Synchronous Switching Buck Charging IC for Single Cell Lithium Battery with 30V Input Withstanding Voltage

1 Features

- **Input withstand voltage 30V**
- **Synchronous switch-mode buck charger**
  - ✧ Built-in power MOS, maximum 2.4A switching charging, efficiency 92%
  - ✧ Standard 4.20V, other voltages need to be customized, support lithium iron phosphate battery, full voltage customization range 3.5V~4.4V
  - ✧ Charging current ISET pin can be set
- **Support NTC protection function**
- **Support 2-way LED lights**
  - ✧ LED1 supports constant current output function (no string current limit resistor required)
- **Low standby power consumption**
  - ✧ BAT power consumption is less than 2uA at VIN=0
- **Multiple protection and high reliability**
  - ✧ Input over-voltage, under-voltage and output over-charge protection
  - ✧ NTC monitoring battery temperature, 5-stage charging (Compatible with JEITA standard)
  - ✧ Chip over-temperature protection
  - ✧ ESD 4KV

2 Typical Applications

- **Single lithium battery charging**

3 Description

IP2332N is a synchronous buck charge management chip with 30V input withstand voltage, supporting single-cell lithium battery.

IP2332N integrated power MOS and synchronous switching architecture enable it to require only a few peripheral components for the application, and effectively reduce the size of the overall solution and reduce the BOM cost.

IP2332N buck switching charging converter works at 500KHz, the maximum charging current is 2.4A, 5V input, 3.7V/2A conversion efficiency is 92%; The charging current can be set by an external resistor.

IP2332N input voltage is 5V and the input can intelligently regulate the charging current to prevent adapter failure.

IP2332N can support 2-channel LED light display; LED1 supports constant current output function (no string current limiting resistor required), and LED1 customizes breathing lamp function.

IP2332N supports NTC function, supports 5-segment NTC charging standard, NTC low or high temperature to stop charging, medium-low or medium-high temperature can reduce the charging current or reduce the full voltage.

IP2332N is packaged in ESOP8.

4 Simplify the application schematic

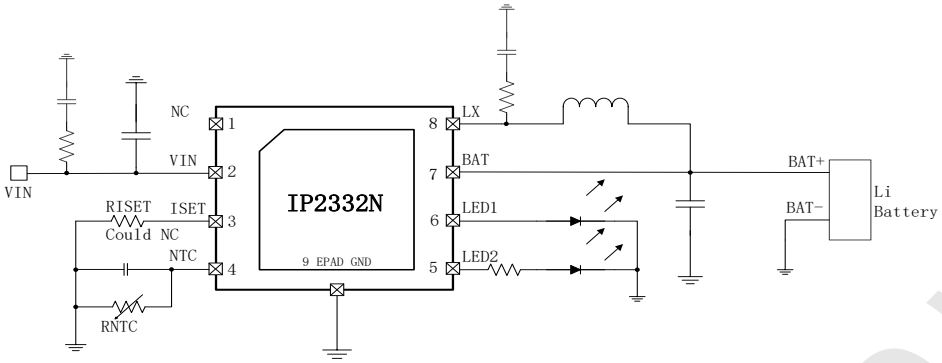


Figure 1 Simplify the application schematic

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（2024.7） **页码**

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

6 Common Model

Type name	Function
IP2332N	Standard model with 500KHz switching frequency using a 2.2uH inductor.
IP2332N_1M	Modifying the switching frequency to 1MHz and using a 1uH inductor, the relationship between the charging current and the external resistor RISET at the ISET pin is different from the standard model.

7 PIN Description

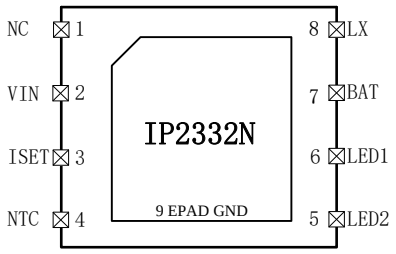


Figure 2 Pin of IP2332N

Pin Name	Pin Num	Pin Description
NC	1	
VIN	2	5V DC input pin
ISET	3	Charge current setting pin
NTC	4	The battery temperature detection pin is externally connected to the negative temperature coefficient resistor (NTC) to detect the battery temperature
LED2	5	LED2 output pin (common IO output)
LED1	6	LED1 output pin (support constant current output, breathing light)
BAT	7	BAT pin, connect to the positive terminal of the battery
LX	8	DCDC switch node
GND	EPAD	Ground

8 Limit parameters

Parameters	Symbol	Value	Unit
VIN Voltage Range	V_{IN}	-0.3 ~30	V
Other 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	℃
Thermal resistance (junction temperature to ambient)	θ_{JA}	90	℃/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.

9 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4.5	--	5.5	V
Charge Current	I_{BAT}		--	2.4	A

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

10 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	5.5	V
Input over-voltage threshold	V_{IN-OV}		5.8	5.9	6.0	V
Input overvoltage protection hysteresis				200		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}=620Ω		2.4		A
		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，R_{ISET}=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	℃

11 Function Description

11.1 Functional Block Diagram

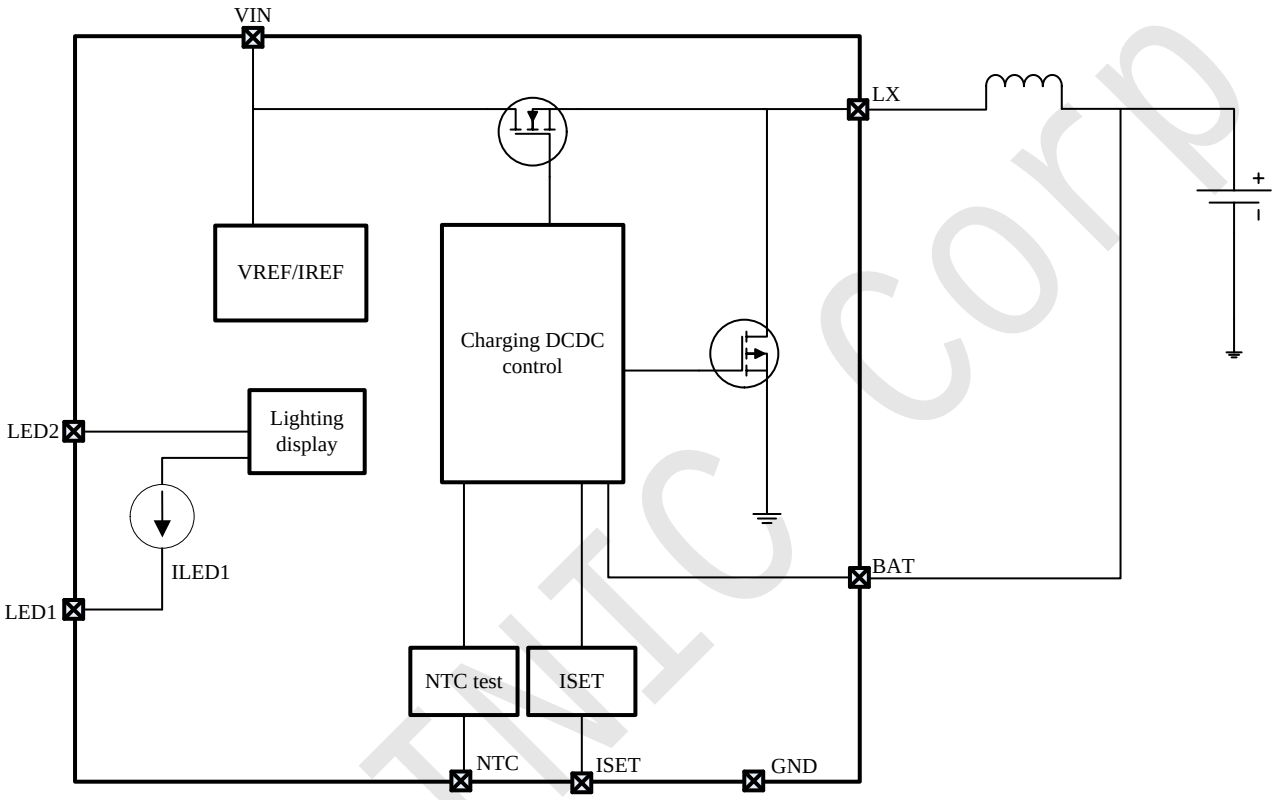


Figure 3 IP2332N Functional Block Diagram

11.2 Charging efficiency

IP2332N integrates a synchronous buck charge controller, integrated power MOS, switching frequency 500KHz, input 5V buck to charge the lithium battery. 5V input, 3.7V/2A output with 92% efficiency..

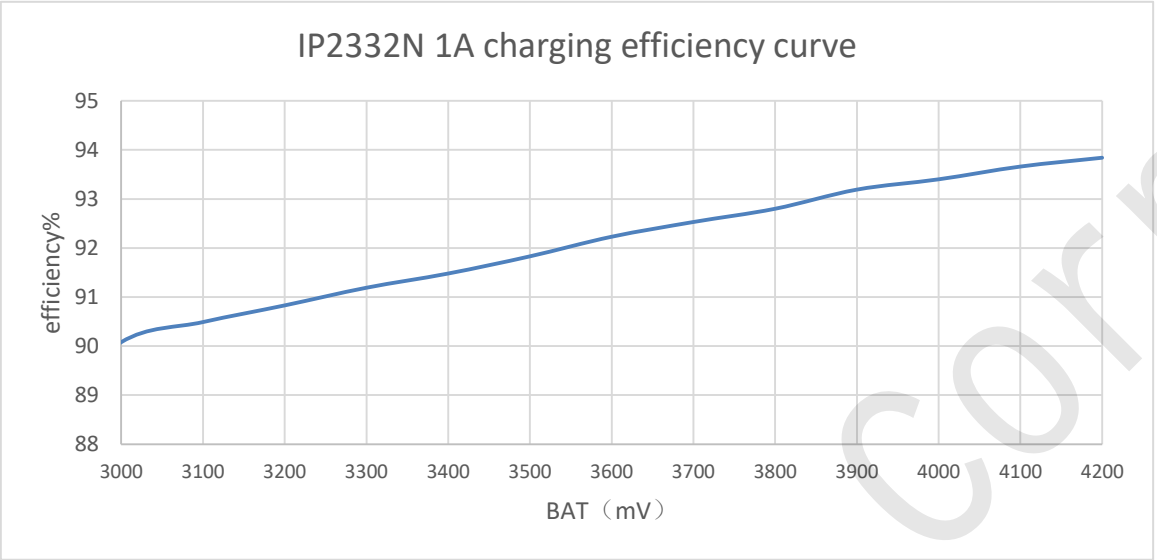


Figure 4 IP2332N 1A charging efficiency curve

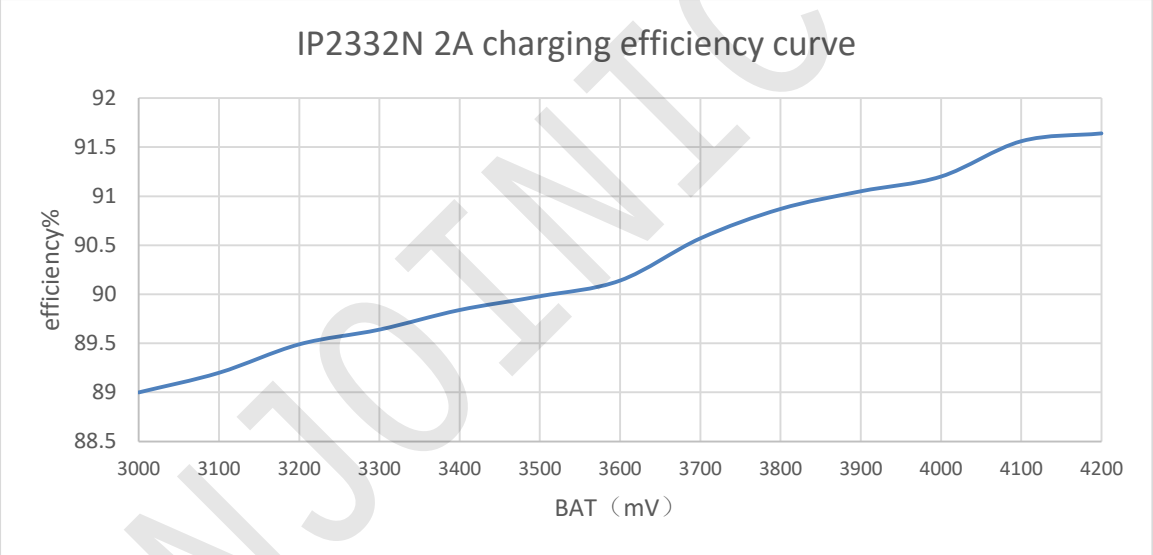


Figure 5 IP2332N 2A charging efficiency curve

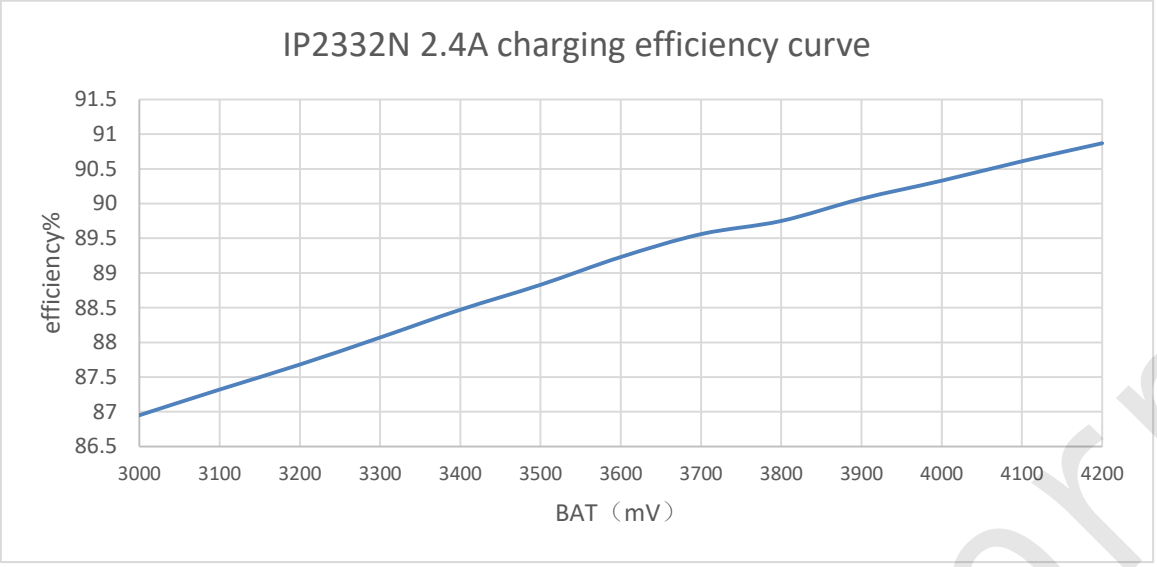


Figure 6 IP2332N 2.4A charging efficiency curve

11.3 Charge Process

The IP2332N 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.

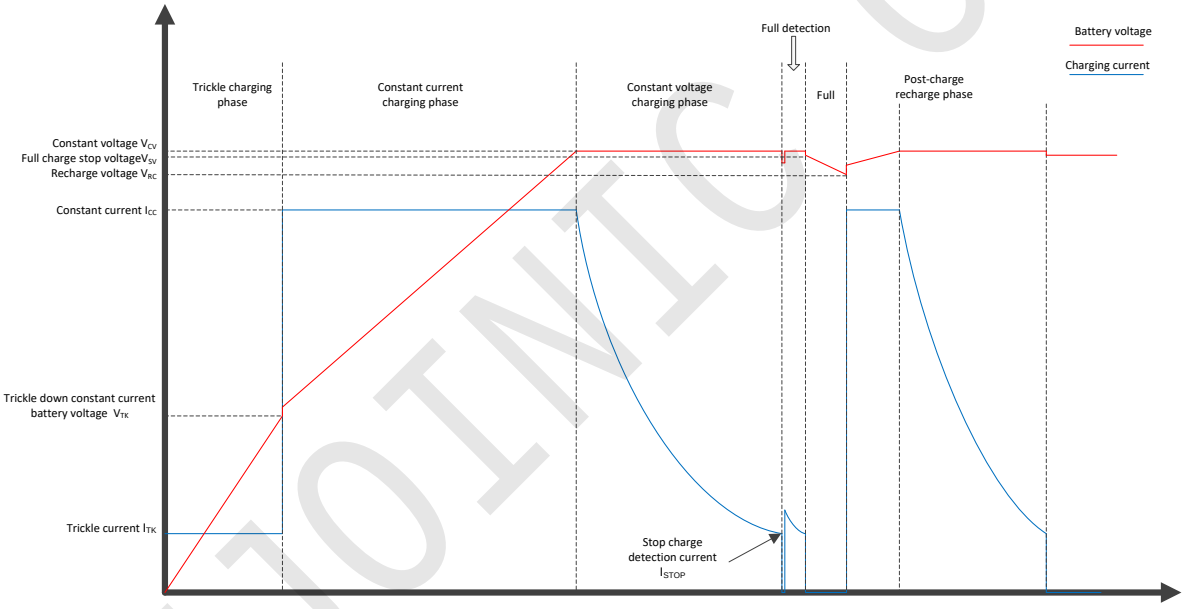


Figure 7 IP2332N Schematic diagram of the charging process

11.4 Charging protection

IP2332N 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.

IP2332N integrates an input overvoltage protection function that stops charging when it detects an input voltage greater than the 6V overvoltage threshold.

IP2332N integrated NTC function, with NTC resistor, can detect the battery temperature, when it is too high

or too low, the system can stop charging. When the battery temperature is detected to be medium-low or medium-high, the charging current can be reduced or the charging voltage can be reduced.

IP2332N integrated over-temperature protection function, when the chip internal temperature is detected more than 145℃, the system will be forced to stop charging.

11.5 Charge current setting

IP2332N supports an external resistor RISET on the ISET pin to set the constant current charging current.

For IP2332N standard, the charging current I_{CC} versus RISET using a 2.2uH inductor is:

$$I_{CC}（A）=0.33+1.3/R_{ISET}(K\Omega)$$

R_{ISET}（Ω）	Constant current charging current
620Ω	2.4A
1.1K	1.5A
2.0K	1A
8.2K	0.49A
NC（≥120K）	1.0A

For IP2332N_1M, the charging current ICC versus RISET using a 1uH inductor is:

$$I_{CC}（A）=0.58+0.8/R_{ISET}(K\Omega)$$

R_{ISET}（Ω）	Constant current charging current
470Ω	2.4A
560Ω	2A
910Ω	1.5A
2K	1A
NC（≥120K）	1.0A

11.6 NTC

IP2332N supports NTC protection function which can cooperate with NTC resistance to detect battery temperature;

IP2332N puts out 30/100uA current through the NTC pin, then detects the voltage generated by this current on the NTC resistor to determine the temperature high or low, and turns off charging when the detected temperature exceeds the set temperature.

The default is to put out 100uA current, and when the pin voltage is detected to be greater than 1.5V (NTC resistance is greater than 15K), the output current is reduced to 30uA.at 30uA output, when the pin voltage is detected to be less than 0.3V (NTC resistance is less than 10K), the output current becomes 100uA.

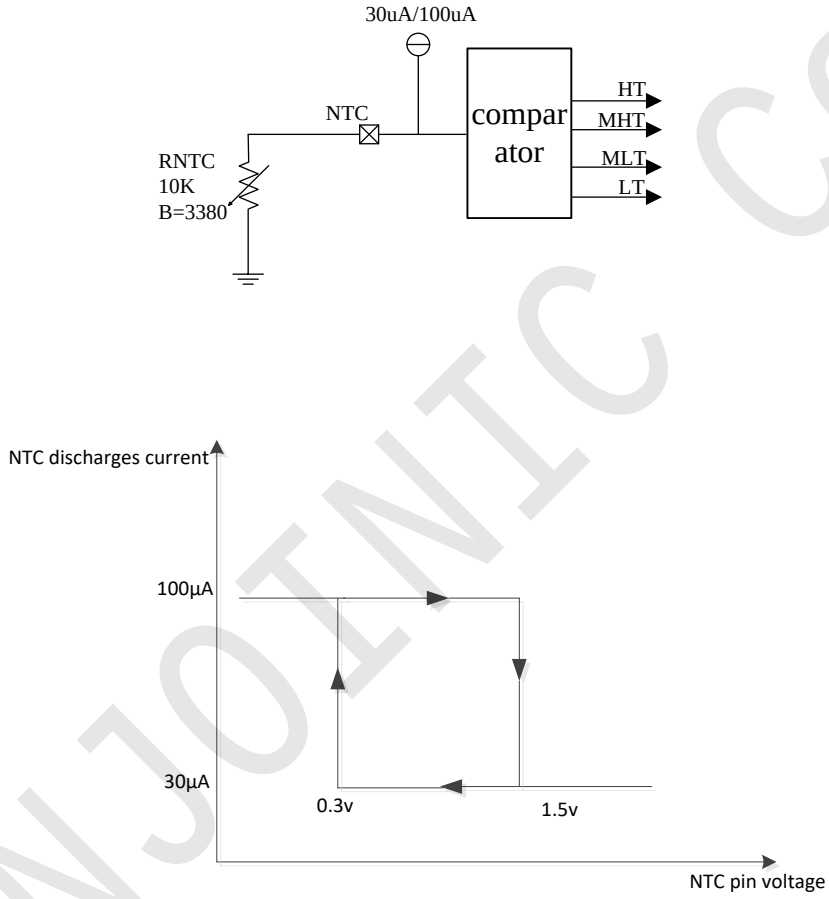


Figure 8 NTC

When IP2332N detects that the NTC pin voltage rises to 0.82V@30uA, it triggers the low temperature protection and stops charging;

When IP2332N detects that the NTC pin voltage is between 0.54V@30uA~0.82V@30uA, it triggers the medium-low temperature protection and the charging current is reduced to half;

When IP2332N detects NTC pin voltage between 0.49V@100uA~0.54V@30uA, it indicates that the battery temperature is normal and normal charging;

When IP2332N detects NTC pin voltage between 0.3V@100uA~0.49V@100uA, it triggers medium-high

temperature protection and full voltage CV-100mV;

When IP2332N detects that the NTC pin voltage drops to less than 0.3V@100uA, trigger high temperature protection and stop charging;

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

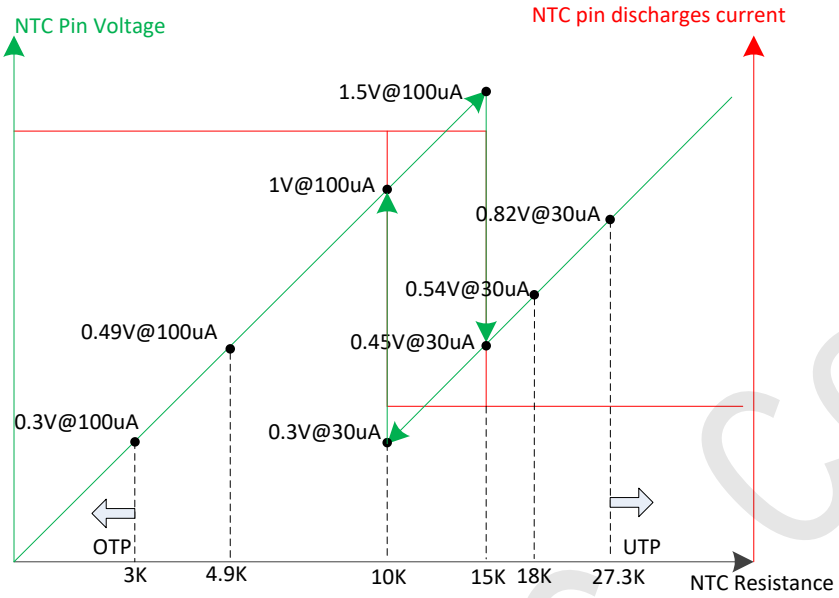


Figure 9 Relationship between NTC voltage and NTC resistance

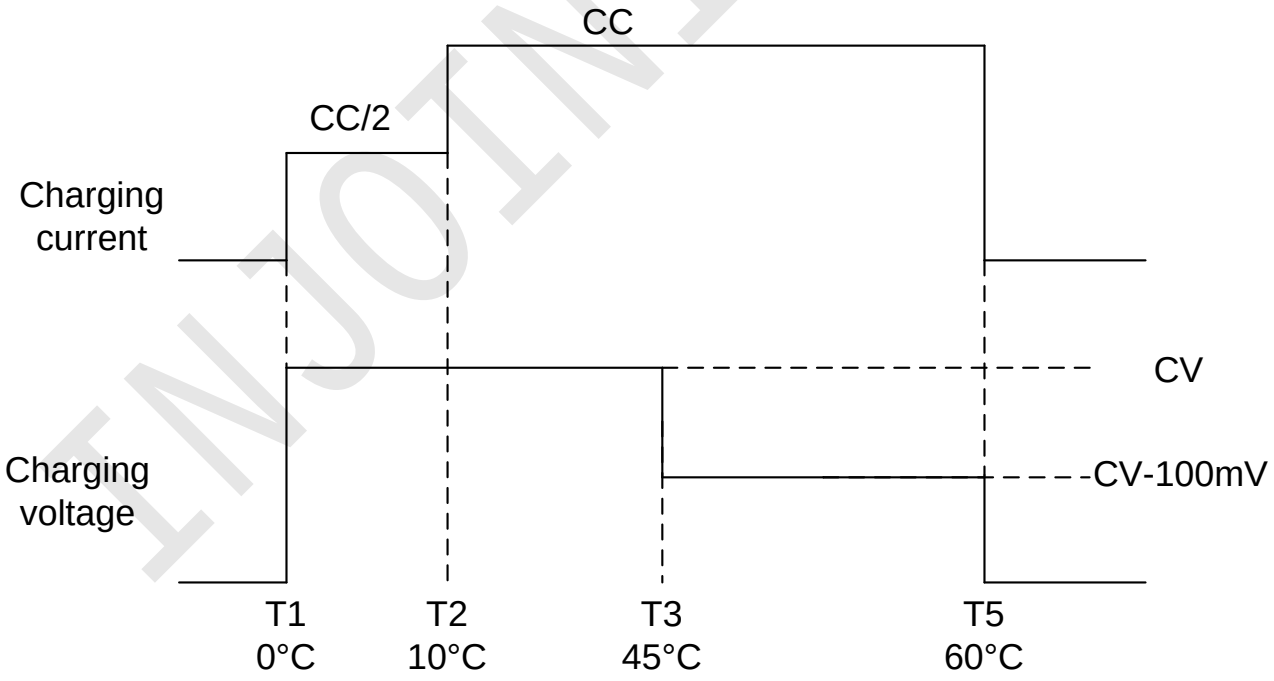


Figure 10 Schematic diagram of 5-segment battery temperature charge protection (JEITA compliant)

11.7 Charging LED indication

IP2332N has two LED indicators, LED1 is on and LED2 is off during charging, and LED1 is off and LED2 is on when fully charged. When an abnormality is detected (including input over-voltage protection, NTC protection, and chip over-temperature protection), LED1 and LED2 flash at the same time (500ms on, 500ms off).

IP2332N has battery detection function, when only VIN is connected but not connected to the battery, LED1 and LED2 will flash alternately (LED1 is on for 60ms, off for 150ms, LED2 is on for 150ms, off for 60ms) to indicate abnormality; When the LED of the unconnected battery flashes abnormally, it will enter the normal charging process after connecting the battery.

12 Typical Application Schematic

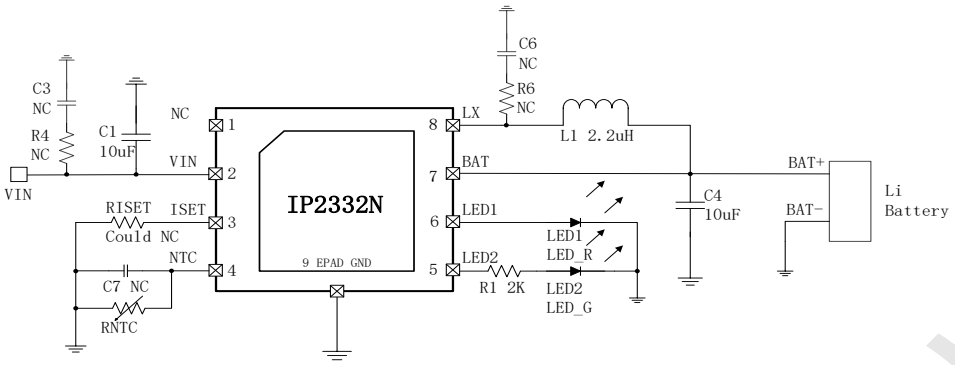
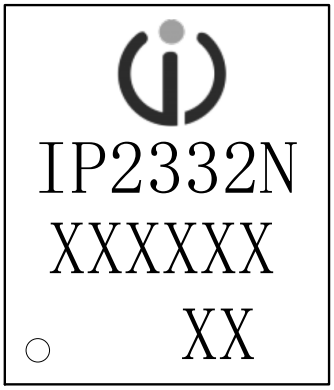


Figure 11 Typical Application Schematic

13 BOM

No.	Part Name	Type &Specification	Units	Quantity	Location	Note
1	IC	IP2332N	PCS	1	U1	
2	Inductance	CD43	PCS	1	L1	Saturate current (Isat), temperature rise current (Idc) larger than 3.5A, DCR less than 20mΩ, inductance 2.2uH @ 500kHz
3	SMD capacitors	0805 10uF 16V 10%	PCS	2	C1、C4	SMD ceramic capacitor is required
4	SMD capacitors	0603 NC	PCS	3	C3、C6、C7	Certified reservations
5	SMD resistors	0603 NC	PCS	2	R4、R6	Certified reservations
6	SMD resistors	0603 2K 5%	PCS	1	R1	Adjust LED2 brightness
7	LED	0603	PCS	2	LED1 、LED2	LED indicator
8	NTC resistors	NTC 10K B=3380	PCS	1	RNTC	When not in use, connect 10K resistor to ground
9	SMD resistors	0603 NC	PCS	1	RISET	Set the constant current charging current. Select as needed

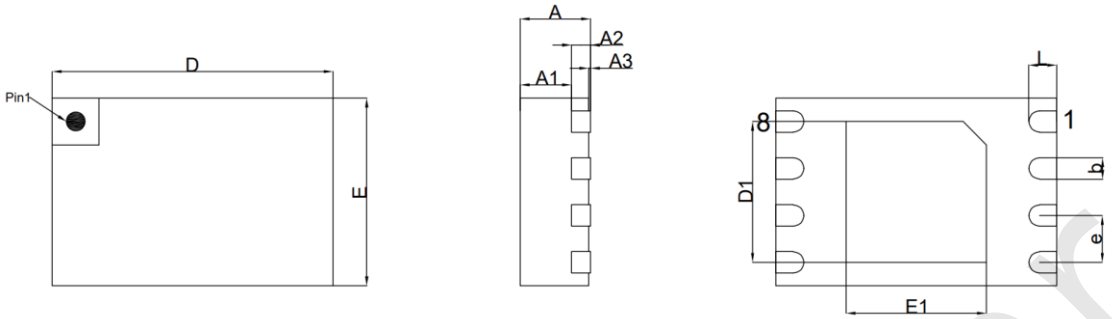
14 Silkscreen



说明：
1、 --英集芯标志
2、IP2332N --产品型号
3、XXXXXX --生产批号
4、XX --生产批号
5、○ --PIN1脚的位置标识

Figure 12 Silkscreen

15 Package



	POD	DFNWB2×3-8L-NA(P0.5T0.75)		
		Size unit: mm		
	Symbol	Minimum	Normal	Maximum
Total Thickness	A	0.70	0.75	0.80
Molding Thickness	A1	-	0.55	-
LF Thickness	A2	-	0.203	-
Stand Off	A3	0.00	-	0.05
Body Size	D	2.90	3.00	3.10
	E	1.90	2.00	2.10
Exposed Pad Size	D1	1.40	1.50	1.60
	E1	1.40	1.50	1.60
Lead Width	b	0.18	0.23	0.28
Lead Length	L	0.25	0.30	0.35
Lead Pitch	e	0.50 BSC		

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