IP5516

TWS Bluetooth Earphone Charging Box SOC integrated with MCU

1. Features

- **Discharge**
  - ✧ Output capacity: 5V/300mA
  - ✧ Up to 93%@5V/150mA 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, 4.30V 4.35V, 4.40V batteries
- **Battery indicators**
  - ✧ Built-in 10bits ADC , accurate calculation of battery capacity
  - ✧ 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 temperature protection
  - ✧ Vin pin can withstand up to 15V(transient voltage)
  - ✧ ESD 4KV
- **In-depth customization**
  - ✧ Flexible and low-cost customized program
- **Package: QFN16 (4*4*0.75mm)**

2. Applications

- TWS Bluetooth Earphone Charging Box
- Lithium Battery Portable Device

3. Description

IP5516 is a multi-functional power management SOC for total solution on TWS Bluetooth Earphone Charging Box. It integrates with 5V boost converter, lithium battery charging management and battery level indicators.

IP5516 is highly integrated with abundant functions, which makes the total solution with minimized-size and low-cost BOM.

The synchronous 5V-boost system of IP5516 provides rated 300mA output current with conversion efficiency up to 93%. DC-DC converter operates at 1.5MHz frequency, can support low-cost inductors and capacitors.

IP5516's linear charger supplies max 500mA charging current. With the change of IC temperature and input voltage, IP5516 can automatically adjust the charging current.

IP5516 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 30uA. The earphone's charge-end current can be Flexible and customizable, such as 4mA or 8mA.

IP5516 can support 1/2/3/4 LED battery indicator, The built-in 10bits ADC can accurately calculate the Chargering Box's battery capacity.

IP5516 is packaged with QFN16(4*4*0.75mm).

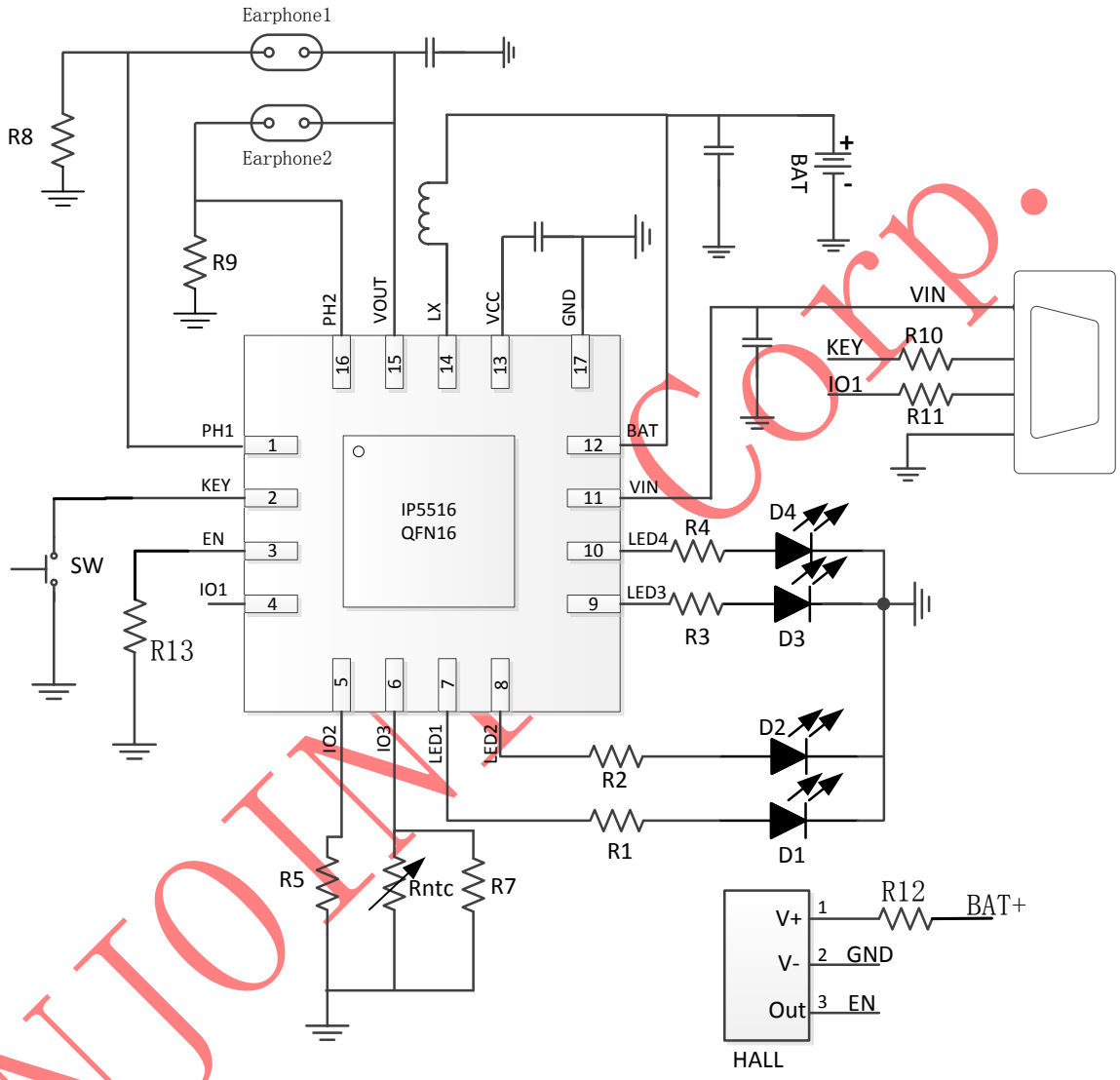


Figure1 IP5516 Simplified Application Diagram

4. Pin Definition

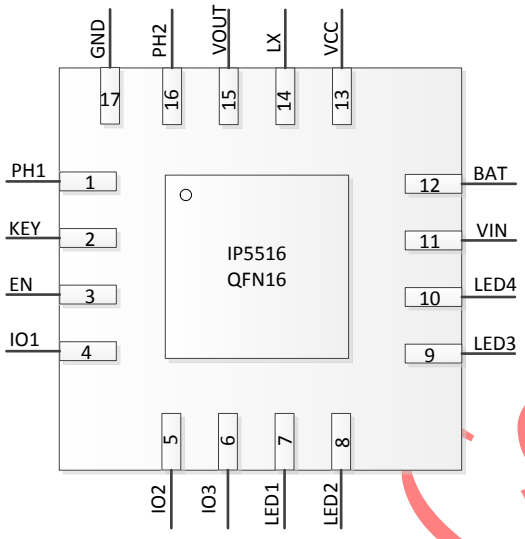


Figure2 IP5516 Pin Assignments

Pin Num	Pin Name	Description
1	PH1	Earphone 1 negative
2	KEY	Key/firmware update
3	EN	HALL switch output signal , By default, it does not support hall. 10K resistance is required to be pulled down to the ground. Hall function needs to be customized individually
4	IO1	firmware update
5	IO2	Battery charging current setting pin
6	IO3	NTC pin
7	LED1	LED driver pin1
8	LED2	LED driver pin2
9	LED3	LED driver pin3
10	LED4	LED driver pin4
11	VIN	5V input pin
12	VBAT	Battery voltage positive pin
13	VCC	LDO output pin, connect to 2.2uF inductor
14	LX	DCDC switch node
15	VOUT	Boost5V output
16	PH2	Earphone 2 negative
17	GND	Ground

5. IP Series TWS Charging IC Products List

	IC Part No.	LED Mode	Charging Current	Light-Load time	Key mode	Light-Load Current to enter standby	auto-wakeup supporting	always-5V supporting	Minimum order quantity
IP5303T series	IP5303T_BT_200MA	1/2	200mA	32 seconds	single start, double close	5mA	yes	no	4K
	IP5303T_BT_500MA	1/2	500mA	32 seconds	single start, double close	5mA	yes	no	4K
	IP5303T_500MA_S_NAT	1/2	500mA	32 seconds	single start, double close	5mA	no	no	4K
IP5305T series	IP5305T_BT	1/2/3/4	1A	32 seconds	single start, double close	5mA	yes	no	4K
	IP5305T_BT_500MA	1/2/3/4	500mA	32 seconds	single start, double close	5mA	yes	no	4K
	IP5305T_BT_300MA	1/2/3/4	300mA	32 seconds	single start, double close	5mA	yes	no	4K
	IP5305T_BT_8S	1/2/3/4	1A	8 seconds	single start, double close	5mA	yes	no	4K
	IP5305T_BT_8S_300MA	1/2/3/4	300mA	8 seconds	single start, double close	5mA	yes	no	4K
IP5403 series	IP5403_CK10_5M	4	500mA	36 seconds	single start, no key close	10mA	no	yes	4K
	IP5403_CK10_5M_D1D2	1/2	500mA	36 seconds	single start, no key close	10mA	no	yes	4K
	IP5403_CK10_2M	4	200mA	36 seconds	single start, no key close	10mA	no	yes	4K
	IP5403_CK10_2M_D1D2	1/2	200mA	36 seconds	single start, no key close	10mA	no	yes	4K
	IP5403_BT10_5M	4	500mA	36 seconds	single start, no key close	10mA	no	no	4K
	IP5403_BT10_5M_D1D2	1/2	500mA	36 seconds	single start, long close	10mA	no	no	4K
	IP5403_BT10_2M	4	200mA	36 seconds	single start, long close	10mA	no	no	4K
	IP5403_BT10_2M_D1D2	1/2	200mA	36 seconds	single start, long close	10mA	no	no	4K

6. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 15	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.

7. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}, V_{BUS}	4.5	5	6.0	V
Operating Temperature	T_A	0	--	70	℃

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

8. Electrical Characteristics

Unless otherwise specified, TA=25℃， L=1uH

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	V_{IN}	VBAT=3.7V	4.5	5	6.0	V
Input Over Voltage	V_{INOV}		5.8	6	6.2	V
VIN activation voltage	V_{INOk}		3.0	3.2	3.4	V
Input Under Voltage	V_{INUV}		4.0	4.2	4.4	V
Constant Charge Voltage	$CV_{4.2V}$	4.2V battery	4.15	4.20	4.24	V
	$CV_{4.30V}$	4.3V battery	4.28	4.30	4.34	V
	$CV_{4.35V}$	4.35V battery	4.33	4.35	4.4	V
	$CV_{4.4V}$	4.4V battery	4.38	4.40	4.44	V
Charge Stop Current	$Ivin_{stop}$	VIN=5V	10	20	30	mA
Charge Current	I_{VIN}	VIN=5V, VBAT=3.7V, Set the charge current=350mA	300	350	400	mA
Trickle Charge Current	I_{TRKL}	VIN=5v， BAT=2.7v	20	25	30	mA
Trickle Charge Stop Voltage	V_{TRKL}		2.9	3	3.1	V
Recharge Voltage Threshold	V_{RCH}		4.07	4.1	4.13	V
Charge Cut-Off Time	T_{END}		20	24	28	Hours
Boost System						
BatteryOperation Voltage	V_{BAT}		3.0	3.7	4.4	V
Low Power Shutdown Voltage	V_{BATLOW}	IOUT=200mA	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 @300mA	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 Threshold	I_{shut}	VBAT=3.0V~4.4V	0.7	0.8	0.9	A

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. (When no VBAT is connected，only VIN supplys power and the charger is disabled, then the VCC is 3.3V)	VBAT-0.1	VBAT	VABT	V
Battery Input Standby Current 1	I_{STB1}	VIN=0V，VBAT=3.7V	20	27	35	uA
Battery Input Standby Current 2	I_{STB2}	VIN=0V，VBAT=3.7V,support hall switch	30	35	40	uA
IO Driving Current	I_{Gpio}		4	6	8	mA
Light Load Shut Down Detect Time	T_{loadD}	Load current less than 4mA	5	6	8	s
Light Load Shut Down Current	I_{plout}	VBAT=3.7V, The load current of both headphones must be less than Iplout 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	℃

9. Function Description

System Diagram

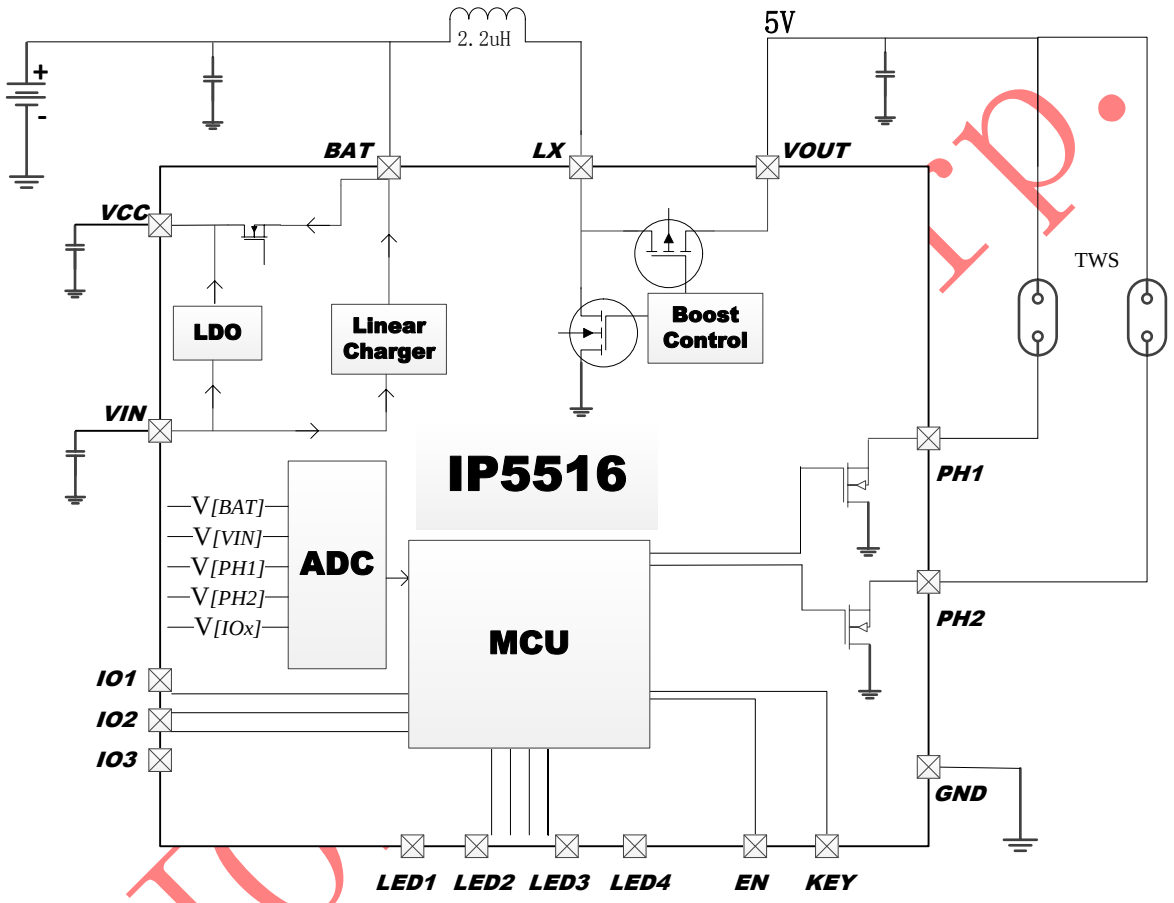


Figure3 IP5516 Internal System Diagram

Boost

IP5516 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.

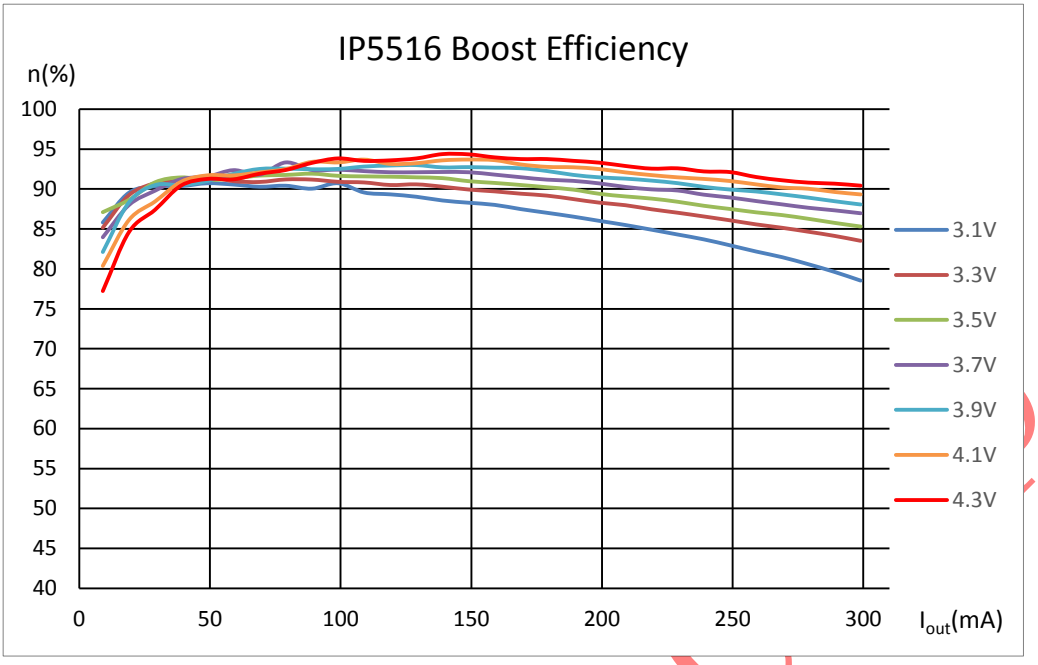


Figure4 IP5516 Boost Efficiency Curve

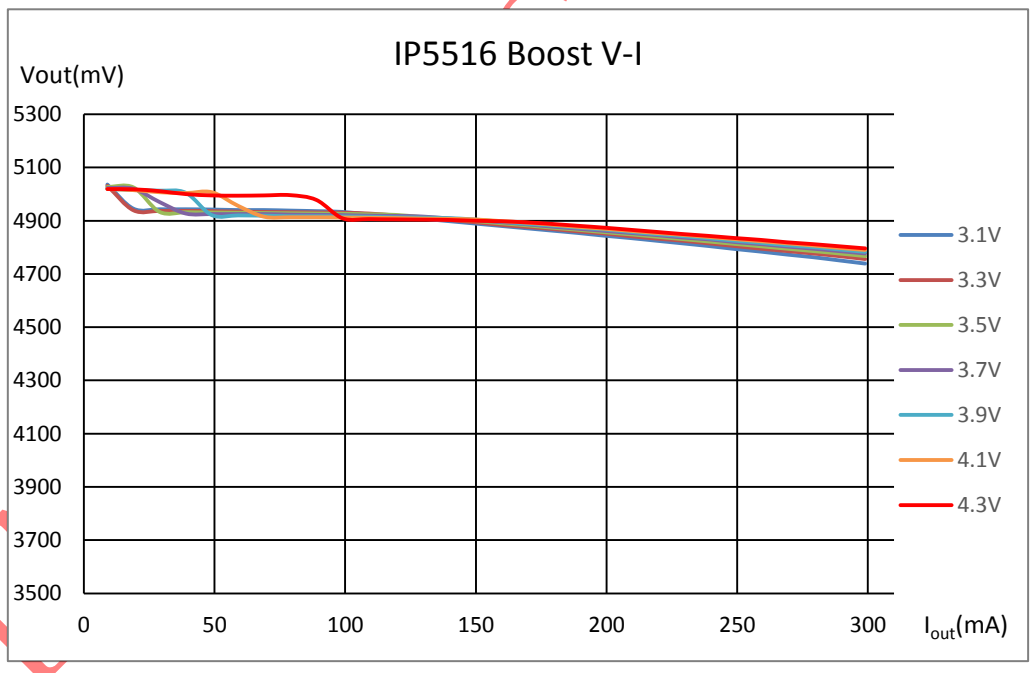


Figure5 IP5516 Boost Output V-I Curve

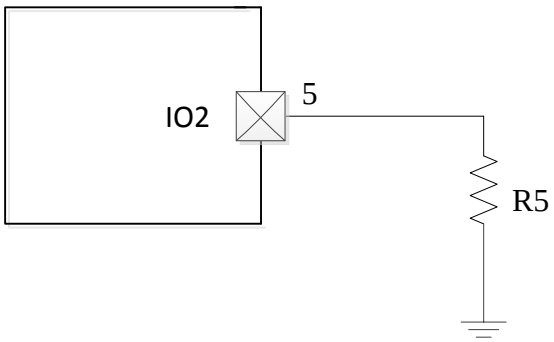
Charge

IP5516 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/4.3V/4.35V/4.4V, enter constant voltage charging. When the charging is accomplished, once the battery voltage falls under 4.1V, battery charging stage will be restarted.

IP5516 supports max 500mA linear charging, According to the IC temperature and input voltage, IP5516 can

intelligently adjust charging current.

IP5516 can select the constant current charging current of the battery by connecting different resistors on the IO2 pin.



Constant current charging	R5
200mA	10K
300mA	82K
400mA	120K
500mA	150K

Figure6 Constant Charging Current Setting Circuit

IP5516 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.

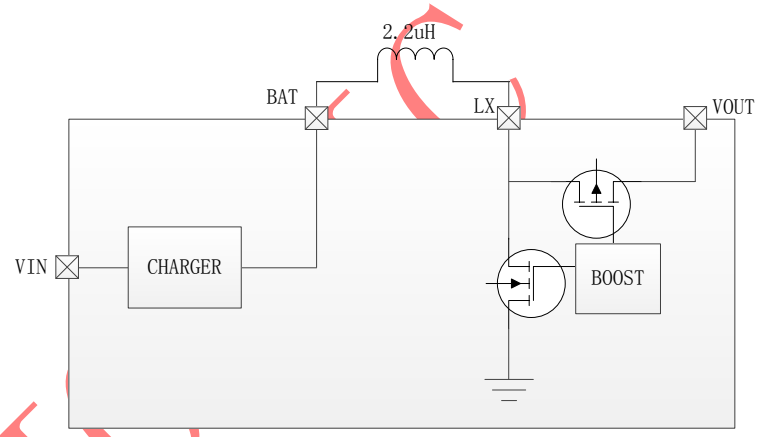


Figure7 IP5516 Power Path Diagram

Battery level display

IP5516 has a built-in power algorithm, which can accurately display the remaining battery power according to the cell capacity.

IP5516 can support 1/2/3/4 LED battery indicator, and the system can automatically identify several LED modes.

LED light display mode

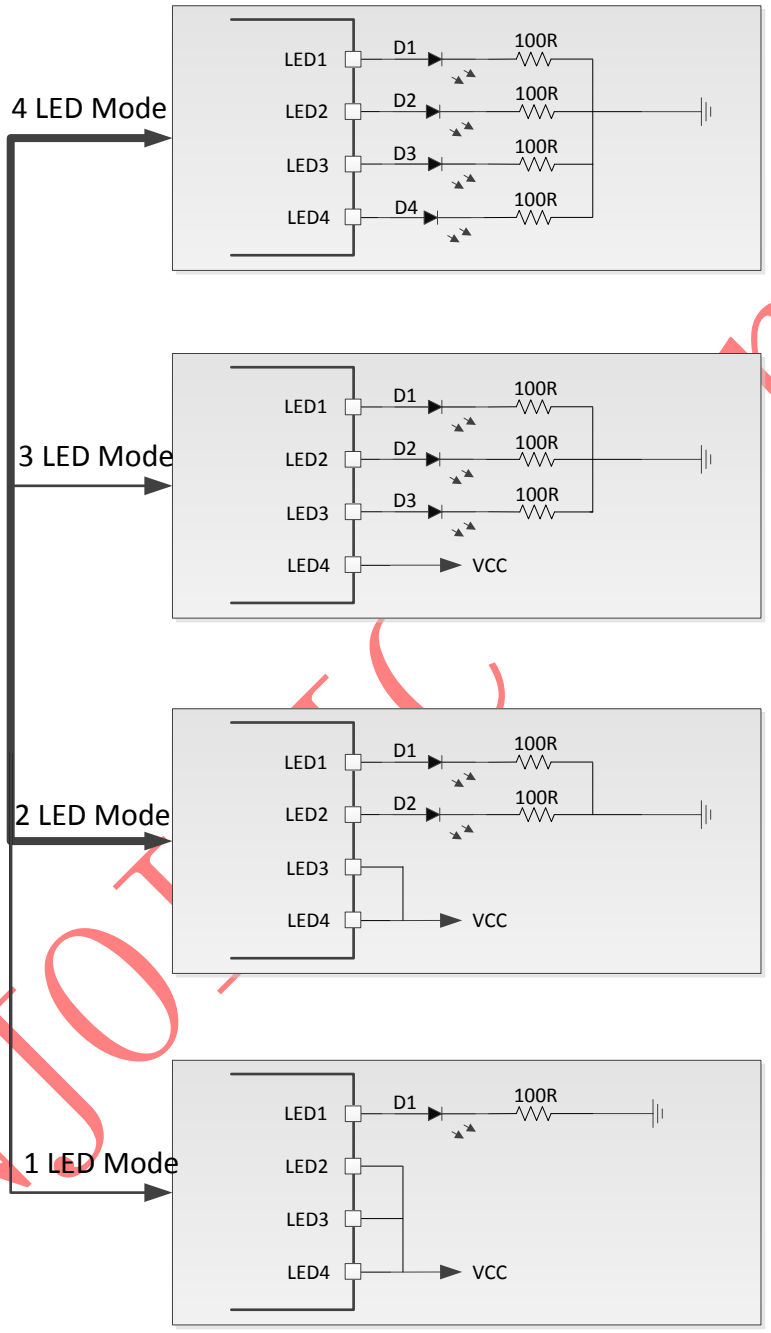


Figure8 LED Mode Seleciton Circuit

■ 4 LED Mode

Discharge

Battery capacity(c)(%)	LED1	LED2	LED3	LED4
C≥75%	on	on	on	on

50%≤C＜75%	on	on	on	off
25%≤C＜50%	on	on	off	off
3%≤C＜25%	on	off	off	off
0%＜C＜3%	1Hz blink	off	off	off

Charge

Battery capacity(c)(%)	LED1	LED2	LED3	LED4
full	on	on	on	on
75%≤C	on	on	on	0.5Hz blink
50%≤C＜75%	on	on	0.5Hz blink	off
25%≤C＜50%	on	0.5Hz blink	off	off
C＜25%	0.5Hz blink	off	off	off

■ 3 LED Mode

Discharge

Battery capacity(c)(%)	LED1	LED2	LED3
C≥66%	on	on	on
33%≤C＜66%	on	on	off
3%≤C＜33%	on	off	off
0%＜C＜3%	1Hz blink	off	off

Charge

Battery capacity(c)(%)	LED1	LED2	LED3
75%≤C	on	on	on
66%≤C＜100%	on	on	0.5Hz blink
33%≤C＜66%	on	0.5Hz blink	off
C＜33%	0.5Hz blink	off	off

■ 2 LED Mode

	state	LED1	LED2
charge	charging	0.5Hz 闪烁	off
	full	on	off
discharge	dischareging	off	on
	low	off	1Hz blink

■ 1 LED Mode

	state	LED1
charge	charging	0.5Hz blink
	full	on
discharge	dischareging	on
	low	1Hz blink

NTC

IP5516 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.

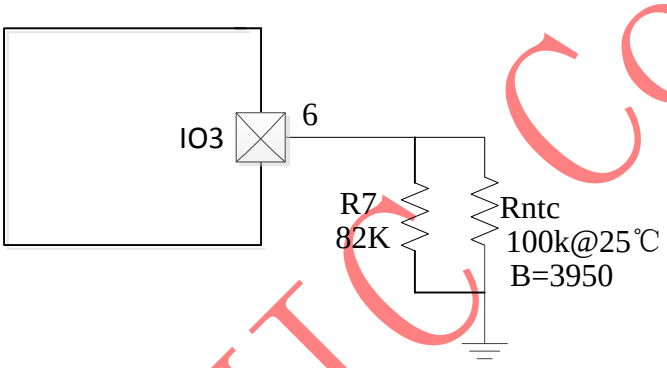


Figure9 NTC Circuit

Under charging state:

Voltage on NTC resistance is higher than 1.3V meaning the battery temperature is under 0 centigrade, then stop charging the battery;

Voltage on NTC resistance is lower than 0.5V meaning the battery temperature is above 50 centigrade, then stop charging the battery;

Under discharging state:

Voltage on NTC resistance is higher than 1.47V meaning the battery temperature is under -15 centigrade, stop discharging;

Voltage on NTC resistance is lower than 0.44V meaning the battery temperature is above 55 centigrade, stop discharging.

If NTC function is not required in the scheme, the IO3 pin shall be connected 51K to GND. IO3 pin shall not float, otherwise abnormal charging and discharging may be caused.

plug-in/plug-out detection

Once detecting the insertion of the earphone, the IP5516 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 IP5516 supports light-load auto standby function. When the earphone's load current on PH1 and PH2 are less than 4mA for 6 seconds, IP5516 will automatically enter standby mode. In the standby mode, the VOUT pin voltage has three configurations: 5V, VBAT, and 2.4V. The standard standby VOUT output voltage is 2.4V, and other

specifications need to be customized separately.

When the earphones are charged end, the IP5516 will enter standby mode and the VOUT output will change to 2.4V. In this case,in order to make the earphones also enter power-saved mode, You need to adjust the resistance R8/R9 on PH1/PH2. Taking PH1 as an example, the adjustment method is as follows:

1. R8 default resistance is 100K

2. If IP5516 can enters standby mode , but the earphone cannot enter the standby mode, then gradually reduce the R8.

3. If IP5516 can enters standby , but it can not be waked up by the earphone's plug-in, then gradually increase the R8.

4. Repeat steps 2/3 until you find a suitable resistor R8, which makes IP5516 can enter standby mode, and the earphone can enter stanby mode,and IP5516 can be waked up by the plug-in of earphone.

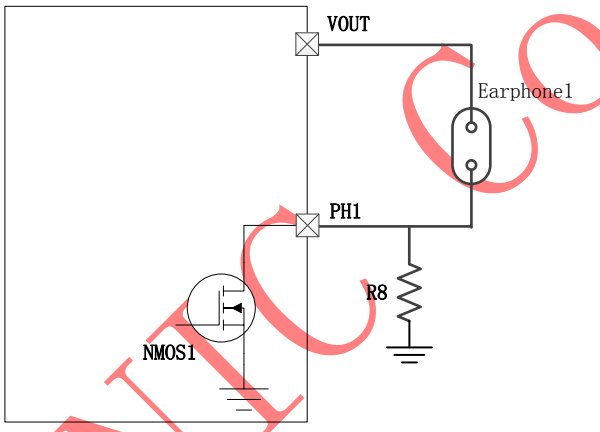
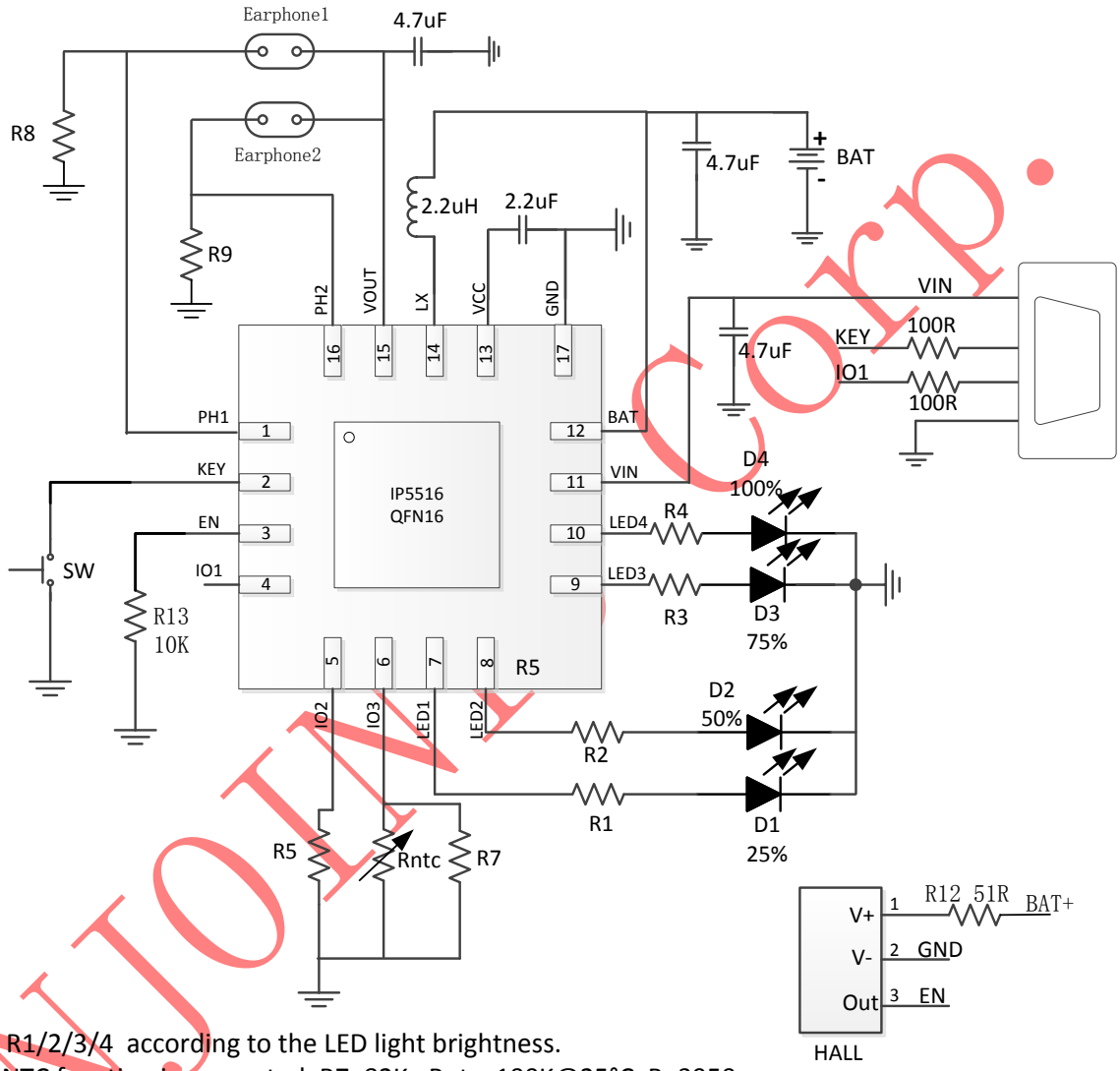


Figure10 IP5516 Earphone Standby Resistance Adjustment Diagram

10.Typical Application Diagram

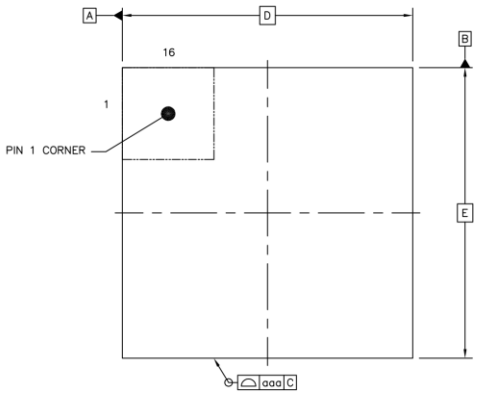
Total solution of IP5516 charging Box is merely realized by passive devices of inductor, capacitor capacitors and resistors.(The solution with HALL switch or 188 digital tube LEDS need to be customized separately)



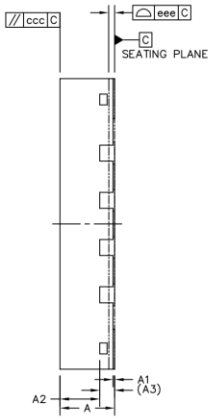
1. Adjust R1/2/3/4 according to the LED light brightness.
2. When NTC function is supported, R7=82K , Rntc=100K@25°C, B=3950.
   When NTC function is not supported, R7=51K , Rntc is floating.
3. R5 is the constant charging current Setting.
4. Please adjust R8/R9 according to different Bluetooth earphone solutions
5. Hall switch is not supported by default. To support Hall switch, you need to customize it separately. R13 is not welded if Hall switch is used

Figure11 IP5516 Typical Application Diagram

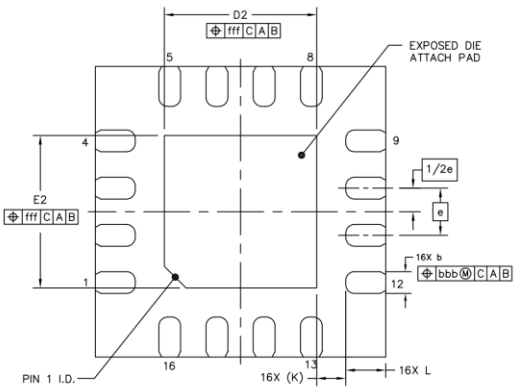
11. Package



TOP VIEW



SIDE VIEW



BOTTOM VIEW

		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.7	0.75	0.8
STAND OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.55	---
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.25	0.3	0.35
BODY SIZE	X	D		4 BSC	
	Y	E		4 BSC	
LEAD PITCH		e		0.65 BSC	
EP SIZE	X	D2	2	2.1	2.2
	Y	E2	2	2.1	2.2
LEAD LENGTH		L	0.45	0.55	0.65
LEAD TIP TO EXPOSED PAD EDGE		K		0.4 REF	
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		ccc		0.1	
COPLANARITY		eee		0.08	
LEAD OFFSET		bbb		0.1	
EXPOSED PAD OFFSET		fff		0.1	

12.Mark description

Note:
1、 ——Injoinic Logo
2、 IP5516 ——Part Number
3、LLLLLLLL——Manufacture number
4、 ——Pin1 location

IMPORTANT NOTICE

INJOINIC TECHNOLOGY and its subsidiaries reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to INJOINIC TECHNOLOGY's terms and conditions of sale supplied at the time of order acknowledgment.

INJOINIC TECHNOLOGY assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using INJOINIC TECHNOLOGY's components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of INJOINIC TECHNOLOGY's components in its applications, notwithstanding any applications-related information or support that may be provided by INJOINIC TECHNOLOGY. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify INJOINIC TECHNOLOGY and its representatives against any damages arising out of the use of any INJOINIC TECHNOLOGY's components in safety-critical applications.

Reproduction of significant portions of INJOINIC TECHNOLOGY's information in INJOINIC TECHNOLOGY's data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. INJOINIC TECHNOLOGY is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

INJOINIC TECHNOLOGY will update this document from time to time. The actual parameters of the product may vary due to different models or other items. This document voids all express and any implied warranties.

Resale of INJOINIC TECHNOLOGY's components or services with statements different from or beyond the parameters stated by INJOINIC TECHNOLOGY for that component or service voids all express and any implied warranties for the associated INJOINIC TECHNOLOGY's component or service and is an unfair and deceptive business practice. INJOINIC TECHNOLOGY is not responsible or liable for any such statements.

