英集芯科技 INJOINIC TECHNOLOGY

IP5322

Fully-Integrated Fast Charge Power Bank SOC with Multiple Input and Output Ports

Features

- **Support multiple ports simultaneously**
  - ✧ 2 USB A output ports
  - ✧ 1 USB B input port
- **Fast charge**
  - ✧ Every port support fast charge
  - ✧ Support QC2.0/QC3.0 output
    - ➢ QC3.0 Verification：4788056929-2
    - ➢ https://www.qualcomm.com/documents/quick-charge-device-list
  - ✧ Support FCP input/output
  - ✧ Support AFC input/output
  - ✧ Support SFCP input/output
  - ✧ Support MTK PE1.1&2.0 output
  - ✧ Support BC1.2, Apple, Samsung
- **Charger**
  - ✧ Up to 5.0A charging current at battery port
  - ✧ Adaptive charging current adjustment
  - ✧ Support 4.20V, 4.35V, 4.40V, 4.50V batteries
- **Discharger**
  - ✧ Current output capacity:
    5V: 3.1A 9V: 2.0A 12V: 1.5A
  - ✧ Up to 95% @ 5V/2A discharge efficiency of Synchronous switching
  - ✧ Support line compensate
- **Battery level display**
  - ✧ Integrated 14-bit ADC and coulometer
  - ✧ Support 1/2/3/4 LED battery indicator
  - ✧ Auto recognition of LED number
  - ✧ Adjustable battery level curve, uniform brightness
- **Others**
  - ✧ Integrated torch-light driver
  - ✧ Support auto detect of plug in and out
  - ✧ Fast charge status indicator
  - ✧ Support key control
  - ✧ Enter standby mode automatically in light load
- **Multiple protection, high reliability**
  - ✧ Input overvoltage and under voltage protection
  - ✧ Output overcurrent, overvoltage and short circuit protection
  - ✧ Battery overcharge, over discharge and overcurrent protection
  - ✧ Over temperature protection
  - ✧ Battery NTC protection
  - ✧ 4KV ESD, input voltage up to 25V
- **Simplified BOM**
  - ✧ Integrated switch power MOSFET
  - ✧ Single inductor for charging and discharging
- **In-depth customization**
  - ✧ I2C interface for flexible and low cost customized solution
- **Package: 5 mm × 5 mm, 0.5mm pitch QFN32**

Applications

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

Description

IP5322 is a fast charge power management SOC for total solution on fast charge Power Bank. IP5322 support QC2.0/QC3.0 output, FCP/AFC/SFCP input/output, MTK PE+ 1.1&2.0 output, BC1.2/Apple/Samsung; it integrate Li-battery charging and discharging management, support battery level display, etc. Three USB ports can work simultaneously, 2*USB A and USB B, each port support fast charge when working alone, 5V mode for two or more ports working state.

IP5322 are highly integrated with abundant function, support Buck and Boost with one single inductor, along with few peripheral devices make the total solution size minimized and BOM cost down.

IP5322 supply up to 18W output ability using synchronized switch boost system, efficiency is higher than 90% for 18W output even when the battery voltage is low. If no load detected, the system enters standby mode automatically.

IP5322 synchronized switch charging system supply up to 5.0A charging current. In control of IC and battery temperature and input voltage loop, intelligently adjust charging current.

IP5322 integrate 14-bit ADC, ADC data can be accessed through I2C interface. Together with internal coulometer and algorithm for accurate battery voltage and current measurement. Battery level curve can be customized for precise battery level display.

IP5322 support battery level display on 1/2/3/4 LED, auto-detect display mode; support torch light; support key function.

Customized functions: charging battery and phones at the same time, charging for wearable devices.

Typical Application

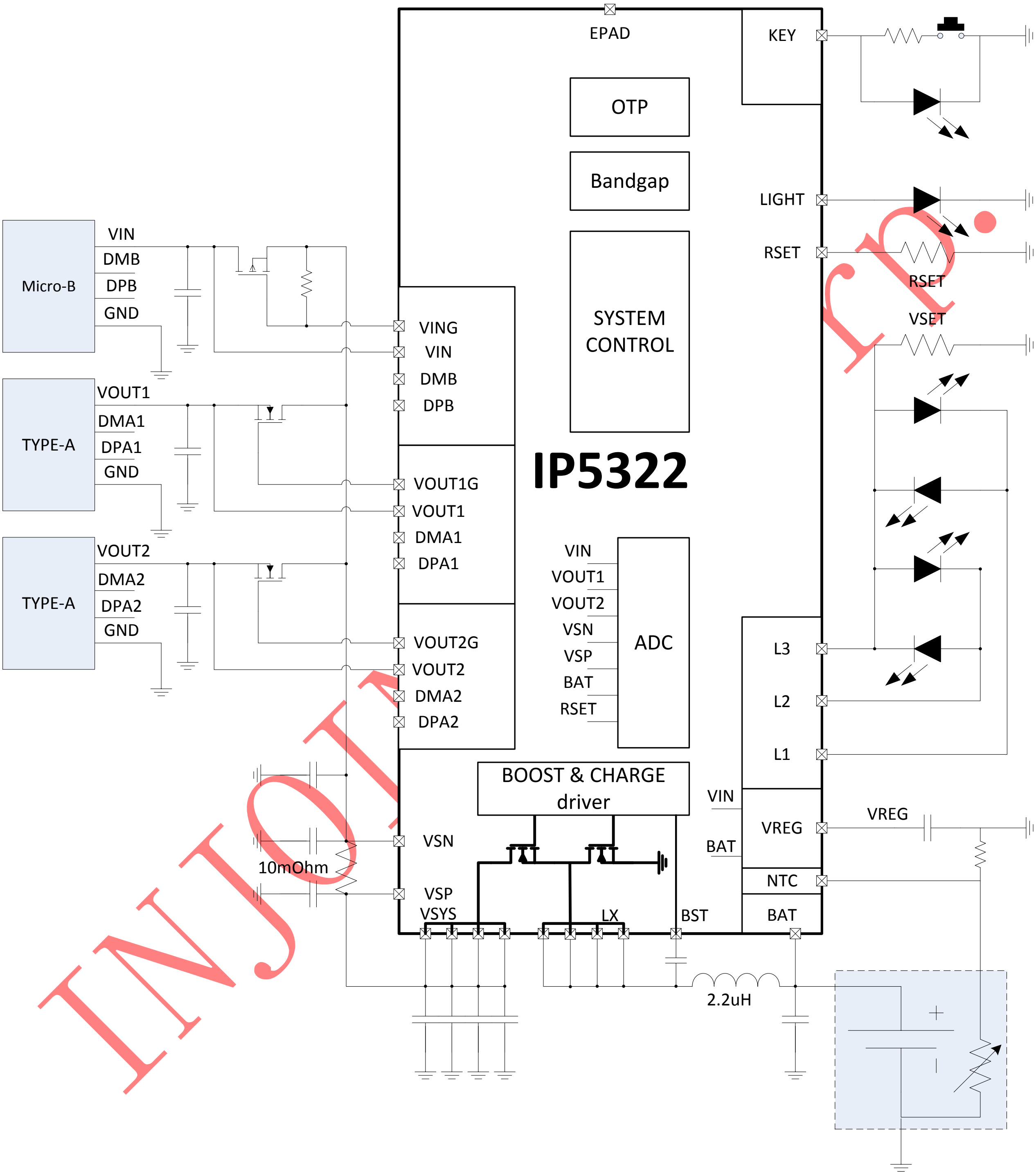


Figure 1 Simplified Application Diagram (4 LED for Battery Level Display)

1. Pin Definition

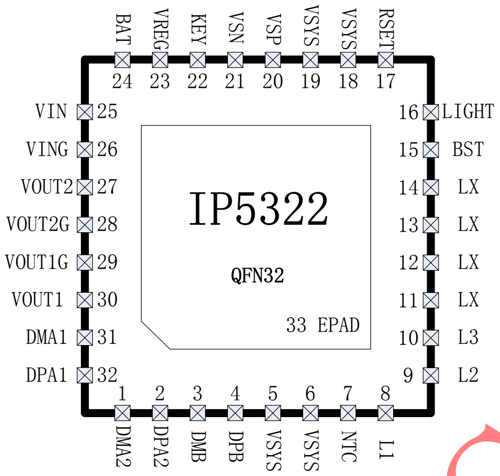


Figure 2 IP5322 Pin Assignments

Pin Num	Pin Name	Description
1	DMA2	DM data line on VOUT2 USB port
2	DPA2	DP data line on VOUT2 USB port
3	DMB	DM data line on Micro USB port, reused as I2C2 SCK
4	DPB	DP data line on Micro USB port, reused as I2C2 SDA
5/6/18/19	VSYS	Public Node of system input and output
7	NTC	NTC Resistor input for battery temperature sense
8	L1	Battery level display drive pin L1, reused as I2C1 SCK
9	L2	Battery level display drive pin L2, reused as I2C1SDA
10	L3	Battery level display drive pin L3, reused as VSET, used for MCU wake up output pin during I2C1 mode
11/12/13/14	LX	DCDC switch node, connect to inductor
15	BST	Internal high voltage drive, serial capacitor to LX
16	LIGHT	Fast charge mode indicator
17	RSET	Battery internal resistance compensate, trimming the battery level curve, used as MCU wake up pin during I2C2 mode
20	VSP	Positive sample node of VSYS current, separate layout with VSYS
21	VSN	Negative sample node of VYSY current
22	KEY	Key detect pin, reused as WLED torch light function.
23	VREG	3.1V Voltage output
24	BAT	Battery supply pin
25	VIN	VIN charge detect pin

26	VING	VIN charge input PMOS control pin
27	VOUT2	VOUT2 discharge load detect pin
28	VOUT2G	VOUT2 discharge NMOS control pin
29	VOUT1G	VOUT1 discharge NMOS control pin
30	VOUT1	VOUT1 discharge load detect pin
31	DMA1	DM data line on VOUT1 USB port
32	DPA1	DP data line on VOUT1 USB port
33(EPAD)	GND	Power and dissipation ground

2. IP Series Products List

Power Bank IC

IC Part No.	Charge /Discharge		Features							Package	
	Charge	Discharge	LED Num	Lighting	Keys	I2C	DCP	USB 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	
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	

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 Certi-ficate	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}	-0.3 ~ 16	**V**
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	Tstg	-60 ~ 150	℃
Thermal Resistance (Junction to Ambient)	θ_{JA}	26	**℃/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}	4.5	5	14	V
Battery Voltage	Vbat	3.0	3.7	4.5	V

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

5. Electrical Characteristics

Unless otherwise specified, TA=25℃, L=2.2uH

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input voltage	V_{IN}		4.5	5/7/9/12	13	V
Input Over Voltage	V_{IN}		13	14	15	V
Constant Charge Voltage	V_{TRGT}	R_{VSET} = NC	4.16	4.2	4.24	V
		R_{VSET} = 120k	4.31	4.35	4.39	V
		R_{VSET} = 68k	4.36	4.4	4.44	V
		R_{VSET} = 10k	4.46	4.5	4.54	V
Charge Current	I_{CHRG}	VIN =5V, input current		2.0		A
		VIN >=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}		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=375KHz	3	5		mA
DC output voltage	QC2.0 V_{OUT}	V_{OUT}=5V@1A	4.95	5.12	5.23	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		95		%
		V_{BAT}=3V, V_{OUT}=9V, I_{OUT}=2A		92		%
		V_{BAT}=3V, V_{OUT}=12V, I_{OUT}=1.5A		90.8		%
Boost overcurrent shut down threshold	I_{shut}	VBAT=3.7V, 10mohm sample resistor at output	3.5	3.8	4.0	A
Load overcurrent detect time	T_{UVD}	Duration of output voltage under 4.2V		30		ms
Load short circuit detect time	T_{OCD}	Duration of output current above 4.2A	150		200	us
Control System						
Switch frequency	fs	Discharge switch frequency	325	375	425	KHz
		Charge switch frequency	450	500	550	KHz
NMOS on resistance	r_{DSON}	Upper NMOS		9	11	mΩ
NMOS on resistance		Lower NMOS		9	11	mΩ

VREG output voltage	V_{REG}	VBAT=3.7V	3.0	3.1	3.2	V
Battery port standby current	I_{STB}	VIN=0V, VBAT=3.7V, average current		100		uA
LDO output current	I_{LDO}		20	30	40	mA
LED light driving current	I_{WLED}		10	15	20	mA
LED display driving current	I_{L1} I_{L2} I_{L3}	Voltage decrease 10%	5	7	9	mA
Light load shut down detect time	$T1_{load}$	Total load power lower than 300mW	25	32	44	s
Output port light load shut down detect time	$T2_{load}$	Duration of voltage drop from VSN to VOUT2 (or VOUT2) less than 1.8mV		$T1_{load}/2$		s
Short press on key wake up time	$T_{OnDebounce}$		60		500	ms
Time of WLED turn on	$T_{Keylight}$		1.2	2	3	s
Thermal shut down temperature	T_{OTP}	Rising temperature	130	140	150	℃
Thermal shut down hysteresis	ΔT_{OTP}			40		℃

6. Function Description

Low power lock out and activation

The first time IP5322 access to the battery, whatever the battery voltage, IC is in lock out state, battery level indicator LED will flash four times; Under non-charging state, if the battery voltage is too low to trigger the low power shutdown, IP5322 will enter lock out state too.

Under the lock out state, to decrease the quiescent power, IP5322 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 IP5322's full function.

Charge

IP5322 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.

IP5322 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.

IP5322 will adjust charge current automatically applicable to adaptors with different load capacity.

IP5322 do not support charging the battery and phone at the same time, the output discharge port will be close while charging the battery, in case the input high voltage will take damage on the device under charge.

Boost

IP5322 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. 375kHz switching frequency. When VBAT = 3V, efficiency of 5V/2A can reach 95%; 9V/2A can reach 92%; 12V/1.5A can reach 90%.

Built-in 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.

Fast Charge

IP5322 support several fast charge standards: QC2.0/QC3.0, FCP, AFC, SFCP, MTK, Apple, Samsung.

Input QC standard is not support for charging the power bank, if input QC standard is needful, the Qualcomm QC charging IC (SMB1351) is recommended.

Input fast charge standard of FCP, AFC, SFCP are supported for charging the power bank, because of the fast charging request is send on the DP/DM line, if other fast charge IC is applied, the FCP, AFC and SFCP fast charge cannot be supported at the same time.

If the power bank is to charge for the phone, when IP5322 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 ouput 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.

Charge and Discharge Path Management

Standby:

If VIN is attached to charge will start the charging process directly.

If sink device is attached on VOUT port, will start discharge function automatically.

If key is pressed, whether or not load is on VOUT1 port, VOUT1 port output will be force to open; but the VOUT2 will open only when load is detected on the according port, or the output on these port will be closed. So VOUT1 must be retained if only one VOUT port is needed, if VOUT2 is not needed, MOSFET can be eliminated, but the 10uF capacitor should be retained.

Discharge:

If key not pressed, only when sink device attached will the output port open, non-attached output port will not open. If the opened output port current is less than 180mA @ 10mOhm, it will wait for a period of time before close the port automatically. The output current is detected by the voltage drop between VSN to output, 180mA current is equivalent to 1.8mV on 10mOhm, when the resistance (including MOSFET internal resistance) between VSN and ouput is larger than 10mOhm, the current threshold will be decreased proportionally.

When only VOUT1 port opened, single short press on key do not take any effect; when VOUT2 is opened and in non-fast charge mode, single short press on key will force to open VOUT1 port; when VOUT2 is opened and in fast charge mode, the first single short press on key will force to close the fast charge on VOUT2, the second short press on key will force to open VOUT1 port, the time interval between the first and second short press should be longer than 1 second, otherwise will force to shut down the system.

Either one of the VOUT1 and VOUT2 port support all the fast charge standards separately, but due to the single inductor design, only one output are support, only under single port opened situation fast charge is allowed. Two or more output port open at the same time, fast charge will be disabled automatically.

According to 'Typical Application Diagram', when one port is already in fast charge mode, if sink device is attached on another port (key press action is equal to VOUT1 load attached), all the output port together with the fast charge mode will be disabled firstly, then open the ports with sink device attached, after which all the ports only support Apple, Samsung and BC1.2 mode. If the sink device decreased from multiple to one and keep this situation for 16s, all the output ports will be closed firstly (pay special attention to PCB layout routing for this case, otherwise will lead to failure on restore of fast charge function, please refer to 'PCB Layout'), and then the high voltage fast charge function are enabled, then the output port of the only one sink device attached will be opened, such that will re-activate the sink device to send fast charge request . when only one port is opened, if the total power is lower than 300mW for about 32s, the output port and discharge will be closed and the system enters low standby mode.

Charging：

When power are applied on VIN port can activate the IP5322 enter charging process.

if additional input fast charge IC are needed, 2 back-to-back PMOS should be applied on the added input port for power partition control, in case current flow from high voltage port to low voltage port when two ports attached at the same time.

In single port charging mode, the fast charge mode can be distinguished automatically, appropriate voltage and current will be auto matched.

Standard solution do not support charging the sink device and battery at the same time, during charging mode, even if sink devices are attached on the output port, the output port will not be opened. But if battery is fully charged and the charging power supply is not detached, IP5322 will open the output port for the sink device on the premise of 5V voltage on the charging port.

Charging and discharging at the Same Time (Customized Solution)：

In this customized solution, RSET function is not available; the RSET is redefined as an indicator of this customized mode. If IP5322 are in charging the battery and sink device at the same time, RSET will output high voltage, otherwise RSET will output low voltage.

When the charging power supply and sink device are attached at the same time, IP5322 will charge the battery and sink device at the same time. Under this mode, IP5322 will disable the input fast charge function (if the additional fast charge IC is applied , RSET pin is used to control the enable pin of the additional fast charge IC), when VSYS is only 5V, the discharge path will be enabled for the sink device. If the VSYS voltage is higher than 5.8V, for safety consideration, the discharge path will be disabled. To make insurance of the normal charging and high priority of charging the sink device, IP5322 will increase the charging under voltage threshold to 4.9V.

During the process of charging and discharging at the same time, if the input charging power supply is unplugged, IP5322 will disable the input charging function and restart the discharge function for the sink device. For safety consideration and to re-activate the sink device to send fast charge request, the voltage will fall to 0 during this conversion process.

During the process of charging and discharging at the same time, if the discharging sink device is unplugged or the sink device stop to sink current for 16s, the discharge path will be closed automatically. When all the discharge paths are disabled and return to single port charge state, the under voltage threshold will be decreased, fast charge for the power bank will be auto re-activated.

Auto detection on sink device/phone attachment

IP5322 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

IP5322 detect the current output current through off-chip 10mOhm resistor, when the total power is lower than 300mW for 32s, IP5322 will consider all the output port is plug out, the output voltage will be closed then.

Key

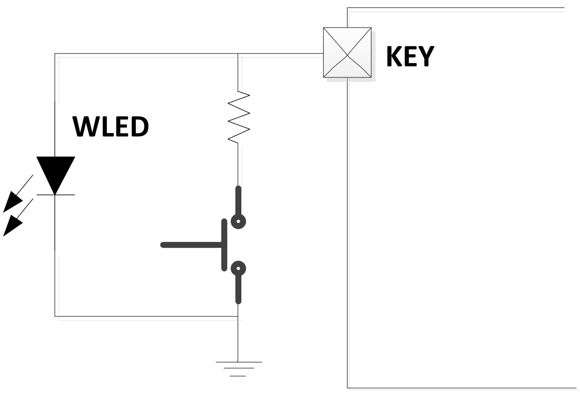


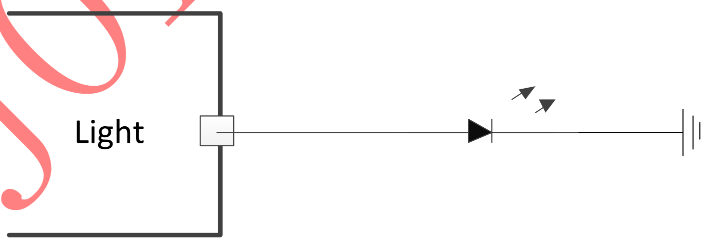
Figure 3 Key circuit

Key circuit is illustrated in Figure 3, which can recognize short press or long press operation.

- Short press (pressed time in range of 60ms~2s): turn on the battery level display LED and BOOST output
- Long press (pressed time longer than 2s): turn on or turn off the torch light WLED
- No response on press time less than 30ms
- Two short press in 1s: turn off boost output, battery level display LED and torch light WLED
- Long 10s press will reset the whole system

Fast Charge state indication

Light 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.



Coulombmeter and battery level display

Built-in coulombmeter support battery capacity calculation without measuring the current on the BAT pin.

IP5322 support 1/2/3/4 LED display solution, by internal intelligent algorithm, the LED applied outside can be distinguished by IP5322.

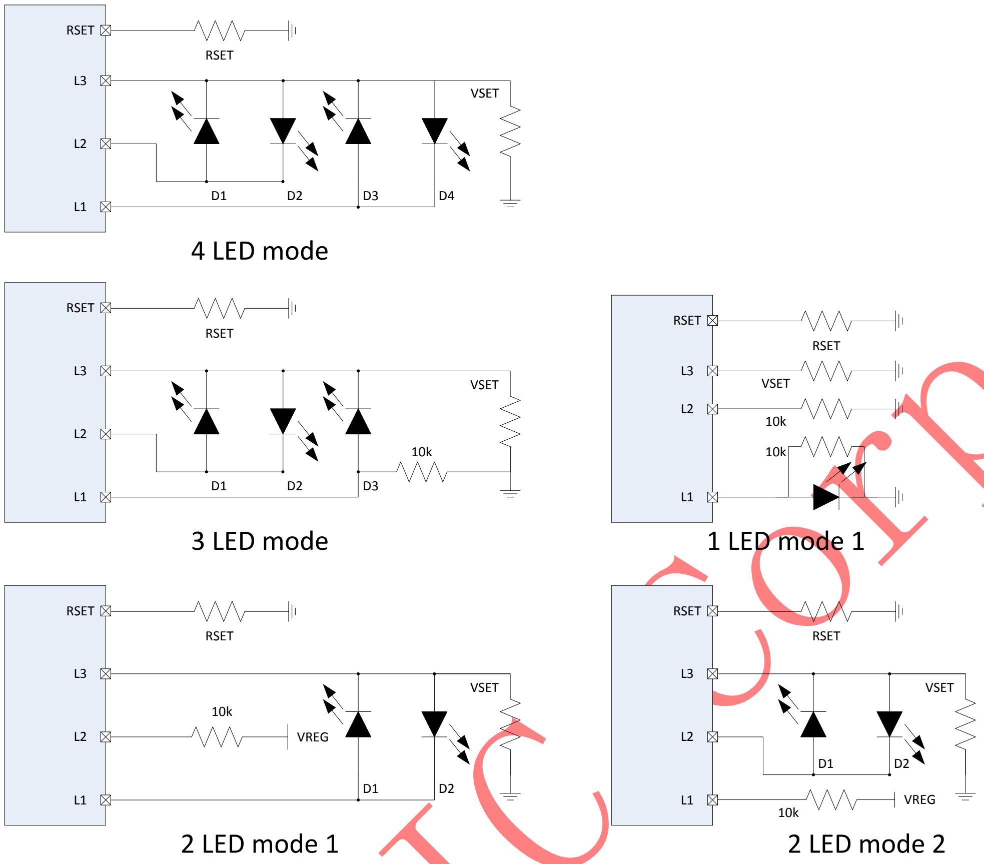


Figure 4 1/2/3/4 LED circuit

4 LED display:

During charging:

Battery capacity (C) (%)	D1	D2	D3	D4
Fully charged	ON	ON	ON	ON
75%≤C	ON	ON	ON	1.5Hz Flash
50%≤C＜75%	ON	ON	1.5Hz Flash	OFF
25%≤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≥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
C=0%	OFF	OFF	OFF	OFF

3 LED display:

During charging:

Battery capacity (C) (%)	D1	D2	D3
Fully charged	ON	ON	ON
66%≤C	ON	ON	1.5Hz Flash
33%≤C＜66%	ON	1.5Hz Flash	OFF
C＜25%	1.5Hz Flash	OFF	OFF

During discharging:

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
C=0%	OFF	OFF	OFF

2 LED display mode 1 is bi-color LED:

During charging:

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

During discharging:

Battery capacity (C) (%)	D1	D2
66%≤C＜100%	OFF	ON
33%≤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.

RSET (Battery internal resistor set)

The internal resistor of the battery can be set by RSET pin, the charging and discharging threshold voltage on LED will be changed at the same time, accordingly the uniformity of the LED display on the battery level are adjusted at the same time.

RSET resistor (Kohm)	Battery internal resistance set(mOhm)
>179	93.75
169~179	87.5
159~169	81.25
149~159	75
139~149	68.75
129~139	62.5
119~129	56.25
109~119	50
99~109	43.75
89~99	37.5
79~89	31.25
69~79	25
59~69	18.75
49~59	12.5
39~49	6.25
0~39	0

VSET (battery type set)

Battery type can be set by the VSET pin, accordingly, the battery level display threshold voltage and Constant Voltage charging threshold voltage are changed at the same time. VSET resistor and battery type are listed below:

VSET resistor (Kohm)	Battery type
NC	4.2V
120	4.35V
68	4.4V
10	4.5V

NTC

IP5322 support NTC function used for battery temperature detection. NTC pin output 20uA current then detect the voltage on NTC pin to determine the present battery temperature.

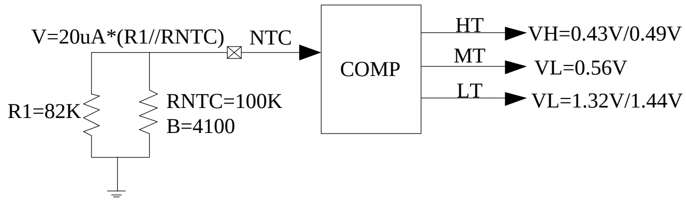


Figure 5 Battery NTC comparator

Under charging state:

Voltage on NTC pin is 1.44V meaning the battery temperature is low -10 centigrade, stop charging the battery;

Voltage on NTC pin is 0.56V meaning the battery temperature is medium 45 centigrade, charging current half down;

Voltage on NTC pin is 0.43V meaning the battery temperature is medium 55 centigrade, stop charging the battery;

Under discharging state:

Voltage on NTC pin is 1.52V meaning the battery temperature is low -20 centigrade, stop discharging;

Voltage on NTC pin is 0.43V meaning the battery temperature is high 55 centigrade, stop discharging;

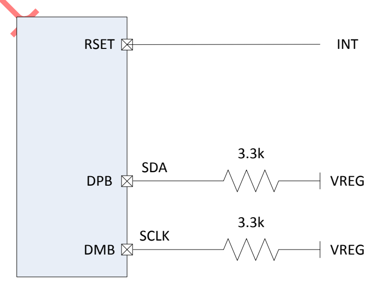
If NTC is not needed, NTC should serial a 51kOhm resistor to ground, do not float NTC or tie it to ground directly.

VREG

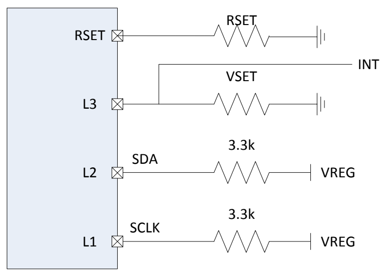
VREG is a normally opened 3.1V LDO, load capacity is 30mA.

I2C

I2C connection:



I2C2



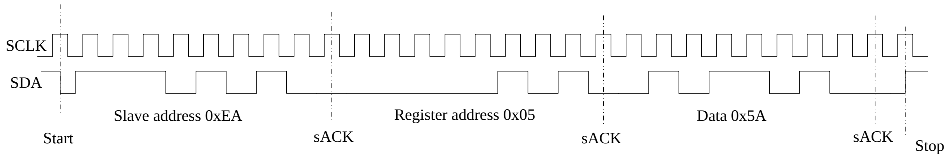
I2C1

IP5322 support to connect with I2C1 or I2C2 at a time, when I2C circuit is deployed, the two pins will work as I2C_SDA and I2C_SCLK and the reused function will be disabled. Under I2C mode, INT signal is high-z at standby and high level at working state, which is used for waking up the MCU.

I2C support up to 400Kbps transfer rate, 8-bit address and 8-bit data, MSB on rending and receiving. Device address is 0xEA for write, 0xEB for read.

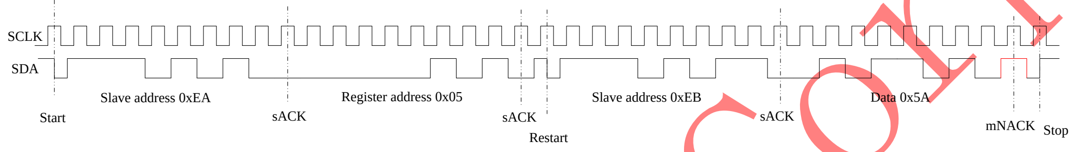
For example:

Writing data into 0x05 register:



I2C WRITE

Reading data from 0x05 register:



I2C Read

Under I2C mode, RSET is low level when IP5322 is power down and high level when IP5322 is power up, thus RSET can be used for MCU wake up.

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

Both power and current is large under normal operating, location of capacitor on VSYS net affects the stability of DCDC. VSYS capacitor should be placed as close to VSYS pin and EPAD as possible, deploy large copper pour and add more vias, decrease the area of current loop between capacitor and IC and reduce the parasitic parameter.

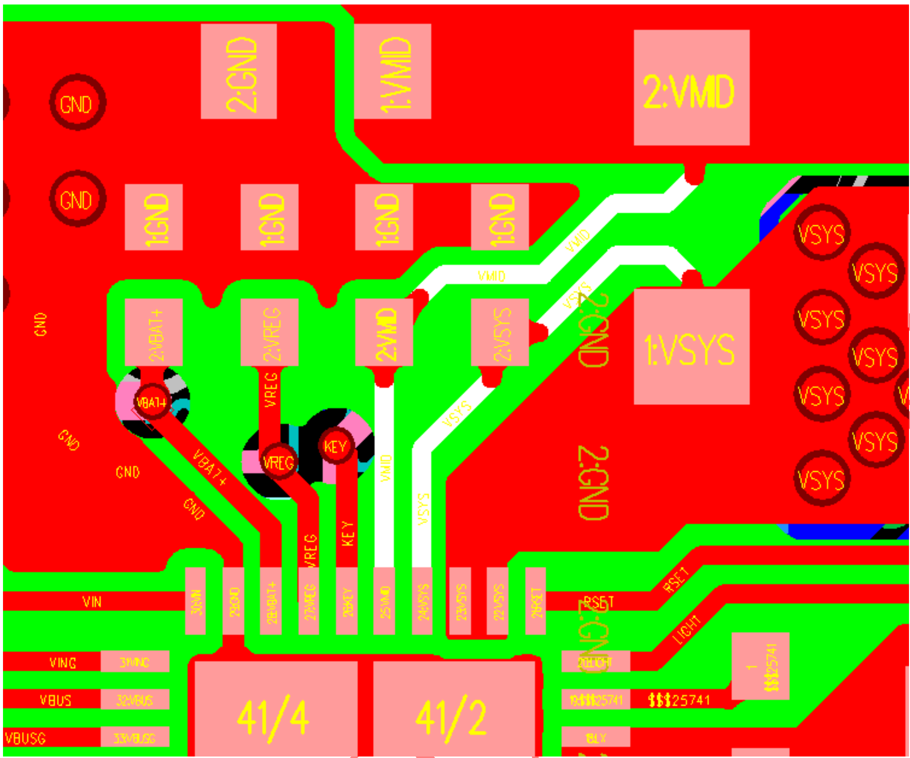
VSYS pin distribute at two sides of the IC, capacitor should be placed on each side and connect the two pins with wide (wider than 100mil) copper on PCB board.

10mOhm sample resistor

IP5322 sample the current on 10mOhm between VSN and VSP pin to take control of input charging current, output overcurrent protection, output light load power down. VSN and VSP tracks should keep away from signals that may generate large interference, lay to the 10mOhm resistor separately, do not overlay with other current track or VSYS track. Though VSP and VSYS are same net on PCB, layout of those two pins should be separated.

To enhance the immunity of interference of sample signal, 100nF filter capacitor are needed on VSN and VSP pins and place as close as possible.

The layout is illustrated below:



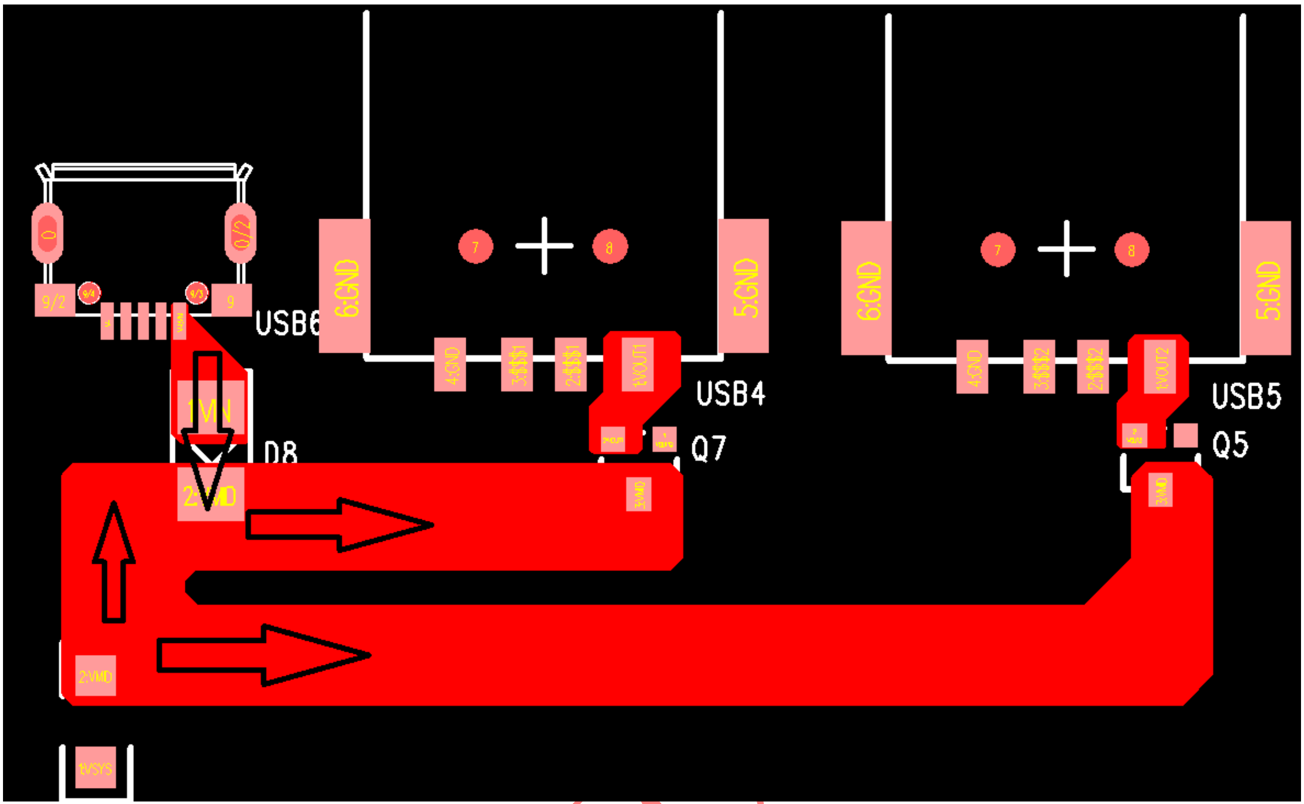
Layout from 10mOhm sample resistor to input/output MOSFET

Application example: non-fast charge phone is attached VOUT1, fast charge phone is attached on VOUT2, this is multiple output ports case, IP5322 will output 5V for both phones. When VOUT1 is plug out or power consumption is lower than the preset value, IP5322 will disable VOUT1 output and maintain VOUT2 output, fast charge output will be re-activated and supplied on VOUT2.

To realize the self-recovery of fast charge, output current on VOUT1 port should be detected accurately. This current is detected by measuring the voltage drop between VSN and VOUT1 pin, the precondition of closing the VOUT1 port is voltage drop lower than 1.8mV. So no other current tack is allowed to flow through VSN and VOUT1, or false current will form voltage drop and lead to erroneous judgment on current. Similarly, pay special attention on the other output ports.

Above all, lay separately on 10mOhm to VOUT1, 10mOhm to VOUT2 and 10mOhm to VIN on PCB independently, any two current tracks should not overlay, if not, self-recovery of fast charge function in the application example above may fail now and then.

The layout example is demonstrated below:

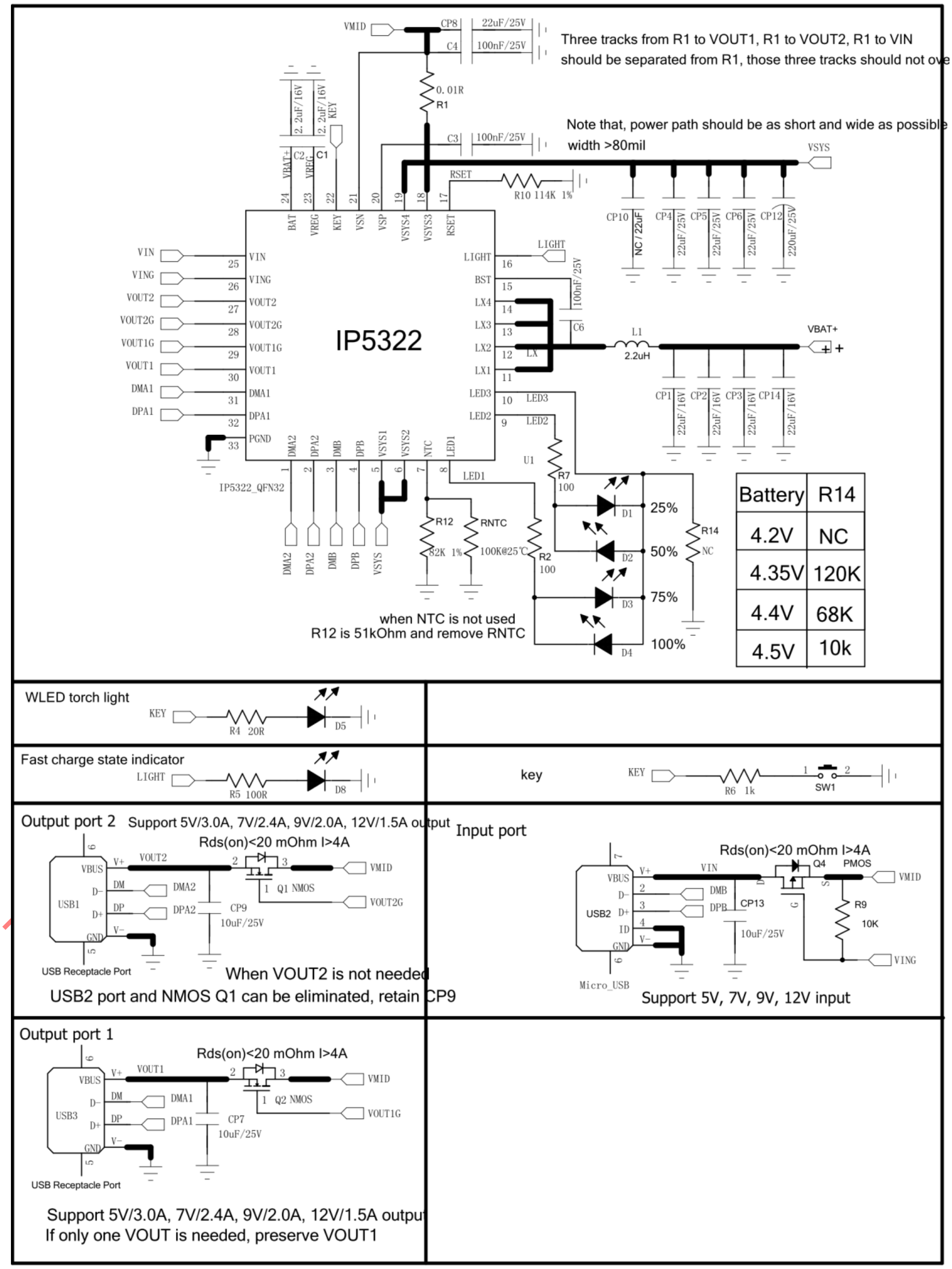


If improper layout lead to 1mOhm overlayed track on VOUT1 and VOUT2 output current, 2A current on VOUT2 output will bring in 2mV voltage drop on the 1mOhm overlayed track. In this case, IP5322 cannot judge if VOUT1 still has device attached even though device is plug out, thus lead to a failure on recovery of fast charge function on VOUT2. Only when the output current on VOUT2 port is lower than 1.8A, and the corresponding voltage drop on 1mOhm overlayed track is lower than 1.8V, can VOUT2 fast charge function be re-activated.

8. Typical Application Diagram

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

TYPE-A + TYPE-A + Micro-B



Battery	R14
4.2V	NC
4.35V	120K
4.4V	68K
4.5V	10k

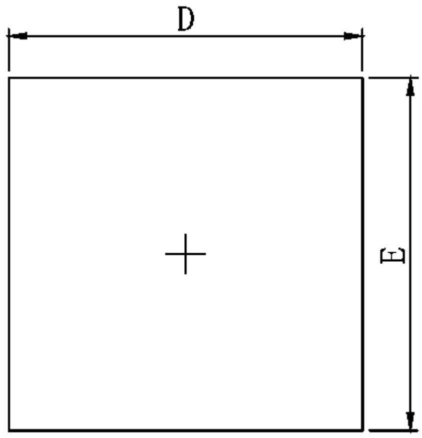
BOM List

No.	Part Name	Type	Location	Num	Note
1	SMT IC	QFN32 IP5322	U1	1	
2	SMT capacitor	0603 100nF 10% 25V	C3 C4	2	
3	SMT capacitor	0603 2.2uF 10% 16V	C1 C2	2	
4	SMT capacitor	0805 22uF 10% 16V	CP1 CP2 CP3 CP14	4	
5	SMT capacitor	0805 22uF 10% 25V	CP4 CP5 CP6 CP8	4	
6	SMT capacitor	0805 10uF 10% 25V	CP7 CP9 CP13	3	
7	electrolytic capacitor	220uF 25V 10%	CP12	1	
8	SMT resistor	1206R 0.01R 1%	R1	1	
9	SMT resistor	0603R 20R 5%	R4	1	Adjust brightness of the light
10	SMT resistor	0603R 100R 5%	R2 R5 R7	3	
11	SMT resistor	0603R 1K 5%	R6	1	
12	SMT resistor	0603R 10K 5%	R9	1	
13	SMT resistor	0603R 110K 1%	R10	1	
14	SMT resistor	0603R 82K 1%	R12	1	For NTC only
15	NTC thermal resistor	100K@25℃ B=4200	RNTC	1	For NTC only
16	SMT LED	0603 blue LED	D1 D2 D3 D4	4	
17	SMT LED	0603 green LED	D8	1	
18	LED light	5MM LED	D5	1	
19	SMT inductor	2.2UH 10*10	L1	1	
20	SMT PMOS	SOT23-3 RU20P7C-I	Q4	1	Rds(on)<20m ohm I>=4A
21	SMT NMOS	SOT23-3 RU207C-I	Q1 Q2	2	Rds(on)<20m ohm I>=4A
22	key	SMT 3*6 key	SW1	1	
23	Output USB	AF10 8 pin USB	USB1 USB3	2	
24	Input USB	MICRO-7-DIP-5.9	USB2	1	

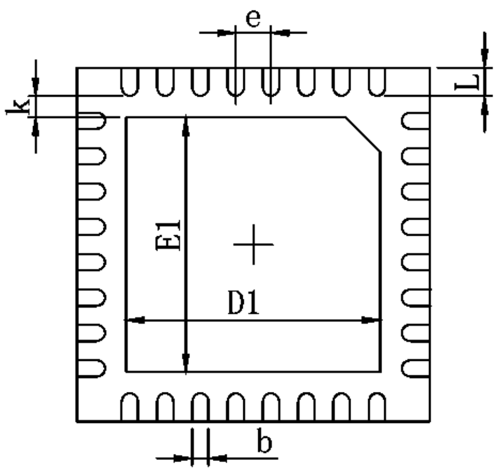
Recommended inductor type:

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	

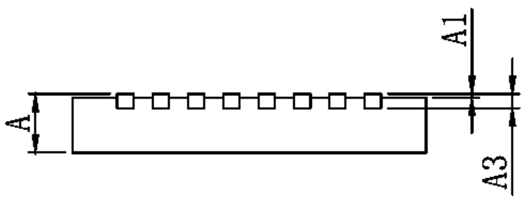
9. Package



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	3.300	3.500	0.130	0.138
E1	3.300	3.500	0.130	0.138
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019

10. Verification

QUALCOMM® QUICK CHARGE™ 3.0 TECHNOLOGY

HIGH VOLTAGE DEDICATED CHARGING PORT VERIFICATION

ISSUED BY
UL TAIWAN CO., LTD.

CERTIFICATE NO	4788056929-2
SPECIFICATION	Qualcomm HVDCP Interface Specification Revision J
APPROVAL DATE	August 28, 2017
APPROVAL TYPE	ORIGINAL ASSESSMENT
CERTIFICATE HOLDER	INJOINIC TECHNOLOGY Room 101, 5th floor, East Science and Technology Building, Keyuan Road NO.16, Nanshan District, Shenzhen, Guangdong, 518000, China
TYPE OF EQUIPMENT	Chipset Reference Design
TRADE NAME AND MODEL	INJOINIC TECHNOLOGY IP5322
	MEASUREMENT FACILITIES
LABORATORY NAME AND ADDRESS	UL Verification Services (Guangzhou) Co., Ltd., Song Shan Lake Branch Building 10, Innovation Technology Park, Song Shan Lake Hi-Tech Development Zone, Dongguan, 523808, China

Verification of equipment means only that the equipment has met the requirements of the above-noted specification. Trademark applications and agreements regarding the use of Quick Charge 3.0 Logo, are acted on accordingly by Qualcomm Technologies, Inc. This certificate is issued on condition that the holder complies and will continue to comply with the Quick Charge 3.0 program requirements established by Qualcomm Technologies, Inc. The equipment for which this certificate is issued shall not bear the Qualcomm Quick Charge 3.0 Logo unless the equipment complies with the applicable technical specifications and agreements issued by Qualcomm Technologies, Inc. as applicable to the Type Of Equipment designated above.

I hereby attest that the subject equipment was tested and found in compliance with the above-noted specification.

ISSUED BY: Daniel Chiang

Daniel Chiang
Project Engineer, UL Taiwan Co., Ltd.

ISSUED ON: August 28, 2017

Qualcomm® Quick Charge™ 3.0

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