1. General description

NPN/NPN high power double bipolar transistor in a SOT1205 (LFPAK56D) Surface-Mounted Device (SMD) power plastic package.

2. Features and benefits

- High thermal power dissipation capability
- Suitable for high temperature applications up to 175 °C
- Reduced Printed-Circuit Board (PCB) requirements comparing to transistors in DPAK
- High energy efficiency due to less heat generation
- Qualified according to AEC-Q101 and recommended for use in automotive applications

3. Applications

- Motor control
- Power management
- Load switch
- Linear mode voltage regulator
- Backlighting applications
- Relay replacement

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_{CEO}</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td>I_C</td>
<td>collector current</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>R_{CEsat}</td>
<td>collector-emitter saturation resistance</td>
<td>I_C = 3 A; I_B = 0.3 A; pulsed; t_p ≤ 300 µs; δ ≤ 0.02; T_{amb} = 25 °C</td>
<td>-</td>
<td>75</td>
<td>110</td>
<td>mΩ</td>
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</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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<tbody>
<tr>
<td>1</td>
<td>E1</td>
<td>emitter TR1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>B1</td>
<td>base TR1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>E2</td>
<td>emitter TR2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>B2</td>
<td>base TR2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>C2</td>
<td>collector TR2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>C2</td>
<td>collector TR2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>C1</td>
<td>collector TR1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>C1</td>
<td>collector TR1</td>
<td></td>
<td></td>
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6. Ordering information

Table 3. Ordering information

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<td>PHPT610030NK-Q</td>
<td>LFPAK56D; Dual LFPAK plastic, single ended surface mounted package (LFPAK56D); 8 leads</td>
<td>SOT1205</td>
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7. Marking

Table 4. Marking codes

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8. Limiting values

Table 5. Limiting values

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

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<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>100</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEO}$</td>
<td>collector-emitter voltage</td>
<td>open base</td>
<td>-</td>
<td>100</td>
<td>V</td>
</tr>
<tr>
<td>$V_{EBO}$</td>
<td>emitter-base voltage</td>
<td>open collector</td>
<td>-</td>
<td>7</td>
<td>V</td>
</tr>
<tr>
<td>$I_C$</td>
<td>collector current</td>
<td></td>
<td>-</td>
<td>3</td>
<td>A</td>
</tr>
<tr>
<td>$I_{CM}$</td>
<td>peak collector current</td>
<td>single pulse; $t_p \leq 1\text{ ms}$</td>
<td>-</td>
<td>8</td>
<td>A</td>
</tr>
<tr>
<td>$I_B$</td>
<td>base current</td>
<td></td>
<td>-</td>
<td>0.5</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} \leq 25\text{ °C}$</td>
<td>[1]</td>
<td>-</td>
<td>1 W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>2.4 W</td>
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**Per device**

<table>
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<th>[2]</th>
<th>[3]</th>
<th>Unit</th>
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</thead>
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<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} \leq 25\text{ °C}$</td>
<td>-</td>
<td>1.25</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[4]</td>
<td>-</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>3</td>
<td>W</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td></td>
<td>-</td>
<td>175</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>ambient temperature</td>
<td></td>
<td>-55</td>
<td>175</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>175</td>
<td></td>
<td>°C</td>
</tr>
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Fig. 1. **Per transistor: power derating curves**

(1) FR4 PCB, mounting pad for collector 6 cm$^2$
(2) FR4 PCB, standard footprint
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>$R_{th(j-a)}$</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1]</td>
<td>-</td>
<td>-</td>
<td>150  K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>-</td>
<td>62.5 K/W</td>
</tr>
<tr>
<td>$R_{th(j-sp)}$</td>
<td>thermal resistance from junction to solder point</td>
<td></td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>K/W</td>
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</table>

Per device

<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>$R_{th(j-a)}$</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1]</td>
<td>-</td>
<td>-</td>
<td>120  K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>-</td>
<td>50   K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[3]</td>
<td>-</td>
<td>-</td>
<td>30   K/W</td>
</tr>
</tbody>
</table>


![Fig. 2. Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values](image-url)
FR4 PCB, mounting pad for collector 6 cm²

Fig. 3. Per transistor: 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>$V_{CB} = 80 \text{ V}; I_{E} = 0 \text{ A}; T_{amb} = 25 \degree \text{C}$</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>$V_{EB} = 7 \text{ V}; I_{C} = 0 \text{ A}; T_{amb} = 25 \degree \text{C}$</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>$V_{CE} = 80 \text{ V}; V_{BE} = 0 \text{ V}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$h_{FE}$</td>
<td>DC current gain</td>
<td>$V_{CE} = 10 \text{ V}; I_{C} = 500 \text{ mA};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>150</td>
<td>250</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 \text{ V}; I_{C} = 1 \text{ A};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>80</td>
<td>250</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 \text{ V}; I_{C} = 2 \text{ A};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>20</td>
<td>100</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{CE} = 10 \text{ V}; I_{C} = 3 \text{ A};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>10</td>
<td>40</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$V_{CE_{sat}}$</td>
<td>collector-emitter saturation voltage</td>
<td>$I_{C} = 1 \text{ A}; I_{B} = 50 \text{ mA};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>90</td>
<td>150</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{C} = 3 \text{ A}; I_{B} = 300 \text{ mA};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>225</td>
<td>330</td>
<td>mV</td>
</tr>
<tr>
<td>$R_{CE_{sat}}$</td>
<td>collector-emitter saturation resistance</td>
<td>$I_{C} = 3 \text{ A}; I_{B} = 0.3 \text{ A};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>75</td>
<td>110</td>
<td>mΩ</td>
</tr>
<tr>
<td>$V_{BE_{sat}}$</td>
<td>base-emitter saturation voltage</td>
<td>$I_{C} = 1 \text{ A}; I_{B} = 50 \text{ mA};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>0.86</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{C} = 2 \text{ A}; I_{B} = 200 \text{ mA};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>1</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>$V_{BE_{on}}$</td>
<td>base-emitter turn-on voltage</td>
<td>$V_{CE} = 2 \text{ V}; I_{C} = 0.1 \text{ A};$ pured; $t_{p} \leq 300 \mu\text{s}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>0.67</td>
<td>0.85</td>
<td>V</td>
</tr>
<tr>
<td>$t_d$</td>
<td>delay time</td>
<td>$V_{CC} = 12.5 \text{ V}; I_{C} = 1 \text{ A}; I_{B_{on}} = 50 \text{ mA}; I_{B_{off}} = -50 \text{ mA}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_r$</td>
<td>rise time</td>
<td>-</td>
<td>300</td>
<td>-</td>
<td>ns</td>
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<td>$t_{on}$</td>
<td>turn-on time</td>
<td>-</td>
<td>320</td>
<td>-</td>
<td>ns</td>
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<td>$t_s$</td>
<td>storage time</td>
<td>-</td>
<td>830</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
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<td>$t_f$</td>
<td>fall time</td>
<td>-</td>
<td>470</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{off}$</td>
<td>turn-off time</td>
<td>-</td>
<td>1300</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$f_t$</td>
<td>transition frequency</td>
<td>$V_{CE} = 10 \text{ V}; I_{C} = 100 \text{ mA}; f = 100 \text{ MHz}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>140</td>
<td>-</td>
<td>MHz</td>
</tr>
<tr>
<td>$C_c$</td>
<td>collector capacitance</td>
<td>$V_{CB} = 10 \text{ V}; I_{E} = 0 \text{ A}; I_{C} = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \degree \text{C}$</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>pF</td>
</tr>
</tbody>
</table>
**Nexperia**

**PHPT610030NK-Q**

**NPN/NPN high power double bipolar transistor**

---

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

\[
\begin{align*}
V_{CE} &= 10 \text{ V} \\
(1) \ T_{amb} &= 100 \ ^\circ \text{C} \\
(2) \ T_{amb} &= 25 \ ^\circ \text{C} \\
(3) \ T_{amb} &= -55 \ ^\circ \text{C}
\end{align*}
\]

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

\[
\begin{align*}
V_{CE} &= 2 \text{ V} \\
(1) \ T_{amb} &= -55 \ ^\circ \text{C} \\
(2) \ T_{amb} &= 25 \ ^\circ \text{C} \\
(3) \ T_{amb} &= 100 \ ^\circ \text{C}
\end{align*}
\]

---

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

\[
\begin{align*}
V_{BE} &= 2 \text{ V} \\
(1) \ T_{amb} &= -55 \ ^\circ \text{C} \\
(2) \ T_{amb} &= 25 \ ^\circ \text{C} \\
(3) \ T_{amb} &= 100 \ ^\circ \text{C}
\end{align*}
\]

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

\[
\begin{align*}
V_{BESat} &= 2 \text{ V} \\
(1) \ T_{amb} &= -55 \ ^\circ \text{C} \\
(2) \ T_{amb} &= 25 \ ^\circ \text{C} \\
(3) \ T_{amb} &= 100 \ ^\circ \text{C}
\end{align*}
\]
**Fig. 8.** Collector-emitter saturation voltage as a function of collector current; typical values

\[
\begin{align*}
V_{CEsat} & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

\[
\begin{align*}
I_C & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

- \(I_C/I_B = 20\)
  - (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

\[
\begin{align*}
V_{CEsat} & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

\[
\begin{align*}
I_C & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

- \(T_{amb} = 25 \, ^\circ C\)
  - (1) \(I_C/I_B = 50\)
  - (2) \(I_C/I_B = 20\)
  - (3) \(I_C/I_B = 10\)

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

\[
\begin{align*}
R_{CEsat} & = 10^3 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

\[
\begin{align*}
I_C & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

- \(I_C/I_B = 20\)
  - (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

\[
\begin{align*}
R_{CEsat} & = 10^3 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

\[
\begin{align*}
I_C & = 10 \quad (1) \\
& = 1 \quad (2) \\
& = 0.1 \quad (3)
\end{align*}
\]

- \(T_{amb} = 25 \, ^\circ C\)
  - (1) \(I_C/I_B = 50\)
  - (2) \(I_C/I_B = 20\)
  - (3) \(I_C/I_B = 10\)
11. Test information

**Fig. 12. Switching time definition**

**Fig. 13. 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

Plastic single ended surface mounted package LFPAK56D; 8 leads

SOT1205

Fig. 14. Package outline LFPAK56D; Dual LFPAK (SOT1205)
13. Soldering

Footprint information for reflow soldering of LFPAK56D package

![Footprint diagram]

Fig. 15. Reflow soldering footprint for LFPAK56D; Dual LFPAK (SOT1205)
## 14. Revision history

Table 8. Revision history

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<thead>
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<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
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<td>20230210</td>
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15. Legal information

Data sheet status

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<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
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<tbody>
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<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>
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[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.

Definitions

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