



# PHPT610035PK

PNP/PNP matched high power double bipolar transistor

24 October 2014

Product data sheet

## 1. General description

PNP/PNP high power matched double bipolar transistor in a SOT1205 (LFPAK56D) Surface-Mounted Device (SMD) power plastic package. Matched version of PHPT610030PK.

NPN/NPN complement: PHPT610035NK.

## 2. Features and benefits

- Current gain matching 10 %
- 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
- AEC-Q101 qualified

## 3. Applications

- Current mirror
- Motor control
- Power management
- Backlighting applications
- Relay replacement
- Differential amplifiers

## 4. Quick reference data

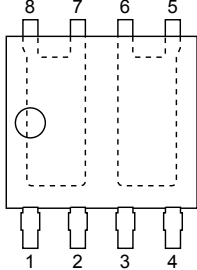
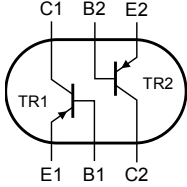
Table 1. Quick reference data

| Symbol                | Parameter                               | Conditions  | Min | Typ | Max  | Unit       |
|-----------------------|---|---|-----|-----|------|------------|
| <b>Per transistor</b> |   |   |     |     |      |            |
| $V_{CEO}$             | collector-emitter voltage               | open base   | -   | -   | -100 | V          |
| $I_C$                 | collector current                       |   | -   | -   | -3   | A          |
| <b>Per transistor</b> |   |   |     |     |      |            |
| $R_{CEsat}$           | collector-emitter saturation resistance | $I_C = -2\text{ A}; I_B = -200\text{ mA};$ pulsed;<br>$t_p \leq 300\ \mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$ | -   | 110 | 180  | m $\Omega$ |



## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description   | Simplified outline   | Graphic symbol   |
|-----|--------|---------------|--|--|
| 1   | E1     | emitter TR1   |  <p><b>LFPAK56D (SOT1205)</b></p> |  <p><i>sym138</i></p> |
| 2   | B1     | base TR1      |  |  |
| 3   | E2     | emitter TR2   |  |  |
| 4   | B2     | base TR2      |  |  |
| 5   | C2     | collector TR2 |  |  |
| 6   | C2     | collector TR2 |  |  |
| 7   | C1     | collector TR1 |  |  |
| 8   | C1     | collector TR1 |  |  |

## 6. Ordering information

Table 3. Ordering information

| Type number  | Package  |  |         |
|--------------|----------|--|---------|
|              | Name     | Description  | Version |
| PHPT610035PK | LFPAK56D | Plastic single ended surface mounted package (LFPAK56D); 8 leads | SOT1205 |

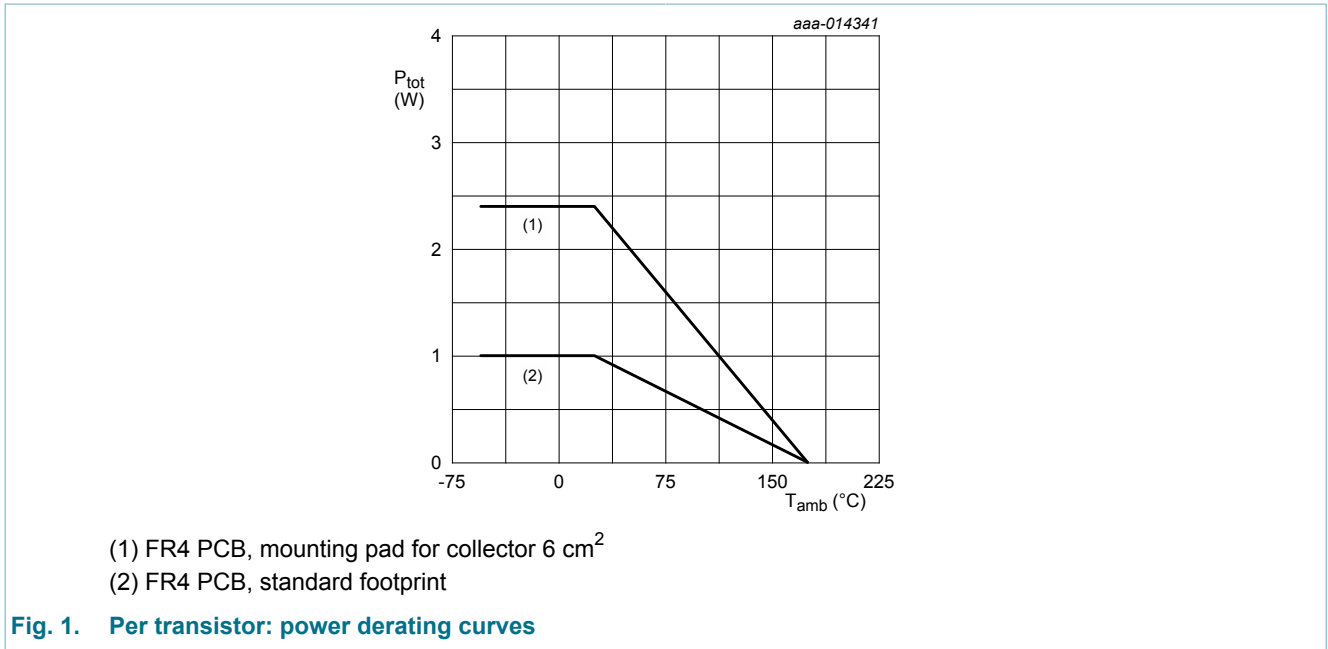
## 7. Limiting values

**Table 4. Limiting values**

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

| Symbol                | Parameter                 | Conditions                          |     | Min | Max  | Unit |
|-----------------------|---------------------------|-------------------------------------|-----|-----|------|------|
| <b>Per transistor</b> |                           |                                     |     |     |      |      |
| V <sub>CBO</sub>      | collector-base voltage    | open emitter                        |     | -   | -100 | V    |
| V <sub>CEO</sub>      | collector-emitter voltage | open base                           |     | -   | -100 | V    |
| V <sub>EBO</sub>      | emitter-base voltage      | open collector                      |     | -   | -8   | V    |
| I <sub>C</sub>        | collector current         |                                     |     | -   | -3   | A    |
| I <sub>CM</sub>       | peak collector current    | single pulse; t <sub>p</sub> ≤ 1 ms |     | -   | -8   | A    |
| I <sub>B</sub>        | base current              |                                     |     | -   | -0.5 | A    |
| P <sub>tot</sub>      | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1] | -   | 1    | W    |
|                       |                           |                                     | [2] | -   | 2.4  | W    |
|                       |                           |                                     | [3] | -   | 25   | W    |
| <b>Per device</b>     |                           |                                     |     |     |      |      |
| P <sub>tot</sub>      | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1] | -   | 1.25 | W    |
|                       |                           |                                     | [2] | -   | 3    | W    |
|                       |                           |                                     | [4] | -   | 5    | W    |
| T <sub>j</sub>        | junction temperature      |                                     |     | -   | 175  | °C   |
| T <sub>amb</sub>      | ambient temperature       |                                     |     | -55 | 175  | °C   |
| T <sub>stg</sub>      | storage temperature       |                                     |     | -65 | 175  | °C   |

- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 6 cm<sup>2</sup>.
- [3] Power dissipation from junction to mounting base.
- [4] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.

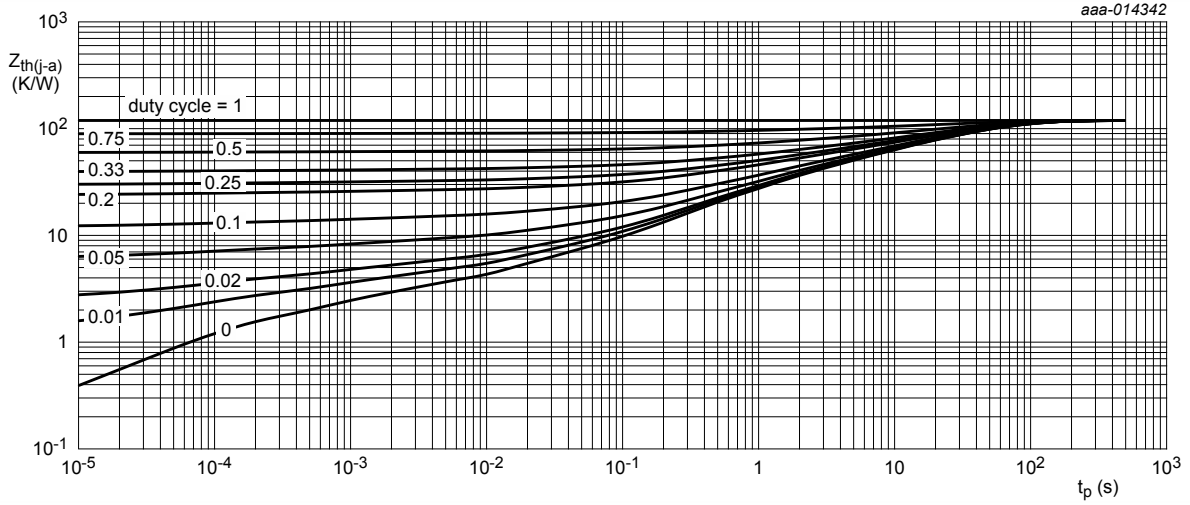


## 8. Thermal characteristics

Table 5. Thermal characteristics

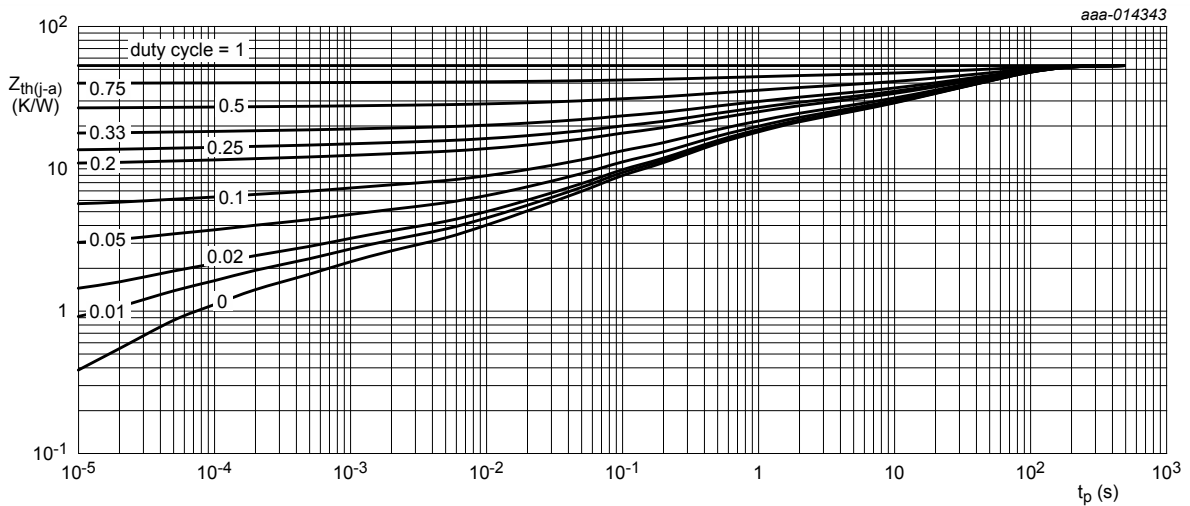
| Symbol                | Parameter  | Conditions  |     | Min | Typ | Max  | Unit |
|-----------------------|--|-------------|-----|-----|-----|------|------|
| <b>Per transistor</b> |  |             |     |     |     |      |      |
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 150  | K/W  |
|                       |  |             | [2] | -   | -   | 62.5 | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |             |     | -   | -   | 6    | K/W  |
| <b>Per device</b>     |  |             |     |     |     |      |      |
| R <sub>th(j-a)</sub>  | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 120  | K/W  |
|                       |  |             | [2] | -   | -   | 50   | K/W  |
|                       |  |             | [3] | -   | -   | 30   | K/W  |

- [1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 6 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



FR4 PCB, standard footprint

**Fig. 2. Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



FR4 PCB, mounting pad for collector  $6\text{ cm}^2$

**Fig. 3. Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

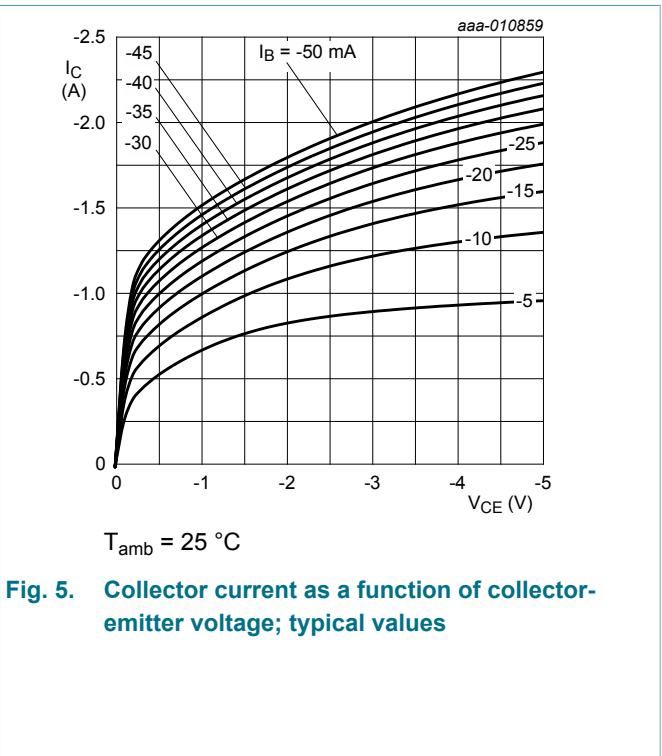
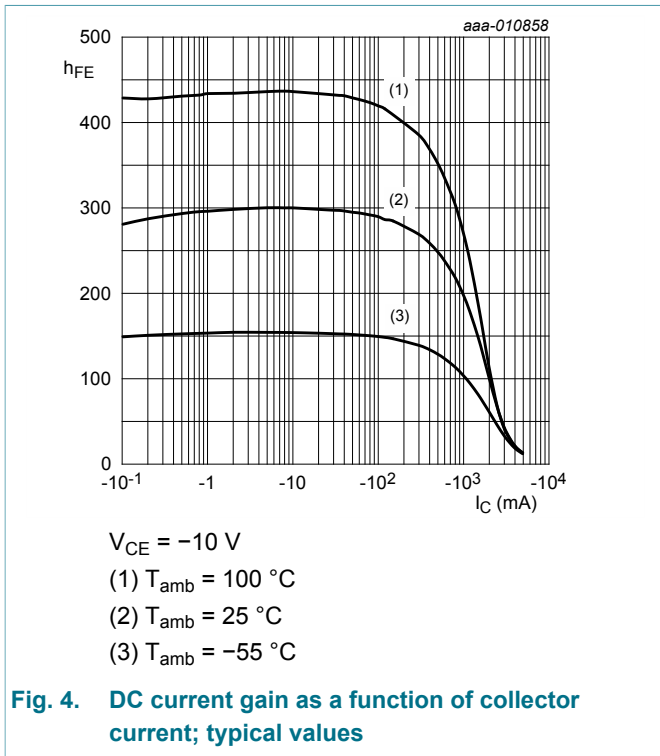
## 9. Characteristics

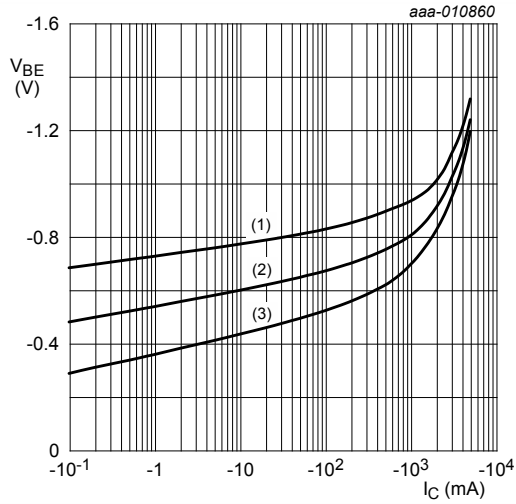
Table 6. Characteristics

| Symbol                | Parameter                               | Conditions   | Min | Typ   | Max  | Unit             |
|-----------------------|---|--|-----|-------|------|------------------|
| $h_{FE1}/h_{FE2}$     | $h_{FE}$ matching                       | $V_{CE} = -2\text{ V}; I_C = 1\text{ A}$   | 0.9 | 1     | 1.1  |                  |
| <b>Per transistor</b> |   |  |     |       |      |                  |
| $I_{CBO}$             | collector-base cut-off current          | $V_{CB} = -80\text{ V}; I_E = 0\text{ A}; T_{amb} = 25\text{ }^\circ\text{C}$  | -   | -     | -100 | nA               |
|                       |   | $V_{CB} = -80\text{ V}; I_E = 0\text{ A}; T_j = 150\text{ }^\circ\text{C}$   | -   | -     | -50  | $\mu\text{A}$    |
| $I_{CES}$             | collector-emitter cut-off current       | $V_{CE} = -80\text{ V}; V_{BE} = 0\text{ V}; T_{amb} = 25\text{ }^\circ\text{C}$   | -   | -     | -100 | nA               |
| $I_{EBO}$             | emitter-base cut-off current            | $V_{EB} = -7\text{ V}; I_C = 0\text{ A}; T_{amb} = 25\text{ }^\circ\text{C}$   | -   | -     | -100 | nA               |
| $h_{FE}$              | DC current gain                         | $V_{CE} = -10\text{ V}; I_C = -500\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$  | 150 | 220   | -    |                  |
|                       |   | $V_{CE} = -10\text{ V}; I_C = -1\text{ A};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$   | 80  | 210   | -    |                  |
|                       |   | $V_{CE} = -10\text{ V}; I_C = -2\text{ A};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$   | 20  | 100   | -    |                  |
|                       |   | $V_{CE} = -2\text{ V}; I_C = -1\text{ A}; T_{amb} = 25\text{ }^\circ\text{C}$  | 100 | 200   | -    |                  |
|                       |   | $V_{CE} = -10\text{ V}; I_C = -3\text{ A};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$   | 10  | 40    | -    |                  |
| $V_{CEsat}$           | collector-emitter saturation voltage    | $I_C = -500\text{ mA}; I_B = -50\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$  | -   | -70   | -110 | mV               |
|                       |   | $I_C = -2\text{ A}; I_B = -200\text{ mA};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$    | -   | -220  | -360 | mV               |
| $R_{CEsat}$           | collector-emitter saturation resistance | $t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$  | -   | 110   | 180  | $\text{m}\Omega$ |
| $V_{BEsat}$           | base-emitter saturation voltage         | $I_C = -1\text{ A}; I_B = -50\text{ mA};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$     | -   | -0.91 | -1   | V                |
|                       |   | $I_C = -2\text{ A}; I_B = -200\text{ mA};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$    | -   | -1.02 | -1.2 | V                |
| $V_{BEon}$            | base-emitter turn-on voltage            | $V_{CE} = -2\text{ V}; I_C = -100\text{ mA};$ pulsed;<br>$t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ }^\circ\text{C}$ | -   | -0.68 | -0.9 | V                |
| $t_d$                 | delay time                              | $V_{CC} = -12.5\text{ V}; I_C = -1\text{ A}; I_{Bon} = -50\text{ mA}; I_{Boff} = 50\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$               | -   | 20    | -    | ns               |
| $t_r$                 | rise time                               |  | -   | 180   | -    | ns               |
| $t_{on}$              | turn-on time                            |  | -   | 200   | -    | ns               |
| $t_s$                 | storage time                            |  | -   | 350   | -    | ns               |
| $t_f$                 | fall time                               |  | -   | 220   | -    | ns               |
| $t_{off}$             | turn-off time                           |  | -   | 570   | -    | ns               |

PNP/PNP matched high power double bipolar transistor

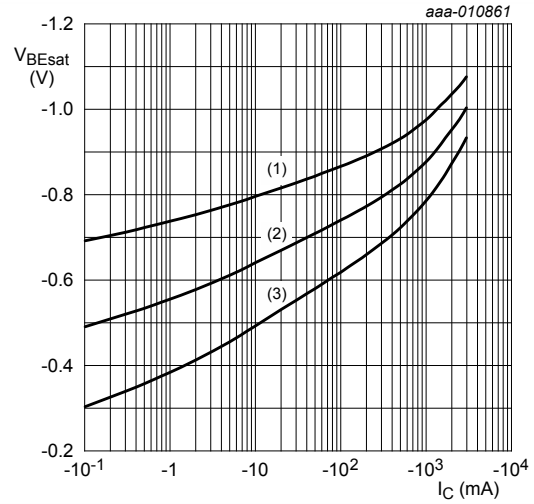
| Symbol | Parameter             | Conditions   | Min | Typ | Max | Unit |
|--------|-----------------------|--|-----|-----|-----|------|
| $f_T$  | transition frequency  | $V_{CE} = -10\text{ V}$ ; $I_C = -100\text{ mA}$ ;<br>$f = 100\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$                | -   | 125 | -   | MHz  |
| $C_c$  | collector capacitance | $V_{CB} = -10\text{ V}$ ; $I_E = 0\text{ A}$ ; $i_e = 0\text{ A}$ ;<br>$f = 1\text{ MHz}$ ; $T_{amb} = 25\text{ }^\circ\text{C}$ | -   | 30  | -   | pF   |





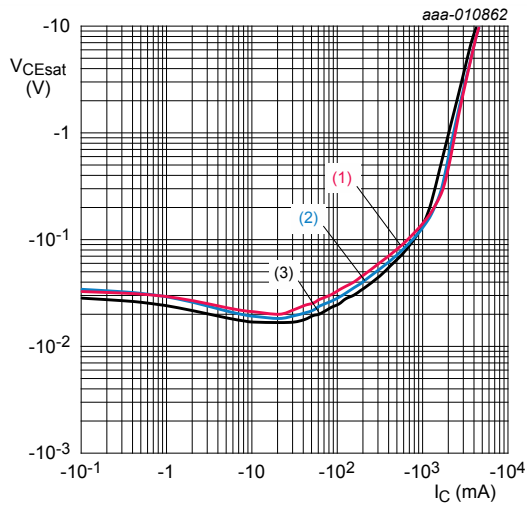
$V_{CE} = -2 \text{ V}$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

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



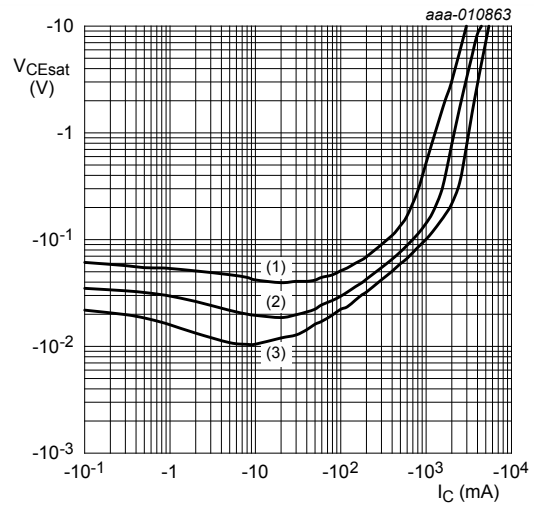
$I_C/I_B = 20$   
 (1)  $T_{amb} = -55 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

**Fig. 7. Base-emitter saturation voltage 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)  $T_{amb} = -55 \text{ }^\circ\text{C}$

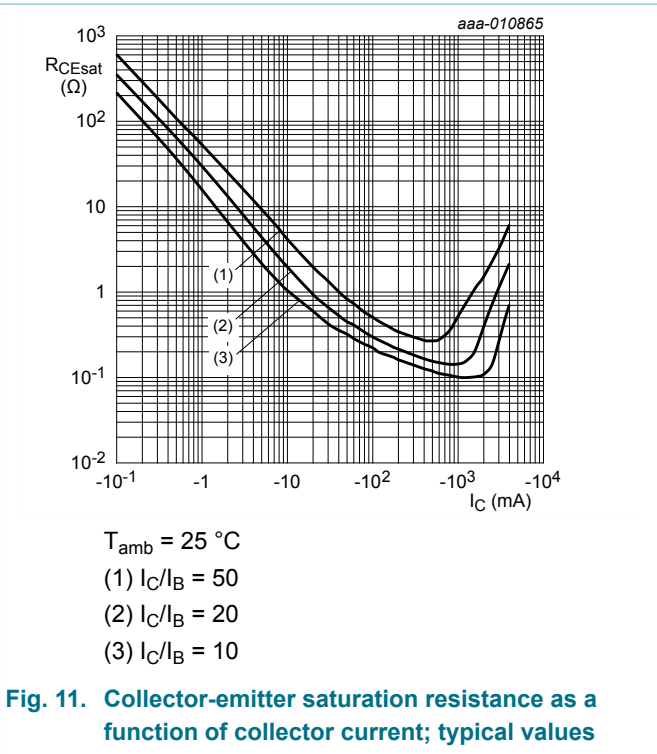
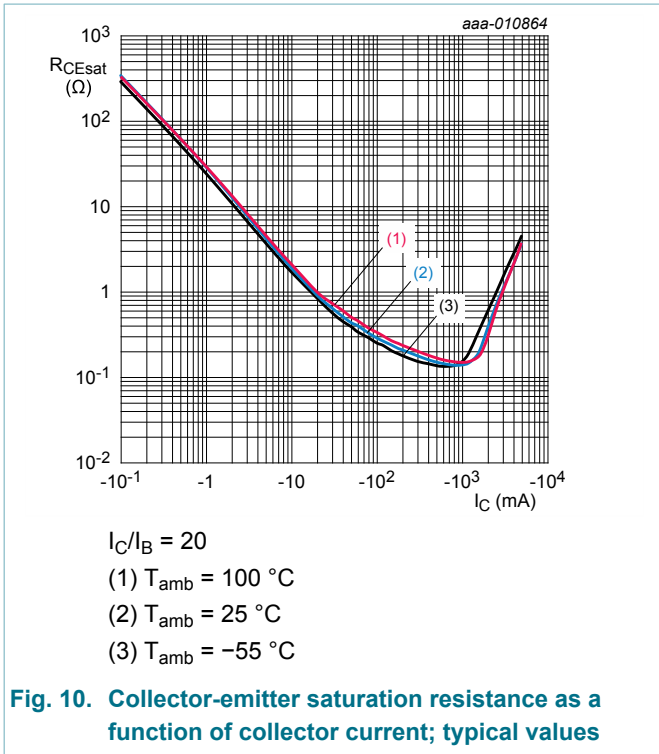
**Fig. 8. Collector-emitter saturation voltage as a function of collector current; typical values**



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

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





### 10. Test information

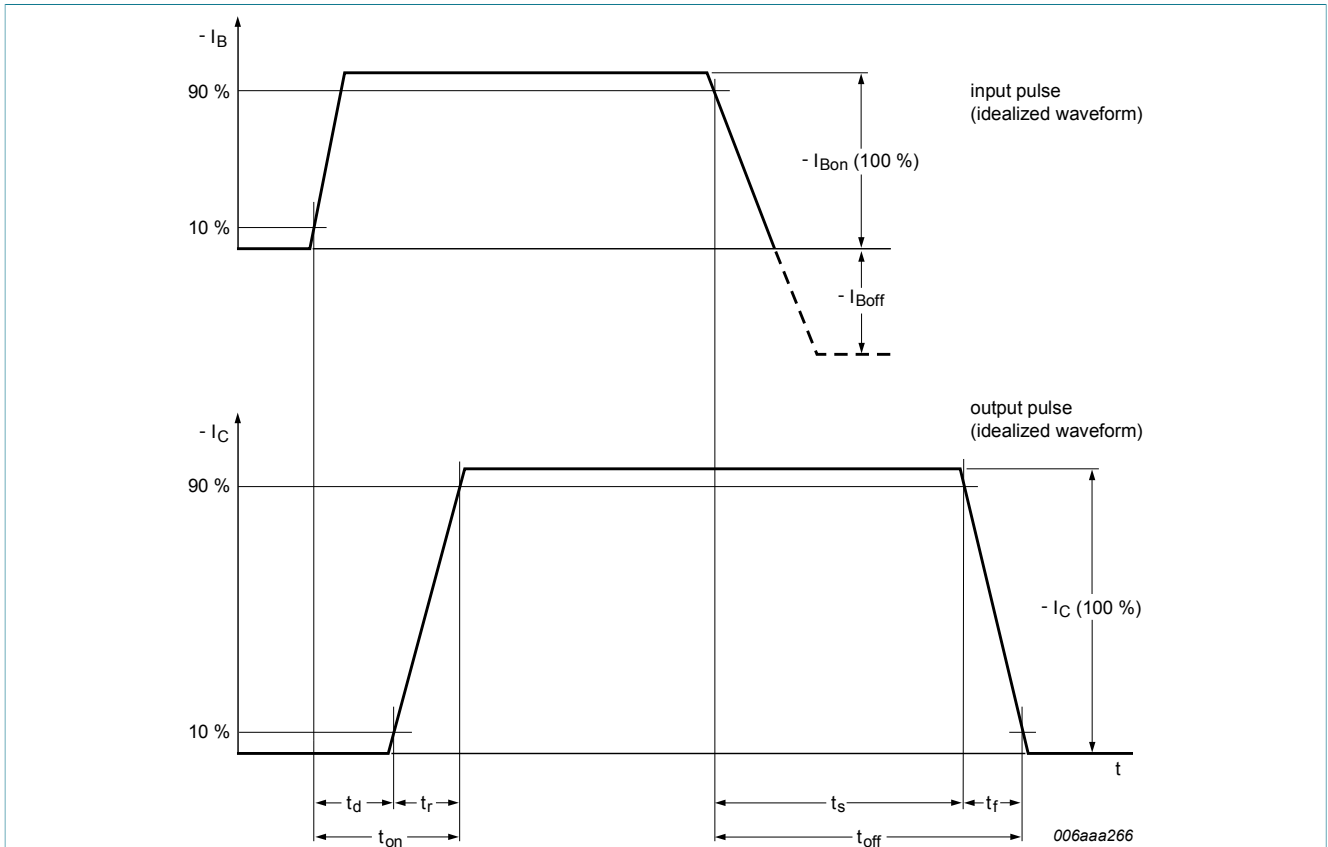


Fig. 12. BISS transistor switching time definition

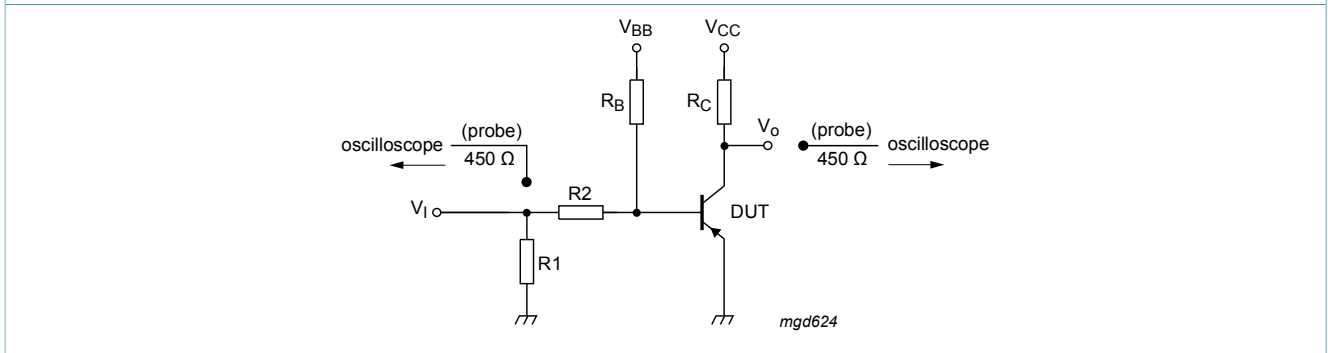


Fig. 13. Test circuit for switching times

#### 10.1 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.

### 11. Package outline

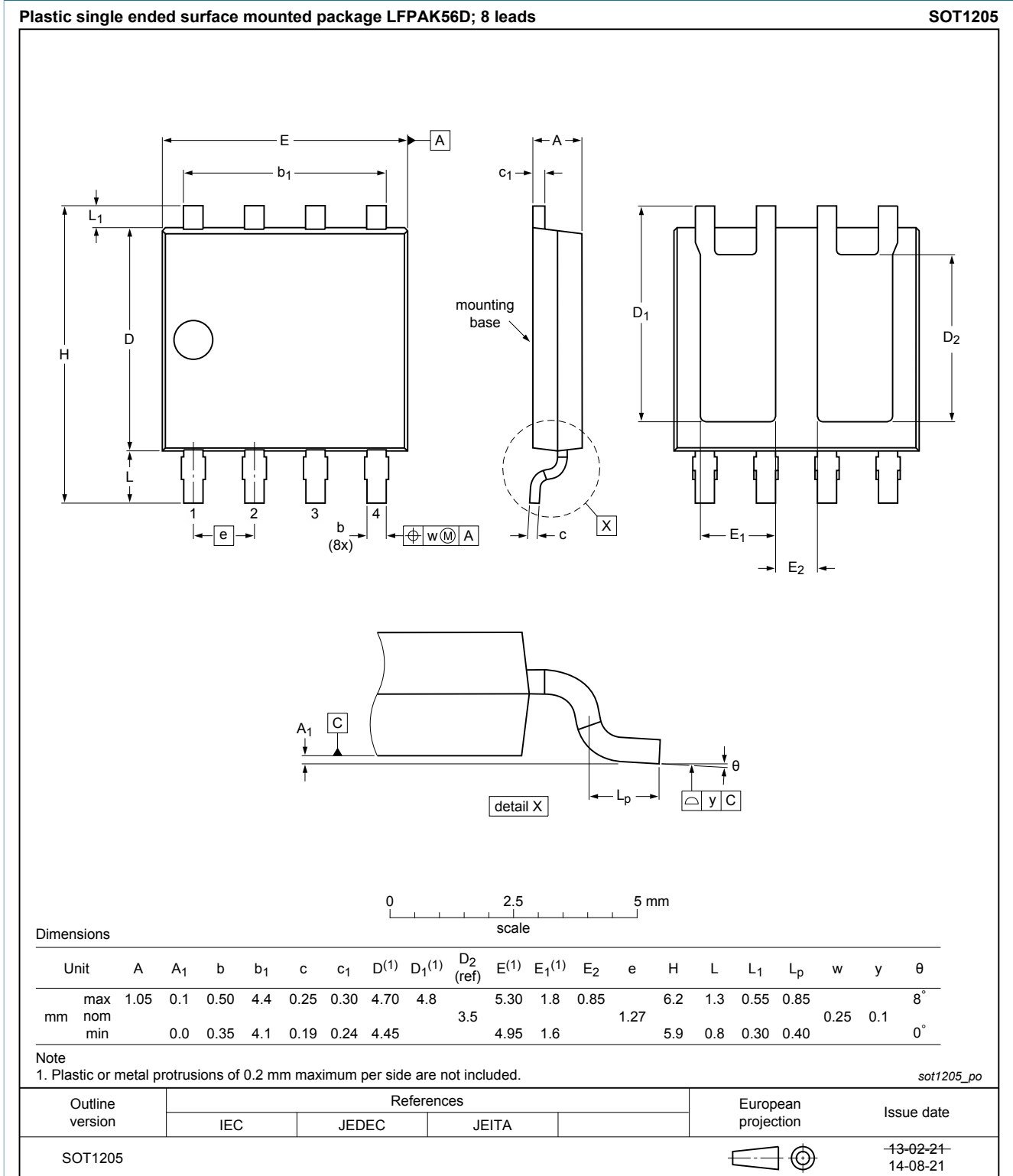


Fig. 14. Package outline LFAK56D (SOT1205)

## 12. Soldering

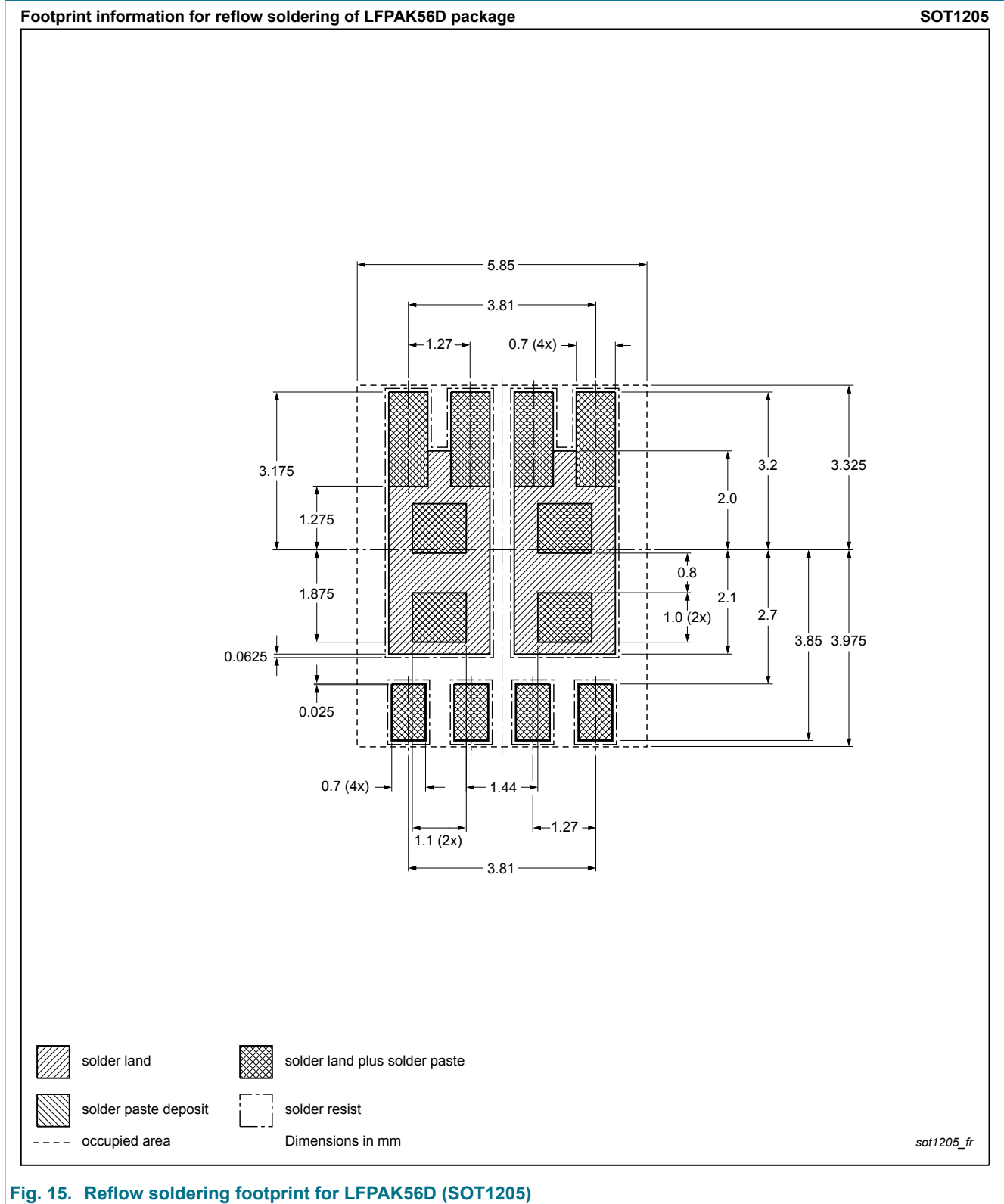


Fig. 15. Reflow soldering footprint for LFPAK56D (SOT1205)

## 13. Revision history

Table 7. Revision history

| Data sheet ID    | Release date | Data sheet status  | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| PHPT610035PK v.1 | 20141024     | Product data sheet | -             | -          |

## 14. Legal information

### 14.1 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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