



# PNU65010EP

650 V, 1 A ultrafast recovery rectifier

30 September 2022

Product data sheet

## 1. General description

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

## 2. Features and benefits

- Reverse voltage  $V_R \leq 650$  V
- Forward current  $I_F \leq 1$  A
- Typical switching time  $t_{rr}$  of 35 ns
- Pt doped life time control
- Low inductance
- Power and flat lead SMD plastic package
- High power capability due to clip-bond technology
- Planar die design

## 3. Applications

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

## 4. Quick reference data

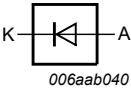
Table 1. Quick reference data

| Symbol      | Parameter                       | Conditions                                                       |     | Min | Typ  | Max  | Unit    |
|-------------|---------------------------------|------------------------------------------------------------------|-----|-----|------|------|---------|
| $I_{F(AV)}$ | average forward current         | $\delta = 0.5$ ; $f = 20$ kHz; square wave; $T_{sp} \leq 167$ °C |     | -   | -    | 1    | A       |
| $V_{RRM}$   | repetitive peak reverse voltage | $T_j = 25$ °C                                                    |     | -   | -    | 650  | V       |
| $V_R$       | reverse voltage                 |                                                                  |     | -   | -    | 650  | V       |
| $V_F$       | forward voltage                 | $I_F = 1$ A; $T_j = 25$ °C                                       | [1] | -   | 1    | 1.2  | V       |
|             |                                 | $I_F = 1$ A; $T_j = 125$ °C                                      | [1] | -   | 0.93 | 1.06 | V       |
| $I_R$       | reverse current                 | $V_R = 650$ V; $T_j = 25$ °C                                     | [1] | -   | -    | 1    | $\mu$ A |
|             |                                 | $V_R = 650$ V; $T_j = 125$ °C                                    | [1] | -   | 0.5  | 10   | $\mu$ 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     | <br>CFP5 (SOD128) | <br>006aab040 |
| 2   | A      | anode       |                                                                                                    |                                                                                                  |

6. Ordering information

Table 3. Ordering information

| Type number                | Package |                                                                                        |                        |
|----------------------------|---------|----------------------------------------------------------------------------------------|------------------------|
|                            | Name    | Description                                                                            | Version                |
| <a href="#">PNU65010EP</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 |
|-------------|--------------|
| PNU65010EP  | ES           |

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     | $T_j = 25\text{ }^{\circ}\text{C}$                                                                                                     |     | -   | 650  | V                  |
| $V_R$       | reverse voltage                     |                                                                                                                                        |     | -   | 650  | V                  |
| $V_{RMS}$   | RMS voltage                         |                                                                                                                                        |     | -   | 460  | V                  |
| $I_F$       | forward current                     | $\delta = 1; T_{sp} \leq 165\text{ }^{\circ}\text{C}$                                                                                  |     | -   | 1.4  | A                  |
| $I_{F(AV)}$ | average forward current             | $\delta = 0.5; f = 20\text{ kHz}; \text{square wave}; T_{sp} \leq 167\text{ }^{\circ}\text{C}$                                         |     | -   | 1    | A                  |
| $I_{FSM}$   | non-repetitive peak forward current | $t_p = 8.3\text{ ms}; \text{single half sine wave (applied at rated load condition)}; T_{j(\text{init})} = 25\text{ }^{\circ}\text{C}$ |     | -   | 33   | 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 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 cathode tab.

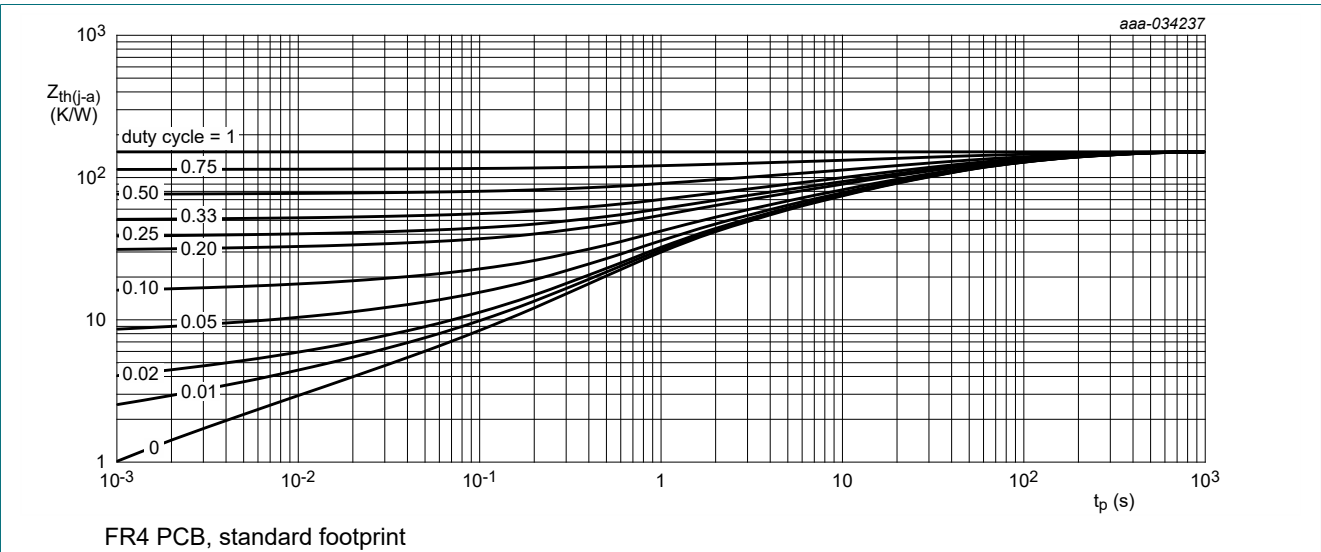


Fig. 1. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

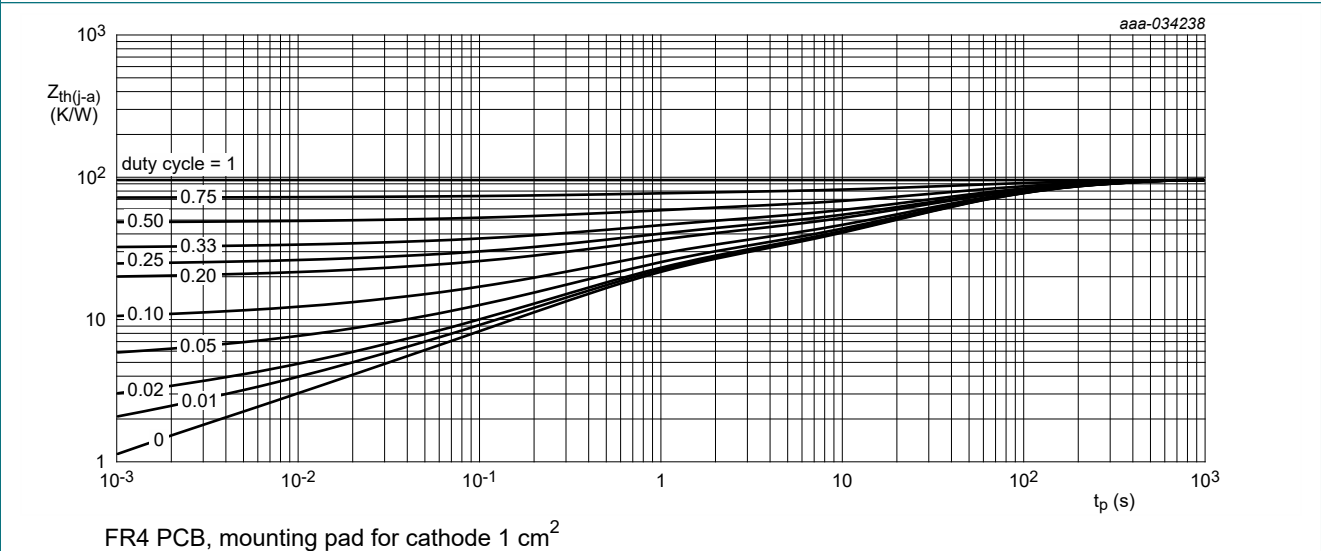


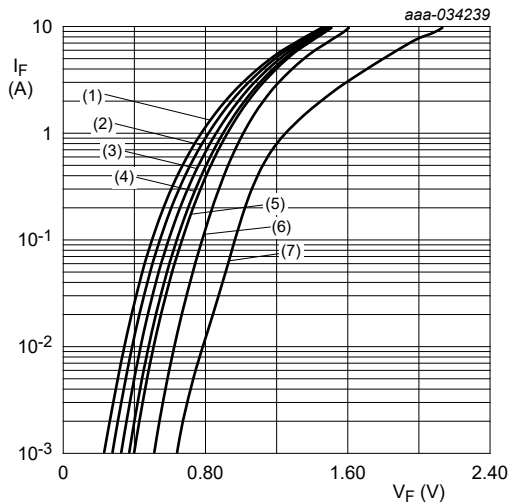
Fig. 2. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

| Symbol      | Parameter                             | Conditions                                                                                                       |     | Min | Typ  | Max  | Unit          |
|-------------|---------------------------------------|------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|---------------|
| $V_{(BR)R}$ | reverse breakdown voltage             | $I_R = 100\ \mu\text{A}$ ; $T_j = 25\ ^\circ\text{C}$                                                            | [1] | 650 | -    | -    | V             |
| $V_F$       | forward voltage                       | $I_F = 1\ \text{A}$ ; $T_j = 25\ ^\circ\text{C}$                                                                 | [1] | -   | 1    | 1.2  | V             |
|             |                                       | $I_F = 1\ \text{A}$ ; $T_j = 125\ ^\circ\text{C}$                                                                | [1] | -   | 0.93 | 1.06 | V             |
| $I_R$       | reverse current                       | $V_R = 650\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$                                                               | [1] | -   | -    | 1    | $\mu\text{A}$ |
|             |                                       | $V_R = 650\ \text{V}$ ; $T_j = 125\ ^\circ\text{C}$                                                              | [1] | -   | 0.5  | 10   | $\mu\text{A}$ |
| $C_d$       | diode capacitance                     | $V_R = 4\ \text{V}$ ; $f = 1\ \text{MHz}$ ; $T_j = 25\ ^\circ\text{C}$                                           |     | -   | 11   | -    | pF            |
| $t_{rr}$    | reverse recovery time ; step recovery | $I_F = 0.5\ \text{A}$ ; $I_R = 1\ \text{A}$ ; $I_{R(\text{meas})} = 0.25\ \text{A}$ ; $T_j = 25\ ^\circ\text{C}$ |     | -   | 35   | 65   | ns            |
|             | reverse recovery time ; ramp recovery | $I_F = 1\ \text{A}$ ; $dI_F/dt = 50\ \text{A}/\mu\text{s}$ ; $V_R = 30\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$   |     | -   | 39   | 85   | ns            |
|             |                                       | $I_F = 1\ \text{A}$ ; $dI_F/dt = 100\ \text{A}/\mu\text{s}$ ; $V_R = 30\ \text{V}$ ; $T_j = 25\ ^\circ\text{C}$  |     | -   | 26   | -    | ns            |
| $I_{RM}$    | peak reverse recovery current         | $T_j = 25\ ^\circ\text{C}$                                                                                       |     | -   | 1.5  | -    | A             |
| $Q_{rr}$    | reverse recovery charge               |                                                                                                                  |     | -   | 20   | -    | nC            |
| $V_{FRM}$   | peak forward recovery voltage         | $I_F = 1\ \text{A}$ ; $dI_F/dt = 50\ \text{A}/\mu\text{s}$ ; $T_j = 25\ ^\circ\text{C}$                          |     | -   | 5.2  | -    | V             |

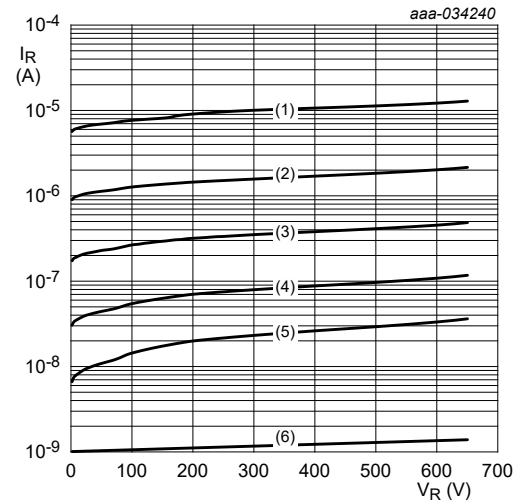
[1] Very short pulse, in order to maintain a stable junction temperature.



pulsed condition

- (1)  $T_j = 175\ ^\circ\text{C}$
- (2)  $T_j = 150\ ^\circ\text{C}$
- (3)  $T_j = 125\ ^\circ\text{C}$
- (4)  $T_j = 100\ ^\circ\text{C}$
- (5)  $T_j = 85\ ^\circ\text{C}$
- (6)  $T_j = 25\ ^\circ\text{C}$
- (7)  $T_j = -40\ ^\circ\text{C}$

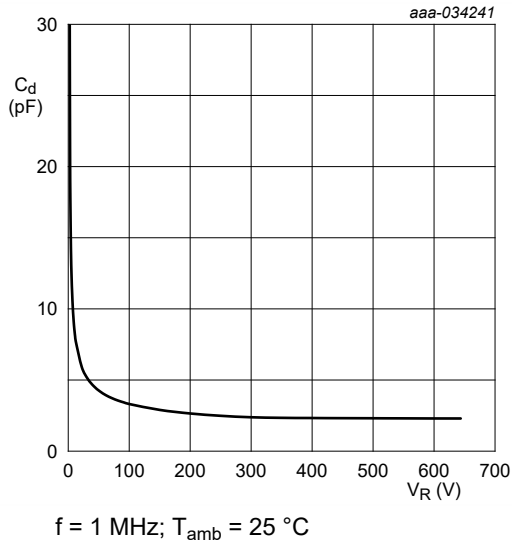
Fig. 3. Forward current as a function of forward voltage; typical values



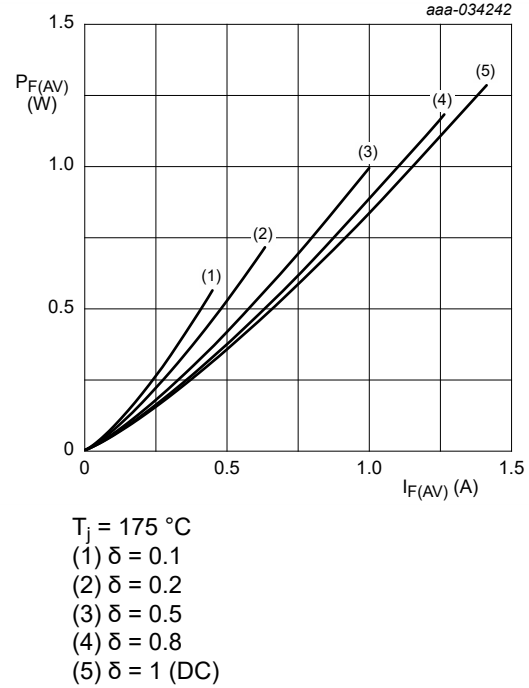
pulsed condition

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

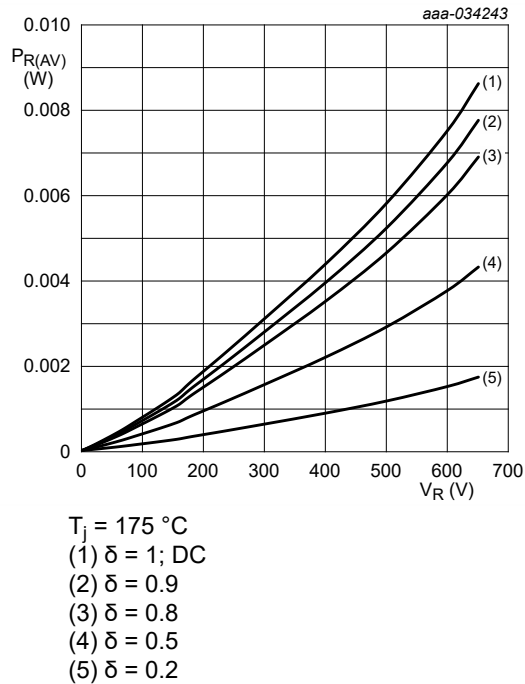
Fig. 4. Reverse current as a function of reverse voltage; typical values



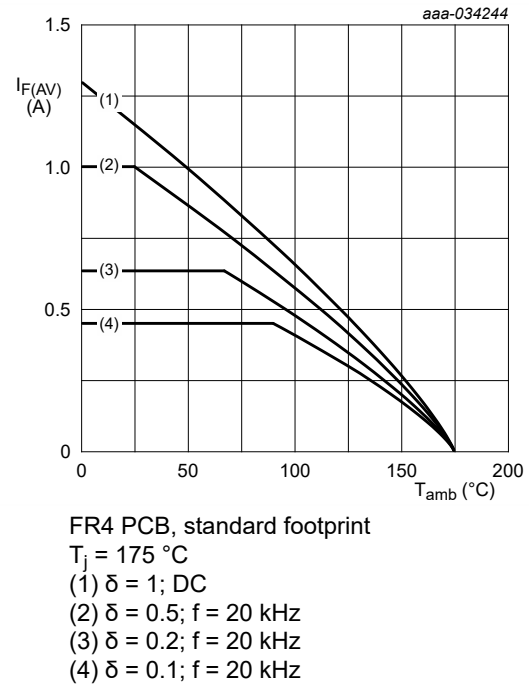
**Fig. 5.** Diode capacitance as a function of reverse voltage; typical values



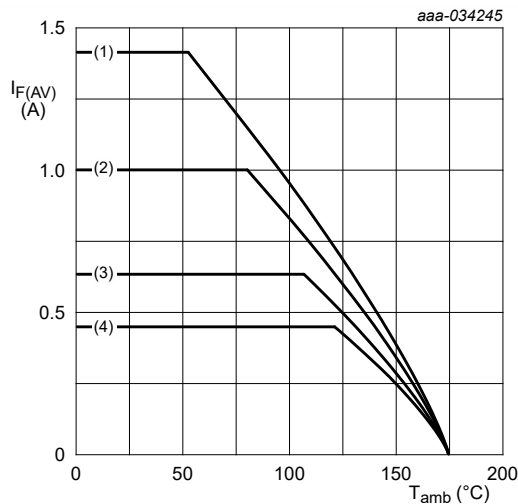
**Fig. 6.** Average forward power dissipation as a function of average forward current; typical values



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

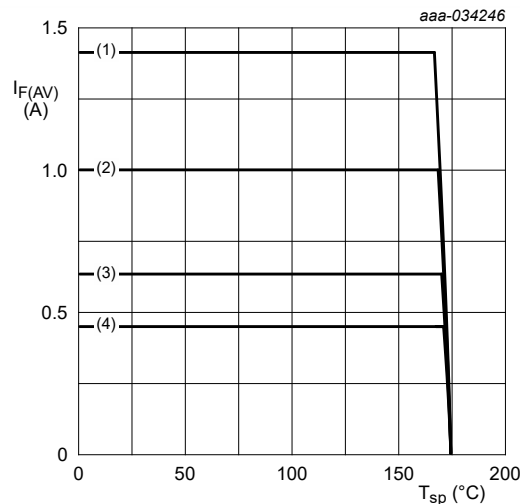


**Fig. 8.** Average forward current as a function of ambient temperature; typical values



FR4 PCB, mounting pad for cathode 1 cm<sup>2</sup>  
 $T_j = 175\text{ °C}$   
(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. 9. Average forward current as a function of ambient temperature; 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)  $\delta = 0.1$ ;  $f = 20\text{ kHz}$

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

11. Test information

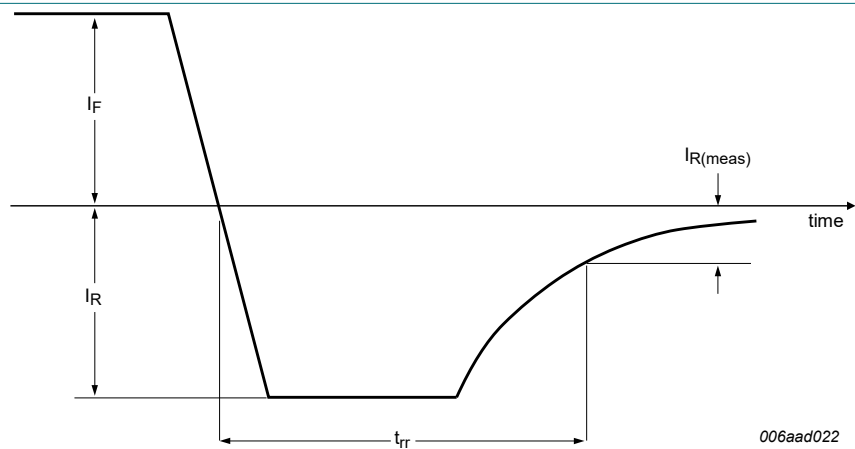
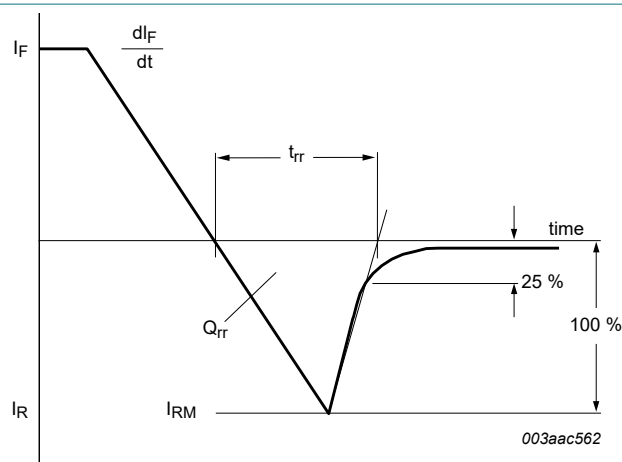
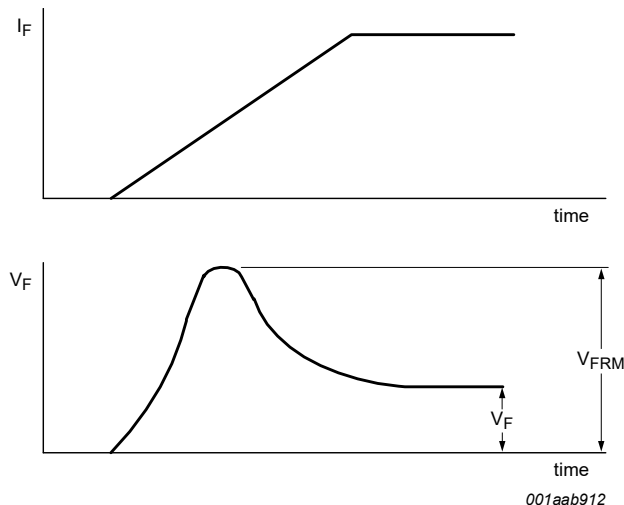


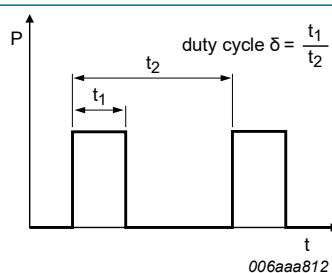
Fig. 11. Reverse recovery definition; step recovery



**Fig. 12. Reverse recovery definition; ramp recovery**



**Fig. 13. Forward recovery definition**



**Fig. 14. Duty cycle definition**

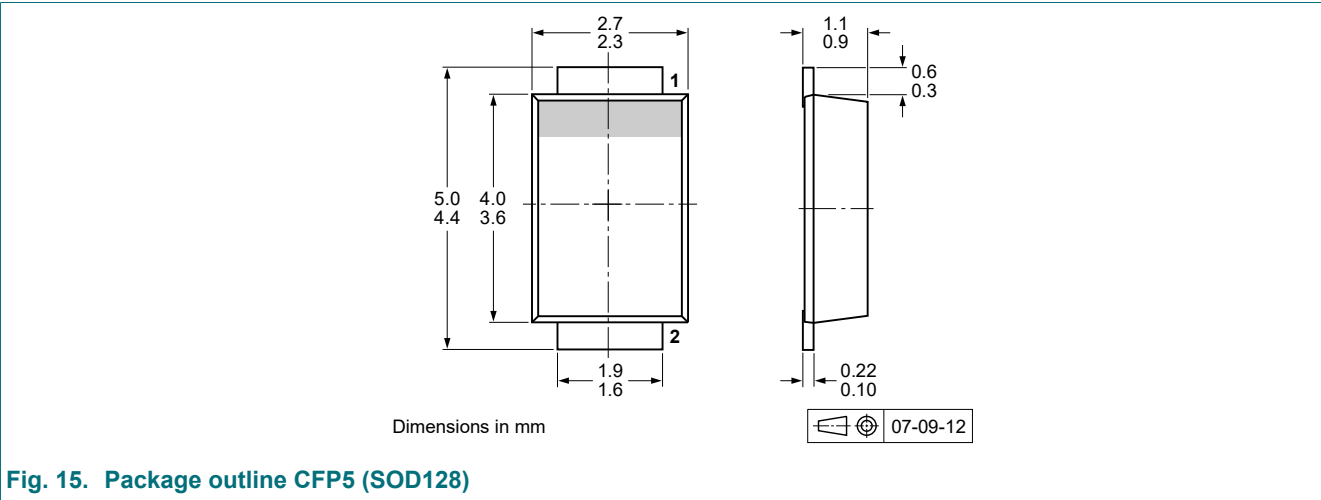
The current ratings for the typical waveforms are calculated according to the equations:

$$I_{F(AV)} = I_M \times \delta \text{ with } I_M \text{ defined as peak current}$$

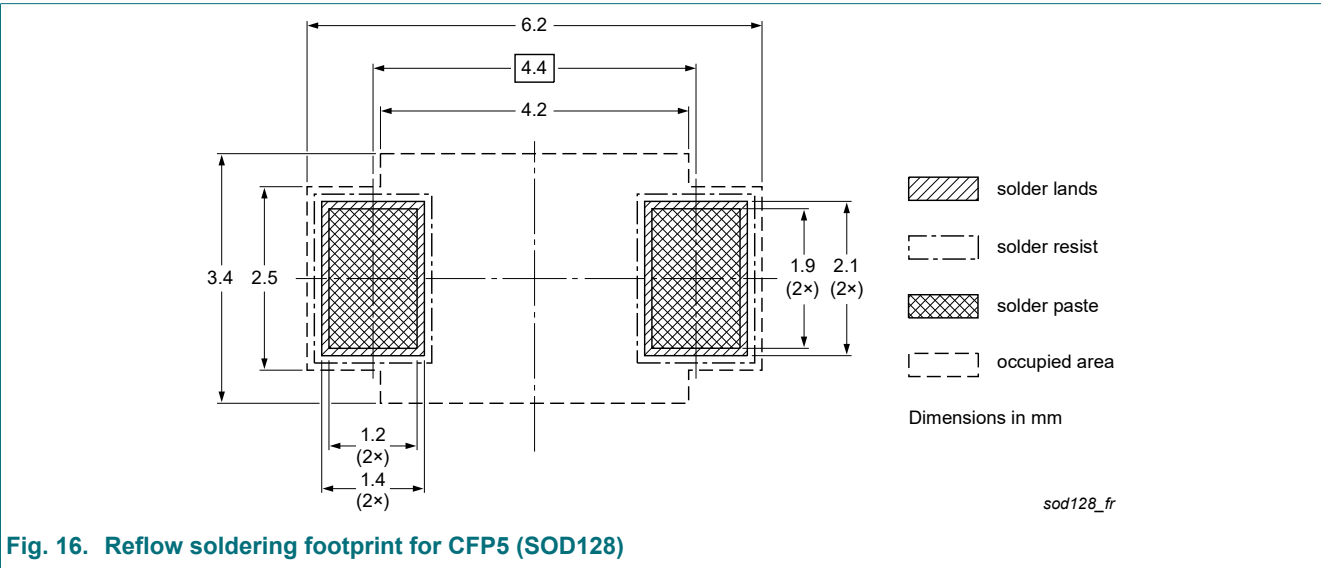
$$I_{RMS} = I_{F(AV)} \text{ at DC, and } I_{RMS} = I_M \times \sqrt{\delta}$$

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

12. Package outline



13. Soldering



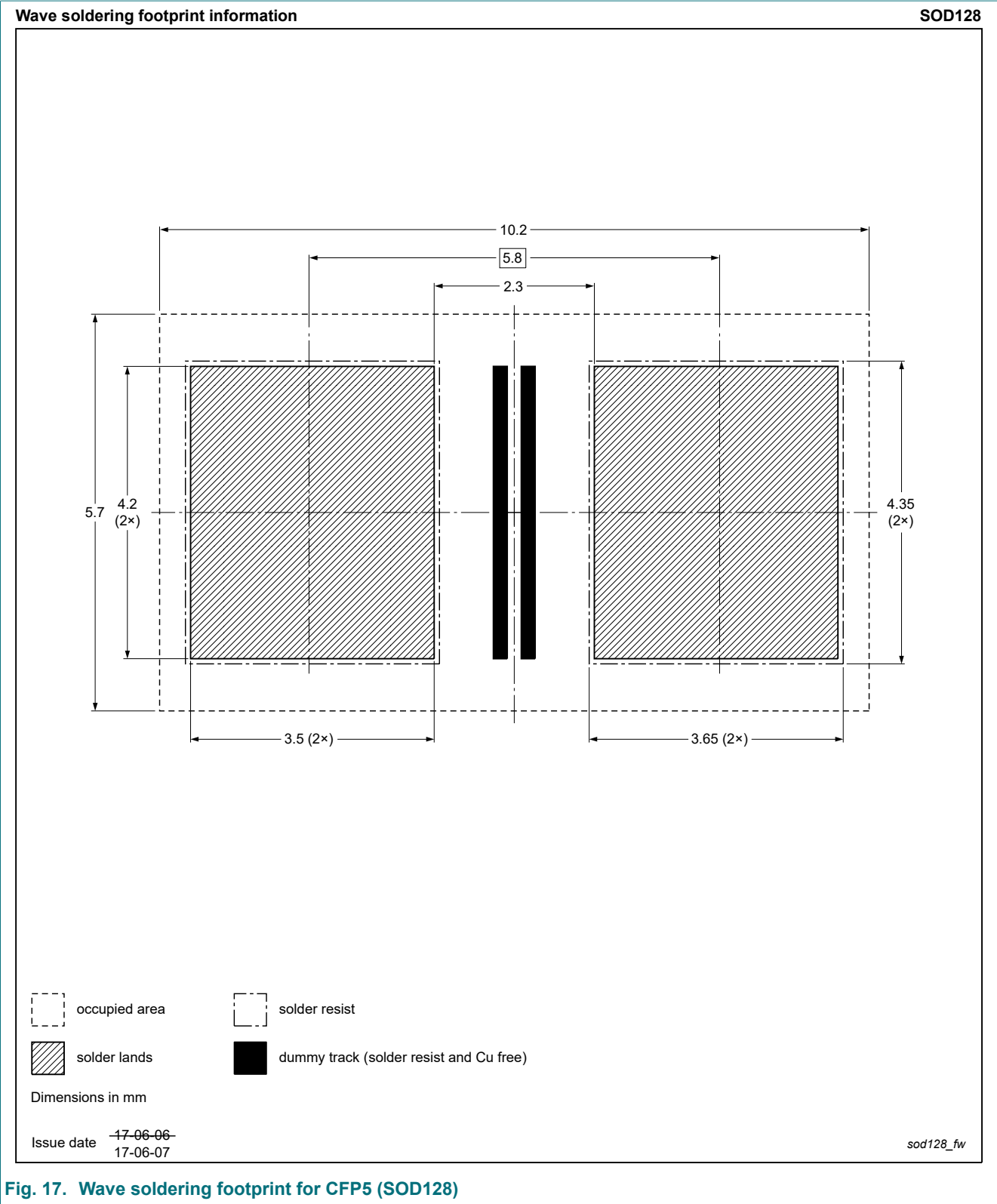


Fig. 17. Wave soldering footprint for CFP5 (SOD128)

## 14. Revision history

Table 8. Revision history

| Data sheet ID  | Release date                                                                                                                                                                                                                                      | Data sheet status      | Change notice | Supersedes     |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------|----------------|
| PNU65010EP v.3 | 20220930                                                                                                                                                                                                                                          | Product data sheet     | -             | PNU65010EP v.2 |
| Modifications: | <ul style="list-style-type: none"><li>• Product status changed</li><li>• Limiting values: <math>I_{FSM}</math> value changed</li><li>• Characteristics: Several parameter added</li><li>• Characteristics: Fig 6. x-axis typo corrected</li></ul> |                        |               |                |
| PNU65010EP v.2 | 20220629                                                                                                                                                                                                                                          | Preliminary data sheet | -             | PNU65010EP v.1 |
| PNU65010EP v.1 | 20211222                                                                                                                                                                                                                                          | Objective 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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