FS4054

Standalone Linear Li-Ion Battery Charger With Thermal Regulation In Thinsot

- **Features**

Programmable Charge Current Up to 800mA
Linear Charger for single Cell Lithium-Ion Batteries
Preset 4.2V Charge Voltage with ±1% Accuracy
C/10 Charge Termination
25μA Supply Current in Shutdown
2.9V Trickle Charge Threshold (FS4054)
Soft-Start Limits Inrush Current

- **Applications**

Cellular Telephones, PDAs, MP3 Players
Charging Docks and Cradles
Bluetooth Applications

- **General Description**

The FS4054 is a complete constant-current/constant-voltage linear charger for single cell lithium-ionbatteries. Its ThinSOT package and low external component count make the FS4054 ideally suited forportable applications. Furthermore, the FS4054 is specifically designed to work within USB power specifications.

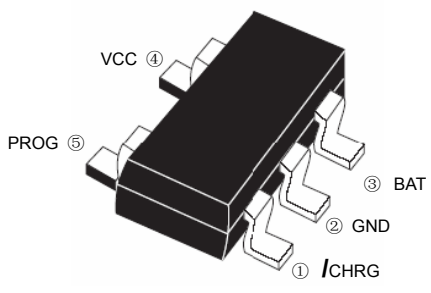
No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The FS4054 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the FS4054 automatically enters a low current state, dropping the battery drain current to less than 2 A. The FS4054 can be put into shutdown mode, reducing the supply current to 25μA.

Other features include charge current monitor, under-voltage lockout, automatic recharge and a status pin to indicate charge termination and the presence of an input voltage.

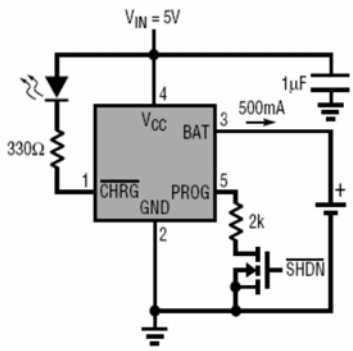
- **Pin Configurations**

FS4054



SOT23-5L

- **Typical Application Circuit**



- **Absolute Maximum Ratings**

Parameter	Symbol	Ratings	Unit
Input Supply Voltage	Vcc	VSS-0.3～VSS+10	V
PROG pin Voltage	Vprog	VSS-0.3～Vcc+0.3	
BAT pin Voltage	Vbat	Vss-0.3～7	
CHAG pin Voltage	Vchrg	VSS-0.3～VSS+10	
BAT pin Current	Ibat	800	mA
PROG pin Current	Iprog	800	μA
Operating Ambient Temperature	Topa	-40～+85	℃
Storage Temperature	Tstr	-65～+125	

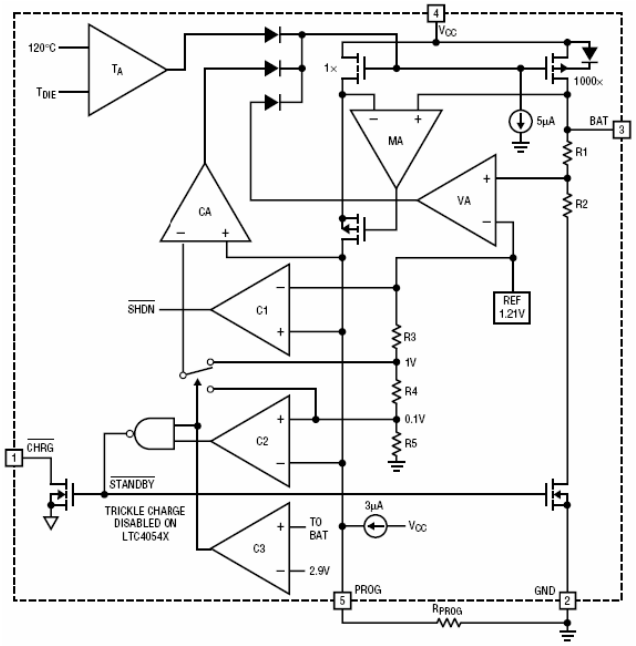
Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

- **Electrical Characteristics**

Parameter	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Input supply voltage	Vcc		4.25		6.5	V
Input supply current	Icc	Charge mode,Rprog=10K		300	2000	uA
		Standby mode		200	500	uA
		Shutdown mode(Rprog not connected,Vcc<Vbat or Vcc<Vuv)		25	50	uA
Regulated Output Voltage	Vfloat	0℃≤TA≤85℃，IBAT = 40mA	4.158	4.2	4.342	V
BAT pin Current	Ibat	Rprog=10k,Current mode	93	100	107	mA
		Rprog=2k,Current mode	465	500	535	mA
		Standby mode,Vbat=4.2V	0	-2.5	-6	uA
		Shutdown mode		1	2	uA
		Sleep mode,Vcc=0V		1	2	uA
Trickle charge current	Itrikl	Vbat<Vtrikl,Rprog=2k	20	45	70	mA
Trickle charge Threshold Voltage	Vtrikl	Rprog=10K，Vbat Rising	2.8	2.9	3.0	V
Trickle voltage hysteresis voltage	Vtrhys	Rporg=10k	60	80	110	mV
Vcc Undervoltage lockout Threshold	Vuv	From Vcc low to high	3.7	3.8	3.93	V
Vcc undervoltage lockout hysteresis	Vuvhys		150	200	300	mV
Manual shutdown threshold voltage	Vmsd	PROG pin rising	1.15	1.21	1.30	V
		PROG pin falling	0.9	1.0	1.1	V
Vcc-Vbat Lockout Threshold voltage	Vasd	Vcc from low to high	70	100	140	mV
		Vcc from high to low	5	30	50	Mv
C/10 Termination Current Threshold	Iterm	Rprog=10k	0.085	0.10	0.115	mA/mA
		Rprog=2k	0.085	0.10	0.115	mA/mA
PROG pin Voltage	Vprog	Rprog=10k, Current mode	0.93	1.0	1.07	V

Parameter	Symbol	CONDITION	MIN	TYP	MAX	UNIT
CHRG pin weak pull-down Current	Ichrg	Vchrg=5V	8	20	35	uA
CHRG pin Output low voltage	Vchrg	Ichrg=5mA		0.35	0.6	V
Recharge Battery threshold Voltage	∆ Vrecg	VFLOAT - VRECHRG		100	200	mV

- **Typical Block Diagram**



- **PIN FUNCTION**

CHRG (Pin 1): Open-Drain Charge Status Output. When the battery is charging, the CHRG pin is pulled low by an internal N-channel MOSFET.When the charge cycle is completed, a weak pull-down of approximately 20µA is connected to the CHRG pin, indicating an “AC present” condition. When the FS4054SK detects an undervoltage lockout condition, CHRG is forced high impedance.

GND (Pin 2): Ground.

BAT (Pin 3): Charge Current Output. Provides charge current to the battery and regulates the final float voltage to 4.2V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.

VCC (Pin 4): Positive Input Supply Voltage. Provides power to the charger. VCC can range from 4.25V to 6.5V and should be bypassed with at least a 1 F capacitor.When VCC drops to within 30mV of the BAT pin voltage, the FS4054SK enters shutdown mode, dropping IBAT to less than 2µA.

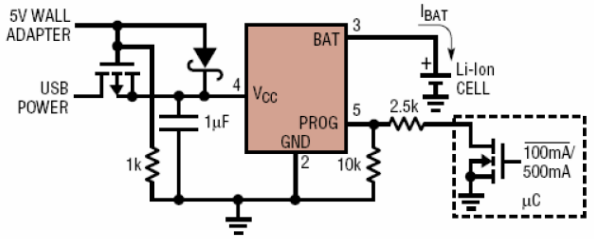
PROG (Pin 5): Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor, RPROG, to ground. When charging in constant-current mode, this pin servos to 1V. In all modes, the voltage on this pin can be used to measure the charge current using the following formula:

IBAT = (VPROG/RPROG) •1000

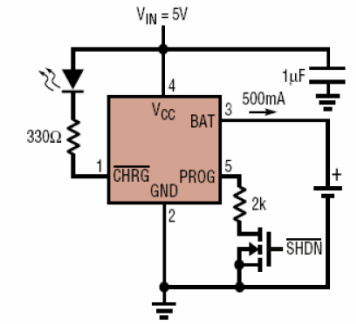
The PROG pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a 3 A current to pull the PROG pin high. When it reaches the 1.21V shutdown threshold voltage, the charger enters shutdown mode, charging stops and the input supply current drops to 25 A. This pin is also clamped to approximately 2.4V. Driving this pin to voltages beyond the clamp voltage will draw currents as high as 1.5mA. Reconnecting RPROG to ground will return the charger to normal operation.

- **TYPICAL APPLICATION CIRCUIT**

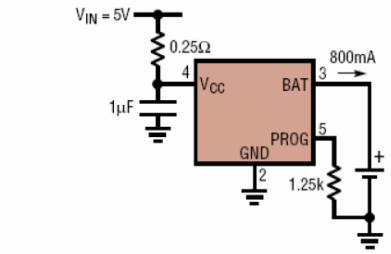
USB/Wall Adapter Power Li-Ion Charger



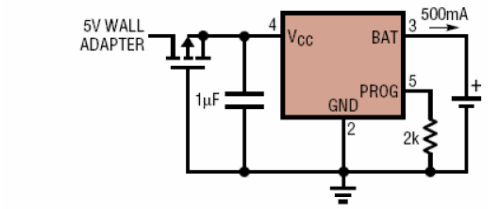
Full Featured Single Cell Li-Ion Charger



800mA Li-Ion Charger with External Power Dissipation

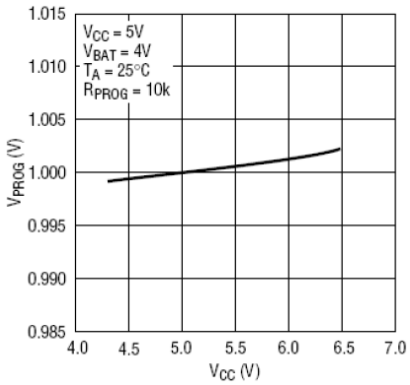


Basic Li-Ion Charger with Reverse Polarity Input Protection

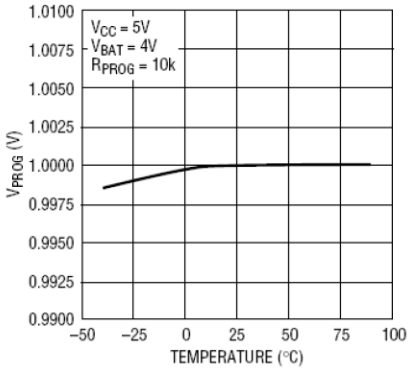


- **Typical Performance Characteristics**

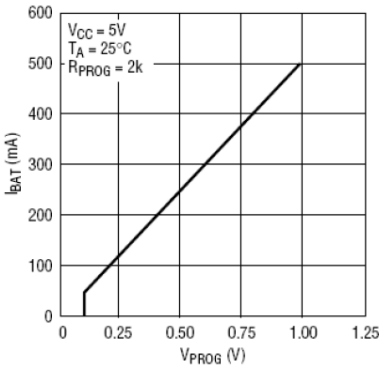
PROG Pin Voltage vs Supply Voltage(Constant Current Mode)



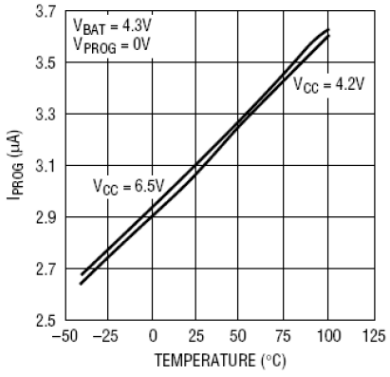
PROG Pin Voltage vs Temperature



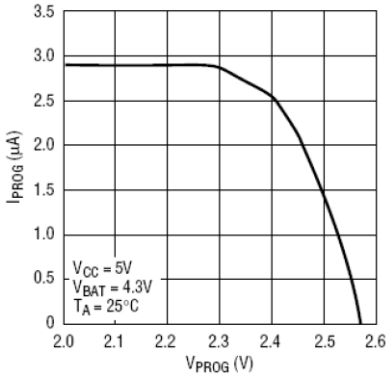
Charge Current vs PROG Pin Voltage



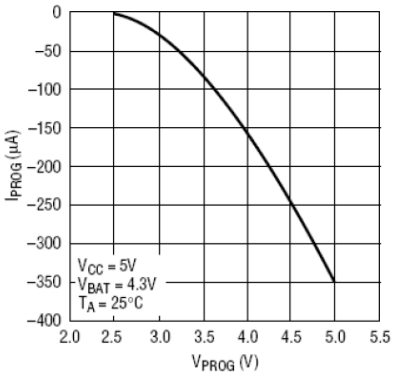
PROG Pin Pull-Up Current vs Temperature and Supply Voltage



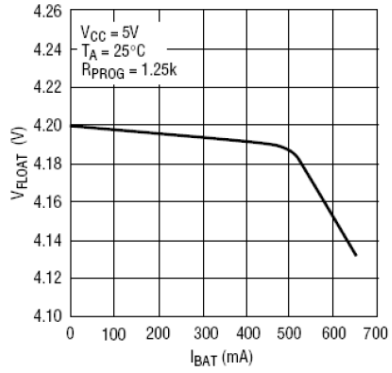
PROG Pin Current vs PROG Pin Voltage (Pull-Up Current)



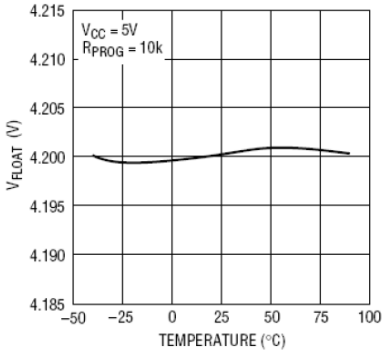
PROG Pin Current vs PROG Pin Voltage (Clamp Current)



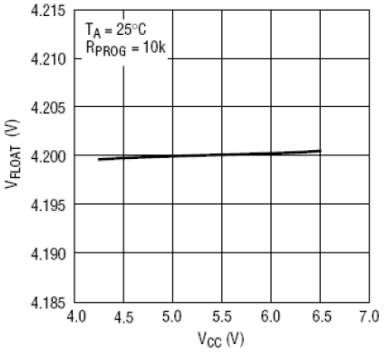
Regulated Output (Float) Voltage vs Charge Current



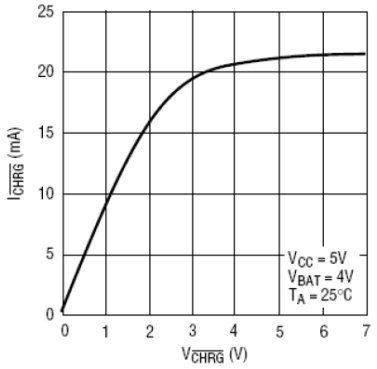
Regulated Output (Float) Voltage vs Temperature



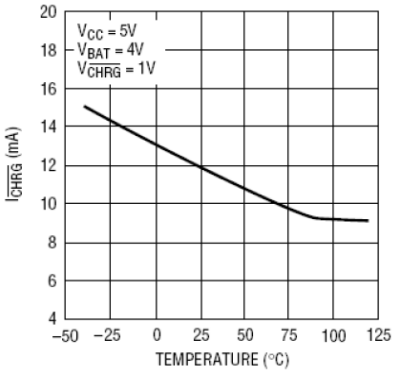
Regulated Output (Float) Voltage vs Supply Voltage



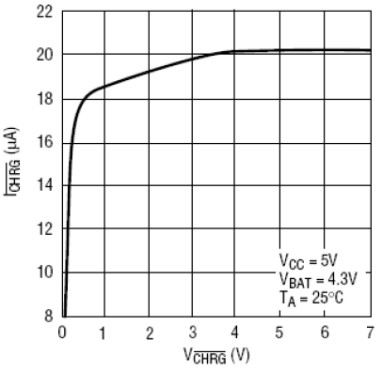
$\overline{CHRG}$ Pin I-V Curve (Strong Pull-Down State)



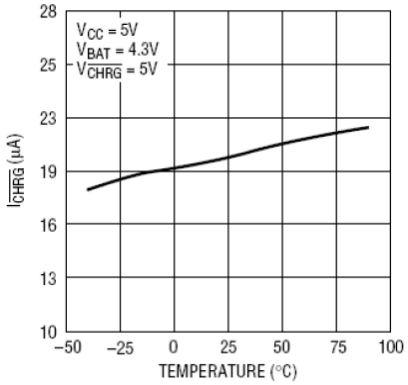
$\overline{CHRG}$ Pin Current vs Temperature (Strong Pull-Down State)



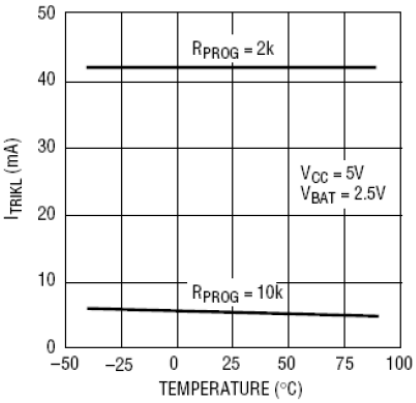
$\overline{CHRG}$ Pin I-V Curve (Weak Pull-Down State)



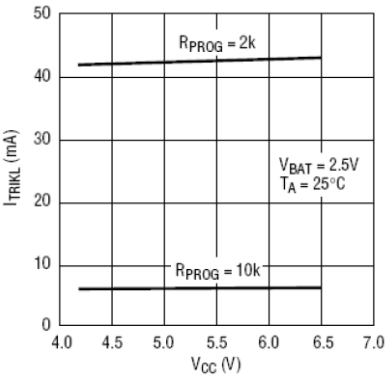
$\overline{CHRG}$ Pin Current vs Temperature (Weak Pull-Down State)



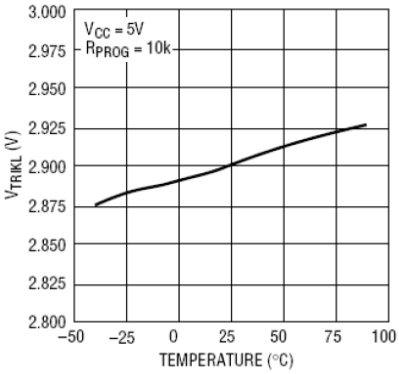
Trickle Charge Current vs Temperature



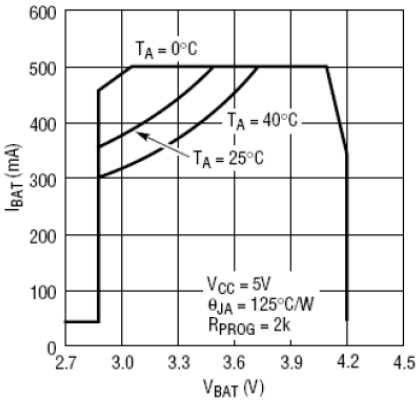
Trickle Charge Current vs Supply Voltage



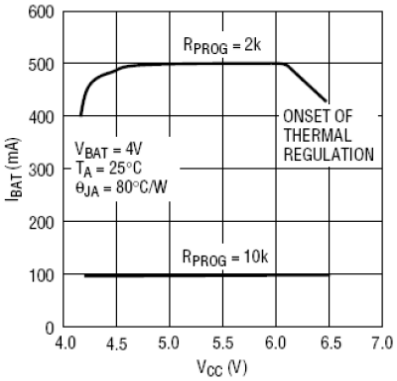
Trickle Charge Threshold vs Temperature



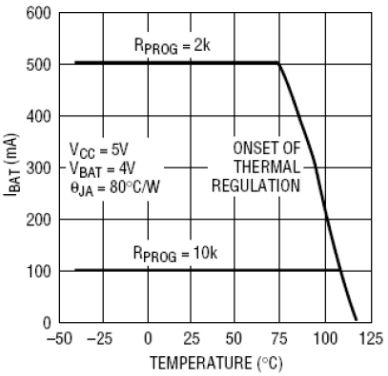
Charge Current vs Battery Voltage



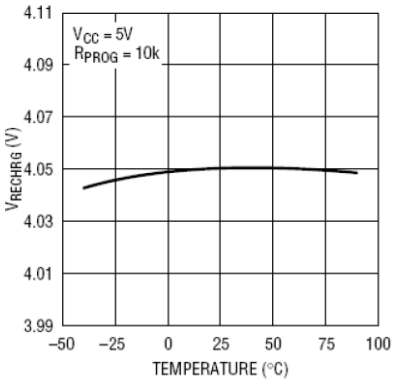
Charge Current vs Supply Voltage



Charge Current vs Ambient Temperature



Recharge Voltage Threshold vs Temperature



Power FET "ON" Resistance vs Temperature