



# PBL56024D

60 V, 1.5 A PNP loadswitch

20 October 2023

Product data sheet

## 1. General description

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

## 2. Features and benefits

- Low  $V_{CEsat}$  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

## 3. Applications

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

## 4. Quick reference data

Table 1. Quick reference data

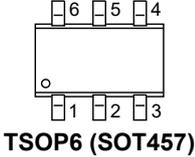
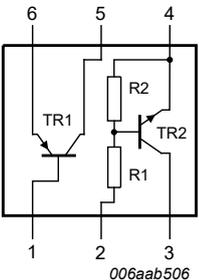
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>TR1; PNP low <math>V_{CEsat}</math> transistor</b>							
$V_{CEO}$	collector-emitter voltage	open base	-	-	-60	V	
$I_C$	collector current		-	-	-1.5	A	
$I_{CM}$	peak collector current	$t_p \leq 1$ ms; single pulse	-	-	-3	A	
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -1500$ mA; $I_B = -100$ mA; $T_{amb} = 25$ °C	[1]	110	175	mΩ	
<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)		[2]	15.4	22	28.6	kΩ
R2/R1	bias resistor ratio		[2]	0.8	1	1.2	

[1] Pulse test:  $t_p \leq 300$  μs;  $\delta \leq 0.02$

[2] See "Section 11: Test information" for resistor calculation and test conditions.

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	B1	base TR1	 <p>TSOP6 (SOT457)</p>	 <p>006aab506</p>
2	I2	input (base) TR2		
3	O2	output (collector) TR2		
4	GND	GND (emitter) TR2		
5	C1	collector TR1		
6	E1	emitter TR1		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
<a href="#">PBL6024D</a>	TSOP6	plastic, surface-mounted package (SC-74; TSOP6); 6 leads	<a href="#">SOT457</a>

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PBL6024D	KH

## 8. Limiting values

**Table 5. Limiting values**

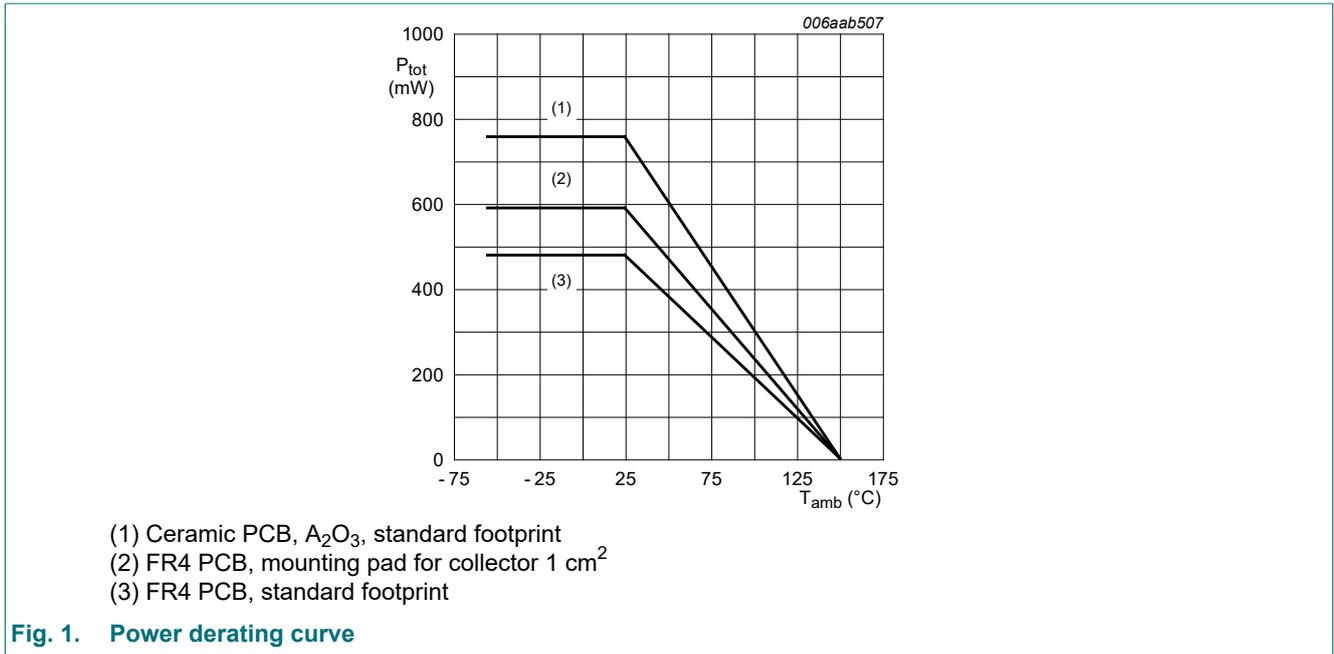
In accordance with the Absolute Maximum Rating System (IEC 60134).

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	$t_p \leq 1$ ms; single pulse		-	-3	A
$I_B$	base current			-	-300	mA
$I_{BM}$	peak base current	single pulse; $t_p \leq 1$ ms		-	-1000	mA
$P_{tot}$	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	$t_p \leq 1$ ms; single pulse		-	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, 35  $\mu$ m 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.

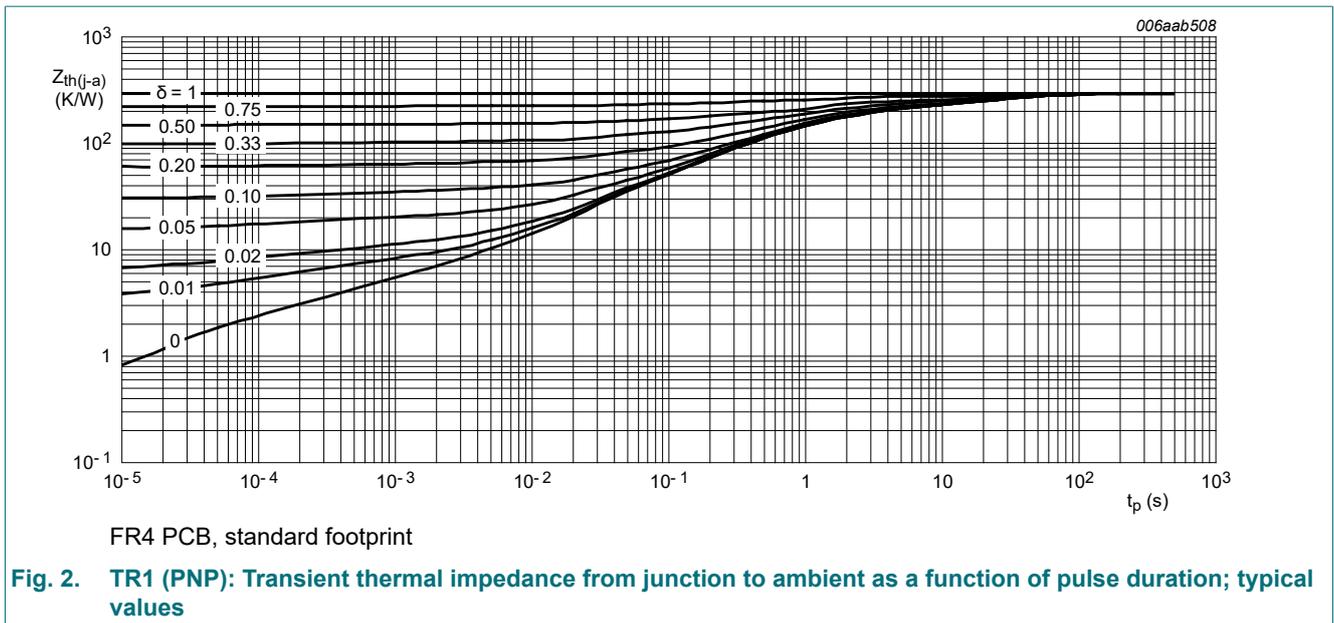


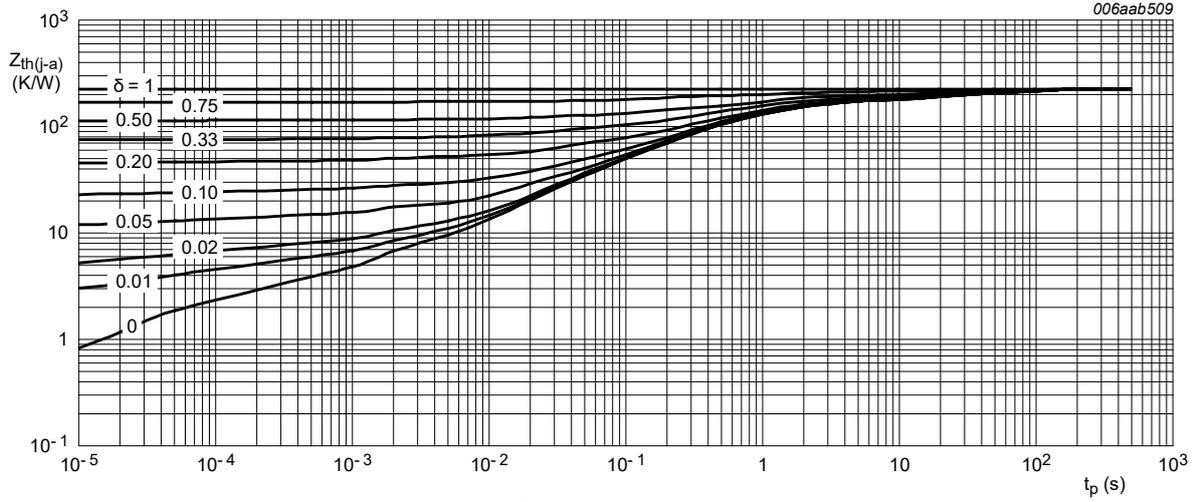
## 9. Thermal characteristics

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	

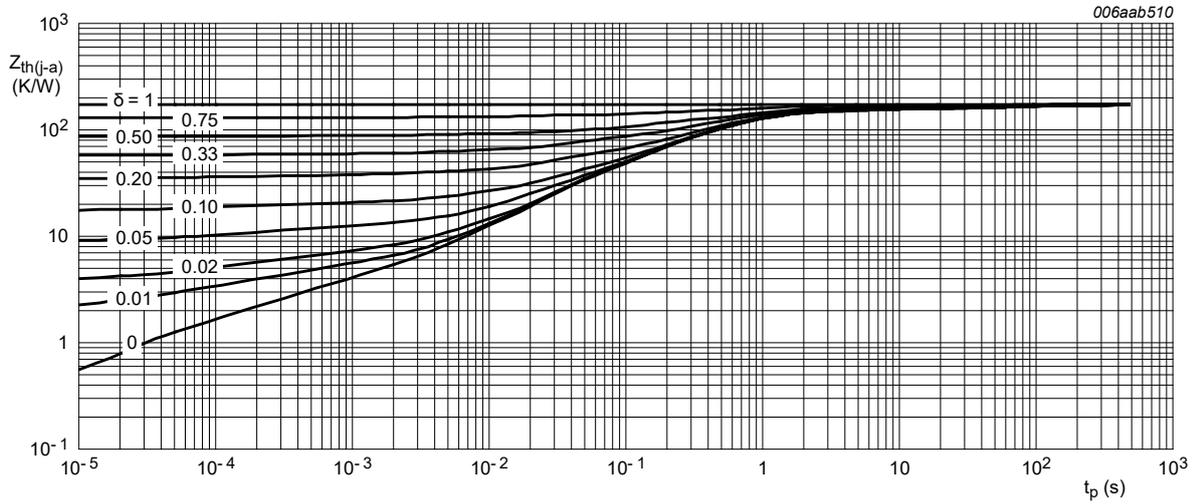
- [1] Device mounted on an FR4 PCB, single-sided, 35 μm copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.





FR4 PCB, 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,  $\text{Al}_2\text{O}_3$ , standard footprint

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

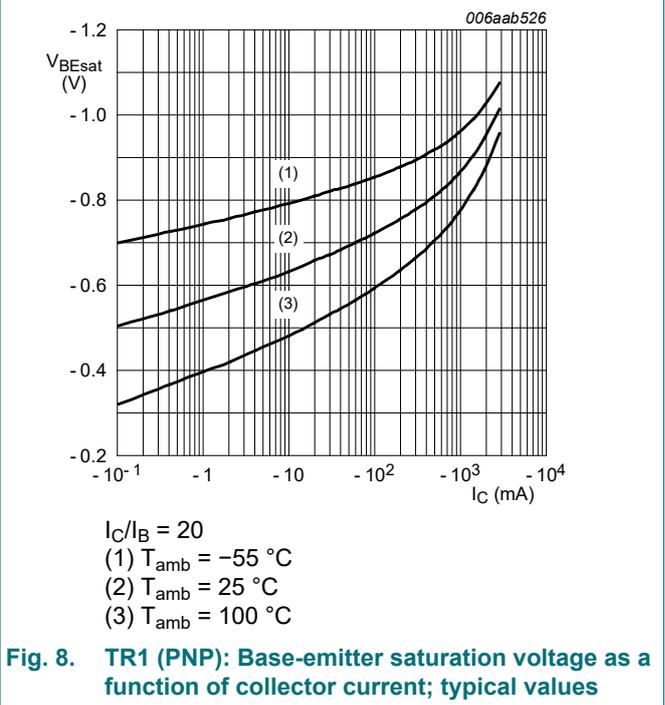
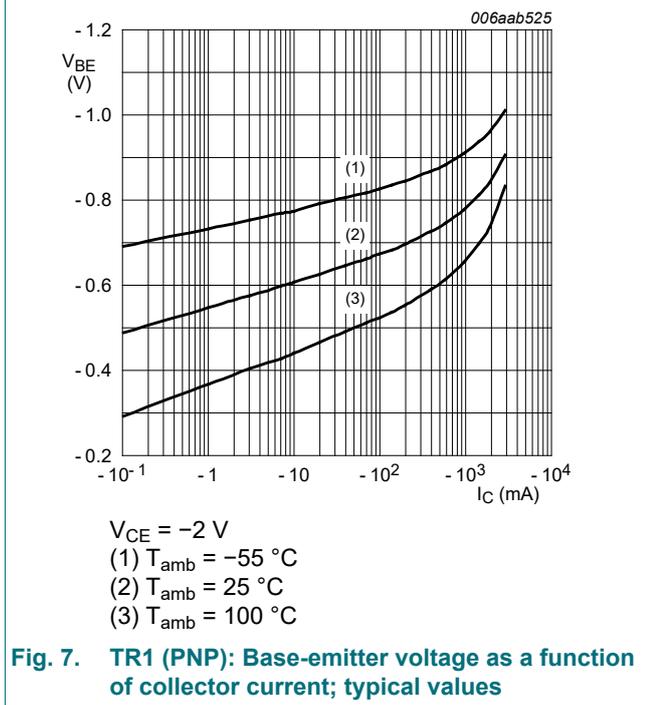
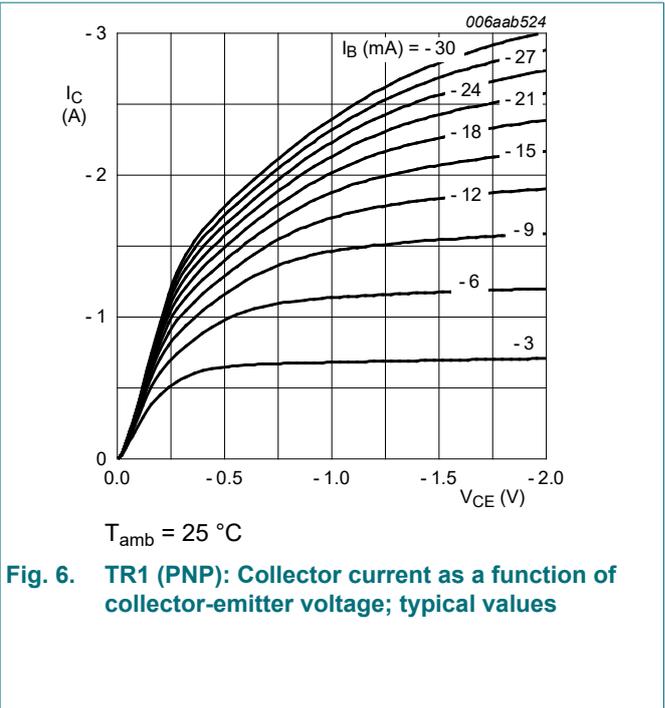
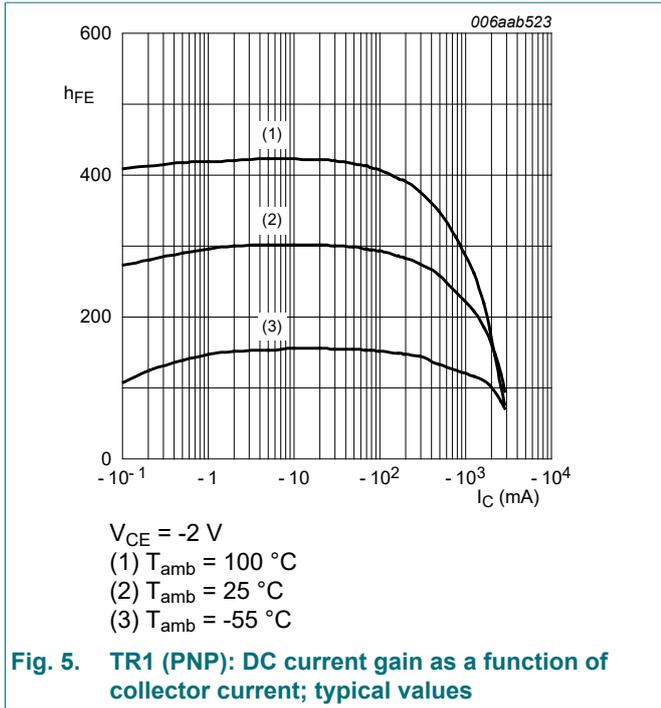
## 10. Characteristics

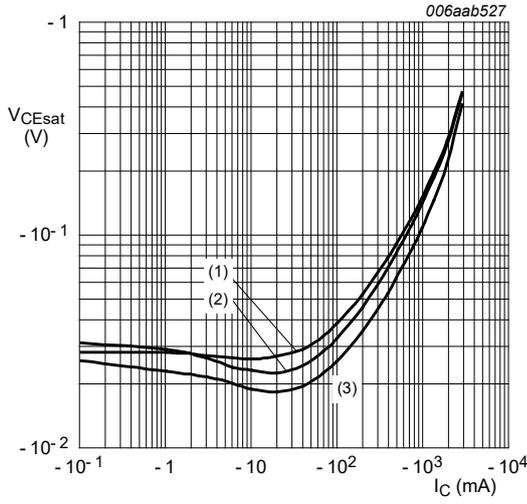
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>TR1; PNP low <math>V_{CEsat}</math> transistor</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = -60\text{ V}; I_E = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	-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	$V_{CE} = -48\text{ V}; T_{amb} = 25\text{ °C}; V_{BE} = 0\text{ A}$	-	-	-100	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = -5\text{ V}; I_C = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	-100	nA
$h_{FE}$	DC current gain	$V_{CE} = -2\text{ V}; I_C = -100\text{ mA}; T_{amb} = 25\text{ °C}$	180	285	-	
		$V_{CE} = -2\text{ V}; I_C = -500\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	150	255	-	
		$V_{CE} = -2\text{ V}; I_C = -1\text{ A}; T_{amb} = 25\text{ °C}$ [1]	140	210	-	
		$V_{CE} = -2\text{ V}; I_C = -1.5\text{ A}; T_{amb} = 25\text{ °C}$ [1]	120	185	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -0.5\text{ A}$ [1]	-	-65	-100	mV
		$I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1\text{ A}$ [1]	-	-130	-200	mV
		$I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1\text{ A}$ [1]	-	-110	-170	mV
		$I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1.5\text{ A}$ [1]	-	-165	-260	mV
$R_{CEsat}$	collector-emitter saturation resistance	$I_C = -1000\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	-	110	170	$\text{m}\Omega$
		$I_C = -1500\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	-	110	175	$\text{m}\Omega$
$V_{BEsat}$	base-emitter saturation voltage	$I_C = -500\text{ mA}; I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	-	-0.85	-1	V
		$I_C = -1500\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	-	-0.93	-1.1	V
$V_{BEon}$	base-emitter turn-on voltage	$V_{CE} = -10\text{ V}; I_C = -1000\text{ mA}; T_{amb} = 25\text{ °C}$ [1]	-	-0.75	-1.1	V
$t_d$	delay time	$V_{CC} = -10\text{ V}; I_C = -1\text{ A}; I_{Bon} = -50\text{ mA}; I_{Boff} = 50\text{ mA}; T_{amb} = 25\text{ °C}$	-	17	-	ns
$t_r$	rise time		-	38	-	ns
$t_{on}$	turn-on time		-	55	-	ns
$t_s$	storage time		-	350	-	ns
$t_f$	fall time		-	65	-	ns
$t_{off}$	turn-off time		-	415	-	ns
$C_c$	collector capacitance		$V_{CB} = -10\text{ V}; I_E = 0\text{ A}; i_e = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$	-	30	-
$f_T$	transition frequency	$V_{CE} = -10\text{ V}; I_C = -50\text{ mA}; f = 100\text{ MHz}; T_{amb} = 25\text{ °C}$	-	150	-	MHz
<b>TR2; NPN resistor-equipped transistor</b>						
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 50\text{ V}; I_E = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	100	nA
$I_{CEO}$	collector-emitter cut-off current	$V_{CE} = 30\text{ V}; I_B = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	1	$\mu\text{A}$
		$V_{CE} = 30\text{ V}; I_B = 0\text{ A}; T_j = 150\text{ °C}$	-	-	50	$\mu\text{A}$
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 5\text{ V}; I_C = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	180	$\mu\text{A}$
$h_{FE}$	DC current gain	$V_{CE} = 5\text{ V}; I_C = 5\text{ mA}; T_{amb} = 25\text{ °C}$	60	-	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 0.5\text{ mA}; T_{amb} = 25\text{ °C}$	-	-	150	mV

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_{I(off)}$	off-state input voltage	$V_{CE} = 5 \text{ V}; I_C = 100 \mu\text{A}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	1.1	0.8	V	
$V_{I(on)}$	on-state input voltage	$V_{CE} = 0.3 \text{ V}; I_C = 5 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$	2.5	1.7	-	V	
R1	bias resistor 1 (input)		[2]	15.4	22	28.6	k $\Omega$
R2/R1	bias resistor ratio		[2]	0.8	1	1.2	
$C_c$	collector capacitance	$V_{CB} = 10 \text{ V}; I_E = 0 \text{ A}; i_e = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$	-	-	2.5	pF	

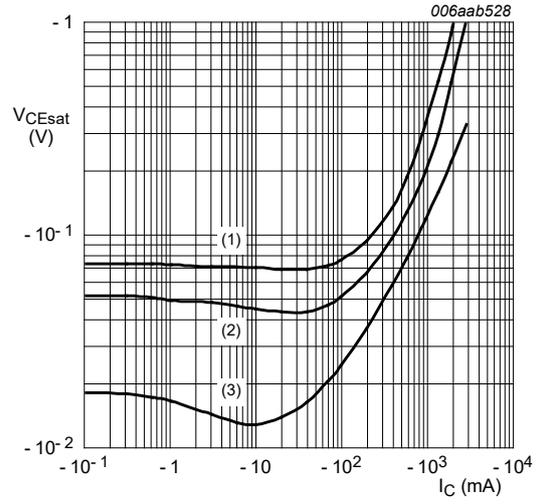
- [1] Pulse test:  $t_p \leq 300 \mu\text{s}; \delta \leq 0.02$
- [2] See "Section 11: Test information" for resistor calculation and test conditions.





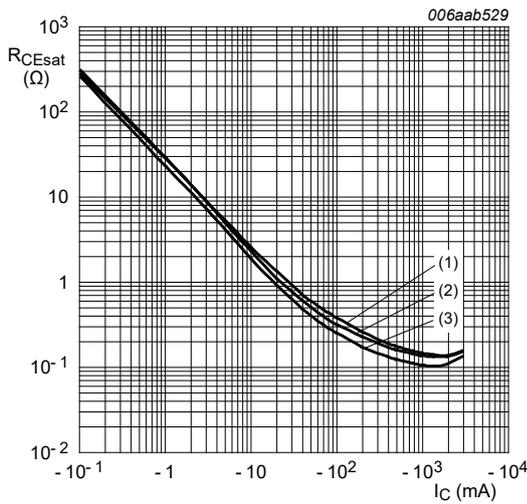
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



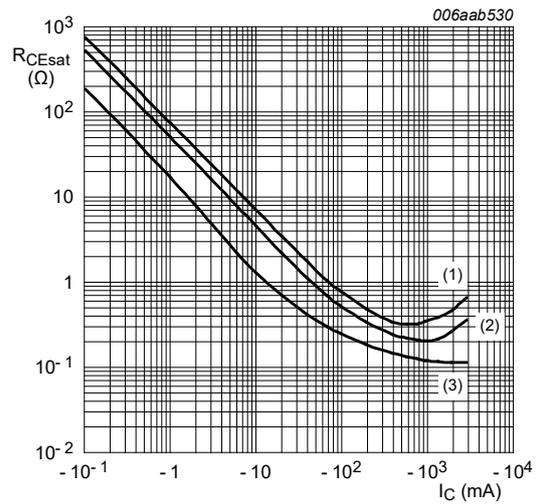
$T_{amb} = 25\text{ °C}$   
 (1)  $I_C/I_B = 100$   
 (2)  $I_C/I_B = 50$   
 (3)  $I_C/I_B = 10$

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



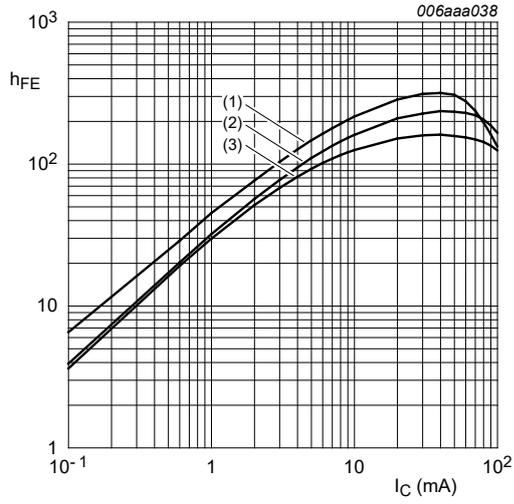
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



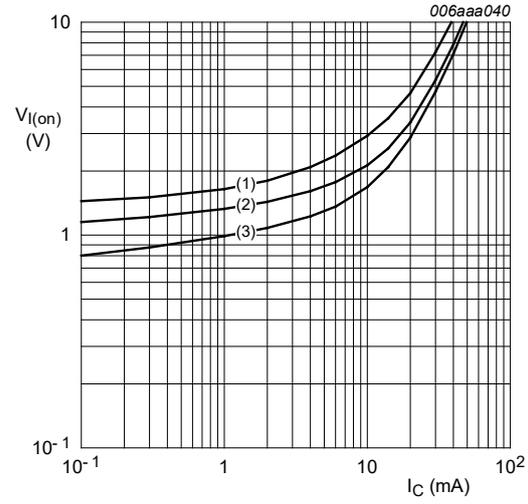
$T_{amb} = 25\text{ °C}$   
 (1)  $I_C/I_B = 100$   
 (2)  $I_C/I_B = 50$   
 (3)  $I_C/I_B = 10$

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



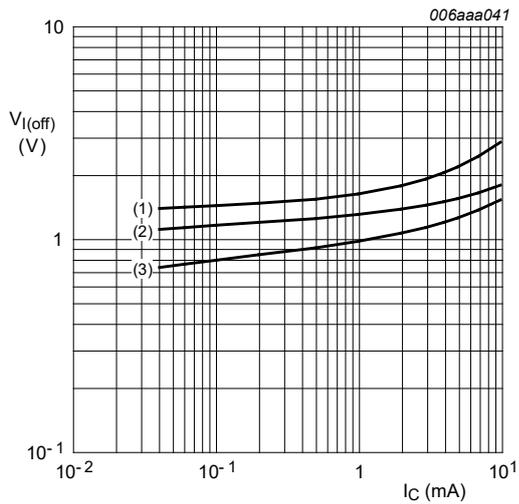
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

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



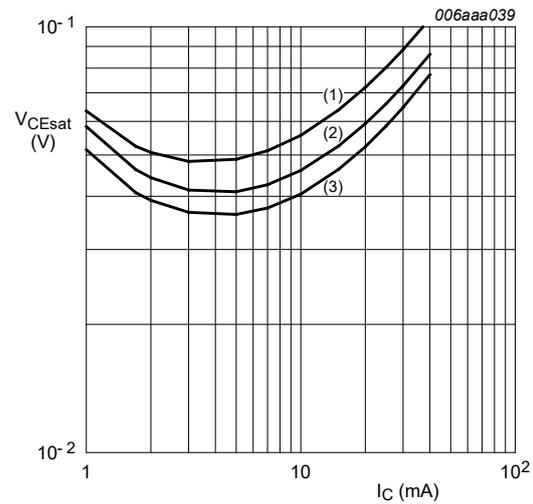
$V_{CE} = 0.3\text{ V}$   
 (1)  $T_{amb} = -40\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

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



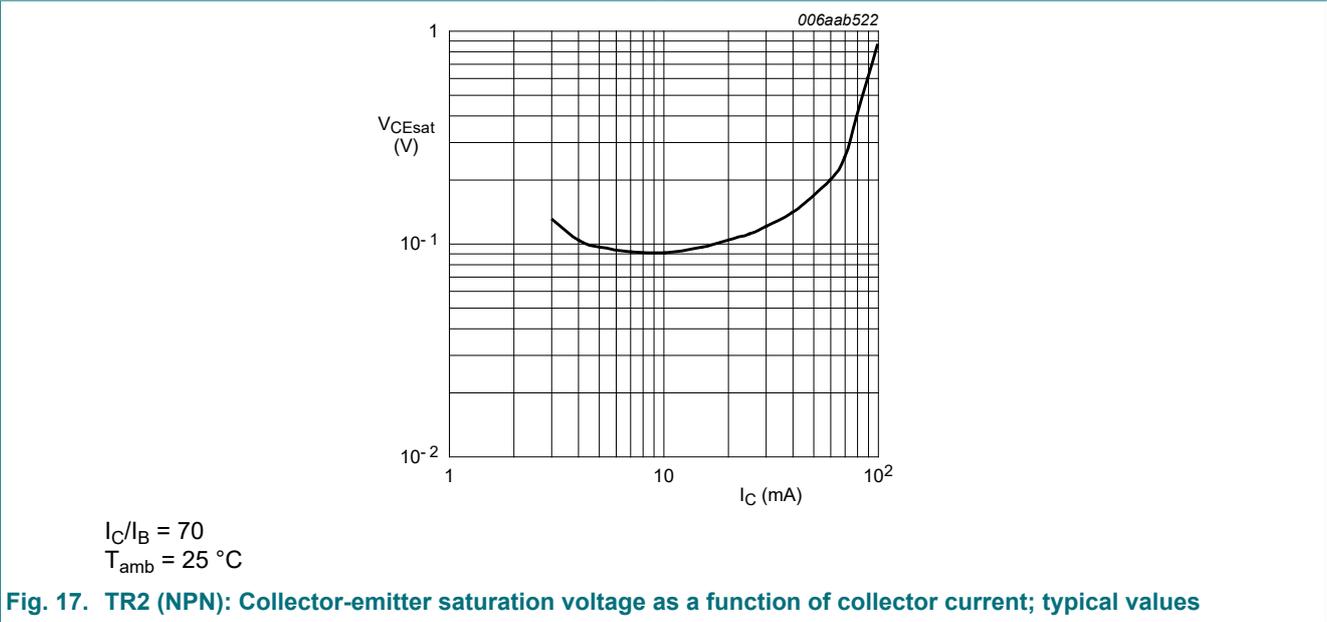
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = -40\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

**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**



### 11. Test information

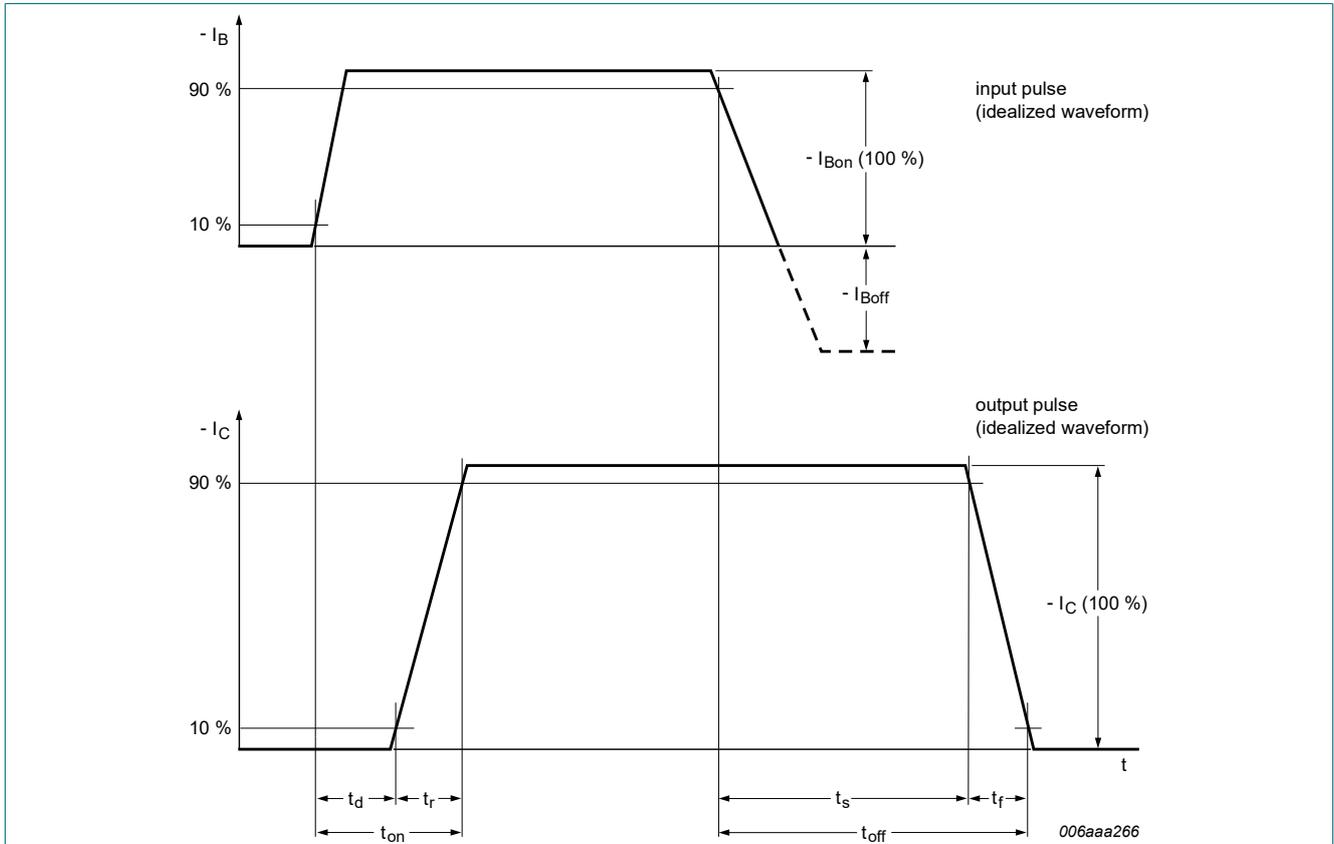


Fig. 18. TR1: Transistor switching time definition

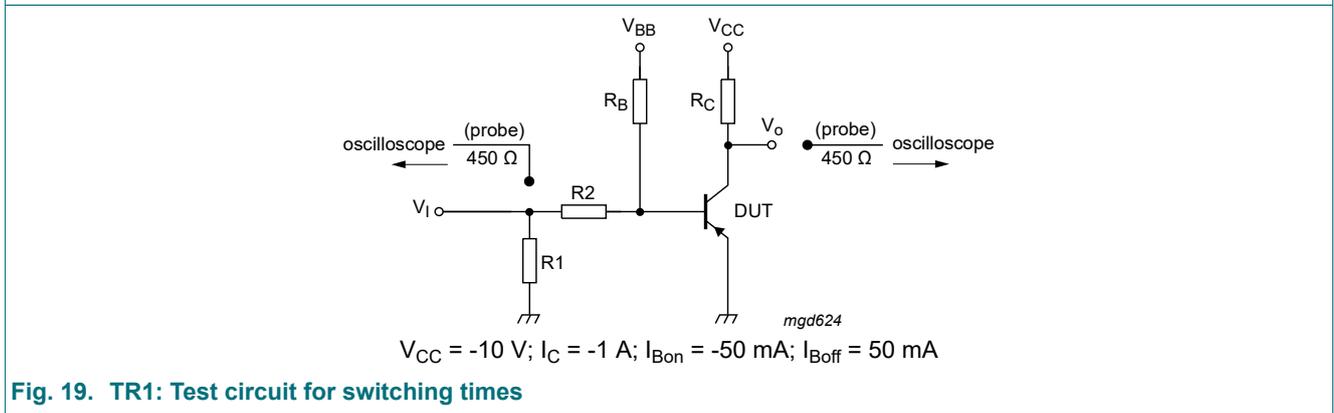


Fig. 19. TR1: Test circuit for switching times

### 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.



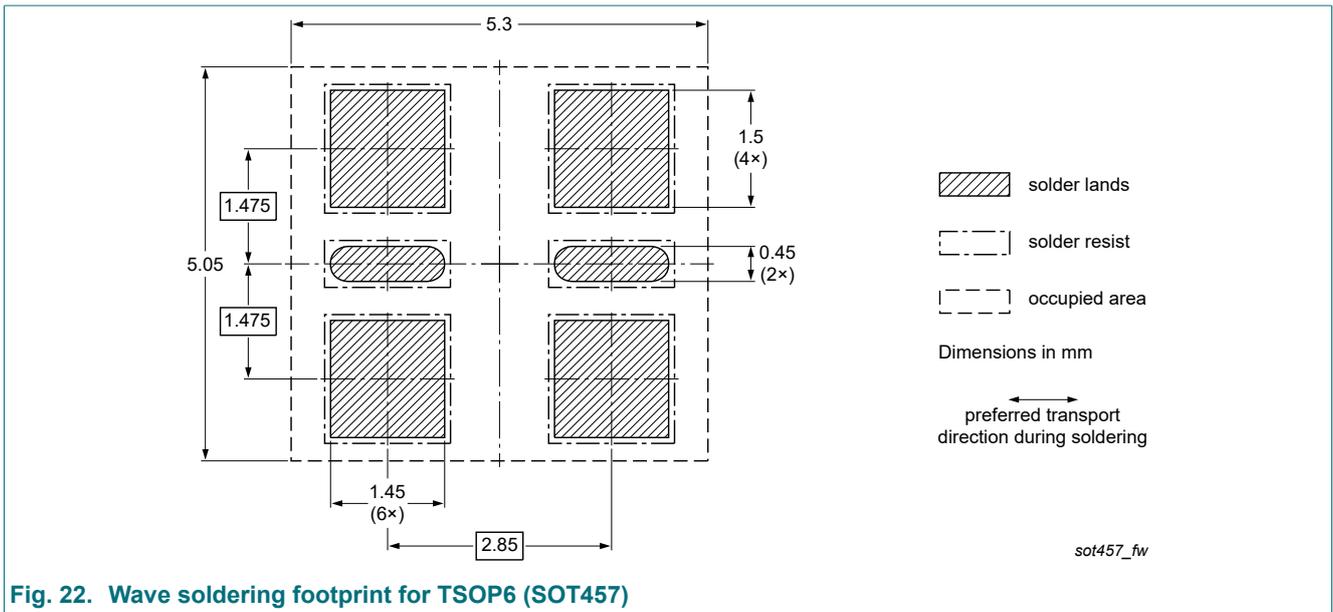


Fig. 22. Wave soldering footprint for TSOP6 (SOT457)

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PBL6024D v.2	20231020	Product data sheet	-	PBL6024D_1
Modifications:	<ul style="list-style-type: none"><li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li><li>Legal texts have been adapted to the new company name where appropriate.</li><li>Section "Packing information" removed.</li></ul>			
PBL6024D_1	20090814	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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