# PHP54N06T

## N-channel TrenchMOS standard level FET

**Rev. 02 — 14 December 2009** **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

- Low conduction losses due to low on-state resistance
- Suitable for thermally demanding environments due to 175 °C rating

### 1.3 Applications

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

### 1.4 Quick reference data

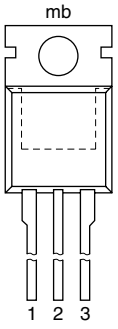
**Table 1. Quick reference**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | - | - | 55 | V |
| $I_D$ | drain current | $T_{mb}$ = 25 °C; $V_{GS}$ = 10 V; see Figure 1 and 3 | - | - | 54 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; see Figure 2 | - | - | 118 | W |
| **Dynamic characteristics** | | | | | | |
| $Q_{GD}$ | gate-drain charge | $V_{GS}$ = 10 V; $I_D$ = 40 A; $V_{DS}$ = 44 V; $T_j$ = 25 °C; see Figure 13 | - | 11.5 | - | nC |
| **Static characteristics** | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 175 °C; see Figure 11 and 12 | - | - | 40 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; see Figure 11 and 12 | - | 17 | 20 | mΩ |

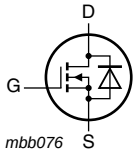
## 2. Pinning information

**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**

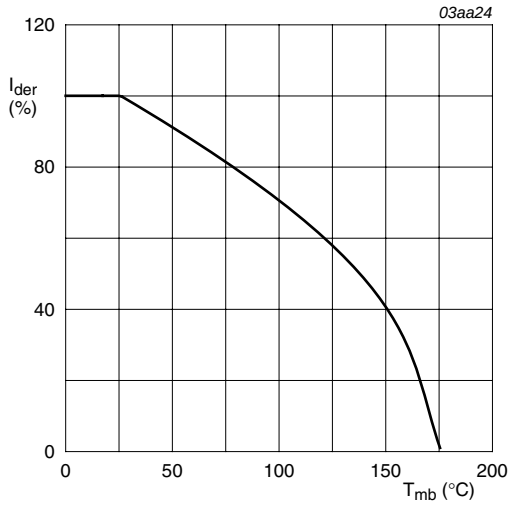
| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| PHP54N06T | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78 |

## 4. Limiting values

**Table 4. Limiting values**

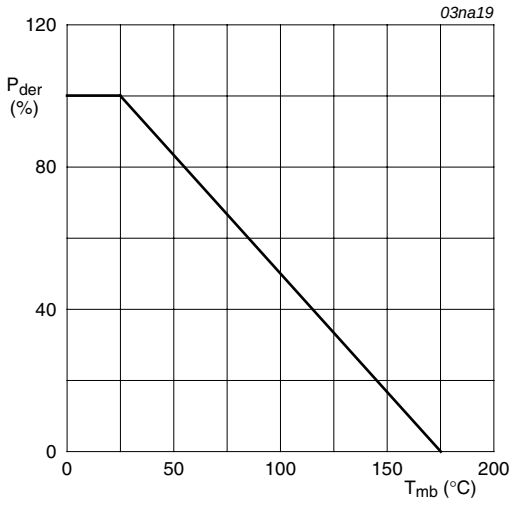
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | - | 55 | V |
| $V_{DGR}$ | drain-gate voltage | $R_{GS}$ = 20 kΩ | - | 55 | V |
| $V_{GS}$ | gate-source voltage | | -20 | 20 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{mb}$ = 100 °C; see Figure 1 | - | 38 | A |
| | | $V_{GS}$ = 10 V; $T_{mb}$ = 25 °C; see Figure 1 and 3 | - | 54 | A |
| $I_{DM}$ | peak drain current | $t_p \leq 10$ µs; pulsed; $T_{mb}$ = 25 °C; see Figure 3 | - | 217 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; see Figure 2 | - | 118 | W |
| $T_{stg}$ | storage temperature | | -55 | 175 | °C |
| $T_j$ | junction temperature | | -55 | 175 | °C |
| **Source-drain diode** | | | | | |
| $I_S$ | source current | $T_{mb}$ = 25 °C | - | 54 | A |
| $I_{SM}$ | peak source current | $t_p \leq 10$ µs; pulsed; $T_{mb}$ = 25 °C | - | 217 | A |
| **Avalanche ruggedness** | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $V_{GS}$ = 10 V; $T_{j(init)}$ = 25 °C; $I_D$ = 48 A; $V_{sup} \leq 55$ V; unclamped; $R_{GS}$ = 50 Ω | - | 115 | mJ |



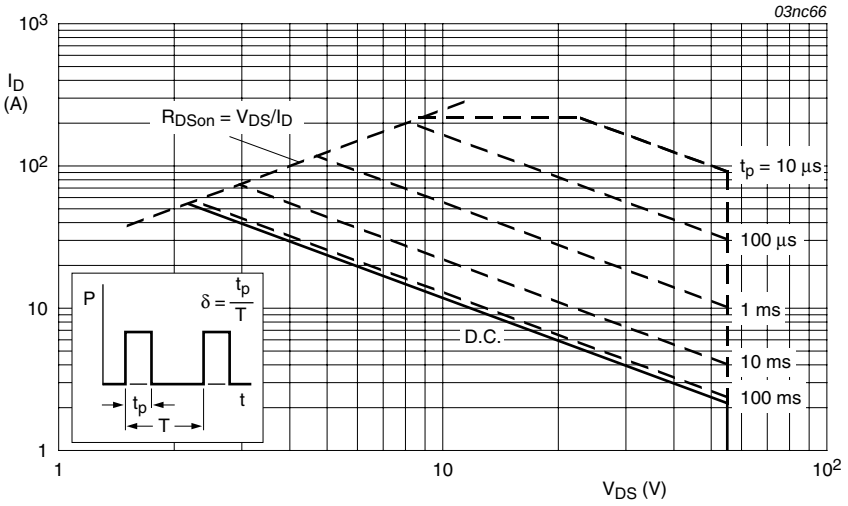

$$I_{der} = \frac{I_D}{I_{D(25°C)}} \times 100\,\%$$

**Fig 1. Normalized continuous drain current as a function of mounting base temperature**




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

**Fig 2. Normalized total power dissipation as a function of mounting base temperature**




$T_{mb} = 25°C; I_{DM}$ is single pulse

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

## 5. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $R_{th(j\text{-}mb)}$ | thermal resistance from junction to mounting base | see Figure 4 | - | - | 1.2 | K/W |
| $R_{th(j\text{-}a)}$ | thermal resistance from junction to ambient | vertical in still air | - | - | 60 | K/W |

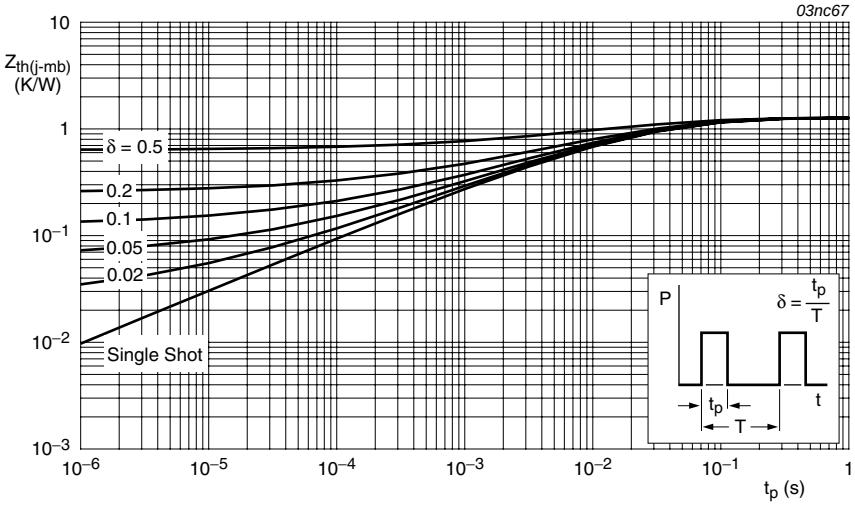
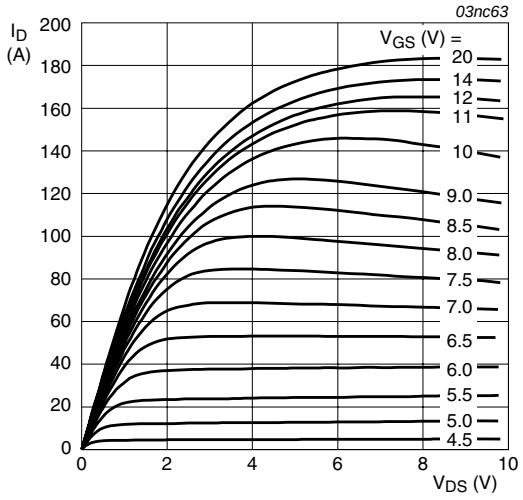



**Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration**

## 6. Characteristics

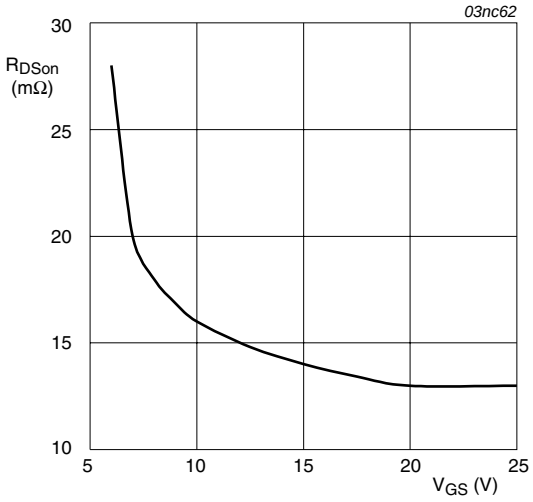
**Table 6. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 0.25 mA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | 50 | - | - | V |
| | | $I_D$ = 0.25 mA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | 55 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$= $V_{GS}$; $T_j$ = 175 °C; see Figure 10 | 1 | - | - | V |
| | | $I_D$ = 1 mA; $V_{DS}$= $V_{GS}$; $T_j$ = -55 °C; see Figure 10 | - | - | 4.4 | V |
| | | $I_D$ = 1 mA; $V_{DS}$= $V_{GS}$; $T_j$ = 25 °C; see Figure 10 | 2 | 3 | 4 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 55 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 0.05 | 10 | µA |
| | | $V_{DS}$ = 55 V; $V_{GS}$ = 0 V; $T_j$ = 175 °C | - | - | 500 | µA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 20 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| | | $V_{GS}$ = -20 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 175 °C; see Figure 11 and 12 | - | - | 40 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 A; $T_j$ = 25 °C; see Figure 11 and 12 | - | 17 | 20 | mΩ |
| **Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 40 A; $V_{DS}$ = 44 V; $V_{GS}$ = 10 V; $T_j$ = 25 °C; see Figure 13 | - | 36 | - | nC |
| $Q_{GS}$ | gate-source charge | | - | 8.4 | - | nC |
| $Q_{GD}$ | gate-drain charge | | - | 11.5 | - | nC |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 25 V; $V_{GS}$ = 0 V; f = 1 MHz; $T_j$ = 25 °C; see Figure 14 | - | 1200 | 1592 | pF |
| $C_{oss}$ | output capacitance | | - | 290 | 356 | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 179 | 240 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 30 V; $R_L$ = 1.2 Ω; $V_{GS}$ = 10 V; $R_{G(ext)}$ = 10 Ω; $T_j$ = 25 °C | - | 15 | - | ns |
| $t_r$ | rise time | | - | 74 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 70 | - | ns |
| $t_f$ | fall time | | - | 40 | - | ns |
| $L_D$ | internal drain inductance | from drain lead 6 mm from package to centre of die; $T_j$ = 25 °C | - | 4.5 | - | nH |
| | | from contact screw on mounting base to centre of die; $T_j$ = 25 °C | - | 3.5 | - | nH |
| $L_S$ | internal source inductance | from source lead to source bond pad; $T_j$ = 25 °C | - | 7.5 | - | nH |
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 20 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; see Figure 15 | - | 0.85 | 1.2 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 20 A; $dI_S/dt$ = -100 A/µs; $V_{GS}$ = -10 V; $V_{DS}$ = 30 V; $T_j$ = 25 °C | - | 45 | - | ns |
| $Q_r$ | recovered charge | | - | 110 | - | nC |



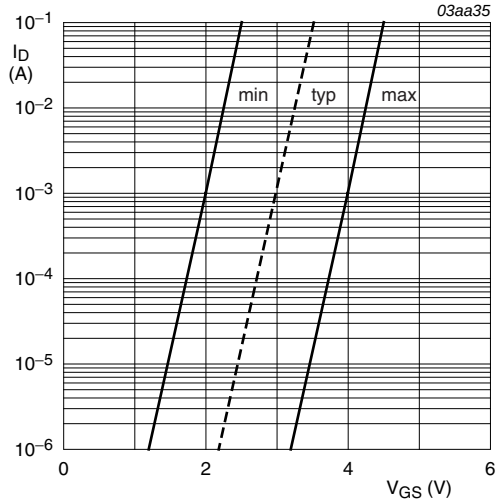

$T_j = 25°C; t_p = 300\mu s$

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



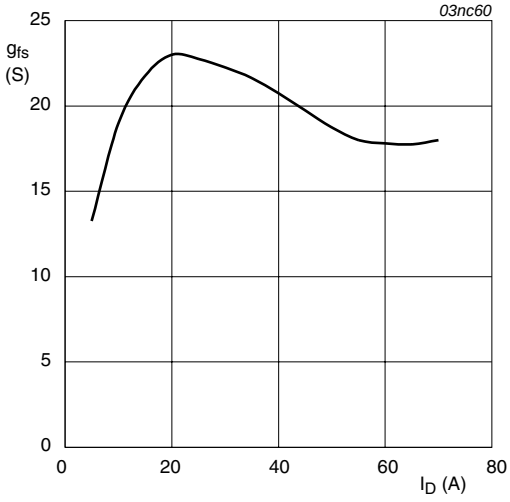

$T_j = 25°C; I_D = 25A$

**Fig 6. Drain-source on-state resistance as a function of drain current; typical values**



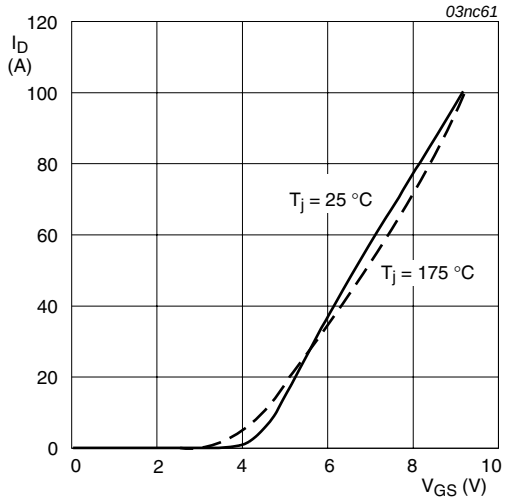

$T_j = 25°C; V_{DS} = 5V$

**Fig 7. Sub-threshold drain current as a function of gate-source voltage**



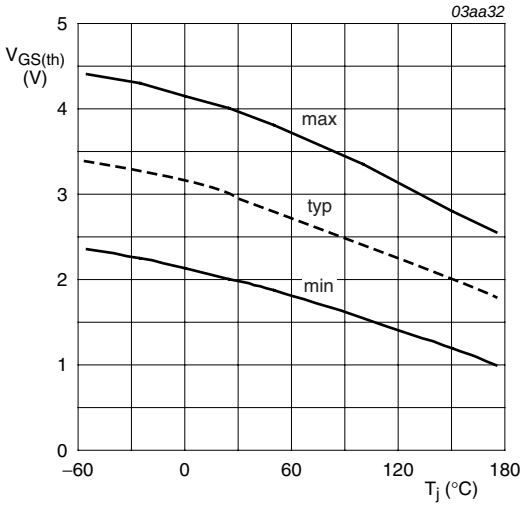

$T_j = 25°C; V_{DS} = 25V$

**Fig 8. Forward transconductance as a function of drain current; typical values**



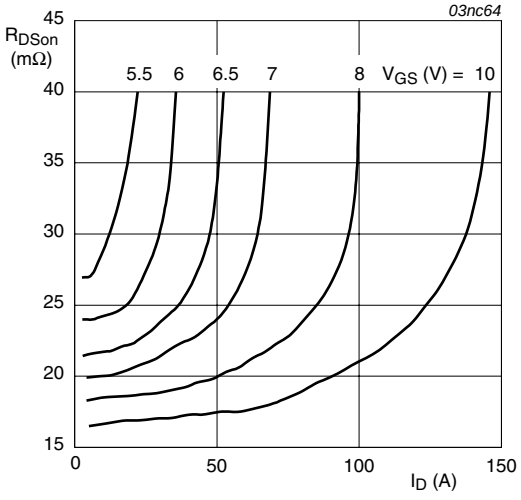

$V_{DS} = 25V$

**Fig 9. Transfer characteristics: drain current as a function of gate-source voltage; typical values**



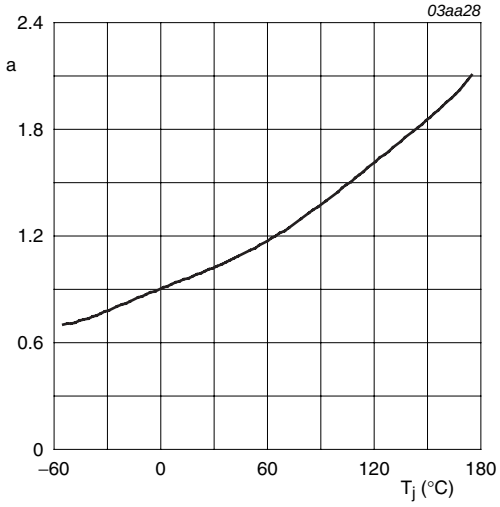

$I_D = 1mA; V_{DS} = V_{GS}$

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



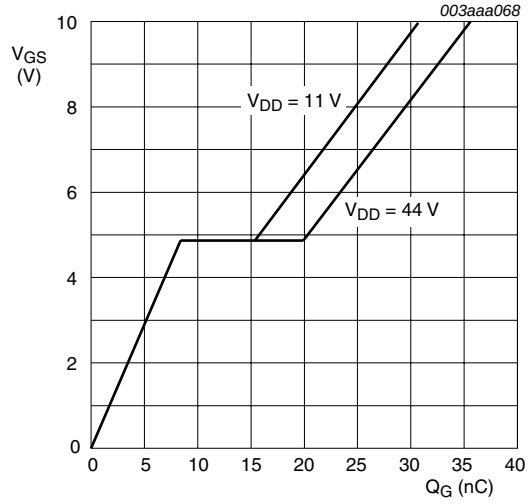

$T_j = 25°C$

**Fig 11. Drain-source on-state resistance as a function of drain current; typical values**



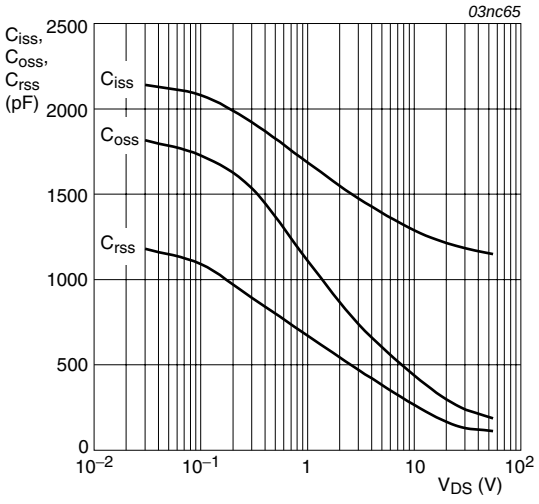

$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

**Fig 12. Normalized drain-source on-state resistance factor as a function of junction temperature**



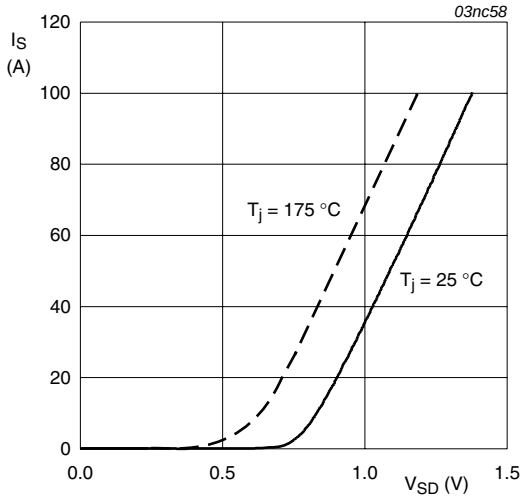

$T_j = 25°C; I_D = 40A$

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




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

**Fig 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**

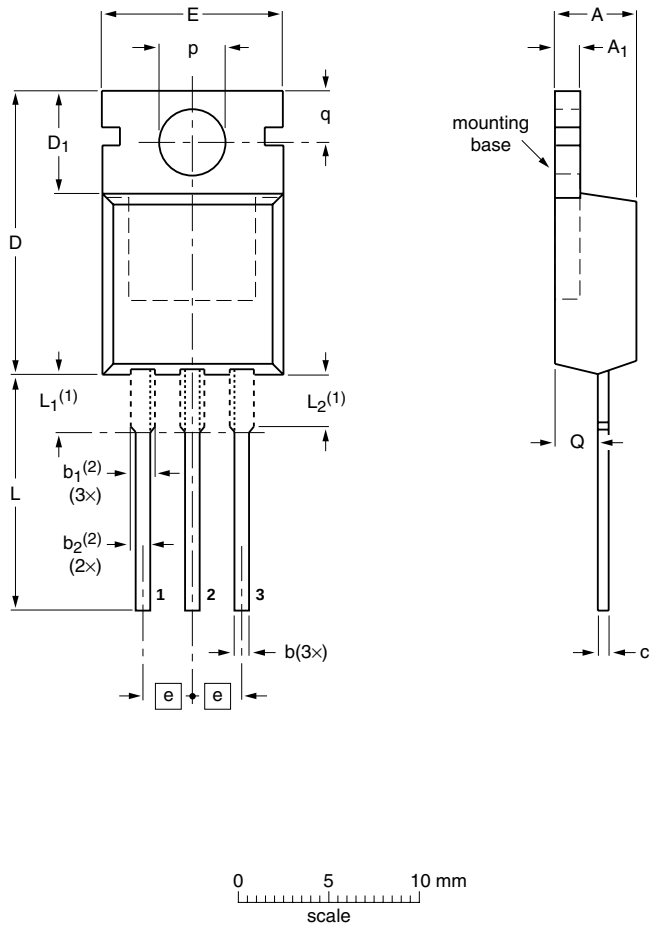



$V_{GS} = 0V$

**Fig 15. Reverse diode current as a function of reverse diode voltage; typical values**

## 7. 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 | $b_1$(2) | $b_2$(2) | c | D | $D_1$ | E | e | L | $L_1$(1) | $L_2$(1) max. | p | q | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.7<br>4.1 | 1.40<br>1.25 | 0.9<br>0.6 | 1.6<br>1.0 | 1.3<br>1.0 | 0.7<br>0.4 | 16.0<br>15.2 | 6.6<br>5.9 | 10.3<br>9.7 | 2.54 | 15.0<br>12.8 | 3.30<br>2.79 | 3.0 | 3.8<br>3.5 | 3.0<br>2.7 | 2.6<br>2.2 |

**Notes**

1. Lead shoulder designs may vary.
2. Dimension includes excess dambar.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT78 | | 3-lead TO-220AB | SC-46 | | | ~~08-04-23~~<br>08-06-13 |

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

## 8. Revision history

**Table 7. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PHP54N06T_2 | 20091214 | Product data sheet | - | PHP54N06T-01 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.<br>• Legal texts have been adapted to the new company name where appropriate. | | | |
| PHP54N06T-01<br>(9397 750 08022) | 20010214 | Product specification | - | - |

# 9. Legal information

## 9.1 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. |

[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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# 10. Contact information

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## 11. Contents





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**Document identifier: PHP54N06T_2**

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