

# 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

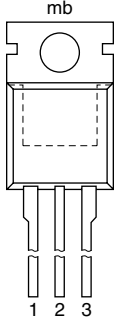
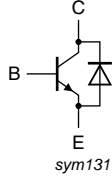
Table 1. Quick reference data

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



## 2. Pinning information

Table 2. Pinning information

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

**SOT78 (TO-220AB)**

## 3. Ordering information

Table 3. Ordering information

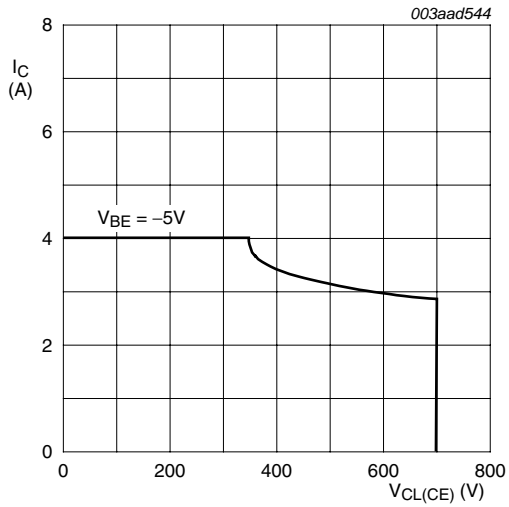
Type number	Package		
	Name	Description	Version
PHD13005	TO-220AB	plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB	SOT78

## 4. Limiting values

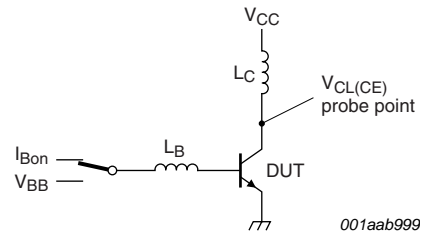
Table 4. Limiting values

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

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



$$T_j \leq T_{j(max)} \text{ } ^\circ\text{C}$$

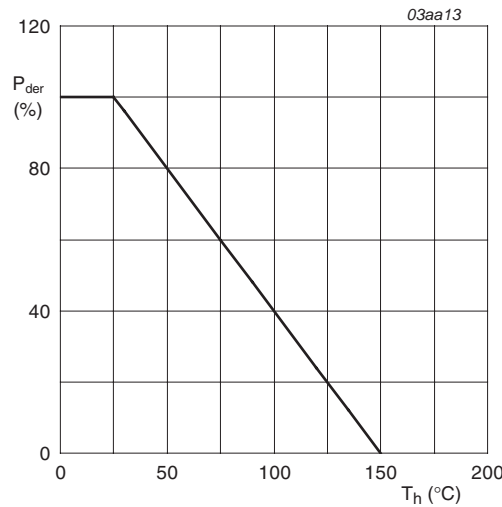


$$V_{CL(CE)} \leq 1000 \text{ V}; V_{CC} = 150 \text{ V}; V_{BB} = -5 \text{ V};$$

$$L_B = 1 \mu\text{H}; L_C = 200 \mu\text{H}$$

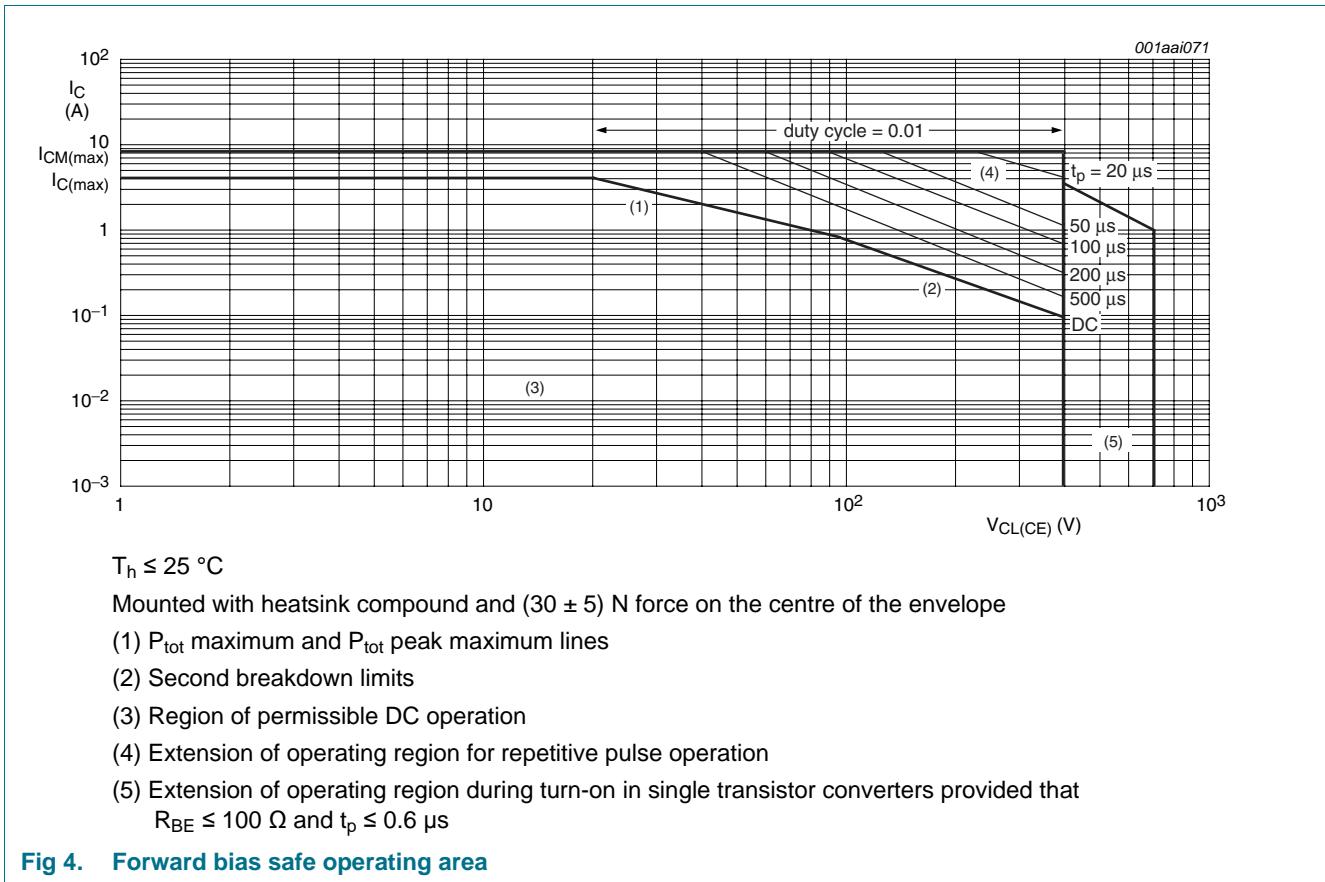
Fig 1. Reverse bias safe operating area

Fig 2. Test circuit for reverse bias safe operating area



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

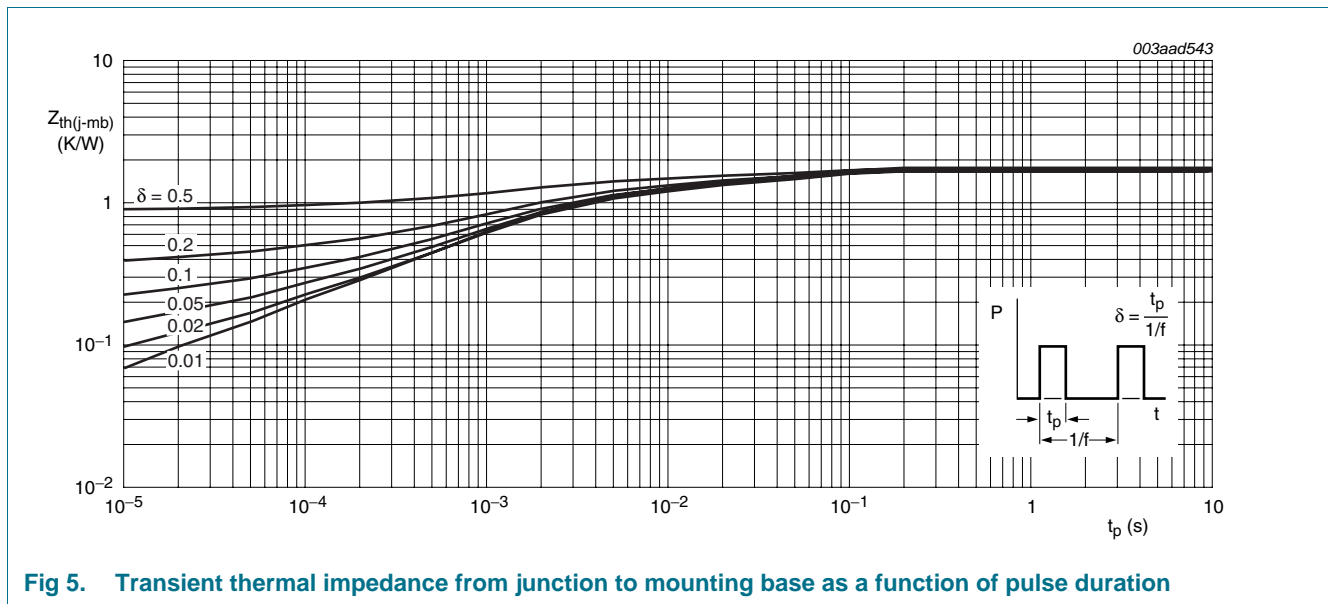
Fig 3. Normalized total power dissipation as a function of heatsink temperature



### 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 <a href="#">Figure 5</a>	-	-	1.67	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	-	60	-	K/W



## 6. Characteristics

Table 6. Characteristics

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

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

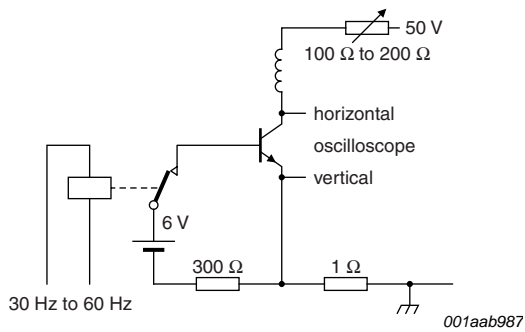


Fig 6. Test circuit for collector-emitter sustaining voltage

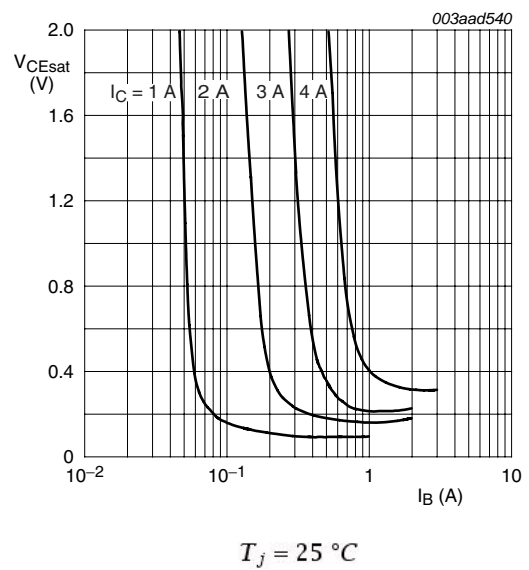


Fig 7. Collector-emitter saturation voltage; typical values

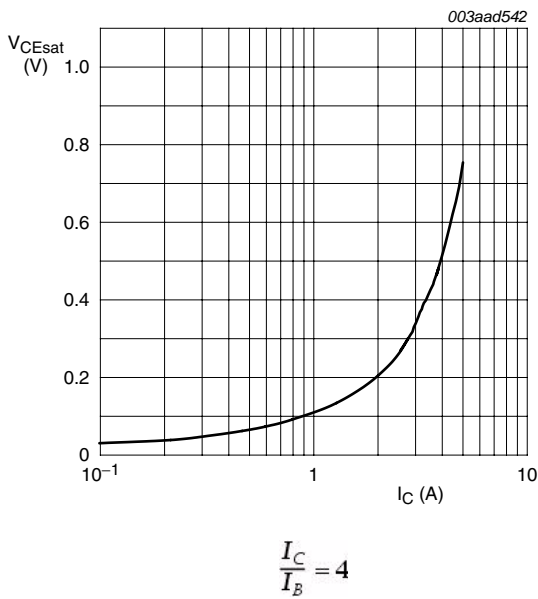


Fig 8. Collector-emitter saturation voltage as a function of collector current; typical values

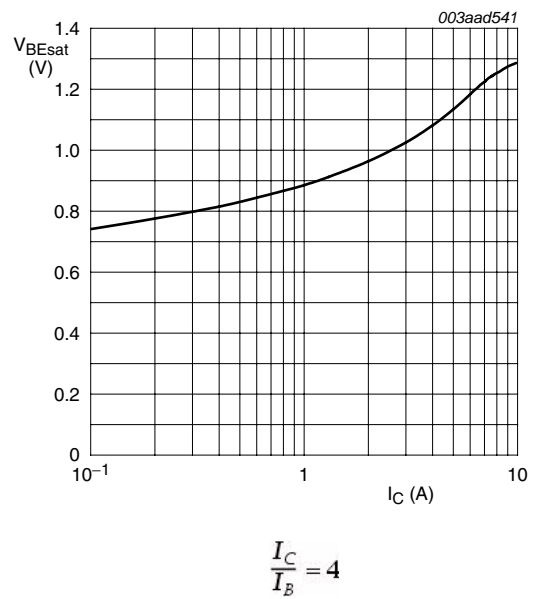
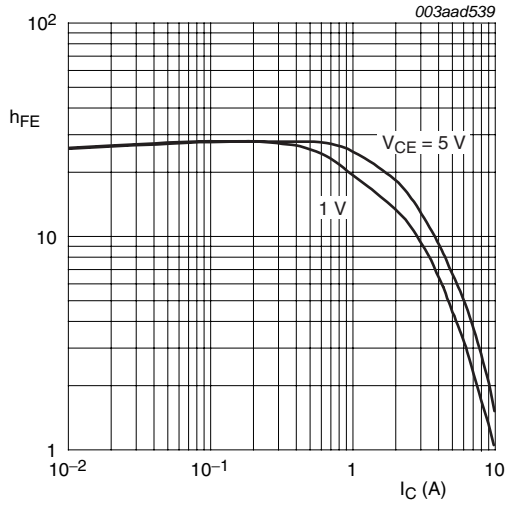
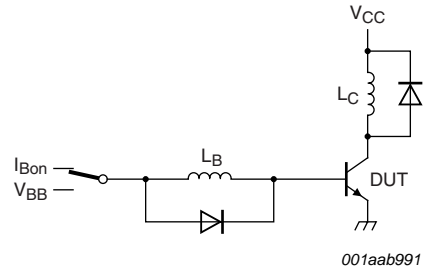


Fig 9. Base-emitter saturation voltage; typical values



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

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



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

Fig 11. Test circuit for inductive load switching

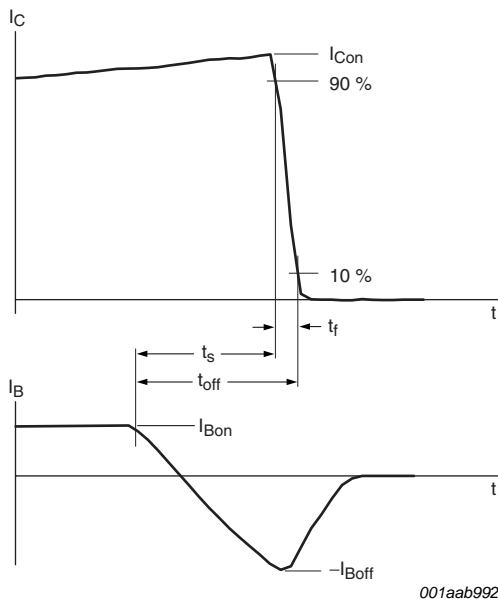
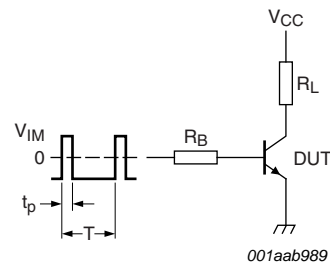


Fig 12. Switching times waveforms for inductive load



$V_{IM} = -6\text{ to }+8\text{ V}; V_{CC} = 250\text{ V}; t_p = 20\text{ }\mu\text{s}; \delta = \frac{t_p}{T} = 0.01$   
 $R_B$  and  $R_L$  calculated from  $I_{COn}$  and  $I_{BOn}$  requirements.

Fig 13. Test circuit for resistive load switching



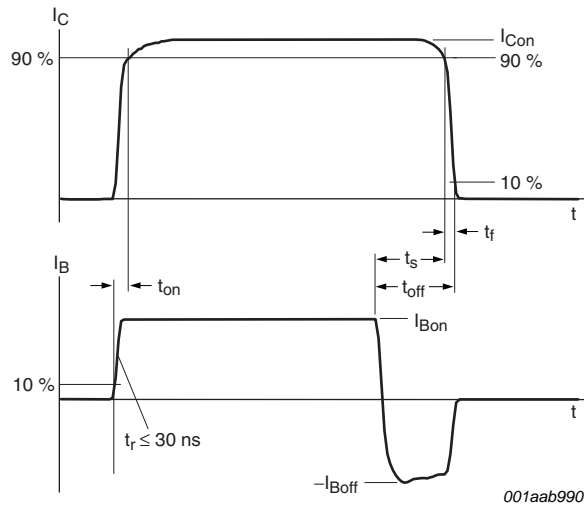


Fig 14. Switching times waveforms for resistive load

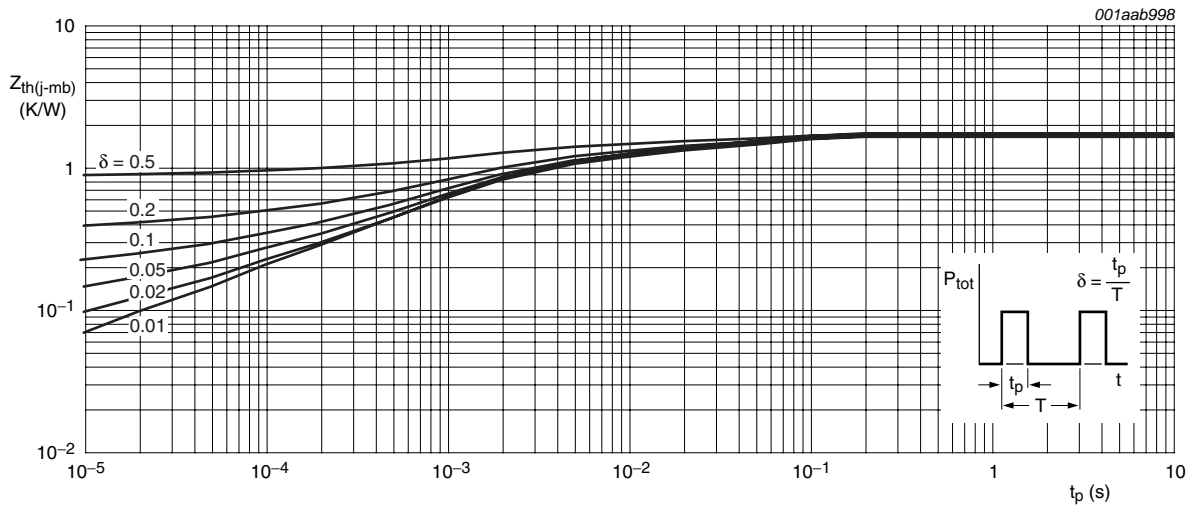


Fig 15. Transient thermal impedance from junction to mounting base as a function of pulse width

## 7. Package outline

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

SOT78

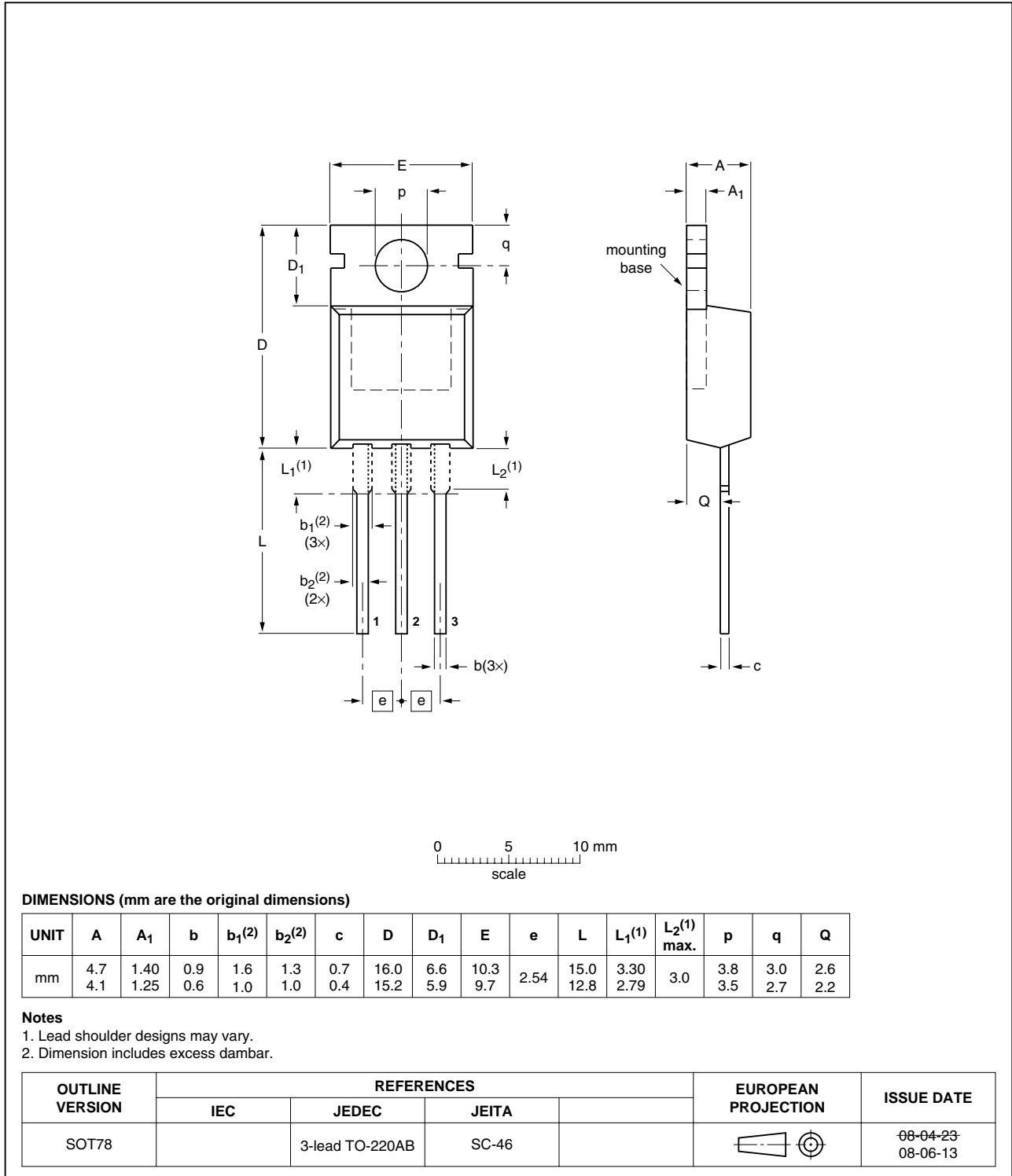


Fig 16. Package outline SOT78 (TO-220AB)

## 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 <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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.

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

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