1. General description

Standard level N-channel MOSFET in a SOT404 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

- AEC Q101 compliant
- Repetitive avalanche rated
- Suitable for thermally demanding environments due to 175 °C rating
- True standard level gate with VGS(th) rating of greater than 1V at 175 °C

3. Applications

- 12 V Automotive systems
- Motors, lamps and solenoid control
- Start-Stop micro-hybrid applications
- 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>VDS</td>
<td>drain-source voltage</td>
<td>Tj ≤ 25 °C; Tj ≤ 175 °C</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>ID</td>
<td>drain current</td>
<td>VGS = 10 V; Tmb = 25 °C; Fig. 2</td>
<td>-</td>
<td>-</td>
<td>58</td>
<td>A</td>
</tr>
<tr>
<td>Ptot</td>
<td>total power dissipation</td>
<td>Tmb = 25 °C; Fig. 1</td>
<td>-</td>
<td>-</td>
<td>96</td>
<td>W</td>
</tr>
</tbody>
</table>

Static characteristics

- RDSon: drain-source on-state resistance
  - VGS = 10 V; ID = 15 A; Tj = 25 °C; Fig. 11
  - 9.44 mΩ

Dynamic characteristics

- QGD: gate-drain charge
  - ID = 15 A; VDS = 48 V; VGS = 10 V; Fig. 13; Fig. 14
  - 6.9 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>G</td>
<td>gate</td>
<td>mb</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td>drain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>source</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>

6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUK7613-60E</td>
<td>D2PAK</td>
<td>plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped)</td>
<td>SOT404</td>
<td></td>
</tr>
</tbody>
</table>

7. Marking

Table 4. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUK7613-60E</td>
<td>BUK7613-60E</td>
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</table>

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>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DS}$</td>
<td>drain-source voltage</td>
<td>$T_j \geq 25 , ^C; T_j \leq 175 , ^C$</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DGR}$</td>
<td>drain-gate voltage</td>
<td>$R_{GS} = 20 , k\Omega$</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>gate-source voltage</td>
<td>$T_j \leq 175 , ^C; DC$</td>
<td>-20</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , ^C$; [Fig. 1]</td>
<td>-</td>
<td>96</td>
<td>W</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$T_{mb} = 25 , ^C; V_{GS} = 10 , V$; [Fig. 2]</td>
<td>-</td>
<td>58</td>
<td>A</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>peak drain current</td>
<td>$T_{mb} = 100 , ^C; V_{GS} = 10 , V$; [Fig. 2]</td>
<td>-</td>
<td>41</td>
<td>A</td>
</tr>
<tr>
<td>$I_{D}$</td>
<td>peak drain current</td>
<td>$T_{mb} = 25 , ^C$; pulsed; $t_p \leq 10 , \mu s$; [Fig. 3]</td>
<td>-</td>
<td>234</td>
<td>A</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td>$T_{mb} = 25 , ^C$</td>
<td>-55</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td>-55</td>
<td>175</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>
## Symbol Parameter Conditions Min Max Unit

### 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>
<tbody>
<tr>
<td>$I_S$</td>
<td>source current</td>
<td>$T_{mb} = 25 , ^\circ$C</td>
<td>-</td>
<td>58</td>
<td>A</td>
</tr>
<tr>
<td>$I_{SM}$</td>
<td>peak source current</td>
<td>pulsed; $t_p \leq 10 , \mu$s; $T_{mb} = 25 , ^\circ$C</td>
<td>-</td>
<td>234</td>
<td>A</td>
</tr>
</tbody>
</table>

### 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>
<tbody>
<tr>
<td>$E_{DS(AS)}$</td>
<td>non-repetitive drain-source avalanche energy</td>
<td>$I_D = 58 , A; V_{sup} \leq 60 , V; R_{GS} = 50 , \Omega; V_{GS} = 60 , V; T_j\text{(init)} = 25 , ^\circ$C; unclamped;</td>
<td></td>
<td>37</td>
<td>mJ</td>
</tr>
</tbody>
</table>

[1] Continuous current is limited by package.
[2] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.

---

![Fig. 1. Normalized total power dissipation as a function of mounting base temperature](image1)

![Fig. 2. Continuous drain current as a function of mounting base temperature](image2)

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

$V_{GS} \geq 10V$
Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

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

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

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>-</td>
<td>1.56</td>
<td>K/W</td>
</tr>
<tr>
<td>R_{\text{th(j-a)}}</td>
<td>thermal resistance from junction to ambient</td>
<td>minimum footprint ; mounted on a printed-circuit board</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>K/W</td>
</tr>
</tbody>
</table>
10. Characteristics

Table 7. 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_{(BR)DSS} )</td>
<td>drain-source breakdown voltage</td>
<td>( I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = 25 \text{ °C} )</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = -55 \text{ °C} )</td>
<td>54</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 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ °C}; ) ( \text{Fig. 9; Fig. 10} )</td>
<td>2.4</td>
<td>3</td>
<td>4</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = 175 \text{ °C}; ) ( \text{Fig. 9} )</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 1 \text{ mA}; V_{DS} = V_{GS}; T_j = -55 \text{ °C}; ) ( \text{Fig. 9} )</td>
<td>-</td>
<td>-</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td>( I_DSS )</td>
<td>drain leakage current</td>
<td>( V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ °C} )</td>
<td>-</td>
<td>0.025</td>
<td>1</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 \text{ °C} )</td>
<td>-</td>
<td>-</td>
<td>500</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( I_{GSS} )</td>
<td>gate leakage current</td>
<td>( V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ °C} )</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>( nA )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = -20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ °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} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 25 \text{ °C}; ) ( \text{Fig. 11; Fig. 12} )</td>
<td>-</td>
<td>9.44</td>
<td>13</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = 10 \text{ V}; I_D = 15 \text{ A}; T_j = 175 \text{ °C}; ) ( \text{Fig. 11; Fig. 12} )</td>
<td>-</td>
<td>-</td>
<td>28.2</td>
<td>m( \Omega )</td>
</tr>
</tbody>
</table>

Dynamic characteristics

\( Q_{(Gbx)} \) total gate charge
\( I_D = 15 \text{ A}; V_{DS} = 48 \text{ V}; V_{GS} = 10 \text{ V}; \) \( \text{Fig. 13; Fig. 14} \)
- 22.9 - nC

\( Q_{GS} \) gate-source charge
- 5 - nC

\( Q_{GD} \) gate-drain charge
- 6.9 - nC

Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration
### Symbol | Parameter | Conditions | Min | Typ | Max | Unit
---|---|---|---|---|---|---
$C_{iss}$ | input capacitance | $V_{GS} = 0 \, V; \, V_{DS} = 25 \, V; \, f = 1 \, MHz$; $T_j = 25 \, ^\circ C$; [Fig. 15] | - | 1298 | 1730 | pF
$C_{oss}$ | output capacitance | - | 197 | 237 | pF
$C_{rss}$ | reverse transfer capacitance | - | 122 | 162 | pF
$t_{d(on)}$ | turn-on delay time | $V_{DS} = 45 \, V; \, R_L = 3 \, \Omega; \, V_{GS} = 10 \, V$; $R_{G(Ext)} = 5 \, \Omega$ | - | 10.8 | - | ns
$t_r$ | rise time | - | 9.2 | - | ns
$t_{d(off)}$ | turn-off delay time | - | 21.9 | - | ns
$t_f$ | fall time | - | 9.8 | - | ns
$L_D$ | internal drain inductance | from upper edge of mounting base to centre of die | - | 2.5 | - | nH
$L_S$ | internal source inductance | measured from source lead to source bond pad | - | 7.5 | - | nH

**Source-drain diode**

- $V_{SD}$ | source-drain voltage | $I_S = 15 \, A; \, V_{GS} = 0 \, V; \, T_j = 25 \, ^\circ C$; [Fig. 16] | 0.84 | 1.2 | V
- $t_{rr}$ | reverse recovery time | $I_S = 15 \, A; \, dI_S/dt = -100 \, A/\mu s; \, V_{GS} = 0 \, V$; | - | 21.3 | - | ns
- $Q_r$ | recovered charge | $V_{DS} = 25 \, V$ | - | 18.1 | - | 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

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

\[ I_D = 1\text{ mA}; \quad V_{DS} = V_{GS} \]

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

\[ T_J = 25^\circ\text{C}; \quad V_{DS} = 5\text{V} \]

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

\[ T_J = 25^\circ\text{C}; \quad t_p = 300\mu\text{s} \]
Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

\[ a = \frac{R_{DSon}}{R_{DSon(25 \, ^\circ\!C)}} \]

Fig. 13. Gate charge waveform definitions

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

\[ T_J = 25^\circ\!C; \; I_D = 15A \]

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

\[ V_{GS} = 0V; \; f = 1MHz \]
Fig. 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values

\[ V_{GS} = 0V \]
11. Package outline

Plastic single-ended surface-mounted package (D2PAK); 3 leads (one lead cropped) 

Dimensions (mm are the original dimensions)

<table>
<thead>
<tr>
<th>Unit</th>
<th>A</th>
<th>$A_1$</th>
<th>$b_2$</th>
<th>c</th>
<th>D</th>
<th>$D_1$</th>
<th>E</th>
<th>$e$</th>
<th>$H_D$</th>
<th>$L_P$</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>nom</td>
<td>4.0</td>
<td>1.40</td>
<td>0.85</td>
<td>1.45</td>
<td>0.64</td>
<td>11</td>
<td>1.6</td>
<td>10.3</td>
<td>15.8</td>
<td>2.9</td>
<td>2.6</td>
</tr>
<tr>
<td>max</td>
<td>4.5</td>
<td>1.40</td>
<td>0.85</td>
<td>1.45</td>
<td>0.64</td>
<td>11</td>
<td>1.6</td>
<td>10.3</td>
<td>15.8</td>
<td>2.9</td>
<td>2.6</td>
</tr>
<tr>
<td>min</td>
<td>4.1</td>
<td>1.27</td>
<td>0.60</td>
<td>1.05</td>
<td>0.46</td>
<td>1.2</td>
<td>9.7</td>
<td>14.8</td>
<td>14.8</td>
<td>2.1</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Fig. 17. Package outline D2PAK (SOT404)
12. Legal information

12.1 Data sheet status

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<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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