Nanjing Tuowei Integrated Circuit Co., Ltd.

NanJing Top Power ASIC Corp.

data sheet

DATASHEET

TP5410

(1A lithium battery charging and 5V/1A boost control chip)

describe

TP5410A single-cell lithium-ion battery charger and constant5VBoost controller, the charging part integrates functions such as high-precision voltage and charging current regulators, pre-charging, charging status indication and charging cut-off, and can output maximum1Arecharging current. The boost circuit usesCMOSProcess manufactured with extremely low no-load currentVFMswitch typeDC/DCboost converter. It has extremely low no-load power consumption (less than10uA), and the boost output drive current capability can reach1A. No need for external keys, plug and play.

The charging part is a linear step-down method, built-inPMOSFET, plus an anti-backflow circuit, so no external sense resistors and blocking diodes are required. Thermal feedback automatically adjusts the charge current to limit the die temperature during high power operation or high ambient temperature conditions, and the full voltage is fixed at4.2V. The charge current can be set externally with a resistor. When the battery reaches4.2VAfter that, the charging current gradually decreases to the set current value1/5,TP5410Charging will be terminated automatically. The boost part also has built-in power NMOSFET, the smaller internal resistance can provide the driving ability to reach 5V/1A. The higher level of integration makesTP5410Only a small number of peripheral components are required to work properly.TP5410It also integrates charging temperature protection, boost input power current limiting loop, can dynamically adjust current according to load conditions, and has fast response and overcurrent shutdown functions. The boost converter adopts the frequency conversion method, so it has extremely low no-load power consumption, ripple, stronger driving ability and higher efficiency than similar products at home and abroad.

Features

★ Programmable charging current up to 1000mA typical, up to 1.2A;

★ Up to 1A boost output current (Vbat=3.3V), maximum output 1.5A (Vbat=3.8v);

★ Automatic frequency adjustment (VFM), adapt to different boost loads (5V no-load standby current is less than 10uA), no button to start

Low battery voltage (less than 2.7V) automatically stops boosting;

・ Special circuit for single-cell lithium-ion battery mobile power supply;

・ Boost high efficiency:88%(Typ),maximum92%;

・ Constant current/constant voltage operation with thermal regulation to maximize charging rate without risk of overheating;

4.2V preset charging voltage with an accuracy of ±1%;

5V preset boost accuracy with an accuracy of ±2.5%, and the 5V voltage can be fine-tuned through an external resistor;

The highest input can reach 10V;

2 charging status indications: open-drain output drives LEDs;

・ C/5 charge termination current;

・ Trickle charge below 2.9VC/5;

・ Soft start of charging reduces inrush current;

・ No needMOSFET, sense resistor or blocking diode;

・ 8-pin ESOP thermally enhanced package.

application

・ mobile power

・ Portable devices

Absolute Maximum Ratings

・ Input supply voltage (V_{CC}): -0.3V～12V

・ PROG: -0.3V～V_{CC}+0.3V

・ BAT: 0V～7V

・ LX: -2V～10V

・ VOUT: -0.3V～10V

・ $\overline{\text{CHRG}}$: -0.3V～10V

・ BATShort Circuit Duration: Continuous

・ BATPin current: 1200mA

・ Boost maximum output current1.8A/5V

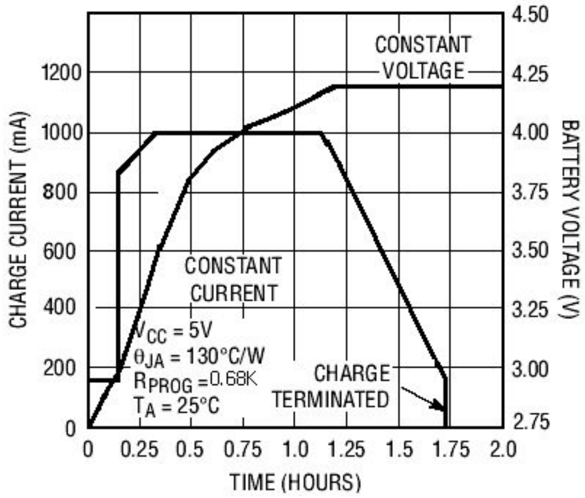
・ Maximum junction temperature: 145°C

・ Working temperature range: -40°C～85°C

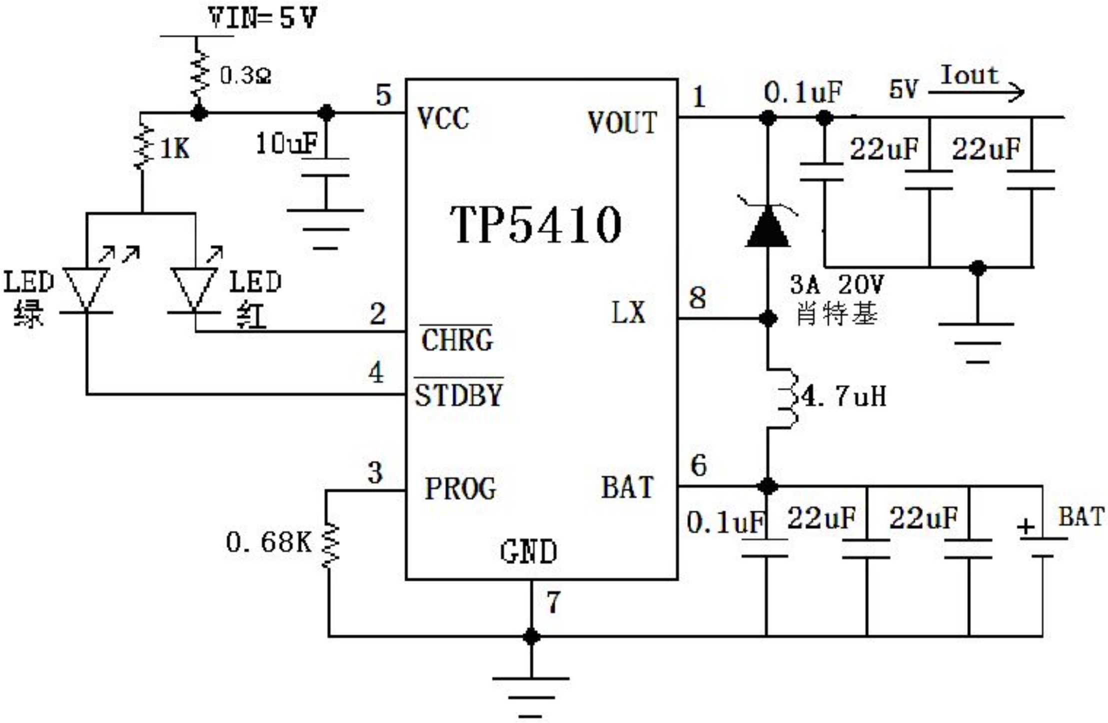
・ Storage temperature range: -65°C～125°C

・ Pin temperature (soldering time 10 seconds) : 260°C

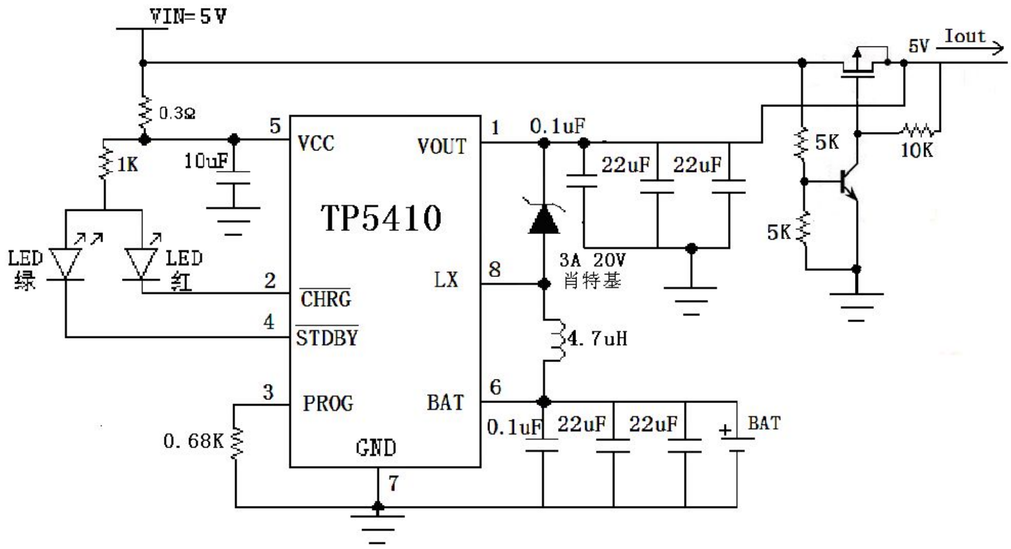
complete charge cycle (1000mAhBattery)



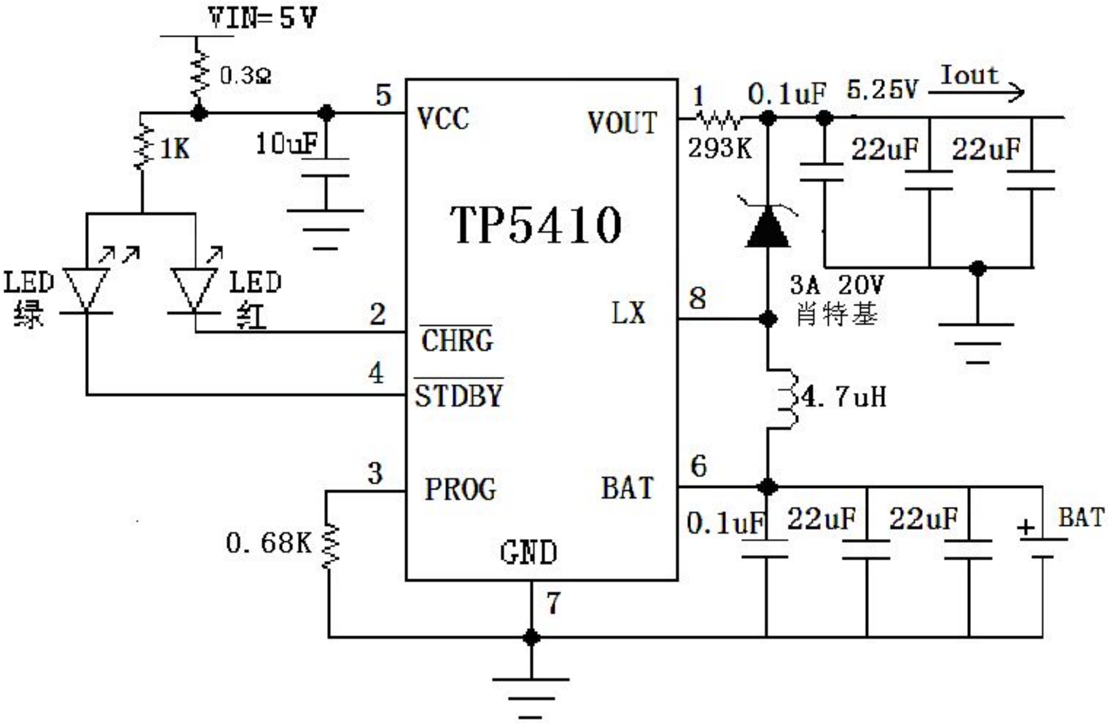
typical application



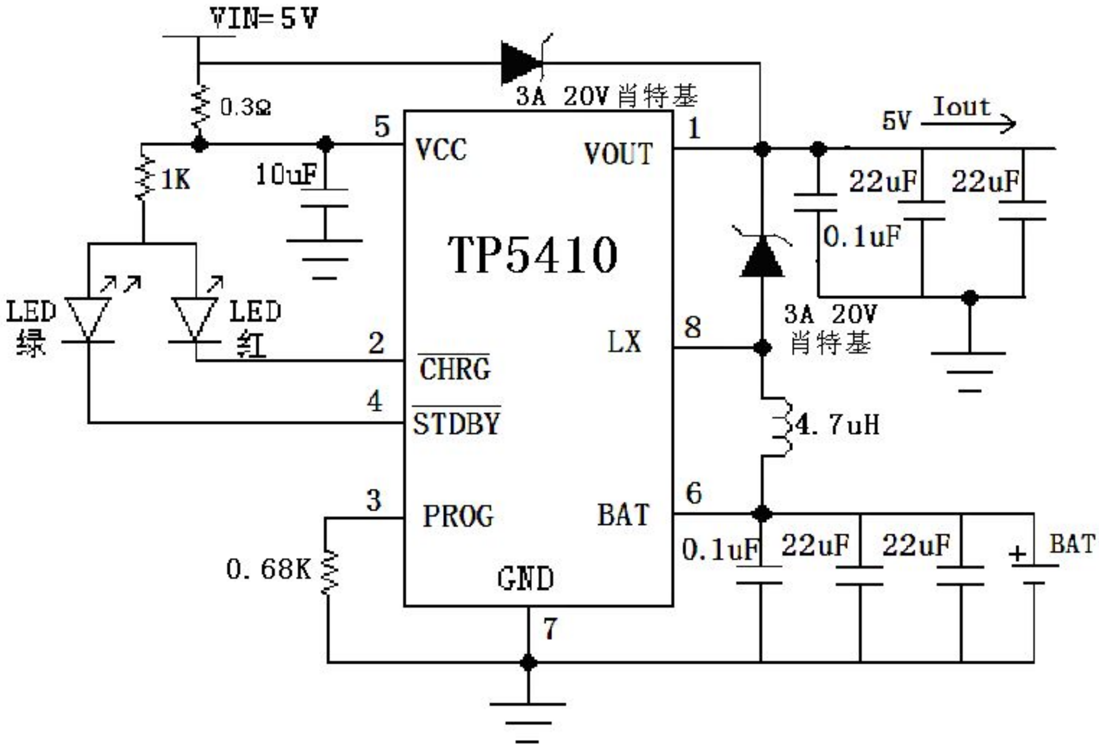
picture1Single-cell Li-ion battery charging1Aand boost5Voutput1Acontroller



picture2Single-cell Li-ion battery charging1Aand charging5Voutput controller

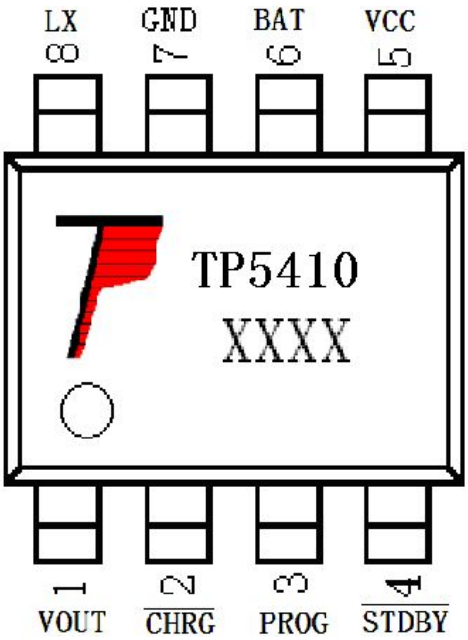


picture3Single-cell Li-ion battery charging1Aand trim boost5.25Voutput controller



picture4Single-cell Li-ion battery charging1Aand charging5Voutput controller

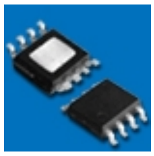
Packaging/Ordering Information



8pinESOPPackage (with heat sink on the bottom

The heat sink is recommended to be grounded)

XXXXis the production date (year.week)

Order model
TP5410-ESOP8
Device marking
TP5410
Physical picture


Electrical characteristics

Where the note ● indicates that the indicator is suitable for the entire working temperature range, otherwise it only refers to T_A=**25°C, V_{CC}=5V**unless otherwise noted.

symbol	parameter	condition		Min Typ Max			unit
V_{CC}	Input supply voltage		●	4.0	5	10	V
I_{CC}	Input supply current	charging mode,R_{PROG}=10K Standby	●		150	500	µA
		Mode (Charge Termination)	●		60	100	µA
		stop mode (R_{PROG}not connected,	●		60	100	µA
		V_{CC}<V_{BAT},orV_{CC}<V_{UV})			60	100	µA
		boost start			0		µA
V_{FLOAL}	Stable output (float) voltage	0°C⩽T_A⩽85°C,I_{BAT}=40mA		4.158	4.2	4.242	V
I_{BAT}	BATpin current (except as statedVbat=4.0v)	R_{PROG}=1.2K, charging mode R	●	560	580	600	mA
		PROG=0.68K, charge mode	●	990	1000	1050	mA
		boost without load,V_{BAT}=3.8V	●		- 10	- 100	µA
I_{TRIKL}	Trickle Charge Current	V_{BAT}<V_{TRIKL},R_{PROG}=1.2K	●	120	130	140	mA
V_{TRIKL}	Trickle Charge Threshold Voltage	R_{PROG}=1.5K,V_{BAT}rise		2.8	2.9	3.0	V
V_{UV}	V_{CC}Undervoltage Lockout Threshold	fromV_{CC}low to high	●	3.4	3.6	3.8	V
I_{TERM}	C/5Termination Current Threshold	R_{PROG}=0.68K	●	150	200	250	mA
V_{PROG}	PROGpin voltage	R_{PROG}=1.2K, charging mode	●	0.9	1.0	1.1	V

$V_{\overline{CHRG}}$	$\overline{CHRG}$pin output low voltage	$I_{\overline{CHRG}}$ =5mA			0.3	0.6	V
$V_{\overline{STDBY}}$	$\overline{STDBY}$ pin output low level	$I_{\overline{STDBY}}$ =5mA			0.3	0.6	V
ΔV_{RECHRG}	Rechargeable battery threshold voltage	V_{FLOAT}-V_{RECHRG}		100	150	200	mV
T_{LIM}	Junction Temperature in Limited Temperature Mode				120		°C
$ChargeR_{ON}$	ChargeMOSTube "turns on" electricity resistance (atV_{CC}andBATbetween)				450		mΩ
t_{SS}	Soft start time	I_{BAT}=0toI_{BAT}=700V/R_{PROG}			20		us
t_{TERM}	Terminate Comparator Filter Time	I_{BAT}down toI_{CHG}/5the following		0.8	1.8	4	ms
VOUT	boost output5V	Load ResistanceRL=1k		4.875	5	5.125	V
V_{BatLOW}	Battery undervoltage protection	Vbatfrom3.6Vdecline	●	2.5	2.7	2.9	V
$V_{BatHigh}$	Battery undervoltage protection unlocked	Vbatfrom2.7Vrise	●	2.8	3	3.2	V
F_{OSC}	Oscillation frequency			300	400	500	KHZ
η boost	boost efficiency	V_{BAT}=3.8VI_{OUT}=500mA			90		%
η boost	boost efficiency	V_{BAT}=3.8VI_{OUT}=1000mA			88		%
Dty	maximum duty cycle				75		%
$boostR_{ON}$	boostNMOSTube internal resistance	V_{LX}=0.4V			120		mΩ
I_{Lxleak}	boostNMOSTube leakage current	V_{LX}=6V				1	uA
Ilmt_nmos	Boost switch current limiting				4	4.5	A

pin function

VOUT(pin1): Output voltage detection pin. connect boost5Voutput.

$\overline{CHRG}$**(pin2): The charging of the open-drain output during charging Electricity status indicator.**When the charger charges the battery, $\overline{CHRG}$pins are internally openedGuan La to low level, indicating that charging is in progress; otherwiseCHRGpin in high impedance state.

PROG(pin3): charging current setting, charging current monitor and shutdown pins. Connect a The precision is1%the resistorR_{PROG}The charging current can be set. When charging in constant current mode, the pin voltage is maintained at1V.

PROGThe pin can also be used to shut down the charger. will set the power resistor is disconnected from ground, an internal one2.5μAcurrent will PROGpin is pulled high. When the voltage of this pin reaches arrive2.7Vof the shutdown threshold voltage, the charger enters shutdown machine mode, charging stops and the input supply current drops to60 μA. resetR_{PROG}Connecting to ground will restore the charger return to normal operation.

$\overline{STDBY}$ **(pin4): indicating terminal of battery charging completion.** When battery charging is complete$\overline{STDBY}$pulled by the internal switch A low level indicates that charging is complete. besides,$\overline{STDBY}$ The pins will be in a high impedance state.

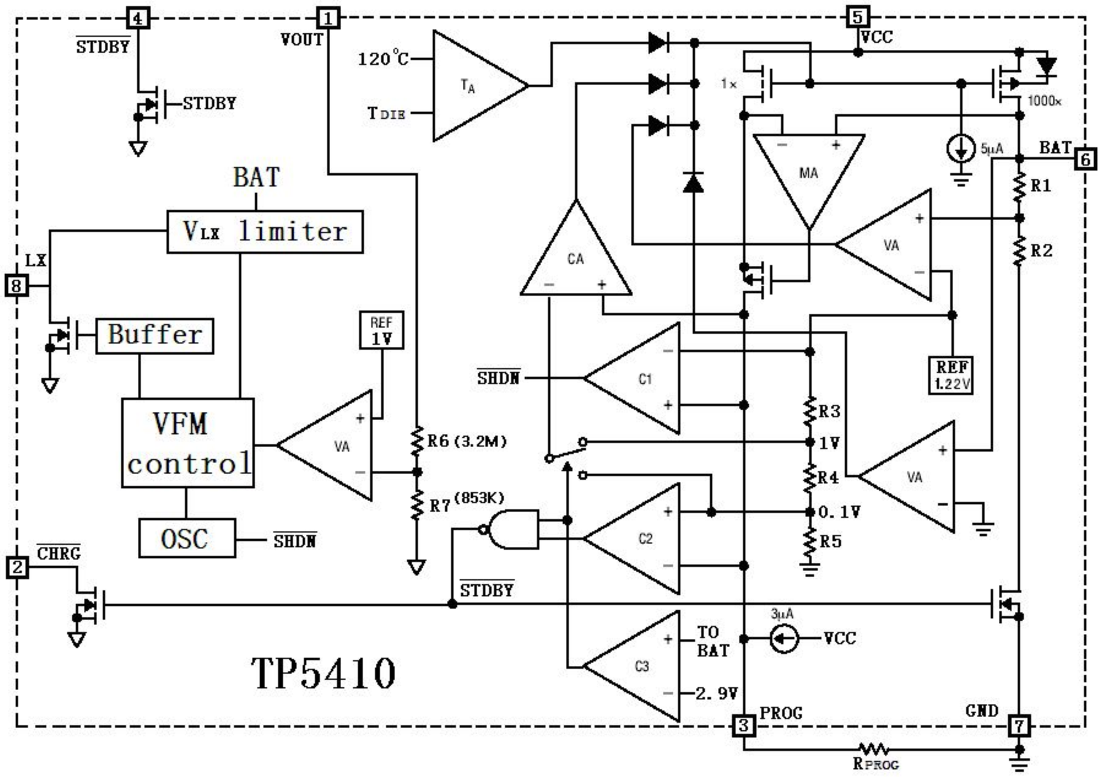
V_{CC}**(pin5): Charger input power supply voltage.**Charge Input Power Pin. Typical value5V, and should pass at least one10μFcapacitors are bypassed. whenV_{CC}down to BATpin voltage30mVwithin,TP5410The charging section enters shutdown mode, boosting the voltage thus enablingI_{BAT}down to 10μAthe following.

BAT(pin6) **: Charge current output.**This pin provides the battery charge current and regulate the final float voltage to4.2V. A precision internal resistor divider on this pin sets the float voltage, in shutdown mode In the formula, the internal resistor divider is disconnected, and the internal working power supply is in boost mode.

GND(pin7):land

LX(**pin8**):The output terminal of the power tube inside the boost circuit.

block diagram



working principle

TP5410 is a constant current/constant voltage Charge and boost discharge controller for single-cell Li-Ion batteries. It is capable of supplying 1000mA of charge current (with a good thermal design of the PCB layout). The boost circuit has a built-in NMOS power transistor, and only needs an external inductor and a Schottky two The 5V boost output can be completed with a pole tube and a small amount of capacitors.

When the VOUT end is connected to the load, the TP5410 can provide a 5V voltage regulator with a driving capacity of 1A.

charge cycle

When the Vcc pin voltage rises above the UVLO threshold level and a setting is connected between the PROG pin and ground resistor and when a battery is connected to the charger output , a charging cycle begins. If the BAT pin level is lower than 2.9V, the charger enters the trickle precharge mode. In this mode, the TP5410 provides a set charge current of 1/5 of the constant current in order to boost the current voltage to a a safe level for full current charging.

When the BAT pin voltage rises above 2.9V, the charger enters the constant current mode, which supplies constant current to the battery. fixed charging current. When the BAT pin voltage reaches the final float voltage (4.2V), the TP5410 enters constant voltage mode mode, and the charging current begins to decrease. When the charging current drops to 1/5 of the set value, the charging cycle ends.

Setting of charging current

The charge current is taken using a connection inPROGpin with resistor between ground to set. Set the resistor and charge The electrical current is calculated using the following approximate formulas as required the charging current to determine the resistor value,

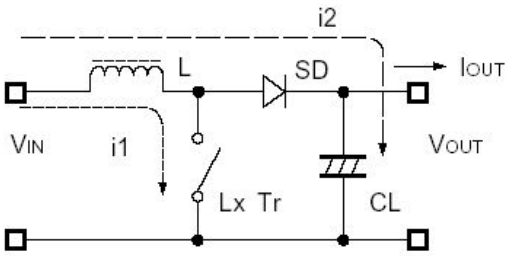
formula: R_{PROG}- $\frac{700}{I_{BAT}}$

In customer applications,RPROGThe relationship with the charging current can be determined by referring to the following table:

RPROG(Ω)	IBAT
10k	80mA
5k	160mA
1.2k	580mA
0.75k	900 mA
0.68k	1000mA

Charge terminated

When the charging current reaches the final float voltage



The charge cycle is terminated when it falls to 1/5 of the set value. This condition is achieved by using an internal filtered comparator to The PROG pin is monitored to detect. When the PROG pin voltage falls below 200mV for more than t_{TERM}(Typically 1.8ms), charging is terminated. The charging current is latched off, and the TP5410 enters standby mode, at which point the input supply current drops to 60µA. (Note: C/5 terminates at trickle charge and disabled in thermal limiting mode).

While charging, transient loads on the BAT pin can cause The PROG pin voltage briefly drops below 200mV before the DC charge current drops to 1/5 of the programmed value. 1.8ms filter time on the termination comparator (t_{TERM}) to ensure that transient loads of this nature do not cause the charge cycle to terminate prematurely end. Once the average charge current falls below 1/5 of the programmed value, the TP5410 terminates the charge cycle and stops supplying any current through the BAT pin. In this state, BAT leads All loads on the feet must be powered by batteries.

In standby mode, TP5410 continuously monitors the BAT pin voltage. If this pin voltage drops to 4.1V The recharge threshold of (V_{RECHRG})Following, another charge cycle begins and current is supplied to the battery again. when in When manually restarting a charge cycle in standby mode, input voltage must be removed and then reapplied, or must be turned off Disconnect the charger and restart using the PROG pin.

Charge Status Indicator (CHRG STDBY)

TP5410There are two open-drain status indication outputs end,CHRGandSTDBY. When the charger is charging,CHRGis pulled low, in other states state,CHRGin a high impedance state. When the battery is not connected to the charger,CHRGThe output pulse signal indicates no Install the battery. When the battery connectionBATThe external capacitance of the pin is10uFTimeCHRGBlink period approx.0.5-2second.

When the status indication function is not used, the unused status Indicates that the output is connected to ground.

The status of the indicator light can refer to the following table:

charging	red light CHRG	green light STDBY
charging status	Bright	extinguish
battery fully charged	extinguish	Bright
no battery status	flicker	Bright
When boost works	extinguish	extinguish

Charge undervoltage lockout

An internal undervoltage lockout circuit regulates the input voltage is monitored and will be monitored after Vcc rises above the undervoltage lockout threshold. before leaving the charger in shutdown mode. The UVLO circuit will make The charger remains in shutdown mode. If the UVLO comparator trips, the charger will not come out of shutdown until Vcc rises to 50mV above the battery voltage.

In the case of charging lockout, if the lithium battery voltage is higher than 3V, the boost circuit starts automatically.

automatic restart

Once the charge cycle is terminated, the TP5410 takes with a filter time of 1.8ms ($t_{RECHARGE}$) to continuously monitor the voltage on the BAT pin control. When the battery voltage drops to 4.1V (roughly corresponding to the battery 80% to 90% of capacity), the charge cycle is heavy Fresh start. This ensures that the battery is maintained at (or close to) a fully charged state and eliminates the need for periodic charging The need for cycle start. During the recharge cycle, CHRGpin output re-enters a strong pull-down state state,STDBYpin output re-enters a high impedance state state.

Charge current soft start

The TP5410 includes a soft-start circuit that minimizes inrush current when When a charge cycle is initiated, the charge current will be Rise from 0 to full scale value in about 20mS. During startup, this maximizes Reduce the effect of transient current loads on the power supply.

Boost discharge circuit

The boost circuit utilizes the energy storage of the inductor and passes the Through its common bleeder effect with the input power supply, the output voltage higher than the input voltage. As shown below:

The boost circuit is not connected to the charging power supply and the lithium battery When the battery voltage is 3V-4.2V, the booster circuit will automatically start and continuously output a 5V constant voltage source. In addition, when the BAT voltage is 3V-4.2V, and the input power Vcc is less than 3.8V, or Vcc<Vbat+50mV and the PROG terminal is floating, the boost will also work.

Boost circuit with lithium battery low voltage protection function Yes, when the lithium battery voltage is as low as 2.7V, the TP5410 will automatically turn off the boost.

The booster circuit has the function of the normal no-load standby state Has very low no-load current, the average no-load current is about less than 10uA, which ensures that the lithium battery is idle for a long time It can still effectively maintain its own power, extending the power bank The standby time of the system.

Boost output voltage trimming

The boosted output voltage can be passed between diodes and VOUT String an external resistor between the pins for adjustment. Adjusted drive energy The force will decrease accordingly. As shown in the circuit of Figure 3 in a typical application. The relationship between common output voltage and resistance is shown in the following table Show:

The output voltage	Resistance
5.25V	293K
5.5V	479K
6V	710K
6.5V	1.12M

Lithium battery under voltage automatic shutdown

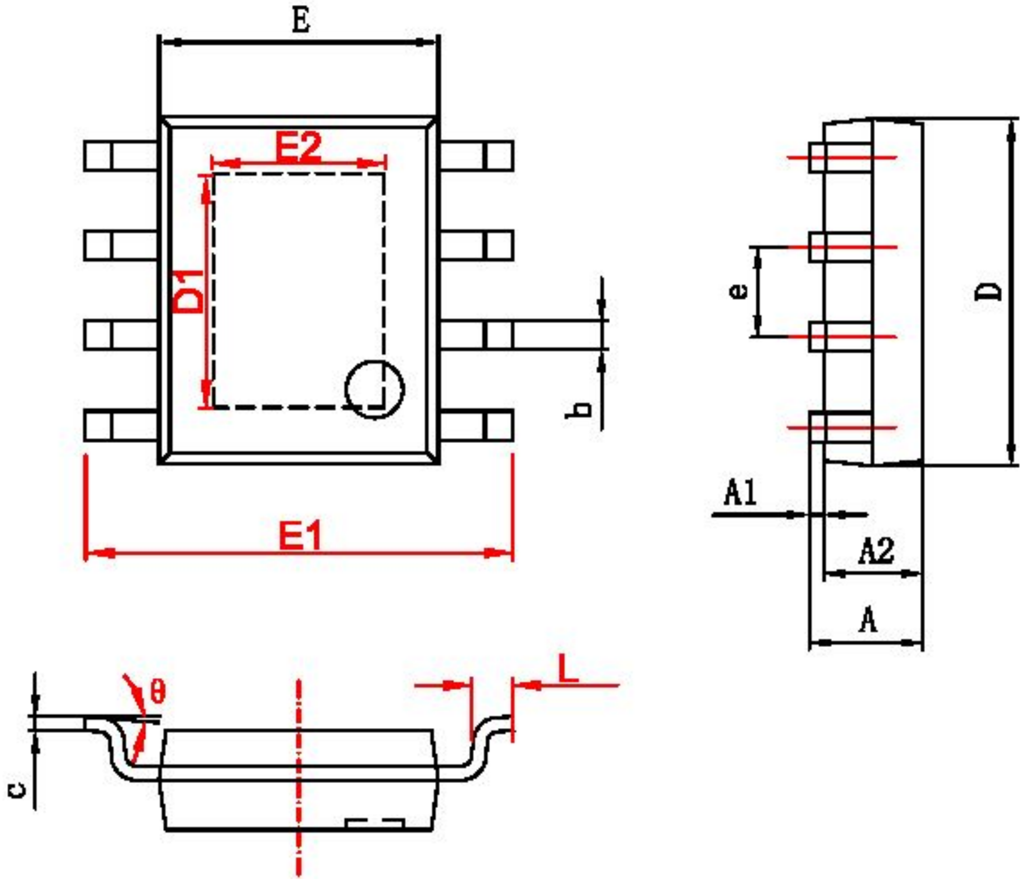
The boost circuit has low voltage protection function of lithium battery, when When the lithium battery voltage is as low as 2.7V, the TP5410 will automatically turn off the boost. When the lithium battery recovers to above 3V, the shutdown state is cancelled and the booster resumes work.

Heatsink Connections and Thermal Considerations

becauseESOP8The package size is small, large Poor heat dissipation in current applications may cause charging The flow is reduced by temperature protection. Recommended heat sink at the bottom of the chip andPCBCopper connections, bottom heatsink can be grounded or It is left floating and cannot be connected to other potentials. using a thermal design SophisticatedPCboard layout to maximize the available The charging current is equally important. for dissipationIC The heat generated by the heat dissipation path from the die to the lead frame rack, and through the peak post lead (especially the ground lead) arrivePCPlate copper surface.PCThe copper surface of the board is the heat sink. The copper foil area connected to the pins should be as wide as possible and extended outward Reach out to a larger copper area to spread the heat around Environment. when carried outPCWhen designing the board layout, other heat sources on the board that are not related to the charger must also be Considered as they will have an overall temperature rise and maximum charge current is affected.

Package description

8pinESOPpackage (unitmm)



字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

TP5410Precautions for test use

1, In order to ensure reliable use in various situations and prevent chip reliability caused by spikes and glitches drop, suggestedTP5410in applicationVcc,BATandVOUTThe capacitor required by the terminal is preferably close to the chip pin, not too far, and it is strongly recommended to connect in parallel0.1uFof ceramic capacitors close to the pins. 2,BAT, VOUTThe terminal capacitance value is recommended to use two parallel22uFCapacitance (capacitor value too small will lead to cause the chip to work unstable, and at the same time have good frequency characteristics). Furthermore, sinceLXWhen the switch driving transistor is turned off, a peak voltage will be generated, and the withstand voltage value of the capacitor should be at least the designed output voltage.3times.

3, inductance value3.3-22uHrecommend4.7uH. In addition, the DC impedance of the external inductor should be small and the current capacity should be high and will not reach magnetic saturation during operation.

4, The external diode should choose a Schottky diode with a higher switching speed, it is recommended to useSS32. 5, The chip is designed to drive a large load, so the smaller the distance between the peripheral components and the chip, the better. Shorter is better. especially receivedVOUTThe components at the end should minimize the length of the connection with the capacitor. 6, GNDThe terminal should be fully grounded, otherwise the zero potential inside the chip will change with the switching current, causing The working state is unstable.