



PMBT3946VPN

40 V, 200 mA NPN/PNP switching transistor

28 December 2022

Product data sheet

1. General description

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

NPN/NPN complement: PMBT3904VS

PNP/PNP complement: PMBT3906VS

2. Features and benefits

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

3. Applications

- General-purpose switching and amplification

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per transistor; for the PNP transistor with negative polarity						
V_{CEO}	collector-emitter voltage	open base	-	-	40	V
I_C	collector current		-	-	200	mA
TR1 (NPN)						
h_{FE}	DC current gain	$V_{CE} = 1\text{ V}; I_C = 10\text{ mA}; T_{amb} = 25\text{ °C}$	100	180	300	
TR2 (PNP)						
h_{FE}	DC current gain	$V_{CE} = -1\text{ V}; I_C = -10\text{ mA}; T_{amb} = 25\text{ °C}$	100	180	300	

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	E1	emitter TR1	<p style="text-align: center;">SOT666</p>	<p style="text-align: center;"><i>sym019</i></p>
2	B1	base TR1		
3	C2	collector TR2		
4	E2	emitter TR2		
5	B2	base TR2		
6	C1	collector TR1		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PMBT3946VPN	SOT666	plastic, surface-mounted package; 6 leads; 0.5 mm pitch; 1.6 mm x 1.2 mm x 0.55 mm body	SOT666

7. Marking

Table 4. Marking codes

Type number	Marking code
PMBT3946VPN	ZE

8. Limiting values

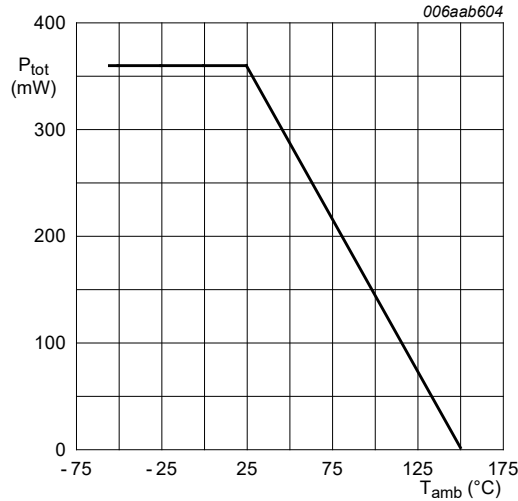
Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
TR1 (NPN)					
V_{CBO}	collector-base voltage	open emitter	-	60	V
TR2 (PNP)					
V_{CBO}	collector-base voltage	open emitter	-	-40	V
Per transistor; for the PNP transistor with negative polarity					
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		-	100	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	[1] [2]	240	mW
Per device					
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °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] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[2] Reflow soldering is the only recommended soldering method.



FR4 PCB, standard footprint

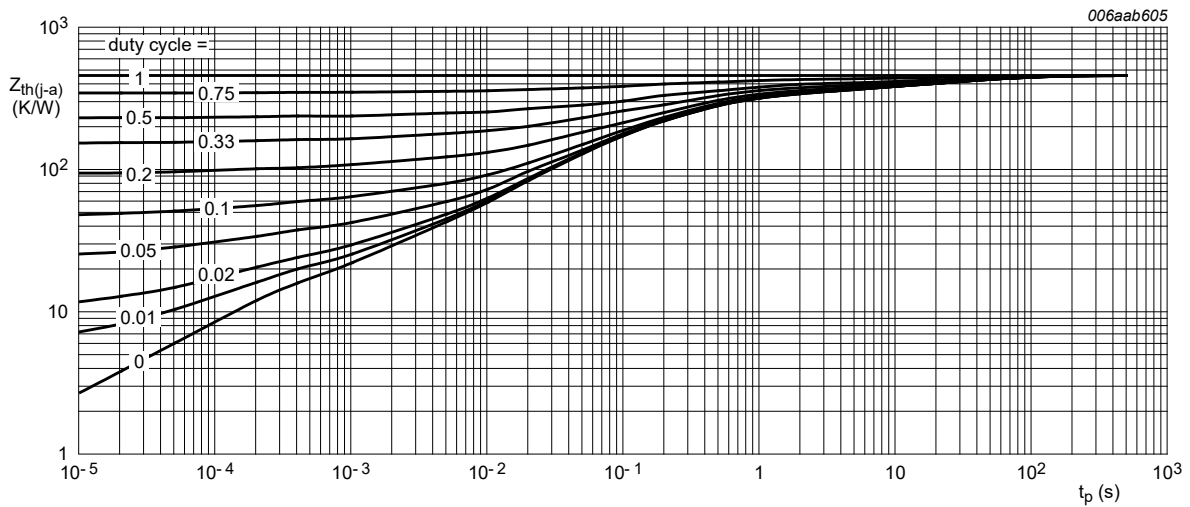
Fig. 1. Per device: Power derating curve

9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Per transistor							
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
Per device							
R _{th(j-a)}	thermal resistance from junction to ambient	in free air	[1] [2]	-	-	347	K/W

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



FR4 PCB, standard footprint

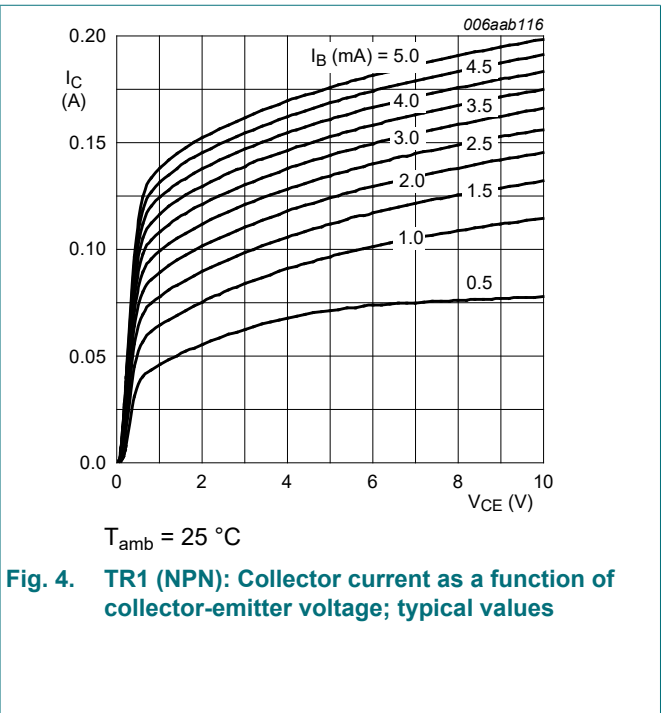
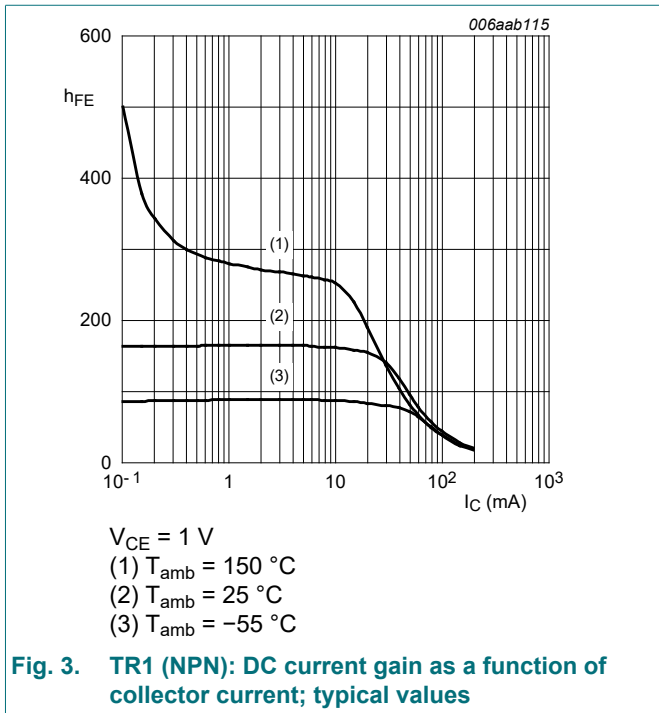
Fig. 2. Per transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

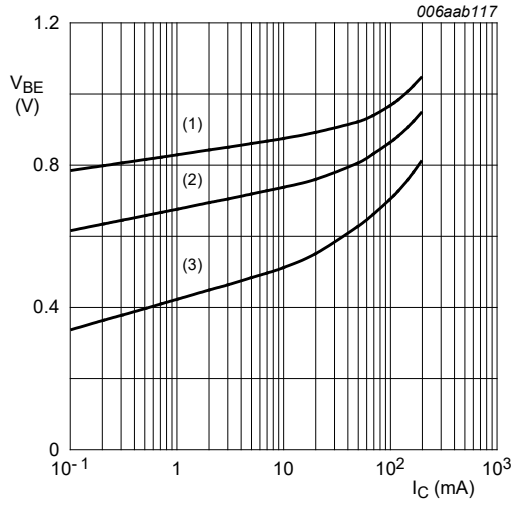
10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
TR1 (NPN)							
I_{CBO}	collector-base cut-off current	$V_{CB} = 30 \text{ V}; I_E = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	50	nA	
I_{EBO}	emitter-base cut-off current	$V_{EB} = 6 \text{ V}; I_C = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	50	nA	
h_{FE}	DC current gain	$V_{CE} = 1 \text{ V}; I_C = 0.1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	60	180	-		
		$V_{CE} = 1 \text{ V}; I_C = 1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	80	180	-		
		$V_{CE} = 1 \text{ V}; I_C = 10 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	100	180	300		
		$V_{CE} = 1 \text{ V}; I_C = 50 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	60	105	-		
		$V_{CE} = 1 \text{ V}; I_C = 100 \text{ mA}; \text{pulsed}; t_p \leq 300 \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	30	50	-		
V_{CEsat}	collector-emitter saturation voltage	$I_C = 10 \text{ mA}; I_B = 1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	75	200	mV	
		$I_C = 50 \text{ mA}; I_B = 5 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	120	300	mV	
V_{BEsat}	base-emitter saturation voltage	$I_C = 10 \text{ mA}; I_B = 1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	650	750	850	mV	
		$I_C = 50 \text{ mA}; I_B = 5 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	850	950	mV	
t_d	delay time	$I_C = 10 \text{ mA}; I_{Bon} = 1 \text{ mA}; I_{Boff} = -1 \text{ mA}; V_{CC} = 3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	35	ns	
t_r	rise time		-	-	35	ns	
t_{on}	turn-on time		-	-	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		$V_{CB} = 5 \text{ V}; I_E = 0 \text{ A}; i_e = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	4	pF
C_e	emitter capacitance		$V_{EB} = 500 \text{ mV}; I_C = 0 \text{ A}; i_c = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	8	pF
f_T	transition frequency	$V_{CE} = 20 \text{ V}; I_C = 10 \text{ mA}; f = 100 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	300	-	-	MHz	
NF	noise figure	$V_{CE} = 5 \text{ V}; I_C = 100 \mu\text{A}; R_S = 1 \text{ k}\Omega; f = 10 \text{ Hz to } 15.7 \text{ kHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	5	dB	
TR2 (PNP)							
I_{CBO}	collector-base cut-off current	$V_{CB} = -30 \text{ V}; I_E = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	-50	nA	
I_{EBO}	emitter-base cut-off current	$V_{EB} = -6 \text{ V}; I_C = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	-50	nA	
h_{FE}	DC current gain	$V_{CE} = -1 \text{ V}; I_C = -0.1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	60	180	-		
		$V_{CE} = -1 \text{ V}; I_C = -1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	80	180	-		
		$V_{CE} = -1 \text{ V}; I_C = -10 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	100	180	300		
		$V_{CE} = -1 \text{ V}; I_C = -50 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	60	130	-		
		$V_{CE} = -1 \text{ V}; I_C = -100 \text{ mA}; \text{pulsed}; t_p \leq 300 \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$	30	50	-		
V_{CEsat}	collector-emitter saturation voltage	$I_C = -10 \text{ mA}; I_B = -1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-100	-250	V	
		$I_C = -50 \text{ mA}; I_B = -5 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-165	-400	V	

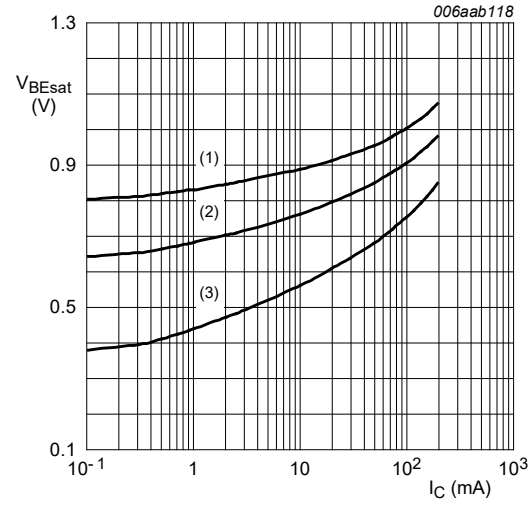
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{BEsat}	base-emitter saturation voltage	$I_C = -10 \text{ mA}; I_B = -1 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-750	-850	V
		$I_C = -50 \text{ mA}; I_B = -5 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-850	-950	V
t_d	delay time	$I_C = -10 \text{ mA}; I_{B(on)} = -1 \text{ mA}; I_{B(off)} = 1 \text{ mA}; V_{CC} = -3 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	35	ns
t_r	rise time		-	-	35	ns
t_{on}	turn-on time		-	-	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		$V_{CB} = -5 \text{ V}; I_E = 0 \text{ A}; i_e = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	4.5
C_e	emitter capacitance	$V_{EB} = -500 \text{ mV}; I_C = 0 \text{ mA}; i_c = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	10	pF
f_T	transition frequency	$V_{CE} = -20 \text{ V}; I_C = -10 \text{ mA}; f = 100 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	250	-	-	MHz
NF	noise figure	$V_{CE} = -5 \text{ V}; I_C = -100 \text{ } \mu\text{A}; R_S = 1 \text{ k}\Omega; f = 10 \text{ Hz to } 15.7 \text{ kHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	4	dB





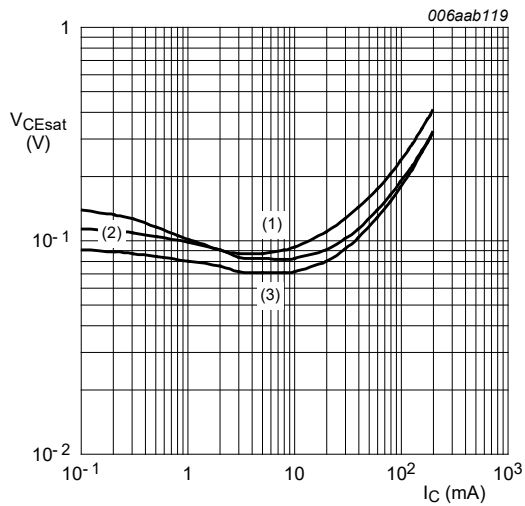
$V_{CE} = 1\text{ V}$
 (1) $T_{amb} = -55\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = 150\text{ °C}$

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



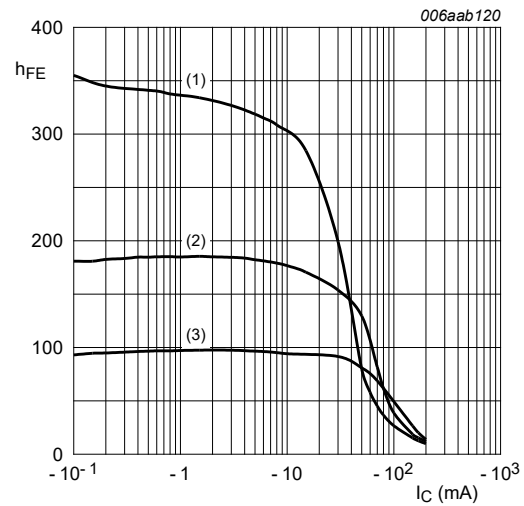
$I_C/I_B = 10$
 (1) $T_{amb} = -55\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = 150\text{ °C}$

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

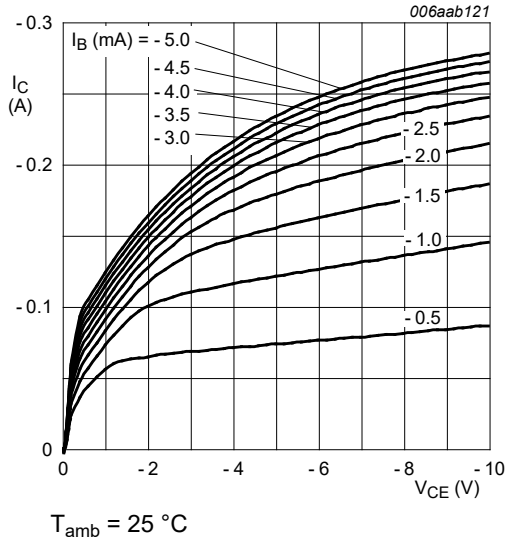


Fig. 9. TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values

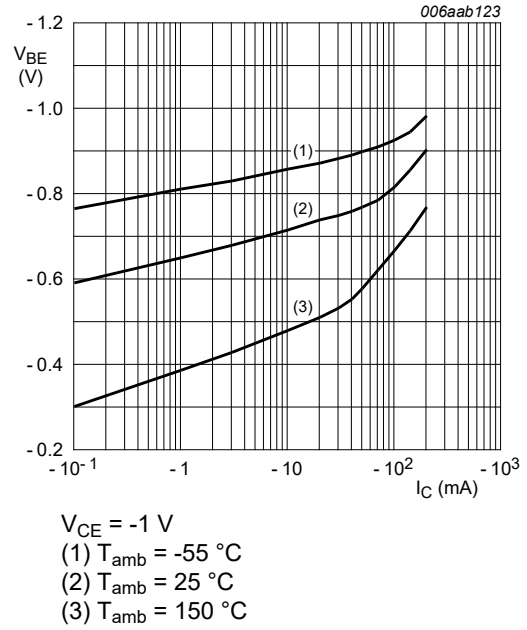


Fig. 10. TR2 (PNP): Base-emitter voltage as a function of collector current; typical values

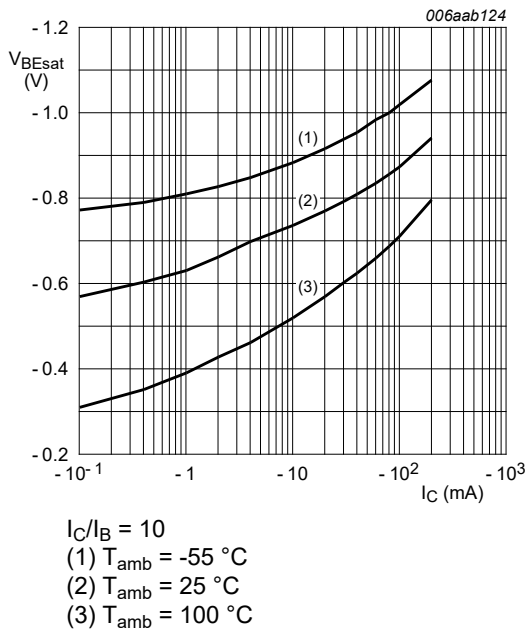


Fig. 11. TR2 (PNP): Base-emitter saturation voltage as a function of collector current; typical values

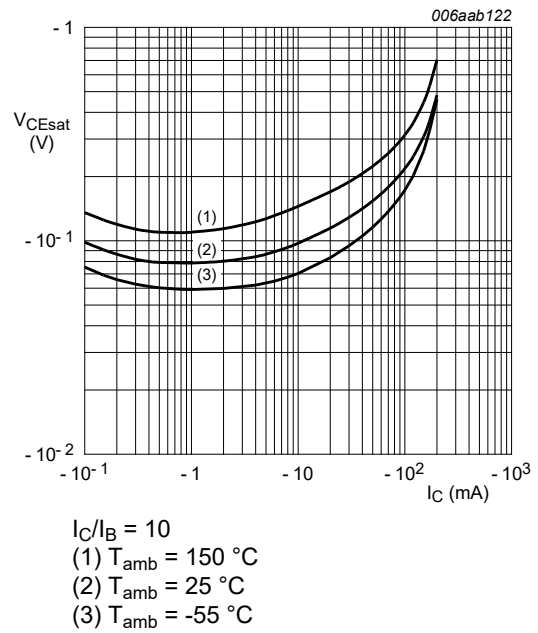
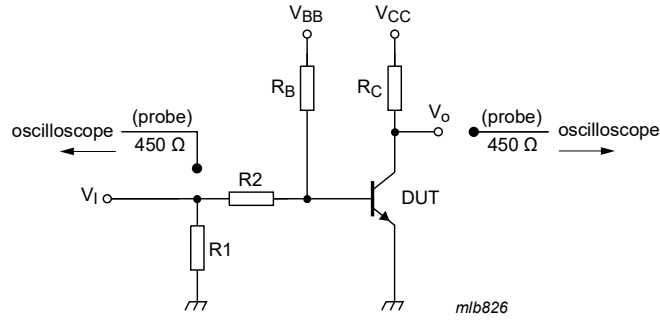


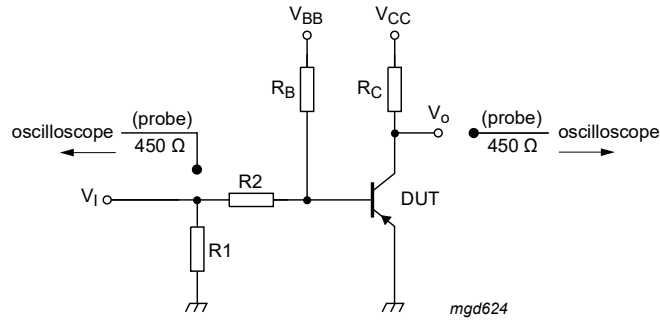
Fig. 12. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

11. 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

12. Package outline

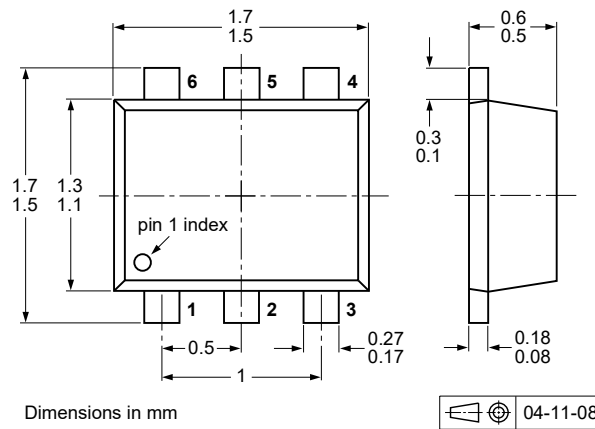


Fig. 15. Package outline SOT666

13. Soldering

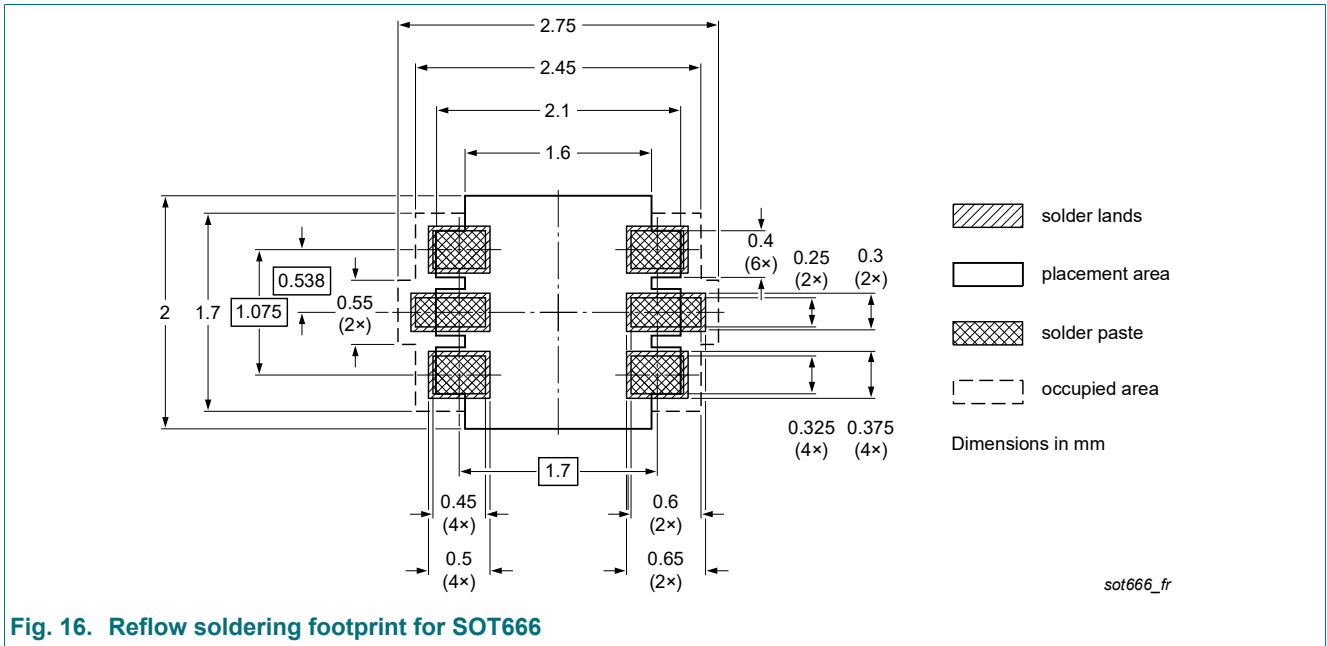


Fig. 16. Reflow soldering footprint for SOT666

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PMBT3946VPN v.2	20221228	Product data sheet	-	PMBT3946VPN v.1
Modifications:	<ul style="list-style-type: none">• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.• Legal texts have been adapted to the new company name where appropriate.• Packing information removed• Product(s) changed to non-automotive qualification.			
PMBT3946VPN v.1	20090831	Product data sheet	-	-

15. Legal information

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 <https://www.nexperia.com>.

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Date of release: 28 December 2022
