MIRACO
connecting technology

QUICK LASER™

Design Guide

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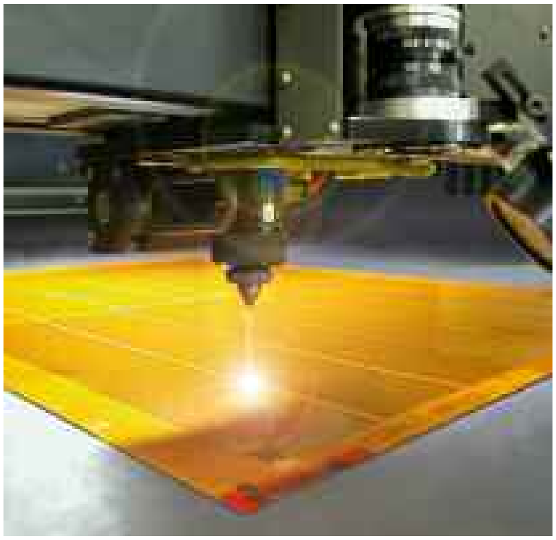
Introduction



We at Miraco, Inc. continue to strive to be the industry leader in laser preparation of flexible FPC and PCB manufacturers with quality service based on knowledge and expertise in the printed circuit industry made possible by our dedicated staff of seasoned industry veterans who bring decades of experience to the table. We believe that understanding your process is the key to consistently providing you with the results that you need and as an ISO 9001:2008 registered company, you can be assured that Miraco will do just that.

Quick Laser Service features state of the art 3-axis, flying optic, CO_2 laser systems equipped with machine vision for precise registration. The systems are capable of registering to a circuit or group of circuits on a flexible circuit panel using optical targets or circuit features and then ablating the insulation to expose conductors or pads, cutting holes through the insulation, outlining or partially outlining circuits or ZIF ends. The systems can be used on a wide variety of materials in sizes up to 48" x 48".

Many flexible circuit manufacturers are currently realizing and taking advantage of the reduced cost and significant time savings that Quick Laser offers. Miraco's application engineers work closely with each customer to find new applications and new advantages with each laser processing assignment. Quick Laser makes it possible to eliminate pre-drilling or routing cover films and avoid the expense associated with coverlayer registration problems, dielectric shrinkage, glue squeeze-out, and “swimming” during lamination. Reverse baring of clad materials is also easily achieved, as well as precision outlining previously only possible with male/female dies.

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Miraco Inc. is dedicated to developing innovative high-density interconnect solutions for the flexible printed circuit (FPC) and laminated flat flexible cable (FFC) industries. Miraco solutions not only offer a complete line of standard interconnect products and customized connectors, but also the revolutionary QUICK LASER™ and QUICK CABLE™ circuit and cable finishing services. Miraco continues to maintain an aggressive research and development program focused on developing new products and processes to meet tomorrow's electronic packaging challenges.

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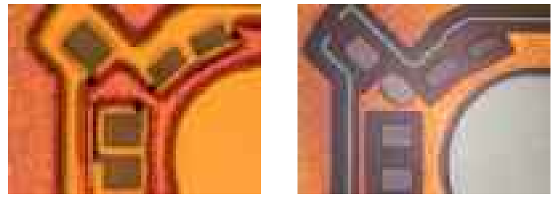
Applications

Complete Circuit Finishing

Laser processing eliminates the need to purchase steel rule or hard dies for prototype and small production runs. Outlines can be laser cut with extreme accuracy using machine vision registration, without the tearing and inconsistencies associated with routing or hand trimming. Shapes, sizes, and profiles that are not possible with a steel rule die are easily accommodated with the laser. Design changes are easy, with only a simple program modification needed to change the outline instead of rebuilding tooling.

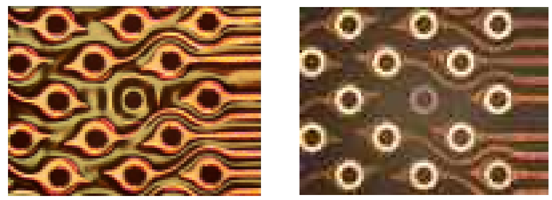
Before **After**



Single-sided exposure and outline of two-layer FPC with .030" x .050" rectangular pads

Single and Double-Sided Exposure

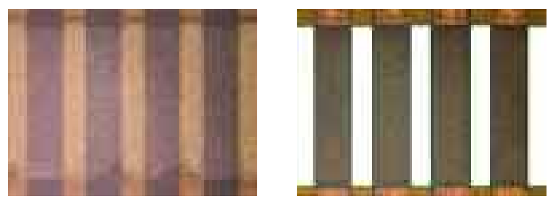
Conductors, pads, fingers, or other features can be exposed from one or both sides of the panel after lamination to provide accurate exposures, free of glue squeeze-out, with tighter registration tolerances than achievable with pre-routed cover films. The laser also makes it possible to create apertures in the base film when using pre-laminated material. Sizes and shapes, which cannot be routed by traditional means, such as square corners are easily created.



Single-sided exposure and through-holes of a two-layer FPC with .042" dia. exposures on a .100" x .050" through-hole connector pattern

Centerfilm Removal

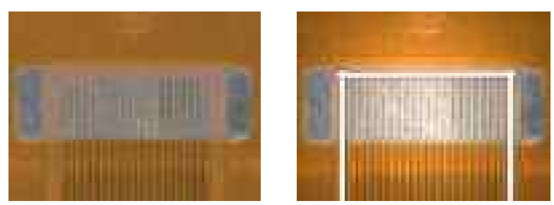
Creating reverse bared, double-sided circuits can be a problem for many manufacturers. The solution is to laser expose the pads or fingers by removing the centerfilm. This operation can be performed either before or after final lamination of coverfilms to produce exposures with no glue squeeze-out and tightly held tolerances.



Double-sided exposure of 2 oz. copper fingers on .100" pitch FPC

Outlining and Selective Outlining

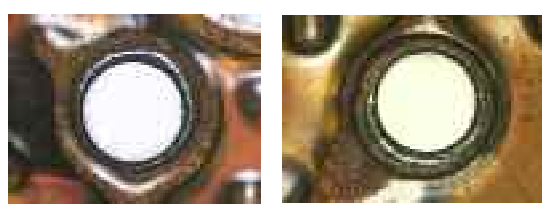
If you have a critical area with tolerances unattainable with a steel rule die, and or don't want to invest in hard tooling, a partial outline can be laser cut, leaving the circuit tied into the panel. This can easily be combined with a single or double-sided exposure operation. The ZIF end(s) of a circuit can be laser cut to within +/- .002" without having to invest in hard tooling, leaving the remainder of the circuit to be outlined using an inexpensive steel rule die.



ZIF outlining of FPC with 0.5 mm pitch conductors and polymide stiffener on far side

Adhesive Removal

Rejected parts can be saved by laser reworking to remove glue squeeze-out to meet minimum annular ring or pad size requirements. In addition, for parts that have historically been a problem, elminate the drilled coverfilm exposures and simply laser expose the pads from the start.

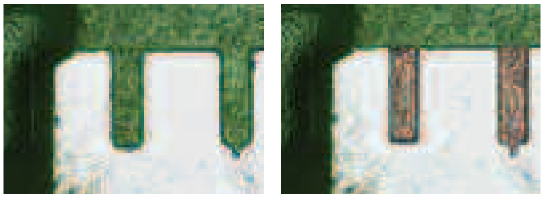


Glue "squeeze out" removal from .050" dia. hole to create 0.010" minimum platable annular ring

Applications

Solder Mask Removal

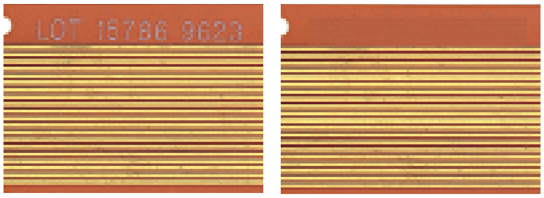
Solder mask defects can be corrected by laser exposing pads or traces. Don't throw away an expensive board or rigid-flex or spend hours trying to manually rework the solder mask when it can be lasered in minutes.



Rework to remove solder mask from a high value rigid-flex

Nomenclature Removal

Permanent nomenclature can be inexpensively removed to rework parts. Don't spend hours reworking parts to remove an incorrect part number or date code, just laser rework it.



Permanent epoxy ink removed from an FPC

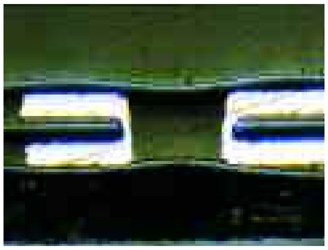
Coverfilm Preparation

Coverfilms can be laser cut before lamination. Smaller features and square corners can be routinely achieved to meet special requirements. As an additional benefit, the adhesive along the cut edge may be partially cured by the heat from lasering thereby reducing glue squeeze-out.

Kapton coverfilm and adhesive with rectangular lasered openings down to 0.20" x 0.020"

Micro-Vias

Contrary to popular belief, both blind and through-hole micro-vias can be created in flexible printed circuits using a CO2 laser instead of a UV or YAG laser. Since a CO2 laser does not efficiently cut copper, the same vias must be created using a slightly different two step process where the holes are first etched to size using standard photolithographic methods typically using double sided clad material. The size of the via is only limited by the etching process. The material is then lasered from one or two sides to remove the centerfilm from inside the holes by using the copper as a mask. After lasering, the material is cleaned by plasma etching and then imaged and etched to create the circuit patterns



Etched 0.006" vias created in a copper clad laminated by a laser removal of the insulation

To achieve accurate and consistent results in all of the above cases, it is important to understand and follow some simple guidelines when designing the flex panel for laser processing.

Registration Targeting

When designing a flexible circuit panel for laser processing, it is very important to properly select the type and location(s) for the optical targets to be used for registration. The type of target will usually be dictated by the required tolerances, available space on the panel, and the type of material. In general, the lasered features can only be positioned as accurately as the targets. For example, a drilled registration hole with a drill to etch registration tolerance of +/-.005" cannot be used to locate a ZIF outline which requires an outline to etch registration of +/-.003" since the lasered outline will be accurate to the drilled feature and not the etched feature.

The machine vision system shown in Figures 1 and 2 uses a CCD camera to identify and record the position of one or more pre-programmed optical targets and then compares the actual locations to those of the laser program. Compensations for position and rotation are calculated from this data and the program position is adjusted to match the target locations. The calculations adjust the pattern position for panel shrinkage when using two targets by centering the program between the targets. In most instances the size of the lasered features are not adjusted. In special cases where it is necessary for the pattern to match the panel shrinkage, the laser program can be scaled based on measured values for the shrinkage. A single target may also be used for registration but there will be no positional compensation for rotation or shrinkage.

It is also important that the optical targets are consistent and accurate. To achieve the best results, we recommend using a .125" diameter clearance etched in the same copper layer as the critical feature(s) of the circuit, visible from the side of the panel that is being lasered, and with a larger etched clearance on any other copper layers. These registration features can be covered on both sides with polyimide insulation, covered on one side, left bare, or plated. If a drilled coverfilm exposure is provided for the target, the exposure should be large enough to sufficiently to expose a square area around the target so that it is free of coverfilm and adhesive or the insulation may need to be lasered off to expose the target at additional cost. To achieve this, the coverfilm clearance hole diameter in the insulation should be a minimum of 1.5 times the etched hole diameter. Figure 3 shows a cross-section of an etched target hole on copper layer 1 with a clearance hole on copper layer 2 and coverfilm on both sides. An etched clearance is preferred over a copper pad due to the possibility of a pad to shift or "swim" slightly during lamination but pads may also be used for registration.

Figure 1

Figure 2

Figure 3

Registration Targeting

The lighting system used with the CCD camera illuminates the target area with a specially developed LED light array as shown in Figure 4. Diffused light is applied at an angle to the surface of the panel resulting in regular reflection from glossy surfaces and diffuse reflection from porous, rough, or textured surfaces as shown in Figure 4. Due to the lack of diffuse reflection, polyimide produces a dark image and copper or plated surfaces create a light image as shown in Figure 5.

The vision system uses a pixel match method for comparing the optical targets to a saved image. Larger targets use more pixels, making the targeting more accurate since there is more data available for comparison. Although a .125" diameter etched hole is recommended, feature sizes from .025" to .250" can be used as well as etched pads or other circuit features, which can be of any shape as long as all target features are identical throughout the panel. In special cases, multiple types of targets can be used on a panel but it significantly increases setup and run time, as well as cost.

In most cases, it is best to position the optical targets either horizontally or vertically in line with the centerline of the part or feature being lasered as shown in Figure 6A. Positioning the targets in this manner reduces the effect of unequal panel shrinkage in the X and Y directions. In cases where the targets are positioned diagonally about the part or feature as shown in Figure 6B, unequal panel shrinkage can cause the lasered pattern to be rotated slightly, thereby reducing accuracy. In the case of ZIF outlines or other tight tolerance lasered features, it is best to include two targets for each feature, located as close to the feature as possible. This will provide the most accurate targeting.

In most cases, the combination of the 3-axis laser system and machine vision makes it unnecessary to use masks when lasering flexible circuits. Therefore, the time and cost associated with producing and inspecting a mask is eliminated. The problems of trying to manually register or pin the mask to the panel and the problems of misalignment of the mask due to panel shrinkage are also eliminated.

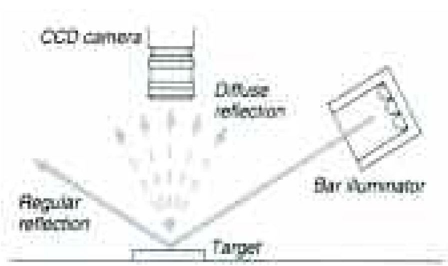


Figure 4

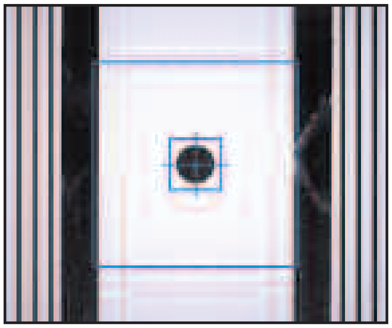


Figure 5

Figure 6A

Figure 6B

Nesting and Orientation

When exposing flexible circuits, the proper nesting and orientation of parts can lead to significant cost and time savings. Most exposures are created using a raster technique in which the laser head rapidly travels back and forth in the X-direction over the area to be exposed, only firing when it passes over the area to be exposed, similar to the way an ink jet printer operates. Due to this, it is not important how many exposures are within the given area, only how large the combined area is. Therefore, when exposing a group of circuits, if circuits are more densely nested, more features can be exposed in roughly the same amount of time thereby reducing the time and cost per individual part.

The size of the circuit groupings to be lasered is generally determined by the required tolerances. Circuits with larger allowable tolerances can be grouped in larger numbers and areas, which decreases the time required for both targeting and lasering. Circuits with tighter tolerances such as +/-.003" ZIF ends are usually targeted and lasered individually. Large circuits requiring tight tolerances may require additional registration features for each critical area. It is also important to size the exposures to only what is necessary because lasering material that will eventually become scrap unnecessarily increases run time and cost.

The most efficient nesting method places the circuit exposures horizontally in line with one another with minimum space between them. This nesting method reduces the raster area on the panel, thereby reducing the lasering time and cost since processing time is directly related to raster area.

Figure 7A shows a typical flexible circuit panel layout for a group of four circuits with two pad exposures per circuit and a raster area of 12.30 in^2 per group yielding an average raster area of 3.07 in^2 per circuit. The raster area is shown enclosed by dashed lines. In Figure 7B the circuits have been tightly nested to maximize the number of circuits per panel and now a group of 8 circuits can be lasered with a raster area of 25.68 in^2 yielding an average raster area of 3.21 in^2 per circuit. The time per circuit to laser the exposures with this layout is approximately the same as in Figure 7A since the raster area is approximately the same. In Figure 7C the circuits have been nested to horizontally align the exposures and reduce the raster area to 13.36 in^2 per group of six circuits yielding an average raster area of 2.23 in^2 per circuit. The time to laser the exposures in this layout is approximately 30% less than in Figure 7A and 7B, which results in a lower per part cost. Also, the layout in Figure 7C gives the added advantages of reduced material cost and reduced handling costs due to the need for fewer panels.

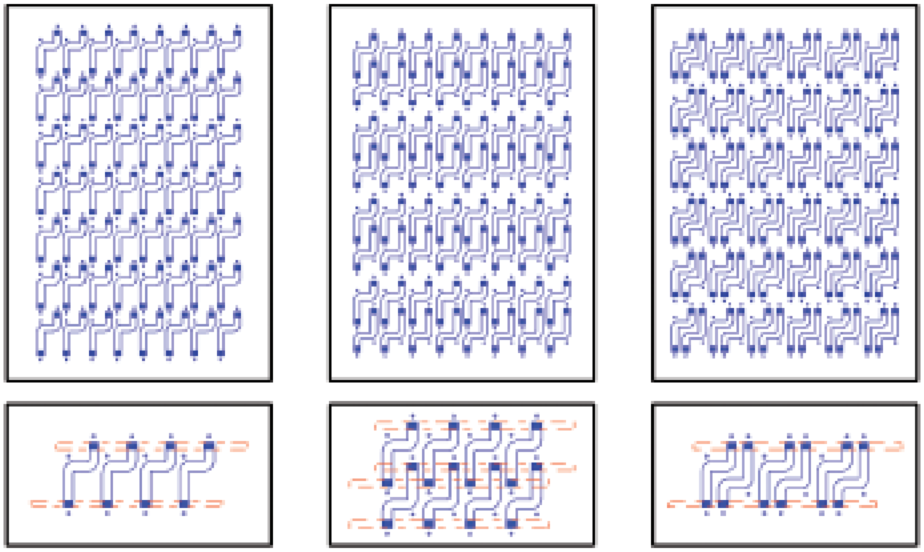


Figure 7A Figure 7B Figure 7C

Feature Sizes and Tolerances

The CO_2 laser beam used is not perfectly straight and is more the shape of an hourglass. Therefore, the spot size of the beam can be changed by adjusting the focal height of the laser. The smallest cutting beam width (kerf) achievable with this system is .006" diameter yielding a .003" minimum internal corner radius. Larger corner radii can be achieved by changing the cut path. Holes or exposures as small as .006" diameter can also be achieved. Figure 8A and 8B show before and after pictures, respectively, of a flexible circuit with lasered pad exposures and a partial outline. The pad exposure sizes are all less than .040" wide and the outline was cut with a .006" wide beam.

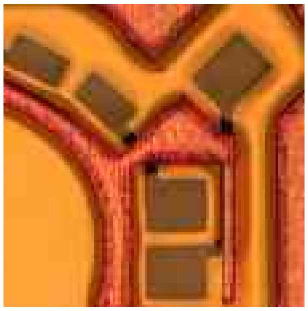


Figure 8A

Figure 8B

The Miraco Quick Laser System is capable of registering to optical targets and producing lasered features that are positioned accurately to the target within +/-.002". The positional accuracy of the lasered feature, however, is directly related to the quality and consistency of the optical targets as previously stated. Therefore a drilled hole should not be used for targeting if the lasered feature location is required to be more accurate than the drill to etch registration.

In most cases, lasered feature sizes can be held to a +/- .002" tolerance. When creating a double-sided exposure on a flexible circuit, there will be an increased size tolerance due to layer registration. Achieving tighter tolerances significantly increases setup time as well as processing time. Therefore, when designing a flexible circuit panel for lasering, the largest acceptable tolerance should be specified to both decrease setup and processing time and reduce the number of possible rejects. There is an additional tolerance of +/- .001" per foot due to laser machine accuracy; as a result, a 24" long part will have an additional +/-.002" tolerance over its length. Also, as with any other outlining process process, panel shrinkage may be a factor and affect the accuracy of the outline to feature registration.

In comparison, laser cutting of circuit outlines can produce tolerances equivalent to a punch and die hard tool without expensive tooling investment. The information for the following chart was adapted from the Minco Flex-Circuit Design Guide® combined with Miraco's tolerances for laser outlining. For each type of tooling shown below, tighter tolerances can be attained, but at a higher tooling cost. Lasering also offers the added benefit of being able to easily modify, adjust, or scale the outline

Circuit Dimension In Inches	**Outline Dimensions (Profile Tolerances)**				**Hole-to-border Dimensions**			
	Hand Trim	**Steele Rule**	**Punch & Die**	**Miraco Laser**	**Hand Trim**	**Steele Rule**	**Punch & Die**	**Miraco Laser**
1	+/-.020”	+/-.015”	+/-.003”	+/-.003”	+/-.015”	+/-.015”	+/-.007”	+/-.003”
5	+/-.025”	+/-.020”	+/-.007”	+/-.003”	+/-.020”	+/-.020”	+/-.012”	+/-.004”
10	+/-.030”	+/-.025”	+/-.012”	+/-.003”	+/-.025”	+/-.025”	+/-.017”	+/-.005”
15	+/-.035”	+/-.030”	+/-.017”	+/-.004”	+/-.030”	+/-.030”	+/-.022”	+/-.005”
20	+/-.040”	+/-.035”	+/-.022”	+/-.004”	+/-.035”	+/-.035”	+/-.027”	+/-.006”

Note: All dimensions are shown in inches

Material Considerations

In general, any organic based materials such as wood and plastics, including polyester, polyimide (Kapton™), acetal (Delrin™), nylon, and acrylic can be cut with the CO_2 laser because they readily absorb the laser energy. Some metallic materials such as steel and stainless steel can be cut, but copper and aluminum reflect most of the laser energy and are not easily affected by the laser, making them suitable for masks and backing for exposures.

Polyimide (i.e. Kapton™)

For double and single sided exposures that are fully backed by copper, all standard thicknesses of polyimide are easily lasered completely through. For single sided exposures that are not fully backed by copper, the thickness of the backing material and adhesive become more critical.

The depth of material removal in solid, uniform density materials such as polyimide coverfilms can typically be controlled to +/-.001" but when single sided exposing a flexible circuit, the adhesive between the pads or fingers becomes an issue. The particular circuit design may cause areas of densely packed adhesive to form on or between fingers or pads during lamination as well as cause the formation of less dense areas of adhesive. The laser cut depth in the exposed area will be inconsistent since there is more material to absorb the laser in the dense areas. In thin materials (less than or equal to .001" polyimide/ .001" adhesive) the depth inconsistencies caused by glue flow can exceed the material thickness creating areas where the laser will burn completely through the circuit. To reduce this effect, it is recommended that the material backing the exposure be .002" polyimide with .001" adhesive or .001" polyimide with .002" adhesive or any thicker combination of materials to provide additional material to make up for the inconsistencies in laser cut depth.

For post-laser cleaning of polyimide materials, plasma etching is recommended. Panels that have been plasma etched are generally ready for standard plating processes. Polymide parts may also be Bio-Blast™ cleaned, Bio-Scrub™ cleaned, or hand cleaned with a variety of solvents to remove the carbon soot.

Polyester (PET, PEN)

The same methods of lasering and cleaning apply to both PET and PEN polyester circuits as polyimide circuits with the exception that plasma etching is not recommended due to the high temperature involved in the process.

Glass-Fiber Composites

Materials such as G10/FR4 bonded stiffeners may also be lasered. Thicker G10 materials will not produce a smooth edge since the epoxy and glass fiber components do not process at the same rate and produce a significant amount of carbon. We do not recommend laser cutting G10 materials thicker than .030".

G10/FR4 materials may be either plasma etched, Bio-Blast cleaned, or hand cleaned with a brush and a variety of solvents.

Material Considerations

Photoimageable Covercoat (PIC)

Photoimageable covercoat can also be accurately lasered and usually does not require any cleaning unless polyimide film is cut at the same time which can produce soot. It is not recommended that PIC be used on the far side of a single sided exposure because it is lasered away more easily than polyimide or polyester and it will not be possible to accurately control the depth of the laser cut without burning through PIC. If necessary, solvent cleaning after lasering is recommended because both plasma etching and the Bio-Blast process may erode the covercoat.

Solder Mask

Solder masking agents are easily removed with the laser, producing little or no soot. Solvent cleaning after lasering is recommended because both plasma etching and the Bio-Blast process may erode the solder mask.

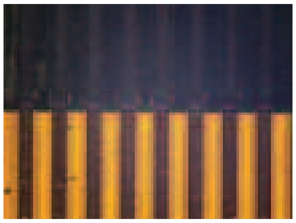
Additional Materials

The following list includes many of the materials that can be cut on the Quick Laser system but you are not limited to the materials on the list. If you are considering using any non-standard materials, please contact Miraco Sales for more information. We would be happy to test a sample of your material prior to production.

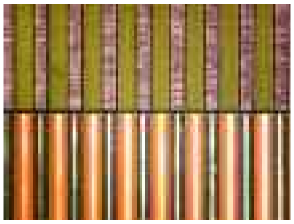
Acetal (i.e. Delrin™) up to .5" thick
Acrylic (i.e. Plexiglass™) up to .5" thick
Anodizing (Removal and Engraving)
Cardboard
Ceramic
Composites
Conformal Coatings
Fabric
Fiberglass (G10/FR4)
Foam
Glass
Laminates
Leather
Masonite
Matte Board
Paint (Removal and Engraving)
Paper Products
Phenolics
Photoimageable Covercoat (PIC)
Plastics
Polycarbonate
Polyester Films & Adhesives (i.e. Mylar™)
Polyimide Films & Adhesives (i.e. Kapton™)
Pressure Sensitive Adhesive
Rubber (i.e. Neoprene™, Nitrile™, Furon™)
Silicone
Solder Mask
Stainless Steel
Steel
Styrene
Teflon
Vinyl
Veneer
Wood Products (i.e. Plywood) up to .5" thick

Cleaning Considerations

With polyimide materials, a bi-product of the laser process is a layer of carbon soot, as shown to the right, on the cut surface that must be removed before plating of conductors or circuit finishing. There are several cleaning options available that may be used to remove the carbon soot layer and the best method is dependent on the circuit material stack-up.

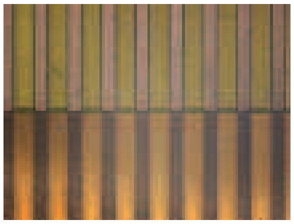


Plasma Etch Cleaning



Plasma etching is a process that uses RF ionized gases to remove carbon and other contaminants from the holes and surfaces of circuits. The panels are suspended between electrodes in a vacuum chamber which is then evacuated to 200 mTorr. Process gases are added and the electrodes energized with RF energy thereby generating the plasma. Ions, atoms, and molecules from the highly reactive process gases combine with the carbon and other contaminants forming new compounds which are stripped away leaving the cleaned circuit behind. This is the preferred cleaning method for both exposed copper and laser outlined parts since the carbon residue can be removed without abrading the dielectric surfaces of the FPC and requires the least handling of individual parts. For fully outlined parts, it is necessary to leave the parts tied into the panel at multiple locations to facilitate hanging of the parts in the plasma etcher. In these cases, the tie-ins are trimmed after plasma etching either by hand or steel rule die. Because plasma etching is not appropriate in all cases, Miraco offers alternative cleaning options.

Bio-Blast™ Cleaning

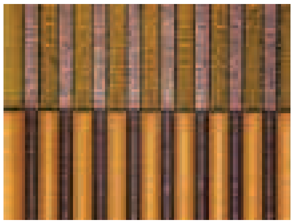


Miraco's proprietary Bio-Blast™ micro-abrasive cleaning process is used when aggressive cleaning of the copper surface is needed. In this process, the panels or circuits are placed in a chamber and the lasered areas of the circuit are blasted with a water soluble, micro-abrasive and then rinsed with a high-pressure water spray followed by air knife drying. The process leaves the cleaned areas with a textured surface similar to that caused by plasma etching which is ready for plating. The micro-abrasive cleaning process is not recommended for copper thinner than 1oz or single sided exposures backed by .001" or thinner insulation because they will be too easily deformed. This process is generally performed using a laser-cut mask and may cause a dulling of the insulation surrounding the cleaned area. As with any new process, Miraco, Inc. strongly recommends that each customer technically evaluate our Bio-Blast abrasive cleaning process and its compatibility with their plating,

Cleaning Considerations

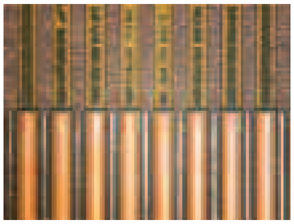
soldering, and assembly processes.

Bio-Scrub™ Cleaning



Another process that may be used alone or in conjunction with other processes is Miraco's proprietary Bio-Scrub process. In this process, parts are scrubbed with a mild, biodegradable abrasive and a rotary brush and then rinsed with a high-pressure water spray. This process is well suited to single sided pad exposures or double sided exposure of stiff fingers and will provide a copper surface that can be plated without plasma etching. The Bio-Scrub™ process may cause a slight discoloration of the copper due to surface oxidation as well as a dulling of the surrounding insulation but will significantly increase plating adhesion potential. As with any new process, Miraco, Inc. strongly recommends that each customer technically evaluate our Bio-Scrub cleaning process and its compatibility with their plating, soldering, and assembly processes.

Solvent Cleaning



In more critical applications which are not appropriate for Plasma Etching or where thin materials are used which would not be suitable for the Bio-Blast and/or Bio-Scrub cleaning processes, the circuits may be hand cleaned using isopropyl alcohol, MEK, Acetone, or other solvents and a stiff brush and then rinsed with a high-pressure water spray. Miraco, Inc. is also continually developing and testing environmentally friendly, biodegradable solvents for flexible circuit cleaning. Circuits cleaned with this process which are to be plated may need additional cleaning to increase the plating adhesion. This cleaning process is typically used for parts that are already plated and require laser outlining only.

Quality Considerations

Job Travelers

All laser jobs are issued a traveler containing the process operations and parameters so that your job is run with the same process every time. Each operation is bar coded & scanned by the operator to electronically track and record information regarding processing time and efficiency.

First Article Inspections

Each job receives a first article inspection after laser setup to verify that the dimensions and quality meet your specifications.

In-Process Inspections

Each job receives an in-process inspection to verify that there are no unforeseen deviations from the first article.

Final Inspection

All jobs receive a final inspection verify quality and cleanliness prior to shipment.

Platability Concerns

Some customers have concerns about the platability of copper surfaces that have been laser exposed due to the possibility of contaminants remaining on the surfaces after cleaning. For these customers, Miraco offers an electroless tin dip service as part of the inspection process where typically one part or section of a part is dipped in electroless tin solution after cleaning to verify that there are no remaining contaminants on the surface. Since the tin solution reacts by copper replacement, the tin will not adhere in areas where the copper is not fully exposed. The tin plated areas are inspected to verify that all exposed copper has been coated. The panels are shipped to the customer with the tested part indicated for easy incoming inspection. The customer can then strip the electroless tin prior to plating or just plate or solder coat over it.

Tips & Cost Saving Ideas

Please consider the following tips when designing your next job for Quick Laser processing:

Stepped Pads (Sculptured™) - Try to avoid exposures that overlap the edges of stepped pads or fingers because the step radius created by the etched copper feature can reflect the laser beam to the side causing damage to surrounding insulation.

Tooling Holes - To obtain stiffer and more accurate tooling holes for die registration, etch the holes to the correct size and laser the centers out. The etched copper ring will act as a mask so the finished through hole will be exactly the size of the etched hole and will be fully supported by insulation to prevent tear-out. This is especially helpful when using 1 oz. or 1/2 oz. copper.

Glue Squeeze-Out - In areas where glue squeeze-out is historically a problem, eliminate the drilled coverfilm exposures and laser expose the pads or fingers after lamination.

Quick Turn Prototypes - You can speed prototyping by eliminating all drilling and outlining. Image, etch, and laminate your panels and then the exposures and a partial outline can be lasered in one step. The panels can then be plated and the outline tie-ins trimmed by hand to remove parts from the panel. Using this process, all coverfilm registration and glue-squeeze-out problems, as well as, the cost and time of producing drill programs and steel rule dies can be eliminated.

Tolerances - Feature tolerances should not be tighter than necessary. Unnecessarily tight tolerances increase both setup and run time, therefore increasing panel cost.

Additional Targets - Whenever possible, include a minimum of two targets for each part. This makes it possible to easily control the lasered group size or laser each part individually on tight tolerance parts.

Nesting & Alignment - Parts should be tightly nested with exposures aligned horizontally or vertically. Also, if possible, align rectangular exposures with the same orientation such as all horizontal or vertical.

Scrap Area - Exposures should be sized to only what is necessary with a minimum of overlap into the scrap area. Unnecessary lasering and cleaning of material that will become scrap can significantly increase cost.

Pinning Holes - Two or more 1/8", 3/16", or 1/4" holes should be punched or drilled in the panel border for pin registration to the laser. Pinning is used for rough alignment to the laser and speeds loading and unloading of the machine as well as increasing accuracy.

Step & Repeat - Step and repeats (arrays) should be consistent without breaks or spaces in the step. Current software only allows for one step and repeat per program. If part groups on panels are broken up into half or quarter panels, additional time is required to reposition for each group.

Optical Targets - All optical targets should be identical to speed setup and processing. Also, avoid etched holes with edges that are broken out or incomplete.

Shrinkage - To prevent shrinkage from skewing the lasered features, locate optical targets either horizontally or vertically in line with the center of the part.

Panels vs. Strips - It is much more cost effective to laser process flex circuits in panel form than in strips or individual pieces due to the reduced handling time for loading and unloading the laser.

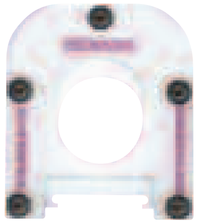
Vias - Vias or microvias less that .006" diameter can be lasered using a traditional mask or by using a copper ring incorporated into the flexible printed circuit as the mask.

Other Capabilities

Although the primary function of the Quick Laser Service is processing of flexible circuit panels, Miraco, Inc. offers a wide variety of services to assist our customers.

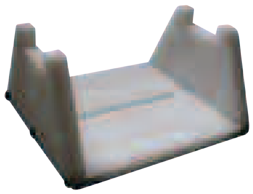
Soft Tooling

We can produce a wide variety of tools for flexible circuit or other types of assembly from Delrin and acrylic. In most cases we can produce multiple tools using the laser for less than it would cost to have one tool machined conventionally. This service is great for quick-turn jobs where you need multiple people working on the same product and don't want to invest in hard tooling. The connector extraction tool shown was lasered from acrylic and engraved with our company logo and information.



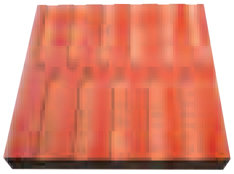
Assembly Aides

We can easily build manufacturing and assembly aides from the simple to the complex to make any task easier for your workers. This fixture was built to assist in the loading of a specialized wave soldering fixture.



Hand Soldering Fixtures

We can make hand soldering fixtures from simple to complex to increase your throughput for any volume of production. Using materials such as G10/FR4 or phenolics, multiple fixtures can be laser cut in a fraction of the time it would take to machine them conventionally.



Electrical Test Fixtures

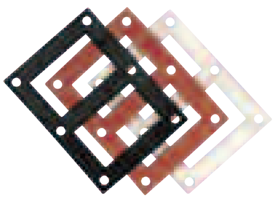
We can take the monotony out of building electrical test fixtures by drilling hundreds of holes in minutes in Delrin up to .5" thick. We can also cut complex shapes for circuit positioning, add threaded inserts, and engrave tool numbers on the fixtures. The electrical tester shown was built as a sales aide to demonstrate connector reliability.

Prototypes and Mockups

We can produce mockups and visual aids for connectors or other components like the connector shown which was lasered from acrylic then painted to represent a 1:1 scale, non-functioning prototype.

Gasket Outlining

Gaskets for flex-circuit sealing or other applications can be laser cut from most standard materials (i.e. Silicone, Rubber, Neoprene™, Nitrile™, Furon™)



Services & Disclaimer

Requesting a Quotation

In order to provide you with a fast and accurate Quick Laser quotation, it is important that you provide all of the necessary information. It is also important that a database or electronic drawing file be provided showing the part or panel layout as well as all applicable dimensions including material type and thickness information. The drawing file will be used to determine the processing time for the panel and to generate the laser program once an order is placed. File formats currently accepted are Autocad™ (.dxf, .dwg), Cadkey™ (.prt, .ptn), Gerber (.gbr), HPGL (.hpg, .hp, .plt), Drill (.drl, .dpt), Mill Route (.rte, .rou), Iges (.igs, .iges), SolidWorks™ (.sldprt, .drw, .slddrw), and many others, with Autocad .dfx being the preferred file format.

To assist us in providing you with an accurate quotation, please use the following checklist as a guide when submitting a request for quotation:

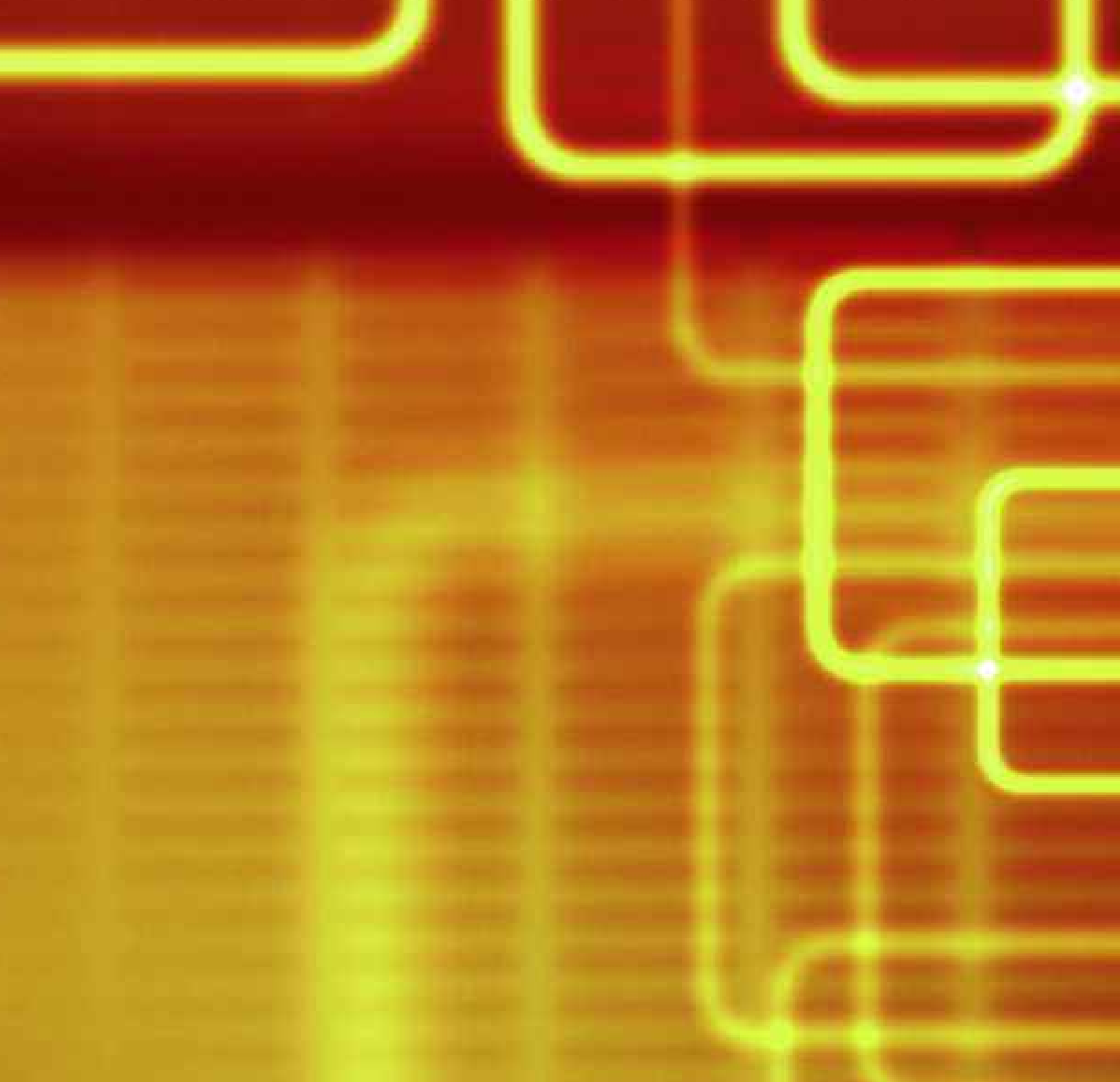
- ✔ A unique part number, part name, or artwork number to be used as a referece on the quote.
- ✔ The quantity of panels or parts per lot and the total quantity for the order.
- ✔ The lead time required per lot.
- ✔ A description of the work required (partial or full outline, single or double side exposure, etc.)
- ✔ A dimensioned drawing or statement of the tolerances required.
- ✔ An electronic data file which includes the panel layout and a separate layer with the features to be lasered.
- ✔ A person to contact with questions regarding the job.

Engineering Assistance

Miraco, Inc. would be glad to assist you in any engineering design and panel layouts at the start or redesign of a project to help you optimize your product for laser processing and reduce cost. We both stand to benefit from providing the best service at the lowest cost to our customers. If you have any questions or require any assistance, please contact a Miraco sales associate.

Disclaimer

This document is designed to be a reference guide only and is not a guarantee of results. Each Quick Laser application is considered to be unique, is subject to different assembly techniques and operating environments, and must be evaluated on an individual basis. For this reason, each laser application must be individually designed and the resulting product thoroughly tested to insure that it meets the overall requirements of the application before production begins.



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