

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, DP/DM Withstand up to 30V
 - 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.

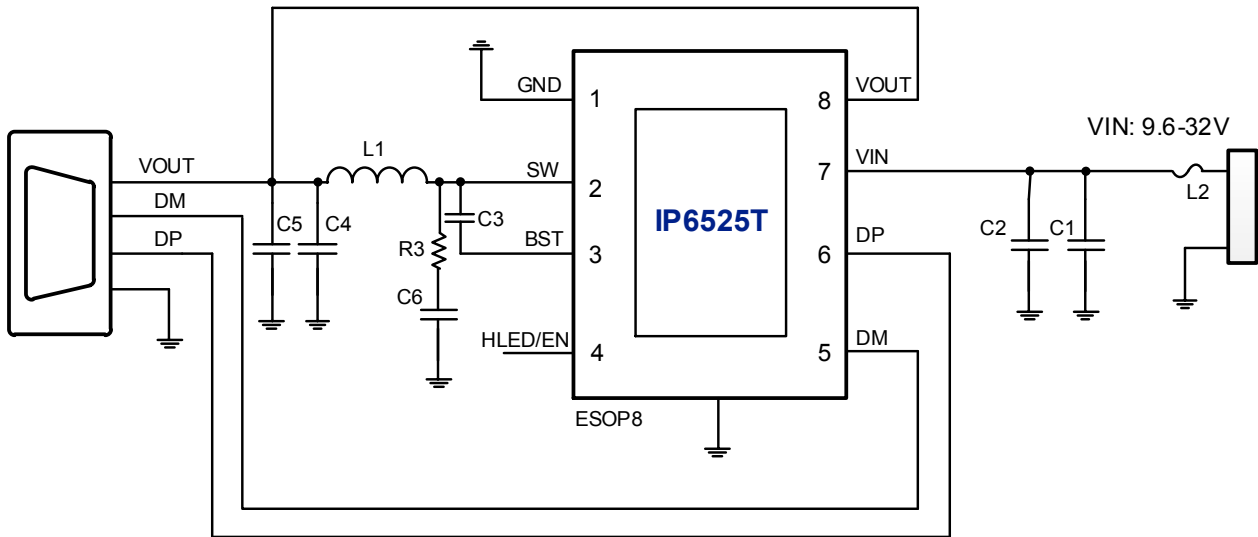


Fig. 1 Simplified Application Schematic

4 PIN Definition

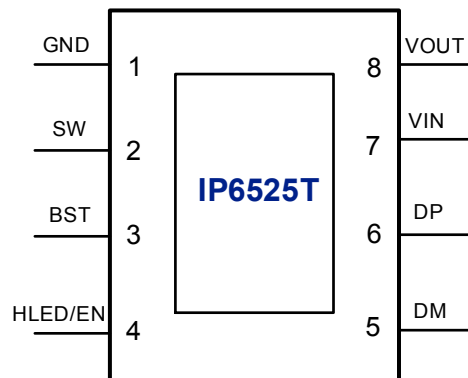


Fig. 2 IP6525T PIN Configuration

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

Product	Max. I _{OUT}	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	3.6A	-	✓	-	-	-	-	-	-	-	-	-	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	

Note: The default function of HLED/EN PIN of IP6525T is fast charge indication. The chip enable function needs to be customized. Please contact Injoinic sales for more information.

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)	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}	9.6	12/24	32	V

8 Electrical Characteristics

TA=25℃, 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}		9.6	12	32	V
Input under voltage threshold	V _{IN-UV}			9.6		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}			150		KHz
Output System						
Output voltage	V _{OUT}		3	5	12	V
Output voltage ripple	ΔV _{OUT}	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 _{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
		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	ΔT_{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 150KHz. The conversion efficiency is up to 95.5% at VIN=12V, VOUT=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.

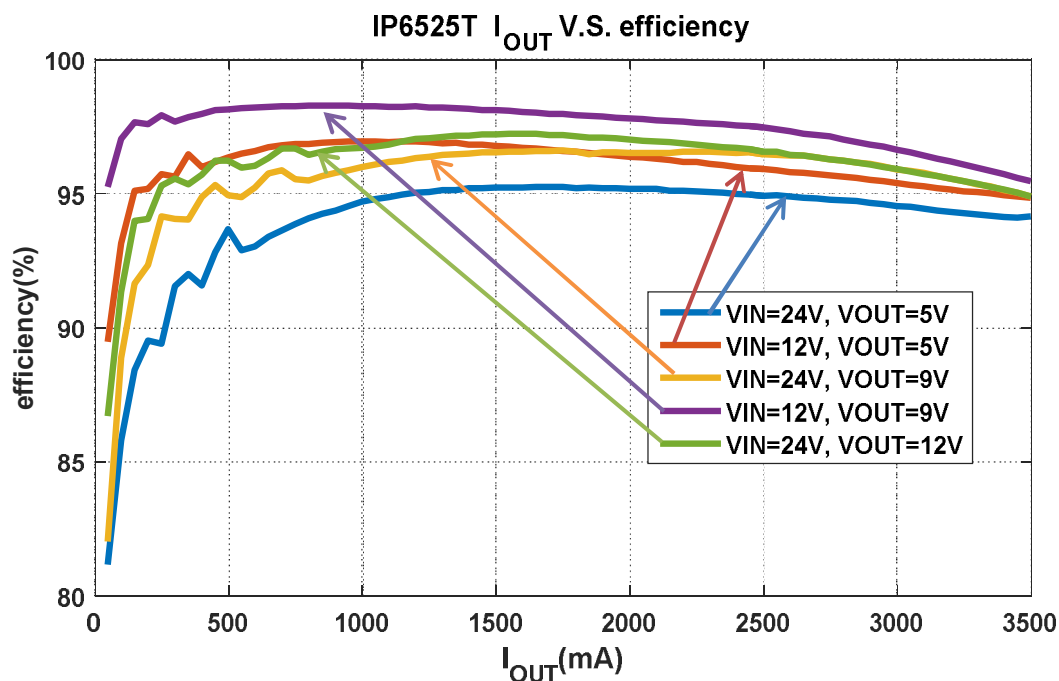


Fig. 3 IP6525T Conversion Efficiency

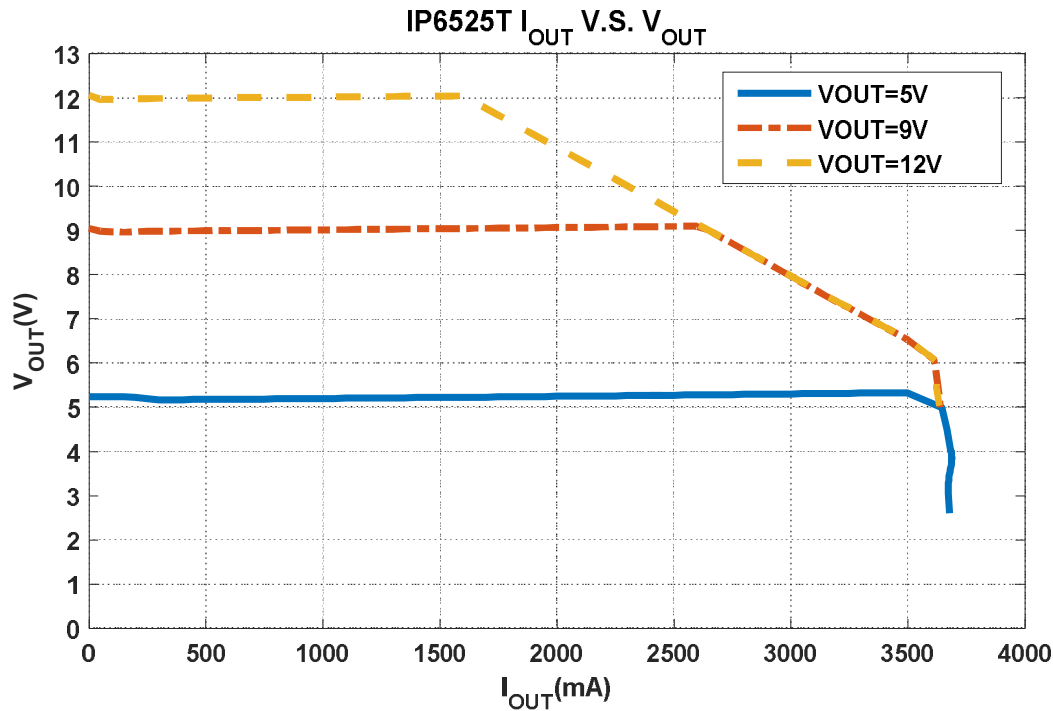


Fig. 4 IP6525T Output Voltage Characteristics

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.

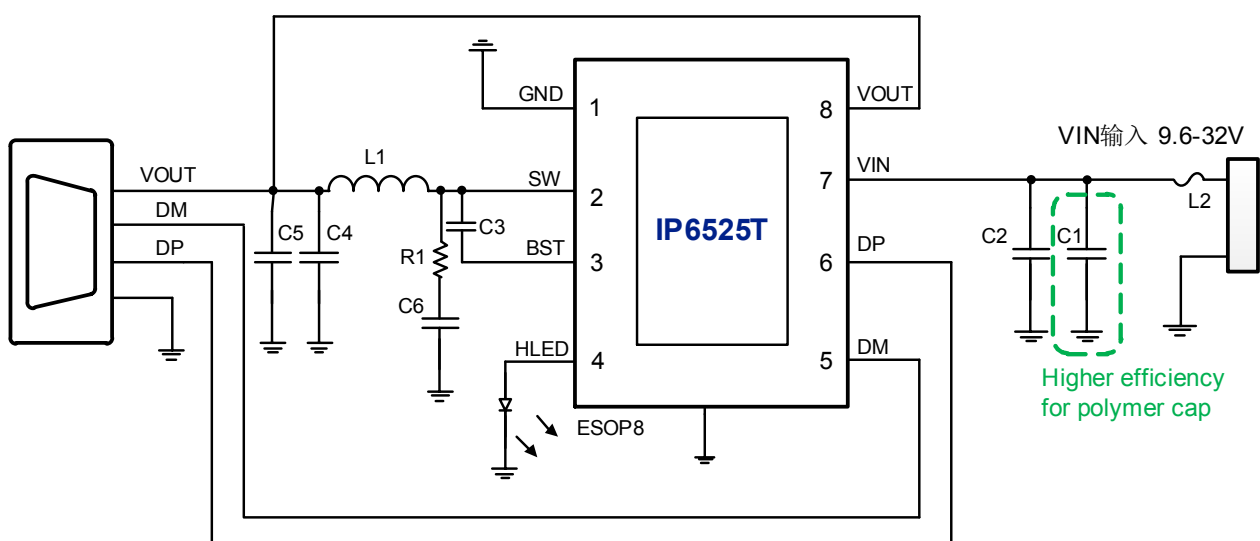


Fig. 5 IP6525T Application Schematic

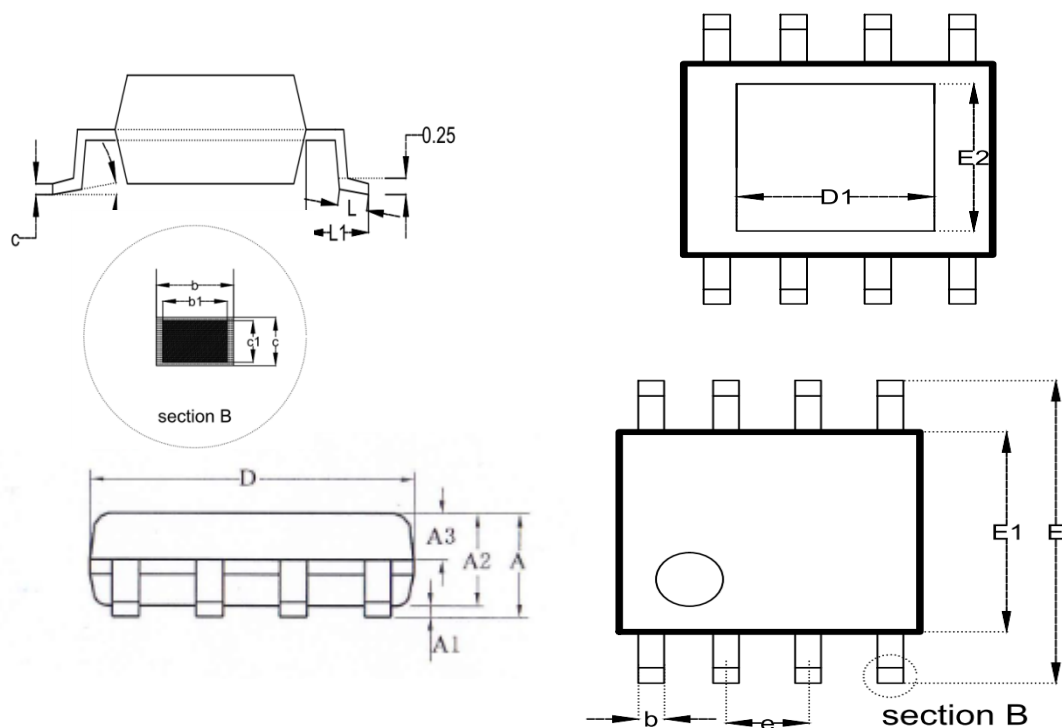
11 BOM

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	Reserved for EMI improvement
8	ceramic capacitor	0603 1nF 10%	PCS	1	C6	Rated voltage>50V. Reserved for EMI improvement.
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	--	0.48
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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