



Rework of Underfilled Components

Underfilled components are used in consumer electronics (mobile devices, portable computers, etc.), in the automotive industry (sensor modules, motor control units) or wherever flip chips are integrated in highly miniaturized environments. An underfilled chip contributes to overall product quality thanks to higher reliability and extended service life. The underfill material protects against moisture, thermal stress and all possible mechanical influences.

The underfill represents a very special challenge for the rework process, in addition to thermal energy, mechanical energy must also be used to separate the chip and substrate. Unfortunately there is no relevant "reworkable underfill", therefore the rework success rate is always strongly dependent on the underfill materials used, the surface quality and the processing of component and substrate. The equipment and tooling used also have a great influence on the probability of success. Reworking components with underfill makes sense when the components or substrates are expensive or difficult to obtain, or if the entire product needs to be saved.

WHAT ARE THE CHALLENGES?

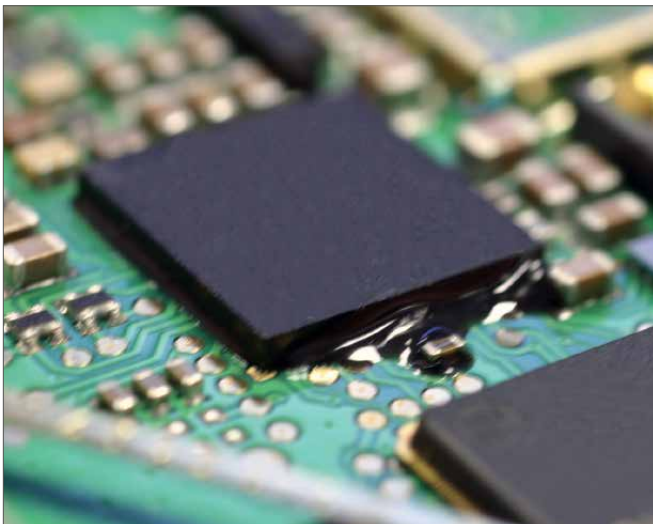


Fig. 1: Underfill component

- » Prevent interference of adjacent components on densely populated printed circuit boards with distances of less than 300 µm
- » Avoid thermal and mechanical stress on the metallic surface layer and the solder resist
- » Finding the right process according to the underfill material available

- » Variable part heights require adapted tooling and specialized rework equipment

TYPICAL PROCESS STEPS

Finetech offers a solution to carry out the entire rework cycle on a single platform:

- » underfill cutting
- » desoldering
- » removing residual solder and underfill
- » soldering

It is important that all process steps (temperature and process time) and tools are individually adapted to the component and printed circuit board (PCB).

The appropriate rework process is mainly determined by the underfill material and the surface finish of the component and substrate. There are various epoxy-based underfills, which differ in composition and properties:

- » hard or flexible
- » ability to expand
- » curing temperature
- » temperature required for removal
- » purely mechanical or chemical underfill removal

PREPARATION

Preparation considerations and customized soldering head design

Soldering heads for underfill rework must be able to clamp the component firmly and securely, since the components are also firmly connected to the PCB with liquid solder through the underfill. In addition, an underfill knife is used to cut the component free and create space for the clamping jaws of the desoldering tool.



Fig. 2: Tools for Underfill Rework

Sample Board

Ideally, a sample board is prepared with thermocouples to calibrate the profiles for the rework process. Test series allow statements on the quality and reproducibility of the reflow profiles.



Fig. 3: Typical aids for preparation

Preparation is either non-destructive or destructive. This has advantages and disadvantages that need to be weighed in each individual case.

Preparation: Non-destructive method

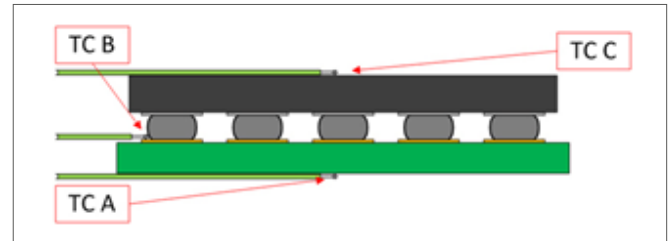


Fig. 4: Non-destructive preparation

In the non-destructive method, the thermocouples are fixed with Kapton tape.

- » **Advantages:** time-saving, reusable board
- » **Disadvantages:** inaccurate (contact may be lost), not reproducible

Preparation: Destructive method

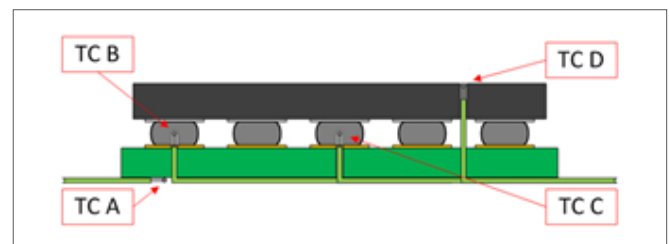


Fig. 5: Scheme of a destructive preparation

In the destructive method, the PCB or component is drilled and the thermocouples are fixed with SMD adhesive.

- » **Advantages:** More accurate and reproducible (no slippage)
- » **Disadvantages:** Destruction of the assembly and components, time-consuming preparation

Since the process camera cannot be used to check the measured temperatures in an underfill process, the destructive preparation is the better choice here.

Clamping the board

Depending on the size and shape of the boards, it is sometimes difficult to clamp the board into the ta-

ble under the spring-loaded clamping jaws. Sometimes special small board holders, flexible holders or customer-specific solutions are necessary.



Fig. 6: Clamped board

Creating the reflow profiles

For the rework cycle according to IPC/JEDEC, the software profiles must be created for the individual processes with the help of the thermocouples:

- » Underfill cutting
- » Desoldering profile
- » Removing residual solder
- » Soldering profile

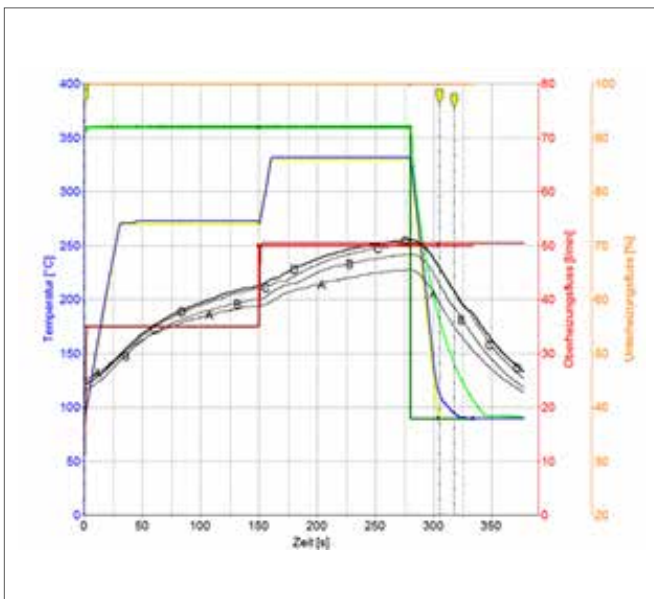


Fig. 7: Example of a soldering profile

WORKING STEPS IN DETAIL

Cutting the component free

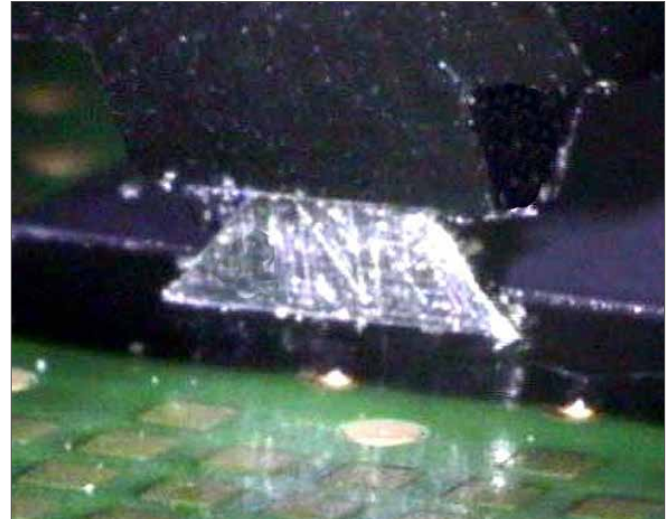


Fig. 8: Cutting the component free with an underfill knife

Before desoldering, the component must be cut all around. This is especially necessary if adjacent components are located under the underfill to prevent adjacent components from lifting off. Furthermore, space is also created for the clamping jaws of the desoldering tool and a better contact surface. To avoid damaging the solder resist with the knife, the knife sits on the component (see Fig. 9).

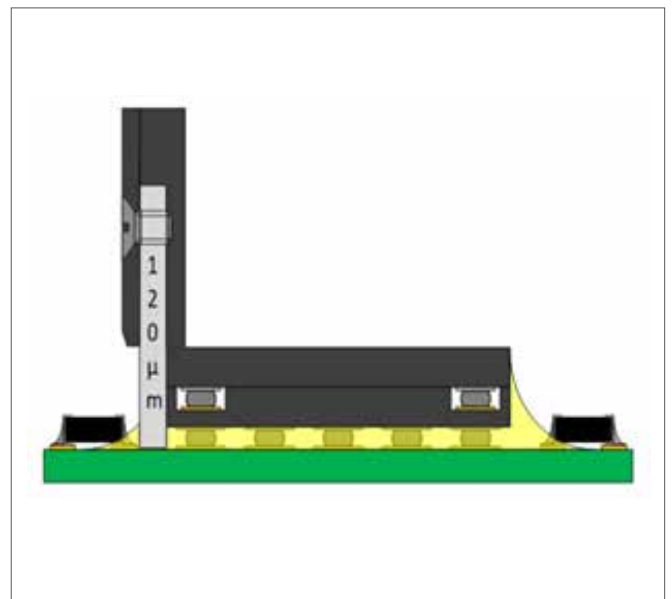


Fig. 9: Cutting the component free - sketch

Desoldering

In order to desolder underfill components, the appropriate soldering head must be clamped; in this case it is important that the clamping mechanism is open. In the next step, the circuit board is aligned to the solder head via the superimposed image and the temperature process can be started. If the solder is liquid (if necessary using flux or nitrogen), the clamping is closed and the component can be lifted off.

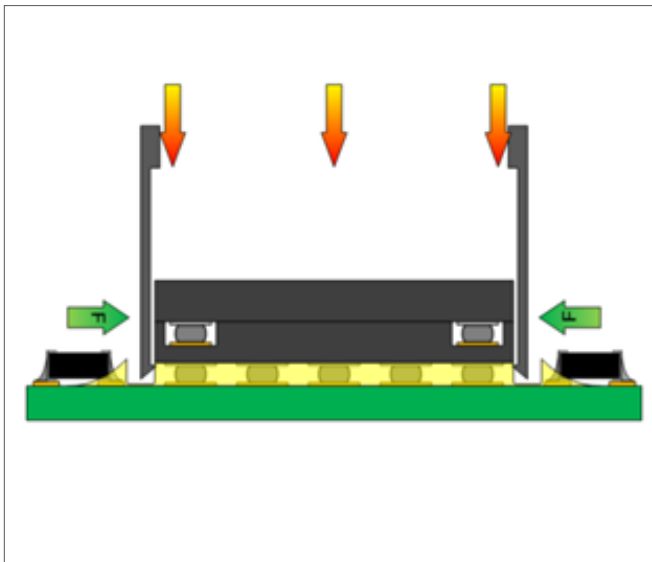


Fig. 10: Desoldering of underfill components - sketch



Fig. 11: Clamping head in process



Fig. 12: Underfilled components after desoldering

Remove residual solder and underfill residues

The remaining solder is melted. The solder is sucked off and at the same time the underfill is sheared off with the soldering head. Any remaining underfill can be removed with a brush.



Fig. 13: Underfill residues after component removal

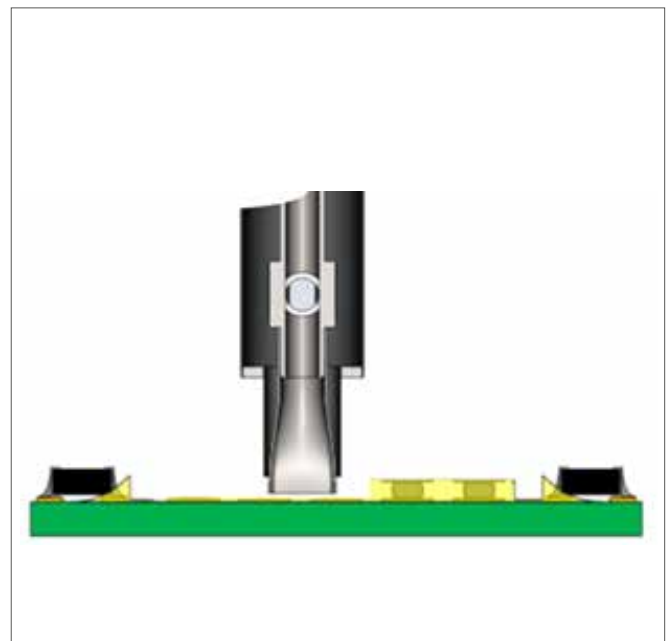


Fig. 14: Shearing off the underfill - sketch

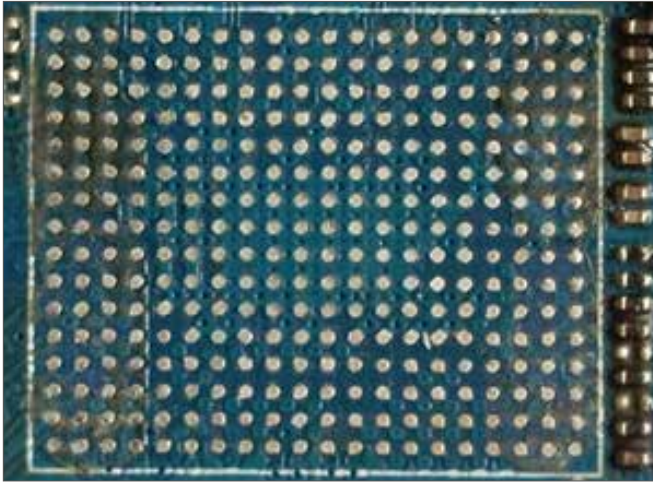


Fig. 15: Footprint after residual solder and underfill removal

Reballing

The remaining solder is melted. The solder is sucked off and at the same time the underfill is sheared off with the soldering head. Any remaining underfill can be removed with a brush.

New components that are already equipped with solder balls can be soldered in directly. It is recommended to dip them in flux or solder paste beforehand.

- » To be able to solder a BGA again, new solder balls are attached to the component.
- » Apply flux (with brush or squeegee)
- » Use a small amount of sticky flux to facilitate subsequent removal of the reballing stencil.
- » Fix the BGA with the help of the reballing set and put on the template
- » Use suitable solder balls
- » Pour on solder balls and spread with a brush, wipe off any superfluous solder balls
- » Melt with a suitable soldering head



Fig. 16: Reballing module, template is aligned

Solder paste printing on PCB

In addition to reballing, there are other methods for applying new solder. However, these variants only serve as support and cannot replace solder balls on the component. When solder paste is printed onto the PCB, the solder is applied directly onto the assembly at the mounting position using a printing stencil and a squeegee. The print stencil on the solder paste print head corresponds to the component footprint and is aligned with the suctioned pads utilizing optics. With the FINEPLACER®, the stencil is placed in the mounting position and the solder paste is pressed through the openings with a squeegee.

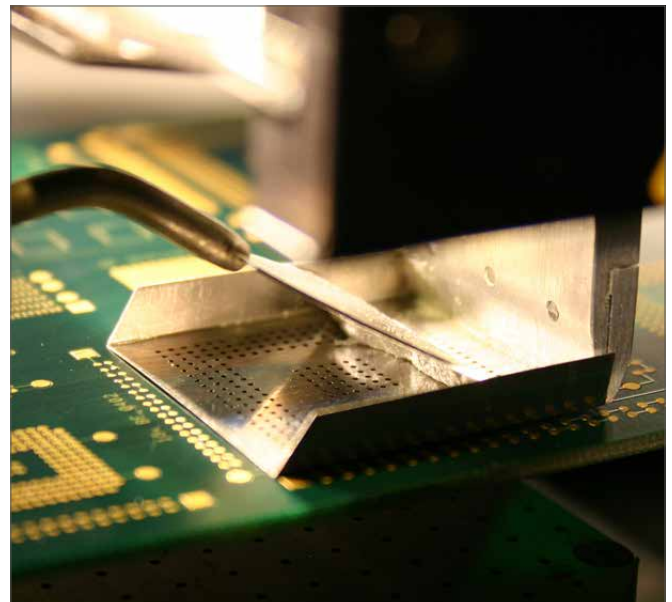


Fig. 17: Solder application with solder paste print head

- » **Advantage:** Fast, reproducible
- » **Disadvantage:** Each printed image requires its own stencil. Only supporting the solder material on the component

Dispensing of solder material

During dispensing, solder paste is applied using a cannula. The solder points must be placed individually on each pad to avoid bridging and to ensure an even distribution of the solder.

- » **Advantage:** flexible
- » **Disadvantage:** laborious



Fig. 18: Dispensing of solder paste

Soldering

After successful solder paste application, the new component can be soldered in. Alignment to the pads is simplest with an optical system that can display solder balls and "landing pads" simultaneously with the aid of an overlay image. In order to re-solder the BGA, the same soldering head and a very similar profile can be used as in the desoldering process. The only significant change is an additional cooling step to allow the solder paste to solidify again.

- » Alignment of the component to the mounting position using the overlay image
- » If necessary, use of split-field optics for large components
- » During the temperature process (soldering) the component floats in automatically



Fig. 19: Replaced component

Application of fresh underfill

After the new component has been soldered in place, new underfill can be applied. Depending on the type of underfill, a new heating process is necessary to harden the material.

Cleaning and optical inspection

After soldering, the board and the equipment should be cleaned, removing solder and flux residues. Visual inspection of the solder joints under a microscope is important. More precise findings can be obtained by X-ray and electrical testing. If necessary, secure the re-soldered component (e.g. refill with underfill material).