TECH GUIDE

FLEXIBLE PRINTED CIRCUITS (FPCs)

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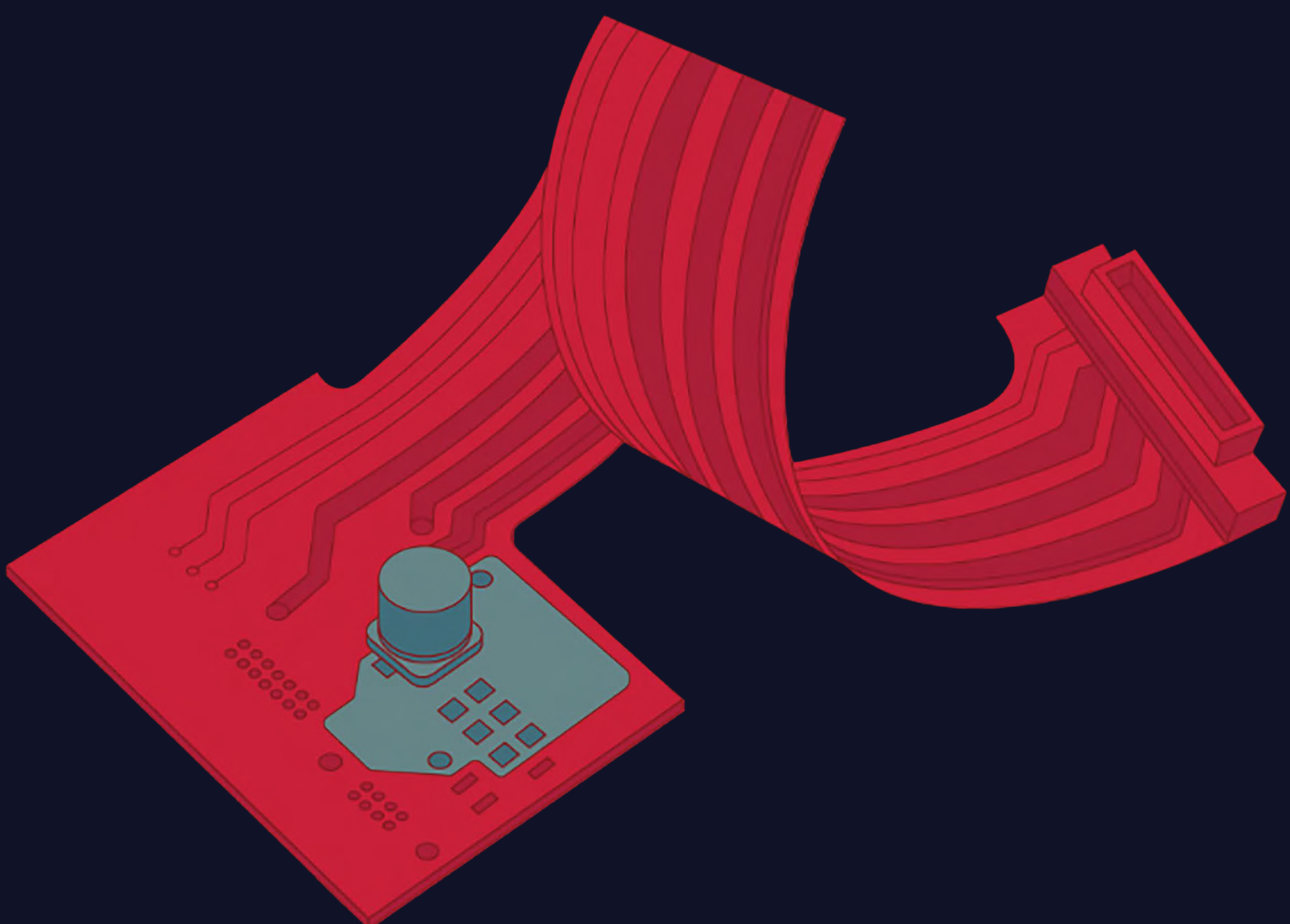
Keyword: FPC



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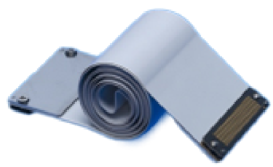
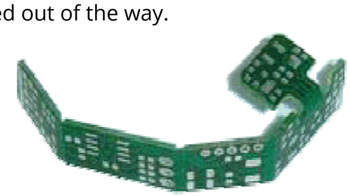
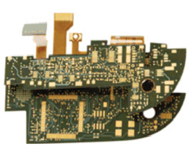
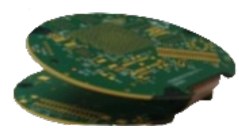
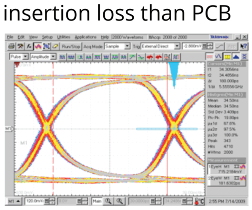
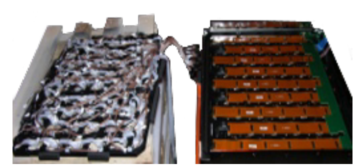
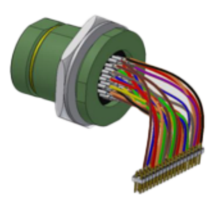
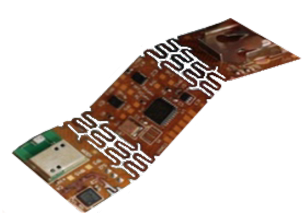
What Are FPCs?

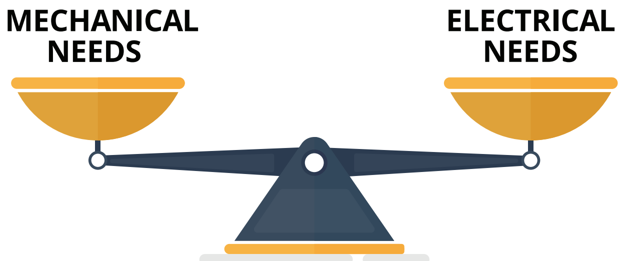
Flexible printed circuits (FPCs) are etched circuits manufactured using processes that are similar to printed circuit boards (PCBs). FPCs provide a hybrid of PCB routing and component assembly, with the flexibility of a cable assembly. This means that FPCs provide a packaging solution for electronics design and manufacturing that can be used in all industries and products. Below is a table showing the different ways FPCs can enable your electronic design.

PACKAGING SOLUTIONS		
3D ROUTING	**MECHANICAL MOTION**	**SERVICEABILITY**
FPCs can be folded or creased and positioned into the smallest areas, supporting 3D packaging geometries that help enable device miniaturization. 	FPCs enable intermittent or continuous motion to mechanical devices such as printer heads or storage drawers. 	FPCs can provide much more serviceability compared to wires or cable. Their thin profiles and the addition of service loops make it easy to interconnect devices that can then be folded out of the way. 
OPTIMIZED FORM FACTOR	**IMPROVED ASSEMBLY**	**IMPROVED RELIABILITY**
FPCs fit where no other solutions can. They provide the ability to design your circuitry to fit the device, instead of having to build a device to fit the circuit board.  	FPCs can reduce the clutter of cables and wires, making the box-level assembly much simpler and more repeatable. 	Rigid-Flex, or rigidized flex technology, which integrates both a flex circuit and a rigid PCB or FPCs with stiffeners, further reduces the number of interconnects. The lower number of interconnects results in fewer sources of potential failure. 
IMPROVED SIGNAL INTEGRITY	**IMPROVED TOLERANCES**	**IMPROVED AIRFLOW**
FPC material properties work very well in high-speed "controlled impedance" designs, allowing better control of impedances and achieve lower insertion loss than PCB materials do. 	Connector mating can be difficult to achieve with the stack-up of tolerances. Using an FPC to interconnect PCBs to each other can eliminate these issues. 	FPCs reduce the bulk of wires and cables that can block airflow and negatively affect electrical performance. 
IMPROVED THERMAL PERFORMANCE	**REDUCED WEIGHT**	**REDUCED SHOCK AND VIBRATION**
The exceptional thermal stability of polyimide allows the circuit to withstand applications that involve extreme heat. New materials can be used at continuous operating temperatures of 225ºC. 	Incorporating an FPC solution into your design can offer a substantial weight reduction compared with using wires and wire harnesses.  	An FPC's ductility and low mass reduces the impact of vibration and shock and improves performance. 

Design Guide

Product design always requires a careful balance of many competing requirements and priorities in order to deliver the desired performance of the product. Below is an example of the different design requirements that influence FPC design.

Mechanical Challenges
- Tight spaces
- Tight bending
- 3D routing
- Continuous flexing
- Long-term reliability
- Positional float
- Custom solution requirements

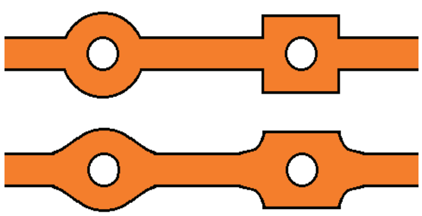


Electrical Challenges
- Higher I/O count than wire
- Controlled impedance
- High-speed/low-loss signals
- Tight cross-talk budget
- High-current return paths
- Low voltage drop
- EMI protection
- Power (1 to 60A)

There are many options available for FPCs that can influence your final design. Reach out to Molex to review your design and get feedback from our application engineers on how to optimize your design.
https://www.molex.com/en-us/products/printed-electronics/flexible-printed-circuits

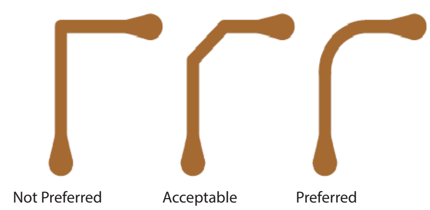
Below are just a few considerations to think about when designing your FPC.

Fillet Pads



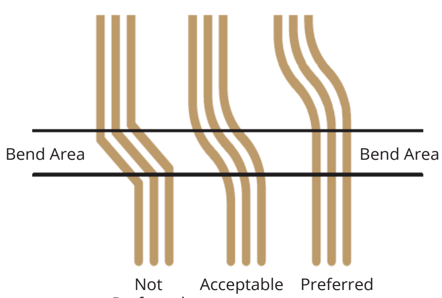
It is important to add fillets to each of the conductor pad interfaces to reduce or eliminate stress concentration points that can cause conductor breakage.

Radius Conductors



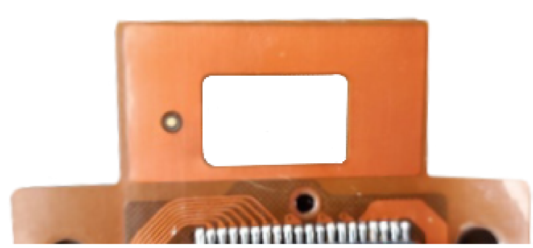
Conductors should always change directions through the implementation of soft curves rather than sharp corners. Sharp corners focus stress that can cause conductors to break. Soft curves spread the stress out, reducing the risk of conductor breakage.

Trace Routing



When possible, conductors should be routed through bending or flexing areas with the conductors running perpendicular to the bend. This will minimize stress on the conductors during flexing and maximize circuit life.

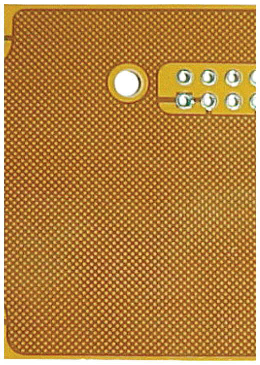
Handles



Handles of various types can be added to reduce stress on parts and installers.

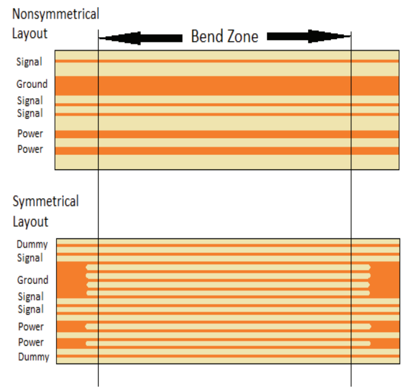
Design Guide (cont.)

Cross-Hatch Design



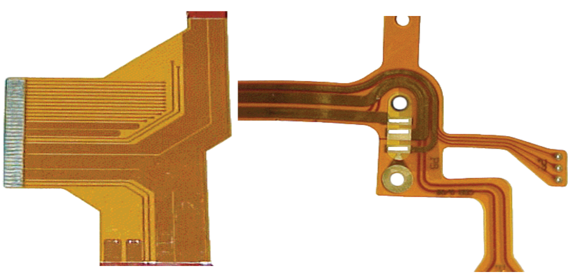
Plane layers should be designed with cross-hatch patterns to reduce weight and increase the circuits' flexibility. Cross-hatching reduces circuit thickness compared to solid ground planes. It also allows wider traces to be used, thereby increasing manufacturing tolerance and capability. Molex has successfully designed cross-hatched reference planes in high-frequency applications up to 16 Gbps.

Symmetrical Design



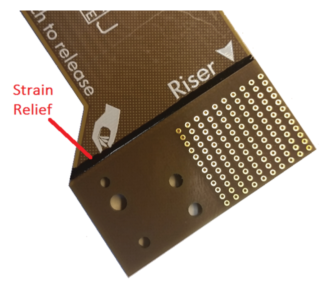
Nonsymmetrical conductor layouts cause disproportionate stresses on the conductors. This can cause the smaller conductors to break more quickly. Uniform conductor layouts spread the stresses evenly, reducing the risk of conductor breakage. Dummy traces should be added where possible to protect the conductors along the edges.

Radius Cut Lines



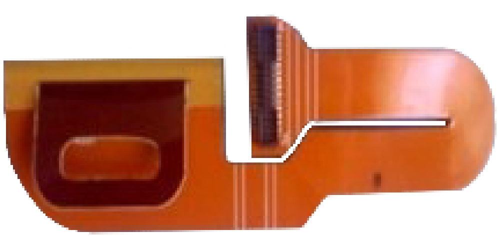
FPC materials resist tearing but are poor at resisting tear migration. Sharp inside corners focus stress on the materials and make the circuit more prone to tearing. Radiused corners resist tearing by spreading the stress out over a larger area. Dummy traces can be added as tear stops.

Hardboard/Stiffener Strain Relief



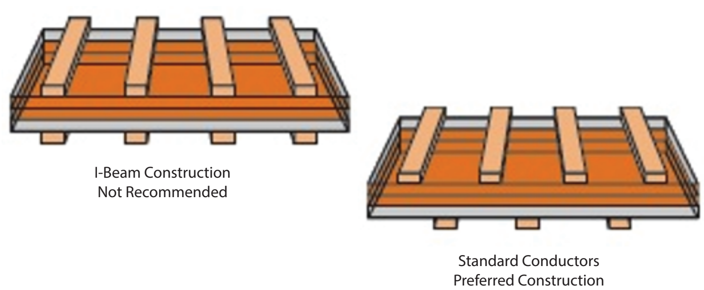
FR4 hardboards, metal and molded plastic backers are all used to relieve strain in component attachment areas. When they are applied using thermal-set adhesives, it is a good practice to apply a bead of Eccobond or RTV along the edges of the hardboard to relieve strain on the flex-to-rigid interface. This greatly reduces the risk of conductors breaking at these interfaces.

Service Loops

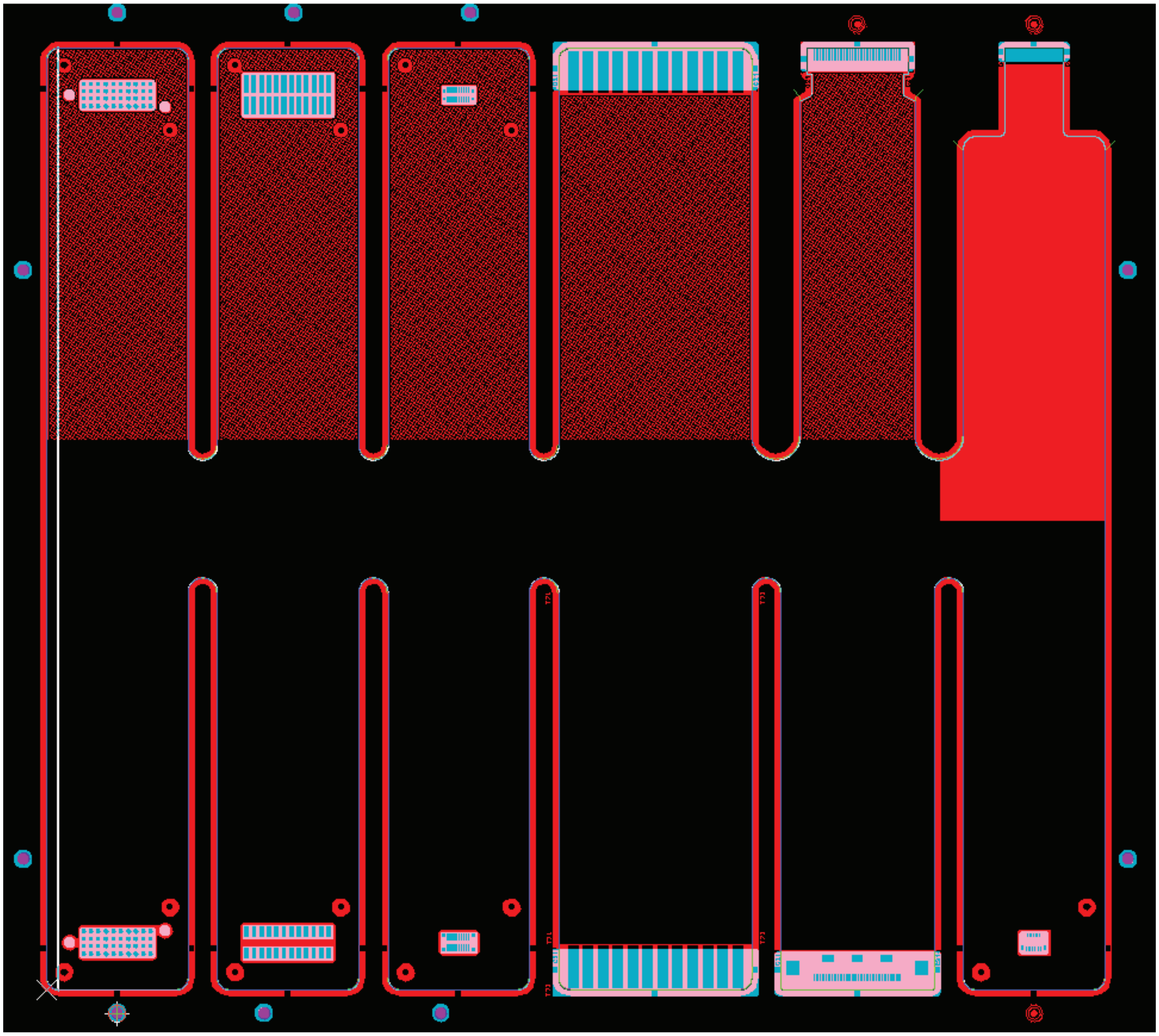


The shortest distance between two points is a straight line. Most FPCs are designed this way. However, in tight bend or repetitive bending applications, these types of designs are the most likely to fail due to the stresses put on them. Service loops allow stresses to be spread out over a larger area and reduce the risks of cracked and broken conductors. Service loops can vary in shape and length.

I-Beams



I-beams in circuit layouts occur when traces on adjacent layers are stacked on top of one another. When these circuits are bent or folded, there is greater stress exerted on the traces, which can lead to conductor breakage issues. To avoid this problem, the traces should be staggered from one side to the other so the bending forces from the traces on the inside of the bend are not exerted on the traces on the outside of the bend.



1532102001

2-layer Button Plate Cross-Hatched Shield Stack-Up

Thickness After Lamination	Layer	Material
25µm	ZIF coverlay	25µm Polyimide
15µm		35µm Adhesive
18µm	ZIF pads and trace layer 100	18µm RA Copper
25µm		25µm Polyimide
18µm	ZIF pads and cross-hatched shield layer 200	18µm RA Copper
15µm		35µm Adhesive
25µm		25µm Polyimide
30µm		35µm Adhesive
175µm	Backside PI stiffener	175µm Polyimide
		35µm Adhesive
	Backside hardboard	.5mm FR4

306µm 141µm

1532102003

2-layer Button Plate Cross-Hatched Shield Stack-Up

Thickness After Lamination	Layer	Material
25µm	ZIF coverlay	25µm Polyimide
15µm		35µm Adhesive
35µm	ZIF pads and trace layer 100	35µm Polyimide
20µm		20µm Adhesive
25µm		25µm Polyimide
20µm		20µm Adhesive
35µm	ZIF pads and cross-hatched shield layer 200	35µm RA Copper
15µm		35µm Adhesive
25µm		25µm Polyimide
30µm		35µm Adhesive
125µm	Backside PI stiffener	125µm Polyimide
		35µm Adhesive
	Backside hardboard	.5mm FR4

330µm 215µm

1532103001

3-layer Button Plate Cross-Hatched Shield Stack-Up

Thickness After Lamination	Layer	Material
25µm	ZIF coverlay	25µm Polyimide
15µm		35µm Adhesive
18µm	ZIF pads & cross-hatched shield layer 200	18µm RA Copper
25µm		25µm Polyimide
20µm		25µm Adhesive
18µm	ZIF pads & trace layer 100	18µm RA Copper
50µm		50µm Polyimide
18µm	ZIF pads & cross-hatched shield layer 200	18µm RA Copper
20µm		35µm Adhesive
25µm		25µm Polyimide
30µm		35µm Adhesive
175µm	Backside PI stiffener	175µm Polyimide
		35µm Adhesive
	Backside hardboard	.5mm FR4

336µm 234µm

1532103002

3-layer Button Plate Cross-Hatched Shield Stack-Up

Thickness After Lamination	Layer	Material
25µm	ZIF coverlay	25µm Polyimide
20µm		35µm Adhesive
18µm	ZIF pads and solid shield layer 201	18µm RA Copper
20µm		20µm Adhesive
50µm		50µm Polyimide
20µm		25µm Adhesive
18µm	ZIF pads and trace layer 100	18µm RA Copper
20µm		20µm Adhesive
50µm		50µm Polyimide
20µm		20µm Adhesive
18µm	ZIF pads and solid shield layer 201	18µm RA Copper
20µm		35µm Adhesive
25µm		25µm Polyimide
30µm		35µm Adhesive
25µm	Backside PI stiffener	25µm Polyimide
		35µm Adhesive
	Backside hardboard	.5mm FR4

316µm 324µm

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A Circuit Designed for Every Industry

Medical
Building secure, seamless connectivity for lifesaving therapies

DataCom
Accelerating networking that's ready to go even faster

Automotive
Enabling next-gen vehicle technology to meet changing connectivity needs

Consumer and Appliance
Advancing connected devices through the Internet of Things

Industrial
Collaborating with our customers to enable digital manufacturing

Aerospace and Defense
Supplying highly optimized designs to adapt to changing requirements

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