
# PHPT61006NY

## 100 V, 6 A NPN high power bipolar transistor

**26 January 2015** **Product data sheet**

## 1. General description

NPN high power bipolar transistor in a SOT669 (LFPAK56) Surface-Mounted Device (SMD) power plastic package.

PNP complement: PHPT61006PY

## 2. Features and benefits

- High thermal power dissipation capability
- 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

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

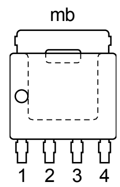
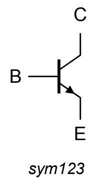
## 4. Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CEO}$ | collector-emitter voltage | open base | | - | - | 100 | V |
| $I_C$ | collector current | | | - | - | 6 | A |
| $I_{CM}$ | peak collector current | single pulse; $t_p \leq 1$ ms | | - | - | 12 | A |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C = 6$ A; $I_B = 600$ mA; $t_p \leq 300$ µs; $\delta \leq 0.02$; $T_{amb} = 25$ °C; pulsed | | - | 35 | 57 | mΩ |

## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | E | emitter |   **LFPAK56; Power-SO8 (SOT669)** |   |
| 2 | E | emitter | | |
| 3 | E | emitter | | |
| 4 | B | base | | |
| mb | C | collector | | |

## 6. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| PHPT61006NY | LFPAK56; Power-SO8 | Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads | SOT669 |

## 7. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| PHPT61006NY | 1006NAB |

# 8. Limiting values

**Table 5. Limiting values**

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

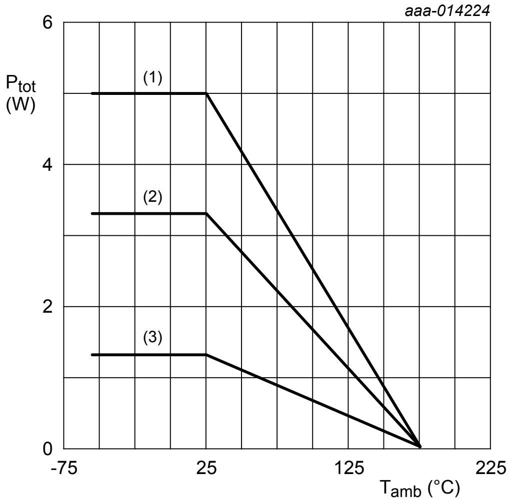
| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CBO}$ | collector-base voltage | open emitter | | - | 100 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | | - | 100 | V |
| $V_{EBO}$ | emitter-base voltage | open collector | | - | 7 | V |
| $I_C$ | collector current | | | - | 6 | A |
| $I_{CM}$ | peak collector current | single pulse; $t_p \leq 1$ ms | | - | 12 | A |
| $I_B$ | base current | | | - | 1 | A |
| $I_{BM}$ | peak base current | single pulse; $t_p \leq 1$ ms | | - | 2 | A |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq 25$ °C | [1] | - | 1.3 | W |
| | | | [2] | - | 3.3 | W |
| | | | [3] | - | 5 | W |
| | | | [4] | - | 25 | 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 Printed-Circuit Board (PCB); single-sided copper; tin-plated and standard footprint.

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

[3] Device mounted on an ceramic PCB; $Al_2O_3$, standard footprint.

[4] Power dissipation from junction to mounting base.




(1) Ceramic PCB, $Al_2O_3$, standard footprint

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

(3) FR4 PCB, standard footprint

**Fig. 1. Power derating curves**

## 9. Thermal characteristics

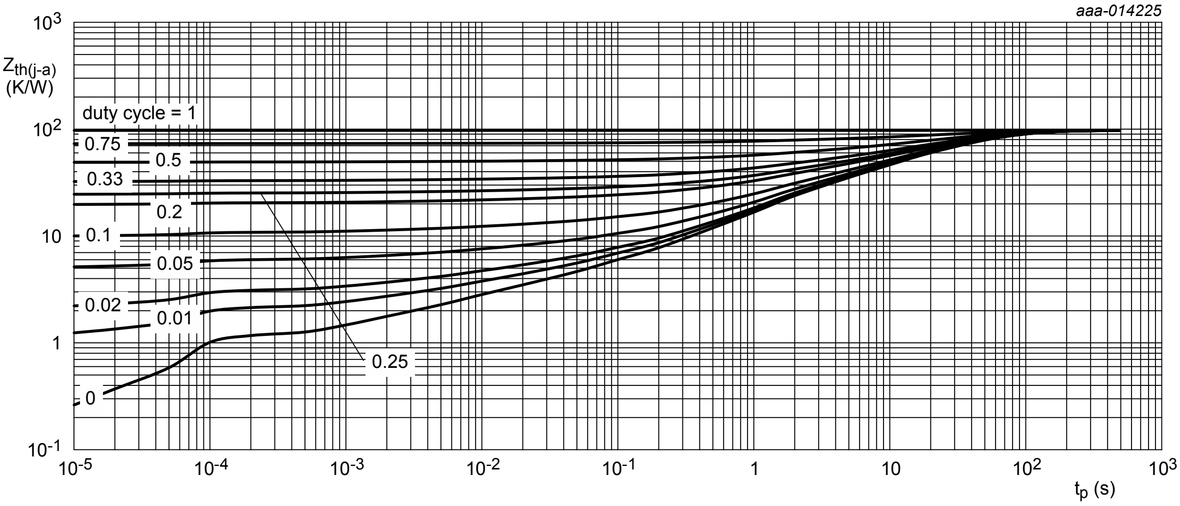
**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 115 | K/W |
| | | | [2] | - | - | 45 | K/W |
| | | | [3] | - | - | 30 | K/W |
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | | | - | - | 6 | K/W |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

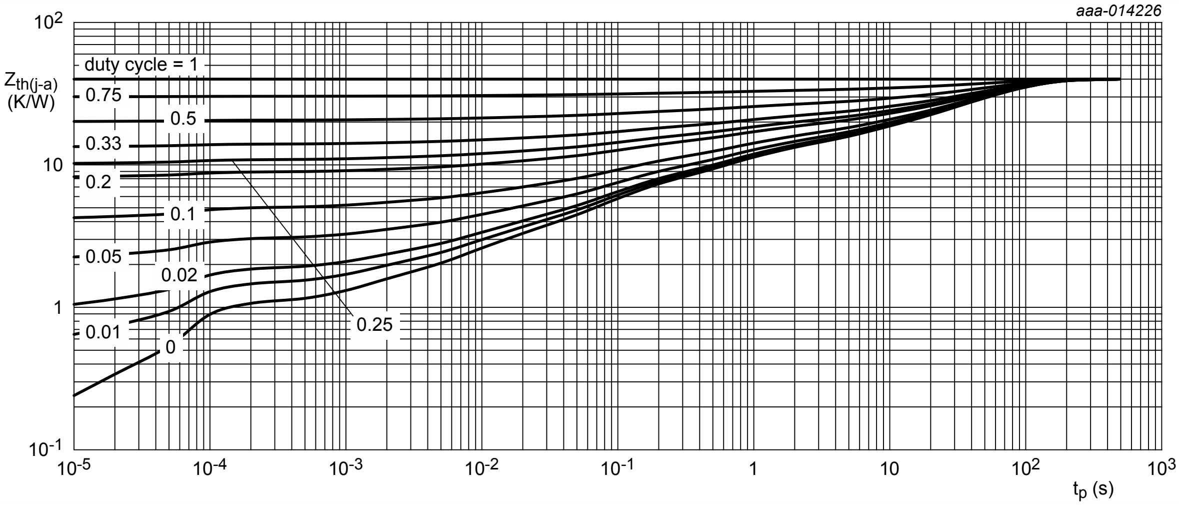
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated mounting pad for collector 6 $cm^2$.

[3] Device mounted on an ceramic Printed-Circuit Board (PCB), $Al_2O_3$, standard footprint.




FR4 PCB, standard footprint

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




FR4 PCB, mounting pad for collector 6 $cm^2$

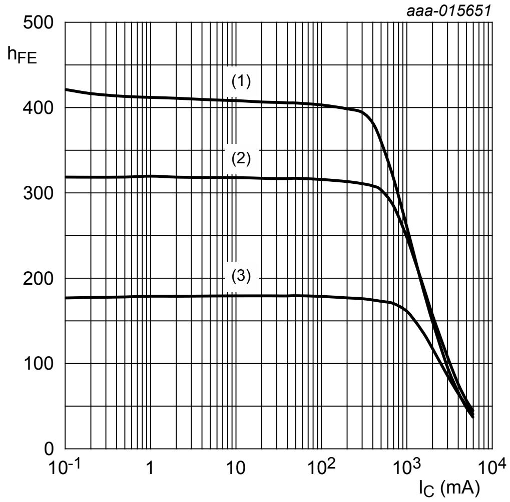
**Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 10. Characteristics

**Table 7. Characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CBO}$ | 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; $T_{amb}$ = 25 °C | | - | - | 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 | $V_{CE}$ = 2 V; $I_C$ = 500 mA; $T_{amb}$ = 25 °C | | 140 | 260 | - | |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_{CE}$ = 2 V; $I_C$ = 1 A; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 120 | 210 | - | |
| | | $V_{CE}$ = 2 V; $I_C$ = 3 A; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | 50 | 90 | - | |
| | | $V_{CE}$ = 2 V; $I_C$ = 6 A; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C; pulsed | | 25 | 40 | - | |
| $V_{CEsat}$ | collector-emitter saturation voltage | $I_C$ = 1 A; $I_B$ = 50 mA; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C; pulsed | | - | 45 | 65 | mV |
| | | $I_C$ = 3 A; $I_B$ = 300 mA; pulsed; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 100 | 150 | mV |
| | | $I_C$ = 6 A; $I_B$ = 600 mA; pulsed; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 210 | 340 | mV |
| $R_{CEsat}$ | collector-emitter saturation resistance | $I_C$ = 6 A; $I_B$ = 600 mA; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C; pulsed | | - | 35 | 57 | mΩ |
| $V_{BEsat}$ | base-emitter saturation voltage | $I_C$ = 1 A; $I_B$ = 50 mA; pulsed; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 0.85 | 1 | V |
| | | $I_C$ = 3 A; $I_B$ = 300 mA; pulsed; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 1.05 | 1.3 | V |
| | | $I_C$ = 6 A; $I_B$ = 600 mA; pulsed; $t_p$ ≤ 300 μs; δ ≤ 0.02; $T_{amb}$ = 25 °C | | - | 1.1 | 1.3 | V |
| $V_{BEon}$ | base-emitter turn-on voltage | $V_{CE}$ = 2 V; $I_C$ = 500 mA; $T_{amb}$ = 25 °C | | - | 0.7 | 0.9 | V |
| $t_d$ | delay time | $V_{CC}$ = 12.5 V; $I_C$ = 3 A; $I_{Bon}$ = 150 mA; $I_{Boff}$ = -150 mA; $T_{amb}$ = 25 °C | | - | 10 | - | ns |
| $t_r$ | rise time | | | - | 365 | - | ns |
| $t_{on}$ | turn-on time | | | - | 375 | - | ns |
| $t_s$ | storage time | | | - | 285 | - | ns |
| $t_f$ | fall time | | | - | 385 | - | ns |
| $t_{off}$ | turn-off time | | | - | 670 | - | ns |
| $f_T$ | transition frequency | $V_{CE}$ = 10 V; $I_C$ = 500 mA; f = 100 MHz; $T_{amb}$ = 25 °C | | - | 170 | - | MHz |
| $C_c$ | collector capacitance | $V_{CB}$ = 10 V; $I_E$ = 0 A; $i_e$ = 0 A; f = 1 MHz; $T_{amb}$ = 25 °C | | - | 22 | - | pF |



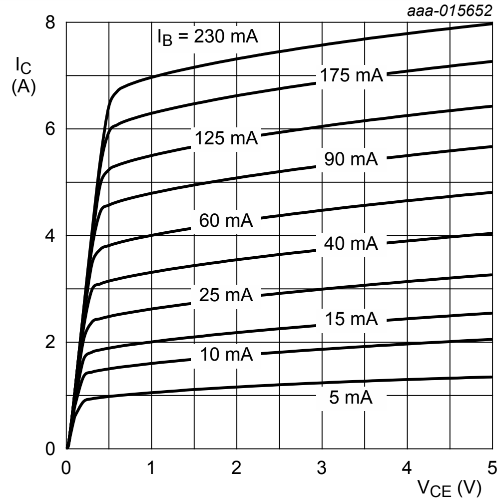

$V_{CE}$ = 2 V

(1) $T_{amb}$ = 100 °C

(2) $T_{amb}$ = 25 °C

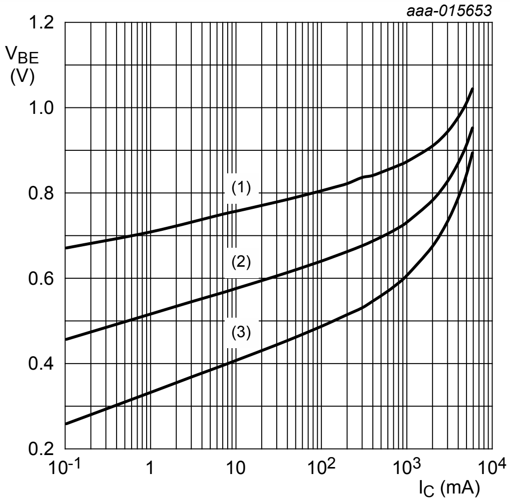
(3) $T_{amb}$ = −55 °C

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




$T_{amb}$ = 25 °C

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



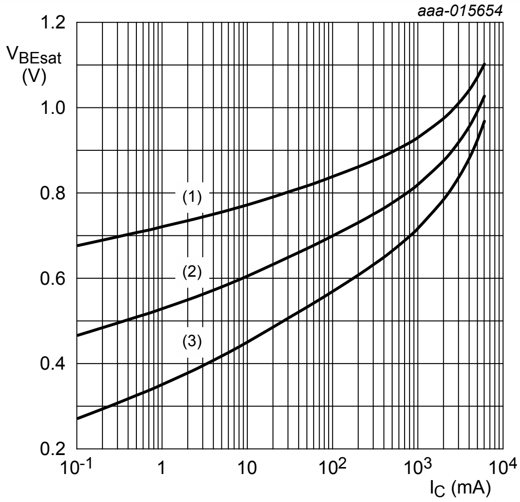

$V_{CE}$ = 2 V

(1) $T_{amb}$ = −55 °C

(2) $T_{amb}$ = 25 °C

(3) $T_{amb}$ = 100 °C

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



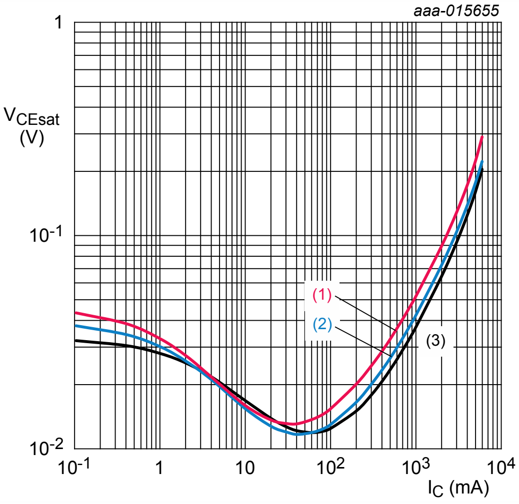

$I_C/I_B$ = 20

(1) $T_{amb}$ = −55 °C

(2) $T_{amb}$ = 25 °C

(3) $T_{amb}$ = 100 °C

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



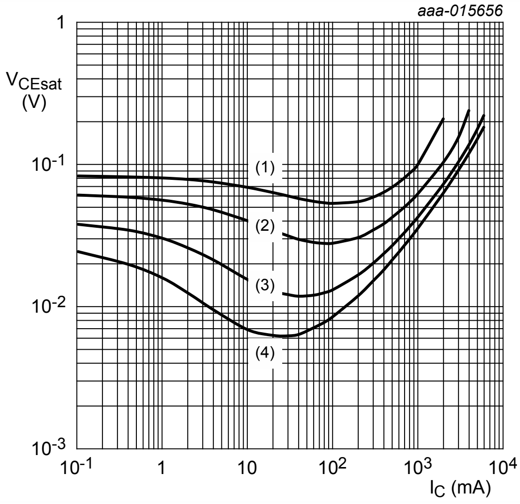

$I_C/I_B = 20$

(1) $T_{amb} = 100\ °C$

(2) $T_{amb} = 25\ °C$

(3) $T_{amb} = -55\ °C$

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




$T_{amb} = 25\ °C$

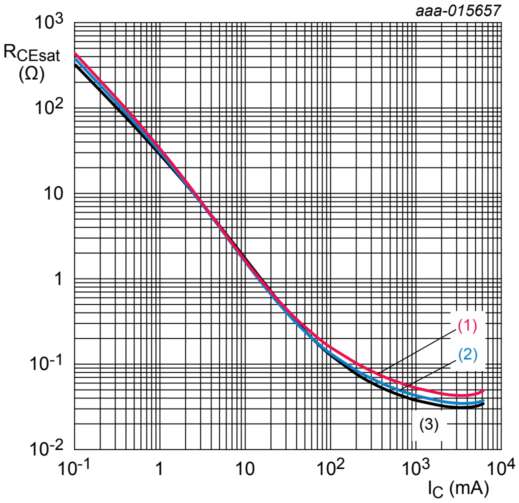
(1) $I_C/I_B = 100$

(2) $I_C/I_B = 50$

(3) $I_C/I_B = 20$

(4) $I_C/I_B = 10$

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



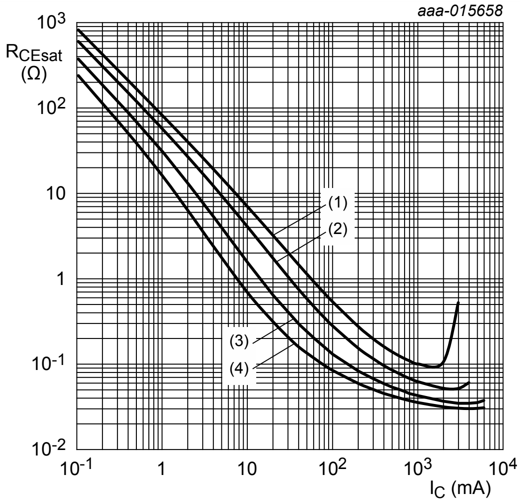

$I_C/I_B = 20$

(1) $T_{amb} = 100\ °C$

(2) $T_{amb} = 25\ °C$

(3) $T_{amb} = -55\ °C$

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




$T_{amb} = 25\ °C$

(1) $I_C/I_B = 100$

(2) $I_C/I_B = 50$

(3) $I_C/I_B = 20$

(4) $I_C/I_B = 10$

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

## 11. Test information

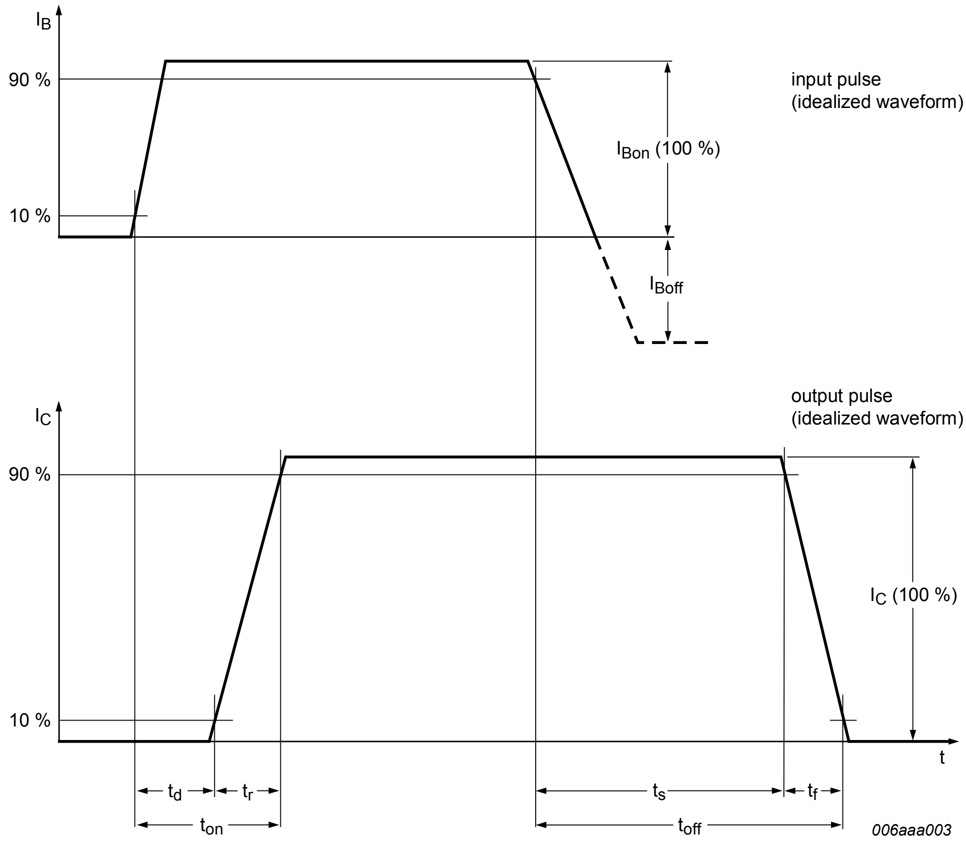



**Fig. 12. BISS transistor switching time definition**

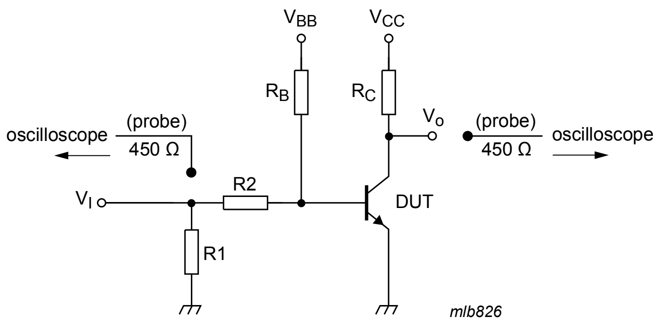


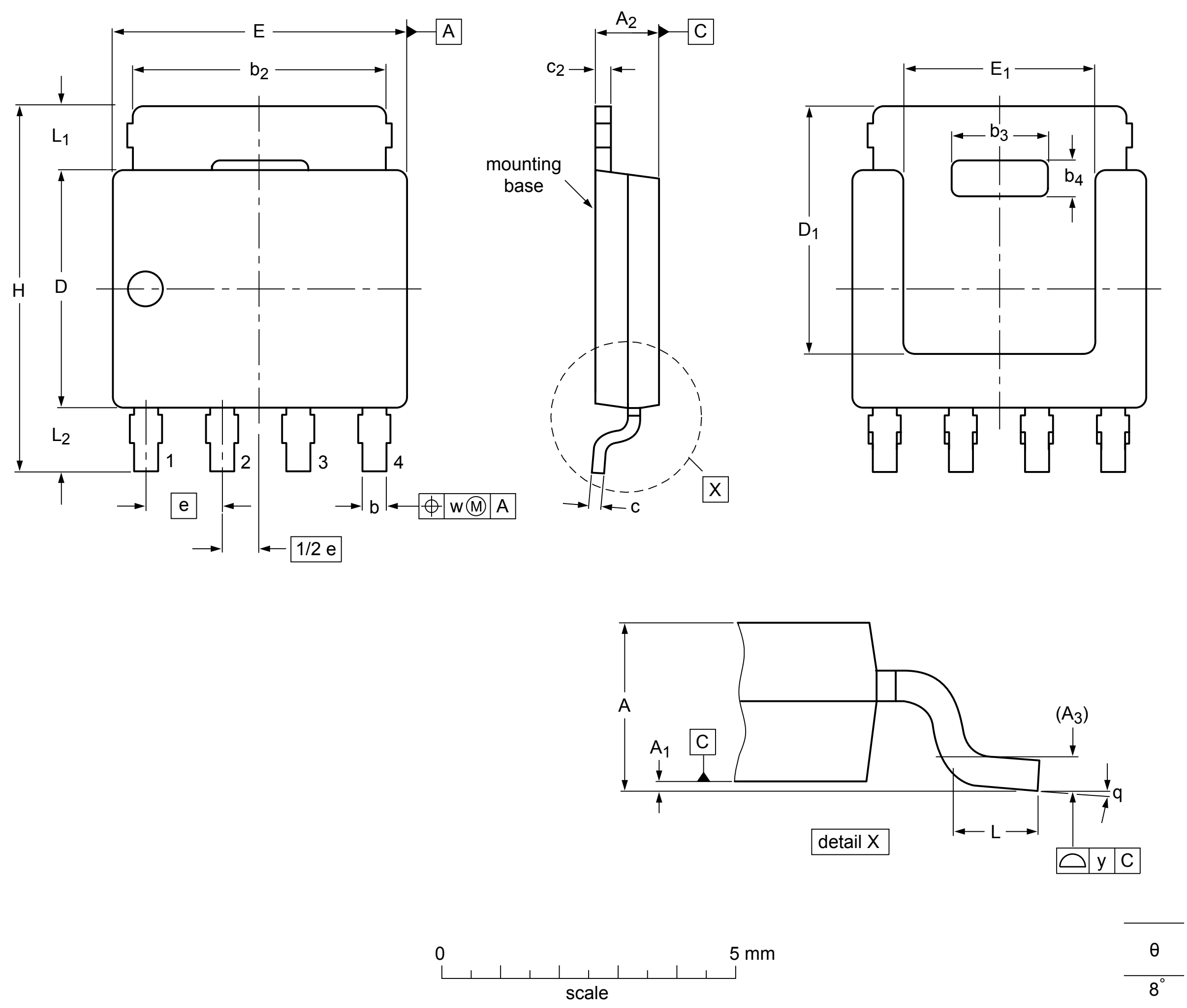

**Fig. 13. Test circuit for switching times**

### 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 single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads** **SOT669**




Dimensions (mm are the original dimensions)

| Unit(1) | | A | $A_1$ | $A_2$ | $A_3$ | b | $b_2$ | $b_3$ | $b_4$ | c | $c_2$ | D(1) | $D_1$(1) | E(1) | $E_1$(1) | e | H | L | $L_1$ | $L_2$ | w | y | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 1.20 | 0.15 | 1.10 | | 0.50 | 4.41 | 2.2 | 0.9 | 0.25 | 0.30 | 4.10 | 4.20 | 5.0 | 3.3 | | 6.2 | 0.85 | 1.3 | 1.3 | | | 8° |
| | nom | | | | 0.25 | | | | | | | | | | | 1.27 | | | | | 0.25 | 0.1 | |
| | min | 1.01 | 0.00 | 0.95 | | 0.35 | 3.62 | 2.0 | 0.7 | 0.19 | 0.24 | 3.80 | | 4.8 | 3.1 | | 5.8 | 0.40 | 0.8 | 0.8 | | | 0° |

Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

*sot669_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT669 | | MO-235 | | | | ~~11-03-25~~<br>13-02-27 |

**Fig. 14. Package outline LFPAK56; Power-SO8 (SOT669)**

## 13. Soldering

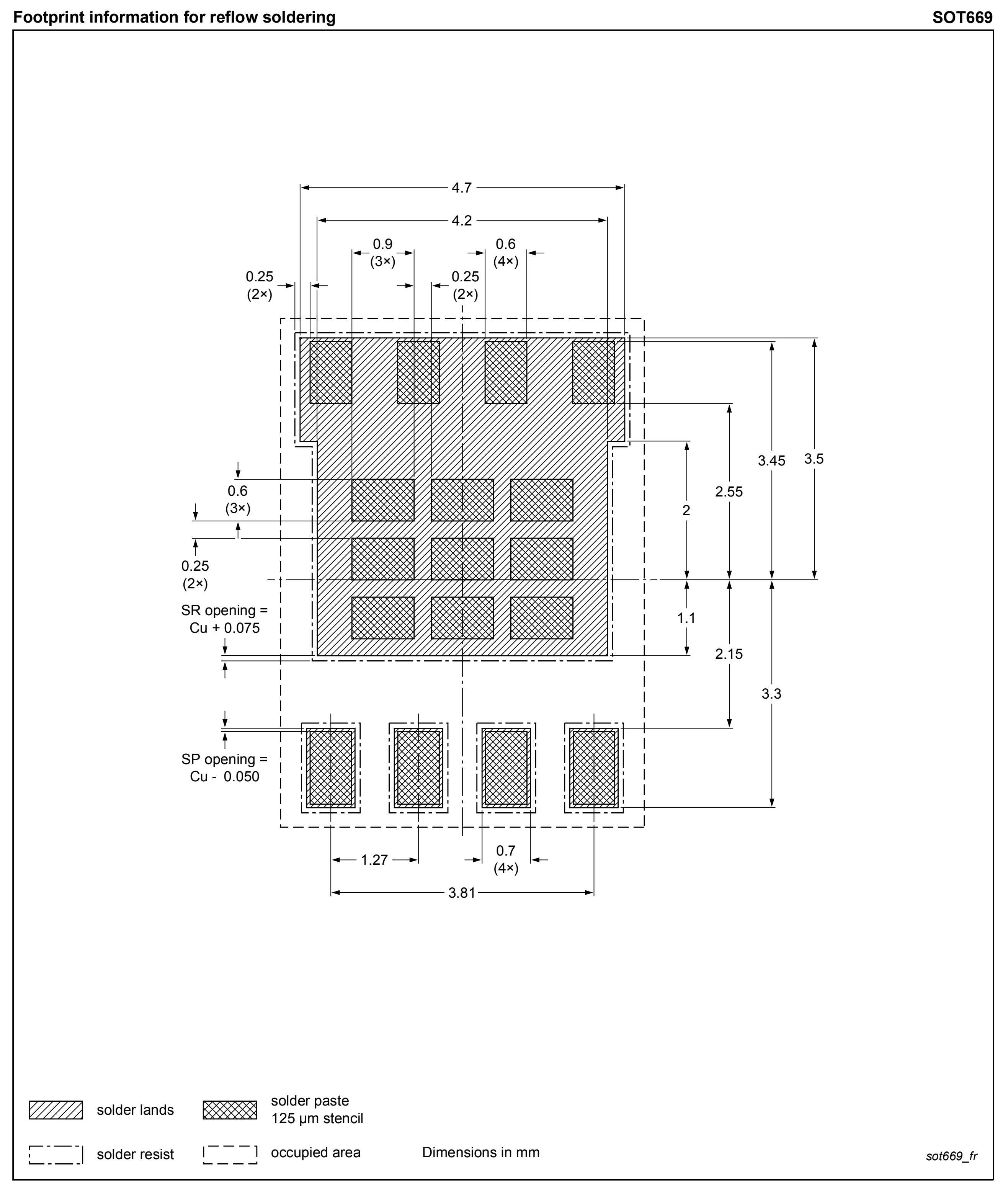



**Fig. 15. Reflow soldering footprint for LFPAK56; Power-SO8 (SOT669)**

## 14. Revision history

**Table 8. Revision history**

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PHPT61006NY v.1 | 20150126 | Product data sheet | - | - |

# 15. Legal information

## 15.1 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. |

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**Date of release: 26 January 2015**