IP5521

30V high voltage withstand TWS Charging Box SOC integrated

1. Features

- **Discharge**
  - ✧ Output capacity: 5V/300mA
  - ✧ Up to 92% discharge efficiency of synchronous switch
  - ✧ Built-in power path management supports charging and discharging at the same time
- **Charge**
  - ✧ Max 500mA linear charger, adjustable charging current
  - ✧ Adjusts charging current automatically to adapt to different load capacity adapters
  - ✧ Supports 4.20V, 4.35V batteries, adjustable battery initial capacity by external PIN
  - ✧ Supports adjusting charging current by external PIN
- **Battery indicators**
  - ✧ Supports 4/3/2/1 LED battery indicator
- **Low-power dissipation**
  - ✧ Automatically detect earphone plugged-in/ plugged-out/charger-end, Automatically enter standby mode
  - ✧ Support detection of earphone plug-in/plug-out independly
  - ✧ Standby power consumption up to 25uA minimum
- **Simplified BOM**
  - ✧ Built-in power MOS, only a few peripheral devices are needed in the complete charging and discharging scheme
- **Multiple protection, high reliability**
  - ✧ Output：over current and short circuit protection
  - ✧ Input：over voltage protection and Battery over charged protection
  - ✧ Over NTC temperature protection
  - ✧ Vin pin can withstand up to 30V(transient voltage)
  - ✧ ESD 4KV
- **Package: QFN16 (3*3*0.55mm)**

2. Applications

- TWS Bluetooth Earphone Charging Box
- Lithium Battery Portable Device

3. Description

IP5521 is a multi-functional power management SOC for total solution on TWS Bluetooth Earphone Charging Box. It integrates a boost converter, lithium battery charging management and battery level indicators.

IP5521 is highly integrated with abundant functions, which makes the total solution with minimized-size and low-cost BOM.

The synchronous boost system of IP5521 provides rated 300mA output current with conversion efficiency up to 92%. DC-DC converter operates at 1.5MHz frequency, can support low-cost inductors and capacitors.

IP5521's linear charger supplies max 500mA charging current. With the change of IC temperature and input voltage, IP5521 can automatically adjust the charging current.

IP5521 can detects the TWS earphone plug-in/plug-out in the Chargering Box independently. While the earphone is put in the Chargering Box, it enters the discharging mode automaticaly. When the earphone is fully charged, the Chargering Box automatically enters the sleep state, and the standby current can be reduced to 25uA.

IP5521 can support 1/2/3/4 LED battery indicator.

Contents

4. Reversion History

Note: Page numbers of previous editions may differ from those of the current edition.

Version V1.00 changed in January 2023	Page
• First Release	1

Version V1.00 changed to version V1.01 in February 2023	Page
• Chapter 6: Increased new products	5
• Chapter 13: Updated LED light display Voltage point	25

Version V1.01 changed to version V1.02 in February 2023	Page
• Chapter 12: Revised scope of the Charge Stop Current	11

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• Chapter 6: Increased new products	5

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• Chapter 13: Updated the explanation of LED light display	16

Version V1.04 changed to version V1.05 in December 2023	Page
• Chapter 17: Update Package	37

5. Simplified Application Schematic

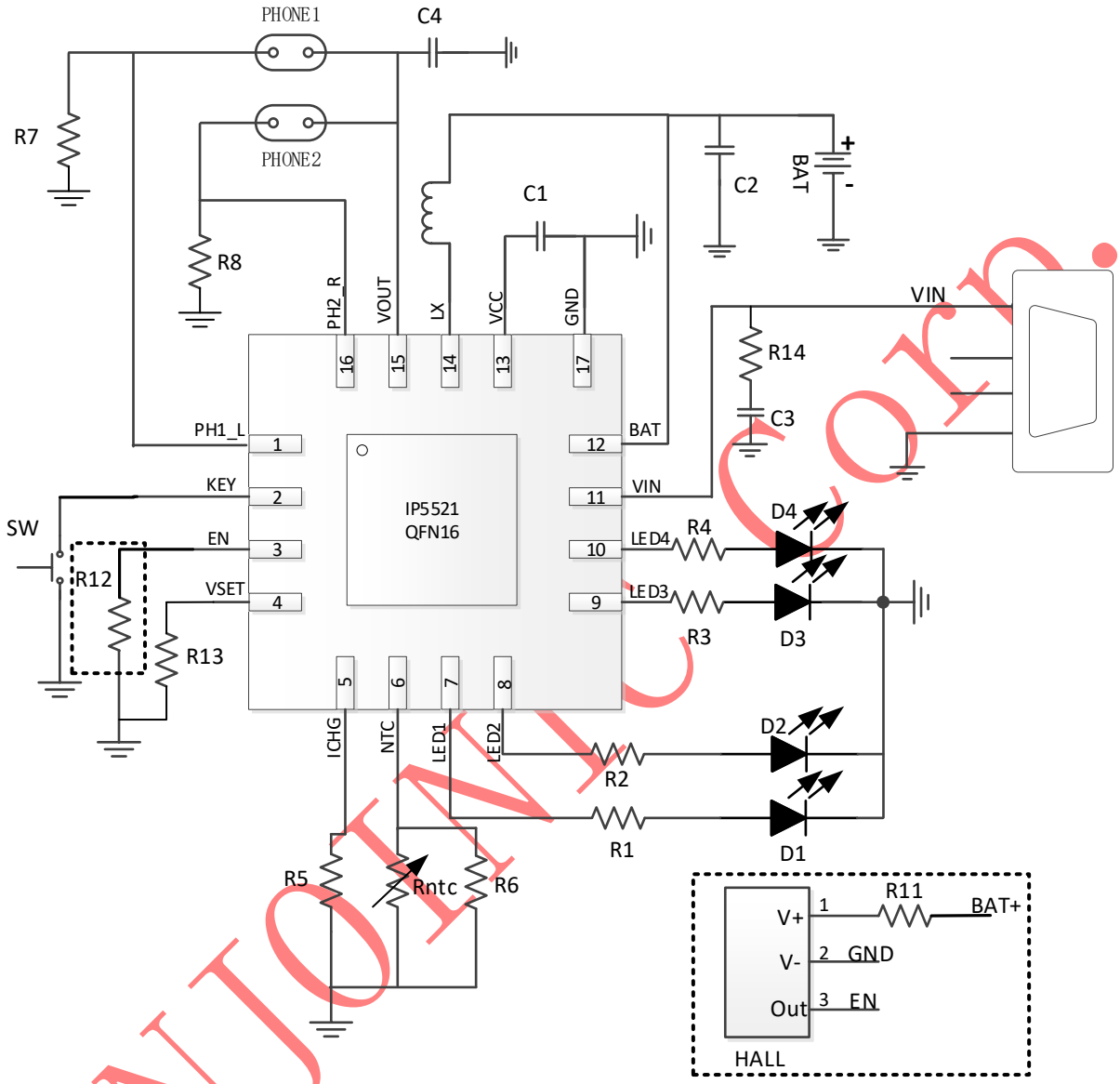


Figure1 IP5521 Simplified Application Diagram

6. IP5521 IC Products List

IC Part No.	Charing Current	Standby Voltage	Constant Charge Voltage	Key Mode	Light Load Shut Down/ Light Off Time	HALL	NTC Protection
IP5521_BT	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Not support	Support
IP5521_CK	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Not support	Support
IP5521_BT_HALL	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Support	Support
IP5521_CK_HALL	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Support	Support
IP5521_BT_BRE	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Not support	Support
IP5521_CK_BRE	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Not support	Support
IP5521_BT_HALL _BRE	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Support	Support
IP5521_CK_HALL _BRE	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	5s	Support	Support
IP5521_BT_CL	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Not support	Support
IP5521_CK_CL	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Not support	Support
IP5521_BT_CL _HALL	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Support	Support

IP5521_CK_CL _HALL	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Support	Support
IP5521_BT_CL _BRE	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Not support	Support
IP5521_CK_CL _BRE	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Not support	Support
IP5521_BT_CL _HALL_BRE	Setting 200/300/ 400/500mA by Resistance R5	BAT	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Support	Support
IP5521_CK_CL _HALL_BRE	Setting 200/300/ 400/500mA by Resistance R5	5V	Setting 4.2V/4.35V by Resistance R13	One Short press power on	on	Support	Support

Note: The light display with "_BRE" product shows the breathing light mode; The light display without "_BRE" product will blink at normal 1Hz.

7. IP Series TWS Charging IC Products List

IC part no	Charge-discharge		Main features							
	discharge	charge	Wireless charging	LED	KEY	HALL	VSET	NTC	USB C	Package
IP5513	300mA	IO option MAX 500mA	-	1/2/3/4/ digital tube	either-or		Customizable	Customizable	-	SOP16
IP5516	300mA	IO option MAX 500mA	-	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN16
IP5518	300mA	IO option MAX 500mA	-	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN24
IP5518H	400mA	IO option MAX 500mA	-	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN24
IP6816	300mA	Customizable MAX 500mA	Support	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN16
IP6818	300mA	Customizable MAX 500mA	Support	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN24
IP5333	1A	IO option MAX 1A	-	1/2/3/4/ digital tube	Support	Support	IO option	Support	Support	QFN24
IP5528	400mA	IO option MAX 1A	-	1/2/3/4/ digital tube	Support	Support	Customizable	Support	-	QFN28
IP5416	200mA	MAX 300mA	-	1/2	Support	Support	Customizable	-	-	SOP8
IP5428	300mA	MAX 1A	-	1/2	Support	Support	Customizable	-	-	SOP8
IP5413T	200mA	MAX 300mA	-	1/2/4	Support	-	Customizable	-	-	SOP8
IP5427	300mA	MAX 1A	-	1/2/4	Support	-	Customizable	-	-	SOP8
IP5521	300mA	ICHG option MAX 500mA	-	1/2/3/4	Support	Support	VSET option	Support	-	QFN16 3mm*3mm

"-" indicates that this function is not supported

8. Pin Definition

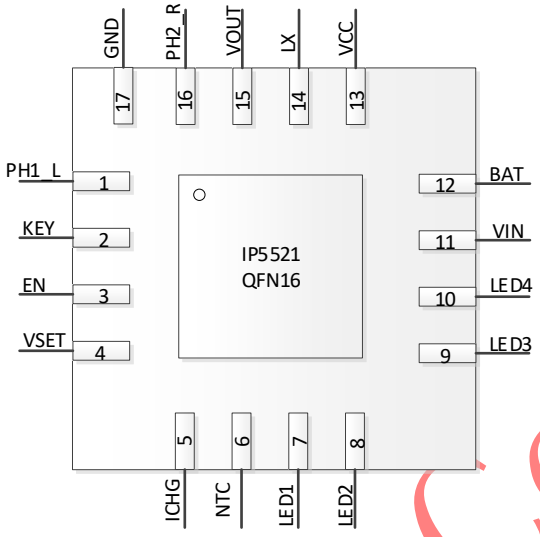


Figure2 IP5521 Pin Assignments

8.1 Pin Description

Pin Num	Pin Name	Description
1	PH1_L	Left earphone negative
2	KEY	KEY
3	EN	HALL switch input signal, using HALL function when contains "_HALL" product, EN pin cover low when turning off state by default; connecting 10K resistor when doesn't contain "_HALL" product
4	VSET	Full battery voltage setting pin
5	ICHG	Charging current setting pin
6	NTC	NTC function pin
7	LED1	Battery level display pin 1
8	LED2	Battery level display pin 2
9	LED3	Battery level display pin 3
10	LED4	Battery level display pin 4
11	VIN	5V input pin
12	BAT	Battery voltage positive pin
13	VCC	LDO output pin
14	LX	DCDC switch node
15	VOUT	Boost 5V output
16	PH2_R	Right earphone negative
17	GND	Ground

9. System Diagram

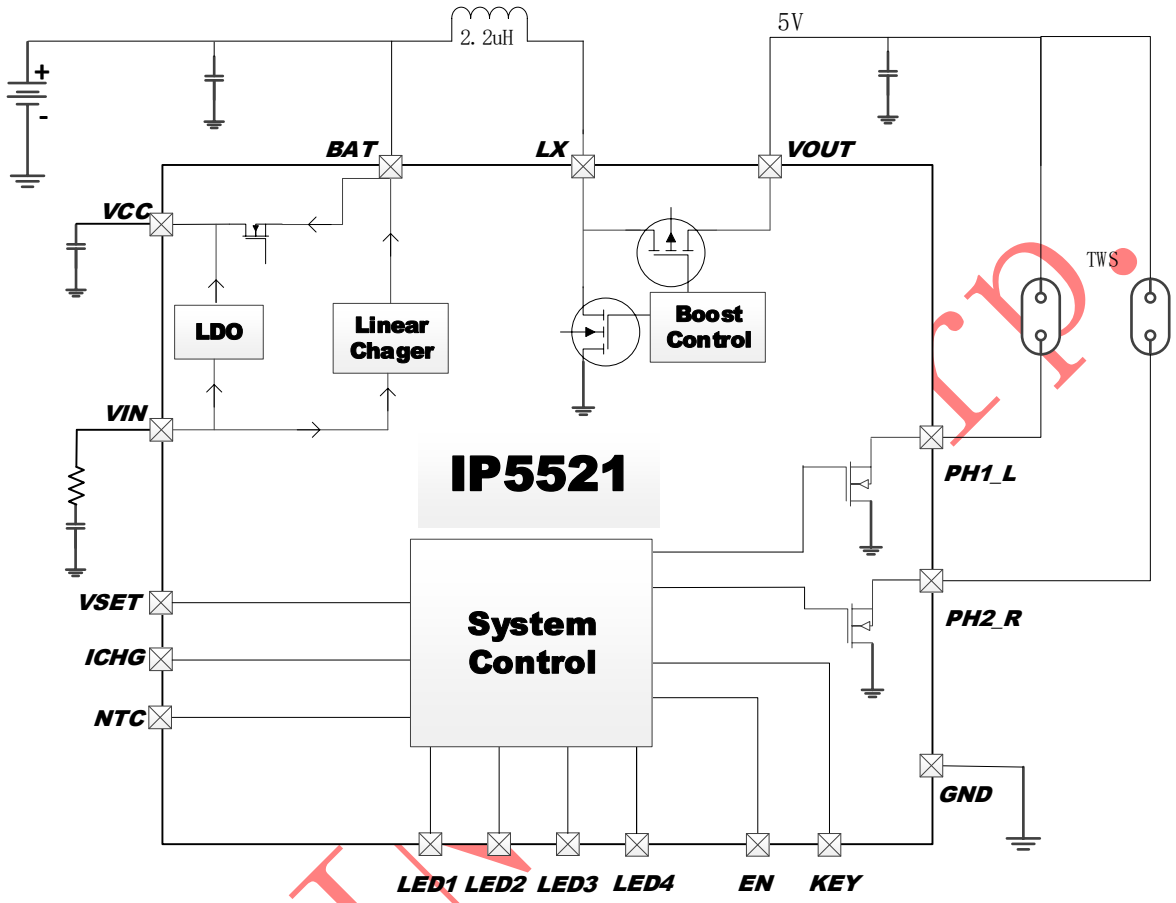


Figure3 IP5521 Internal System Diagram

10. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 30	V
	BAT, LX, PH1_L, PH2_R	-0.3 ~ 10	V
	VOUT	-0.3 ~ 10	V
Other IO Voltage Range	ICHG, NTC and other pin	-0.3 ~ 5	V
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	Tstg	-60 ~ 150	℃
Thermal Resistance (Junction to Ambient)	θ_{JA}	50	℃/W
ESD (Human Body Model)	ESD	4	KV

*Stresses beyond these listed parameter may cause permanent damage to the device.
Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

11. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4.65	5	6.0	V
Operating Temperature	T_A	-20	--	85	℃

*Device performance cannot be guaranteed when working beyond these Recommended Operating Conditions.

12. Electrical Characteristics

Unless otherwise specified, TA=25℃， L=2.2uH

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	VIN_{USB}	VBAT=3.7V	4.65	5	6.0	V
Input Over Voltage	VIN_{OV}		5.8	6.5	6.2	V
Trickle Charge Stop Voltage	V_{TRKL}		2.9	3	3.1	V
Input Wake-up Voltage	VIN_{OK}		3.0	3.2	3.4	V
Input Under Voltage	VIN_{UV}		4.0	4.2	4.4	V
Constant Charge Voltage	$CV_{4.2V}$	4.2V battery	4.15	4.20	4.25	V
	$CV_{4.35V}$	4.35V battery	4.33	4.35	4.4	V
Recharge Voltage Threshold	V_{RCH}		4.07	4.10	4.13	V
Trickle Charge Current	I_{TRKL}	VIN=5V, BAT=2.7V, R5=10K	15	20	25	mA
		VIN=5V, BAT=2.7V, R5=82K	25	30	35	mA
		VIN=5V, BAT=2.7V, R5=120K	35	40	45	mA
		VIN=5V, BAT=2.7V, R5=150K	45	50	55	mA
Charge Current	I_{VIN}	VIN=5V, BAT=3.7V, R5=10K	170	200	230	mA
		VIN=5V, BAT=3.7V, R5=82K	270	300	330	mA
		VIN=5V, BAT=3.7V, R5=120K	370	400	430	mA
		VIN=5V, BAT=3.7V, R5=150K	450	500	550	mA
Charge Stop Current	$Ivin_{stop}$	VIN=5V, R5=10K or 82K	20	30	40	mA
		VIN=5V, R5=120K	30	40	50	mA
		VIN=5V, R5=150K	40	50	60	mA
Charge Cut-Off Time	T_{END}		8	16	24	Hours
Boost System						
Battery Operation Voltage	V_{BAT}		3.0	3.7	4.4	V
Low Power Shutdown Voltage	V_{BATLOW}	IOUT=100mA	2.9	2.95	3.0	V
Switching Battery Input Current	I_{BAT}	VBAT=3.7V, VOUT=5.0V, fs=1.5MHz (without LED indicator, VOUT without load)		4	6	mA

DC Output Voltage	V_{OUT}	VBAT=3.7V @0A	5.0	5.05	5.15	V
		VBAT=3.7V @100mA	4.75	5.00	5.15	V
Output Voltage Ripple	ΔV_{OUT}	VBAT=3.0V~4.4V	50	100	150	mV
Boost Output Current	I_{VOUT}	VBAT=3.0V~4.4V	0		300	mA
Boost Overcurrent Shut Down Current	I_{VOUT}	VBAT=3.0V~4.4V	0.7	0.8	0.9	A
One Earphone Limit Current	I_{shut}	VBAT=3.7V	120	150	180	mA
Load Overcurrent Detect Time	T_{UVD}	Duration of output voltage under 4.2V		30		ms
Control System						
Switch Frequency	fs	Discharge switch frequency	1.3	1.5	1.6	MHz
PMOS On Resistance	r_{DSON}			450		mΩ
NMOS On Resistance				330		mΩ
Vcc Voltage	VCC	VCC=VBAT; VCC=3.3V when VBAT danglings and only VIN inputs	VBAT-0.1	VBAT	VBAT	V
Battery Input Standby Current	I_{STB}	VIN=0V, VBAT=3.7V, “IP5521_BT” product	15	20	25	uA
		VIN=0V, VBAT=3.7V, “IP5521_BT_HALL” product	20	27	35	uA
		VIN=0V, VBAT=3.7V, “IP5521_CK” product	40	45	50	uA
		VIN=0V, VBAT=3.7V, “IP5521_CK_HALL” product	45	50	55	uA
Light Load Shut Down Detect Time	T_{loadD}	Load current less than 4mA	4	5	6	s
Light Load Shut Down Current	I_{plout}	VBAT=3.7V, The load current of both headphones must be less than I_{plout} to shut down.	3	4	5	mA
Short Press On Key Wake Up Time	$T_{OnDebounce}$		100		300	ms
Long Press On Key Wake Up Time	$T_{Keylight}$		2		3	s
Thermal Shut Down Temperature	T_{OTP}	Rising temperature	130	140	150	℃
Thermal Shut Down Hysteresis	ΔT_{OTP}		30	40	50	℃

13. Function Description

13.1 Boost

IP5521 integrates a boost DC-DC converter with 5V/300mA output, 1.5MHz switching frequency. To avoid large rush current causing device failure, it is built in overcurrent, short circuit, overvoltage and over temperature protection function, ensuring the reliability and stability of system operation.

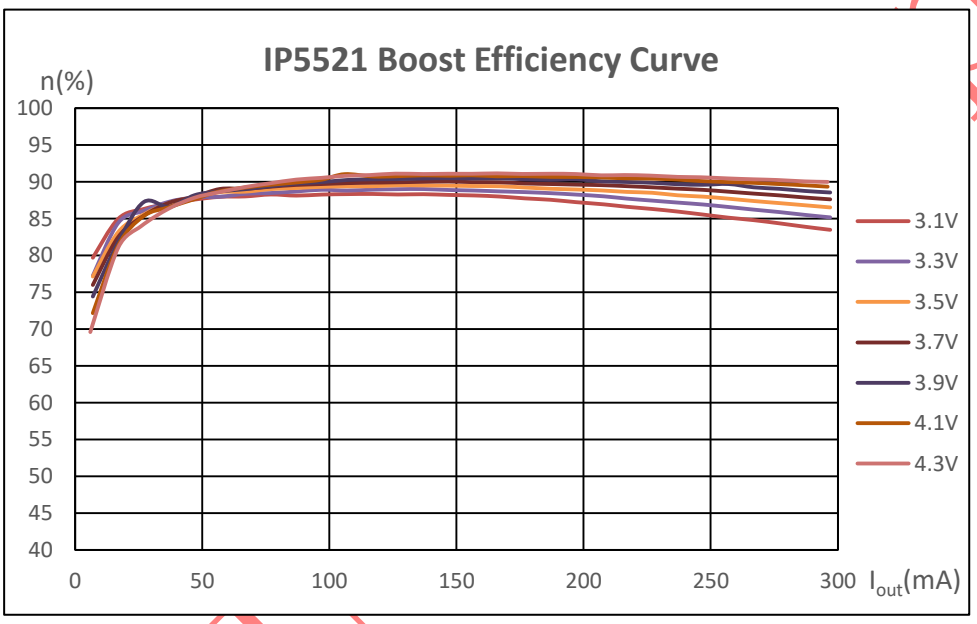


Figure4 IP5521 Boost Efficiency Curve

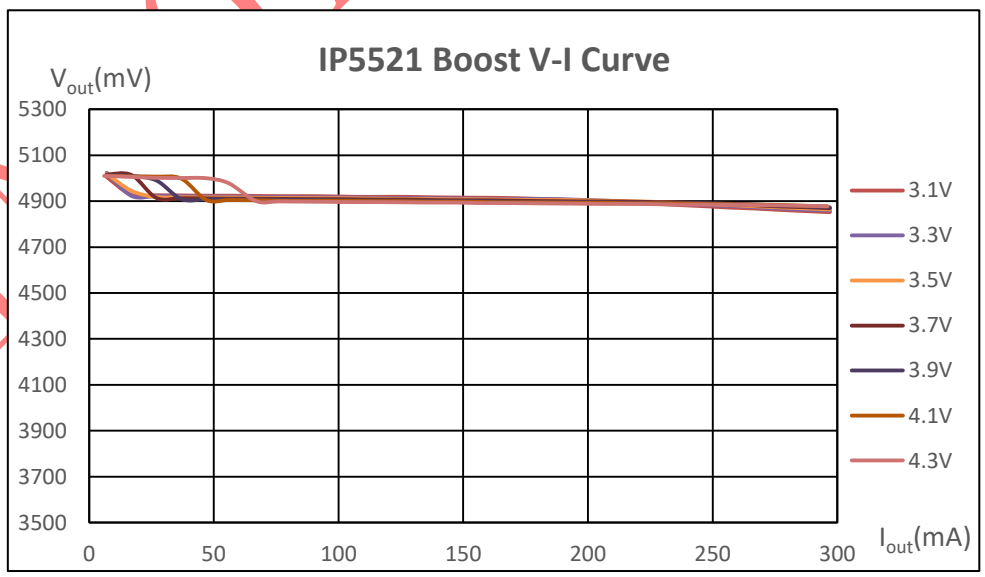


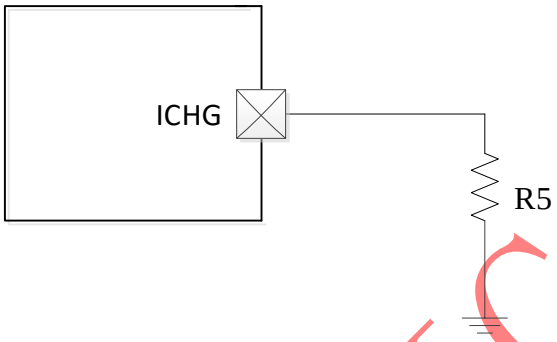
Figure5 IP5521 Boost Output V-I Curve

13.2 Charge

IP5521 integrates a linear lithium battery charger. When the battery voltage is less than 3V, precharge with 0.1 CC; when the battery voltage is greater than 3V, enter constant current CC charging; when the battery voltage is close to 4.2V/4.35V, enter constant voltage charging. When the charging is accomplished, once the battery voltage falls under 4.1V, battery charging stage will be restarted.

IP5521 supports max 500mA linear charging, According to the IC temperature and input voltage, IP5521 can intelligently adjust charging current.

IP5521 can select the constant current charging current of the battery by connecting different resistors on the ICHG pin.



Charging Current	R5
200mA	10K
300mA	82K
400mA	120K
500mA	150K

Figure6 Constant Charging Current Setting Circuit

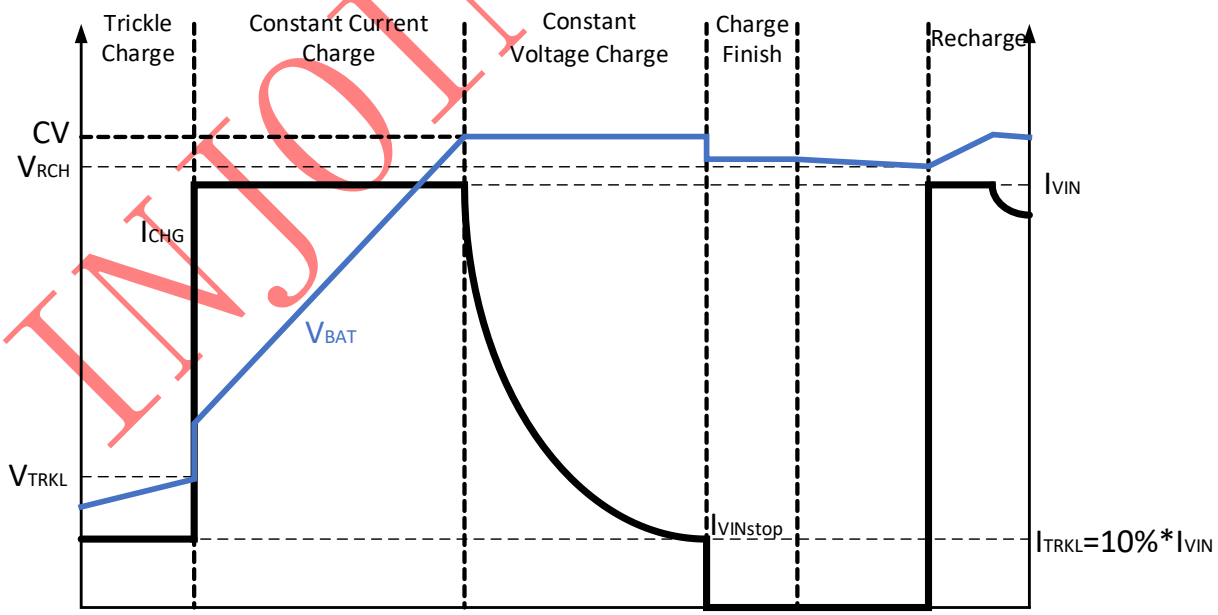


Figure7 Battery Charge Curve

IP5521 has a built-in power path management. When the battery voltage is greater than 3.3V, it supports simultaneous charging and discharging. When the battery voltage is less than 3.1V, it does not support simultaneous charging and discharging, the battery is charged firstly.

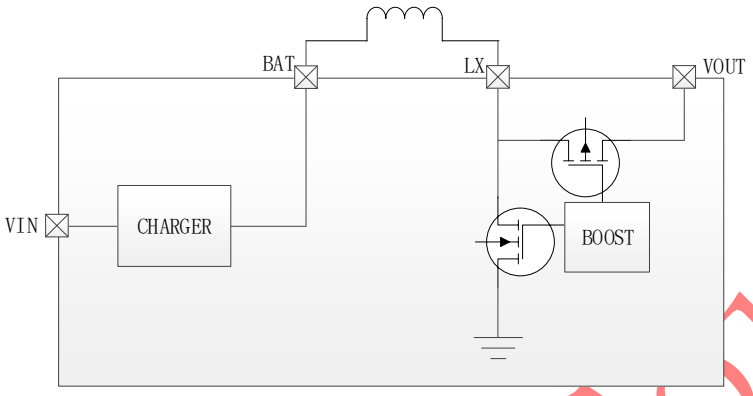
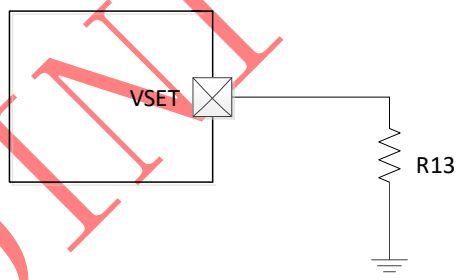


Figure8 IP5521 Power Path Diagram

13.3 Full Battery Voltage Setting

IP5521 can select the full battery voltage by configuring the VSET function on the VSET pin by connecting different pull-down resistors.



Full Battery Voltage	R13
4.2V	10K
4.35V	100K

Figure9 Full Battery Voltage Setting Circuit

13.4 Battery Level Display

IP5521 has a built-in power algorithm, which can accurately display the remaining battery power according to the cell capacity.

IP5521 can support 1/2/3/4 LED battery level display, and the system can automatically identify several LED modes. IP5521 can also support charge, discharge, insert earphone battery level display.

IP5521's LED power source provided by VCC. VBAT=0V and inputing VIN can also light the LED.

13.4.1 4LED Light Display Mode

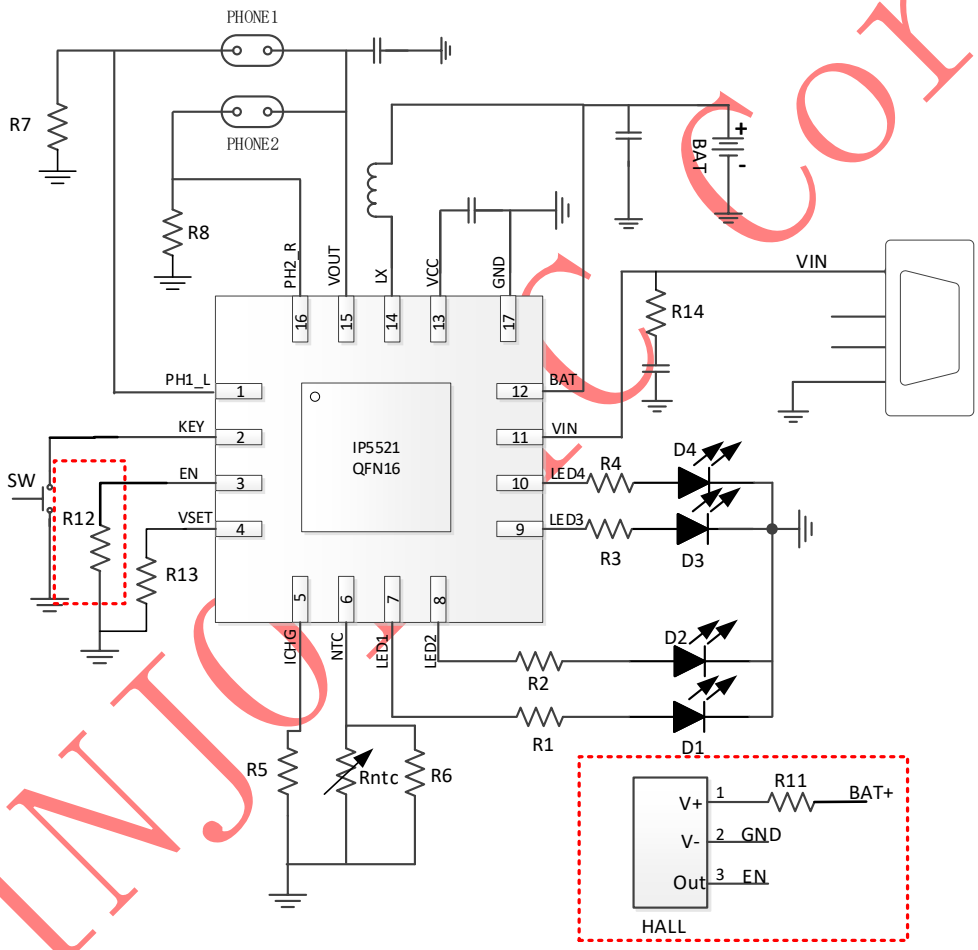


Figure10 4LED Mode Seleciton Circuit

Note:

1. **The red dotted box in the figure is optional. If HALL function is available, HALL device should be welded and resistance R12 should dangling. If there is no HALL function, resistor R12 should connect 10K;**
2. **"1Hz blink" in the following table refers to the light display phenomenon without "_BRE" product. The light display of firmware with "_BRE" product is "1Hz breathing light blink". In the case of 0% - 5% discharge, "1Hz blink 4s and off" is applicable to both with and without "_BRE" product;**
3. **For the following table, "light 4s and off" refers to the light display without "_CL" product. For product with "_CL", when the earphone is charging without HALL function, or the earphone is charging with HALL turn off, the light display phenomenon will be "on";**

For the charge light display and discharge light display under the 4LED light display mode, the description is as follows:

Mode	Light Display	D1	D2	D3	D4
charge	full	on	on	on	on
	75%-100%	on	on	on	1Hz blink
	50%-75%	on	on	1Hz blink	off
	25%-50%	on	1Hz blink	off	off
	0%-25%	1Hz blink	off	off	off
discharge	75%-100%	light 4s and off	light 4s and off	light 4s and off	light 4s and off
	50%-75%	light 4s and off	light 4s and off	light 4s and off	off
	25%-50%	light 4s and off	light 4s and off	off	off
	5%-25%	light 4s and off	off	off	off
	0%-5%	1Hz blink 4s and off	off	off	off

■ Contain "_HALL" product

Mode	HALL state	Earphone in or out	Light Display State
Charge	HALL keep turning on or keep turning off		Show charge light display
	HALL from open to closed		Keep charge light display
	HALL from closed to open		Keep charge light display
	Earphone in when HALL keep turning on		Keep charge light display
Discharge	HALL from open to closed	in	Left/Right earphone in, LED1/LED4 1Hz blink 1s, then show discharge light display
		out	No light display
	HALL from closed to open		Show discharge light display
	Earphone in when HALL keep turning on		No light display

■ Not contain "_HALL" product

Mode	Earphone in Charging Case State	Light Display State
Charge	Earphone keep in	Show charge light display
	Earphone keep out	Show charge light display
	Earphone in → Earphone out	Show charge light display
Discharge	Earphone keep in	Show discharge light display
	Earphone keep out	Show discharge light display
	Earphone in → Earphone out	Left/Right earphone in, LED1/LED4 1Hz blink 1s, then show discharge light display

13.4.2 3LED Light Display Mode

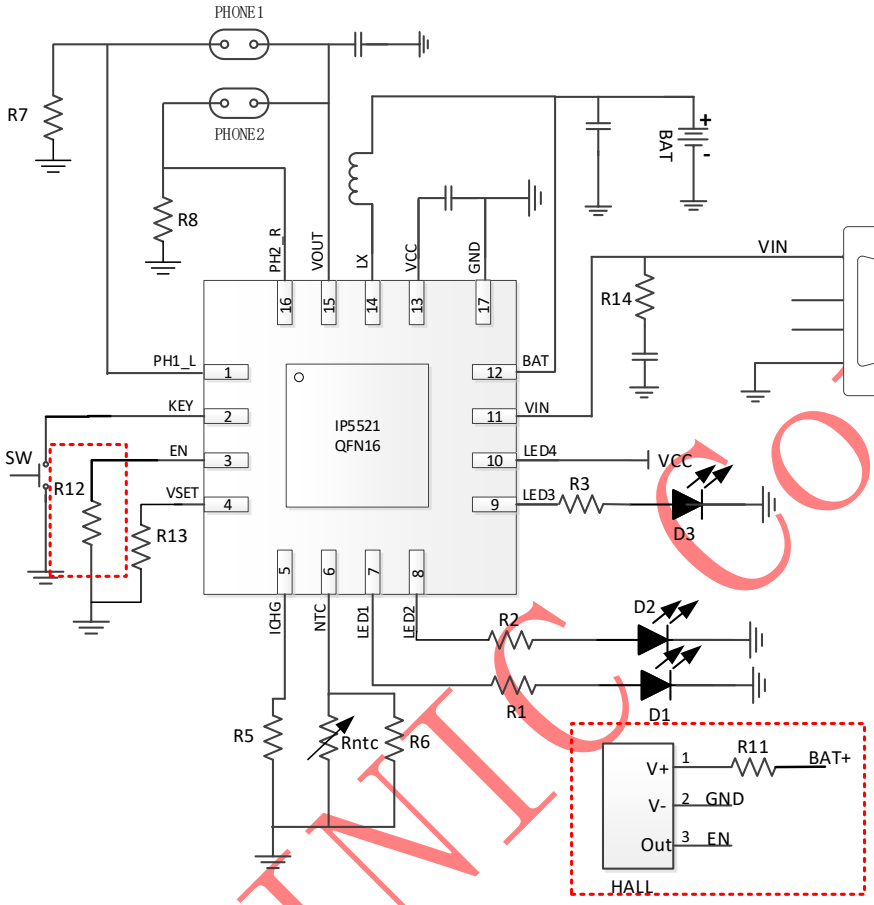


Figure11 3LED Mode Seleciton Circuit

Note:

1. **The red dotted box in the figure is optional. If HALL function is available, HALL device should be welded and resistance R12 should dangling. If there is no HALL function, resistor R12 should connect 10K;**
2. **"1Hz blink" in the following table refers to the light display phenomenon without "_BRE" product. The light display of firmware with "_BRE" product is "1Hz breathing light blink". In the case of 0% - 5% discharge, "1Hz blink 4s and off" is applicable to both with and without "_BRE" product;**
3. **For the following table, "light 4s and off" refers to the light display without "_CL" product. For product with "_CL", when the earphone is charging without HALL function, or the earphone is charging with HALL turn off, the light display phenomenon will be "on";**

For the charge light display and discharge light display under the 3LED light display mode, the description is as follows:

Mode	Light Display	D1	D2	D3
charge	full	on	on	on
	66%-100%	on	on	1Hz blink
	33%-66%	on	1Hz blink	off
	0%-33%	1Hz blink	off	off
discharge	66%-100%	light 4s and off	light 4s and off	light 4s and off
	33%-66%	light 4s and off	light 4s and off	off
	5%-33%	light 4s and off	off	off
	0%-5%	1Hz blink 4s and off	off	off

■ Contain "_HALL" product

Mode	HALL state	Earphone in or out	Light Display State
Charge	HALL keep turning on or keep turning off		Show charge light display
	HALL from open to closed		Keep charge light display
	HALL from closed to open		Keep charge light display
	Earphone in when HALL keep turning on		Keep charge light display
Discharge	HALL from open to closed	in	Left/Right earphone in, LED1/LED3 1Hz blink 1s, then show discharge light display
		out	No light display
	HALL from closed to open		Show discharge light display
	Earphone in when HALL keep turning on		No light display

■ Not contain "_HALL" product

Mode	Earphone in Charging Case State	Light Display State
Charge	Earphone keep in	Show charge light display
	Earphone keep out	Show charge light display
	Earphone in → Earphone out	Show charge light display
Discharge	Earphone keep in	Show discharge light display
	Earphone keep out	Show discharge light display
	Earphone in → Earphone out	Left/Right earphone in, LED1/LED3 1Hz blink 1s, then show discharge light display

13.4.3 2LED Light Display Mode

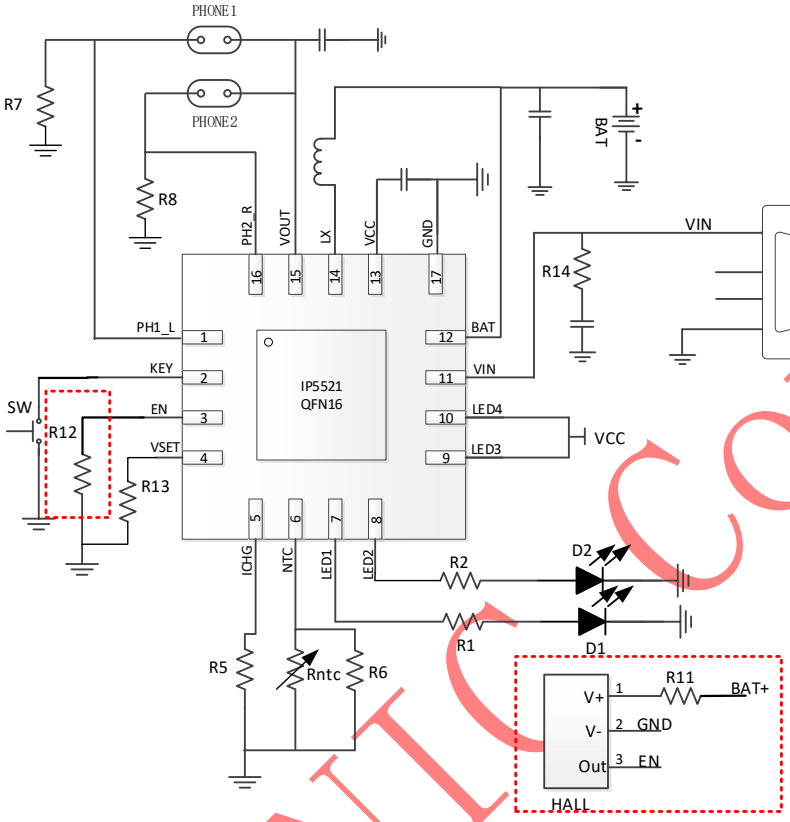


Figure12 2LED Mode Seleciton Circuit

Note:

1. **The red dotted box in the figure is optional. If HALL function is available, HALL device should be welded and resistance R12 should dangling. If there is no HALL function, resistor R12 should connect 10K;**
2. **"1Hz blink" in the following table refers to the light display phenomenon without "_BRE" product. The light display of firmware with "_BRE" product is "1Hz breathing light blink". In the case of 0% - 5% discharge, "1Hz blink 4s and off" is applicable to both with and without "_BRE" product;**
3. **For the following table, "light 4s and off" refers to the light display without "_CL" product. For product with "_CL", when the earphone is charging without HALL function, or the earphone is charging with HALL turn off, the light display phenomenon will be "on";**

For the charge light display and discharge light display under the 2LED light display mode, the description is as follows:

Mode	Light Display	D1	D2
charge	full state	off	on
	charge state	off	1Hz blink
discharge	normal battery level	light 4s and off	off
	low battery level	1Hz blink 4s and off	off

■ Contain "_HALL" product

Mode	HALL state	Earphone in or out	Light Display State
Charge	HALL keep turning on Or keep turning off		Show charge light display
	HALL from open to closed		Keep charge light display
	HALL from closed to open		Keep charge light display
	Earphone in when HALL keep turning on		Keep charge light display
Discharge	HALL from open to closed	in	Left/Right earphone in, LED1 1Hz blink 1s, then show discharge light display
		out	No light display
	HALL from closed to open		Show discharge light display
	Earphone in when HALL keep turning on		No light display

■ Not contain "_HALL" product

Mode	Earphone in Charging Case State	Light Display State
Charge	Earphone keep in	Show charge light display
	Earphone keep out	Show charge light display
	Earphone in → Earphone out	Show charge light display
Discharge	Earphone keep in	Show discharge light display
	Earphone keep out	Show discharge light display
	Earphone in → Earphone out	Left/Right earphone in, LED1 1Hz blink 1s, then show discharge light display

13.4.4 1LED Light Display Mode

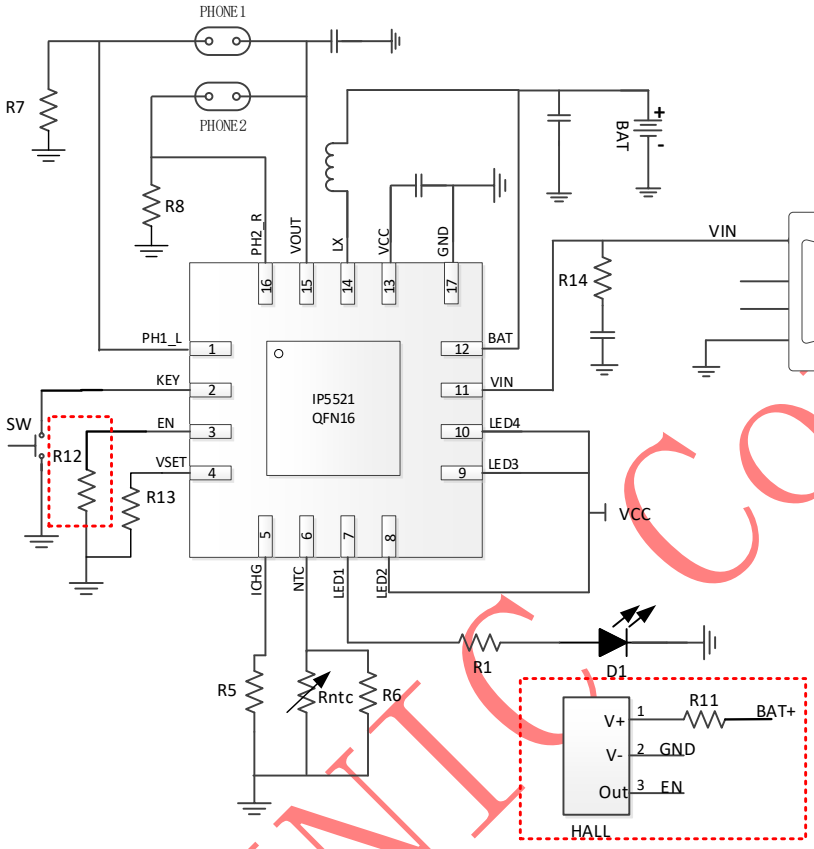


Figure13 1LED Mode Seleciton Circuit

Note:

1. **The red dotted box in the figure is optional. If HALL function is available, HALL device should be welded and resistance R12 should dangling. If there is no HALL function, resistor R12 should connect 10K;**
2. **"1Hz blink" in the following table refers to the light display phenomenon without "_BRE" product. The light display of firmware with "_BRE" product is "1Hz breathing light blink". In the case of 0% - 5% discharge, "1Hz blink 4s and off" is applicable to both with and without "_BRE" product;**
3. **For the following table, "light 4s and off" refers to the light display without "_CL" product. For product with "_CL", when the earphone is charging without HALL function, or the earphone is charging with HALL turn off, the light display phenomenon will be "on";**

For the charge light display and discharge light display under the 1LED light display mode, the description is as follows:

Mode	Light Display	D1
charge	full state	on
	charge state	1Hz blink
discharge	normal battery level	light 4s and off
	low battery level	1Hz blink 4s and off

■ Contain "_HALL" product

Mode	HALL state	Earphone in or out	Light Display State
Charge	HALL keep turning on Or keep turning off		Show charge light display
	HALL from open to closed		Keep charge light display
	HALL from closed to open		Keep charge light display
	Earphone in when HALL keep turning on		Keep charge light display
Discharge	HALL from open to closed	in	Left/Right earphone in, LED1 1Hz blink 1s, then show discharge light display
		out	No light display
	HALL from closed to open		Show discharge light display
	Earphone in when HALL keep turning on		No light display

■ Not contain "_HALL" product

Mode	Earphone in Charging Case State	Light Display State
Charge	Earphone keep in	Show charge light display
	Earphone keep out	Show charge light display
	Earphone in → Earphone out	Show charge light display
Discharge	Earphone keep in	Show discharge light display
	Earphone keep out	Show discharge light display
	Earphone in → Earphone out	Left/Right earphone in, LED1 1Hz blink 1s, then show discharge light display

13.4.5 LED Light Display Voltage Point

During the charging and discharging process of IP5521, the internal logic has the battery level update algorithm, which will calculate the updated power according to the battery voltage, charging time and charging current, and the battery level display is more uniform. The following table is the reference threshold of battery voltage point, the internal algorithm has the ability to limit the sudden change of battery voltage. Every 25% of the power change time needs at least dozens of seconds.

LED Plan	Battery Display	4.20V Battery Plan		4.35V Battery Plan	
		Charge/V	Discharge/V	Charge/V	Discharge/V
4LED plan	75%	4.07V	3.89V	4.2V	4.02V
	50%	3.92V	3.74V	4.0V	3.82V
	25%	3.74V	3.56V	3.8V	3.62V
	5%		3.2V		3.2V
3LED plan	66%	4.1V	3.92V	4.1V	3.92V
	33%	3.8V	3.62V	3.8V	3.62V
	5%		3.2V		3.2V

13.5 NTC

IP5521 support NTC function used for battery temperature detection. NTC pin outputs 20uA current then detects the voltage on NTC resistance to determine the present battery temperature.

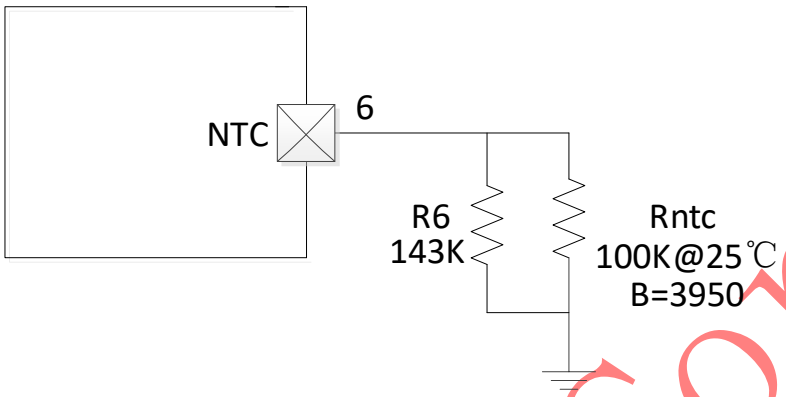


Figure14 NTC Circuit

Under charging state:

Voltage on NTC resistance is higher than 1.98V meaning the battery temperature is under 0 centigrade, then stop charging the battery;

Voltage on NTC resistance is lower than 0.67V meaning the battery temperature is above 45 centigrade, then stop charging the battery;

Under discharging state:

Voltage on NTC resistance is higher than 2.37V meaning the battery temperature is under -15 centigrade, stop discharging;

Voltage on NTC resistance is lower than 0.42V meaning the battery temperature is above 60 centigrade, stop discharging.

If NTC function is not required in the scheme, the NTC pin shall be connected 51K to GND. NTC pin shall not float, otherwise abnormal charging and discharging may be caused.

13.6 Plug-in/Plug-out Detection

Once detecting the insertion of the earphone, the IP5521 wakes up from the standby mode and turns on the boost 5V to charge the earphone, eliminating the button operation and supporting the buttonless mold solution. The IP5521 supports light-load auto standby function. When the earphone's load current on PH1_L and PH2_R are less than 4mA for 5 seconds, IP5521 will automatically enter standby mode. In the standby mode, the VOUT pin voltage has two configurations: 5V, and VBAT.

When IP5521 is in standby mode without earphone, PH1_L/PH2_R internal NMOS shutdown, PH1_L/PH2_R is maintained at 0V through R7/R8 pull-down level. When earphone is plugged in, the equivalent impedance of earphone and R7/R8 form the voltage divider circuit of VOUT to GND. When PH1_L/PH2_R voltage rises from low level to more than 0.4V for a period of time, IP5521 is woken up.

When the earphones are charged end, the IP5521 will enter standby mode and the VOUT output will change to VBAT. In this case, in order to make the earphones also enter power-saved mode, you need to adjust the resistance R7/R8 on PH1_L/PH2_R. Taking PH1_L as an example, the adjustment method is as follows:

1. R7 default resistance is 51K;
2. If IP5521 can enters standby mode, but the earphone cannot enter the standby mode, then gradually reduce the R7;
3. If IP5521 can enters standby, but it can not be waked up by the earphone's plug-in, then gradually increase the R7;
4. Repeat steps 2/3 until you find a suitable resistor R7, which makes IP5521 can enter standby mode, and the earphone can enter stanby mode, and IP5521 can be waked up by the plug-in of earphone.

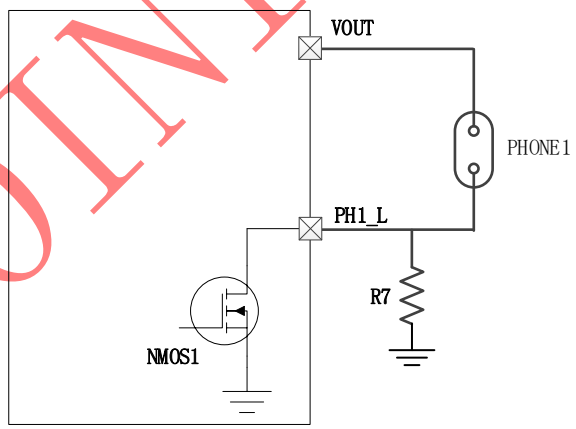


Figure15 IP5521 Earphone Standby Resistance Adjustment Diagram

13.7 KEY

IP5521's KEY is pulled up internally to detect the low level to determine whether the KEY action occurs. It integrates functions such as light display prompt and boost output:

1. In the normal state of battery discharge, one short press the KEY, and the LED displays the corresponding battery indicator for 4s;

2. In the normal power IP5521 standby sleep state, one short press the KEY to wake up IP5521, turn on the boost output, and the LED displays the corresponding power light for 4s;

3. In the state of low battery discharge, one short press the KEY, and the LED displays the corresponding battery light for 4s;

4. In the low power IP5521 standby sleep state, one short press the KEY, Boost will not boost and output, and the LED will display the corresponding power light for 4s.

13.8 HALL

IP5521 supports HALL function. If the HALL function is used, the resistance R12 is suspended, EN pin cover low when turning off state by default. If HALL function is not used, resistance R12 is used to weld 10K resistance.

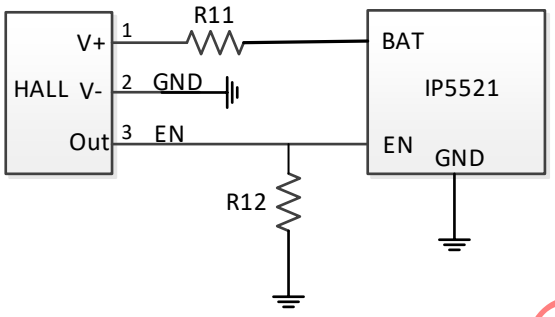


Figure16 IP5521 HALL Circuit

When IP5521 detects the “turning on HALL” signal, VOUT will send a 5V to 0V pulse waveform, as shown in the figure below, to inform the charging case that it has been in the “turning on HALL” state. After the pulse waveform ends, IP5521 will continue to maintain 0V output. At this moment, if the earphone is put in, the VOUT will continue to output 0V.

When HALL is in turning off state, IP5521 detects that both two earphones are fully charged. If IP5521 product doesn’t contain “_CK”, Boost will be turned off and VOUT will output VBAT. If IP5521 product contains “_CK”, VOUT will maintain 5V output.

Please refer to the chapter “Battery level display” for the specific blinking mode of earphones.

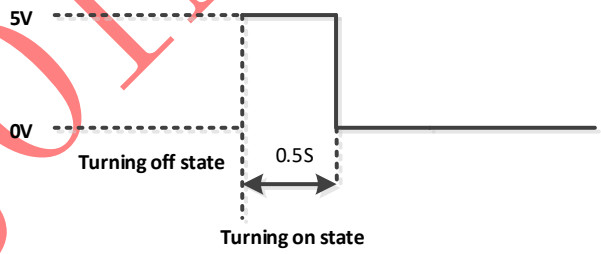


Figure17 IP5521 Turning on HALL Pulse Diagram

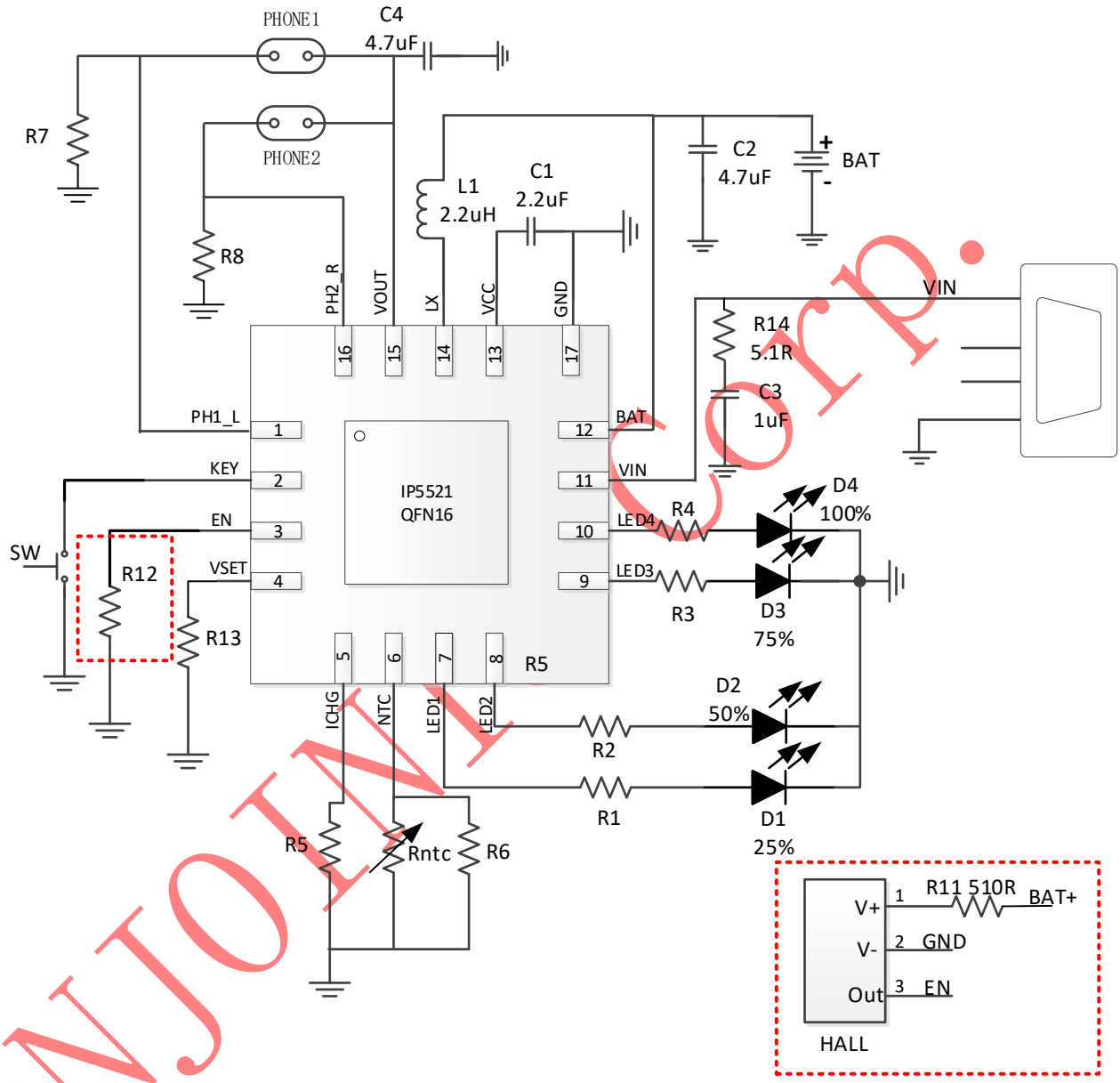
13.9 Output Current-limiting

IP5521 integrates the charge current limit detection function of the earphone, and provides the load insertion recognition and load current-limiting detection function on PH1_L and PH2_R.

In the case of IP5521 without "_HALL" product, when IP5521 detects the load insertion, the boost output module function is turned on, and the VOUT outputs 5V discharge. When PH1_L's and PH2_R's current are less than the light load current threshold (4mA), the chip will be triggered to light load, IC will enter into standby sleep, and then inserting the load can wake the IC out of sleep. For details, please refer to the chapter" Plug-in/Plug-out detection".

PH1_L's and PH2_R's limit current are 150mA. In case of overcurrent or short circuit at the ends of normal output load - VOUT-PH1_L or VOUT-PH2_R, the boost function will be turned off and the standby mode will be entered after burping for 4 times. You can press the key, re-insert and unplug the load or insert the charging line to wake up, and then re-detect the output current limiting function after waking up.

14. Typical Application Diagram



Note:

1. R1/2/3/4 needs to adjust the resistance value according to the actual LED brightness;
2. When NTC function is supported, R6=143kΩ, Rntc= 100K@25℃, B=3950;
   When NTC function is not supported, R6=51kΩ, Rntc is suspended;
3. R5 needs to configure corresponding resistance value according to different constant current charging current;
4. R7/R8 needs to adjust the corresponding resistance value according to different Bluetooth earphone schemes;
5. R13 needs to configure corresponding resistance values according to different cell types;
6. With HALL function, R12 is suspended; Without HALL function, R12=10kΩ.

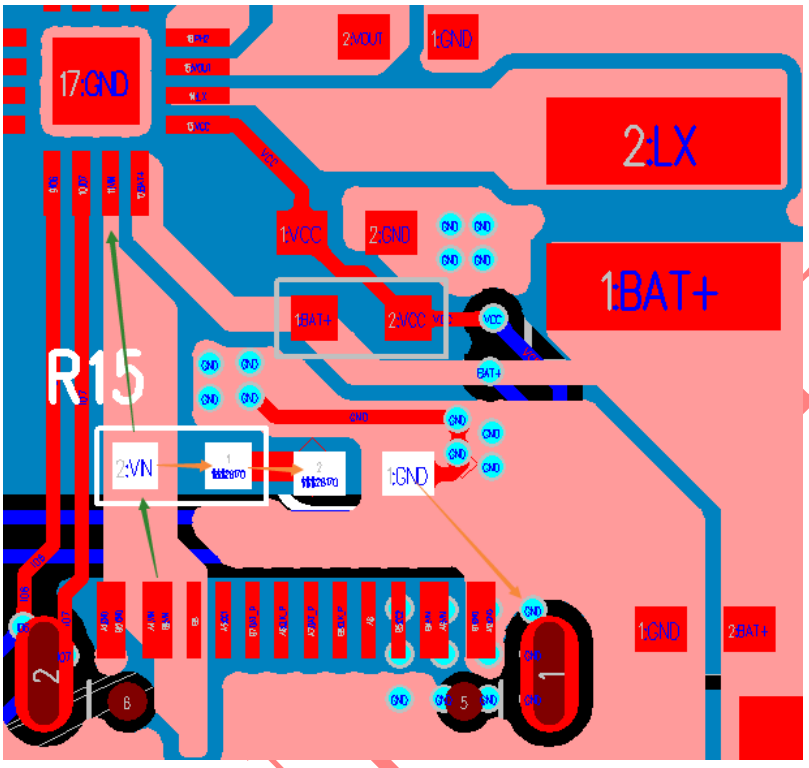
Figure18 IP5521 4LED Typical Application Diagram

Device Parameter Requirements：

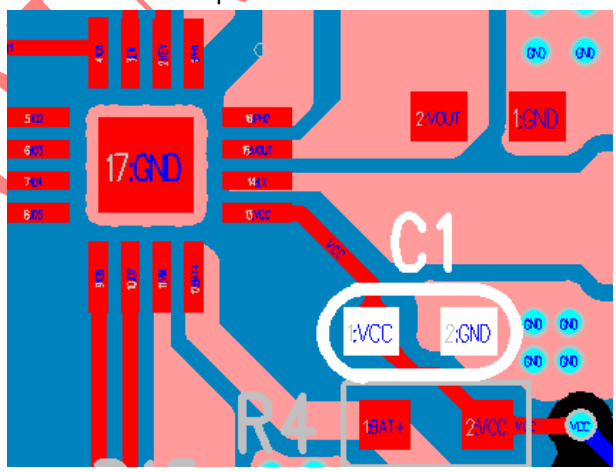
Device	Location	Parameter
C3	Capacitance of RC at VIN input	1uF/±10%/0603，withstanding voltage≥30V
R14	Resistance of RC at VIN input	5.1Ω/±10%/0603
C1	VCC capacitance	2.2uF/±10%/0603，withstanding voltage≥10V
Other capacitance	Other capacitance	precision±10%，withstanding voltage≥10V
L1	Inductance	2.2uH/±20% DCR<100mΩ Saturation current>2.5A

15. PCB LAYOUT

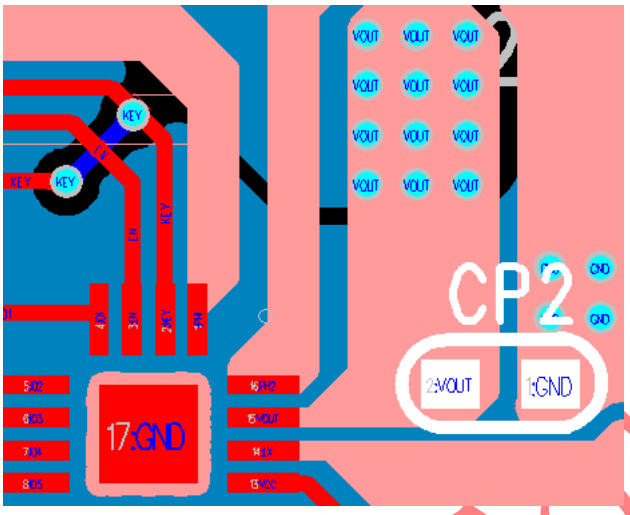
1. VIN capacitor should be placed close to VIN PIN, The ground loop should be as short as possible:



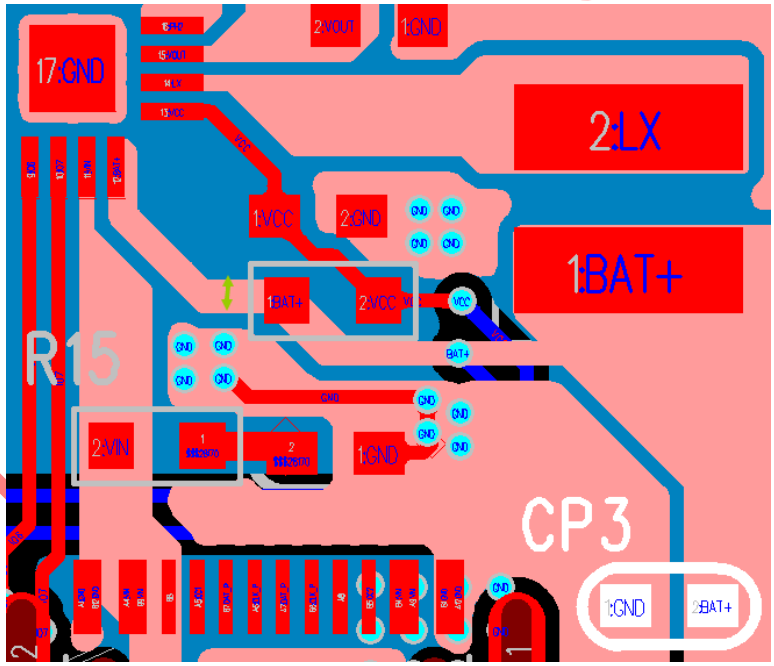
2. VCC capacitor placed close to the VCC pin, When externally connected to other circuits for power supply, this branch needs to be led out from behind the VCC capacitor and connected in series with a current limiting resistor:



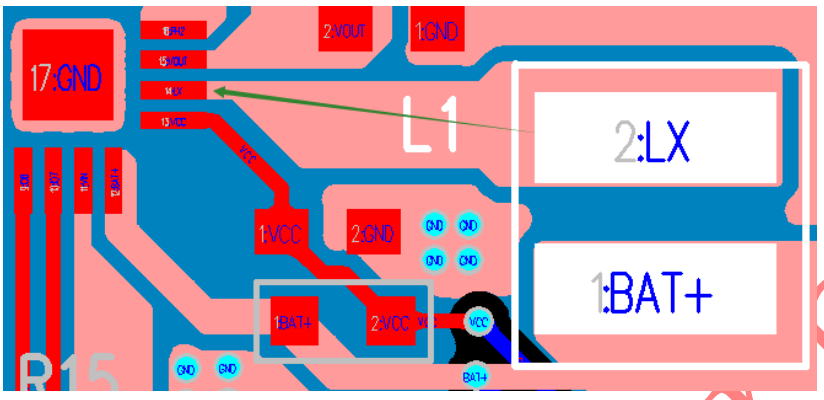
3. VOUT capacitor placed close to the VOUT pin:



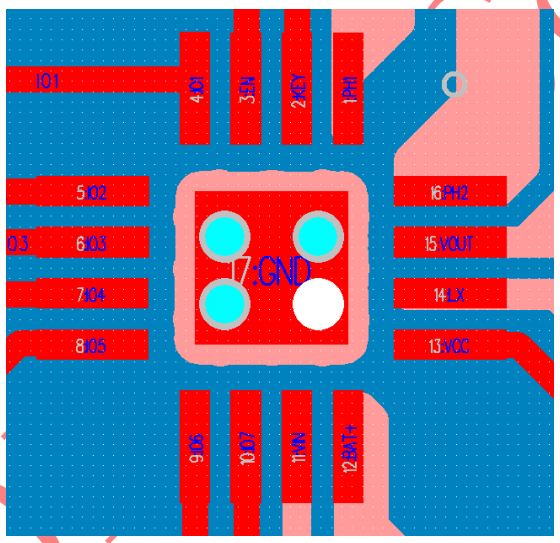
4. BAT pins are shorted together as the positive terminal of the linear charger output connected to the battery. The wiring width needs to be increased to reduce the line resistance to ensure the passage of large current; BAT capacitors should be placed as close to the chip as possible:



5. LX PIN is the connection PIN between the internal boost circuit and the inductance. There is a high-frequency switch signal on the LX wiring, so the wiring should be as short and straight as possible:



6. It is forbidden to layout any other networks wire under the 5521 chip. Only GND vias need to be drilled under the EPAD:

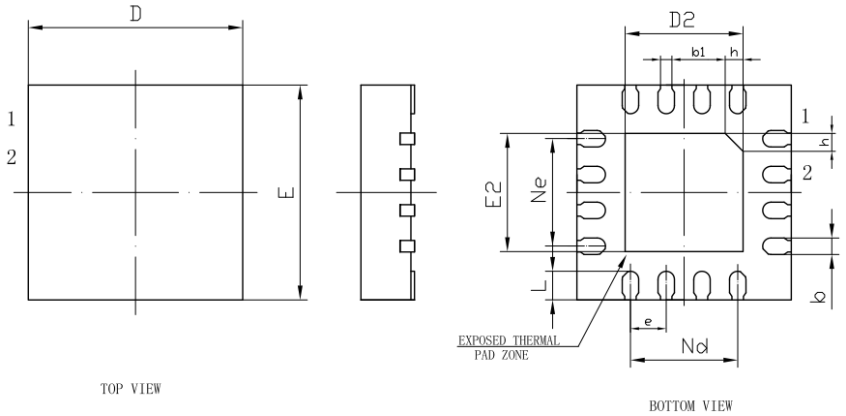


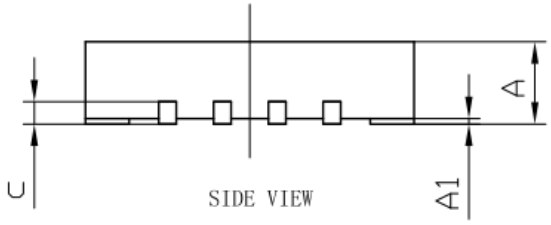
16. IC Mark Description

Note:
1、 --Injoinic Logo
2、IP5521 --Part Number
3、XXXXXXXX --Manufacture number
4、 --PIN1 location

Figure19 IP5521 Mark description

17. Package





SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.18	0.25	0.30
b1	0.16REF		
c	0.18	0.20	0.25
D	2.90	3.00	3.10
D2	1.55	1.65	1.75
e	0.50BSC		
Ne	1.50BSC		
Nd	1.50BSC		
E	2.90	3.00	3.10
E2	1.55	1.65	1.75
L	0.35	0.40	0.45
h	0.20	0.25	0.30
L/F载体尺寸（mil）	75x75		

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