

**bq2941x**

SLUS669G–AUGUST 2005–REVISED AUGUST 2008

## VOLTAGE PROTECTION FOR 2-, 3-, OR 4-CELL Li-Ion BATTERIES (2<sup>nd</sup>-LEVEL PROTECTION)

- **2-, 3-, or 4-Cell Secondary Protection**
- **Low Power Consumption  $I_{CC} < 2 \mu\text{A}$**   
[ $V_{CELL(ALL)} < V_{(PROTECT)}$ ]
- **Fixed High Accuracy Overvoltage Protection Threshold**
  - bq29410 = 4.35 V
  - bq29411 = 4.40 V
  - bq29412 = 4.45 V
  - bq29413 = 4.50 V
  - bq29414 = 4.55 V
  - bq29415 = 4.60 V
  - bq29419 = 4.30 V
- **Programmable Delay Time of Detection**
- **High Power Supply Ripple Rejection**
- **Stable During Pulse Charge Operation**
  
- **2<sup>nd</sup>-Level Overvoltage Protection in Li-Ion Battery Packs in:**
  - **Notebook Computers**
  - **Portable Instrumentation**
  - **Portable Equipment**

The bq2941x is a secondary overvoltage protection IC for 2-, 3-, or 4-cell lithium-ion battery packs that incorporates a high-accuracy precision overvoltage detection circuit. It includes a programmable delay circuit for overvoltage detection time.

Each cell in a multiple-cell pack is compared to an internal reference voltage. If one cell reaches an overvoltage condition, the protection sequence begins. The bq2941x device starts charging an external capacitor through the CD pin. When the CD pin voltage reaches 1.2 V, the OUT pin changes from a low level to a high level.

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<sup>(1)</sup>**

T <sub>A</sub>	V <sub>(PROTECT)</sub> <sup>(2)</sup>	PACKAGE <sup>(3)</sup>			
		MSOV /F6 -m2 Tm	1 0 0 1m2 Tm	1 0 0 1m 1 309.48 Tm	1 0 0 1159 96.7 Tm /m2 Tm 1 0 0 1m2 Tm

**ABSOLUTE MAXIMUM RATINGS**


**PACKAGE DISSIPATION RATINGS**



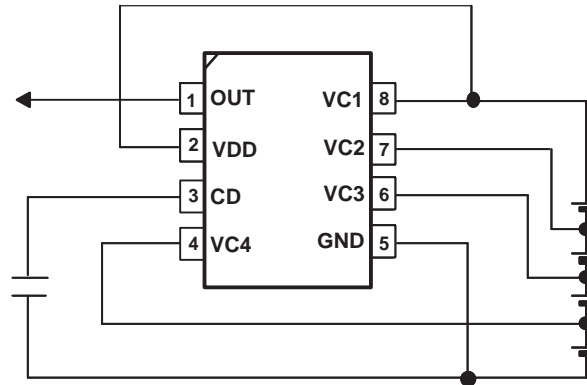
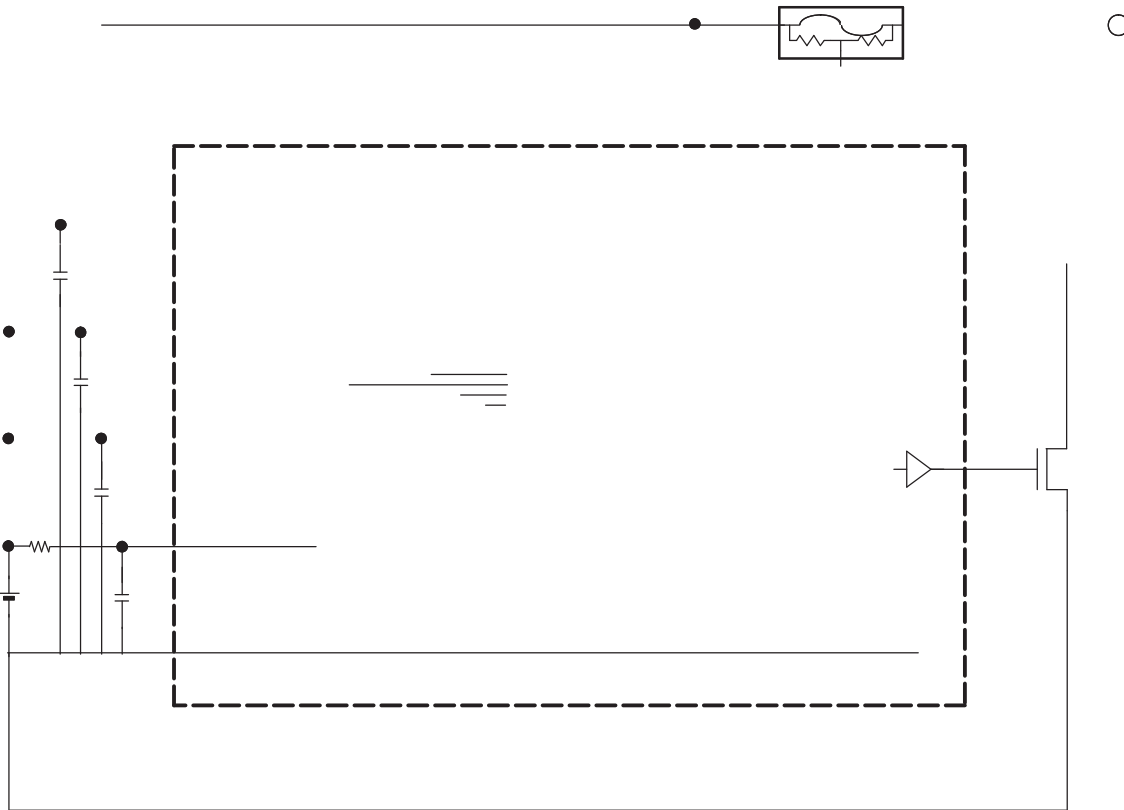



Figure 1.  $I_{CC}$ ,  $I_{IN}$  Measurement (DCT Package)

### Terminal Functions

TERMINAL			DESCRIPTION
MSOP (DCT)	TSSOP (PW)	NAME	
8	1	VC1	Sense voltage input for most positive cell
7	2	VC2	Sense voltage input for second most positive cell
6	3	VC3	Sense voltage input for third most positive cell
5	4	GND	Ground pin
4	5	VC4	Sense voltage input for least positive cell
3	6	CD	An external capacitor is connected to determine the programmable delay time
2	7	VDD	Power supply
1	8	OUT	Output

**FUNCTIONAL BLOCK DIAGRAM**



**OVERVOLTAGE PROTECTION**

When one of the cell voltages exceeds  $V_{(PROTECT)}$ , an internal current source begins to charge the capacitor,  $C_{(DELAY)}$ , connected to the CD pin. If the voltage at the CD pin,  $V_{CD}$ , reaches 1.2 V, the OUT pin is activated and transitions high. An externally connected NCH FET is activated and blows the external fuse in the positive battery rail; see the functional block diagram.

If all cell voltages fall below  $V_{(PROTECT)}$  before the voltage at pin CD reaches 1.2 V, the delay time does not run out. An internal switch clamps the CD pin to GND he

**DELAY TIME CALCULATION**

$$t_d = \frac{[1.2 \text{ V} \times C_{(DELAY)}]}{I_{CD}}$$

$$C_{(DELAY)} = \frac{[t_d \times I_{CD}]}{1.2 \text{ V}}$$

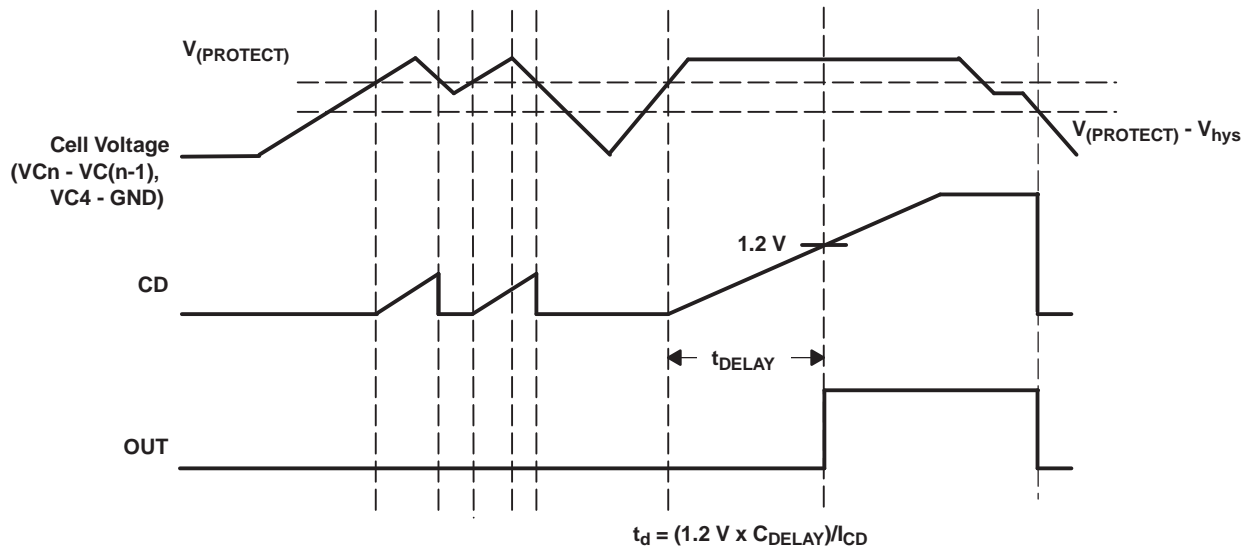


Figure 2. Timing for Overvoltage Sensing

## APPLICATION INFORMATION

### BATTERY CONNECTIONS

The following diagrams show the DCT package device in different cell configurations.

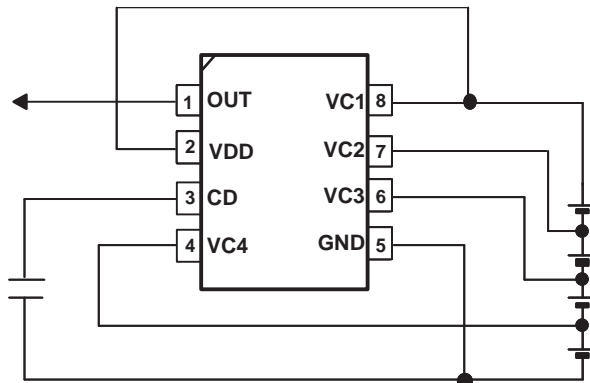


Figure 3. 4-Series Cell Configuration

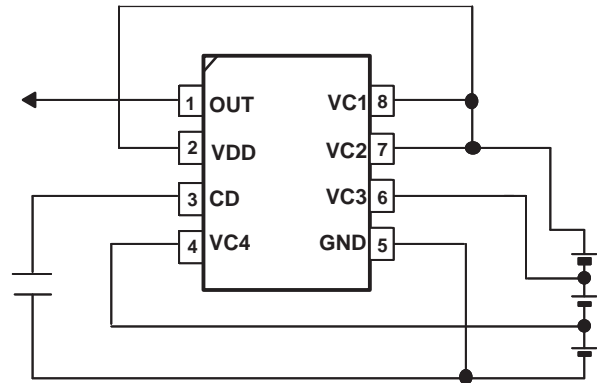


Figure 4. 3-Series Cell Configuration  
 (Connect together VC1 and VC2)

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**Figure 5. 2-Series Cell Configuration**

## **CELL CONNECTIONS**

To prevent incorrect output activation, the following connection sequences must be used.

### *4-Series Cell Configuration*

- VC1(=VDD) VC2 VC3 VC4 GND or
- GND VC4 VC3 VC2 VC1(=VDD)

### *3-Series Cell Configuration*

- VC1(=VC2=VDD) VC3 VC4 GND or
- GND VC4 VC3 VC1(=VC2=VDD)

### *2-Series Cell Configuration*

- VC1(=VC2=VC3=VDD) VC4 GND or
  - GND VC4
-

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
BQ29410DCT3R	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29410DCT3RE6	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29410DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29410DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29410DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29410DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29410PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29410PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29410PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29411DCT3R	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29411DCT3RE6	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29411DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29411DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29411DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29411DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29411PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29411PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29411PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29412DCT3R	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>



Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
BQ29412DCT3RE6	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29412DCT3T	PREVIEW			8		TBD	Call TI	Call TI	Samples Not Available
BQ29412DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29412DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29412DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
BQ29412DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	Contact TI Distributor or Sales Office
BQ29412PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29412PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29412PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29412PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29413DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29413DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29413DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29413DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29413PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29413PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29413PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29413PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29414DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
BQ29414DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29414DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29414DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29414PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29414PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29414PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29414PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29415DCTR	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29415DCTRG4	ACTIVE	SM8	DCT	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Request Free Samples</a>
BQ29415DCTT	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29415DCTTG4	ACTIVE	SM8	DCT	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	<a href="#">Purchase Samples</a>
BQ29415PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29415PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Purchase Samples</a>
BQ29415PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29415PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>
BQ29419PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Contact TI Distributor or Sales Office
BQ29419PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	Contact TI Distributor or Sales Office
BQ29419PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
BQ29419PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	<a href="#">Request Free Samples</a>

<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.

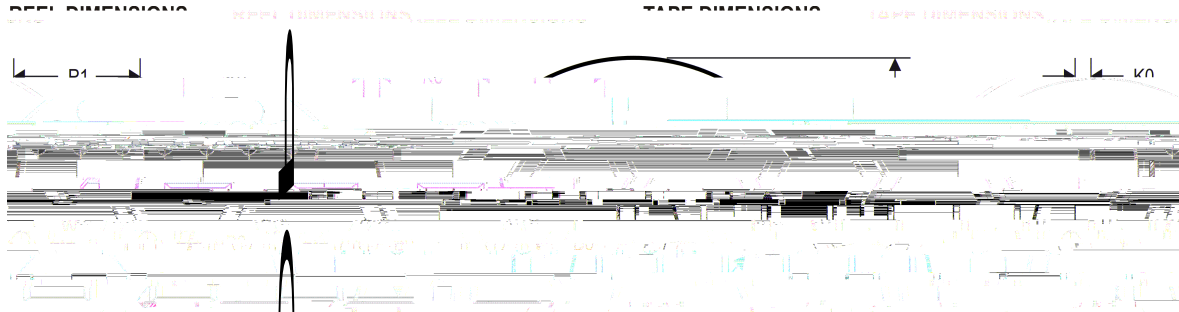
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

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

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

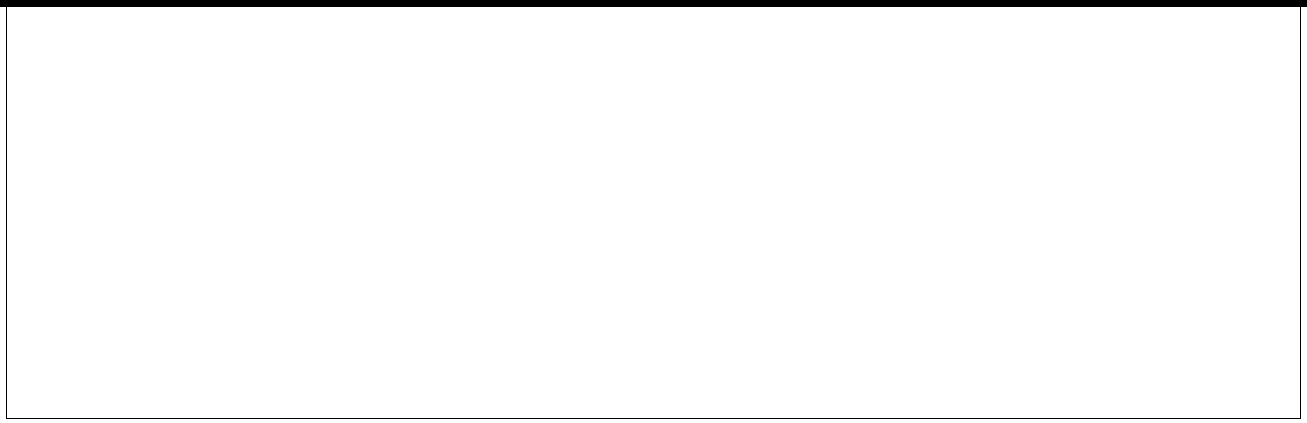
<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

# TAPE AND REEL INFORMATION



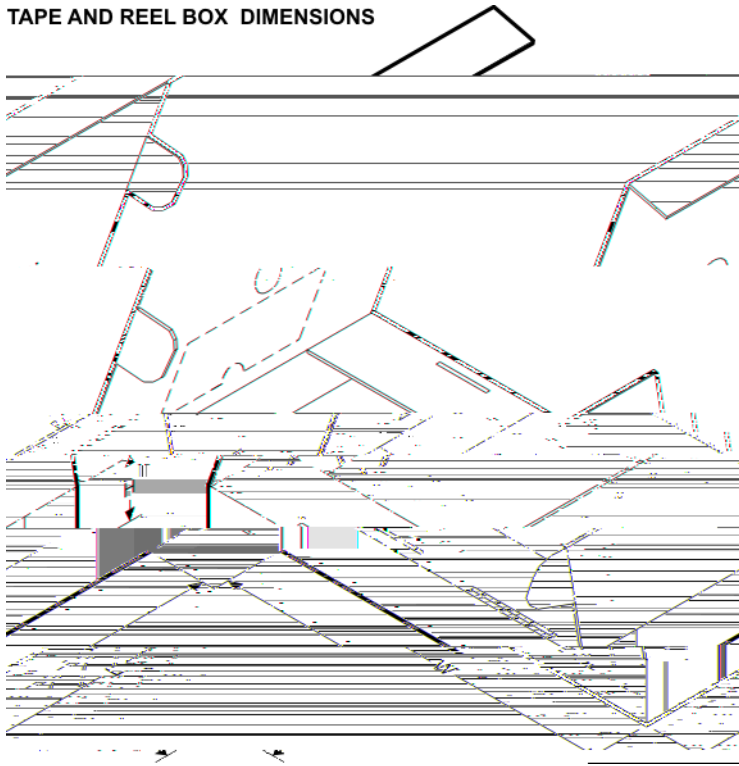
\*All dimensions are nominal

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
BQ29410DCT3R	SM8	DCT	8	3000	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29410DCTR	SM8	DCT	8	3000	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29410DCTT	SM8	DCT	8	250	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29410DCT	SM8	DCT	8	2000	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3

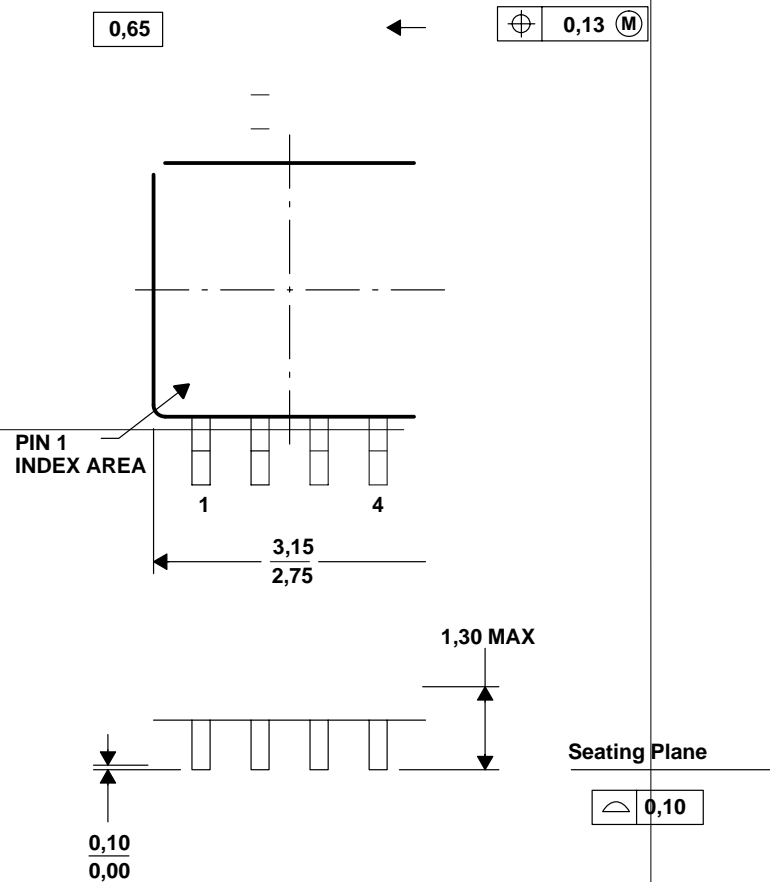


Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
BQ29414DCTT	SM8	DCT	8	250	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29414PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
BQ29415DCTR	SM8	DCT	8	3000	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29415DCTT	SM8	DCT	8	250	180.0	13.0	3.35	4.5	1.55	4.0	12.0	Q3
BQ29415PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
BQ29419PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



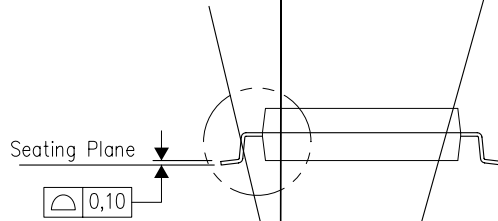
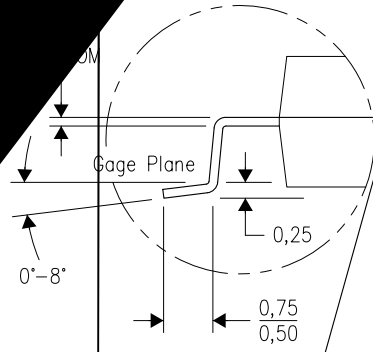
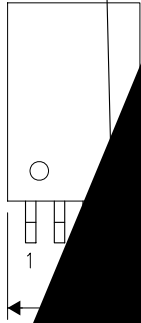
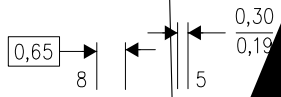
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ29412DCTT	SM8	DCT	8	250	182.0	182.0	20.0
BQ29412PWR	TSSOP	PW	8	2000	367.0	367.0	35.0
BQ29412PWRG4	TSSOP	PW	8	2000	367.0	367.0	35.0
BQ29413DCTR	SM8	DCT	8	3000	182.0	182.0	20.0
BQ29413DCTT	SM8	DCT	8	250	182.0	182.0	20.0
BQ29413PWR	TSSOP	PW	8	2000	367.0	367.0	35.0
BQ29414DCTR	SM8	DCT	8	3000	182.0	182.0	20.0
BQ29414DCTT	SM8	DCT	8	250	182.0	182.0	20.0
BQ29414PWR	TSSOP	PW	8	2000	367.0	367.0	35.0
BQ29415DCTR	SM8	DCT	8	3000	182.0	182.0	20.0
BQ29415DCTT	SM8	DCT	8	250	182.0	182.0	20.0
BQ29415PWR	TSSOP	PW	8	2000	367.0	367.0	35.0
BQ29419PWR	TSSOP	PW	8	2000	367.0	367.0	35.0



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion  
 D. Falls within JEDEC MO-187 variation DA.







NOTES: All linear dimensions are in millimeters. Dimensioning and tolerancing on this drawing is subject to change without notice. Do not include mold flash, protrusions, or burrs. Body width does not include interlead flash. Interlead flash

## **IMPORTANT NOTICE**

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