Miniature linear battery management chip

Summary

TP4054 is a perfect single-chip constant current / constant voltage linear power management chip for lithium-ion batteries. It's portable and small in size Use. What's more, TP4054 is specially designed for USB power supply specifications. Due to the internal MOSFET structure, external resistance and blocking diode are not required in application. In high energy operation and high peripheral temperature, the thermal feedback can control the charging current to reduce the chip temperature.

The charging voltage is limited to 4.2V and the charging current is regulated by resistance. After reaching the target charging voltage, when the charging current is reduced to 1 / 10 ofthe set value, The TP4054 will automatically end the charging process. Tp4054 can also be set in the stop working state to reduce the power supply current to μA 2 5 .

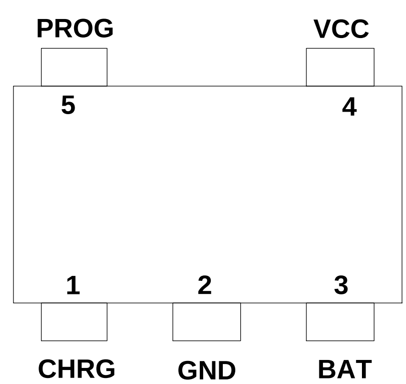
TP4054 ensures that the chip will automatically enter the protection state when the battery is connected reversely, so as to ensure that the IC will not be broken down and lead to battery self discharge accidents. Other features include: charging current monitoring, input low voltage blocking, automatic recharging and signs of full and start charging.

Characteristic

- ◆ Instantaneous withstand voltage 11V
- ◆ The charging current can reach 500mA by programming
- ◆ No MOSFET, sensing resistor and blocking diode are required
- ◆ Full linear charging management of lithium-ion battery with small size
- ◆ The constant current / constant voltage operation and thermal regulation make the battery management more effective, and there is no danger of excessive heat
- ◆ Single chip lithium ion battery management from USB interface
- ◆ 4.2V preset charging voltage with an accuracy of ±1%
- ◆ Monitoring of charging current output
- ◆ Charging status indicator
- ◆ 1 / 10 charging current termination Stop work at 25μA current
- ◆ 2.9v trickle charging threshold voltage
- ◆ Soft start limits surge current
- ◆ Battery reverse connection protection
- ◆ Manage single-chip lithium-ion batteries through USB interface

Application

- ◆ Mobile phone, PDA, MP3
- ◆ Bluetooth application

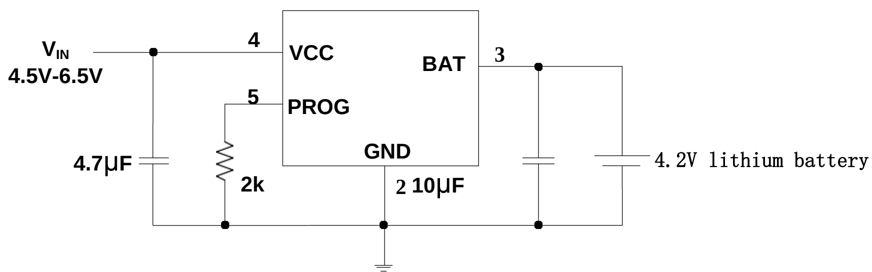


TP4054 is packaged in SOT-23-5L

Typical application circuit

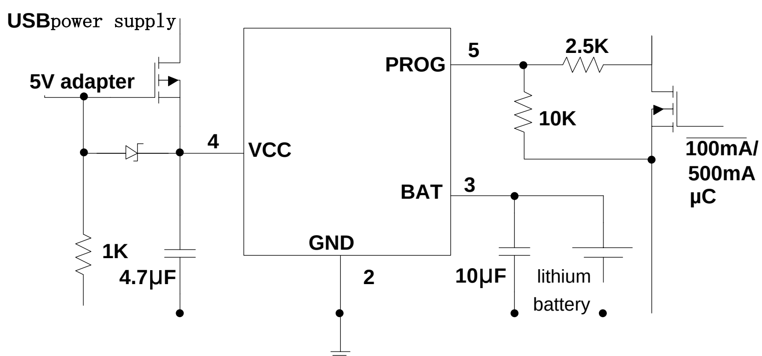
Basic circuit

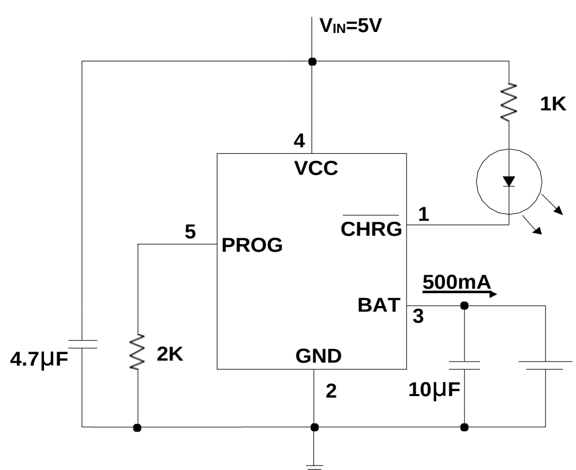
Single lithium battery charger



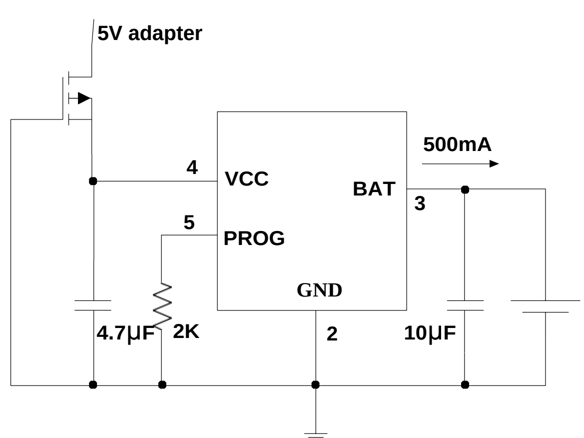
Typical circuit

USB / adapter power lithium charger



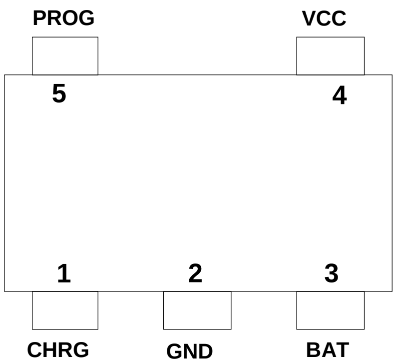


Fully functional single lithium battery charger



Lithium charger with reverse input protection

Pin description



Pin number	Pin name	describe
1	CHRG	Open drain state of charge output.
2	GND	Ground terminal.
3	BAT	Charging current output.
4	VCC	Positive input voltage.
5	PROG	Charging current programming, charging current monitoring and closing terminal.

Pin function

CHRG (pin 1): Open drain charging status output. When charging, the CHRG port is placed at a low potential by a built-in N-channel MOSFET. When charging
When the electricity is completed, CHRG exhibits a high resistance state. When TP4054 detects a low power lock condition, CHRG exhibits a high resistance state. When a 1 μ F capacitor is connected between the BAT pin and ground, it can indicate whether the battery is properly connected. When there is no battery, the LED light will flash quickly

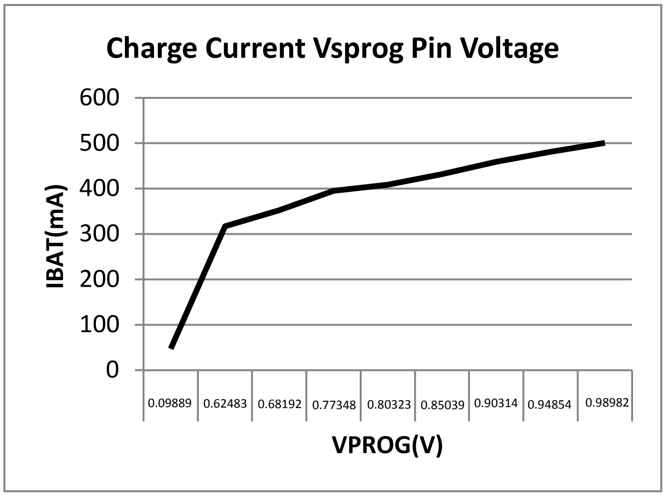
GND (pin 2): Ground terminal.

BAT (pin 3): Charging current output terminal. Provide charging current to the battery and control the floating voltage to ultimately reach 4.2V. When the battery is reversed, the internal protection circuit protects the ESD diode of VBAT from burning out, and a current of approximately 0.7mA is formed between GND and BAT.

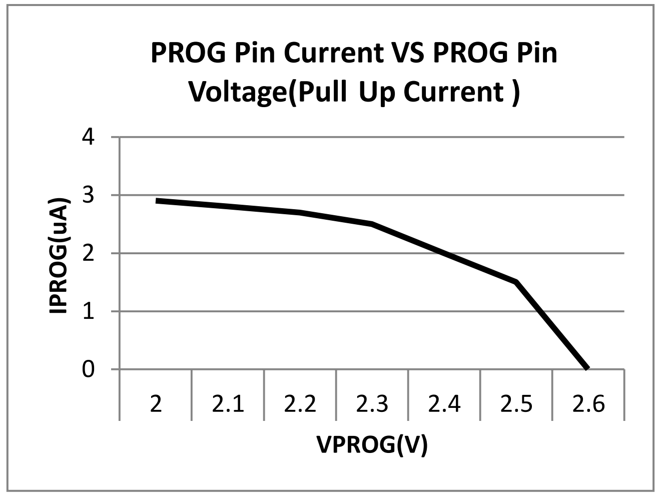
VCC (pin 4): Provide positive voltage input. Power the charger. VCC can range from 4.25V to 6.5V and must have a bypass capacitor of at least 1 μ F. If the voltage difference between the BAT pin terminal and VCC drops below 30mV, TP4054 enters a shutdown state and causes the BAT current to drop below 2 μ A.

PROG (pin 5): Charging current programming, charging current monitoring, and shutdown terminal. The charging current is controlled by a resistor connected to ground with an accuracy of 1% to control the ROG pin. When in a constant charging current state, this port provides a voltage of 1V. In all states, the charging current of this port voltage can be calculated using the following formula: IBAT=(VPROG/RPROG) × 1000. The ROG port can also be used to turn off the charger. Separating the programming resistor from the ground terminal can increase the voltage at the ROG port by pulling up a 2 μ A current source. When the maximum shutdown voltage value of 1.21V is reached, the actuator enters a stopped working state, charging ends, and the input current drops to 25 μ A. This port has a cut-off voltage of approximately 2.4V. Providing a voltage exceeding the pinch off voltage to this port will result in a high current of 1.5 mA. Combining the ROG with the ground terminal will return the charger to its normal state.

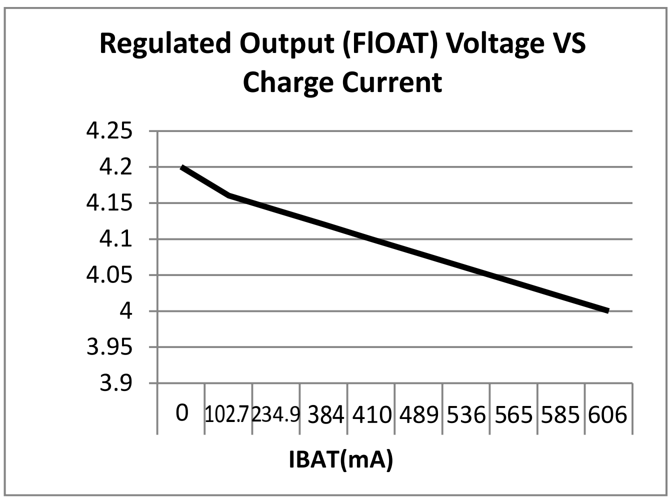
characteristic curve



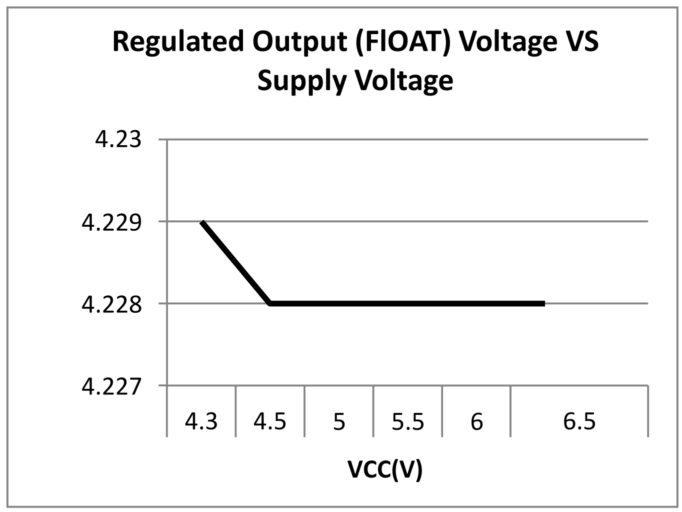
The relationship curve between charging current and voltage at the ROG pin



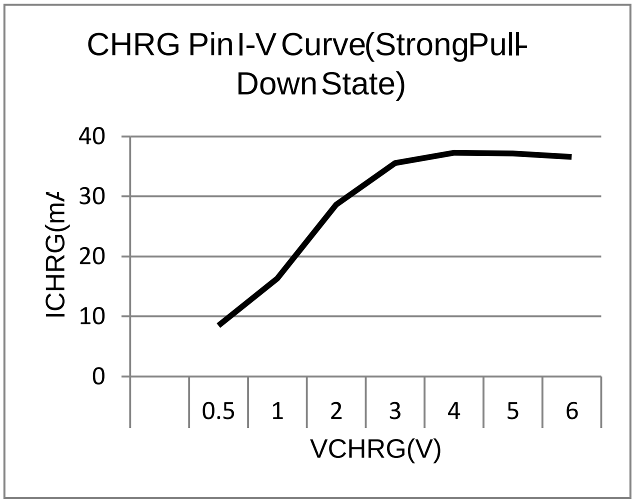
The relationship curve between the voltage of the PROG pin and the pull-up current of the PROG



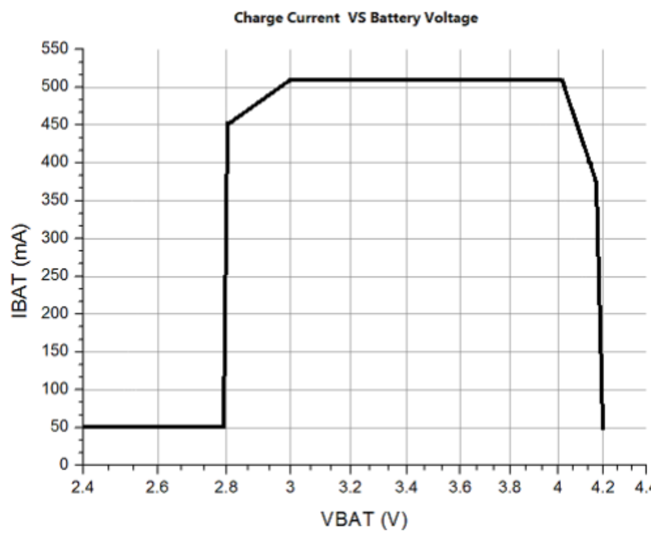
The relationship between float charging voltage and charging current



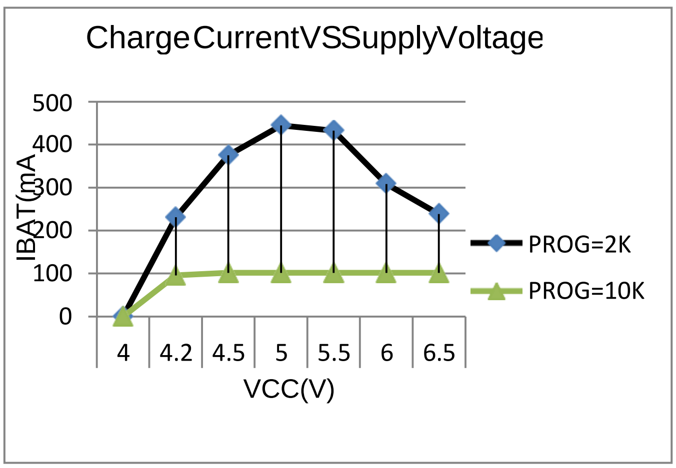
Relationship between Floating Charge Voltage and Power Supply Voltage



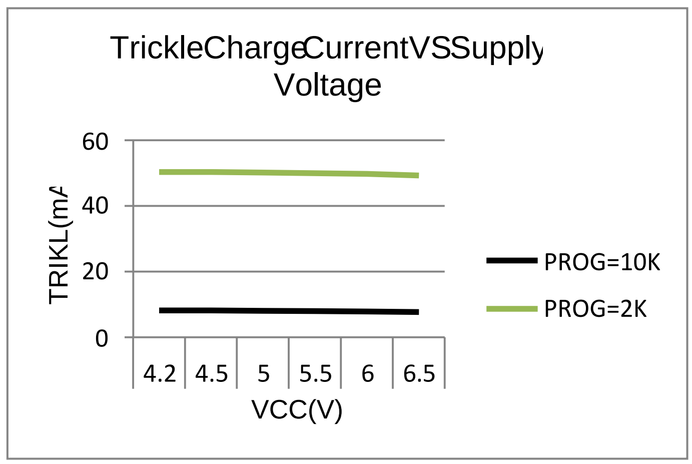
I-V curve



Relationship between charging voltage and charging current



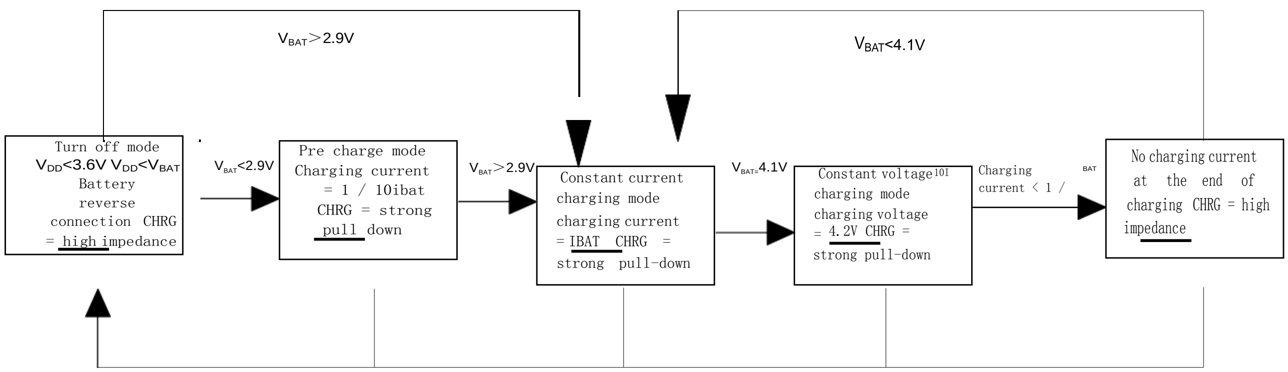
Relationship between charging current and supply voltage



Relationship between trickle current and supply voltage

Working principle

TP4054 is a single cell lithium-ion battery charger that uses a constant current/constant voltage algorithm. It can provide a maximum charging current of around 500mA (with the help of a well-designed PCB layout) and an internal P-channel power MOSFET and thermal regulation circuit. No need for isolation diodes or external current sensing resistors.



Normal charging cycle

When the voltage of the VCC pin rises above the UVLO threshold level and a set resistor with an accuracy of 1% is connected between the PROG pin and ground, or when an electric

When the pool is connected to the output terminal of the charger, a charging cycle begins. If the BAT pin level is below 2.9V, the charger enters trickle charging mode. In this mode,

TP4054 provides about 1/10 of the set charging current to increase the current to a safe level, thereby achieving full current charging.

When the voltage of the BAT pin rises above 2.9V, the charger enters constant current mode, providing a constant charging current to the battery. When BAT pin voltage

When the final float charging voltage (4.2V) is reached, it enters 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.

Setting of charging current

The charging current is set using a resistor connected between the ROG pin and ground. The charging current is 1000 times the output current of the ROG pin. The resistor and charging current are calculated using the following formula:

$$R_{PROG} = \frac{1000V}{I_{CHG}}, I_{CHG} = \frac{1000V}{R_{PROG}}$$

The charging current output from the BAT pin can be determined at any time by monitoring the voltage of the PROG pin, and the formula is as follows:

$$I_{BAT} = \frac{V_{PROG}}{R_{PROG}} \bullet 1000$$

The relationship between rprog and charging current is determined as follows:

RPROG(K)	IBAT(mA)
1.4	600
2	500
2.2	400
3	300
5	200
10	100

Battery reverse connection protection function

TP4054 has a lithium battery reverse connection protection function. When the positive and negative poles of the lithium battery are reversed to the LTC4054ES5-4.2TR current output pin, TP4054 will stop displaying

Fault status indicated, no charging current. In reverse connection, the power supply voltage should be around 5V of the standard voltage and should not exceed 8V. When the power supply voltage is too high and the battery voltage is reversed, the chip voltage difference will exceed 10V, so the power supply voltage should not be too high in reverse connection.

State of charge indicator (CHRG)

TP4054 has an open drain state indicating the output terminal "CHRG". When the charger is in charging state, CHRG is pulled to low power

In other states, CHRG is in a high resistance state. When the battery is not connected to the charger, CHRG outputs a pulse signal indicating that the battery is not installed. When the external capacitance of the BAT pin at the battery connection end is 10uF, the CHRG flashing cycle is about 0.5-2 seconds. When the status indication function is not in use, connect the output terminal of the unused status indication to ground.

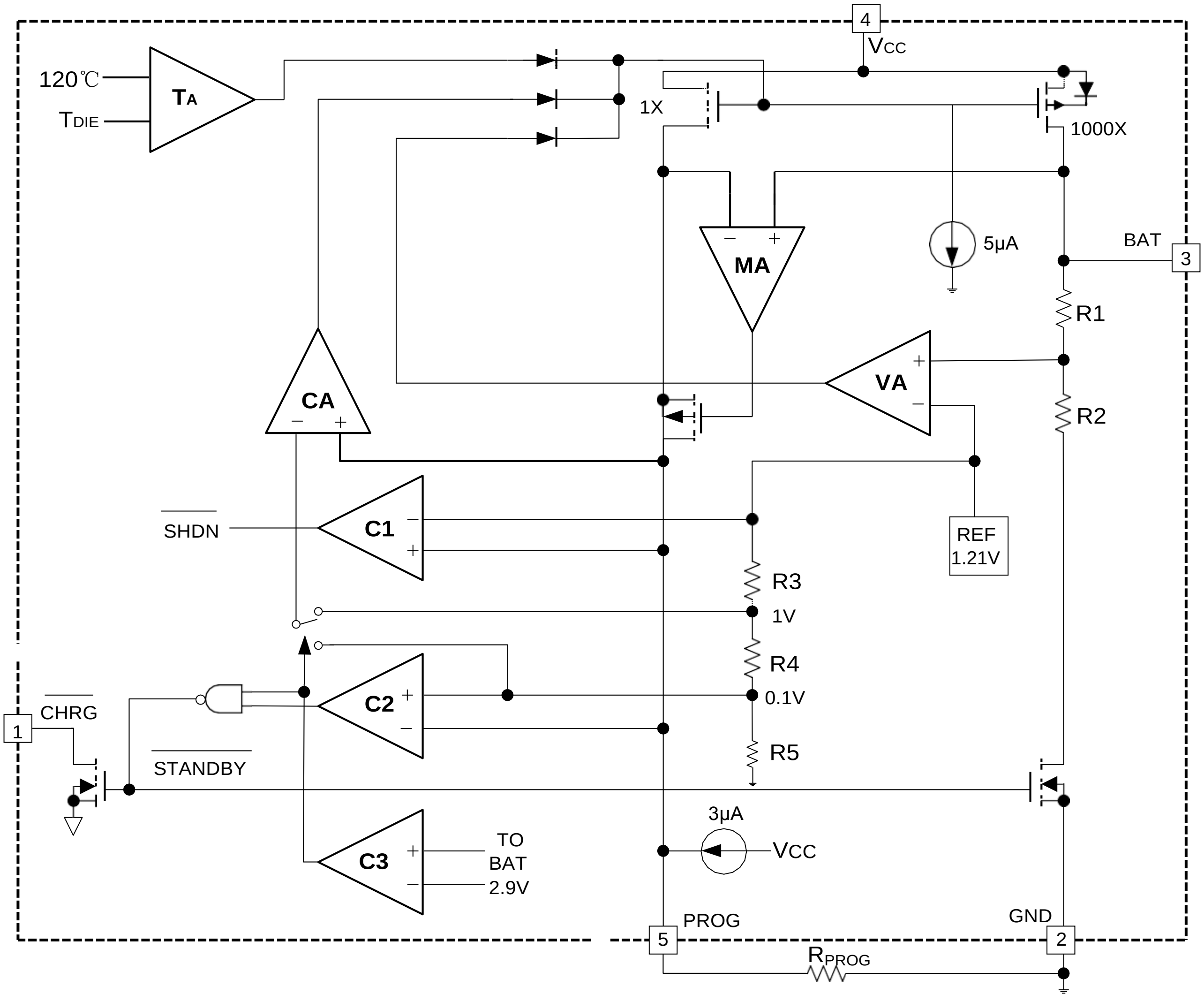
Status of charging indicator with	CHRG
Normal state of	Everbr ight
Battery full state	Extinguish
Battery reverse connection, power supply under voltage	Extinguish
No battery power on	twinkle

Thermal limit

If the chip temperature attempts to rise above the preset value of about 120 ℃, an internal thermal feedback loop will reduce the set charging current. This function can prevent TP4054 from overheating and allow users to increase the upper limit of the power processing capability of a given circuit board without the risk of damaging TP4054.

On the premise of ensuring that the charger will automatically reduce the current under worst-case conditions, the charging current can be set based on typical (rather than worst-case) ambient temperature. The considerations regarding SOT-23 power will be further discussed in the "Thermal Considerations" section.

Structur e diagram



Maximum rating (Note 1)

Symbol	Symbol description	Range	Unit
V_{CC}	input voltage	Vss-0.3~Vss+7	V
V_{PROG}	Prog terminal voltage	Vss-0.3~Vss+0.3	V
V_{BAT}	Bat terminal voltage	Vss-0.3~7	V
V_{CHRG}	CHRG terminal voltage	Vss-0.3~Vss+10	V
P_{DMAX}	power waste	250	mW
I_{BAT}	Bat terminal current	500	mA
I_{PROG}	Prog terminal current	800	μA
V_{ESD}	ESD capability in human mode	4	kV
Latch-Up	Impedance current between pin pins	400	mA
T_{OPA}	Working peripheral temperature	-40~+85	℃
T_{STR}	Storage temperature	-65~+125	℃

Note 1: Devices beyond the maximum range may be damaged. The devices within the recommended working range can work, but their characteristics are not guaranteed. The DC and AC characteristics indicated by electrical characteristics are measured under specific conditions, and their characteristics can be guaranteed. This feature assumes that the device operates within the recommended operating range. Not showing the characteristics does not guarantee its performance.

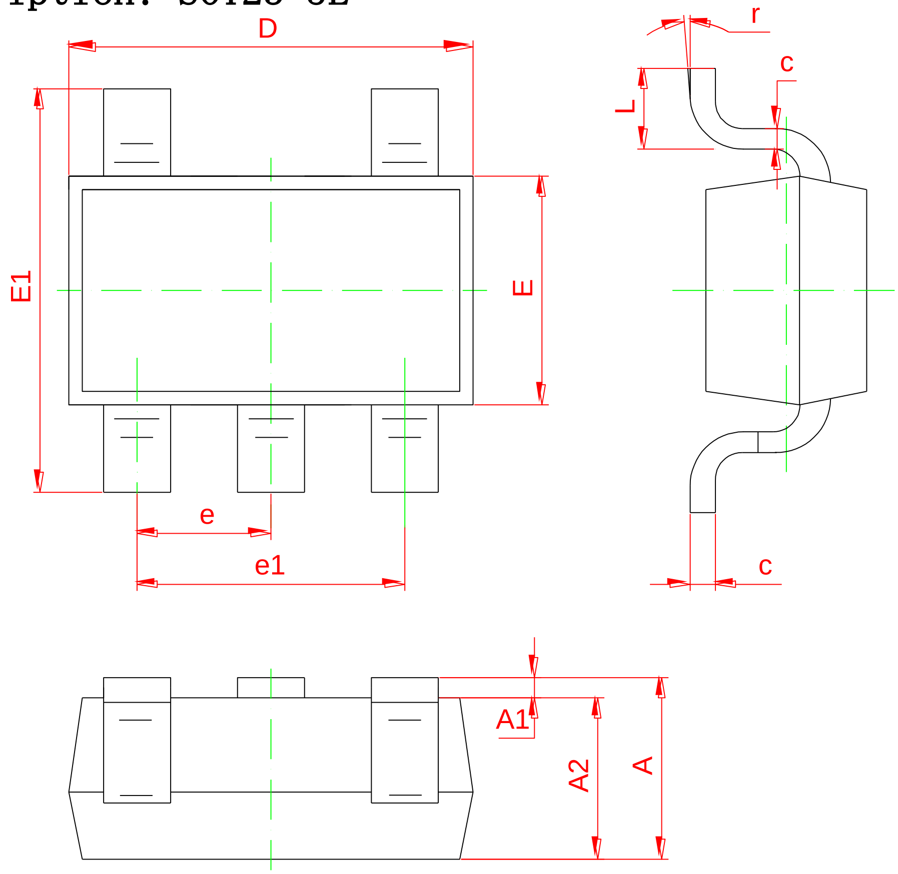
The typical value is the optimal performance point.

Electrical characteristics

The test condition was 25 ℃

Symbol	Symbol description	condition	minimum value	Typical value	Maximum	Company
V_{CC}	input voltage		4.2		6.5	V
I_{CC}	Input current	Charging mode (R_{PROG}= 10K Ω)		300	2000	μA
		standby mode		200	500	μA
		Turn off mode (R_{PROG} is not connected, VCC < Vbat or VCC < VUV)		25	50	μA
V_{FLOAT}	Output control voltage	0℃<Ta<85℃, Ibat=40mA	4.158	4.2	4.242	V
I_{BAT}	Bat terminal current	R_{PROG} = 10K, current mode	93	100	107	mA
		R_{PROG} = 2K, current mode	465	500	535	mA
		V_{BAT} = 4.2V, standby mode	0	-2.5	-6	μA
		Turn off mode		6	10	μA
		V_{BAT}= − 4V, battery reverse mode		0.7		mA
		V_{CC} = 0V, sleep mode		6	10	μA
I_{TRIKL}	trickle charge current	V_{BAT}<V_{TRIKL}, R_{PROG}=2K	40	50	60	mA
V_{TRIKL}	Trickle charging limit voltage	R_{PROG} = 10K, V_{BAT} increased	2.8	2.9	3.0	V
V_{TRHYS}	Trickle charge hysteresis voltage	R_{PROG}=10K	60	80	110	mV
V_{UV}	Low power blocking threshold voltage of power supply	increased from low	3.7	3.8	3.93	V
V_{UVHYS}	Low threshold hysteresis voltage of power supply		150	200	300	mV
V_{MSD}	Manual turn off threshold voltage	Prog feet up	1.15	1.21	1.30	V
		Prog feet up	0.9	1.0	1.1	V
V_{ASD}	VCC-VBAT stop working threshold voltage	V_{CC} from low to high	70	100	140	mV
		V_{CC} from high to low	5	30	50	mV
I_{TERM}	C / 10 terminal threshold current	R_{PROG}=10K	0.085	0.10	0.115	mA/ mA
		R_{PROG}=2K	0.085	0.10	0.115	
V_{PROG}	PROG terminal voltage	R_{PROG}= 10K, current mode	0.93	1.0	1.07	V
V_{CHRG}	Minimum output voltage at CHRG terminal	I_{CHRG}=5mA		0.35	0.6	V
ΔV_{RECG}	Battery recharge hysteresis voltage	V_{FLOAT}-V_{RECHRG}		100	200	mV
t_{RECHG}	Filtering time of charging comparator	V_{BAT} from high to low	0.8	1.8	4	mS
t_{TERM}	Stop comparator filtering time	I_{BAT} fell below I_{CHG}/ 10	0.63	1.4	3	mS
I_{PROG}	Pull up current of PROG pin			2	μA	

Package description: SOT23-5L



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
r	0º	8º	0º	8º