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Kind regards,

Team Nexperia
PBHV8540X

500 V, 0.5 A NPN high-voltage low VCEsat (BISS) transistor
5 December 2013

Product data sheet

1. General description

NPN high-voltage low V_{CEsat} Breakthrough In Small Signal (BISS) transistor in a SOT89 (SC-62) medium power and flat lead Surface-Mounted Device (SMD) plastic package.

PNP complement: PBHV9040X.

2. Features and benefits

- High voltage
- Low collector-emitter saturation voltage V_{CEsat}
- High collector current capability I_C and I_{CM}
- High collector current gain h_{FE} at high I_C
- AEC-Q101 qualified

3. Applications

- LED driver for LED chain module
- LCD backlighting
- Automotive motor management
- Hook switch for wired telecom
- Switch Mode Power Supply (SMPS)

4. Quick reference data

Table 1. 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_{CESM}</td>
<td>collector-emitter peak voltage</td>
<td>V_{BE} = 0 V</td>
<td>-</td>
<td>-</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>V_{CEO}</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>-</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>collector current</td>
<td></td>
<td>-</td>
<td>-</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>h_{FE}</td>
<td>DC current gain</td>
<td>V_{CE} = 10 V; I_C = 50 mA; T_{amb} = 25 °C</td>
<td>100</td>
<td>200</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</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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</thead>
<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>SOT89</td>
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</table>

6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package Name</th>
<th>Description</th>
<th>Version</th>
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<tr>
<td>PBHV8540X</td>
<td>SOT89</td>
<td>plastic surface-mounted package; die pad for good heat transfer; 3 leads</td>
<td>SOT89</td>
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7. Marking

Table 4. Marking codes

<table>
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<th>Type number</th>
<th>Marking code</th>
<th>[1]</th>
</tr>
</thead>
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<tr>
<td>PBHV8540X</td>
<td>%4D</td>
<td></td>
</tr>
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</table>

[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_CBO</td>
<td>collector-base voltage</td>
<td>open emitter</td>
<td>-</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>V_CEO</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>400</td>
<td>V</td>
</tr>
<tr>
<td>V_CESM</td>
<td>collector-emitter peak voltage</td>
<td>V_BE = 0 V</td>
<td>-</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>V_EBO</td>
<td>emitter-base voltage</td>
<td>open collector</td>
<td>-</td>
<td>6</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>collector current</td>
<td></td>
<td>-</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>I_CM</td>
<td>peak collector current</td>
<td>single pulse; t_p ≤ 1 ms</td>
<td>-</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>I_SM</td>
<td>peak base current</td>
<td></td>
<td>-</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>P_tot</td>
<td>total power dissipation</td>
<td>T_amb ≤ 25 °C</td>
<td>[1]</td>
<td>0.52</td>
<td>W</td>
</tr>
</tbody>
</table>
Symbol | Parameter | Conditions | Min | Max | Unit
--- | --- | --- | --- | --- | ---
T<sub>j</sub> | junction temperature | [2] | - | 1.5 | W
T<sub>amb</sub> | ambient temperature | | -55 | 150 | °C
T<sub>stg</sub> | storage temperature | | -65 | 150 | °C


![Derating Curves](image)

Fig. 1. Power derating curves

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&lt;sub&gt;th(j-a)&lt;/sub&gt;</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1]</td>
<td>-</td>
<td>-</td>
<td>240 K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>-</td>
<td>83 K/W</td>
</tr>
<tr>
<td>R&lt;sub&gt;th(j-sp)&lt;/sub&gt;</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>

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

FR4 PCB, standard footprint

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

FR4 PCB, mounting pad for collector 6 cm²
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>$V_{CB} = 320 \text{ V}$; $I_{E} = 0 \text{ A}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{CES}$</td>
<td>collector-emitter cut-off current</td>
<td>$V_{CE} = 320 \text{ V}$; $V_{BE} = 0 \text{ V}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{EBO}$</td>
<td>emitter-base cut-off current</td>
<td>$V_{EB} = 4 \text{ V}$; $I_{C} = 0 \text{ A}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC current gain</td>
<td>$V_{CE} = 10 \text{ V}$; $I_{C} = 50 \text{ mA}$; $T_{amb} = 25 \text{ °C}$</td>
<td>100</td>
<td>200</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 \text{ V}$; $I_{C} = 100 \text{ mA}$; $t_{p} \leq 300 \text{ µs}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ °C}$; pulsed</td>
<td>80</td>
<td>150</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 \text{ V}$; $I_{C} = 300 \text{ mA}$; pulsed; $t_{p} \leq 300 \text{ µs}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ °C}$</td>
<td>10</td>
<td>20</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$V_{CESat}$</td>
<td>collector-emitter saturation voltage</td>
<td>$I_{C} = 100 \text{ mA}$; $I_{B} = 10 \text{ mA}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>100</td>
<td>200</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{C} = 100 \text{ mA}$; $I_{B} = 20 \text{ mA}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>60</td>
<td>90</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{C} = 300 \text{ mA}$; $I_{B} = 60 \text{ mA}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>135</td>
<td>250</td>
<td>mV</td>
</tr>
<tr>
<td>$V_{BEsat}$</td>
<td>base-emitter saturation voltage</td>
<td>$I_{C} = 300 \text{ mA}$; $I_{B} = 60 \text{ mA}$; pulsed; $t_{p} \leq 300 \text{ µs}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>0.91</td>
<td>1.1</td>
<td>V</td>
</tr>
<tr>
<td>$t_{d}$</td>
<td>delay time</td>
<td>$V_{CC} = 6 \text{ V}$; $I_{C} = 0.5 \text{ A}$; $I_{Bon} = 0.1 \text{ A}$; $I_{Boff} = 0.1 \text{ A}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>rise time</td>
<td>-</td>
<td>6200</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>turn-on time</td>
<td>-</td>
<td>6250</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{s}$</td>
<td>storage time</td>
<td>-</td>
<td>800</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{f}$</td>
<td>fall time</td>
<td>-</td>
<td>2200</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>turn-off time</td>
<td>-</td>
<td>3000</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$f_{T}$</td>
<td>transition frequency</td>
<td>$V_{CE} = 10 \text{ V}$; $I_{C} = 100 \text{ mA}$; $f = 100 \text{ MHz}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_{c}$</td>
<td>collector capacitance</td>
<td>$V_{CB} = 20 \text{ V}$; $I_{E} = 0 \text{ A}$; $I_{e} = 0 \text{ A}$; $f = 1 \text{ MHz}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{e}$</td>
<td>emitter capacitance</td>
<td>$V_{EB} = 0.5 \text{ V}$; $I_{C} = 0 \text{ A}$; $I_{L} = 0 \text{ A}$; $f = 1 \text{ MHz}$; $T_{amb} = 25 \text{ °C}$</td>
<td>-</td>
<td>165</td>
<td>-</td>
<td>pF</td>
</tr>
</tbody>
</table>
**Fig. 4.** DC current gain as a function of collector current; typical values

- $V_{CE} = 10 \text{ V}$
  - (1) $T_{amb} = 100 \degree C$
  - (2) $T_{amb} = 25 \degree C$
  - (3) $T_{amb} = -55 \degree C$

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

- $V_{CE} = 10 \text{ V}$
  - (1) $T_{amb} = -55 \degree C$
  - (2) $T_{amb} = 25 \degree C$
  - (3) $T_{amb} = 100 \degree C$

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

- $I_{C}/I_{B} = 5$
  - (1) $T_{amb} = -55 \degree C$
  - (2) $T_{amb} = 25 \degree C$
  - (3) $T_{amb} = 100 \degree C$
Fig. 8. Collector-emitter saturation voltage as a function of collector current; typical values

\[ V_{CE_{sat}}(V) \]

![Graph showing collector-emitter saturation voltage as a function of collector current for different conditions.]

- \( I_C/I_B = 5 \)
  - (1) \( T_{amb} = 100 \, ^\circ C \)
  - (2) \( T_{amb} = 25 \, ^\circ C \)
  - (3) \( T_{amb} = -55 \, ^\circ C \)

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

![Graph showing collector-emitter saturation voltage as a function of collector current for different conditions.]

- \( T_{amb} = 25 \, ^\circ C \)
  - (1) \( I_C/I_B = 20 \)
  - (2) \( I_C/I_B = 10 \)
  - (3) \( I_C/I_B = 5 \)

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

\[ R_{CE_{sat}}(\Omega) \]

![Graph showing collector-emitter saturation resistance as a function of collector current for different conditions.]

- \( I_C/I_B = 5 \)
  - (1) \( T_{amb} = 100 \, ^\circ C \)
  - (2) \( T_{amb} = 25 \, ^\circ C \)
  - (3) \( T_{amb} = -55 \, ^\circ C \)

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

![Graph showing collector-emitter saturation resistance as a function of collector current for different conditions.]

- \( T_{amb} = 25 \, ^\circ C \)
  - (1) \( I_C/I_B = 20 \)
  - (2) \( I_C/I_B = 10 \)
  - (3) \( I_C/I_B = 5 \)
11. Test information

![BISS transistor switching time definition](image1)

Fig. 12. BISS transistor switching time definition

![Test circuit for switching times](image2)

Fig. 13. Test circuit for switching times

11.1 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.
12. Package outline

Plastic surface-mounted package; exposed die pad for good heat transfer; 3 leads

DIMENSIONS (mm are the original dimensions)

<table>
<thead>
<tr>
<th>UNIT</th>
<th>A</th>
<th>b_{p1}</th>
<th>b_{p2}</th>
<th>b_{p3}</th>
<th>c</th>
<th>D</th>
<th>E</th>
<th>e</th>
<th>e_1</th>
<th>H_E</th>
<th>L_p</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>1.6</td>
<td>0.46</td>
<td>0.53</td>
<td>1.8</td>
<td>0.44</td>
<td>4.6</td>
<td>2.8</td>
<td>3.0</td>
<td>1.5</td>
<td>4.25</td>
<td>1.2</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>0.35</td>
<td>0.40</td>
<td>1.4</td>
<td>0.23</td>
<td>4.4</td>
<td>2.4</td>
<td></td>
<td></td>
<td>3.75</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 14. Package outline SOT89
13. Soldering

Fig. 15. Reflow soldering footprint for SOT89

Fig. 16. 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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</thead>
<tbody>
<tr>
<td>PBHV8540X v.1</td>
<td>20131205</td>
<td>Product data sheet</td>
<td>-</td>
<td>-</td>
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</table>
NXP Semiconductors

PBHV8540X

500 V, 0.5 A NPN high-voltage low VCEsat (BISS) transistor

15. Legal information

15.1 Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective [short] data sheet</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 URL http://www.nxp.com.

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16. Contents

1  General description ........................................... 1
2  Features and benefits ....................................... 1
3  Applications .................................................... 1
4  Quick reference data ......................................... 1
5  Pinning information .......................................... 2
6  Ordering information ......................................... 2
7  Marking .............................................................. 2
8  Limiting values .................................................. 2
9  Thermal characteristics ...................................... 3
10 Characteristics .................................................. 5
11 Test information .................................................. 8
11.1 Quality information ......................................... 8
12 Package outline .................................................. 9
13 Soldering ............................................................ 10
14 Revision history ................................................... 11
15 Legal information ................................................ 12
15.1 Data sheet status ............................................. 12
15.2 Definitions ....................................................... 12
15.3 Disclaimers ....................................................... 12
15.4 Trademarks ....................................................... 13

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