5V Input Boost Charger for Two-cell Serial Li Battery

1 Features

- **Charging**
  - ✧ Integrated 5W synchronous switch-mode boost charger
  - ✧ 92% boost charging efficiency
  - ✧ Programmable constant voltage charging voltage by external resistor
  - ✧ The constant current charging current can be set by external resistor
  - ✧ Self-regulated input current, adaptive adapt-or load
  - ✧ LED for charging status indication
- **Minimal BOM**
  - ✧ Power MOSFETs integrated
  - ✧ 400kHz switching frequency, support 2.2uH inductor
- **Multiple protection, high reliability**
  - ✧ Support charging NTC temperature protection, support 10k NTC resistance
  - ✧ Output OC, OV and Short circuit protection
  - ✧ Input voltage withstand 20V
  - ✧ ESD 4kV

2 Typical Applications

- Two-cell Li/Li-Ion battery charging management

3 Description

The IP2320 is a boost charge management IC that supports two series Li-Battery/Li-Ion batteries.

IP2320 integrated power MOS and synchronous switching architecture enable it to require only a few peripheral components for application, and effectively reduce the size of the overall solution and BOM cost.

IP2320 integrate synchronous switching circuit with power FETs at 400kHz switching frequency. The charging efficiency is 92% when VIN is 5V and VOUT is 8V/1A.

IP2320 has the function of input voltage limiting. The charge current is regulated automatically. Adaptive adapter load capacity

IP2320 supports LED pin resistor to set the charging current, and can set 4 levels of constant current charging current.

IP2320 supports an external resistor to adjust the charging voltage.

IP2320 integrated NTC protection function, with 10k NTC resistor.

IP2320 is package in ESO

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4 Reversion History

NOTE：The page numbers of the previous version may differ from the page numbers of the current version.

Initial release version V1.00 (February 2023)

Changes from Revision V1.00 to Revision V1.10 (August 2024)	Page
● Add silk screen printing instructions	16

Changes from Revision V1.10 to Revision V1.20 (July 2024)	Page
● Modified the description of the battery charging current	6

5 Simplify the application schematic

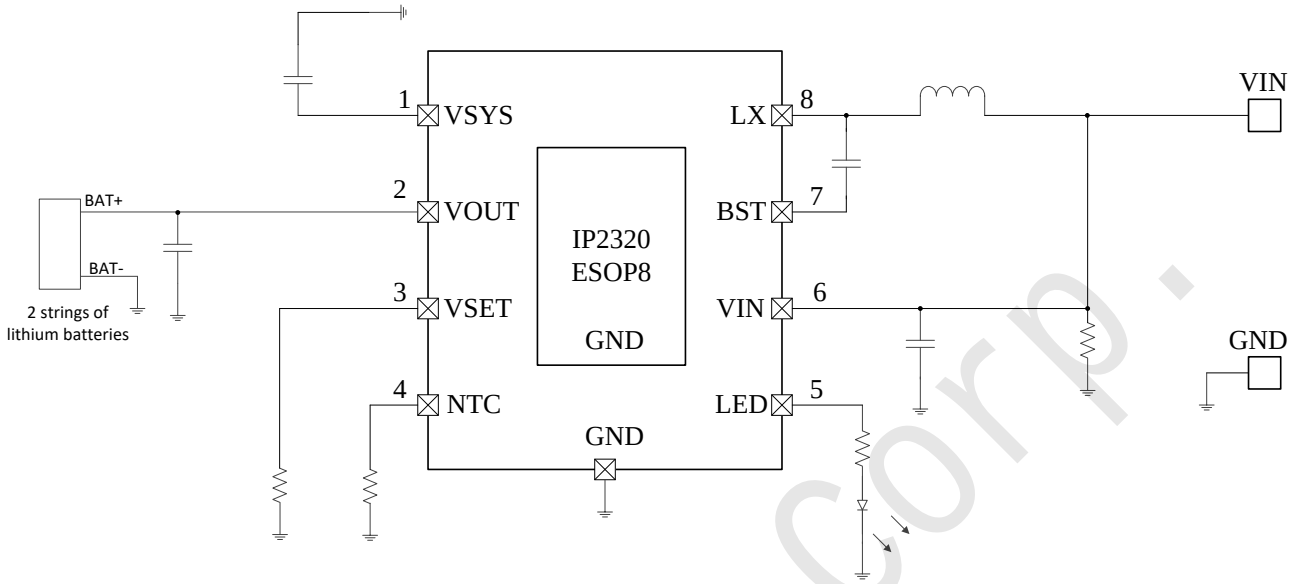


Figure 1 Simplified Application Schematic

6 Pin Configuration And Function

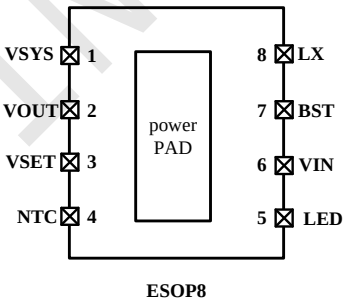


Figure 2 Pin of IP2320

Pin Name	Pin Num	Pin Description
VSYS	1	Two 22uF ceramic capacitors are placed close to the pin at the intermediate node of the boost output
VOUT	2	Boost output pin, connect battery positive
VSET	3	Constant voltage charging voltage setting pin
NTC	4	NTC thermal protection, output 50uA current, connect to 10k NTC resistor
LED	5	LED charging status indication pin
VIN	6	Input power supply and check pin
BST	7	Bootstrap circuit pins with bootstrap capacitance 0.1uF

		placed next to BST and LX pins of the chip
LX	8	DCDC switch node, connect to external inductor
GND	EPAD	System ground and power ground

7 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
VIN/VOUT/VSYS/BST/LX Voltage Range	V	-0.3 ~ 20	V
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	T_{stg}	-60 ~ 150	℃
Junction Temperature(junction to ambient)	θ_{JA}	60	℃/W
Human Body Model (HBM)	ESD	4	kV

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

8 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4. 5	5	5.5	V
Charge Current	I_{OUT}		1		A

*Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

9 Electrical Characteristics

Unless otherwise specified, TA=25℃，L=2.2uH，VIN=5V，VOUT=7.4V

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	V_{IN}		4. 5	5	5.5	V
Input under-voltage threshold	V_{IN-UV}		4.4	4. 5	4.6	V
Input over-voltage threshold	V_{IN-OV}		5.6	5.8	6.0	V
Input overvoltage protection hysteresis				200		mV
Input Current	I_{VIN}	VIN=5V，VOUT=NC，NO LED	10	20	30	mA
Standby Current	$I_{standby-BAT}$	VIN=0，VOUT=7.4V		1	2	uA

Charge Current	I_{CC}	R_{ISET}=1k		0.4		A
		R_{ISET}=68k		0.6		A
		R_{ISET}=120k		0.8		A
		R_{ISET}，NC	0.9	1.0	1.1	A
Charge Target Voltage	V_{CV}	V_{TRGT}=8.00+R_{VSET}*0.08 R_{VSET}=5.1k（Resistance accuracy 1%）	8.36	8.41	8.44	V
Full charge stop detection voltage	V_{SV}			V_{CV}-0.1		V
Charging voltage after full charge	V_{RC}			V_{CV}-0.2		V
Trickle over constant current voltage	V_{TK}	VIN=5V	5.9	6.0	6.1	V
Trickle Charge Current	I_{TK}	VIN=5V，VOUT<6V	70	100	130	mA
Charge Cut-off Current	I_{STOP}			100	200	mA
Control System						
LED drive Current	I_{Led}	VIN=5V			5	mA
LED high level voltage	V_{Led}	VIN=5V，LED outputs high level voltage	4.5	5		V
Thermal shutdown temperature	T_{OTP}	Rising Threshold	125	135	145	℃
Thermal shutdown recovery temperature	T_{OTP-H}	Falling Threshold	100	110	120	℃

10 Function Description

10.1 Functional Block Diagram

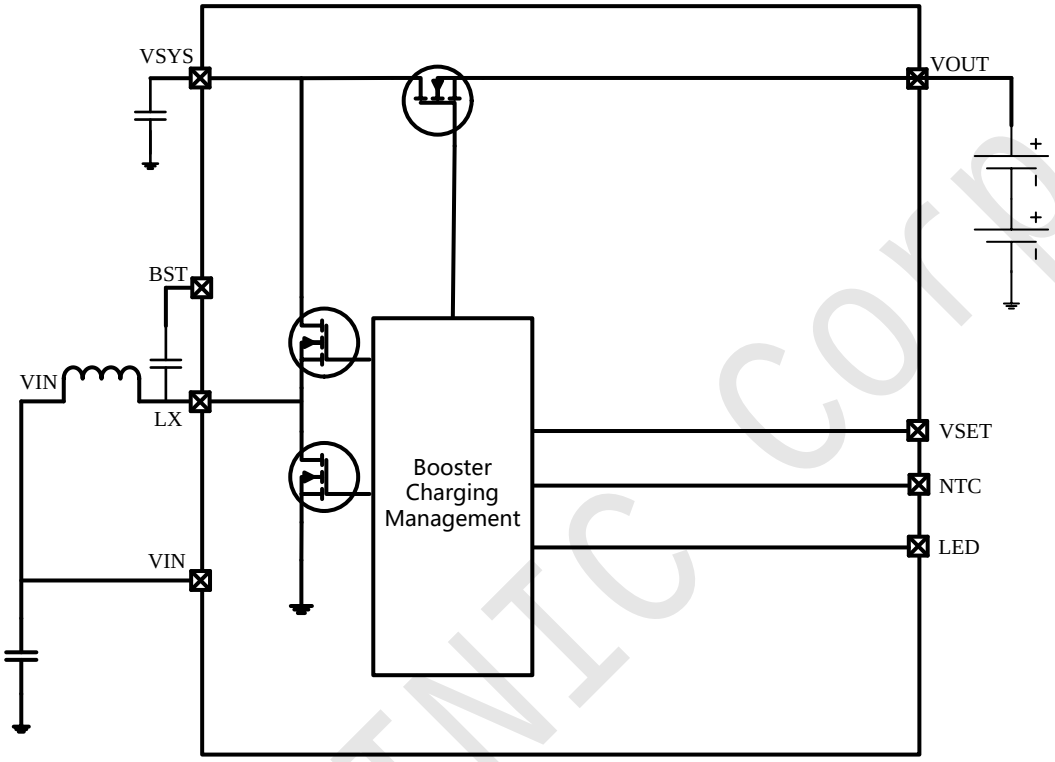


Figure 3 IP2320 Functional Block Diagram

10.2 Boost Charge

IP2320 integrated a synchronous boost charger with 400kHz switching frequency, the output boost to 8.4V for two-cell Li/Li-Ion battery. The efficiency is 92% at 5V input and 8V/1A output.

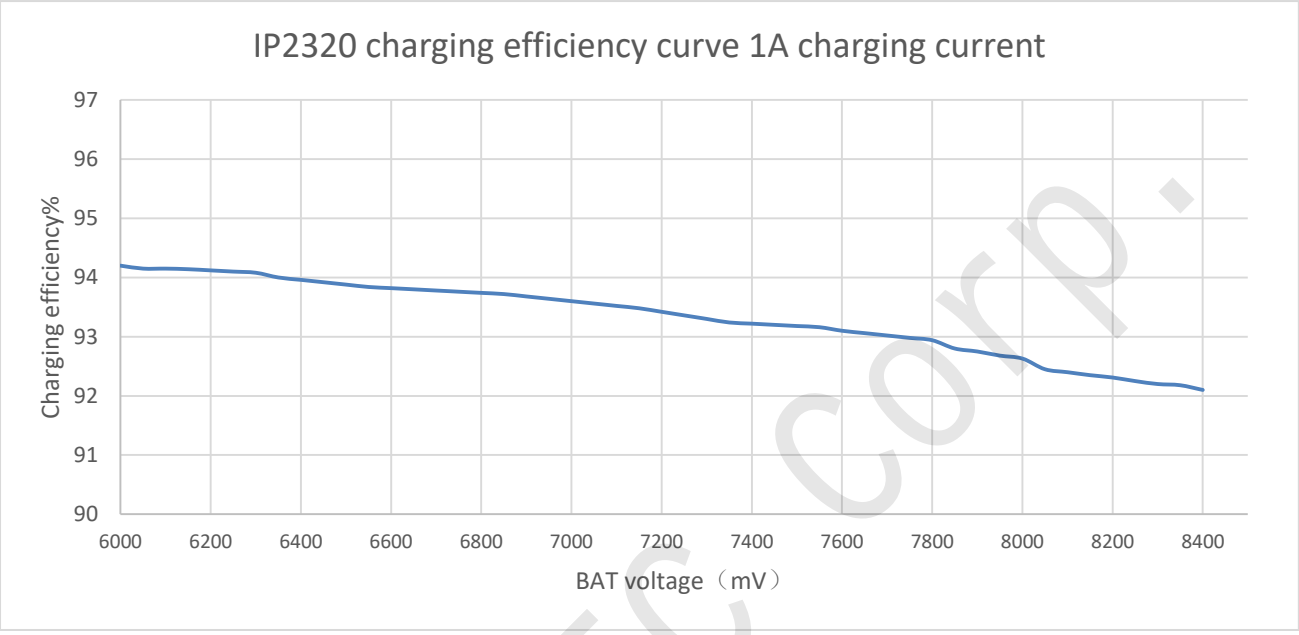


Figure 4 IP2320 Charging efficiency curve

10.3 Charge Process

The IP2320 uses a full trickle/constant/constant voltage charging mode.

When the battery voltage is less than the trickle to constant current voltage V_{TK}, it is charged with trickle charging current I_{TK}.

When the battery voltage is greater than V_{TK}, charge with constant current charging current I_{CC}.

When the battery voltage approaches the set constant voltage charging voltage V_{CV}, the charging voltage V_{CV} remains unchanged, the charging current slowly decreases, and the constant voltage charging mode is entered.

After entering the constant voltage charging mode, if the charging current is less than the full charge stop detection current I_{STOP}. The charging will be stopped first, and then detect whether the battery voltage is higher than the stop voltage V_{SV}. If it is higher than the charging stop voltage V_{SV}, stop charging. If the stop voltage is lower, charging continues.

After the battery is fully charged and stopped, and the input VIN continues to be active, if the battery voltage is less than V_{RC}, it will enter the full charge stage and start the charging process again.

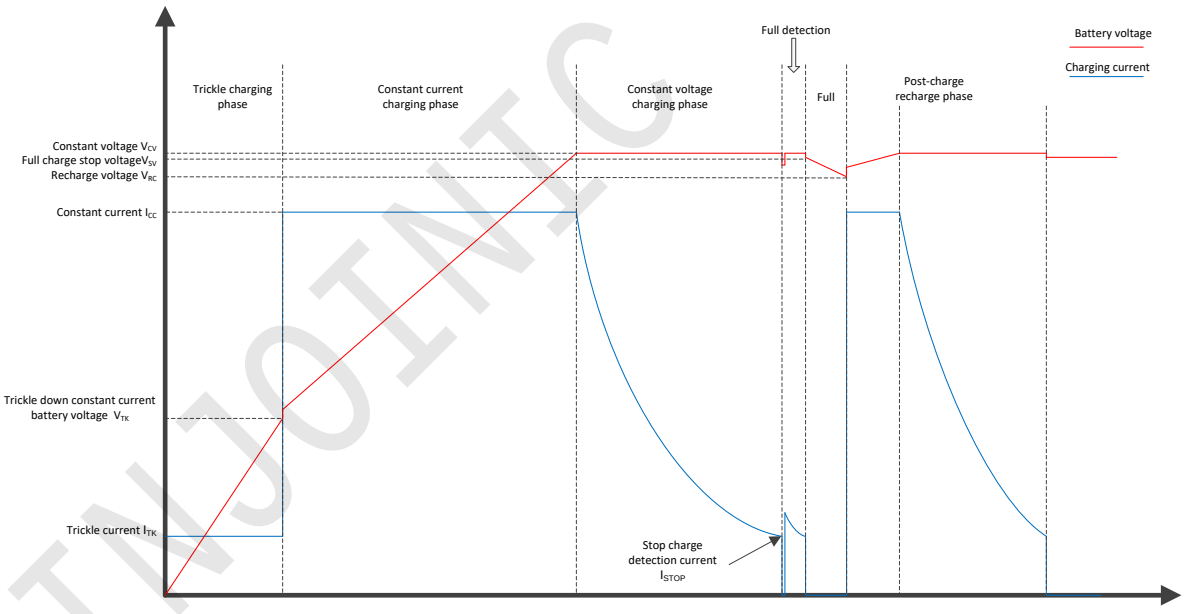


Figure 5 IP2320 Schematic diagram of the charging process

10.4 Charging protection

IP2320 has perfect protection functions, integrated input undervoltage, overvoltage protection, NTC temperature protection, IC over temperature protection and other functions to ensure stable and reliable system work.

IP2320 has an input voltage stabilizing loop for VIN. When the input voltage is close to 4.5V under-voltage threshold, the charging current will be lowered automatically to ensure the input voltage is

stable near the input under-voltage threshold and that the adapter will not fail.

IP2320 integrated input over-voltage protection function, when detected input voltage is greater than 5.8V over-voltage threshold, it will stop charging.

IP2320 integrated NTC function, with NTC resistor, can detect the battery temperature, when it is too high or too low, the system can stop charging.

IP2320 integrated over-temperature protection function, when the chip internal temperature is detected more than 135℃, the system will be forced to stop charging.

10.5 Charge current setting

IP2320 supports LED pin multiplexing, external resistor R_{ISET}, to set the constant current charging current, a total of 4 current options:

R_{ISET}（Ω）	Constant current charging current
1k	0.4A
68k	0.6A
120k	0.8A
NC（≥700k）	1.0A

The R_{ISET} detection process is as follows: it is detected once before charging starts, and the charging current will not change when the R_{ISET} resistance is modified later.

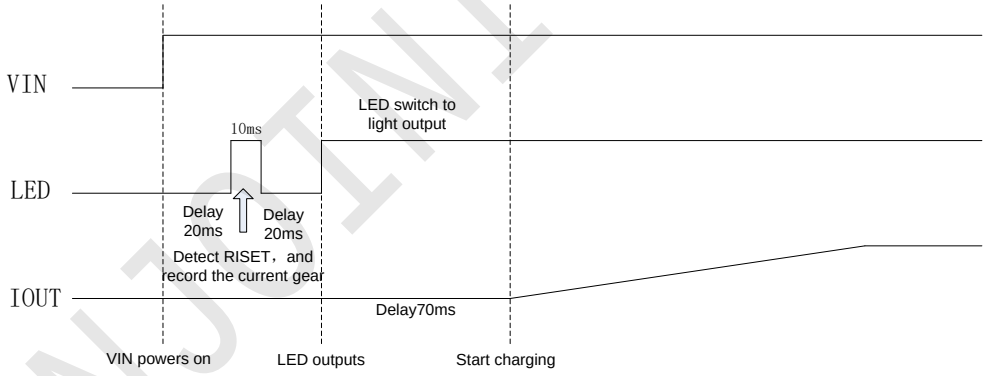


Figure 6 LED pin detection RISET timing diagram

10.6 Charging voltage set

IP2320 supports V_{SET} pin external resistor RVSET to set the constant voltage charging voltage. The constant voltage charging voltage can be continuously adjusted by RVSET resistor.

R_{VSET} resistance range: 0≤RVSET≤12k (Ω), resistance accuracy needs to be within 1%.

$V_{TRGT}=8.00+R_{VSET}*0.08$

R_{VSET}（Ω）	Constant voltage charging voltage
0	8.00V
2k	8.16V
5.1k	8.41V
10k	8.80V
NC（≥90k）	8.40V

10.7 NTC

IP2320 supports NTC protection function which can cooperate with NTC resistance to detect battery temperature;

IP2320 emits 50uA current through the NTC pin, and then detects the voltage generated by the current on the NTC resistor to determine the temperature. When the detection temperature exceeds the set temperature, turn off charging.

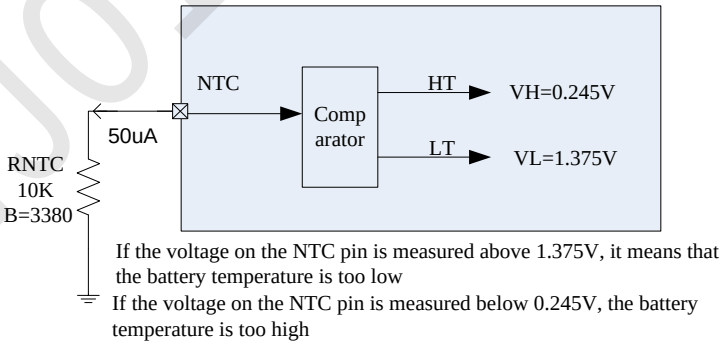


Figure 7 NTC diagram

When IP2320 detects that the NTC pin voltage is between 0.245V~1.375V, it means that the battery temperature is normal and the charge is normal.

When IP2320 detects that the NTC pin voltage drops to less than 0.245V, it means that the battery temperature is too high and the charging is stopped.

When the IP2320 detects that the voltage on the NTC pin rises to greater than 1.375V, it means that the battery temperature is too low and the charging stops.

If NTC function is not required, connect the NTC pin to ground with a 10k resistor.

Example: RNTC = 10k thermistor (B=3380), corresponding temperature and NTC pin voltage:

Temperature (℃)	R_{NTC}（Ω）	NTC pin voltage	Condition
0	27.5k	1.375V	Low temperature protection
25	10k	0.500V	Normal charging
45	4.9k	0.245V	High temperature protection

10.8 Charging LED indication

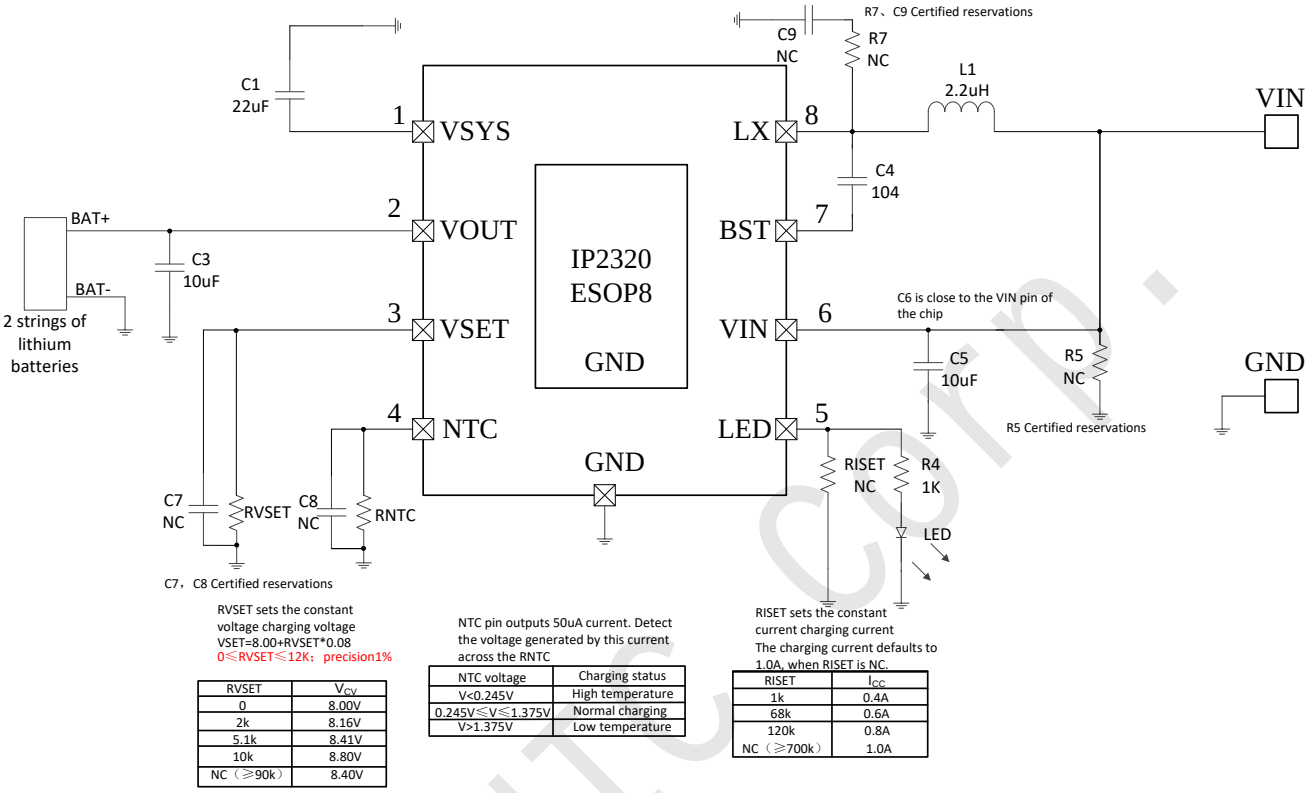
The LED light will light up during charging. The LED light will go off when fully charged. When an abnormal state is detected (abnormal states include: input overvoltage protection, NTC protection, chip overtemperature protection, no access to the battery) LED will flash (400ms high 400ms low).

10.9 Battery detection function

IP2320 has battery detection function, When VIN is not connected to the battery, the LED will flash (400ms high and 400ms low) to indicate an abnormality.

When LED flashes abnormally, the normal charging process will enter after the battery is connected.

11 Application Schematic



RVSET	V_{CV}
0	8.00V
2k	8.16V
5.1k	8.41V
10k	8.80V
NC（≥90k）	8.40V

NTC voltage	Charging status
V<0.245V	High temperature
0.245V≤V≤1.375V	Normal charging
V>1.375V	Low temperature

RISET	I_{CC}
1k	0.4A
68k	0.6A
120k	0.8A
NC（≥700k）	1.0A

Figure 8 Typical Application Schematic

12 BOM

No.	Part Name	Type &Specification	Units	Quantity	Location	Note
1	IC	IP2320	PCS	1	U1	
2	Inductance	CD43	PCS	1	L1	Saturate current (Isat), temperature rise current (Idc) larger than 5A, DCR less than 20mΩ, inductance 2.2uH @ 500kHz
3	SMD capacitors	0805 10uF 25V 10%	PCS	3	C3、C5	Capacitor's voltage higher than 16V, SMD ceramic capacitor is required
4	SMD capacitors	0805 22uF 25V 10 %	PCS	1	C1	Capacitor's voltage higher than 16V, SMD ceramic capacitor is required
5	SMD capacitors	0603 104 25V 10%	PCS	1	C4	
6	SMD capacitors	0603 NC	PCS	3	C7、C8、C9	Certified reservations
7	SMD resistors	0603 1k 5%	PCS	1	R4	Adjust LED brightness
8	SMD resistors	0603 NC	PCS	2	R5、R7	Certified reservations
9	LED	0603	PCS	1	D1	LED indicator, maximum drive capacity 5mA
10	SMD resistors	0603 5.1k 1%	PCS	1	RVSET	Set the constant voltage charging voltage. the resistance accuracy needs to be within 1%, otherwise it will affect the constant voltage charging voltage. Select as needed
11	NTC resistance	NTC 10k B=3380	PCS	1	RNTC	Select according to the design temperature. When not in use, connect 10k resistor to ground.
12	SMD resistors	0603 NC	PCS	1	RISET	Set the constant current charging current. Select as needed

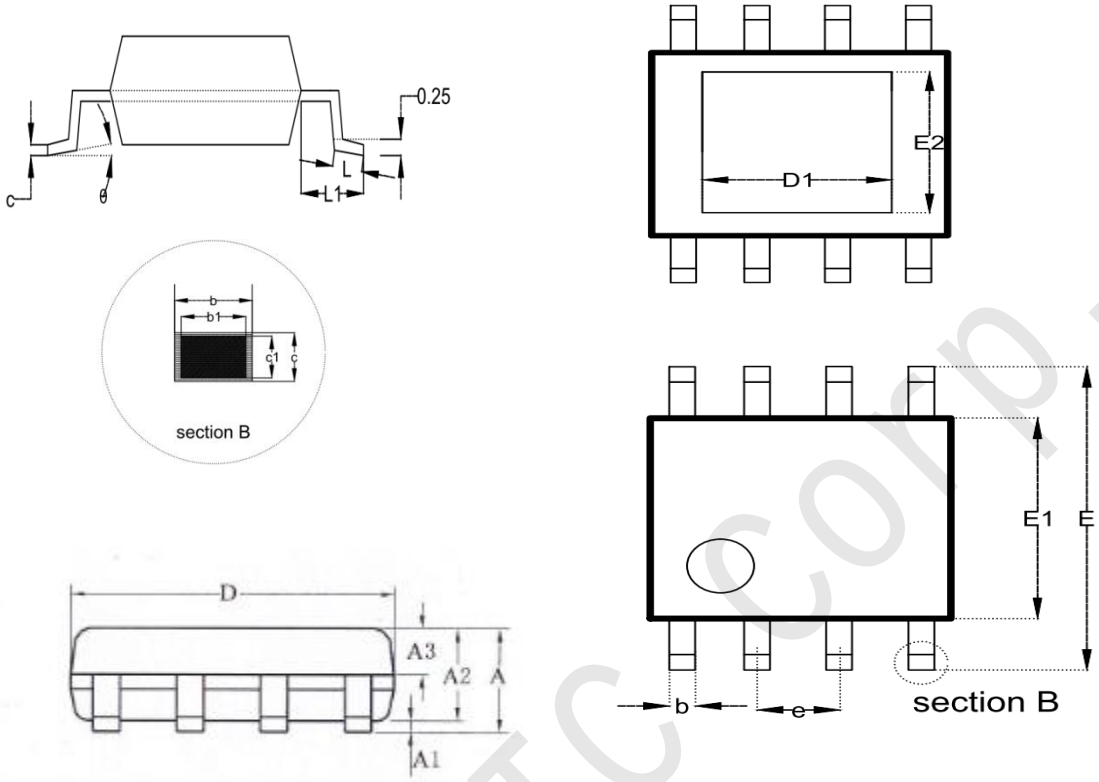
13 MARK DESCRIPTION

Instructions:

1、 --Injoinic Logo
2、IP2320 --Product Model
3、XXXXXXX --Manufacture Number
4、 ○ --Pin1 Location

Figure 9 Silk screen illustration

14 PACKAGE INFORMATION



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.48
b1	0.38	0.41	0.43
c	0.21	--	0.25
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.60	0.80
L1	1.05BSC		
θ	0	--	8°
D1	--	3.10	--
E2	--	2.21	--

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