IP5389

Support bidirectional SCP,VOOC,PD3.0 Waiting for fast charging agreement and support 2~6 Series cells

Integrated buck-boost driver maximum power 100W of mobile power SOC

characteristic

- **Support multiple at the same timeUSBmouth**
  - 2indivualUSB Aport output
  - 1indivualUSB Cport input/output
  - 1indivualUSB Bmouth orLightningport input orCport input/output
- **Fast charging specifications**
  - Any port supports fast charging
  - integratedQC2.0/QC3.0/QC3+Output fast charging protocol
  - integrationFCPInput/output fast charging protocol
  - integratedAFCInput/output fast charging protocol
  - integratedSCPInput/output fast charging protocol
  - integratedVOOCInput/output fast charging protocol
  - integratedDRP try.SRCprotocol,PD3.0Input/output fast charging
  - compatibleBC1.2, Apple mobile phone fast charging
- **integratedUSB Power Delivery(PD2.0/PD3.0)protocol**
  - supportPD2.0Bidirectional input/output protocol
  - supportPD3.0Bidirectional input/output,PPSOutput protocol
  - support5V,9V,12V,15V,20VVoltage level input support5V,9V,
  - 12V,15V,20VVoltage level output supportPPS 20mV/step
  - Output voltage range integrated hardware bidirectional mark
  - encoding and decoding (BMC)protocol
  - Integrated physical layer protocol (PHY)
  - Integrated hardwareCRC
  - supportHard Reset
  - integrated pairE-MARKCable identification and support
- **Integrated power control**

-Integrated bidirectionalBUCK-BOOSTBuck-boost powerNMOSdrive
  - integratedcharge-pumpControl external pathsNMOS
- **Charging specifications**
  - Adaptive charging current regulation
  - support3.65V,4.15V,4.2V,4.3V,4.35V,4.4V Battery
  - support2/3/4/5Series cells
  - Support lithium iron phosphate battery3.65VCharge
- **Discharge specifications**
  - Maximum output power100W
  - Synchronized switch discharge5V 2AEfficiency reaches97%The above supports line
  - compensation
- **Power display**
  - built-in14bit ADCand fuel gauge
  - support4grainledPower display
  - support88,188Various digital tube power displays support externalPIN
  - Choose digital tube orledThe lamp has a self-learning fuel meter for
  - power display, making the power display more even.
  - Initial battery capacityPINSelect configuration
- **Other functions**
  - Automatically detect phone insertion and removal
  - Fast charging status indicator
  - Support battery temperature detection
  - Intelligent load recognition, automatically enters standby under light load
  - Supports multiple button mode selections
  - Built-in lighting driver
- **Multiple protection, high reliability**
  - Input overvoltage and undervoltage protection
  - Output overcurrent, overvoltage, short circuit protection
  - Battery overcharge, over-discharge, and over-current protection
  - ICOver temperature protection
  - Charge and discharge battery temperatureNTCProtect
  - ESD 4KV, input (includingCC/DP/DMpin) withstand voltage30V
- **BOMminimalist**
  - Built-in switching powerMOSdrive
  - Single inductor realizes charging and discharging functions
- **Package specifications:8mm × 8mm 0.4pitch QFN64**

Overview

IP5389It is an integratedQC2.0/QC3.0/QC3+Output the fast charging protocol, AFC/FCP/ SCP/ VOOCInput and output fast charging protocol,USB C PD2.0/PD3.0 input and output protocols,USB C PD3.0 PPSOutput protocol, compatibleBC1.2/Multifunctional power management for iPhones, synchronous bidirectional buck-boost converters, lithium battery charging management, battery power indication, etc.SOC, providing a complete power solution for fast charging mobile power supplies. Can support bothUSB A x2,USB C,USB B(or lightningmouth, orUSBC) fourUSBmouth, use any one aloneUSB All output ports can support fast charging. When using two or more output ports at the same time, only 5V.

IP5389With its high integration and rich functions, only one inductor is needed to realize the bidirectional buck-boost function, and only a few peripheral components are needed in the application, which effectively reduces the size of the overall solution and reduces the cost.BOMcost.

IP5389support2/3/4/5Cells connected in series, the synchronous switching boost and buck system can provide the maximum100WPower input and output. When no-load, it automatically enters sleep state.

IP5389synchronous switch charging systemProvide up to8.0Arecharging current. built-inICTemperature, battery temperature and input voltage control loop to intelligently adjust charging current.

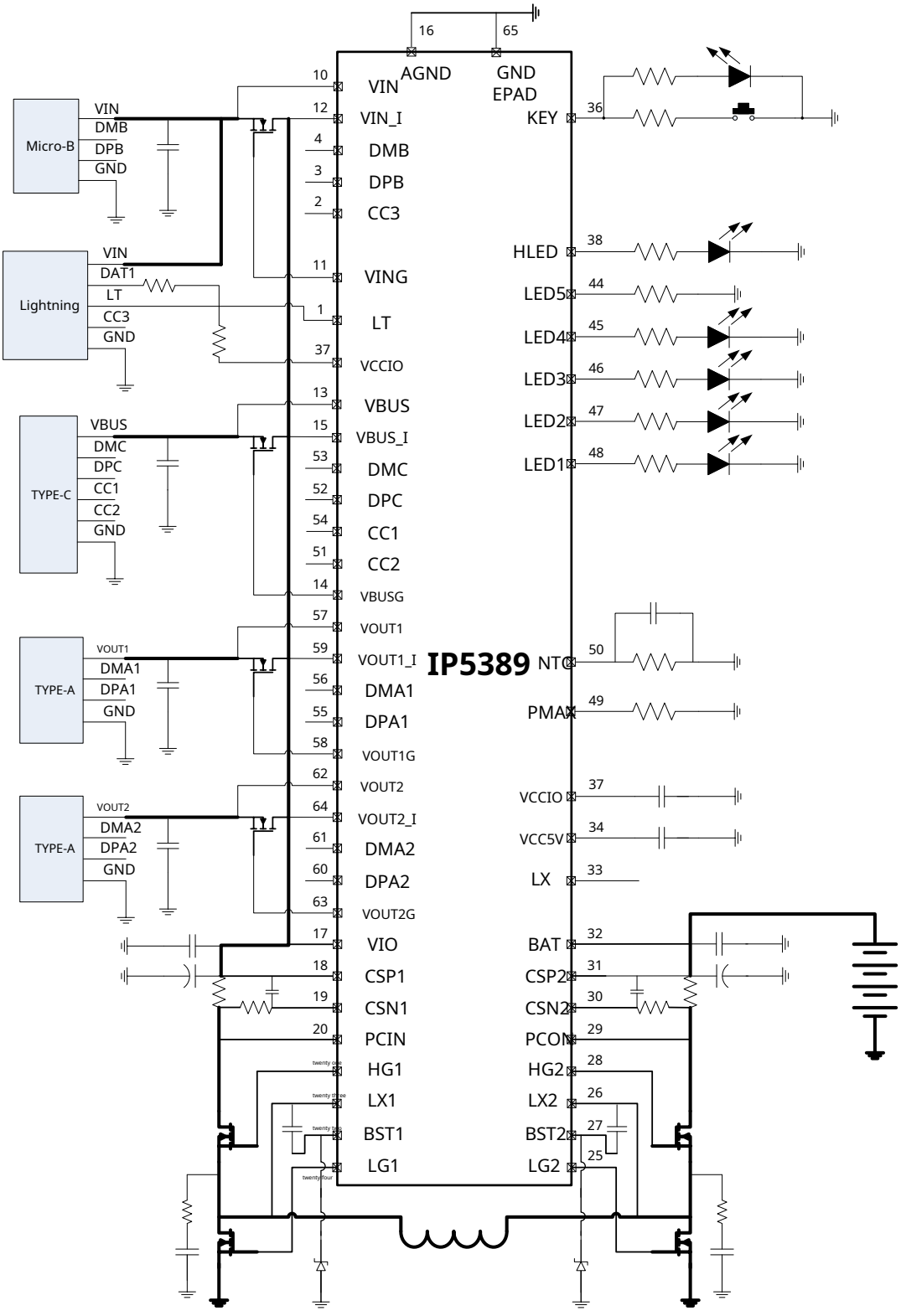
IP5389built-in14bit ADC, Accurately measure battery voltage and current. IP5389 Built-in power calculation method can accurately obtain battery power information. The battery power curve can be customized to accurately display battery power.

IP5389support4grainledPower display, support88,188and other digital tube power display; supports lighting function; supports buttons.

Application products

- **Mobile power supply, power bank**
- **Mobile phones, tablets and other portable devices**

typical application



picture1Simplified application schematic

1.IPSeries model selection table

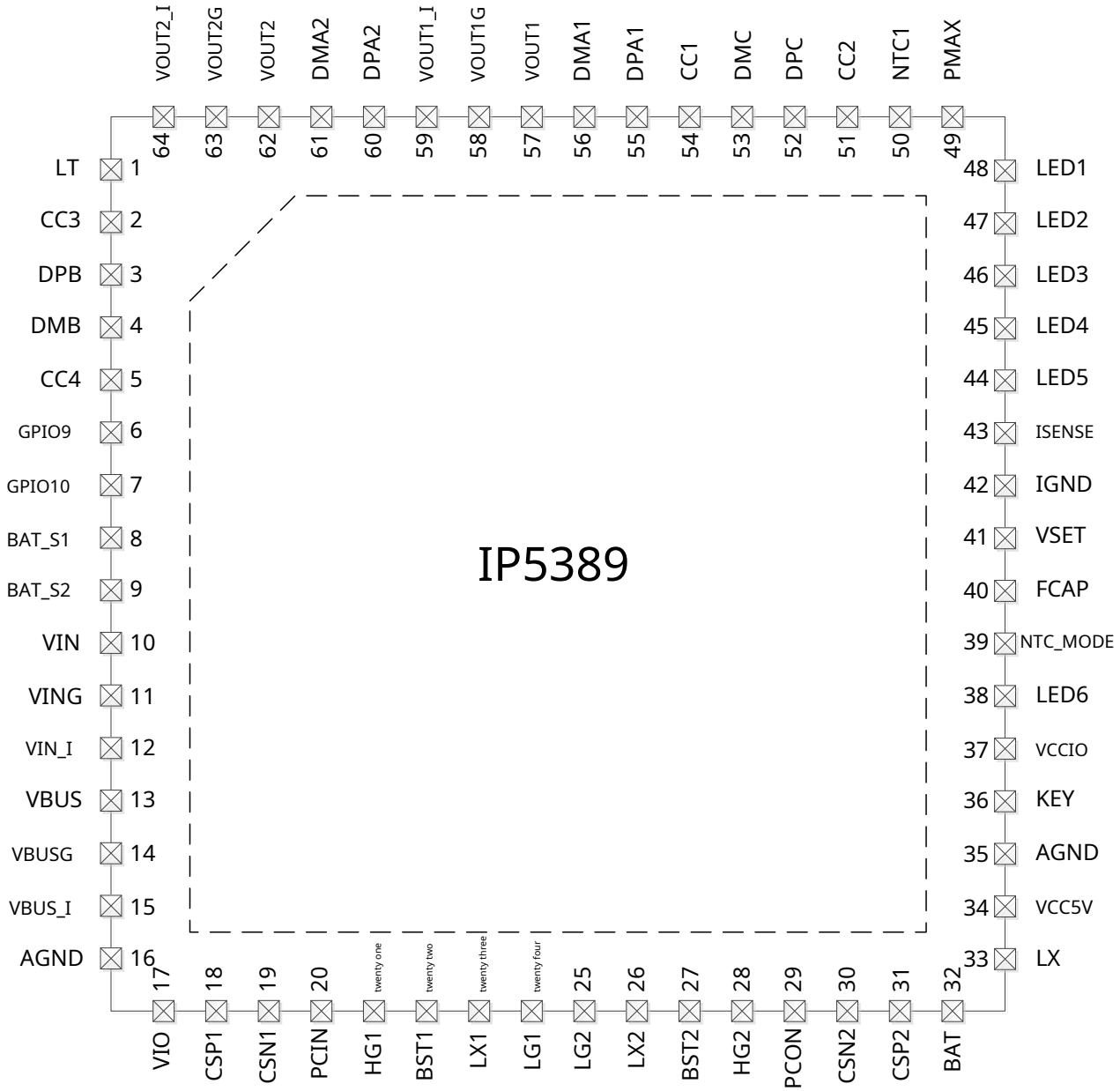
mobile powerIC

IC model	Discharge		main feature								encapsulation	
	discharge	Charge	led Number of lights	illumination lamp	according to key	I2C	DCP	USB C	QC Certification	PD3.0 /PPS	Specification	compatible
IP5303T	1.0A	1.2A	1,2	√	√	-	-	-	-	-	ESOP8	PIN2PIN
IP5305T	1.0A	1.2A	1,2,3,4	√	√	-	-	-	-	-	ESOP8	
IP5306	2.4A	2.1A	1,2,3,4	√	√	√	-	-	-	-	ESOP8	
IP5306H	2.4A	2.1A	1,2,3,4	√	√	√	-	-	-	-	ESOP8	
IP5407	2.4A	2.1A	1,2,4	√	√	-	-	-	-	-	ESOP8	
IP5209	2.4A	2.1A	3,4,5	√	√	√	√	-	-	-	QFN24	PIN2 PIN
IP5209U	2.4A	2.1A	3,4,5	√	√	√	√	-	-	-	QFN24	
IP5189T	2.1A	2.1A	1,2,3,4	√	√	√	√	-	-	-	QFN24	PIN2 PIN
IP5189TH	2.1A	2.1A	1,2,3,4	√	√	√	√	-	-	-	QFN24	
IP5310	3.1A	3.0A	1,2,3,4	√	√	√	√	√	-	-	QFN32	
IP5506	2.4A	2.1A	number code Tube	√	√	-	-	-	-	-	ESOP16	
IP5508	2.4A	2.1A	number code Tube	√	√	-	√	-	-	-	QFN32	
IP5320	3.1A	3.0A	number code Tube	√	√	√	√	√	-	-	QFN28	
IP5566	3.1A	3.0A	1,2,3,4	√	√	-	√	√	-	-	QFN40	
IP5322P	18W	4.0A	1,2,3,4	√	√	√	√	-	√	-	QFN32	
IP5332	18W	4.0A	1,2,3,4	√	√	√	√	√	√	√	QFN32	
IP5328P	18W	4.0A	1,2,3,4	√	√	√	√	√	√	√	QFN40	
IP5356	22.5W	5.0A	number code Tube	√	√	-	√	√	√	√	QFN40	
IP5358	22.5W	5.0A	number code Tube	√	√	-	√	√	√	√	QFN48	
IP5568	22.5W	5.0A	number code Tube	√	√	-	√	√	√	√	QFN64	
IP5388	30W	5.0A	number code Tube	√	√	-	√	√	√	√	QFN64	
IP5389	100W	8.0A	number code Tube	√	√	-	√	√	√	√	QFN64	

IP5389Description of common customized models

model	Function Description
IP5389_BZ	standardIP5389,support2-5Battery saving, maximum power support100W,supportAABCLinterface
IP5389_BZ_AACC	support2-6Battery saving, maximum power support100W,supportAACCinterface,2road two-waytypec

2.Pin definition



picture2IP5389Pin diagram

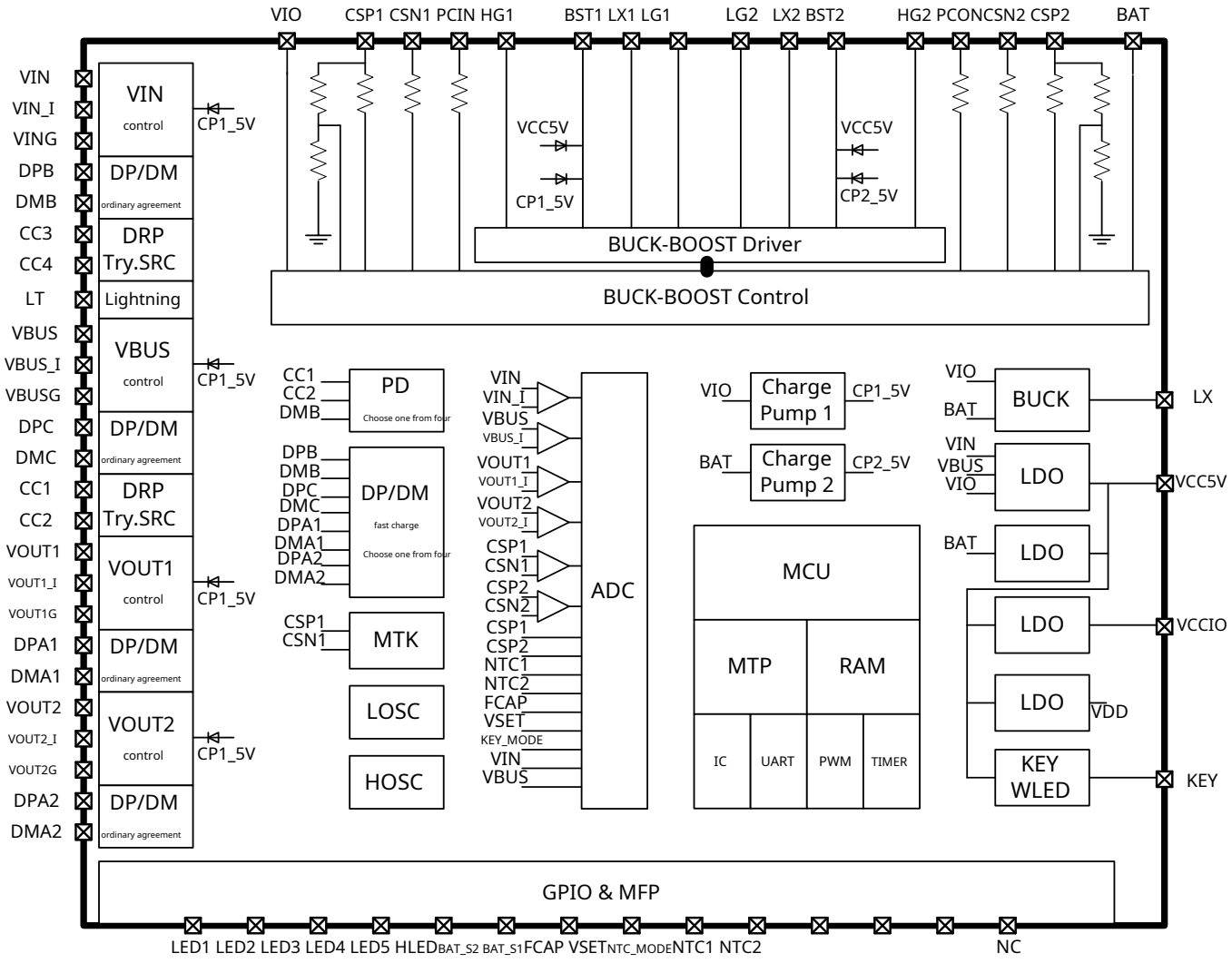
IP5389Pin description

Pin Num	Pin Name	PINDefinition
1	LT	LightningDecode pin
2	CC3	USB C2port detection and fast charge communication pinsCC3
3	DPB	microUSBPort fast charging intelligent identification pinDP
4	DMB	microUSBPort fast charging intelligent identification pinDM
5	CC4	USB C2port detection and fast charge communication pinsCC4
6	GPIO9	UniversalGPIO
7	GPIO10	UniversalGPIO
8	BAT_S1	Selection of the number of battery cells, grounded or ungrounded, different numbers of batteries can be selected
9	BAT_S2	Selection of the number of battery cells, grounded or ungrounded, different numbers of batteries can be selected
10	VIN	microUSBmouthVINInput charging power pin
11	VING	microUSBport input pathNMOScontrol pin
12	VIN_I	microUSBPort path current sense pin
13	VBUS	USB CmouthVBUSInput/output power pins
14	VBUSG	USB Cport input/output pathNMOScontrol pin
15	VBUS_I	USB CPort path current sense pin
16	AGND	Analogly
17	VIO	Mobile power input/output pins
18	CSP1	Input/output current sampling positive terminal
19	CSN1	Input/output current sampling negative terminal
20	PCIN	Input/output peak current sampling pin
twenty one	HG1	HBridge power tube input/output upper tube control pin
twenty two	BST1	HBridge power tube input/output bootstrap voltage pin
twenty three	LX1	Input/output inductor connection pin
twenty four	LG1	HBridge power transistor input/output end lower tube control pin
25	LG2	HBridge power tube battery side lower tube control pin
26	LX2	Battery terminal inductor connection pin
27	BST2	HBridge power tube battery terminal bootstrap voltage pin
28	HG2	HBridge power tube battery side upper tube control pin

29	PCON	Battery terminal peak current sampling pin
30	CSN2	Battery terminal average current sampling negative terminal
31	CSP2	Battery terminal current sampling positive terminal
32	BAT	Battery side power supply pin
33	LX	system5Vpowered byBUCKOutput inductor connection point, floating by default
34	VCC5V	system5Vpower supply, giveICInternal analog circuit power supply
35	AGND	Analogly
36	KEY	Button and lighting pins
37	VCCIO	system3.3Vpower supply, giveICInternal digital circuit power supply
38	LED6	Battery indicator light driverLED6
39	NTC_MODE	Different external resistors can be selected.NTCFunction; used when making digital tube solutionsIOdrive
40	FCAP	Battery capacity selection, connect different resistors to select different battery capacities
41	VSET	Battery voltage selection, connect different resistors, you can select different rechargeable battery voltages
42	IGND	Differential current sampling negative terminal
43	ISENSE	Differential current sampling positive terminal
44	LED5	Battery indicator light driverLED5
45	LED4	Battery indicator light driverLED4
46	LED3	Battery indicator light driverLED3
47	LED2	Battery indicator light driverLED2
48	LED1	Battery indicator light driverLED1
49	PMAX	System input and output maximum power selection, connect different resistance settingsPMAX
50	NTC	NTCResistance detection pin
51	CC2	USB Cport detection and fast charge communication pinsCC2
52	DPC	USB CMouth fast charging intelligent identificationDP
53	DMC	USB CMouth fast charging intelligent identificationDM
54	CC1	USB Cport detection and fast charge communication pinsCC1
55	DPA1	USB A1Mouth fast charging intelligent identificationDP
56	DMA1	USB A1Mouth fast charging intelligent identificationDM
57	VOUT1	USB A1mouthVOUT1Output power pin
58	VOUT1G	USB A1port output pathNMOScontrol pin
59	VOUT1_I	USB A1Port path current sense pin
60	DPA2	USB A2Mouth fast charging intelligent identificationDP
61	DMA2	USB A2Mouth fast charging intelligent identificationDM
62	VOUT2	USB A2mouthVOUT2Output power pin
63	VOUT2G	USB A2port output pathNMOScontrol pin
64	VOUT2_I	USB A2Port path current sense pin

65(EPAD)	GND	System ground and heat dissipation ground need to be maintained withGNDgood contact

3.Chip internal block diagram



picture3Chip internal block diagram

4.Limit parameters

parameter	symbol	value	unit
Port input voltage range	VBAT/VIN/VBUS	- 0.3 ~ 35	**V**
Protocol interface voltage range	DP/DM/CC	- 0.3 ~ 30	**V**
numberGPIOvoltage range	LED/FCAP	- 0.3 ~ 8	**V**
Junction temperature range	T_J	- 40 ~ 125	**℃**

Storage temperature range	Txt	- 60 ~ 150	**℃**
Thermal resistance (junction temperature to ambient)	θ_{JA}	26	**℃/W**
human body model (HBM)	ESD	4	**KV**

*Stresses greater than those listed in the Absolute Maximum Ratings section may cause permanent damage to the device under any Absolute Maximum Rating conditions.

Excessive exposure time may affect the reliability and service life of the device.

5.Recommended working conditions

parameter	symbol	minimum value	Typical value	maximum value	unit
Input voltage	VBAT	5.6		25	**V**
Input voltage	V_{IN}/V_{BUS}	4.5		25	**V**
The output voltage	$V_{OUT1}/V_{OUT2}/V_{BUS}$	3		twenty two	**V**
Working temperature	T_A	- 40		85	**℃**

* Beyond these operating conditions, device operating characteristics are not guaranteed.

6.Electrical characteristics

Unless otherwise stated,TA=25℃,L=10uH

parameter	symbol	Test Conditions	minimum value	Typical value	maximum value	unit
Charging system						
Input voltage	V_{IN}/V_{BUS}		4.5	5/9/12/15/20	25	V
Input overvoltage	V_{IN}				15	V
	V_{BUS}				25	V
Charging constant voltage	V_{TRGT}	The number of battery cells isN,R_{VSET}= 27K	N*4.16	N*4.20	N*4.24	V
		The number of battery cells isN,R_{VSET}= 18K	N*4.26	N*4.30	N*4.34	V
		The number of battery cells isN,R_{VSET}= 13K	N*4.31	N*4.35	N*4.39	V
		The number of battery cells isN,R_{VSET}= 9.1K	N*4.36	N*4.40	N*4.44	V
		The number of battery cells isN,R_{VSET}= 6.2K	N*4.11	N*4.15	N*4.19	V
		The number of battery cells isN,R_{VSET}= 3.6K	N*3.5	N*3.65	N*3.7	V
recharging current	I_{CHRG}	VIN=5V,Input Current	1.7	2.0	2.3	A
		VIN=9V,Input Current	1.7	2.0	2.3	A
		VIN=12V,Input Current	1.2	1.5	1.8	A
		VBUS=5V,Input Current	2.7	3.0	3.3	A

		VBUS=9V, Input Current	NoPDfast charge	1.7	2.0	2.3	A
			PDfast charge	2.7	3.0	3.3	A
		VBUS=12V, Input Current	NoPDfast charge	1.2	1.5	1.8	A
			PDfast charge	2.7	3.0	3.3	A
		VBUS =15V,Input Current		2.7	3.0	3.3	A
		VBUS =20V,Input Current		2.7	3.0	3.3	A
		VBUS=20V,powerPMAXSet as65W		2.9	3.25	3.6	A
		VBUS=20V,powerPMAXSet as100W		4.2	4.7	5.2	A
Trickle charge current	I_{tKR}	VIN=5V, VBAT<2.5V		50	100	150	mA
		VIN=5V, 2.5V<=VBAT<N*3.0V		100	200	300	mA
Trickle cutoff voltage	V_{tKR}	The number of battery cells isN,V_{TRGT}No3.6V		N*2.9	N*3	N*3.1	V
	V_{tKR}	The number of battery cells isN,V_{TRGT}=3.6V		N*2.7	N*2.75	N*2.85	V
Charging stop current	I_{STOP}			100	0.025*FCAP		mA
recharge threshold	V_{RCH}	The number of battery cells isN			V_{TRGT}– N*0.1		V
Charging end time	T_{END}			45	48	51	Hour
Discharge system							
Battery operating voltage	V_{BAT}	The number of battery cells isN		N*2.75		N*4.5	V
Switch working battery Input Current	I_{BAT}	VBAT=4*3.7V, VOUT=5.0V, fs=250kHz, Iout=0mA		3	7		mA
DCThe output voltage	QC2.0 V_{OUT}	V_{OUT}=5V@1A		4.75	5.00	5.25	V
		V_{OUT}=9V@1A		8.70	9	9.30	V
		V_{OUT}=12V@1A		11.60	12	12.40	V
	QC3.0/ QC3+ V_{OUT}	@1A		3.6		12	V
	QC3.0 Step				200		mV
	QC3+ Step				20		mV
Output voltage ripple	ΔV_{OUT}	VBAT=4*3.7V, VOUT=5.0V, fs=250KHz, Iout=1A			120		mV
		VBAT=4*3.7V, VOUT=9.0V,fs=250KHz, Iout=1A			135		mV
		VBAT=4*3.7V, VOUT=12V,fs=250KHz, Iout=1A			370		mV
Discharge system maximum	Pmax	PDUnder the agreement, differentPMAXelectricity		20		100	W

Output Power		Resistance values correspond to differentPmax				
Discharge system efficiency	nout	VBAT=8V, VOUT=5V,I OUT=2A		94.69		%
		VBAT=8V, VOUT=9V, I OUT=2A		95.36		%
		VBAT=8V, VOUT=12V, I OUT=2A		95.86		%
		VBAT=15V, VOUT=5V,I OUT=2A		91.55		%
		VBAT=15V, VOUT=9V, I OUT=2A		95.05		%
		VBAT=15V, VOUT=12V, I OUT=2A		95.37		%
Discharge system overcurrent shutdown current	Ishut	VBAT=N*3.7V,Multi-port output5V	4.1	4.4	4.7	A
		VBAT= N *3.7V,Single port output5V	3.1	3.4	3.8	A
		VBAT= N *3.7V,Single port output 9V,NoPDstate	2.7	3	3.3	A
		VBAT= N *3.7V,Single port output 12V,NoPDstate	2	2.2	2.5	A
		VBAT= N *3.7V,Single port output PDstate		PDO*1.1		A
Output light load shutdown power	Pout	VBAT=3.7V		350		mW
Load overcurrent detection time	TUVD	The output voltage continues to fall below2.4V		30		ms
Load short circuit detection time	TOCD	The output voltage continues to fall below2.2V		40		us
Control System						
On-off level	fs	Discharge switching frequency		250		kHz
		Charging switching frequency		250		kHz
VCCIOoutput Voltage	VCCIO		3.15	3.3	3.45	V
Battery side standby power flow	ISTB	VBAT=14.8V, after pressing the key to turn off the average current		180		uA
LDOOutput power flow	ILDO		25	30	35	mA
ledlighting drive Moving current	IWLED		10	15	20	mA
leddisplay driver Moving current	IL1 IL2 IL3	voltage drop10%	5	7	9	mA
Total load light load limit	T1load	The load power continues to be less than350mW	30	32	34	s

When the machine automatically detects between						
Output port light load switch When the automatic detection is interrupted between	T2load		14	16	18	s
When waking up by short key press between	TOnDebounce		60		500	ms
OpenWLED time	TKeylight		1.2	2	3	s
Thermal shutdown temperature	TOTP	rising temperature	110	125	140	℃
Thermal shutdown temperature is late stagnation	ΔTOTP			40		℃

7.Function description

Low battery lock and activation

IP5389When the battery is connected for the first time, no matter what the battery voltage is, the chip is in a locked state and the lowest level of the battery light will flash.4times, or digital tube0%flash4prompt; in the non-charging state, if the battery voltage is too low to trigger a low-power shutdown,IP5389It will also enter a locked state.

In the low-voltage state of the battery, in order to reduce static power consumption,IP5389There is no load insertion detection function, and it cannot be activated by pressing a button. At this time, the button action cannot activate the buck-boost output, but the lowest level of the battery light will flash.4prompt once.

In the locked state, you must enter the charging state to activate the chip function.

Charge

IP5389It has a constant current and constant voltage lithium battery charging management system that supports synchronous switching structure. Can automatically match different charging voltage specifications.

When the battery voltage is less than$V_{IKR}$when, adopt200mATrickle charging; when the battery voltage is greater thanV_{IKR}, enter the input constant current charging, the maximum charging current at the battery end8.0A; When the battery voltage is close to the set battery voltage, it enters constant voltage charging; when the battery terminal charging current is less than the stop charging currentI_{STOP} And when the battery voltage is close to the constant voltage, charging stops. After charging is completed, if the battery voltage is lower than (V_{TRGT}– N*0.1)VThen, turn on battery charging again.

IP5389Using switching charging technology, switching frequency250kHz. ordinary5VWhen charging, input power10W;Maximum input power when charging with fast charge input100W. Charging efficiency is the highest96%, can be shortened3/4charging time.

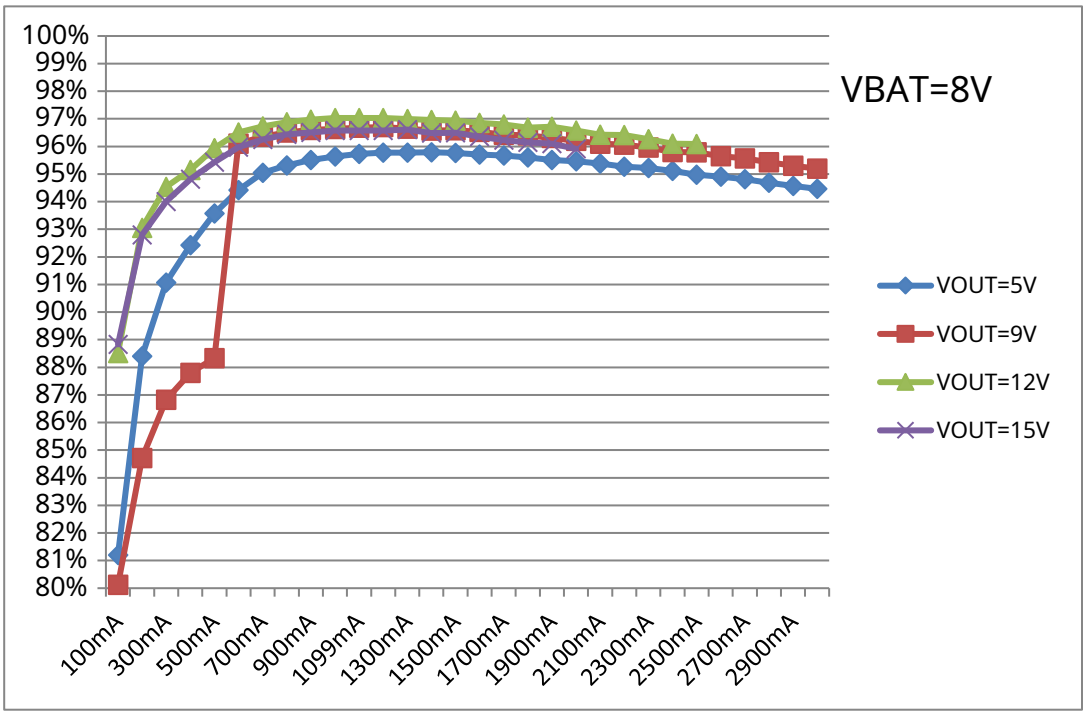
IP5389It will automatically adjust the charging current to adapt to adapters with different load capabilities. IP5389Supports simultaneous charging and discharging. When charging and discharging at the same time, the input and output are both5V.

discharge

IP5389Integrates a synchronous switching converter system with high voltage output, supporting3.0V~21VWide voltage range output, synchronous switching buck-boost system can provide maximum100WOutput capability. The built-in soft-start function prevents faults caused by excessive inrush current during startup. Integrated output over-current, short-circuit, over-voltage, over-temperature and other protection functions ensure stable and reliable operation of the system.

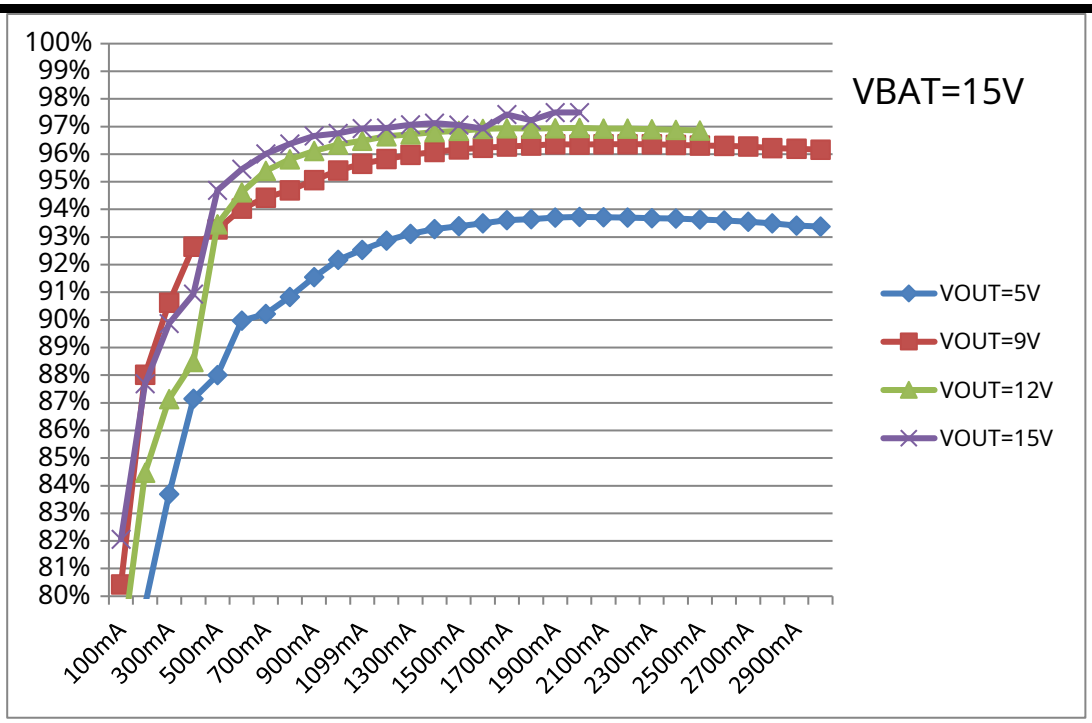
The discharge system current can be automatically adjusted with temperature to ensureICThe temperature is below the set temperature.

VBAT=8V,VOUT=5/9/12/15VWhen , the discharge efficiency curve is as follows:



picture4VBAT=8VDischarge efficiency curve

VBAT=15V,VOUT=5/9/12/15VWhen , the discharge efficiency curve is as follows:



picture5VBAT=15VDischarge efficiency curve

USB C

IP5389integratedUSB CThe input and output identification interface automatically switches the built-in pull-up and pull-down resistors, and automatically identifies the charging and discharging attributes of the inserted device. withTry.SRCfunction when connected to the other party asDRPWhen using the device, you can give priority to charging the other party.

as aDFPWhen working, useCCPin configuration external output3ACurrent capability information; treated asUFPWhen working, the output current capability of the other party can be identified.

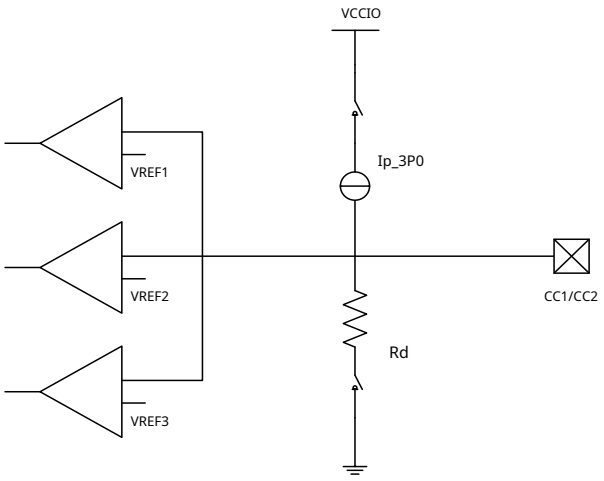


Figure 6 CC internal circuit

Pull up and down ability

name	value

Ip_3P0	330uA
Rd	5.1K

pull upIPComparator threshold when enabled

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

	Minimum Voltage	Maximum Voltage	Threshold
Powered cable/adapter (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		

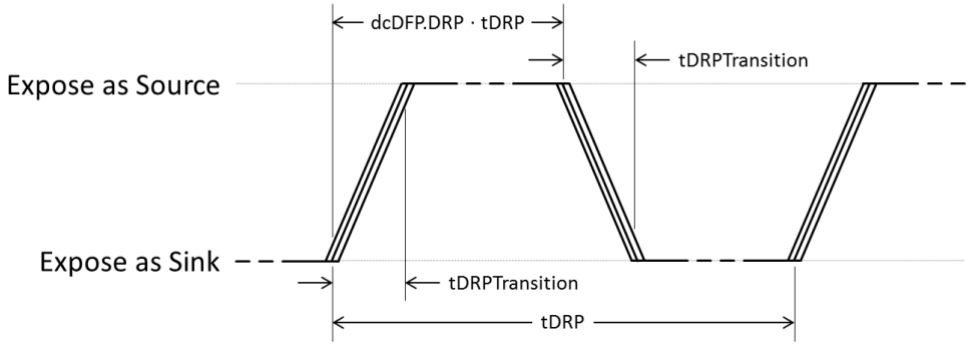
Pull-down resistorRdComparator threshold when enabled

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	

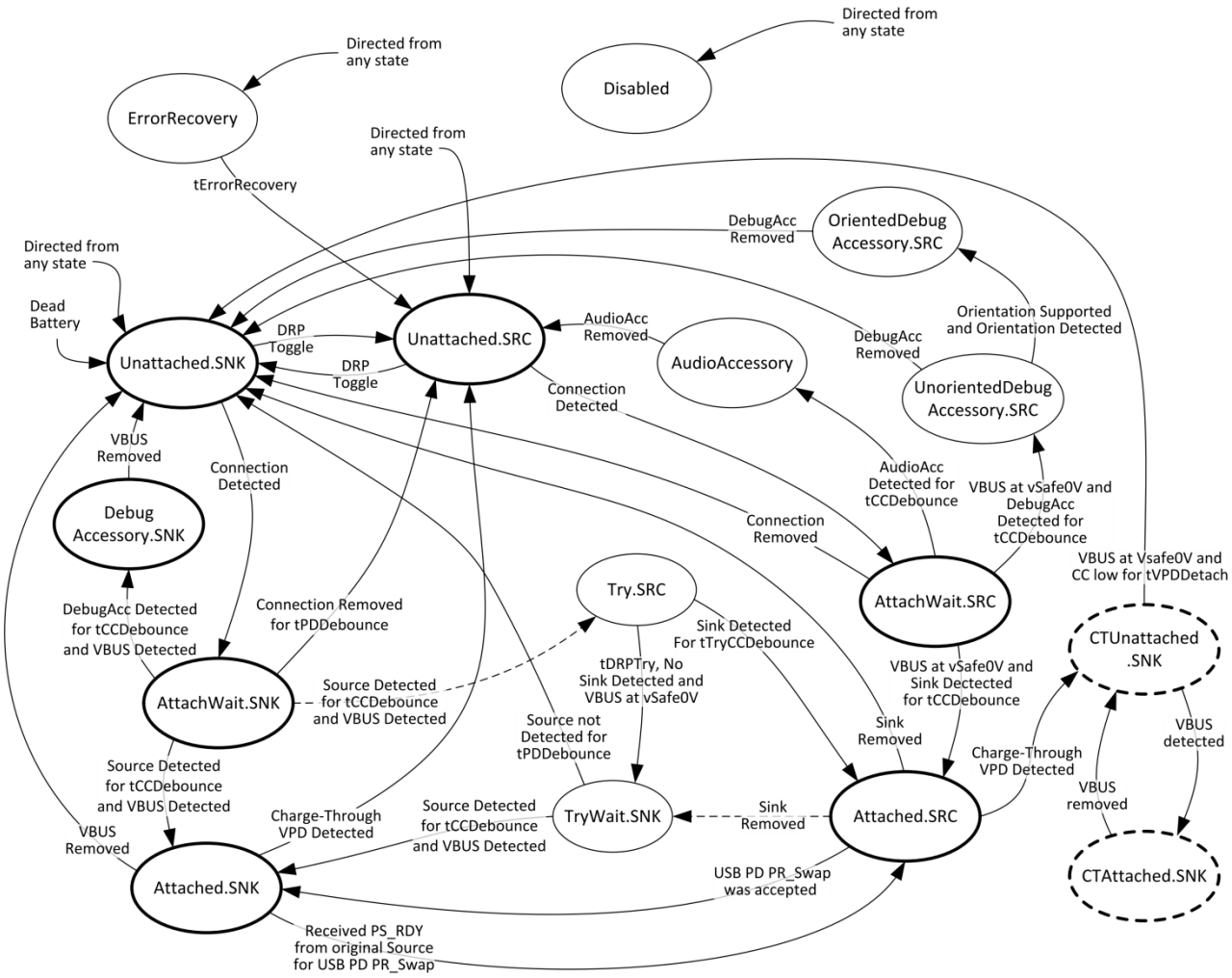
USB CDetection cycle

Figure 4-36 DRP Timing



	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.
tTryTimeout	550 ms	1100 ms	Timeout for transition from Try.SRC to TryWait.SNK.
tVPDDetach	10 ms	20 ms	Time for a DRP to detect that the connected Charge-Through VCONN-Powered USB Device has been detached, after VBUS has been removed.

USB CDetect state transitions



USB C PD

IP5389integratedUSB C Power Delivery PD2.0/PD3.0/PPSprotocol, integrated physical layer protocol (PHY), hardware bidirectional mark encoding and decoding (BMC) module.

supportPD2.0/PD3.0Bidirectional input/output protocol, supportPPSOutput protocol. maximum support100WPower output, input support5V, 9V,12V,15V,20VVoltage level, output support5V,9V,12V,15V,20VVoltage level. After recognizingE-MARKCable output broadcast capability5V/3A,9V/3A,12V/3A,15V/3A,20V/5A,PPS 3.3~21V/3A; not recognizedE-MARKCable output broadcast capability5V/3A,9V/3A,12V/3A,15V/3A,20V/3A,PPS 3.3~21V/3A.

Fast charging function

IP5389Supports multiple specifications of fast charging modes:QC2.0/QC3.0/QC3+,FCP,AFC,SCP,VOOC,Apple. Charging mobile power supply is not supportedQC2.0,QC3.0,QC3+function, does not support external fast charging protocolIC. Charging the mobile power supply can supportFCP,AFCFast charging input due toFCP,AFCis passedDP/DMPerforms fast charging handshake request, so when other fast charging protocols are addedICwhen, can no longer supportFCP,AFCFast charging.

When the mobile power supply charges the mobile phone: After entering the discharge mode, it automatically detectsDP,DMFast charging timing on the pin, intelligent identification of mobile phone type, can supportQC2.0/QC3.0/QC3+,FCP,AFC,SCP,VOOCProtocol mobile phones, as well as iPhones2.4Amodel,BC1.2ordinary Androidcell phone1Amodel.

When supporting Apple phones:DP=DM=2.7V

supportBC1.2hour:DPandDMShort

existBC1.2mode, when detectingDPvoltage greater than0.325Vand less than2Vcontinued1.25sWhen, it is initially judged that there is a fast charge request, and it will be disconnected at this time.DPandDMshort path between theDMdrop down20kto ground if sustained2mssatisfyDPvoltage greater than0.325Vand less than2V,DMvoltage less than0.325V, it is considered that the fast charging connection is successful, and then you can follow theQC2.0/QC3.0/QC3+Demand outputs the requested voltage. any time whenDPvoltage less than0.325V, then the fast charge mode is forced to exit, and the output voltage returns to the default immediately.5V.

QC2.0/QC3.0/QC3+Output voltage request rules

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	Keep

Continuous ModeThat isQC3.0/QC3+Unique working mode, in this mode, the output voltage can be according toQC3.0protocol requirements, in accordance with0.2VofstepFor fine voltage regulation, it is also possible toQC3+After the handshake is successful, follow20mVofstepconduct fine voltage

adjust.

IP5389Fast charging protocols supported by each port:

protocol	VOUT1Output port	VOUT2Output port	Micro USBenter mouth	TYPECoutput	TYPECenter
QC2.0	√	√	-	√	-
QC3.0	√	√	-	√	-
QC3+	√	√	-	√	-
AFC	√	√	√	√	√
FCP	√	√	√	√	√
SCP	√	√	√	√	√
VOOC	√	√	√	-	√
PD2.0	-	-	-	√	√
PD3.0	-	-	-	√	√
PPS	-	-	-	√	-

Support:√

not support:-

Charge and discharge path management

Standby

ifVINorVBUSPlug in the charging power source and start charging directly.

ifVBUSInsert onUSB C UFPdevice orVOUTWhen electrical equipment is plugged in, the discharge function can be automatically turned on. If there is a key press action,VOUT1,VOUT2,USB CIt will only be turned on when there is a load connected to it, otherwise it will remain off.

When discharging

In the absence of any key action, only the output path of the output port that is plugged into the electrical device will be opened; the output path of the output port that is not connected to the device will not be opened.

VOUT1,VOUT2,USB CAny port can support the output fast charging protocol, but since this solution is a single inductor solution and can only support one voltage output, fast charging output can only be supported when only one output port is turned on. When two or three output ports are used at the same time, the fast charging function will be automatically turned off.

Connect as shown in the "Typical Application Principle Diagram". When any output port has entered the fast charging output mode, when an electrical device is inserted into the other output port, all output ports will be turned off first, the high-voltage fast charging function will be turned off, and then turned on again. There are output ports where the device exists. At this time, all output ports only supportApple,BC1.2mode charging. When in multi-port output mode, the output current of any output port is less than approximately80mA(MOS Rds_ON@10mohm), continues16sThe port will be closed automatically. When reduced from multiple powered devices to only one powered device, the duration is approx.16sThen it will first turn off all output ports, turn on the high-voltage fast charging function, and then turn on the output port of the last electrical device to reactivate the device to request fast charging. When only one output port is open, the total output power is less than approximately350mWLasts approx.32s , the output port and discharge function will be turned off and enter the standby state.

While charging

VINmouth andVBUSCharging can be done by plugging in any power supply into any port. If both are connected to the power supply for charging, the power supply plugged in first will be used first for charging.

In the single charging mode, it will automatically identify the fast charging mode of the power supply and automatically match the appropriate charging voltage and charging current.

Charge and discharge at the same time

When the charging power supply and electrical equipment are plugged in at the same time, it will automatically enter the charging and discharging mode. In this mode, the chip will automatically turn off the internal fast charge input request.VIOThe voltage is only5VIn the case of, open the discharge path to supply power to the electrical equipment; ifVIOvoltage greater than5.6V, for safety reasons, the discharge path will not be opened. In order to ensure the normal charging of electrical equipment,IP5389will increase the charging undervoltage loop to4.925VAbove, to ensure priority is given to powering electrical equipment.

During the process of charging and discharging, if the charging power source is unplugged,IP5389The charging function will be turned off and the discharging function will be restarted to provide power to the electrical equipment. For safety reasons and to be able to reactivate the phone and request fast charging, there will be a period of time during the conversion process when the voltage drops to0V.

During the process of charging and discharging, if the electrical equipment is unplugged or the electrical equipment is full and stops drawing power for about16sThen 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, fast charging will be automatically reactivated, and the charging of the mobile power supply will be accelerated.

Mobile phone automatic detection

Mobile phone plug-in automatic detection function

IP5389Automatically detects when a mobile phone is plugged in, wakes up from standby immediately, and turns on boost5VCharge your mobile phone, eliminating the need for button operations, and support button-less mold solutions.

Mobile phone full automatic detection function

IP5389through the filmADCto sample the output current of each port. When the output current of a single port is less than approximately80mA(MOS Rds_ON@10mohm) and lasts approx.16s, the output port will be closed. When the total output power is less than approx.350mWLasts approx.32s , it is considered that all output ports of the mobile phone are fully charged or unplugged, and the boost and buck output will be automatically turned off.

Button selection

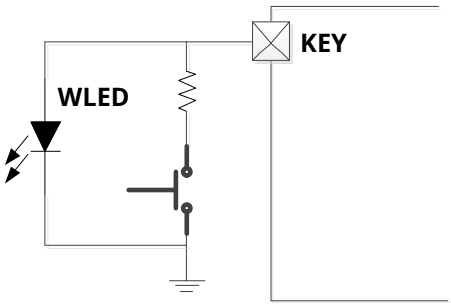


Figure 7 KEY button connection method

The button connection method is as shown in the figure7As shown, long key press and short key press operation can be recognized.

- The key duration is longer than60ms, but less than2s, which is the short press action
- The key duration is longer than2s, which is a long press action.

- less than60msThere will be no response to key presses.
- Super long press10sThe entire system can be reset.

Fast charging status indicator

HLEDIt can indicate the current fast charging mode, whether charging or discharging. When entering the fast charging mode, it is in non-5Vstatus, the indicator light will automatically light up.

can be used as6pinThe digital tube solution6pinDriving pin, there is no fast charging light display at this time (needs to be customized according to the actual digital tube specifications)

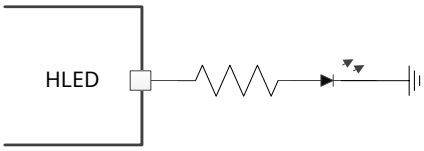


Figure 8 Fast charging indicator light connection method

Fuel gauge and power display

IP5389Built-in fuel gauge function enables accurate battery power calculation. IP5389 Support externalLED5to choose isledThe mode is still the digital tube mode. IP5389support4 light mode. IP5389support188The digital tube displays the power.

fuel gauge

IP5389Supports external setting of the initialization capacity of the battery core, and uses the integration of the battery terminal current and time to manage the remaining capacity of the battery core. When battery terminal current detectionPin CSP2/CSN2use5mohmWhen detecting resistance, the current capacity of the battery cell can be accurately displayed. When battery terminal current detection Pin CSP2/CSN2When short-circuited, the battery current can be estimated to display the estimated current cell capacity; at the same timeIP5389Support power charging from0%Charge to100%A complete charging process automatically calibrates the total capacity of the current battery core, and manages the actual capacity of the battery core more reasonably.

IP5389externalPINThe formula for setting the initial capacity of the battery cell: battery capacity =R_{17}*0.8 (mAH). minimal support2000mAH, maximum support 25000mAH, the capacity is the capacity of a single string of cells.

whenFCAPThe voltage on the pin is less than100mVor greater than2700mVwhen, it will be recognized asR17The resistor is short-circuited or open-circuited.

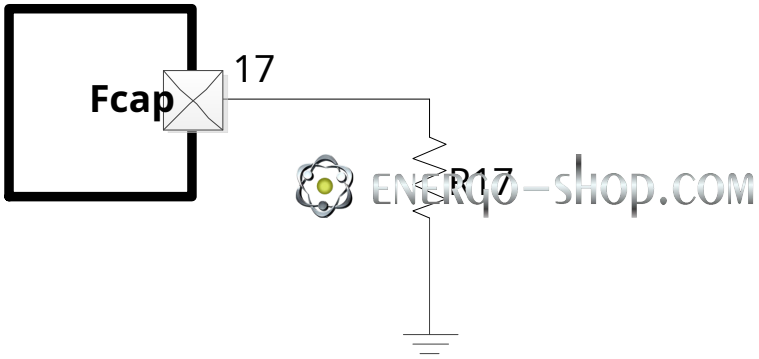


Figure 9 Battery capacity configuration circuit diagram

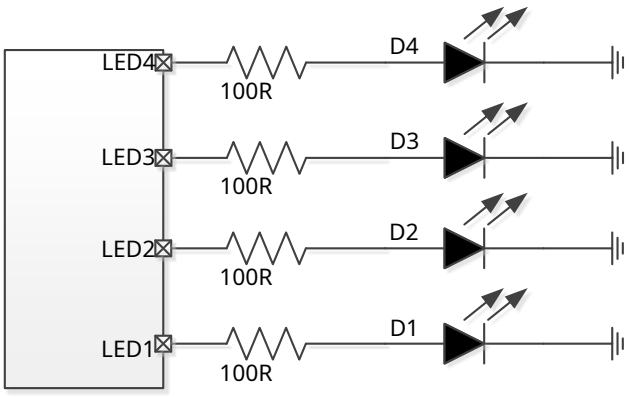
Typical battery capacity configuration table:

R17Resistance value (ohms)	Corresponding to the set battery capacity (mAH)
6.2k	5000mAH
12.4k	10000mAH
18.7k	15000mAH
24.9k	20000mAH
30.9k	25000mAH

Note: The cell capacity in the table refers to the cell capacity of a single battery.

ledLamp power display mode

IP5389 4Battery indicator light solution, the connection method is as follows:



4LED mode

Figure 10 4LED connection method

4How the lights are displayed:

While charging

PowerC(%)	D1	D2	D3	D4

full	Bright	Bright	Bright	Bright
75%≤C	Bright	Bright	Bright	1.5Hzflashing
50%≤C＜75%	Bright	Bright	1.5Hzflashing	destroy
25%≤C＜50%	Bright	1.5Hzflashing	destroy	destroy
C＜25%	1.5Hzflash sparkle	destroy	destroy	destroy

When discharging

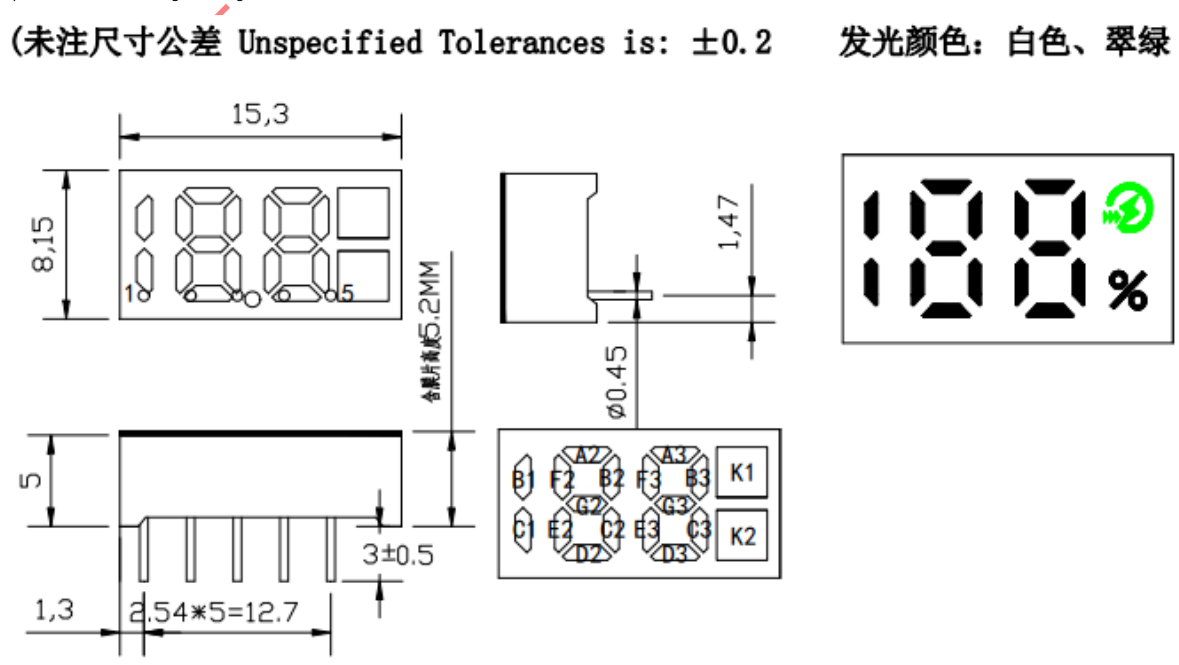
PowerC(%)	D1	D2	D3	D4
C≥75%	Bright	Bright	Bright	Bright
50%≤C＜75%	Bright	Bright	Bright	destroy
25%≤C＜50%	Bright	Bright	destroy	destroy
3%≤C＜25%	Bright	destroy	destroy	destroy
0%＜C＜3%	1.0Hzflash sparkle	destroy	destroy	destroy
C=0%	destroy	destroy	destroy	destroy

Digital tube power display mode

IP5389The default supported digital tubes are as follows.

Digital Tube	Charge		discharge	
	not full state	full state	The battery is less than5%	The power is greater than5%
188type	0-99%indivual Bit 0.5HZflashing	Always on100%	0-5%ones digit1HZflash sparkle	5%-100%Always on

5pin 188The schematic diagram of digital tube is as follows:



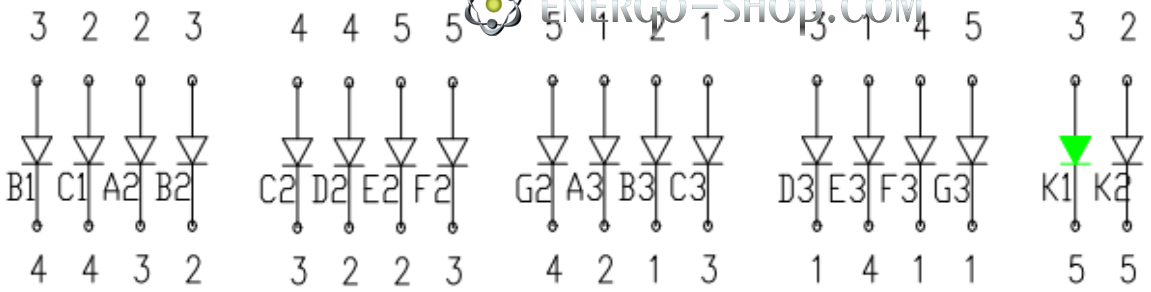


Figure 11 5pin 188 type digital tube circuit diagram

	IP5389 light display driver pin	Digital tube pin	Remark
IP5389 light display drive pin and Digital tube pin Foot order mapping relation	LED1(48 pin)	1 pin	
	LED2(47 pin)	2 pins	
	LED3(46 pin)	3 pins	
	LED4(45 pin)	4 pins	
	LED5(44 pin)	5 pins	
	HLED(38pin)	6 pins	Optional, 6pin digital tube solution

System input and output maximum power setting

IP5389pass judgmentPMAXThe resistance value connected to the pin sets the maximum input and output power of the system. Input and output maximum power configuration table:

PMAX R14 (ohm1%)	Corresponding to the maximum power setPMAX
27k	65W(E-MARKThe output power of the cable is65W)
18k	60W
13k	45W
9.1k	30W
6.2k	27W
3.6k	100W(E-MARKThe output power of the cable is 100W)

Note: If wantE-MARK Cable identification, please refer todemoApplication schematic addedE-MARKpower supply circuit.

Battery series quantity setting

IP5389pass judgmentBAT_S1andBAT_S2Is the pin connected?GNDto set the number of batteries connected in series, Thereby changing the power display threshold, Constant voltage for charging the battery and protection voltage.

Battery series quantity configuration table:

BAT_S1 R18(ohm)	BAT_S2 R19(ohm)	Number of battery cells in series
0	0	2 skewers
NC	0	3 skewers
0	NC	4 skewers
NC	NC	5 skewers

VSET(Battery type setting)

IP5389by inVSETOutput on pin80uAcurrent, connect different external resistors toGNDto set the battery type to change the battery display threshold, the constant voltage for charging the battery, and the protection voltage.VSETexternal pairGNDThe resistor size and set battery type are shown in the table below. Pay attention to the use of external resistors1% Precision resistor, resistor selection needs to take into account as much as possibleVSETThe voltage is taken in the middle of the judgment range. when VSETIf the voltage exceeds all judgment voltage ranges, it will be recognized as a short circuit or open circuit abnormality in the detection resistor.

VSETEnd toGNDresistance (ohm)	VSETVoltage (theoretical voltage) (mV)	VSETDetermine voltage range (mV)	Corresponding battery type
27k	2160	1750~2550	4.2V
18k	1440	1220~1750	4.3V
13k	1040	860~1220	4.35V
9.1k	728	600~860	4.4V
6.2k	496	384~600	4.15V
3.6k	288	216~384	3.65V

Remark:3.65VFor lithium iron phosphate batteries, the corresponding low power shutdown voltage has been adjusted to2.75V

NTCfunction andNTCThreshold selection

IP5389integratedNTCFunction to detect battery temperature.IP5389After power onNTCPINOutput at high temperatures80uAcurrent, output at low temperature20uA current, through the externalNTCresistor to produce voltage,ICInternal testingNTCPINpin voltage to determine the current battery temperature.

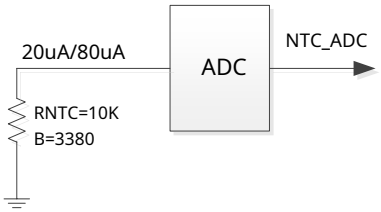


Figure 12 Battery NTC comparison

IP5389existNTC_MODE PINreleased80uACurrent, when different external resistors are connected,ICInternal testingNTC_MODEVoltage can be selected from differentNTCFunction. Pay attention to the use of external resistors1%Precision resistor, resistor selection needs to take into account as much as possibleVNTC_MODEThe voltage is taken in the middle of the judgment range. whenVNTC_MODEIf the voltage exceeds all judgment voltage ranges, it will be recognized as a short circuit or open circuit abnormality in the detection circuit.

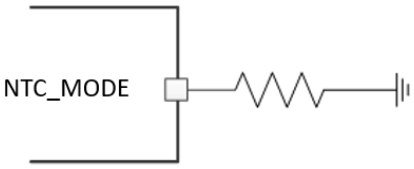


Figure 13 NTC threshold selection

NTC_MODE pinConnect external resistor	NTC_MODE Theoretical voltage (mV)	NTC_MODE Voltage judgment range (mV)	NTCFunction definition
27K	2160	1750~2550	NTCfirst gear
18K	1440	1220~1750	NTCSecond gear
13K	1040	860~1220	NTCthird gear
9.1K	728	600~860	NTCFourth gear
6.2K	496	380~600	NTCfifth gear
3.6K	288	216~380	NTCSixth gear

IP5389Six built-inNTCFeatures are available for selection by changingNTC_MODEFeet arriveGNDThe resistance value of the resistor can be set to the correspondingNTC Function. Each function is as follows:

NTCFirst level threshold:

While charging:NTCtemperature below0Spend(0.55V) stop charging,0~45Normal charging between degrees, the temperature exceeds45Spend(0.39V) Stop charging.

In discharge state: the temperature is lower than -20Spend(1.39V), stop discharging, -20Degree to60Normal discharge between degrees, higher than60Spend(0.24V) Stop discharging;

NTCSecond level threshold:

While charging:NTCtemperature below2Spend(0.50V) stop charging,2~43Normal charging between degrees, the temperature exceeds43Spend(0.42V) Stop charging.

In discharge state: the temperature is lower than -10Spend(0.86V), stop discharging, -10Degree to55Normal discharge between degrees, higher than55Spend(0.28V) Stop discharging;

NTCThird gear threshold:

While charging:NTCtemperature below0Spend(0.55V) stop charging,0~45Normal charging between degrees, the temperature exceeds45Spend(0.39V) Stop charging.

In discharge state: the temperature is lower than -10Spend(0.86V), stop discharging, -10Degree to55Normal discharge between degrees, higher than55Spend(0.28V) Stop discharging;

NTCFour levels of threshold:

While charging:NTCThe temperature is below -10Spend(0.86V) stop charging, -10~0between degreesBATterminal current limit0.2CCharge,Cequal FCAPSet battery capacity,0~45Spend(0.39V) between normal charging;45degree~55The constant voltage charging voltage decreases between degrees0.1V*NCharge the battery with normal current and the temperature exceeds55Spend(0.28V) to stop charging.

In discharge state: the temperature is lower than -20Spend(1.39V), stop discharging, -20Degree to55Normal discharge between degrees, higher than55Spend(0.28V) Stop discharging;

NTCFive-level threshold:

While charging:NTCtemperature below2Spend(0.50V) stop charging,2~17Spend(0.27V)betweenBATterminal current limit0.1CCharge, Cequal FCAPSet battery capacity,17~43Spend(0.42V) between normal charging, the temperature exceeds43Stop charging.

In discharge state: the temperature is lower than -20Spend(1.39V), stop discharging, -20Degree to60Normal discharge between degrees, higher than60Spend(0.24V) Stop discharging;

NTCSixth gear threshold:

While charging:NTCThe temperature is below -10Spend(0.86V) stop charging, -10~0Spend(0.55V)betweenBATterminal current limit0.2CCharge,0~45 Charge normally between degrees,45~55Spend(0.28V)betweenBATterminal current limit0.2CCharge,CequalFCAPThe battery capacity is set and the temperature exceeds55Spend(0.28V) to stop charging.

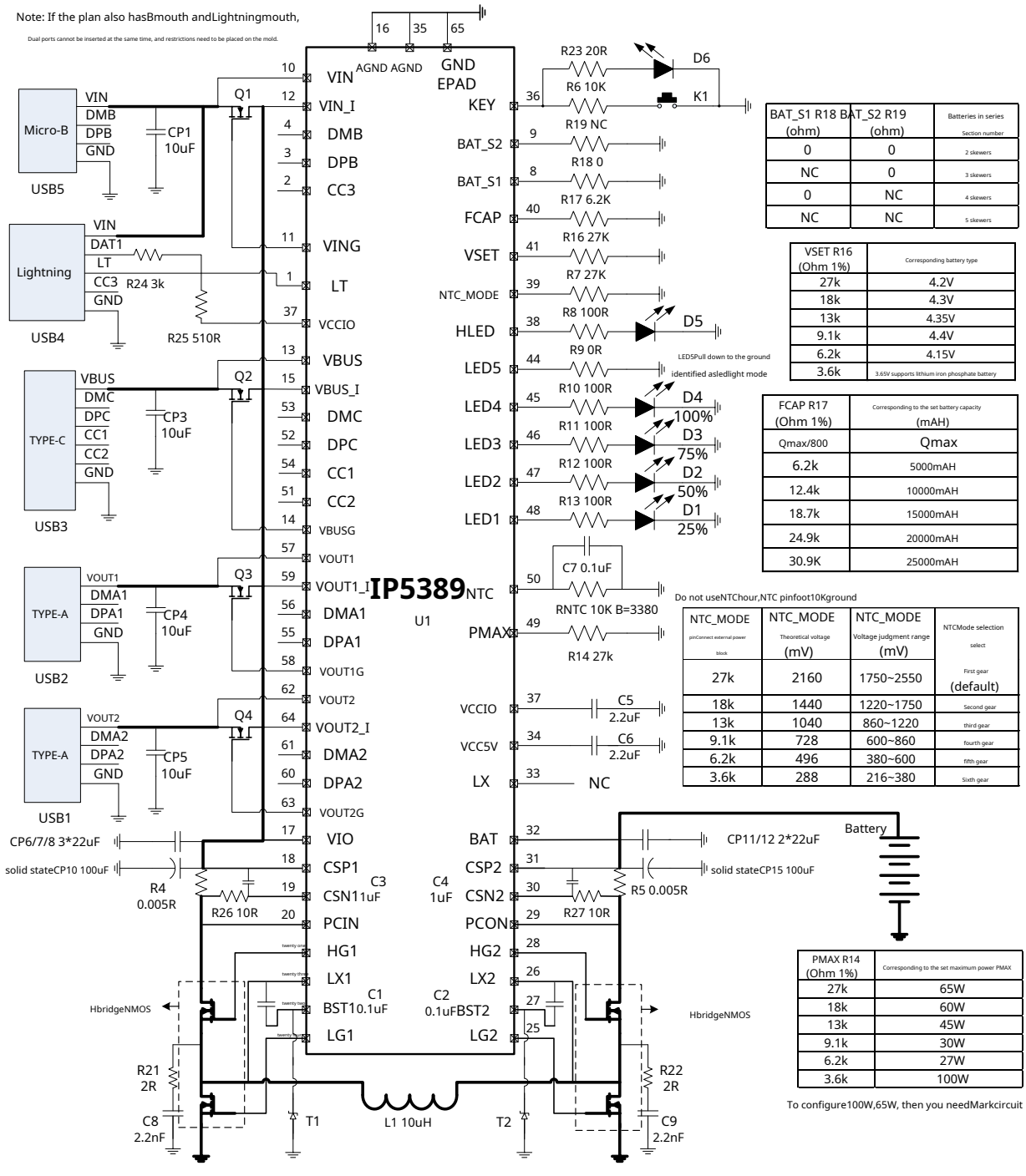
In discharge state: the temperature is lower than -20Spend(1.39V), stop discharging, -20Degree to55Normal discharge between degrees, higher than55Spend(0.28V) Stop discharging;

Remark:

existNTCAfter detecting temperature abnormality, the recovery temperature is the protection temperature ±5Spend. The values in the above brackets corresponding to the temperature areNTCPin voltage, calculated as:NTCThe current discharged by the foot*at this temperatureNTCResistor value.

The above temperature range is for referenceNTCThe resistance parameters are10K@25℃B=3380, there are differences in other models and need to be adjusted. If the plan does not requireNTC,need to be inNTCPin to ground10kResistors cannot be left floating or directly connected to ground.

8.Application schematic



BAT_S1 R18 (ohm)	BAT_S2 R19 (ohm)	Batteries in series Section number
0	0	2 skewers
NC	0	3 skewers
0	NC	4 skewers
NC	NC	5 skewers

VSET R16 (Ohm 1%)	Corresponding battery type
27k	4.2V
18k	4.3V
13k	4.35V
9.1k	4.4V
6.2k	4.15V
3.6k	3.65V supports lithium iron phosphate battery

FCAP R17 (Ohm 1%)	Corresponding to the set battery capacity (mAH)
Qmax/800	Qmax
6.2k	5000mAH
12.4k	10000mAH
18.7k	15000mAH
24.9k	20000mAH
30.9K	25000mAH

NTC_MODE pinConnect external power block	NTC_MODE Theoretical voltage (mV)	NTC_MODE Voltage judgment range (mV)	NTCMode selection select
27k	2160	1750~2550	First gear (default)
18k	1440	1220~1750	Second gear
13k	1040	860~1220	third gear
9.1k	728	600~860	fourth gear
6.2k	496	380~600	fifth gear
3.6k	288	216~380	Sixth gear

PMAX R14 (Ohm 1%)	Corresponding to the set maximum power PMAX
27k	65W
18k	60W
13k	45W
9.1k	30W
6.2k	27W
3.6k	100W

Figure 14 Application schematic diagram

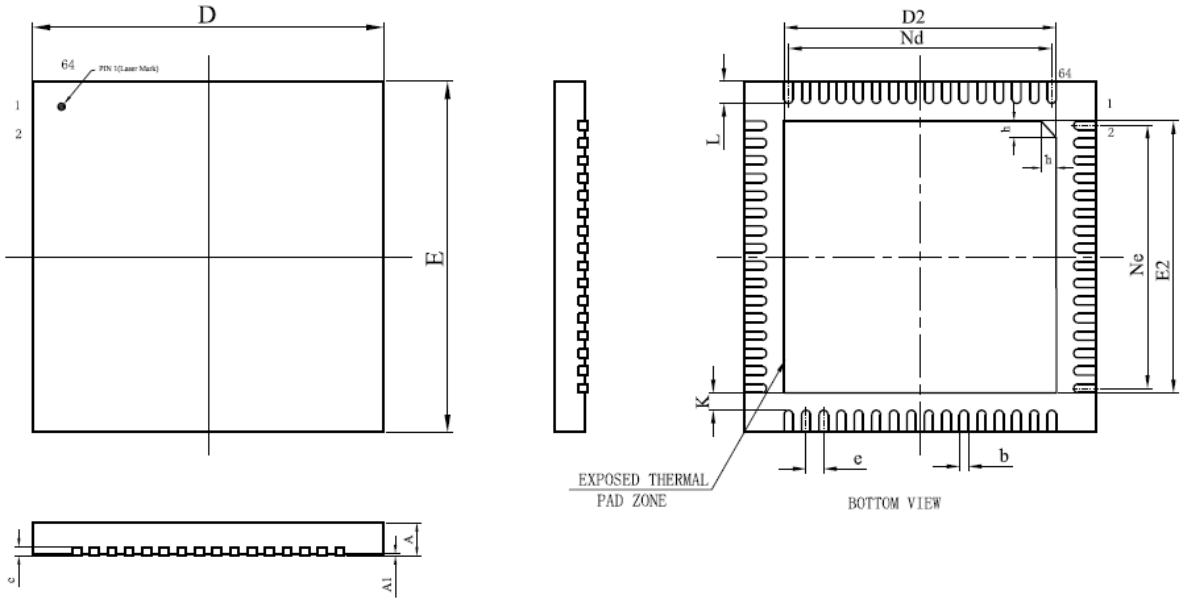
9.BOMsurface

serial number	Component name	Model & Specifications	Location	Dosage	Remark
1	patchIC	QFN64 IP5389	U1	1	
2	Chip capacitors	0603 100nF 10% 50V	C1 C2 C7	3	
3	Chip capacitors	0603 1uF 10% 16V	C3 C4	2	
4	Chip capacitors	0603 2.2uF 10% 16V	C5 C6	2	
6	Chip capacitors	0805 10uF 10% 25V	CP1 CP3 CP4 CP5	4	
7	Chip capacitors	0805 22uF 10% 25V	CP6 CP7 CP8 CP11 CP12	5	
8	solid capacitor	100uF 35V 10%	CP10 CP15	2	
9	Chip resistor	1206 0.005R 1%	R4 R5	2	
10	Chip resistor	0603 10K 5%	R6	1	
11	Chip resistor	0603 27K 1%	R7 R14 R16	3	
12	Chip resistor	0603 6.2K 1%	R17	1	
13	Chip resistor	0603 0R 1%	R18	1	
14	NTCthermistor	10K@25℃B=3380	RNTC	1	
15	Chip resistor	0603 100R 1%	R10 R11 R12 R13	4	Optional,ledSchematic diagram
16	patchled	0603blue light	D1 D2 D3 D4	4	
17	patchled	0603red light	D5	1	
18	Chip resistor	0603 100R 1%	R8	1	
19	Chip resistor	0603 0R 5%	R9	1	
20	Chip resistor	0603 100R 1%	R9 R10 R11 R12 R13	5	Optional, digital tube schematic diagram
twenty one	SMD digital tube	YFTD1508SWPG-5D	SMG1	1	
twenty two	ledlamp	5MM LED	D6	1	
twenty three	One-piece inductor	10uH 7A R_{DC}<0.01R	L1	1	
twenty four	button	SMT 3*6button	K1	1	
25	patchMOSTube	RU3030M2	Q1 Q2 Q3 Q4	4	
26	outputUSB	AF10 8foot plugUSB	USB1 USB2	2	
27	USB CSeat	USB CSeat	USB3	1	
28	LIGHTINGSeat	Apple head female seat	USB4	1	
29	enterUSB	MICRO-7-DIP-5.9	USB5	1	
30	Chip resistor	0603 20R 1%	R23	1	
31	Chip resistor	0603 3k 1%	R24	1	
32	Chip resistor	0603 510R 1%	R25	1	
33	Chip resistor	0603 10R 1%	R26 R27	2	
34	patchMOSTube	RU30J51M	HbridgeNMOS	2	
35	TVS Diode	30VTVS	T1 T2	2	
36	Chip resistor	0603 2R 1%	R21 R22	2	
37	Chip capacitors	0603 2.2nF 10% 50V	C8 C9	2	

38			R19		NC

10.Package information

Chip packaging



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.15	0.20	0.25
c	0.18	0.20	0.25
D	7.90	8.0	8.10
D2	6.10	6.20	6.30
e	0.4BSC		
Nd	6.00BSC		
E	7.90	8.0	8.10
E2	6.10	6.20	6.30
Ne	6.00BSC		
L	0.45	0.50	0.55
K	0.20	-	-
h	0.30	0.35	0.40

Pad design example

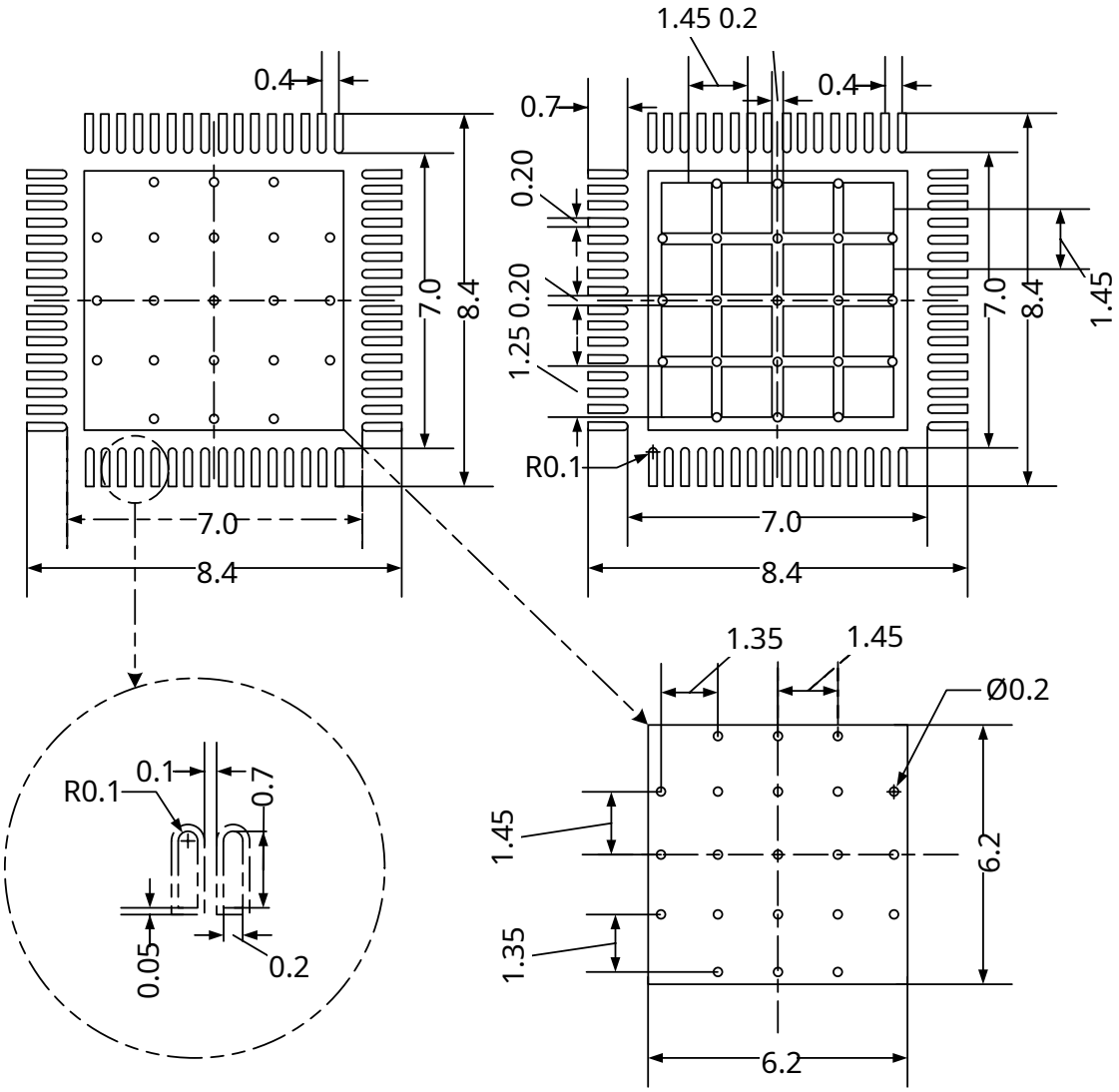


Figure 15 Example of pad design

11.ICPrinting instructions

Chinese version silk screen image

Figure 16 Chinese version of silk screen printing

English version silk screen image

Figure 17 English version of silk screen printing

12.Responsibility and Copyright Statement

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