1. General description

Automotive qualified N-channel MOSFET using the latest Trench 9 low ohmic superjunction technology, housed in a copper-clip LFPAK88 package. This product has been fully designed and qualified to meet beyond AEC-Q101 requirements delivering high performance and reliability.

2. Features and benefits

- Fully automotive qualified to beyond AEC-Q101:
  - -55 °C to +175 °C rating suitable for thermally demanding environments
- LFPAK88 package:
  - Designed for smaller footprint and improved power density over older wire bond packages such as D²PAK for today's space constrained high power automotive applications
  - Thin package and copper clip enables LFPAK88 to be highly efficient thermally
- LFPAK copper clip technology enabling improvements over wire bond packages by:
  - Increased maximum current capability and excellent current spreading
  - Improved $R_{DSon}$
  - Low source inductance
  - Low thermal resistance $R_{th}$
- LFPAK Gull Wing leads:
  - Flexible leads enabling high Board Level Reliability absorbing mechanical and thermal cycling stress, unlike traditional QFN packages
  - Visual (AOI) soldering inspection, no need for expensive x-ray equipment
  - Easy solder wetting for good mechanical solder joint
- Unique 40 V Trench 9 superjunction technology:
  - Reduced cell pitch and superjunction platform enables lower $R_{DSon}$ in the same footprint
  - Improved SOA and avalanche capability compared to standard TrenchMOS
  - Tight $V_{GS(th)}$ limits enable easy paralleling of MOSFETs

3. Applications

- 12 V automotive systems
- 48 V DC/DC systems (on 12 V secondary side)
- Higher power motors, lamps and solenoid control
- Reverse polarity protection
- LED lighting
- 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>$25 , ^\circ C \leq T_j \leq 175 , ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$V_{GS} = 10 , V; T_{mb} = 25 , ^\circ C; \text{ Fig. 2}$</td>
<td>[1]</td>
<td>-</td>
<td>325</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , ^\circ C; \text{ Fig. 1}$</td>
<td>-</td>
<td>-</td>
<td>375</td>
<td>W</td>
</tr>
</tbody>
</table>
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>
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<tbody>
<tr>
<td>1</td>
<td>G</td>
<td>gate</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>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>LFPAK88 (SOT1235)</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>
</tr>
</thead>
<tbody>
<tr>
<td>BUK7S1R0-40H</td>
<td>LFPAK88</td>
<td>plastic, single-ended surface-mounted package (LFPAK88); 4 leads; 2 mm pitch; 8 mm x 8 mm x 1.6 mm body</td>
<td>SOT1235</td>
</tr>
</tbody>
</table>

7. Marking

Table 4. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
</tr>
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<tbody>
<tr>
<td>BUK7S1R0-40H</td>
<td>7S1R040H</td>
</tr>
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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_DSS</td>
<td>drain-source voltage</td>
<td>25 °C ≤ T_j ≤ 175 °C</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
</tbody>
</table>
### Symbol | Parameter | Conditions | Min | Max | Unit
--- | --- | --- | --- | --- | ---
$V_{GS}$ | gate-source voltage | DC; $T_j \leq 175 \, ^\circ C$ | -10 | 20 | V
$P_{\text{tot}}$ | total power dissipation | $T_{mb} = 25 \, ^\circ C$; Fig. 1 | - | 375 | W
$I_D$ | drain current | $V_{GS} = 10 \, V$; $T_{mb} = 25 \, ^\circ C$; Fig. 2 | [1] | - | 325 | A
$I_{\text{DM}}$ | peak drain current | pulsed; $t_p \leq 10 \, \mu s$; $T_{mb} = 25 \, ^\circ C$; Fig. 3 | [1] | - | 1659 | A
$T_{stg}$ | storage temperature | -55 | 175 | °C
$T_j$ | junction temperature | -55 | 175 | °C

### Source-drain diode
$I_S$ | source current | $T_{mb} = 25 \, ^\circ C$ | [2] | - | 350 | A
$I_{\text{SM}}$ | peak source current | pulsed; $t_p \leq 10 \, \mu s$; $T_{mb} = 25 \, ^\circ C$ | - | 1659 | A

### Avalanche ruggedness
$E_{DS(\text{AL})S}$ | non-repetitive drain-source avalanche energy | $I_D = 120 \, A$; $V_{sup} \leq 40 \, V$; $R_{GS} = 50 \, \Omega$; $V_{GS} = 10 \, V$; $T_{j(init)} = 25 \, ^\circ C$; unclamped; Fig. 4 | [3] [4] | - | 437 | mJ

---

[1] 325A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] 350A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[3] single pulse avalanche rating limited by maximum junction temperature of 175°C

[4] refer to application note AN10273 for further information

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**Fig. 1.** Normalized total power dissipation as a function of mounting base temperature

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

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

$V_{GS} \geq 10 \, V$

(1) 325A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
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. Avalanche rating; avalanche current as a function of avalanche time

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

9. Thermal characteristics

Table 6. 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_{th(j-mb)} )</td>
<td>thermal resistance from junction to mounting base</td>
<td>Fig. 5</td>
<td>-</td>
<td>0.35</td>
<td>0.4</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>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = 25 ^\circ \text{C}$</td>
<td>40</td>
<td>43</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{(BR)DSS}$</td>
<td>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = -40 ^\circ \text{C}$</td>
<td>-</td>
<td>40.5</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{(BR)DSS}$</td>
<td>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = -55 ^\circ \text{C}$</td>
<td>36</td>
<td>40</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 25 ^\circ \text{C}$; Fig. 9; Fig. 10</td>
<td>2.4</td>
<td>3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = 175 ^\circ \text{C}$; Fig. 10</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_j = -55 ^\circ \text{C}$; Fig. 10</td>
<td>-</td>
<td>-</td>
<td>4.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 ^\circ \text{C}$</td>
<td>-</td>
<td>0.2</td>
<td>1.5</td>
<td>$\mu$A</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>$V_{DS} = 16 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 125 ^\circ \text{C}$</td>
<td>-</td>
<td>4.7</td>
<td>25</td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>$V_{DS} = 40 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 175 ^\circ \text{C}$</td>
<td>-</td>
<td>287</td>
<td>1000</td>
<td>$\mu$A</td>
<td></td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>gate leakage current</td>
<td>$V_{GS} = 20 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 ^\circ \text{C}$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 ^\circ \text{C}$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{DS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 25 ^\circ \text{C}$; Fig. 11</td>
<td>0.62</td>
<td>0.88</td>
<td>1</td>
<td>m$\Omega$</td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>$V_{DS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 105 ^\circ \text{C}$; Fig. 12</td>
<td>0.87</td>
<td>1.3</td>
<td>1.6</td>
<td>m$\Omega$</td>
<td></td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>$V_{DS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 125 ^\circ \text{C}$; Fig. 12</td>
<td>0.97</td>
<td>1.4</td>
<td>1.75</td>
<td>m$\Omega$</td>
<td></td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>$V_{DS} = 10 \text{ V}; I_D = 25 \text{ A}; T_j = 175 ^\circ \text{C}$; Fig. 12</td>
<td>1.2</td>
<td>1.8</td>
<td>2.2</td>
<td>m$\Omega$</td>
<td></td>
</tr>
<tr>
<td>$R_G$</td>
<td>gate resistance</td>
<td>$f = 1 \text{ MHz}; T_j = 25 ^\circ \text{C}$</td>
<td>0.4</td>
<td>0.9</td>
<td>2.3</td>
<td>$\Omega$</td>
</tr>
</tbody>
</table>

Dynamic characteristics

| $Q_{G(tot)}$ | total gate charge | $I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V}$; Fig. 13; Fig. 14 | - | 98 | 137 | nC |
| $Q_{GS}$ | gate-source charge | - | 27 | 40 | nC |
| $Q_{GD}$ | gate-drain charge | - | 17 | 34 | nC |
Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
Ciss | input capacitance | $V_{DS} = 25 \, \text{V}$; $V_{GS} = 0 \, \text{V}$; $f = 1 \, \text{MHz}$; $T_j = 25 \, ^\circ\text{C}$; Fig. 15 | - | 7373 | 10322 | pF
Coss | output capacitance | | - | 1578 | 2209 | pF
Crss | reverse transfer capacitance | | - | 295 | 649 | pF
\(t_{d(on)}\) | turn-on delay time | $V_{DS} = 30 \, \text{V}$; $R_L = 1.2 \, \Omega$; $V_{GS} = 10 \, \text{V}$; $R_{G(ex)} = 5 \, \Omega$ | - | 23 | - | ns
\(t_r\) | rise time | | - | 19 | - | ns
\(t_{d(off)}\) | turn-off delay time | | - | 59 | - | ns
\(t_f\) | fall time | | - | 26 | - | ns

**Source-drain diode**

\(V_{SD}\) | source-drain voltage | $V_{GS} = 0 \, \text{V}$; $T_j = 25 \, ^\circ\text{C}$; Fig. 16 | - | 0.76 | 1 | V
\(t_{rr}\) | reverse recovery time | $I_S = 25 \, \text{A}$; $dI_S/dt = -100 \, \text{A/µs}$; $V_{GS} = 0 \, \text{V}$; $V_{DS} = 20 \, \text{V}$ | - | 43 | - | ns
\(Q_r\) | recovered charge | $I_S = 25 \, \text{A}$; $dI_S/dt = -100 \, \text{A/µs}$; $V_{GS} = 0 \, \text{V}$; $V_{DS} = 20 \, \text{V}$; $T_j = 25 \, ^\circ\text{C}$ | [1] | 49 | - | nC
\(S\) | softness factor | $I_S = 25 \, \text{A}$; $dI_S/dt = -100 \, \text{A/µs}$; $V_{GS} = 0 \, \text{V}$; $V_{DS} = 20 \, \text{V}$; $T_j = 25 \, ^\circ\text{C}$ | - | 0.8 | - | 
\(I_S = 25 \, \text{A}$; $dI_S/dt = -500 \, \text{A/µs}$; $V_{GS} = 0 \, \text{V}$; $V_{DS} = 20 \, \text{V}$; $T_j = 25 \, ^\circ\text{C}$ | - | 0.7 | - |

[1] Includes capacitive recovery

---

**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

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

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

\( T_J = 25 \, ^\circ C; \quad I_D = 25 \, A \)

Fig. 14. Gate charge waveform definitions

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

\( V_{GS} = 0 \, V; \quad f = 1 \, MHz \)
$V_{GS} = 0 \text{ V}$

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

Plastic single-ended surface-mounted package (LFPAK88); 4 leads

Dimensions (mm are the original dimensions)

<table>
<thead>
<tr>
<th>Unit</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>b</th>
<th>b2</th>
<th>c</th>
<th>c2</th>
<th>D(1)</th>
<th>D2(1)</th>
<th>E(1)</th>
<th>E1(1)</th>
<th>e</th>
<th>H(1)</th>
<th>L</th>
<th>L2</th>
<th>w</th>
<th>y</th>
<th>θ</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>0.15</td>
<td>1.7</td>
<td>0.25</td>
<td>7.3</td>
<td>0.24</td>
<td>0.55</td>
<td>6.3</td>
<td>5.1</td>
<td>8.1</td>
<td>6.9</td>
<td>8.1</td>
<td>6.9</td>
<td>2.0</td>
<td>1.3</td>
<td>0.25</td>
<td>0.10</td>
<td>8°</td>
<td></td>
</tr>
<tr>
<td>nom</td>
<td>0.00</td>
<td>1.5</td>
<td>0.9</td>
<td>7.1</td>
<td>0.18</td>
<td>0.45</td>
<td>6.1</td>
<td>4.9</td>
<td>7.9</td>
<td>6.7</td>
<td>7.9</td>
<td>6.7</td>
<td>2.0</td>
<td>0.9</td>
<td>0.00</td>
<td>0°</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note
1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

Fig. 17. Package outline LFPAK88 (SOT1235)
12. Soldering

Footprint information for reflow soldering of LFPAK88 package

---

Fig. 18. Reflow soldering footprint for LFPAK88 (SOT1235)
13. Legal information

Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1][2]</td>
<td>[3]</td>
<td></td>
</tr>
</tbody>
</table>

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.

[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 https://www.nexperia.com.

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Contents

1. General description......................................................1
2. Features and benefits.................................................. 1
3. Applications.................................................................. 1
4. Quick reference data....................................................1
5. Pinning information......................................................2
6. Ordering information....................................................2
7. Marking.......................................................................... 2
8. Limiting values............................................................2
9. Thermal characteristics..................................................4
10. Characteristics.............................................................5
11. Package outline........................................................10
12. Soldering...................................................................... 11
13. Legal information.......................................................12

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