

SOC Output 20W Power with Type-C PD and Fast Charge

Fast Charge Standards: DCP/QC2.0/QC3.0/FCP/HSCP/AFC/MTK PE/ PD3.0/PPS

1 Features

- **Synchronized Switch Regulator**
 - ◇ Built-in power MOSFET
 - ◇ Input voltage range: 7.1V~32V
 - ◇ Output voltage range: 3V~12V, adjust along with fast charge negotiation
 - ◇ Output power of PD: up to 20W (5V@3A, 9V@2.22A, 12V@1.67A)
 - ◇ Output voltage line compensate: 50mV/A
 - ◇ conversion efficiency up to 93.8% with VIN=24V, VOUT=5V/3A
 - ◇ Soft start function
- **Support Type-C output and USB PD protocol**
 - ◇ **USB PD3.0 Certificate TID:3277**
 - ◇ Support 5V, 9V, 12V output
 - ◇ Support PD2.0/PD3.0(PPS) output protocol
 - ◇ PPS support 3~11V adjustable voltage with 20mV/step output
- **Fast charge output**
 - ◇ Support Type-C PD output
 - ◇ Support BC1.2 and Apple
 - ◇ Support Qualcomm QC2.0, QC3.0
 - ◇ Support Huawei Fast charge: FCP and HSCP
 - ◇ Support Samsung fast charge : AFC(MAX 12V)
 - ◇ Support MTK PE+2.0 and PE+ 1.1
- **Multi-protection and high reliability**
 - ◇ Input overvoltage, input under voltage, output short circuit, output overcurrent protection
 - ◇ Whole system over temperature protection
 - ◇ DP/DM/CC over voltage protection
 - ◇ CC withstand voltage of 30V
 - ◇ ESD 4KV, DC voltage withstand 40V
- **Package:ESOP8**

2 Applications

- Car Charger
- Fast Charge Adaptor
- Smart Power Strip

3 Description

IP6520 is a synchronized switch buck regulator and support multiple fast charge output standards, support Type-C and USB PD2.0/PD3.0(PPS)output protocol, providing solutions for car charger, fast charge adaptor and smart power strip.

IP6520 has built-in power MOSFET, input voltage range is 7.1V to 32V, output voltage ranges from 3V to 12V, and supply up to 20W output power (5V@3A, 9V@2.22A, 12V@1.67A)

IP6520 PD output power support CV/CC output, when the output current is lower than the preset value, it is in CV mode with a constant output voltage; when the output current is higher than the preset value, it enters CC mode with a lower output voltage.

IP6520 has the function of automatic output overcurrent adjustment. IP6520 support maximum 10V/2.5A output power when the working fast charge protocol is HSCP. When the smart device connected with IP6520 support HSCP and PD protocol, HSCP is given priority. Compared with PD output, HSCP charging power is higher for the same smart phone.

IP6520 support soft start, providing resistibility on the large inrush current during circuit start up.

IP6520 support Type-C output and integrate several fast charge standards, CC1/CC2 or DP/DM support auto distinguish on the fast charge of the accessed devices, and IP6520 will adjust the output voltage and current according to the fast charge standard automatically.

IP6520 support multi-protection on input overvoltage and under voltage, output overcurrent, overvoltage, under voltage and short circuit.

4 IP6520 Series Product Introduction

IP6520	USB Type-C	PDO	5V/3A	9V/2A	12V/1.5A	--	--
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520_PPS	USB Type-C	PDO	5V/3A	9V/2A	12V/1.5A	3.3V-5.9V/3A	3.3V-11V/2A
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520_20W	USB Type-C	PDO	5V/3A	9V/2.22A	--	3.3V-11V/2A	--
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520_20W_NPPS	USB Type-C	PDO	5V/3A	9V/2.22A	--	--	--
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520_20W12V	USB Type-C	PDO	5V/3A	9V/2.22A	12V/1.67A	3.3V-5.9V/3A	3.3V-11V/2A
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520_20W12V_NPPS	USB Type-C	PDO	5V/3A	9V/2.22A	12V/1.67A	--	--
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--

Notes:

- QC represents the output power of high voltage fast charge.
- QC fast charge output of IP6520 supports CV/CP/CC power loop

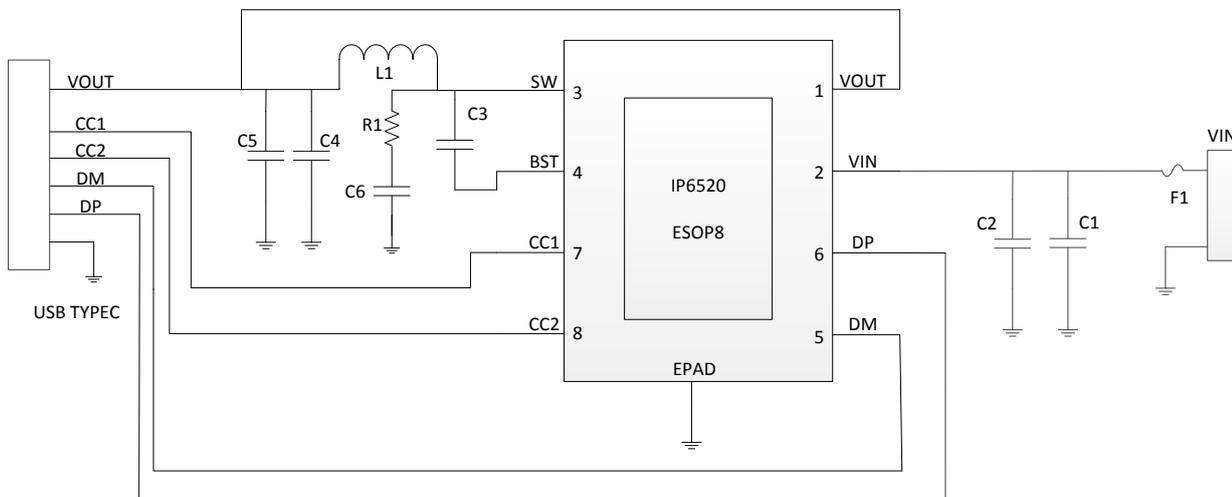


Figure 1 IP6520 simplified application schematic

5 Pin Definition

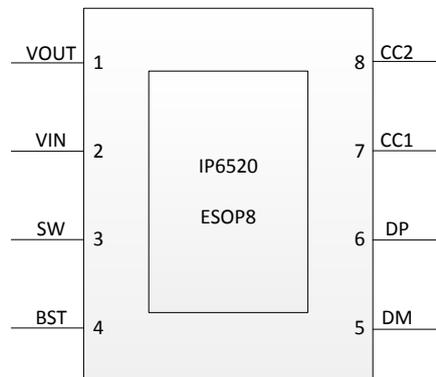


Figure 2 Pin Assignment

PIN List:

Pin		Description
No	Name	
1	VOUT	Output voltage feedback pin
2	VIN	Input voltage, place filter capacitor nearby.
3	SW	DCDC switch node, connect to the inductor
4	BST	Bootstrap circuit pin, place a 0.1uF capacitor close to the BST pin and LX pin, providing drive voltage for the gate of the upper MOSFET
5	DM	Connect to USB DM data line
6	DP	Connect to USB DP data line
7	CC1	Connect to USB Type-C CC1 line
8	CC2	Connect to USB Type-C CC2 line
9(EPAD)	GND	Power and heat dissipation ground

6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input voltage	V_{IN}	-0.3 ~ 40	V
LX voltage	V_{LX}	-0.3 ~ $V_{IN}+0.3$	V
CC voltage	$V_{CC1/CC2}$	-0.3 ~ 30	V
DM/DP/CC1/CC2 voltage	$V_{DM/DP}$	-0.3 ~ 6	V
Junction temperature	T_J	-40 ~ 150	°C
Storage temperature	Tstg	-60 ~ 150	°C
Thermal resistance (junction to ambient)	θ_{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.

7 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	7.1	12/24	32	V

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

8 Electrical Characteristics

Unless otherwise specified,

$T_A=25^{\circ}\text{C}$, $L=22\mu\text{H}$, $C_{out}=100\mu\text{F}$ Solid state capacitor (About 40mΩ ESR) $V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}$

Parameters	Symbol	Test Condition	Min.	Typ.	Max	Unit
Input system						
Input voltage	V_{IN}		7.1	12	32	V
Input under voltage	V_{IN-UV}	Rising voltage	7.05	7.1	7.2	V
		Falling voltage	6.8	6.9	6.95	V
Input over voltage	V_{IN-OV}	Rising voltage	32.4	32.6	33	V
		Falling voltage	31.9	32.1	32.3	V
Input quiescent current	I_Q	$V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}/0\text{A}$	--	3	--	mA
Power system						
High-side MOS Ron resistance	$R_{DS(ON)}$		--	30	--	mΩ
Low-side MOS Ron resistance	$R_{DS(ON)}$		--	20	--	mΩ
Switching frequency	F_S		--	100	--	KHz
Output system						
Output voltage	V_{OUT}		3	5	12	V
Output voltage ripple	ΔV_{OUT}	$V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}/3\text{A}$	80	85	90	mV
		$V_{IN}=12\text{V}$, $V_{OUT}=9\text{V}/2\text{A}$	85	90	95	mV
		$V_{IN}=24\text{V}$, $V_{OUT}=12\text{V}/1.5\text{A}$	90	95	100	mV
Soft start time	T_{SS}	$V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}$	--	4	--	ms
Output line compensate voltage	V_{COMP}	$V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}$, $I_{OUT}=2\text{A}$	--	100	--	mV
Single port max output current in CC mode	I_{OUT}	$V_{IN}=12\text{V}$, $V_{OUT}\leq 4\text{V}$	--	3.1	--	A
		$V_{IN}=12\text{V}$, $4\text{V}<V_{OUT}\leq 5\text{V}$	--	3.1	--	A
		$V_{IN}=12\text{V}$, $7\text{V}<V_{OUT}\leq 9\text{V}$	--	2	--	A
		$V_{IN}=24\text{V}$, $9\text{V}<V_{OUT}\leq 12\text{V}$	--	1.5	--	A
Output hiccup restart voltage	V_{OUT}	Hiccup restart voltage when output enter CC mode (V_{OUT} preset voltage $\geq 5\text{V}$)	--	4.1	--	V
		Hiccup restart voltage	--	3	--	V

		when output enter CC mode (VOUT preset voltage < 5V)				
Output hiccup restart time	T_{HIC}	VIN=12V, output short circuit	--	2	--	S
DPDM over voltage protection voltage	V_{OVP_DPDM}	VIN=12V, VOUT=5V	--	4.5	--	V
CC over voltage protection voltage	V_{OVP_CC}	VIN=12V, VOUT=5V	--	6.0	--	V
Thermal shutdown temperature	T_{OTP}	Rising temperature	--	150	--	°C
Thermal shutdown temperature hysteresis	ΔT_{OTP}		--	40	--	°C

9 Function Description

9.1 IP6520 Internal block diagram

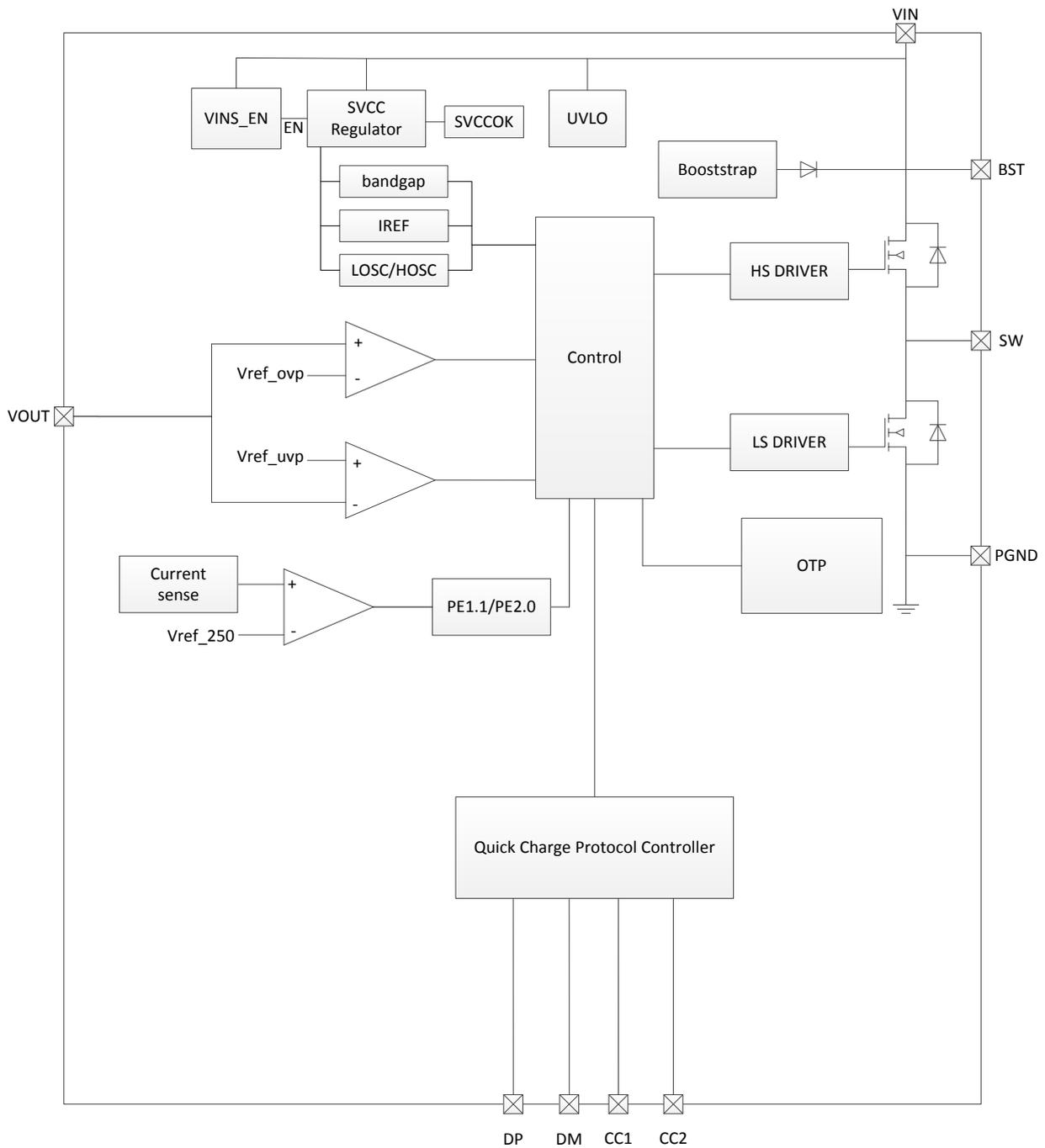


Figure3 IP6520 Internal block diagram

9.2 Synchronized switch buck regulator

IP6520 integrate a synchronized switch buck regulator, input voltage ranges from 7.1V to 32V and output from 3V to 12V. IP6520 integrate power switch MOSFET with 100 kHz working frequency.

When $V_{IN}=24V$, $V_{OUT}=5V@3A$, the power conversion efficiency is 93.8%.

IP6520 support soft start, in avoidance of the inrush current during start up, and the soft start time is 4ms.

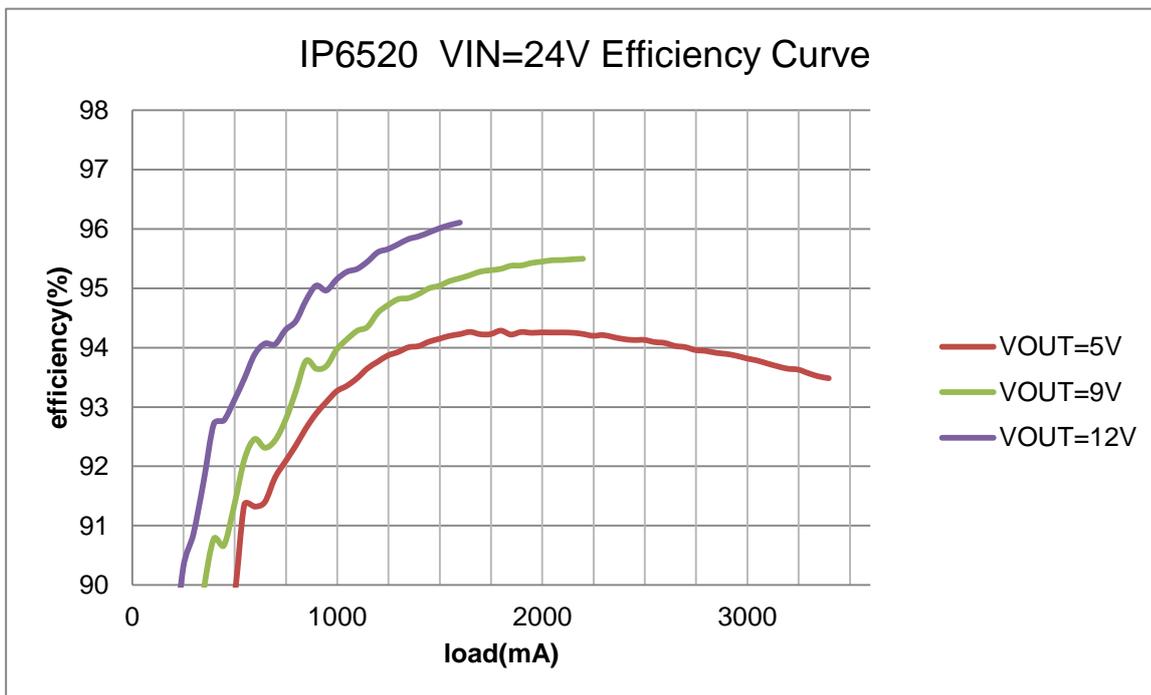


Figure4 IP6520 VIN=24V Efficiency Curve

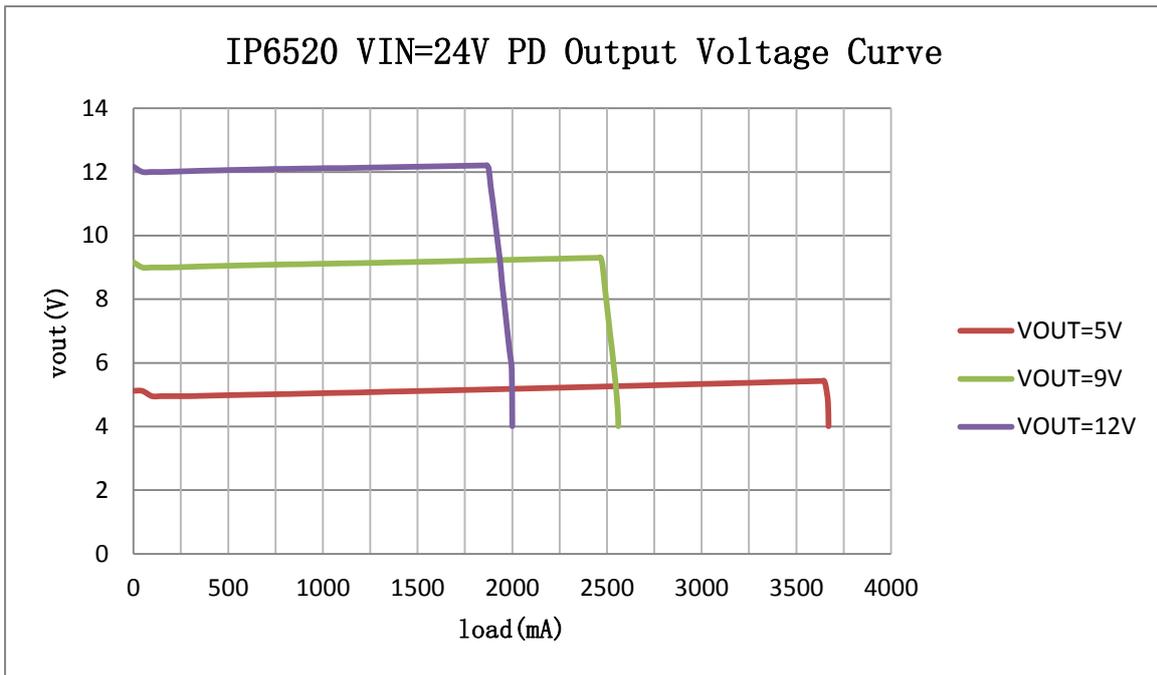


Figure 5 IP6520 VIN=24V PD output VOUT-IOUT curve

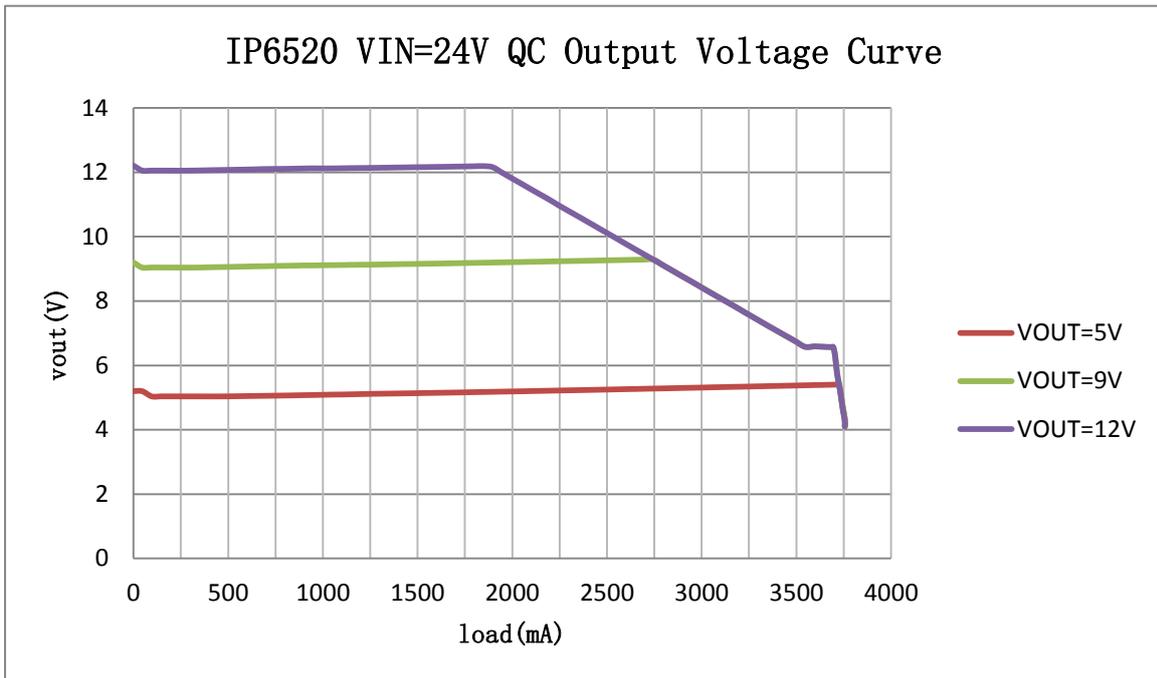


Figure 6 IP6520 VIN=24V QC output VOUT-IOUT curve

9.3 Output voltage line compensate

IP6520 support output line compensate, output voltage will increase about 50mV as output current increase 1A.

9.4 Output CV/CC characteristic

When IP6520 works with QC high voltage protocol ,IP6520 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 IP6520 works with PD high voltage protocol, IP6520 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 4.1V, 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.

9.5 Protection

IP6520 detect the VIN voltage and enters standby mode when VIN is lower than 7.1V, the output will be shut down during standby mode.

IP6520 support input overvoltage protection; when VIN is above 32.6V, an overvoltage will be determined output will be shut down; IP6520 will reckon a normal working state and turn on the output only when VIN falls under 32.1V.

IP6520 support output under voltage protection: when VOUT voltage is lower or equals 5V, if the VOUT voltage is lower than 4.1V, IP6520 determines the output is under voltage and will shut down the output and hiccup restart after 2sec. when VOUT voltage is lower than 5V, if the VOUT voltage is lower than 3V, IP6520 determines the output is under voltage and will shut down the output and hiccup restart after 2sec.

IP6520 support output under voltage protection. IP6520 will enter under voltage state when the VOUT is under 4.1V and shut down the output, after 2sec turn on the output with hiccup.

IP6520 support output short circuit protection, 4ms after start up. If VOUT is lower than 4.1V, output short circuit is determined and output will be shut down and hiccup restart after 2sec.

IP6520 support DP/DM/CC over voltage protection, when the DP/DM voltage is higher than 4.5V, or when the CC1/CC2 voltage is higher than 6.0V, IP6520 determine the signals of DP/DM/CC over voltage and will shut down the output and hiccup restart after 2sec.

IP6520 support over temperature, when the chip temperature is higher than 150°C, the output will be shut down; When the temperature decreases below 110°C, IP6520 determines that the temperature has recovered and will restart the output.

9.6 Output fast charge standard

IP6520 support fast charge protocol:

- ✧ Support BC1.2 and Apple
- ✧ Support Qualcomm QC2.0, QC3.0
- ✧ Support Huawei Fast charge: FCP and HSCP
- ✧ Support Samsung fast charge : AFC(MAX 12V)
- ✧ Support MTK PE+1.1 and MTK PE+2.0

9.7 Type-C port and USB PD protocol

IP6520 support Type-C output and USB PD2.0/PD3.0 (PPS) protocol.

IP6520 support USB PD protocol output 18W; Package broadcast: 5V/3A, 9V/2A, 12V/1.5A and don't support PPS

IP6520_PPS support USB PD protocol output 18W; Package broadcast: 5V/3A, 9V/2A, 12V/1.5A and PPS 3.3V-5.9V/3A, 3.3V-11V/2A.

IP6520 supports the standard Type-C specification and will not turn on the output until the CC connection is successful.

IP6520 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

Just with inductor, capacitor and resistor peripherals, can IP6520 realize a total solution of car charger.

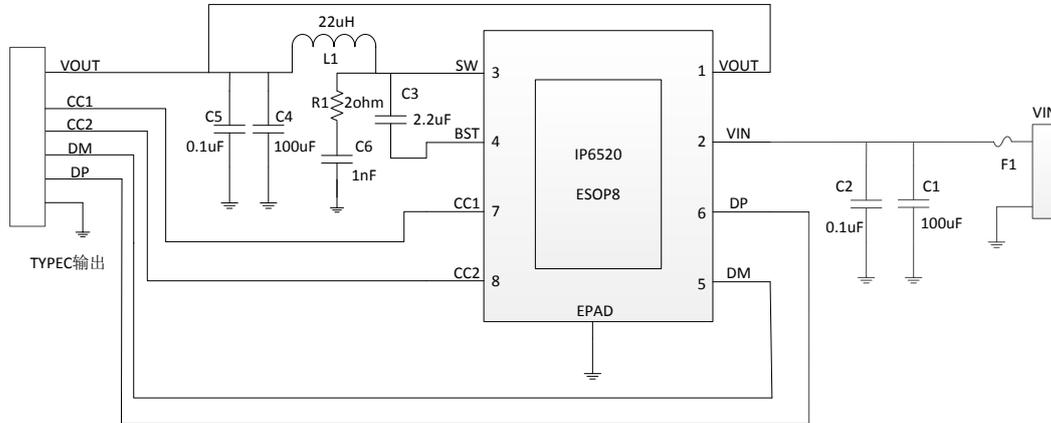


Figure 7 Type-C port PD fast charge output application schematic

NOTES:

1. EPAD of IP6520 must have good contact with PCB board ground.
2. C1 and C2 must be connected to PIN 2;
3. C5 must be connected to PIN 1;
4. R1 and C6 should be placed close to the PIN3 of IP6520, the loop composed of SW(PIN3), R1, C6 and PGND should be minimized on the PCB board;

11 BOM List

No.	Part Name	Type	Unit	Num.	Location	Note
1	IC	IP6520	PCS	1	U1	
2	electrolytic capacitor	100uF/35v	PCS	1	C1	Withstand voltage higher than 35V
3	electrolytic capacitor r	100uF/25v	PCS	1	C4	Withstand voltage higher than 25V
4	TC-220M-4.5A-CS137125	22uH+/-20%,current 4.5A DCR<12mohm	PCS	1	L1	3L Electronic
5	SMT capacitor	0603 2.2uF 10%	PCS	2	C3	Withstand voltage higher than 16V
6	SMT capacitor	0603 100nF 10%	PCS	1	C2	Withstand voltage higher than 35V, place near IC pin in layout.
7	SMT capacitor	0603 100nF 10%	PCS	2	C5	Withstand voltage higher than 16V
8	SMD resistor	0603 2R 5%	PCS	1	R1	
9	SMT capacitor	0603 1nF 10%	PCS	1	C6	
10	Fuse	F1	PCS	1	F1	Current value 4A

Inductor type recommend:

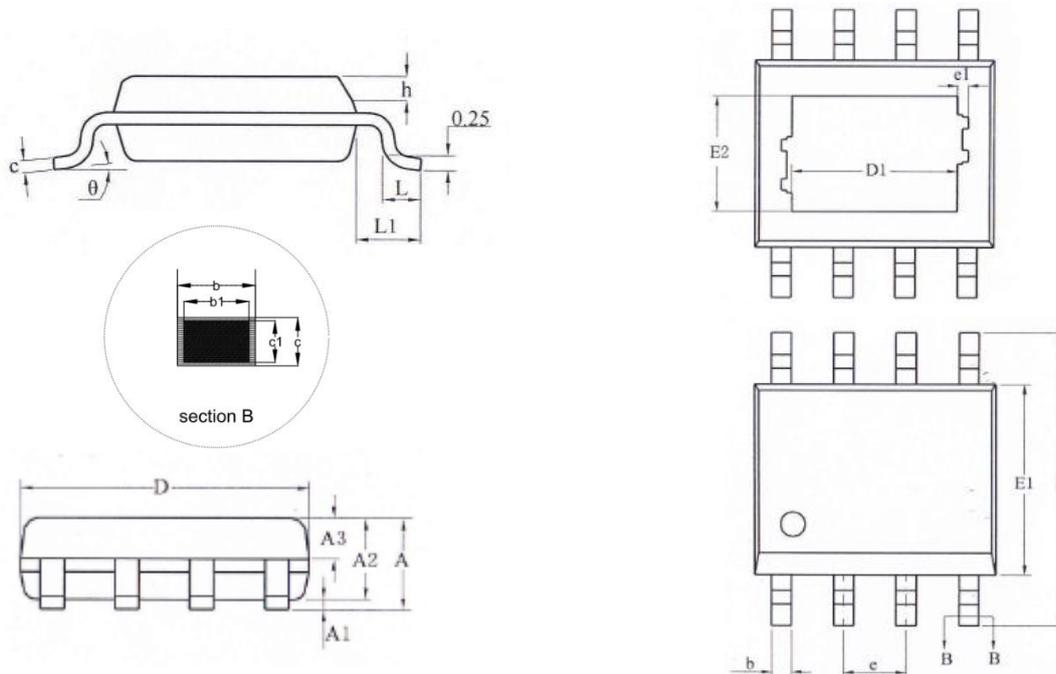
TC-220M-4.5A-CS137125

3L product No.	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.	
TC-220M-4.5A-CS137125	22.0	±20%	12	14	8.0	8	

12 IP series IC Products List

IC 型号	放电 电流	双 路	支持的协议										封装		
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	规格	兼 容	
IP6523S_N	3.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
IP6536	2.4A	√	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6525T	18W	-	√	√	√	√	-	√	-	-	-	-	ESOP8	PIN2PIN	
IP6525S	18W	-	√	√	√	√	√	√	√	√	-	-	ESOP8		
IP6510	18W	-	√	√	√	√	-	√	-	-	√	-	ESOP8	PIN2PIN	
IP6520	18W	-	√	√	√	√	√	√	√	-	√	-	ESOP8		
IP6520_PPS	18W	-	√	√	√	√	√	√	√	-	√	√	ESOP8		
IP6537_C	18W	-	√	√	√	√	√	√	√	√	√	√	QFN24	PIN2PIN	
IP6537_C_30W20V	30W	-	√	√	√	√	√	√	√	√	√	√	QFN24		
IP6515	4.8A	√	√	-	-	-	-	-	-	-	-	-	QFN32		
IP6538_CC	27W	√	√	√	√	√	-	√	√	-	√	√	QFN32	PIN2PIN	
IP6538_AC	27W	√	√	√	√	√	√	√	√	-	√	√	QFN32		
IP6538_AA	24W	√	√	√	√	√	√	√	√	-	-	-	QFN32		
IP6527S_A	24W	-	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN	
IP6527S_C	27W	-	√	√	√	√	-	√	√	-	√	√	QFN32		
IP6527S_C_18WPD	18W	-	√	√	√	√	-	√	√	-	√	√	QFN32		
IP6566_CC	20W	√	√	√	√	√	-	√	-	√	√	√	QFN28	PIN2PIN	
IP6566_AC	20W	√	√	√	√	√	√	√	-	√	√	√	QFN28		
IP6566_AA	18W	√	√	√	√	√	√	√	-	√	-	-	QFN28		

13 Package



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.47
b1	0.38	0.41	0.44
c	0.20	--	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	--	0.50
L	0.50	0.60	0.80
L1	1.05REF		
θ	0	--	8°
D1	--	3.10REF	--
E2	--	2.21REF	--

IMPORTANT NOTICE

INJOINIC TECHNOLOGY and its subsidiaries reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to INJOINIC TECHNOLOGY's terms and conditions of sale supplied at the time of order acknowledgment.

INJOINIC TECHNOLOGY assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using INJOINIC TECHNOLOGY's components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of INJOINIC TECHNOLOGY's components in its applications, notwithstanding any applications-related information or support that may be provided by INJOINIC TECHNOLOGY. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify INJOINIC TECHNOLOGY and its representatives against any damages arising out of the use of any INJOINIC TECHNOLOGY's components in safety-critical applications.

Reproduction of significant portions of INJOINIC TECHNOLOGY's information in INJOINIC TECHNOLOGY's data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. INJOINIC TECHNOLOGY is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

INJOINIC TECHNOLOGY will update this document from time to time. The actual parameters of the product may vary due to different models or other items. This document voids all express and any implied warranties.

Resale of INJOINIC TECHNOLOGY's components or services with statements different from or beyond the parameters stated by INJOINIC TECHNOLOGY for that component or service voids all express and any implied warranties for the associated INJOINIC TECHNOLOGY's component or service and is an unfair and deceptive business practice. INJOINIC TECHNOLOGY is not responsible or liable for any such statements.