

BUT12AX

Silicon diffused power transistor

Rev. 01 — 16 June 2004

Product data

1. Product profile

1.1 Description

High voltage, high speed, NPN power transistor in a plastic package.

1.2 Features

- Isolated package
- Fast switching.

1.3 Applications

- Inverters
- Switching regulators
- Motor control systems
- DC-to-DC converters.

1.4 Quick reference data

- $V_{CESM} \leq 1000 \text{ V}$
- $I_C \leq 8 \text{ A}$
- $P_{tot} \leq 23 \text{ W}$
- $t_f \leq 0.8 \mu\text{s}$.

2. Pinning information

Table 1: Pinning - SOT186A (TO-220F), simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	base (b)		
2	collector (c)		
3	emitter (e)		
mb	mounting base; isolated		

SOT186A (TO-220F)



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3. Ordering information

Table 2: Ordering information

Type number	Package		Version
	Name	Description	
BUT12AX	TO-220F	Plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3 leads.	SOT186A

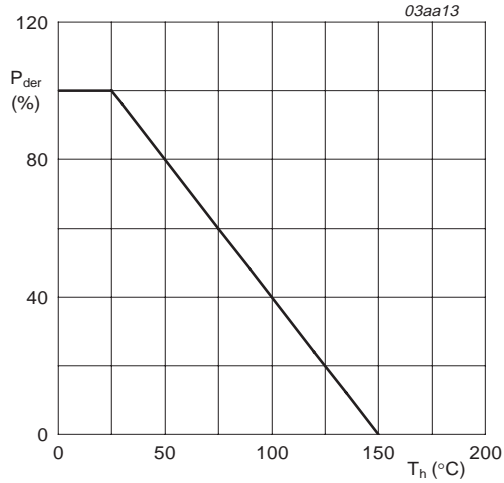
4. Limiting values

Table 3: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

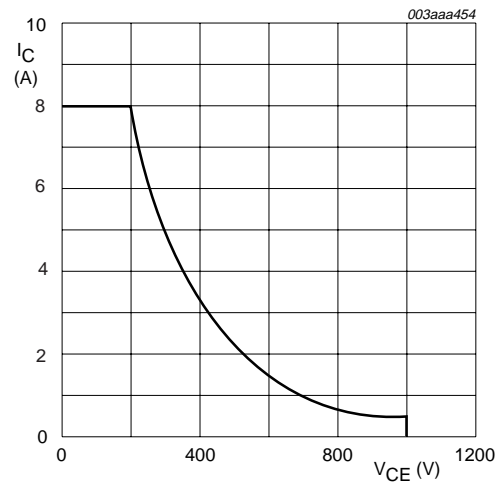
Symbol	Parameter	Conditions	Min	Max	Unit
V_{CESM}	peak collector-emitter voltage	$V_{BE} = 0\text{ V}$	-	1000	V
V_{CEO}	collector-emitter voltage	base open circuit	-	450	V
I_C	collector current	Figure 2 and 3	-	8	A
I_{Csat}	collector saturation current		-	5	A
I_{CM}	peak collector current	Figure 3	-	20	A
I_B	base current (DC)		-	4	A
I_{BM}	peak base current		-	6	A
P_{tot}	total power dissipation	$T_h = 25\text{ °C}$; Figure 1	[1] -	23	W
T_{stg}	storage temperature		-65	+150	°C
T_j	junction temperature		-	+150	°C

[1] Mounted without heatsink compound.



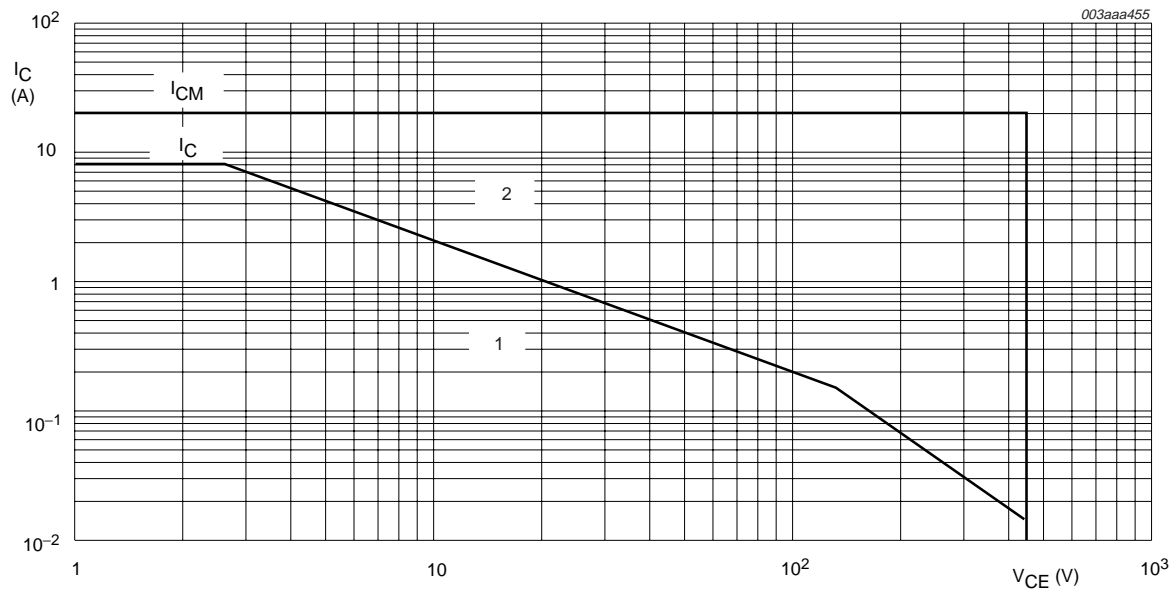
$$P_{der} = \frac{P_{tot}}{P_{tot(25^\circ C)}} \times 100\%$$

Fig 1. Normalized total power dissipation as a function of heatsink temperature.



$V_{BE} = -1 \text{ V to } -5 \text{ V}; T_h = 100^\circ \text{C}.$

Fig 2. Reverse bias safe operating area; continuous collector current as a function of collector-emitter voltage.



$T_h = 25^\circ \text{C}$

- 1 - Region of permissible DC operation.
- 2 - Permissible extension for repetitive operation.

Fig 3. Forward bias safe operating area; continuous and peak collector currents as a function of collector-emitter voltage.

5. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$R_{th(j-h)}$	thermal resistance from junction to heatsink	Mounted without heatsink compound	[1]	-	-	5.5	K/W
		Mounted with heatsink compound	[1]	-	-	3.9	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient		-	55	-	K/W	

[1] External heatsink connected to mounting base.

6. Characteristics

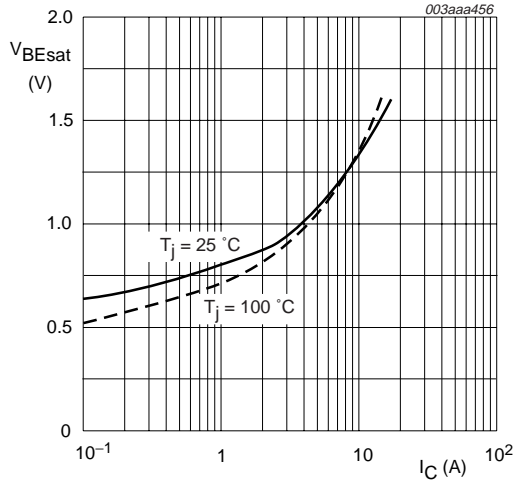
Table 5: Characteristics

$T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
Static characteristics							
V_{CE0sus}	collector-emitter sustaining voltage	$I_C = 100\text{ mA}$; $I_{Boff} = 0\text{ A}$; $L = 25\text{ mH}$; Figure 9 and 10	400	-	-	V	
V_{CEsat}	collector-emitter saturation voltage	$I_C = 5\text{ A}$; $I_B = 1\text{ A}$; Figure 5	-	-	1.5	V	
V_{BEsat}	base-emitter saturation voltage	$I_C = 5\text{ A}$; $I_B = 1\text{ A}$; Figure 4	-	-	1.5	V	
I_{CES}	collector-emitter cut-off current	$V_{CE} = V_{CESM}$; $V_{BE} = 0\text{ V}$					
		$T_j = 25\text{ }^\circ\text{C}$	[1]	-	-	1	mA
		$T_j = 125\text{ }^\circ\text{C}$	[1]	-	-	3	mA
h_{FE}	DC current gain	$V_{CE} = 5\text{ V}$; Figure 8					
		$I_C = 10\text{ mA}$	10	18	35		
		$I_C = 1\text{ A}$	10	20	35		
Dynamic characteristics							
t_{on}	turn-on time	$I_{Con} = 5\text{ A}$; $I_{Bon} = I_{Boff} = 1\text{ A}$; resistive load; Figure 11 and 12	-	-	1	μs	
t_s	carrier storage time	$I_{Con} = 5\text{ A}$; $I_{Bon} = I_{Boff} = 1\text{ A}$; resistive load; Figure 11 and 12	[2]	-	-	4	μs
		$I_{Con} = 5\text{ A}$; $I_{Bon} = 1\text{ A}$; $V_{CL} = 250\text{ V}$; $T_{mb} = 100\text{ }^\circ\text{C}$; inductive load; Figure 13 and 14	-	1.9	2.5	μs	
t_f	fall time	$I_{Con} = 5\text{ A}$; $I_{Bon} = I_{Boff} = 1\text{ A}$; resistive load; Figure 11 and 12	-	-	0.8	μs	
		$I_{Con} = 5\text{ A}$; $I_{Bon} = 1\text{ A}$; $V_{CL} = 300\text{ V}$; $T_{mb} = 100\text{ }^\circ\text{C}$; inductive load; Figure 13 and 14	-	200	300	ns	

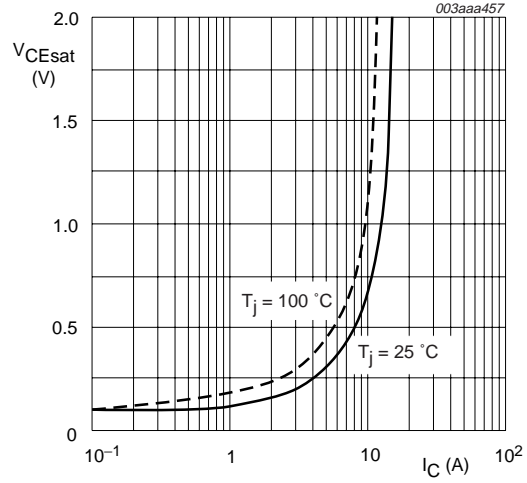
[1] Measured with a half-sinewave voltage.

[2] turn-off storage time



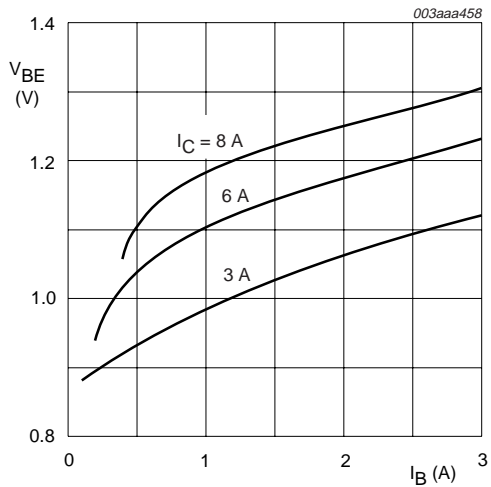
$T_j = 25^\circ\text{C}$ and 100°C

Fig 4. Base-emitter saturation voltage as a function of collector current; typical values.



$T_j = 25^\circ\text{C}$ and 100°C

Fig 5. Collector-emitter saturation voltage as a function of collector current; typical values.



$T_j = 25^\circ\text{C}$

Fig 6. Base-emitter voltage as a function of base current; typical values.

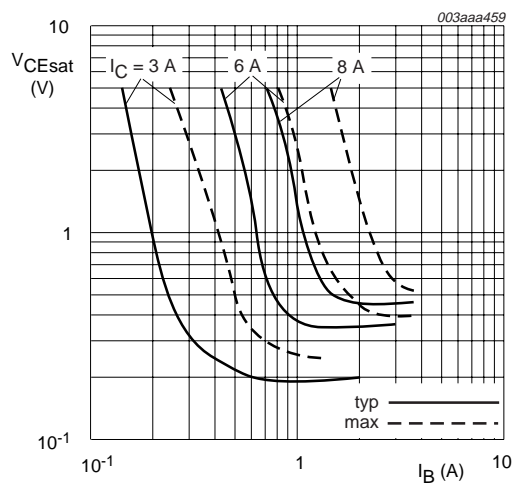
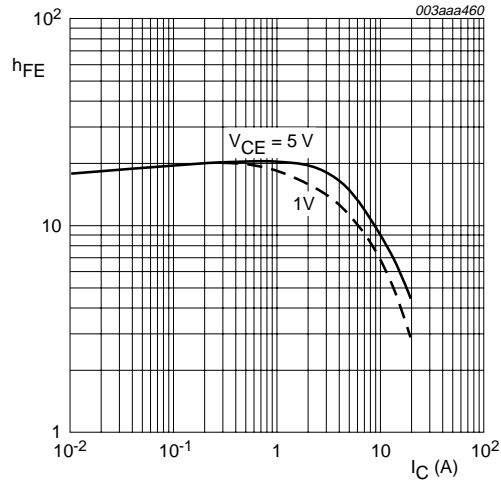


Fig 7. Collector-emitter saturation voltage as a function base current; typical and maximum values.



$V_{CE} = 5\text{ V}$ and 1 V

Fig 8. DC current gain as a function of collector current; typical values.

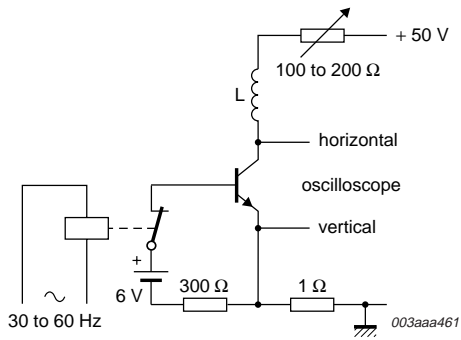


Fig 9. Test circuit for collector-emitter sustaining voltage.

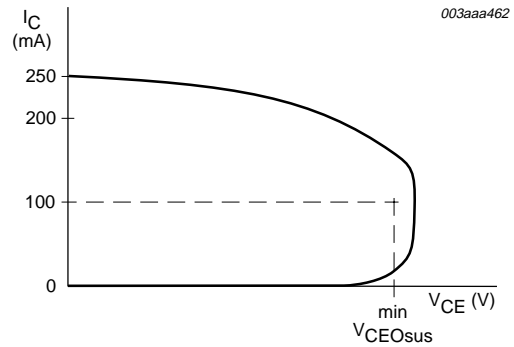
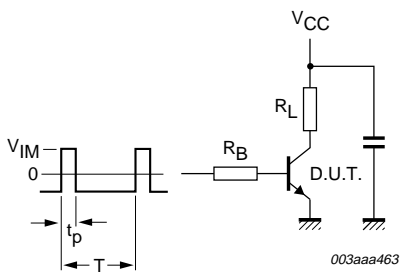


Fig 10. Oscilloscope display for collector-emitter sustaining voltage.



$V_{CC} = 250 \text{ V}$; $t_p = 20 \mu\text{s}$; $V_{IM} = -6 \text{ V to } 8 \text{ V}$; $t_p/T = 0.01$.
The values of R_B and R_L are selected in accordance with I_{Con} and I_{Bon} requirements.

Fig 11. Test circuit for resistive load switching times

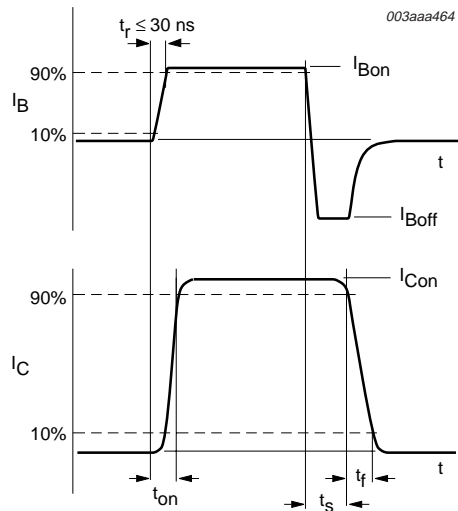
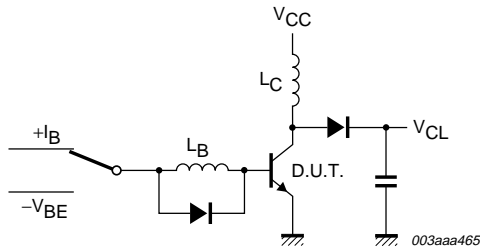


Fig 12. Switching time waveforms with resistive load.



$V_{CL} \leq 1000 \text{ V}$; $V_{CC} = 30 \text{ V}$; $V_{BE} = -1 \text{ V to } -5 \text{ V}$;
 $L_B = 1 \mu\text{H}$; $L_C = 200 \mu\text{H}$

Fig 13. Test circuit for inductive load switching and reverse bias safe operating area.

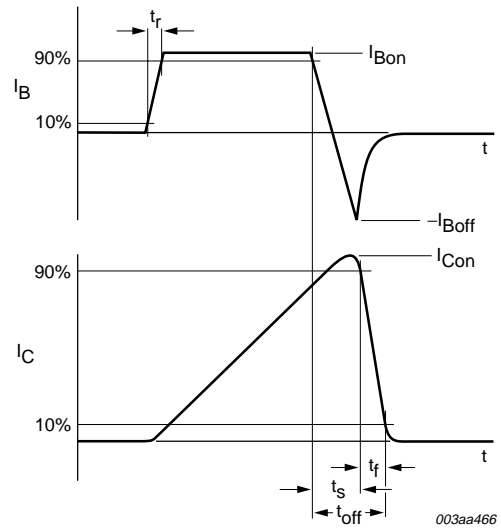


Fig 14. Switching time waveforms with inductive load.

7. Isolation characteristics

Table 6: Isolation characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{isol(RMS)M}$	Peak RMS isolation voltage from all three terminals to external heatsink.	$f = 50 \text{ to } 60 \text{ Hz}$; sinusoidal waveform; $RH \leq 65\%$; clean and dust-free.	-	-	2500	V
C_{c-h}	Capacitance from collector to external heatsink.		-	12	-	pF

8. Package outline

Plastic single-ended package; isolated heatsink mounted;
1 mounting hole; 3 lead TO-220 'full pack'

SOT186A

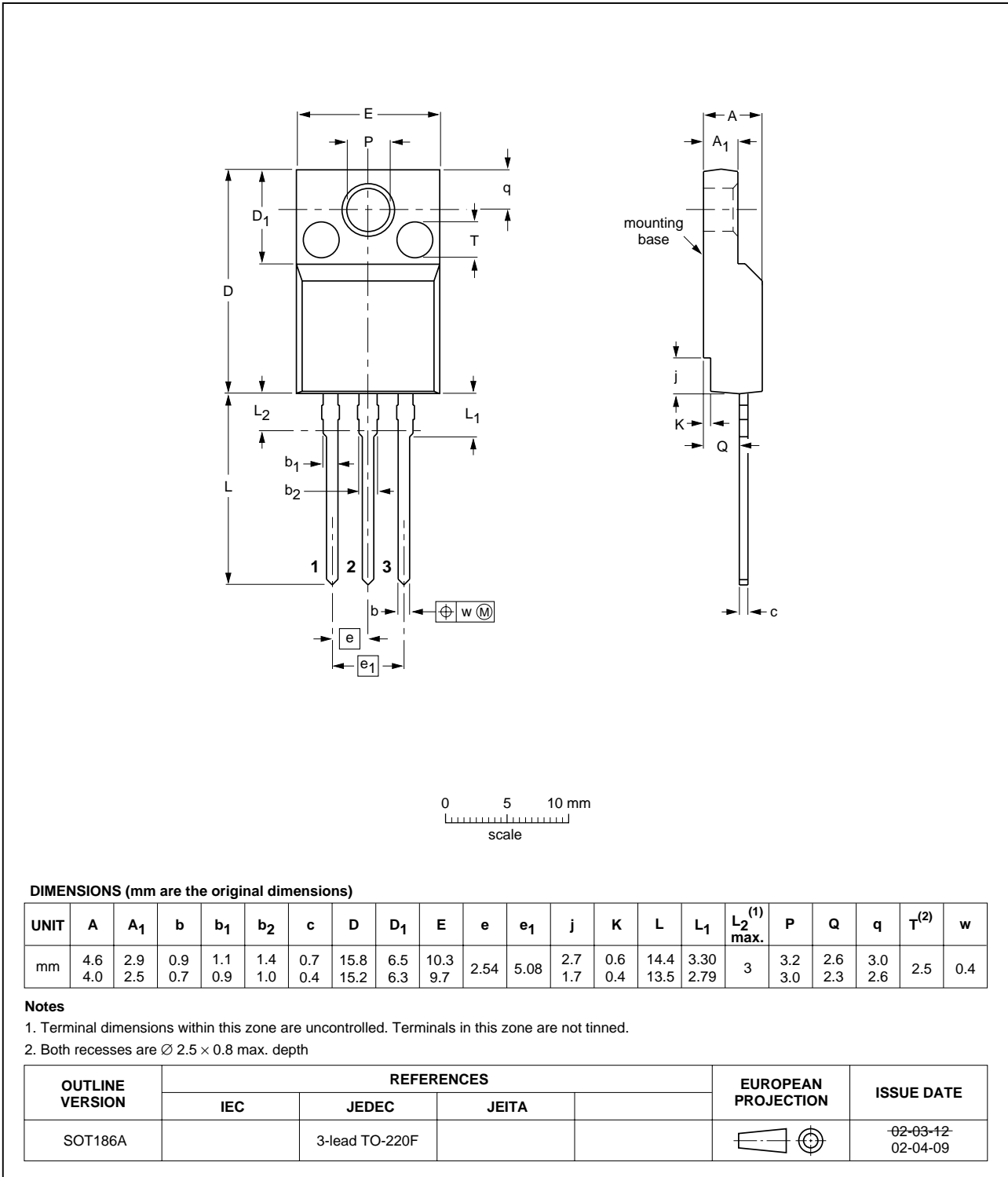


Fig 15. SOT186A (TO-220F).

9. Revision history

Table 7: Revision history

Rev	Date	CPCN	Description
01	20040616	-	Product data (9397 750 13442)

10. Data sheet status

Level	Data sheet status ^[1]	Product status ^{[2][3]}	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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