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
- 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 $</td>
<td>[1]</td>
<td>-</td>
<td>500</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , ^\circ C; \ $Fig. 1</td>
<td>-</td>
<td>-</td>
<td>375</td>
<td>W</td>
</tr>
</tbody>
</table>
Nexperia

BUK7S0R5-40H

N-channel 40 V, 0.5 mOhm standard level MOSFET in LFPAK88

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Static characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{DSon}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 10 \text{ V}; I_D = 25 \text{ A}; T_J = 25 \degree \text{C};$</td>
<td>0.33</td>
<td>0.47</td>
<td>0.55</td>
<td>mΩ</td>
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<tr>
<td>Dynamic characteristics</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Q_{GD}$</td>
<td>gate-drain charge</td>
<td>$I_D = 25 \text{ A}; V_{DS} = 32 \text{ V}; V_{GS} = 10 \text{ V};$</td>
<td>-</td>
<td>32</td>
<td>65</td>
<td>nC</td>
</tr>
<tr>
<td>Source-drain diode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Q_r$</td>
<td>recovered charge</td>
<td>$I_S = 25 \text{ A}; \frac{dI_S}{dt} = -100 \text{ A/µs}; V_{GS} = 0 \text{ V};$</td>
<td>[2]</td>
<td>-</td>
<td>93</td>
<td>nC</td>
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<td>$S$</td>
<td>softness factor</td>
<td>$V_{DS} = 20 \text{ V}; T_J = 25 \degree \text{C}$</td>
<td>-</td>
<td>0.83</td>
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[1] 500A 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>
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<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
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<th>Graphic symbol</th>
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<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>
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<tr>
<td>3</td>
<td>S</td>
<td>source</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>S</td>
<td>source</td>
<td></td>
<td></td>
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<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>
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<td>BUK7S0R5-40H</td>
<td>LFPAK88 plastic, single-ended surface-mounted package (LFPAK88); 4 leads; 2 mm pitch; 8 mm x 8 mm x 1.6 mm body</td>
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<td>SOT1235</td>
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7. Marking

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8. Limiting values

<table>
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<tr>
<th>Symbol</th>
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<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>

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).
### Symbol  | Parameter  | Conditions  | Min  | Max  | Unit   
--- | --- | --- | --- | --- | ---  
$V_{GS}$ | gate-source voltage  | DC; $T_j = 175 \, ^\circ \text{C}$  | -10  | 20  | V  
$P_{tot}$ | total power dissipation  | $T_{mb} = 25 \, ^\circ \text{C}$; Fig. 1  | -  | 375  | W  
$I_D$ | drain current  | $V_{GS} = 10 \, V$; $T_{mb} = 25 \, ^\circ \text{C}$; Fig. 2  | [1] -  | 500  | A  
$I_{DM}$ | peak drain current  | pulsed; $t_p \leq 10 \, \mu\text{s}$; $T_{mb} = 25 \, ^\circ \text{C}$; Fig. 3  | -  | 2237  | A  
$T_{stg}$ | 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  | $T_{mb} = 25 \, ^\circ \text{C}$  | [1] -  | 500  | A  
$I_{SM}$ | peak source current  | pulsed; $t_p \leq 10 \, \mu\text{s}$; $T_{mb} = 25 \, ^\circ \text{C}$  | -  | 2237  | A  

### Avalanche ruggedness

| Symbol  | Parameter  | Conditions  | Min  | Max  | Unit   
--- | --- | --- | --- | --- | ---  
$E_{DS(\text{AL})S}$ | non-repetitive drain-source avalanche energy  | $I_D = 120 \, A$; $V_{\text{sup}} \leq 40 \, V$; $R_{GS} = 50 \, \Omega$; $V_{GS} = 10 \, V$; $T_{j(init)} = 25 \, ^\circ \text{C}$; unclamped; Fig. 4  | [2] [3] -  | 1375  | mJ  
$I_{AS}$ | non-repetitive avalanche current  | $V_{\text{sup}} = 40 \, V$; $V_{GS} = 10 \, V$; $T_{j(init)} = 25 \, ^\circ \text{C}$; $R_{GS} = 50 \, \Omega$; Fig. 4  | [4] -  | 315  | A  

[1] 500A continuous current has been successfully demonstrated during application. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.


[4] Protected by 100% test.

---

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

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

$P_{der} = \frac{P_{tot}}{P_{tot(25\, ^\circ \text{C})}} \times 100\%$
Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

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

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>
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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>$I_D = 250 \mu A; V_{GS} = 0 , V; T_J = 25 , ^\circ C$</td>
<td>40</td>
<td>43</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 250 \mu A; V_{GS} = 0 , V; T_J = -40 , ^\circ C$</td>
<td>-</td>
<td>40.5</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 250 \mu A; V_{GS} = 0 , V; T_J = -55 , ^\circ C$</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>$I_D = 1 , mA; V_{DS}=V_{GS}; T_J = 25 , ^\circ C$; 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>$I_D = 1 , mA; V_{DS}=V_{GS}; T_J = -55 , ^\circ C$; Fig. 10</td>
<td>-</td>
<td>-</td>
<td>4.3</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 1 , mA; V_{DS}=V_{GS}; T_J = 175 , ^\circ C$; 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>$V_{DS} = 40 , V; V_{GS} = 0 , V; T_J = 25 , ^\circ C$</td>
<td>-</td>
<td>0.2</td>
<td>2.9</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DS} = 16 , V; V_{GS} = 0 , V; T_J = 125 , ^\circ C$</td>
<td>-</td>
<td>4.6</td>
<td>25</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DS} = 40 , V; V_{GS} = 0 , V; T_J = 175 , ^\circ C$</td>
<td>-</td>
<td>455</td>
<td>1000</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>gate leakage current</td>
<td>$V_{GS} = 20 , V; V_{DS} = 0 , V; T_J = 25 , ^\circ C$</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>$R_{DS(on)}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 10 , V; I_D = 25 , A; T_J = 25 , ^\circ C$; Fig. 11</td>
<td>0.33</td>
<td>0.47</td>
<td>0.55</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 , V; I_D = 25 , A; T_J = 105 , ^\circ C$; Fig. 12</td>
<td>0.47</td>
<td>0.68</td>
<td>0.87</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 , V; I_D = 25 , A; T_J = 125 , ^\circ C$; Fig. 12</td>
<td>0.52</td>
<td>0.75</td>
<td>0.95</td>
<td>mΩ</td>
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<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 , V; I_D = 25 , A; T_J = 175 , ^\circ C$; Fig. 12</td>
<td>0.65</td>
<td>0.93</td>
<td>1.19</td>
<td>mΩ</td>
</tr>
<tr>
<td>$R_G$</td>
<td>gate resistance</td>
<td>$f = 1 , MHz; T_J = 25 , ^\circ C$</td>
<td>0.37</td>
<td>0.92</td>
<td>2.31</td>
<td>Ω</td>
</tr>
</tbody>
</table>

Dynamic characteristics

| $Q_{G(total)}$ | total gate charge | $I_D = 25 \, A; V_{DS} = 32 \, V; V_{GS} = 10 \, V$; Fig. 13; Fig. 14 | - | 190 | 267 | nC |
| $Q_{GS}$ | gate-source charge | - | 51 | 77 | nC |
| $Q_{GD}$ | gate-drain charge | - | 32 | 65 | nC |
## Symbol Parameter Conditions Min Typ Max Unit

<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>Ciss</td>
<td>input capacitance</td>
<td>$V_{DS} = 25 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$; $T_j = 25 ^\circ \text{C}$; [Fig. 15]</td>
<td>-</td>
<td>15116</td>
<td>21162</td>
<td>pF</td>
</tr>
<tr>
<td>Coss</td>
<td>output capacitance</td>
<td>$T_j = 25 ^\circ \text{C}$</td>
<td>-</td>
<td>2718</td>
<td>3805</td>
<td>pF</td>
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<tr>
<td>Crss</td>
<td>reverse transfer capacitance</td>
<td></td>
<td>-</td>
<td>544</td>
<td>1197</td>
<td>pF</td>
</tr>
<tr>
<td>td(on)</td>
<td>turn-on delay time</td>
<td>$V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ Ω}; V_{GS} = 10 \text{ V}$; $R_{G(\text{ext})} = 5 \text{ Ω}$</td>
<td>-</td>
<td>40</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>tr</td>
<td>rise time</td>
<td>$V_{DS} = 30 \text{ V}; R_L = 1.2 \text{ Ω}; V_{GS} = 10 \text{ V}$; $R_{G(\text{ext})} = 5 \text{ Ω}$</td>
<td>-</td>
<td>33</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>td(off)</td>
<td>turn-off delay time</td>
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<td>-</td>
<td>117</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>tf</td>
<td>fall time</td>
<td></td>
<td>-</td>
<td>48</td>
<td>-</td>
<td>ns</td>
</tr>
</tbody>
</table>

### Source-drain diode

- **Source-drain voltage**
  - $I_S = 25 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 ^\circ \text{C}$; [Fig. 16]
  - Min: 0.79, Typ: 1 V
- **Reverse recovery time**
  - $I_S = 25 \text{ A}; dI_S/dt = -100 \text{ A/µs}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 ^\circ \text{C}$
  - Min: 62, Typ: - ns
- **Recovered charge**
  - $I_S = 25 \text{ A}; dI_S/dt = -500 \text{ A/µs}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 ^\circ \text{C}$
  - Min: 93, Typ: - nC
- **Softness factor**
  - $I_S = 25 \text{ A}; dI_S/dt = -500 \text{ A/µs}; V_{GS} = 0 \text{ V}$; $V_{DS} = 20 \text{ V}; T_j = 25 ^\circ \text{C}$
  - Min: 0.83, Typ: -

[1] Includes capacitive recovery

### Graphs

**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
**N-channel 40 V, 0.5 mOhm standard level MOSFET in LFPAK88**

**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

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A summary of the diagrams:

**Fig. 8:**
- Transfer characteristics showing how drain current ($I_D$) changes with gate-source voltage ($V_{GS}$) at various temperatures.
- $T_J = 25 \degree C$; $V_{DS} = 8 \text{ V}$

**Fig. 9:**
- Sub-threshold drain current as a function of $V_{GS}$.
- $T_J = 25 \degree C$; $V_{DS} = 5 \text{ V}$

**Fig. 10:**
- Gate-source threshold voltage ($V_{GS(th)}$) as a function of junction temperature ($T_J$).
- $I_D = 1 \text{ mA}$; $V_{DS} = V_{GS}$

**Fig. 11:**
- Drain-source on-state resistance ($R_{DS(on)}$) as a function of drain current ($I_D$) at different $V_{DS}$ values.
- $T_J = 25 \degree C$
Fig. 12. Normalized drain-source on-state resistance factor as a function of junction temperature

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

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

\[T_J = 25 \degree C; I_D = 25 A\]

Fig. 14. Gate charge waveform definitions

\[V_{DS} = 32 \text{ V}; V_{DS} = 14 \text{ V}; T_J = 25 \degree C; I_D = 25 \text{ A}\]

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

\[ V_{GS} = 0 \text{ V} \]
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>D₁⁽¹⁾</th>
<th>D₂⁽¹⁾</th>
<th>E₁⁽¹⁾</th>
<th>E₂⁽¹⁾</th>
<th>e</th>
<th>h₁⁽¹⁾</th>
<th>L</th>
<th>L₂</th>
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<tr>
<td>mm</td>
<td>0.15</td>
<td>1.7</td>
<td>0.25</td>
<td>1.1</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>2.0</td>
<td>8.1</td>
<td>0.8</td>
<td>1.3</td>
<td>0.25</td>
<td>0.10</td>
<td>8°</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>7.8</td>
<td>0.6</td>
<td>0.9</td>
<td>4.9</td>
<td>8°</td>
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<td></td>
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</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

**Document status**

Document status

<table>
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</thead>
<tbody>
<tr>
<td>Development</td>
<td>Qualification</td>
<td>Production</td>
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</tbody>
</table>

**Definition**

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**Definitions**

- **Draft**
- **Short data sheet**
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