



# PHP45NQ10T

N-channel TrenchMOS standard level FET

Rev. 02 — 8 July 2010

Product data sheet

## 1. Product profile

### 1.1 General description

Standard level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product is designed and qualified for use in computing, communications, consumer and industrial applications only.

### 1.2 Features and benefits

- Higher operating power due to low thermal resistance
- Low conduction losses due to low on-state resistance
- Suitable for high frequency applications due to fast switching characteristics

### 1.3 Applications

- DC-to-DC convertors
- Switched-mode power supplies

### 1.4 Quick reference data

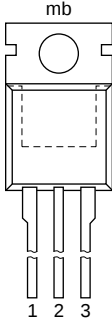
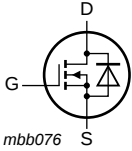
Table 1. Quick reference data

| Symbol                         | Parameter                        | Conditions                                                                                                 | Min | Typ | Max | Unit       |
|--------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------|-----|-----|-----|------------|
| $V_{DS}$                       | drain-source voltage             | $T_j \geq 25\text{ }^{\circ}\text{C}$ ; $T_j \leq 175\text{ }^{\circ}\text{C}$                             | -   | -   | 100 | V          |
| $I_D$                          | drain current                    | $T_{mb} = 25\text{ }^{\circ}\text{C}$ ; $V_{GS} = 10\text{ V}$                                             | -   | -   | 47  | A          |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ }^{\circ}\text{C}$                                                                      | -   | -   | 150 | W          |
| <b>Static characteristics</b>  |                                  |                                                                                                            |     |     |     |            |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 10\text{ V}$ ; $I_D = 25\text{ A}$ ; $T_j = 25\text{ }^{\circ}\text{C}$                          | -   | 22  | 25  | m $\Omega$ |
| <b>Dynamic characteristics</b> |                                  |                                                                                                            |     |     |     |            |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 10\text{ V}$ ; $I_D = 45\text{ A}$ ; $V_{DS} = 80\text{ V}$ ; $T_j = 25\text{ }^{\circ}\text{C}$ | -   | 25  | -   | nC         |

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2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline                                                                | Graphic symbol                                                                      |
|-----|--------|-----------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | G      | gate                              |  |  |
| 2   | D      | drain                             |                                                                                   |                                                                                     |
| 3   | S      | source                            |                                                                                   |                                                                                     |
| mb  | D      | mounting base; connected to drain |                                                                                   |                                                                                     |
|     |        |                                   | SOT78 (TO-220AB)                                                                  |                                                                                     |

3. Ordering information

Table 3. Ordering information

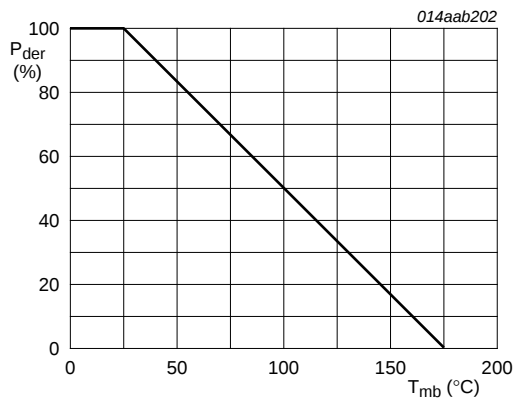
| Type number | Package  |                                                                                  |         |
|-------------|----------|----------------------------------------------------------------------------------|---------|
|             | Name     | Description                                                                      | Version |
| PHP45NQ10T  | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78   |

## 4. Limiting values

**Table 4. Limiting values**

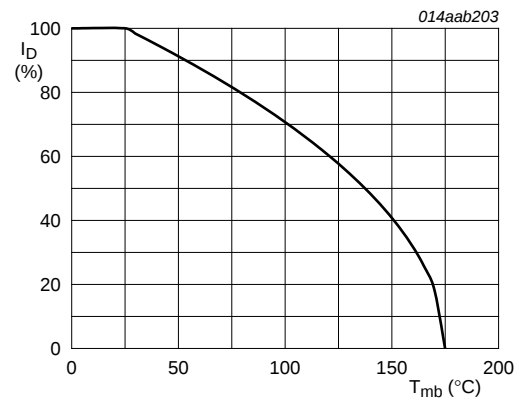
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol                      | Parameter                                    | Conditions                                                                                                                                                                                      | Min | Max | Unit |
|-----------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|
| $V_{DS}$                    | drain-source voltage                         | $T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$                                                                                                                                              | -   | 100 | V    |
| $V_{DGR}$                   | drain-gate voltage                           | $T_j \leq 175\text{ °C}$ ; $T_j \geq 25\text{ °C}$ ; $R_{GS} = 20\text{ k}\Omega$                                                                                                               | -   | 100 | V    |
| $V_{GS}$                    | gate-source voltage                          |                                                                                                                                                                                                 | -20 | 20  | V    |
| $I_D$                       | drain current                                | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 100\text{ °C}$                                                                                                                                               | -   | 33  | A    |
|                             |                                              | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$                                                                                                                                                | -   | 47  | A    |
| $I_{DM}$                    | peak drain current                           | pulsed; $T_{mb} = 25\text{ °C}$                                                                                                                                                                 | -   | 188 | A    |
| $P_{tot}$                   | total power dissipation                      | $T_{mb} = 25\text{ °C}$                                                                                                                                                                         | -   | 150 | W    |
| $T_{stg}$                   | storage temperature                          |                                                                                                                                                                                                 | -55 | 175 | °C   |
| $T_j$                       | junction temperature                         |                                                                                                                                                                                                 | -55 | 175 | °C   |
| <b>Source-drain diode</b>   |                                              |                                                                                                                                                                                                 |     |     |      |
| $I_S$                       | source current                               | $T_{mb} = 25\text{ °C}$                                                                                                                                                                         | -   | 47  | A    |
| $I_{SM}$                    | peak source current                          | pulsed; $T_{mb} = 25\text{ °C}$                                                                                                                                                                 | -   | 188 | A    |
| <b>Avalanche ruggedness</b> |                                              |                                                                                                                                                                                                 |     |     |      |
| $E_{DS(AL)S}$               | non-repetitive drain-source avalanche energy | $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; $I_D = 40\text{ A}$ ;<br>$V_{sup} \leq 25\text{ V}$ ; unclamped; $t_p = 100\text{ }\mu\text{s}$ ;<br>$R_{GS} = 50\text{ }\Omega$ | -   | 260 | mJ   |
| $I_{AS}$                    | non-repetitive avalanche current             | $V_{sup} \leq 25\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ;<br>$R_{GS} = 50\text{ }\Omega$ ; unclamped                                                          | -   | 47  | A    |



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

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



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

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

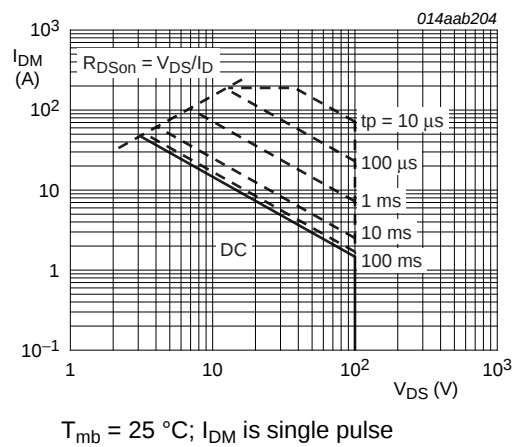


Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

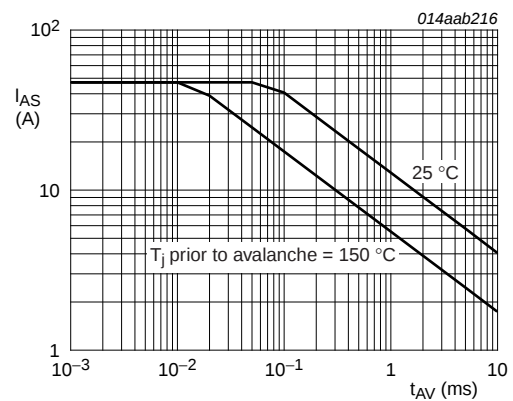


Fig 4. Single-shot avalanche rating; avalanche current as a function of avalanche period

5. Thermal characteristics

Table 5. Thermal characteristics

| Symbol         | Parameter                                         | Conditions  | Min | Typ | Max | Unit |
|----------------|---------------------------------------------------|-------------|-----|-----|-----|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base |             | -   | -   | 1   | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | in free air | -   | 60  | -   | K/W  |

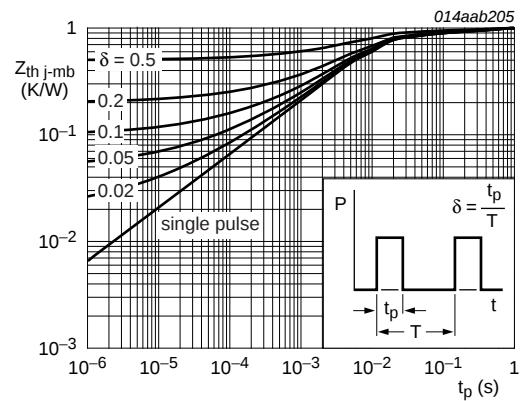
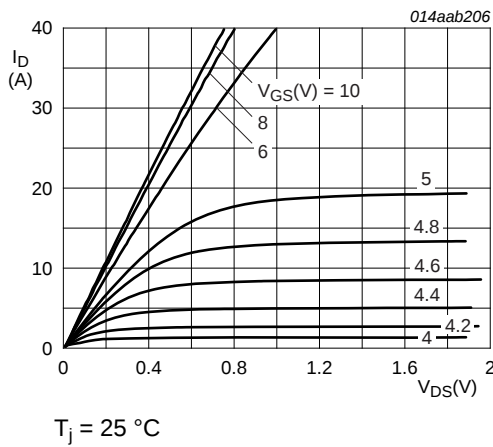


Fig 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

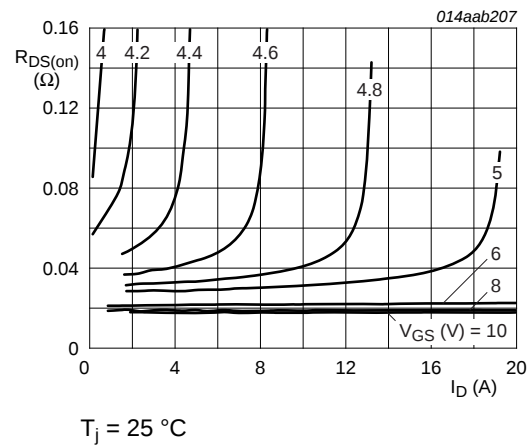
## 6. Characteristics

Table 6. Characteristics

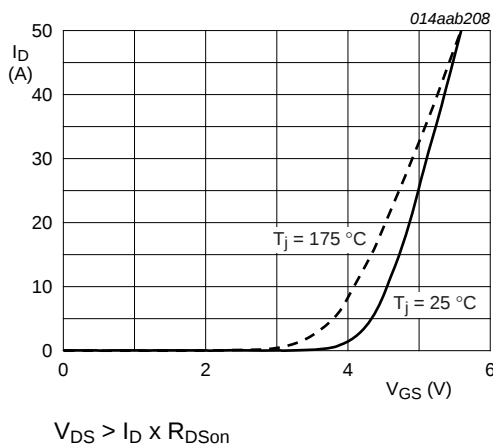
| Symbol                  | Parameter                        | Conditions                                                                                                                    | Min | Typ  | Max | Unit |
|-------------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| Static characteristics  |                                  |                                                                                                                               |     |      |     |      |
| V <sub>(BR)DSS</sub>    | drain-source breakdown voltage   | I <sub>D</sub> = 0.25 mA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = -55 °C                                                      | 89  | -    | -   | V    |
|                         |                                  | I <sub>D</sub> = 0.25 mA; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C                                                       | 100 | -    | -   | V    |
| V <sub>GS(th)</sub>     | gate-source threshold voltage    | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = -55 °C                                            | -   | -    | 6   | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = 175 °C                                            | 1   | -    | -   | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>J</sub> = 25 °C                                             | 2   | 3    | 4   | V    |
| I <sub>DSS</sub>        | drain leakage current            | V <sub>DS</sub> = 100 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 175 °C                                                       | -   | -    | 500 | µA   |
|                         |                                  | V <sub>DS</sub> = 100 V; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C                                                        | -   | 0.05 | 10  | µA   |
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C                                                         | -   | 0.02 | 100 | nA   |
|                         |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>J</sub> = 25 °C                                                        | -   | 0.02 | 100 | nA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 175 °C                                                        | -   | -    | 68  | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 25 A; T <sub>J</sub> = 25 °C                                                         | -   | 22   | 25  | mΩ   |
| Dynamic characteristics |                                  |                                                                                                                               |     |      |     |      |
| Q <sub>G(tot)</sub>     | total gate charge                | I <sub>D</sub> = 45 A; V <sub>DS</sub> = 80 V; V <sub>GS</sub> = 10 V; T <sub>J</sub> = 25 °C                                 | -   | 61   | -   | nC   |
| Q <sub>GS</sub>         | gate-source charge               |                                                                                                                               | -   | 13   | -   | nC   |
| Q <sub>GD</sub>         | gate-drain charge                |                                                                                                                               | -   | 25   | -   | nC   |
| C <sub>iss</sub>        | input capacitance                | V <sub>DS</sub> = 25 V; V <sub>GS</sub> = 0 V; f = 1 MHz; T <sub>J</sub> = 25 °C                                              | -   | 2600 | -   | pF   |
| C <sub>oss</sub>        | output capacitance               |                                                                                                                               | -   | 340  | -   | pF   |
| C <sub>rss</sub>        | reverse transfer capacitance     |                                                                                                                               | -   | 195  | -   | pF   |
| t <sub>d(on)</sub>      | turn-on delay time               | V <sub>DS</sub> = 50 V; R <sub>L</sub> = 1.8 Ω; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 5.6 Ω; T <sub>J</sub> = 25 °C   | -   | 18   | -   | ns   |
| t <sub>r</sub>          | rise time                        |                                                                                                                               | -   | 72   | -   | ns   |
| t <sub>d(off)</sub>     | turn-off delay time              |                                                                                                                               | -   | 69   | -   | ns   |
| t <sub>f</sub>          | fall time                        |                                                                                                                               | -   | 58   | -   | ns   |
| L <sub>D</sub>          | internal drain inductance        | from tab to centre of die ; T <sub>J</sub> = 25 °C                                                                            | -   | 3.5  | -   | nH   |
|                         |                                  | from drain lead to centre of die ; T <sub>J</sub> = 25 °C                                                                     | -   | 4.5  | -   | nH   |
| L <sub>S</sub>          | internal source inductance       | from source lead to source bond pad ; T <sub>J</sub> = 25 °C                                                                  | -   | 7.5  | -   | nH   |
| Source-drain diode      |                                  |                                                                                                                               |     |      |     |      |
| V <sub>SD</sub>         | source-drain voltage             | I <sub>S</sub> = 25 A; V <sub>GS</sub> = 0 V; T <sub>J</sub> = 25 °C                                                          | -   | 0.87 | 1.2 | V    |
| t <sub>rr</sub>         | reverse recovery time            | I <sub>S</sub> = 20 A; dI <sub>S</sub> /dt = -100 A/µs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V; T <sub>J</sub> = 25 °C | -   | 82   | -   | ns   |
| Q <sub>r</sub>          | recovered charge                 |                                                                                                                               | -   | 0.26 | -   | µC   |



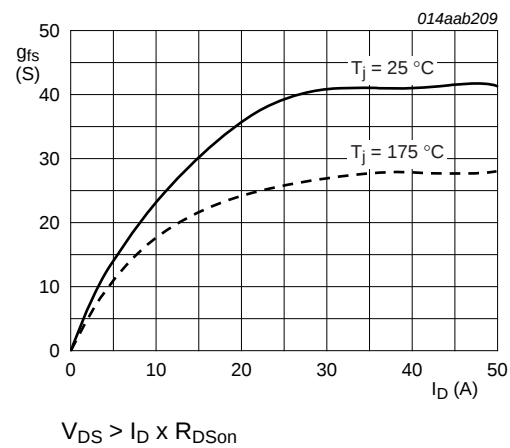
**Fig 6. Output characteristics: drain current as a function of drain-source voltage; typical values**



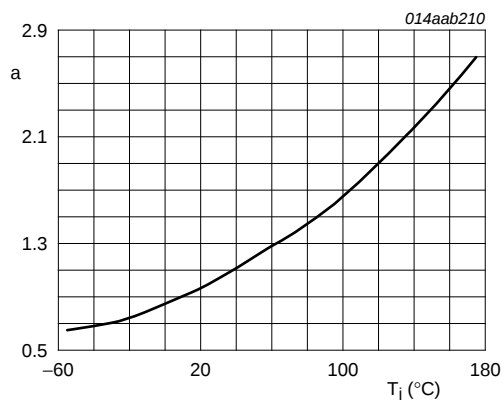
**Fig 7. Drain-source on-state resistance as a function of drain current; typical values**



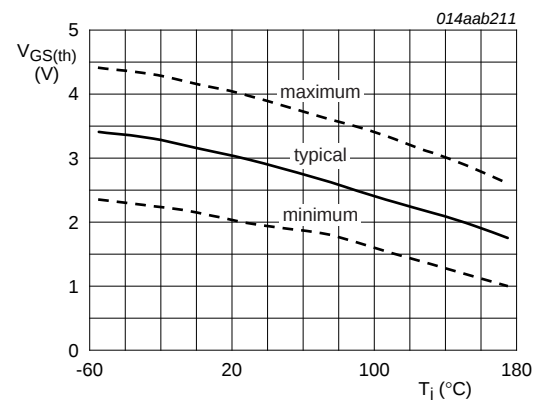
**Fig 8. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



**Fig 9. Forward transconductance as a function of drain current; typical values**



**Fig 10. Normalized drain-source on-state resistance factor as a function of junction temperature**



**Fig 11. Gate-source threshold voltage as a function of junction temperature**

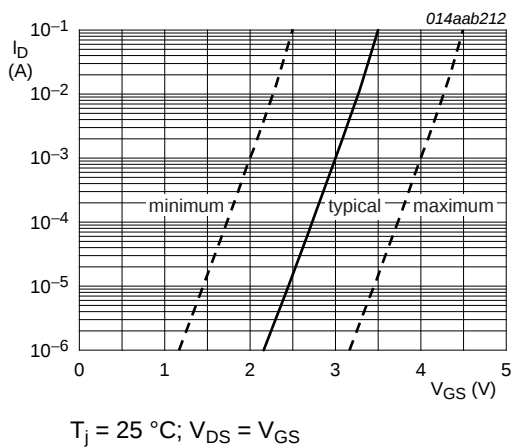


Fig 12. Sub-threshold drain current as a function of gate-source voltage

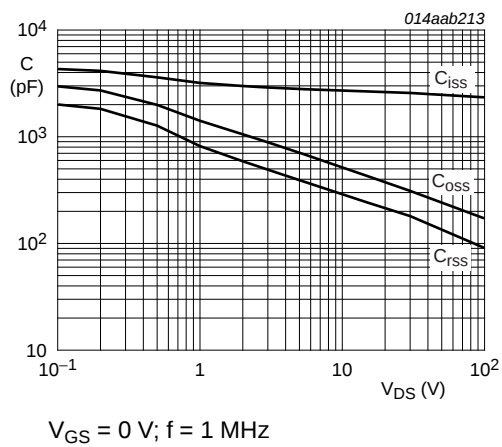


Fig 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

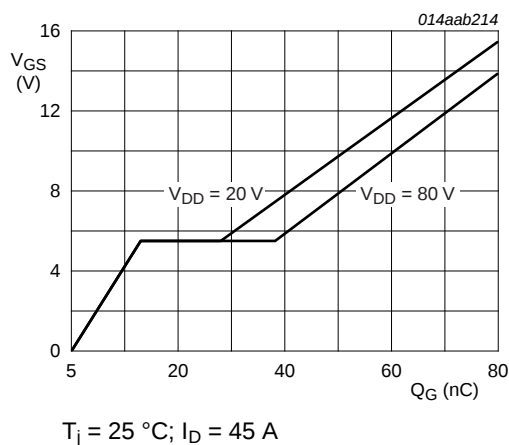


Fig 14. Gate-source voltage as a function of gate charge; typical values

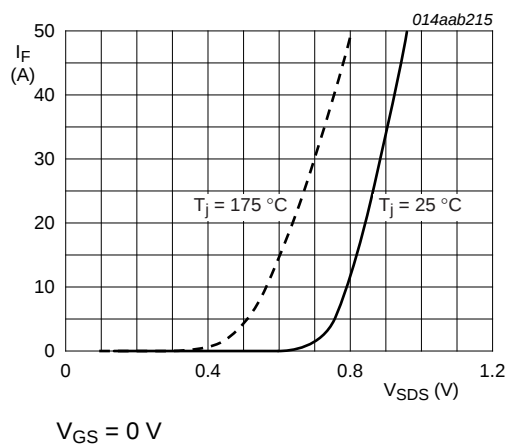


Fig 15. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

7. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB SOT78

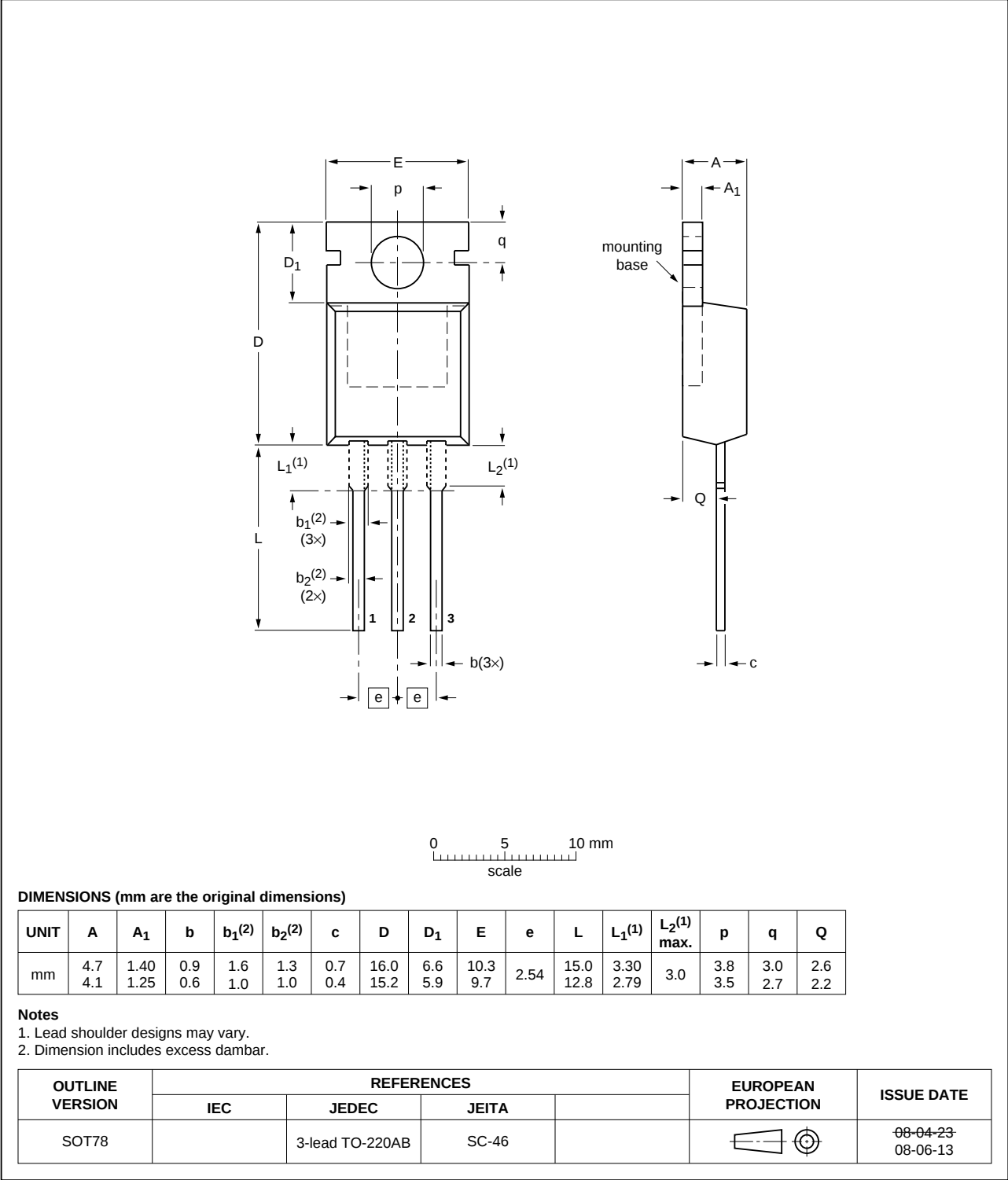


Fig 16. Package outline SOT78 (TO-220AB)

## 8. Revision history

Table 7. Revision history

| Document ID            | Release date                                                                                                                                                                                                                                                                                                                                | Data sheet status     | Change notice | Supersedes             |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|------------------------|
| PHP45NQ10T v.2         | 20100708                                                                                                                                                                                                                                                                                                                                    | Product data sheet    | -             | PHB_PHP_PHW45NQ10T v.1 |
| Modifications:         | <ul style="list-style-type: none"><li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li><li>• Legal texts have been adapted to the new company name where appropriate.</li><li>• Type number PHP45NQ10T separated from data sheet PHB_PHP_PHW45NQ10T v.1.</li></ul> |                       |               |                        |
| PHB_PHP_PHW45NQ10T v.1 | 19990801                                                                                                                                                                                                                                                                                                                                    | Product specification | -             | -                      |

## 9. Legal information

### 9.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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".

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11. Contents

1 Product profile .....1

1.1 General description .....1

1.2 Features and benefits .....1

1.3 Applications .....1

1.4 Quick reference data .....1

2 Pinning information .....2

3 Ordering information .....2

4 Limiting values .....3

5 Thermal characteristics .....4

6 Characteristics .....5

7 Package outline .....8

8 Revision history .....9

9 Legal information .....10

9.1 Data sheet status .....10

9.2 Definitions .....10

9.3 Disclaimers .....10

9.4 Trademarks .....11

10 Contact information .....11

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