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SOC Output 18W Power with Type-C PD and Fast Charge

Fast Charge Standards: DCP/QC2.0/QC3.0/FCP/AFC/USB PD

1 Features

- **Synchronized Switch Regulator**
 - ✧ Built-in power MOSFET
 - ✧ Input voltage range: 4.5V~32V
 - ✧ Output voltage range: 3V~12V, adjust along with fast charge negotiation
 - ✧ Output power: up to 18W (5V@3.1A, 7V/2.4A, 9V@2A, 12V@1.5A)
 - ✧ Output voltage line compensate: 50mV/A
 - ✧ Output CV/CC characteristic: CV—output current lower than preset value; CC—output current higher than preset value
 - ✧ Conversion efficiency: up to 97%
 - ✧ Soft start function
- **Support Type-C output and USB PD protocol**
 - ✧ Support 5V, 9V, 12V output
- **Fast charge output**
 - ✧ Support BC1.2, Apple, Samsung
 - ✧ Support Qualcomm QC2.0, QC3.0 Support Huawei Fast charge: FCP
 - ✧ Support Samsung fast charge : AFC
- **Multi-protection and high reliability**
 - ✧ Input overvoltage, input under voltage, output short circuit, output overcurrent protection
 - ✧ Whole system over temperature protection
 - ✧ ESD 4KV, DC voltage withstand 48V
- **Package:ESOP8**

2 Applications

- Car Charger
- Fast Charge Adaptor
- Smart Power Strip

3 Description

IP6510 is a synchronized switch buck regulator and support 9 fast charge output standards, support Type-C and PD output, providing solutions for car charger, fast charge adaptor and smart power strip.

IP6510 has built-in power MOSFET, input voltage range is 4.5V to 32V, output voltage ranges from 3V to 12V, and supply up to 18W output power; support voltage and current auto adjust according to the fast charge standard. Typical output voltage and current including: 5V@3.1A, 7V/2.4A, 9V@2A, 12V@1.5A. Power conversion efficiency is up to 97%.

IP6510 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.

IP6510 output voltage support line compensate, the output voltage will be increased along with an increased current, providing compensation on the voltage drop introduced by the wire resistance.

IP6510 support soft start, providing resistibility on the large inrush current during circuit start up.

IP6510 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 IP6510 will adjust the output voltage and current according to the fast charge standard automatically. Supported fast charge standards including: DCP (Apple, Samsung and BC1.2), Qualcomm QC2.0/QC3.0, Samsung fast charge AFC, Huawei FCP, USB PD.

IP6510 support multi-protection on input overvoltage and under voltage, output overcurrent, overvoltage, under voltage and short circuit.

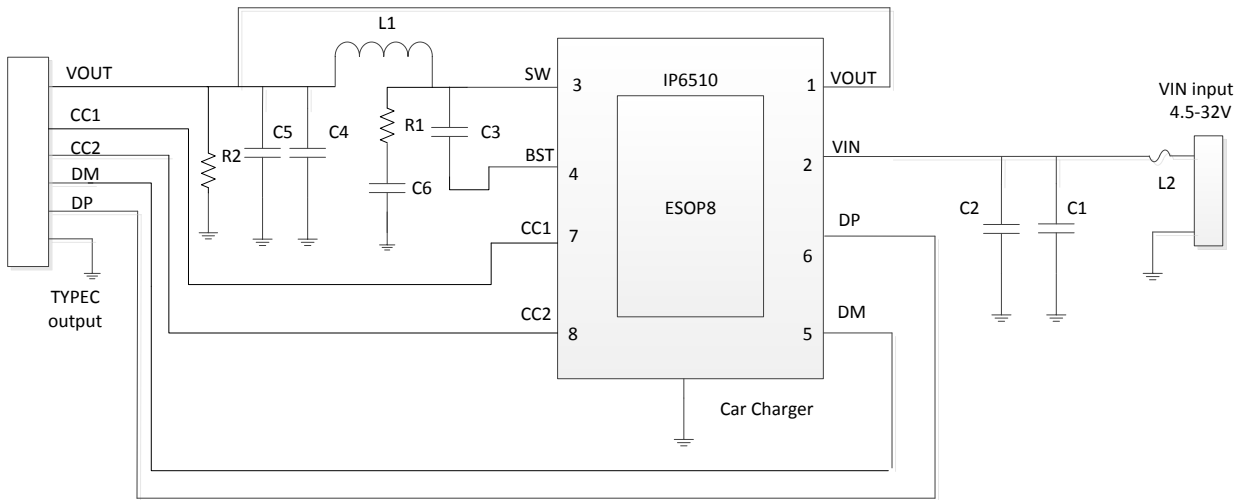


Figure 1 IP6510 simplified application schematic

4 Pin Definition

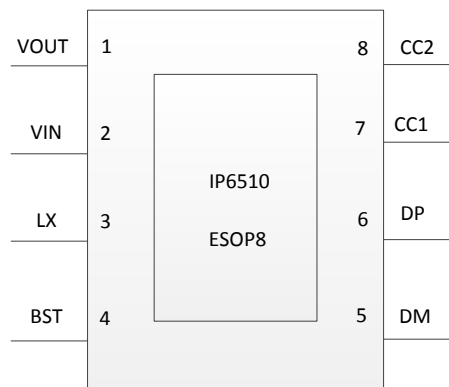


Figure 2 Pin Assignment

PIN List:

Pin		Description
No	Name	
1	VOUT	Output voltage feedback pin
2	VIN	Input voltage, place filter capacitor (22uF recommended) 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

5 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	
IP6502	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	SOP8	PIN2PIN
IP6503	3.1A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6503_2A4	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6503S	3.1A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
IP6503S_2A4	2.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6523S	3.4A	-	√	-	-	-	-	-	-	-	-	-	-	ESOP8	
IP6505	24W	-	√	√	√	√	√	√	√	√	√	-	-	ESOP8	
IP6505T	24W	-	√	√	√	√	√	√	√	√	√	-	-	ESOP8	PIN2PIN
IP6525T	18W	-	√	√	√	√	-	√	-	-	-	-	-	ESOP8	
IP6510	18W	-	√	√	√	√	-	√	-	-	-	√	-	ESOP8	
IP6518C	36W	-	√	√	√	√	√	√	√	√	√	√	-	QFN24	PIN2PIN
IP6518	45W	-	√	√	√	√	√	√	√	√	√	√	-	QFN24	
IP6515	4.8A	√	√	-	-	-	-	-	-	-	-	-	-	QFN32	
IP6528_CC	27W	√	√	√	√	√	-	√	√	-	-	√	√	QFN32	PIN2PIN
IP6528_AC_H	27W	√	√	√	√	√	-	√	√	-	-	√	√	QFN32	
IP6528_AA_H	24W	√	√	√	√	√	-	√	√	-	-	-	-	QFN32	
IP6527_A	24W	-	√	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN
IP6527_C	27W	-	√	√	√	√	-	√	√	-	-	√	-	QFN32	

6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input voltage	V_{IN}	-0.3 ~ 48	V
LX voltage	V_{LX}	-0.3 ~ $V_{IN}+0.3$	V
DM/DP/CC1/CC2 voltage	$V_{DM/DP/CC1/CC2}$	-0.3 ~ 6	V
Junction temperature	T_J	-40 ~ 150	°C
Storage temperature	T_{stg}	-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.

*Voltages are referenced to GND unless otherwise noted.

7 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	4.5	12/24	32	V

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

8 Electrical Characteristics

Unless otherwise specified, $T_A=25^\circ\text{C}$, $L=22\mu\text{H}$, $V_{IN}=12\text{V}$, $V_{out}=5\text{V}$

Parameter	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Input system						
Input voltage	V_{IN}		4.5	12	32	V
Input under voltage threshold	V_{IN-UV}	Rising voltage		4.5		V
		Falling voltage		4		V
Input over voltage threshold	V_{IN-OV}	Rising voltage		34		V
		Falling voltage		32		V
Input quiescent current	I_Q	$V_{IN}=12\text{V}$, $V_{OUT}=5\text{V}@0\text{A}$		2		mA
Standby current	$I_{standby}$	$V_{IN}=10\text{V}$		230		uA
Power switch system						
Upper MOSFET on resistance	$R_{DS(ON)}$			50		mΩ

Lower MOSFET on resistance	$R_{DS(ON)}$			40		mΩ
Switch frequency	F_S			220		KHz
Output system						
Output voltage	V_{OUT}		3	5	20	V
Output voltage ripple	ΔV_{OUT}	VIN=12V, VOUT=5V@3A		120		mV
		VIN=12V, VOUT=9V@2A		120		mV
		VIN=24V, VOUT=12V@1.5A		120		mV
Soft start time	T_{SS}	VIN=12V, VOUT=5V		10		ms
Output line compensate voltage	V_{COMP}	VIN=12V, VOUT=5V, IOU=1A		50		mV
Max current of output CC mode	I_{OUT}	VIN=12V, VOUT≤4V		3.1		A
		VIN=12V, 4V<VOUT≤5V		3.1		A
		VIN=12V, 5V<VOUT≤7V		2.5		A
		VIN=12V, 7V<VOUT≤9V		2		A
		VIN=24V, 9V<VOUT≤12V		1.5		A
Output hiccup restart voltage	V_{OUT}	When output enters CC mode, output hiccup restart voltage		2.7		V
Thermal shutdown temperature	T_{OTP}	Rising temperature		140		°C
Thermal shutdown temperature hysteresis	ΔT_{OTP}			40		°C

9 Function Description

Synchronized switch buck regulator

IP6510 integrate a synchronized switch buck regulator, input voltage ranges from 4.5V to 32V and output from 3V to 12V. The frequency of the switch is 220kHz. When $V_{IN}=12V$, $V_{OUT}=5V@3A$, the power conversion efficiency is 92.5%.

IP6510 support soft start, in avoidance of the inrush current during start up, and the soft start time is 10ms.

IP6510 VIN=12V Efficiency curve

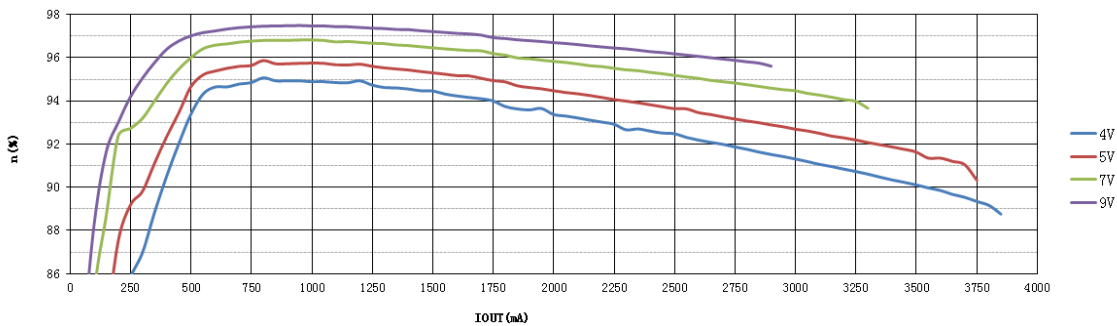


Figure 3 IP6510 Efficiency Curve

IP6510 VIN=12V Output voltage curve

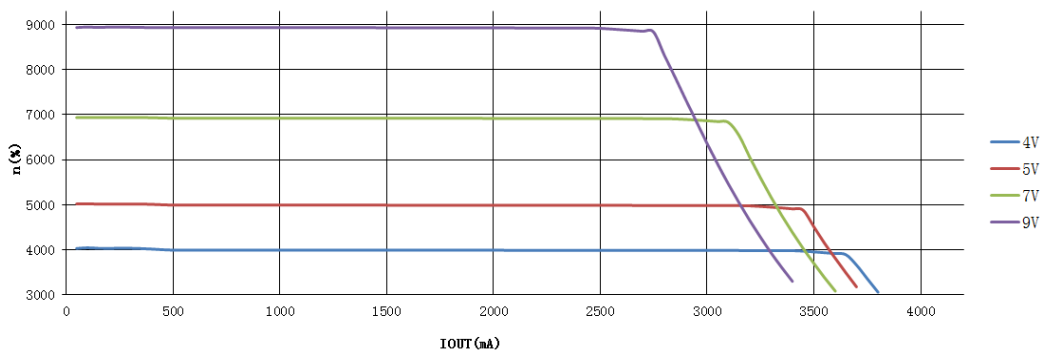


Figure 4 IP6510 VOUT-IOUT curve

Output voltage line compensate

IP6510 support output line compensate, output voltage will increase about 50mV as output current increase

1A.

Output CV/CC characteristic

IP6510 support 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 with decreased output voltage; when the output voltage is lower than 2.7V, output will be shut down and restart with a 2s interval of hiccup.

Protection

IP6510 detect the VIN voltage and enters standby mode when VIN is lower than 4.5V, the output will be shut down during standby mode.

IP6510 support input overvoltage protection; when VIN is above 34V, an overvoltage will be determined output will be shut down; IP6510 will reckon a normal working state and turn on the output only when VIN falls under 32V.

IP6510 support output under voltage protection; IP6510 will enter under voltage state when the VOUT is under 2.7V and shut down the output, after 2sec turn on the output with hiccup.

IP6510 support output short circuit protection, 4ms after start up, if VOUT is lower than 2.7V, output short circuit is determined and output will be shut down.

IP6510 support over temperature, when the chip temperature is higher than 140°C, the output will be shut down; IP6510 will reckon a normal working state and turn on the output only when the temperature falls under 100°C.

Output fast charge standard

IP65100 support several Fast charge output

- ✧ Support BC1.2, Apple, Samsung
- ✧ Support Qualcomm QC2.0, QC3.0
- ✧ Support Huawei Fast charge: FCP
- ✧ Support Samsung fast charge : AFC

Type-C port and USB PD protocol

IP6510 support Type-C output and USB PD protocol, USB PD support output of : 5V/2.4A, 9V/2A, 12V/1.5A.

IP6510 Type-C support several fast charge standards with DP/DM and CC1/CC2 pins, when IP6510 Type-C output 5V, other fast charge request will be accepted and voltage/current will be changed accordingly. But when IP6510 Type-C output non-5V voltage, other fast charge request will be ignored.

10 Typical Application Schematic

Just with inductor, capacitor and resistor peripherals, can IP6510 realize a total solution of car charger.

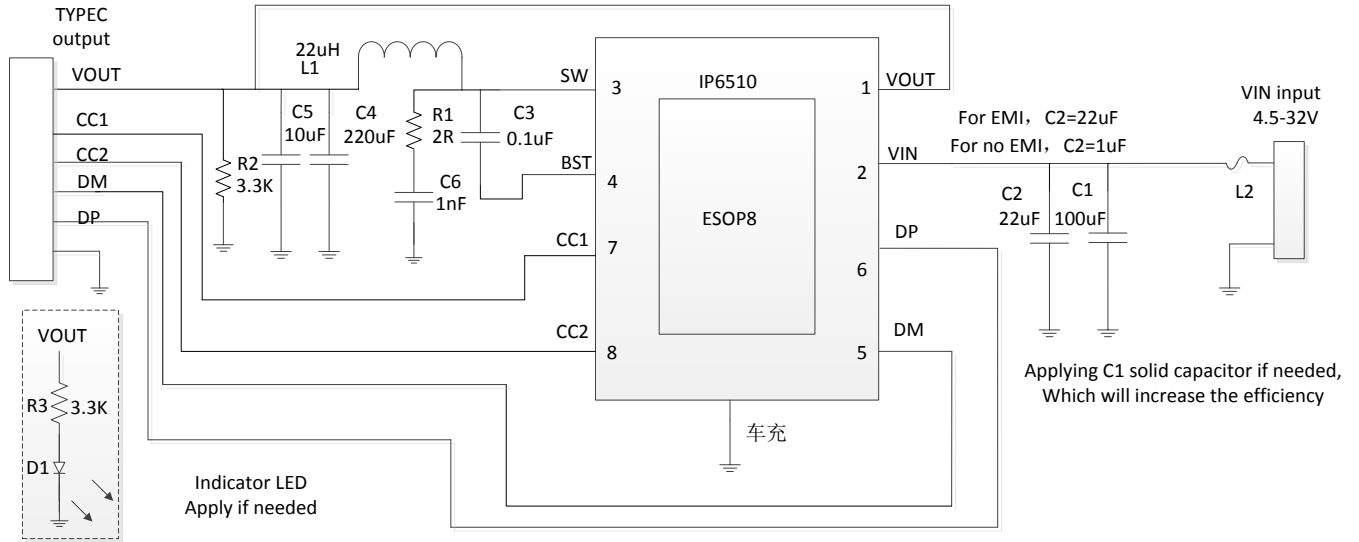


Figure 5 Type-C port PD fast charge output application schematic

11 BOM List

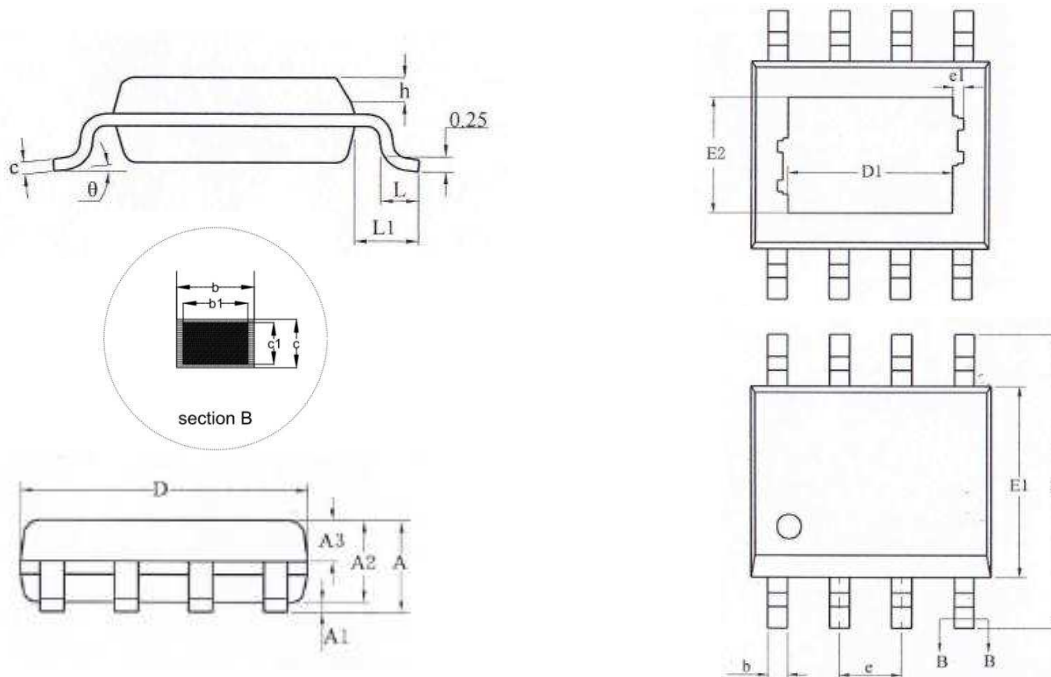
No.	Part Name	Type	Unit	Num.	Location	Note
1	IC	IP6510	PCS	1	U1	
2	SMT resistor	0603 2R 5%	PCS	1	R1	
4	SMT resistor	0603 3.3K 5%	PCS	1	R2、 R3	R3 adjust indicator LED brightness
5	SMT LED	0603	PCS	1	D1	
6	SMT capacitor	0603 1nF 10%	PCS	1	C6	Withstand voltage higher than 25V
7	SMT capacitor	0603 0.1uF 10%	PCS	1	C3	Withstand voltage higher than 10V
8	SMT capacitor	0805 10uF 10%	PCS	1	C5	Withstand voltage higher than 16V
9	SMT capacitor	0805 22uF 10%	PCS	2	C2	Withstand voltage higher than 35V, place near IC pin in layout. For EMI certificate, C2=22uF; otherwise C2=1uF
9	electrolytic capacitor	100uF/35v	PCS	1	C1	Withstand voltage higher than 35V
10	electrolytic capacitor	220uF/25v	PCS	1	C4	Withstand voltage higher than 25V
11	TC-220M-4.5A-CS137125	22uH+/-20%, current 4.5A DCR<12mohm	PCS	1	L1	3L Electronic
12	FUSE	L2	PCS	1	L2	Current 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	4.5	8	

12 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	--

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