Support PD3.0 fast charge input protocol, support 2~6 series batteries
Integrated buck-boost drive, Charging management chip with a maximum charging power of 100W

IP2368 Features

- **Charging specifications**
  - ✧ Integrated BUCK-BOOST, power NMOS diver
  - ✧ Maximum charging power 100W
  - ✧ Adaptive charging current adjustment
  - ✧ External resistor can set full voltage, The full voltage of a single lithium battery can be set in the range of 4.1V to 4.4V, The full voltage of a single lithium iron phosphate battery can be set of 3.5V to 3.7V
  - ✧ External resistor can set maximum charging power, maximum support 100W
  - ✧ External resistance selection 2/3/4/5/6 series battery cell charging
- **Quick charge specifications**
  - ✧ Integrated FCP input fast charge protocol
  - ✧ Integrated AFC input fast charge protocol
  - ✧ Integrated PD2.0/PD3.0 input fast charge protocol
- **Power display**
  - ✧ Built-in 14bit ADC and fuel gauge
  - ✧ Self-learning fuel gauge, more uniform power display
  - ✧ Initial battery capacity PIN selection configuration
- **Other functions**
  - ✧ 4/2/1 LED battery indicator
  - ✧ Support NTC battery temperature detection
  - ✧ Support I2C function
- **Multiple protection, high reliability**
  - ✧ Input over-voltage and under-voltage protection
  - ✧ Battery overcharge, over-discharge, over-current protection
  - ✧ IC over temperature protection
  - ✧ Rechargeable battery temperature NTC protection
  - ✧ ESD 4KV, input（CC/DP/DM pin）Withstand voltage 30V
- **Package specifications：7mm × 7mm 0.5pitch QFN48**

IP2368 Overview

IP2368 is a lithium battery charge management chip that integrates AFC/FCP/PD2.0/PD3.0 input fast charge protocol and synchronous buck-boost converter;

IP2368's high integration and rich functions require only one inductor to realize the synchronous buck-boost function, and only a few peripheral components are required in application, which effectively reduces the size of the overall solution and lowers the BOM cost.

IP2368 supports 2/3/4/5/6 series battery cells, the number of battery series can be selected through external resistance; IP2368 supports external resistance to choose ordinary lithium battery or lithium iron phosphate battery, external resistance can be set to full voltage, lithium battery is fully charged The voltage can be set to: 4.15V/4.2V/4.3V/4.35V/4.4V, and the full voltage of the lithium iron phosphate battery can be set to: 3.5V/3.55V/3.6V/3.65V/3.7V.

The IP2368 synchronous switch charging system provides up to 5.0A charging current. The maximum charging power or the charging current of the battery can be set through an external resistor, and the maximum charging can reach 100W. IP2368 has built-in IC temperature, battery NTC temperature and input voltage control detection loop, which can intelligently adjust the charging current according to different power chargers.

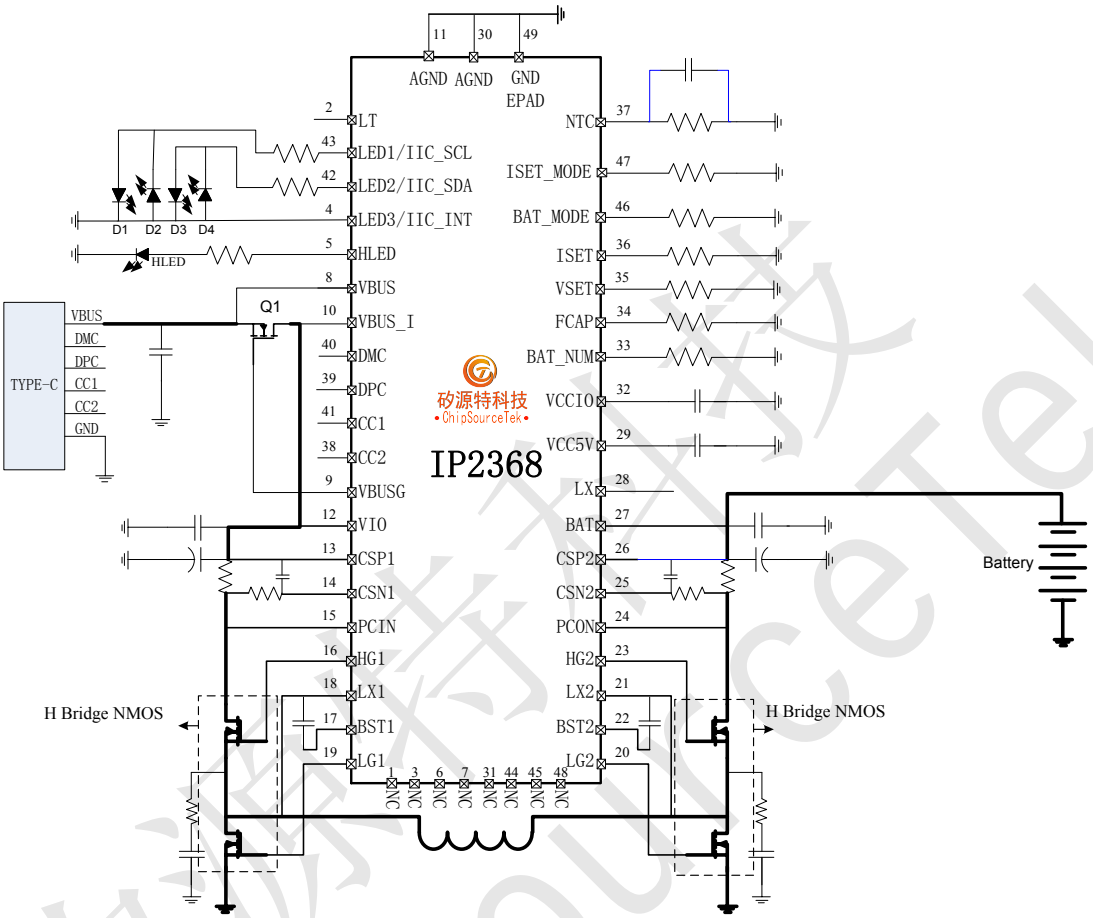
IP2368 built-in 14bit ADC, can accurately measure the charging input voltage and current, battery voltage and current. IP2368 has a built-in power calculation method, which can obtain battery power, charging voltage, charging current and other information through I2C.

IP2368 supports 2 charging status indicators.

IP2368 Application Products

- 2~6 series lithium battery/lithium iron phosphate battery charging

IP2368 typical application



Common Custom Product Description

Part No.	function description
IP2368_BZ	Standard IP2368, support 2-6 batteries
IP2368_COUT	Add discharge output function to IP2368_BZ
IP2368_I2C_COUT	Add I2C function to IP2368_COUT, can be used as I2C slave
IP2368_NF	Can be upgraded to any other model
IP2368_NACT	Remove the function of charging activation based on IP2368_COUT
IP2368_I2C_NACT	Remove the function of charging activation based on IP2368_I2C_COUT

IP2368 Pin Description

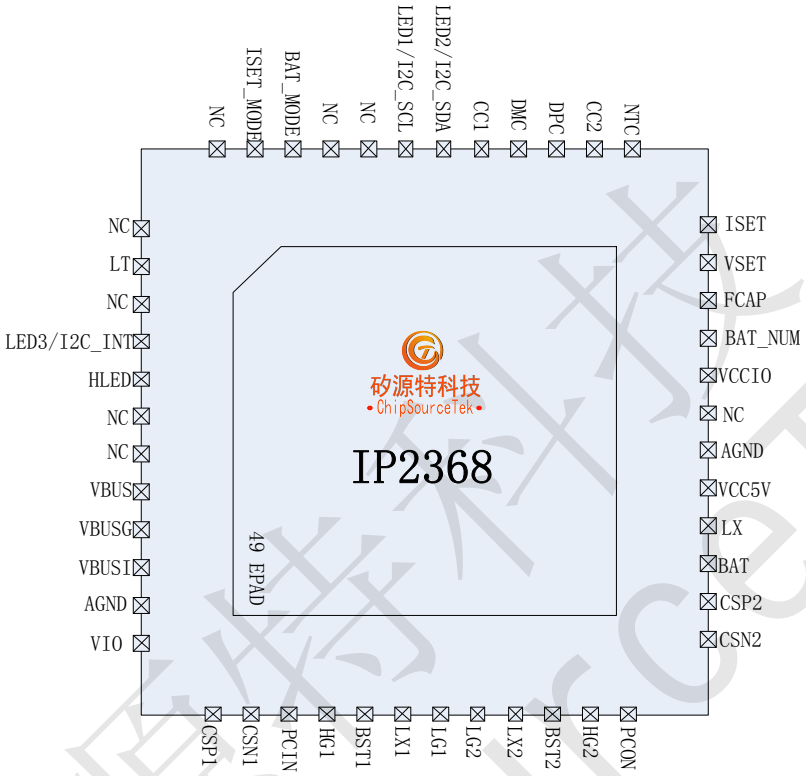


Figure 2 IP2326 Pin Assignment

IP2368 Pin description

Pin Num	Pin Name	PIN Definition description
1	NC	Undefined pin, keep floating
2	LT	Lighting decoding pin
3	NC	Undefined pin, keep floating
4	LED3/I2C_INT	Charge status light display output indicator pin 3,or used as I2C_INT interface status indicator output;
5	HLED	Fast charge indicator pin, after the fast charge protocol handshake is successful, output high level
6	NC	Undefined pin, keep floating
7	NC	Undefined pin, keep floating
8	VBUS	VBUS input detection pin
9	VBUSG	VBUS input path NMOS control pin
10	VBUS_I	VBUS input path current detection pin
11	AGND	Analog ground

12	VIO	Power input pin
13	CSP1	Input current sampling positive terminal
14	CSN1	Input current sampling negative terminal
15	PCIN	Input peak current sampling pin
16	HG1	The upper tube control pin at the input end of the H-bridge power tube
17	BST1	Bootstrap voltage pin at the input end of the H-bridge power tube
18	LX1	Input terminal inductance connection pin
19	LG1	H-bridge power tube input end lower tube control pin
20	LG2	H-bridge power tube output battery end lower tube control pin
21	LX2	Battery terminal inductance connection pin
22	BST2	Bootstrap voltage pin of H-bridge power tube battery terminal
23	HG2	The upper tube control pin of the battery end of the H-bridge power tube
24	PCON	Battery peak current sampling pin
25	CSN2	Average battery current sampling negative terminal
26	CSP2	Battery terminal current sampling positive terminal
27	BAT	Battery side power supply pin
28	LX	System 5V power supply BUCK output inductor connection point, floating by default
29	VCC5V	System 5V power supply, to supply power to the internal analog circuit of the IC
30	AGND	Analog ground
31	NC	Undefined pin, keep floating
32	VCCIO	System 3.3V power supply, to supply power to the internal digital circuit of the IC
33	BAT_NUM	Selection of the number of battery cells in series, connect different resistors, and choose a different number of cells in series
34	FCAP	Battery capacity selection, connect different resistors, and choose different battery capacities
35	VSET	Battery full voltage selection, connect different resistors, you can choose different rechargeable battery voltages
36	ISET	Constant current charging power or charging current setting
37	NTC	NTC resistance detection pin
38	CC2	USB C port detection and fast charge communication pin

		CC2
39	DPC	USB C port fast charge and intelligent recognition of DP
40	DMC	USB C port fast charge and intelligent identification DM
41	CC1	USB C port detection and fast charge communication pin CC1
42	LED2/I2C_SDA	Charge status indicator output indicator pin 2, or used as I2C_SDA;
43	LED1/I2C_SCL	Charge status indicator output indicator pin 1, or used as I2C_SCL;
44	NC	Undefined pin, keep floating
45	NC	Undefined pin, keep floating
46	BAT_MODE	Battery type selection, grounding selection lithium iron phosphate battery, floating or high connection selection ordinary lithium battery
47	ISET_MODE	ISET current setting mode selection, grounding selection ISET setting battery terminal constant current charging, floating or high connection selection ISET setting charging input power
48	NC	Undefined pin, keep floating
49(EPAD)	GND	System ground and heat dissipation ground, need to keep good contact with GND

IP2368 Internal block diagram of the chip

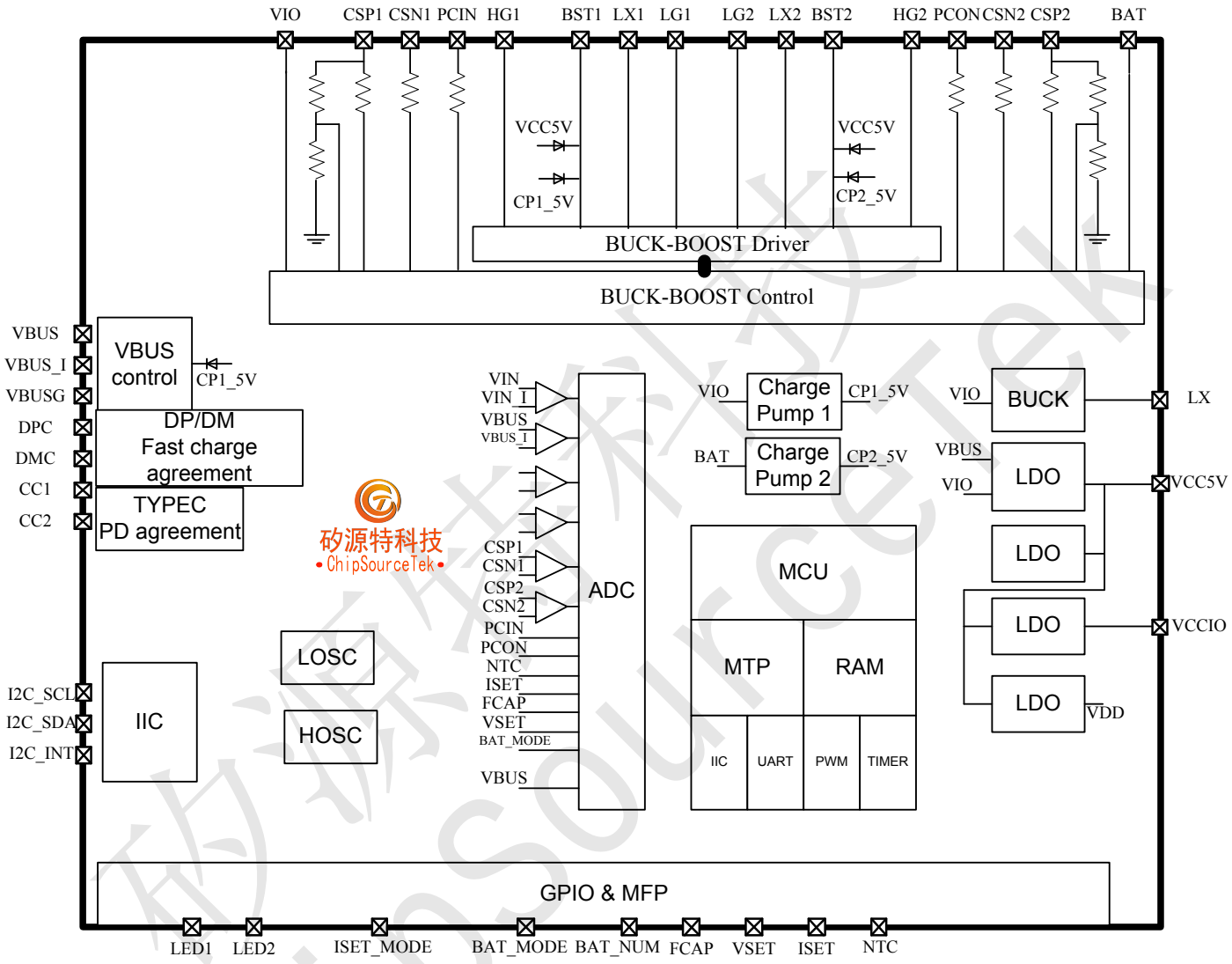


Figure 3 Internal block diagram of the chip

IP2368 Limit parameters

parameter	symbol	value	unit
Port voltage range	VBAT/VBUS	-0.3 ~ 35	V
Protocol interface voltage range	DPC/DMC/CC1/CC2	-0.3 ~ 30	V
Digital GPIO voltage range	LED/GPIO	-0.3 ~ 8	V
Junction temperature range	T_J	-40 ~ 125	℃
Storage temperature range	Tstg	-60 ~ 150	℃

Thermal resistance (junction temperature to environment)	θ_{JA}	30	℃/W
Human Body Model (HBM)	ESD	4	KV

*Stresses higher than the values listed in the Absolute Maximum Ratings section may cause permanent damage to the device. Excessive exposure under any absolute maximum rating conditions may affect the reliability and service life of the device.

IP2368 Recommended working conditions

parameter	symbol	Min	Typical	Max	unit
Input voltage	VBUS	4.5		25	V
battery voltage	VBAT			28	V
Working temperature	T_A	-40		85	℃

*Beyond these operating conditions, device operating characteristics cannot be guaranteed.

IP2368 Electrical characteristics

Unless otherwise specified, TA=25℃, L=10uH

Parameter	Symbol	Test Conditions		Min	Typical	Max	unit
Charging system							
Input voltage	V_{BUS}			4.5	5/9/12/15/20	25	V
Input over-voltage	V_{BUS}	Rising voltage				25	V
Charging Target Voltage	V_{TRGT}	BAT_MODE is floating V_{TRGT}=4000+0.02*R_{VSET} (Unit mV) step=10mV	R_{VSET} = 7.5K	N*4.11	N*4.15	N*4.19	V
			R_{VSET} = 10K	N*4.16	N*4.20	N*4.24	V
			R_{VSET} = 15K	N*4.26	N*4.30	N*4.34	V
			R_{VSET} = 17.5K	N*4.31	N*4.35	N*4.39	V
			R_{VSET} ≥20K	N*4.36	N*4.40	N*4.44	V
		BAT_MODE is grounded V_{TRGT}=3500+0.01*R_{VSET} (Unit mV) step=10mV	R_{VSET} = 5K	N*3.51	N*3.55	N*3.59	V
			R_{VSET} = 10K	N*3.56	N*3.60	N*3.64	V
			R_{VSET} = 15K	N*3.61	N*3.65	N*3.69	V
			R_{VSET} ≥20K	N*3.66	N*3.70	N*3.74	V
Charging power or current	P_{CCIN} OR I_{CHRG}	ISET_MODE is floating P_{CCIN}=4*R_{ISET} (UnitmW) step=1W	R_{ISET}= 5K		20		W
			R_{ISET}= 7.5K		30		W
			R_{ISET}= 11.2K		45		W
			R_{ISET}= 15K		60		W
			R_{ISET}≥ 25K		100		W
		ISET_MODE is grounded I_{CHRG}=0.2*R_{ISET} (UnitmA) step=100mA	R_{ISET}= 5K		1		A
			R_{ISET}= 10K		2		A
			R_{ISET}= 12.5K		2.5		A
			R_{ISET}= 15K		3		A
			R_{ISET}≥ 25K		5		A
Peak current	I_{L_PK}	Inductance peak current limit				10	A
Trickle charge current	I_{TRKL}	VIN=5V, VBAT<2.5V		30	50	70	mA
		VIN=5V, 2.5V<=VBAT<VTRKL		100	200	300	mA
Trickle cut-off voltage	V_{TRKL}	BAT_MODE pin NC is floating, the number of battery cells is N		N*2.9	N*3	N*3.1	V
		BAT_MODE pin is grounded, the number of battery cells is N		N*2.4	N*2.5	N*2.6	V
Stop charging current	I_{STOP}				100		mA

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Recharge threshold	V_{RCH}	The number of battery cells is N		V_{TRGT} – N*0.1		V
Charging timeout	T_{END}		45	48	51	Hour
Discharge system						
Battery working voltage	V_{BAT}	The number of battery cells is N	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
DC 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
Maximum output power	Pmax		20		100	W
Discharge system efficiency	η_{out}	V_{BAT}=8V, V_{OUT}=5V, I_{OUT}=2A		94.69		%
		V_{BAT}=8V, V_{OUT}=9V, I_{OUT}=2A		95.36		%
		V_{BAT}=8V, V_{OUT}=12V,I_{OUT}=2A		95.86		%
		V_{BAT}=15V, V_{OUT}=5V,I_{OUT}=2A		91.55		%
		V_{BAT}=15V, V_{OUT}=9V,I_{OUT}=2A		95.05		%
		V_{BAT}=15V, V_{OUT}=12V,I_{OUT}=2A		95.37		%
Output shutdown current	I_{shut}	VBAT=N*3.7V, Output 5V	3.1	3.4	3.8	A
		VBAT= N *3.7V, Output 9V，not inPD	2.7	3	3.3	A
		VBAT= N *3.7V, Output 12V，not inPD	2	2.2	2.5	A
		VBAT= N *3.7V, Output in PD		PDO * 1.1		A

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Output overcurrent detection time	T_{UVD}	output voltage is continuously lower than 2.4V		30		ms
Output short detection time	T_{OCD}	output voltage is continuously lower than 2.2V		40		us
Control System						
Frequency	fs	Discharge switching frequency		250		kHz
		Charging switching frequency		250		kHz
VCCIO output voltage	V_{CCIO}		3.15	3.3	3.45	V
VCCIO output current	I_{CCIO}		25	30	35	mA
standby current	I_{STB}	VBAT=14.8V，average current after shutdown		180		uA
LED Pin drive current	I_{L1} I_{L2} I_{L3}	Voltage drop 10%	5	7	9	mA
Thermal shutdown temperature	T_{OTP}	Rising temperature	110	125	140	℃
Thermal shutdown temperature hysteresis	ΔT_{OTP}			40		℃

IP2368 Function description

Charging process

IP2368 has a constant current and constant voltage lithium battery charging management system that supports a synchronous switch structure.

IP2368 uses switch charging technology with a switching frequency of 250kHz.

IP2368 can set different battery types, full voltage and charging current through external resistors, and can support 2/3/4/5/6 series lithium iron phosphate or lithium battery charging, the maximum charging current can reach 5A or 100W charging input, charging efficiency Up to 96%;

IP2368 supports trickle-constant current-constant voltage charging process:

When the battery voltage VBAT≤2.5V, it is a small current trickle charge, and the battery charging current is about 100mA;

When the battery voltage is 2.5V <VBAT≤ VTRKL, it is trickle charge, and the battery charging current is about 200mA; when BAT_MODE is floating, the trickle charge cut-off voltage VTRKL is N*3V; when BAT_MODE is grounded, the trickle charge cut-off voltage VTRKL is N* 2.5V;

When the battery voltage VTRKL<VBAT<VTRGT, it is constant current charging, and the charging current charges the battery according to the set constant current charging current; the full voltage VTRGT and constant current charging current can be set by connecting RVSET and RISET;

When the battery voltage VBAT = VTRGT, when the battery voltage rises to close to the full voltage, the charging current will slowly drop and enter constant voltage charging;

After entering the constant voltage charging, when the battery charging current is less than ISTOP (100mA) and the battery voltage is close to the constant voltage voltage, the charging is stopped, and the battery is fully charged and then fully charged.

After the battery is fully charged and stopped, the battery voltage will continue to be detected. When the battery voltage is lower than VBAT <VTRGT – N*0.1V, the charging will restart;

IP2368 can customize different trickle charge cut-off voltage VTRKL, and can also customize 0V battery charging prohibition function;

IP2368_COUT needs to be charged and activated before it can be discharged,when the battery is connected for the first time; it can be customized to remove the charging activation function;

Type_C PD

IP2368 integrates USB Type_C input and output identification interfaces, automatically switches the built-in pull-up and pull-down resistors, and automatically recognizes the charge and discharge properties of the inserted device. With Try.SRC function, when connected to the other party as a DRP device, the other party can be charged first.

IP2368 supports PD2.0/PD3.0 bidirectional input/output protocol. Maximum support 100W power

output, input support 5V, 9V, 12V, 15V, 20V voltage range, output support 5V, 9V, 12V, 15V, 20V voltage range. IP2368 customization can realize PPS output function;

Fast charge function

IP2368 supports a variety of fast charging modes: QC2.0/QC3.0/QC3+, FCP, AFC, SCP, Apple.

Charging the battery input can support fast charging inputs such as FCP and AFC. Since FCP and AFC are used for fast charging handshake requests through DP/DM, when other fast charging protocol ICs are added, FCP and AFC fast charging can no longer be supported.
IP2368 integrates AFC/FCP/PD2.0/PD3.0 input fast charging protocol, you can apply for fast charging voltage to the fast charging adapter through DPC/DMC/CC1/CC2 on the TypeC port, and it will automatically adjust the charging current to adapt Adapters with different load capacities.
When charging with an ordinary 5V charger or power supply without fast charging, the maximum maximum charging current at the input terminal will be set to 3A;
When charging with a charger that only has Huawei FCP or Samsung AFC fast charge protocol, but does not have PD fast charge, the maximum charging power at the input end will be limited to 18W (9V/2A, 12V/1.5A);
When charging with a PD fast charge adapter, the maximum input charging power will be limited according to the received PD package. When the received PD package power is less than the power required for charging set by ISET, the charging current will be actively reduced to maximize the input end The power is less than or equal to the PD broadcast power given by the adapter;

For example 1: ISET_MODE is floating, RISET=15K, and the maximum input power during constant current charging is set to 60W. If a 30W PD adapter is used to charge the IP2368, the input charging current will be limited to 30W; only a PD adapter of 60W or more is used Charge the IP2368, the input power will reach the set 60W;

For example 2: ISET_MODE is grounded, RBAT_NUM=9.1K, 3 strings of batteries are charged, RISET=15K, the maximum charging current of the battery terminal is set to 3A, the 30W PD adapter is used to charge the IP2368, and the PD fast charge is successfully entered, regardless of charging conversion Efficiency. When the battery voltage VBAT<10V, the charging power is less than 30W, and the maximum output power of the adapter is not reached. The battery charging current can guarantee 3A constant current charging; when the battery voltage VBAT>10V, the power required for charging is already greater than 30W, exceeding the maximum output power of the PD adapter, so it will automatically reduce the battery charging current to maintain the input power at 30W;

If the charging input is a fixed voltage input, not the adapter used, you can use a customized model of IP2368_NA;
Regardless of the adapter power, the customized model of IP2368_NA will be charged according to the input power or battery charging current set by the ISET pin, and will not automatically reduce the charging power or charging current, but it is necessary to ensure that the power load capacity of the charging input is greater than the set maximum charging power ；

When the battery is discharged externally, it automatically detects the fast charge timing on the DP and DM pins, and intelligently recognizes the type of mobile phone. It can support mobile phones with QC2.0/QC3.0/QC3+, FCP, AFC, SCP protocol, and 2.4A mode of Apple mobile phones. , BC1.2 ordinary Android phone 1A mode.

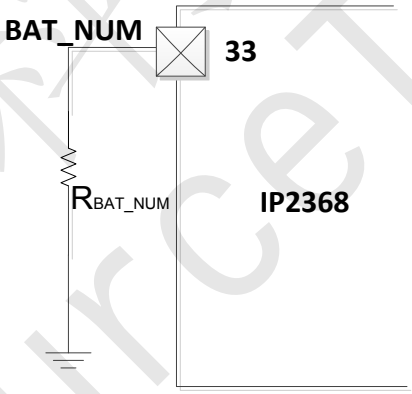
Setting the number of batteries in series

IP2368 can support the charging of 2/3/4/5/6 strings of batteries;

IP2368 can select and set the number of batteries connected in series by connecting different resistors to the BAT_NUM pin;

The relationship between the external resistor RBAT_NUM of the BAT_NUM pin and the number of battery cells in series is as follows:

R_{BAT_NUM}(ohm)	Set the number of batteries connected in series(string)
6.2k	2
9.2k	3
13k	4
18k	5
27k	6

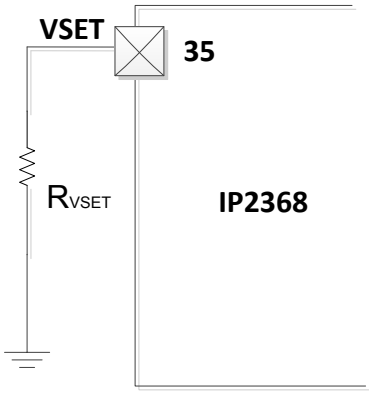


When the RBAT_NUM resistance is greater than 33K, it will be detected that the RBAT_NUM resistance is open. In order to ensure the safety of charging, the charging status indicator will give an abnormal alarm;

Battery type and full voltage setting

The BAT_MODE pin of IP2368 is left floating, select ordinary lithium battery, the full voltage range of a single battery is 4.1V~4.4V; BAT_MODE pin is grounded, select lithium iron phosphate battery, the full voltage range of single battery is 3.5V~3.7V;

The relationship between VSET pin ground resistance RVSET and the set full voltage is as follows:



R_{BAT_MODE} floating, Ordinary lithium battery		R_{BAT_MODE} to ground, Lithium iron phosphate battery	
Single battery full voltage $V_{TRG}T=4000+0.02*R_{VSET}$ unit mV step=10mV	R_{VSET}	Single battery full voltage $V_{TRG}T=3500+0.01*R_{VSET}$ unit mV step=10mV	R_{VSET}
4.15V	7.5K	3.55V	7.5K
4.20V	10K	3.60V	10K
4.30V	15K	3.65V	15K
4.35V	17.5K	3.70V	≥20K
4.40V	≥20K		

Notice:

1. For the full voltage of a single battery set by RVSET, the actual BAT output voltage must be multiplied by the number of battery cells;

2. The voltage setting step for full voltage of a single battery is 10mV. In order to ensure accuracy, RVSET should use a 1% precision resistor;

3. When the RVSET resistance is greater than 33K, it will be detected that the RVSET resistance is open. In order to ensure the safety of charging, the charging status indicator will alarm abnormally;

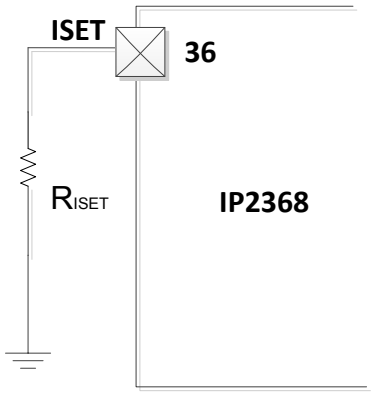
Charging current setting

IP2368 can set the charging current through the ISET pin;

When the ISET_MODE pin is floating, the ISET pin sets the maximum input power during charging. During constant current charging, the input voltage and current remain unchanged. As the battery voltage rises, the charging current at the battery terminal will decrease;

When the ISET_MODE pin is grounded, the ISET pin sets the charging current of the battery terminal. When the input load capacity is sufficient, the charging current of the battery terminal remains constant. As the battery voltage rises, the current and power at the input terminal will increase;

The relationship between ISET pin resistance RISET and the set input power or charging current is



as follows:

I_{SET_MODE} floating, RISET set the maximum input power of constant current		I_{SET_MODE} to ground, RISET set constant current maximum battery current	
Maximum input power when charging $P_{CCIN}=4*R_{ISET}$ Unit mV step=1W	R_{ISET}	Single battery full voltage $I_{CHRG}=0.2*R_{ISET}$ Unit mA step=100mA	R_{ISET}
20W	5K	1A	5K
30W	7.5K	2A	10K
45W	11.2K	2.5A	12.5K
60W	15K	3A	15K
100W	≥25K	5A	≥25K

Notice:

1. When setting the input power, the minimum step is 1W and the maximum input power is 100W; when setting the battery current, the minimum step is 100mA and the maximum input current is 5A; when the RISET is greater than 25K, it will be set to a maximum of 100W or 5A for charging;
2. When the RISET resistance is greater than 33K, it will be detected that the RISET resistance is open. In order to ensure the safety of charging, the charging status indicator will alarm abnormally;
3. The standard product will automatically adjust the charging current according to the power supply capacity of the charger used; if the power supply capacity of the charger used is less than the charging power set by RISET, the charging current will be automatically reduced;
4. If the input power is not a third-party charger, but a fixed input power, you can use the customized model of P2368_NA, which will not automatically reduce the charging current according to the power supply capacity of the charger;

IP2368_COUT supports the C port discharge output function. The discharge output PDO can also be set through the ISET pin.

Specific setting method of output power:

22.5K≤RISET<33K, the output power is set to 100W;
12.5K≤RISET<22.5K, the output power is set to 60W;
10K≤RISET<12.5K, the output power is set to 45W;
7K≤RISET<10K, the output power is set to 30W;
5.8K≤RISET<7K, the output power is set to 25W;

RISET<5.8K, the output power is set to 20W;

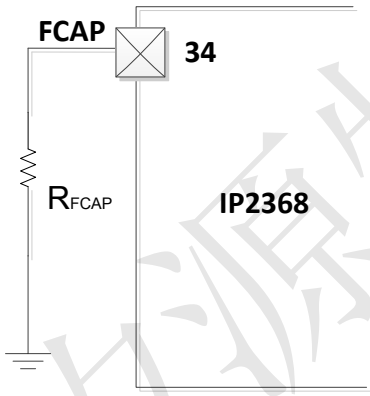
When the set power is greater than 60W, when the E-MARK cable is not recognized, the output broadcast capacity will be limited to the maximum 60W. Output PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/3A. When the E-MARK cable is recognized (additional EMARK circuit is required), the output broadcasting capacity can be up to 100W, and the output PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/5A;

Fuel gauge

IP2368 has a built-in fuel gauge function, which can realize accurate battery power calculation.

IP2368 supports external setting of battery cell capacity, using the integral of the current and time of the cell terminal to calculate the battery's charged capacity.

The formula of IP2368 external PIN setting battery initial capacity: battery capacity=RFCAP*0.8 (mAH). The minimum support 2000mAH, the maximum support 25000Mah, the set capacity is the capacity of a single string of cells.



Typical battery capacity configuration table:

R17Resistance value (ohm)	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;

NTC function

IP2368 integrates NTC function to detect battery temperature. After the IP2368 is powered on, the NTC PIN outputs 80uA current at high temperature and 20uA current at low temperature. The voltage is generated by the external NTC resistor. The IC detects the voltage of the NTC PIN pin to determine the current battery temperature.

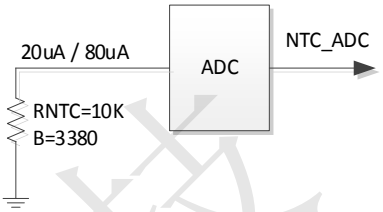


Figure 12 Comparison of battery NTC

In the charging state: the NTC temperature is lower than 0 degrees (0.55V) to stop charging, the normal charging is between 0 and 45 degrees, and the temperature exceeds 45 degrees (0.39V) to stop charging.

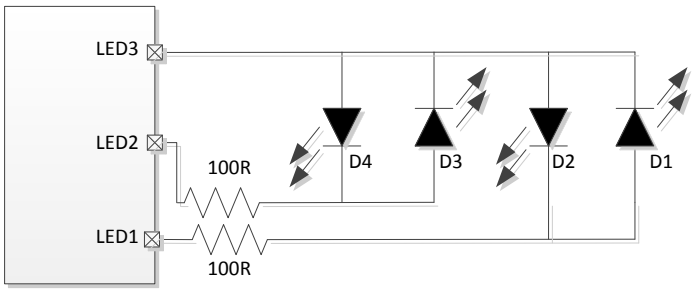
In the discharge state: when the temperature is lower than -20 degrees (1.39V), the discharge is stopped, the discharge is normal between -20 degrees and 60 degrees, and the discharge is stopped when the temperature is higher than 60 degrees (0.24V);

*The NTC resistance parameter referenced in the above temperature range is 10K@25℃ B=3380. Other models have differences and need to be adjusted.

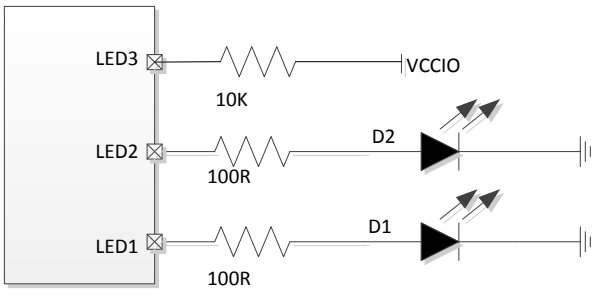
If the solution does not require NTC, a 10k resistor must be connected to the NTC pin to ground, and it cannot be left floating or grounded directly.

Light show

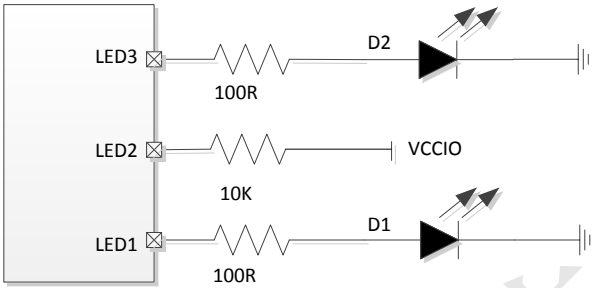
IP2368 Support 4, 2, and 1 battery indicator, the connection method is as follows.



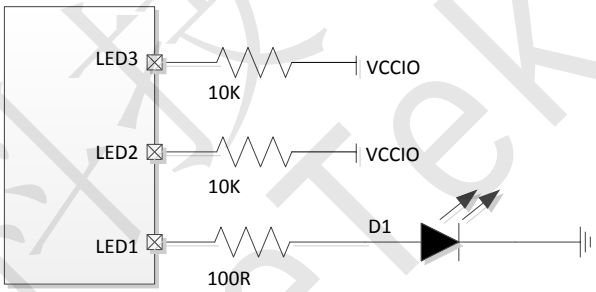
4-light mode



2-light mode 1



2-light mode 2



1-light mode

4, 2, 1LED connection mode

The display mode of 4 lights is:

When charging normally

Electricity C（%）	D1	D2	D3	D4
full	on	on	on	on
75%≤C	on	on	on	0.5HzFlashing
50%≤C＜75%	on	on	0.5HzFlashing	off
25%≤C＜50%	on	0.5HzFlashing	off	off
C＜25%	0.5HzFlashing	off	off	off

When discharging normally

Electricity C（%）	D1	D2	D3	D4
75%≤C	on	on	on	on
50%≤C＜75%	on	on	on	off
25%≤C＜50%	on	on	off	off
C＜25%	on	off	off	off
C=0	flash 4 times	off	off	off

After flashing 4 times (200ms on and 200ms off), stopping the discharge.

The display mode of 2 lamp mode 1 is two-color lamp:

When charging normally

Electricity C（%）	D1	D2
full	off	on
66%≤C＜100%	off	0.5HzFlashing
33%≤C＜66%	0.5HzFlashing	0.5HzFlashing
C＜33%	0.5HzFlashing	off

When discharging normally

Electricity C（%）	D1	D2
66%≤C＜100%	off	on
33%≤C＜66%	on	on
C＜33%	on	off
C=0	flash 4 times	off

After flashing 4 times (200ms on and 200ms off), stopping the discharge.

The display mode of 2 lamp mode 2 is:

D1 is on during charging, D2 is off, D1 is off when fully charged, and D2 is on; when charging is abnormal, D1 and D2 flash at the same time (on for 250ms and off for 250ms)

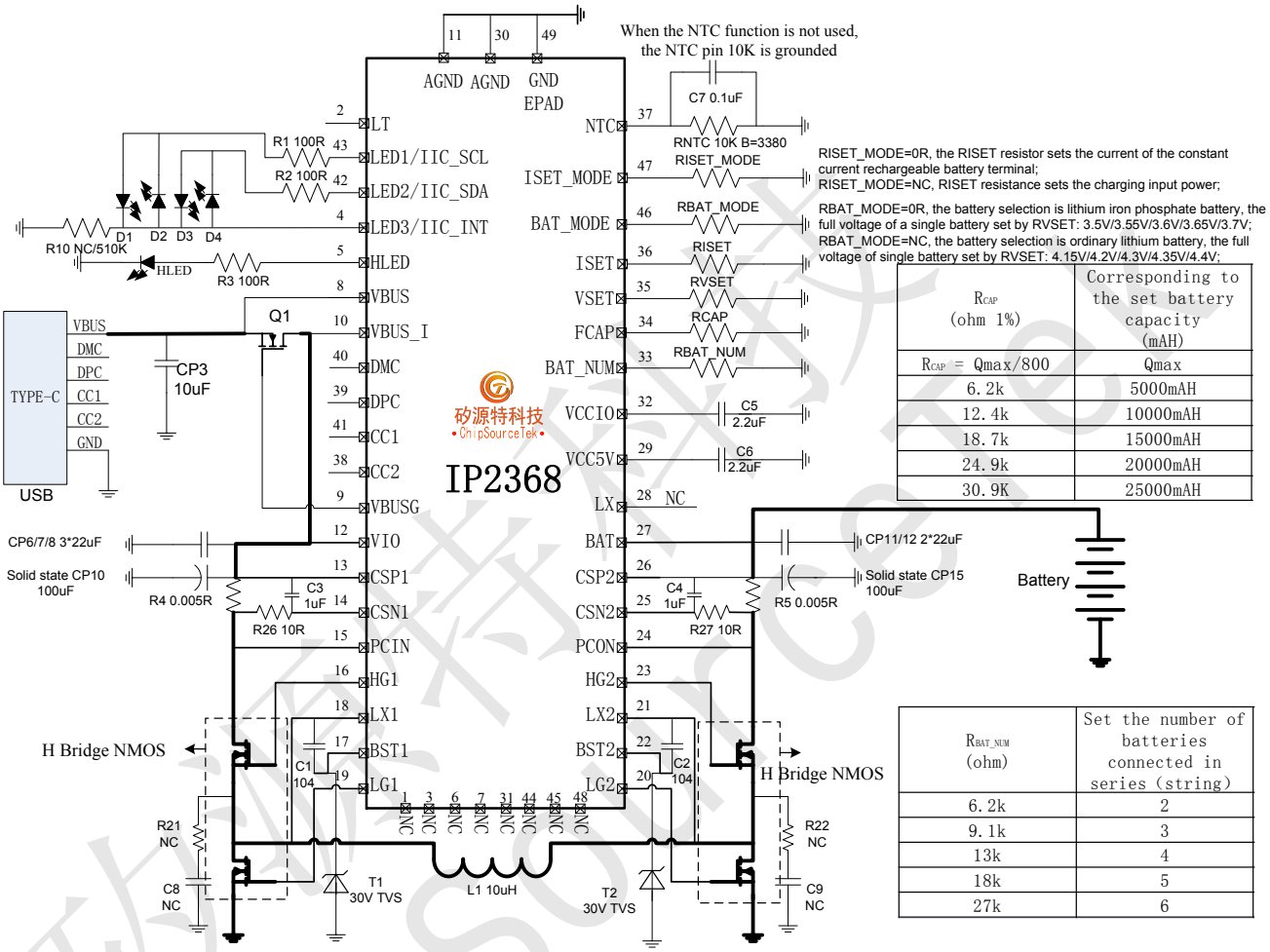
D1 is always on during discharge, and when C=0, D1 flashes 4 times (on for 200ms and off for 200ms) and then stops discharging.

The display mode of 1 light mode is:

D1 flashes during charging (1s on and 1s off), when fully charged, D1 is always on; D1 flashes quickly when charging is abnormal (250ms on and 250ms off)

D1 is always on during discharge, and when C=0, D1 flashes 4 times (on for 200ms and off for 200ms) and then stops discharging.

IP2368 Typical application schematic



R_{CAP} (ohm 1%)	Corresponding to the set battery capacity (mAH)
R_{CAP} = Qmax/800	Qmax
6.2k	5000mAH
12.4k	10000mAH
18.7k	15000mAH
24.9k	20000mAH
30.9K	25000mAH

R_{BAT_NUM} (ohm)	Set the number of batteries connected in series (string)
6.2k	2
9.1k	3
13k	4
18k	5
27k	6

RBAT_MODE floating, ordinary lithium battery		RBAT_MODE is grounded, lithium iron phosphate battery	
Single battery full voltage VTRGT=4000+0.02*RVSET unit mV step=10mV	RVSET	Single battery full voltage VTRGT=3500+0.01*RVSET unit mV step=10mV	RVSET
4.15V	7.5K	3.55V	7.5K
4.20V	10K	3.60V	10K
4.30V	15K	3.65V	15K
4.35V	17.5K	3.70V	≥20K
4.40V	≥20K		

ISET_MODE is floating RISET sets the maximum input power of constant current		ISET_MODE is grounded RISET sets the maximum battery current of constant current	
Maximum input power when charging PCCIN=4*RISET unit mW step=1W	RISET	Single battery full voltage ICHRG=0.2*RISET unit mA step=100mA	RISET
20W	5K	1A	5K
30W	7.5K	2A	10K
45W	11.2K	2.5A	12.5K
60W	15K	3A	15K

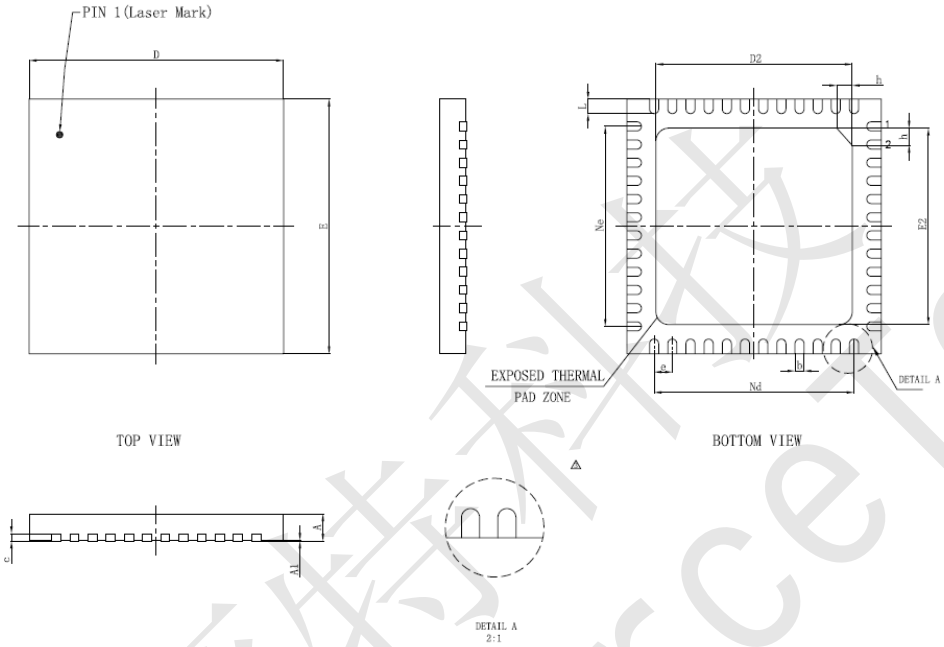
Figure 13 Application schematic

IP2368 BOM

Number	Component name	Model & Specification	Location	Dosage	Remark
1	IC	QFN48 7*7	U1	1	

		IP2368			
2	SMD capacitors	0603 100nF 10% 50V	C1 C2 C7	3	
3	SMD capacitors	0603 1uF 10% 16V	C3 C4	2	
4	SMD capacitors	0603 2.2uF 10% 16V	C5 C6	2	
5	SMD capacitors	0805 10uF 10% 25V	CP3	1	
6	SMD capacitors	0805 22uF 10% 25V	CP6 CP7 CP8 CP11 CP12	5	
7	Solid capacitor	100uF 35V 10%	CP10 CP15	2	
8	SMD resistor	1206 0.005R 1%	R4 R5	2	Sampling resistors require high-precision and low-temperature floating metal film resistors
9	SMD resistor	0603 100R 5%	R1 R2 R3	3	
10	SMD LED	0603 LED light	D1 D2 D3 D4 HLED	5	
11	Chip resistor	0603 10R 1%	R26 R27	2	
12	NTC thermistor	10K@25 ℃ B=3380	RNTC	1	NTC resistance
13	Buck-boost inductor	10uH 6A R_{DC}<0.01R	L1	1	
14	SMD MOS	RU3030M2	Q1	1	Can be omitted
15	USB C socket	USB C Base	USB3	1	
16	SMD MOS	RUH30J51M	Half-bridge double NMOS	2	
17	SMD resistor	0603	R_{ISET} R_{VSET} R_{CAP} R_{BAT_NUM} R_{BAT_MODE} R_{ISET_MODE}	6	Function selection resistance, patch according to actual needs
18	Transient Voltage Suppressor Diode	30V TVS	T1 T2	2	30V TVS
19			C8 C9 R21 R22		NC

IP2368 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

IP2368 Silk Screen instructions

Figure 15 Screen printing

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