Double-cell series lithium battery boost charging with charge balancing functionIC

1characteristic

- 15WInput synchronous switch boost charging
- Boost charging efficiency94%
- Integrated charge balancing circuit
- Charging current can be adjusted by external resistor
- Constant voltage charging voltage adjustable by external resistor
- Automatically adjust input current to match all adapters
- Support chargingNTCtemperature protection
- supportledCharging status indication
- powerMOSbuilt-in
- 500KHzswitching frequency, can support2.2uHInductor output
- overcurrent, overvoltage, short circuit protection
- Input overvoltage and undervoltage protection, external resistor adjustable
- ICOver temperature protection
- Charging timeout protection
- Input withstand voltage25V
- ESD 4KV

2application

- Dual-cell lithium battery/lithium-ion battery charging

3Introduction

IP2326It is a boost charging management device that supports dual-cell series lithium batteries/lithium-ion batteries.IC.

IP2326Integrated powerMOS, using a synchronous switching architecture, which requires only a few peripheral components during application and effectively reduces the overall body scheme size, reducingBOMcost.

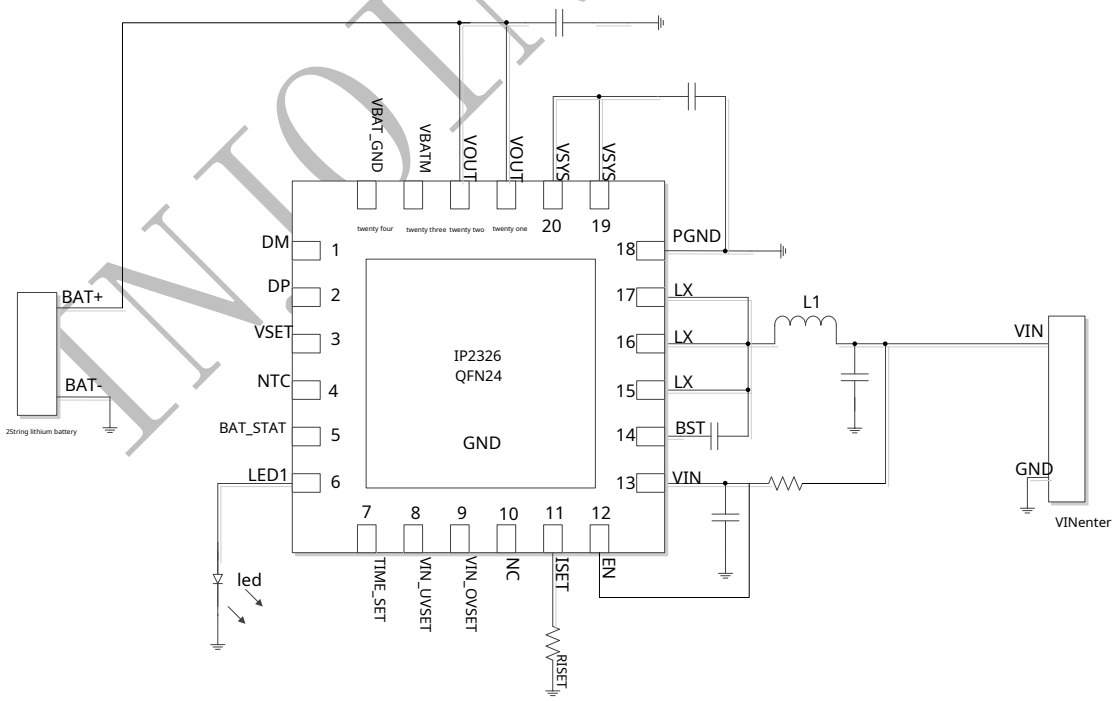
IP2326The boost switching charge converter operating frequency 500KHz;maximum15WEnter charging,5Venter,8V/1AOutput conversion efficiency94%,8V/1.5AOutput conversion efficiency92%.

IP2326It has an input voltage limiting function that can intelligently adjust the charging current to prevent the adapter from being pulled.

IP2326Supports external resistors to adjust charging current, charging voltage, input undervoltage threshold, input overvoltage threshold, charging timeout threshold and other parameters;

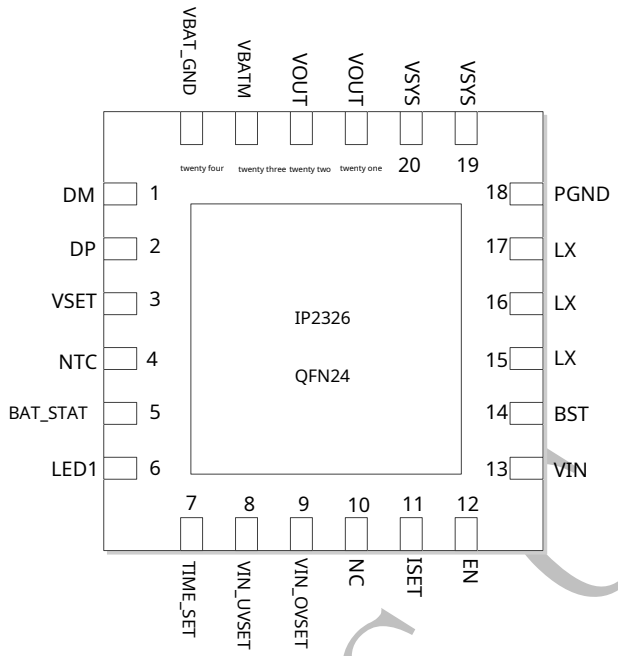
IP2326Integrated charge balancing circuit can detect the voltage of each battery during charging to ensure2Balance of battery voltage;

IP2326integratedNTCprotection function, coordinationNTC resistance IP2326use4*4mm QFN24Encapsulation.



picture1**Simplified application schematic**

4Pin definition



picture2**IP2326Pin diagram**

Pin Name	Pin Num	Pin Description
DM	1	USB DM
DP	2	USBDP
VSET	3	Constant voltage charging voltage settingPIN
NTC	4	NTCTemperature protection, connectNTCresistor, output20uAof current
BAT_STAT	5	Charging status output indication, outputs low level during trickle charging and outputs high level after entering constant current charging.
LED1	6	Charging instructionsled
TIME_SET	7	Charging timeout protection settingsPIN
VIN_UVSET	8	Input undervoltage threshold settingPIN
VIN_OVSET	9	Input overvoltage threshold settingPIN
NC	10	undefined, left empty
ISET	11	Charging current settingPIN
EN	12	EnablePIN, the chip does not work after grounding
VIN	13	Input power and detectionPIN
BST	14	Bootstrap circuit pin,close to the chipBSTpins andLXPin placement bootstrap capacitor0.1uF
LX	15,16,17	DCDCSwitch node, connect the inductor
PGND	18	Powerfully
VSYS	19,20	Boost output intermediate node, placed close to the pin2indivual22uFCeramic capacitors
VOUT	twenty one,twenty two	Boost outputPIN, connect to the positive terminal of the battery
VBATM	twenty three	Charge balancing function, intermediate battery voltage detectionPIN, left floating when this function is not used
VBAT_GND	twenty four	Charge balancing function, battery ground detectionPIN, left floating when this function is not used

5Limit parameters

parameter	symbol	value	unit
Port input voltage range	V_{IN}	- 0.3 ~ 25	V
Junction temperature range	T_J	- 40 ~ 150	℃
Storage temperature range	Txt	- 60 ~ 150	℃
Thermal resistance (junction temperature to ambient)	θ_{JA}	60	℃/W
human body model (HBM)	ESD	4	KV

*Stresses greater than those listed in the Absolute Maximum Ratings section may cause permanent damage to the device under any Absolute Maximum Rating conditions.

Excessive exposure time may affect the reliability and service life of the device.

6Recommended working conditions

parameter	symbol	minimum value	Typical value	maximum value	unit
Input voltage	V_{IN}	4.5	5	5.5	V
recharging current	I	0		1.5	A

* Beyond these operating conditions, device operating characteristics are not guaranteed.

7Electrical characteristics

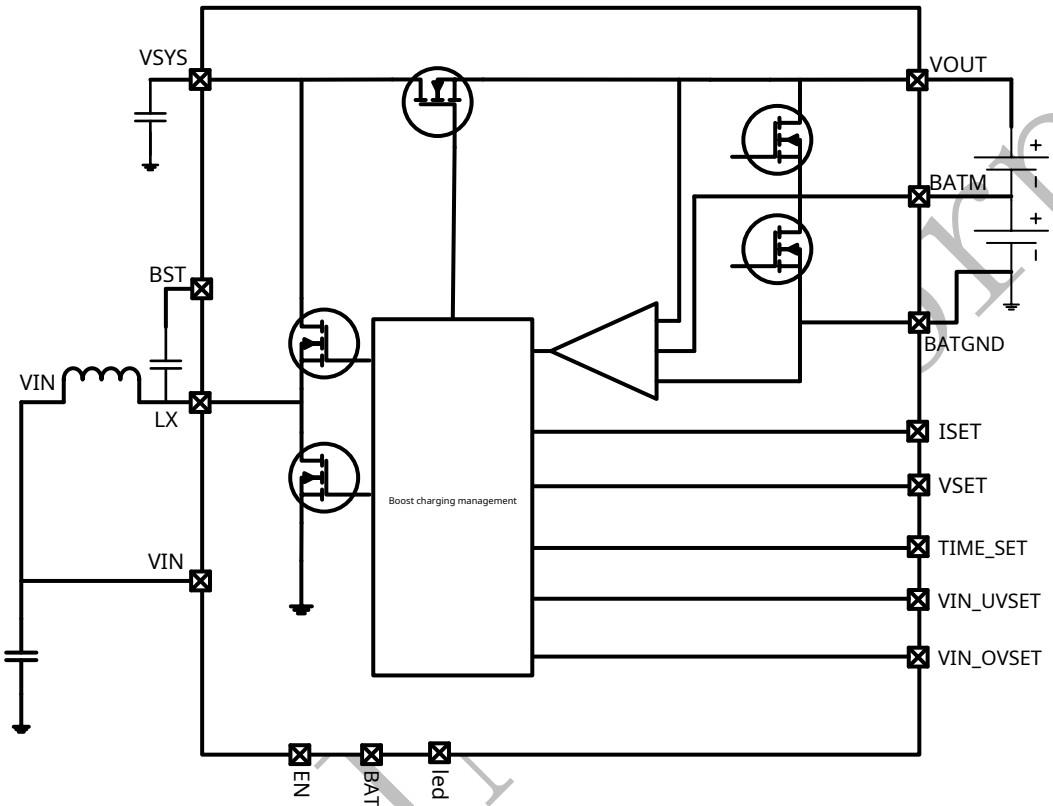
Unless otherwise stated,TA=25℃,L=2.2uH,VIN=5V,VOUT=7.4V

parameter	symbol	Test Conditions	smallest value	typical value	maximum value	unit
Charging system						
Input voltage	V_{IN}		4.5	5	5.5	V
Input undervoltage threshold	drop voltage	R_{UV}=NC	4.55	4.65	4.75	V
		R_{UV}=120K	4.35	4.45	4.55	V
		R_{UV}=68K	4.25	4.35	4.45	V
		R_{UV}=1K	4.15	4.25	4.35	V
Input overvoltage threshold	rising voltage	R_{OV}=NC	6.1	6.25	6.4	V
		R_{OV}=120K	5.85	6	6.15	V
		R_{OV}=68K	5.6	5.75	5.9	V
Input working current	I_{VIN}	EN=1,VIN=5V,VOUT=NC,Noled	10	20	30	mA

stand-by current	$I_{standby-BAT}$	EN=0,VIN=0,VOUT=7.4V		0.7	1	uA
		EN=0,VIN=5V,VOUT=7.4V		2.5	3	uA
Charging target voltage	V_{TRGT}	R_{VSET}=NC	8.3	8.4	8.5	V
		R_{VSET}=120K	8.2	8.3	8.4	V
		R_{VSET}=68K	8.1	8.2	8.3	V
		R_{VSET}=1K	8.0	8.1	8.2	V
recharging current	I_{CHRG}	Constant output current			1.5	A
Trickle charge current	I_{tKR}	VIN=5V,VOUT<3.6V	30	50	70	mA
		VIN=5V,3.7V<VOUT<6V	50	100	150	mA
Charge cut-off current	I_{STOP}			150	250	mA
Control System						
ledDisplay drive current	I_{Led}	VIN=5V			5	mA
ENhigh level	EN_{INH}		1.4		VIN	V
ENlow level	EN_{INL}		0		1.2	V
Thermal shutdown temperature	T_{OTP}	rising temperature	125	135	145	℃
Thermal shutdown recovery temperature	T_{OTP-H}	drop temperature	100	110	120	℃

8Function description

Block diagram structure



picture3IP2326Internal block diagram

Boost charging

IP2326Integrate aBoostSynchronous boost charge controller, switching frequency500KHz,5Venter,8.0V/1AThe output efficiency is94%. The output is boosted to8.4V, to charge dual-cell lithium/lithium-ion batteries.

Charging process

IP2326Use the completeCC/CVcharging mode. When the double battery voltage is less than3.7Vtime, with50mAThe current charges the battery. When the double battery voltage is greater than or less than6V,by100mAThe current charges the battery. When the battery voltage is greater than1.2When the input voltage is times the input voltage, the constant currentI_{CC}Charging; when the battery voltage is close to8.4Vwhen, enter the constant voltage charging mode.

After entering constant voltage mode, if the charging current is less than150mA,Pass30sThen stop charging and check whether the battery voltage is higher than the charging-stop voltage; if it is higher than the charging-stop voltage, stop charging; if it is lower than the charging-stop voltage, continue charging, and then30sThen continue testing.

Charging protection

IP2326It has complete protection functions and integrates output overcurrent, input undervoltage, overvoltage, overtemperature and other protection functions to ensure stable and reliable operation of the system.

IP2326has inputVINinput voltage regulation loop, upon detecting that the input voltage is close toR_{UV}When the input undervoltage threshold is set, it will automatically adjust and reduce the charging current to ensure that the input voltage is stable near the input undervoltage threshold and ensure that the adapter will not be pulled.

IP2326Integrated input overvoltage protection function, when the input voltage is detected to be greater thanR_{OV}Charging will stop when the set overvoltage threshold is reached;

IP2326integratedNTCfunction, coordinationNTCResistor can detect the battery temperature. When the battery temperature is too high or too low, charging can be stopped;

IP2326Integrated over-temperature protection function, when the internal temperature of the chip is detected to exceed135After reaching a certain temperature, charging will be forcibly stopped; IP2326Integrated charging timeout protection, when charging time exceedsR_{OT}The set maximum charging time will forcefully stop charging;

Charge balancing function

IP2326Integrated charge balancing function;

During the charging process,IP2326Will detect in real time2battery voltage when any1The battery voltage reaches the equilibrium turn-on voltageV_{CBON}, turn onIP2326internal corresponding equilibriumMOS, reduce the charging current of this battery;

Conditions for equilibrium closure:

1,2Each battery voltage is higher than the equilibrium turn-on voltageV_{CBON};

2, exit the normal charging state (such asNTCprotection, input overvoltage, battery full, etc.);

Can be adjusted byR_{CB}To set the balancing current, the balancing current will be consumed in the internal balancing in the form of heatMOSandRCBon, so the balancing current setting should be less than40mA(R_{CB}should be greater than100ohm)

Charging voltage setting

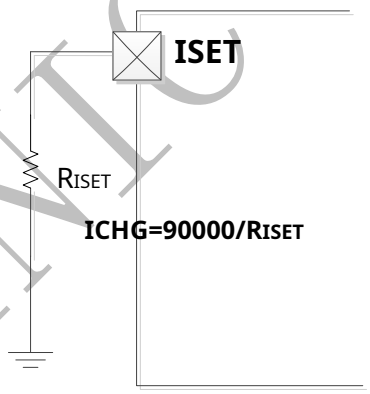
IP2326supportVSETPin external resistorRVSET, to set the constant voltage charging voltage;

RVSETSet constant voltage charging voltage

RVSET	Constant charging voltage
1K	8.1V
68K	8.2V
120K	8.3V
NC	8.4V

Charging current setting

IP2326supportISETPin external resistorRISET, to set the constant current charging current. The set current is the maximum charging current at the battery end (accuracy ±10%).



Typical current recommended resistor:

RISETSet the battery end charging current:

ICHG=90000/RISET

RISET	recharging current
180K	0.5A
90K	1A
75K	1.2A
60K	1.5A

Input undervoltage threshold setting

IP2326supportVIN_UVSETPin external resistorRUV, to set the input undervoltage threshold;

RUVSet input undervoltage threshold

RUV	Input undervoltage threshold
1K	4.25V
68K	4.35V
120K	4.45V
NC	4.65V

IP2326 VINWhen the input loop detects that the input voltage is close to the set input undervoltage threshold, it will automatically adjust and reduce the charging current to ensure that the input voltage is stable near the input undervoltage threshold and ensure that the adapter will not be pulled.

Input overvoltage threshold setting

IP2326supportVIN_OVSETPin external resistorROV, to set the input overvoltage threshold;

ROVSet input undervoltage threshold

ROV	Input overvoltage threshold
1K	disable, no overvoltage
68K	5.75V
120K	6V
NC	6.25V

Charging timeout setting

IP2326supportTIME_SETPin external resistorROT, to set the charging timeout;

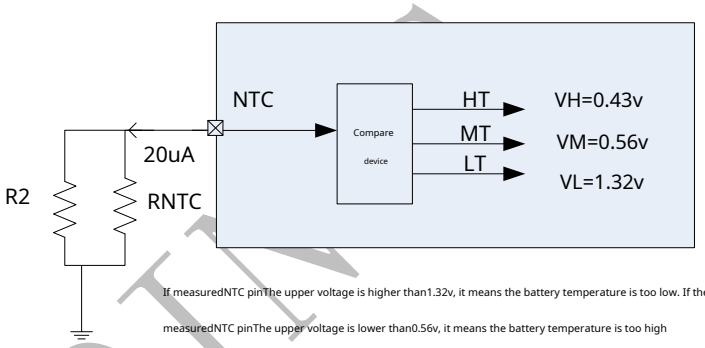
ROTSet charging timeout

ROT	Charging timeout
1K	disable, no timeout
68K	4H
120K	12H
NC	24H

ChargeNTC

IP2326supportNTCProtection function, can be matched withNTCResistor to detect battery temperature;

IP2326passNTCpin out20uAcurrent, and then detect the current inNTCThe voltage generated on the resistor is used to determine the temperature. When the detected temperature exceeds the set temperature, charging is turned off.



If measuredNTC pinThe upper voltage is higher than1.32v, it means the battery temperature is too low. If the measuredNTC pinThe upper voltage is lower than0.56v, it means the battery temperature is too high

If measuredNTC pinThe upper voltage is lower than0.43v, it means the battery temperature is too high

picture4NTCblock diagram

whenIP2326detectedNTCThe pin voltage is at0.56V~1.32Vbetween, it means the battery temperature is normal and charging is normal; whenIP2326 detectedNTCThe pin voltage is at0.43V~0.56Vbetween, it means the battery temperature is high and the charging current is reduced by half; whenIP2326 detectedNTCpin voltage drops to less than0.43V, indicating that the battery temperature is too high, stop charging; whenIP2326detectedNTCpin voltage rises to greater than1.32V, indicating that the battery temperature is too low and charging is stopped;

if not neededNTCfunction, willNTCPin connection51Kresistor to ground.

Example:RNTC=100Kthermistor (B=4100),R2=82K, the corresponding temperature andNTCPin voltage:

Temperature (degrees)	RNTCResistor value	R2//RNTCResistance	NTCpin voltage
0	246.7K	66.3K	1.32V
45	41.2K	27.8K	0.56V
55	28.4K	21.1K	0.43V

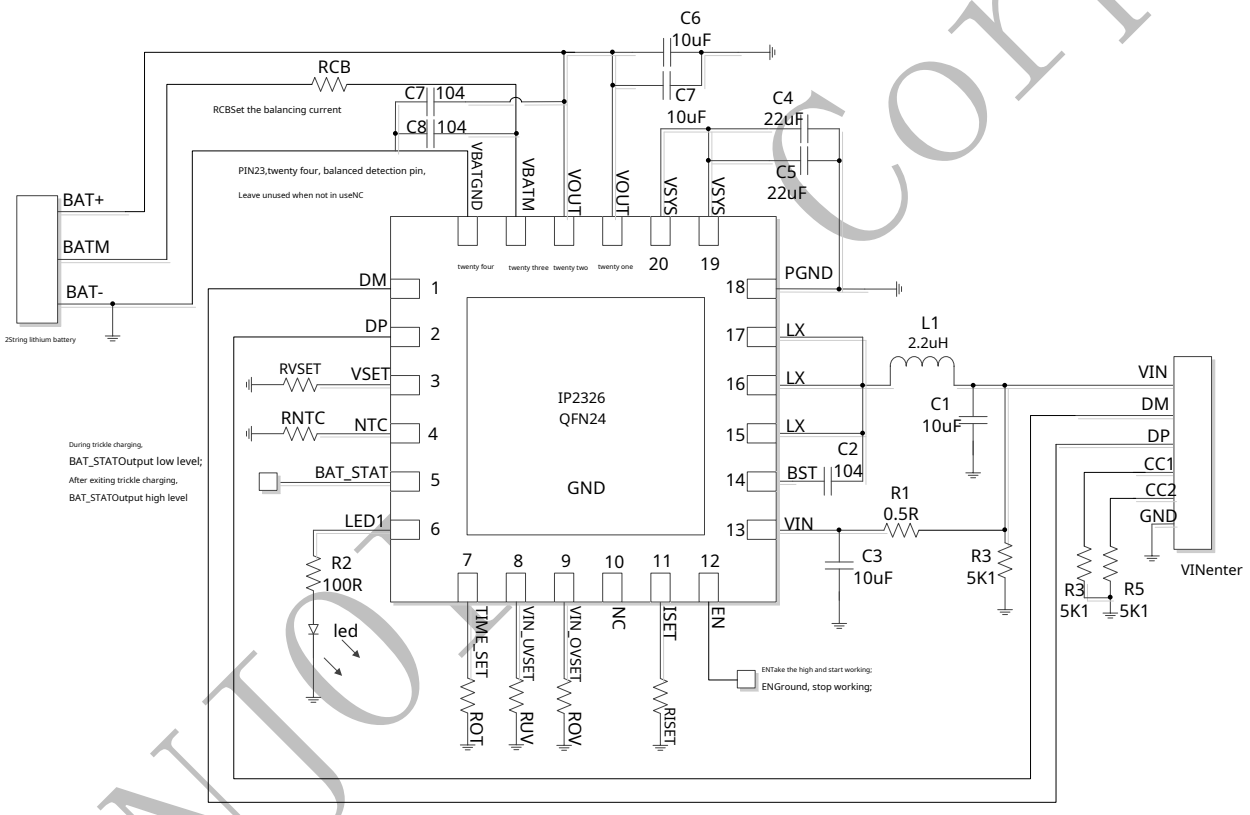
Chargeledinstruct

Charging batteriesledIndicator light, charging processledOn, after fully chargedledOff, after an abnormality is detectedledFlashing.

BAT_STATinstruct

BAT_STATIndicates the charging status, outputs low level during trickle charging, and outputs high level after entering constant current charging;

9Typical application schematic diagram



NTCPin output20uAcurrent, detect the current inRNTCvoltage generated on

NTCVoltage	charging
V<0.43V	High temperature protection, stop charging
0.43V<V<0.56V	Medium temperature protection, current halved
0.56V<V<1.32V	Normal charging
V>1.32V	Low temperature protection, stop charging

RVSETSet constant voltage charging voltage

RVSET	Constant charging voltage
1K	8.1V
68K	8.2V
120K	8.3V
NC	8.4V

ROTSet charging timeout

ROT	Charging timeout
1K	disable, no timeout
68K	4H
120K	12H
NC	24H

RUVSet input undervoltage threshold

RUV	Input undervoltage threshold
1K	4.25V
68K	4.35V
120K	4.45V
NC	4.65V

ROVSet input undervoltage threshold

ROV	Input overvoltage threshold
1K	disable, no overvoltage
68K	5.75V
120K	6V
NC	6.25V

RISETSet the battery end charging current:
ICHG=90000/RISET

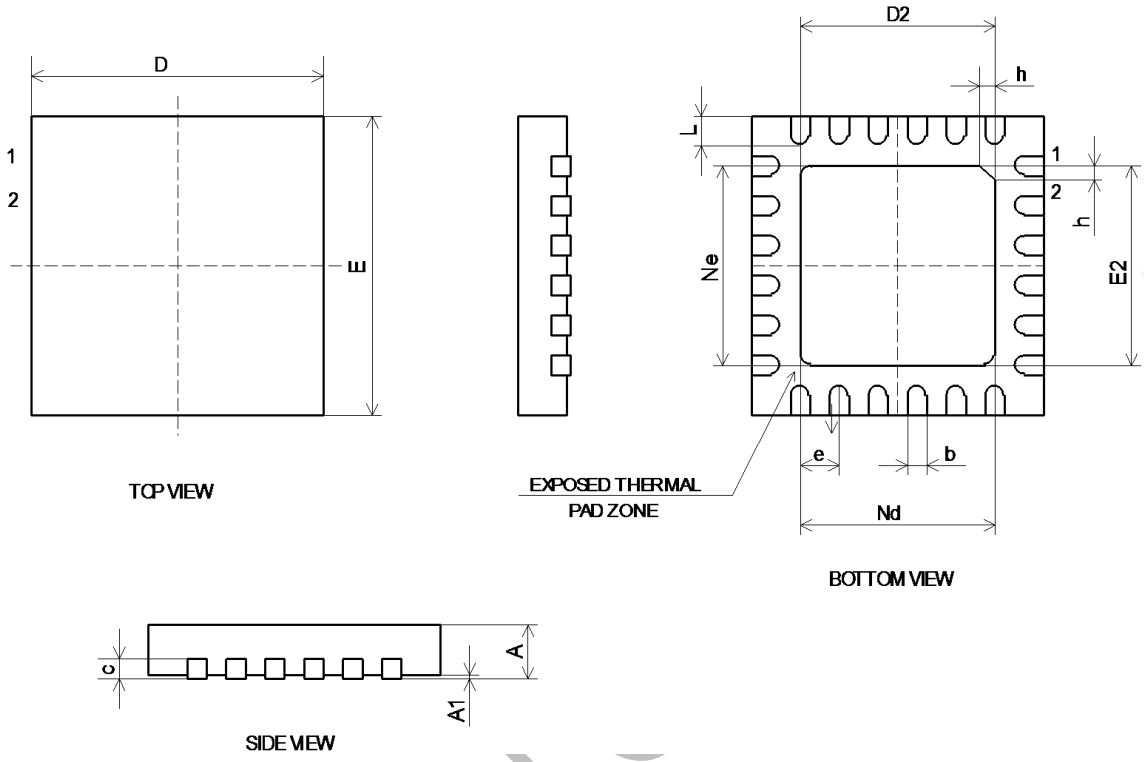
RISET	recharging current
180K	0.5A
90K	1A
75K	1.2A
60K	1.5A

picture5Typical application schematic diagram

BOM

serial number	Component name	Model & Specifications	unit	Dosage	Location	Remark
1	IC	IP2326	PCS	1	U1	
2	inductance	CD43	PCS	1	L1	saturationIsat, temperature rise currentIdcmore than the5A, DCR less than20Milliohms, inductance2.2uH @500KHz
2	Chip capacitors	0805 10uF 10%	PCS	4	C1,C3,C6, C7	The withstand voltage value is greater than16V, need to use chip ceramic circuit Allow
4	Chip capacitors	0805 22uF 10%	PCS	2	C4,C5	The withstand voltage value is greater than16V, need to use chip ceramic circuit Allow
5	Chip capacitors	0603 104 10%	PCS	1	C2	
6	Chip resistor	0603 0.5R 5%	PCS	1	R1	for protectionVIN PIN
7	Chip resistor	0603 100R 5%	PCS	1	R2	for adjustmentledbrightness
8	patchled	0603	PCS	1	D1	ledIndicator light, maximum drive capacity5mA
9	Chip resistor	0603	PCS	1	RVSET	Set the constant voltage charging voltage; select as needed
10	Chip resistor	0603	PCS	1	RISET	Set charging current; select as needed
11	Chip resistor	0603	PCS	1	RUV	Set input undervoltage; select as needed
12	Chip resistor	0603	PCS	1	ROV	Set input overvoltage; select as needed
13	Chip resistor	0603	PCS	1	ROT	Set charging timeout; select as needed
14	NTCresistance	NTCresistance	PCS	1	RNTC	Select according to design temperature; When not in use, connect51KResistor to ground;
15	Chip resistor	1206 100R 5%	PCS	1	RCB	Set the balancing current when the balancing function is not used Its not mandatory
16	Chip capacitors	0603 104 10%	PCS	1	C7,C8	You don't need to use the equalization function when you don't use it.

10Package information



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.18	0.25	0.30
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.40	2.50	2.60
e	0.50BSC		
Ne	2.50BSC		
Nd	2.50BSC		
E	3.90	4.00	4.10
E2	2.40	2.50	2.60
L	0.35	0.40	0.45
h	0.30	0.35	0.40

Responsibility and Copyright Statement

Yingjixin Technology Co., Ltd. reserves the right to make corrections, modifications, enhancements, improvements or other changes to the products and services provided, Customer

You should obtain the latest relevant information before placing an order and verify that this information is complete and up-to-date. All products are sold according to the order confirmation

Terms and conditions of sale provided at the time.

Yingjixin Technology Co., Ltd. assumes no obligation for application assistance or customer product design. Customers should be responsible for the products and applications they use Yingjixin

Use your own responsibility. To minimize risks associated with customer products and applications, customers should provide adequate design and operational safety verification.

Customer acknowledges and agrees that, although any application-related information or support may still be provided by Yingjixin, they will be solely responsible for meeting the requirements of their product

products and all legal, regulatory and safety-related requirements related to the use of Yingjixin products in their applications. Customer represents and agrees that they have the ability to develop

with all the expertise and knowledge required to implement safety measures, to foresee the dangerous consequences of faults, to monitor faults and their consequences, to reduce the risk of

The probability of malfunction causing personal injury and taking appropriate remedial measures. The customer will fully indemnify the customer for any use of any Yingji in such critical applications.

Any loss caused to Yingjixin and its agents due to the core products.

For Yingjixin's product manuals or data sheets, only if there is no tampering with the content and the relevant authorizations, conditions, restrictions and statements are included.

Copying is only allowed under the circumstances. Yingjixin assumes no responsibility or liability for such tampered documents. Copying third party information may require

Additional restrictions apply.

Yingjixin will update the content of this document from time to time. The actual parameters of the product may vary due to different models or other matters. This document does not

for any express or implied warranty or authorization

When reselling Yingjixin products, if the statement of the product parameters is different or false compared with the parameters marked by Yingjixin, it will

Loss of all express or implied authorizations for related Yingjixin products, and this is an unfair and fraudulent business practice. Yingjixin is not responsible for any such false

None of the representations assumes any responsibility or liability.

