南京拓品微电子有限公司

NanJing Top Power ASIC Corp.

数据手册

DATASHEET

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TP4054

(400mA Linear Li-Ion Battery Charger)

DESCRIPTION

The TP4054 is a complete linear charger for single cell lithium-ion batteries. Its SOT23-5 package and low external component count make the TP4054 ideally suited for portable applications. Furthermore, the TP4054 can work within USB and wall adapter.

Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage can be divided 4.2 V, and the charge current can be programmed externally with a single resistor. The TP4054 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage reaching.

When the input supply (wall adapter or USB supply) is removed, the TP4054 automatically enters a low current state, dropping the battery drain current to less than 2uA. The TP4054 can be put into shut down mode, reducing the supply current to 45uA. Other features include under voltage lockout, automatic recharge and one status pins to indicate charge termination.

FEATURES

- Maximize Charge Rate Without Risk of Overheating
- For Single Cell titanic acid Lithium-Ion Batteries
- Trickle, constant-current and constant-voltage control
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset Charge Voltage with 1% Accuracy Automatic Recharge
- One Charge Status Output Pins
- C/10 Charge Termination
- 45uA Supply Current in Shutdown
- Available in 5-Lead SOT-23 Package

APPLICATIONS

- Miniature lithium battery
- Cellular phone、PAD、MP3 player

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TYPICAL APPLICATION

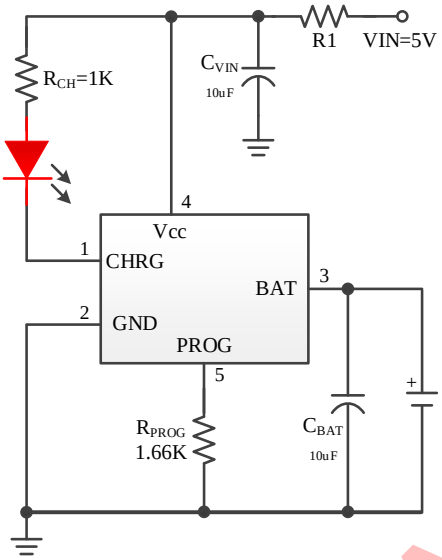
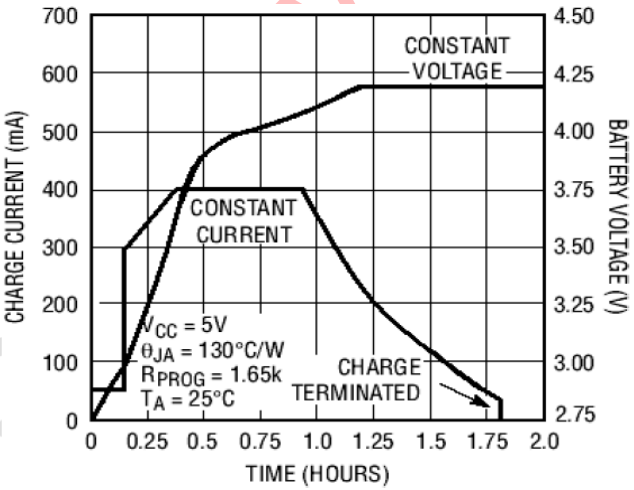


Figure 1　400mA Single Cell Li-Ion Charger

Note: Proposed R1 dissipation resistor, it can get a larger charge current, and also improve the reliability of the machine. Resistance is selected according to the actual situation　(0 ~ 0.6 Ω).

Complete Charge Cycle (650mAh Battery)



ABSOLUTE MAXIMUM RATINGS

- VCC：-0.3V～8V
- PROG：-0.3V～VCC+0.3V
- BAT：-0.3V～7V
- CHRG：-0.3V～10V
- BAT Pin Current：800mA
- PROG Pin Current：800uA
- Maximum Junction Temperature：150℃
- Operating Ambient Temperature Range：-40℃～85℃
- Storage Temperature Range：-65℃～125℃
- Lead Temperature(Soldering, 10sec)：260℃

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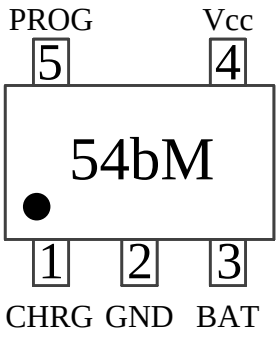
PACKAGE DESCRIPTION



ORDER PART NUMBER
TP4054-42-SOT235
PART MARKING
54bM→4.2V

Pin Description

CHRG (Pin1): Open Drain Charge Status Output When the battery is being charged, the CHRG pin is pulled low by the internal switch to indicate that charging is in progress; otherwise, the CHRG pin is in a high-impedance state.

GND (Pin2): Ground Terminal

BAT (Pin3): Battery Connection Pin This pin provides the charging current to the battery and adjusts the final float voltage to 4.2V. An accurate internal resistor divider for this pin sets the float voltage, which in the shutdown mode, the internal resistor divider is disconnected.

Vcc (Pin4): Positive Input Supply Voltage

This pin supplies power to the internal circuit. Vcc varies from 4V to 8V and should be bypassed by at least one 10μF capacitor. When Vcc drops to within 30mV of the BAT pin voltage, TP4054 enters low power sleep mode, dropping BAT pin's current to less than 2uA.

PROG（Pin5）: Charge current setting, charge current monitoring and shutdown pin

A precision of 1% of the resistance R_{PROG} between the pin and ground to set the charge current. When in constant charge current mode, the voltage of the pin is maintained at 1V.The PROG pin can also be used to turn off the charger. Setting the resistor to ground, a 2.5uA current internally pulls the PROG pin high. When the pin voltage reaches the shutdown threshold voltage 2.7V, the charger enters shutdown mode, charging is stopped and the input supply current to 45μA.Re-connecting R_{PROG} to ground will cause the charger to return to normal operation.

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ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at TA=25℃， VCC=5V，unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
VCC	Input Supply Voltage		●	4.0	5	8.0	V
ICC	Input Supply Current	Charge Mode, R_{PROG} = 10K	●		150	500	μA
		Standby Mode (Charge Terminated)	●		45	100	μA
		Shutdown Mode (R_{PROG} Not Connected, VCC < VBAT, or VCC < VUV)	●		45	100	μA
V_{FLOAL}	Regulated Output (Float) Voltage	0 ℃ ≤ TA ≤ 85 ℃， I_{BAT}=25mA, R_{PROG}=10K		4.158	4.2	4.242	V
I_{BAT} (Take the cut-off voltage 4.2V for example)	BAT Pin Current (Except that VBAT=4.0V)	R_{PROG} = 10K, Current Mode	●	85	100	115	mA
		R_{PROG} = 1.66K, Current Mode	●	340	400	460	mA
		Standby Mode, VBAT = 4.3V	●	0	-2.5	-6	mA
		Shutdown Mode (R_{PROG} Not Connected)			±1	±2	μA
		Sleep Mode, VCC = 0V			-1	-2	μA
I_{TRIKL}	Trickle Charge Current	VBAT<V_{TRIKL}, R_{PROG}=10K	●	15	25	35	mA
VUV	VCC Undervoltage Lockout Threshold	From VCC Low to High	●	3.4	3.6	3.8	V
ITERM	C/10 Termination Current Threshold	R_{PROG}=10K	●	8	10	12	mA
		R_{PROG}=1.66K	●	30	40	50	mA
VPROG	PROG Pin Voltage	R_{PROG}=10K，Current Mode	●	0.9	1.0	1.1	V
VCHRG	CHRG Pin Output versr Low Voltage	I_{CHRG} =5mA		0.1	0.3	0.5	V

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OPERATION

TP4054 is a single lithium ion battery charger using constant current/constant voltage algorithm. It is capable of providing 400mA charging current (with the help of a thermally designed PCB layout) and an internal P-channel power MOSFET and thermal regulation circuit. No isolation diodes or external current detection resistors; Thus, the basic charger circuit requires only two external components. Not only that, the TP4054 can also get a working power supply from a USB power supply.

Normal charging cycle

A charging cycle begins when the Vcc pin voltage rises above the UVLO threshold level and a 1% precision setting resistor is connected between the PROG pin and ground or when a battery is connected to the charger output. If the BAT pin level is lower than the trickle charging threshold voltage, then the charger enters the trickle charging mode. In this mode, the TP4054 provides about 15% of the set charging current in order to raise the current voltage to a safe level for full current charging.

When the BAT pin voltage rises above the trickle charging threshold voltage, the charger enters the constant current mode, which provides a constant charging current to the battery. When the BAT pin voltage reaches the final floating charging voltage, TP4054 enters the constant voltage mode and the charging current begins to decrease. When the charging current drops to 1/10 of the set value, the charging cycle ends.

Charging current setting

The charging current is set by a resistor connected between the PROG pin and the ground. The setting resistor and charging current are calculated by the following formula, and the resistance value of the resistor is determined according to the required charging current:

Formula one :

$$R_{PROG} = \frac{1000}{I_{BAT}} \times \left(1.2 - \frac{4}{3} I_{BAT}\right)$$

(I_{BAT}>0.15A)

Formula two: $R_{PROG} = \frac{1000}{I_{BAT}}$ (I_{BAT}≤0.15A)

Charge termination

The charging cycle is terminated when the charging current drops to 1/10 of the set value after reaching the final floating charging voltage. This condition is detected by using an internal filter comparator to monitor the PROG pins. Charging is terminated when the PROG pin voltage drops below 100mV for more than t_{TERM}. The charging current is locked off, and the TP4054 enters the standby mode. At this time, the input power current drops to 45μA. (Note: C/10 terminates in trickle charging and heat limiting modes).

When charging, the transient load on the BAT pin will cause the PROG pin voltage to drop below 100mV temporarily between 1/10 of the DC charging current to the set value. The 1.8ms filter time (t_{TERM}) on the termination comparator ensures that transient loads of this nature do not cause premature termination of the charging cycle. Once the average charging current drops below 1/10 of the set value, the TP4054 terminates the charging cycle and stops providing any current through the BAT pin. In this state, all loads on the BAT pins must be powered by batteries.

In standby mode, TP4054 continuously monitors the BAT pin voltage. If the pin voltage drops below the recharging voltage threshold (V_{RECHRG}), another charging cycle starts and supplies current to the battery again. When manual restart of the charging cycle is

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performed in standby mode, either the charger must be cancelled and then the input voltage applied, or the charger must be turned off and restarted using the PROG pin..

Charging status indicator (CHRG)

The CHRG pin can provide an indication that the input voltage is higher than the undervoltage lockout threshold level. About 20 μ The weak pull-down current of A indicates that sufficient voltage is applied to the VCC pin to start the charging cycle. When a discharged battery is connected to a charger, the constant current part of the charging cycle begins and the pin level is pulled to ground. The CHRG pin can absorb up to 10mA of current to drive an LED indicating that a charging cycle is in progress.As the battery approaches full charge, the charger enters the constant voltage part of the charging cycle, and the charging current begins to decrease. When the charging current drops to less than 1/10 of the set current, the charging cycle ends and the forced pull is triggered by a 20 μ A is replaced by a dropdown, indicating that the charging cycle has ended. If the input voltage is removed or drops below the undervoltage lockout threshold, the pin becomes high impedance.

Automatic restart

Once the charging cycle is terminated, the TP4054 immediately employs a comparator with a filter time ($t_{RECHARGE}$) to continuously monitor the voltage on the BAT pin. The charging cycle restarts when the battery voltage drops below the recharging voltage point, which roughly corresponds to 80 to 90 percent of the battery capacity. This ensures that the battery is maintained at (or near) a full charge and obviates the need to start a periodic charging cycle. During the recharging cycle, the CHRG pin output re-enters a strong pull-down state.

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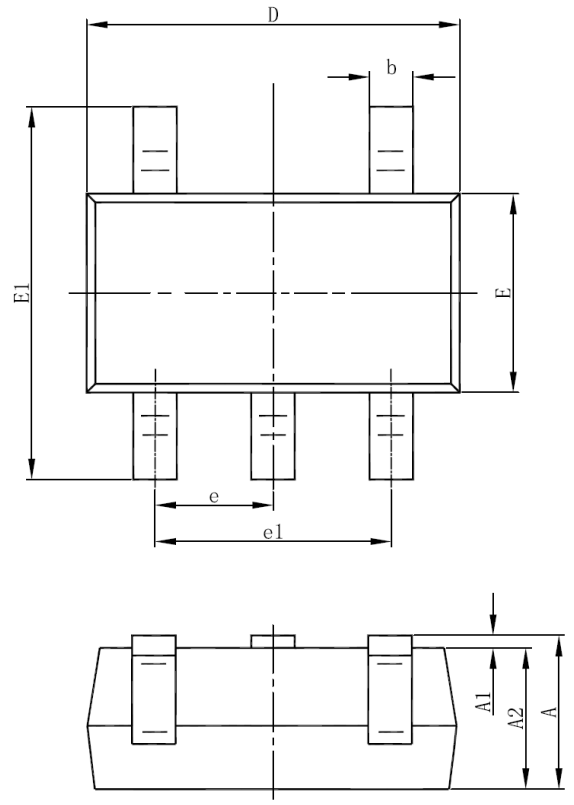
Packaging description

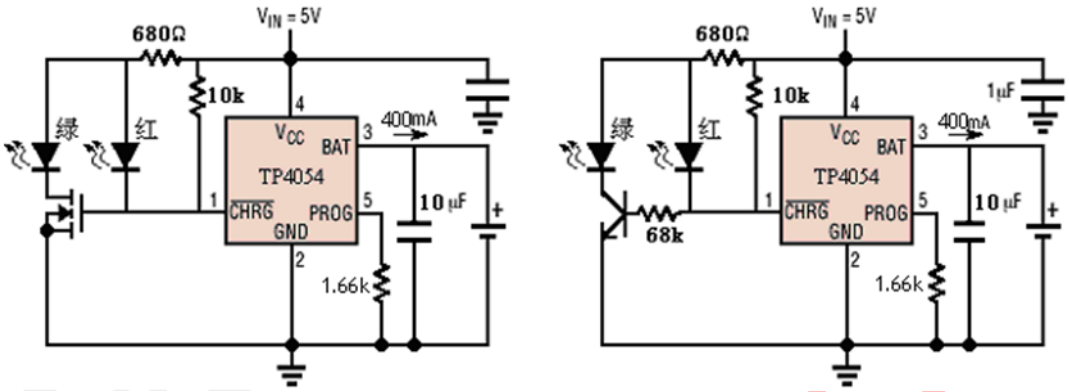
SOT-23-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Other Typical Applications

Traffic light control circuit



NOTES: In normal charging state, the red light is on and the green light is off. After charging, the red light goes off and the green light comes on.

When there is no battery connection, the green light is on and the red light flashes periodically, indicating standby mode.

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