

## Dual ports Type-C Buck Converter with PD3.0/PPS/PD2.0

### 1 Features

- **Synchronous-rectified buck converter**
  - ◇ Built-in power MOSFET
  - ◇ Input voltage range: 8.2V~32V
  - ◇ Output voltage range: 3V~12V, adjustable according to the fast charge protocol
  - ◇ Output voltage has line compensate function of 50mV/A
  - ◇ Support CV/CC output mode: CV mode (output current < preset value); CC mode (output current > preset value)
  - ◇ conversion efficiency up to 92.2% with VIN=24V, VOUT=5V/3A
- **Type-C USB PD protocol output**
  - ◇ Support 5V, 9V, 12V voltage output
  - ◇ Support PD2.0/PD3.0(PPS) output protocol
  - ◇ PPS support 3.3~11V adjustable voltage with 20mV/step output
- **Fast charge output of dual Type-C and dual USB A ports**
  - ◇ Support 2 ports of Type-C PD output
  - ◇ Support 2 ports of BC1.2 and Apple
  - ◇ Support 2 ports of QC3.0 and QC2.0
  - ◇ Support 2 ports of FCP and SCP
  - ◇ Support 2 ports of Samsung fast charge: AFC
  - ◇ Support 2 ports of SFCP
- **Dual ports fast charge output**
  - ◇ Support dual ports USB Type-C output
  - ◇ Support USB Type-C and USB A output
  - ◇ Support dual ports USB A output
  - ◇ Support any port fast charge output
  - ◇ Dual ports auto plug-in and plug-out detection
- **Multi protection and high reliability**
  - ◇ Support input over voltage and under voltage protection, support output short circuit, over current and over temperature protection
  - ◇ DP/DM/CC over voltage protection
  - ◇ CC withstand voltage of 30V
  - ◇ ESD 4KV, DC withstand voltage of 40V
- **Package: 4\*4mm QFN32**

### 2 Application

- Car charger
- Fast charge adaptor
- Smart power strip

### 3 Description

IP6565 is a Synchronous-Rectified Buck Converter which supports multiple fast charge output standards with dual Type-C output ports and dual USB A output ports. It provides solutions for car charger, fast charge adaptor and smart power strip.

IP6565 supports dual Type-C output ports or dual USB A output ports or a Type-C output port plus a USB A output port. Includes dual ports auto plug detection function, fast charge is supported on any single port, the two ports will output 5V when two ports have attached devices at which the overall output power is 5V/3.4A.

IP6565 has built-in power MOSFET, input voltage range is 4.5V to 32V, output voltage ranges from 3V to 12V with up to 36W power supply. The output voltage and current is auto adjusted dynamically based on the fast charge requirement. IP6565 has a conversion efficiency of up to 92.2% when output 5V/3A.

IP6565 PD output has CV/CC mode, when the output current is lower than preset value, the output voltage will be constant in CV output mode; when the output current is higher than preset value, the output voltage will decrease in CC output mode.

IP6565 supports output line compensation, when output current increases, the output voltage will increase accordingly that makes up the resistive voltage drop introduced by connection, wire, and PCB traces.

IP6565 supports soft start function that protects the input power source from inrush current at start up.

## 目录

1 Features .....	1
2 Application .....	1
3 Description .....	1
4 Reversion History .....	3
5 Typical Application Schematic .....	3
6 Pin Configuration And Function .....	5
7 IP Comparison Table .....	6
7.1 Car Charger IC .....	6
7.2 IP6565 Series Product Introduction .....	7
8 Absolute Maximum Ratings .....	8
9 Recommended Operating Conditions .....	8
10 Electrical Characteristics .....	9
11 Function Description .....	11
11.1 IP6565 Internal block diagram .....	11
11.2 Synchronous-Rectified Buck Converter .....	12
11.3 Output Voltage Line Compensation Function .....	13
11.4 Output CC/CV Character .....	13
11.5 Output CC Current Set .....	13
11.6 EN Function .....	14
11.7 HLED Function .....	14
11.8 Protection Function .....	14
11.9 Dual Fast Charge Output Ports .....	14
11.10 Output Fast Charge Protocol .....	15
11.11 Type-C Port and USB PD Protocol .....	15
12 BOM .....	16
13 Package Information .....	17
14 Mark Description .....	18
15 Photos Of Physical Objects .....	18
16 Land Pattern Layout Example .....	19
17 IMPORTANT NOTICE .....	20

## 4 Reversion History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Initial Release V1.00 (May 2023)	page
• Preliminary release.....	1
Changes from Reversion 1.00 to Reversion V1.01 (October 2023)	page
• Maximum support for power adjustment.....	1

## 5 Typical Application Schematic

IP6565 car charging solution only needs inductor, capacitor and resistor.

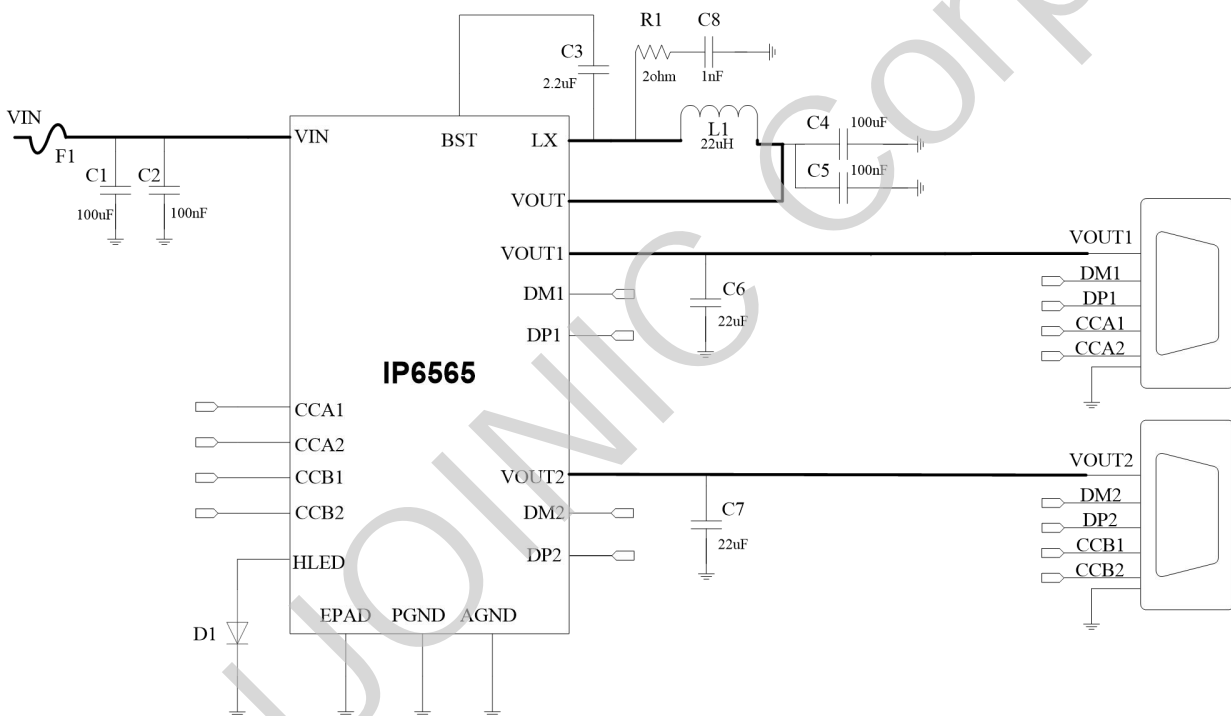


Figure 1. IP6565\_CC dual USB Type-C output ports fast charge application schematic diagram

### NOTES:

- PIN CCA1/CCA2/DM1/DP1 must be connected to USB Type-C 1;
- PIN CCB1/CCB2/DM2/DP2 must be connected to USB Type-C 2;
- C2 should be placed close to the VIN PIN;
- C5 should be placed close to the VOUT;
- C6 should be placed close to the VOUT1 PIN;
- C7 should be placed close to the VOUT2 PIN;
- R1 and C8 should be placed close to the LX PIN of IP6565, the loop composed of LX, R1, C8

and PGND should be minimized on the PCB board;

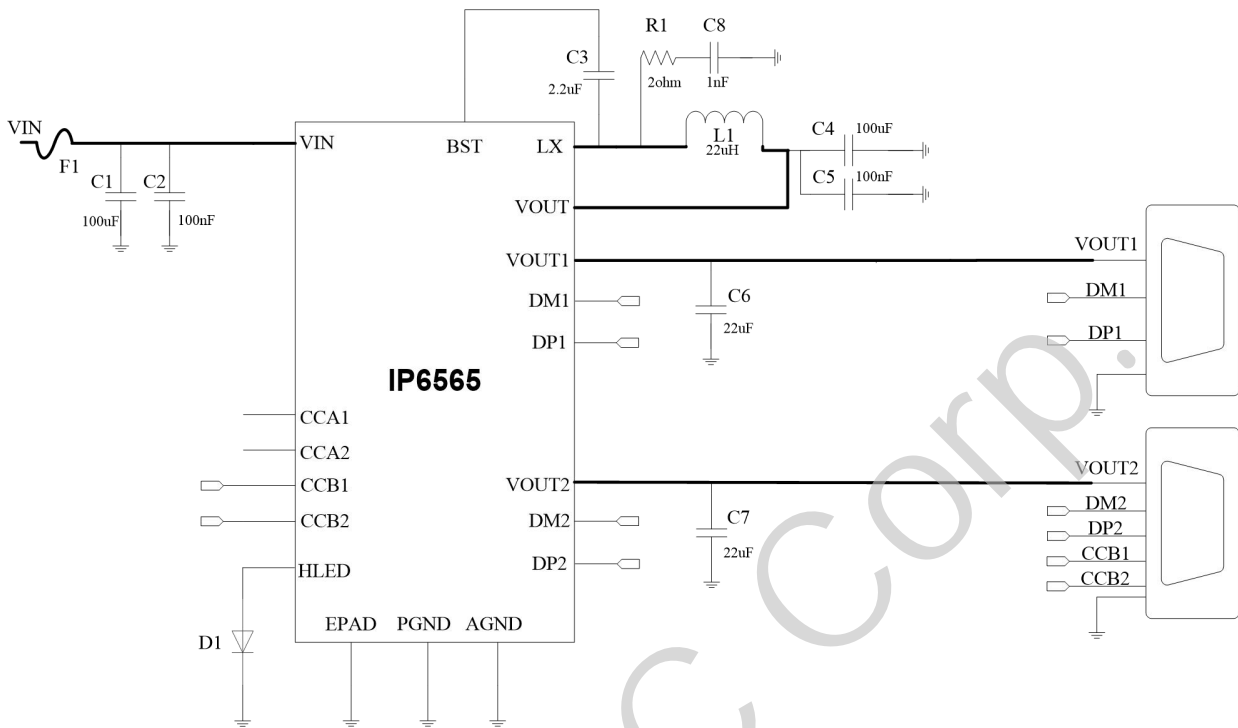


Figure 2. IP6565\_AC USB A plus USB Type-C output ports fast charge application schematic diagram

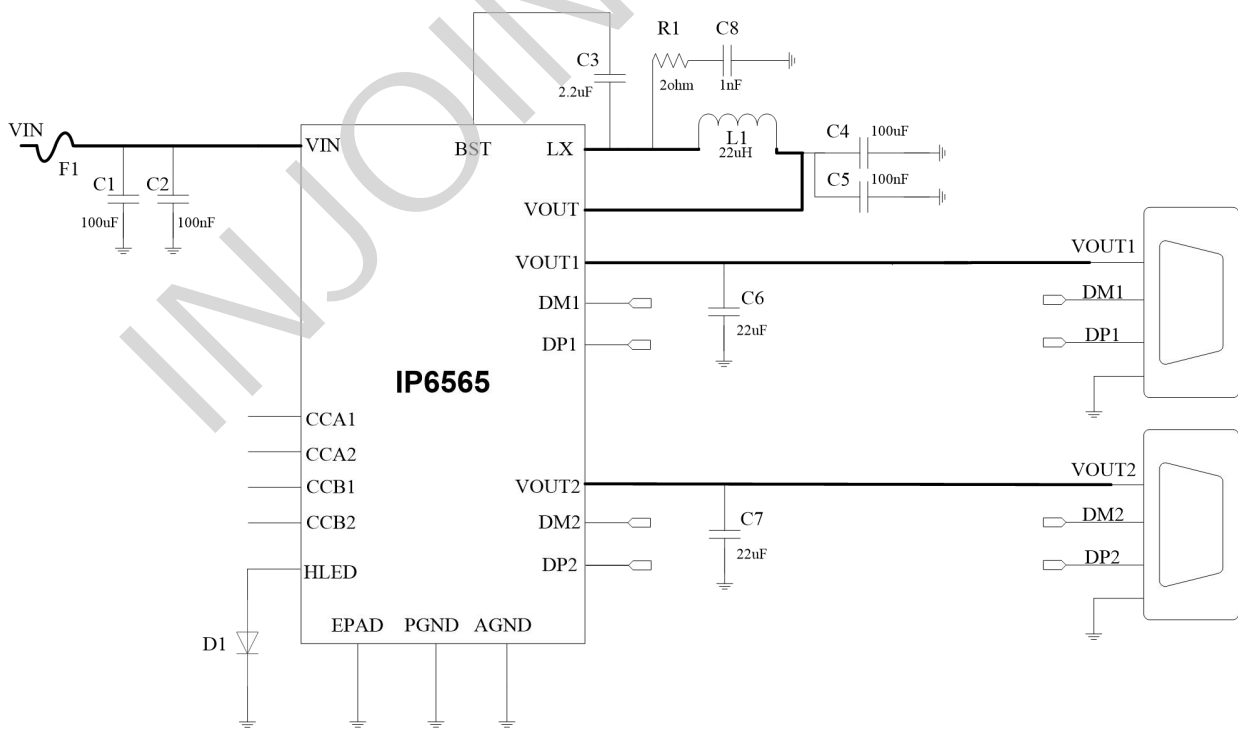


Figure 3. IP6565\_AA dual USB A output ports fast charge application schematic diagram

## 6 Pin Configuration And Function

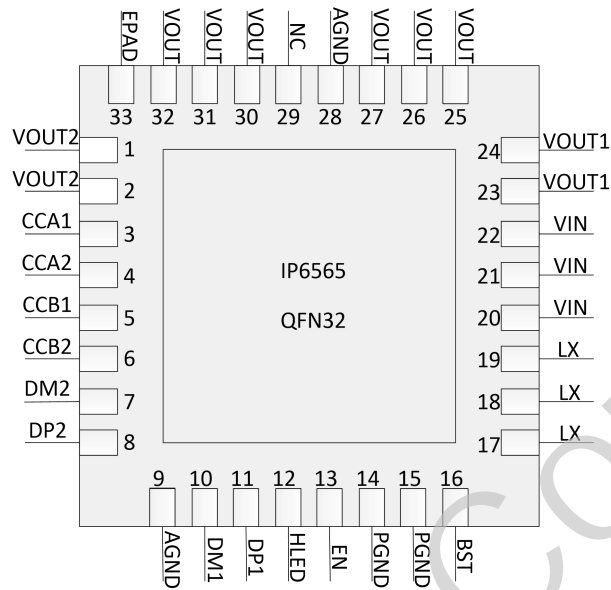


Figure 4. IP6565 Pin Functions

### Pin description:

Pins		Description
Pin No.	Pin Name	
1/2	VOUT2	VOUT2 output pin
3	CCA1	Group A CC1 (For Type-C 1)
4	CCA2	Group A CC2 (For Type-C 1)
5	CCB1	Group B CC1 (For Type-C 2)
6	CCB2	Group B CC2 (For Type-C 2)
7	DM2	VOUT2 DM
8	DP2	VOUT2 DP
9/28	AGND	Analog ground
10	DM1	VOUT1 DM
11	DP1	VOUT1 DP
12	HLED	Fast charge state indicator LED drive, floating when this function is not required
13	EN	EN pin, floating when this function is not required
14/15	PGND	Power ground
16	BST	Connect to bootstrap capacitor
17/18/19	LX	DCDC switch point, connect to inductor
20/21/22	VIN	Power input
23/24	VOUT1	VOUT1 output pin
25/26/27/30/31/32	VOUT	VOUT output and voltage sense pin
29	NC	NC pin, floating
33	EPAD	Power ground

## 7 IP Comparison Table

### 7.1 Car Charger IC

IC Model	Output current	Dual ports	Supported Protocols										Package	
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	Pkg	P2P
IP6536	2.4A	√	√	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
IP6523S_NU	3.4A	-	√	-	-	-	-	-	-	-	-	-	ESOP8	
IP6525TQ	18W	-	√	√	√	√	-	√	-	-	-	-	ESOP8	
IP6525T_NU	18W	-	√	√	√	√	-	√	-	-	-	-	ESOP8	PIN2PIN
IP6525S	18W	-	√	√	√	√	√	√	√	√	-	-	ESOP8	
IP6525S_OC	18W	-	√	√	√	√	√	√	-	√	-	-	ESOP8	
IP6520	18W	-	√	√	√	√	√	√	√	-	√	-	ESOP8	PIN2PIN
IP6520T	20W	-	√	√	√	√	-	√	-	-	√	-	ESOP8	
IP6520T_PPS	20W	-	√	√	√	√	-	√	-	-	√	√	ESOP8	
IP6537U_C	18W	-	√	√	√	√	-	√	√	√	√	√	QFN24	PIN2PIN
IP6537U_1_35W_27W5_7W5	35W	-	√	√	√	√	-	√	√	√	√	√	QFN24	
IP6538U_AA	24W	√	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN
IP6538U_AC	27W	√	√	√	√	√	√	√	√	-	√	√	QFN32	
IP6551	4.8A	√	√	-	-	-	-	-	-	-	-	-	QFN32	
IP6527U_A	24W	-	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN
IP6527U_C	27W	-	√	√	√	√	-	√	√	-	√	√	QFN32	
IP6559_C	100W	-	√	√	√	√	√	√	-	-	√	√	QFN64	PIN2PIN
IP6559_AC	100W	√	√	√	√	√	√	√	-	-	√	√	QFN64	
IP6557_C	140W	-	√	√	√	√	√	√	√	√	√	√	QFN40	

## 7.2 IP6565 Series Product Introduction

IP6565-CC	VOUT1	USB Type-C	PDO	5V/3A	9V/2.22A	3.3V-11V/2A
			QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A
	VOUT2	USB Type-C	PDO	5V/3A	9V/2.22A	3.3V-11V/2A
			QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A
IP6565-AC <sup>(2)</sup>	VOUT1	USB A	QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A
			PDO	5V/3A	9V/2.22A	3.3V-11V/2A
	VOUT2	USB Type-C	QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A
			PDO	5V/3A	9V/2.22A	3.3V-11V/2A
IP6565-AA	VOUT1	USBA	QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A
	VOUT2	USBA	QC <sup>(1)</sup>	5V/3A	9V/2A	12V/1.5A

### Notes:

- (1)QC represents the output power of high voltage fast charge.
- (2)PDO of USB type-c port in the table can be customized.
- (3)IP6565\_AC VOUT1 should be connected to USB A port; VOUT2 should be connected to USB Type-C port.
- (4)IP6565 supports SCP and HSCP fast charge protocol.
- (5)IP6565\_AC and IP6565\_CC USB Type-C output power is same with PDO when attached protocol is PD, it is 18W (5V/3A, 9V/2A, 12V/1.5A) when attached protocol is not PD.

## 8 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input Voltage Range	$V_{IN}$	-0.3 ~ 40	V
LX Voltage Range	$V_{LX}$	-0.3 ~ $V_{IN}+0.3$	V
DP/DM Voltage Range	$V_{DM1/DP1/DM2/DP2}$	-0.3 ~ 6	V
CC Voltage Range	$V_{CCA1/CCA2/CCB1/CCB2}$	-0.3 ~ 30	V
Junction Temperature Range	$T_J$	-40 ~ 150	°C
Storage Temperature Range	$T_{stg}$	-60 ~ 150	°C
Package Thermal Resistance	$\theta_{JA}$	40	°C/W
Human Body Model (HBM)	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.

## 9 Recommended Operating Conditions

Parameters	Symbol	Min	Typ	Max	Unit
Input Voltage	$V_{IN}$	8.2	12/24	32	V

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



## 10 Electrical Characteristics

Unless otherwise specified, TA=25°C, L=22uH, Cout=100uF Solid state capacitor (About 40mΩ ESR)  
 VIN=12V, VOUT=5V

Parameters	Symbol	Test Condition	Min	Typ	Max	Unit
<b>Input system</b>						
Input voltage	V <sub>IN</sub>		8.2	12	32	V
Input under voltage	V <sub>IN-UV</sub>	Rising voltage	8.1	8.2	8.3	V
		Falling voltage	7.8	7.9	8.0	V
Input over voltage	V <sub>IN-OV</sub>	Rising voltage	32.7	32.8	33	V
		Falling voltage	32.3	32.5	32.6	V
Input quiescent current	I <sub>Q</sub>	V <sub>IN</sub> =12V, V <sub>OUT</sub> =5V/0A	--	4	--	mA
<b>Power system</b>						
High-side MOS Ron resistance	R <sub>DS(ON)</sub>		--	30	--	mΩ
Low-side MOS Ron resistance	R <sub>DS(ON)</sub>		--	30	--	mΩ
Switching frequency	F <sub>S</sub>		--	110	--	kHz
Maximum duty cycle	D <sub>MAX</sub>	V <sub>IN</sub> =12V	--	97	--	%
<b>Output system</b>						
Output voltage	V <sub>OUT</sub>		3	5	12	V
Output voltage ripple	ΔV <sub>OUT</sub>	V <sub>IN</sub> =12V, V <sub>OUT</sub> =5V/3A	70	80	90	mV
		V <sub>IN</sub> =12V, V <sub>OUT</sub> =9V/2A	50	60	70	mV
		V <sub>IN</sub> =24V, V <sub>OUT</sub> =12V/1.5A	70	80	90	mV
Soft start time	T <sub>SS</sub>	V <sub>IN</sub> =12V, V <sub>OUT</sub> =5V	--	4	--	ms
Output line compensate voltage	V <sub>COMP</sub>	V <sub>IN</sub> =12V, V <sub>OUT</sub> =5V, I <sub>OUT</sub> =1A	--	50	--	mV
Single port max output current in CC mode	I <sub>OUT</sub>	V <sub>IN</sub> =12V, V <sub>OUT</sub> =5V	--	3	--	A
		V <sub>IN</sub> =12V, V <sub>OUT</sub> =9V	--	2	--	A
		V <sub>IN</sub> =24V, V <sub>OUT</sub> =12V	--	1.5	--	A
Output hiccup restart voltage	V <sub>OUT</sub>	Hiccup restart voltage when output enter CC mode (V <sub>OUT</sub> preset voltage >= 5V)	--	4.0	--	V

		Hiccup restart voltage when output enter CC mode ( $V_{OUT}$ preset voltage < 5V)	--	3.0	--	V
No-load output voltage	$V_{out1}$	$V_{IN}=12V$ , IP6565_AC no device connected	--	5	--	V
	$V_{out2}$		--	0	--	V
DPDM over voltage protection voltage	$V_{OVP\_DP\_DM}$	$V_{IN}=12V$ , $V_{OUT}=5V$	--	4.8	--	V
CC over voltage protection voltage	$V_{OVP\_CC}$	$V_{IN}=12V$ , $V_{OUT}=5V$	--	6.5	--	V
Thermal shutdown temperature	$T_{OTP}$	Rising temperature	--	150	--	°C
Thermal shutdown temperature hysteresis	$\Delta T_{OTP}$		--	35	--	°C

## 11 Function Description

### 11.1 IP6565 Internal block diagram

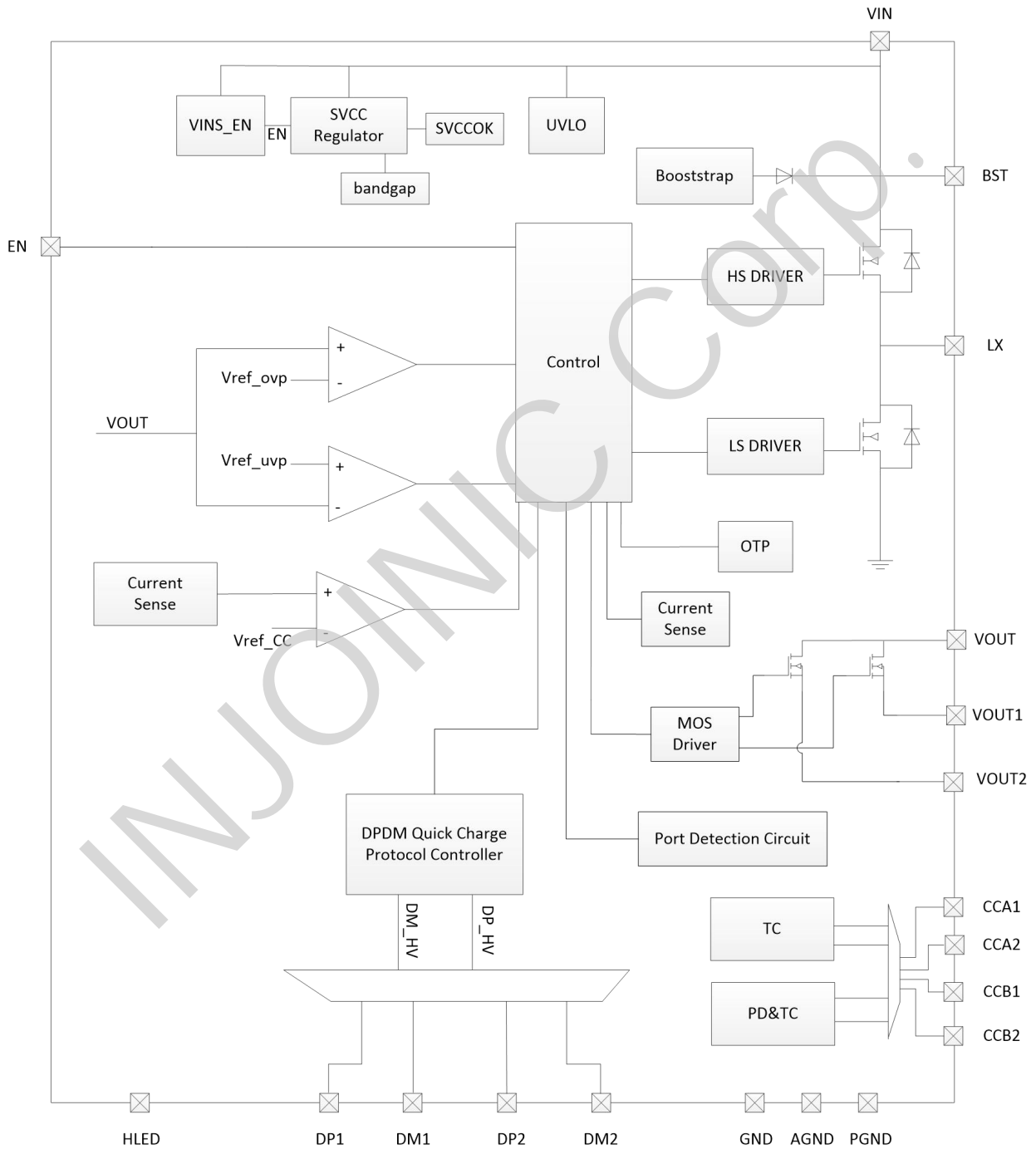


Figure 5. IP6565 internal block diagram

## 11.2 Synchronous-Rectified Buck Converter

IP6565 integrate a Synchronous-Rectified Buck Converter, input voltage range is 8.2V~32V, output voltage range is 3V~12V, maximum dual port output current is 3.4A.

IP6565 integrate power switch MOSFET with 110 kHz working frequency.

The conversion efficiency is 92.2% at  $V_{IN}=24V$ ,  $V_{OUT}=5V/3A$ . The conversion efficiency is 93.4% at  $V_{IN}=24V$ ,  $V_{OUT}=5V/3A$ .

IP6565 auto adjust output voltage and current according to the fast charge requirement.

IP6565 has soft start function, preventing the huge inrush current cause damage to the IC.

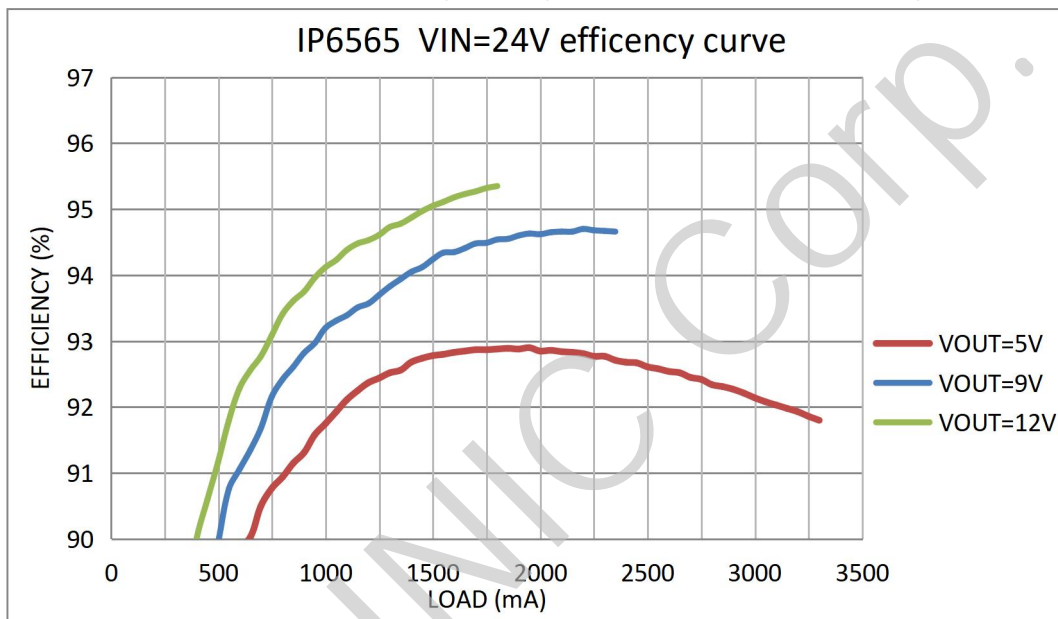


Figure 6. IP6565 output efficiency curve when  $V_{IN} = 24V$

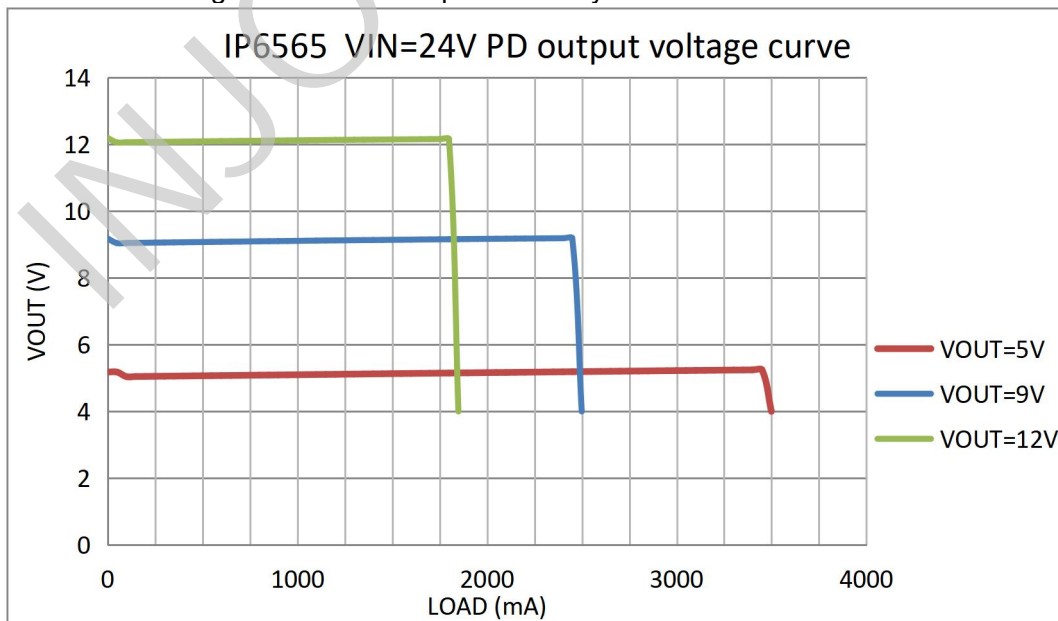


Figure 7. IP6565 PD output  $V_{out}$ - $I_{out}$  curve when  $V_{IN}=24V$

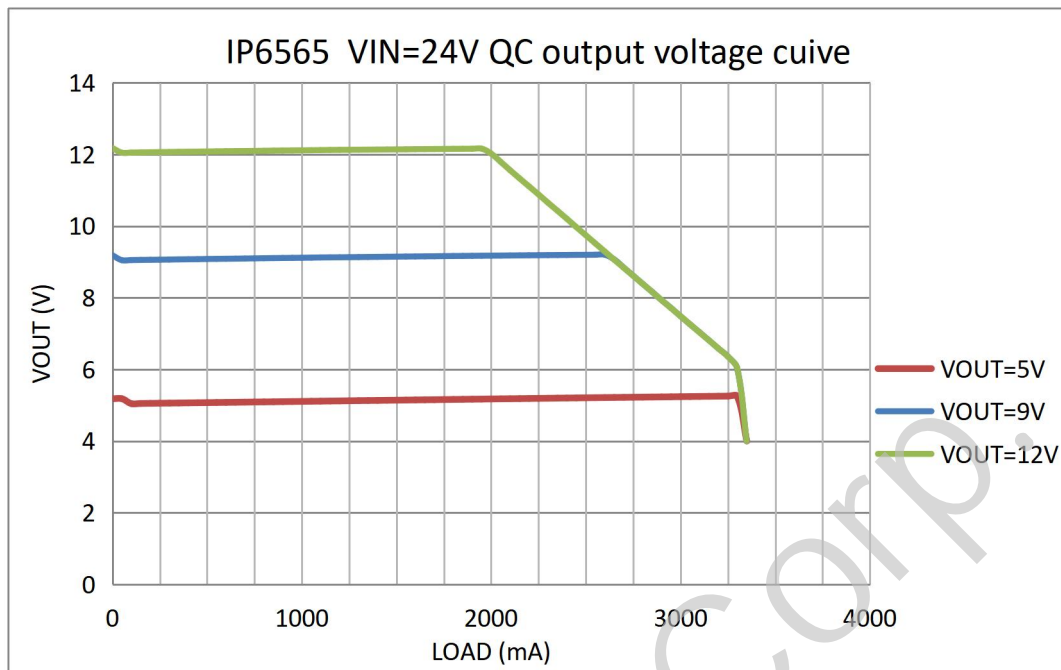


Figure 8. IP6565 QC output Vout-lout curve when VIN=24V

### 11.3 Output Voltage Line Compensation Function

IP6565 output support line compensation function: the output voltage will increase 50mV as output current increase 1A.

### 11.4 Output CC/CV Character

When IP6565 works with QC high voltage protocol ,IP6565 supports output CV/CP/CC, when the output current is lower than the preset value, output is CV mode with constant output voltage; while the output current is higher than the preset value, output is CP mode, as the load increases, the output voltage decreases; when the voltage drops to 6.5V, CC mode is entered, The load continues to increase and the output voltage rapidly decreases until the output voltage undervoltage protection is triggered.

When IP6565 works with PD high voltage protocol, IP6565 supports output CV /CC, when the output current is lower than the preset value, output is CV mode with constant output voltage; while the output current is higher than the preset value, output is CC mode, The load continues to increase and the output voltage rapidly decreases until the output voltage undervoltage protection is triggered.

When VOUT preset voltage is higher or equal to 5V, if the load continues to increase, output voltage is lower than 4.0V, the output will be shut down and hiccup restart after 2sec; When VOUT preset voltage is lower than 5V, if the output voltage is lower than 3V, the output will be shut down and hiccup restart after 2sec.

### 11.5 Output CC Current Set

IP6565 can determine whether the load of VOUT1 or VOUT2 reaches the set current value by sampling the MOS current between VOUT and VOUT1 or between VOUT and VOUT2 in the device.

## 11.6 EN Function

The EN pin of IP6565 has the device enabling function. By default, the EN function is not enabled and the EN pin should be floating.

The EN pin will be pulled up inside the device when IP6565 EN function is enabled. When the EN pin is floating or the voltage is higher than 2V, the device is turned on; When the pin is low under external control, the device is turned off.

The maximum withstand voltage of IP6565 EN pin is 6V, which cannot be connected to a higher voltage to prevent it from being damaged by high voltage breakdown.

## 11.7 HLED Function

The HLED pin of IP6565 can be used by external connection of LED. The default display mode is: LED turns on when the fast charge protocol request voltage level higher than 5V.

The hled of IP6565 supports customization in the display mode of 5V charging and fast charging.

When the hled function of IP6565 is not required, the HLED pin should be floating.

## 11.8 Protection Function

IP6565 will detect the VIN voltage, if VIN voltage is lower than 7.9V, IP6565 will enter standby mode and shut down the output.

IP6565 support input over voltage protection: when the VIN voltage is higher than 32.8V, IP6565 determines the VIN is over voltage and shutdown the output; when VIN decrease under 32.5V, IP6565 determines the input voltage recovers and opens the output.

IP6565 support output under voltage protection: when VOUT voltage is lower than 5V, if the VOUT voltage is lower than 3.0V, IP6565 determines the output is under voltage and will shut down the output and hiccup restart after 2sec. when VOUT voltage is larger than or equal to 5V, if the VOUT voltage is lower than 4.0V, IP6565 determines the output is under voltage and will shut down the output and hiccup restart after 2sec.

IP6565 support short circuit protect, 4ms after the circuit is started, if VOUT voltage is under 3.0V, IP6565 determines the output is short circuit and will shut down the output and hiccup restart after 2sec.

IP6565 support DP/DM/CC over voltage protection, when the DP1/DM1/DP2/DM2 voltage is higher than 4.8V, or when the CCA1/CCA2/CCB1/CCB2 voltage is higher than 6.5V, IP6565 determines the signals are over voltage and will shut down the output and hiccup restart after 2sec.

IP6565 support over temperature protection: when the temperature detected is higher than 150 °C, the output will be shut down. When the temperature decreases below 115 °C, IP6565 determines the temperature has recovered and will restart the output.

When the junction temperature is high, the output voltage and current will be adjusted automatically by IP6565 to keep the constant temperature of the junction temperature.

## 11.9 Dual Fast Charge Output Ports

IP6565 support two USB output ports: dual USB Type-C ports or dual USB A ports or USB A port plus USB Type-C port. Any port support fast charge output when working along, when the two ports are working at the same time, both ports output 5V.

IP6565\_AC and IP6565\_CC single port output power 20W: 5V/3A, 9V/2.22A, and 3.3V-11V/2A.

IP6565\_AA single port output power 5V/3A, 9V/2A, and 12V/1.5A.

Dual ports both in working, IP6565 output 5V/3A for single port and 5V/3.4A for two ports together, current limit is based on single port.

IP6565 integrate dual port auto plug detection function, any ports plug in or plug out can be detected and the USB ports will be open or shut down based on the detect result.

## 11.10 Output Fast Charge Protocol

IP6565 support fast charge protocol:

- ◇ Support 2 ports of Type-C PD output
- ◇ Support 2 ports of BC1.2 and Apple
- ◇ Support 2 ports of Qualcomm QC2.0, QC3.0
- ◇ Support 2 ports of Huawei Fast charge: FCP and SCP
- ◇ Support 2 ports of Samsung fast charge : AFC
- ◇ Support 2 ports of SFCP

## 11.11 Type-C Port and USB PD Protocol

IP6565\_CC support dual ports Type-C output and USB PD2.0/PD3.0 (PPS) protocol, USB PD protocol output 20W; Package broadcast: 5V/3A, 9V/2.22A and PPS 3.3V-11V/2A.

IP6565\_AC support single port Type-C output and USB PD2.0/PD3.0 (PPS) , USB PD protocol output 20W; Package broadcast: 5V/3A, 9V/2.22A and PPS 3.3V-11V/2A.

IP6565\_AA do not support Type-C output or PD2.0/PD3.0 (PPS) protocol.

IP6565 Type-C port detects the fast charge requirement automatically through DP/DM and CC1/CC2 pins and adjusts the output voltage and current accordingly.

## 12 BOM

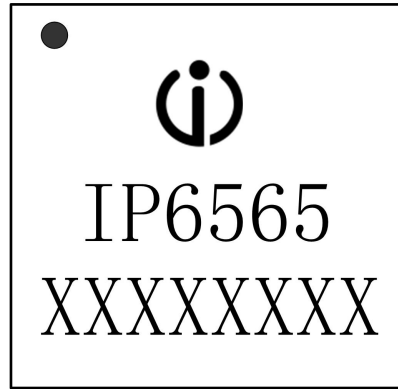
With the application of IP6565\_AC, the finished BOM is as follows:

No.	Part Name	Type	Unit	Qty	Location	Notes
1	IC	IP6565	PCS	1	U1	
2	Power inductor	22uH+/-20%, current 5A DCR<12mohm	PCS	1	L1	
3	Electrolytic capacitor	100uF/35V	PCS	1	C1	Withstand voltage higher than 35V, Use solid-state capacitor will increase efficiency
4	SMD capacitor	0603 0.1uF 10%	PCS	1	C2、C5	Withstand voltage higher than 35V
5	SMD capacitor	0603 2.2uF 10%	PCS	1	C3	Withstand voltage higher than 10V
6	Electrolytic capacitor	100uF/25V	PCS	1	C4	Withstand voltage higher than 25V, Use solid-state capacitor will increase efficiency
7	SMD capacitor	0603 22uF 10%	PCS	2	C6、C7	Withstand voltage higher than 25V
8	SMD capacitor	0603 1nF 10%	PCS	1	C8	Withstand voltage higher than 35V
9	SMD LED	0603	PCS	1	D1	
10	SMD resistor	0603 2R 5%	PCS	1	R1	
11	fuse	F1	PCS	1	F1	





## 14 Mark Description



Illustrate:


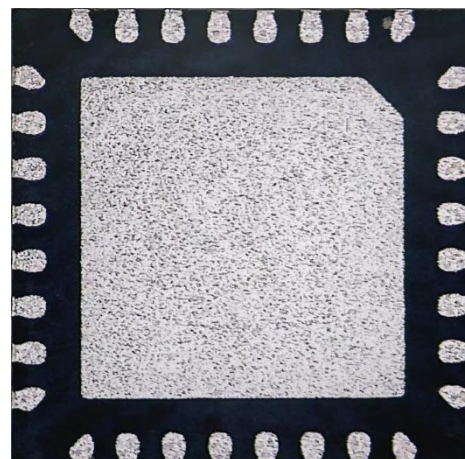
- 1、 --INJOINIC LOGO
- 2、IP6565 --Product model
- 3、XXXXXXXX --Production lot number
- 4、● --PIN1 location identification

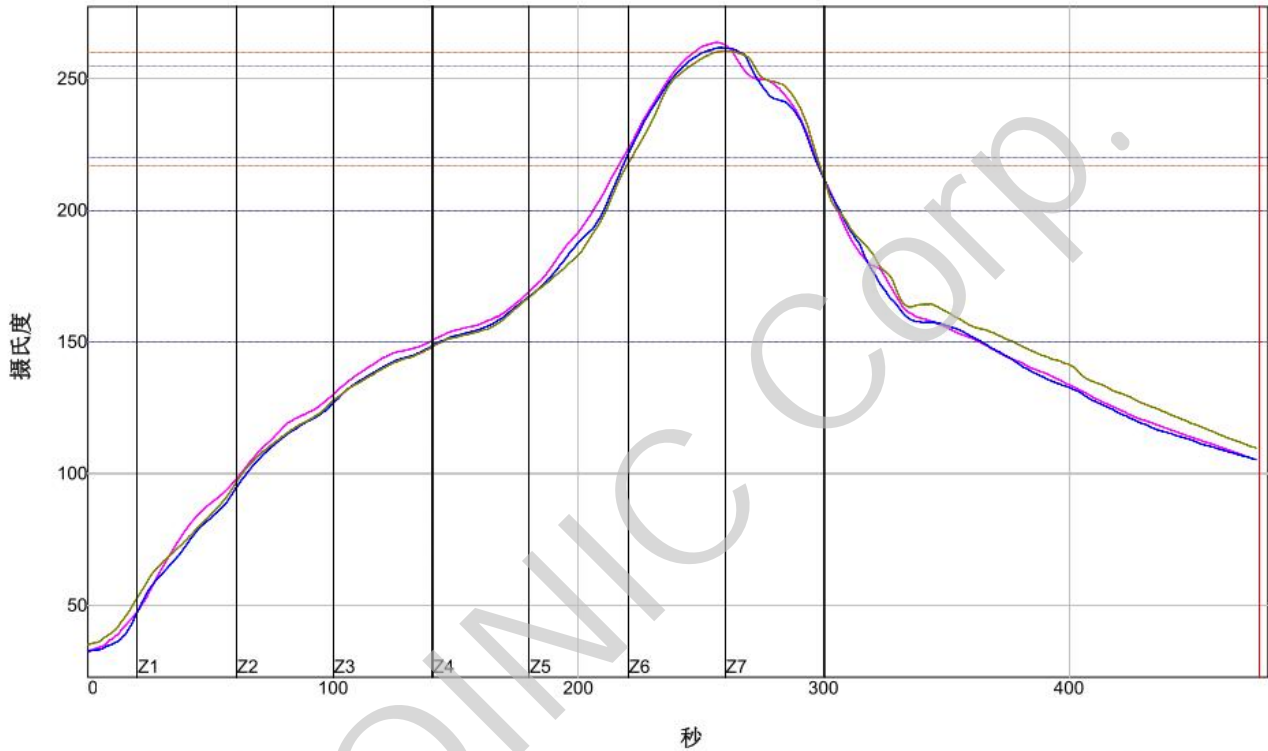
Figure 9. IP6565 Silk screen instructions

## 15 Photos Of Physical Objects



## 16 Land Pattern Layout Example

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	总时间 /217C		斜率1 (217-260C)		预热220至255C-(2)		总时间 /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:

统计数名称	最低界限	最高界限	单位
锡膏: 260			
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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