How to Design With Flex in Mind

Quick and Easy Design Improvements

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Why Flex?

- Space Savings
- Eliminate wiring errors
- Electrical Performance
- Circuit Density
- Termination Variety

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Space Savings

- Flex circuits can fold and bend to fit into the available space
- Custom shape ensures a perfect fit on every assembly
- Flex circuits take up a fraction of the space of discrete wires
- Bulky board-to-board connectors can be eliminated
- Bulky wire harnesses can be eliminated

Wire Harness Vs Flex

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Wire Harness Vs Flex

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Wire Harness Vs Flex

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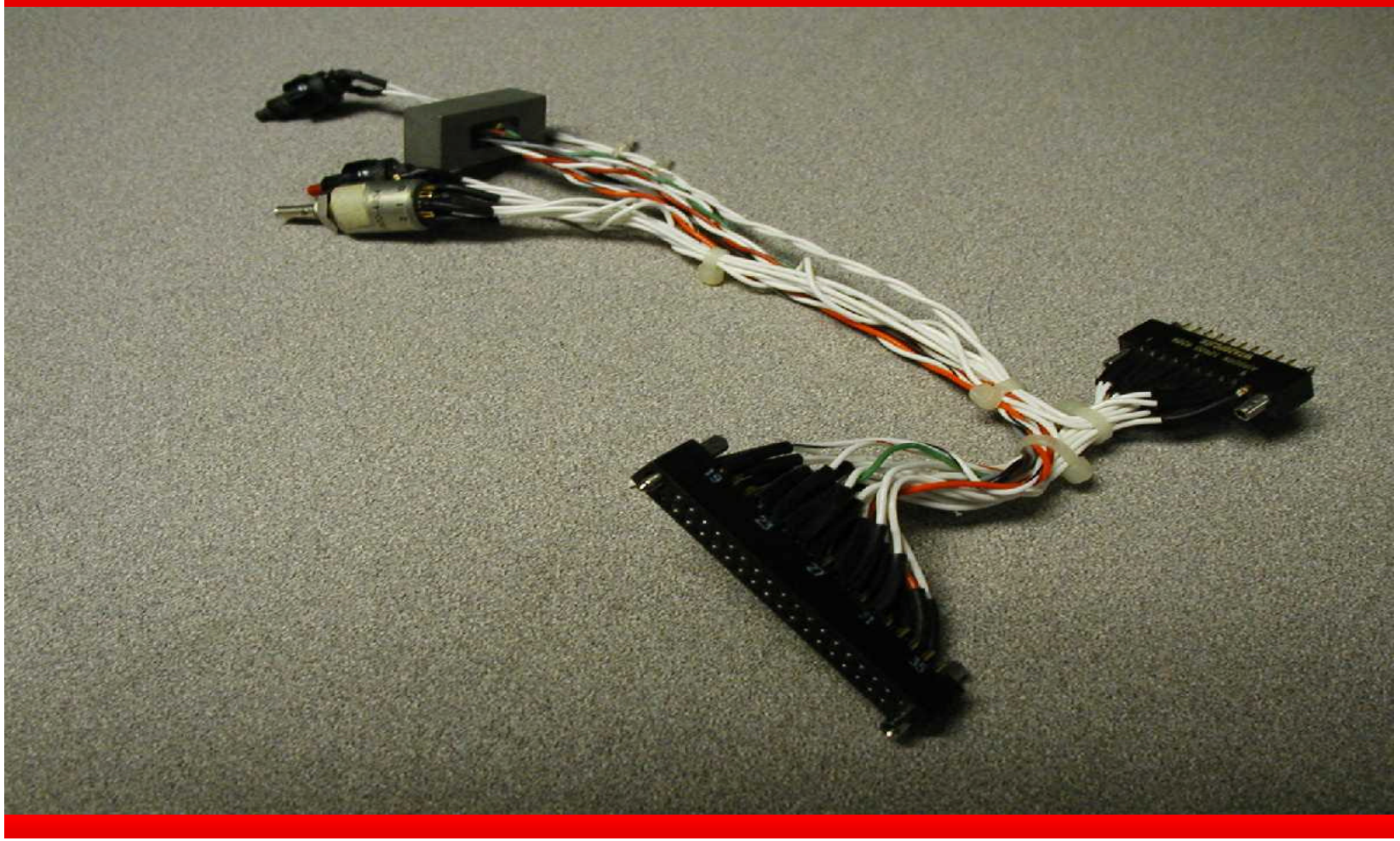
Wire Harness Vs Flex



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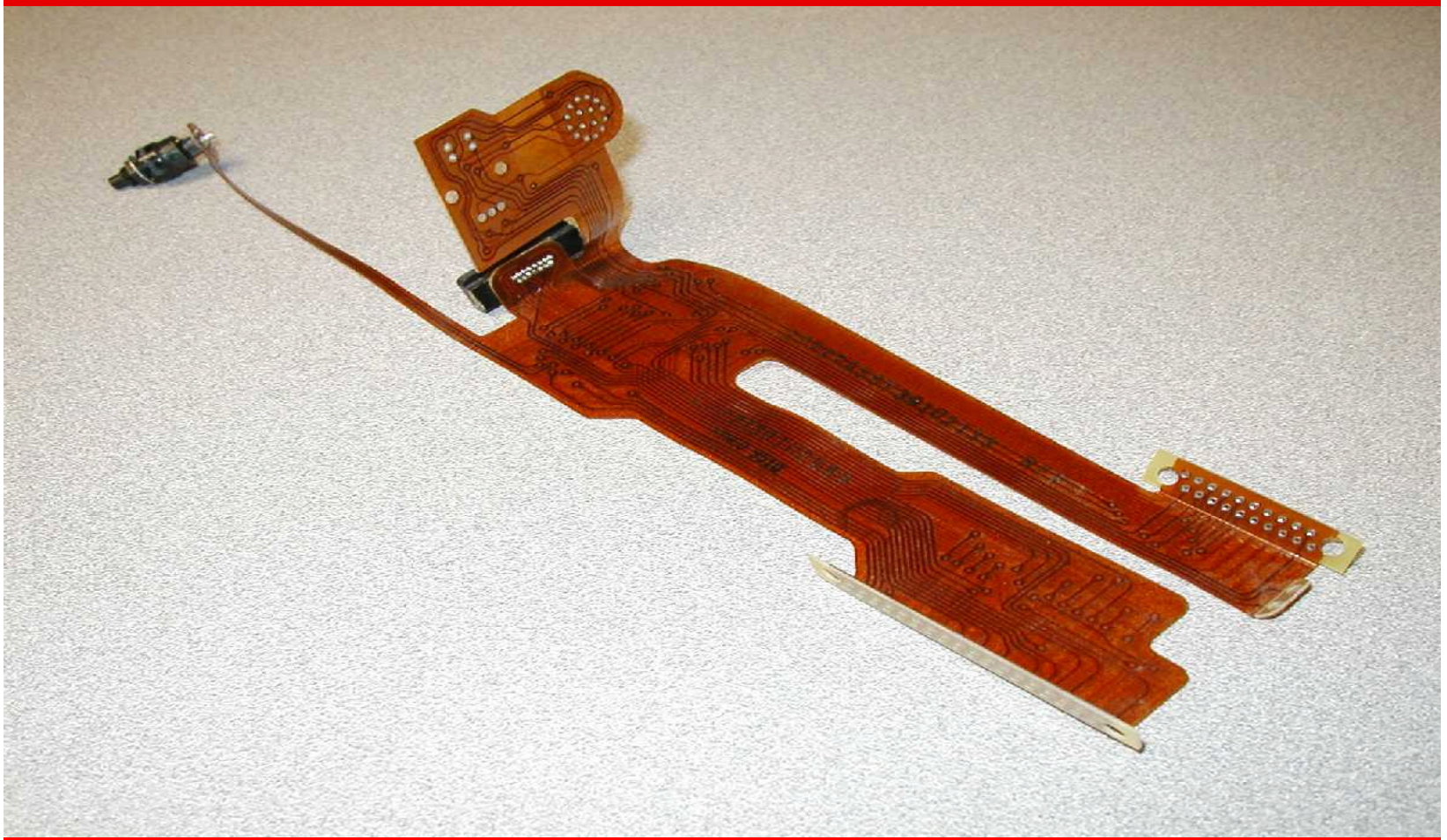
Wire Harness Vs Flex



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Wire Harness Vs Flex

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Flex Circuit Design Steps

- **Create paper dolls and modify to achieve best fit.**
- **Create “paper” doll with .010” Mylar to better represent circuit flexibility.**
- **If bend ratios are a concern, contact a flex circuit manufacturer to have a mechanical sample built.**
- **Rout conductors using IPC-2223 guidelines.**

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Flex Circuit Design Steps

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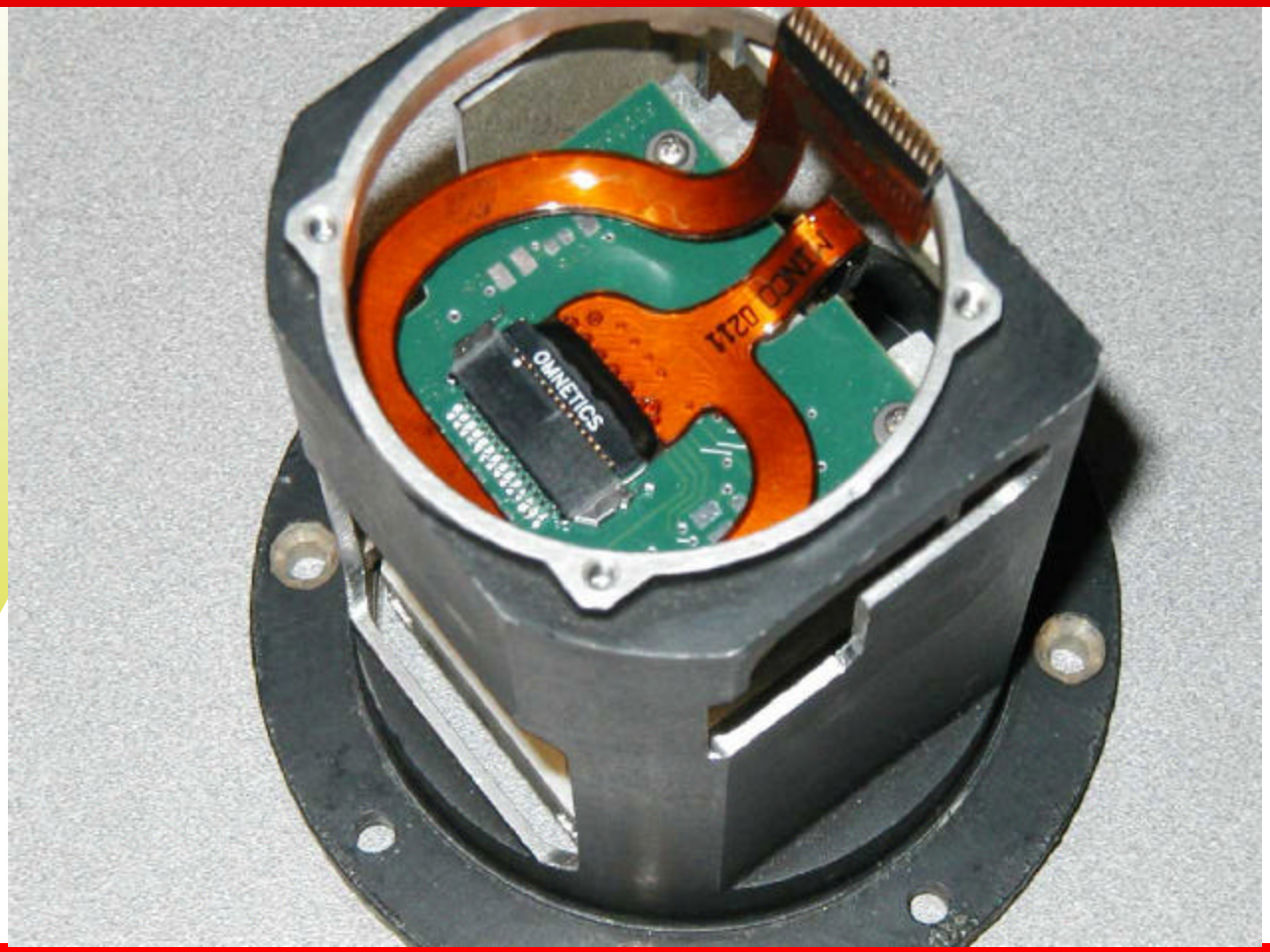
Flex Circuit Design Steps



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Termination Design

- **Terminations**
  - **Robust During Installation and Use**
  - **No Strain on Termination Areas**
  - **Matched to Circuit for Signal Integrity and Current Load**
  - **Should be Addressed at Beginning of Design Cycle**

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Terminations

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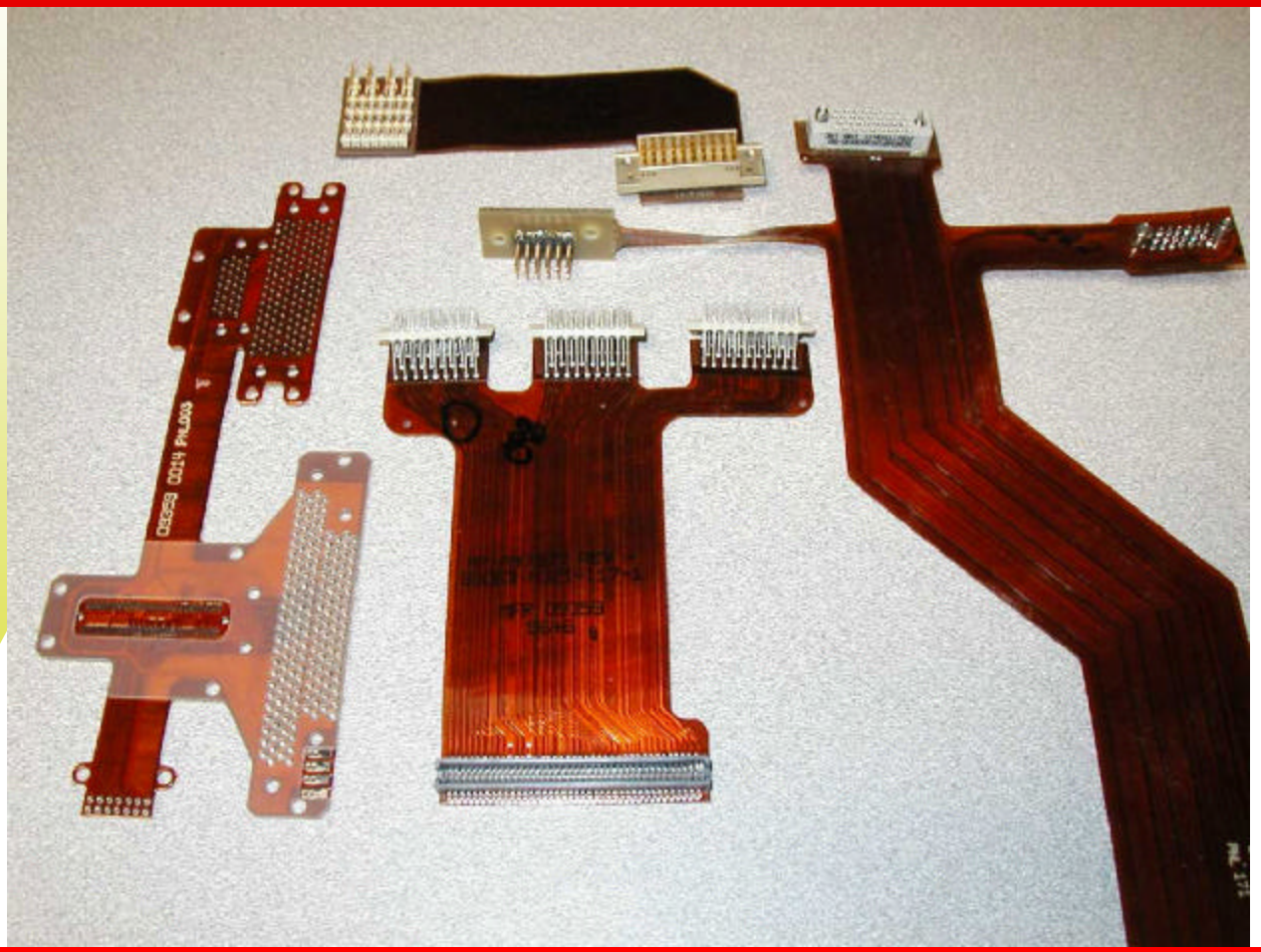
Terminations



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Design for Etching

- 5:1 Conductor width to foil thickness ratio
- Optimize Artwork
  - Center auto-routed patterns between pads
  - Enhance pads, conductor widths and spacing where room permits
  - Verify sufficient border to edge
- Avoid conductor width reductions at bend points and access openings- Stress Risers
- Provide relief areas for pads located on large conductor areas

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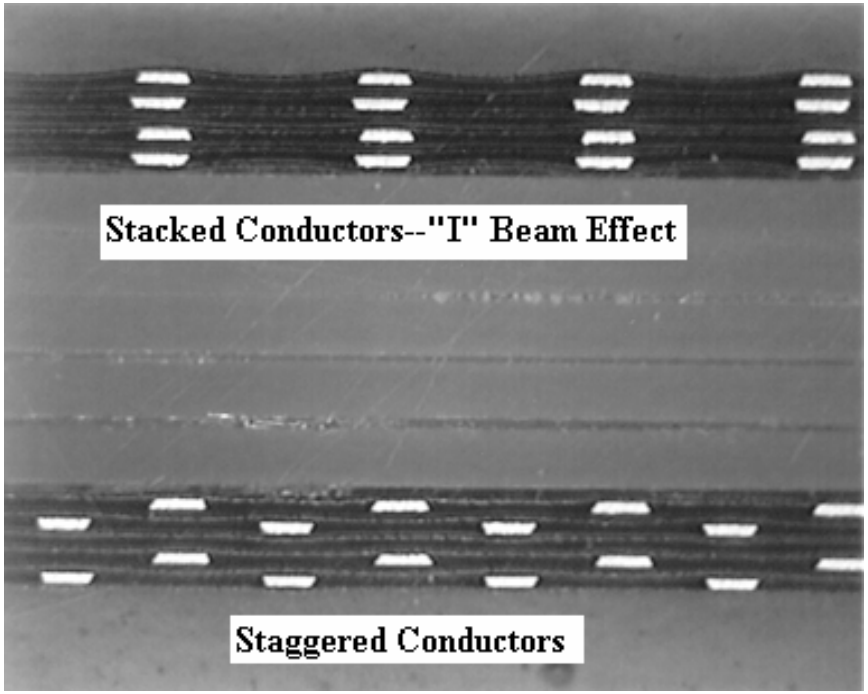
Conductor Pattern Considerations

- Is the Construction Balanced?
- Stagger Conductors to Eliminate “I Beam” Effect



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Design for Flexibility

- **Bending (static or dynamic?)**
  - **Refer to IPC-2223 for acceptable bend ratios**
  - **Strive for >10:1**
  - **No cracking or wrinkling of conductors**
  - **No tearing or delamination of insulation material**
- **Remove Cover Material on Outer Layers Where There is no Circuitry**
- **Consider Adding “Pads Only” Layers to Top And Bottom Of Circuit**
  - **Elimination Of Plated Copper on Outer Layers**

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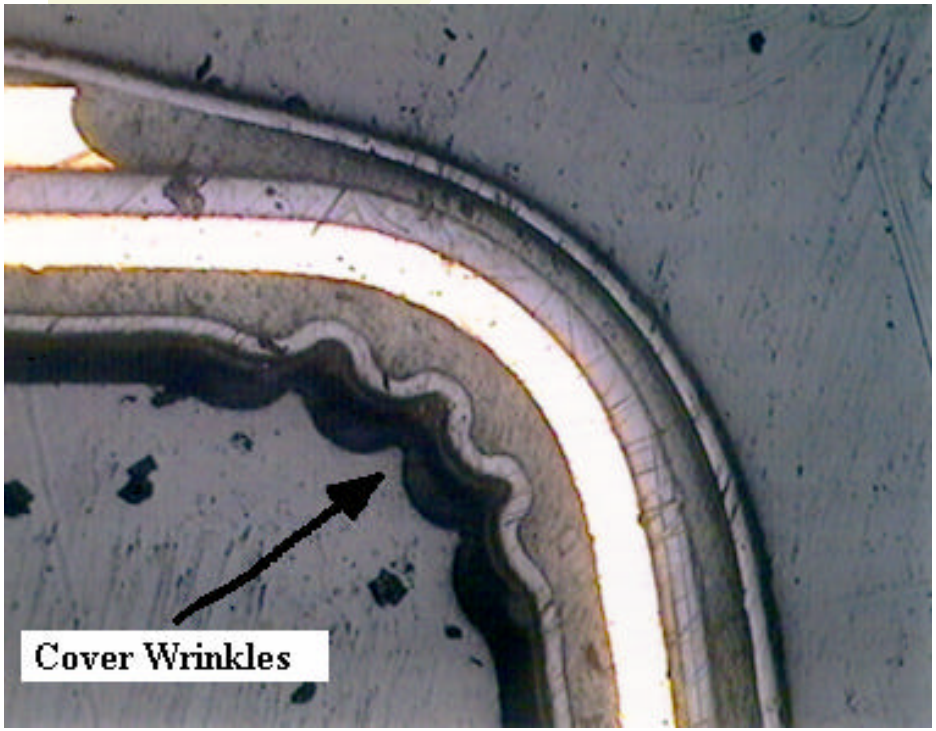
Bend Related Defects



- Cover Wrinkles from Compression

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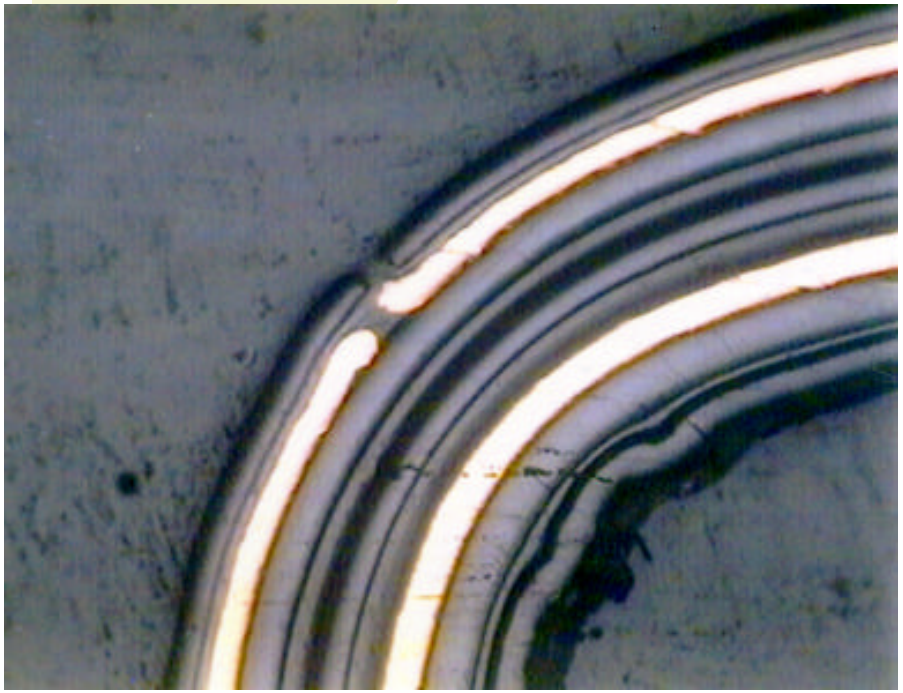
Bend Related Defects



- Torn Cover material or Cracked Conductors

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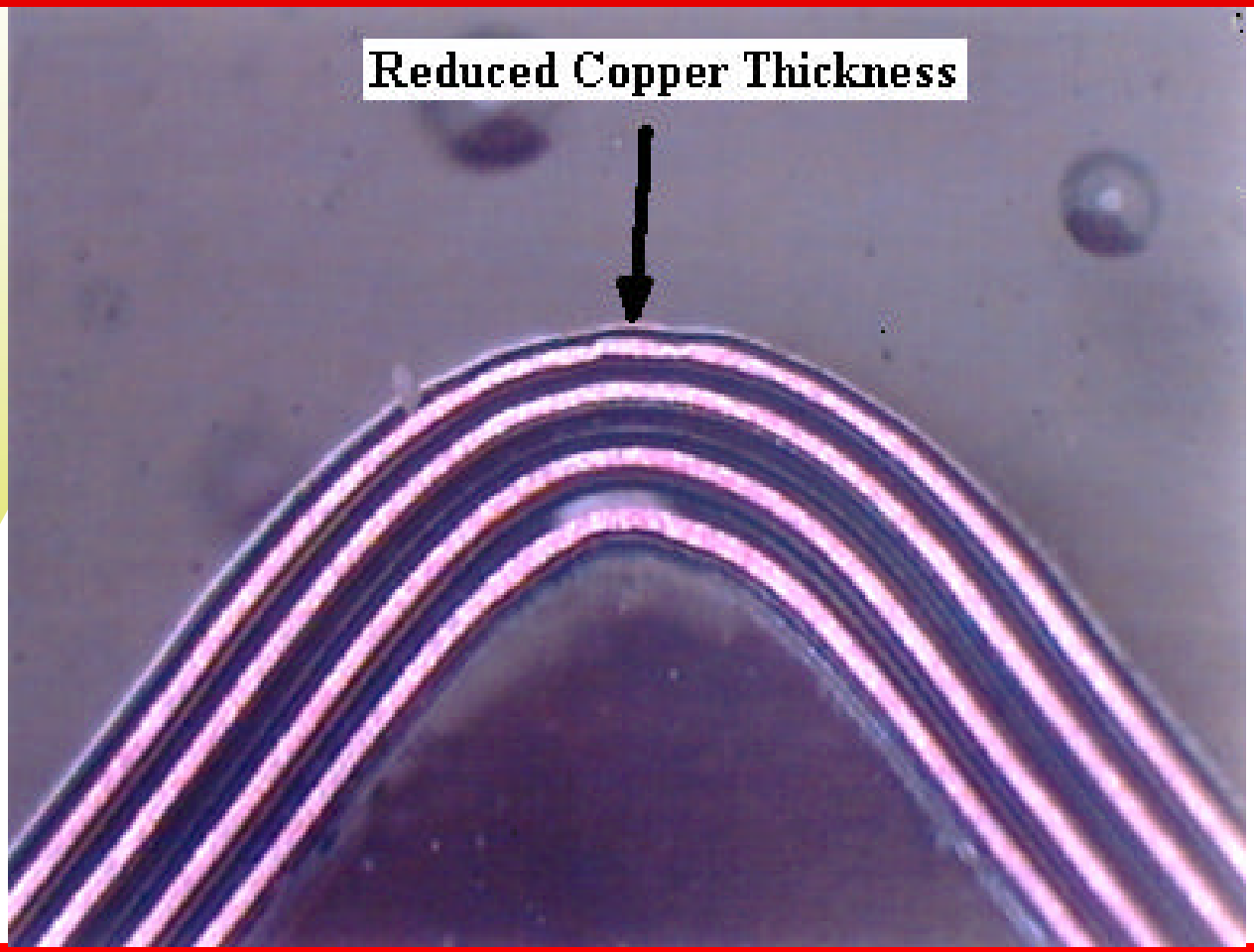
Bend Related Defects



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Design for Lamination

- Adhesive Thickness
  - Allow for 1 mil per 1 ounce foil thickness
  - Allow for 3-5 mils of flow per mil thickness
  - Thicker Polyimide film may require extra adhesive
- Stiffeners
  - FR-4 material – routed
    - 0.010" to 0.062" thick (thicknesses over 0.031" can be more expensive)
    - Dimensionally small stiffeners are more difficult to work with
  - Kapton – punched
    - 0.001", 0.002", 0.003", and 0.005" thick
    - Less expensive than FR-4, cleaner, and better registration

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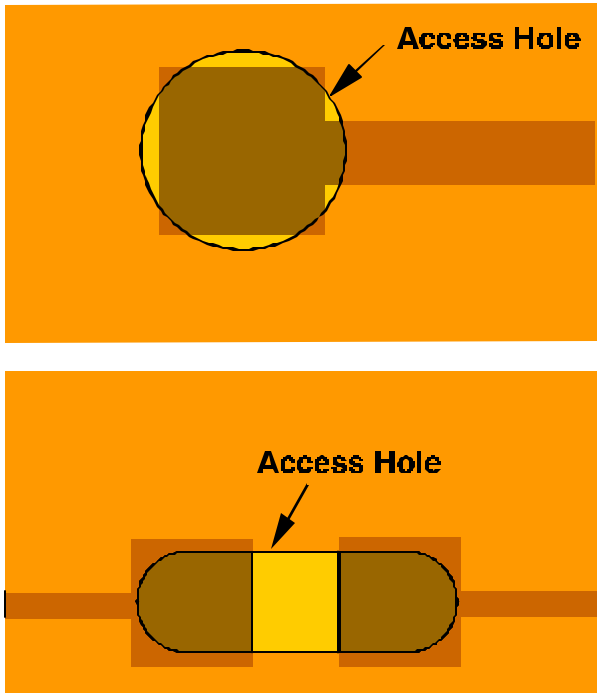
Access Considerations

- **Standard Coverlay**
  - Square pad with round access hole
  - Square pads with slotted access hole
- **PIC Coverlay**
  - Allows any geometry



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Design for Dimensioning

- **Follow Recommended Tolerances**
  - **Use Multiple Datums**
    - **Looser Tolerances between datums**
    - **Tighter Tolerances within a datum**
  - **Use Profile Tolerances**
    - **Easier to Inspect**
  - **Remember it is *Flexible***
    - **Measure in constrained condition**

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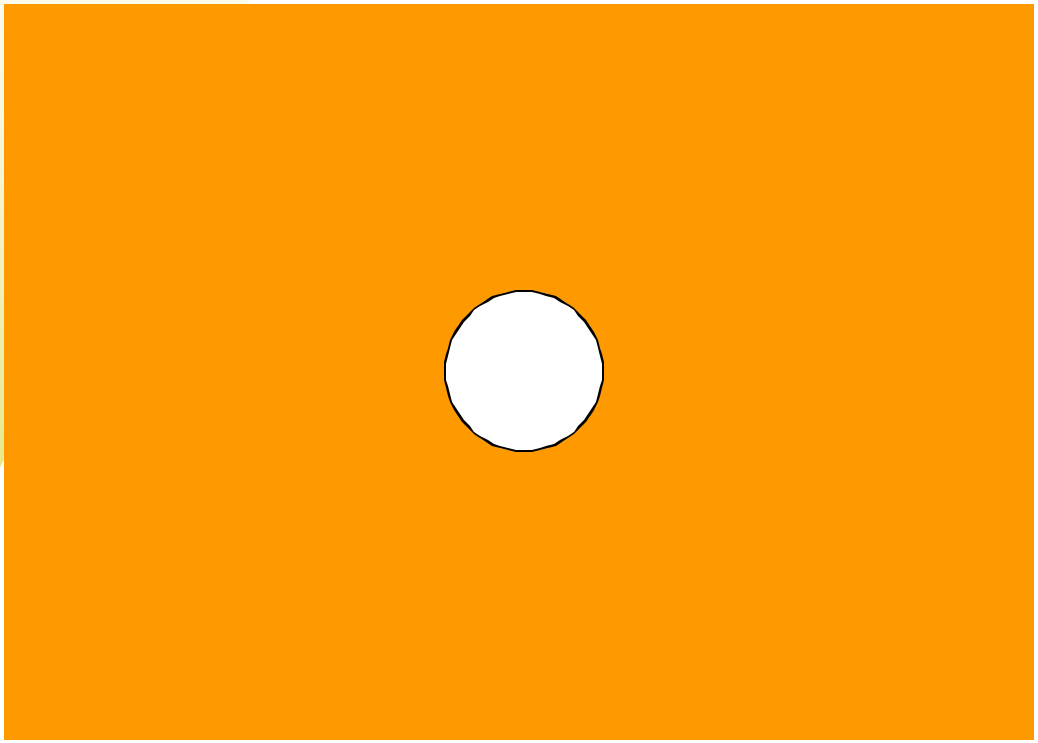
Tolerances



Drill hole in base material and plate

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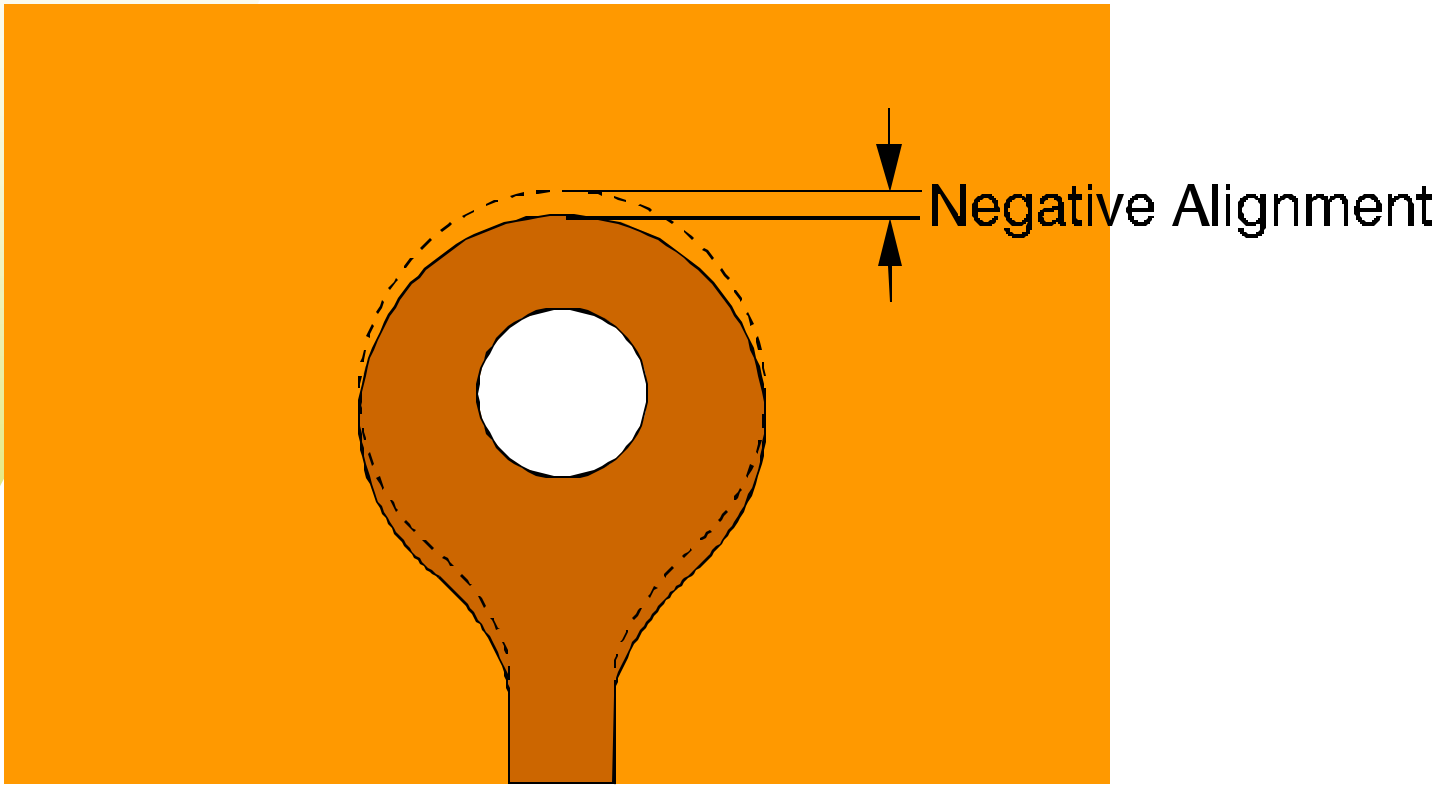
Tolerances



Align negative, print, and etch

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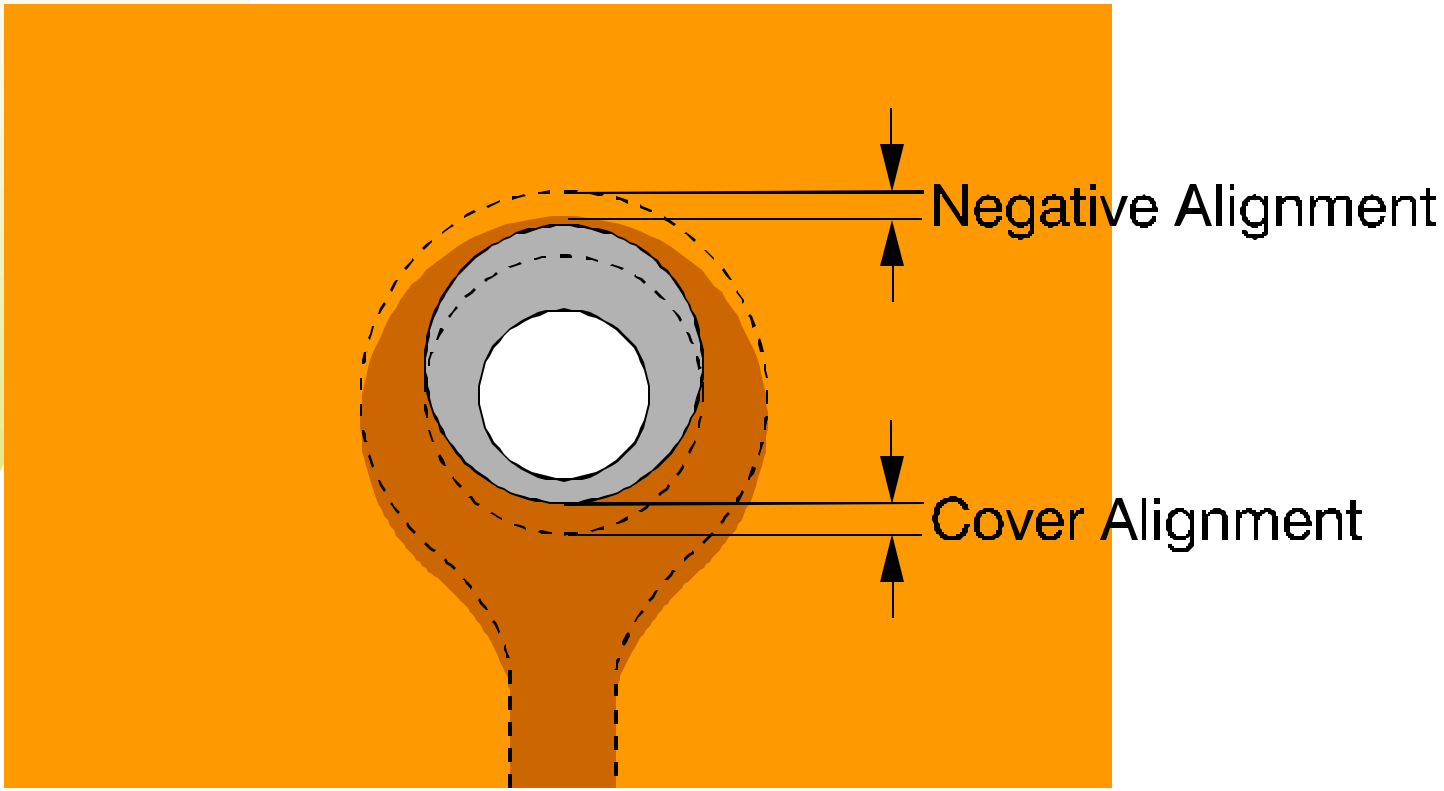
Tolerances



Align cover and laminate

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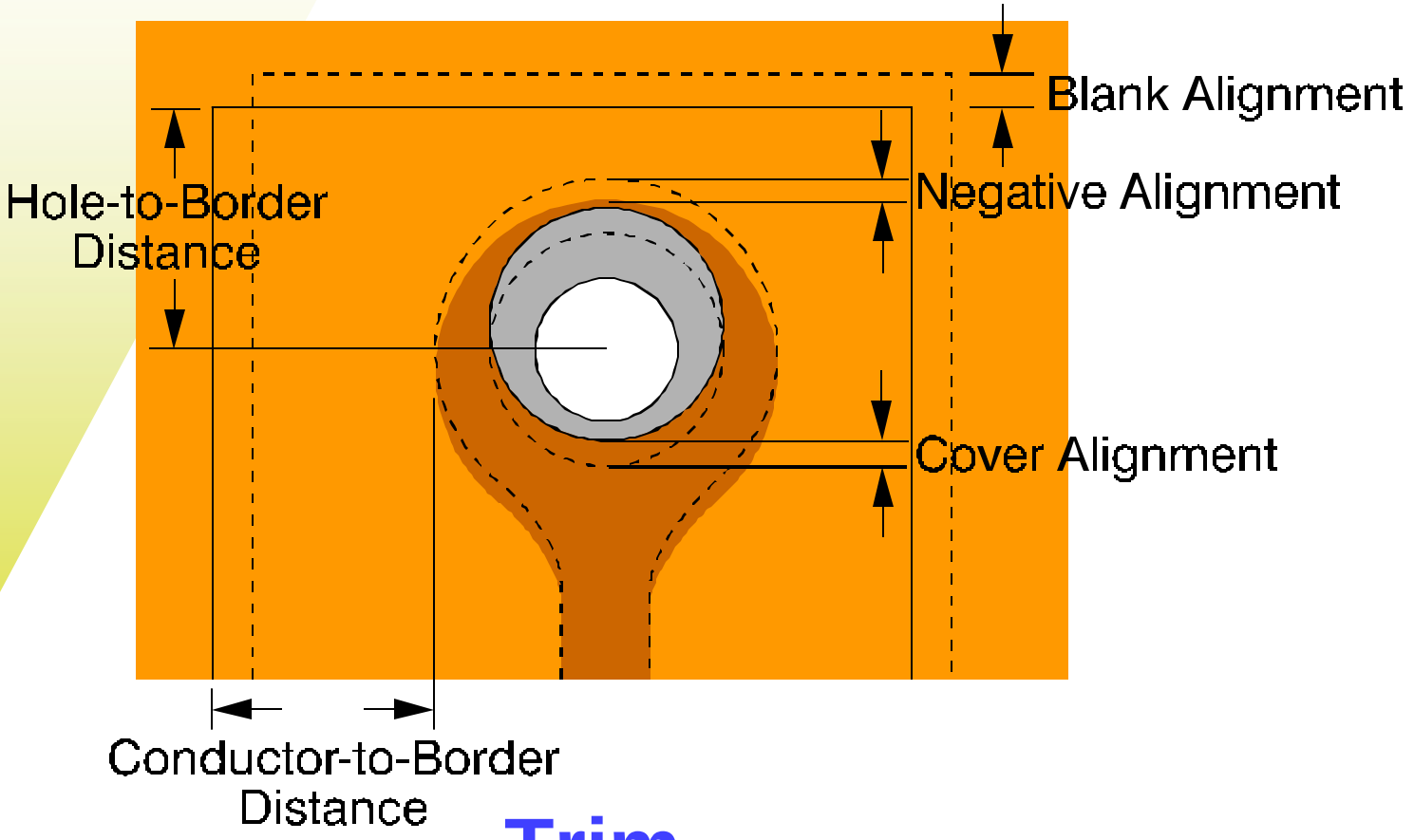
Tolerances



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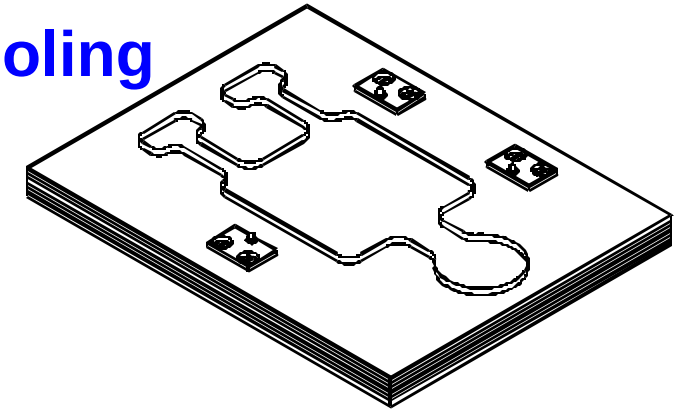
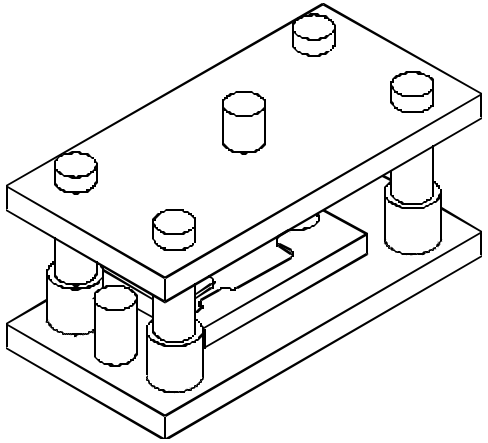
Tooling Options

- **Volume and Tolerances define Tooling**
  - **Laser**
    - **tight tolerances; complex cutouts**
    - **small quantities**
  - **Steel rule die**
    - **intermediate tolerances**
    - **intermediate quantities**
  - **Punch & die**
    - **tight tolerances; complex circuits**
    - **high quantities**





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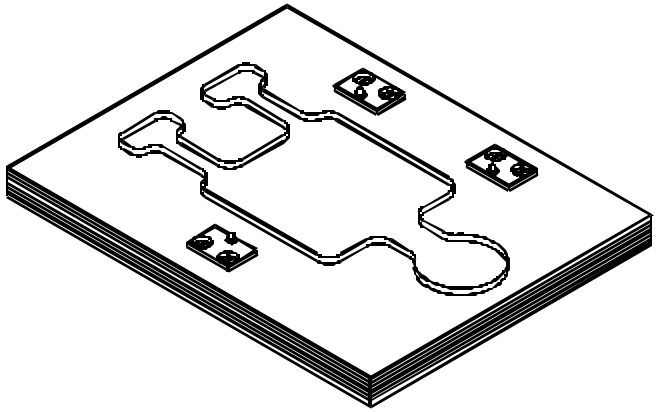
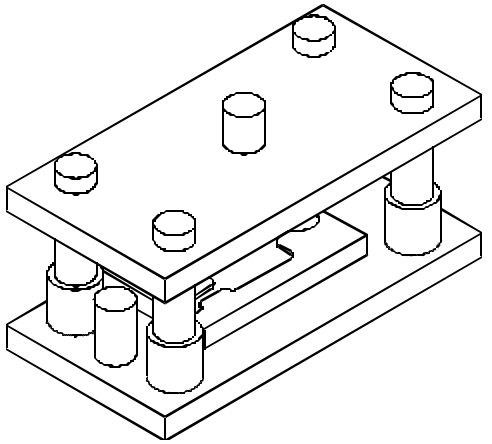
Tooling Costs

- **Laser**
  - Low Cost Set-up
  - Higher cost per part
  - Easily modified
- **Steel rule die**
  - Low to moderate cost
  - Short lead time
- **Punch & die**
  - Highest cost
  - Lowest per part cost





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Design With Flex in Mind

- Utilize Mock-ups for Best Fit
- Select Termination Style Early
- Optimize Artwork
- Consider Flexibility Needs
- Lamination- Don’t Forget Adhesive
- Apply Tolerances Liberally

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Questions?

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