

# PMBT3946VPN

40 V, 200 mA NPN/PNP switching transistor

Rev. 01 — 31 August 2009

Product data sheet

## 1. Product profile

### 1.1 General description

NPN/PNP double switching transistor in a SOT666 ultra small and flat lead Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

Type number	Package		NPN/PNP complement	PNP/PNP complement
	NXP	JEITA		
PMBT3946VPN	SOT666	-	PMBT3904VS	PMBT3906VS

### 1.2 Features

- Double general-purpose switching transistor
- Board-space reduction
- Ultra small and flat lead SMD plastic package

### 1.3 Applications

- General-purpose switching and amplification

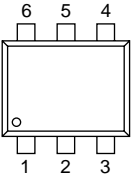
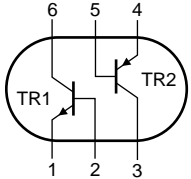
### 1.4 Quick reference data

Table 2. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor; for the PNP transistor with negative polarity</b>						
$V_{CE0}$	collector-emitter voltage	open base	-	-	40	V
$I_C$	collector current		-	-	200	mA
<b>TR1 (NPN)</b>						
$h_{FE}$	DC current gain	$V_{CE} = 1\text{ V};$ $I_C = 10\text{ mA}$	100	180	300	
<b>TR2 (PNP)</b>						
$h_{FE}$	DC current gain	$V_{CE} = -1\text{ V};$ $I_C = -10\text{ mA}$	100	180	300	

## 2. Pinning information

**Table 3. Pinning**

Pin	Description	Simplified outline	Graphic symbol
1	emitter TR1		
2	base TR1		
3	collector TR2		
4	emitter TR2		
5	base TR2		
6	collector TR1		

*sym019*

## 3. Ordering information

**Table 4. Ordering information**

Type number	Package		
	Name	Description	Version
PMBT3946VPN	-	plastic surface-mounted package; 6 leads	SOT666

## 4. Marking

**Table 5. Marking codes**

Type number	Marking code
PMBT3946VPN	ZE

## 5. Limiting values

**Table 6. Limiting values**

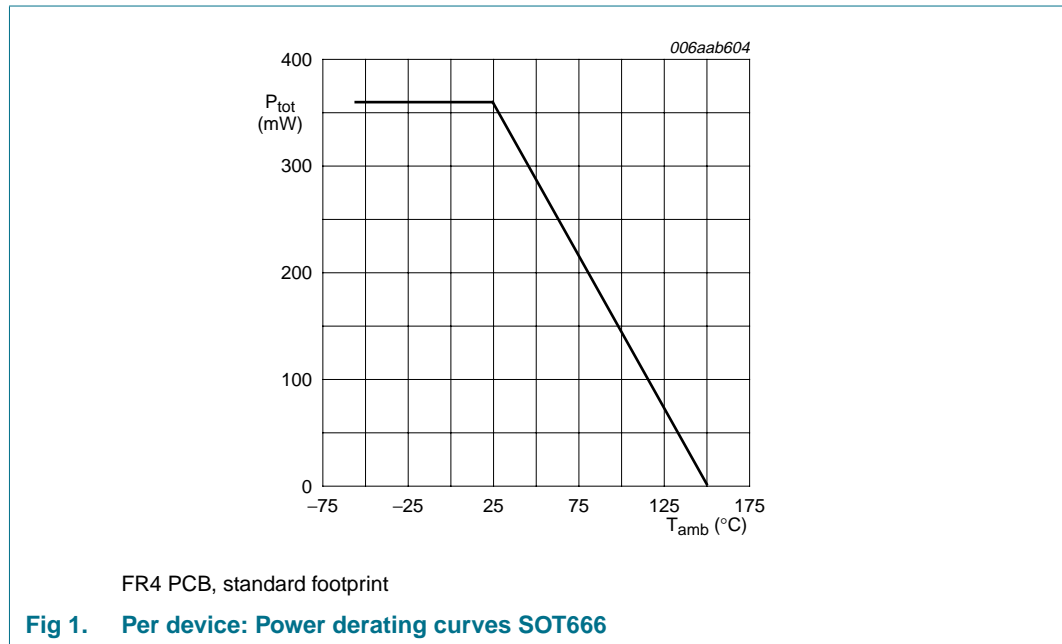
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

Symbol	Parameter	Conditions	Min	Max	Unit
<b>TR1 (NPN)</b>					
$V_{CBO}$	collector-base voltage	open emitter	-	60	V
<b>TR2 (PNP)</b>					
$V_{CBO}$	collector-base voltage	open emitter	-	-40	V
<b>Per transistor; for the PNP transistor with negative polarity</b>					
$V_{CEO}$	collector-emitter voltage	open base	-	40	V
$V_{EBO}$	emitter-base voltage	open collector	-	6	V
$I_C$	collector current		-	200	mA
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	200	mA
$I_{BM}$	peak base current	single pulse; $t_p \leq 1$ ms	-	100	mA
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1][2]	-	240 mW

**Table 6. Limiting values ...continued**  
 In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
<b>Per device</b>					
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$ [1][2]	-	360	mW
$T_j$	junction temperature		-	150	°C
$T_{amb}$	ambient temperature		-55	+150	°C
$T_{stg}$	storage temperature		-65	+150	°C

- [1] Reflow soldering is the only recommended soldering method.
- [2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

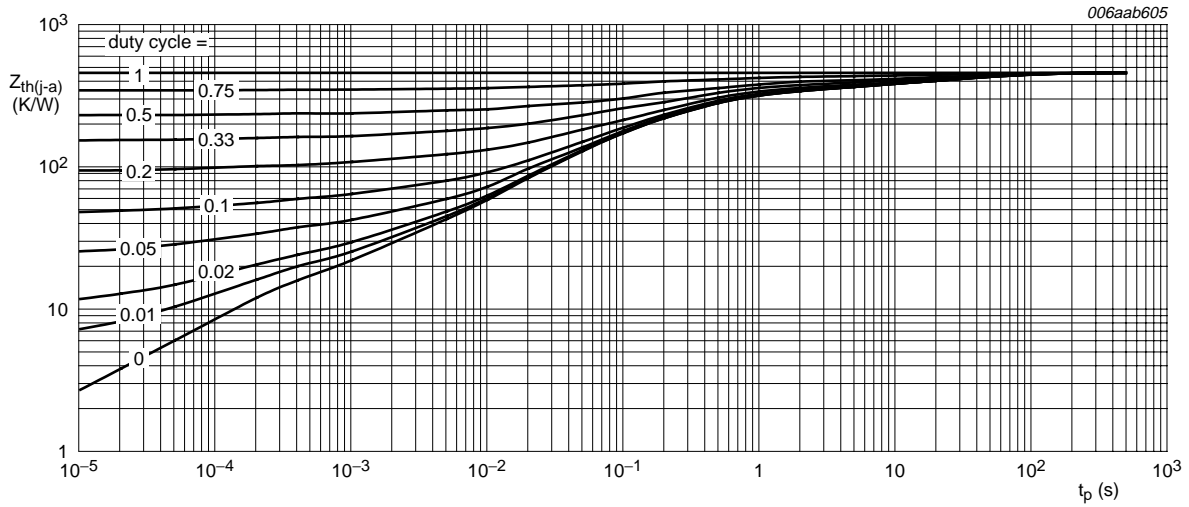


## 6. Thermal characteristics

**Table 7. Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Per transistor</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1][2]	-	521	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	100	K/W
<b>Per device</b>						
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1][2]	-	347	K/W

- [1] Reflow soldering is the only recommended soldering method.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.



FR4 PCB, standard footprint

Fig 2. Per transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 7. Characteristics

Table 8. Characteristics

$T_{amb} = 25^{\circ}C$  unless otherwise specified.

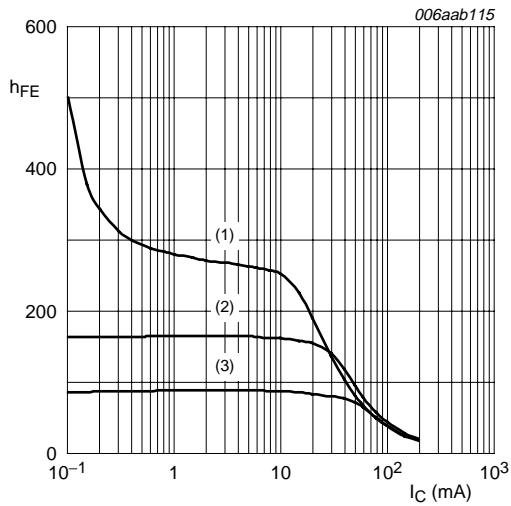
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1 (NPN)</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 30\text{ V}; I_E = 0\text{ A}$	-	-	50	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 6\text{ V}; I_C = 0\text{ A}$	-	-	50	nA
$h_{FE}$	DC current gain	$V_{CE} = 1\text{ V}$				
		$I_C = 0.1\text{ mA}$	60	180	-	
		$I_C = 1\text{ mA}$	80	180	-	
		$I_C = 10\text{ mA}$	100	180	300	
		$I_C = 50\text{ mA}$	60	105	-	
		$I_C = 100\text{ mA}$	30	50	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	-	75	200	mV
		$I_C = 50\text{ mA}; I_B = 5\text{ mA}$	-	120	300	mV
$V_{BEsat}$	base-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 1\text{ mA}$	650	750	850	mV
		$I_C = 50\text{ mA}; I_B = 5\text{ mA}$	-	850	950	mV

**Table 8. Characteristics ...continued**  
 $T_{amb} = 25^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$t_d$	delay time	$V_{CC} = 3\text{ V}; I_C = 10\text{ mA};$	-	-	35	ns
$t_r$	rise time	$I_{Bon} = 1\text{ mA};$	-	-	35	ns
$t_{on}$	turn-on time	$I_{Boff} = -1\text{ mA}$	-	-	70	ns
$t_s$	storage time		-	-	200	ns
$t_f$	fall time		-	-	50	ns
$t_{off}$	turn-off time		-	-	250	ns
$C_c$	collector capacitance	$V_{CB} = 5\text{ V}; I_E = i_e = 0\text{ A};$ $f = 1\text{ MHz}$	-	-	4	pF
$C_e$	emitter capacitance	$V_{EB} = 500\text{ mV};$ $I_C = i_c = 0\text{ A}; f = 1\text{ MHz}$	-	-	8	pF
$f_T$	transition frequency	$V_{CE} = 20\text{ V}; I_C = 10\text{ mA};$ $f = 100\text{ MHz}$	300	-	-	MHz
NF	noise figure	$V_{CE} = 5\text{ V}; I_C = 100\text{ }\mu\text{A};$ $R_S = 1\text{ k}\Omega;$ $f = 10\text{ Hz to }15.7\text{ kHz}$	-	-	5	dB
<b>TR2 (PNP)</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = -30\text{ V}; I_E = 0\text{ A}$	-	-	-50	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = -6\text{ V}; I_C = 0\text{ A}$	-	-	-50	nA
$h_{FE}$	DC current gain	$V_{CE} = -1\text{ V}$				
		$I_C = -0.1\text{ mA}$	60	180	-	
		$I_C = -1\text{ mA}$	80	180	-	
		$I_C = -10\text{ mA}$	100	180	300	
		$I_C = -50\text{ mA}$	60	130	-	
		$I_C = -100\text{ mA}$	30	50	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = -10\text{ mA}; I_B = -1\text{ mA}$	-	-100	-250	mV
		$I_C = -50\text{ mA}; I_B = -5\text{ mA}$	-	-165	-400	mV
$V_{BEsat}$	base-emitter saturation voltage	$I_C = -10\text{ mA}; I_B = -1\text{ mA}$	-	-750	-850	mV
		$I_C = -50\text{ mA}; I_B = -5\text{ mA}$	-	-850	-950	mV
$t_d$	delay time	$V_{CC} = -3\text{ V};$	-	-	35	ns
$t_r$	rise time	$I_C = -10\text{ mA};$	-	-	35	ns
$t_{on}$	turn-on time	$I_{Bon} = -1\text{ mA};$ $I_{Boff} = 1\text{ mA}$	-	-	70	ns
$t_s$	storage time		-	-	225	ns
$t_f$	fall time		-	-	75	ns
$t_{off}$	turn-off time		-	-	300	ns
$C_c$	collector capacitance	$V_{CB} = -5\text{ V}; I_E = i_e = 0\text{ A};$ $f = 1\text{ MHz}$	-	-	4.5	pF

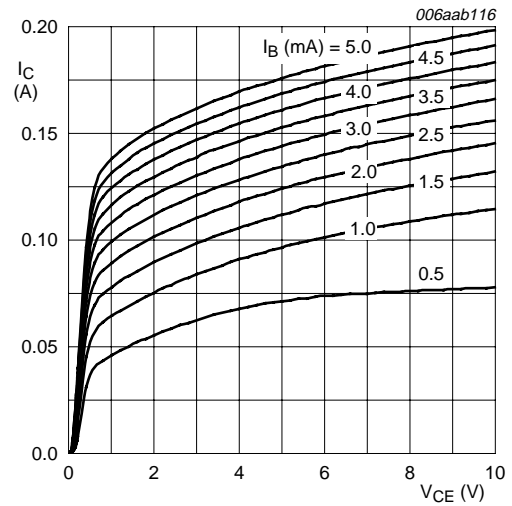
**Table 8. Characteristics ...continued**  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$C_e$	emitter capacitance	$V_{EB} = -500\text{ mV};$ $I_C = i_c = 0\text{ A}; f = 1\text{ MHz}$	-	-	10	pF
$f_T$	transition frequency	$V_{CE} = -20\text{ V};$ $I_C = -10\text{ mA};$ $f = 100\text{ MHz}$	250	-	-	MHz
NF	noise figure	$V_{CE} = -5\text{ V};$ $I_C = -100\text{ }\mu\text{A}; R_S = 1\text{ k}\Omega;$ $f = 10\text{ Hz to }15.7\text{ kHz}$	-	-	4	dB



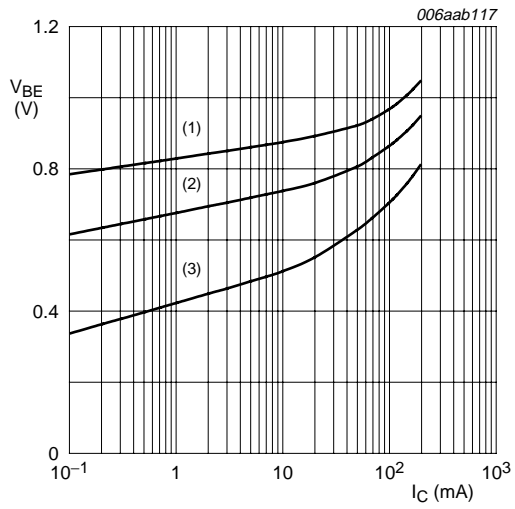
$V_{CE} = 1\text{ V}$   
 (1)  $T_{amb} = 150\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = -55\text{ }^{\circ}\text{C}$

**Fig 3. TR1 (NPN): DC current gain as a function of collector current; typical values**



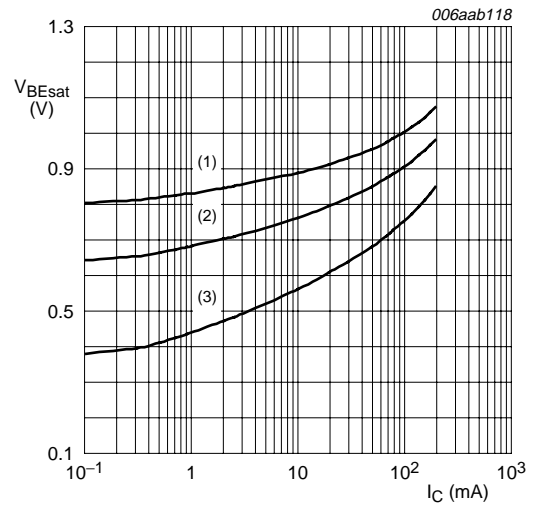
$T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig 4. TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values**



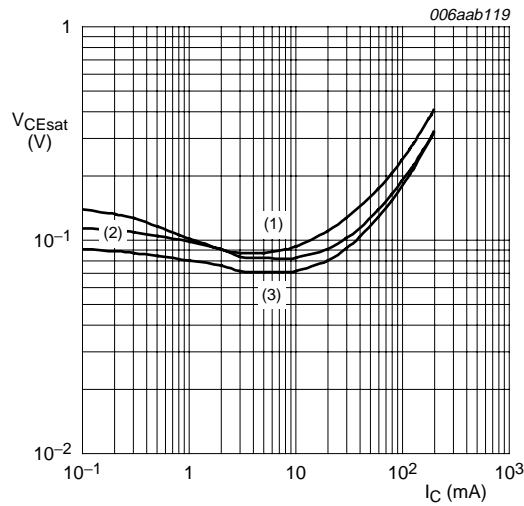
$V_{CE} = 1\text{ V}$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 150\text{ °C}$

**Fig 5. TR1 (NPN): Base-emitter voltage as a function of collector current; typical values**



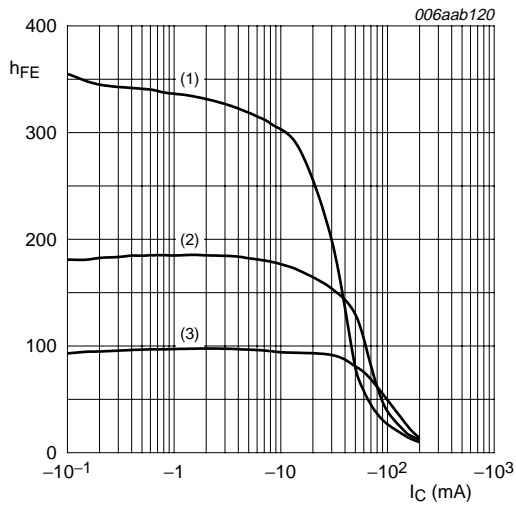
$I_C/I_B = 10$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 150\text{ °C}$

**Fig 6. TR1 (NPN): Base-emitter saturation voltage as a function of collector current; typical values**



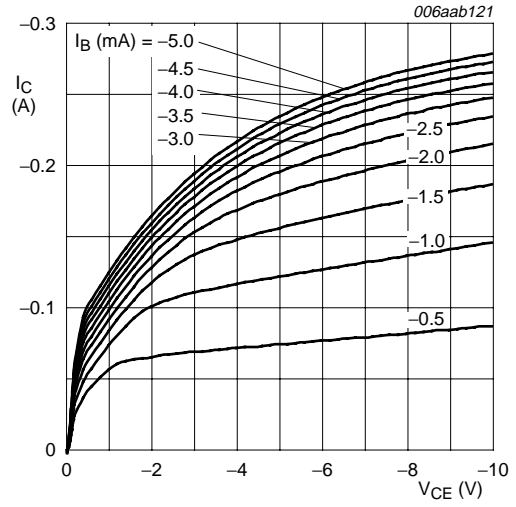
$I_C/I_B = 10$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

**Fig 7. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



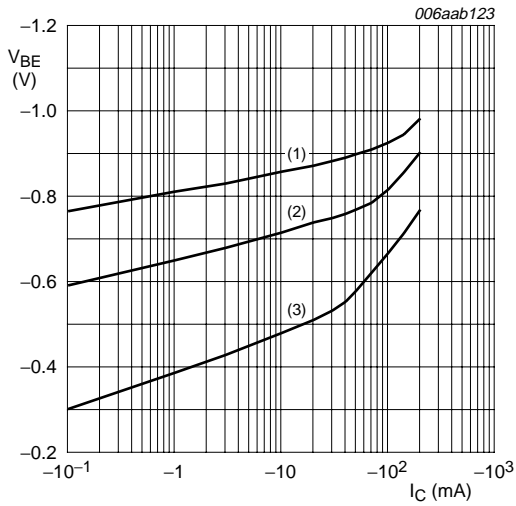
$V_{CE} = -1\text{ V}$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

**Fig 8. TR2 (PNP): DC current gain as a function of collector current; typical values**



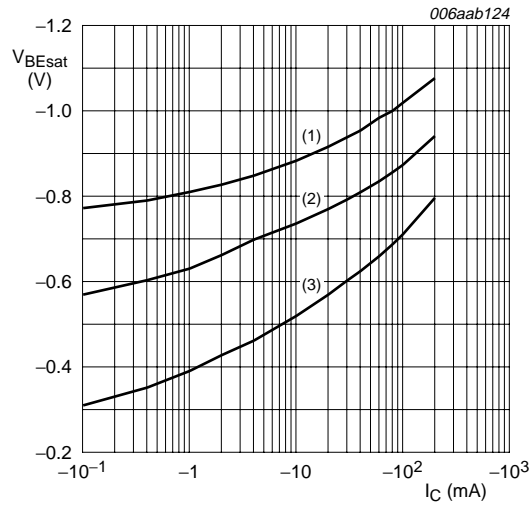
$T_{amb} = 25\text{ °C}$

**Fig 9. TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



$V_{CE} = -1\text{ V}$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 150\text{ °C}$

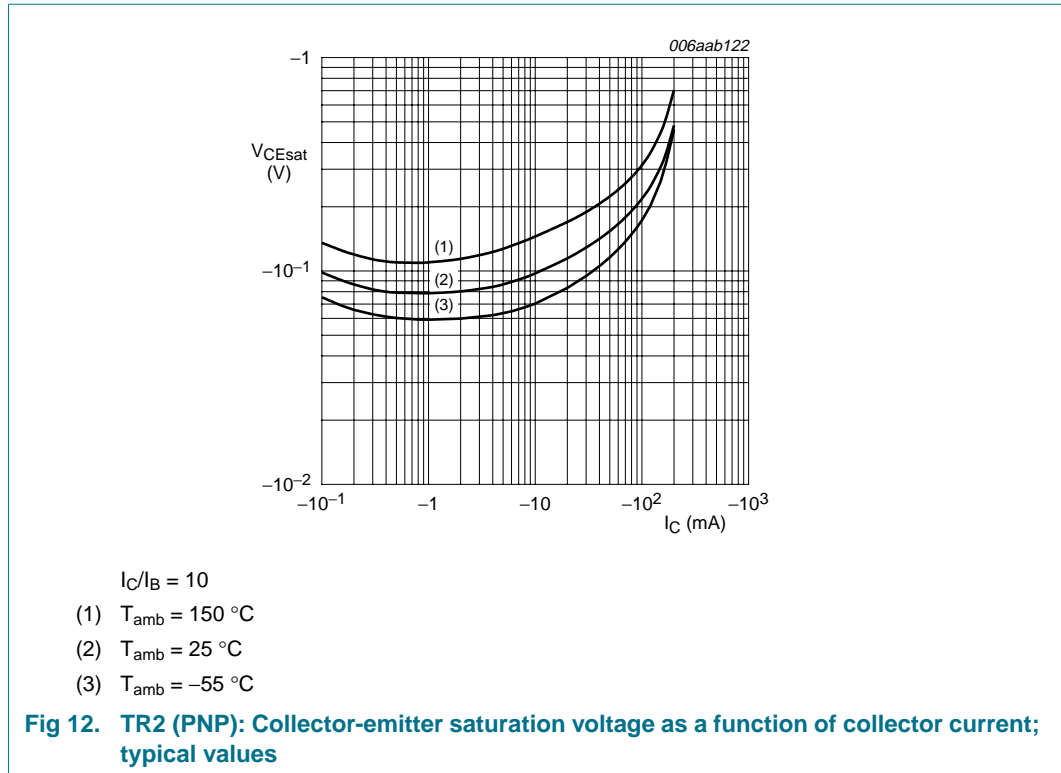
**Fig 10. TR2 (PNP): Base-emitter voltage as a function of collector current; typical values**



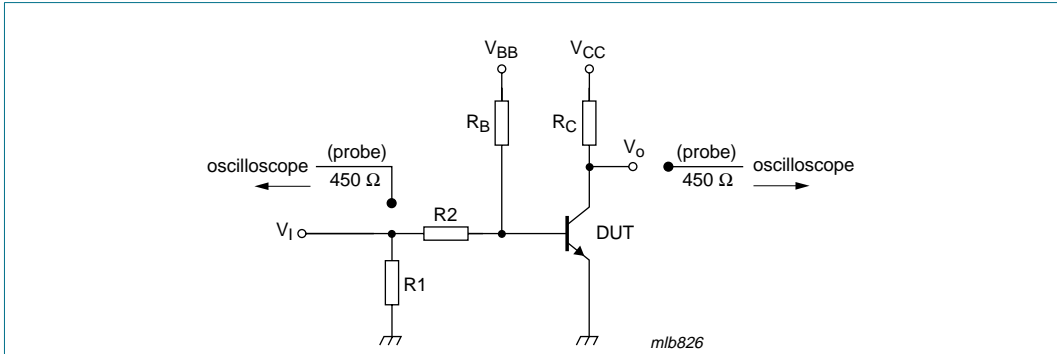
$I_C/I_B = 10$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 150\text{ °C}$

**Fig 11. TR2 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**



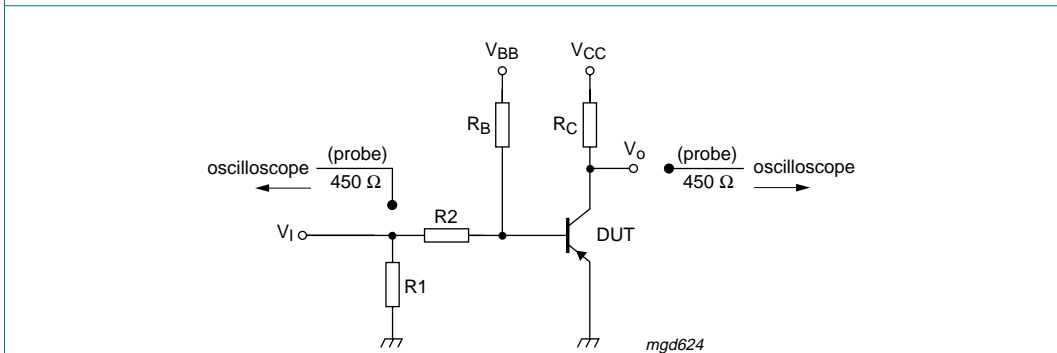


**8. Test information**



$V_I = 5\text{ V}$ ;  $t = 600\ \mu\text{s}$ ;  $t_p = 10\ \mu\text{s}$ ;  $t_r = t_f \leq 3\ \text{ns}$   
 $R_1 = 56\ \Omega$ ;  $R_2 = 2.5\ \text{k}\Omega$ ;  $R_B = 3.9\ \text{k}\Omega$ ;  $R_C = 270\ \Omega$   
 $V_{BB} = -1.9\ \text{V}$ ;  $V_{CC} = 3\ \text{V}$   
 Oscilloscope: input impedance  $Z_i = 50\ \Omega$

**Fig 13. TR1 (NPN): Test circuit for switching times**



$V_I = 5\text{ V}$ ;  $t = 600\ \mu\text{s}$ ;  $t_p = 10\ \mu\text{s}$ ;  $t_r = t_f \leq 3\ \text{ns}$   
 $R_1 = 56\ \Omega$ ;  $R_2 = 2.5\ \text{k}\Omega$ ;  $R_B = 3.9\ \text{k}\Omega$ ;  $R_C = 270\ \Omega$   
 $V_{BB} = 1.9\ \text{V}$ ;  $V_{CC} = -3\ \text{V}$   
 Oscilloscope: input impedance  $Z_i = 50\ \Omega$

**Fig 14. TR2 (PNP): Test circuit for switching times**

## 9. Package outline

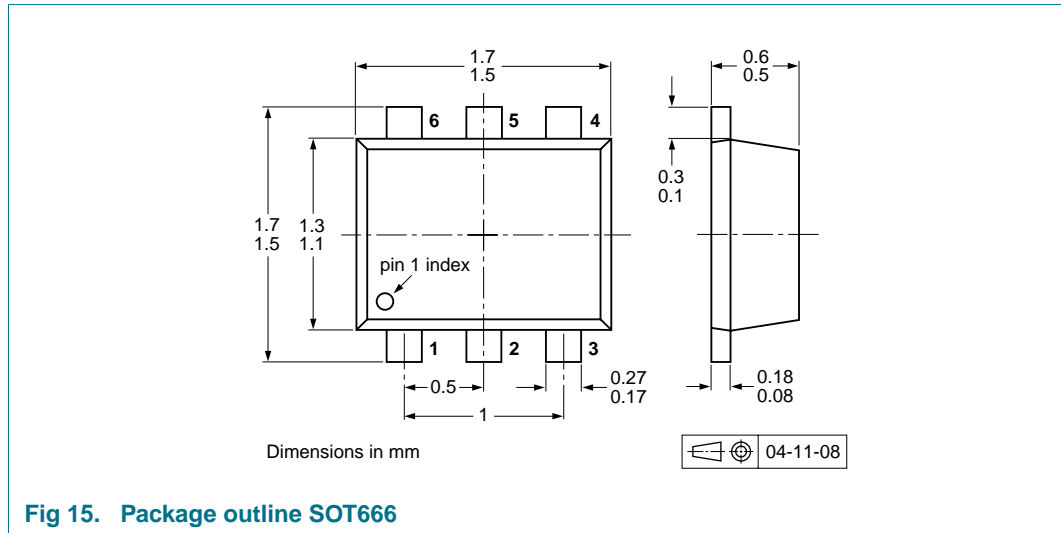


Fig 15. Package outline SOT666

## 10. Packing information

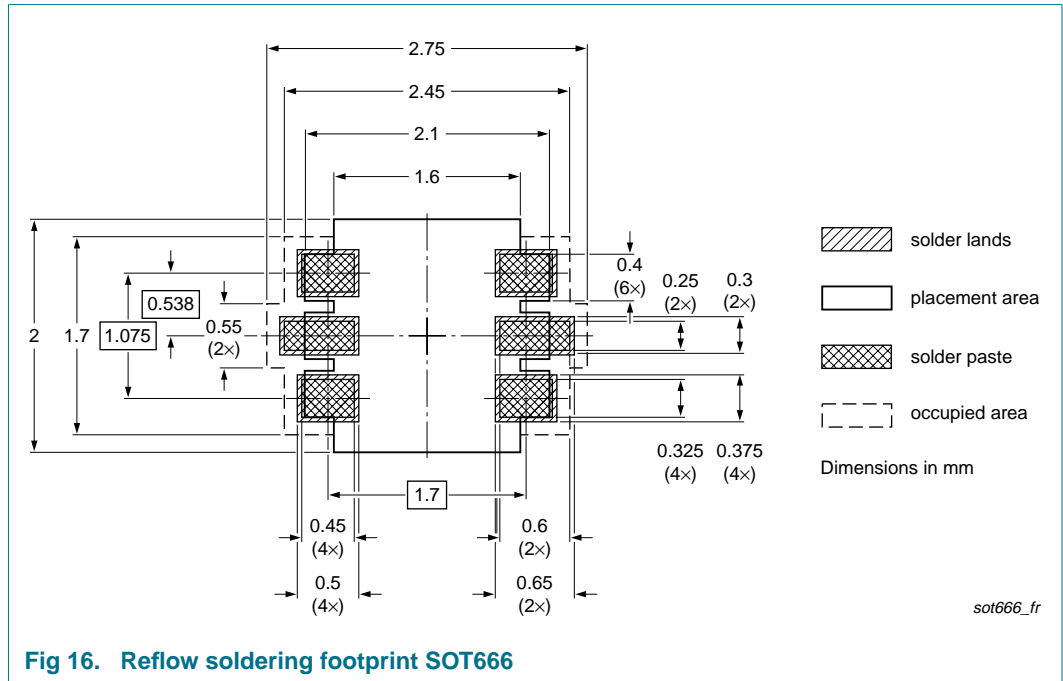
**Table 9. Packing methods**

The indicated -xxx are the last three digits of the 12NC ordering code.<sup>[1]</sup>

Type number	Package	Description	Packing quantity	
			4000	8000
PMBT3946VPN	SOT666	2 mm pitch, 8 mm tape and reel	-	-315
		4 mm pitch, 8 mm tape and reel	-115	-

[1] For further information and the availability of packing methods, see [Section 14](#).

## 11. Soldering



## 12. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PMBT3946VPN_1	20090831	Product data sheet	-	-

## 13. Legal information

### 13.1 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.

[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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## 14. Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

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Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

