WHAT IS A FLEXIBLE PRINTED CIRCUIT?
Exactly as the name implies, it is an electronic circuit fabricated on a flexible substrate, typically polyimide film. The traces in a flex circuit are most often made of thin copper. However, other materials can be used for specific applications such as high resistance metals (kvar/stainless steel) for heater applications, thicker copper for high power requirements, or beryllium copper for applications which require spring properties. The circuitry is electrically insulated using photo-imageable flexible solder mask or by adding layers of polyimide film bonded with adhesive over the circuit layer.

WHAT FINISHES ARE AVAILABLE FOR CIRCUITS?
The final finish applied to a flex circuit can be tailored to support the end-customer’s assembly process. For example, exposed pads on the flex circuits can be plated with tin to support soldering or soft gold to support more sophisticated assembly processes like wire bonding. Because flexible circuits are sometimes used to interconnect different electronic modules, selective finishing can be applied (below) to the different areas of the circuit to support multiple assembly processes.

WHAT ARE THE BENEFITS OF FLEXIBLE CIRCUITS OVER PRINTED CIRCUIT BOARDS?
Flexible circuits provide the thinnest and lightest interconnect method available. They contribute to reducing overall system complexity by facilitating assembly and eliminating wiring errors. Another advantage of flexible circuits is their ability to conform to the available geometry allowing for connections of electronics on different planes within the finished electronic device, sometimes referred to as 3D packaging.

WHAT ARE THE BENEFITS OF “ADHESIVELESS” CIRCUITS?
As mentioned above, one of the inherent benefits of flexible circuits is their extreme thinness making them well suited for dynamic applications where the flex will be in constant or periodic motion. For applications where thinness is a concern, adhesiveless base materials can be used to further reduce the overall thickness of the flexible circuit. These materials do not have the layer of adhesive typically found between the polyimide film and copper circuitry layer. The use of these materials can reduce the thickness of the flexible circuit by approximately 0.001 in. per copper layer.

CAN SURFACE MOUNT COMPONENTS BE ADDED TO FLEXIBLE CIRCUITS?
Yes, the same surface mount components typically used on printed circuit boards can also be attached to flexible circuits. For these applications a rigid stiffener, typically FR-4, is added to the opposite side of the flex circuit to strain-relieve the solder joints. In addition to surface mount components, high density surface mount connectors can also be added as a way to connect the flexible circuit to the corresponding electronic components.
BESIDES CONNECTORS, ARE THERE OTHER WAYS TO INTERCONNECT TO A FLEXIBLE CIRCUIT?

Yes, for some applications it is desirable to attach the leads of the flex circuit directly to a corresponding pad array on a printed-wiring board or other substrate. For these designs a vendor that can selectively remove the polyimide insulating film is advantageous because selective removal allows the creation of copper leads that are exposed from both the top and bottom sides. These leads can then be aligned to the corresponding pad array and soldered, welded, or tab bonded to the substrate.

Other applications may require the flexible circuit be soldered directly into the through-hole vias of a printed circuit board. These designs require the flexible circuit be fabricated with a series of thicker copper leads (0.010 in. thick is common) extending from the edge of the circuit which can be inserted into the corresponding via array on the printed wiring board and subsequently reflow soldered. These designs are typically known as Contoured Circuits.

WHAT ARE THE MAIN MARKETS AND USES FOR HIGH RELIABILITY FLEX CIRCUITS?

The markets taking advantage of the benefits of flexible circuits continue to expand. After early success in military and aerospace, the drive to smaller and thinner electronics led to the mainstream adoption of flex circuits in consumer electronics. In addition, the demand for wireless, portable, and more sophisticated electronic assemblies has led to the use of flexible circuits in high-reliability medical and industrial applications that include ultrasound probes, medical devices, semiconductor test and manufacturing equipment, as well as other electronics applications.

The advent of more complex electronic assemblies has driven the need for high density interconnect circuits. These difficult designs must be sourced from very capable flexible circuit manufacturers that are able to produce multi-layer, fine-line circuits. These manufacturers will typically use laser drilling technology to fabricate very small micro vias in addition to laser direct imaging to generate equally dense circuit patterns. In some cases, these features are so small they cannot be electrically tested using the conventional test fixture process. Quality must be confirmed using the more sophisticated flying probe electrical test process.

Examples of flex circuits with surface mount components and various interconnect options are shown above. The close-up below of the small circuit above shows integral beryllium copper spring contacts. Below that is a close-up of a circuit with multiple surface mount components.