3A Charge/Discharge Power Bank SOC Integrated With 5W Wireless Charging Transmitter

1. Features

- **Charge /discharge with synchronous switch**
  - ✧ Charge /discharge with 3A current by synchronous switch
  - ✧ Up to 93% boost efficiency
  - ✧ Up to 92% charging efficiency
  - ✧ Built-in power path management supports charging and discharging at the same time
  - ✧ Supports line compensation
- **Charge**
  - ✧ Adjusts charging current automatically to adapt to different load capacity adapters
  - ✧ Supports TYPEC port 3A, MICRO B port 2A charging current
  - ✧ Supports 4.20V, 4.30V 4.35V, 4.40V batteries
- **5W Wireless charging transmitter**
  - ✧ Compatible with WPC v1.2.4 protocol
  - ✧ H bridge MOS driver
  - ✧ Internal voltage/current demodulation
  - ✧ Supports FOD foreign body detection
- **Indicators**
  - ✧ Supports 4/3/2/1 LED power indicators and 2/1 wireless charging status indicators
- **Others**
  - ✧ 14-bit ADC
  - ✧ Built-in illuminator drive
  - ✧ Automatically load insertion and removal detection
  - ✧ Supports Type-C DRP protocol and C port input/output
  - ✧ Supports mobile phone charging current intelligent identification DCP protocol
- **Low-power dissipation**
  - ✧ Enter standby mode automatically with light load
  - ✧ Standby power consumption is less than 150μA
- **Simplified BOM**
  - ✧ Integrated switch power MOSFETs
  - ✧ Single inductor for charging and discharging
- **Multiple protection, high reliability**
  - ✧ Output over current, over voltage and short circuit protection
  - ✧ Input over voltage protection
  - ✧ Battery over charge, over discharge and over current protection
  - ✧ Over temperature protection
  - ✧ Vin transient withstand up to 16V
- **In-depth customization**
  - ✧ Flexible and low-cost customized program
- **Package: 6mm*6mm, 0.5mm pitch, QFN40**

2. Applications

- **Power Bank with Wireless Charging**
- **Bluetooth Speaker with Wireless Charging**

3. Description

IP5566 is a multi-functional power management SOC for total solution on wireless charging Power Bank. It also integrates with booster converter, lithium battery charging management, battery level indicators and wireless charging transmitter controller.

IP5566 is highly integrated with abundant functions, which makes the total solution size minimized and BOM costed down.

IP5566 requires only one inductor to achieve buck and boost functions, and can support low-cost inductors and capacitors.

The synchronous boost system of IP5566 provides rated 3A output current with conversion efficiency up to 93%. When there is no load, it will automatically enter the sleep state, and the static current will drop to less than 150uA.

IP5566's switch charging system supplies 3A (Type-C port) or 2A(micro-B port) charging current with charging efficiency up to 92%. According to the IC temperature and input voltage, IP5566 can intelligently adjust charging current.

IP5566 is integrated with 5W wireless charging transmitter controller, compatible with the latest standard of WPC Qi v1.2.4. It is also integrated with full-bridge driver of wireless charging module, voltage & current two-way ASK communication demodulation module.

IP5566 contains 14bit ADC, which can accurately measure battery's voltage and current.

IP5566 supports 4/3/2/1 LED power indicators and flashlight function, and supports 2/1 wireless charging status indicators.

Typical Application

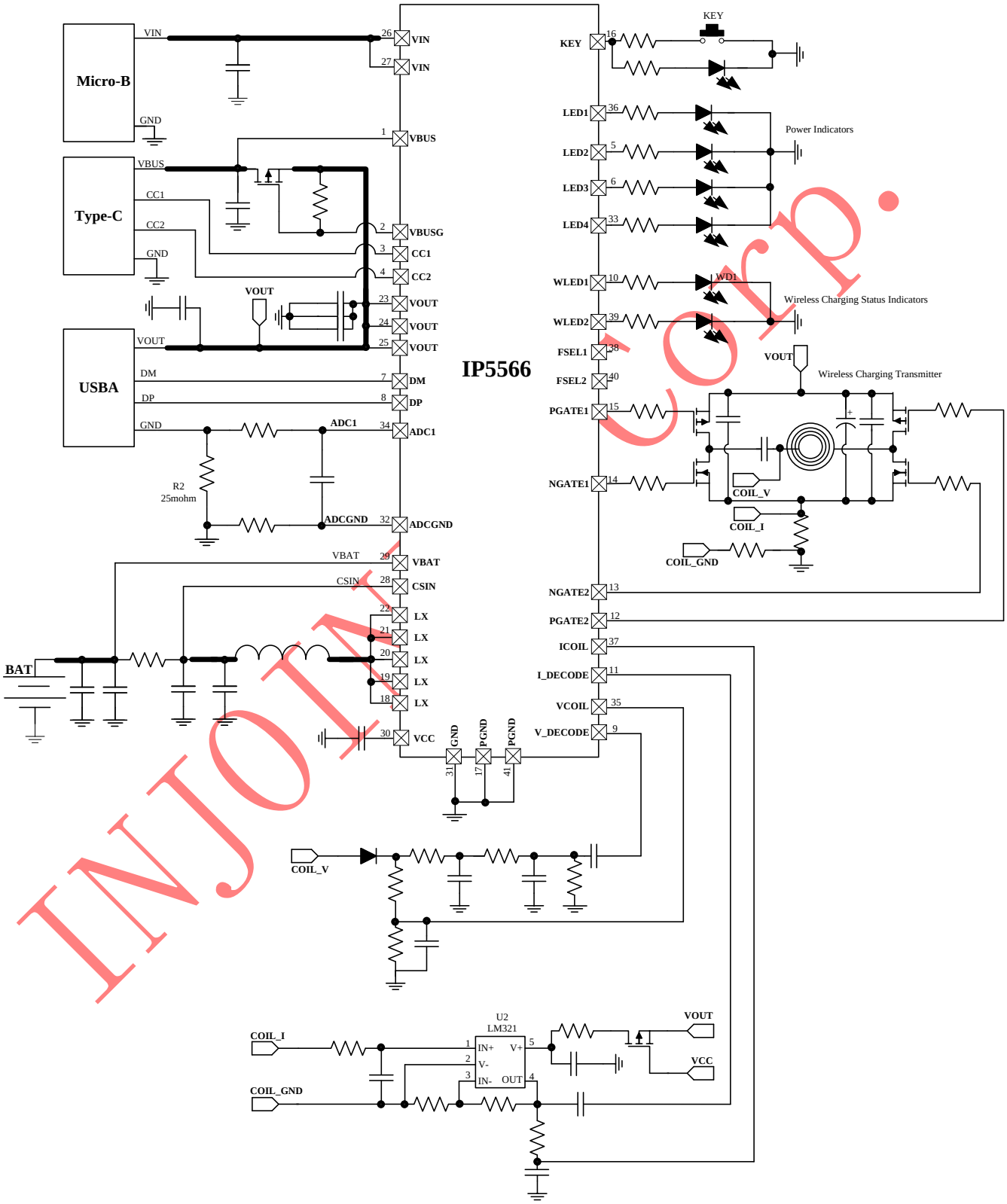


Figure 1 Simplified Application Diagram

4. Pin Definition

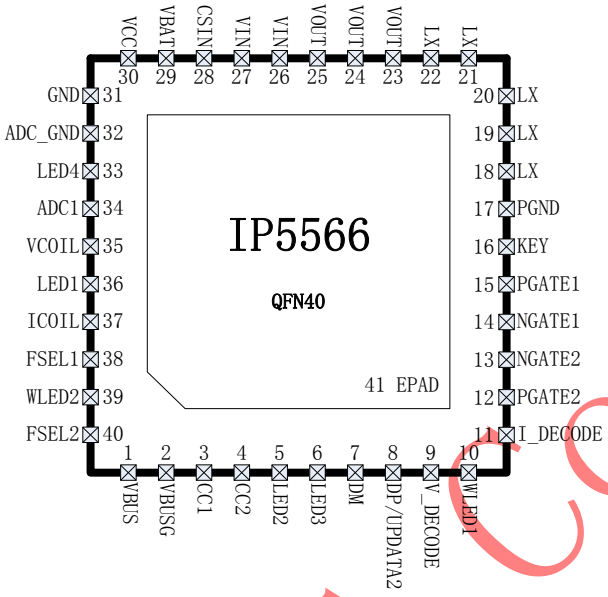


Figure 2 IP5566 Pin Assignments

Pin Num	Pin Name	Description
1	VBUS	Type-C charge detect pin
2	VBUSG	Type-C charge input PMOS control pin
3	CC1	CC1 line on Type-C port
4	CC2	CC2 line on Type-C port
5	LED2	Power indicator driver 2
6	LED3	Power indicator driver 3
7	DM	DM data line on USB A
8	DP	DP data line on USB A
9	V_DECODE	Voltage demodulation input pin of wireless charging transmitter
10	WLED1	Wireless charging status indicator driver 1
11	I_DECODE	Current demodulation input pin of wireless charging transmitter
12	PGATE2	High-side PMOS gate driver of wireless charging full-bridge 2
13	NGATE2	Low-side NMOS gate driver of wireless charging full-bridge 2
14	NGATE1	Low-side NMOS gate driver of wireless charging full-bridge 1
15	PGATE1	High-side PMOS gate driver of wireless charging full-bridge 1
16	KEY	Key input pin, multiplexed WLED illumination function
17	PGND	Power groud
18-22	LX	DCDC switch node, connect to inductor
22-25	VOUT	Output pin
26-27	VIN	Input pin

28	CSIN	Battery current detection input pin
29	VBAT	Battery voltage input and detection of pin
30	VCC	LDO 3.1V output
31	GND	System ground
32	ADCGND	ADC ground
33	LED4	Power indicator driver 4
34	ADC1	ADC1 input detection pin
35	VCOIL	Coil voltage detection pin
36	FSEL1	Function select pin 1, which is used to set the battery full voltage by default
37	ICOIL	Coil current detection pin
38	LED1	Power indicator driver 1
39	WLED2	Wireless charging status indicator driver 2
40	FSEL2	Function select pin 2, which is used to connect to external NTC resistance by default
41(EPAD)	GND	Power and dissipation ground

5. Customized model list

Model number	Specification
IP5566_TC	Standard TYPEC port is supported. When TYPEC function is not used, the associated pin can be suspended
IP5566_TA	TYPEC port is not supported. Some special functions can be customized

6. IP Series Products List

IC Part No.	Charge /Discharge		Features							Package	
	Charge	Dis-charge	LED Num	Lighting	Keys	I2C	DCP	Type-C	QC Certificate	Package	Compatibility
IP5303	1.0A	1.2A	1,2	√	√	–	–	–	–	ESOP8	PIN2PIN
IP5305	1.0A	1.2A	1,2,3,4	√	√	–	–	–	–	ESOP8	
IP5306	2.4A	2.1A	1,2,3,4	√	√	√	–	–	–	ESOP8	
IP5207T	1.2A	1.2A	3,4,5	√	√	–	√	–	–	QFN24	
IP5109	2.1A	2.1A	3,4,5	√	√	√	–	–	–	QFN24	PIN2PIN
IP5209	2.4A	2.1A	3,4,5	√	√	√	√	–	–	QFN24	
IP5407	2.4A	2A	1,2 ,4	√	√	–	√	–	–	ESOP8	
IP5219	2.4A	3A	1,2,3,4	√	√	√	√	√	–	QFN24	
IP5310	3.1A	3A	1,2,3,4	√	√	√	√	√	–	QFN32	
IP5506	2.4A	2A	Nixie tube	√	√	–	–	–	–	ESOP16	
IP5508	2.4A	2A	Nixie tube	√	√	–	√	–	–	QFN32	
IP5330	3A	3A	Nixie tube	√	√	–	√	√	–	QFN32	
IP5566	3A	3A	1,2,3,4	√	√	–	√	√	–	QFN40	
IP5322	18W	4A	1,2,3,4	√	√	√	√	–	√	QFN32	
IP5328P	18W	4A	1,2,3,4	√	√	√	√	√	√	QFN40	

7. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 12	V
VBUS Input Voltage Range	V_{BUS}	-0.3 ~ 8	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 those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

*Voltages are referenced to GND unless otherwise noted.

8. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}, V_{BUS}	4.5	5	5.8	V
Operating Temperature	T_A	0	--	70	℃

*Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

9. 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	5.8	V
Input Over Voltage	V_{INOV}		5.6	5.8	6	V
Input Under Voltage	V_{INUV}		4.4	4.5	4.6	V
Constant Charge Voltage	$CV_{4.2V}$	4.2V battery configuration	4.18	4.21	4.24	V
	$CV_{4.30V}$	4.3V battery configuration	4.28	4.31	4.34	V
	$CV_{4.35V}$	4.35V battery configuration	4.33	4.36	4.4	V
	$CV_{4.4V}$	4.4V battery configuration	4.38	4.41	4.44	V
Charge Stop Current	$Ivin_{stop}$	VIN=5V	200	300	500	mA
Charge Current	I_{VIN}	VIN=5V, VBAT=3.7V, MICRO B port current	1.7	2	2.3	A
	I_{VBUS}	VBUS=5V, VBAT=3.7V , Battery current	2.3	2.8	3.2	A
Trickle Charge Current	I_{TRKL}	VIN=5v，BAT=2.7v	100	200	300	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						
Battery Operation Voltage	V_{BAT}		3	3.7	4.4	V
Low Power Shutdown	V_{BATLOW}	IOUT=3A	2.9	2.95	3.0	V

Voltage						
Dc Output Voltage	V_{OUT}	VBAT=3.7V @0A	5.0	5.12	5.25	V
		VBAT=3.7V @3A	5	5.25	5.35	V
Output Voltage Ripple	ΔV_{OUT}	VBAT=3.0V~4.4V @Iout=2A,Cout=100uF	50	100	150	mV
Boost Output Current	I_{vout}	VBAT=3.0V~4.4V	0	3		A
Boost Overcurrent Shut Down Threshold	I_{shut}	VBAT=3.0V~4.4V		3.5		A
Load Overcurrent Detect Time	T_{UVD}	Duration of output voltage under 4.2V		30		ms
Control System						
Switch Frequency	fs	Discharge switch frequency		600		KHz
		Charge switch frequency		500		KHz
PMOS On Resistance	r_{DSON}			30		mΩ
NMOS On Resistance				25		mΩ
VOUT PMOS On Resistance		VIN=5V		90		mΩ
Vout Pmos Overcurrent	I_{IDOCP}	VIN=5V		3		A
Vcc Voltage	VCC	Vbat=3.7V	3.05	3.1	3.15	V
Battery Input Standby Current	I_{STB}	VIN=0V，VBAT=3.7V		80	150	uA
LED Light Driving Current	Ilight		5	10	15	mA
IO Driving Current	I_{Gpio}		4	5	8	mA
Light Load Shut Down Detect Time	T_{loadD}	Load current less than 100mA	27	30	33	s
Light Load Shut Down Current	I_{plout}	VBAT=3.7V	30	60	100	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	℃

10. Function Description

System Diagram

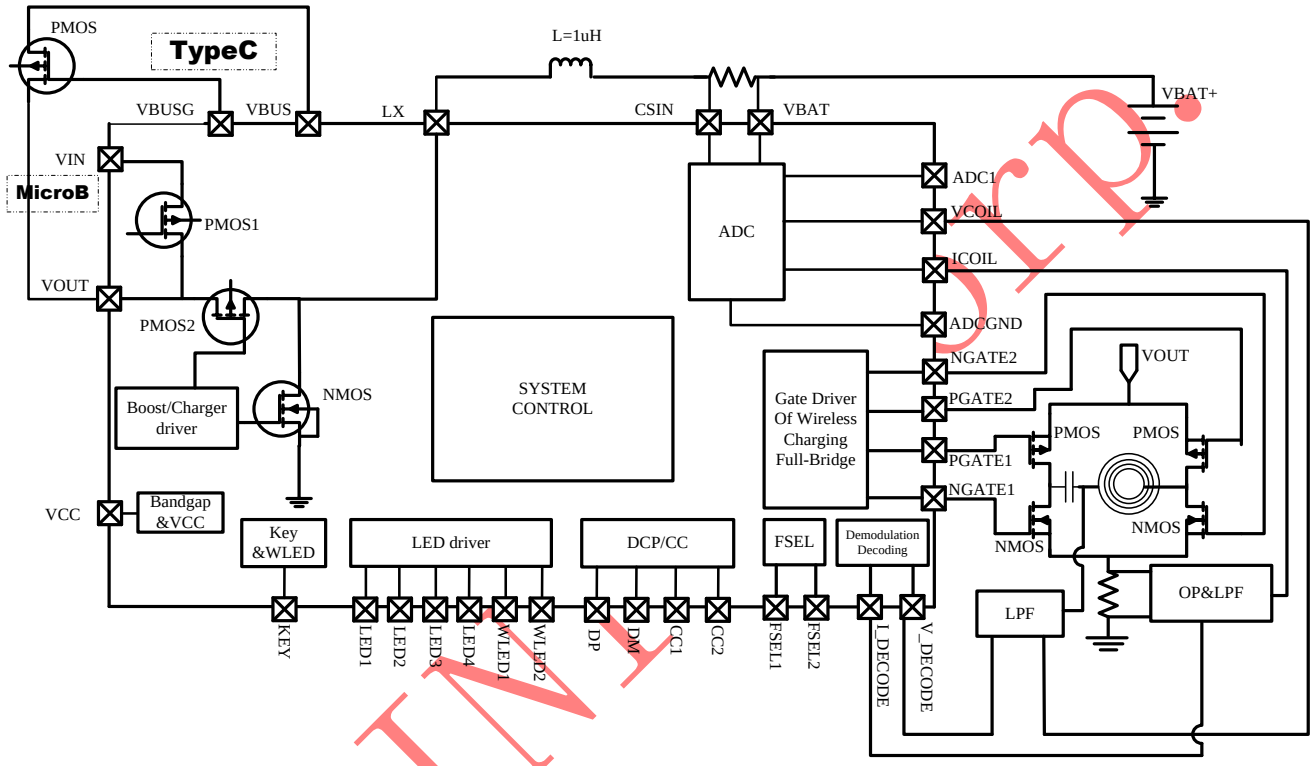


Figure 3 IP5566 Internal System Diagram

Boost

IP5566 integrates a boost dc-dc converter with 5V3A output. Switching frequency: 600KHz; input: 3.7V; efficiency @ 5V/3A output: 92% (without wireless charging). Built-in soft start function, to prevent the shock current at the start. Integrated output over current, short circuit, over voltage, over temperature and other protections, to ensure the system stable and reliable. The output current of the boost system can be automatically adjusted with the temperature to ensure that the IC is below the setted temperature.

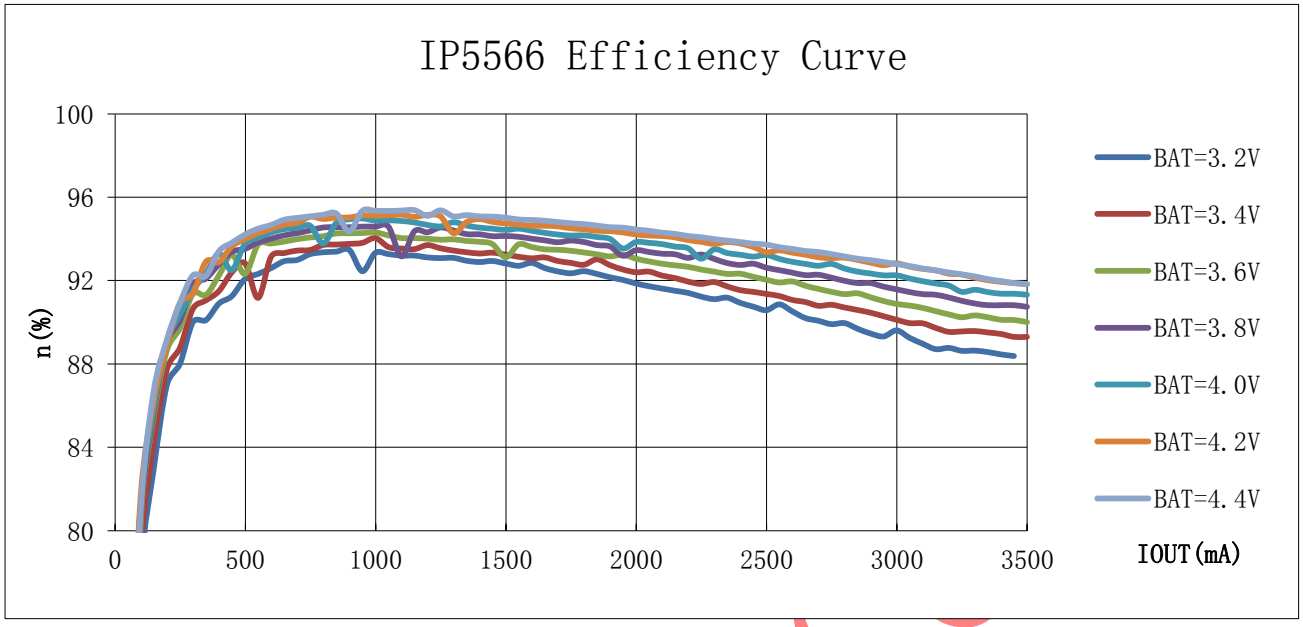


Figure 4 IP5566 Efficiency Curve

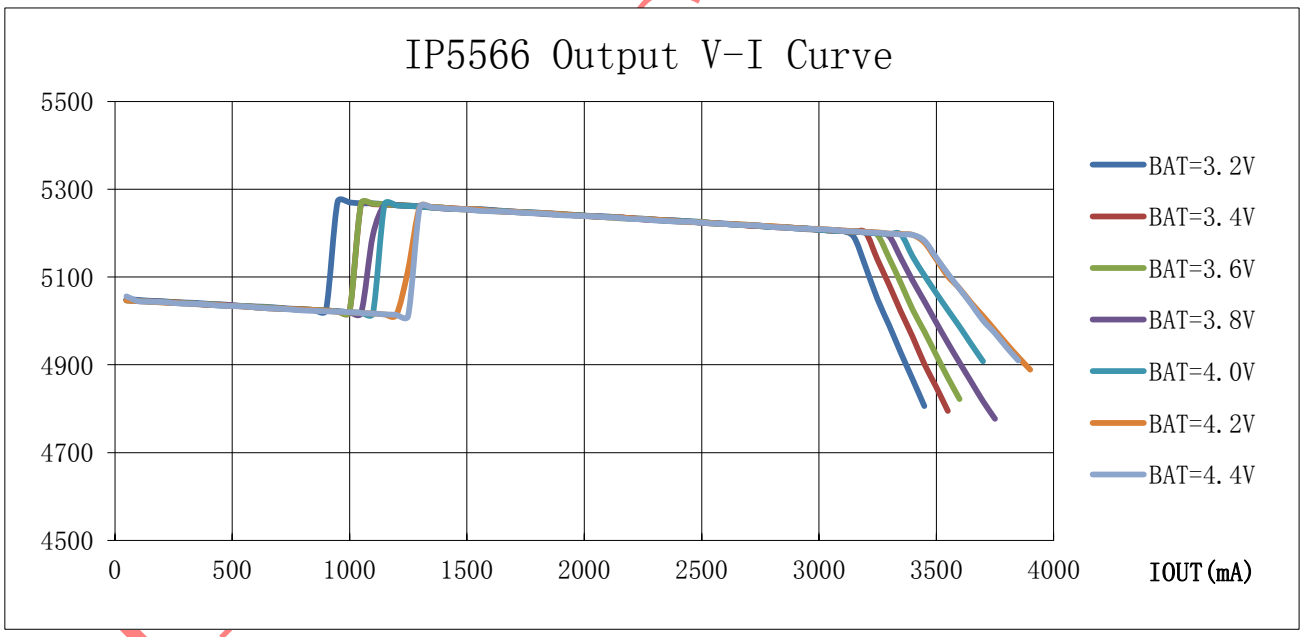


Figure 5 IP5566 Output V-I Curve

Charge

IP5566 integrates a constant current and constant voltage Li battery charging management system with synchronous switch. When the battery voltage is lower than 3V, enters trickle charging stage and trickle charging current is less than 200mA; when the battery voltage is higher than 3V, enters constant current charging stage; when the battery voltage is near the preset battery voltage, enters constant voltage charging stage. When the charging is accomplished, once the battery voltage falls under 4.1V, battery charging will be restarted.

IP5566 supports TYPEC port 3A charging, Micro B port 2A charging, and at the same time detects the input

voltage and IC temperature to automatically adjust the charging current.

IP5566 supports Micro B (VIN) insertion and charging, or Type C (VBUS) insertion and charging. Plug in first, charge first.

When IP5566 is in charging state, it will detect whether the VOUT (output voltage) is higher than 4.55v. If it is higher than 4.55v, it will charge the cell with the maximum current; if it is lower than 4.55v, it will reduce the charging current and automatically adapt to the load output capacity of the adapter.

IP5566 built-in power path management supports charging and releasing at the same time. PMOS of VIN or VBUS and PMOS of VOUT will be turned on to charge external devices when charging.

When charging and discharging at the same time, IP5566 will test the output current of port A. If the output current of port A is greater than 200mA, reduce the battery charging current to the minimum, and give priority to charge the device at port A.

IP5566 will test the connection of port C when charging and releasing at the same time. If there is equipment in charging outside port C, IP5566 will reduce the battery charging current to the minimum, and give priority to the equipment at port C.

When IP5566 is charging and discharging at the same time, PMOS of VIN and VOUT has such functions as over temperature, 3A over current and short circuit protection.

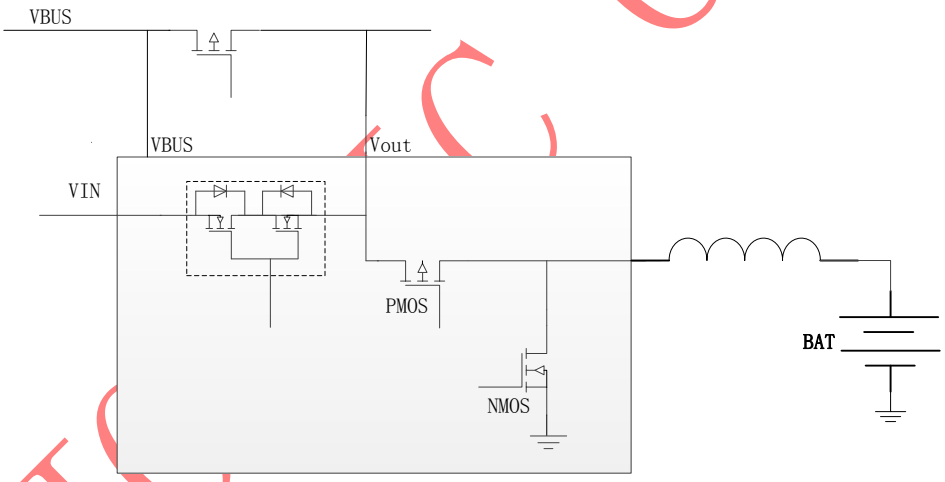


Figure 6 Schematic Diagram Of Power Path Management

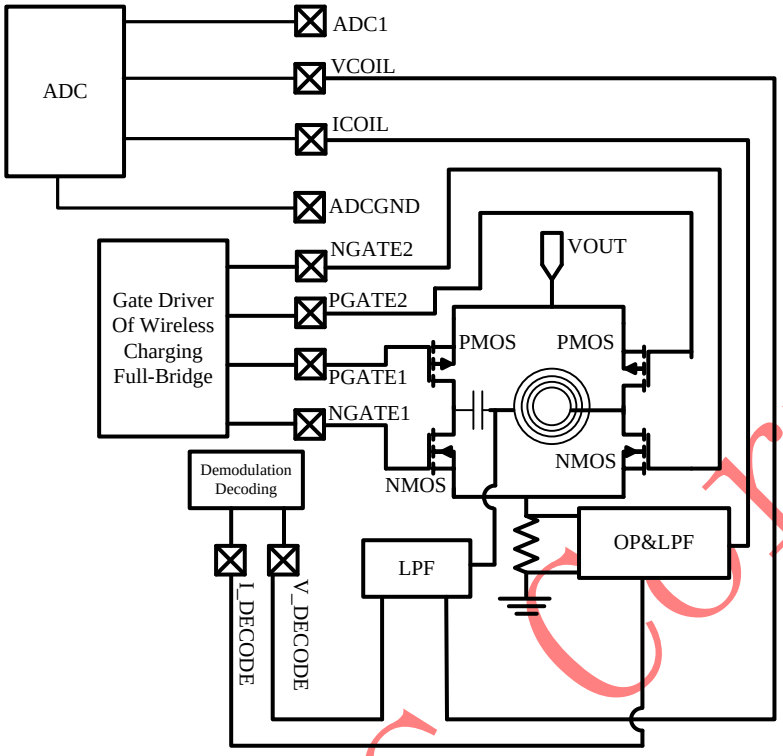
Wireless Charging Transmitter

IP5566 is integrated with 5w wireless charging transmitter module.

IP5566's internal integration has two symmetrical half bridge driver module (High-side PMOS and low-side NMOS driver).

IP5566 has two ASK demodulation modules, which can collect coil voltage and current respectively for ASK communication demodulation and decoding. Current decoding needs off-chip discrete devices for filtering and one-stage amplification. Then it is directly sent to the chip for digital demodulation and decoding after the DC block. Voltage decoding, no need for amplification, can be directly sent to the chip for digital demodulation and decoding after the filter and DC block.

IP5566 can detect the voltage and current of the coil through the built-in ADC.



Key and WLED

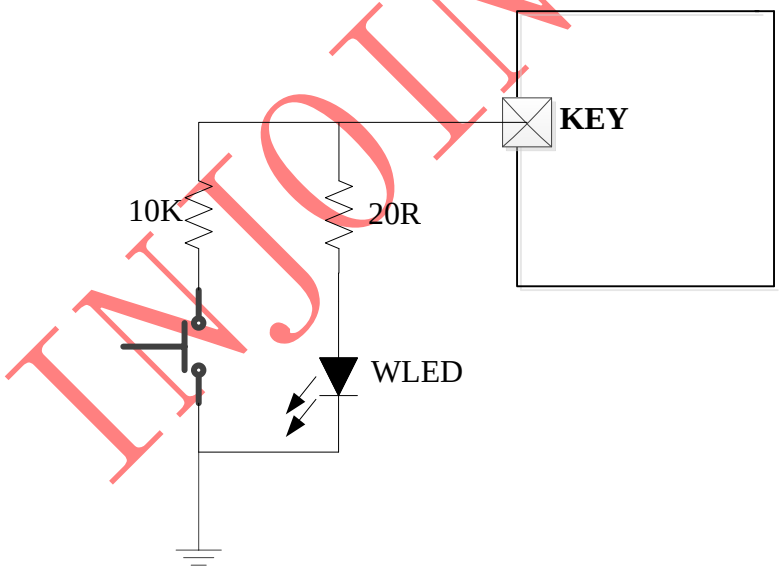


Figure 7 Key and WLED circuit

Key circuit is illustrated in Figure 7, which can recognize short press or long press operation.

- Short press (pressed time in range of 100ms~1s): turn on the LED power indicators, BOOST output, and wireless charging transmitter.

- Long press (pressed time longer than 2s): turn on or turn off the torch light WLED.
- No response on press time less than 50ms
- Two short press in 1s: turn off the LED power indicators, BOOST output, and wireless charging transmitter.

Power Indicators

IP5566 can support 1/2/3/4/ LED, used to indicate state of charge; IP5566 supports 4 lights by default. If you need 3, 2, 1 lights, you need to customize.

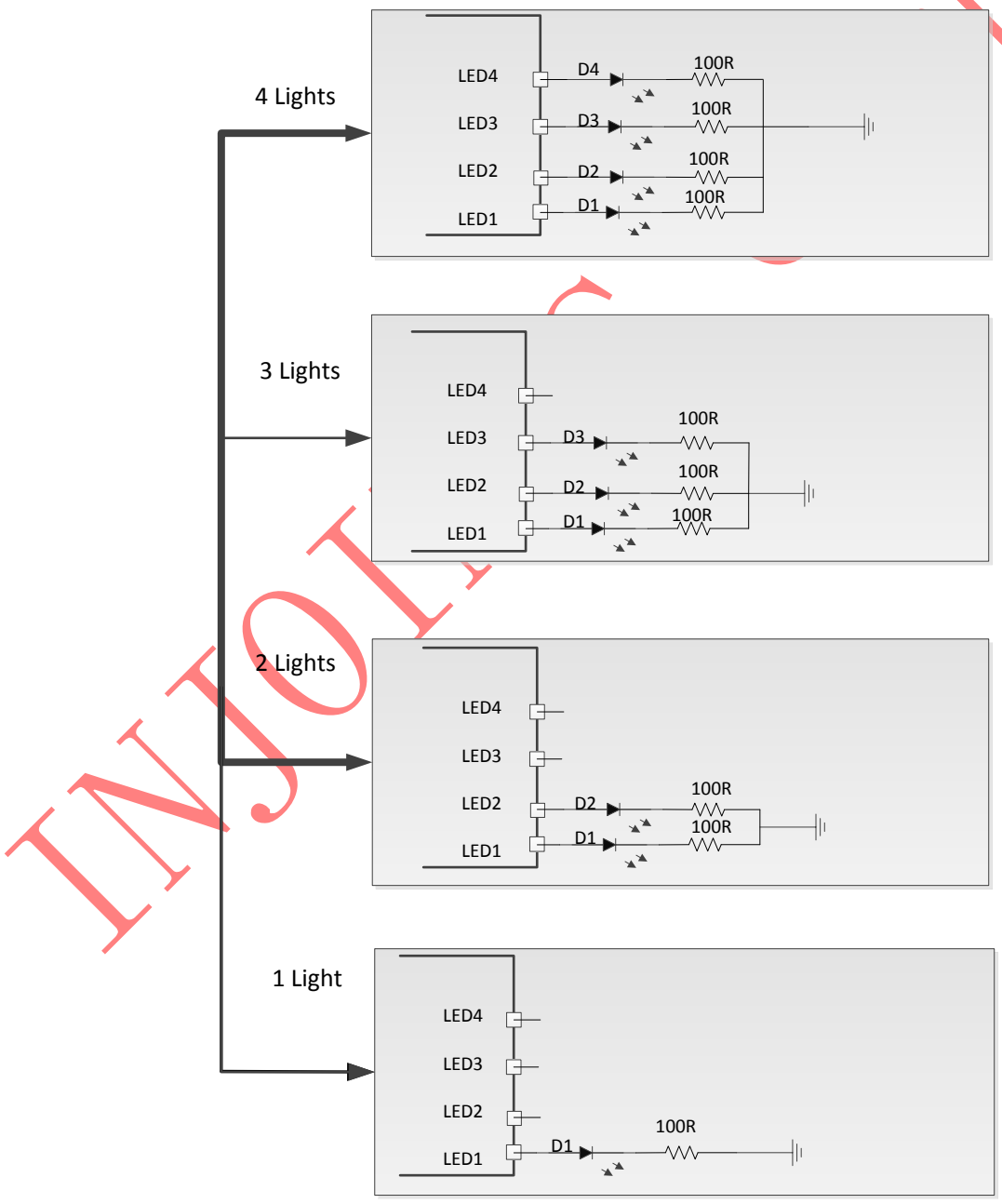


Figure 8 LED Configuration Circuit

■ 4 LED:

Charge:

Battery capacity (C) (%)	D1	D2	D3	D4
Fully charged	ON	ON	ON	ON
75%≤C	ON	ON	ON	0.5Hz Flash
50%≤C＜75%	ON	ON	0.5Hz Flash	OFF
25%≤C＜50%	ON	0.5Hz Flash	OFF	OFF
C＜25%	0.5Hz Flash	OFF	OFF	OFF

DisCharge:

Battery capacity (C) (%)	D1	D2	D3	D4
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%	1.0Hz Flash	OFF	OFF	OFF

■ 3 LED:

Charge:

Battery capacity (C) (%)	D1	D2	D3
75%≤C	ON	ON	ON
66%≤C＜75%	ON	ON	0.5Hz Flash
33%≤C＜66%	ON	0.5Hz Flash	OFF
C＜33%	0.5Hz Flash	OFF	OFF

DisCharge:

Battery capacity (C) (%)	D1	D2	D3
C≥66%	ON	ON	ON
33%≤C＜66%	ON	ON	OFF
3%≤C＜33%	ON	OFF	OFF
0%＜C＜3%	1.0Hz Flash	OFF	OFF

■ 2 LED:

State		D1	D2
Charge	Charging	0.5Hz Flash	OFF
	Fully charged	ON	OFF
DisCharge	Discharging	OFF	ON
	Low battery	OFF	1.0Hz Flash

■ 1 LED:

State		D1
Charge	Charging	0.5Hz Flash
	Fully charged	ON
DisCharge	Discharging	ON
	Low battery	1.0Hz Flash

Wireless Charging Status Indicators

IP5566 can indicate the wireless charging status by driving 2 LED. The corresponding relationship between LED state and wireless charging state is as follows:

State	LED1	LED2
Abnormal (foreign body, etc.)	ON	OFF
Fully charged	ON	ON
Charging	OFF	1.0Hz Flash
Standby	OFF	ON

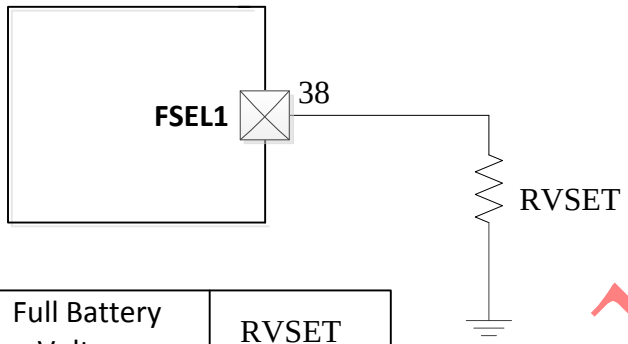
Auto Detection On Phone Attachment And Enter Standby Mode Automatically With Light Load

After IP5566 detects the phone's insertion, it will immediately wake up from standby mode and turn on the boost 5V to charge the phone.

IP5566 automatically enters standby state when Vout end load current (including power consumption current of wireless charging end) is less than 50mA and lasts for 30s.

Full Battery Voltage Setting

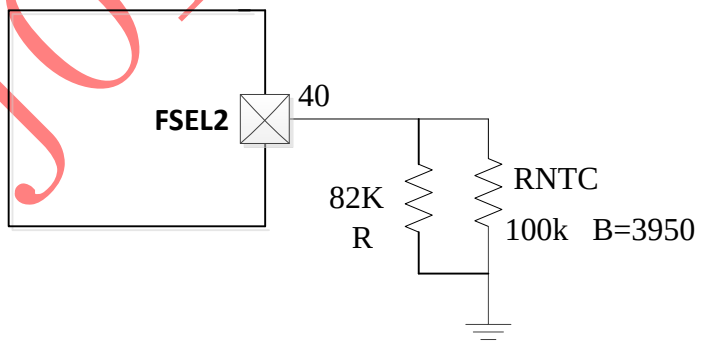
IP5566 can choose the full battery voltage by connecting different resistors to FSEL1:



Full Battery Voltage	RVSET
4.2V	10K
4.3V	43K
4.35V	75K
4.4V	120K

NTC

IP5566 can connect NTC resistance on FSEL2 to realize the NTC function of the battery. FSEL2 pin outputs 20uA current then detects the voltage on NTC resistance to determine the present battery temperature.



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.

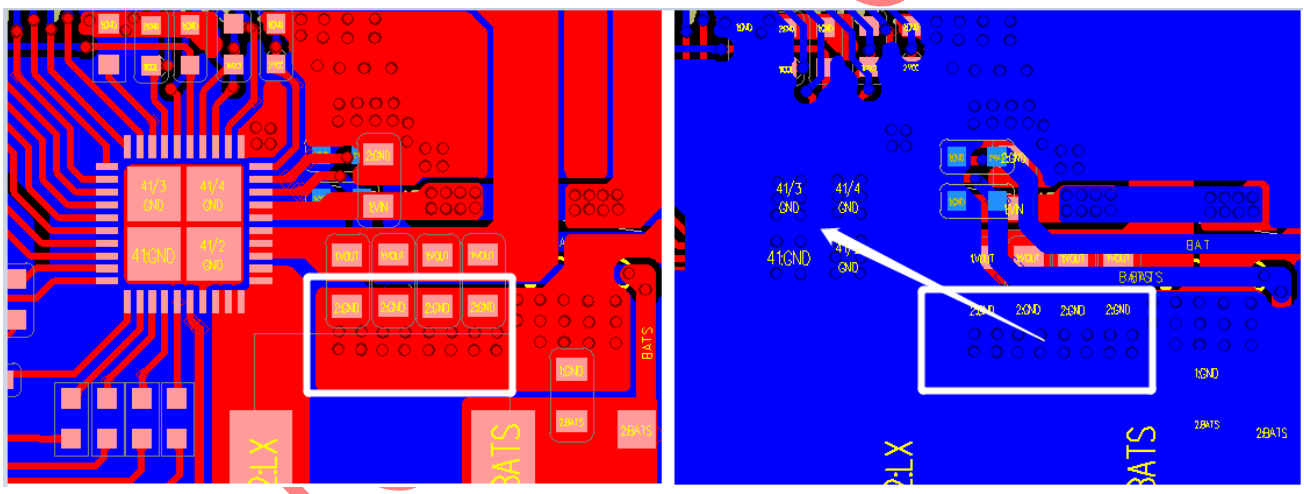
If NTC is not required in the scheme, the NTC pin shall be connected 51K to GND. NTC pin shall not float, otherwise abnormal charging and discharging may be caused.

VCC

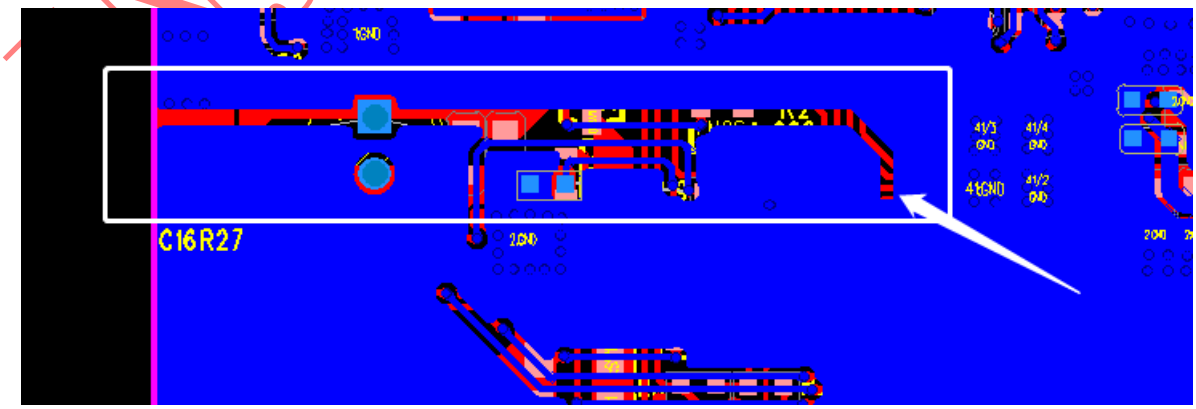
VCC is a normally opened 3.1V LDO. Load capacity is 30mA.

11. Schematic And PCB Layout

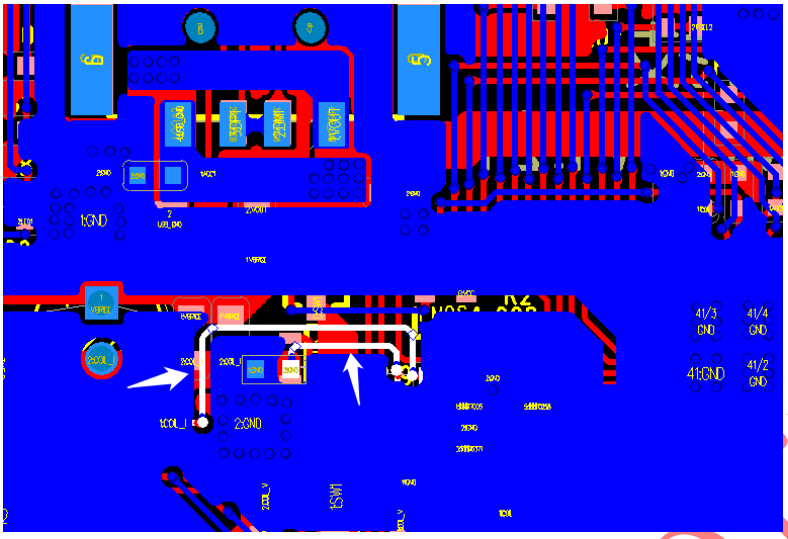
1. Three 22uF ceramic capacitors (C3, C4 and C5) are required for IP5566 VOUT PIN (23, 24 and 25 PIN), which cannot be replaced by electrolytic capacitors; In PCB design, the capacitor on VOUT should be placed as close as possible to the VOUT pin, and the capacitor's ground should be drilled nearby. The circuit between the capacitor and EPAD should be as small as possible. It is required that there should be no wiring on the back of PCB to cut off the VOUT capacitor to the IP5566 EPAD.



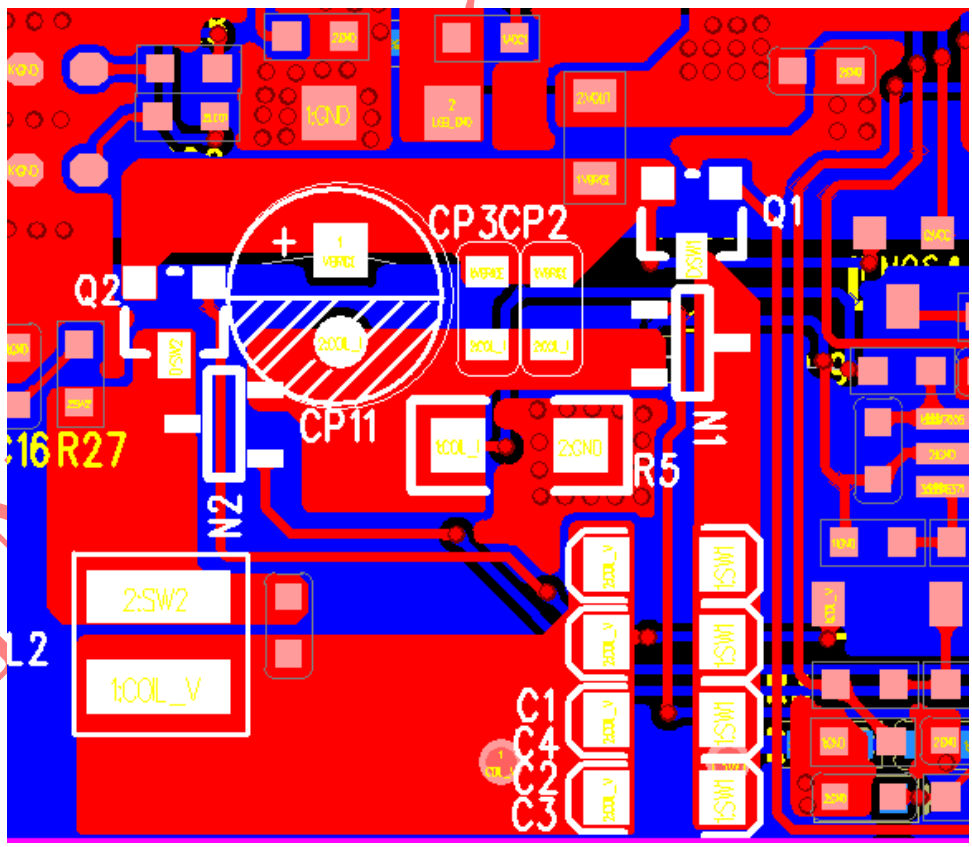
2. The ground of the wireless charging part of IP5566 is required to be separated from the ground of the output port of USB port to prevent mutual influence between the output port A and the wireless charging.



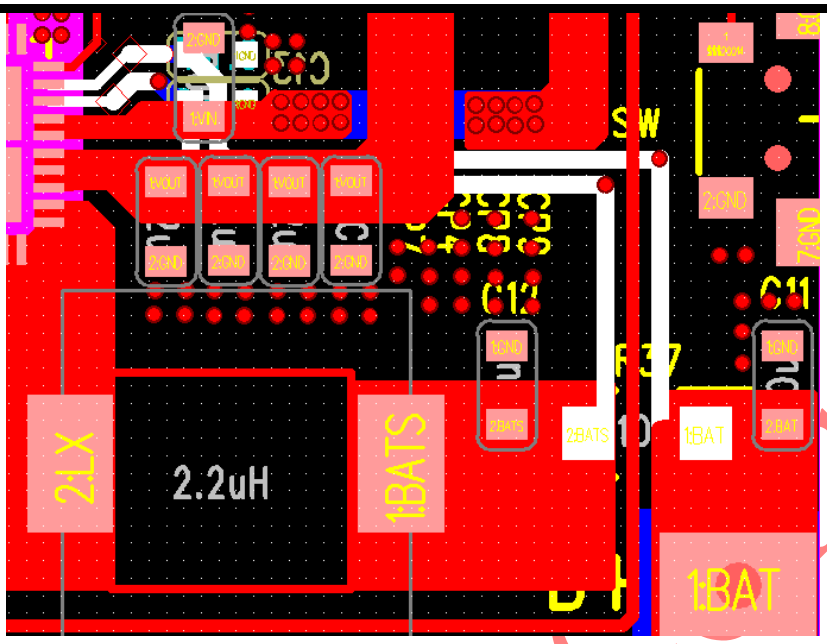
3. The coil current sampling line (COIL_I and IGND) of the wireless charging should go directly from the leads on both ends of the sampling resistor to the op amp LM321 in differential form.



4. Wiring requirements of the wireless charging part: a. Input capacitors (two 22uF ceramic capacitors +220uF electrolytic capacitor) are required for the wireless charging power input, and two 22uF ceramic capacitors are required for close to the input of H bridge and the coil current sampling resistor; b. The current path of H bridge is shown in the figure, and the loop area formed by the current path is required to be as small as possible.



5. IP5566 detects battery current by sampling resistance of 10 milliohms; For the 28th and 29th pins of IP5566, they are required to use the differential form to IP5566 PIN directly from the leads at both ends of the 10 milliohms resistor. At the same time, the PIN shall be larger than 20mil, and a 0.47uf capacitor filter shall be placed near each PIN.

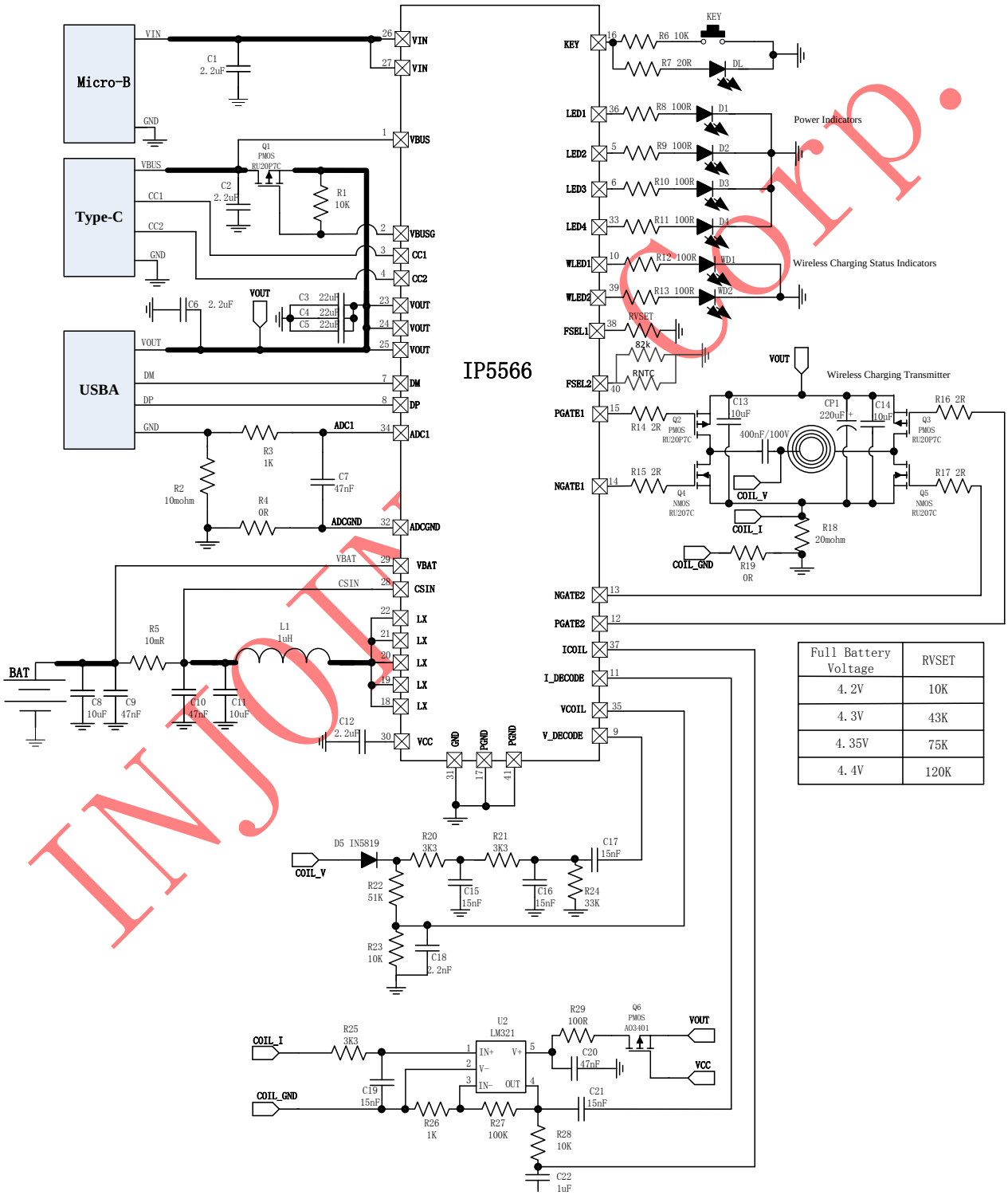


6. The wiring of ADC signals (ADC1, ADCGND, ICOIL, VCOIL) and wireless charging/decode signals (I_DECODE and V_DECODE) should be avoided to the wiring of large current (such as VIN, VOUT, etc.), so as to prevent the signal being disturbed and unable to work normally.
7. The wiring of the wireless charging coil and resonant capacitor should be avoided from low-voltage signals of IP5566 or other IC, and should not be parallel to the low-voltage signals to prevent the high-voltage signals of the coil or capacitor coupling to the low-voltage signals, leading to abnormal IC operation; The COIL_V network wiring needs to be as short and thick as possible, and should be avoided from low-voltage signals .

12. Typical Application Diagram

AABC Typical Application Diagram (IP5566_TC)

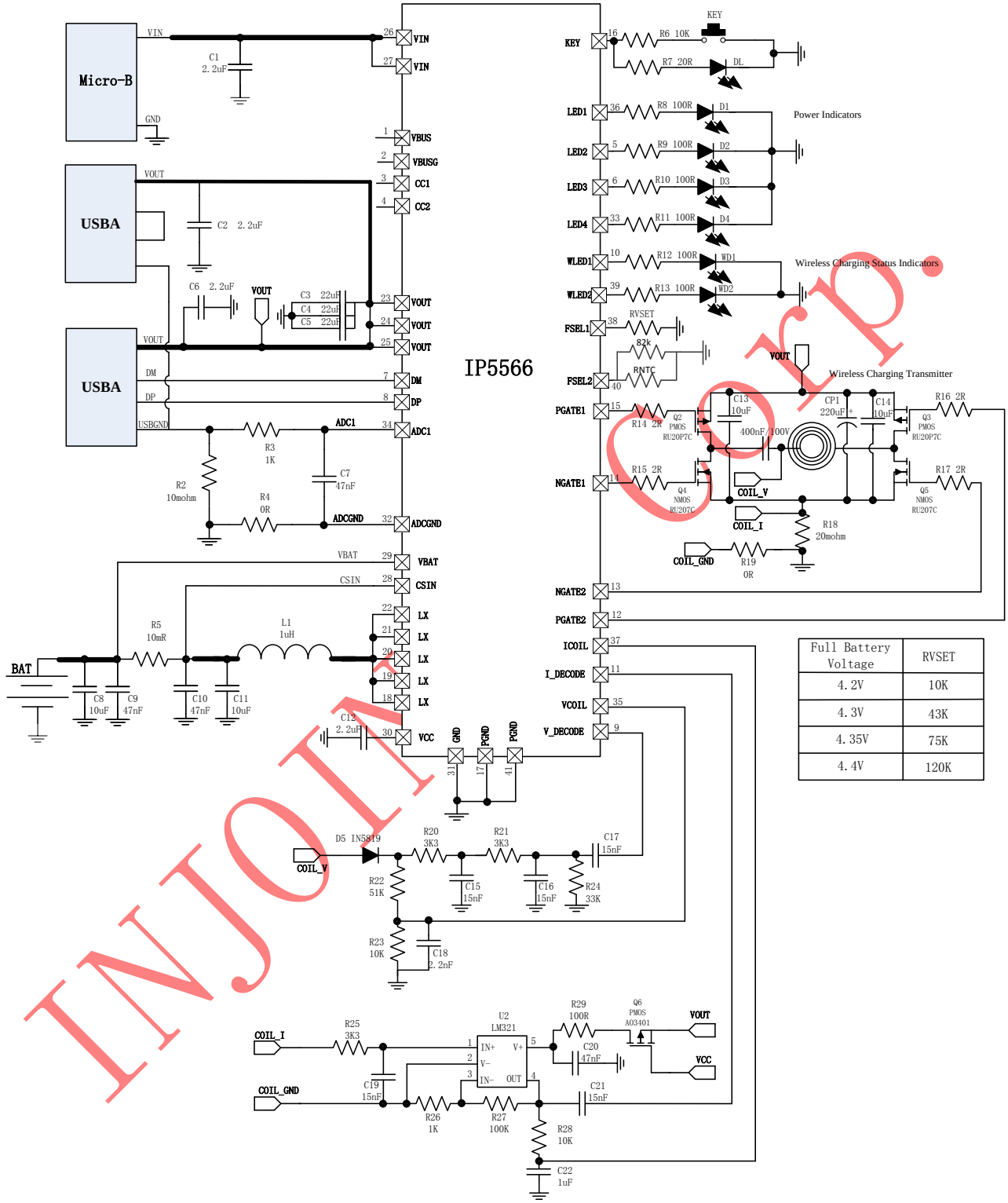
IP5566 only needs inductors, capacitors and resistors to realize the complete scheme of mobile power supply with wireless charging transmitter.



Full Battery Voltage	RVSET
4.2V	10K
4.3V	43K
4.35V	75K
4.4V	120K

Figure 9 IP5566 AABC Typical Application Diagram

AAB Typical Application Diagram(IP5566_TA)



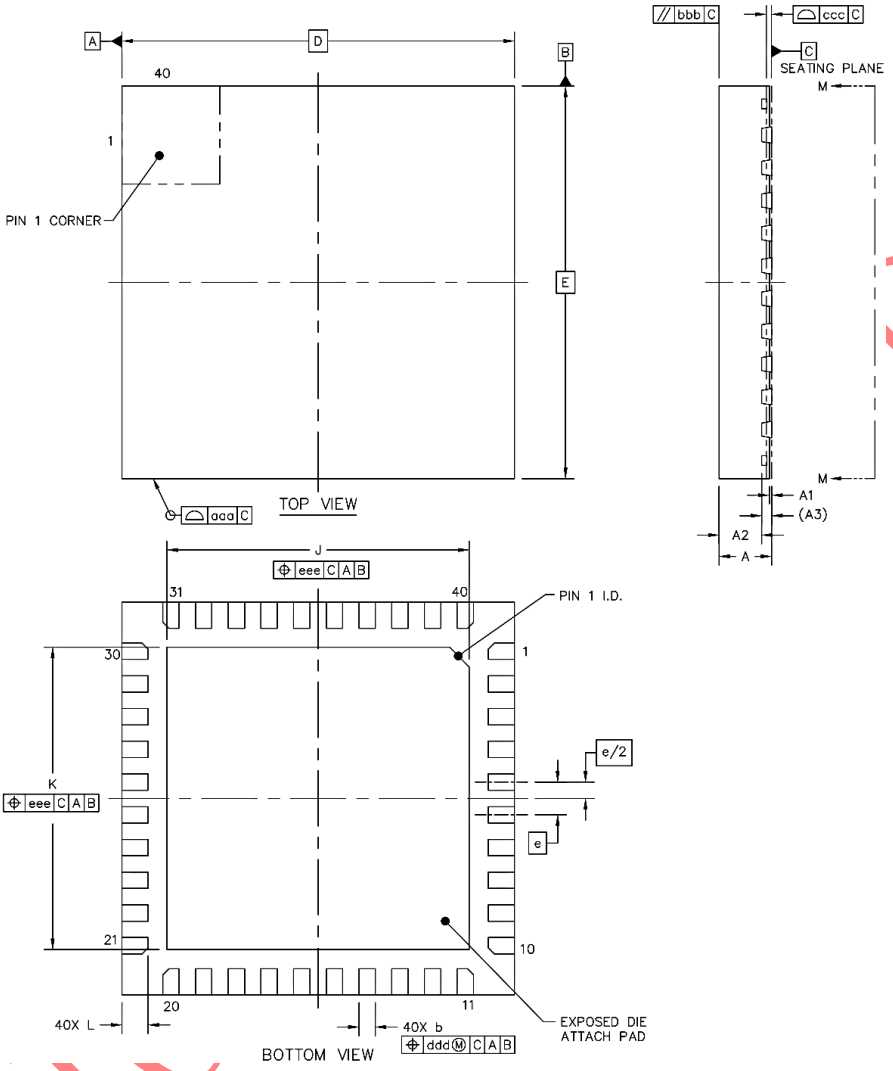
Full Battery Voltage	RVSET
4.2V	10K
4.3V	43K
4.35V	75K
4.4V	120K

Figure 10 IP5566 AAB Typical Application Diagram

Recommended inductance model:

DARFON PIN	Thickness (mm)	Inductance (uH)	Tolerance	DC Resistance (mΩ)		Heat Rating Current DC Amp.	Saturation Current DC Amps.	Measuring Condition
				Typ.	Max.	Idc(A)Max.	Isat(A)Max.	
SPM70701R0MESQ	5	1	±20%	9	10.2	10.5	13.5	100kHz/1.0V
SPM10101R0MESN	4	1	±20%	6	7	12	18	100kHz/1.0V

13. Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.035	0.05
A2	-	0.65	0.67
A3	-	0.125	-
b	0.2	0.25	0.30
e		0.5 BSC	
D		6 BSC	
E		6 BSC	
J	4.52	4.62	4.72
K	4.52	4.62	4.72
L	0.35	0.40	0.45
aaa		0.1	
bbb		0.1	
ccc		0.08	
ddd		0.1	
eee		0.1	

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