IP6566

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 93.8% with VIN=12V, VOUT=5V/3A
- **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
- **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 HSCP
  - ✧ Support 2 ports of Samsung fast charge: AFC
  - ✧ Support 2 ports of SFCP
- **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 QFN28**

2 Application

- Car charger
- Fast charge adaptor
- Smart power strip

3 Description

IP6566 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.

IP6566 supports dual Type-C output ports or dual USB A output ports or a Type-C output port plus a USB A port 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.

IP6566 has built-in power MOSFET, input voltage range is 4.5V to 32V, output voltage ranges from 3V to 12V with up to 20W power supply. The output voltage and current is auto adjusted dynamically based on the fast charge requirement. IP6566 has a conversion efficiency of up to 93.8% when output 5V/3A.

IP6566 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.

IP6566 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.

IP6566 supports soft start function that protects the input power source from inrush current at start up.

4 IP6566 Series Product Introduction

			PDO	5V/3A	9V/2.22A	3.3V-11V/2A
IP6566-CC	**VOUT1**	USB Type-C	QC[1]	5V/3A	9V/2A	12V/1.5A
	VOUT2	USB Type-C	PDO	5V/3A	9V/2.22A	3.3V-11V/2A
			QC[1]	5V/3A	9V/2A	12V/1.5A
IP6566_AC[2]	**VOUT1**	USB A	QC[1]	5V/3A	9V/2A	12V/1.5A
	VOUT2	USB Type-C	PDO	5V/3A	9V/2.22A	3.3V-11V/2A
			QC[1]	5V/3A	9V/2A	12V/1.5A
IP6566_AA	**VOUT1**	USBA	QC[1]	5V/3A	9V/2A	12V/1.5A
	VOUT2	USBA	QC[1]	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) IP6566_AC VOUT1 should be connected to USB A port; VOUT2 should be connected to USB Type-C port.

(4) IP6566 supports SCP and HSCP fast charge protocol.

(5) IP6566_AC and IP6566_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.
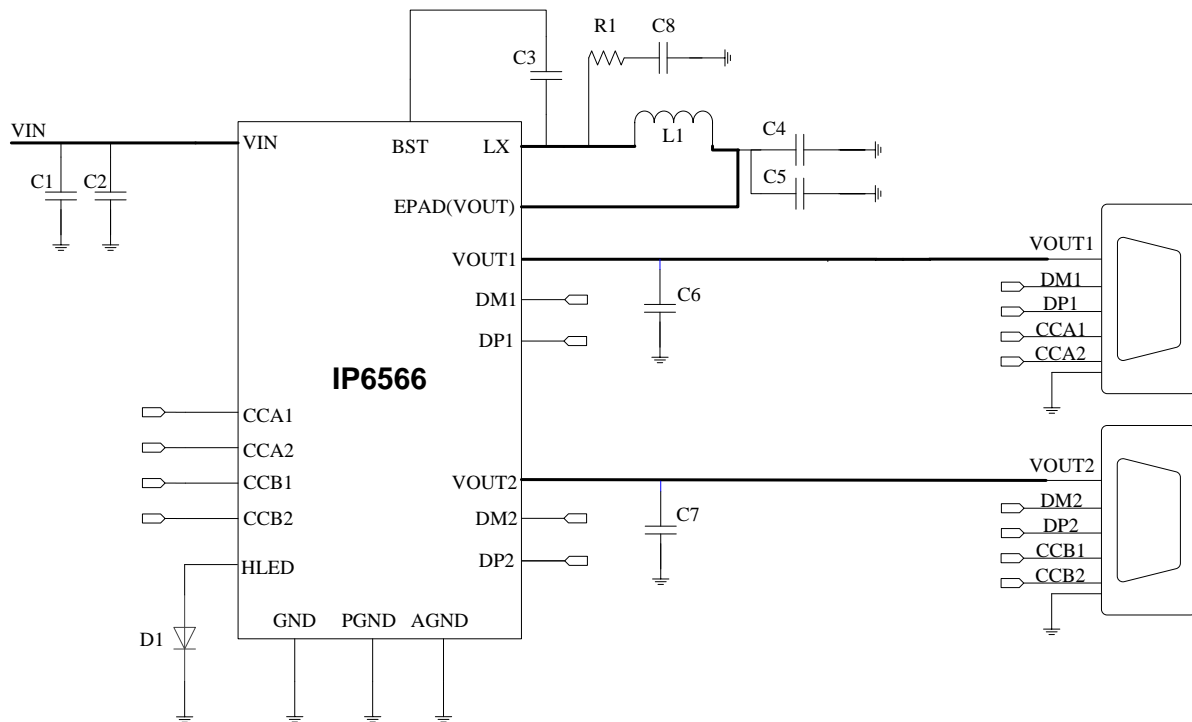

Figure 1. IP6566_CC dual USB Type-C output ports simplified application schematic diagram
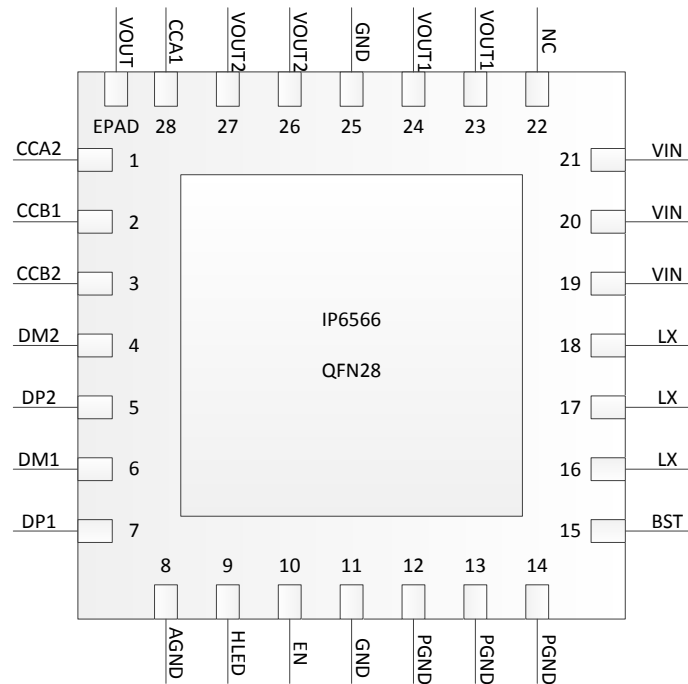
5 Pin Functions

Figure 2. Pin Functions

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

6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 40	**V**
LX Voltage Range	V_{LX}	-0.3 ~ VIN+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	℃
Storage Temperature Range	Tstg	-60 ~ 150	℃
Package Thermal Resistance	$θ_{JA}$	40	℃**/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.

7 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.

8 Electrical Characteristics

Unless otherwise specified,

T_A=25℃， L=22uH,Cout=100uF Solid state capacitor(About 40mΩ ESR) VIN=12V, VOUT=5V

Parameters	Symbol	Test Condition	Min.	Typ.	Max	Unit
Input system						
Input voltage	V_{IN}		8.2	12	32	V
Input under voltage	V_{IN-UV}	Rising voltage	8.1	8.2	8.3	V
		Falling voltage	7.8	7.9	8	V
Input over voltage	V_{IN-OV}	Rising voltage	32.7	32.8	33	V
		Falling voltage	32.3	32.5	32.6	V
Input quiescent current	I_Q	VIN=12V, VOUT=5V/0A	--	4	--	mA
Power system						
High-side MOS Ron resistance	$R_{DS(ON)}$		--	30	--	mΩ
Low-side MOS Ron resistance	$R_{DS(ON)}$		--	30	--	mΩ
Switching frequency	F_S		--	105	--	KHz
Maximum duty cycle	D_{MAX}	VIN=12V	--	97	--	%
Output system						
Output voltage	V_{OUT}		3	5	12	V
Output voltage ripple	ΔV_{OUT}	VIN=12V, VOUT=5V/3A COUT: 220uF+22uF	50	60	70	mV
		VIN=12V, VOUT=9V/3A COUT: 220uF+22uF	65	70	80	mV
		VIN=24V, VOUT=12V/2.25A COUT: 220uF+22uF	80	90	100	mV
Soft start time	T_{SS}	VIN=12V, VOUT=5V	--	4	--	ms
Output line compensate voltage	V_{COMP}	VIN=12V, VOUT=5V, IOUT=1A	--	50	--	mV
Single port max output current in CC mode	I_{OUT}	VIN=12V, VOUT<=4V	--	3	--	A
		VIN=12V, 4V<VOUT<=5V	--	3	--	A
		VIN=12V, 7V<VOUT<=9V	--	2	--	A
		VIN=24V, 9V<VOUT<=12V	--	1.5	--	A
Output hiccup restart voltage	V_{OUT}	Hiccup restart voltage when output enter CC mode	--	4.0	--	V

		(VOUT preset voltage >= 5V)	--		--	
		Hiccup restart voltage when output enter CC mode (VOUT preset voltage < 5V)	--	3.0	--	V
No-load output voltage	V_{out1}	VIN=12V, IP6566_AC no device connected	--	5	--	V
	V_{out2}		--	0	--	V
DPDM over voltage protection voltage	V_{OVP_DPDM}	VIN=12V, VOUT=5V	--	4.8	--	V
CC over voltage protection voltage	V_{OVP_CC}	VIN=12V, VOUT=5V	--	6.5	--	V
Thermal shutdown temperature	T_{OTP}	Rising temperature	--	150	--	℃
Thermal shutdown temperature hysteresis	ΔT_{OTP}		--	35	--	℃

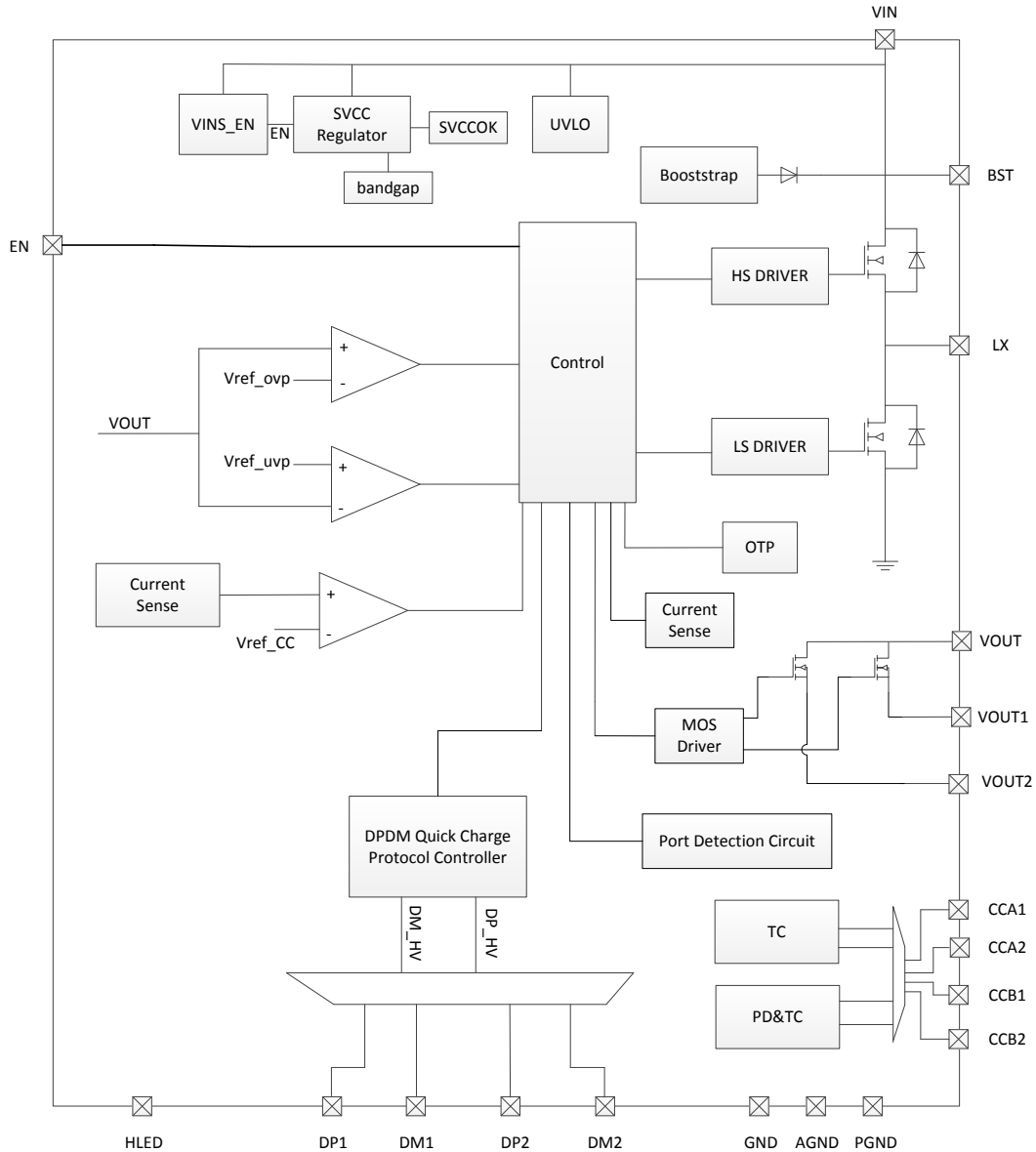# 9 Function Description

IP6566 Internal block diagram

Figure 3. IP6566 internal block diagram

Synchronous-Rectified Buck Converter

IP6566 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.

IP6566 integrate power switch MOSFET with 105 kHz working frequency.

The conversion efficiency is 93.8% at VIN=24V, VOUT=5V/3A. The conversion efficiency is 92.5% at VIN=24V, VOUT=5V/3A.

IP6566 auto adjust output voltage and current according to the fast charge requirement.

IP6566 has soft start function, preventing the huge inrush current cause damage to the IC.
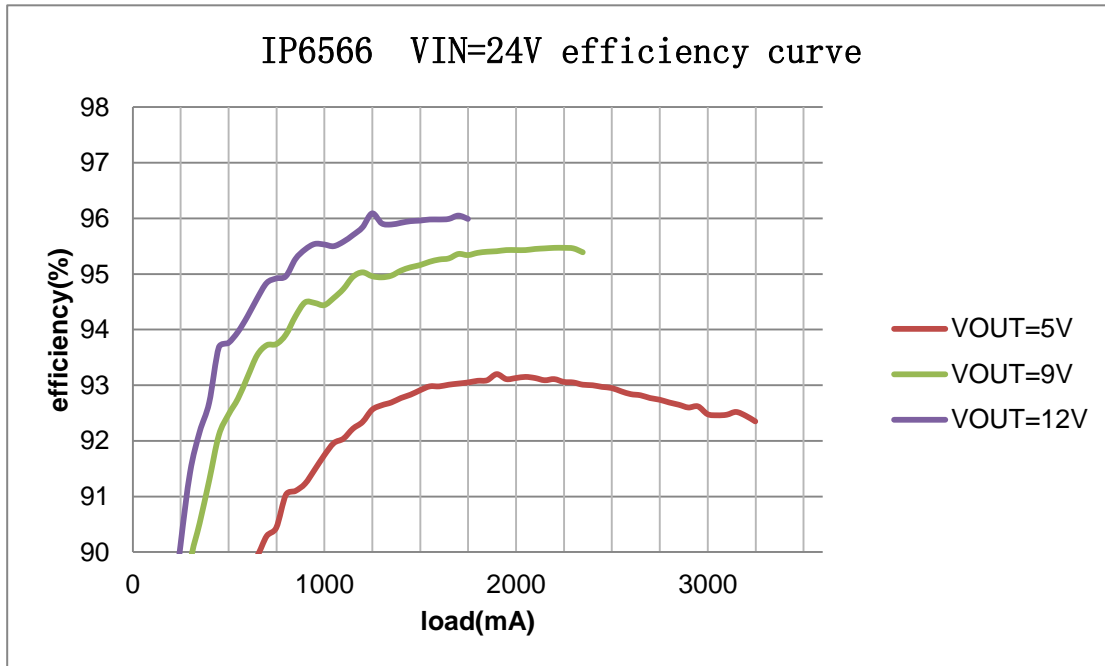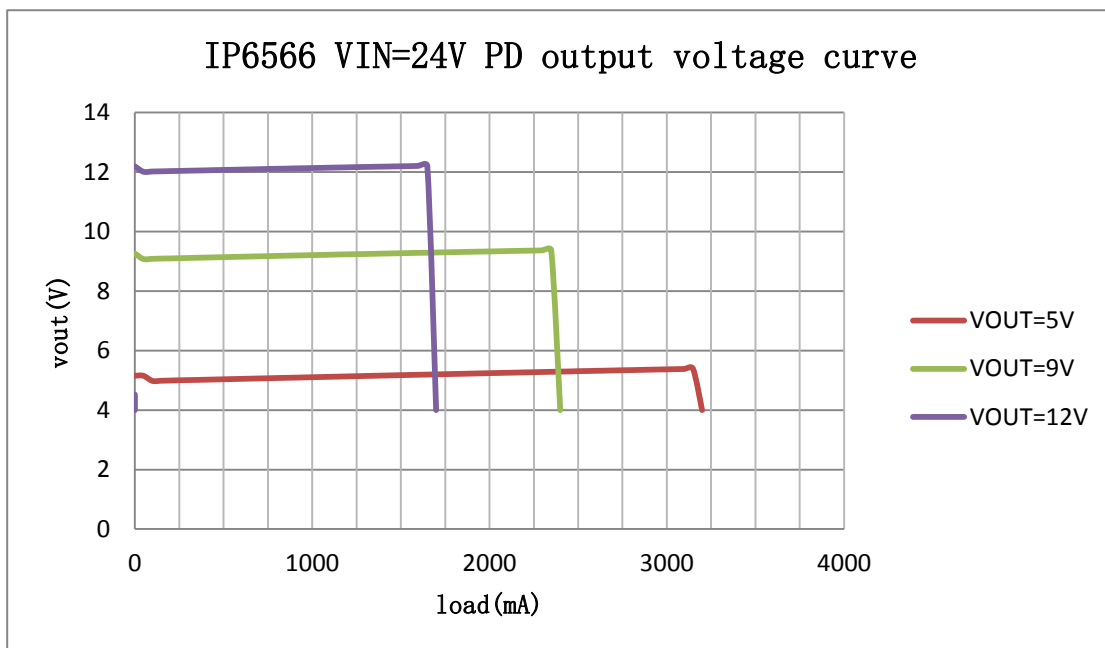
Figure 4. IP6566 output efficiency curve when VIN = 24V

Figure 5. IP6566 PD output Vout-Iout curve when VIN=24V
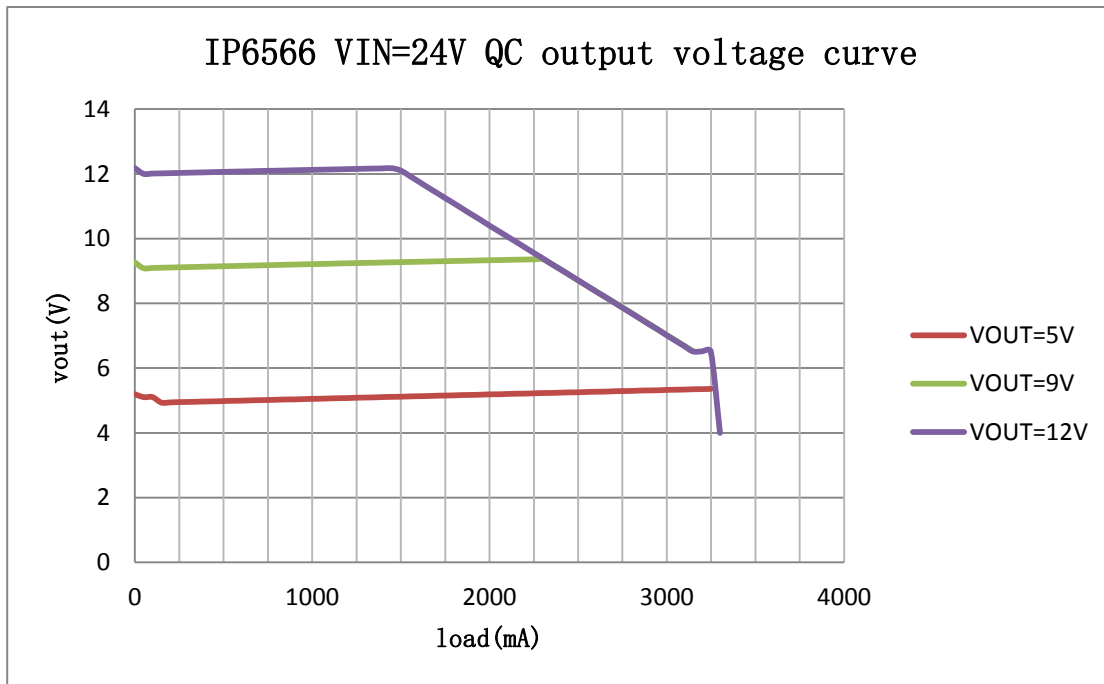
IP6566 VIN=24V QC output voltage curve

Figure 6. IP6566 QC output Vout-Iout curve when VIN=24V

Output Voltage Line Compensation Function

IP6566 output support line compensation function: the output voltage will increase 50mV as output current increase 1A.

Output CC/CV Character

When IP6566 works with QC high voltage protocol ,IP6566 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 IP6566 works with PD high voltage protocol, IP6566 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.

Output CC Current Set

IP6566 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

EN Function

The EN pin of IP6566 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 IP6566 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 IP6566 EN pin is 6V, which cannot be connected to a higher voltage to prevent it from being damaged by high voltage breakdown

HLED Function

The HLED pin of IP6566 can be used by external connection of LED. The default display mode is: when the output voltage is 5V, the display is breathing light mode; when the request voltage of high-voltage fast charging such as QC is not 5.0V, the display is always on; under the low-voltage fast charging, it is always on.

The hled of IP6566 supports customization in the display mode of 5V charging and fast charging.

When the hled function of IP6566 is not required, the HLED pin should be floating.

Protection Function

IP6566 will detect the VIN voltage, if VIN voltage is lower than 7.9V, IP6566 will enter standby mode and shut down the output.

IP6566 support input over voltage protection: when the VIN voltage is higher than 32.8, IP6566 determines the VIN is over voltage and shutdown the output; when VIN decrease under 32.5V, IP6566 determines the input voltage recovers and opens the output.

IP6566 support output under voltage protection: when VOUT voltage is lower than 5V, if the VOUT voltage is lower than 3.0V, IP6566 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, IP6566 determines the output is under voltage and will shut down the output and hiccup restart after 2sec.

IP6566 support short circuit protect, 4ms after the circuit is started, if VOUT voltage is under 3.0V, IP6566 determines the output is short circuit and will shut down the output and hiccup restart after 2sec.

IP6566 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, IP6566 determines the signals are over voltage and will shut down the output and hiccup restart after 2sec.

IP6566 support over temperature protection: when the temperature detected is higher than 150℃, the

output will be shut down. When the temperature decreases below 115℃, IP6566 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 IP6566 to keep the constant temperature of the junction temperature.

Dual Fast Charge Output Ports

IP6566 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.

IP6566_AC and IP6566_CC single port output power 20W: 5V/3A, 9V/2.22A, and 3.3V-11V/2A.

IP6566_AA single port output power 5V/3A, 9V/2A, and 12V/1.5A.

Dual ports both in working, IP6566 output 5V/3A for single port and 5V/3.4A for two ports together, current limit is based on single port.

IP6566 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.

Output Fast Charge Protocol

IP6566 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 HSCP
- ✧ Support 2 ports of Samsung fast charge : AFC
- ✧ Support 2 ports of SFCP

Type-C Port and USB PD Protocol

IP6566_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.

IP6566_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.

IP6566_AA do not support Type-C output or PD2.0/PD3.0 (PPS) protocol.

IP6566 Type-C port detects the fast charge requirement automatically through DP/DM and CC1/CC2 pins and adjusts the output voltage and current accordingly.

10 Typical Application Schematic Diagram

IP6566 car charging solution only needs inductor, capacitor and resistor.
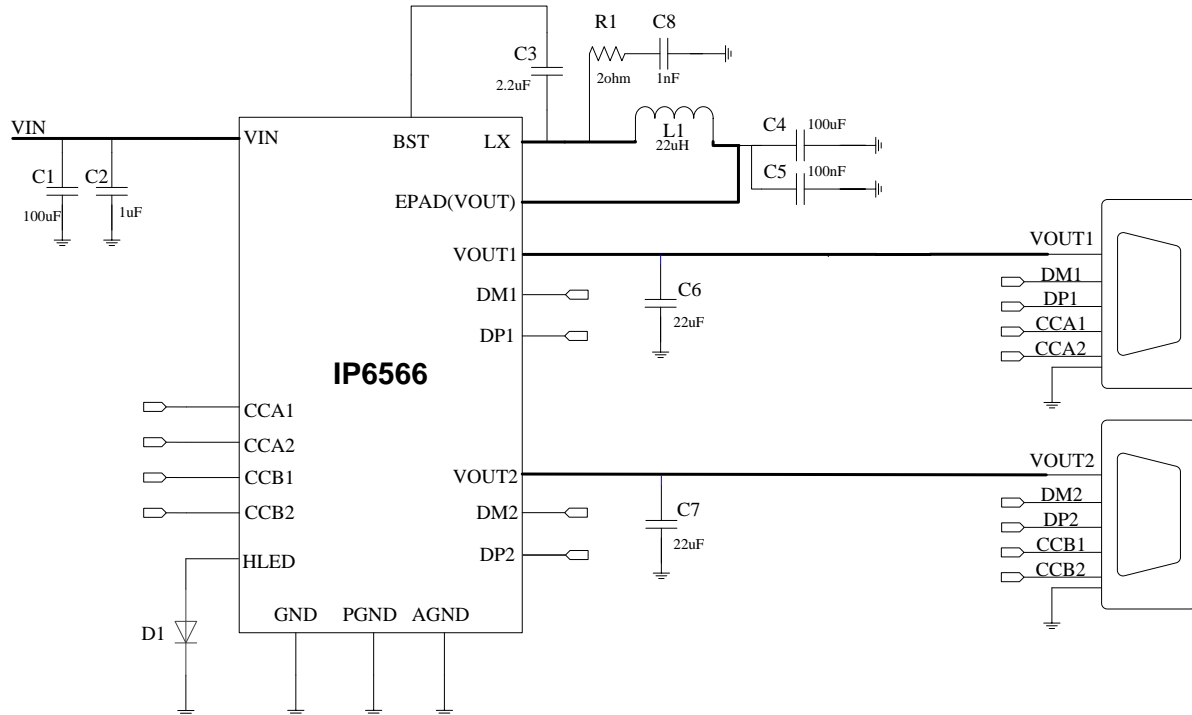
Figure 7. IP6566_CC dual USB Type-C output ports fast charge application schematic diagram

NOTES:

1. PIN CCA1/CCA2/DM1/DP1 must be connected to USB Type-C 1;
2. PIN CCB1/CCB2/DM2/DP2 must be connected to USB Type-C 2;
3. C2 should be placed close to the VIN PIN;
4. C5 should be placed close to the EPAD(VOUT);
5. C6 should be placed close to the VOUT1 PIN;
6. C7 should be placed close to the VOUT2 PIN;
7. R1 and C8 should be placed close to the LX PIN of IP6566, the loop composed of LX, R1, C8 and PGND should be minimized on the PCB board;
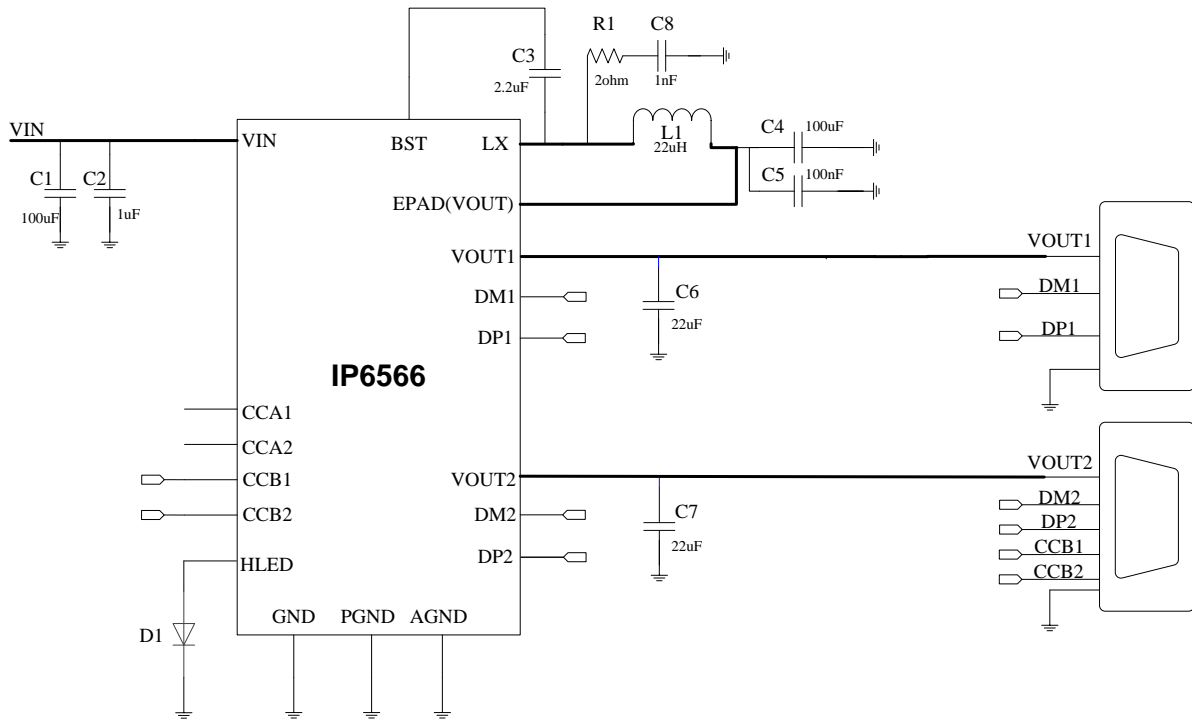
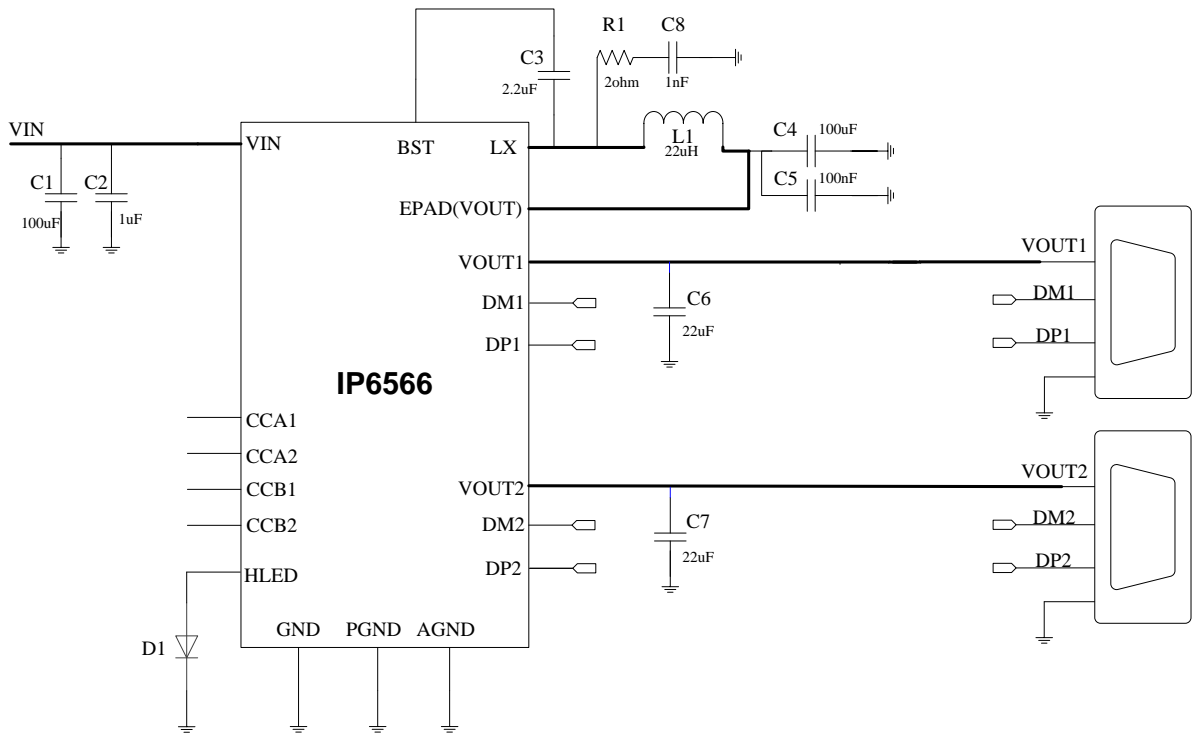Figure 8. IP6566_AC USB A plus USB Type-C output ports fast charge application schematic diagram

Figure 9. IP6566_AA dual USB A output ports fast charge application schematic diagram

11 BOM List

No.	Part Name	Type	Unit	Qty	Location	Notes
1	IC	IP6566	PCS	1		
2	Power inductor	22uH+/-20%, current 5A DCR<12mohm	PCS	1	L1	
3	SMD capacitor	0603 0.1uF 10%	PCS	1	C5	Withstand voltage higher than 25V
4	SMD capacitor	0603 2.2uF 10%	PCS	1	C3	Withstand voltage higher than 10V
5	SMD capacitor	0805 22uF 10%	PCS	2	C6,C7	Withstand voltage higher than 25V
6	SMD LED	0603	PCS	1	D1	
7	Electrolytic capacitor	100uF/35V	PCS	1	C1	Withstand voltage higher than 35V Use solid-state capacitor will increase efficiency
8	Electrolytic capacitor	220uF/16V	PCS	1	C4	Withstand voltage higher than 16V
9	SMD capacitor	0603 10uF 10%	PCS	1	C2	Withstand voltage higher than 35V
10	SMD resistor	0603 2R 5%	PCS	1	R1	
11	SMD capacitor	0603 1nF, 50V 10%	PCS	1	C8	

12 IP series IC Products List

IC Part	Output Current	Dual Ports	DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	Pkg	P2P
IP6523S_N	3.4A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	PIN2PIN
IP6536	2.4A	√	√	–	–	–	–	–	–	–	–	–	ESOP8	PIN2PIN
IP6525T	18W	–	√	√	√	√	–	√	–	–	–	–	ESOP8	PIN2PIN
IP6525S	18W	–	√	√	√	√	√	√	√	√	–	–	ESOP8	PIN2PIN
IP6510	18W	–	√	√	√	√	–	√	–	–	√	–	ESOP8	PIN2PIN
IP6520	18W	–	√	√	√	√	√	√	√	–	√	–	ESOP8	PIN2PIN
IP6520_PPS	18W	–	√	√	√	√	√	√	√	–	√	√	ESOP8	PIN2PIN
IP6537_C	18W	–	√	√	√	√	√	√	√	√	√	√	QFN24	PIN2PIN
IP6537_C_30W20V	30W	–	√	√	√	√	√	√	√	√	√	√	QFN24	PIN2PIN
IP6515	4.8A	√	√	–	–	–	–	–	–	–	–	–	QFN32	
IP6538_CC	27W	√	√	√	√	√	–	√	√	–	√	√	QFN32	PIN2PIN
IP6538_AC	27W	√	√	√	√	√	√	√	√	–	√	√	QFN32	PIN2PIN
IP6538_AA	24W	√	√	√	√	√	√	√	√	–	–	–	QFN32	PIN2PIN
IP6527S_A	24W	–	√	√	√	√	√	√	√	–	–	–	QFN32	PIN2PIN
IP6527S_C	27W	–	√	√	√	√	–	√	√	–	√	√	QFN32	PIN2PIN
IP6527S_C_18WPD	18W	–	√	√	√	√	–	√	√	–	√	√	QFN32	PIN2PIN
IP6566_CC	20W	√	√	√	√	√	–	√	–	√	√	√	QFN28	PIN2PIN
IP6566_AC	20W	√	√	√	√	√	√	√	–	√	√	√	QFN28	PIN2PIN
IP6566_AA	18W	√	√	√	√	√	√	√	–	√	–	–	QFN28	PIN2PIN

13 Package

TOP VIEW

SIDE VIEW

BOTTOM VIEW
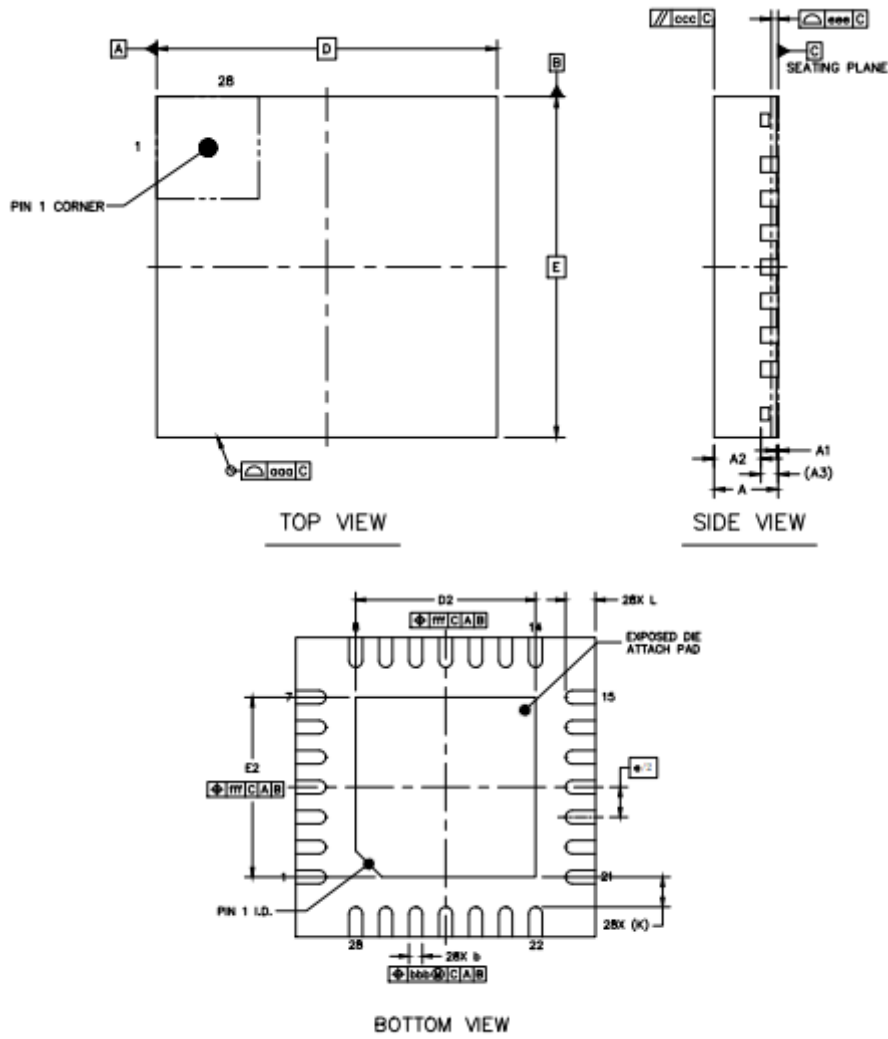
		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.7	0.75	0.8
STAND OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.55	---
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.15	0.20	0.25
BODY SIZE	X	D		4 BSC	
	Y	E		4 BSC	
LEAD PITCH		e		0.4 BSC	
EP SIZE	X	D2	2.3	2.4	2.5
	Y	E2	2.3	2.4	2.5
LEAD LENGTH		L	0.3	0.4	0.5
LEAD TIP TO EXPOSED PAD EDGE		K		0.4 REF	
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		ccc		0.1	
COPLANARITY		eee		0.08	
LEAD OFFSET		bbb		0.07	
EXPOSED PAD OFFSET		fff		0.1	

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