



# PNS40010ER

400 V, 1 A high power density, standard switching time  
PN-rectifier

Rev. 2 — 21 August 2012

Product data sheet

## 1. Product profile

### 1.1 General description

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

### 1.2 Features and benefits

- Forward current  $I_F \leq 1$  A
- Reverse voltage  $V_R \leq 400$  V
- Standard switching time
- Low forward voltage
- Low reverse current
- Low inductance
- Small and flat lead SMD plastic package
- Package height typ. 1 mm
- High power capability
- AEC-Q101 qualified

### 1.3 Applications

- General-purpose rectification
- Reverse polarity protection
- Standard switching applications

### 1.4 Quick reference data

Table 1. Quick reference data


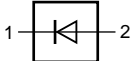
| Symbol      | Parameter                           | Conditions                                                                 | Min | Typ  | Max | Unit |
|-------------|-------------------------------------|----------------------------------------------------------------------------|-----|------|-----|------|
| $I_F$       | forward current                     | $T_{sp} \leq 160$ °C                                                       | -   | -    | 1.4 | A    |
| $V_{RRM}$   | repetitive peak reverse voltage     |                                                                            | -   | -    | 400 | V    |
| $V_R$       | reverse voltage                     |                                                                            | -   | -    | 400 | V    |
| $I_{FSM}$   | non-repetitive peak forward current | $T_{j(\text{init})} = 25$ °C; $t_p = 8$ ms; square wave                    | -   | -    | 32  | A    |
| $V_F$       | forward voltage                     | $I_F = 1$ A; $t_p \leq 300$ $\mu$ s; $\delta \leq 0.02$ ;<br>$T_j = 25$ °C | -   | 0.93 | 1.1 | V    |
| $I_{F(AV)}$ | average forward current             | $\delta = 0.5$ ; $f = 20$ kHz; $T_{amb} \leq 115$ °C; square wave          | [1] | -    | 1   | A    |
|             |                                     | $\delta = 0.5$ ; $f = 20$ kHz; $T_{sp} \leq 170$ °C; square wave           | -   | -    | 1   | A    |

[1] Device mounted on a ceramic Printed-Circuit Board (PCB),  $Al_2O_3$ , standard footprint.



## 2. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline                                                                               | Graphic symbol                                                                                       |
|-----|--------|-------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| 1   | K      | cathode     |  <p>SOD123W</p> |  <p>006aab040</p> |
| 2   | A      | anode       |                                                                                                  |                                                                                                      |

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package |                                          |         |
|-------------|---------|------------------------------------------|---------|
|             | Name    | Description                              | Version |
| PNS40010ER  | SOD123W | plastic surface mounted package; 2 leads | SOD123W |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|-------------|--------------|
| PNS40010ER  | EH           |

## 5. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol      | Parameter                           | Conditions                                                                                        | Min | Max  | Unit             |
|-------------|-------------------------------------|---------------------------------------------------------------------------------------------------|-----|------|------------------|
| $V_{RRM}$   | repetitive peak reverse voltage     |                                                                                                   | -   | 400  | V                |
| $V_R$       | reverse voltage                     |                                                                                                   | -   | 400  | V                |
| $V_{RMS}$   | RMS voltage                         |                                                                                                   | -   | 280  | V                |
| $I_F$       | forward current                     | $T_{sp} \leq 160 \text{ }^\circ\text{C}$                                                          | -   | 1.4  | A                |
| $I_{F(AV)}$ | average forward current             | $\delta = 0.5$ ; $f = 20 \text{ kHz}$ ; square wave;<br>$T_{amb} \leq 115 \text{ }^\circ\text{C}$ | [1] | 1    | A                |
|             |                                     | $\delta = 0.5$ ; $f = 20 \text{ kHz}$ ; $T_{sp} \leq 170 \text{ }^\circ\text{C}$ ;<br>square wave | -   | 1    | A                |
| $I_{FSM}$   | non-repetitive peak forward current | square wave; $T_{j(\text{init})} = 25 \text{ }^\circ\text{C}$ ; $t_p = 8 \text{ ms}$              | -   | 32   | A                |
| $P_{tot}$   | total power dissipation             | $T_{amb} \leq 25 \text{ }^\circ\text{C}$                                                          | [2] | 750  | mW               |
|             |                                     |                                                                                                   | [3] | 1300 | mW               |
|             |                                     |                                                                                                   | [4] | 2300 | mW               |
| $T_j$       | junction temperature                |                                                                                                   | -   | 175  | $^\circ\text{C}$ |
| $T_{amb}$   | ambient temperature                 |                                                                                                   | -55 | 175  | $^\circ\text{C}$ |
| $T_{stg}$   | storage temperature                 |                                                                                                   | -65 | 175  | $^\circ\text{C}$ |

[1] Device mounted on a ceramic Printed-Circuit Board (PCB),  $\text{Al}_2\text{O}_3$ , standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[3] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for cathode  $1 \text{ cm}^2$ .

[4] Device mounted on a ceramic PCB,  $\text{Al}_2\text{O}_3$ , standard footprint.

## 6. Thermal characteristics

**Table 6. Thermal characteristics**

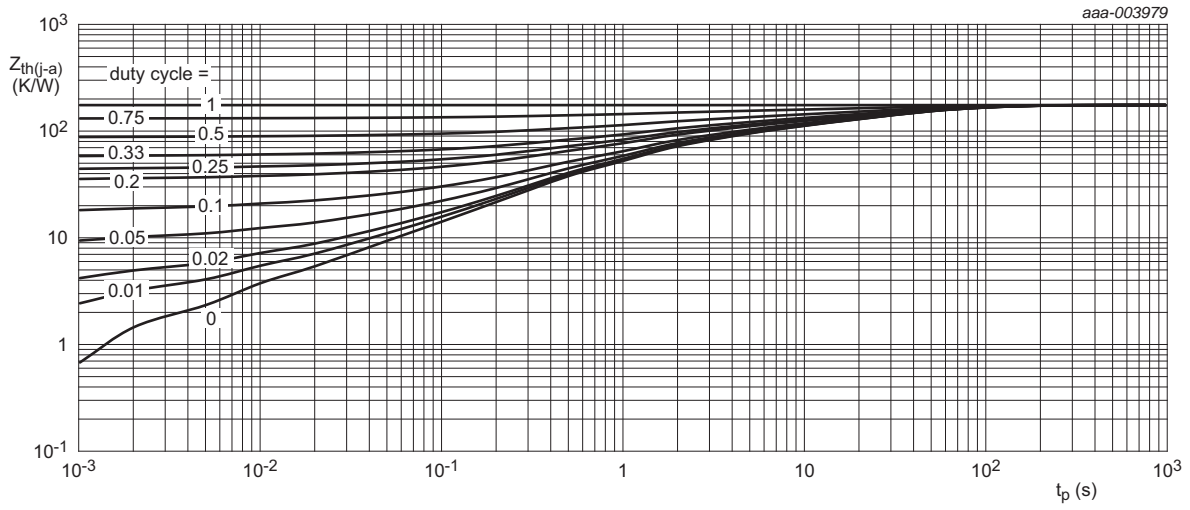
| Symbol         | Parameter                                              | Conditions  | Min | Typ | Max | Unit |
|----------------|--------------------------------------------------------|-------------|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance<br>from junction to<br>ambient      | in free air | [1] | -   | 200 | K/W  |
|                |                                                        |             | [2] | -   | 115 | K/W  |
|                |                                                        |             | [3] | -   | 65  | K/W  |
| $R_{th(j-sp)}$ | thermal resistance<br>from junction to solder<br>point |             | [4] | -   | 15  | K/W  |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for cathode  $1 \text{ cm}^2$ .

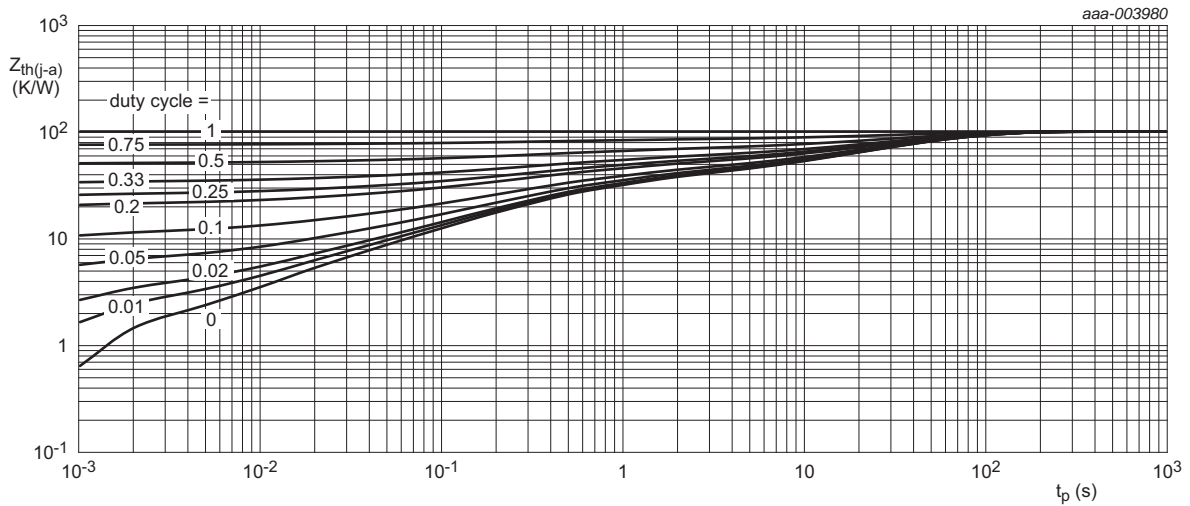
[3] Device mounted on an FR4 PCB,  $\text{Al}_2\text{O}_3$ , standard footprint.

[4] Soldering point of cathode tab.



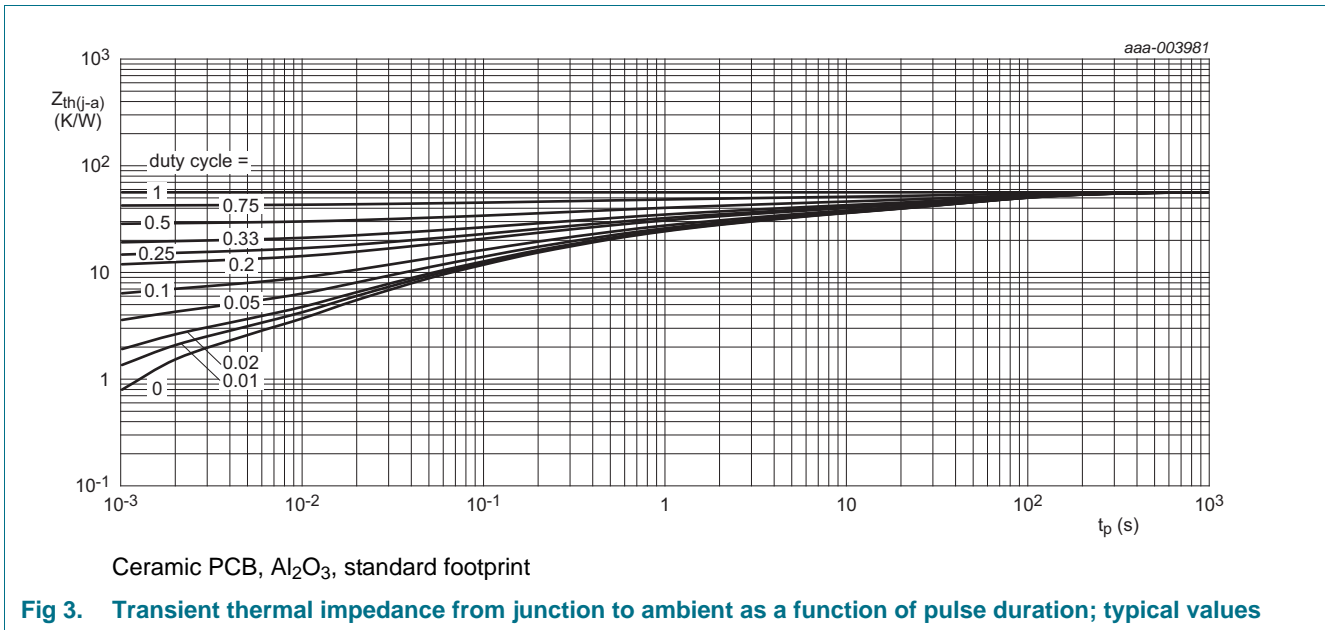
FR4 PCB, standard footprint

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



FR4 PCB, mounting pad for cathode  $1\text{ cm}^2$

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



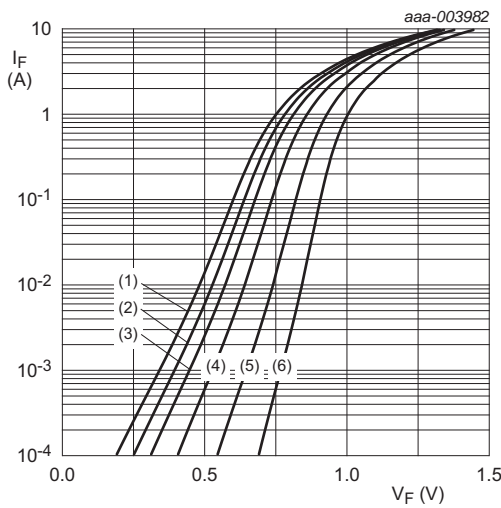
## 7. Characteristics

Table 7. Characteristics

| Symbol         | Parameter       | Conditions                                                                             | Min | Typ  | Max  | Unit |
|----------------|-----------------|----------------------------------------------------------------------------------------|-----|------|------|------|
| V <sub>F</sub> | forward voltage | I <sub>F</sub> = 0.5 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 25 °C  | -   | 0.89 | 1.05 | V    |
|                |                 | I <sub>F</sub> = 0.7 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 25 °C  | -   | 0.91 | 1.07 | V    |
|                |                 | I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 25 °C    | -   | 0.93 | 1.1  | V    |
|                |                 | I <sub>F</sub> = 0.5 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 125 °C | -   | 0.76 | 0.92 | V    |
|                |                 | I <sub>F</sub> = 0.7 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 125 °C | -   | 0.78 | 0.95 | V    |
|                |                 | I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 125 °C   | -   | 0.81 | 0.98 | V    |
|                |                 | I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = -40 °C   | -   | 1.01 | 1.18 | V    |
|                |                 | I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 150 °C   | -   | 0.78 | 0.95 | V    |
|                |                 | I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02 ;<br>T <sub>j</sub> = 175 °C   | -   | 0.75 | 0.92 | V    |

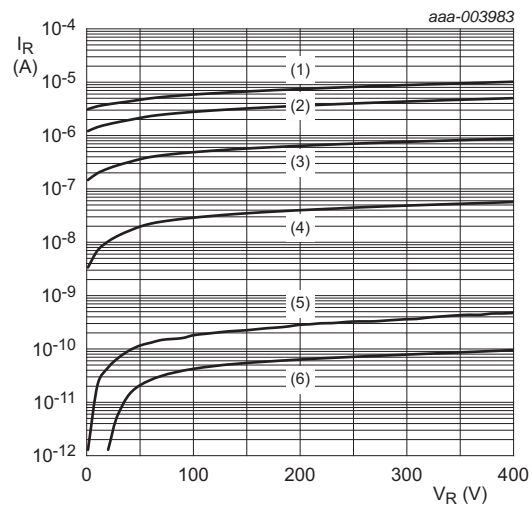
Table 7. Characteristics ...continued

| Symbol   | Parameter             | Conditions                                                                                                            | Min | Typ   | Max | Unit          |
|----------|-----------------------|-----------------------------------------------------------------------------------------------------------------------|-----|-------|-----|---------------|
| $I_R$    | reverse current       | $V_R = 400\text{ V}; T_j = -40\text{ }^\circ\text{C}$                                                                 | -   | 0.1   | 10  | nA            |
|          |                       | $V_R = 400\text{ V}; T_j = 25\text{ }^\circ\text{C}$                                                                  | -   | 0.001 | 1   | $\mu\text{A}$ |
|          |                       | $V_R = 400\text{ V}; T_j = 125\text{ }^\circ\text{C}$                                                                 | -   | 1     | 50  | $\mu\text{A}$ |
|          |                       | $V_R = 400\text{ V}; T_j = 150\text{ }^\circ\text{C}$                                                                 | -   | 5     | 250 | $\mu\text{A}$ |
|          |                       | $V_R = 400\text{ V}; T_j = 175\text{ }^\circ\text{C}$                                                                 | -   | 10    | 500 | $\mu\text{A}$ |
| $C_d$    | diode capacitance     | $V_R = 4\text{ V}; f = 1\text{ MHz}; T_{\text{amb}} = 25\text{ }^\circ\text{C}$                                       | -   | 8     | 20  | pF            |
| $t_{rr}$ | reverse recovery time | $I_F = 0.5\text{ A}; I_R = 1\text{ A}; I_{R(\text{meas})} = 0.25\text{ A}; T_{\text{amb}} = 25\text{ }^\circ\text{C}$ | -   | 0.8   | 1.8 | $\mu\text{s}$ |



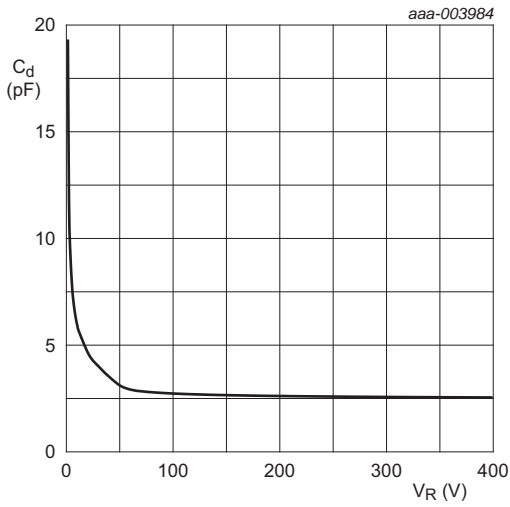
- (1)  $T_j = 175\text{ }^\circ\text{C}$
- (2)  $T_j = 150\text{ }^\circ\text{C}$
- (3)  $T_j = 125\text{ }^\circ\text{C}$
- (4)  $T_j = 85\text{ }^\circ\text{C}$
- (5)  $T_j = 25\text{ }^\circ\text{C}$
- (6)  $T_j = -40\text{ }^\circ\text{C}$

Fig 4. Forward current as a function of forward voltage; typical values



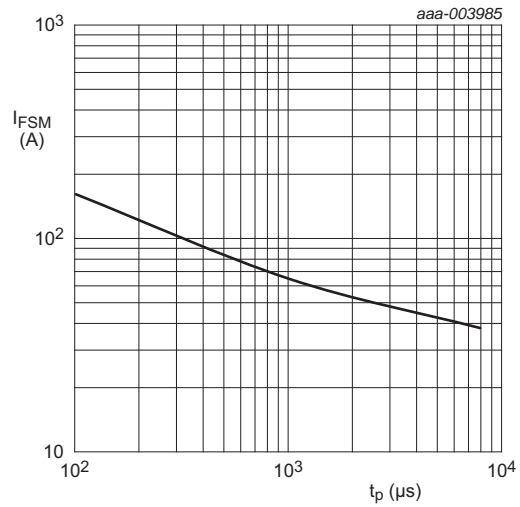
- (1)  $T_j = 175\text{ }^\circ\text{C}$
- (2)  $T_j = 150\text{ }^\circ\text{C}$
- (3)  $T_j = 125\text{ }^\circ\text{C}$
- (4)  $T_j = 85\text{ }^\circ\text{C}$
- (5)  $T_j = 25\text{ }^\circ\text{C}$
- (6)  $T_j = -40\text{ }^\circ\text{C}$

Fig 5. Reverse current as a function of reverse voltage; typical values



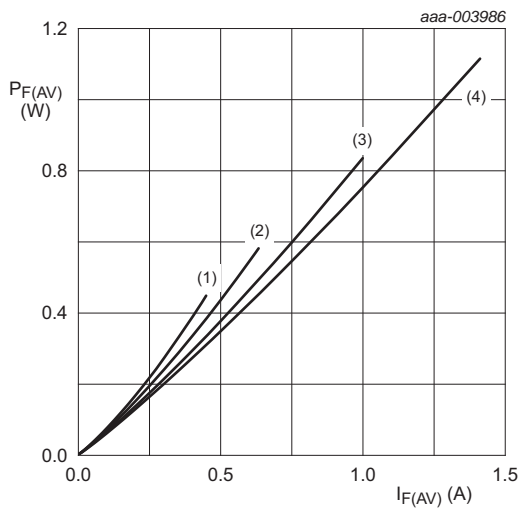
$f = 1 \text{ MHz}; T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

**Fig 6. Diode capacitance as a function of reverse voltage; typical values**



$T_{\text{amb}} = 25 \text{ }^\circ\text{C}$

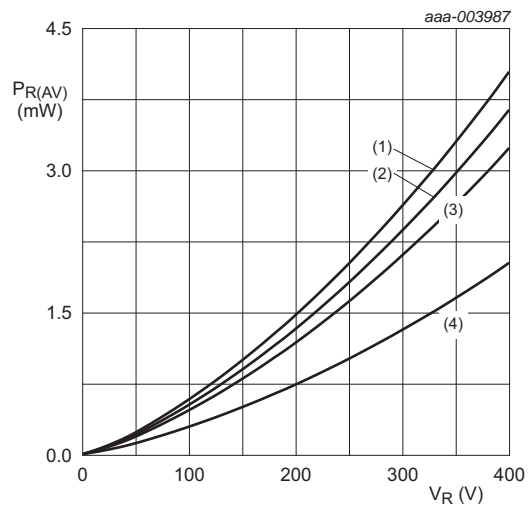
**Fig 7. Non-repetitive peak forward current as a function of pulse duration; typical values**



$T_j = 175 \text{ }^\circ\text{C}$

- (1)  $\delta = 0.1$
- (2)  $\delta = 0.2$
- (3)  $\delta = 0.5$
- (4)  $\delta = 1$

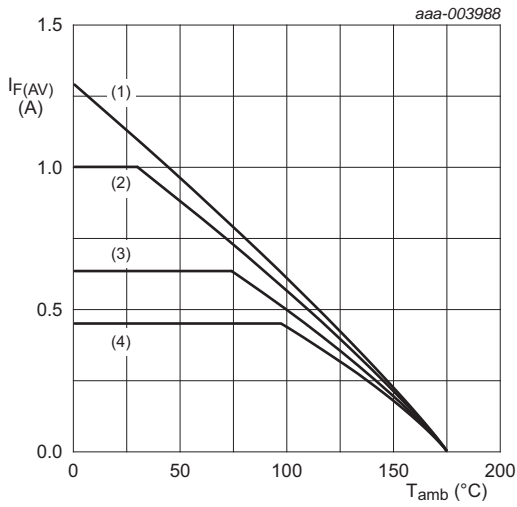
**Fig 8. Average forward power dissipation as a function of average forward current; typical values**



$T_j = 175 \text{ }^\circ\text{C}$

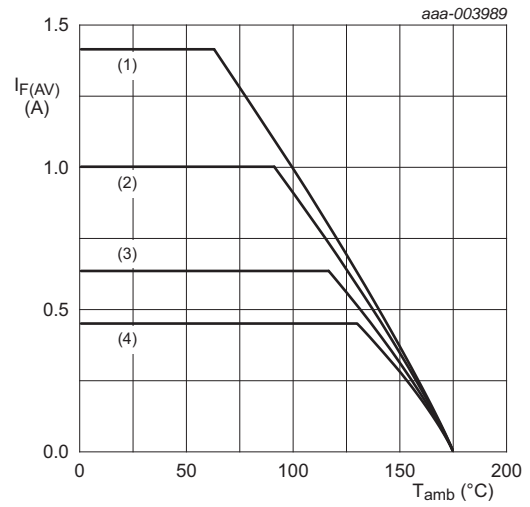
- (1)  $\delta = 1$
- (2)  $\delta = 0.9$
- (3)  $\delta = 0.8$
- (4)  $\delta = 0.5$

**Fig 9. Average reverse power dissipation as a function of reverse voltage; typical values**



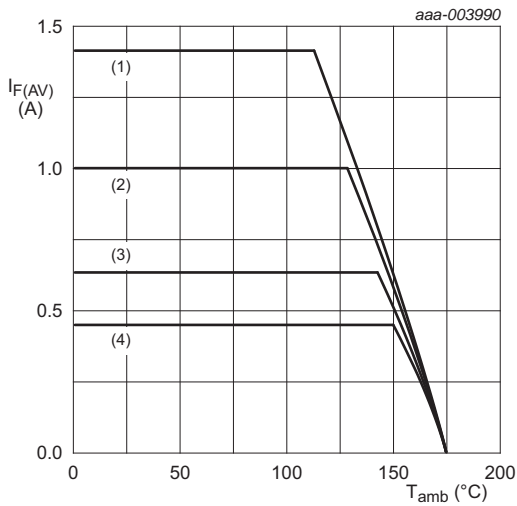
FR4 PCB, standard footprint  
 $T_j = 175\text{ °C}$   
 (1)  $\delta = 1$  (DC)  
 (2)  $\delta = 0.5$ ;  $f = 20\text{ kHz}$   
 (3)  $\delta = 0.2$ ;  $f = 20\text{ kHz}$   
 (4)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$

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



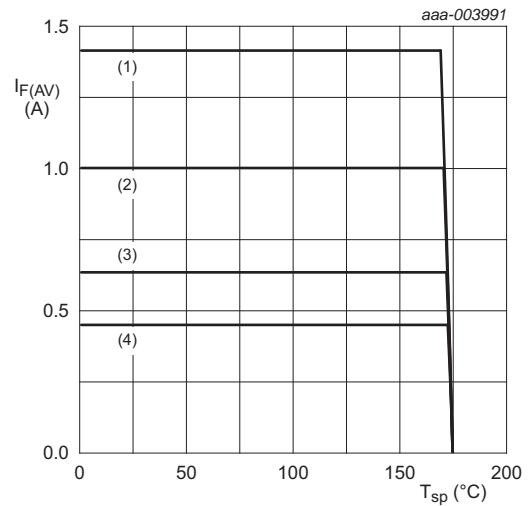
FR4 PCB, mounting pad for cathode  $1\text{ cm}^2$   
 $T_j = 175\text{ °C}$   
 (1)  $\delta = 1$  (DC)  
 (2)  $\delta = 0.5$ ;  $f = 20\text{ kHz}$   
 (3)  $\delta = 0.2$ ;  $f = 20\text{ kHz}$   
 (4)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$

Fig 11. Average forward current as a function of ambient temperature; typical values



Ceramic PCB,  $\text{Al}_2\text{O}_3$ , standard footprint  
 $T_j = 175\text{ °C}$   
 (1)  $\delta = 1$  (DC)  
 (2)  $\delta = 0.5$ ;  $f = 20\text{ kHz}$   
 (3)  $\delta = 0.2$ ;  $f = 20\text{ kHz}$   
 (4)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$

Fig 12. Average forward current as a function of ambient temperature; typical values



$T_j = 175\text{ °C}$   
 (1)  $\delta = 1$  (DC)  
 (2)  $\delta = 0.5$ ;  $f = 20\text{ kHz}$   
 (3)  $\delta = 0.2$ ;  $f = 20\text{ kHz}$   
 (4)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$

Fig 13. Average forward current as a function of solder point temperature; typical values



## 8. Test information

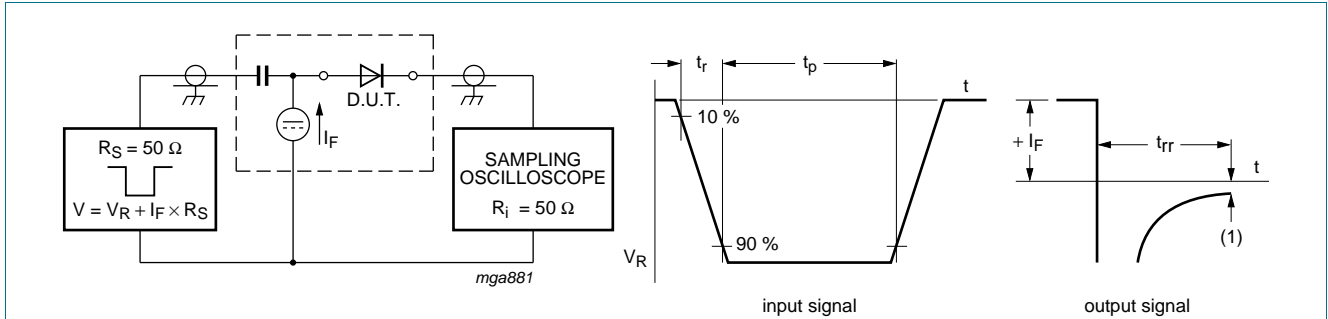


Fig 14. Reverse recovery time: test circuit and waveforms

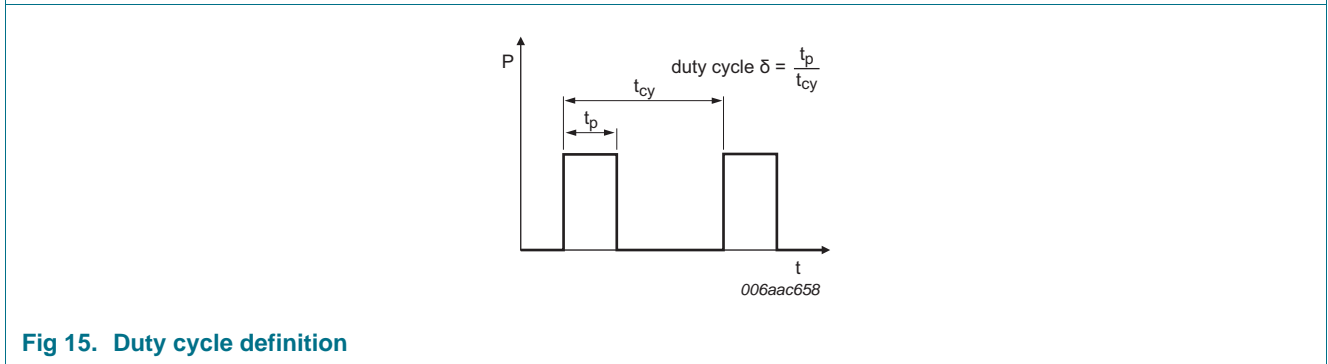


Fig 15. Duty cycle definition

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.

### 8.1 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.

## 9. Package outline

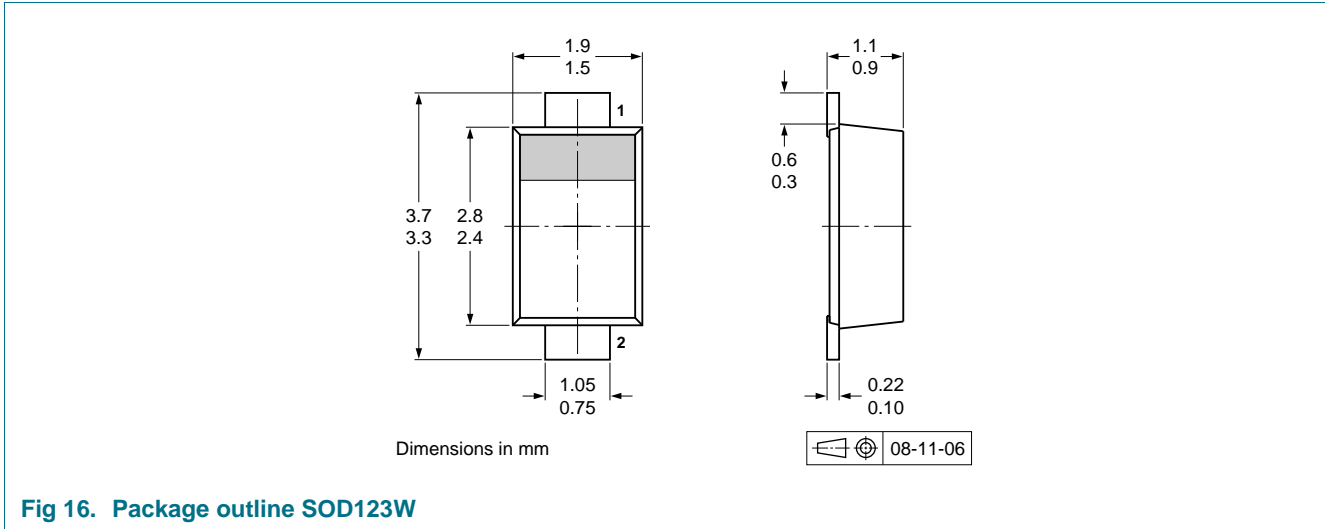


Fig 16. Package outline SOD123W

## 10. Soldering

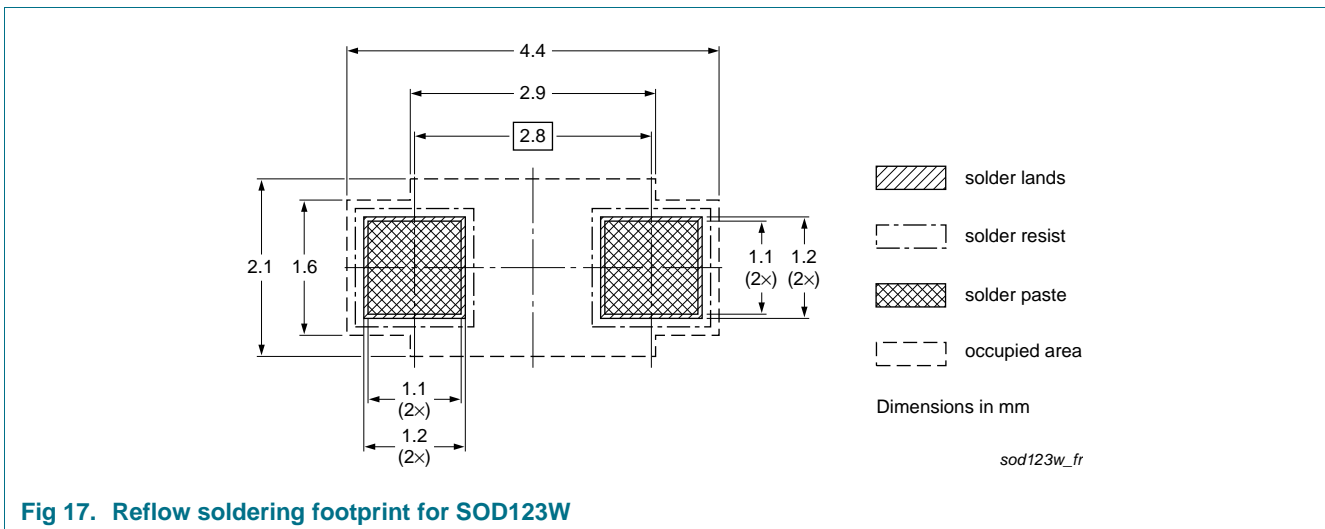


Fig 17. Reflow soldering footprint for SOD123W

## 11. Revision history

Table 8. Revision history

| Document ID    | Release date                | Data sheet status      | Change notice | Supersedes     |
|----------------|-----------------------------|------------------------|---------------|----------------|
| PNS40010ER v.2 | 20120821                    | Product data sheet     | -             | PNS40010ER v.1 |
| Modifications: | • Data sheet status updated |                        |               |                |
| PNS40010ER v.1 | 20120615                    | Preliminary data sheet | -             | -              |

## 12. Legal information

### 12.1 Data sheet status

| Document status <sup>[1] [2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|------------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet       | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet     | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet         | Production                    | This document contains the product specification.                                     |

[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 URL <http://www.nxp.com>.

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## 13. Contact information

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For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

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Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.