Overvoltage and Overcurrent Protection IC and Li+ Charger Front-End Protection IC With LDO Mode

FEATURES

- **Input Overvoltage Protection**
- **Accurate Battery Overvoltage Protection**
- **Output Short-Circuit Protection**
- **Soft-Start to Prevent Inrush Currents**
- **Soft-Stop to Prevent Voltage Spikes**
- **30-V Maximum Input Voltage**
- **Supports up to 1.7-A Load Current**
- **Thermal Shutdown**
- **Enable Function**
- **Fault Status Indication**
- **Small 2 mm × 2 mm 8-Pin SON Package**

APPLICATIONS

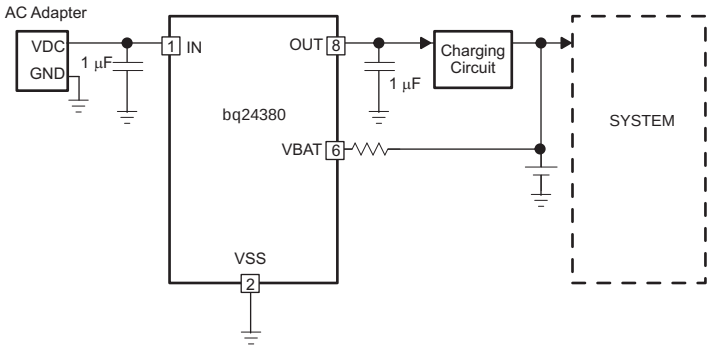
- **Smart Phones, Mobile Phones**
- **PDAs**
- **MP3 Players**
- **Low-Power Handheld Devices**

DESCRIPTION

The bq2438x family are charger front-end integrated circuits designed to provide protection to Li-ion batteries from failures of the charging circuitry. The IC continuously monitors the input voltage and the battery voltage. The device operates like a linear regulator, maintaining a 5.5-V (bq24380) or 5-V (bq24381, bq24382) output with input voltages up to the Input overvoltage threshold. During input overvoltage conditions, the IC immediately turns off the internal pass FET disconnecting the charging circuitry from the damaging input source. Additionally, if the battery voltage rises to unsafe levels while charging, power is removed from the system. The IC checks for short-circuit or overload conditions at its output when turning the pass FET on, and if it finds unsafe conditions, it switches off, and then rechecks the conditions. Additionally, the IC also monitors its die temperature and switches off if it exceeds 140°C.

When the IC is controlled by a processor, the IC provides status information about fault conditions to the host.

APPLICATION SCHEMATIC



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

DEVICE	V_{OVP}	$V_{O(REG)}$	PACKAGE(1)	MARKING
bq24380	6.3 V	5.5 V	2mm x 2mm SON	CFE
bq24381	7.1 V	5 V	2mm x 2mm SON	CFW
bq24382	10.5 V	5 V	2mm x 2mm SON	OBE

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

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

			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	V
		$\overline{FAULT}$, $\overline{CE}$, VBAT (with respect to VSS)	–0.3 to 7	V
I_{OUT}max	Output source current	OUT	2	A
	Output sink current	$\overline{FAULT}$	15	mA
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.

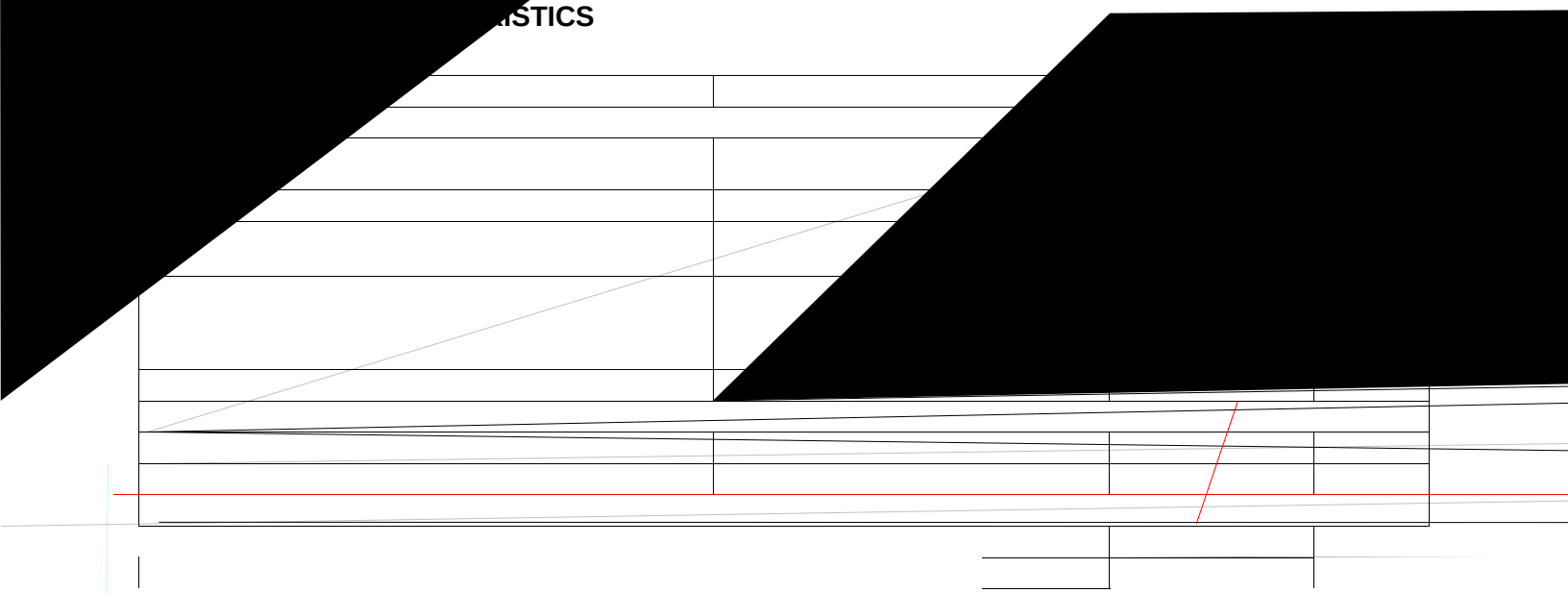
DISSIPATION RATINGS

PACKAGE	$R_{\theta JC}$	$R_{\theta JA}$
DSG	5°C/W	75°C/W

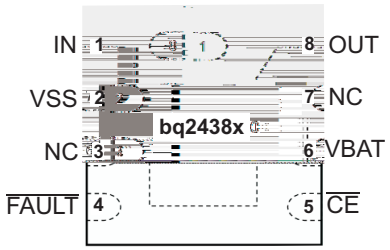
RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_I	IN voltage range	3.3	30	V
I_O	Current, OUT pin		1.7	A
T_J	Junction temperature	-40	125	°C

ISTICS



DEVICE INFORMATION

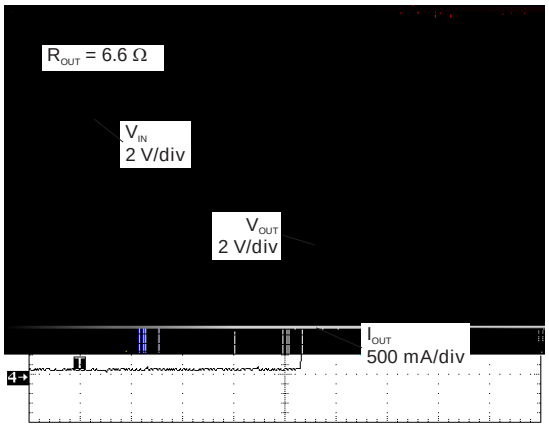


TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
IN	1	I	Input power, connected to external DC supply. Bypass IN to VSS with a ceramic capacitor (1 μF minimum)
VSS	2	–	Ground

TYPICAL CHARACTERISTICS

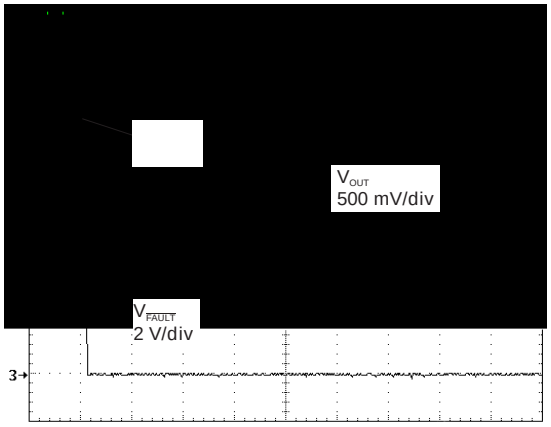
NORMAL POWER-ON SHOWING SOFT-START (bq24380)



t - Time - 2 ms/div

Figure 1.

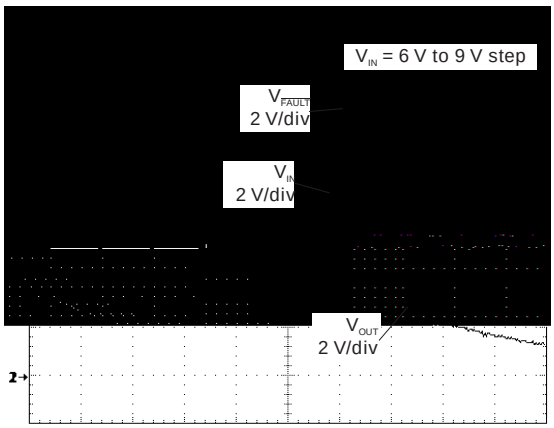
OVP at POWER-ON



t - Time - 2 ms/div

Figure 2.

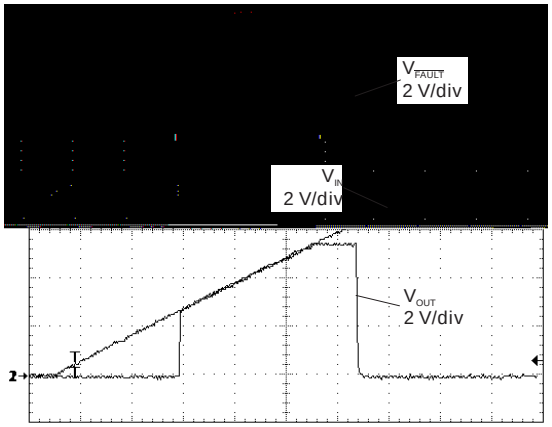
OVP RESPONSE for INPUT STEP (bq24380)



t - Time - 5 s/div

Figure 3.

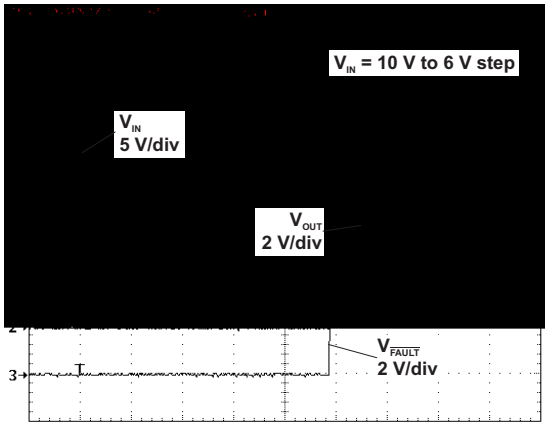
SLOW INPUT RAMPINTO OVP EVENT (bq24380)



t - Time - 200 ms/div

Figure 4.

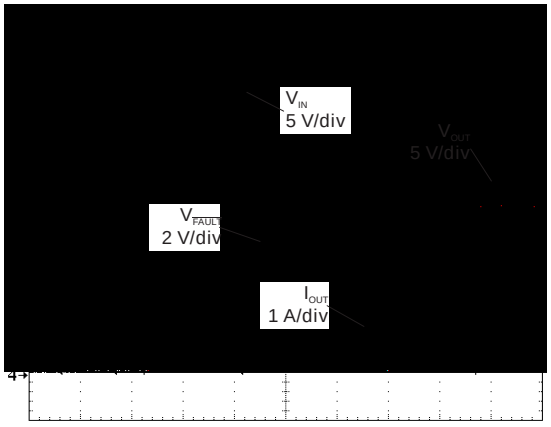
RECOVERY FROM OVP (bq24380)



t - Time - 2 ms/div

Figure 5.

POWER UP INTO SHORT CIRCUIT



t - Time - 5 ms/div

Figure 6.

TYPICAL CHARACTERISTICS (continued)

SOFT-STOP DURING OCP EVENT (bq24380)

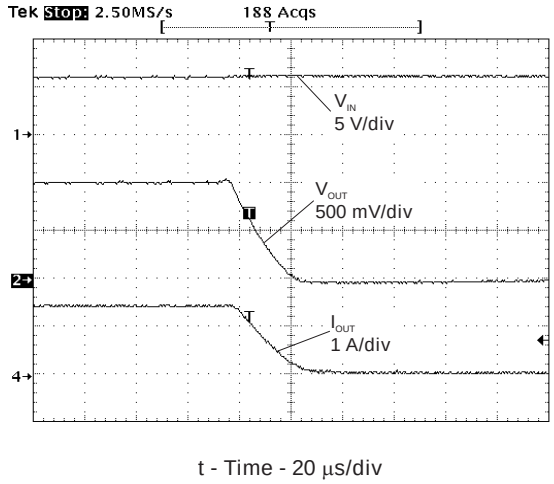


Figure 7.

BATTERY OVP EVENT (bq24380)

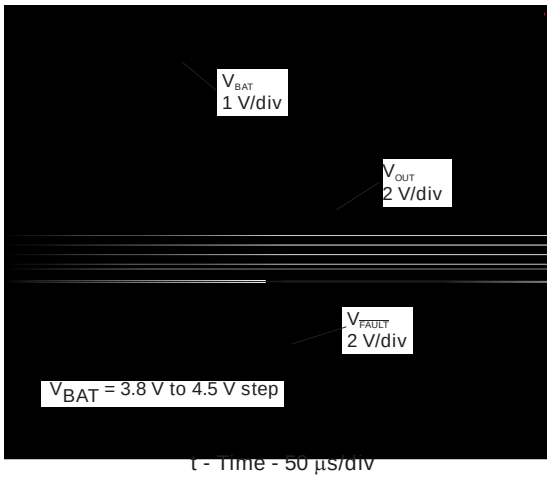


Figure 8.

UVLO vs FREE-AIR TEMPERATURE

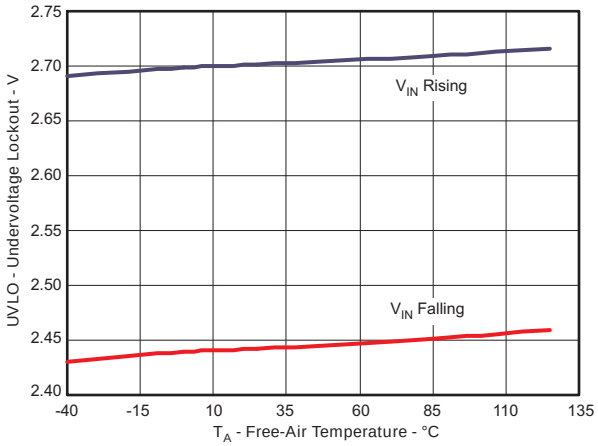


Figure 9.

DROPOUT VOLTAGE vs FREE-AIR TEMPERATURE

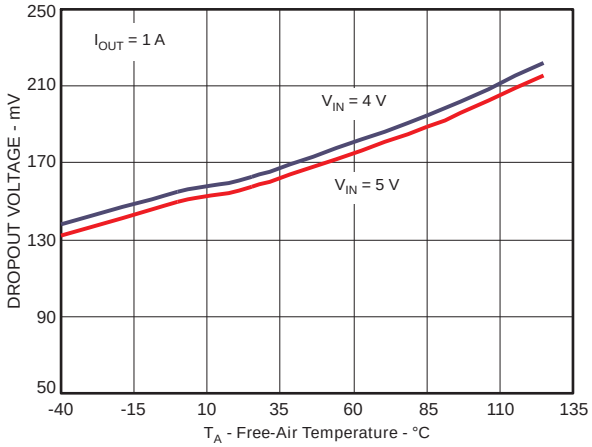


Figure 10.

OUTPUT VOLTAGE REGULATION, $V_{O(REG)}$ vs FREE-AIR TEMPERATURE

Figure 11.

OVP THRESHOLD vs FREE-AIR TEMPERATURE

Figure 12.

TYPICAL CHARACTERISTICS (continued)

OVP THRESHOLD, V_{BOVP} VS FREE-AIR TEMPERATURE

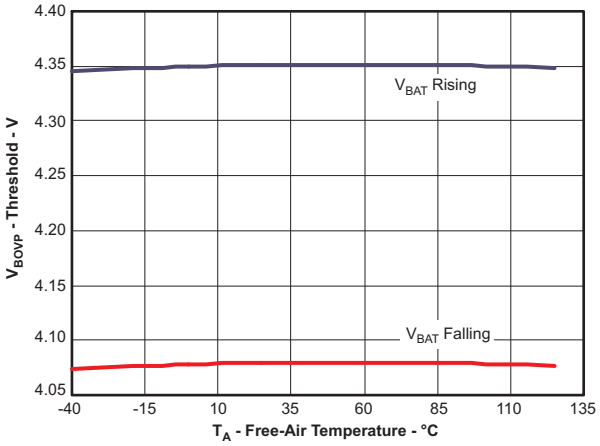


Figure 13.

LEAKAGE CURRENT (VBAT PIN) VS FREE-AIR TEMPERATURE

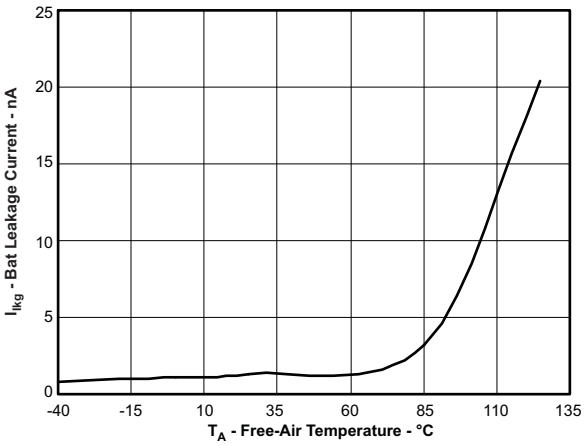


Figure 14.

SUPPLY CURRENT VS INPUT VOLTAGE (bq24380)

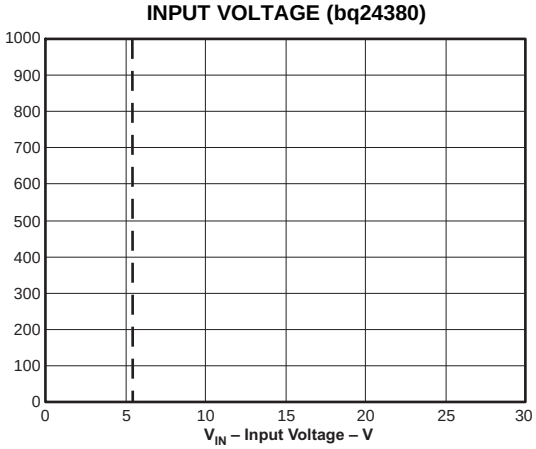


Figure 15.

SUPPLY CURRENT VS INPUT VOLTAGE (bq24381)

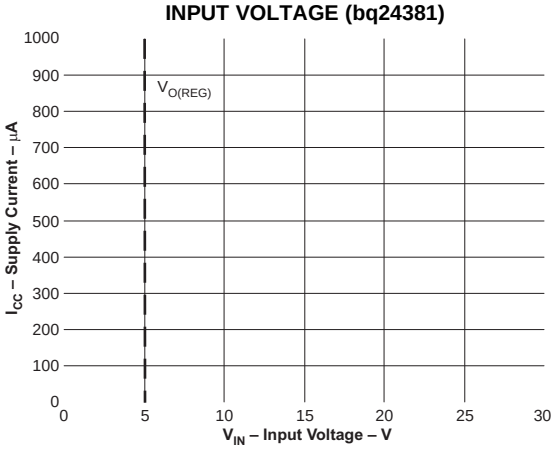


Figure 16.

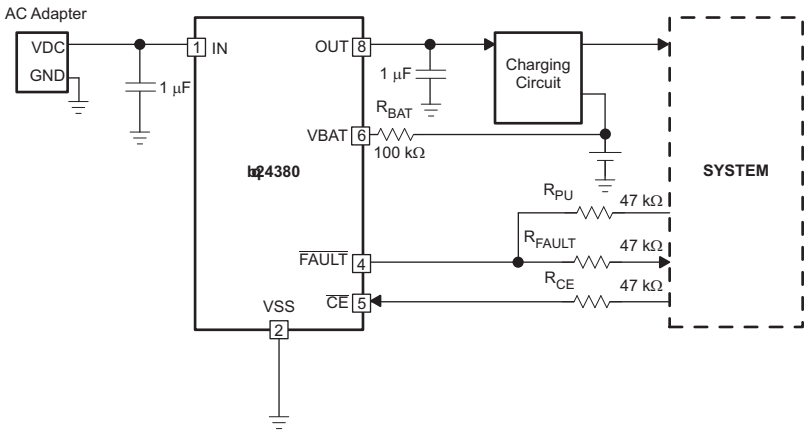


Figure 17. Typical Application Circuit

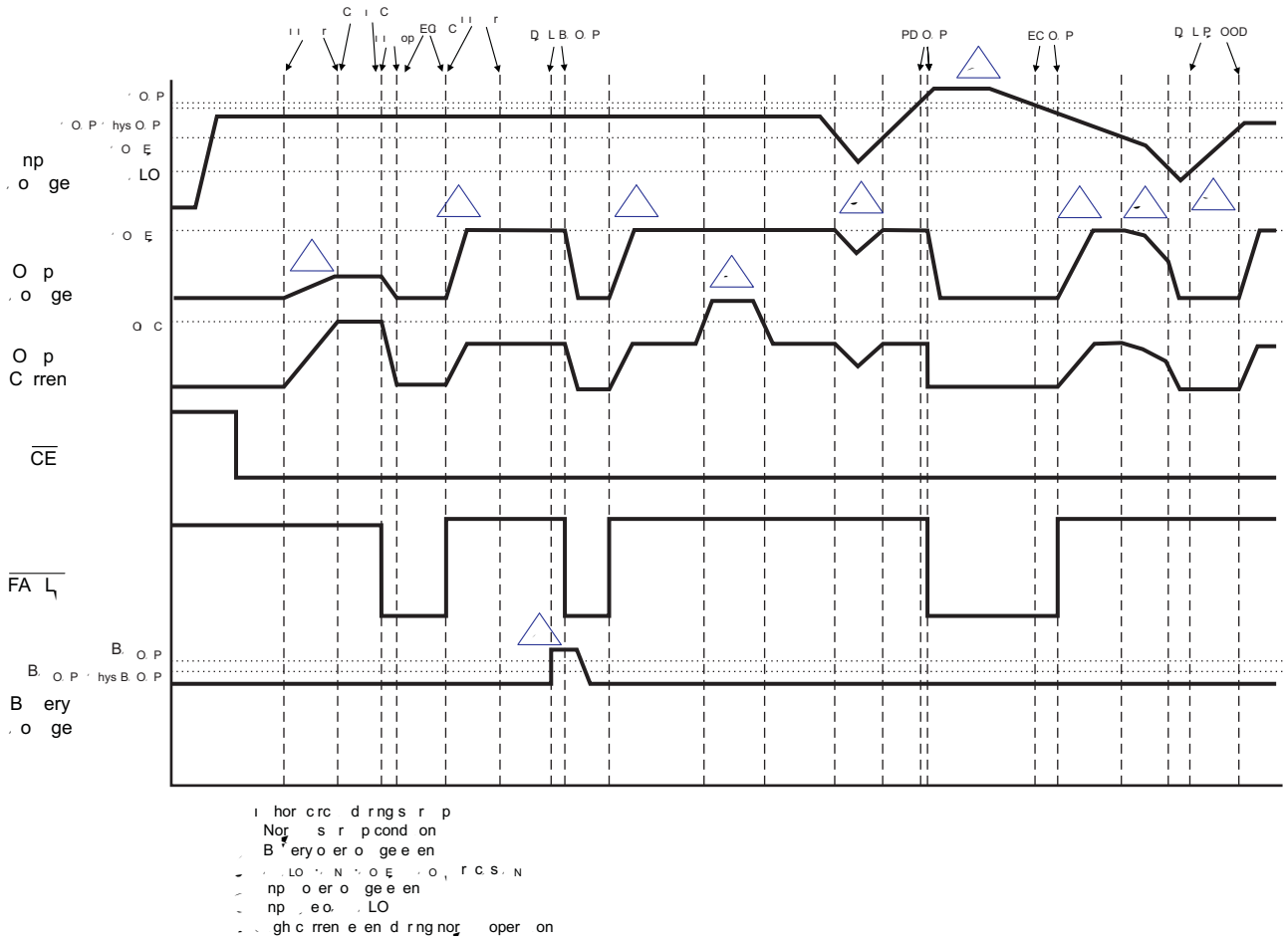


Figure 18. Timing Diagram

DETAILED FUNCTIONAL DESCRIPTION

POWER DOWN

POWER ON RESET

DETAILED FUNCTIONAL DESCRIPTION

Input Overvoltage Protection

Battery Overvoltage Protection

Thermal Protection

Start-Up Short-Circuit Protection

The bq2438x features overload current protection during start-up. The *condition 1* in Figure 18 illustrates start-up into an overload condition. If after the eight soft-start steps are complete, and the current limit is exceeded, the IC initiates a short-circuit check timer ($t_{CHK(SC)}$). During this check, the current is clamped to $I_{O(SC)}$. If the 5-ms $t_{CHK(SC)}$ timer expires and the current remains clamped by the current limit, the internal pass FET is turned off using the soft-stop method, $\overline{FAULT}$ is pulled low and the $t_{REC(SC)}$ timer begins. Once the $t_{REC(SC)}$ timer expires, $\overline{FAULT}$ becomes high impedance and the soft-start sequence restarts. The device repeats the start/fail sequence until the overload condition is removed. Once the overload condition is removed, the current limit circuitry is disabled and the device enters normal operation. Additionally, if the current is not limited after the completion of the soft-start sequence, the $t_{CHK(SC)}$ timer does not start and the current limit circuitry is disabled for normal operation.

Enable Function

The IC has an enable pin which is used to enable and disable the device. Connect the $\overline{CE}$ pin high to turn off the internal pass FET. Connect the $\overline{CE}$ pin low to turn on the internal pass FET and enter the start-up routine. The $\overline{CE}$ pin has an internal pulldown resistor and can be left unconnected. The $\overline{FAULT}$ pin is high impedance when the $\overline{CE}$ pin is high.

Fault Indication

The $\overline{FAULT}$ 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 $\overline{CE}$ high. With $\overline{CE}$ low, the $\overline{FAULT}$ pin goes low whenever any of these events occurs:

1. Output short-circuit at power-on
2. Input overvoltage
3. Battery overvoltage
4. IC overtemperature

See Figure 18 for an example of $\overline{FAULT}$ conditions during these events. Connect the $\overline{FAULT}$ pin to the desired logic level voltage rail through a resistor between 1 k and 50 k .

APPLICATION INFORMATION

Selection of $R_{(BAT)}$

Selection of $R_{(CE)}$

Selection of Input and Output Bypass Capacitors

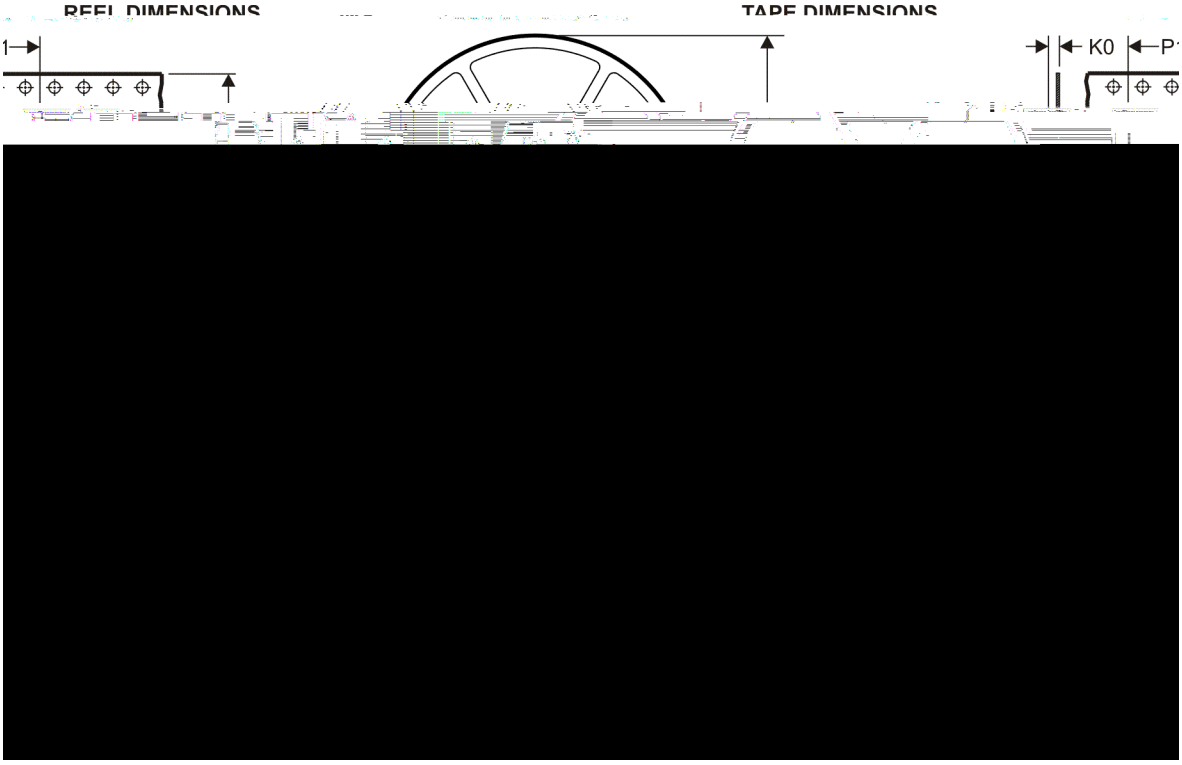
PCB Layout Guidelines

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
BQ24380DSGR	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24380DSGRG4	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24380DSGT	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24380DSGTG4	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24381DSGR	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24381DSGRG4	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24381DSGT	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24381DSGTG4	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24382DSGR	ACTIVE	WSON	DSG	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ24382DSGT	ACTIVE	WSON	DSG	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

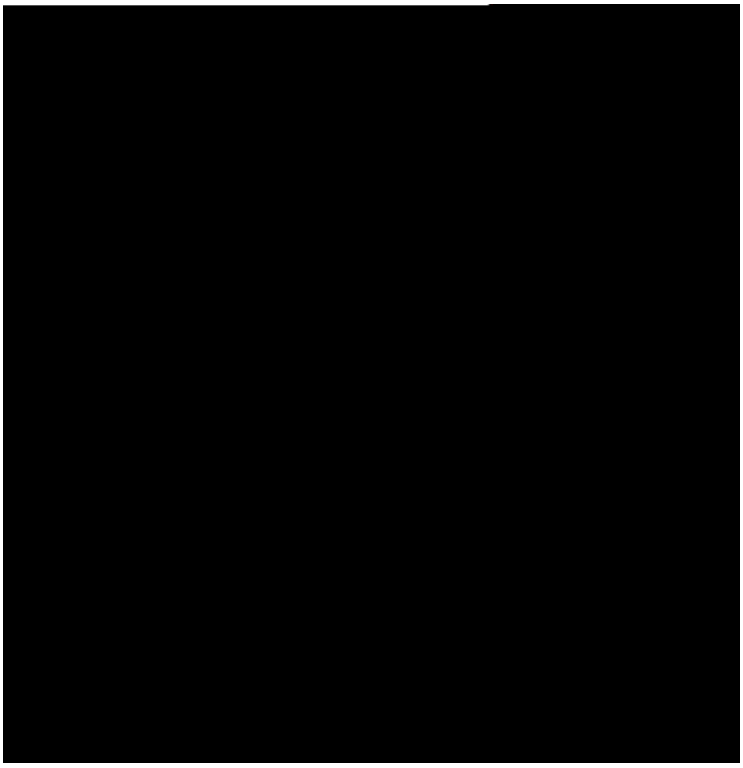
(1)

TAPE AND REEL INFORMATION



*All dimensions are nominal

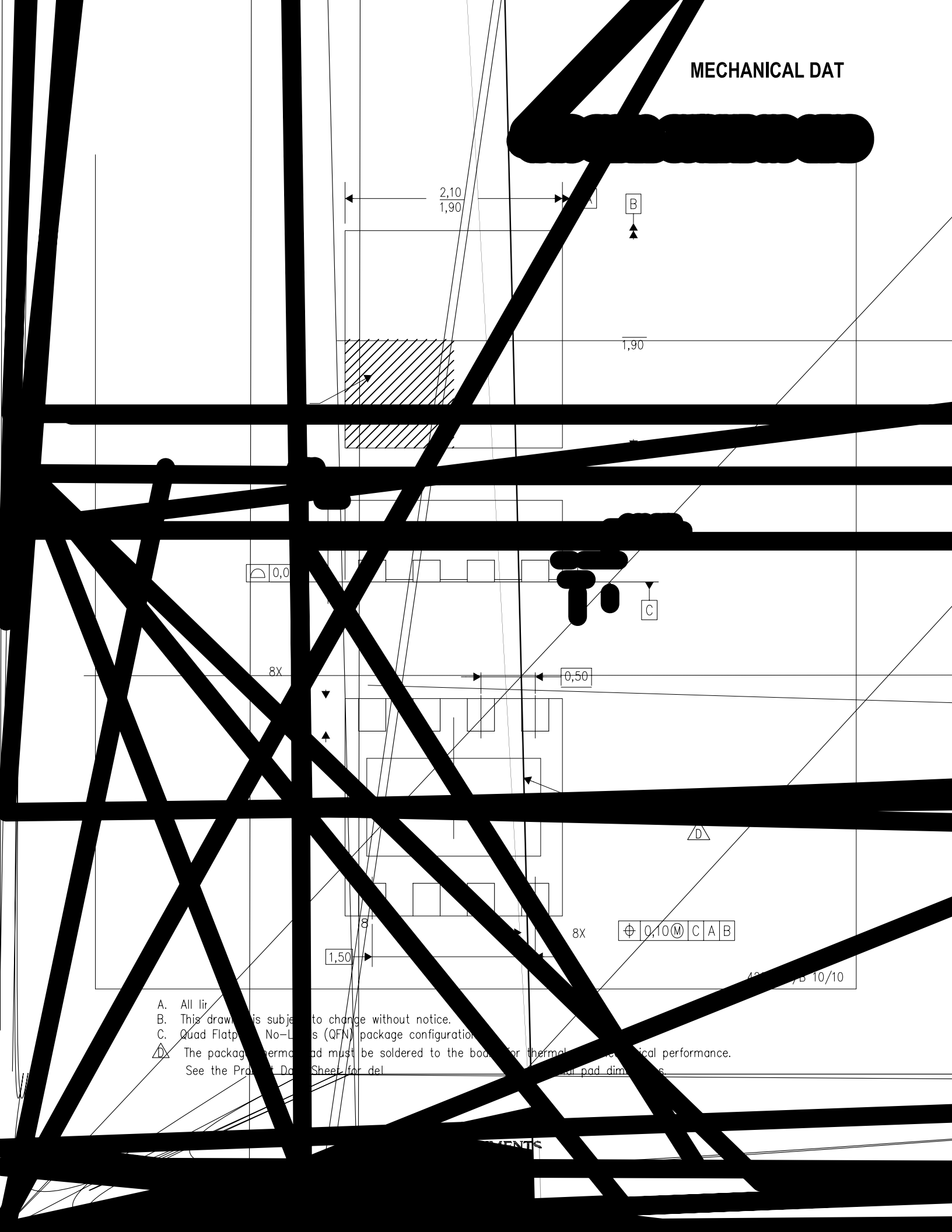
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
BQ24380DSGR	WSON	DSG	8	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24380DSGT	WSON	DSG	8	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24381DSGR	WSON	DSG	8	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24381DSGT	WSON	DSG	8	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24382DSGR	WSON	DSG	8	3000	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
BQ24382DSGT	WSON	DSG	8	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
BQ24380DSGR	WSON	DSG	8	3000	195.0	200.0	45.0
BQ24380DSGT	WSON	DSG	8	250	195.0	200.0	45.0
BQ24381DSGR	WSON	DSG	8	3000	195.0	200.0	45.0
BQ24381DSGT	WSON	DSG	8	250	195.0	200.0	45.0
BQ24382DSGR	WSON	DSG	8	3000	195.0	200.0	45.0
BQ24382DSGT	WSON	DSG	8	250	195.0	200.0	45.0

MECHANICAL DAT



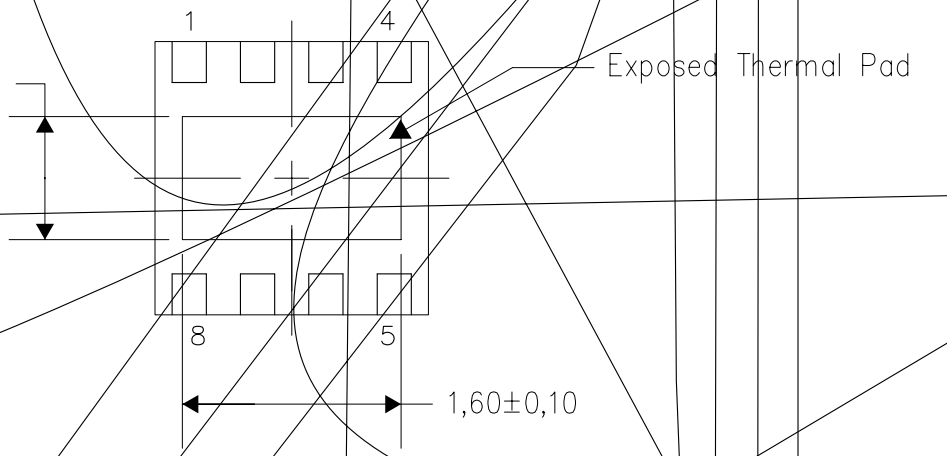
A. All lin
B. This drawi is subje to change without notice.
C. Quad Flatp No–L s (QFN) package configuratio
D. The packag hermal ad must be soldered to the boa for thermal ical performance.
See the Pro t Da Sheet for del ul pad dim s.

PLASTIC SMALL OUTLINE NO–LEAD

al 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). 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 alternat

For information on the Quad Flatpack No–Lead (QFN) package and its advantages, refer to Application Report,

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



Bottom View

Exposed Thermal Pad Dimensions

4208347/E 11/10

NOTE: A. All linear dimensions are in millimeters

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