Maximum output 24W, SOC IC integrating various fast charging protocols (DCP/QC2.0/QC3.0/MTK PE1.1/PE2.0/FCP/SCP/AFC/SFCP)

1. Characteristics

- **Synchronous Switching Buck Converters**
  - Built-in Power MOS
  - Input Voltage Range: 4.5V to 32V
  - Output voltage Range: 3v to 12V, Automatically adjusted according to the fast charging protocol
  - Output power 24W Max (4V@3.6A, 5V@3.4A, 9V@2.5A, 12V@2A)
  - Output voltage cable compensation
  - The output has CV/CC characteristics (if output current is less than the set value, CV mode is enabled. If the output current is greater than the set value, CC mode is enabled)
  - Up to 97% conversion efficiency
  - Soft start function
- **Fast Charging Output**
  - Supports BC 1.2, Apple, and Samsung protocols
  - Supports Qualcomm QC2.0 and QC3.0 (Certification No. 4788120153-2)
  - Supports MTK PE1.1/PE2.0
  - Supports Huawei FCP
  - Supports Huawei SCP
  - Supports Samsung AFC
  - Supports Spreadtrum SFPC
- **Multiple protections, high reliability**
  - Output overcurrent, input overvoltage, input permanent overvoltage, output short-circuit protections
  - Over temperature protection
  - ESD protection: 4kV, DC withstand voltage: 48V

2. Applications

- **Car chargers**
- **Fast Charge Adapter**
- **Smart Socket**

3. Introduction

IP6505 is a buck converter with integrated synchronous switch, which supports 11 output fast charging protocols to provide a complete solution for car chargers, fast charging adapters, and smart power strips.

IP6505 has built-in power MOS, the input voltage range is 4.5V to 32V, the output voltage range is 3V to 12V, the maximum output power is 24W, and the output voltage and current can be automatically adjusted according to the recognized fast charging protocol.

Typical output voltage and current: 4V@3.6A, 5V@3.4A, 7V@3A, 9V@2.5A, 12V@2A.

The step-down conversion efficiency of IP6505 is as high as 97%.

The output of IP6505 has CV/CC characteristics. If the output requirement is less than the set value, it operates in constant voltage mode. If the output current is greater than the set requirement, the output voltage is reduced and it operates in constant current mode.

The output of IP6505 has a cable compensation function. When the output current increases, the output voltage will be increased correspondingly to compensate for the voltage drop due to the impedance of the connecting cable.

IP6505 has a soft start function which can prevent inrush current from affecting the stability of the power supply.

IP6505 integrates various fast charging protocols, and can automatically identify the fast charging protocols supported by the device connected to the output terminal through DP/DM, and then automatically adjust the output voltage and current. The fast charging protocols supported byIP6505 are: DCP (Apple, Samsung and BC1.2), Qualcomm QC2.0/QC3.0, MTK PE1.1/2.0, Huawei Fast Charging Protocol FCP/SCP, Samsung Fast Charging Protocol AFC, Spreadtrum Fast Charge Protocol SFCP.

IP6505 has a variety of protection functions with input overvoltage, undervoltage protection output overcurrent, overvoltage, undervoltage, short circuit protection and other functions. IP6505 adopts ESOP8 package.
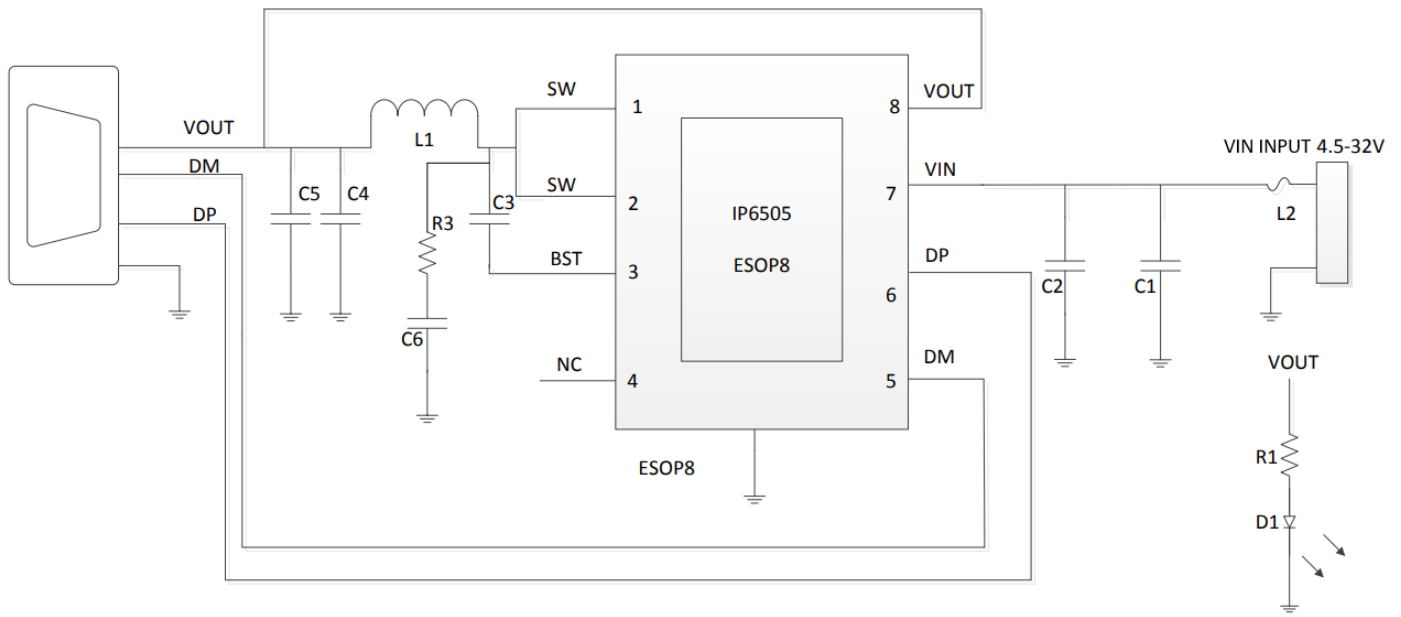
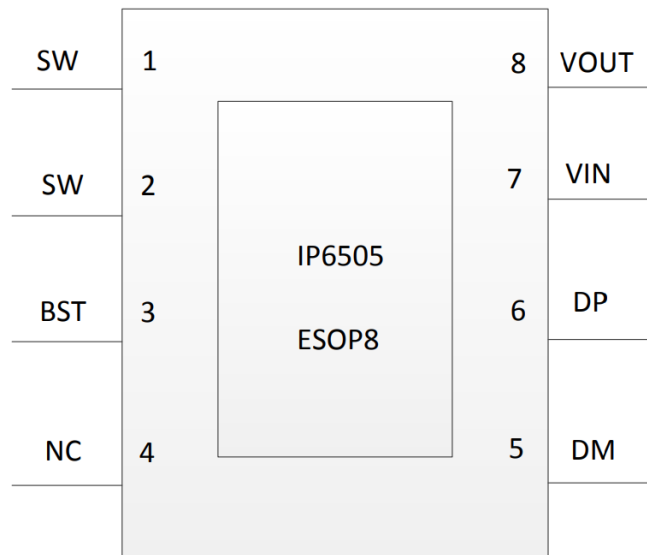Figure 1 IP6505 Simplified application schematic

4. Pin definitions

Figure 2 IP6505 Pin diagram

Number	Name	Description
1/2	SW	DC-DC Switch mode inductor connection
3	BST	The bootstrap circuit pins are placed close to the chip BST pin and LX pin to place the bootstrap capacitor to provide voltage for the upper gate drive
4	NC	Leave pin floating, do not connect anywhere
5	DM	USB Fast charging identification signal DM (D- / D minus)
6	DP	USB Fast charging identification signal DP (D+ / D Plus)
7	VIN	Input voltage pin. Filter capacitor needs to be close to the IC, 22µF recommended.
8	VOUT	Output voltage feedback pin
9 (EPAD)	GND	Power ground and cooling ground. Need to keep good contact with GND.

5. IP Series car charger IC model selection table

IC Model	Output Current/Power	2 Way	Supported Protocols										Package	
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	Specificiaton	Compatibility
IP6502	2.4A	-	√	-	-	-	-	-	-	-	-	-	SOP8	PIN2PIN
IP6503	3.1A	-	√	-	-	-	-	-	-	-	-	-	ESOP8	PIN2PIN
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

Parameter	Symbol	Value	Unit
Input voltage range	V_{IN}	-0.3 ~ 48	**V**
LX Voltage Range	V_{LX}	-0.3 ~ V_{IN}+0.3	**V**
DM/DP Voltage range	$V_{DM/DP}$	-0.3 ~ 6	**V**
VOUT voltage range	$V_{VSP/VSN}$	-0.3 ~ 28	**V**
Junction temperature range	T_J	-40 ~ 150	**°C**
Storage temperature range	T_{stg}	-60 ~ 150	**°C**
Thermal Resistance (Junction Temperature to Ambient)	Θ_{JA}	40	**°C/W**
Human Body Model (HBM)	ESD	4	**kV**

* Stresses outside the values listed in the Absolute Maximum Ratings section can impair the durability of the device. Excessive exposure to any of the Absolute Maximum Ratings conditions may affect device reliability and service life.

7. Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Input Voltage	V_{IN}	4	12/24	32	V

* Device operating characteristics are not guaranteed outside these operating conditions.

8. Electrical Characteristics

Unless otherwise specified, TA=25°C, L = 22μH, VIN = 12V, VOUT = 5V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input System						
Input Voltage	V_{IN}		4.5	12	28	V
Undervoltage threshold	V_{IN-UV}	Rising voltage		4.5		V
		Falling voltage		4		V
Overvoltage threshold	V_{IN-OV}	Rising voltage		34		V
		Falling voltage		32		V
Input quiecsent current	I_Q	VIN=12V, VOUT=5V@0A		2		mA
Switchmode Power Supply						
Transistor High on-resistance	$R_{DS(ON)}$			50		mΩ
Transistor Low on-resistance	$R_{DS(ON)}$			40		mΩ
Operating frequency	F_S			200		kHz
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
		Note: Typical test values from the Demo board reference design				
Soft Start Time	T_{SS}	VIN=12V, VOUT=5V		10		ms
Output line compensation voltage	V_{COMP}	VIN=12V, VOUT=5V, IOUT=1A		50		mV
CC Mode Maximum Output Current	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=12V, 9V<VOUT<=12V		2		A
Output Hiccup Restart Voltage	V$_{OUT}$	Restart voltage after interruption by CC Mode(?)		2.7		V
Thermal Shutdown Temperature	T$_{OTP}$	Rising temperature		140		°C
Thermal Shutdown Temperature Hysteresis Band	ΔT$_{OTP}$			40		°C

9. Functional Description

Synchronous Switching Buck Converters

The IP6505 integrates a synchronous switching buck converter. The input voltage range is 4.5V~32V, the output voltage range is 3V~12V, and the maximum output current is 4A. IP6505 has a built-in power switch transistor, and the switching frequency during operation is 200kHz. The conversion efficiency is 93% at VIN = 12V, VOUT = 5V @ 3A.
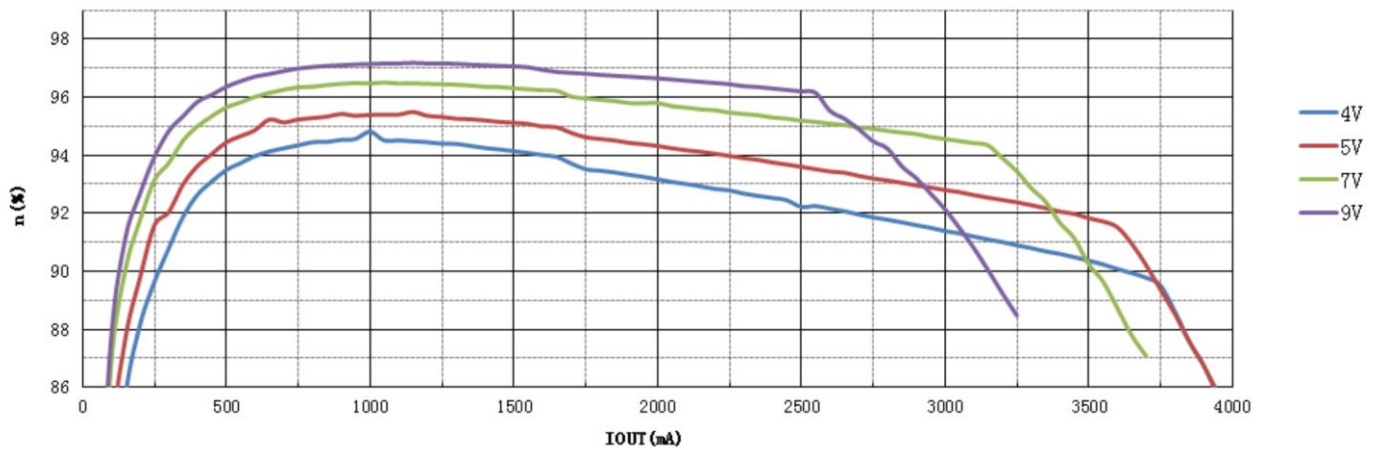
IP6505 VIN = 12V Efficiency curve

Figure 3 IP6505 Efficiency Curve

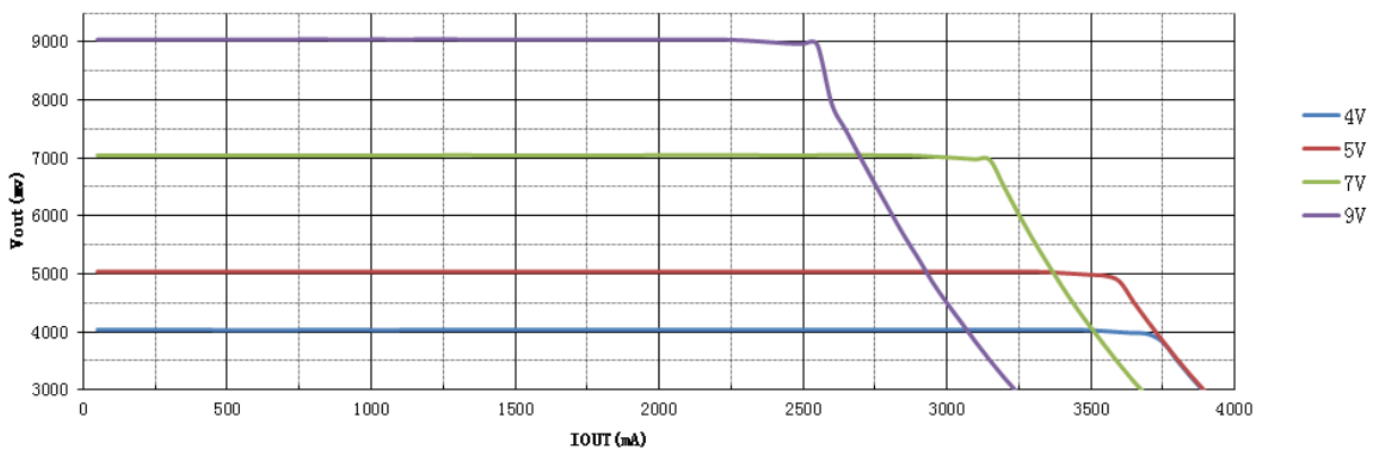IP6505 VIN = 12V Output voltage curve

Figure 4 IP6505 Output voltage curve

Output Voltage Line Compensation

For every 1A increase in output current, the output voltage will increase by 50mV.

Output CC/CV Characteristics

The output of the IP6505 has CC/CV characteristics. When the output current is less than the set value, it operates in CV mode. When the output current is greater than the set value, it operates in CC mode.

Protective Functions

IP6505 monitors the VIN voltage. If VIN < 4V, IP6505 will turn off the output and enter standby mode.

IP6505 has input overvoltage protection. When VIN rises above 34V, IP6505 detects input overvoltage and shuts down the output. When VIN drops to 32V, IP6505 will re-enable the output.

IP6505 has output undervoltage protection. When VOUT drops to 2.7V for a short time, IP6505 detects the undervoltage condition, turns off the output, and restarts after 2s.

IP6505 has short circuit protection. If the VOUT voltage is <2.7V 4ms after starting, IP6505 considers the output short-circuited and disables the output.

IP6505 has over temperature protection. When IP6505 detects the chip temperature has reached 140°C, it will turn off the output; when the temperature drops to 100°C the output is re-enabled.

Output Fast Charging Protocol

IP6505 supports multiple fast charging protocols:

- o Supports BC 1.2, Apple, and Samsung protocols
- o Supports Qualcomm QC2.0 and QC3.0 (Certification No. 4788120153-2)
- o Supports MTK PE1.1/PE2.0
- o Supports Huawei FCP
- o Supports Huawei SCP
- o Supports Samsung AFC
- o Supports Spreadtrum SFPC

10. Typical Application Circuit

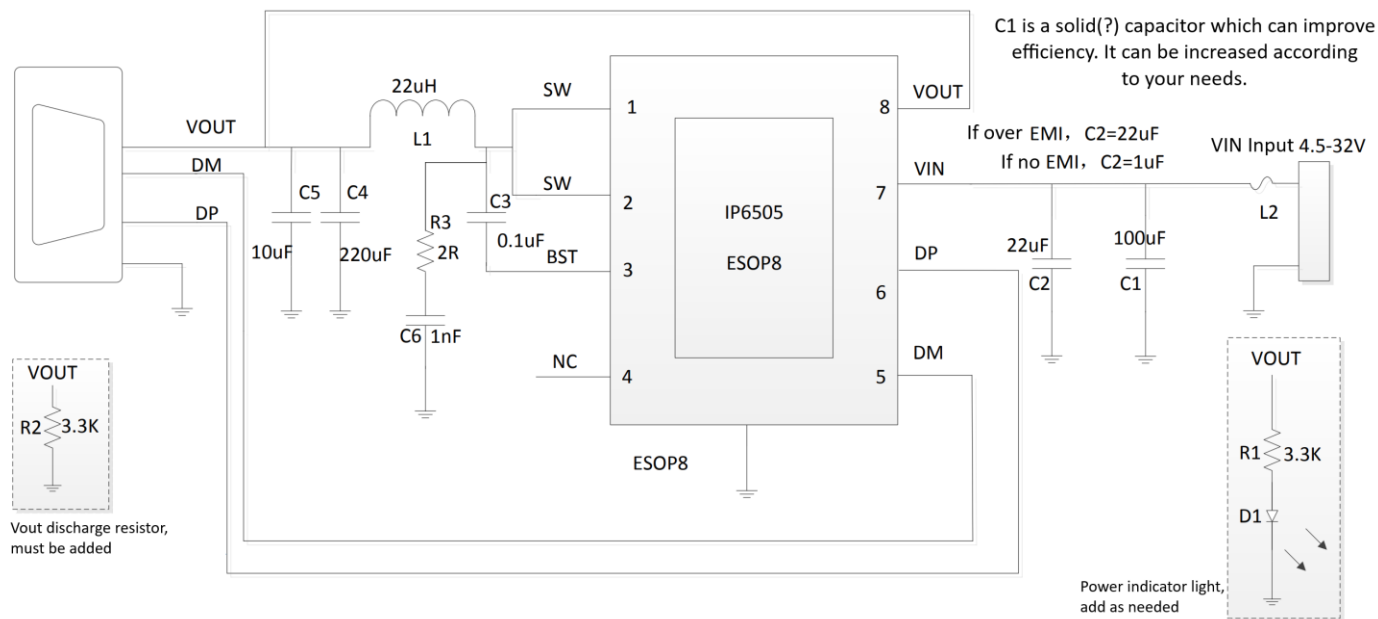IP6505 only needs inductors, capacitors, and resistors to achieve a complete car charger solution.

Figure 5 IP6505 typical application schematic diagram

11. BOM

Number	Component	Model & Specifications	Unit	Qty	Location	Remarks
1	IC	IP6505	PCS	1	U1	
2	SMT Resistors	0603 3.3K 5%	PCS	1	R1, R2	R1 adjusts brightness of the power indicator light
3	TC-220M-4.5A-CS137125	22μH±20%, Current: 4.5A DCR<12mOhm	PCS	1	L1	3L Electronic
4	SMT Capacitors	0805, 22μF, 10%	PCS	1	C2	Min 35V. It's recommended to use a ceramic capacitor placed claose to the IC Pin during layout; if EMI is not required, 1μF can be used.
5	SMT Capacitors	0805, 10μF, 10%	PCS	1	C5	Min 16V
6	SMT LED	0603	PCS	1	D1	
7	SMT Capacitors	0603, 0.1μF, 10%	PCS	1	C3	Min 25V
8	Electrolytic Capacitor	110μF, 35V	PCS	1	C1	Min 35V. C1 is a solid capacitor, which can improve the efficiency.
9	Electrolytic Capacitor	220μF, 25V	PCS	1	C4	Min 25V
10	SMT Resistors	0603, 2R, 5%	PCS	1	R3	
11	SMT Capacitors	0603, 1nF, 10%	PCS	1	C6	Min 10V
12	Fuse	L2	PCS	1	L2	4A

Recommended Inductor:

TC-220M-4.5A-CS137125

3L Product No.	Inductance (μH)	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 Information
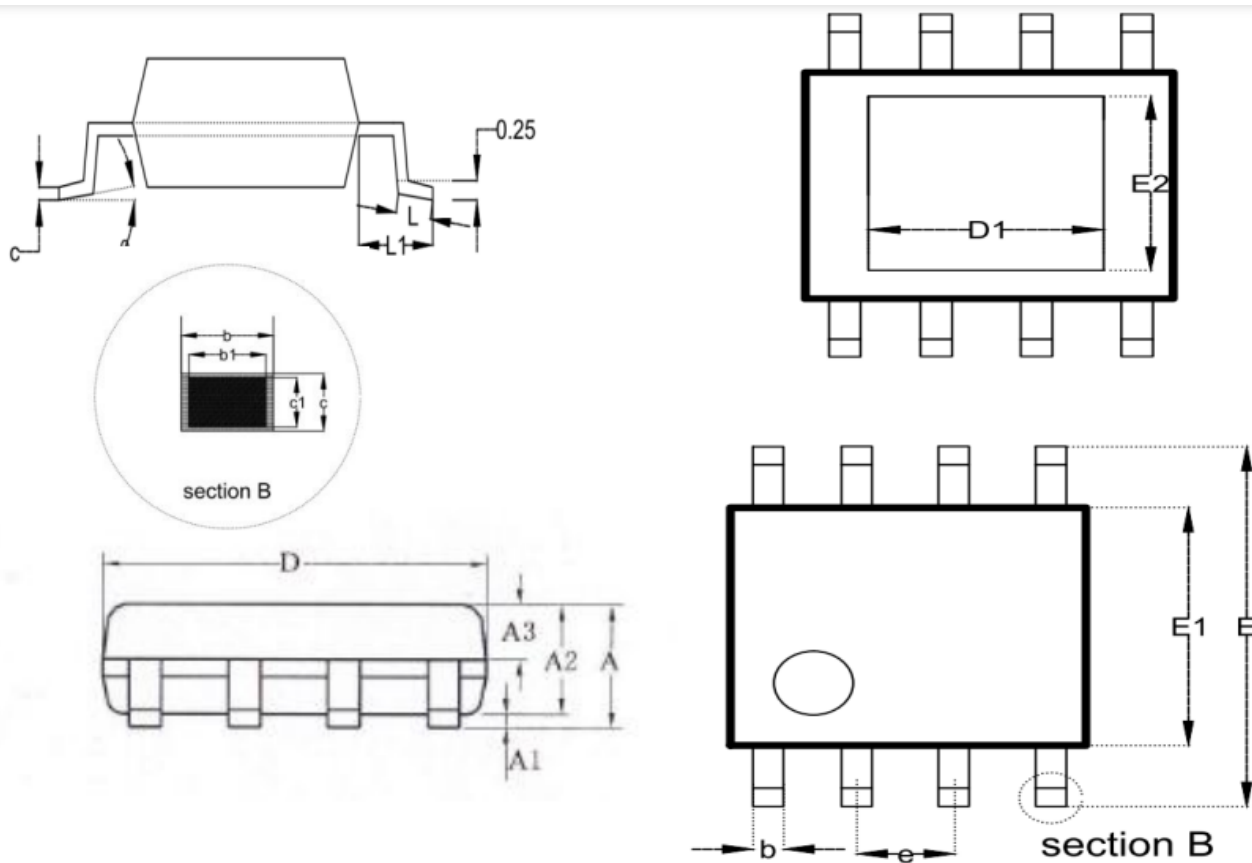
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.65
A1	0.05	--	0.15
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	--	0.48
b1	0.38	0.41	0.43
c	0.21	--	0.25
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.60	0.80
L1	1.05BSC		
θ	0	--	8°
D1	--	2.09	--
E2	--	2.09	--

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