

Support SCP、VOOC、Bi-directional PD3.0 and Fast Charge protocol Power

Bank SOC

Features

- **Support multiple ports simultaneously**
 - ✧ 2USB A output ports, 1 USB B input port
 - ✧ 1 USB C input/output port
- **Fast charge**
 - ✧ Every port support fast charge
 - ✧ Support QC2.0/QC3.0 output
 - ✧ Support FCP/AFC/SFCP input/output
 - ✧ Support SCP output
 - ✧ Support VOOC output
 - ✧ Support MTK PE1.1&2.0 output
 - ✧ Support USB C DRP input/output
 - ✧ Support BC1.2/Apple/Samsung
- **Integrated USB PD2.0/PD3.0 protocol**
 - ✧ Support PD2.0 input/output protocol
 - ✧ Support PD3.0 input/output and PPS output protocol
 - ✧ Support 5V/9V/12V voltage input/output
 - ✧ PPS support 5~11v adjustable voltage with 20mv/step
- **Charger**
 - ✧ Up to 5A charging current at battery port
 - ✧ Adaptive charging current adjustment
 - ✧ Support 4.2v/4.3v/4.35v/4.4v battery
- **Boost**
 - ✧ Output current:
5V: 3.1A 9V: 2.0A 12V: 1.5A
 - ✧ Up to 95%@5V/2A efficiency with synchronous switching
 - ✧ Support line compensate
- **Battery level display**
 - ✧ Integrated 14bit ADC and coulometer
 - ✧ Support 1/2/4 LED battery level indicator
 - ✧ Support 88/188 nixie tube
 - ✧ External PIN chooses nixie tube or LED for battery level indicator
 - ✧ Auto recognition of LED number
 - ✧ Adjustable battery level curve
- **Others**
 - ✧ Support auto detect of plug in and out
 - ✧ Fast charge status indicator
 - ✧ Support Battery NTC and PCBA NTC
 - ✧ Enter standby mode automatically in light load
 - ✧ Support a variety of key mode selection
 - ✧ Integrated torch-light driver
- **Multiple protection,high reliability**
 - ✧ Input overvoltage and undervoltage protection
 - ✧ Output overcurrent, overvoltage and short circuit protection
 - ✧ Battery overcharge, over discharge and overcurrent protection
 - ✧ Over temperature protection

✧ 4KV ESD, Input voltage up to 20v (including CC pins)

- **Low BOM cost**
 - ✧ Integrated switch power MOSFET
 - ✧ Single inductor for charging and discharging
- **Package size: 7mm × 7mm 0.5pitch QFN48**

Description

IP5358 is a power management SOC. It integrates qc2.0 / qc3.0 / SCP / vooc output fast charging protocol, FCP / AFC / SFCP input and output fast charging protocol, MTK PE + 1.1 & 2.0 output fast charging protocol, USB C / pd2.0 / pd3.0 input and output protocol, USB C pd3.0 PPS output protocol, and bc1.2 / apple / Samsung mobile phone charging protocol. It integrates the functions of synchronous up / down converter, lithium battery charging management, battery power indication, etc. to provide a complete power solution for fast charging mobile power bank. Two USB A ports, one USB B port and one USB C port can be connected at the same time, any single USB port can support fast charging. When two or more output ports are used at the same time, only 5V is supported.

Only one inductor is needed to realize the function of buck and boost, and only a few peripheral devices are needed in the application, which effectively reduces the size of the overall PCB and reduces the cost of BOM.

The synchronous switch boost system of IP5358 can provide the maximum output capacity of 18W, which can maintain the efficiency of more than 90% even when the battery voltage is low.

IP5358 charger provides charging current up to 5.0A. Built in IC temperature, battery temperature and input voltage control loop, intelligent regulation of charging current.

IP5358 integrates a 14bit ADC, which can accurately measure battery voltage and current. The algorithm of remaining battery capacity of IP5358 can accurately obtain battery level information. The battery level curve can be customized to accurately display the remaining battery capacity.

IP5358 supports 1 / 2 / 4 LED battery level indicator,

and 88/188 digital tube battery level indicator. IP5358 supports lighting function and supports buttons.

Applications

- Power Bank, Portable Charger
- Smart Phones, Tablets and Portable devices

Typical Application

A. If there is both USB-B and LIGHTNING ports in the application:
1. USB-B and LIGHTNING do not plug in at the same time. It can be make restrictions on the mold. At the same time, Omitting D7/D8;
2. If there is a case of simultaneous insertion, D12/D13 not to be omitted;

B. If there is only USB-B or LIGHTNING ports in the application:
Omitting D7/D8;

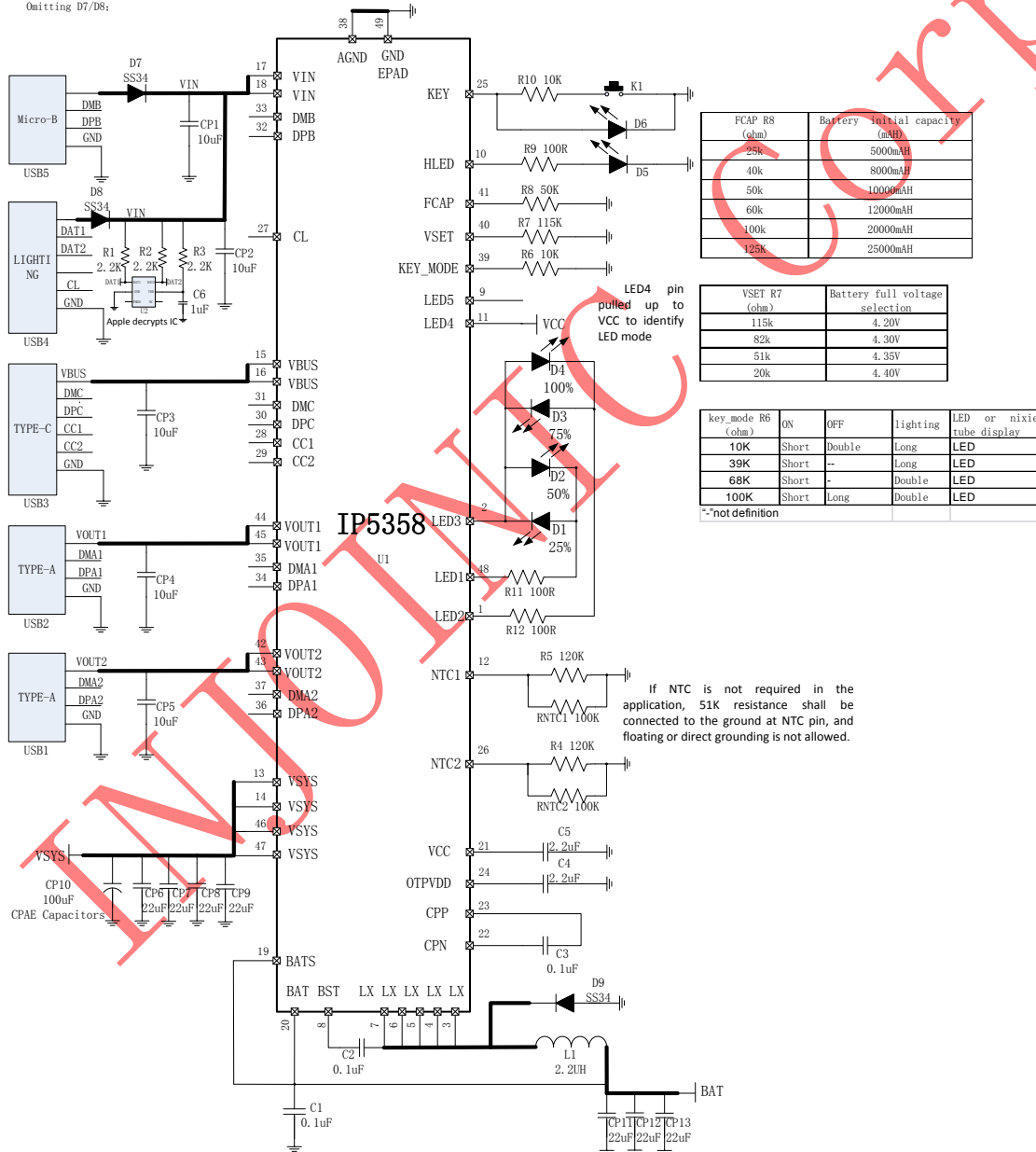


Figure 1 Simplified Application Diagram

1. Pin Definition

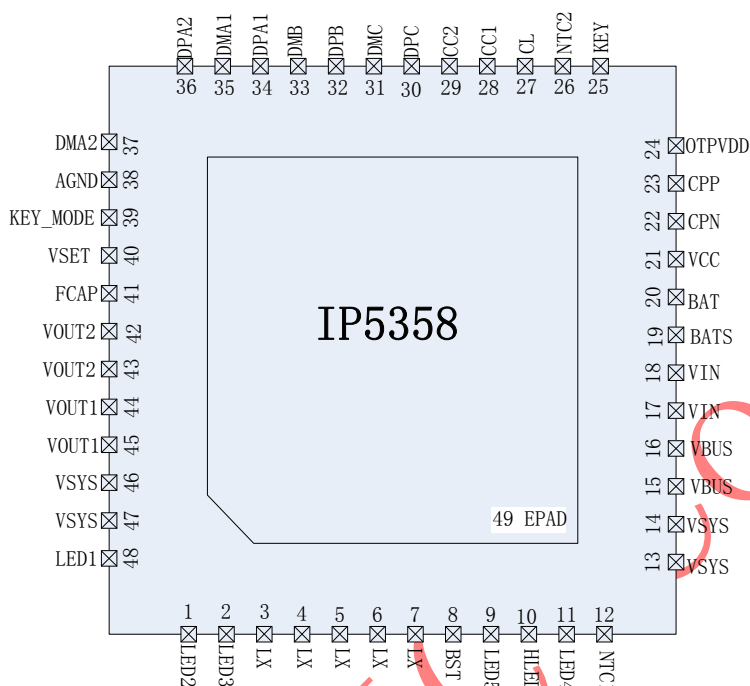


Figure 2 IP5358 Pin Assignments

Pin Num	Pin Name	PIN 定义说明
1	LED2	Battery level display drive pin LED2
2	LED3	Battery level display drive pin LED3
3、4、5、6、7	LX	DCDC switch node, connect to inductor
8	BST	Internal high voltage drive, serial capacitor to LX
9	LED5	Battery level display drive pin LED5
10	HLED	Fast charge status indicator drive pin
11	LED4	Battery level display drive pin LED4
12	NTC1	NTC1 PIN
13、14、46、47	VSYS	Public Node of system power input and output
15、16	VBUS	USB typec port power pin
17、18	VIN	microUSB power pin
19	BATS	Battery voltage sense pin
20	BAT	Battery supply pin
21	VCC	3.1V Voltage output pin

22	CPN	Internal chargepump flying capacitor connection pin
23	CPP	Internal chargepump flying capacitor connection pin, Connect 0.1uF capacitor between CPP and CPN
24	OTPVDD	Internal chargepump output pin, connect 2.2uF capacitor to GND
25	KEY	Key detect pin, reused as WLED torch light function.
26	NTC2	NTC2 PIN
27	CL	CC signal of lightning input port, connecting the 8th pin of Apple lightning input port
28	CC1	USB typec cc1 pin
29	CC2	USB typec cc2 pin
30	DPC	USB typec port DP pin
31	DMC	USB typec port DM pin
32	DPB	MICRO USB port DP pin
33	DMB	MICRO USB port DM pin
34	DPA1	VOUT1 port DP pin
35	DMA1	VOUT1 port DM pin
36	DPA2	VOUT2 port DM pin
37	DMA2	VOUT2 port DP pin
38	AGND	Analog ground
39	KEY_MODE	Key function definition pin, connecting different resistances, different key function definitions can be selected. Used as IO driver when making digital tube scheme
40	VSET	Battery voltage selection, different resistance connection, different charging battery voltage can be selected
41	FCAP	Battery capacity selection, different resistance connection, different battery capacity can be selected
42\43	VOUT2	VOUT2 output port power pin
44\45	VOUT1	VOUT1 output port power pin
48	LED1	Battery level display drive pin LED1
49(EPAD)	GND	GROUND

2. IP Series Products List

Power Bank IC

IC Part No.	boost/charge		Main feature								Package	
	boost	charge	LED number	light	key	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	
IP5312	15W	3.6A	2,3,4,5	✓	✓	✓	✓	—	—	—	QFN32	
IP5318Q	18W	4.0A	2,3,4,5	✓	✓	✓	✓	—	✓	—	QFN40	PIN2 PIN
IP5318	18W	4.0A	2,3,4,5	✓	✓	✓	✓	✓	✓	—	QFN40	
IP5322	18W	4.0A	1,2,3,4	✓	✓	✓	✓	—	✓	—	QFN32	
IP5328	18W	4.0A	1,2,3,4	✓	✓	✓	✓	✓	✓	—	QFN40	PIN2 PIN
IP5328P	18W	4.0A	1,2,3,4	✓	✓	✓	✓	✓	✓	✓	QFN40	
IP5358	18W	5A	1,2,3,4	✓	✓	✓	✓	✓	✓	✓	QFN48	
IP5568	18W	5A	1,2,3,4	✓	✓	✓	✓	✓	✓	✓	QFN64	

USB Charging Port Control IC

IC Part No.	Channel	Standards Supported											Package
		BC1.2 & APPLE	QC3.0 & QC2.0	FCP	SCP	AFC	SFCP	MTK PE+ 2.0&1.1	USB C	NTC	QC Certificate	PD3.0	
IP2110	1	✓	—	—	—	—	—	—	—	—	—	—	SOT23-5
IP2111	1	✓	—	—	—	—	—	—	—	—	—	—	SOT23-6
IP2112	2	✓	—	—	—	—	—	—	—	—	—	—	SOT23-6
IP2161	1	✓	✓	✓	—	✓	✓	—	—	—	✓	—	SOT23-6
IP2163	1	✓	✓	✓	—	✓	✓	✓	—	✓	✓	—	SOP8
IP2701	1	✓	✓	✓	—	✓	✓	—	✓	—	—	—	SOP8
IP2703	1	✓	✓	✓	—	✓	✓	✓	✓	✓	—	—	DFN10

IP2705	1	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	DFN12
IP2707	2	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	QFN16
IP2716	1	✓	✓	✓	✓	✓	-	1.1	✓	-	✓	✓	QFN32

3. Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input Voltage Range	V_{IN}, V_{BUS}	-0.3 ~ 16	V
Junction Temperature Range	T_J	-40 ~ 150	°C
Storage Temperature Range	T_{stg}	-60 ~ 150	°C
Thermal Resistance (Junction to Ambient)	θ_{JA}	26	°C/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.

4. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}, V_{BUS}	4.5	5/9/12	14	V
Battery Voltage	V_{bat}	3.0	3.7	4.4	V

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

5. Electrical Characteristics

Unless otherwise specified, $T_A=25^{\circ}\text{C}$, $L=2.2\mu\text{H}$

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input voltage	V_{IN} V_{BUS}		4.5	5/9/12	14	V
Input Over Voltage	V_{IN} V_{BUS}		13	14	15	V
Constant Charge Voltage	V_{TRGT}	$R_{VSET} = 115\text{K}$	4.16	4.20	4.24	V
		$R_{VSET} = 82\text{K}$	4.26	4.30	4.34	V
		$R_{VSET} = 51\text{K}$	4.31	4.35	4.39	V
		$R_{VSET} = 20\text{K}$	4.36	4.40	4.44	V

Charge Current	I_{CHRG}	VIN =5V, input current		2.0		A
		VBUS =5V, input current		2.4		A
		VIN or VBUS >=7V, input power		18		W
Trickle Charge Current	I_{TRKL}	VIN=5V, BAT<1.5V	50	100	150	mA
		VIN=5V, 1.5V<=BAT<3.0V	100	250	400	mA
Trickle Charge Stop Voltage	V_{TRKL}		2.9	3	3.1	V
Charge Stop Current	I_{STOP}	VIN=5V, battery current	200	300	400	mA
Recharge Voltage Threshold	V_{RCH}		4.08	4.1	4.13	V
Charge Safety Time	T_{END}		20	24	27	Hour
Boost System						
Battery operation voltage	V_{BAT}		3.0		4.5	V
Battery input current	I_{BAT}	VBAT=3.7V, VOUT=5.1V, fs=325KHz Iout=0mA	3	5		mA
DC output voltage	QC2.0 V_{OUT}	$V_{OUT}=5V@1A$	4.95	5.12	5.25	V
		$V_{OUT}=9V@1A$	8.75	9	9.25	V
		$V_{OUT}=12V@1A$	11.75	12	12.25	V
	QC3.0 V_{OUT} @1A		4.95		12.25	V
	QC3.0 Step			200		mV
Output voltage ripple	ΔV_{OUT}	VBAT=3.7V, VOUT=5.0V, fs=375KHz		100		mV
Boost output current	I_{out}	$V_{OUT}=5V$		3.1		A
		$V_{OUT}=9V$		2.0		A
		$V_{OUT}=12V$		1.5		A
Boost efficiency	η_{out}	$V_{BAT}=3V, V_{OUT}=5V, I_{OUT}=2A$		93		%
		$V_{BAT}=3V, V_{OUT}=9V, I_{OUT}=2A$		91		%
		$V_{BAT}=3V, V_{OUT}=12V, I_{OUT}=1.5A$		90		%
Boost overcurrent shut down threshold	I_{shut}	VBAT=3.7V, Vout=5V	3.5	3.8	4.2	A
Load overcurrent	T_{UVD}	Duration of output voltage under 4.2V,		30		ms

detect time		output voltage setting $\geq 5V$				
Load short circuit detect time	T_{OCD}	Duration of output current above 4.4A, output voltage setting $\geq 5V$	150		200	us
Control System						
Switch frequency	fs	Discharge switch frequency	300	325	350	KHz
		Charge switch frequency	450	500	550	KHz
NMOS on resistance	$r_{DS(on)}$	Upper NMOS		9	11	mΩ
NMOS on resistance		Lower NMOS		9	11	mΩ
VCC output voltage	V_{CC}	VBAT=3.7V	2.95	3.1	3.25	V
Battery port standby current	I_{STB}	VIN=0V, VBAT=3.7V, average current		80		uA
VCC output current	I_{LDO}	VBAT=3.7V	40	50	60	mA
LED light driving current	I_{WLED}		10	15	20	mA
LED display driving current	I_{LED1} I_{LED2} I_{LED3}	Voltage decrease 10%	5	7	9	mA
Total load Light load shut down detect time	T_{1load}	boost output power continued less than 300mW	25	32	44	s
Output port light load shut down detect time	T_{2load}	Between VSN and VOUT1(VOUT2 and VBUS) continued less than 1.8mV	14	16	18	s
Short press on key wake up time	$T_{OnDebounce}$		60		500	ms
Time of WLED turn on	$T_{Keylight}$	Long press key time	1.2	2	3	s
Thermal shut down temperature	T_{OTP}	Rising temperature	130	140	150	°C
Thermal shut down hysteresis	ΔT_{OTP}			40		°C

6. Function Description

Low power lock out and activation

The first time IP5358 access to the battery, whatever the battery voltage, IC is in lock out state, battery level indicator LED will flash four times, or the digit 0 of the nixie tube flashes 4 times for prompt; Under non-charging state, if the battery voltage is too low to trigger the low power shutdown, IP5358 will enter lock out state too.

In low battery state, to decrease the quiescent power, IP5358 do not support plug in detect function or key press activation function. During which, key press action will not trigger boost output, and battery level indicator LED will flash four times

Under the lock out state, only by entering charging status can activate IP5358 's full function.

Charge

IP5358 integrated a constant current and constant voltage Li battery charging management system with synchronous switch, adaptive to various charging voltage.

When the battery voltage is lower than 3V, trickle charging less than 250mA charging current is applied; when the battery voltage is higher than 3V, enters constant current charging stage, the maximum charging current at battery port is 5.0A; when the battery voltage is near the preset battery voltage, enters constant voltage charging stage; when the charging current is less than 300mA and battery voltage is near the constant voltage charging stage, the charging process is stopped. When the charging stage is accomplished, once the battery voltage falls under 4.1V, battery charging stage will be restarted.

IP5358 adopted switch charging technology, switch frequency is 500kHz. During 5V input voltage, maximum input power is 10W; During the fast charging state, maximum input power is 18W. The highest charging current is up to 5.0A, charging efficiency can be up to 94%, such can reduce 3/4 charging time.

IP5358 will adjust charge current automatically applicable to adaptors with different load capacity.

IP5358 supports charging the battery and phone at the same time, output voltage is 5v.

Boost

IP5358 Integrated a synchronized switch converter which supports high voltage output, providing 5V~12V output voltage output, load capacity can be: 5V/3.1A, 7v-2.4A, 9V/2.0A and 12V/1.5A. 325KHz switching frequency. Internal soft start function. In avoid of large rush current causing device failure at start up stage, built-in overcurrent, short circuit, overvoltage and over temperature protection function, make insurance of the stability and reliability of power system.

Boost system output current can be auto-modulated according to the temperature, ensuring the IC is under the preset temperature.

USB C

IP5358 integrated USB C DRP port, auto-switching the internal pull-up and pull-down circuit on CC1 and CC2 by distinguishing the role of the attached device. Support Try.SRC function, when the attached device is also DRP device, IP5358 will supply power for the opposite device.

When worked as DFP, the output current can be set as three levels; when worked as UFP, the current capability from the opposite device can be detected.

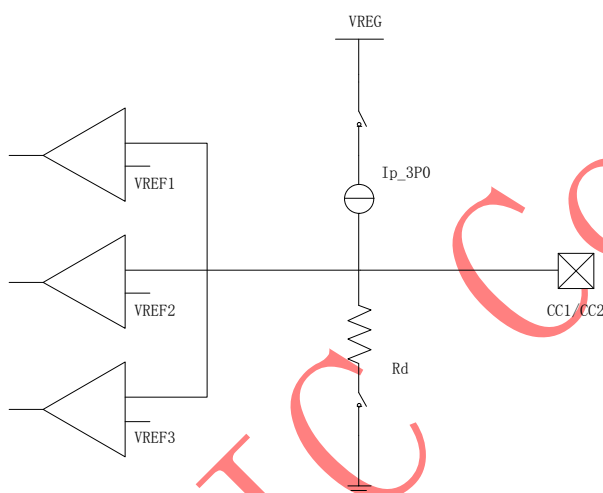


Figure 3 CC internal circuit

Pull-up and pull-down ability:

Name	Value
Ip_3P0	330uA
Rd	5.1K

Comparator Threshold of pull-up Ip:

Table 4-23 CC Voltages on Source Side – 3.0 A @ 5 V

	Minimum Voltage	Maximum Voltage	Threshold
Powered cable/adaptor (vRa)	0.00 V	0.75 V	0.80 V
Sink (vRd)	0.85 V	2.45 V	2.60 V
No connect (vOPEN)	2.75 V		

Comparator Threshold of Pull-down Resistor Rd:

Table 4-25 Voltage on Sink CC pins (Multiple Source Current Advertisements)

Detection	Min voltage	Max voltage	Threshold
vRa	-0.25 V	0.15 V	0.2 V
vRd-Connect	0.25 V	2.04 V	
vRd-USB	0.25 V	0.61 V	0.66 V
vRd-1.5	0.70 V	1.16 V	1.23 V
vRd-3.0	1.31 V	2.04 V	

USB C detects cycle:

Figure 4-36 DRP Timing

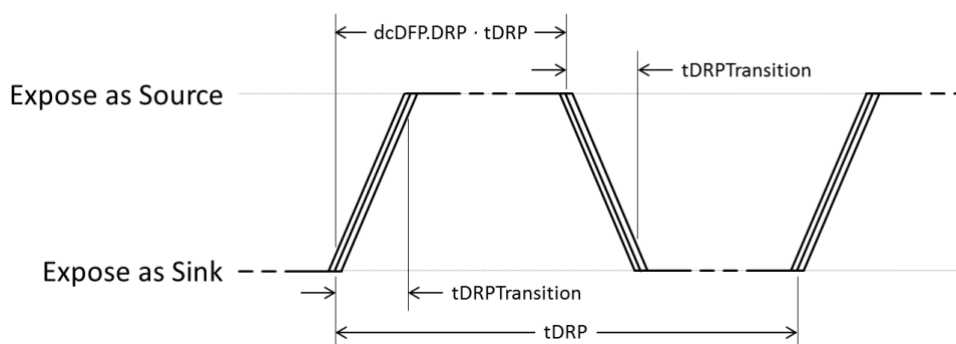
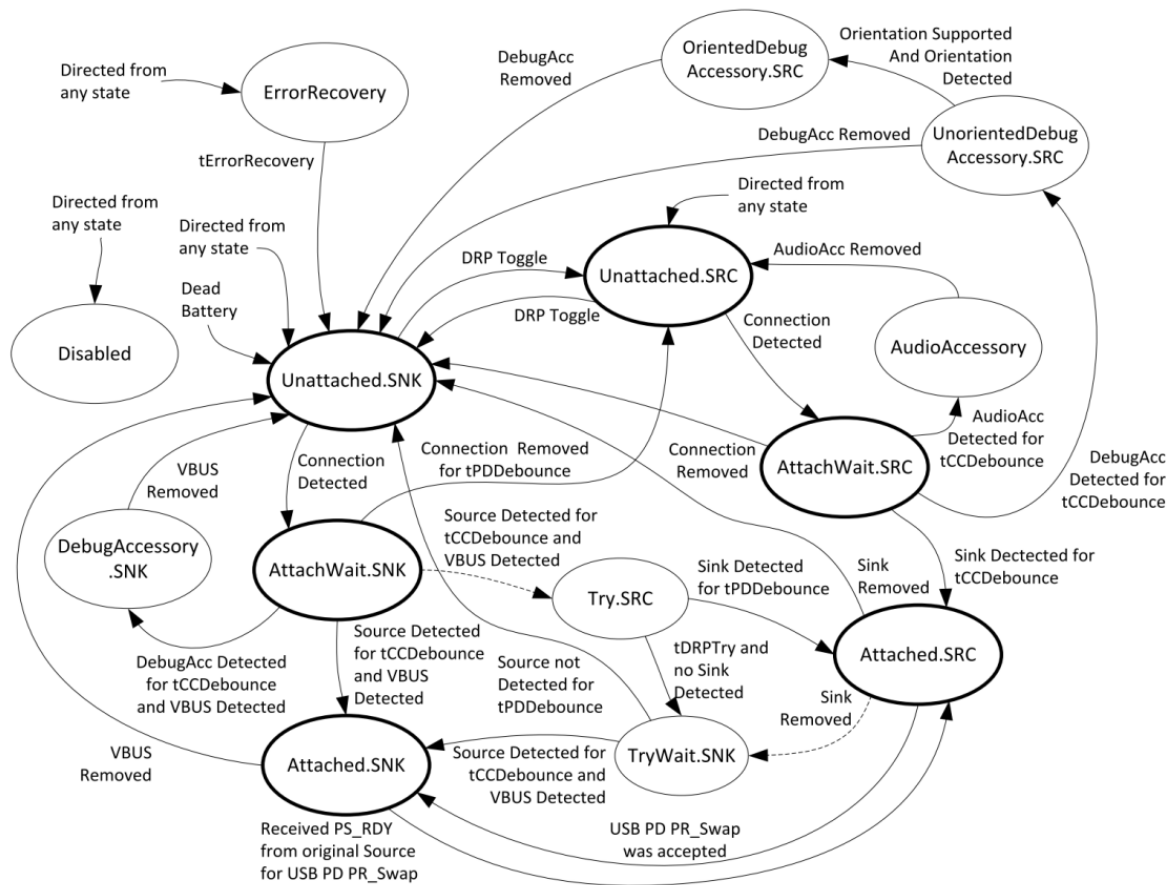


Table 4-21 DRP Timing Parameters

	Minimum	Maximum	Description
tDRP	50 ms	100 ms	The period a DRP shall complete a Source to Sink and back advertisement
dcSRC.DRP	30%	70%	The percent of time that a DRP shall advertise Source during tDRP
tDRPTransition	0 ms	1 ms	The time a DRP shall complete transitions between Source and Sink roles during role resolution
tDRPTry	75 ms	150 ms	Wait time associated with the Try.SRC state.
tDRPTryWait	400 ms	800 ms	Wait time associated with the Try.SNK state.

USB C detects state transition:

Figure 4-16 Connection State Diagram: DRP with Accessory and Try.SRC Support



USB C PD

IP5358 integrated USB C Power Delivery PD2.0/PD3.0/PPS (Programmable Power Supply) protocol, integrate physical (PHY) layer for data transmitting/receiving across the cc wire, hardware biphas mark coding (BMC) module and hardware CRC protect the data integrity.

Support PD2.0/PD3.0 bi-directional input/output and PPS output protocol. Input and output voltage support 5V/9V/12V. Output source cap: 5V/2.4A, 9V/2.0A, 12V/1.5A .PPS 3.3~5.9V/3A , 5~11V/1.5A output voltage adjustable with 20mV/step. Support up to 18W power level.

Fast Charge Protocol

IP5358 support multi fast charge protocols: QC2.0/QC3.0, FCP, AFC, SFCP, MTK, Apple, Samsung.

Input QC2.0/QC3.0/MTK protocol is not support for charging the power bank. External fast charging protocol IC is not supported.

Input fast charge protocol of FCP, AFC, SFCP are supported for charging the power bank.

If the power bank is to charge for the phone, when IP5328P enter discharge mode, it will detect the fast charge type and request on DP, DM, which support fast charge for devices of QC2.0/QC3.0, FCP, AFC, SFCP, MTK, and Apple 2.4A mode, Samsung 2.0A mode and BC1.2 1.0A mode.

For Apple 2.4A mode: DP=DM=2.7V

For Samsung 2.0A mode: DP=DM=1.2V

For BC1.2 1.0A mode: DP short to DM

Under BC1.2 mode, when the DP voltage is detected in the range of 2V~0.325V for 1.25s, fast charge will be initially determined, then the short status between DP and DM will be disconnected, and DM pull-down 20kOhm to GND at the same time. After which, if in the following 2ms the DP voltage is in range of 2V~0.325V and DM lower than 0.325V, fast charge handshake is accomplished successfully. Then QC2.0/QC3.0 device can request for desired voltage according to the QC standards. Any time DP lower than 0.325V will force to exit the fast charge mode, the output voltage will fall back to default 5V.

QC2.0/QC3.0 output voltage request rule:

DP	DM	Result
0.6V	GND	5V
3.3V	0.6V	9V
0.6V	0.6V	12V
0.6V	3.3V	Continuous Mode
3.3V	3.3V	sustain

Continuous mode is supported by QC3.0, voltage can be adjusted by 0.2V/step according to QC3.0 request under the continues mode.

Fast charging protocol supported by each port of IP5358

protocols	VOUT1 output	VOUT2 output	Micro USB input	Typec output	TypeC input
QC2.0	✓	✓	-	✓	-
QC3.0	✓	✓	-	✓	-
AFC	✓	✓	✓	✓	✓
FCP	✓	✓	✓	✓	✓
SFCP	✓	✓	✓	✓	✓
SCP	✓	-	-	-	-
VOOC	✓	-	-	-	-
MTK PE1.0	✓	✓	-	✓	-
MTK PE2.0	✓	✓	-	✓	-
PD2.0	-	-	-	✓	✓
PD3.0	-	-	-	✓	✓
PPS	-	-	-	✓	-

supported: ✓

not supported: -

Charge and Discharge Path Management

Standby:

If VIN or VBUS is attached , IP5358 will start the charging process directly.

If USB C UFP device is attached on VBUS or sink device is attached on VOUT port, IP5358 will start discharge function automatically.

If key is pressed, the VOUT1、VOUT2 and USB C port will open only when load is detected on the according port, or the output on these port will be closed.

Discharge:

In the case of no key action, only the output path of the output port plugged in the electrical equipment will be opened; the output path of the output port not connected to the equipment will not be opened. When the output current of the opened output port is less than about 80mA, it will automatically close after a period of time.

Any port of Vout1, vout2 and USB C can support the output fast charging protocol. However, since this application is a single inductance application, it can only support one voltage output, so it can only support the fast charging output when only one output port is open. When two or three outlets are used at the same time, the quick charge function will be automatically turned off.

According to the connection shown in the "typical application diagram", when any output port has entered the fast charging output mode, when the other output port is plugged in with electrical equipment, all the output ports will be closed first, the high-voltage fast charging function will be closed, and then the output ports with equipment will be opened. In this case, all the output ports only support the charging of apple, Samsung and bc1.2 modes. When the number of electrical equipment is reduced to only one, after 16 seconds, all output ports will be closed first, the high-voltage fast charging function will be turned on, and then the output port of the last electrical equipment will be turned on, so as to reactivate the equipment to request fast charging. When only one output port is open and the total output current is less than about 80mA for about 32S, the output port and discharge function will be closed and the standby mode will be entered.

Charging:

Any port of VIN port and VBUS port can be charged by inserting the power supply. If both ports are connected to the power supply for charging, the first inserted power supply will be used for charging.

In the single charging mode, the fast charging mode of the power supply will be automatically identified, and the appropriate charging voltage and current will be automatically matched

Charging and discharging at the Same Time:

When the charging power supply and the electrical equipment are plugged in at the same time, the charging and discharging mode will be automatically entered. In this mode, the chip will automatically turn off the internal fast charge input request. When the vsys voltage is only 5V, turn on the discharge path to supply power to the electrical equipment; if the vsys voltage is greater than 6.0v, for safety reasons, the discharge path will not be turned on. In order to ensure the normal charging of electrical equipment, IP5358 will increase the charging undervoltage loop to more than 4.9v to ensure the priority of power supply to electrical equipment.

In the process of charging and discharging, if the charging power is unplugged, IP5358 will turn off the charging function and restart the discharging function to supply power to the electric equipment. For the sake of safety, and in order to be able to reactivate the mobile phone to request fast charging, the voltage will drop to 0V for a period of time during the conversion process.

In the process of charging and discharging, if the electric equipment is unplugged, or the electric equipment is full and stops pumping for 16s, the corresponding discharge path will be automatically closed. When the discharge paths are closed and the state returns to single charging mode, the charging undervoltage loop will be reduced, and the fast charging will be automatically reactivated to accelerate the charging of mobile power supply.

Automatic detection of mobile phone

Auto detection on sink device/phone attachment:

IP5358 support auto detection on sink device/phone attachment/ plug in, once the attachment is detected, the boost will be turned on charging the sink device/phone, so non-key solution are supported.

Auto detection on sink device/phone fully charged:

IP5358 measures the output current of each port through the on-chip ADC. When the output current of a single port is less than about 80mA and lasts for about 16s, the output port will be closed. When the total current is less than about 80mA for about 32S, it is considered that all output cell phones are full or unplugged, and the boost output will be automatically turned off.

KEY\Key_mode selection\LED and nixie tube selection

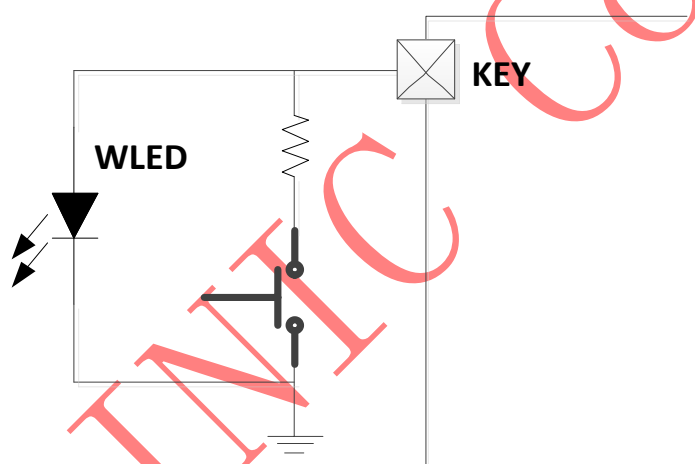
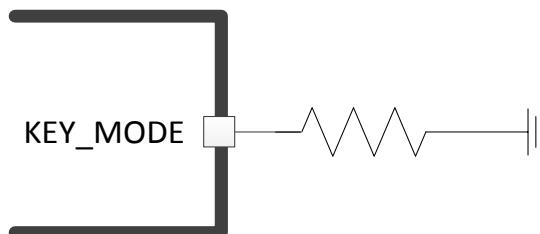


Figure 4 KEY circuit

Key circuit is illustrated in Figure 4, which can recognize short press or long press operation.

- Short press : pressed time in range of 60ms~2s
- Long press :pressed time longer than 2s
- No response on press time less than 30ms
- Long 10s press will reset the whole system



IP5358 outputs 20uA current on the key mode pin, and different resistance is connected externally to get different voltage. Different key definition can be selected for IC internal detection of key mode voltage(LED4 pin pulled up to VCC to identify LED mode). Pay attention to 1% precision resistance for external resistance, Resistance selection needs to take into account the V_{KEY_MODE} voltage as far as possible in the middle of the judgment range.

KEY_MODE external resistance	pin	Key_mode ideal voltage (v)	KEY_MODE voltage range (v)	KEY function definition
10K		0.2	0.1~0.5	Short press: turn on Double short press in 1s: turn off Long press: turn on or turn off the lighting
39K		0.78	0.5~1.1	Short press: turn on Double short press in 1s: no definition Long press: turn on or turn off the lighting
68K		1.36	1.1~1.7	Short press: turn on Double short press in 1s: turn on or turn off the lighting Long press: no definition
100K		2.0	1.7~2.4	Short press: turn on Double short press in 1s: turn on or turn off the lighting Long press: turn off

key_mode R6 (ohm)	ON	OFF	lighting
10K	Short	Double	Long
39K	Short	--	Long
68K	Short	-	Double
100K	Short	Long	Double
“-”not definition			

Fast Charge state indication

HLED is used for indication for the present fast charge mode, either in fast charging or discharging mode, when the system enters fast charge mode and in non-5V mode, the light LED will turn on.

It can be used as the 6pin driver for the 6pin nixie tube application. When 6pin nixie tube is selected, there is no fast charge light LED display.

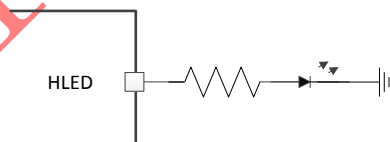


Figure 5 fast charge state indication

Coulombmeter and battery level display

IP5358 has built-in coulombmeter function, which can realize accurate calculation of the remaining battery capacity.

External PIN chooses nixie tube or LED for battery level indicator(KEY function definition)

IP5358 supports 4 LED, 2 LED and 1 LED mode automatic selection.

IP5358 supports 88/188 nixie tube to display the remaining battery capacity .

Battery level display for LED mode

IP5358 4LED、2LED、1LED battery level display

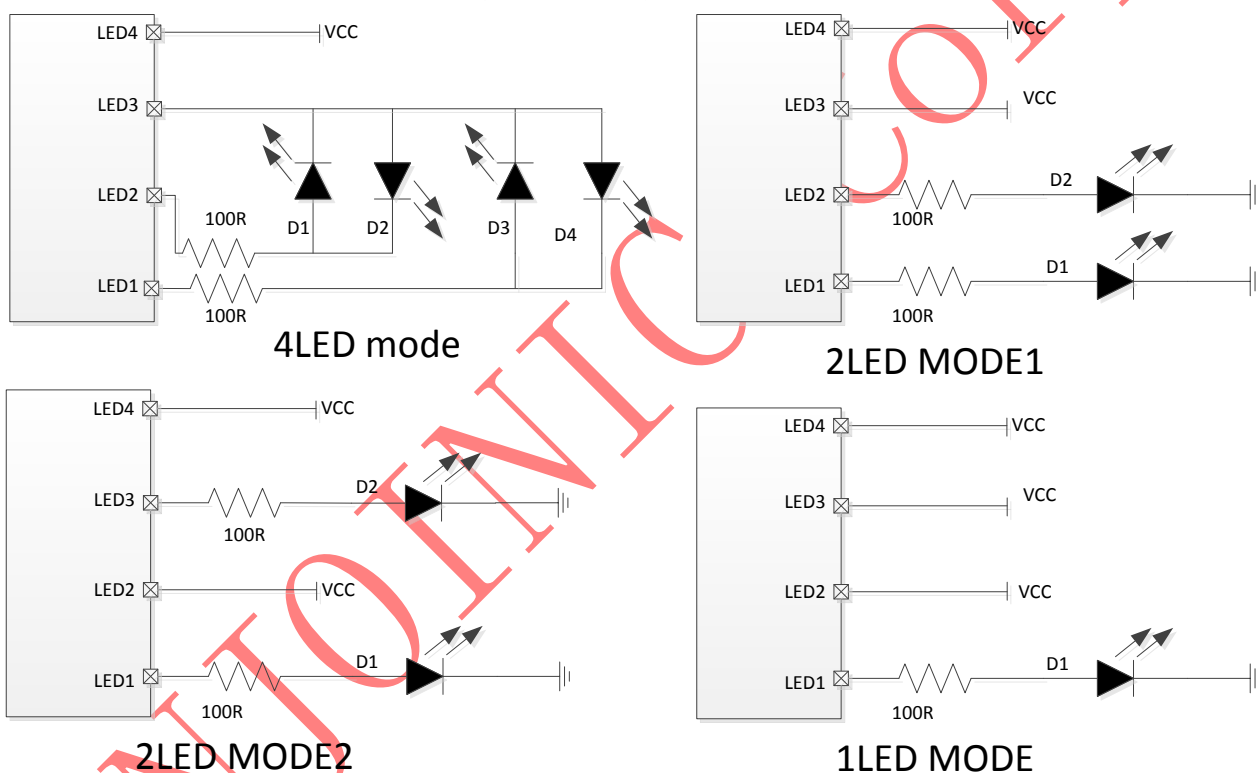


Figure 6 4LED、2LED、1LED circuits

4LED display mode:

During charging

Battery capacity (C) (%)	D1	D2	D3	D4
Fully charged	ON	ON	ON	ON
$75\% \leq C$	ON	ON	ON	1.5Hz Flash
$50\% \leq C < 75\%$	ON	ON	1.5Hz Flash	OFF
$25\% \leq C < 50\%$	ON	1.5Hz Flash	OFF	OFF

$C < 25\%$	1.5Hz Flash	OFF	OFF	OFF
------------	-------------	-----	-----	-----

During discharging

Battery capacity (C) (%)	D1	D2	D3	D4
$C \geq 75\%$	ON	ON	ON	ON
$50\% \leq C < 75\%$	ON	ON	ON	OFF
$25\% \leq C < 50\%$	ON	ON	OFF	OFF
$3\% \leq C < 25\%$	ON	OFF	OFF	OFF
$0\% < C < 3\%$	1.0Hz Flash	OFF	OFF	OFF
$C = 0\%$	OFF	OFF	OFF	OFF

2 LED display mode 1 is bi-color LED:

During charging:

Battery capacity (C) (%)	D1	D2
Fully charged	OFF	ON
$66\% \leq C < 100\%$	OFF	1.5Hz Flash
$33\% \leq C < 66\%$	1.5Hz Flash	1.5Hz Flash
$C < 33\%$	1.5Hz Flash	OFF

During discharging:

Battery capacity (C) (%)	D1	D2
$66\% \leq C < 100\%$	OFF	ON
$33\% \leq C < 66\%$	ON	ON
$C < 33\%$	ON	OFF
$C < 3\%$	1.0Hz Flash	OFF

2 LED mode 2 display:

During charging: D1 LED flash on cycle of 2s (1s on and 1s off), when fully charged, constantly on;

During discharging: D2 LED is constantly on, when voltage lower than 3.2V, flash on cycle of 1s (0.5s on and 0.5s off), when voltage is lower than 3.0V, system is power down.

1 LED mode 1 display:

During charging: LED flash on cycle of 2s (1s on and 1s off), when fully charged, constantly on;

During discharging: LED is constantly on, when voltage lower than 3.2V, flash on cycle of 1s (0.5s on and 0.5s off), when voltage is lower than 3.0V, system is power down.

188 nixie tube display mode

The 188 nixie tube model IP5358 supported as below

Nixie Tube	During charging		During discharging	
	Not fully charged	Fully charged	Battery capacity <5%	Battery capacity >5%
188 (YF2252SR-5)	0-99% 0.5HZ Flash	constantly on 100%	0-5% 1.0Hz Flash	5%-100% constantly on

5pin 188 nixie tube:

(未注尺寸公差 Unspecified Tolerances is: ± 0.2)

发光颜色: 红色

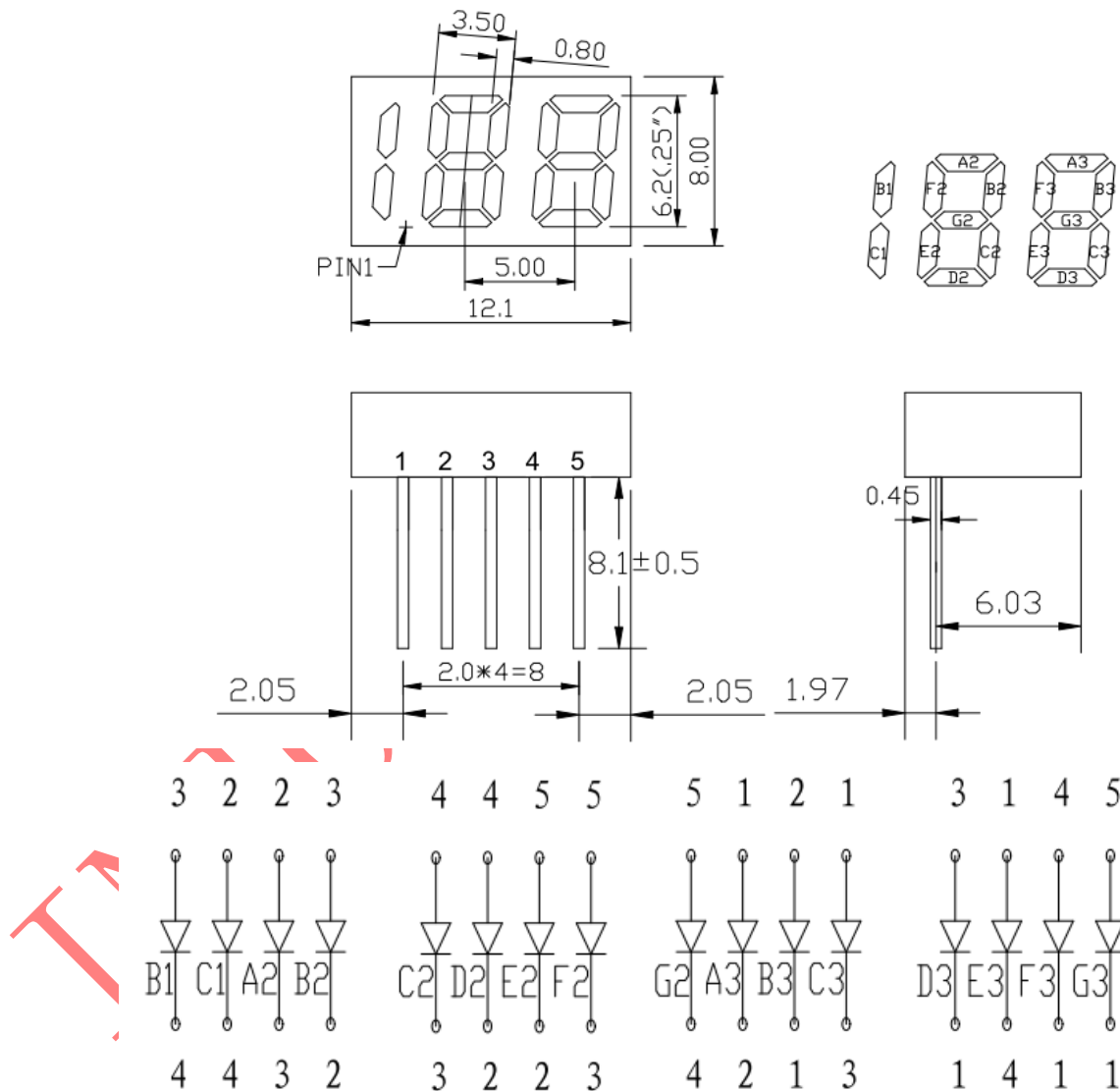


Figure 7 5pin 188 nixie tube circuit

	IP5358 display driver pin	nixie tube pin	备注
The sequence mapping	LED1 (48 pin)	1 pin	

relationship between IP5358 display driver pin and nixie tube pin	LED2(1 pin)	2 pin	
	LED3(2 pin)	3 pin	
	LED4(11 pin)	4 pin	
	LED5(9 pin)	5 pin	
	HLED(10 pin)	6 pin	choosable, 6 pin nixie tube

Coulombmeter

IP5358 supports the external resistor setting of the initial capacity of the battery, and uses the integration of the current and time at the port of the battery to manage the remaining capacity of the battery, which can accurately display the current remaining capacity of the battery. IP5358 supports the automatic calibration of the total capacity of the current battery in a complete charging process from 0% to 100%, and more reasonable management of the actual capacity of the battery.

IP5358 external pin sets the initial cell capacity formula: battery capacity = $R8 * 0.2$ (mAH). Up to 25000mah.

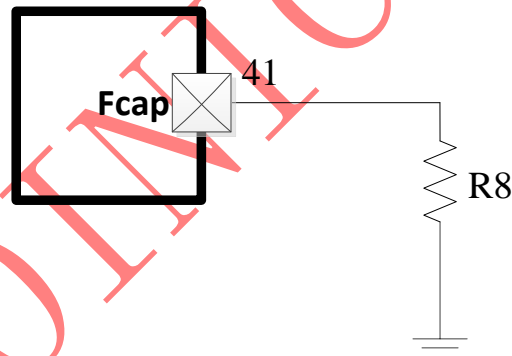


Figure 8 battery initial capacity circuit

Typical battery capacity config table

R8 resistance (ohm)	battery initial capacity (mAH)
25k	5000mAH
40k	8000mAH
50k	10000mAH
60k	12000mAH
100k	20000mAH
125K	25000mAH

VSET (Battery full voltage selection)

IP5358 sets the battery type by outputting 20uA current on Vset pin and connecting different resistance to

GND, so as to change the threshold value of battery level display, the constant voltage to charge the battery and the protection voltage. The resistance of Vset external to GND and the set battery type are shown in the table below. Pay attention to 1% precision resistance for external resistance, Resistance selection needs to take into account the V_{Vset} voltage as far as possible in the middle of the judgment range.

VSET pin external resistance to GND(ohm)	VSET PIN voltage	VSET voltage judgement range	Battery full voltage selection
115k	2.30v	>2.1v	4.20V
82k	1.64v	1.3v~2.1v	4.30V
51k	1.02v	0.6v~1.3v	4.35V
20k	0.40v	0~0.6v	4.40V

VSET also reserves a special function. If VSET resistance = 1K, battery full voltage is 4.2V by default, and DPA2 pin is used as serial port print port output.

NTC function

IP5358 integrates NTC function, which can detect battery temperature and PCB temperature. IP5358 has two NTCs, NTC1 detects battery temperature and NTC2 detects PCB temperature. When IP5358 is working, NTC1 and NTC2 pin output 20uA current, and generate voltage through external NTC resistance. IC internal detects the voltage of NTC1 and NTC2 pin to determine the current battery temperature and PCB temperature.

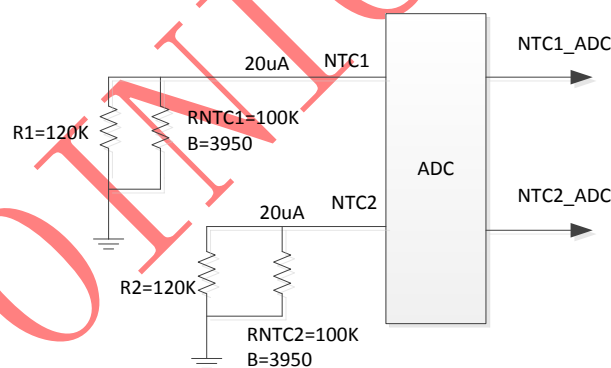


Figure 9 NTC circuit

In the state of charge:

When NTC1 pin detects that the voltage is 1.96v, it represents low temperature of battery - 10 °C; when NTC1 voltage is higher than 1.96v, it stops charging; when NTC1 voltage is lower than 1.85v, it resumes charging.

When NTC1 pin detects that the voltage is 0.64v, it means the battery temperature is 45 degrees; when NTC1 voltage is lower than 0.64v, the charging current is reduced by half; when NTC1 voltage is higher than 0.7V, the charging current is restored to normal value.

When NTC1 pin detects that the voltage is 0.47v, it represents the battery temperature of 55 °C; when NTC1 voltage is lower than 0.47v, it stops charging; when NTC1 voltage is higher than 0.7V, it restores the charging current to normal value

In the state of discharge:

When NTC1 pin detects that the voltage is 2.13v, it represents low temperature of battery - 20 °C; when NTC1 voltage is higher than 2.13v, it stops discharging; when NTC1 voltage is lower than 2.04v, it resumes discharging.

When NTC1 pin detects that the voltage is 0.47V, it represents the battery high temperature of 55 °C; when NTC1 voltage is lower than 0.47V, it stops discharging; when NTC1 voltage is higher than 0.55V, it resumes discharging.

NTC2 pin is used to detect the temperature of PCB. When NTC2 pin detects that the voltage is 0.35V, it means that the PCB temperature exceeds 65 degrees, and Charging and discharging currents will gradually decrease. When NTC2 voltage is lower than 0.35V, Charging and discharging currents will gradually decrease. When NTC2 voltage is higher than 0.41V, recover charging and discharging currents.

*The above temperature range refers to NTC resistance z104fbxv050 (B = 3950). Other models have differences and need to be adjusted.

If NTC is not required in the application, 51K resistance shall be connected to the ground at NTC pin, and floating or direct grounding is not allowed.

VCC

VCC is a normally open 3.1V LDO with a load capacity of 50mA.

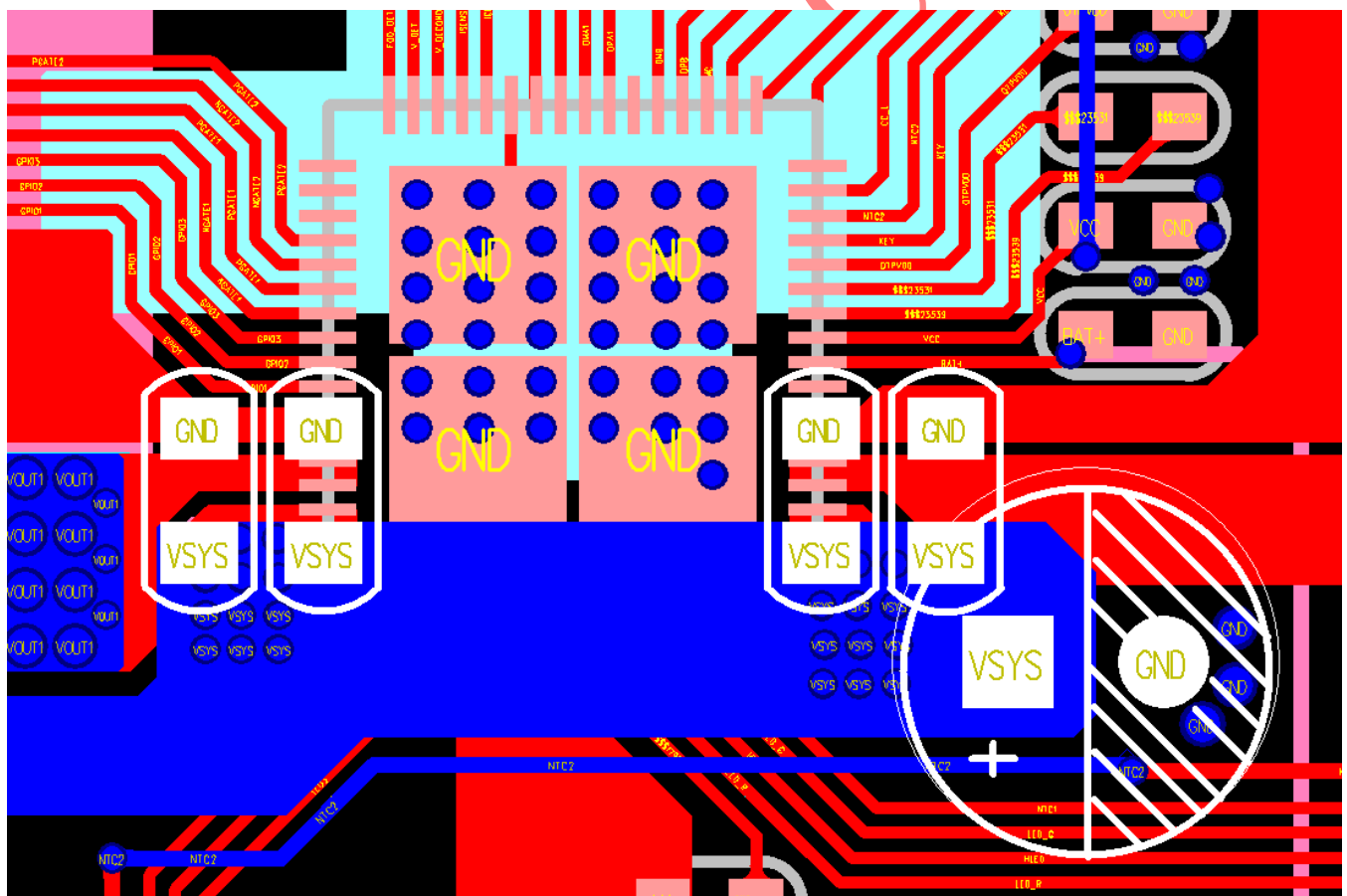
7. PCB Layout

Here below lists essential precautions that may affect the function and performance on PCB layout, more details will be attached in another document if any.

Location of VSYS capacitor

The power and current of the chip are relatively large, and the position of the capacitor on the vsys network will affect the stability of the DCDC. The capacitors on the vsys network need to be as close to the vsys pin and EPAD of the IC as possible, and copper is laid on a large area, and more vias are added to reduce the area of current loop between the capacitors and the IC and reduce parasitic parameters.

Vsys pins are distributed on both sides of the chip, and capacitors need to be placed near the pins on both sides, and the vsys pins on both sides are connected by a wide (no less than 100mil) copper laying on the PCB



8. Typical Application Diagram

Total solution of fast charge power bank is merely realized by passive devices of MOSFET, inductor, capacitor and resistor.

IP5358 LED application

- A. If there is both USB-B and LIGHTNING ports in the application:
 1. USB-B and LIGHTNING do not plug in at the same time. It can make restrictions on the mold. At the same time, Omitting D7/D8;
 2. If there is a case of simultaneous insertion, D7/D8 not to be omitted;
- B. If there is only USB-B or LIGHTNING ports in the application:
 Omitting D7/D8;

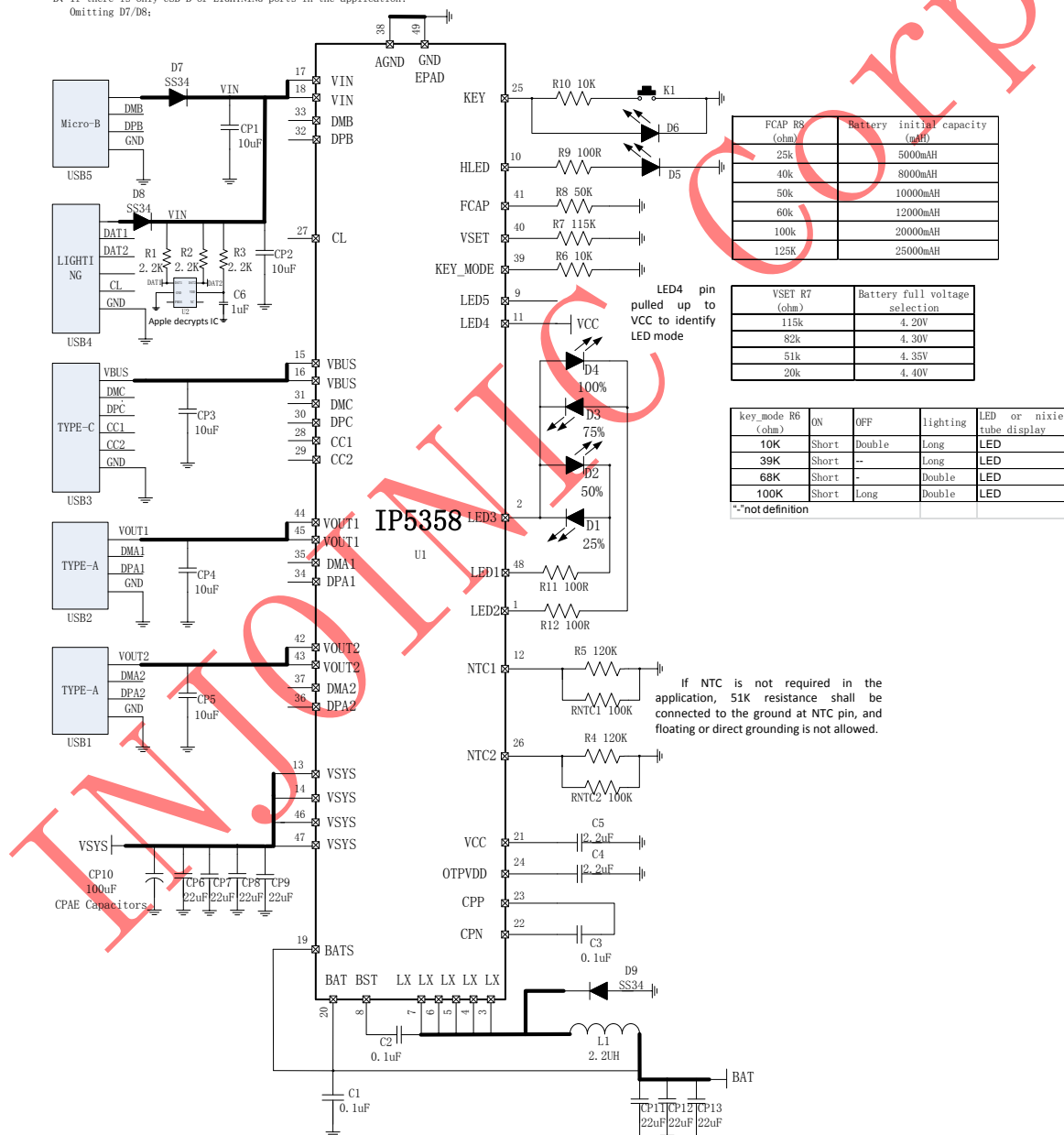


Figure 10 IP5358 LED application circuit

IP5358 188 nixie tube application

A. If there is both USB-B and LIGHTNING ports in the application:

1. USB-B and LIGHTNING do not plug in at the same time. It can be make restrictions on the mold. At the same time, Omitting D7/D8;
2. If there is a case of simultaneous insertion, D7/D8 not to be omitted;

B. If there is only USB-B or LIGHTNING ports in the application:
Omitting D7/D8;

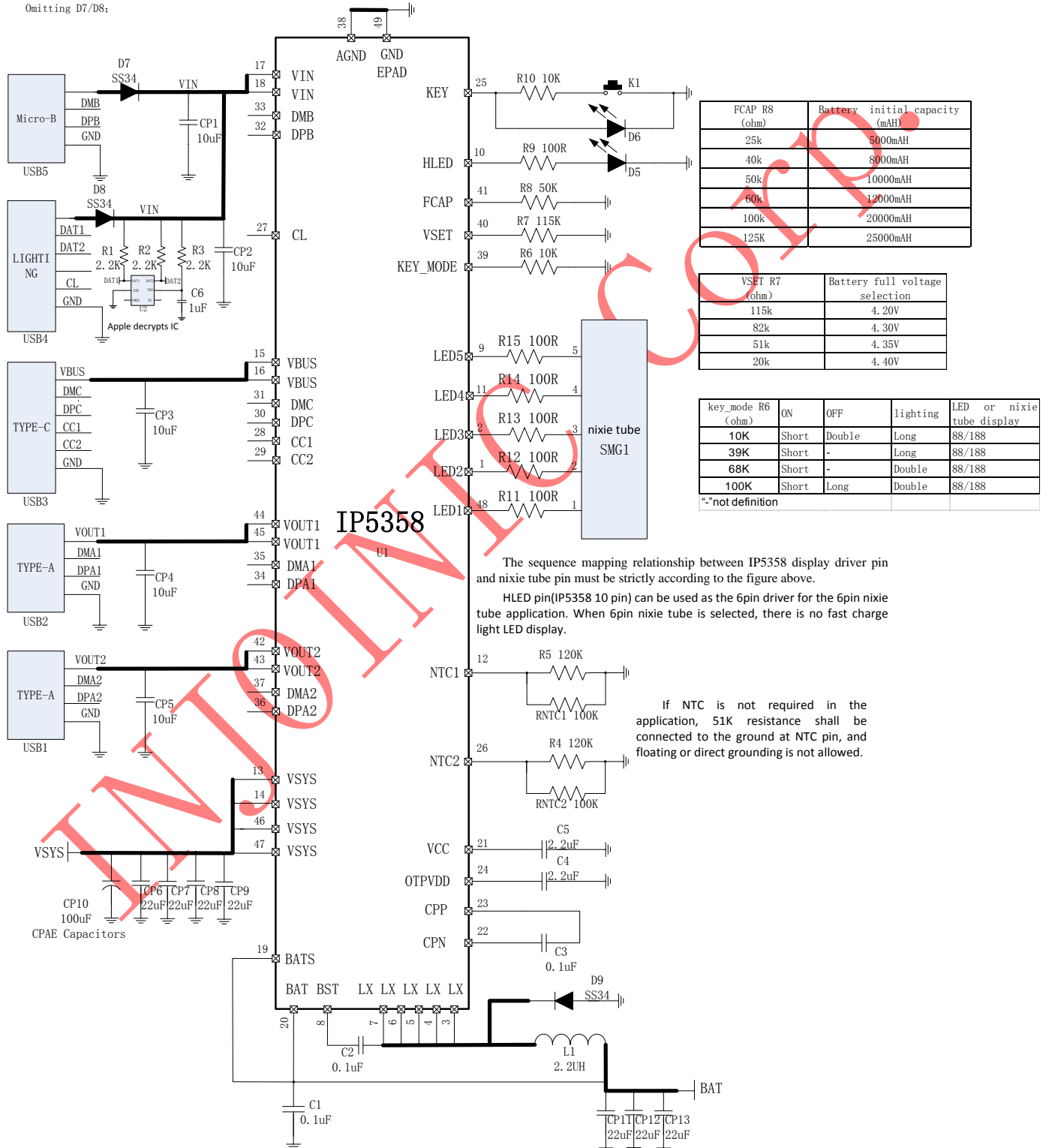


Figure 11 IP5358 nixie tube application circuit

BOM list

No.	Part Name	Type	Location	Num	Note
1	SMT IC	QFN48 IP5358	U1	1	
2	SMT capacitor	0603 100nF 10% 16V	C1	1	
3	SMT capacitor	0603 100nF 10% 25V	C2 C3	2	
4	SMT capacitor	0603 2.2uF 10% 16V	C4 C5	2	
5	SMT capacitor	0805 22uF 10% 16V	CP11 CP12 CP13	3	
6	SMT capacitor	0805 22uF 10% 25V	CP6 CP7 CP8 CP9	4	
7	SMT capacitor	0805 10uF 10% 25V	CP1 CP2 CP3 CP4 CP5	5	
8	CPAE Capacitors	100uF 25V 10%	CP10	1	
9	SMT resistor	0603R 100R 1%	R9	1	
10	SMT resistor	0603R 100R 1%	R11 R12	2	choosable, LED application circuit
11	SMT LED	0603 BLUE	D1 D2 D3 D4	4	
10	SMT resistor	0603R 100R 1%	R11 R12 R13 R14 R15	5	choosable, Nixie tube application circuit
11	SMT Schottky	YF2252SR-5	SMG1	1	
12	SMT Schottky	SS34	D7 D8 D9	3	
13	Apple decrypts IC		U2	1	Apple decrypts IC circuit BOM
14	SMT resistor	0603R 2.2K 1%	R1 R2 R3	3	
15	SMT resistor	0603 1uF 10% 16V	C6	1	
16	SMT resistor	0603R 10K 51%	R6 R10	2	
17	SMT resistor	0603R 50K 1%	R8	1	
18	SMT resistor	0603R 115K 1%	R7	1	
19	SMT resistor	0603R 120K 1%	R4 R5	2	NTC circuit BOM
20	NTC THERMAL RESISTOR	100K@25°C B=4200	RNTC1 RNTC2	2	
21	SMT LED	0603 REG	D5	1	
22	LED	5MM LED	D6	1	
23	inductor	2.2uH 10*10	L1	1	
24	KEY	SMT 3*6	K1	1	
25	output USB	AF10 8 USB	USB1 USB2	2	
26	input usb	MICRO-7-DIP-5.9	USB5	1	
27	USB C CONNECTOR	USB C CONNECTOR	USB3	1	
28	LIGHTNING CONNECTOR	apple lightning connector	USB4	1	

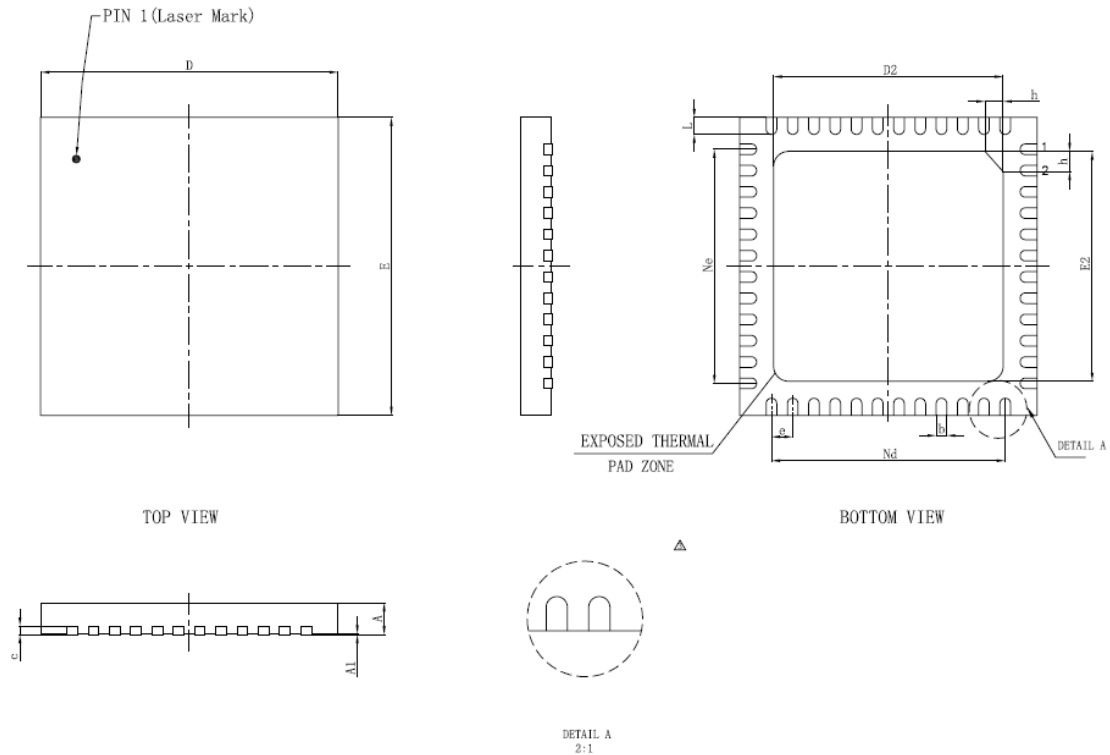
电感推荐型号

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.	

SPM70702R2MESQ	5	2.2	±20%	9	10.2	10.5	13.5	100kHz/1.0V
SPM10102R2MESN	4	2.2	±20%	6	7	12	18	100kHz/1.0V
SHC1004-2R2M	4	2.2	±20%	7	9	12	24	

INJOINIC Corp.

9. Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.18	0.25	0.30
b1	0.11	0.16	0.21
c	0.18	0.20	0.23
D	6.90	7.0	7.10
D2	5.30	5.40	5.50
e	0.5 BSC		
Ne	5.50BSC		
Nd	5.50BSC		
E	6.90	7.0	7.10
E2	5.30	5.40	5.50
L	0.35	0.40	0.45
h	0.30	0.35	0.40

10. Certificate Information

INJOINIC Corp.

11. IMPORTANT NOTICE

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