Benchmarq Products from Texas Instruments

bq2000T

Programmable Multi-Chemistry Fast-Charge Management IC

Features

➤ Safe management of fast charge for NiCd, NiMH, or Li-Ion battery packs

➤ High-frequency switching controller for efficient and simple charger design

➤ Pre-charge qualification for detecting shorted, damaged, or overheated cells

➤ Fast-charge termination by ∆/∆t minimum current (Li-Ion), maximum temperature, and maximum charge time

➤ Selectable top-off mode for achieving maximum capacity in NiMH batteries

➤ Programmable trickle-charge mode for reviving deeply discharged batteries and for post-charge maintenance

➤ Built-in battery removal and insertion detection

➤ Sleep mode for low power consumption

General Description

The bq2000T is a programmable, monolithic IC for fast-charge management of nickel cadmium (NiCd), nickel metal-hydride (NiMH), or lithium-ion (Li-Ion) batteries in single- or multi-chemistry applications. The bq2000T detects the battery chemistry and proceeds with the optimal charging and termination algorithms. This process eliminates undesirable undercharged or overcharged conditions and allows accurate and safe termination of fast charge.
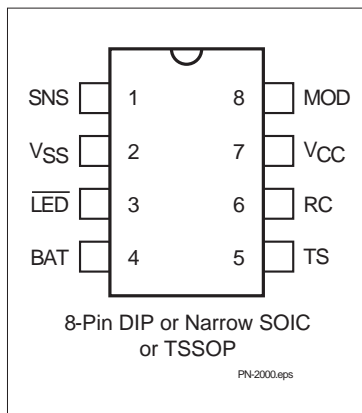
Depending on the chemistry, the bq2000T provides a number of charge termination criteria:

■ Rate of temperature rise, ∆/∆t (for NiCd and NiMH)

■ Minimum charging current (for Li-Ion)

■ Maximum temperature

■ Maximum charge time

For safety, the bq2000T inhibits fast charge until the battery voltage and temperature are within user-defined limits. If the battery voltage is below the low-voltage threshold, the bq2000T uses trickle-charge to condition the battery. For NiMH batteries, the bq2000T provides an optional top-off charge to maximize the battery capacity.

The integrated high-frequency comparator allows the bq2000T to be the basis for a complete, high-efficiency power-conversion circuit for both nickel-based and lithium-based chemistries.

Pin Connections

SNS 1   8 MOD
V_{SS} 2   7 V_{CC}
$\overline{LED}$ 3   6 RC
BAT 4   5 TS

8-Pin DIP or Narrow SOIC or TSSOP

PN-2000.eps

Pin Names

SNS	Current-sense input	TS	Temperature-sense input
V_{SS}	System ground	RC	Timer-program input
$\overline{LED}$	Charge-status output	V_{CC}	Supply-voltage input
BAT	Battery-voltage input	MOD	Modulation-control output

bq2000T

Pin Descriptions

SNS   **Current-sense input**

Enables the bq2000T to sense the battery current via the voltage developed on this pin by an external sense-resistor connected in series with the battery pack

V_{SS} **System Ground**

$\overline{LED}$ **Charge-status output**

Open-drain output that indicates the charging status by turning on, turning off, or flashing an external LED

BAT   **Battery-voltage input**

Battery-voltage sense input. A simple resistive divider, across the battery terminals, generates this input.

TS   **Temperature-sense input**

Input for an external battery-temperature monitoring circuit. An external resistive divider network with a negative temperature-coefficient thermistor sets the lower and upper temperature thresholds.

RC   **Timer-program input**

RC input used to program the maximum charge-time, hold-off period, and trickle rate during the charge cycle, and to disable or enable top-off charge

V_{CC} **Supply-voltage input**

MOD   **Modulation-control output**

Push-pull output that controls the charging current to the battery. MOD switches high to enable charging current to flow and low to inhibit charging- current flow.

Functional Description

The bq2000T is a versatile, multi-chemistry battery-charge control device. See Figure 1 for a functional block diagram and Figure 2 for the state diagram.
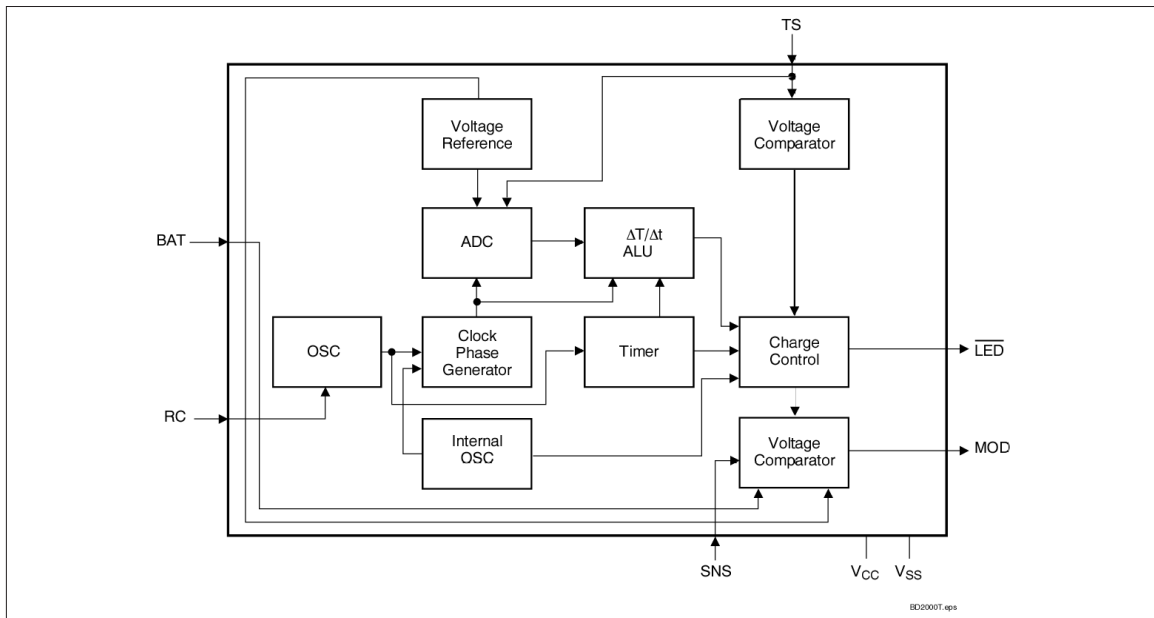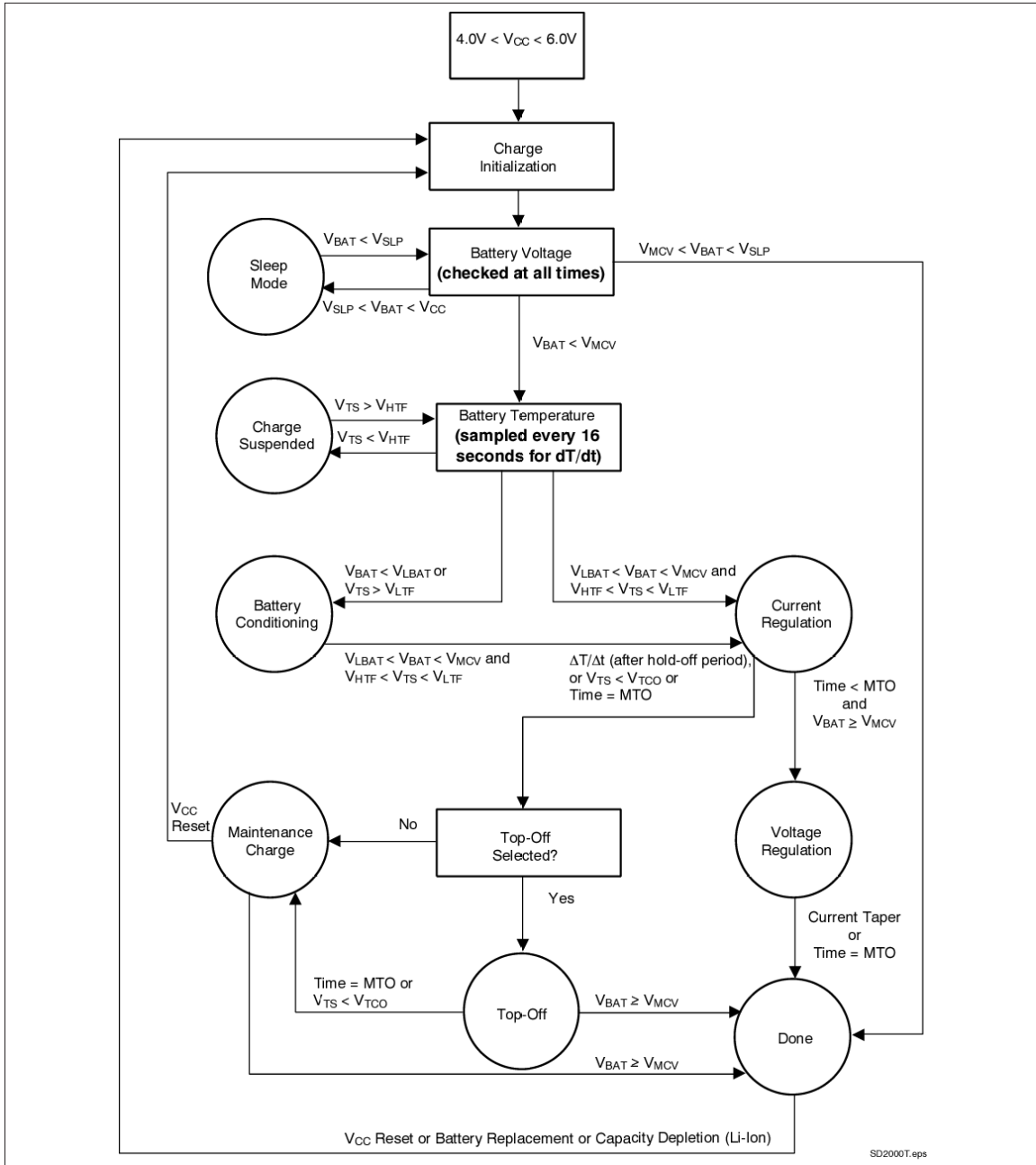

Figure 1. Functional Block Diagram

2

Figure 2. State Diagram

bq2000T

Initiation and Charge Qualification

The bq2000T initiates a charge cycle when it detects

■ Application of power to V_{CC}

■ Battery replacement

■ Exit from sleep mode

■ Capacity depletion (Li-Ion only)

Immediately following initiation, the IC enters a charge-qualification mode. The bq2000T charge qualification is based on battery voltage and temperature. If voltage on pin BAT is less than the internal threshold, V_{LBAT}, the bq2000T enters the charge-pending state. This condition indicates the possiblility of a defective or shorted battery pack. In an attempt to revive a fully depleted pack, the bq2000T enables the MOD pin to trickle-charge at a rate of once every 1.0s. As explained in the section "Top-Off and Pulse-Trickle Charge," the trickle pulse-width is user-selectable and is set by the value of the resistance connected to pin RC.

During this period, the $\overline{\text{LED}}$ pin blinks at a 1Hz rate, indicating the pending status of the charger.

Similarly, the bq2000T suspends fast charge if the battery temperature is outside the V_{LTF} to V_{HTF} range. (See Table 4.) For safety reasons, however, it disables the pulse trickle, in the case of a battery over-temperature condition (i.e., $V_{TS} < V_{HTF}$). Fast charge begins when the battery temperature and voltage are valid.

Battery Chemistry

The bq2000T detects the battery chemistry by monitoring the battery-voltage profile during fast charge. If the voltage on BAT input rises to the internal V_{MCV} reference, the IC assumes a Li-Ion battery. Otherwise the bq2000T assumes NiCd/NiMH chemistry.

As shown in Figure 6, a resistor voltage-divider between the battery pack's positive terminal and V_{SS} scales the battery voltage measured at pin BAT. In a mixed-chemistry design, a common voltage-divider is used as long as the maximum charge voltage of the nickel-based pack is below that of the Li-Ion pack. Otherwise, different scaling is required.

Once the chemistry is determined, the bq2000T completes the fast charge with the appropriate charge algorithm (Table 1). The user can customize the algorithm by programming the device using an external resistor and a capacitor connected to the RC pin, as discussed in later sections.

NiCd and NiMH Batteries

Following qualification, the bq2000T fast-charges NiCd or NiMH batteries using a current-limited algorithm. During the fast-charge period, it monitors charge time, temperature, and voltage for adherence to the termination criteria. This monitoring is further
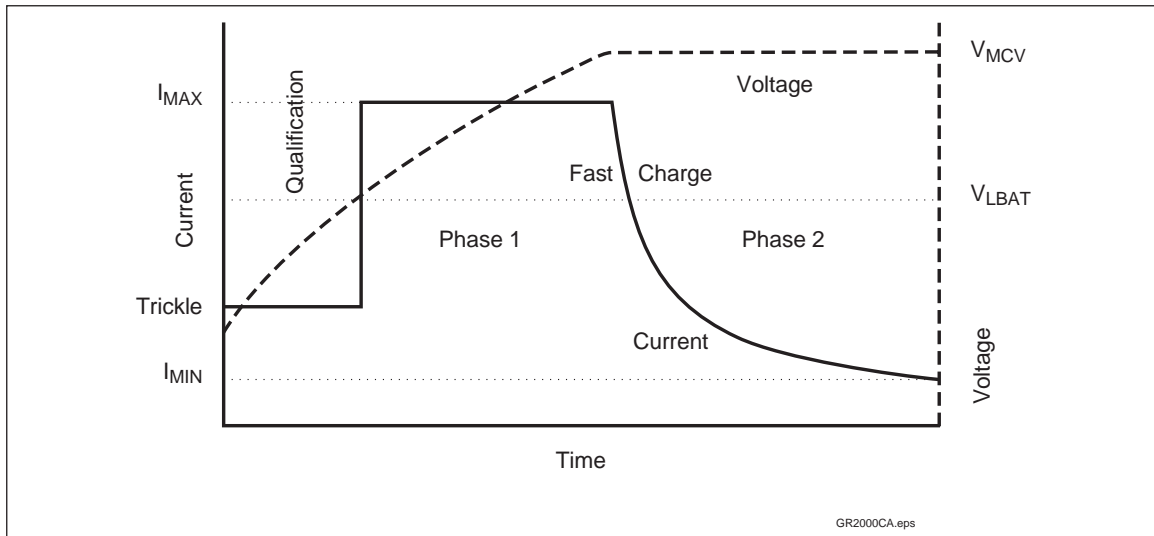

Figure 3. Lithium-Ion Charge Algorithm

Table 1. Charge Algorithm

Battery Chemistry	Charge Algorithm
NiCd or NiMH	1. Charge qualification 2. Trickle charge, if required 3. Fast charge (constant current) 4. Charge termination ($\Delta T/\Delta t$, time) 5. Top-off (optional) 6. Trickle charge
Li-Ion	1. Charge qualification 2. Trickle charge, if required 3. Two-step fast charge (constant current followed by constant voltage) 4. Charge termination (minimum current, time)

explained in later sections. Following fast charge, the battery is topped off, if top-off is selected. The charging cycle ends with a trickle maintenance-charge that continues as long as the voltage on pin BAT remains below V_{MCV}.

Lithium-Ion Batteries

The bq2000T uses a two-phase fast-charge algorithm for Li-Ion batteries (Figure 3). In phase one, the bq2000T regulates constant current until V_{BAT} rises to V_{MCV}. The bq2000T then moves to phase two, regulates the battery with constant voltage of V_{MCV}, and terminates when the charging current falls below the I_{MIN} threshold. A new charge cycle is started if the cell voltage falls below the V_{RCH} threshold.

During the current-regulation phase, the bq2000T monitors charge time, battery temperature, and battery voltage for adherence to the termination criteria. During the final constant-voltage stage, in addition to the charge time and temperature, it monitors the charge current as a termination criterion. There is no post-charge maintenance mode for Li-Ion batteries.

Charge Termination

Maximum Charge Time (NiCD, NiMH, and Li-Ion)

The bq2000T sets the maximum charge-time through pin RC. With the proper selection of external resistor and capacitor, various time-out values may be achieved. Figure 4 shows a typical connection.

The following equation shows the relationship between the R_{MTO} and C_{MTO} values and the maximum charge time (MTO) for the bq2000T:

$$MTO = R_{MTO} * C_{MTO} * 35,988$$

MTO is measured in minutes, R_{MTO} in ohms, and C_{MTO} in farads. (**Note:** R_{MTO} and C_{MTO} values also de-

termine other features of the device. See Tables 2 and 3 for details.)

For Li-Ion cells, the bq2000T resets the MTO when the battery reaches the constant-voltage phase of the charge. This feature provides the additional charge time required for Li-Ion cells.

Maximum Temperature (NiCd, NiMH, Li-Ion)

A negative-coefficient thermistor, referenced to V_{SS} and placed in thermal contact with the battery, may be used as a temperature-sensing device. Figure 5 shows a typical temperature-sensing circuit.

During fast charge, the bq2000T compares the battery temperature to an internal high-temperature cutoff threshold, V_{TCO}. As shown in Table 4, high-temperature termination occurs when voltage at pin TS is less than this threshold.

$\Delta T/\Delta t$ (NiCd, NiMH)

When fast charging, the bq2000T monitors the voltage at pin TS for rate of temperature change detection, $\Delta T/\Delta t$. The bq2000T samples the voltage at the TS pin every 16s and compares it to the value measured 2 samples earlier. This feature terminates fast charge if this voltage declines at a rate of

$$\frac{V_{CC}}{161}\left(\frac{V}{Min}\right)$$

Figure 5 shows a typical connection diagram.

Minimum Current (Li-Ion Only)

The bq2000T monitors the charging current during the voltage-regulation phase of Li-Ion batteries. Fast charge is terminated when the current is tapered off to 7% of the maximum charging current. **Please note that this threshold is different for the bq2000.**
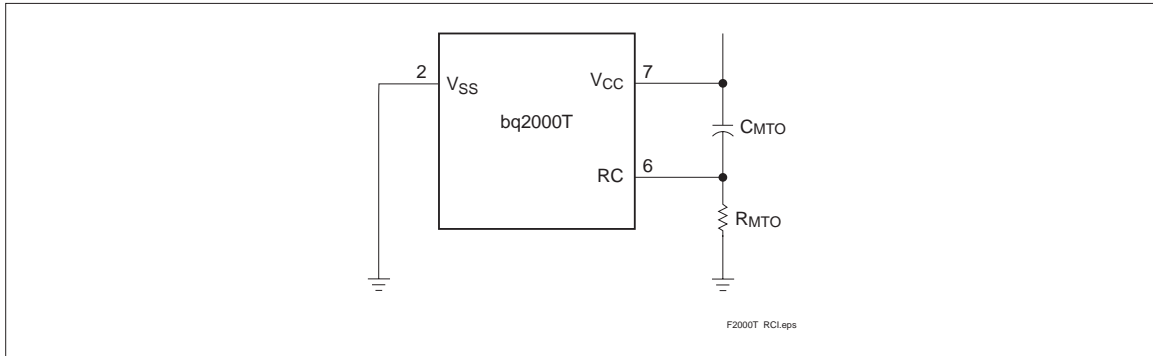
Initial Hold-Off Period

Figure 4. Typical Connection for the RC Input

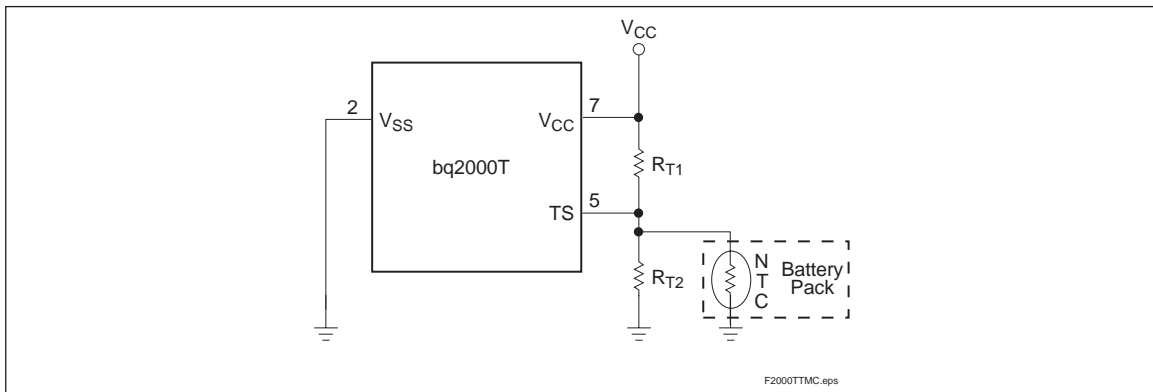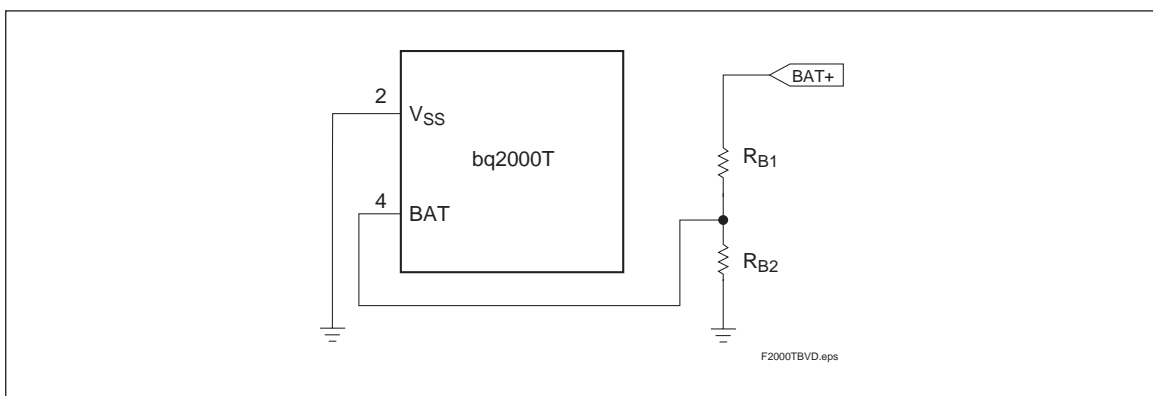**Figure 5. Temperature Monitoring Configuration**

Figure 6. Battery Voltage Divider

Figure 8. Single-Cell Li-Ion, Three-Cell NiCd/NiMH 1A Charger

NOTES: 1. For Li-Ion, the CHEMISTRY is left floating.
For NiCd/NiMH, the CHEMISTRY is tied to BAT-
2. DC input voltage: 9–16V
3. Charge current: 1A
4. L1: 3L Global P/N PKSMD-1005-470K-1A

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Table 2. Summary of NiCd or NiMH Charging Characteristics

Parameter	Value
Maximum cell voltage (V_{MCV})	2V
Minimum pre-charge qualification voltage (V_{LBAT})	950mV
High-temperature cutoff voltage (V_{TCO})	$0.225 * V_{CC}$
High-temperature fault voltage (V_{HTF})	$0.25 * V_{CC}$
Low-temperature fault voltage (V_{LTF})	$0.5 * V_{CC}$
bq2000T fast-charge maximum time out (MTO)	$R_{MTO} * C_{MTO} * 35,988$
Fast-charge charging current (I_{MAX})	$0.05/R_{SNS}$
Hold-off period	MTO/32
Top-off charging current (optional)	$I_{MAX}/16$
Top-off period (optional)	MTO
Trickle-charge frequency	1Hz
Trickle-charge pulse-width	See Figure 7

For Li-Ion battery packs, the resistor values R_{B1} and R_{B2} are calculated by the following equation:

$$\frac{R_{B1}}{R_{B2}} = \left(N * \frac{V_{CELL}}{V_{MCV}}\right) - 1$$

where N is the number of cells in series and V_{CELL} is the manufacturer-specified charging voltage. The end-to-end input impedance of this resistive divider network should be at least 200kΩ and no more than 1MΩ.

A NiCd or NiMH battery pack consisting of N series-cells may benefit by the selection of the R_{B1} value to be N-1 times larger than the R_{B2} value.

In a mixed-chemistry design, a common voltage-divider is used as long as the maximum charge voltage of the nickel-based pack is below that of the Li-Ion pack. Otherwise, different scaling is required.

Temperature Monitoring

The bq2000T measures the temperature by the voltage at the TS pin. This voltage is typically generated by a negative-temperature-coefficient thermistor. The bq2000T compares this voltage against its internal threshold voltages to determine if charging is safe.

Table 3. Summary of Li-Ion Charging Characteristics

Parameter	Value
Maximum cell voltage (V_{MCV})	2V
Minimum pre-charge qualification voltage (V_{LBAT})	950mV
High-temperature cutoff voltage (V_{TCO})	$0.225 * V_{CC}$
High-temperature fault voltage (V_{HTF})	$0.25 * V_{CC}$
Low-temperature fault voltage (V_{LTF})	$0.5 * V_{CC}$
bq2000T fast-charge maximum time-out (MTO)	$2 * R_{MTO} * C_{MTO} * 35,988$
Fast-charge charging current (I_{MAX})	$0.05/R_{SNS}$
Hold-off period	MTO/32
Minimum current (for fast-charge termination)	$I_{MAX}/14$
Trickle-charge frequency (before fast charge only)	1Hz
Trickle-charge pulse-width (before fast charge only)	See Figure 7

Table 4. Temperature-Monitoring Conditions

Temperature	Condition	Action
$V_{TS} > V_{LTF}$	Cold battery—checked at all times	Suspends fast charge or top-off and timer Allows trickle charge—LED flashes at 1Hz rate during pre-charge qualification and fast charge
$V_{HTF} < V_{TS} < V_{LTF}$	Optimal operating range	Allows charging
$V_{TS} < V_{HTF}$	Hot battery—checked during charge qualification and top-off and trickle-charge	Suspends fast-charge initiation, does not allow trickle charge—LED flashes at 1Hz rate during pre-charge qualification

These thresholds are the following:

■ High-temperature cutoff voltage: $V_{TCO} = 0.225 * V_{CC}$ This voltage corresponds to the maximum temperature (TCO) at which fast charging is allowed. The bq2000T terminates fast charge if the voltage on pin TS falls below V_{TCO}.

■ High-temperature fault voltage: $V_{HTF} = 0.25 * V_{CC}$ This voltage corresponds to the temperature (HTF) at which fast charging is allowed to begin.

■ Low-temperature fault voltage: $V_{LTF} = 0.5 * V_{CC}$ This voltage corresponds to the minimum temperature (LTF) at which fast charging or top-off is allowed. If the voltage on pin TS rises above $V_{LTF,}$ the bq2000T suspends fast charge or

Table 5. Charge Status Display

Charge Action State	$\overline{LED}$ Status
Battery absent	High impedance
Pre-charge qualification	1Hz flash
Trickle charge (before fast charge)	1Hz flash
Fast charging	Low
Top-off or trickle (after fast charge, NiCd, NiMH only)	High impedance
Charge complete	High impedance

top-off but does not terminate charge. When the voltage falls back below $V_{LTF,}$ fast charge or top-off resumes from the point where suspended. Trickle-charge is allowed during this condition.

Table 4 summarizes these various conditions.

Charge Status Display

The charge status is indicated by open-drain output LED. Table 5 summarizes the display output of the bq2000T.

Figure 9. Current-Sensing Circuit

Sleep Mode

The bq2000T features a sleep mode for low power consumption. This mode is enabled when the voltage at pin BAT is above the low-power-mode threshold, V_{SLP}. During sleep mode, the bq2000T shuts down all internal circuits, drives the LED output to high-impedance state, and drives pin MOD to low. Restoring BAT below the V_{MCV} threshold initiates the IC and starts a fast-charge cycle.

Absolute Maximum Ratings

Symbol	Parameter	Minimum	Maximum	Unit	Notes
V_{CC}	V_{CC} relative to V_{SS}	-0.3	+7.0	V	
V_T	DC voltage applied on any pin, excluding V_{CC} relative to V_{SS}	-0.3	+7.0	V	
T_{OPR}	Operating ambient temperature	-20	+70	°C	
T_{STG}	Storage temperature	-40	+125	°C	
T_{SOLDER}	Soldering temperature	-	+260	°C	10s max.

Note: Permanent device damage may occur if Absolute Maximum Ratings are exceeded. Functional operation should be limited to the Recommended DC Operating Conditions detailed in this data sheet. Exposure to conditions beyond the operational limits for extended periods of time may affect device reliability.

DC Thresholds ($T_A = T_{OPR}$; V_{CC} = 5V ±20% unless otherwise specified)

Symbol	Parameter	Rating	Tolerance	Unit	Notes
V_{TCO}	Temperature cutoff	$0.225 * V_{CC}$	±5%	V	Voltage at pin TS
V_{HTF}	High-temperature fault	$0.25 * V_{CC}$	±5%	V	Voltage at pin TS
V_{LTF}	Low-temperature fault	$0.5 * V_{CC}$	±5%	V	Voltage at pin TS
V_{MCV}	Maximum cell voltage	2.00	±0.75%	V	$V_{BAT} > V_{MCV}$ inhibits fast charge
V_{LBAT}	Minimum cell voltage	950	±5%	mV	Voltage at pin BAT
V_{THERM}	TS input change for ΔT/Δt detection	$-\dfrac{V_{CC}}{161}$	±25%	V/Min	
V_{SNSHI}	High threshold at SNS, resulting in MOD-low	50	±10	mV	Voltage at pin SNS
V_{SNSLO}	Low threshold at SNS, resulting in MOD-high	-50	±10	mV	Voltage at pin SNS
V_{SLP}	Sleep-mode input threshold	V_{CC} - 1	±0.5	V	Applied to pin BAT
V_{RCH}	Recharge threshold	V_{MCV} - 0.1	±0.02	V	At pin BAT

bq2000T

Recommended DC Operating Conditions $(T_A = T_{OPR})$

Symbol	Condition	Minimum	Typical	Maximum	Unit	Notes
V_{CC}	Supply voltage	4.0	5.0	6.0	V	
I_{CC}	Supply current	-	0.5	1	mA	Exclusive of external loads
I_{CCS}	Sleep current	-	-	5	μA	$V_{BAT} = V_{SLP}$
V_{TS}	Thermistor input	0.5	-	V_{CC}	V	$V_{TS} < 0.5V$ prohibited
V_{OH}	Output high	V_{CC} - 0.2	-	-	V	MOD, $I_{OH} = 20mA$
V_{OL}	Output low	-	-	0.2	V	MOD, LED, $I_{OL} = 20mA$
I_{OZ}	High-impedance leakage current	-	-	5	μA	LED
I_{snk}	Sink current	-	-	20	mA	MOD, LED
R_{MTO}	Charge timer resistor	2	-	250	kΩ	
C_{MTO}	Charge timer capacitor	0.001	-	1.0	μF	

Note: All voltages relative to V_{SS} except as noted.

Impedance

Symbol	Parameter	Minimum	Typical	Maximum	Unit
R_{BAT}	Battery input impedance	10	-	-	MΩ
R_{TS}	TS input impedance	10	-	-	MΩ
R_{SNS}	SNS input impedance	10	-	-	MΩ

Timing $(T_A = T_{OPR}; V_{CC} = 5V \pm 20\%$ unless otherwise specified$)$

Symbol	Parameter	Minimum	Typical	Maximum	Unit
d_{MTO}	MTO time-base variation	-5	-	+5	%
f_{TRKL}	Pulse-trickle frequency	0.9	1.0	1.1	Hz

Data Sheet Revision History

Change No.	Page No.	Description	Nature of Change
1	5	Minimum current termination	Was: 14% Is: 7%
1	3	Added state diagram	
1	7	Changed capacitor value for en - abling top-off	Was: 0.13µF Is: 0.26µF
1	8	Figure 8	Schematic updated
1	10	V_{TCO}, V_{HTF}, V_{LTF}	Tolerance updated
2	9	Minimum current (for fast charge termination)	Was: $I_{MAX}/7$ Is: $I_{MAX}/14$
3	2	Change Figure 1	Connection added between TS and ADC and connection deleted between BAT and ADC.
3	2	Change Figure 2	Battery temperature was: (checked at all times) Is: (sampled every 16 seconds for $\Delta T/\Delta t$)
3	14	Change package	Was: 8-Pin TSSOP ~TS Package Suffix Is: 8-Pin PSOP
3	13	Change Ordering Information	Was: TS = 8-pin TSSOP Is: PW = 8-pin TSSOP
4	7	Change value	Was: 15kΩ Is: 250kΩ

Note: Change 1 = May 1999 B changes to Final from Jan. 1999 Preliminary data sheet.
Change 2 = February 2000 changes from May 1999 B.
Change 3 = February 2001 changes from February 2000.
Change 4 = January 2008 changes from February 2001.
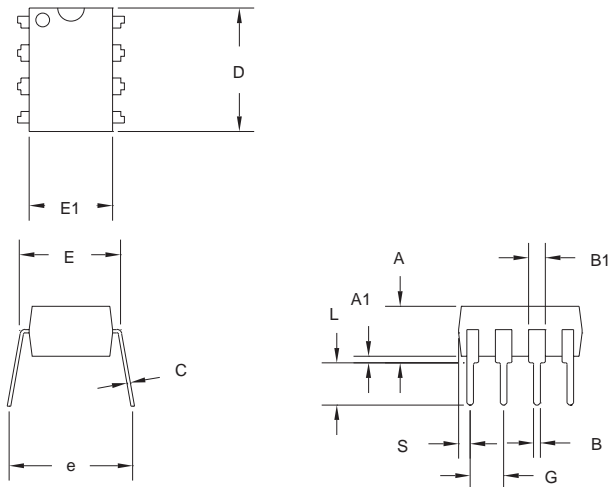
Ordering Information

bq2000T __

Package Option:
PN = 8-pin narrow plastic DIP
SN = 8-pin narrow SOIC
PW = 8-pin SSOP

Device:
bq2000T Multi-Chemistry Fast-Charge IC with $\Delta T/\Delta t$ Detection

8-Pin DIP (PN)

8-Pin PN (0.300" DIP)

Dimension	Inches		Millimeters	
	Min.	**Max.**	**Min.**	**Max.**
A	0.160	0.180	4.06	4.57
A1	0.015	0.040	0.38	1.02
B	0.015	0.022	0.38	0.56
B1	0.055	0.065	1.40	1.65
C	0.008	0.013	0.20	0.33
D	0.350	0.380	8.89	9.65
E	0.300	0.325	7.62	8.26
E1	0.230	0.280	5.84	7.11
e	0.300	0.370	7.62	9.40
G	0.090	0.110	2.29	2.79
L	0.115	0.150	2.92	3.81
S	0.020	0.040	0.51	1.02

8-Pin SOIC Narrow (SN)
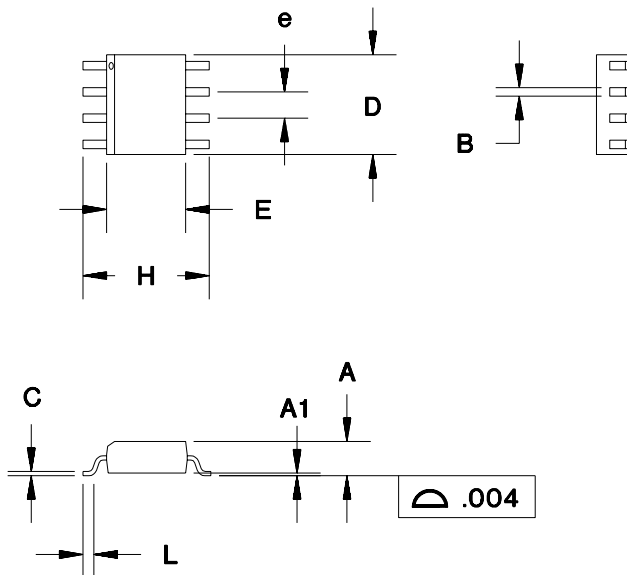
8-Pin SN (0.150" SOIC)

Dimension	Inches		Millimeters	
	Min.	**Max.**	**Min.**	**Max.**
A	0.060	0.070	1.52	1.78
A1	0.004	0.010	0.10	0.25
B	0.013	0.020	0.33	0.51
C	0.007	0.010	0.18	0.25
D	0.185	0.200	4.70	5.08
E	0.150	0.160	3.81	4.06
e	0.045	0.055	1.14	1.40
H	0.225	0.245	5.72	6.22
L	0.015	0.035	0.38	0.89

bq2000T

8-Pin PSOP
14 PINS SHOWN
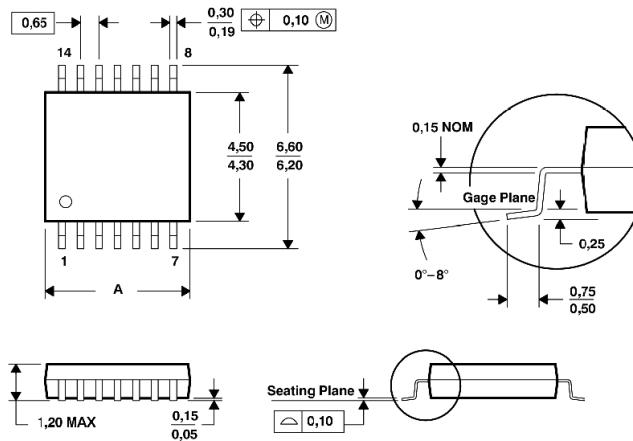
PINS ****** DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

15

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
BQ2000TPN-B5	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
BQ2000TPW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ2000TPWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ2000TPWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ2000TPWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
BQ2000TSN-B5	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
BQ2000TSN-B5G4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
BQ2000TSN-B5TR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
BQ2000TSN-B5TRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

[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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TAPE AND REEL INFORMATION

REEL DIMENSIONS

Reel Diameter

Reel Width (W1)

TAPE DIMENSIONS

Cavity

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

Sprocket Holes

User Direction of Feed

Pocket Quadrants

*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
BQ2000TPWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
BQ2000TSN-B5TR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	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)
BQ2000TPWR	TSSOP	PW	8	2000	346.0	346.0	29.0
BQ2000TSN-B5TR	SOIC	D	8	2500	346.0	346.0	29.0

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