Flex/Rigid Flex Capabilities & DFM
Located in the Heart of Silicon Valley, Streamline Circuits is your premier PCB manufacture of leading edge Technology and Innovation. We offer full service solutions for Rigid PCB’s, Flex PCB’s and Rigid-Flex PCB’s in both Ultra Quick Turn options along with Standard Production lead times. You will find that Streamline holds the necessary certifications to insure the highest standards of workmanship while supporting your companies specifications.

Mil / Aerospace
DataCom
Medical
TeleCom
Industrial
Streamline Circuit Corp’s Facility

- Manufacturing all levels of technology
  - Time sensitive prototyping through production

- The facility was established in 1982
  - New management team installed September 2003

- 75,000 sq. ft. PCB manufacturing facility
  - Complete manufacturing process under one roof

- 1 mile from the San Jose Airport
  - Delivery convenience for out of state customers

- Located in Silicon Valley
  - Short car ride away for pick up & deliveries

- Financially secure in current market conditions
  - Low cost infrastructure
Management and their Experience

Chuck Dimick – CEO / Founder
• Over 35 years of experience in PCB manufacturing. Former CEO of Dynamic Details Inc. and founder of the company's predecessor, Dynamic Circuits Inc. (1991)

Greg Halvorson – President / Founder
• Over 33 years of experience in PCB manufacturing. Former VP of Operations of Dynamic Details Inc. and Dynamic Circuits Inc.

Tom Doslak – Sr. Vice President of Sales & Marketing / Founder
• Over 25 years of industry experience. Former Director of Sales for Braztek Intl. and Western Regional Sales Manager for Dynamic Details Inc.

Gary Greenberg – VP of Operations
• Over 31 years of industry experience. Previously VP of West Coast Operations for the EMS Division. Has held roles in Operations, Engineering, and Quality at DDI, Teradyne and Raytheon.

Glenn Holland – Director of Quality
• Over 31 years of Industry experience. Previously held position of Director of Quality at TTM / Via Systems. Has experience in Operations, Assembly, Engineering and Quality.

Mike Trammel – Director of Engineering
• Over 27 years of industry experience. Former Director of Engineering for DDI and Dynavision. 12 years of Materials Application Engineering and R&D experience.
Management and their Experience Cont.

**JR Ramirez – Production Manager / Founder**
- Over 35 years of industry experience. Former Production Manager for both Dynamic Details Inc. and Dynamic Circuits Inc.

**Louis Oliveira – Pre-Production Engineering Manager**
- Over 28 years of CAM “Computer Aided Manufacturing” experience to Streamline Circuits. Previously was Pre-Production Engineering at Dynamic Details. Held various key positions at Davila International Circuits.

**Phil Ramon – Pre-Production Engineering Supervisor**
- Over 37 years of experience in the PCB industry. Previously worked for 16 years on the management team for South Bay Circuits, more than 9 years as Pre-Production Engineering Manager and 10 years at CTS Printex.
Streamline Circuits has flex and rigid-flex PCB capabilities that other companies can't compete with. As your PCB supplier, you will be able to build boards with line and width spacing down to .5 mil and 1 mil micro vias. Please view our full Flex/Rigid-Flex Capabilities Presentation to learn more or contact our engineering services team to help you determine what the optimal technologies are for your application.
RIGID-FLEX EXAMPLES

- 6 Layer Rigid Flex
- 8 Layer Rigid Flex Microvia
- 6 Layer Rigid Flex with Cavity
- 10 Layer Rigid Flex Microvia BGA
- 10 Layer Rigid Flex with Cavity and 4 flex, Microvia, Buried and Blind vias
# MANUFACTURING CAPABILITIES

<table>
<thead>
<tr>
<th></th>
<th>STANDARD</th>
<th>ADVANCED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SINGLE-SIDE FLEXIBLE PANEL SIZE</strong></td>
<td>12&quot;x18&quot; 18&quot;x24&quot;</td>
<td>20&quot;x26&quot; 24&quot;x36&quot;</td>
</tr>
<tr>
<td><strong>DOUBLE-SIDE FLEXIBLE PANEL SIZE</strong></td>
<td>12&quot;x18&quot; 18&quot;x24&quot; and up</td>
<td>18&quot;x24&quot; and up</td>
</tr>
<tr>
<td><strong>MULTILAYER FLEX PANEL SIZE</strong></td>
<td>12&quot;x18&quot; 18&quot;x24&quot; and up</td>
<td>Layer Count: Up to 13+</td>
</tr>
<tr>
<td><strong>RIGID FLEX PANEL SIZE</strong></td>
<td>12&quot;x18&quot; 18&quot;x24&quot; and up</td>
<td>Layer Count: 2 to 28</td>
</tr>
<tr>
<td><strong>Multiple Lamination</strong></td>
<td>Copper Foil Weights Internal/Internal</td>
<td>1/4 to 2 ounce</td>
</tr>
<tr>
<td></td>
<td>Kapton Polyimide Stiffener</td>
<td>Up to 3 ounce</td>
</tr>
<tr>
<td></td>
<td>FR4 Stiffener</td>
<td>.003&quot; to .062&quot;</td>
</tr>
<tr>
<td></td>
<td>Polyimide Rigid Stiffener</td>
<td>.003&quot; to .062&quot;</td>
</tr>
</tbody>
</table>
| **Lines, spaces & pad diameters** | Internal Line Width | .0035"
Left: .001" |
|                        | Internal Spacing | .0035"
Left: .001" |
|                        | External Line Width | .0035"
Left: .001" |
|                        | External Spacing | .0035"
Left: .001" |
|                        | SMT Pitch | .010"
Left: .010" |
|                        | Controlled Impedance | 10% 5% |
| **Via hole Finish** | Laser Micro Vias | .004" |
|                        | Blind/buried Vias | .004" |
|                        | Laser Pads | .004" |
|                        | Minimum Drilled Hole Size | .012" |
|                        | Drilled Hole to Copper | .008" |
|                        | Castellation | Yes |
| **Finish surface** | Tin Lead Plating Thickness | .0003" to .0005" |
|                        | Tin Nickel Plating Thickness | 150 Micro Inches |
|                        | Low Stress Nickel | 100 Micro Inches |
|                        | Gold Plating Thickness | 30 Micro Inches |
|                        | Electroless Nickel/Immersion Gold | Yes |
|                        | Immersion Gold | Yes |
|                        | Immersion Silver | Yes |
|                        | Entek 106A HT | Yes |
|                        | HASL | Yes |
| **TOLERANCES** | Plated Hole Tolerances (+/-) | .002" |
|                        | Non-Plated Hole Tolerances (+/-) | .001" |
|                        | Fabrication Tolerance (+/-) | .005" |
|                        | Vision Rout (+/-) | .003" |
|                        | Laser Rout (+/-) | .002" |
|                        | Vision Rout to Copper | .001" |
# Base Material Flex and Rigid Flex

**Other Material Flex and Flex-Rigid**

<table>
<thead>
<tr>
<th>IPC-</th>
<th>Manufacturer</th>
<th>Material Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>4202/1</td>
<td>DuPont</td>
<td>Pyralux FR</td>
</tr>
<tr>
<td>4203/1</td>
<td>DuPont</td>
<td>Pyralux FR</td>
</tr>
<tr>
<td>4203/18</td>
<td>DuPont</td>
<td>Pyralux FR, Pyralux</td>
</tr>
<tr>
<td>4204/1</td>
<td>DuPont</td>
<td>Pyralux FR, Pyralux</td>
</tr>
<tr>
<td>4204/11</td>
<td>DuPont</td>
<td>Pyralux AP</td>
</tr>
<tr>
<td>4101/21</td>
<td>Isola</td>
<td>FR406, FR408, 370</td>
</tr>
<tr>
<td>4101/24</td>
<td>Isola</td>
<td>FR406, FR408, 370</td>
</tr>
<tr>
<td>Aolon PrePreg</td>
<td>49N</td>
<td></td>
</tr>
<tr>
<td>4101B/124</td>
<td>Aolon</td>
<td>PrePreg 51N</td>
</tr>
<tr>
<td>4101/26</td>
<td>Isola</td>
<td>FR406, FR408, 370</td>
</tr>
<tr>
<td>Isola Prepreg</td>
<td>FR406N</td>
<td></td>
</tr>
<tr>
<td>Grace</td>
<td>GA-170LL</td>
<td></td>
</tr>
<tr>
<td>4101/41</td>
<td>Aolon</td>
<td>35N</td>
</tr>
<tr>
<td>Isola Prepreg</td>
<td>P26</td>
<td></td>
</tr>
<tr>
<td>4101/42</td>
<td>Aolon PrePreg</td>
<td>38N</td>
</tr>
<tr>
<td>4101/99</td>
<td>Isola</td>
<td>370HR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Manufacturer</th>
<th>Material Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductive Silver Ink</td>
<td>DuPont</td>
<td>CB028</td>
</tr>
<tr>
<td>Flex LPI Solder Mask</td>
<td>Taiyo</td>
<td>PSR-9000FXT, PSR-900</td>
</tr>
<tr>
<td>Rogers</td>
<td></td>
<td>RFLEX 8080 Liquid Coverlay</td>
</tr>
<tr>
<td>Kapton/Polyimide Stiffener</td>
<td>DuPont</td>
<td>Pyralux, FR, Pyralux</td>
</tr>
<tr>
<td>FR4 Stiffener</td>
<td>Isola</td>
<td>FR406, FR408, 370</td>
</tr>
<tr>
<td>Grace</td>
<td></td>
<td>GA-170LL</td>
</tr>
<tr>
<td>Polyimide Stiffener</td>
<td>Arlon</td>
<td>35N</td>
</tr>
<tr>
<td>Aluminum Stiffener</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Sensitive Adhesive</td>
<td>3M</td>
<td>467MP, F9469PC, F9460PC</td>
</tr>
<tr>
<td>Strain Relief (Epoxy)</td>
<td>Emerson &amp;Cuming</td>
<td>Eccobond 45 Clear, Black</td>
</tr>
</tbody>
</table>

**Note:** Other materials available and have been manufactured, but non standard on per customer request.
IPC INFORMATION

IPC-6012 Qualification and Performance Specification for Rigid Printed Boards
IPC-6013 Qualification and Performance Specification for Flexible Printed Boards
IPC-A-600 Acceptability of Printed Circuit Boards
IPC-4101 Specifications for Base Materials for Rigid and Multilayer Printed Boards.
IPC-4202 Flexible Base Dielectrics for Use in Flexible Printed Circuitry
IPC-4203 Adhesive Coated Dielectric Films for Use as Cover Sheets for Flexible Printed Circuitry and Flexible Adhesive Bonding Films
IPC-4204 Flexible Metal-Clad Dielectrics for Use in Fabrication of Flexible Printed Circuitry
IPC-SM-840 Qualification and Performance of Permanent Polymer Coating for Printed Boards
IPC 6012,13,15,16,18 Class 3
ITAR
AS9100 Rev C
Mil-Spec 55110
Mil-Spec 31032 anticipated for March 2014
FLEX SINGLE-SIDE CIRCUIT CONSTRUCTION

**SINGLE-SIDE FLEXIBLE CIRCUITS**
- Single-Side flexible circuits consist of a single conductive layer on a flexible dielectric film. (see constructions below)

**SINGLE-SIDED FEATURES:**
- Very thin construction .003”-.008” (.075mm-.20mm)
- One conductive layer
- Reverse bared or back bared pads, provide access from both sides of the part
- Support & unsupported finger areas

**SCULPTURED FLEX CIRCUITS**
- Sculptured flex circuits have variable copper thicknesses within the part. Thin copper is used for the flexible regions & thicker copper is used at the interconnection point. Sculptured flex circuits provide bare metal connection & are a highly reliable alternative to mechanically crimped contact pins

**WHEN TO USE SINGLE-SIDED FLEX:**
- Dynamic flexing applications
- Unusual folding and forming applications
- Installation/service applications / repair
- Limitations on space / thickness
- Installation / service flexing
FLEX DOUBLE-SIDE CIRCUIT CONSTRUCTION

**DOUBLE-SIDE FLEXIBLE CIRCUITS**
- Double-side flexible circuits consist of two conductive layers & can be with or without plated-through holes, depending on design requirements (see constructions below)

**DOUBLE-SIDED FEATURES:**
- Two conductive layers
- Component assembly available on both sides
- Operating high frequency applications
- Supported and unsupported component areas

**WHEN TO USE DOUBLE-SIDED FLEX:**
- Required when circuit density and layout can not be routed on a single layer
- Signal or ground / power plane applications
- Used for shielding applications
- Dense surface mount assembly
- Controlled impedance applications
**MULTILAYER FLEX CIRCUIT CONSTRUCTION**

**MULTILAYER FLEX CIRCUITS**
- The construction that have three or more conductor layers are referred to as multilayer flex. The layers of the circuit are interconnected with plated-through holes, and with or without stiffeners.

**MULTILAYER FLEX FEATURES:**
- Three or more conductive layers
- Component assembly available on both sides
- Controlled impedance and shielding possible
- Supported and unsupported finger/component areas

**Adhesive**

**Adhesiveless**

**WHEN TO USE MULTILAYER FLEX:**
- Required when circuit density and layout can not be routed on a single layer or double layer
- Signal or ground / power plane applications
- Increased circuit density
- EMI/RFI shielding
- Used for shielding applications
- Dense surface mount assembly
- Controlled impedance with shielding applications
RIGID-FLEX CIRCUIT CONSTRUCTION

When to Use Rigid Flex:
- Required when circuit density and layout cannot be routed on a single layer.
- Used when components are mounted on both sides of the rigid and flex section.
- Used to solve high-density packaging problems.
- EMI/RFI shielding.
- Used for shielding applications.
- Dense surface mount assembly.
- Controlled impedance with shielding applications.
- Used to connect rigid boards together.

Rigid flex circuits are a hybrid construction, consisting of rigid and flexible substrates laminated together into a single package and electrically interconnected by means of plated-through holes with solid flexible or loose leaf flexible construction, and with or without stiffener (see construction below).

Rigid flex boards are normally multilayer design, but double-sided (two-metal layer) constructions are possible as well, and in fact, have been selected for certain microelectronic chip-packaging applications (see constructions below).

Rigid Flex Features:
- Two or more conductive layers.
- Combined rigid & flex to achieve high-density packaging.
- Eliminate wires and wire harness assemblies.
- Folded/bended/positioned into package size.
- Easy assembly and installation.
SHIELDING

Shielding:
- If the application requires limits in electromagnetic interference/radiofrequency interference (EMI/RFI) shielding on-board or to fabricate low-voltage circuitry, on rigid or flexible substrates. Shields are material around a conductor or group of conductors that limit these factors.

SOLID COPPER:
- Solid copper is the most common method of shielding. Copper shield can be put on one or both sides of the circuit. Solid copper can also cover selective conductors. Solid copper shields increase the rigidity of the circuit, and should be included in thickness to bend radius ratios.

CROSSHATCHED COPPER:
- Crosshatching is an artwork design that relieves much of the copper shield areas by the use of a pattern. Crosshatch shielding can also cover selective conductor. It also helps the circuit to retain its flexibility and can be put on one or both side.

CONDUCTIVE SILVER:
- Conductive silver can be substituted for the copper for shielding purposes in some applications. Silver can be a solid or crosshatched shield and can be put on one or both sides of the circuit. It can also cover selected conductors only. Silver shielding is not recommended for a dynamic flexing application due to its brittle characteristic, and may be prone to cracking in severe bending applications.

MINIMUM EDGE OF SILVER SHIELD:
- The minimum distance edge of silver epoxy to edge of non common electrical feature of pad / trace coverlay openings exposed pads / traces is -.010” and the edge of flex is -.005”.

(See “Clearance” picture below).

SHIELDED 4 LAYER FLEX

-010”
-005”

Clearance

Edge of flex

Silver Epoxy
Finish Surface Dielectrics

Surface dielectrics are applied to the outside layers of the circuit to insulate the copper conductors. Following are types of surface dielectrics used at all flex.

**COVERLAY:**
- Coverlay is the layer of insulation film and adhesive that is applied totally or partially over a conductive pattern on the outer surfaces of a printed board. This material is normally produced with laser “CO2” drill/rout or mechanical drill/rout process. The common via holes are covered with coverlay. The minimum coverlay openings exposed pads for the component holes are .005” larger than the copper pads. The coverlay openings can be individual barrel pads or gang relief pads depending on area available.

**LIQUID PHOTOIMAGEABLE SOLDERMASK:**
- Liquid Photoimageable Solder Mask (LPI) is produced by a photo controlled process and used of tight pad spaces. This process enables unique openings to be applied anywhere on the circuit. LPI is usually not used with 2oz copper or above due to the thickness of the copper as it may not conform around the area of some copper features. The via holes are covered with solder mask. The LPI openings expose pads are .003” larger than the copper pads with .003” minimum web spacing. LPI is not recommended for dynamic flex applications.
Bending and Folding Guidelines

- Even though flex circuits are very pliable and flexible, there are limits to their flexibility. If the bend radius is too tight, the result can be de-lamination and conductor fracture.

**BEND RADIUS:**
- For single and double-sided flexible printed wiring boards (PWBs), the minimum bend radius should be six times the overall thickness and at least .050” away from the plated through hole (see diagram below).
  
  Example:
  
  If the overall thickness of the flex circuits is .012”, the minimum bend radius should be .072”

- For multilayer flexible PWBs and multilayer rigid and flexible PWBs (bonded inner layers), the minimum bend radius should be 12 times overall thickness.
  
  Example:
  
  If the overall thickness of the flex circuit is .030”, the minimum bend radius should be .360”

**RADIUSED TRACES:**
- The radiused traces help to alleviate breading during folding and bending

**FOLD LINES:**
- The fold lines may be designated by “tick” marks which may be either in the copper layers or silkscreen layers. These features aid in bending and designating bend location.

**BUTTON OR PADS (BARREL) PLATING:**
- The button or barrel plating is a process that allows for the plated through holes to maintain their connection while the traces are not plated, allowing the circuit to have increased flexibility.

**CIRCUIT TRACE WIDTH:**
- The circuit trace width should not change in bend areas the transition should be at least .030” (.76mm) from the fold line.
STIFFENERS/PSA STIFFENERS

The common stiffeners require support in areas where connectors or other components are applied. Here are the recommended types of guidelines for stiffeners.

**POLYIMIDE (KAPTON) STIFFENER:**
- Come in a variety of thickness from .001” (.02mm) up to .007” (.14mm) or higher.
- Can be used to give added thickness under conductors to meet ZIF connector requirement.
- Can be used to give added strength in high wear areas.
- Can be blanked at the same time as the circuit outline to meet tight tolerance requires.
- Can be bonded to flex circuits using a pressure sensitive adhesive or a thermoset adhesive.

**AREA OF STIFFENER:**
- The stiffener and coverlay termination points should overlap a minimum of .030” (.76mm) to void stress points. Eliminating stress points reduce the chance of traces breaking and cracking.

**FR4/POLYIMIDE RIGID STIFFENER:**
- Come in a variety of thicknesses such as .003” (.076mm), .010” (.25mm) or higher.
- Can be used to give added rigidity under a component area.
- Can be used as carrier panel for automated assembly processing.
- Can be bonded to a flex circuit using a pressure sensitive adhesive or a thermoset adhesive.

**COMPONENT HOLES:**
- The holed size in the stiffener is recommended .015” (.38mm) minimum larger than the circuit component holes to allow for registration tolerances.

**PSA:**
- Pressure Sensitive Adhesive is used to bond flex circuits or rigid circuits without heat requirement. The common PSA is used to bond flex circuits to stiffener to support in areas where connectors are applied.
- PSA also placed in key location to improve circuit placement and mounting.
STIFFENERS/ PSA STIFFENERS cont
Glossary

- **Acrylic Adhesive**: Used to bond Multi-layered flex together and also used as part of the coverlay and stiffener used on flex layers/boards.

- **Annular Ring**: That portion of conductive material completely surrounding a hole. This is found on inner and out layers.

- **Apply a fillet**: Used the eccobond or equivalent adhesives along the rigid to flex transitions edges.

- **Artwork**: An accurately-scaled configuration that is used to produce the "Artwork Master" or "Production Master."

- **Aspect Ratio (Hole)**: The Ratio of the length of depth of a hole to its preplated diameter.

- **Base Material**: The insulating material upon which a conductive pattern may be formed. (The base material can be rigid or flexible, or both. It may be a dielectric or insulated metal sheet.)

- **Blind Via**: A via extending only to one surface for a printed board.

- **B-Stage**: An intermediate stage in the reaction of a thermosetting resin in which the material softens when heated and swells, but does not entirely fuse or dissolve, when it is in contact with certain liquids.

- **Covercoat (LPI)**: The material deposited as a Liquid Photo Imageable onto the circuitry that subsequently becomes a permanent dielectric coating.

- **Coverlay**: A film and adhesive made from separate layers of generically different chemistries.

- **Delamination/Blister**: Delamination in the form of a localized swelling and separation between any of the layers of a lamination base material, or between base material and conductive foil of protective coating.

- **Dielectric**: A material with a high resistance to the flow of direct current, and which is capable of being polarized by an electrical field.

- **Dielectric Constant**: The ratio of the capacitance of a configuration of electrodes with a specific material as the dielectric between them to the capacitance of the same electrode configuration with a vacuum or air as the dielectric.
- **Etchback**: The controlled removal by a chemical or gaseous process, to a specific depth, of nonmetallic materials from the sidewalls of holes in order to remove resin smear and to expose additional internal conductor surfaces.

- **Solder Wicking**: The capillary movement of solder between metal surfaces, such as strands of wire.

- **Thermoset**: A plastic that undergoes a chemical reaction when exposed to elevated temperatures that leads to it having a relatively infusible or cross linked state that cannot be softened or reshaped by subsequent heating.

- **Test Coupon**: A portion of quality conformance test circuitry that is used for a specific test, or group of related tests, in order to determine the acceptability of a product.

- **Ultrasonic Cleaning**: Immersion cleaning that is done by passing high-frequency sound waves through a cleaning medium to cause micro agitation.

- **Via**: A plated-through hole that is used as an interlayer connection, but in which there is no intention to insert a component lead or other reinforcing material.