

5V Input PFM Boost-Type 2-Cell Series-Connected Lithium Battery Charging Control Circuit

summary :

The HM6038 is a PFM-boosted dual-cell lithium battery charging control IC operating across 3.0V to 6.5V. It employs quasi-CV™ (constant current and constant voltage modes) for battery management, featuring integrated components including a reference voltage source, inductor current detection unit, battery voltage sensing circuit, and built-in field-effect transistor driver circuit. This design offers advantages such as minimal external components and simplified circuitry.

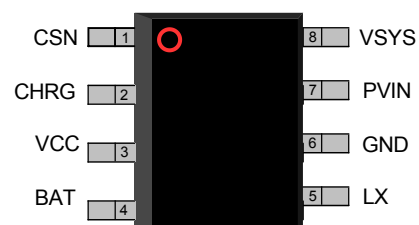
characteristic :

- Input voltage range: 3.0V to 6.5V
- ↳ Operating current: 280 A @VIN=5V
- ↳ Inductance current detection
- Up to 1MHz switching frequency
- Constant voltage charging mode compensates for battery internal resistance and battery connection lines Voltage loss due to resistance
- ↳ Automatic recharging function
- ↳ UP to 1.2A output charging current
- When the battery voltage is lower than the input voltage or the battery is short-circuited, charge with a small current.
- Adaptive power input function
- ↳ Battery overvoltage protection
- ↳ Status indicator output
- Working temperature range: -40° to 85°
- ↳ 8-pin SOP8 package
- The product is lead-free, meets the requirements of the RoHS directive, and does not contain halogens.

apply :

- Dual battery charging control
- ↳ POS machine, electric fan
- ↳ Audio
- Standalone charger

Pin layout:



absolute rating :

VCC, CHRG, and CSN pin voltages.....	-0.3V to 12V	Maximum junction temperature.....	150°R
Other pin voltages.....	-0.3V to 18V	Operating temperature range.....	-40°R to 85°R
CSN and VCC pin voltage.....	-0.3V to 0.3V	Storage temperature.....	-65°R to 150°R
		Welding temperature (10 seconds).....	260°R

Exceeding the above listed limit parameters may cause permanent damage to the device. The above is only the limit range, working under such limit conditions, the technical indicators of the device will not be guaranteed, and long-term under such conditions will affect the reliability of the device.

Electrical parameters:

(Voltage: 5V, Temperature: -40°C to +85°C; typical values measured at +25°C unless otherwise specified.)

Parameter	symbol	Test condition	Min	Typ	Max	Unit	
Input voltage range	VCC		3.0		6.5	V	
Working current	I _{VCC}	V _{BAT} = 8.6V, No Switching	200	280	360	uA	
Shut-off current	I _{off}	CE pin low level		0	2	uA	
Switching frequency	f _{SW}		200		1000	KHz	
Inductive current detection comparator							
RCS Voltage thresholds	V _{CSHI}	Constant current	(VCC-V _{CSN}) rises from 0V until V _{LDRV} < 0.5V	95	110	125	mV
		Constant pressure		16		31	
CSN pin input current	I _{CSN}				15	uA	
BAT pin							
BAT pin charge termination threshold	V _{BAT}	BAT pin voltage rises	8.32	8.4	8.48	V	
BAT pin recharge threshold	V _{RECHRG}	BAT voltage decreases,V _{BAT} -V _{RECHRG}	200	500	800	mV	
BAT pin current	I _{BAT}	VCC = 0V, V _{BAT} = 8.4V	5		14	uA	
Trickle charge							
Trickle charging current	I _{TRIKL}	V _{BAT} <V _{TRIKL} , RCS=0.062R	30	40	50	mA	
Jiu Liu charging threshold voltage	V _{TRIKL}	RCS=0.062R, V _{BAT} increases	5.5	5.6	5.7	V	
CHRG pin							
The pin outputs a high level	I _{CHRG}	V _{CHRG} =5V,charging mode		10		mA	

Typical application circuits:

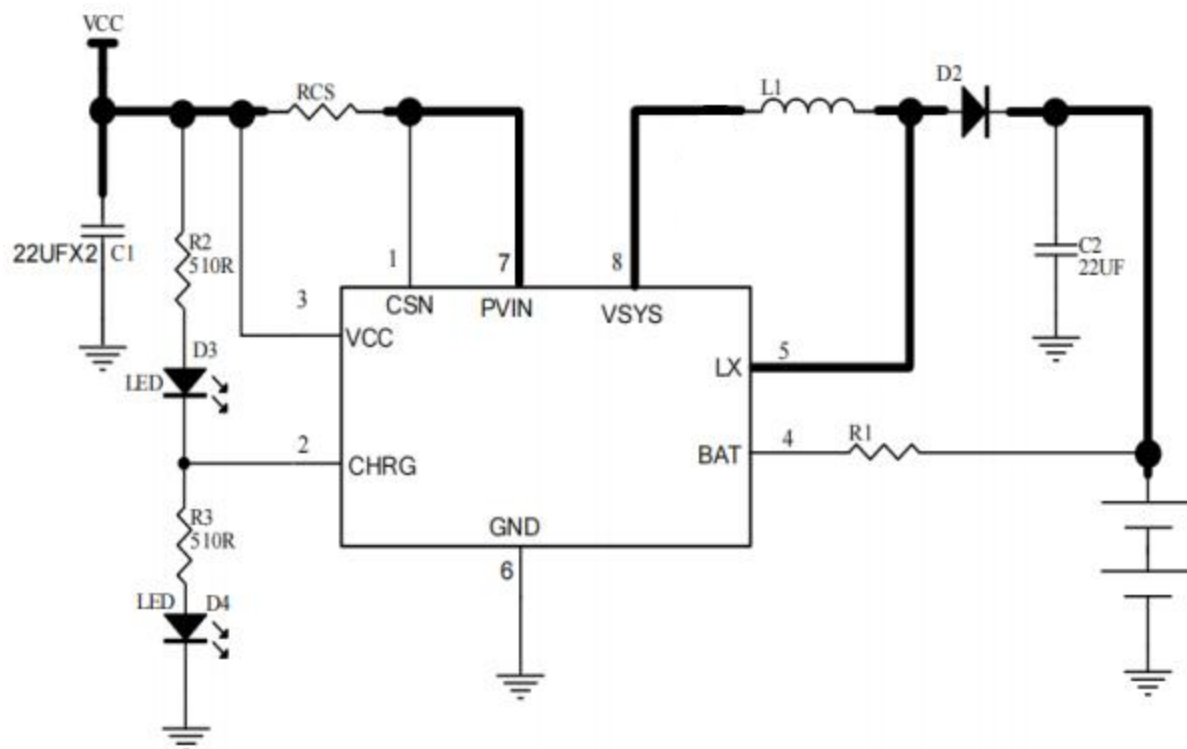


Figure 1 Typical Application Circuit

Order details:

Device Model	Encapsulation form	pack	Device markings
HM6038	SOP-8	Packaging, 4000 per plate	 XX is labeled as the production cycle

functional block diagram :

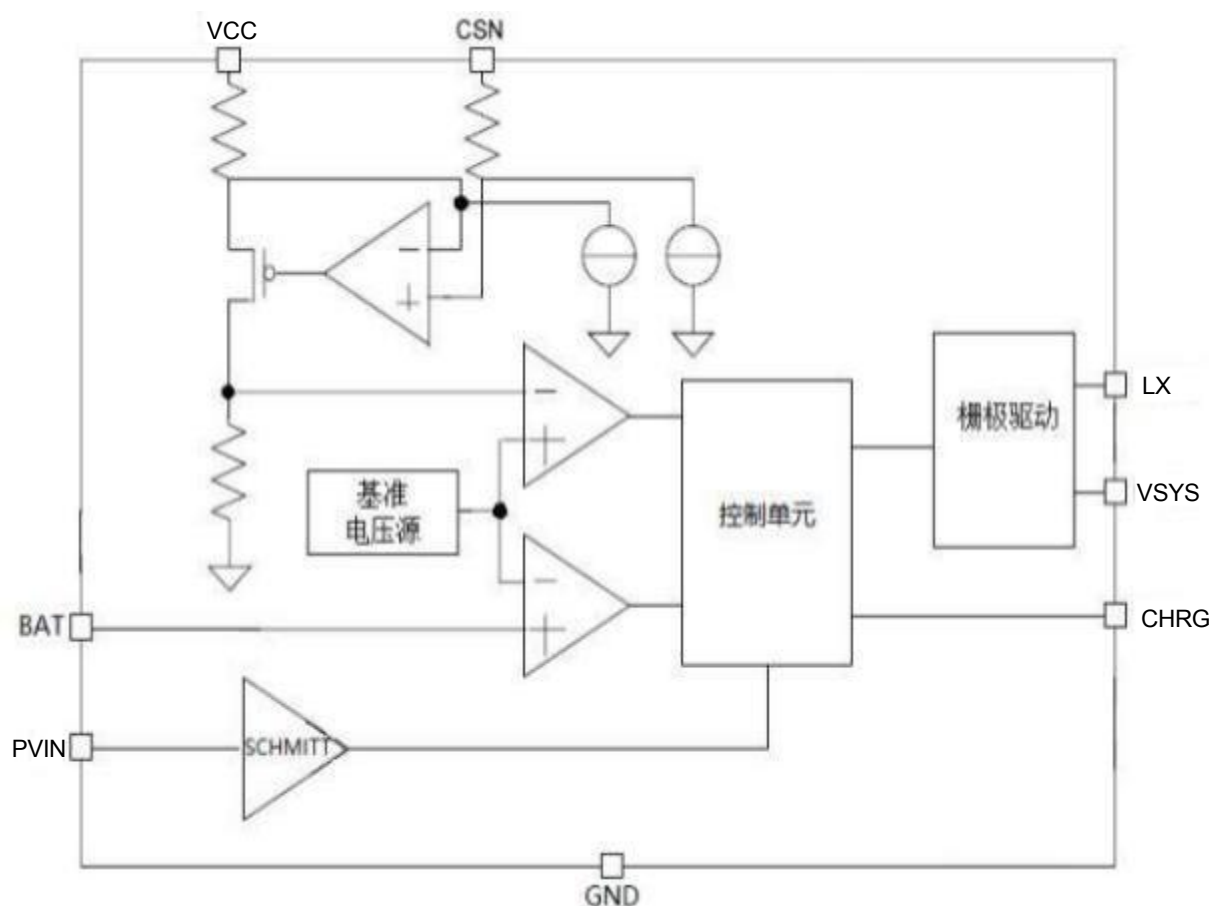


Figure 3: Function Block Diagram

Charge Current and Battery Voltage Relationship Diagram

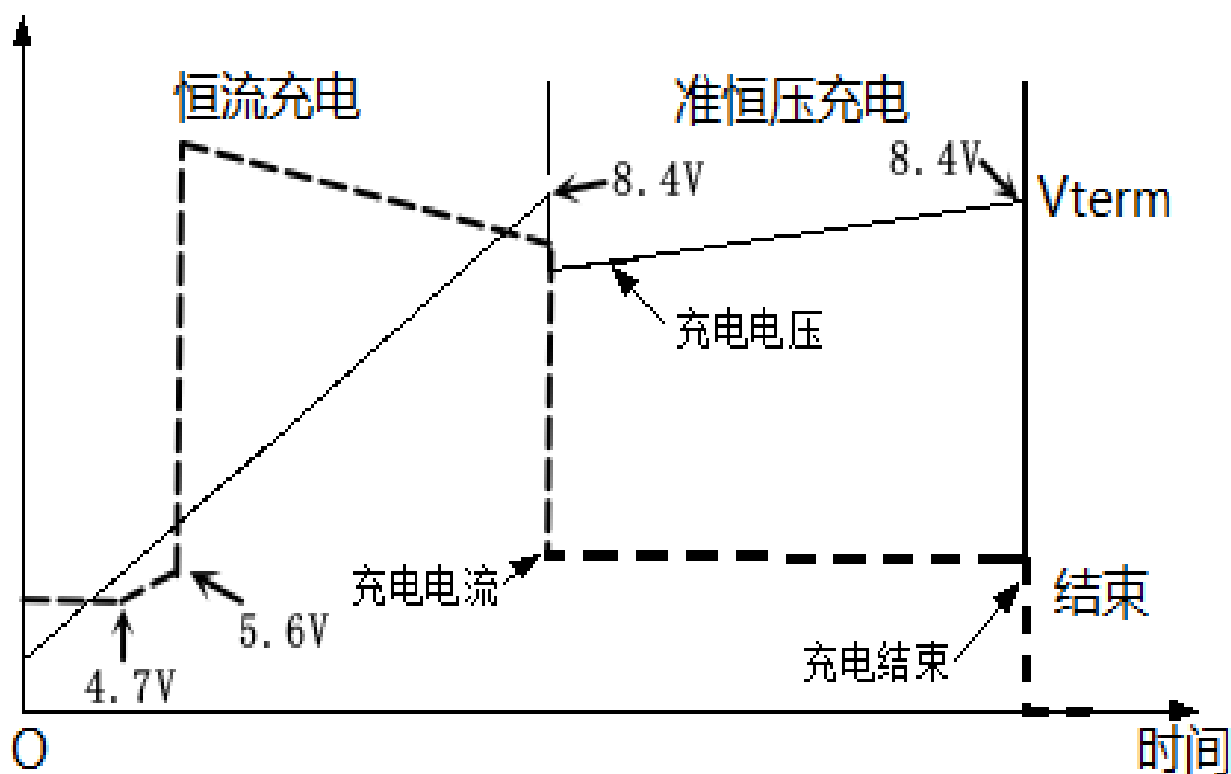


Figure 4 Charging Process

Pin Description:

CSN (pin 1): Charging current control terminal.

An RCS current detection resistor is placed between the VCC and CSN pins to monitor the charging current.

CHRG (pin 2): Charging status indicator.

When the battery is charging, the CHRG pin is high, indicating the charging state, and the CHRG pin is low when the charging is complete.

VCC (pin 3): Positive power input.

Power input, with built-in under-voltage protection.

BAT (pin 4): Battery voltage feedback detection terminal.

This pin is directly connected to the battery's positive terminal to measure its voltage. Placing a resistor between the battery's positive terminal and the chip's BAT pin allows adjustment of the battery's charging termination voltage upward, with the adjustment not exceeding 0.4 V.

The typical value of the battery charging termination voltage is determined by the following formula:

$$V_{bat} = 8.4 + (0.007 \times R1) \text{ (V) (R1 unit is K)}$$

LX (pin 5): Switching end.

Internal power MOSFET junction.

GND (pin 6): power ground.

Connect the power ground and battery GND.

PVIN (pin 7): Current input.

Connect to the source of the internal MOSFET.

VSYS (pin 8): Current output terminal.

The intermediate boost connection is connected to the drain of an internal field-effect transistor (MOSFET).

Operational Principle

The HM6038 is a PFM-based two-cell lithium battery charging control IC. With an input voltage range of 3.0V to 6.5V, it features an integrated reference voltage source, inductor current detection unit, battery voltage monitoring circuit, output overvoltage protection circuit, and low-voltage protection circuit. Specifically designed for 5V input applications, this IC delivers multiple functionalities with minimal external components and a simplified circuit design, making it an ideal solution for two-cell lithium battery charging control systems.

When the input power is connected, HM6038 enters the charging state. The CHRG pin outputs a high level, which activates the internal drive field-effect transistor. This causes the inductor current to rise, transferring energy from the output capacitor to the battery. When the inductor current reaches the upper limit set by the external current detection resistor, the

The inductor current decreases as energy is transferred to the output capacitor and battery. When the current drops below the preset threshold, the internal field-effect transistor (FET) reactivates, initiating a continuous cycle. The battery voltage is sampled through the chip's internal resistor network and fed back to the voltage comparator. Upon the first detection of 8.4V (typical threshold) at the BAT pin, HM6038 enters quasi-constant voltage charging mode after a jitter delay. This reduces input current to approximately 30% of the constant current level, consequently lowering the charging current. When the battery voltage reaches 8.4V again, the charging process terminates after the jitter delay, with HM6038 switching to end-of-charging state and the CHRG pin outputting a low level. During this state, no current flows from the input to the battery. When the BAT pin voltage drops to the recharge threshold of 7.9V (typical threshold), HM6038 resumes charging. The HM6038 operates at a maximum frequency of 1 MHz.

The HM6038 is a boost-type charge control IC. Under normal conditions, the battery voltage is higher than the input voltage. In some cases, if the battery voltage is lower than the input voltage or even a short circuit occurs, the turn-off time of the field-effect transistor is prolonged and the charging current decreases, thus protecting the battery.

Charging Status Indicator

The HM6038 features a status indicator for charging output. When the charger is in operation, CHRG outputs a high level; otherwise, it remains low.

Charged state	CHRG
Charge	High level
The battery is full	Low level
Battery not connected	Low level

Set the Charging Current

In the application circuit, the current is set by connecting the current detection resistor RCS between the VCC and CSN pins of HM6038

Therefore, the charging current can be set by the following equation:

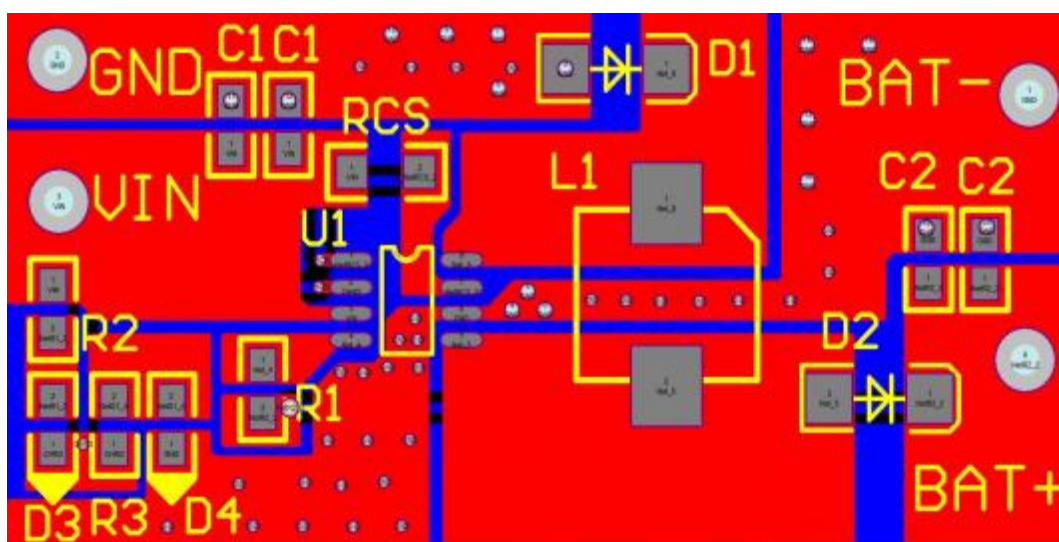
$$I_{BAT} = 110\text{mV} / R_{CS} / 1.6$$

The BAT unit is milli-ampere (mA) and the RCS unit is ohm ()

PCB Design Considerations

For the main current path and power-to-ground routing, use wide and short traces. Input and output capacitors should be placed as close to the chip as possible. The ground trace should be as wide as possible, and the ground terminal should be placed as close to the chip as possible. The current-sensing resistor R_{CS} should be placed as close as possible to the input power filter capacitor.

Determine the inductance value based on the required switching frequency. The switching frequency ranges from 200KHz to 1MHz. Generally, selecting a switching frequency between 300KHz and 600KHz can achieve better conversion efficiency and a better balance between inductance size.



	充电电流 0.5A	充电电流 1A
输入滤波电容 C1	22uF,0805	2 x 22 F, 0805
二极管 D2	SS24 or SS34	SS34 or SS54
电流检测电阻 R_{CS}	0.12Ω, 0.15W	0.062Ω, 0.25W
电感 L1	10uH, $I_{SAT}>2A$	4.7uH, $I_{SAT}>3A$
输出滤波电容 C2	22uF,0805	2 x 22 F, 0805

Packaging Information

