



PNU650200EJ-Q

650 V, 20 A ultrafast recovery rectifier

3 May 2024

Product data sheet

1. General description

High power density, ultrafast switching time 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 32 ns
- Pt doped life time control
- Low inductance
- 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

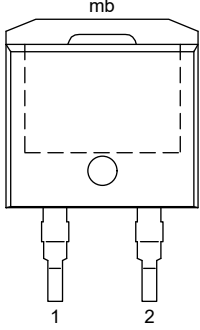
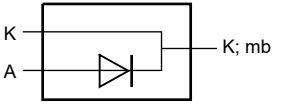
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$I_{F(AV)}$	average forward current	$\delta = 0.5$; $f = 20$ kHz; square wave; $T_c \leq 130$ °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]	-	1.25	1.55	V
		$I_F = 20$ A; pulsed; $T_j = 125$ °C	[1]	-	1.14	1.4	V
		$I_F = 20$ A; pulsed; $T_j = 175$ °C	[1]	-	1.06	-	V
I_R	reverse current	$V_R = 650$ V; pulsed; $T_j = 25$ °C	[1]	-	-	5	μ A
		$V_R = 650$ V; pulsed; $T_j = 125$ °C	[1]	-	2.7	50	μ A
		$V_R = 650$ V; pulsed; $T_j = 175$ °C	[1]	-	47	-	μ 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>D2PAK R2P (SOT8018)</p>	 <p>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
PNU650200EJ-Q	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	SOT8018

7. Marking

Table 4. Marking codes

Type number	Marking code
PNU650200EJ-Q	U65020Q

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	
I_F	forward current	$\delta = 1; T_c \leq 118\text{ °C}$	-	28	A	
$I_{F(AV)}$	average forward current	$\delta = 0.5; f = 20\text{ kHz}$; square wave; $T_c \leq 130\text{ °C}$	-	20	A	
I_{FSM}	non-repetitive peak forward current	$t_p = 8.3\text{ ms}$; single half sine wave (applied at rated load condition); $T_{j(\text{init})} = 25\text{ °C}$	-	209	A	
		$t_p = 10\text{ ms}$; square wave; $T_{j(\text{init})} = 25\text{ °C}$	-	158	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 cm².

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 cm².
- [3] Soldering point of cathode tab.

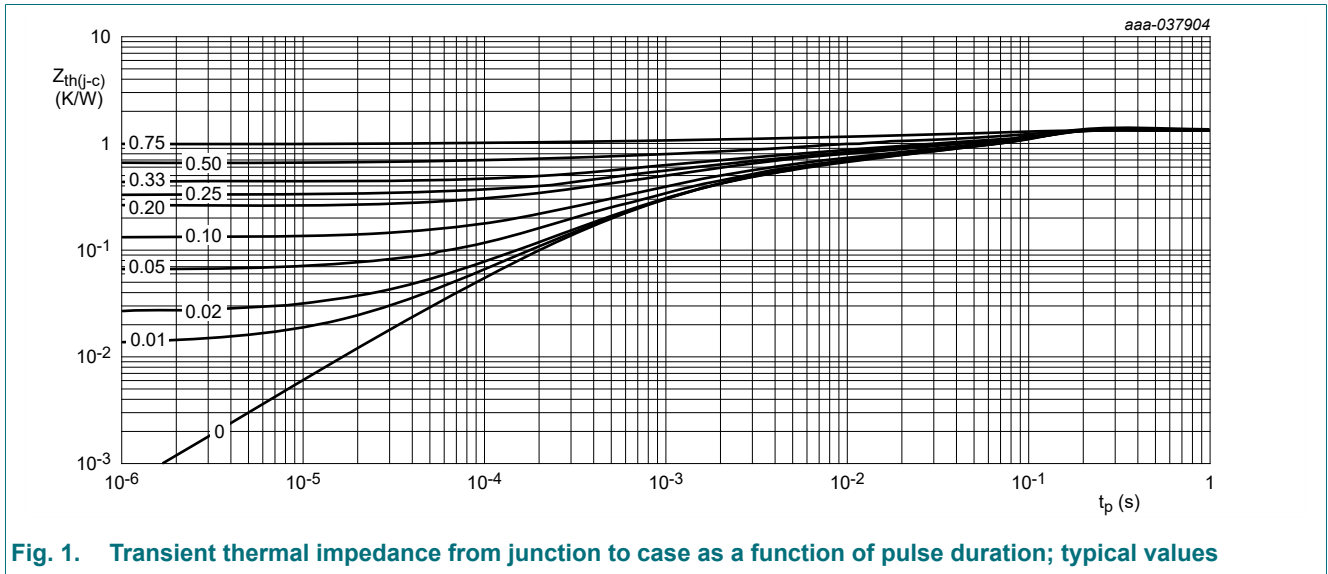


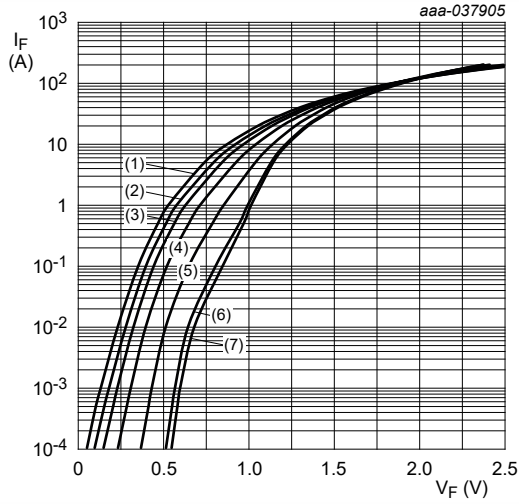
Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

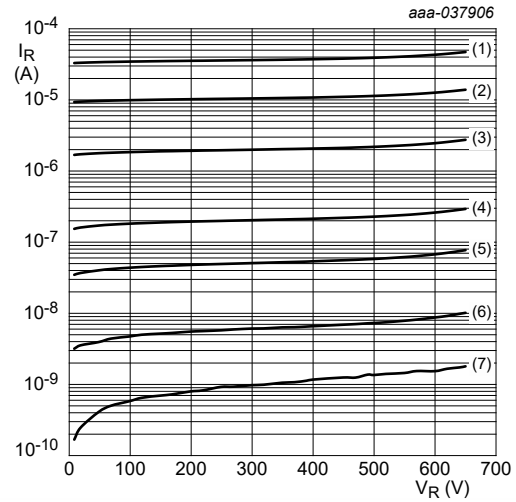
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{(BR)R}$	reverse breakdown voltage	$I_R = 100 \mu\text{A}$; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	650	-	-	V
V_F	forward voltage	$I_F = 20 \text{ A}$; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	-	1.25	1.55	V
		$I_F = 20 \text{ A}$; pulsed; $T_j = 125 \text{ }^\circ\text{C}$	[1]	-	1.14	1.4	V
		$I_F = 20 \text{ A}$; pulsed; $T_j = 175 \text{ }^\circ\text{C}$	[1]	-	1.06	-	V
I_R	reverse current	$V_R = 650 \text{ V}$; pulsed; $T_j = 25 \text{ }^\circ\text{C}$	[1]	-	-	5	μA
		$V_R = 650 \text{ V}$; pulsed; $T_j = 125 \text{ }^\circ\text{C}$	[1]	-	2.7	50	μA
		$V_R = 650 \text{ V}$; pulsed; $T_j = 175 \text{ }^\circ\text{C}$	[1]	-	47	-	μA
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	$I_F = 0.5 \text{ A}$; $I_R = 1 \text{ A}$; $I_{R(\text{meas})} = 0.25 \text{ A}$; $T_j = 25 \text{ }^\circ\text{C}$		-	32	60	ns
	reverse recovery time ; ramp recovery	$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	119	-	ns
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	70	-	ns
		$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	189	-	ns
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	99	-	ns
I_{RM}	peak reverse recovery current	$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	8	-	A
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	24	-	A
		$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	14	-	A
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	37	-	A
Q_{rr}	reverse recovery charge	$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	588	-	nC
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 25 \text{ }^\circ\text{C}$		-	1015	-	nC
		$I_F = 20 \text{ A}$; $di_F/dt = -200 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	1568	-	nC
		$I_F = 20 \text{ A}$; $di_F/dt = -1000 \text{ A}/\mu\text{s}$; $V_R = 400 \text{ V}$; $T_j = 125 \text{ }^\circ\text{C}$		-	2242	-	nC

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



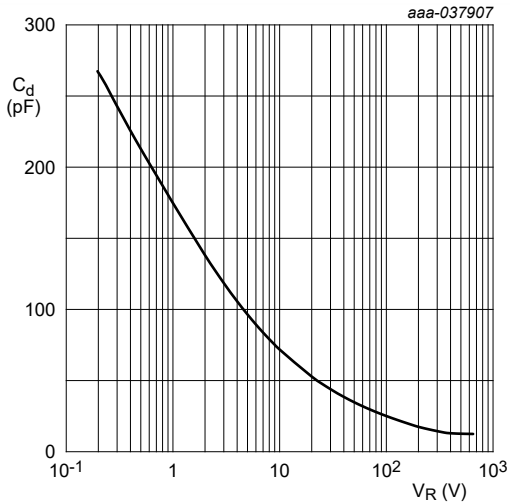
pulsed condition
 (1) $T_j = 175\text{ °C}$
 (2) $T_j = 150\text{ °C}$
 (3) $T_j = 125\text{ °C}$
 (4) $T_j = 85\text{ °C}$
 (5) $T_j = 25\text{ °C}$
 (6) $T_j = -40\text{ °C}$
 (7) $T_j = -55\text{ °C}$

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



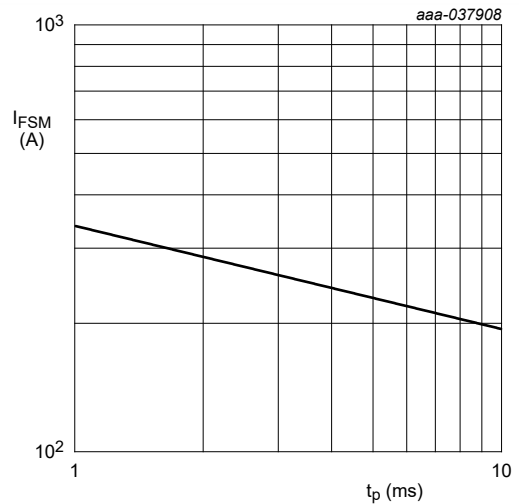
pulsed condition
 (1) $T_j = 175\text{ °C}$
 (2) $T_j = 150\text{ °C}$
 (3) $T_j = 125\text{ °C}$
 (4) $T_j = 100\text{ °C}$
 (5) $T_j = 85\text{ °C}$
 (6) $T_j = 55\text{ °C}$
 (7) $T_j = 25\text{ °C}$

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



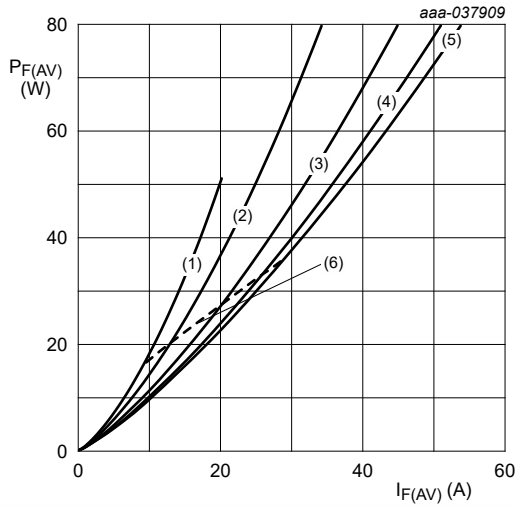
$f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$

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



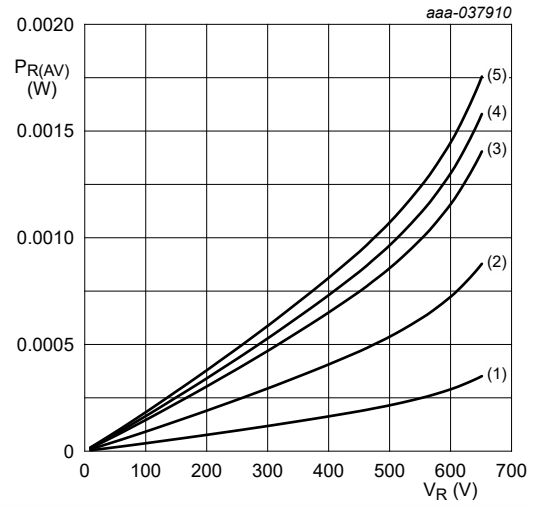
square wave; $T_{amb} = 25\text{ °C}$

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



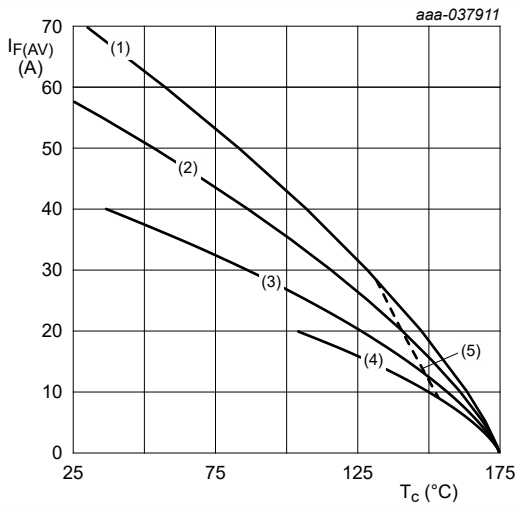
$T_j = 125\text{ °C}$
 (1) $\delta = 0.1$
 (2) $\delta = 0.2$
 (3) $\delta = 0.5$
 (4) $\delta = 0.8$
 (5) $\delta = 1$ (DC)
 (6) RMS limit

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



$T_j = 125\text{ °C}$
 (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



$T_j = 175\text{ °C}$
 (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

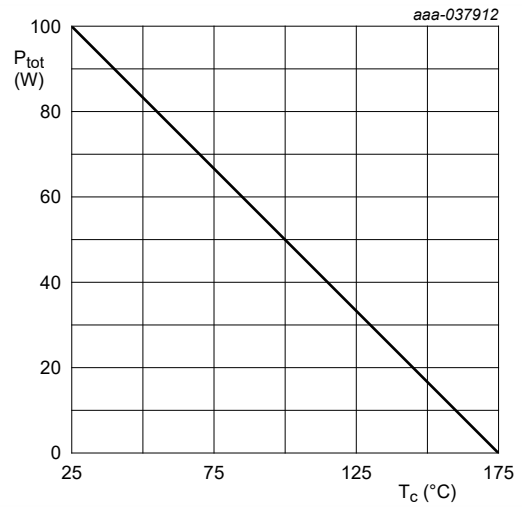
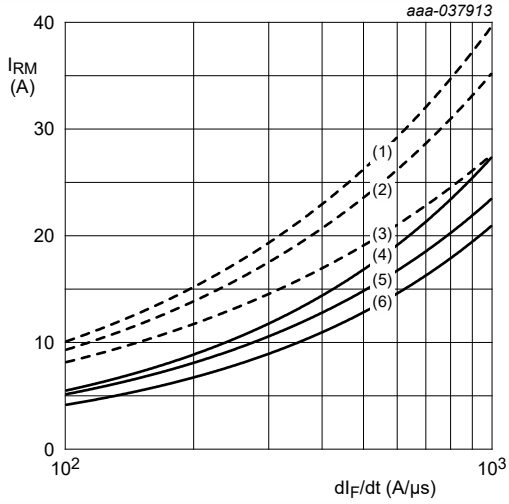
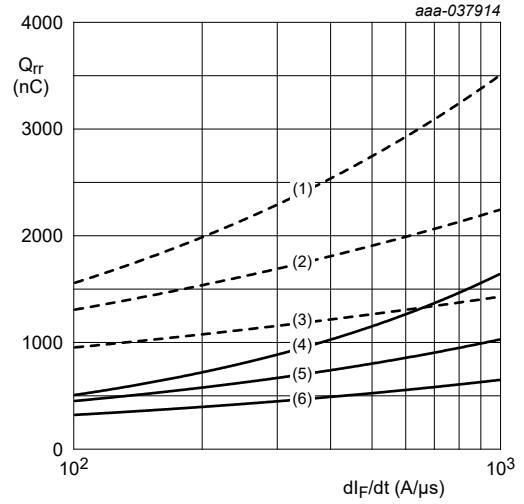


Fig. 9. Power dissipation as a function of case temperature; maximum values



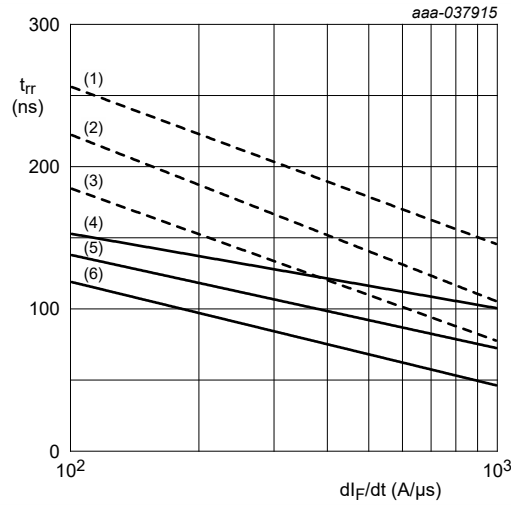
$V_R = 400$ V
 (1) $I_F = 40$ A; $T_j = 125$ °C
 (2) $I_F = 20$ A; $T_j = 125$ °C
 (3) $I_F = 10$ A; $T_j = 125$ °C
 (4) $I_F = 40$ A; $T_j = 25$ °C
 (5) $I_F = 20$ A; $T_j = 25$ °C
 (6) $I_F = 10$ A; $T_j = 25$ °C

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

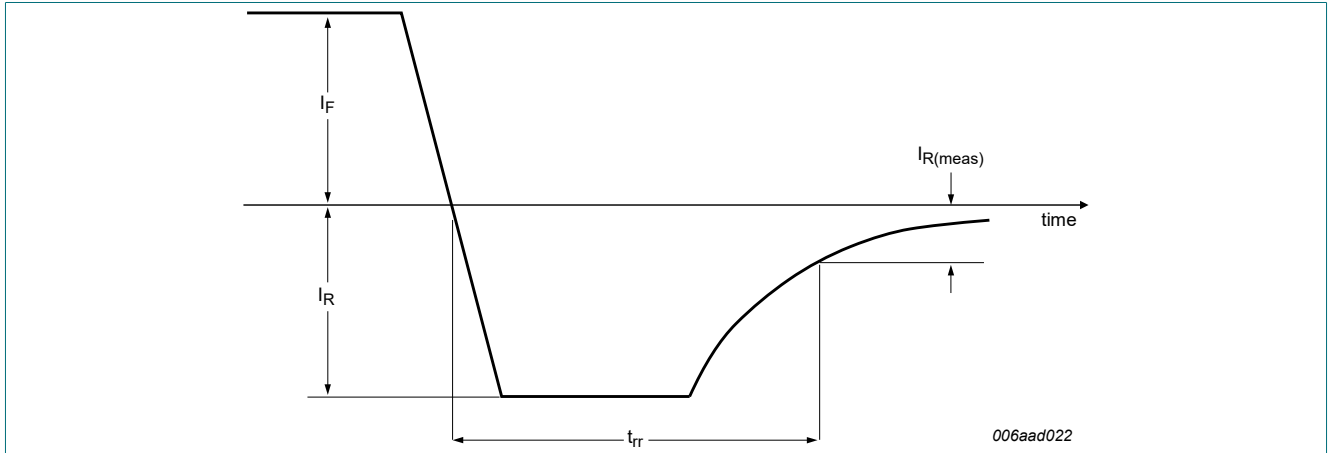


Fig. 13. Reverse recovery definition; step recovery

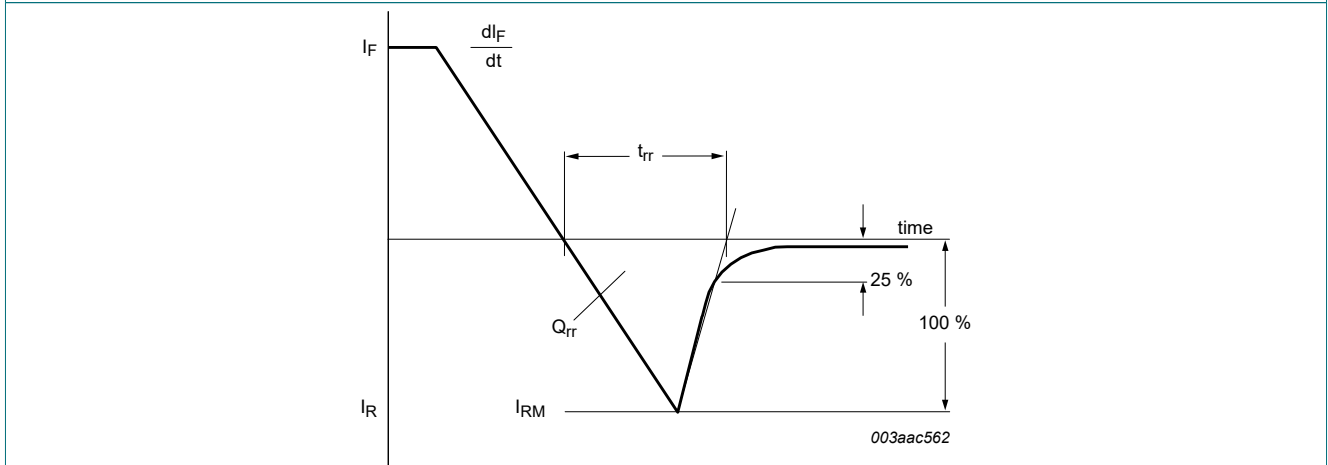


Fig. 14. Reverse recovery definition; ramp recovery

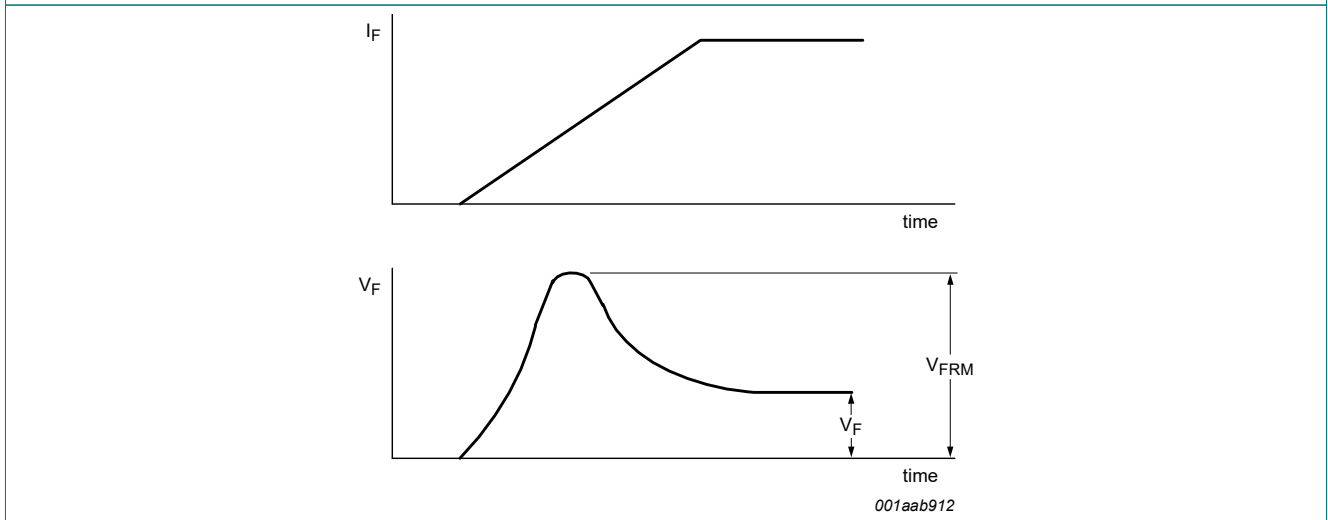


Fig. 15. Forward recovery definition

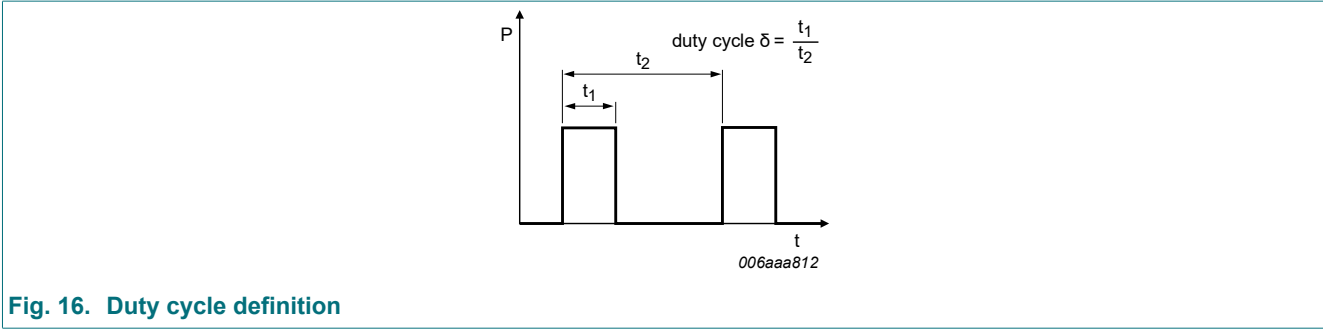


Fig. 16. Duty cycle definition

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.

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

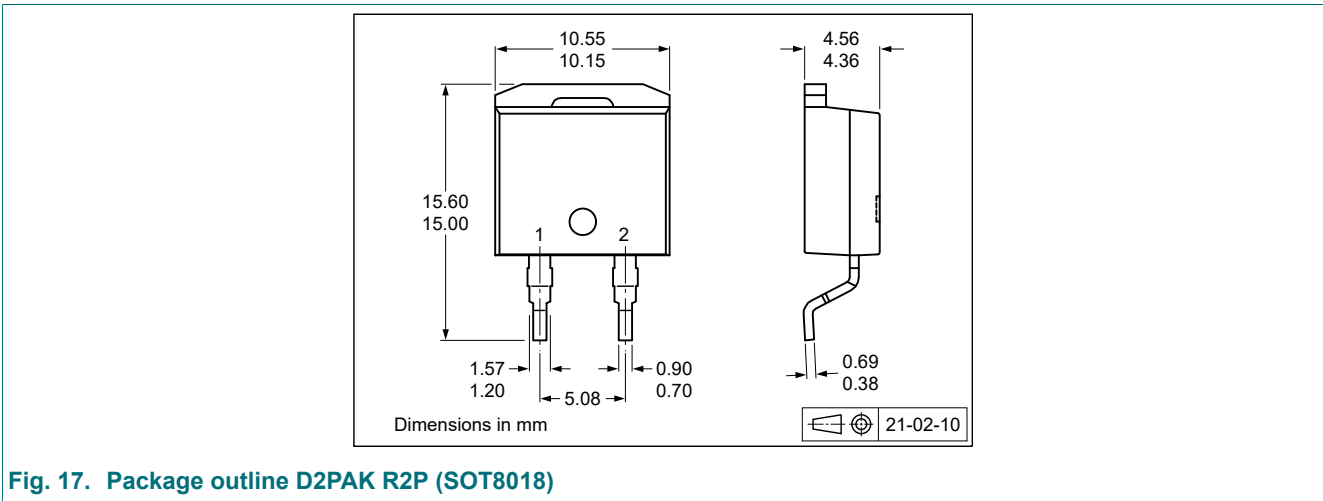


Fig. 17. Package outline D2PAK R2P (SOT8018)

13. Soldering

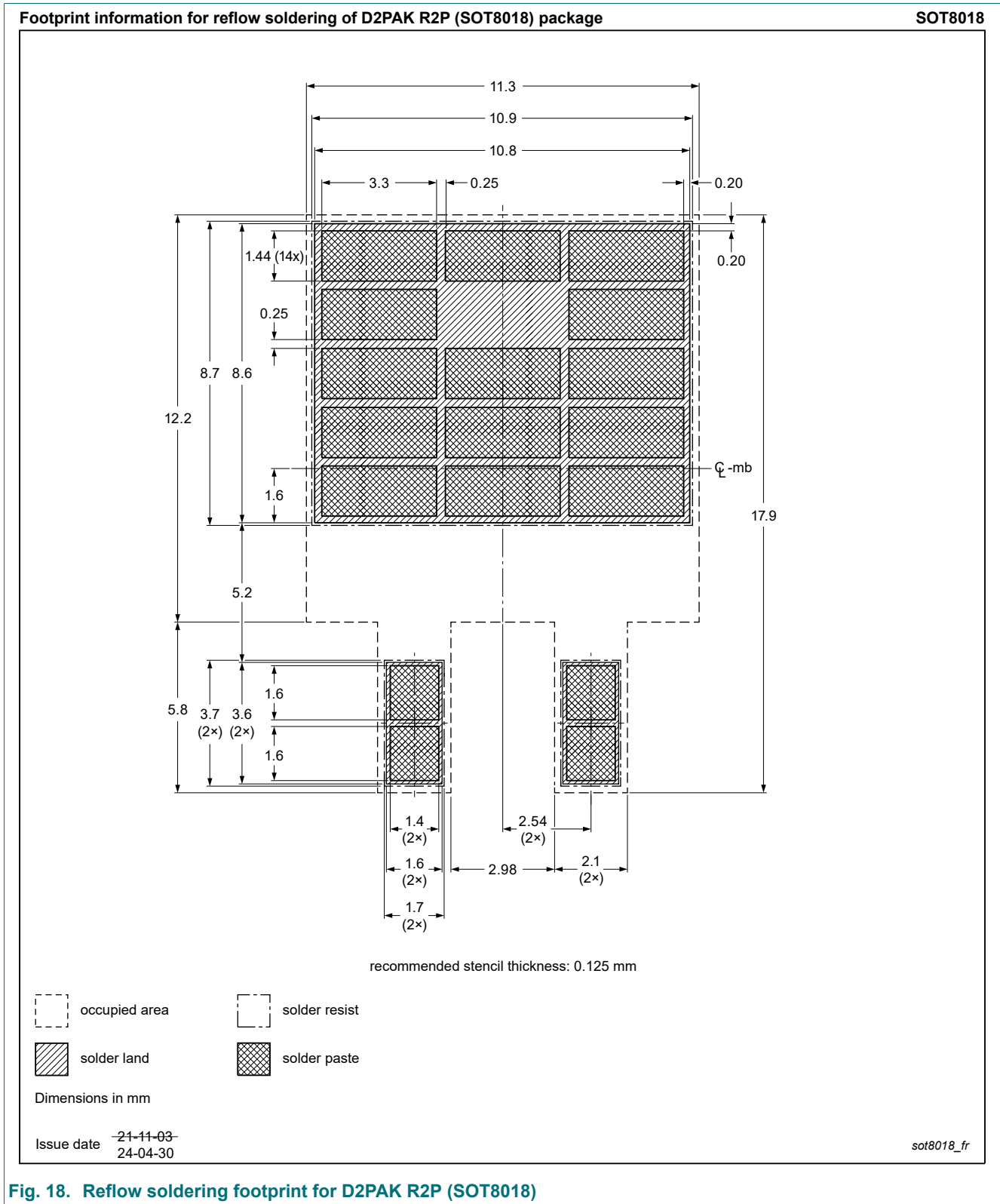


Fig. 18. Reflow soldering footprint for D2PAK R2P (SOT8018)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PNU650200EJ-Q v.2	20240503	Product data sheet	-	PNU650200EJ-Q v.1
Modifications:	• Product status changed			
PNU650200EJ -Q v.1	20240117	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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