



# BUK9M10-30E

N-channel 30 V, 10 mΩ logic level MOSFET in LFPAK33

19 September 2016

Product data sheet

## 1. General description

Logic level N-channel MOSFET in an LFPAK33 (Power33) 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

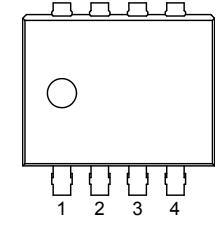
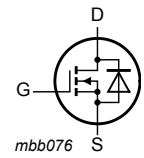
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                         | Parameter                        | Conditions  | Min | Typ | Max | Unit |
|--------------------------------|----------------------------------|---|-----|-----|-----|------|
| $V_{DS}$                       | drain-source voltage             | $25\text{ °C} \leq T_j \leq 175\text{ °C}$  | -   | -   | 30  | V    |
| $I_D$                          | drain current                    | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>  | -   | -   | 54  | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 1</a>  | -   | -   | 55  | W    |
| <b>Static characteristics</b>  |                                  |   |     |     |     |      |
| $R_{DSon}$                     | drain-source on-state resistance | $V_{GS} = 5\text{ V}$ ; $I_D = 15\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>  | -   | 8.1 | 10  | mΩ   |
| <b>Dynamic characteristics</b> |                                  |   |     |     |     |      |
| $Q_{GD}$                       | gate-drain charge                | $I_D = 15\text{ A}$ ; $V_{DS} = 24\text{ V}$ ; $V_{GS} = 5\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> | -   | 5.5 | -   | nC   |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline  | Graphic symbol  |
|-----|--------|-----------------------------------|---|---|
| 1   | S      | Source                            |  <p>LFAK33 (SOT1210)</p> |  <p>mbb076</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 |
| BUK9M10-30E | LFAK33  | Plastic single ended surface mounted package (LFAK33); 8 leads | SOT1210 |

## 7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| BUK9M10-30E | 91030E       |

## 8. Limiting values

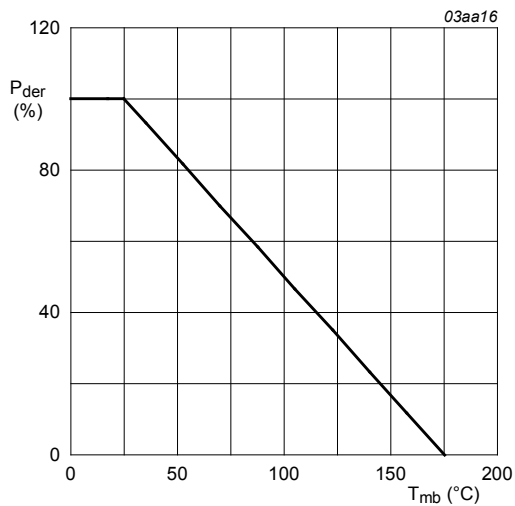
Table 5. Limiting values

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

| Symbol    | Parameter               | Conditions  | Min    | Max | Unit |
|-----------|-------------------------|---|--------|-----|------|
| $V_{DS}$  | drain-source voltage    | $25\text{ °C} \leq T_j \leq 175\text{ °C}$                                  | -      | 30  | V    |
| $V_{DGR}$ | drain-gate voltage      | $R_{GS} = 20\text{ k}\Omega$  | -      | 30  | V    |
| $V_{GS}$  | gate-source voltage     | DC; $T_j \leq 175\text{ °C}$  | -10    | 10  | V    |
|           |                         | Pulsed; $T_j \leq 175\text{ °C}$  | [1][2] | 15  | V    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ °C}$ ; Fig. 1  | -      | 55  | W    |
| $I_D$     | drain current           | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 2                    | -      | 54  | A    |
|           |                         | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 100\text{ °C}$ ; Fig. 2                   | -      | 38  | A    |
| $I_{DM}$  | peak drain current      | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 3 | -      | 216 | A    |

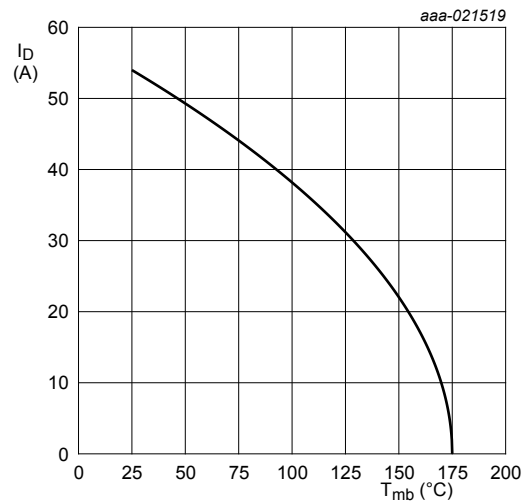
| Symbol                      | Parameter                                    | Conditions   | Min    | Max | Unit    |
|-----------------------------|--|--|--------|-----|---------|
| T <sub>stg</sub>            | storage temperature                          |  | -55    | 175 | °C      |
| T <sub>j</sub>              | junction temperature                         |  | -55    | 175 | °C      |
| <b>Source-drain diode</b>   |  |  |        |     |         |
| I <sub>S</sub>              | source current                               | T <sub>mb</sub> = 25 °C  | -      | 45  | A       |
| I <sub>SM</sub>             | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C  | -      | 216 | A       |
| <b>Avalanche ruggedness</b> |  |  |        |     |         |
| E <sub>DS(AL)S</sub>        | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 54 A; V <sub>sup</sub> ≤ 30 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. 4</a> | [3][4] | -   | 28.3 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. 1. Normalized total power dissipation as a function of mounting base temperature**

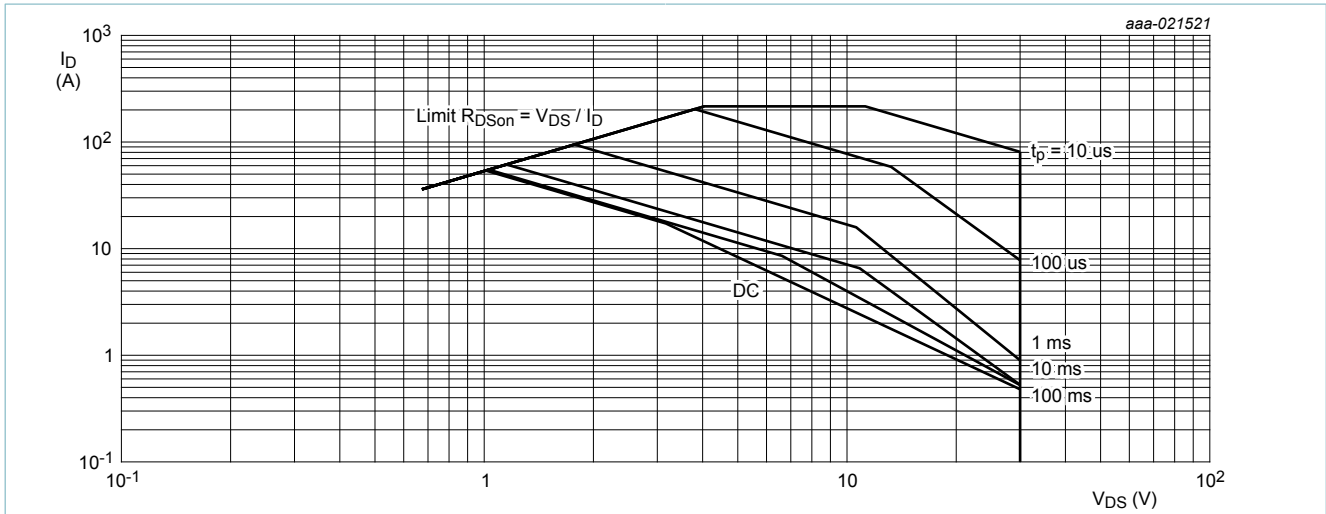
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$



V<sub>GS</sub> ≥ 5 V

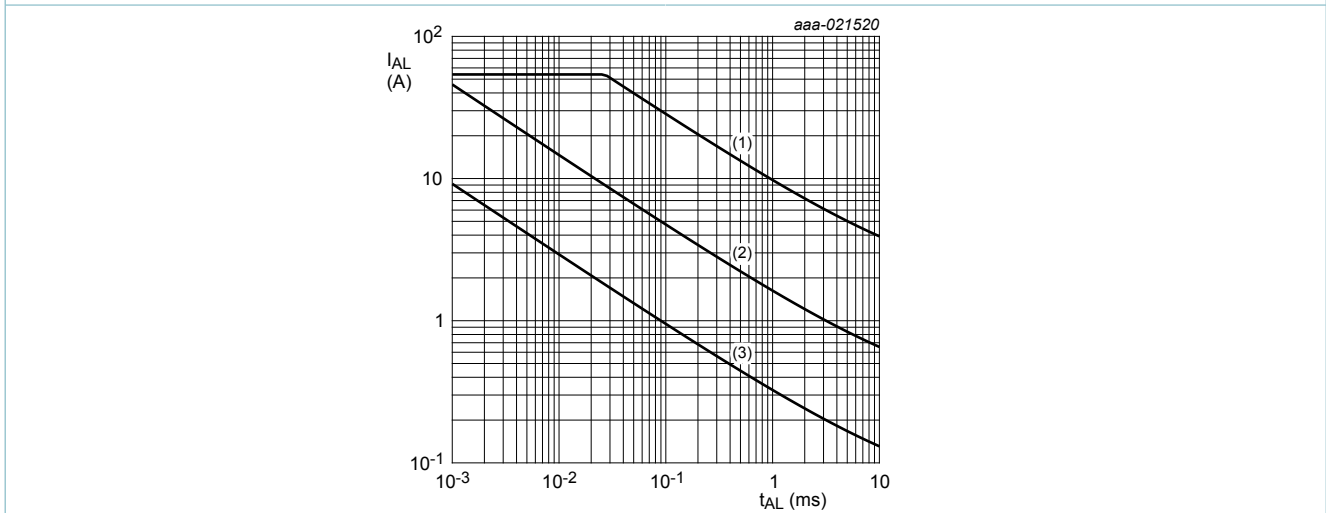
**Fig. 2. Continuous drain current as a function of mounting base temperature**

$$I_D = 54A \times \sqrt{\frac{175^{\circ}C - T_{mb}}{150^{\circ}C}} \quad \text{for } T_{mb} \geq 25^{\circ}C$$



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

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



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

**Fig. 4. Avalanche rating; avalanche current as a function of avalanche time**

## 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> | -   | 2.46 | 2.75 | K/W  |

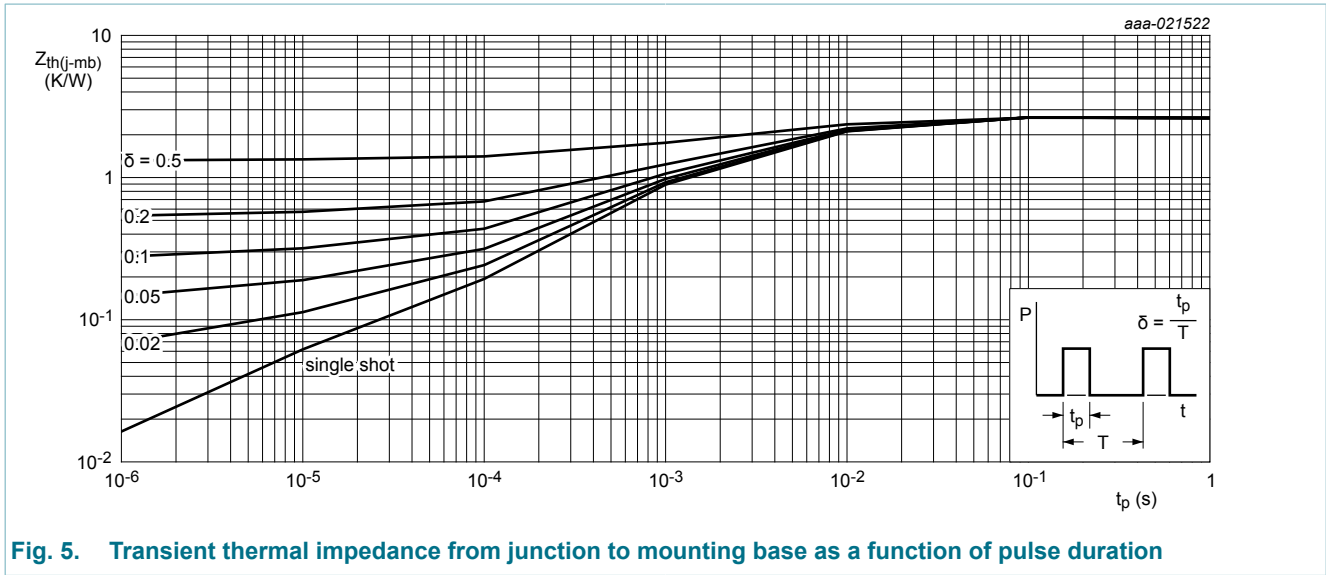


Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

Table 7. Characteristics

| Symbol                         | Parameter                        | Conditions  | Min | Typ  | Max  | Unit    |
|--------------------------------|----------------------------------|---|-----|------|------|---------|
| <b>Static characteristics</b>  |                                  |   |     |      |      |         |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$  | 30  | -    | -    | V       |
|                                |                                  | $I_D = 250 \mu A; V_{GS} = 0 V; T_j = -55 \text{ }^\circ C$   | 27  | -    | -    | 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. 10</a>               | -   | -    | 2.45 | V       |
|                                |                                  | $I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ }^\circ C;$<br><a href="#">Fig. 10</a>               | 0.5 | -    | -    | V       |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 30 V; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$  | -   | 0.02 | 1    | $\mu A$ |
|                                |                                  | $V_{DS} = 30 V; V_{GS} = 0 V; T_j = 175 \text{ }^\circ C$   | -   | -    | 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 | $V_{GS} = 5 V; I_D = 15 A; T_j = 25 \text{ }^\circ C;$ <a href="#">Fig. 11</a>                              | -   | 8.1  | 10   | mΩ      |
|                                |                                  | $V_{GS} = 10 V; I_D = 15 A; T_j = 25 \text{ }^\circ C;$<br><a href="#">Fig. 11</a>                          | -   | 6.4  | 7.8  | mΩ      |
|                                |                                  | $V_{GS} = 5 V; I_D = 15 A; T_j = 175 \text{ }^\circ C;$<br><a href="#">Fig. 12</a>                          | -   | -    | 18.7 | mΩ      |
| <b>Dynamic characteristics</b> |                                  |   |     |      |      |         |
| $Q_{G(tot)}$                   | total gate charge                | $I_D = 15 A; V_{DS} = 24 V; V_{GS} = 5 V;$<br>$T_j = 25 \text{ }^\circ C;$ <a href="#">Fig. 13; Fig. 14</a> | -   | 12.2 | -    | nC      |
| $Q_{GS}$                       | gate-source charge               |   | -   | 2.6  | -    | nC      |

| Symbol                    | Parameter                    | Conditions   | Min | Typ  | Max  | Unit |
|---------------------------|------------------------------|--|-----|------|------|------|
| $Q_{GD}$                  | gate-drain charge            |  | -   | 5.5  | -    | nC   |
| $C_{iss}$                 | input capacitance            | $V_{DS} = 25\text{ V}; V_{GS} = 0\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 15}$                        | -   | 939  | 1249 | pF   |
| $C_{oss}$                 | output capacitance           |  | -   | 201  | 241  | pF   |
| $C_{rss}$                 | reverse transfer capacitance |  | -   | 128  | 176  | pF   |
| $t_{d(on)}$               | turn-on delay time           | $V_{DS} = 25\text{ V}; R_L = 1.5\text{ } \Omega; V_{GS} = 5\text{ V}; R_{G(ext)} = 5\text{ } \Omega; T_j = 25\text{ }^\circ\text{C}$ | -   | 8.8  | -    | ns   |
| $t_r$                     | rise time                    |  | -   | 22   | -    | ns   |
| $t_{d(off)}$              | turn-off delay time          |  | -   | 17.8 | -    | ns   |
| $t_f$                     | fall time                    |  | -   | 17.2 | -    | ns   |
| <b>Source-drain diode</b> |                              |  |     |      |      |      |
| $V_{SD}$                  | source-drain voltage         | $I_S = 15\text{ A}; V_{GS} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}; \text{Fig. 16}$   | -   | 0.84 | 1.2  | V    |
| $t_{rr}$                  | reverse recovery time        | $I_S = 15\text{ A}; di_S/dt = -100\text{ A}/\mu\text{s}; V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V}; T_j = 25\text{ }^\circ\text{C}$  | -   | 13.9 | -    | ns   |
| $Q_r$                     | recovered charge             |  | -   | 4.6  | -    | nC   |

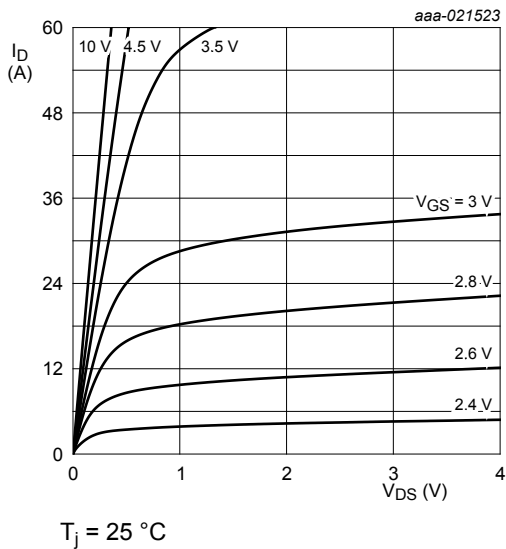


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

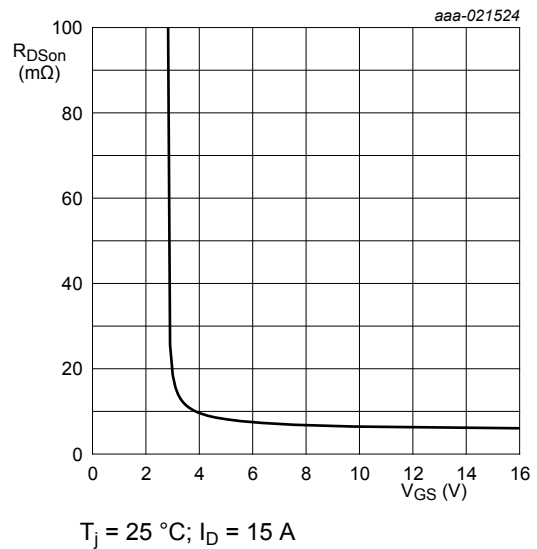
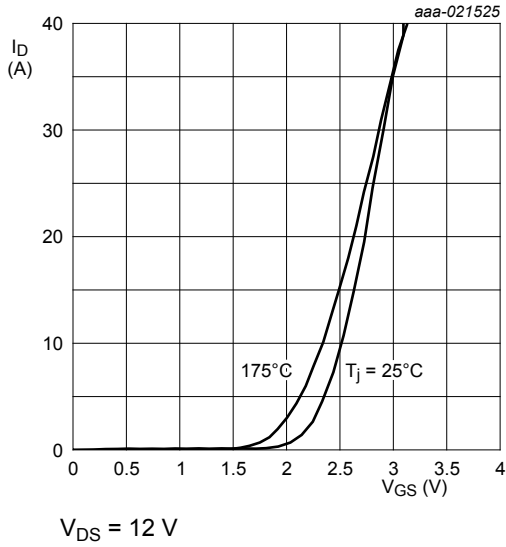
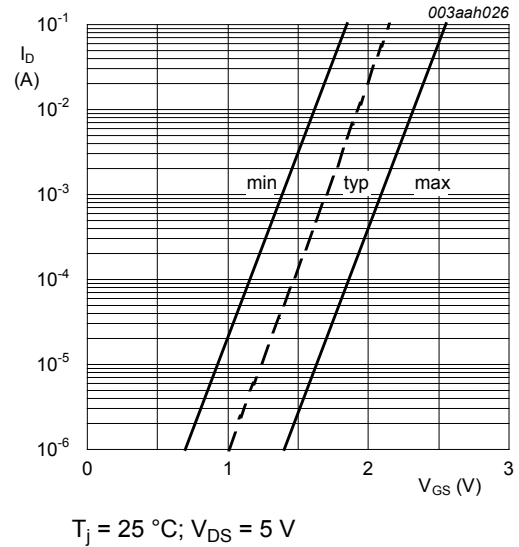


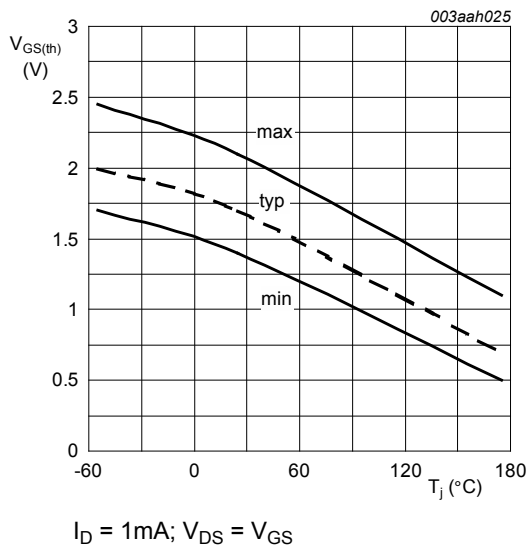
Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values



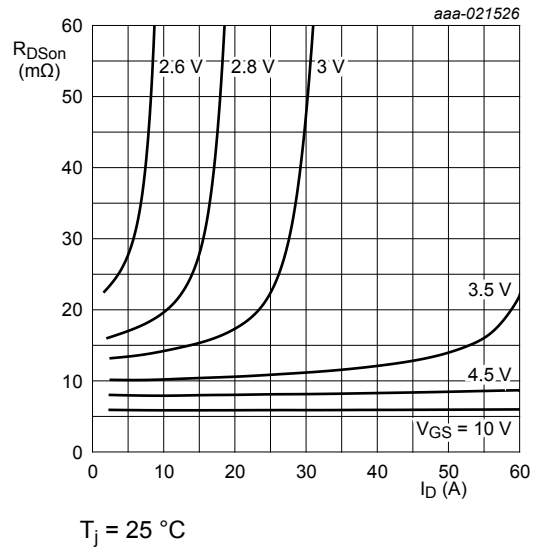
**Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values**



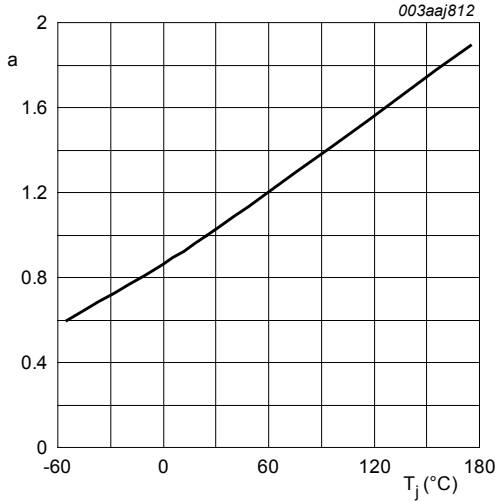
**Fig. 9. Sub-threshold drain current as a function of gate-source voltage**



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

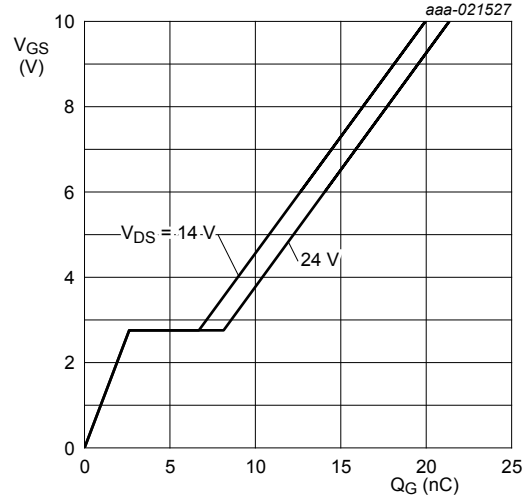


**Fig. 11. Drain-source on-state resistance as a function of drain current; typical values**



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

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

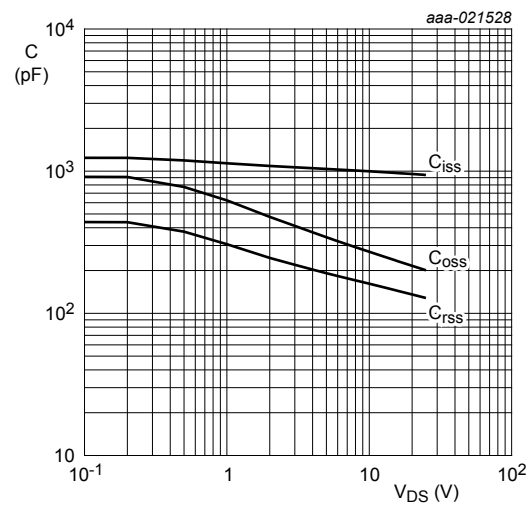


$T_j = 25^{\circ}C$ ;  $I_D = 15 A$

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



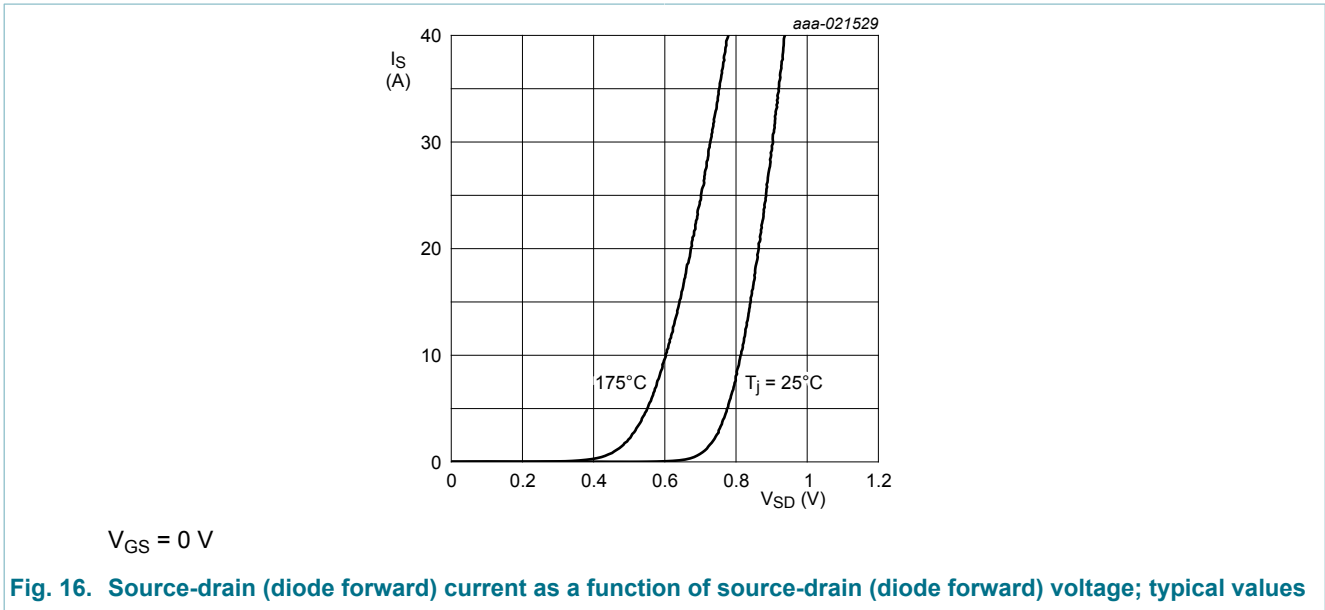
**Fig. 14. Gate charge waveform definitions**



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

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



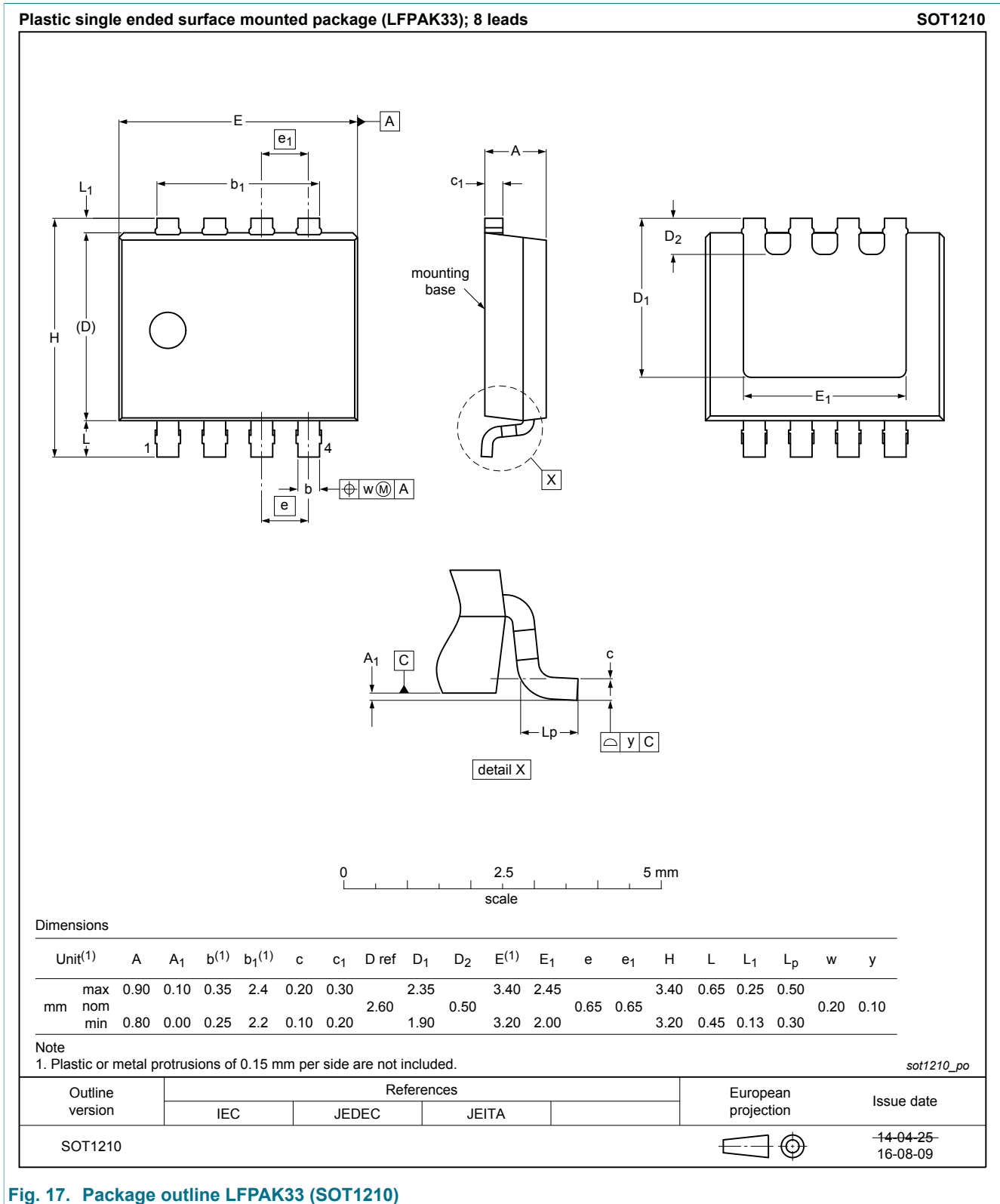


**Fig. 16. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values**

## 11. Application information

For guidance on how to use and understand this datasheet, please refer to application note [AN11158](#) "Understanding power MOSFET datasheet parameters".

## 12. Package outline



**Fig. 17. Package outline LFPAK33 (SOT1210)**

## 13. Legal information

### 13.1 Data sheet status

| Document status [1][2]         | Product status [3] | Definition  |
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| 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.                       |
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- [2] The term 'short data sheet' is explained in section "Definitions".
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