Input Current Adaptation and NTC Function, 2A Synchronous Step-down Single Section Multi Type Lithium Battery Charging Management IC

General Description

IU5302T is a 5V input that supports buck charging management IC for single lithium or lithium-ion polymer batteries. It integrated power MOS adopts a synchronous switch architecture, which requires very few peripheral devices during application, effectively reducing the overall solution size and BOM cost. The IU5302T converter has a charging current capacity of 2A, and the charging current can be flexibly adjusted through external resistors.

The IU5302T has four built-in loops to control the charging process, namely a constant current (CC) loop, a constant voltage (CV) loop, a chip temperature adjustment loop, and an intelligent adjustable charging current to prevent the output of the adapter from collapsing, and to match the input adaptive loops of all adapters. The IU5302T input adaptive point is flexibly adjustable through an external voltage divider resistor.

IU5302T adjusts the voltage sharing ratio of the external feedback resistor of the battery to obtain different constant voltage charging voltage values, thereby adapting to different specifications of single lithium batteries.

IU5302T has comprehensive protection functions, including input undervoltage/overvoltage protection, battery overvoltage and short circuit protection, battery temperature protection NTC function, chip temperature protection, and charging timeout protection. In addition, the chip monitors the entire charging process through an external LED indicator light.

Features

- Synchronous Step-down Charging
- External Adjustable Charging Current
- ±1% Battery Constant Voltage Accuracy
- Input Adaptive Current Limiting Function, Adaptive Point Externally Adjustable
- NTC Function
- The Constant Voltage Charging Voltage is Independently Adjustable, Suitable for Different Specifications of Single Lithium Batteries
- Maximum Charging Time Limit
- Built-in Power MOS
- Charging State Indication
- Chip over Temperature Protection, Chip Temperature Adaptive adjustment
- Input Undervoltage and Overvoltage Protection
- Battery Short Circuit and Overvoltage Protection

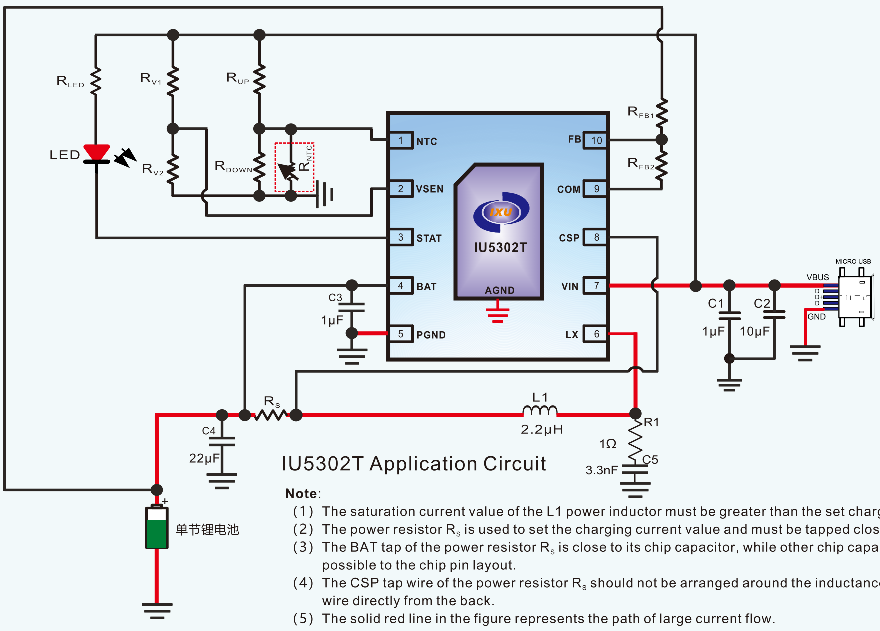
Package

- DFN2X2_10L

Applications

- Lithium Iron Phosphate Battery Pack
- 4.2V/4.3V/4.35V/4.4V Lithium Battery Pack
- Other Types of Single Lithium Battery Pack

Typical Applications



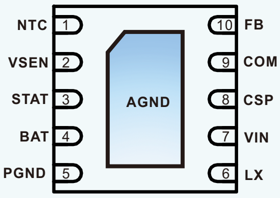
IU5302T Application Circuit

Note:

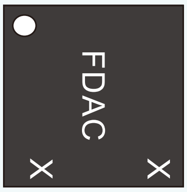
(1) The saturation current value of the L1 power inductor must be greater than the set charging current, with sufficient margin left.
(2) The power resistor R_S is used to set the charging current value and must be tapped closely at both ends.
(3) The BAT tap of the power resistor R_S is close to its chip capacitor, while other chip capacitors should be placed as close as possible to the chip pin layout.
(4) The CSP tap wire of the power resistor R_S should not be arranged around the inductance, and it is recommended to run the wire directly from the back.
(5) The solid red line in the figure represents the path of large current flow.

PIN Configuration and Functions

DFN2X2_10L



(TOP PERSPECTIVE)



(TOP VIEW)

PIN	NAME	TYPE	DESCRIPTION
1	NTC	I	Thermistor input pin, through the external thermistor to detect the battery temperature
2	VSEN	I	VIN voltage detection and input adaptive threshold modulation pins
3	STAT	O	Charging status indication port
4	BAT	I	Battery positive pin.
5	PGND	-	Power ground
6	LX	I	Switch node, inductor connector
7	VIN	P	Power supply
8	CSP	I	Battery charging current detection positive input
9	COM	O	Battery voltage detection resistance and internal switch tube connection terminal of the chip
10	FB	I	Battery voltage feedback terminal
11	AGND	-	Analog ground

Absolute Maximum Ratings [1]

SYMBOL	PARAMETER	VALUE	UNIT
VMAX	VIN,BAT,LX,CSP,STAT,NTC,VSEN,FB,COM	-0.3~8	V
T_J	Junction operating temperature range	-40~150	℃
T_{STG}	Storage temperature range	-55~150	℃
T_{SDR}	Lead temperature (Soldering, 10 sec.)	260	℃

Recommended Operating Conditions

SYMBOL	PARAMETER	VALUE	UNIT
V_{IN}	Input power supply voltage	3.5~7	V
T_J	Junction operating temperature range	-40~125	℃
T_A	Ambient temperature range	-40~85	℃

Thermal Information [2]

SYMBOL	PARAMETER	VALUE	UNIT
θ_{JA}	Package thermal resistance - chip to environment thermal resistance	80	℃/W

Ordering Information

Device	Package Type	Device Marking	Reel Size	Tape Width	Quantity
IU5302T	DFN2X2_10L		7″	8mm	3000

ESD Ratings

HBM (Human Body Model) -- ±2kV

MM (Machine model) -- ±200V

1. The above parameters are only the limit values of device operation. It is not recommended that the working conditions of the device exceed the limit values. Otherwise, the reliability and life of the device will be affected, and even permanent damage will be caused.
2. Where the PCB board is placed in IU5302T, a heat dissipation design is needed. The heat sink at the bottom of IU5302T is connected with the heat sink area of PCB board.

Electrical Characteristics (V_{IN}=5V，R_{CS}=25mΩ，L=2.2uH，unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
VIN	Supply voltage		3. 5	5	8	V
VIN_{UVLO}	VIN under voltage lockout threshold	VIN Falling		3.5		V
ΔVIN_{UVLO}	VIN under voltage lockout hysteresis			200		mV
VIN_{OVP}	VIN over voltage protection	VIN Rising		8.47		V
ΔVIN_{OVP}	VIN over voltage protection hysteresis			240		mV
I_Q	Input quiescent current			1		mA
I_{SD}	Input shutdown current	V_{VSEN}=0		70		µA
I_{BAT}	Battery leakage current	Unplug charger or V_{VSEN}=0			1	µA
		plug charger, R_{FB1}=510KΩ, R_{FB2}=160KΩ		20		
V_{VSEN}	VSEN pin modulation voltage			1		V
V_{FB}	Feedback voltage modulation threshold		0.99	1	1.01	V
V_{CV}	Terminal battery voltage	$K=1+R_{B1}/R_{B2}$		$K*V_{FB}$		V
V_{RCH}	Recharge voltage	V_{BAT} Falling		$0.975V_{CV}$		V
V_{TRK}	TC charge mode battery voltage threshold	V_{BAT} Rising		$0.6V_{CV}$		V
V_{SHORT}	Battery short threshold	V_{BAT} Falling		$0.25V_{CV}$		V
V_{OVPB}	BAT over voltage threshold	V_{BAT} Rising		$1.1V_{CV}$		V

Electrical Characteristics (V_{IN}=5V，R_{CS}=25mΩ，L=2.2uH，unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{SENSE}	Maximum current sense voltage			50		mV
I_{CC}	CC charge mode current	R_S=25mΩ	1.8	2	2.2	A
I_{TC}	TC charge mode current			10%		I_{CC}
I_{BF}	Terminate charge current			10%		I_{CC}
V_{cold}	NTC low temp falling threshold	Percentage of VIN		80		%
V_{cold_hys}	NTC low temperature protection hysteresis	Percentage of VIN		0.74		%
V_{hot}	NTC high temp rising threshold	Percentage of VIN		45		%
V_{hot_hys}	NTC high temperature protection hysteresis	Percentage of VIN		0.74		%
F_{SW}	Switching frequency			900		KHz
TMR_{TC}	Trick charge time limit			14		Hour
$TMR_{CC/CV}$	CC/CV charge time limit			23		Hour
T_{REG}	Thermal regulation threshold			120		℃
T_{SD}	Thermal shutdown temperature			150		℃
ΔT	Thermal shutdown temperature hysteresis			40		℃

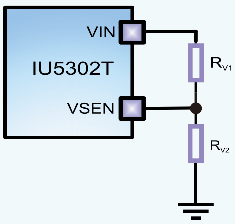
IU5302T Application Points

1. Charge Process

The IU5302T adopts a complete TC/CC/CV charging process. When the voltage of a single lithium battery is less than the trickle point, the system charges at 10% * I_{CC} charging current; When the voltage of a single lithium battery is greater than the trickle point, the system charges with I_{CC} charging current; When the battery voltage approaches the set float charging voltage, the system enters constant voltage charging, and the charging current continues to decrease. When the charging current is less than 10% * I_{CC}, the system will stop charging; When the battery is fully charged and the battery voltage drops to the set recharge voltage due to self discharge or load consumption, the system will restore the charging state.

2. Input Current Adaptive Function

The IU5302T has a special built-in loop that can automatically adjust the charging current to prevent the input DC power from entering an overdrive state, thereby preventing any improper setting that may cause the adapter to collapse.The voltage of the VSEN pin of the IU5302T input adaptive function is modulated at 1V, and the minimum input voltage that can be reduced to VIN_{AJ} is determined by selecting two resistors, R_{V1} and R_{V2}. The specific calculation formula is as follows:



$$VIN_{AJ} = \frac{1*(R_{V1}+R_{V2})}{R_{V2}}$$

If the pin is connected to a VIN, this function is disabled; If grounded, charging is prohibited.

3. Protection Function

IU5302T has a comprehensive battery charging protection function. When the chip experiences input overvoltage, output overvoltage, or chip overheating, the system charging will be prohibited until the protection state is released; When the battery voltage is below 1V, the output short circuit protection function is activated; When the input voltage is lower than the undervoltage protection threshold of 3.5V, all main functional modules of the chip will be turned off to avoid misoperation of the system due to low power supply voltage; In addition, the system has a protection function for charging out of date. If there is a problem with a lithium battery, it will cause the charging time to be too long. When the TC stage charging time is greater than 12 hours or the CC charging time is greater than 20 hours, the charging expiration protection function will be activated and the charging process will be forcibly terminated. Only when the system is powered on again or the battery status changes will the timer be reset.

4. Charging Indication Function

The STAT state pin of the chip outputs a 0 level or high resistance state. If the LED lamp is not connected, but directly connected to the main control, there must be a pull-up resistor to convert the high resistance state into the exact high level.

- The charging process is constantly on, but it goes off after charging.
- When there is input overvoltage, battery overvoltage, battery short circuit, NTC port detects temperature abnormality, chip overheating, and charging timeout, the LED indicator light will flash at a frequency of 2Hz.
- When the chip is turned off or the input is under voltage, the LED indicator light turns off.
- When the battery is not connected, the LED indicator light flashes several times and then goes out.

5. Charge Current Setting

The constant current charging current can be set by resistance R_S, and the specific calculation formula is as follows:

$$I_{CC} = \frac{50mV}{R_S(m\Omega)}(A)$$

In order to obtain 2A charging current, it is only necessary to select a detection resistance R_S with a resistance value of 25mΩ. Thus, the charge current I_{TC} of TC stage is determined by the following formula:

$$I_{TC} = 10\% I_{CC} = \frac{5mV}{R_S(m\Omega)}(A)$$

Pay special attention that when the charging current is 1A, the rated power of the corresponding R_S is greater than 0.1W (0805 100mΩ 1/8W), and when the charging current is 2A, the rated power of the corresponding R_S is greater than 0.2W (1206 50mΩ 1/4W).

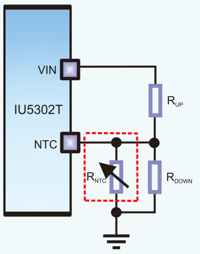
6. Chip Temperature Regulation Function

The IU5302T has a built-in temperature adaptive adjustment loop. When the chip is in the charging process, if the temperature rises to 120℃, the temperature control loop begins to work, and the charging current gradually decreases. The chip temperature will then decrease, and ultimately the chip temperature will stabilize at the set value, thereby protecting the chip.

7. NTC Resistor Setting

Battery charging supports NTC protection function, and the temperature of the battery is detected through the NTC pin. When NTC detects that the battery temperature is within the set temperature window range, it charges normally; When NTC detects that the battery temperature is below the set low temperature protection point or above the set high temperature protection point, it stops charging and alarms.
If the NTC function is not used, the pin must be grounded.

The following figure shows the high temperature reference points and low temperature reference points set internally through voltage divider resistors, with the low temperature reference point being VIN*80% and the high temperature reference point being VIN*45%. Set the temperature range for normal operation of NTC by selecting appropriate external resistors.



$$\frac{R_{DOWN}//R_{NTC\_Cold}}{R_{UP}+R_{DOWN}//R_{NTC\_Cold}}=80\%$$

$$\frac{R_{DOWN}//R_{NTC\_Hot}}{R_{UP}+R_{DOWN}//R_{NTC\_Hot}}=45\%$$

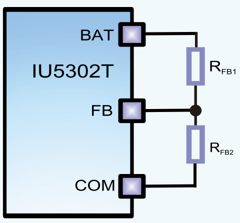
R_{NTC_Cold} in the above equation is the resistance value corresponding to NTC resistance at the set low temperature point, while R_{NTC_Hot} is the resistance value corresponding to the NTC resistor at the set high temperature point. Due to the independent setting of low and high temperature windows for R_{DOWN} and R_{UP} resistors, IU5302T can meet most NTC resistance models, which brings great convenience to applications. The relationship between resistance R_{DOWN}, R_{UP}, and NTC resistance can be given by the following formula based on the above definition:

$$R_{UP}=\frac{35*R_{NTC\_Hot}*R_{NTC\_Cold}}{36*(R_{NTC\_Cold}-R_{NTC\_Hot})}$$

$$R_{DOWN}=\frac{35*R_{NTC\_Hot}*R_{NTC\_Cold}}{9*R_{NTC\_Cold}-44*R_{NTC\_Hot}}$$

8. Battery Floating Charge Voltage Setting

The internal clamping voltage threshold corresponding to the FB pin of the chip is 1V. According to this voltage and the two external voltage dividing resistors R_{FB1} and R_{FB2}, the floating charge voltage value of battery charging can be set. The specific formula is as follows:



$$V_{CV}=\frac{1*(R_{FB1}+R_{FB2})}{R_{FB2}}$$

9. Selection of Inductance Value

In order to choose the right inductance, a trade-off between cost, size and efficiency is needed. A smaller inductance has a small size, but it will lead to high peak current, high magnetic loss and large output filter capacitance. On the contrary, large inductance has small peak current and small output filter capacitance, but its high DCR will lead to large power loss. Based on practical experience, the peak current value of inductance should not exceed 30% of the maximum charging current value in the worst case. The specific value of inductance can be determined according to the following formula:

$$L=\frac{VIN-V_{BAT}}{\Delta I_{L\_MAX}}*\frac{V_{BAT}}{VIN*F_S}$$

Among them, V_{IN}, V_{BAT} and F_S represent input voltage, battery voltage and system working frequency respectively. ΔI_{L_MAX} is the maximum peak-peak current of inductance, generally 30% of CC charging current is taken as follows:

$$\Delta I_{L\_MAX}=30\%*I_{CC}$$

In order to improve the system efficiency, the DC resistance of the selected inductor should be less than 50mΩ.

10. Selection of Input Capacitance

The input capacitance is used to absorb the input peak current of the step-down converter. The selected input capacitance shall ensure that the temperature rise due to peak current cannot be greater than 10℃. Because of its smaller temperature coefficient and lower ESR, the ceramic capacitor with dielectric constant of X5R or X7R can be selected. For most applications, 22uF capacitance can meet the requirements.

11. Selection of Output Capacitor

The output capacitor is connected with the battery in parallel, which can absorb the peak current of the high frequency switch and smooth the output voltage. Its impedance must be much smaller than that of the battery to ensure that it can absorb most of the high frequency current. Small ESR and small ceramic capacitance can be selected. The value of the output voltage ripple is given by the following formula:

$$\Delta r_O=\frac{\Delta V_O}{V_O}=\frac{1-\frac{V_O}{VIN}}{8C_O F_S^2 L}$$

In order to ensure ±1% output battery voltage accuracy, the maximum output voltage ripple should not be higher than 1%.

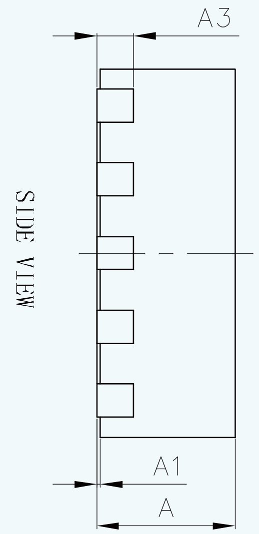
12. PCB Layout Note

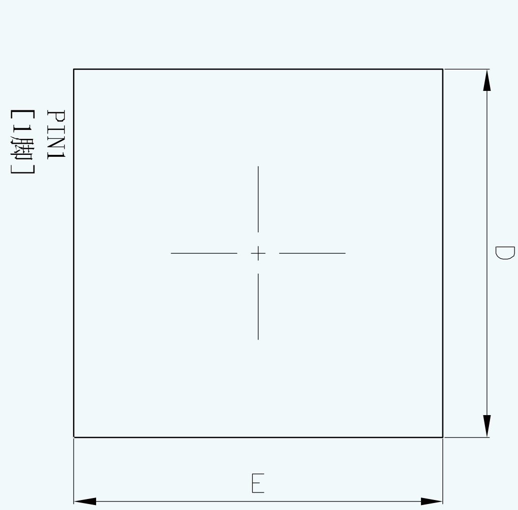
The PCB shown on our DEMO board is only for reference. Please layout and wiring according to the actual components and product requirements, but with its general principles:

- The power cord should be as wide as possible, and the chip should be powered separately from the power cord.
- The power cord should be as wide as possible, and the chip should be powered separately from the power cord.
- The LX wiring should be as short as possible to reduce EMI.
- Inductance and RS resistor connections are short and thick to avoid through hole jumpers.
- The capacitor at the power supply end should be placed as close to the chip as possible.

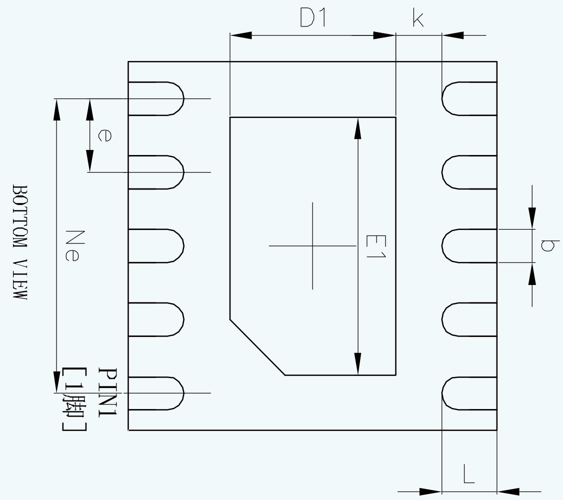
Package Information

IU5302T DFN2X2_10L





SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
A1	0.000	0.025	0.050
A3	0.203REF.		
D	1.900	2.000	2.100
E	1.900	2.000	2.100
D1	0.800	0.900	1.000
E1	1.300	1.400	1.500
k	0.250REF.		
b	0.155	0.180	0.205
e	0.400BSC		
Ne	1.600BSC		
L	0.250	0.300	0.350



TAPE AND REEL INFORMATION