PHE13005X

Silicon diffused power transistor

Rev. 02 — 20 November 2009 | Product data sheet

1. Product profile

1.1 General description

High-voltage, high-speed planar-passivated, NPN power switching transistor in a full pack plastic package for use in high frequency electronic lighting ballast applications

1.2 Features and benefits

- Fast switching
- High voltage capability of 700 V
- Isolated package
- Low thermal resistance

1.3 Applications

- Electronic lighting ballasts

1.4 Quick reference data

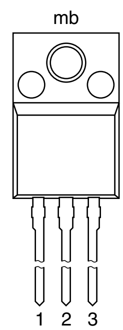
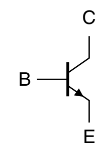
Table 1. Quick reference

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_C	collector current	DC; see Figure 3, 1 and 2	-	-	4	A
P_{tot}	total power dissipation	$T_h \leq 25$ °C; see Figure 4	-	-	26	W
V_{CESM}	collector-emitter peak voltage	$V_{BE} = 0$ V	-	-	700	V
Static characteristics						
h_{FE}	DC current gain	$I_C = 1$ A; $V_{CE} = 5$ V; $T_h = 25$ °C; see Figure 11	12	20	40	
		$V_{CE} = 5$ V; $I_C = 2$ A; $T_h = 25$ °C; see Figure 11	10	17	28	

founded by Philips

2. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	B	base	 SOT186A (TO-220F)	
2	C	collector		
3	E	emitter		
mb	n.c.	isolated		

3. Ordering information

Table 3. Ordering information

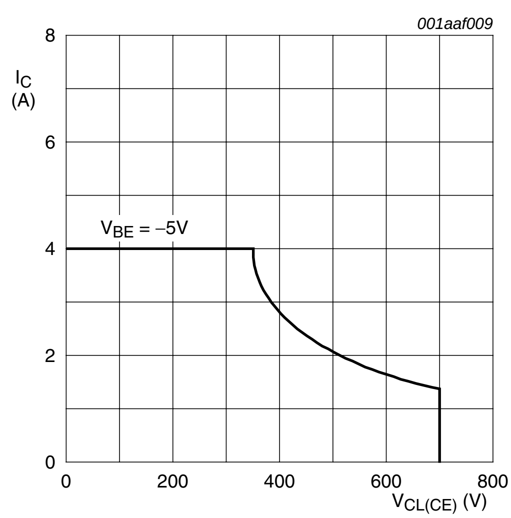
Type number	Package		
	Name	Description	Version
PHE13005X	TO-220F	plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack"	SOT186A

4. Limiting values

Table 4. Limiting values

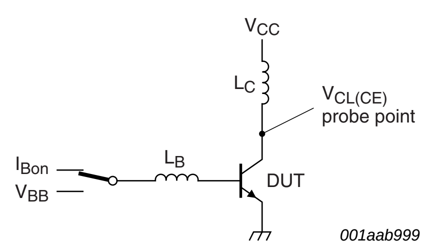
In accordance with the Absolute Maximum Rating System (IEC 60134).

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 3, 1 and 2	-	4	A
I_{CM}	peak collector current		-	8	A
I_B	base current		-	2	A
I_{BM}	peak base current		-	4	A
P_{tot}	total power dissipation	$T_h \leq 25$ °C; see Figure 4	-	26	W
T_{stg}	storage temperature		-65	150	°C
T_j	junction temperature		-	150	°C



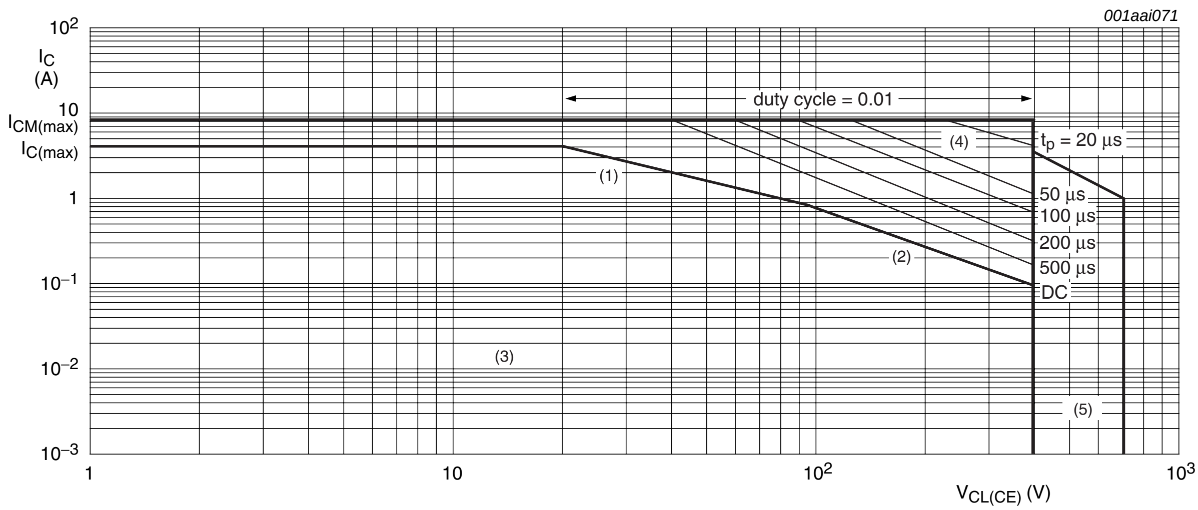
$$T_j = T_{j(max)} \text{ °C}$$

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



$T_h \leq 25$ °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

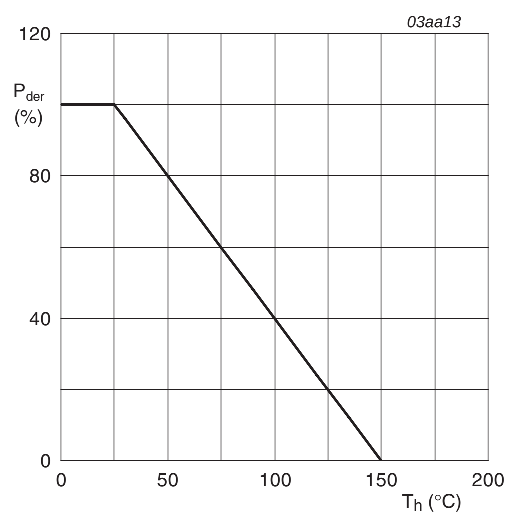
(2) Second breakdown limits

(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 $t_p \leq 0.6\ \mu s$

Fig 3. Forward bias safe operating area



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

Fig 4. Normalized total power dissipation as a function of heatsink temperature

5. Thermal characteristics

Table 5. Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-h)}$	thermal resistance from junction to heatsink	with heatsink compound; see Figure 5	-	-	4.8	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient		-	55	-	K/W

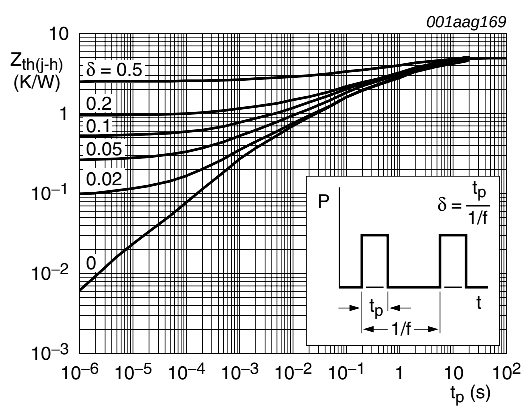


Fig 5. Transient thermal impedance from junction to heatsink as a function of pulse duration

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

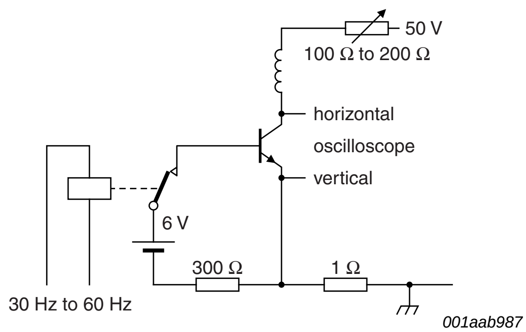


Fig 6. Test circuit for collector-emitter sustaining voltage

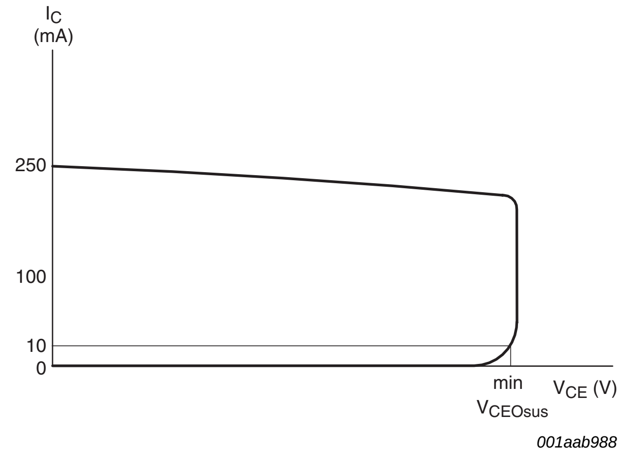
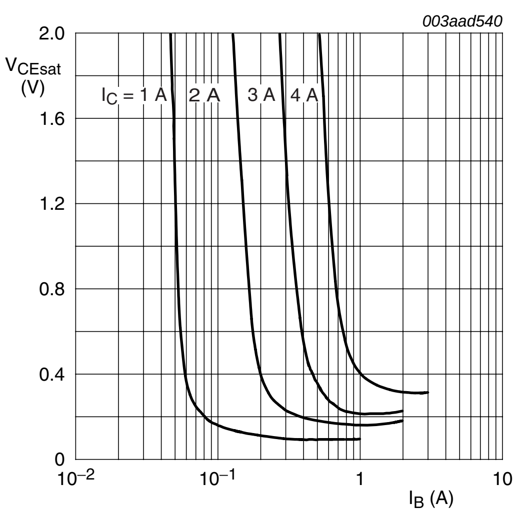
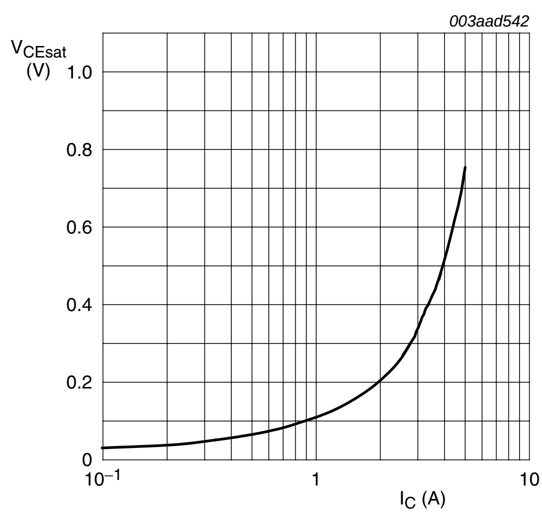


Fig 7. Oscilloscope display for collector-emitter sustaining voltage test waveform



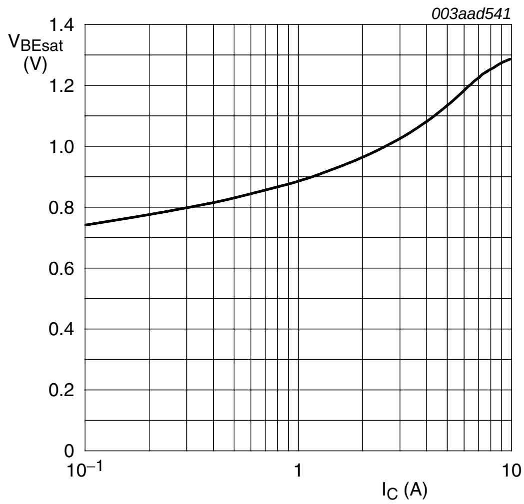
$T_j = 25\ °C$

Fig 8. Collector-emitter saturation voltage; typical values



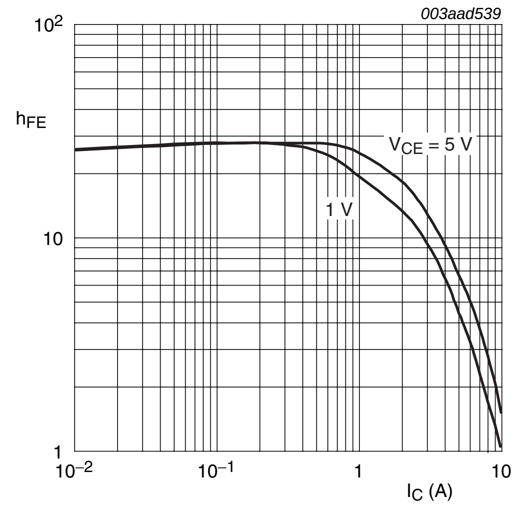
$\frac{I_C}{I_B} = 4$

Fig 9. Collector-emitter saturation voltage as a function of collector current; typical values



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

Fig 10. Base-emitter saturation voltage; typical values



$$T_j = 25\ °C$$

Fig 11. DC current gain as a function of collector current; typical values

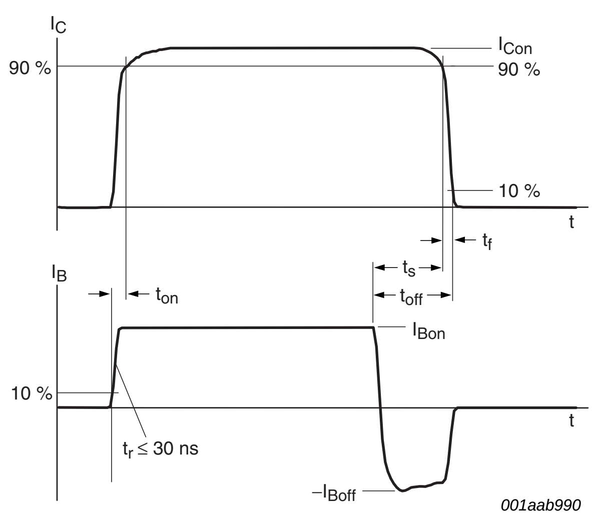
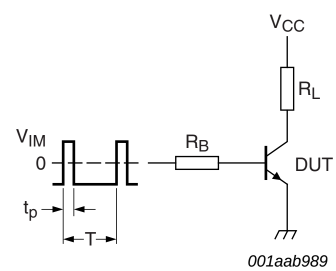


Fig 12. Switching times waveforms for resistive load



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

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

Fig 13. Test circuit for resistive load switching

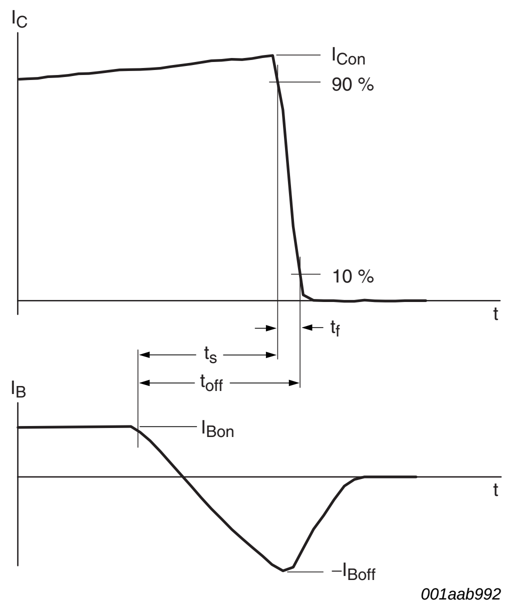
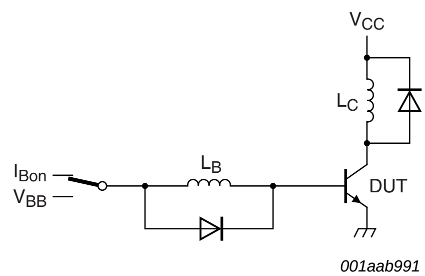


Fig 14. Switching times waveforms for inductive load



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

Fig 15. Test circuit for inductive load switching

7. Isolation characteristics

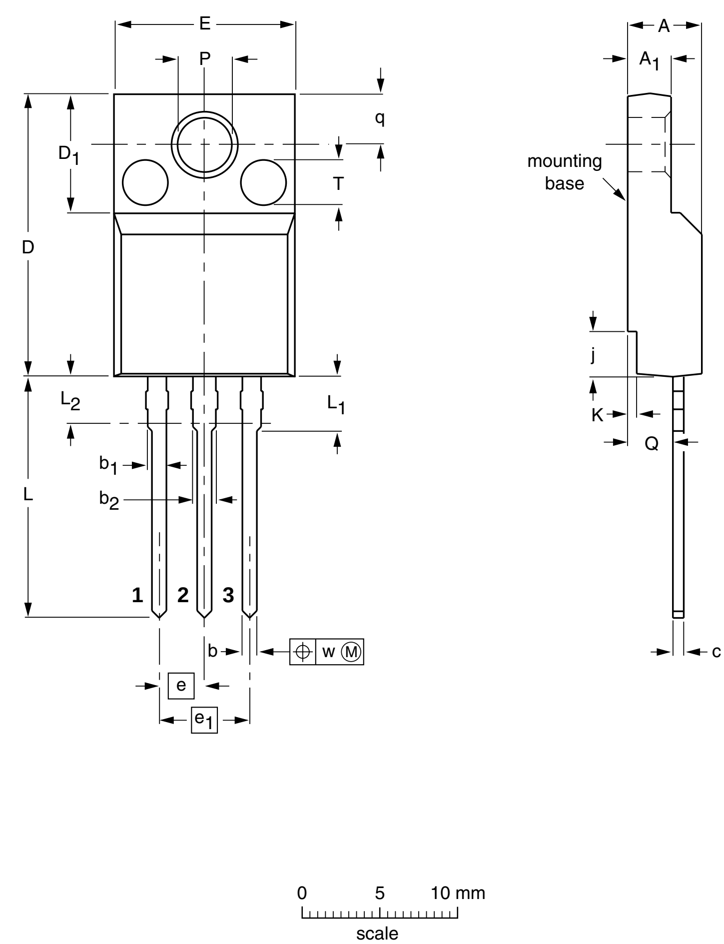
Table 7. Isolation characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{isol(RMS)}$	RMS isolation voltage	50 Hz ≤ f ≤ 60 Hz; RH ≤ 65 %; T_h = 25 °C; from all terminals to external heatsink; clean and dust free	-	-	2500	V
C_{isol}	isolation capacitance	from collector to external heatsink; f = 1 MHz; T_h = 25 °C	-	10	-	pF

8. Package outline

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

SOT186A



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	b_1	b_2	c	D	D_1	E	e	e_1	j	K	L	L_1	L_2 (1) max.	P	Q	q	T (2)	w
mm	4.6 4.0	2.9 2.5	0.9 0.7	1.1 0.9	1.4 1.0	0.7 0.4	15.8 15.2	6.5 6.3	10.3 9.7	2.54	5.08	2.7 1.7	0.6 0.4	14.4 13.5	3.30 2.79	3	3.2 3.0	2.6 2.3	3.0 2.6	2.5	0.4

Notes

1. Terminal dimensions within this zone are uncontrolled.
2. Both recesses are ∅ 2.5 × 0.8 max. depth

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT186A		3-lead TO-220F				~~02-04-09~~ 06-02-14

Fig 16. Package outline SOT186A (TO-220F)

9. Revision history

Table 8. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PHE13005X_2	20091120	Product data sheet	-	PHE13005X_1
Modifications:	• Various changes to content.			
PHE13005X_1	20080515	Product data sheet	-	-

10. Legal information

10.1 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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