2.3A, Switch Mode Li-Lon Battery Charger

Description

The SC61B23 is a complete battery charger controller for one (4.2V) cell lithium-ion battery. The SC61B23 provides a small, simple and efficient solution to fast charge Li-ion battery. An external sense resistor sets the charge current with high accuracy.

An internal resistor divider and precision reference set the final float voltage to 4.22V per cell with ±1% accuracy.

When the input supply is removed, the SC61B23 automatically enters a low current sleep mode, dropping the battery drain current to 4μA. After the charge cycle ends, if the battery voltage drops below 4.05V per cell, a new charge cycle will automatically begin.

The SC61B23 is available in the SOP-8L package.

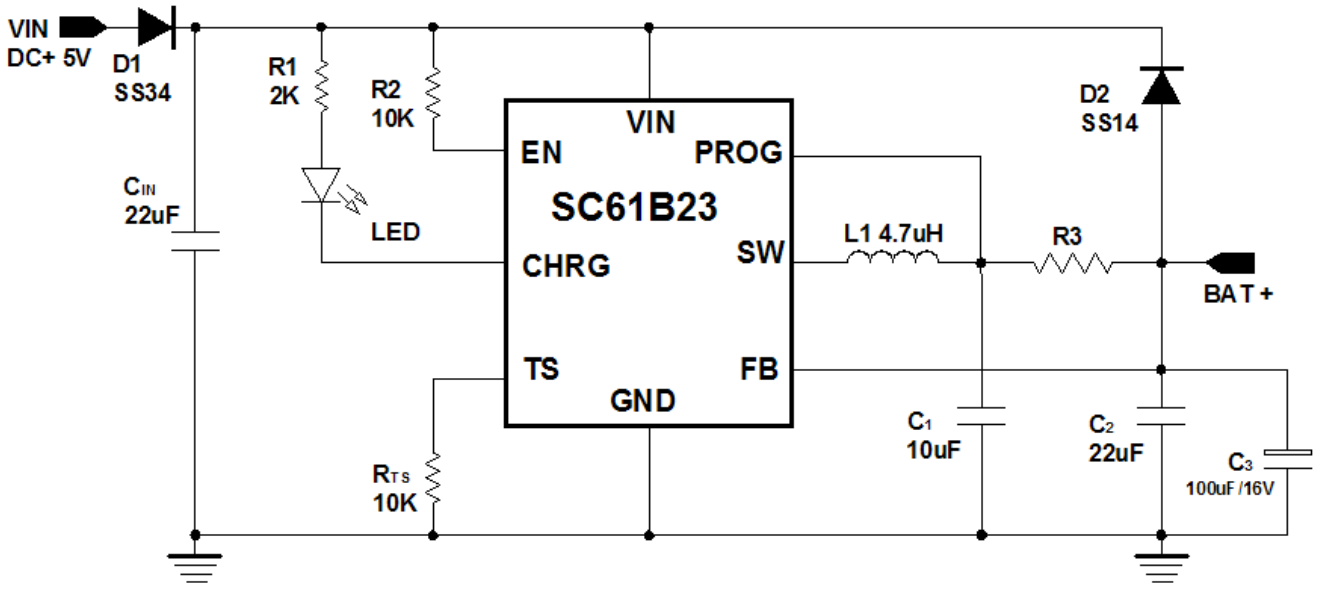
Features

- Input Voltage Range: 4.5V~6V
- ±1% Charge Voltage Accuracy
- Automatic Battery Recharge
- High Efficiency Current Mode PWM Controller
- Automatic Shutdown When Input Supply is Removed
- Automatic Trickle Charging of Low Voltage Batteries
- End - Charge - Current Detection Output
- Constant Switching Frequency for Minimum Noise
- Battery Temperature Sensing
- Stable with Ceramic Output Capacitor
- SOP-8L Package

Applications

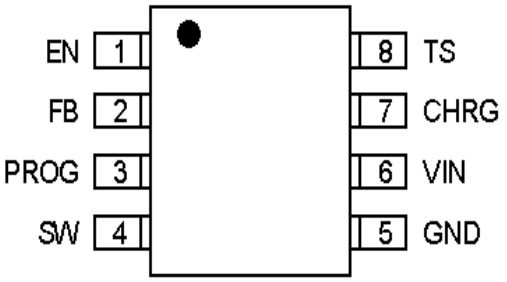
- Charging Docks
- Portable MP3 Players
- Portable Computers，MID

Typical Application



* **The charge current can be set by I_{OUT}= 0.17V/R3.**

Pin Configurations

Part Number	Pin Configurations
SC61B23 **SOP-8L**	

Pin Description

PIN SOP-8L	NAME	DESCRIPTION
1.	EN	ON/OFF Control（High Enable）.
2.	FB	Feedback Pin. Receives the feedback voltage from an external resistor across the output.
3.	PROG	Charge Current Program. The output current is set by an external resistor according to the following formula: I_{OUT} = 0.17V/R3.
4.	SW	Charge Current Output. It provides charge current to the battery and regulates the final float voltage to 4.22V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.
5.	GND	Ground.
6.	VIN	Positive Input Supply Voltage. It Provides power to the charger VIN can range from 4.5V to 6V. A 10μF low ESR capacitor is required at the source pins of the power P-channel MOSFET.
7.	CHRG	Open-Drain Charge Status Output. When the charge current drops below the End-of-Charge threshold for more than 120μs, the N-channel MOSFET turns off and a weak current source is connected from the CHRG pin to GND. When the input supply is removed, the weak current source is turned off and the CHRG pin becomes high impedance.
8.	TS	Temperature Sense.

Absolute Maximum Ratings

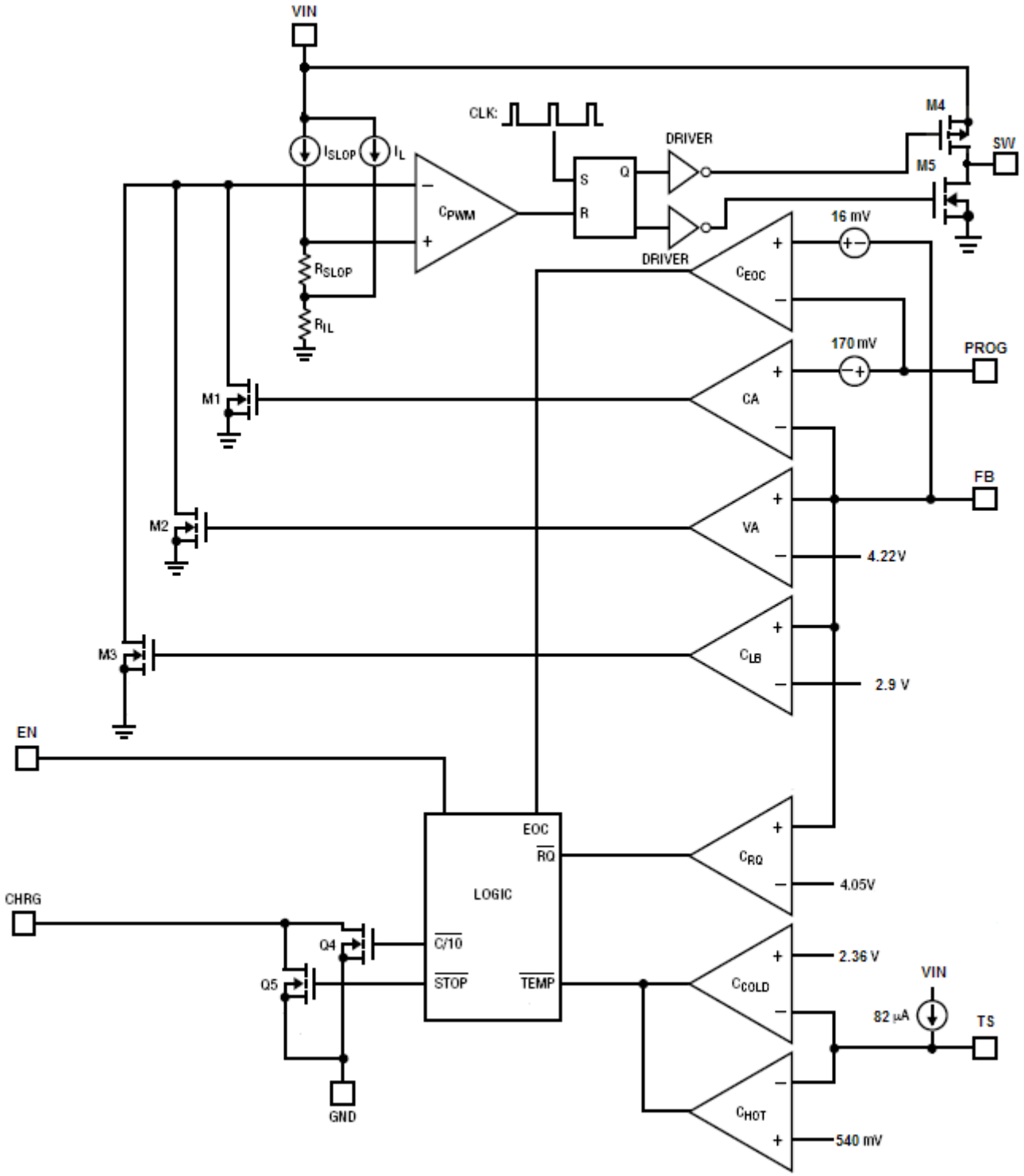
- V_{IN}, , V_{SW} ---------- –0.3V to 6.5V
- V_{CHRG} ---------- – 0.3V to 6.5V
- V_{PROG} ---------- –0.3V to 6.5V
- SW Pin Current ---------- 3.8A
- Operating Temperature Range ---------- –40℃ to 85℃
- Operating Junction Temperature ---------- –40℃ to 125℃
- Storage Temperature Range ---------- –65℃ to 125℃
- Lead Temperature (Soldering, 10 sec) ---------- 300℃

Electrical Characteristics

Operating Conditions: T_A=25 ℃, V_{IN}=5V, R3 = 0.1Ω unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	SC61B23			UNITS
			MIN	TYP	MAX	
V_{IN}	Input Supply Voltage		4.5	5.0	6.0	V
I_{IN}	Input Supply Current	Shutdown Mode		17		μA
		Current Mode		200		
		Sleep Mode		4		
V_{FLOAT}	Regulated Output (Float) Voltage	0℃≤T_A≤85℃,I_{OUT}=1.2A	4.17	4.22	4.26	V
I_{OUT}	V_{OUT} Pin Current	Standby Mode (Charge Terminated),V_{OUT}=4.2V		10.9		μA
		Shutdown Mode		4.3		
$V_{(LOWV)}$	Precharge to fast-charge transition threshold	Voltage on output pin		2.84		V
I_{TRIKL}	Trickle Charge Current	V_{BAT} < V_{TRIKL}		145		mA
F_{OSC}	Switching Frequency			1		MHz
V_{FB}	FB Pin Voltage	Current Mode		0.17		V
I_{TERM}	Termination Current Threshold			202		mA
V_{TS}	TS Pin Threshold Voltage（Cold）	V_{TS} from Low to High		2.5		V
	TS Pin Threshold Voltage（Hot）	V_{TS} from High to Low		0.5		
I_{TS}	TS Pin Output Current	V_{TS} = 0.85V		80		μA
DC	Maximum Duty Cycle				100	%
$V_{SNS(CHG)}$	Constant Current Sense Voltage	V≤V_{BAT}≤4V		170		mV
$V_{SNS(TRKL)}$	Trickle Current Sense Voltage	V_{BAT} = 0V		10		mV
V_{TRKL}	Trickle Charge Threshold Voltage	V_{BAT} Rising		2.9		V
ΔV_{UV}	VIN Undervoltage Lockout Hysteresis Voltage			300		mV
ΔV_{RECHRG}	Recharge Battery Voltage Offset from Full Charged Battery Voltage	$V_{BAT(FULLCHARGED)}$–V_{RECHRG}, V_{BAT} Falling		170		mV

Block Diagram



Application Information

Functional Description

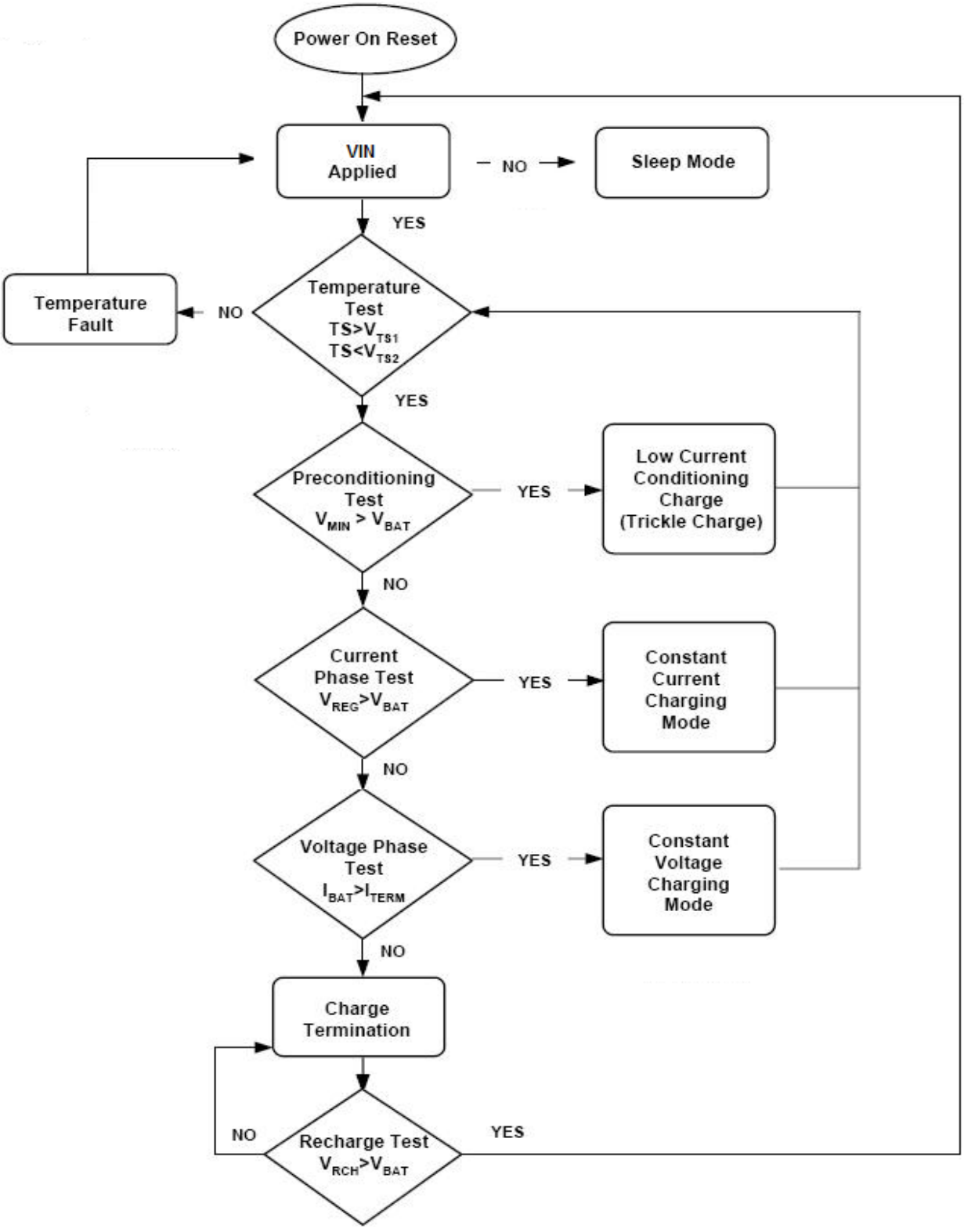


Figure 1: Operation Flow Chart

Operation

The SC61B23 is a constant current, constant voltage Li-Ion battery charger controller that uses a current mode PWM step-down (buck) switching architecture. The charge current is set by an external sense resistor (R3) across the PROG and FB pins. The final battery float voltage is internally set to 4.2V. For batteries like lithium-ion that require accurate final float voltage, the internal reference, voltage amplifier and the resistor divider provide regulation with high accuracy.

A charge cycle begins when the voltage at the VIN pin rises above the UVLO level and is 250mV or greater than the battery voltage. At the beginning of the charge cycle, if the battery voltage is less than the trickle charge threshold, the charger goes into trickle charge mode. The trickle charge current is internally set to 9% of the full-scale current.

When the battery voltage exceeds the trickle charge threshold, the charger goes into the full-scale constant current charge mode. In constant current mode, the charge current is set by the external sense resistor R3 and an internal 170mV reference; I_{OUT} = 170mV/R3.

When the battery voltage approaches the programmed float voltage, the charge current will start to decrease. When the current drops to 15% of the full-scale charge current, an internal comparator turns off the internal pull-down N-channel MOSFET at the CHRG pin, and connects a weak current source to ground to indicate a end-of-charge condition and then the charge cycle is terminated and the CHRG pin is forced high impedance.

To restart the charge cycle, remove and reapply the input voltage or momentarily shut the charger down. Also, a new charge cycle will begin if the battery voltage drops below the recharge threshold voltage. When the input voltage is present, the charger can be shut down. When the input voltage is not present, the charger goes into sleep mode. This will greatly reduce the current drain on the battery and increase the standby time.

A 10kΩTS (negative temperature coefficient) thermistor can be connected from the TS pin to ground for battery temperature qualification.

Qualification and Precharge

The SC61B23 suspends charge if the battery temperature is outside the V_{TS1} to V_{TS2} range and suspends charge until the battery temperature is within the allowed range. The SC61B23 also checks the battery voltage. If the battery voltage is below the precharge threshold V(min) , the SC61B23 uses precharge to condition the battery. The conditioning charge rate $I_{(PRECHG)}$ is set at approximately 8% of the regulation current. See Figure2 for a typical charge-profile.

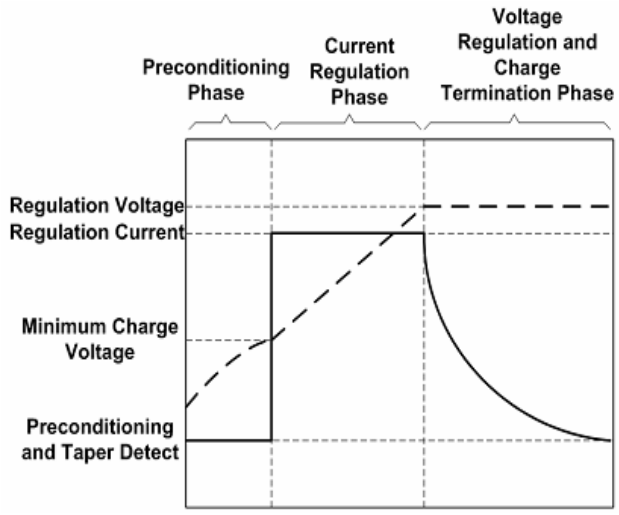


Figure 2: Typical Charge Profile

Charge Termination Recharge

The SC61B23 monitors the charging current during the voltage-regulation phase. The SC61B23 declares a done condition and terminates charge when the current drops to the charge termination threshold, ITERM. A new charge cycle begins when the battery voltage falls below the VRCH threshold.

Battery Temperature Monitoring

The SC61B23 continuously monitors temperature by measuring the voltage between the TS and GND pin. An internal current source provides the bias for most common 10-kΩ negative-temperature coefficient thermistors. The SC61B23 compares this voltage against its internal VTS1 and VTS2 thresholds to determine if charging is allowed ,See Figure 3.

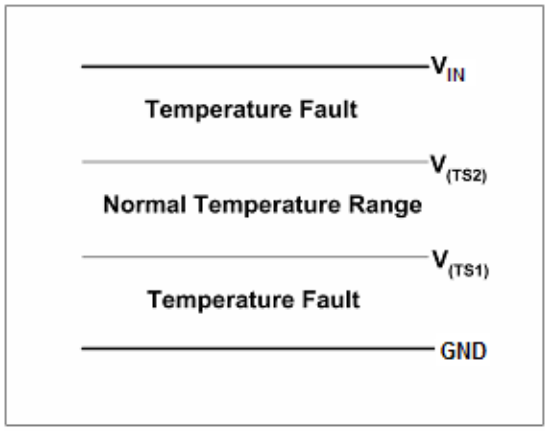


Figure 3: TS Input Thresholds

Charge Status Indication

The SC61B23 reports the status of the charge on the CHRG pin. The following Table 1 summarized the operation of the CHRG pin. The CHRG pin can be used to drive a chip LED.

CONDITION	CHRG Pin
Battery conditioning and charging	Low
Temperature fault or sleep mode	Hi-Z
Charge complete(done)	Hi-Z

Table 1

Undervoltage Lockout (UVLO)

An undervoltage lockout circuit monitors the input voltage and keeps the charger off until VIN rises above the UVLO threshold (4.2V) and at least 250mV above the battery voltage. To prevent oscillation around the threshold voltage, the UVLO circuit has 200mV per cell of built-in hysteresis. When specifying minimum input voltage requirements, the voltage drop across the input blocking diode must be added to the minimum supply voltage specification.

Trickle Charge

At the beginning of a charge cycle, if the battery voltage is below the trickle charge threshold, the charger goes into trickle charge mode with the charge current reduced to 9% of the full-scale current.

Shutdown

The SC61B23 can be shut down by pulling the EN pin to ground. In shutdown, the output of the CHRG pin is high impedance and the quiescent current remains at 4.3uA.

Input and Output Capacitors

Since the input capacitor is assumed to absorb all input switching ripple current in the converter, it must have an adequate ripple current rating. Worst-case RMS ripple current is approximately one-half of output charge current. Actual capacitance value is not critical. Solid tantalum capacitors have a high ripple current rating in a relatively small surface mount package, but caution must be used when tantalum capacitors are used for input bypass. High input surge currents can be created when the adapter is hot-plugged to the charger and solid tantalum capacitors have a known failure mechanism when subjected to very high turn-on surge currents. Selecting the highest possible voltage rating on the capacitor will minimize problems. Consult with the manufacturer before use. The selection of output capacitor COUT is primarily determined by the ESR required to minimize ripple voltage and load ste transients. The output ripple ΔVOUT is approximately bounded by:

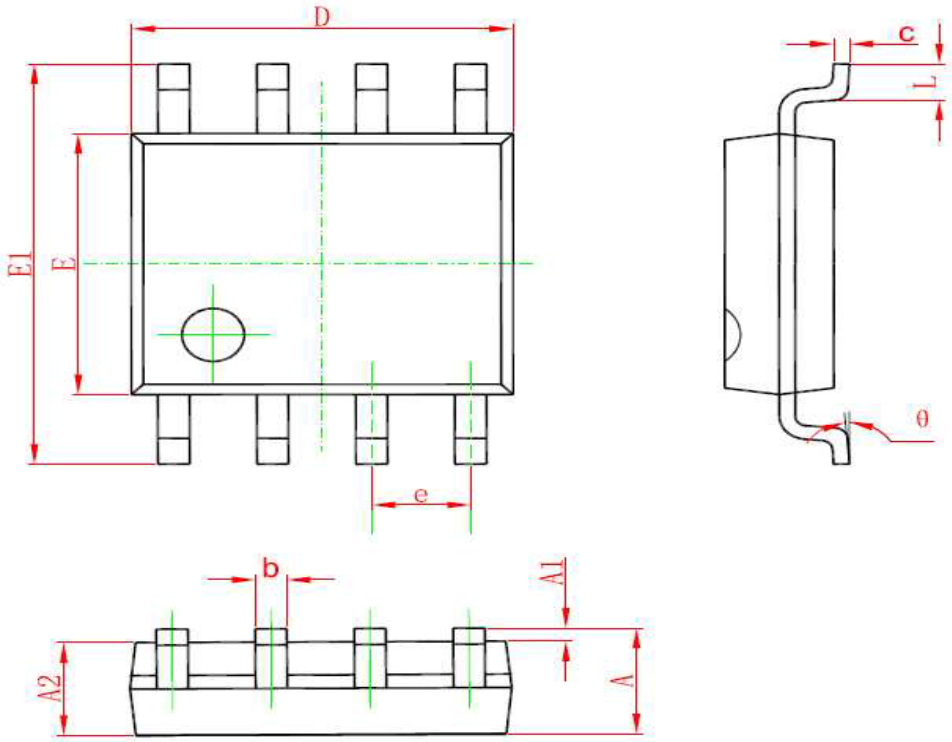
$$\Delta V_{OUT} \le \Delta I_L \left(ESR + \frac{1}{8 f_{OSC} C_{OUT}} \right)$$

Since ΔIL increases with input voltage, the output ripple is highest at maximum input voltage. Typically,once the ESR requirement is satisfied, the capacitance is adequate for filtering and has the necessary RMS current rating.

Switching ripple current splits between the battery and the output capacitor depending on the ESR of the output capacitor and the battery impedance. EMI considerations usually make it desirable to minimize ripple current in the battery leads. Ferrite beads or an inductor may be added to increase battery impedance at the 500kHz switching frequency. If the ESR of the output capacitor is 0.2Ω andthe battery impedance is raised to 4Ω with a bead or inductor, only 5% of the current ripple will flow ithe battery.

Packaging Information

SOP-8L Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°