



# BUK7M12-60E

N-channel 60 V, 12 mΩ standard level MOSFET in LPAK33

19 September 2016

Product data sheet

## 1. General description

Standard 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 standard level gate with  $V_{GS(th)}$  rating of greater than 1 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                    | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; <a href="#">Fig. 2</a>                                                                        | -   | -   | 53  | 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 | $V_{GS} = 10\text{ V}$ ; $I_D = 15\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 11</a>                                                    | -   | 10  | 12  | mΩ   |
| <b>Dynamic characteristics</b> |                                  |                                                                                                                                                  |     |     |     |      |
| $Q_{GD}$                       | gate-drain charge                | $I_D = 15\text{ A}$ ; $V_{DS} = 48\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> | -   | 8.5 | -   | nC   |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                       | Simplified outline                                                                                        | Graphic symbol                                                                                    |
|-----|--------|-----------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| 1   | S      | Source                            |  <p>LPAK33 (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 |
| BUK7M12-60E | LPAK33  | Plastic single ended surface mounted package (LPAK33); 8 leads | SOT1210 |

## 7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| BUK7M12-60E | 71260E       |

## 8. Limiting values

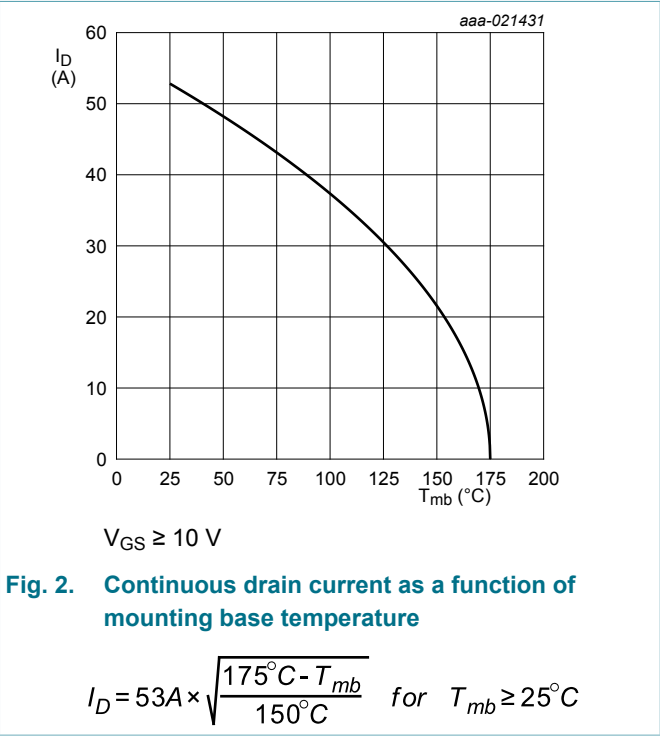
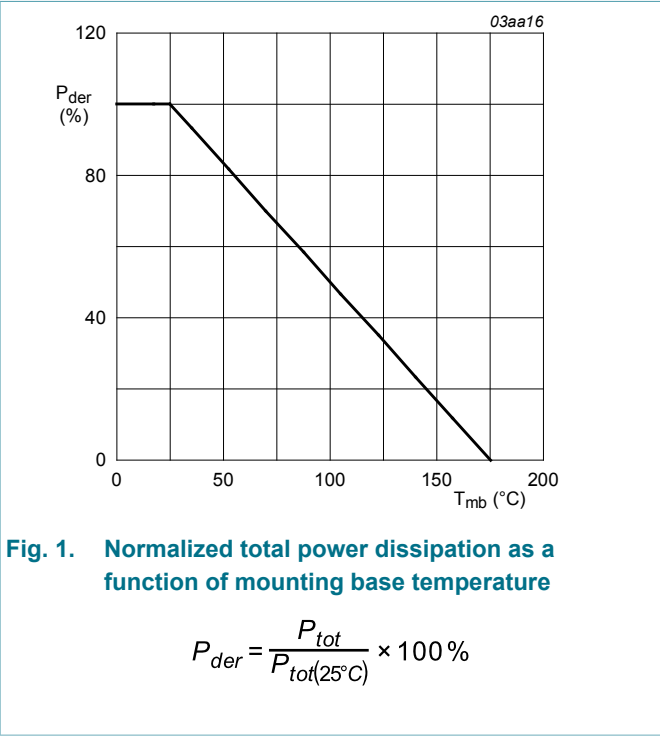
Table 5. Limiting values

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; $T_j \leq 175\text{ °C}$                                                | -20 | 20  | V    |
| $P_{tot}$ | total power dissipation | $T_{mb} = 25\text{ °C}$ ; Fig. 1                                            | -   | 75  | W    |
| $I_D$     | drain current           | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 2                   | -   | 53  | A    |
|           |                         | $V_{GS} = 10\text{ V}$ ; $T_{mb} = 100\text{ °C}$ ; Fig. 2                  | -   | 37  | A    |
| $I_{DM}$  | peak drain current      | pulsed; $t_p \leq 10\text{ }\mu\text{s}$ ; $T_{mb} = 25\text{ °C}$ ; Fig. 3 | -   | 211 | A    |
| $T_{stg}$ | storage temperature     |                                                                             | -55 | 175 | °C   |

| Symbol               | Parameter                                    | Conditions                                                                                                                                                            |                        | Min | Max  | Unit |
|----------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----|------|------|
| T <sub>j</sub>       | junction temperature                         |                                                                                                                                                                       |                        | -55 | 175  | °C   |
| Source-drain diode   |                                              |                                                                                                                                                                       |                        |     |      |      |
| I <sub>S</sub>       | source current                               | T <sub>mb</sub> = 25 °C                                                                                                                                               |                        | -   | 53   | A    |
| I <sub>SM</sub>      | peak source current                          | pulsed; t <sub>p</sub> ≤ 10 μs; T <sub>mb</sub> = 25 °C                                                                                                               |                        | -   | 211  | A    |
| Avalanche ruggedness |                                              |                                                                                                                                                                       |                        |     |      |      |
| E <sub>DS(AL)S</sub> | non-repetitive drain-source avalanche energy | I <sub>D</sub> = 53 A; V <sub>sup</sub> ≤ 60 V; R <sub>GS</sub> = 50 Ω;<br>V <sub>GS</sub> = 10 V; T <sub>j(init)</sub> = 25 °C; unclamped;<br><a href="#">Fig. 4</a> | <a href="#">[1][2]</a> | -   | 34.3 | mJ   |

[1] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.  
[2] Refer to application note AN10273 for further information.



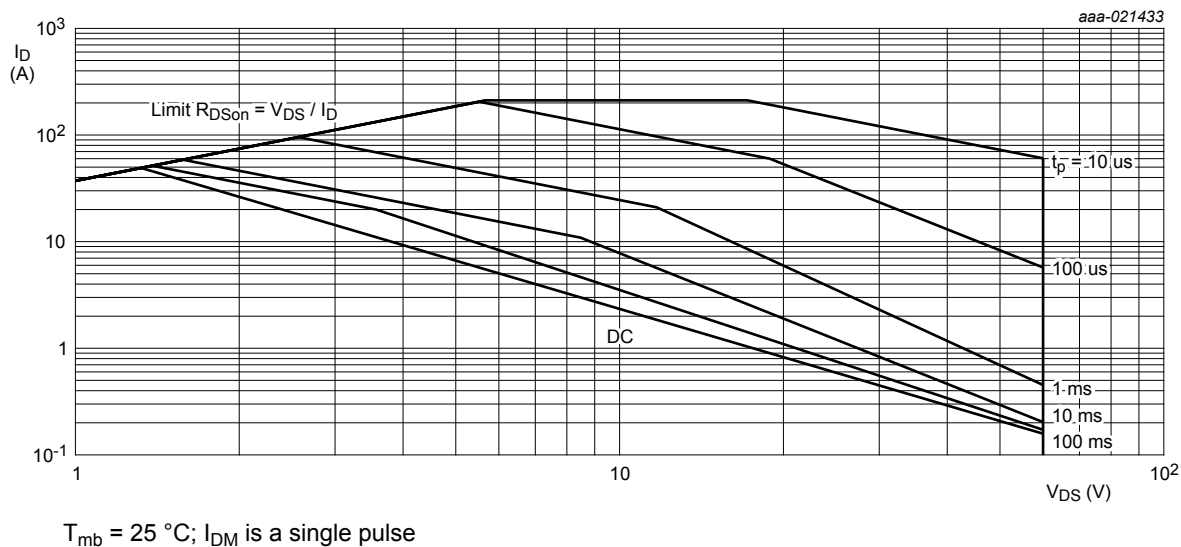
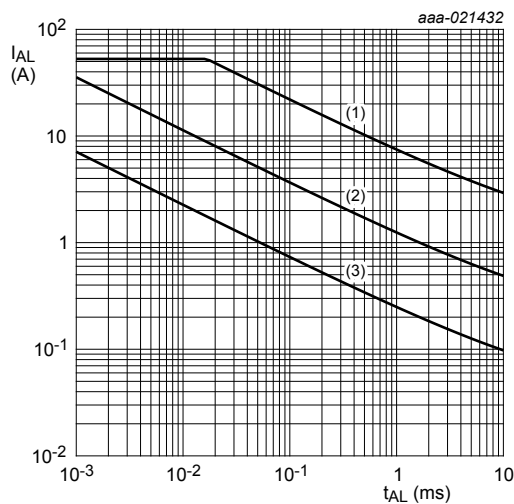


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage



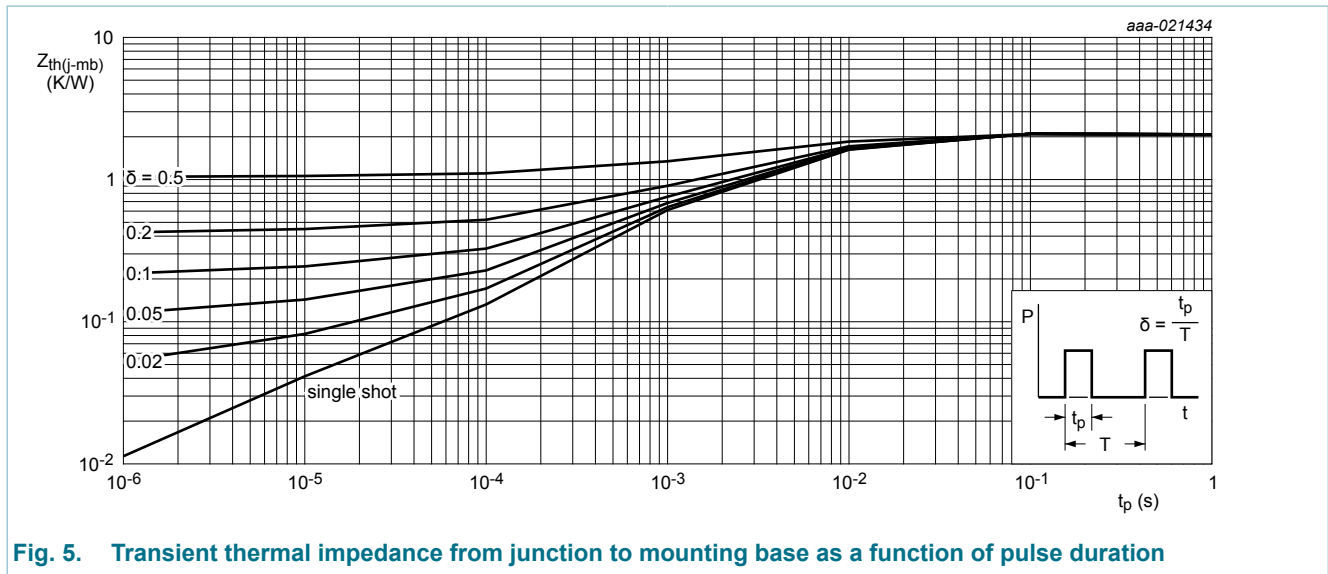
(1)  $T_{j\text{ (init)}} = 25\text{ }^{\circ}\text{C}$ ; (2)  $T_{j\text{ (init)}} = 150\text{ }^{\circ}\text{C}$ ; (3) Repetitive Avalanche

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



## 10. Characteristics

Table 7. Characteristics

| Symbol                  | Parameter                        | Conditions                                                                                                                                                   |  | Min | Typ  | Max | Unit          |
|-------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|------|-----|---------------|
| Static characteristics  |                                  |                                                                                                                                                              |  |     |      |     |               |
| $V_{(BR)DSS}$           | drain-source breakdown voltage   | $I_D = 250\text{ }\mu\text{A}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$                                                                    |  | 60  | -    | -   | V             |
|                         |                                  | $I_D = 250\text{ }\mu\text{A}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = -55\text{ }^\circ\text{C}$                                                                   |  | 54  | -    | -   | V             |
| $V_{GS(th)}$            | gate-source threshold voltage    | $I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 9</a> ; <a href="#">Fig. 10</a>                                |  | 2.4 | 3    | 4   | V             |
|                         |                                  | $I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$ ; $T_j = -55\text{ }^\circ\text{C}$ ; <a href="#">Fig. 9</a>                                                         |  | -   | -    | 4.5 | V             |
|                         |                                  | $I_D = 1\text{ mA}$ ; $V_{DS} = V_{GS}$ ; $T_j = 175\text{ }^\circ\text{C}$ ; <a href="#">Fig. 9</a>                                                         |  | 1   | -    | -   | V             |
| $I_{DSS}$               | drain leakage current            | $V_{DS} = 60\text{ V}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$                                                                            |  | -   | 0.02 | 1   | $\mu\text{A}$ |
|                         |                                  | $V_{DS} = 60\text{ V}$ ; $V_{GS} = 0\text{ V}$ ; $T_j = 175\text{ }^\circ\text{C}$                                                                           |  | -   | -    | 500 | $\mu\text{A}$ |
| $I_{GSS}$               | gate leakage current             | $V_{GS} = 20\text{ V}$ ; $V_{DS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$                                                                            |  | -   | 2    | 100 | nA            |
|                         |                                  | $V_{GS} = -20\text{ V}$ ; $V_{DS} = 0\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$                                                                           |  | -   | 2    | 100 | nA            |
| $R_{DSon}$              | drain-source on-state resistance | $V_{GS} = 10\text{ V}$ ; $I_D = 15\text{ A}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 11</a>                                                    |  | -   | 10   | 12  | m $\Omega$    |
|                         |                                  | $V_{GS} = 10\text{ V}$ ; $I_D = 15\text{ A}$ ; $T_j = 175\text{ }^\circ\text{C}$ ; <a href="#">Fig. 12</a>                                                   |  | -   | -    | 27  | m $\Omega$    |
| Dynamic characteristics |                                  |                                                                                                                                                              |  |     |      |     |               |
| $Q_{G(tot)}$            | total gate charge                | $I_D = 15\text{ A}$ ; $V_{DS} = 48\text{ V}$ ; $V_{GS} = 10\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 13</a> ; <a href="#">Fig. 14</a> |  | -   | 24.8 | -   | nC            |
| $Q_{GS}$                | gate-source charge               |                                                                                                                                                              |  | -   | 5.6  | -   | nC            |
| $Q_{GD}$                | gate-drain charge                |                                                                                                                                                              |  | -   | 8.5  | -   | nC            |

| Symbol              | Parameter                    | Conditions                                                                                                                       |  | Min | Typ  | Max  | Unit |
|---------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------|--|-----|------|------|------|
| 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>                     |  | -   | 1222 | 1625 | pF   |
| C <sub>oss</sub>    | output capacitance           |                                                                                                                                  |  | -   | 167  | 200  | pF   |
| C <sub>rss</sub>    | reverse transfer capacitance |                                                                                                                                  |  | -   | 104  | 143  | pF   |
| t <sub>d(on)</sub>  | turn-on delay time           | V <sub>DS</sub> = 45 V; R <sub>L</sub> = 3 Ω; V <sub>GS</sub> = 10 V;<br>R <sub>G(ext)</sub> = 5 Ω; T <sub>j</sub> = 25 °C       |  | -   | 6.6  | -    | ns   |
| t <sub>r</sub>      | rise time                    |                                                                                                                                  |  | -   | 9.7  | -    | ns   |
| t <sub>d(off)</sub> | turn-off delay time          |                                                                                                                                  |  | -   | 17.4 | -    | ns   |
| t <sub>f</sub>      | fall time                    |                                                                                                                                  |  | -   | 10.5 | -    | ns   |
| Source-drain diode  |                              |                                                                                                                                  |  |     |      |      |      |
| V <sub>SD</sub>     | source-drain voltage         | I <sub>S</sub> = 15 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 16</a>                                    |  | -   | 0.85 | 1.2  | V    |
| t <sub>rr</sub>     | reverse recovery time        | I <sub>S</sub> = 15 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 |  | -   | 19.5 | -    | ns   |
| Q <sub>r</sub>      | recovered charge             |                                                                                                                                  |  | -   | 16.6 | -    | nC   |

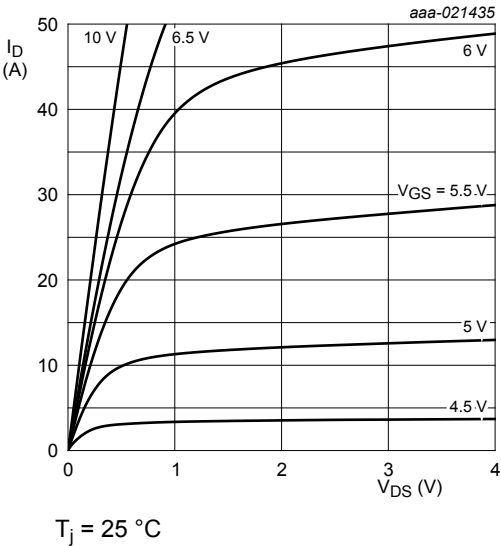


Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values

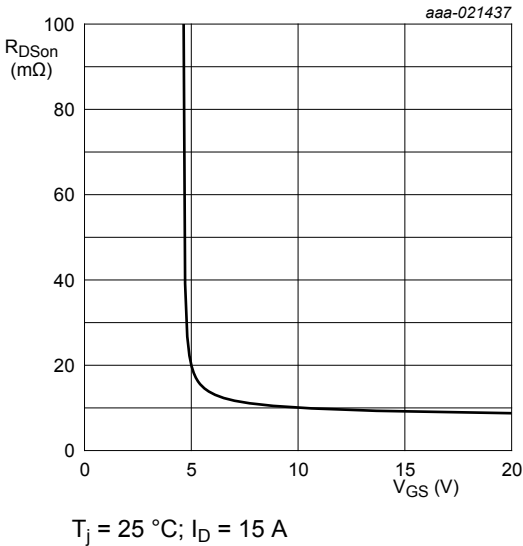


Fig. 7. Drain-source on-state resistance as a function of gate-source voltage; typical values

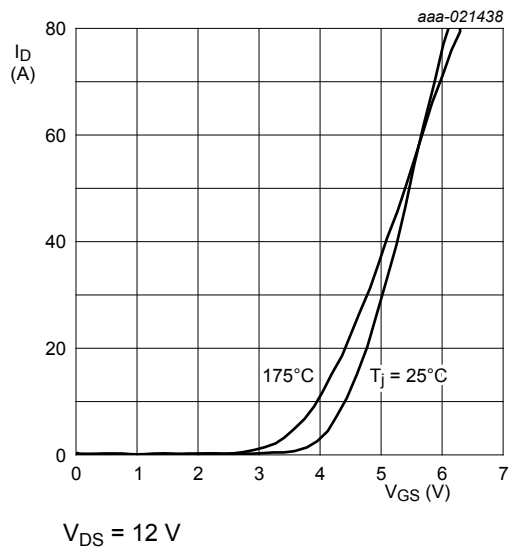


Fig. 8. Transfer characteristics; drain current as a function of gate-source voltage; typical values

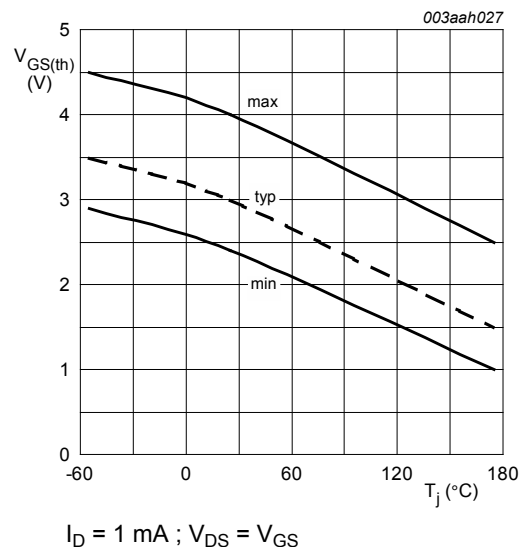


Fig. 9. Gate-source threshold voltage as a function of junction temperature

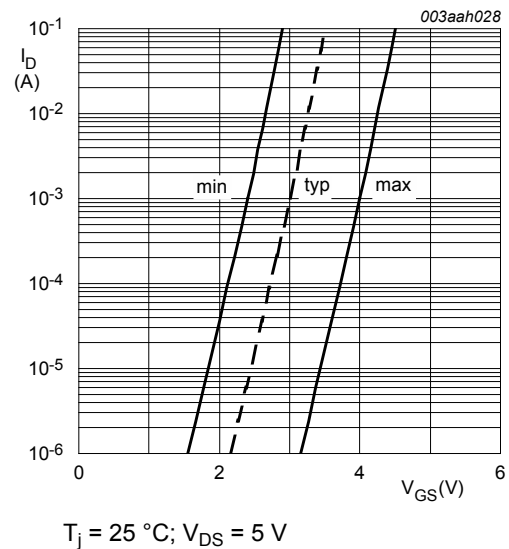


Fig. 10. Sub-threshold drain current as a function of gate-source voltage

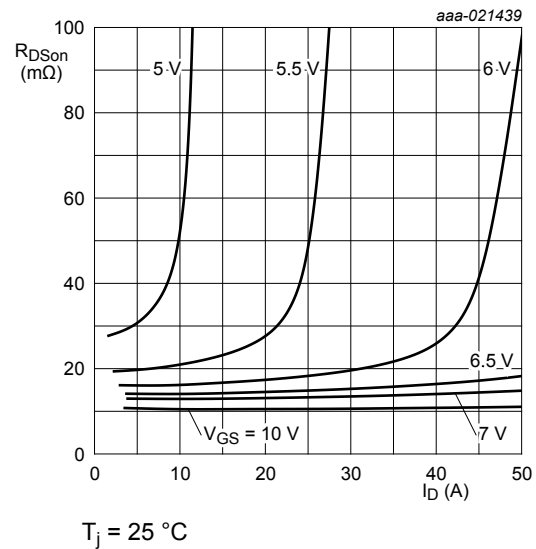


Fig. 11. Drain-source on-state resistance as a function of drain current; typical values

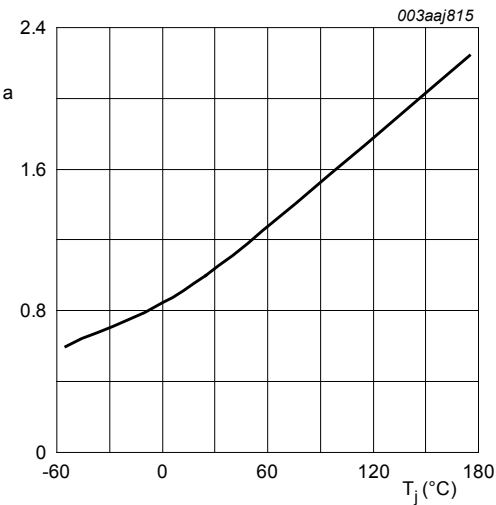
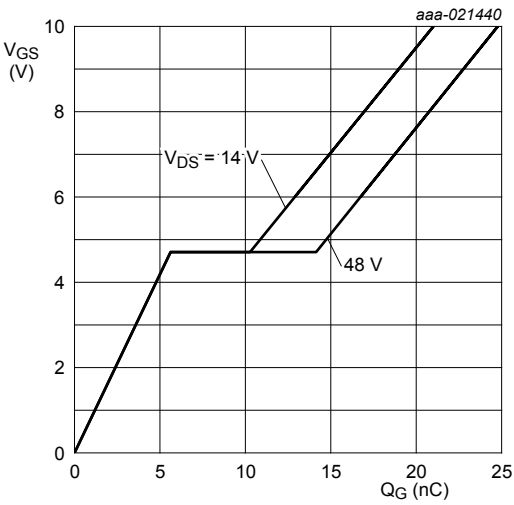


Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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



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

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

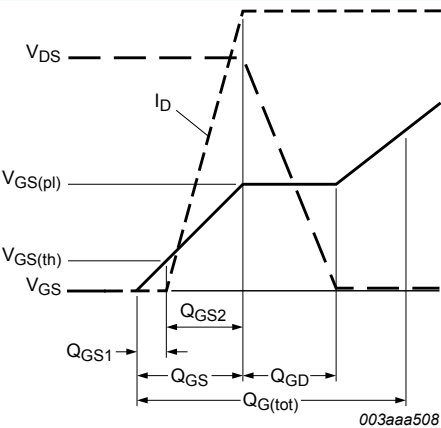
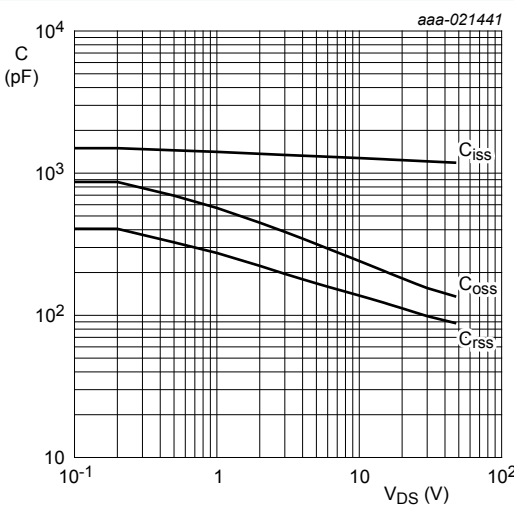
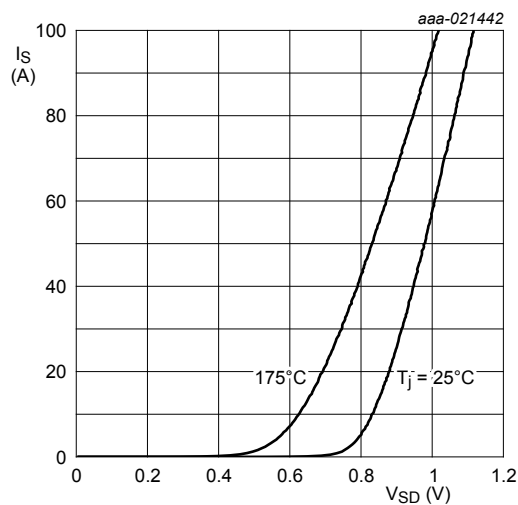


Fig. 14. Gate charge waveform definitions



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

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



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

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. |
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