



# PBRN113ET-Q

40 V, 600 mA NPN PB RET; R1 = 1 k $\Omega$ , R2 = 1 k $\Omega$

5 May 2021

Product data sheet

## 1. General description

NPN low  $V_{CEsat}$  Performance-Based (PB) Resistor-Equipped Transistor (RET) in a small SOT23 (TO-236AB) Surface-Mounted Device (SMD) plastic package.

PNP complement: PBRP113ET-Q

## 2. Features and benefits

- 600 mA output current capability
- Low collector-emitter saturation voltage  $V_{CEsat}$
- High current gain  $h_{FE}$
- Reduces component count
- Built-in bias resistors
- Reduces pick and place costs
- Simplifies circuit design
- $\pm 10\%$  resistor ratio tolerance
- Qualified according to AEC-Q101 and recommended for use in automotive applications

## 3. Applications

- Digital application in automotive and industrial segments
- Switching loads
- Medium current peripheral driver

## 4. Quick reference data

Table 1. Quick reference data

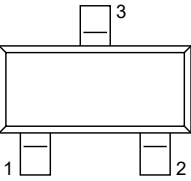
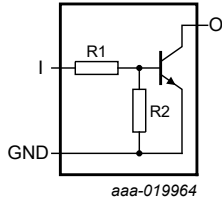
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{CEO}$	collector-emitter voltage	open base		-	-	40	V
$I_O$	output current		[1]	-	-	600	mA
R1	bias resistor 1		[2]	0.7	1	1.3	k $\Omega$
R2/R1	bias resistor ratio		[2]	0.9	1	1.1	

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided, 35  $\mu$ m copper, tin-plated and standard footprint.

[2] See section "Test information" for resistor calculation and test conditions

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	I	input (base)	 <p style="text-align: center;"><b>SOT23</b></p>	 <p style="text-align: right;"><small>aaa-019964</small></p>
2	GND	ground (emitter)		
3	O	output (collector)		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PBRN113ET-Q	SOT23	plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body	SOT23

## 7. Marking

Table 4. Marking codes

Type number	Marking code <sup>[1]</sup>
PBRN113ET-Q	%7G

[1] % = placeholder for manufacturing site code

## 8. Limiting values

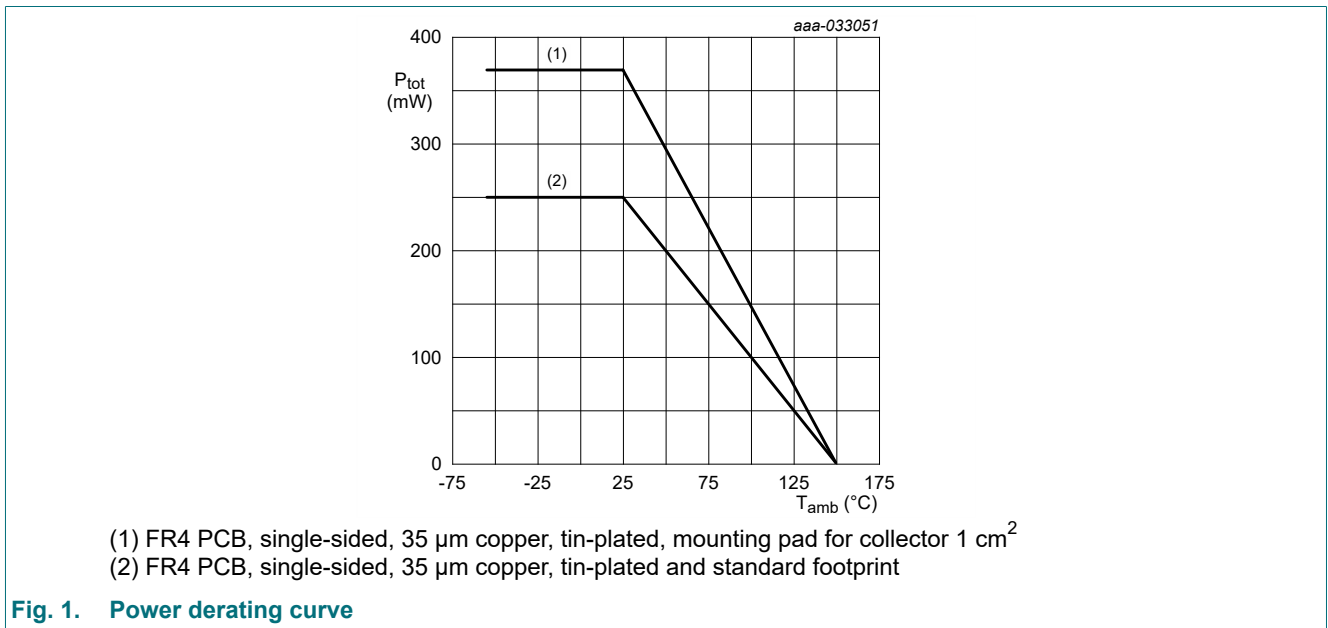
**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
V <sub>CBO</sub>	collector-base voltage	open emitter		-	40	V
V <sub>CEO</sub>	collector-emitter voltage	open base		-	40	V
V <sub>EBO</sub>	emitter-base voltage	open collector		-	10	V
V <sub>I</sub>	input voltage	positive		-	10	V
		negative		-	-10	V
I <sub>O</sub>	output current		[1]	-	600	mA
			[2]	-	700	mA
I <sub>ORM</sub>	repetitive peak output current	t <sub>p</sub> ≤ 1 ms; δ ≤ 0.33		-	800	mA
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> ≤ 25 °C	[1]	-	250	mW
			[2]	-	370	mW
T <sub>j</sub>	junction temperature			-	150	°C
T <sub>amb</sub>	ambient temperature			-65	150	°C
T <sub>stg</sub>	storage temperature			-65	150	°C

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided, 35 μm copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided, 35 μm copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.



### 9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	500	K/W
			[2]	-	-	338	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	105	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, 35 μm copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.

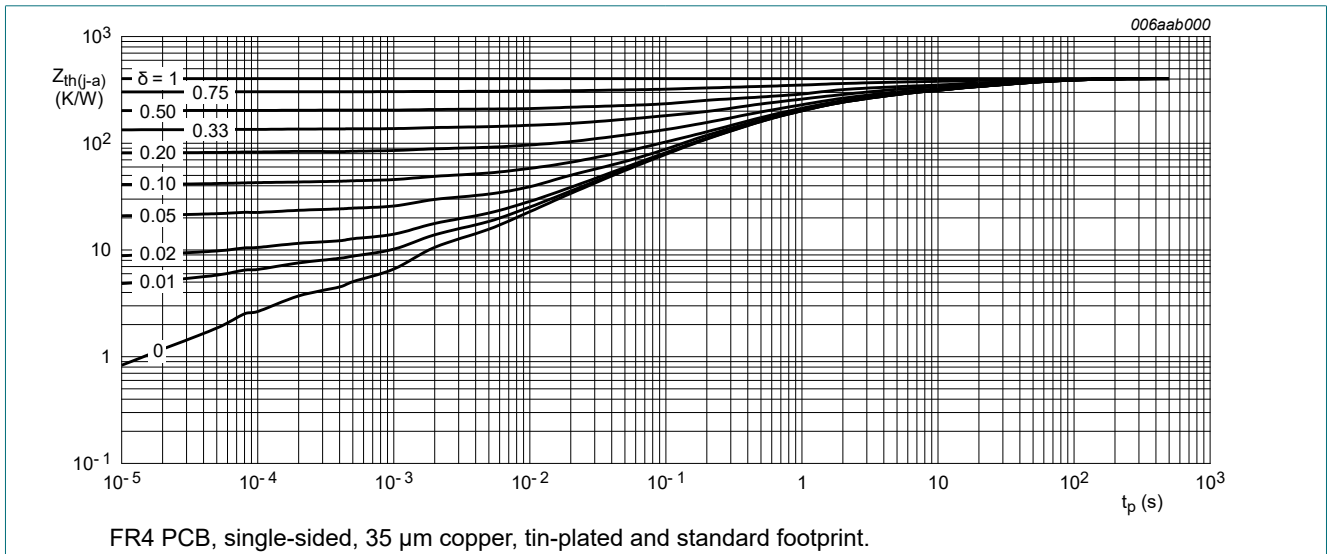


Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

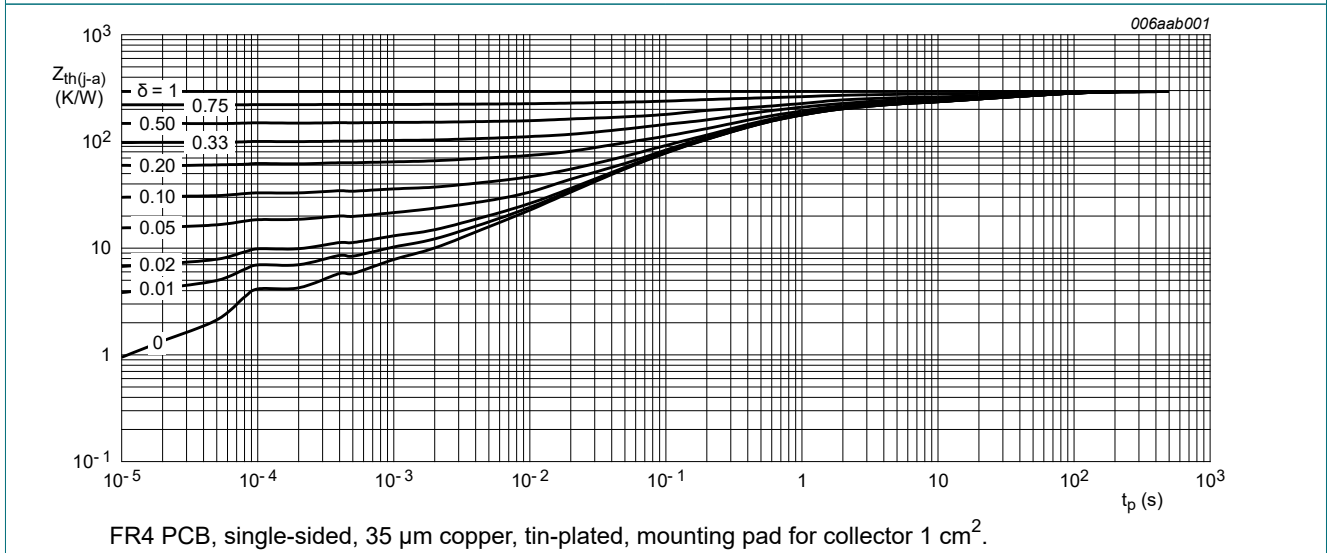


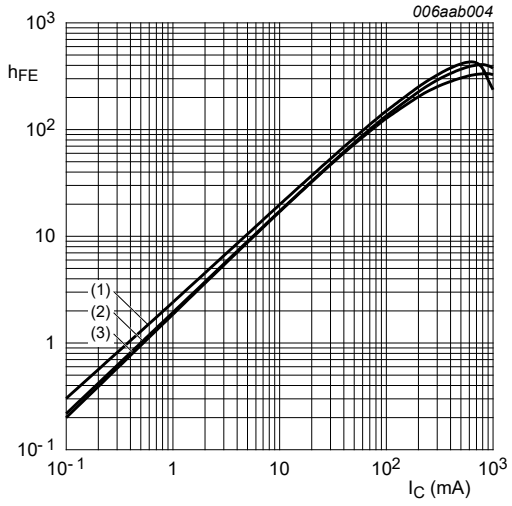
Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

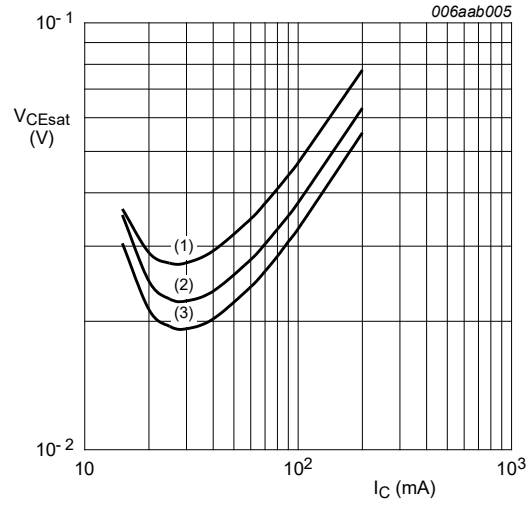
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 100 \mu\text{A}$ ; $I_E = 0 \text{ A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	40	-	-	V	
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 10 \text{ mA}$ ; $I_B = 0 \text{ A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	40	-	-	V	
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 30 \text{ V}$ ; $I_E = 0 \text{ A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	-	100	nA	
$I_{CEO}$	collector-emitter cut-off current	$V_{CE} = 30 \text{ V}$ ; $I_B = 0 \text{ A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	-	0.5	$\mu\text{A}$	
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 5 \text{ V}$ ; $I_C = 0 \text{ A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	-	4	mA	
$h_{FE}$	DC current gain	$V_{CE} = 5 \text{ V}$ ; $I_C = 50 \text{ mA}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	40	75	-		
		$V_{CE} = 5 \text{ V}$ ; $I_C = 300 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	180	300	-		
		$V_{CE} = 5 \text{ V}$ ; $I_C = 600 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	250	400	-		
		$V_{CE} = 5 \text{ V}$ ; $I_C = 800 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	270	420	-		
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 50 \text{ mA}$ ; $I_B = 2.5 \text{ mA}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	25	35	mV	
		$I_C = 200 \text{ mA}$ ; $I_B = 10 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	60	85	mV	
		$I_C = 500 \text{ mA}$ ; $I_B = 10 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	160	220	mV	
		$I_C = 600 \text{ mA}$ ; $I_B = 6 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	320	550	mV	
		$I_C = 800 \text{ mA}$ ; $I_B = 8 \text{ mA}$ ; pulsed; $t_p \leq 300 \mu\text{s}$ ; $\delta \leq 0.02$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	680	1150	mV	
$V_{I(off)}$	off-state input voltage	$V_{CE} = 5 \text{ V}$ ; $I_C = 100 \mu\text{A}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	0.6	1	1.5	V	
$V_{I(on)}$	on-state input voltage	$V_{CE} = 0.3 \text{ V}$ ; $I_C = 20 \text{ mA}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	1	1.3	1.8	V	
R1	bias resistor 1		[1]	0.7	1	1.3	kΩ
R2/R1	bias resistor ratio		[1]	0.9	1	1.1	
$C_c$	collector capacitance	$V_{CB} = 10 \text{ V}$ ; $I_E = 0 \text{ A}$ ; $i_e = 0 \text{ A}$ ; $f = 1 \text{ MHz}$ ; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	7	-	pF	

[1] See section "Test information" for resistor calculation and test conditions



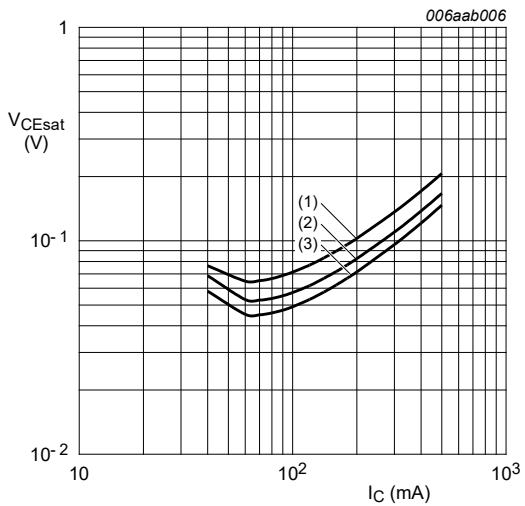
$V_{CE} = 5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 4. DC current gain as a function of collector current; typical values**



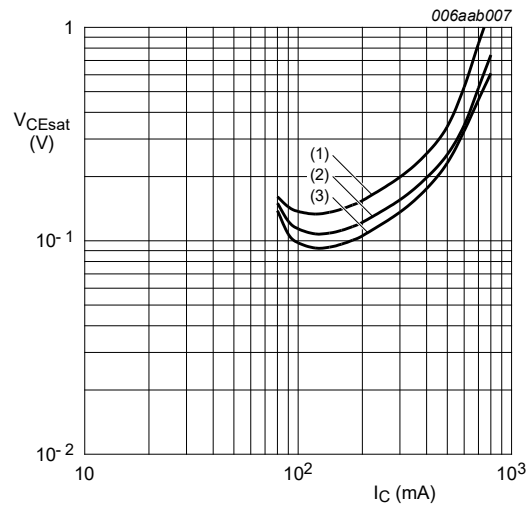
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 5. Collector-emitter saturation voltage as a function of collector current; typical values**



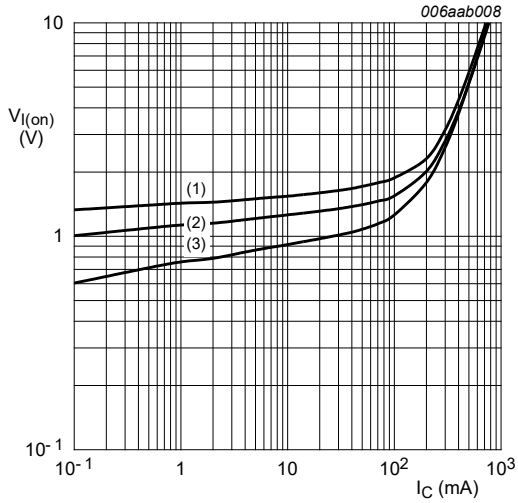
$I_C/I_B = 50$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 6. Collector-emitter saturation voltage as a function of collector current; typical values**



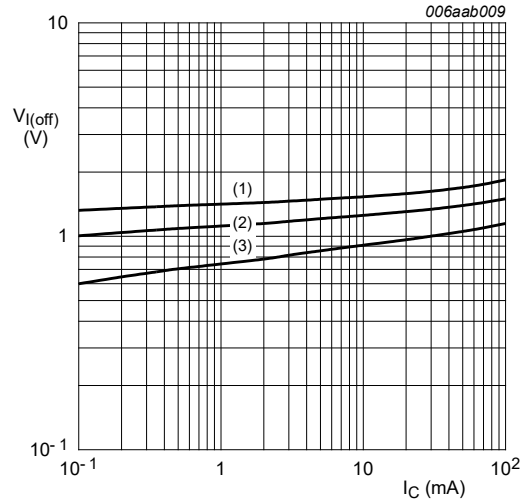
$I_C/I_B = 100$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -40\text{ °C}$

**Fig. 7. Collector-emitter saturation voltage as a function of collector current; typical values**



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

**Fig. 8. On-state input voltage as a function of collector current; typical values**



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

**Fig. 9. Off-state input voltage as a function of collector current; typical values**

## 11. Test information

### Resistor calculation

- Calculation of bias resistor 1 (R1)

$$R_1 = \frac{V(I_{I2}) - V(I_{I1})}{I_{I2} - I_{I1}}$$

- Calculation of bias resistor ratio (R2/R1)

$$\frac{R_2}{R_1} = \frac{V(I_{I3})}{R_1 \cdot I_{I3}} - 1$$

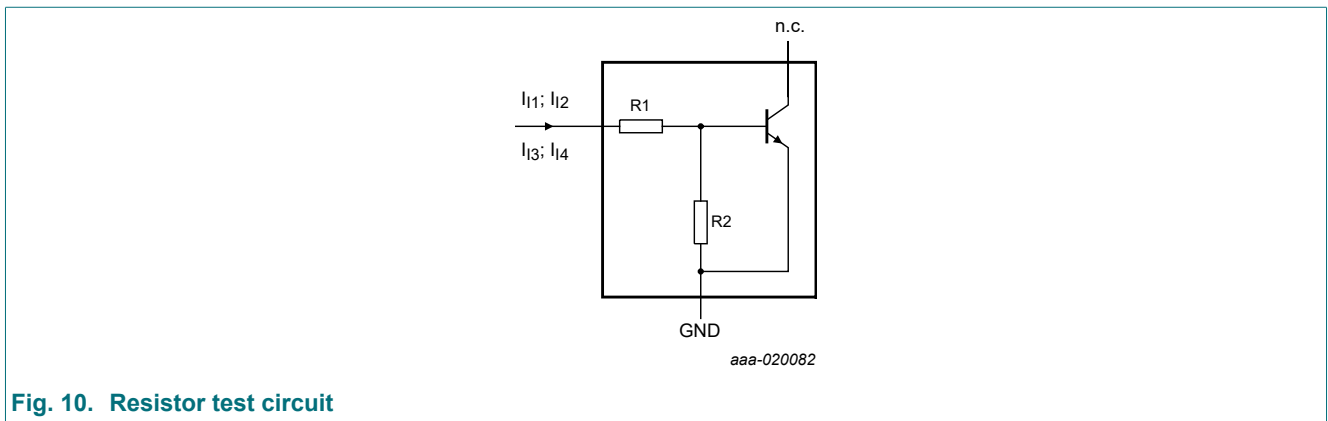


Fig. 10. Resistor test circuit

### Resistor test conditions

Table 8. Resistor test conditions

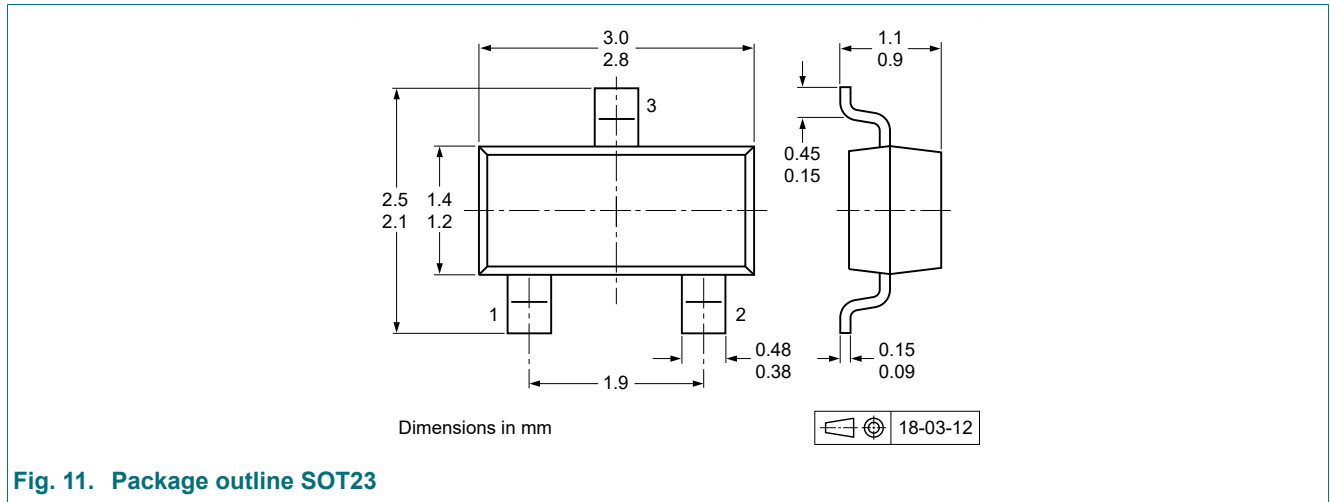
Type number	R1 (kΩ)	R2 (kΩ)	Test conditions		
			I <sub>I1</sub>	I <sub>I2</sub>	I <sub>I3</sub>
PBRN113ET	1	1	1.6 mA	1.7 mA	-1.65 mA

### Quality information

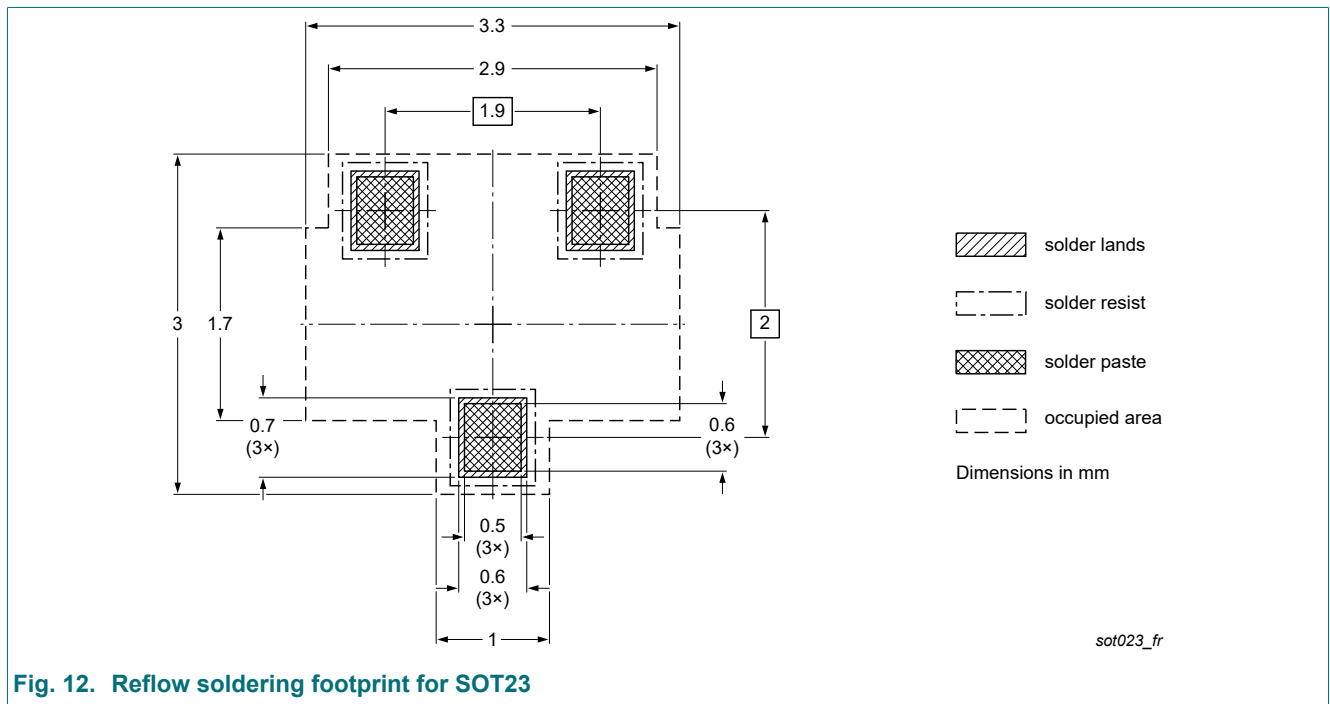
This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - *Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.



### 12. Package outline



### 13. Soldering



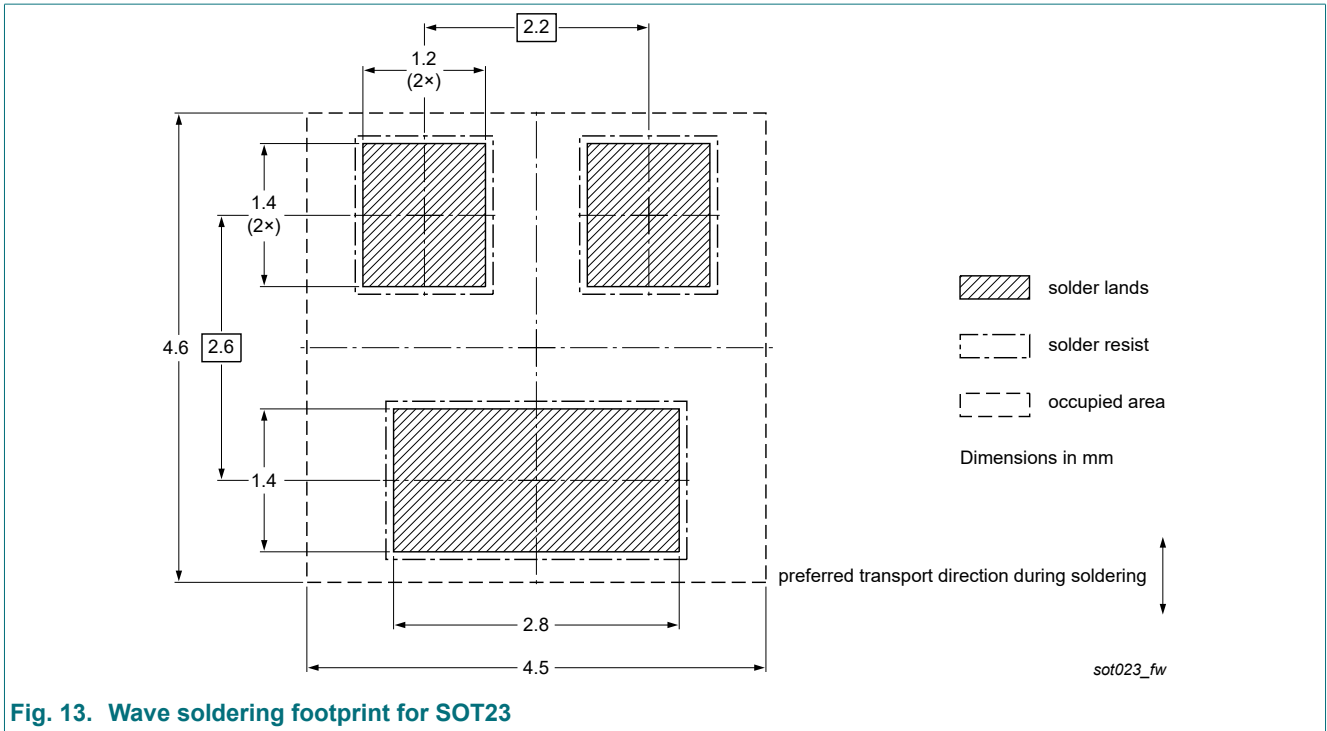


Fig. 13. Wave soldering footprint for SOT23

## 14. Revision history

**Table 9. Revision history**

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PBRN113ET-Q v.2	20210505	Product data sheet	-	PBRN113ET-Q v.1
Modifications:	• Features and benefits: added recommendation for automotive applications			
PBRN113ET-Q v.1	20210331	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".
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