



# BUK963R2-40B

## N-channel TrenchMOS logic level FET

13 March 2014

Product data sheet

### 1. General description

Logic level N-channel enhancement mode Field-Effect Transistor (FET) in a plastic package using TrenchMOS technology. This product has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 2. Features and benefits

- AEC Q101 compliant
- Low conduction losses due to low on-state resistance
- Suitable for logic level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

### 3. Applications

- 12 V loads
- Automotive systems
- General purpose power switching
- Motors, lamps and solenoids

### 4. Quick reference data

Table 1. Quick reference data

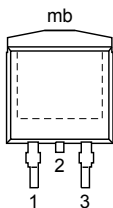
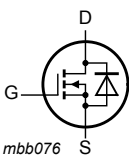
| Symbol                         | Parameter                        | Conditions  |     | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|-----|-----|-----|-----|------|
| $V_{DS}$                       | drain-source voltage             | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$   |     | -   | -   | 40  | V    |
| $I_D$                          | drain current                    | $V_{GS} = 5\text{ V}; T_{mb} = 25\text{ °C};$ <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>                   | [1] | -   | -   | 100 | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C};$ <a href="#">Fig. 1</a>   |     | -   | -   | 300 | W    |
| <b>Static characteristics</b>  |                                  |   |     |     |     |     |      |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 25\text{ A}; T_j = 25\text{ °C}$   |     | -   | 2.4 | 2.8 | mΩ   |
|                                |                                  | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 11</a> ; <a href="#">Fig. 12</a> |     | -   | 2.7 | 3.2 | mΩ   |
| <b>Dynamic characteristics</b> |                                  |   |     |     |     |     |      |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; V_{DS} = 32\text{ V};$ $T_j = 25\text{ °C};$ <a href="#">Fig. 13</a>   |     | -   | 37  | -   | nC   |

| Symbol                      | Parameter                                    | Conditions   | Min | Typ | Max | Unit |
|-----------------------------|--|--|-----|-----|-----|------|
| <b>Avalanche ruggedness</b> |  |  |     |     |     |      |
| $E_{DS(AL)S}$               | non-repetitive drain-source avalanche energy | $I_D = 100\text{ A}$ ; $V_{sup} \leq 40\text{ V}$ ; $R_{GS} = 50\ \Omega$ ;<br>$V_{GS} = 5\text{ V}$ ; $T_{j(\text{init})} = 25\text{ }^\circ\text{C}$ ; unclamped | -   | -   | 1.2 | J    |

[1] All individual parts of device must be  $\leq 175\text{ }^\circ\text{C}$  to achieve maximum current rating.

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline   | Graphic symbol  |
|-----|--------|-----------------------------------|--|---|
| 1   | G      | gate                              |  <p><b>D2PAK (SOT404)</b></p> |  <p>mbb076</p> |
| 2   | D      | drain[1]                          |  |   |
| 3   | S      | source                            |  |   |
| mb  | D      | mounting base; connected to drain |  |   |

[1] It is not possible to make connection to pin 2.

## 6. Ordering information

Table 3. Ordering information

| Type number  | Package |  |         |
|--------------|---------|--|---------|
|              | Name    | Description  | Version |
| BUK963R2-40B | D2PAK   | plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) | SOT404  |

## 7. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| BUK963R2-40B | BUK963R2-40B |

## 8. Limiting values

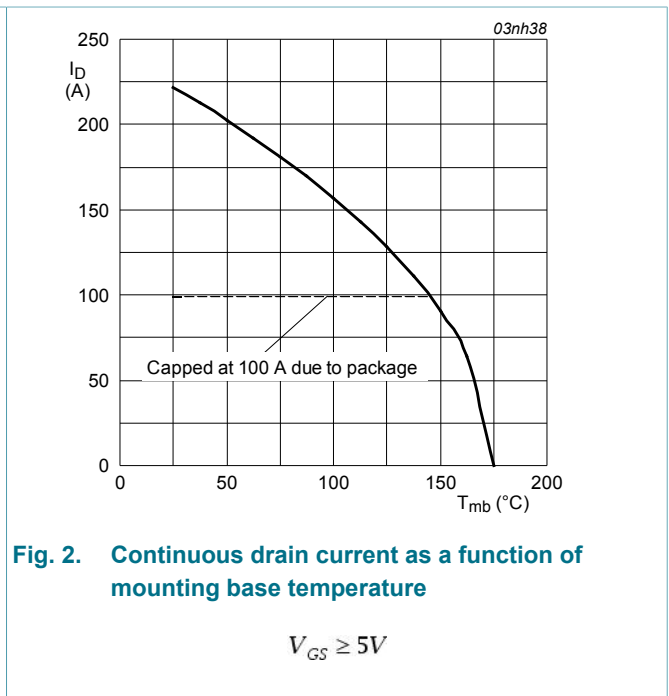
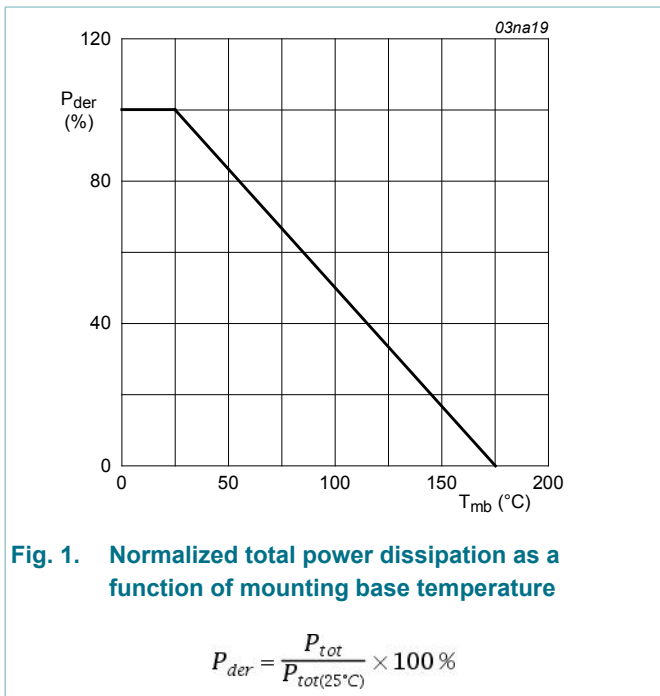
Table 5. Limiting values

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

| Symbol    | Parameter            | Conditions   | Min | Max | Unit |
|-----------|----------------------|--|-----|-----|------|
| $V_{DS}$  | drain-source voltage | $T_j \geq 25\text{ }^\circ\text{C}$ ; $T_j \leq 175\text{ }^\circ\text{C}$ | -   | 40  | V    |
| $V_{DGR}$ | drain-gate voltage   | $R_{GS} = 20\text{ k}\Omega$   | -   | 40  | V    |

| Symbol                      | Parameter                                    | Conditions  |     | Min | Max | Unit |
|-----------------------------|--|---|-----|-----|-----|------|
| V <sub>GS</sub>             | gate-source voltage                          |   |     | -15 | 15  | V    |
| P <sub>tot</sub>            | total power dissipation                      | T <sub>mb</sub> = 25 °C; <a href="#">Fig. 1</a>   |     | -   | 300 | W    |
| I <sub>D</sub>              | drain current                                | T <sub>mb</sub> = 25 °C; V <sub>GS</sub> = 5 V; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>   | [1] | -   | 222 | A    |
|                             |  | T <sub>mb</sub> = 100 °C; V <sub>GS</sub> = 5 V; <a href="#">Fig. 2</a>   | [2] | -   | 100 | A    |
|                             |  | T <sub>mb</sub> = 25 °C; V <sub>GS</sub> = 5 V; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>   | [2] | -   | 100 | A    |
| I <sub>DM</sub>             | peak drain current                           | T <sub>mb</sub> = 25 °C; pulsed; t <sub>p</sub> ≤ 10 μs; <a href="#">Fig. 3</a>   |     | -   | 888 | A    |
| T <sub>stg</sub>            | storage temperature                          |   |     | -55 | 175 | °C   |
| T <sub>j</sub>              | junction temperature                         |   |     | -55 | 175 | °C   |
| <b>Source-drain diode</b>   |  |   |     |     |     |      |
| I <sub>S</sub>              | source current                               | T <sub>mb</sub> = 25 °C   | [1] | -   | 222 | A    |
|                             |  |   | [2] | -   | 100 | A    |
| I <sub>SM</sub>             | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C   |     | -   | 888 | A    |
| <b>Avalanche ruggedness</b> |  |   |     |     |     |      |
| E <sub>DS(AL)S</sub>        | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 100 A; V <sub>sup</sub> ≤ 40 V; R <sub>GS</sub> = 50 Ω; V <sub>GS</sub> = 5 V; T <sub>j(init)</sub> = 25 °C; unclamped |     | -   | 1.2 | J    |

- [1] Current is limited by power dissipation chip rating.
- [2] All individual parts of device must be ≤ 175 °C to achieve maximum current rating.



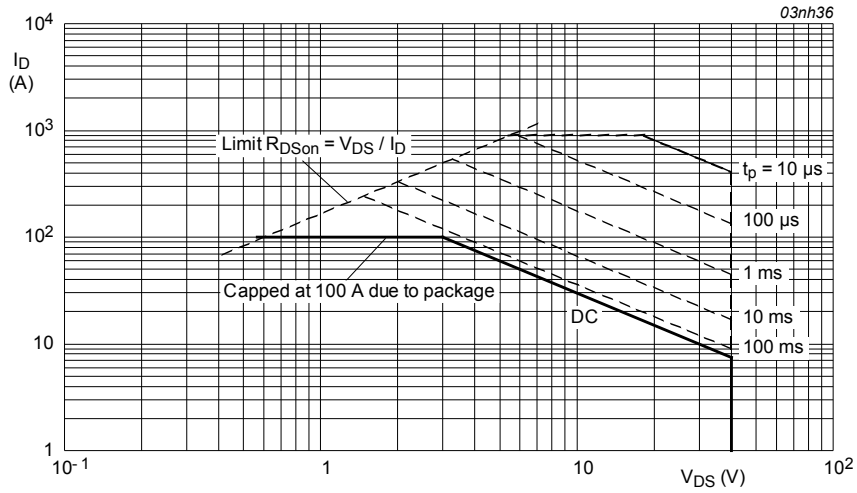


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

### 9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol         | Parameter   | Conditions  | Min | Typ | Max | Unit |
|----------------|---|---|-----|-----|-----|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | Fig. 4  | -   | -   | 0.5 | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | minimum footprint; mounted on a printed-circuit board | -   | 50  | -   | K/W  |

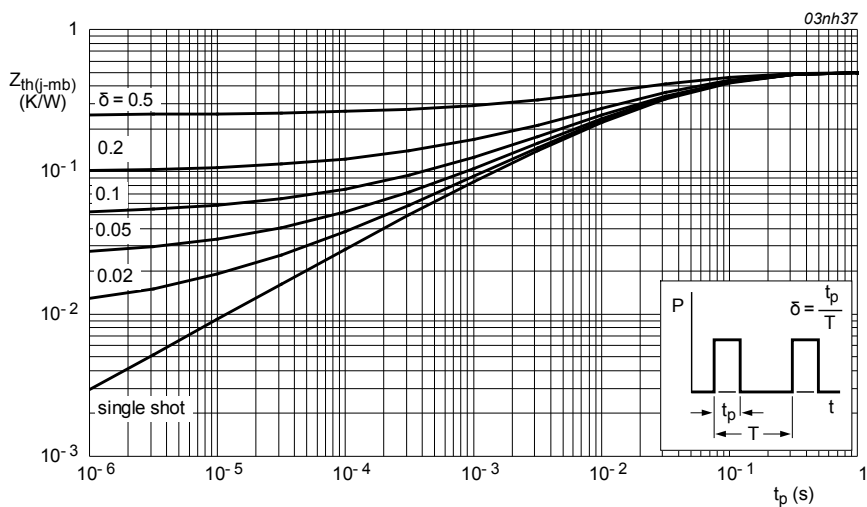


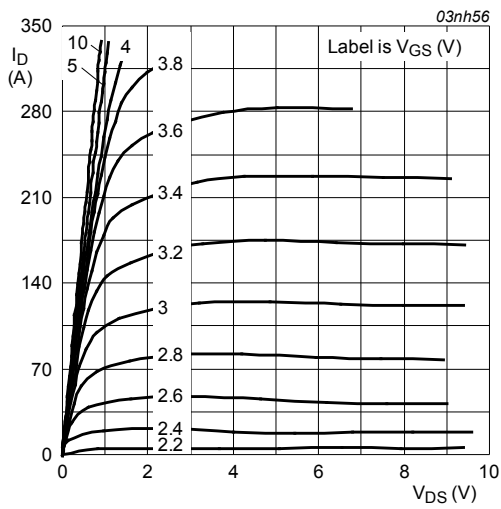
Fig. 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

Table 7. Characteristics

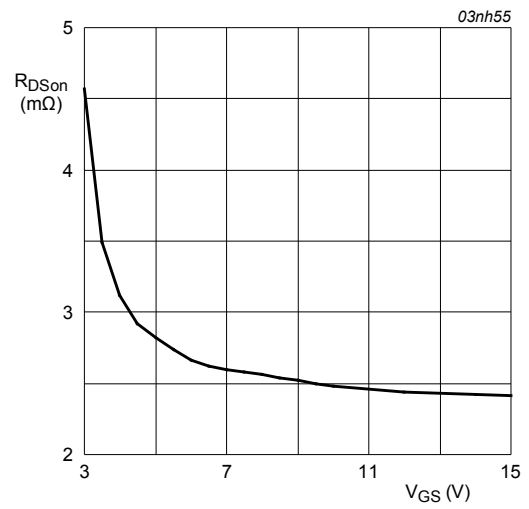
| Symbol                         | Parameter                        | Conditions   | Min   | Typ  | Max   | Unit          |
|--------------------------------|----------------------------------|--|---|------|-------|---------------|
| <b>Static characteristics</b>  |                                  |  |   |      |       |               |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$  | 36  | -    | -     | V             |
|                                |                                  | $I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$   | 40  | -    | -     | V             |
| $V_{GS(th)}$                   | gate-source threshold voltage    | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C};$<br><a href="#">Fig. 10</a>                               | 1.1   | 1.5  | 2     | V             |
|                                |                                  | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$<br><a href="#">Fig. 10</a>                              | 0.5   | -    | -     | V             |
|                                |                                  | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$<br><a href="#">Fig. 10</a>                              | -   | -    | 2.3   | V             |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$   | -   | 0.02 | 1     | $\mu\text{A}$ |
|                                |                                  | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$  | -   | -    | 500   | $\mu\text{A}$ |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 15 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$   | -   | 2    | 100   | nA            |
|                                |                                  | $V_{GS} = -15 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$  | -   | 2    | 100   | nA            |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$   | -   | 2.4  | 2.8   | m $\Omega$    |
|                                |                                  | $V_{GS} = 4.5 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$  | -   | -    | 3.5   | m $\Omega$    |
|                                |                                  | $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$<br><a href="#">Fig. 11; Fig. 12</a>                | -   | -    | 6     | m $\Omega$    |
|                                |                                  | $V_{GS} = 5 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$<br><a href="#">Fig. 11; Fig. 12</a>                 | -   | 2.7  | 3.2   | m $\Omega$    |
| <b>Dynamic characteristics</b> |                                  |  |   |      |       |               |
| $Q_{G(tot)}$                   | total gate charge                | $I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 5 \text{ V};$<br>$T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 13</a> | -   | 94   | -     | nC            |
| $Q_{GS}$                       | gate-source charge               |  | -   | 17   | -     | nC            |
| $Q_{GD}$                       | gate-drain charge                |  | -   | 37   | -     | nC            |
| $C_{iss}$                      | input capacitance                | $V_{GS} = 0 \text{ V}; V_{DS} = 25 \text{ V}; f = 1 \text{ MHz};$<br>$T_j = 25 \text{ }^\circ\text{C};$ <a href="#">Fig. 14</a>  | -   | 7877 | 10502 | pF            |
| $C_{oss}$                      | output capacitance               |  | -   | 1397 | 1676  | pF            |
| $C_{rss}$                      | reverse transfer capacitance     |  | -   | 608  | 833   | pF            |
| $t_{d(on)}$                    | turn-on delay time               |  | $V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ } \Omega; V_{GS} = 5 \text{ V};$<br>$R_{G(ext)} = 10 \text{ } \Omega; T_j = 25 \text{ }^\circ\text{C}$ | -    | 68    | -             |
| $t_r$                          | rise time                        | -  |   | 268  | -     | ns            |
| $t_{d(off)}$                   | turn-off delay time              | -  |   | 257  | -     | ns            |
| $t_f$                          | fall time                        | -  |   | 192  | -     | ns            |
| $L_D$                          | internal drain inductance        | from drain lead 6 mm from package to center of die; $T_j = 25 \text{ }^\circ\text{C}$  | -   | 4.5  | -     | nH            |

| Symbol                    | Parameter                  | Conditions   | Min | Typ  | Max | Unit |
|---------------------------|----------------------------|--|-----|------|-----|------|
|                           |                            | from upper edge of drain mounting base to center of die; $T_j = 25\text{ }^\circ\text{C}$                | -   | 2.5  | -   | nH   |
| $L_S$                     | internal source inductance | from source lead to source bond pad; $T_j = 25\text{ }^\circ\text{C}$                                    | -   | 7.5  | -   | nH   |
| <b>Source-drain diode</b> |                            |  |     |      |     |      |
| $V_{SD}$                  | source-drain voltage       | $I_S = 40\text{ A}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 15</a> | -   | 0.85 | 1.2 | V    |
| $t_{rr}$                  | reverse recovery time      | $I_S = 20\text{ A}$ ; $dI_S/dt = -100\text{ A}/\mu\text{s}$ ;  | -   | 70   | -   | ns   |
| $Q_r$                     | recovered charge           | $V_{GS} = -10\text{ V}$ ; $V_{DS} = 20\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$                      | -   | 127  | -   | nC   |



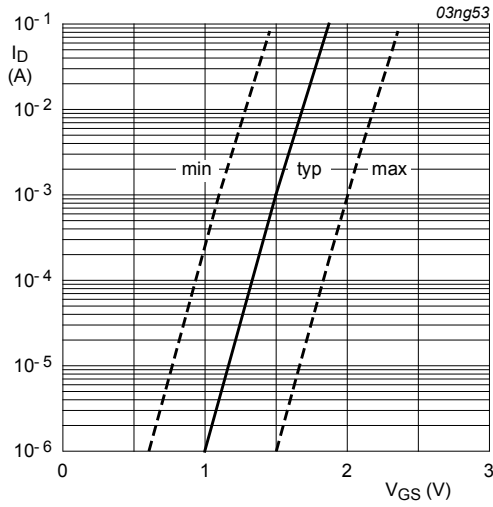
**Fig. 5. Output characteristics: drain current as a function of drain-source voltage; typical values**

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



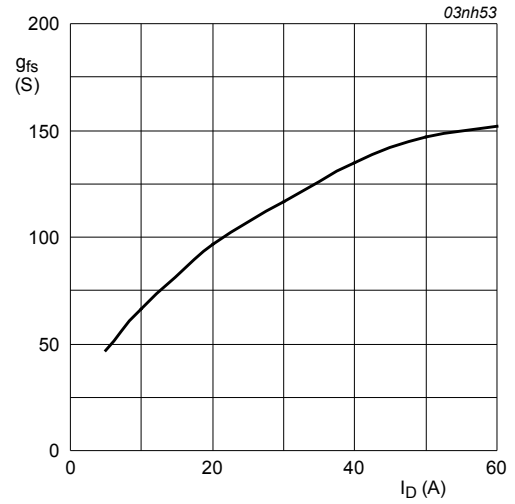
**Fig. 6. Drain-source on-state resistance as a function of gate-source voltage; typical values**

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



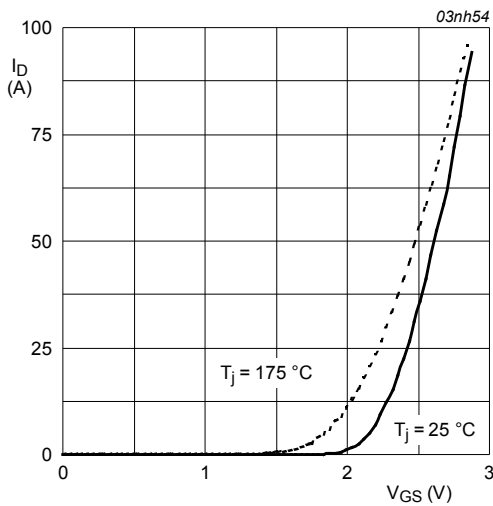
**Fig. 7. Sub-threshold drain current as a function of gate-source voltage**

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



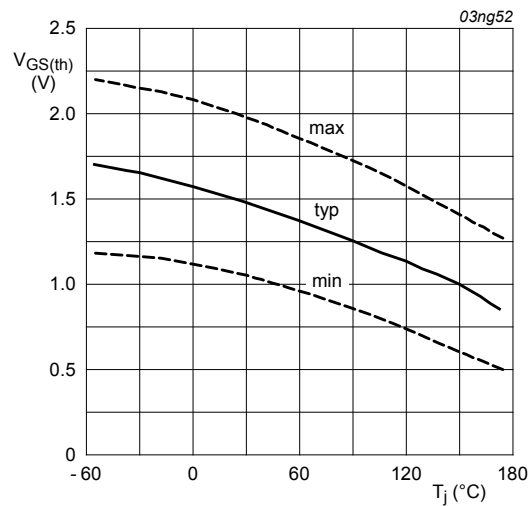
**Fig. 8. Forward transconductance as a function of drain current; typical values**

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



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

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



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

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

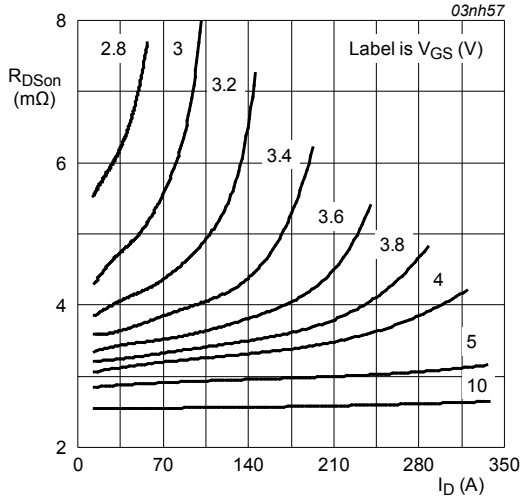


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

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

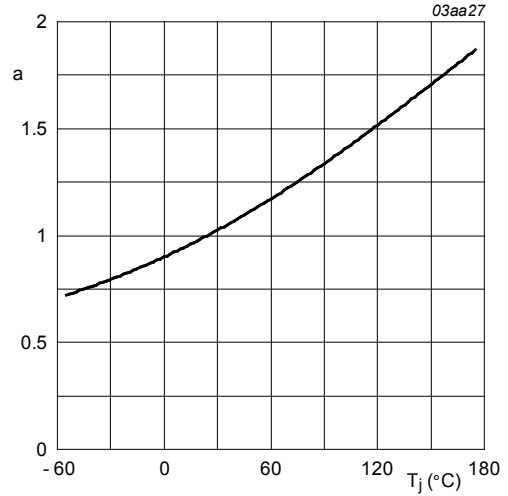


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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

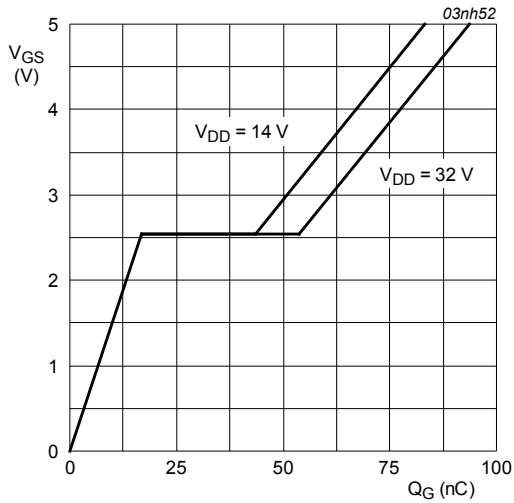


Fig. 13. Gate-source voltage as a function of gate charge; typical values

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

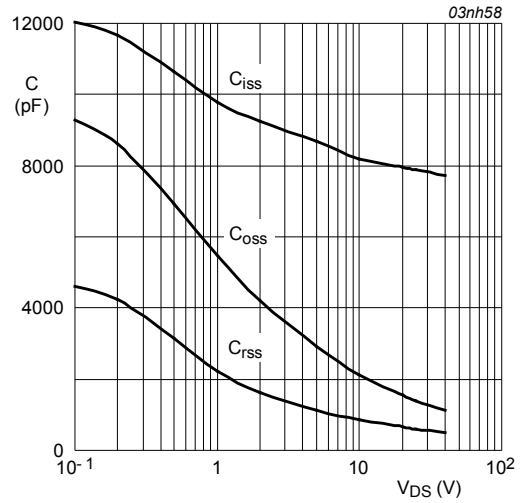


Fig. 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

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



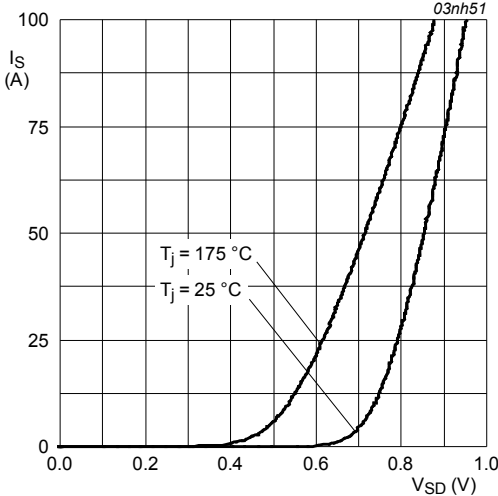
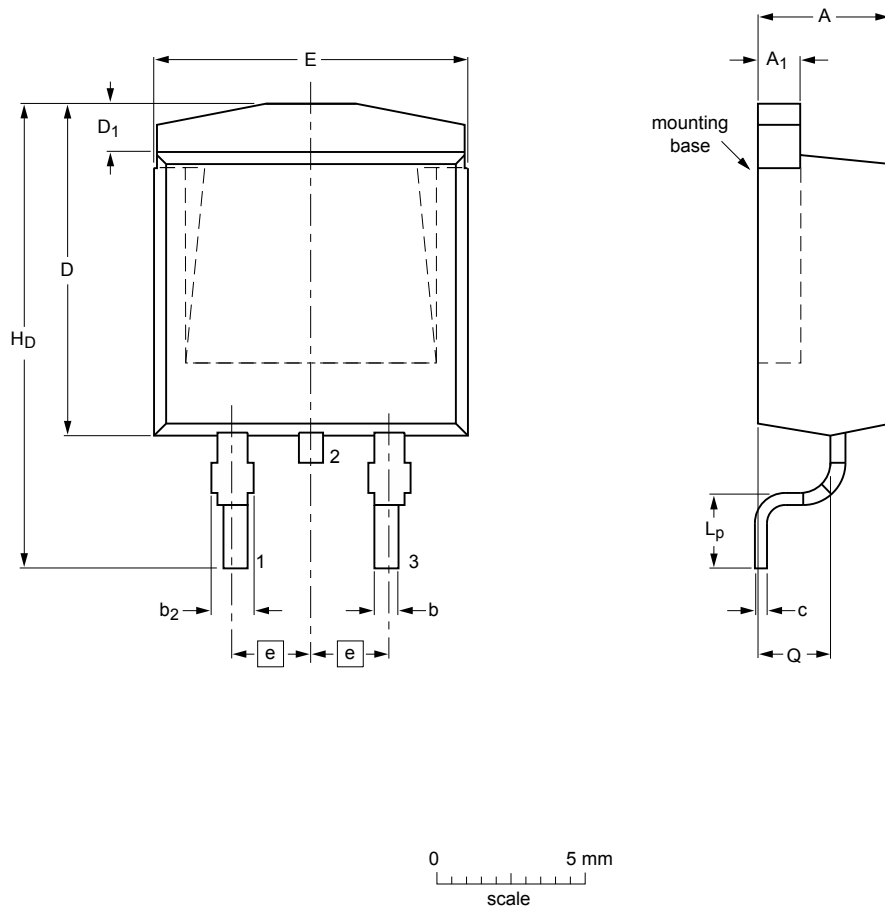


Fig. 15. Source current as a function of source-drain voltage; typical values

$V_{GS} = 0V$

### 11. Package outline

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



Dimensions (mm are the original dimensions)

| Unit | A   | A <sub>1</sub> | b    | b <sub>2</sub> | c    | D  | D <sub>1</sub> | E    | e    | H <sub>D</sub> | L <sub>p</sub> | Q   |
|------|-----|----------------|------|----------------|------|----|----------------|------|------|----------------|----------------|-----|
| max  | 4.5 | 1.40           | 0.85 | 1.45           | 0.64 | 11 | 1.6            | 10.3 |      | 15.8           | 2.9            | 2.6 |
| nom  |     |                |      |                |      |    |                |      | 2.54 |                |                |     |
| min  | 4.1 | 1.27           | 0.60 | 1.05           | 0.46 |    | 1.2            | 9.7  |      | 14.8           | 2.1            | 2.2 |

sot404\_po

| Outline version | References |       |       | European projection | Issue date             |
|-----------------|------------|-------|-------|---------------------|------------------------|
|                 | IEC        | JEDEC | JEITA |                     |                        |
| SOT404          |            |       |       |                     | -06-03-16-<br>13-02-25 |

Fig. 16. Package outline D2PAK (SOT404)

## 12. Legal information

### 12.1 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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