



PHPT60610NY

60 V, 10 A NPN high power bipolar transistor

15 January 2019

Product data sheet

1. General description

NPN high power bipolar transistor in a SOT669 (LFAK56) Surface-Mounted Device (SMD) power plastic package.

PNP complement: PHPT60610PY

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

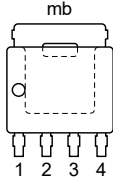
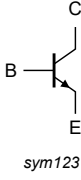
4. Quick reference data

Table 1. Quick reference data

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------|---|---|-----|-----|-----|------------|
| V_{CEO} | collector-emitter voltage | open base | - | - | 60 | V |
| I_C | collector current | | - | - | 10 | A |
| I_{CM} | peak collector current | single pulse; $t_p \leq 1$ ms | - | - | 20 | A |
| R_{CEsat} | collector-emitter saturation resistance | $I_C = 10$ A; $I_B = 1$ A; $t_p \leq 300$ μ s; pulsed; $\delta \leq 0.02$; $T_{amb} = 25$ °C | - | 25 | 36 | m Ω |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|-------------|--|---|
| 1 | E | emitter |  <p>LFPAK56; Power-SO8 (SOT669)</p> |  |
| 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 |
| PHPT60610NY | 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 |
|-------------|--------------|
| PHPT60610NY | 0610NAB |

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 | - | 60 | V | |
| V_{CEO} | collector-emitter voltage | open base | - | 60 | V | |
| V_{EBO} | emitter-base voltage | open collector | - | 7 | V | |
| I_C | collector current | | - | 10 | A | |
| I_{CM} | peak collector current | single pulse; $t_p \leq 1$ ms | - | 20 | A | |
| I_B | base current | | - | 1.5 | 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] | - | 1.5 | W |
| | | | [2] | - | 3.7 | 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 cm².
- [3] Device mounted on a ceramic PCB; Al₂O₃, standard footprint.
- [4] Power dissipation from junction to mounting base.

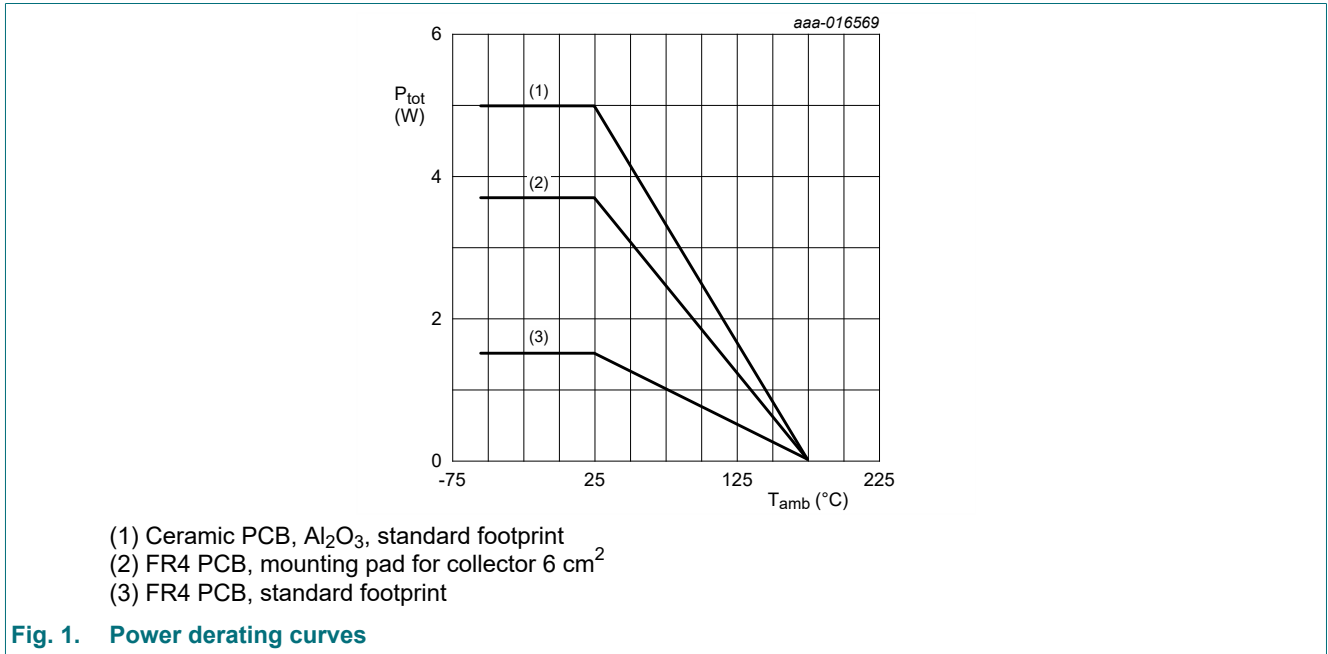


Fig. 1. Power derating curves

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] | - | - | 100 | K/W |
| | | | [2] | - | - | 41 | 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 and mounting pad for collector 6 cm².
- [3] Device mounted on a ceramic Printed-Circuit Board (PCB), Al₂O₃, standard footprint.

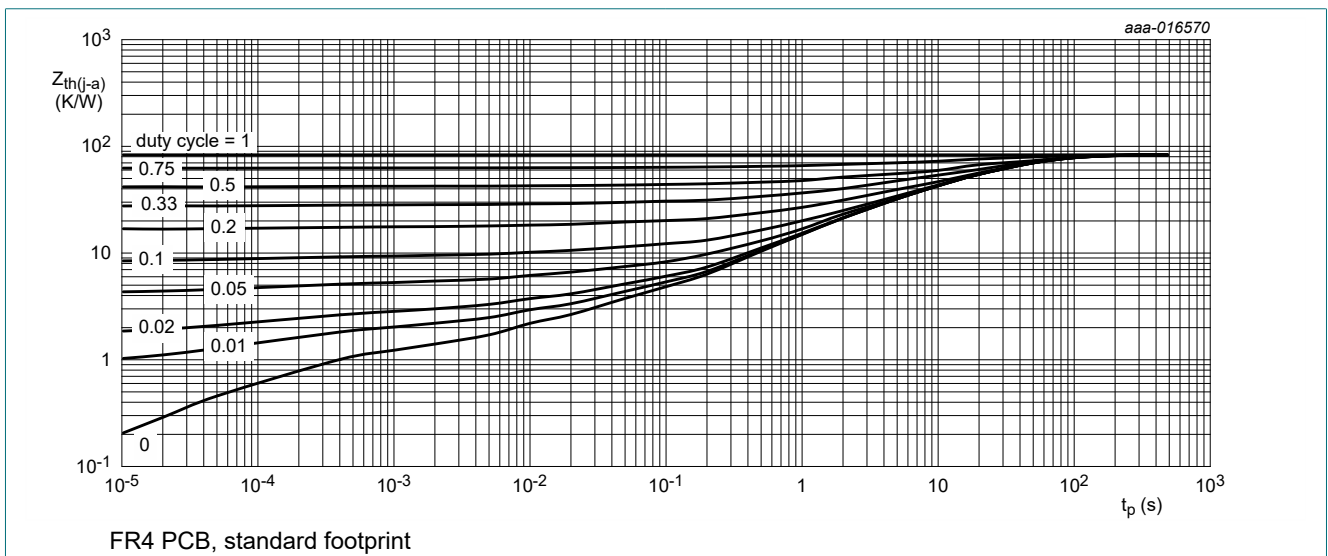


Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

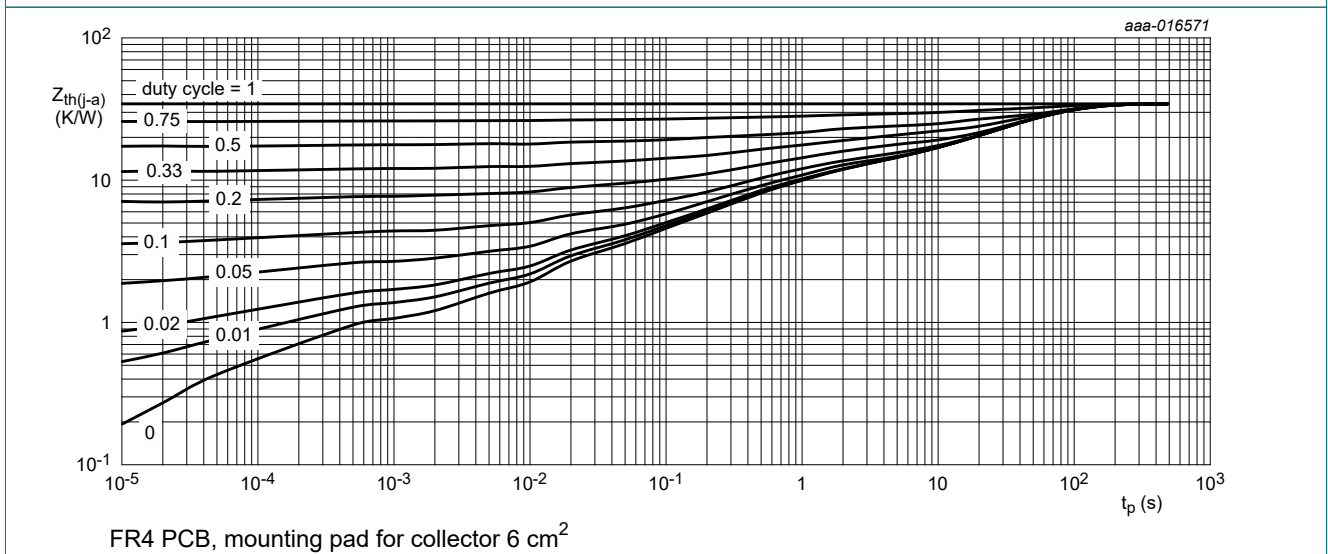
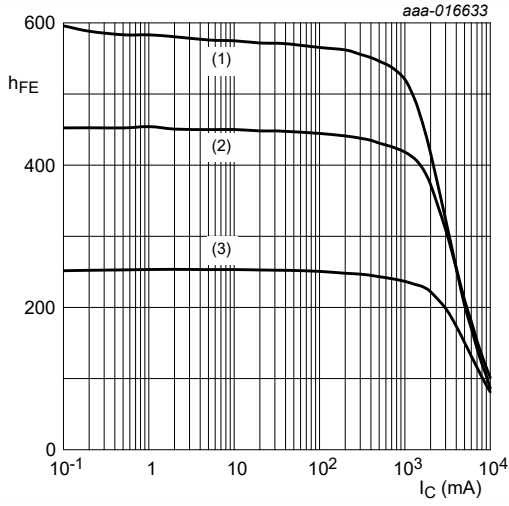


Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

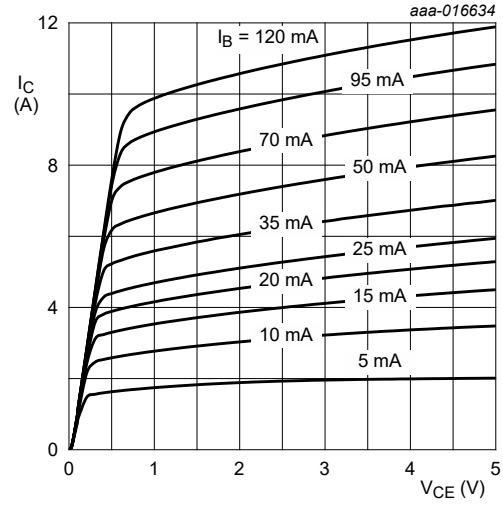
Table 7. Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|-------------|---|---|---|-----|------|---------------|
| I_{CBO} | collector-base cut-off current | $V_{CB} = 48 \text{ V}; I_E = 0 \text{ A}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 100 | nA |
| | | $V_{CB} = 48 \text{ V}; I_E = 0 \text{ A}; T_J = 150 \text{ }^\circ\text{C}$ | - | - | 50 | μA |
| I_{CES} | collector-emitter cut-off current | $V_{CE} = 48 \text{ V}; V_{BE} = 0 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 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 | $V_{CE} = 2 \text{ V}; I_C = 500 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$ | 240 | 410 | - | |
| | | $V_{CE} = 2 \text{ V}; I_C = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | 210 | 400 | - | |
| | | $V_{CE} = 2 \text{ V}; I_C = 5 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | 100 | 200 | - | |
| | | $V_{CE} = 2 \text{ V}; I_C = 10 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}; \text{pulsed}$ | 50 | 100 | - | |
| V_{CEsat} | collector-emitter saturation voltage | $I_C = 1 \text{ A}; I_B = 50 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}; \text{pulsed}$ | - | 30 | 40 | mV |
| | | $I_C = 5 \text{ A}; I_B = 500 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 115 | 160 | mV |
| | | $I_C = 10 \text{ A}; I_B = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 250 | 360 | mV |
| R_{CEsat} | collector-emitter saturation resistance | | - | 25 | 36 | m Ω |
| V_{BEsat} | base-emitter saturation voltage | $I_C = 1 \text{ A}; I_B = 50 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 0.95 | V |
| | | $I_C = 5 \text{ A}; I_B = 500 \text{ mA}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 1.2 | V |
| | | $I_C = 10 \text{ A}; I_B = 1 \text{ A}; t_p \leq 300 \text{ } \mu\text{s}; \text{pulsed}; \delta \leq 0.02; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 1.4 | V |
| V_{BEon} | base-emitter turn-on voltage | $V_{CE} = 2 \text{ V}; I_C = 500 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | - | 0.8 | V |
| t_d | delay time | $V_{CC} = 12.5 \text{ V}; I_C = 5 \text{ A}; I_{B(on)} = 250 \text{ mA}; I_{B(off)} = -250 \text{ mA}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 20 | - | ns |
| t_r | rise time | | - | 180 | - | ns |
| t_{on} | turn-on time | | - | 200 | - | ns |
| t_s | storage time | | - | 340 | - | ns |
| t_f | fall time | | - | 165 | - | ns |
| t_{off} | turn-off time | | - | 505 | - | ns |
| f_T | transition frequency | | $V_{CE} = 10 \text{ V}; I_C = 500 \text{ mA}; f = 100 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 140 | - |
| C_c | collector capacitance | $V_{CB} = 10 \text{ V}; I_E = 0 \text{ A}; i_e = 0 \text{ A}; f = 1 \text{ MHz}; T_{amb} = 25 \text{ }^\circ\text{C}$ | - | 50 | - | pF |



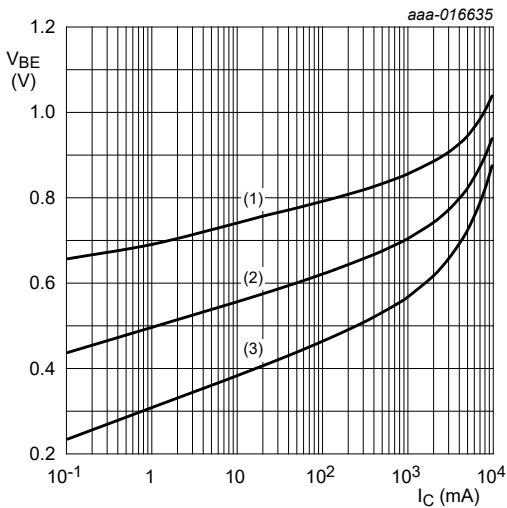
$V_{CE} = 2\text{ V}$
 (1) $T_{amb} = 100\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = -55\text{ °C}$

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



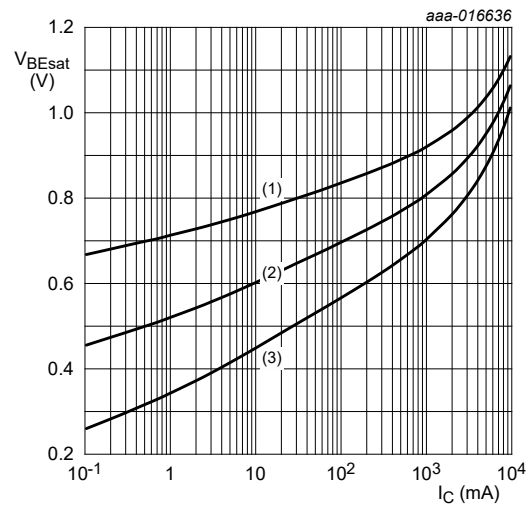
$T_{amb} = 25\text{ °C}$

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



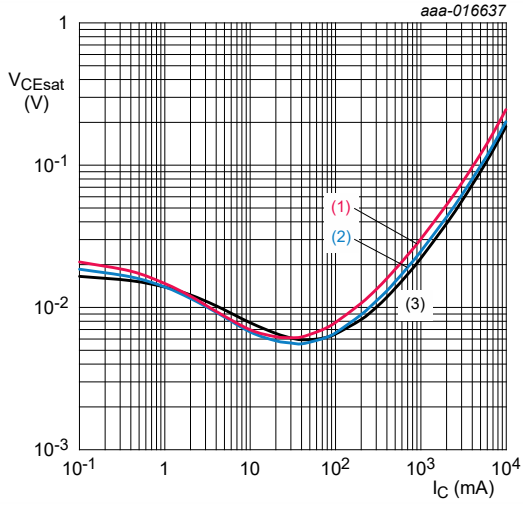
$V_{CE} = 2\text{ V}$
 (1) $T_{amb} = -55\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = 100\text{ °C}$

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



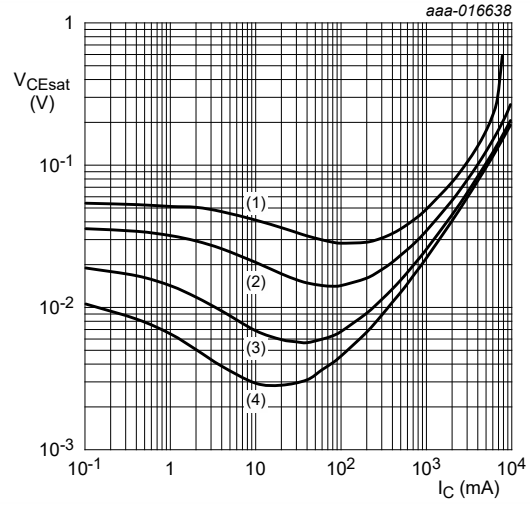
$I_C/I_B = 20$
 (1) $T_{amb} = -55\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = 100\text{ °C}$

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



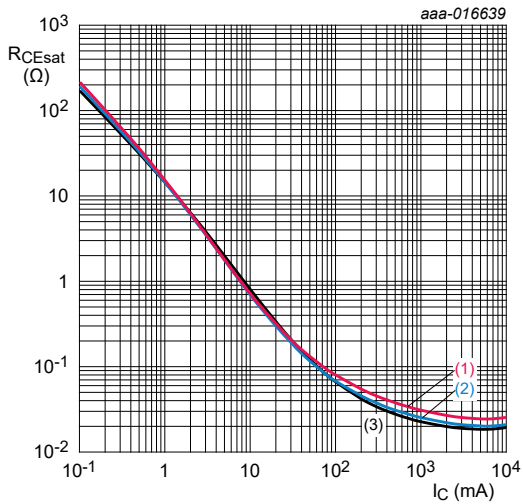
$I_C/I_B = 20$
 (1) $T_{amb} = 100\text{ °C}$
 (2) $T_{amb} = 25\text{ °C}$
 (3) $T_{amb} = -55\text{ °C}$

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



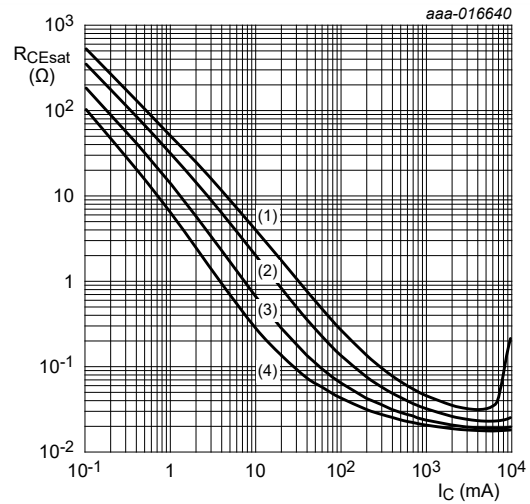
$T_{amb} = 25\text{ °C}$
 (1) $I_C/I_B = 100$
 (2) $I_C/I_B = 50$
 (3) $I_C/I_B = 20$
 (4) $I_C/I_B = 10$

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



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

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



$T_{amb} = 25\text{ °C}$
 (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

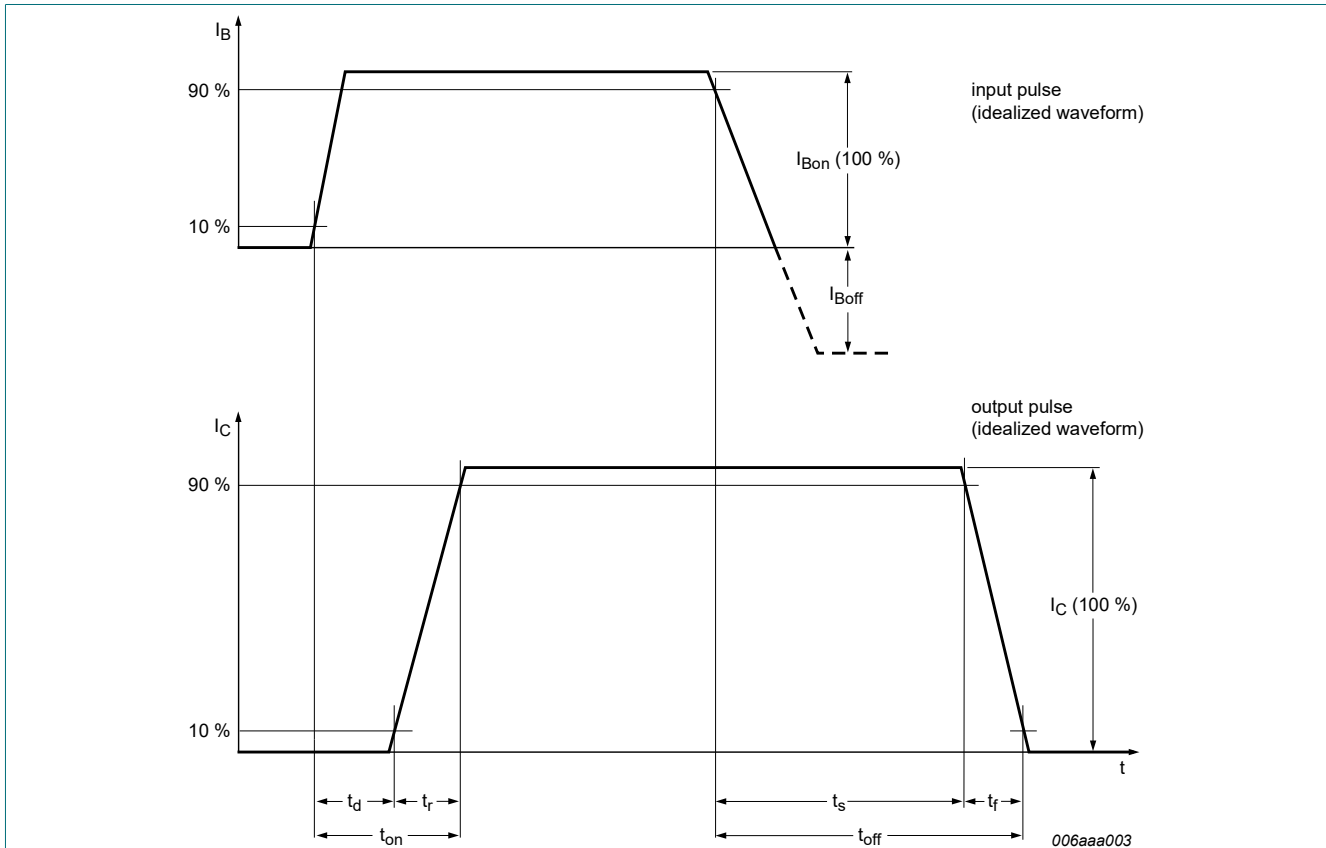


Fig. 12. BISS transistor switching time definition

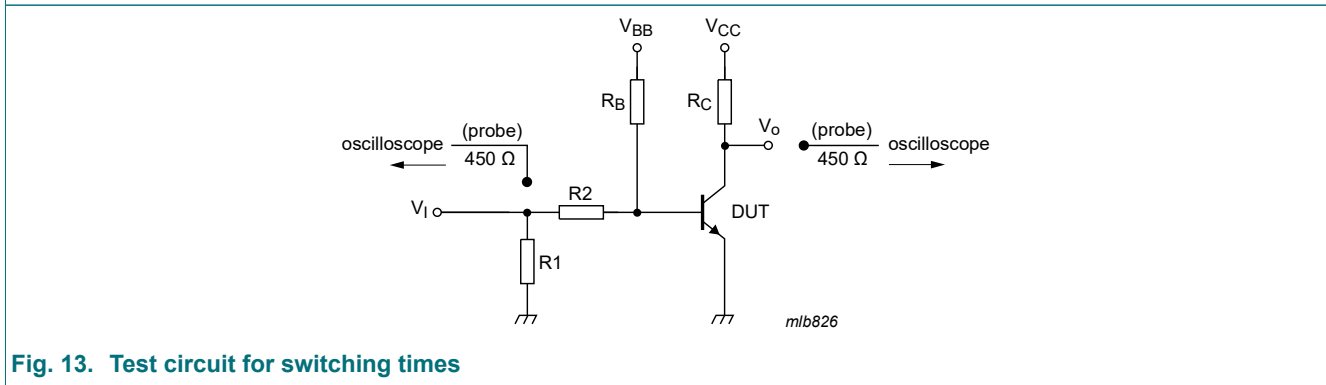


Fig. 13. Test circuit for switching times

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

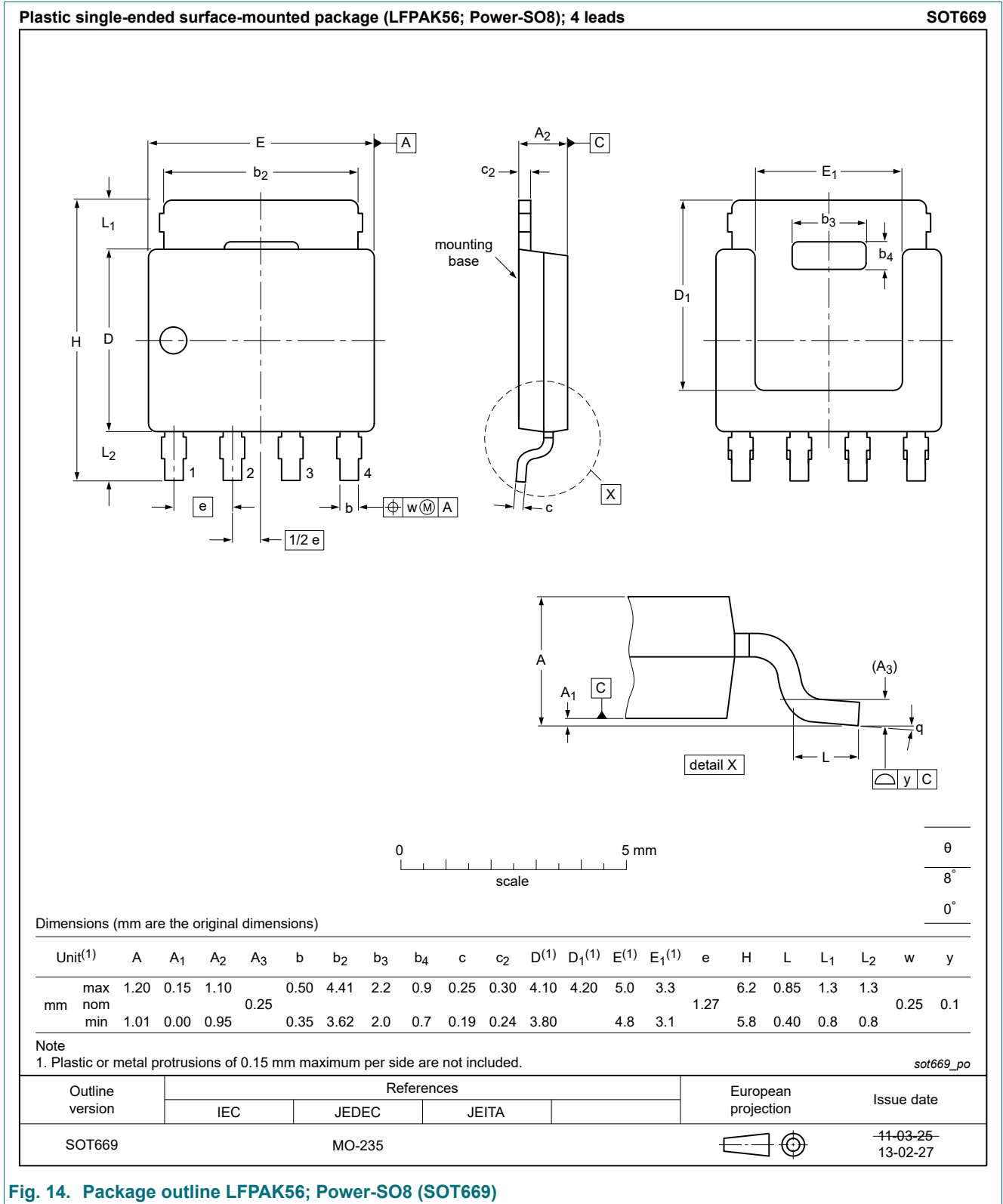


Fig. 14. Package outline LFAK56; Power-SO8 (SOT669)

13. Soldering

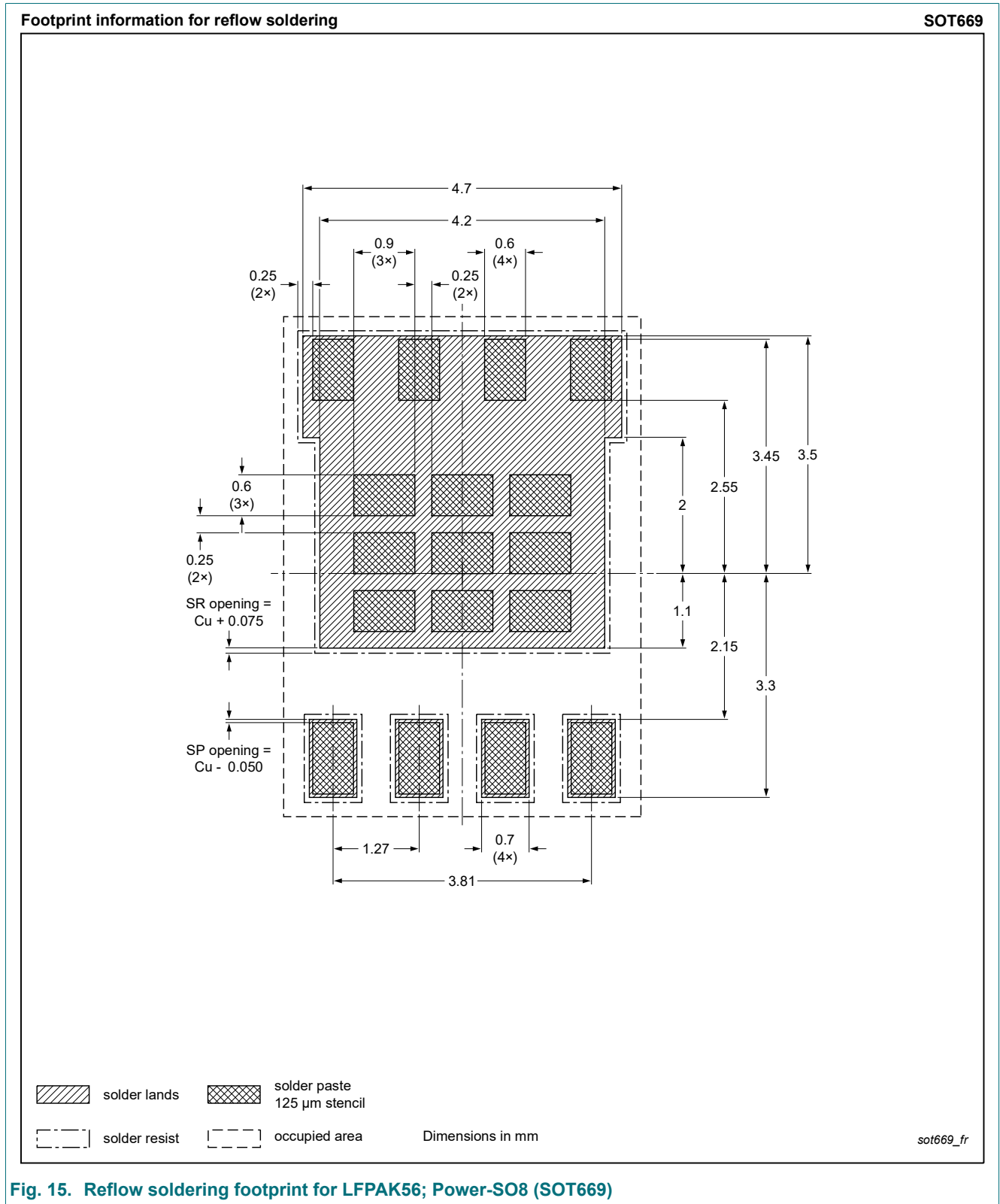


Fig. 15. Reflow soldering footprint for LFPAK56; Power-SO8 (SOT669)

14. Revision history

Table 8. Revision history

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|-----------------|---|--------------------|---------------|-----------------|
| PHPT60610NY v.2 | 20190115 | Product data sheet | - | PHPT60610NY v.1 |
| Modifications: | • Typo at figures 2 and 3: unit corrected from ns to s at x-scale | | | |
| PHPT60610NY v.1 | 20150527 | 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. |

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- [2] The term 'short data sheet' is explained in section "Definitions".
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