# Fast Charging Physical Layer IC for USB Interfaces

**TypeC PD2.0/PD3.0/PPS, QC2.0/QC3.0/QC3+/QC4/QC4+,BC1.2**

## 1. Features

- **Fast charge**
  - ✧ Support QC4/QC4+
    - Compatible with QC2.0/QC3.0
    - Support QC3.0 Class B: 3.6V~20V(0.2V/step)
  - ✧ Support QC3+
    - Support 3.6V~20V(0.02V/step)
    - Support 18W/27W/40W
  - ✧ Support Apple 2.4A, Samsung 2.0A and BC1.2
  - ✧ Support TYPE-C DFP
  - ✧ Support PD2.0/PD3.0/PPS
  - ✧ **USB PD3.0 with PPS Certificate Number：TID:6667**
- **Power Manage**
  - ✧ Build in ADC to monitor the current of the external NMOS FET
  - ✧ Build in power path manage.
  - ✧ Built-in automatic discharge function
  - ✧ Cable drop Compensation
  - ✧ Built-in VCONN power and switch for E-marked cable
- **Power Control Mode**
  - ✧ Optocoupler Mode: Build-in TL431.Drive optocoupler directly
  - ✧ FB Mode: External TL431,connected to feedback node
  - ✧ I2C Mode: Cooperate with the power supply chip, such as Inno3 pro.
- **Multiple protection, high reliability**
  - ✧ Output overcurrent, overvoltage and short circuit protection
  - ✧ NTC over temperature protection
  - ✧ DP,DM,CC1,CC2 overvoltage protection
  - ✧ DP,DM short with GND circuit protection
  - ✧ DP/DM/CC1/CC2 input voltage up to 25V
- **Support 100kHz-400kHz IIC Interface**
- **Working voltage : 3 V~30V**
- **Package : QFN24**

## 2. Description

**IP2732 is a highly-integrated, flexible high voltage charging protocol controller. It supports the most popular high voltage charging protocol, such as TYPE-C, PD2.0/PD3.0, QC2.0/QC3.0, QC3+/QC4/QC4+, BC1.2 etc.**

**The SOC could be a powerful protocol controller used in AC adapter, power-bank, Car charger or other power charging solution, and make the total solution size minimized and BOM cost down.**

## 3. Typical Applications

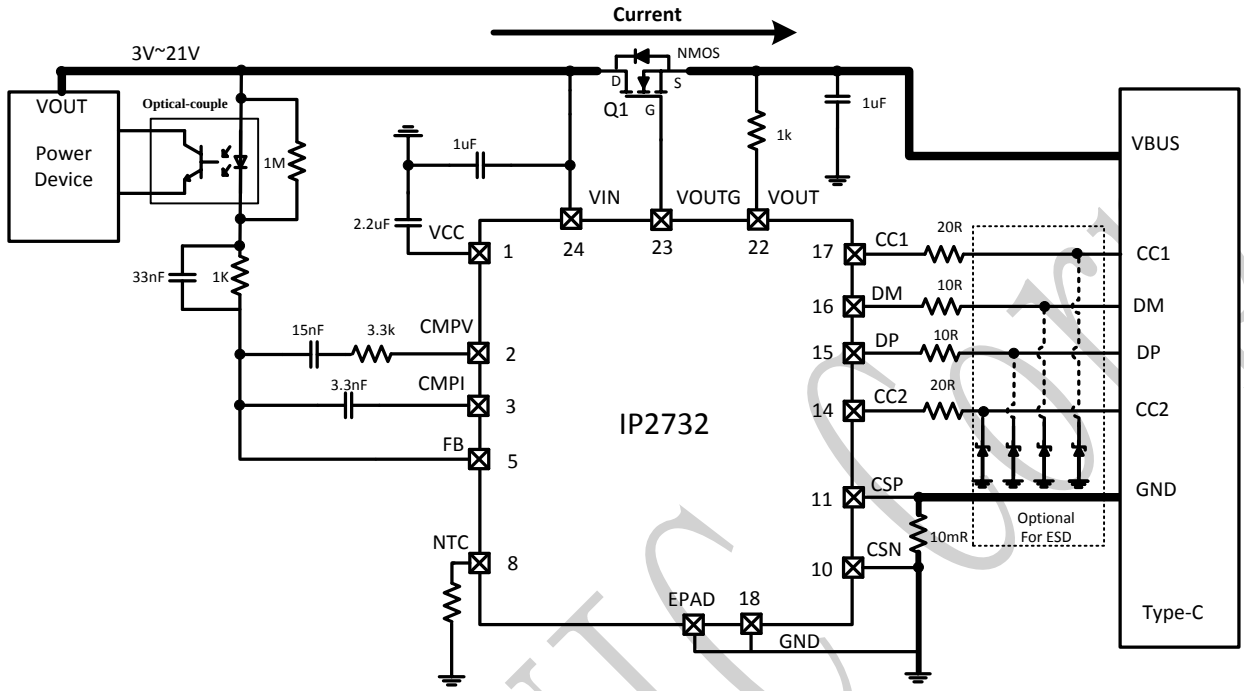
- **USB power output ports for AC adapters, Power Banka, Car chargers**
- **Battery chargers for smart phones, tablets, netbooks, digital cameras, and Bluetooth accessories**



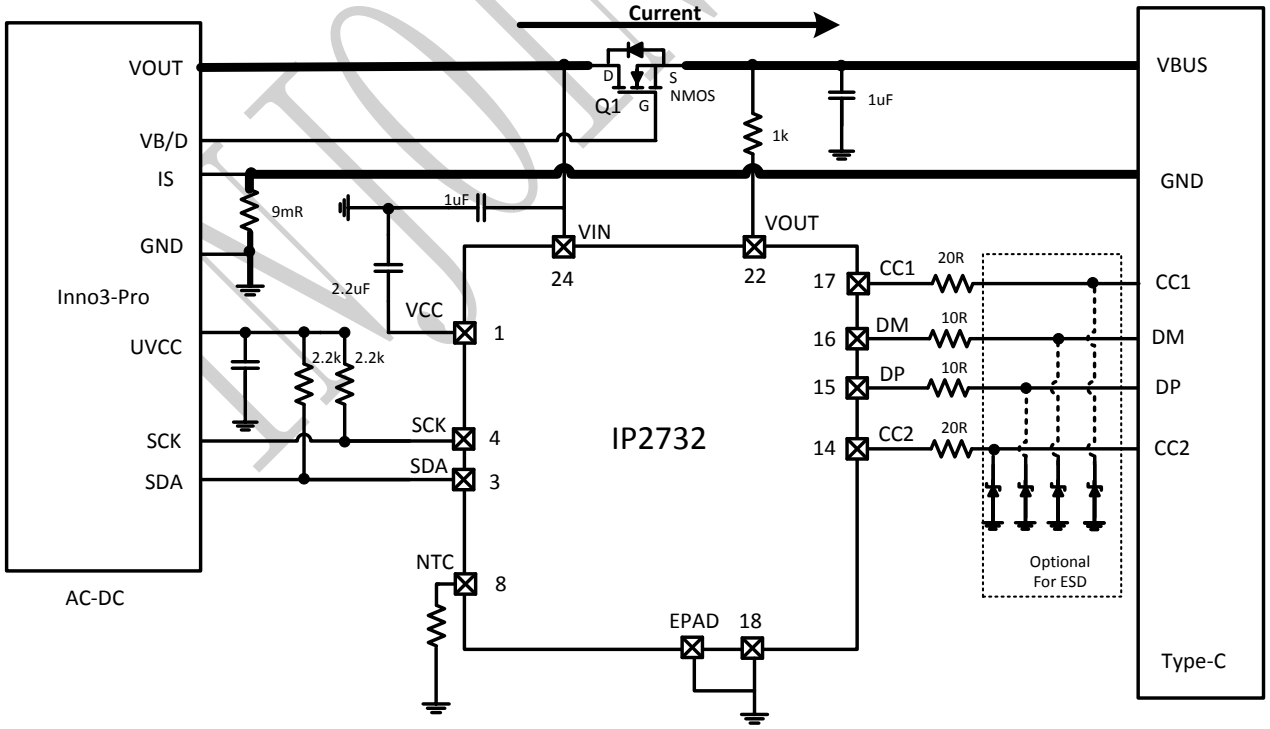
 

# 4. Typical Application Schematic

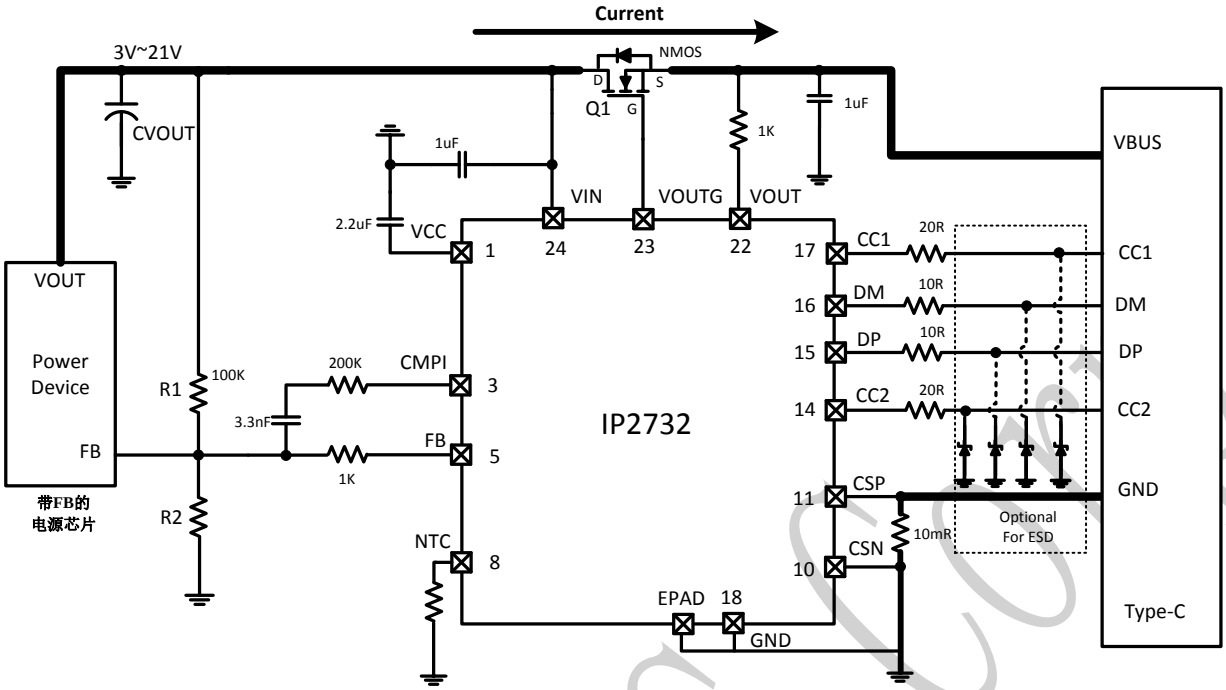
## Optocoupler MODE



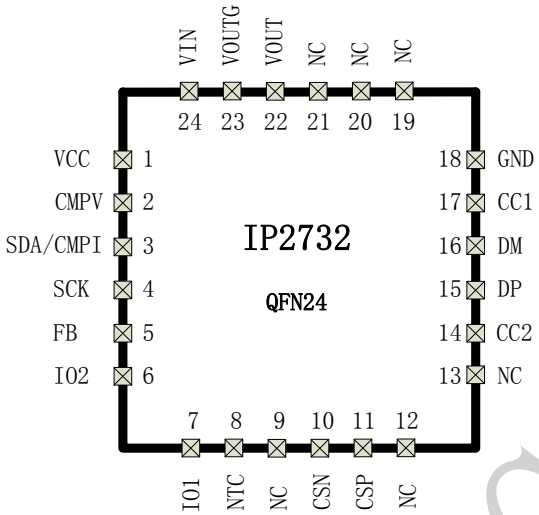

## I2C MODE



## FB MODE



## 5. PIN Description




| Pin No. | Pin name | Pin description |
|---|---|---|
| 1 | VCC | VCC Internal power supply output, need external 2.2 uF capacitance |
| 2 | CMPV | Feedback loop compensation of voltage |
| 3 | CMPI/SDA | Feedback loop compensation of current<br>I2C data |
| 4 | SCK | I2C clock |
| 5 | FB | Feedback PIN. Connect to the FB line of Regulator to the power device with FB control, current source/sink for voltage regulation |
| 6 | GPIO2 | General purpose IO2 |
| 7 | GPIO1 | General purpose IO1 |
| 8 | NTC | NTC Resistor input for temperature sense<br>General purpose IO0 |
| 9 | NC | Not connect |
| 10 | CSN | Current sense negative PIN |
| 11 | CSP | Current sense positive PIN |
| 12 | NC | Not connect |
| 13 | NC | Not connect |
| 14 | CC2 | Type-C CC2 line |
| 15 | DP | USB DP data line |
| 16 | DM | USB DM data line |
| 17 | CC1 | Type-C CC1 line |
| 18 | GND | ground |
| 19 | NC | Not connect |
| 20 | NC | Not connect |
| 21 | NC | Not connect |
| 22 | VOUT | VOUT discharge pin |



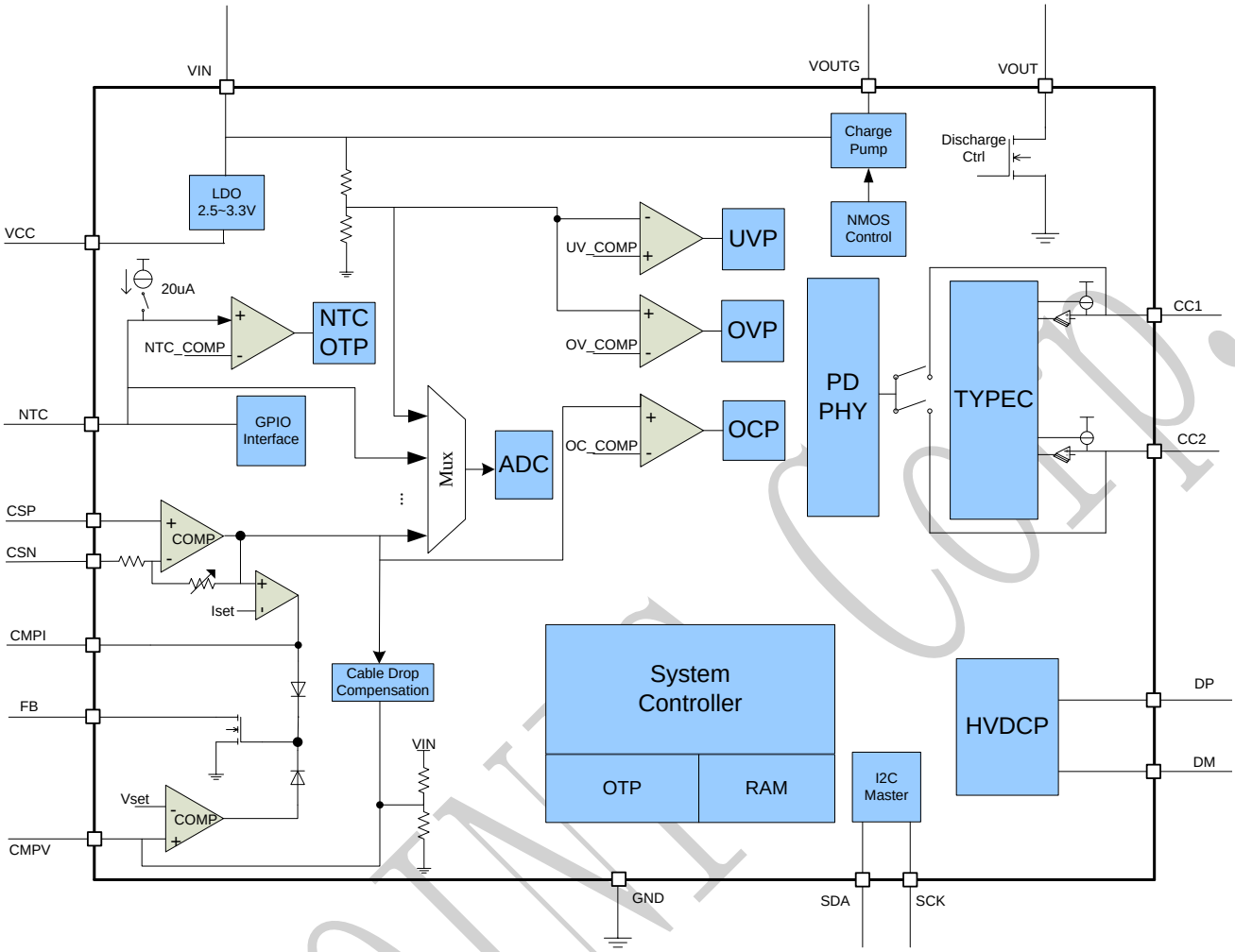
 

| | | |
|---|---|---|
| 23 | VOUTG | VOUT output path control on the NMOS |
| 24 | VIN | Power input |

## 6. Type Specification

| 型号 | 模式 | PDO/APDO(PPS)配置 | QC 配置 | QC3+ | 封装 |
|---|---|---|---|---|---|
| IP2732_0C20W | 光耦 | PDO: 5V/3A, 9V/2.22A, 12V/1.67A | ClassA 3.6v-12v | 18W | QFN24 |
| IP2732_FB20W | FB | | | | |
| IP2732_0C20WP | 光耦 | PDO: 5V/3A, 9V/2.22A, 12V/1.67A<br>PPS: 3.3V-5.9V/3A<br>PPS: 3.3V-11V/1.8A | ClassA 3.6v-12v | 18W | QFN24 |
| IP2732_FB20WP | FB | | | | |
| IP2732_0C25W | 光耦 | PDO: 5V/3A, 9V/2.77A | ClassA 3.6v-12v | 18W | QFN24 |
| IP2732_FB25W | FB | | | | |
| IP2732_0C25WP | 光耦 | PDO: 5V/3A, 9V/2.77A<br>PPS: 3.3V-5.9V/3A<br>PPS: 3.3V-11V/2.25A | ClassA 3.6v-12v | 18W | QFN24 |
| IP2732_FB25WP | FB | | | | |
| IP2732_0C30W | 光耦 | PDO: 5V/3A, 9V/3A, 12V/2.5A, 15V/2A, 20V/1.5A | ClassB 3.6v-20v | 27W | QFN24 |
| IP2732_FB30W | FB | | | | |
| IP2732_0C30WP | 光耦 | PDO: 5V/3A, 9V/3A, 12V/2.5A, 15V/2A, 20V/1.5A<br>PPS: 3.3V-11V/3A | ClassB 3.6v-20v | 27W | QFN24 |
| IP2732_FB30WP | FB | | | | |
| IP2732_0C45W | 光耦 | PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A | ClassB 3.6v-20v | 45W | QFN24 |
| IP2732_FB45W | FB | | | | |
| IP2732_0C45WP | 光耦 | PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A<br>PPS: 3.3V-16V/3A | ClassB 3.6v-20v | 45W | QFN24 |
| IP2732_FB45WP | FB | | | | |
| IP2732_0C65W | 光耦 | PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/3.25A | ClassB 3.6v-20v | 45W | QFN24 |
| IP2732_FB65W | FB | | | | |
| IP2732_0C65WP | 光耦 | PDO: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/3.25A<br>PPS: 3.3V-21V/3.25A | ClassB 3.6v-20v | 45W | QFN24 |
| IP2732_FB65WP | FB | | | | |
| 可定制 | 可定制 | 可定制 | 可定制 | 可定制 | QFN24 |

## 7. Internal Block Diagram




## 8. Absolute Maximum Ratings

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| VIN Input Voltage Range | VIN | -0.3 ~ 30 | V |
| VOUT Input Voltage Range | VOUT | -0.3 ~ 30 | V |
| FB Input Voltage Range | FB | -0.3 ~ 30 | V |
| DP，DM Input Voltage Range | $V_{DP}$，$V_{DM}$ | -0.3 ~ 25 | V |
| CC1，CC2 Input Voltage Range | $V_{CC1}$，$V_{CC2}$ | -0.3 ~ 30 | V |
| Other Pins Input Voltage Range | | -0.3 ~ 6 | V |
| Junction Temperature Range | $T_J$ | -40 ~ 150 | ℃ |
| Storage Temperature Range | Tstg | -60 ~ 150 | ℃ |
| Lead Temperature Range | Ts | 260 | ℃ |

| | | | |
|---|---|---|---|
| (Soldering, 10sec) | | | |
| Ambient Temperature Range | $T_A$ | -40~120 | ℃ |
| Package Thermal Resistance | $\theta_{JA}$ | 90 | ℃/W |
| Package Thermal Resistance | $\theta_{JC}$ | 39 | ℃/W |
| Human Body Model (HBM) | ESD | 4 | KV |
| Moisture Sensitivity Level (MSL) | MSL | 3 | Level |

* 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.

## 9. Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Input Voltage | VIN | 3 | | 25 | V |
| Ambient Temperature | $T_A$ | -40 | | 85 | ℃ |

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

## 10.Electrical Characteristics

Unless otherwise specified, TA=25℃, 4.5V ≤ VIN ≤ 5.5V

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Input Voltage | VIN | Supplied directly | 3 | | 25 | V |
| Input UVLO Threshold | UVLO | VIN/VCC Falling | 2.5 | | 2.9 | V |
| Output Voltage Range | VOUT | | 3 | | 21 | V |
| Output Voltage Range Accuracy | △VOUT | | -3 | | 3 | % |
| OCP current point | $I_{OCP}$ | Rs=10mR, TA=25℃ | 0.2 | | 6.4 | A |
| OCP current point accuracy | $\triangle I_{OCP}$ | Rs=10mR, TA=25℃ | -150 | | +150 | mA |
| Quiescent Current | $I_{NOR}$ | No load, CC pin connect, VIN=5V | 3 | 4 | 5 | mA |
| | $I_{STDBY}$ | Standby mode, CC pin floating, VIN=5V | 0.4 | 0.8 | 1.2 | mA |
| **HVDCP (QC2.0&QC3.0)** | | | | | | |
| Data Detect Voltage Threshold | $V_{DATA\_REF}$ | | 0.25 | 0.325 | 0.4 | V |

| | | | | | | |
|---|---|---|---|---|---|---|
| Output Voltage Selection Reference | $V_{SEL\_REF}$ | | 1.8 | 2 | 2.2 | V |
| DP High Glitch Filter Time | $T_{GLITCH(BC)\_DP\_H}$ | | 1000 | 1250 | 1500 | ms |
| DM Low Glitch Filter Time | $T_{GLITCH(BC)\_DM\_L}$ | | 1 | 2 | 3 | ms |
| Output Voltage Glitch Filter Time | $T_{GLITCH(V)\_CHANGE}$ | | 20 | 40 | 60 | ms |
| Continuous Mode Glitch Filter Time | $T_{GLITCH\_CONT\_CHANGE}$ | | 100 | | 200 | us |
| DM and DP Short Resistance | $R_{SHORT}$ | $V_{DP}$=0.6V | 20 | 30 | 40 | Ohm |
| DM Pull-down Resistance | $R_{DM\_DOWN}$ | $V_{DP}$=0.6V | 14.25 | 20 | 24.8 | kOhm |
| DP Pull-down Resistance | $R_{DAT\_LKG}$ | $V_{DP}$=0.6V | 200 | 500 | 800 | kOhm |
| **DCP** | | | | | | |
| Samsung DP/DM Output Voltage | | | 1.08 | 1.2 | 1.32 | V |
| Samsung DP/DM Output Impedance | | | 70 | 100 | 130 | kOhm |
| Apple 2.4A DP/DM Output Voltage | | | 2.64 | 2.7 | 2.76 | V |
| Apple 2.4A DP/DM Output Impedance | | | 20 | 30 | 40 | kOhm |
| **NTC** | | | | | | |
| NTC OTP Current Source | $I_{OTP}$ | | 19.4 | 20 | 20.6 | uA |
| NTC OTP Voltage Threshold | $V_{OTP}$ | | 0.1 | | 3 | V |

# 11.Function Description

## DP/DM Quick Charge

IP2732 can automatically detects Quick Charge 2.0/3.0 /QC3+ capable devices with handshake by USB D+/D- data line. It's also complaint with BC1.2.

- BC1.2: Shorting D+ Line to D- Line.
- QC3+: Support 18W/27W/40W. It can be disabled independently.
- Quick Charge 2.0/3.0: D+ and D- line configuration see **Table 1**.

**Table 1 QC2.0/3.0 DP/DM configuration:**

| DP | DM | Result(Class A) | Result(Class B) |
|---|---|---|---|
| 0.6 V | GND | 5 V | 5 V |
| 3.3 V | 0.6 V | 9 V | 9 V |
| 0.6 V | 0.6 V | 12 V | 12 V |
| 0.6 V | 3.3 V | Continue Mode | Continue Mode |
| 3.3 V | 3.3 V | Keep | 20V |

## TYPE-C

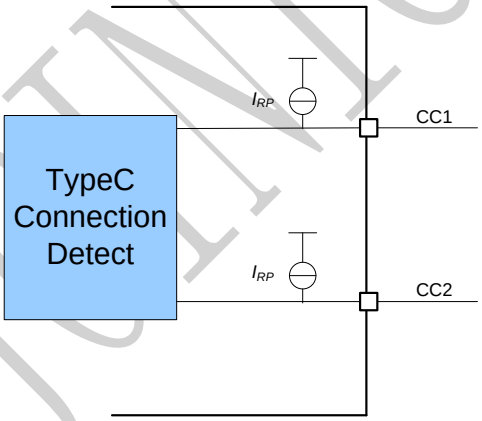
Two pins on the TypeC connector, CC1 and CC2 are used to establish and manage the Source-to-Sink connection.

Only CC1 is used for USB-A connector.

TypeC source exposes independent pull-up(Rp) teminations by current sources on CC1 and CC2 pins to advertise current capability and monitors the voltage by multiple comparators to detect a attach/detach.

The USB Type-C connector uses CC pins for configuration including the ability for a Source to advertise to its port partner (Sink) the amount of current it can apply:

- Default values defined by the USB Specification (500 mA for USB 2.0 ports, 900 mA for USB 3.1 ports)
- 1.5A
- 3.0A




## PD Physical Layer

The USB PD Physical Layer consists of a pair of transmitters and receivers that communicate across a single signal wire (CC).

The transmitter performs the following functions:

- Receive packet data from the protocol layer.
- Calculate and append a CRC.

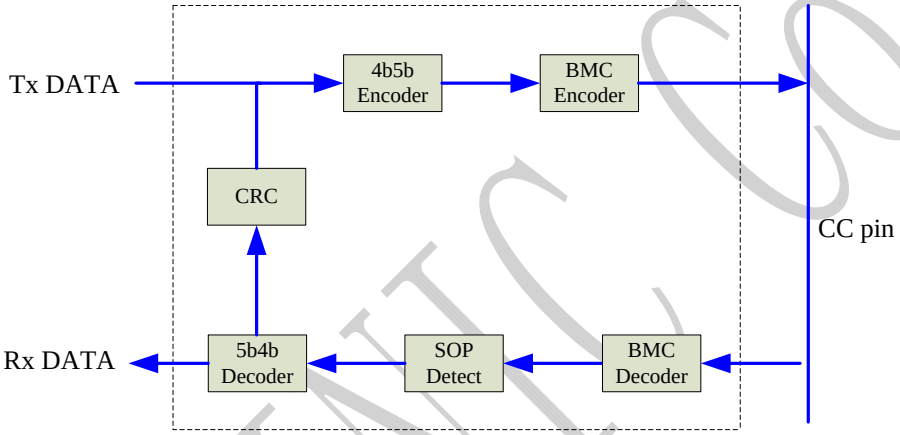
- Encode the packet data including the CRC (i.e. the payload).
- Transmit the Packet (Preamble, SOP*, payload, CRC and EOP) across the channel using Biphase Mark Coding (BMC) over CC.

The receiver performs the following functions:

- Recover the clock and lock onto the Packet from the Preamble.
- Detect the SOP*.
- Decode the received data including the CRC.
- Detect the EOP and validate the CRC:

  If the CRC is Valid, deliver the packet data to the protocol layer.

  If the CRC is Invalid, flush the received data.




## VOUT Discharge

When the device is unplugged, the VOUT pin can discharge energy to meet the time requirements of the USB- PD protocol

## Voltage regulation mode

### ➢ FB Mode

IP2732 integrated FB control line used for accurate voltage regulation by source/sink current with precise 2uA/step in minimum. FB sink 40uA current for 9V output voltage; FB sink 70uA current for 12V output voltage; FB sink 150uA current for 20V output voltage; when the output voltage is default 5V, FB neither source nor sink current.

In typical applications, IP2732 FB connects to the regulator's FB line, resistor (R1) between VOUT and FB should apply 100kOhm with high precision (1%), resistor (R2) value between FB and GND should refer to the



regulator adopted, resistance of R2 can be calculated by equation:

$$VFB = \frac{VOUT}{R1 + R2} * R2$$

### ➢ Optocoupler Mode

IP2732 integrates an optocoupler driver circuit, and the FB pin is connected to the Cathode end of the optocoupler for use in isolated power supplies. The value of external compensation network capacitance, resistance of CMPV and CMPI needs to be adjusted according to the specific parameters of the front-end power network, The CMPV compensation network is used to achieve VOUT output voltage stability. The CMPI compensation network is used to achieve stability of power control.

### ➢ I2C Mode

IP2732 integrate I2C master control interface, can cooperate with the power supply chip, such as Inno3 pro etc.

## Cable Drop Compensation

IP2732 integrates the line compensation function, which can increase the output voltage in a certain proportion according to the current output current to compensate for linear loss. FB mode and Optocoupler mode can be increased according to the compensation coefficients of 0mV/A, 62.5mV/A, and 125mV/A.

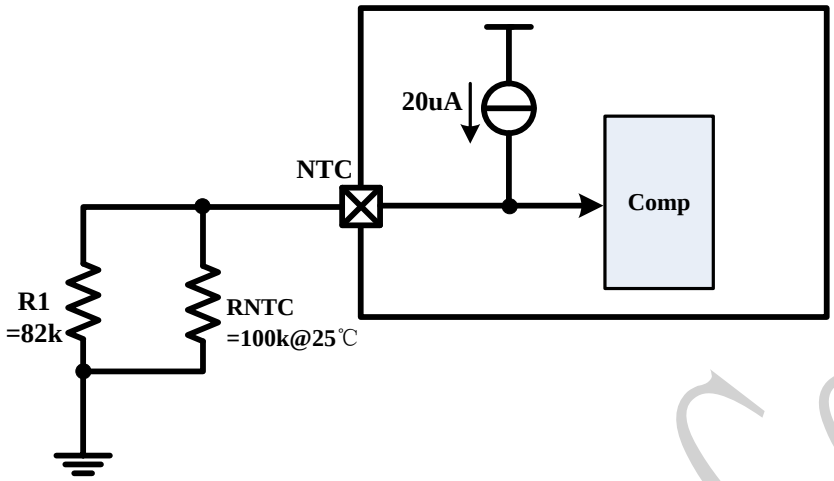
For example, if the compensation coefficient of 125mV/A is selected, if the no-load output voltage is 5.0V, then the actual output voltage=5.0V+3A*125mV/A=5.375V when the output current is 3A



## Protections

### ➢ NTC




IP2732 support NTC function used for temperature detection. NTC pin output 20uA current then detect the voltage on NTC pin to determine the present temperature.

### ➢ OVP and UVP

IP2732 realizes over-voltage and under-voltage protection functions by detecting the voltage of VIN. The over-voltage threshold and the under-voltage threshold can be flexibly set according to the percentage of the current output voltage. When an abnormal event of over-voltage or under-voltage occurs, the Gate will be pulled low and the external path NMOS transistor will be closed. If the abnormal event disappears, the Type-C handshake and PD communication will be re-established.。

### ➢ OTP

IP2732 integrates internal junction temperature OTP protection. Junction temperature protection occurs when the junction temperature exceeds 135 ℃

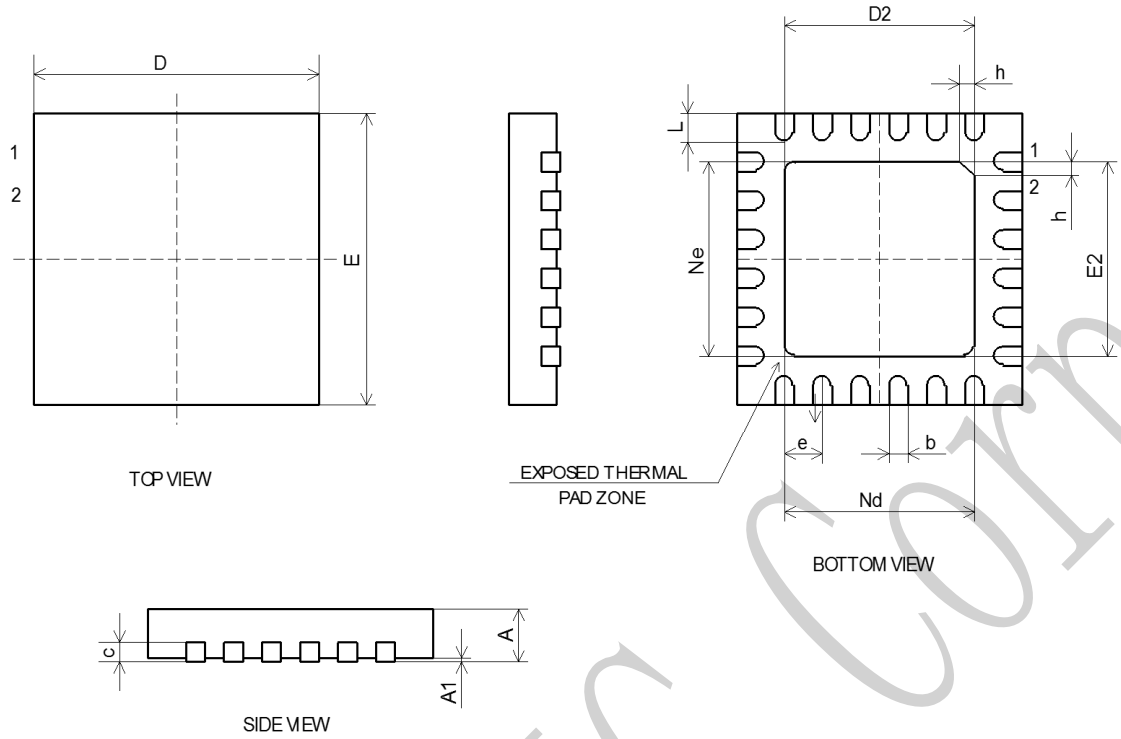
### ➢ OCP

IP2732 realizes OCP overcurrent protection by detecting the current flowing through the sampling resistor. The overcurrent threshold can be flexibly set. When the current reaches the over-current threshold, the over-current abnormal protection occurs, and the Gate will be pulled low, closing the external path NMOS transistor. If the abnormal event disappears, the Type-C handshake and PD communication will be re-established.



## 12.Package

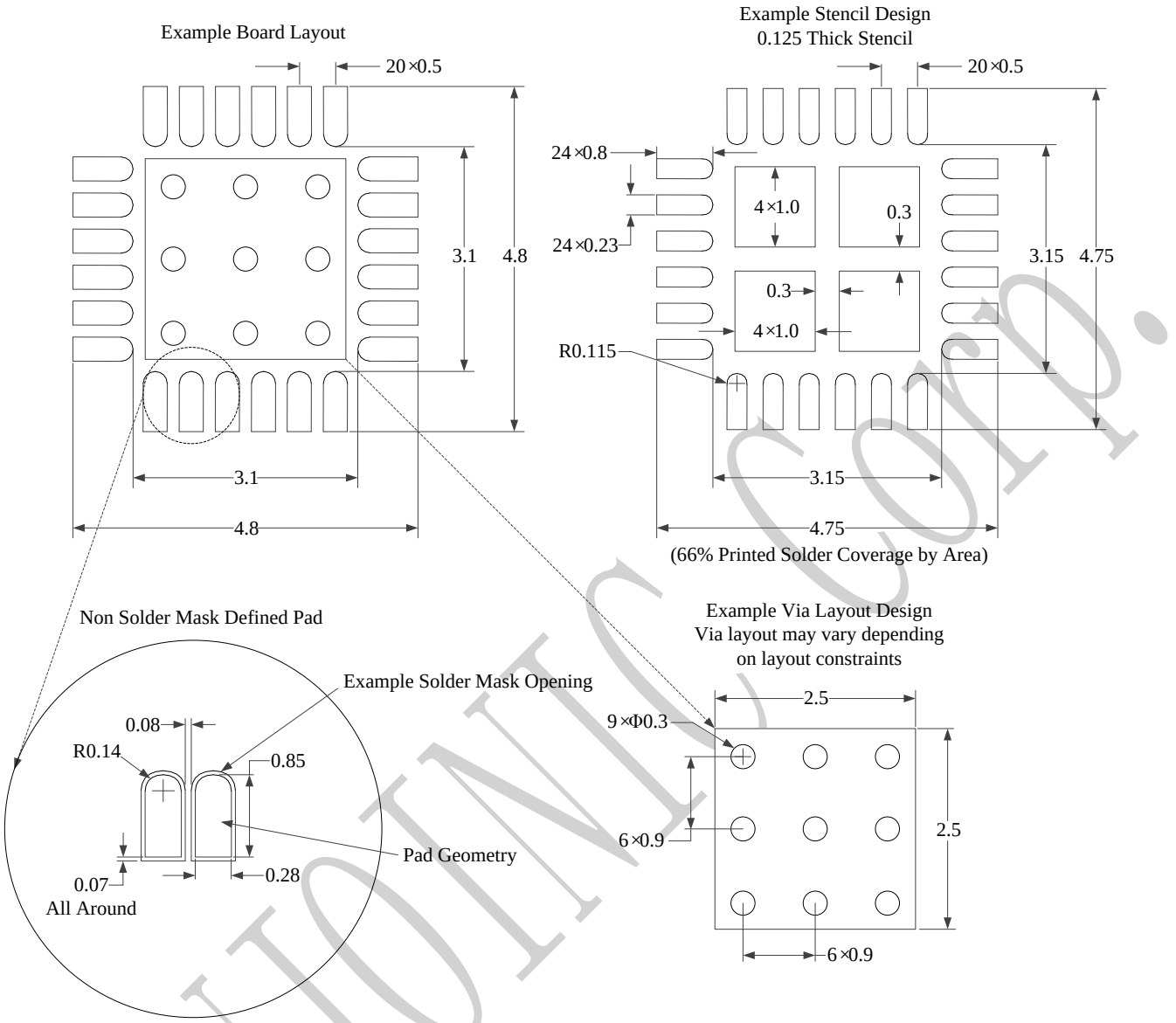



| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0.70 | 0.75 | 0.80 |
| A1 | - | 0.02 | 0.05 |
| b | 0.18 | 0.25 | 0.30 |
| c | 0.18 | 0.20 | 0.25 |
| D | 3.90 | 4.00 | 4.10 |
| D2 | 2.40 | 2.50 | 2.60 |
| e | 0.50BSC | | |
| Ne | 2.50BSC | | |
| Nd | 2.50BSC | | |
| E | 3.90 | 4.00 | 4.10 |
| E2 | 2.40 | 2.50 | 2.60 |
| L | 0.35 | 0.40 | 0.45 |
| h | 0.30 | 0.35 | 0.40 |



# 13.Layout Design




NOTES: 1. All linear dimensions are in millimeters.
2. This drawing is subject to change without notice.
3. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.



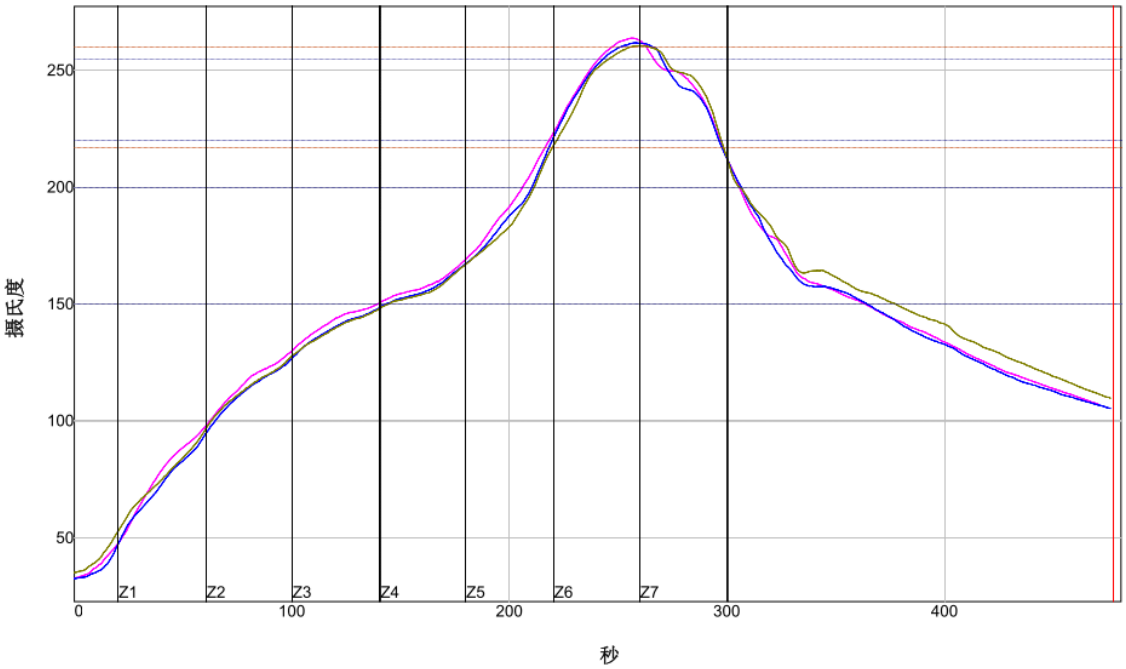
 

## 14. Solder Instruction

温度设置 (摄氏度)

| 温区 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 上温区 | 130 | 140 | 160 | 160 | 200 | 320 | 265 |
| 下温区 | 130 | 140 | 160 | 160 | 200 | 320 | 265 |

传送带速度 (公分/分): 39.0




| PWI= 75% | 最高上升斜率 | | 预热150至200C | | 最高温度 | | 总共 时间 /217C | | 斜率1 (217-260C) | | 预热220至255C-(2) | | 总共 时间 /260C-2 | | 距峰值5C区域时间 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VP 1 | 1.69 | -31% | 66.21 | -59% | 263.87 | 18% | 80.99 | -70% | 1.70 | -30% | 22.81 | -36% | 15.90 | -30% | 18.13 | -75% |
| VP 2 | 1.99 | -1% | 66.91 | -54% | 261.84 | -9% | 78.97 | -73% | 1.87 | -13% | 23.44 | -33% | 15.74 | -31% | 23.64 | -31% |
| VP 3 | 1.83 | -17% | 66.61 | -56% | 260.76 | -23% | 78.19 | -74% | 1.88 | -12% | 23.97 | -30% | 9.37 | -66% | 23.95 | -28% |
| 温差 | 0.30 | | 0.70 | | 3.11 | | 2.80 | | 0.18 | | 1.16 | | 6.53 | | 5.82 | |

制程界限:

锡膏: 260

| 统计数名称 | 最低界限 | 最高界限 | 单位 |
|---|---|---|---|
| 最高温度上升斜率 (目标=2.0) (计算斜率的时间距离= 20 秒) | 1.0 | 3.0 | 度/秒 |
| 斜率1 (目标=2.0) 介于 217.0 和 260.0 (计算斜率的时间距离= 10 秒) | 1.0 | 3.0 | 度/秒 |
| 预热时间150-200摄氏度 | 60 | 90 | 秒 |
| 预热时间220-255摄氏度-( 2 ) | 10 | 50 | 秒 |
| 最高温度 | 255 | 270 | 度 摄氏度 |
| 在217摄氏度以上时间 | 60 | 200 | 秒 |
| 在260摄氏度以上时间-( 2 ) | 3 | 40 | 秒 |
| 距峰值5C区域时间 | 15 | 40 | 秒 |

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