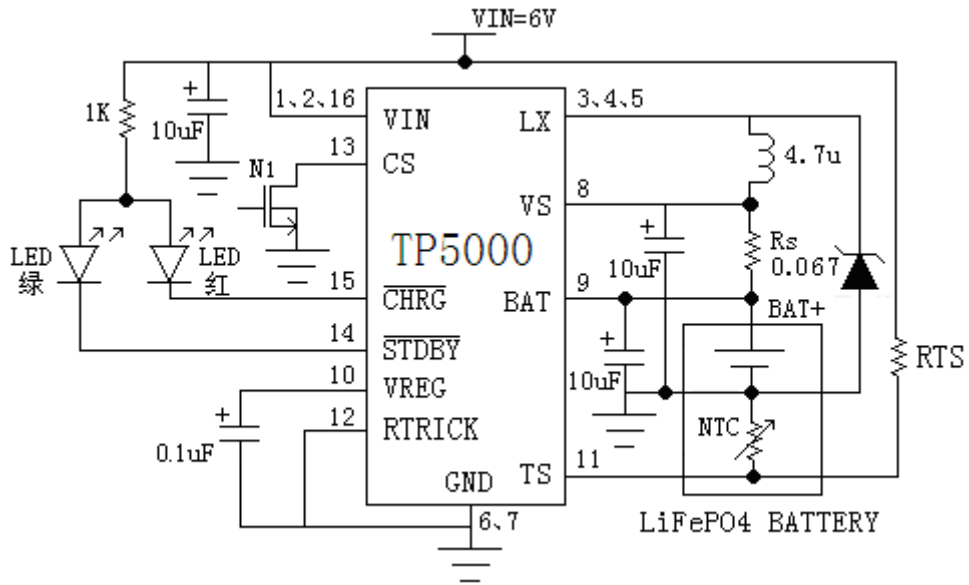


Data Sheet
DATASHEET

TP5000

(2A switching 4.2V lithium battery lithium iron /3.6V

Battery charger)

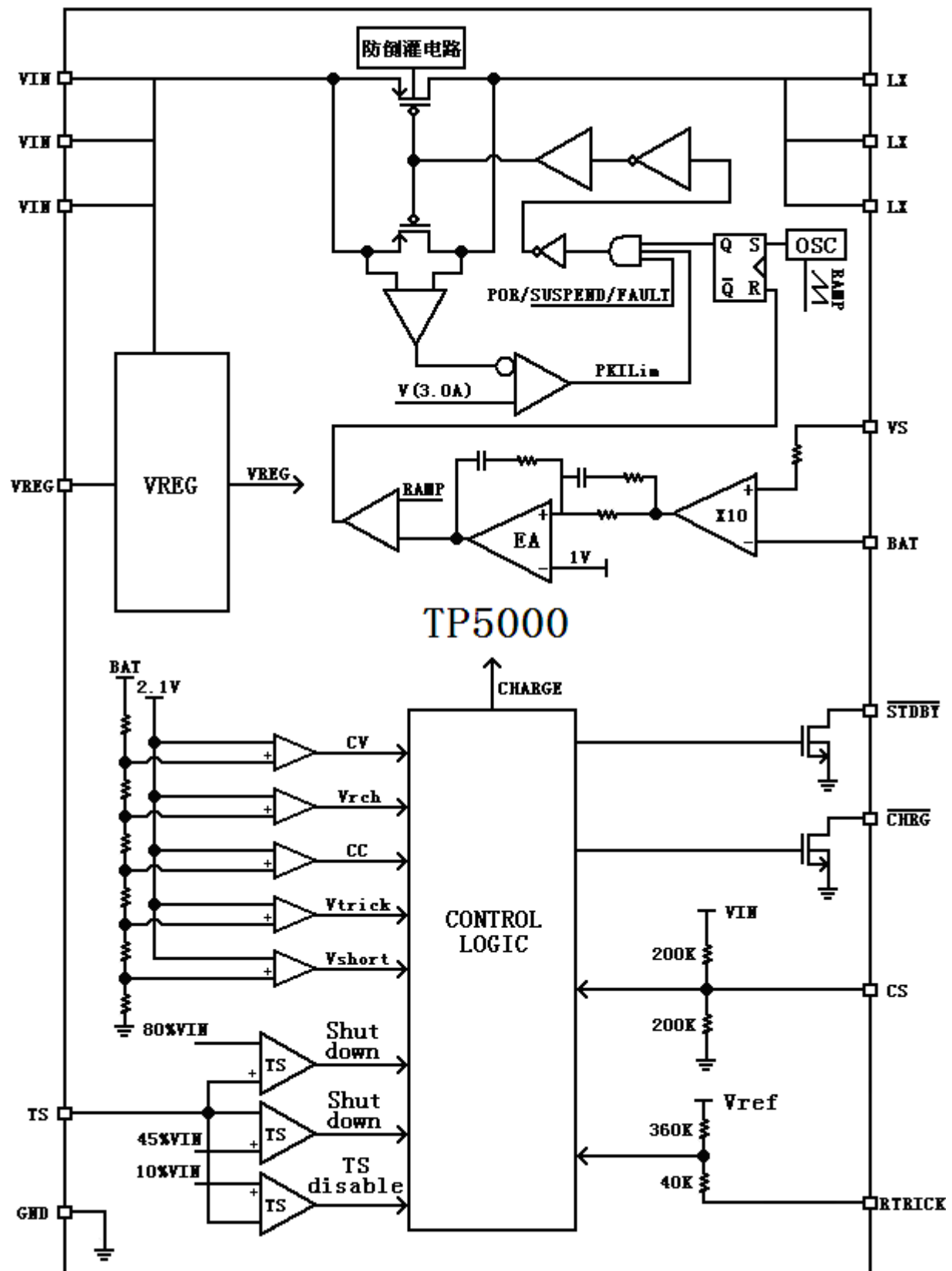


Map 2 TP5000 for 3.6V Lithium iron phosphate battery 1.5A Charging (150MA) Application schematic prefilled

Package / Ordering Information

<p>16 Pin 4mm * 4mm QFN16 A top view of the package (Pin 6 unacceptably other ground potential)</p>	<p>Orders models</p> <p>TP5000-QFN16</p> <p>Device Marking</p> <p>TP5000</p> <p>Physical picture</p>

TP5000 Functional block diagram





Map 3 TP5000 Functional Block Diagram

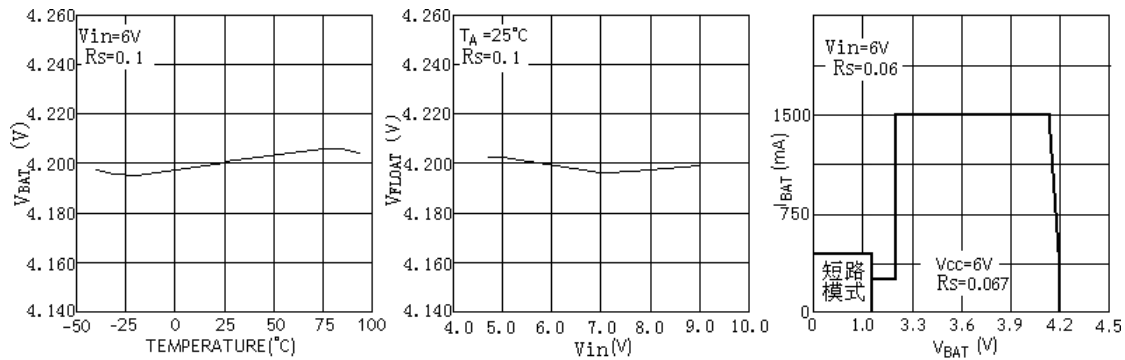
Electrical characteristics

Table 1 TP5000 electric characteristics can parameter

The • denotes specifications which apply over the full operating temperature range, otherwise specifications are T_A = 25 °C, VIN = 6V, unless otherwise noted.

symbol	parameter	condition		Min Typ Max Units				
VIN	Input supply voltage		•	4.0	5	9.0	V	
Icc	Input supply current	Charging mode, R_S = 0.1 Ω standby mode (charge termination) Stop mode (CS = GND , V_{in} < V_{BAT} ,or V_{in} < V_{UV})	• • •		250 180 180 250 250	300 300 250 250	μ A μ A μ A	
V _{FLOAL}	Charge cutoff voltage	4.2V Lithium Ion Battery		4.158	4.2	4.242	V	
		3.6V Lithium iron phosphate battery		3.564	3.6	3.636	V	
I _{BAT}	BAT Pin Current: (current mode test conditions CS = VIN Battery = 3.8V)	R _S = 0.1 Ω, constant current mode	•	950 1450 1000	1000	11,001,600	mA	
		R _S = 0.067 [Ωmega], the constant current mode, a standby mode, V _{BAT} = 4.2V VIN = 0V , V _{BAT} = 4.2V	•		1500			mA
			•		- 4	- 6		uA
			•		- 4	- 6		uA
I _{TRIKL}	Trickle pre-charge current RTRICK Pin to ground	1.2V < V_{BAT} < V_{TRIKL} , R_S = 0.067	•	150	170	190	mA	
F	The oscillation frequency			650	800	950	KHz	
D _{MAX}	The maximum duty cycle				100%			
D _{MIN}	The minimum duty cycle			0%				
V _{TRIKL}	Trickle charge threshold voltage (4.2V) (3.6V) R_S = 0.067 Ω, V_{BAT} rise			2.8	2.9	3.0	V	
				2.4	2.5	2.6		
V _{TRHYS}	Trickle charge voltage hysteresis	R _S = 0.067 Ω		60	80	100	mV	
V _{UV}	V _{in} Undervoltage lockout threshold	From V _{in} Low to High	•	3.5	3.7	3.9	V	
V _{UVHYS}	V _{in} Undervoltage lockout hysteresis		•	150	200	300	mV	
V _{ASD}	V _{in} V _{BAT} Lockout threshold voltage	V _{in} From low to high		605	10030	14050	mV	
		V _{in} High to Low					mV	
I _{TERM}	C / 10 Termination current threshold	R _S = 0.067 Ω	•	130	150	170	mA	
V _{CHRG}	 Low voltage output pin	I _{CHRG} = 5mA			0.3	0.6	V	
V _{STDBY}	 Pin output low	I _{STDBY} = 5mA			0.3	0.6	V	
V _{TEMP-H}	TEMP Pin high voltage shutdown				> 80	82	% * VIN	
V _{TEMP-L}	TEMP Pin low-end voltage shutdown			43	<45		% * VIN	
Δ V _{RECHRG}	Threshold voltage of the rechargeable battery	V _{FLOAL} - V _{RECHRG}		100	150	200	mV	
T _{LIM}	Chip temperature protection				145		°C	
R _{ON}	power FET "On" resistance				260		m Ω	
t _{ss}	Soft start time	I _{BAT} = 0 to I _{BAT} = 0.1V / R _S			20		u S	
t _{RECHARGE}	Filter Time recharge	V _{BAT} High to Low		0.8	1.8	4	mS	
t _{TERM}	Termination Comparator Filter Time	I _{BAT} Drops C / 10 the following		0.8	1.8	4	mS	

Typical performance indicators (CS Set as 4.2V Lithium battery charging mode)



Cutoff voltage and off-voltage relationship between the ambient temperature and power source voltage relationship of the battery charging current and voltage relationship

Pin Function

VIN (Pins 1 , 2 , 16) : Input voltage at the positive input terminal. This voltage is the power supply pin of the internal circuit, VIN

Changes in scope 4.5V to 9V Between, and through a

10 μ F Tantalum capacitor bypass. when VIN with V_{BAT} Pressure lower than 30mV Time, TP5000 Enter shutdown mode, reducing the I_{BAT} Drops 4 μ A .

LX (Pins 3 , 4 , 5) : Built-in power drain of PMOSFET connection point. LX is TP5000 current output terminal of the external inductor is connected to a battery charging current input terminal.

GND (Pins 6 , 7) : Power ground.

VS (Pins 8) : Positive input of the output current detection.

BAT (Pins 9) : Battery voltage detection terminal. The positive terminal of the battery is connected to this pin.

VREG (Pins 10) : An internal power supply. VREG is an internal power supply, it is an external bypass capacitor 0.1 μ F to ground.

TS (Pins 11) : Battery temperature detection input terminal. will TS Pin to battery NTC (Negative temperature coefficient thermistor) sensor output. in case TS Pin voltage less than the input voltage 45% Or greater than the input voltage 80% It means that the battery temperature is too low or too high, the charging is suspended. in case TS Direct access GND Battery temperature detection function is canceled, another charging function properly.

RTRICK (Pins 12) : Trickle precharge current set terminal. will RTRICK Pin to ground to the pre-charge current 10%

Setting a constant current, the precharge current may be provided by an

external resistor. in case RTRICK Floating the precharge current equals the constant current.

CS (Pins 13) : Lithium iron phosphate or a lithium-ion state of the chip select input. CS High-end input level will TP5000 In the lithium-ion battery 4.2V Off-state voltage. CS The vacant end TP5000 In lithium iron phosphate 3.6V Off-state voltage. Low input level so TP5000 It is shutdown.

CS End can be TTL or CMOS Level driver.

STDBY (Pins 14) : Indicating completion of charging the battery terminal.

When the battery is fully charged STDBY Internal switch is pulled low to

indicate the completion of charging. In addition,

STDBY The pin is in high impedance state.

CHRG (Pins 15) : Charging indicator status. When the battery is

being charged, CHRG Internal switch pin is pulled low, indicating the charging progress; otherwise

CHRG Pin is high impedance.

working principle

TP5000 is designed for single 4.2V lithium ion/ 3.6V

Switching high current charger IC, a chip inside a power transistor using lithium iron phosphate for the design of the battery and trickle, constant current and constant voltage charging. The charging current can be programmed with an external resistor, the charging current up to the **maximum continuous 2A , No additional anti-intrusion diode. TP5000** comprising two open-drain output state indication output terminal, the **charging indicator status CHRG And FULL status outputs STDBY . Power** management circuitry inside the chip junction temperature of the chip **exceeds 14 Automatically reduces the charge current 5 °C, this feature allows** the user to use the maximum power handling capability of the chip, do not worry about damaging the chip or the chip overheating external components.

When the input voltage is greater than the threshold voltage of the chip enable and chip enable input terminal HIGH or floating time, TP5000 start charging the battery, CHRG Output pin to indicate that charging is in progress. If the lithium ion battery voltage is below 2.9V (Lithium iron phosphate is lower than the voltage 2.5V), The battery trickle charger for pre-charging (pre-charge current through the external adjustable resistance) with a small current. The **constant current VS Pin and VBAT Determining the resistance between the pin. When the voltage is close to the lithium ion battery 4.2V (Proximity lithium iron phosphate 3.6V)**, The charge cut-off voltage of about from 50mV (Connection resistance to the internal resistance of the battery voltage differs depending on the circuit), the charging current is gradually reduced, TP5000 constant voltage charging mode. When the charge current is reduced to the off **current, the charging period ends, CHRG End a high impedance state, STDBY** The low potential side. _____

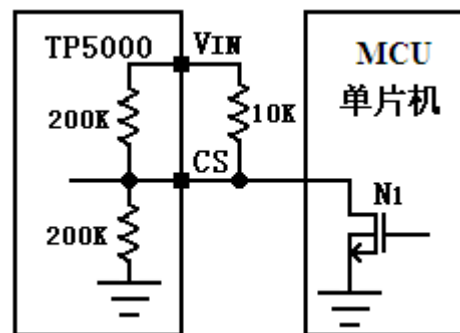
When the battery voltage falls below the recharge threshold (lithium ion battery 4.05V ,Lithium iron phosphate battery 3.45V), The charge cycle starts automatically. Inside the chip precision voltage reference source, an error amplifier and the resistor divider network to ensure that the battery **terminal voltage cutoff accuracy + - 1% Or less, a lithium ion battery** satisfying the lithium iron phosphate and charging requirements. When the input voltage or input voltage down below the battery voltage, the charger enters a low power shutdown mode, no external anti-intrusion diode chip drain from the battery approaches 4uA . Charge cutoff voltage selection

TP5000 having a single lithium-ion / iron phosphate lithium two charging cut-off voltage selected. when CS High end connected

Electric potential VIN , The lithium-ion battery is 4.2V standard cut-off voltage 4.2V. When the vacant terminal CS, the charging standard lithium iron phosphate, the cutoff voltage 3.6V. When CS Termination low GND , The charger stops charging.

TP5000 composite design of the CS terminal can be determined by an external control TP5000 is in charging mode is switched to the stop mode.

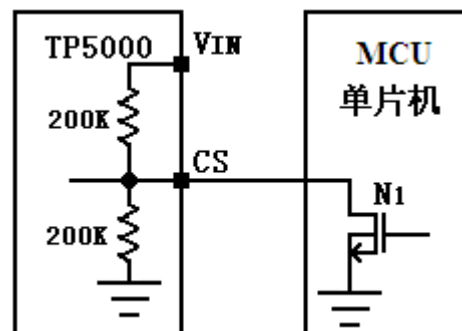
4.2V lithium-ion battery and a state of the stop mode Switch. 4, the output port of the CS terminal via an open-drain, the gate of NMOS transistor if the input low, NI off, then terminating CS high, the charge-cutoff voltage of 4.2V, TP5000 lithium ion batteries. When the NMOS transistor gate input high, NI turned on, when CS is pulled down to GND, TP5000 is a stop mode.



Map 4 By external control 4.2V Shaped lithium-ion battery

State and stopping state of the switch

3.6V The switching state of charge of the lithium iron phosphate in the off state. 5, if the gate of the NMOS input low, NI off, then CS is floating, the charge-cutoff voltage of 3.6V, TP5000 rechargeable lithium iron phosphate. When the NMOS transistor gate input high, N1 is turned on, CS terminal is pulled down to GND, TP5000 is a stop mode.



Map 5 By lithium iron phosphate in the state of charge of the external control

And stopping the switching state

Charging current setting

Battery charging current I_{BAT} is determined by the external current sense resistor R_s . R_s ratio adjust the threshold voltage V_s and the constant charge current across the resistor is determined by the voltage across the constant current condition R_s is 100mV.

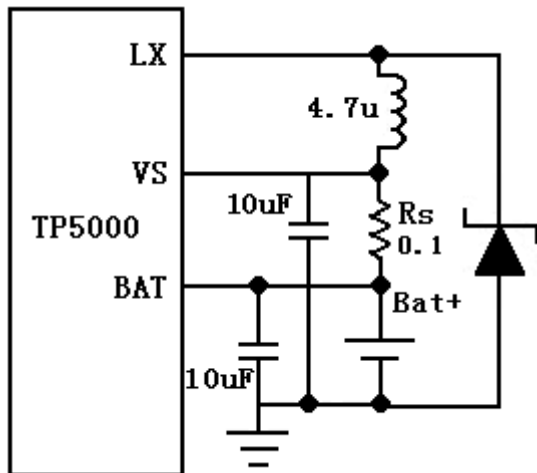


FIG 6 is provided a battery charging current and the charging current setting resistor is calculated using the following equation:

$$R_s = \frac{0.1 \text{ V} (\text{Current units A Resistance per unit})}{I_{BAT}}$$

For example:

To set the charging current 1A, Calculated into the formula

$$R_s = 0.1$$

table 2 It gives some different settings corresponding to the current R_s Resistance, I_{BAT} Relationship:

to facilitate rapid design desired circuit. table 2 : R_s The charge current and the corresponding

R_s ()	I_{BAT} (mA) 1
	100
0.2	500
0.1	1000
0.067	1500
0.05	2000

Trickle precharge current is provided

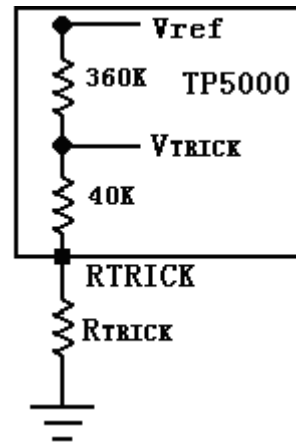
If the battery voltage is below the precharge threshold voltage,

TP5000 A pre-charging operation starts charging the battery, TP5000

The pre-charge current by TRICK

Port settings. A precharge current is employed in connection

TRICK Resistor connected between the pin and ground to set.



Map 7 TRICK From the end of the inner circuit diagram of FIG. 7

As can be seen, if R_{TRICK} Port directly to ground, the resistance ratio obtained by dividing the precharge voltage is the trickle charge current ratio of the constant current. Precharging current is constant charge current 1/10. This pin only changes trickle current, shutdown current is not affected by this, still 10% Constant current.

Setting resistor and a pre-charge current is calculated using the following equation:

$$R_{TRICK} = \frac{400 \text{ k} I_{TRICK} \cdot 40 \text{ k} I_{BAT}}{I_{BAT} \cdot I_{TRICK}}$$

In order to facilitate customers to quickly design, table 3 Gives R_{TRICK}

And the precharge current and constant trickle current setting of I_{BAT}

Relationship. table 3 : R_{TRICK} And setting the constant current trickle current

R_{TRICK} (k)	I_{TRICK} (mA)
0	10% I_{BAT}
50k	20% I_{BAT}
114k	30% I_{BAT}
320k	50% I_{BAT}
Pin floating	100% I_{BAT}

Charge termination

CV phase, when the charging current drops below the maximum value constant 1/10 When the charge cycle is terminated. This condition is achieved by using an internal filtered comparator R_s The pressure drop is monitored to detect. when R_s To a voltage difference across the 10mV For longer than t_{TERM} (Is typically 1.8ms), charging is terminated. Charging current is turned off, TP5000 enters standby mode, where the input supply current to 170µA, about the battery drain current flows 4µA.

In standby mode, TP5000 of BAT Pin voltage is continuously monitored. If the lithium ion battery 4.05V this voltage drops (voltage drops lithium iron phosphate

3.45V) recharging limit switches V_{RECHRG} Or less, and a new charging cycle begins again, a current supplied to the battery. Charging status indicator

TP5000 Two open-drain status output terminal, CHRG with STDBY . When the charger is in the charging state, CHRG It is pulled low, in other states, CHRG in a high impedance state. When the outside temperature of the battery is in a normal temperature range, CHRG with

STDBY Pins are high impedance. When no indication state, the pin can not be connected to ground. Table 4: state of charge indicator

Green <u>STDBY</u>	red light <u>CHRG</u>	charging
Destroy	bright	Charging status
bright	Destroy	Battery is fully charged state
Destroy	Destroy	Voltage, battery temperature is too high, too low or non-fault state battery Access (TS end use)
Green light, red light flashes F = 0.5-2S		BAT termination 10u capacitor, no battery standby state (TS ground)

Battery over-temperature protection

In order to prevent the temperature is too high or too low battery damage caused, TP5000 integrated internal battery temperature detecting circuit. Battery temperature is detected by measuring the voltage pin TS implemented, the voltage pin TS is an NTC thermistor in a battery and a resistor divider network, as shown in FIG. TP5000 inside the TS pin chip with two voltage thresholds V_{LOW} with V_{HIGH} Compared to confirm that the temperature of the battery exceeds a normal range. Inside the TP5000, V_{LOW} is fixed 45%

V_{CC} ,

V_{HIGH} is fixed 80% V_{CC} . If the TS pin

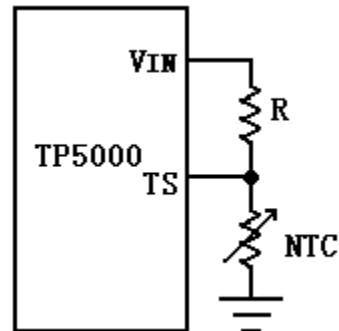
Voltage V_{TS} V_{LOW} V_{HIGH} , Then V_{TS}

Temperature of the battery is too high or too low, the charging process is

suspended; if voltage pin TS V_{TS} in V_{LOW} with V_{HIGH}

Among the charge cycle continues. If the TS pin to ground, battery temperature detection function can be disabled.

Example: room temperature 25 °C $R_{NTC} = 10k$, set protection temperature 60 °C, at 60 °C $R_{NTC} = 3k$, $R = 3.6k$ the calculated time, the NTC resistor-divider ratio is 45% of the supply voltage, i.e. 60 °C TP5000 stop charge.



Map 8 NTC Connection diagram

chip internal thermal limit

If the chip temperature attempts to rise to about 145 °C predetermined value or more, the heat inside a feedback loop to reduce the charge current is set. This feature prevents overheating TP5000, and allows the user increases the maximum for a given power handling capability of the circuit board without risk of damaging the TP5000. In ensuring the charger will automatically reduce the current in the worst case conditions of the premise, according to a typical (but not the worst case) the ambient temperature is set to the charging current. Limiting the short-circuit and an output

TP5000 integrates a variety of protection, the chip input limiting the maximum peak current 3.5A, to prevent chip damage due to excessive current. When the output voltage below about 1.2V, the chip into short-circuit protection mode, the chip input current limit is 10% of the maximum peak current of about 350mA. Of different magnitude of the current with the input voltage difference. Undervoltage lockout

An internal undervoltage lockout circuit monitors the input voltage, and Vin It rises above the undervoltage lockout threshold before the charger in shutdown mode. UVLO Charger circuitry will remain in shutdown mode, no discharge current of the battery. in case UVLO The comparator transition occurs at VIN Raised higher than the battery voltage 50mV Before charger will not retire

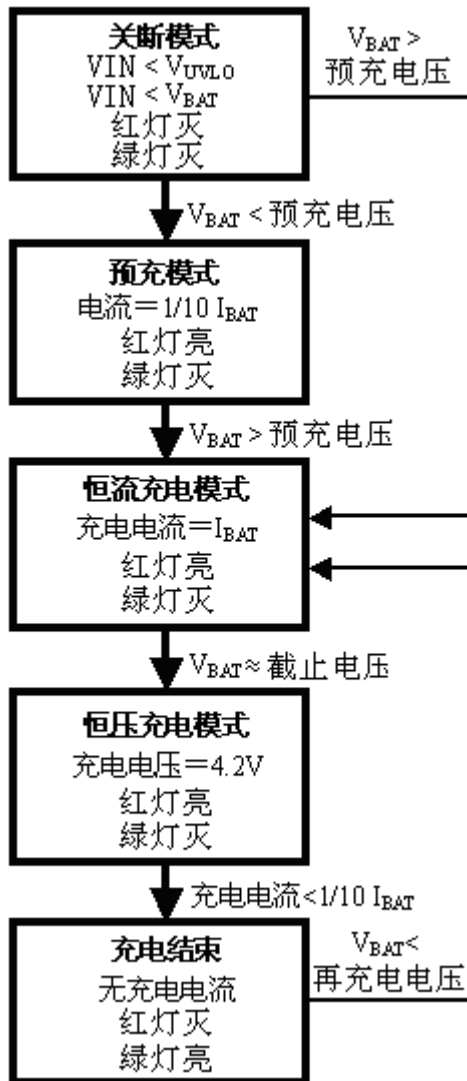
A shutdown mode. So customers need not worry about the input power

Battery power is insufficient relief situations.

Automatic restart

Once the charge cycle is terminated, TP5000 taken immediately

With a filter having a time 1.8ms ($t_{RECHARGE}$) To the voltage comparator on the BAT pin for continuous monitoring. When the battery voltage falls below 90% of the battery capacity, the charging cycle begins again. This ensures that the battery is maintained at (or near) a fully charged state. In the recharge cycle, CHRG Output pin to re-enter a strong pull-down state.



Map 9 A typical lithium-ion battery circulation state in FIG.

White LED driver

TP5000 may be designed to operate at 4.2V lithium battery charge mode, using 2 input string lithium (8.4V) or 4 as an input string of batteries (6V), the output of the direct drive WLED, the white LED is turned on since the operating voltage is about 3.6V, this when in the constant current phase. TP5000 may be provided as single or multiple pieces of parallel white LED white LED efficient, stable driving current, 4.2V and the output voltage limiting protection. Rs adjusts the driving current according to the setting, can be driven

0.5W-7W white LED. Input, output, terminal of the capacitor VS

You can use many types of capacitors, but requires high-quality power capacitors. When the multilayer ceramic capacitor with particular care must be taken, some types of ceramic capacitors having high EMI characteristic values, therefore, under certain conditions (such as the battery charger is connected to the power supply input and a work) may produce a high voltage transient damaging the chip-state signal, tantalum 10uF recommended, to use electrolytic capacitors, electrolytic capacitors need to add a 0.1uF be bypassed and the link pin chip must be mounted close position. Thermal Considerations

although QFN16 The small form factor package, but its good heat dissipation properties, but need PCB Version of the design with the best use of a sophisticated thermal design PCB Plate layout to most significantly increase the charging current may be used. For dissipate IC Cooling path of the generated heat from the chip to the lead frame, by die and reaches the bottom of the fin PCB Board copper. The footprint copper pads should be as wide, and extends outwardly to a large copper area to spread the heat to the surroundings. It recommended to pay more through holes inside or backside copper layer, to improve the overall thermal performance of the charger.

When performing PCB Board layout design, other heat sources related to the charger board also must be considered, because they will affect overall temperature rise and the maximum charge current has been affected.

Inductor Selection

To ensure system stability, and constant current charging the pre-charge phase, the system needs to ensure that operate in continuous mode (CCM). The inductor current equation:

$$I = \frac{1}{LFS} \frac{V_{IN} V_{BAT}}{V_{IN}}$$

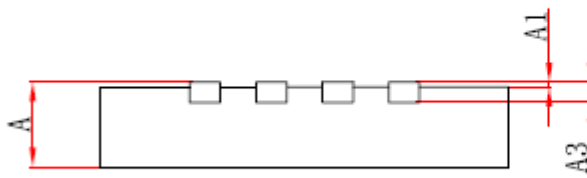
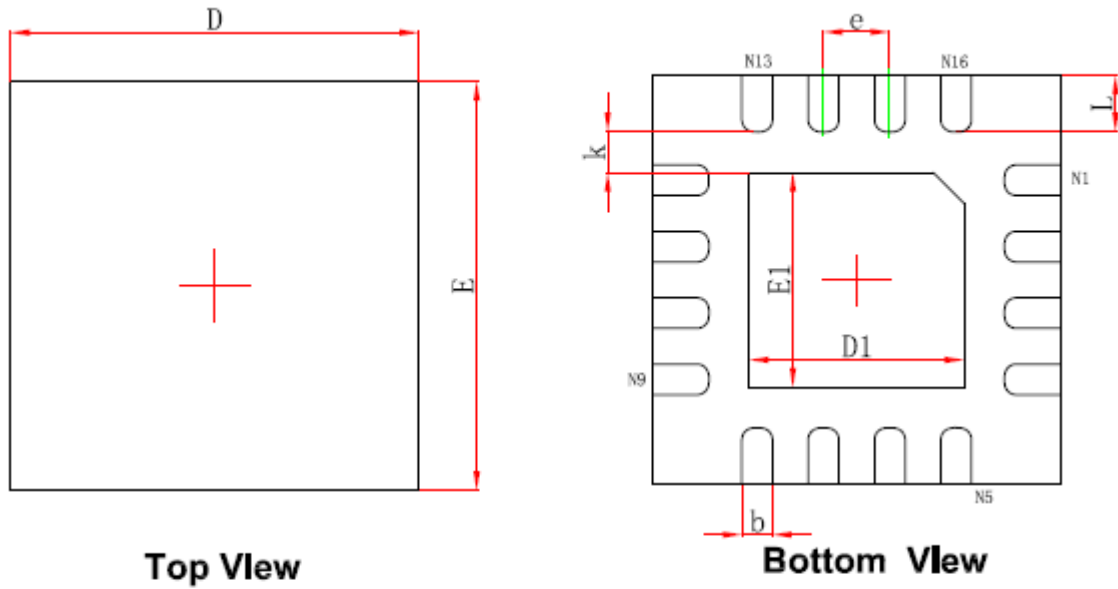
among them I is the inductor ripple, FS is the switching frequency, in order to guarantee pre-charging and constant current charging mode are in CCM,

I Take pre-charge current value, that is 1/5 of the constant current charging, the inductance value can be calculated according to the input voltage requirements.

Inductance values 2.2uH-10uH, recommended recommended 4.7uH. Inductor rated current greater than a charge current is chosen, the smaller the internal resistance of power inductors.

Package Description

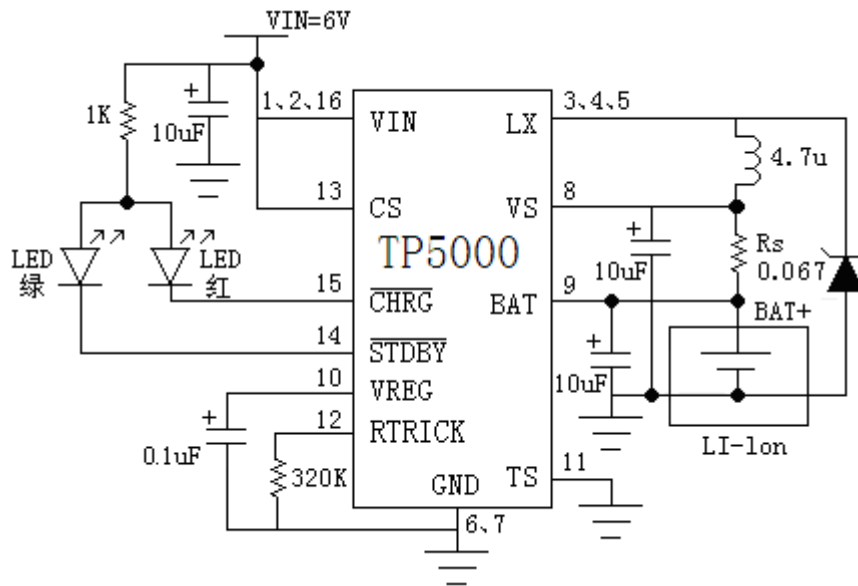
4mm * 4mm 16 Pin QFN Package



Side View

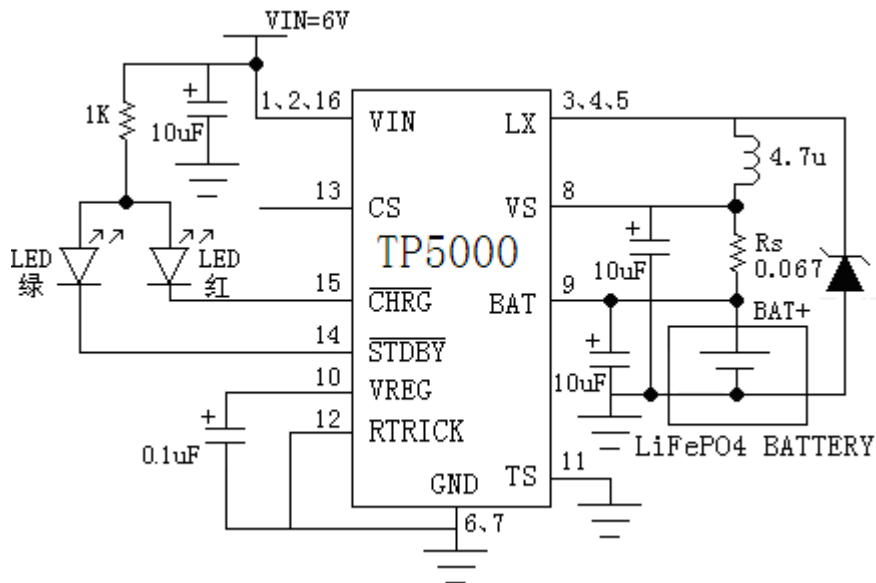
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	3.900	4.100	0.154	0.161
E	3.900	4.100	0.154	0.161
D1	2.000	2.200	0.079	0.087
E1	2.000	2.200	0.079	0.087
k	0.200MIN.		0.008MIN.	
b	0.250	0.350	0.010	0.014
e	0.650TYP.		0.026TYP.	
L	0.450	0.650	0.018	0.026

TP5000 Other application circuit



Map 10 TP5000 is 4.2V A lithium ion battery without the battery temperature trickle protection 0.75A Constant current 1.5A Application schematic charging

(CS Pin is connected to high)



Map 11 TP5000 lithium iron phosphate without battery temperature protection 1.5A Schematic charging applications (CS Pin floating)

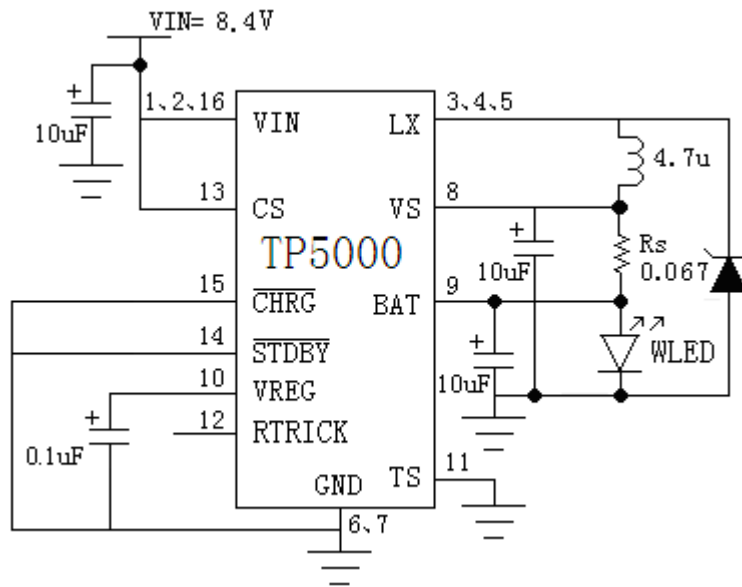
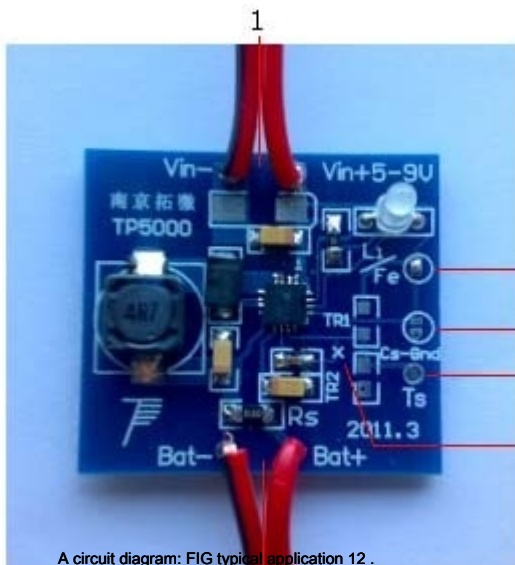


FIG 12 TP5000 5W WLED connected two driven application diagram lithium
(RTRICK pin floating)

TP5000 Precautions

1. The circuit chip capacitors should be as close as possible.
2. VS BAT terminal end and electrolytic capacitors using tantalum or ceramic capacitors added.
3. Please choose the inductor current capability enough power inductors.
4. Selection Schottky diode voltage drop greater than or equal 2A small current capability of the Schottky diode.
5. For VIN and LX to be wider than the signal line common trace current loop.
6. Note that the capacitance of each node location of the grounding line, that the grounding point should be focused, well grounded.
7. chip large current should be considered a good heat sink and the bottom of the chip to the PCB, to ensure good heat dissipation.

TP5000 demo board circuit and use instructions



A circuit diagram: FIG typical application 12 .

Components	model	Package	Quantity
chip	TP5000	QFN16	1
inductance	4.7uH		1
Tantalum capacitors	10uF	1206	3
Ceramic capacitors	0.1uF ,	0603	1
Schottky diodes S495			1
RS resistance	0.067 Ohms or 0.1 and 0.2 Ω	1206	1
led Limiting resistor 1k		0805	1
Red and green common anode led		3mm	1

2

TP5000 Demo version of the pin and Port Description:

Input: Vin + Vin- (Numbering 1) Output: Bat + Bat- (Numbering 2)

CS : Default 4.2V Manganese lithium battery charging mode, CS Meet Vin . Use (No. 3) Solder adhesion;

To 3.6V Lithium iron charge mode, CS Vacant, we need to change (No. 3) To prohibit adhesion;

CS = GND Shutdown mode, (No. 3) Prohibits adhesion, the (No. 4) Adhesion to the pad. Prohibited (No. 3)(Numbering 4)

While adhesions.

TS : No default temperature detector, TS = GND For the use of the (No. 6) Crossed wires at the cut, customers

Can RNTC Sized resistor voltage dividing resistors reserved TR1 , TR2 Two 0805 Pads. TR1 for

TS To Vin resistance, TR2 for TS To GND resistance.

RS : Charge current default 1.5A Figure on RS resistance 1206 resistance. Customers can change the design according to their own needs.

RTRICK : Ground, the default precharge current is 10% Constant current. Use test

Description:

Properly connected and the battery power supply, to charge the battery, charging the red light, green light charging end. In the constant current charging phase, the positive terminal may be an ammeter connected in series in the battery, the charging current is detected, ammeter large range gear. Considering the resistance meter, the final test is not recommended in the fully charged battery voltage mode ammeter connected in series. Resistance will cause shutdown battery voltage is lower than the actual turn-off voltage of the chip itself.

To drive white led After simply adjust suitable current output (No. 2) Bat + Bat- Respectively, then white led

Positive and negative.

Note that selection of the Schottky diode reverse leakage current is less than 1uA At the end of charging or standby battery drain through the Schottky diode may be reversed. Reverse battery does not damage the chip, but the battery will be through the Schottky diode, an inductor,

RS Short circuit loop itself. To replace the chip, it is recommended to use a heat gun such as welding equipment.