IP6505

24W Max Synchronous-Rectified Buck Converter for

DCP/QC2.0/QC3.0/FCP/SCP/AFC/SFCP

1 Features

- **Synchronized Switch Regulator**
  - ✧ Built-in power MOSFET
  - ✧ 48V Input Voltage Surge
  - ✧ Input voltage range: 4.5V~32V
  - ✧ Output voltage range: 3V~12V, Output power: up to 24W
  - ✧ fixed line-compensation
  - ✧ Support CV (Constant Output Voltage) mode & CC(Constant Output Current) mode
  - ✧ Conversion efficiency: up to 97%
  - ✧ Soft start function
- **Fast charge output**
  - ✧ Support BC1.2, Apple, Samsung
  - ✧ Support Qualcomm QC2.0, QC3.0
  - ✧ Support MTK PE+1.1 and MTK PE+2.0
  - ✧ Support Huawei Fast charge: FCP & SCP
  - ✧ Support Samsung fast charge : AFC
  - ✧ Support Spreadtrum fast charge : SFCP
- **Multi-protection and high reliability**
  - ✧ OVP/UVP/OTP/OCP/short circuit protection
  - ✧ ESC 4KV,
- **Package: ESOP8**

2 Applications

- **Car Charger**
- **Fast Charge Adaptor**
- **Smart Power Strip**

3 Description

IP6505 is a Synchronous-Rectified Buck Converter and support 10 fast charge output standards, providing solutions for car charger, fast charge adaptor and smart power strip.

IP6505 has built-in power MOSFET, input voltage range is 4.5V to 32V, output voltage ranges from 3V to 12V, and supply up to 24W output power; support voltage and current auto adjust according to the fast charge standard. Typical output voltage and current including: 4V@3.6A, 5V@3.4A, 7V@3A, 9V@2.5A, 12V@2A. Power conversion efficiency is up to 97%.

IP6505 built-in fixed line-compensation,, the output voltage will be increased along with an increased current, providing compensation on the voltage drop introduced by the wire resistance.

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IP6505 support several fast charge standards, DP/DM support auto distinguish on the fast charge of the accessed devices, and IP6505 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, MTK PE1.1/2.0, Huawei FCP&SCP, Spreadtrum SFCP.

IP6505 support multi-protection on overvoltage protection **and under voltage** protection**, over current** protection**, and short circuit** protection**.**
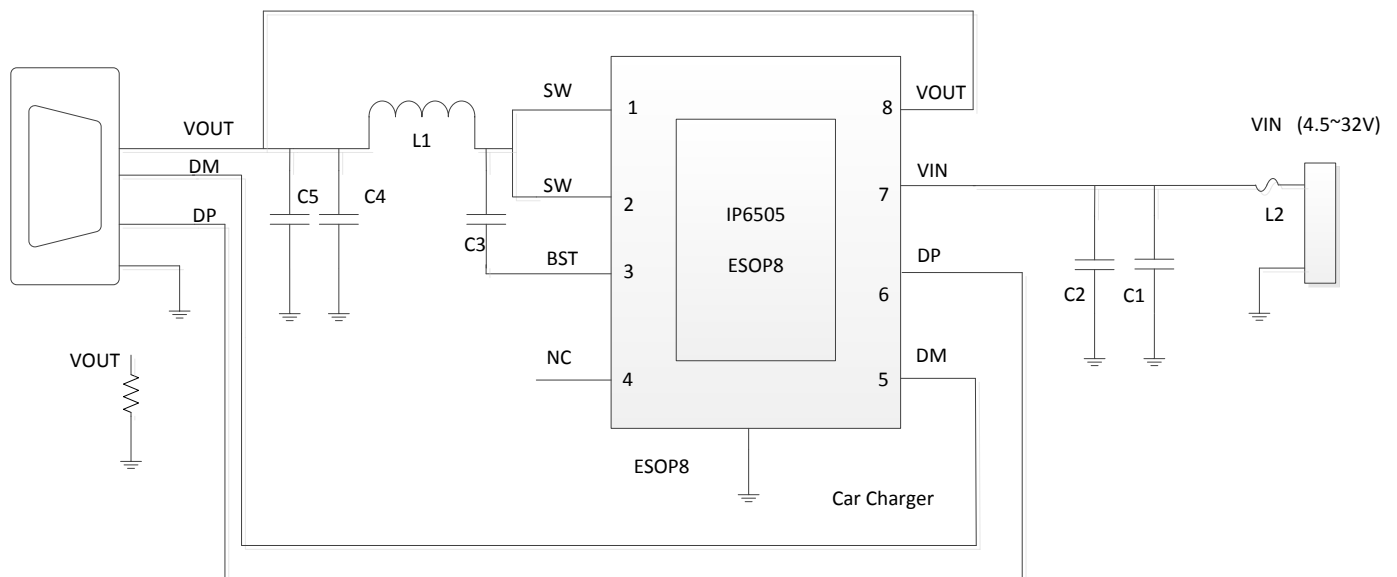
Figure 1   IP6505 simplified application schematic
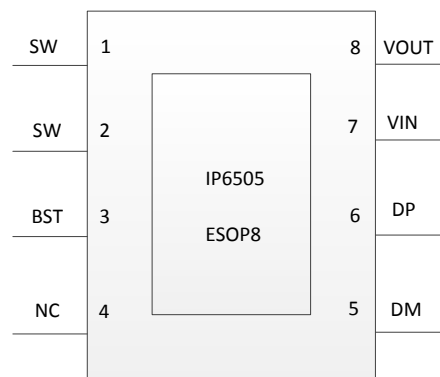
4 Pin Definition

Figure 2 Pin Assignment

PIN list:

Pin		Description
No	**Name**	
1, 2	SW	DCDC switch node, connect to the inductor
3	BST	Boost strap circuit pin, place capacitor close to the BST pin and LX pin, providing drive voltage for the gate of the upper MOSFET
4	NC	Float pin, do not connect
5	DM	Connect to USB DM data line
6	DP	Connect to USB DP data line
7	VIN	Input voltage, place filter capacitor (22uF recommended) near this pin.
8	VOUT	Output voltage feedback
9(EPAD)	GND	Power and heat dissipation ground

5 IP Series Car Charger Products List

IC Part	Charge/ Discharge	Dual ports	Protocols										Package	
			DCP	QC 2.0	QC 3.0	FCP	SCP	AFC	MTK PE	SFCP	PD 2.0	PD3.0 (PPS)	Pkg	P2P
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	27W	√	√	√	√	√	√	√	√	-	√	√	QFN32	
IP6528_AA	24W	√	√	√	√	√	-	√	√	-	-	-	QFN32	

6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input voltage	V_{IN}	-0.3 ~ 48	**V**
LX voltage	V_{LX}	-0.3 ~ VIN+0.3	**V**
DM/DP voltage	$V_{DM/DP}$	-0.3 ~ 6	**V**
VSP/VOUT voltage	$V_{VSP/VSN}$	-0.3 ~ 28	**V**
Junction temperature	T_J	-40 ~ 150	℃
Storage temperature	Tstg	-60 ~ 150	℃
Thermal resistance (junction to ambient)	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

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	V_{IN}	10.5	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℃,L=22uH, VIN=12v, Vout=5v

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	VIN=12V, VOUT=5V@0A		2		mA
Power switch system						
Hi-side MOSFET on resistance	$R_{DS(ON)}$			50		mΩ

Low-side MOSFET on resistance	$R_{DS(ON)}$			40		mΩ
Switch frequency	F_S			200		KHz
Maximum duty ratio	Dmax			100		%
Output system						
Output voltage	V_{OUT}		3	5	12	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, IOUT=1A		50		mV
Max current of output CC mode	I_{OUT}	VIN=12V, VOUT<=4V		3.6		A
		VIN=12V, 4V<VOUT<=5V		3.6		A
		VIN=12V, 5V<VOUT<=7V		3		A
		VIN=12V, 7V<VOUT<=9V		2.5		A
		VIN=24V, 9V<VOUT<=12V		2		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		℃
Thermal shutdown hysteresis	ΔT_{OTP}			40		℃

9 Function Description

Synchronized switch buck regulator

IP6505 integrate a synchronized switch buck regulator, input voltage ranges from 4.5V to 32V and output from 3V to 12V, maximum output current if 4A. The frequency of the switch is 200kHz. When VIN=12V, VOUT=5V@3A, the power conversion efficiency is 93%.

IP6505 can recognize the accessed fast charge standard and adjust the output voltage automatically.

IP6505 support soft start, in avoidance of the inrush current during start up, and the soft start time is 10ms.

IP6505 VIN=12V Efficiency Curve
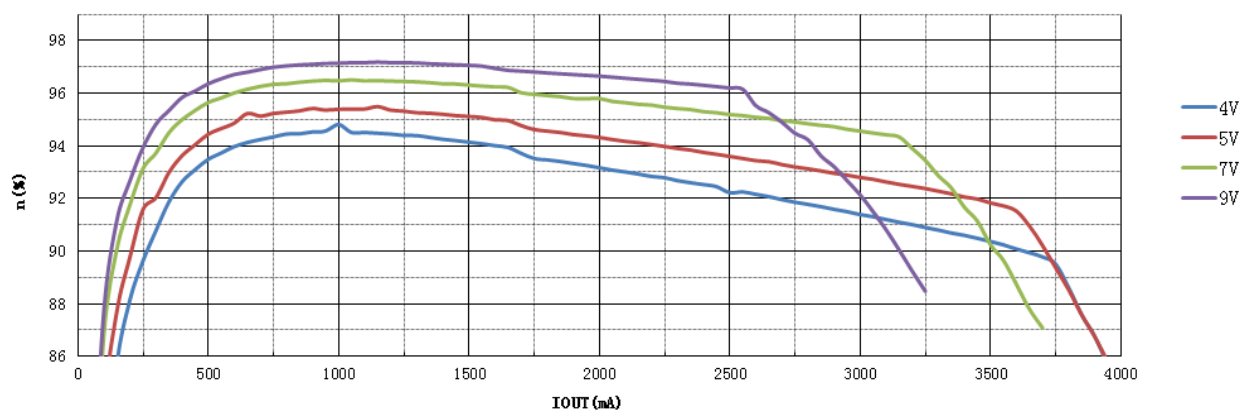
Figure 3   IP6505 Efficiency Curve

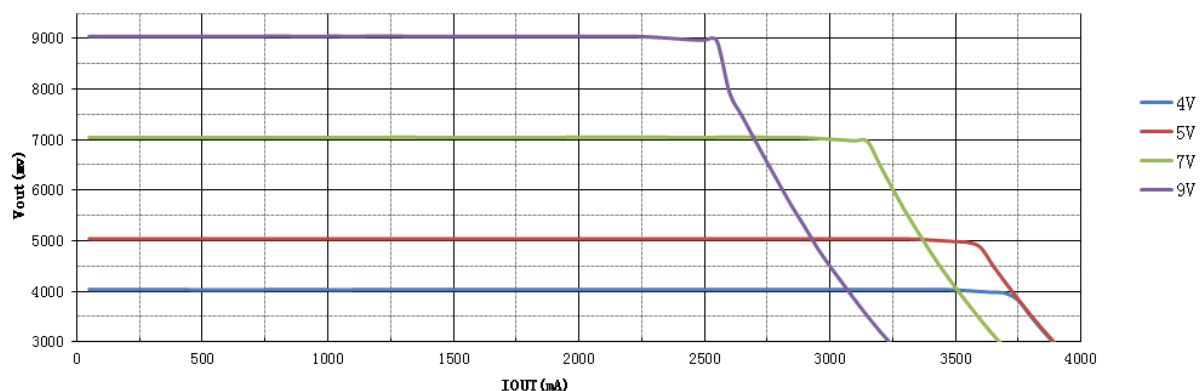## IP6505 VIN=12V Output Voltage Curve

Figure 4   IP6505 Output Voltage Curve

Output voltage line compensate

IP6505 support output line compensate, output voltage will increase 50mV as output current increase 1A.

Output CV/CC characteristic

IP6505 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.

Protection

IP6505 detect the VIN voltage and enters standby mode when VIN is lower than 4V, the output will be shut down during standby mode.

IP6505 support input overvoltage protection; when VIN is above 34V, an overvoltage will be determined output will be shut down; IP6505 will reckon a normal working state and turn on the output only when VIN falls under 32V.

IP6505 support output under voltage protection; IP6505 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.

IP6505 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.

IP6505 support over temperature, when the chip temperature is higher than 140℃, the output will be shut down; IP6505 will reckon a normal working state and turn on the output only when the temperature falls under 100℃.

Output fast charge standard

IP65050 support several Fast charge output
- ✧ Support BC1.2, Apple, Samsung
- ✧ Support Qualcomm QC2.0, QC3.0
- ✧ Support MTK PE+1.1 and MTK PE+2.0
- ✧ Support Huawei Fast charge: FCP&SCP
- ✧ Support Samsung fast charge : AFC
- ✧ Support Spreadtrum fast charge : SFCP

10 Typical Application Schematic

Just with inductor, capacitor and resistor peripherals, can IP6505 realize a total solution of car charger.
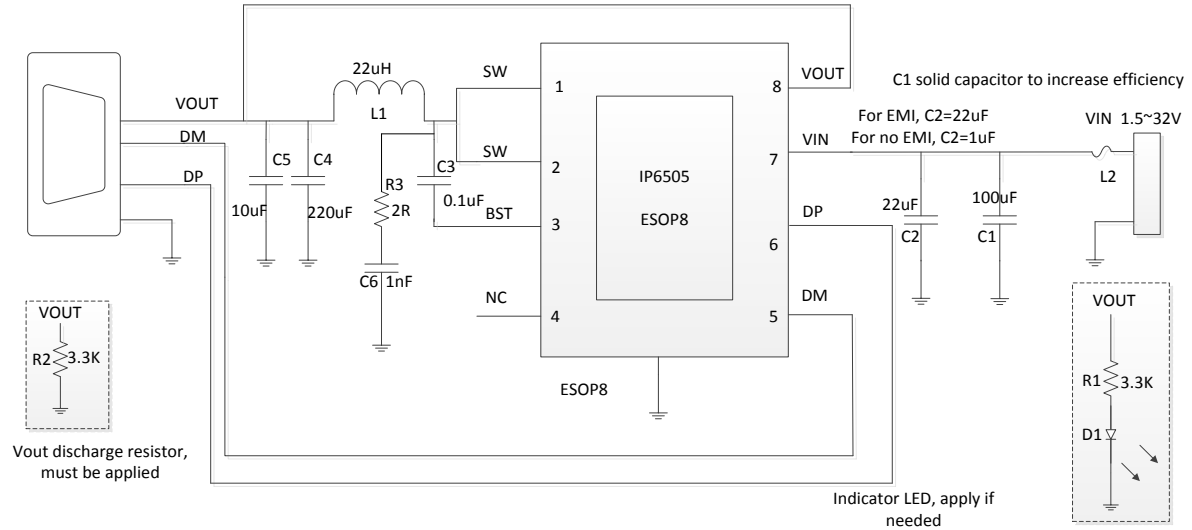

Figure 5   Output application schematic

11 BOM List

No.	Part Name	Type	Unit	Num.	Location	Note
1	IC	IP6505	PCS	1	U1	
2	SMT resistor	0603　3.3K　5%	PCS	1	R1, R2	R1 adjust indicator LED brightness
3	TC-220M-4.5A-CS137125	22uH+/-20%, current 4.5A DCR<12mohm	PCS	1	L1	3L Electronic
4	SMT capacitor	0805　22uF 10%	PCS	2	C2	Withstand voltage higher than 35V, SMT ceramic capacitor is recommended; Place near IC pin in PCB layout; Can be replaced by 1uF if no need for EMI.
5	SMT capacitor	0805　10uF 10%	PCS	1	C5	Withstand voltage higher than 16V
6	SMT LED	0603	PCS	1	D1	
7	SMT capacitor	0603　0.1uF 10%	PCS	1	C3	Withstand voltage higher than 25V
8	electrolytic capacitor	110uF/35v	PCS	1	C1	Withstand voltage higher than 35V C1 solid capacitor to increase efficiency
9	electrolytic capacitor	220uF/25v	PCS	1	C4	Withstand voltage higher than 25V
10	SMT resistor	0603　2R　5%	PCS	1	R3	
11	SMT capacitor	0603　1nF 10%	PCS	1	C6	Withstand voltage higher than 10V
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
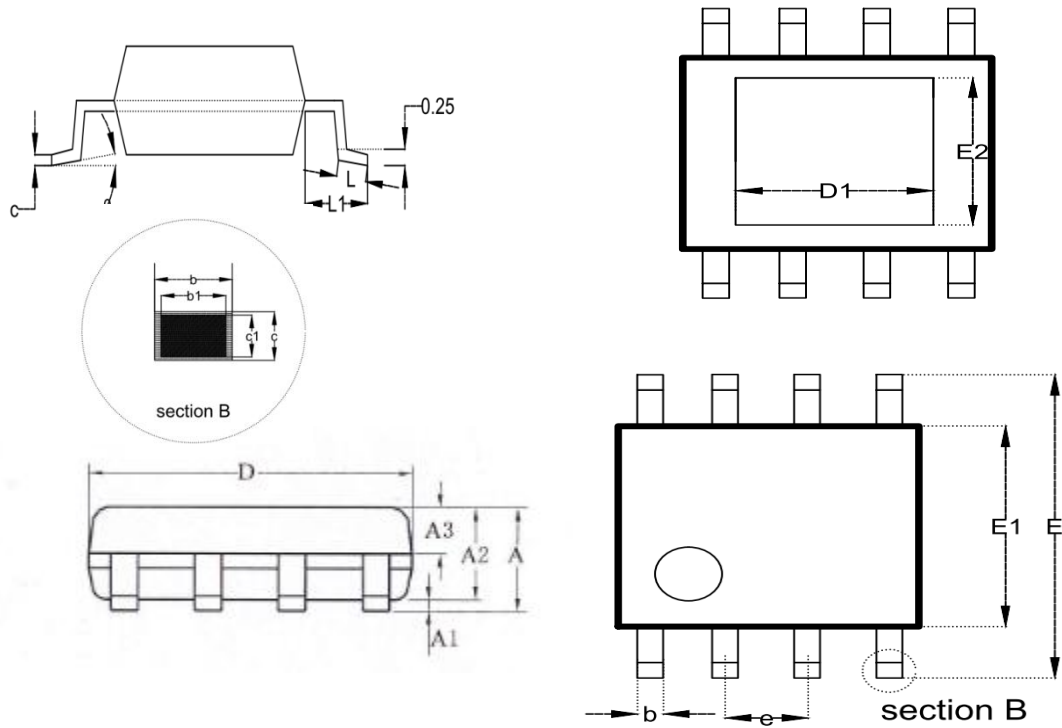
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.48
b1	0.38	0.41	0.43
c	0.21	--	0.25
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.60	0.80
L1	1.05BSC		
θ	0	--	8º
D1	--	2.09	--
E2	--	2.09	--

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