2A Charging / 2.4A Discharging Power Bank SOC With Integrated Digital Tube Driver

1. Features

- **Switch buck charger and boost**
  - ✧ 2.4A synchronous boost conversion
  - ✧ 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
  - ✧ 2A synchronous switch charging
  - ✧ Supports 4.20V, 4.30V, 4.35V and 4.4V batteries
- **Battery indicator**
  - ✧ Built-in 14bitsADC and accurate coulomb calculation method
  - ✧ Support 5/4/3/2/1 LED power or digital tube display
  - ✧ Supports selecting battery initial capacity by external PIN
  - ✧ Supports self calibration of battery capacity
- **Feature-rich**
  - ✧ Built-in illuminator driver
  - ✧ Automatically load insertion and removal detection
- **Low-power dissipation**
  - ✧ Intelligently identify the load and automatically enter standby
  - ✧ Standby power consumption is less than 100 μA
- **Simplified BOM**
  - ✧ Built-in power MOS, 1uH single inductor to achieve charge and discharge
  - ✧ Built-in various digital tube drive circuits
- **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
  - ✧ ESD 4KV ,Vin transient withstand up to 18V
- **In-depth customization**
  - ✧ Flexible and low-cost customized program
- **Package: ESOP16**

2. Applications

- **Power Bank**
- **Mobile phones, tablets and other portable devices**
- **Hydrator/hand warmer**

3. Description

IP5506 is a multi-functional power management SOC for total solution on Power Bank. It also integrates with boost converter, lithium battery charging management and battery level indicators.

IP5506 is highly integrated with abundant functions, which makes the total solution size minimized and BOM costed down.

IP5506 requires only one inductor to achieve buck and boost functions, DC-DC converter works at 500KHz and can support low-cost inductors and capacitors.

The synchronous boost system of IP5506 provides rated 2.4A output current with conversion efficiency up to 93%. When there is no load, it will automatically enter the standby state, and the static current will drop to less than 100uA.

IP5506's switch charging system supplies 2A charging current with charging efficiency up to 92%. According to the IC temperature and input voltage, IP5506 can intelligently adjust charging current.

IP5506 contains 14bits ADC, which can accurately measure battery's voltage and current. The built-in coulomb meter algorithm of IP5506 can accurately obtain the battery power information.

IP5506 can support digital tube display and illuminator function.

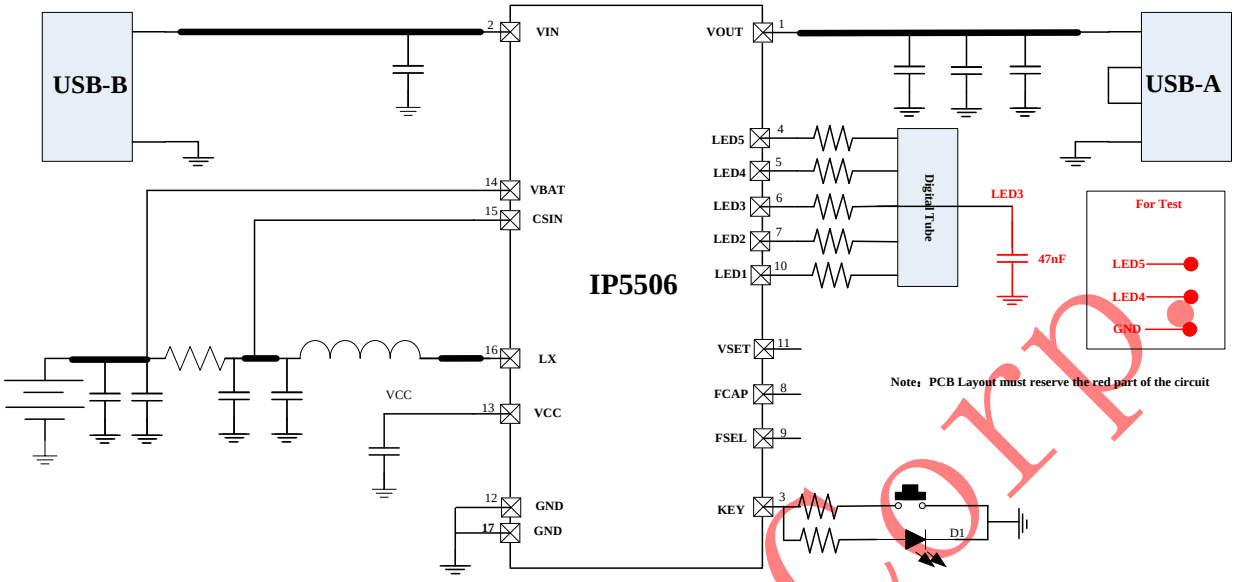
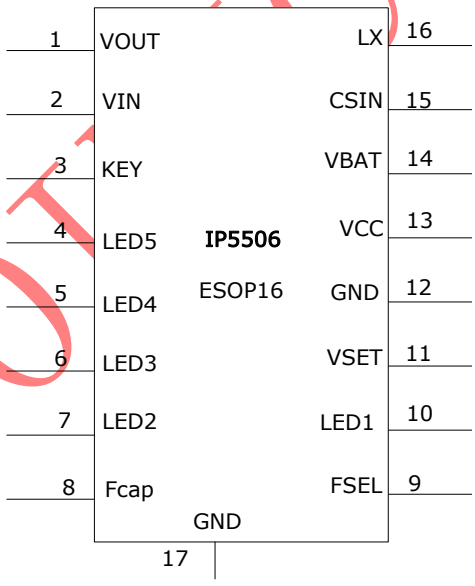


Figure 1 IP5506 simplified application schematic diagram (digital tube displays power)



4. Pin definition.

Figure 2 IP5506 pin diagram

PIN		description
PIN NUM	PIN Name	
1	VOUT	DC-DC 5V Output pin
2	VIN	DC-DC 5V Charge pin
3、	KEY	key and LED driver pin
4、	LED5	digital tube/LED driver pin5

5	LED4	digital tube/LED driver pin4
6	LED3	digital tube/LED driver pin3
7	LED2	digital tube/LED driver pin2
8	FCap	Battery initialization capacity setting pin
9	FSEL	key setting pine
10	LED1	digital tube/LED driver pin1
11	VSET	Full battery voltage setting (4.2v,4.3v,4.35v,4.4)
12	GND	System GND
13	VCC	LDO 3.1V output
14	VBAT	System power and bat voltage sampling pin
15	CSIN	Bat voltage sampling pin
16	LX	DCDC switch node, connect inductance
17	GND	Power and dissipation ground, maintain good contact with GND

5. IP Series Products List

IC Part No.	Charge /Discharge		Features								Package	
	Dis-charge	Charge	LED Num	Lighting	Keys	I2C	DCP	USB C	QC Certificate	PD3.0/ PPS	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	
IP5206	2A(Max)	1.5A	3,4,5	√	√	-	-	-	-	-	eSOP16	PIN2PIN
IP5108E	2.0A	1.0A	3,4,5	√	√	-	-	-	-	-	eSOP16	
IP5108	2.0A	2.0A	3,4,5	√	√	√	-	-	-	-	eSOP16	
IP5207	1.2A	1.2A	3,4,5	√	√	-	-	-	-	-	QFN24	PIN2PIN
IP5207T	1.2A	1.2A	1,2,3,4	√	√	√	√	-	-	-	QFN24	
IP5109	2.1A	2.1A	3,4,5	√	√	√	-	-	-	-	QFN24	
IP5209	2.4A	2.1A	3,4,5	√	√	√	√	-	-	-	QFN24	
IP5219	2.4A	2.1A	1,2,3,4	√	√	√	√	√	-	-	QFN24	
IP5310	3.1A	3.0A	1,2,3,4	√	√	√	√	√	-	-	QFN32	
IP5506	2.1A	2.4A	Digital tube	√	√	-	-	-	-	-	eSOP16	
IP5508	2.1A	2.4A	Digital tube	√	√	-	√	-	-	-	QFN32	
IP5330	3.1A	3A	Digital tube	√	√	-	√	√	-	-	QFN32	
IP5322	18W	4.0A	1,2,3,4	√	√	√	√	-	√	-	QFN32	
IP5328P	18W	4.0A	1,2,3,4	√	√	√	√	√	√	√	QFN40	

6. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 12	**V**
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	Tstg	-60 ~ 150	℃
Thermal resistance (from junction to ambient air)	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.

7. 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.

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	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	$CV_{4.2V}$	VSET PIN connets GND	4.18	4.21	4.24	V
	$CV_{4.30V}$	VSET PIN connets 1V Voltage	4.28	4.31	4.34	V
	$CV_{4.35V}$	VSET PIN connets VCC	4.33	4.36	4.4	V
	$CV_{4.4V}$	VSET PIN connets 2V Voltage	4.38	4.41	4.44	V
Charge Stop Current	$Ivin_{stop}$	Input Vin=5V	200	300	500	mA
Charge Current	I_{VIN}	VIN Port charging current input terminal current, VBAT=3.7V	1.7	2	2.3	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	Hour
Boost System						
Battery Operation Voltage	V_{BAT}		3	3.7	4.4	V
Low Power Shutdown Voltage	V_{BATLOW}	IOUT=2A	2.9	2.95	3.0	V

Battery input current	I_{BAT}	VBAT=3.7V，VOUT=5.1V,fs=500KHz (no digital tube, no LED display, Vout no load)		2	6	mA
DC Output Voltage	V_{OUT}	VBAT=3.7V @0A	5.0	5.12	5.25	V
		VBAT=3.7V @2.4A	4.85	5	5.35	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		2.4	A
Boost Overcurrent Shut Down Threshold	I_{vout}	VBAT=3.0V~4.4V	2.45	2.8	3.2	A
Load Overcurrent Detect Time	T_{UVD}	The output voltage is continuously below 4.2V		30		ms
Control System						
Switch Frequency	fs	Boost Switching frequency	450	500	550	KHz
		Charge Switching frequency	450	500	550	KHz
PMOS On Resistance	r_{DSON}			40		mΩ
NMOS On Resistance				35		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	120	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}	The load current is continuously less than 45mA	27	30	33	s
Light Load Shut Down Current	I_{plout}	VBAT=3.7V	20	45	70	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

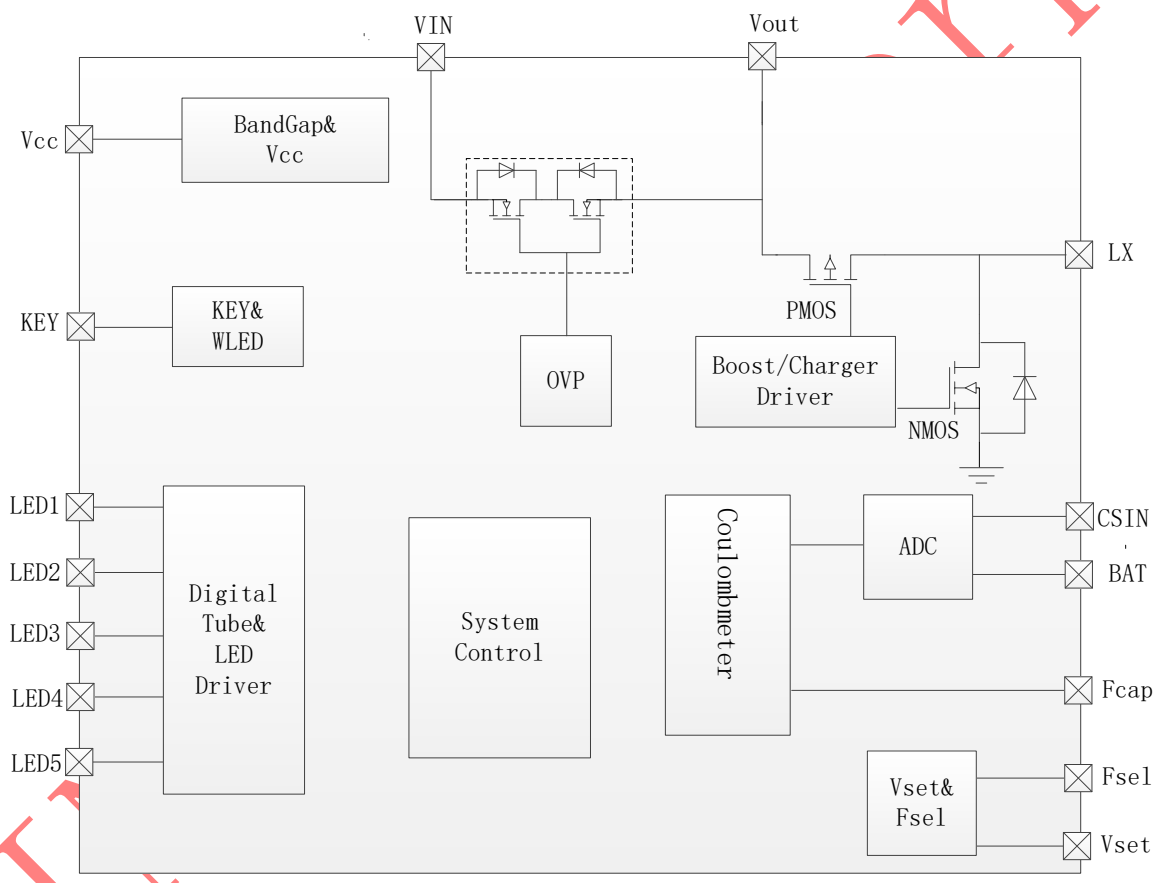


Figure 3 IP5506 Internal System Diagram

Boost

IP5330 integrates a boost dc-dc converter with 5V/2.4A output. Switching frequency: 500KHz; input: 3.7V; efficiency @ 5V/1A output: 94%. 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.

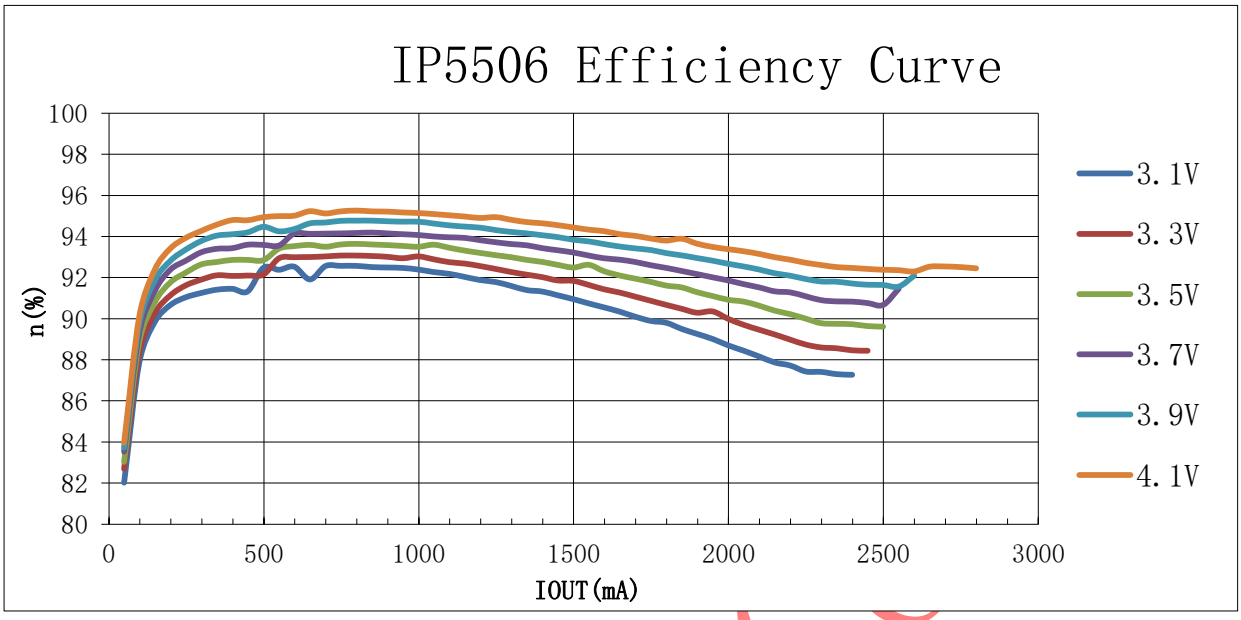


Figure 4 IP5506 Efficiency Curve

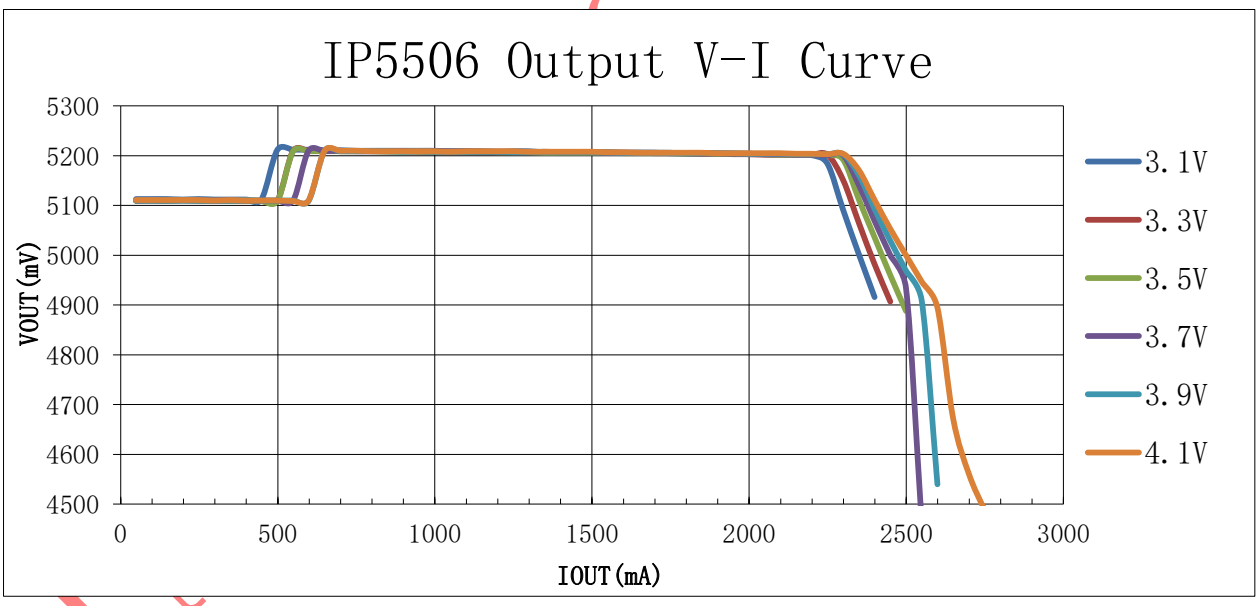


Figure 5 IP5506 Output V-I Curve

Charge

IP5506 has a constant current, constant voltage lithium battery charger with synchronous switch structure. When the battery voltage is less than 3V, use 200mA clear current charging; when the battery voltage is greater than 3V, enter constant current charging; when the battery voltage is greater than 4.2V/4.35V/4.4V, enter constant voltage charging. After the charging is completed, if the battery voltage is lower than 4.1V, restart the battery charging.

IP5506 has built-in power path management and supports charging and discharging. When charging, turn on the input VIN and output VOUT PMOS tubes to charge external devices. At the same time, IP5506 will detect whether the VOUT output voltage is high voltage 4.55V. Charge the battery cell with the maximum current. If it is lower than 4.55V, the charging current will be reduced to automatically adapt to the load output capacity of the adapter. The IP5506 PMOS tube that inputs VIN and outputs VOUT while charging and discharging has functions such as over-temperature, 3A over-current, and short-circuit protection.

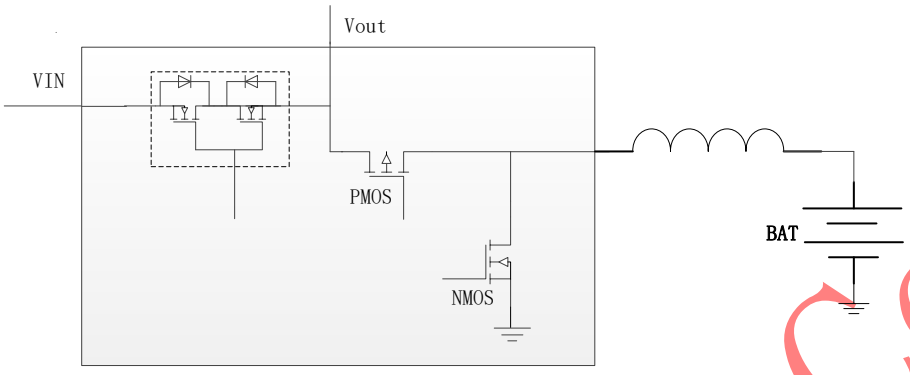


Figure 6 Schematic Diagram Of Power Path Management

Key and WLED

IP5330 has built-in Key and WLED function, which supports external PIN selection, Key startup & shutdown and switch lighting. Specific reference is as follows:

FSEL	Key mode description
1K	Short press to boot ,short press twice to shut out ,Long press 2s switch to flashlight
33K	Short press to boot; Press the button twice in a row to switch flashlight;Without key to shut out function
51K	Short press to boot; Press the key twice in a row to switch flashlight ,Long press 2s to power off
82K	Short press to boost,short press twice to switch flashlight,long press 2S to power off
100K	Support shock switch and shake switch to boost,The key without boost and shut out function,without flashlight function

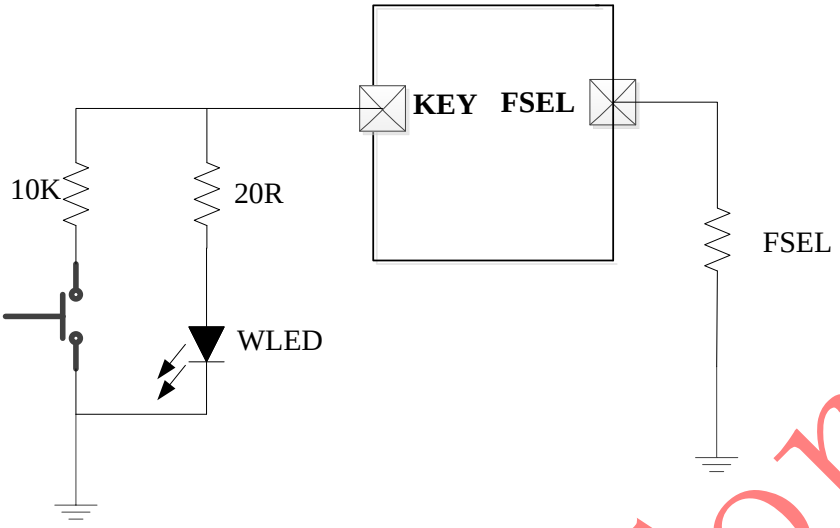


Figure 7 Key and WLED circuit

Description of battery voltage configuration:

R10	R9	Battery Voltage.
NC	0R	4.20V
300K	150K	4.30V
0R	NC	4.35V
150K	300K	4.40V

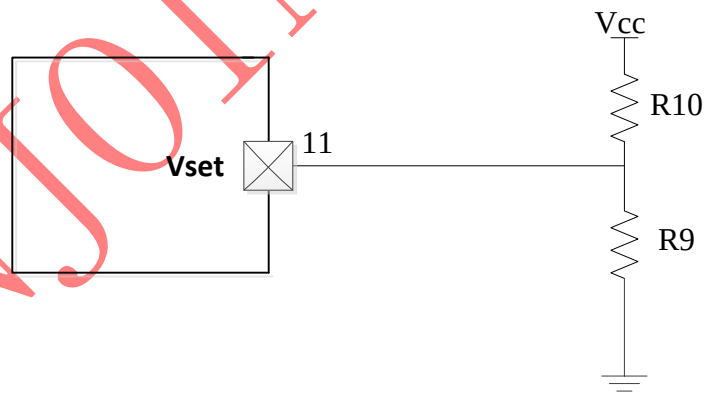


Figure 8 Vset battery voltage configuration circuit

Coulombmeter and battery level display

IP5506 has built-in accurate coulomb electricity meter algorithm, according to the battery capacity accurately display the remaining battery power.

IP5506 can be customized to support LED lamp, type 88, type 188, type 888 digital tube and other power display.

The specific corresponding models are as follows:

IP5506_BZ_LED Support 1/2/3/4/5 LEDs

IP5506_BZ_188 Support 5pin188 type digital tube (if you need to support other types of digital tube, please inquire our sales or FAE)

LED display mode

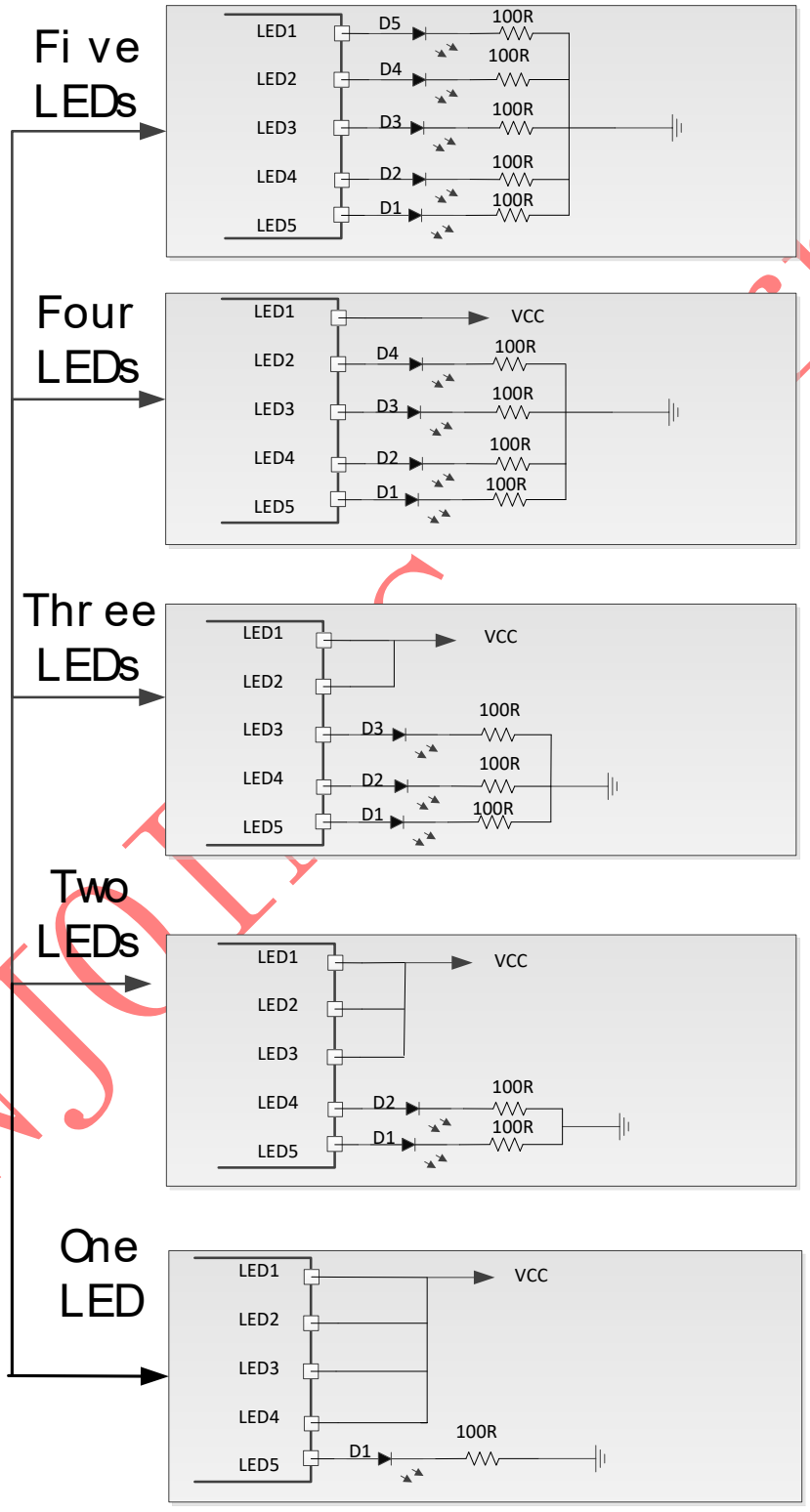


Figure 9 LED display configuration circuit

■ Five LEDs mode

Boost

SOC（%）	D1	D2	D3	D4	D5
C≥80%	ON	ON	ON	ON	ON
60%≤C＜80%	ON	ON	ON	ON	OFF
40%≤C＜60%	ON	ON	ON	OFF	OFF
20%≤C＜40%	ON	ON	OFF	OFF	OFF
3%≤C＜20%	ON	OFF	OFF	OFF	OFF
0%＜C＜3%	1Hz blink	OFF	OFF	OFF	OFF

Charge

SOC（%）	D1	D2	D3	D4	D5
Full	ON	ON	ON	ON	ON
C≥80%	ON	ON	ON	ON	0.5Hz blink
60%≤C＜80%	ON	ON	ON	0.5Hz blink	OFF
40%≤C＜60%	ON	ON	0.5Hz blink	OFF	OFF
20%≤C＜40%	ON	0.5Hz blink	OFF	OFF	OFF
＜20%	0.5Hz blink	OFF	OFF	OFF	OFF

■ Four LEDs mode

Boost

SOC（%）	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%	1Hz blink	OFF	OFF	OFF

Charge

SOC（%）	D1	D2	D3	D4
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

■ Three LEDs mode

Boost

SOC（%）	D1	D2	D3
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

SOC（%）	D1	D2	D3
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

■ Two LEDs mode

	State	D1	D2
Charge	In charging	0.5Hz blink	OFF
	Full	ON	OFF
discharge	In discharging	OFF	ON
	Low Battery	OFF	1Hz blink

■ One LED mode

	State	D1
Charge	In charging	0.5Hz blink
	Full	ON
discharge	In discharging	ON
	Low Battery	1Hz blink

Digital Tube Mode

Digital Tube	Charge		discharge	
	In charging	Full	SOC<5%	SOC>5%
188 mode（YF2252SR-5）	0-99% 0.5Hz blink	100% Always bright	0-5% 1Hz blink	5%-100% Always bright

The schematic diagram of 5pin188 digital tube is as follows:

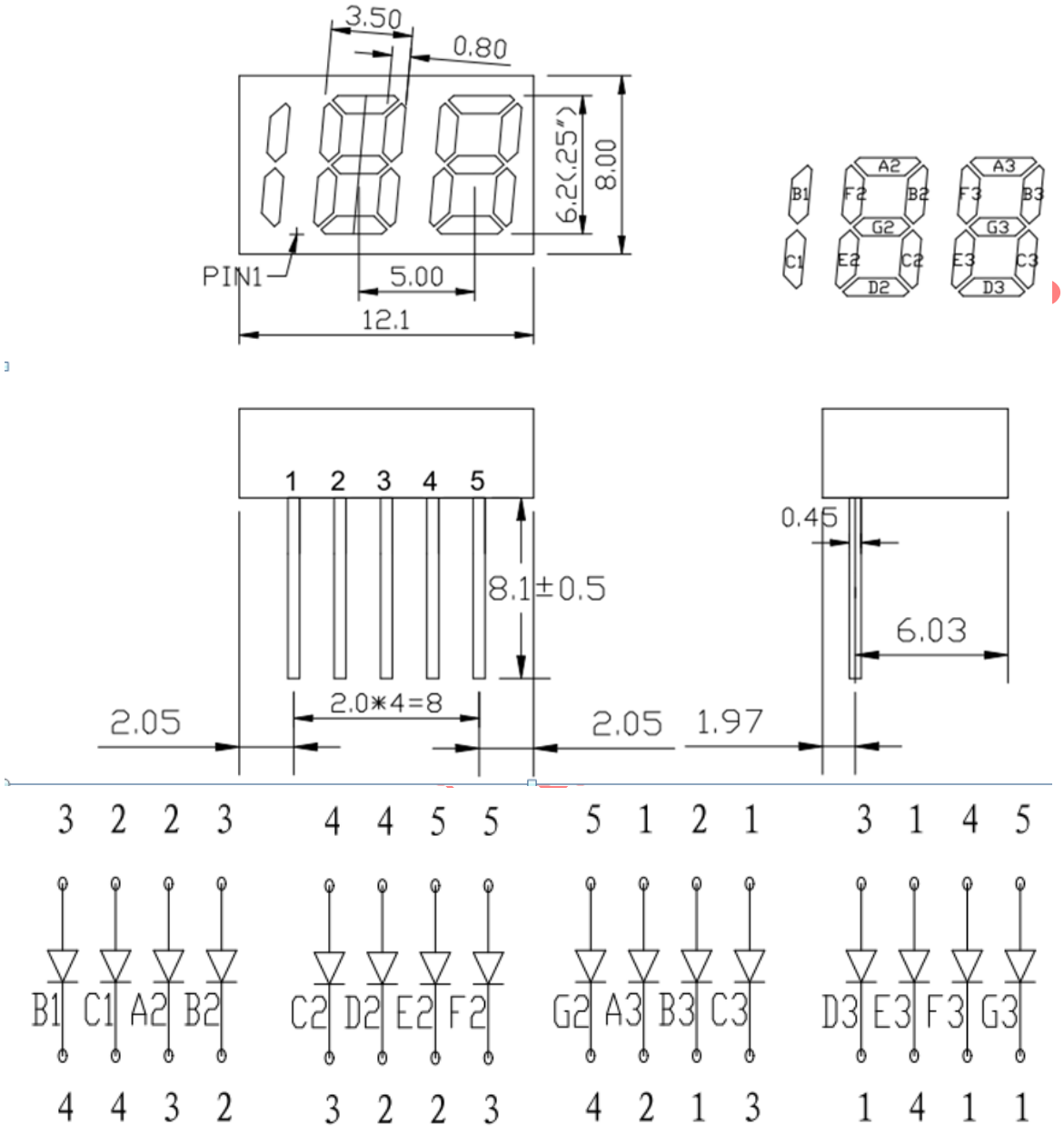


Figure 10 5pin188 digital tube circuit diagram

Coulombmeter

IP5506 supports the external setting of the initial capacity of the battery. The residual capacity of the battery can be managed by integrating the current and time of the battery end, which can accurately display the current capacity of the battery. At the same time, IP5506 supports a complete charging process from 0% to 100% to automatically calibrate the total capacity of the current battery, so as to manage the actual capacity of the battery more reasonably.

IP5506 initial capacity formula setted by external PIN: battery capacity Fcap= R_7*0.2 (mAH)

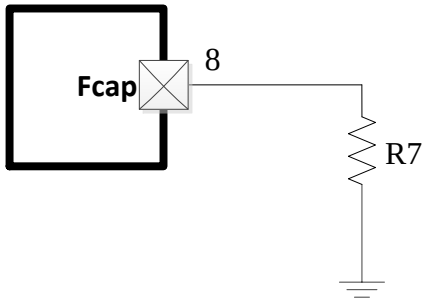


Figure 11 Battery capacity configuration circuit diagram

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

After IP5506 detects the phone's insertion, it will immediately wake up from standby mode and turn on the boost 5V to charge the phone.

IP5506 automatically enters standby state when Vout end load current is less than 50mA and lasts for 30s.

VCC

VCC is a normally opened 3.1V LDO. Load capacity is 50mA.

Test

LED4 / LED5 / GND is the system test point, please be sure to reserve this test point when PCB layout

10 Typical Application Diagram

IP5506 only needs inductors, capacitors and resistors to realize the complete scheme of mobile power supply.

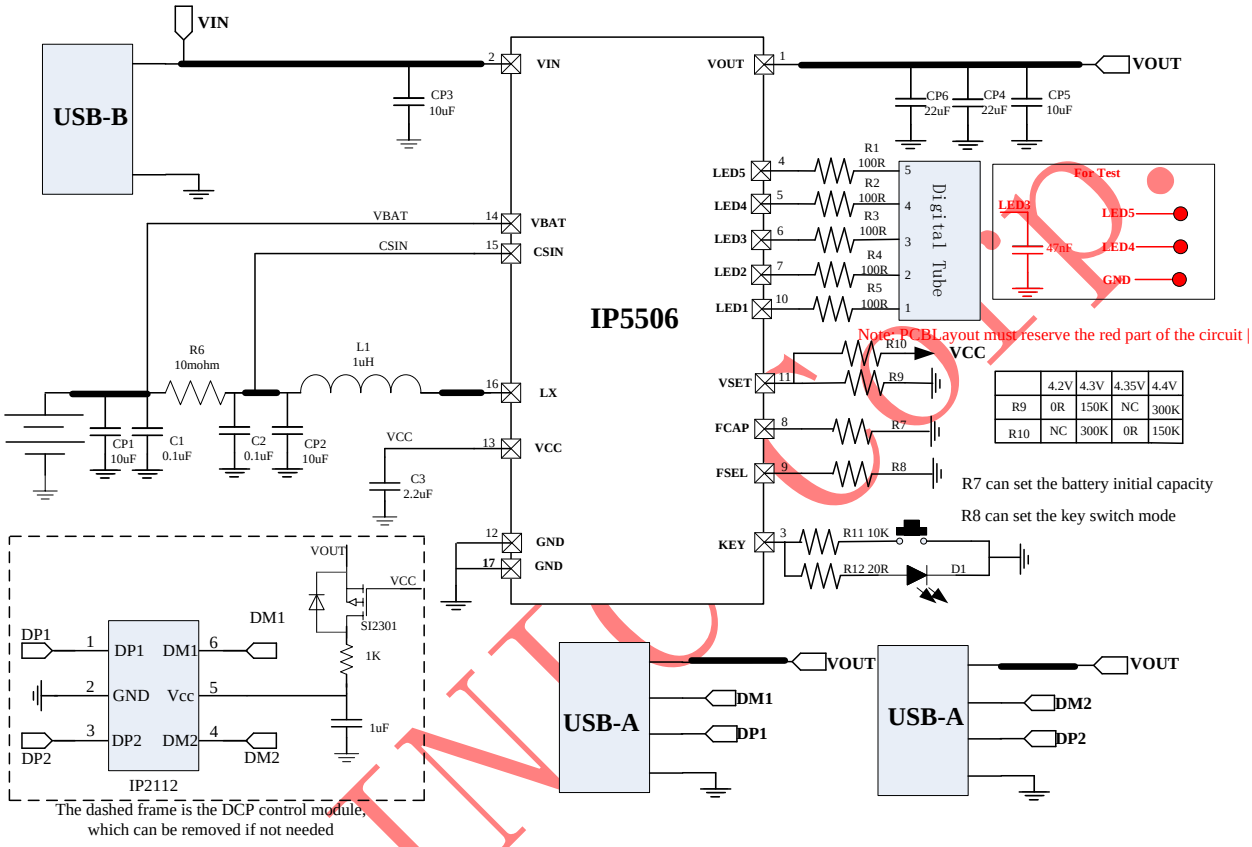


Figure 12 Typical application principle diagram of IP5506 digital tube application

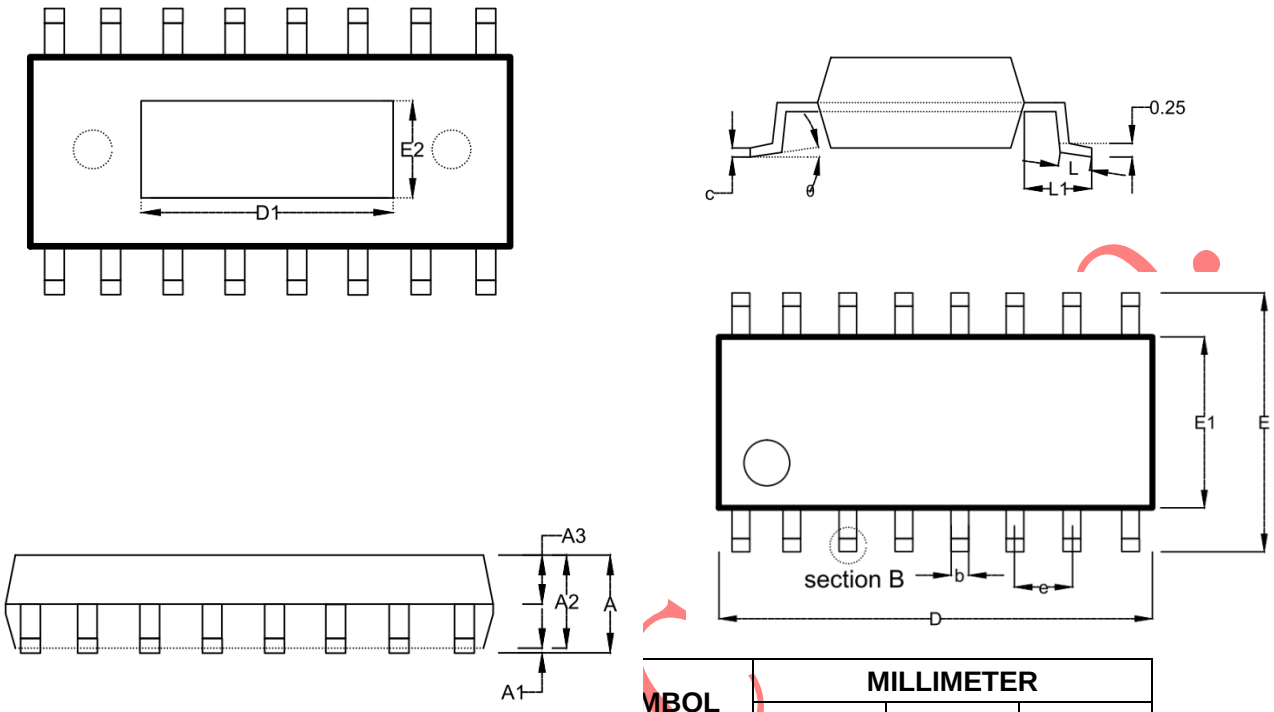
Recommended model of inductance SPM70701R0

DARFON PIN	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.	
SPM70701R0	1.0	±20%	8.5	8	12	15	

Recommended models of lithium battery protection IC

INJOINIC	Pack age	Overcharge Detection Voltage [VCU] (V)	Overdischarge Detection Voltage [VDL] (V)	Overcurrent Detection Current [IOV] (A)
IP3005A	ESOP8	4.28V	2.5V	7A

11.Package information



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	-	-	1.75
A1	0.05	-	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	-	0.48
b1	0.38	0.41	0.43
c	0.21	-	0.26
c1	0.19	0.20	0.21
D	9.70	9.90	10.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
h	0.25	-	0.5
L	0.50	-	0.80
L1	1.05BSC		
D1		4.57	
E2		2.41	

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