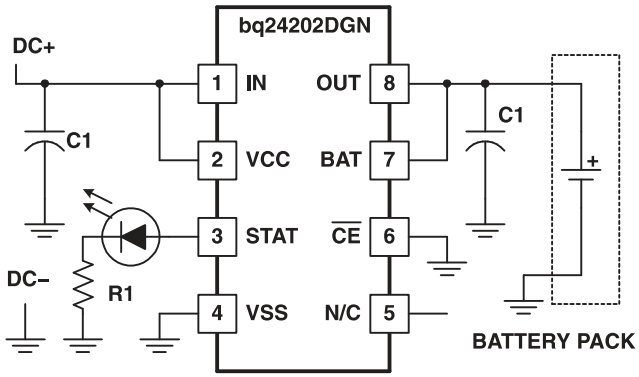
# SINGLE-CHIP LI-ION AND LI-POL CHARGE MANAGEMENT IC FOR CURRENT-LIMITED APPLICATIONS

## FEATURES

- **Designed Specifically to Work With Current-Limited Wall Supplies**
- **Ideal for Low Dropout Charger Design for Single-Cell Li-Ion Packs With Coke or Graphite Anodes**
- **Integrated PowerFET for 500 mA**
- **Integrated Voltage Regulation With 0.5% Accuracy**
- **Battery Insertion and Removal Detection**
- **Charge Termination by Minimum Current and Time**
- **Pre-Charge Conditioning With Safety Timer**
- **Sleep Mode for Low-Power Consumption**
- **Charge Status Output for LED or Host Processor Interface Indicates**
- **Charge-in-Progress, Charge Completion, and Fault Conditions**
- **Optional Temperature Monitoring Before and During Charge**
- **Small, 8-Pin Power-Pad MSOP Package**

## TYPICAL APPLICATION




## DESCRIPTION

The bq2420x series are simple Li-Ion linear charge management devices targeted at low-cost and space limited charger applications. The bq2420x series offer integrated powerFET, high-accuracy voltage regulation, temperature monitoring, charge status, and charge termination, in a single monolithic device.

The bq2420x is designed to work with a current-limited wall-mount transformer and therefore does not provide any current regulation. However, these devices offer a fixed internal current limit to prevent damage to the internal powerFET. A time-limited pre-conditioning phase is provided to condition deeply discharged cells. Once the battery reaches the charge voltage, the high accuracy voltage regulation loop takes over and completes the charge cycle. Charge is terminated based on minimum current. An internal charge timer provides a backup safety for charge termination.

Other standard features include an automatic sleep mode activated when $V_{CC}$ falls below the battery voltage and a recharge feature activated when the battery voltage falls below the $V_{RCH}$ threshold.

In addition to the standard features, the core product provides two additional enhancements: temperature monitoring and status display. The temperature-sense circuit continuously measures battery temperature using an external thermistor and inhibits charge until the battery temperature is within the user-defined thresholds. The STAT pin indicates three conditions of operation of the charger. These conditions are *charge-in-progress, charge complete*, and *fault*. This output can be used to drive an LED or an interface to a microcontroller.

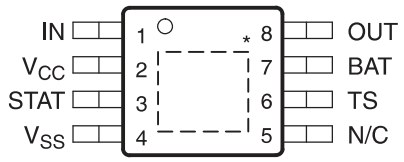
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## AVAILABLE OPTIONS

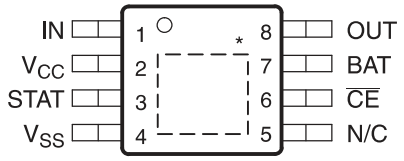
| $T_J$ | CHARGE REGULATION VOLTAGE | OPTIONAL FUNCTIONS | MARKING | PACKAGED DEVICES (DGN)(1) |
|---|---|---|---|---|
| –40°C to 125°C | 4.2 V | STAT and TS | AZC | bq24200DGN |
| | 4.1 V | STAT and TS | AZD | bq24201DGN |
| | 4.2 V | STAT | AZE | bq24202DGN |
| | 4.1 V | STAT | AZF | bq24203DGN |
| | 4.2 V | – | AZG | bq24204DGN |
| | 4.1 V | – | AZI | bq24205DGN |

(1) The DGN package is available taped and reeled. Add TR suffix to device type (e.g. bq24200DGNTR) to order. Quantities 2500 devices per reel.

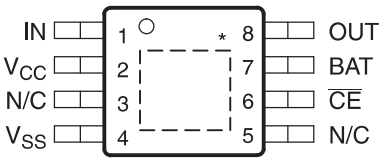
**bq24200, bq24201**
**HTSSOP (DGN) PACKAGE**
**(TOP VIEW)**




**bq24202, bq24203**
**HTSSOP (DGN) PACKAGE**
**(TOP VIEW)**




**bq24204, bq24205**
**HTSSOP (DGN) PACKAGE**
**(TOP VIEW)**




## TERMINAL FUNCTIONS

| NAME | TERMINAL NO. bq24200 bq24201 | TERMINAL NO. bq24202 bq24203 | TERMINAL NO. bq24204 bq24205 | I/O | DESCRIPTION |
|---|---|---|---|---|---|
| BAT | 7 | 7 | 7 | I | Battery voltage sense input |
| $\overline{CE}$ | – | 6 | 6 | I | Charge enable input (active low) |
| IN | 1 | 1 | 1 | I | Charge input voltage |
| N/C | 5 | 5 | 3, 5 | – | No connection. Must be left floating |
| OUT | 8 | 8 | 8 | O | Charge current output |
| STAT | 3 | 3 | – | O | Charge status output |
| TS | 6 | – | – | I | Temperature sense input |
| $V_{CC}$ | 2 | 2 | 2 | I | $V_{CC}$ input |
| $V_{SS}$ | 4 | 4 | 4 | – | Ground input |

## ABSOLUTE MAXIMUM RATINGS(1)

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

| | | VALUE | UNIT |
|---|---|---|---|
| | Supply voltage (Vcc with respect to GND) | 16.5 | V |
| | Input voltage, IN, STAT, TS (all with respect to GND) | 16.5 | V |
| | Input voltage, BAT, OUT (all with respect to GND) | 7 | V |
| | Output sink/source current (STAT) | 15 | mA |
| $T_{stg}$ | Storage temperature range | –65 to 150 | °C |
| $T_J$ | Junction temperature range | –40 to 125 | °C |
| | Lead temperature (soldering, 10 sec) | 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.

## DISSIPATION RATINGS

| PACKAGE | THERMAL IMPEDANCE JUNCTION-TO-AMBIENT ($\theta_{JA}$) | THERMAL IMPEDANCE JUNCTION-TO-CASE ($\theta_{JC}$) | $T_A \le 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25°C$ |
|---|---|---|---|---|
| 8 Pin DGN(1) | 57.20°C/W | 4.4°C/W | 1.75 W | 0.017 W/°C |

(1) This data is based on using JEDEC High-K board and topside traces, top and bottom thermal pad (2 mm × 3 mm), internal 1 oz. power and ground planes, four thermal via underneath the die connecting to ground plane.

## RECOMMENDED OPERATING CONDITIONS

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | $V_{(LOWV-MIN)}$ | 13.5 | V |
| $V_{IN}$ | Input voltage | $V_{(LOWV-MIN)}$ | 13.5 | |
| $T_J$ | Operating junction temperature range | –40 | 125 | °C |

## ELECTRICAL CHARACTERISTICS

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{CC(VCC)}$ | Vcc Current | Vcc > Vcc(min) | | 1.7 | 2.5 | mA |
| $I_{CC(SLP)}$ | Sleep current | Sum of currents into OUT and BAT pins, Vcc < $V_{(SLP)}$, 0°C ≤ $T_J$ ≤ 85°C | | | 5 | µA |
| | | Sum of currents into OUT and BAT pins, Vcc < $V_{(SLP)}$ | | | 10 | µA |
| $I_{CC(STDBY)}$ | Standby current | Sum of currents into Vcc, IN and TS pins, (Vcc–$V_{I(TS)}$) ≤ 300 mV | | | 1 | mA |
| $I_{IB(BAT)}$ | Input bias current on BAT pin | | | | 1 | µA |
| $I_{IB(TB)}$ | Input bias current on TS pin | 0.1 × Vcc ≤ $V_{I(TS)}$ ≤ 0.8 × Vcc | | | 1 | µA |

## VOLTAGE REGULATION

$V_{O(REG)}$ + $V_{(DO.MAX)}$ ≤ VCC, $I_{(TERM)}$ < $I_{O(OUT)}$ ≤500 mA, over 0°C ≤ $T_J$ ≤125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{O(REG)}$ | Output voltage | $V_{O(REG)}$ + $V_{(DO–MAX)}$ ≤ 10 V, $I_{(TERM)}$ < $I_{O(OUT)}$ ≤ 250 mA | 4.0795 | 4.10 | 4.1205 | V |
| | | | 4.05 | 4.10 | 4.15 | V |
| | | $V_{O(REG)}$ + $V_{(DO–MAX)}$ ≤ 10 V, $I_{(TERM)}$ < $I_{O(OUT)}$ ≤ 250 mA | 4.1790 | 4.20 | 4.2210 | V |
| | | | 4.15 | 4.20 | 4.25 | V |
| $V_{(DO)}$ | Dropout voltage ($V_{(IN)}$ – $V_{(OUT)}$) | $V_{O(REG)}$ + $V_{(DO–MAX)}$ ≤ Vcc, $I_{O(OUT)}$ = 500 mA | 200 | 350 | 500 | mV |

## OUTPUT CURRENT

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{O(OUT)}$ | Output current | See (1) | | | 500 | mA |
| $I_{(SC)}$ | Short-circuit trip current | See (1) | 1 | | 1.6 | A |

(1) Assured by design, not production tested.

## PRE-CHARGE CURRENT REGULATION

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{(PRECHG)}$ | Pre-charge current | $V_{I(BAT)} < V_{(LOWV)}$, $t < t_{(30min)}$ | 10 | 13.5 | 19 | mA |
| $I_{(DETECT)}$ | Battery detection current | $V_{I(BAT)} < 2.5$ V, $t < t_{(30min)}$ | 160 | 210 | 300 | µA |

## CHARGE TERMINATION DETECTION

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{(TAPER)}$ | Taper current detect threshold | $V_{I(BAT)} > V_{(RCH)}$ | 21 | 25.5 | 31 | mA |
| $I_{(TERM)}$ | Charge termination current detect threshold | $V_{I(BAT)} > V_{(RCH)}$ | 0.8 | 1.1 | 1.4 | mA |

## TEMPERATURE COMPARATOR

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{(TS1)}$ | Lower temperature threshold | TS pin voltage | | 30 | | %VCC |
| $V_{(TS2)}$ | Upper temperature threshold | TS pin voltage | | 60 | | %VCC |
| | Accuracy | | –0.7 | | 0.7 | %VCC |
| | Hysteresis | | | 1 | | %VCC |

## LOW VOLTAGE BATTERY THRESHOLD

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{(LOWV)}$ | LowV threshold | 0°C ≤ $T_J$ ≤ 85°C | 2.8 | 2.95 | 3.1 | V |
| | | | 2.8 | 3.0 | 3.2 | V |

## BATTERY RECHARGE THRESHOLD

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Recharge threshold, $V_{RCH}$ (typically 100 mV below regulation) | | $V_{O(REG)}$ –0.115 | $V_{O(REG)}$ –0.1 | $V_{O(REG)}$ –0.085 | V |

## STAT OUTPUT

Vcc ≥ $V_{O(REG)}$ , over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{OL(STAT)}$ | Output (low) saturation voltage | $I_O$ = 10 mA | | | 0.5 | V |
| $V_{OH(STAT)}$ | Output (high) saturation voltage | $I_O$ = –5 mA | Vcc–1.5 | | | V |

## $\overline{CE}$

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{IL(CE)}$ | Input (low) voltage | $I_{IL}$ = 5 µA | 0 | | Vcc–1 | V |
| $V_{IH(CE)}$ | Input (high) voltage | $I_{IH}$ = 20 µA | Vcc–0.3 | | | V |

## TIMERS

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{(PRECHG)}$ | Pre-charge and taper timer | | 1,548 | 2,065 | 2,581 | sec |
| $t_{(TAPER)}$ | Taper timer | | 1,548 | 2,065 | 2,581 | sec |
| $t_{(CHG)}$ | Charge timer | | 9,292 | 12,389 | 15,486 | sec |

## SLEEP COMPARATOR

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{(SLP)}$ | Sleep-mode threshold | 2.3 V ≤ $V_{I(BAT)}$ ≤ $V_{O(REG)}$ | V(BAT) –10mV | | | V |

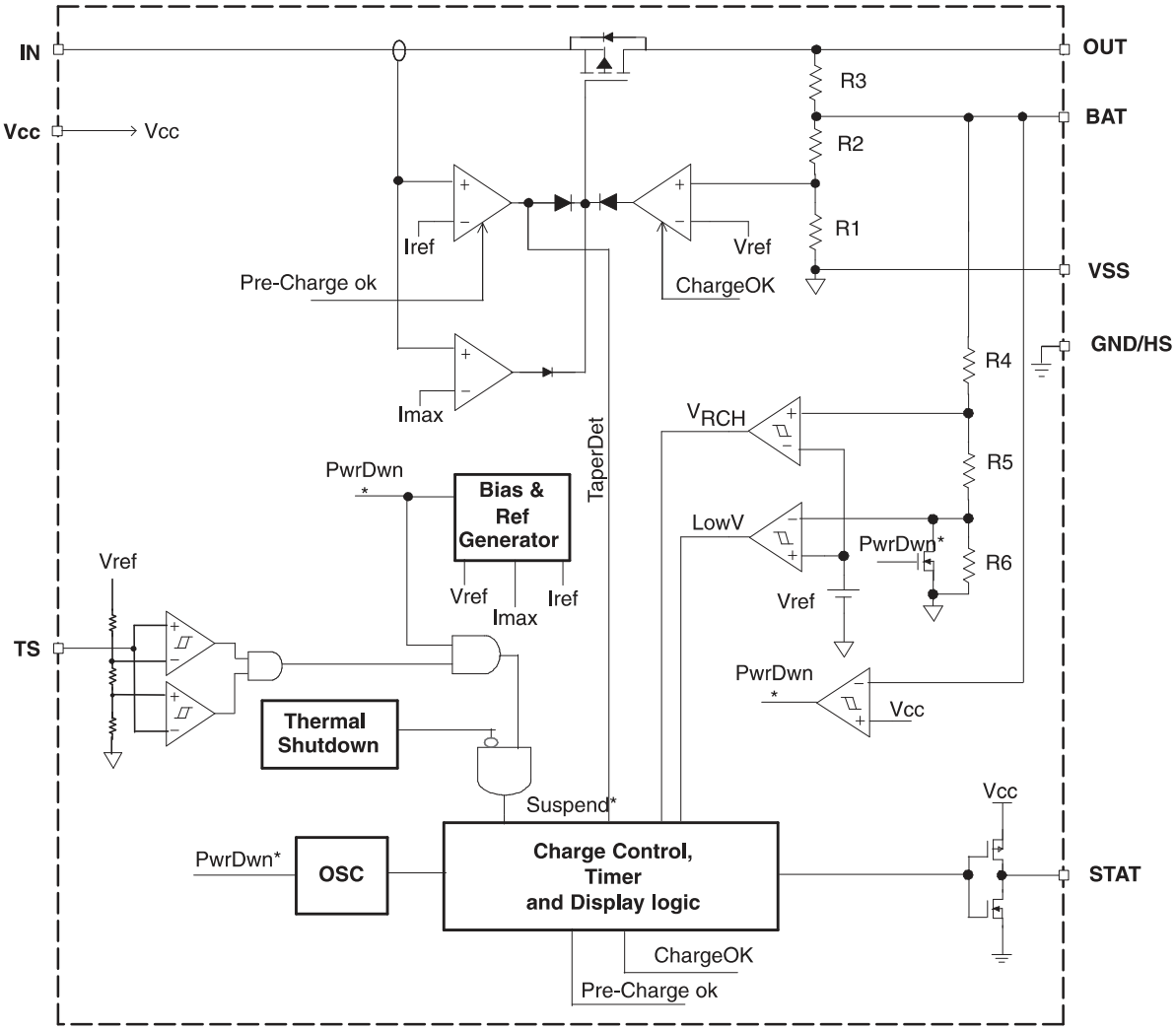
## POWER-ON-RESET AND $V_{IN}$ RAMP RATE

over 0°C ≤ $T_J$ ≤ 125°C and supply voltage range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{POR}$ | POR threshold | See (1) | 2.3 | 2.4 | 2.5 | V |
| | Slew rate | See (1) | 5 | | $5\times10^{-5}$ | V/µs |

(1) Ensured by design, not production tested.

## FUNCTIONAL BLOCK DIAGRAM




## DETAILED DESCRIPTION

**IN:** This pin is connected to the source of the internal P-channel powerFET.

**OUT:** This pin is connected to the drain of the internal P-channel powerFET.

**Battery voltage sense (BAT):** Voltage sense-input tied directly to the positive side of the battery.

**Temperature sense input (TS):** Input for an external battery-temperature monitoring circuit.

**Charge status output (STAT):** High-impedance indication of various charge conditions.

**Supply voltage input (VCC):** Power supply input

## TYPICAL CHARACTERISTICS

OUTPUT VOLTAGE
vs
JUNCTION TEMPERATURE

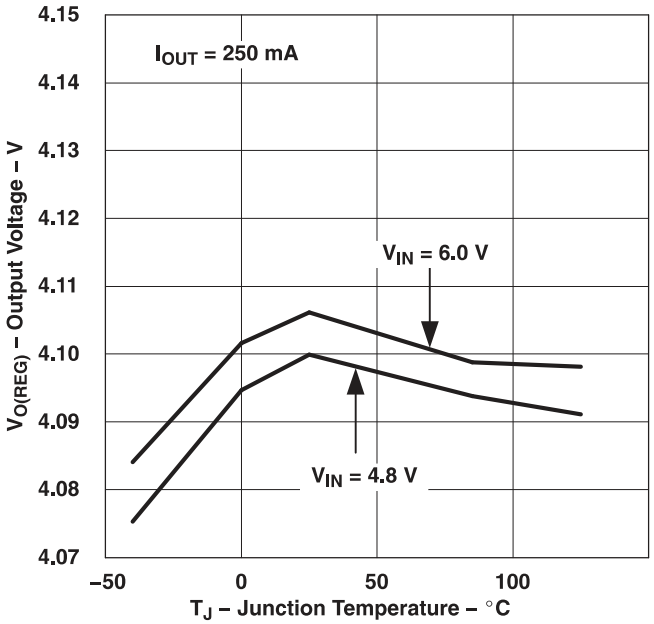



Figure 1.

DROPOUT VOLTAGE
vs
JUNCTION TEMPERATURE

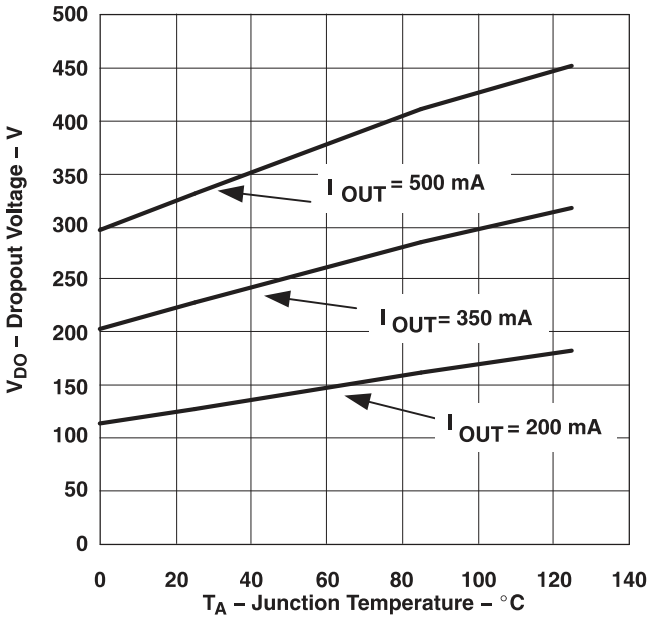



Figure 2.

DROPOUT VOLTAGE
vs
OUTPUT VOLTAGE

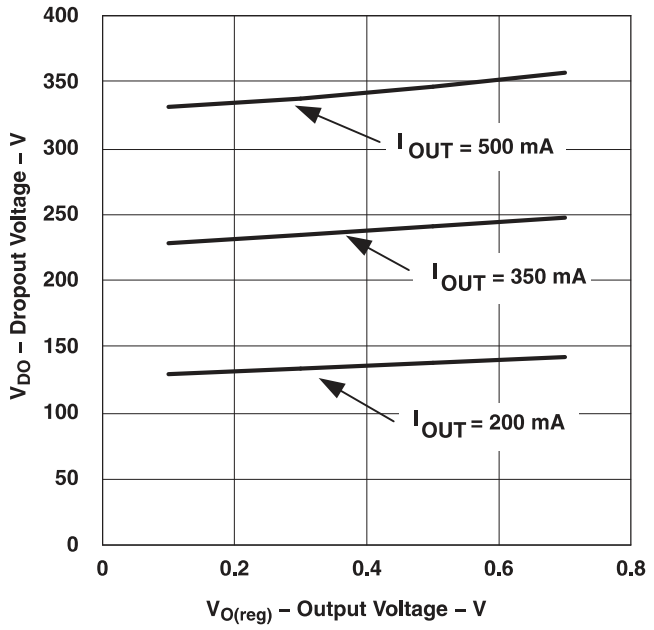



Figure 3.

SUPPLY CURRENT
vs
JUNCTION TEMPERATURE

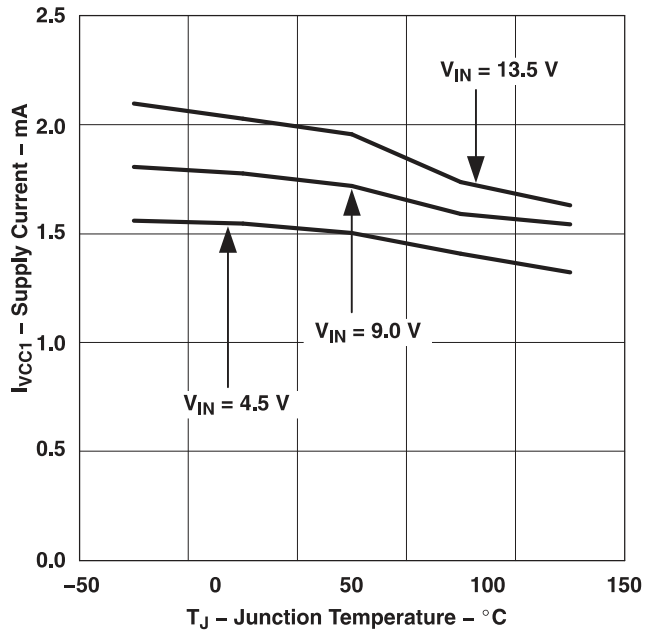



Figure 4.

## APPLICATION INFORMATION

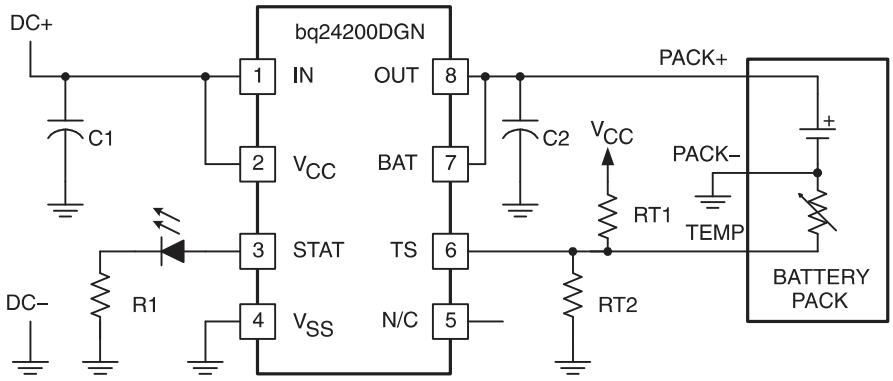



**Figure 5. Low Dropout Single-Cell Li-Ion/Li-Pol Charger**

## FUNCTIONAL DESCRIPTION

The bq2420x supports a precision Li-Ion or Li-Pol charging system suitable for single-cells with either coke or graphite anodes. Figure 5 shows an application schematic and Figure 6 shows the typical charge profile.

## TEMPERATURE QUALIFICATION (bq24200 and bq24202 only)

The bq24200 and bq24201 continuously monitors battery temperature by measuring the voltage between the TS and VSS pins. A negative- or a positive-temperature coefficient thermistor (NTC, PTC) and an external voltage divider typically develop this voltage (see Figure 5). The bq24200 and bq24201 compare this voltage against the internal $V_{(TS1)}$ and $V_{(TS2)}$ thresholds to determine if charging is allowed (see Figure 7). The temperature sensing circuit is immune to any fluctuation in Vcc since both the external voltage divider and the internal thresholds are referenced to Vcc.

Once a temperature outside the $V_{(TS1)}$ and $V_{(TS2)}$ thresholds is detected the bq24200 and bq24201 immediately suspend the charge. The bq24200 and bq24201 suspend the charge by turning off the power FET and holding the timer value (i.e., timers are NOT reset). Charge is resumed when the temperature returns to the normal range.

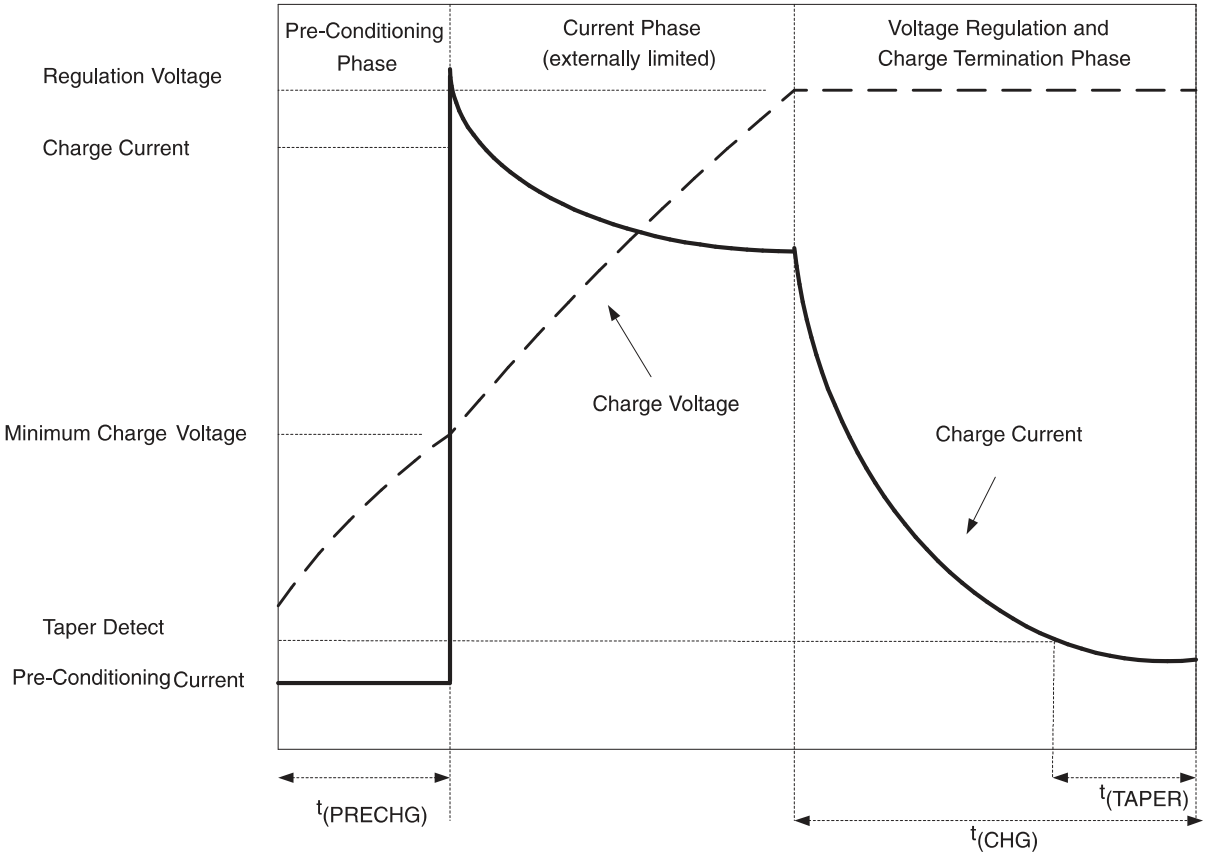



**Figure 6. Typical Charge Profile**

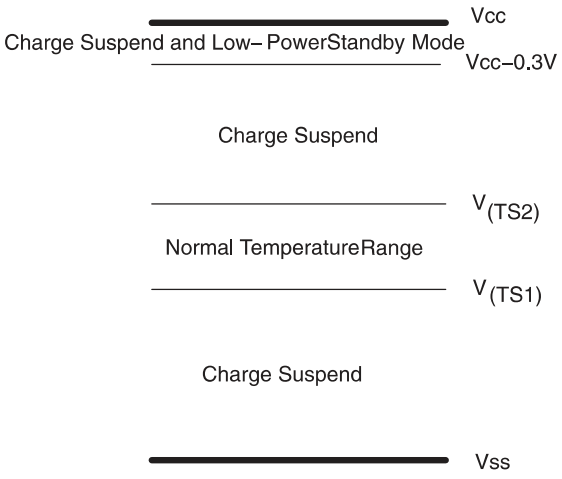



**Figure 7. TS Pin Thresholds**

## OPERATIONAL FLOW DIAGRAM

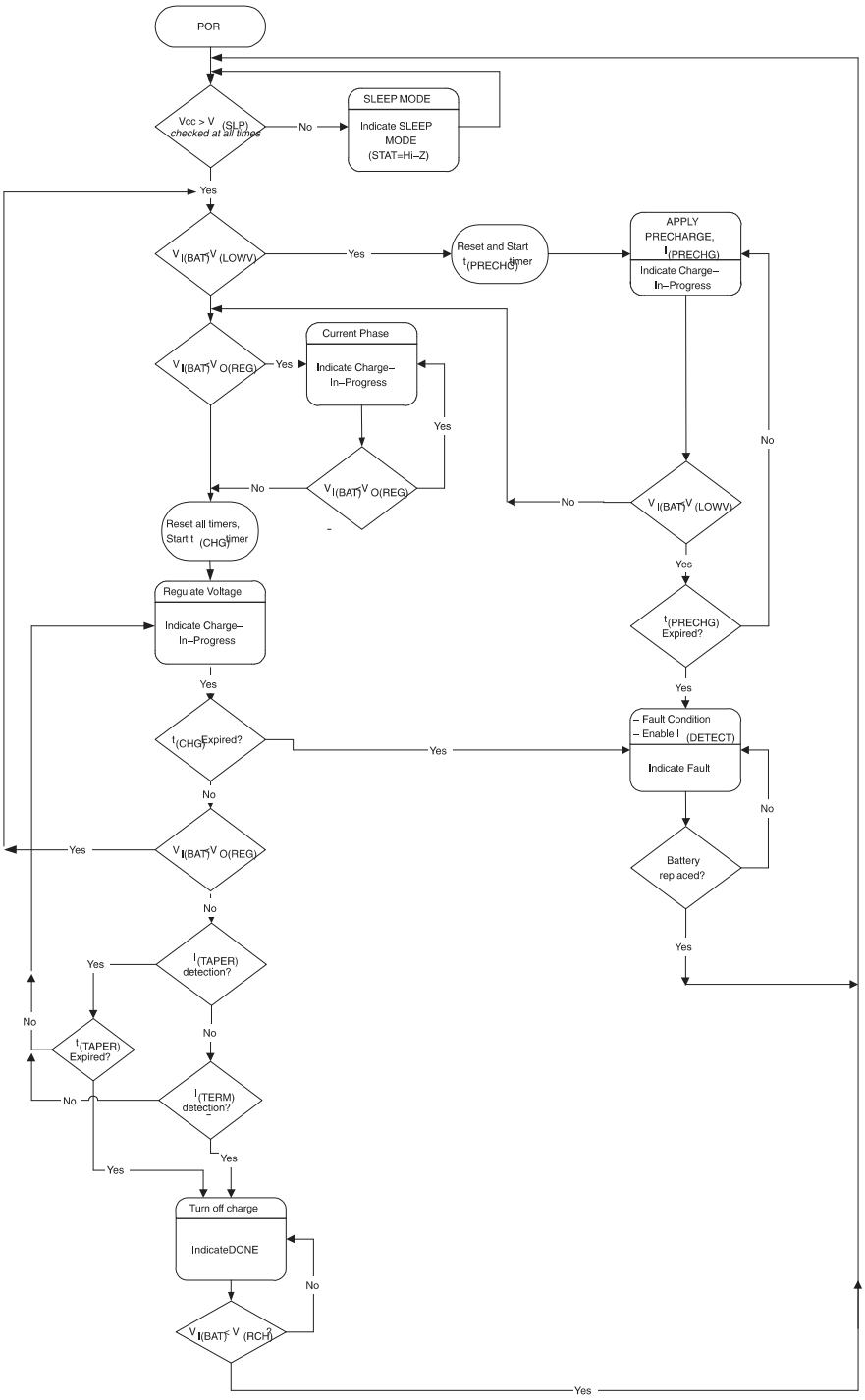



**Figure 8. Operational Flow Chart**

The resistor values of RT1 and RT2 are calculated by the following equations:

For NTC Thermistors:

$$R_{T1} = \frac{\left(5 \times RT_H \times RT_C\right)}{\left(3 \times \left(RT_C - RT_H\right)\right)} \quad (1)$$

$$R_{T2} = \frac{\left(5 \times RT_H \times RT_C\right)}{\left(2 \times RT_C\right) - \left(7 \times RT_H\right)} \quad (2)$$

For PTC Thermisters:

$$R_{T1} = \frac{\left(5 \times RT_H \times RT_C\right)}{\left(3 \times \left(RT_H - RT_C\right)\right)} \quad (3)$$

$$R_{T2} = \frac{\left(5 \times RT_H \times RT_C\right)}{\left(2 \times RT_H\right) - \left(7 \times RT_C\right)} \quad (4)$$

Where $RT_C$ is the cold temperature resistance and $RT_H$ is the hot temperature resistance of thermistor, as specified by the thermistor manufacturer.

$R_{T1}$ or $R_{T2}$ can be omitted If only one temperature (hot or cold) setting is required. Applying a voltage between the $V_{TS1}$ and $V_{TS2}$ thresholds to pin TS disables the temperature-sensing feature. Also applying a voltage between ($V_{CC}$ – 0.3 V) and Vcc suspends the charge and places the IC in the low-power standby mode.

## BATTERY PRE-CONDITIONING

Figure 7 shows the operational flow chart for the bq2420x.

Upon power-up, if the battery voltage is below the $V_{(LOWV)}$ threshold, the bq2420x applies a pre-charge current, $I_{(PRECHG)}$, to the battery. This feature revives deeply discharged cells. The bq2420x activates a safety timer, $t_{(PRECHG)}$, during the conditioning phase. If $V_{(LOWV)}$ threshold is not reached within the timer period, the bq2420x turns off the charger and enunciates FAULT on the STAT pin. In the case of a FAULT condition, the bq2420x reduces the current to $I_{(DETECT)}$. $I_{(DETECT)}$ is used to detect a battery replacement condition. Fault condition is cleared by POR or battery replacement.

## BATTERY CHARGE CURRENT

Following a successful pre-conditioning, the bq2420x relies on an external current-limited supply to limit the charge current to the cell. The bq2420x continues this phase until the battery reaches the voltage regulation phase.

During this phase (and all other phases of operation) in order to protect the integrated powerFET, the internal short circuit and thermal protection circuits are active.

## BATTERY VOLTAGE REGULATION

The voltage regulation feedback is through the BAT pin. This input is tied directly to the positive side of the battery pack. The bq2420x monitors the battery-pack voltage between the BAT and VSS pins. The bq2420x is offered in two fixed-voltage versions: 4.1 V and 4.2 V.

As a safety backup, the bq2420x also monitors the charge time in the voltage regulation mode. If taper current is not detected within this time period, $t_{(CHG)}$, the bq2420x turns off the charger and enunciates FAULT on the STAT pin. Fault condition is cleared by POR or battery replacement. Note that the safety timer is reset if the bq2420x is forced out of the voltage regulation mode.

## CHARGE TERMINATION AND RECHARGE

The bq2420x monitors the charging current during the voltage regulation phase. Once the taper threshold, $I_{(TAPER)}$, is detected the bq2420x initiates the taper timer, $t_{(TAPER)}$. Charge is terminated after the timer expires. The bq2420x resets the taper timer in the event that the charge current returns above the taper threshold, $I_{(TAPER)}$.

In addition to the taper current detection, the bq2420x terminates charge in the event that the charge current falls below the $I_{(TERM)}$ threshold. This feature allows for quick recognition of a battery removal condition.

After a charge termination, the bq2420x restarts the charge once the voltage on the BAT pin falls below the $V_{(RCH)}$ threshold. This feature keeps the battery at full capacity at all times.

## SLEEP MODE

The bq2420x enters the low-power sleep mode if the Vcc is removed from the circuit (i.e., the Vcc and IN pins are floating). For applications where these pins are not floating, placing a low-power 10 Ω (1/16 W) between the IN and VCC pins ensures the $V_{(SLP)}$ conditions are met (see Figure 9).This feature prevents draining the battery during the absence of $V_{CC}$.

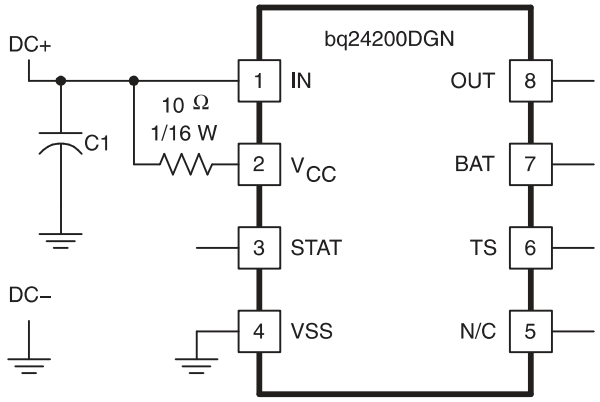



**Figure 9. Sleep Mode**

## CHARGE ENABLE PIN

The $\overline{CE}$ pin on bq24202, bq24203, bq24204 and bq24205 can be used to enable or suspend the charge. Charge is enabled if the voltage $V_{IL(CE)}$ is applied to the pin. Applying the $V_{IH(CE)}$ suspends the charge. During a charge suspend mode, the internal powerFET is turned off and all timers are reset.

## CHARGE STATUS OUTPUT

The STAT pin on the bq2420x, indicates various conditions of operation. These conditions are summarized in Table 1.

**Table 1. STAT Pin**

| CONDITION | STAT |
|---|---|
| Pre-charge | High |
| Fast-charge | High |
| Charge-complete | Low |
| Taper timer done | Low |
| Charge suspend (due to temperature or $\overline{CE}$ input) | Hi-Z |
| Thermal shutdown | Hi-Z |
| Pre-charge timer fault | Hi-Z |
| Sleep mode | Hi-Z |
| Charge timer fault | Hi-Z |

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BQ24200DGN | ACTIVE | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZC | Samples |
| BQ24200DGNR | ACTIVE | HVSSOP | DGN | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZC | Samples |
| BQ24201DGN | ACTIVE | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZD | Samples |
| BQ24202DGN | ACTIVE | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZE | Samples |
| BQ24202DGNR | ACTIVE | HVSSOP | DGN | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZE | Samples |
| BQ24203DGN | ACTIVE | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZF | Samples |
| BQ24205DGN | ACTIVE | HVSSOP | DGN | 8 | 80 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | AZI | 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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

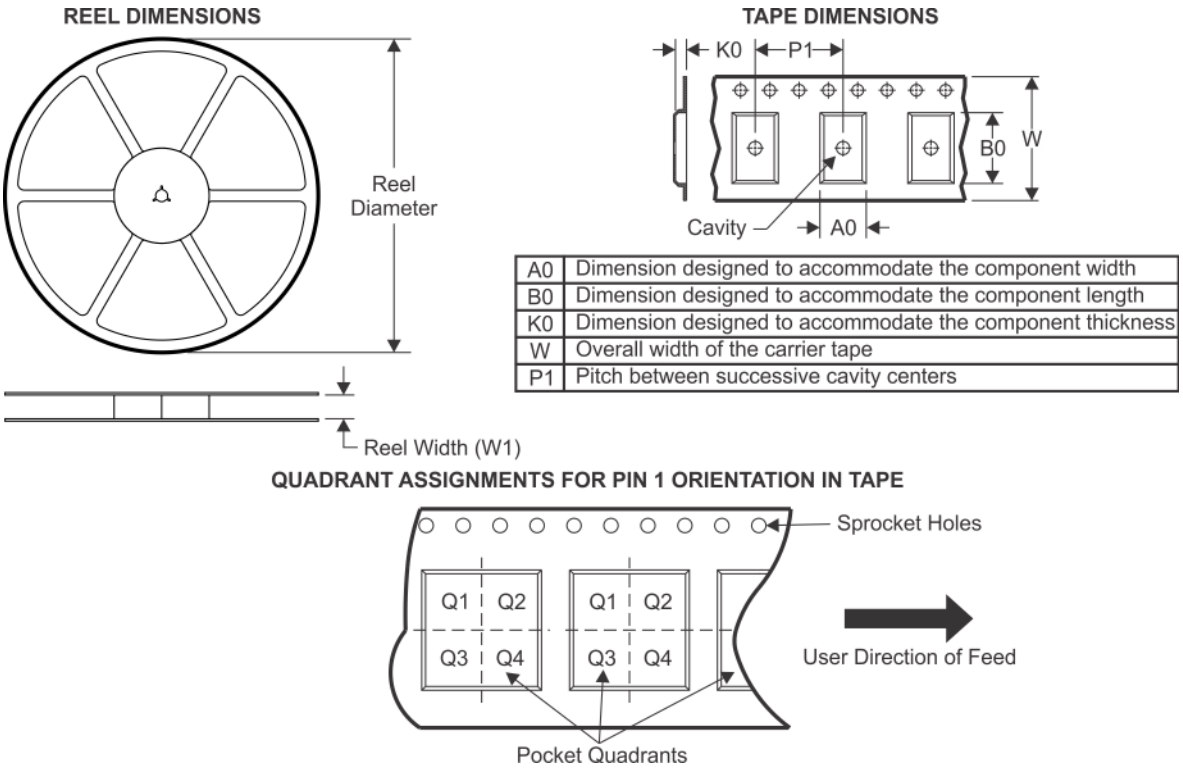
(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

## TAPE AND REEL INFORMATION

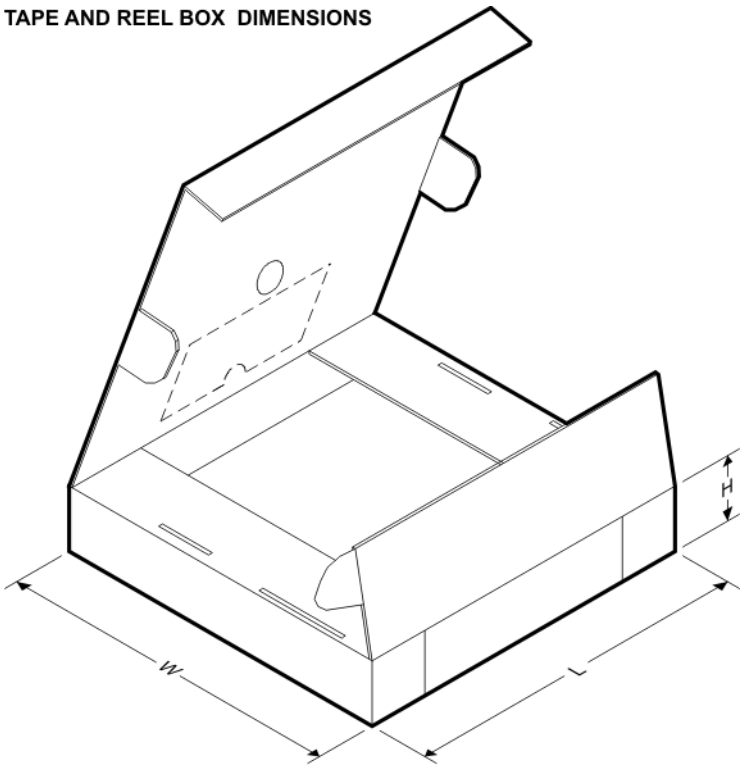



| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BQ24200DGNR | HVSSOP | DGN | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| BQ24202DGNR | HVSSOP | DGN | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 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) |
|---|---|---|---|---|---|---|---|
| BQ24200DGNR | HVSSOP | DGN | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| BQ24202DGNR | HVSSOP | DGN | 8 | 2500 | 358.0 | 335.0 | 35.0 |

# GENERIC PACKAGE VIEW

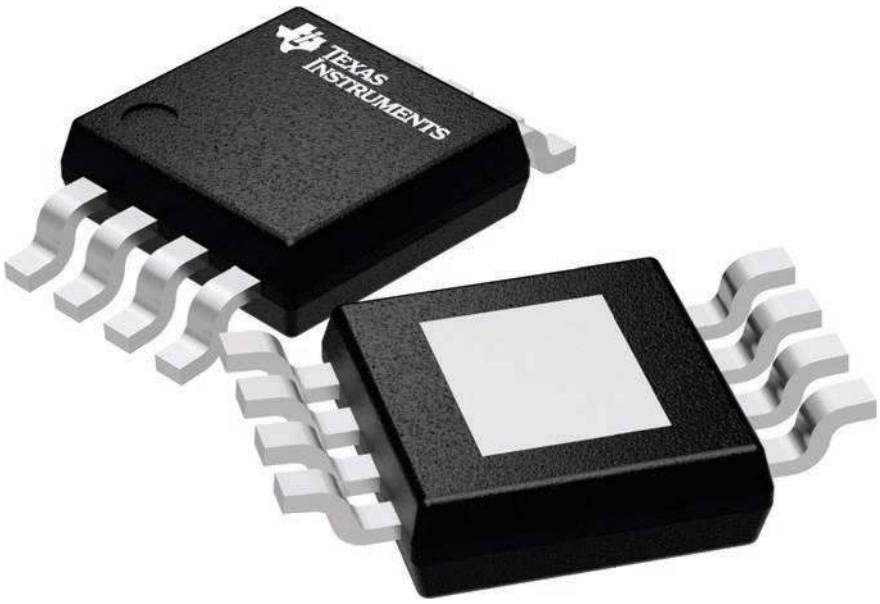
## DGN 8

## PowerPAD VSSOP - 1.1 mm max height

**3 x 3, 0.65 mm pitch**

SMALL OUTLINE PACKAGE

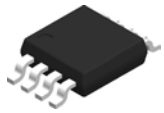
This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.




4225482/A

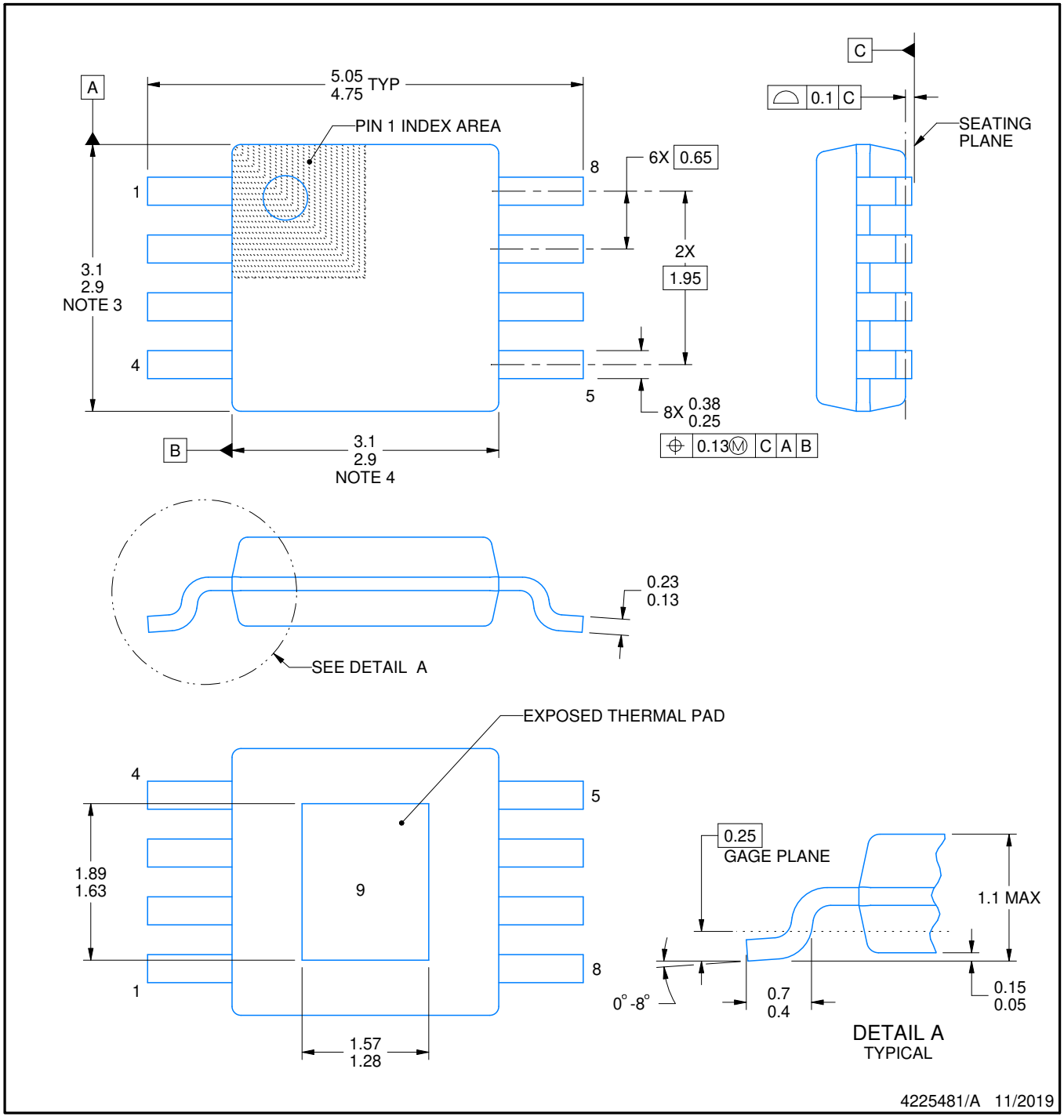
# PACKAGE OUTLINE

## DGN0008D



## PowerPAD™ VSSOP - 1.1 mm max height

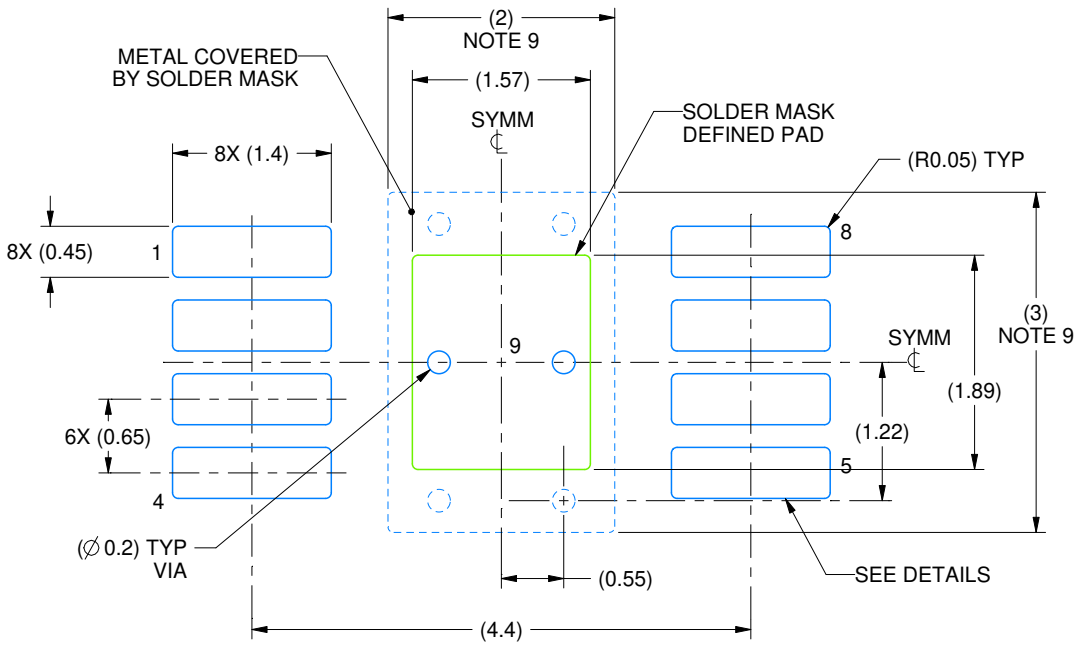
SMALL OUTLINE PACKAGE



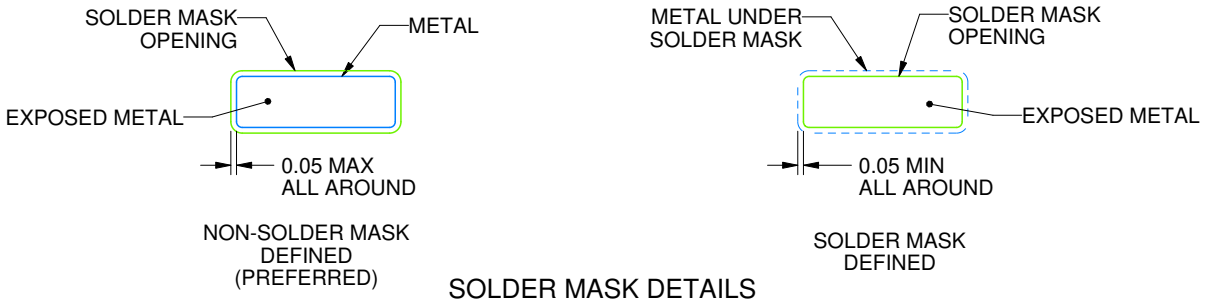

PowerPAD is a trademark of Texas Instruments.

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X

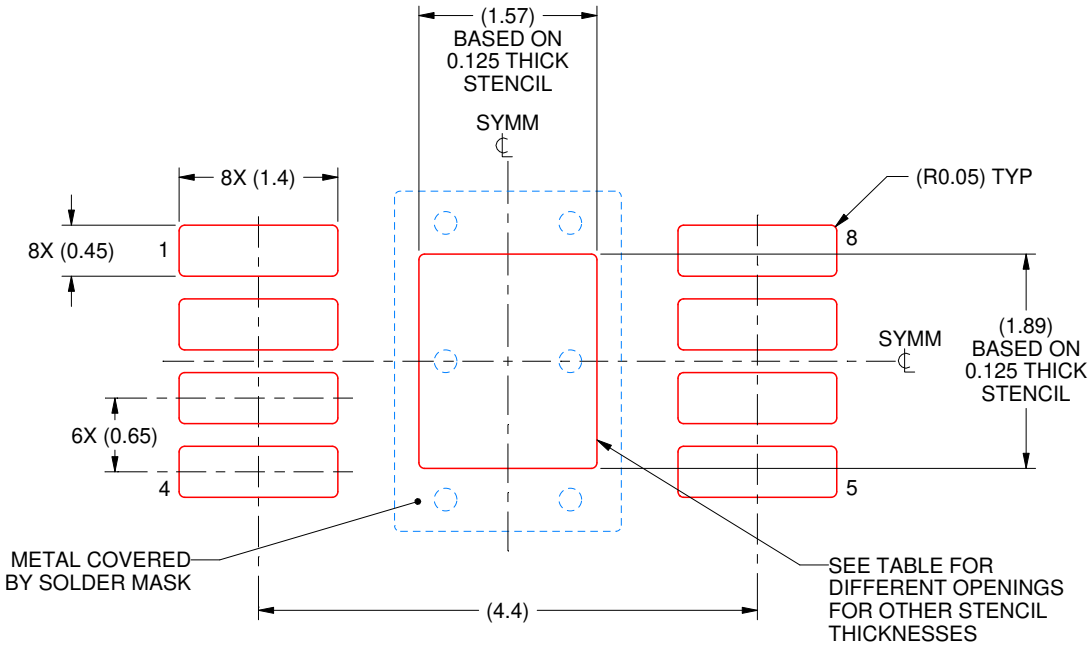



SOLDER MASK DETAILS

4225481/A 11/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.




SOLDER PASTE EXAMPLE
EXPOSED PAD 9:
100% PRINTED SOLDER COVERAGE BY AREA
SCALE: 15X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|---|---|
| 0.1 | 1.76 X 2.11 |
| 0.125 | 1.57 X 1.89 (SHOWN) |
| 0.15 | 1.43 X 1.73 |
| 0.175 | 1.33 X 1.60 |

4225481/A 11/2019

NOTES: (continued)

10. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
11. Board assembly site may have different recommendations for stencil design.

# IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265