Wireless Power Transmitter Compliant with WPC V1.2.4 protocol of 7.5W/10W

Features

- **Compliant with the WPC V1.2.4 specificatiosn transmitter design**
- **Support 5~10W applications**
  - ✧ **Single 5W applications**
  - ✧ **Fast charge input for 5~10W applications**
- **Input withstand voltage up to 16V**
- **Integrate NMOS full bridge driver and full bridge power MOS**
- **Integrate voltage/current demodulator**
- **Support FOD (Foreign Object Detection) function**
  - ✧ **High sensitivity**
  - ✧ **Support dynamic FOD**
  - ✧ **External resistor adjusts FOD parameters**
- **Low quiescent dissipation and high efficiency**
  - ✧ **10mA quiescent current**
  - ✧ **Charging efficiency is up to 79%**
- **Compatible with NPO and CBB capacitors**
- **Support Dynamic Power Modulation (DPM) for insufficient USB power source**
  - ✧ Support low voltage charger of 5V/500mA
- **Input overvoltage, overcurrent protection**
- **Support Fast Charge input**
- **Supports up to 3 LEDs for system states indication**
- **Pacage: 5 mm × 5 mm 0.5pitch QFN32**

Description

IP6806 is a wireless power transmitter controller SoC that integrates all required functions for the latest WPC Qi V1.2.4 specifications compliant wireless power transmitter design. Support A11 coil, support 5W, Apple 7.5W, Samsung 10W charging. It used analog PING to detect a RX wireless device for charging with low standby power. Once RX device is detected, the IP6806 establish a communication with the RX wireless device and controls the coil power transfer by adjusting operation frequency, depended on calculating the data packages, received from RX device, with PID algorithm. IP6806 terminate power transfer when RX device is fully charged.

IP6806 integrate full-bridge driver and full bridge power MOS, includes voltage and current two-way ASK demodulation module, and input overvoltage/current protection and FOD module. IP6806 is a highly integrated SoC for small-size and low bom cost solutions and reduced time-to-market.

Applications

- **Charge Jacket, wireless charging base**
- **Car wireless charging device**

System Functional Diagram

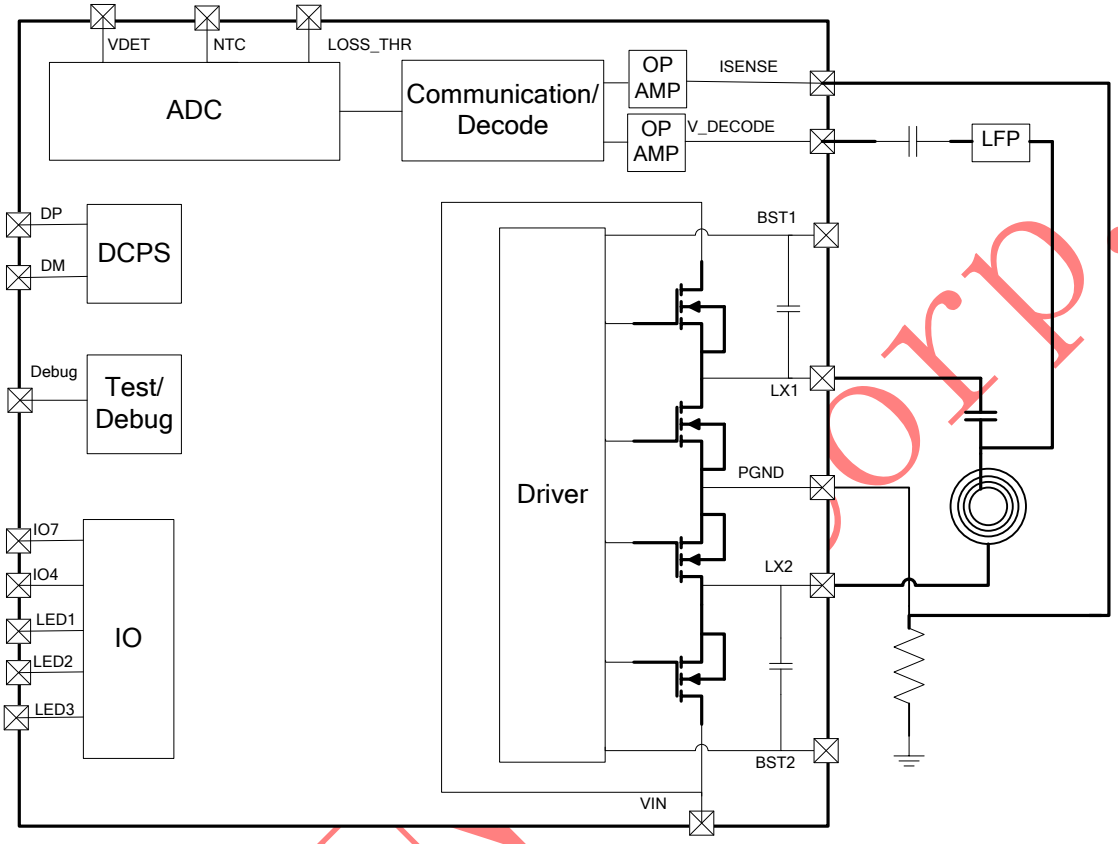
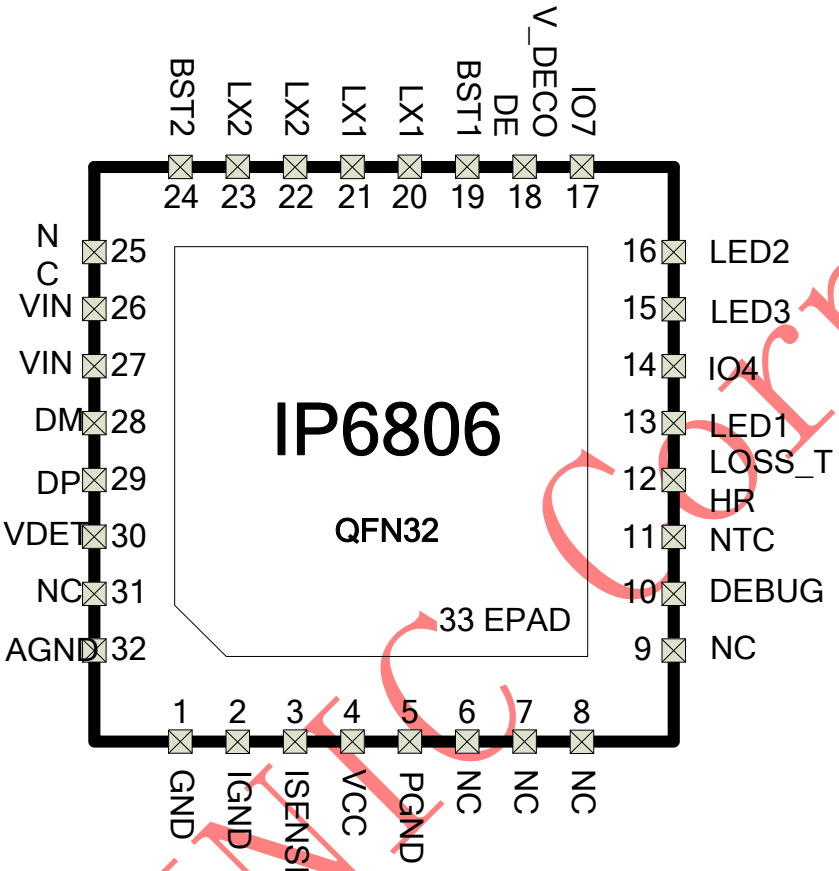


Figure System functional diagram

Product Package Introduction

Product	Description
IP6806_5	5W wireless charging application, support 5V DC input
IP6806_A	5W~10W wireless charging application, support 5V/9V DC input

1. Pin Description



Pin No.	Pin Name	Description
1	GND	Analog Ground
2	IGND	Current communication/demodulation negative input
3	ISENSE	Current communication/demodulation positive input
4	VCC	Internal VCC supply, powered from VIN to 100R resistor or 4V LDO
5	PGND	The power ground of the internal power MOS transistor is connected to the external 20 mΩ sampling resistor positive terminal
6	NC	NC PIN is left floating and cannot be grounded
7	NC	NC PIN is left floating and cannot be grounded
8	NC	NC PIN is left floating and cannot be grounded
9	NC	NC PIN is left floating and cannot be grounded
10	DEBUG	Debug pin, serial output print information
11	NTC	NTC input PIN
12	LOSS_THR	Dynamic FOD parameter adjustment, external resistor to GND adjustment

13	LED1	LED1 output
14	IO4	Internal GPIO4
15	LED3	LED3 output
16	LED2	LED2 output
17	IO7	Internal GPIO7
18	V_DECODE	Voltage communication/demodulation input
19	BST1	Internal high voltage drive, connect to capacitor to LX1
20	LX1	H-bridge switching node 1
21	LX1	H-bridge switching node 1
22	LX2	H-bridge switching node 2
23	LX2	H-bridge switching node 2
24	BST2	Internal high voltage drive, connect to capacitor to LX2
25	NC	NC PIN is left floating and cannot be grounded
26	VIN	External voltage input PIN
27	VIN	External voltage input PIN
28	DM	USB DM
29	DP	USB DP
30	VDET	Coil voltage sense input
31	NC	NC PIN is left floating and cannot be grounded
32	AGND	Analog Ground
33	EPAD (PGND)	The power ground of the internal power MOS transistor is connected to the external 20 mΩ sampling resistor positive terminal

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Max	Unit
Input Voltage Range	VIN	-0.3	16	V
	VCC	-0.3	12	
	DP,DM	-0.3	12	
Junction Temperature Range	T_J	-40	125	℃
Storage Temperature Range	Tstg	-60	125	℃
Package Thermal Resistance	θ_{JA}	40		℃/W
Human Body Model (HBM)	ESD	4KV		V

*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.

3. Recommended Operating Conditions

Parameters	Symbol	Min	Typ	Max	Unit
VIN input Voltage Range	VIN	4.5	5/9	12	V
VCC Voltage Range	VCC	3.8	4.2	5	V
I/O Voltage Range	LED1,LED2,LED3	GND-0.3		VCC+0.3	V
	NTC,LOSS_THR	GND-0.3		VCC+0.3	
	IO4,IO7	GND-0.3		VCC+0.3	
	DP, DM	GND-0.3		5.5	

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

4. Electrical Characteristics

Unless otherwise specified, TA =25℃

Parameters	Symbol	Min	Typ	Max	Unit	Test Condition
VIN		4.5	5/9	12	V	
VCC		3.8	4.2	5	V	
VIH	Input high level	0.7xVCC			V	
VIL	Input low level			0.3xVCC	V	
VOH	Input high level		VCC		V	
VOL	Input low level		GND		V	

Parameters	Symbol	Min	Typ	Max	Unit	Test Condition
Source current	LED1,LED2,LED3 Output current capability		2	4	mA	Source current to output high level is 0.8*VCC

5. Function Description

Full-bridge and Power MOS

IP6806 includes two symmetry half-bridge drive module with built-in power MOS, PWM frequency adjustable range is 110kHz~205kHz with 0.25kHz/step.

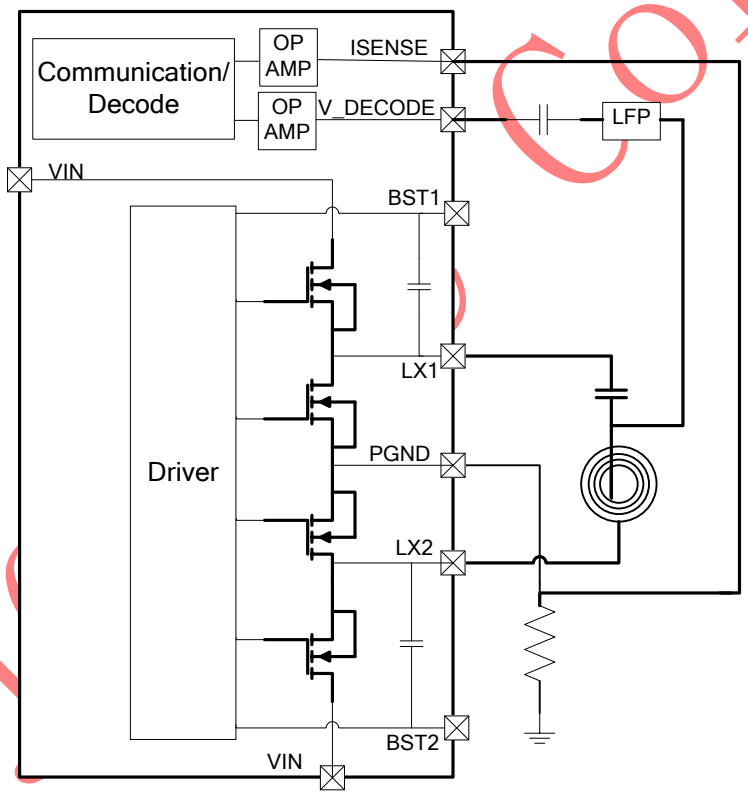


Figure full-bridge drive application circuit

DPM

IP6806 support Dynamic Power Management function for USB power source with insufficient power supply ability, which can guarantee the charging status will not break off or suspend. When the system detect the input voltage is lower than 4.3V, DPM function will be enabled and the transmitting power will be reduced. When the input voltage returns to above 4.75V and the input current is reduced by 200mA compared to when entering DPM, the system exits the DPM state.

Digital Demodulation

Integrate two-way ASK demodulation module, sampling the voltage and current of the coil separately. Current demodulation, additional separate devices are needed for low pass filters and first amplifier, signals is send to IC for digital demodulation and decode after DC blocked.

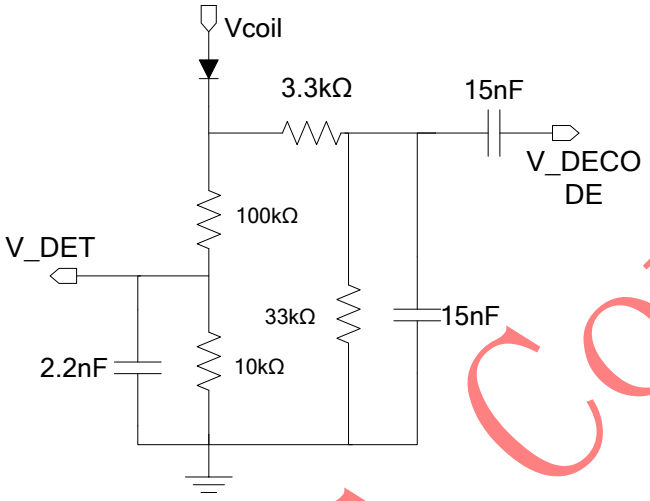


Figure Voltage ASK demodulation external circuit

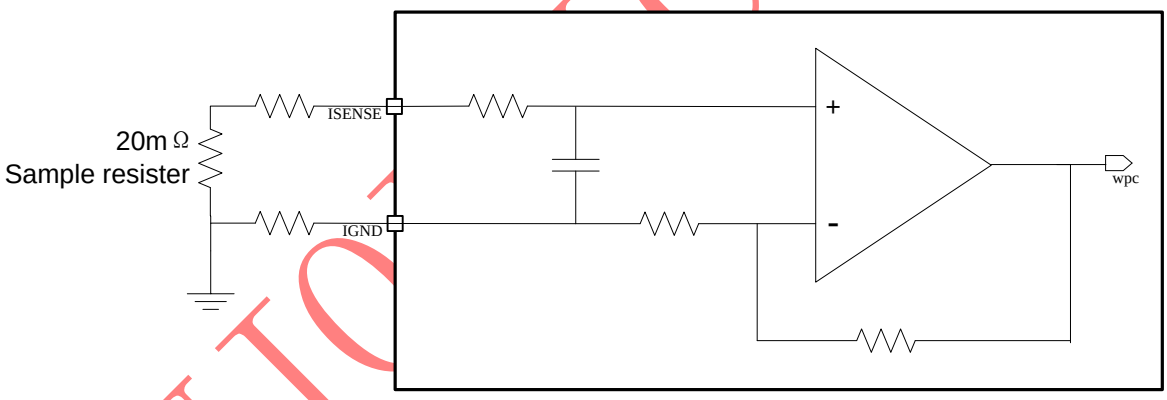
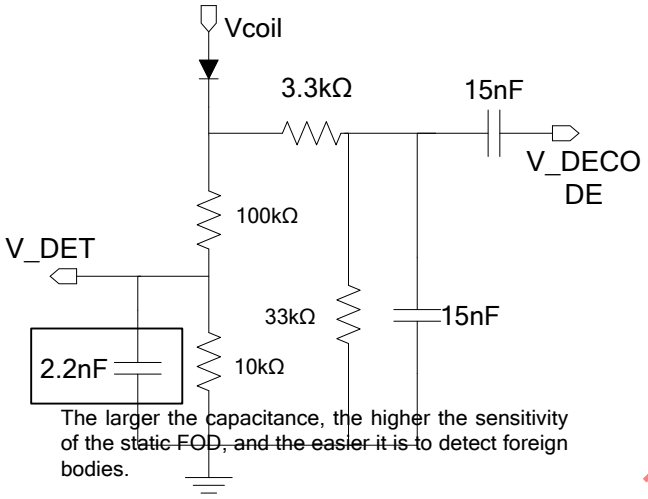


Figure Current ASK demodulation external circuit

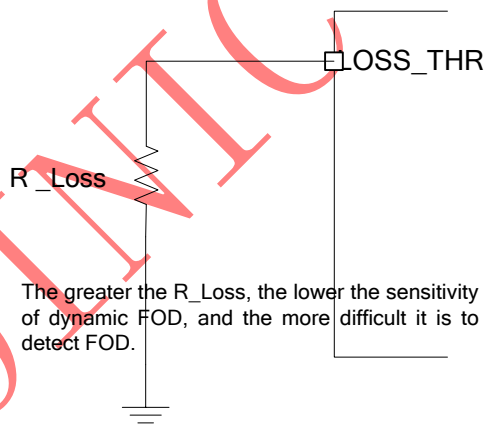
FOD parameter adjustment

IP6806 supports static FOD foreign object detection and dynamic FOD foreign object detection;
Static FOD means that foreign objects on the coil can be detected without wireless charging;
Dynamic FOD means that foreign objects on the coil can be detected while charging wirelessly;

The IP6806 can adjust the sensitivity of the static FOD by adjusting the capacitance on the V_DET pin; the default is to connect the 2.2nF capacitor to ground, standard static FOD sensitivity: the greater the capacitance, the higher the sensitivity of static FOD, and the easier to detect foreign bodies.



IP6806 can adjust the sensitivity of dynamic FOD by external resistor to GND on the LOSS_THR pin; The LOSS_THR pin defaults to a 100K resistor to ground, using standard dynamic FOD sensitivity; The larger the external resistor R_Loss of LOSS_THR, the lower the sensitivity of dynamic FOD, the less easy to detect FOD; The sensitivity of the dynamic FOD is set only by detecting the resistance of the LOSS_THR pin at power-on; 50K<R_LOSS resistor <130K。



NTC Thermal Protection

The NTC pin of the IP6806 is fixed to output 20uA current, and the NTC PIN determines the NTC temperature by sampling the voltage of the NTC pin. The NTC thermal shutdown protection is for enhancement application, but not limited to thermal shutdown. When NTC voltage is lower than 0.5V, the system will terminate the power transmittion. After entering NTC protection, the NTC voltage is greater than 0.72V, and normal charging resumes. If NTC is not used, this pin is grounded through a 100K resistor.

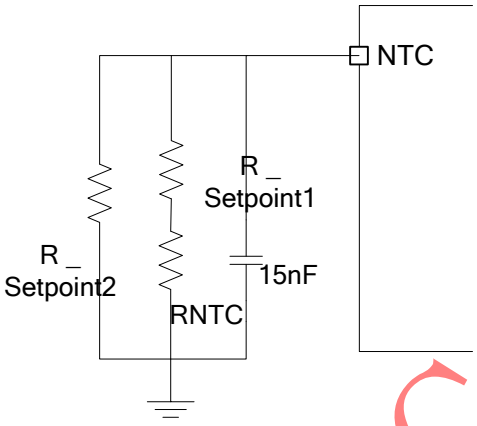
NTC resistor selection, refer to the following stage:

1. Refer to NTC resistor data handbook, search the resistor-temperature relation sheet
2. Find the related resistor R_NTC according to the protection temperature
3. Determine series resistance R_SetPoint1 and parallel resistance R_SetPoint2 according to the following formula:

   If the temperature protection point needs to be increased: parallel resistance R_SetPoint2 NC, change series

esistance R_SetPoint1 = 25K-RNTC;

If the temperature protection point needs to be reduced: series resistance R_SetPoint1 = 0 ohm, parallel resistance R_SetPoint2 = 25K*RNTC/(RNTC-25K);



Protection temperature 60 degrees Celsius, resistance recommended as follows:
RNTC=100K@25 degrees Celsius B=3950, R _ Setpoint1=0 ohm, R _ Setpoint2 NC;
Protection temperature 70 degrees Celsius, resistance recommended as follows:
RNTC=100K@25 degrees Celsius B=3950, R _ Setpoint1=7.5K ohm, R _ Setpoint2 NC;
Protection temperature 50 degrees Celsius, resistance recommended as follows:
RNTC=100K@25 degrees Celsius B=3950, R _ Setpoint1=0 ohm, R _ Setpoint2 = 82K ohm;

LED Status Indicator

IP6806 can drive 2 LEDs directly through serial current-limit resistor. LEDs' status and system status relations are listed below:

Status	LED1	LED2
Power-on	Flashing three times simultaneously	
Standby	Off	Off
Charging	On	Off
Abnormal	Off	Flashing

Firmware can be modified by customization or configuration tools to support up to three LEDs.

Test Waveform

Using TI bq51020 solution for RX device, the relationship of efficiency and system output power and test method are outlined below. (VOUT=5V).

$$\eta_{\text{system}} = \frac{P_{\text{OL}}}{P_{\text{in}}}$$

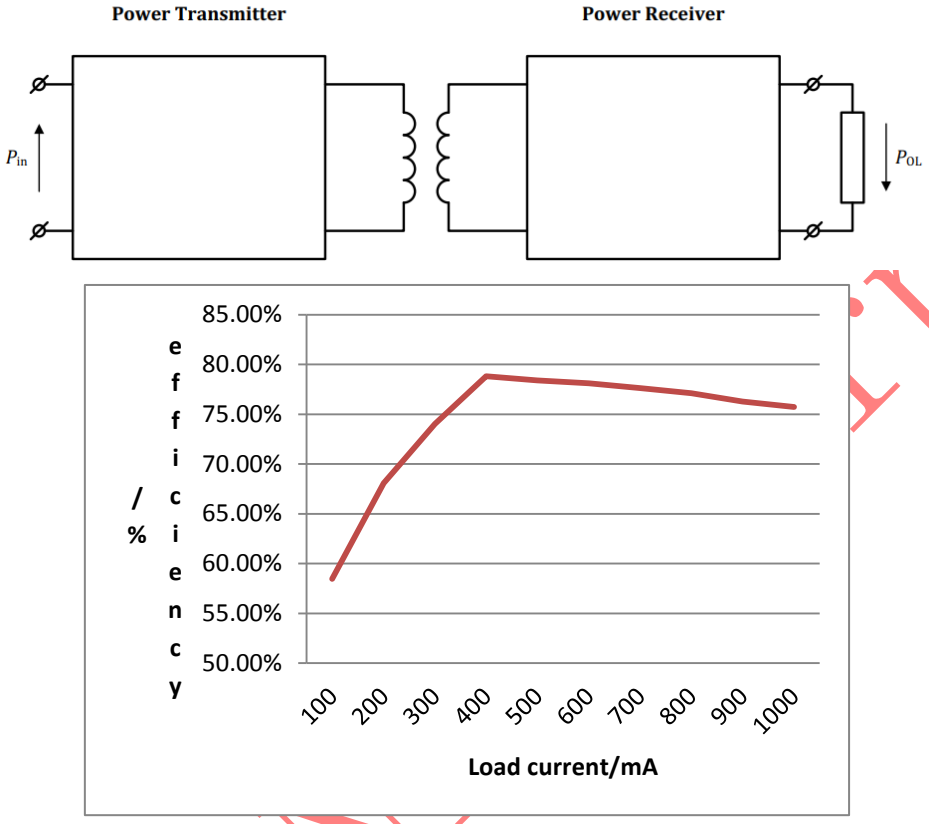
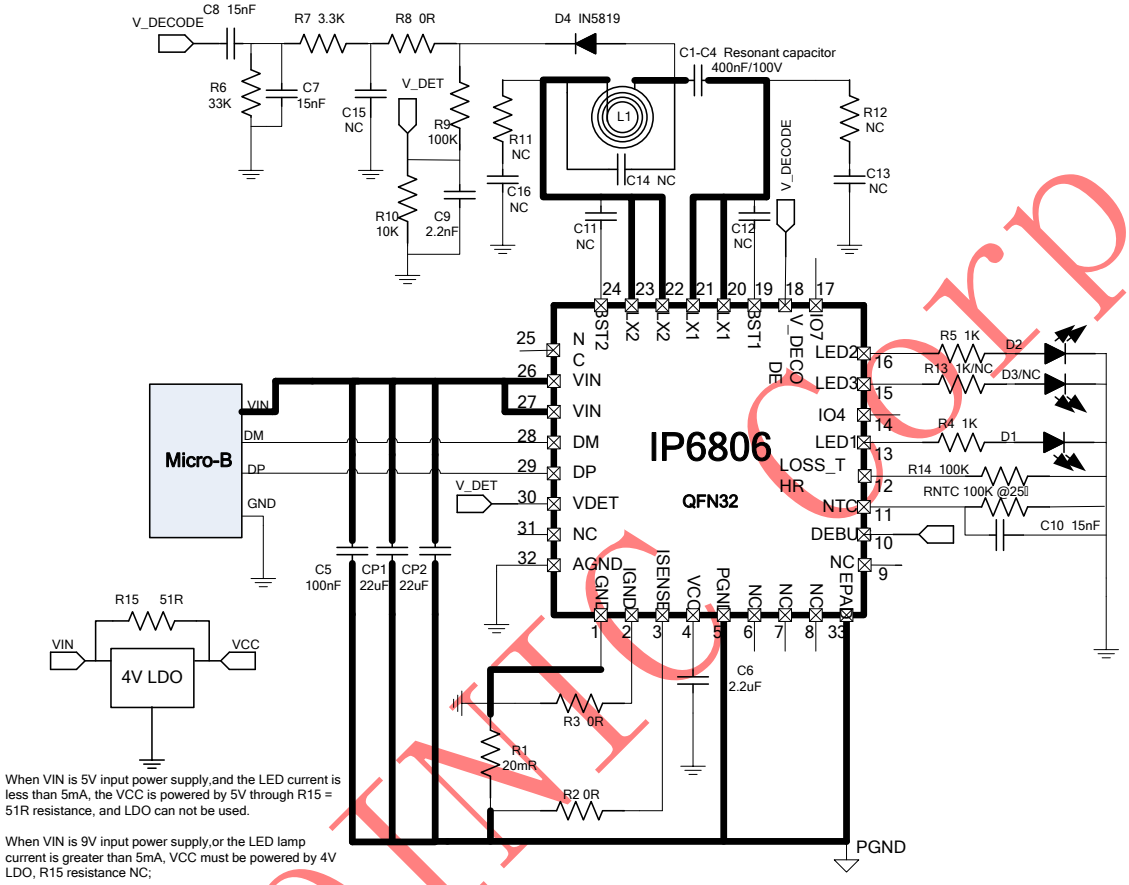


Figure System efficiency (using bq51020 RX)

6. Typical Application Schematic

IP6806 wireless charging solution only needs capacitors, resistors and few passive devices.



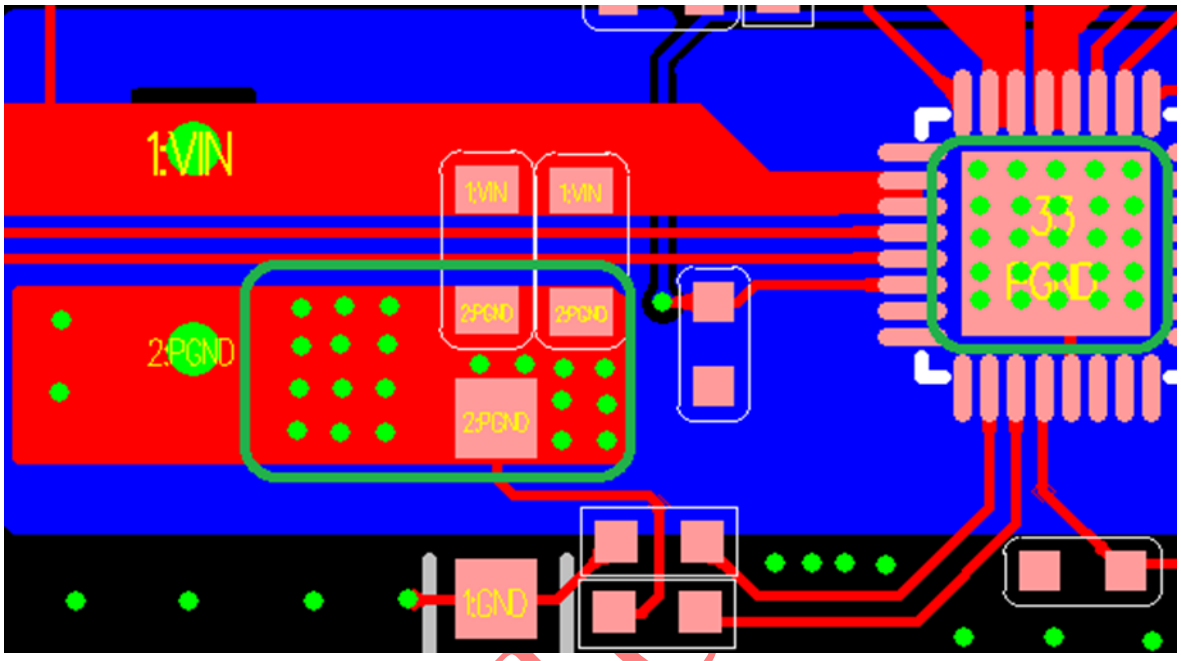
BOM List

Item	Part Name	Description&specification	Description	Qty
1	IP6806	QFN32 IP6806	U1	1
2	NPO or CBB capacitor	400nF 100V	C1-C4	4
3	SMD capacitor	0603C 100nF 25V	C5	1
4	SMD capacitor	0603C 2.2uF 25V	C6	1
5	SMD capacitor	0603C 15nF 25V	C7 C8 C10	3
6	SMD capacitor	0603C 2.2nF 25V	C9	1
7	SMD capacitor	0805C 22uF 25V	CP1 CP2	2
8	Precision low temperature drift resistor	1206R 20mR 1%	R1	1
9	SMD resistor	0603R 0R	R2 R3 R8	3
10	SMD resistor	0603R 1K	R4 R5	2
11	SMD resistor	0603R 33K	R6	1
12	SMD resistor	0603R 3.3K	R7	1
13	SMD resistor	0603R 100K	R9 R14	2

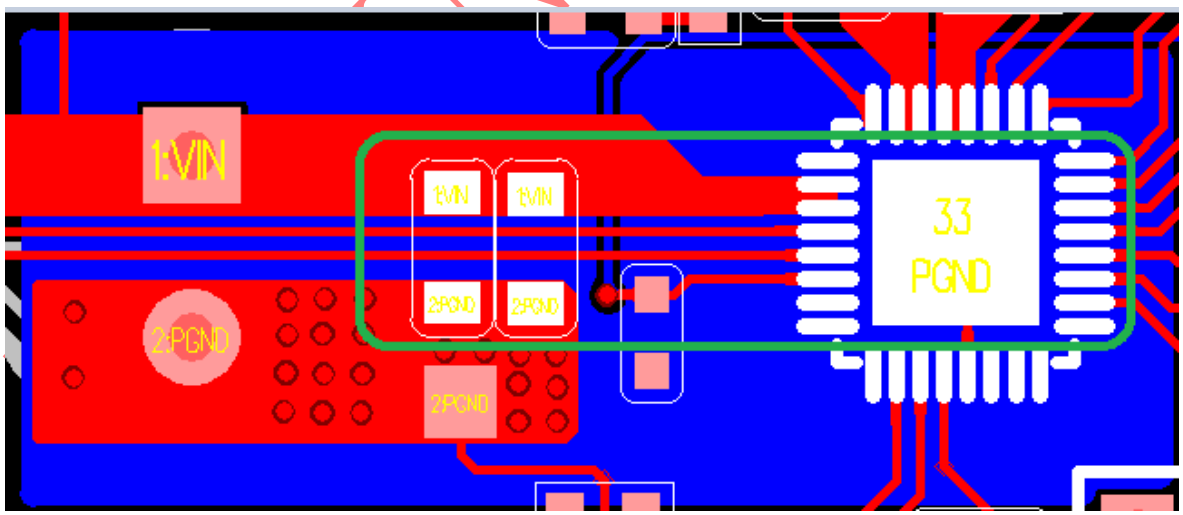
14	SMD resistor	0603R 10K	R10	1
15	SMD resistor	0603R 51R	R15	1
16	NTC thermistor	100K 25℃ B=3950	RNTC	1
17	Diode	IN5819	D4	1
18	LED	0603D	D1 D2	2
19	Wireless charging coil	A11	L1	1

7. Layout Notifications

1. As shown in the following figure: current sampling resistance and IP6806's PGND are power lines, which need to be as short as possible, and more holes need to be added when changing layers;

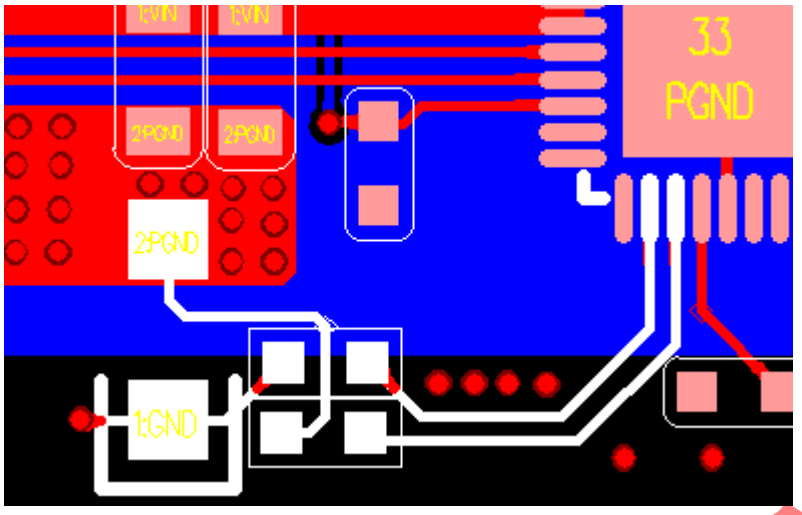


2. As shown in the following figure: input the filter capacitance between VIN and PGND, the smaller the ring road area, the better;

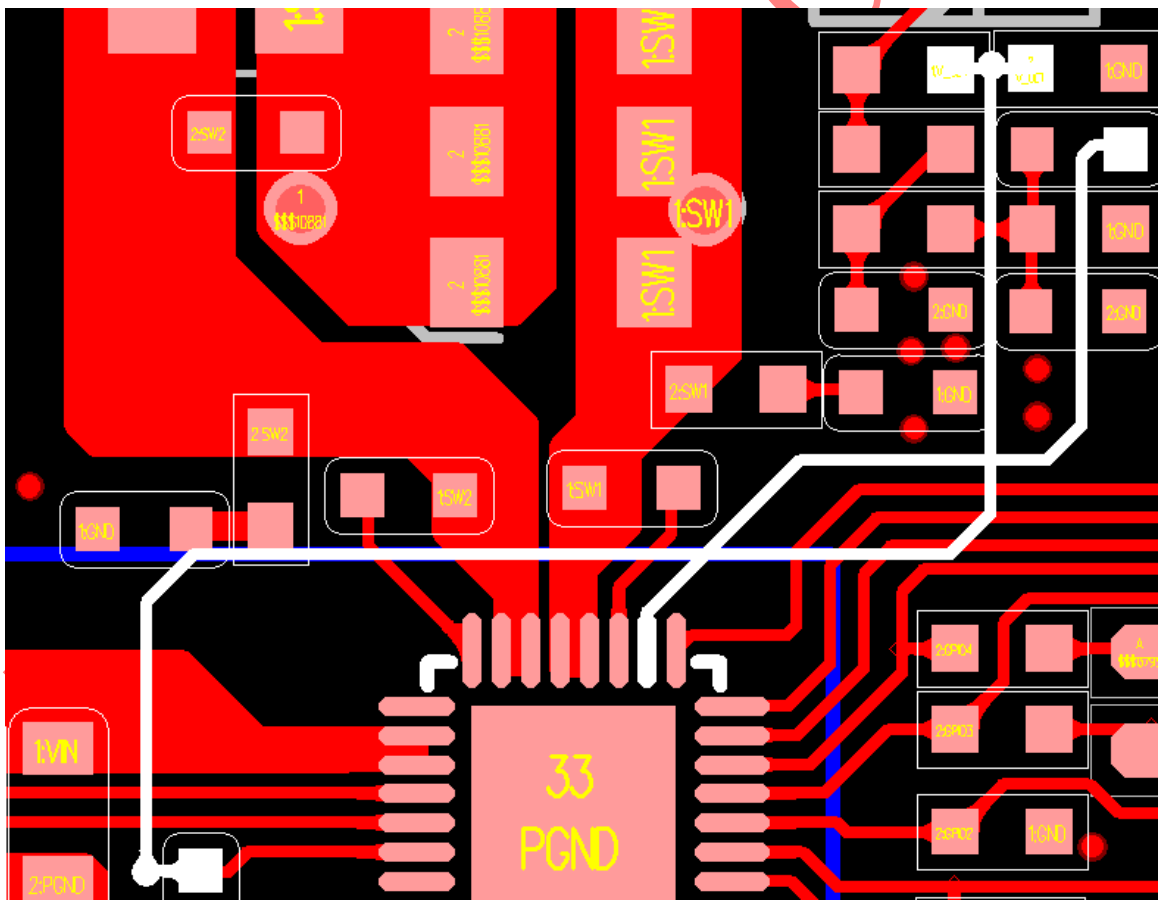


3. As shown in the following figure: Sampling routes from current sampling resistors to IP6806 ISENSE and IGND need separate leads from both ends of resistors, not to coincide with the power routes of the same network

and to be as short as possible, while away from resonant capacitors and coils.

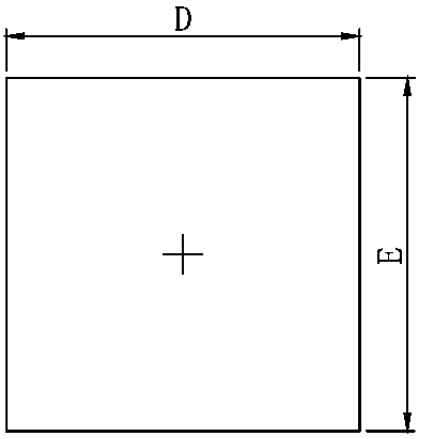


4. As shown in the following figure: The V_DECODE and V_DET routes of IP6806 are as far away as possible from resonant capacitors, coils and other power routes, and need to be surrounded by ground.

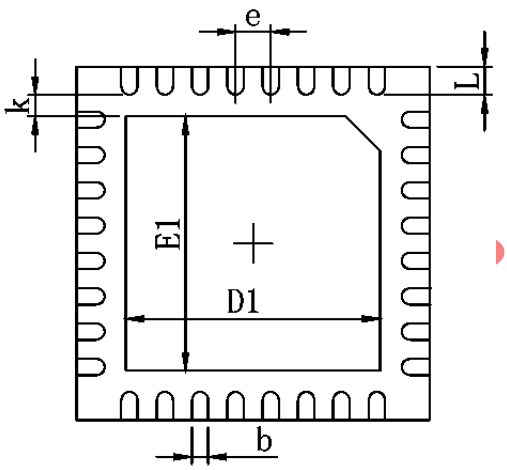


5. The loop area between the resonant capacitor and the coil and the IP6806 needs to be as small as possible, and away from the low-voltage signal lines such as LED, NTC, and IO.
6. The capacitance of the 4th pin VCC should ensure sufficient capacity of 2.2uF, and the capacitor position is close to the chip pin; and the ground loop of the VCC capacitor ground to the chip 1 pin cannot be blocked by other signals.

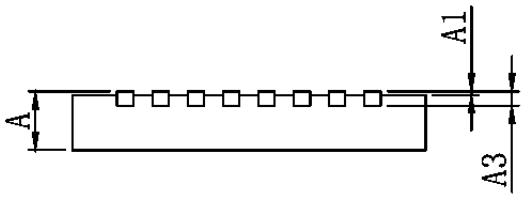
8. Package



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	4.924	5.076	0.194	0.200
E	4.924	5.076	0.194	0.200
D1	3.700	3.900	0.146	0.154
E1	3.700	3.900	0.146	0.154
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.250	0.350	0.010	0.014

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