Lithium Ion Fast-Charge IC

Features

- ➤ Safe charge of Li-Ion battery packs
- ➤ Voltage-regulated current-limited charging
- ➤ Programmable high-side/low-side current-sense
- ➤ Fast charge terminated by selectable minimum current; safety backup termination on maximum time
- ➤ Pre-charge qualification detects shorted or damaged cells and conditions battery
- ➤ Charging continuously qualified by temperature and voltage limits
- ➤ Pulse-width modulation control
  - Ideal for high-efficiency switch-mode power conversion
  - Configurable for linear or gated current use
- ➤ Direct LED control outputs display charge status and fault conditions

General Description

The bq2954 Li-Ion Fast-Charge IC uses a flexible pulse-width modulation regulator to control voltage and current during charging. The regulator frequency is set by an external capacitor for design flexibility. The switch-mode design minimizes power dissipation.

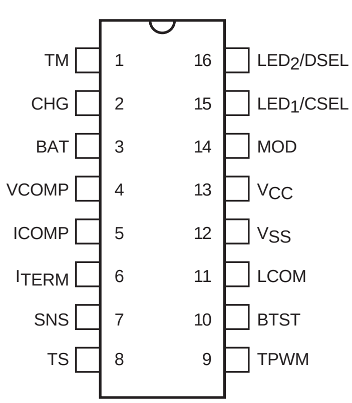
The bq2954 measures battery temperature using an external thermistor for charge qualification. Charging begins when power is applied or the battery is inserted

For safety, the bq2954 inhibits fast charging until the battery voltage and temperature are within configured limits. If the battery voltage is less than the low-voltage threshold, the bq2954 provides low-current conditioning of the battery.

The bq2954 charges a battery in two phases. A constant-current phase replenishes approximately 70% of battery capacity. A voltage-regulation phase completes the battery charge.

The bq2954 provides status indications of all charger states and faults for accurate determination of the battery and charge system conditions.

Pin Connections



16-Pin Narrow DIP or SOIC

PN295401.eps

Pin Names

TM	Time-out programming input
CHG	Charge active output
BAT	Battery voltage input
VCOMP	Voltage loop comp input
ICOMP	Current loop comp input
I_{TERM}	Minimum current termination select input
SNS	Sense resistor input
TS	Temperature sense input
TPWM	Regulator timebase input
BTST	Battery test output
LCOM	Common LED output
V_{SS}	System ground
V_{CC}	5.0V±10% power
MOD	Modulation control output
LED_1/ CSEL input	Charge status output 1/ Charge sense select
LED_2/ DSEL	Charge status output 2/ Display select input

Pin Descriptions

TM **Time-out programming input**

Sets the maximum charge time. The resistor and capacitor values are determined using Equation 5. Figure 5 shows the resistor/capacitor connection.

CHG **Charge active output**

An open-drain output which is driven low when the battery is removed, during a temperature pend, when a fault condition is present, or when charge is done. CHG may be used to disable a high value load capacitor to detect quickly any battery removal.

BAT **Battery voltage input**

Sense input. This potential is generally developed using a high-impedance resistor divider network connected between the positive and the negative terminals of the battery. See Figure 3a and 3b and Equation 1.

VCOMP **Voltage loop compensation input**

Connects to an external R-C network to stabilize the regulated voltage.

ICOMP **Current loop compensation input**

Connects to an external R-C network to stabilize the regulated current.

I_{TERM} **Charge full and minimum current termination select**

Three-state input is used to set I_{FULL} and I_{MIN} for fast charge termination. See Table 2.

SNS **Charging current sense input**

Battery current is sensed via the voltage developed on this pin by an external sense resistor.

TS **Temperature sense input**

Used to monitor battery temperature. An external resistor divider network sets the lower and upper temperature thresholds. (See Figures 4a and 4b and Equations 3 and 4.)

TPWM **Regulation timebase input**

Uses an external timing capacitor to ground to set the pulse-width modulation (PWM) frequency. See Equation 7.

BTST **Battery test output**

Driven high in the absence of a battery in order to provide a potential at the battery terminal when no battery is present.

LCOM **Common LED output**

Common output for LED_{1-2}. This output is in a high-impedance state during initialization to read programming input on DSEL and CSEL.

V_{SS} **Ground**

V_{CC} **V_{CC} supply**

5.0V, ±10% power

MOD **Current-switching control output**

Pulse-width modulated push/pull output used to control the charging current to the battery. MOD swithces high to enable current flow and low to inhibit current flow. (The maximum duty cycle is 80% at 100kHz)

LED_1–LED_2 **Charger display status 1-2 outputs**

Drivers for the direct drive of the LED display. These outputs are tri-stated during initialization so that DSEL and CSEL can be read.

DSEL **Display select input (shared pin with LED_2)**

This three-level input controls the LED_{1-2} charge display modes.

CSEL **Charge sense-select input (shared pin with LED_1)**

Input that controls whether current is sensed on low side of battery or high side of battery. A current mirror is required for high-side sense.

Functional Description

The bq2954 functional operation is described in terms of the following:

- Charge algorithm
- Charge qualification
- Charge status display
- Configuring the display and termination
- Voltage and current monitoring
- Battery insertion and removal
- Temperature monitoring
- Maximum time--out
- Charge regulation
- Recharge after fast charge

Charge Algorithm

The bq2954 uses a two-phase fast-charge algorithm. In phase 1, the bq2954 regulates constant current (I_{SNS} = I_{MAX}) until V_{BAT} rises to V_{REG}. The bq2954 then transitions to phase 2 and regulates constant voltage (V_{BAT} = V_{REG}) until the charging current falls below the programmed I_{MIN} threshold. Fast charge then terminates and the bq2954 enters the Charge Complete state. (See Figure 1.)

Charge Qualification

The bq2954 starts a charge cycle when power is applied while a battery is present or when a battery is inserted. Figure 1 shows the state diagram for pre-charge qualification and temperature monitoring. The bq2954 first checks that the battery temperature is within the allowed, user-configurable range. If the temperature is out of range, the bq2954 enters the Charge Pending state and waits until the battery temperature is within the allowed range.

If during any state of charge, a temperature excursion occurs HOT, the bq2954 proceeds to the DONE state and indicates this state by LED and provides no current. If this occurs, the bq2954 remains in the DONE state unless the following two conditions are met:

- Temperature falls within valid charge range
- V_{CELL} falls below V_{MIN}

If these two conditions are met, a new charge cycle begins. If during any state of charge, a temperature excursion occurs COLD, the bq2954 terminates charge and returns to BATTST state. Charge restarts if V_{BAT} and temperature are in valid range.

When the temperature is valid, the bq2954 then regulates current to I_{COND} (=I_{MAX}/10). After an initial holdoff period t_{HO} (which prevents the chip from reacting to transient voltage spikes that may occur when charge current is first applied), the chip begins monitoring V_{BAT}. If V_{BAT} does not rise to at least V_{MIN} before the expiration of time-out limit t_{QT} (i.e., the battery has failed short), the bq2954 enters the Fault state. If V_{MIN} is achieved before expiration of the time limit, the chip begins fast charging.

Once in the Fault state, the bq2954 waits until V_{CC} is cycled or a new battery insertion is detected. It then starts a new charge cycle and begins the qualification process again.

Charge Status Display

Charge status is indicated by the LED driver outputs LED_1–LED_2. Three display modes are available in the bq2954; the user selects a display mode by configuring pin DSEL. Tables 1a through 1c show the three display modes. Table 1a illustrates a normal fast charge cycle, 1b a recharge-after-fast-charge cycle, and 1c an abnormal condition.

Configuring the Display Mode, I_{FULL}/I_{MIN}, and I_{SENSE}

DSEL/LED_2 and CSEL/LED_1 are bi-directional pins with two functions: as LED driver pins as output and as programming pins as input. The selection of pull-up, pull-down, or no-resistor programs the display mode on DSEL as shown in Tables 1a through 1c. A pull-down or no-resistor programs the current-sense mode on CSEL.

The bq2954 latches the programming data sensed on the DSEL and CSEL input when V_{CC} rises to a valid level. The LEDs go blank for approximately 400ms (typical) while new programming data is latched.

When fast charge reaches a condition where the charging current drops below I_{FULL}, the LED1 and LED2 outputs indicate a full battery condition. Fast charge terminates when the charging current drops below a minimum current threshold. The I_{FULL} and I_{MIN} thresholds are programmed using the I_{TERM} input pin (See Table 2.)

Figures 2a and 2b show the bq2954 configured for display mode 2 and I_{FULL} = I_{MAX}/5 while I_{MIN} = I_{MAX}/10.

Voltage and Current Monitoring

In low-side sensing, the bq2954 monitors the battery pack voltage as a differential voltage between BAT and

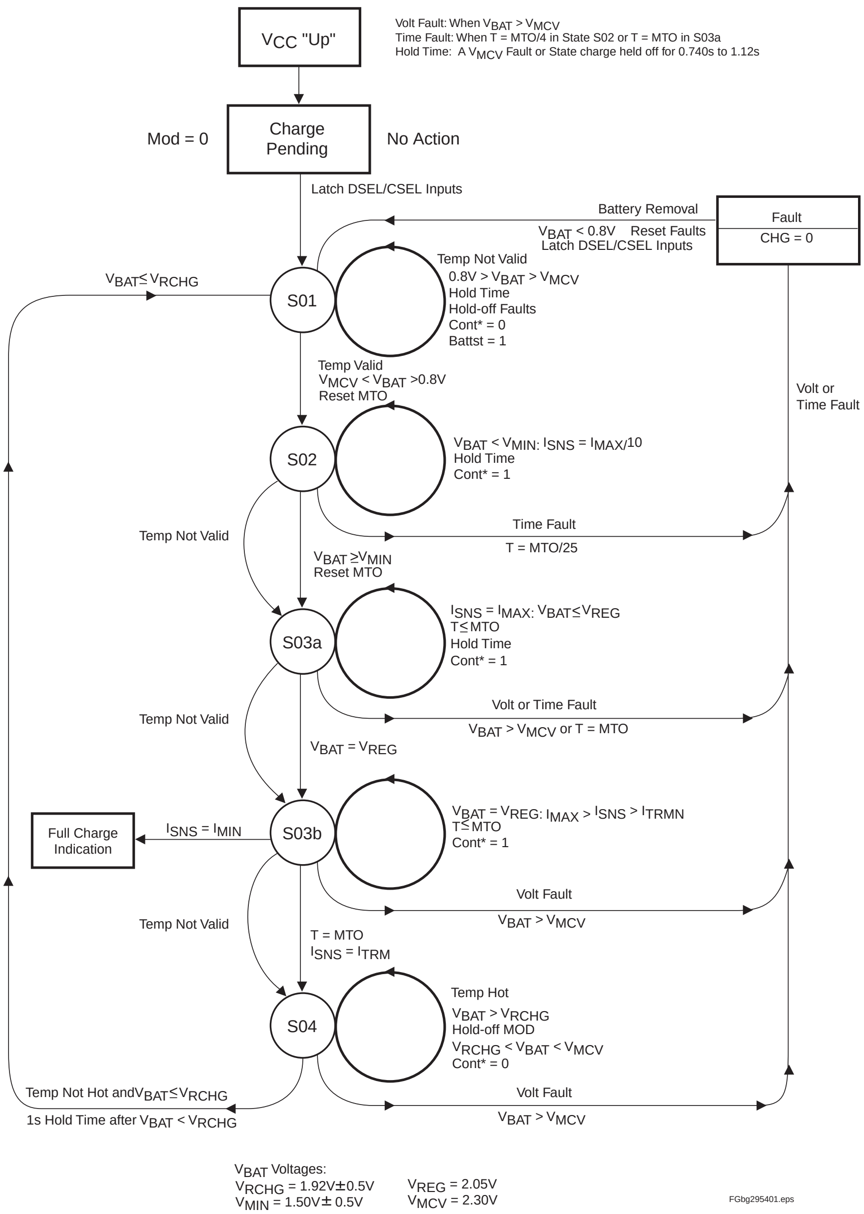
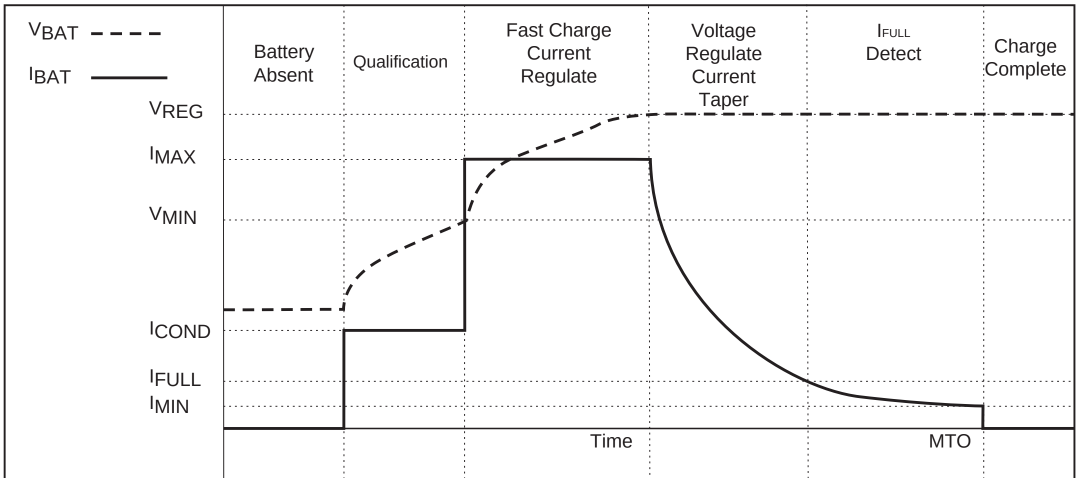


Figure 1. bq2954 Charge Algorithm

Table 1a. Normal Fast Charge Cycle



		Battery Absent	Qualification	Fast Charge Current Regulate	Voltage Regulate Current Taper	I_{FULL} Detect	Charge Complete
Mode 1 (DSEL = 0)	LED1	Low	High	High	High	Low	Low
	LED2	Low	Low	Low	Low	High	High
Mode 2 (DSEL = 1)	LED1	Low	High	High	High	Low	Low
	LED2	Low	Low	Low	Low	High	High
Mode 3 (DSEL = F)	LED1	Low	High	High	High	Low	Low
	LED2	Low	Low	Low	High	High	High
Mode 1 and 2	CHG	Low	High	High	High	High	Low
	BTST	High	Low	Low	Low	Low	Low
Mode 3	CHG	Low	High	High	High	High	Low
	BTST	High	High	Low	Low	Low	Low

GR295401.eps

SNS. In high-side sensing, the bq2954 monitors the battery pack voltage as a differentialvoltage between BAT and GND. This voltage is derived by scaling the battery voltage with a voltage divider. (See Figures 3a and 3b.) The resistance of the voltage divider must be high enough to minimize battery drain but low enough to minimize noise susceptibility. RB1 + RB2 is typically between 150K and 1Meg. The voltage-divider resistors are calculated from the following:

Equation 1

$$\frac{RB1}{RB2} = \frac{N * V_{CELL}}{V_{REG}} - 1$$

where:

V_{CELL} = Manufacturer-specified charging cell voltage
N = Number of cells in series
V_{REG} = 2.05V

The current sense resistor, R_{SNS} (see Figures 3a and 3b), determines the fast charge current. The value of R_{SNS} is given by the following:

Equation 2

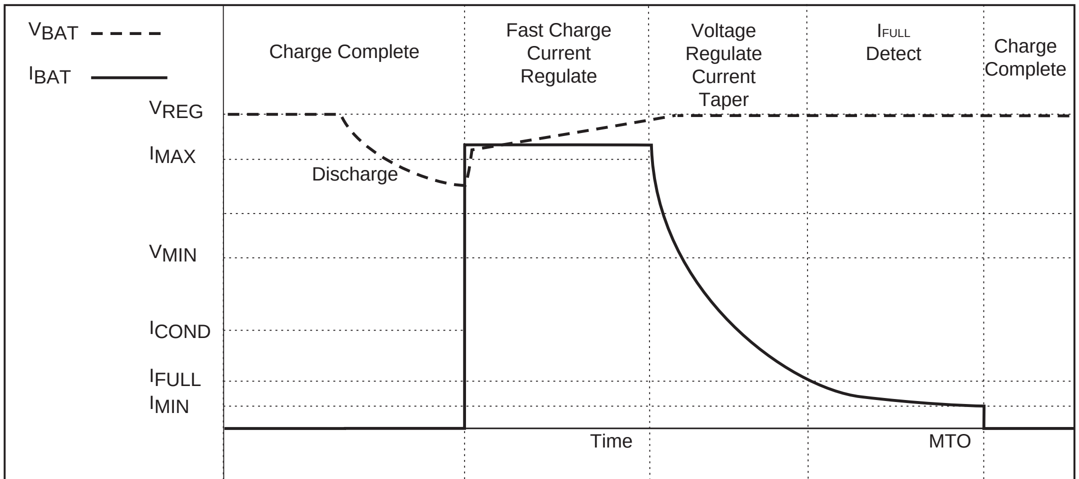
$$R_{SNS} = \frac{0.25V}{I_{MAX}}$$

Where I_{MAX} is the current during the constant-current phase of the charge cycle. (See Table 1a.)

Battery Insertion and Removal

V_{BAT} is interpreted by the bq2954 to detect the presence or absence of a battery. The bq2954 determines that a battery is present when V_{BAT} is between the High-Voltage Cutoff (V_{HCO} = V_{REG} + 0.25V) and the Low-Voltage Cutoff (V_{LCO} = 0.8V). When V_{BAT} is

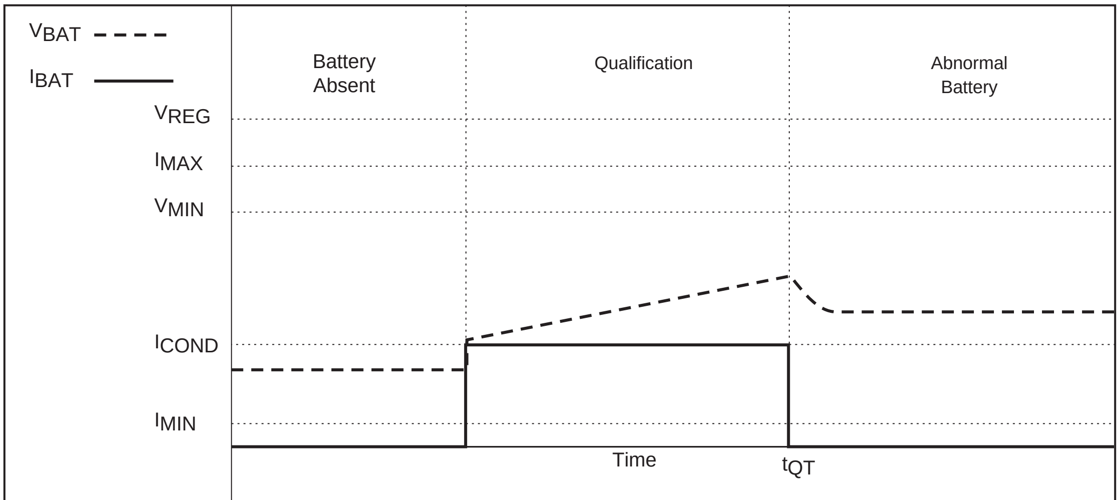
Table 1b. Recharge After Fast Charge Cycle



		Charge Complete	Fast Charge Current Regulate	Voltage Regulate Current Taper	I_{FULL} Detect	Charge Complete
Mode 1 (DSEL = 0)	LED1	Low	High	High	Low	Low
	LED2	High	Low	Low	High	High
Mode 2 (DSEL = 1)	LED1	Low	High	High	Low	Low
	LED2	High	Low	Low	High	High
Mode 3 (DSEL = F)	LED1	Low	High	High	Low	Low
	LED2	High	Low	High	High	High
Mode 1 and 2	CHG	Low	High	High	High	Low
	BTST	Low	Low	Low	Low	Low
Mode 3	CHG	Low	High	High	High	Low
	BTST	Low	Low	Low	Low	Low

Grbq295402.eps

Table 1c. Abnormal Condition



		Battery Absent	Qualification	Abnormal Battery
Mode 1 (DSEL = 0)	LED1	Low	High	Flash
	LED2	Low	Low	Low
Mode 2 (DSEL = 1)	LED1	Low	High	Low
	LED2	Low	Low	Low
Mode 3 (DSEL = F)	LED1	Low	High	Low
	LED2	Low	Low	Low
CHG		Low	High	Low
BTST		High	Low	Low

GR295403.eps

Table 2. I_{FULL} and I_{MIN} Thresholds

I_{TERM}	I_{FULL}	I_{MIN}
0	$I_{MAX}/5$	$I_{MAX}/10$
1	$I_{MAX}/10$	$I_{MAX}/15$
Z	$I_{MAX}/15$	$I_{MAX}/20$

outside this range, the bq2954 determines that no battery is present and transitions to the battery test state, testing for valid battery voltage. The bq2954 detects battery removal when V_{BAT} falls below V_{LCO}. The BTST pin is driven high during battery test and can activate an external battery contact pull-up. This pull-up may be used to activate an over-discharged Li-Ion battery pack. The V_{HCO} limit implicitly serves as an over-voltage charge fault. The CHG output can be used to disconnect capacitors from the regulation circuitry in order to quickly detect a battery-removed condition.

Battery insertion is enunciated within 500ms. Transition to the fast-charge phase, however, will not occur for time t_{HO} (approximately one second), even if voltage qualification V_{MIN} is reached. This is done so that the fast-charge phase is not entered prematurely from a voltage spike at the BAT input. It also creates a delay in enunciation of battery removal if the battery is removed during this hold-off period.

Temperature Monitoring

Temperature is measured as a *differential* voltage between TS and BAT-. This voltage is typically generated by a NTC (negative tempco) thermistor and thermistor linearization network. The bq2954 compares this voltage against its internal threshold voltages to determine if charging is allowed. These thresholds are:

- High-Temperature Cutoff Voltage: $V_{TCO} = 0.4 * V_{CC}$ This voltage corresponds to the maximum temperature (TCO) at which charging is allowed.
- High-Temperature Fault Voltage: $V_{HTF} = 0.44 * V_{CC}$ This voltage corresponds to the temperature (HTF) at which charging resumes after exceeding TCO.
- Low-Temperature Fault Voltage: $V_{LTF} = 0.6 * V_{CC}$ This voltage corresponds to the minimum temperature (LTF) at which charging is allowed.

Charging is inhibited if the temperature is outside the LTF—TCO window. Once the temperature exceeds TCO, it must drop below HTF before charging resumes.

RT1 and RT2 for the thermistor linearization network are determined as follows:

Equation 3

$$0.6 * V_{CC} = \frac{(V_{CC} - 0.250)}{1 + \frac{RT1 * (RT2 + R_{LTF})}{(RT2 * R_{LTF})}}$$

Equation 4

$$0.44 = \frac{1}{1 + \frac{RT1 * (RT2 + R_{HTF})}{(RT2 * R_{HTF})}}$$

where:

R_{LTF} = thermistor resistance at LTF

R_{HTF} = thermistor resistance at HTF

TCO is determined by the values of RT1 and RT2. 1% resistors are recommended.

Disabling Temperature Sensing

Temperature sensing can be disabled by placing a 10kΩ resistor between TS and BAT- and a 10kΩ resistor between TS and V_{CC}. See Figure 4a and 4b.

Maximum Time-Out

MTO is programmed from 1 to 24 hours by an R-C network on the TM pin (see Figure 5) per the following equation:

Equation 5

$$t_{MTO} = 500 * R * C$$

The MTO timer is reset at the beginning of fast charge. If the MTO timer expires during the voltage regulated phase, fast charging terminates and the bq2954 enters the Charge Complete state. If the conditioning phase continues for time equal to t_{QT} (MTO/4) such that the battery potential does not reach V_{MIN}, the bq2954 enters the fault state and terminates charge. See Table 1c. If the MTO timer expires during the current-regulated portion of the fast-charge phase (V_{BAT} never reaches V_{REG}), fast charging is terminated, and the bq2954 enters the fault state.

Charge Regulation

The bq2954 controls charging through pulse-width modulation of the MOD output pin, supporting both constant-current and constant-voltage regulation. Charge current is monitored at the SNS pin, and charge voltage is monitored at the BAT pin. These voltages are compared to an internal reference, and the MOD output is modulated to maintain the desired value. The maximum duty cycle is 80% at 100kHz.

Voltage at the SNS pin is determined by the value of resistor R_{SNS}, so nominal regulated current is set by the following equation:

Equation 6

$$I_{MAX} = 0.250V/R_{SNS}$$

The switching frequency of the MOD output is determined by an external capacitor (CPWM) between the pin TPWM and ground, per the following:

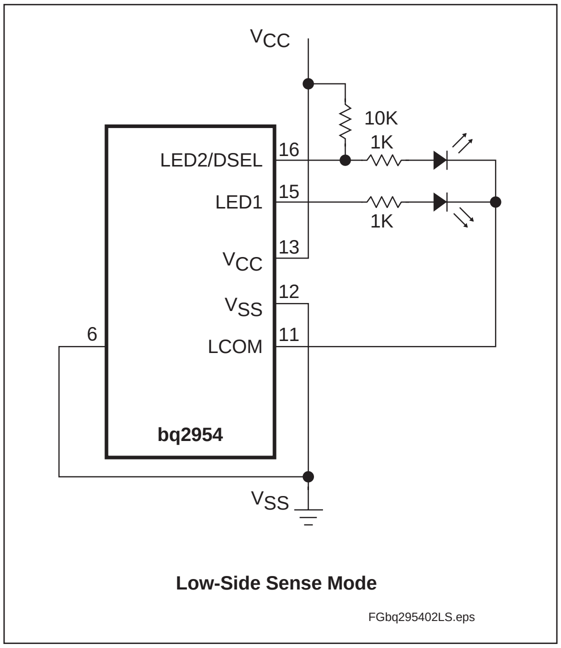


Figure 2a. Configured Display Mode (Low-Side Sense)

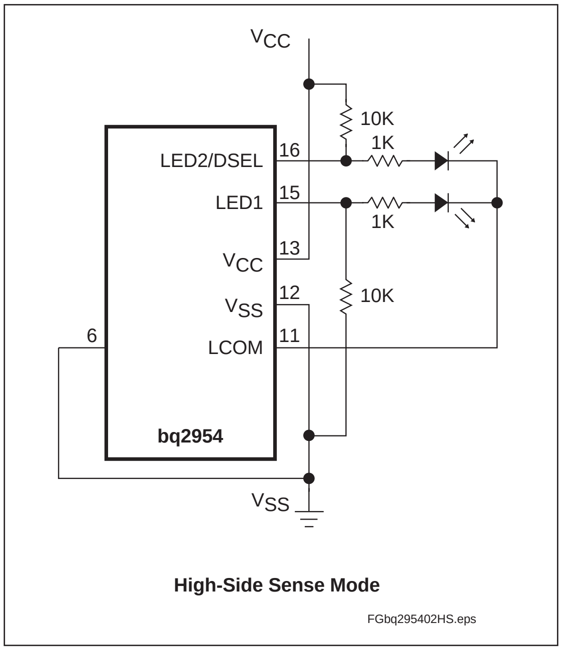


Figure 2b. Configured Display Mode (High-Side Sense)

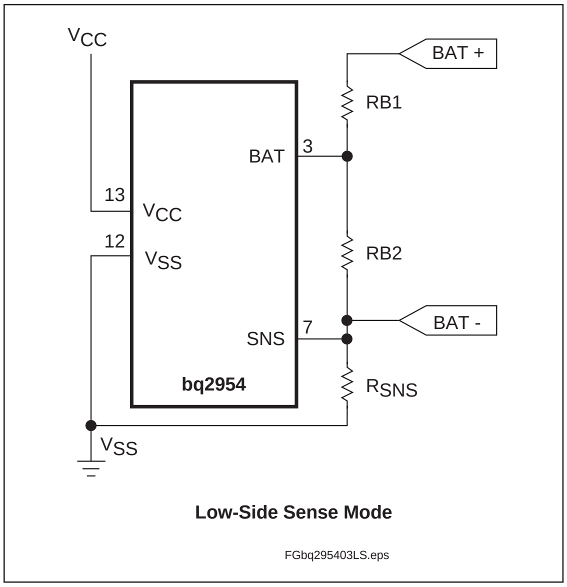


Figure 3a. Configuring the Battery Divider (Low-Side Sense)

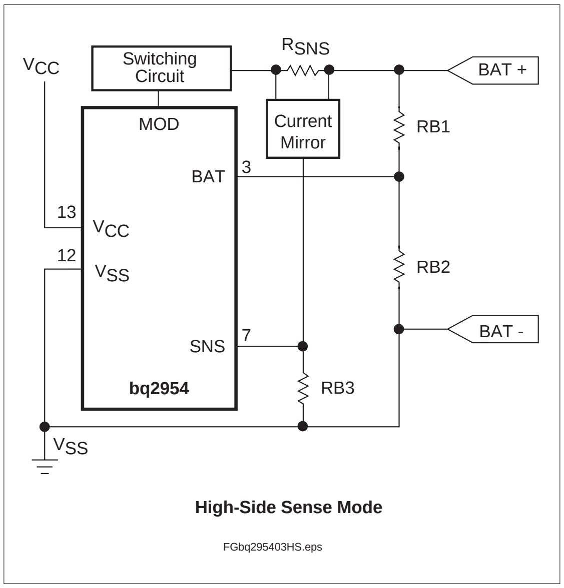


Figure 3b. Configuring the Battery Divider (High-Side Sense)

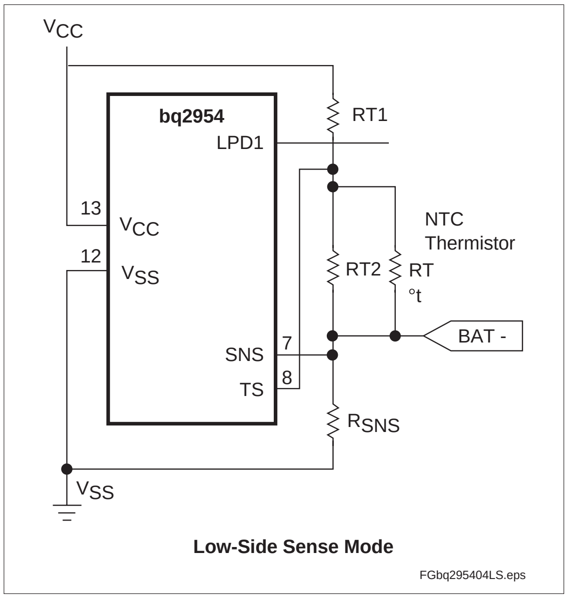


Figure 4a. Low-Side Temperature Sensing

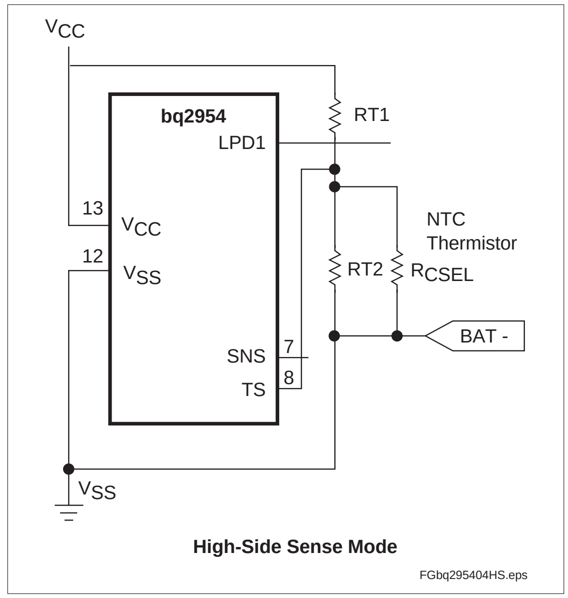


Figure 4b. High-Side Temperature Sensing

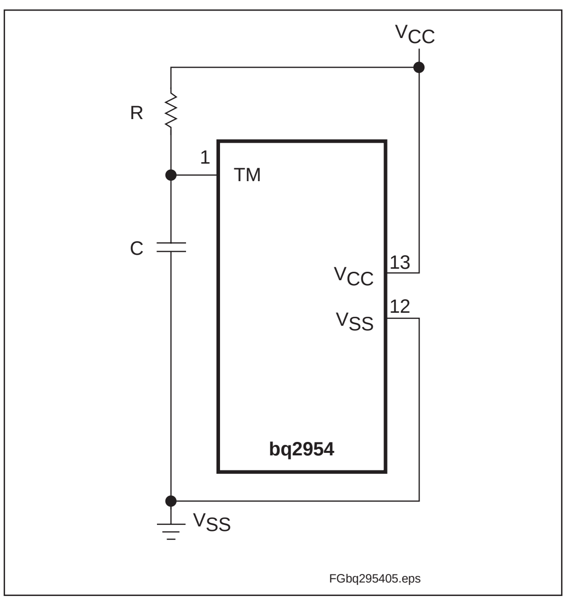


Figure 5. R-C Network/Setting MTO

Equation 7

$$f_{PWM} = \frac{1 * 10^{-4}\ \text{Hz F}}{C_{PWM}}$$

Where C is in farads and the frequency is in Hz. A typical switching rate is 100kHz, implying C_{PWM} = 0.001µF. MOD pulse width is modulated between 0 and 80% of the switching period.

To prevent oscillation in the voltage and current control loops, frequency compensation networks (C or R-C) are typically required on the V_{COMP} and I_{COMP} pins (respectively).

Recharge After Fast Charge

Once charge completion occurs, a fast charge is initiated when the battery voltage falls below V_{RECHG}. A delay of approximately one second passes before recharge begins so that adequate time is allowed to detect for battery removal. See Table 1b.

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	Commercial
		-40	+85	°C	Industrial "N"
T_{STG}	Storage temperature	-55	+125	°C	
T_{SOLDER}	Soldering temperature	-	+260	°C	10 sec. 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 ±10%)

Symbol	Parameter	Rating	Unit	Tolerance	Notes
V_{REG}	Internal reference voltage	2.05	V	1%	T_A = 25°C
	Temperature coefficient	-0.5	mV/°C	10%	
V_{LTF}	TS maximum threshold	0.6 ∗ V_{CC}	V	±0.03V	Low-temperature fault
V_{HTF}	TS hysteresis threshold	0.44 ∗ V_{CC}	V	±0.03V	High-temperature fault
V_{TCO}	TS minimum threshold	0.4 ∗ V_{CC}	V	±0.03V	Temperature cutoff
V_{HCO}	High cutoff voltage	V_{REG} + 0.25V	V	±0.03V	
V_{MIN}	Under-voltage threshold at BAT	1.5	V	±0.05V	
V_{RECHG}	Recharge voltage threshold at BAT	1.92	V	±0.05V	
V_{LCO}	Low cutoff voltage	0.8	V	±0.03V	
V_{SNS}	Current sense at SNS	0.250	V	10%	I_{MAX}
		0.025	V	10%	I_{COND}

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

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
V_{CC}	Supply voltage	4.5	5.0	5.5	V	
V_{TEMP}	TS voltage potential	0	-	V_{CC}	V	V_{TS} - V_{SNS}
V_{BAT}	BAT voltage potential	0	-	V_{CC}	V	
I_{CC}	Supply current	-	2	4	mA	Outputs unloaded
I_{IZ}	DSEL tri-state open detection	-2	-	2	µA	Note
	I_{TERM} tri-state open detection	-2		2	µA	
V_{IH}	Logic input high	V_{CC}-0.3	-	-	V	DSEL, I_{TERM}
V_{IL}	Logic input low	-	-	V_{SS}+0.3	V	DSEL, CSEL, I_{TERM}
V_{OH}	LED_1, LED_2, BTST, output high	V_{CC}-0.8	-	-	V	$I_{OH} \leq$ 10mA
	MOD output high	V_{CC}-0.8	-	-	V	$I_{OH} \leq$ 10mA
V_{OL}	LED_1, LED_2, BTST, output low	-	-	V_{SS}+0.8	V	$I_{OL} \leq$ 10mA
	MOD output low	-	-	V_{SS}+0.8	V	$I_{OL} \leq$ 10mA
	CHG output low	-	-	V_{SS} + 0.8	V	$I_{OL} \leq$ 5mA, Note 3
	LCOM output low	-	-	V_{SS}+0.5	V	$I_{OL} \leq$ 30mA
I_{OH}	LED_1, LED_2, BTST, source	-10	-	-	mA	V_{OH} =V_{CC} - 0.5V
	MOD source	-5.0	-	-	mA	V_{OH} =V_{CC} - 0.5V
I_{OL}	LED_1, LED_2, BTST, sink	10	-	-	mA	V_{OL} = V_{SS} + 0.5V
	MOD sink	5	-	-	mA	V_{OL} = V_{SS} + 0.8V
	CHG sink	5	-	-	mA	V_{OL} = V_{SS} + 0.8V, Note 3
	LCOM sink	30	-	-	mA	V_{OL} = V_{SS} + 0.5V
I_{IL}	DSEL logic input low source	-	-	+30	µA	V = V_{SS} to V_{SS} + 0.3V, Note 2
	I_{TERM} logic input low source	-	-	+70	µA	V = V_{SS} to V_{SS} + 0.3V
I_{IH}	DSEL logic input high source	-30	-	-	µA	V = V_{CC} - 0.3V to V_{CC}
	I_{TERM} logic input high source	-70	-	-	µA	V = V_{CC} - 0.3V to V_{CC}

Notes:
1. All voltages relative to V_{SS}.
2. Conditions during initialization after V_{CC} applied.
3. SNS = 0V

Impedance

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
R_{BATZ}	BAT pin input impedance	50	-	-	MΩ	
R_{SNSZ}	SNS pin input impedance	50	-	-	MΩ	
R_{TSZ}	TS pin input impedance	50	-	-	MΩ	
R_{PROG1}	Soft-programmed pull-up or pull-down resistor value (for programming)	-	-	10	kΩ	DSEL, CSEL
R_{PROG2}	Pull-up or pull-down resistor value	-	-	3	kΩ	I_{TERM}
R_{MTO}	Charge timer resistor	20	-	480	kΩ	

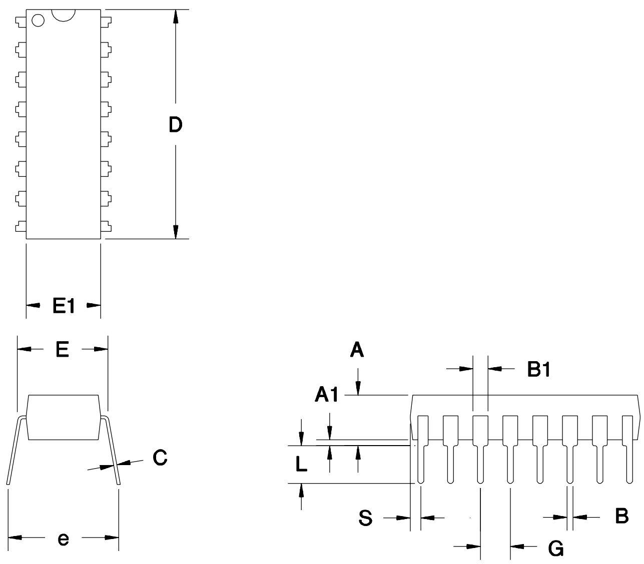
Timing ($T_A = T_{OPR}$; $V_{CC} = 5V \pm 10\%$)

Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
t_{MTO}	Charge time-out range	1	-	24	hours	See Figure 5
t_{QT}	Pre-charge qual test time-out period	-	$0.25t_{MTO}$	-	-	
t_{HO}	Pre-charge qual test hold-off period	300	600	900	ms	
f_{PWM}	PWM regulator frequency range	-	100	200	kHz	See Equation 7
d_{PWM}	Duty cycle	0		80	%	f_{PWM} = 100kHz

Capacitance

Symbol	Parameter	Minimum	Typical	Maximum	Unit
C_{MTO}	Charge timer capacitor	-	-	0.1	µF
C_{PWM}	PWM capacitor	-	0.001	-	µF

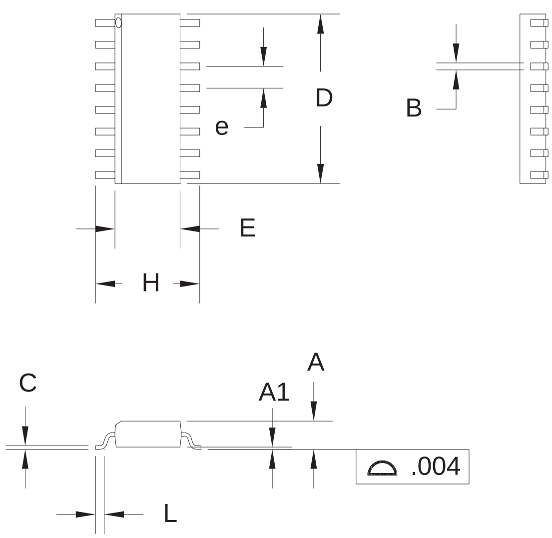
16-Pin DIP Narrow (PN)



16-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	0.740	0.770	18.80	19.56
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

16-Pin SOIC Narrow (SN)



16-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	0.385	0.400	9.78	10.16
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

Ordering Information

bq2954 __

Package Option:
PN = 16-pin plastic DIP
SN = 16-pin narrow SOIC

Device:
bq2954 Li-Ion Fast-Charge IC

BENCHMARQ® Microelectronics, Inc.
17919 Waterview Parkway
Dallas, Texas 75252
Fax: (972) 437-9198
Tel: (972) 437-9195
E-mail: benchmarq@benchmarq.com
World Wide Web: http://www.benchmarq.com

Nov. 1997