



# PNS40010ER

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

19 August 2019

Product data sheet

## 1. General description

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

## 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
- Capable for reflow and wave soldering

## 3. Applications

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

## 4. Quick reference data

Table 1. Quick reference data


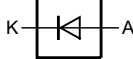
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{F(AV)}$	average forward current	$\delta = 0.5$ ; $f = 20$ kHz; square wave; $T_{amb} \leq 115$ °C	-	-	1	A
$V_{RRM}$	repetitive peak reverse voltage		-	-	400	V
$V_R$	reverse voltage		-	-	400	V
$V_F$	forward voltage	$I_F = 0.5$ A; $t_p \leq 300$ $\mu$ s; $\delta \leq 0.02$ ; $T_j = 25$ °C	-	0.89	1.05	V
		$I_F = 0.7$ A; $t_p \leq 300$ $\mu$ s; $\delta \leq 0.02$ ; $T_j = 25$ °C	-	0.91	1.07	V
$I_R$	reverse current	$V_R = 400$ V; $T_j = -40$ °C	-	0.1	10	nA
		$V_R = 400$ V; $T_j = 25$ °C	-	0.001	1	$\mu$ A

[1] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.

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## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	K	cathode	 CFP3 (SOD123W)	 006aab040
2	A	anode		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PNS40010ER	CFP3	plastic, surface mounted package; 2 terminals; 2.6 mm x 1.7 mm x 1 mm body	SOD123W

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PNS40010ER	EH

## 8. 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	$T_{sp} \leq 160\text{ °C}$		-	1.4	A
$I_{F(AV)}$	average forward current	$\delta = 0.5$ ; $f = 20\text{ kHz}$ ; square wave; $T_{amb} \leq 115\text{ °C}$	[1]	-	1	A
		$\delta = 0.5$ ; $f = 20\text{ kHz}$ ; square wave; $T_{sp} \leq 170\text{ °C}$		-	1	A
$I_{FSM}$	non-repetitive peak forward current	$t_p = 8\text{ ms}$ ; $T_{j(\text{init})} = 25\text{ °C}$ ; square wave		-	32	A
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$	[2]	-	750	mW
			[3]	-	1.3	W
			[1]	-	2.3	W
$T_j$	junction temperature			-	175	°C
$T_{amb}$	ambient temperature			-55	175	°C
$T_{stg}$	storage temperature			-65	175	°C

[1] Device mounted on a ceramic PCB,  $Al_2O_3$ , 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  $1\text{ cm}^2$ .

## 9. Thermal characteristics

**Table 6. Thermal characteristics**

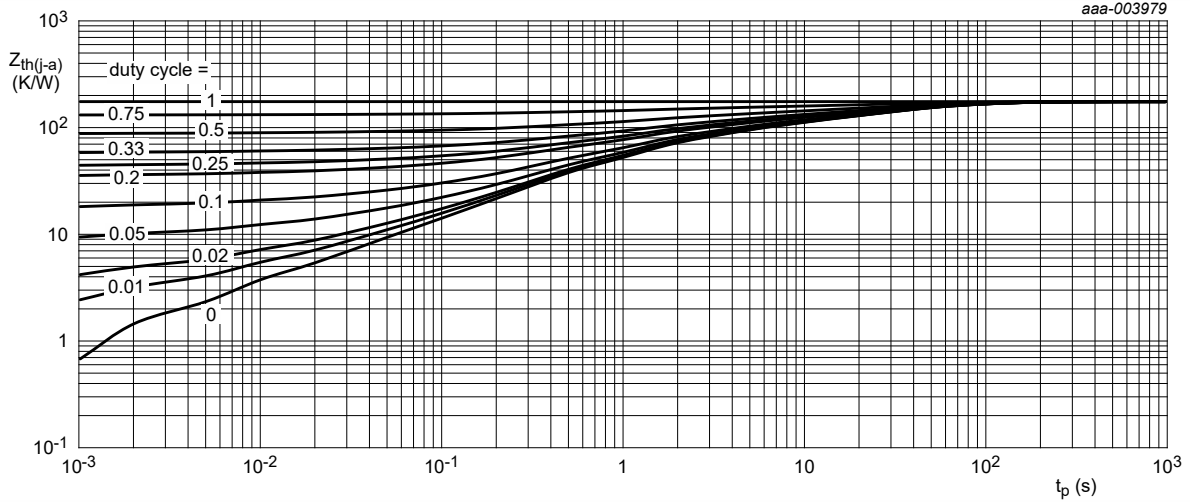
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	200	K/W
			[2]	-	-	115	K/W
			[3]	-	-	65	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point		[4]	-	-	15	K/W

[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  $1\text{ cm}^2$ .

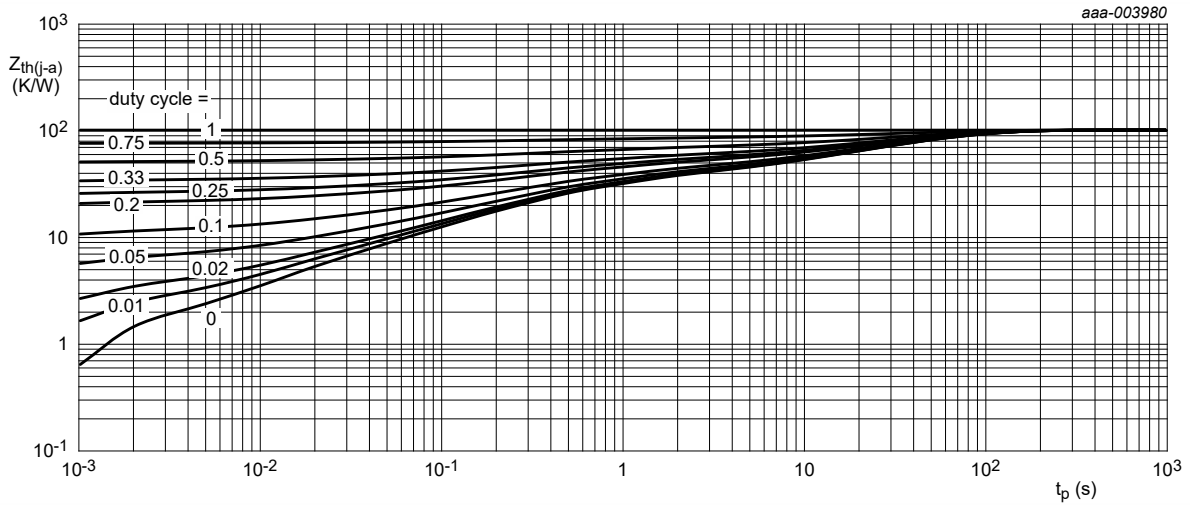
[3] Device mounted on an FR4 PCB,  $Al_2O_3$ , standard footprint.

[4] Soldering point of cathode tab.



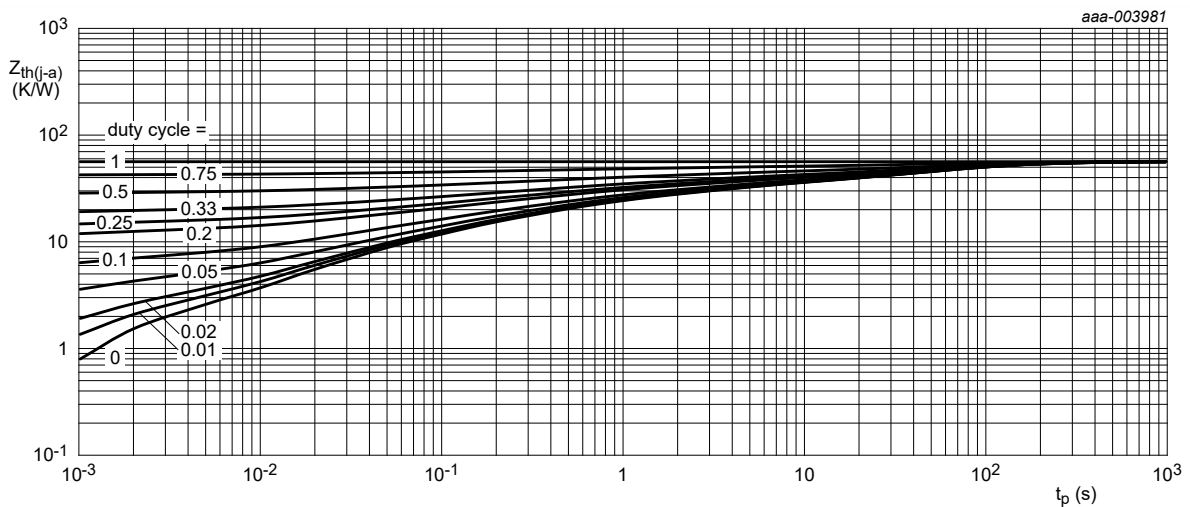
FR4 PCB, standard footprint

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



Ceramic PCB,  $\text{Al}_2\text{O}_3$ , standard footprint

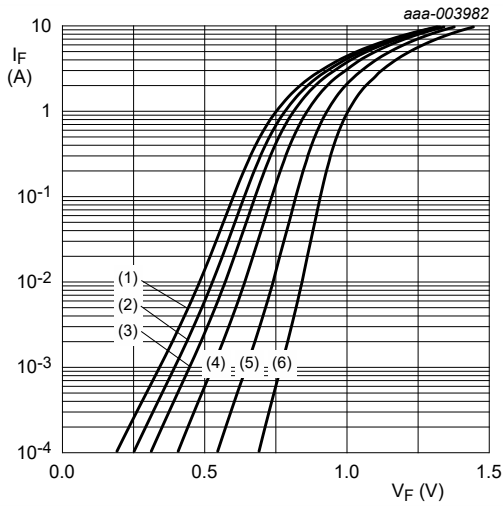
Fig. 3. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

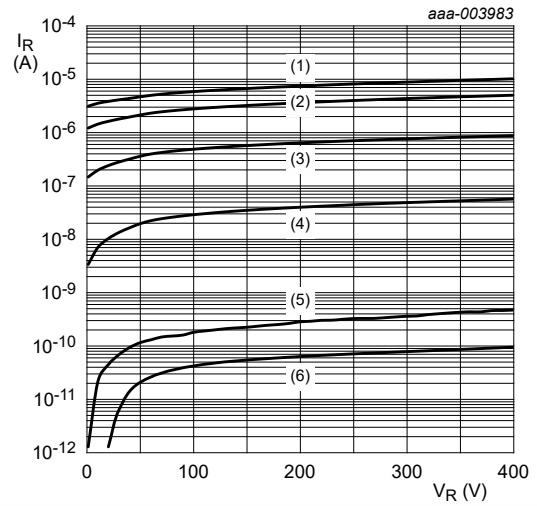
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>F</sub>	forward voltage	I <sub>F</sub> = 0.5 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>j</sub> = 25 °C	-	0.89	1.05	V
		I <sub>F</sub> = 0.7 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>j</sub> = 25 °C	-	0.91	1.07	V
		I <sub>F</sub> = 1 A; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; 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; 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; 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; 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; 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; 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; T <sub>j</sub> = 175 °C	-	0.75	0.92	V
I <sub>R</sub>	reverse current	V <sub>R</sub> = 400 V; T <sub>j</sub> = -40 °C	-	0.1	10	nA
		V <sub>R</sub> = 400 V; T <sub>j</sub> = 25 °C	-	0.001	1	μA
		V <sub>R</sub> = 400 V; T <sub>j</sub> = 125 °C	-	1	50	μA
		V <sub>R</sub> = 400 V; T <sub>j</sub> = 150 °C	-	5	250	μA
		V <sub>R</sub> = 400 V; T <sub>j</sub> = 175 °C	-	10	500	μA
C <sub>d</sub>	diode capacitance	V <sub>R</sub> = 4 V; f = 1 MHz; T <sub>amb</sub> = 25 °C	-	8	20	pF
t <sub>rr</sub>	reverse recovery time	I <sub>F</sub> = 0.5 A; I <sub>R</sub> = 1 A; I <sub>R(meas)</sub> = 0.25 A; T <sub>amb</sub> = 25 °C	-	0.8	1.8	μs

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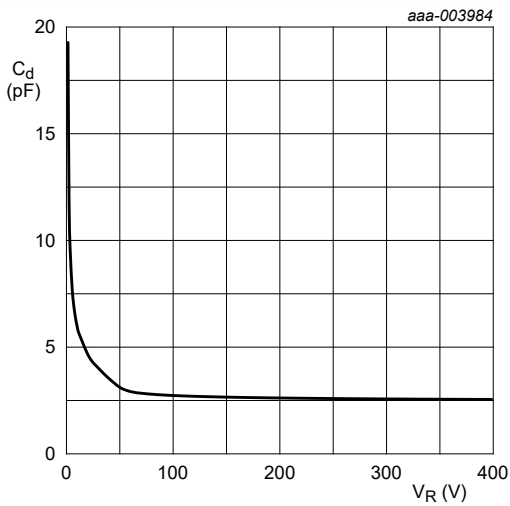
- (1)  $T_j = 175\text{ °C}$
- (2)  $T_j = 150\text{ °C}$
- (3)  $T_j = 125\text{ °C}$
- (4)  $T_j = 85\text{ °C}$
- (5)  $T_j = 25\text{ °C}$
- (6)  $T_j = -40\text{ °C}$

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



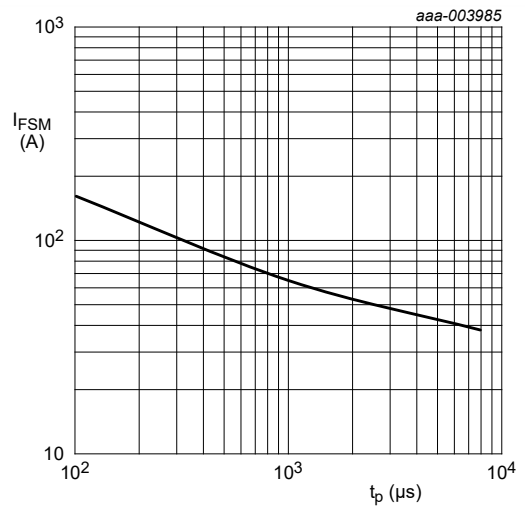
- (1)  $T_j = 175\text{ °C}$
- (2)  $T_j = 150\text{ °C}$
- (3)  $T_j = 125\text{ °C}$
- (4)  $T_j = 85\text{ °C}$
- (5)  $T_j = 25\text{ °C}$
- (6)  $T_j = -40\text{ °C}$

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



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

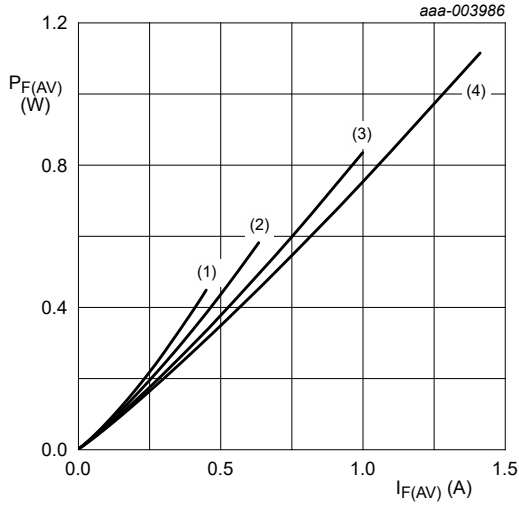
**Fig. 6. Diode capacitance as a function of reverse voltage; typical values**



$T_{amb} = 25\text{ °C}$

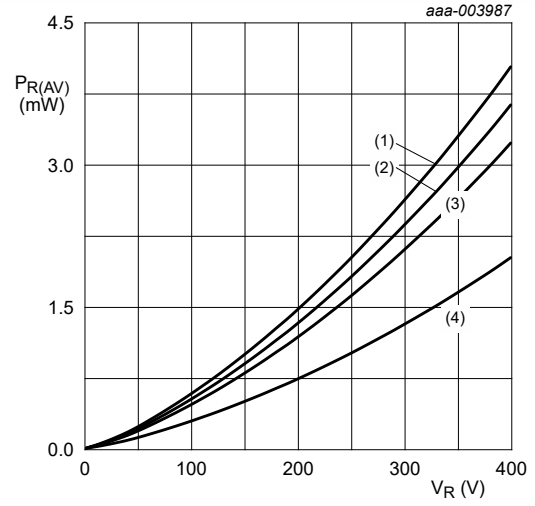
**Fig. 7. Non-repetitive peak forward current as a function of pulse duration; typical values**

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



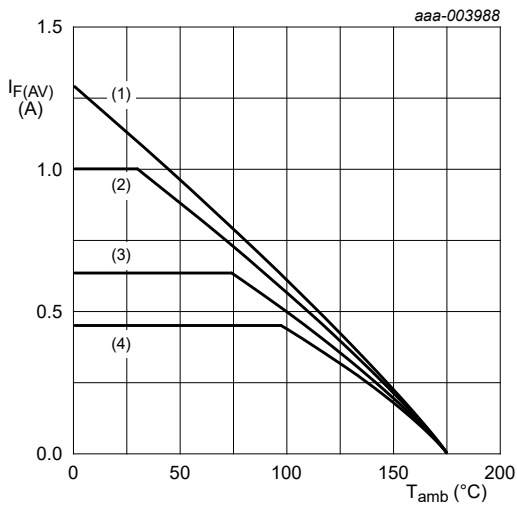
$T_j = 175\text{ }^\circ\text{C}$   
 (1)  $\delta = 0.1$   
 (2)  $\delta = 0.2$   
 (3)  $\delta = 0.5$   
 (4)  $\delta = 1$

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



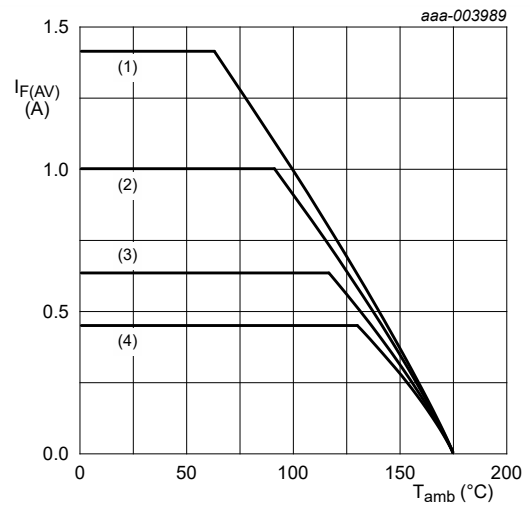
$T_j = 175\text{ }^\circ\text{C}$   
 (1)  $\delta = 1$   
 (2)  $\delta = 0.9$   
 (3)  $\delta = 0.8$   
 (4)  $\delta = 0.5$

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



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

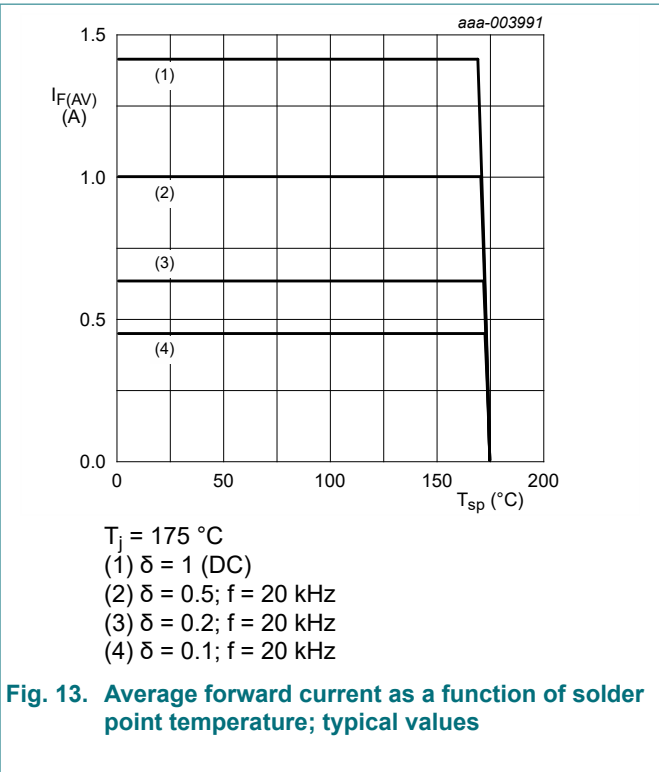
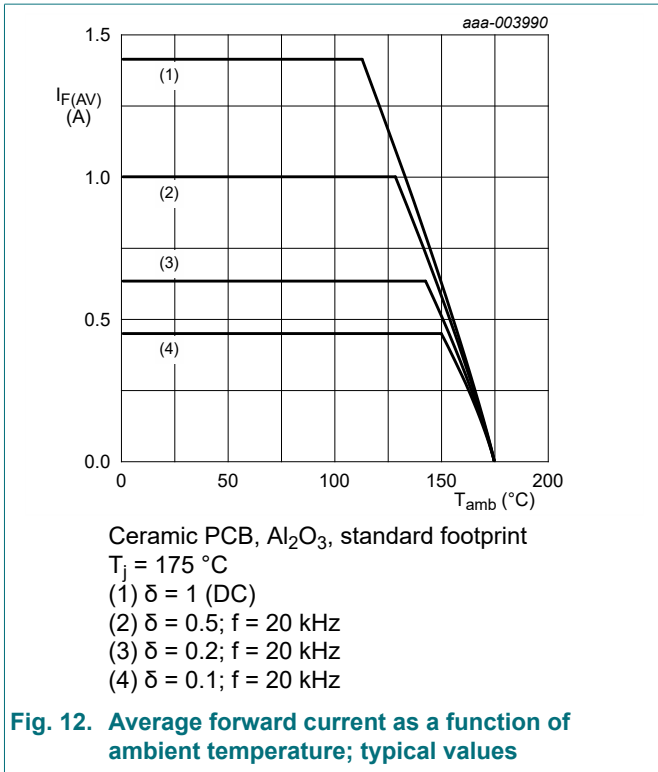
**Fig. 10. Average forward current as a function of ambient temperature; typical values**



FR4 PCB, mounting pad for cathode  $1\text{ cm}^2$   
 $T_j = 175\text{ }^\circ\text{C}$   
 (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**

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





### 11. Test information

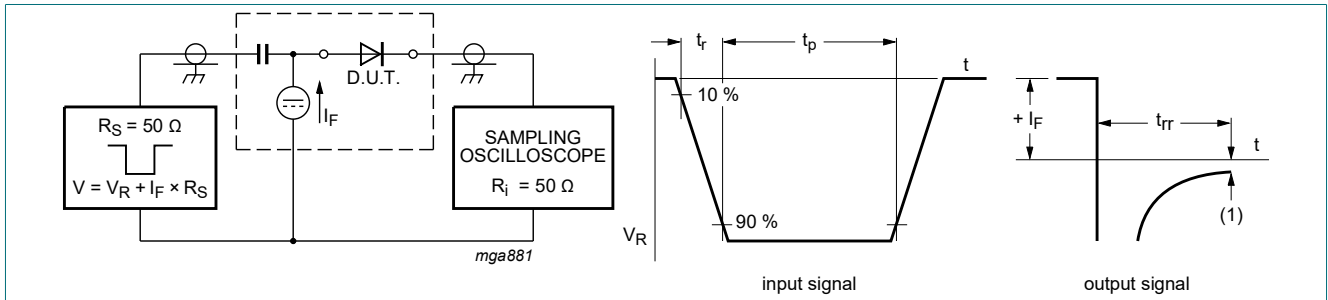


Fig. 14. Reverse recovery time: test circuit and waveforms

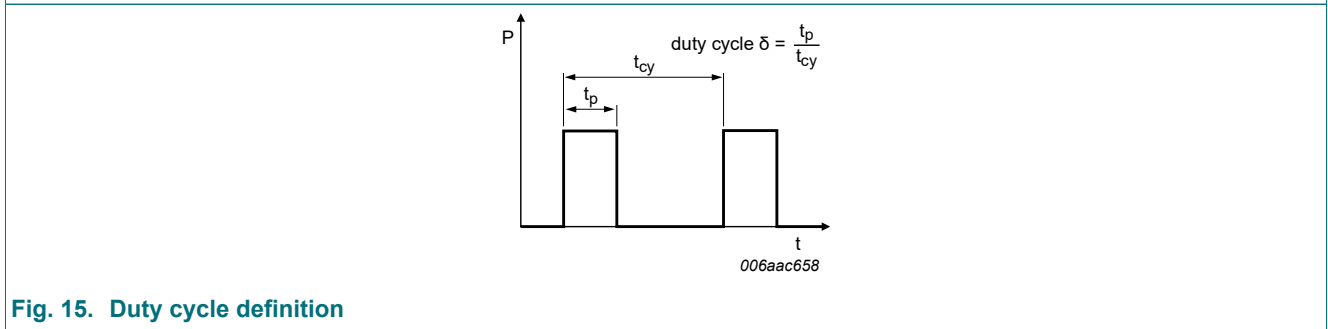


Fig. 15. Duty cycle definition

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.

#### 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

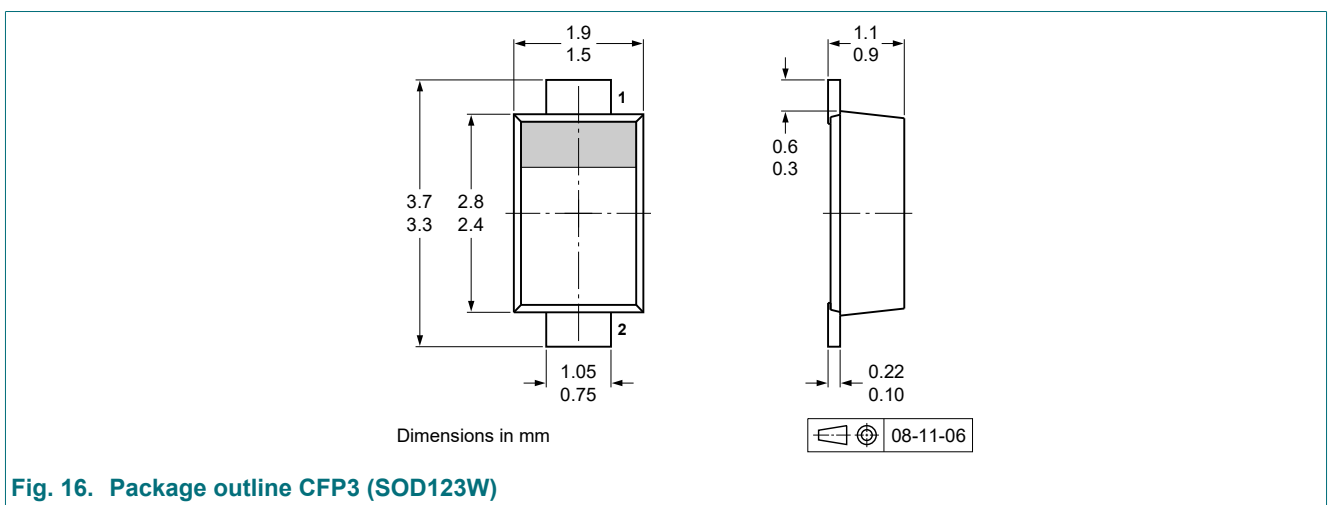


Fig. 16. Package outline CFP3 (SOD123W)

### 13. Soldering

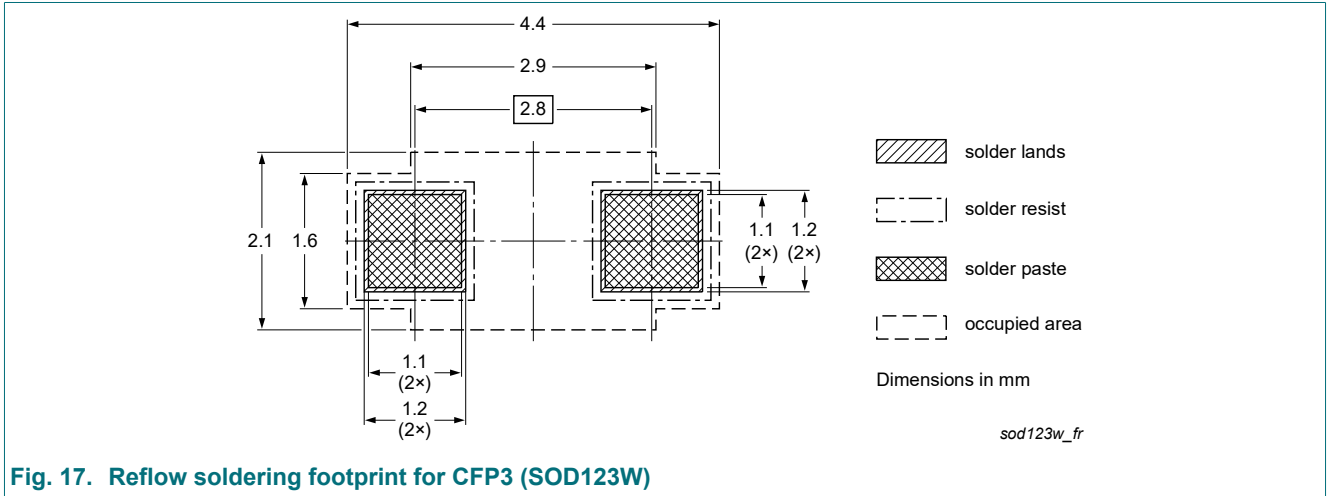
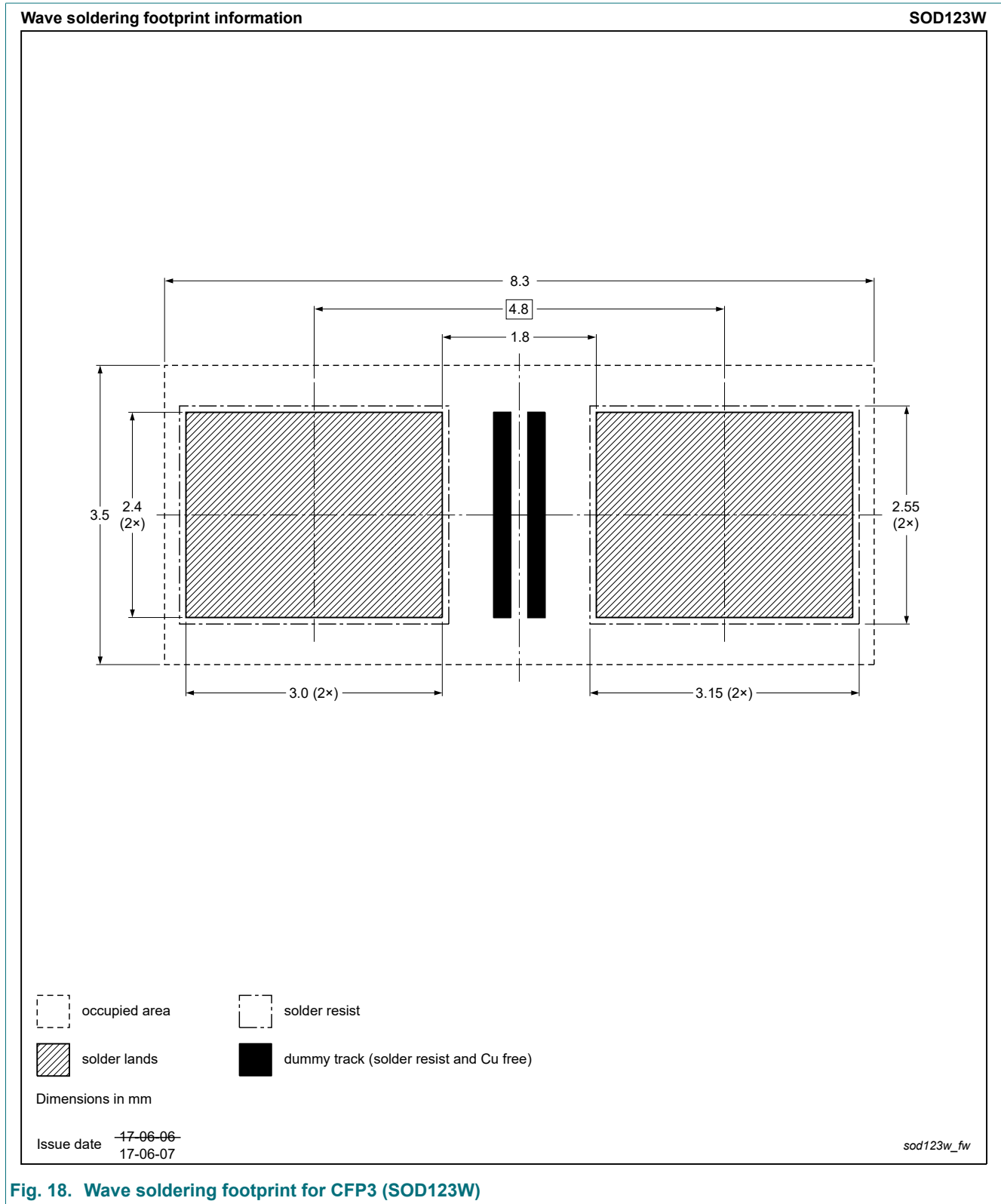


Fig. 17. Reflow soldering footprint for CFP3 (SOD123W)



**Fig. 18. Wave soldering footprint for CFP3 (SOD123W)**

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PNS40010ER v.4	20190819	Product data sheet	-	PNS40010ER v.3
Modifications:	• Category changed from PN-rectifier to recovery rectifier			
PNS40010ER v.3	20180822	Product data sheet	-	PNS40010ER v.2
PNS40010ER v.2	20120821	Product data sheet	-	PNS40010ER v.1
PNS40010ER v.1	20120615	Preliminary data sheet	-	-

## 15. Legal information

### Data sheet status

Document status [1][2]	Product status [3]	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".
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