



PBRN123ET-Q

40 V, 600 mA NPN PB RET; R1 = 2.2 k Ω , R2 = 2.2 k Ω

6 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: PBRP123ET-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

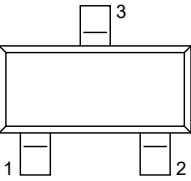
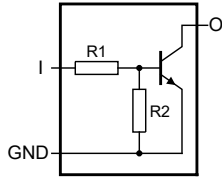
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{CEO}	collector-emitter voltage	open base		-	-	40	V
I_O	output current		[1]	-	-	600	mA
R1	bias resistor 1		[2]	1.54	2.2	2.96	k Ω
R2/R1	bias resistor ratio		[2]	0.9	1	1.1	

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided, 35 μ 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;">SOT23</p>	 <p style="text-align: center;">aaa-019964</p>
2	GND	ground (emitter)		
3	O	output (collector)		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PBRN123ET-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 ^[1]
PBRN123ET-Q	%7J

[1] % = placeholder for manufacturing site code

8. Limiting values

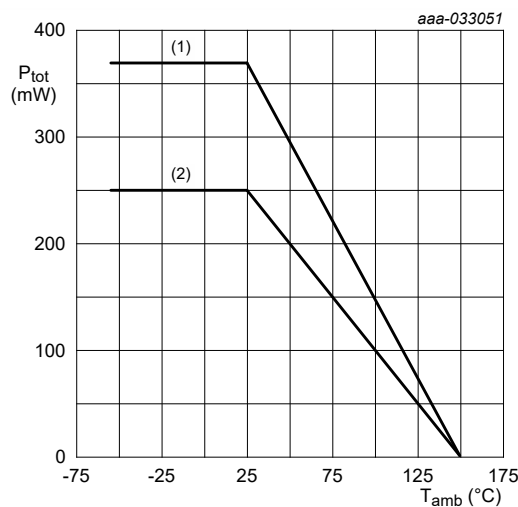
Table 5. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CBO}	collector-base voltage	open emitter	-	40	V
V_{CEO}	collector-emitter voltage	open base	-	40	V
V_{EBO}	emitter-base voltage	open collector	-	10	V
V_I	input voltage	positive	-	22	V
		negative	-	-10	V
I_O	output current	[1]	-	600	mA
		[2]	-	700	mA
I_{ORM}	repetitive peak output current	$t_p \leq 1 \text{ ms}$; $\delta \leq 0.33$	-	800	mA
P_{tot}	total power dissipation	[1]	-	250	mW
		[2]	-	370	mW
T_j	junction temperature		-	150	°C
T_{amb}	ambient temperature		-65	150	°C
T_{stg}	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 cm².



(1) FR4 PCB, single-sided, 35 μm copper, tin-plated, mounting pad for collector 1 cm²

(2) FR4 PCB, single-sided, 35 μm copper, tin-plated and standard footprint

Fig. 1. Power derating curve

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 cm².

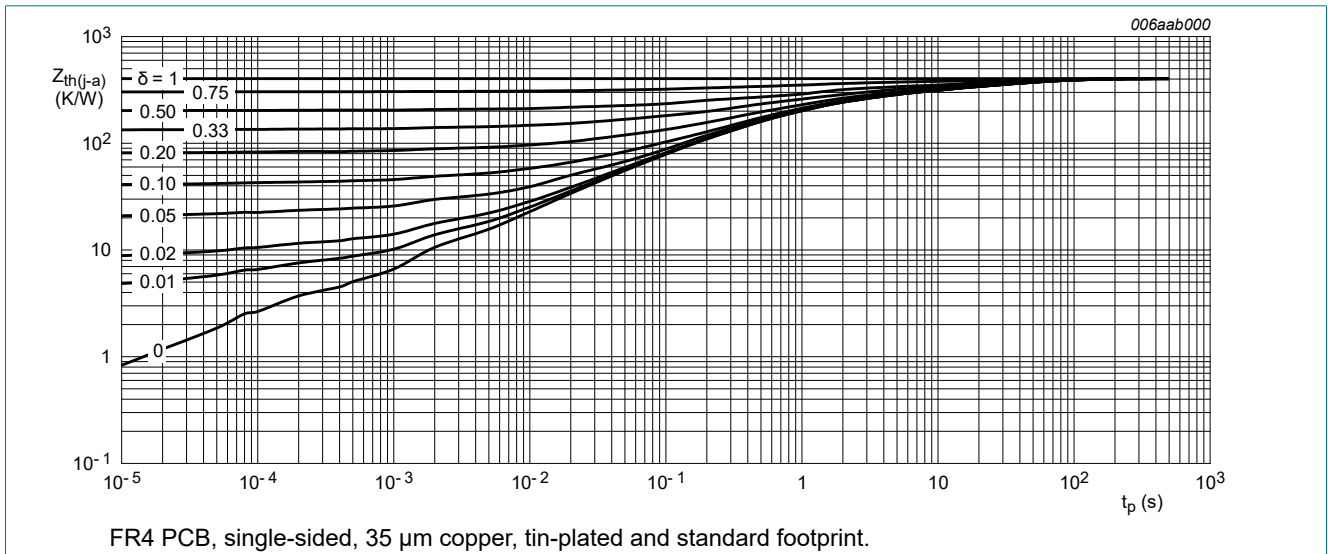


Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

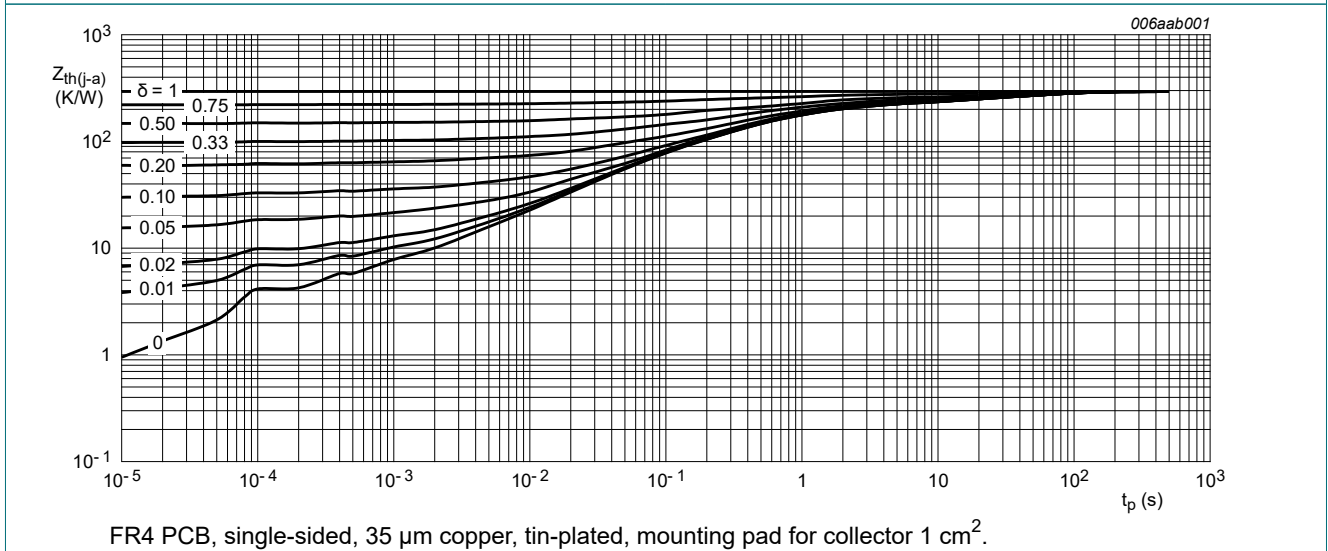


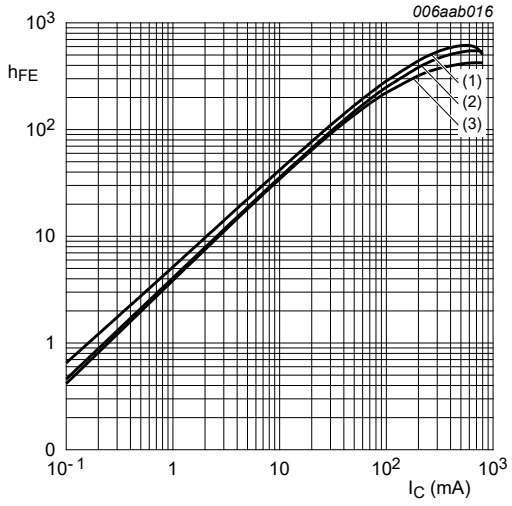
Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

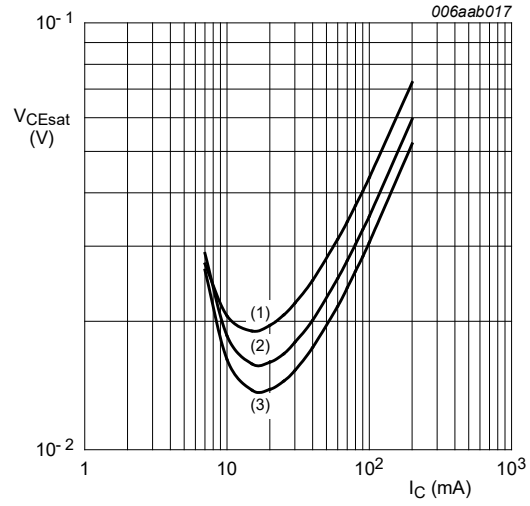
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 100 \mu\text{A}$; $I_E = 0 \text{ A}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	40	-	-	V	
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 10 \text{ mA}$; $I_B = 0 \text{ A}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	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	μA	
I_{EBO}	emitter-base cut-off current	$V_{EB} = 5 \text{ V}$; $I_C = 0 \text{ A}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	-	2	mA	
h_{FE}	DC current gain	$V_{CE} = 5 \text{ V}$; $I_C = 50 \text{ mA}$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	70	135	-		
		$V_{CE} = 5 \text{ V}$; $I_C = 300 \text{ mA}$; pulsed; $t_p \leq 300 \mu\text{s}$; $\delta \leq 0.02$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	280	460	-		
		$V_{CE} = 5 \text{ V}$; $I_C = 600 \text{ mA}$; pulsed; $t_p \leq 300 \mu\text{s}$; $\delta \leq 0.02$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	350	560	-		
		$V_{CE} = 5 \text{ V}$; $I_C = 800 \text{ mA}$; pulsed; $t_p \leq 300 \mu\text{s}$; $\delta \leq 0.02$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	340	550	-		
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; $t_p \leq 300 \mu\text{s}$; $\delta \leq 0.02$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	290	550	mV	
		$I_C = 800 \text{ mA}$; $I_B = 8 \text{ mA}$; pulsed; $t_p \leq 300 \mu\text{s}$; $\delta \leq 0.02$; $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$	-	630	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	1.8	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	2	V	
R1	bias resistor 1		[1]	1.54	2.2	2.96	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



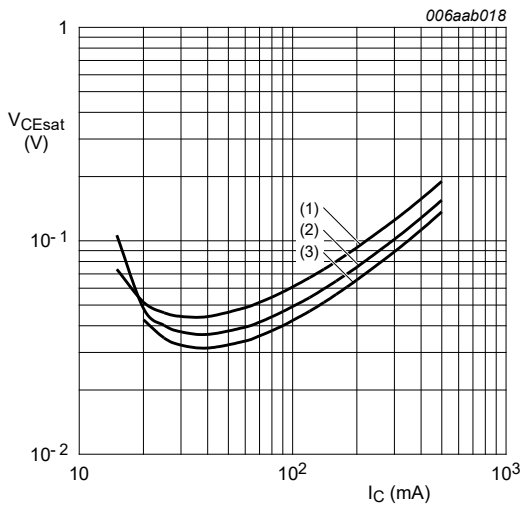
$V_{CE} = 5\text{ V}$
 (1) $T_{amb} = 100\text{ }^\circ\text{C}$
 (2) $T_{amb} = 25\text{ }^\circ\text{C}$
 (3) $T_{amb} = -40\text{ }^\circ\text{C}$

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



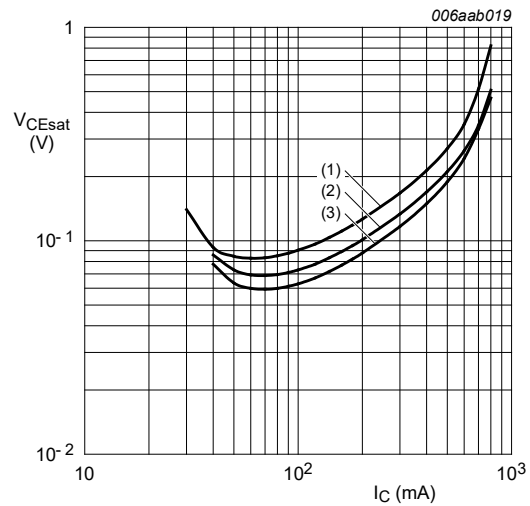
$I_C/I_B = 20$
 (1) $T_{amb} = 100\text{ }^\circ\text{C}$
 (2) $T_{amb} = 25\text{ }^\circ\text{C}$
 (3) $T_{amb} = -40\text{ }^\circ\text{C}$

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



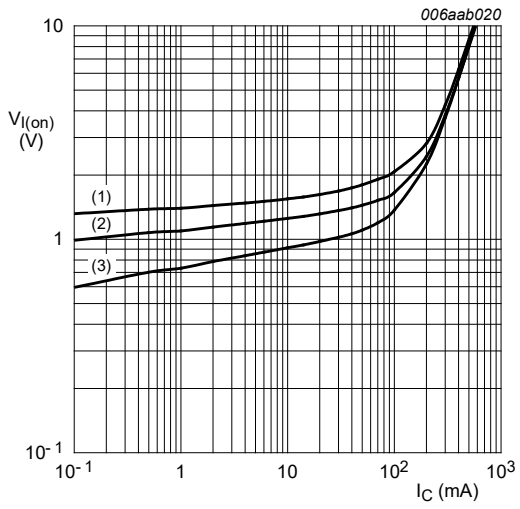
$I_C/I_B = 50$
 (1) $T_{amb} = 100\text{ }^\circ\text{C}$
 (2) $T_{amb} = 25\text{ }^\circ\text{C}$
 (3) $T_{amb} = -40\text{ }^\circ\text{C}$

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



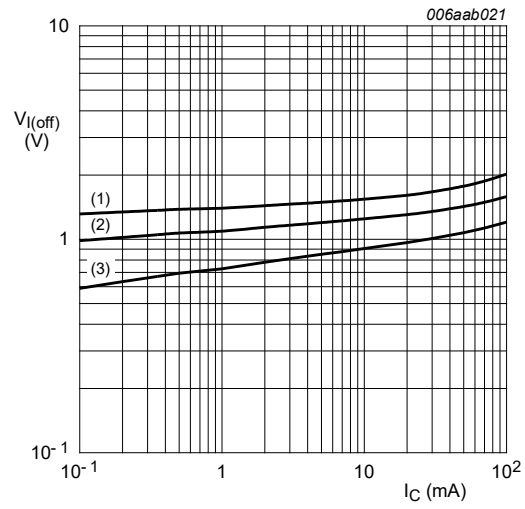
$I_C/I_B = 100$
 (1) $T_{amb} = 100\text{ }^\circ\text{C}$
 (2) $T_{amb} = 25\text{ }^\circ\text{C}$
 (3) $T_{amb} = -40\text{ }^\circ\text{C}$

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



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

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



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

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)

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

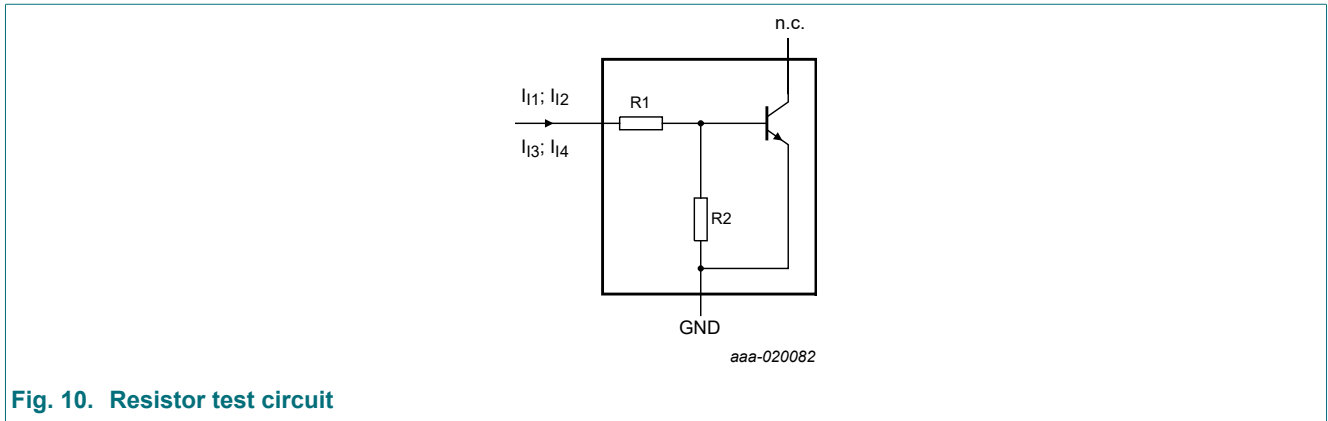


Fig. 10. Resistor test circuit

Resistor test conditions

Table 8. Resistor test conditions

Type number	R1 (kΩ)	R2 (kΩ)	Test conditions		
			I _{I1}	I _{I2}	I _{I3}
PBRN123ET	2.2	2.2	700 μA	800 μA	-750 μA

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

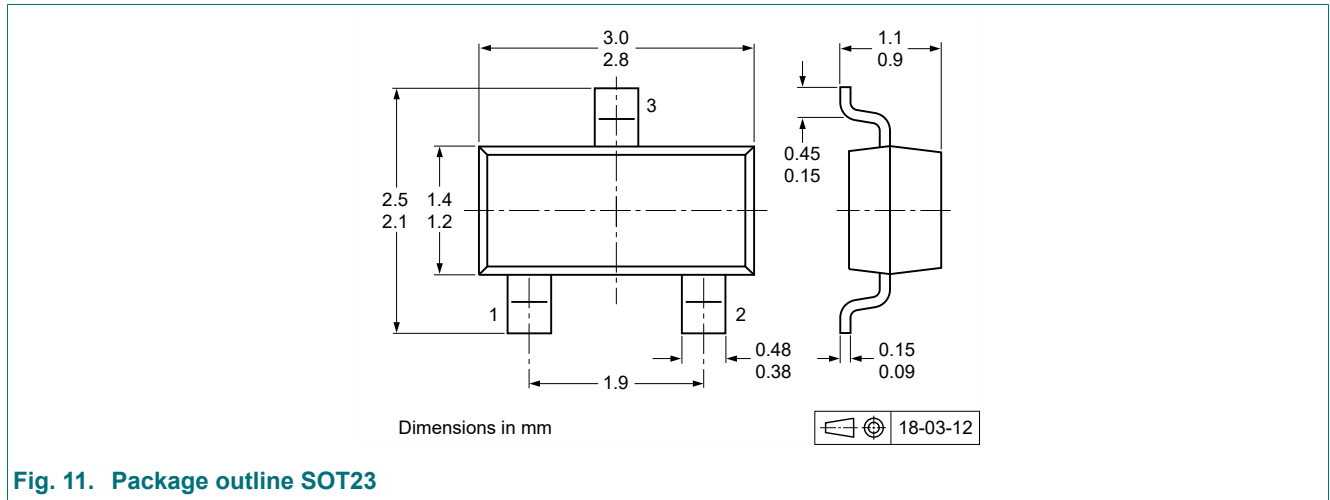


Fig. 11. Package outline SOT23

13. Soldering

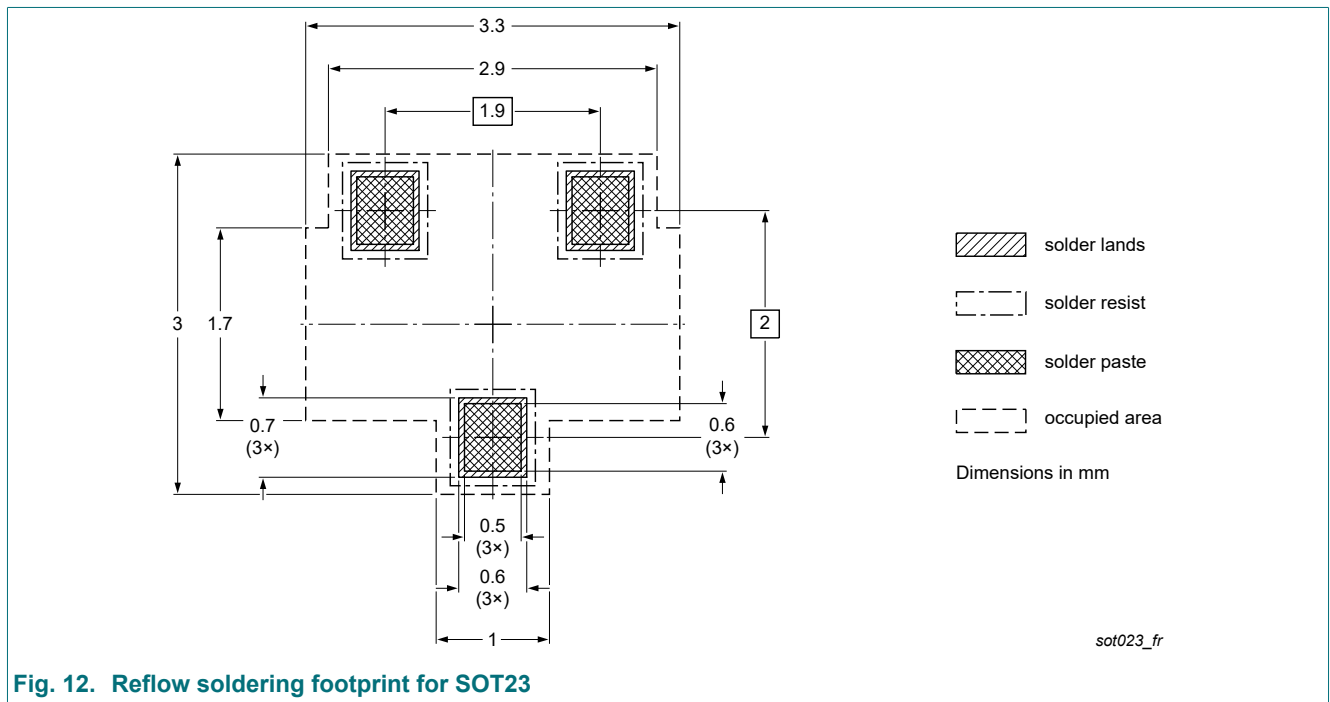


Fig. 12. Reflow soldering footprint for SOT23

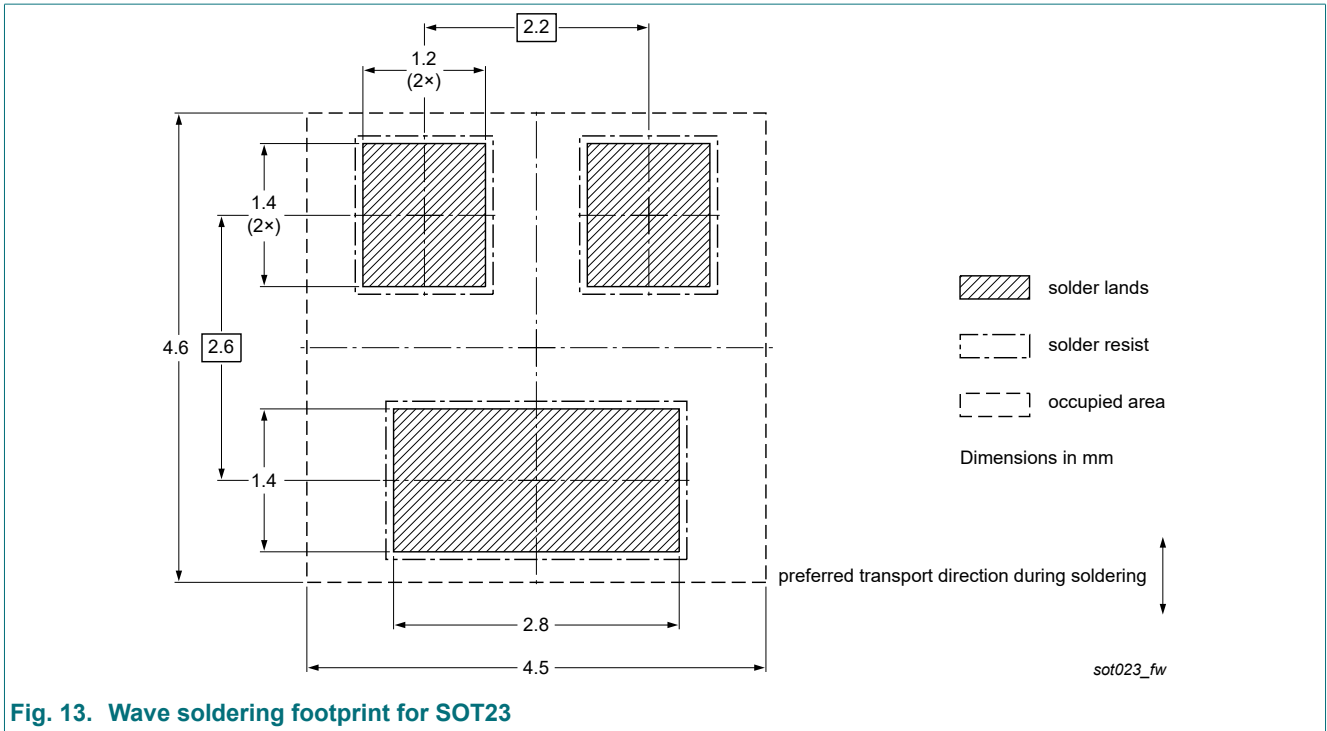


Fig. 13. Wave soldering footprint for SOT23

14. Revision history

Table 9. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PBRN123ET-Q v.2	20210506	Product data sheet	-	PBRN123ET-Q v.1
Modifications:	• Features and benefits: added recommendation for automotive applications			
PBRN123ET-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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