



# BUK9M15-60E

N-channel 60 V, 15 mΩ logic level MOSFET in LPAK33

19 September 2016

Product data sheet

## 1. General description

Logic level N-channel MOSFET in an LPAK33 (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

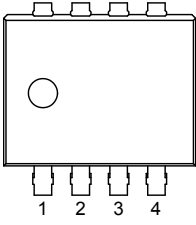
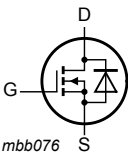
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                         | Parameter                        | Conditions                                                                                                                                      | Min | Typ  | Max | Unit |
|--------------------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| $V_{DS}$                       | drain-source voltage             | $25\text{ °C} \leq T_j \leq 175\text{ °C}$                                                                                                      | -   | -    | 60  | V    |
| $I_D$                          | drain current                    | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>                                                                        | -   | -    | 47  | A    |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 1</a>                                                                                                | -   | -    | 75  | W    |
| <b>Static characteristics</b>  |                                  |                                                                                                                                                 |     |      |     |      |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 5\text{ V}$ ; $I_D = 10\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>                                                    | -   | 12.5 | 15  | mΩ   |
| <b>Dynamic characteristics</b> |                                  |                                                                                                                                                 |     |      |     |      |
| $Q_{GD}$                       | gate-drain charge                | $I_D = 10\text{ A}$ ; $V_{DS} = 48\text{ V}$ ; $V_{GS} = 5\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> | -   | 6.4  | -   | nC   |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline                                                                                    | Graphic symbol                                                                                |
|-----|--------|-----------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| 1   | S      | Source                            | <br>LPAK33 (SOT1210) | <br>mbb076 |
| 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 |
| BUK9M15-60E | LPAK33  | Plastic single ended surface mounted package (LPAK33); 8 leads | SOT1210 |

## 7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| BUK9M15-60E | 91560E       |

## 8. Limiting values

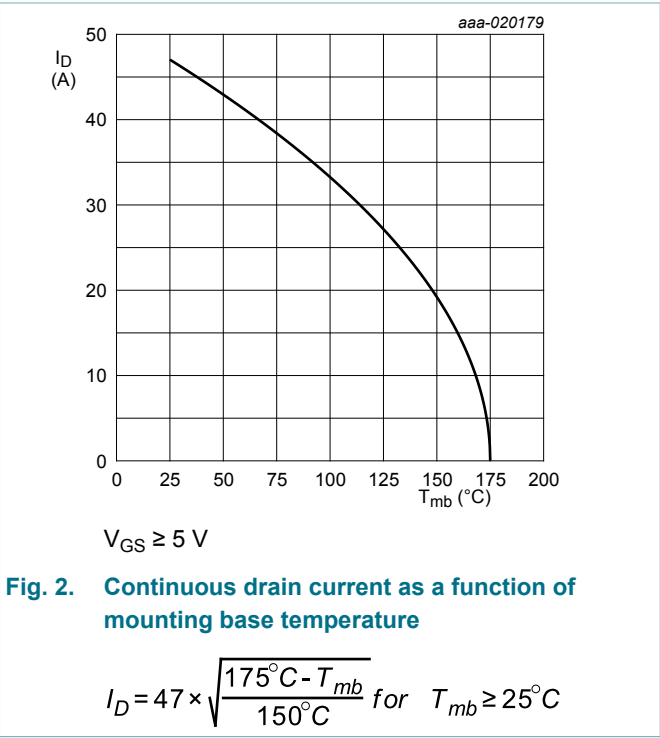
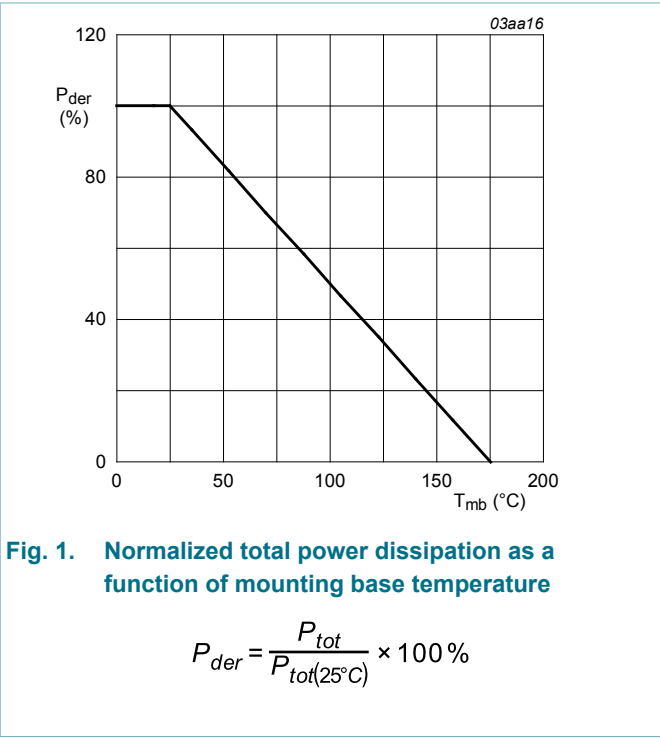
Table 5. Limiting values

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

| Symbol    | Parameter               | Conditions                                                                  |        | Min | Max | Unit |
|-----------|-------------------------|-----------------------------------------------------------------------------|--------|-----|-----|------|
| $V_{DS}$  | drain-source voltage    | $25\text{ °C} \leq T_j \leq 175\text{ °C}$                                  |        | -   | 60  | V    |
| $V_{DGR}$ | drain-gate voltage      | $R_{GS} = 20\text{ k}\Omega$                                                |        | -   | 60  | 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 | 15  | V    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ °C}$ ; Fig. 1                                            |        | -   | 75  | W    |
| $I_D$     | drain current           | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 2                    |        | -   | 47  | A    |
|           |                         | $V_{GS} = 5\text{ V}$ ; $T_{mb} = 100\text{ °C}$ ; Fig. 2                   |        | -   | 33  | A    |
| $I_{DM}$  | peak drain current      | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 3 |        | -   | 188 | 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   |
| Source-drain diode   |                                              |                                                                                                                                                                    |                        |     |     |      |
| I <sub>S</sub>       | source current                               | T <sub>mb</sub> = 25 °C                                                                                                                                            |                        | -   | 47  | A    |
| I <sub>SM</sub>      | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C                                                                                                            |                        | -   | 188 | A    |
| Avalanche ruggedness |                                              |                                                                                                                                                                    |                        |     |     |      |
| E <sub>DS(AL)S</sub> | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 47 A; V <sub>sup</sub> ≤ 60; 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> | <a href="#">[3][4]</a> | -   | 39  | 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.



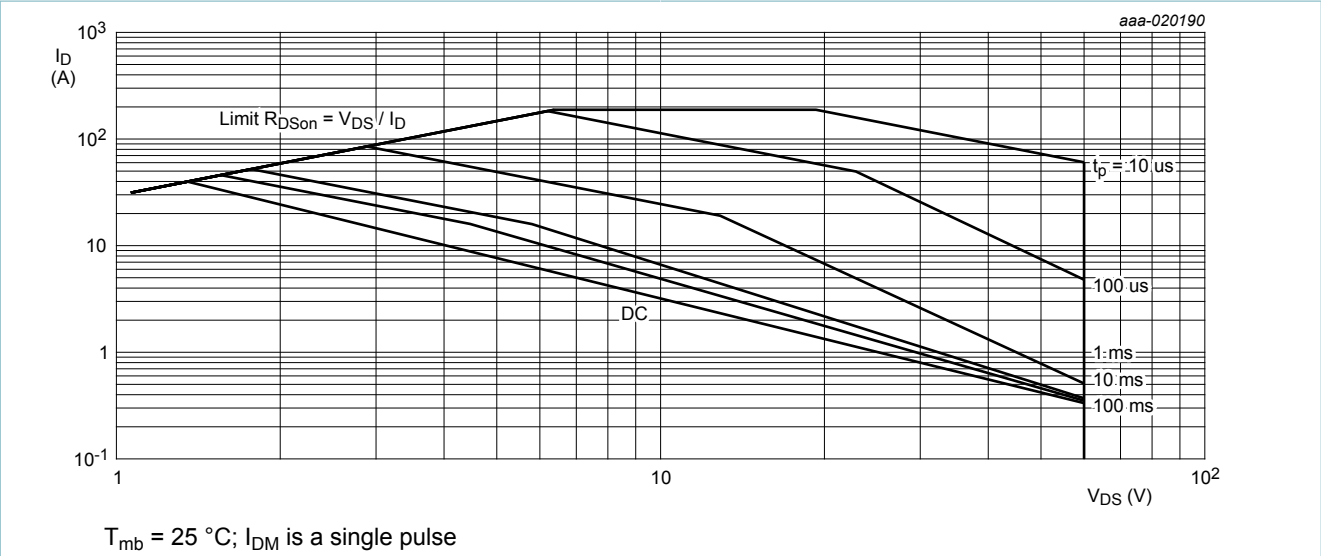


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

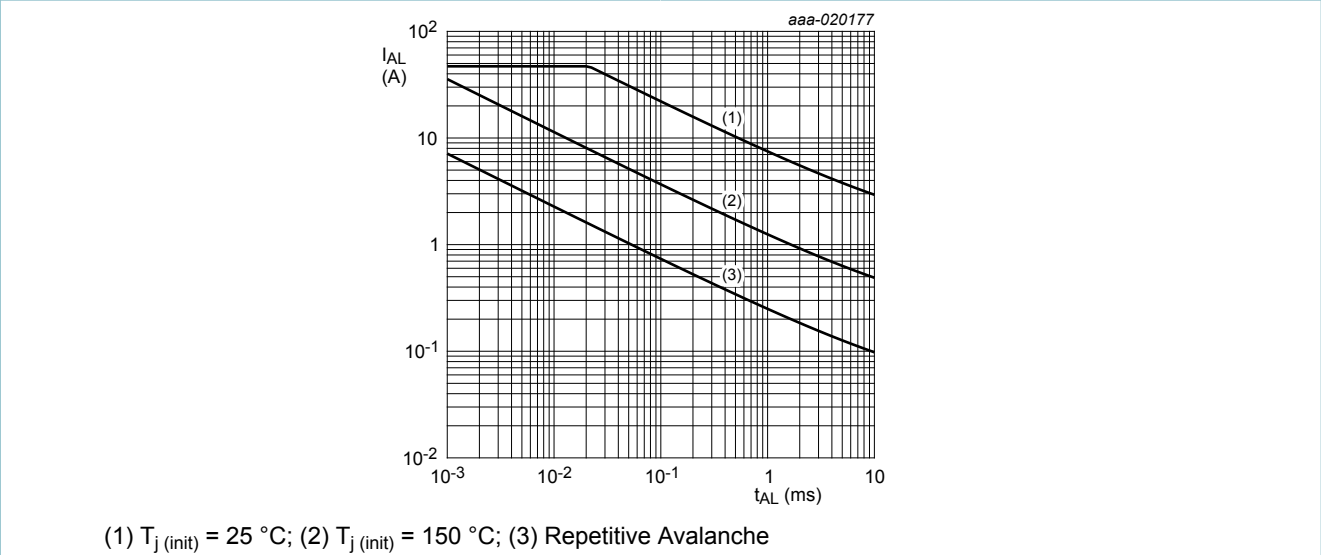
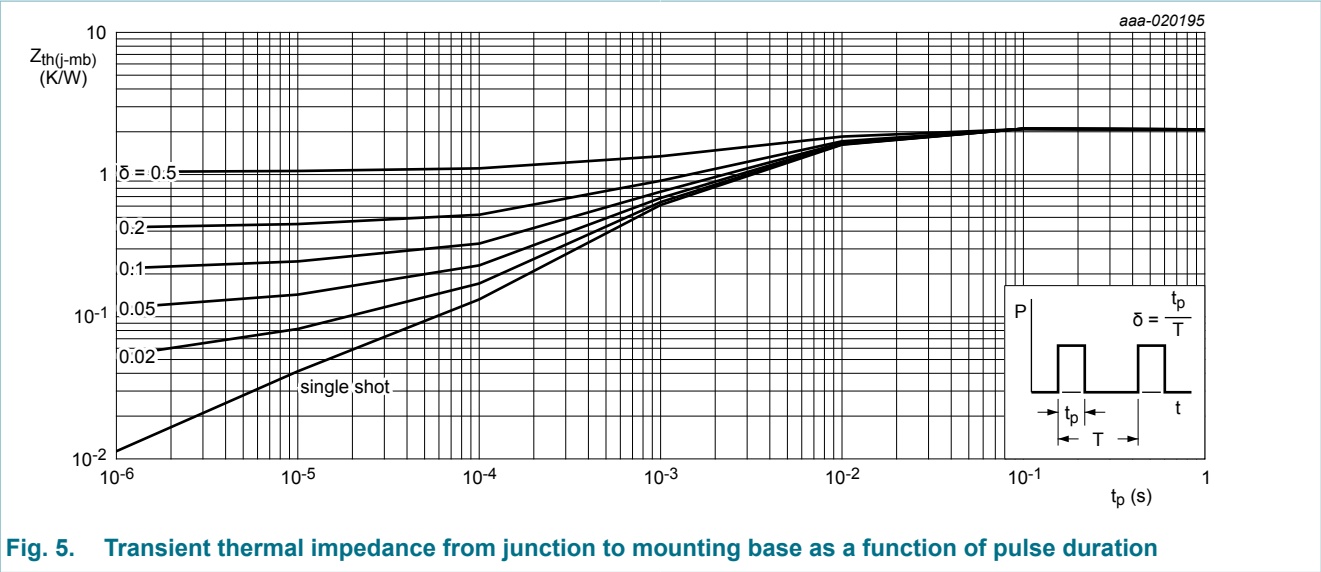


Fig. 4. Avalanche rating; avalanche current as a function of avalanche time

## 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 | Fig. 5     | -   | 1.82 | 2   | K/W  |



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. 10</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. 10</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> = 10 A; T <sub>J</sub> = 25 °C; <a href="#">Fig. 11</a>                                                   |  | -   | 12.5 | 15   | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 10 A; T <sub>J</sub> = 25 °C; <a href="#">Fig. 11</a>                                                  |  | -   | 11   | 13   | mΩ   |
|                         |                                  | V <sub>GS</sub> = 5 V; I <sub>D</sub> = 10 A; T <sub>J</sub> = 175 °C; <a href="#">Fig. 12</a>                                                  |  | -   | -    | 34   | mΩ   |
| Dynamic characteristics |                                  |                                                                                                                                                 |  |     |      |      |      |
| Q <sub>G(tot)</sub>     | total gate charge                | I <sub>D</sub> = 10 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> |  | -   | 17   | -    | nC   |
| Q <sub>GS</sub>         | gate-source charge               |                                                                                                                                                 |  | -   | 4.1  | -    | nC   |

| Symbol              | Parameter                    | Conditions                                                                                                                       |  | Min | Typ  | Max  | Unit |
|---------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------|--|-----|------|------|------|
| Q <sub>GD</sub>     | gate-drain charge            |                                                                                                                                  |  | -   | 6.4  | -    | nC   |
| C <sub>iss</sub>    | input capacitance            | V <sub>DS</sub> = 25 V; V <sub>GS</sub> = 0 V; f = 1 MHz;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 15</a>                     |  | -   | 1677 | 2230 | pF   |
| C <sub>oss</sub>    | output capacitance           |                                                                                                                                  |  | -   | 160  | 192  | pF   |
| C <sub>rss</sub>    | reverse transfer capacitance |                                                                                                                                  |  | -   | 85   | 116  | pF   |
| t <sub>d(on)</sub>  | turn-on delay time           | V <sub>DS</sub> = 45 V; R <sub>L</sub> = 4.3 Ω; V <sub>GS</sub> = 5 V;<br>R <sub>G(ext)</sub> = 5 Ω; T <sub>j</sub> = 25 °C      |  | -   | 10.3 | -    | ns   |
| t <sub>r</sub>      | rise time                    |                                                                                                                                  |  | -   | 16.9 | -    | ns   |
| t <sub>d(off)</sub> | turn-off delay time          |                                                                                                                                  |  | -   | 24   | -    | ns   |
| t <sub>f</sub>      | fall time                    |                                                                                                                                  |  | -   | 15.4 | -    | ns   |
| Source-drain diode  |                              |                                                                                                                                  |  |     |      |      |      |
| V <sub>SD</sub>     | source-drain voltage         | I <sub>S</sub> = 10 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>                                    |  | -   | 0.81 | 1.2  | V    |
| t <sub>rr</sub>     | reverse recovery time        | I <sub>S</sub> = 10 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 |  | -   | 19.3 | -    | ns   |
| Q <sub>r</sub>      | recovered charge             |                                                                                                                                  |  | -   | 17.3 | -    | nC   |

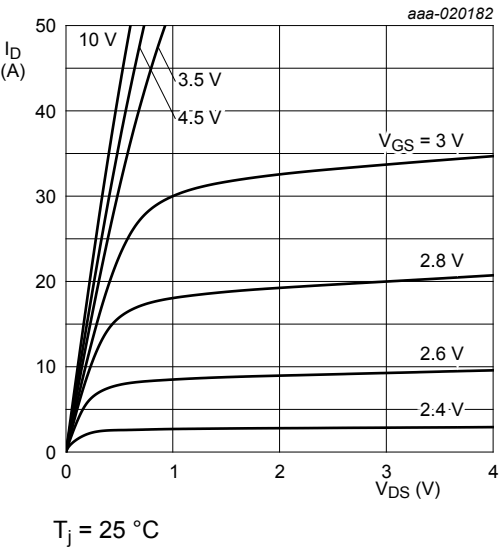


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

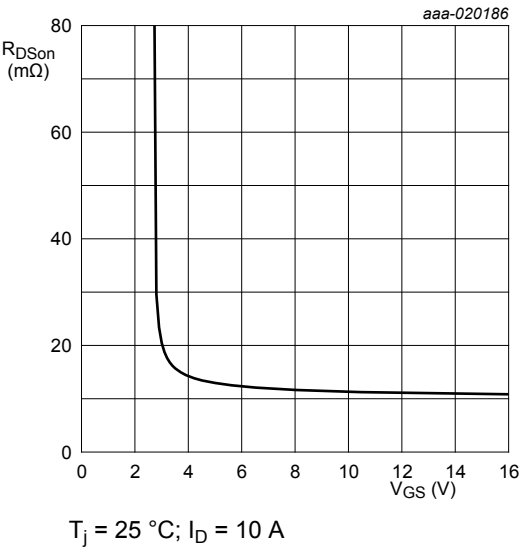


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

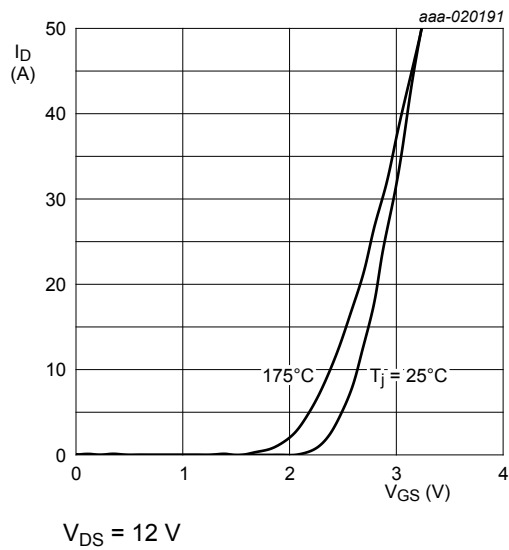


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

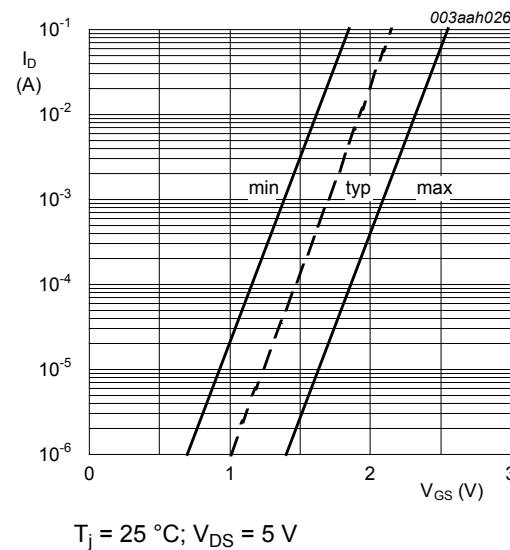


Fig. 9. Sub-threshold drain current as a function of gate-source voltage

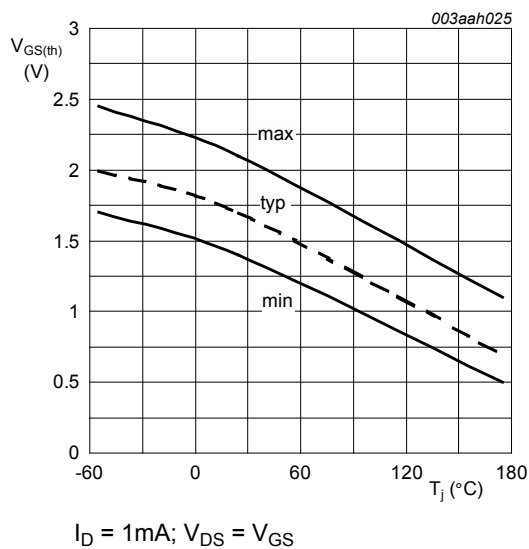


Fig. 10. Gate-source threshold voltage as a function of junction temperature

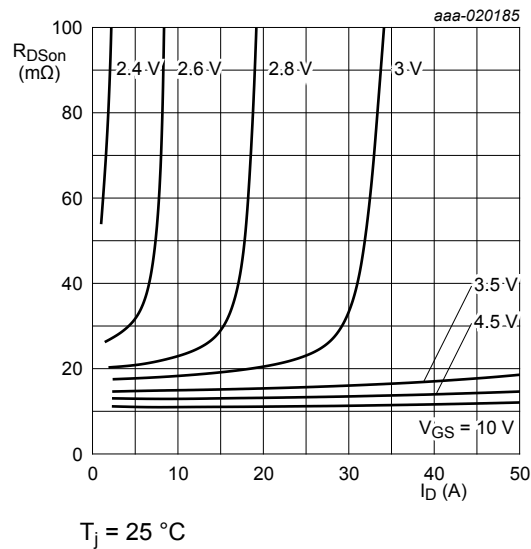
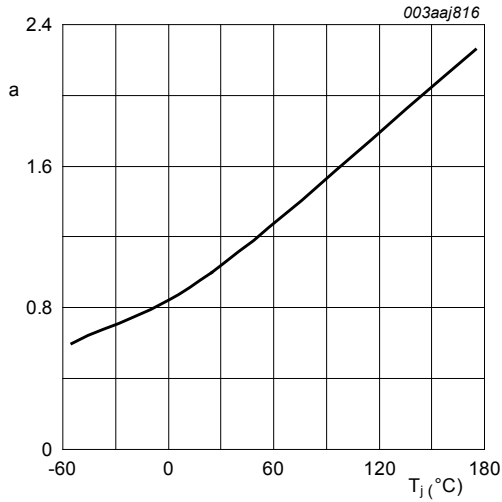
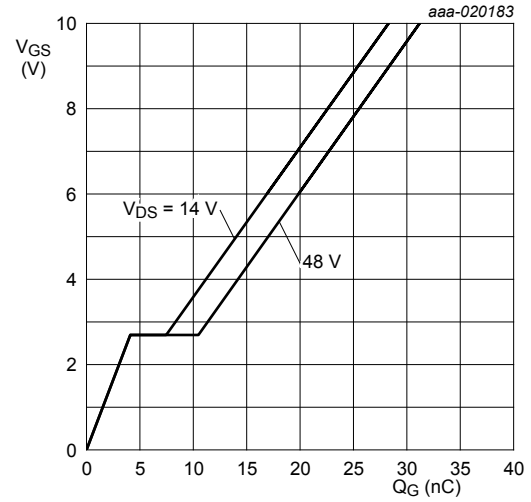


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values



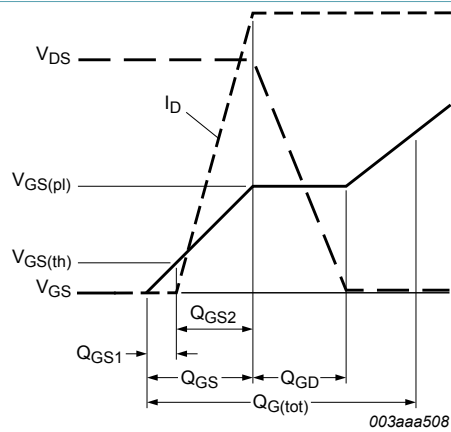
**Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature**

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

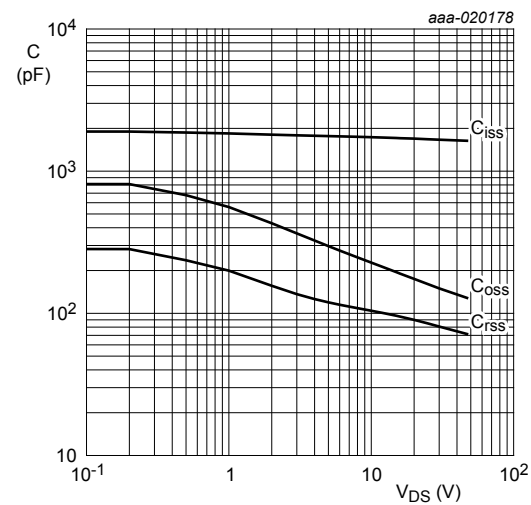


$T_j = 25^{\circ}\text{C}; I_D = 10\text{ A}$

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



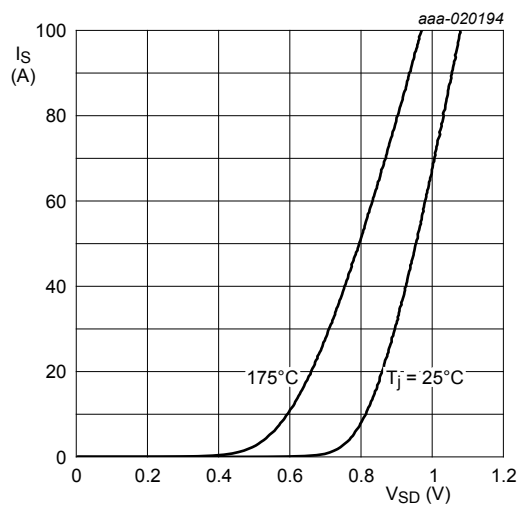
**Fig. 14. Gate charge waveform definitions**



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

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





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

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

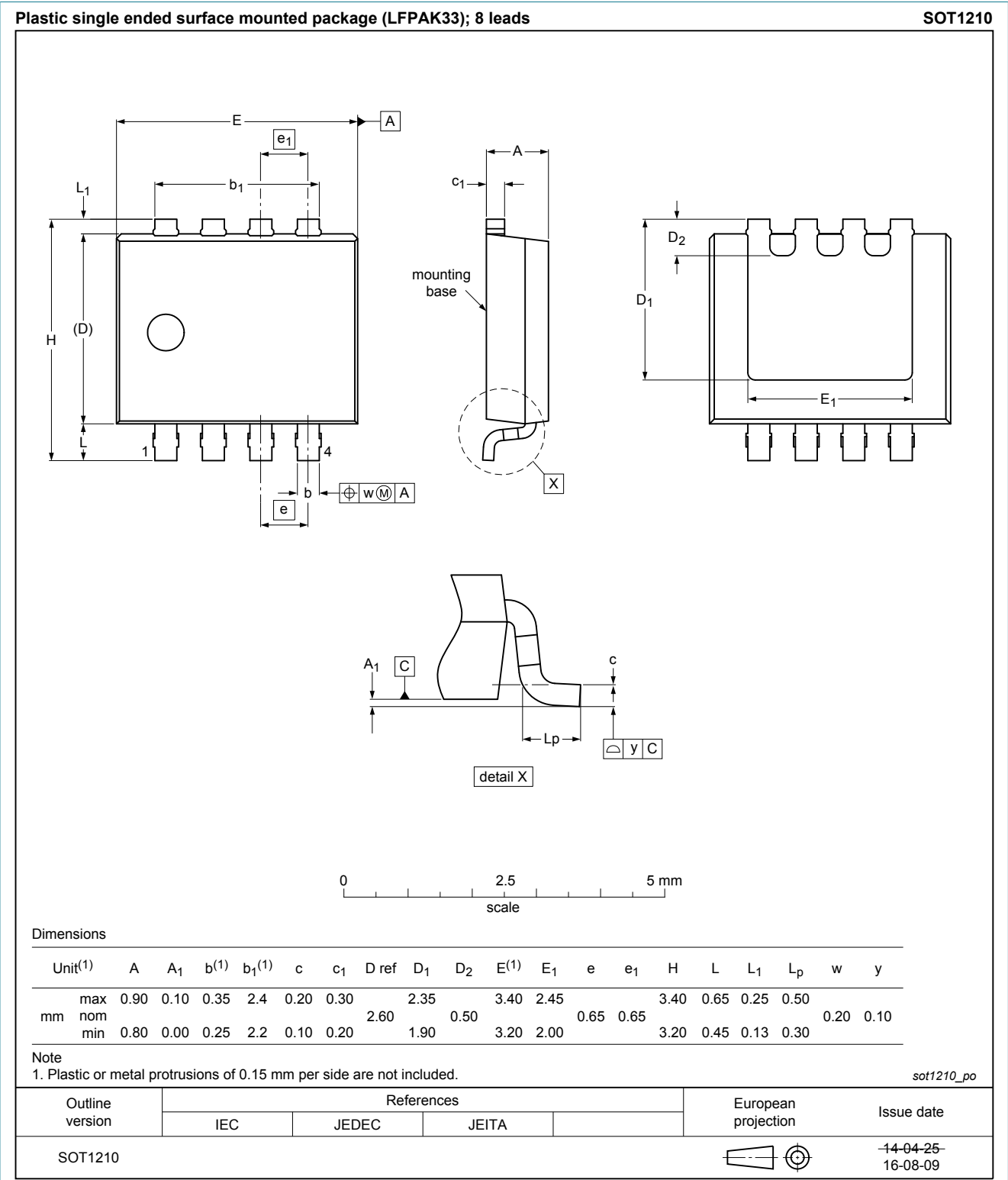


Fig. 17. Package outline LPAK33 (SOT1210)

## 13. Legal information

### 13.1 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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