

PHB/PHD38N02LT

TrenchMOS™ logic level FET

Rev. 01 — 30 June 2003

Product data

1. Product profile

1.1 Description

N-channel logic level field-effect transistor in a plastic package using TrenchMOS™ technology.

Product availability:

PHB38N02LT in SOT404 (D²-PAK)

PHD38N02LT in SOT428 (D-PAK).

1.2 Features

- Low on-state resistance
- 2.5 V gate drive.

1.3 Applications

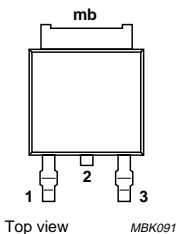
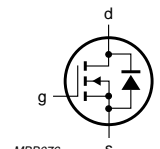
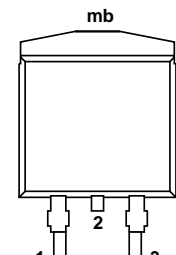
- Linear regulator for DDR memory.

1.4 Quick reference data

- $V_{DS} = 20\text{ V}$
- $I_D = 44.7\text{ A}$
- $P_{tot} = 57.6\text{ W}$
- $R_{DSon} \leq 16\text{ m}\Omega$

2. Pinning information

Table 1: Pinning - SOT404 and SOT428 simplified outlines and symbol

| Pin | Description | Simplified outline | Symbol |
|-----|--|--|---|
| 1 | gate (g) |  Top view MBK091 |  MBB076 |
| 2 | drain (d) [1] | | |
| 3 | source (s) | | |
| mb | mounting base; connected to drain (d) |  MBK116 | |
| | | SOT428 (D-PAK) | SOT404 (D²-PAK) |

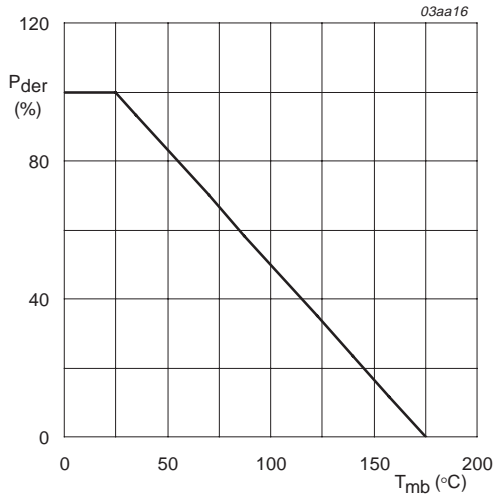
[1] It is not possible to make connection to pin 2 of the SOT404 and SOT428 packages.

3. Limiting values

Table 2: Limiting values

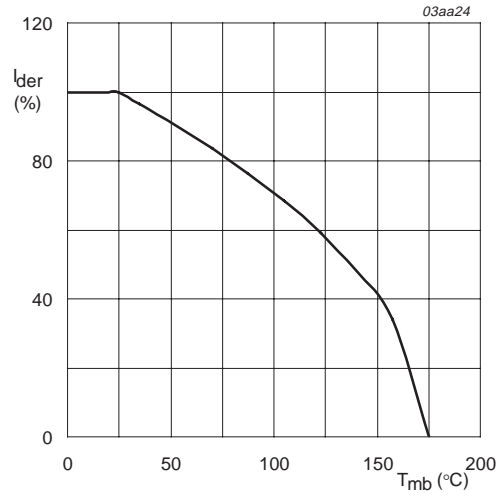
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---------------------------|-------------------------------------|--|-----|------|------|
| V_{DS} | drain-source voltage (DC) | $25\text{ °C} \leq T_j \leq 175\text{ °C}$ | - | 20 | V |
| V_{DGR} | drain-gate voltage (DC) | $25\text{ °C} \leq T_j \leq 175\text{ °C}$; $R_{GS} = 20\text{ k}\Omega$ | - | 20 | V |
| V_{GS} | gate-source voltage (DC) | | - | 12 | V |
| I_D | drain current (DC) | $T_{mb} = 25\text{ °C}$; $V_{GS} = 5\text{ V}$; Figure 2 and 3 | - | 44.7 | A |
| | | $T_{mb} = 100\text{ °C}$; $V_{GS} = 5\text{ V}$; Figure 2 | - | 31.6 | A |
| I_{DM} | peak drain current | $T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$; Figure 3 | - | 179 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C}$; Figure 1 | - | 57.6 | W |
| T_{stg} | storage temperature | | -55 | +175 | °C |
| T_j | junction temperature | | -55 | +175 | °C |
| Source-drain diode | | | | | |
| I_S | source (diode forward) current (DC) | $T_{mb} = 25\text{ °C}$ | - | 44.7 | A |
| I_{SM} | peak source (diode forward) current | $T_{mb} = 25\text{ °C}$; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ | - | 179 | A |



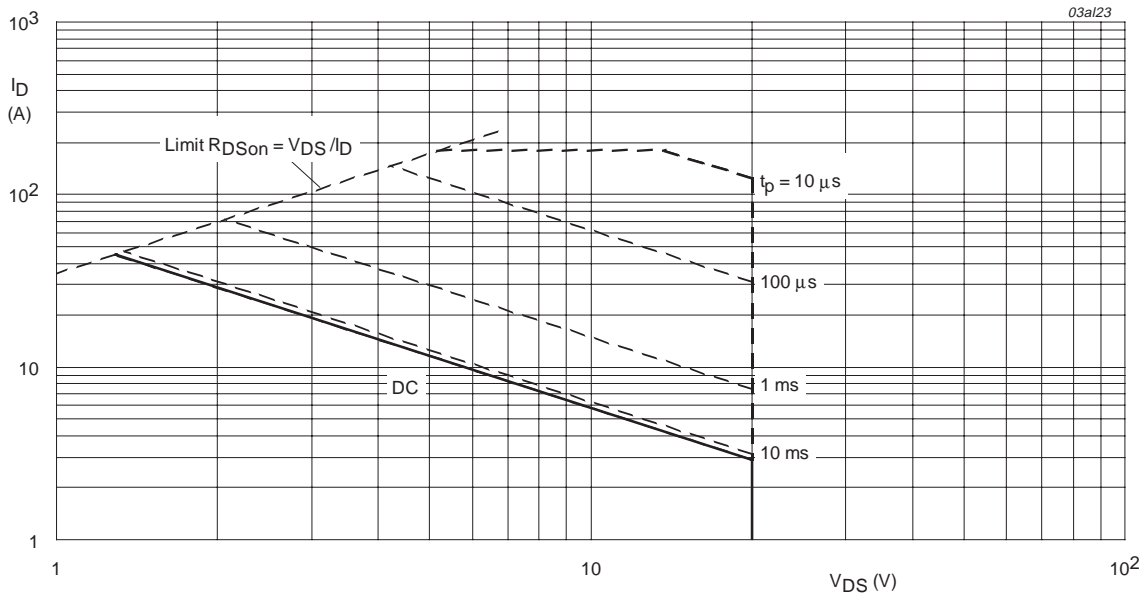
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



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

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



T_{mb} = 25 °C; I_{DM} is single pulse; V_{GS} = 5 V.

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

4. Thermal characteristics

Table 3: Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|--|-----|-----|-----|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Figure 4 | - | - | 2.6 | K/W |
| $R_{th(j-a)}$ | SOT428 | SOT428 minimum footprint; mounted on a PCB | - | 75 | - | K/W |
| | | SOT404 minimum footprint; mounted on a PCB | - | 50 | - | K/W |
| | SOT404 | SOT404 minimum footprint; mounted on a PCB | - | 50 | - | K/W |

4.1 Transient thermal impedance

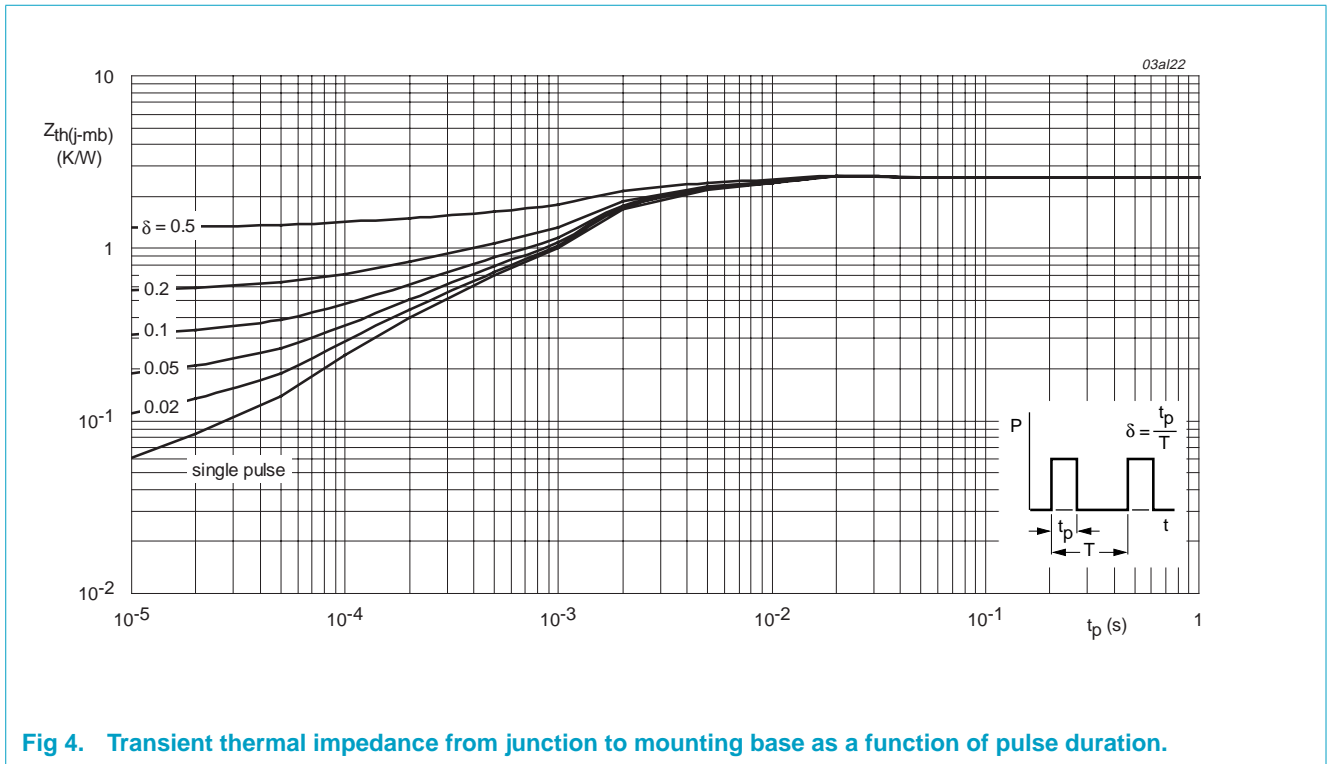


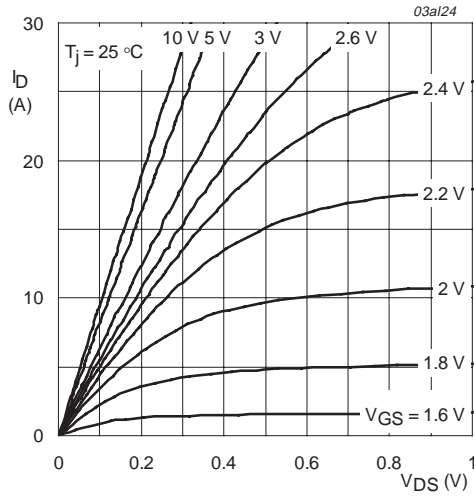
Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration.

5. Characteristics

Table 4: Characteristics

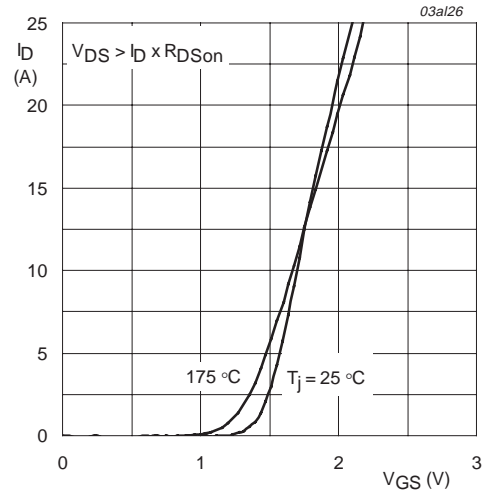
$T_j = 25\text{ °C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------|--------------------------------------|--|-----------------|--------------------|------------------|--|
| Static characteristics | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D = 250\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$ $T_j = 25\text{ °C}$ $T_j = -55\text{ °C}$ | 20 18 | - - | - - | V V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D = 250\ \mu\text{A}$; $V_{DS} = V_{GS}$; Figure 9 $T_j = 25\text{ °C}$ $T_j = 175\text{ °C}$ $T_j = -55\text{ °C}$ | 0.5 0.3 - | 1 - - | 1.5 - 1.8 | V V V |
| I_{DSS} | drain-source leakage current | $V_{DS} = 20\ \text{V}$; $V_{GS} = 0\ \text{V}$ $T_j = 25\text{ °C}$ $T_j = 175\text{ °C}$ | - - - | 0.05 - - | 1 500 | μA μA |
| I_{GSS} | gate-source leakage current | $V_{GS} = \pm 12\ \text{V}$; $V_{DS} = 0\ \text{V}$ | - | 10 | 100 | nA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS} = 5\ \text{V}$; $I_D = 25\ \text{A}$; Figure 7 and 8 $T_j = 25\text{ °C}$ $T_j = 175\text{ °C}$ $V_{GS} = 2.5\ \text{V}$; $I_D = 8\ \text{A}$; Figure 8 | - - - | 13.5 24.3 20 | 16 28.8 30 | m Ω m Ω m Ω |
| Dynamic characteristics | | | | | | |
| $Q_{g(tot)}$ | total gate charge | $I_D = 25\ \text{A}$; $V_{DD} = 10\ \text{V}$; $V_{GS} = 5\ \text{V}$; Figure 13 | - | 15.1 | - | nC |
| Q_{gs} | gate-source charge | | - | 4.5 | - | nC |
| Q_{gd} | gate-drain (Miller) charge | | - | 4.2 | - | nC |
| C_{iss} | input capacitance | $V_{GS} = 0\ \text{V}$; $V_{DS} = 20\ \text{V}$; $f = 1\ \text{MHz}$; Figure 11 | - | 800 | - | pF |
| C_{oss} | output capacitance | | - | 260 | - | pF |
| C_{rss} | reverse transfer capacitance | | - | 190 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DD} = 10\ \text{V}$; $I_D = 25\ \text{A}$; $V_{GS} = 10\ \text{V}$; $R_G = 5.6\ \Omega$ | - | 4 | - | ns |
| t_r | rise time | | - | 12.5 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 30 | - | ns |
| t_f | fall time | | - | 23 | - | ns |
| Source-drain diode | | | | | | |
| V_{SD} | source-drain (diode forward) voltage | $I_S = 25\ \text{A}$; $V_{GS} = 0\ \text{V}$; Figure 12 | - | 0.98 | 1.2 | V |



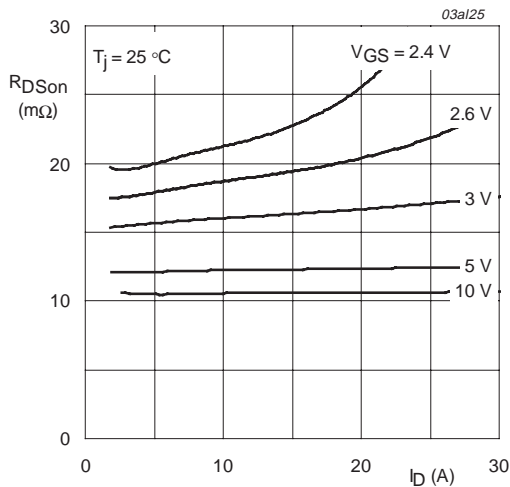
$T_j = 25\text{ }^\circ\text{C}$

Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values.



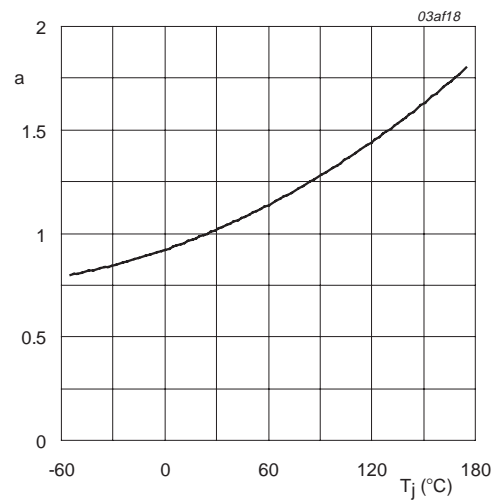
$T_j = 25\text{ }^\circ\text{C}$ and $175\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DSon}$

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



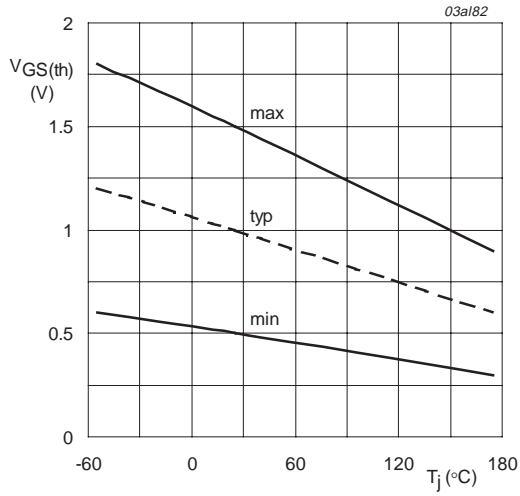
$T_j = 25\text{ }^\circ\text{C}$

Fig 7. Drain-source on-state resistance as a function of drain current; typical values.



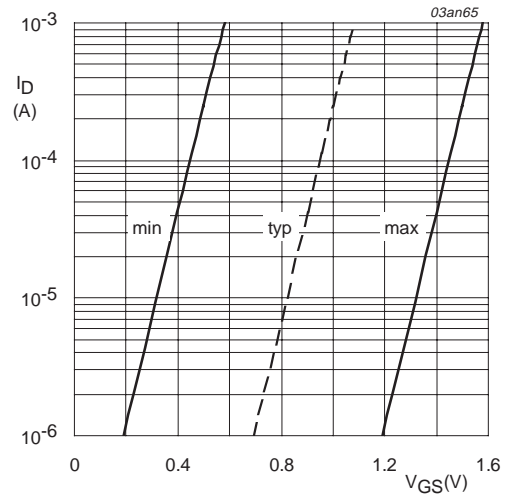
$$a = \frac{R_{DSon}}{R_{DSon}(25^\circ\text{C})}$$

Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature.



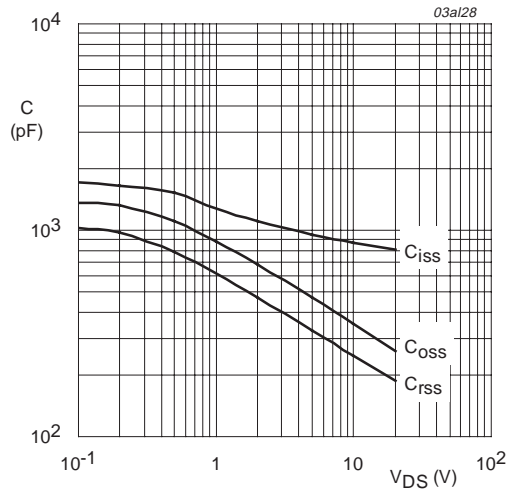
$I_D = 0.25 \text{ mA}; V_{DS} = V_{GS}$

Fig 9. Gate-source threshold voltage as a function of junction temperature.



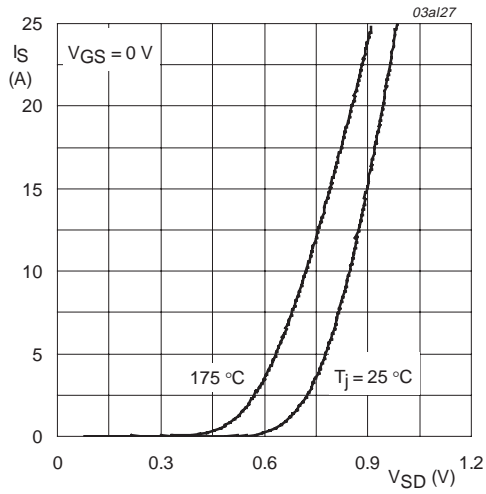
$T_j = 25 \text{ °C}; V_{DS} = 5 \text{ V}$

Fig 10. Sub-threshold drain current as a function of gate-source voltage.



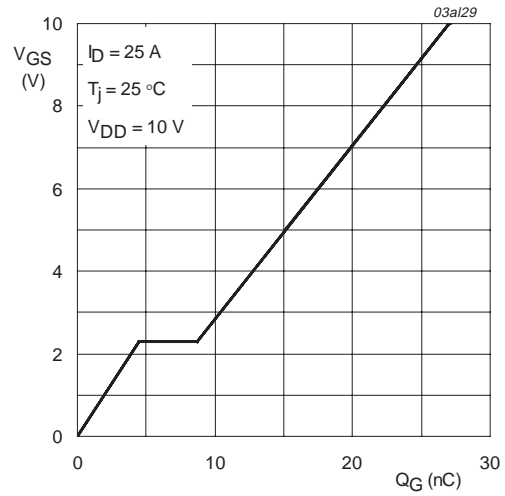
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig 11. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



$T_j = 25$ °C and 175 °C; $V_{GS} = 0$ V

Fig 12. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.



$I_D = 25$ A; $V_{DD} = 10$ V

Fig 13. Gate-source voltage as a function of gate charge; typical values.

6. Package outline

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

SOT404

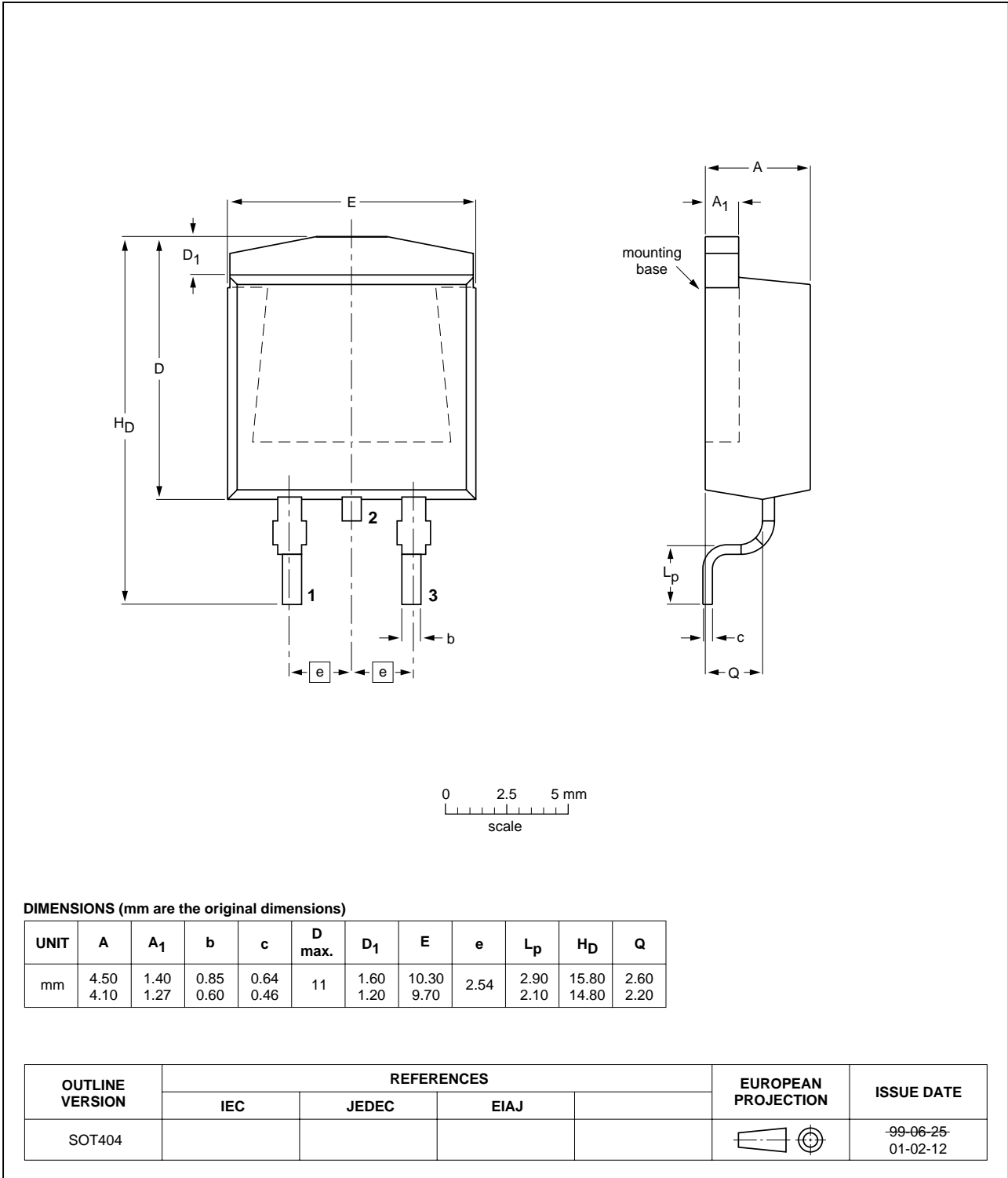


Fig 14. SOT404 (D²-PAK).

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

SOT428

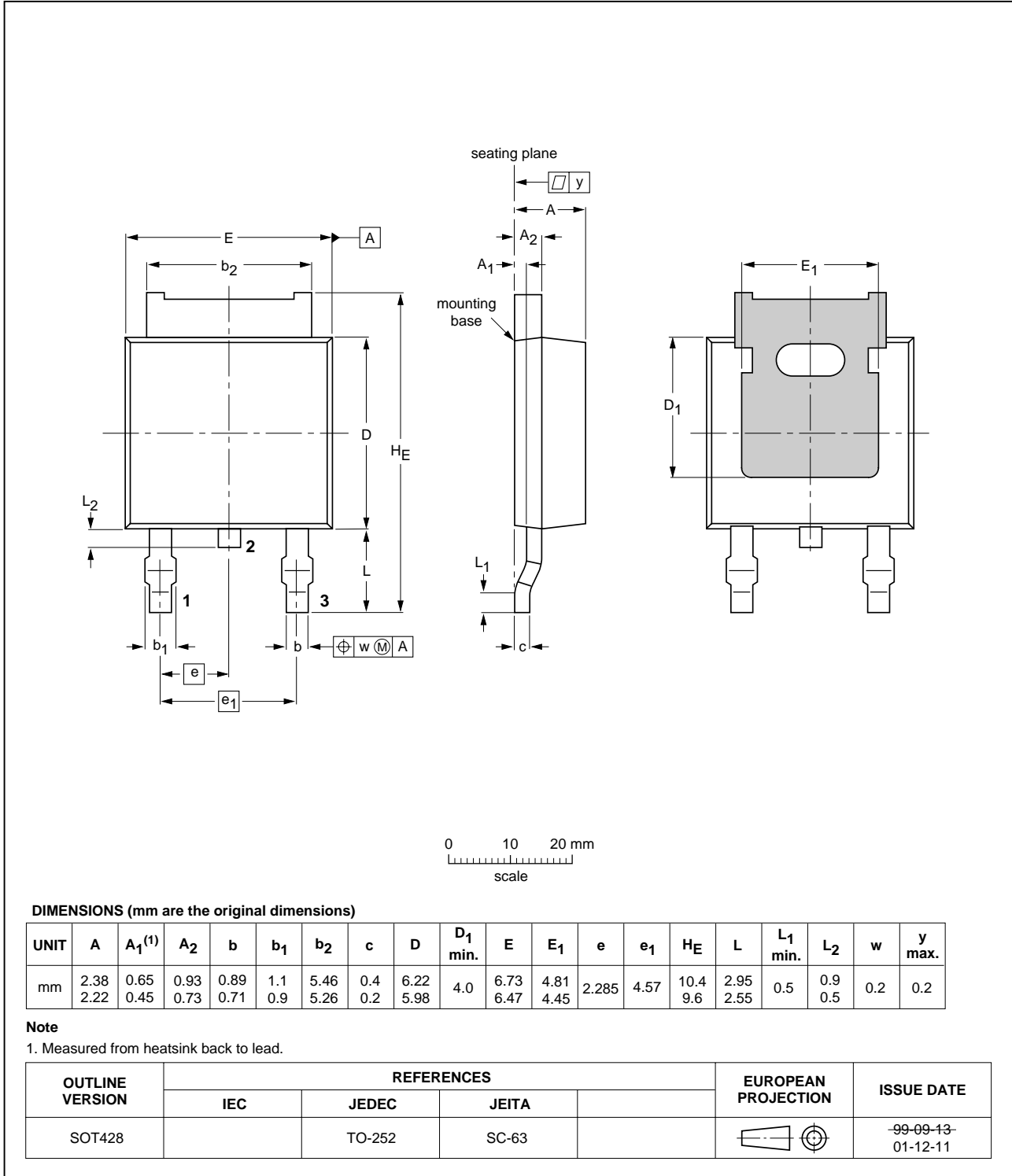


Fig 15. SOT428 (D-PAK).

7. Revision history

Table 5: Revision history

| Rev | Date | CPCN | Description |
|-----|----------|------|-------------------------------|
| 01 | 20030630 | - | Product data (9397 750 11614) |

8. Data sheet status

| Level | Data sheet status ^[1] | Product status ^{[2][3]} | Definition |
|-------|----------------------------------|----------------------------------|--|
| I | 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. |
| II | Preliminary data | Qualification | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product. |
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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>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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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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Contact information

For additional information, please visit <http://www.semiconductors.philips.com>.

For sales office addresses, send e-mail to: sales.addresses@www.semiconductors.philips.com.

Fax: +31 40 27 24825

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