

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

### FEATURES

- 2-, 3-, or 4-Cell Secondary Protection
- Low Power Consumption  $I_{CC} < 2 \mu A$  [ $V_{CELL(ALL)} < V_{(PROTECT)}$ ]
- High Accuracy Over Sense Voltage:
  - bq29400: 4.35 V  $\pm 25$  mV
  - bq29400A: 4.40 V  $\pm 25$  mV
  - bq29401: 4.45 V  $\pm 25$  mV
  - bq29405: 4.65 V  $\pm 25$  mV
- Prefixed Protection Threshold Voltage
- Programmable Delay Time
- High

### APPLICATIONS

#### 2<sup>nd</sup> Level Protection in Lion Battery Packs in

- Notebook PCs
- Portable Instrumentation
- Medical and Test Equipment

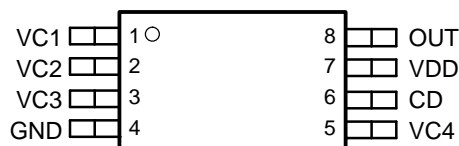
### DESCRIPTION

The bq29400, bq29400A, bq29401, and bq29405 are BiCMOS secondary protection ICs for 2-, 3-, or 4-cell Lithium-Ion battery packs that incorporate a high-accuracy precision over voltage detection circuit. They include a programmable delay circuit for over voltage detection time.

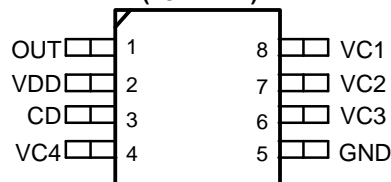
### FUNCTION

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 bq2940x 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.

**PW PACKAGE  
(TOP VIEW)**



**DCT PACKAGE  
(TOP VIEW)**



### ORDERING INFORMATION

T <sub>A</sub>	V <sub>(PROTECT)</sub>	PACKAGE			
		MSSOP (DCT3)	SYMBOL	TSSOP (PW) <sup>(1)</sup>	SYMBOL
–25°C to 85°C	4.35 V	bq29400DCT3	CIQ	bq29400PW	2400
	4.40 V	bq29400ADCT3	CIT	Not Available	-
	4.45 V	bq29401DCT3	CIR	bq29401PW	2401
	4.65 V	bq29405DCT3	CIS	Not Available	-

(1) The bq29400, bq29400A, bq29401, and bq29405 are available taped and reeled. Add an R suffix to the device type (e.g., bq29400PWR) to order tape and reel version.



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.

## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted<sup>(1)(2)</sup>

		UNIT
Supply voltage range	(VDD)	–0.3 V to 28 V
Input voltage range	(VC1, VC2, VC3, VC4)	–0.3 V to 28 V
Output voltage range	(OUT)	–0.3 V to 28 V
	(CD)	–0.3 V to 28 V
Continuous total power dissipation		See Dissipation Rating Table
Storage temperature range, T <sub>stg</sub>		–65°C to 150°C
Lead temperature (soldering, 10 sec)		300°C

- 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.
- All voltages are with respect to ground of this device except the differential voltage of VC1-VC2, VC2-VC3, VC3-VC4 and VC4-GND.

## PACKAGE DISSIPATION RATINGS

PACKAGE	T <sub>A</sub> = 25°C POWER RATING	DERATING FACTOR ABOVE T <sub>A</sub> = 25°C	T <sub>A</sub> = 70°C POWER RATING	T <sub>A</sub> = 85°C POWER RATING
DCT	412 mW	3.3 mW/°C	264 mW	214 mW
PW	525 mW	4.2 mW/°C	336 mW	273 mW

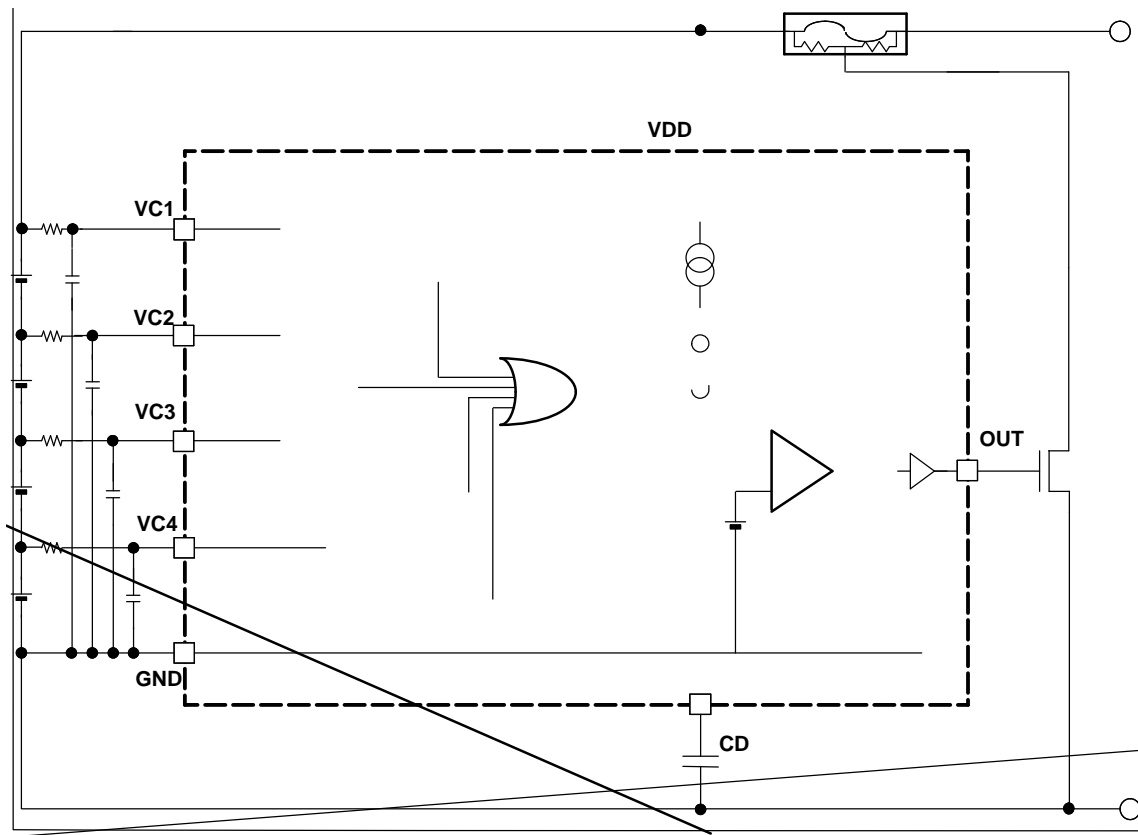
## RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
V <sub>DD</sub>	Supply Voltage	4.0		25	V
V <sub>I</sub>	Input voltage range	0		V <sub>DD</sub> +0.3	V
t <sub>d(CD)</sub>	Delay time capacitance		0.22		μF
R <sub>IN</sub>	Voltage-monitor filter resistance	100	1k		Ω
C <sub>IN</sub>	Voltage-monitor filter capacitance	0.01	0.1		μF
R <sub>VD</sub>	Supply-voltage filter resistance	0		1	kΩ
C <sub>VD</sub>	Supply-voltage filter capacitance		0.1		μF
T <sub>A</sub>	Operating ambient temperature range	–25		85	°C



**Terminal Functions (continued)**

TERMINAL			DESCRIPTION
MSOP (DTC)	TSSOP (PW)	NAME	
3	6	CD	An external capacitor is connected to determine the programmable delay time
2			



**OVERVOLTAGE PROTECTION**

**DELAY TIME CALCULATION**

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

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

Where  $I_{(\text{CD})}$  = CD current source = 0.2  $\mu\text{A}$

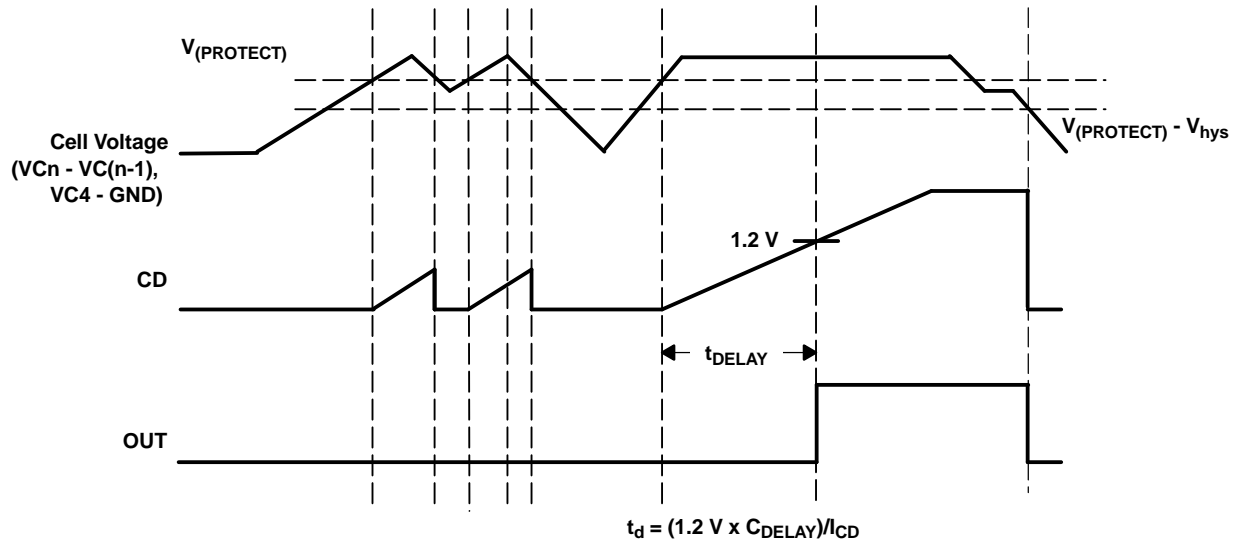


Figure 2. Timing for Overvoltage Sensing

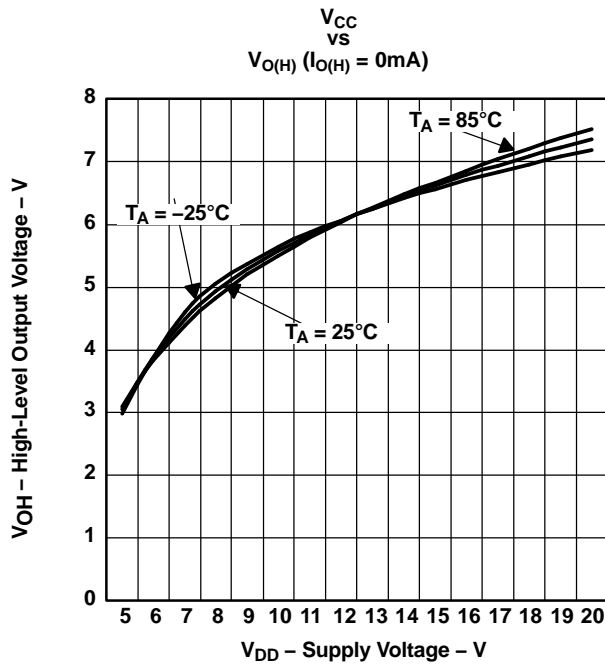


Figure 3.

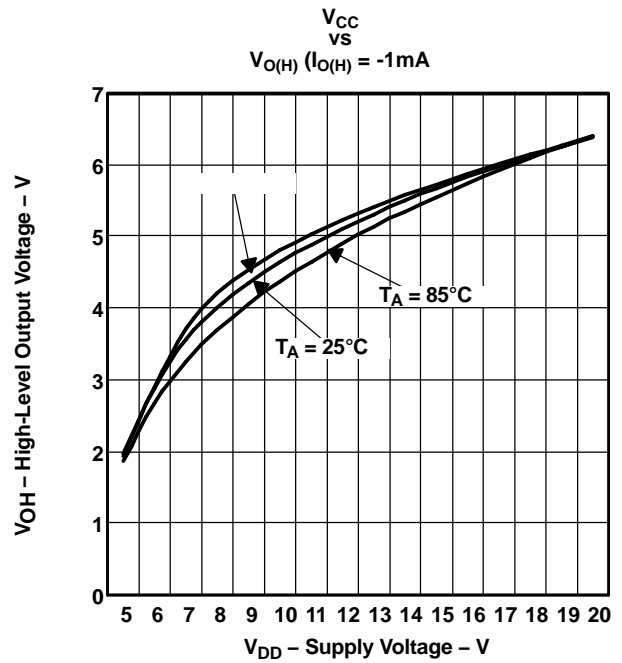


Figure 4.

## APPLICATION INFORMATION

### BATTERY CONNECTIONS

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

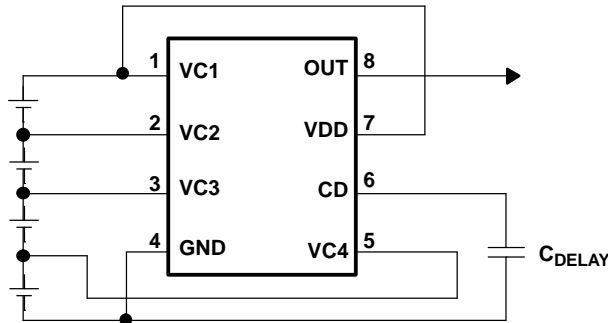


Figure 5. 4-Series Cell Configuration

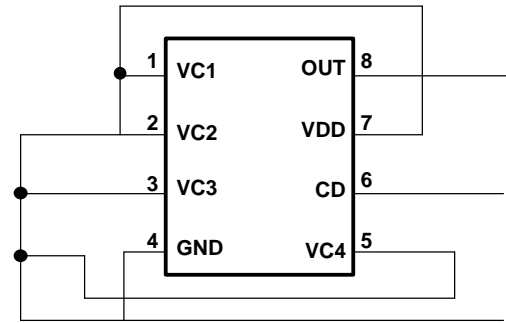


Figure 6. 3-Series Cell Configuration  
(Connect together VC1 and VC2)

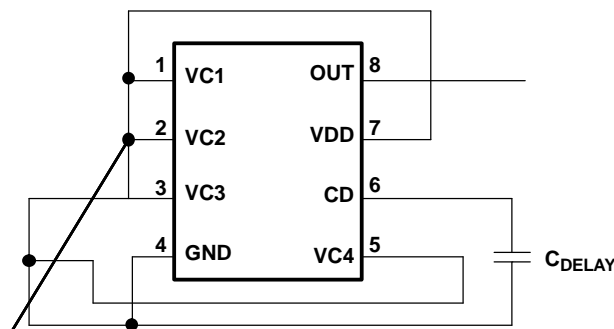


Figure 7. 2-Series Cell Configuration

### 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 → VC1(=VC2=VC3=VDD)

**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
BQ29400ADCT3	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	-25 to 85	CIT W	<a href="#">Samples</a>
BQ29400ADCT3E6	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM	-25 to 85	CIT W	<a href="#">Samples</a>
BQ29400ADCT3R	OBSOLETE	SM8	DCT	8		TBD	Call TI	Call TI			
BQ29400DCT3	ACTIVE	SM8	DCT	8	3000 -20 to 85	Pb-Free (RoHS)	<del>CU SNBI</del>	Level-1-260C-UNLIM		CIQ	<a href="#">Samples</a>
BQ29400DCT3E6	ACTIVE	SM8	DCT	8	3000	Pb-Free (RoHS)	CU SNBI	Level-1-260C-UNLIM		CIQ	<a href="#">Samples</a>
BQ29400PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-25 to 85	29400	<a href="#">Samples</a>
BQ29400PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-25 to 85	29400	<a href="#">Samples</a>
BQ29401DCT	NRND	SM8	DCT	8		TBD	Call TI	Call TI	-20 to 85		
BQ29401DCT3	OBSOLETE	SM8	DCT	8		TBD					

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<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.

**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)

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

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

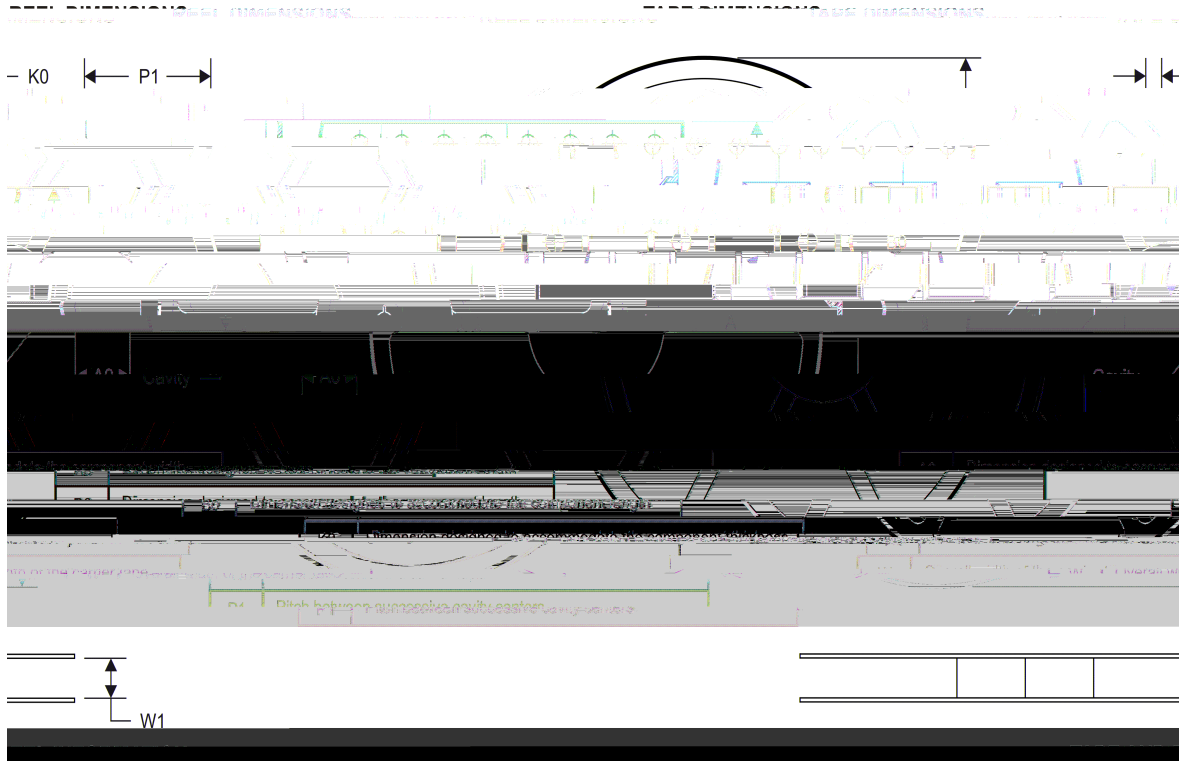
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TAPE AND REEL INFORMATION

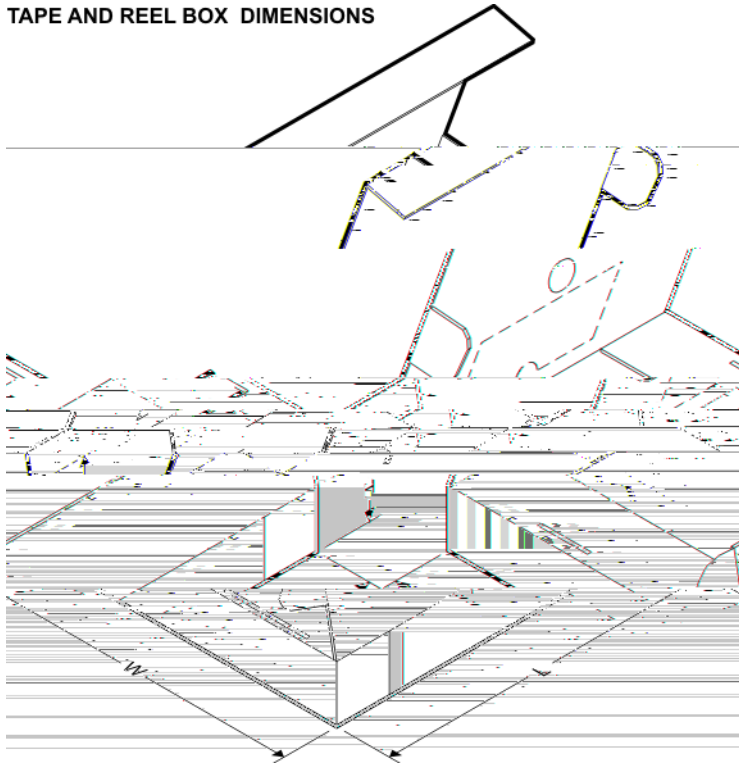


\*All dimensions are nominal

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
BQ29400PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1



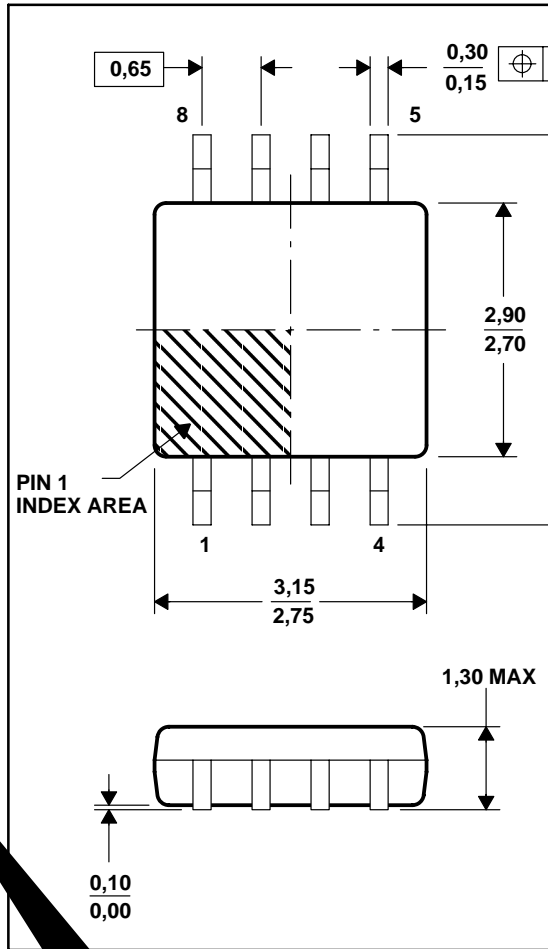
## TAPE AND REEL BOX DIMENSIONS



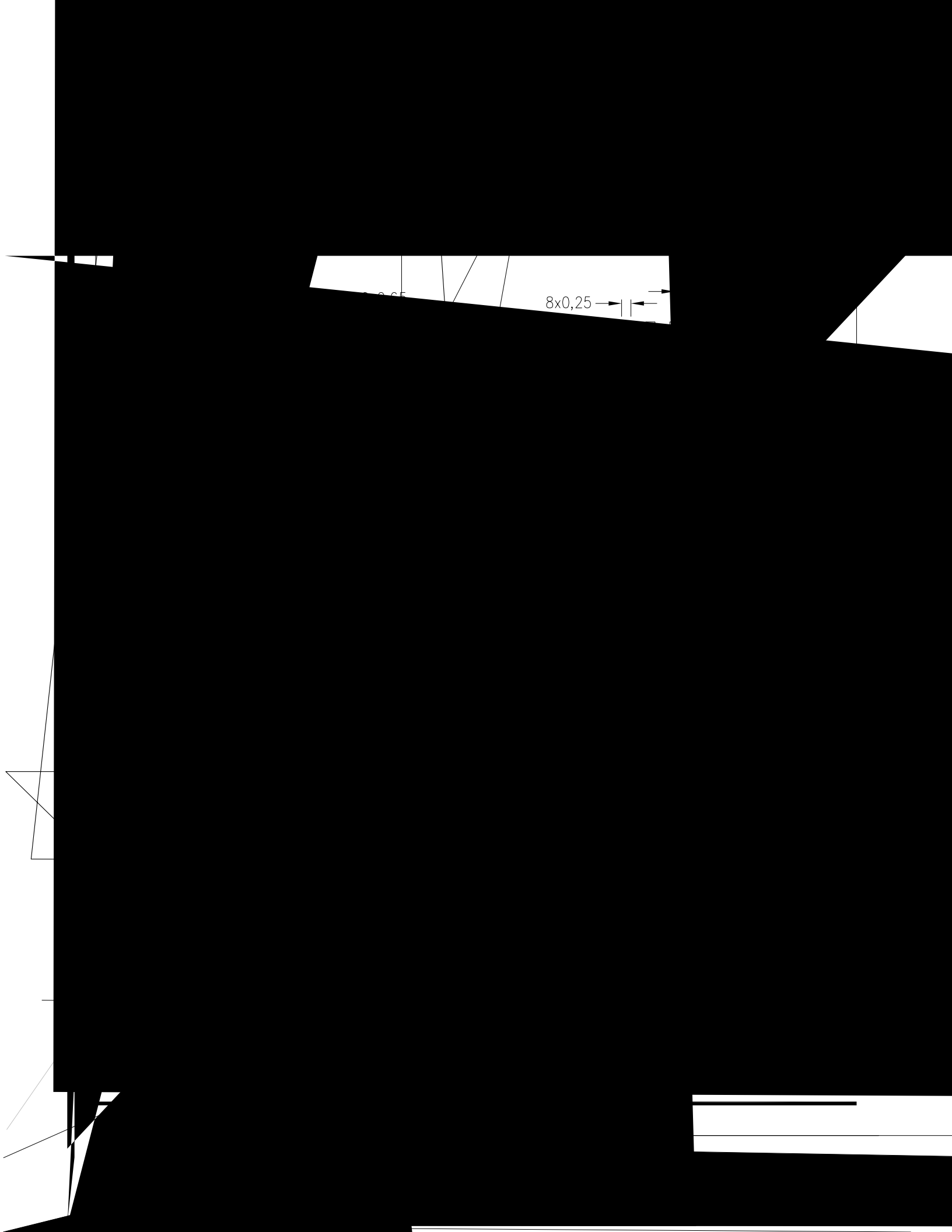
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ29400PWR	TSSOP	PW	8	2000	367.0	367.0	35.0

DCT (R-PDSO-G8)

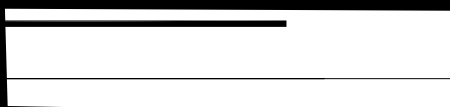


NOTE: All linear dimensions are in millimeters.  
This drawing is subject to change without notice.  
Body dimensions do not include mold flash or protrusions.  
Dimensions within JEDEC MO-187 variation DA.



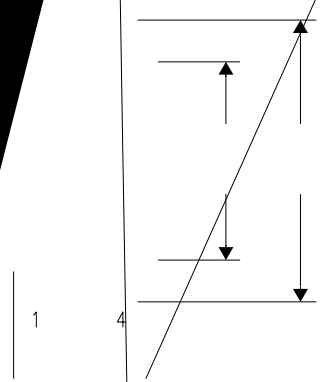
8,65

8x0,25



0

$\phi 0,10$



$\sqrt{0,10}$

40400

NOTES: A. All dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.  
B. This drawing is subject to change without notice.  
C. Molded parts include mold flash, protrusions, or gate burrs. Mold

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