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## 2.4A/3.1A OUTPUT STEP-DOWN CONVERTER with DCP PROTOCOLS

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### 1 Features

- **Synchronous step-down converter**
  - Built-in Power MOSFETs
  - Wide Input Voltage Range, 8V to 32V
  - Output Voltage Range, 5V
  - Output Current, 2.4A/3.1A
  - Output Current Limit Protection
  - Conversion efficiency up to 94%
  - Soft-Start
  - Output Voltage Line Loss Compensation, 50mV@1A
- **Supports DCP(BC1.2, Apple, Samsung)**
- **Multiple Safety Protections**
  - Input Over-Current Protection, Output Over-Current Protection, Input Over/Under Voltage Protection, Short Circuit Protection
  - Over Temperature Protection
  - Input Voltage Withstand up to 40V
  - ESD 4KV

### 2 Application

- **Car Charger**
- **Charge Adapter**
- **Intelligent Power Hub**

### 3 Introduction

IP6503S is a synchronous step-down converter with built-in power MOSFETs. IP6503S supports DCP protocols (BC1.2, Apple and Samsung), providing total solution to car charger, charge adapter and intelligent power hub applications.

IP6503S exhibits CV/CC characteristics. The output in CV mode when the load current lower than current limit, otherwise in CC mode, in which the output voltage decreases as the load current increases.

IP6503S supports output voltage compensation due to the line loss. The output voltage increases at 50mV@1A rate as the load current increases.

IP6503S incorporates soft-start function to prevent the inrush current during start-up.

IP6503S incorporates multiple safety protections, such as input OV/UV, output OV/UV/OC and SC protection.

The package of IP6503S is ESOP8.

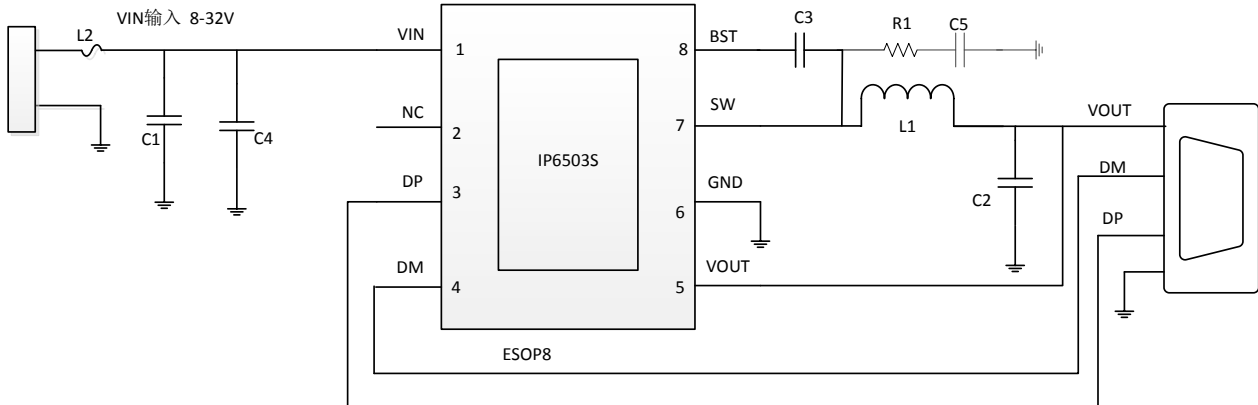


Fig. 1 IP6503S Simplified Schematic

## 4 PIN Definition

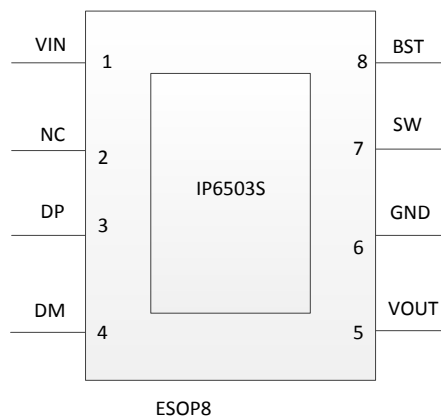


Fig. 2 IP6503S PIN Configuration

NO.	Name	Description
1	VIN	Input voltage node
2	NC	Floating PIN, do not connect
3	DP	Connect to USB DP data line
4	DM	Connect to USB DM data line
5	VOUT	Output voltage feedback node
6	GND	Power ground
7	SW	Switching node of the DC-DC converter
8	BST	Bootstrap capacitor node
9(EPAD)	GND	Power and thermal ground

## 5 Product Selection Table

Product	Max. I <sub>OUT</sub>	Dual output	Protocol										Package		
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)			
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	27W	√	√	√	√	√	√	-	√	√	-	-	-	QFN32	

## 6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input voltage range	$V_{IN}$	-0.3 ~ 40	V
SW voltage range	$V_{SW}$	-0.3 ~ 40	V
DM/DP voltage range	$V_{DM/DP}$	-0.3 ~ 30	V
VOOUT voltage range	$V_{VSP/VSN}$	-0.3 ~ 30	V
Junction Temp range	$T_J$	-40 ~ 150	°C
Storage Temp range	$T_{stg}$	-60 ~ 150	°C
Thermal resistance (junction to ambient)	$\theta_{JA}$	40	°C/W
ESD (HBM)	ESD	4	KV

\* Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. Unless otherwise specified, all voltages are referenced to VSS pin.

## 7 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input voltage	$V_{IN}$	8	12/24	32	V

## 8 Electrical Characteristics

TA=25°C, L=22uH, C<sub>OUT</sub>=220uF E-cap(About 100mΩ ESR), VIN=12V, VOUT=5V, otherwise specified

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
<b>Input System</b>						
Input voltage	V <sub>IN</sub>		8	12	32	V
Input under voltage threshold	V <sub>IN-UV</sub>			8.1		V
		hysteresis		0.3		V
Input over voltage threshold	V <sub>IN-OV</sub>			32		V
		hysteresis		0.2		V
Input quiescent current	I <sub>Q</sub>	VIN=12V, VOUT=5V@0A		1		mA
<b>Converter System</b>						
High side MOSFET on resistance	R <sub>DS(ON)</sub>			100		mΩ
Low side MOSFET on resistance	R <sub>DS(ON)</sub>			80		mΩ
Switching frequency	F <sub>SW</sub>			150		KHz
<b>Output System</b>						
Output voltage	V <sub>OUT</sub>		4.75	5	5.25	V
Output voltage ripple	ΔV <sub>OUT</sub>	VIN=12V, VOUT=5V@3A		150		mV
Soft-start time	T <sub>SS</sub>	VIN=12V, VOUT=5V		10		ms
Line loss compensation	V <sub>COMP</sub>	VIN=12V, VOUT=5V, IOUT=3A		180		mV
Current limit in CC mode	I <sub>OUT</sub>	VIN=12V, VOUT=5V		3.1		A
Output hiccup restart voltage	V <sub>OUT</sub>	When output enters CC mode, output hiccup restart voltage		4		V
Thermal shutdown Temp.	T <sub>OTP</sub>			150		°C
Thermal shutdown Temp. hysteresis	ΔT <sub>OTP</sub>			40		°C

## 9 Detailed Description

### Synchronous Step-Down Converter

The IP6503S is a synchronous step-down converter with built-in power MOSFETs. .IP6503S supports wide input voltage range (8-32V) and 5V output at 3.1A Max. load current. The switching frequency is 150KHz. The conversion efficiency is up to 94% at VIN=12V, VOUT=5V@2A.

The efficiency under different input voltage and load current is shown in Fig. 3. Fig. 4 shows the output voltage characteristics under different load current.

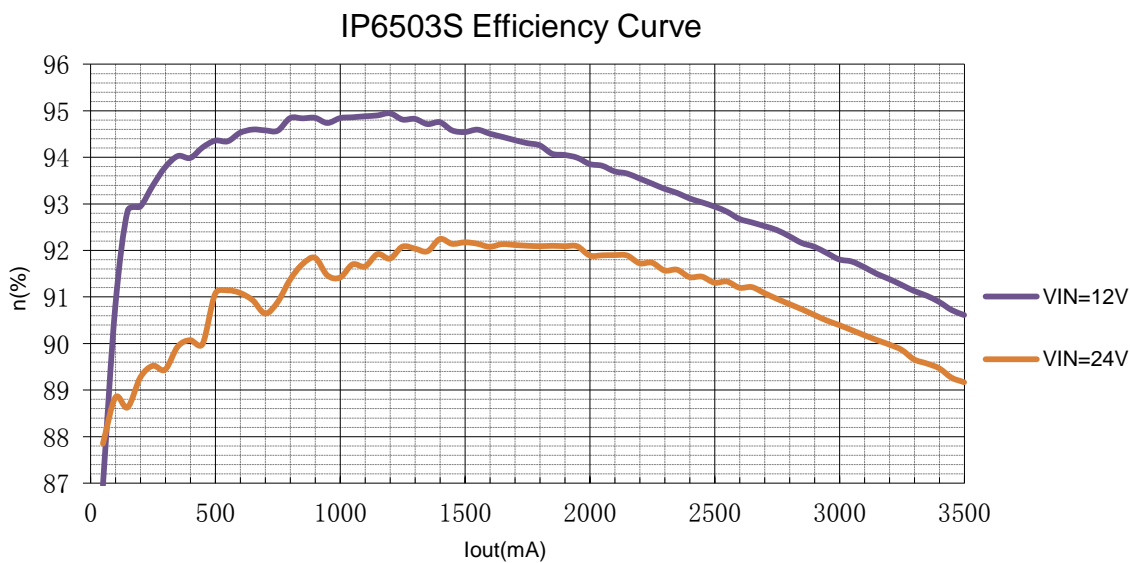


Fig. 3 IP6503S Conversion Efficiency

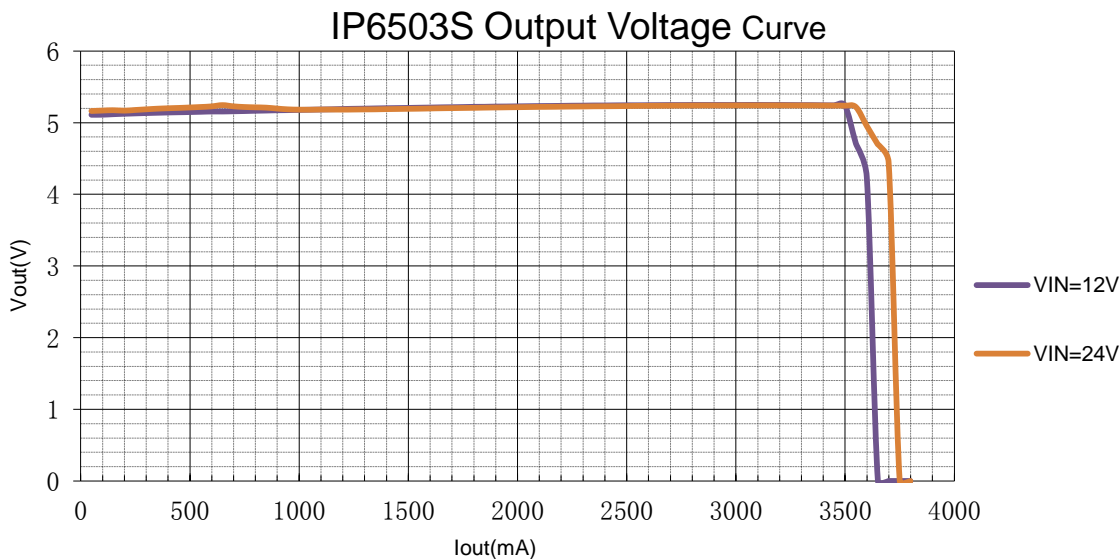


Fig.4 IP6503S Output Voltage Characteristics

## Output Voltage Line Loss Compensation

IP6503S supports output line loss compensation. The output voltage increases at 50mV/1A rate.

## CC/CV Characteristics

IP6503S exhibits CV/CC characteristics. The output in CV mode when the load current lower than current limit, otherwise in CC mode, in which the output voltage decreases as the load current increases.

## Protections

IP6503S monitors voltage on VIN. If the voltage is lower than 8.1V, IP6503S enters standby mode, and shuts down the converter. If the voltage is higher than 32V, IP6503S detects over voltage, and then shuts down the converter. When VIN decreases 0.2V lower than the over voltage threshold, IP6503S resumes the output voltage.

IP6503S also monitors voltage on VOUT. If the voltage is lower than 4V, IP6503S detects output under voltage, and then shuts down the converter. During output under voltage protection, IP6503S enters hiccup mode, and restarts the converter every 2 seconds.

IP6503S incorporates short circuit protection. After 8ms from start-up, if VOUT is lower than 4V, IP6503S detects output short circuit, then shutting down the converter, and enters hiccup mode. IP6503S restarts the converter every 2 seconds.

IP6503S detects over temperature when the chip temperature is higher than 150°C. IP6503S shuts down the converter and restarts the every 2 seconds. When the chip temperature decreases below 110°C, IP6503S returns to normal state.

## Charge Protocols

IP6503S supports DCP (BC1.2, Apple, Samsung).

## 10 Typical Application

Fig.5 shows the typical application schematic.

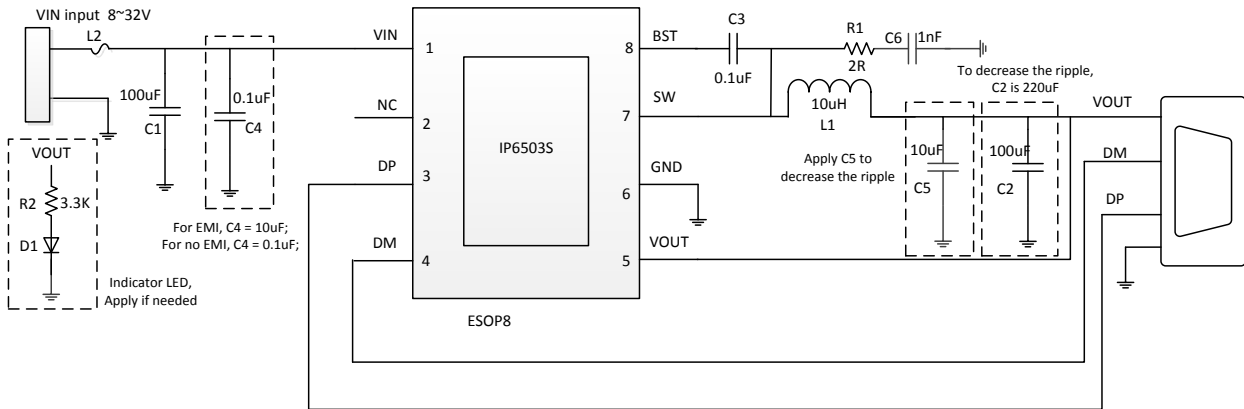


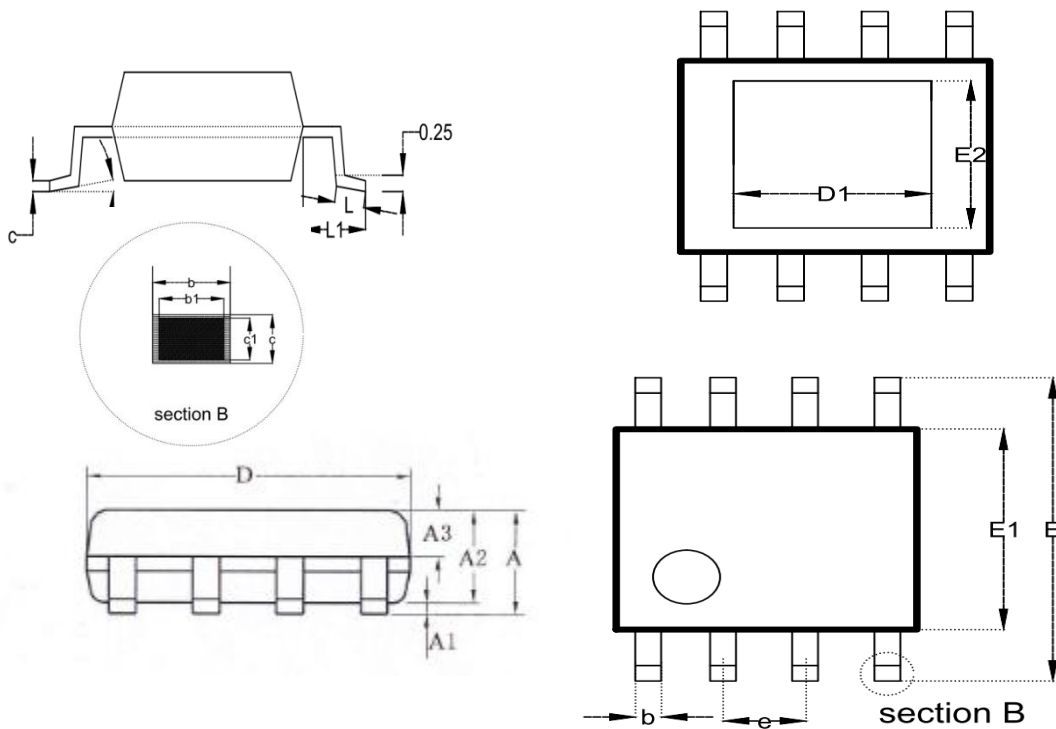
Fig. 5 IP6503S Application Schematic



## 11 BOM

NO.	Device	Spec.	Unit	Counts	Designator	备注
1	IC	IP6503	PCS	1	U1	
2	electrolytic capacitor	100uF/35v	PCS	1	C1	Withstand voltage higher than 35V
3	electrolytic capacitor	100uF/16v	PCS	1	C2	Withstand voltage higher than 16V To decrease ripple, C2 is 220uF
4	SMT capacitor	0603 0.1uF 10%	PCS	1	C3	Withstand voltage higher than 10V
5	SMT capacitor	0603 0.1uF 10%	PCS	1	C4	Withstand voltage higher than 35V For EMI certificate, C4 is 10uF
6	Inductor	10uH+/-20%, current 4.5A DCR<12mohm	PCS	1	L1	
7	SMT resistor	0603 2R 5%	PCS	1	R1	
8	SMT resistor	0603 3.3K 5%	PCS	1	R2	Current-limit resistor for LED indicator
9	SMT capacitor	0603 10uF 10%	PCS	1	C5	Withstand voltage higher than 16V To decrease the ripple, apply C5, otherwise C5 NC.
10	SMT capacitor	0603 1nF 10%	PCS	1	C6	Withstand voltage higher than 35V
11	SMT LED	0603	PCS	1	D1	
12	FUSE	L2	PCS	1	L2	Current 3A

## 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		
$\theta$	0	--	8°
D1	--	2.09	--
E2	--	2.09	--

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