# IP5330

## 3A Charge/Discharge Power Bank SOC Integrated With Digital Tube Driver And TYPE_C Protocol

## 1. Features

- **Charge /discharge with synchronous switch**
  - ✧ Charge /discharge with 3A current by synchronous switch
  - ✧ Up to 93% boost efficiency
  - ✧ Up to 92% charging efficiency
  - ✧ Built-in power path management supports charging and discharging at the same time
  - ✧ Supports line compensation
- **Charge**
  - ✧ Adjusts charging current automatically to adapt to different load capacity adapters
  - ✧ Supports TYPEC port 3A, MICRO B port 2A charging current
  - ✧ Supports 4.20V, 4.30V 4.35V, 4.40V batteries
- **Battery indicators**
  - ✧ Built-in 14bits ADC and accurate coulomb calculation method
  - ✧ Supports digital tube display, 1A/2A outlet identification
  - ✧ Supports selecting battery initial capacity by external PIN
  - ✧ Supports self calibration of battery capacity
- **Others**
  - ✧ Built-in illuminator driver
  - ✧ Supports NTC
  - ✧ Automatically load insertion and removal detection
  - ✧ Supports Type-C DRP protocol and single port input/output
  - ✧ Supports mobile phone charging current intelligent identification of DCP protocol
- **Low-power dissipation**
  - ✧ Enter standby mode automatically with light load
  - ✧ Standby power consumption is less than 150μA
- **Simplified BOM**
  - ✧ Integrated switch power MOSFETs
  - ✧ Single inductor for charging and discharging
  - ✧ Built-in various digital tube drive circuits
- **Multiple protection, high reliability**
  - ✧ Output over current, over voltage and short circuit protection
  - ✧ Input over voltage protection
  - ✧ Battery over charge, over discharge and over current protection
  - ✧ Over temperature protection
  - ✧ Vin transient withstand up to 16V
- **In-depth customization**
  - ✧ Flexible and low-cost customized program
- **Package: 5mm*5mm, QFN32**

## 2. Applications

- **Power Bank**
- **Mobile phones, tablets and other portable devices**
- **Hydrator/hand warmer**

## 3. Description

IP5330 is a multi-functional power management SOC for total solution on Power Bank. It also integrates with boost converter, lithium battery charging management and battery level indicators.

IP5330 is highly integrated with abundant functions, which makes the total solution size minimized and BOM costed down.

IP5330 requires only one inductor to achieve buck and boost functions, and can support low-cost inductors and capacitors.

The synchronous boost system of IP5330 provides rated 3A output current with conversion efficiency up to 93%. When there is no load, it will automatically enter the standby state, and the static current will drop to less than 150uA.

IP5330's switch charging system supplies 3A charging current with charging efficiency up to 92%. According to the IC temperature and input voltage, IP5330 can intelligently adjust charging current.

IP5330 contains 14bits ADC, which can accurately measure battery's voltage and current. The built-in coulomb meter algorithm of IP5330 can accurately obtain the battery power information.

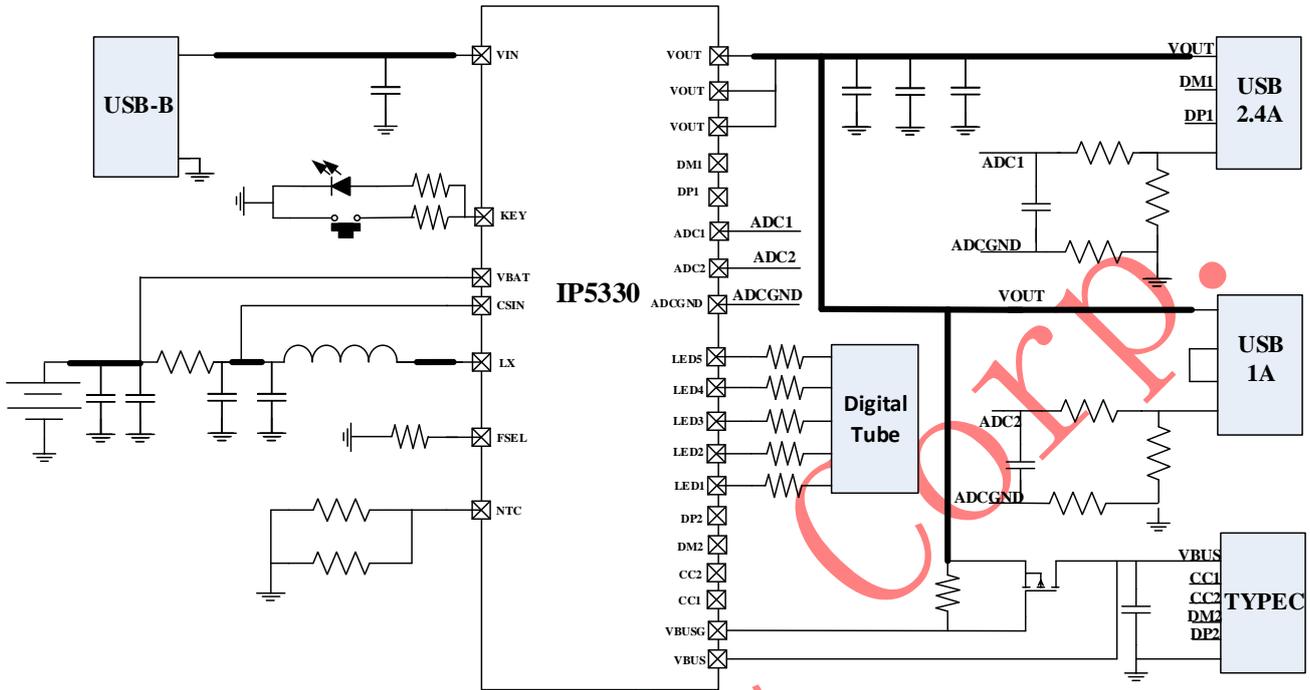IP5330 can support digital tube display and illuminator function.

# Typical Application



**Figure 1    Simplified Application Diagram (Digital tube indicates battery level)**
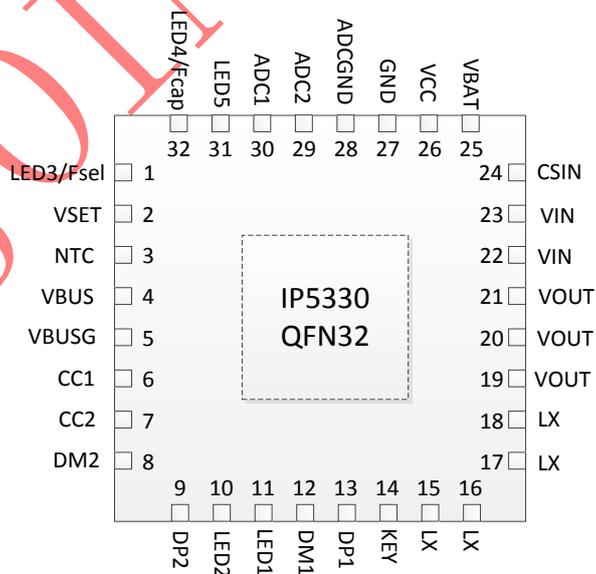
# 4. Pin Definition



**Figure 2    IP5330 Pin Assignments**

# IP5330

| Pin Num | Pin Name | Description |
|---------|----------|-------------|
| 1 | LED3/Fsel | Digital tube driver pin3/Key selection Pin |
| 2 | VSET | Full battery voltage setting (4.2V/4.3V/4.35V/4.4V) |
| 3 | NTC | NTC function pin |
| 4 | VBUS | VBUS charging power detection pin |
| 5 | VBUSG | VBUS charging input PMOS control pin |
| 6 | CC1 | CC1 line on Type-C port |
| 7 | CC2 | CC2 line on Type-C port |
| 8 | DM2 | DM data line on DCP2 |
| 9 | DP2 | DP data line on DCP2 |
| 10 | LED2 | Digital tube driver pin2 |
| 11 | LED1 | Digital tube driver pin1 |
| 12 | DM1 | DM data line on DCP1 |
| 13 | DP1 | DP data line on DCP1 |
| 14 | KEY | Key input pin, multiplexed WLED illumination function |
| 15 | LX | DCDC switch node, connect to inductor |
| 16 | LX | DCDC switch node, connect to inductor |
| 17 | LX | DCDC switch node, connect to inductor |
| 18 | LX | DCDC switch node, connect to inductor |
| 19 | VOUT | DCDC 5V output pin |
| 20 | VOUT | DCDC 5V output pin |
| 21 | VOUT | DCDC 5V output pin |
| 22 | VIN | DCDC 5V input pin |
| 23 | VIN | DCDC 5V input pin |
| 24 | CSIN | System power supply and battery voltage sampling pin |
| 25 | VBAT | Battery voltage sampling pin |
| 26 | VCC | LDO 3.3V output pin |
| 27 | GND | System grand |
| 28 | ADCGND | ADC sampling grand |
| 29 | ADC2 | ADC sampling pin2 |
| 30 | ADC1 | ADC sampling pin1 |
| 31 | LED5 | Digital tube driver pin5 |
| 32 | LED4/Fcap | Digital tube driver pin4/Battery initialization capacity setting pin |
| 33 | EPAD/PGND | Power and dissipation ground, maintain good contact with GND |

## 5. IP Series Products List

| IC Part No. | Charge /Discharge | | Features | | | | | | | | Package | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Dis-charge | Charge | LED Num | Lighti ng | Keys | I2C | DCP | USB C | QC Certifi cate | PD3.0/ PPS | Package | Compa tibility |
| IP5303 | 1.0A | 1.2A | 1,2 | √ | √ | - | - | - | - | - | eSOP8 | PIN2PIN |
| IP5305 | 1.0A | 1.2A | 1,2,3,4 | √ | √ | - | - | - | - | - | eSOP8 | PIN2PIN |
| IP5306 | 2.4A | 2.1A | 1,2,3,4 | √ | √ | - | - | - | - | - | eSOP8 | PIN2PIN |
| IP5206 | 2A(Max) | 1.5A | 3,4,5 | √ | √ | - | - | - | - | - | eSOP16 | PIN2PIN |
| IP5108E | 2.0A | 1.0A | 3,4,5 | √ | √ | - | - | - | - | - | eSOP16 | PIN2PIN |
| IP5108 | 2.0A | 2.0A | 3,4,5 | √ | √ | √ | - | - | - | - | eSOP16 | PIN2PIN |
| IP5207 | 1.2A | 1.2A | 3,4,5 | √ | √ | - | - | - | - | - | QFN24 | PIN2PIN |
| IP5207T | 1.2A | 1.2A | 1,2,3,4 | √ | √ | √ | √ | - | - | - | QFN24 | PIN2PIN |
| IP5109 | 2.1A | 2.1A | 3,4,5 | √ | √ | √ | - | - | - | - | QFN24 | PIN2PIN |
| IP5209 | 2.4A | 2.1A | 3,4,5 | √ | √ | √ | √ | - | - | - | QFN24 | PIN2PIN |
| IP5219 | 2.4A | 2.1A | 1,2,3,4 | √ | √ | √ | √ | √ | - | - | QFN24 | |
| IP5310 | 3.1A | 3.0A | 1,2,3,4 | √ | √ | √ | √ | √ | - | - | QFN32 | |
| IP5506 | 2.1A | 2.4A | Digital tube | √ | √ | - | - | - | - | - | eSOP16 | |
| IP5508 | 2.1A | 2.4A | Digital tube | √ | √ | - | √ | - | - | - | QFN32 | |
| IP5330 | 3.1A | 3A | Digital tube | √ | √ | - | √ | √ | - | - | QFN32 | |
| IP5322 | 18W | 4.0A | 1,2,3,4 | √ | √ | √ | √ | - | √ | - | QFN32 | |
| IP5328P | 18W | 4.0A | 1,2,3,4 | √ | √ | √ | √ | √ | √ | √ | QFN40 | |

## 6. Customized model list

| Model number | Specification |
| --- | --- |
| IP5330_BZ_VOUT12 | Standard IP5330, supports 188 digital tube with OUT icon |
| IP5330_BZ_188 | Supports 188 digital tube without OUT icon |

## 7. Absolute Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | -0.3 ~ 12 | **V** |
| VBUS Input Voltage Range | $V_{BUS}$ | -0.3 ~ 6 | **V** |
| Junction Temperature Range | $T_J$ | -40 ~ 150 | ℃ |
| Storage Temperature Range | Tstg | -60 ~ 150 | ℃ |
| Thermal Resistance (Junction to Ambient) | $\theta_{JA}$ | 40 | ℃/W |
| ESD (Human Body Model) | ESD | 4 | **KV** |

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

*Voltages are referenced to GND unless otherwise noted.

## 8. Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Input Voltage | $V_{IN}$, $V_{BUS}$ | 4.5 | 5 | 5.8 | V |
| Operating Temperature | $T_A$ | 0 | -- | 70 | ℃ |

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

## 9. Electrical Characteristics

Unless otherwise specified, TA=25℃，L=1uH

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Charging System** | | | | | | |
| Input Voltage | $V_{IN}$ | VBAT=3.7V | 4.5 | 5 | 5.8 | V |
| Input Over Voltage | $V_{INOV}$ | | 5.6 | 5.8 | 6 | V |
| Input Under Voltage | $V_{INUV}$ | | 4.4 | 4.5 | 4.6 | V |
| Constant Charge Voltage | $CV_{4.2V}$ | 4.2V battery configuration | 4.18 | 4.21 | 4.24 | V |
| | $CV_{4.30V}$ | 4.3V battery configuration | 4.28 | 4.31 | 4.34 | V |
| | $CV_{4.35V}$ | 4.35V battery configuration | 4.33 | 4.36 | 4.4 | V |
| | $CV_{4.4V}$ | 4.4V battery configuration | 4.38 | 4.41 | 4.44 | V |
| Charge Stop Current | $Ivin_{stop}$ | VIN=5V | 200 | 300 | 500 | mA |
| Charge Current | $I_{VIN}$ | VIN=5V, VBAT=3.7V, VIN port charge current | 1.7 | 2 | 2.3 | A |

| | | | | | | |
|---|---|---|---|---|---|---|
| | I<sub>VBUS</sub> | VBUS=5V, VBAT=3.7V, Battery current | 2.3 | 2.8 | 3.2 | A |
| Trickle Charge Current | I<sub>TRKL</sub> | VIN=5v，BAT=2.7v | 100 | 200 | 300 | mA |
| Trickle Charge Stop Voltage | V<sub>TRKL</sub> | | 2.9 | 3 | 3.1 | V |
| Recharge Voltage Threshold | V<sub>RCH</sub> | | 4.07 | 4.1 | 4.13 | V |
| Charge Cut-Off Time | T<sub>END</sub> | | 20 | 24 | 28 | Hours |
| **Boost System** | | | | | | |
| Battery Operation Voltage | V<sub>BAT</sub> | | 3 | 3.7 | 4.4 | V |
| Low Power Shutdown Voltage | V<sub>BATLOW</sub> | IOUT=1A | 2.9 | 2.95 | 3.0 | V |
| Dc Output Voltage | V<sub>OUT</sub> | VBAT=3.7V   @0A | 5.0 | 5.12 | 5.25 | V |
| | | VBAT=3.7V   @3A | 5.0 | 5.25 | 5.35 | V |
| Output Voltage Ripple | ΔV<sub>OUT</sub> | VBAT=3.0V~4.4V @Iout=2A,Cout=100uF | 50 | 100 | 150 | mV |
| Boost Output Current | I<sub>vout</sub> | VBAT=3.0V~4.4V | 0 | 3 | | A |
| Boost Overcurrent Shut Down Threshold | I<sub>shut</sub> | VBAT=3.0V~4.4V | | 3.5 | | A |
| Load Overcurrent Detect Time | T<sub>UVD</sub> | Duration of output voltage under 4.2V | | 30 | | ms |
| **Control System** | | | | | | |
| Switch Frequency | fs | Discharge switch frequency | | 600 | | KHz |
| | | Charge switch frequency | | 500 | | KHz |
| PMOS On Resistance | | | | 30 | | mΩ |
| NMOS On Resistance | r<sub>DSON</sub> | | | 25 | | mΩ |
| VOUT PMOS On Resistance | | VIN=5V | | 90 | | mΩ |
| Vout Pmos Overcurrent | I<sub>IDOCP</sub> | VIN=5V | | 3 | | A |
| Vcc Voltage | VCC | Vbat=3.7V | | 3.3 | | V |
| Battery Input Standby Current | I<sub>STB</sub> | VIN=0V，VBAT=3.7V | | 80 | 150 | uA |
| LED Light Driving Current | Ilight | | 5 | 10 | 15 | mA |
| IO Driving Current | I<sub>Gpio</sub> | | 4 | 5 | 8 | mA |
| Light Load Shut Down Detect Time | T<sub>loadD</sub> | Load current less than 100mA | 27 | 30 | 33 | s |

$I_{VBUS}$, $I_{TRKL}$, $V_{TRKL}$, $V_{RCH}$, $T_{END}$, $V_{BAT}$, $V_{BATLOW}$, $V_{OUT}$, $\Delta V_{OUT}$, $I_{vout}$, $I_{shut}$, $T_{UVD}$, $r_{DSON}$, $I_{IDOCP}$, $I_{STB}$, $I_{Gpio}$, $T_{loadD}$

| Light Load Shut Down Current | $I_{plout}$ | VBAT=3.7V @R9=R17= 10 milliohms | 30 | 60 | 100 | mA |
|---|---|---|---|---|---|---|
| Short Press On Key Wake Up Time | $T_{OnDebounce}$ | | 100 | | 300 | ms |
| Long Press On Key Wake Up Time | $T_{Keylight}$ | | 2 | | 3 | s |
| Thermal Shut Down Temperature | $T_{OTP}$ | Rising temperature | 130 | 140 | 150 | ℃ |
| Thermal Shut Down Hysteresis | $\Delta T_{OTP}$ | | 30 | 40 | 50 | ℃ |

# 10. Function Description

**System Diagram**
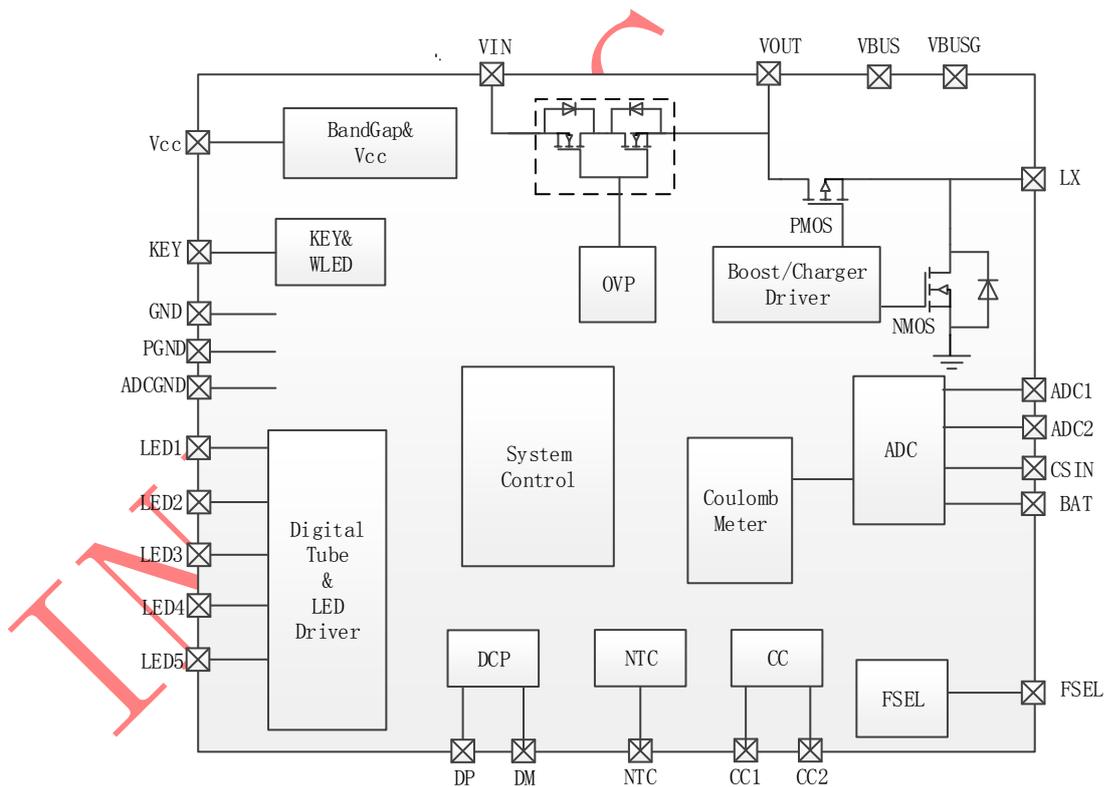


**Figure 3    IP5330 Internal System Diagram**

**Boost**

IP5330 integrates a boost dc-dc converter with 5V3A output. Switching frequency: 600KHz; input: 3.7V;

efficiency @ 5V/3A output: 92%. Built-in soft start function, to prevent the shock current at the start. Integrated output over current, short circuit, over voltage, over temperature and other protections, to ensure the system stable and reliable. The output current of the boost system can be automatically adjusted with the temperature to ensure that the IC is below the setted temperature.
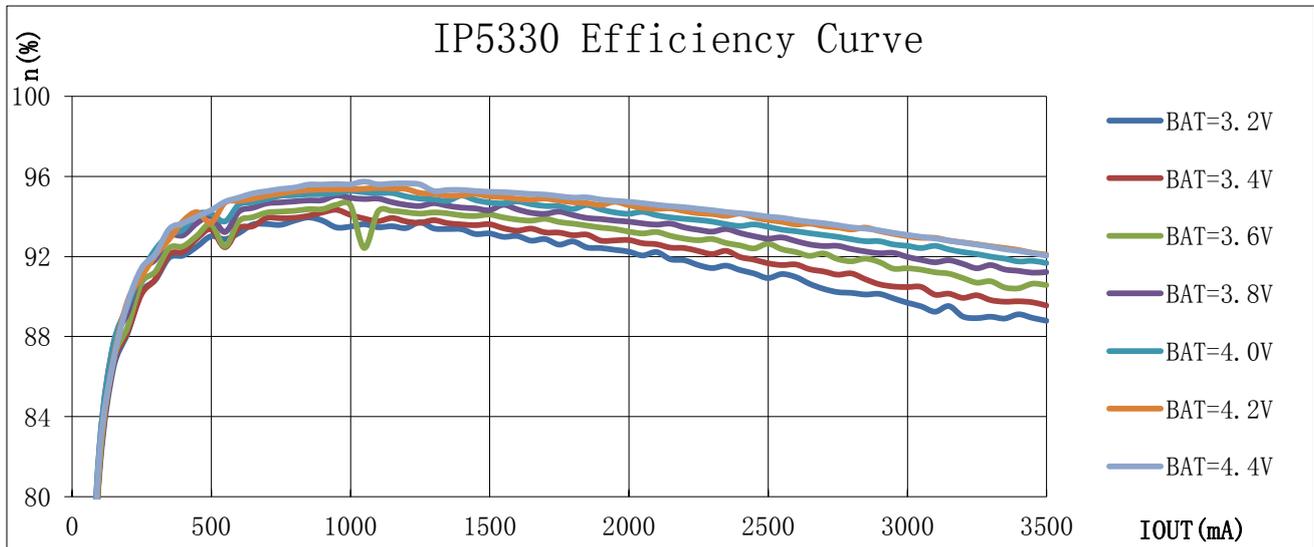


**Figure 4    IP5330 Efficiency Curve**
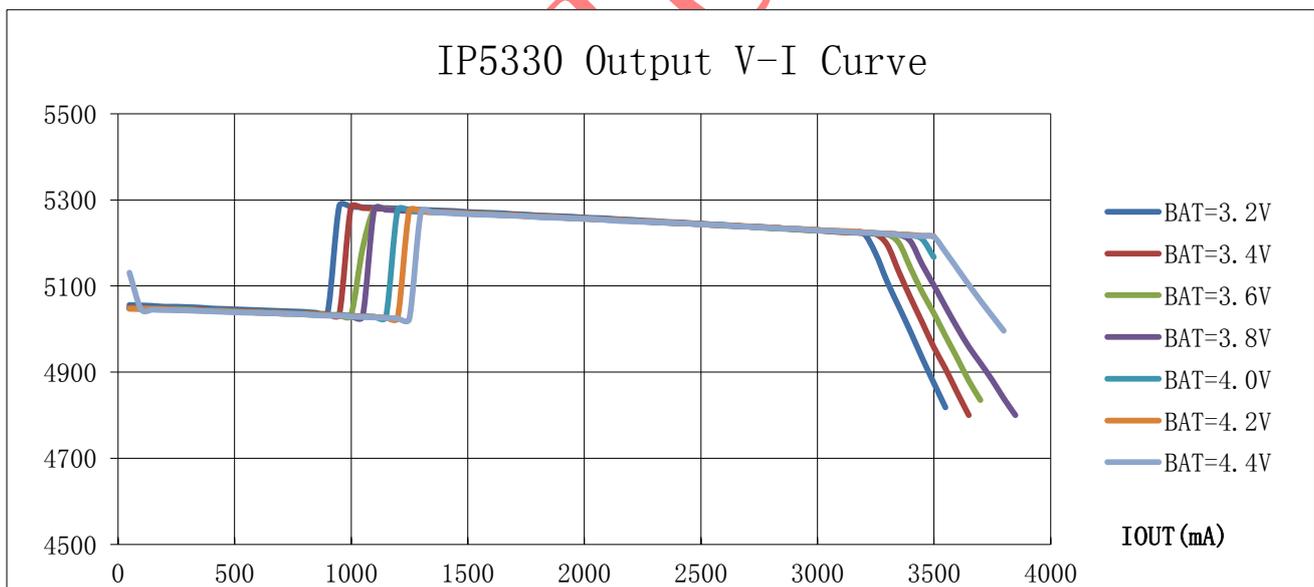


**Figure 5    IP5330 Output V-I Curve**

**Charge**

IP5330 integrates a constant current and constant voltage Li battery charging management system with synchronous switch. When the battery voltage is lower than 3V, enters trickle charging stage and trickle charging current is less than 200mA; when the battery voltage is higher than 3V, enters constant current charging stage; when the battery voltage is near the preset battery voltage, enters constant voltage charging stage. When the

charging is accomplished, once the battery voltage falls under 4.1V, battery charging will be restarted.

IP5330 supports TYPEC port 3A charging, Micro B port 2A charging, and at the same time detects the input voltage and IC temperature to automatically adjust the charging current.

IP5330 supports Micro B (VIN) insertion and charging, or Type C (VBUS) insertion and charging. Plug in first, charge first.

When IP5330 is in charging state, it will detect whether the VOUT (output voltage) is higher than 4.55V. If it is higher than 4.55V, it will charge the battery with the maximum current; if it is lower than 4.55V, it will reduce the charging current and automatically adapt to the load output capacity of the adapter.

IP5330 built-in power path management supports charging and discharging at the same time. PMOS of VIN or VBUS and PMOS of VOUT will be turned on to charge external devices when charging.

When charging and discharging at the same time, IP5330 will test the output current of port A. If the output current of port A is greater than 200mA, reduce the battery charging current to the minimum, and give priority to charge the device at port A.

IP5330 will test the connection of port C when charging and discharging at the same time. If there is equipment in charging outside port C, IP5330 will reduce the battery charging current less than 1A, and give priority to the equipment at port C.

When IP5330 is charging and discharging at the same time, PMOS of VIN and VOUT has such functions as over temperature, 3A over current and short circuit protection.
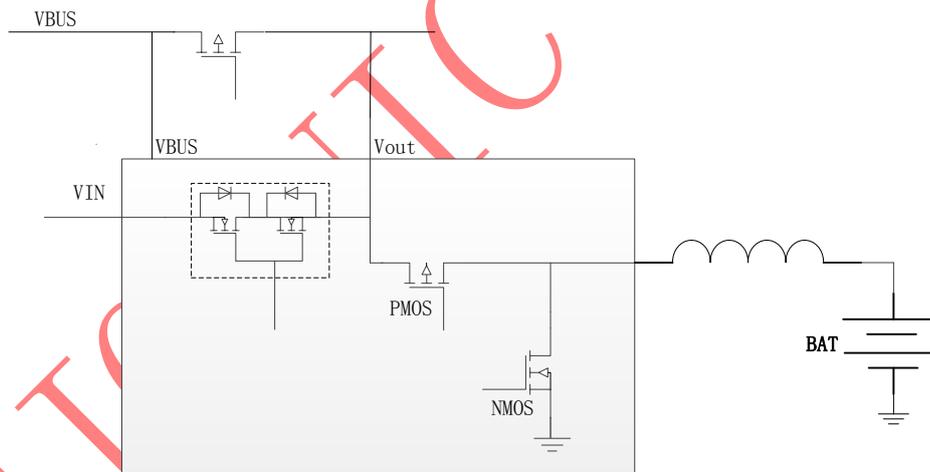


**Figure 6    Schematic Diagram Of Power Path Management**

## Key and WLED

IP5330 has built-in Key and WLED function, which supports external PIN selection, Key startup & shutdown and switch lighting. Specific reference is as follows:

| R19 | Key mode |
|-----|----------|
| 10K | Short press to boot; Press the button twice in a row to shut down;Long press 2s switch to flashlight |
| 24K | Short press to boot;Long press 2s switch to flashlight |
| 39K | Short press to boot; Press the button twice in a row to switch flashlight |
| 56K | Short press to boot; Press the button twice in a row to switch flashlight;Long press 2s to power off |
| 68K | Support vibration switch to power on/off |
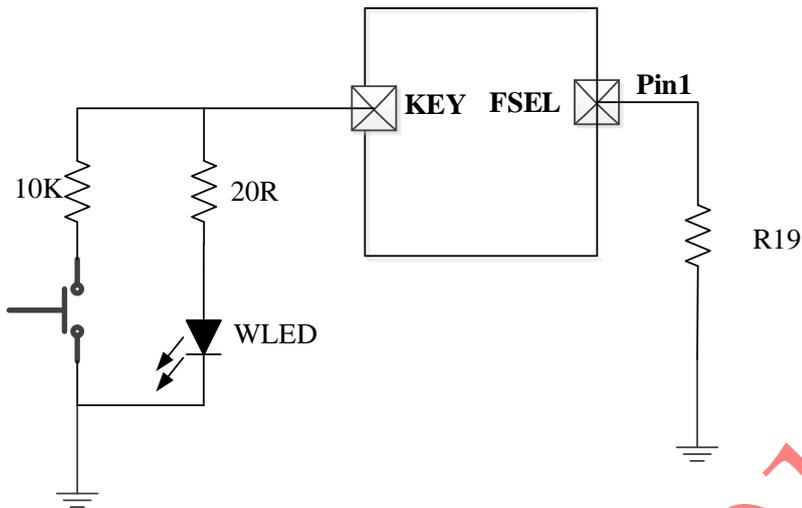
**Figure 7    Key and WLED circuit**

## Coulombmeter and battery level display

IP5330 has built-in accurate coulomb electricity meter algorithm, according to the battery capacity accurately display the remaining battery power.

IP5330 can be customized to support LED lamp, type 88, type 188, type 888 digital tube and other power display.

IP5330_BZ_VOUT12 supports 188 digital tube with OUT icon

| Digital Tube | Charge | | Discharge | |
|---|---|---|---|---|
| | Not Fully Charged | Fully Charged | Power Is Less Than 5% | Power Is More Than 5% |
| 5pin 188 | IN LED 0.5Hz Flash | 100% On | The Ones Place LED 1Hz Flash | 5%-100% On |

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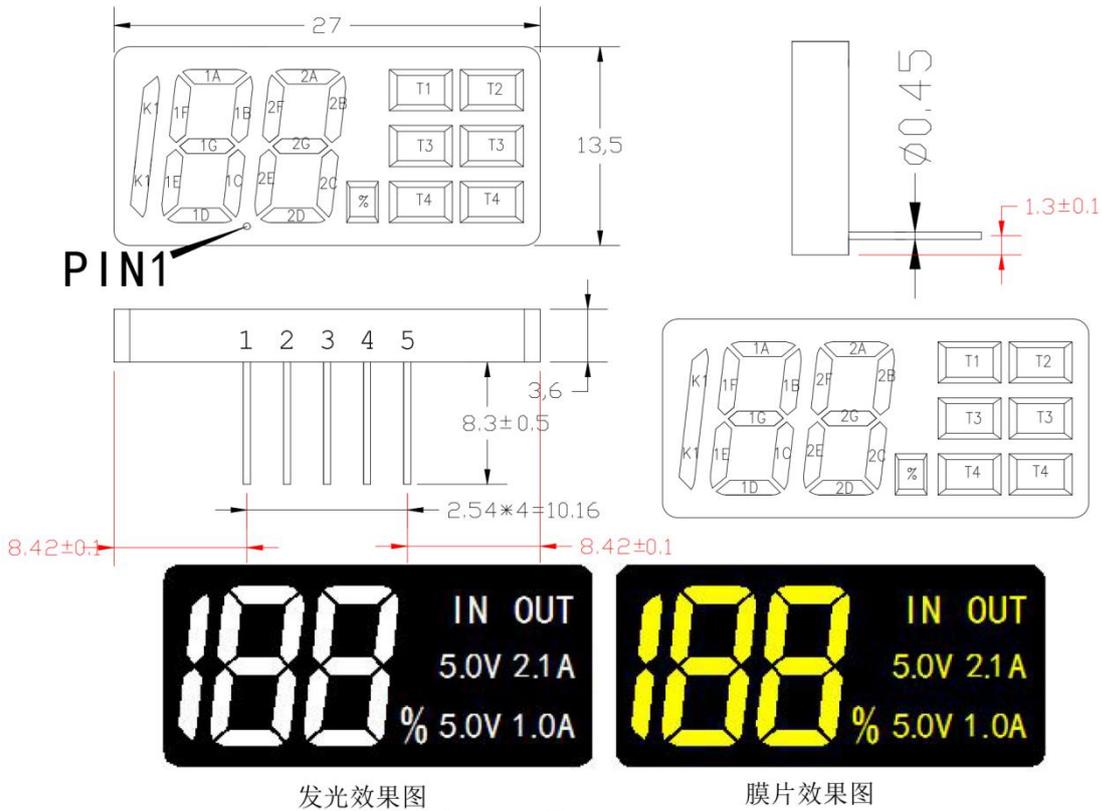


发光效果图                膜片效果图
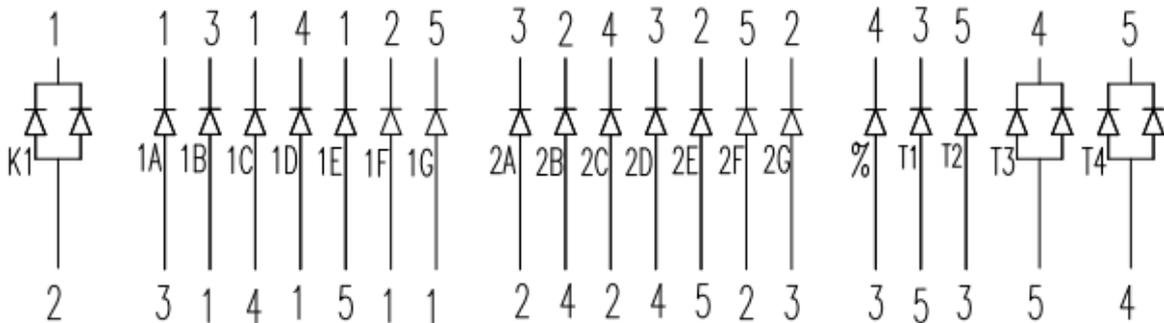


**Figure 8    188 digital tube with OUT icon**

IP5330_BZ_188 supports 188 digital tube without OUT icon

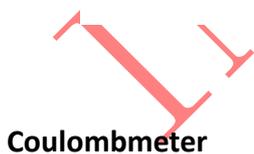| Digital | Charge | | Discharge | |
|---|---|---|---|---|
| Tube | Not Fully Charged | Fully Charged | Power Is Less Than 5% | Power Is More Than 5% |
| 188（YF2252SR-5） | 0%-99% 0.5Hz Flash | 100% On | 0%-5% 1Hz Flash | 5%-100% On |

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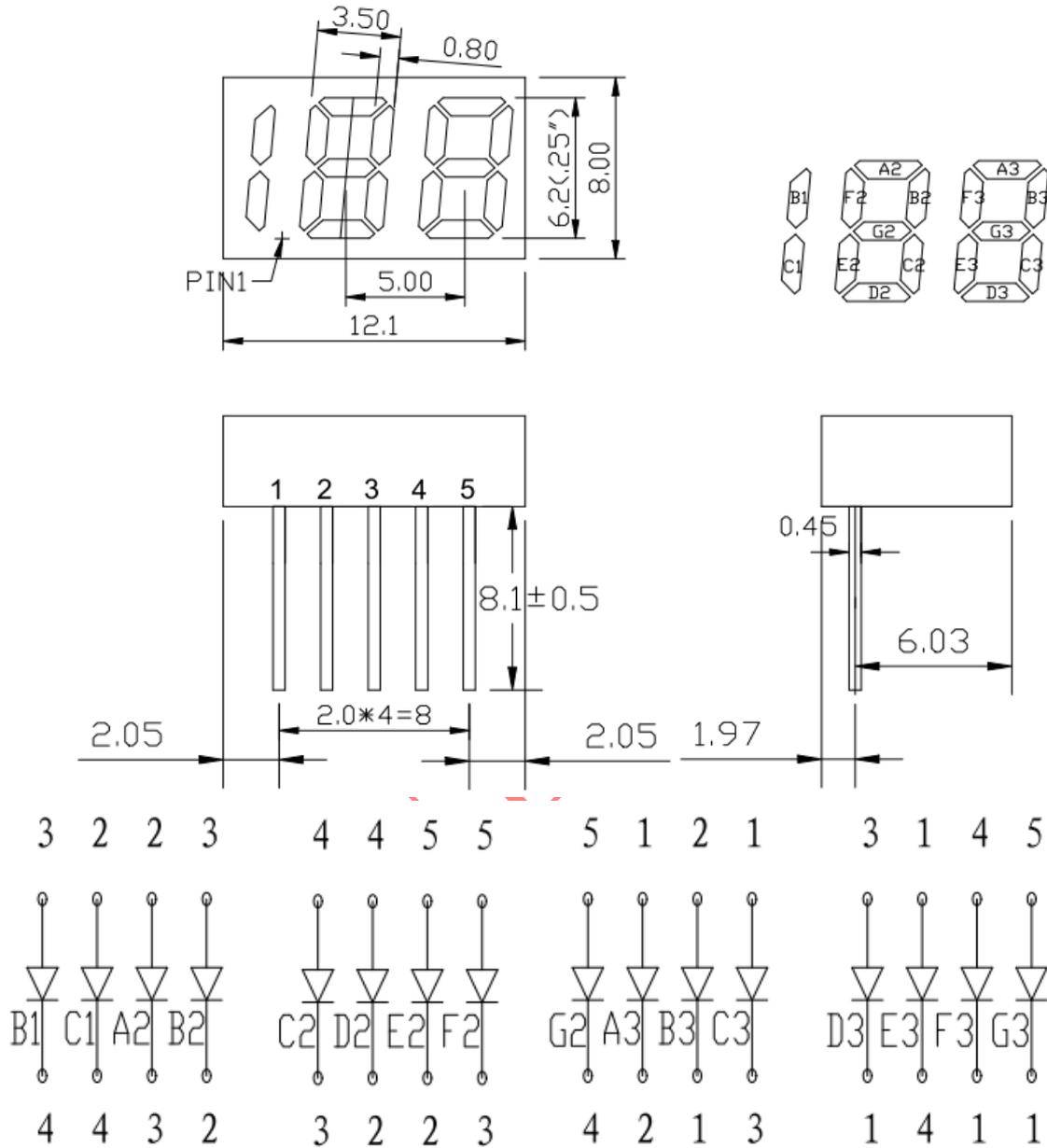


**Figure 9　188 digital tube without OUT icon**

**Coulombmeter**

IP5330 supports the external setting of the initial capacity of the battery. The residual capacity of the battery can be managed by integrating the current and time of the battery end, which can accurately display the current capacity of the battery. At the same time, IP5330 supports a complete charging process from 0% to 100% to automatically calibrate the total capacity of the current battery, so as to manage the actual capacity of the battery more reasonably.

IP5330 initial capacity formula setted by external PIN: battery capacity Fcap=( $R_{18}$-25)*400+5000, (resistance $R_{18}$ unit is Kohm, Fcap unit is mAH, support capacity range is 5000 mAH to 25000 mAH).
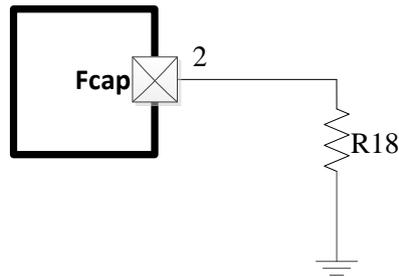
## Auto Detection On Phone Attachment And Enter Standby Mode Automatically With Light Load

After IP5330 detects the phone's insertion, it will immediately wake up from standby mode and turn on the boost 5V to charge the phone.

IP5330 automatically enters standby state when Vout end load current is less than 70mA and lasts for 30s.

## NTC

IP5330 can connect NTC resistance on NTC pin to realize the NTC function of the battery. NTC pin outputs 20uA current then detects the voltage on NTC resistance to determine the present battery temperature.
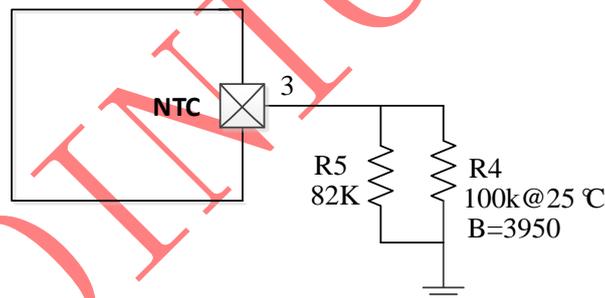


**Under charging state:**

Voltage on NTC resistance is higher than 1.3V meaning the battery temperature is under 0 centigrade, then stop charging the battery;

Voltage on NTC resistance is lower than 0.5V meaning the battery temperature is above 50 centigrade, then stop charging the battery;

**Under discharging state:**

Voltage on NTC resistance is higher than 1.47V meaning the battery temperature is under -15 centigrade, stop discharging;

Voltage on NTC resistance is lower than 0.44V meaning the battery temperature is above 55 centigrade, stop discharging.

If NTC is not required in the scheme, the NTC pin shall be connected 51K to GND. NTC pin shall not float, otherwise abnormal charging and discharging may be caused.

**Full Battery Voltage Setting**

IP5330 can choose the full battery voltage by connecting different resistors to VSET pin:
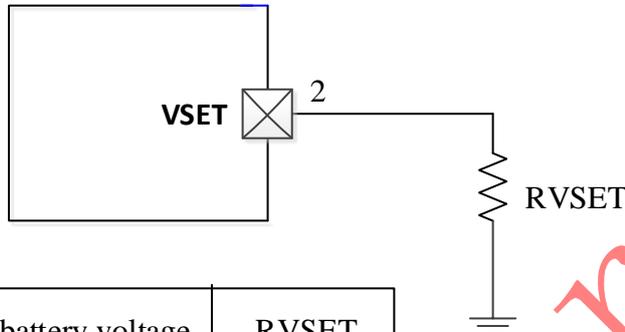
| Full battery voltage | RVSET |
|---|---|
| 4.2V | 1K |
| 4.3V | 33K |
| 4.35V | 82K |
| 4.4V | 120K |

**VCC**

VCC is a normally opened 3.3V LDO. Load capacity is 30mA. External connect a 2.2uF capacitor to GND.

## 11. Schematic And PCB Layout

1. Three 22uF ceramic capacitors (C3, C4 and C5) are required for IP5330 VOUT PIN (19, 20 and 21 PIN), which cannot be replaced by electrolytic capacitors; In PCB design, the capacitor on VOUT should be placed as close as possible to the VOUT pin, and the capacitor's ground should be drilled nearby. The circuit between the capacitor and EPAD should be as small as possible. It is required that there should be no wiring on the back of PCB to cut off the VOUT capacitor to the IP5330 EPAD.
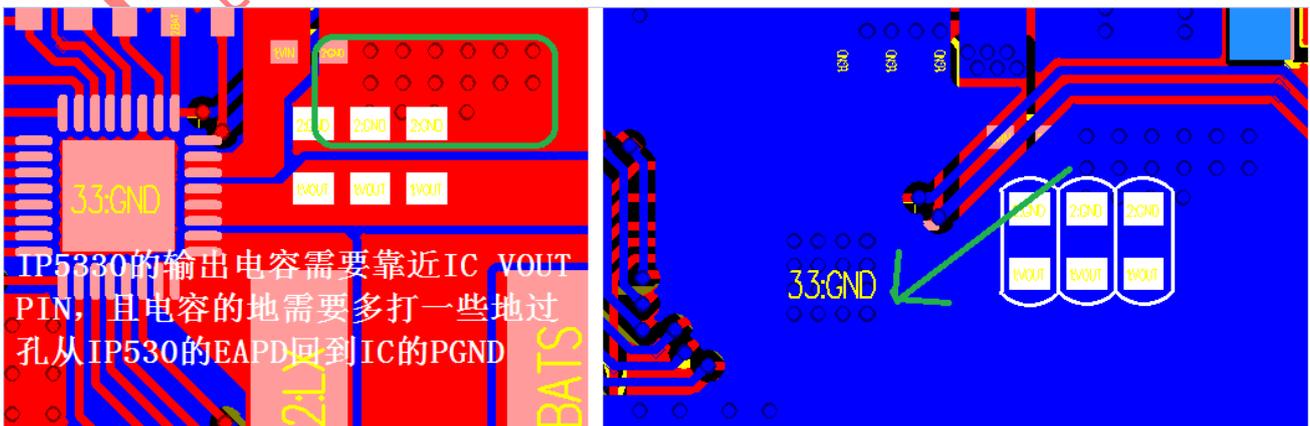
2. IP5330 detects battery current by sampling resistance of 10 milliohms; For the 24th and 25th pins of IP5330, they are required to use the differential form to IP5330 PIN directly from the leads at both ends of the 10 milliohms resistor. At the same time, the PIN shall be larger than 20mil, and a 47nf capacitor filter shall be placed near each PIN.
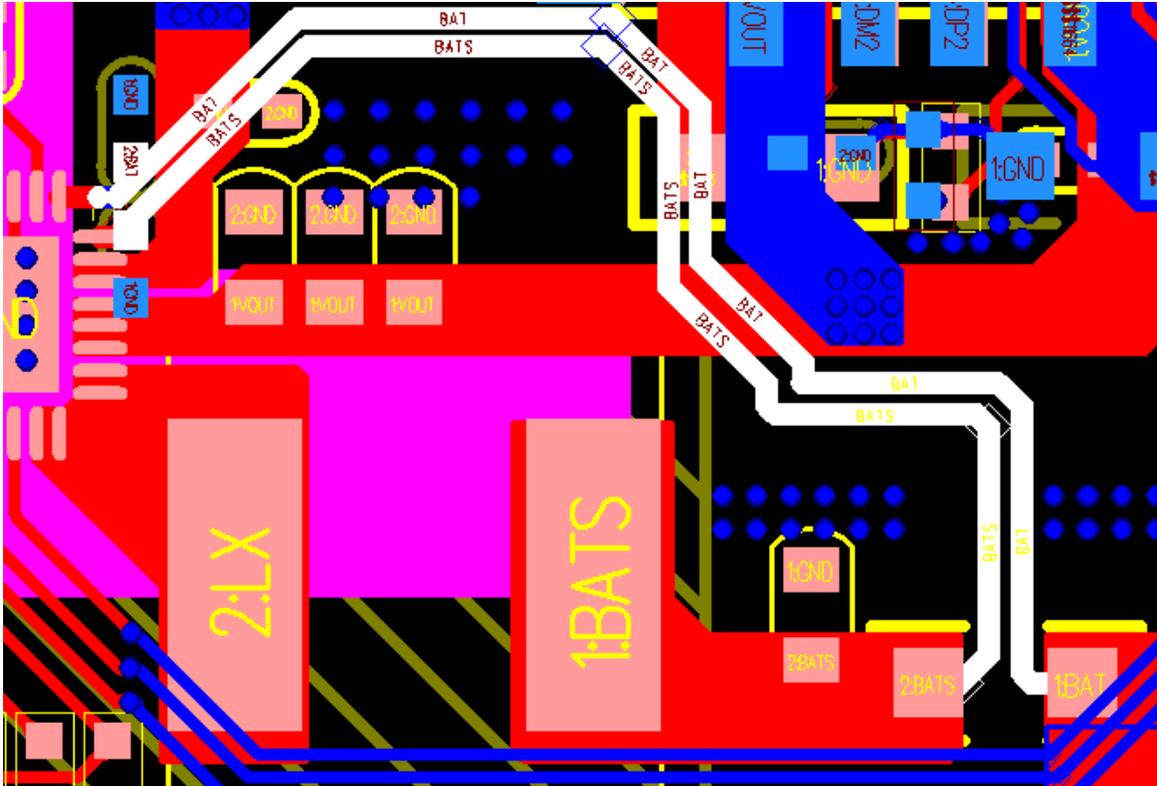
# IP5330

## 12. Typical Application Diagram

IP5330 only needs inductors, capacitors and resistors to realize the complete scheme of mobile power supply.

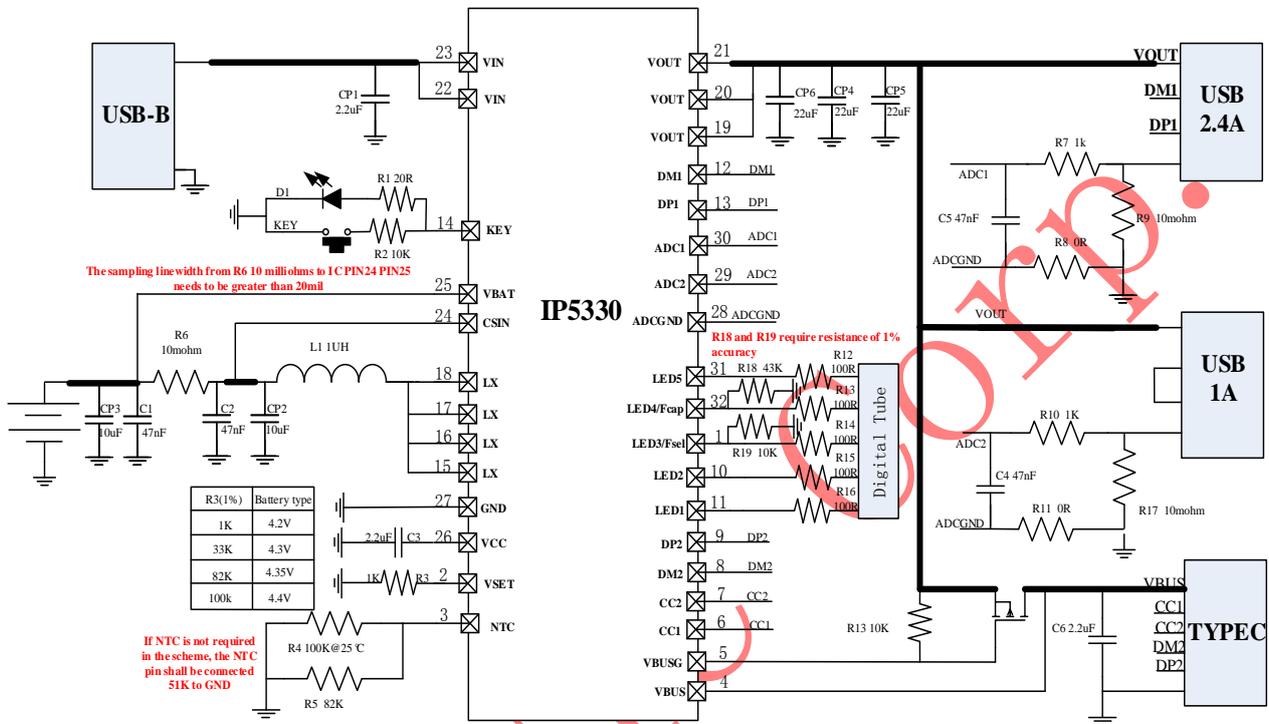**1、IP5330_BZ_VOUT12 supports 188 digital tube with OUT icon**



**Figure 10    Typical Application Diagram (188 digital tube with OUT icon)**

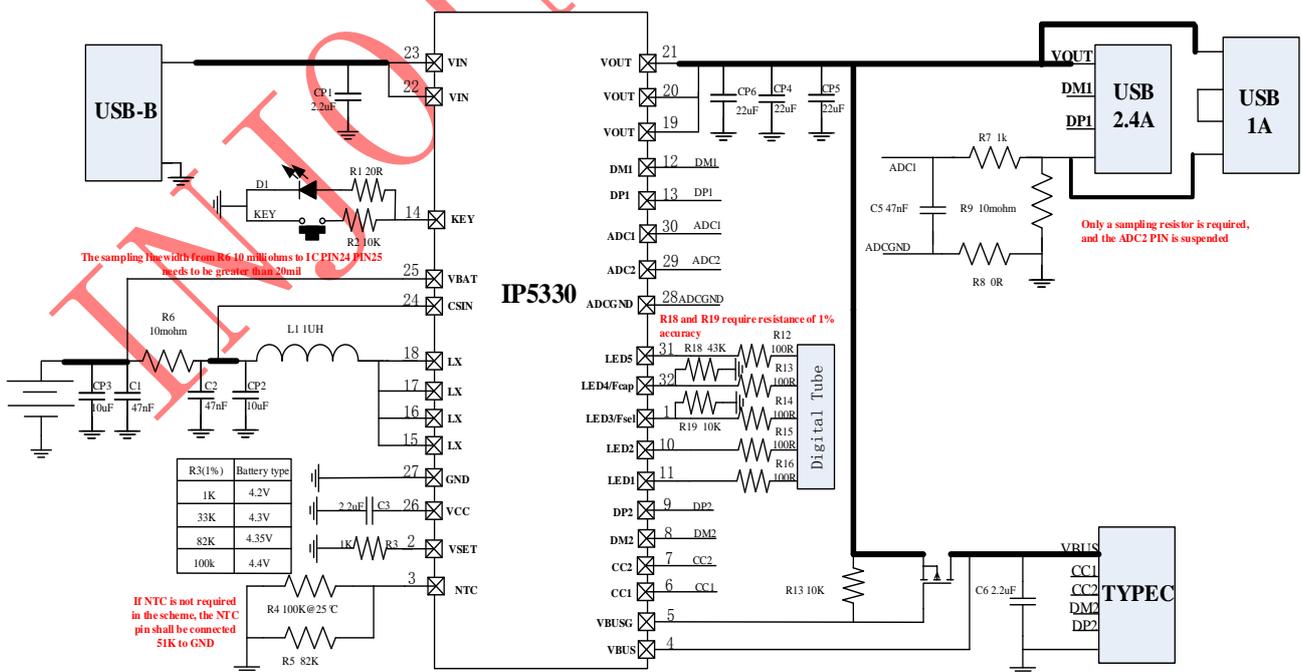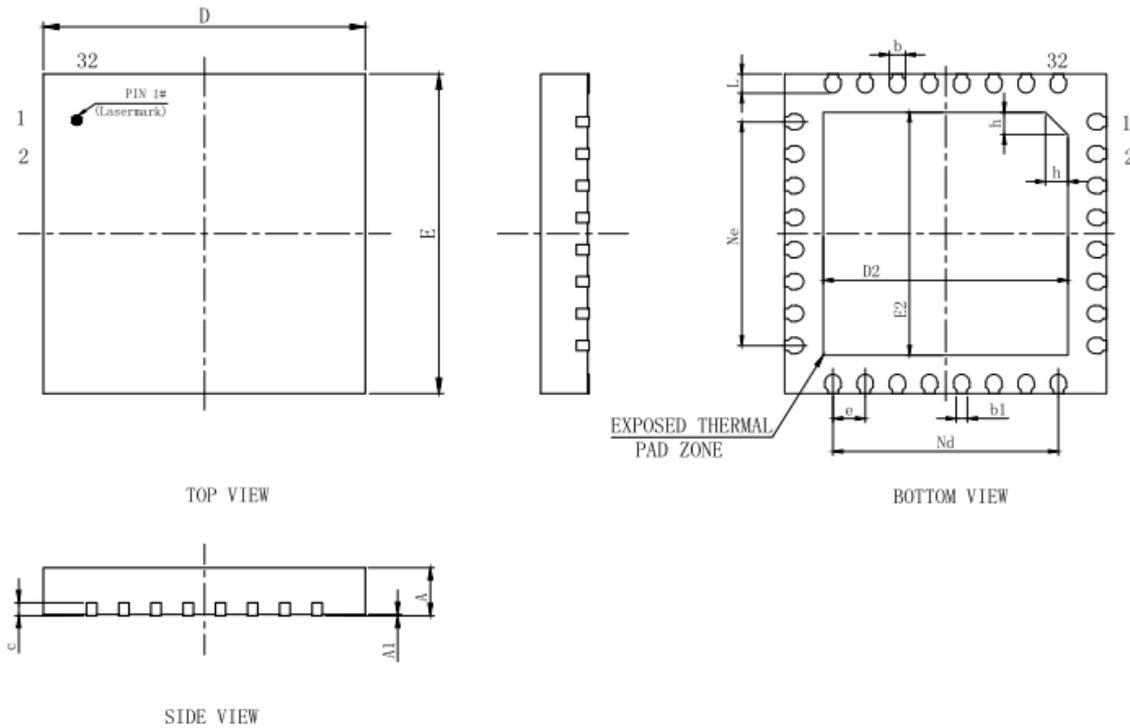**2、IP5330_BZ_188 supports 188 digital tube without OUT icon**



**Figure 11    Typical Application Diagram (188 digital tube with OUT icon)**

Recommended inductance model:

| DARFON PIN | Thickness (mm) | Inductance (uH) | Tolerance | DC Resistance (mΩ) | | Heat Rating Current DC Amp. | Saturation Current DC Amps. | Measuring Condition |
|---|---|---|---|---|---|---|---|---|
| | | | | Typ. | Max. | Idc(A)Max. | Isat(A)Max. | |
| SPM70701R0MESQ | 5 | 1 | ±20% | 9 | 10.2 | 10.5 | 13.5 | 100kHz/1.0V |
| SPM10101R0MESN | 4 | 1 | ±20% | 6 | 7 | 12 | 18 | 100kHz/1.0V |

## 13. Package



TOP VIEW

SIDE VIEW

EXPOSED THERMAL
PAD ZONE

BOTTOM VIEW

| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0 | 0.02 | 0.05 |
| b | 0.20 | 0.25 | 0.30 |
| b1 | 0.16REF | | |
| c | 0.18 | 0.20 | 0.25 |
| D | 4.90 | 5.00 | 5.10 |
| D2 | 3.70 | 3.80 | 3.90 |
| e | 0.50BSC | | |
| Ne | 3.50BSC | | |
| Nd | 3.50BSC | | |
| E | 4.90 | 5.00 | 5.10 |
| E2 | 3.70 | 3.80 | 3.90 |
| L | 0.25 | 0.30 | 0.35 |
| h | 0.30 | 0.35 | 0.40 |
| L/下载体尺寸 | 4.10X4.10 | | |

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