



# BUK9Y3R0-40E

N-channel 40 V 3.0 mΩ logic level MOSFET in LFPAK56

12 February 2013

Product data sheet

## 1. General description

Logic level N-channel MOSFET in LFPAK56 (Power SO8) package using TrenchMOS technology. This product has been designed and qualified to AEC Q101 standard for use in high performance automotive applications.

## 2. Features and benefits

- Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True logic level gate with  $V_{GS(th)}$  rating of greater than 0.5 V at 175 °C

## 3. Applications

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

## 4. Quick reference data

Table 1. Quick reference data

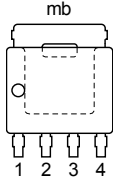
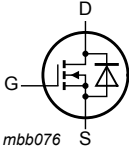
| Symbol                         | Parameter                        | Conditions  | Min | Typ  | Max | Unit |
|--------------------------------|----------------------------------|---|-----|------|-----|------|
| $V_{DS}$                       | drain-source voltage             | $T_j \geq 25\text{ °C}; T_j \leq 175\text{ °C}$   | -   | -    | 40  | V    |
| $I_D$                          | drain current                    | $V_{GS} = 5\text{ V}; T_{mb} = 25\text{ °C};$ <a href="#">Fig. 1</a>                                | [1] | -    | 100 | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C};$ <a href="#">Fig. 2</a>   | -   | -    | 194 | W    |
| <b>Static characteristics</b>  |                                  |   |     |      |     |      |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; T_j = 25\text{ °C};$ <a href="#">Fig. 11</a>               | -   | 2.47 | 3   | mΩ   |
| <b>Dynamic characteristics</b> |                                  |   |     |      |     |      |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 5\text{ V}; I_D = 25\text{ A}; V_{DS} = 32\text{ V};$<br><a href="#">Fig. 13; Fig. 14</a> | -   | 10.7 | -   | nC   |

[1] Continuous current is limited by package.



## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description                       | Simplified outline   | Graphic symbol  |
|-----|--------|-----------------------------------|--|---|
| 1   | S      | source                            |  <p><b>LFAK56; Power-SO8 (SOT669)</b></p> |  |
| 2   | S      | source                            |  |   |
| 3   | S      | source                            |  |   |
| 4   | G      | gate                              |  |   |
| mb  | D      | mounting base; connected to drain |  |   |

## 6. Ordering information

**Table 3. Ordering information**

| Type number  | Package           |   |         |
|--------------|-------------------|---|---------|
|              | Name              | Description   | Version |
| BUK9Y3R0-40E | LFAK56; Power-SO8 | plastic single-ended surface-mounted package; 4 leads | SOT669  |

## 7. Marking

**Table 4. Marking codes**

| Type number  | Marking code |
|--------------|--------------|
| BUK9Y3R0-40E | 93E040       |

## 8. Limiting values

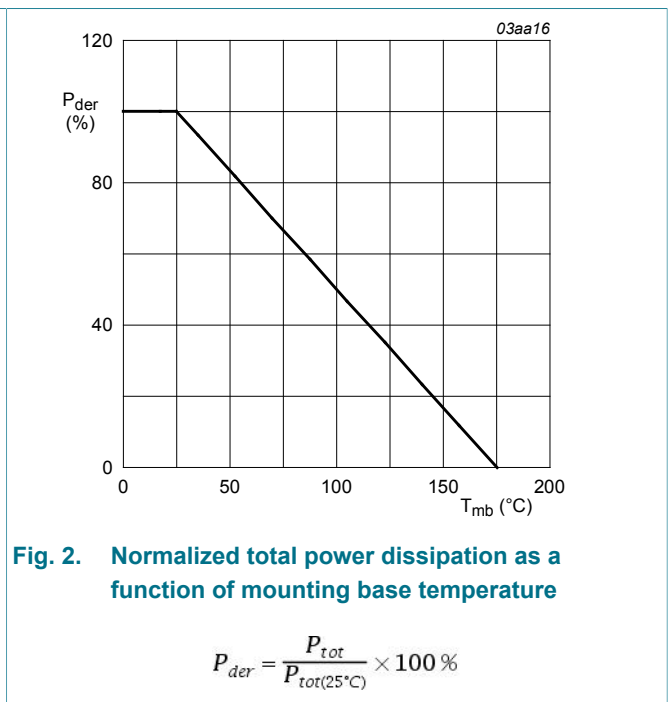
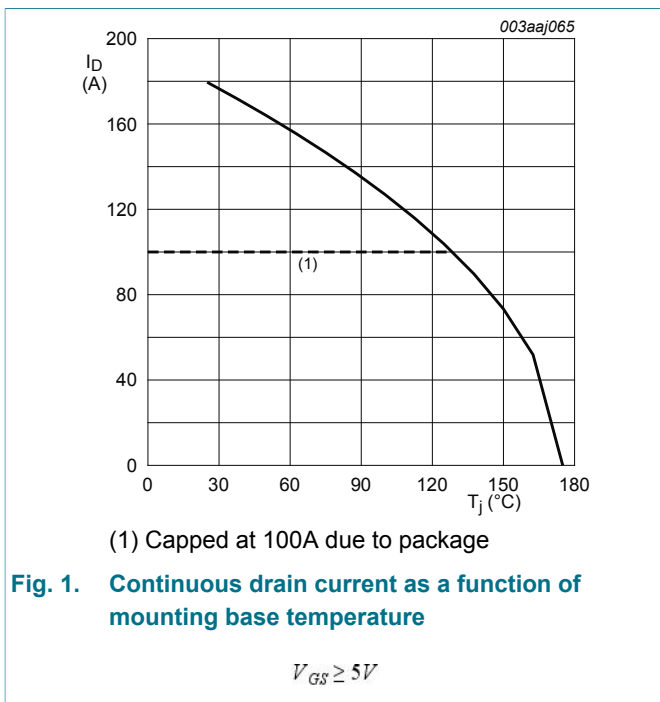
**Table 5. Limiting values**

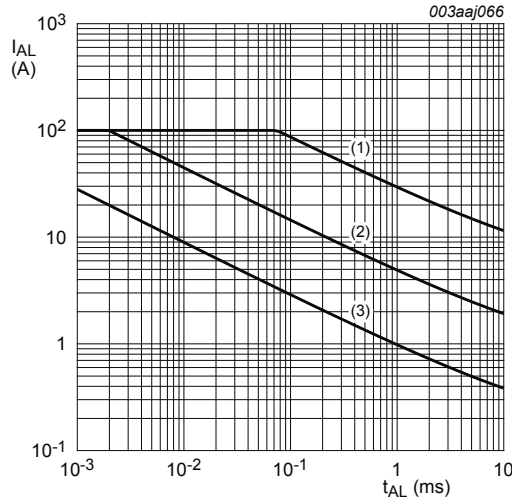
In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol    | Parameter               | Conditions  | Min    | Max | Unit |
|-----------|-------------------------|---|--------|-----|------|
| $V_{DS}$  | drain-source voltage    | $T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$                          | -      | 40  | V    |
| $V_{DGR}$ | drain-gate voltage      | $R_{GS} = 20\text{ k}\Omega$  | -      | 40  | V    |
| $V_{GS}$  | gate-source voltage     | $T_j \leq 175\text{ °C}$ ; DC   | -10    | 10  | V    |
|           |                         | $T_j \leq 175\text{ °C}$ ; Pulsed   | [1][2] | 15  | V    |
| $I_D$     | drain current           | $T_{mb} = 25\text{ °C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1                    | [3]    | 100 | A    |
|           |                         | $T_{mb} = 100\text{ °C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1                   | [3]    | 100 | A    |
| $I_{DM}$  | peak drain current      | $T_{mb} = 25\text{ °C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; Fig. 4 | -      | 718 | A    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ °C}$ ; Fig. 2  | -      | 194 | W    |

| Symbol                      | Parameter                                    | Conditions  |        | Min | Max   | Unit |
|-----------------------------|--|---|--------|-----|-------|------|
| 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   | [3]    | -   | 100   | A    |
| I <sub>SM</sub>             | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C   |        | -   | 718   | 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; <a href="#">Fig. 3</a> | [4][5] | -   | 193.8 | mJ   |

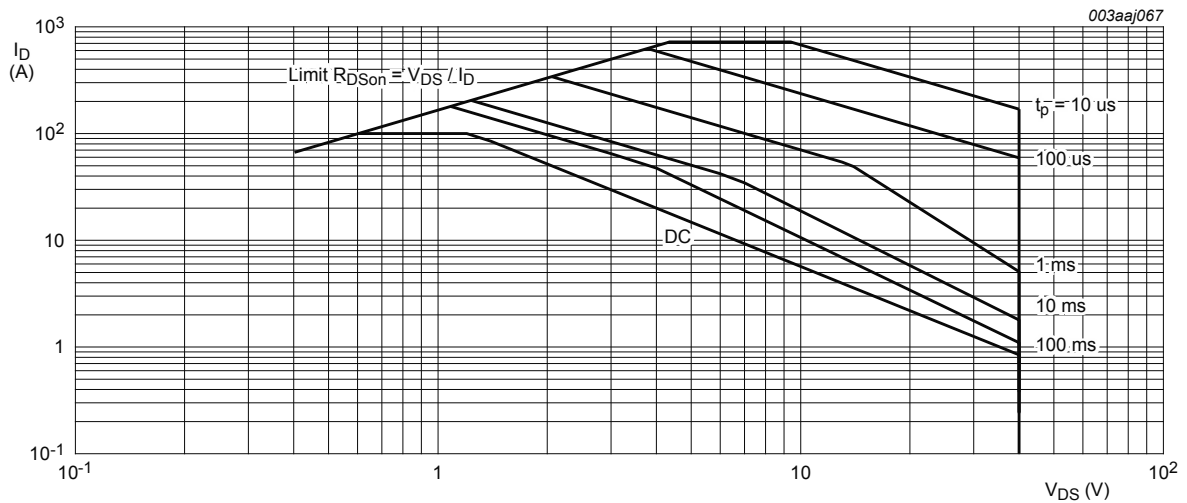
- [1] Accumulated pulse duration up to 50 hours delivers zero defect ppm
- [2] Significantly longer life times are achieved by lowering T<sub>j</sub> and or V<sub>GS</sub>
- [3] Continuous current is limited by package.
- [4] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [5] Refer to application note AN10273 for further information.





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

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



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

$T_{mb} = 25^{\circ}C$ ;  $I_{DM}$  is a 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 | <a href="#">Fig. 5</a> | -   | -   | 0.77 | K/W  |

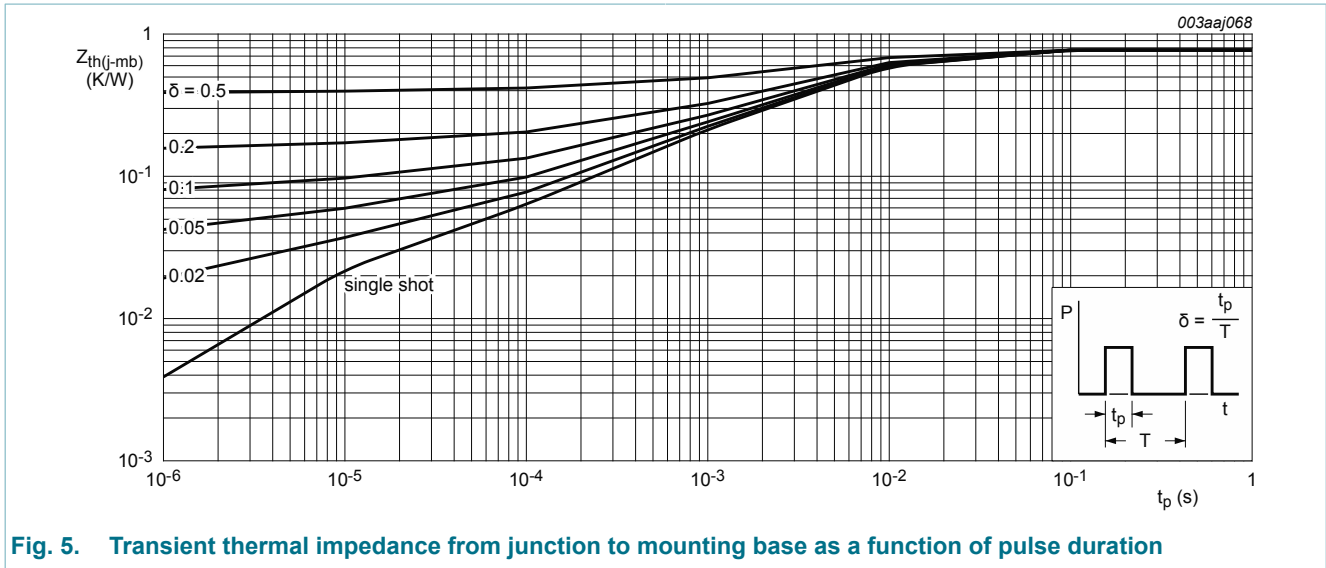


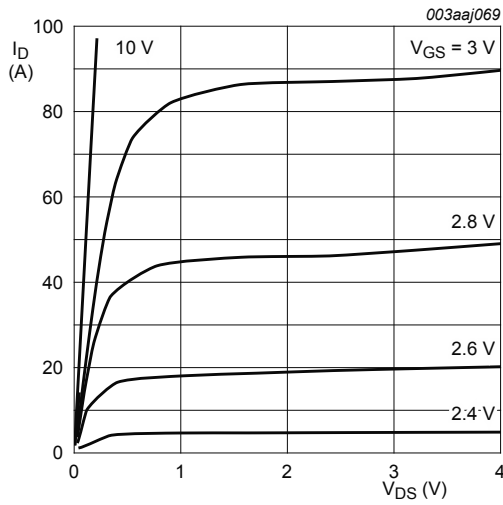
Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

Table 7. Characteristics

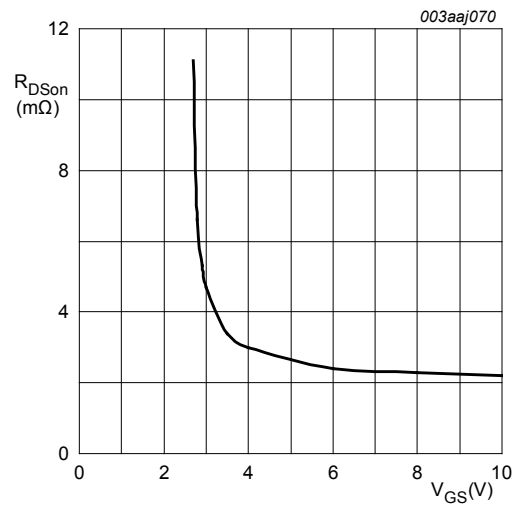
| Symbol                         | Parameter                        | Conditions   | Min | Typ  | Max  | Unit    |
|--------------------------------|----------------------------------|--|-----|------|------|---------|
| <b>Static characteristics</b>  |                                  |  |     |      |      |         |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$   | 40  | -    | -    | V       |
|                                |                                  | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$  | 36  | -    | -    | V       |
| $V_{GS(th)}$                   | gate-source threshold voltage    | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C;$<br><a href="#">Fig. 9; Fig. 10</a> | 1.4 | 1.7  | 2.1  | V       |
|                                |                                  | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ }^\circ C;$<br><a href="#">Fig. 9</a>         | -   | -    | 2.45 | V       |
|                                |                                  | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C;$<br><a href="#">Fig. 9</a>         | 0.5 | -    | -    | V       |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 40 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$   | -   | 0.13 | 10   | $\mu A$ |
|                                |                                  | $V_{DS} = 40 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$  | -   | -    | 500  | $\mu A$ |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$   | -   | 2    | 100  | nA      |
|                                |                                  | $V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 \text{ }^\circ C$  | -   | 2    | 100  | nA      |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 5 V; I_D = 25 A; T_j = 25 \text{ }^\circ C;$ <a href="#">Fig. 11</a>                       | -   | 2.47 | 3    | mΩ      |
|                                |                                  | $V_{GS} = 10 V; I_D = 25 A; T_j = 25 \text{ }^\circ C;$<br><a href="#">Fig. 11</a>                   | -   | 1.98 | 2.5  | mΩ      |
|                                |                                  | $V_{GS} = 5 V; I_D = 25 A; T_j = 175 \text{ }^\circ C;$<br><a href="#">Fig. 12; Fig. 11</a>          | -   | -    | 6    | mΩ      |
| <b>Dynamic characteristics</b> |                                  |  |     |      |      |         |
| $Q_{G(tot)}$                   | total gate charge                | $I_D = 25 A; V_{DS} = 32 V; V_{GS} = 5 V;$<br><a href="#">Fig. 13; Fig. 14</a>                       | -   | 35.5 | -    | nC      |
| $Q_{GS}$                       | gate-source charge               |  | -   | 11.7 | -    | nC      |

| Symbol                    | Parameter                    | Conditions   | Min | Typ  | Max  | Unit |
|---------------------------|------------------------------|--|-----|------|------|------|
| $Q_{GD}$                  | gate-drain charge            |  | -   | 10.7 | -    | nC   |
| $C_{iss}$                 | input capacitance            | $V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; f = 1\text{ MHz};$                           | -   | 4471 | 5962 | pF   |
| $C_{oss}$                 | output capacitance           | $T_j = 25\text{ }^\circ\text{C}; \text{Fig. 15}$   | -   | 563  | 676  | pF   |
| $C_{rss}$                 | reverse transfer capacitance |  | -   | 251  | 344  | pF   |
| $t_{d(on)}$               | turn-on delay time           | $V_{DS} = 30\text{ V}; R_L = 1.2\text{ }\Omega; V_{GS} = 5\text{ V};$                    | -   | 24   | -    | ns   |
| $t_r$                     | rise time                    | $R_{G(ext)} = 5\text{ }\Omega$   | -   | 44   | -    | ns   |
| $t_{d(off)}$              | turn-off delay time          |  | -   | 53   | -    | ns   |
| $t_f$                     | fall time                    |  | -   | 34   | -    | ns   |
| <b>Source-drain diode</b> |                              |  |     |      |      |      |
| $V_{SD}$                  | source-drain voltage         | $I_S = 25\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 16}$ | -   | 0.81 | 1.2  | V    |
| $t_{rr}$                  | reverse recovery time        | $I_S = 20\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V};$           | -   | 30   | -    | ns   |
| $Q_r$                     | recovered charge             | $V_{DS} = 25\text{ V}$   | -   | 25   | -    | nC   |



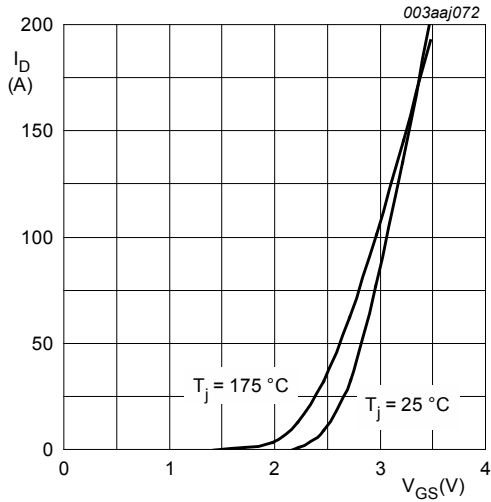
$T_j = 25\text{ }^\circ\text{C}; t_p = 300\text{ }\mu\text{s}$

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



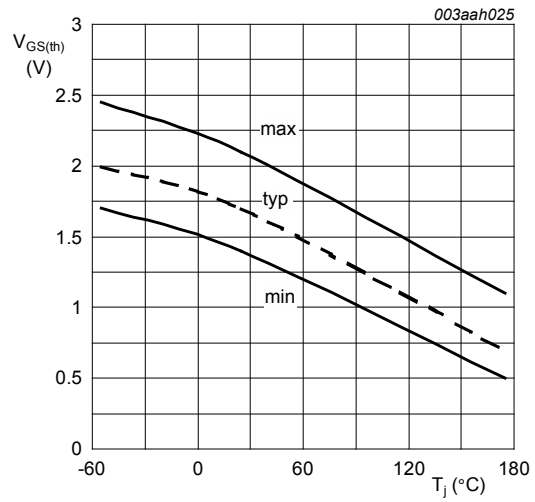
**Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values**

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



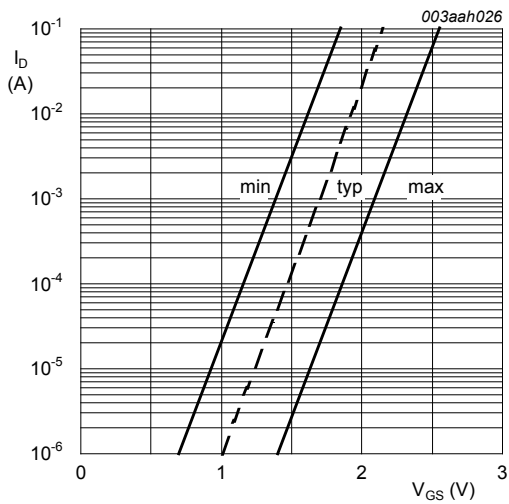
**Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values**

$V_{DS} = 10V$



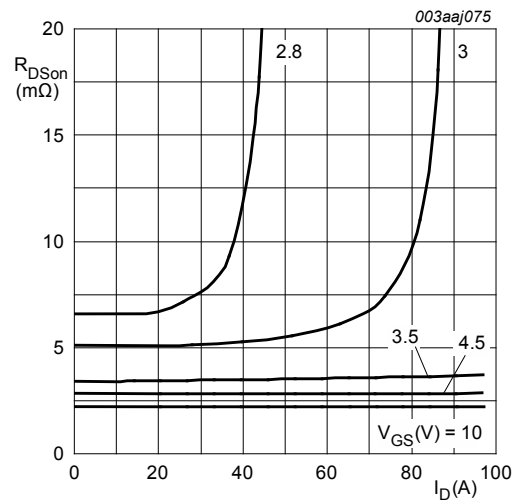
**Fig. 9. Gate-source threshold voltage as a function of junction temperature**

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



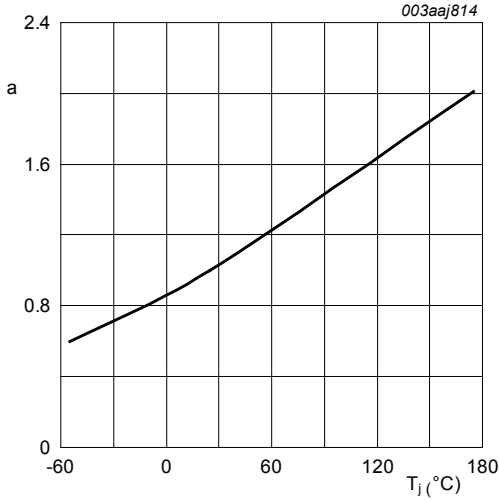
**Fig. 10. Sub-threshold drain current as a function of gate-source voltage**

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



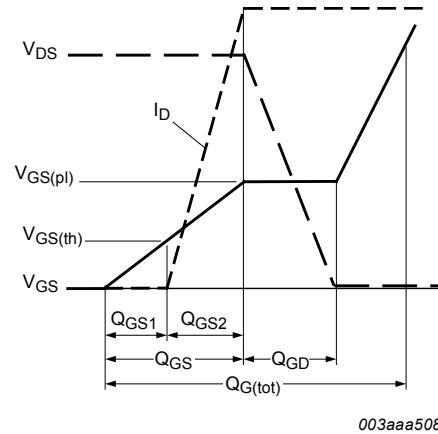
**Fig. 11. Drain-source on-state resistance as a function of drain current; typical values**

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

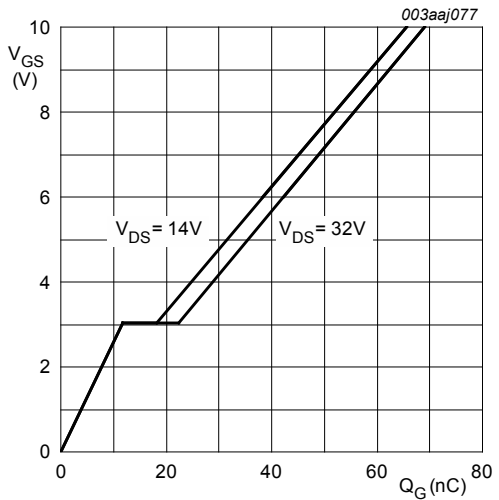


**Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature**

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

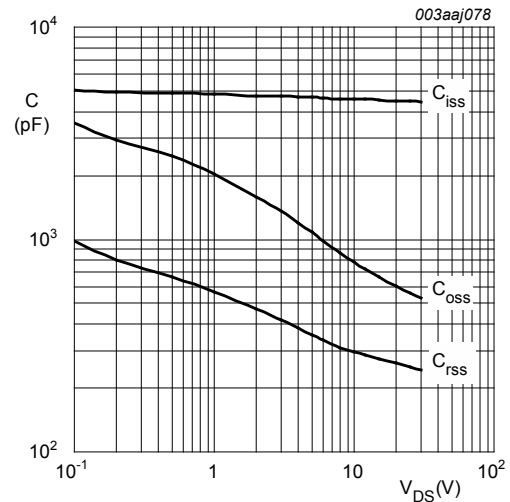


**Fig. 13. Gate charge waveform definitions**



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

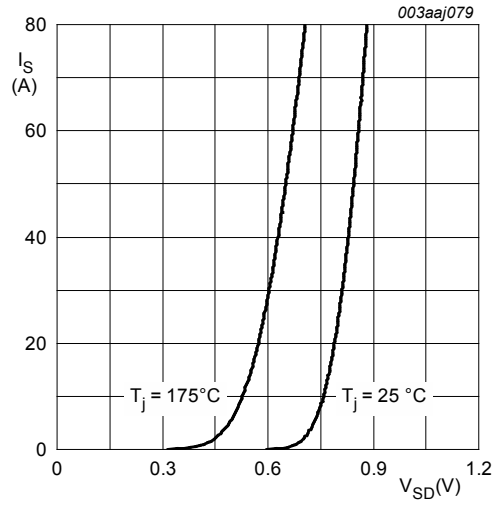
$$T_j = 25^\circ\text{C}; I_D = 25A$$



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

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

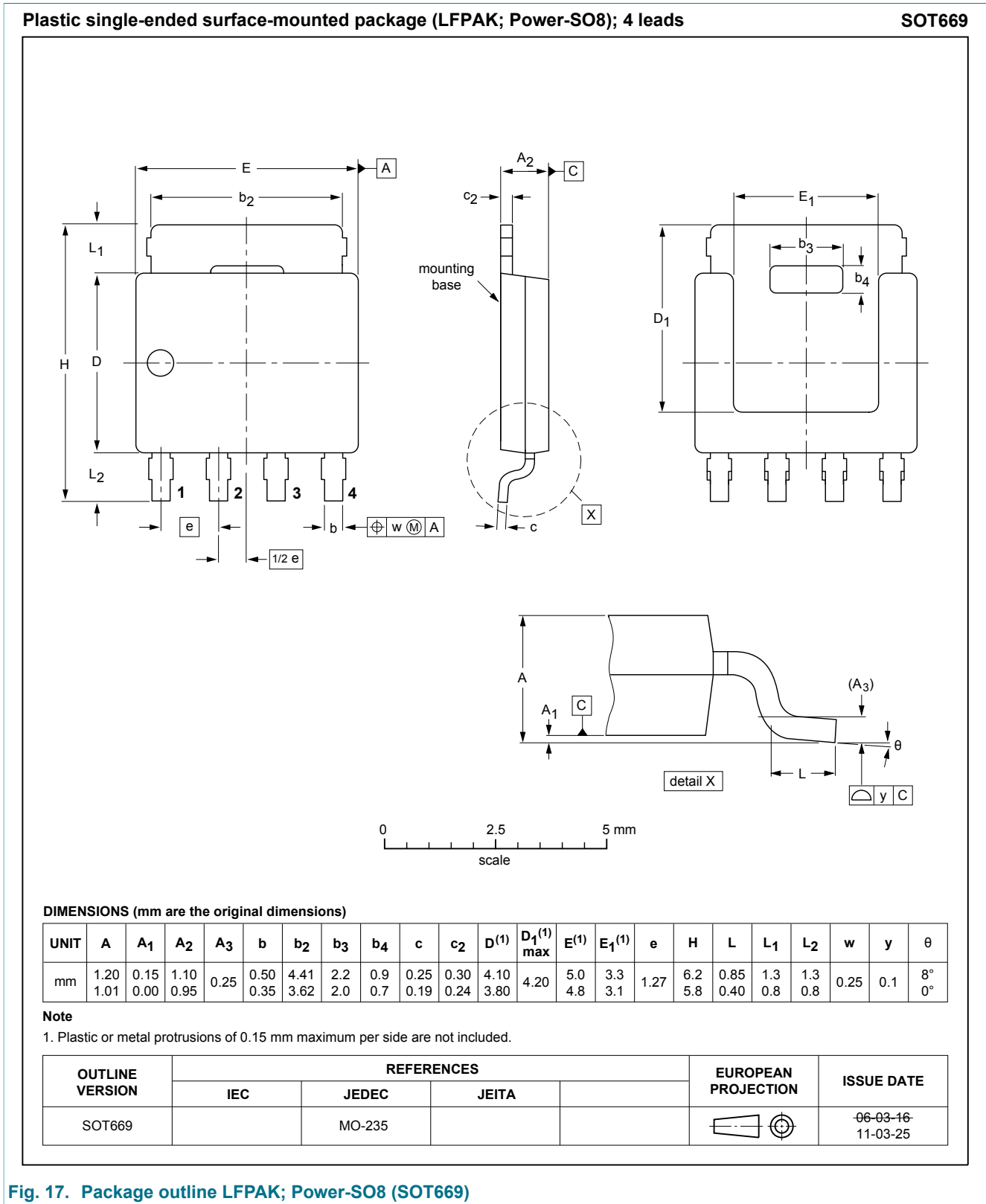




**Fig. 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values**

$$V_{GS} = 0V$$

**11. Package outline**



**Fig. 17. Package outline LPAK; Power-SO8 (SOT669)**

## 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.                                     |

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- [2] The term 'short data sheet' is explained in section "Definitions".
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