“selective soldering”
of high density interconnect PWBs

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**Abstract**

♦ For double sided reflow boards the well known wave soldering process for leaded components can’t be used any longer!

♦ After 2x reflow, some leaded components will remain, even on boards with high density components:
  - shielding
  - connectors
  - capacitors

✓ **THE AIM!**
An appropriate selective soldering process is necessary to settle this soldering task (or problem)
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• Comparison of 2 selective soldering methods

- simultaneous soldering (all joints in one step)
  ♦ Higher Throughput
  ♦ Lower Flexibility

- sequential soldering (one joint after the other)
  ♦ Higher Flexibility
  ♦ Lower Throughput
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• Process requirements

♦ The requirements for selective soldering are similar to the wave soldering process! The process flow is shown below:

Layout:
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- Process requirements for selective soldering used as a successor of the well known wave soldering process:
  - Process cycle time less than 30 seconds per PWB
  - Suitable for medium and high volume production (inline)
  - Exact control of flux and preheating profile
  - Precise and repeatable solder joints
  - Ease of operation and less operator handling
  - Good accessibility for maintenance
  - Zero defects
among different types of selective soldering machines the 3 following process types left over after first benchmarking:

1. Mini-Wave Soldering with robot handling (sequential process)

- The liquid solder supplies the required energy to the solder joint
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• 1. Mini-Wave Soldering with robot handling (sequential process)

**Advantage:**
- high flexibility
- short down time for product change over
- one nozzle for all solder joints
- well defined peel off

**Disadvantage:**
- *production rate low*
- *process cycle time high*
- loss of space (PWB design)
- *high thermal stress HDI-PWB*
- low temperature transmission
- programming must be improved
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1.1 Mini-Wave Soldering, solder pot on x-, y-, z-table (sequential process)

- PWB transport inside the machine is designed as a segmented conveyor
- pros & cons see previous sheet
- the solder pot as well as the flux head are mounted on 2 separate servo driven x/y/z tables
- dragging & dipping possible
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2. Chimney Plate Soldering with overflow (simultaneous process)

♦ dynamic flow process
♦ segmented conveyor
♦ robot handling possible
♦ when using finger conveyor a support plate is necessary
♦ only dipping
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• 2. Chimney Plate Soldering with overflow (simultaneous process)

**Advantage:**
- ♦ production rate high
- ♦ process cycle time short

**Disadvantage:**
- ♦ low flexibility
- ♦ large process down time for product change over and machine set up
- ♦ expensive tooling necessary
- ♦ great deal of maintenance
- ♦ the overflow represents a disadvantage due to the undefined flow behaviour of the liquid alloy (PWB design)
- ♦ during one shift production the chimneys become encrusted
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- **3. Stamp Soldering without overflow (simultaneous process)**
  - Very fast and precise soldering system for medium and high volume
  - PWB handling can be done using a robot handling or a conveyor system
3. Stamp Soldering without overflow (simultaneous process)

**Advantage:**
- production rate high
- process cycle time short
- no undefined flow behaviour (statical process)
- suitable for warped PWB’s due to top and bottom contour plate
- very accurate solder level height
- low thermal stress for HDI PWBs

**Disadvantage:**
- low flexibility
- 30 min. process down time for product change over and machine set up
- expensive tooling necessary
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- Conclusion after first benchmarking
  - With respect to the cycle time request a simultaneous process must be used
  - The chimney plate process with overflow or the stamp soldering process without overflow could be used
  - Robot handling offers higher flexibility
  - Each process has got its own advantage and disadvantage
  - Design Rules are always the same
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• Design Rules

♦ For each type of selective soldering process an occupied area around the solder lands of leaded components is absolutely necessary!

♦ The following design rules must be considered for all our products:
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• Design Rules
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- Design Rules

**Radial-Component**

**Test Pads**

**correct**

**wrong**

**correct**

**wrong**
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- Industrial point of view
  - The best selective soldering process is a none selective soldering process
  - If there is a need for selective soldering that means some leaded components remains on the PWB, the number of pins (solder joints) has to be as less as possible
  - The design rules mentioned in the previous sheets are valid for each new PWB. At all costs the rules have to be taken into account
  - Every selective soldering process available on the market has got its own disadvantages regarding the loss of flexibility, quality and operator handling compared to the well known wave soldering process
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• Industrial point of view

♦ Solder balls will be a problem (depending on PWB and process parameter)

♦ Specific tooling are necessary using a simultaneous process

♦ The very flexible single nozzle process (dragging mode) can’t be used for the HDI PWBs due to temperature stress during soldering

♦ The chimney plate process with overflow is using one solder pump to get the demanded solder level height at each chimney (size). If the size is too different, an undefined flow of the largest chimney can be expected

♦ The stamp soldering process with no overflow is the most precise process


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**Decision**

- After investigations into selective soldering (trial runs) and because of experiences over some years on chimney plate process (several machines have been installed in the past for different applications),

  stamp soldering process with no overflow will be used for the future as a successor for the well known wave soldering process

  applied to do the soldering task of remaining leaded components on double sided reflow boards
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- Advantage of the stamp soldering process with robot handling compared to chimney soldering
  - Tooling is less expensive
  - No overflow, because of that well defined solder level height
  - Because of high mechanical accuracy and well defined solder level height the occupied area between a selective solder joint and a component located in the neighbourhood is clearly smaller (space saving)
  - Elimination of the PWB warpage due to the usage of the top and bottom contour plate which makes it possible to keep the PWB even while soldering
  - The stamp does not become encrusted when dipping into the liquid alloy
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- Advantage of the stamp soldering process with robot handling compared to mini wave soldering
  - Small deal of maintenance
  - Higher throughput
  - Solder joints with very different thermal mass does not represent a problem
  - In case of having a high number of solder joints there is no loss of preheating temperature between the first and the last soldering task
  - Very similar temperature stress to the PWB because of soldering each solder joint in one step
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- Realisation phase: selective soldering production line for double sided reflow boards
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- The HDI PWB
  - 10 layer
    1/4dk/4dk/1
  - tetra functional material
  - OSP surface
  - stamp size examples
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- Temperature-time-profile

  ♦ temperature of liquid alloy 280°C
  
  ♦ solder joint temperature 242 °C at most critical or coldest joint (metal lug)
  
  ♦ $T < 7$ °C
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• EMLS 2030; empty solder pot & double flux station (micro drop)
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- EMLS 2030; convection pre heaters and gripper in pick up position
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- EMLS 2030; PWB at soldering position & machine entrance