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 $R_{DS(on)}$
  - 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 $R_{DS(on)}$ 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
- 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>$V_{GS} = 10 , V$; $T_{mb} = 25 , ^\circ C$; Fig. 2</td>
<td>[1]</td>
<td>-</td>
<td>190</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , ^\circ C$; Fig. 1</td>
<td>-</td>
<td>-</td>
<td>183</td>
<td>W</td>
</tr>
</tbody>
</table>
Nexperia

BUK7S2R0-40H

N-channel 40 V, 2 mOhm standard level MOSFET in LFPAK88

### Static 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>$R_{DS\text{on}}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_J = 25 \degree \text{C}$; [Fig. 11]</td>
<td>1.19</td>
<td>1.7</td>
<td>2</td>
<td>mΩ</td>
</tr>
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</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>$Q_{GD}$</td>
<td>gate-drain charge</td>
<td>$I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V}$; [Fig. 13, Fig. 14]</td>
<td>-</td>
<td>9</td>
<td>18</td>
<td>nC</td>
</tr>
</tbody>
</table>

### Source-drain diode

<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>$Q_r$</td>
<td>recovered charge</td>
<td>$I_S = 25 \text{ A}; dI_S/dt = -100 \text{ A/\mu s}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_J = 25 \degree \text{C}$</td>
<td>[2]</td>
<td>25</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>S</td>
<td>softness factor</td>
<td></td>
<td>-</td>
<td>0.88</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

[1] 190A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] Includes capacitive recovery.

### 5. 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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<td>gate</td>
<td><img src="image" alt="Simplified outline" /></td>
<td><img src="image" alt="Graphic symbol" /></td>
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<tr>
<td>2</td>
<td>S</td>
<td>source</td>
<td></td>
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</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>
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### 6. Ordering information

<table>
<thead>
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<th>Package</th>
<th>Name</th>
<th>Description</th>
<th>Version</th>
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</thead>
<tbody>
<tr>
<td>BUK7S2R0-40H</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>
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### 7. Marking

<table>
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<th>Marking code</th>
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<td>BUK7S2R0-40H</td>
<td>7S2R040H</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>$25 \degree \text{C} \leq T_J \leq 175 \degree \text{C}$</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
</tbody>
</table>
### Symbol | Parameter | Conditions | Min | Max | Unit
---|---|---|---|---|---
$V_{GS}$ | gate-source voltage | DC; $T_j = 175 \, ^\circ\text{C}$ | -10 | 20 | V
$P_{\text{tot}}$ | total power dissipation | $T_{\text{mb}} = 25 \, ^\circ\text{C}$; Fig. 1 | - | 183 | W
$I_D$ | drain current | $V_{GS} = 10 \, \text{V}$; $T_{\text{mb}} = 25 \, ^\circ\text{C}$; Fig. 2 | [1] | 190 | A
$I_{DM}$ | peak drain current | pulsed; $t_p \leq 10 \, \mu\text{s}$; $T_{\text{mb}} = 25 \, ^\circ\text{C}$; Fig. 3 | - | 819 | A
$T_{\text{stg}}$ | storage temperature | -55 | 175 | °C
$T_j$ | junction temperature | -55 | 175 | °C

### Source-drain diode

| Symbol | Parameter | Conditions | Min | Max | Unit
---|---|---|---|---|---
$I_S$ | source current | $T_{\text{mb}} = 25 \, ^\circ\text{C}$ | [2] | - | 183 | A
$I_{SM}$ | peak source current | pulsed; $t_p \leq 10 \, \mu\text{s}$; $T_{\text{mb}} = 25 \, ^\circ\text{C}$ | - | 819 | A

### Avalanche ruggedness

| Symbol | Parameter | Conditions | Min | Max | Unit
---|---|---|---|---|---
$E_{DS(\text{AL})S}$ | non-repetitive drain-source avalanche energy | $I_D = 120 \, \text{A}$; $V_{\sup} \leq 40 \, \text{V}$; $R_{\text{GS}} = 50 \, \Omega$; $V_{\text{GS}} = 10 \, \text{V}$; $T_{j(\text{init})} = 25 \, ^\circ\text{C}$; unclamped; Fig. 4 | [3] [4] | - | 112 | mJ
$I_{AS}$ | non-repetitive avalanche current | $V_{\sup} = 40 \, \text{V}$; $V_{\text{GS}} = 10 \, \text{V}$; $T_{j(\text{init})} = 25 \, ^\circ\text{C}$; $R_{\text{GS}} = 50 \, \Omega$ | [5] | - | 131 | A

[1] 190A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] 183A continuous current has been successfully demonstrated during application. 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.

[5] Protected by 100% test.

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

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

- $P_{\text{der}}$: Derated power dissipation
- $P_{\text{tot}}$: Total power dissipation
- $P_{\text{tot}(25^\circ\text{C})}$: Power dissipation at 25 °C

---

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

- $V_{\text{GS}} \geq 10 \, \text{V}$
- (1) 190A 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

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

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

$$T_{j (init)} = 25 \, ^\circ\text{C}; (2) T_{j (init)} = 150 \, ^\circ\text{C}; (3)$$ 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>0.72</td>
<td>0.82</td>
<td>K/W</td>
</tr>
</tbody>
</table>
Fig. 5. Transient thermal impedance from junction to mounting base as a function of pulse duration

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 ) V; ( T_j = 25 ) °C</td>
<td>40</td>
<td>43</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 250 \mu A; V_{GS} = 0 ) V; ( T_j = -40 ) °C</td>
<td>-</td>
<td>40.5</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 ) °C</td>
<td>36</td>
<td>40</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 ) °C; Fig. 9; Fig. 10</td>
<td>2.4</td>
<td>3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 1 ) mA; ( V_{DS} = V_{GS}; T_j = -55 ) °C; Fig. 10</td>
<td>-</td>
<td>-</td>
<td>4.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_D = 1 ) mA; ( V_{DS} = V_{GS}; T_j = 175 ) °C; Fig. 10</td>
<td>1</td>
<td>-</td>
<td>-</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 ) °C</td>
<td>-</td>
<td>0.06</td>
<td>1</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{DS} = 16 ) V; ( V_{GS} = 0 ) V; ( T_j = 125 ) °C</td>
<td>-</td>
<td>1.3</td>
<td>10</td>
<td>( \mu A )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{DS} = 40 ) V; ( V_{GS} = 0 ) V; ( T_j = 175 ) °C</td>
<td>-</td>
<td>133</td>
<td>500</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>I_GSS</td>
<td>gate leakage current</td>
<td>( V_{GS} = 20 ) V; ( V_{DS} = 0 ) V; ( T_j = 25 ) °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 ) °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 ) V; ( I_D = 25 ) A; ( T_j = 25 ) °C; Fig. 11</td>
<td>1.19</td>
<td>1.7</td>
<td>2</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = 10 ) V; ( I_D = 25 ) A; ( T_j = 105 ) °C; Fig. 12</td>
<td>1.69</td>
<td>2.6</td>
<td>3.18</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = 10 ) V; ( I_D = 25 ) A; ( T_j = 125 ) °C; Fig. 12</td>
<td>1.87</td>
<td>2.83</td>
<td>3.5</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{GS} = 10 ) V; ( I_D = 25 ) A; ( T_j = 175 ) °C; Fig. 12</td>
<td>2.34</td>
<td>3.55</td>
<td>4.36</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td>R_G</td>
<td>gate resistance</td>
<td>( f = 1 ) MHz; ( T_j = 25 ) °C</td>
<td>0.36</td>
<td>0.89</td>
<td>2.23</td>
<td>( \Omega )</td>
</tr>
</tbody>
</table>

Dynamic characteristics

- \( Q_{G(tot)} \) total gate charge
  \( I_D = 25 \) A; \( V_{DS} = 32 \) V; \( V_{GS} = 10 \) V; Fig. 13; Fig. 14
  - 50 70 nC
- \( Q_{GS} \) gate-source charge
  - 14 21 nC
- \( Q_{GD} \) gate-drain charge
  - 9 18 nC
### Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{iss}$</td>
<td>input capacitance</td>
<td>$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$; $T_j = 25 \text{ °C}$; [Fig. 15]</td>
<td>-</td>
<td>3625</td>
<td>5075</td>
<td>pF</td>
</tr>
<tr>
<td>$C_{oss}$</td>
<td>output capacitance</td>
<td>-</td>
<td>950</td>
<td>1330</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$C_{rsw}$</td>
<td>reverse transfer capacitance</td>
<td>-</td>
<td>156</td>
<td>343</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>$t_{d(on)}$</td>
<td>turn-on delay time</td>
<td>$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$; $T_j = 25 \text{ °C}$; Fig. 15</td>
<td>-</td>
<td>12.2</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>rise time</td>
<td>-</td>
<td>10.4</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{d(off)}$</td>
<td>turn-off delay time</td>
<td>-</td>
<td>29</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{f}$</td>
<td>fall time</td>
<td>-</td>
<td>14</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$V_{SD}$</td>
<td>source-drain voltage</td>
<td>$I_S = 25 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ °C}$; [Fig. 16]</td>
<td>-</td>
<td>0.74</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>reverse recovery time</td>
<td>$I_S = 25 \text{ A}; dI_S/dt = -100 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 \text{ °C}$</td>
<td>-</td>
<td>32.6</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$Q_r$</td>
<td>recovered charge</td>
<td>$V_{DS} = 25 \text{ A}; dI_S/dt = -500 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 \text{ °C}$</td>
<td>[1]</td>
<td>25</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>$S$</td>
<td>softness factor</td>
<td>$I_S = 25 \text{ A}; dI_S/dt = -500 \text{ A}/\mu\text{s}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 \text{ °C}$</td>
<td>-</td>
<td>0.88</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

[1] Includes capacitive recovery

![Fig. 6](aaa-032627)

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

![Fig. 7](aaa-032628)

**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

$T_j = 25 \, ^\circ\text{C}; \, V_{DS} = 8 \, \text{V}$

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

$T_j = 25 \, ^\circ\text{C}; \, V_{DS} = 5 \, \text{V}$

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

$I_D = 1 \, \text{mA}; \, V_{DS} = V_{GS}$

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

$T_j = 25 \, ^\circ\text{C}$
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

\[ V_GS(V) \]

\[ Q_GS(nC) \]

\[ Q_GD(nC) \]

\[ Q_{GS1}(nC) \]

\[ Q_{GS2}(nC) \]

Fig. 14. Gate charge waveform definitions

\[ V_{DS} \]

\[ I_D \]

\[ V_{GS(pl)} \]

\[ V_{GS(m)} \]

\[ V_{GS} \]

\[ Q_{GD} \]

\[ Q_{GS1} \]

\[ Q_{GS2} \]

\[ Q_{GS} \]

\[ Q_{GS(ox)} \]

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

\[ C(pF) \]

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

\( V_{GS} = 0 \text{ V} \)
11. Package outline

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

SOT1235

![Package outline diagram](image)

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>D₁⁽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>max</td>
<td>0.15</td>
<td>1.7</td>
<td>0.25</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>2.0</td>
<td>8.1</td>
<td>0.8</td>
<td>1.3</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
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Note
1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

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<th>Outline version</th>
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<th>European projection</th>
<th>Issue date</th>
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<td>IEC</td>
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Fig. 17. Package outline LFPAK88 (SOT1235)
12. Soldering

Footprint information for reflow soldering of LFPAK88 package

SOT1235

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

Data sheet status

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[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".

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