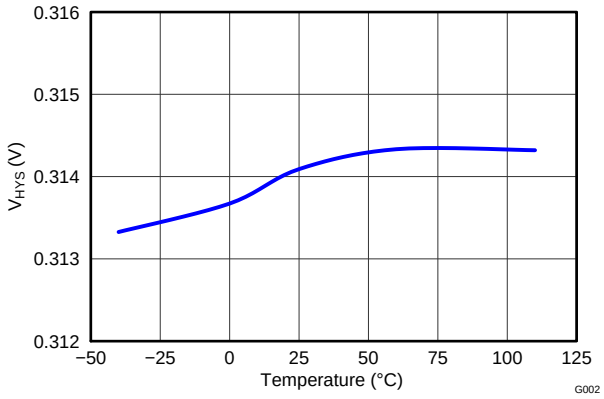


Figure 16. Hysteresis V_{HYS} vs. Temperature

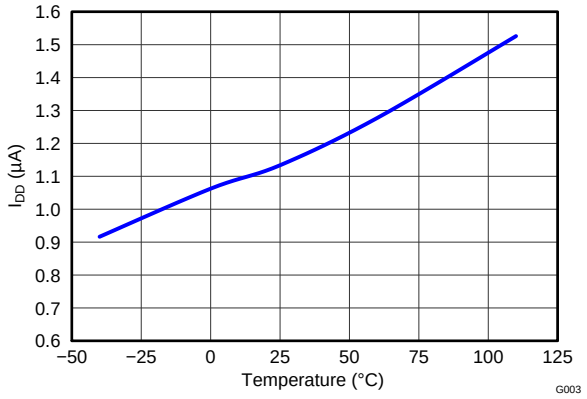


Figure 17. I_{DD} Current Consumption vs. Temperature at VDD = 16 V

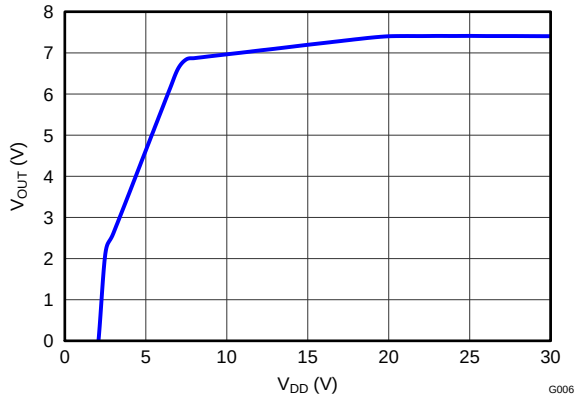


Figure 18. V_{OUT} vs. V_{DD}

10 Power Supply Recommendations

The maximum power of this device is 20 V on V_{DD}.

11 Layout

11.1 Layout Guidelines

1. Ensure the RC filters for the Vx pins and VDD pin are placed as close as possible to the target terminal, reducing the tracing loop area.
2. The capacitor for CD should be placed close to the IC terminals.
3. Ensure the trace connecting the fuse to the gate, source of the NFET to the Pack– is sufficient to withstand the current during fuse blown event.

11.2 Layout Example

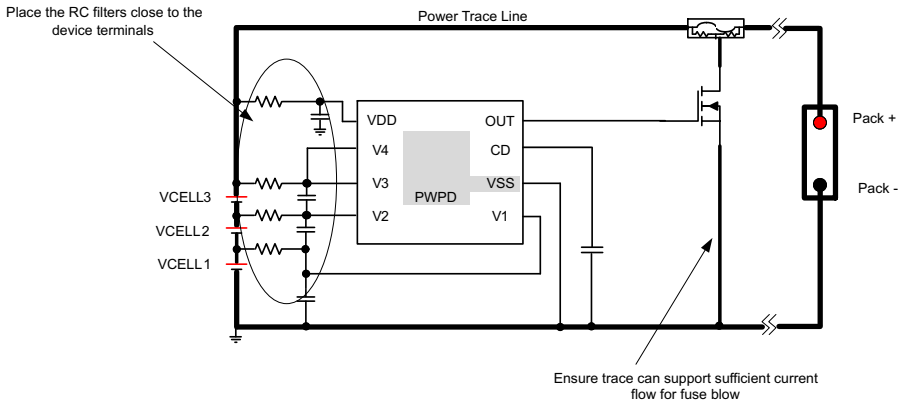


Figure 19. Layout Example

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation, see *bq2945xy and bq2947xy Cascade Voltage Monitoring* (SLUA662).

12.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	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
BQ294707DSGR	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	707	Samples
BQ294707DSGT	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 85	707	Samples
BQ294708DSGR	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU | Call TI	Level-2-260C-1 YEAR	-40 to 85	708	Samples
BQ294708DSGT	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU | Call TI	Level-2-260C-1 YEAR	-40 to 85	708	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.

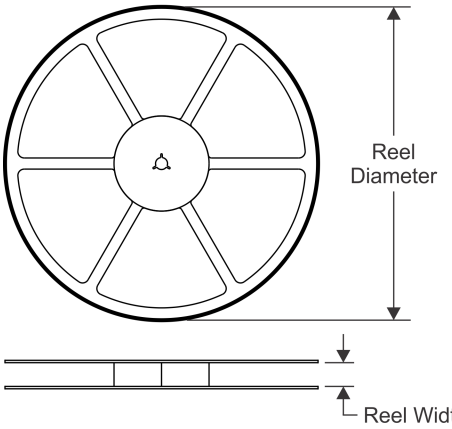
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

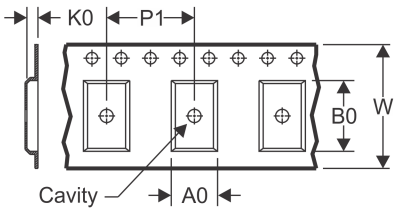
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

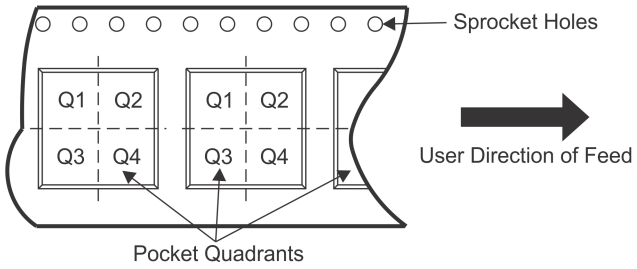


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

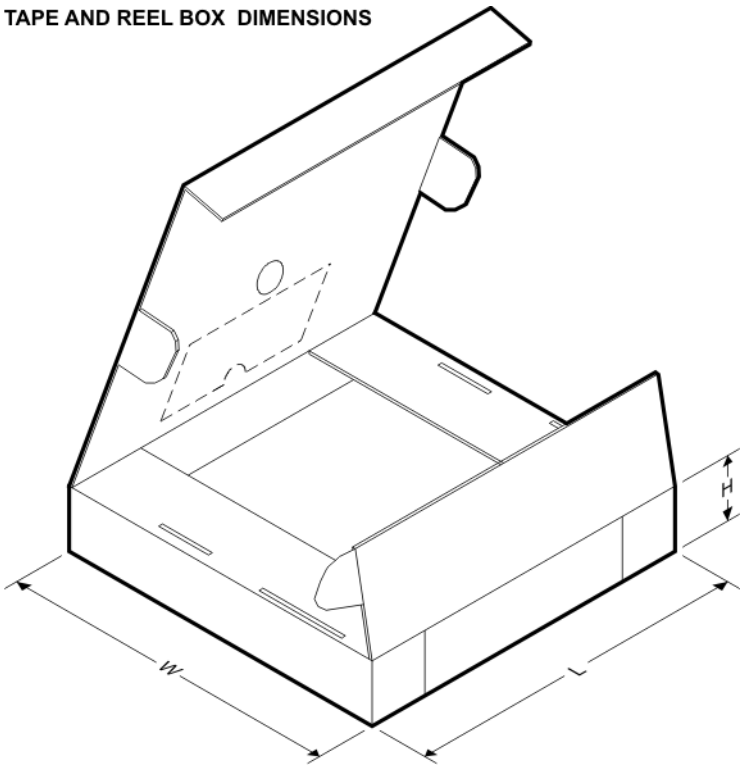
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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	180.0	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	180.0	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	180.0	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	180.0	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	180.0	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	180.0	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
BQ294707DSGR	WSON	DSG	8	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
BQ294707DSGT	WSON	DSG	8	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
BQ294708DSGR	WSON	DSG	8	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
BQ294708DSGT	WSON	DSG	8	250	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2

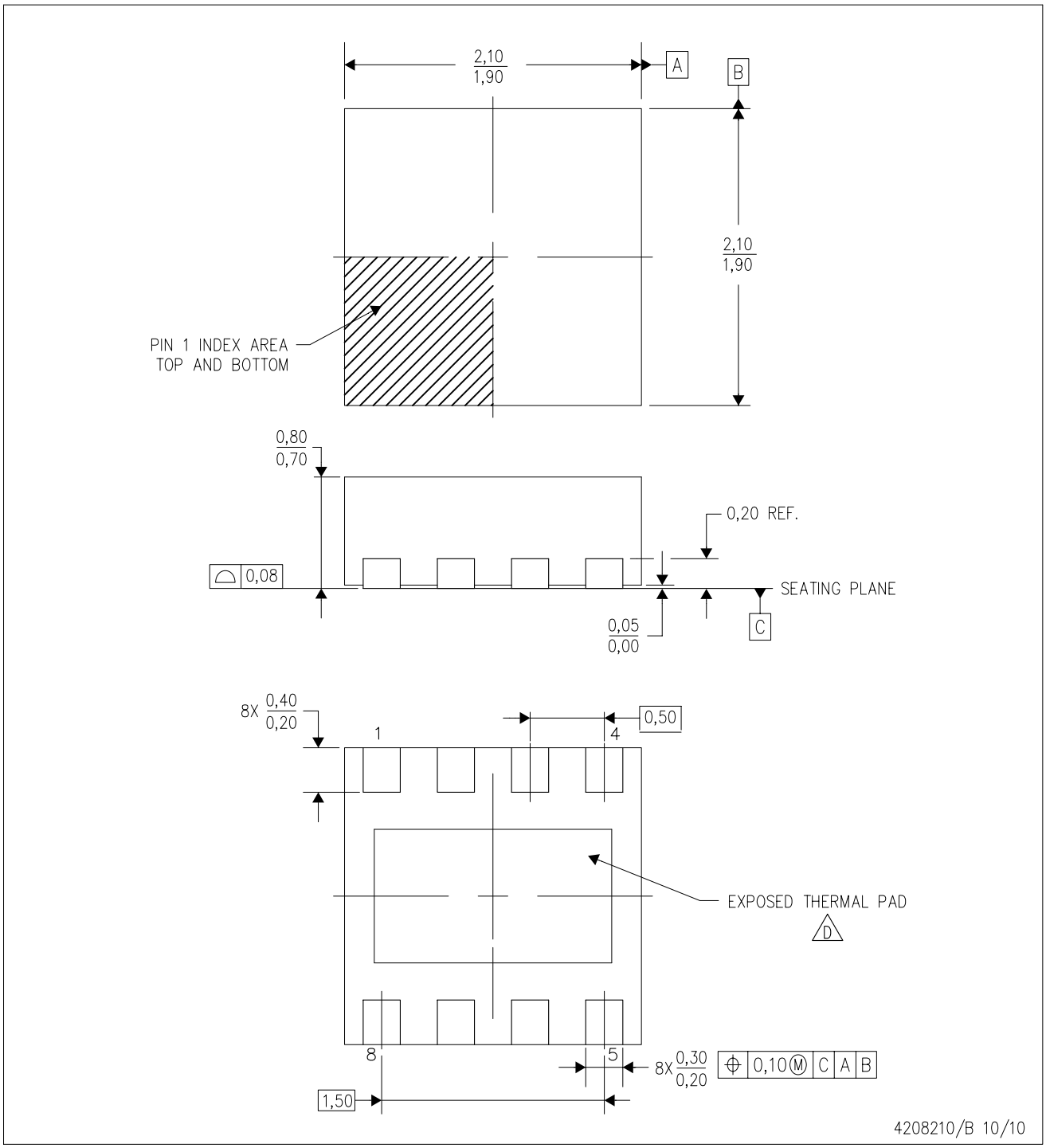
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ294700DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294700DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294701DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294701DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294702DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294702DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294703DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294703DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294704DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294704DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294705DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294705DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294707DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294707DSGT	WSON	DSG	8	250	210.0	185.0	35.0
BQ294708DSGR	WSON	DSG	8	3000	210.0	185.0	35.0
BQ294708DSGT	WSON	DSG	8	250	210.0	185.0	35.0

DSG (S–PWSON–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. Quad Flatpack, No–Leads (QFN) package configuration.
D. 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.

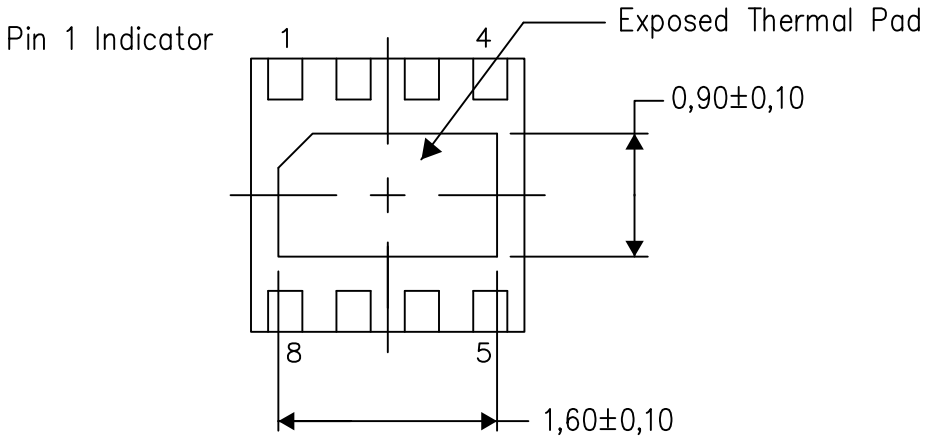
DSG (S–PWSON–N8) PLASTIC SMALL OUTLINE NO–LEAD

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.



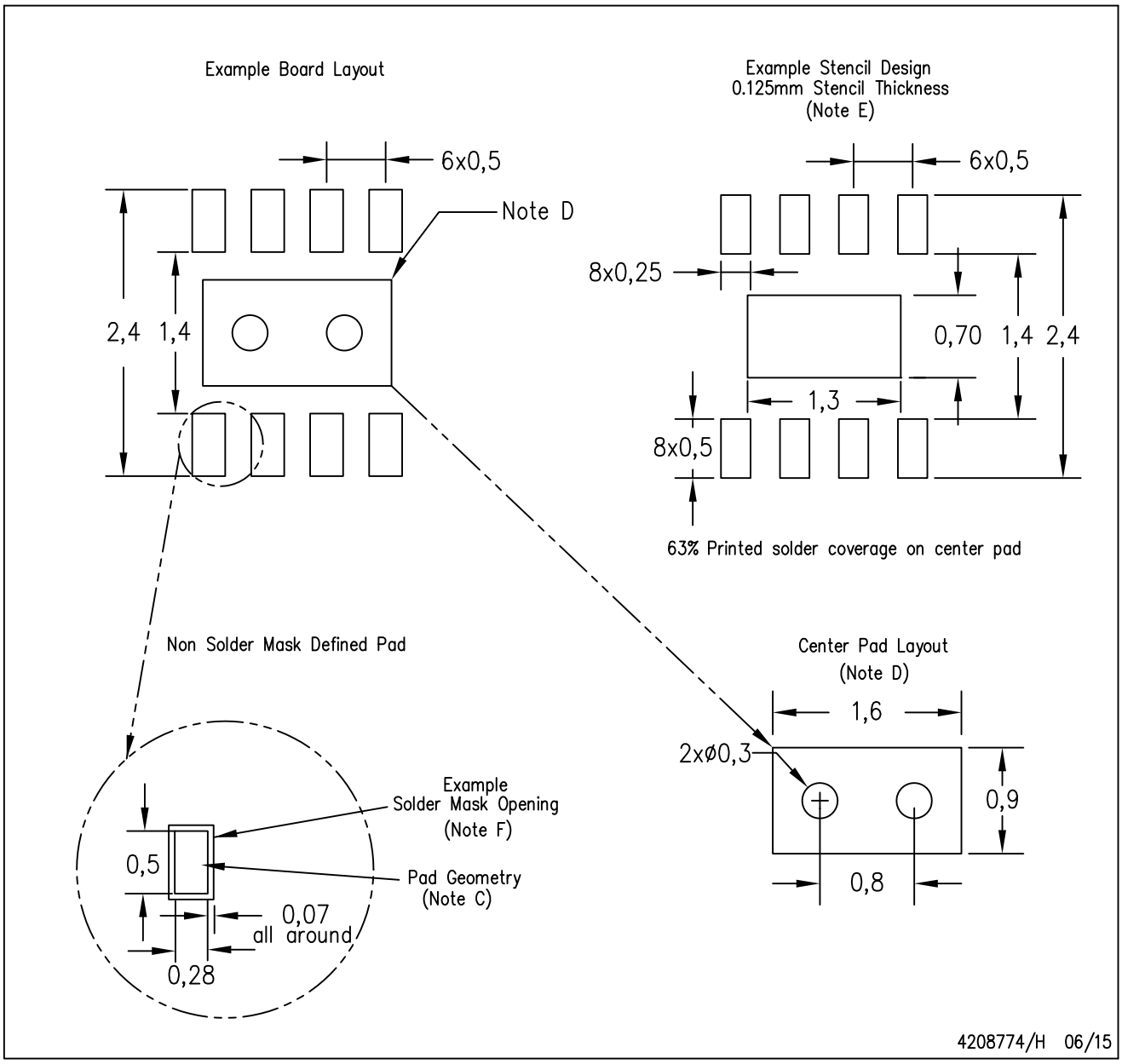
Bottom View

Exposed Thermal Pad Dimensions

4208347/I 06/15

NOTE: All linear dimensions are in millimeters

DSG (S–PWSON–N8) PLASTIC SMALL OUTLINE NO–LEAD



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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>.
E. 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.
F. Customers should contact their board fabrication site for solder mask tolerances.

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