Synchronous Switch Buck Charger for Single-cell Li Battery

1 Features

- **Synchronous switching buck charging**
  - ✧ Power MOS built-in, maximum 1.5A switching charging current, 92% efficiency
  - ✧ Standard 4.20V, other voltages need to be customized, support lithium iron phosphate batteries, full voltage customization range 3.5V ~ 4.4V
  - ✧ Charging current ISET pin settable
- **Support 1 channel LED, support single pin control double light function.**
- **Low power consumption in standby**
  - ✧ BAT draws less than 2uA at VIN=0
- **Multiple protection, high reliability**
  - ✧ Input over-voltage, under-voltage and output over-charge protection
  - ✧ Chip over-temperature protection
  - ✧ ESD 4KV

2 Typical Applications

- **Single lithium battery charging**

3 Description

The IP2330 is a 5V input, synchronous buck charging management chip that supports single lithium battery

IP2330 integrated power MOS with synchronous switching architecture allows it to be applied with very few peripheral devices, effectively reducing the size of the overall solution and lowering the BOM cost.

IP2330's buck-switching charging converter operates at 500KHz and the maximum charging current is 1.5A, the 5V input, 3.7V/1A conversion efficiency is 92%,and the charging current can be set by an external resistor.

The IP2330 input voltage is 5V, and the input can intelligently regulate the charging current to prevent adapter failure.

IP2330 can support 1 way LED light display, can realize single pin control dual light function。

IP2330 is packaged in SOT23-6.

4 Simplify the application schematic

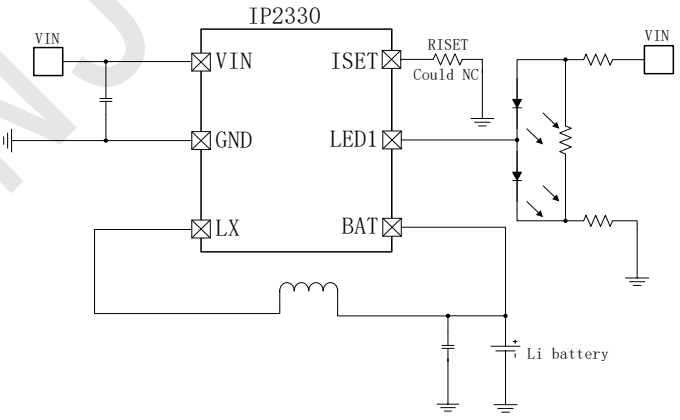


Figure 1 Simplify the application schematic

Directory

5 Modify records

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

release version V1.00（2023.12） 页码

- **Initial release version**.....1

6 PIN Description

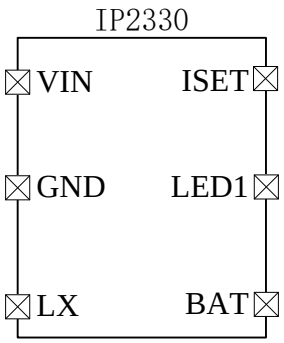


Figure 2 Pin of IP2330

Pin Name	Pin Num	Pin Description
VIN	1	5V DC input pin
GND	2	Ground
LX	3	DCDC switch node
BAT	4	BAT pin, connect to the positive terminal of the battery
LED1	5	LED1 output pin (supports single pin control of dual lamp function)
ISET	6	Charge current setting pin

7 Limit parameters

Parameters	Symbol	Value	Unit
Pin input voltage range	V_{MAX}	-0.3 ~7.5	V
Operating ambient temperature range	T_A	0 ~ 70	℃
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	T_{stg}	-65 ~ 150	℃
Reflow temperature	T_{RFL}	260	℃
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	--	6	V
Charge Current	I_{BAT}		--	2.4	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=3.7V

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	V_{IN}		4.5	5	6	V
Input over-voltage threshold	V_{IN-OV}		5.8	6	6.2	V
Input overvoltage protection hysteresis				300		mV
Input Current	I_{VIN}	VIN=5V,VBAT=NC,NO LED		5	10	mA
Standby Current	$I_{standby-BAT}$	VIN=0V,VBAT=3.7V		1	2	uA
Charge Current	I_{CC}	R_{ISET}=1.1K		1.5		A
		R_{ISET}=2K		1		A

		R_{ISET}=8.2K		0.49		A
		R_{ISET}>=120K，NC	0.9	1	1.1	A
Charge Target Voltage	V_{CV}	VIN=5V	4.16	4.2	4.24	V
Full charge stop detection voltage	V_{SV}			4.15		V
Charging voltage after full charge	V_{RC}			4.1		V
Trickle over constant current voltage	V_{TK}	VIN=5V	2.9	3	3.1	V
Trickle Charge Current	I_{TK}	VIN=5V,VBAT<3V,RISET=NC		1/5 I_{CC}		mA
Charge Cut-off Current	I_{STOP}			200		mA
Control System						
LED drive Current	I_{Led}	VIN=5V			5	mA
Thermal shutdown temperature	T_{OTP}	Rising Threshold	130	140	150	℃
Thermal shutdown hysteresis	ΔT_{OTP}		30	40	50	℃

10 Function Description

10.1 Functional Block Diagram

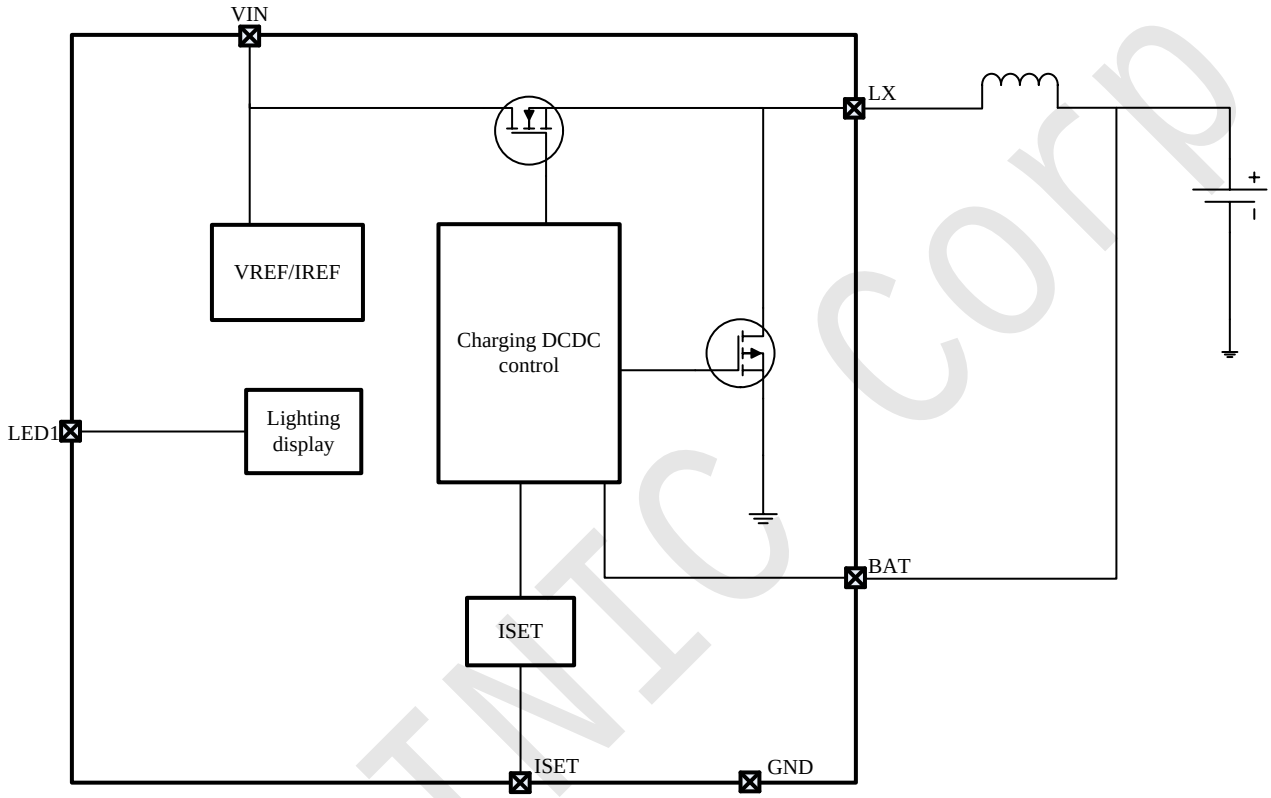


Figure 3 IP2330 Functional Block Diagram

10.2 Charging efficiency

IP2330 integrates a synchronous buck charge controller, integrated power MOS, switching frequency 500KHz, input 5V, buck to charge Li battery. 5V input, 3.7V/1A output with 92% efficiency..

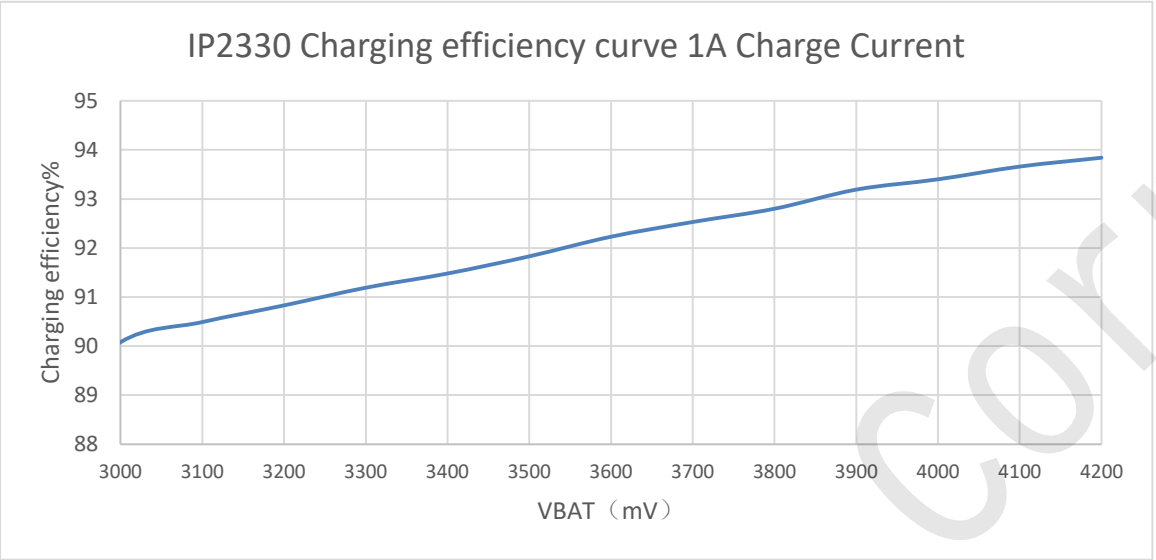


Figure 4　IP2330 1A Charging efficiency curve

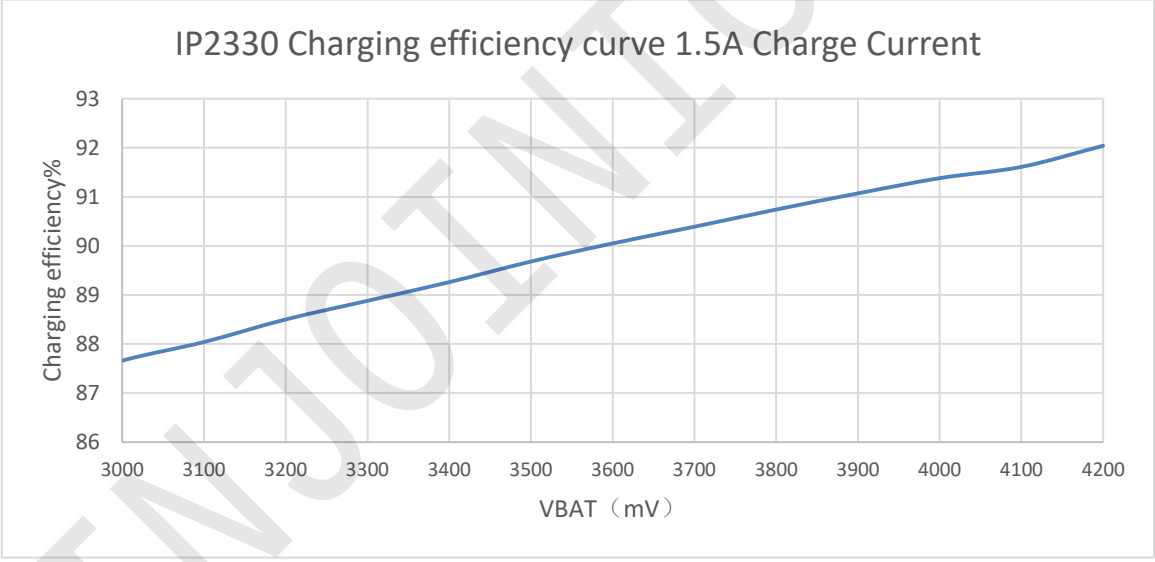


Figure 5　IP2330 1.5A Charging efficiency curve

10.3 Temperature profile

IP2330 has a maximum temperature of 39.6°C for the chip and 39.2°C for the inductor when charging at 3.7V/1A..

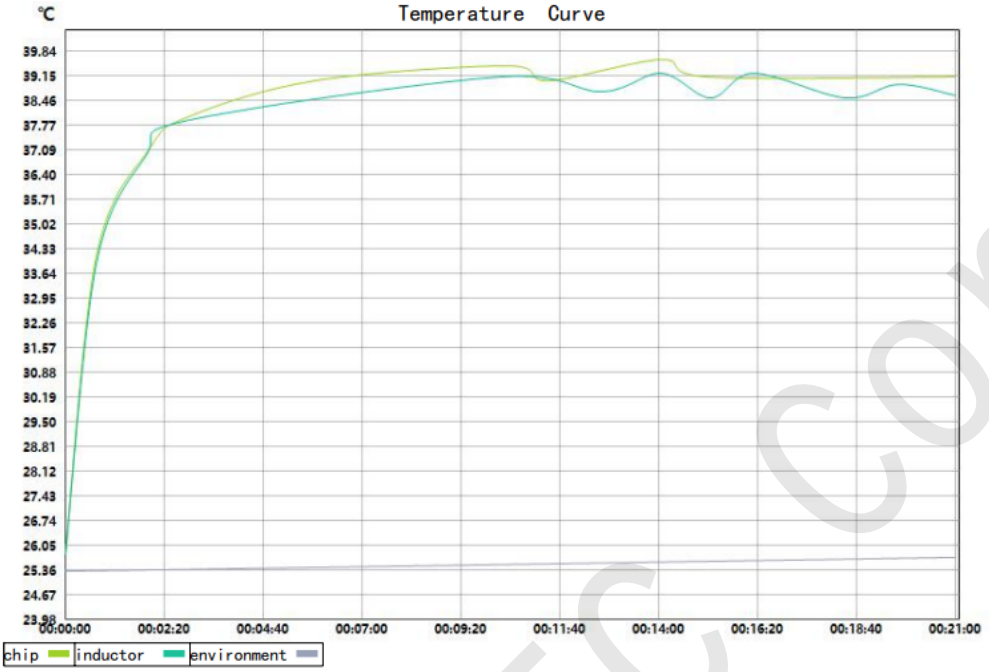


Figure 6 IP2330 3.7V/1A Charging Temperature Curve

IP2330 has a maximum temperature of 50.3°C for the chip and 51.3°C for the inductor when charging at 3.7V/1.5A.

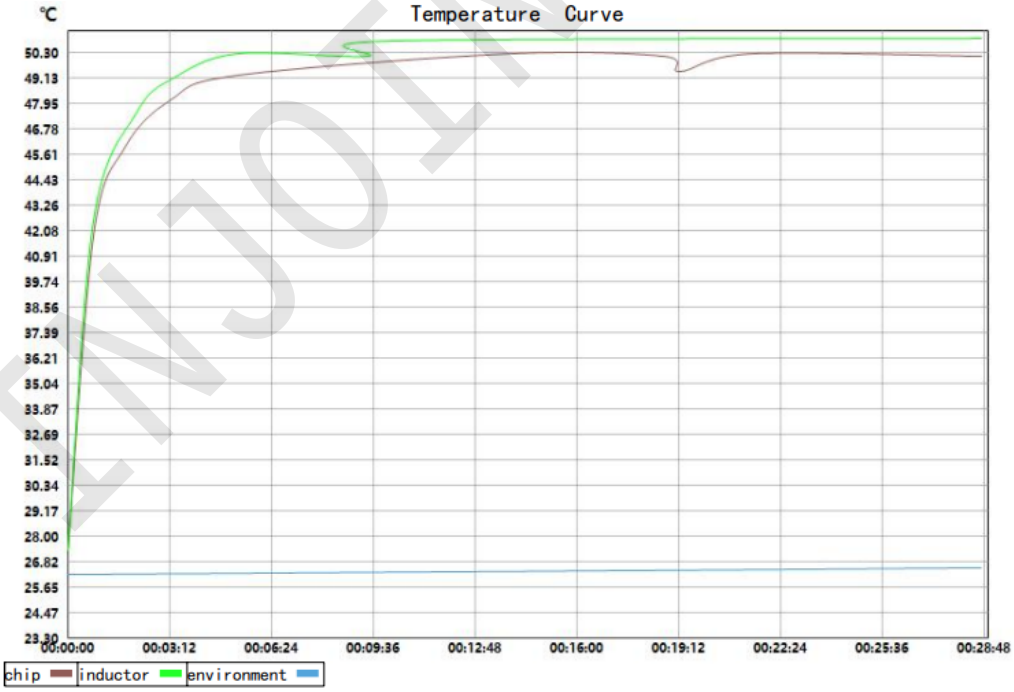


Figure 7 IP2330 3.7V/1.5A Charging Temperature Curve

10.4 Charge Process

The IP2330 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.

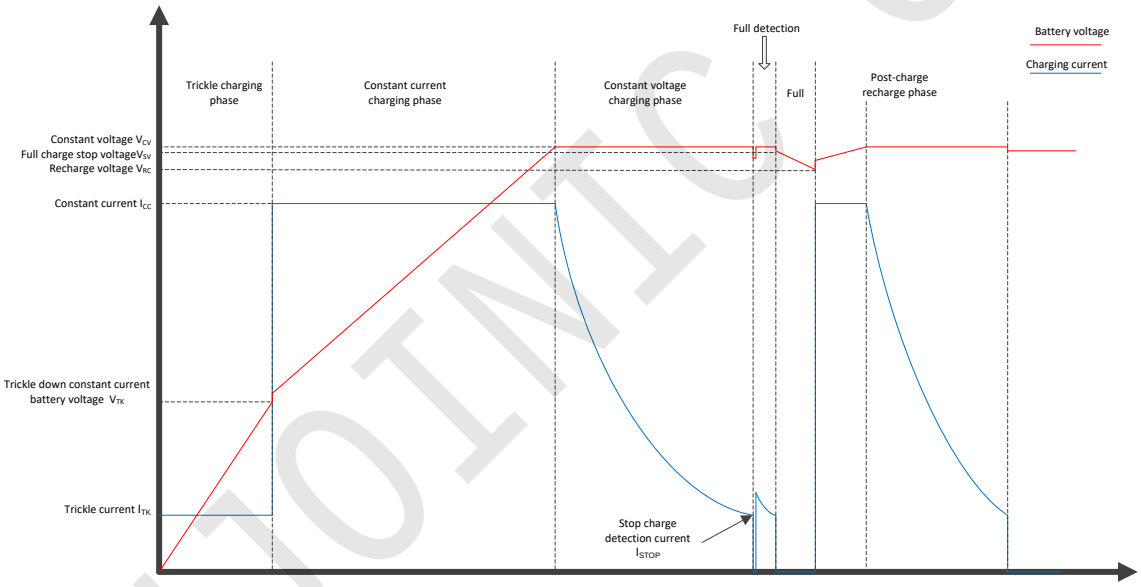


Figure 8 IP2330 Schematic diagram of the charging process

10.5 Charging protection

IP2330 has perfect protection functions, integrated input over-voltage protection, IC over-temperature protection and other functions to ensure stable and reliable operation of the system.

IP2330 integrates an input overvoltage protection function that stops charging when the input voltage is detected to be greater than the overvoltage threshold of 6V.

IP2330 integrates an over-temperature protection function, which will force charging to stop when the internal temperature of the chip is detected to exceed 145 degrees.

10.6 Charge current setting

IP2330 supports an external resistor RISET on the ISET pin to set the constant current charging current, and the relationship between the charging current ICC and RISET is:

I_{CC}（A）=0.33+1.3/R_{ISET}(KΩ)。

R_{ISET}（Ω）	Constant current charging current
1.1K	1.5A
2.0K	1A
8.2K	0.49A
NC（≥120K）	1.0A

10.7 Charging LED indication

IP2330 supports single pin control of dual-light function, LED1 is on and LED2 is off during charging, LED1 is off and LED2 is on after full charging. LED1 and LED2 flash alternately (500ms on and 500ms off) after detecting an abnormality (abnormality includes: input over-voltage protection and chip over-temperature protection).

IP2330 has a battery detection function, only connected to the VIN connected to the battery, LED1 and LED2 will flash alternately to indicate anomalies; in the case of unconnected batteries LED abnormally flashing, access to the battery will enter the normal charging process.

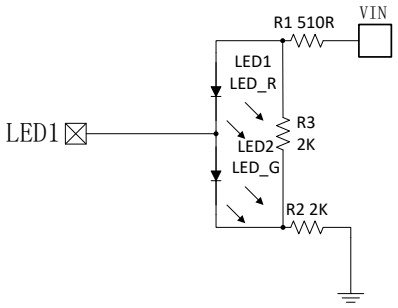
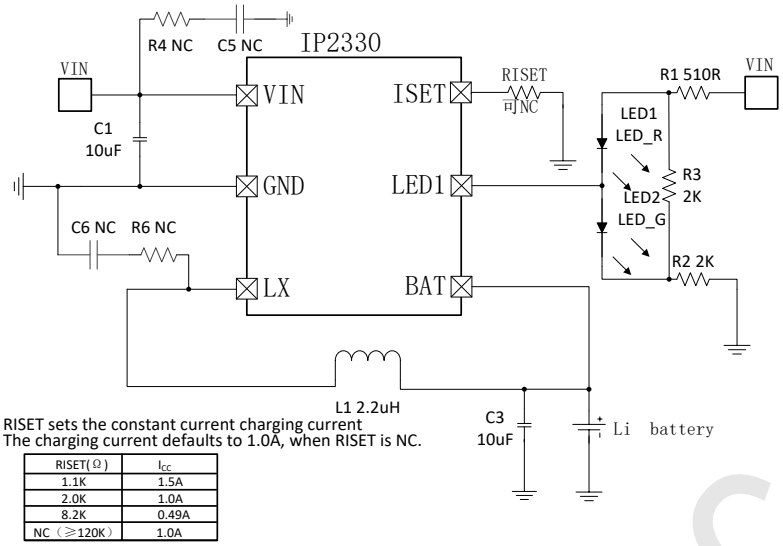


Figure 9 LED Indicator Schematic

11 Typical Application Schematic



RISET(Ω)	I_{CC}
1.1K	1.5A
2.0K	1.0A
8.2K	0.49A
NC（≥120K）	1.0A

Figure 10 Typical Application Schematic

12 BOM

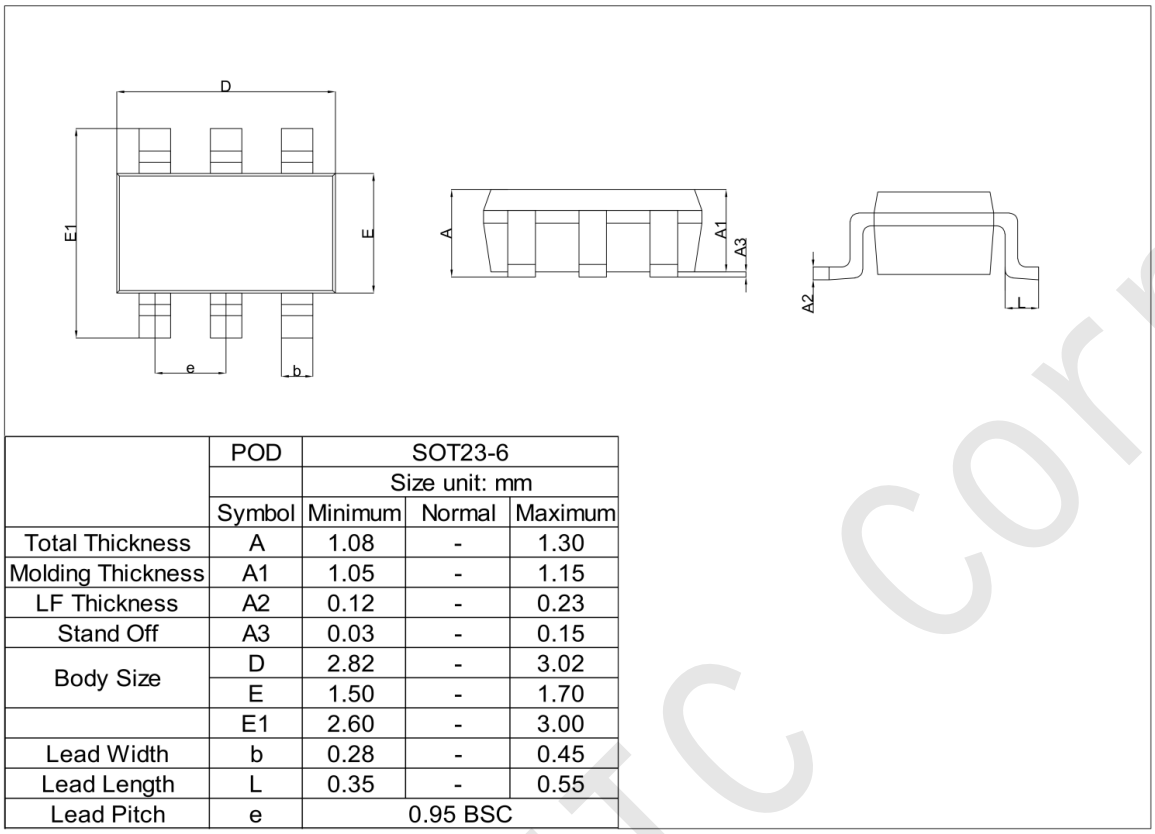
No.	Part Name	Type &Specification	Units	Quantity	Location	Note
1	IC	IP2330	PCS	1	U1	
2	Inductance	L2520	PCS	1	L1	Saturate current (Isat), temperature rise current (Idc) larger than 2.0A, DCR less than 115mΩ, inductance 2.2uH @ 500kHz
3	SMD capacitors	0805 10uF 16V 10%	PCS	2	C1、C3	SMD ceramic capacitor is required
4	SMD capacitors	0603 NC	PCS	2	C5、C6	Certified reservations
5	SMD resistors	0603 NC	PCS	2	R4、R6	Certified reservations
6	SMD resistors	0603 510R 5%	PCS	1	R1、	Adjust LED brightness
7	SMD resistors	0603 2K 5%	PCS	1	R2、R3	Adjust LED brightness
8	LED	0603	PCS	2	LED1、LED2	LED indicator
9	SMD resistors	0603 NC	PCS	1	RISET	Set the constant current charging current. Select as needed

13 Silkscreen

Instruction:
1、2330 --Product name
2、XXXXX --Product number
3、○ --PIN1 Position

Figure 11 Silkscreen

14 Package



	POD	SOT23-6		
		Size unit: mm		
	Symbol	Minimum	Normal	Maximum
Total Thickness	A	1.08	-	1.30
Molding Thickness	A1	1.05	-	1.15
LF Thickness	A2	0.12	-	0.23
Stand Off	A3	0.03	-	0.15
Body Size	D	2.82	-	3.02
	E	1.50	-	1.70
	E1	2.60	-	3.00
Lead Width	b	0.28	-	0.45
Lead Length	L	0.35	-	0.55
Lead Pitch	e	0.95 BSC		

15 IMPORTANT NOTICE

INJOINIC TECHNOLOGY and its subsidiaries reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to INJOINIC TECHNOLOGY's terms and conditions of sale supplied at the time of order acknowledgment.

INJOINIC TECHNOLOGY assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using INJOINIC TECHNOLOGY's components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of INJOINIC TECHNOLOGY's components in its applications, notwithstanding any applications-related information or support that may be provided by INJOINIC TECHNOLOGY. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify INJOINIC TECHNOLOGY and its representatives against any damages arising out of the use of any INJOINIC TECHNOLOGY's components in safety-critical applications.

Reproduction of significant portions of INJOINIC TECHNOLOGY's information in INJOINIC TECHNOLOGY's data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. INJOINIC TECHNOLOGY is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

INJOINIC TECHNOLOGY will update this document from time to time. The actual parameters of the product may vary due to different models or other items. This document voids all express and any implied warranties.

Resale of INJOINIC TECHNOLOGY's components or services with statements different from or beyond the parameters stated by INJOINIC TECHNOLOGY for that component or service voids all express and any implied warranties for the associated INJOINIC TECHNOLOGY's component or service and is an unfair and deceptive business practice. INJOINIC TECHNOLOGY is not responsible or liable for any such statements.