PNE650200EJ-Q

650 V, 20 A hyperfast recovery rectifier

8 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_{rr} of 20 ns
- Pt doped life time control
- Low inductance
- 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

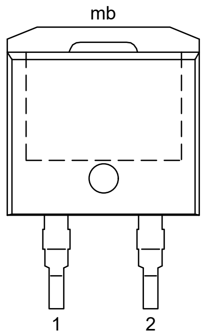
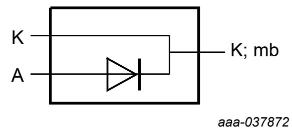
Table 1. Quick reference data

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	µA
		V_R = 650 V; pulsed; T_j = 125 °C	[1]	-	4.2	50	µA
		V_R = 650 V; pulsed; T_j = 175 °C	[1]	-	81.6	-	µA

[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	 D2PAK R2P (SOT8018)	
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
PNE650200EJ-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
PNE650200EJ-Q	E65020Q

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 °C		-	650	V
V_R	reverse voltage			-	650	V
V_{RMS}	RMS voltage			-	460	V
I_F	forward current	δ = 1; T_c ≤ 106 °C		-	28	A
$I_{F(AV)}$	average forward current	δ = 0.5; f = 20 kHz; square wave; T_c ≤ 119 °C		-	20	A
I_{FSM}	non-repetitive peak forward current	t_p = 8.3 ms; single half sine wave (applied at rated load condition); $T_{j(init)}$ = 25 °C		-	173	A
		t_p = 10 ms; square wave; $T_{j(init)}$ = 25 °C		-	143	A
P_{tot}	total power dissipation	T_c ≤ 25 °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^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]	-	-	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^2.
[3] Soldering point of cathode tab.

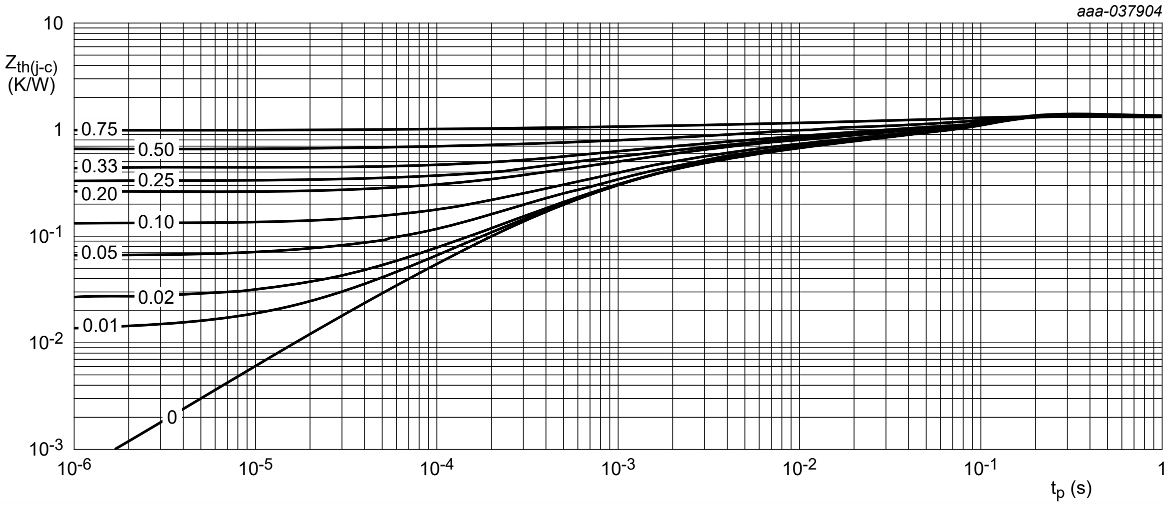


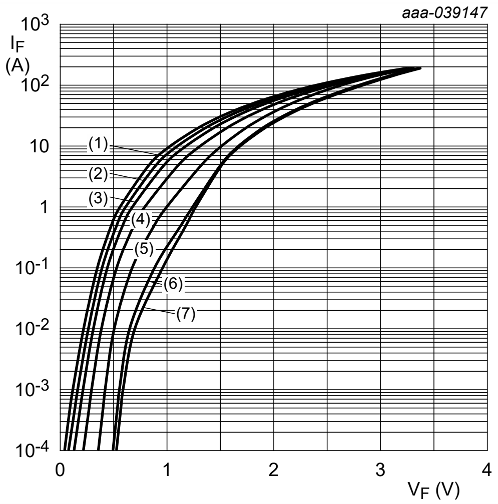
Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

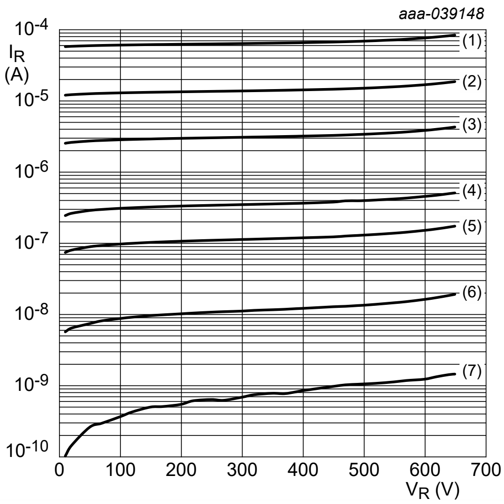
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{(BR)R}$	reverse breakdown voltage	I_R = 100 µA; pulsed; T_j = 25 °C	[1]	650	-	-	V
V_F	forward voltage	I_F = 20 A; pulsed; T_j = 25 °C	[1]	-	1.73	2.4	V
		I_F = 20 A; pulsed; T_j = 125 °C	[1]	-	1.42	1.93	V
		I_F = 20 A; pulsed; T_j = 175 °C	[1]	-	1.28	-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

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



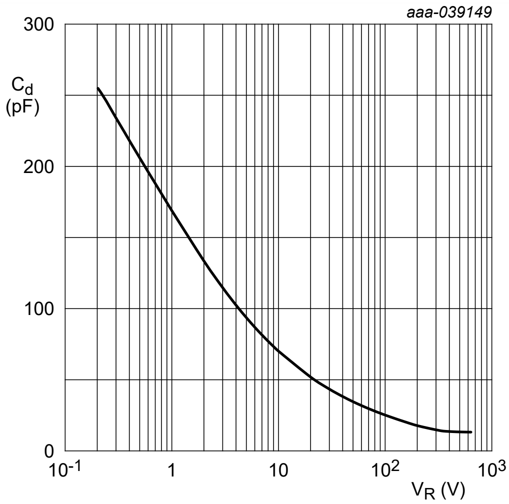
pulsed condition
(1) T_j = 175 °C
(2) T_j = 150 °C
(3) T_j = 125 °C
(4) T_j = 85 °C
(5) T_j = 25 °C
(6) T_j = -40 °C
(7) T_j = -55 °C

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



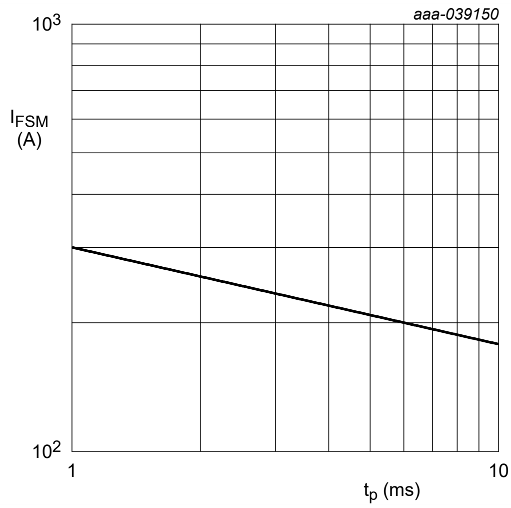
pulsed condition
(1) T_j = 175 °C
(2) T_j = 150 °C
(3) T_j = 125 °C
(4) T_j = 100 °C
(5) T_j = 85 °C
(6) T_j = 55 °C
(7) T_j = 25 °C

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



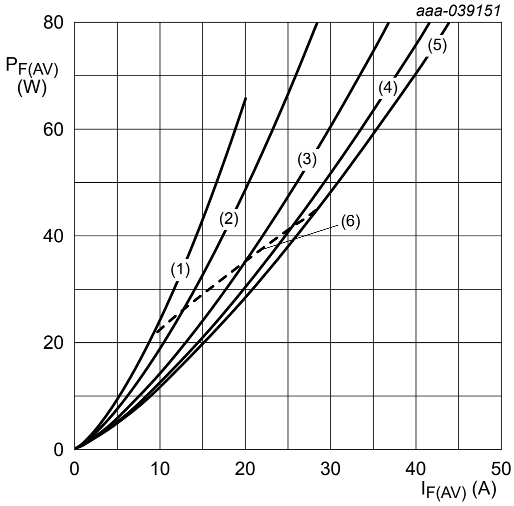
f = 1 MHz; T_{amb} = 25 °C

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



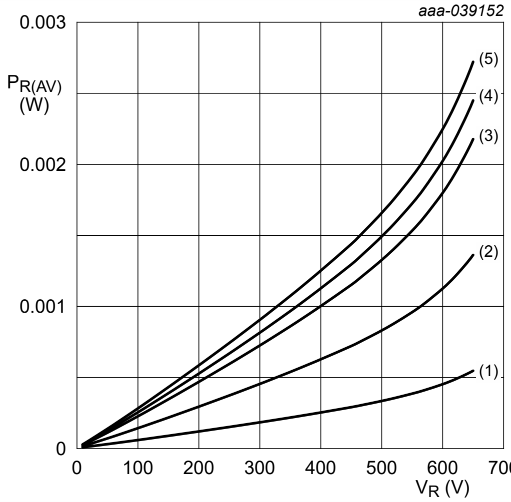
square wave; T_{amb} = 25 °C

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



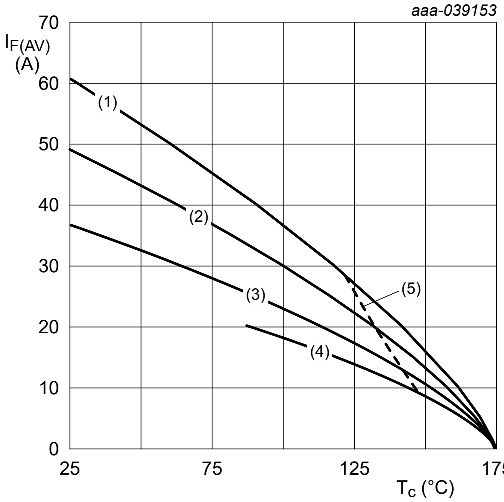
T_j = 125 °C
(1) δ = 0.1
(2) δ = 0.2
(3) δ = 0.5
(4) δ = 0.8
(5) δ = 1 (DC)
(6) RMS limit

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



T_j = 125 °C
(1) δ = 0.2
(2) δ = 0.5
(3) δ = 0.8
(4) δ = 0.9
(5) δ = 1 (DC)

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



T_j = 175 °C
(1) δ = 1; DC
(2) δ = 0.5; f = 20 kHz
(3) δ = 0.2; f = 20 kHz
(4) δ = 0.1; f = 20 kHz
(5) RMS limit

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

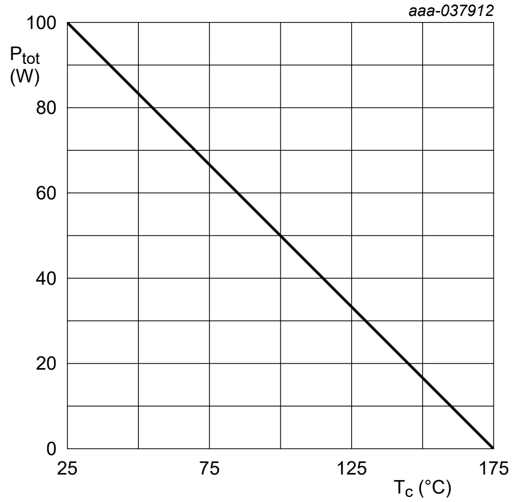
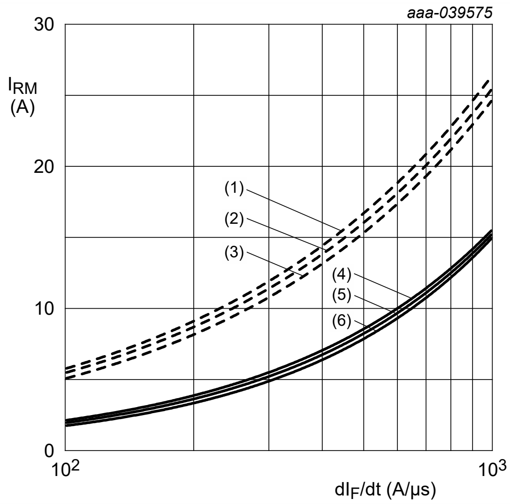
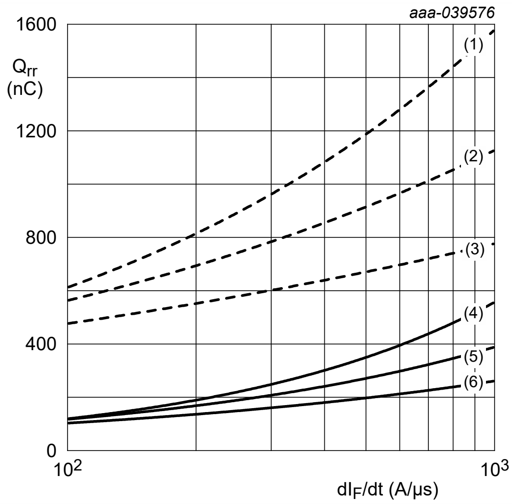


Fig. 9. Power dissipation as a function of case temperature; maximum values



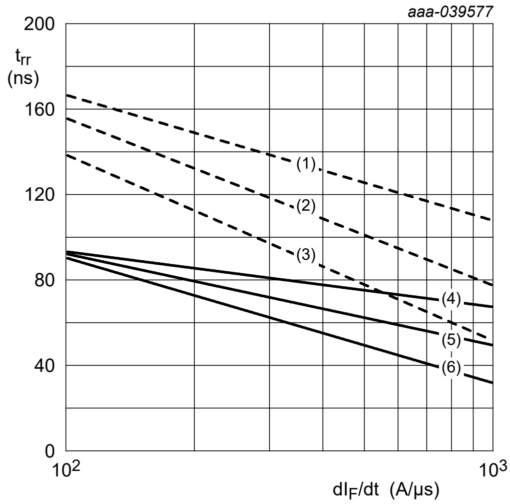
V_R = 400 V
(1) I_F = 40 A; T_j = 125 °C
(2) I_F = 20 A; T_j = 125 °C
(3) I_F = 10 A; T_j = 125 °C
(4) I_F = 40 A; T_j = 25 °C
(5) I_F = 20 A; T_j = 25 °C
(6) I_F = 10 A; T_j = 25 °C

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

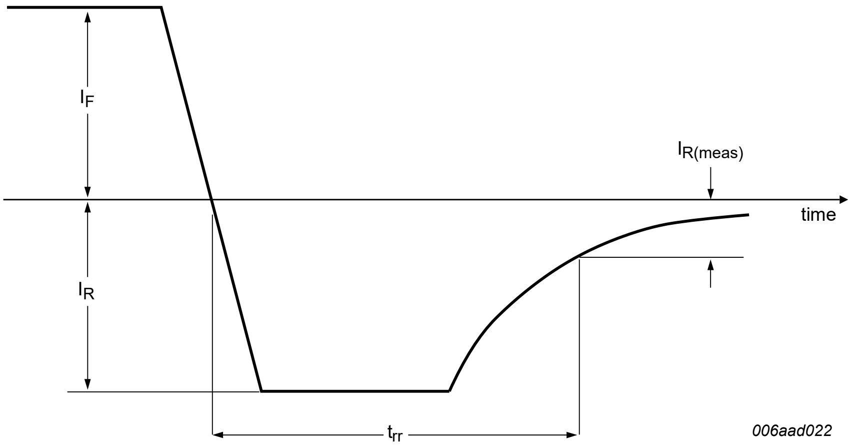


Fig. 13. Reverse recovery definition; step recovery

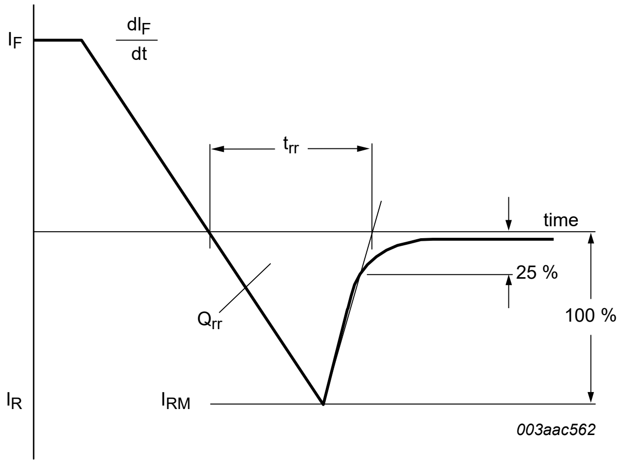


Fig. 14. Reverse recovery definition; ramp recovery

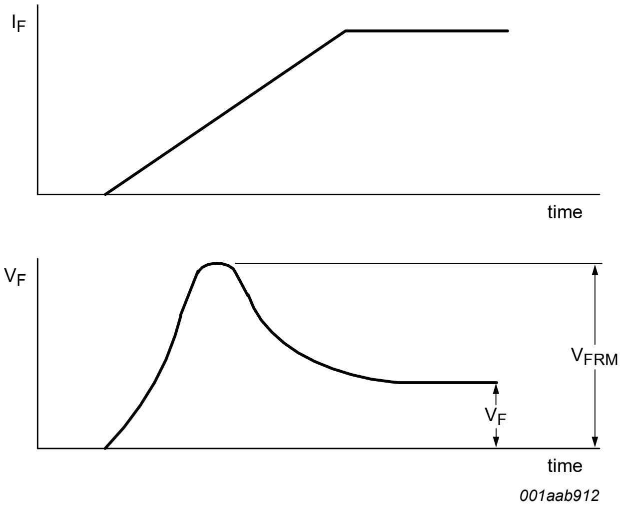


Fig. 15. Forward recovery definition

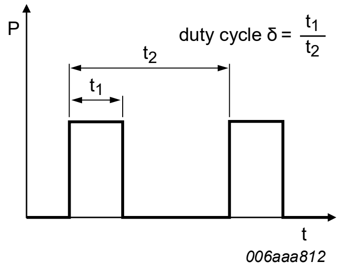


Fig. 16. Duty cycle definition

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

$I_{RMS}=I_{F(AV)}$ 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

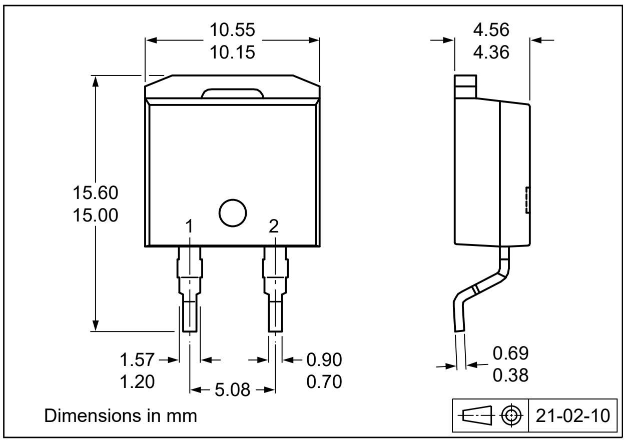


Fig. 17. Package outline D2PAK R2P (SOT8018)

13. Soldering

Footprint information for reflow soldering of D2PAK R2P (SOT8018) package **SOT8018**

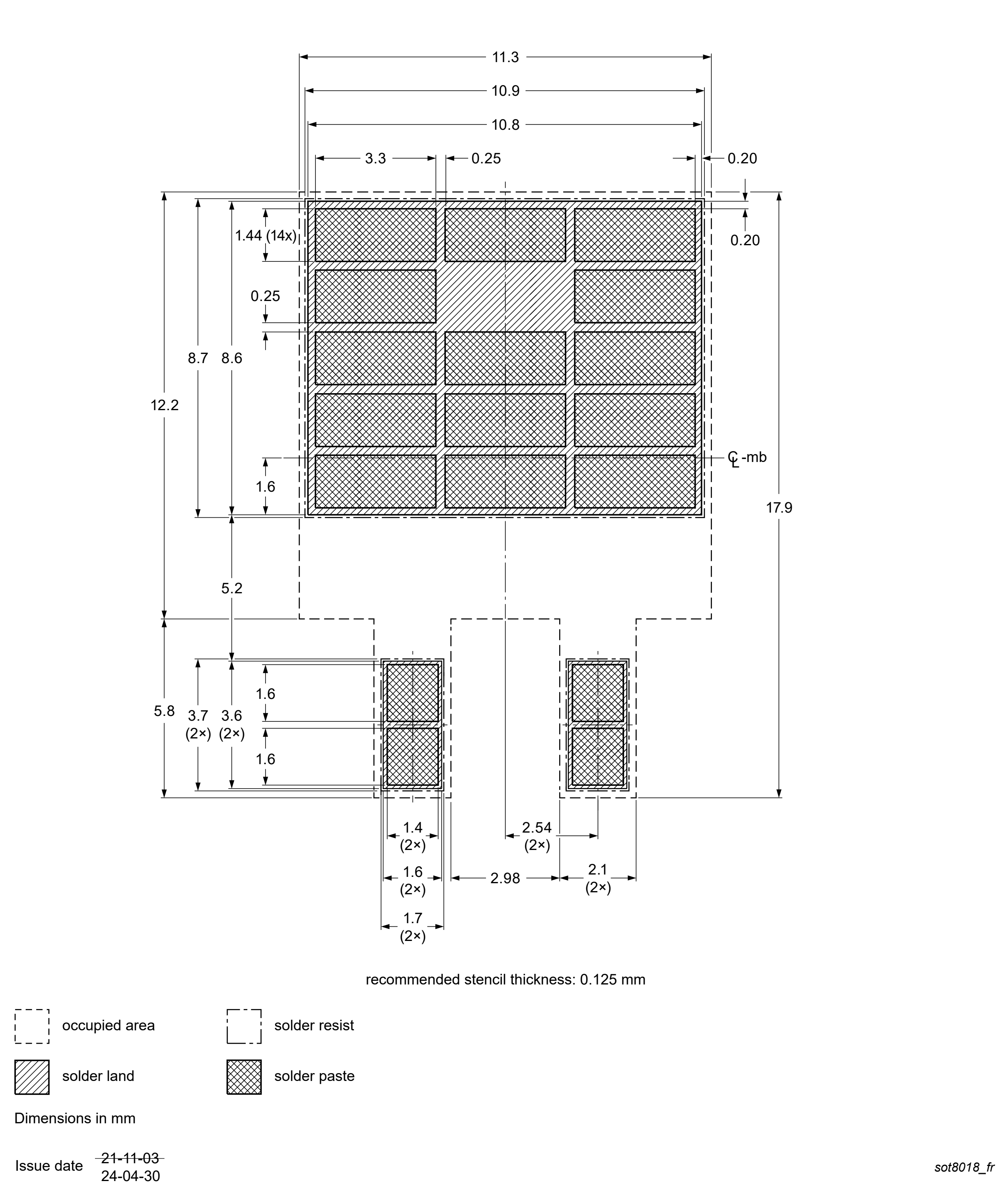


Fig. 18. Reflow soldering footprint for D2PAK R2P (SOT8018)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
PNE650200EJ-Q v.3	20240508	Product data sheet	-	PNE650200EJ-Q v.2
Modifications:	• Characteristics: Temperatures added in conditions at t_{rr}			
PNE650200EJ-Q v.2	20240503	Product data sheet	-	PNE650200EJ-Q v.1
PNE650200EJ-Q 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".
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Contents

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Date of release: 8 May 2024