

---

## 18W OUTPUT STEP-DOWN CONVERTER with FAST CHARGE PROTOCOLS (DCP/QC2.0/QC3.0/FCP/AFC)

---

### 1 Features

- **Synchronous step-down converter**
  - Built-in Power MOSFETs
  - Wide Input Voltage Range, 9.6V to 32V
  - Wide Output Voltage Range, 3V to 12V, Automatically Adjusted Based on Corresponding Fast Charge Protocol
  - 18W Max. Output Power (5V@3.4A, 9V@2A, 12V@1.5A)
  - Output Current Limit Protection
  - Conversion efficiency up to 98%
  - Soft-Start
  - Output Voltage Line Loss Compensation, 100mV@1A
- **Fast Charge Protocols**
  - Supports DCP (BC1.2, Apple, Samsung)
  - Supports Qualcomm Quick Charge Protocol QC2.0 and QC3.0
  - Supports Huawei Fast Charge Protocol FCP
  - Supports Samsung Fast Charge Protocol AFC
- **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

IP6525T is a synchronous step-down converter with built-in power MOSFETs. IP6525T supports four fast charge protocols, providing total solution to car charger, fast charge adapter and intelligent power hub applications.

IP6525T supports wide input and output voltage range with 18W max. output power. The output voltage is automatically adjusted based on the corresponding protocol identified by IP6525T. Typical output portfolio is 5V@3.4A, 9V@2A and 12V@1.5A. The Max. conversion efficiency is up to 98%

IP6525T 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.

IP6525T supports output voltage compensation due to the line loss. The output voltage increases at 100mV@1A rate as the load current increases.

IP6525T incorporates soft-start function to prevent the inrush current during start-up.

IP6525T supports multiple fast charge protocols. The protocol is identified by the signal on DP/DM, and IP6525T adjusts output voltage according to the corresponding protocols. IP6525T supports DCP (BC1.2, Apple, Samsung), Qualcomm Quick Charge QC2.0 and QC3.0, Huawei FCP and Samsung AFC.

IP6525T incorporates multiple safety protections, such as input OV/UV, output OV/UV/OC and SC protection.

The package of IP6525T is ESOP8.

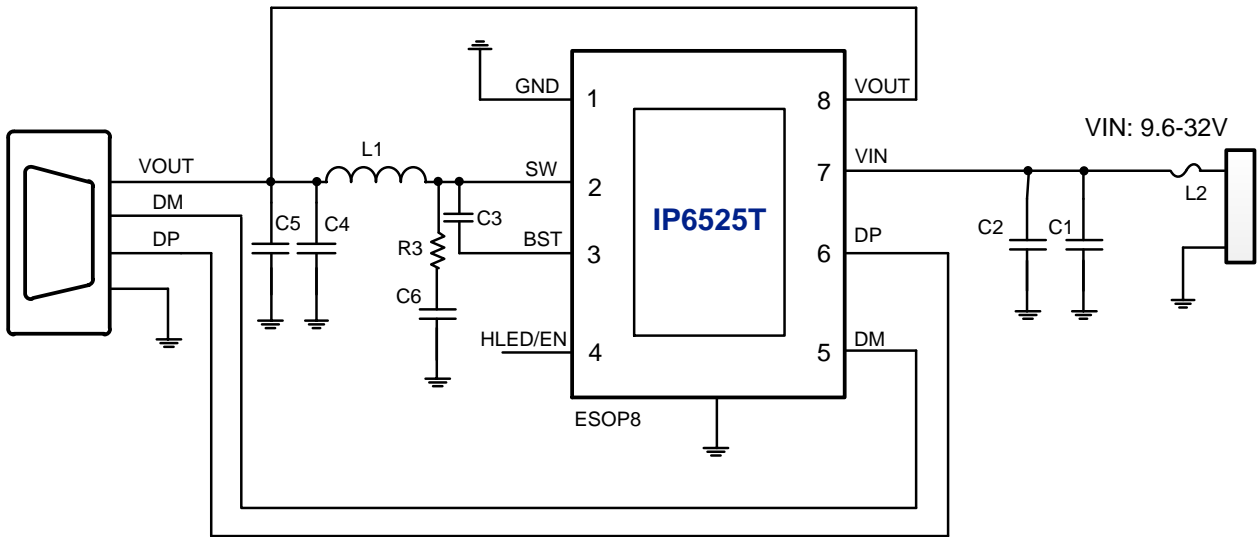


Fig. 1 Simplified Application Schematic

## 4 PIN Definition

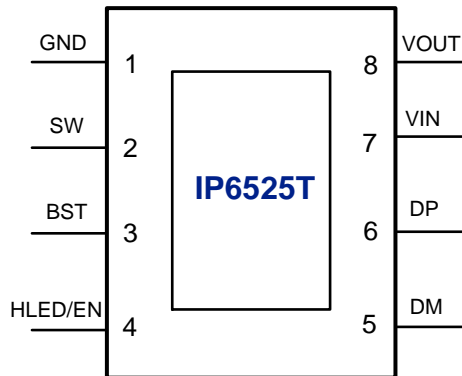


Fig. 2 IP6525T PIN Configuration

NO.	Name	Description
1	GND	Power ground
2	SW	Switching node of the DC-DC converter
3	BST	Bootstrap capacitor node
4	HLED/EN	Fast charge LED indication/chip enable(EN function needs to be customized)
5	DM	USB DM terminal for fast charge protocol
6	DP	USB DP terminal for fast charge protocol
7	VIN	Input voltage node
8	VOUT	Output voltage feedback node
9(EPAD)	GND	Power and thermal ground

## 5. Product Selection Table

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	
IP6536	2.4A	√	√	-	-	-	-	-	-	-	-	-	-	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	
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 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
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	$V_{IN}$	9.6	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>		9.6	12	32	V
Input under voltage threshold	V <sub>IN-UV</sub>			9.6		V
		hysteresis		0.5		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		1.5		mA
<b>Converter System</b>						
High side MOSFET on resistance	R <sub>DS(ON)</sub>			30		mΩ
Low side MOSFET on resistance	R <sub>DS(ON)</sub>			20		mΩ
Switching frequency	F <sub>SW</sub>			125		KHz
<b>Output System</b>						
Output voltage	V <sub>OUT</sub>		3	5	12	V
Output voltage ripple	ΔV <sub>OUT</sub>	VIN=12V, VOUT=5V@3A		135		mV
		VIN=12V, VOUT=9V@2A		75		mV
		VIN=24V, VOUT=12V@1.5A		180		mV
Soft-start time	T <sub>SS</sub>	VIN=12V, VOUT=5V		450		us
Line loss compensation	V <sub>COMP</sub>	VIN=12V, VOUT=5V, IOUT=3A		300		mV
Current limit in CC mode	I <sub>OUT</sub>	VIN=12V, VOUT<=4V		3.4		A
		VIN=12V, 4V<VOUT<=5V		3.4		A
		VIN=12V, 7V<VOUT<=9V		2		A
		VIN=24V, 9V<VOUT<=12V		1.5		A

Hiccup output voltage	$V_{OUT}$	CC mode		2.6		V
Thermal shutdown Temp.	$T_{OTP}$			155		°C
Thermal shutdown Temp. hysteresis	$\Delta T_{OTP}$			40		°C

## 9 Detailed Description

### 9.1 Synchronous Step-Down Converter

The IP6525T is a synchronous step-down converter with built-in power MOSFETs. IP6525T supports four fast charge protocols, providing total solution to car charger, fast charge adapter and intelligent power hub applications. IP6525T supports wide input and output voltage range with 18W max. output power. The output voltage is automatically adjusted based on the corresponding protocol identified by IP6525T. Typical output portfolio is 5V@3.4A, 9V@2A and 12V@1.5A. 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 show the output voltage characteristics under different load current.

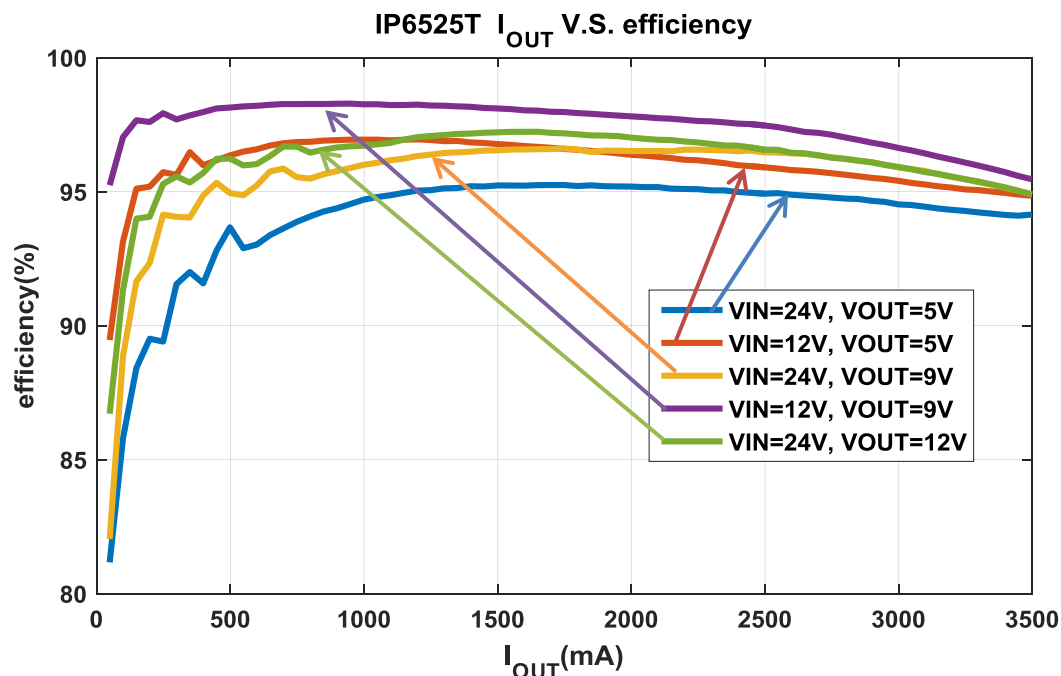


Fig. 3 IP6525T Conversion Efficiency

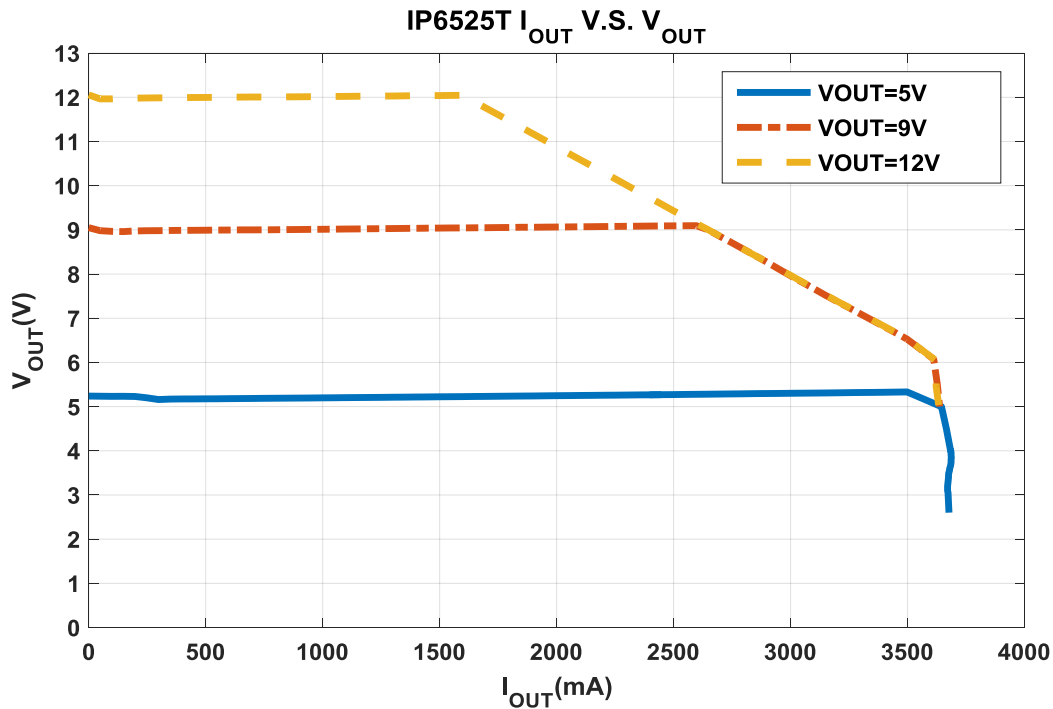


Fig. 4 IP6525T Output Voltage Characteristics

## 9.2 Output Voltage Line Loss Compensation

IP6525T supports output line loss compensation. The output voltage increases at 100mV/1A rate.

## 9.3 External Chip Enable Function

PIN-4(HLED/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 Fast Charge Indication Function

PIN-4(HLED/EN) can be used as fast charge indication. Indication led can be direct connected to this PIN. LED turns on when the fast charge protocol request voltage level higher than 5V.

## 9.5 CC/CV Characteristics

IP6525T 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

IP6525T monitors voltage on VIN. If the voltage is lower than 9.6V, IP6525T enters standby mode, and shuts down the converter. If the voltage is higher than 32V, IP6525T detects over voltage, and then

shuts down the converter. When VIN decreases 0.2V lower than the over voltage threshold, IP6525T resumes the output voltage.

IP6525T also monitors voltage on VOUT. If the voltage is lower than 2.5V, IP6525T detects output under voltage, and then shuts down the converter. During output under voltage protection, IP6525T enters hiccup mode, and restarts the converter every 2 seconds.

IP6525T incorporates short circuit protection. After 8ms from start-up, if VOUT is lower than 2.6V, IP6525T detects output short circuit, then shutting down the converter, and enters hiccup mode. IP6525T restarts the converter every 2 seconds.

IP6525T detects over temperature when the chip temperature is higher than 155°C. IP6525T shuts down the converter and restarts the every 2 seconds. When the chip temperature decreases below 125°C, IP6525T returns to normal state.

## 9.7 Fast Charge Protocols

IP6525T supports multiple fast charge protocols:

- DCP (BC1.2, Apple, Samsung)
- Qualcomm quick charge QC2.0 and QC3.0
- Huawei FCP
- Samsung AFC

## 10 Typical Application

Fig.5 shows the typical application schematic.

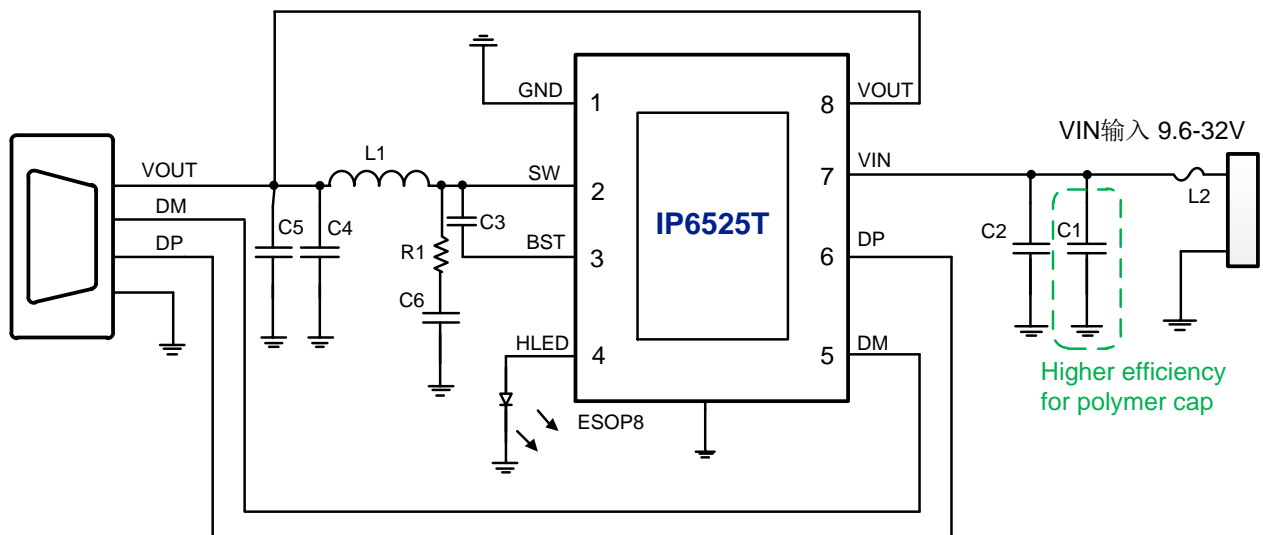


Fig. 5 IP6525T Application Schematic

Notes:

1. IP6525T EPAD must have a good contact with PCB GND;
2. PIN4 should not be connected anywhere if the HLED indicator light is not needed.



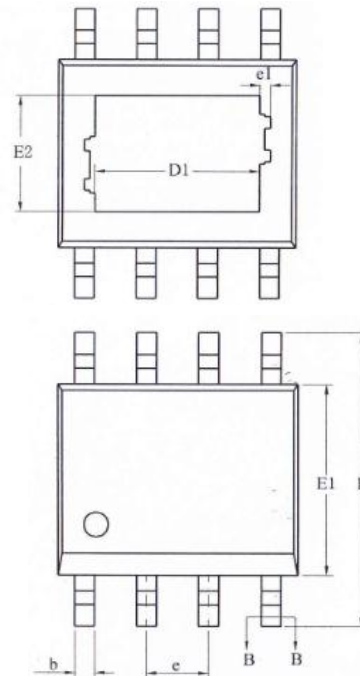
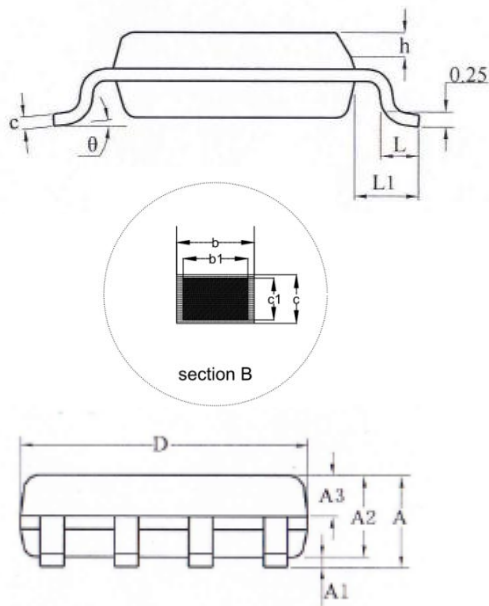
## 11 BOM

NO.	Device	Spec.	Unit	Counts	Designator	备注
1	IC	IP6525T	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-4.5A-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
10	LED	0603	PCS	1	D1	

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 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	--

## 责任及版权申明

英集芯科技有限公司有权根据所提供的产品和服务进行更正、修改、增强、改进或其它更改，客户在下订单前应获取最新的相关信息，并验证这些信息是否完整且是最新的。所有产品的销售都遵循在订单确认时所提供的销售条款与条件。

英集芯科技有限公司对应用帮助或客户产品设计不承担任何义务。客户应对其使用英集芯的产品和应用自行负责。为尽量减小与客户产品和应用相关的风险，客户应提供充分的设计与操作安全验证。

客户认可并同意，尽管任何应用相关信息或支持仍可能由英集芯提供，但他们将独力负责满足与其产品及在其应用中使用英集芯产品相关的所有法律、法规和安全相关要求。客户声明并同意，他们具备制定与实施安全措施所需的全部专业技术和知识，可预见故障的危险后果、监测故障及其后果、降低有可能造成人身伤害的故障的发生机率并采取适当的补救措施。客户将全额赔偿因在此类关键应用中使用任何英集芯产品而对英集芯及其代理造成的任何损失。

对于英集芯的产品手册或数据表，仅在没有对内容进行任何篡改且带有相关授权、条件、限制和声明的情况下才允许进行复制。英集芯对此类篡改过的文件不承担任何责任或义务。复制第三方的信息可能需要服从额外的限制条件。

英集芯会不定期更新本文档内容，产品实际参数可能因型号或者其他事项不同有所差异，本文档不作为任何明示或暗示的担保或授权

在转售英集芯产品时，如果对该产品参数的陈述与英集芯标明的参数相比存在差异或虚假成分，则会失去相关英集芯产品的所有明示或暗示授权，且这是不正当的、欺诈性商业行为。英集芯对任何此类虚假陈述均不承担任何责任或义务。