南京拓品微电子有限公司

Nanjing Top Power ASIC Corp

Datasheet

TP5602/TP5602B 4-in-1 Single Chip System Mobile Power Only

(Low cost synchronous type 3A in rechargeable lithium battery, 5V3A boost, display, battery protection)

TP5602/TP5602B 4-in-1 One Chip System Mobile Power

Summary

TP5602 and TP5602B only have differences in LED display mode when in boost mode. The LED light of TP5602 lights up for 3 seconds and then goes off when the button is pressed to boost or automatically boost the voltage; When TP5602B is working with boost, it remains on continuously until the boost stops and the LED goes out. The other functions, typical application circuit diagrams, precautions, packaging, etc. of the two are the same, and are not specifically explained in the following text. Both are introductions to the TP5602 chip.

TP5602 is a powerful VLSI, single chip system, specially designed for medium power mobile supply. Automatic charge management, battery isolation PMOS2, boost management, power display, battery protection and other features are all integrated into a single chip, plus only an input isolation PMOS1, a power NMOS1 and one inductor, a small amount of resistive and capacitive components. Application circuit is simple, reliable performance, free debugging in production, high efficiency and high yield.

TP5602 takes a unique single inductor multiplexing technology, built-in high efficient synchronous step-down 4.2V 3A lithium battery charge circuit and synchronous boost 5V 2.5A output circuit ; 4 LED display output, 5 segment display during charging and discharging the battery, directly to drive red, green, blue LED, and also for the abnormal state of alarm display. No need for external battery protection circuit, battery internal integration of multiple input and output protection inside (overvoltage, overcharge, under voltage, over current, short circuit etc.).

TP5602 additional features: automatic plug charge, Key boost, light load automatic shut down (boost); buck charging adjustable constant; 5V boost externally adjustable output current.

Ultra-small QFN24 package, simple peripheral circuit, making TP5602 is also ideal for other portable devices in independent large current charge and independent boost management application.

TP5602 has a wide input voltage (4.2-7V MAX), anti power-reverse, charging the battery by three phases: trickle charging, constant current, constant voltage. Trickle charging current, constant current through an external resistor adjustment, maximum charging current up to 3A. When charging, the battery voltage raises 4LED segment display status and power. Charging switch frequency 800 KHz makes it possible to use smaller external components and high-current charging still maintain a smaller heat.

TP5602 Built 4.25V VIO adaptive charging circuit, when VIO current drive is not enough to cause VIO down to 4.2V, internal automatically reduce the charge current, the user need not worry about setting over-current encountered a low-power USB port, power supply or adapter .

Built-in anti-intrusion PMOS2 circuit need not for anti-intrusion protection and other external Schottky diode.

TP5602 synchronous boost circuit can output constant voltage / constant current , voltage internal fixed 5V, current up to 3A, the constant current value can be set via an external adjustment (VIlmt): limiting the battery current output , thereby controlling VOUT output power, plus compensation circuit internal to battery voltage and VIO voltage, the output can be kept constant.

The boost start is protected by soft start, output short circuit and over-current protection (250ms over-current / short circuit shutdown).

External NMOS, by-cycle limit current. Typical drive 5V 3A, 5V 3A@Vbat=4V efficiency> 93.5%.

Key Property

Charge the battery on the machine:

■ Single 4.2V lithium battery charging, maximum 3A

■Wide operating voltage, maximum 7V

■ By pass output, Adaptive Power

■ Anti power-reverse, 4.3V overvoltage protection, safer

■ Built-in power management PMOS2, fully synchronous switching mode

■Trickle, constant current, constant voltage, three charging sections, to protect the battery

■ Programmable Charge Current ISET, 0.1A - 3A

■ Trickle pre-charge: 20% ISET, Constant Shutdown Current: 20% ISET

■ 4 LED charge status indicator, the highest bit flashes

■Chip over temperature power automatic reduction protection, under-voltage protection

■ Battery short-circuit protection

■Built-in multi-battery protection, without external protection devices

■Switching frequency 700KHz, typical inductance 2.2uH

■ 4.2V±1% charging voltage control accuracy

■Adopt QFN24 4mm * 4mm ultra-small package

Boost circuit:

■ Button to start the VIO fixed 5V output

■ Adjustable maximum output current, typical output 5V 3A

■ 4 LED charge status indicator, automatic lights off after 3 seconds. （TP5602B light is constantly on）.

6 times less than 3V battery alarm protection, less than 2.4V full stop, no action

■ Chip over temperature protection, automatically reduce the output current, under-voltage, over-current, short circuit protection automatic standby

■ Switching frequency 300KHz

■ Light load (output <30mA) automatic standby after 10 seconds

■ After standby battery current low to 6uA

■ 5V 3A, 4V bat typical output efficiency of> 93.5%.

maximum output5V 3.5A .

Absolute maximum ratings

- ■ VIN: -10 ~ 9V
- ■ VBAT: -0.7V ~ 5V
- ■ Maximum junction temperature: 145 ℃
- ■ Operating ambient temperature range: -40 ℃ ~ 85 ℃
- ■ Storage temperature range: -65 ℃ ~ 125 ℃
- ■Pin Temperature (soldering time of 10 seconds): 260 ℃

Applications

- ■ Mobile Power
- ■ portable device
- ■ Electronic cigarette

Typical Application Circuit

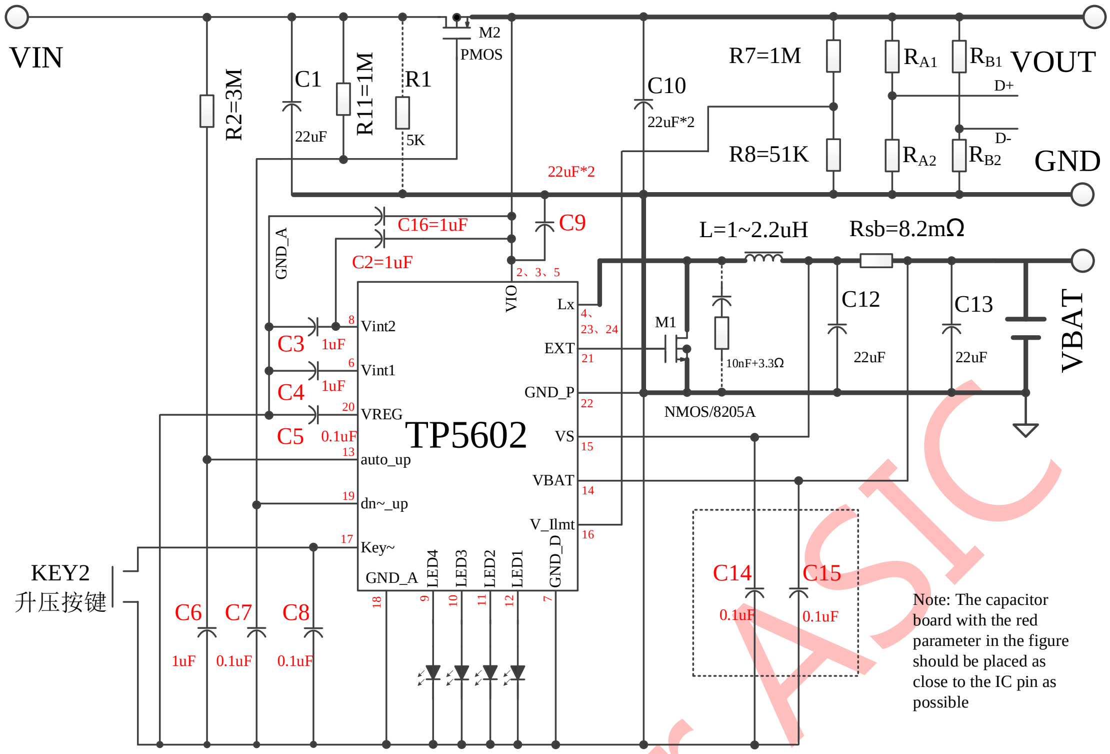
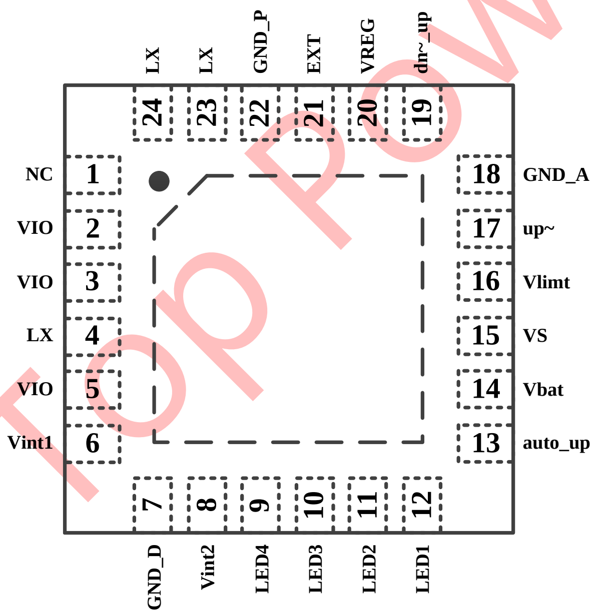


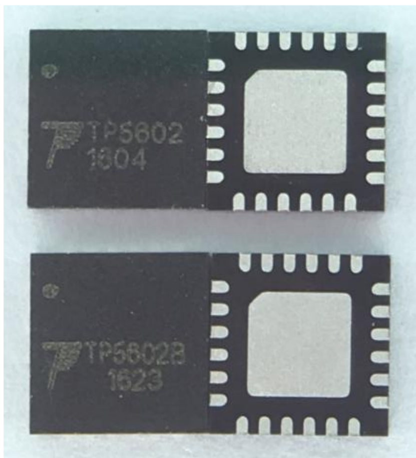
Figure 1 TP5602 4.2V rechargeable Li-ion battery3A, 5V3A boost diagram

Package / Order Information



24 引脚 4mm*4mmQFN24 封装顶视图
（散热片接地不可接其他电位）

ORDER PART NUMBER
TP5602-QFN24/ TP5602B-QFN24
PART MARKING
TP5602/ TP5602B
实物图片



Functional Block

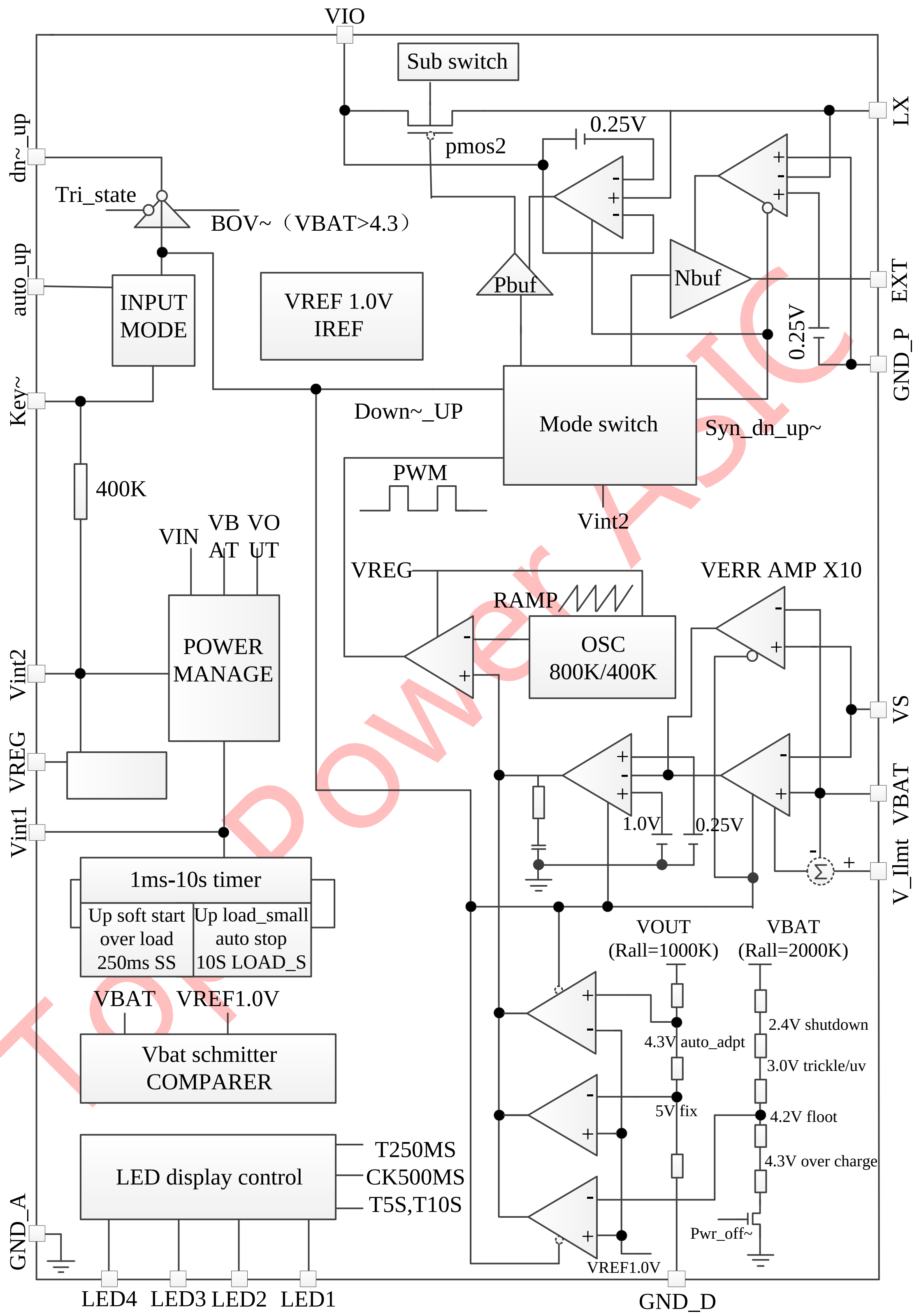


Fig 2 Functional Block Diagram

Electrical Characteristics

Table 1 TP5602 electrical characteristic parameters

The ● denotes specifications which apply over the full operating temperature range, a typical circuit diagram, otherwise specifications are TA = 25 ℃, VIO = 5V, unless otherwise stated. Ron_nmos1 = 15mΩ, Ron_pmos1 = 60mΩ.

Symbol	Parameters	Condition		Min	Typ	Max	Unit
	Buck Charge						
VIN	Input Supply Voltage		●	4.2	5	7.0	V
IVIN	The input supply current (no lights)	Charging mode, RSb = 0.1Ω Standby mode (VB = 4.25) Shutdown Mode (Vin <VBAT; or Vin <VUV)	● ● ●		240 550 550	 750 750	mA μA μA
VFLOAT	Charging cut-off voltage	Rsb = 0.1 4.2V lithium-ion battery		4.160	4.2	4.250	V
Vsb	Constant set voltage reference accuracy	Rsb = 0.1		22	25	28	mV
IBAT	BAT Pin Current: (Current-mode test conditions Battery = 3.8V)	RS = 0.1Ω, constant current mode RS = 8.2mΩ, constant current mode Standby mode, VBAT = 4.25V VIN=0V，VBAT=4.25V	● ● ● ●	 0 0	250 3000 −6 −6	 −10 −10	mA mA uA uA
ITRIKL	Trickle pre-charge current	1.2V<VBAT<VTRIKL，RS=8.2mΩ	●		600		mA
Fdn	Oscillation frequency			600	700	800	KHz
DMAX	The maximum duty cycle				100%		
DMIN	The minimum duty cycle			0%			
VTRIKL	Trickle charge threshold voltage (4.2V)	RS = 0.1Ω, VBAT rise		2.8	2.9	3.0	V
VTRHYS	Trickle charging hysteresis voltage	RS = 0.1Ω		60	80	100	mV
VUV	VIN under voltage lockout threshold	VIN from low to high	●	3.7	3.8	4.0	V
VUVHYS	VIN under voltage lockout hysteresis		●	150	200	300	mV
VADPT	Vin Adaptive starting voltage	VIN High to Low		4.15	4.25	4.35	mV
IBTERM	ISET / 5 termination current threshold	RS = 0.1Ω	●	40	50	70	mA

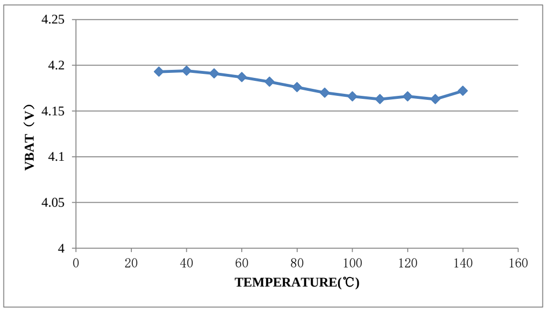
VLED	LED1-4 pin output driver	ILED=2mA		2.5	3	4.0	V
ΔV_{RECHRG}	The rechargeable battery threshold voltage	V_{FLOAT}-V_{RECHRG}		100	120	150	mV
T_{LIM}	Chip Protection Temperature				145		℃
R_{ONP1}	Power PMOS2 on-resistance				30		mΩ
ILMTp	Power PMOS2 by-cycle current limit	0.25V/Ronp1			6		A
$t_{RECHARGE}$	Recharge Comparator Filter Time	VBAT High to Low		300	500	700	mS
t_{TERM}	Termination Comparator Filter Time	IBAT fell CR / 5 or less		1	1.8	2.5	mS

Unless specified otherwise, VIN = 0, VBAT = 3.8V, TEMP = 25 ℃, VIO = 5V, Rout = 5 ohms, Cout = 88uF, Rsb = 8.2mΩ, KEY ~ key to start the step-up

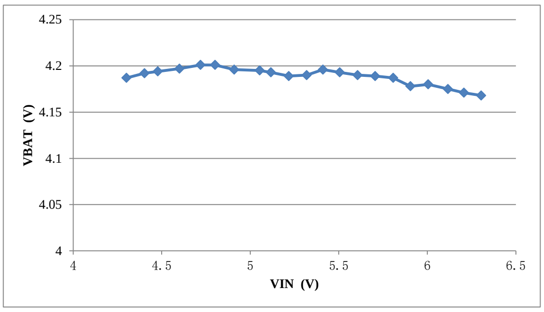
Symbol	Parameters	Condition		Min	Typ	Max	Unit
	Boosting						
VBAT	Input Supply Voltage		●	3.0	3.8	4.5	V
I_{BAT}	Battery output current (lamp not included)	Boost VIO = 5V, Rout = 50K Standby mode Shutdown Mode (VBAT = 2.2)	 ● ●	 2 4 0	 3 6 0.5	 10 15 2	mA µA µA
V_{OUT}	Output voltage accuracy	Rsb=8.2mΩ，IOUT=100mA		4.87	5.02	5.17	V
VIlmt	Setting constant voltage effective range	VIlmt have VIO made by dividing resistors		0		1000	mV
IOUT MAX	VOUT (4.8V) Maximum current	Rsb=8.2mΩ，VIlmt=0.5V		2.8	3	3.2	A
Iout_LS	Light load stop current threshold	L = 2.2u (positive correlation with the inductance)		20	50	100	mA
Fup	Boost oscillation frequency			250	300	400	KHz

DMAX	The maximum duty cycle				85%		
DMIN	The minimum duty cycle			0%			
VLMTn	Power NMOS1-by-cycle current limit voltage	Design value		0.22	0.25	0.28	V
Tdisp	Power LED display period			2.5	3	5	S
Tnoload	Light-load detection period	IOUT = 200mA down to 5mA		5	10	20	S
VuvB3	Battery under voltage standby point	VBAT High to Low		2.8	3	3.2	V
VuvB2	Battery low shutdown point	VBAT High to Low		2.1	2.4	2.6	V
VLED	LED1-4 pin output driver	ILED=2mA		2.5	3	4.0	V
$TEMP_{LIM}$	Chip Protection Temperature				145		℃
T_{ss_up}	Boost Soft-Start Time	VIO = 0 to VBAT (COUT = 100uF)		100	500	2000	uS
IBAT_UP_ST	Output short-circuit battery current			50	100	200	mA
TUP_ST	VIO short detection time	VIO=0V		200	450	600	mS

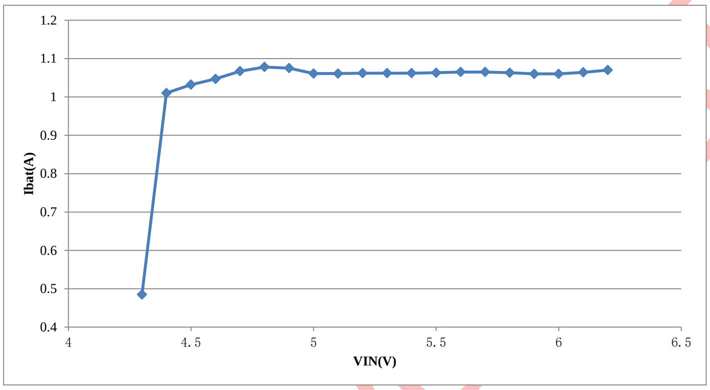
Typical Performance Indicators (Lithium battery charging mode)



Cut-off voltage and temperature

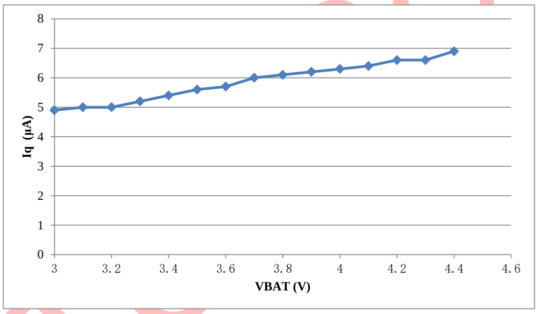


cut-off voltage and Power Voltage

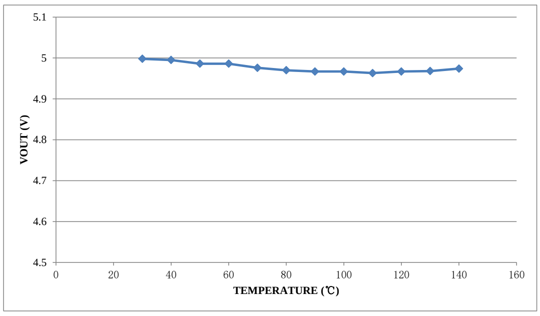


Charging current vs. Power voltage

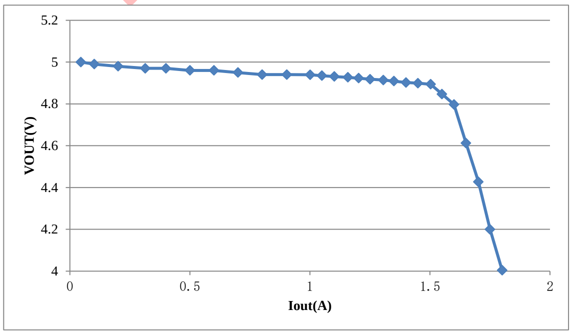
Typical performance indicators (boost mode)

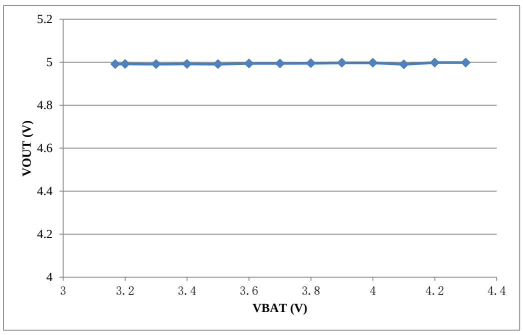


Standby current VS battery voltage



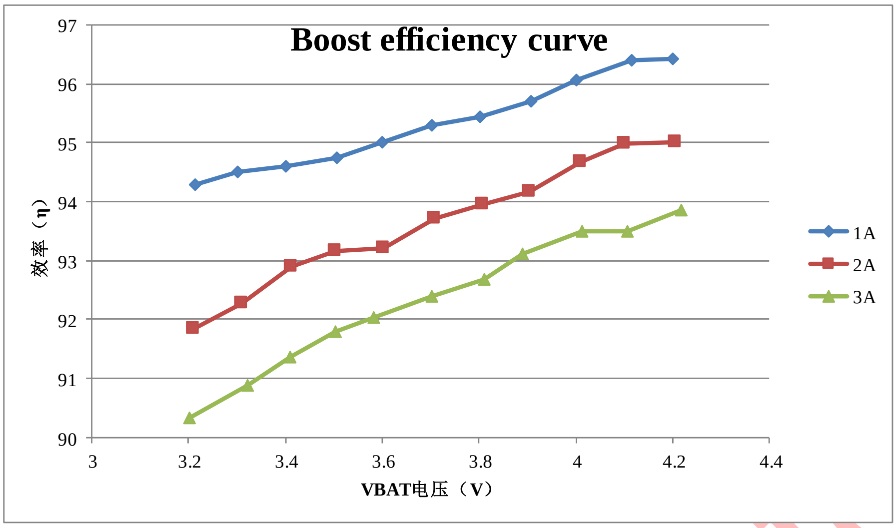
VOUT VS ambient temperature





VOUT and the battery

voltage and output current VOUT



Boosting efficiency VS VBAT

Pin Key Functions and Instructions

VIO (pin 2,3,5): 5V input / output utility port

Connected to an external 5V power as supply to charge battery, system automatic start to charge mode (if in boost mode, may delay 6S-12S till boost automatic stop); at boosting (Press Key ~), 5V output port;

VIO is also the inner workings of the main power supply, the capacitance of the output accuracy of location is important, we need to prioritize and close proximity to the chip outlet. See PCB board considerations. Recommend an external ceramic capacitor 2 * 22uF + 0.1uF. If the VIO ripple is large or unstable under high current, it is recommended to connect a larger capacitor externally, such as 4 * 22uF or 2 * 47uF, or larger and more stable capacitors for 5V3A.

External interface PMOS1:

When the chip is in standby mode (charge mode: dn ~ _up = 0), VIN through PMOS1 output to VIO. When VIO> 4.25V, TP5602 automatically enters charge mode.

When the chip is in boost mode (dn ~ _up = VOUT = 5V), internal protection PMOS1 is turned off, VIN not output to VIO, VIN power does not automatically trigger a charge mode, only when the boost mode ends, dn ~ _up = 0, will enter charging mode; but if auto_up pin through a resistor to VIN can automatically detect the VIN power, when auto_up> 3.5V, the automatic shut boost, start charging mode.

GND_A, GND_D (pin 18, 7) internal ground

GND_P (pin 22) drives and power ground.

LX (pin 4,23,24): Built-in power PMOS2 tube, external NMOS drain connection.

LX and external inductor connected as a battery charge and discharge of the switch terminal, but also as synchronous detection terminal voltage and over-current voltage.

Vint1 (Pin 6): internal power supply 1. External capacitance 1uF

Work (charge or boost) start = VIO, standby = 0;

Vint2 (Pin 8): Internal main power supply 2, the external capacitance 1uF.Remains to output the highest current.

By the internal power supply switching circuit automatically switches to VBAT, VIO the highest level as the internal power supply. Work = VIO, standby = VBAT.

In order to prevent VIO transient too large when mode switching, and cause Vint2 and VIO two power different transient, internally generating misuse, a 2uF capacitors is needed bridging between Vint2 and VIO to curb the power transient differences.

LED4-1 (pin 9, 10, 11, 12): to external light emitting diode LED anode, the high work 5V, can drive blue, white, red, green LED.

It is normal battery indicator port and abnormal alarm indication. There is 1KΩ current limiting resistor inside. Customers can select additional series resistor in terms of different LED and brightness. See LED instructions.

Auto_up (pin 13): mode detection port 2.

A typical use of a direct connection GND;

When forced to charge high mode (Prohibition boost); falling by launching a boost; mode is determined by the KEY ~ key has been low; (in the charge or standby mode, charging or not depends on whether the VIN or VOUT Voltage).

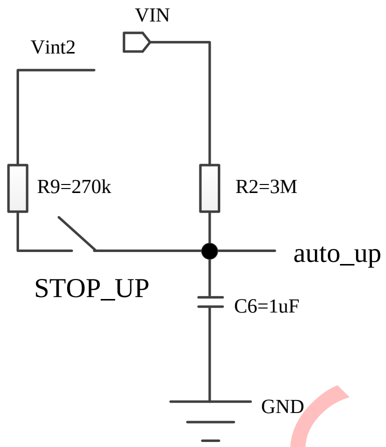
Usage 1:

3M resistor and VIN are connected (PMOS1 in other applications, see below page 3), automatically stops boost mode after detecting high level ,changed into the charging mode; detected falling VIN (power off) automatic start boost mode, VIO output 5V, boost, automatically shut down at light loads. Typical application circuit connection as Fig 3.

(VIO input / output single-port of Figure 1, Use 1 invalid).

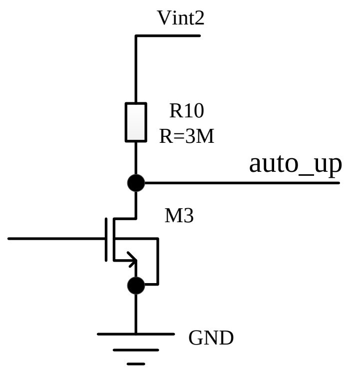
Usage 2:

Press the switch, connect Vint2 port the high level, and manually turn off the boost mode, after the release of starting boost mode, light load automatic stop. The method is as below:



Usage 3:

External MPU controls the charging mode and boost mode, NMOS open drain end directly connected auto_up, a pull-up resistor Vint2 high. MPU close (pull up) or open (to a falling edge) boost mode (without KEY ~), light load automatic shutdown. Connection is as follows:



If directly connected to 0 potential, VIN power off will not automatically turn boost. VIO output is 0. When mode switches, in order to prevent VIN glitch false triggering from, auto_up port needs to use RC delay circuit, greater COUT , the greater the need for RC delay. General> 500mS, (3M 1uF).

VBAT (Pin 14): Battery voltage terminal.

The positive terminal of the battery is connected to this pin.

VS (Pin 15): Battery input / output current detection terminal.

Rsb connecting VBAT and VS, as the battery current sampling resistor, there is current polarity automatic judge circuit.

Rsb set the maximum charging current value; V_Ilmt set the maximum discharge current value. Other current is automatically adjusted internally. Vsb=VS-VBAT.

Constant current charging Vsb = 25mv:

Maximum input current ISET0 = 25mv / Rsb

Trickle charging Vsb = 5mv:

Maximum input current ISET1 = 5mv / Rsb

When boost discharge, Vbsmax = 4 * 25mv

The maximum discharge limit of about ISET2 = 4 * ISET0 (i.e. when no voltage modulation VBAT = 4.2V, VIO = 5V, V_Ilmt = 1/5 VIO)

ISET2 internal VBAT and V_Ilmt (VIO sampling voltage) modulation:

VbsMAX = (25m 75m * V_Ilmt) (1+ (4.2-VBAT) /4.2)

ISET2 = VbsMAX / Rsb

When VBAT drops ISET2 increase;

V_Ilmt when dropped ISET2 reduce, V_Ilmt = [0-1];

ISET2 is decided by Rsb and V_Ilmt jointly.

For example:

Rsb = 0.025, V_Ilmt = 0.5V (= 1/10 VIO)

The charging constant current ISET0 = 0.025 / 0.025 = 1A

5V OUT, while limiting the discharge 4.2VBAT

ISET2= (0.025+0.075*0.5) /0.025=2.5A

Output current limiting IOUT about 0.9 * 4.2 * 2.5 / 5 = 1.8A

If V_Ilmt = 0.25 (= 1/20 VIO), then

ISET2=(0.025+0.075*0.25)/0.025=1.7A

Output current limit

IOUT approximately = 0.9 * 4.2 * 1.75 / 5 = 1.3A

Battery current setting is shown in Table (customer shall be measured)

Rsb MOhm	Charging current limit (A)	V_Ilmt= 5* R8/(R7+R8)	Discharge limit (VB=4.2)	Iout(A) (vout= 4.8)
25	1.0	0.5	1.9A	1.76A
25	1.0	0.12	1.0A	0.90A
25	1.0	0	0.8A	0.77A
12	2	0.5	3.5A	3.40A
12	2	0.1	2.0A	1.90A
12	2	0	1.6A	1.49A
8	3	0.5		
8	3	0.1	3.0A	2.94A

V-Ilmt (pin 16): The battery discharge current set terminal.

When charging, the port does not work, when discharge, set different initial value of the voltage 0-1V, (internal 1V clamping circuit). You can change the battery discharge maximum limiting factor. If sampling VIO by voltage divider resistors, we can get the input limit current value modulated with VIO (joint with Rsb), thereby maintaining output current constant.

Key ~ (Pin 17): Boost Mode Port 1
External buttons control, low pulse effectively. After the button activates the boost mode (when auto_up = low):
As VBAT <= 3V; or VIO short circuit over current, the LED flash 6 times abnormal alarm automatic standby, no boost.
As VBAT> 3V, battery indicator displays 5 seconds and then turns off. VIO output 5V power supply. Press Key~ again, redisplays the power 5 seconds. If continuous output light load, (Iout <= 30mA), stop after10 seconds, turn to standby mode, battery consumption <= 6uA.

Dn ~ _up (Pin 19): Multi-purpose protection PMOS1 gate input, and working status indication:
Dn~_up=0 charge mode , as synchronous buck mode, external PMOS1 on conduction(Fig 3), PMOS2 as charge switch, NMOS as buck synchronous tube.
When the system is damaged as PMOS2 feed through caused VBAT> = 4.3V ,overvoltage protection circuit works: dn ~ _up = high-impedance state, through the external 1M resistor pulled to VIN protective tube PMOS1 forced to close, stop charging.
External capacitor C7 = 0.1u can prevent charge not start when VBAT = 0, Dn ~ _up = VIO (5V) boost mode, PMOS1 closed, NMOS to discharge switch, PMOS2 to boost synchronized tube.

VREG (Pin 20): Internal power supply 3. VREG is an internal secondary power, 0.1uF an external bypass capacitor to ground. About VREG = 4.0V, only start at work, 0V when standby.

EXT (Pin 21): External NMOS gate drive.
External expansion a power NMOS, switching signal, CMOS output, high to VIO, low to zero. Maximum drive a Cg = 2000p NMOS power transistor.

Works Principle

TP5602 is specifically designed for single-cell 4.2V built-in lithium-ion battery, while the need for efficient and stable power 5V DC power supplies system design. Since the internal integration of multiple battery protection circuit input and output, without external battery protection board or circuit. Plus built-in 4-way power display and alarm display. Unique inductance and power multiplex technology, a set of devices and boost and buck automatic switching mode, all of those help to realize high efficient synchronous buck charge and boost output. Greatly reduces the complexity of production, cost down while system reliability and safety is greatly improved.

External PMOS1: unique multi-purpose protection and bypass PMOS1 design, not only can guarantee the same time while charging bypass output, but also to prevent the charging power reversal. When the battery is overvoltage PMOS1 will automatically cut off, plus PMOS2 charging voltage limiters, dual protection battery. When boost PMOS1 closed, in order to avoid anti-leak into the VIN terminal VIO.

Charging process:

Charging starts automatically reset inside, chip after exceptional cases stop, disorder or battery replacement, and may need to charge about activation and initialization.

In standby mode, PMOS1 is conducting state, dn ~ _up = 0, VIO = VIN .When VIN power is empowered, VIO <3.8V not start charging circuit, battery no current input, LED no light

When 3.8 <VIO <4.3, not start charging circuit, LED display power;

When the VIO> = 4.3V to start the charging circuit, synchronous buck mode activated, PMOS2 charging the inductor, NMOS synchronous control, current flows through the external Rsb VS to the battery. Vsb sampling voltage control switches duty cycle and the charging current value.

When charging LED light display power as follows;

Battery voltage (charging mode)	Flashing / long bright	Flashes
0- 3.0	LED1 / no long bright	0.5 seconds to 50% flash
3.0-3.5	LED1 / No	1 second 25% flash
3.5-3.8	LED2/LED1	1 second 25% flash
3.8-4.0	LED3/ LED2-1	1 second 25% flash
4.0-4.2	LED4/ LED3-1	1 second 25% flash
4.2	No flash / LED4-1	

Charging process:

Trickle (0 <= VBAT <3.0): Vsb = 5mV, LED1 high frequency flashes, other LED off.

Constant (3.0V <VBAT <4.18): Vsb = 25mV

LED highest bit slow flash, other low long light.

Constant (4.18 <VBAT <4.20), four LED lights are long bright, not flash, full.

Constant setting: ISET0 = Vsb / Rsb = 25mv / Rsb

Trickle: ISET1 = 5mv / Rsb

At constant voltage phase the current decrease sharply as VBAT rise, until charging current to less than about 20% ISET0 to remain more than 250mS, produce full signal: LED long bright, buck tube closed.

Automatic Recharge: battery is fully charged to 4.2V Standby, if the battery voltage drops to about 4.08V, restart the charging process until VBAT back to 4.2V.

Internal over-temperature reaches 140 degrees, the protection circuit automatically reduces the output current until the internal temperature does not rise. This feature allows the user not worry about the chip overheating and damage.

When VIN power off, functional selection:

VIN-down to 4.3V, the adaptive circuit starts automatically reduce the output current until the VIN not decrease, this feature allows a large current charging system with USB or small power supply adapter, do solar power, while avoiding a power reset or restart.

VIN power off :

Auto_up port, no fixed access VIN, then auto_up and key ~ can be used as a manual mode switch button. No automatic change to boost after VIN power off, direct standby; but does not prohibit charging key ~ key (stop the charging mode, enter boost mode, VOUT = VIN and 5V, the higher the boost). auto_up key will enter charge or standby mode (stop boost mode).

Auto_up port RC circuit connected to VIN (as typical application circuit), the VIN charging mode automatically after power on, no matter what the state previously, Key ~ is invalid. VIN boost mode automatically after power off (no press key ~), Key ~ is also effective. Recommend using this feature.

Boost discharge process:

In typical applications, both charging off and key ~ low pulse can trigger VOUT from 0V to 5V boost process. Meanwhile LED display extinguishes after 5 seconds.

When boost, PMOS1 closed, dn ~ _up = VIO, VIN = 0V, Vint1 and VREG start, EXT drive NMOS switch inductance, PMOS2 to boost synchronize the VIO pump to 5V DC, for mobile phones, Pad and other portable equipment charging.

Adaptive VOUT soft-start current limiting inside (VOUT rises, allowing the output current increases), by-cycle current limit, the average battery current limit, chip and over temperature protection, multiple protections for a long time (250ms) short-circuit and over current shutdown protection function, may not require the use of additional external battery protection circuit. Also reduce the loss of external protection circuitry, improve cell power conversion efficiency.

When boost LED lights display the following:

TP5602

Battery voltage (discharging mode)	Flashing / long bright 3S	Flashes
0 - 2.4	Not bright	Shutdown
2.4- 3.0	LED4-1 / no long bright	Flash 6 times Under voltage alarm
3.0-3.5	None/ LED1	
3.5-3.7	None/ LED2-1	
3.7-3.9	None/ LED3-1	
3.9-4.2	None/ LED4-1	
VIO overload	LED4-1/ No	Flash 6 times
Over Temperature	LED4-1/ No	Flash 6 times

TP5602B

Battery voltage (discharging mode)	Flashing / long bright	Flashes
0 - 2.4	Not bright	Shutdown
2.4- 3.0	LED4-1 / no long bright	Flash 6 times Under voltage alarm
3.0-3.5	None/ LED1	
3.5-3.7	None/ LED2-1	
3.7-3.9	None/ LED3-1	
3.9-4.2	None/ LED4-1	
VIO overload	LED4-1/ No	Flash 6 times
Over Temperature	LED4-1/ No	Flash 6 times

Automatic stop boost at work:

After the booster circuit to work on, if there is an output load, while the load is large enough, under typical conditions IOUT> 50mA, the booster circuit has been working non-stop; if light load IOUT <50mA (depending on the temperature, battery voltage, inductance values, etc. will be different), usually indicates that the external charging is completed, or no-load access, through continuously detected for 10 seconds or so, the chip will automatically stop boosting, into standby mode;

Standby mode can boost again (Key ~ low pulse trigger), you can automatically charge (VIN> 4.3V) in standby mode, VIO, VIN and VBAT completely isolated, chip system power only 6uA.

When boost, require manual or external control stop

Whether light load or not, the user can make auto_up port through a switch or resistance pulled high VBAT, boost stops. Key ~ does not work, this time as standby mode, you can enter the charge mode; Auto_Up goes low, the chip automatically returns to boost state (regardless of whether or not press Key ~).

CPU control shutdown connection:

CPU NMOS open-drain output port

pull-3M ohm resistor connected between auto_up and Vint2. Great 3M resistance is to reduce battery standby current.

VIO and output current:

Chip has VOUT = 5V fixed output sample resistor, the user not need to adjust external resistor. Maximum output current is determined by the value Rsb and V_Ilmt (see set VS port). The maximum charging current is set by Rsb, regardless of V_Ilmt.

Maximum battery discharge current is set by an external set V_Ilmt 1-4 times (corresponding to 0V-1V V_Ilmt) maximum charging current. When coupled with the built-in boost VBAT, VIO voltage modulation and boosting efficiency (typically 93.5%) together determine the maximum IOUT. VIO = 5V down to VBAT, IOUT constant current output, VIO under VBAT to 0V, IOUT linear down to about 100mA (VIO short circuit).

If VOUT keeps less than VBAT in 250ms, it means output overload or short circuit, automatic shutdown protection and 6 times flash for overload alarm.

Battery voltage protection:

When the boost, if the battery voltage drops <3V, the automatic shutdown, and 6 times flash for under voltage alarm.

If battery voltage is below 2.4V, in order to prevent the damage of lithium batteries, the chip all shut down and locked; if below 1uA, the external key is invalid. Even after the battery voltage above 2.4V, will not unlock, only automatic reset of VIN one time high level charged, can unlock.

Note: when engineers test the chip or in production, if VBAT shortly removed, may result in VBAT not work when recharge due to the shutdown lock of CBAT capacitor voltage <2.4V, only need to power VIN power or discharge the capacitor CBAT to 0 ,VBAT power on reset ）

Chip thermal limiting

Regardless of the charge or discharge mode, if the chip temperature rises above the preset 145, an internal thermal feedback loop will automatically reduce the set battery current. This function can prevent overheating, and allows the user to increase a given circuit board power handling capacity limitation without the risk of damage to TP5602. In the premise of system chip will automatically reduce the current in the worst case conditions, according to the typical (not the worst) ambient temperature to set the charge / discharge current.

Input VIN, output VIO, VS, VBAT side capacitor

Can use many types of ceramic capacitors, but requires a high-quality power capacitors. Best plus a 0.1uF bypass ceramic capacitor, and the connection must be close to the chip lead. Other ports may use non-power small capacitance ceramic capacitors.

Especially VIO increase the capacitance value and power capabilities as much as possible (such as ceramic power capacitors two 22uF or 47uF in parallel in two VIO pin), and need to be very close to the chip VIO pin.

Thermal Considerations

Although the size of the QFN24 package is very small, but the heat dissipation is very good, and also need to cooperate with good PCB design. The best recommend is to select a sophisticated thermal design PCB board to increase charge / discharge current as much as possible. The IC pathway of heat dissipation leads heat from the chip to the lead frame and through heat sink hole at the bottom of the chip to copper surface PCB backplane. Copper area connected pin should be as wide as possible extending to the larger copper area, so as to spread the heat to the surrounding environment. Suggest more internal holes or holes in back copper circuit layer to improve the overall thermal performance of the charger. When design of PCB board, other heat source independent from charger on board must be considered as well, because, they will impact on the overall temperature rise and the maximum charge current.

Inductor Selection

When charging, FOSC = 700KHz, when discharging, to reduce the loss of MOS, FOSC down to 300KHz.

Depending on the output current requirements, inductance values 1.1uH-2.2uH, recommended 2.2 (uH).

Recommend that the rated inductance current is 2 times greater than the boost output current. To the smaller resistance power inductance, high inductance values is preferable under the same condition, the system efficiency will be higher.

TP5602 other applications and notes as following pages:

TP5602 other application circuit and components

Figure 3, Figure 4 TP5602 is a circuit diagram of other applications:

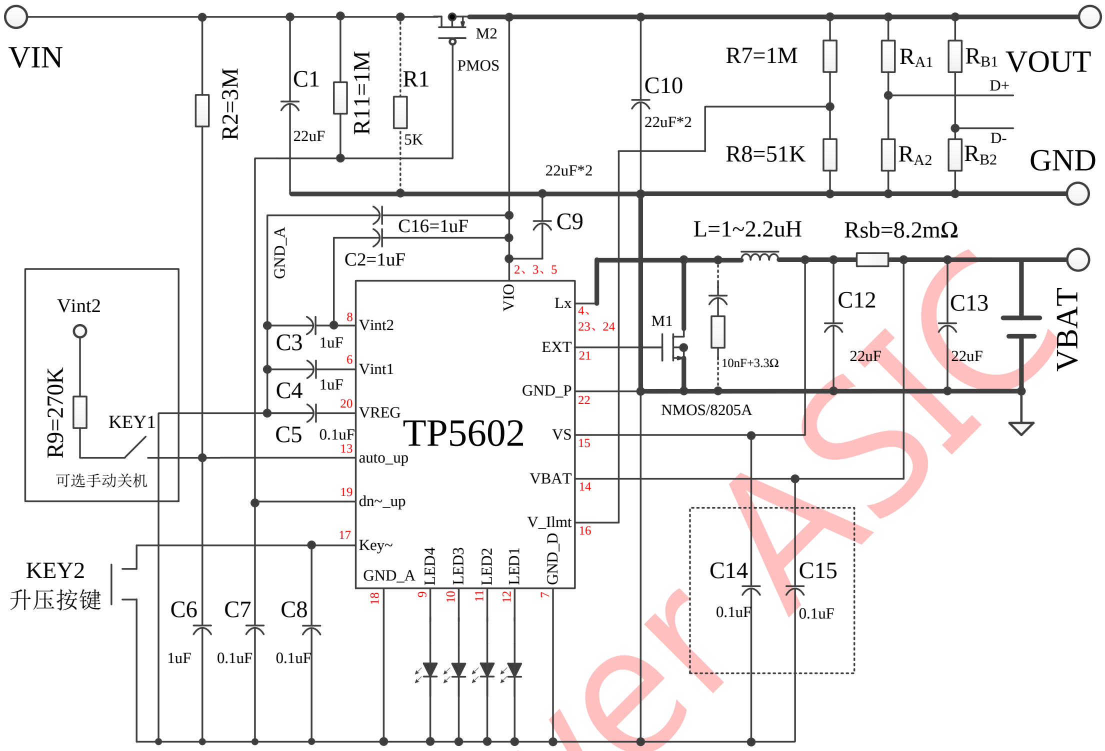


Figure 3: When boost control can be achieved manually or CPU stop

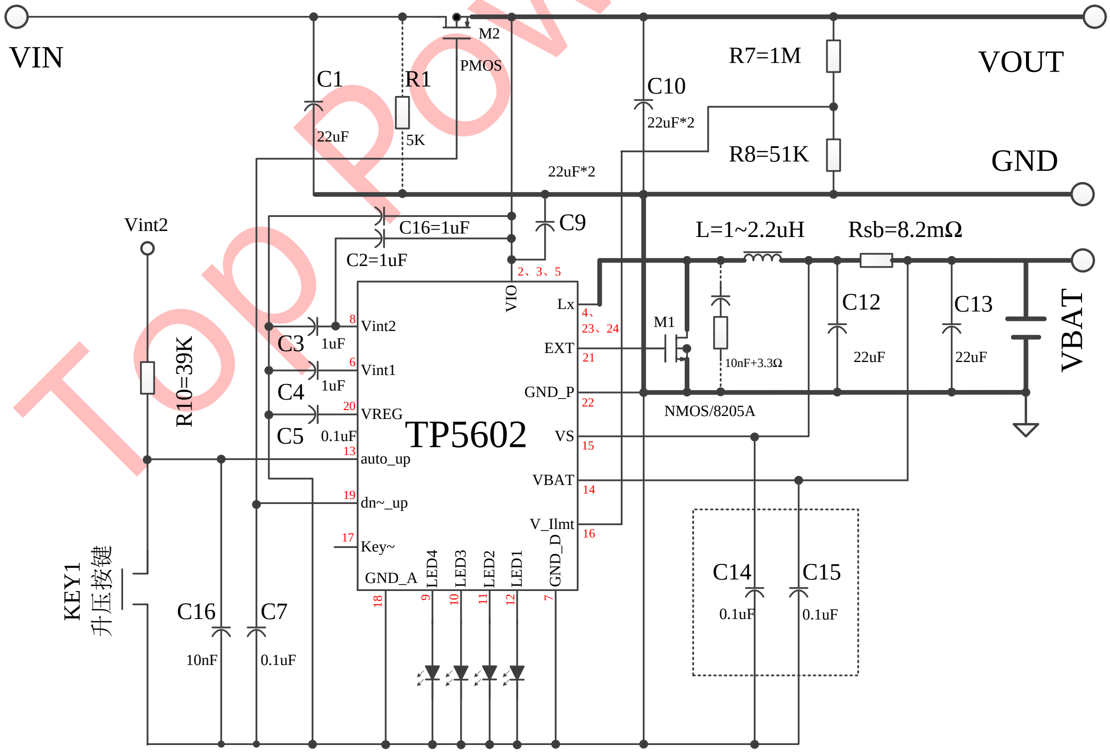


Figure 4: 15W push-button electronic cigarette scheme

The following table shows a typical application circuit recommended list of components:

Table 2 4.2V 3A rechargeable lithium-ion battery, 5V 3A boost

NUM	Lib ref	Model&Specifications	Tag Number	amount	NOTE
1	IC	TP5602 QFN24 -4*4	U1	1	
2	SMD Power Inductors	1.0uH/10*10	L	1	**Saturation Isat, temperature rise current Idc greater than 7A, DCR less than 0.01, inductance value 1.0uH**
3	chip capacitor	0.1uF/0603 10%	**C5 C7 C8 C14 C15**	5	**The withstand voltage should not be less than 16V. It is recommended to use surface mount ceramic capacitors, and the red tag capacitors should be placed as close as possible to the chip pins in the circuit**
4	chip capacitor	22uF/1206 10%	C1 **C9** C10 C12 C13	7	
5	chip capacitor	1uF/0603 10%	**C2 C3 C4 C6 C16**	5	
6	chip capacitor	0.01uF/0603 10%	CLX	1	**EMC Test reserved components**
7	chip resistor	3.3R/0805 1%	RLX	1	
8	chip resistor	0.0082R/1206 1%	RSB	1	**Accuracy1%, packaging is 1206 or above**
9	chip resistor	5.1K/0603 5%	R1	1	
10	chip resistor	3M/0603 5%	R2	1	
11	chip resistor	1M/0603 5%	R7 R11	2	
12	chip resistor	51K/0603 5%	R8	1	
13	LED	0603	LED1~4	4	**Used for power indication**
14	MOS	8205A/TSSOP8	M1	1	**NMOS**
15	MOS	2301/SOT23-3	M2	2	**PMOS**
16	KEY	6.5mm*5.1mm	KEY2	1	**KEY+ socket**
17	USB	Micro USB 5 pin	INPUT	1	
18	USB socket	USB-A socket /white, 4P USB socket A	OUTPUT	1	

TP5602 Notes in Use

1. All capacitors should be as close to the chip, rather than to PCB board port.

2. VIO, VS, VBAT, VIN must use high-quality ceramic capacitors.
3. CLX capacitor series connected with inductance (or link LX to the ground) to reduce LX high frequency radiation, therefore, need very good suppression, selective in 1nF-10nF. Greater CLX can improve the stability of boost current and voltage output accuracy, but CLX consume power much as well. Basing on the difference of PCB layout and output current require, the best CLX may be different. Customers can decide by selves by experiment. In better PCB layout, C_{LX}+R_{LX} can be omitted.
4. Please use enough current capacity power inductance; mainly consider the required current in boosting, usually more than 2 times of IOUT maximum current.
5. For VOUT and LX, the current loop line should be wider than other current signal line.
6. Note the location of each node capacitance grounding wire, Vint1, Vint2, Vreg, VIO several ports should be connected to the same side of the capacitor ground, priority near GND_P; GND_A, GND_D, GND_P best connected by chip negatives, VBAT, VS with the same side of the ground line, well-connected to GND_P.
7. When chip used in high current work, should consider good connection of the chip heat sink and the back of the PCB, to ensure good heat dissipation.
8. TP5602 QFN chip repair, disassembly and installation method:

   TP5602 is an ultra QFN24 package, recommended to use temperature adjustable hot air gun in disassembly and installation.

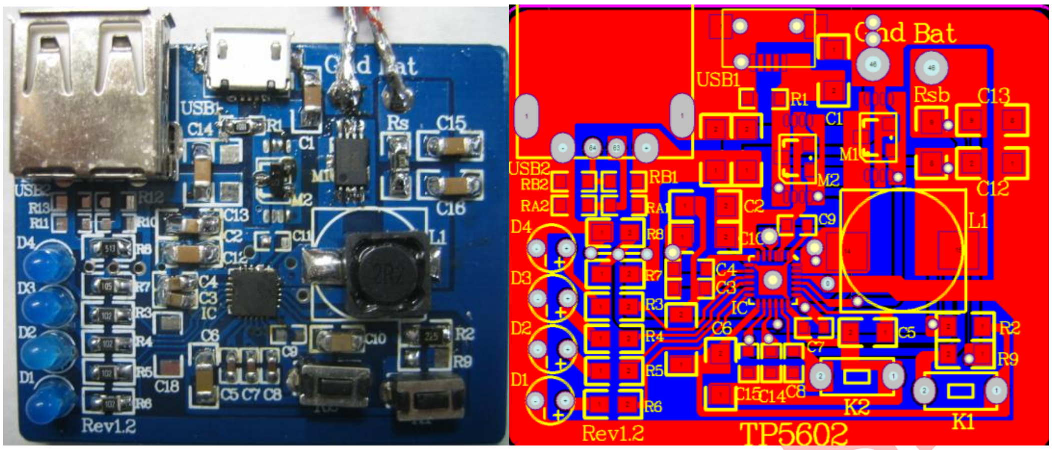
   Disassembly:
   Define hot air gun as 280-300 degree. First to blow QFN 20 seconds for preheating, then move tuyere to the center of the chip within 10mm, continuously blowing 20 to 60 seconds (fin time different).When the chip is movable, to remove quickly by tweezers. If there is a large area of back hole or sink on chip, recommended first to use iron and tin suction gun to suck the most solder from back hole area.

   Installation:
   1) By iron, fill a small amount of tin uniformly in PCB QFN chip pin.
   2) Or directly spread a thin layer of solder paste in the PCB QFN pin.
   3) by tweezers to pinch up QFN chip, hot air gun to blow at the chip bottom (a foot side) 5 seconds, quickly to rub a little oil at the bottom surface
   4) Put the chip on the welding position central of the PCB according to the QFN pins correct order, probably aligned.
   5) Using a hot-air gun to blow the chip center up to down 20 -60 seconds, and also

blow the heat around the chip as needed, the chip will automatically position the pin by melting the solder due to surface tension. If the position difference is too large, may adjust slightly by clamp while blowing, for use after cooling.

TP5602 demo board circuit and instructions

Below is TP5602 demo graphics. PCB schematic diagram of a typical application in Figure 3



TP5602 demo Pin and Port Description: Charging 4.2V3A, discharge 5V3A

Input: Micro USB. Output: USB.

BAT: battery terminals.

Connect the power and battery, charges, LED flash gradually, charging over, four LED lights . Details refer to charging LED display. K2 key is a boost button, when not charging, press the Start booster.

K1 is boost stop switch, press and stop, release and start boost.

In constant current charging stage, an ammeter can be linked to battery positive end in series to detect charging current, using wide range ammeter. Considering the internal resistance of ammeter, test battery cut-off voltage, please not connect the ammeter series in the battery terminal. The resistance will cause the actual cut off voltage of battery lower than the chip itself off voltage.

If need to replace the chip, recommend the use of air guns and other welding equipment.

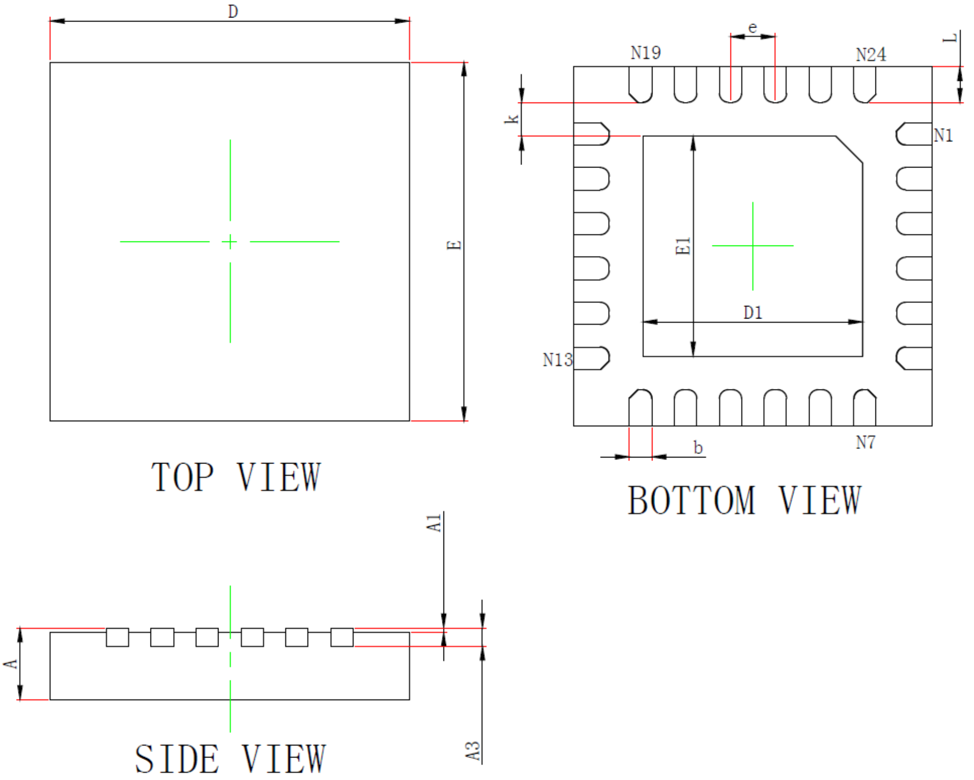
Demo Layout Special Notes:

GND: Ground layout is extremely important; the chip has a digital ground, analog and power ground. Digital and analog ground can be connected together, together with some other devices to; power to require directly connected to the output, the output ground to the Vout port-based.

VIO end of the capacitor: VIO has three PIN, must be connected together, and the need to take 2 to 4 22uF capacitor, and close to the chip port. Capacitance ground is also connected to a large current.

Package Description

4mm * 4mm 24-pin QFN package



Symbol \ Size	Min	TYP	Max	Symbol \ Size	Min	TYP	Max
A	0.70	0.75	0.80	D1	2.20	0.203REF	0.203REF
A1	0.00	–	0.05	E1	2.20	0.203REF	0.203REF
A3	0.203REF			e	0.50TYP		
b	0.20	0.25	0.30	K	0.20	–	–
D	3.90	4.00	4.10	L	0.30	0.40	0.50
E	3.90	4.00	4.10				

Previous Version

Date	Imprint	Release
2024.08.27	Add TP5602B， LED long-term illumination scheme during boost	Rev2.1