# PHPT610030NPK

## NPN/PNP high power double bipolar transistor

10 September 2020 — Product data sheet

## 1. General description

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

NPN/NPN complement: PHPT610030NK

PNP/PNP complement: PHPT610030PK

## 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
- AEC-Q101 qualified

## 3. Applications

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

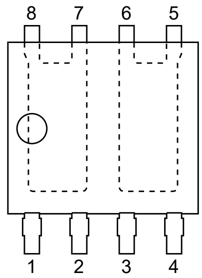
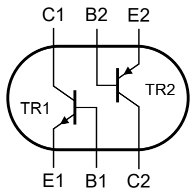
## 4. Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Per transistor; for the PNP transistor with negative polarity** | | | | | | | |
| $V_{CEO}$ | collector-emitter voltage | open base | | - | - | 100 | V |
| $I_C$ | collector current | | | - | - | 3 | A |
| **TR1 (NPN)** | | | | | | | |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C$ = 3 A; $I_B$ = 300 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | 75 | 110 | mΩ |
| **TR2 (PNP)** | | | | | | | |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C$ = -2 A; $I_B$ = -200 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | 110 | 180 | mΩ |

## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | E1 | emitter TR1 |   LFPAK56D; Dual LFPAK (SOT1205) |   |
| 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 |
| PHPT610030NPK | LFPAK56D; Dual LFPAK | plastic, single ended surface mounted package (LFPAK56D); 8 leads | SOT1205 |

## 7. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| PHPT610030NPK | 1003NPK |

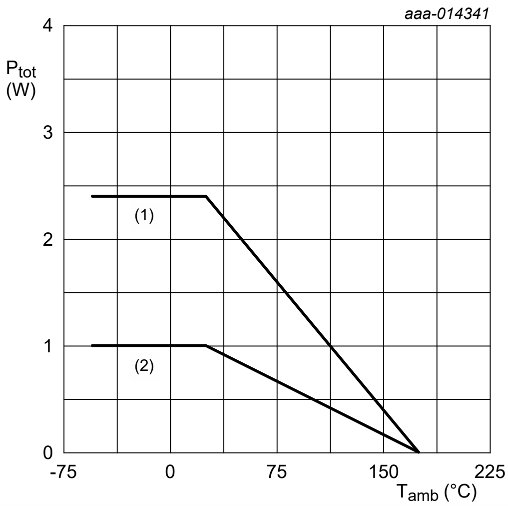
# 8. Limiting values

**Table 5. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **Per transistor; for the PNP transistor with negative polarity** | | | | | | |
| $V_{CBO}$ | collector-base voltage | open emitter | | - | 100 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | | - | 100 | V |
| $V_{EBO}$ | emitter-base voltage | open collector | | - | 7 | V |
| $I_C$ | collector current | | | - | 3 | A |
| $I_{CM}$ | peak collector current | single pulse; $t_p \leq$ 1 ms | | - | 8 | A |
| $I_B$ | base current | | | - | 0.5 | A |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq$ 25 °C | [1] | - | 1 | W |
| | | | [2] | - | 2.4 | W |
| | | | [3] | - | 25 | W |
| **Per device** | | | | | | |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq$ 25 °C | [1] | - | 1.25 | W |
| | | | [2] | - | 3 | W |
| | | | [4] | - | 5 | W |
| $T_j$ | junction temperature | | | - | 175 | °C |
| $T_{amb}$ | ambient temperature | | | -55 | 175 | °C |
| $T_{stg}$ | 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 $cm^2$.
[3] Power dissipation from junction to mounting base.
[4] Device mounted on a ceramic PCB, $Al_2O_3$, standard footprint.




(1) FR4 PCB, mounting pad for collector 6 $cm^2$
(2) FR4 PCB, standard footprint

**Fig. 1. Per transistor: power derating curves**

# 9. Thermal characteristics

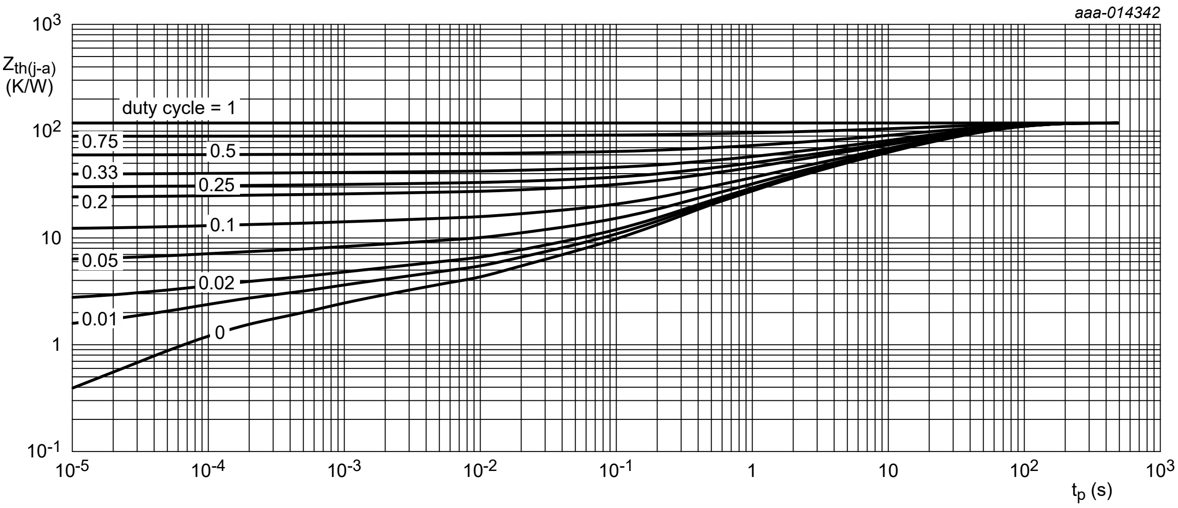
**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Per transistor** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 150 | K/W |
| | | | [2] | - | - | 62.5 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 6 | K/W |
| **Per device** | | | | | | | |
| $R_{th(j-a)}$ | 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.

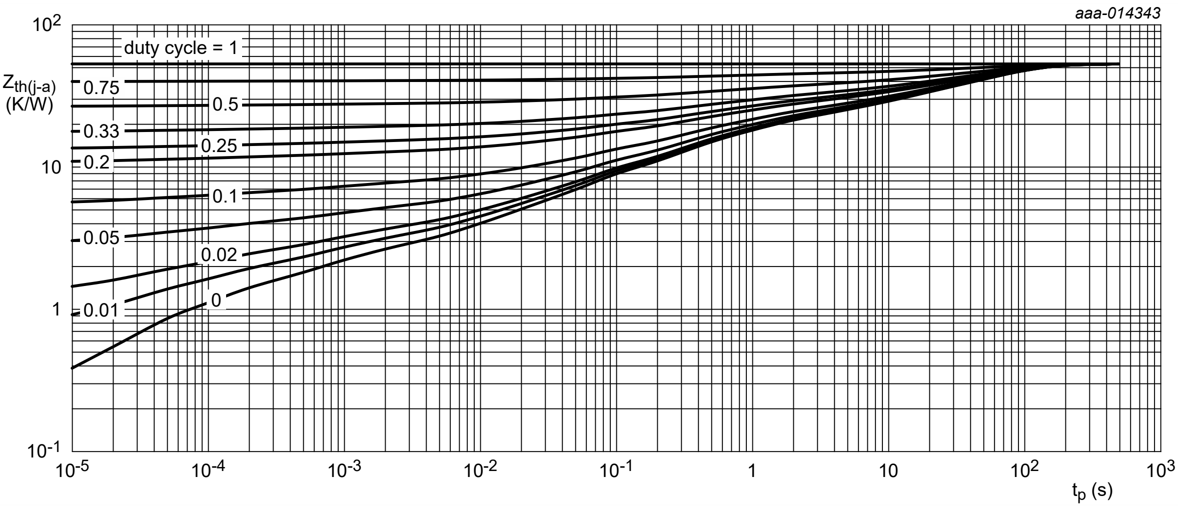
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 6 $cm^2$.

[3] Device mounted on a ceramic PCB, $Al_2O_3$, 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 $cm^2$

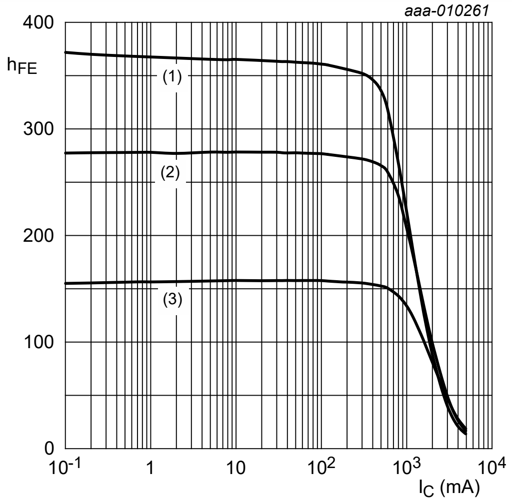
**Fig. 3. Per transistor: transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 10. Characteristics

**Table 7. Characteristics**

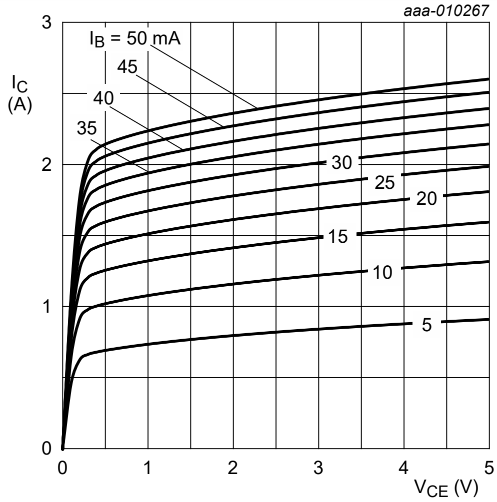
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **TR1 (NPN)** | | | | | | | |
| $I_{CBO}$ | collector-base cut-off current | $V_{CB}$ = 80 V; $I_E$ = 0 A; $T_{amb}$ = 25 °C | | - | - | 100 | nA |
| | | $V_{CB}$ = 80 V; $I_E$ = 0 A; $T_j$ = 150 °C | | - | - | 50 | µA |
| $I_{CES}$ | collector-emitter cut-off current | $V_{CE}$ = 80 V; $V_{BE}$ = 0 V | | - | - | 100 | nA |
| $I_{EBO}$ | emitter-base cut-off current | $V_{EB}$ = 7 V; $I_C$ = 0 A; $T_{amb}$ = 25 °C | | - | - | 100 | nA |
| $h_{FE}$ | DC current gain | $V_{CE}$ = 10 V; $I_C$ = 500 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 150 | 250 | - | |
| | | $V_{CE}$ = 10 V; $I_C$ = 1 A; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 80 | 250 | - | |
| | | $V_{CE}$ = 10 V; $I_C$ = 2 A; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 20 | 100 | - | |
| | | $V_{CE}$ = 10 V; $I_C$ = 3 A; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 10 | 40 | - | |
| $V_{CEsat}$ | collector-emitter saturation voltage | $I_C$ = 1 A; $I_B$ = 50 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 90 | 150 | mV |
| | | $I_C$ = 3 A; $I_B$ = 0.3 A; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 225 | 330 | mV |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C$ = 3 A; $I_B$ = 300 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 75 | 110 | mΩ |
| $V_{BEsat}$ | base-emitter saturation voltage | $I_C$ = 1 A; $I_B$ = 50 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 0.86 | 1 | V |
| | | $I_C$ = 2 A; $I_B$ = 200 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 1 | 1.2 | V |
| $V_{BEon}$ | base-emitter turn-on voltage | $V_{CE}$ = 2 V; $I_C$ = 100 mA; $t_p$ ≤ 300 µs; pulsed; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 0.67 | 0.85 | V |
| $t_d$ | delay time | $V_{CC}$ = 12.5 V; $I_C$ = 1 A; $I_{Bon}$ = 50 mA; $I_{Boff}$ = -50 mA; $T_{amb}$ = 25 °C | | - | 20 | - | ns |
| $t_r$ | rise time | | | - | 300 | - | ns |
| $t_{on}$ | turn-on time | | | - | 320 | - | ns |
| $t_s$ | storage time | | | - | 830 | - | ns |
| $t_f$ | fall time | | | - | 470 | - | ns |
| $t_{off}$ | turn-off time | | | - | 1300 | - | ns |
| $f_T$ | transition frequency | $V_{CE}$ = 10 V; $I_C$ = 100 mA; f = 100 MHz; $T_{amb}$ = 25 °C | | - | 140 | - | MHz |
| $C_c$ | collector capacitance | $V_{CB}$ = 10 V; $I_E$ = 0 A; $i_e$ = 0 A; f = 1 MHz; $T_{amb}$ = 25 °C | | - | 11 | - | pF |
| **TR2 (PNP)** | | | | | | | |
| $I_{CBO}$ | collector-base cut-off current | $V_{CB}$ = -80 V; $I_E$ = 0 A | | - | - | -100 | nA |
| | | $V_{CB}$ = -80 V; $I_E$ = 0 A; $T_j$ = 150 °C | | - | - | -50 | µA |
| $I_{CES}$ | collector-emitter cut-off current | $V_{CE}$ = -80 V; $V_{BE}$ = 0 V | | - | - | -100 | nA |
| $I_{EBO}$ | emitter-base cut-off current | $V_{EB}$ = -7 V; $I_C$ = 0 A | | - | - | -100 | nA |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $h_{FE}$ | DC current gain | $V_{CE}$ = -10 V; $I_C$ = -500 mA; $T_{amb}$ = 25 °C | | 150 | 200 | - | |
| | | $V_{CE}$ = -10 V; $I_C$ = -1 A; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | 80 | 210 | - | |
| | | $V_{CE}$ = -10 V; $I_C$ = -2 A; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | 20 | 100 | - | |
| | | $V_{CE}$ = -10 V; $I_C$ = -3 A; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | 10 | 40 | - | |
| $V_{CEsat}$ | collector-emitter saturation voltage | $I_C$ = -500 mA; $I_B$ = -50 mA; $T_{amb}$ = 25 °C | | - | -70 | -110 | mV |
| | | $I_C$ = -2 A; $I_B$ = -0.2 A; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | -220 | -360 | mV |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C$ = -2 A; $I_B$ = -200 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | 110 | 180 | mΩ |
| $V_{BEsat}$ | base-emitter saturation voltage | $I_C$ = -1 A; $I_B$ = -50 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | -0.91 | -1 | V |
| | | $I_C$ = -2 A; $I_B$ = -200 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | -1.02 | -1.2 | V |
| $V_{BEon}$ | base-emitter turn-on voltage | $V_{CE}$ = -2 V; $I_C$ = -100 mA; $t_p \leq$ 300 µs; pulsed; $\delta \leq$ 0.02; $T_{amb}$ = 25 °C | | - | -0.68 | -0.9 | V |
| $t_d$ | delay time | $V_{CC}$ = -12.5 V; $I_C$ = -1 A; $I_{Bon}$ = -50 mA; $I_{Boff}$ = 50 mA; $T_{amb}$ = 25 °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 |
| $f_T$ | transition frequency | $V_{CE}$ = -10 V; $I_C$ = -100 mA; f = 100 MHz; $T_{amb}$ = 25 °C | | - | 125 | - | MHz |
| $C_c$ | collector capacitance | $V_{CB}$ = -10 V; $I_E$ = 0 A; $i_e$ = 0 A; f = 1 MHz; $T_{amb}$ = 25 °C | | - | 30 | - | pF |



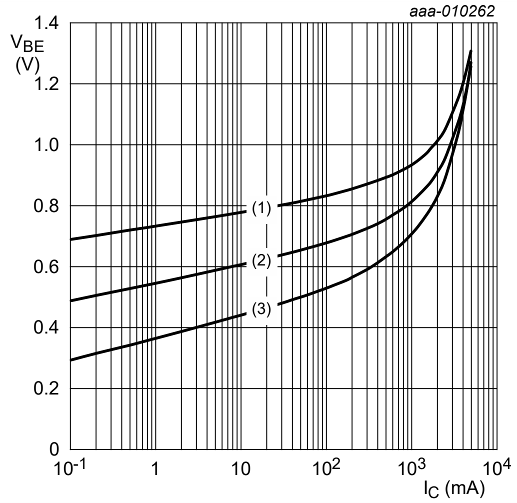

$V_{CE}$ = 10 V
(1) $T_{amb}$ = 100 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = −55 °C

**Fig. 4. TR1 (NPN): DC current gain as a function of collector current; typical values**



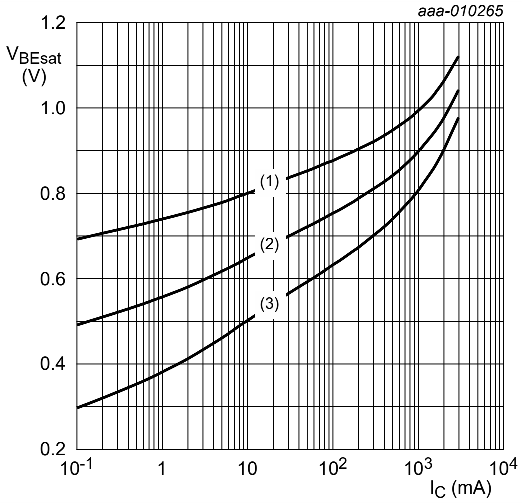

$T_{amb}$ = 25 °C

**Fig. 5. TR1 (NPN): Collector current as a function of collector-emitter voltage; typical values**



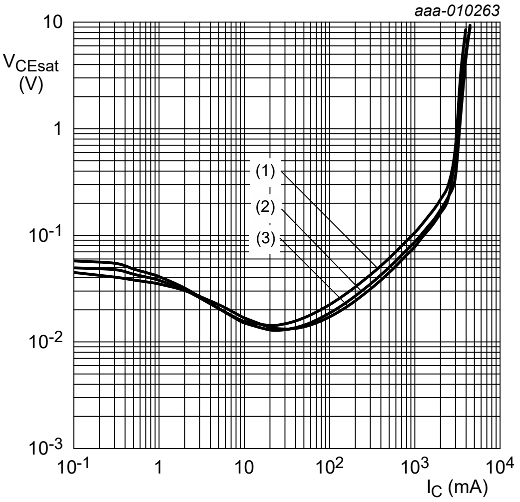

$V_{CE}$ = 2 V
(1) $T_{amb}$ = −55 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = 100 °C

**Fig. 6. TR1 (NPN): Base-emitter voltage as a function of collector current; typical values**



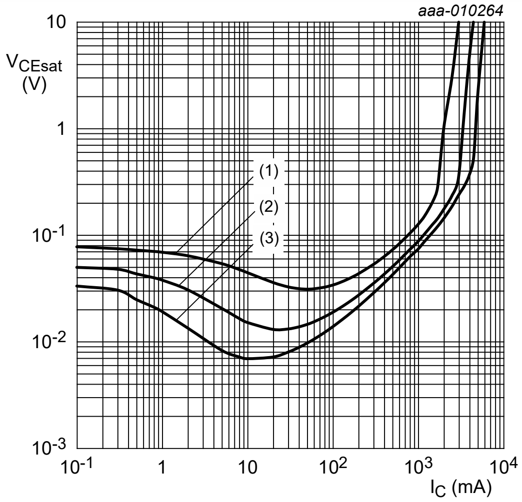

$I_C/I_B$ = 20
(1) $T_{amb}$ = −55 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = 100 °C

**Fig. 7. TR1 (NPN): Base-emitter saturation voltage as a function of collector current; typical values**



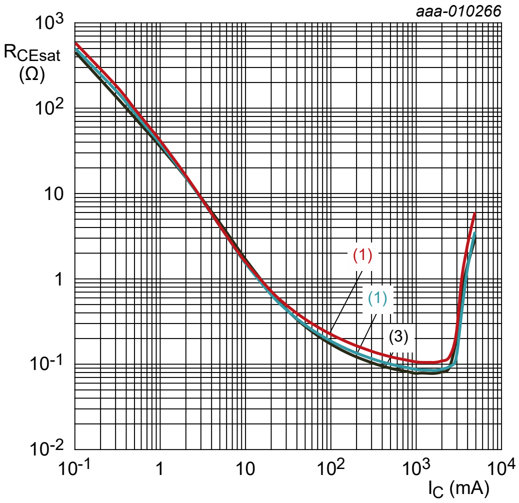

$I_C/I_B$ = 20
(1) $T_{amb}$ = 100 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = −55 °C

**Fig. 8. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



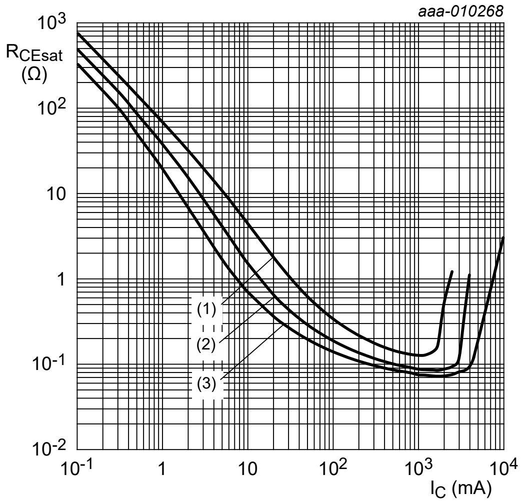

$T_{amb}$ = 25 °C
(1) $I_C/I_B$ = 50
(2) $I_C/I_B$ = 20
(3) $I_C/I_B$ = 10

**Fig. 9. TR1 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values**



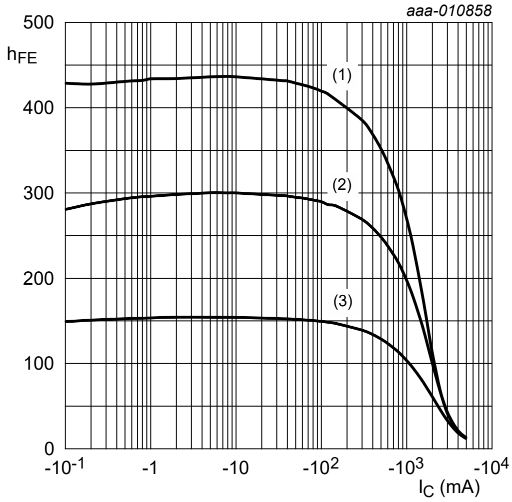

$I_C/I_B = 20$
(1) $T_{amb} = 100$ °C
(2) $T_{amb} = 25$ °C
(3) $T_{amb} = -55$ °C

**Fig. 10. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values**



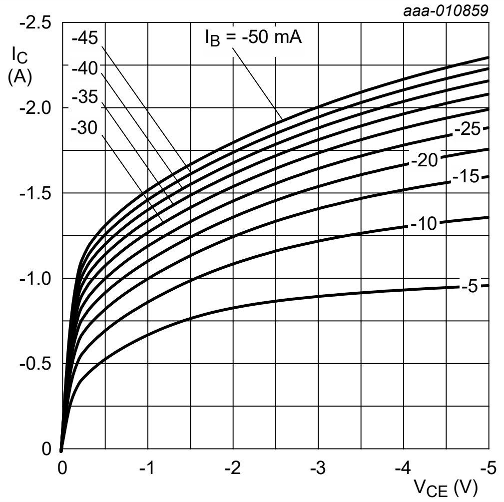

$T_{amb} = 25$ °C
(1) $I_C/I_B = 50$
(2) $I_C/I_B = 20$
(3) $I_C/I_B = 10$

**Fig. 11. TR1 (NPN): Collector-emitter saturation resistance as a function of collector current; typical values**



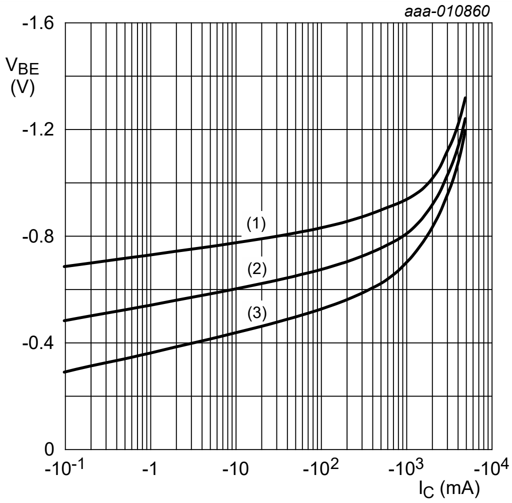

$V_{CE} = -10$ V
(1) $T_{amb} = 100$ °C
(2) $T_{amb} = 25$ °C
(3) $T_{amb} = -55$ °C

**Fig. 12. TR2 (PNP): DC current gain as a function of collector current; typical values**



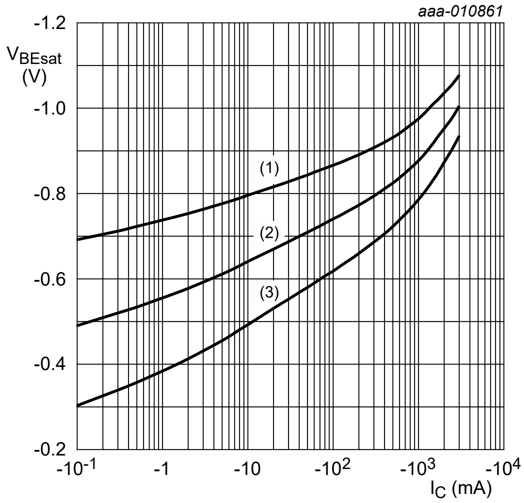

$T_{amb} = 25$ °C

**Fig. 13. TR2 (PNP): Collector current as a function of collector-emitter voltage; typical values**



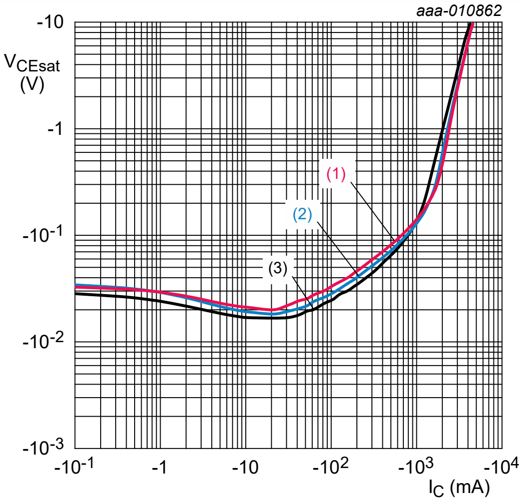

$V_{CE} = -2$ V
(1) $T_{amb} = -55$ °C
(2) $T_{amb} = 25$ °C
(3) $T_{amb} = 100$ °C

**Fig. 14. TR2 (PNP): Base-emitter voltage as a function of collector current; typical values**



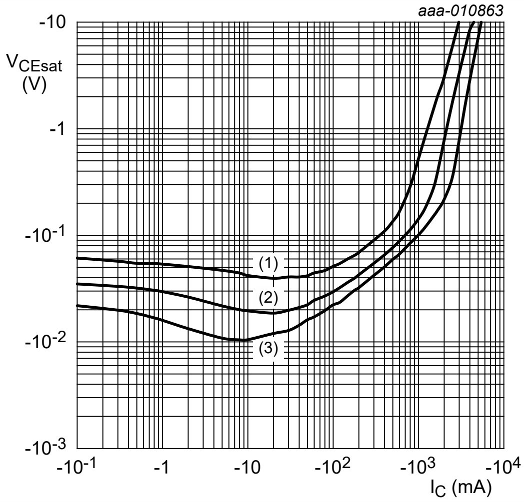

$I_C/I_B = 20$
(1) $T_{amb} = -55$ °C
(2) $T_{amb} = 25$ °C
(3) $T_{amb} = 100$ °C

**Fig. 15. TR2 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**



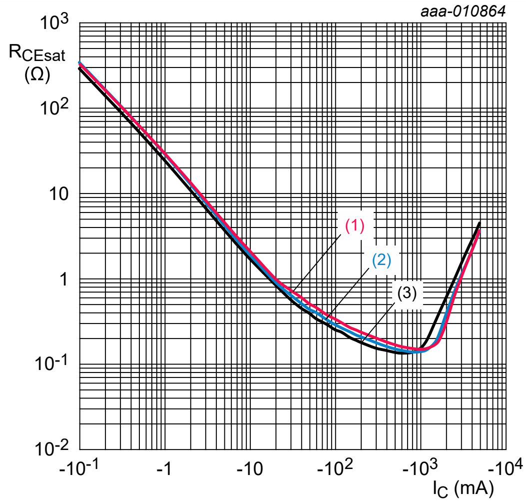

$I_C/I_B = 20$
(1) $T_{amb} = 100$ °C
(2) $T_{amb} = 25$ °C
(3) $T_{amb} = -55$ °C

**Fig. 16. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**



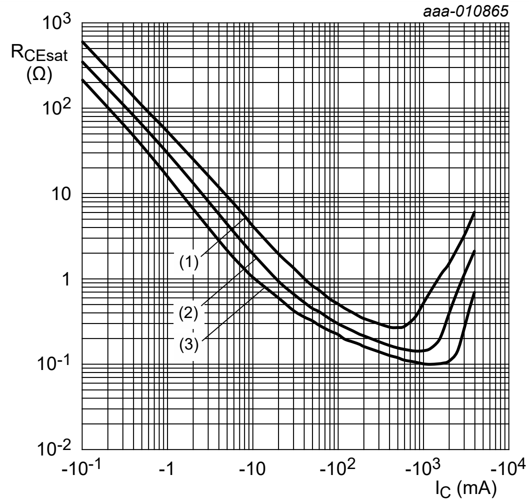

$T_{amb} = 25$ °C
(1) $I_C/I_B = 50$
(2) $I_C/I_B = 20$
(3) $I_C/I_B = 10$

**Fig. 17. TR2 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**




$I_C/I_B = 20$
(1) $T_{amb}$ = 100 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = −55 °C

**Fig. 18. TR2 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values**




$T_{amb}$ = 25 °C
(1) $I_C/I_B = 50$
(2) $I_C/I_B = 20$
(3) $I_C/I_B = 10$

**Fig. 19. TR2 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values**

## 11. Test information

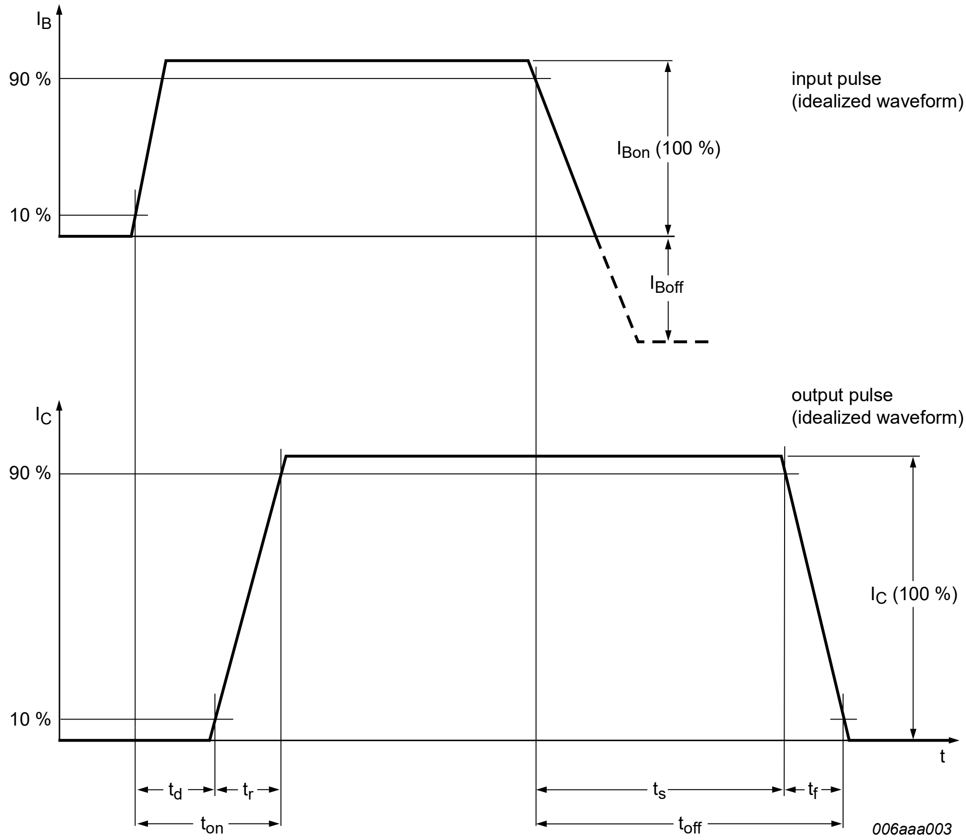



**Fig. 20. TR1 (NPN): BISS transistor switching time definition**

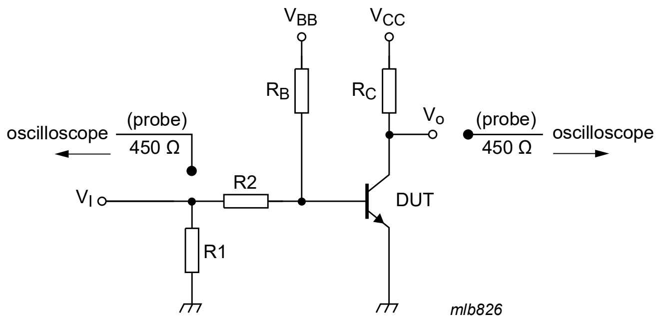



**Fig. 21. TR1 (NPN): Test circuit for switching times**

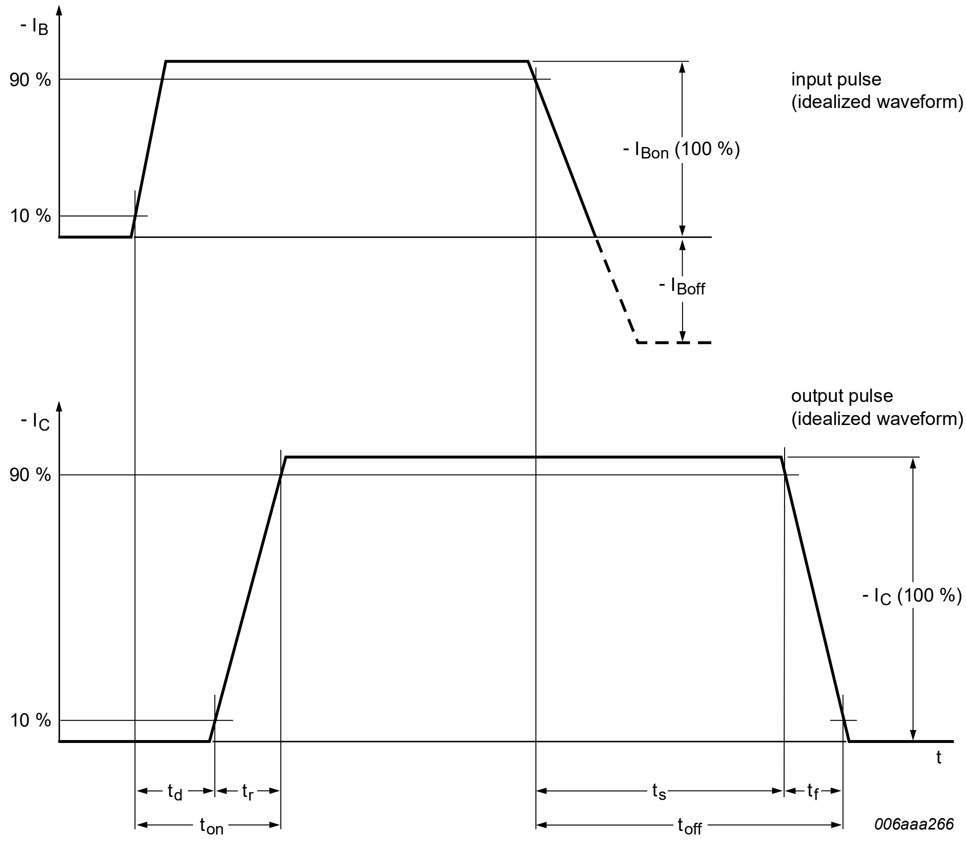



**Fig. 22. TR2 (PNP): BISS transistor switching time definition**

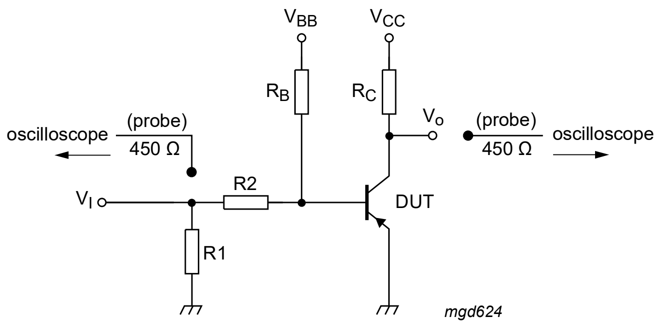


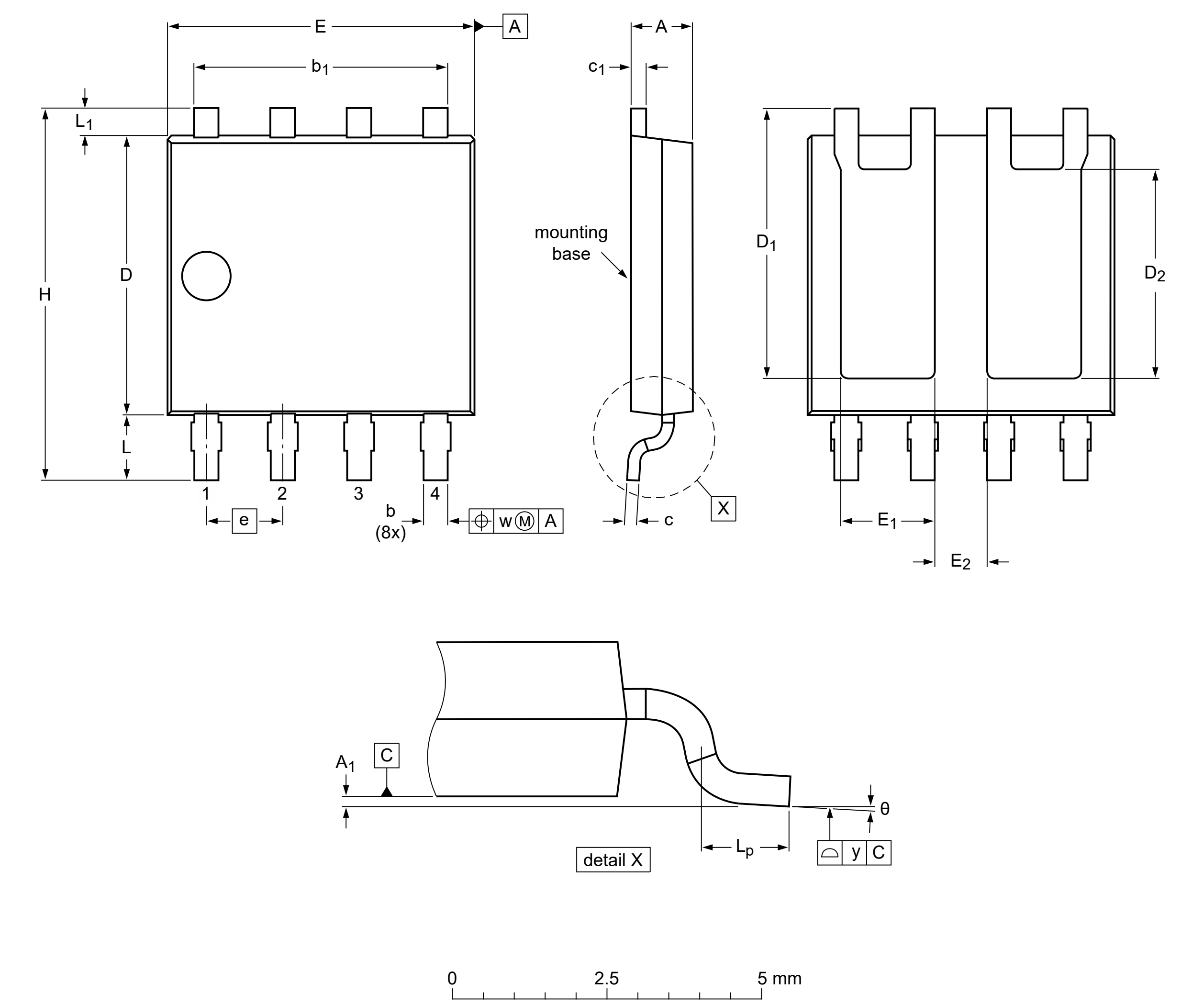

**Fig. 23. TR2 (PNP): Test circuit for switching times**

## 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**




Dimensions

| Unit | | A | $A_1$ | b | $b_1$ | c | $c_1$ | D(1) | $D_1$(1) | $D_2$ (ref) | E(1) | $E_1$(1) | $E_2$ | e | H | L | $L_1$ | $L_p$ | w | y | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 1.05 | 0.1 | 0.50 | 4.4 | 0.25 | 0.30 | 4.70 | 4.55 | 3.5 | 5.30 | 1.8 | 0.85 | | 6.2 | 1.3 | 0.55 | 0.85 | | | 8° |
| | nom | | | | | | | | | | | | | 1.27 | | | | | 0.25 | 0.1 | |
| | min | 1.02 | 0.0 | 0.35 | 4.1 | 0.19 | 0.24 | 4.45 | 4.35 | 3.4 | 4.95 | 1.6 | 0.60 | | 5.9 | 0.8 | 0.30 | 0.40 | | | 0° |

Note

1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

*sot1205_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT1205 | | | | | | ~~14-08-21~~<br>14-10-28 |

**Fig. 24. Package outline LFPAK56D; Dual LFPAK (SOT1205)**

## 13. Soldering

**Footprint information for reflow soldering of LFPAK56D package** **SOT1205**

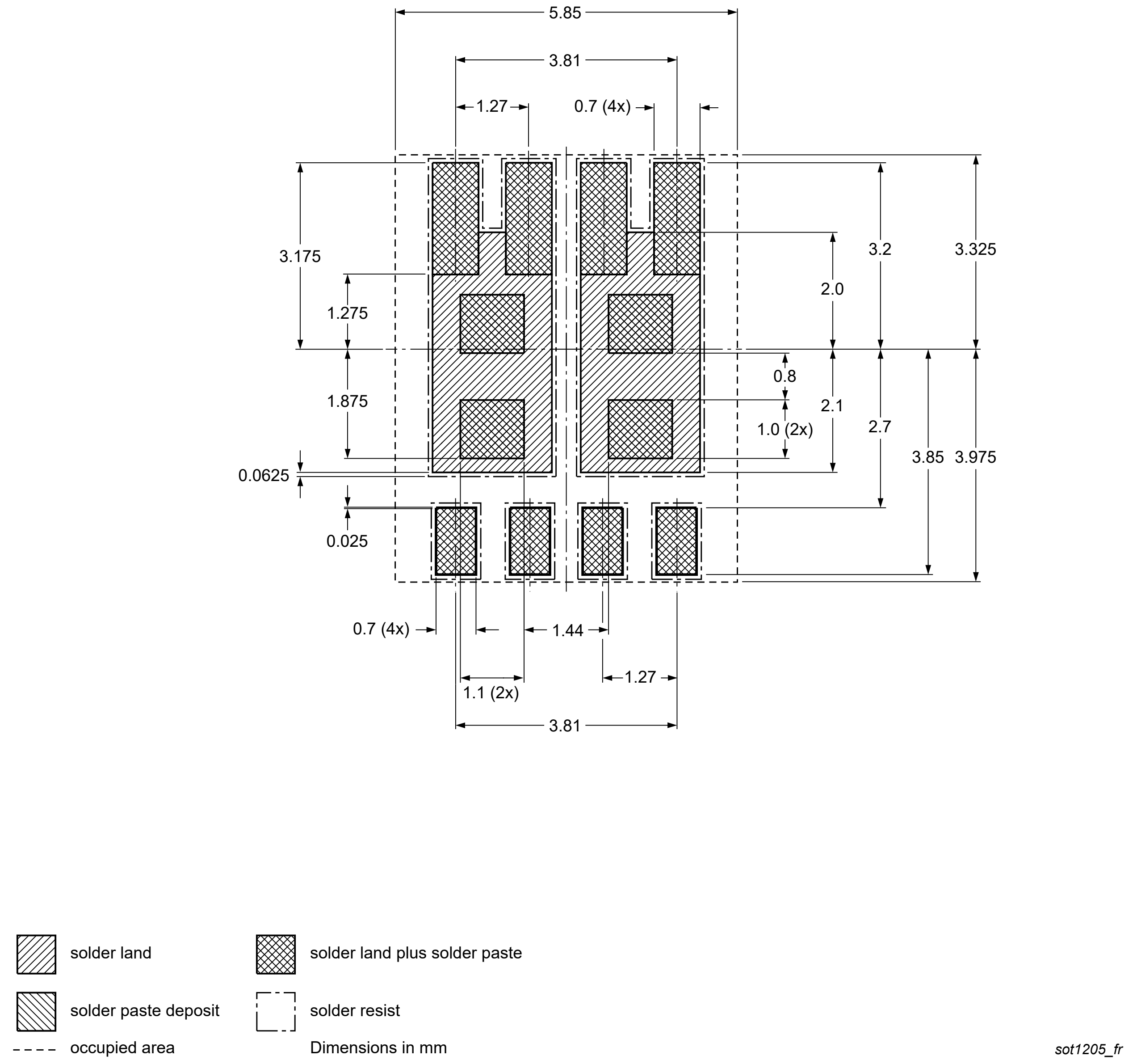



**Fig. 25. Reflow soldering footprint for LFPAK56D; Dual LFPAK (SOT1205)**

## 14. Revision history

**Table 8. Revision history**

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PHPT610030NPK v.2 | 20200910 | Product data sheet | - | PHPT610030NPK v.1 |
| Modifications: | • Characteristics: Figures 6, 7, 8 and 10 corrected | | | |
| PHPT610030NPK v.1 | 20141014 | 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".
[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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**Date of release: 10 September 2020**