HX6202

Standalone Li-Lon Switch Mode Battery Charger

Features

- Input Supple Range: 4.7V-5V
- High Efficiency Current Mode PWM Controller
- End - Charge - Current Detection Output
- Constant Switching Frequency for Minimum Noise
- Automatic Battery Recharge
- Automatic Shutdown When Input Supply is Removed
- Automatic Trickle Charging of Low Voltage Batteries
- Battery Temperature Sensing
- Stable with Ceramic Output Capacitor
- SOP-8L Package

Description

The HX6202 is a complete battery charger controller for one (4.2V) cell lithium-ion battery. The HX6202 provides a small, simple and efficient solution to fast charge Li-ion battery. An external sense resistor sets the charge current with high accuracy.

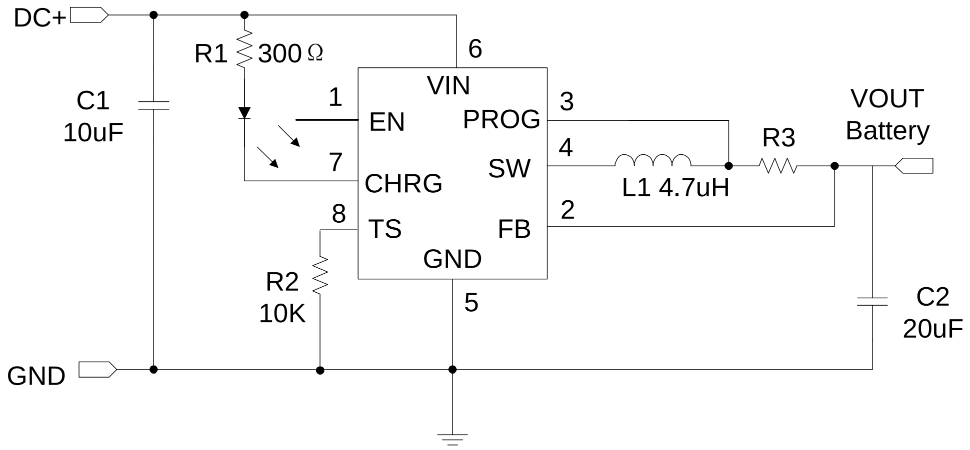
An internal resistor divider and precision reference set the final float voltage to 4.2V. When the input supply is removed, the HX6202 automatically enters a low current sleep mode.

The HX6202 is available in the SOP-8L package.

Application

- Charging Docks
- Handheld Instruments
- Portable Computers

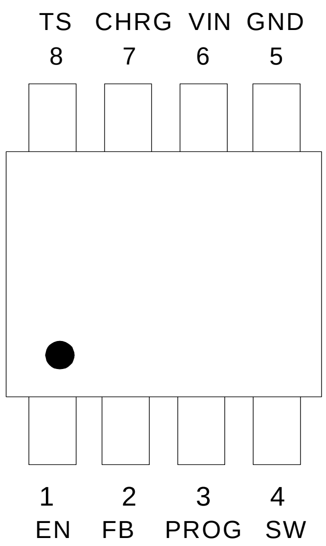
Typical Application



⁎ The charge current can be set by $I_{OUT1} = 0.17V/R3$.

Pin Assignment

Top View



SOP-8L

PIN NUMBER	PIN NAME	FUNCTION
1	EN	ON/OFF Control
2	FB	Feedback
3	PROG	Charge Current Program
4	SW	Switch Output
5	GND	Ground
6	VIN	Input
7	CHRG	Open-Drain Charge Status for Output
8	TS	Temperature Sense

Electrical Characteristics

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

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Voltage		4.7	5.0	5.5	V
I_{IN}	Input Supply Current	Charge Mode		17		μA
		Standby Mode (Charge Terminated)		19.6		
V_{FLOAT}	Regulated Output (Float) Voltage	0℃≤T_A≤85℃, I_{OUT} = 1.2A	4.15	4.2	4.24	V
I_{OUT}	VOUT 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
$V_{TS-COLD}$	TS Pin Threshold Voltage（Cold）	V_{TS} from Low to High		2.5		V
V_{TS-HOT}	TS Pin Threshold Voltage（Hot）	V_{TS} from High to Low		0.5		
I_{TERM}	Termination Current Threshold			202		mA
V_{FB}	FB Pin Voltage	Current Mode		0.17		V
f_{OSC}	Switching Frequency			980		kHz

Absolute Maximum Ratings (Note 1)

- VIN, CHRG, SW, PROG Voltage.. –0.3V to 6.5V
- SW Pin Current 3.8A
- Operating Temperature Range (Note 2).. –40℃ to 85℃
- Operating Junction Temperature (Note 3).. –40℃ to 125℃
- Storage Temperature Range ………………………………………….................. –65 ℃to 125℃
- Lead Temperature (Soldering, 10 sec).. 300℃

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The HX6202 is guaranteed to meet performance specifications from 0℃ to 85℃. Specifications over the –40℃ to 85℃ operating temperature range are assured by design, characterization and correlation with statistical process controls.

Note 3: This IC includes over temperature protection that is intended to protect the device during momentary overload. Junction temperature will exceed 125℃ when over te mperature protection is active. Continuous operation above the specified maximum operating junction temperature my impair device reliability.

Pin Description

EN (Pin 1): ON/OFF Control（High Enable）.

FB (Pin 2): Feedback Pin. Receives the feedback voltage from an external resistor across the output.

PROG (Pin 3): Charge Current Program. The output current is set by an external resistor according to the following formula: I_{OUT} = 0.17V/R3.

SW (Pin 4): Charge Current Output. 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.

GND (Pin 5): Ground.

VIN (Pin 6): Positive Input Supply Voltage. It Provides power to the charger VIN can range from 4.7V to 5V and should be bypassed with at least a 10uF capacitor.

CHRG (Pin 7): 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 or reverse battery lockout / No AC is detected, CHRG is forced high impedance.

TS (Pin 8): Temperature Sense.

Operation

The HX6202 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 10kΩ TS (negative temperature coefficient) thermistor can be connected from the TS pin to ground for battery temperature qualification.

Application Information

Functional Description

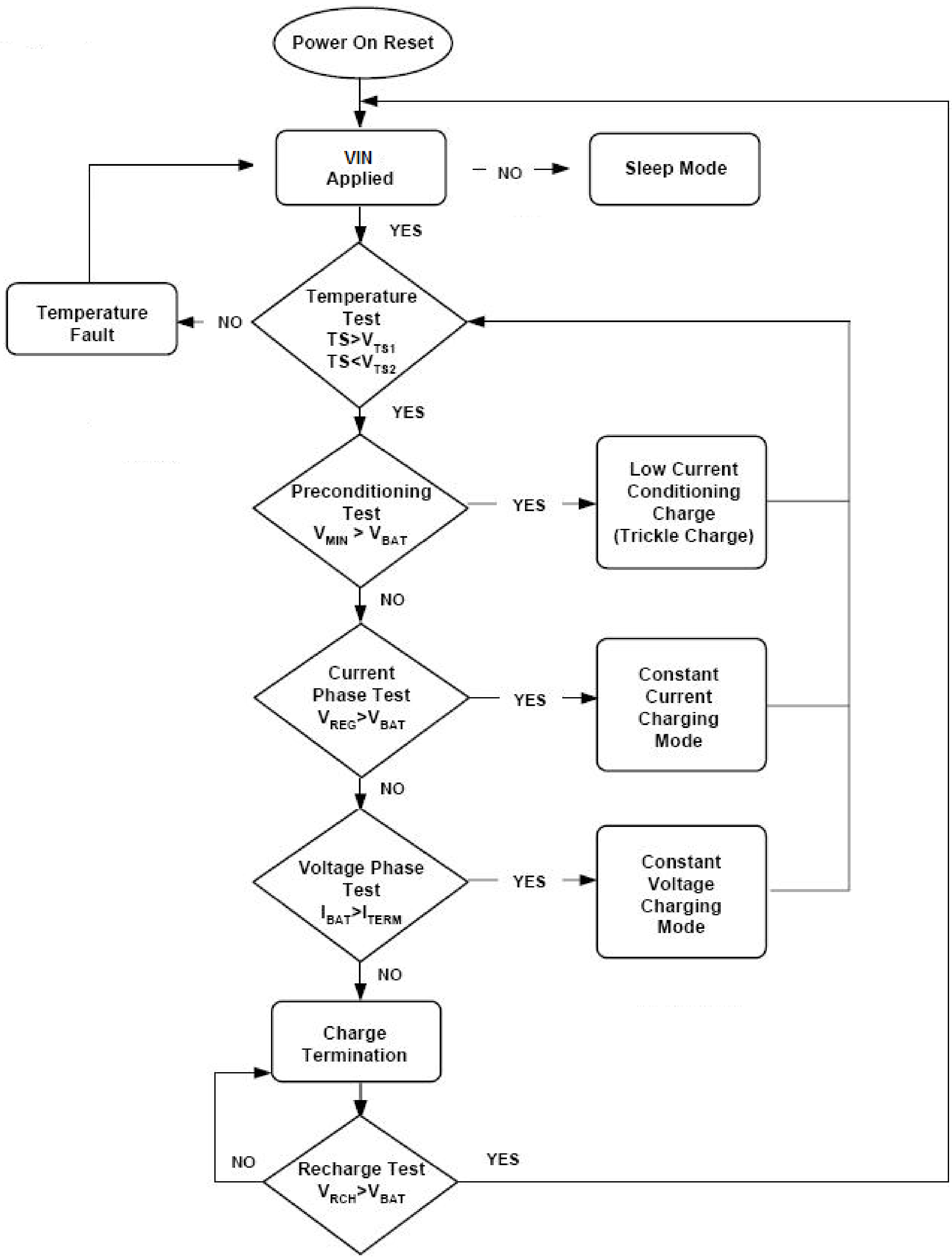


Figure 1: Operation Flow Chart

Qualification and Precharge

The HX6202 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 HX6202 also checks the battery voltage. If the battery voltage is below the precharge threshold $V_{(min)}$, the HX6202 uses precharge to condition the battery. The conditioning charge rate $I_{(PRECHG)}$ is set at approximately 8% of the regulation current. See Figure 2 for a typical charge-profile.

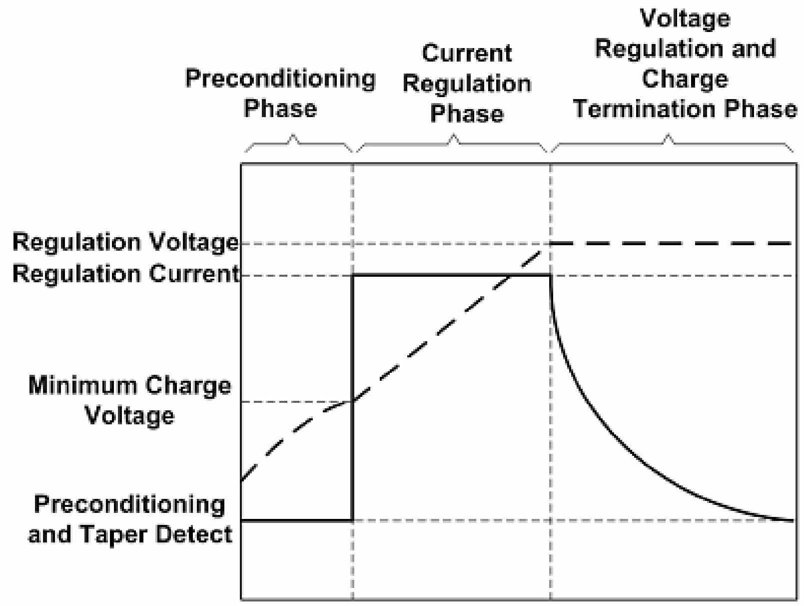


Figure 2: Typical Charge Profile

Charge Termination Recharge

The HX6202 monitors the charging current during the voltage-regulation phase. The HX6202 declares a done condition and terminates charge when the current drops to the charge termination threshold, I_{TERM}. A new charge cycle begins when the battery voltage falls below the V_{RCH} threshold.

Battery Temperature Monitoring

The HX6202 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 HX6202 compares this voltage against its internal V_{TS1} and V_{TS2} thresholds to determine if charging is allowed (See Figure 3).

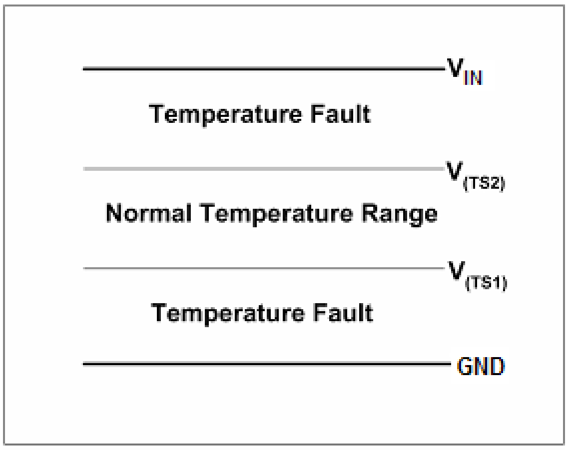


Figure 3: TS Input Thresholds

Charge Status Indication

The HX6202 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
Charge complete(done)	Hi-Z
Temperature fault or sleep mode	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 HX6202 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 step transients. The output ripple ΔV_{OUT} is approximately bounded by:

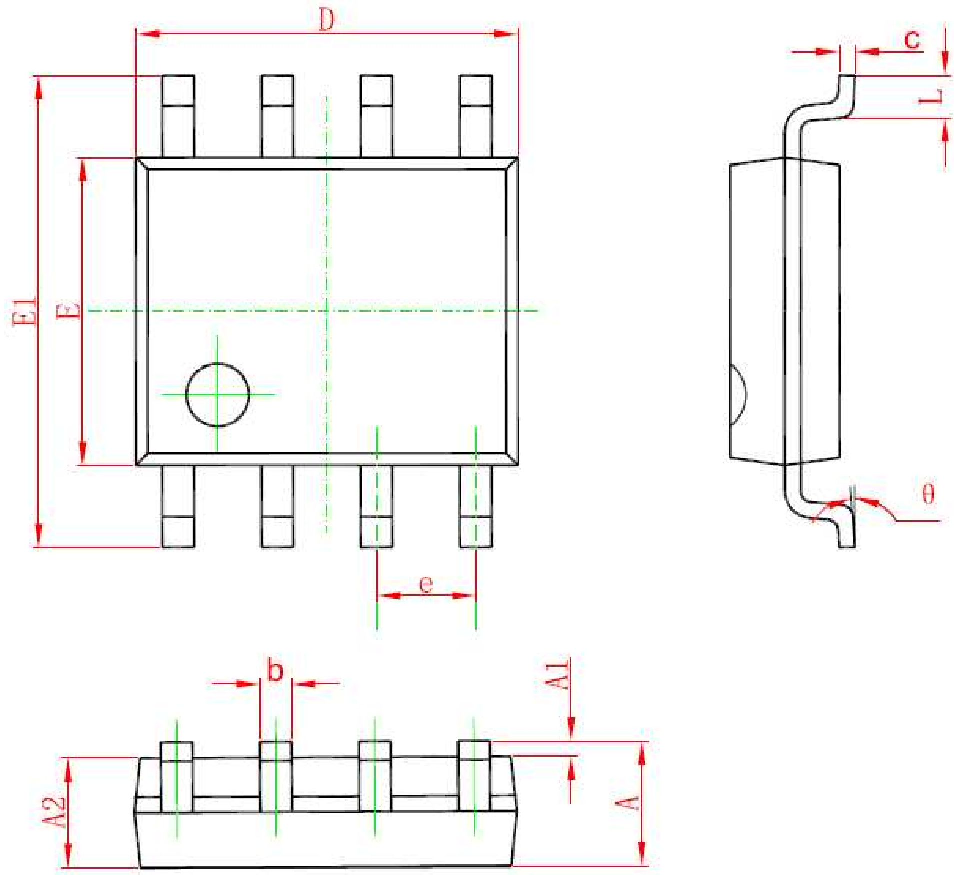
$$\Delta V_{OUT} \le \Delta I_L \left(ESR + \frac{1}{8 f_{OSC} C_{OUT}} \right)$$

Since ΔI_L 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 and the battery impedance is raised to 4Ω with a bead or inductor, only 5% of the current ripple will flow in the 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	0.100	0.250	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
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°