OVERVOLTAGE AND OVERCURRENT PROTECTION IC AND Li+ CHARGER FRONT-END PROTECTION IC

FEATURES

- **Provides Protection for Three Variables:**
  - **Input Overvoltage Protection**
  - **User-Programmable Overcurrent with Current Limiting**
  - **Battery Overvoltage**
- **30V Maximum Input Voltage**
- **Supports up to 1.5A Input Current**
- **Robust Against False Triggering Due to Current Transients**
- **Thermal Shutdown**
- **Enable Input**
- **Status Indication – Fault Condition**
- **Available in Space-Saving Small 8 Lead 2×2 SON**

APPLICATIONS

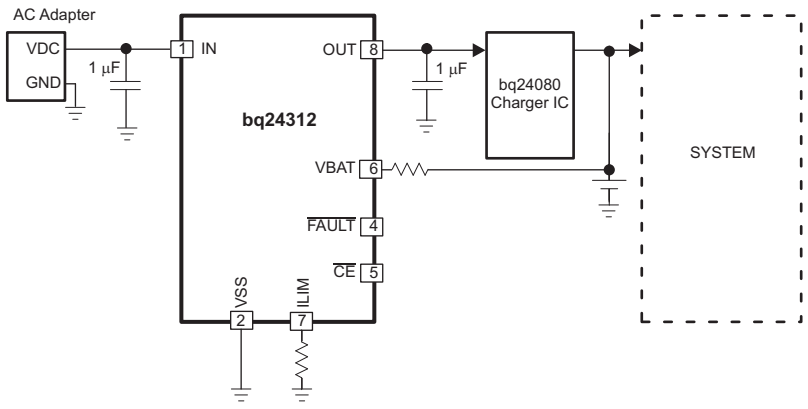
- **Mobile Phones and Smart Phones**
- **PDAs**
- **MP3 Players**
- **Low-Power Handheld Devices**
- **Bluetooth™ Headsets**

DESCRIPTION

The bq24312 is a highly integrated circuit designed to provide protection to Li-ion batteries from failures of the charging circuit. The IC continuously monitors the input voltage, the input current, and the battery voltage. In case of an input overvoltage condition, the IC immediately removes power from the charging circuit by turning off an internal switch. In the case of an overcurrent condition, it limits the system current at the threshold value, and if the overcurrent persists, switches the pass element OFF after a blanking period. Additionally, the IC also monitors its own die temperature and switches off if it exceeds 140°C. The input overcurrent threshold is user-programmable.

The IC can be controlled by a processor and also provides status information about fault conditions to the host.

APPLICATION SCHEMATIC



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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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(1)

DEVICE(2)	OVP THRESHOLD	PACKAGE	MARKING
bq24312DSG	5.85 V	2mm x 2mm SON	OUE

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.
(2) To order a 3000-piece reel add R to the part number, or to order a 250-piece reel add T to the part number.

PACKAGE DISSIPATION RATINGS

PART NO.	PACKAGE	$R_{\theta JC}$	$R_{\theta JA}$
bq24312DSG	10 pin 2mm × 2mm SON	5°C/W	75°C/W

ABSOLUTE MAXIMUM RATINGS(1)

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

	PARAMETER	PIN	VALUE	UNIT
V_I	Input voltage	IN (with respect to VSS)	–0.3 to 30	V
		OUT (with respect to VSS)	–0.3 to 12	
		ILIM, $\overline{FAULT}$, $\overline{CE}$, VBAT (with respect to VSS)	–0.3 to 7	
I_I	Input current	IN	-1.8(2) to 2	A
I_O	Output current	OUT	2	A
	Output sink current	$\overline{FAULT}$	15	mA
ESD	Withstand Voltage	All (Human Body Model per JESD22-A114-E)	2000	V
		All (Machine Model per JESD22-A115-E)	200	V
		All (Charge Device Model per JESD22-C101-C)	500	V
		IN(IEC 61000-4-2) (with IN bypassed to the VSS with a 1-µF low-ESR ceramic capacitor)	15 (Air Discharge) 8 (Contact)	kV
T_J	Junction temperature		–40 to 150	°C
T_{stg}	Storage temperature		–65 to 150	°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. All voltage values are with respect to the network ground terminal unless otherwise noted.
(2) Negative current is specified for a maximum of 50 hours at T_J = 175°C.

RECOMMENDED OPERATING CONDITIONS

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

		MIN	MAX	UNIT
V_{IN}	Input voltage range	3	30	V
I_{IN}	Input current, IN pin		1.5	A
I_{OUT}	Output current, OUT pin		1.5	A
R_{ILIM}	OCP Programming resistor	15	90	kΩ
T_J	Junction temperature	–40	125	°C

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ELECTRICAL CHARACTERISTICS

over junction temperature range –40°C to 125°C and recommended supply voltage (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
IN						
UVLO	Undervoltage lock-out, input power detected threshold	$\overline{CE}$ = Low, V_{IN} increasing from 0V to 3V	2.6	2.7	2.8	V
$V_{hys(UVLO)}$	Hysteresis on UVLO	$\overline{CE}$ = Low, V_{IN} decreasing from 3V to 0V	200	260	300	mV
$T_{DGL(PGOOD)}$	Deglitch time, input power detected status	$\overline{CE}$ = Low. Time measured from V_{IN} 0V → 5V 1µs rise-time, to output turning ON		8		ms
I_{DD}	Operating current	$\overline{CE}$ = Low, No load on OUT pin, V_{IN} = 5V, R_{ILIM} = 25kΩ		400	600	µA
I_{STDBY}	Standby current	$\overline{CE}$ = High, V_{IN} = 5.0V		65	95	µA
INPUT TO OUTPUT CHARACTERISTICS						
VDO	Drop-out voltage IN to OUT	$\overline{CE}$ = Low, V_{IN} = 5V, I_{OUT} = 1A		170	280	mV
INPUT OVERVOLTAGE PROTECTION						
V_{OVP}	Input overvoltage protection threshold	$\overline{CE}$ = Low, V_{IN} increasing from 5V to 7.5V	5.71	5.85	6.00	V
$V_{hys(OVP)}$	Hysteresis on OVP	$\overline{CE}$ = Low, V_{IN} decreasing from 7.5V to 5V	20	60	110	mV
$t_{BLANK(OVP)}$	Blanking time on OVP	$\overline{CE}$ = Low, Time measured from V_{IN} 5V → 7.5V, 1µs fall-time to output turning OFF		64		µs
$t_{ON(OVP)}$	Recovery time from input overvoltage condition	$\overline{CE}$ = Low, Time measured from V_{IN} 7.5V → 5V, 1µs fall-time		8		ms
INPUT OVERCURRENT PROTECTION						
I_{OCP}	Input overcurrent protection threshold range		300		1500	mA
I_{OCP}	Input overcurrent protection threshold	$\overline{CE}$ = Low, R_{ILIM} = 24.9kΩ, 3 V ≤ V_{IN} < V_{OVP} -$V_{hys(OVP)}$	900	1000	1100	mA
K_{ILIM}	Programmable current limit factor			25		AkΩ
$t_{BLANK(OCP)}$	Blanking time, input overcurrent detected			176		µs
$t_{REC(OCP)}$	Recovery time from input overcurrent condition			64		ms
BATTERY OVERVOLTAGE PROTECTION						
BV_{OVP}	Battery overvoltage protection threshold	$\overline{CE}$ = Low, V_{IN} > 4.4V	4.30	4.35	4.4	V
$V_{hys(Bovp)}$	Hysteresis on BV_{OVP}	$\overline{CE}$ = Low, V_{IN} > 4.4V	200	275	320	mV
I_{VBAT}	Input bias current on VBAT pin	V_{BAT} = 4.4V, T_J = 25°C			10	nA
$T_{DGL(Bovp)}$	Deglitch time, battery overvoltage detected	$\overline{CE}$ = Low, V_{IN} > 4.4V. Time measured from V_{VBAT} rising from 4.1V to 4.4V to $\overline{FAULT}$ going low.		176		µs
THERMAL PROTECTION						
$T_{J(OFF)}$	Thermal shutdown temperature			140	150	°C
$T_{J(OFF-HYS)}$	Thermal shutdown hysteresis			20		°C
LOGIC LEVELS ON $\overline{CE}$						
V_{IL}	Low-level input voltage		0		0.4	V
V_{IH}	High-level input voltage		1.4			V
I_{IL}	Low-level input current	V_{CE} = 0V			1	µA
I_{IH}	High-level input current	V_{CE} = 1.8V			15	µA
LOGIC LEVELS ON $\overline{FAULT}$						
V_{OL}	Output low voltage	I_{SINK} = 5mA			0.2	V
I_{HI-Z}	Leakage current, $\overline{FAULT}$ pin HI-Z	V_{FAULT} = 5V			10	µA

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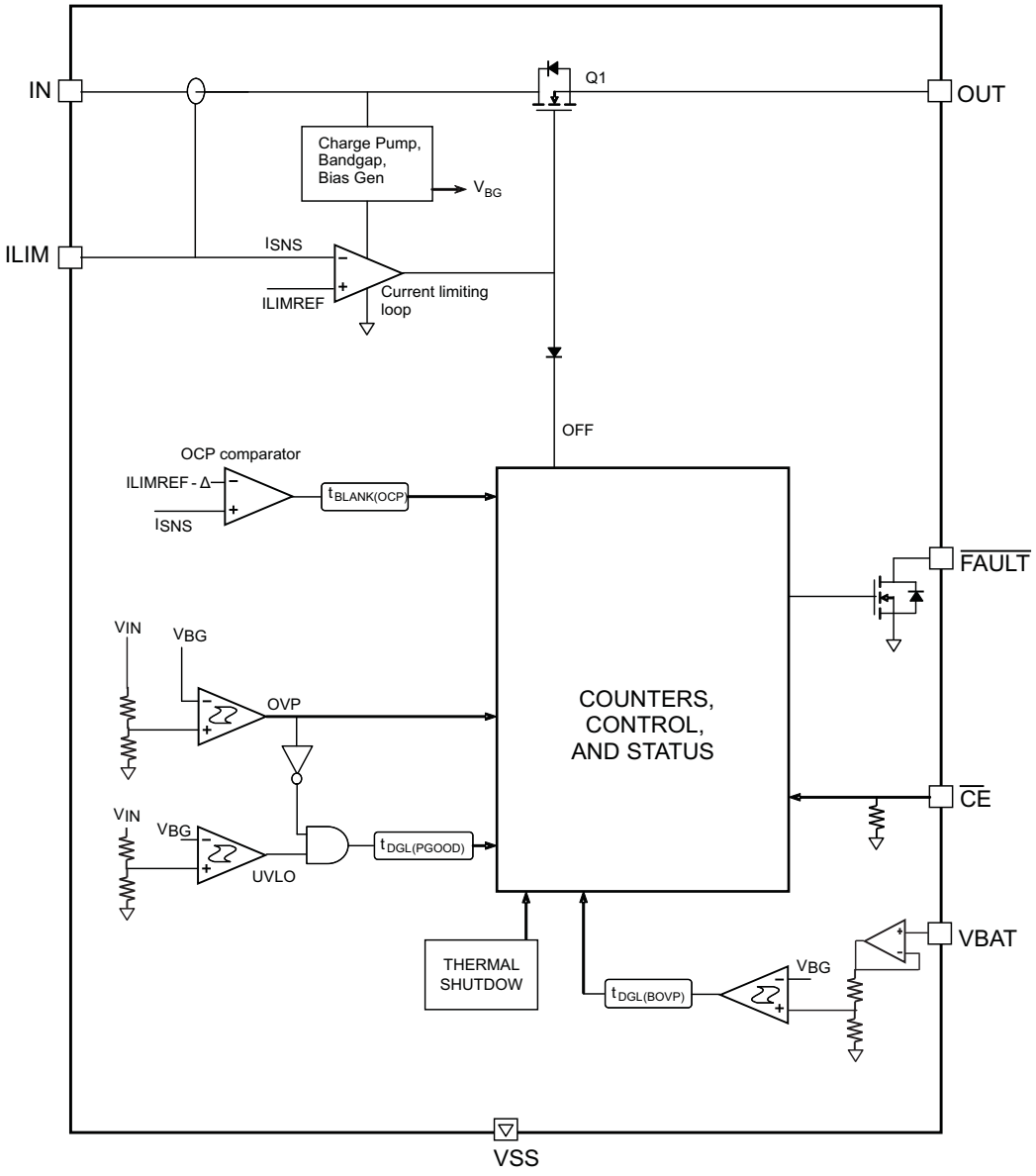


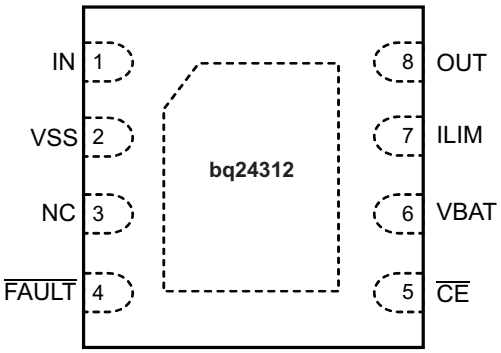
Figure 1. Simplified Block Diagram

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TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	DSG		
IN	1	I	Input power, connect to external DC supply. Connect external 1µF ceramic capacitor (minimum) to V_{SS}.
OUT	8	O	Output terminal to the charging system. Connect external 1µF ceramic capacitor (minimum) to V_{SS}.
VBAT	6	I	Battery voltage sense input. Connect to pack positive terminal through a resistor.
ILIM	7	I/O	Input overcurrent threshold programming. Connect a resistor to VSS to set the overcurrent threshold.
$\overline{CE}$	5	I	Chip enable input. Active low. When $\overline{CE}$ = High, the input FET is off. Internally pulled down.
$\overline{FAULT}$	4	O	Open-drain output, device status. $\overline{FAULT}$ = Low indicates that the input FET Q1 has been turned off due to input overvoltage, input overcurrent, battery overvoltage, or thermal shutdown.
VSS	2	–	Ground terminal
NC	3		These pins may have internal circuits used for test purposes. Do not make any external connections at these pins for normal operation.
Thermal PAD		–	There is an internal electrical connection between the exposed thermal pad and the V_{SS} pin of the device. The thermal pad must be connected to the same potential as the V_{SS} pin on the printed circuit board. Do not use the thermal pad as the primary ground input for the device. The VSS pin must be connected to ground at all times.

DSG Package
(Top View)



TYPICAL OPERATING PERFORMANCE

Test conditions (unless otherwise noted) for typical operating performance: V_{IN} = 5 V, C_{IN} = 1 µF, C_{OUT} = 1 µF, R_{ILIM} = 25 kΩ, R_{BAT} = 100 kΩ, T_A = 25°C, V_{PU} = 3.3V (see Figure 20 for the Typical Application Circuit)

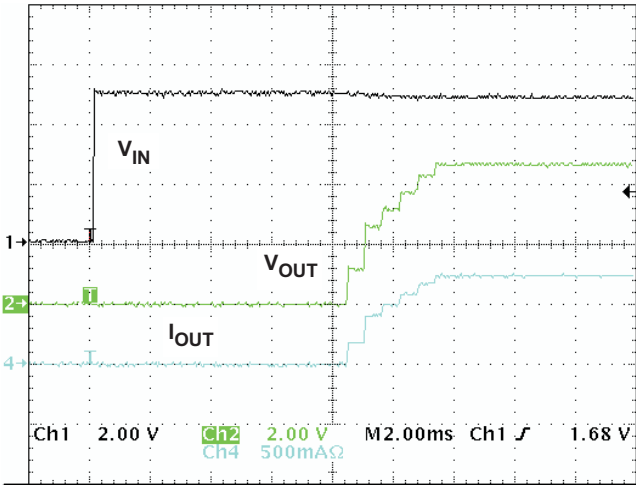


Figure 2. Normal Power-On Showing Soft-Start, R_{OUT} = 6.6Ω

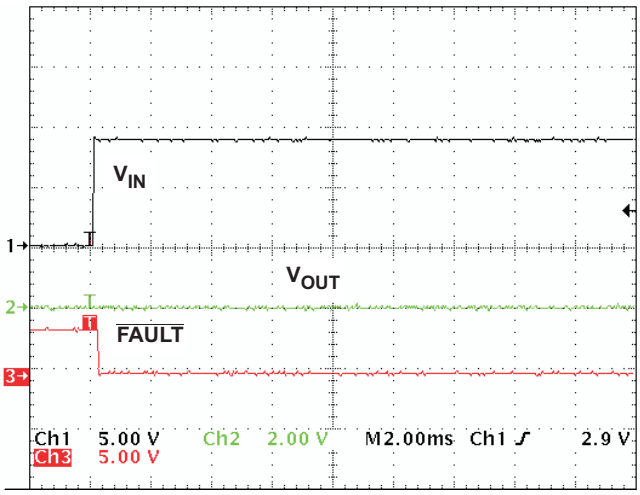


Figure 3. OVP at Power-On, V_{IN} = 0V to 9V, t_r = 50µs

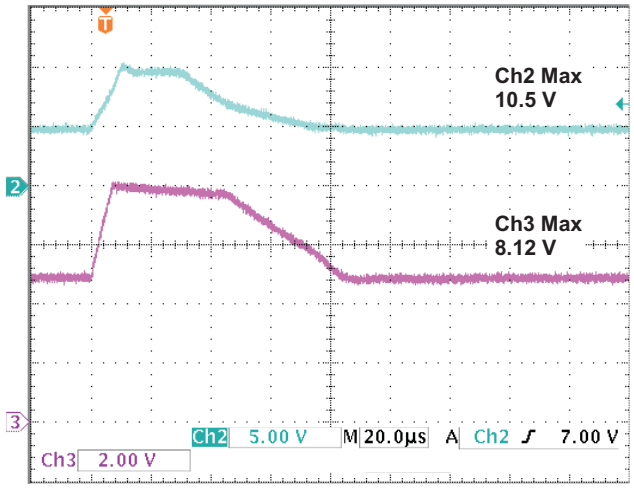


Figure 4. OVP Response for Input Step, V_{IN} = 5V to 10V back to 5V, t_r = 10µs, CH2 input voltage peak = 10.5V, CH3 output voltage peak = 8.12V. OVP duration is shorter than Blanking time.

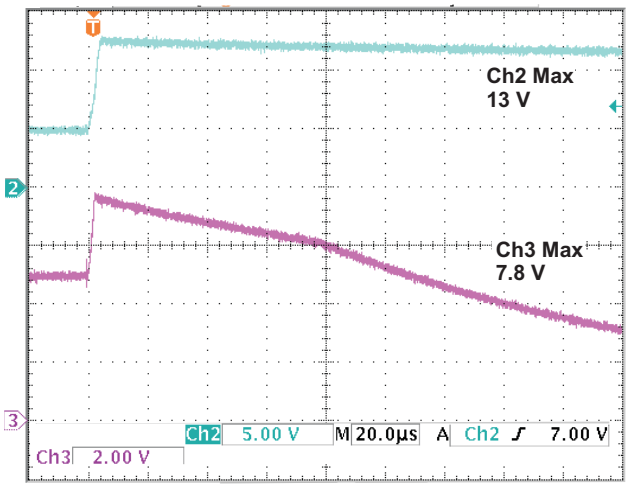


Figure 5. OVP Response for Input Step, V_{IN} = 5V to 12V, t_r = 4µs. CH2 input voltage peak = 13V, CH3 output voltage peak = 7.8V. OVP duration is longer than Blanking time.

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TYPICAL OPERATING PERFORMANCE (continued)

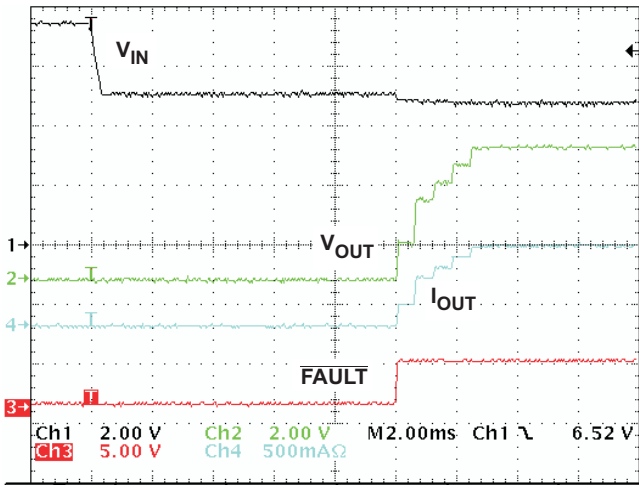


Figure 6. Recovery from OVP, V_{IN} = 7.5V to 5V, t_f = 400µs

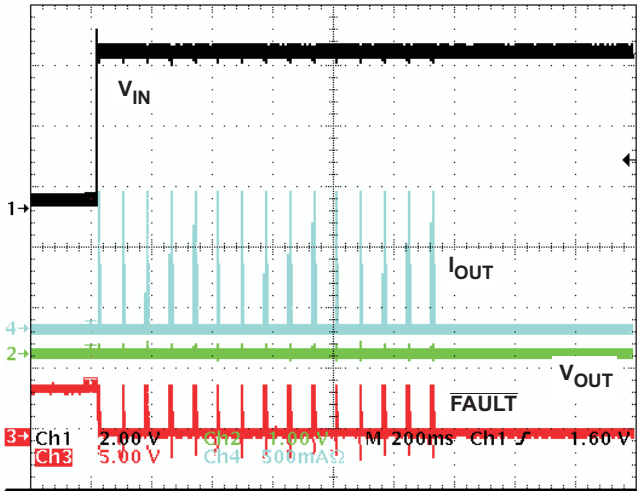


Figure 7. OCP, Powering Up into a Short Circuit on OUT Pin, OCP Counter Counts to 15 Before Switching OFF the Device

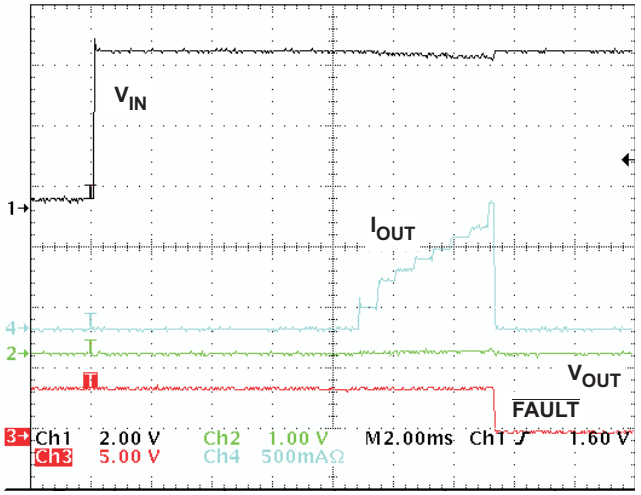


Figure 8. OCP, Zoom-in on the First Cycle of Figure 7

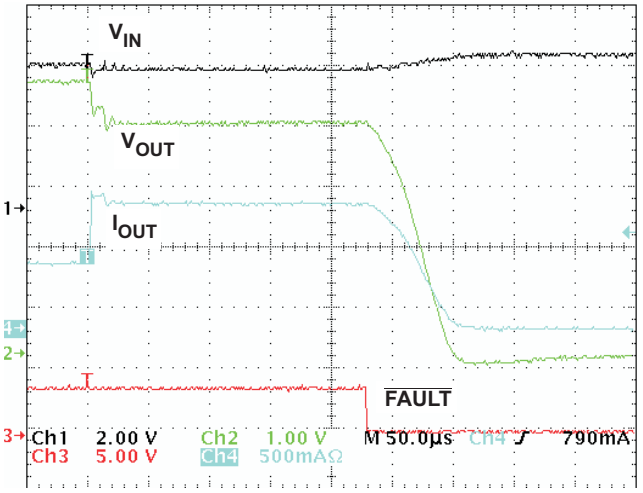


Figure 9. OCP, R_{OUT} Switches from 6.6Ω to 3.3Ω, Shows Current Limiting and Soft-Stop

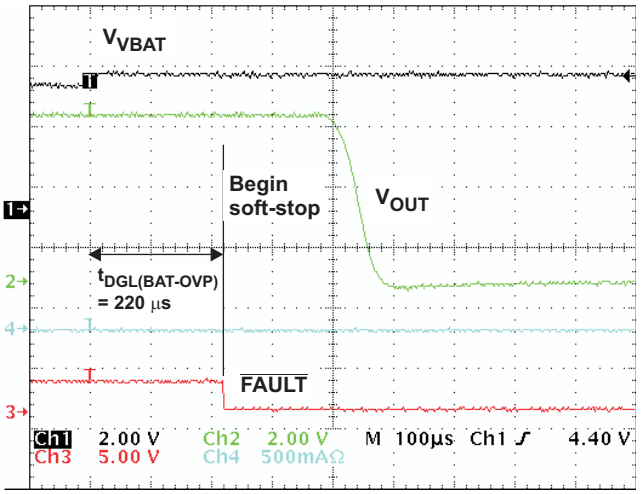


Figure 10. BAT-OVP, V_{VBAT} Steps from 4.2V to 4.4V, Shows $t_{DGL(BAT-OVP)}$ and Soft-Stop

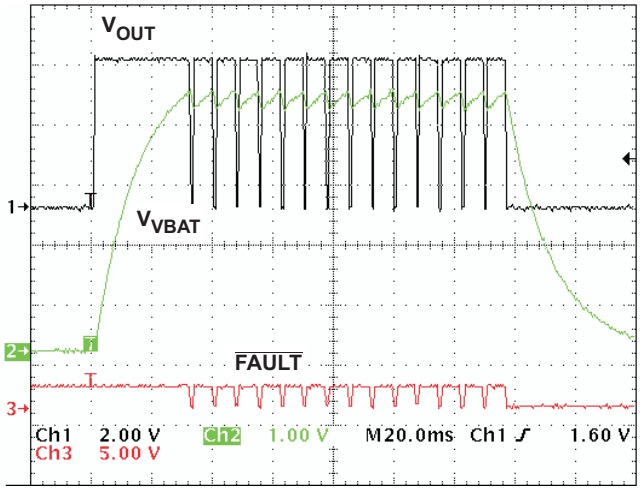


Figure 11. BAT-OVP, V_{VBAT} Cycles Between 4.1V and 4.4V, Shows BAT-OVP Counter

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TYPICAL OPERATING PERFORMANCE (continued)

UNDERVOLTAGE LOCKOUT vs FREE-AIR TEMPERATURE

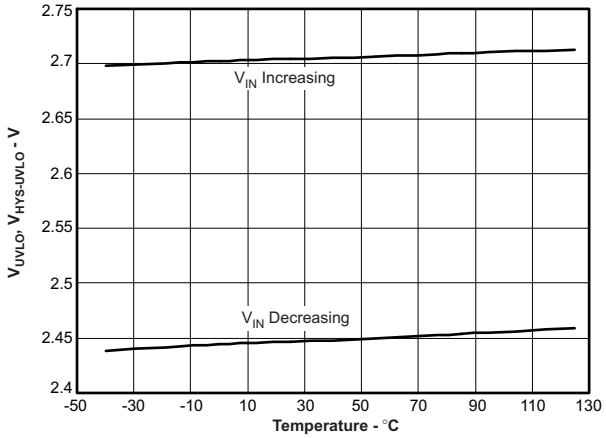


Figure 12.

DROPOUT VOLTAGE (IN to OUT) vs FREE-AIR TEMPERATURE

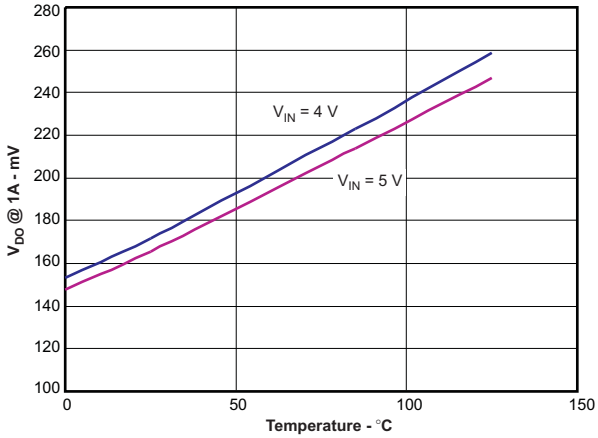


Figure 13.

OVERVOLTAGE THRESHOLD PROTECTION vs FREE-AIR TEMPERATURE

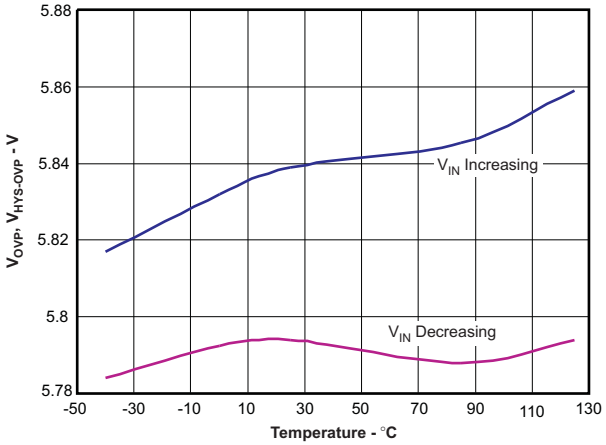


Figure 14.

INPUT OVERCURRENT PROTECTION vs ILIM RESISTANCE

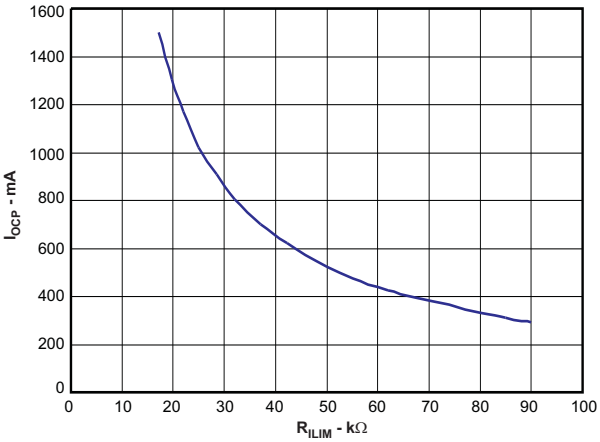


Figure 15.

INPUT OVERCURRENT PROTECTION vs FREE-AIR TEMPERATURE

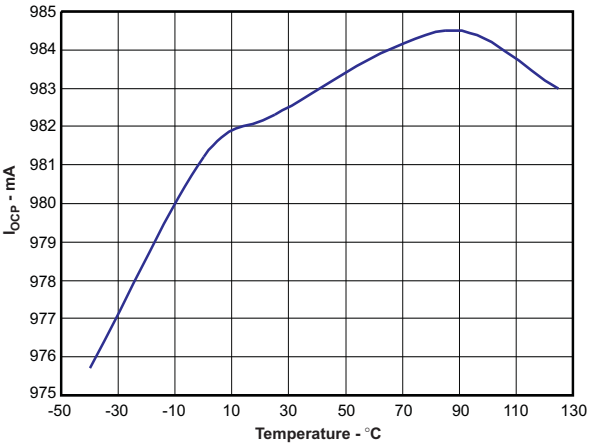


Figure 16.

BATTERY OVERVOLTAGE PROTECTION vs FREE-AIR TEMPERATURE

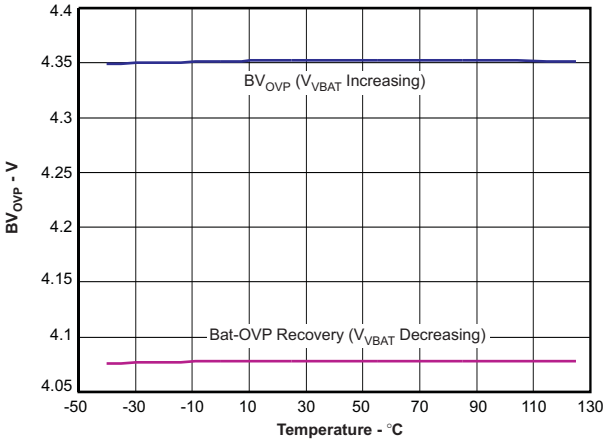


Figure 17.

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TYPICAL OPERATING PERFORMANCE (continued)

LEAKAGE CURRENT (VBAT Pin)
vs
FREE-AIR TEMPERATURE

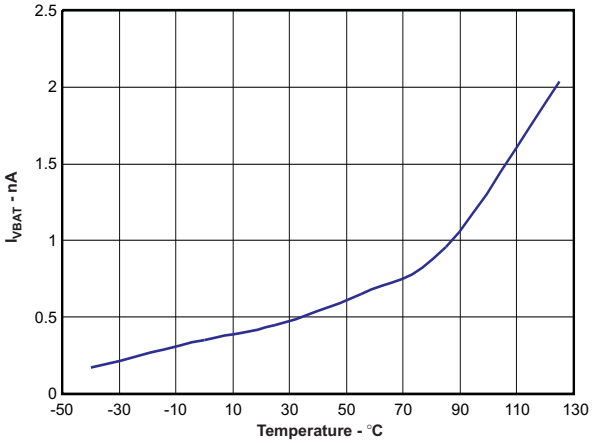


Figure 18.

SUPPLY CURRENT
vs
INPUT VOLTAGE

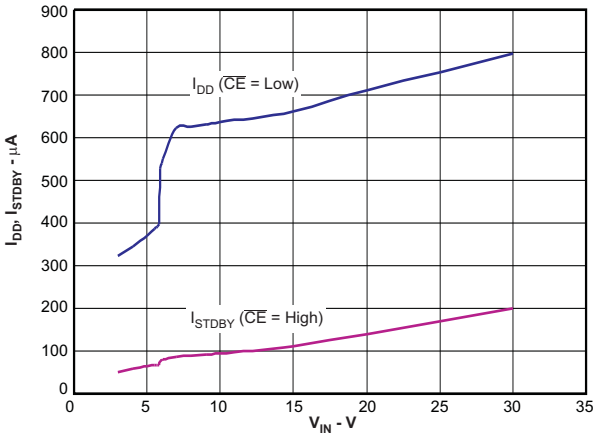


Figure 19.

TYPICAL APPLICATION CIRCUIT

V_{OVP} = 5.85V, I_{OCP} = 1000mA, BV_{OVP} = 4.35V (Terminal numbers shown are for the 2×2 DSG package)

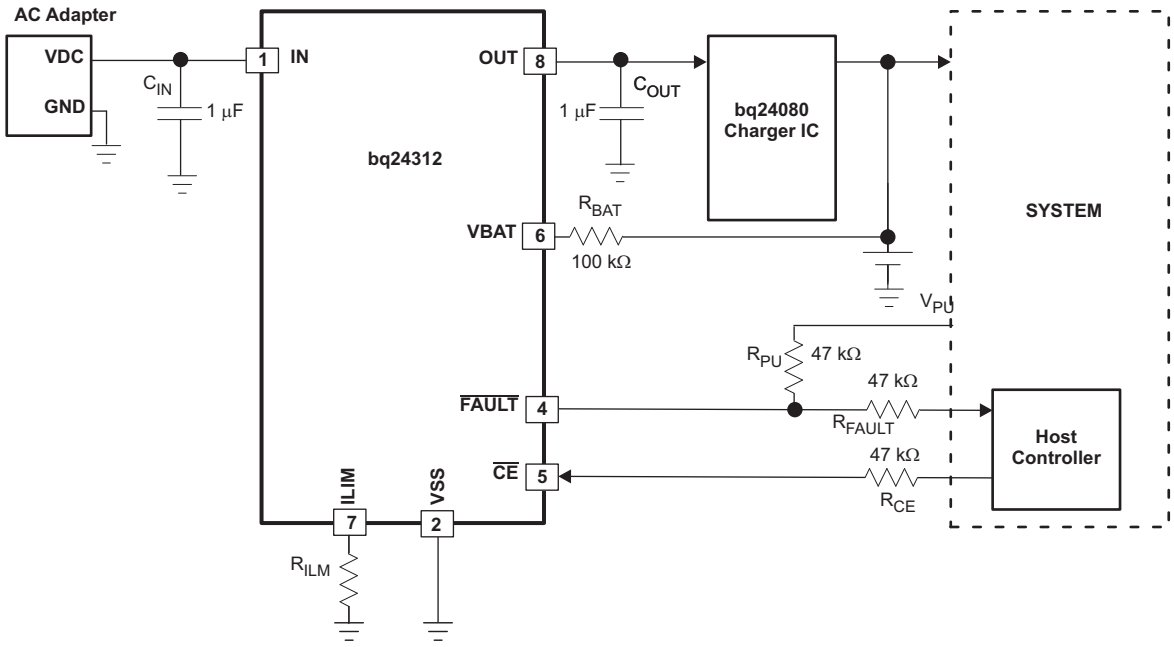


Figure 20.

DETAILED FUNCTIONAL DESCRIPTION

The bq24312 is a highly integrated circuit designed to provide protection to Li-ion batteries from failures of the charging circuit. The IC continuously monitors the input voltage, the input current and the battery voltage. In case of an input overvoltage condition, the IC immediately removes power from the charging circuit by turning off an internal switch. In the case of an overcurrent condition, it limits the system current at the threshold value, and if the overcurrent persists, switches the pass element OFF after a blanking period. If the battery voltage rises to an unsafe level, the IC disconnects power from the charging circuit until the battery voltage returns to an acceptable value. Additionally, the IC also monitors its own die temperature and switches off if it exceeds 140°C. The input overcurrent threshold is user-programmable. The IC can be controlled by a processor, and also provides status information about fault conditions to the host.

POWER DOWN

The device remains in power down mode when the input voltage at the IN pin is below the undervoltage threshold UVLO. The FET Q1 connected between IN and OUT pins is off, and the status output, $\overline{\text{FAULT}}$, is set to Hi-Z.

POWER-ON RESET

The device resets when the input voltage at the IN pin exceeds the UVLO threshold. All internal counters and other circuit blocks are reset. The IC then waits for duration $t_{DGL(PGOOD)}$ for the input voltage to stabilize. If, after $t_{DGL(PGOOD)}$, the input voltage and battery voltage are safe, FET Q1 is turned ON. The IC has a soft-start feature to control the inrush current. The soft-start minimizes the ringing at the input (the ringing occurs because the parasitic inductance of the adapter cable and the input bypass capacitor form a resonant circuit). Figure 2 shows the power-up behavior of the device. Because of the deglitch time at power-on, if the input voltage rises rapidly to beyond the OVP threshold, the device will not switch on at all, instead it will go into protection mode and indicate a fault on the $\overline{\text{FAULT}}$ pin, as shown in Figure 3.

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OPERATION

The device continuously monitors the input voltage, the input current, and the battery voltage as described in detail in the following sections.

Input Overvoltage Protection

As long as the input voltage is less than $V_{O(REG)}$, the output voltage tracks the input voltage (less the drop caused by $R_{DS}ON$ of Q1). If the input voltage is greater than $V_{O(REG)}$ (plus the $R_{DS}ON$ drop) and less than V_{OVP}, the device acts like a series linear regulator, with the output voltage regulated to $V_{O(REG)}$. If the input voltage rises above V_{OVP}, the output voltage is clamped to $V_{O(REG)}$ for a blanking duration $t_{BLANK(OVP)}$. If the input voltage returns below V_{OVP} within $t_{BLANK(OVP)}$, the device continues normal operation (See Figure 4). This provides protection against turning power off due to transient overvoltage spikes while still protecting the system. However, if the input voltage remains above V_{OVP} for more than $t_{BLANK(OVP)}$, the internal FET is turned off, removing power from the circuit (see Figure 5). When the input voltage comes back to a safe value the device waits for $t_{ON(OVP)}$, then switches on Q1 and goes through the soft-start routine (see Figure 6).

Input Overcurrent Protection

The overcurrent threshold is programmed by a resistor R_{ILIM} connected from the ILIM pin to VSS. Figure 15 shows the OCP threshold as a function of R_{ILIM}, and may be approximated by the following equation: $I_{OCP} = 25 \div R_{ILIM}$ (current in A, resistance in kΩ), where R_{ILIM} must be between 15 kΩ and 90 kΩ.

If the load current tries to exceed the I_{OCP} threshold, the device limits the current for a blanking duration of $t_{BLANK(OCP)}$. If the load current returns to less than I_{OCP} before $t_{BLANK(OCP)}$ times out, the device continues to operate. However, if the overcurrent situation persists for $t_{BLANK(OCP)}$, the FET Q1 is turned off for a duration of $t_{REC(OCP)}$, and the $\overline{FAULT}$ pin is driven low. The FET is then turned on again after $t_{REC(OCP)}$ and the current is monitored all over again. Each time an OCP fault occurs, an internal counter is incremented. If 15 OCP faults occur in one charge cycle, the FET is turned off permanently. The counter is cleared either by removing and re-applying input power, or by disabling and re-enabling the device with the $\overline{CE}$ pin. Figure 7 to Figure 9 show what happens in an overcurrent fault.

To prevent the input voltage from spiking up due to the inductance of the input cable, Q1 is turned off slowly, resulting in a “soft-stop”, as shown in Figure 9.

Battery Overvoltage Protection

The battery overvoltage threshold BV_{OVP} is internally set to 4.35V. If the battery voltage exceeds the BV_{OVP} threshold, the FET Q1 is turned off, and the $\overline{FAULT}$ pin is driven low. The FET is turned back on once the battery voltage drops to $BV_{OVP} - V_{hys(Bovp)}$ (see Figure 10 and Figure 11). Each time a battery overvoltage fault occurs, an internal counter is incremented. If 15 such faults occur in one charge cycle, the FET is turned off permanently. The counter is cleared either by removing and re-applying input power, or by disabling and re-enabling the device with the $\overline{CE}$ pin. In the case of a battery overvoltage fault, Q1 is switched OFF gradually (see Figure 10).

Thermal Protection

If the junction temperature of the device exceeds $T_{J(OFF)}$, the FET Q1 is turned off, and the $\overline{FAULT}$ pin is driven low. The FET is turned back on when the junction temperature falls below $T_{J(OFF)} - T_{J(OFF-HYS)}$.

Enable Function

The IC has an enable pin which can be used to enable or disable the device. When the $\overline{CE}$ pin is driven high, the internal FET is turned off. When the $\overline{CE}$ pin is low, the FET is turned on if other conditions are safe. The OCP counter and the Bat-OVP counter are both reset when the device is disabled and re-enabled. The $\overline{CE}$ pin has an internal pulldown resistor and can be left floating. Note that the $\overline{FAULT}$ pin functionality is also disabled when the $\overline{CE}$ pin is high.

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Fault Indication

The $\overline{\text{FAULT}}$ pin is an active-low open-drain output. It is in a high-impedance state when operating conditions are safe, or when the device is disabled by setting $\overline{\text{CE}}$ high. With $\overline{\text{CE}}$ low, the $\overline{\text{FAULT}}$ pin goes low whenever any of these events occurs:

- Input overvoltage
- Input overcurrent
- Battery overvoltage
- IC Overtemperature

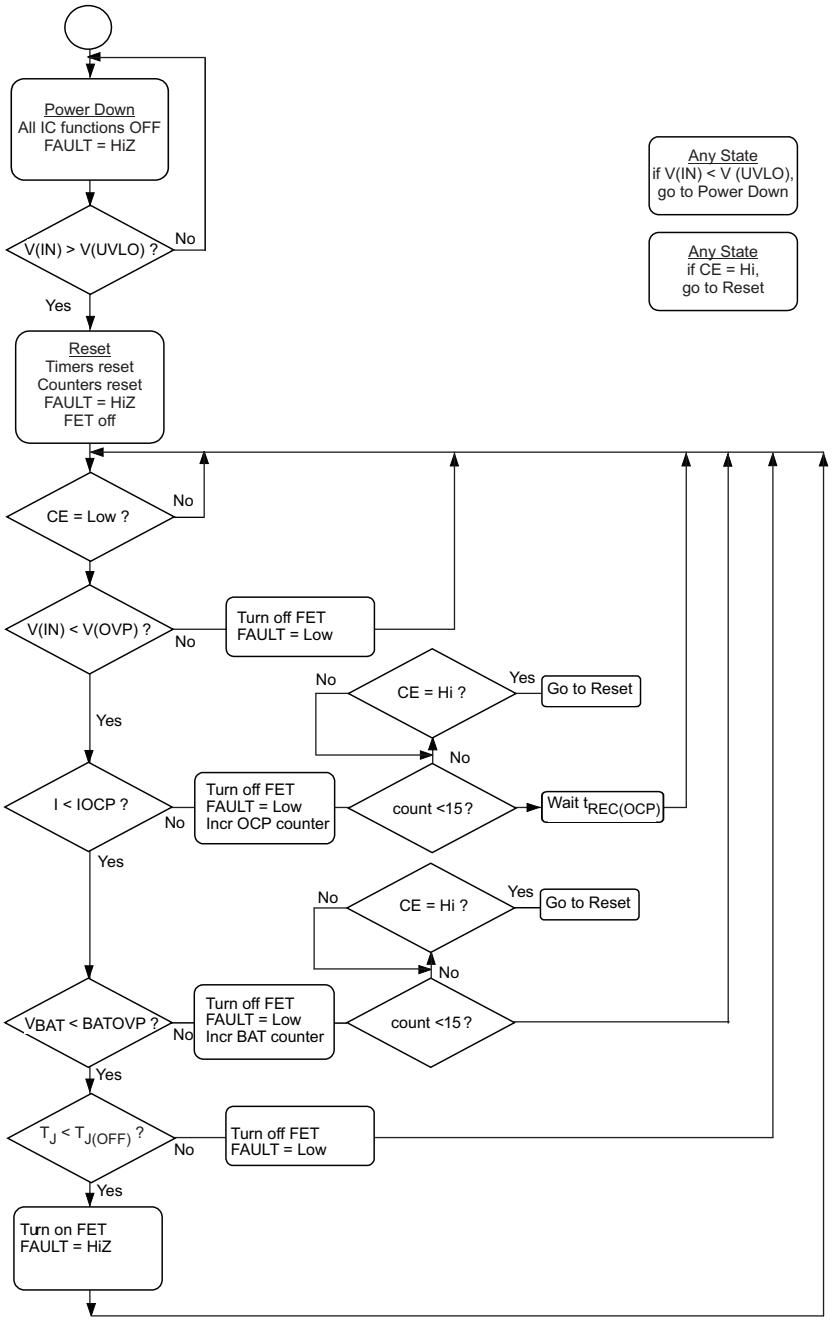


Figure 21. Flow Diagram

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APPLICATION INFORMATION (WITH REFERENCE TO FIGURE 20)

Selection of R_{BAT}

It is strongly recommended that the battery not be tied directly to the VBAT pin of the device, as under some failure modes of the IC, the voltage at the IN pin may appear on the VBAT pin. This voltage can be as high as 30V, and applying 30V to the battery in case of the failure of the bq24312 can be hazardous. Connecting the VBAT pin through R_{BAT} prevents a large current from flowing into the battery in case of a failure of the IC. In the interests of safety, R_{BAT} should have a very high value. The problem with a large R_{BAT} is that the voltage drop across this resistor because of the VBAT bias current I_{VBAT} causes an error in the BV_{OVP} threshold. This error is over and above the tolerance on the nominal 4.35V BV_{OVP} threshold.

Choosing R_{BAT} in the range 100kΩ to 470kΩ is a good compromise. In the case of an IC failure, with R_{BAT} equal to 100kΩ, the maximum current flowing into the battery would be (30V – 3V) ÷ 100kΩ = 246μA, which is low enough to be absorbed by the bias currents of the system components. R_{BAT} equal to 100kΩ would result in a worst-case voltage drop of $R_{BAT} \times I_{VBAT}$ = 1mV. This is negligible to compared to the internal tolerance of 50mV on BV_{OVP} threshold.

If the Bat-OVP function is not required, the VBAT pin should be connected to VSS.

Selection of R_{CE}, R_{FAULT}, and R_{PU}

The $\overline{CE}$ pin can be used to enable and disable the IC. If host control is not required, the $\overline{CE}$ pin can be tied to ground or left un-connected, permanently enabling the device.

In applications where external control is required, the $\overline{CE}$ pin can be controlled by a host processor. As in the case of the VBAT pin (see above), the $\overline{CE}$ pin should be connected to the host GPIO pin through as large a resistor as possible. The limitation on the resistor value is that the minimum V_{OH} of the host GPIO pin less the drop across the resistor should be greater than V_{IH} of the bq24312 $\overline{CE}$ pin. The drop across the resistor is given by $R_{CE} \times I_{IH}$.

The $\overline{FAULT}$ pin is an open-drain output that goes low during OV, OC, battery-OV, and OT events. If the application does not require monitoring of the $\overline{FAULT}$ pin, it can be left unconnected. But if the $\overline{FAULT}$ pin has to be monitored, it should be pulled high externally through R_{PU}, and connected to the host through R_{FAULT}. R_{FAULT} prevents damage to the host controller if the bq24312 fails (see above). The resistors should be of high value, in practice values between 22kΩ and 100kΩ should be sufficient.

Selection of Input and Output Bypass Capacitors

The input capacitor C_{IN} in Figure 20 is for decoupling, and serves an important purpose. Whenever there is a step change downwards in the system load current, the inductance of the input cable causes the input voltage to spike up. C_{IN} prevents the input voltage from overshooting to dangerous levels. It is strongly recommended that a ceramic capacitor of at least 1μF be used at the input of the device. It should be located in close proximity to the IN pin.

C_{OUT} in Figure 20 is also important: If a very fast (< 1μs rise time) overvoltage transient occurs at the input, the current that charges C_{OUT} causes the device's current-limiting loop to kick in, reducing the gate-drive to FET Q1. This results in improved performance for input overvoltage protection. C_{OUT} should also be a ceramic capacitor of at least 1μF, located close to the OUT pin. C_{OUT} also serves as the input decoupling capacitor for the charging circuit downstream of the protection IC.

Powering Accessories

In some applications, the equipment that the protection IC resides in may be required to provide power to an accessory (e.g. a cellphone may power a headset or an external memory card) through the same connector pins that are used by the adapter for charging. Figure 22 and Figure 23 illustrate typical charging and accessory-powering scenarios:

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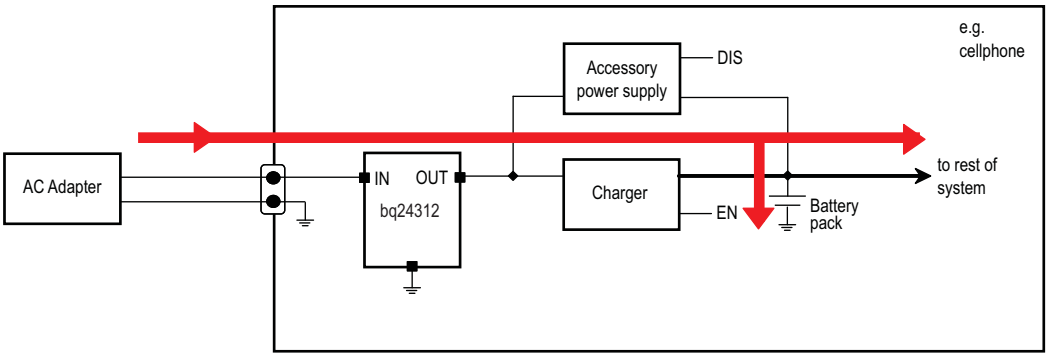


Figure 22. Charging - The Red Arrows Show the Direction of Current Flow

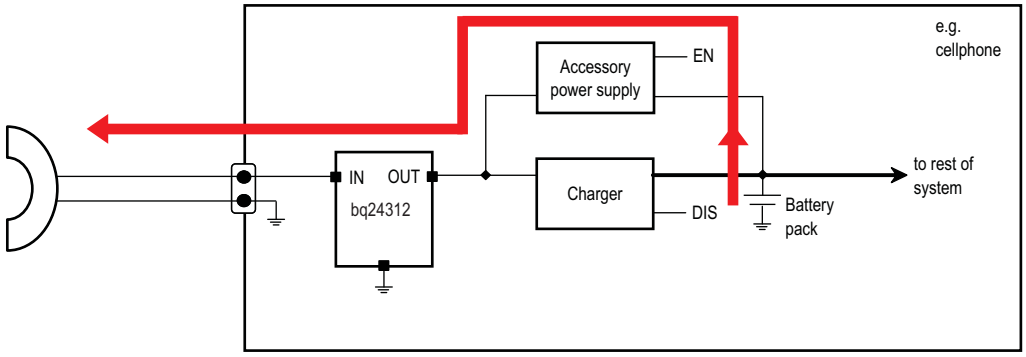


Figure 23. Powering an Accessory - The Red Arrows Show the Direction of Current Flow

In the second case, when power is being delivered to an accessory, the bq24312 device is required to support current flow from the OUT pin to the IN pin.

If V_{OUT} > UVLO + 0.7V, FET Q1 is turned on, and the reverse current does not flow through the diode but through Q1. Q1 will then remain ON as long as V_{OUT} > UVLO – $V_{hys(UVLO)}$ + $R_{DS(on)}$ × $I_{ACCESSORY}$. Within this voltage range, the reverse current capability is the same as the forward capability, 1.5A. It should be noted that there is no overcurrent protection in this direction.

PCB Layout Guidelines:

- This device is a protection device, and is meant to protect down-stream circuitry from hazardous voltages. Potentially, high voltages may be applied to this IC. It has to be ensured that the edge-to-edge clearances of PCB traces satisfy the design rules for high voltages.
- The device uses SON packages with a PowerPAD™. For good thermal performance, the PowerPAD should be thermally coupled with the PCB ground plane. In most applications, this will require a copper pad directly under the IC. This copper pad should be connected to the ground plane with an array of thermal vias.
- C_{IN} and C_{OUT} should be located close to the IC. Other components like R_{ILIM} and R_{BAT} should also be located close to the IC.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
BQ24312DSGR	ACTIVE	SON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24312DSGT	ACTIVE	SON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

(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)

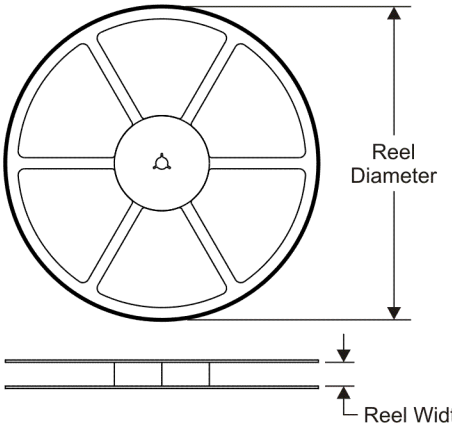
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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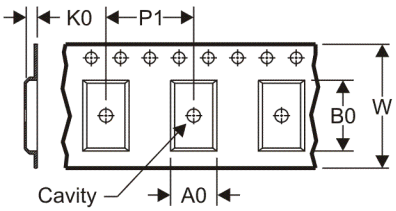
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REEL DIMENSIONS

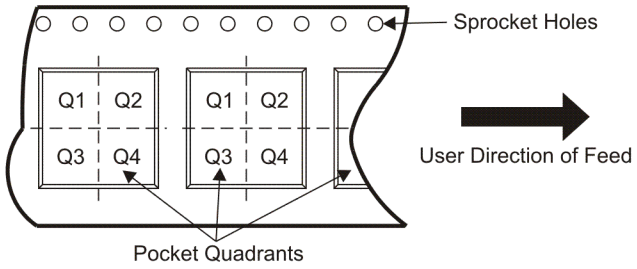


TAPE DIMENSIONS



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

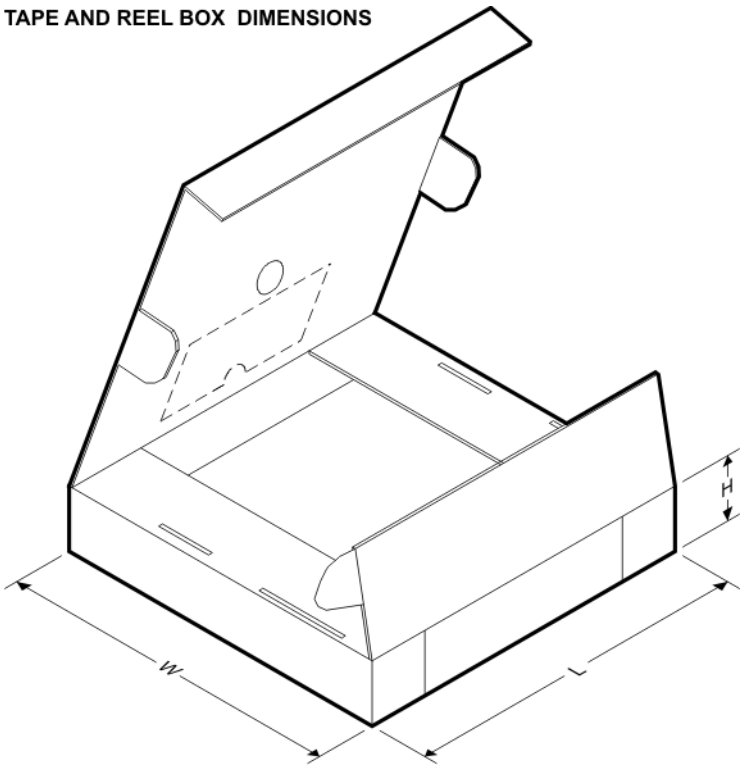
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
BQ24312DSGR	SON	DSG	8	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24312DSGT	SON	DSG	8	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2

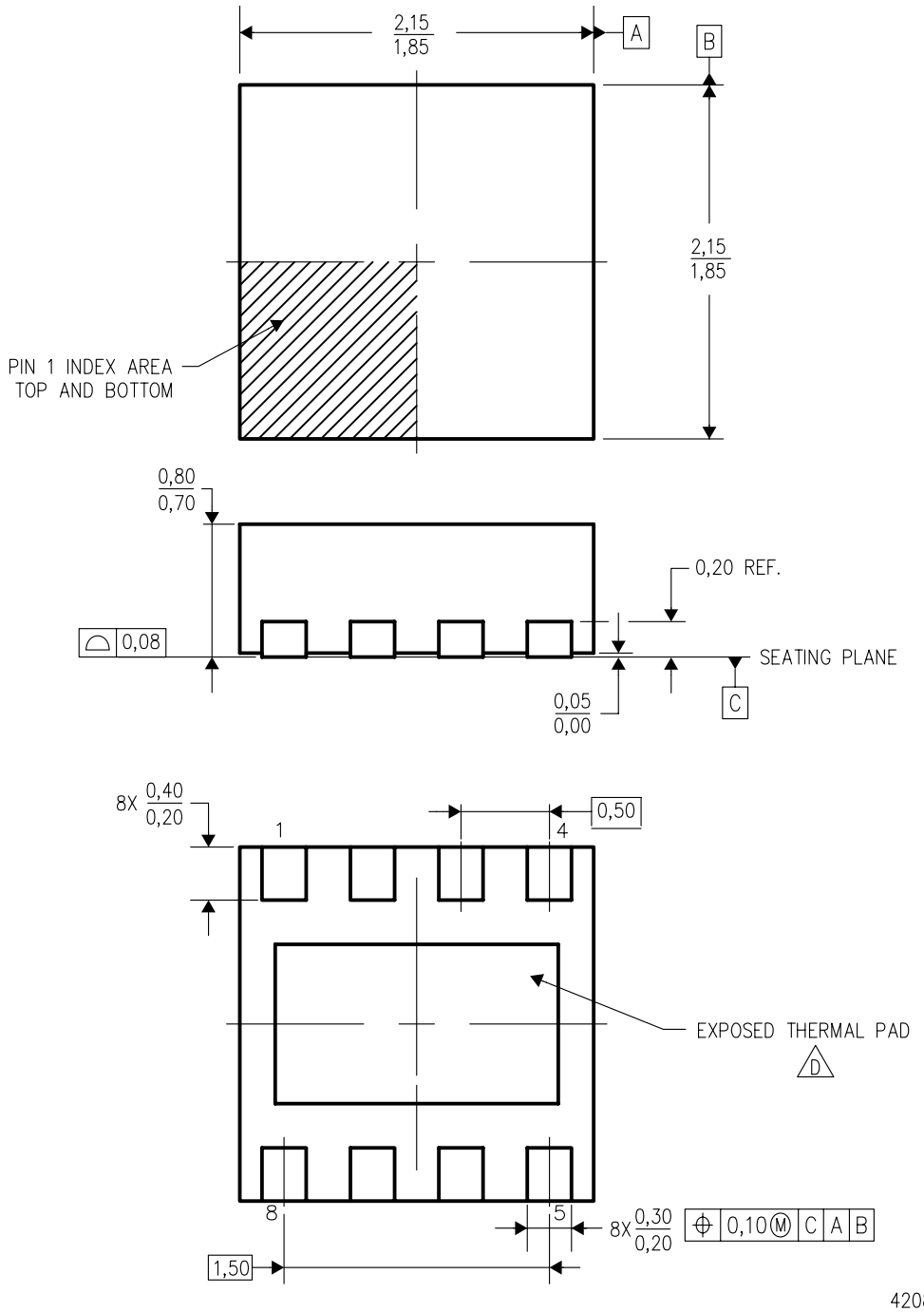
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ24312DSGR	SON	DSG	8	3000	195.0	200.0	45.0
BQ24312DSGT	SON	DSG	8	250	195.0	200.0	45.0

DSG (S–PDSO–N8) PLASTIC SMALL OUTLINE



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.

THERMAL PAD MECHANICAL DATA

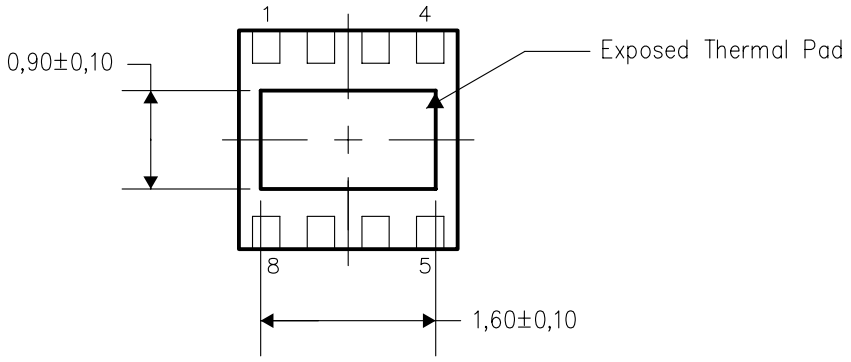
DSG (S–PDSO–N8)

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, Quad Flatpack No–Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at www.ti.com.

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

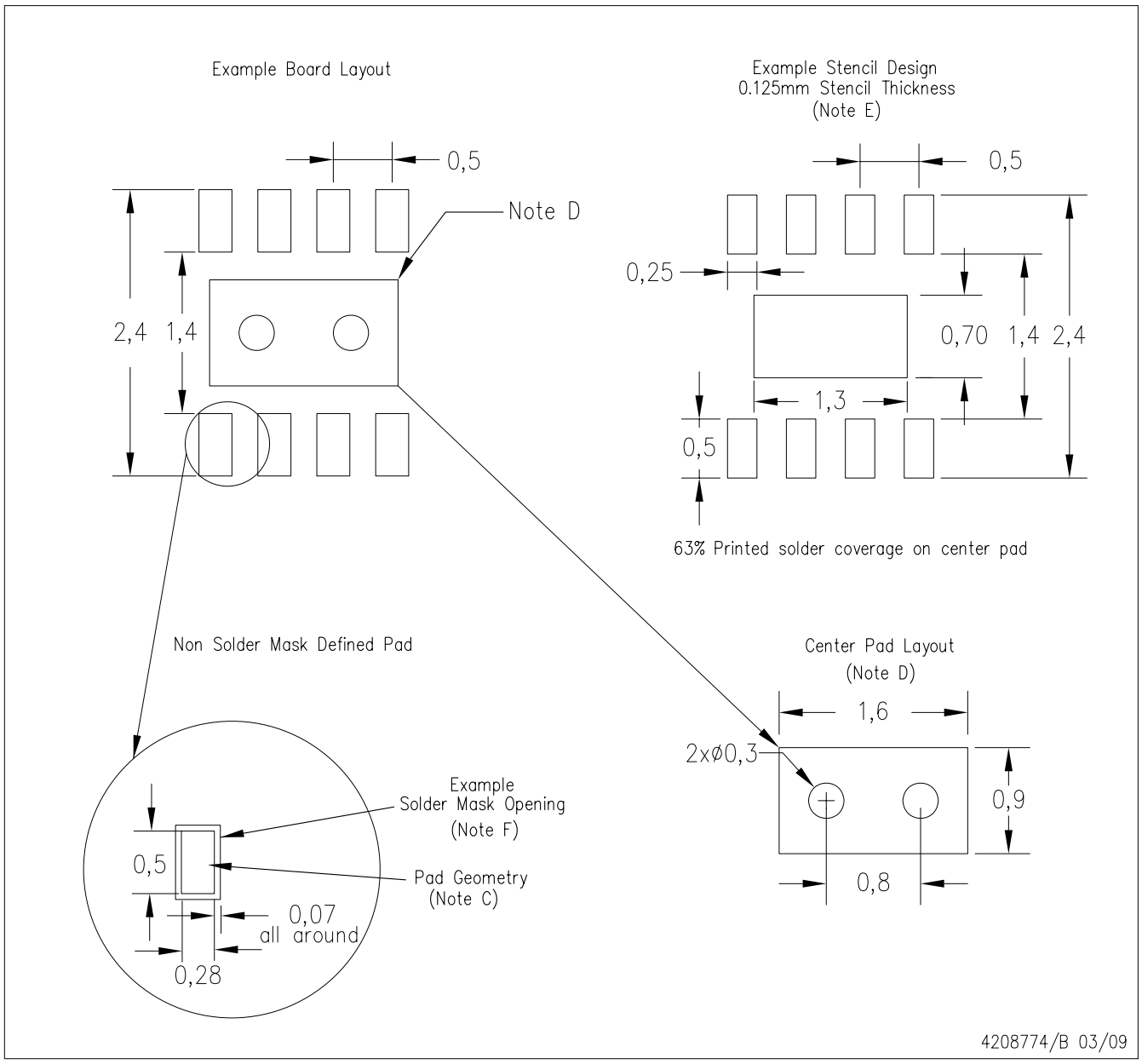


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

DSG (S–PWSON–N8) – Minimized Design



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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