AN90002

Wave soldering guidelines for flatpack packages

Rev. 2 — 2 November 2023 application note

Document information

Information	Content
Keywords	Wave soldering, flatpack, SOD123F, CFP2HP, CFP3, CFP5, CFP15, CFP15B, footprint design
Abstract	This application note provides wave soldering guidelines for Nexperia flatpacks, SOD123F, CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B). The content includes wave soldering footprint recommendations, wave soldering process and temperature profile.

nexperia

1. Introduction

This application note provides guidelines for board mounting by wave soldering of five flatpacks (package with flat leads): SOD123F, CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B).

Although reflow soldering is major technology for soldering of surface mount devices, wave soldering is also widely applied at many customers, especially for power supply applications.

This application note describes the recommendations for wave soldering of the Printed-Circuit Board (PCB) land pattern, including:

- the guidelines for component mounting
- the process requirements for wave soldering

While this application note helps minimizing any unexpected failures, following the advice in this document is not a guarantee for a perfect assembly result. The result may differ depending on the machine capability, ambient conditions, material, etc.

2. SOD123F, CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B): Package details

SOD123F, CFP2HP(SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/ CFP15B (SOT1289B) are plastic, flat leads, Surface-Mounted Device (SMD) packages.

Key features:

- SOD123F, CFP3 (SOD123W) and CFP5 (SOD128): small and flat lead SMD plastic packages
- CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128), CFP15 (SOT1289) and CFP15 (SOT1289)/CFP15B (SOT1289B): high power capability due to clip bond technology
- CFP15 (SOT1289) and CFP15B (SOT1289B): small and ultra-thin SMD plastic package with heat sink

The visual appearance of SOD123F is shown in Fig. 1 whereas Fig. 2 shows the package dimensions.

The visual appearance of CFP2HP (SOD323HP) is shown in Fig. 3 whereas Fig. 4 shows the package dimensions.

The visual appearance of CFP3 (SOD123W) is shown in Fig. 5 whereas Fig. 6 shows the package dimensions.

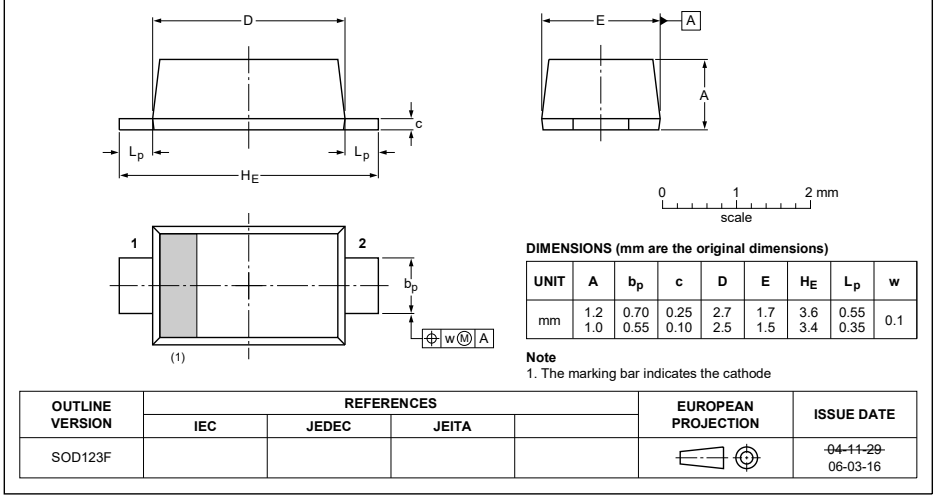
The visual appearance of CFP5 (SOD128) is shown in Fig. 7 whereas Fig. 8 shows the package dimensions.

The visual appearance of CFP15 (SOD1289) is shown in Fig. 9 whereas Fig. 10 shows the package dimensions.

The visual appearance of CFP15B (SOD1289B) is shown in Fig. 11 whereas Fig. 12 shows the package dimensions.

Fig. 1. SOD123F: visual appearance

Plastic surface-mounted package; 2 leads SOD123F



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	c	D	E	H_E	L_p	w
mm	1.2 1.0	0.70 0.55	0.25 0.10	2.7 2.5	1.7 1.5	3.6 3.4	0.55 0.35	0.1

Note
1. The marking bar indicates the cathode

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOD123F						~~04-11-29~~ 06-03-16

Fig. 2. SOD123F: package dimensions

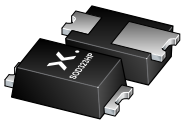
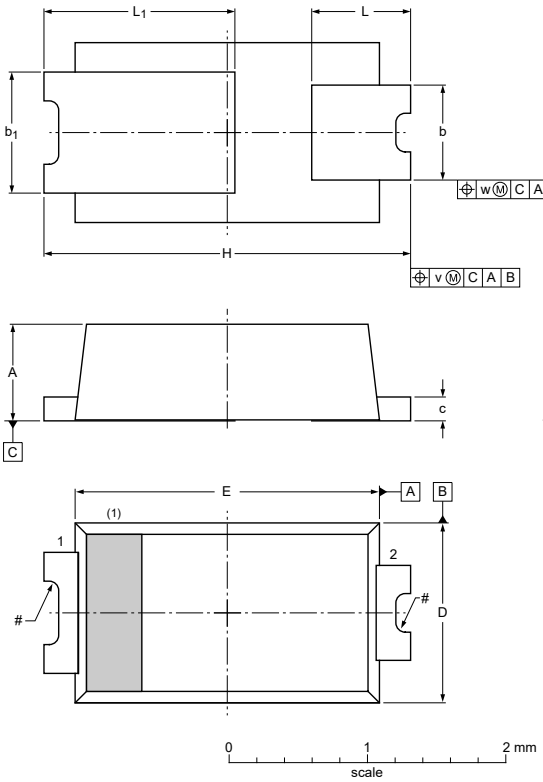


Fig. 3. CFP2HP (SOD323HP): visual appearance

SOD323HP: plastic surface-mounted package with Side-Wettable Flanks (SWF); 1.3 mm x 2.2 mm x 0.68 mm body **SOD323HP**



Dimensions (mm are the original dimensions)

Unit		A	b	b_1	c	D	E	H	L	L_1	v	w
mm	max	0.75	0.75	0.98	0.25	1.4	2.3	2.70	0.80	1.50		
	nom	0.68	0.70	0.90	0.18	1.3	2.2	2.65	0.72	1.38	0.13	0.13
	min	0.61	0.65	0.82	0.11	1.2	2.1	2.60	0.64	1.26		

Note
1. (1) The marking band indicates the cathode.
2. # Side wettable Flank (SWF).

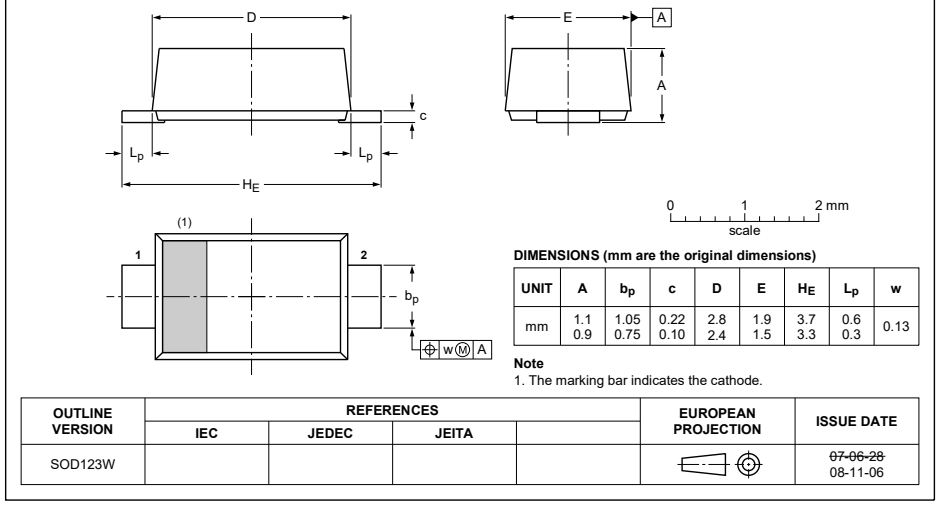
sod323hp_po

Outline version	References			European projection	Issue date
	IEC	JEDEC	JEITA		
SOD323HP		DO-219AD (compatible)			~~21-04-02~~ 21-04-07

Fig. 4. CFP2HP (SOD323HP): package dimensions

Fig. 5. CFP3 (SOD123W): visual appearance

Plastic surface-mounted package; 2 leads SOD123W



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	c	D	E	H_E	L_p	w
mm	1.1 0.9	1.05 0.75	0.22 0.10	2.8 2.4	1.9 1.5	3.7 3.3	0.6 0.3	0.13

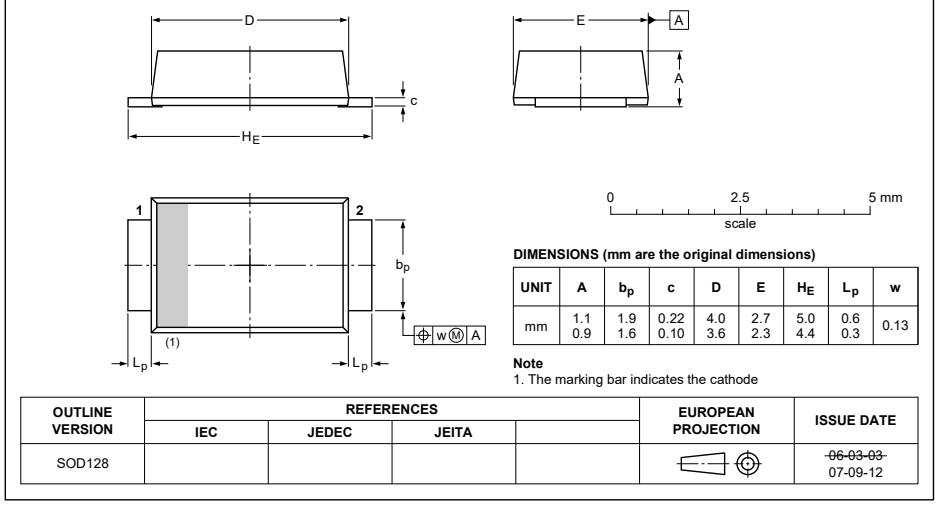
Note
1. The marking bar indicates the cathode.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOD123W						~~07-06-28~~ 08-11-06

Fig. 6. CFP3 (SOD123W): package dimensions

Fig. 7. CFP5 (SOD128): visual appearance

Plastic surface-mounted package; 2 leads SOD128



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	c	D	E	H_E	L_p	w
mm	1.1 0.9	1.9 1.6	0.22 0.10	4.0 3.6	2.7 2.3	5.0 4.4	0.6 0.3	0.13

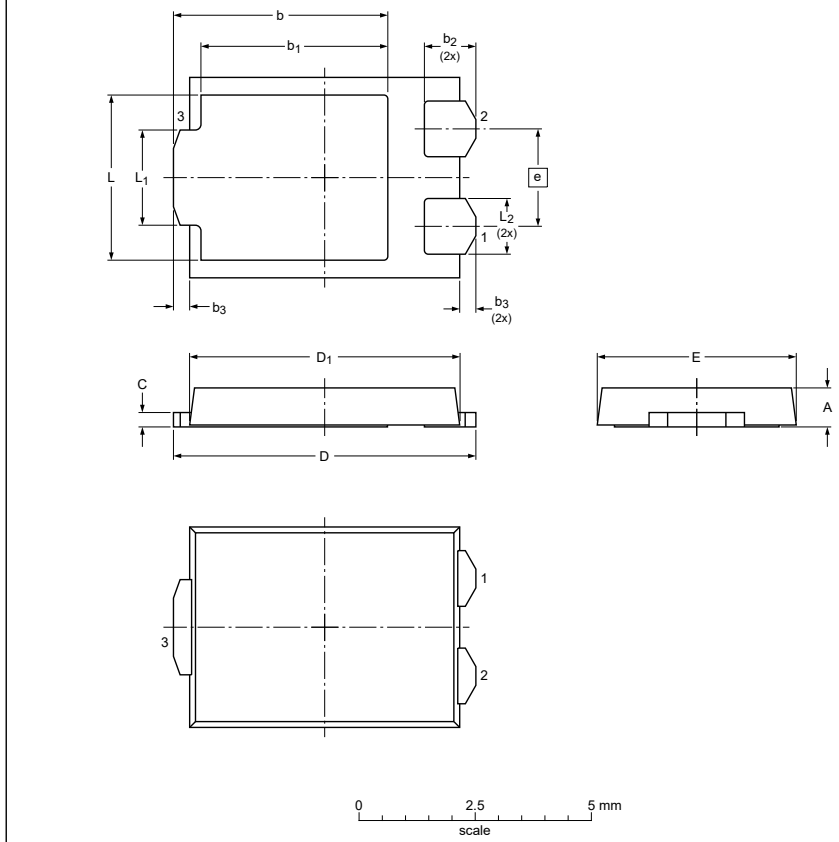
Note
1. The marking bar indicates the cathode

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOD128						~~06-03-03~~ 07-09-12

Fig. 8. CFP5 (SOD128): package dimensions

Fig. 9. CFP15 (SOT1289): visual appearance

CFP15: plastic, thermal enhanced ultra thin SMD package; 3 leads; body: 5.8 x 4.3 x 0.78 mm SOT1289



Dimensions (mm are the original dimensions)

Unit		A	C	D	D_1	E	e	b	b_1	b_2	b_3	L	L_1	L_2
mm	max	0.82	0.24	6.6	5.9	4.4		4.8	4.2	1.3	0.45	3.5	2.15	1.3
	nom	0.78	0.20	6.5	5.8	4.3	2.13	4.6	4.0	1.1	0.35	3.3	2.05	1.2
	min	0.74	0.16	6.4	5.7	4.2		4.4	3.8	0.9	0.25	3.1	1.95	1.1

sot1289_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1289						~~14-07-23~~ 14-09-01

Fig. 10. CFP15 (SOT1289): package dimensions

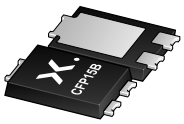
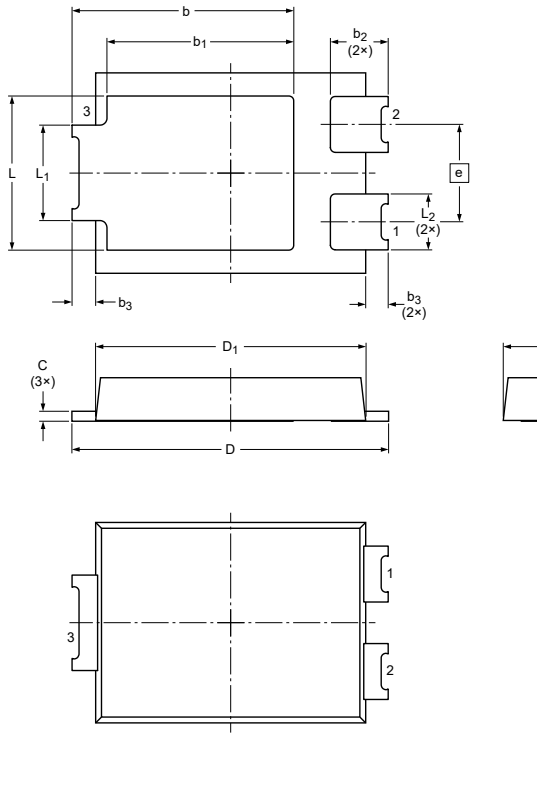


Fig. 11. CFP15B (SOT1289B): visual appearance

CFP15B: plastic, thermal enhanced ultra thin SMD package; 3 leads; body: 5.8 x 4.3 x 0.95 mm SOT1289B



Dimensions (mm are the original dimensions)

Unit		A	C	D	D_1	E	e	b	b_1	b_2	b_3	L	L_1	L_2
mm	max	0.99	0.24	6.9	5.9	4.4		4.96	4.2	1.44	0.6	3.5	2.15	1.3
	nom	0.95	0.20	6.8	5.8	4.3	2.13	4.76	4.0	1.24	0.5	3.3	2.05	1.2
	min	0.91	0.16	6.7	5.7	4.2		4.56	3.8	1.04	0.4	3.1	1.95	1.1

sot1289b_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1289B		- - -				~~18-02-01~~ 19-01-10

Fig. 12. CFP15B (SOT1289B): package dimensions

3. PCB requirements and solder pattern

3.1. PCB material and surface finishing

The substrates used for mounting the packages can be made of a variety of materials with different properties such as FR4, FR5, Bismaleimide-Triazine resin (BT), flexible polymers (polyimides or polyamide), etc. There are no special constraint for wave soldering application, as long as the board can sustain wave-soldering temperature.

Common board finishes include NiAu, Organic Solderability Preservative (OSP), immersion Sn and Hot Air Surface Leveling (HASL). Although finishes may look different after soldering, and some appear to have better wetting characteristics than other, all common finishes can be used, provided that they are in accordance with the specifications (for example IPC-A-610).

3.2. Solder mask (resist) design

There are two types of solder pad / solder resist designs:

Solder Mask Defined (SMD) and Non-Solder Mask Defined (NSMD).

SMD is a method of designing the solder resist to partially overlap the copper (Cu) landing pattern on the PCB. NSMD designs have a gap between the solder resist and the Cu landing pattern on the PCB. These two types are described in more details on Fig. 13.

For wave soldering, any of the solder mask configurations can be used without significant impact to soldering outcome. It is recommended to use NSMD in this document, because it is an easy PCB manufacturing method.

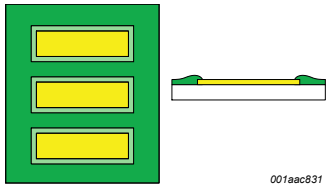


Fig. 13. SMD solder pad

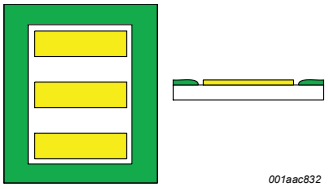


Fig. 14. NSMD solder pad

3.3. Solder land (footprint) design

A footprint design describes the recommended dimensions of the solder lands on the PCB, to make reliable solder joints between the semiconductor package and the PCB. In wave soldering, the solder pad dimensions should be larger than normal footprint dimensions for reflow soldering. This is to allow the molten solder from the wave to have enough contact area with Cu pad, and a path to flow through the pad underneath the package.

Reduce the glue volume to a minimum, as long as it can hold the package. To avoid excessive glue that may spread onto solder pads, place two small glue dots at side of the package. However, if glue volume is controlled to avoid that the glue spreads onto Cu pads, it is sufficient to apply one glue dot at the center of the device for SOD123F, CFP3 (SOD123W) and CFP5 (SOD128).

In addition, to give the glue some room under the plastic body of a package, dummy tracks on PCB can be designed under the plastic body. Etch away the Cu and make an opening in solder resist to generate a trench underneath the plastic body. A similar effect can be achieved with NSMD tracks. This is a known method to balance surface topography differences of the PCB by designing either normal or dummy tracks underneath a component.

Wave soldering footprint design for SOD123F, CFP2HP(SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B), including glue dot, are shown in Fig. 15, Fig. 16, Fig. 17, Fig. 18 and Fig. 19, respectively.

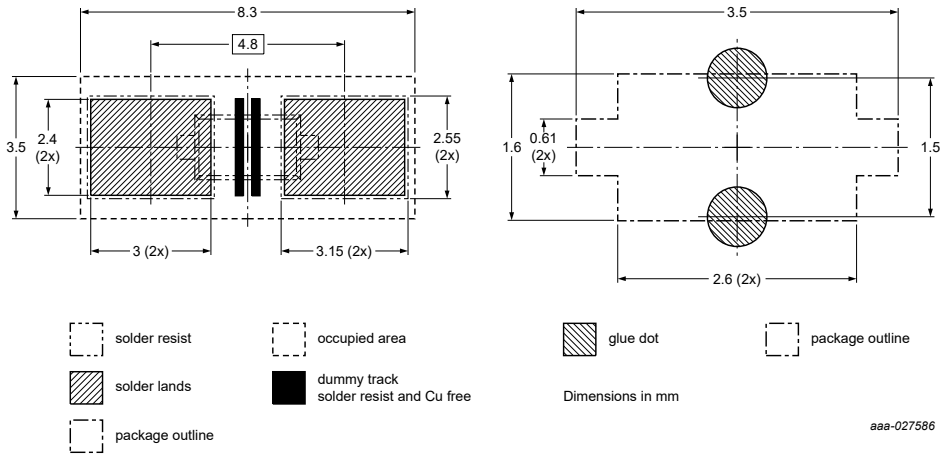


Fig. 15. SOD123F: recommended wave soldering footprint

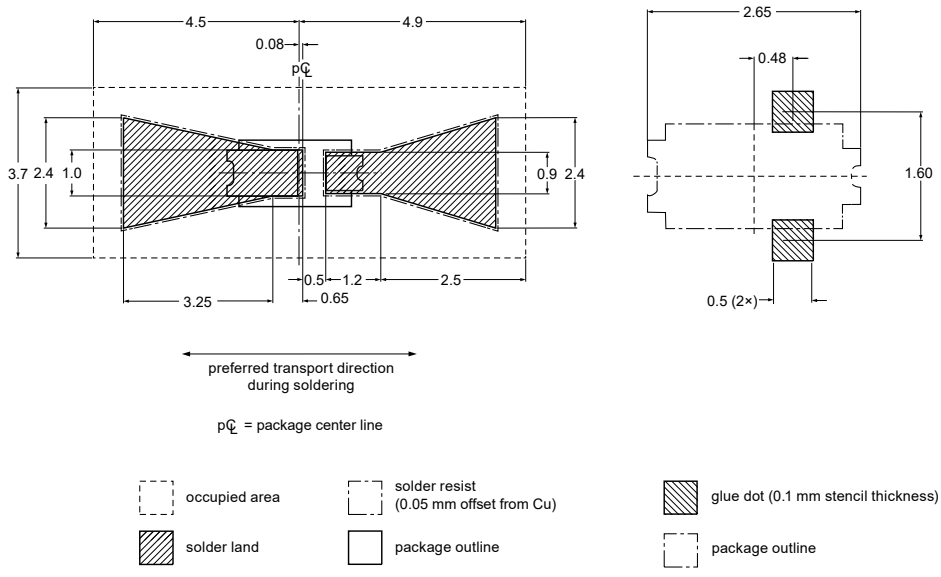


Fig. 16. CFP2HP (SOD323HP): recommended wave soldering footprint

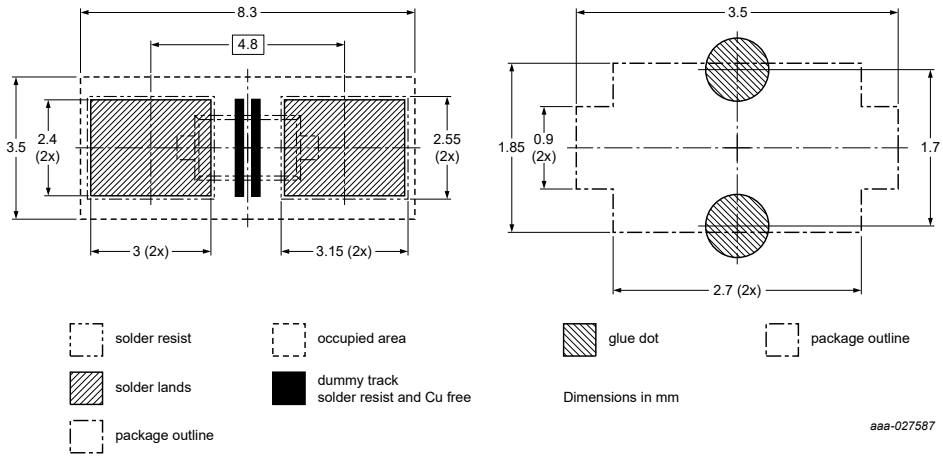


Fig. 17. CFP3 (SOD123W): recommended wave soldering footprint

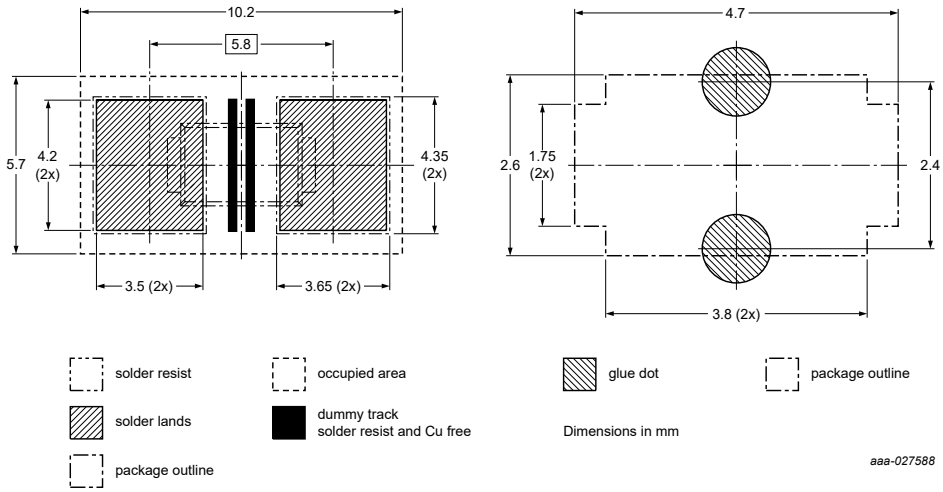


Fig. 18. CFP5 (SOD128): recommended wave soldering footprint

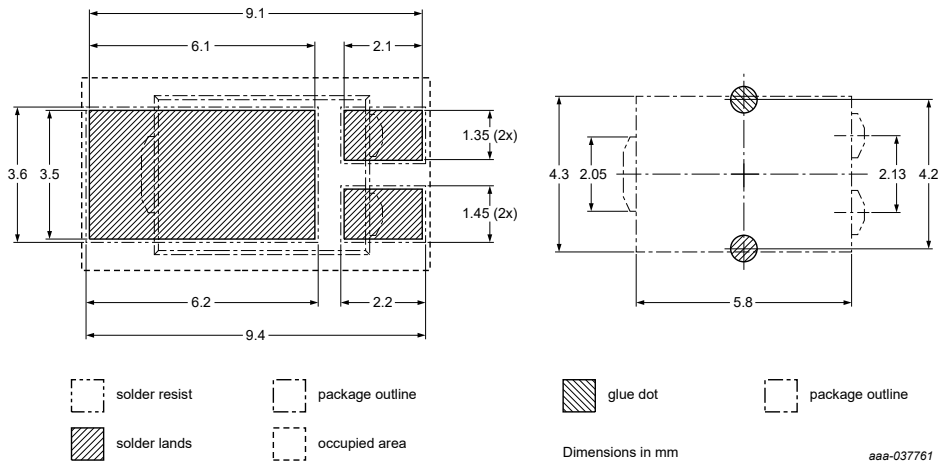


Fig. 19. CFP15 (SOT1289)/CFP15B (SOT1289B): recommended wave soldering footprint

3.4. Component orientation

The component orientation on board refers to the direction of the component on the wave soldering machine conveyor. The orientation can be either:

- 0 °: The long axis of the component is parallel to the direction of board traveling along the wave soldering machine conveyor.
- 90 °: The long axis of the component is perpendicular to the direction of board traveling along the wave soldering machine conveyor.

According to the standard IPC-7351, an orientation of 90 ° is preferable for SOD123F, CFP3 (SOD123W), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B). However, Nexperia investigations confirmed that both travel directions result in good solder connections.

4. Wave soldering process

4.1. Adhesive

To hold components on the board during wave soldering, it is necessary to bond them to the PCB with adhesive dots. The glue must be tacky enough and have sufficent volume so that the component would not move or fall off during transport from peak and place machine to curing equipment. It also must have good adhesion strength after curing to prevent it from falling off during the whole wave soldering process.

4.1.1. Applying adhesive

For SOD123F, CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289)/CFP15B (SOT1289B), either printing or dispensing of adhesive is possible. In order to achieve better planarity and consistent volume, Nexperia wave soldering investigations used the method of printing with stencil thickness of 0.1 mm (4 mil).

4.1.2. Curing adhesive

Adhesive must be cured according to the specified conditions of the supplier. Glue should be fully cured before wave soldering.

4.2. Solder flux

Fluxing is necessary to promote wetting of both the PCB and the mounted components. Fluxing ensures good and even solder joints. After the fluxing process, the solder side of the PCB (including the components) is covered with a thin layer of flux. Flux can be applied onto PCB by spraying or foaming.

Use no-clean flux with low corrosive content like Rosin Mildly Activated (RMA) flux.

4.3. Wave soldering

Recommended wave soldering profile is described in Fig. 20 and Table 1.

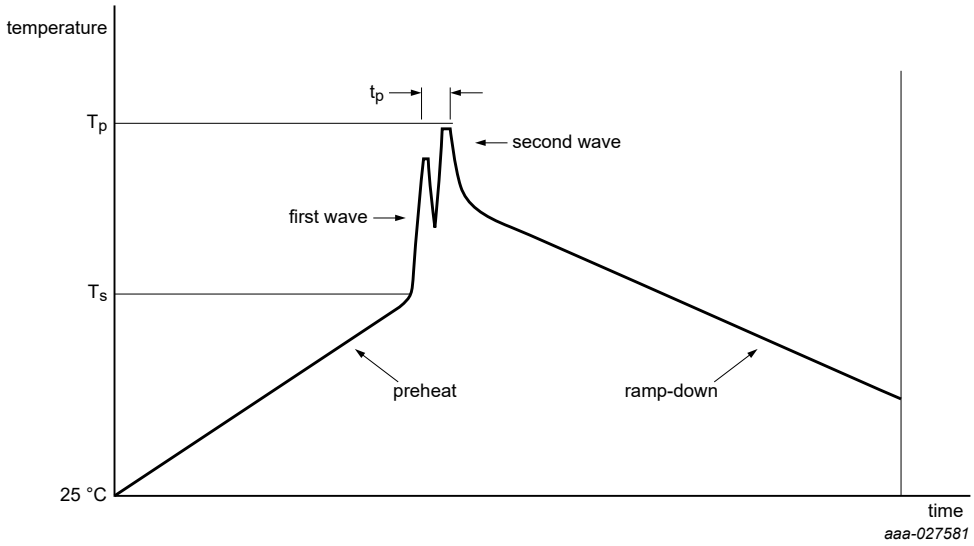


Fig. 20. Wave soldering profile

Table 1. Wave soldering parameters

Profile Feature	SnBb eutectic assembly	Pb-free assembly
Average ramp-up rate	~ 200 °C/s	~ 200 °C/s
Heating rate during preheat	1°C/s to 2 °C/s typical, 4 °C/s maximum	1°C/s to 2 °C/s typical, 4 °C/s maximum
Final preheat temperature T_s	~ 130 °C	~ 130 °C
Peak temperature T_p	235 °C	260 °C
Maximum time within peak temperature t_p	10 s	10 s
Ramp-down rate	5 °C/s maximum	5 °C/s maximum

5. Nexperia wave soldering trials

Nexperia performed wave soldering trials at third party institute for SOD123F, CFP2HP (SOD323HP), CFP3 (SOD123W), CFP5 (SOD128) and CFP15 (SOT1289). The trials were based on already mentioned designs, recommendations and guidelines . The results of the trials confirmed the recommendations given in this application note. The complete report is available on request.

Due to very similar construction and body dimensions of CFP15 (SOT1289) and CFP15B (SOT1289B) wave solder performance for CFP15B was not evaluated, but the evaluation of the CFP15 (SOT1289) is applicable.

The results from wave soldering trials are summarized in Table 2.

Table 2. Wave soldering trials

Performances	SOD123F	CFP2HP (SOD323HP)	CFP3 (SOD123W)	CFP5 (SOD128)	CFP15 (SOT1289)
Adhesive printing	Good	Good	Good	Good	Good
Component placement	Good	Good	Good	Good	Good
Shear force - After adhesive curing	> 1500 g	> 2600 g	> 1400 g	> 3200 g	Pass
Solder joint	Good	Good	Good	Good	Good
Shear force - After wave soldering	> 5600 g	> 5200 g	> 6700 g	> 10700 g	> 15000 g

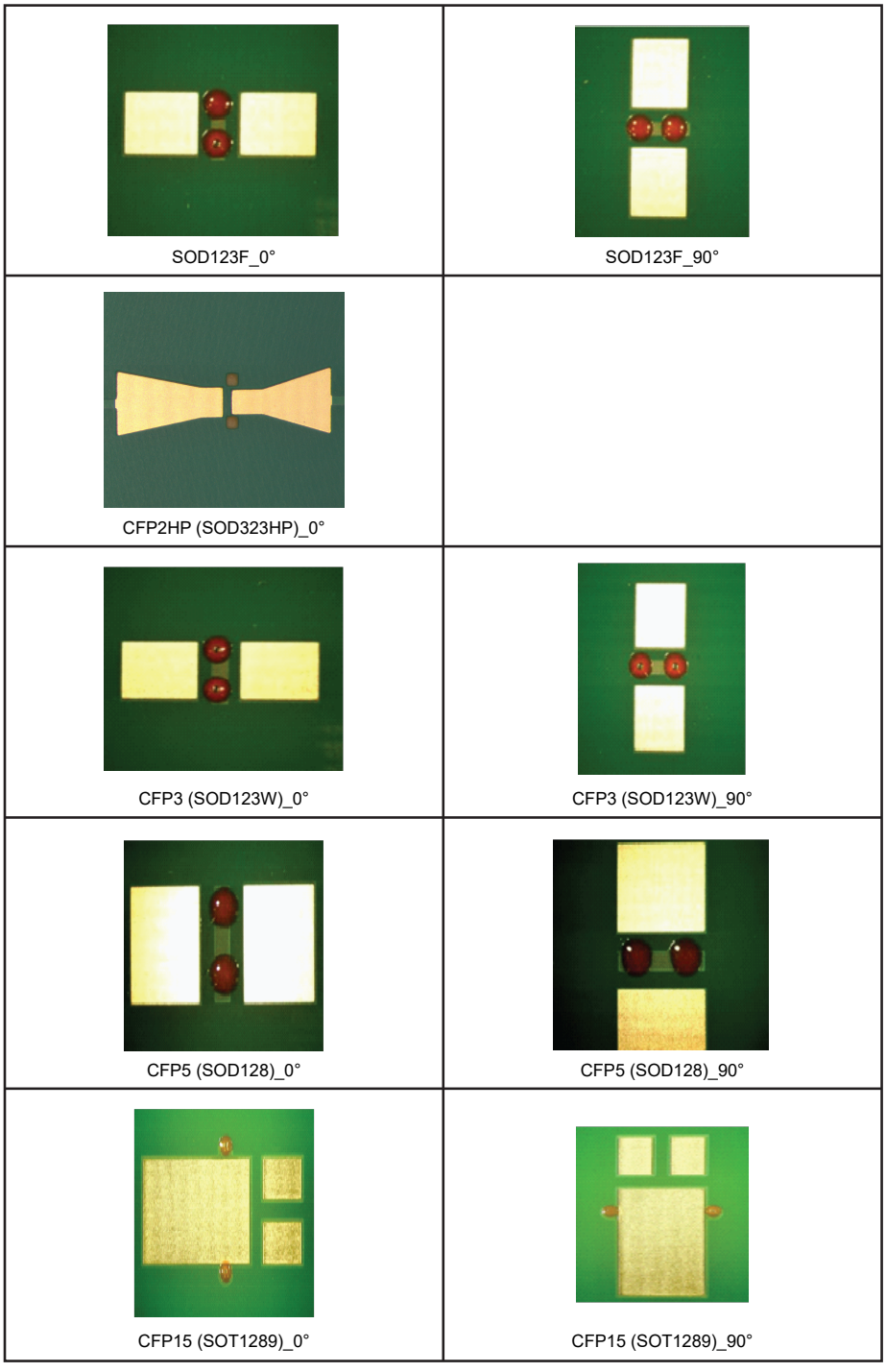
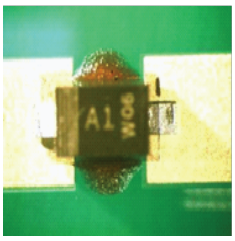
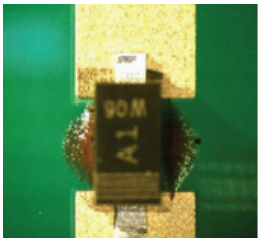
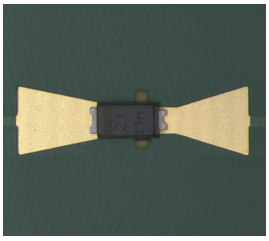
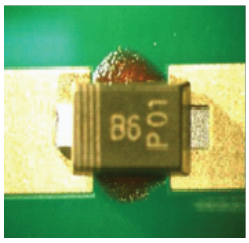
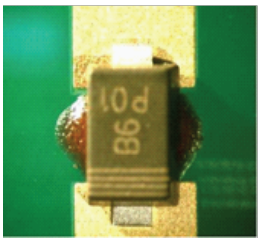
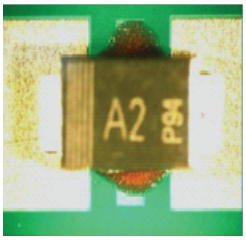
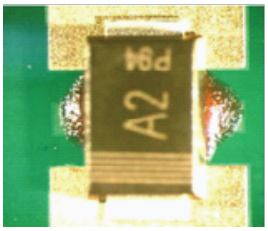
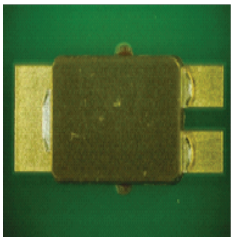
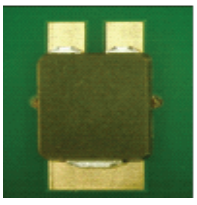


Fig. 21. After adhesive printing

 SOD123F_0°	 SOD123F_90°
 CFP2HP (SOD323HP)_0°	
 CFP3 (SOD123W)_0°	 CFP3 (SOD123W)_90°
 CFP5 (SOD128)_0°	 CFP5 (SOD128)_90°
 CFP15 (SOT1289)_0°	 CFP15 (SOT1289)_90°

aaa-027583

Fig. 22. After component placement and adhesive curing

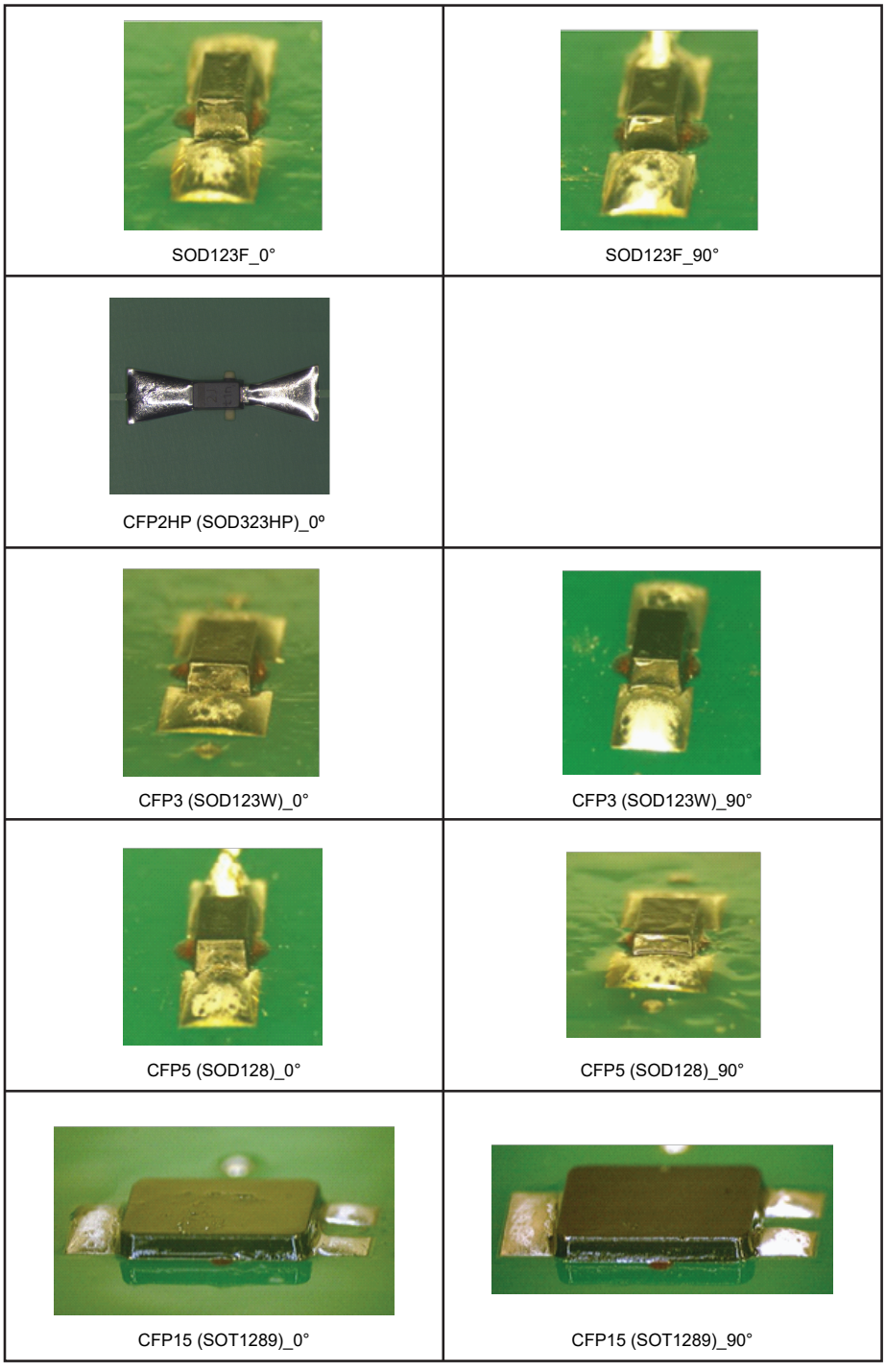


Fig. 23. After wave soldering

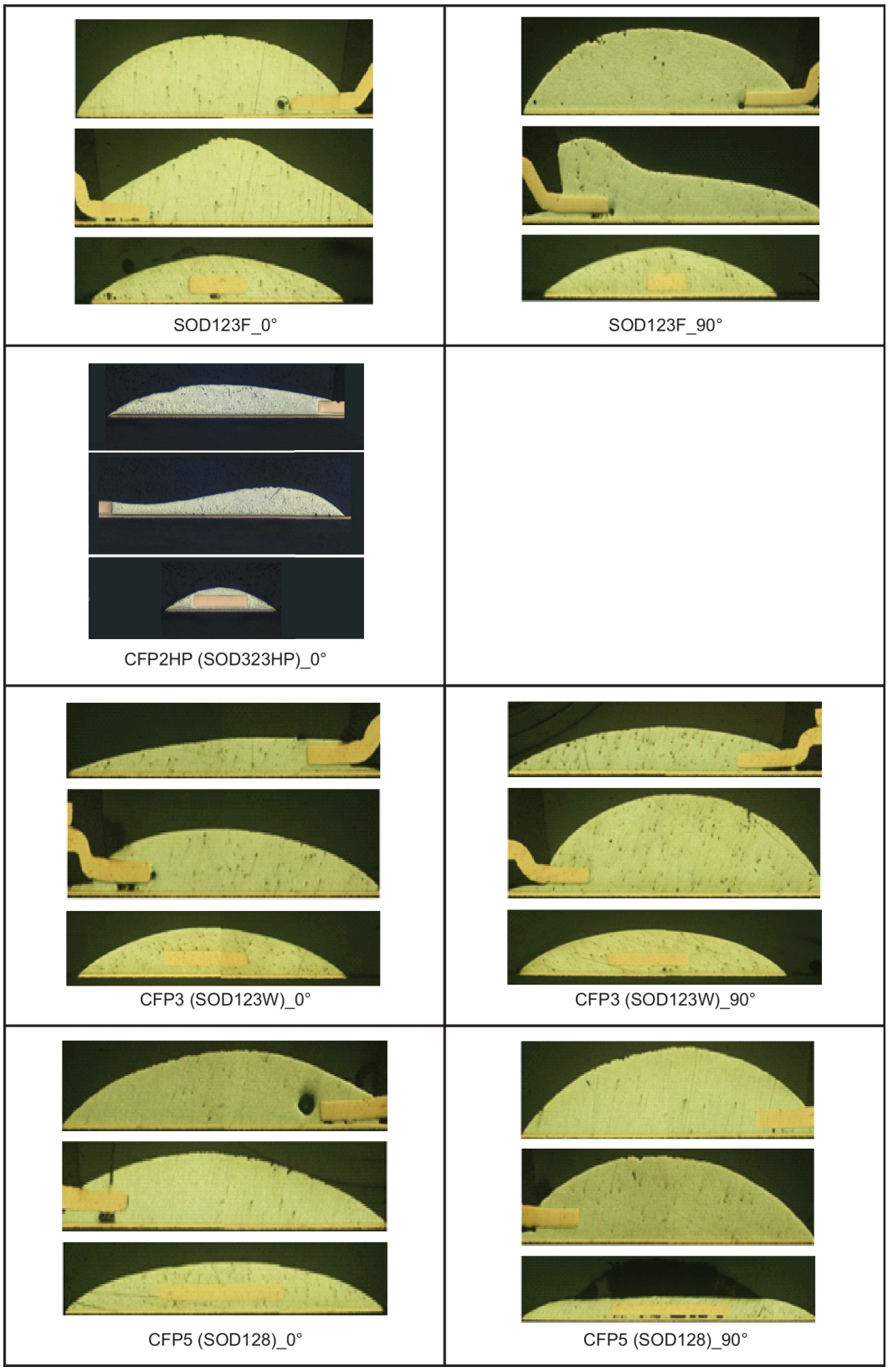


Fig. 24. Cross-section inspection

6.

Table 3. Revision history

Revision number	Date	Description
2.0	20231102	Update, CFP2HP (SOD323HP) and CFP15B (SOT1289B) are added
1.0	20171130	Initial version of the document

Table 4. Contact information

For more information, please visit: http://www.nexperia.com
For sales office addresses, please send an email to: salesaddresses@nexperia.com

7. Legal information

Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, Nexperia does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. Nexperia takes no responsibility for the content in this document if provided by an information source outside of Nexperia.

In no event shall Nexperia be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, Nexperia's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of Nexperia.

Right to make changes — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — Nexperia products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia and its suppliers accept no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using Nexperia products, and Nexperia accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Nexperia product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

Nexperia does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Nexperia products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Nexperia does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

List of Tables

List of Figures

Contents

For more information, please visit: http://www.nexperia.com
For sales office addresses, please send an email to: salesaddresses@nexperia.com
Date of release: 2 November 2023