# BUK7613-100E

## N-channel TrenchMOS standard level FET

5 October 2012 Product data sheet

## 1. Product profile

### 1.1 General description

Standard level N-channel MOSFET in a SOT404 package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

### 1.2 Features and benefits

- AEC Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True standard level gate with VGS(th) rating of greater than 1V at 175 °C

### 1.3 Applications

- 12V, 24V and 48V Automotive systems
- Motors, lamps and solenoid control
- Start-Stop micro-hybrid applications
- Transmission control
- Ultra high performance power switching

### 1.4 Quick reference data

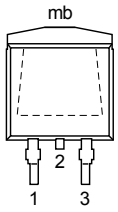
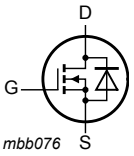
**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | $T_j \geq 25$ °C; $T_j \leq 175$ °C | | - | - | 100 | V |
| $I_D$ | drain current | $V_{GS}$ = 10 V; $T_{mb}$ = 25 °C; Fig. 1 | | - | - | 72 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; Fig. 2 | | - | - | 182 | W |
| **Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 20 A; $T_j$ = 25 °C; Fig. 11 | | - | 10.2 | 13 | mΩ |
| **Dynamic characteristics** | | | | | | | |
| $Q_{GD}$ | gate-drain charge | $V_{GS}$ = 10 V; $I_D$ = 20 A; $V_{DS}$ = 80 V; $T_j$ = 25 °C; Fig. 13; Fig. 14 | | - | 25.4 | 35.6 | nC |

Scan or click this QR code to view the latest information for this product

## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | G | gate |   D2PAK (SOT404) |   |
| 2 | D | drain | | |
| 3 | S | source | | |
| mb | D | mounting base; connected to drain | | |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| BUK7613-100E | D2PAK | plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) | SOT404 |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| BUK7613-100E | BUK7613-100E |

## 5. Limiting values

**Table 5. 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 | | - | 100 | V |
| $V_{DGR}$ | drain-gate voltage | $R_{GS}$ = 20 kΩ | | - | 100 | V |
| $V_{GS}$ | gate-source voltage | $T_j \leq 175$ °C; DC | | -20 | 20 | V |
| $I_D$ | drain current | $T_{mb}$ = 25 °C; $V_{GS}$ = 10 V; Fig. 1 | | - | 72 | A |
| | | $T_{mb}$ = 100 °C; $V_{GS}$ = 10 V; Fig. 1 | | - | 51 | A |
| $I_{DM}$ | peak drain current | $T_{mb}$ = 25 °C; pulsed; $t_p \leq 10$ µs; Fig. 4 | | - | 288 | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C; Fig. 2 | | - | 182 | W |
| $T_{stg}$ | storage temperature | | | -55 | 175 | °C |
| $T_j$ | junction temperature | | | -55 | 175 | °C |

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **Source-drain diode** | | | | | | |
| $I_S$ | source current | $T_{mb}$ = 25 °C | | - | 72 | A |
| $I_{SM}$ | peak source current | pulsed; $t_p \leq 10$ µs; $T_{mb}$ = 25 °C | | - | 288 | A |
| **Avalanche ruggedness** | | | | | | |
| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D$ = 72 A; $V_{sup} \leq 100$ V; $R_{GS}$ = 50 Ω; $V_{GS}$ = 10 V; $T_{j(init)}$ = 25 °C; unclamped; Fig. 3 | [1][2] | - | 121 | mJ |

[1] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
[2] Refer to application note AN10273 for further information.

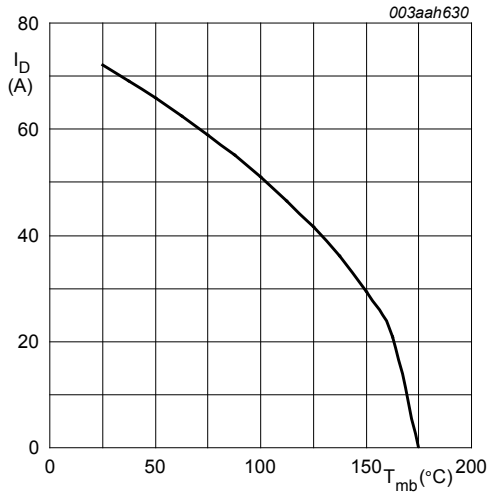



**Fig. 1. Continuous drain current as a function of mounting base temperature**

$V_{GS} \geq 10V$

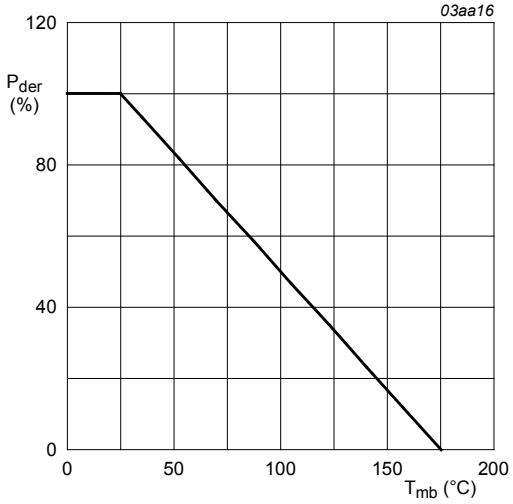



**Fig. 2. Normalized total power dissipation as a function of mounting base temperature**

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

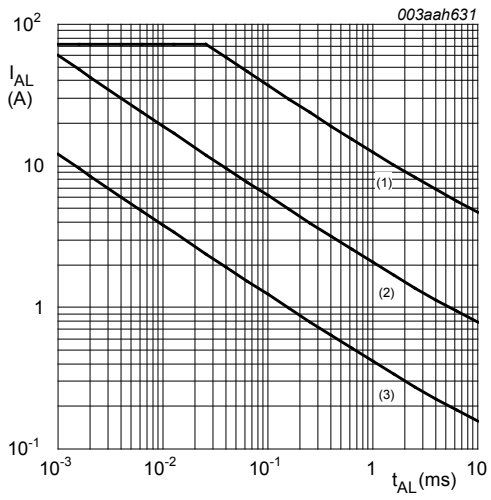



**Fig. 3. Avalanche rating; avalanche current as a function of avalanche time**

(1) $T_{j\ (init)} = 25°C$; (2) $T_{j\ (init)} = 150°C$; (3) Repetitive Avalanche

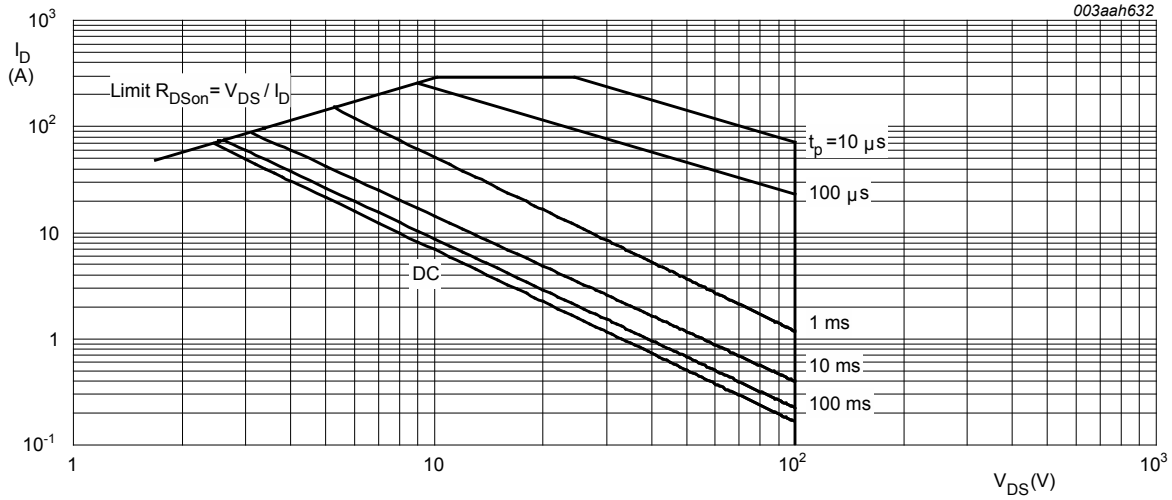



**Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage**

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

# 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{th(j\text{-}mb)}$ | thermal resistance from junction to mounting base | Fig. 5 | | - | - | 0.82 | K/W |
| $R_{th(j\text{-}a)}$ | thermal resistance from junction to ambient | minimum footprint ; mounted on a printed-circuit board | | - | 50 | - | K/W |

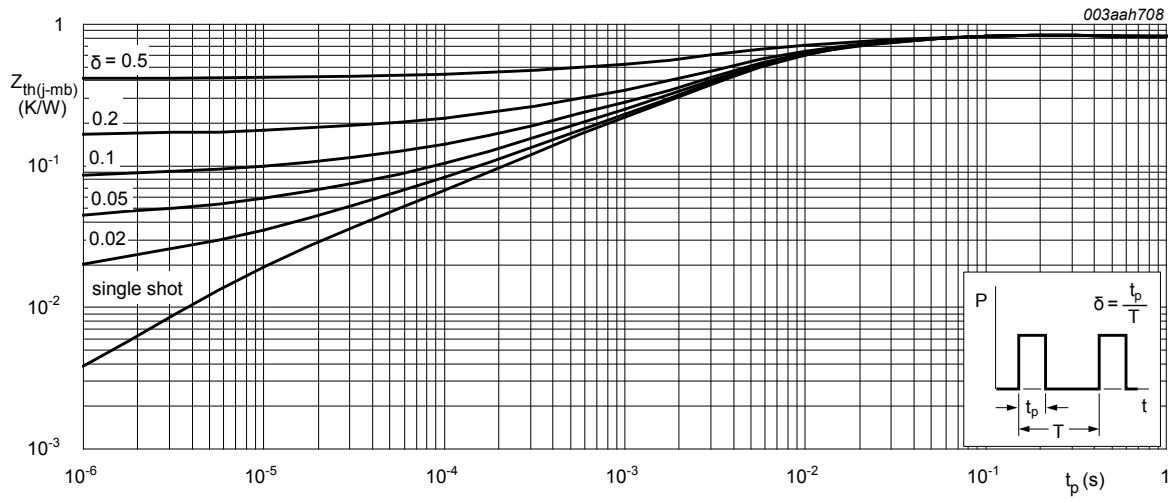


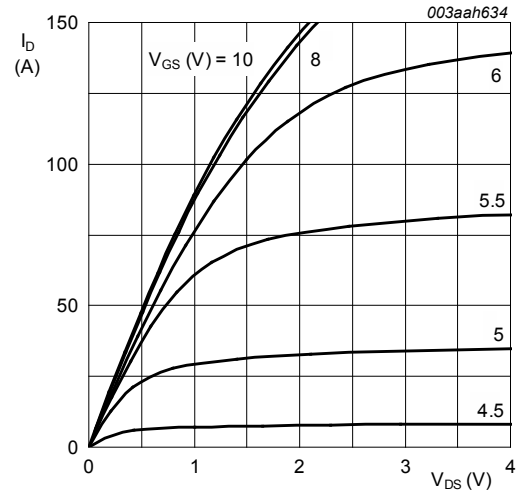

**Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration**

# 7. Characteristics

**Table 7. Characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | 100 | - | - | V |
| | | $I_D$ = 250 µA; $V_{GS}$ = 0 V; $T_j$ = -55 °C | | 90 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 25 °C; Fig. 9; Fig. 10 | | 2.4 | 3 | 4 | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = 175 °C; Fig. 9 | | 1 | - | - | V |
| | | $I_D$ = 1 mA; $V_{DS}$ = $V_{GS}$; $T_j$ = -55 °C; Fig. 9 | | - | - | 4.5 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 100 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | - | 0.06 | 1 | µA |
| | | $V_{DS}$ = 100 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; $I_D$ = 20 A; $T_j$ = 25 °C; Fig. 11 | | - | 10.2 | 13 | mΩ |
| | | $V_{GS}$ = 10 V; $I_D$ = 20 A; $T_j$ = 175 °C; Fig. 11; Fig. 12 | | - | - | 35.1 | mΩ |
| $R_G$ | gate resistance | f = 1 MHz | | 0.48 | 0.96 | 1.92 | Ω |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 20 A; $V_{DS}$ = 80 V; $V_{GS}$ = 10 V; $T_j$ = 25 °C; Fig. 13; Fig. 14 | | - | 69.4 | 97.2 | nC |
| $Q_{GS}$ | gate-source charge | | | - | 15.5 | 21.7 | nC |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $Q_{GD}$ | gate-drain charge | | | - | 25.4 | 35.6 | nC |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 20 V; f = 1 MHz; $T_j$ = 25 °C; Fig. 15 | | - | 3400 | 4533 | pF |
| $C_{oss}$ | output capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = 25 V; f = 1 MHz; $T_j$ = 25 °C; Fig. 15 | | - | 327 | 392 | pF |
| $C_{rss}$ | reverse transfer capacitance | | | - | 225 | 308 | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 80 V; $R_L$ = 4 Ω; $V_{GS}$ = 10 V; $R_{G(ext)}$ = 5 Ω | | - | 17.5 | 26.3 | ns |
| $t_r$ | rise time | | | - | 34 | 51 | ns |
| $t_{d(off)}$ | turn-off delay time | | | - | 44.8 | 67.2 | ns |
| $t_f$ | fall time | | | - | 34.1 | 51.2 | ns |
| $L_D$ | internal drain inductance | from upper edge of mounting base to centre of die | | - | 2.5 | - | nH |
| $L_S$ | internal source inductance | measured 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; Fig. 16 | | - | 0.83 | 1.2 | V |
| $t_{rr}$ | reverse recovery time | $I_S$ = 20 A; $dI_S/dt$ = -100 A/µs; $V_{GS}$ = 0 V; $V_{DS}$ = 25 V | | - | 48.8 | 63.4 | ns |
| $Q_r$ | recovered charge | | | - | 106 | 137.8 | nC |




$T_j$ = 25 °C; $t_p$ = 300 µs

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

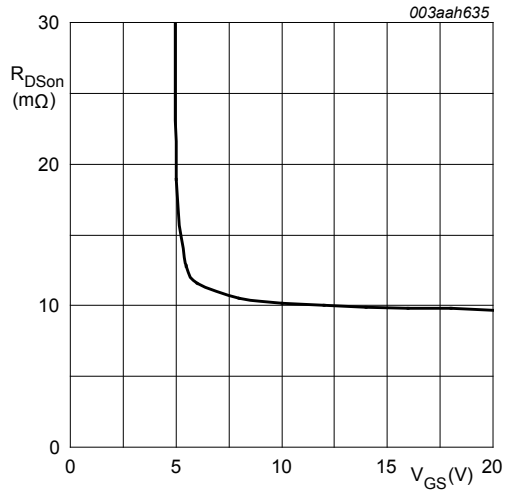



**Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values**

$T_j = 25°C;\ I_D = 20A$

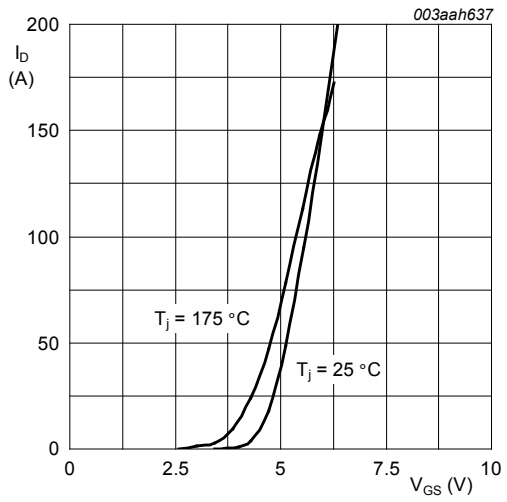



**Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values**

$V_{DS} = 10V$

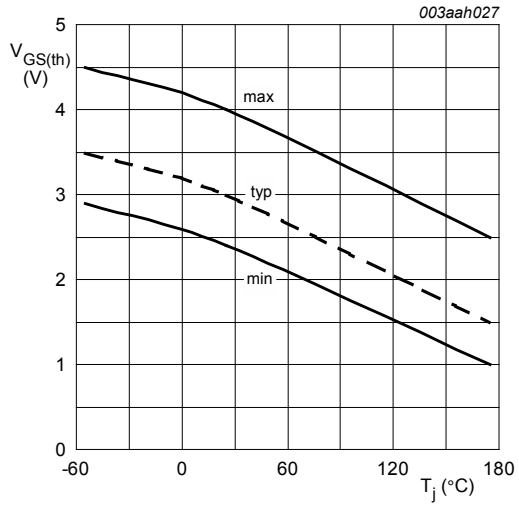



**Fig. 9. Gate-source threshold voltage as a function of junction temperature**

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

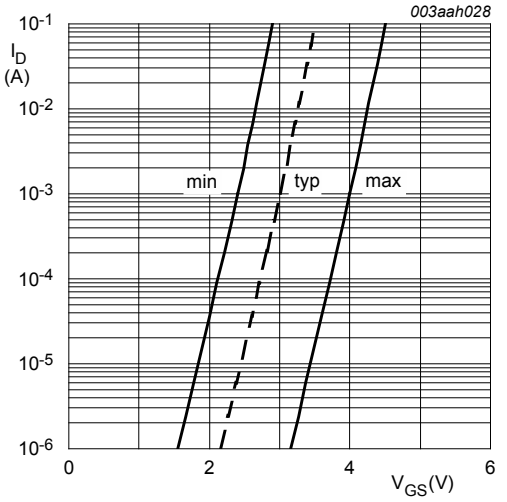
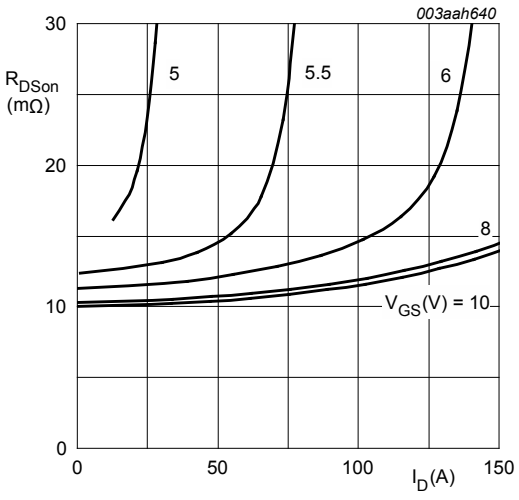



**Fig. 10. Sub-threshold drain current as a function of gate-source voltage**

$T_j = 25°C$; $V_{DS} = 5V$




$T_j$ = 25 °C; $t_p$ = 300 µs

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

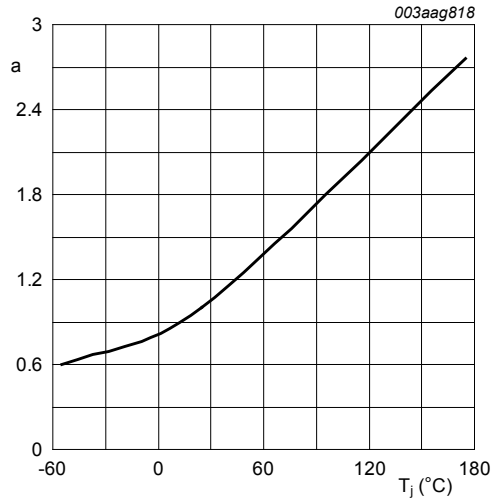



**Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature**

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

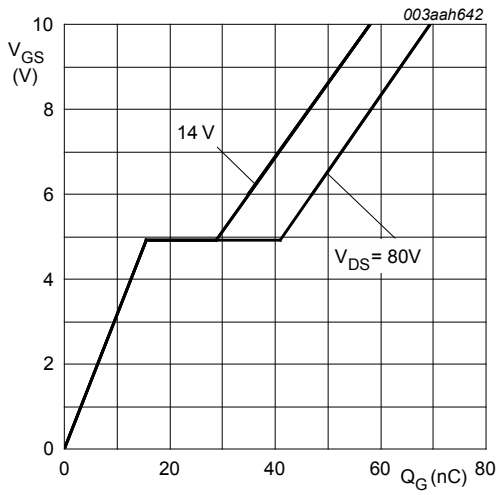



**Fig. 13. Gate-source voltage as a function of gate charge; typical values**

$$T_j = 25°C;\ I_D = 20A$$

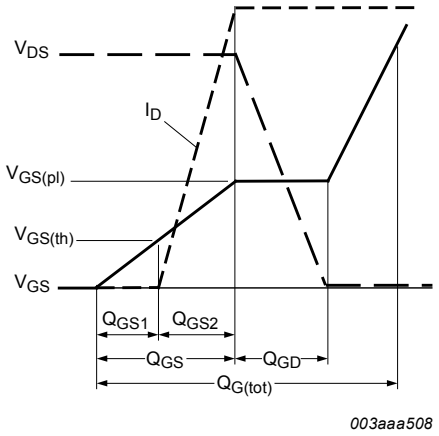



**Fig. 14. Gate charge waveform definitions**

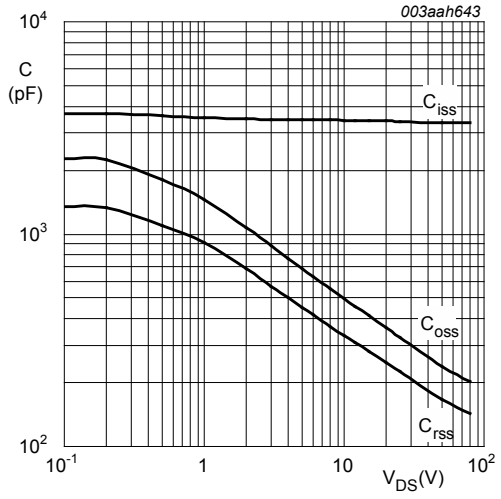



**Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**

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

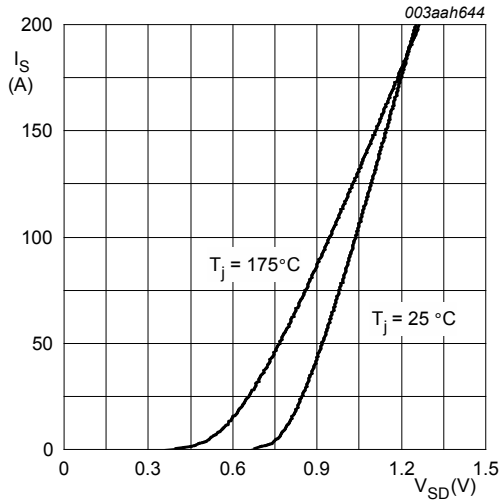
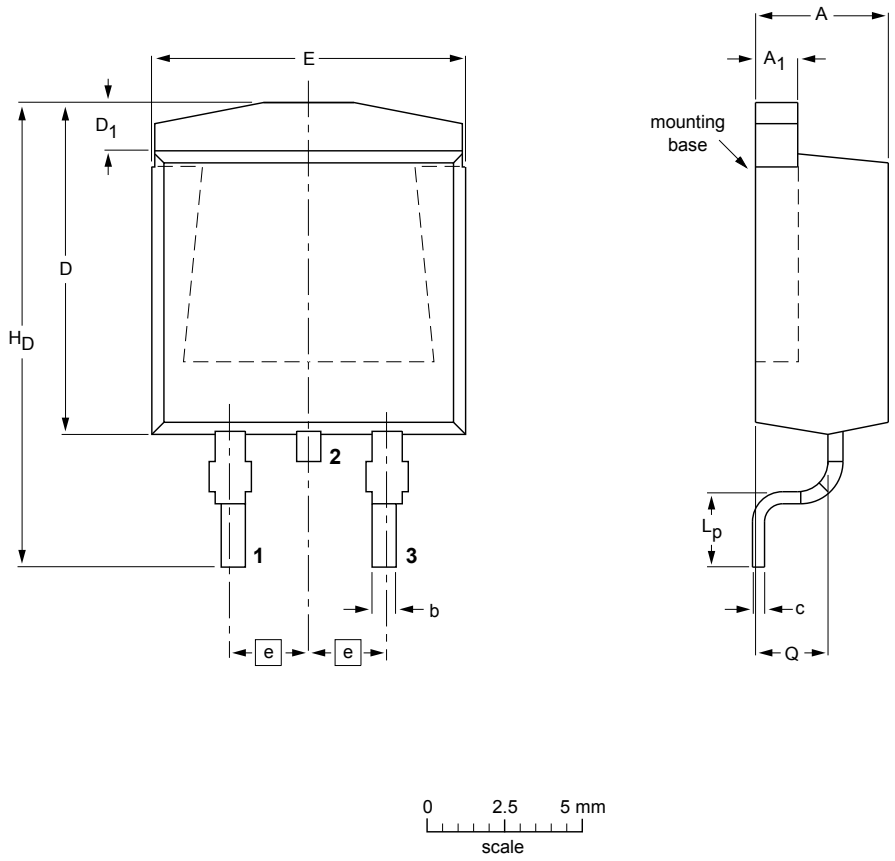



**Fig. 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values**

$V_{GS} = 0\,V$

# 8. Package outline

**Plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped)** **SOT404**




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

| UNIT | A | $A_1$ | b | c | D max. | $D_1$ | E | e | $L_p$ | $H_D$ | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.50<br>4.10 | 1.40<br>1.27 | 0.85<br>0.60 | 0.64<br>0.46 | 11 | 1.60<br>1.20 | 10.30<br>9.70 | 2.54 | 2.90<br>2.10 | 15.80<br>14.80 | 2.60<br>2.20 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT404 | | | | | | ~~05-02-11~~<br>06-03-16 |

**Fig. 17. Package outline D2PAK (SOT404)**

# 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. |
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[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. Contents





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