

BUK95/9608-55A

TrenchMOS™ logic level FET

Rev. 03 — 6 May 2002

Product data

1. Description

N-channel enhancement mode field-effect power transistor in a plastic package using TrenchMOS™ technology, featuring very low on-state resistance.

Product availability:

BUK9508-55A in SOT78 (TO-220AB)

BUK9608-55A in SOT404 (D²-PAK).

2. Features

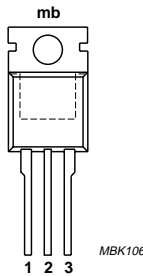
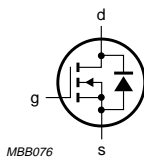
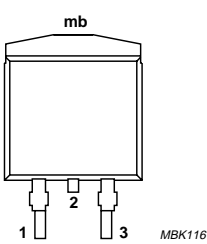
- TrenchMOS™ technology
- Q101 compliant
- 175 °C rated
- Logic level compatible.

3. Applications

- Automotive and general purpose power switching:
 - ◆ 12 V and 24 V loads
 - ◆ Motors, lamps and solenoids.

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 (D ² -PAK) |

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

5. Quick reference data

Table 2: Quick reference data

| Symbol | Parameter | Conditions | Typ | Max | Unit |
|------------|----------------------------------|--|-----|-----|------|
| V_{DS} | drain-source voltage (DC) | | - | 55 | V |
| I_D | drain current (DC) | $T_{mb} = 25\text{ °C}; V_{GS} = 5\text{ V}$ | - | 125 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C}$ | - | 253 | W |
| T_j | junction temperature | | - | 175 | °C |
| R_{DSon} | drain-source on-state resistance | $T_j = 25\text{ °C}; V_{GS} = 5\text{ V}; I_D = 25\text{ A}$ | 6.8 | 8 | mΩ |
| | | $T_j = 25\text{ °C}; V_{GS} = 4.5\text{ V}; I_D = 25\text{ A}$ | - | 8.5 | mΩ |
| | | $T_j = 25\text{ °C}; V_{GS} = 10\text{ V}; I_D = 25\text{ A}$ | 6.4 | 7.5 | mΩ |

6. Limiting values

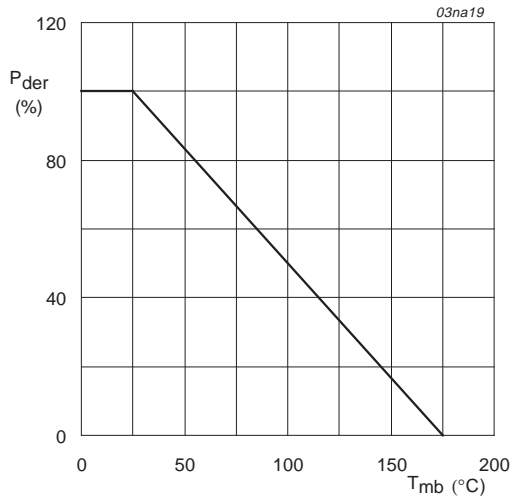
Table 3: Limiting values

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

| Symbol | Parameter | Conditions | Min | Max | Unit |
|-----------------------------|--|--|-------|------|------|
| V_{DS} | drain-source voltage (DC) | | - | 55 | V |
| V_{DGR} | drain-gate voltage (DC) | $R_{GS} = 20\text{ k}\Omega$ | - | 55 | V |
| V_{GS} | gate-source voltage (DC) | | - | ±15 | V |
| I_D | drain current (DC) | $T_{mb} = 25\text{ °C}; V_{GS} = 5\text{ V};$ Figure 2 and 3 | [1] - | 125 | A |
| | | | [2] - | 75 | A |
| | | $T_{mb} = 100\text{ °C}; V_{GS} = 5\text{ V};$ Figure 2 | [2] - | 75 | A |
| I_{DM} | peak drain current | $T_{mb} = 25\text{ °C};$ pulsed; $t_p \leq 10\text{ }\mu\text{s};$ Figure 3 | - | 503 | A |
| P_{tot} | total power dissipation | $T_{mb} = 25\text{ °C};$ Figure 1 | - | 253 | W |
| T_{stg} | storage temperature | | -55 | +175 | °C |
| T_j | junction temperature | | -55 | +175 | °C |
| Source-drain diode | | | | | |
| I_{DR} | reverse drain current (DC) | $T_{mb} = 25\text{ °C}$ | [1] - | 125 | A |
| | | | [2] - | 75 | A |
| I_{DRM} | peak reverse drain current | $T_{mb} = 25\text{ °C};$ pulsed; $t_p \leq 10\text{ }\mu\text{s}$ | - | 503 | A |
| Avalanche ruggedness | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | unclamped inductive load; $I_D = 75\text{ A};$ $V_{DS} \leq 55\text{ V}; V_{GS} = 5\text{ V}; R_{GS} = 50\text{ }\Omega;$ starting $T_{mb} = 25\text{ °C}$ | - | 670 | mJ |

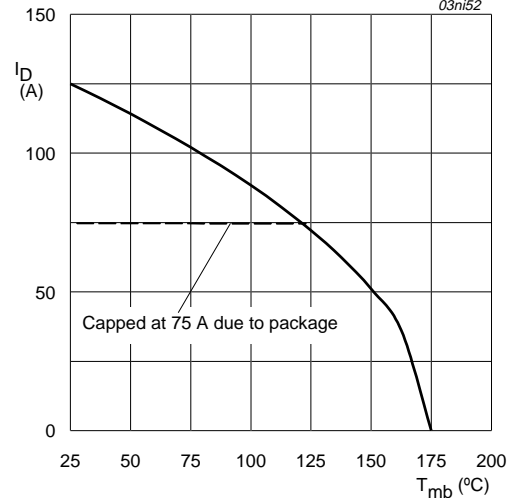
[1] Current is limited by power dissipation chip rating

[2] Continuous current is limited by package.



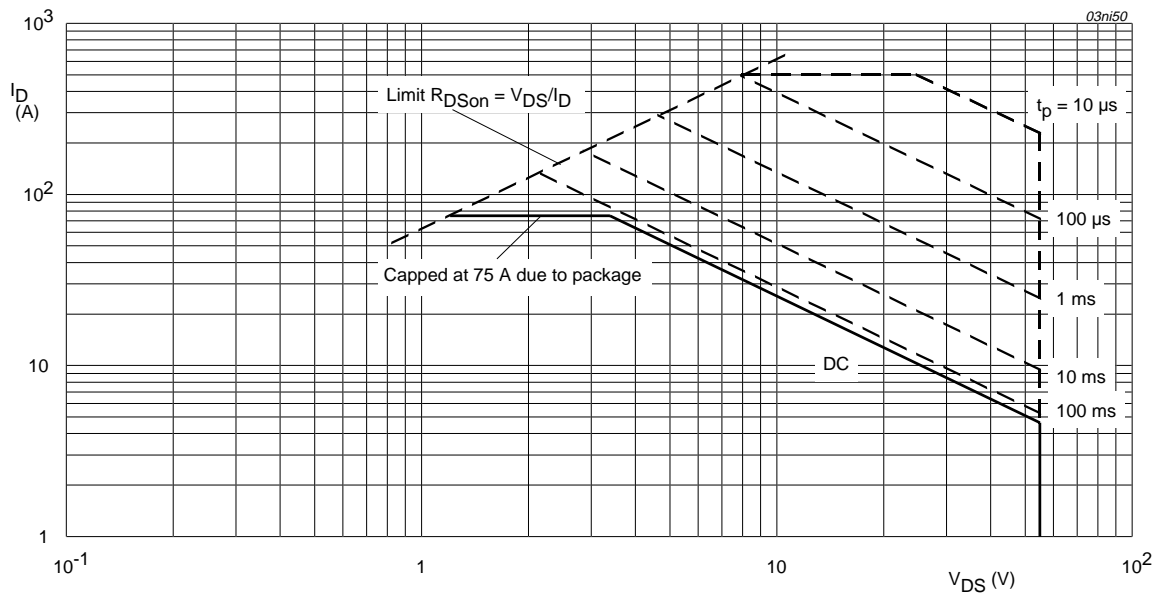
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

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



$V_{GS} \geq 4.5$ V

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



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

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

7. Thermal characteristics

Table 4: Thermal characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|----------------|---|---|-----|-----|------|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Figure 4 | - | - | 0.59 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | | | | | |
| | SOT78 | vertical in still air | - | 60 | - | K/W |
| | SOT404 | mounted on a printed circuit board; minimum footprint | - | 50 | - | K/W |

7.1 Transient thermal impedance

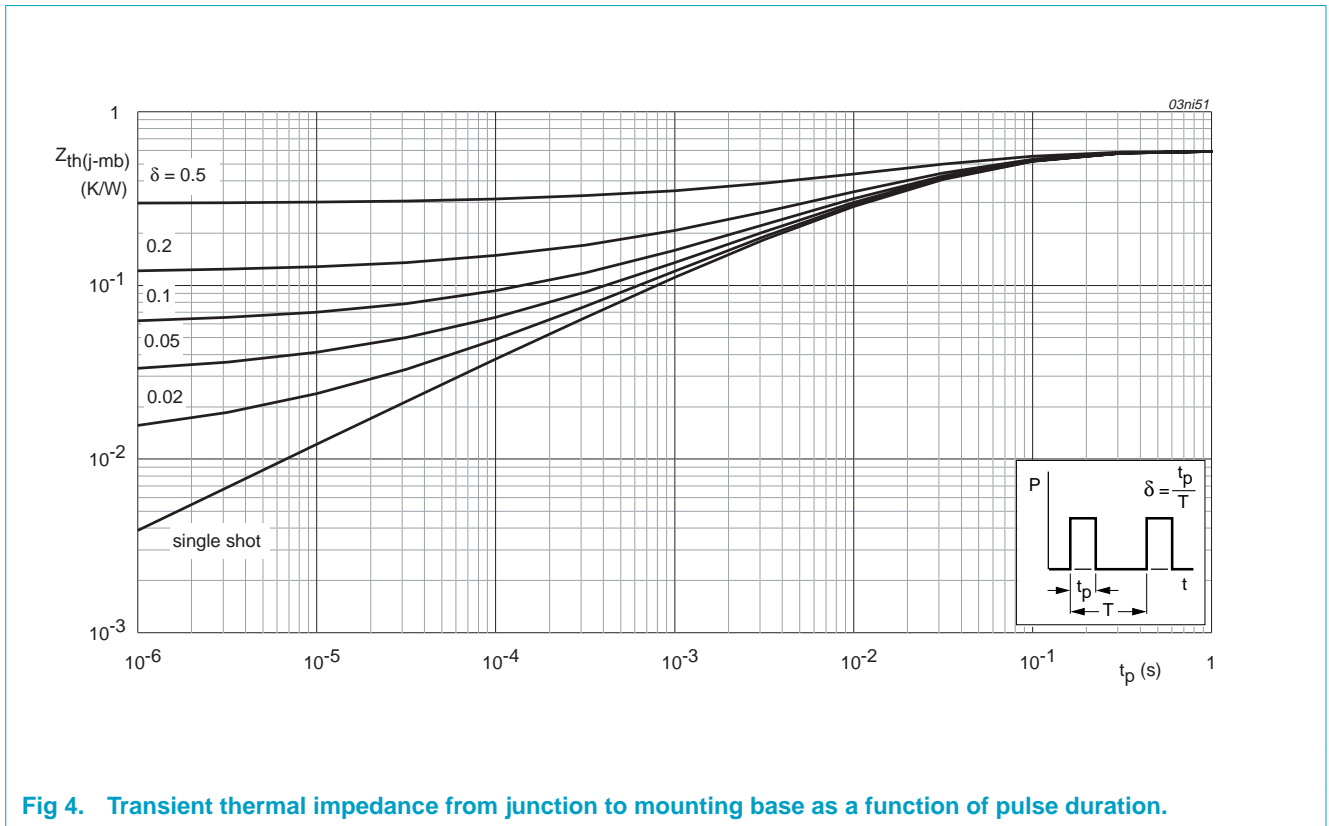


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration.

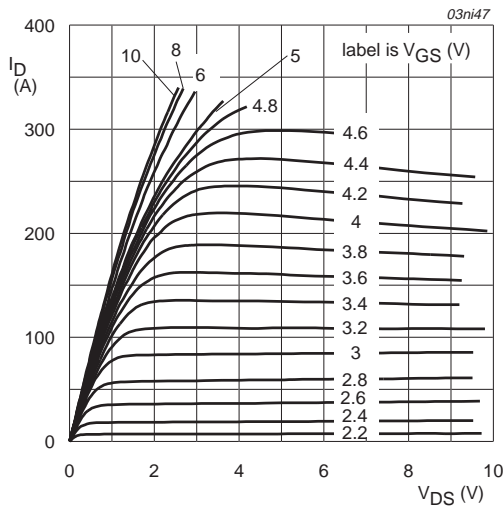
8. Characteristics

Table 5: Characteristics
T_j = 25 °C unless otherwise specified.

| 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 = 25 °C | 55 | - | - | V |
| | | T _j = -55 °C | 50 | - | - | V |
| V _{GS(th)} | gate-source threshold voltage | I _D = 1 mA; V _{DS} = V _{GS} ; Figure 9 | | | | |
| | | T _j = 25 °C | 1 | 1.5 | 2 | V |
| | | T _j = 175 °C | 0.5 | - | - | V |
| | | T _j = -55 °C | - | - | 2.3 | V |
| I _{DSS} | drain-source leakage current | V _{DS} = 55 V; V _{GS} = 0 V | | | | |
| | | T _j = 25 °C | - | 0.05 | 10 | μA |
| | | T _j = 175 °C | - | - | 500 | μA |
| I _{GSS} | gate-source leakage current | V _{GS} = ±10 V; V _{DS} = 0 V | - | 2 | 100 | nA |
| R _{DS(on)} | drain-source on-state resistance | V _{GS} = 5 V; I _D = 25 A; Figure 7 and 8 | | | | |
| | | T _j = 25 °C | - | 6.8 | 8 | mΩ |
| | | T _j = 175 °C | - | - | 16 | mΩ |
| | | V _{GS} = 4.5 V; I _D = 25 A | - | - | 8.5 | mΩ |
| | | V _{GS} = 10 V; I _D = 25 A | - | 6.4 | 7.5 | mΩ |
| Dynamic characteristics | | | | | | |
| Q _{g(tot)} | total gate charge | V _{GS} = 5 V; V _{DD} = 44 V; I _D = 25 A; Figure 14 | - | 92 | - | nC |
| Q _{gs} | gate-to-source charge | | - | 11 | - | nC |
| Q _{gd} | gate-to-drain (Miller) charge | | - | 43 | - | nC |
| C _{iss} | input capacitance | V _{GS} = 0 V; V _{DS} = 25 V; f = 1 MHz; Figure 12 | - | 4551 | 6021 | pF |
| C _{oss} | output capacitance | | - | 760 | 900 | pF |
| C _{rss} | reverse transfer capacitance | | - | 500 | 687 | pF |
| t _{d(on)} | turn-on delay time | V _{DD} = 30 V; R _L = 1.2 Ω; V _{GS} = 5 V; R _G = 10 Ω | - | 40 | - | ns |
| t _r | rise time | | - | 175 | - | ns |
| t _{d(off)} | turn-off delay time | | - | 280 | - | ns |
| t _f | fall time | | - | 167 | - | ns |
| L _d | internal drain inductance | from drain lead 6 mm from package to centre of die | - | 4.5 | - | nH |
| | | from contact screw on mounting base to centre of die SOT78 | - | 3.5 | - | nH |
| | | from upper edge of drain mounting base to centre of die SOT404 | - | 2.5 | - | nH |
| L _s | internal source inductance | from source lead to source bond pad | - | 7.5 | - | nH |

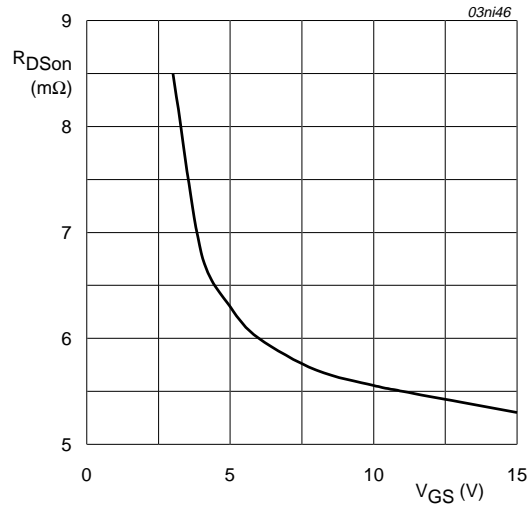
Table 5: Characteristics...continued
 $T_j = 25\text{ }^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---------------------------|--------------------------------------|---|-----|------|-----|------|
| Source-drain diode | | | | | | |
| V_{SD} | source-drain (diode forward) voltage | $I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; Figure 15 | - | 0.85 | 1.2 | V |
| t_{rr} | reverse recovery time | $I_S = 75\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$ | - | 70 | - | ns |
| Q_r | recovered charge | $V_{GS} = -10\text{ V}$; $V_{DS} = 25\text{ V}$ | - | 170 | - | nC |



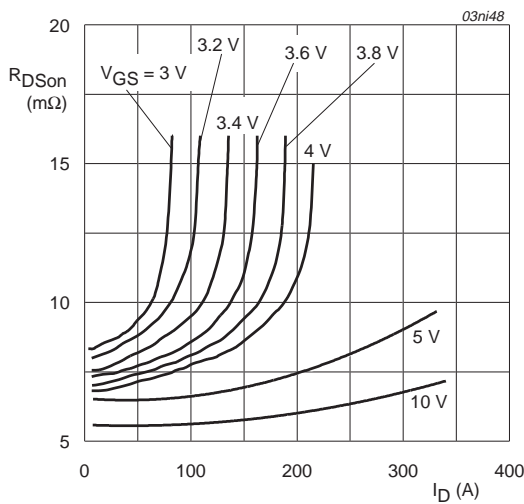
$T_j = 25\text{ }^\circ\text{C}$; $t_p = 300\text{ }\mu\text{s}$

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



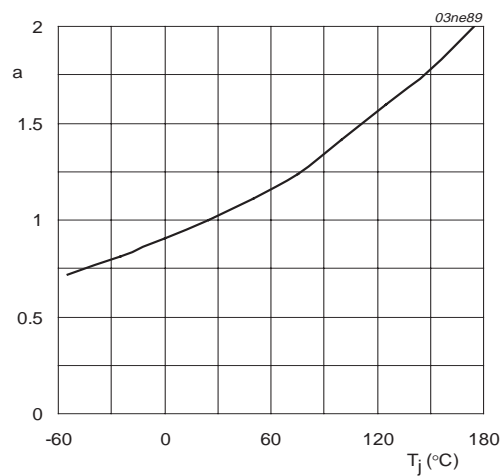
$T_j = 25\text{ }^\circ\text{C}$; $I_D = 25\text{ A}$

Fig 6. Drain-source on-state resistance as a function of gate-source voltage; typical values.



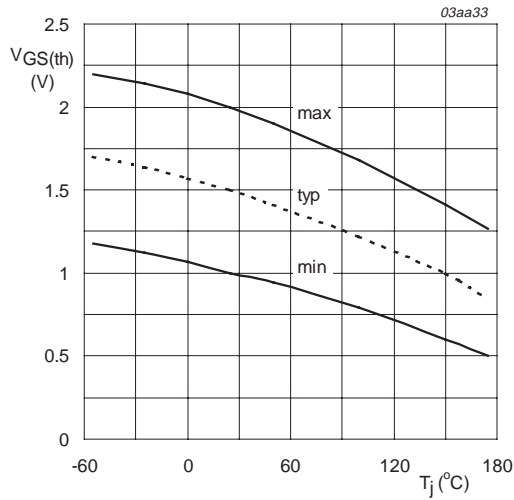
$T_j = 25\text{ }^\circ\text{C}$

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



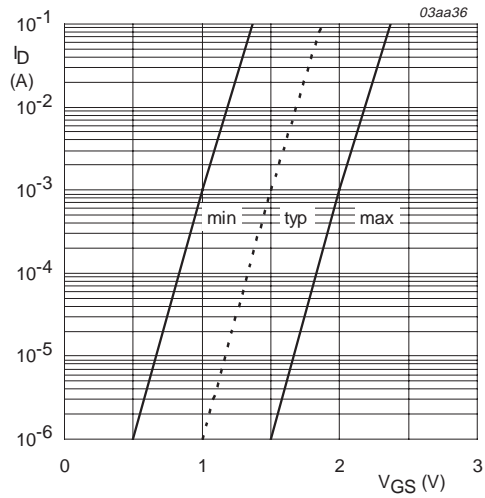
$a = R_{DSon}/R_{DSon}(25\text{ }^\circ\text{C})$

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



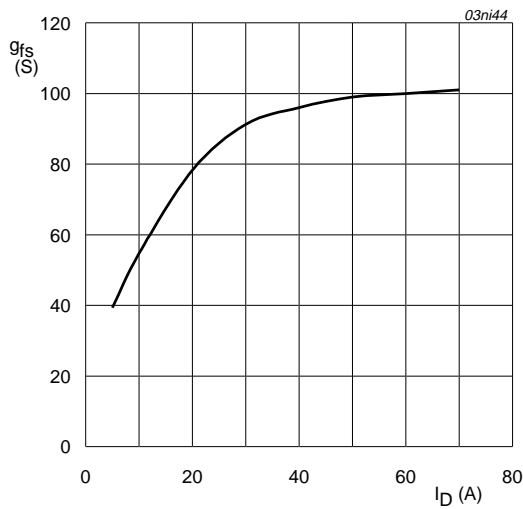
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

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



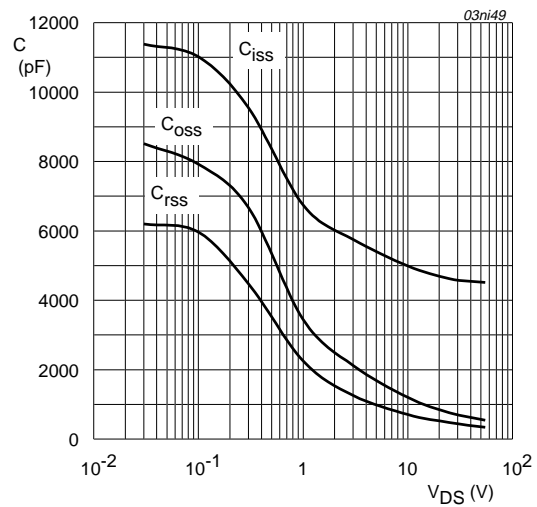
$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = V_{GS}$

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



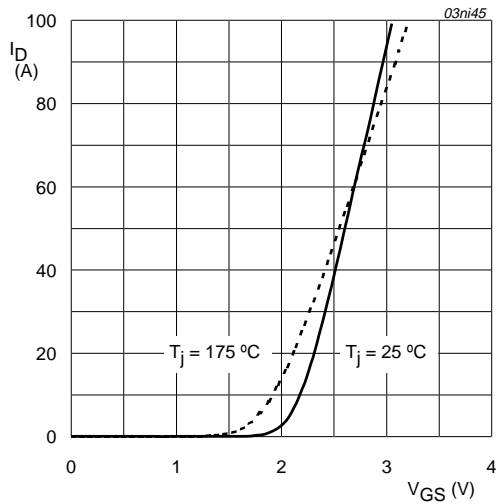
$T_j = 25 \text{ }^\circ\text{C}; V_{DS} = 25 \text{ V}$

Fig 11. Forward transconductance as a function of drain current; typical values.



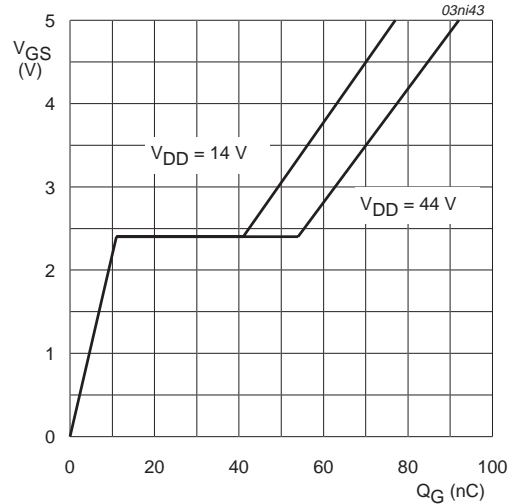
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



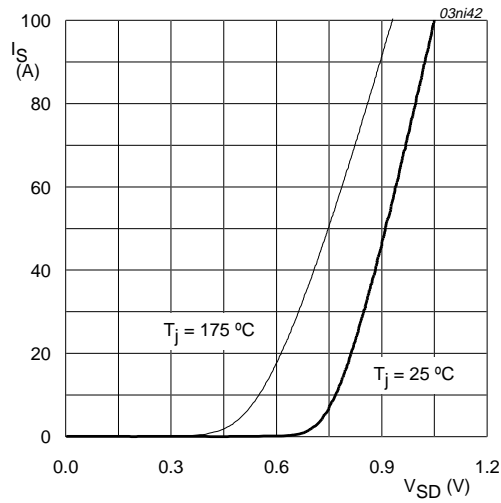
$V_{DS} = 25\text{ V}$

Fig 13. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



$T_j = 25\text{ °C}; I_D = 25\text{ A}$

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



$V_{GS} = 0\text{ V}$

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

9. Package outline

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

SOT78



Fig 16. SOT78 (TO-220AB).

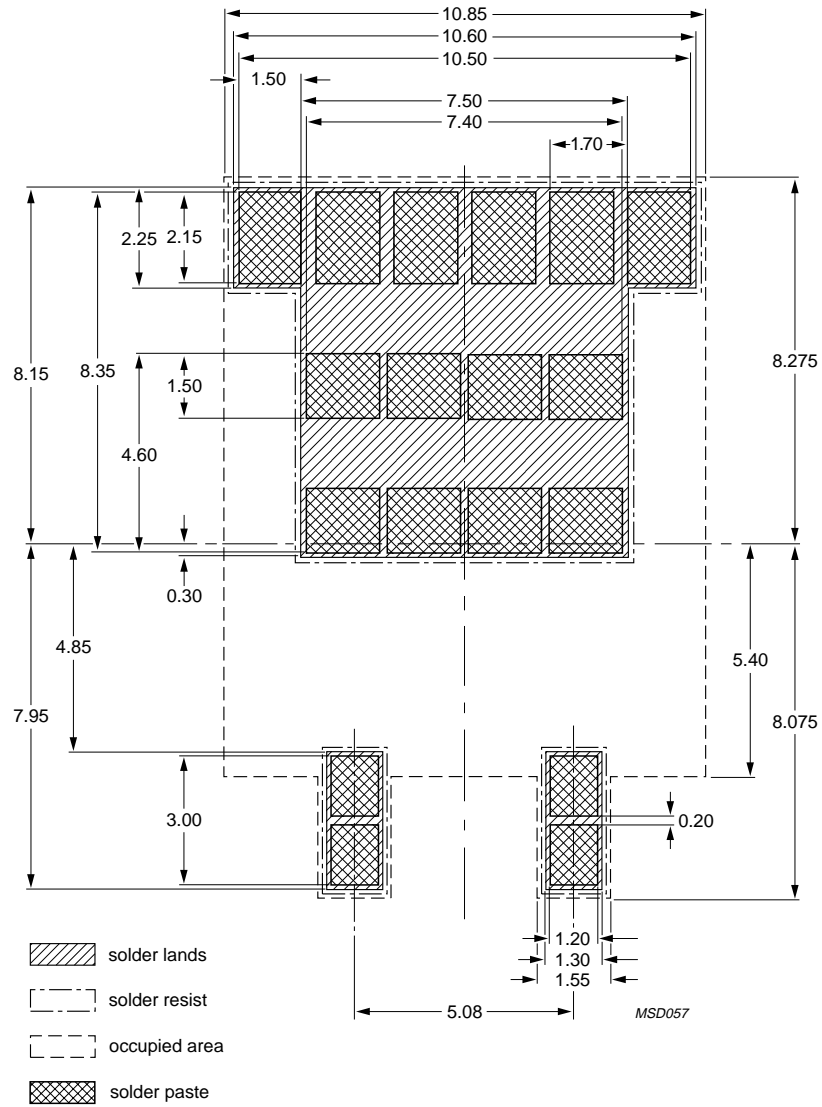
Plastic single-ended surface mounted package (Philips version of D²-PAK); 3 leads
(one lead cropped)

SOT404



Fig 17. SOT404 (D²-PAK).

10. Soldering



Dimensions in mm.

Fig 18. Reflow soldering footprint for SOT404.

11. Revision history

Table 6: Revision history

| Rev | Date | CPCN | Description |
|-----|----------|------|--|
| 03 | 20020506 | - | <p>Product data (9397 750 09573); supersedes Product data of BUK9508_9608-55A_2 of 4 of September 2000.</p> <p>Modifications:</p> <ul style="list-style-type: none">• The format of this specification has been redesigned to comply with Philips Semiconductors' new presentation and information standard.• Thermal resistance figure lowered (j-mb) Section 7. This has a knock on effect on the devices current and power handling capabilities (See Section 5 and Section 6).• Maximum gate-source voltage increased from ± 10 to ± 15 V (Section 6).• Switching speeds re-measured in dynamic characteristics Section 8. |

12. 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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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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