IMPORTANT NOTICE

10 December 2015

1. Global joint venture starts operations as WeEn Semiconductors

Dear customer,

As from November 9th, 2015 NXP Semiconductors N.V. and Beijing JianGuang Asset Management Co. Ltd established Bipolar Power joint venture (JV), **WeEn Semiconductors**, which will be used in future Bipolar Power documents together with new contact details.

In this document where the previous NXP references remain, please use the new links as shown below.

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Thank you for your cooperation and understanding,

WeEn Semiconductors

founded by NXP

PHD13005

NPN power transistor with integrated diode

Rev. 02 — 29 July 2010 | Product data sheet

1. Product profile

1.1 General description

High voltage, high speed, planar passivated NPN power switching transistor with integrated anti-parallel E-C diode in a SOT78 plastic package.

1.2 Features and benefits

- Fast switching
- High voltage capability
- Integrated anti-parallel E-C diode
- Low thermal resistance

1.3 Applications

- Integrated fluorescent lamp ballasts e.g. high power cluster lamps
- Low Voltage Tungsten Halogen transformers
- Remote fluorescent lamp ballasts
- Self Oscillating Power Supplies

1.4 Quick reference data

Table 1. Quick reference data

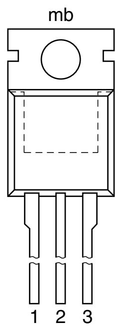
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_C	collector current	see Figure 1; see Figure 2; see Figure 4; DC	-	-	4	A
P_{tot}	total power dissipation	see Figure 3; $T_{mb} \leq 25$ °C	-	-	75	W
V_{CESM}	collector-emitter peak voltage	$V_{BE} = 0$ V	-	-	700	V
Static characteristics						
h_{FE}	DC current gain	$V_{CE} = 5$ V; $I_C = 1.0$ A; see Figure 10	12	20	40	
		$V_{CE} = 5$ V; $I_C = 2.0$ A; see Figure 10	10	17	28	

2. Pinning information

Table 2. Pinning information

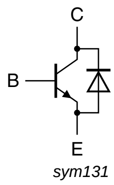
Pin	Symbol	Description
1	B	base
2	C	collector
3	E	emitter
mb	C	mounting base; connected to collector

Simplified outline



SOT78 (TO-220AB)

Graphic symbol



3. Ordering information

Table 3. Ordering information

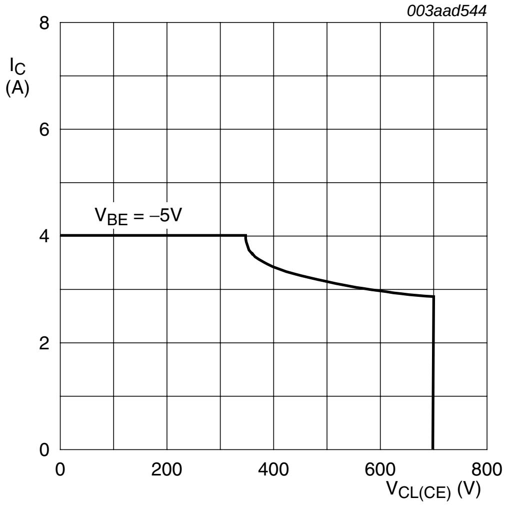
Type number	Package		
	Name	Description	Version
PHD13005	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

4. Limiting values

Table 4. Limiting values

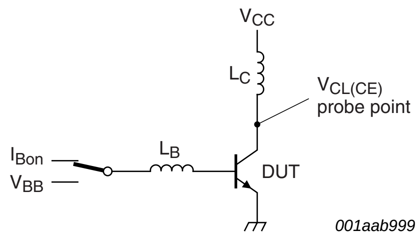
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CESM}	collector-emitter peak voltage	V_{BE} = 0 V	-	700	V
V_{CBO}	collector-base voltage	I_E = 0 A	-	700	V
V_{CEO}	collector-emitter voltage	I_B = 0 A	-	400	V
I_C	collector current	DC; see Figure 1; see Figure 2; see Figure 4	-	4	A
I_{CM}	peak collector current	see Figure 4; see Figure 1; see Figure 2	-	8	A
I_B	base current	DC	-	2	A
I_{BM}	peak base current		-	4	A
P_{tot}	total power dissipation	$T_{mb} \leq 25$ °C; see Figure 3	-	75	W
T_{stg}	storage temperature		-65	150	°C
T_j	junction temperature		-	150	°C



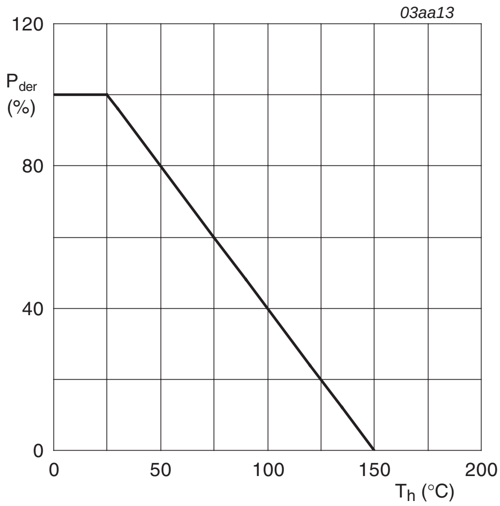
$$T_j \leq T_{j(max)}\ °C$$

Fig 1. Reverse bias safe operating area



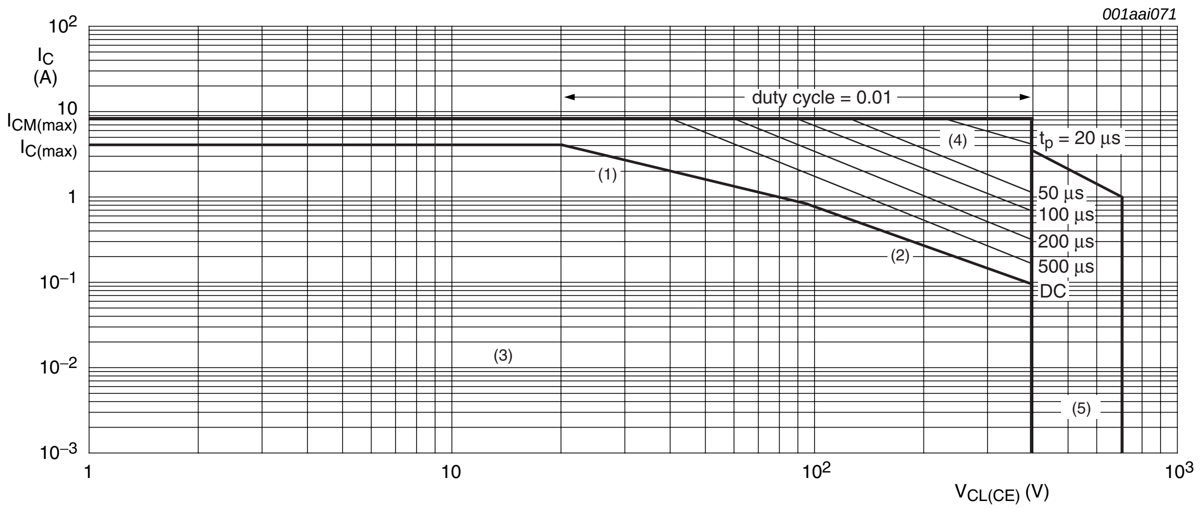
$$V_{CL(CE)} \leq 1000\ V; V_{CC} = 150\ V; V_{BB} = -5\ V;$$
$$L_B = 1\ \mu H; L_C = 200\ \mu H$$

Fig 2. Test circuit for reverse bias safe operating area



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

Fig 3. Normalized total power dissipation as a function of heatsink temperature



$T_h \leq 25$ °C

Mounted with heatsink compound and (30 ± 5) N force on the centre of the envelope

(1) P_{tot} maximum and P_{tot} peak maximum lines

(2) Second breakdown limits

(3) Region of permissible DC operation

(4) Extension of operating region for repetitive pulse operation

(5) Extension of operating region during turn-on in single transistor converters provided that $R_{BE} \leq 100\ \Omega$ and $t_p \leq 0.6$ µs

Fig 4. Forward bias safe operating area

5. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	see Figure 5	-	-	1.67	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	-	60	-	K/W

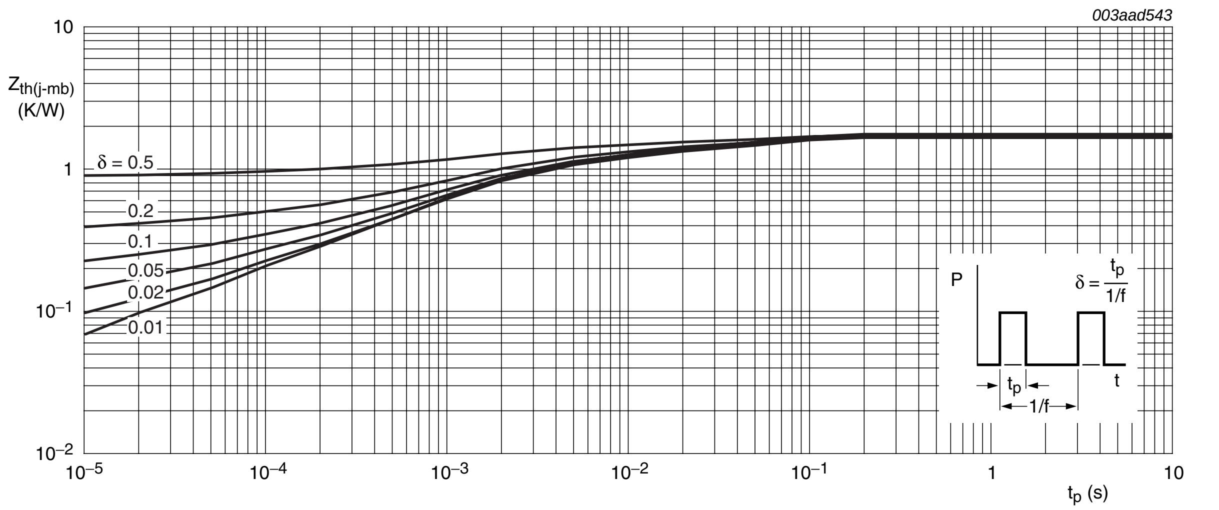


Fig 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

6. Characteristics

Table 6. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
I_{CES}	collector-emitter cut-off current	V_{BE} = 0 V; V_{CE} = 700 V; T_j = 100 °C	[1]	-	-	5	mA
		V_{BE} = 0 V; V_{CE} = 700 V	[1]	-	-	1	mA
I_{CBO}	collector-base cut-off current	V_{CB} = 700 V; I_E = 0 A	[1]	-	-	1	mA
I_{CEO}	collector-emitter cut-off current	V_{CE} = 400 V; I_B = 0 A	[1]	-	-	0.1	mA
I_{EBO}	emitter-base cut-off current	V_{EB} = 9 V; I_C = 0 A		-	-	10	mA
V_{CEOsus}	collector-emitter sustaining voltage	I_B = 0 A; I_C = 10 mA; L_C = 25 mH; see Figure 6; see Figure 15		400	-	-	V
V_{CEsat}	collector-emitter saturation voltage	I_C = 1.0 A; I_B = 0.2 A; see Figure 7; see Figure 8		-	0.1	0.5	V
		I_C = 2.0 A; I_B = 0.5 A; see Figure 7; see Figure 8		-	0.2	0.6	V
		I_C = 4.0 A; I_B = 1.0 A; see Figure 7; see Figure 8		-	0.3	1	V
V_{BEsat}	base-emitter saturation voltage	I_C = 2.0 A; I_B = 0.5 A; see Figure 9		-	0.92	1.6	V
		I_C = 1.0 A; I_B = 0.2 A; see Figure 9		-	0.85	1.2	V
V_F	forward voltage	I_F = 2.0 A		-	1.04	1.5	V
h_{FE}	DC current gain	I_C = 1.0 A; V_{CE} = 5 V; see Figure 10		12	20	40	
		I_C = 2.0 A; V_{CE} = 5 V; see Figure 10		10	17	28	
Dynamic characteristics							
t_s	storage time	I_C = 2.0 A; I_{Bon} = 0.4 A; V_{BB} = -5 V; L_B = 1 µH; inductive load; see Figure 11; see Figure 12		-	1.2	2	µs
		I_C = 2.0 A; I_{Bon} = 0.4 A; I_{Boff} = -0.4 A; R_L = 75 Ω; resistive load; see Figure 13; see Figure 14		-	2.7	4	µs
		I_C = 2.0 A; I_{Bon} = 0.4 A; V_{BB} = -5 V; L_B = 1 µH; T_j = 100 °C; inductive load; see Figure 11; see Figure 12		-	1.4	4	µs
t_f	fall time	I_C = 2.0 A; I_{Bon} = 0.4 A; I_{Boff} = -0.4 A; R_L = 75 Ω; resistive load; see Figure 13; see Figure 14		-	0.3	0.9	µs
		I_C = 2.0 A; I_{Bon} = 0.4 A; V_{BB} = -5 V; L_B = 1 µH; T_j = 100 °C; inductive load; see Figure 11; see Figure 12		-	0.16	0.9	µs
		I_C = 2.0 A; I_{Bon} = 0.4 A; V_{BB} = -5 V; L_B = 1 µH; inductive load; see Figure 11; see Figure 12		-	0.1	0.5	µs

[1] measured with half-sine wave voltage (curve tracer)

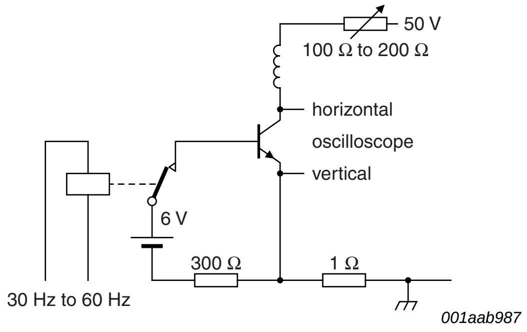
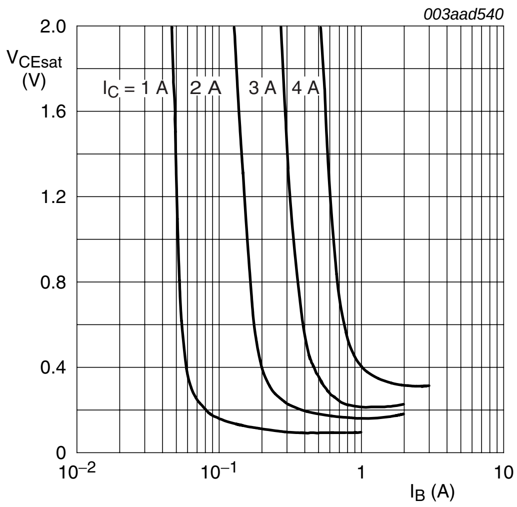
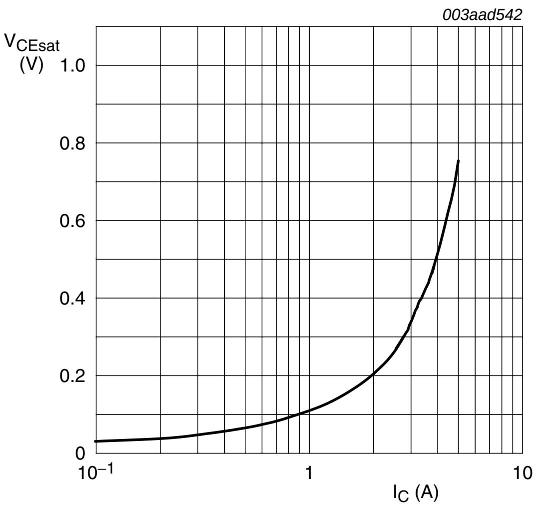


Fig 6. Test circuit for collector-emitter sustaining voltage



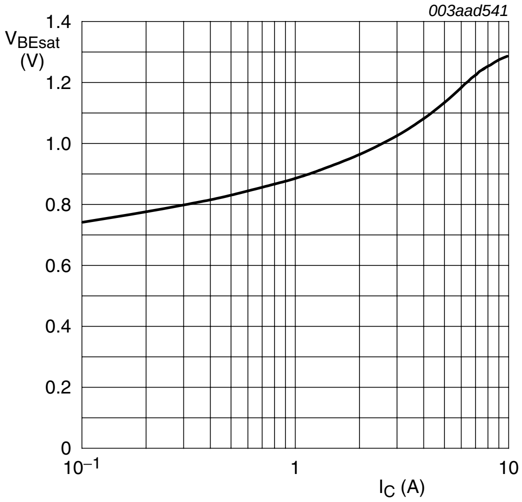
$T_j = 25\ °C$

Fig 7. Collector-emitter saturation voltage; typical values



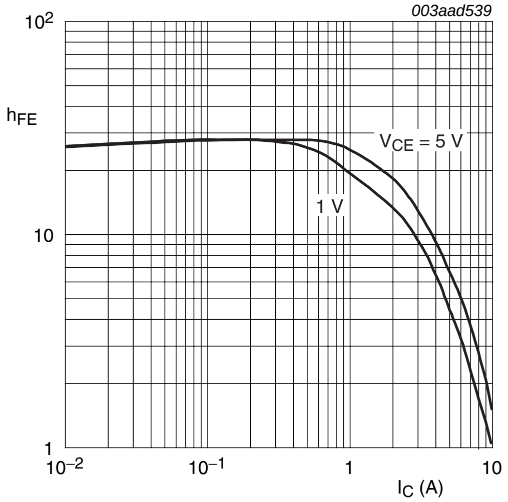
$$\frac{I_C}{I_B} = 4$$

Fig 8. Collector-emitter saturation voltage as a function of collector current; typical values



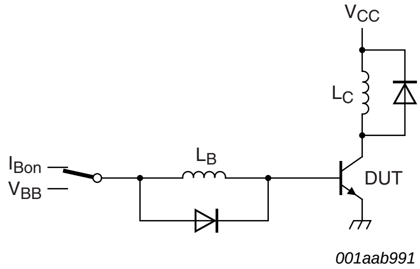
$$\frac{I_C}{I_B} = 4$$

Fig 9. Base-emitter saturation voltage; typical values



$T_j = 25\ °C$

Fig 10. DC current gain as a function of collector current; typical values



$V_{CC} = 300\ V;\ V_{BB} = -5\ V;\ L_C = 200\ \mu H;\ L_B = 1\ \mu H$

Fig 11. Test circuit for inductive load switching

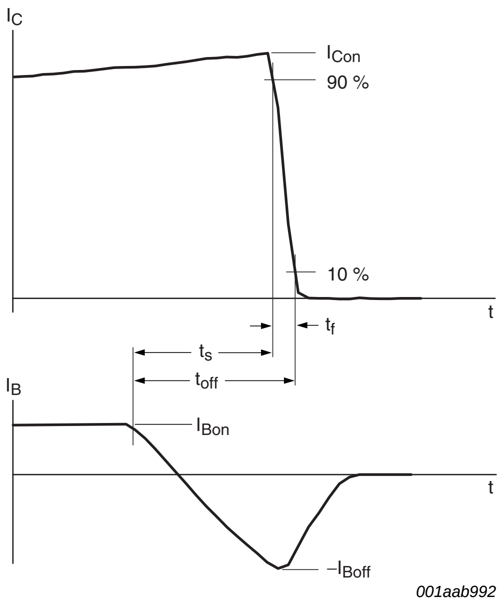
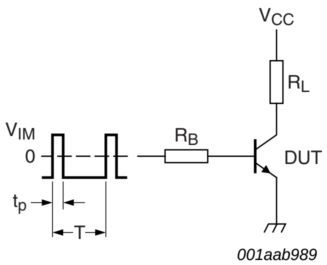


Fig 12. Switching times waveforms for inductive load



$V_{IM} = -6$ to $+8\ V;\ V_{CC} = 250\ V;\ t_p = 20\ \mu s;\ \delta = \frac{t_p}{T} = 0.01$

R_B and R_L calculated from I_{Con} and I_{Bon} requirements.

Fig 13. Test circuit for resistive load switching

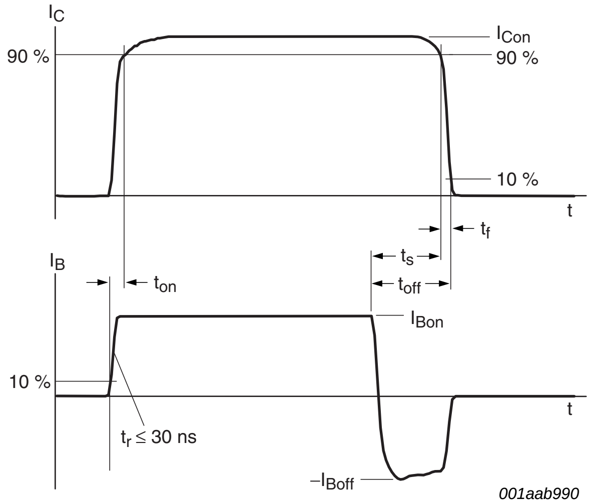


Fig 14. Switching times waveforms for resistive load

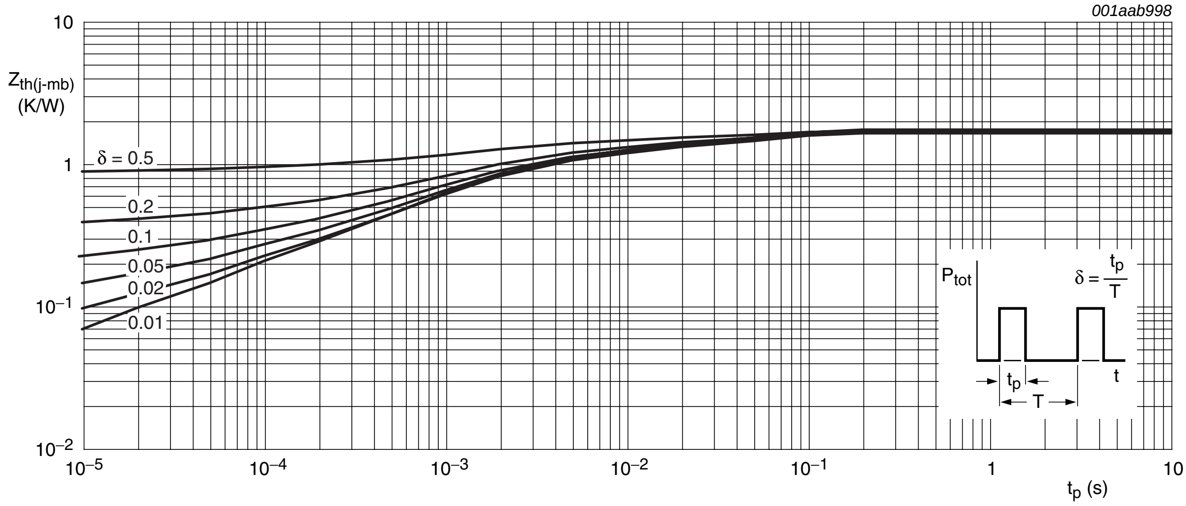
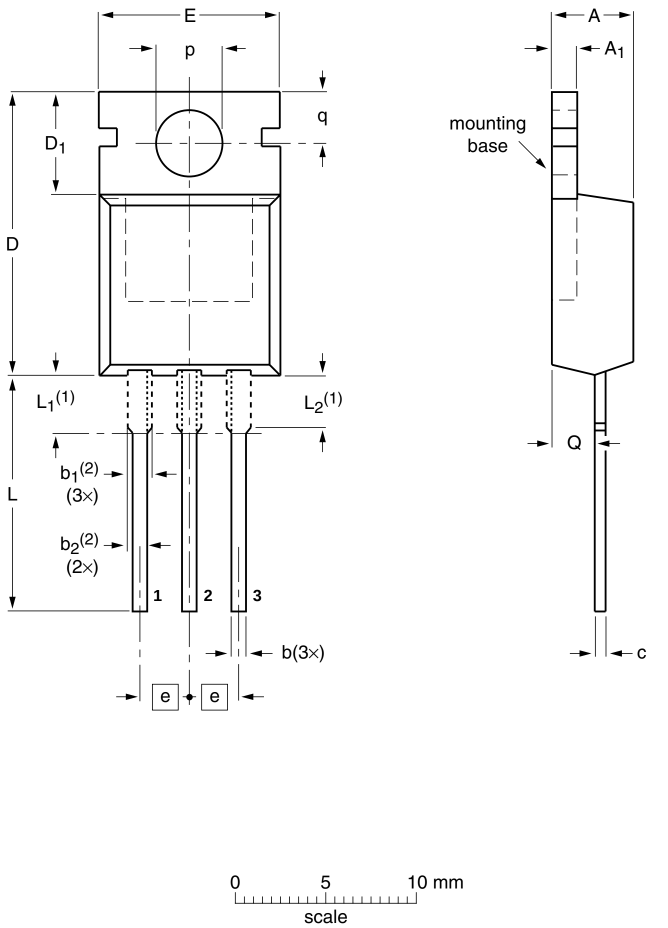


Fig 15. Transient thermal impedance from junction to mounting base as a function of pulse width

7. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB **SOT78**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	$b_1^{(2)}$	$b_2^{(2)}$	c	D	D_1	E	e	L	$L_1^{(1)}$	$L_2^{(1)}$ max.	p	q	Q
mm	4.7 4.1	1.40 1.25	0.9 0.6	1.6 1.0	1.3 1.0	0.7 0.4	16.0 15.2	6.6 5.9	10.3 9.7	2.54	15.0 12.8	3.30 2.79	3.0	3.8 3.5	3.0 2.7	2.6 2.2

Notes

1. Lead shoulder designs may vary.
2. Dimension includes excess dambar.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT78		3-lead TO-220AB	SC-46			~~08-04-23~~ 08-06-13

Fig 16. Package outline SOT78 (TO-220AB)

8. Revision history

Table 7. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PHD13005 v.2	20100729	Product data sheet	-	PHD13005 v.1
Modifications:	• Various changes to content.			
PHD13005 v.1	20100520	Product data sheet	-	-

9. Legal information

9.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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11. Contents

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