Features

- Programmable Charge Current Up to 500mA
- No MOSFET, Sense Resistor or Blocking Diode Required
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate
- Without Risk of Overheating
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset 4.2V Charge Voltage with 1% Accuracy
- Automatic Recharge
- 2.9V Trickle Charge Threshold
- Available in 6-Lead SOT-23 Package

Applications

- Charger for Li-Ion Coin Cell Batteries
- Portable MP3 Players, Wireless Headsets
- Bluetooth Applications
- Multifunction Wristwatches

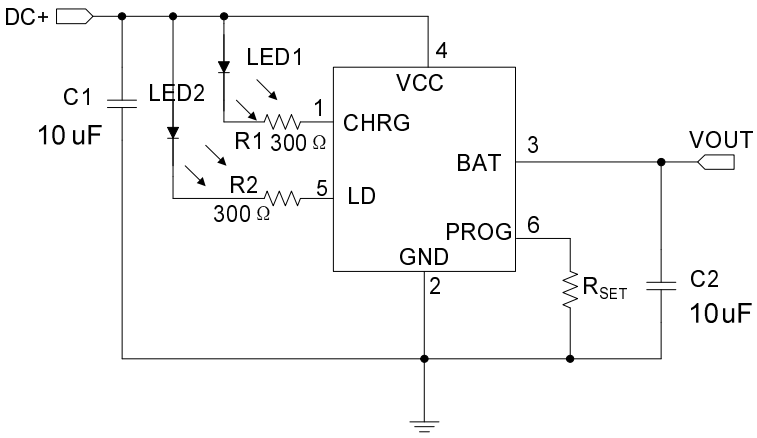
Description

The SD6003 is a complete constant-current/constant voltage linear charger for single cell lithium-ion batteries. Its package and low external component count make the SD6003 ideally suited for portable applications. Furthermore, the SD6003 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. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The SD6003 automatically terminates the charge cycle when the charge current drops to $1/10^{th}$ the programmed value after the final float voltage is reached.

The SD6003 converters are available in the industry standard SOT-23-6L power packages (or upon request).

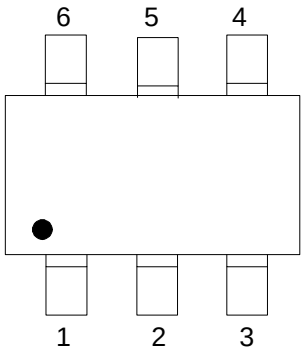
Typical Application



* $I_{BAT} = (V_{PROG}/R_{SET})*900$
* When charging in constant-current mode, the V_{PROG} is usually 1V.

Pin Assignment

TOP VIEW



SOT-23- 6L

PIN NUMBER SOT-23- 6L	PIN NAME	FUNCTION
1	CHRG	Open-Drain Charge Status Output
2	GND	Ground
3	BAT	Charge Current Output
4	VCC	Positive Input Supply Voltage.
5	LD	Open-Drain Charge Status Output
6	PROG	Charge Current Program

Pin Description

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, high impedance is forced to the CHRG pin and LD (pin 5) is pulled low, indicating an “AC present” condition.

GND (Pin 2): Ground.

BAT (Pin 3): Charge Current Output. It should be bypassed with at least a 1uF capacitor. It 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. It Provides power to the charger VCC can range from 4.5V to 6V and should be bypassed with at least a 10uf capacitor.

LD (Pin 5): Open-Drain Charge Status Output. See CHRG pin (Pin 1).

PROG (Pin 6): Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor, R_{PROG}, 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: $I_{BAT} = (V_{PROG}/R_{SET})*900$.

Absolute Maximum Ratings (Note 1)

- Input Supply Voltage (V_{CC}) ..... –0.3V to 7V
- PROG..... – 0.3V to V_{CC} + 0.3V
- BAT ..... –0.3V to 7V
- CHRG..... –0.3V to 7V
- BAT Pin Current 800mA
- Maximum Junction Temperature ..... 125℃
- Operating Ambient Temperature Range (Note 2)..... –40℃ to 85℃
- Storage Temperature Range ……..... –65 ℃to 125℃
- Lead Temperature (Soldering, 10 sec)..... 300℃

Note 1: Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

Note 2: The SD6003 is guaranteed to meet performance specifications from 0℃ to 70℃. Specifications over the –40℃ to 85℃ operating temperature range are assur ed by design, characterization and correlation with statistical process controls.

Electrical Characteristics

Operating Conditions: T_A=25℃, V_{CC}=5V unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{CC}	Input Supply Voltage		4.75	5	6	V
I_{CC}	Input Supply Current	Standby Mode (Charge Terminated) I		48		μA
		Shutdown Mode (R_{PROG} Not Connected, V_{CC} < V_{BAT})		80		μA
V_{FLOAT}	Regulated Output (Float) Voltage	0℃≤T_A≤85℃, I_{BAT} = 50mA	4.15	4.2	4.24	V
I_{BAT}	BAT Pin Current	R_{PROG} = 10k, Current Mode		90		mA
		R_{PROG} = 2k, Current Mode		450		mA
		Standby Mode, V_{BAT} = 4.2V		7		μA
		Shutdown Mode (R_{PROG} Not Connected)		13		μA
		Sleep Mode, V_{CC} = 0V		0.1		μA
I_{TRIKL}	Trickle Charge Current	V_{BAT} < V_{TRIKL}, R_{PROG} = 2k		45		mA
V_{TRIKL}	Trickle Charge Threshold Voltage	RPROG = 10k, VBAT Rising		2.9		V
I_{TERM}	C/10 Termination Current Threshold	R_{PROG} = 2k		45		mA
V_{PROG}	PROG Pin Voltage	R_{PROG} = 2k, Current Mode		1		V
ΔVRECHRG	Recharge Battery Threshold Voltage	VFLOAT - VRECHRG		250		mV
R_{ON}		Power FET “ON” Resistance (Between VCC and BAT)		660		mΩ

Application Information

The SD6003 is a single cell lithium-ion battery chargerusing a constant-current/constant-voltage algorithm. It can deliver up to 800mA of charge current (using a good thermal PCB layout) with a final float voltage accuracy of ±1%. The SD6003 includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required; thus, the basic charger circuit requires only two external components. Furthermore, the SD6003 is capable of operating from a USB power source.

Normal Charge Cycle

A charge cycle begins when the voltage at the V_{CC} pin rises above 4.5V and a 1% program resistor is connected from the PROG pin to ground or when a battery is connected to the charger output. If the BAT pin is less than 2.9V, the charger enters trickle charge mode.

In this mode, the SD6003 supplies approximately 1/10 the programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above 2.9V, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage (4.2V), the SD6003 enters constant-voltage mode and the charge current begins to decrease. When the charge current drops to 1/10 of the programmed value, the charge cycle ends.

Charge Termination

A charge cycle is terminated when the charge current falls to 1/10th the programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the PROG pin.

When charging, transient loads on the BAT pin can cause the PROG pin to fall below 100mV for short periods of time before the DC charge current has dropped to 1/10th the programmed value. Once the average charge current drops below 1/10th the programmed value, the SD6003 terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the BAT pin must be supplied by the battery.

The SD6003 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4V recharge threshold (V_{RECHRG}), another charge cycle begins and current is once again supplied to the battery. To manually restart a charge cycle when in standby mode, the input voltage must be removed and reapplied, or the charger must be shut down and restarted using the PROG pin.

Thermal Limiting

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 120° C. This feature protects the SD6003 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the SD6003. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions. ThinSOT power considerations are discussed further in the Applications Information section.

Automatic Recharge

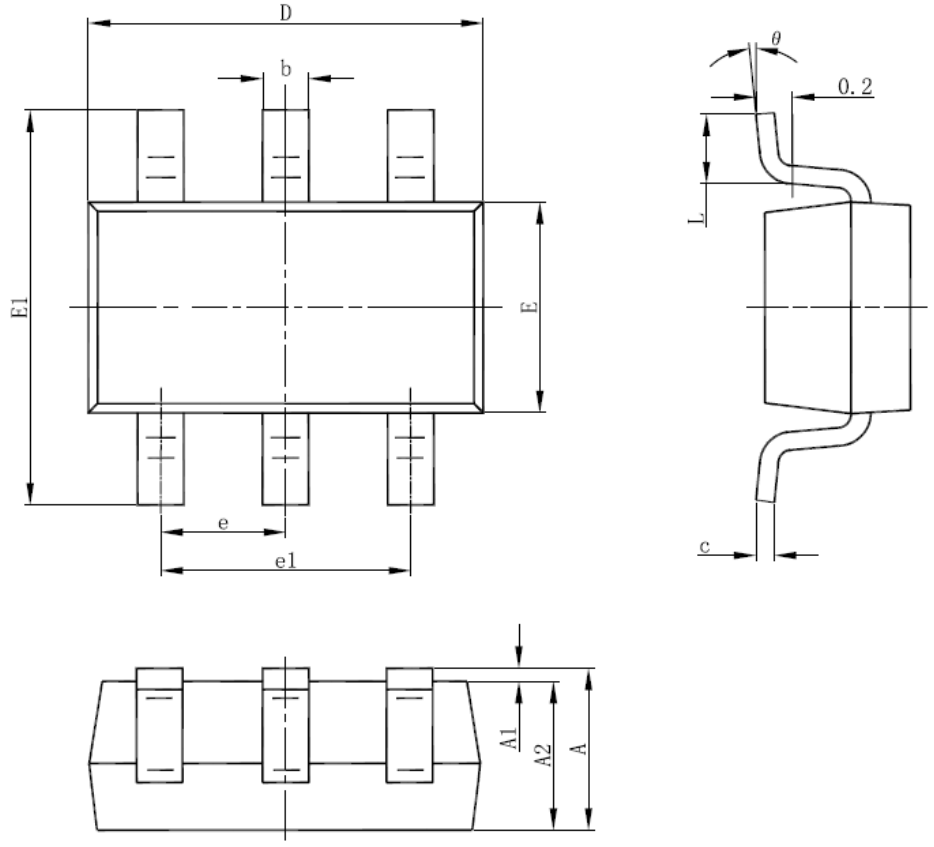
A charge cycle restarts when the battery voltage falls below 4V (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations. CHRG output enters a strong pull down state during recharge cycles.

VCC Bypass Capacitor

Many types of capacitors can be used for input bypassing, however, caution must be exercised when using multilayer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, high voltage transients can be generated under some start-up conditions, such as connecting the charger input to a live power source. Adding a 1.5W resistor in series with an X5R ceramic capacitor will minimize start-up voltage transients.

Packaging Information

SOT-23-6L Package Outline Dimension



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