1. General description

High power density, ultrafast switching time recovery rectifier with high-efficiency planar technology, encapsulated in a small and flat lead CFP3 (SOD123W) Surface-Mounted Device (SMD) plastic package.

2. Features and benefits

- Reverse voltage \( V_R \leq 650 \) V
- Forward current \( I_F \leq 1 \) A
- Typical switching time \( t_{rr} \) of 35 ns
- Pt doped life time control
- Low inductance
- Power and flat lead SMD plastic package
- High power capability due to clip-bond technology
- Planar die design
- Qualified according to AEC-Q101 and recommended for use in automotive applications

3. Applications

- On Board Charger
- DC/DC converter
- AC/DC converter
- Battery heating/cooling
- Inverter
- Freewheeling applications

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>( I_{F(AV)} )</td>
<td>average forward current</td>
<td>( \delta = 0.5; f = 20 ) kHz; square wave; ( T_{sp} \leq 166 ) °C</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>( V_{RRM} )</td>
<td>repetitive peak reverse voltage</td>
<td>( T_j = 25 ) °C</td>
<td>-</td>
<td>-</td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>( V_R )</td>
<td>reverse voltage</td>
<td>( T_j = 25 ) °C</td>
<td>-</td>
<td>-</td>
<td>650</td>
<td>V</td>
</tr>
<tr>
<td>( V_F )</td>
<td>forward voltage</td>
<td>( I_F = 1 ) A; ( T_j = 25 ) °C</td>
<td>[1]</td>
<td>1</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_F = 1 ) A; ( T_j = 125 ) °C</td>
<td>[1]</td>
<td>0.93</td>
<td>1.06</td>
<td>V</td>
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<tr>
<td>( I_R )</td>
<td>reverse current</td>
<td>( V_R = 650 ) V; ( T_j = 25 ) °C</td>
<td>[1]</td>
<td>-</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_R = 650 ) V; ( T_j = 125 ) °C</td>
<td>[1]</td>
<td>0.5</td>
<td>10</td>
<td>µA</td>
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[1] Very short pulse, in order to maintain a stable junction temperature.
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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<tr>
<td>1</td>
<td>K</td>
<td>cathode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>anode</td>
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6. Ordering information

Table 3. Ordering information

<table>
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<th>Type number</th>
<th>Package</th>
<th>Name</th>
<th>Description</th>
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<tr>
<td>PNU65010ER-Q</td>
<td>CFP3</td>
<td>plastic, surface mounted</td>
<td>package; 2 terminals; 2.6 mm x 1.7 mm x 1 mm body</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Version SOD123W</td>
</tr>
</tbody>
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7. Marking

Table 4. Marking codes

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<th>Marking code</th>
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<td>PNU65010ER-Q</td>
<td>ER</td>
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</table>

8. Limiting values

Table 5. Limiting values

*In accordance with the Absolute Maximum Rating System (IEC 601134).*

<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>$V_{RRM}$</td>
<td>repetitive peak reverse voltage</td>
<td>$T_j = 25 ^\circ C$</td>
<td>650</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_R$</td>
<td>reverse voltage</td>
<td></td>
<td>650</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{RMS}$</td>
<td>RMS voltage</td>
<td></td>
<td>460</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_F$</td>
<td>forward current</td>
<td>$\delta = 1; T_{sp} \leq 163 ^\circ C$</td>
<td>1.4</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>$I_{F(AV)}$</td>
<td>average forward current</td>
<td>$\delta = 0.5; f = 20 \text{ kHz};$ square wave; $T_{sp} \leq 166 ^\circ C$</td>
<td>1</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>$I_{FSM}$</td>
<td>non-repetitive peak forward current</td>
<td>$t_p = 8.3 \text{ ms};$ single half sine wave (applied at rated load condition); $T_{j(init)} = 25 ^\circ C$</td>
<td>33</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} \leq 25 ^\circ C$</td>
<td>0.75</td>
<td>1.2</td>
<td>W</td>
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</tbody>
</table>


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>$R_{th(j-a)}$</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1]</td>
<td>-</td>
<td>-</td>
<td>200  K/W</td>
</tr>
<tr>
<td>$R_{th(j-sp)}$</td>
<td>thermal resistance from junction to solder point</td>
<td></td>
<td>[2]</td>
<td>-</td>
<td>-</td>
<td>125  K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[3]</td>
<td>-</td>
<td>-</td>
<td>8    K/W</td>
</tr>
</tbody>
</table>


Fig. 1. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

FR4 PCB, standard footprint

Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

FR4 PCB, mounting pad for cathode 1 cm²
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>$V_{(BR)R}$</td>
<td>reverse breakdown voltage</td>
<td>$I_R = 100 \mu A; T_j = 25 ^\circ C$</td>
<td>[1]</td>
<td>650</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_F$</td>
<td>forward voltage</td>
<td>$I_F = 1 A; T_j = 25 ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_F = 1 A; T_j = 125 ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>0.93</td>
<td>V</td>
</tr>
<tr>
<td>$I_R$</td>
<td>reverse current</td>
<td>$V_R = 650 V; T_j = 25 ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_R = 650 V; T_j = 125 ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>0.5</td>
<td>10</td>
</tr>
<tr>
<td>$C_d$</td>
<td>diode capacitance</td>
<td>$V_R = 4 V; f = 1 MHz; T_j = 25 ^\circ C$</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>reverse recovery time; step recovery</td>
<td>$I_F = 0.5 A; I_R = 1 A; I_{R(meas)} = 0.25 A; T_j = 25 ^\circ C$</td>
<td>-</td>
<td>35</td>
<td>65</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>reverse recovery time; ramp recovery</td>
<td>$I_F = 1 A; dI_F/dt = 50 A/\mu s; V_R = 30 V; T_j = 25 ^\circ C$</td>
<td>-</td>
<td>39</td>
<td>85</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_F = 1 A; dI_F/dt = 100 A/\mu s; V_R = 30 V; T_j = 25 ^\circ C$</td>
<td>-</td>
<td>26</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$I_{RM}$</td>
<td>peak reverse recovery current</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>reverse recovery charge</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>nC</td>
<td></td>
</tr>
<tr>
<td>$V_{FRM}$</td>
<td>peak forward recovery voltage</td>
<td>$I_F = 1 A; dI_F/dt = 50 A/\mu s; T_j = 25 ^\circ C$</td>
<td>-</td>
<td>5.2</td>
<td>-</td>
<td>V</td>
</tr>
</tbody>
</table>

[1] Very short pulse, in order to maintain a stable junction temperature.

Fig. 3. Forward current as a function of forward voltage; typical values

Fig. 4. Reverse current as a function of reverse voltage; typical values
650 V, 1 A ultrafast recovery rectifier

**Fig. 5.** Diode capacitance as a function of reverse voltage; typical values

\[ f = 1 \text{ MHz}; T_{\text{amb}} = 25 \degree C \]

\[ V_R (V) \]

\[ C_D (\text{pF}) \]

\[ 0 \]

\[ 10 \]

\[ 20 \]

\[ 30 \]

\[ 0 \]

\[ 100 \]

\[ 200 \]

\[ 300 \]

\[ 400 \]

\[ 500 \]

\[ 600 \]

\[ 700 \]

**Fig. 6.** Average forward power dissipation as a function of average forward current; typical values

\[ T_J = 175 \degree C \]

(1) \( \delta = 0.1 \)

(2) \( \delta = 0.2 \)

(3) \( \delta = 0.5 \)

(4) \( \delta = 0.8 \)

(5) \( \delta = 1 \) (DC)

\[ I_{F(AV)} (A) \]

\[ P_{F(AV)} (W) \]

**Fig. 7.** Average reverse power dissipation as a function of reverse voltage; typical values

\[ V_R (V) \]

\[ P_{R(AV)} (W) \]

\[ 0 \]

\[ 0.002 \]

\[ 0.004 \]

\[ 0.006 \]

\[ 0.008 \]

\[ 0.010 \]

\[ 0 \]

\[ 100 \]

\[ 200 \]

\[ 300 \]

\[ 400 \]

\[ 500 \]

\[ 600 \]

\[ 700 \]

**Fig. 8.** Average forward current as a function of ambient temperature; typical values

\[ T_{J} = 175 \degree C \]

(1) \( \delta = 1 \); DC

(2) \( \delta = 0.5 \); \( f = 20 \text{ kHz} \)

(3) \( \delta = 0.2 \); \( f = 20 \text{ kHz} \)

(4) \( \delta = 0.1 \); \( f = 20 \text{ kHz} \)

\[ T_{\text{amb}} (\text{°C}) \]

\[ I_{F(AV)} (A) \]

\[ 0 \]

\[ 0.5 \]

\[ 1.0 \]

\[ 1.5 \]

\[ 0 \]

\[ 50 \]

\[ 100 \]

\[ 150 \]

\[ 200 \]
FR4 PCB, mounting pad for cathode 1 cm²

$T_j = 175 \, ^\circ C$

(1) $\delta = 1$; DC
(2) $\delta = 0.5$; $f = 20 \, kHz$
(3) $\delta = 0.2$; $f = 20 \, kHz$
(4) $\delta = 0.1$; $f = 20 \, kHz$

Fig. 9. Average forward current as a function of ambient temperature; typical values

$T_j = 175 \, ^\circ C$

(1) $\delta = 1$; DC
(2) $\delta = 0.5$; $f = 20 \, kHz$
(3) $\delta = 0.2$; $f = 20 \, kHz$
(4) $\delta = 0.1$; $f = 20 \, kHz$

Fig. 10. Average forward current as a function of solder point temperature; typical values

11. Test information

Fig. 11. Reverse recovery definition; step recovery
The current ratings for the typical waveforms are calculated according to the equations:

\[ I_{F(AV)} = I_M \times \delta \] with \( I_M \) defined as peak current

\[ I_{RMS} = I_{F(AV)} \] at DC, and

\[ I_{RMS} = I_M \times \sqrt{\delta} \]

with \( I_{RMS} \) defined as RMS current.

**Quality information**

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - Stress test qualification for discrete semiconductors, and is suitable for use in automotive applications.
12. Package outline

Fig. 15. Package outline CFP3 (SOD123W)
13. Soldering

Footprint information for reflow soldering of CFP3 package

![Soldering diagram]

- Recommended stencil thickness: 0.1 mm
- Dimensions in mm
- Solder land
- Solder resist
- Solder paste

Fig. 16. Reflow soldering footprint for CFP3 (SOD123W)
Wave soldering footprint information

Fig. 17. Wave soldering footprint for CFP3 (SOD123W)
14. Revision history

<table>
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<tr>
<th>Data sheet ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
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<td>PNU65010ER-Q v.2</td>
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<td>Characteristics: Several parameter added</td>
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<td>Characteristics: Graphs adapted to the non-automotive data sheet (PNU65010ER)</td>
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15. Legal information

Data sheet status

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<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
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<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
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<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
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<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
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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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Nexperia

650 V, 1 A ultrafast recovery rectifier

Product data sheet

30 September 2022

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PNU65010ER-Q

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