
3.4A OUTPUT STEP-DOWN CONVERTER with DCP PROTOCOLS

1 Features

- **Synchronous step-down converter**
 - Built-in Power MOSFETs
 - Wide Input Voltage Range, 8V to 32V
 - Output Voltage Range, 5V
 - Max. Output Current, 3.4A
 - Input Line Loss Compensation
 - Output Current Limit Protection
 - Conversion efficiency up to 96%
 - Soft-Start
 - Output Voltage Line Loss Compensation, 100mV@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
 - DP/DM Over Voltage Protection
 - Input Voltage Withstand up to 40V
 - ESD 4KV

2 Application

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

3 Introduction

IP6523S is a synchronous step-down converter with built-in power MOSFETs. IP6523S supports DCP protocols (BC1.2, Apple, Samsung), providing total solution to car charger, fast charge adapter and intelligent power hub applications.

IP6523S 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.

IP6523S supports output voltage compensation due to the line loss. The output voltage increases at 100mV@1A rate as the load current increases.

IP6523S incorporates soft-start function to prevent the inrush current during start-up.

IP6523S incorporates multiple safety protections, such as input OV/UV, output OV/UV/OC and SC protection.

The package of IP6523S is ESOP8.

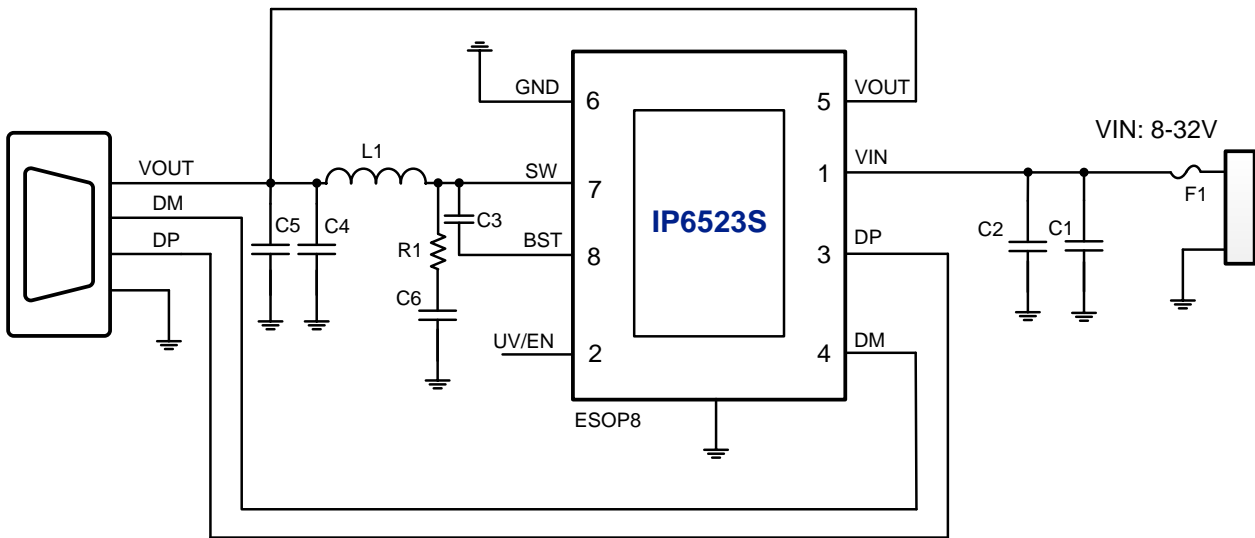


Fig. 1 Simplified Schematic

4 PIN Definition

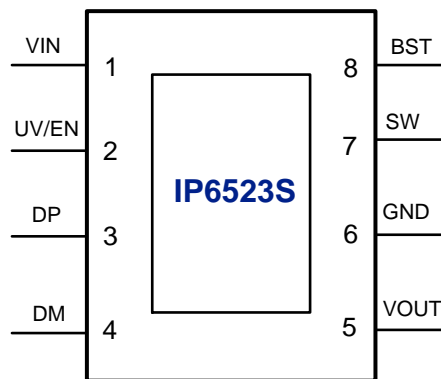


Fig. 2 IP6523S PIN Configuration

NO.	Name	Description
1	VIN	Input voltage node
2	UV/EN	Input under voltage setting/chip enable
3	DP	USB DM terminal for fast charge protocol
4	DM	USB DP terminal for fast charge protocol
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. IP6523S Series Product Introduction

Product	NOTE
IP6523S	PIN2 should be floating, can't connect anywhere.
IP6523S_EN	PIN2 is set to EN function.
IP6523S_UV	PIN2 is set to the line loss compensation function for input undervoltage threshold.

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 ~ 6	V
VOUT voltage range	$V_{VSP/VSN}$	-0.3 ~ 30	V
Junction Temp range	T_J	-40 ~ 150	°C
Storage Temp range	Tstg	-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. 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_{OUT}=220uF E-cap(About 100mΩ ESR), VIN=12V, VOUT=5V, otherwise specified

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input System						
Input voltage	V _{IN}		8	12	32	V
Input under voltage threshold	V _{IN-UV}			8		V
		hysteresis		0.5		V
Input over voltage threshold	V _{IN-OV}			32		V
		hysteresis		0.2		V
Input quiescent current	I _Q	VIN=12V, VOUT=5V@0A		1.5		mA
Converter System						
High side MOSFET on resistance	R _{DS(ON)}			30		mΩ
Low side MOSFET on resistance	R _{DS(ON)}			20		mΩ
Switching frequency	F _{SW}			125		KHz
Output System						
Output voltage	V _{OUT}			5		V
Output voltage ripple	ΔV _{OUT}	VIN=12V, VOUT=5V@3A		135		mV
Soft-start time	T _{SS}	VIN=12V, VOUT=5V		450		us
Line loss compensation	V _{COMP}	VIN=12V, VOUT=5V, IOUT=3A		300		mV
Current limit in CC mode	I _{OUT}	VIN=12V, VOUT≤4V		3.4		A
		VIN=12V, 4V<VOUT≤5V		3.4		A
Hiccup output voltage	V _{OUT}	CC mode		2.6		V
Thermal shutdown Temp.	T _{OTP}			155		°C
Thermal shutdown Temp. hysteresis	ΔT _{OTP}			40		°C

9 Detailed Description

9.1 Synchronous Step-Down Converter

The IP6523S is a synchronous step-down converter with built-in power MOSFETs. IP6523S supports wide input voltage range (9-32V) and 5V output at 3.4A Max. load current. The switching frequency is 125KHz. The conversion efficiency is up to 95.5% at $V_{IN}=12V$, $V_{OUT}=5V@3A$. 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.

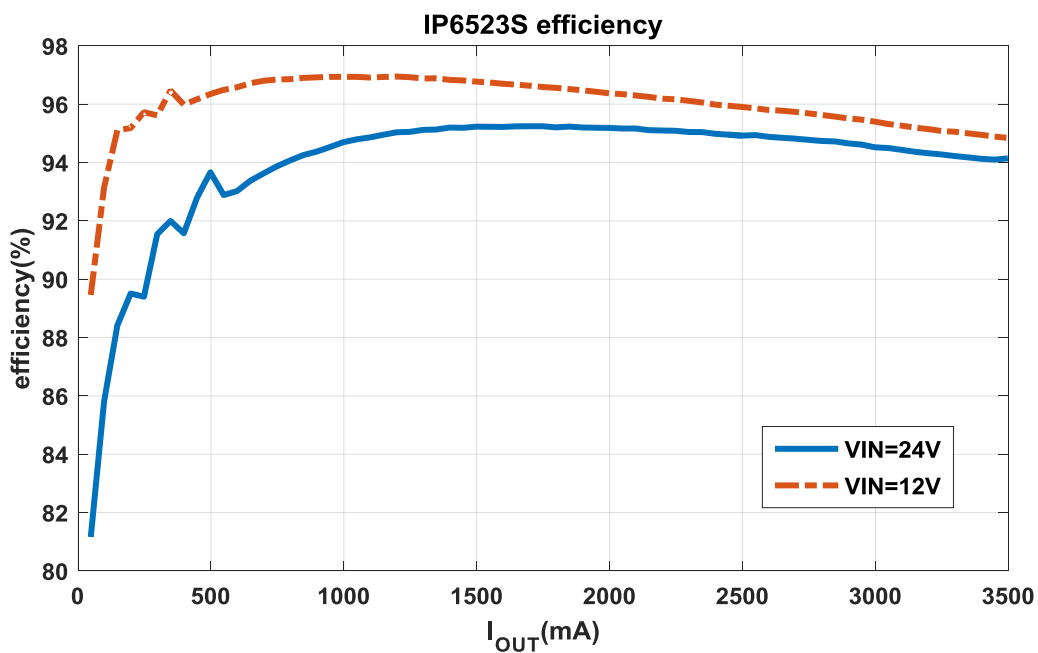


Fig. 3 IP6523S Conversion Efficiency

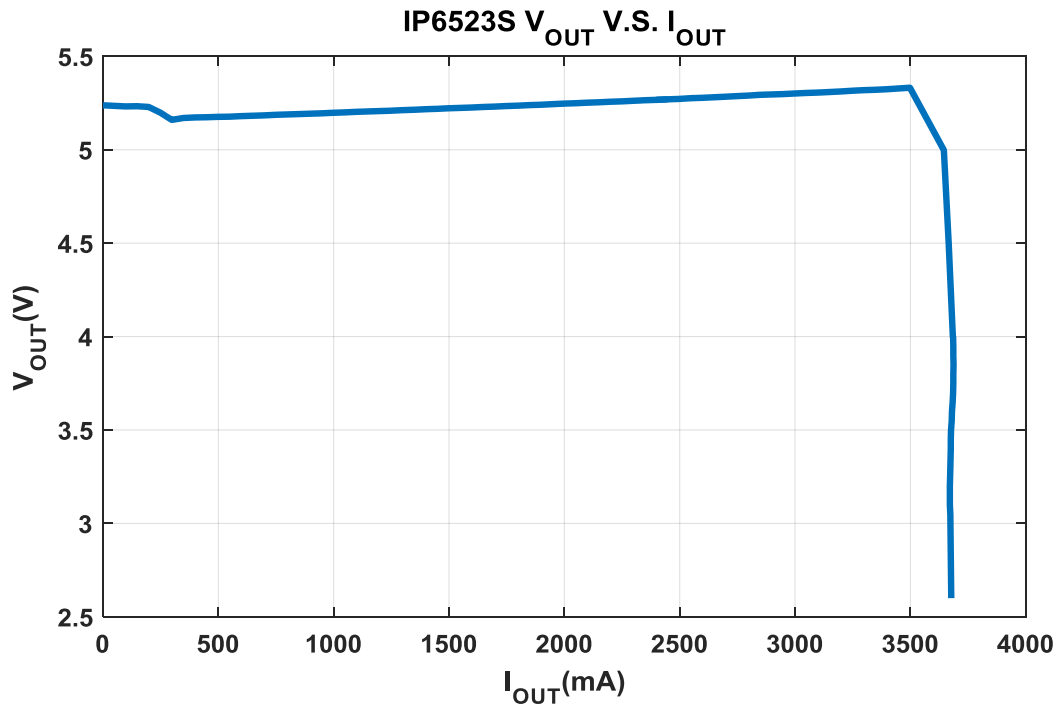


图 4 IP6523S Output Voltage Characteristics

9.2 Output Voltage Line Loss Compensation

IP6523S supports output line loss compensation. The output voltage increases at 100mV/1A rate.

9.3 External Chip Enable Function

PIN-2(UV/EN) can be alternatively used as external chip enable function. Pulling down EN PIN will shut down DC-DC converter. EN PIN cannot be connected to VIN, or else EN PIN will be damaged by high voltage.

9.4 Input Under Voltage Line Loss Compensation

PIN-2 can be alternatively used as input under voltage line loss compensation. IP6523S adjusts UV threshold based on the resistor value connected on the UV PIN. The following table shows the relation between resistor value and the corresponding voltage that UV threshold to be decreased by.

Line Impedance (ohm)	UV Resistor Value (ohm)	UV Voltage to be Decreased by at 1A
0.2	floating	0.2V
0.6	300K	0.6V
1.0	200K	1.0V
1.4	130K	1.4V

1.6	30K	1.6V
1.8	15K	1.8V

9.5 CC/CV Characteristics

IP6523S 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.

9.6 Protections

IP6523S monitors voltage on VIN. If the voltage is lower than 8V, IP6523S enters standby mode, and shuts down the converter. If the voltage is higher than 32V, IP6523S detects over voltage, and then shuts down the converter. When VIN decreases 0.2V lower than the over voltage threshold, IP6523S resumes the output voltage.

IP6523S also monitors voltage on VOUT. If the voltage is lower than 2.5V, IP6523S detects output under voltage, and then shuts down the converter. During output under voltage protection, IP6523S enters hiccup mode, and restarts the converter every 2 seconds.

IP6523S incorporates short circuit protection. After 8ms from start-up, if VOUT is lower than 2.6V, IP6523S detects output short circuit, then shutting down the converter, and enters hiccup mode. IP6523S restarts the converter every 2 seconds.

IP6523S detects over temperature when the chip temperature is higher than 155°C. IP6523S shuts down the converter and restarts the every 2 seconds. When the chip temperature decreases below 125°C, IP6523S returns to normal state.

9.7 Fast Charge Protocols

IP6523S supports DCP (BC1.2, Apple, Samsung).

10 Typical Application

Fig.5 shows the typical application schematic.

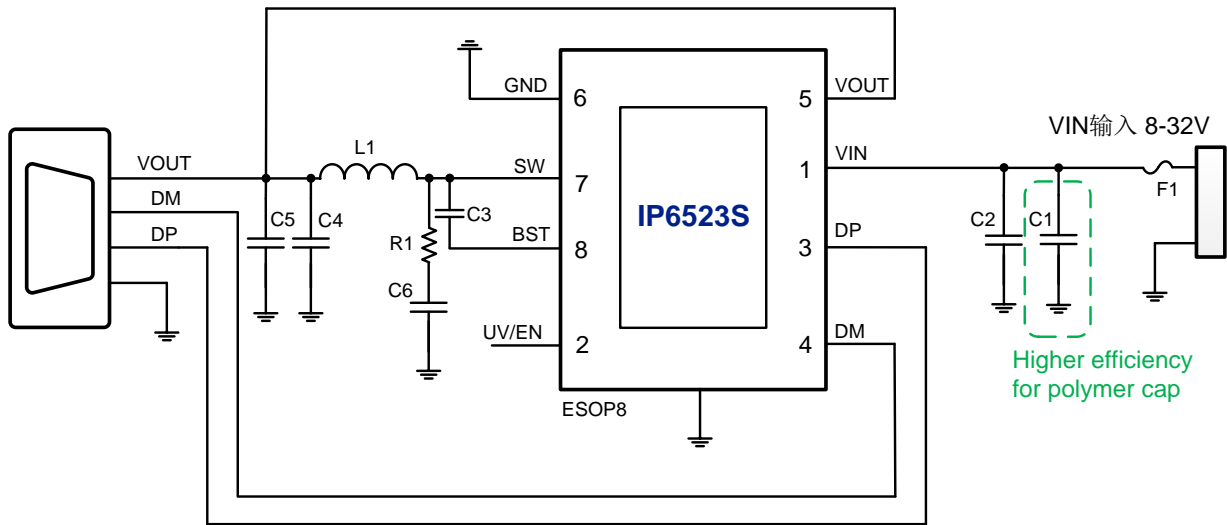


Fig. 5 IP6523S Application Schematic

Notes:

1. IP6523S EPAD must have a good contact with PCB GND;
2. DCDC conversion efficiency can be improved if polymer capacitors are used for C1.

11 BOM

NO.	Device	Spec.	Unit	Counts	Designator	备注
1	IC	IP6523S	PCS	1	U1	
2	electrolytic capacitor	100uF/35V	PCS	1	C1	Rated voltage>35V. Higher efficiency for polymer cap.
3	electrolytic capacitor	220uF/25V	PCS	1	C4	Rated voltage>25V
4	TC-220M-4.5 A-CS137125	22uH+/-20%, Nominal current 4.5A DCR<12mohm	PCS	1	L1	3L Electronic
5	ceramic capacitor	0603 100nF 10%	PCS	1	C2	Rated voltage>35V. Close to IC PIN.
6	ceramic capacitor	0603 100nF 10%	PCS	2	C3 C5	Rated voltage>16V
7	resistor	0603 2ohm 5%	PCS	1	R1	
8	ceramic capacitor	0603 1nF 10%	PCS	1	C6	
9	fuse	F1	PCS	1	F1	Nominal current>4A

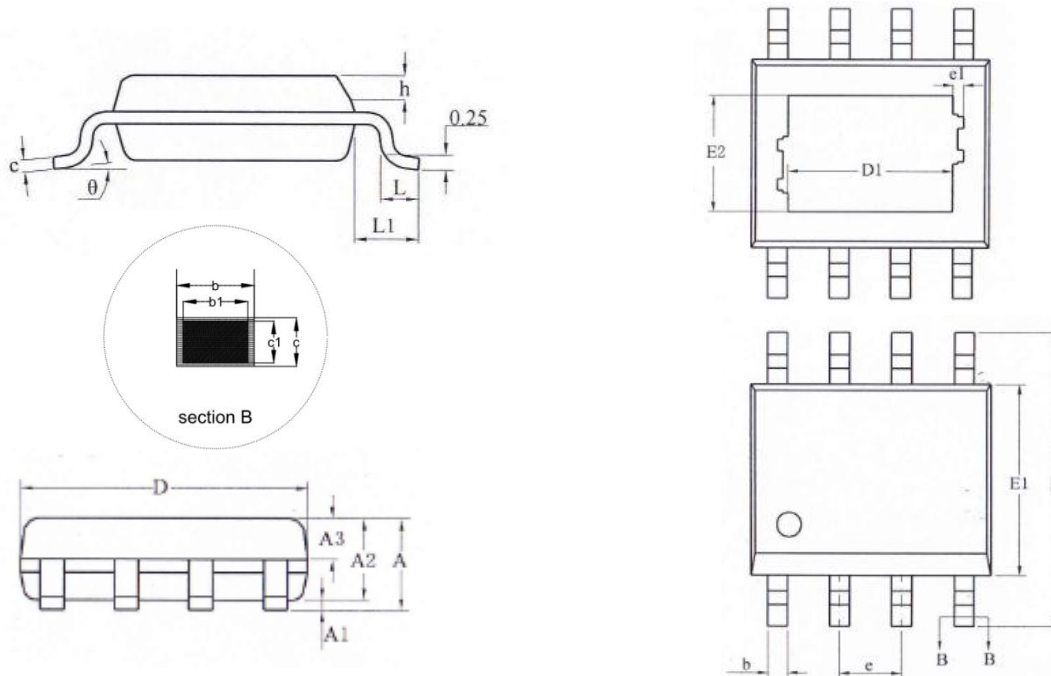
Recommended inductor: TC-220M-4.5A-CS137125

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.IP Series IC 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_N	3.4A	-	√	-	-	-	-	-	-	-	-	-	ESOP8	
IP6505	24W	-	√	√	√	√	√	√	√	√	-	-	ESOP8	
IP6505T	24W	-	√	√	√	√	√	√	√	√	-	-	ESOP8	PIN2PIN
IP6525T_N	18W	-	√	√	√	√	-	√	-	-	-	-	ESOP8	
IP6510	18W	-	√	√	√	√	-	√	-	-	√	-	ESOP8	
IP6518C	36W	-	√	√	√	√	√	√	√	√	√	-	QFN24	PIN2PIN
IP6518	45W	-	√	√	√	√	√	√	√	√	√	-	QFN24	
IP6515	4.8A	√	√	-	-	-	-	-	-	-	-	-	QFN32	
IP6538_CC	27W	√	√	√	√	√	-	√	√	-	√	√	QFN32	PIN2PIN
IP6538_AC	27W	√	√	√	√	√	-	√	√	-	√	√	QFN32	
IP6538_AA	24W	√	√	√	√	√	-	√	√	-	-	-	QFN32	
IP6527_A	24W	-	√	√	√	√	√	√	√	-	-	-	QFN32	PIN2PIN
IP6527_C	27W	-	√	√	√	√	-	√	√	-	√	-	QFN32	

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		
theta	0	--	8°
D1	--	3.10REF	--
E2	--	2.21REF	--

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