

Minco Flex Circuit Technology Overview

Confidence at every step of your product life cycle

For over 40 years Minco has designed and manufactured flexible circuits for advanced medical, aerospace, defense and other demanding applications. We deliver comprehensive solutions, including flex circuit design, partnering with you at every step of your product cycle.

Flex circuits can be shaped to fit where no other design can. They are a hybrid of ordinary printed circuit boards and round wire, exhibiting benefits of each. In essence, flex circuits give you unlimited freedom of packaging geometry while retaining the precision density and repeatability of printed circuits. Minco specializes in tight tolerance, fine-line flex circuits, with different types of circuits offering different advantages. Some offer lower cost, others increased functionality. We'll work with you to ensure a circuit solution tightly aligned with your requirements.

Simplify Installation by Adding Components

When Minco Engineers familiarize themselves with a project, often they are able to make cost-saving suggestions taking advantage of the company's broad array of products and competencies.

We have the capability to build in through-hole and surface-mount pads, stiffeners for component assembly, and heaters to maintain temperature in different parts of the enclosure. We can even install induction coils for communication telemetry.

Perhaps the most appealing feature might be Minco's ability to simplify assembly. Our unsurpassed capabilities allow us to integrate any combination of our high-quality flex circuits, heaters, sensors, and control electronics. Minco offers a wide array of built-in connectors and can incorporate them into High Density Interconnect (HDI) technology -- making miswiring

nearly impossible. In addition to streamlining the assembly process, Minco's integrated components simplify the supply chain, enabling our customers to get to market faster and reduce their direct costs. Put simply, Minco's high reliability Integrated Solutions reduce time to market and assembly costs for our customers.

Flex Resources

Do you want to learn more about Minco's Flex capabilities? Our website has numerous articles and downloadable resources.

- Flex Circuits Design Guide
- Podcasts
- White Papers
- Blog Posts
- Tips and FAQs
- Case Studies

Visit us at www.minco.com today.

Involve Minco Early

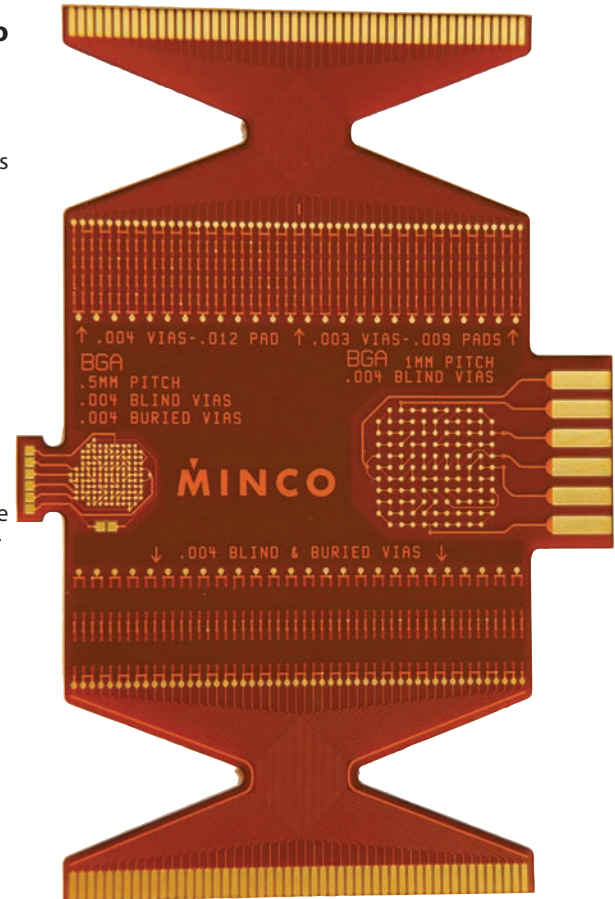
While we often arrive late in a project, it benefits our customers to involve Minco in the beginning of the design phase. Most of the cost savings from Integrated Solutions involve designing the circuit early in the process. If we've entered the picture long after all the design decisions have been made, it's harder for us to find synergies and efficiencies.

Case in point: A medical device manufacturer wanted Minco to create a thermal stabilization

package for a rotating carousel of biomedical vials. The prototype consisted of a heater and tab sensor for each vial, an assembly that involved dozens of wires laid out in a confusing tangle. Minco's engineering team responded by suggesting a solution with surface mount temperature sensors embedded in the same piece of polyimide as the heaters themselves, with a fine-pitch connector serving as a foolproof interface between the circuit and the main project electronics. The customer saved money on manufacturing costs and simplified installation, resulting in further savings.

If the customer hadn't involved us in the prototyping phase, our engineers would have a harder time finding an elegant solution that fulfilled project parameters while creating a thinner and more efficient package than the prototype.

Greater space efficiency and lower cost to market make Integrated Solutions a winner in most projects. Contact Minco to learn how our diverse capabilities can be put to work for you.



Types of Flex Circuits

Know the various flex circuits Minco manufactures

Flex

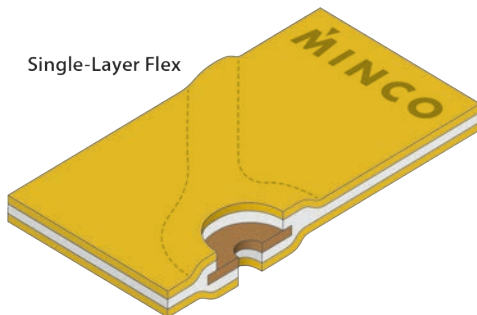
As markets trend toward miniaturization, customers rely on Minco's broad Flexible Printed Circuit (FPC) design capabilities when flexibility is required for tight, small spaces. Our flex circuits offer the same advantages of Printed Circuit Board (PCB) including repeatability, reliability and high density but with the added twist of flexibility and vibration resistance.

Manufacturers use flex circuits for their superior reliability and ability to condense their electronic package size. A flex circuit offers a customizable and repeatable routing path in a thin package. The materials used are robust enough to withstand high vibration, resist abrasion, and endure thousands to millions of flexing cycles.

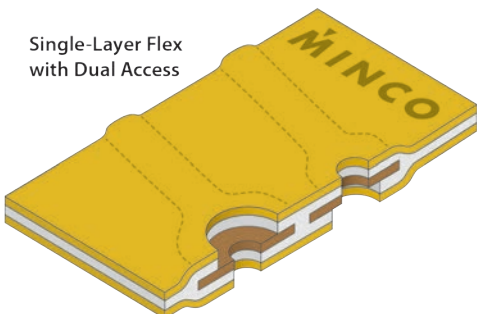
Perhaps the most important attribute customers prefer in choosing flex circuit technology is the capability of the flex circuit to assume three-dimensional configurations: they can be shaped to fit where no other design can and offer unlimited freedom of packaging geometry while retaining density and repeatability of printed circuits.

Single-layer

- IPC-6013 - Type 1
- One conductive layer with an insulating layer generally on each side.



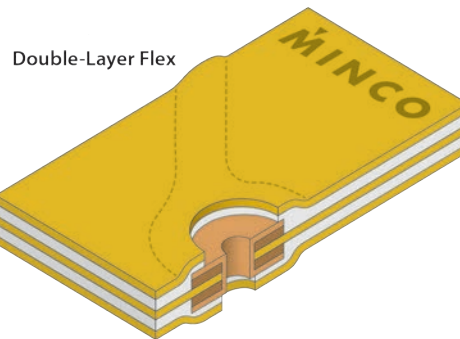
Single-Layer Flex



Single-Layer Flex with Dual Access

Double-layer

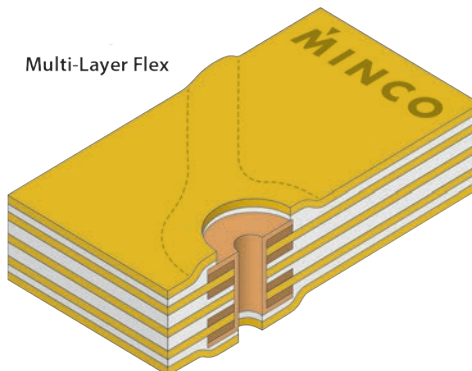
- IPC-6013 - Type 2
- Two conductive layers with an insulating layer between them; outer layers may have covers or exposed pads.
- Plated through-holes provide connection between layers.
- Access holes or exposed pads without covers maybe on either or both sides; vias can be covered on both sides.
- Stiffeners, pins, connectors, components are optional.



Double-Layer Flex

Multilayer

- IPC-6013 - Type 3
- Three or more flexible conductive layers with flexible insulating layers between each one; outer layers may have covers or exposed pads.
- Plated through-holes provide connection between layers.
- Access holes or exposed pads without covers may be on either or both sides.
- Vias can be blind or buried.
- Stiffeners, pins, connectors, components are optional.

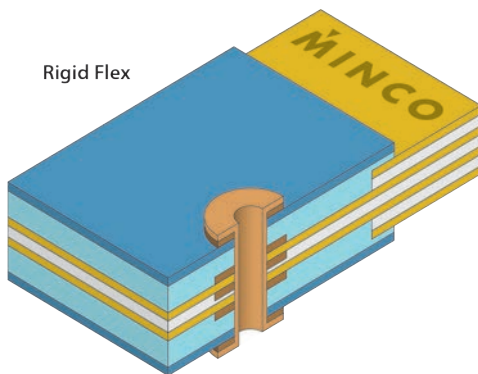


Multi-Layer Flex

Rigid-Flex (Type 4)

A blend of rigid and flex emphasizing the best of both constructions, adding synergistic capabilities neither possess alone. In its most typical configuration, the rigid-flex is a series of rigid PCBs joined by integrated flex circuits. Circuits designed primarily as flex circuits have great opportunities to increase your design capabilities when integrated rigid areas are added.

Rigid areas provide excellent hard mount points for components, connectors and chassis while flex areas offer dynamic flexing, flex to fit, and component mounting poised to take advantage of these low mass and vibration resistant zones. This blending leads to creative solutions for your most demanding applications.



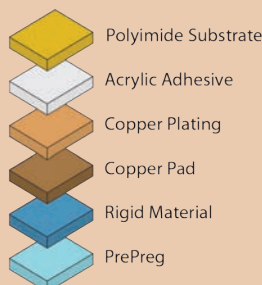
- Double side component mounting: Rigid-flex circuits are the ideal solution for flex circuits where surface mount components must be mounted on both sides of the board.
- Total cost of assembly: The maximum benefit of rigid-flex is realized when the complete installation is reviewed for total cost of assembly. Using rigid-flex eliminates connections in the flex-to-rigid transitions which can improve reliability and improve impedance control.
- Most capable/maximum vibration resistance: Lets you integrate the best capabilities of resistant rigid areas and resilient flex areas.
- High mass component mounting: When mounting a high mass component, a rigid board is the right solution. A rigid-flex board gives you a smooth transition between rigid and flex areas while preserving the benefits of each.

A rigid-flex has conductors on the rigid layers, which differentiates it from multilayer circuits with stiffeners. Plated through-holes extend through both rigid and flexible layers. Rigid-flex costs more than a standard circuit with stiffeners.

Access holes or exposed pads without covers may be on either or both sides. Vias or interconnects can be fully covered for maximum insulation. Stiffeners, pins, connectors, components, heat sinks, and mounting brackets are optional. We also manufacture “flush” rigid-flex, where the top surface of contact areas is level with adjacent adhesive/insulation.

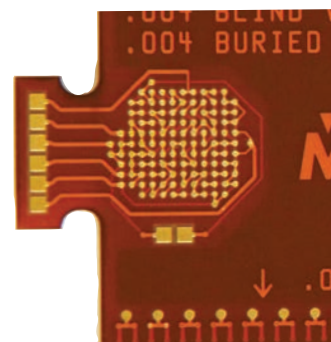
Minco is capable of sequentially laminating, drilling, and plating circuits, which allows for more flexibility in designing the circuit. This allows for smaller feature sizes and tighter layer-to-layer registration.

Legend



High Density Interconnect (HDI)

High Density Interconnect (HDI) flexible circuits offer increased design, layout and construction options over typical flexible circuits. Each High Density Interconnect incorporates microvias and fine features to achieve highly dense flex circuitry, smaller form factor and increased functionality. This technology offers better electrical performance, access to advanced integrated circuit (IC) package use, and improved reliability.



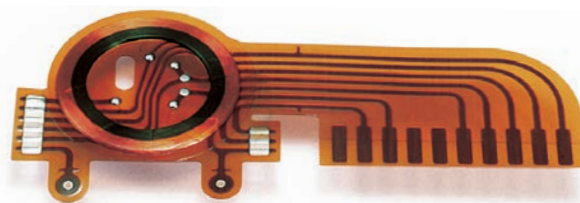
- Lower cost and smaller size—increased circuit density can eliminate extra layers and save up to 40% compared to non-HDI designs.
- Use advanced component packaging—high-I/O and fine-pitch feature capabilities possible with HDI.
- More design options and flexibility—blind and buried microvias allow for conductor routing on the internal layers under vias, creating more usable design space per layer.
- Improved electrical performance and signal integrity—microvias in high-speed circuits improve electrical performance by allowing shorter circuit paths, stub reduction and lower cross talk and noise.
- Improved thermal performance and reliability—microvias lower the z-axis thermal stresses between adjacent layers.
- Improved cost effectiveness—Minco's 18" x 24" (45.7 cm x 61 cm) panel size maximizes panel density to increase the efficiency of your assembly process

Flex-Coils™

Custom wire-wound or etched coils may be integrated with any of our flex circuit or rigid-flex board types. Whether bonded to the surface or encapsulated in a high dielectric and abrasion resistant covering, these assemblies offer special capabilities to your coil designs.

Flex-Coils™ are flex circuits containing integral wire coils for use as antennas or inductors. There are three basic types of Flex-Coils:

- Simple, flat coils with wire leads
- Coils laminated inside flex circuits
- “Rim” coils that are built up in the Z-axis



General Capabilities

While Minco's capabilities are always improving as we explore new equipment, techniques, and materials, the following represents a sampling of standard capabilities we use in typical projects.

Contact us today to learn how we can assist with your next project.

Physical properties

Circuit size/standard panel size:

10.5 × 22" max./12 × 24" [267 × 559mm max./305 × 610mm], 16.5 × 22" max./18 × 24" [419 × 559mm max./457 × 610mm]

Layers: 18 for selected designs

Conductor width/space: 0.002" (0.05mm) minimum / 0.002" (0.05mm) minimum for thinnest foils

Hole diameter (plated): 0.002" (0.051mm) minimum.

Aspect ratio (ratio of hole depth/hole diameter): 10:1 maximum.

Outline dimensions and hole-to-border tolerance:

SRD: 0.015" (0.38mm) + 0.1% linear distance

CMD: 0.010" (0.25mm) + 0.1% linear distance

Laser/Hard tool: 0.003" (0.08mm) + 0.1% linear distance

Hole positional tolerance within a pattern: .002"

Hole positional tolerance pattern to pattern: 0.002" (0.05mm) + 0.2% linear distance

Bend radius (flexibility):

Double-layer: 12 × circuit thickness (minimum)

Multilayer: 24 × circuit thickness (minimum)

Circuit thickness is approximately 0.006" (0.15mm) per layer. Sharper, permanent bends are common for static bend-to-install applications of single layer circuits. Dynamic applications require special consideration.

Temperature: -65 to 150°C (-85 to 302°F) for standard materials.

Will withstand a 5-second solder immersion at 260°C (500°F) without blistering, delaminating, or discoloring. Extended exposure to temperatures over 105°C will result in some darkening of adhesive.

Higher-temperature offerings are available, up to 200°C.

Chemical resistance: No detrimental loss of physical properties when immersed for 15 minutes in acetone, methyl alcohol, toluene, or trichloroethylene.

Materials

Cover/substrate: Polyimide film: ½ mil (12µm), 1 mil (25µm), 2 mil (50µm), 3 mil (75µm), 5 mil (125µm); Liquid Photoimageable Coverlay (LPI); Epoxy glass or polyimide glass (rigid-flex).

Conductor: Copper: 1/8 oz. (5µm), 1/4 oz. (9µm), 1/3 oz. (12µm), 1/2 oz. (18µm), 1 oz. (35µm), 2 oz. (71µm), 3 oz. (107µm)

Cupronickel: 0.625 mil (15µm), 0.9 mil (22µm), 1.3 mil (33µm), 1.9 mil (48µm), 2.3 mil (58µm)

Nickel: 2 mil (50µm), 5 mil (125µm)

Adhesive: Acrylic, flame retardant acrylic, epoxy, epoxy prepreg, polyimide prepreg.

Stiffener: Epoxy-glass (FR-4), polyimide-glass, polyimide, copper, aluminum.

Surface finish (plating)

Plating methods: Panel, selective (button plate), through-hole, blind via, buried via

Plating materials: Solder, hard gold, soft gold, tin, nickel, silver, electroless nickel with immersion gold (ENIG), electroless nickel/palladium immersion gold (ENEPIG), organic solderability preservative (OSP)

Electrical characteristics:

Insulation resistance: 100 MΩ minimum @ 25°C (77°F) typical.

Continuity: 5 ohms typical.

Dielectric (typical): 1000 VRMS @ 60 Hz for 30 seconds, 1 mA maximum leakage current.

Shield layers: Solid or grid patterns; copper foil or screened conductive ink.

Inductor/Antenna coils: Wire-wound coils may be integrated into the circuit. The cover encapsulates the coil, conductors, and coil connections.

Certificates and Accreditations

To ensure reliable production of your products using these technologies, Minco has acquired extensive certifications and accreditations.

- Nadcap accredited
- AS9100C certified
- ITAR registered
- IPC-6013 Class III Product
- IPC J-STD certified
- IPC CID Certified Engineers and Designers