

# PBL6023D

60 V, 1.5 A PNP BISS loadswitch

Rev. 01 — 13 August 2009

Product data sheet

## 1. Product profile

### 1.1 General description

PNP low  $V_{CEsat}$  Breakthrough In Small Signal (BISS) transistor and NPN Resistor-Equipped Transistor (RET) in a SOT457 (SC-74) small Surface-Mounted Device (SMD) plastic package.

### 1.2 Features

- Low  $V_{CEsat}$  (BISS) and resistor-equipped transistor in one package
- Low threshold voltage (<1 V) compared to MOSFET
- Space-saving solution
- Reduction of component count
- AEC-Q101 qualified

### 1.3 Applications

- Supply line switches
- Battery charger switches
- High-side switches for LEDs, drivers and backlights
- Portable equipment

### 1.4 Quick reference data

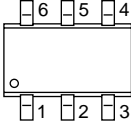
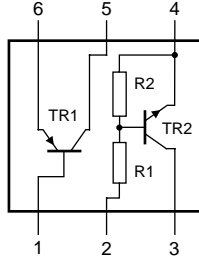
Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1; PNP low <math>V_{CEsat}</math> transistor</b>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	-60	V
$I_C$	collector current		-	-	-1.5	A
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-	-3	A
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -1.5$ A; $I_B = -100$ mA	[1]	110	175	m $\Omega$
<b>TR2; NPN resistor-equipped transistor</b>						
$V_{CEO}$	collector-emitter voltage	open base	-	-	50	V
$I_O$	output current		-	-	100	mA
R1	bias resistor 1 (input)		7	10	13	k $\Omega$
R2/R1	bias resistor ratio		0.8	1	1.2	

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

## 2. Pinning information

Table 2. Pinning

Pin	Description	Simplified outline	Graphic symbol
1	base TR1		
2	input (base) TR2		
3	output (collector) TR2		
4	GND (emitter) TR2		
5	collector TR1		
6	emitter TR1		

006aab506

## 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PBL56023D	SC-74	plastic surface-mounted package (TSOP6); 6 leads	SOT457

## 4. Marking

Table 4. Marking codes

Type number	Marking code
PBL56023D	KG

## 5. Limiting values

**Table 5. Limiting values**

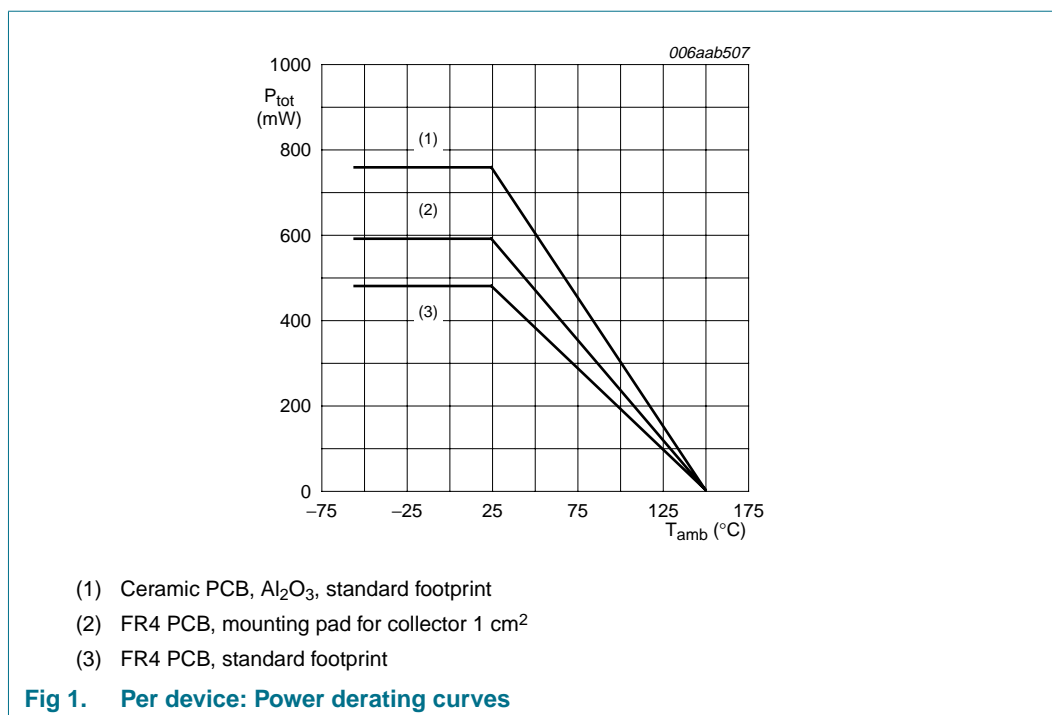
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
<b>TR1; PNP low <math>V_{CEsat}</math> transistor</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	
$I_C$	collector current		-	-1.5	A	
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	-3	A	
$I_B$	base current		-	-300	mA	
$I_{BM}$	peak base current	single pulse; $t_p \leq 1$ ms	-	-1	A	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	370	mW
			[2]	-	480	mW
			[3]	-	630	mW
<b>TR2; NPN resistor-equipped transistor</b>						
$V_{CBO}$	collector-base voltage	open emitter	-	50	V	
$V_{CEO}$	collector-emitter voltage	open base	-	50	V	
$V_{EBO}$	emitter-base voltage	open collector	-	10	V	
$V_I$	input voltage					
		positive	-	+40	V	
		negative	-	-10	V	
$I_O$	output current		-	100	mA	
$I_{CM}$	peak collector current	single pulse; $t_p \leq 1$ ms	-	100	mA	
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1][2]	-	200	mW
			[3]			
<b>Per device</b>						
$P_{tot}$	total power dissipation	$T_{amb} \leq 25$ °C	[1]	-	480	mW
			[2]	-	590	mW
			[3]	-	760	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] 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

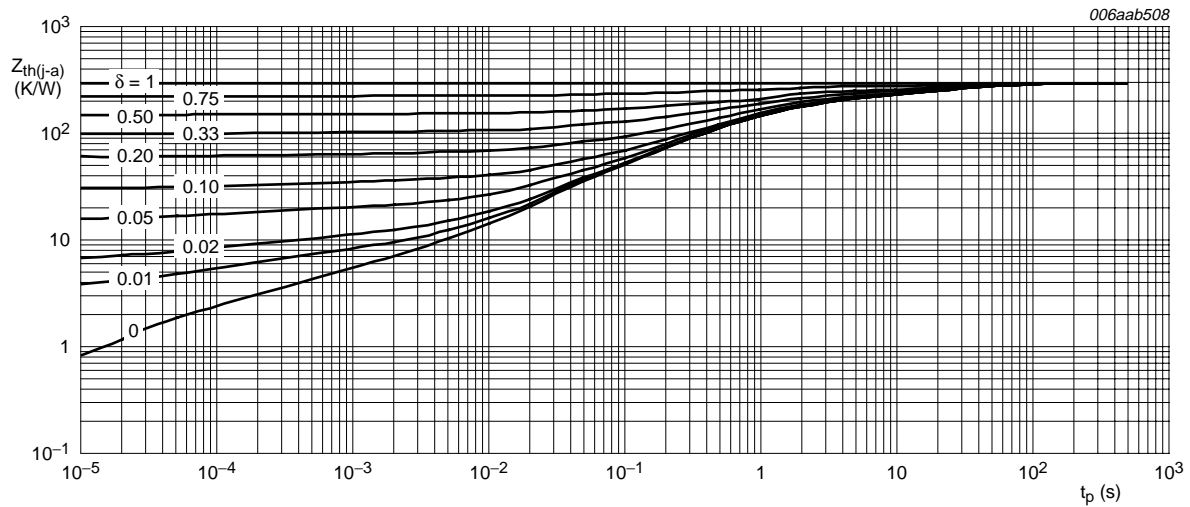
**Table 6. Thermal characteristics**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Per device</b>							
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	[1]	-	-	260	K/W
			[2]	-	-	211	K/W
			[3]	-	-	165	K/W
R <sub>th(j-sp)</sub>	thermal resistance from junction to solder point		-	-	100	K/W	

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

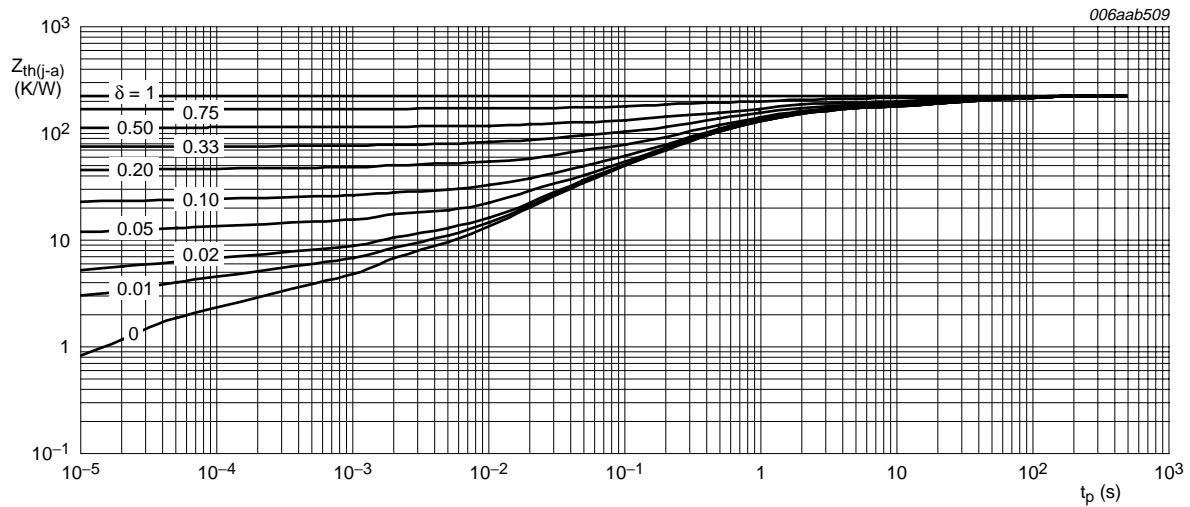
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.

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

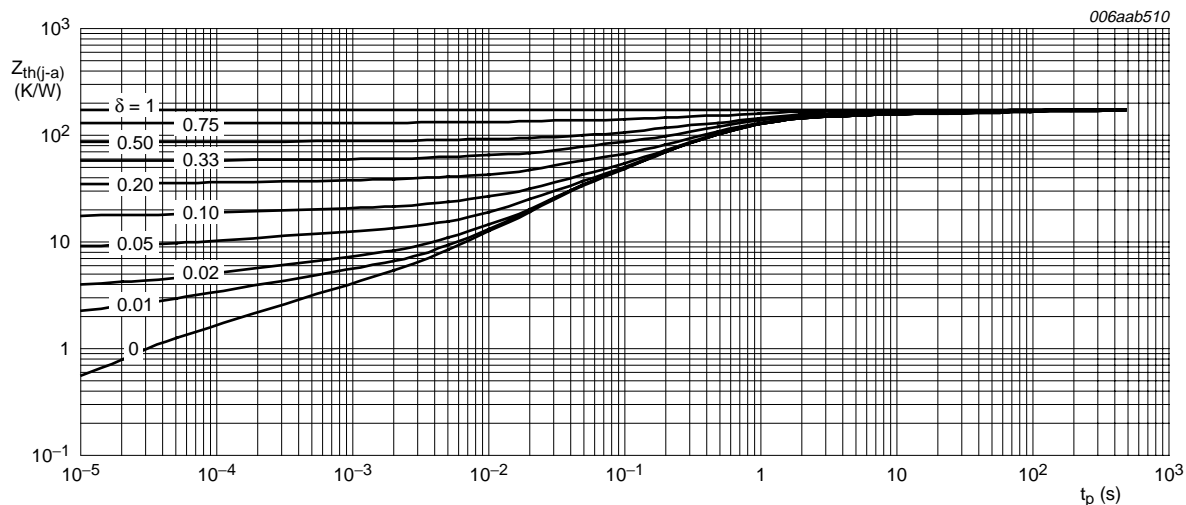


FR4 PCB, standard footprint

**Fig. 2. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

FR4 PCB, mounting pad for collector  $1 \text{ cm}^2$ 

**Fig. 3. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



Ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint

Fig 4. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 7. Characteristics

Table 7. Characteristics

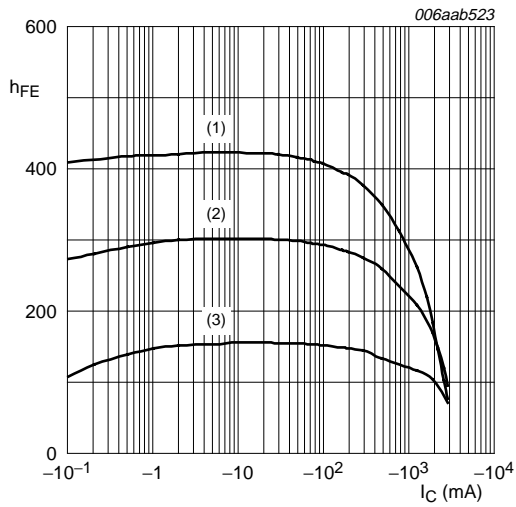
$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1; 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
		$V_{CB} = -60\text{ V}; I_E = 0\text{ A}; T_j = 150\text{ }^{\circ}\text{C}$	-	-	-50	$\mu\text{A}$
$I_{CES}$	collector-emitter cut-off current	$V_{CE} = -48\text{ V}; V_{BE} = 0\text{ A}$	-	-	-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	$V_{CE} = -2\text{ V}; I_C = -100\text{ mA}$	180	285	-	
		$V_{CE} = -2\text{ V}; I_C = -500\text{ mA}$	[1] 150	255	-	
		$V_{CE} = -2\text{ V}; I_C = -1\text{ A}$	[1] 140	210	-	
		$V_{CE} = -2\text{ V}; I_C = -1.5\text{ A}$	[1] 120	185	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = -0.5\text{ A}; I_B = -50\text{ mA}$	[1] -	-65	-100	mV
		$I_C = -1\text{ A}; I_B = -50\text{ mA}$	[1] -	-130	-200	mV
		$I_C = -1\text{ A}; I_B = -100\text{ mA}$	[1] -	-110	-170	mV
		$I_C = -1.5\text{ A}; I_B = -100\text{ mA}$	[1] -	-165	-260	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -1\text{ A}; I_B = -100\text{ mA}$	[1] -	110	170	$\text{m}\Omega$
		$I_C = -1.5\text{ A}; I_B = -100\text{ mA}$	[1] -	110	175	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = -0.5\text{ A}; I_B = -50\text{ mA}$	[1] -	-0.85	-1	V
		$I_C = -1.5\text{ A}; I_B = -100\text{ mA}$	[1] -	-0.93	-1.1	V

**Table 7. Characteristics ...continued** $T_{amb} = 25^{\circ}\text{C}$  unless otherwise specified.

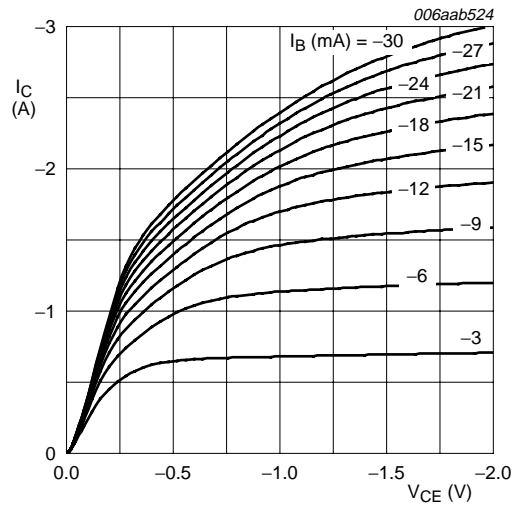
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = -10\text{ V}; I_C = -1\text{ A}$	[1] -	-0.75	-1.1	V
$t_d$	delay time	$V_{CC} = -10\text{ V}; I_C = -1\text{ A};$	-	17	-	ns
$t_r$	rise time	$I_{Bon} = -50\text{ mA};$	-	38	-	ns
$t_{on}$	turn-on time	$I_{Boff} = 50\text{ mA}$	-	55	-	ns
$t_s$	storage time		-	350	-	ns
$t_f$	fall time		-	65	-	ns
$t_{off}$	turn-off time		-	415	-	ns
$f_T$	transition frequency	$I_C = -50\text{ mA}; V_{CE} = -10\text{ V};$ $f = 100\text{ MHz}$	-	150	-	MHz
$C_c$	collector capacitance	$V_{CB} = -10\text{ V}; I_E = i_e = 0\text{ A};$ $f = 1\text{ MHz}$	-	30	-	pF
<b>TR2; NPN resistor-equipped transistor</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 50\text{ V}; I_E = 0\text{ A}$	-	-	100	nA
$I_{CEO}$	collector-emitter cut-off current	$V_{CE} = 30\text{ V}; I_B = 0\text{ A}$	-	-	1	$\mu\text{A}$
		$V_{CE} = 30\text{ V}; I_B = 0\text{ A};$ $T_j = 150^{\circ}\text{C}$	-	-	50	$\mu\text{A}$
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 5\text{ V}; I_C = 0\text{ A}$	-	-	400	$\mu\text{A}$
$h_{FE}$	DC current gain	$V_{CE} = 5\text{ V}; I_C = 5\text{ mA}$	30	-	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 0.5\text{ mA}$	-	-	150	mV
$V_{I(off)}$	off-state input voltage	$V_{CE} = 5\text{ V}; I_C = 100\text{ }\mu\text{A}$	-	1.1	0.8	V
$V_{I(on)}$	on-state input voltage	$V_{CE} = 0.3\text{ V}; I_C = 10\text{ mA}$	2.5	1.8	-	V
R1	bias resistor 1 (input)		7	10	13	k $\Omega$
R2/R1	bias resistor ratio		0.8	1	1.2	
$C_c$	collector capacitance	$V_{CB} = 10\text{ V}; I_E = i_e = 0\text{ A};$ $f = 1\text{ MHz}$	-	-	2.5	pF

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



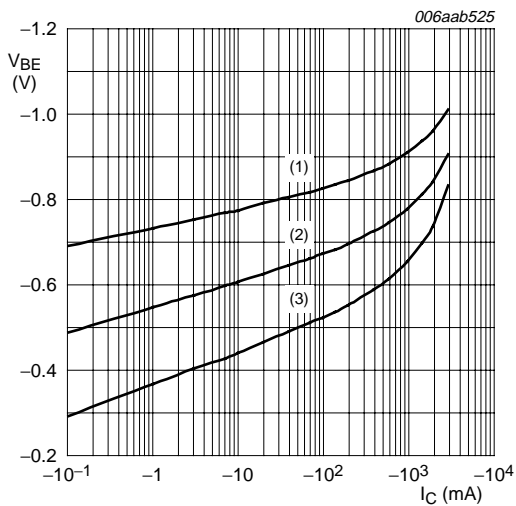
$V_{CE} = -2\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



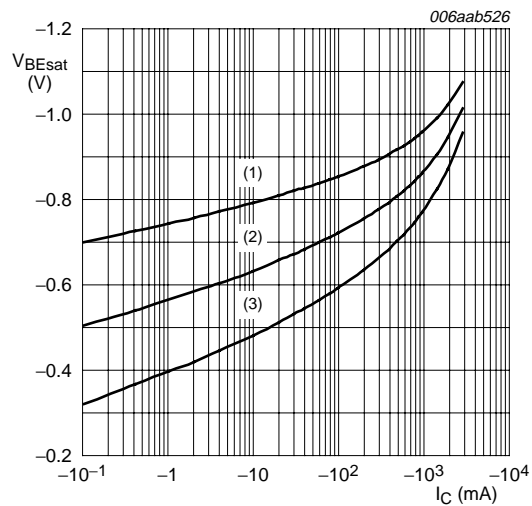
$T_{amb} = 25\text{ °C}$

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



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

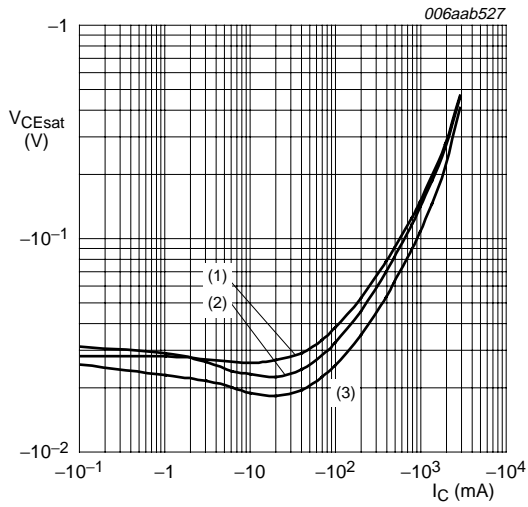
**Fig 7. TR1 (PNP): Base-emitter voltage as a function of collector current; typical values**



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

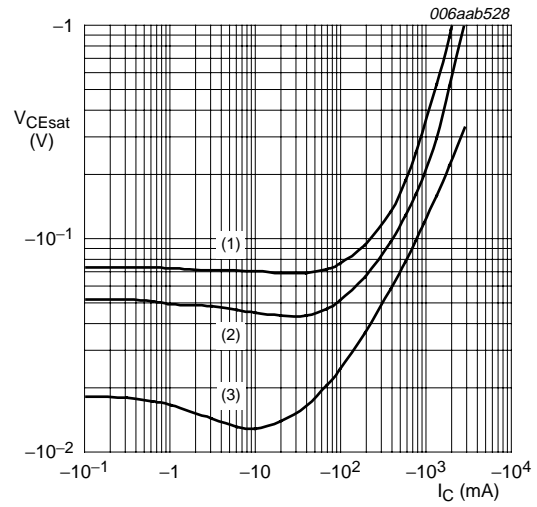
**Fig 8. TR1 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**





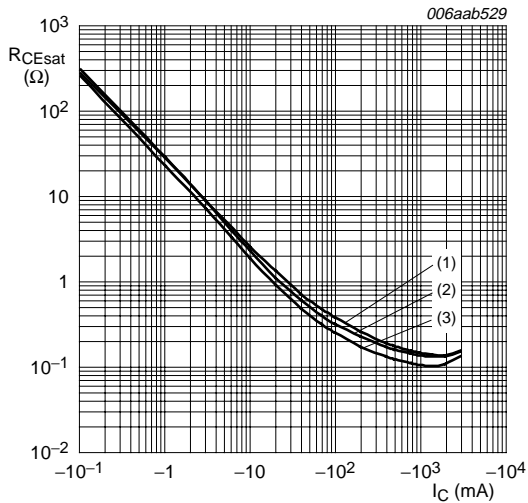
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

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



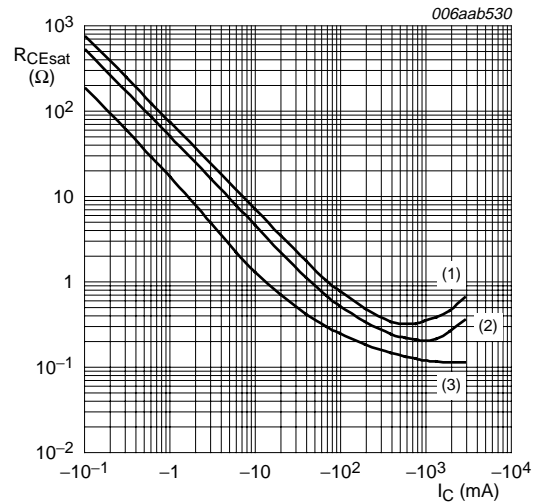
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

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



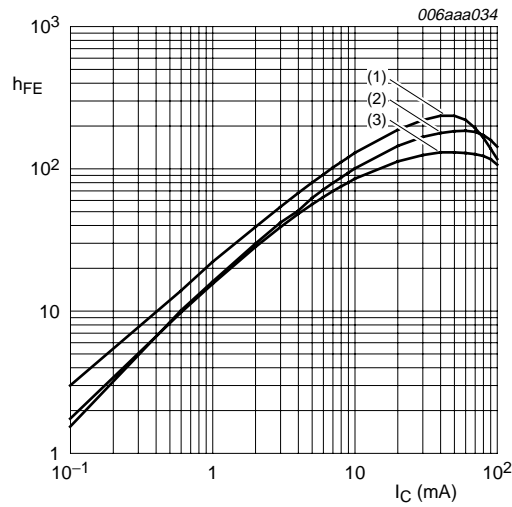
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -55\text{ °C}$

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



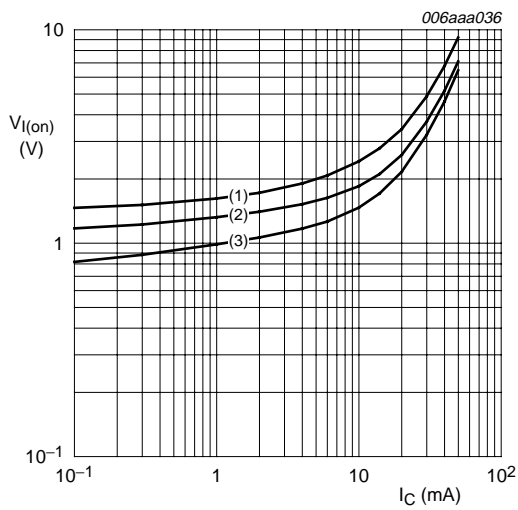
- $T_{amb} = 25\text{ °C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

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



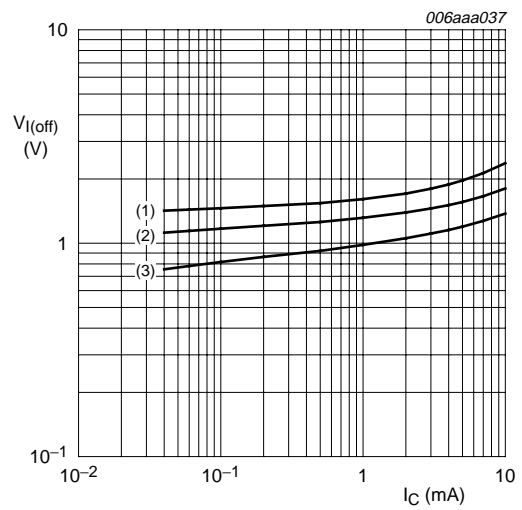
- $V_{CE} = 5\text{ V}$
- (1)  $T_{amb} = 150\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = -40\text{ °C}$

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



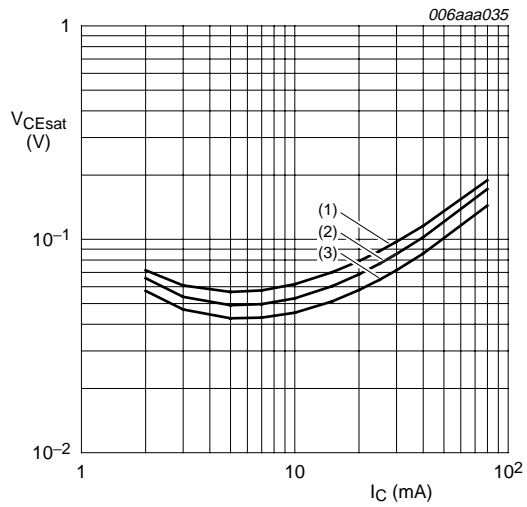
- $V_{CE} = 0.3\text{ V}$
- (1)  $T_{amb} = -40\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = 100\text{ °C}$

Fig 14. TR2 (NPN): On-state input voltage as a function of collector current; typical values



- $V_{CE} = 5\text{ V}$
- (1)  $T_{amb} = -40\text{ °C}$
  - (2)  $T_{amb} = 25\text{ °C}$
  - (3)  $T_{amb} = 100\text{ °C}$

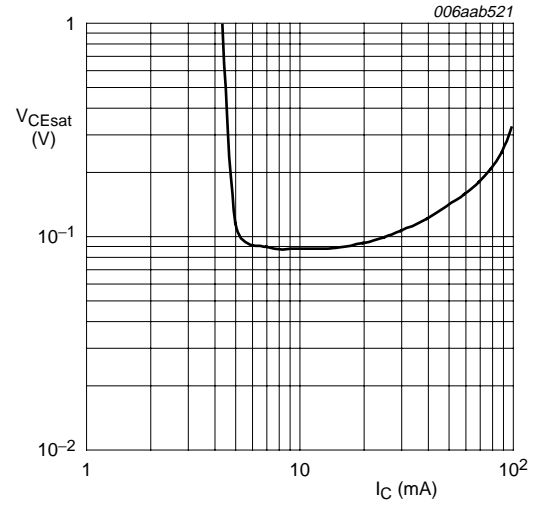
Fig 15. TR2 (NPN): Off-state input voltage as a function of collector current; typical values



$I_C/I_B = 20$

- (1)  $T_{amb} = 100\text{ °C}$
- (2)  $T_{amb} = 25\text{ °C}$
- (3)  $T_{amb} = -40\text{ °C}$

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



$I_C/I_B = 50; T_{amb} = 25\text{ °C}$

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

## 8. Test information

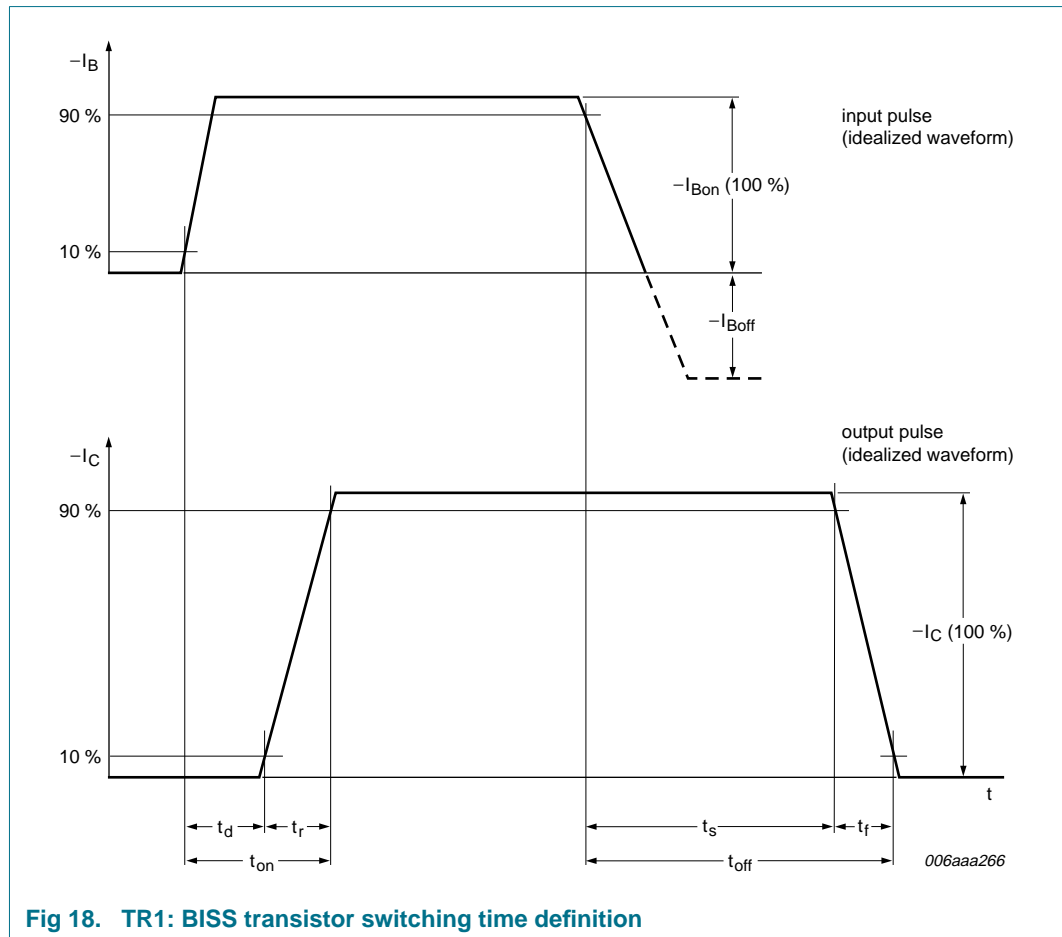
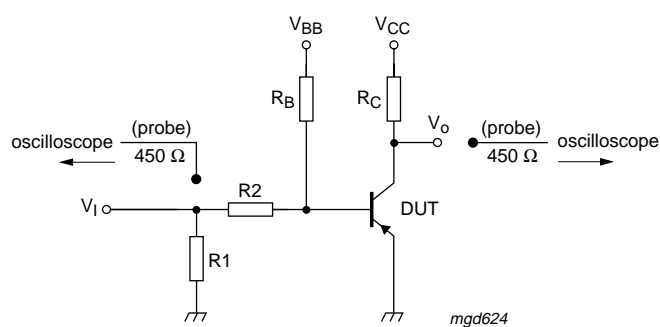


Fig 18. TR1: BISS transistor switching time definition



$V_{CC} = -10\text{ V}$ ;  $I_C = -1\text{ A}$ ;  $I_{Bon} = -50\text{ mA}$ ;  $I_{Boff} = 50\text{ mA}$

Fig 19. TR1: Test circuit for switching times

### 8.1 Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard *Q101 - Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

## 9. Package outline

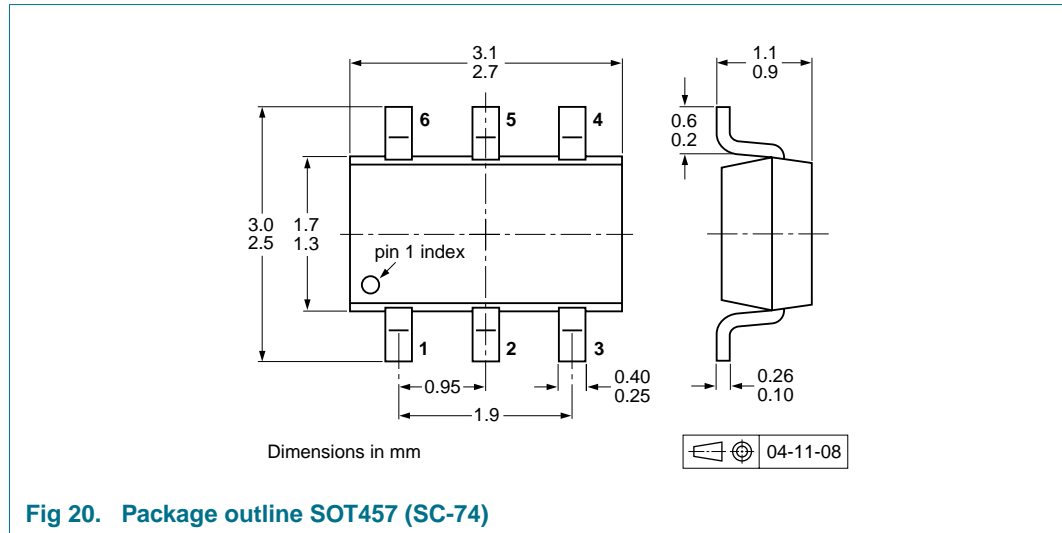


Fig 20. Package outline SOT457 (SC-74)

## 10. Packing information

**Table 8. Packing methods**

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

Type number	Package	Description	Packing quantity	
			3000	10000
PBL6023D	SOT457	4 mm pitch, 8 mm tape and reel; T1	<sup>[2]</sup> -115	-135
		4 mm pitch, 8 mm tape and reel; T2	<sup>[3]</sup> -125	-165

[1] For further information and the availability of packing methods, see [Section 13](#).

[2] T1: normal taping

[3] T2: reverse taping

## 11. Revision history

**Table 9.** Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PBL6023D_1	20090813	Product data sheet	-	-

## 12. Legal information

### 12.1 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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## 13. Contact information

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

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