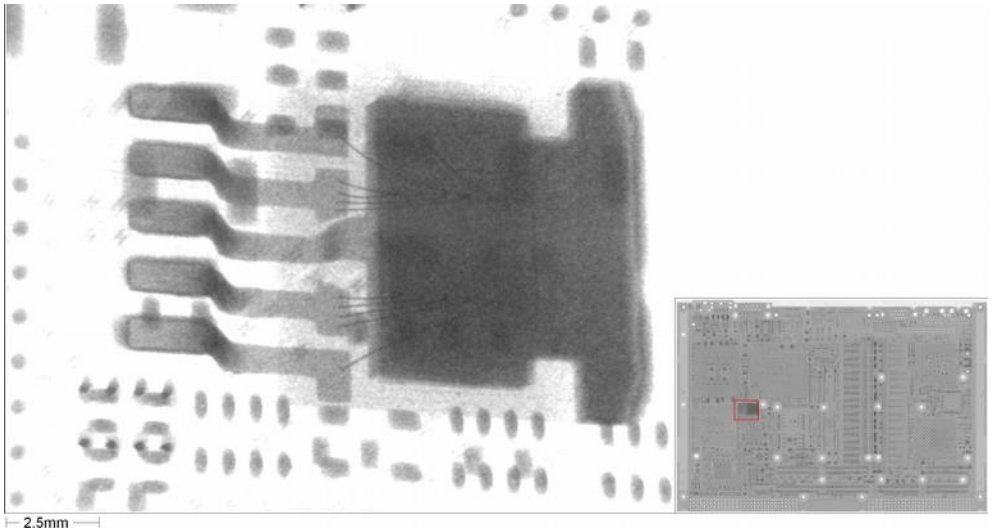
Void free soldering with Vapor Phase



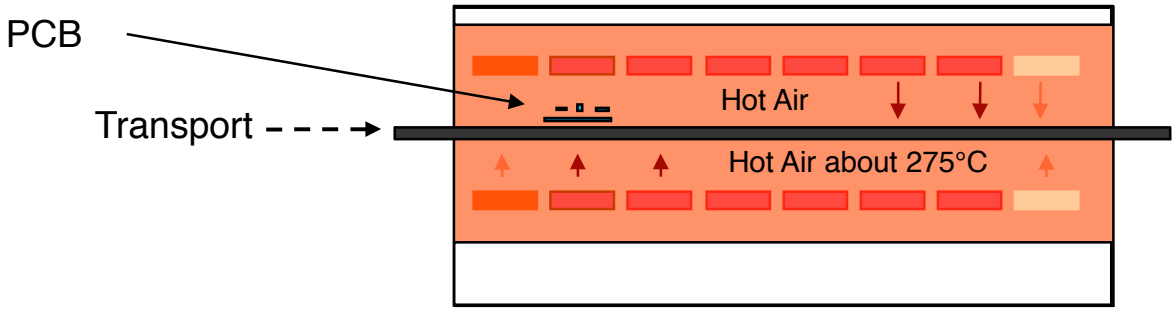
Andreas Thumm

Reflow Soldering with Vapor Phase

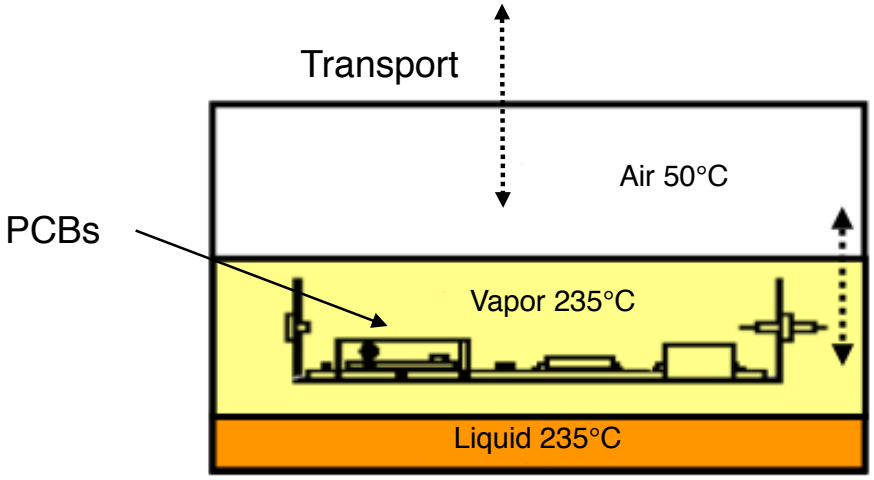
- Introducing Vapor Phase soldering
- Qualities of Vapor Phase soldering
- Reflow soldering and voiding
- Vacuum soldering to reduce voids
- Summary

Reflow Soldering with Vapor Phase

Convection: Transfering heat with hot air



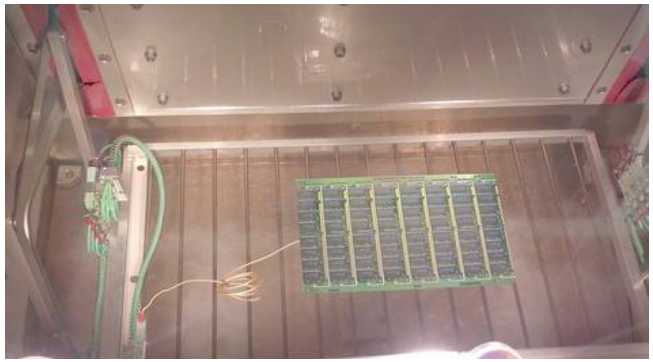
Vapor Phase: Transfering heat with a hot vapor



Reflow Soldering with Vapor Phase

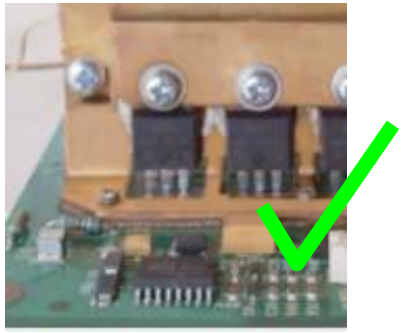
Heat distribution with vapor

The heat distribution is much more efficient and equal in a vapor (condensation) than in convection or forced convection

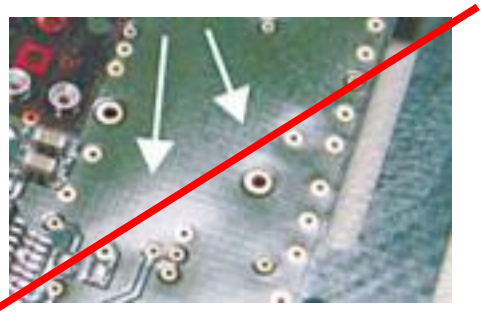


Heat transfer coefficient: α [$Wm^{-2}K^{-1}$]		
radiation	20 - 30 60	preheating peak
convection	5 10 - 20 40 - 60	air in rest at 5 m/s at 5 - 20 m/s
condensation	100 - 400	
contact (liquid solder)	4000	

Vapor Phase characteristics

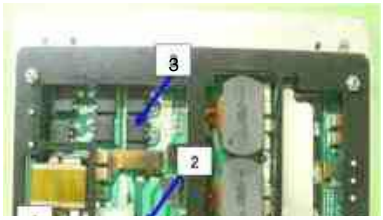


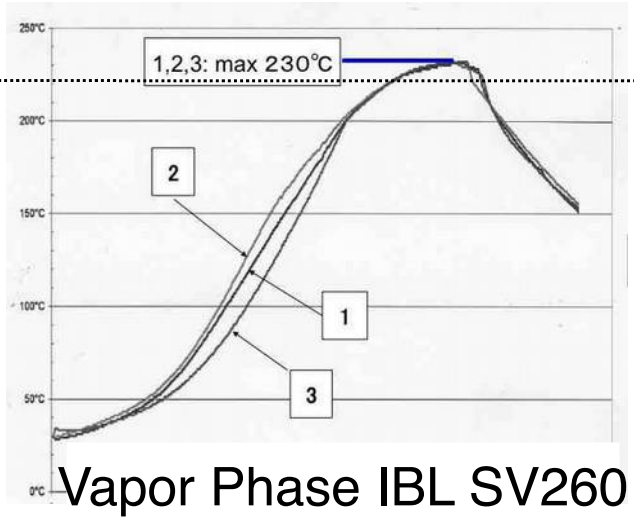
- Very good, equal and uniform heat transfer
- Lower process temperatures
  for less stress on boards, parts, materials
- Physically no overheating
- No delamination
- No ΔT between different mass components
- No oxygen - no oxidation in soldering
  for best wetting of solder



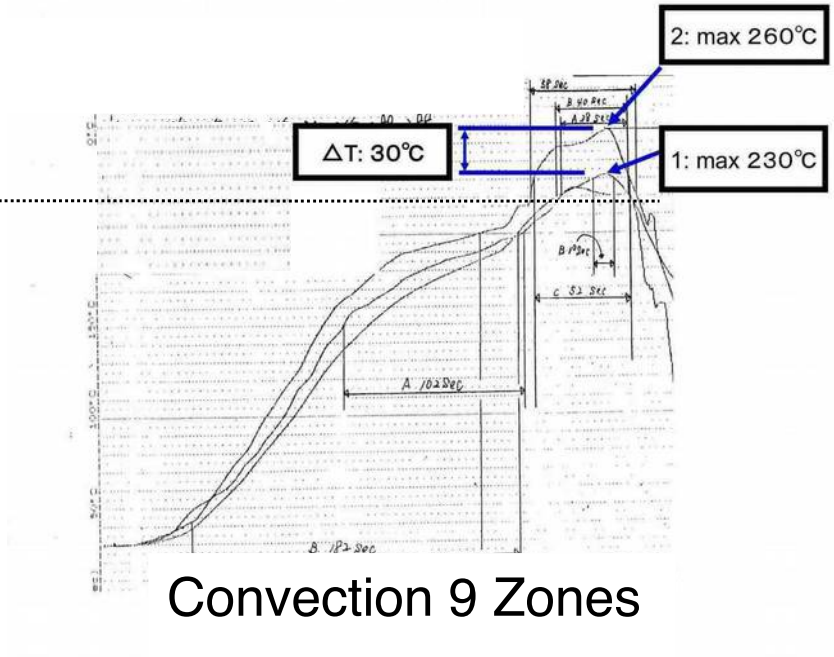
Vapor Phase characteristics

= low to no ΔT between different mass components





Vapor Phase IBL SV260

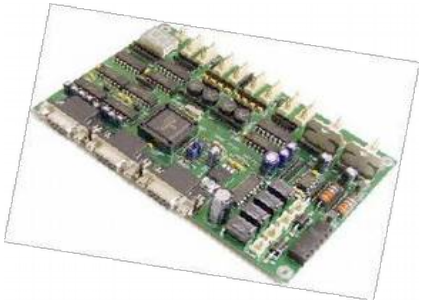


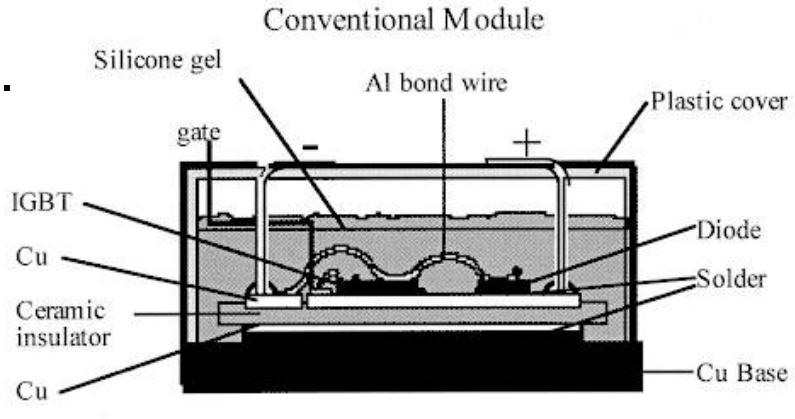
Convection 9 Zones

Reflow Soldering with Vapor Phase

Vapor Phase - a great solution for difficult solder jobs

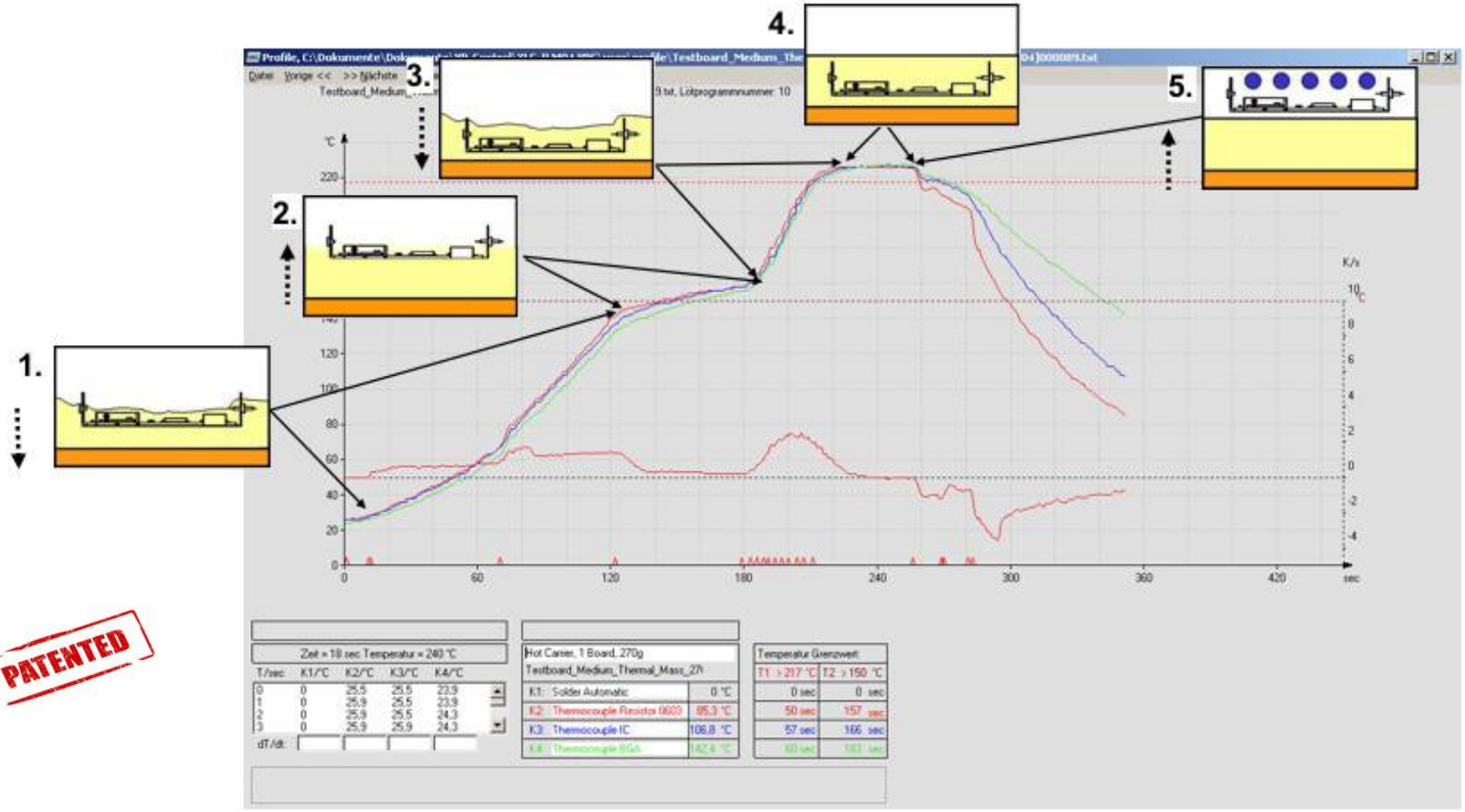
- Multi layer -, ceramics -, metal core boards, IGBTs, ...
- Ceramic-, glass substrates, …
- LGAs, BGAs, LEDs, ...
- High masses, transformers, ...
- Heat sinks, shieldings, ...
- Lead free and tin lead solder
- ...





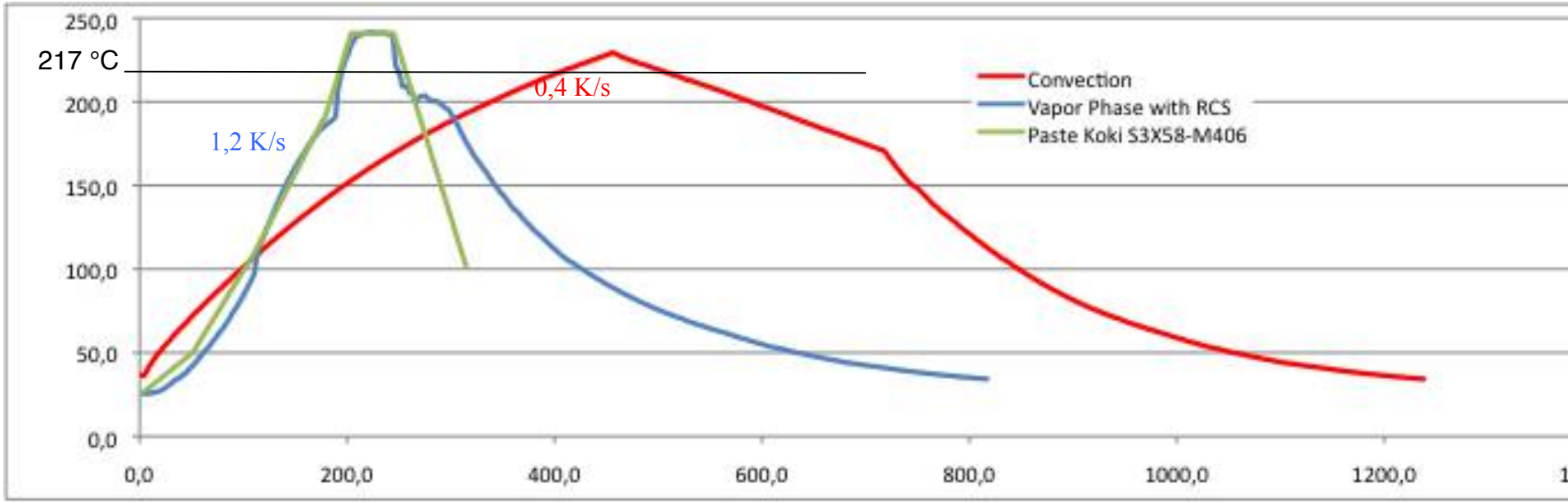
Reflow Soldering with Vapor Phase

Solder profiles in IBL Premium Vapor phase machines



Reflow Soldering with Vapor Phase

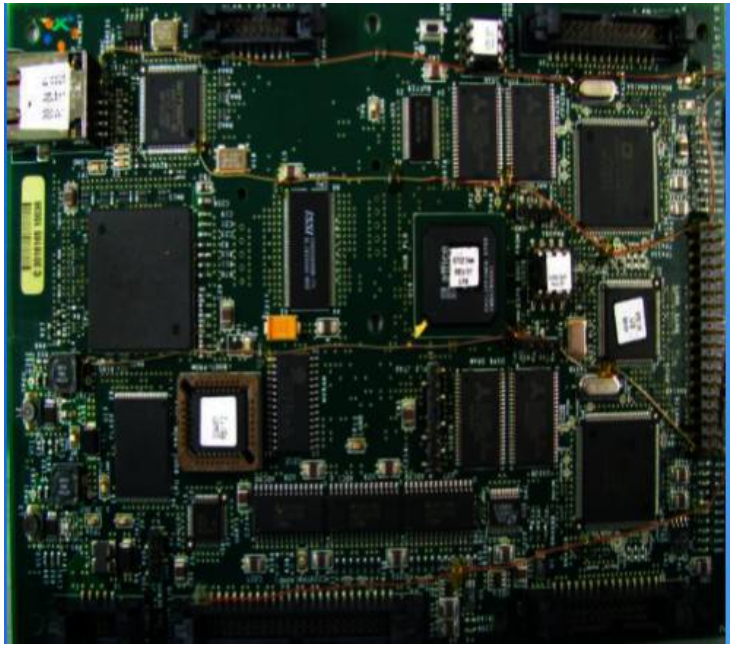
Solder profile comparison of a high mass unit

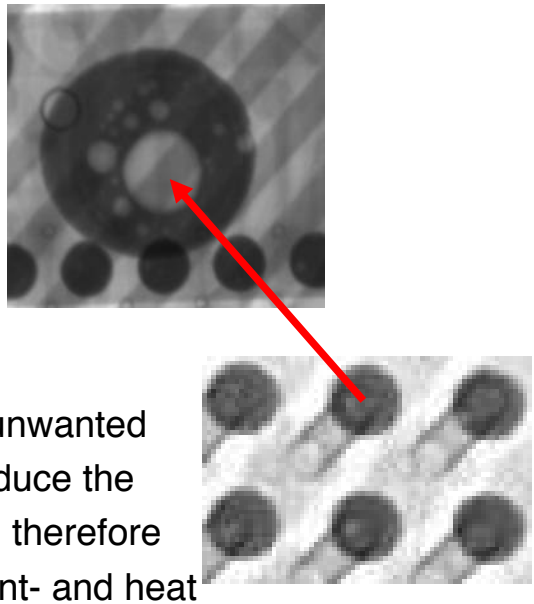


Solder profile of a ceramic unit (0,4 K/s vs 1,2 K/s) in direct comparison of Vapor Phase and Convection

Reflow Soldering

Voiding in reflow soldering

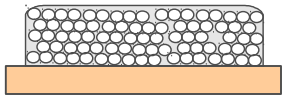




Voids are often unwanted because they reduce the section area and therefore reduce the current- and heat flow.
They have also an influence on the mechanical property of the solder joint.

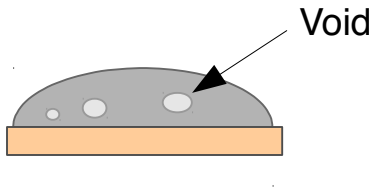
Reflow Soldering with Vapor Phase

Solder paste and voiding

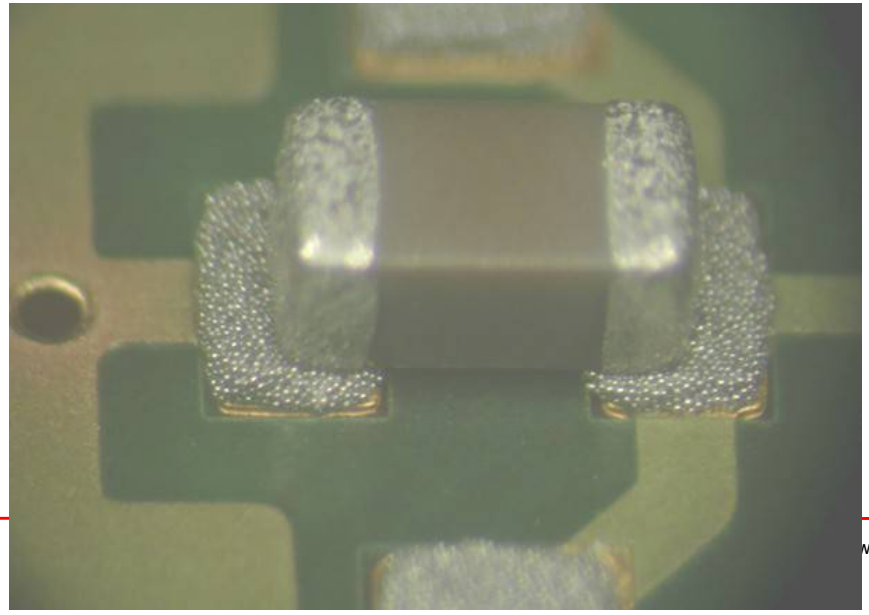


Paste printed

Paste at melting



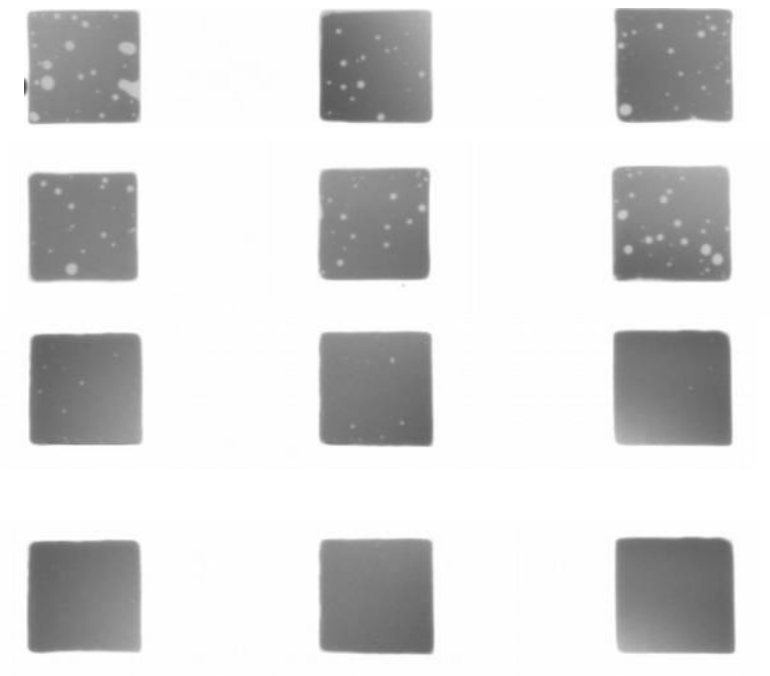
Paste molten



Vacuum Reflow Soldering with Vapor Phase

Voiding at reflow soldering with solder paste

Test pad 10 x 10 mm²



Normal soldered (without vacuum)l

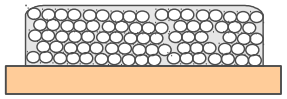
Soldered with optimized profile (without vacuum)

Vacuum soldered at 50 mbar

Vacuum soldered at 20 mbar

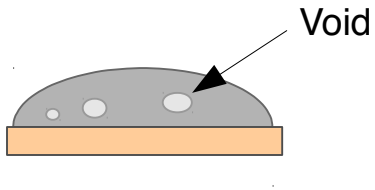
Reflow Soldering with Vapor Phase

Solder paste and voiding

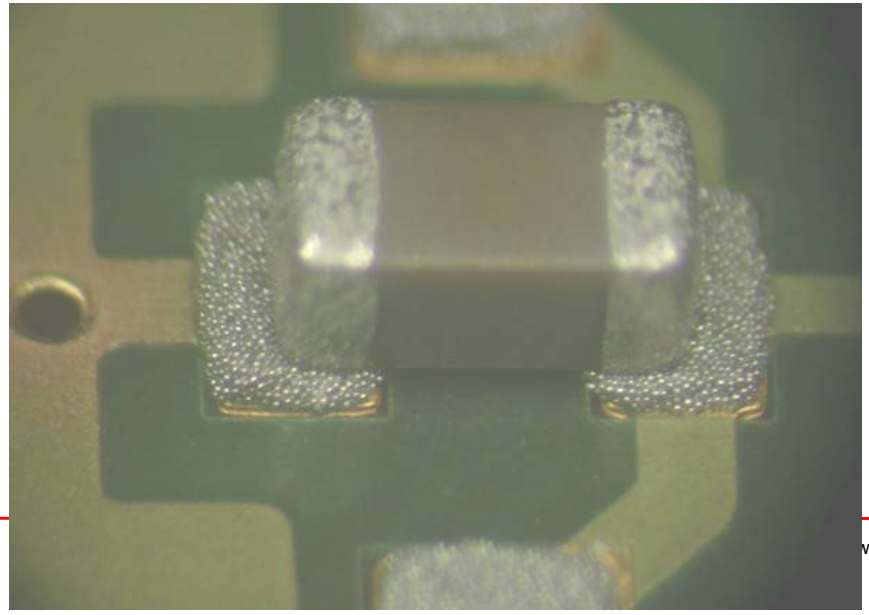


Paste printed

Paste at meting

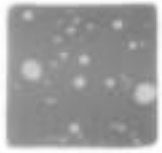


Paste molten

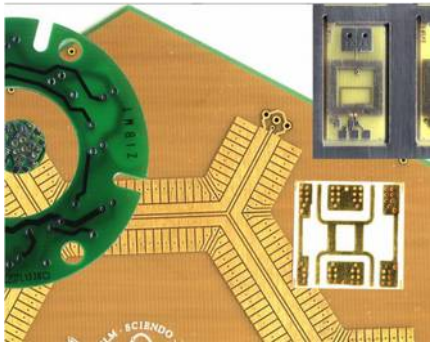


Vacuum Reflow Soldering with Vapor Phase

Major voiding influences



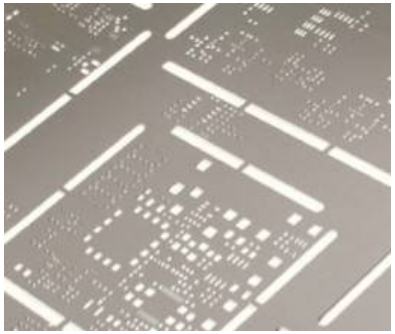
- Size of the solder area
- Pad materials and thickness
- Coatings and surfaces (Ag, Au, Sn, …) and thickness
- Oxides in paste and pads
- Design of solder mask
- Vias und microvias
- …..



Vacuum Reflow Soldering with Vapor Phase

Major voiding influences

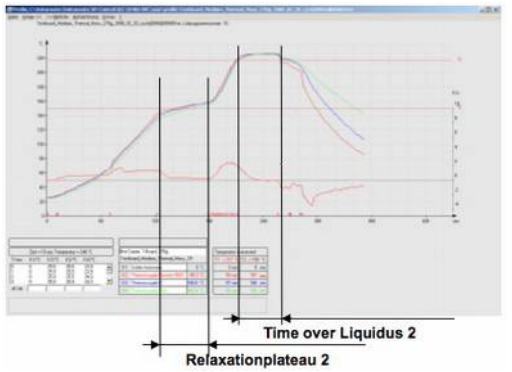
- The solder paste und its content
- The flux type and amount
- Chemical reactions of flux and oxides
- Outgassing PCBs and plastics
- Print thickness
- The wetting characteristics
- Solder profiles (temperatures und process times)
- .....



Actions to reduce voids

- Proper handling of components and boards

  moisture sensitivity, oxidation, temperatures, ...
- Replace solder paste with preforms when possible
- Select proper solder paste and flux
- Minimize oxidation during soldering (nitrogen or vapor)
- Optimize the soldering profile (soak, TAL,..)
- Use vacuum to reduce voids
- .....



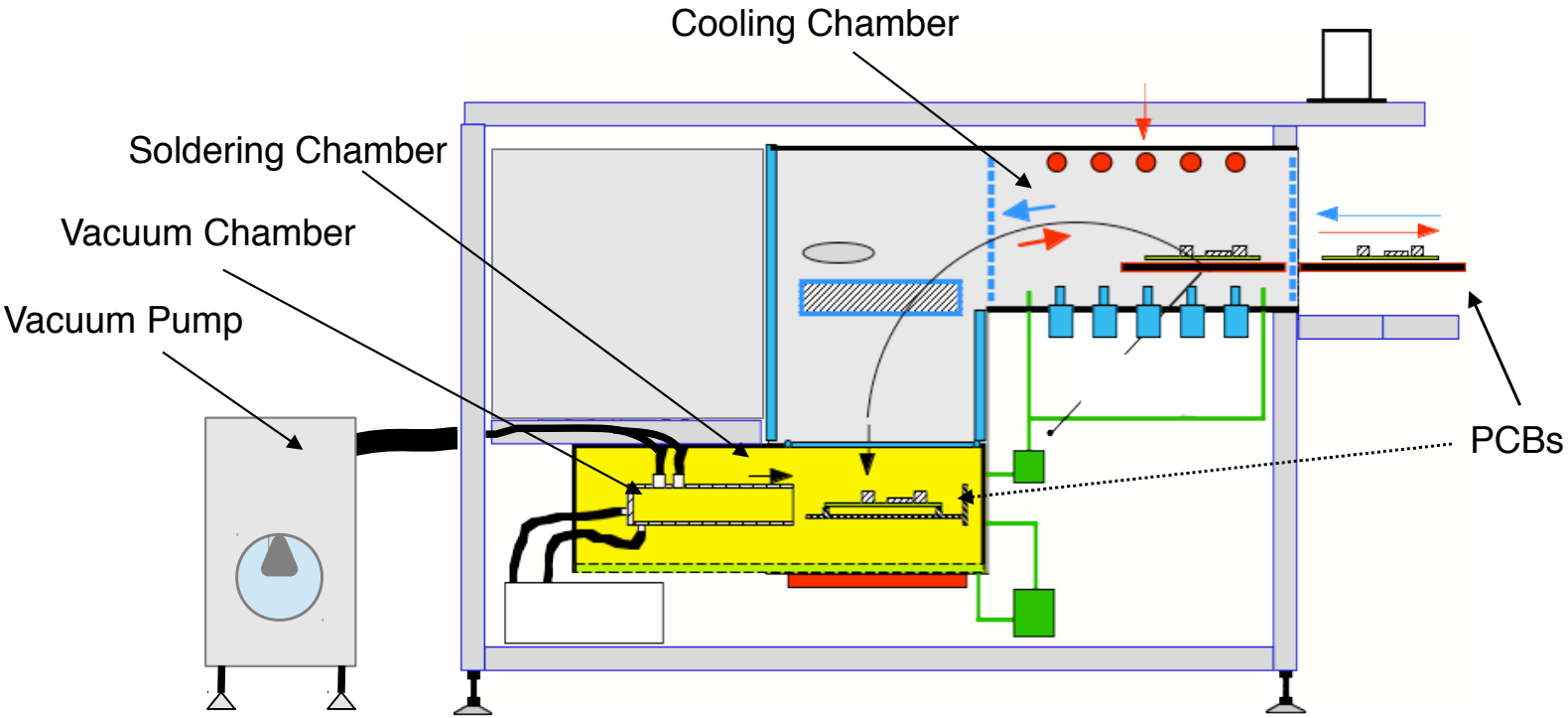
Vacuum Reflow Soldering with Vapor Phase

Vacuum reflow solder machines

as batch or inline type available

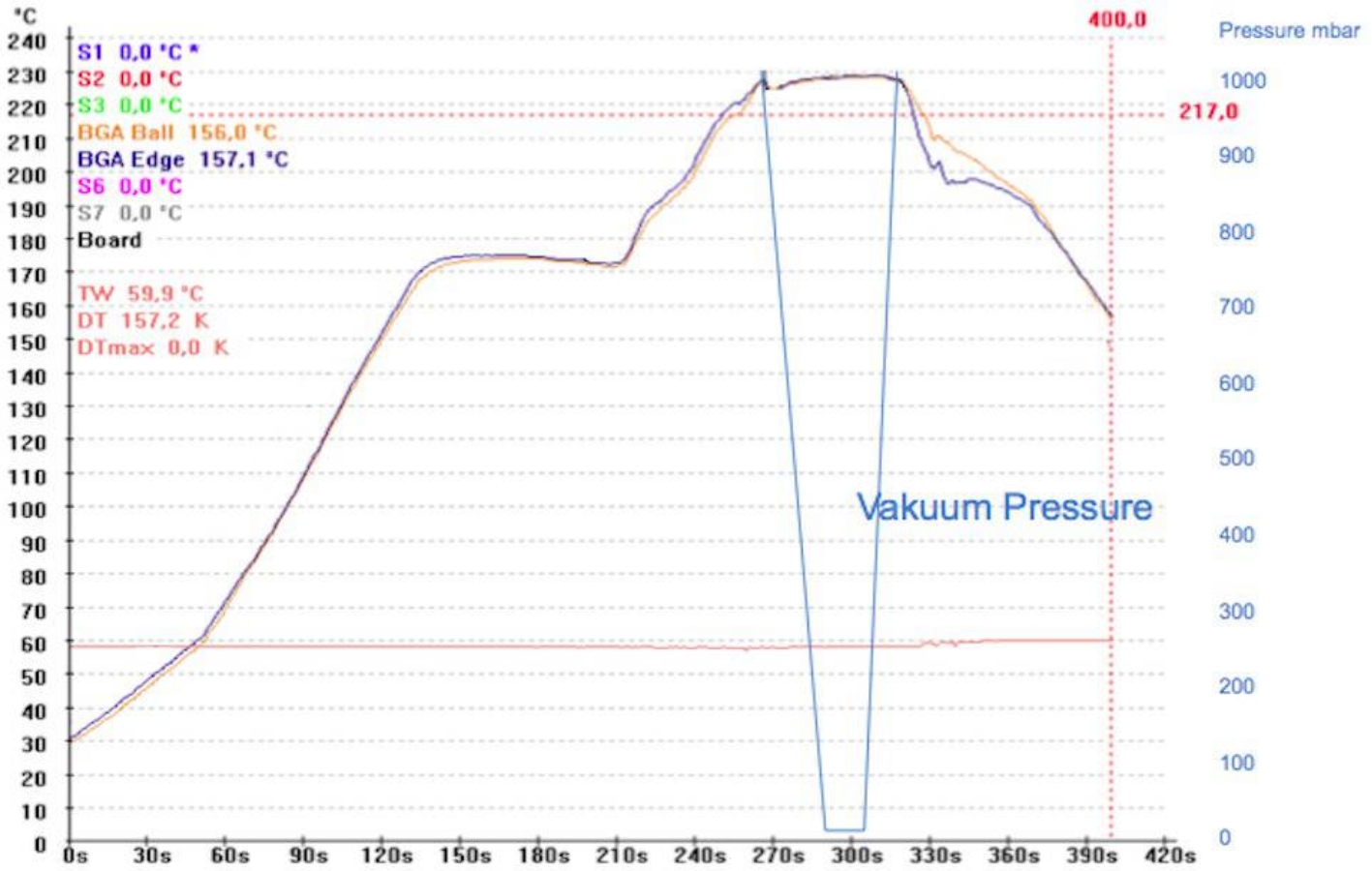
Vacuum Reflow Soldering with Vapor Phase

Draft of a vacuum solder machine



Vacuum Reflow Soldering with Vapor Phase

Vacuum solder profile



Vacuum Reflow Soldering with Vapor Phase

Large soldering areas

- have typically more voids
- a pressure of < 20 mbar shows good results
- the solder print thickness has an influence and should not be too thin
-

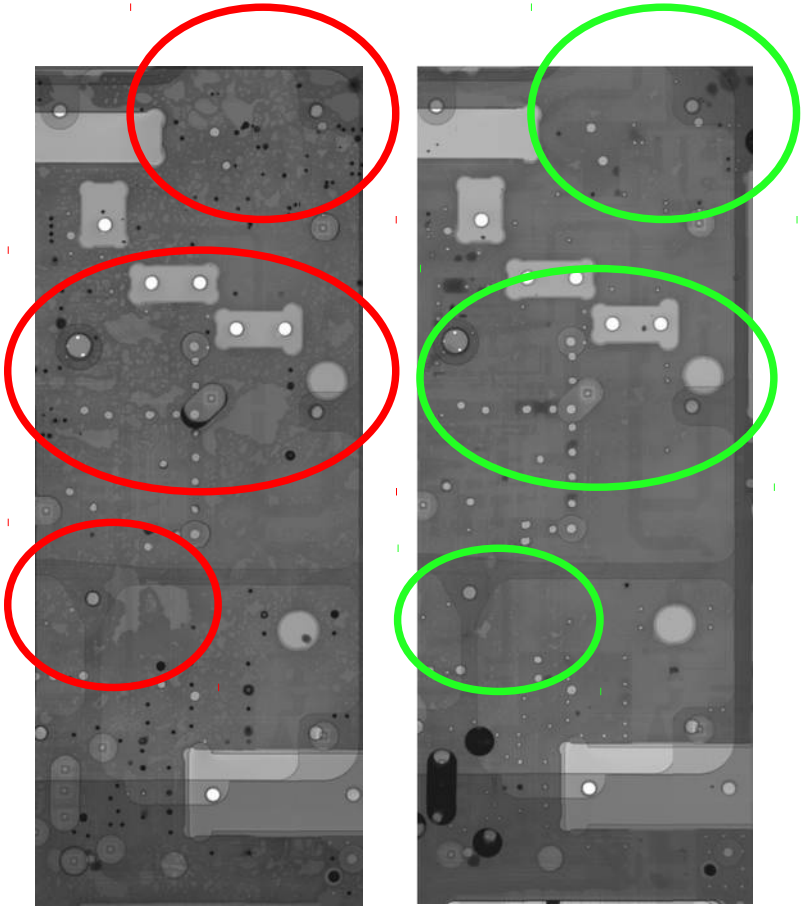


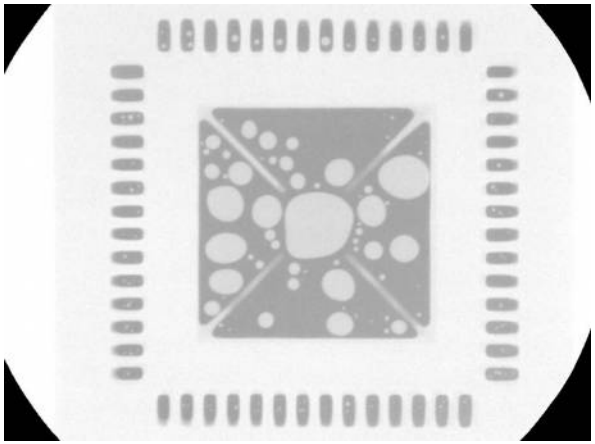
Bild 1
Ohne Vakuum

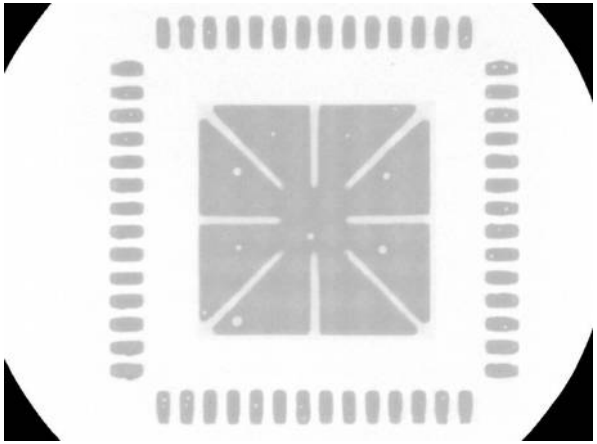
Bild 2
Mit Vakuum

Vacuum Reflow Soldering with Vapor Phase

Packages in general

- a pressure of < 20 mbar
  for good results
- mind the moisture sensitivity of
  boards and components (MSL)
- optimize the printing layout with
channels etc.
- …..

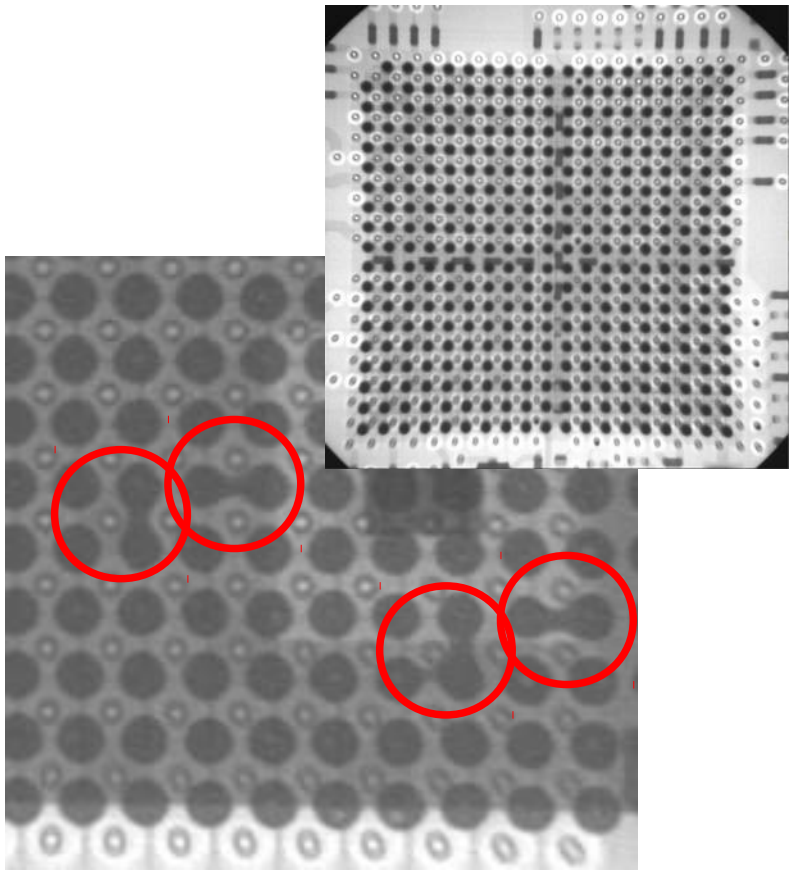




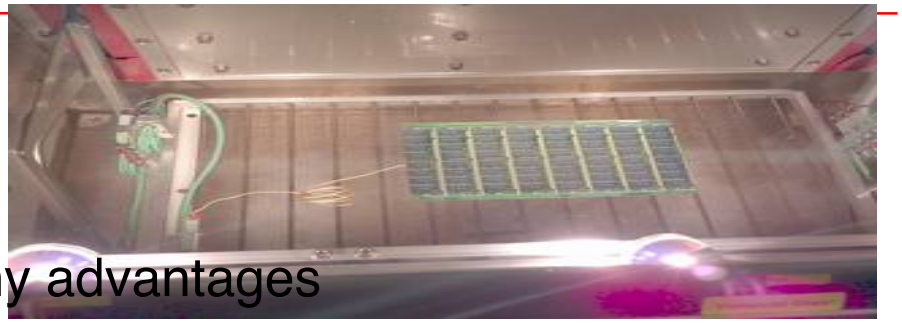
Vacuum Reflow Soldering with Vapor Phase

BGAs und Packages

- adjust vacuum speed
- optimize holding time of the vacuum
- adjustable speed of releasing the vacuum
- Avoid vibrations
- …..



Reflow Soldering with Vapor Phase



Summary

- Vapor phase soldering has many advantages

  perfect heat transfer, lower process temperatures, no oxidation, no ΔT …..

- Vapor phase can be combined with vacuum

  for void free soldering

- Design and Layout has an Influence on voiding

  Selection of materials and surfaces, placing vias, channels, …..

- The process must be adjusted for best results

  Thickness of solder paste, vacuum pressure, vacuum speed, vac holding time, …..

- Solder equipment has an Influence on the quality

  Machine concept, flexibility and adaption of processes, repeatability of profiles, …..

Reflow Soldering with Vapor Phase

Thank You for Your Attention !

Andreas Thumm