



# PBSS4041SPN

60 V NPN/PNP low  $V_{CEsat}$  (BISS) transistor

Rev. 2 — 20 October 2010

Product data sheet

## 1. Product profile

### 1.1 General description

NPN/PNP low  $V_{CEsat}$  Breakthrough In Small Signal (BISS) transistor in a SOT96-1 (SO8) medium power Surface-Mounted Device (SMD) plastic package.

Table 1. Product overview

Type number	Package		NPN/PNP complement	PNP/PNP complement
	Nexperia	Name		
PBSS4041SPN	SOT96-1	SO8	PBSS4041SN	PBSS4041SP

### 1.2 Features and benefits

- Very low collector-emitter saturation voltage  $V_{CEsat}$
- High collector current capability  $I_C$  and  $I_{CM}$
- High collector current gain ( $h_{FE}$ ) at high  $I_C$
- High efficiency due to less heat generation
- Smaller required Printed-Circuit Board (PCB) area than for conventional transistors

### 1.3 Applications

- Loadswitch
- Battery-driven devices
- Power management
- Charging circuits
- Power switches (e.g. motors, fans)

### 1.4 Quick reference data

Table 2. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1; NPN low <math>V_{CEsat}</math> transistor</b>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	60	V
$I_C$	collector current		-	-	6.7	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-	15	A
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 4$ A; $I_B = 0.2$ A	[1] -	32	48	m $\Omega$

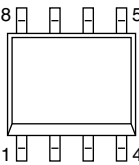
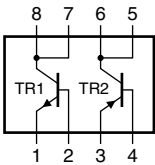
Table 2. Quick reference data ...continued

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR2; PNP low <math>V_{CEsat}</math> transistor</b>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	-60	V
$I_C$	collector current		-	-	-5.9	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-	-15	A
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -4$ A; $I_B = -0.4$ A	[1]	-	47	70 m $\Omega$

[1] Pulse test:  $t_p \leq 300$   $\mu$ s;  $\delta \leq 0.02$ .

## 2. Pinning information

Table 3. Pinning

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

## 3. Ordering information

Table 4. Ordering information

Type number	Package		Version
	Name	Description	
PBSS4041SPN	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

## 4. Marking

Table 5. Marking codes

Type number	Marking code
PBSS4041SPN	4041SPN

## 5. Limiting values

**Table 6. Limiting values**

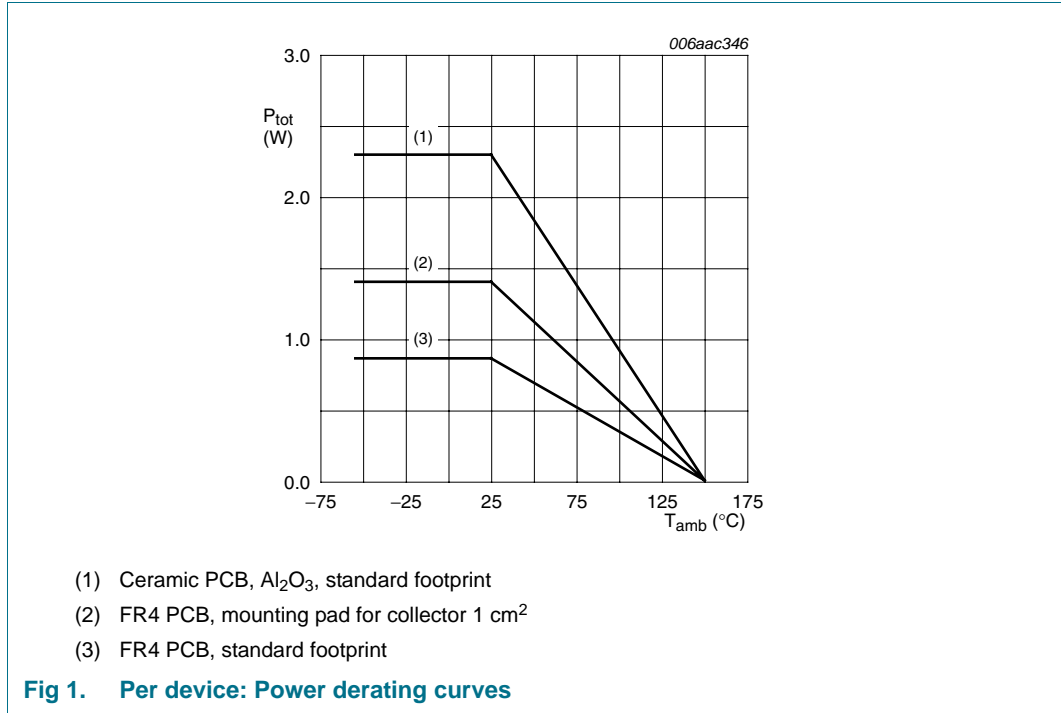
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

Symbol	Parameter	Conditions	Min	Max	Unit	
<b>TR1 (NPN)</b>						
$I_C$	collector current		-	6.7	A	
<b>TR2 (PNP)</b>						
$I_C$	collector current		-	-5.9	A	
<b>Per transistor; for the PNP transistor with negative polarity</b>						
$V_{CBO}$	collector-base voltage	open emitter	-	60	V	
$V_{CEO}$	collector-emitter voltage	open base	-	60	V	
$V_{EBO}$	emitter-base voltage	open collector	-	5	V	
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	15	A	
$I_B$	base current		-	1	A	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	0.73	W
			[2]	-	1	W
			[3]	-	1.7	W
<b>Per device</b>						
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	0.86	W
			[2]	-	1.4	W
			[3]	-	2.3	W
$T_j$	junction temperature		-	150	°C	
$T_{amb}$	ambient temperature		-55	+150	°C	
$T_{stg}$	storage temperature		-65	+150	°C	

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.

[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



## 6. Thermal characteristics

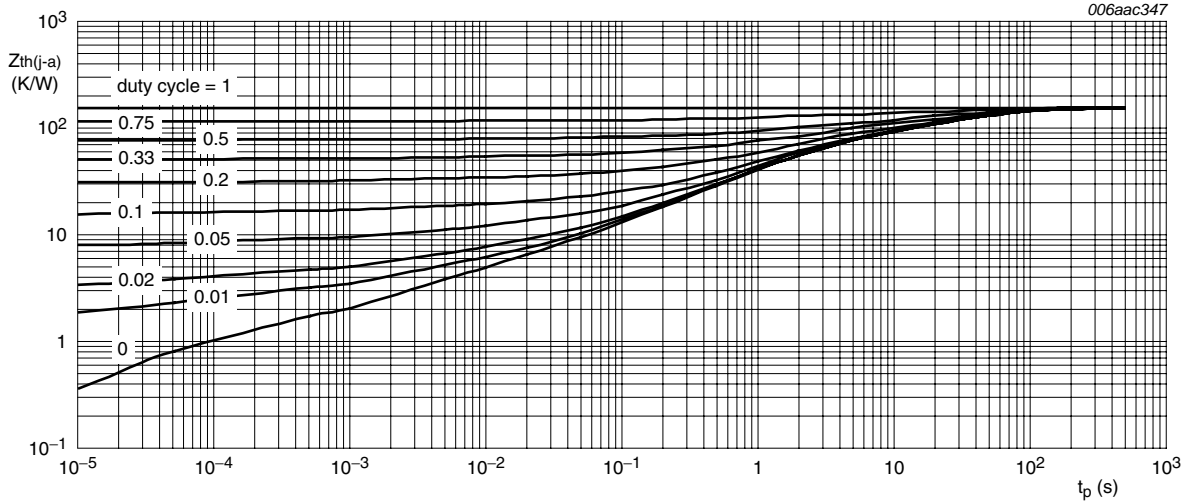
**Table 7. Thermal characteristics**

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]	-	-	170	K/W
			[2]	-	-	125	K/W
			[3]	-	-	75	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		-	-	40	K/W	
<b>Per device</b>							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	145	K/W
			[2]	-	-	90	K/W
			[3]	-	-	55	K/W

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

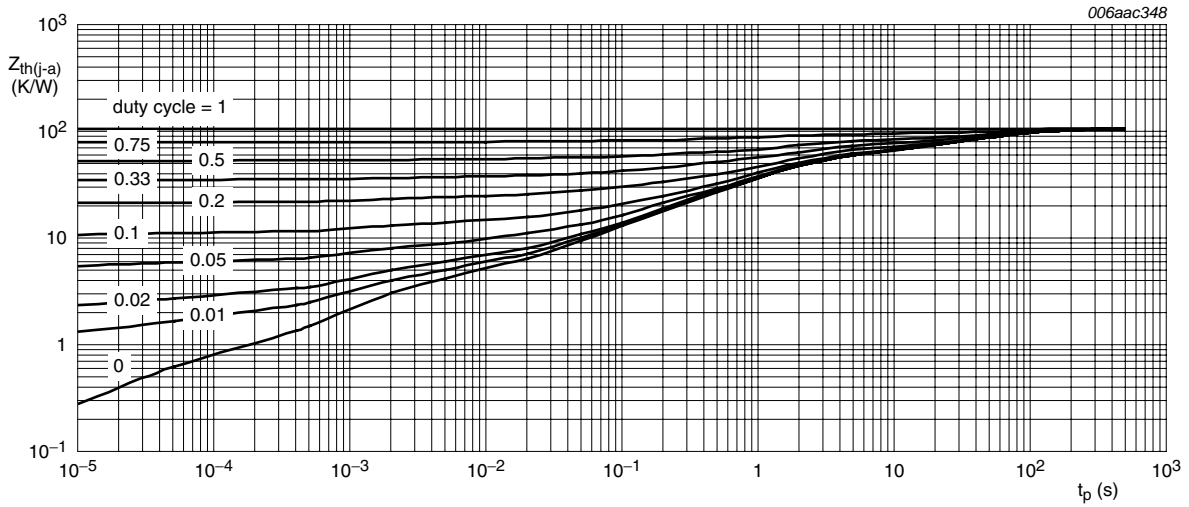
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.

[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



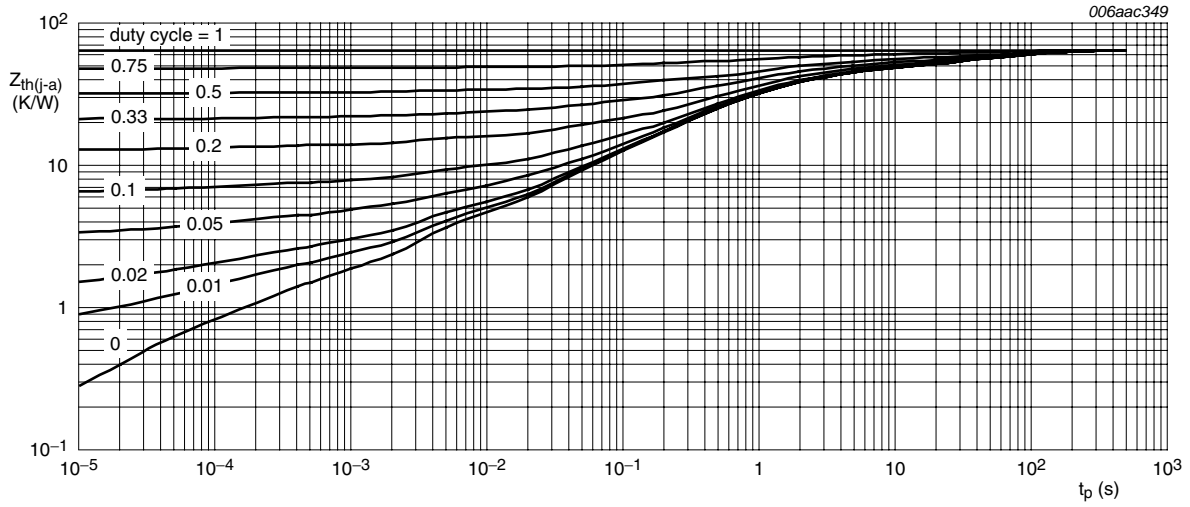
FR4 PCB, standard footprint

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



FR4 PCB, mounting pad for collector 1 cm<sup>2</sup>

**Fig 3.** Per transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values



Ceramic PCB,  $Al_2O_3$ , standard footprint

**Fig 4. Per transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 7. Characteristics

**Table 8. Characteristics**

$T_{amb} = 25\text{ °C}$  unless otherwise specified.

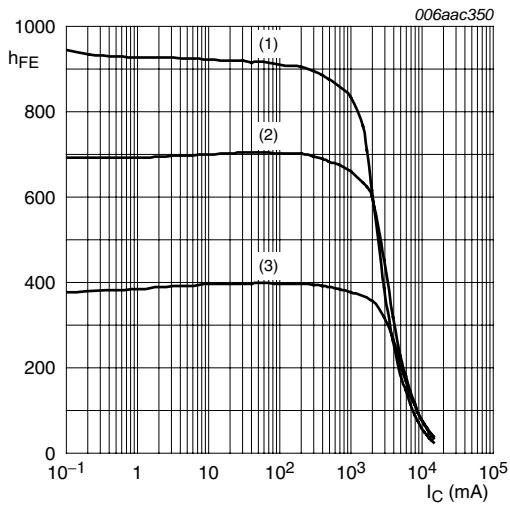
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>TR1; NPN low <math>V_{CEsat}</math> transistor</b>							
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 60\text{ V}; I_E = 0\text{ A}$	-	-	100	nA	
		$V_{CB} = 60\text{ V}; I_E = 0\text{ A}; T_j = 150\text{ °C}$	-	-	50	$\mu\text{A}$	
$I_{CES}$	collector-emitter cut-off current	$V_{CE} = 48\text{ V}; V_{BE} = 0\text{ V}$	-	-	100	nA	
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 5\text{ V}; I_C = 0\text{ A}$	-	-	100	nA	
$h_{FE}$	DC current gain	$V_{CE} = 2\text{ V}$	[1]				
		$I_C = 500\text{ mA}$	300	500	-		
		$I_C = 1\text{ A}$	300	500	-		
		$I_C = 2\text{ A}$	250	450	-		
		$I_C = 4\text{ A}$	150	250	-		
		$I_C = 6\text{ A}$	75	150	-		
$V_{CEsat}$	collector-emitter saturation voltage	[1]					
		$I_C = 1\text{ A}; I_B = 50\text{ mA}$	-	40	60	mV	
		$I_C = 1\text{ A}; I_B = 10\text{ mA}$	-	65	100	mV	
		$I_C = 2\text{ A}; I_B = 40\text{ mA}$	-	85	145	mV	
		$I_C = 4\text{ A}; I_B = 200\text{ mA}$	-	125	190	mV	
		$I_C = 4\text{ A}; I_B = 40\text{ mA}$	-	220	320	mV	
		$I_C = 7\text{ A}; I_B = 350\text{ mA}$	-	230	350	mV	
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = 4\text{ A}; I_B = 200\text{ mA}$	[1]	-	32	48	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	[1]					
		$I_C = 1\text{ A}; I_B = 100\text{ mA}$	-	0.86	1	V	
		$I_C = 4\text{ A}; I_B = 400\text{ mA}$	-	1.05	1.2	V	
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = 2\text{ V}; I_C = 2\text{ A}$	[1]	-	0.75	0.85	V
$t_d$	delay time	$V_{CC} = 12.5\text{ V}; I_C = 1\text{ A}; I_{Bon} = 0.05\text{ A}; I_{Boff} = -0.05\text{ A}$	-	35	-	ns	
$t_r$	rise time		-	65	-	ns	
$t_{on}$	turn-on time		-	100	-	ns	
$t_s$	storage time		-	1050	-	ns	
$t_f$	fall time		-	220	-	ns	
$t_{off}$	turn-off time		-	1270	-	ns	
$f_T$	transition frequency	$V_{CE} = 10\text{ V}; I_C = 100\text{ mA}; f = 100\text{ MHz}$	-	130	-	MHz	
$C_C$	collector capacitance	$V_{CB} = 10\text{ V}; I_E = I_e = 0\text{ A}; f = 1\text{ MHz}$	-	35	-	pF	

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>TR2; PNP low <math>V_{CEsat}</math> transistor</b>							
$I_{CBO}$	collector-base cut-off current	$V_{CB} = -60\text{ V}; I_E = 0\text{ A}$	-	-	-100	nA	
		$V_{CB} = -60\text{ V}; I_E = 0\text{ A}; T_j = 150\text{ °C}$	-	-	-50	$\mu\text{A}$	
$I_{CES}$	collector-emitter cut-off current	$V_{CE} = -48\text{ V}; V_{BE} = 0\text{ V}$	-	-	-100	nA	
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = -5\text{ V}; I_C = 0\text{ A}$	-	-	-100	nA	
$h_{FE}$	DC current gain	$V_{CE} = -2\text{ V}$	[1]				
		$I_C = -500\text{ mA}$	200	300	-		
		$I_C = -1\text{ A}$	180	270	-		
		$I_C = -2\text{ A}$	150	250	-		
		$I_C = -4\text{ A}$	120	180	-		
$V_{CEsat}$	collector-emitter saturation voltage	$V_{CE} = -2\text{ V}$	[1]				
		$I_C = -1\text{ A}; I_B = -50\text{ mA}$	-	-65	-90	mV	
		$I_C = -1\text{ A}; I_B = -10\text{ mA}$	-	-130	-190	mV	
		$I_C = -2\text{ A}; I_B = -40\text{ mA}$	-	-155	-230	mV	
		$I_C = -4\text{ A}; I_B = -200\text{ mA}$	-	-220	-330	mV	
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -4\text{ A}; I_B = -400\text{ mA}$	[1]	-	47	70	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$V_{CE} = -2\text{ V}$	[1]				
		$I_C = -1\text{ A}; I_B = -100\text{ mA}$	-	-0.84	-1	V	
		$I_C = -4\text{ A}; I_B = -400\text{ mA}$	-	-1	-1.2	V	
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = -2\text{ V}; I_C = -2\text{ A}$	[1]	-	-0.78	-0.85	V
$t_d$	delay time	$V_{CC} = -12.5\text{ V}; I_C = -1\text{ A}; I_{Bon} = -0.05\text{ A}; I_{Boff} = 0.05\text{ A}$	-	45	-	ns	
$t_r$	rise time		-	60	-	ns	
$t_{on}$	turn-on time		-	105	-	ns	
$t_s$	storage time		-	440	-	ns	
$t_f$	fall time		-	75	-	ns	
$t_{off}$	turn-off time		-	515	-	ns	
$f_T$	transition frequency	$V_{CB} = -10\text{ V}; I_C = -100\text{ mA}; f = 100\text{ MHz}$	-	110	-	MHz	
$C_c$	collector capacitance	$V_{CB} = -10\text{ V}; I_E = I_e = 0\text{ A}; f = 1\text{ MHz}$	-	85	-	pF	

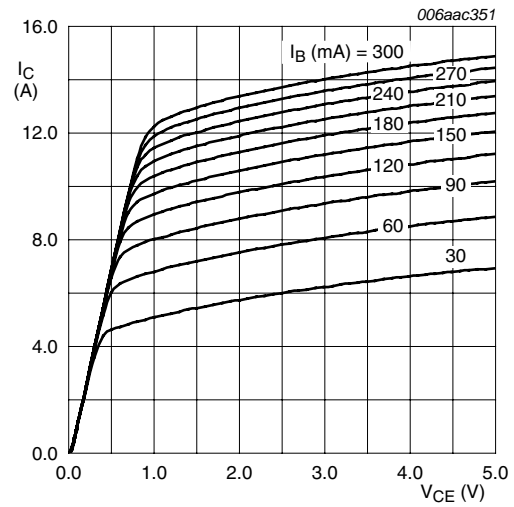
[1] Pulse test:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.02$ .





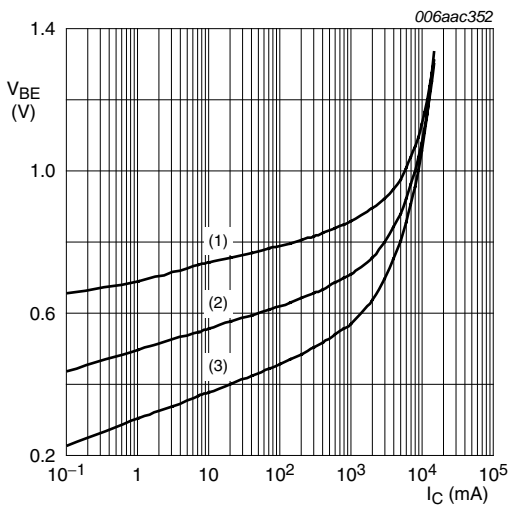
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = 100\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = -55\text{ }^{\circ}\text{C}$

**Fig 5. TR1 (NPN): DC current gain as a function of collector current; typical values**



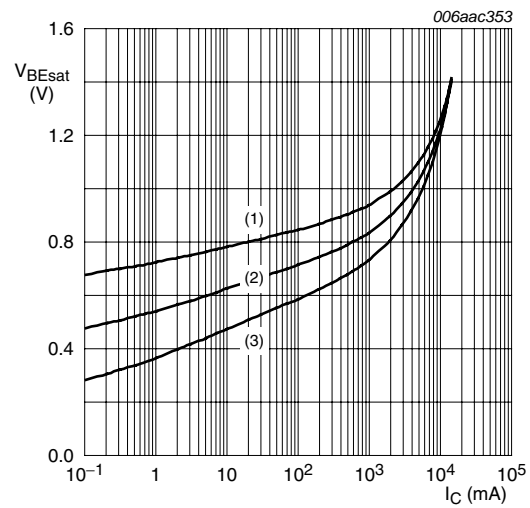
$T_{amb} = 25\text{ }^{\circ}\text{C}$

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



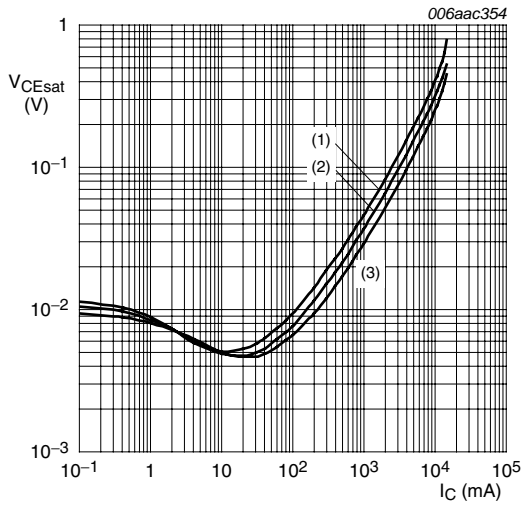
$V_{CE} = 2\text{ V}$   
 (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

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



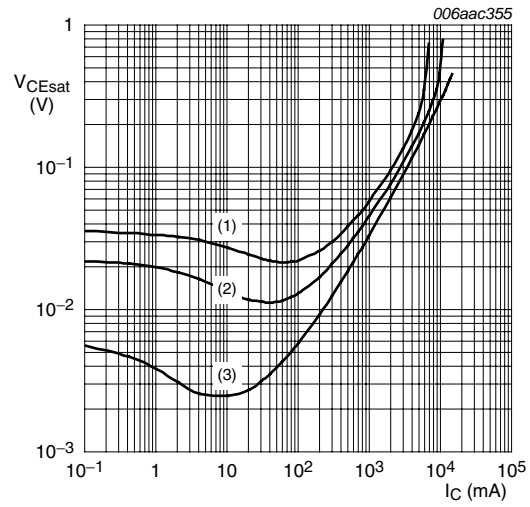
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$   
 (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$   
 (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

**Fig 8. TR1 (NPN): Base-emitter saturation voltage as a function of collector current; typical values**



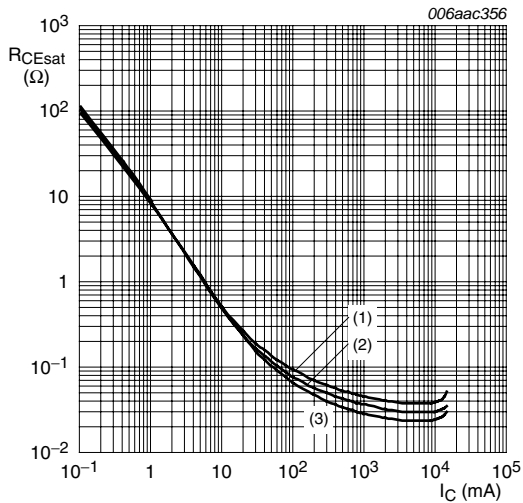
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

**Fig 9. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



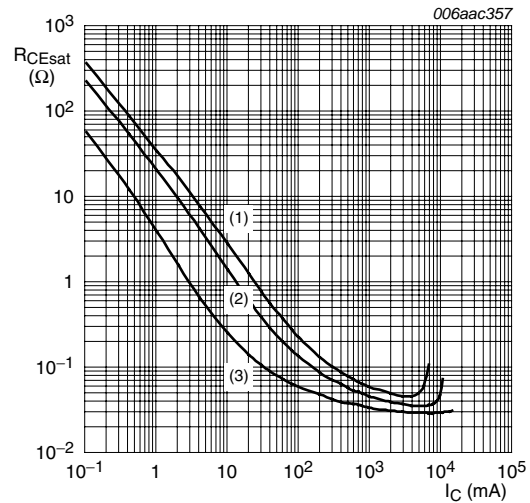
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

**Fig 10. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



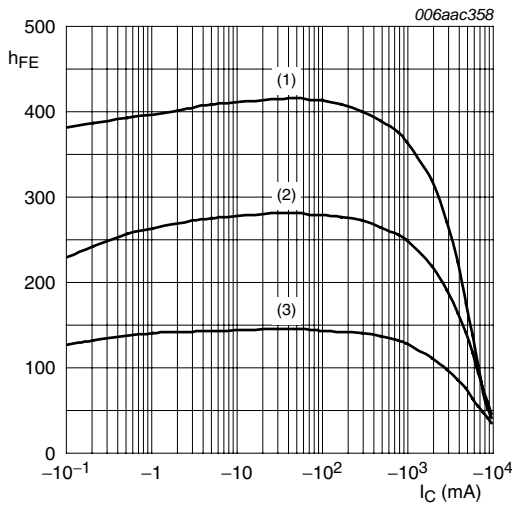
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

**Fig 11. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values**



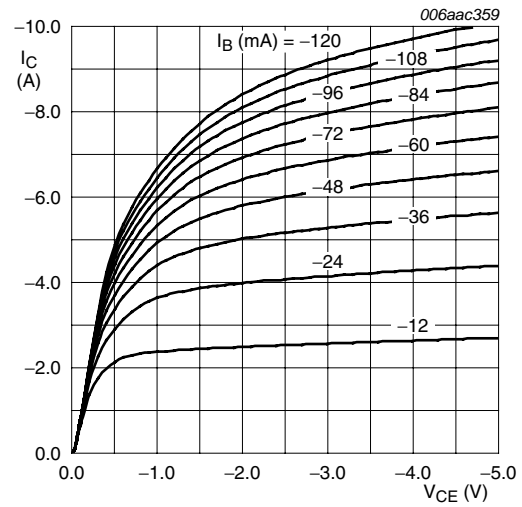
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

**Fig 12. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values**



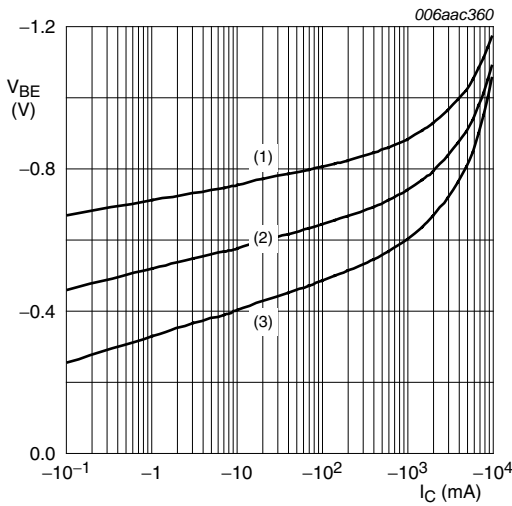
$V_{CE} = -2 \text{ V}$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -55 \text{ }^\circ\text{C}$

**Fig 13. TR2 (PNP): DC current gain as a function of collector current; typical values**



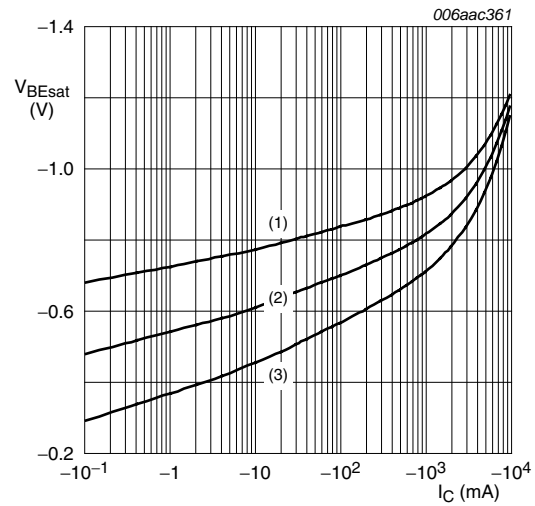
$T_{amb} = 25 \text{ }^\circ\text{C}$

**Fig 14. TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



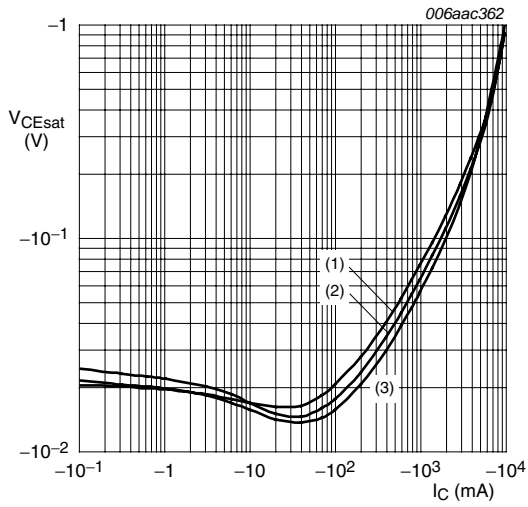
$V_{CE} = -2 \text{ V}$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig 15. TR2 (PNP): Base-emitter voltage as a function of collector current; typical values**



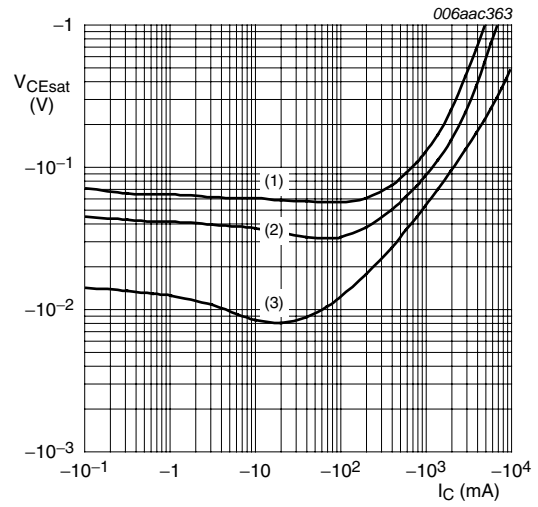
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig 16. TR2 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**



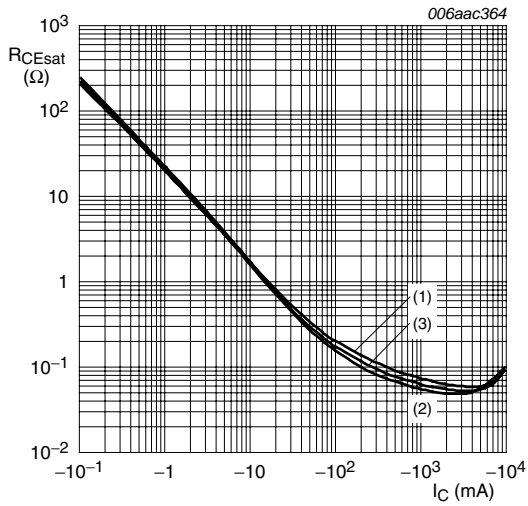
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

**Fig 17. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**



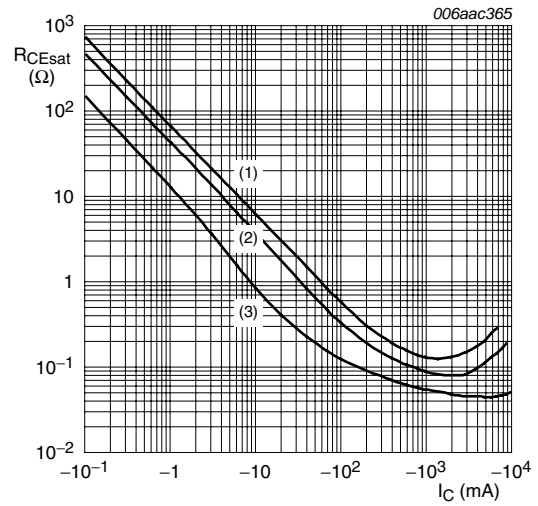
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

**Fig 18. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**



- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

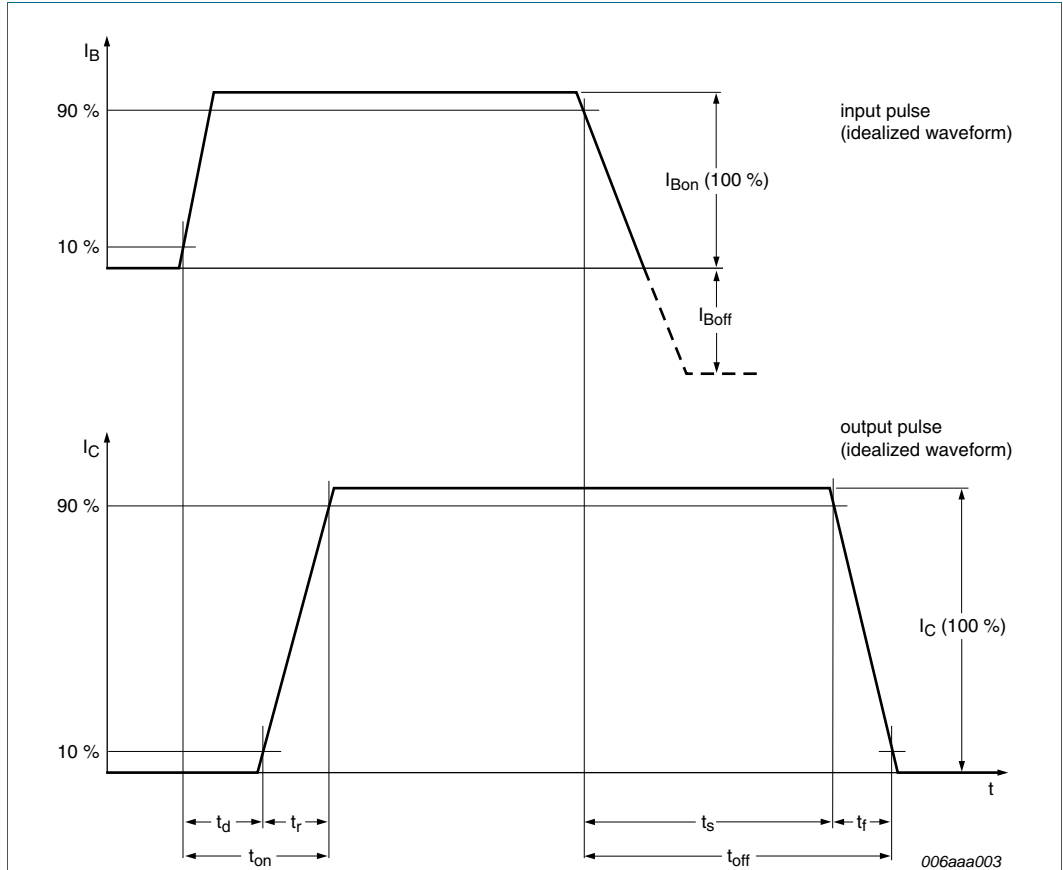
**Fig 19. TR2 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values**



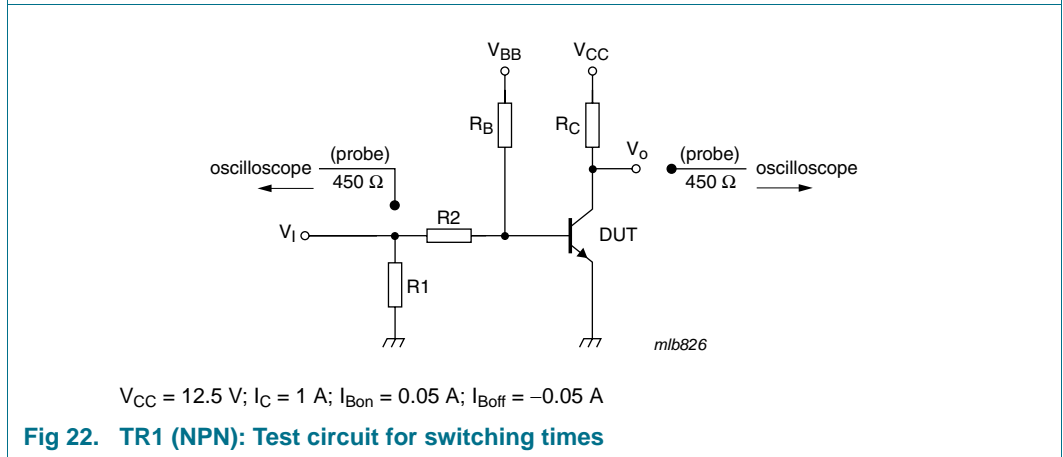
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

**Fig 20. TR2 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values**

**8. Test information**



**Fig 21. TR1 (NPN): BISS transistor switching time definition**



**Fig 22. TR1 (NPN): Test circuit for switching times**

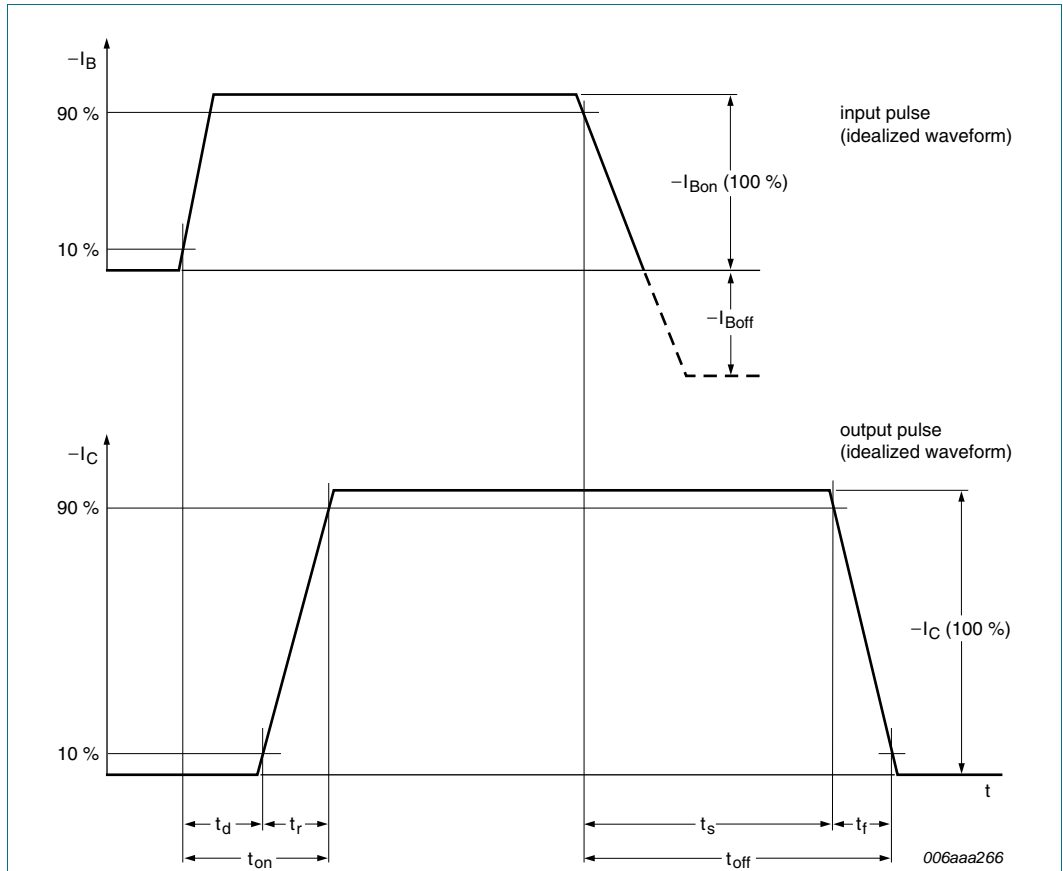


Fig 23. TR2 (PNP): BISS transistor switching time definition

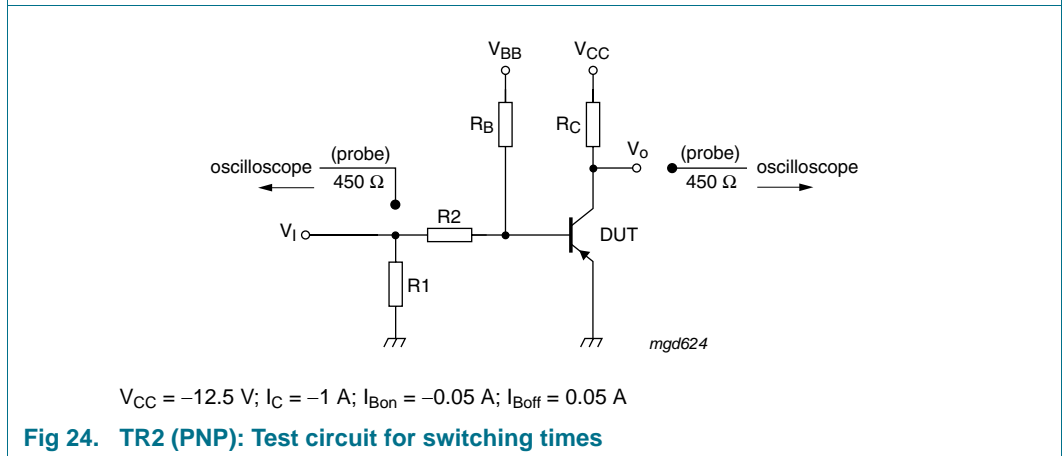
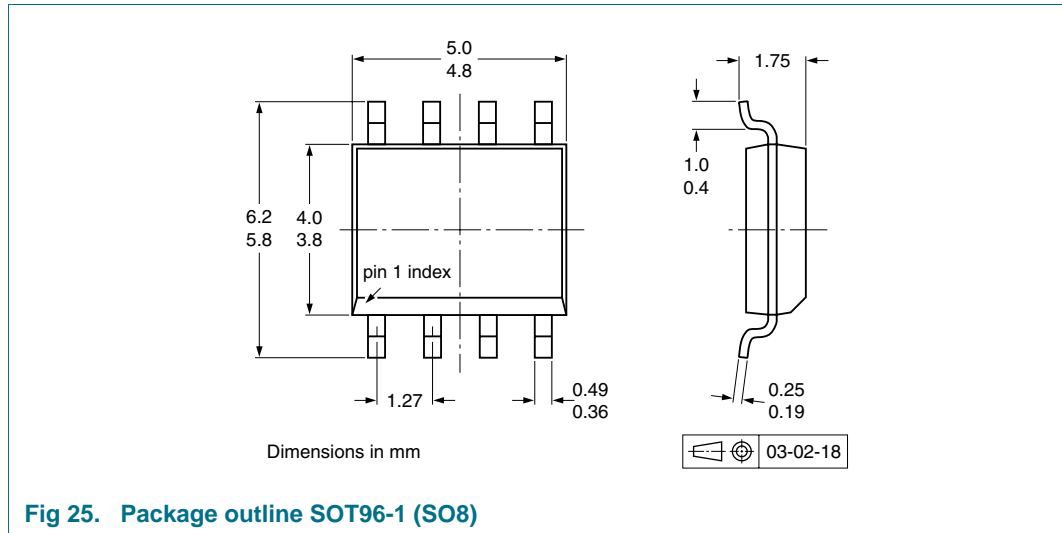


Fig 24. TR2 (PNP): Test circuit for switching times

## 9. Package outline



## 10. Packing information

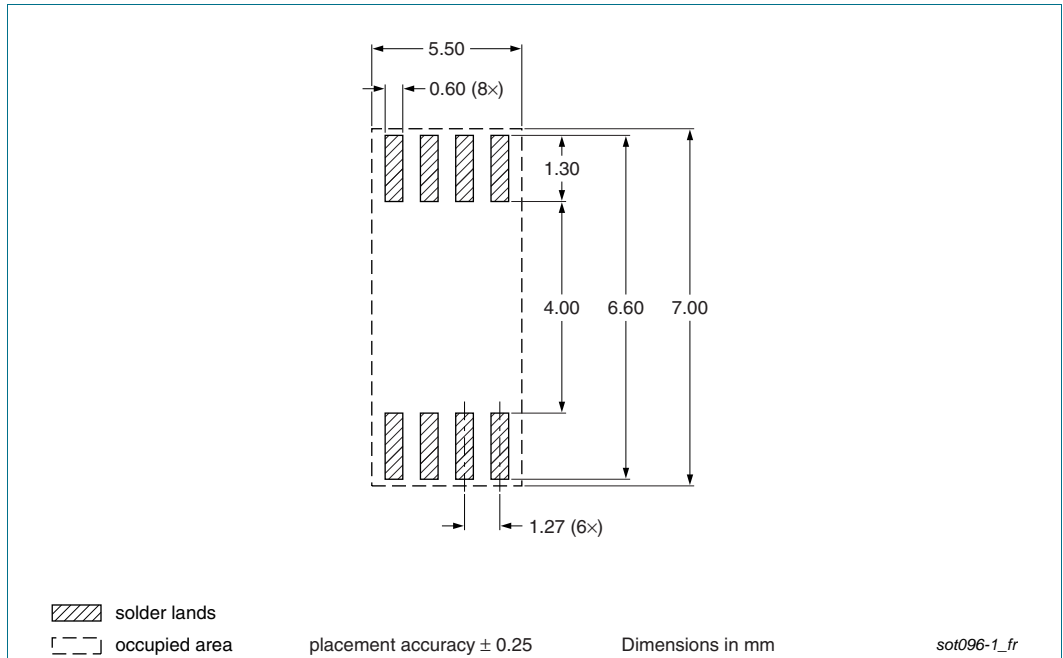
**Table 9. Packing methods**

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

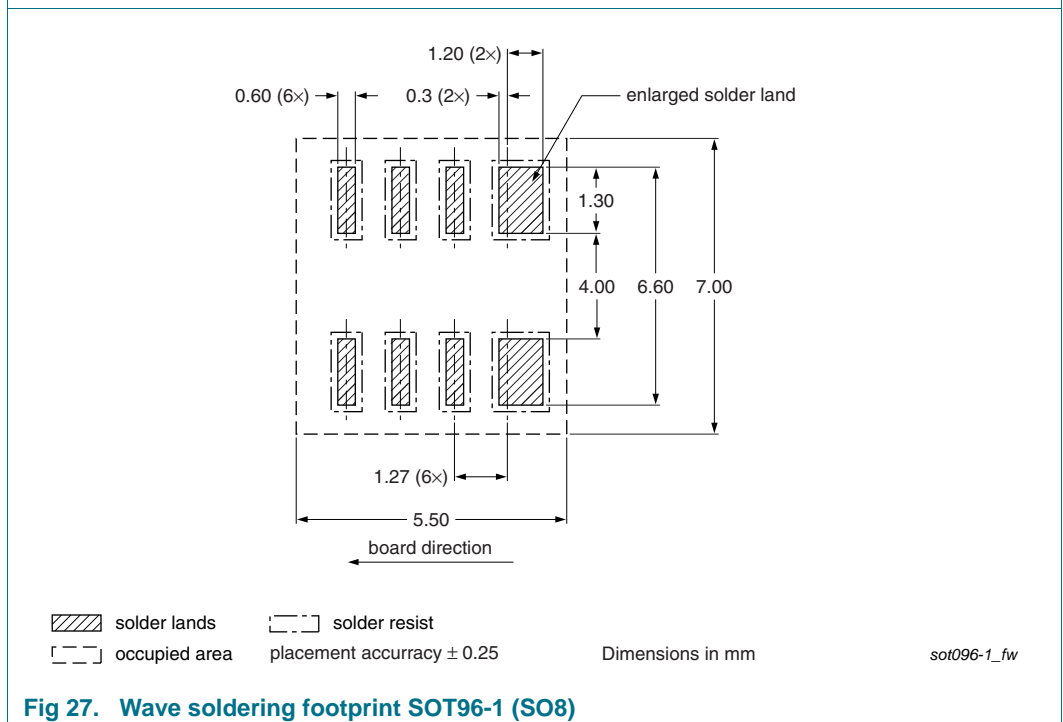
Type number	Package	Description	Packing quantity	
			1000	2500
PBSS4041SPN	SOT96-1	8 mm pitch, 12 mm tape and reel	-115	-118

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

**11. Soldering**



**Fig 26. Reflow soldering footprint SOT96-1 (SO8)**



**Fig 27. Wave soldering footprint SOT96-1 (SO8)**



## 12. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PBSS4041SPN v.2	20101020	Product data sheet	-	PBSS4041SPN v.1
Modifications:	• <a href="#">Figure 1 "Per device: Power derating curves"</a> : updated.			
PBSS4041SPN v.1	20100714	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.nexperia.com>.

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