1. General description

NPN low V<sub>CEsat</sub> transistor in a SOT89 (SC-62/TO-243) small and flat lead Surface-Mounted Device (SMD) plastic package.

PNP complement: PBSS304PX-Q

2. Features and benefits

- Low collector-emitter saturation voltage V<sub>CEsat</sub>
- High collector current capability I<sub>C</sub> and I<sub>CM</sub>
- High collector current gain (h<sub>FE</sub>) at high I<sub>C</sub>
- High efficiency due to less heat generation
- Smaller required Printed-Circuit Board (PCB) area than for conventional transistors
- Qualified according to AEC-Q101 and recommended for use in automotive applications

3. Applications

- High-voltage DC-to-DC conversion
- High-voltage MOSFET gate driving
- High-voltage motor control
- High-voltage power switches (e.g. motors, fans)
- Automotive applications

4. Quick reference data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;CEO&lt;/sub&gt;</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>collector current</td>
<td>-</td>
<td>-</td>
<td>4.7</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;CM&lt;/sub&gt;</td>
<td>peak collector current</td>
<td>single pulse; t&lt;sub&gt;p&lt;/sub&gt; ≤ 1 ms</td>
<td>-</td>
<td>-</td>
<td>9.4</td>
<td>A</td>
</tr>
<tr>
<td>R&lt;sub&gt;CEsat&lt;/sub&gt;</td>
<td>collector-emitter saturation resistance</td>
<td>I&lt;sub&gt;C&lt;/sub&gt; = 4 A; I&lt;sub&gt;B&lt;/sub&gt; = 200 mA; pulsed; t&lt;sub&gt;p&lt;/sub&gt; ≤ 300 μs; δ ≤ 0.02; T&lt;sub&gt;amb&lt;/sub&gt; = 25 °C</td>
<td>-</td>
<td>37</td>
<td>53</td>
<td>mΩ</td>
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</table>
5. Pinning information

Table 2. Pinning information

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
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<tbody>
<tr>
<td>1</td>
<td>E</td>
<td>emitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>collector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>base</td>
<td></td>
<td></td>
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6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBSS304NX-Q</td>
<td>SOT89</td>
<td>plastic, surface-mounted package; 3 leads; 1.5 mm pitch; 4.5 mm x 2.5 mm x 1.5 mm body</td>
<td>SOT89</td>
</tr>
</tbody>
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7. Marking

Table 4. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code[1]</th>
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<tbody>
<tr>
<td>PBSS304NX-Q</td>
<td>%5E</td>
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[1] % = placeholder for manufacturing site code

8. Limiting values

Table 5. Limiting values

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;CBO&lt;/sub&gt;</td>
<td>collector-base voltage</td>
<td>open emitter</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;CEO&lt;/sub&gt;</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;EBO&lt;/sub&gt;</td>
<td>emitter-base voltage</td>
<td>open collector</td>
<td>-</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>I&lt;sub&gt;C&lt;/sub&gt;</td>
<td>collector current</td>
<td></td>
<td>-</td>
<td>4.7</td>
<td>A</td>
</tr>
<tr>
<td>I&lt;sub&gt;CM&lt;/sub&gt;</td>
<td>peak collector current</td>
<td>single pulse; t&lt;sub&gt;p&lt;/sub&gt; ≤ 1 ms</td>
<td>-</td>
<td>9.4</td>
<td>A</td>
</tr>
<tr>
<td>P&lt;sub&gt;tot&lt;/sub&gt;</td>
<td>total power dissipation</td>
<td>T&lt;sub&gt;amb&lt;/sub&gt; ≤ 25 °C</td>
<td>[1]</td>
<td>0.6</td>
<td>W</td>
</tr>
<tr>
<td>[2]</td>
<td></td>
<td></td>
<td></td>
<td>1.65</td>
<td>W</td>
</tr>
<tr>
<td>[3]</td>
<td></td>
<td></td>
<td></td>
<td>2.1</td>
<td>W</td>
</tr>
<tr>
<td>T&lt;sub&gt;j&lt;/sub&gt;</td>
<td>junction temperature</td>
<td></td>
<td>-</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>T&lt;sub&gt;amb&lt;/sub&gt;</td>
<td>ambient temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
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</table>

9. Thermal characteristics

Table 6. Thermal characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>R(θ(j-a))</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td></td>
<td></td>
<td>208</td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>[2]</td>
<td></td>
<td></td>
<td>76</td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[3]</td>
<td></td>
<td></td>
<td>60</td>
<td>K/W</td>
</tr>
<tr>
<td>R(θ(j-sp))</td>
<td>thermal resistance from junction to solder point</td>
<td>-</td>
<td></td>
<td></td>
<td>20</td>
<td>K/W</td>
</tr>
</tbody>
</table>


FR4 PCB, standard footprint

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

Table 7. Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{CBO}</td>
<td>collector-base cut-off current</td>
<td>$V_{CB} = 60 , V; , I_E = 0 , A; , T_{amb} = 25 , ^{\circ}C$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CB} = 60 , V; , I_E = 0 , A; , T_J = 150 , ^{\circ}C$</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>µA</td>
</tr>
<tr>
<td>I_{EBO}</td>
<td>emitter-base cut-off current</td>
<td>$V_{EB} = 5 , V; , I_C = 0 , A; , T_{amb} = 25 , ^{\circ}C$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
</tbody>
</table>

FR4 PCB, mounting pad for collector 6 cm²

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

Ceramic PCB, Al₂O₃, standard footprint

Fig. 4. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values
### Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
$h_{FE}$ | DC current gain | $V_{CE} = 2 V; I_C = 0.5 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | 300 | 520 | - | -
 | | $V_{CE} = 2 V; I_C = 1 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | 300 | 500 | - | -
 | | $V_{CE} = 2 V; I_C = 2 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | 250 | 470 | - | -
 | | $V_{CE} = 2 V; I_C = 4 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | 150 | 250 | - | -
 | | $V_{CE} = 2 V; I_C = 6 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | 75 | 115 | - | -
$V_{CE_{Sat}}$ | collector-emitter saturation voltage | $I_C = 0.5 A; I_B = 50 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 25 | 35 | mV
 | | $I_C = 1 A; I_B = 50 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 50 | 70 | mV
 | | $I_C = 2 A; I_B = 10 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 85 | 120 | mV
 | | $I_C = 2 A; I_B = 50 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 105 | 150 | mV
 | | $I_C = 4 A; I_B = 200 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 145 | 210 | mV
 | | $I_C = 4 A; I_B = 400 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 140 | 200 | mV
 | | $I_C = 4 A; I_B = 80 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 190 | 290 | mV
 | | $I_C = 4.7 A; I_B = 235 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 170 | 245 | mV
$R_{CE_{Sat}}$ | collector-emitter saturation resistance | $I_C = 4 A; I_B = 200 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 37 | 53 | mΩ
 | | $I_C = 4 A; I_B = 80 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 48 | 73 | mΩ
$V_{BE_{Sat}}$ | base-emitter saturation voltage | $I_C = 1 A; I_B = 100 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 0.82 | 0.9 | V
 | | $I_C = 4 A; I_B = 400 mA; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 0.94 | 1.05 | V
$V_{BE_{On}}$ | base-emitter turn-on voltage | $V_{CC} = 2 V; I_C = 2 A; \text{pulsed; } t_p \leq 300 \mu s; \delta \leq 0.02; T_{amb} = 25 ^\circ C$ | - | 0.75 | 0.85 | V
$t_d$ | delay time | $V_{CC} = 12.5 V; I_C = 3 A; I_{Bon} = 0.15 A; I_{Boff} = -0.15 A; T_{amb} = 25 ^\circ C$ | - | 15 | - | ns
$t_r$ | rise time | - | 95 | - | ns
$t_{on}$ | turn-on time | - | 110 | - | ns
$t_s$ | storage time | - | 360 | - | ns
$t_f$ | fall time | - | 195 | - | ns
$t_{off}$ | turn-off time | - | 555 | - | ns
$f_T$ | transition frequency | $V_{CE} = 10 V; I_C = 100 mA; f = 100 MHz; T_{amb} = 25 ^\circ C$ | - | 130 | - | MHz
$C_C$ | collector capacitance | $V_{GB} = 10 V; I_E = 0 A; I_B = 0 A; f = 1 MHz; T_{amb} = 25 ^\circ C$ | - | 48 | 70 | pF
60 V, 4.7 A NPN low VCEsat transistor

Fig. 5. DC current gain as a function of collector current; typical values

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

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

\[ V_{BE} = 2 \text{ V} \]
(1) \( T_{amb} = -55 \degree C \)
(2) \( T_{amb} = 25 \degree C \)
(3) \( T_{amb} = 100 \degree C \)

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

\[ I_{C}/I_{B} = 20 \]
(1) \( T_{amb} = -55 \degree C \)
(2) \( T_{amb} = 25 \degree C \)
(3) \( T_{amb} = 100 \degree C \)

Fig. 8. Base-emitter saturation voltage as a function of collector current; typical values
**PBSS304NX-Q**

60 V, 4.7 A NPN low VCEsat transistor

---

**Fig. 9.** Collector-emitter saturation voltage as a function of collector current; typical values

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

**Fig. 10.** Collector-emitter saturation voltage as a function of collector current; typical values

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

**Fig. 11.** Collector-emitter saturation resistance as a function of collector current; typical values

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

**Fig. 12.** Collector-emitter saturation resistance as a function of collector current; typical values

- $T_{amb} = 25 \, ^\circ C$
- (1) $I_C/I_B = 100$
- (2) $I_C/I_B = 50$
- (3) $I_C/I_B = 10$
11. Test information

**Fig. 13. Switching time definition**

**Fig. 14. 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.
12. Package outline

![Package outline SOT89](image)

Fig. 15. Package outline SOT89

13. Soldering

![Reflow soldering footprint for SOT89](image)

Fig. 16. Reflow soldering footprint for SOT89
Fig. 17. Wave soldering footprint for SOT89
14. Revision history

Table 8. Revision history

<table>
<thead>
<tr>
<th>Data sheet ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
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<td>PBSS304NX-Q v.1</td>
<td>20231109</td>
<td>Product data sheet</td>
<td>-</td>
<td>-</td>
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15. Legal information

Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1][2]</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[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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For sales office addresses, please send an email to: salesaddresses@nexperia.com
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