

PHP47NQ10T; PHB47NQ10T

N-channel enhancement mode field-effect transistor

Rev. 01 — 16 May 2001

Product data

1. Description

N-channel enhancement mode field-effect power transistor in a plastic package using TrenchMOS™¹ technology.

Product availability:

PHP47NQ10T in SOT78 (TO-220AB)

PHB47NQ10T in SOT404 (D²-PAK).

2. Features

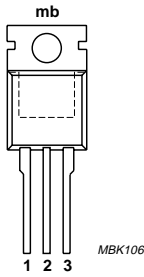
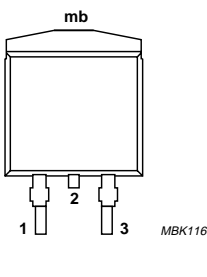
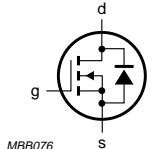
- Fast switching
- Very low on-state resistance.

3. Applications

- DC to DC converters
- Switched mode power supplies.

4. Pinning information

Table 1: Pinning - SOT78 and SOT404, simplified outline and symbol

| Pin | Description | Simplified outline | Symbol |
|-----|--|--|---|
| 1 | gate (g) |   |  |
| 2 | drain (d) [1] | | |
| 3 | source (s) | | |
| mb | mounting base; connected to drain (d) | | |
| | | SOT78 (TO-220AB) | SOT404 (D²-PAK) |

[1] It is not possible to make connection to pin 2 of the SOT404 package.

1. TrenchMOS is a trademark of Royal Philips Electronics.



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5. Quick reference data

Table 2: Quick reference data

| Symbol | Parameter | Conditions | Typ | Max | Unit |
|--------------|----------------------------------|--|-----|-----|------|
| V_{DS} | drain-source voltage (DC) | $T_j = 25$ to 175 °C | – | 100 | V |
| I_D | drain current (DC) | $T_{mb} = 25$ °C; $V_{GS} = 10$ V | – | 47 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25$ °C | – | 166 | W |
| T_j | junction temperature | | – | 175 | °C |
| $R_{DS(on)}$ | drain-source on-state resistance | $T_j = 25$ °C; $V_{GS} = 10$ V; $I_D = 25$ A | 20 | 28 | mΩ |

6. Limiting values

Table 3: Limiting values

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

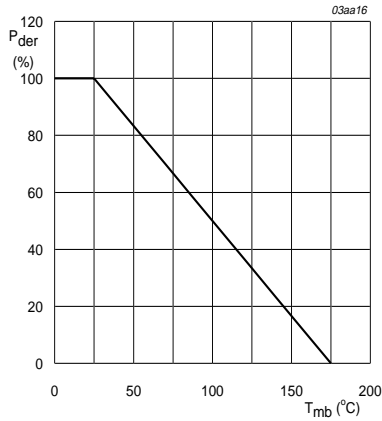
| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------|--------------------------------|---|-----|-----|------|
| V_{DS} | drain-source voltage (DC) | $T_j = 25$ to 175 °C | – | 100 | V |
| V_{DGR} | drain-gate voltage (DC) | $T_j = 25$ to 175 °C; $R_{GS} = 20$ kΩ | – | 100 | V |
| V_{GS} | gate-source voltage (DC) | | – | ±20 | V |
| I_D | drain current (DC) | $T_{mb} = 25$ °C; $V_{GS} = 10$ V Figure 2 and 3 | – | 47 | A |
| | | $T_{mb} = 100$ °C; $V_{GS} = 10$ V Figure 2 | – | 33 | A |
| I_{DM} | peak drain current | $T_{mb} = 25$ °C; pulsed; $t_p \leq 10$ μs; Figure 3 | – | 187 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25$ °C; Figure 1 | – | 166 | W |
| T_{stg} | storage temperature | | –55 | 175 | °C |
| T_j | operating junction temperature | | –55 | 175 | °C |

Source-drain diode

| | | | | | |
|----------|-------------------------------------|--|---|-----|---|
| I_S | source (diode forward) current (DC) | $T_{mb} = 25$ °C | – | 47 | A |
| I_{SM} | peak source (diode forward) current | $T_{mb} = 25$ °C; pulsed; $t_p \leq 10$ μs | – | 187 | A |

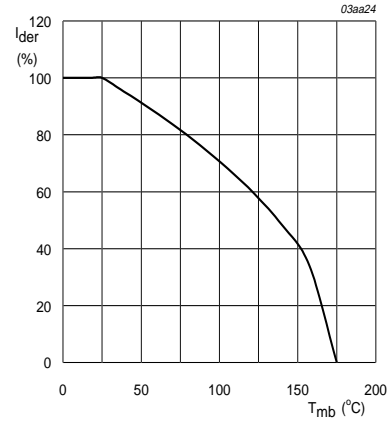
Avalanche ruggedness

| | | | | | |
|----------|---------------------------------|---|---|----|----|
| E_{AS} | non-repetitive avalanche energy | unclamped inductive load; $I_{AS} = 30$ A; $t_p = 0.1$ ms; $V_{DD} \leq 25$ V; $R_{GS} = 50$ Ω; $V_{GS} = 5$ V; starting $T_j = 25$ °C; Figure 4 | – | 45 | mJ |
|----------|---------------------------------|---|---|----|----|



$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

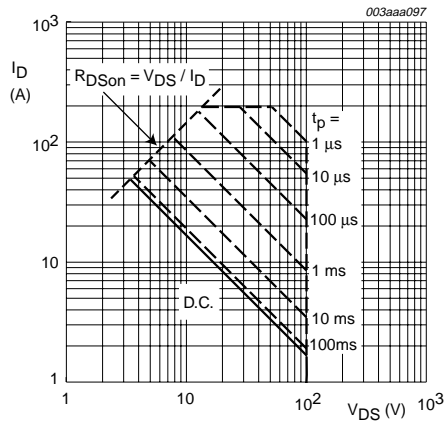
Fig 1. Normalized total power dissipation as a function of mounting base temperature.



$$V_{GS} \geq 10 \text{ V}$$

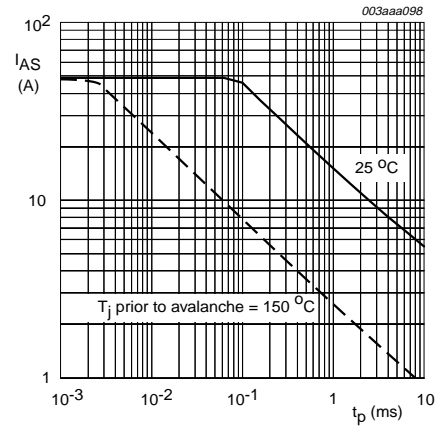
$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

Fig 2. Normalized continuous drain current as a function of mounting base temperature.



$T_{mb} = 25^{\circ}C$; I_{DM} is single pulse.

Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.



Unclamped inductive load; $V_{DD} \leq 25 \text{ V}$; $R_{GS} = 50 \Omega$; $V_{GS} = 5 \text{ V}$; starting $T_j = 25^{\circ}C$ and $150^{\circ}C$.

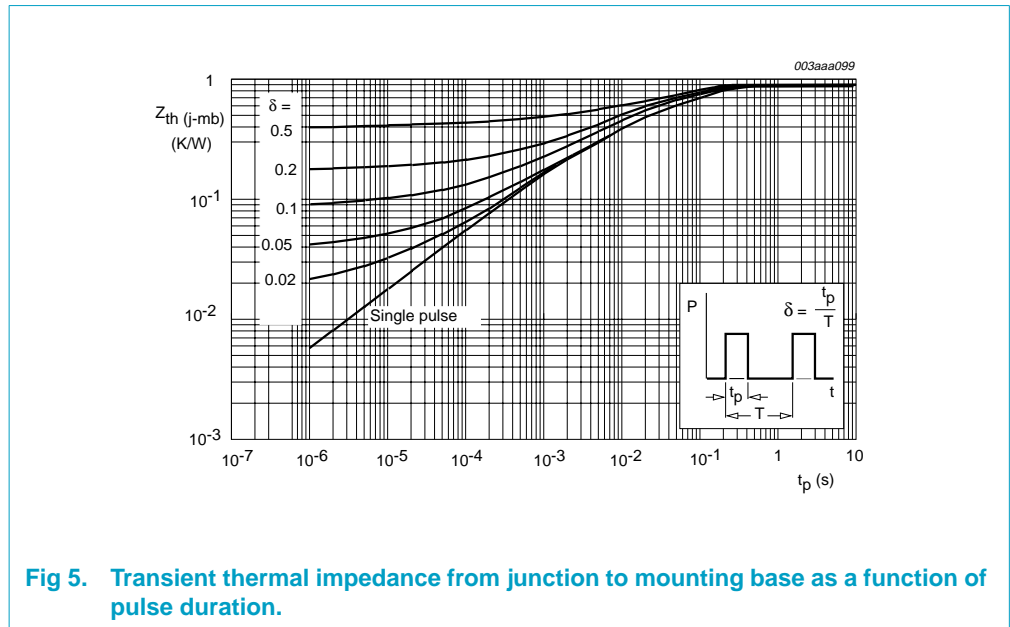
Fig 4. Non-repetitive avalanche ruggedness current as a function of pulse duration.

7. Thermal characteristics

Table 4: Thermal characteristics

| Symbol | Parameter | Conditions | Value | Unit |
|----------------|---|--|-------|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Figure 5 | 0.9 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | SOT78 package; vertical in still air. | 60 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | SOT404 package; mounted on printed circuit board; minimum footprint. | 50 | K/W |

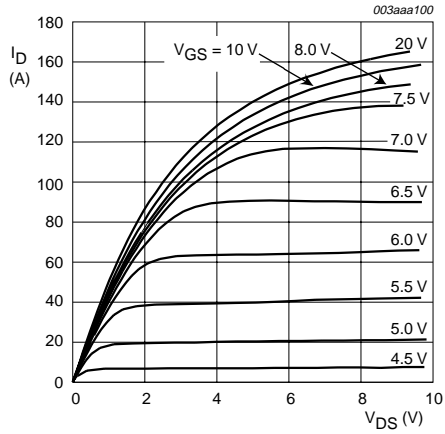
7.1 Transient thermal impedance



8. Characteristics

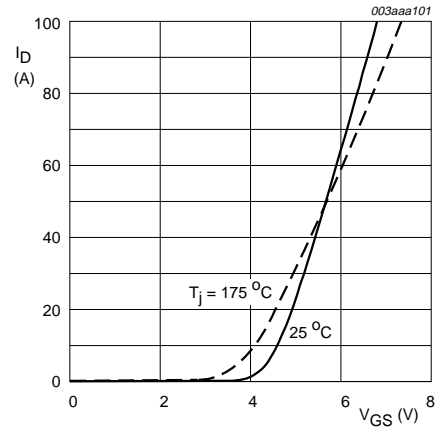
Table 5: Characteristics
 $T_j = 25\text{ °C}$ unless otherwise specified

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|--------------------------------------|---|-----|------|------|---------------|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$ | 100 | – | – | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 1\ \text{mA}$; $V_{DS} = V_{GS}$; Figure 10 | | | | |
| | | $T_j = 25\text{ °C}$ | 2 | 3 | 4 | V |
| | | $T_j = 175\text{ °C}$ | 1 | – | – | V |
| I_{DSS} | drain-source leakage current | $V_{GS} = 0\ \text{V}$; $V_{DS} = 100\ \text{V}$ | | | | |
| | | $T_j = 25\text{ °C}$ | – | 0.05 | 10 | μA |
| | | $T_j = 175\text{ °C}$ | – | – | 500 | μA |
| I_{GSS} | gate-source leakage current | $V_{DS} = 0\ \text{V}$; $V_{GS} = \pm 20\ \text{V}$ | – | 2 | 100 | nA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 10\ \text{V}$; $I_D = 25\ \text{A}$; Figure 8 and 9 | | | | |
| | | $T_j = 25\text{ °C}$ | – | 20 | 28 | m Ω |
| | | $T_j = 175\text{ °C}$ | – | – | 76 | m Ω |
| Dynamic characteristics | | | | | | |
| $Q_{g(tot)}$ | total gate charge | $I_D = 40\ \text{A}$; $V_{DD} = 80\ \text{V}$; | – | 66 | – | nC |
| Q_{gs} | gate-source charge | $V_{GS} = 10\ \text{V}$; Figure 15 | – | 12 | – | nC |
| Q_{gd} | gate-drain (Miller) charge | | – | 21 | – | nC |
| C_{iss} | input capacitance | $V_{GS} = 0\ \text{V}$; $V_{DS} = 25\ \text{V}$; | – | 2320 | 3100 | pF |
| C_{oss} | output capacitance | $f = 1\ \text{MHz}$; Figure 13 | – | 315 | 378 | pF |
| C_{rss} | reverse transfer capacitance | | – | 187 | 256 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DD} = 30\ \text{V}$; $R_D = 1.2\ \Omega$; | – | 15 | 23 | ns |
| t_r | rise time | $V_{GS} = 10\ \text{V}$; $R_G = 10\ \Omega$ | – | 70 | 105 | ns |
| $t_{d(off)}$ | turn-off delay time | | – | 83 | 116 | ns |
| t_f | fall time | | – | 45 | 63 | ns |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain (diode forward) voltage | $I_S = 25\ \text{A}$; $V_{GS} = 0\ \text{V}$; Figure 14 | – | 0.85 | 1.2 | V |
| t_{rr} | reverse recovery time | $I_S = 47\ \text{A}$; | – | 66 | – | ns |
| Q_r | recovered charge | $dI_S/dt = -100\ \text{A}/\mu\text{s}$; $V_{GS} = -10\ \text{V}$; $V_R = 30\ \text{V}$ | – | 0.24 | – | μC |



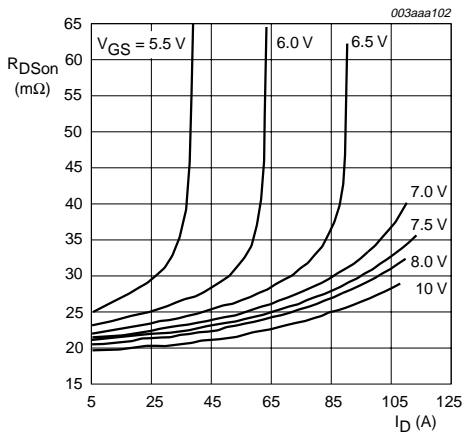
$T_j = 25\text{ }^\circ\text{C}$

Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values.



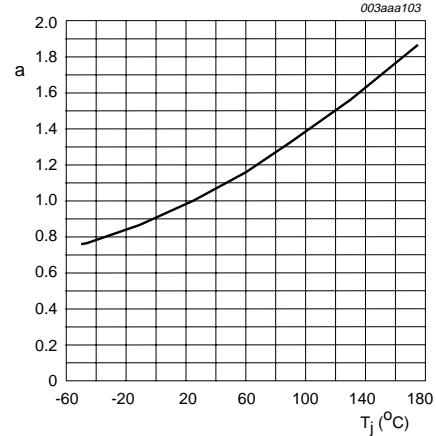
$T_j = 25\text{ }^\circ\text{C}$ and 175 °C; $V_{DS} > I_D \times R_{DSon}$

Fig 7. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



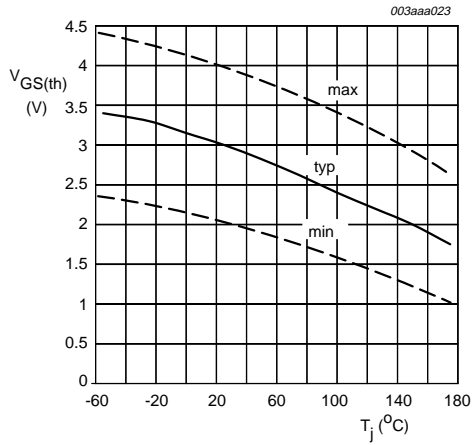
$T_j = 25\text{ }^\circ\text{C}$

Fig 8. Drain-source on-state resistance as a function of drain current; typical values.



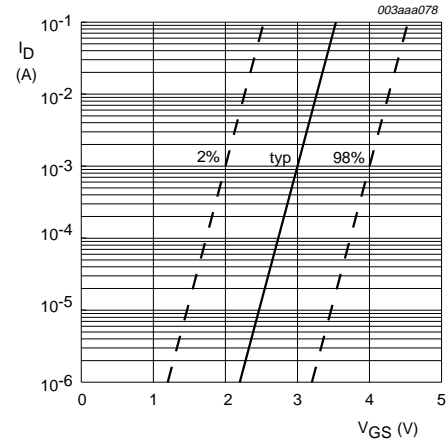
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

Fig 9. Normalized drain-source on-state resistance factor as a function of junction temperature.



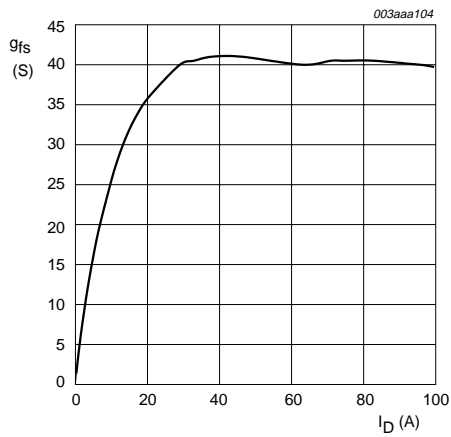
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

Fig 10. Gate-source threshold voltage as a function of junction temperature.



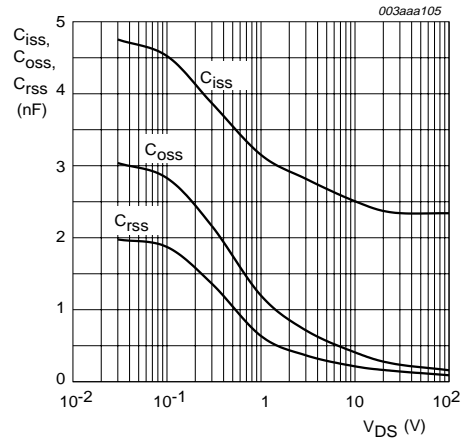
$T_j = 25 \text{ }^{\circ}C$

Fig 11. Sub-threshold drain current as a function of gate-source voltage.



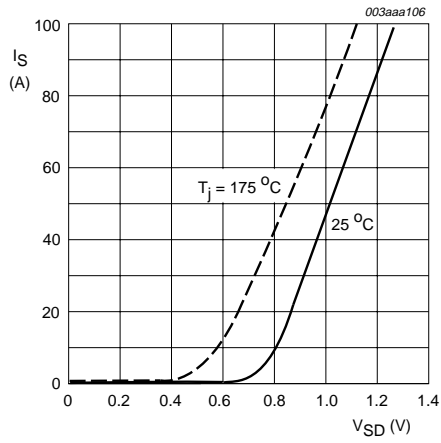
$T_j = 25 \text{ }^{\circ}C; V_{DS} = 25 \text{ V}$

Fig 12. Forward transconductance as a function of drain current; typical values.



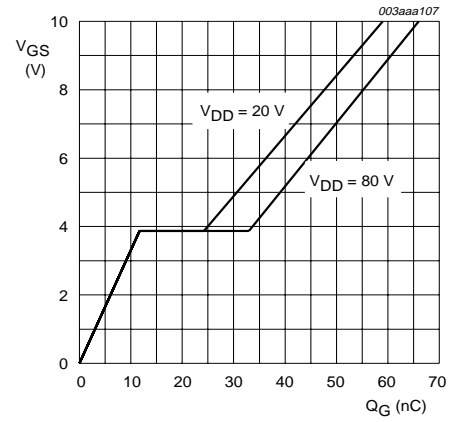
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



$T_j = 25^\circ\text{C}$ and 175°C ; $V_{GS} = 0\text{ V}$

Fig 14. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.



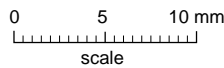
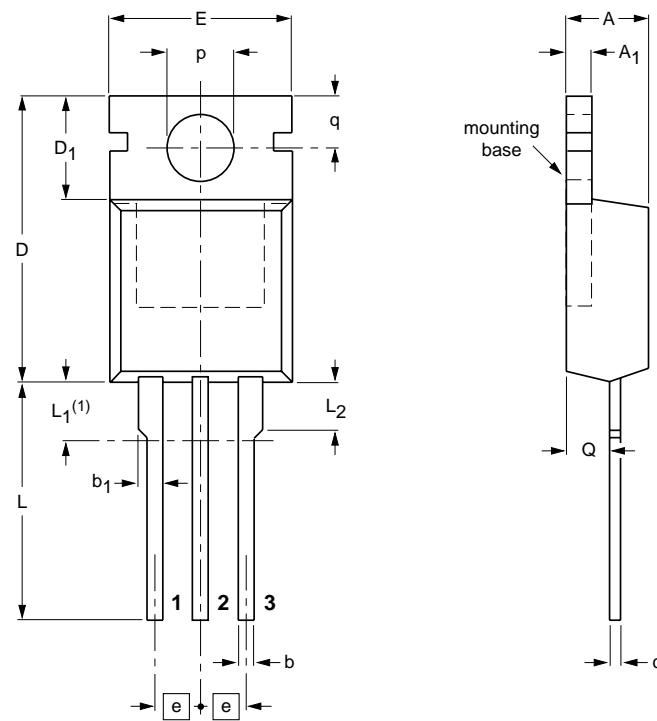
$I_D = 40\text{ A}$; $V_{DD} = 20\text{ V}$ and 80 V

Fig 15. Gate-source voltage as a function of gate charge; typical values.

9. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78



DIMENSIONS (mm are the original dimensions)

| UNIT | A | A ₁ | b | b ₁ | c | D | D ₁ | E | e | L | L ₁ ⁽¹⁾ | L ₂ max. | p | q | Q |
|------|-----|----------------|-----|----------------|-----|------|----------------|------|------|------|-------------------------------|------------------------|-----|-----|-----|
| mm | 4.5 | 1.39 | 0.9 | 1.3 | 0.7 | 15.8 | 6.4 | 10.3 | 2.54 | 15.0 | 3.30 | 3.0 | 3.8 | 3.0 | 2.6 |
| | 4.1 | 1.27 | 0.7 | 1.0 | 0.4 | 15.2 | 5.9 | 9.7 | | 13.5 | 2.79 | | 3.6 | 2.7 | 2.2 |

Note

1. Terminals in this zone are not tinned.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|--------------------|------------|-----------------|-------|--|------------------------|-------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT78 | | 3-lead TO-220AB | SC-46 | | | 00-09-07-01-02-16 |

Fig 16. SOT78 (TO-220AB)

Plastic single-ended surface mounted package (Philips version of D²-PAK); 3 leads
(one lead cropped)

SOT404

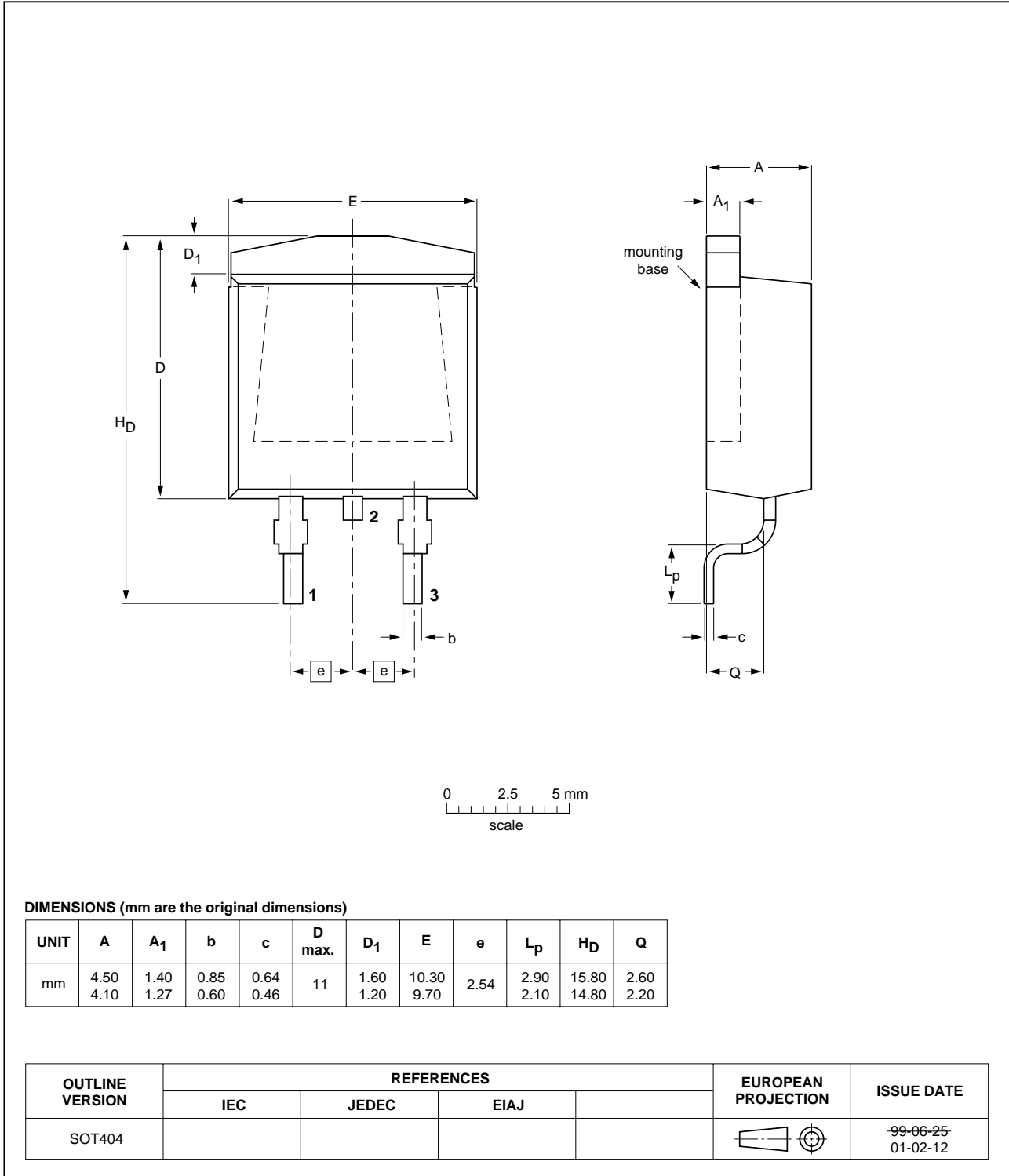


Fig 17. SOT404 (D²-PAK).

10. Revision history

Table 6: Revision history

| Rev | Date | PCPN | Description |
|-----|----------|------|--------------------------------|
| 01 | 20010516 | - | Product data. Initial version. |

11. Data sheet status

| Data sheet status ^[1] | Product status ^[2] | Definition |
|----------------------------------|-------------------------------|--|
| Objective data | Development | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice. |
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[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

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Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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(SCA72)

Contents

| | | |
|-----|---------------------------------------|----|
| 1 | Description | 1 |
| 2 | Features | 1 |
| 3 | Applications | 1 |
| 4 | Pinning information | 1 |
| 5 | Quick reference data | 2 |
| 6 | Limiting values | 2 |
| 7 | Thermal characteristics | 4 |
| 7.1 | Transient thermal impedance | 4 |
| 8 | Characteristics | 5 |
| 9 | Package outline | 9 |
| 10 | Revision history | 11 |
| 11 | Data sheet status | 12 |
| 12 | Definitions | 12 |
| 13 | Disclaimers | 12 |



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