



# BUK765R2-40B

N-channel TrenchMOS standard level FET

Rev. 3 — 22 November 2011

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 has been designed and qualified to the appropriate AEC standard for use in automotive critical applications.

### 1.2 Features and benefits

- Q101 compliant
- Suitable for standard level gate drive sources
- Suitable for thermally demanding environments due to 175 °C rating

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1. Quick reference data

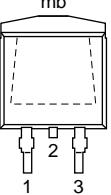
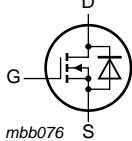
| Symbol                         | Parameter                                    | Conditions  | Min | Typ | Max | Unit             |
|--------------------------------|--|---|-----|-----|-----|------------------|
| $V_{DS}$                       | drain-source voltage                         | $T_j \geq 25 \text{ }^\circ\text{C}; T_j \leq 175 \text{ }^\circ\text{C}$   | -   | -   | 40  | V                |
| $I_D$                          | drain current                                | $V_{GS} = 10 \text{ V}; T_{mb} = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 1</a> ; <a href="#">[1]</a> see <a href="#">Figure 3</a>   | -   | -   | 75  | A                |
| $P_{tot}$                      | total power dissipation                      | $T_{mb} = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 2</a>   | -   | -   | 203 | W                |
| <b>Static characteristics</b>  |  |   |     |     |     |                  |
| $R_{DSon}$                     | drain-source on-state resistance             | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>    | -   | 4.4 | 5.2 | $\text{m}\Omega$ |
| <b>Dynamic characteristics</b> |  |   |     |     |     |                  |
| $Q_{GD}$                       | gate-drain charge                            | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$ ; see <a href="#">Figure 13</a>             | -   | 16  | -   | nC               |
| <b>Avalanche ruggedness</b>    |  |   |     |     |     |                  |
| $E_{DS(AL)S}$                  | non-repetitive drain-source avalanche energy | $I_D = 75 \text{ A}; V_{sup} \leq 40 \text{ V}; R_{GS} = 50 \Omega; V_{GS} = 10 \text{ V}; T_{j(init)} = 25 \text{ }^\circ\text{C}$ ; unclamped | -   | -   | 494 | $\text{mJ}$      |

[1] Continuous current is limited by package.

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## 2. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline  | Graphic symbol  |
|-----|--------|-----------------------------------|---|---|
| 1   | G      | gate                              |   |   |
| 2   | D      | drain <sup>[1]</sup>              |   |   |
| 3   | S      | source                            |   |   |
| mb  | D      | mounting base; connected to drain |  |  |

SOT404 (D2PAK)

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

## 3. Ordering information

Table 3. Ordering information

| Type number  | Package | Version |  |
|--------------|---------|---------|--|
|              |         | Name    | Description  |
| BUK765R2-40B | D2PAK   |         | plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) |

## 4. Limiting values

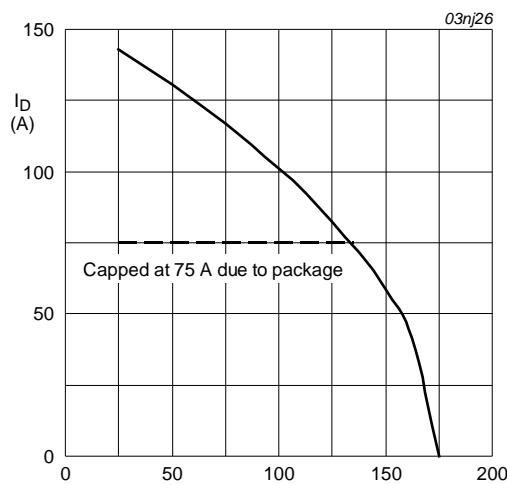
**Table 4. Limiting values**

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

| Symbol                      | Parameter                                    | Conditions   | Min   | Max | Unit |
|-----------------------------|--|--|-------|-----|------|
| $V_{DS}$                    | drain-source voltage                         | $T_j \geq 25^\circ\text{C}; T_j \leq 175^\circ\text{C}$  | -     | 40  | V    |
| $V_{DGR}$                   | drain-gate voltage                           | $R_{GS} = 20\text{ k}\Omega$   | -     | 40  | V    |
| $V_{GS}$                    | gate-source voltage                          |  | -20   | 20  | V    |
| $I_D$                       | drain current                                | $T_{mb} = 25^\circ\text{C}; V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 1</a> ; see <a href="#">Figure 3</a>                            | [1] - | 143 | A    |
|                             |  | $T_{mb} = 100^\circ\text{C}; V_{GS} = 10\text{ V}$ ; see <a href="#">Figure 1</a>  | [2] - | 75  | A    |
| $I_{DM}$                    | peak drain current                           | $T_{mb} = 25^\circ\text{C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; see <a href="#">Figure 3</a>                                      | -     | 573 | A    |
| $P_{tot}$                   | total power dissipation                      | $T_{mb} = 25^\circ\text{C}$ ; see <a href="#">Figure 2</a>   | -     | 203 | W    |
| $T_{stg}$                   | storage temperature                          |  | -55   | 175 | °C   |
| $T_j$                       | junction temperature                         |  | -55   | 175 | °C   |
| <b>Source-drain diode</b>   |  |  |       |     |      |
| $I_S$                       | source current                               | $T_{mb} = 25^\circ\text{C}$  | [1] - | 143 | A    |
|                             |  |  | [2] - | 75  | A    |
| $I_{SM}$                    | peak source current                          | pulsed; $t_p \leq 10\text{ }\mu\text{s}; T_{mb} = 25^\circ\text{C}$  | -     | 573 | A    |
| <b>Avalanche ruggedness</b> |  |  |       |     |      |
| $E_{DS(AL)S}$               | non-repetitive drain-source avalanche energy | $I_D = 75\text{ A}; V_{sup} \leq 40\text{ V}; R_{GS} = 50\text{ }\Omega; V_{GS} = 10\text{ V}; T_{j(init)} = 25^\circ\text{C}$ ; unclamped | -     | 494 | mJ   |

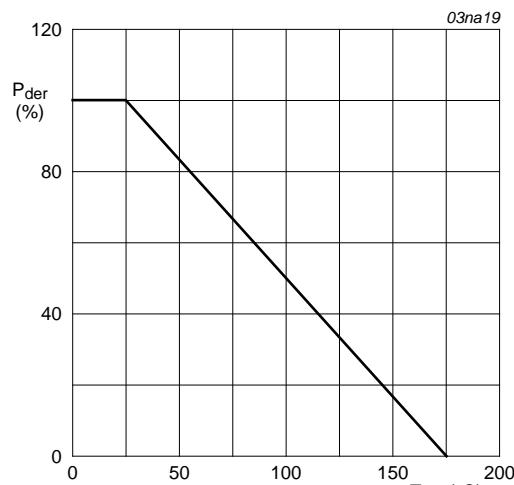
[1] Current is limited by power dissipation chip rating.

[2] Continuous current is limited by package.

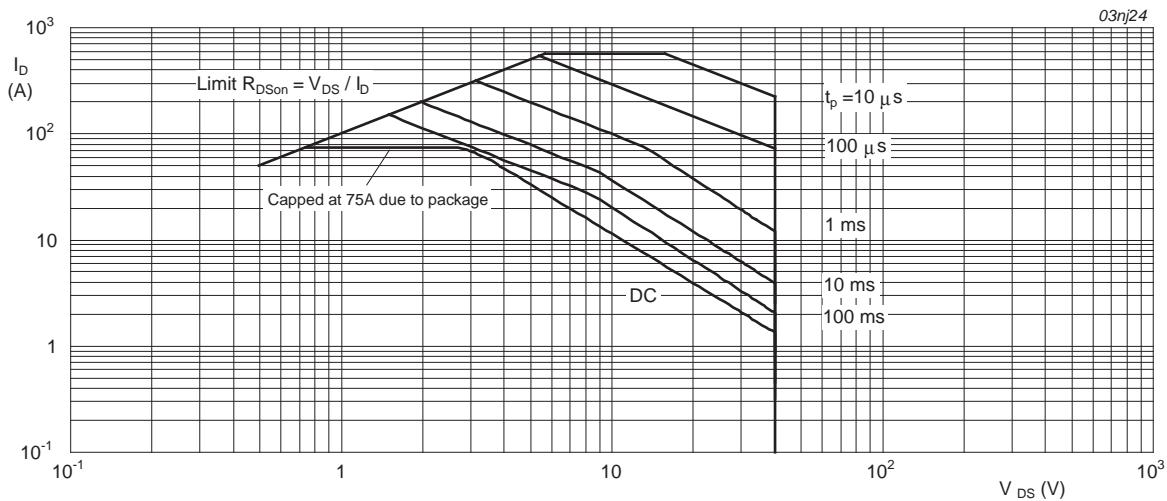


$V_{GS} \geq 4.5\text{V}$

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



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



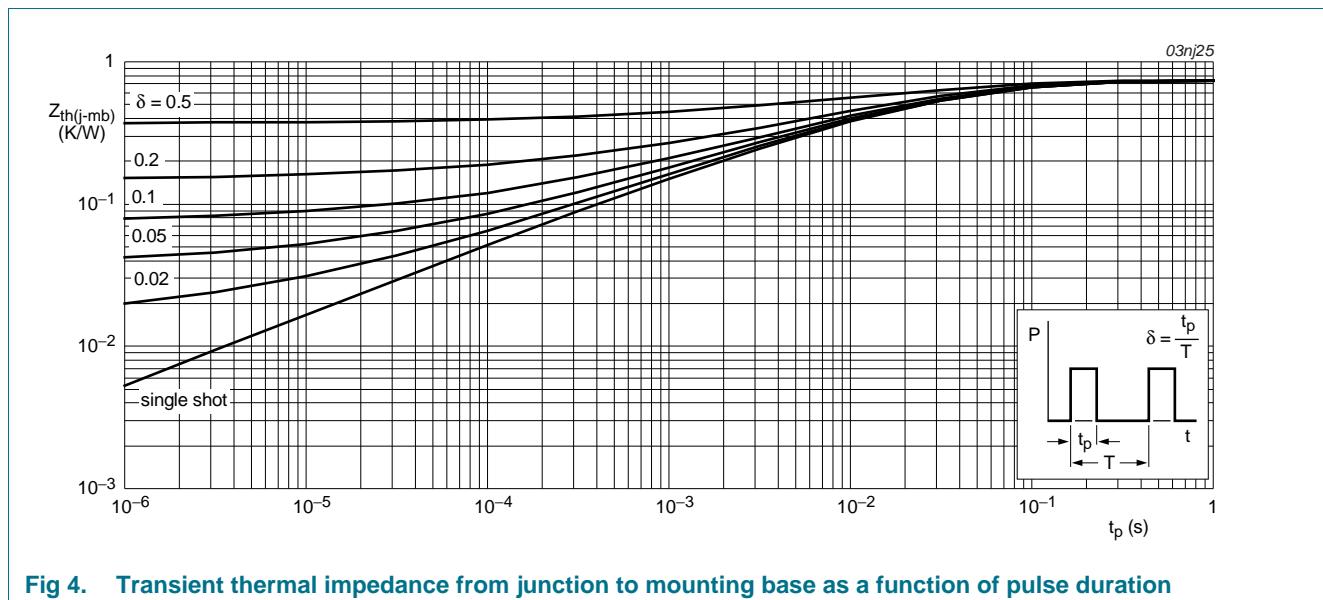
$T_{mb} = 25^\circ C$ ;  $I_{DM}$  is single pulse

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 <a href="#">Figure 4</a>                           | -   | -   | 0.74 | K/W  |
| $R_{th(j\text{-}a)}$  | thermal resistance from junction to ambient       | minimum footprint ; mounted on a printed-circuit board | -   | 50  | -    | K/W  |

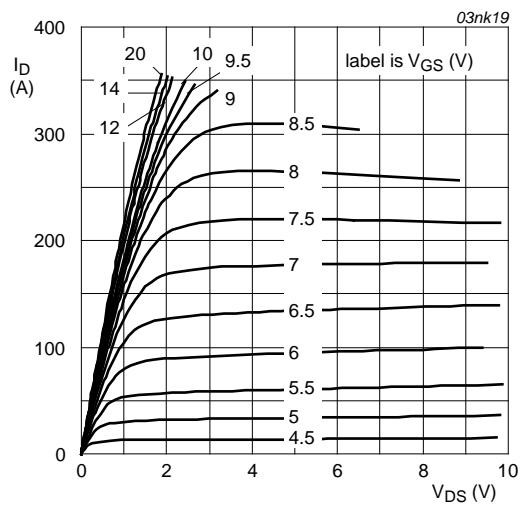


**Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration**

## 6. Characteristics

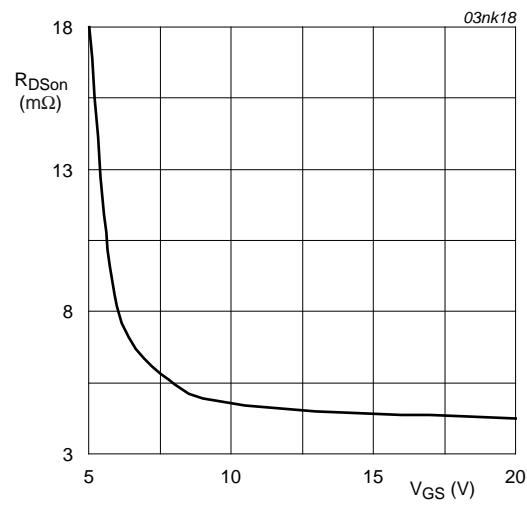
**Table 6. Characteristics**

| Symbol                         | Parameter                        | Conditions   | Min | Typ  | Max  | Unit             |
|--------------------------------|----------------------------------|--|-----|------|------|------------------|
| <b>Static characteristics</b>  |                                  |  |     |      |      |                  |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$<br>$I_D = 0.25 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = -55 \text{ }^\circ\text{C}$  | 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>see <a href="#">Figure 10</a><br>$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ\text{C};$<br>see <a href="#">Figure 10</a><br>$I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ\text{C};$<br>see <a href="#">Figure 10</a> | 2   | 3    | 4    | V                |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$<br>$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ }^\circ\text{C}$  | -   | 0.02 | 1    | $\mu\text{A}$    |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$<br>$V_{GS} = -20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$  | -   | 2    | 100  | nA               |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 175 \text{ }^\circ\text{C};$<br>see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a><br>$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 \text{ }^\circ\text{C};$<br>see <a href="#">Figure 11</a> ; see <a href="#">Figure 12</a>                                  | -   | -    | 9.9  | $\text{m}\Omega$ |
| <b>Dynamic characteristics</b> |                                  |  |     |      |      |                  |
| $Q_{G(\text{tot})}$            | total gate charge                | $I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V};$  | -   | 52   | -    | nC               |
| $Q_{GS}$                       | gate-source charge               | $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 13</a>   | -   | 12   | -    | nC               |
| $Q_{GD}$                       | gate-drain charge                |  | -   | 16   | -    | nC               |
| $C_{iss}$                      | input capacitance                | $V_{GS} = 0 \text{ V}; V_{DS} = 25 \text{ V}; f = 1 \text{ MHz};$  | -   | 2842 | 3789 | pF               |
| $C_{oss}$                      | output capacitance               | $T_j = 25 \text{ }^\circ\text{C};$ see <a href="#">Figure 14</a>   | -   | 711  | 853  | pF               |
| $C_{rss}$                      | reverse transfer capacitance     |  | -   | 296  | 406  | pF               |
| $t_{d(on)}$                    | turn-on delay time               | $V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ }\Omega; V_{GS} = 10 \text{ V};$  | -   | 15   | -    | ns               |
| $t_r$                          | rise time                        | $R_{G(\text{ext})} = 10 \text{ }\Omega; T_j = 25 \text{ }^\circ\text{C}$   | -   | 51   | -    | ns               |
| $t_{d(off)}$                   | turn-off delay time              |  | -   | 81   | -    | ns               |
| $t_f$                          | fall time                        |  | -   | 56   | -    | ns               |
| $L_D$                          | internal drain inductance        | from drain lead 6 mm from package to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$<br>from upper edge of drain mounting base to centre of die ; $T_j = 25 \text{ }^\circ\text{C}$  | -   | 4.5  | -    | 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             | $I_S = 25 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C};$<br>see <a href="#">Figure 15</a>  | -   | 0.85 | 1.2  | V                |
| $t_{rr}$                       | reverse recovery time            | $I_S = 20 \text{ A}; dI_S/dt = -100 \text{ A}/\mu\text{s};$<br>$V_{GS} = -10 \text{ V}; V_{DS} = 20 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$  | -   | 54   | -    | ns               |
| $Q_r$                          | recovered charge                 |  | -   | 38   | -    | nC               |



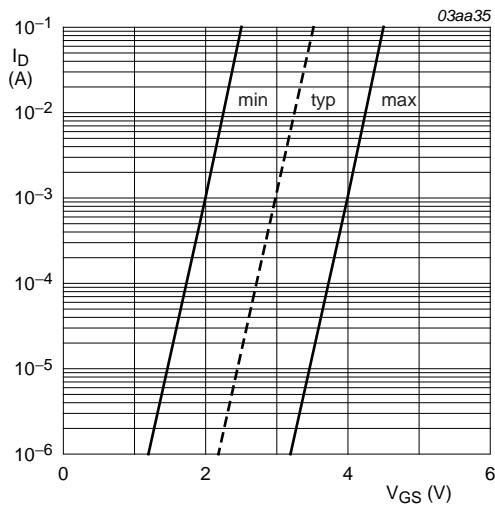
$T_j = 25^\circ C; t_p = 300\mu s$

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



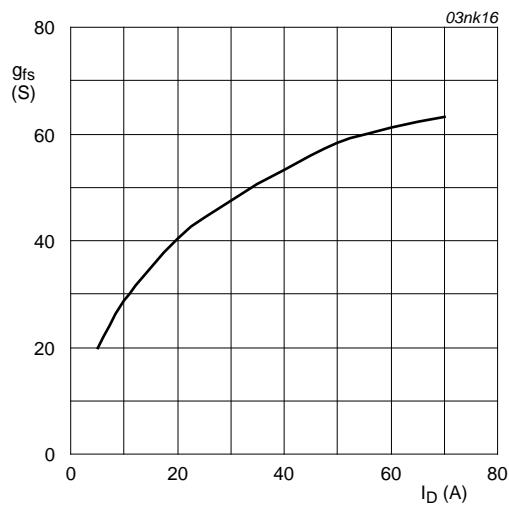
$T_j = 25^\circ C; I_D = 25A$

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



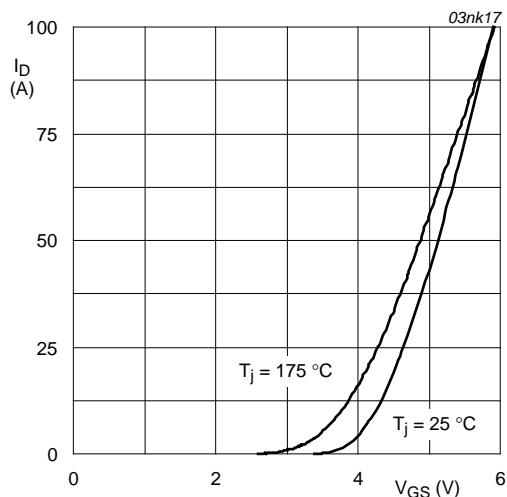
$T_j = 25^\circ C; V_{DS} = 5V$

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



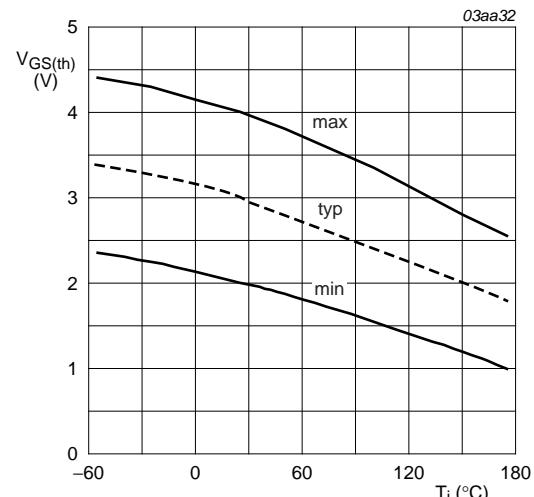
$T_j = 25^\circ C; V_{DS} = 25V$

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



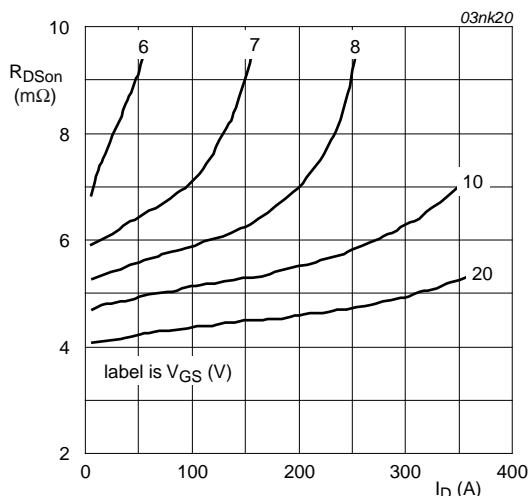
$V_{DS} = 25V$

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



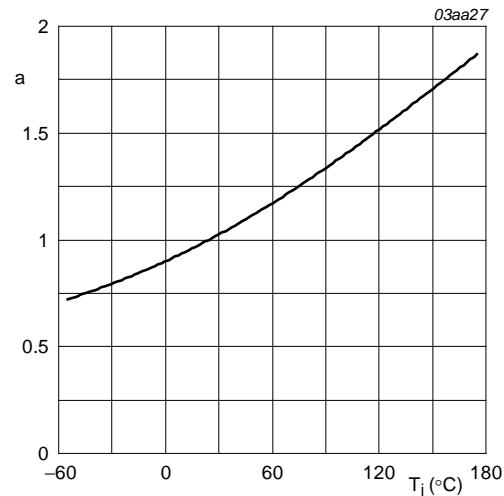
$I_D = 1mA; V_{DS} = V_{GS}$

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



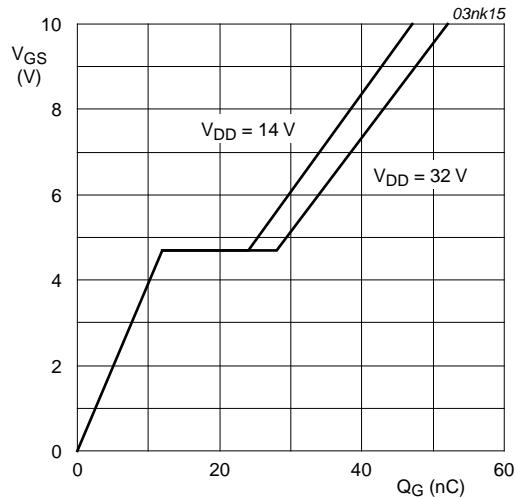
$T_j = 25°C$

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



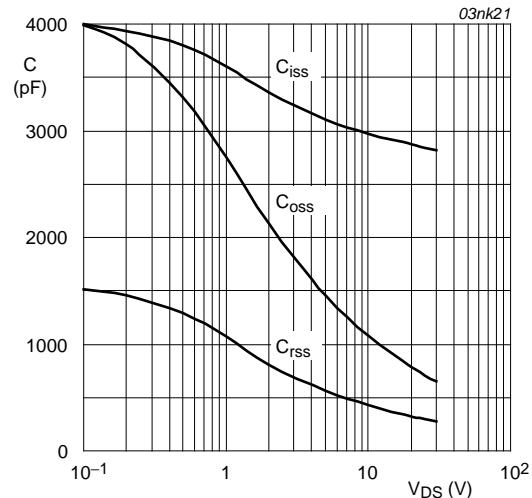
$$a = \frac{R_{DSon}}{R_{DSon}(25°C)}$$

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



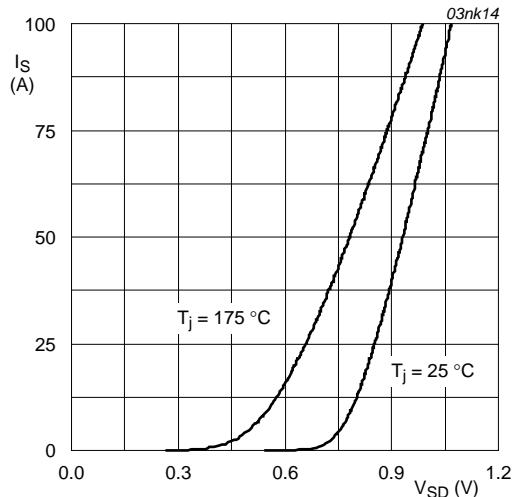
$T_j = 25^\circ\text{C}$ ;  $I_D = 25\text{A}$

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



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

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



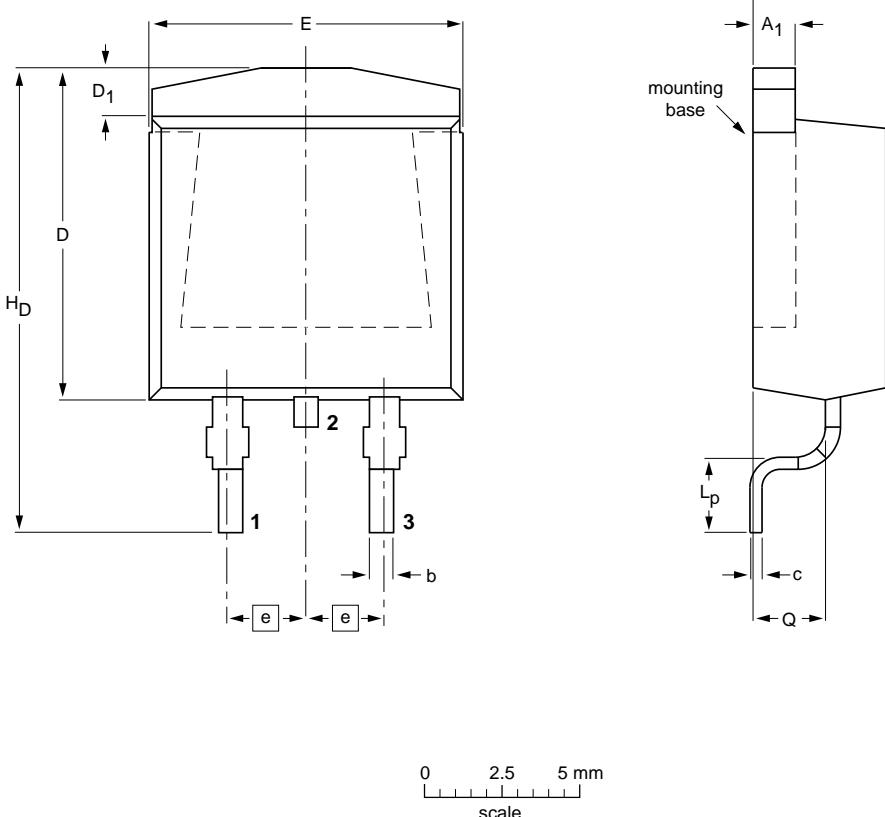
$V_{GS} = 0\text{V}$

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

## 7. 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            | c            | D <sub>max.</sub> | D <sub>1</sub> | E             | e    | L <sub>p</sub> | H <sub>D</sub> | 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 16. Package outline SOT404 (D2PAK)

## 8. Revision history

**Table 7. Revision history**

| Document ID      | Release date | Data sheet status             | Change notice | Supersedes          |
|------------------|--------------|-------------------------------|---------------|---------------------|
| BUK765R2-40B v.3 | 20111122     | Product data sheet            | -             | BUK765R2-40B v.2    |
| Modifications:   |              | • Various changes to content. |               |                     |
| BUK765R2-40B v.2 | 20090116     | Product data sheet            | -             | BUK75_765R2_40B v.1 |

## 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.nexperia.com>.

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## 11. Contents

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