

Output 45W Power Buck SOC with Multiple Fast Charge Protocols (DCP/QC2.0/QC3.0/FCP/HSCP/AFC/MTK PE/ PD3.1)

1 Features

- **Synchronous Switching Buck Converter**
 - ◇ Built-in Power MOSFETs
 - ◇ Input Voltage Range: 7.1V to 32V
 - ◇ Output voltage range: 3.3V to 21V, adjusts to fast charge protocols
 - ◇ Output voltage line complement function: 50mV/A
 - ◇ VIN=24V, VOUT=5V/3A, Conversion efficiency up to 93.06%
 - ◇ Soft start function
- **Support Type-C Output and PD Protocol**
 - ◇ Support 5V, 9V, 12V,15V,20V output
 - ◇ Support PD3.1/PPS output protocol
 - ◇ PPS support 3.3~21V adjustable voltage with 20mV/step output
- **Fast Charge Output**
 - ◇ Support Type-C PD output
 - ◇ Support BC1.2 and Apple
 - ◇ Support QC2.0 and QC3.0
 - ◇ Support Huawei fast charge FCP and high voltage SCP
 - ◇ Support Samsung fast charge AFC(MAX 12V)
 - ◇ Support MTK PE+1.1 and PE+2.0
- **Multi-Protection and High Reliability**
 - ◇ Input overvoltage, input under voltage, output short circuit, output overcurrent protection
 - ◇ Over temperature protection
 - ◇ DP/DM/CC over voltage protection
 - ◇ CC withstand voltage of 30V
 - ◇ HBM ESD 4KV, DC withstand voltage 40V

2 Application

- Car Charger
- Fast Charge Adapter
- Smart Plug

3 Introduction

IP6520U is a buck converter with integrated synchronous switch, supports multiple output fast charging protocols, supports USB-C interface PD3.1/PPS protocol, and provides a complete solution for car chargers, fast charging adapters, and smart plugs.

IP6520U has a built-in power MOS with an input voltage range of 7.1V to 32V and an output voltage range of 3.3V to 21V. It is capable of delivering a maximum output power of 45W, and is able to automatically adjust the output voltage and current according to the recognized fast charging protocol.

IP6520U output power has CV/CC characteristic. 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 and the output voltage decreases as the output current increases.

IP6520U has the function of automatic overcurrent point adjustment, and can support high-voltage SCP output when the high-voltage SCP, fast charging protocol handshake is successful. When the device connected to the USB-C interface of IP6520U supports high-voltage SCP, it will prioritize the output of high-voltage SCP, which will result in higher charging power compared with PD output.

The IP6520U's output voltage has a line compensation function that increases the output voltage as output current increases to compensate for the voltage drop caused by wire impedance.

The IP6520U has a soft-start function that prevents the inrush current during startup from affecting the stability of the input power supply.

IP6520U supports USB-C interface output and integrates various fast charging protocols, which can automatically identify the fast charging protocols supported by the devices accessed at the output terminal through CC1/CC2 or DP/DM, and then automatically adjust the output voltage and current. The fast charging protocols supported by IP6520U are: DCP (Apple and BC1.2), Qualcomm QC2.0/QC3.0, Huawei fast charging protocols FCP and high-voltage SCP, Samsung fast charging protocol AFC (MAX 12V), IP6520U supports USB PD3.1/PPS output protocol.

IP6520U has a variety of protection functions, with input over-voltage, under-voltage protection, output over-current, over-voltage, under-voltage, short-circuit protection and other functions

The IP6520U is available in an ESOP8 package.

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4 Revision History

Notes: The page number of the previous version may differ from the page number of the current version

Initial Release V1.00 (Sept. 2023)

5 IP6520U Series Product Selection

IP6520U	USB Type-C	PDO	5V/3A	9V/2A	12V/1.5A	--	--
		QC ⁽¹⁾	5V/3A	9V/2A	12V/1.5A	--	--
IP6520U_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	--	--

Note:

- ◆ QC in the table refers to the output power of high voltage fast charging;
- ◆ QC fast charging output of IP6520U supports CV/CP/CC loops;

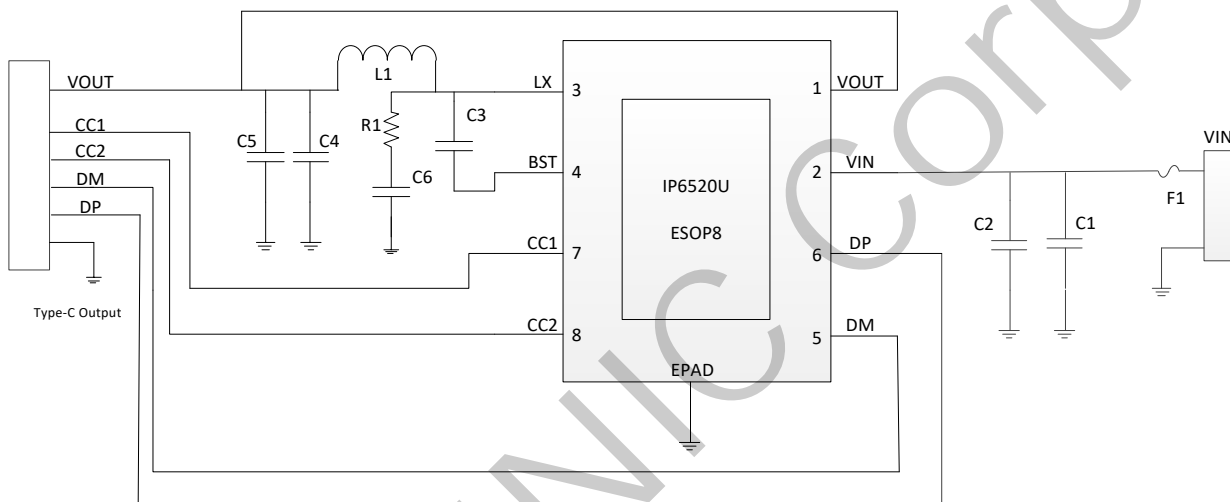


Fig.1 IP6520U Simplified Application Schematic

6 PIN Definition

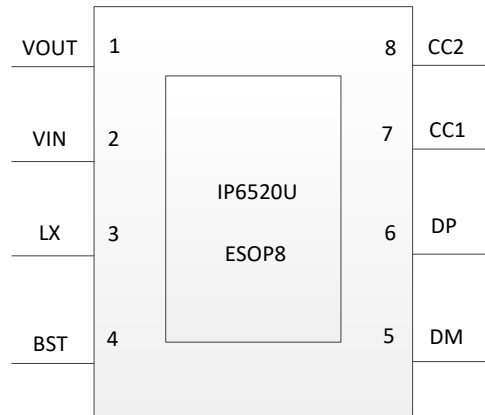


Fig. 2 IP6520U PIN Configuration

Pin NO.	Pin Name	Description
1	VOUT	Output Voltage Feedback Pin
2	VIN	Input voltage pin, close to the IC needs to be placed filter capacitor
3	LX	DCDC switch node, connected to external inductor
4	BST	Bootstrap circuit pins, bootstrap capacitors are placed adjacent to the BST and LX pins of the chip to provide voltage for the upper gate drive.
5	DM	USB fast charge recognition signal DM
6	DP	USB fast charge recognition signal DP
7	CC1	Type-C detection pin CC1
8	CC2	Type-C detection pin CC2
9(EPAD)	GND	Power ground and heat sink ground, need to keep good contact with GND

7 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
CC voltage range	$V_{CC1/CC2}$	-0.3 ~ 30	V
DP/DM voltage range	$V_{DP/DM}$	-0.3 ~ 6	V
Junction Temp range	T_J	-40 ~ 150	°C
Storage Temp range	T_{stg}	-60 ~ 150	°C
Thermal resistance (junction to ambient)	θ_{JA}	40	°C/W
ESD (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.

8 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.

9 Electrical Characteristics

Unless otherwise specified, TA=25°C, L=22uH, C_{OUT}=100uF (Solid-state capacitors, About 40mΩ ESR), VIN=12V, VOUT=5V

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	VIN=24V, Standby status	--	400	--	uA
Power switching system						
High-side MOS Ron resistance	R _{DS(ON)_H}			30		mΩ
Low-side MOS Ron resistance	R _{DS(ON)_L}			20		mΩ
Switching frequency	F _S		90	110	130	KHz
Output system						
Output voltage	V _{OUT}		3	5	21	V
Output voltage ripple (IP6520U)	ΔV _{OUT}	VIN=12V, VOUT=5V@3A	80	85	90	mV
		VIN=12V, VOUT=9V@2A	85	90	95	mV
		VIN=24V, VOUT=12V@1.5A	90	95	100	mV
Soft start time	T _{SS}	VIN=12V, VOUT=5V		4		ms
Output line compensate voltage	V _{COMP}	VIN=12V, VOUT=5V, IOU=3A		150		mV
Max output current in CC mode (IP6520U)	I _{OUT}	VIN=24V, VOUT=5V		3		A
		VIN=24V, VOUT=9V		2		A
		VIN=24V, VOUT=12V		1.5		A
Output hiccup restart voltage	V _{OUT}	Hiccup restart voltage when output enter CC mode (VOUT preset voltage >= 5V)	--	4.1	--	V
		Hiccup restart voltage when output enter CC mode (VOUT preset voltage < 5V)	--	3	--	V
Output hiccup restart time	T _{HIC}	VIN=12V, VOUT 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

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10 Function Description

10.1 IP6520U Internal Block Diagram

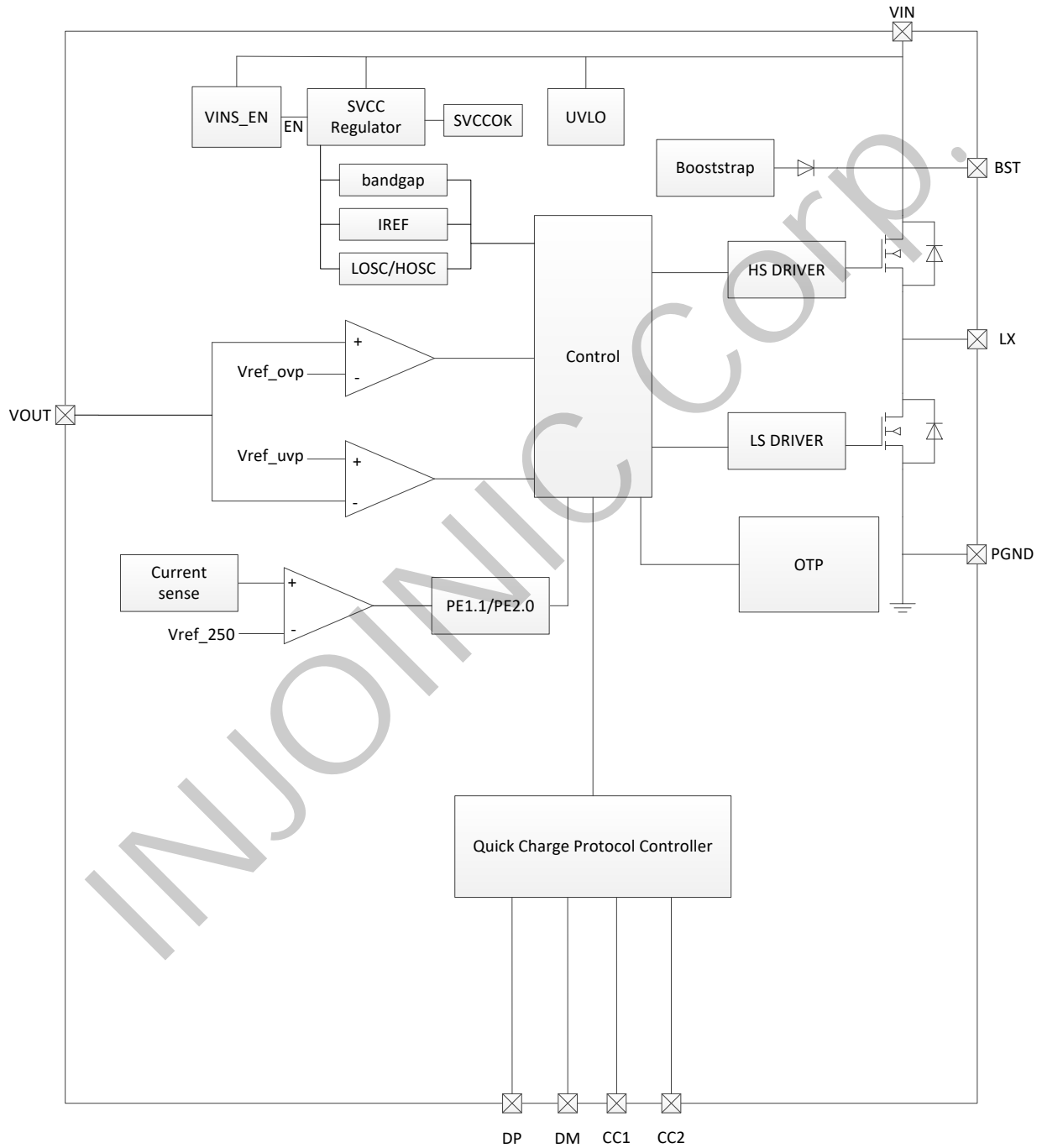


Fig. 3 IP6520U Internal Block Diagram

10.2 Synchronized Switch Buck Regulator

The IP6520U integrates a synchronous switching buck converter. The input voltage range is 7.1V~32V and the output voltage range is 3.3V~21V. The IP6520U has built-in power switching MOSFET and operates at a switching frequency of 110KHz.

The conversion efficiency is 93.06% when $V_{IN}=24V$ and $V_{OUT}=5V/3A$.

IP6520U has a soft-start function to prevent malfunction caused by excessive inrush current at startup. Soft-start time is 4 ms.

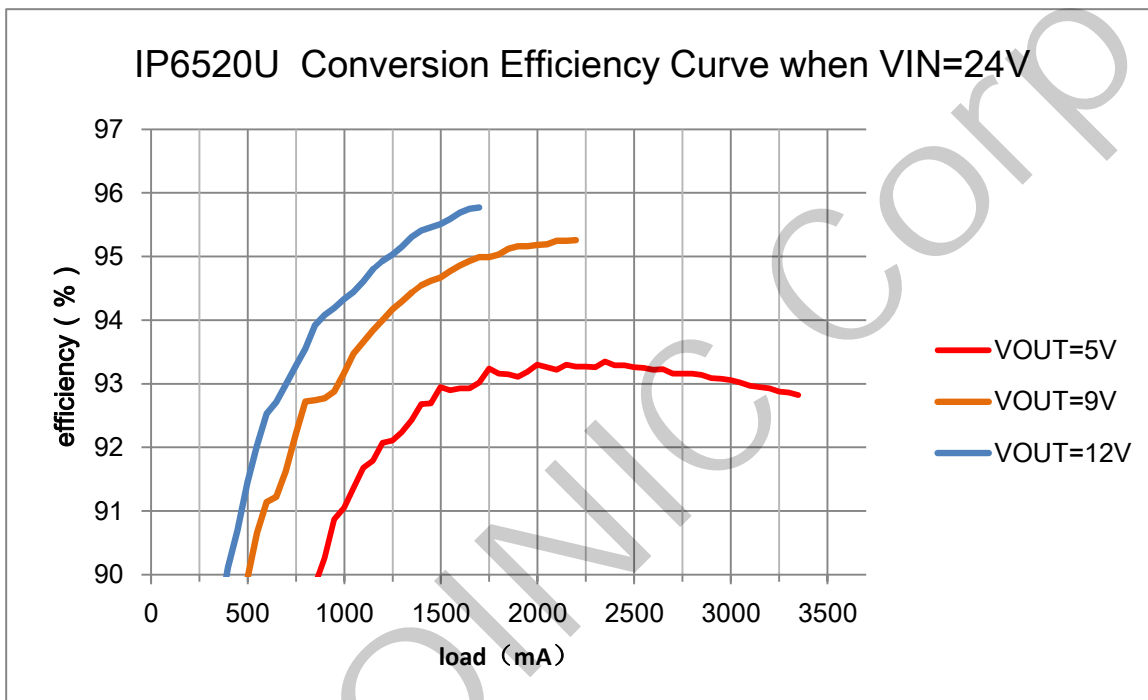


Fig. 4 IP6520U Conversion Efficiency Curve when $V_{IN}=24V$

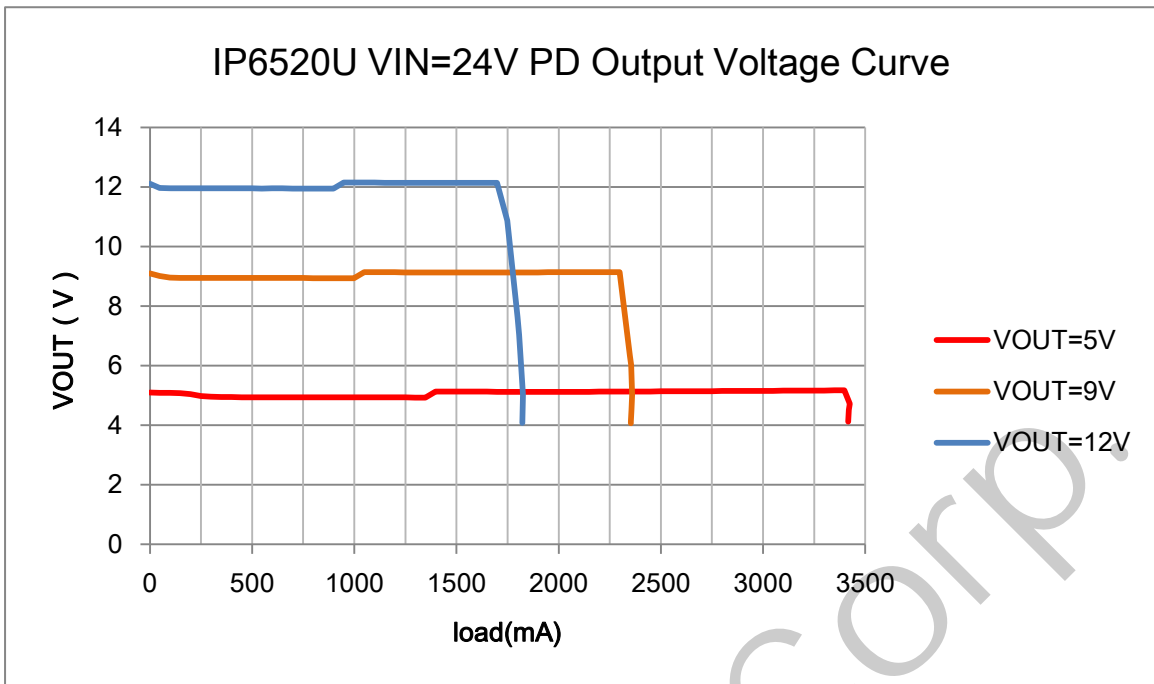


Fig. 5 IP6520U Vout-lout curve when VIN=24V PD output

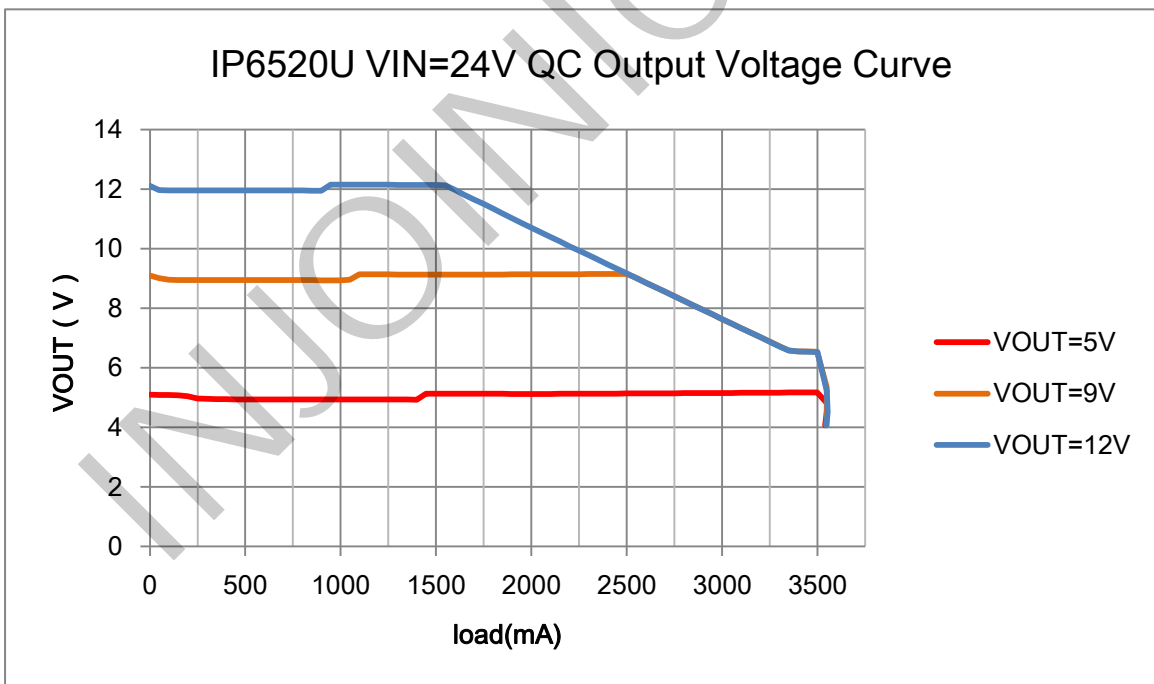


Fig. 6 IP6520U Vout-lout curve when VIN=24V QC output

10.3 Output Voltage Line Complement Function

IP6520U supports output line compensate, output voltage will increase about 50mV as output current increase 1A.

10.4 Output CC/CV/CP Characteristic

When IP6520U works with QC high voltage protocol ,IP6520U 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 IP6520U works with PD high voltage protocol, IP6520U 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.

10.5 Protections

IP6520U supports input undervoltage protection: When the VIN voltage is lower than 7.1V, IP6520U detects the input undervoltage and turns off the output.

IP6520U supports input over voltage protection: When the VIN voltage is higher than 32.6V, IP6520U will turns off the output. When the VIN drops under 32.1V, IP6520U will consider the VIN normal and turn on the output.

IP6520U supports output under voltage protection: When VOUT preset voltage is higher or equal to 5V, if the VOUT voltage is lower than 4.1V, IP6520U determines the output is under voltage and will turn off the output 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 turned off and hiccup restart after 2sec.

IP6520U supports short circuit protection: 4ms after the circuit is started, if VOUT voltage is under 4.1V, IP6520U determines the output is short circuit and will turn off the output and hiccup restart after 2sec.

IP6520U supports DP/DM/CC over voltage protection, when DP/DM voltage is higher than 4.5V, or CC1/CC2 voltage is higher than 6.0V, IP6520U determines relevant signal PIN is over voltage and will turn off the output and hiccup restart after 2sec.

IP6520U supports over temperature protection: when the temperature detected is higher than 150°C, the output will be turned off. When the temperature decreases below 110°C, IP6520U determines the temperature has recovered and will restart the output.

10.6 Fast Charge Protocols

The IP6520U can automatically adjust the output voltage according to the recognized fast charging protocol.

IP6520U supports multiple fast charge protocols:

- ✧ Support DCP (BC1.2 and Apple)
- ✧ Support Qualcomm quick charge QC2.0, QC3.0
- ✧ Supports Huawei Fast Charging Protocol FCP and High Voltage SCP
- ✧ Support Samsung AFC (MAX 12V)
- ✧ Support MTK PE+2.0 and PE+ 1.1

10.7 Type-C Port and USB PD Protocol

IP6520U supports Type-C output and USB PD3.1/PPS protocol.

IP6520U supports USB PD protocol output 18W; Package broadcast: 5V/3A, 9V/2A, 12V1.5A, does not support PPS.

IP6520U_PPS supports USB PD protocol output 18W; Package broadcast: 5V/3A, 9V/2A, 12V1.5A; PPS: 3.3V-5.9V/3A, 3.3V-11V/2A.

IP6520U supports the standard Type-C specification and will not turn on the output until the CC connection is successful.

IP6520U Type-C port detects the fast charge requirement automatically through DP/DM and CC1/CC2 pins and adjusts the output voltage and current accordingly.

11 Typical Application Schematic Diagram

IP6520U requires only inductors, capacitors and resistors to realize a full-featured car charger solution.

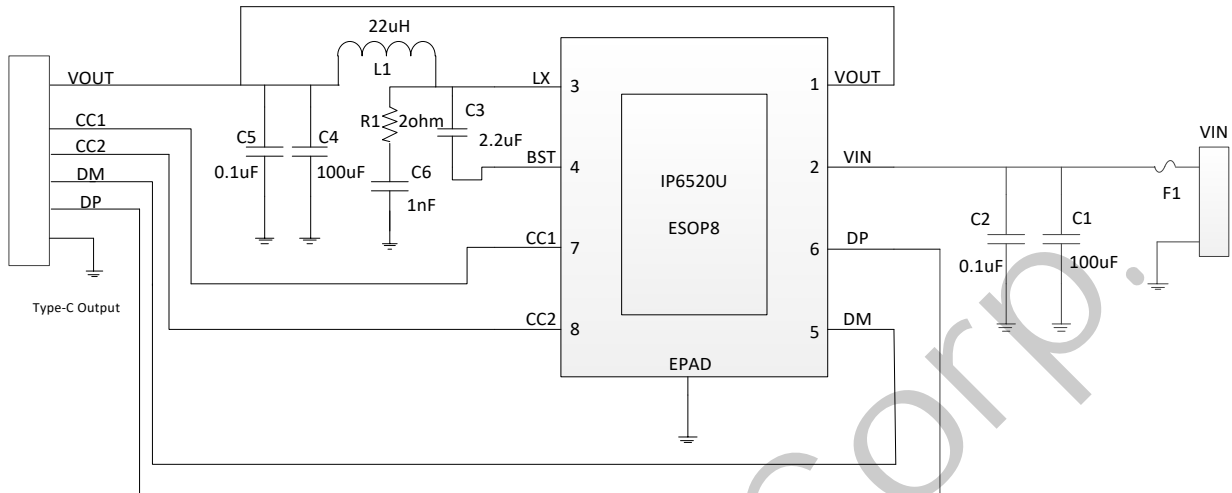


Fig. 7 IP6520U Application Schematic of Single Type-C Port PD Fast Charging Output

Note:

1. The EPAD of the IP6520U must be in good contact with the GND of the PCB;
2. C1 and C2 should be placed close to PIN 2;
3. C5 should be placed close to PIN 1;
4. The RC circuit consisting of R1 and C6 is placed close to PIN3, and the loop consisting of the RC circuit and the IC's LX and PGND should have the smallest area on the PCB;

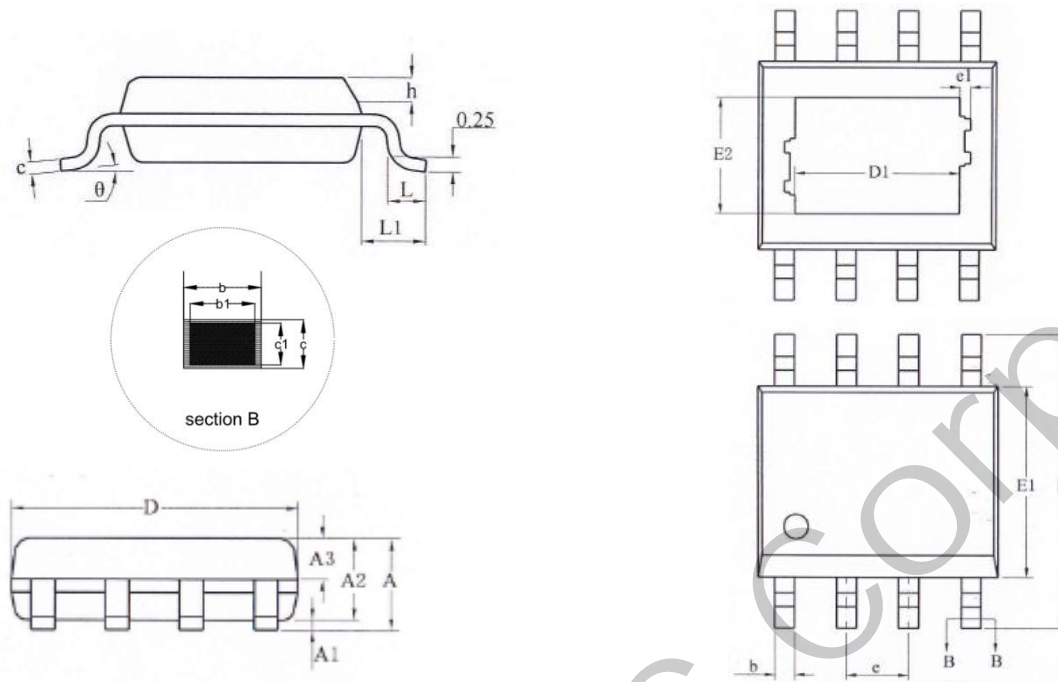
12 BOM

NO.	Device	Spec.	Unit	Counts	Designator	Note
1	IC	IP6520U	PCS	1	U1	
2	electrolytic capacitor	100uF/35V	PCS	1	C1	Rated voltage>35V
3	electrolytic capacitor	100uF/25V	PCS	1	C4	Rated voltage>25V
4	magnetic ring inductor	22uH+/-20%, Nominal current 5A DCR<12mohm	PCS	1	L1	
5	SMD capacitor	0603 2.2uF 10%	PCS	1	C3	Rated voltage>35V
6	SMD capacitor	0603 100nF 10%	PCS	1	C2	Rated voltage>35V, needs to be placed close to the IC PIN.
7	SMD capacitor	0603 100nF 10%	PCS	1	C5	Rated voltage>25V
8	SMD resistor	0603 2ohm 5%	PCS	1	R1	
9	SMD capacitor	0603 1nF 10%	PCS	1	C6	
10	Fuse	F1	PCS	1	F1	4A

13 IP Series Model Selection Table

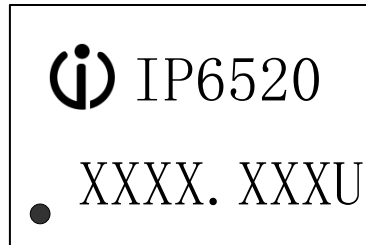
IC Model	Output current	Dual ports	Supported Protocols										Package		
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	Pkg	P2P	
IP6536	2.4A	√	√	-	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
IP6523S_NU	3.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6525TQ	18W	-	√	√	√	√	-	√	-	-	-	-	-	ESOP8	
IP6535	18W	-	√	√	√	√	-	√	-	-	-	-	-	SOP8L	
IP6525T_NU	18W	-	√	√	√	√	-	√	-	-	-	-	-	ESOP8	PIN2PIN
IP6525S_OC	18W	-	√	√	√	√	√	√	-	√	-	-	-	ESOP8	
IP6520	18W	-	√	√	√	√	√	√	√	-	√	-	-	ESOP8	PIN2PIN
IP6520U	18W	-	√	√	√	√	√	√	√	-	√	-	-	ESOP8	
IP6520T	20W	-	√	√	√	√	-	√	-	-	√	-	-	ESOP8	
IP6520T_PPS	20W	-	√	√	√	√	-	√	-	-	√	√	-	ESOP8	
IP6537U_C	18W	-	√	√	√	√	-	√	√	√	√	√	√	QFN24	
IP6529_C	27W	-	√	√	√	√	-	√	-	-	√	√	√	QFN24	
IP6565_CC	20W	√	√	√	√	√	-	√	-	√	√	√	√	QFN32	PIN2PIN
IP6565_AC	20W	√	√	√	√	√	√	√	-	√	√	√	√	QFN32	
IP6538U_AC	27W	√	√	√	√	√	√	√	√	-	√	√	√	QFN32	
IP6551	4.8A	√	√	-	-	-	-	-	-	-	-	-	-	QFN32	
IP6527U_C	27W	-	√	√	√	√	-	√	√	-	√	√	√	QFN32	
IP6559_C	100W	-	√	√	√	√	√	√	-	-	√	√	√	QFN64	
IP6557_C	140W	-	√	√	√	√	√	√	-	-	√	√	√	QFN40	PIN2PIN
IP6557_AC	140W	√	√	√	√	√	√	√	-	-	√	√	√	QFN40	
IP6557_CC	140W	√	√	√	√	√	√	√	-	-	√	√	√	QFN40	

14 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	--

15 Silk Screen Information

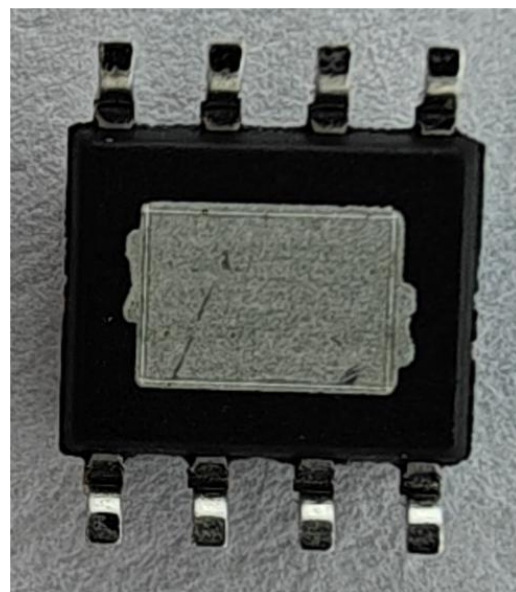


Illustrate:

- 1、 --INJOINIC LOGO
- 2、IP6520 --Product model
- 3、XXXX.XXXU--Production lot number
- 4、● --PIN1 location identification

IP6520U Silk screen instructions

16 Photos of Physical Objects



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