# Support PD3.0 fast charge input protocol, support 2~5 series batteries
# Integrated buck-boost drive, Charging management chip with a maximum charging power of 100W

## 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**

## 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 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.

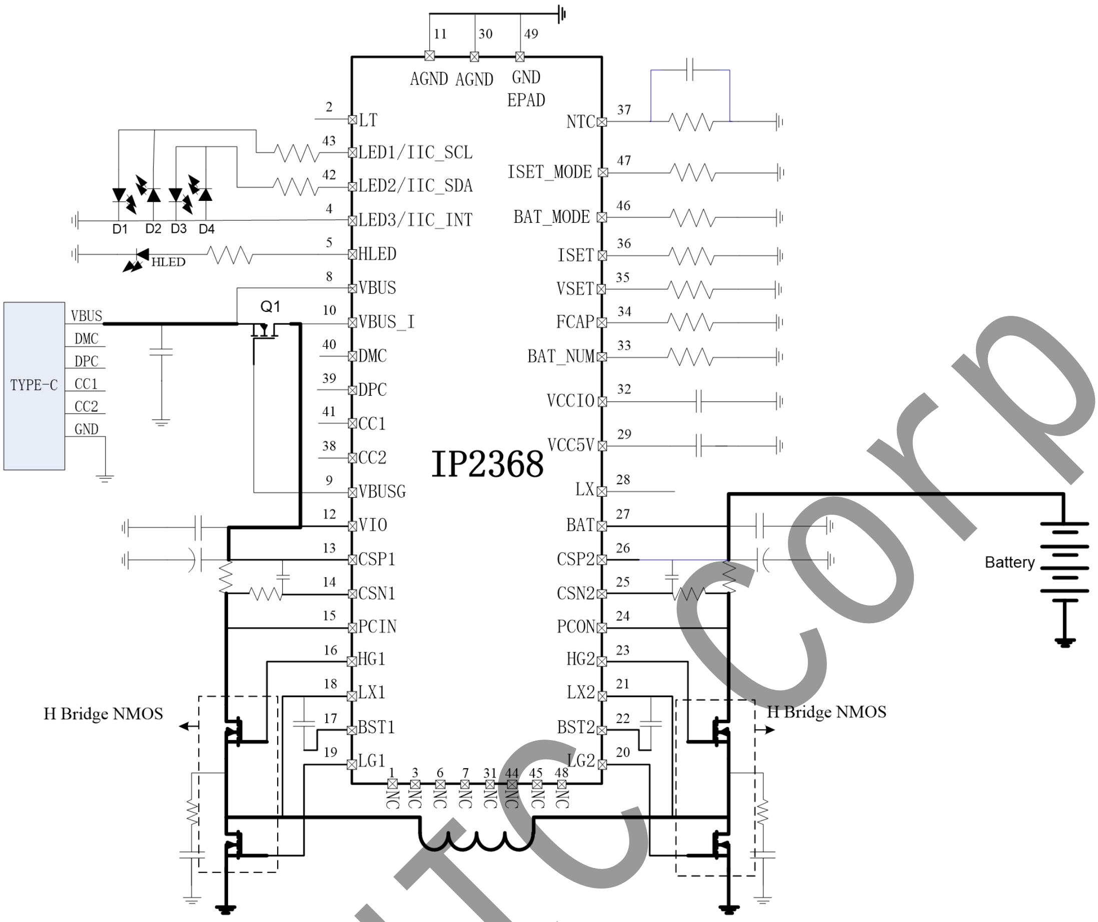
## Application Products

- 2~5 series lithium battery/lithium iron phosphate battery charging

# 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 |



# 1. Pin Description

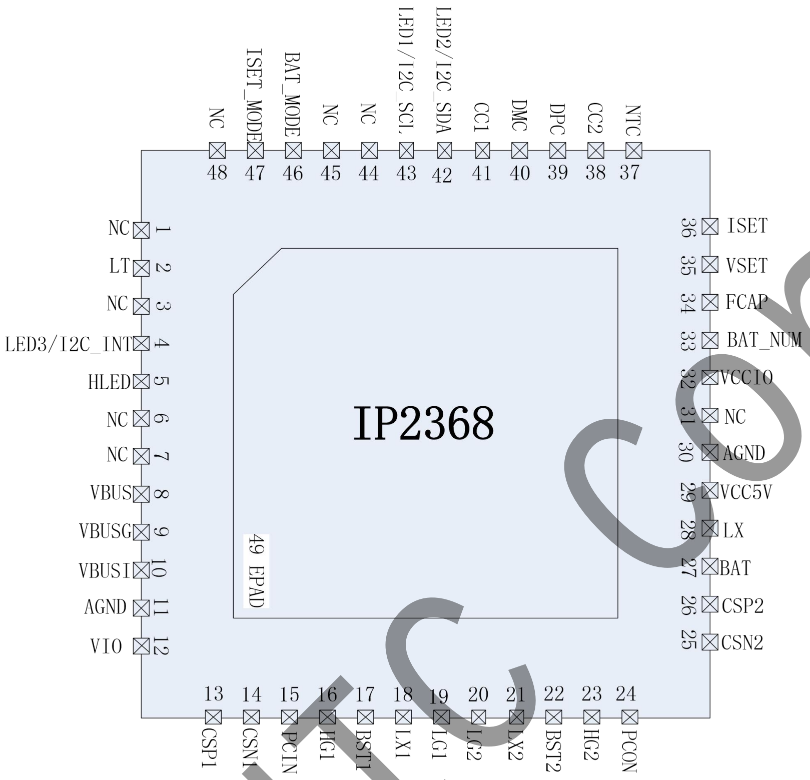



**Figure 2 IP2326 Pin Assignment**

## 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 |



# 2. Internal block diagram of the chip

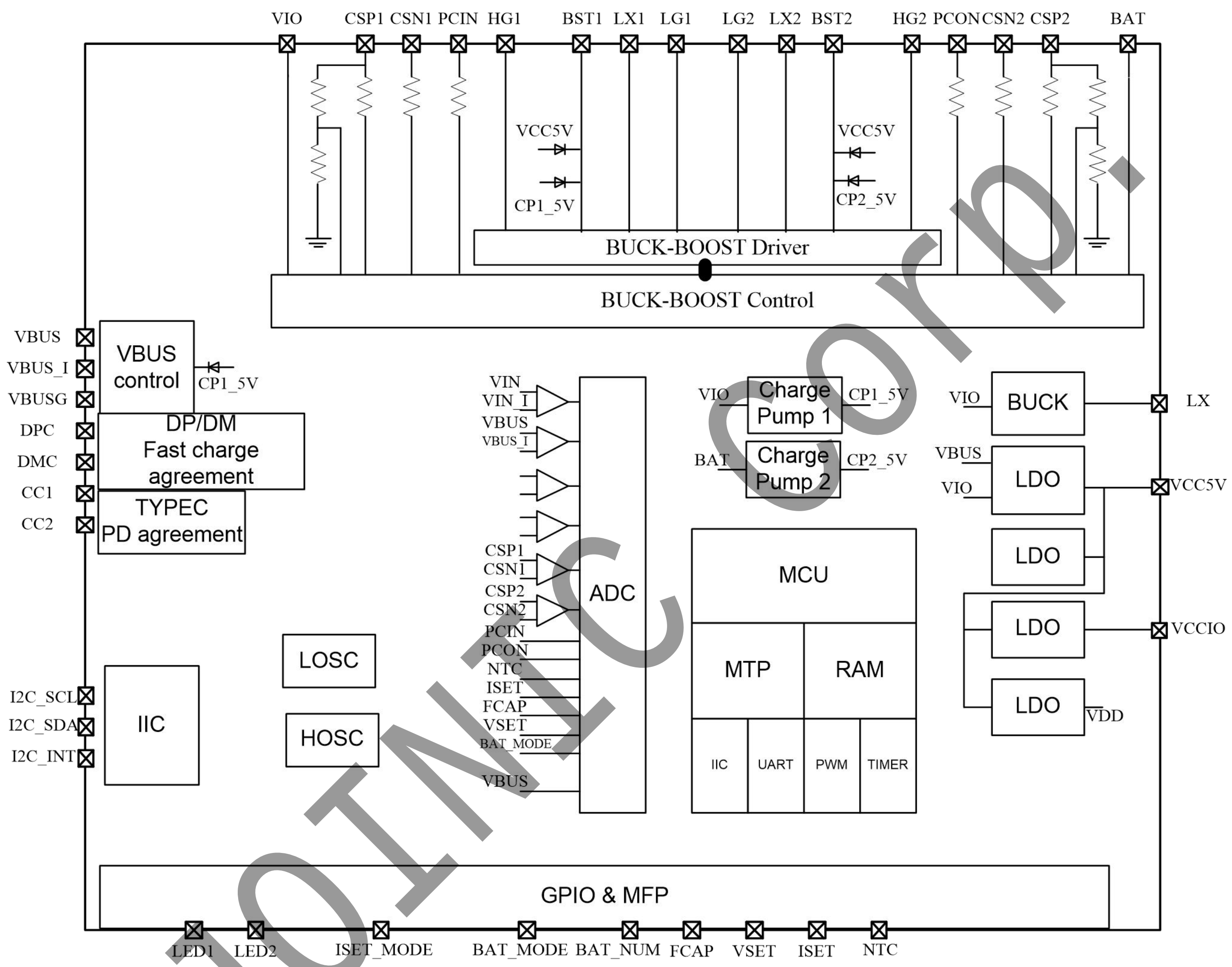



**Figure 3 Internal block diagram of the chip**

# 3. Limit parameters

| parameter | symbol | value | unit |
|---|---|---|---|
| Port voltage range | VBAT/VBUS | -0.3 ~ 30 | 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) | $\theta_{JA}$ | 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.

# 4. Recommended working conditions

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

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



# 5. 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 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 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 | $\Delta V_{OUT}$ | 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 | $\eta_{out}$ | $V_{BAT}$=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 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 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 | $\Delta T_{OTP}$ | | | 40 | | ℃ |

# 6. 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 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.

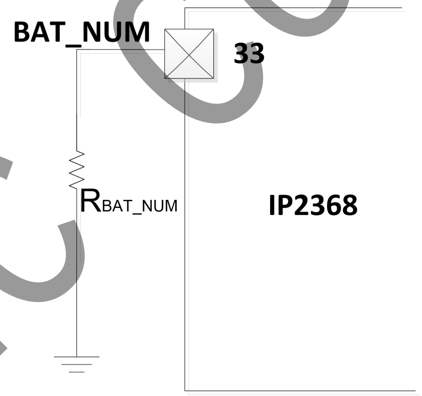
## Setting the number of batteries in series

IP2368 can support the charging of 2/3/4/5 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 |

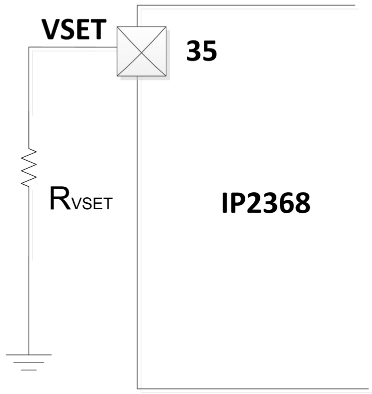



When the RBAT_NUM resistance is greater than 33K, it will be detected that the RBAT_NUM resistance is open. In order to ensure the safety of charging, the charging status indicator will give an abnormal alarm;

## 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;

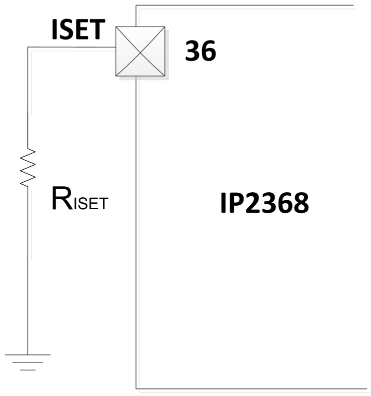
## Charging current setting

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;

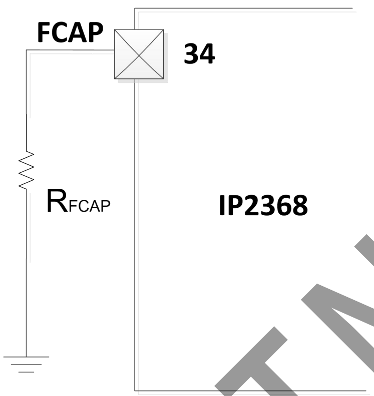
When the set power is greater than 60W, when the E-MARK cable is not recognized, the output broadcast capacity will be limited to the maximum 60W. Output PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/3A. When the E-MARK cable is recognized (additional EMARK circuit is required), the output broadcasting capacity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

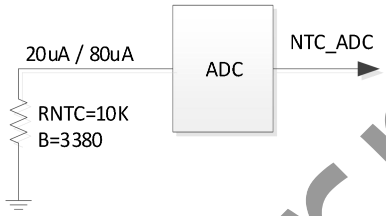



**Figure 12 Comparison of battery NTC**

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.

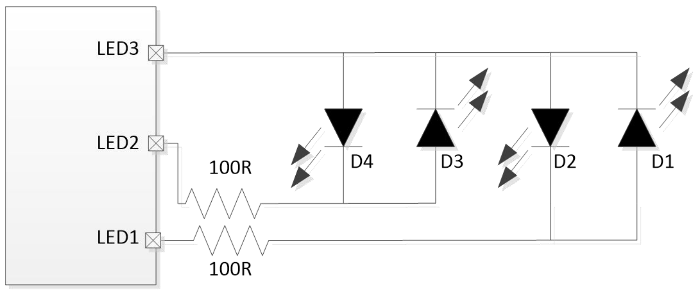
If the solution does not require NTC, a 10k resistor must be connected to the NTC pin to ground, and it cannot be left floating or grounded directly.

## Light show

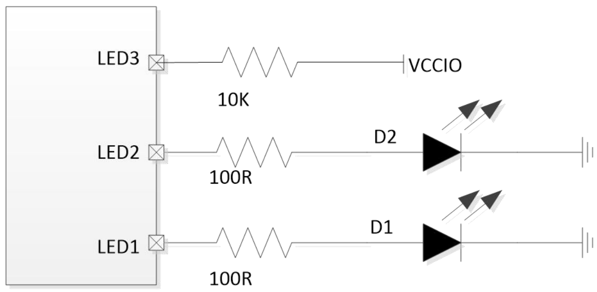
IP2368 Support 4, 2, and 1 battery indicator, the connection method is as follows.



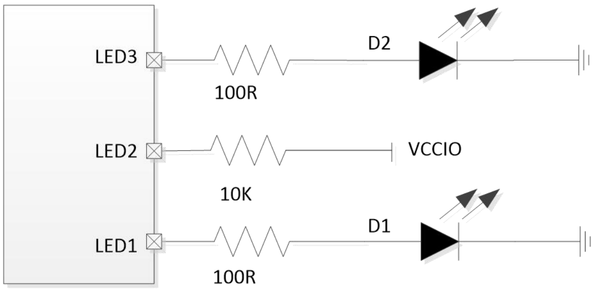
 



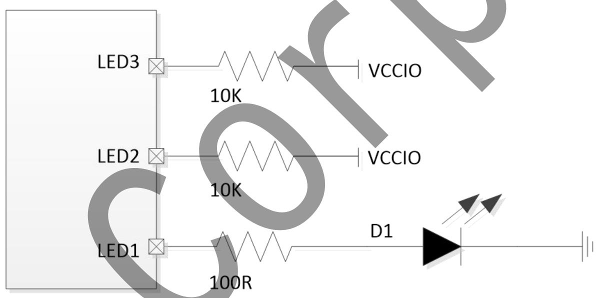

4-light mode




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:

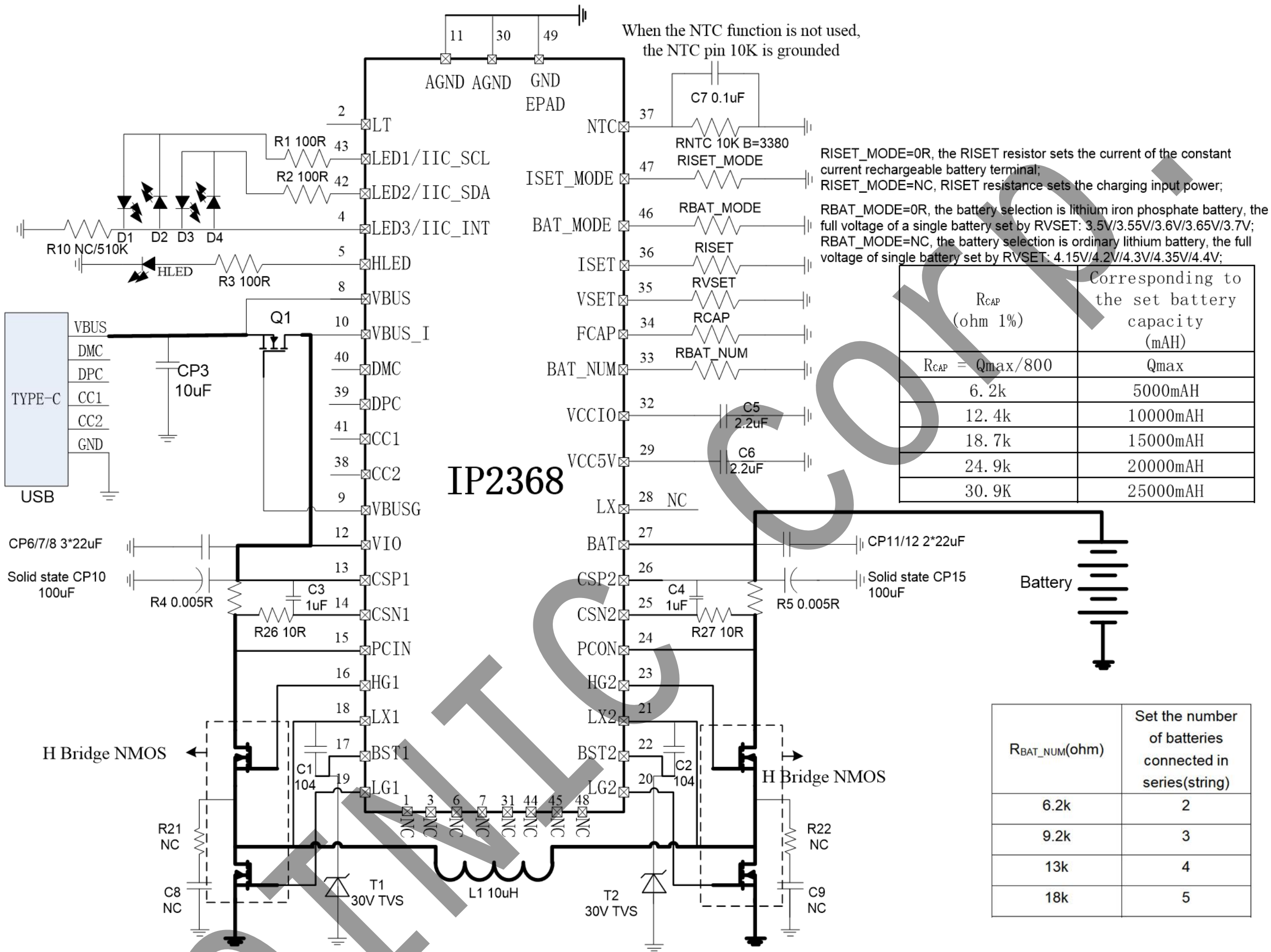
D1 flashes during charging (1s on and 1s off), when fully charged, D1 is always on; D1 flashes quickly when charging is abnormal (250ms on and 250ms off)

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.



# 7. Typical application schematic




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

| RBAT_NUM(ohm) | Set the number of batteries connected in series(string) |
|---|---|
| 6.2k | 2 |
| 9.2k | 3 |
| 13k | 4 |
| 18k | 5 |

| 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**



# 8. BOM

| Number | Component name | Model & Specification | Location | Dosage | Remark |
|---|---|---|---|---|---|
| 1 | IC | QFN48 7*7 IP2368 | U1 | 1 | |
| 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 | 30V TVS | T1 T2 | 2 | 30V TVS |



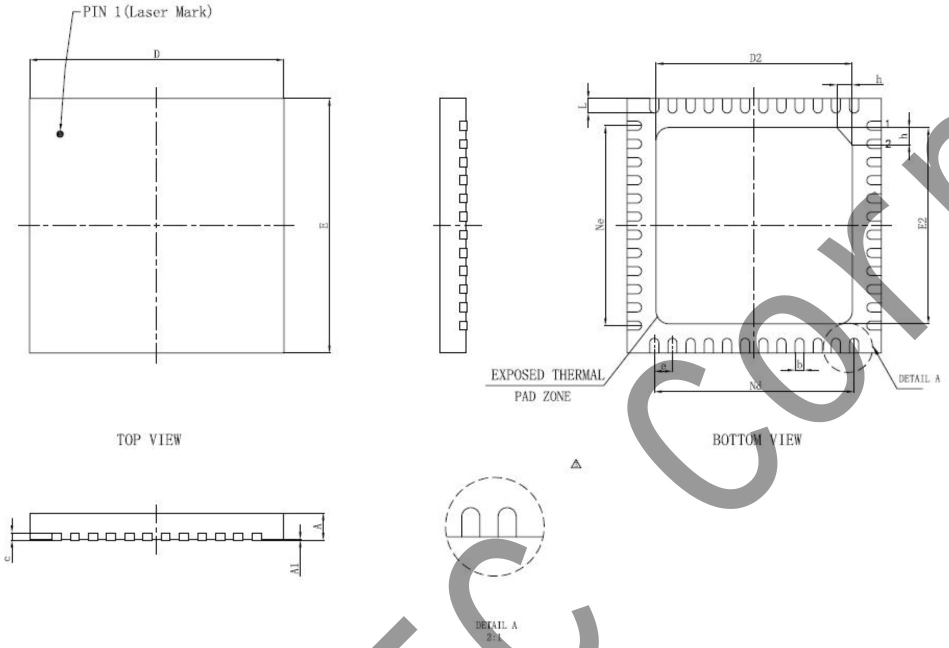
 

| | | | | | |
|---|---|---|---|---|---|
| | Suppressor Diode | | | | |
| 19 | | | C8 C9 R21 R22 | | NC |



# 9. Package




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



# 10. Silk Screen instructions

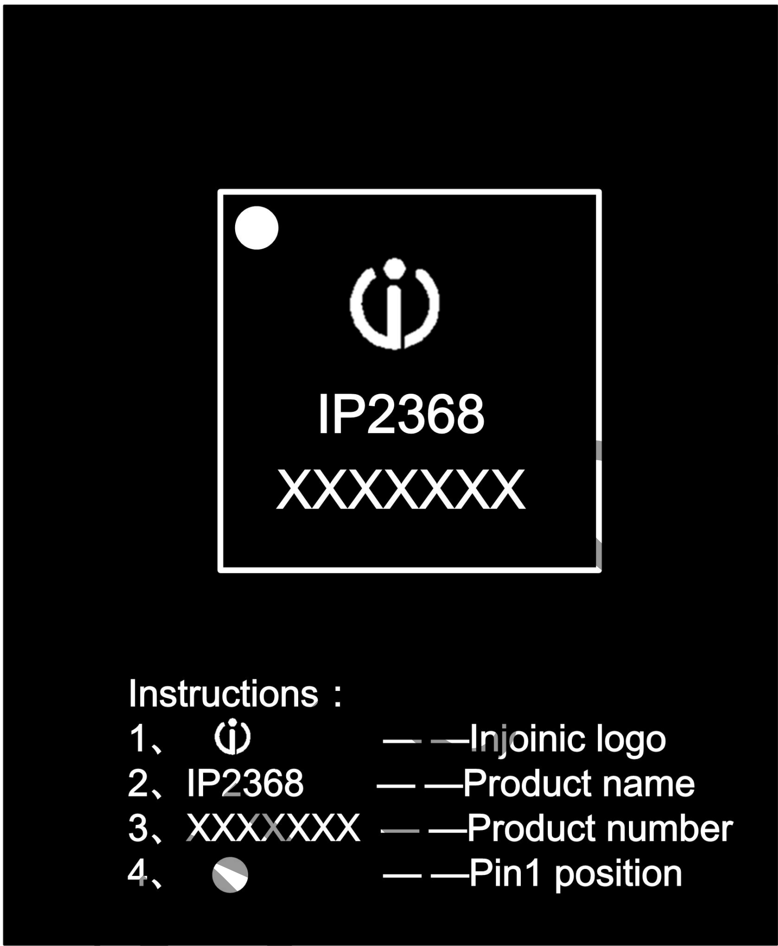



**Figure 15 Screen printing**



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