Laser Cutting Epoxy Film

Abstract – White Paper

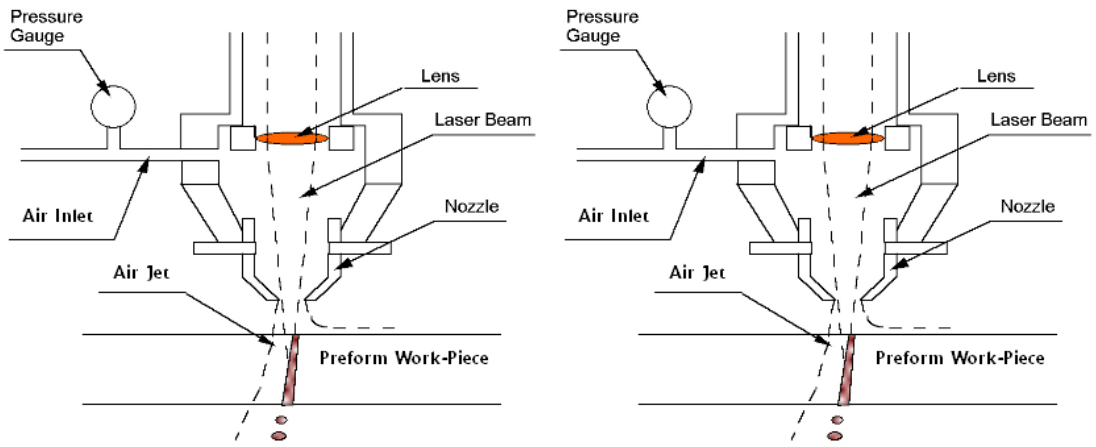
1.0 Introduction. The RF Microwave and microelectronics industry has been using epoxy film for circuit board attachment to carriers and housings for years as an effective method to achieve electrical ground plane and mechanical attachment requirements. Historically, the epoxy preforms have been die cut to match the circuit board layout, ensure critical tolerances are met, and aid in the assembly process. In recent years the advantage of laser cutting epoxy film has become widely accepted in the defense electronics, and commercial RF Microwave and microelectronics industries. This paper will discuss the basic fundamentals of laser cutting and the advantages over the die cutting process.

2.0 The Laser System

Bonding Source utilizes a custom built C02 laser with a high precision Aerotech X Y postioning stage and controller system providing a published accuracy of .000015".

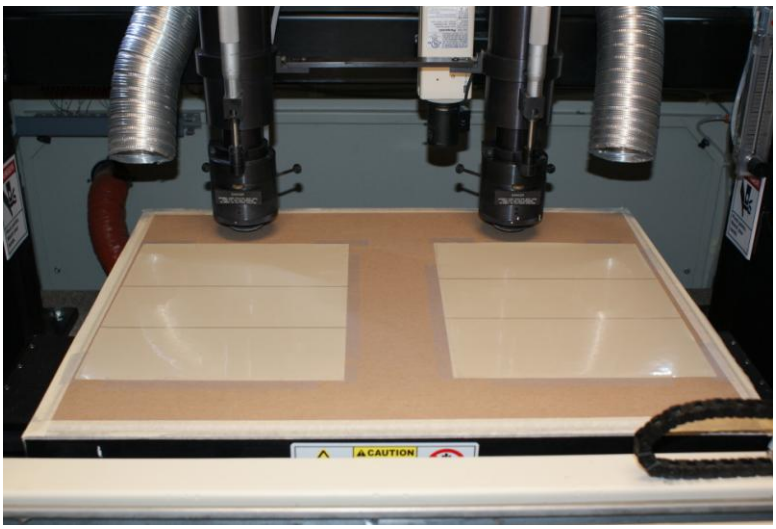
The CO2 Laser Cutting Workstation is designed strictly for Epoxy Preform cutting. It meets ANSI Laser Safety Standard [Z136] Class 1 with integrated appropriate safety interlocks and aperture protection. The custom built delivery system with dual beam cutting heads allows for the processing of multiple of parts at the same time, which increases productivity and lowers overall cutting cost. Based on .DXF or .DWG files, the laser system control unit can output almost any geometry required for pre-form cutting within required tolerances.

2.1 Dual Beam Capability



2.2 Available Working Area

The available XY working area of the laser system is 19.5” x 22.5”. Depending on the type of material the system can process sheet stock up to .150” thick.



2.3 Tolerances are limits of variation that are held for part manufacturing.

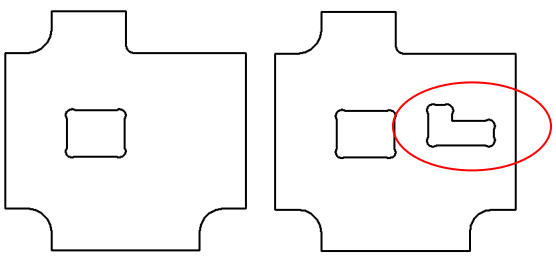
2.3.1 Our standard tolerances are:

- +/- .003” up to 4.0”
- +/- .005” between 4.0” and 8.0”
- +/- .010” for 8.0” or larger

2.3.2 Depending on features and epoxy type or thickness, tolerances could be permitted to +/- .001”
Smallest hole diameter .010” +/- .002”
Smallest radius .008 +/- .003”

2.4 Software

PC based BobCAD software has an intuitive interface that simplifies the programming of complex parts. G-code program language allows for full command of working file tool paths and helps reduce overall machine cycle time on the cutting process. The system accepts DXF, DWG, 2D Solidworks, IGS, CAD, ASC, IGES, STEP, STP, SAT, 3DM file formats. The software allows for making adjustments to features as required, revision changes, and the most efficient pallet layout to optimize epoxy film usage.

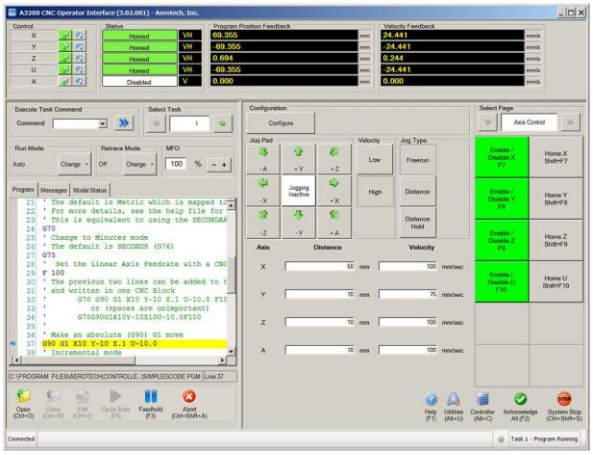


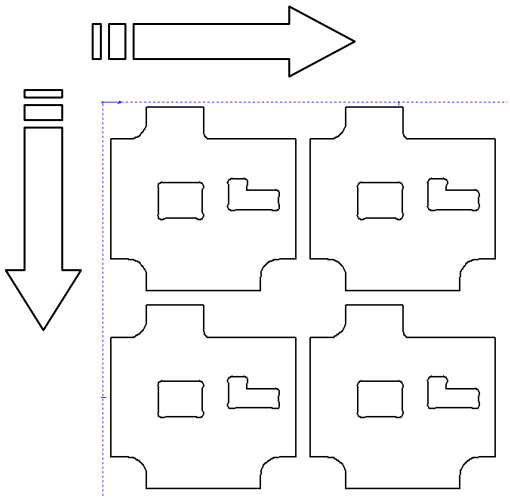
Added feature to existing file and new Rev made for adjustments

2.4.1 System Interface

The Aerotech A3200 System interface provides a multi-axis readout with position, velocity shown in user units, immediate command and program scan during execution. The A3200 focuses on ease of use for the programmer to implement G-Code and execute linear geometry into a pattern to maximize pre-forms on one sheet of epoxy. It also shortens development times and provides the flexibility to use the tools most familiar to the programmer. It is an environment for developing and debugging programs and also functions as a laser operating interface for the programmer.

In example shown below you can see a pattern of 4 parts. Using the A3200 software, it is simple enough to make changes and run 10, 100 or even 1000s of parts.





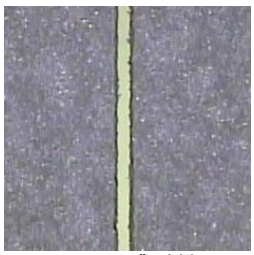
3.0 Laser Cutting

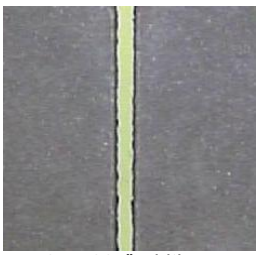
3.1 Laser controlled parameters

The basic parameters used to control the cut quality are Power, Frequency, Focus, Speed, and Air. Depending on the type and thickness of epoxy film, the combination of parameters will need to be adjusted to achieve the optimal cut quality.

Rejectable Cut Not Preferred Optimal Cut

3.2 Kerf- also known as laser cut width varies between .003”-.007” depending on the type of epoxy film and application.


Mag: 21x .003” width


Mag: 21x .005” width

Note: A common question from engineering and quality professionals is;

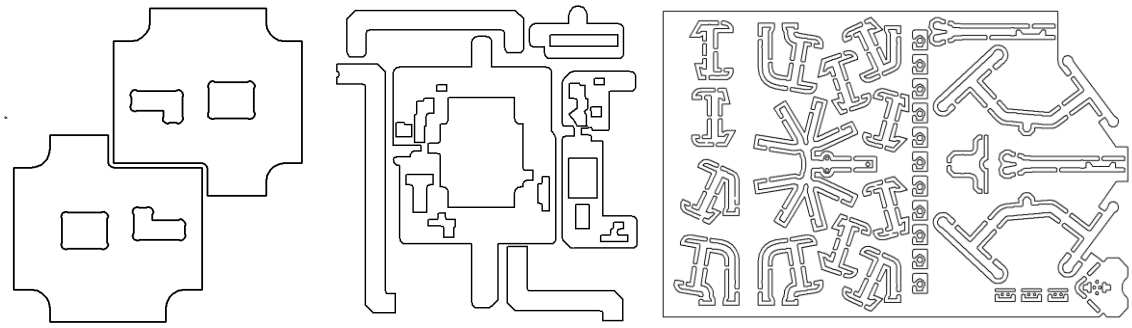
“Does laser cutting leave burnt edges on the material after making the cut?”

With the proper parameters as described above, the laser beam does not leave burnt edges. The laser vaporizes the material leaving the kerf, with no burnt edges on either side of the kerf.

4.0 Advantages of laser cutting

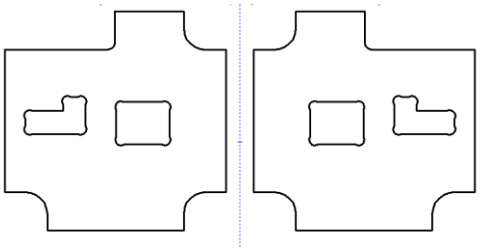
4.1 Combination and preform sets

Preforms could be designed and cut as individual or as a set of multiple preforms to maximize layout and minimize unused epoxy.



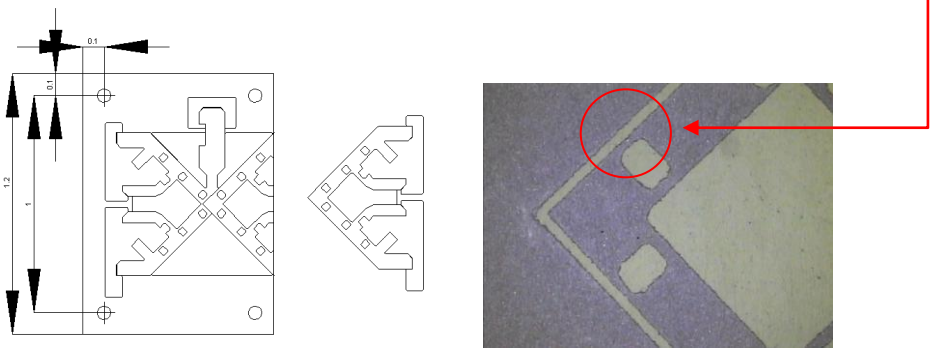
4.1 Mirror image

Preforms can be cut and presented in a mirror image to the drawing. This facilitates the removal of the backside release paper so that the preform can be B-stage attached to the substrate or carrier.



4.2 Complex Geometry

Features that are designed very close to each other within a preform, such as holes, arcs and lines, require an extremely precise and accurate cut. The distance between the edge cutout and the inner cutout in this particular example is .010”



5.0 Release sheets

Depending on preform complexity and tight features, almost any type of epoxy we stock can be laser cut with no release sheet on top. Cutting with no release sheet on top may aid in the board attachment process.

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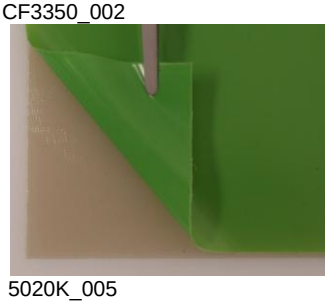

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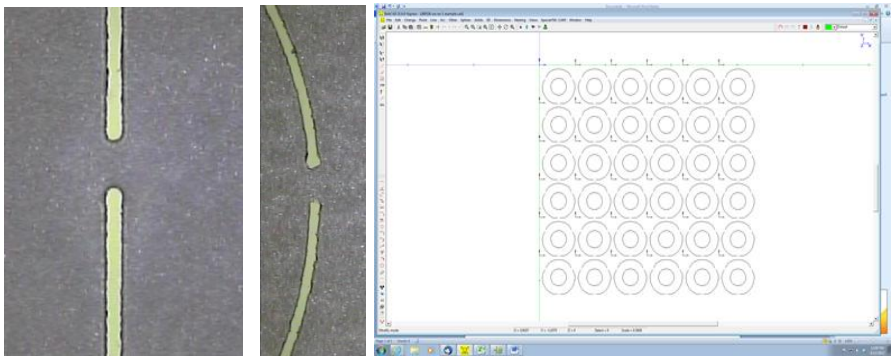
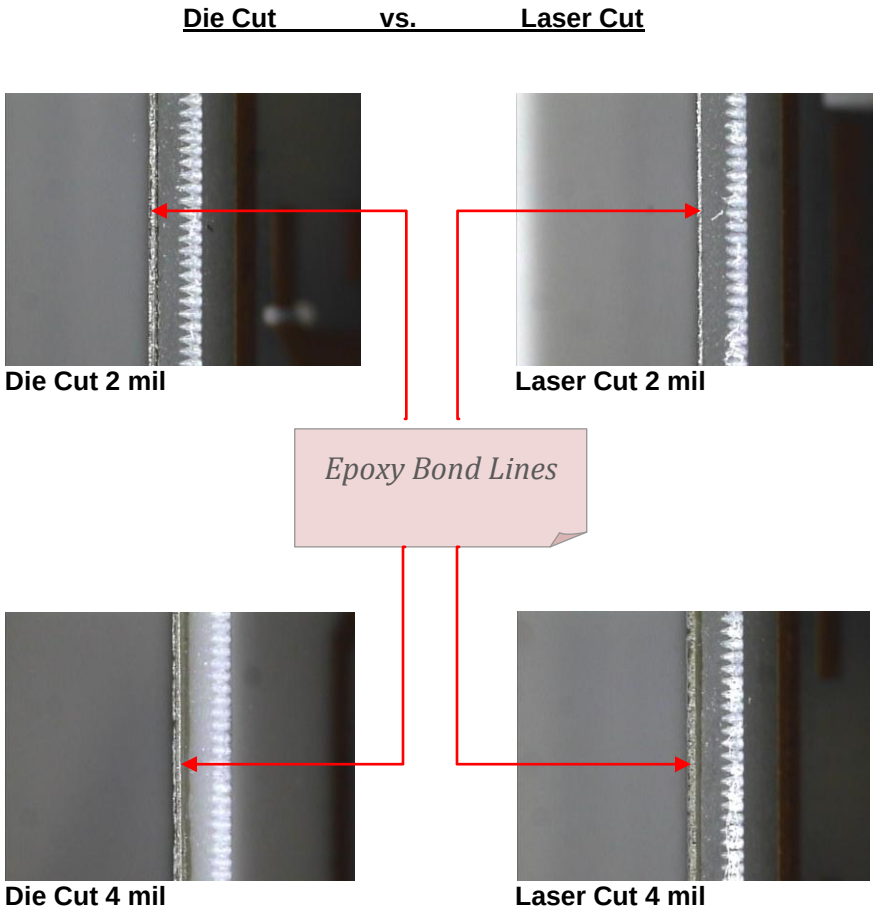
6.0 Tabs on straight edges or round features

Some parts must be tabbed due to their geometry or size so that the individual parts do not blow apart during cutting. 10”x12”, 12”x12” or 10”x18” sizes of epoxy sheets are placed on laser system stages for individual preforms to be cut out. Tabs are placed on the outer geometry of the part. One or several tabs could be placed along the side. In the example below you will find parts being tabbed to a sheet of epoxy.



Although tabbing is necessary to keep individual preforms on a single sheet, larger parts could be cut with no tabs. Smaller parts in size also could be untabbed using a secondary cut process.

7.0 Post cure die cut versus laser cut bonding quality.



The advantages of laser cutting

	CO2 Laser Cut	Die Cut
Lead time	✓	
Overall cut quality	✓	✓
Flexibility for revision changes	✓	
Maximizing epoxy usage	✓	
Tight tolerance	✓	
Fine features cut quality	✓	
Set of multiple parts	✓	
Mirror image for B-Stage applications	✓	
Maintenance / no die sharpening required	✓	
Cutting Efficiency	✓	✓

Conclusions:
This paper explains the advantages of laser cutting epoxy preforms. Although die cutting epoxy film is an efficient way to cut high volumes of epoxy preforms, many companies in the industry are migrating to laser cutting as a more flexible and economical solution for short and mid-sized production orders. The quality of the laser cut both pre and post epoxy cure, has proven to be equal to die cut, and in some instances more reliable as cut quality diminishes with the repeated use of the die tool. Rapid programming of the laser software allows for faster JIT delivery of epoxy preforms, eliminating the lead time associated with die tool manufacture. The flexibility of the software allows for the most efficient use of the raw epoxy stock, and layouts can be tailored to meet the preferences of the subsequent substrate mounting assembly operation. Changes to the pre-form features and dimensions can be easily modified and controlled through a normal ECN and revision control process with the laser application software. Laser cutting film is not new and has been market tested and proven. Bonding Source alone has shipped over 800,000 epoxy preform worldwide to the Defense and Aerospace, Medical, Industrial controls and telecom markets.

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