

## Void Free Soldering with Vacuum

*From laboratory level to mass production*

*Vacuum application in the soldering process reduces the void rate in the soldered joints considerably, typically to below 1%.*

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Shrinking package sizes of electronic devices require a perfect thermal management thus, void free soldering. Voids reduce the electrical and thermal conductivity and cause hot spots. In addition, lead free solder escalates the formation of voids. The only reliable method available to remove voids from the liquid solder is the use of vacuum. The patented inline soldering system with vacuum – VADU – by PINK eliminates voids. Heating and cooling is based on contact heat transfer. The temperature gradients are adjustable by distance regulation between the heating plate and the substrate. A controlled application of vacuum at any time improves the heating process by possible reduction of spluttering. Vacuum applied in the liquid phase of the solder, removes voids to zero, respectively to below 1%. Any product, independent from its thermal mass, can be soldered void free, with temperature profiles according to customers specifications, or IPC / JEDEC recommendations.

### History

The VADU was developed already in the mid 90's, based on a customer's request for an inline soldering system with vacuum. The task was void free soldering of large surface connections in the power module manufacturing. The VADU soldering process with vacuum is meanwhile well established through many years of serial production and is protected by worldwide patents.

### Soldering process

Basically all usual solder materials such as solder paste or preforms can be handled and high temperature solder can be processed up to 400 °C. An efficient flux management system steadily removes all flux residues and protects the process chamber as well as the vacuum pump from con-

tamination. Flux free soldering is possible by using forming gas or formic acid for activation. Combined processes, such as die attaché with solder paste and DBC to base plate soldering with preforms and formic acid for activation are also possible in one step.

### Heat transfer and temperature gradients

The applied heating method by contact heat transfer and distance control is very efficient and flexible. The heating gradient is adjustable and is independent from the thermal mass of a product. Even heavy mass substrates (i.e. 1 kg) can be heated up and cooled down with the usual IPC / JEDEC gradients. This heating method by contact

about 100°C. A second critical phase is at approx. 180°C, caused by other volatile properties of the solder paste.

### Vacuum application

Vacuum is used in every process chamber for:

- Preparation of the chambers by removal of oxygen and purging with nitrogen in order to create an inert atmosphere. By this, the residual oxygen is reduced from 22% (ambient), to 3 or 5ppm, depending on the nitrogen quality used by a customer.
- Process improvements during preheating, for removal of out gassing.
- Void removal from the liquid solder



Figure 1:

also allows an interruption of the heating profile and a "holding time" at any temperature range, to allow a soft escape of gas bubbles and to avoid critical "volcano effects". For example in case of hygroscopic solder paste, the moisture changes immediately to vapour and expands explosively at

### Flexibility of all process parameters

All process parameters such as temperature gradients, vacuum profiles, applied process gases and process time in the individual chambers, are very flexible and can be set via program. A mixed production with smallest batch sizes and very different process

profiles can be handled by using an identification system, such as barcode reading. It is therefore possible to handle a batch with lead free solder paste, followed by a batch with lead solder, followed by flux free soldering and vice versa. The best possible process conditions for every product can be developed and utilized with the result of reliable and reproducible void free soldering connections.

**Heat flow and thermal stress for the assemblies**

The heating plate of the VADU has a constant high temperature. Heating of the substrates is done by contact between the heating plate and the base plates of the substrates. The heat flow is therefore from the bottom side, the heavy mass part of the product. Only after these heavy mass parts have reached their wetting temperature, the heat is transferred to the substrates and components on top and the solder starts melting. The total time, in which the sensitive parts, such as dies, are exposed to the high soldering temperatures, is therefore very short and overheating is excluded.

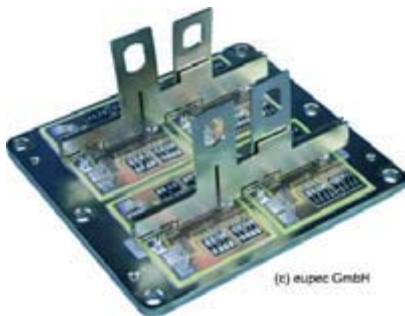
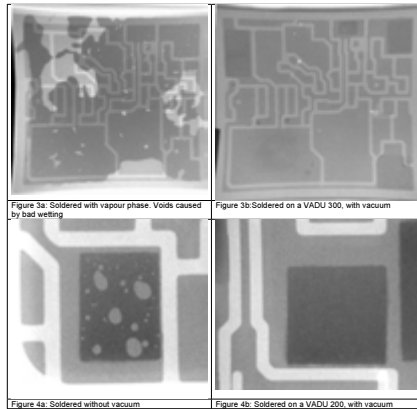


Figure 2 : Module Example from eupec

In case of conventional heating methods the entire assembly heats up simultaneously. This means that all parts involved are exposed to the high soldering temperatures during the entire heating process. The solder starts melting before the heavy mass base plates have reached wetting temperature. This causes areas of “bad wetting” and additional serious voids.

**Traceability**

The entire process takes place under controlled and reproducible conditions. The temperature profile and the process atmospheres as well as the vacuum profiles can be pre-set. The actual data can get permanently collected and recorded and can be assigned to an individual batch for traceability.



Figures 3a-4b : Possible quality improvements with the PINK VADU technology.

**Customers benefits of the patented VADU- technology**

- Void free soldering
- Inline operation (VADU 300 only)
- Temperature profiles in accordance with IPC / JEDEC
- Adjustable temperature gradients
- Separate process chambers for heating and cooling
- Process temperatures up to 400°C
- Soldering with preforms or solder paste
- Flux free soldering possible
- Operation with formic acid or forming gas
- Consistent process control and traceability



Picture 1: VADU 300  
Standard inline system for serial production.  
Loading and unloading of products either manual or automated.



Picture 2: VADU 100  
For laboratories and small batch sizes.

**Product range:**

VADU technology is available in different sizes, for different throughput requirements, from the small, laboratory type VADU 100, to the VADU 200, for serial production, to the high speed VADU 300 for inline operation. All systems offer the same concept of technology and identical process performance. The only difference is the possible throughput. Soldering and vacuum processes developed on the small VADU 100 can directly be transferred to the high speed inline VADU 300XXL.

The x - ray examples of typical products demonstrate the advantage of vacuum solder process technology.

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