



# PNE650200EJ

650 V, 20 A hyperfast recovery rectifier

3 May 2024

Product data sheet

## 1. General description

High power density, hyperfast switching recovery rectifier with high-efficiency planar technology, encapsulated in D2PAK Real-2-Pin (SOT8018).

## 2. Features and benefits

- Reverse voltage  $V_R \leq 650$  V
- Forward current  $I_F \leq 20$  A
- Typical switching time  $t_{tr}$  of 20 ns
- Pt doped life time control
- Low inductance
- Planar die design

## 3. Applications

- AC/DC converter
- DC/DC converter
- SMPS / UPS
- Battery charger
- Inverter
- Freewheeling applications

## 4. Quick reference data

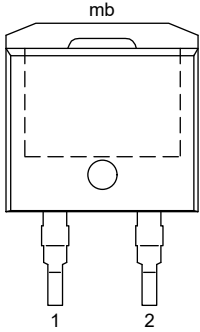
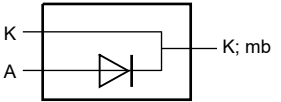
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$I_{F(AV)}$	average forward current	$\delta = 0.5$ ; $f = 20$ kHz; square wave; $T_c \leq 119$ °C		-	-	20	A
$V_{RRM}$	repetitive peak reverse voltage	$T_j = 25$ °C		-	-	650	V
$V_R$	reverse voltage			-	-	650	V
$V_F$	forward voltage	$I_F = 20$ A; pulsed; $T_j = 25$ °C	[1]	-	1.73	2.4	V
		$I_F = 20$ A; pulsed; $T_j = 125$ °C	[1]	-	1.42	1.93	V
		$I_F = 20$ A; pulsed; $T_j = 175$ °C	[1]	-	1.28	-	V
$I_R$	reverse current	$V_R = 650$ V; pulsed; $T_j = 25$ °C	[1]	-	-	5	$\mu$ A
		$V_R = 650$ V; pulsed; $T_j = 125$ °C	[1]	-	4.2	50	$\mu$ A
		$V_R = 650$ V; pulsed; $T_j = 175$ °C	[1]	-	81.6	-	$\mu$ A

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

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	K	cathode	 <p style="text-align: center;">D2PAK R2P (SOT8018)</p>	 <p style="text-align: right; font-size: small;">aaa-037872</p>
2	A	anode		
mb	K	mounting base; connected to cathode, also referred to as the case		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
<a href="#">PNE650200EJ</a>	D2PAK R2P	Plastic, single-ended surface-mounted package (D2PAK R2P); Real-2-Pin configuration; 5.08 mm pitch; 8.8 mm x 10.35 mm x 4.46 mm body	<a href="#">SOT8018</a>

## 7. Marking

Table 4. Marking codes

Type number	Marking code
PNE650200EJ	E65020

## 8. Limiting values

**Table 5. Limiting values**

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

Symbol	Parameter	Conditions		Min	Max	Unit
$V_{RRM}$	repetitive peak reverse voltage	$T_j = 25\text{ °C}$		-	650	V
$V_R$	reverse voltage			-	650	V
$V_{RMS}$	RMS voltage			-	460	V
$I_F$	forward current	$\delta = 1; T_c \leq 106\text{ °C}$		-	28	A
$I_{F(AV)}$	average forward current	$\delta = 0.5; f = 20\text{ kHz};$ square wave; $T_c \leq 119\text{ °C}$		-	20	A
$I_{FSM}$	non-repetitive peak forward current	$t_p = 8.3\text{ ms};$ single half sine wave (applied at rated load condition); $T_{j(\text{init})} = 25\text{ °C}$		-	173	A
		$t_p = 10\text{ ms};$ square wave; $T_{j(\text{init})} = 25\text{ °C}$		-	143	A
$P_{tot}$	total power dissipation	$T_c \leq 25\text{ °C}$	[1]	-	2.4	W
			[2]	-	4.2	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 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 6 cm<sup>2</sup>.

## 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]	-	-	61	K/W
			[2]	-	-	36	K/W
$R_{th(j-c)}$	thermal resistance from junction to case		[3]	-	-	1.5	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 6 cm<sup>2</sup>.
- [3] Soldering point of cathode tab.

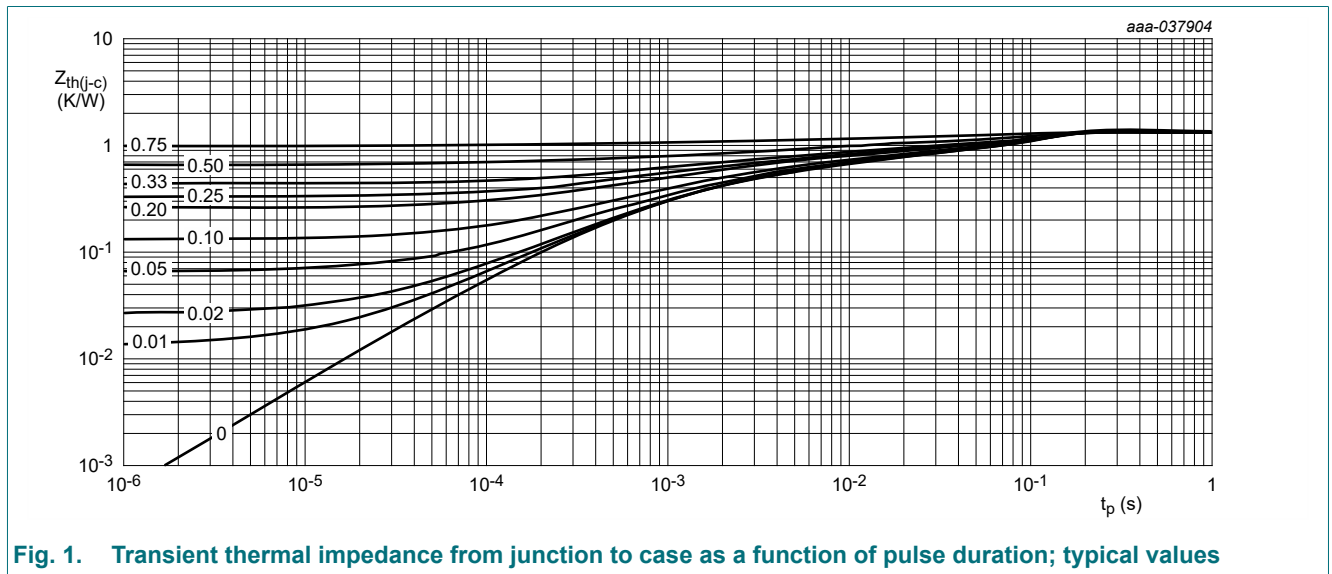


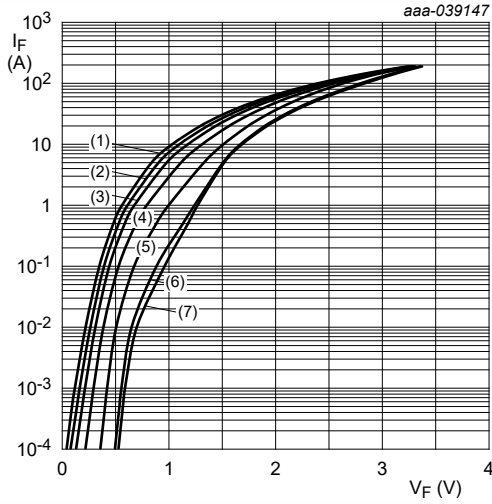
Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

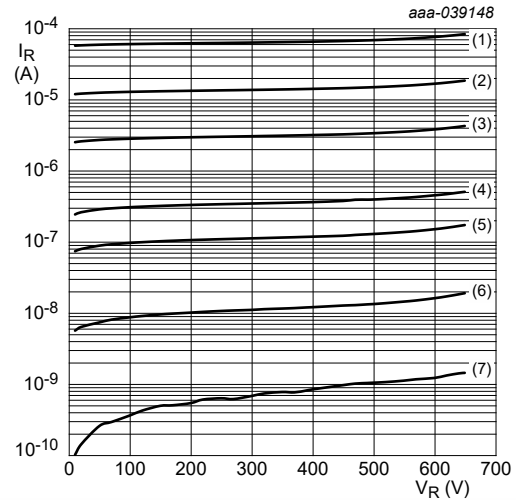
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{(BR)R}$	reverse breakdown voltage	$I_R = 100 \mu\text{A}$ ; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	650	-	-	V
$V_F$	forward voltage	$I_F = 20 \text{ A}$ ; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	-	1.73	2.4	V
		$I_F = 20 \text{ A}$ ; pulsed; $T_j = 125 \text{ }^\circ\text{C}$	[1]	-	1.42	1.93	V
		$I_F = 20 \text{ A}$ ; pulsed; $T_j = 175 \text{ }^\circ\text{C}$	[1]	-	1.28	-	V
$I_R$	reverse current	$V_R = 650 \text{ V}$ ; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	-	-	5	$\mu\text{A}$
		$V_R = 650 \text{ V}$ ; pulsed; $T_j = 125 \text{ }^\circ\text{C}$	[1]	-	4.2	50	$\mu\text{A}$
		$V_R = 650 \text{ V}$ ; pulsed; $T_j = 175 \text{ }^\circ\text{C}$	[1]	-	81.6	-	$\mu\text{A}$
$C_d$	diode capacitance	$V_R = 400 \text{ V}$ ; $f = 1 \text{ MHz}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	13	-	pF
$t_{rr}$	reverse recovery time ; step recovery	$I_F = 0.5 \text{ A}$ ; $I_R = 1 \text{ A}$ ; $I_{R(\text{meas})} = 0.25 \text{ A}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	20	30	ns
	reverse recovery time ; ramp recovery	$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	79	-	ns
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$		-	49	-	ns
		$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 125 \text{ }^\circ\text{C}$		-	132	-	ns
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$		-	77	-	ns
$I_{RM}$	peak reverse recovery current	$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	3.7	-	A
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	15.2	-	A
		$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 125 \text{ }^\circ\text{C}$		-	8.7	-	A
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 125 \text{ }^\circ\text{C}$		-	25.4	-	A
$Q_{rr}$	reverse recovery charge	$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	167	-	nC
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 25 \text{ }^\circ\text{C}$		-	386	-	nC
		$I_F = 20 \text{ A}$ ; $di_F/dt = -200 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 125 \text{ }^\circ\text{C}$		-	693	-	nC
		$I_F = 20 \text{ A}$ ; $di_F/dt = -1000 \text{ A}/\mu\text{s}$ ; $V_R = 400 \text{ V}$ ; $T_j = 125 \text{ }^\circ\text{C}$		-	1124	-	nC

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



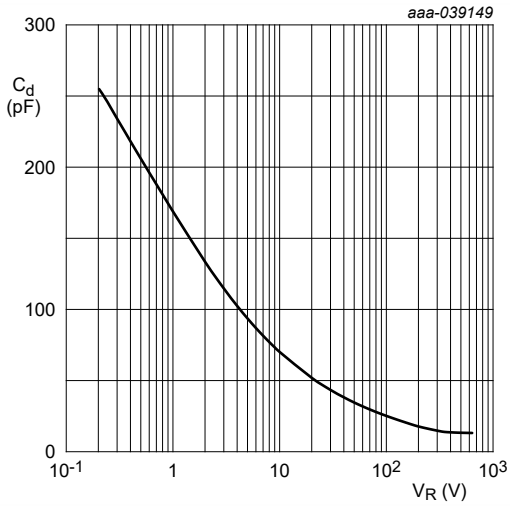
pulsed condition  
 (1)  $T_j = 175\text{ }^\circ\text{C}$   
 (2)  $T_j = 150\text{ }^\circ\text{C}$   
 (3)  $T_j = 125\text{ }^\circ\text{C}$   
 (4)  $T_j = 85\text{ }^\circ\text{C}$   
 (5)  $T_j = 25\text{ }^\circ\text{C}$   
 (6)  $T_j = -40\text{ }^\circ\text{C}$   
 (7)  $T_j = -55\text{ }^\circ\text{C}$

Fig. 2. Forward current as a function of forward voltage; typical values



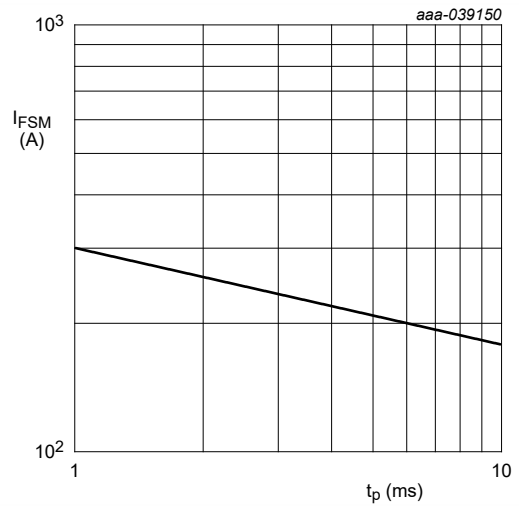
pulsed condition  
 (1)  $T_j = 175\text{ }^\circ\text{C}$   
 (2)  $T_j = 150\text{ }^\circ\text{C}$   
 (3)  $T_j = 125\text{ }^\circ\text{C}$   
 (4)  $T_j = 100\text{ }^\circ\text{C}$   
 (5)  $T_j = 85\text{ }^\circ\text{C}$   
 (6)  $T_j = 55\text{ }^\circ\text{C}$   
 (7)  $T_j = 25\text{ }^\circ\text{C}$

Fig. 3. Reverse current as a function of reverse voltage; typical values



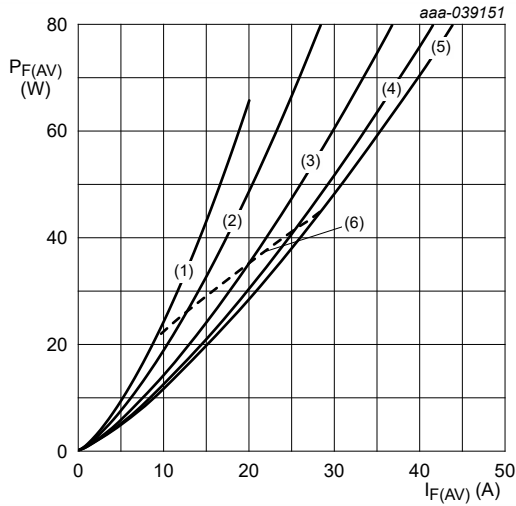
$f = 1\text{ MHz}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 4. Diode capacitance as a function of reverse voltage; typical values



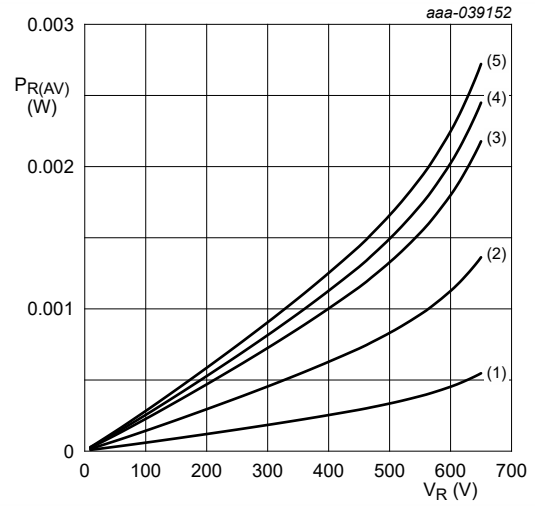
square wave;  $T_{amb} = 25\text{ }^\circ\text{C}$

Fig. 5. Non-repetitive peak forward current as a function of pulse duration; typical values



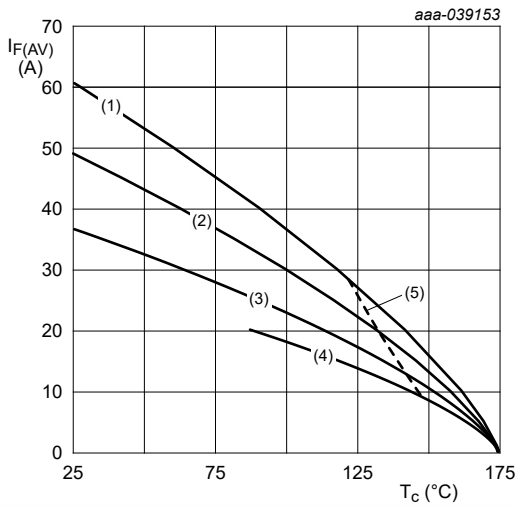
$T_j = 125\text{ }^\circ\text{C}$   
 (1)  $\delta = 0.1$   
 (2)  $\delta = 0.2$   
 (3)  $\delta = 0.5$   
 (4)  $\delta = 0.8$   
 (5)  $\delta = 1$  (DC)  
 (6) RMS limit

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



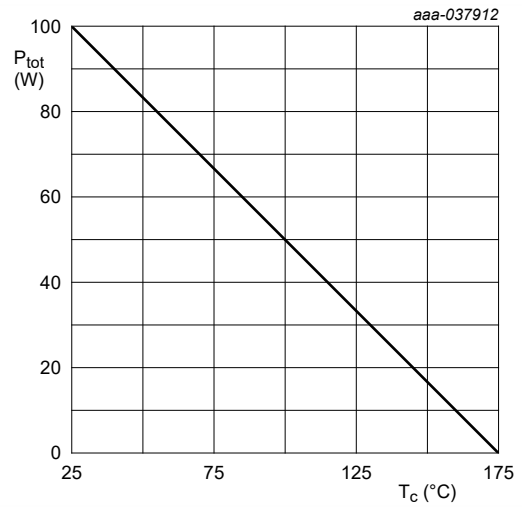
$T_j = 125\text{ }^\circ\text{C}$   
 (1)  $\delta = 0.2$   
 (2)  $\delta = 0.5$   
 (3)  $\delta = 0.8$   
 (4)  $\delta = 0.9$   
 (5)  $\delta = 1$  (DC)

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

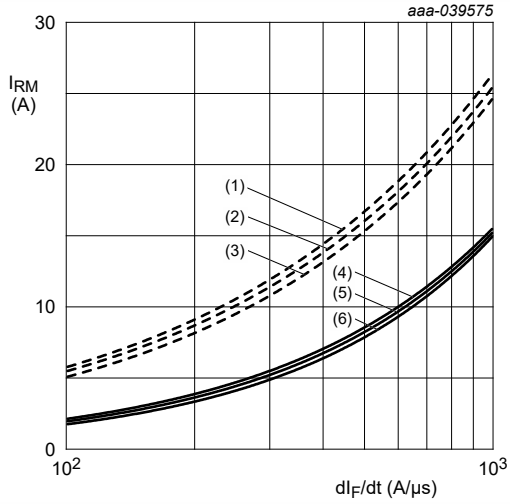


$T_j = 175\text{ }^\circ\text{C}$   
 (1)  $\delta = 1$ ; DC  
 (2)  $\delta = 0.5$ ;  $f = 20\text{ kHz}$   
 (3)  $\delta = 0.2$ ;  $f = 20\text{ kHz}$   
 (4)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$   
 (5) RMS limit

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

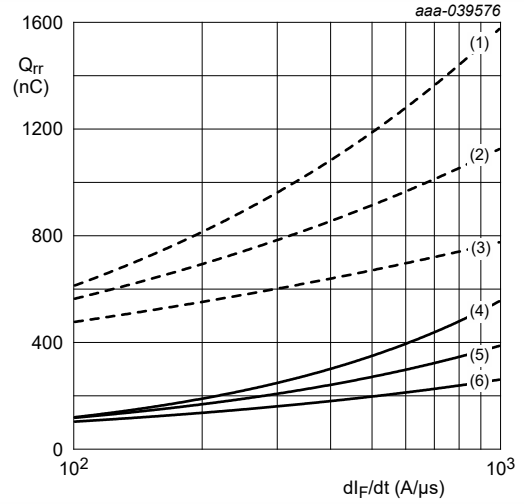


**Fig. 9. Power dissipation as a function of case temperature; maximum values**



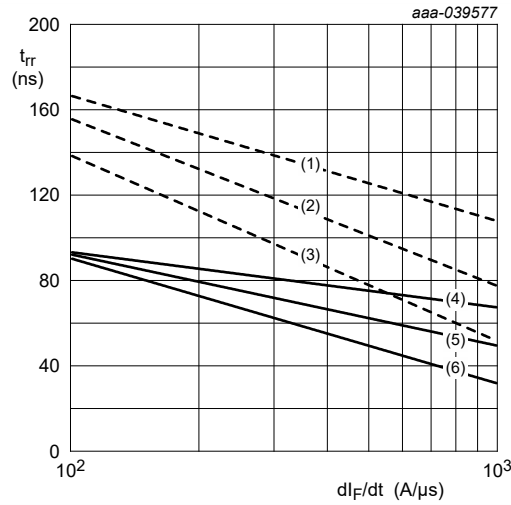
$V_R = 400$  V  
 (1)  $I_F = 40$  A;  $T_j = 125$  °C  
 (2)  $I_F = 20$  A;  $T_j = 125$  °C  
 (3)  $I_F = 10$  A;  $T_j = 125$  °C  
 (4)  $I_F = 40$  A;  $T_j = 25$  °C  
 (5)  $I_F = 20$  A;  $T_j = 25$  °C  
 (6)  $I_F = 10$  A;  $T_j = 25$  °C

**Fig. 10. Peak reverse recovery current as a function of ramp rate; typical values**



$V_R = 400$  V  
 (1)  $I_F = 40$  A;  $T_j = 125$  °C  
 (2)  $I_F = 20$  A;  $T_j = 125$  °C  
 (3)  $I_F = 10$  A;  $T_j = 125$  °C  
 (4)  $I_F = 40$  A;  $T_j = 25$  °C  
 (5)  $I_F = 20$  A;  $T_j = 25$  °C  
 (6)  $I_F = 10$  A;  $T_j = 25$  °C

**Fig. 11. Reverse recovery charge as a function of ramp rate; typical values**



$V_R = 400$  V  
 (1)  $I_F = 40$  A;  $T_j = 125$  °C  
 (2)  $I_F = 20$  A;  $T_j = 125$  °C  
 (3)  $I_F = 10$  A;  $T_j = 125$  °C  
 (4)  $I_F = 40$  A;  $T_j = 25$  °C  
 (5)  $I_F = 20$  A;  $T_j = 25$  °C  
 (6)  $I_F = 10$  A;  $T_j = 25$  °C

**Fig. 12. Reverse recovery time as a function of ramp rate; typical values**



11. Test information

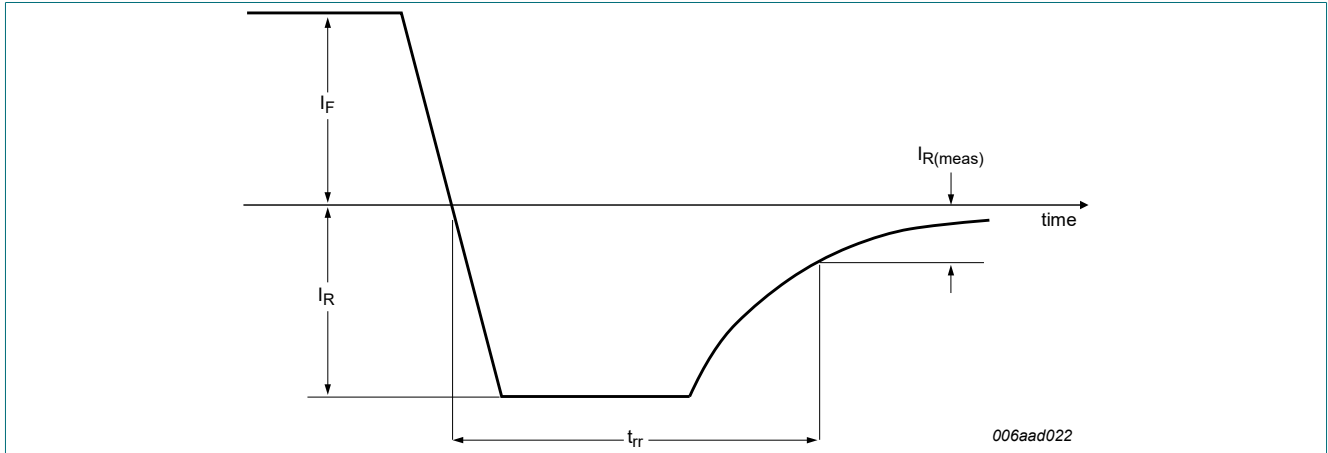


Fig. 13. Reverse recovery definition; step recovery

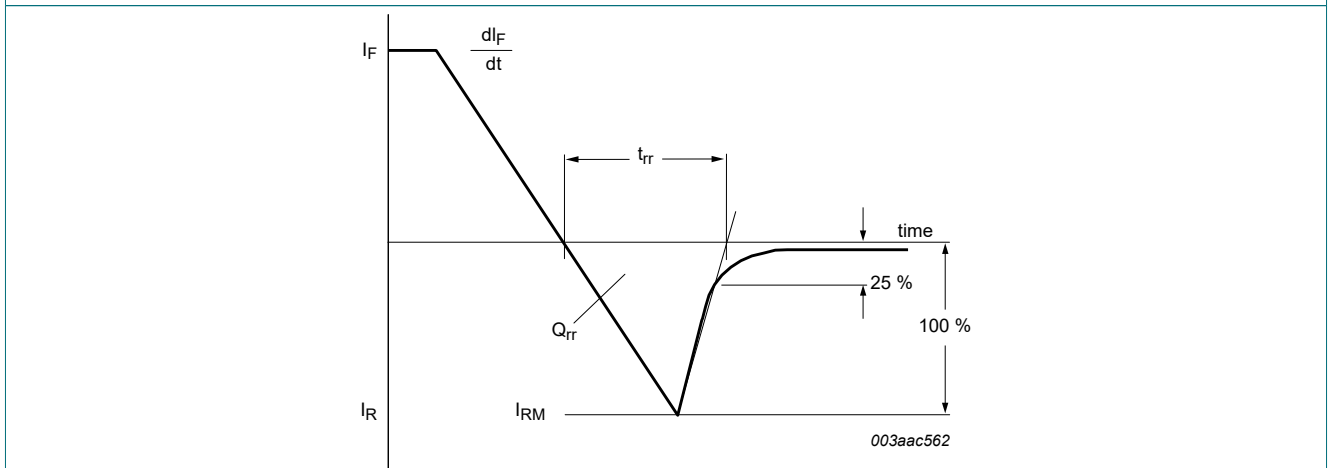


Fig. 14. Reverse recovery definition; ramp recovery

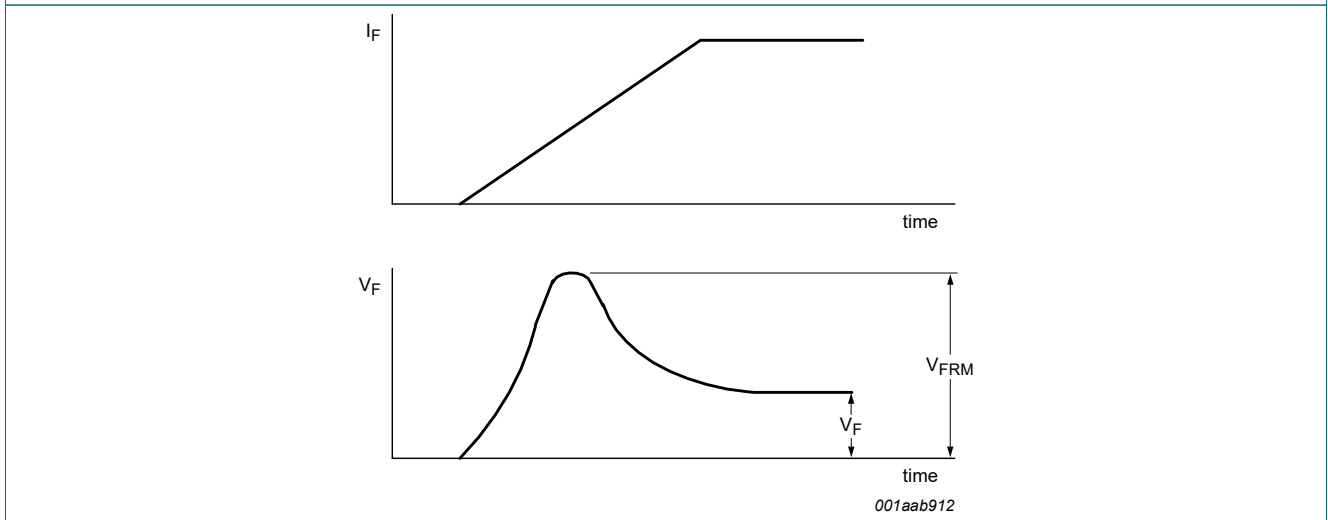


Fig. 15. Forward recovery definition

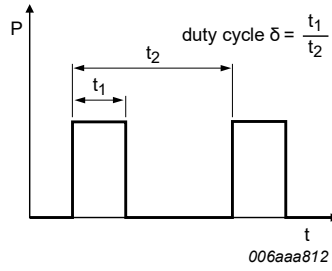


Fig. 16. Duty cycle definition

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

$$I_{RMS} = I_{F(AV)} \text{ at DC, and } I_{RMS} = I_M \times \sqrt{\delta}$$

with  $I_{RMS}$  defined as RMS current.

## 12. Package outline

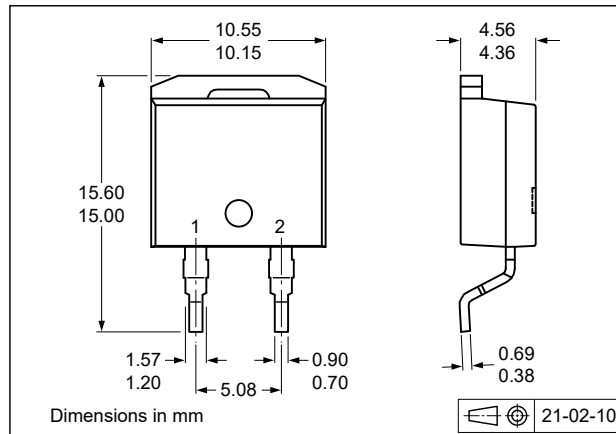
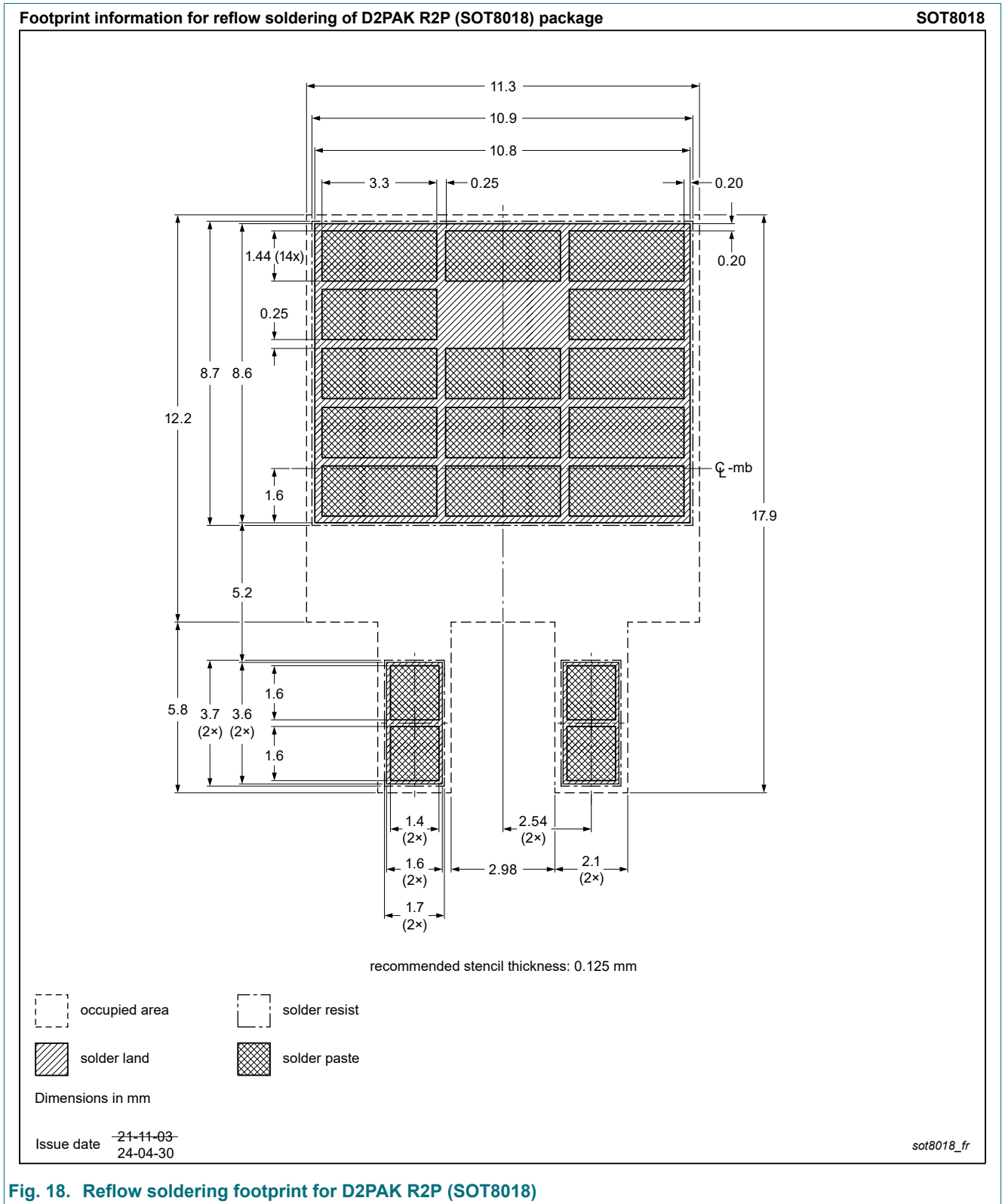


Fig. 17. Package outline D2PAK R2P (SOT8018)

### 13. Soldering



**Fig. 18. Reflow soldering footprint for D2PAK R2P (SOT8018)**

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PNE650200EJ v.2	20240503	Product data sheet	-	PNE650200EJ v.1
Modifications:	• Product status changed			
PNE650200EJ v.1	20240301	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".
- [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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## Contents

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1. General description.....	1
2. Features and benefits.....	1
3. Applications.....	1
4. Quick reference data.....	1
5. Pinning information.....	2
6. Ordering information.....	2
7. Marking.....	2
8. Limiting values.....	3
9. Thermal characteristics.....	4
10. Characteristics.....	5
11. Test information.....	9
12. Package outline.....	10
13. Soldering.....	11
14. Revision history.....	12
15. Legal information.....	13

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Date of release: 3 May 2024

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