# BUK7905-40AI

## N-channel TrenchPLUS standard level FET

Rev. 02 — 16 February 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. The devices include TrenchPLUS current sensing. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 1.2 Features and benefits

- Low conduction losses due to low on-state resistance
- Q101 compliant
- Reduced component count due to integrated current sensor
- Suitable for standard level gate drive sources

### 1.3 Applications

- Electrical Power Assisted Steering (EPAS)
- Variable Valve Timing for engines

### 1.4 Quick reference data

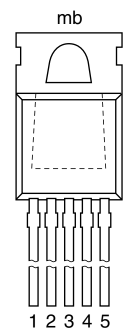
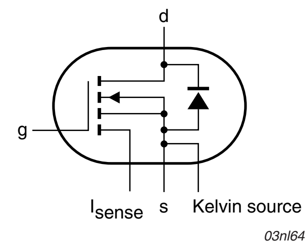
Table 1. Quick reference

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | | - | - | 40 | V |
| $I_D$ | drain current | $V_{GS} = 10$ V; $T_{mb} = 25$ °C; see Figure 2; see Figure 3; | [1] | - | - | 155 | A |
| **Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS} = 10$ V; $I_D = 50$ A; $T_j = 25$ °C; see Figure 7; see Figure 8 | | - | 4.5 | 5 | mΩ |
| $I_D/I_{sense}$ | ratio of drain current to sense current | $T_j > -55$ °C; $V_{GS} > 10$ V; $T_j < 175$ °C | | 450 | 500 | 550 | |

[1] Current is limited by power dissipation chip rating.

## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | G | gate | <br>**SOT263B (TO-220)** |  |
| 2 | ISENSE | current sense | | |
| 3 | D | drain | | |
| 4 | KS | Kelvin source | | |
| 5 | S | source | | |
| mb | D | mounting base; connected to drain | | |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BUK7905-40AI | TO-220 | plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220 | SOT263B |

# 4. Limiting values

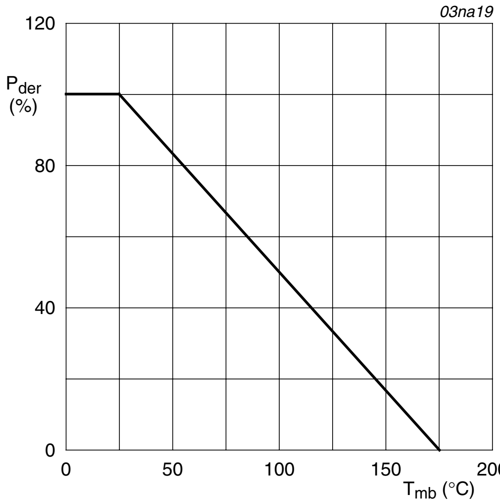
**Table 4. Limiting values**

*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 | | - | 40 | V |
| $V_{DGR}$ | drain-gate voltage | $R_{GS} = 20$ kΩ | | - | 40 | V |
| $V_{GS}$ | gate-source voltage | | | -20 | 20 | V |
| $I_D$ | drain current | $T_{mb} = 25$ °C; $V_{GS} = 10$ V; see Figure 2; see Figure 3; | [1] | - | 155 | A |
| | | | [2] | - | 75 | A |
| | | $T_{mb} = 100$ °C; $V_{GS} = 10$ V; see Figure 2; | [2] | - | 75 | A |
| $I_{DM}$ | peak drain current | $T_{mb} = 25$ °C; $t_p \leq 10$ µs; pulsed; see Figure 3 | | - | 620 | A |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25$ °C; see Figure 1 | | - | 272 | 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; | [1] | - | 155 | A |
| | | | [2] | - | 75 | A |
| $I_{SM}$ | peak source current | $t_p \leq 10$ µs; pulsed; $T_{mb} = 25$ °C | | - | 620 | A |
| **Avalanche ruggedness** | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 75$ A; $V_{sup} \leq 40$ V; $R_{GS} = 50$ Ω; $V_{GS} = 10$ V; $T_{j(init)} = 25$ °C; unclamped | | - | 1.46 | J |
| **Electrostatic discharge** | | | | | | |
| $V_{esd}$ | electrostatic discharge voltage | HBM; C = 100 pF; R = 1.5 kΩ | | - | 4 | kV |

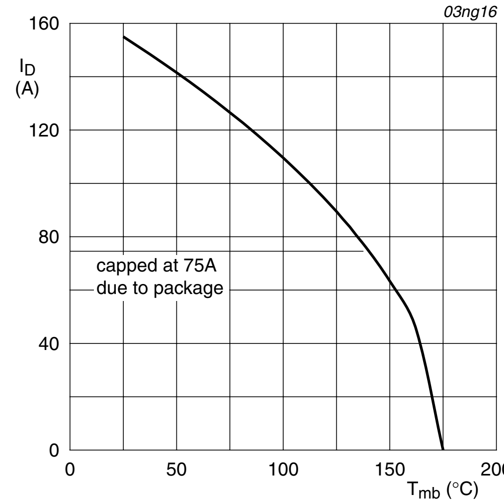
[1] Current is limited by power dissipation chip rating.

[2] Continuous current is limited by package.



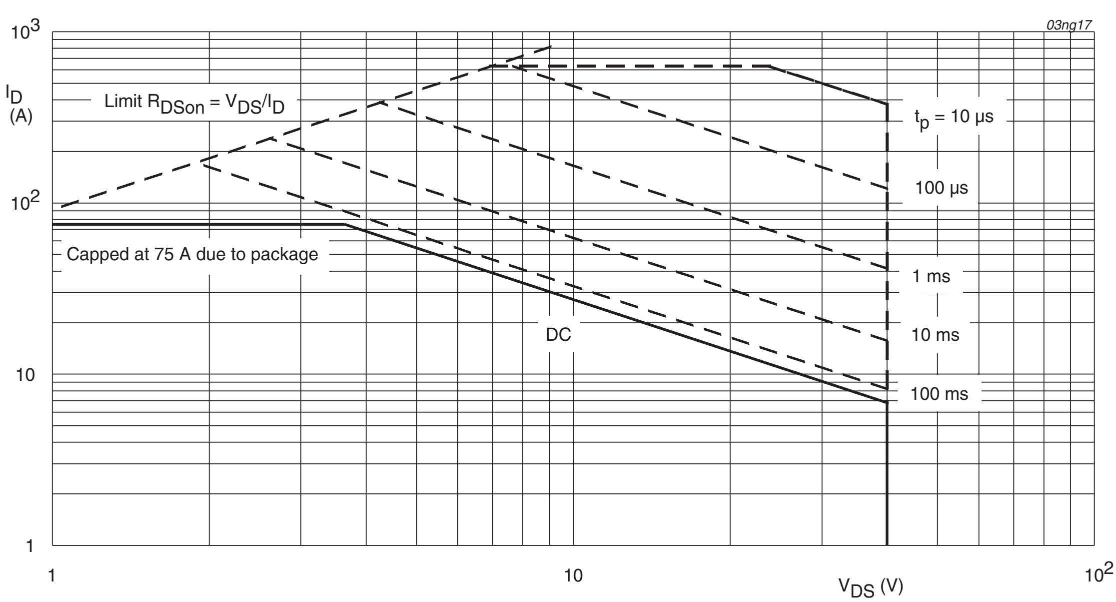

$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

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




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

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




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

**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 |
|---|---|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | vertical in still air | - | 60 | - | K/W |
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | see Figure 4 | - | - | 0.55 | K/W |

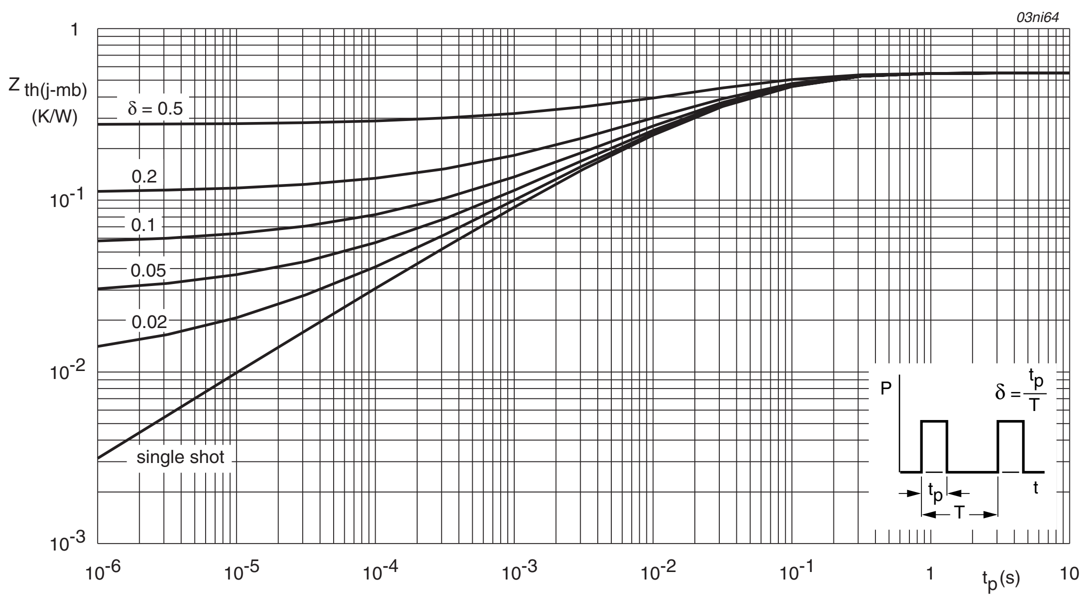



**Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration**

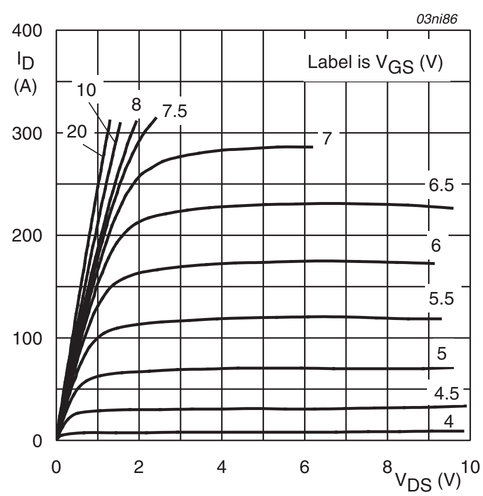
# 6. Characteristics

**Table 6. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 0.25 mA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | 40 | - | - | V |
| | | $I_D$ = 0.25 mA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | 36 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C; see Figure 9 | 2 | 3 | 4 | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 175 °C; see Figure 9 | 1 | - | - | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = -55 °C; see Figure 9 | - | - | 4.4 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 0.1 | 10 | µA |
| | | $V_{DS}$ = 40 V; $V_{GS}$ = 0 V; $T_j$ = 175 °C | - | - | 500 | µA |
| $I_{GSS}$ | gate leakage current | $V_{DS}$ = 0 V; $V_{GS}$ = 20 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| | | $V_{DS}$ = 0 V; $V_{GS}$ = -20 V; $T_j$ = 25 °C | - | 2 | 100 | nA |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 50 A; $T_j$ = 25 °C; see Figure 7; see Figure 8 | - | 4.5 | 5 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 50 A; $T_j$ = 175 °C; see Figure 7; see Figure 8 | - | - | 9.5 | mΩ |
| $I_D/I_{sense}$ | ratio of drain current to sense current | $V_{GS}$ > 10 V; $T_j$ > -55 °C; $T_j$ < 175 °C | 450 | 500 | 550 | |
| $R_{(D-ISENSE)on}$ | drain-ISENSE on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 25 mA; $T_j$ = 25 °C; see Figure 16 | 0.98 | 1.08 | 1.18 | Ω |
| | | $V_{GS}$ = 10 V; $I_D$ = 25 mA; $T_j$ = 175 °C; see Figure 16 | 1.86 | 2.05 | 2.24 | Ω |
| **Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 25 A; $V_{DS}$ = 32 V; $V_{GS}$ = 10 V; $T_j$ = 25 °C; see Figure 14 | - | 120 | 127 | nC |
| $Q_{GS}$ | gate-source charge | | - | 19 | 22 | nC |
| $Q_{GD}$ | gate-drain charge | | - | 50 | 60 | nC |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 25 V; f = 1 MHz; $T_j$ = 25 °C; see Figure 12 | - | 4300 | 5000 | pF |
| $C_{oss}$ | output capacitance | | - | 1400 | 1670 | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 820 | 1100 | 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 | - | 35 | - | ns |
| $t_r$ | rise time | | - | 115 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 155 | - | ns |
| $t_f$ | fall time | | - | 110 | - | ns |
| $L_D$ | internal drain inductance | measured from upper edge of drain mounting base to center of die; $T_j$ = 25 °C | - | 2.5 | - | nH |
| $L_S$ | internal source inductance | measured from source lead to source bond pad; $T_j$ = 25 °C | - | 7.5 | - | nH |

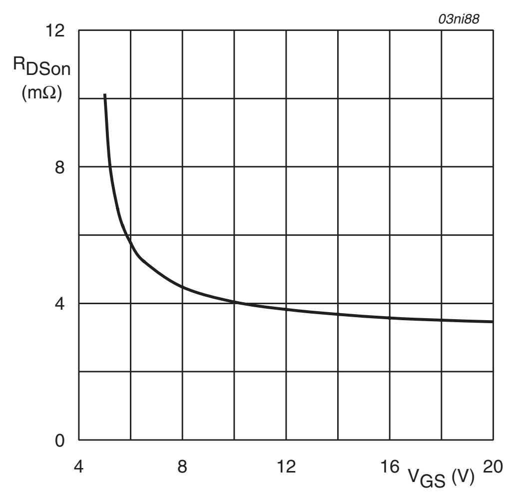
**Table 6. Characteristics** *...continued*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Source-drain diode** | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = 40 A; $V_{GS}$ = 0 V; $T_j$ = 25 °C; see Figure 17 | - | 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 | - | 96 | - | ns |
| $Q_r$ | recovered charge | | - | 224 | - | nC |



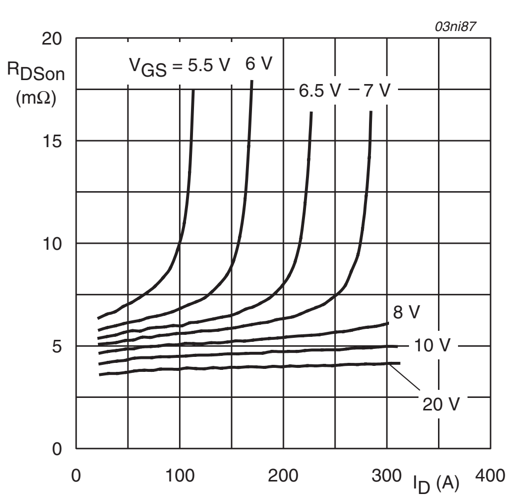

$T_j = 25°C; t_p = 300 \mu s$

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



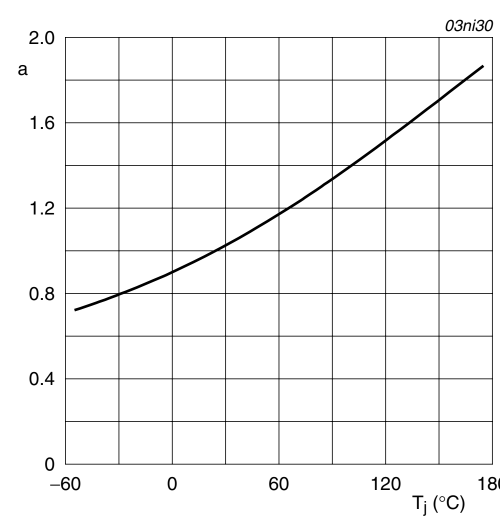

$T_j = 25°C; I_D = 50A$

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



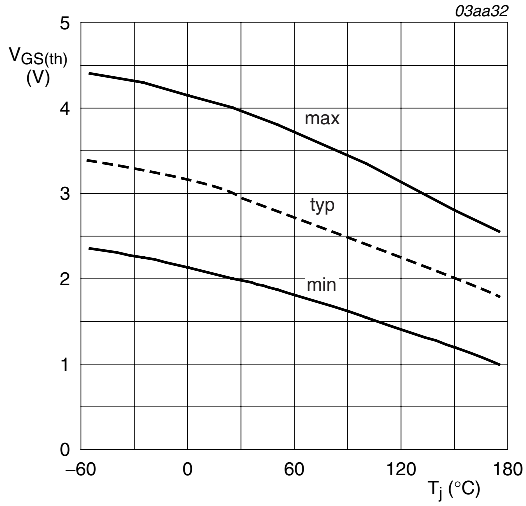

$T_j = 25°C; t_p = 300 \mu s$

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



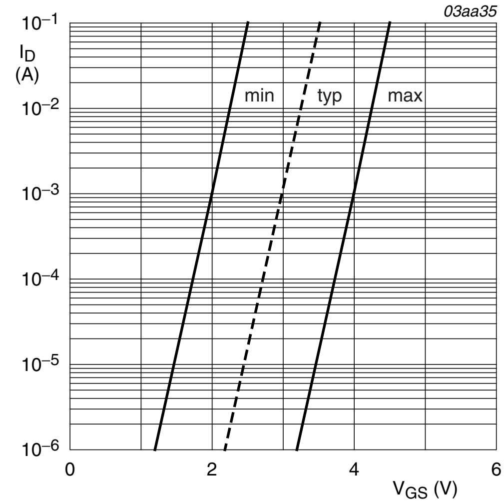

$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

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



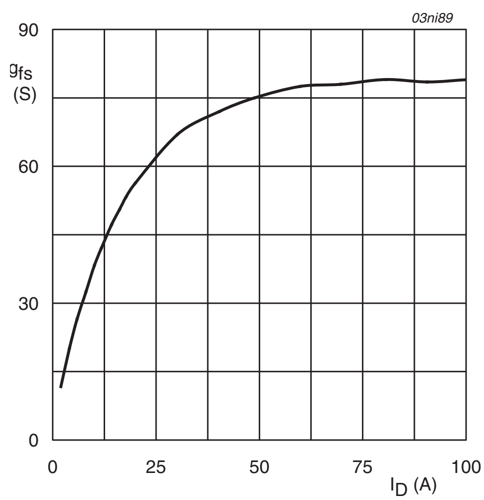

$I_D = 1mA; V_{DS} = V_{GS}$

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



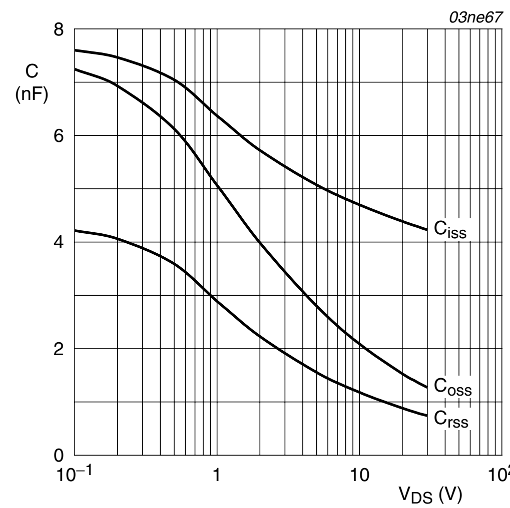

$T_j = 25\,°C; V_{DS} = 5V$

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



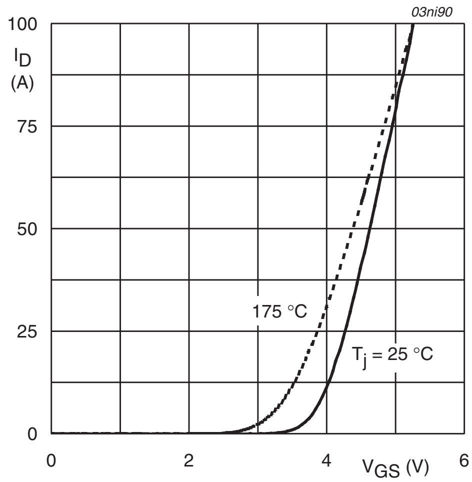

$T_j = 25°C; V_{DS} = 25V$

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



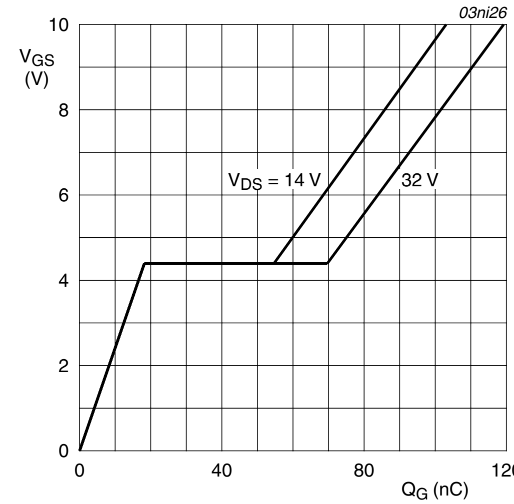

$V_{GS} = 0V; f = 1MHz$

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



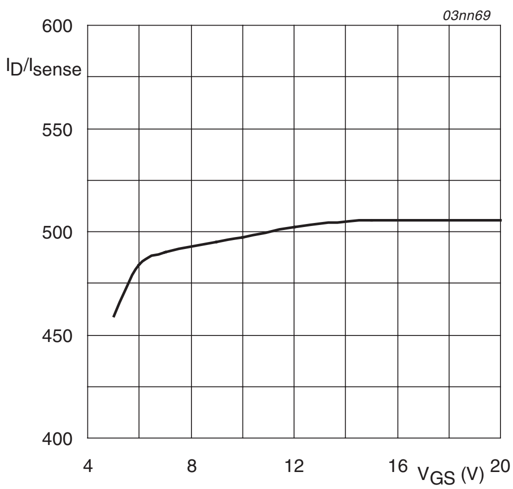

$V_{DS} = 25V$

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



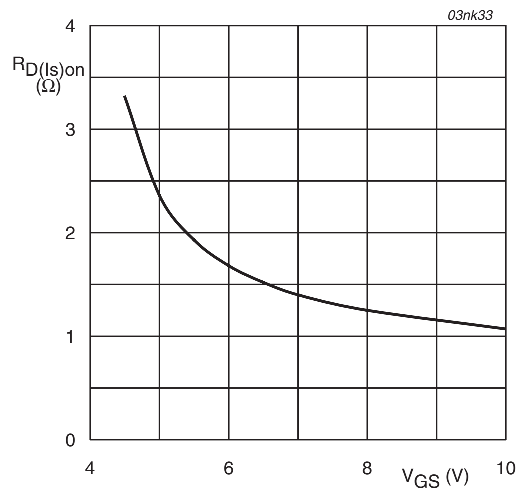

$T_j = 25°C; I_D = 25A$

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



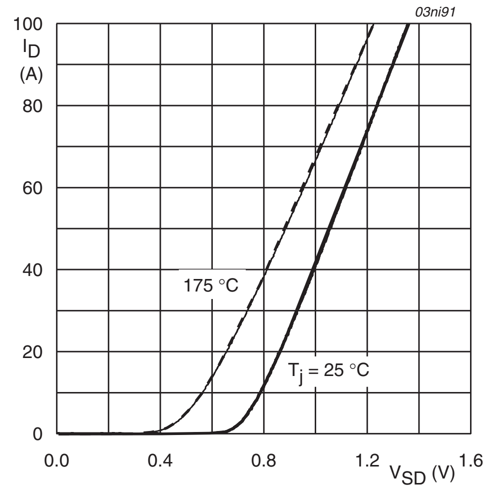

$I_D = 50A$

**Fig 15. Drain-sense current ratio as a function of gate-source voltage; typical values**




$I_{sense} = 25mA$

**Fig 16. Drain-sense current on-state resistance as a function of gate-source voltage; typical values**

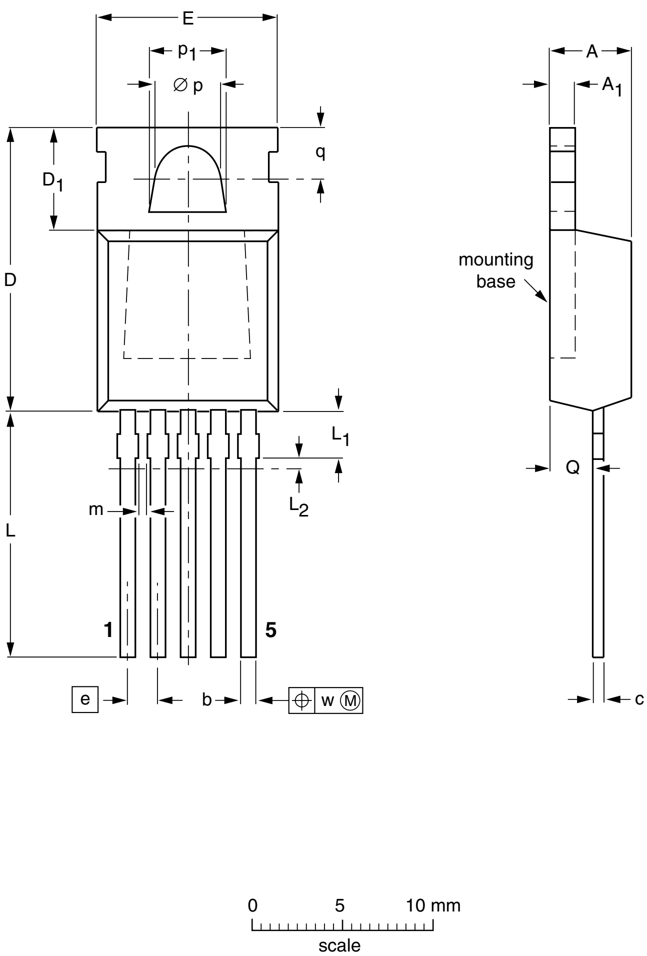



$V_{GS} = 0V$

**Fig 17. Drain current as a function of source-drain diode voltage; typical values**

## 7. Package outline

**Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220** **SOT263B**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ | b | c | D | $D_1$ | E | e | L | $L_1$(1) | $L_2$(2) | m | ∅ p | $p_1$ | q | Q | w |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.5<br>4.1 | 1.39<br>1.27 | 0.85<br>0.70 | 0.7<br>0.4 | 15.8<br>15.2 | 6.4<br>5.9 | 10.3<br>9.7 | 1.7 | 15.0<br>13.5 | 2.4<br>1.6 | 0.5 | 0.8<br>0.6 | 3.8<br>3.6 | 4.3<br>4.1 | 3.0<br>2.7 | 2.6<br>2.2 | 0.4 |

**Notes**

1. Terminal dimensions are uncontrolled in this zone.
2. Positional accuracy of the terminals is controlled in this zone.

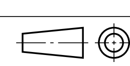
| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT263B | | 5-lead TO-220 | | |  | 01-01-11 |

Fig 18. Package outline SOT263B (TO-220)

# 8. Revision history

**Table 7. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| BUK7905-40AI_2 | 20090216 | Product data sheet | - | BUK7905_40AI-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. | | | |
| BUK7905_40AI-01 (9397 750 12346) | 20040209 | Product data sheet | - | - |

# 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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# 10. Contact information

For more information, please visit: http://www.nxp.com

For sales office addresses, please send an email to: salesaddresses@nxp.com

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