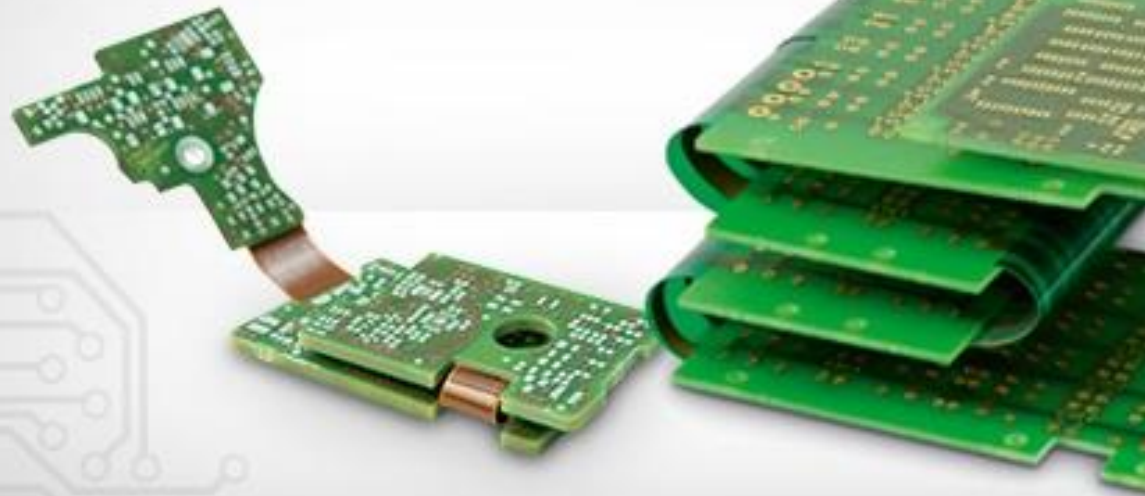


MINIATURIZATION TO THE POWER OF TWO

Combine the advantages of RIGID.flex and HDI on your printed circuit board!



Niedernhall

15.06.2021

AGENDA



- 1 What is HDI?
- 2 Which Design Rules need to be observed?
- 3 What types of filling are possible?
- 4 What are the options for BGA unbundling?
- 5 Conclusion

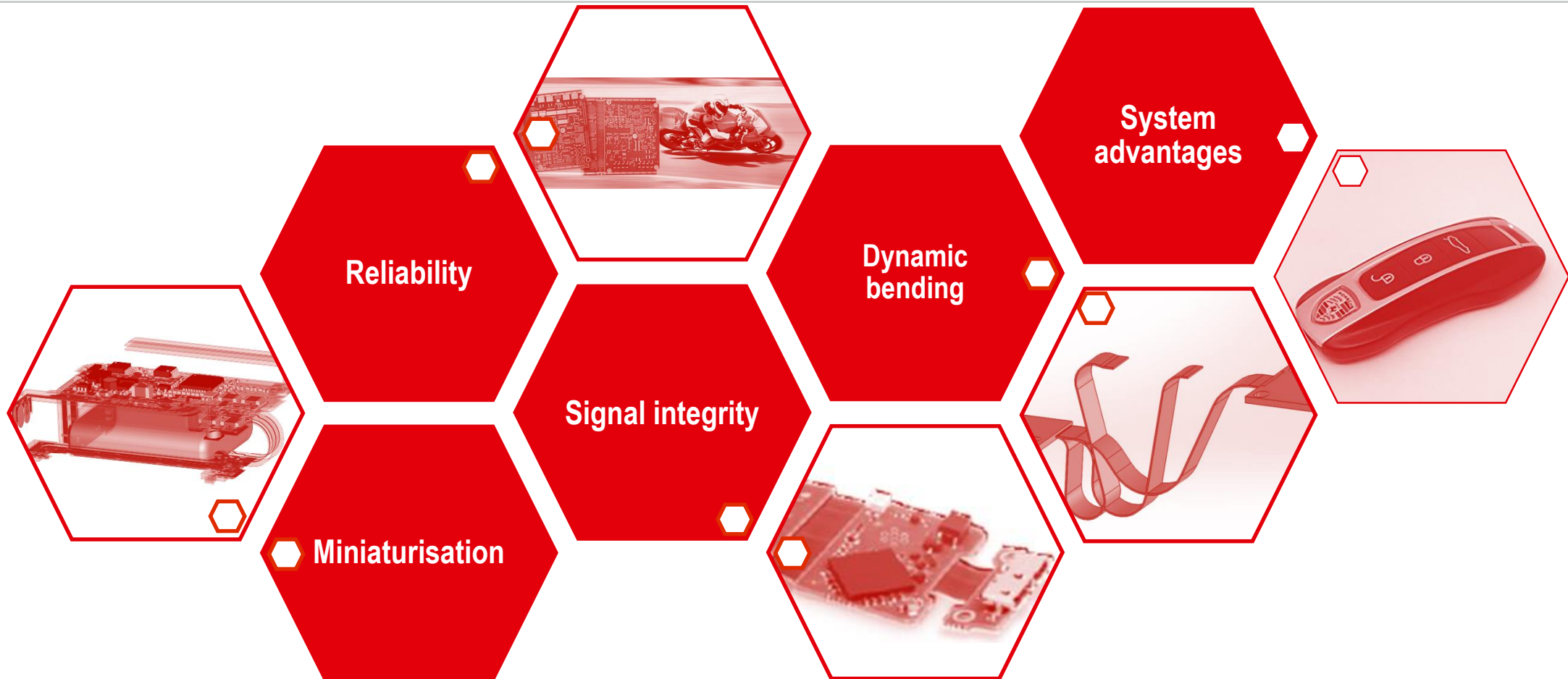


Verena Laukemann
Technical project management



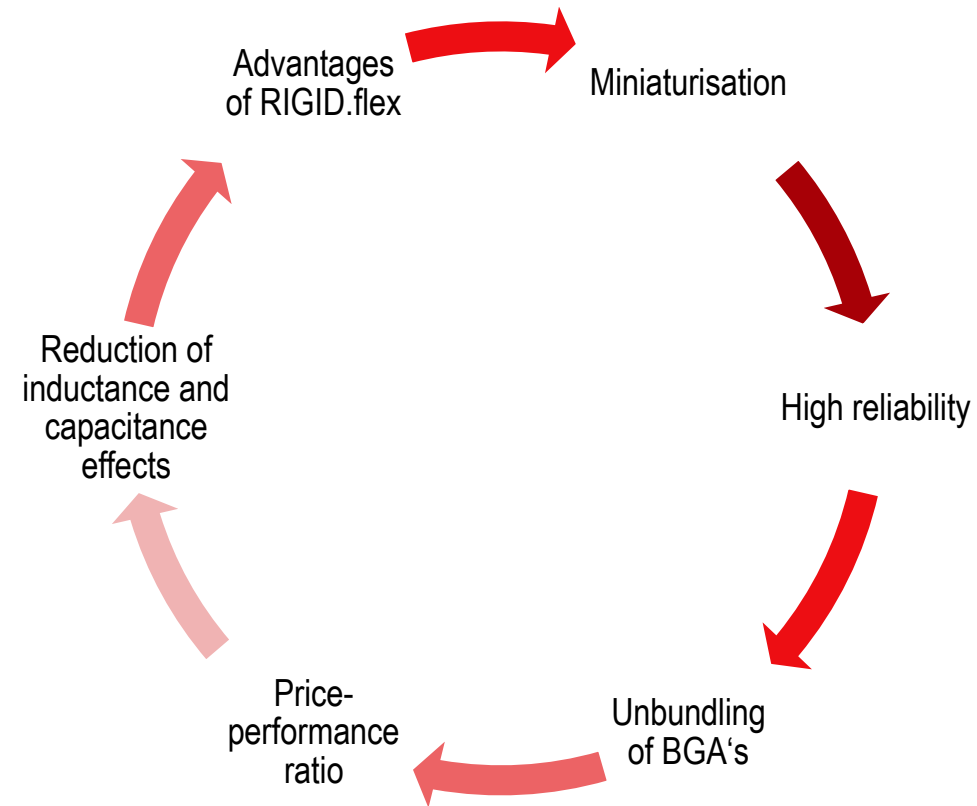
WHAT IS HDI?

Advantages of RIGID.flex



WHAT IS HDI?

Advantages



WHAT IS HDI?

Definition and nomenclature



HDI = High Density Interconnection

„Under the help of fine structures and vias, which do not necessarily connect all layers, space is gained in the layout or the total system size is reduced.“

Nomenclature:

2Ri-4F-2Ri_1,6_17_HDI_1-6b-1

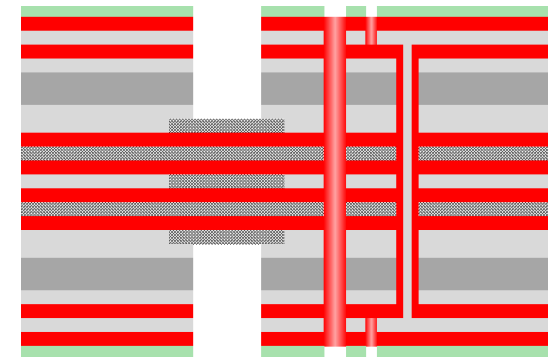
Technology RIGID.flex
here: 8 layers, thereof 4 flex inner layers

Total thickness incl. galv. Copper and s/m

Base copper inner layers

Technology HDI

here: Micro vias between L1 & L2 or L8 & L7
Buried vias between L2 & L7



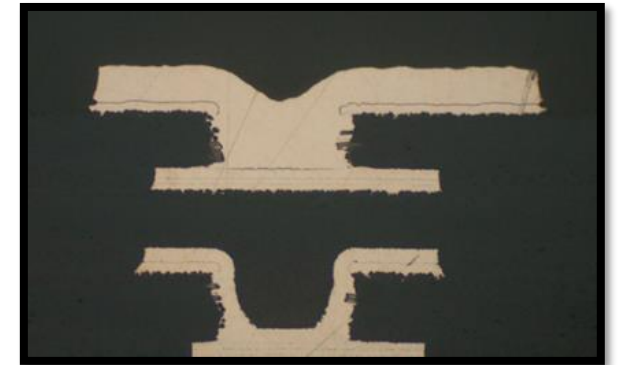
WHAT IS HDI?

Via types



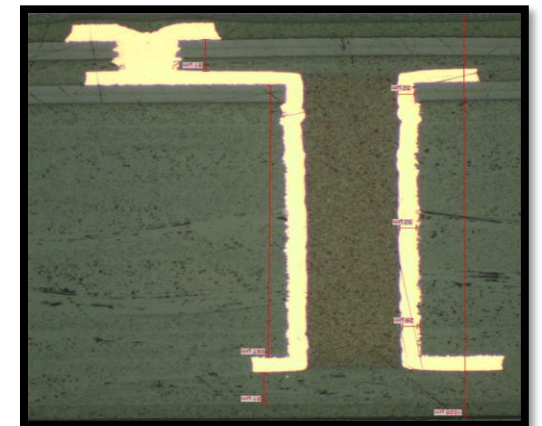
Micro Vias = small drills, which are typically drilled with the laser

- Min. Via-End-Ø 0.05mm
- Min. Pad-Ø 0.25mm



Buried Vias = mechanical drills, which are embedded in the stack-up

- \geq Via-End-Ø 0.10mm
- \geq Pad-Ø 0.45mm



Legend:

MV: Micro Via **PTH:** Plated Through Hole **BV:** Buried Via

SURVEY



- **What is the min. pad diameter you use for PTH as vias?**
 - 0.60mm or bigger
 - 0.50mm
 - 0.45mm
 - 0.40mm
 - 0.35mm

DESIGN RULES

Aspect Ratio



- Ratio drill-diameter b – drill depth a
- PTH & BV: max. 1:8

➤ Important for a complete and even the sleeve.

?

Can't it be smaller?

Example PTH:

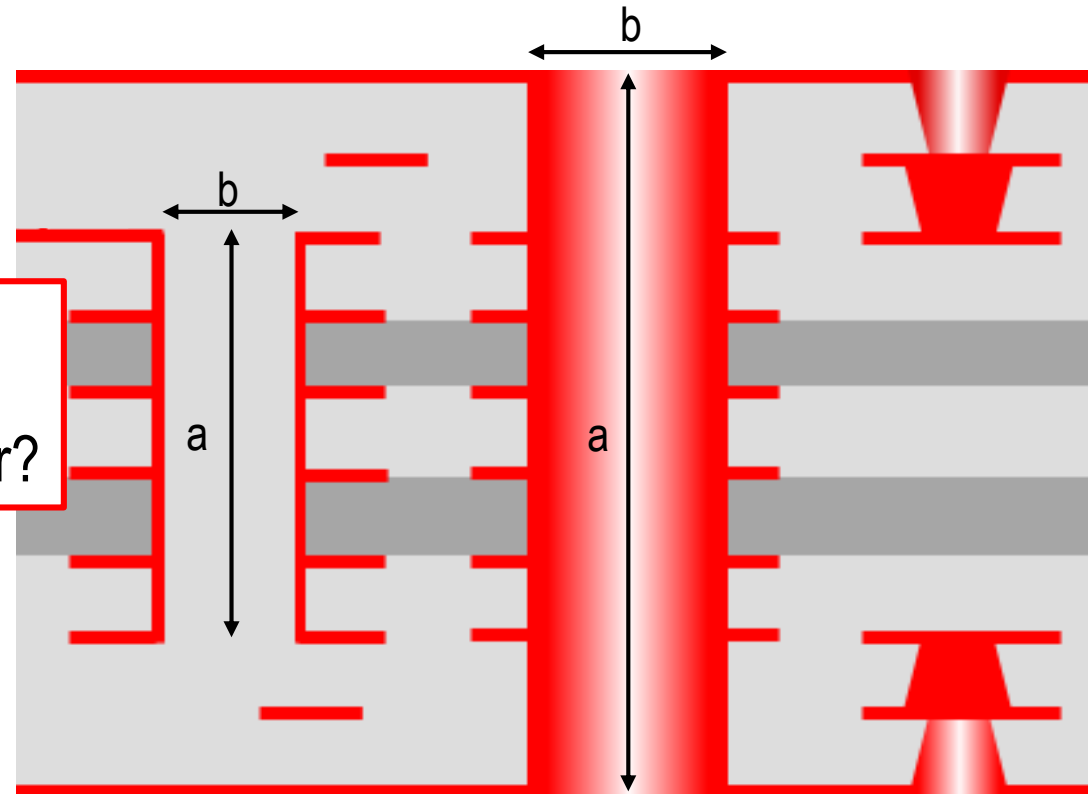
$b = ?$

$a = 1.6\text{mm}$

$b = a / 8 = 0.20\text{mm}$

→ Smallest drill- $\varnothing = 0.20\text{mm}$

→ Smallest pad- $\varnothing = 0.45\text{mm}$



DESIGN RULES

Aspect Ratio



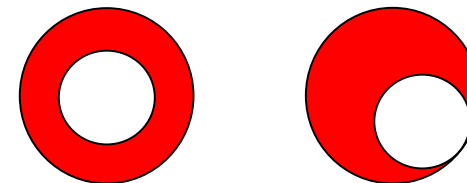
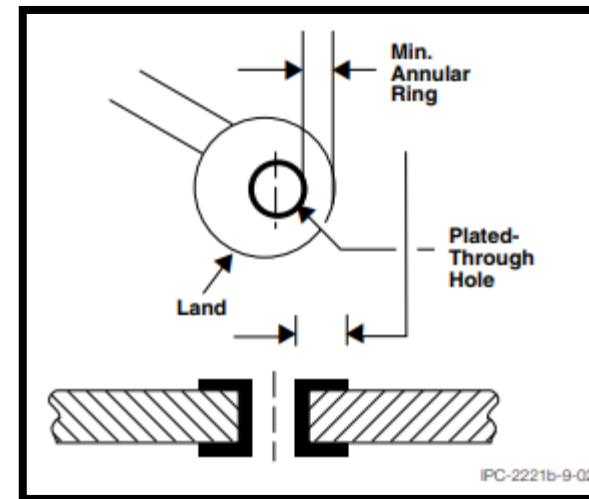
PTH with 0.40mm-Pads

- Specifications for annular ring of the IPC classes
- Impact of drilling tool
- Impact of machine
- Layout-dependent shrinkage/expansion values

An individual clarification is necessary.

Contact us as early as possible!

flex@we-online.de



DESIGN RULES

Aspect Ratio



- Ratio drill-diameter b – drill depth a
- MV: max. 1:0.8

- Important for a complete and even copper build-up in the sleeve.

Example MV:

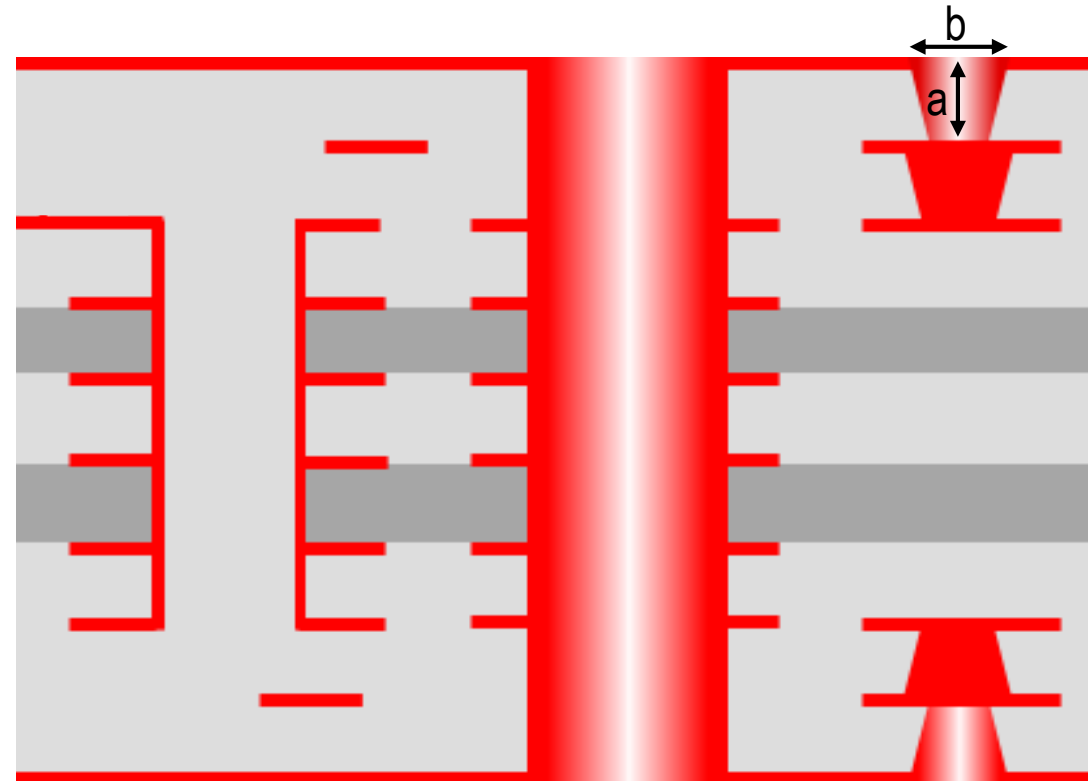
$b = ?$

$a = 0.08\text{mm}$

$b = a / 0.8 = 0.10\text{mm}$

→ Smallest drill- $\varnothing = 0.10\text{mm}$

→ Smallest pad- $\varnothing = 0.25\text{mm}$



DESIGN RULES

Micro vias



	2 x 106	1 x 1080	1 x 2116	1 x 50µm Polyimid & 1 x 106 Low Flow																																																			
	<table border="1"> <tr><td>17</td><td></td><td></td></tr> <tr><td>85</td><td>2 x 106</td><td></td></tr> <tr><td>40</td><td>incl. plating</td><td></td></tr> <tr><td>15</td><td></td><td></td></tr> </table>	17			85	2 x 106		40	incl. plating		15			<table border="1"> <tr><td>17</td><td></td><td></td></tr> <tr><td>65</td><td>1 x 1080</td><td></td></tr> <tr><td>40</td><td>incl. plating</td><td></td></tr> <tr><td>15</td><td></td><td></td></tr> </table>	17			65	1 x 1080		40	incl. plating		15			<table border="1"> <tr><td>17</td><td></td><td></td></tr> <tr><td>105</td><td>1 x 2116</td><td></td></tr> <tr><td>40</td><td>incl. plating</td><td></td></tr> <tr><td>15</td><td></td><td></td></tr> </table>	17			105	1 x 2116		40	incl. plating		15			<table border="1"> <tr><td>15</td><td></td><td></td></tr> <tr><td>40</td><td>* Incl. Plating</td><td></td></tr> <tr><td>50</td><td>Polyimide</td><td></td></tr> <tr><td>50</td><td>1 x 106 Low Flow</td><td></td></tr> <tr><td>17</td><td></td><td></td></tr> </table>	15			40	* Incl. Plating		50	Polyimide		50	1 x 106 Low Flow		17		
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Dielectric	80-90µm	60-70µm	100-110µm	90-100µm (Depending on polyimide-thickness)																																																			
Min. MV-Pad-Ø	300µm	250µm	300µm	300µm																																																			

Based on HDI design rules – Cannot be implemented 1:1!

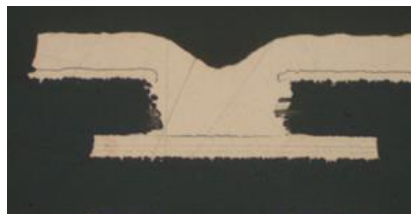
DESIGN RULES

Filling



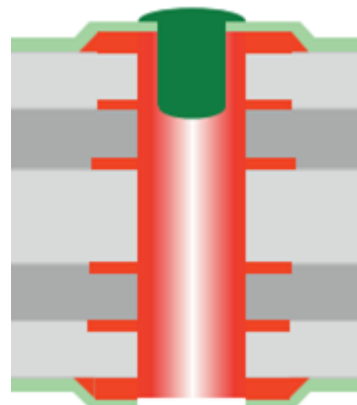
MV copper filled

- Filling with copper
- Filling level depends on depth of MV



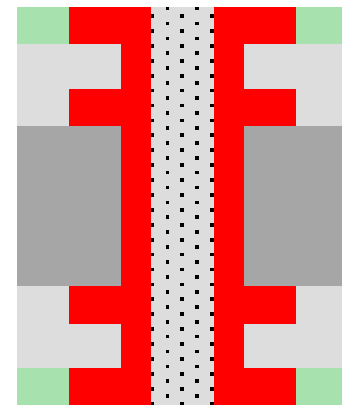
Typ III-a

- Filling with paste
- Max. \varnothing : 0.60mm
- Only one-sided
- Space to solder areas



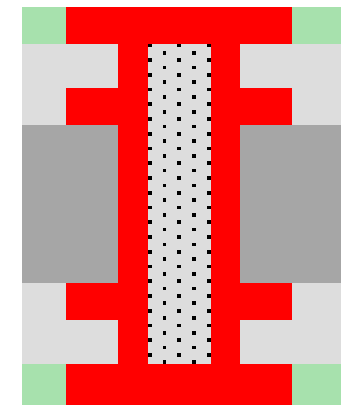
Typ V

- Filling with resin
- Max. \varnothing : 0.50mm
- Coating with solder mask possible (Typ VI)



Typ VII

- Filling with resin and over plating with copper
- Max. \varnothing : 0.50mm


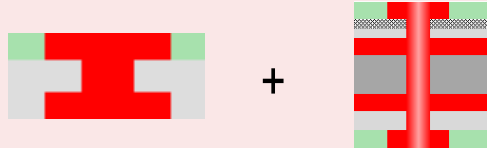
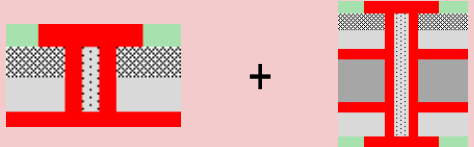
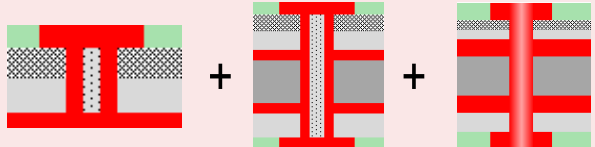


DESIGN REGELN

Filling



- **Limitation through the combination of technology and processes**
 - Micro via copper filling
 - Plated through holes filled & capped (Type VII)

No.	Description	Schematic picture	Space
1)	MV copper filled		100
2)	MV copper filled + PTH/BV (IL + OL)		100
3)	MV + PTH/BV filled & capped (IL + OL)		125
4)	MV + PTH filled & capped + additional PTH (OL)		150

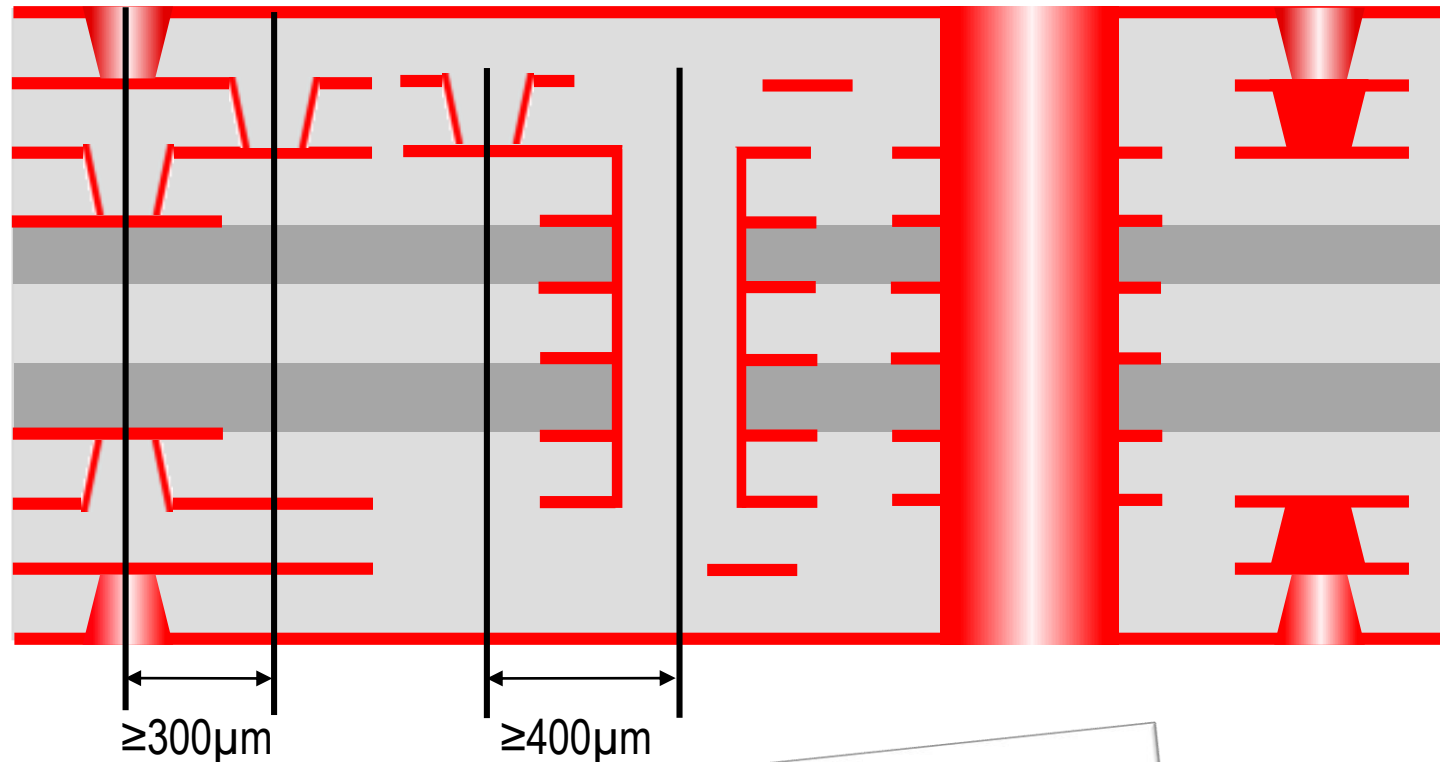
SURVEY



- **What are the BGA-pitches you use?**
 - 0.80mm
 - 0.65mm
 - 0.50mm
 - 0.40mm
 - 0.35mm

DESIGN RULES

Stacked and staggered



! If possible, stagger the vias / Micro vias !

DESIGN RULES

IPC-2226A: HDI via-combinations, recommendation



Allowed

Stacked microvia on resin-filled, capped microvia



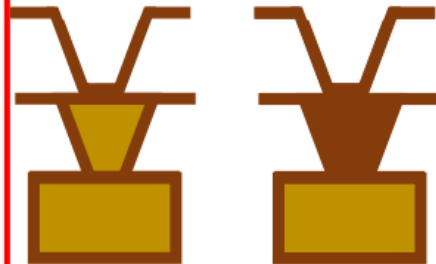
Stacked microvia on resin-filled, capped buried via



Only allowed after approval customer/GL

Stacked microvia on

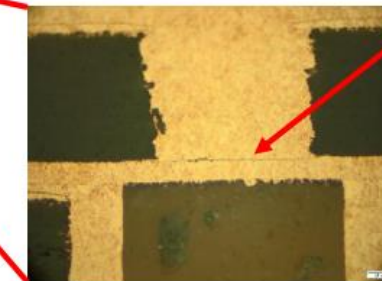
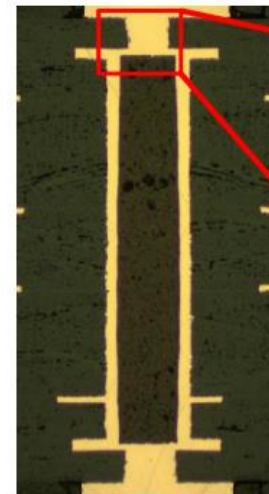
1. Resin-filled, capped microvia and resin-filled capped buried via
2. Copper-filled microvia and resin-filled, capped buried via



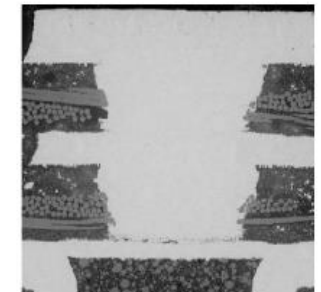
Objective:

➤ Increase the reliability of electronic components

Reduce the risk of copper bond failure due to thermal stress during the soldering process



Thermal stress induced separation



Source: Bill Birch, PWB Interconnect Solutions Inc.

Caution: HDI design with microvias stacked on buried vias is not recommended.

PCB and Electronic Systems Division within the German Electrical and Electronic Manufacturers' Association, Working Group "Quality Management" July_2019

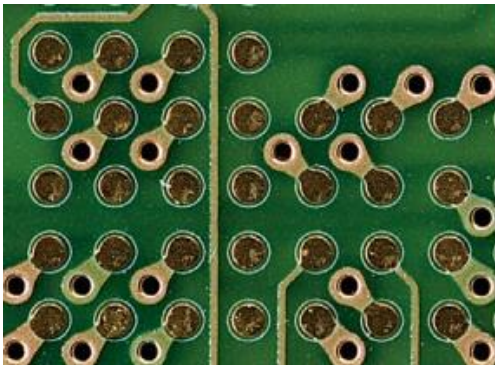
DESIGN RULES

Unbundling of BGA with pitch 0.80mm / 0.50mm



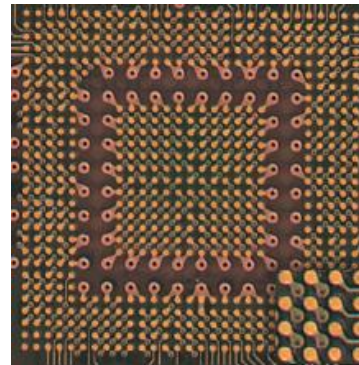
PTH as dog-bone (only 0.80mm!)

- PTH with 0.50mm Pads
- 100/100µm Line/Space
- Option 0.80mm: 1 Circuit between pads
- No Filling necessary



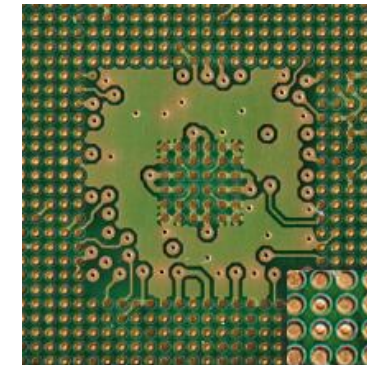
MV as Dog-Bone

- MV with 0.30mm Pads
- 100/100µm Line/Space
- Option 0.80mm: 1 Circuit between Pads
- No Filling necessary



MV in Pads

- MV with 0.30mm Pads
- 100/100µm Line/Space
- Option 0.80mm: 1 Circuit between Pads
- MV Copper Filling necessary



DESIGN RULES

Unbundling of BGA with pitch 0.40mm



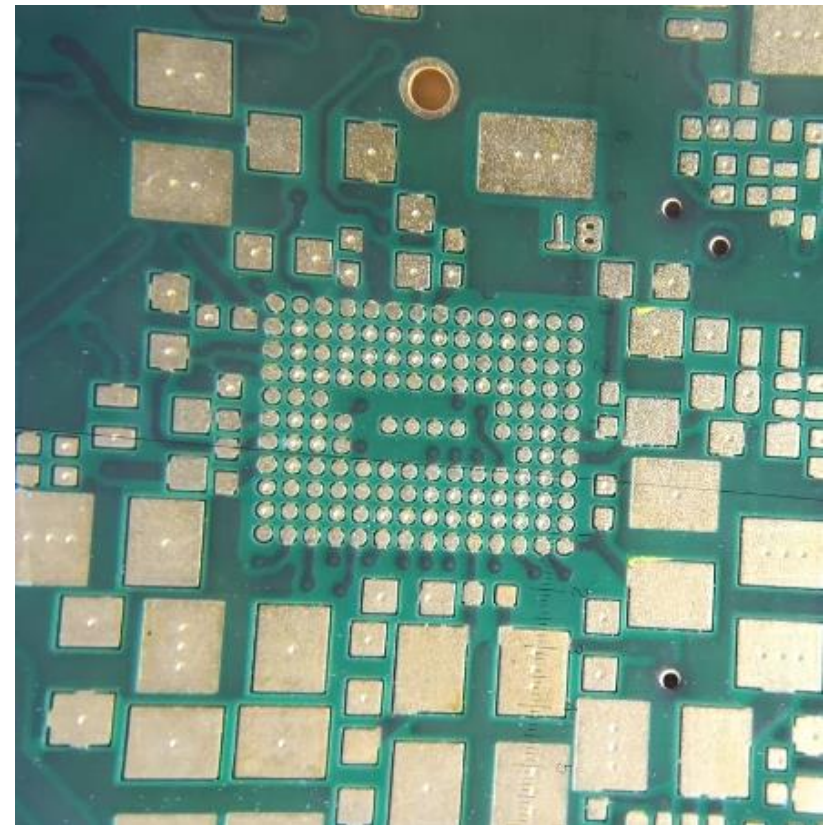
MV-in-Pads

- Stacked Micro vias
- Copper filling necessary
- 100/100µm Line/Space
- No circuits between pads possible
- Solder mask bridges only conditionally possible

An individual clarification is necessary.

Contact us as early as possible!

flex@we-online.de



CONCLUSION

Part 1



- The combination of HDI and RIGID.flex makes optimal use of the advantages of both technologies.
- The technology HDI uses Micro and Buried vias to gain space in the layout or to reduce the size of the total system.
- The aspect ratio is very important for the choice of the correct pad-diameter.
- The different types of filling require adjustments in the layout.

Part 2:

- Stack-ups to combine RIGID.flex and HDI
- Design tips
- Cost consideration



THANK YOU FOR YOUR ATTENTION

