OUR FLEX SOLUTIONS
How much flexibility do you need?
AGENDA

1. The full package of Flex solutions
2. Flexibility or bendability: How do the different options perform?
3. Digital available stackups for your EDA software
4. Project based optimisation
5. Flexibility and costs in relationship
SPECTRUM OF WE FLEX SOLUTIONS

IPC Standards

IPC-2223 (D) – Design for flexible and rigid-flexible printed circuit boards
- Dielectric flexible films like polyimide or polyester
- Copper foils like ED or RA copper
- Completely flexible or a combination of rigid and flexible Printed Circuit Board
- Application A: Flex-to-install / static
- Application B: permanent, specified bending load / dynamic

Bending = tension and compression
SPECTRUM OF WE FLEX-SOLUTIONS

Typical Stackups

- **SEMI.flex / BEND.flex**
- **RIGID.flex 1F-7Ri**
- **PURE.flex 2F**
- **RIGID.flex 2F-6Ri**
- **RIGID.flex 3Ri-2F-3Ri**
- **SLIM.flex 6F**
SPECTRUM OF WE FLEX-SOLUTIONS

SEMI.flex / BEND.flex

SEMI.flex

- Rigid Material, only Tg 135
- ED-Cu + plated Copper
- Flexible solder mask in the flex area
- Z-axis controlled depth milling tool 45°Phase
- Milling in the glass/resin matrix
- Copper on outer radius only

BEND.flex

- Rigid material, Tg135 - Tg170
- ED-Cu + plated copper
- Coverlay or flexible solder mask in the flex area
- Use of spacer, FR4-cores, Lowflow-Prepreg
- Copper on inner and outer radius possible

Direct comparison:

SEMI.flex

BEND.flex
SPECTRUM OF WE FLEX-SOLUTIONS

RIGID.flex

- Multilayer Stack-up with Polyimide
- Z-axis controlled depth milling
- Use of spacer, FR4-cores, Lowflow-Prepreg
- Rigid Material Tg 130-220
- Polyimide adhesiveless
- Coverlay in Flex area
- RA or ED-Copper

- Stack-up xRi-2F-xRi

- Stack-up 2F-xRi

- Microsection 1Ri-8F-1Ri
Any PCB material is flexible if it is thin enough

- **Stiffness** describes the resistance of a body to elastic deformation
- **Flexibility** describes the ability to adapt to changing circumstances. Ability to bend or compress easily
- **Bendability** describes the forming process. Bending stresses act in the forming zone
- **Bending radius** describes the radius with which the material can be bent without cracking. The material is bent as closely as possible for 180°. The radius is determined on the inside of the material
- **Rolling direction** describes the stretching of the copper by rolling. A fiber-like material structure is created. The elongation of the fibres is always in the rolling direction
FLEXIBILITY OR BENDABILITY
Static Application

- Keep the bending radii as large as possible
- Build up of flexible layers with polyimide or FR4
- The minimum bending radius should be ten times the thickness of the finished flexible printed circuit board.
- Flex PCBs should preferably be able to follow their natural curve in the bend
- For FR4-Semiflex printed circuit boards, the use of a bending support / preforming can be useful
- FR material >250µm and polyimide with >4 Cu layers in the flex area can be described as more or less stiff

Guidelines for everyday practice

<table>
<thead>
<tr>
<th>Cu layer 35u</th>
<th>D app. (µm)</th>
<th>R (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flex 1-layer</td>
<td>120</td>
<td>&gt;1.2</td>
</tr>
<tr>
<td>Flex 2-layer</td>
<td>200</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Flex 4-layer</td>
<td>300</td>
<td>&gt;6</td>
</tr>
<tr>
<td>FR4 1-layer</td>
<td>200</td>
<td>&gt;5</td>
</tr>
<tr>
<td>FR4 2-layer</td>
<td>300</td>
<td>&gt;8</td>
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</table>
FLEXIBILITY OR BENDABILITY
Dynamic Application

- Construction of flexible layers only with polyimide/acrylic adhesive
- The neutral axis should be in the middle of the flex layer. Use identical materials on both sides of the tracks
- Use of RA copper and orientation of the rolling direction parallel to the bending direction
- No plated-through holes in the bending area (plated copper)

Guidelines for everyday practice

<table>
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<tr>
<th>Cu layer 35μ</th>
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</thead>
<tbody>
<tr>
<td>Flex 1-layer</td>
<td>120</td>
<td>&gt;12</td>
</tr>
<tr>
<td>Flex 2-layer</td>
<td>200</td>
<td>&gt;30</td>
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<tr>
<td>Flex 4-layer</td>
<td>Not recommended</td>
<td></td>
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Conductor tracks in two-sided printed circuit boards shall not be arranged directly on top of each other

Quelle: IPC-2223
DIGITAL STACKUPS

- Flex-Rigid, Flex inner layer
- Flex-Rigid, Flex outer layer
- Flex with Stiffener
- SLIM.flex

EDA Tools:
- Cadence OrCAD / Allegro
- Altium AD20
- IPC-2581
- further tools in progress
DIGITAL STANDARD STACKUPS

Start your layout faster

- Avoiding errors
- Increase productivity
- Designing reliability
- Achieving safety
PROJECT BASED OPTIMISATION

Key factors

- Material in bending area
  Polyimide from 25-125µm, >10 different coverlay types
- LP thickness in the bending range >130µm
- Copper type (ED / RA...machine direction of rolling process)
- Design - conductor routing, grid/hatching
- Array design
- Processing guidelines
# FLEXIBILITY AND COSTS

An estimation

<table>
<thead>
<tr>
<th>Multilayer</th>
<th>Semiflex</th>
<th>Bendflex</th>
<th>1F-xRi</th>
<th>2F-xRi</th>
<th>xRi-2F-xRi ED-copper</th>
<th>xRi-2F-xRi RA-copper</th>
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<tbody>
<tr>
<td>100</td>
<td>125</td>
<td>170</td>
<td>200</td>
<td>280</td>
<td>300</td>
<td>310</td>
</tr>
<tr>
<td>0</td>
<td>10</td>
<td>20</td>
<td>100</td>
<td>100</td>
<td>500</td>
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Overview costs in % / Bending cycles

Percent

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
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Relative costs  Bending cycles
THANK YOU FOR YOUR ATTENTION!

What kind of application do you have?

How can WE support you?

Contact: flex@we-online.com