



# PNE20040EP-Q

200 V, 4 A hyperfast switching recovery rectifier

21 November 2022

Product data sheet

## 1. General description

High power density, hyperfast switching time recovery rectifier with high-efficiency planar technology, encapsulated in a CFP5 (SOD128) small and flat lead Surface-Mounted Device (SMD) plastic package.

## 2. Features and benefits

- Reverse voltage:  $V_R \leq 200$  V
- Forward current:  $I_F \leq 4$  A
- Switching time:  $t_{rr} \leq 30$  ns
- Planar die design
- Pt doped life time control
- Low inductance
- Power and flat lead SMD plastic package
- High power capability due to clip-bond technology
- Qualified according to AEC-Q101 and recommended for use in automotive applications

## 3. Applications

- General-purpose rectification
- Reverse polarity protection
- Hyperfast switching
- Freewheeling applications
- Engine Control Unit (ECU)

## 4. Quick reference data

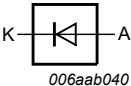
Table 1. Quick reference data

| Symbol      | Parameter                       | Conditions                                                       |     | Min | Typ | Max | Unit |
|-------------|---------------------------------|------------------------------------------------------------------|-----|-----|-----|-----|------|
| $I_{F(AV)}$ | average forward current         | $\delta = 0.5$ ; $f = 20$ kHz; square wave; $T_{sp} \leq 158$ °C |     | -   | -   | 4   | A    |
| $V_{RRM}$   | repetitive peak reverse voltage | $T_j = 25$ °C                                                    |     | -   | -   | 200 | V    |
| $V_R$       | reverse voltage                 |                                                                  |     | -   | -   | 200 | V    |
| $V_F$       | forward voltage                 | $I_F = 4$ A; pulsed; $T_j = 25$ °C                               | [1] | -   | 860 | 930 | mV   |
|             |                                 | $I_F = 4$ A; pulsed; $T_j = 125$ °C                              | [1] | -   | 720 | 780 | mV   |
| $I_R$       | reverse current                 | $V_R = 200$ V; pulsed; $T_j = 25$ °C                             | [1] | -   | -   | 1   | µA   |
|             |                                 | $V_R = 200$ V; pulsed; $T_j = 125$ °C                            | [1] | -   | 1.5 | 10  | 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     | <br>CFP5 (SOD128) | <br>006aab040 |
| 2   | A      | anode       |                                                                                                    |                                                                                                  |

6. Ordering information

Table 3. Ordering information

| Type number                  | Package |                                                                                        |                        |
|------------------------------|---------|----------------------------------------------------------------------------------------|------------------------|
|                              | Name    | Description                                                                            | Version                |
| <a href="#">PNE20040EP-Q</a> | CFP5    | plastic, surface mounted package; 2 terminals; 4 mm pitch; 3.8 mm x 2.6 mm x 1 mm body | <a href="#">SOD128</a> |

7. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| PNE20040EP-Q | ET           |

8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC60134)

| Symbol          | Parameter                           | Conditions                                                                                                                      |     | Min | Max  | Unit               |
|-----------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|--------------------|
| $V_R$           | reverse voltage                     | $T_j = 25\text{ }^{\circ}\text{C}$                                                                                              |     | -   | 200  | V                  |
| $V_{RRM}$       | repetitive peak reverse voltage     |                                                                                                                                 |     | -   | 200  | V                  |
| $V_{R(RMS)lim}$ | limiting RMS reverse voltage        |                                                                                                                                 |     | -   | 140  | V                  |
| $I_F$           | forward current                     | $\delta = 1; T_{sp} \leq 153\text{ }^{\circ}\text{C}$                                                                           |     | -   | 5.6  | A                  |
| $I_{F(AV)}$     | average forward current             | $\delta = 0.5; f = 20\text{ kHz}; \text{square wave}; T_{sp} \leq 158\text{ }^{\circ}\text{C}$                                  |     | -   | 4    | A                  |
| $I_{FSM}$       | non-repetitive peak forward current | $t_p = 8.3\text{ ms}; \text{single half sine wave (applied at rated load condition)}; T_{j(init)} = 25\text{ }^{\circ}\text{C}$ |     | -   | 80   | A                  |
| $P_{tot}$       | total power dissipation             | $T_{amb} \leq 25\text{ }^{\circ}\text{C}$                                                                                       | [1] | -   | 0.81 | W                  |
|                 |                                     |                                                                                                                                 | [2] | -   | 1.3  | W                  |
| $T_j$           | 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 an FR4 Printed-Circuit Board (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 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] | -   | -   | 185 | K/W  |
|                |                                                  |             | [2] | -   | -   | 115 | K/W  |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point |             | [3] | -   | -   | 8   | 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 cm<sup>2</sup>.  
[3] Soldering point of mounting base.

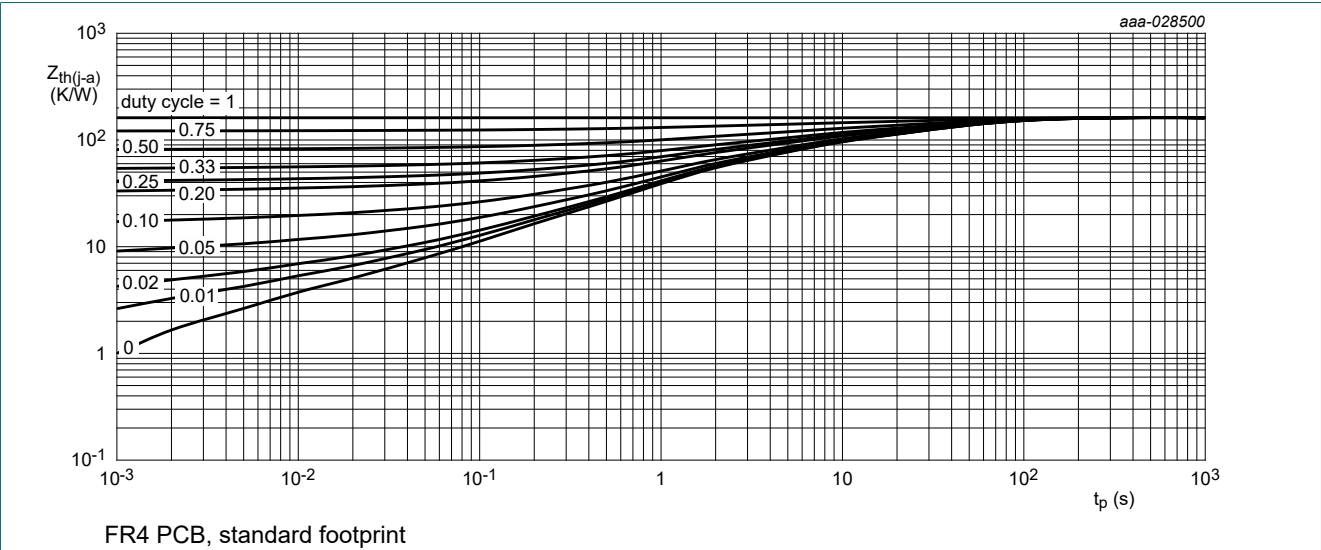


Fig. 1. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

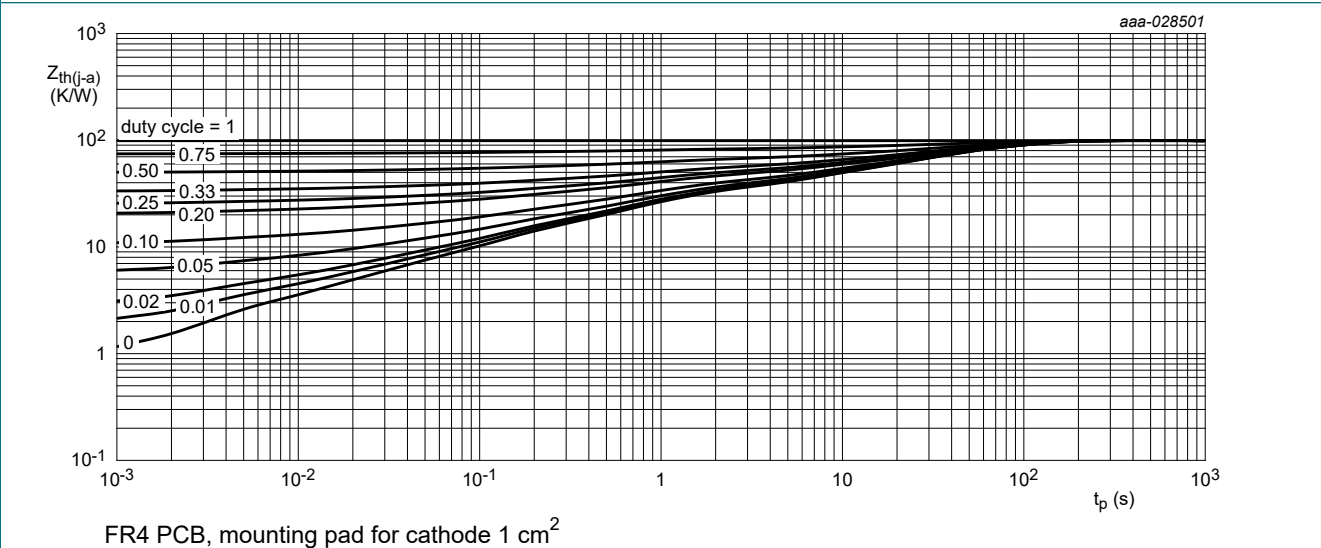


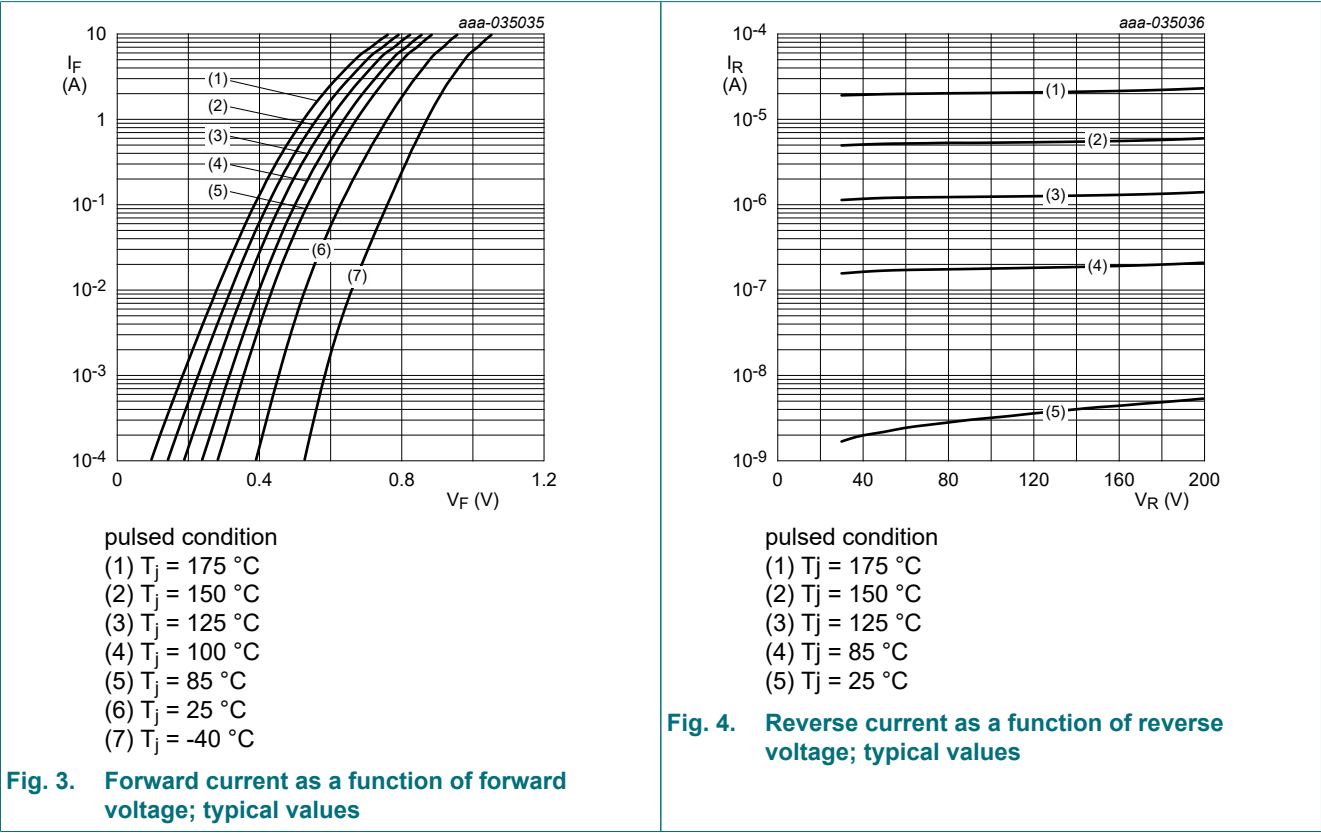
Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

| Symbol      | Parameter                           | Conditions                                                                                                          |     | Min | Typ | Max | Unit          |
|-------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|---------------|
| $V_{(BR)R}$ | reverse breakdown voltage           | $I_R = 100\text{ }\mu\text{A}$ ; $T_j = 25\text{ }^\circ\text{C}$                                                   | [1] | 200 | -   | -   | V             |
| $V_F$       | forward voltage                     | $I_F = 4\text{ A}$ ; pulsed; $T_j = 25\text{ }^\circ\text{C}$                                                       | [1] | -   | 860 | 930 | mV            |
|             |                                     | $I_F = 4\text{ A}$ ; pulsed; $T_j = 125\text{ }^\circ\text{C}$                                                      | [1] | -   | 720 | 780 | mV            |
| $I_R$       | reverse current                     | $V_R = 200\text{ V}$ ; pulsed; $T_j = 25\text{ }^\circ\text{C}$                                                     | [1] | -   | -   | 1   | $\mu\text{A}$ |
|             |                                     | $V_R = 200\text{ V}$ ; pulsed; $T_j = 125\text{ }^\circ\text{C}$                                                    | [1] | -   | 1.5 | 10  | $\mu\text{A}$ |
| $C_d$       | diode capacitance                   | $V_R = 4\text{ V}$ ; $f = 1\text{ MHz}$ ; $T_j = 25\text{ }^\circ\text{C}$                                          |     | -   | 55  | -   | pF            |
| $t_{rr}$    | reverse recovery time step recovery | $I_F = 0.5\text{ A}$ ; $I_R = 1\text{ A}$ ; $I_{R(\text{meas})} = 0.25\text{ A}$ ; $T_j = 25\text{ }^\circ\text{C}$ |     | -   | 13  | 30  | ns            |
|             | reverse recovery time ramp recovery | $dI_F/dt = 100\text{ A}/\mu\text{s}$ ; $I_F = 1\text{ A}$ ; $V_R = 30\text{ V}$ ; $T_j = 25\text{ }^\circ\text{C}$  |     | -   | 17  | -   | ns            |
| $I_{RM}$    | peak reverse recovery current       |                                                                                                                     |     | -   | 1   | -   | A             |
| $Q_{rr}$    | reverse recovery charge             |                                                                                                                     |     | -   | 9   | -   | nC            |
| $V_{FRM}$   | peak forward recovery voltage       | $I_F = 1\text{ A}$ ; $dI_F/dt = 50\text{ A}/\mu\text{s}$ ; $T_j = 25\text{ }^\circ\text{C}$                         |     | -   | 770 | -   | mV            |

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



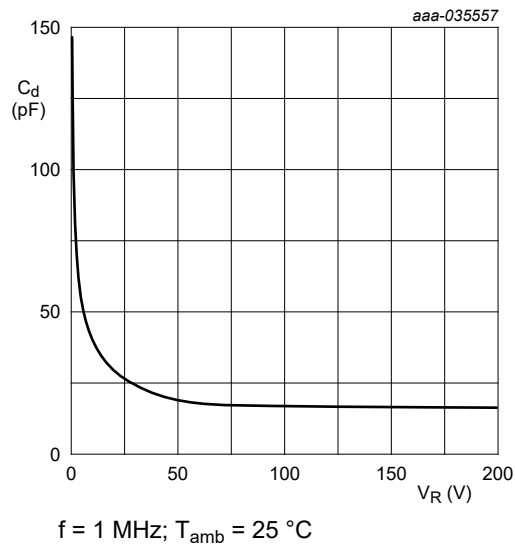


Fig. 5. Diode capacitance as a function of reverse voltage; typical values

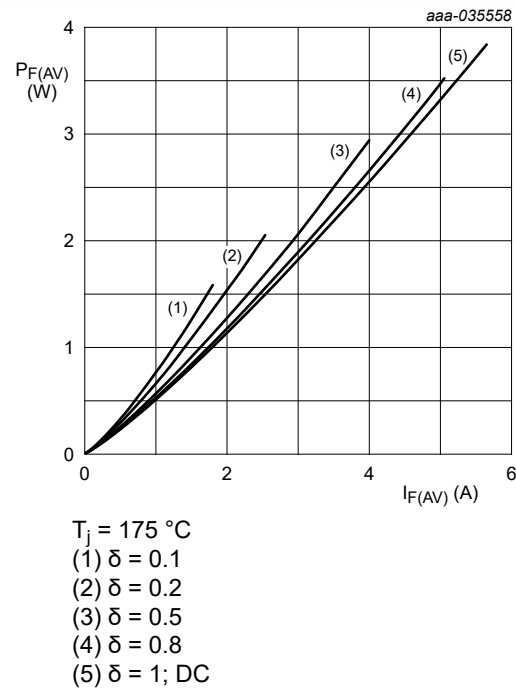


Fig. 6. Average forward power dissipation as a function of average forward current; typical values

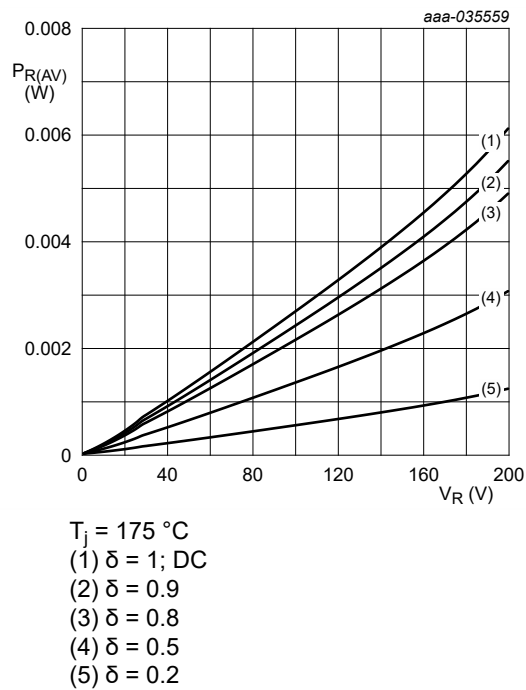


Fig. 7. Average reverse power dissipation as a function of reverse voltage; typical values

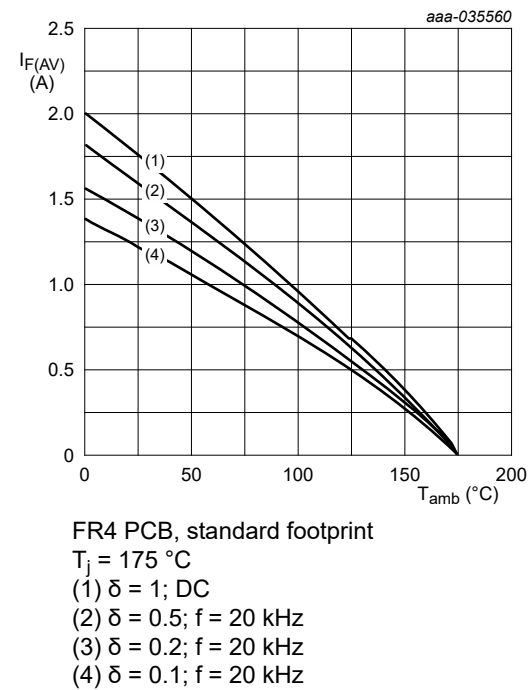
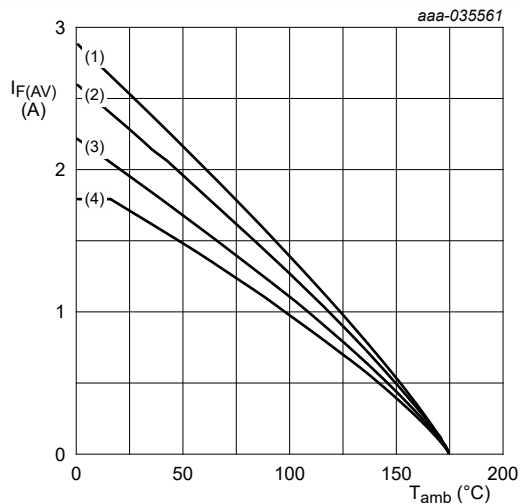
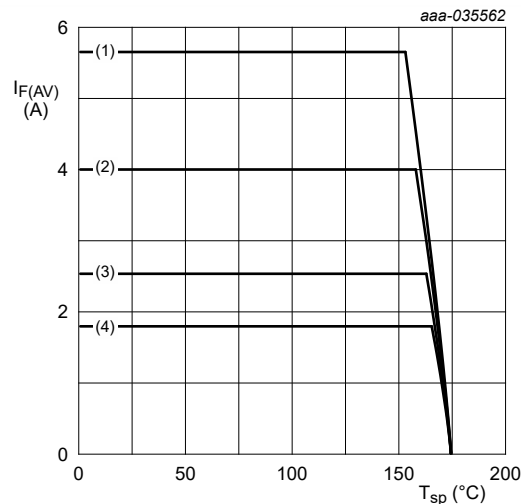


Fig. 8. Average forward current as a function of ambient temperature; typical values



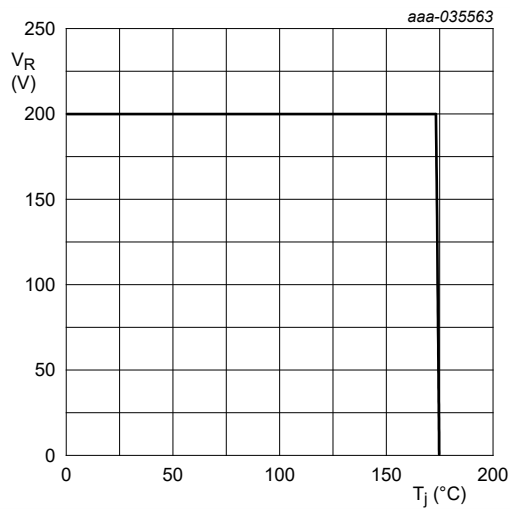
FR4 PCB, mounting pad for cathode 1 cm<sup>2</sup>  
 $T_j = 175$  °C  
(1)  $\delta = 1$ ; DC  
(2)  $\delta = 0.5$ ;  $f = 20$  kHz  
(3)  $\delta = 0.2$ ;  $f = 20$  kHz  
(4)  $\delta = 0.1$ ;  $f = 20$  kHz

Fig. 9. Average forward current as a function of ambient temperature; typical values



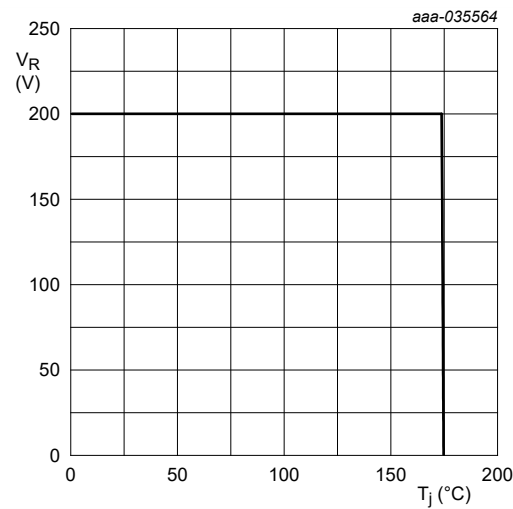
$T_j = 175$  °C  
(1)  $\delta = 1$ ; DC  
(2)  $\delta = 0.5$ ;  $f = 20$  kHz  
(3)  $\delta = 0.2$ ;  $f = 20$  kHz  
(4)  $\delta = 0.1$ ;  $f = 20$  kHz

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



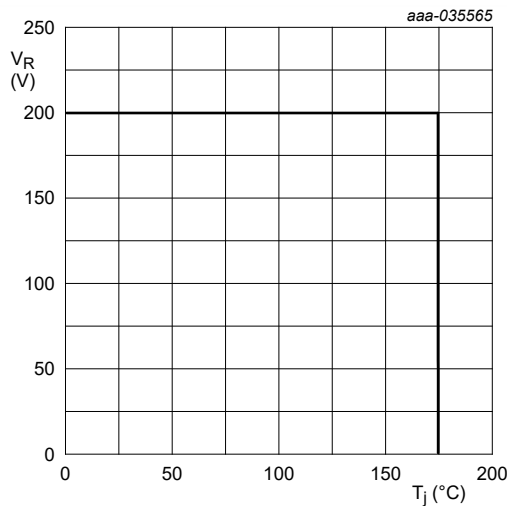
FR4 PCB, standard footprint  
 $R_{th} = 185$  K/W

Fig. 11. Derated maximum reverse voltage as a function of junction temperature; typical values



FR4 PCB, mounting pad for cathode 1 cm<sup>2</sup>  
 $R_{th} = 115$  K/W

Fig. 12. Derated maximum reverse voltage as a function of junction temperature; typical values



Soldering point of cathode tab  
 $R_{th} = 8 \text{ K/W}$

Fig. 13. Derated maximum reverse voltage as a function of junction temperature; typical values

11. Test information

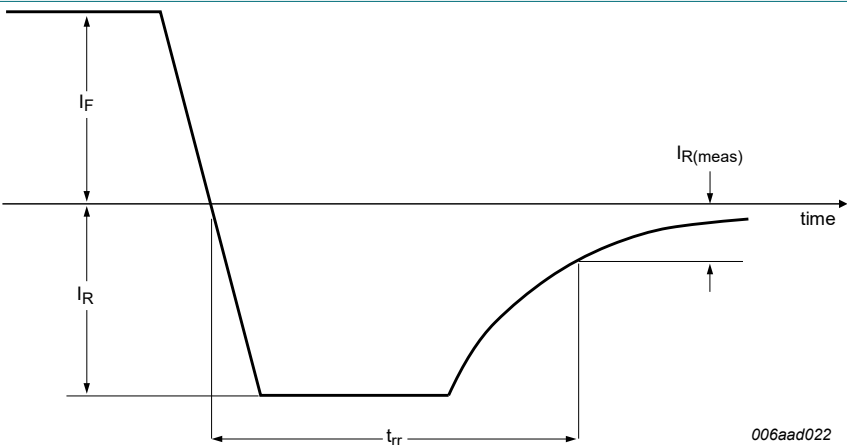


Fig. 14. Reverse recovery definition; step recovery

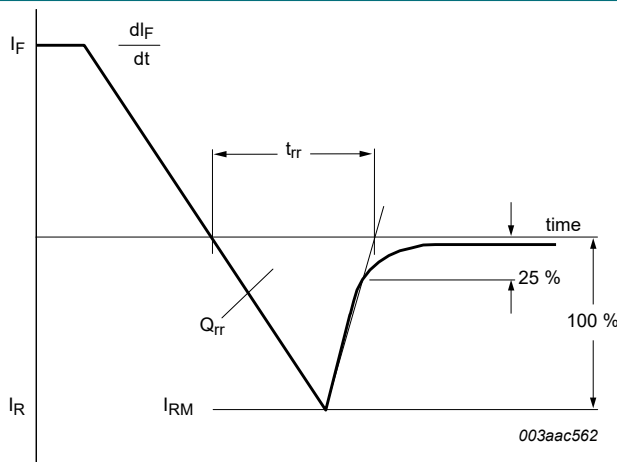


Fig. 15. Reverse recovery definition; ramp recovery

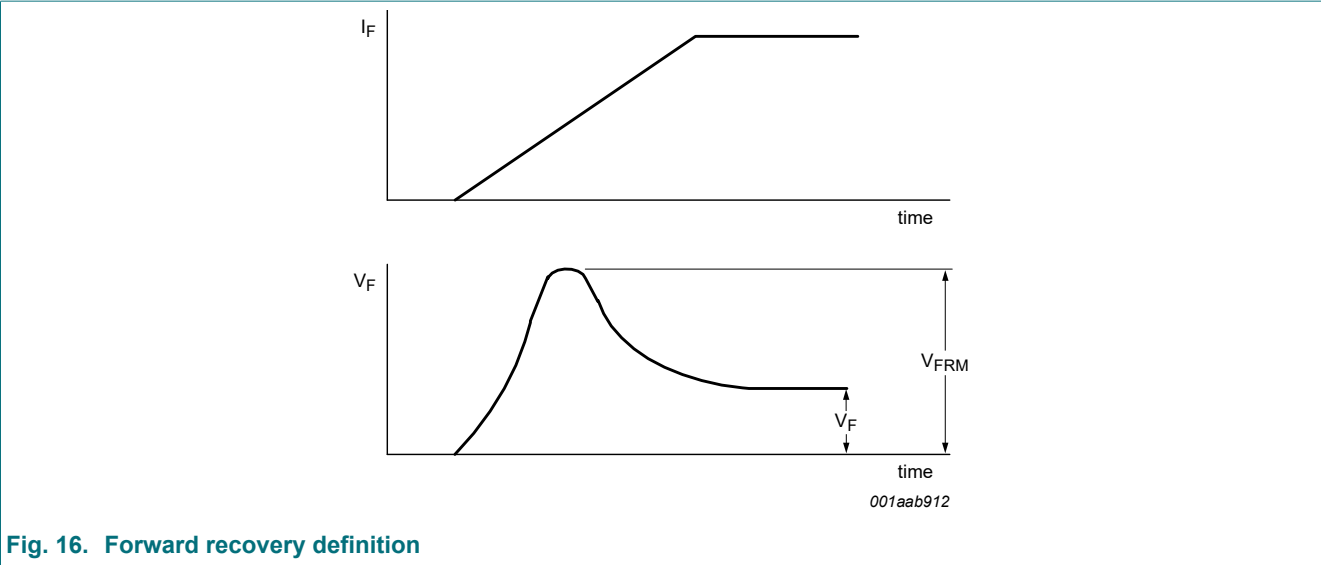


Fig. 16. Forward recovery definition

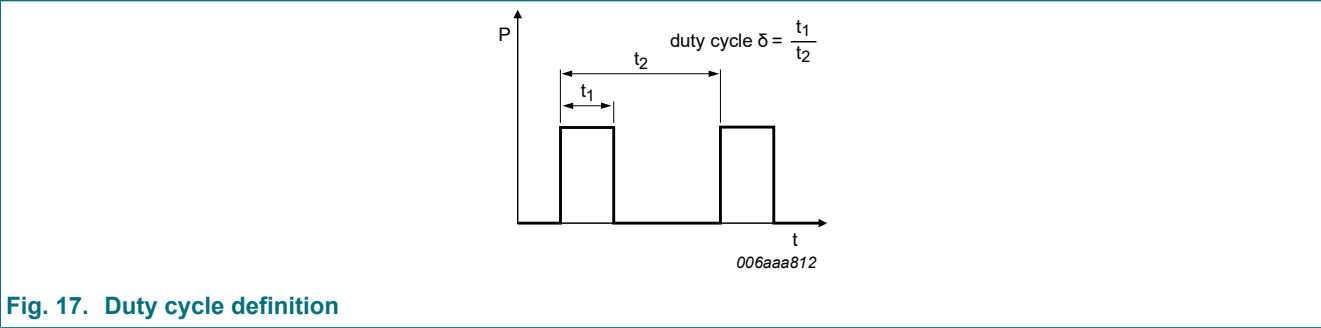


Fig. 17. Duty cycle definition

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  $I_{RMS} = I_M \times \sqrt{\delta}$

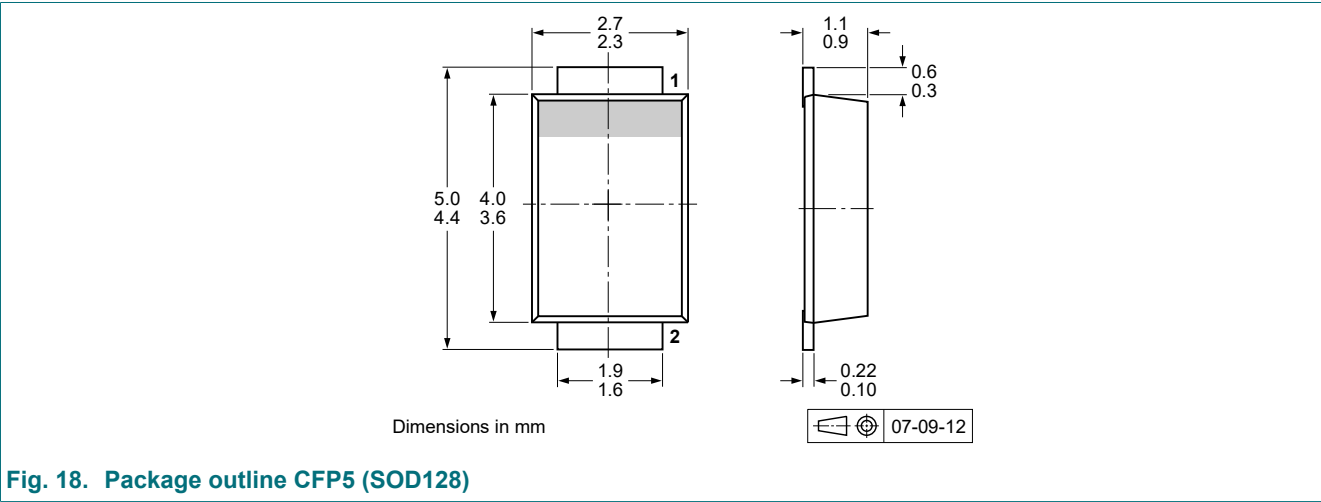
with  $I_{RMS}$  defined as RMS current.

Quality information

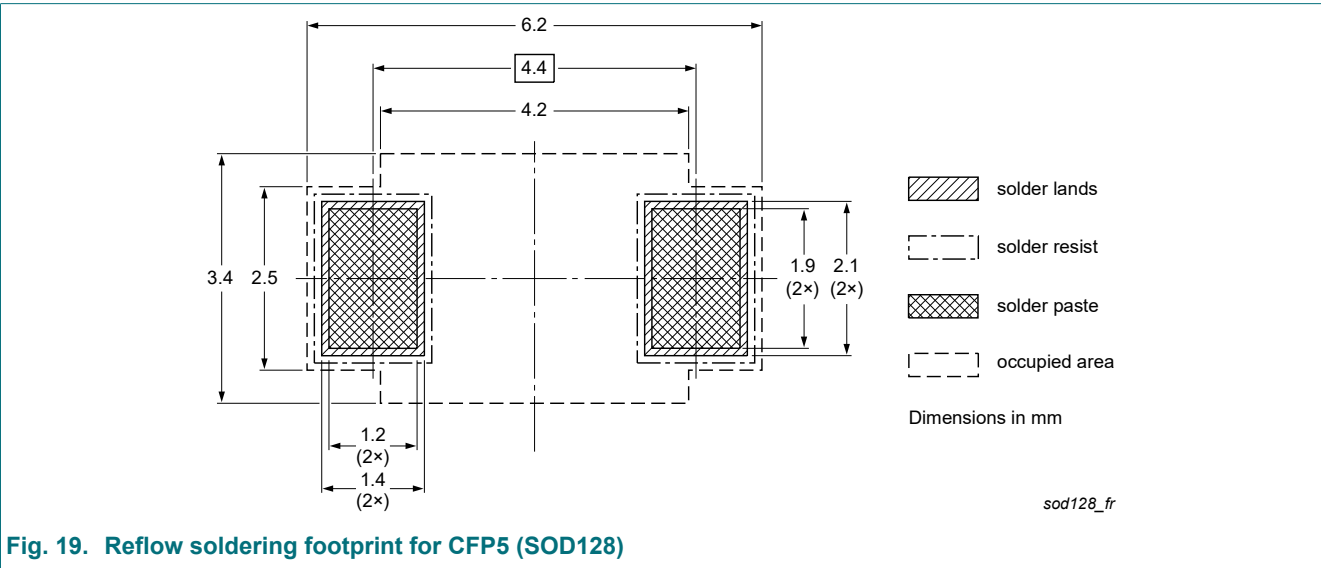
This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - Stress test qualification for discrete semiconductors, and is suitable for use in automotive applications.



12. Package outline



13. Soldering



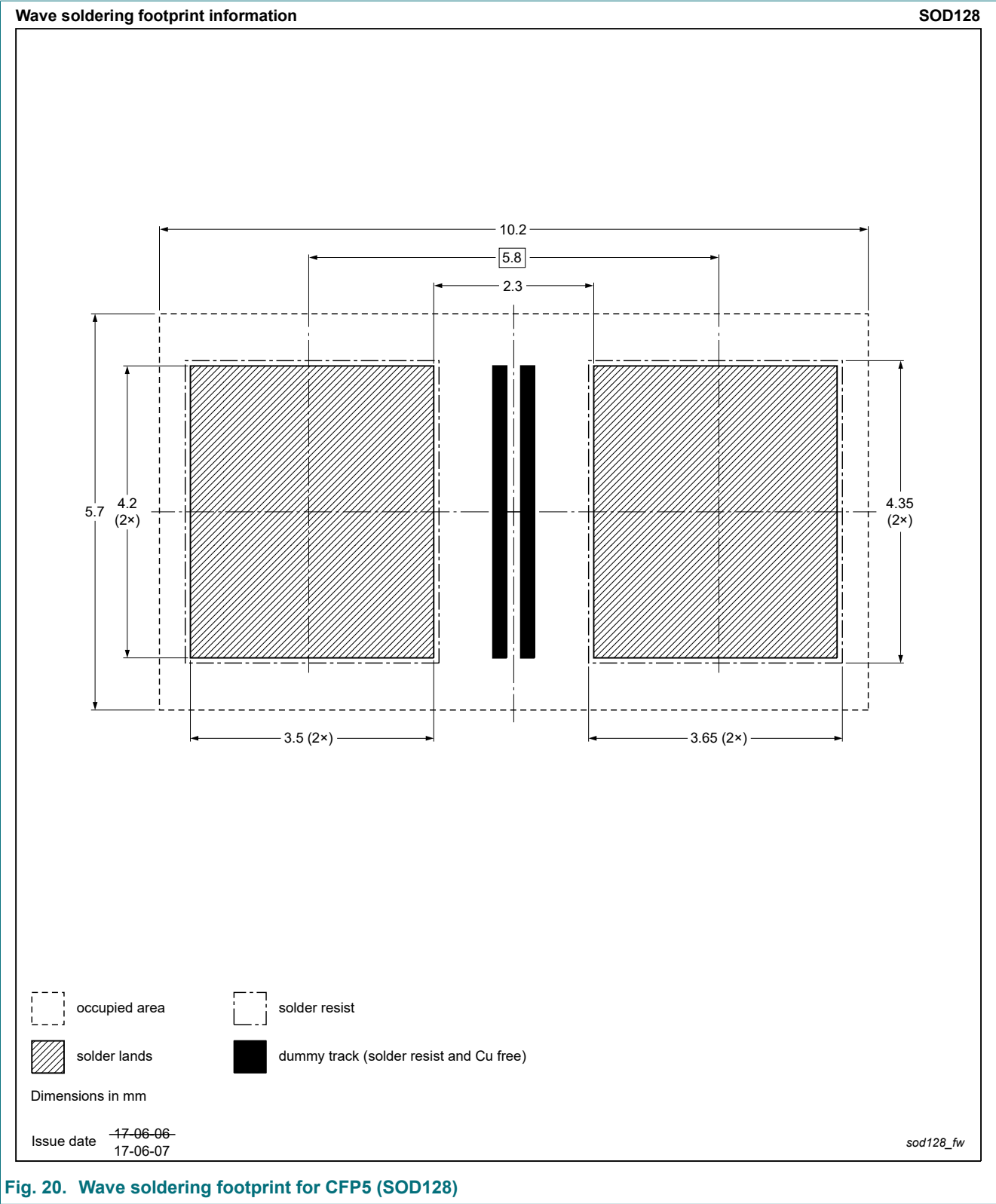


Fig. 20. Wave soldering footprint for CFP5 (SOD128)

14. Revision history

Table 8. Revision history

| Data sheet ID    | Release date                          | Data sheet status  | Change notice | Supersedes       |
|------------------|---------------------------------------|--------------------|---------------|------------------|
| PNE20040EP-Q v.2 | 20221121                              | Product data sheet | -             | PNE20040EP-Q v.1 |
| Modifications:   | • General description: Typo corrected |                    |               |                  |
| PNE20040EP-Q v.1 | 20221110                              | Product data sheet | -             | -                |

## 15. Legal information

### Data sheet status

| Document status<br>[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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