1. General description

290 Amp, standard level gate drive N-channel enhancement mode MOSFET in 175 °C LFPAK56E package using advanced TrenchMOS Superjunction technology. This product has been designed and qualified for high performance power switching applications.

2. Features and benefits

- 290 A continuous $I_D^{(max)}$
- Avalanche rated, 100% tested
- NextPower-S3 technology delivers ‘superfast switching with soft body-diode recovery’
- Low $Q_{RR}$, $Q_{G}$ and $Q_{GD}$ for high system efficiency and low EMI designs
- Schottky-Plus body-diode, gives soft switching without the associated high $I_DSS$ leakage
- Strong linear-mode / SOA rating
- High reliability LFPAK (Power SO8) package, with copper-clip and solder die attach, qualified to 175 °C
- Exposed leads can be wave soldered, visual solder joint inspection and high quality solder joints for ultimate reliability
- Low parasitic inductance and resistance

3. Applications

- High-performance synchronous rectification
- DC-to-DC converters
- High performance and high efficiency server power supply
- Brushless DC motor control
- Battery protection
- Load-switch and eFuse

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>-</td>
<td>40 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>-</td>
<td>290 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>-</td>
<td>333 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**

| $R_{DSon}$ | drain-source on-state resistance | $V_{GS} = 10 V$; $I_D = 25 A$; $T_j = 25 ^\circ C$; [Fig. 10] | - | 0.85 | 1 | mΩ |

**Dynamic characteristics**
Nexperia

PSMN1R0-40YSH

N-channel 40 V, 1 mΩ, 290 A standard level MOSFET in LFPAK56E using NextPower-S3 Schottky-Plus technology

Symbol | Parameter | Conditions | Min | Typ | Max | Unit
---|---|---|---|---|---|---
Q_{GD} | gate-drain charge | I_D = 25 A; V_{DS} = 20 V; V_{GS} = 10 V; \text{Fig. 12, Fig. 13} | - | 13 | 27 | nC
Q_{G(tot)} | total gate charge | - | 87 | 122 | nC

[1] 290A 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

<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>S</td>
<td>source</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>G</td>
<td>gate</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>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Name</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSMN1R0-40YSH</td>
<td>LFPAK56E; Power-SO8</td>
<td>plastic, single-ended surface-mounted package (LFPAK56); 4 leads; 1.27 mm pitch</td>
<td>SOT1023</td>
<td></td>
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7. Marking

<table>
<thead>
<tr>
<th>Type number</th>
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<tbody>
<tr>
<td>PSMN1R0-40YSH</td>
<td>1H0S40J</td>
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8. 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 °C ≤ T_j ≤ 175 °C; \text{Fig. 1}</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{DSM}</td>
<td>peak drain-source voltage</td>
<td>t_{p} ≤ 20 ns; f ≤ 500 kHz; E_{DS(AL)} ≤ 200 nJ; pulsed</td>
<td>-</td>
<td>45</td>
<td>V</td>
</tr>
<tr>
<td>V_{DGR}</td>
<td>drain-gate voltage</td>
<td>25 °C ≤ T_j ≤ 175 °C; R_{GS} = 20 kΩ; \text{Fig. 2}</td>
<td>-</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V_{GS}</td>
<td>gate-source voltage</td>
<td>-20</td>
<td>0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>P_{tot}</td>
<td>total power dissipation</td>
<td>T_{mb} = 25 °C; \text{Fig. 1}</td>
<td>-</td>
<td>333</td>
<td>W</td>
</tr>
<tr>
<td>I_D</td>
<td>drain current</td>
<td>V_{GS} = 10 V; T_{mb} = 25 °C; \text{Fig. 2}</td>
<td>[1]</td>
<td>-</td>
<td>290</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_{GS} = 10 V; T_{mb} = 100 °C; \text{Fig. 2}</td>
<td>-</td>
<td>277</td>
<td>A</td>
</tr>
</tbody>
</table>
N-channel 40 V, 1 mΩ, 290 A standard level MOSFET in LFPAK56E using NextPower-S3 Schottky-Plus technology

<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_{DM} )</td>
<td>peak drain current</td>
<td>pulsed; ( t_p \leq 10 \mu s; T_{mb} = 25 ^\circ C ); [Fig. 3]</td>
<td>-</td>
<td>1564</td>
<td>A</td>
</tr>
<tr>
<td>( T_{stg} )</td>
<td>storage temperature</td>
<td></td>
<td>-55</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>( T_j )</td>
<td>junction temperature</td>
<td></td>
<td>-55</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>( T_{sld(M)} )</td>
<td>peak soldering temperature</td>
<td></td>
<td>-</td>
<td>260</td>
<td>°C</td>
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</table>

**Source-drain diode**

<table>
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<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>278</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>1564</td>
<td>A</td>
</tr>
</tbody>
</table>

**Avalanche ruggedness**

\[
E_{DS(AL)S} = \begin{cases} 
10 & \text{non-repetitive drain-source avalanche energy} \\
\text{290A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.} \\
\text{2710 mJ} & \text{unclamped; } I_0 = 25 A; V_{sup} \leq 40 V; R_{GS} = 50 \Omega; V_{GS} = 10 V; T_{j(init)} = 25 ^\circ C; \text{unclamped; } t_p = 4.2 ms \\
\end{cases}
\]

\[
I_{AS} = \begin{cases} 
\text{non-repetitive avalanche current} \\
\text{unclamped; } I_0 = 83 A; V_{sup} \leq 40 V; R_{GS} = 50 \Omega; V_{GS} = 10 V; T_{j(init)} = 25 ^\circ C; \text{unclamped; } t_p = 0.27 ms \\
\text{190 A} & \text{unclamped; } V_{sup} = 40 V; V_{GS} = 10 V; T_{j(init)} = 25 ^\circ C; R_{GS} = 50 \Omega \\
\end{cases}
\]

[1] 290A 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

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

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>0.33</td>
<td>0.45</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, Fig. 6</td>
<td>-</td>
<td>42</td>
<td>-</td>
<td>K/W</td>
</tr>
<tr>
<td>$Z_{\text{th}(j-mb)}$</td>
<td>transient thermal impedance from junction to mounting base</td>
<td>-</td>
<td>85</td>
<td>-</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
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>Static characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 1 , mA; V_{DS}=V_{GS}; T_j = 25 , ^\circ C$</td>
<td>2.4</td>
<td>3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_{GS(th)}/\Delta T$</td>
<td>gate-source threshold voltage variation with temperature</td>
<td>$25 , ^\circ C \leq T_j \leq 150 , ^\circ C$</td>
<td>-</td>
<td>-7.4</td>
<td>-</td>
<td>mV/K</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 32 , V; V_{GS} = 0 , V; T_j = 25 , ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>1</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>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 10 , V; I_D = 25 , A; T_j = 25 , ^\circ C$</td>
<td>-</td>
<td>0.85</td>
<td>1</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>0.5</td>
<td>1.2</td>
<td>2.9</td>
<td>Ω</td>
</tr>
</tbody>
</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>$Q_{G(tot)}$</td>
<td>total gate charge</td>
<td>$I_D = 25 , A; V_{DS} = 20 , V; V_{GS} = 10 , V$</td>
<td>-</td>
<td>87</td>
<td>122</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{G5}$</td>
<td>gate-source charge</td>
<td>$I_D = 0 , A; V_{DS} = 0 , V; V_{GS} = 10 , V$</td>
<td>-</td>
<td>42</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{GS(th)}$</td>
<td>pre-threshold gate-source charge</td>
<td>$I_D = 25 , A; V_{DS} = 20 , V; V_{GS} = 10 , V$</td>
<td>-</td>
<td>18</td>
<td>27</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{GS(th-pl)}$</td>
<td>post-threshold gate-source charge</td>
<td></td>
<td>-</td>
<td>8.3</td>
<td>13</td>
<td>nC</td>
</tr>
<tr>
<td>$Q_{GD}$</td>
<td>gate-drain charge</td>
<td></td>
<td>-</td>
<td>13</td>
<td>27</td>
<td>nC</td>
</tr>
<tr>
<td>$V_{GS(pl)}$</td>
<td>gate-source plateau voltage</td>
<td>$I_D = 25 , A; V_{DS} = 20 , V$</td>
<td>-</td>
<td>4.3</td>
<td>-</td>
<td>V</td>
</tr>
</tbody>
</table>

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Nexperia

PSMN1R0-40YSH

N-channel 40 V, 1 mΩ, 290 A standard level MOSFET in LFPAK56E using NextPower-S3 Schottky-Plus technology

<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>$V_{DS} = 20 \text{ V}; V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ °C}; \text{ Fig. 14}$</td>
<td>-</td>
<td>6738</td>
<td>9433</td>
<td>pF</td>
</tr>
<tr>
<td>Coss</td>
<td>output capacitance</td>
<td>-</td>
<td>-</td>
<td>1767</td>
<td>2474</td>
<td>pF</td>
</tr>
<tr>
<td>Crss</td>
<td>reverse transfer capacitance</td>
<td>-</td>
<td>-</td>
<td>310</td>
<td>682</td>
<td>pF</td>
</tr>
<tr>
<td>t\text{d(on)}</td>
<td>turn-on delay time</td>
<td>$V_{DS} = 20 \text{ V}; R_L = 0.8 \text{ Ω}; V_{GS} = 10 \text{ V}; R_{G(\text{ext})} = 5 \text{ Ω}$</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>tr</td>
<td>rise time</td>
<td>-</td>
<td>-</td>
<td>17</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>t\text{d(off)}</td>
<td>turn-off delay time</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>tf</td>
<td>fall time</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Qoss</td>
<td>output charge</td>
<td>$V_{GS} = 0 \text{ V}; V_{DS} = 20 \text{ V}; f = 1 \text{ MHz}; T_j = 25 \text{ °C}$</td>
<td>-</td>
<td>59</td>
<td>-</td>
<td>nC</td>
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</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>VSD</td>
<td>source-drain voltage</td>
<td>$I_S = 25 \text{ A}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ °C}; \text{ Fig. 15}$</td>
<td>-</td>
<td>0.77</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>t\text{rr}</td>
<td>reverse recovery time</td>
<td>$I_S = 25 \text{ A}; dI_S/dt = -100 \text{ A/µs}; V_{GS} = 0 \text{ V}; V_{DS} = 20 \text{ V}; \text{ Fig. 16}$</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Qr</td>
<td>recovered charge</td>
<td>-</td>
<td>53</td>
<td>-</td>
<td>-</td>
<td>nC</td>
</tr>
<tr>
<td>t\text{a}</td>
<td>reverse recovery rise time</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>t\text{b}</td>
<td>reverse recovery fall time</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
</tbody>
</table>

[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 40 V, 1 mΩ, 290 A standard level MOSFET in LFPAK56E using NextPower-S3 Schottky-Plus technology.

**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
N-channel 40 V, 1 mΩ, 290 A standard level MOSFET in LFPAK56E using NextPower-S3 Schottky-Plus technology

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 (LFPAK56E); 4 leads

Dimensions

<table>
<thead>
<tr>
<th>Unit</th>
<th>A</th>
<th>A₁</th>
<th>b₁</th>
<th>b₂</th>
<th>c₁</th>
<th>D₁</th>
<th>D₁(1)</th>
<th>E₁</th>
<th>E₁(1)</th>
<th>e</th>
<th>H</th>
<th>L</th>
<th>Lₚ</th>
<th>w</th>
<th>y</th>
<th>θ</th>
</tr>
</thead>
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<tr>
<td>mm</td>
<td>1.10</td>
<td>0.15</td>
<td>0.50</td>
<td>4.41</td>
<td>0.85</td>
<td>0.25</td>
<td>0.30</td>
<td>4.70</td>
<td>4.45</td>
<td>5.30</td>
<td>6.2</td>
<td>1.3</td>
<td>0.85</td>
<td>0.25</td>
<td>0.1</td>
<td>8°</td>
</tr>
<tr>
<td>nom</td>
<td>0.95</td>
<td>0.00</td>
<td>0.35</td>
<td>3.62</td>
<td>0.19</td>
<td>0.19</td>
<td>0.24</td>
<td>4.45</td>
<td>4.95</td>
<td>3.5</td>
<td>1.27</td>
<td>5.9</td>
<td>0.8</td>
<td>0.40</td>
<td>0.1</td>
<td>0°</td>
</tr>
<tr>
<td>min</td>
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</tr>
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Note
1. Plastic or metal protrusions of 0.15 mm per side are not included.

Fig. 17. Package outline LFPAK56E; Power-SO8 (SOT1023)
12. Soldering

Fig. 18. Reflow soldering footprint for LFPAK56E; Power-SO8 (SOT1023)
# 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".
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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