



# BUK9Y43-60E

N-channel 60 V, 43 mΩ logic level MOSFET in LPAK56

8 May 2013

Product data sheet

## 1. General description

Logic level N-channel MOSFET in an LPAK56 (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, lamps and solenoid control
- Transmission control
- Ultra high performance power switching

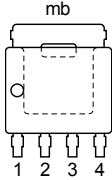
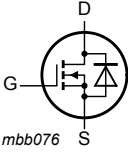
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                         | Parameter                        | Conditions                                                                                                                                     | Min | Typ  | Max | Unit |
|--------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{DS}$                       | drain-source voltage             | $T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$                                                                                             | -   | -    | 60  | V    |
| $I_D$                          | drain current                    | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 1</a>                                                                       | -   | -    | 22  | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>                                                                                               | -   | -    | 45  | W    |
| <b>Static characteristics</b>  |                                  |                                                                                                                                                |     |      |     |      |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 5\text{ V}$ ; $I_D = 5\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>                                                    | -   | 35.8 | 43  | mΩ   |
| <b>Dynamic characteristics</b> |                                  |                                                                                                                                                |     |      |     |      |
| $Q_{GD}$                       | gate-drain charge                | $V_{GS} = 5\text{ V}$ ; $I_D = 5\text{ A}$ ; $V_{DS} = 48\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> | -   | 3.4  | -   | nC   |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline                                                                                                         | Graphic symbol                                                                      |
|-----|--------|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | S      | source                            |  <p><b>LPAK56; 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 |
| BUK9Y43-60E | LPAK56; Power-SO8 | Plastic single-ended surface-mounted package (LPAK56; Power-SO8); 4 leads | SOT669  |

## 7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| BUK9Y43-60E | 94360E       |

## 8. Limiting values

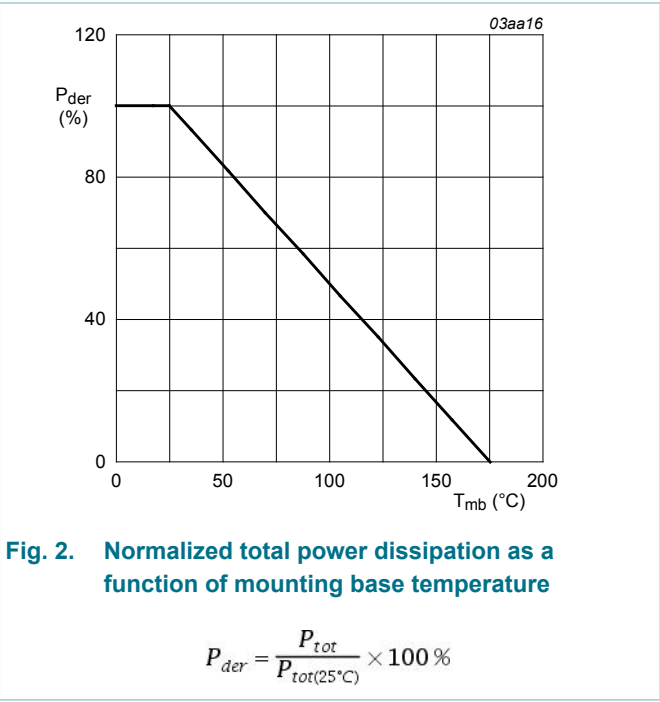
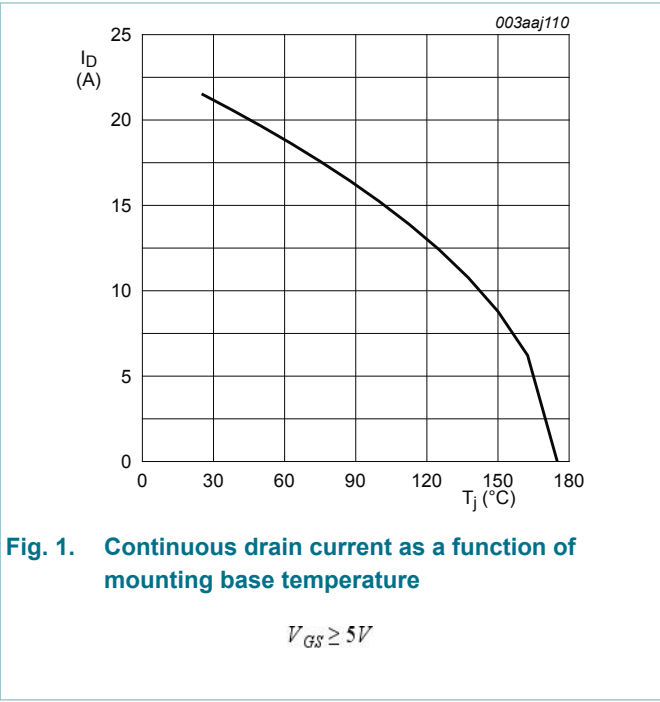
Table 5. Limiting values

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

| Symbol    | Parameter               | Conditions                                                                  |        | Min | Max | Unit |
|-----------|-------------------------|-----------------------------------------------------------------------------|--------|-----|-----|------|
| $V_{DS}$  | drain-source voltage    | $T_j \geq 25\text{ °C}$ ; $T_j \leq 175\text{ °C}$                          |        | -   | 60  | V    |
| $V_{DGR}$ | drain-gate voltage      | $R_{GS} = 20\text{ k}\Omega$                                                |        | -   | 60  | 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 | 15  | V    |
| $I_D$     | drain current           | $T_{mb} = 25\text{ °C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1                    |        | -   | 22  | A    |
|           |                         | $T_{mb} = 100\text{ °C}$ ; $V_{GS} = 5\text{ V}$ ; Fig. 1                   |        | -   | 15  | A    |
| $I_{DM}$  | peak drain current      | $T_{mb} = 25\text{ °C}$ ; pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; Fig. 4 |        | -   | 86  | A    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ °C}$ ; Fig. 2                                            |        | -   | 45  | 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   |
| Source-drain diode   |                                              |                                                                                                                                                                      |                        |     |      |      |
| I <sub>S</sub>       | source current                               | T <sub>mb</sub> = 25 °C                                                                                                                                              |                        | -   | 22   | A    |
| I <sub>SM</sub>      | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C                                                                                                              |                        | -   | 86   | A    |
| Avalanche ruggedness |                                              |                                                                                                                                                                      |                        |     |      |      |
| E <sub>DS(AL)S</sub> | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 22 A; V <sub>sup</sub> ≤ 60 V; R <sub>GS</sub> = 50 Ω;<br>V <sub>GS</sub> = 5 V; T <sub>j(init)</sub> = 25 °C; unclamped;<br><a href="#">Fig. 3</a> | <a href="#">[3][4]</a> | -   | 12.4 | 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] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.
- [4] Refer to application note AN10273 for further information.



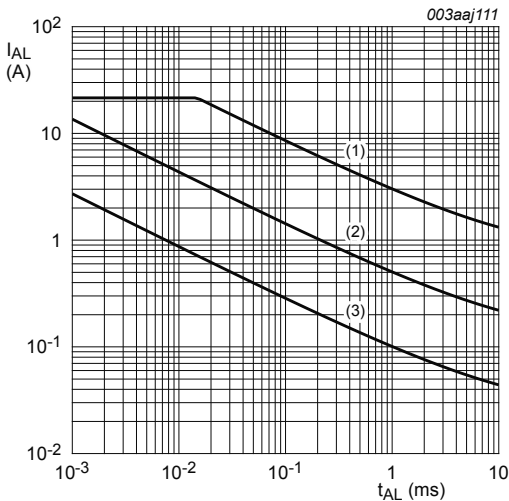


Fig. 3. Avalanche rating; avalanche current as a function of avalanche time

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

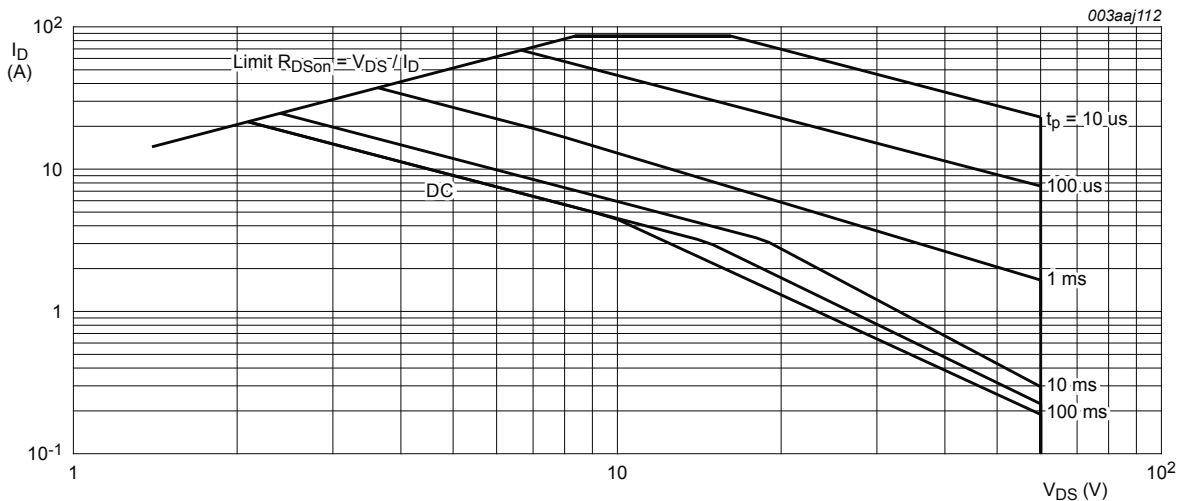


Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

$T_{mb} = 25^{\circ}C$ ;  $I_{DM}$  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 | Fig. 5     | -   | -   | 3.33 | K/W  |

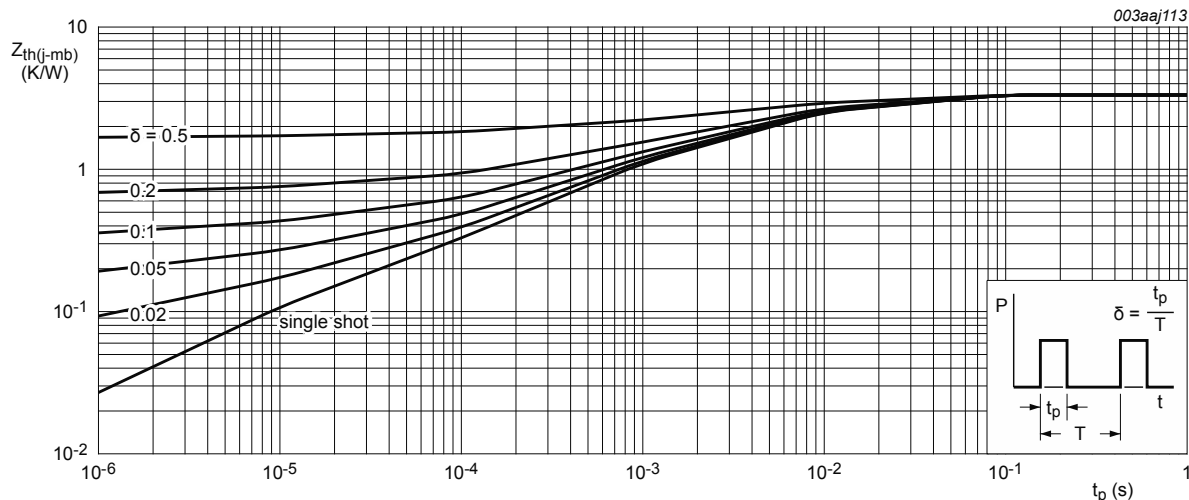


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

Table 7. Characteristics

| Symbol                  | Parameter                        | Conditions                                                                                                                                     |  | Min | Typ  | Max  | Unit |
|-------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|------|------|------|
| Static characteristics  |                                  |                                                                                                                                                |  |     |      |      |      |
| V <sub>(BR)DSS</sub>    | drain-source breakdown voltage   | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                                         |  | 60  | -    | -    | V    |
|                         |                                  | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = -55 °C                                                                        |  | 54  | -    | -    | V    |
| V <sub>GS(th)</sub>     | gate-source threshold voltage    | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 25 °C; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>            |  | 1.4 | 1.7  | 2.1  | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = -55 °C; <a href="#">Fig. 9</a>                                     |  | -   | -    | 2.45 | V    |
|                         |                                  | I <sub>D</sub> = 1 mA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 175 °C; <a href="#">Fig. 9</a>                                     |  | 0.5 | -    | -    | V    |
| I <sub>DSS</sub>        | drain leakage current            | V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                                          |  | -   | 0.01 | 1    | μA   |
|                         |                                  | V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 175 °C                                                                         |  | -   | -    | 500  | μA   |
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                                          |  | -   | 2    | 100  | nA   |
|                         |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                                         |  | -   | 2    | 100  | nA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 5 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 11</a>                                                   |  | -   | 35.8 | 43   | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 5 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 11</a>                                                  |  | -   | 31   | 38   | mΩ   |
|                         |                                  | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 5 A; T <sub>j</sub> = 175 °C; <a href="#">Fig. 12</a> ; <a href="#">Fig. 11</a>                        |  | -   | -    | 97.2 | mΩ   |
| Dynamic characteristics |                                  |                                                                                                                                                |  |     |      |      |      |
| Q <sub>G(tot)</sub>     | total gate charge                | I <sub>D</sub> = 5 A; V <sub>DS</sub> = 48 V; V <sub>GS</sub> = 5 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> |  | -   | 8.2  | -    | nC   |
| Q <sub>GS</sub>         | gate-source charge               |                                                                                                                                                |  | -   | 1.6  | -    | nC   |
| Q <sub>GD</sub>         | gate-drain charge                |                                                                                                                                                |  | -   | 3.4  | -    | nC   |

| Symbol              | Parameter                    | Conditions                                                                                                                      |  | Min | Typ  | Max | Unit |
|---------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--|-----|------|-----|------|
| C <sub>iss</sub>    | input capacitance            | V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 25 V; f = 1 MHz;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 15</a>                    |  | -   | 660  | 880 | pF   |
| C <sub>oss</sub>    | output capacitance           |                                                                                                                                 |  | -   | 90   | 110 | pF   |
| C <sub>rss</sub>    | reverse transfer capacitance |                                                                                                                                 |  | -   | 60   | 85  | pF   |
| t <sub>d(on)</sub>  | turn-on delay time           | V <sub>DS</sub> = 45 V; R <sub>L</sub> = 5 Ω; V <sub>GS</sub> = 5 V;<br>R <sub>G(ext)</sub> = 5 Ω; T <sub>j</sub> = 25 °C       |  | -   | 6.3  | -   | ns   |
| t <sub>r</sub>      | rise time                    |                                                                                                                                 |  | -   | 12.3 | -   | ns   |
| t <sub>d(off)</sub> | turn-off delay time          |                                                                                                                                 |  | -   | 10.1 | -   | ns   |
| t <sub>f</sub>      | fall time                    |                                                                                                                                 |  | -   | 10.6 | -   | ns   |
| Source-drain diode  |                              |                                                                                                                                 |  |     |      |     |      |
| V <sub>SD</sub>     | source-drain voltage         | I <sub>S</sub> = 5 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>                                    |  | -   | 0.83 | 1.2 | V    |
| t <sub>rr</sub>     | reverse recovery time        | I <sub>S</sub> = 5 A; dI <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V;<br>V <sub>DS</sub> = 25 V; T <sub>j</sub> = 25 °C |  | -   | 17.5 | -   | ns   |
| Q <sub>r</sub>      | recovered charge             |                                                                                                                                 |  | -   | 11.2 | -   | nC   |

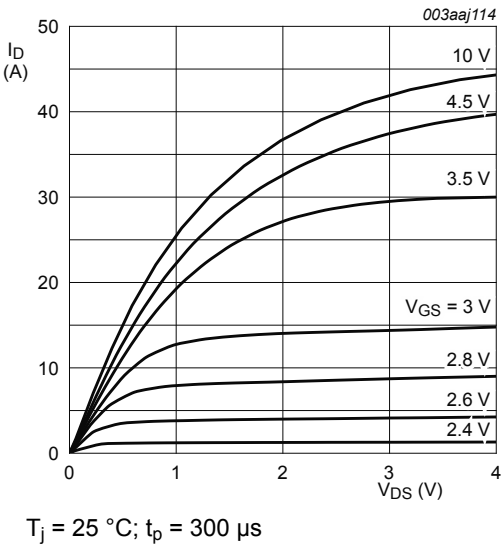


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

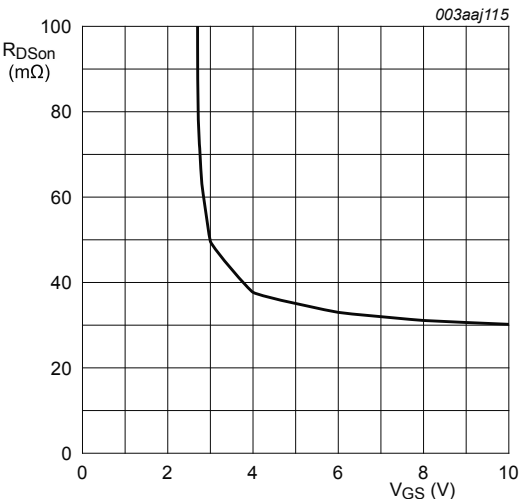


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

$T_j = 25\text{ °C}; I_D = 5\text{ A}$

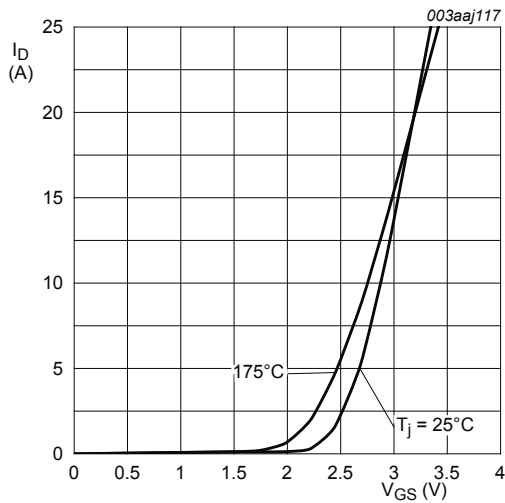


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

$V_{DS} = 10\text{ V}$

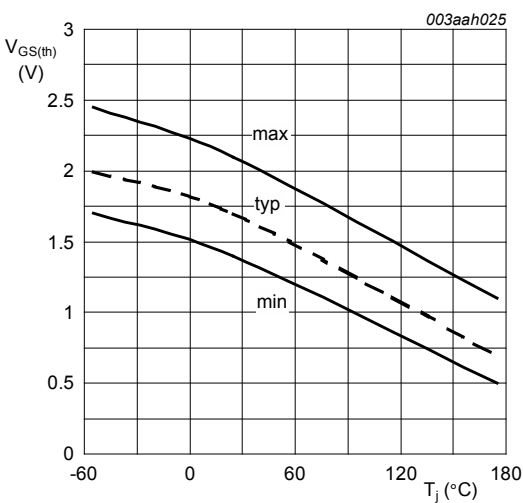


Fig. 9. Gate-source threshold voltage as a function of junction temperature

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

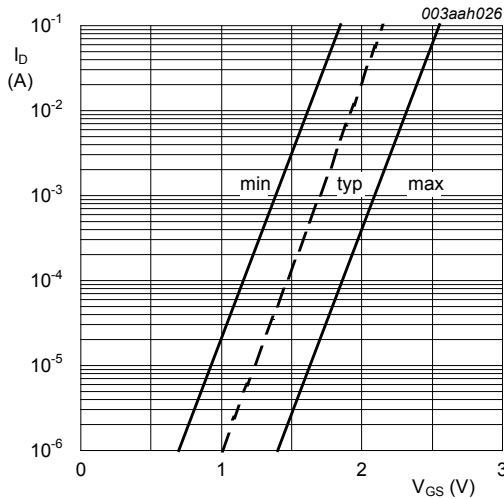
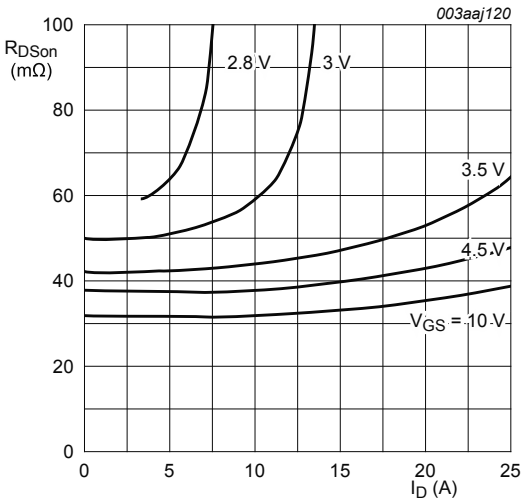


Fig. 10. Sub-threshold drain current as a function of gate-source voltage

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



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

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

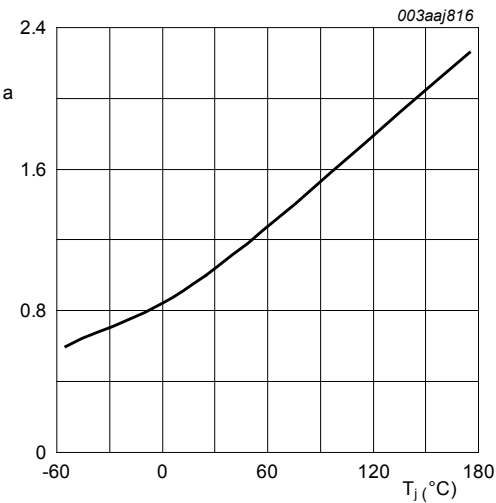


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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

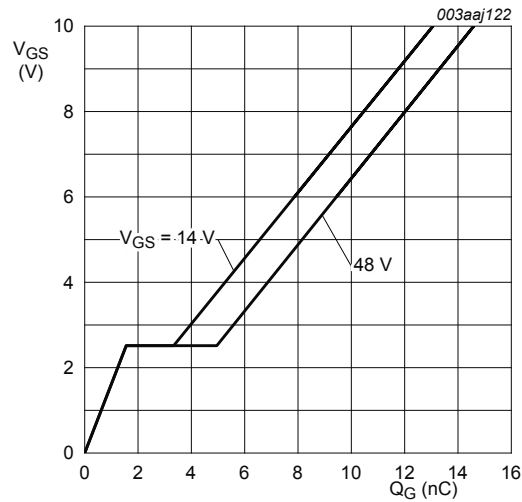


Fig. 14. Gate-source voltage as a function of gate charge; typical values

$$T_j = 25^{\circ}\text{C}; I_D = 5\text{ A}$$

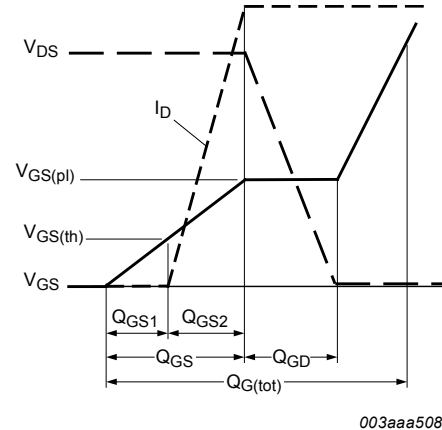


Fig. 13. Gate charge waveform definitions

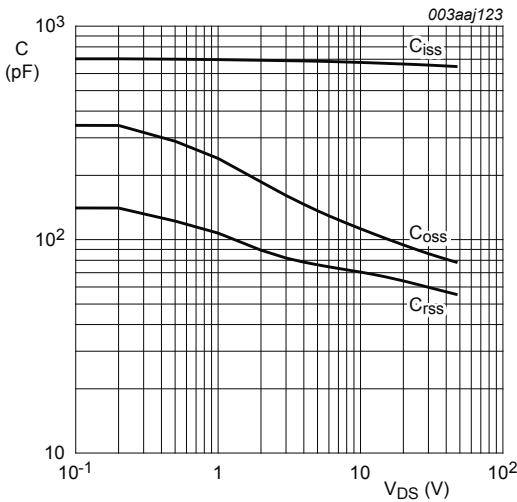


Fig. 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

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



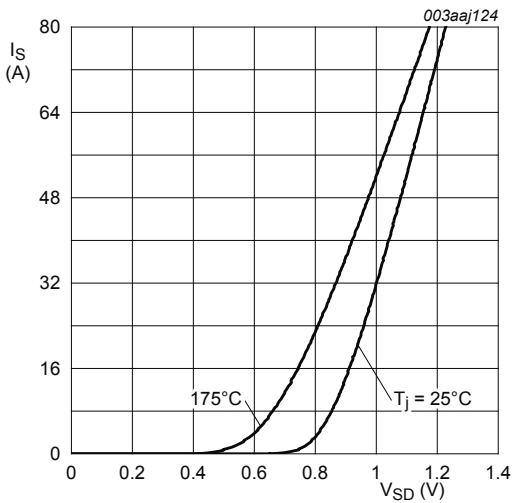


Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

$V_{GS} = 0V$

11. Package outline

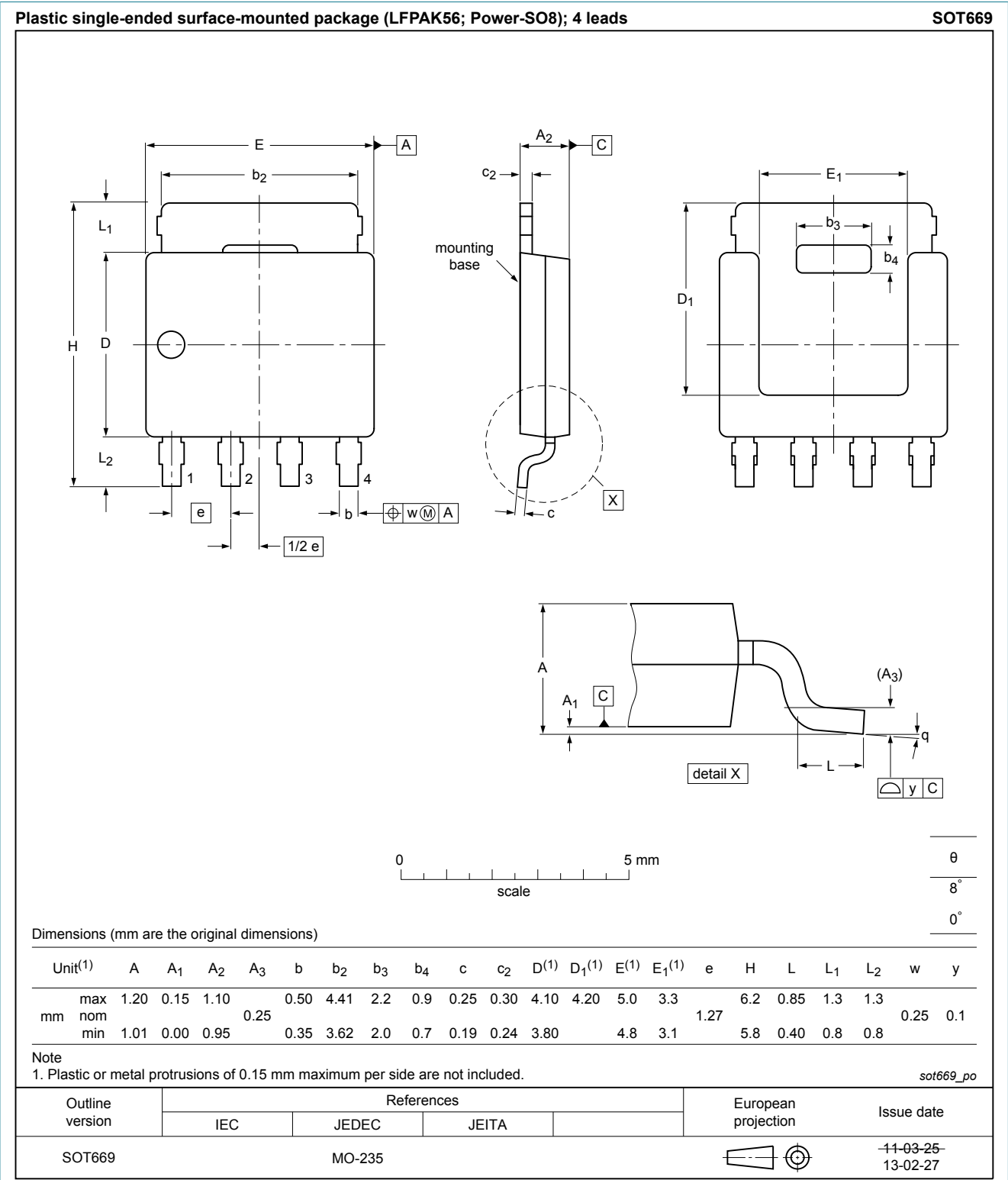


Fig. 17. Package outline LPAK56; Power-SO8 (SOT669)

## 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.                                     |

- [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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13. Contents

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For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)  
Date of release: 08 May 2013