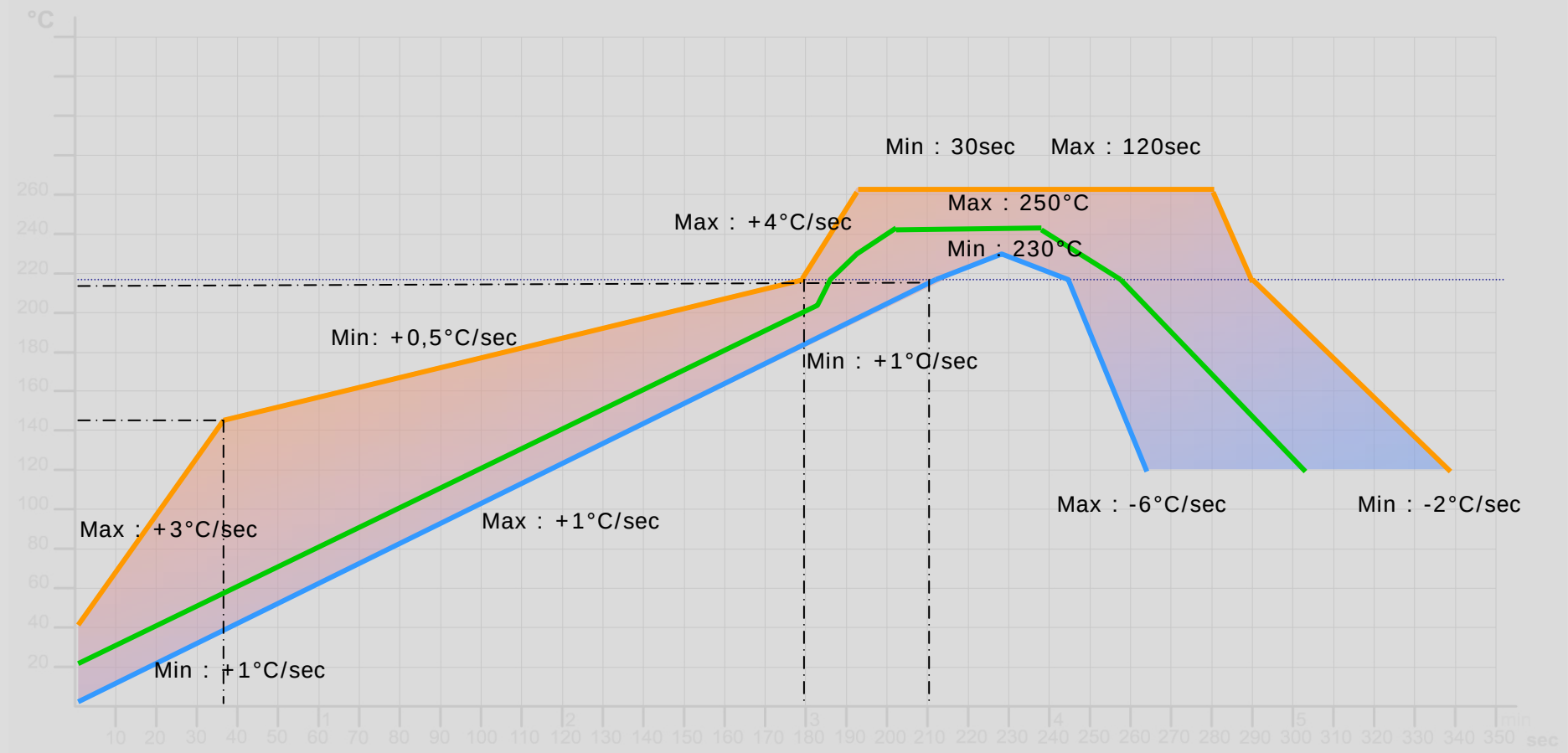
Reflow soldering temperature **profiling**



Reflow soldering temperature **profiling**

What does ‘reflow’ mean?

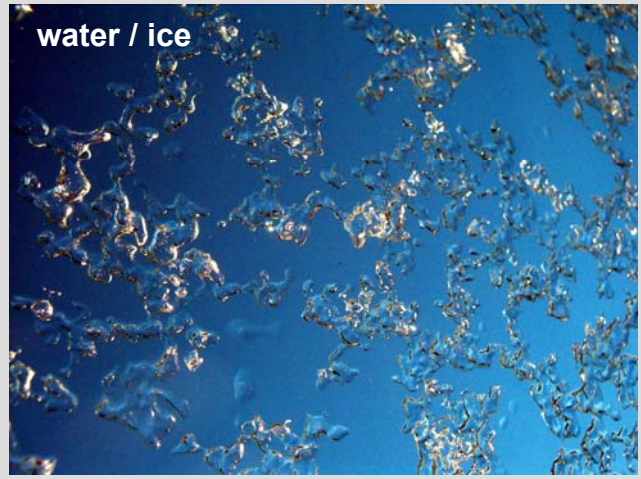
• to ‘re-flow’ is to let a substance flow (again)

When will a *substance* start flowing?

• when it enters its liquid stage
→ melting point, eutecticum, melting range

What *substance* are we going to use?

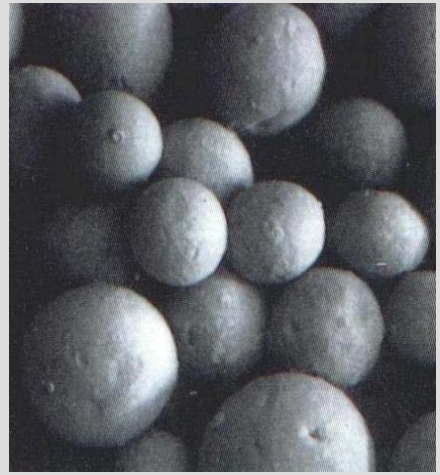
• solder paste properties



Reflow soldering temperature profiling

Solder paste properties

- metal particles in a chemical flow enhancer (flux)
- not just one type of metal but a mixture → alloy



The alloy will determine the ***melting point***

tin (Sn)	m.p. = 232°C
lead (Pb)	m.p. = 327,5°C
silver (Ag)	m.p. = 961,9°C

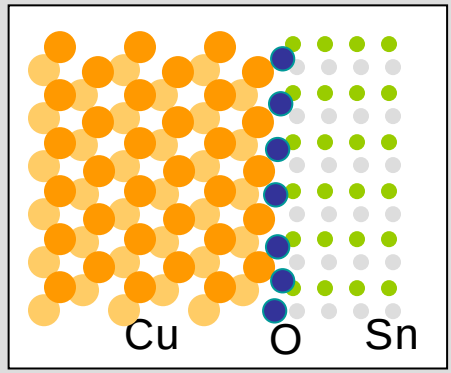
• Sn63 Pb37	e = 183°C
• Sn62 Pb36 Ag2	e = 179°C
• Sn96,5 Ag3 Cu0,5	217°C – 219°C
• Sn96 Ag4	e = 227°C

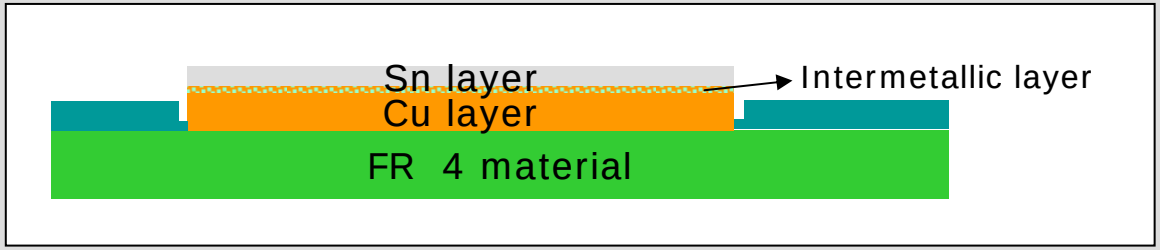
*'**e**' stand for eutectic and means the correct ratio of metals for a single m.p.*

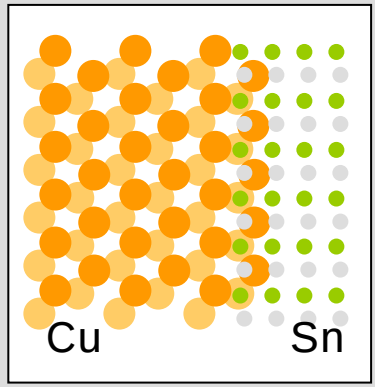
Reflow soldering temperature profiling

Inter metallic bond

- the connection between the different metals
- flux makes flow and inter metallic bond possible
- Sn makes the connection
- during the ***liquid state*** the inter metallic is initiated



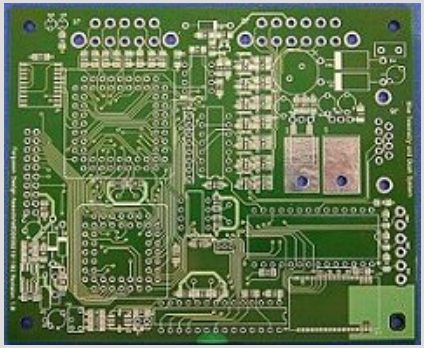




Reflow soldering temperature profiling

Other materials involved in the process

- SMT components
- circuit boards



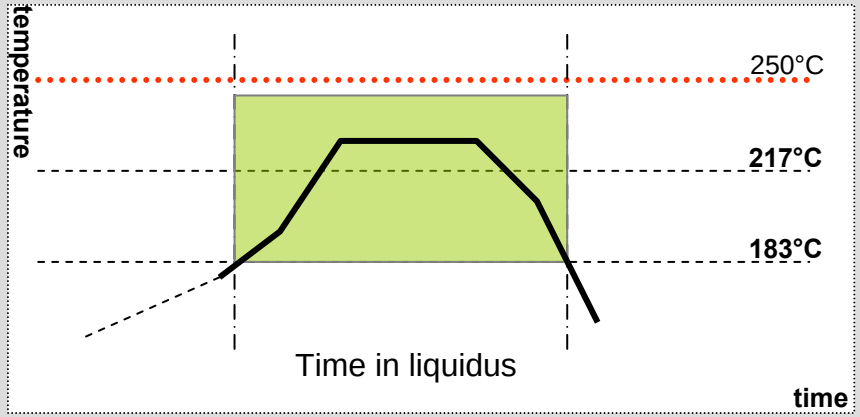
Both have metallic terminations on which the connections have to be made.

Both have ***maximum temperature*** limitations
Most components specified to 250°C
Board material
FR2 paper material with phenolic resin binder. Not for Lead-free soldering
FR4 the phenolic family of curing systems are better suited for higher temperatures

Reflow soldering temperature profiling

Factors of determination | peak zone (zone above liquidus)

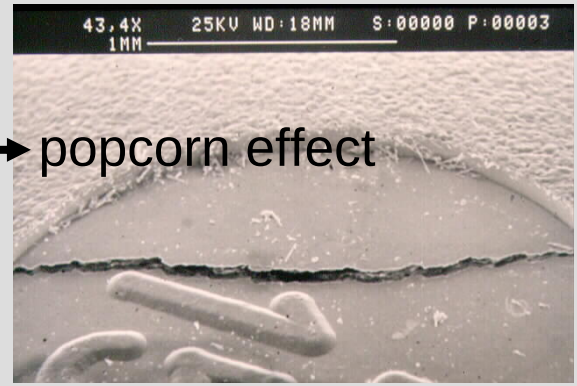
- alloy melting point or phase : liquidus temperature
- time needed in liquidus state to make the inter metallic
- maximum temperature determined by components
- min 25°C over m.p.



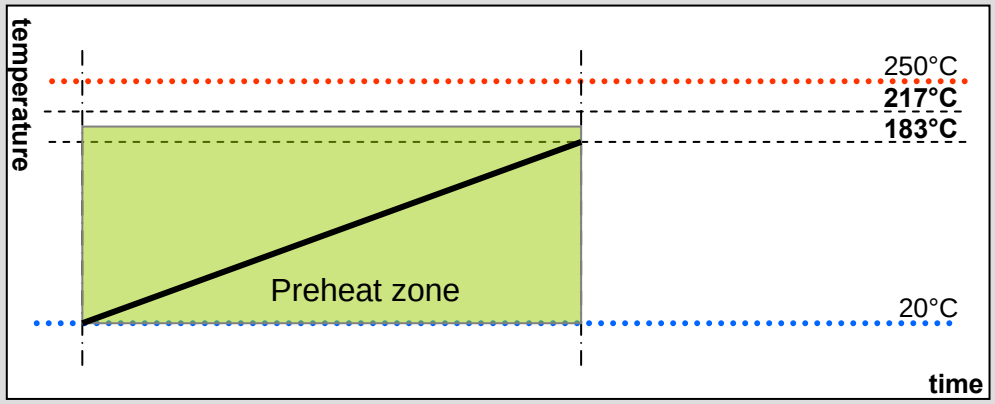
Reflow soldering temperature profiling

Factors of determination | preheat (zone from ambient temperature to liquidus)

- component thermal expansion CTE
- humidity entrapment of components and boards → popcorn effect
- solder paste → evaporation of solvents



Rise rate : established between 1°C/s and 4°C/s

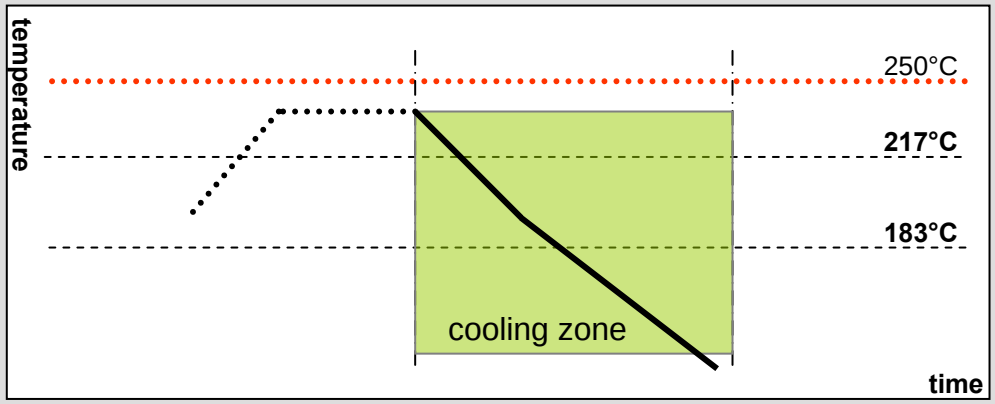


Reflow soldering temperature profiling

Factors of determination | cooling (zone from peak to below liquidus)

- thermal expansion CTE
- solder ‘freezing’ → bad cosmetics
- stress build up → solder cracks

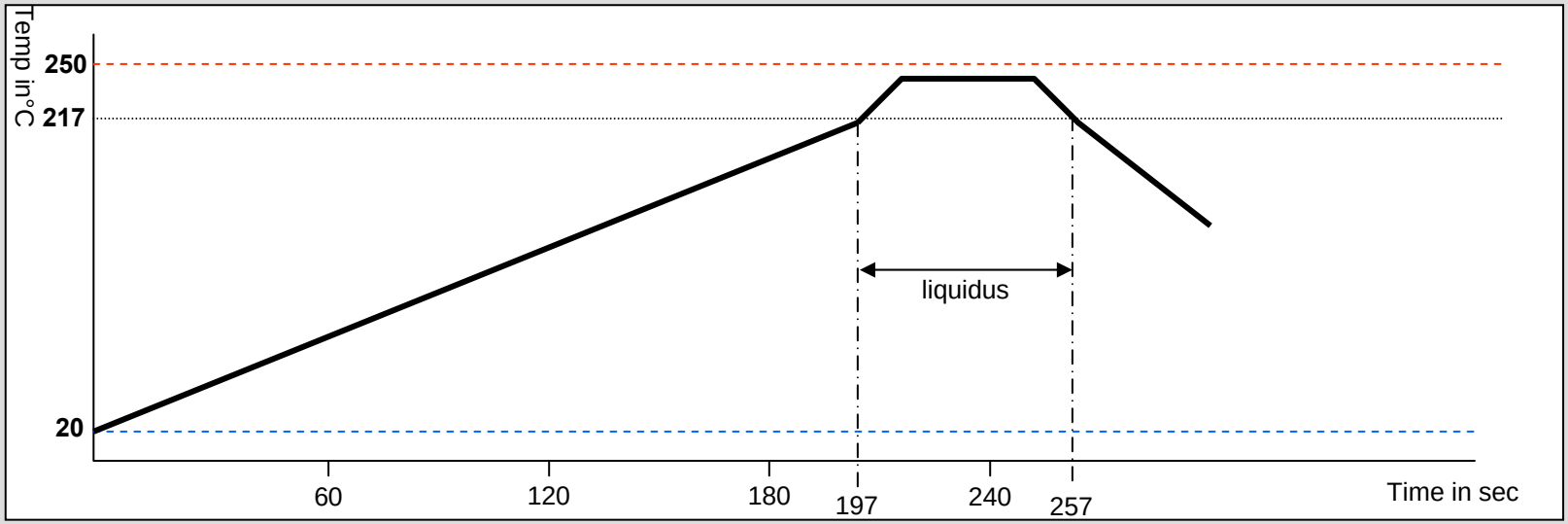
fall rate : established between 2°C/s and 6°C/s



Reflow soldering temperature profiling

First theoretic model of profile for an alloy with m.p. 217°C

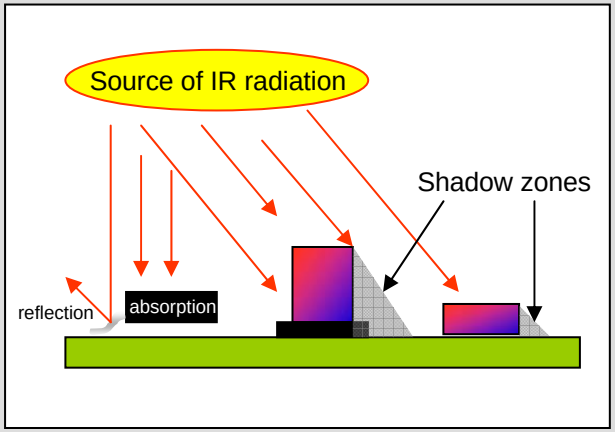
- preheat rate 1°C/s from 20°C to 217°C takes 197s = 3m 17s
- time in liquidus state : 60s
- cooling at 4°C/s



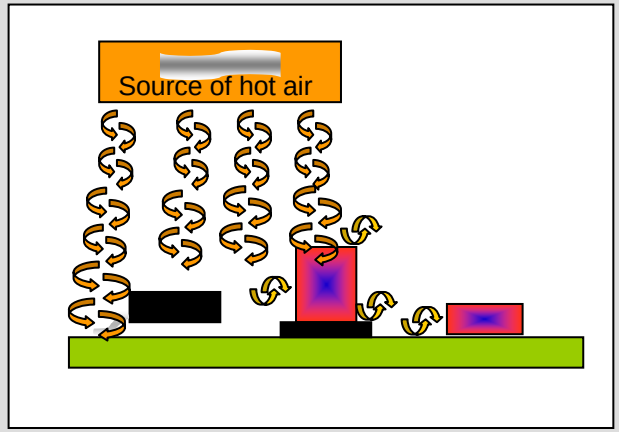
Reflow soldering temperature profiling

The influence of heating technology on the profile
- IR radiation
- Hot air convection

Temperature differences across the board



More equal temperature distribution

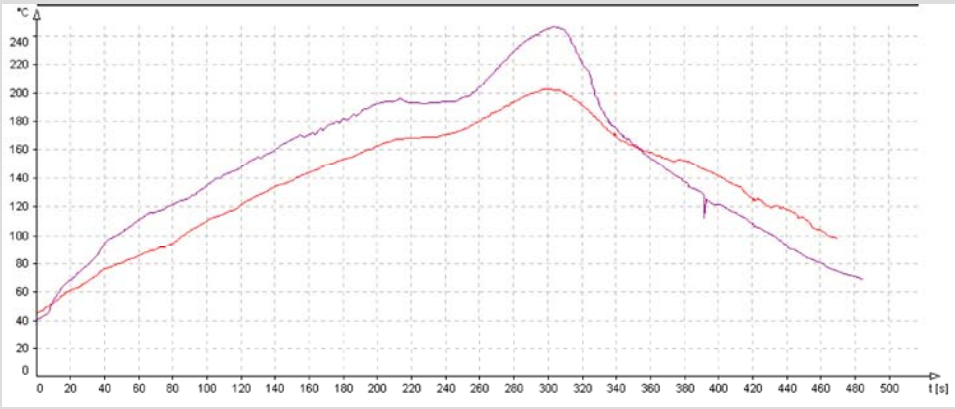


Reflow soldering temperature profiling

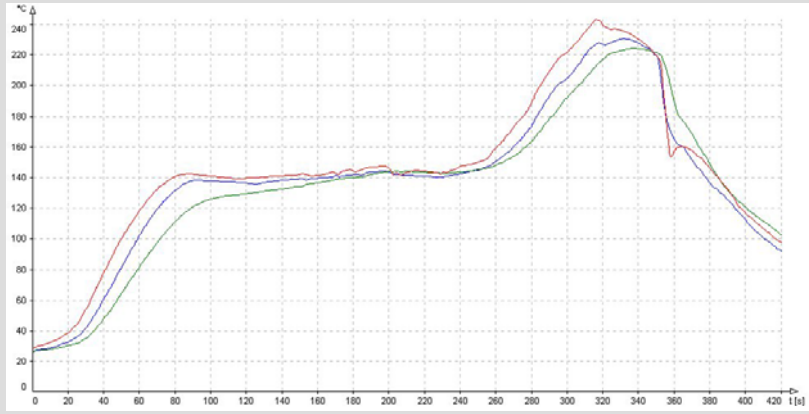
The influence of heating technology on the profile

- IR radiation asks for a levelling or soak zone to minimize temperature differences or **Δ**T

Temperatures running apart as profile advances



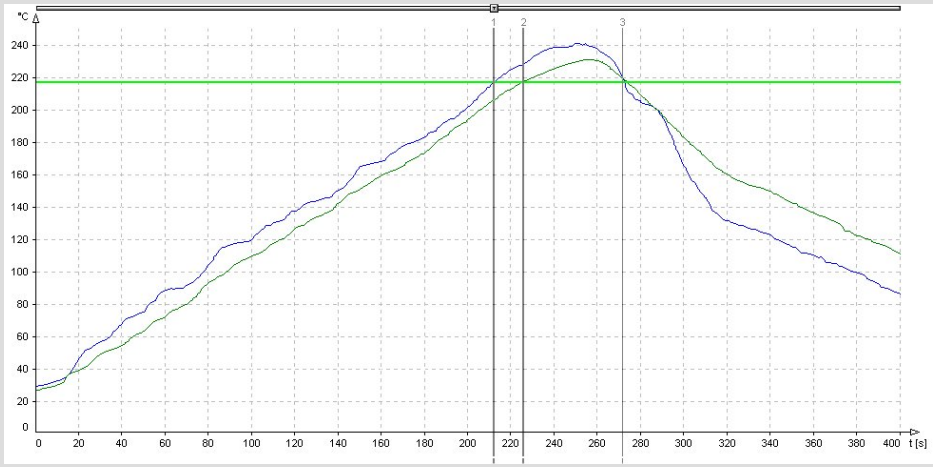
Temperatures equalized at end of soak zone



Reflow soldering temperature profiling

The influence of heating technology on the profile

- Hot air convection is less prone to big **Δ**T



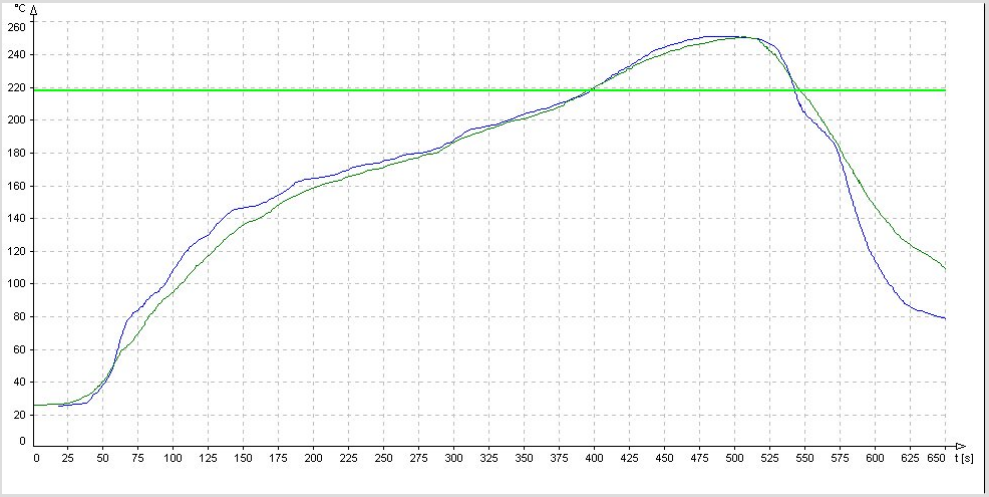
Linear profile on Solano

Zone 1	Zone 2	Zone 3	Zone 4	Ventilator
120	175	227	280	ON
Zone 5	Zone 6	Zone 7	Zone 8	Speed
30	30	30	30	0,36

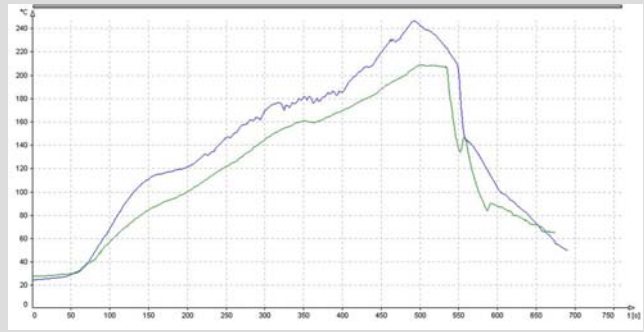
Reflow soldering temperature profiling

The influence of heating technology on the profile

- Hot air convection is less prone to big **Δ**T



Soak profile on Solano



Same board on IR oven from another manuf.

Reflow soldering temperature profiling

Summary of the theoretic part

1. Pre-heating
    - Solvents should evaporate
        - Flux starts at ca. 80-100°C faster to deoxidize on:
          pcb’s
          components
          metal powder

    Time: ca. 120s - 210s (with soak incorporated)
    Heating rate: 1 - 4 °C/s

Reflow soldering temperature profiling

Summary of the theoretic part

2. Pre-heating with soak

- Bring the temperature of components to an equal level
  - Solder paste does not need “soaking“, instead this zone has some negative influences on low activated "No-Clean“ pastes. A possible danger!
  - Solvents can evaporate even more
  - Void reducing when using lead free alloys

holding temp. ca.120 - 150°C, for Pb-free alloys 130 - 170°C
Time: 20 - 80 s depending the mass difference of the components

the shorter the zone, the more the activators remain in the flux for later use!

Reflow soldering temperature profiling

Summary of the theoretic part

3. Reflow zone

- Metal powder should melt together in one solid mass.
    - PCB-pads and component-leads should wet.
    - Solvents should disappear completely.

    Temperature ca.25 - 50°C above the liquid fase of the chosen alloy
    Time: ca. 30-60 Sec

Reflow soldering temperature profiling

Summary of the theoretic part

3. Cooling zone

• The total mass should cool down as fast as possible until the liquid solder becomes rigid again.

• Good timing brings:

equal ,well defined surface

smooth, shiny surface

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