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>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DS}$</td>
<td>drain-source voltage</td>
<td>$25 \degree C \leq T_j \leq 175 \degree C$</td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$V_{GS} = 5 , V$; $T_{mb} = 25 , \degree C$; Fig. 2</td>
<td>-</td>
<td>-</td>
<td>64</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , \degree C$; Fig. 1</td>
<td>-</td>
<td>-</td>
<td>75</td>
<td>W</td>
</tr>
</tbody>
</table>

Static characteristics

| $R_{DSon}$ | drain-source on-state resistance | $V_{DS} = 5 \, V$; $I_D = 20 \, A$; $T_j = 25 \, \degree C$; Fig. 11 | - | 7.5 | 9.1 | mΩ |

Dynamic characteristics

| $Q_{GD}$ | gate-drain charge | $I_D = 20 \, A$; $V_{DS} = 32 \, V$; $V_{GS} = 5 \, V$; $T_j = 25 \, \degree C$; Fig. 13; Fig. 14 | - | 6.3 | - | nC |
5. Pinning information

Table 2. Pinning information

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td>Source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>S</td>
<td>Source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>Source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>G</td>
<td>Gate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mb</td>
<td>D</td>
<td>Mounting base; connected to drain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LFPAK33 (SOT1210)

6. Ordering information

Table 3. Ordering information

<table>
<thead>
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<th>Type number</th>
<th>Package</th>
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<tr>
<td>BUK9M9R1-40E</td>
<td>LFPAK33</td>
</tr>
<tr>
<td></td>
<td>Plastic single ended surface mounted package (LFPAK33); 8 leads</td>
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<tr>
<td></td>
<td>SOT1210</td>
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7. Marking

Table 4. Marking codes

<table>
<thead>
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<tr>
<td>BUK9M9R1-40E</td>
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8. Limiting values

Table 5. Limiting values

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{DS}</td>
<td>drain-source voltage</td>
<td>25 °C ≤ T_{j} ≤ 175 °C</td>
<td>V_{DGR}</td>
<td>drain-gate voltage</td>
<td>R_{GS} = 20 kΩ</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{GS}</td>
<td>gate-source voltage</td>
<td>DC; T_{j} ≤ 175 °C</td>
<td></td>
<td></td>
<td></td>
<td>-10</td>
<td>10</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pulsed; T_{j} ≤ 175 °C</td>
<td></td>
<td></td>
<td></td>
<td>-15</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td>P_{tot}</td>
<td>total power dissipation</td>
<td>T_{mb} = 25 °C; Fig. 1</td>
<td>I_{D}</td>
<td>drain current</td>
<td>V_{GS} = 5 V; T_{mb} = 25 °C; Fig. 2</td>
<td>-</td>
<td>64</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I_{DM}</td>
<td>peak drain current</td>
<td>V_{GS} = 5 V; T_{mb} = 100 °C; Fig. 2</td>
<td>-</td>
<td>45.5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td>258</td>
<td>A</td>
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</table>

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Nexperia

BUK9M9R1-40E

N-channel 40 V, 9.1 mΩ logic level MOSFET in LFPAK33

Symbol | Parameter | Conditions | Min | Max | Unit
---|---|---|---|---|---
$T_{stg}$ | storage temperature |  | -55 | 175 | °C
$T_j$ | junction temperature |  | -55 | 175 | °C

Source-drain diode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
</table>
$I_S$ | source current | $T_{mb} = 25$ °C | - 63 | A |
$I_{SM}$ | peak source current | pulsed; $t_p \leq 10$ µs; $T_{mb} = 25$ °C | - 258 | A |

Avalanche ruggedness

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
</table>
$E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 64$ A; $V_{sup} \leq 40$ V; $R_{GS} = 50$ Ω; $V_{GS} = 5$ V; $T_{j(init)} = 25$ °C; unclamped; [3][4] | - 42.8 | mJ |

[1] Accumulated pulse duration up to 50 hours delivers zero defect ppm.
[2] Significantly longer life times are achieved by lowering $T_j$ and or $V_{GS}$
[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

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

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

$$I_D = 64A \times \sqrt{\frac{175°C - T_{mb}}{150°C}} \text{ for } T_{mb} \geq 25°C$$
Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

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

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

### 9. Thermal characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_{\text{th(j-mb)}} )</td>
<td>thermal resistance from junction to mounting base</td>
<td>Fig. 5</td>
<td>-</td>
<td>1.82</td>
<td>2</td>
<td>K/W</td>
</tr>
</tbody>
</table>

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

10. Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{BRDSS}$</td>
<td>drain-source breakdown voltage</td>
<td>$I_D = 250 \mu A; V_{GS} = 0\ V; T_j = 25\ ^\circ C$</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 250 \mu A; V_{GS} = 0\ V; T_j = -55\ ^\circ C$</td>
<td>36</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 1 mA; V_{DS} = V_{GS}; T_j = 25\ ^\circ C$</td>
<td>1.4</td>
<td>1.7</td>
<td>2.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 1 mA; V_{DS} = V_{GS}; T_j = -55\ ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>2.45</td>
<td>V</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 40\ V; V_{GS} = 0\ V; T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>0.01</td>
<td>1</td>
<td>µA</td>
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<tr>
<td></td>
<td></td>
<td>$V_{DS} = 40\ V; V_{GS} = 0\ V; T_j = 175\ ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>500</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>gate leakage current</td>
<td>$V_{GS} = 10\ V; V_{DS} = 0\ V; T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = -10\ V; V_{DS} = 0\ V; T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 5\ V; I_D = 20\ A; T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>7.5</td>
<td>9.1</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10\ V; I_D = 20\ A; T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>6.2</td>
<td>7.3</td>
<td>mΩ</td>
</tr>
</tbody>
</table>

Dynamic characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_{G(tot)}$</td>
<td>total gate charge</td>
<td>$I_D = 20 \ A; V_{DS} = 32\ V; V_{GS} = 5\ V$</td>
<td>-</td>
<td>16.2</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{GS}$</td>
<td>gate-source charge</td>
<td>$T_j = 25\ ^\circ C$</td>
<td>-</td>
<td>4.2</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{GD}$</td>
<td>gate-drain charge</td>
<td></td>
<td>-</td>
<td>6.3</td>
<td>-</td>
<td>nC</td>
</tr>
</tbody>
</table>
**Symbol** | **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Unit**
--- | --- | --- | --- | --- | --- | ---
$C_{iss}$ | input capacitance | $V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 ^\circ\text{C}$; **Fig. 15** | - | 1540 | 2048 | pF
$C_{oss}$ | output capacitance | - | - | 216 | 259 | pF
$C_{rss}$ | reverse transfer capacitance | - | - | 114 | 156 | pF
$t_{d(on)}$ | turn-on delay time | $V_{DS} = 30 \text{ V}; R_L = 1.5 \Omega; V_{GS} = 5 \text{ V}; R_G(\text{ex}) = 5 \Omega; T_j = 25 ^\circ\text{C}$ | - | 11.9 | - | ns
$t_r$ | rise time | - | - | 25 | - | ns
$t_{d(off)}$ | turn-off delay time | - | - | 24.2 | - | ns
$t_f$ | fall time | - | - | 18.7 | - | ns

**Source-drain diode**

| **Symbol** | **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Unit**
--- | --- | --- | --- | --- | --- | ---
$V_{SD}$ | source-drain voltage | $I_S = 20 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 ^\circ\text{C}$; **Fig. 16** | - | 0.86 | 1.2 | V
$t_{rr}$ | reverse recovery time | $I_S = 20 \text{ A}; dl_{G}/dt = -100 \text{ A/μs}; V_{GS} = 0 \text{ V}$; $V_{DS} = 25 \text{ V}; T_j = 25 ^\circ\text{C}$ | - | 21 | - | ns
$Q_r$ | recovered charge | - | - | 13.4 | - | 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

\[ a = \frac{R_{DS(on)}}{R_{DS(on)(25°C)}} \]

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

\[ V_{GS} = 14 \text{ V} \]
\[ V_{DS} = 32 \text{ V} \]
\[ T_j = 25 \text{ °C}; I_D = 20 \text{ A} \]

Fig. 14. 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

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

Plastic single ended surface mounted package (LFPAK33); 8 leads

![Package outline diagram]

**Dimensions**

<table>
<thead>
<tr>
<th>Unit(1)</th>
<th>A</th>
<th>A1</th>
<th>b(1)</th>
<th>b1(1)</th>
<th>c</th>
<th>c1</th>
<th>D ref</th>
<th>D1</th>
<th>D2</th>
<th>E(1)</th>
<th>e</th>
<th>e1</th>
<th>H</th>
<th>L</th>
<th>L1</th>
<th>Lp</th>
<th>w</th>
<th>y</th>
</tr>
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<tbody>
<tr>
<td>max</td>
<td>0.90</td>
<td>0.10</td>
<td>0.35</td>
<td>2.4</td>
<td>0.20</td>
<td>0.30</td>
<td>2.35</td>
<td>3.40</td>
<td>2.45</td>
<td>3.40</td>
<td>0.65</td>
<td>0.65</td>
<td>0.25</td>
<td>0.50</td>
<td>0.20</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>min</td>
<td>0.80</td>
<td>0.00</td>
<td>0.25</td>
<td>2.2</td>
<td>0.10</td>
<td>0.20</td>
<td>2.60</td>
<td>0.50</td>
<td>1.90</td>
<td>3.20</td>
<td>2.00</td>
<td>0.65</td>
<td>3.20</td>
<td>0.45</td>
<td>0.13</td>
<td>0.30</td>
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<td></td>
</tr>
</tbody>
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**Note**

1. Plastic or metal protrusions of 0.15 mm per side are not included.

**References**

- IEC
- JEDEC
- JEITA

**European projection**

11-01-25

16-08-09

**Fig. 17. Package outline LFPAK33 (SOT1210)**
13. Legal information

13.1 Data sheet status

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<thead>
<tr>
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<tr>
<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[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".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nexperia.com.

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