PSMNR89-25YLE
N-channel 25 V, 0.98 mOhm, ASFET for hotswap with enhanced SOA in LFPAK56
10 January 2023
Product data sheet

1. General description

N-channel enhancement mode ASFET for hotswap with enhanced SOA in LFPAK56 package optimized for low $R_{DSon}$ and strong safe operating area, optimized for hot-swap, inrush and linear-mode applications.

2. Features and benefits

- Fully optimized Safe Operating Area (SOA) for superior linear mode operation
- Optimized for low $R_{DSon}$ / low $I^2R$ conduction losses
- LFPAK56 package for applications that demand the highest performance and reliability in a 30 mm² footprint
- Low leakage <1 µA at 25 °C
- Copper-clip for low parasitic inductance and resistance
- High reliability LFPAK package, qualified to 175 °C

3. Applications

- Hot swap in 12 V - 20 V applications
- e-Fuse
- DC switch
- Load switch
- Battery protection

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>25</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>-</td>
<td>-</td>
<td>270</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>224</td>
<td>W</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td></td>
<td>-55</td>
<td>-</td>
<td>175</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Static characteristics**

- $R_{DSon}$: $V_{GS} = 10 \, V; I_D = 25 \, A; T_j = 25 \, ^\circ C$; $Fig. \, 10$
  - Min: 0.85 mΩ
  - Typ: 0.98 mΩ

- $R_{DSon}$: $V_{GS} = 7 \, V; I_D = 25 \, A; T_j = 25 \, ^\circ C$; $Fig. \, 10$
  - Min: 1.13 mΩ
  - Typ: 1.35 mΩ

**Dynamic characteristics**

- $Q_{GD}$: $I_D = 25 \, A; V_{DS} = 12 \, V; V_{GS} = 4.5 \, V$; $T_j = 25 \, ^\circ C$; $Fig. \, 12$; $Fig. \, 13$
  - Min: 1.8 nC
  - Typ: 10 nC
  - Max: 20 nC

- $Q_{G(tot)}$: $I_D = 25 \, A; V_{DS} = 12 \, V; V_{GS} = 4.5 \, V$; $T_j = 25 \, ^\circ C$; $Fig. \, 12$; $Fig. \, 13$
  - Min: 15 nC
  - Typ: 33 nC
  - Max: 54 nC
N-channel 25 V, 0.98 mOhm, ASFET for hotswap with enhanced SOA in LFPAK56

Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
Source-drain diode

| |  | | | | |
--- | --- | --- | --- | --- | --- | ---
S | softness factor | | | | |

| |  | | | | |
--- | --- | --- | --- | --- | --- | ---
I_S = 25 A; dI_S/dt = -100 A/µs; V_GS = 0 V; V_DS = 12 V; T_J = 25 °C; **Fig. 16** | - | 1 | - | |

[1] 270 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

5. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
--- | --- | --- | --- | ---|
1 | S | source | | |
2 | S | source | | |
3 | S | source | | |
4 | G | gate | | |
mb | D | mounting base; connected to drain | | |

6. Ordering information

| Type number | Package | Description | Version |
--- | --- | --- | ---|
PSMNR89-25YLE | LFPAK56; Power-SO8 | plastic, single-ended surface-mounted package; 4 terminals | SOT669 |

7. Marking

| Type number | Marking code |
--- | ---|
PSMNR89-25YLE | E89L25Y |

8. Limiting values

| Symbol | Parameter | Conditions | Min | Max | Unit |
--- | --- | --- | --- | --- | ---|
V_DS | drain-source voltage | 25 °C ≤ T_J ≤ 175 °C | - | 25 | V |
V_DGR | drain-gate voltage | 25 °C ≤ T_J ≤ 175 °C; R_GS = 20 kΩ | - | 25 | V |
V_GS | gate-source voltage | -20 | 20 | V |
P_tot | total power dissipation | T_mb = 25 °C; **Fig. 1** | - | 224 | W |
I_D | drain current | V_GS = 10 V; T_mb = 25 °C; **Fig. 2** | [1] - | 270 | A |
I_D | peak drain current | pulsed; I_P ≤ 10 µs; T_mb = 25 °C; **Fig. 3** | - | 1359 | A |
T_stg | storage temperature | -55 | 175 | °C |
T_j | junction temperature | -55 | 175 | °C |

In accordance with the Absolute Maximum Rating System (IEC 60134). T_J = 25 °C unless otherwise stated.
### Symbol | Parameter | Conditions | Min | Max | Unit
---|---|---|---|---|---
$T_{\text{std(M)}}$ | peak soldering temperature | - | 260 | °C

#### Source-drain diode

- $I_S$ | source current $T_{mb} = 25 \, ^\circ C$ | - | 224 | A
- $I_{SM}$ | peak source current pulsed; $t_p \leq 10 \, \mu s$ $T_{mb} = 25 \, ^\circ C$ | - | 1359 | A

#### Avalanche ruggedness

- $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy $I_D = 25 \, A$ $V_{sup} \leq 25 \, V$ $R_{GS} = 50 \, \Omega$ $V_{GS} = 10 \, V$ $T_{j(init)} = 25 \, ^\circ C$ unclamped; $t_p = 5 \, ms$ | [2] | - | 2.1 | J
- $I_{AS}$ | non-repetitive avalanche current $V_{sup} \leq 25 \, V$ $V_{GS} = 10 \, V$ $T_{j(init)} = 25 \, ^\circ C$ $R_{GS} = 50 \, \Omega$ | [2] | - | 123 | A

[1] 270 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] 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

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

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

(1) 270 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
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>$R_{\text{th(j-mb)}}$</td>
<td>thermal resistance from junction to mounting base</td>
<td>Fig. 4</td>
<td>-</td>
<td>0.4</td>
<td>0.67</td>
<td>K/W</td>
</tr>
<tr>
<td>$R_{\text{th(j-a)}}$</td>
<td>thermal resistance from junction to ambient</td>
<td>Fig. 5, 6</td>
<td>-</td>
<td>42</td>
<td>-</td>
<td>K/W</td>
</tr>
</tbody>
</table>

Fig. 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

$T_{\text{mb}} = 25 ^\circ \text{C}$ (solid black line); $T_{\text{mb}} = 125 ^\circ \text{C}$ (red dashed line); $I_{\text{DM}}$ is a single pulse

**Fig. 3.** Safe operating area; continuous and peak drain currents as a function of drain-source voltage
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 μA; V_{GS} = 0 V; T_j = 25 °C</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_D = 250 μA; V_{GS} = 0 V; T_j = -55 °C</td>
<td>22.5</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>V_{GS(th)}</td>
<td>gate-source threshold voltage</td>
<td>I_D = 2 mA; V_{DS}=V_{GS}; T_j = 25 °C</td>
<td>1.2</td>
<td>1.96</td>
<td>2.2</td>
<td>V</td>
</tr>
<tr>
<td>ΔV_{GS(th)}/ΔT</td>
<td>gate-source threshold voltage variation with temperature</td>
<td>25 °C ≤ T_j ≤ 150 °C</td>
<td>-</td>
<td>-3.8</td>
<td>-</td>
<td>mV/K</td>
</tr>
<tr>
<td>I_{DSS}</td>
<td>drain leakage current</td>
<td>V_{DS} = 20 V; V_{GS} = 0 V; T_j = 25 °C</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{DS} = 20 V; V_{GS} = 0 V; T_j = 125 °C</td>
<td>-</td>
<td>3.4</td>
<td>-</td>
<td>μA</td>
</tr>
<tr>
<td>I_{GSS}</td>
<td>gate leakage current</td>
<td>V_{GS} = 16 V; V_{DS} = 0 V; T_j = 25 °C</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{GS} = -16 V; V_{DS} = 0 V; T_j = 25 °C</td>
<td>-</td>
<td>-</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. 10</td>
<td>-</td>
<td>0.85</td>
<td>0.98</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{GS} = 10 V; I_D = 25 A; T_j = 150 °C; Fig. 11</td>
<td>-</td>
<td>-</td>
<td>1.8</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{GS} = 7 V; I_D = 25 A; T_j = 25 °C; Fig. 10</td>
<td>-</td>
<td>1.13</td>
<td>1.35</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{GS} = 7 V; I_D = 25 A; T_j = 150 °C; Fig. 11</td>
<td>-</td>
<td>-</td>
<td>2.4</td>
<td>mΩ</td>
</tr>
<tr>
<td>R_G</td>
<td>gate resistance</td>
<td>f = 1 MHz; T_j = 25 °C</td>
<td>1.2</td>
<td>3.1</td>
<td>7.7</td>
<td>Ω</td>
</tr>
<tr>
<td>Q_{G(tot)}</td>
<td>total gate charge</td>
<td>I_D = 25 A; V_{DS} = 12 V; V_{GS} = 4.5 V; T_j = 25 °C; Fig. 12; Fig. 13</td>
<td>15</td>
<td>33</td>
<td>54</td>
<td>nC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_D = 25 A; V_{DS} = 12 V; V_{GS} = 10 V; T_j = 25 °C; Fig. 12; Fig. 13</td>
<td>33</td>
<td>73</td>
<td>120</td>
<td>nC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I_D = 0 A; V_{DS} = 0 V; V_{GS} = 10 V; T_j = 25 °C</td>
<td>-</td>
<td>37</td>
<td>-</td>
<td>nC</td>
</tr>
</tbody>
</table>
### Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
$Q_{GS}$ | gate-source charge | $I_D = 25 \, A; \, V_{DS} = 12 \, V; \, V_{GS} = 4.5 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 12; \, Fig. \, 13$ | 4.3 | 16 | 31 | nC
$Q_{GS(th)}$ | pre-threshold gate-source charge | | 2 | 7.6 | 14 | nC
$Q_{GS(th-pl)}$ | post-threshold gate-source charge | | 2.2 | 8.5 | 16 | nC
$Q_{GD}$ | gate-drain charge | $I_D = 25 \, A; \, V_{DS} = 12 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 12; \, Fig. \, 13$ | 106 | 391 | 938 | pF
$V_{GS(pl)}$ | gate-source plateau voltage | | - | 3.5 | - | V
$C_{iss}$ | input capacitance | $V_{DS} = 12 \, V; \, V_{GS} = 0 \, V; \, f = 1 \, MHz; \, T_J = 25 \, ^\circ C; \, Fig. \, 12; \, Fig. \, 13$ | 2981 | 4968 | 7452 | pF
$C_{oss}$ | output capacitance | $T_J = 25 \, ^\circ C; \, Fig. \, 14$ | 1261 | 2101 | 3152 | pF
$C_{rss}$ | reverse transfer capacitance | $V_{DS} = 12 \, V; \, V_{GS} = 0 \, V; \, f = 1 \, MHz; \, T_J = 25 \, ^\circ C; \, Fig. \, 12; \, Fig. \, 13$ | 106 | 391 | 938 | pF
$t_{d(on)}$ | turn-on delay time | $V_{DS} = 12 \, V; \, R_G = 0.5 \, \Omega; \, V_{GS} = 4.5 \, V; \, R_{G(ext)} = 5 \, \Omega; \, T_J = 25 \, ^\circ C$ | - | 42 | - | ns
$t_r$ | rise time | $I_S = 25 \, A; \, dI_S/dt = -100 \, A/\mu s; \, V_{GS} = 0 \, V; \, V_{DS} = 12 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 16$ | - | 99 | - | ns
$t_{d(off)}$ | turn-off delay time | $V_{DS} = 12 \, V; \, V_{GS} = 0 \, V; \, f = 1 \, MHz; \, T_J = 25 \, ^\circ C$ | - | 27 | - | ns
$t_f$ | fall time | $V_{DS} = 12 \, V; \, V_{GS} = 0 \, V; \, f = 1 \, MHz; \, T_J = 25 \, ^\circ C$ | - | 36 | - | ns
$Q_{oss}$ | output charge | $V_{GS} = 0 \, V; \, V_{DS} = 12 \, V; \, f = 1 \, MHz; \, T_J = 25 \, ^\circ C$ | - | 38 | - | nC

**Source-drain diode**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- | ---
$V_{SD}$ | source-drain voltage | $I_S = 25 \, A; \, V_{GS} = 0 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 15$ | - | 0.78 | 1 | V
$t_{rr}$ | reverse recovery time | $I_S = 25 \, A; \, dI_S/dt = -100 \, A/\mu s; \, V_{GS} = 0 \, V; \, V_{DS} = 12 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 16$ | - | 33 | - | ns
$Q_r$ | recovered charge | $V_{DS} = 12 \, V; \, T_J = 25 \, ^\circ C; \, Fig. \, 16$ | - | 25 | - | nC
$t_a$ | reverse recovery rise time | - | 16.4 | - | ns
$t_b$ | reverse recovery fall time | - | 16.4 | - | ns
$S$ | softness factor | - | 1 | - | |

[1] includes capacitive recovery

---

**Fig. 7.** Output characteristics; drain current as a function of drain-source voltage; typical values  
**Fig. 8.** Drain-source on-state resistance as a function of gate-source voltage; typical values
N-channel 25 V, 0.98 mOhm, ASFET for hotswap with enhanced SOA in LFPAK56

Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values

Fig. 10. Drain-source on-state resistance as a function of drain current; typical values

Fig. 11. Normalized drain-source on-state resistance factor as a function of junction temperature

Fig. 12. Gate-source voltage as a function of gate charge; typical values
Nexperia

PSMNR89-25YLE

N-channel 25 V, 0.98 mOhm, A SFET for hotswap with enhanced SOA in LFPAK56

Fig. 13. Gate charge waveform definitions

Fig. 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

Fig. 15. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

Fig. 16. Reverse recovery timing definition
11. Package outline

Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads

SOT669

Dimensions (mm are the original dimensions)

<table>
<thead>
<tr>
<th>Unit(1)</th>
<th>A</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>b</th>
<th>b2</th>
<th>b3</th>
<th>b4</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</th>
<th>L</th>
<th>L1</th>
<th>L2</th>
<th>W</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm max</td>
<td>1.20</td>
<td>0.15</td>
<td>1.10</td>
<td>0.50</td>
<td>4.41</td>
<td>2.2</td>
<td>0.9</td>
<td>0.25</td>
<td>0.30</td>
<td>4.10</td>
<td>4.20</td>
<td>5.0</td>
<td>3.3</td>
<td>1.27</td>
<td>6.2</td>
<td>0.85</td>
<td>1.3</td>
<td>1.3</td>
<td>0.25</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>mm nom</td>
<td>1.01</td>
<td>0.00</td>
<td>0.95</td>
<td>0.25</td>
<td>3.62</td>
<td>2.0</td>
<td>0.7</td>
<td>0.19</td>
<td>0.24</td>
<td>3.80</td>
<td>4.8</td>
<td>3.1</td>
<td>0.8</td>
<td>5.8</td>
<td>0.40</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Fig. 17. Package outline LFPAK56; Power-SO8 (SOT669)
12. Soldering

**Footprint information for reflow soldering**

![Footprint Diagram]

- **SR opening = Cu** = 0.075
- **SP opening = Cu** = 0.050

**SOT669**

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**Fig. 18. Reflow soldering footprint for LFPAK56; Power-SO8 (SOT669)**
Wave soldering footprint information for LFPAK56 package

Fig. 19. Wave soldering footprint for LFPAK56; Power-SO8 (SOT669)
13. Legal information

Data sheet status

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

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- Qualification: This document contains data from the preliminary specification.

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