Deepen your knowledge

What are Flex & Rigid-flex Printed Circuit Boards? What are their similarities and differences? Their capabilities? And the design rules.

Get to know more about these two PCB technologies.

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Advantages of Flex & Rigid Flex PCB

ICAPE Group offers Printed Circuit Boards thanks to its solid partner factories network. Today let’s talk about Flex & Rigid-Flex PCB solutions which are very effective and reliable for different fields.

Reliability is a major element for many electronic devices and reason why a substantial number of electronics manufacturers mainly focus on the reputation of the brand. Connectors are way too often of deficient performance and thus can affect cable assembly’s overall performance. One solution to avoid quality and reliability issues coming from connectors and cables is to use flexible solutions, mainly in the world of printed circuits. Rigid-Flex PCBs are an ideal solution for connecting two or more PCBs to each other.

**Why using Rigid-Flex PCB?**
There are several advantages to using Rigid-Flex:
- Weight and volume reduction
- 3D Design

Benefits of using Flex & Rigid-Flex PCB

- Cost saving on connectors & wires
- Impedance control
- Dynamic solution

**Different Flex PCB technologies**

Symmetrical and Unsymmetrical structure

The buildup is symmetrical in Z axis, on or several flex parts can be laminated with or without air gap.
PI Flex foils vs Rigid FR4 comparison

<table>
<thead>
<tr>
<th></th>
<th>Cu PEEL STRENGTH (N/cm)</th>
<th>SHRINKAGE AFTER ETCHING (%)</th>
<th>WATER ABSORPTION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLEXIBLE MATERIAL PI</td>
<td>&gt;7</td>
<td>0–0.2</td>
<td>2.9</td>
</tr>
<tr>
<td>RIGID BASE MATERIAL FR4</td>
<td>14</td>
<td>0–0.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Thickness range

<table>
<thead>
<tr>
<th>PI FOIL THICKNESS</th>
<th>THICKNESS RANGE</th>
<th>COST</th>
<th>LEAD TIMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>USUAL PI THICKNESS</td>
<td>25µm / 50µm</td>
<td>Standard</td>
<td>Standard</td>
</tr>
<tr>
<td>INTERMEDIATE PI THICKNESS</td>
<td>12µm / 75µm 100µm</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>UNUSUAL PI THICKNESS</td>
<td>9µm / 125µm 150µm</td>
<td>2 to 3 times the cost of usual thickness</td>
<td>2 to 4 months</td>
</tr>
</tbody>
</table>

This is the most common structure used for Rigid-Flex boards. The Unsymmetrical structure is not symmetrical in Z axis.

**Material and their properties**

Polyimide must be used for flex parts. Standard FR4 or High Tg material can be mixed with polyimide layers for rigid parts. Fully polyimide material can be also considered for high temperature usage.

Prepreg is recommended to be No-flow around flex area, UNIFLOW prepreg is possible on other layers.

Adhesiveless foils are 30 to 50% more expensive than adhesive foil but it is mandatory for plating process. Using this type of foil is expressly recommended by IP 2223 C.

Standard build up for Flex rigid PCB

- Copper base (0.0014 in) + Plating (0.001 in min)
- FR4
- Prepeg (no flow)
- Copper
- Polyimide core (Adhesiveless)
- Copper
- Prepeg (no flow)
- FR4
- Copper base (0.0014 in) + Plating (0.001 in min)
- Soldermask (LPI)
Copper kinds and properties

ED Electro Deposited

ED copper has a better resistance & is more suitable for dynamic, flexible applications

RA Rolled Anodized

RA copper is more ductile and is suited for stable and semi-dynamic applications

<table>
<thead>
<tr>
<th>COPPER PROPERTY</th>
<th>ELECTRODEPOSITED</th>
<th>ROLLED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/4 oz (9 µM)</td>
<td>1 oz (35 µM)</td>
</tr>
<tr>
<td>TENSILE STRENGTH (KPSI)</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>ELONGATION (%)</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>VOL RESISTIVITY (MOHM CM)</td>
<td>1.66</td>
<td>1.78</td>
</tr>
</tbody>
</table>

As for rigid PCB, two kinds of copper layers exist:
- RA, which stands for Rolled Annealed copper: RA copper is manufactured by lamination between rolls.
- ED, electrodeposited copper: Ed copper is manufactured by copper electro-deposition.

**Basic Design Rules**

There are many possible designs, stack-ups of Rigid-Flex, leading to many possible errors when designing. Material is costly, design must help saving cost by achieving the highest possible yield. PI material provides the best thermal, but somehow the worst mechanical properties. Consequently, designing a Rigid-Flex must follow basic guidelines.

**BAKING BEFORE SOLDERING**

The main issue is the moisture absorption. Complete baking is required before soledring process.

**FLEXIBILITY & BENDING RADIUS**

- Single side: 6 times Flex thickness
- Double side: 12 times Flex thickness
- Multi layer: 24 times Flex thickness

**FLEXIBLE SOLDER MASK or PI COVERLAY**

- Suggest Flexible solder for no dynamic flexion
- Suggest PI Coverlay for dynamic flexion

**Typical Design Guidelines**

- It is recommended for the design layout to stagger the traces.
- To increase copper strength, make larger traces around holes.
- Keep all traces as equal and same thickness, they are to be avoided by using flexes.
- All pads: lands through holes and inner: should be filled.
- Peelable tapes improve solder yield and mechanical strength.
- Having a radiused corner within flex bend area reduces or eliminates stress concentrators and improves reliability.
- Applying crosshatching will help the circuit retain its flexibility.
- Incorporate tear stops and reliefs for slits in the circuit to prevent tear from starting and propagating.
- Copper strands should always be perpendicular to the bending or otherwise they tear and scratch.

Above: Basics guidelines

Left: Design guidelines
CONCLUSION:
Even though Rigid-Flex PCBs are more expensive than Rigid boards, we must see that solution as a global solution. The assembly cost can be less expensive than an extensive number of PCB types.

The labor cost for manual operation can be avoided, and mainly, the reliability will be much better. That is a real gain. Rigid-Flex PCBs will be more compact and technically more advanced.

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