



Robot Garden

Full Spectrum L.A.S.E.R. Cutter / Engraver Safety and Basic Usage

Version 1.2 1/14/2024 Jim Berry

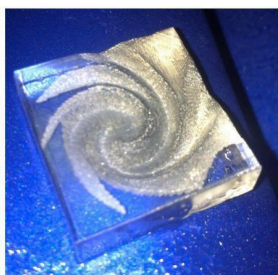


Figure 28 - Example 3D Engraving Result



Welcome to Robot Garden's SBU for the Light Amplification by Stimulated Emissions of Radiation (L.A.S.E.R) cutter/engraver. This SBU covers the safety concerns and procedures for operating the LASER device with a brief tutorial on cutting and engraving. Links will be provided for a more detailed study of engraving and cutting with the system, while basic operations and material usage are included herein.

There are many available resources online for laser cutting and engraving. They present material in handling material and operating a Laser cutter/engraver and we have attached the link below. Take note of the following two sections; Materials we can cut and Materials we cannot cut. These are important.

Resources:

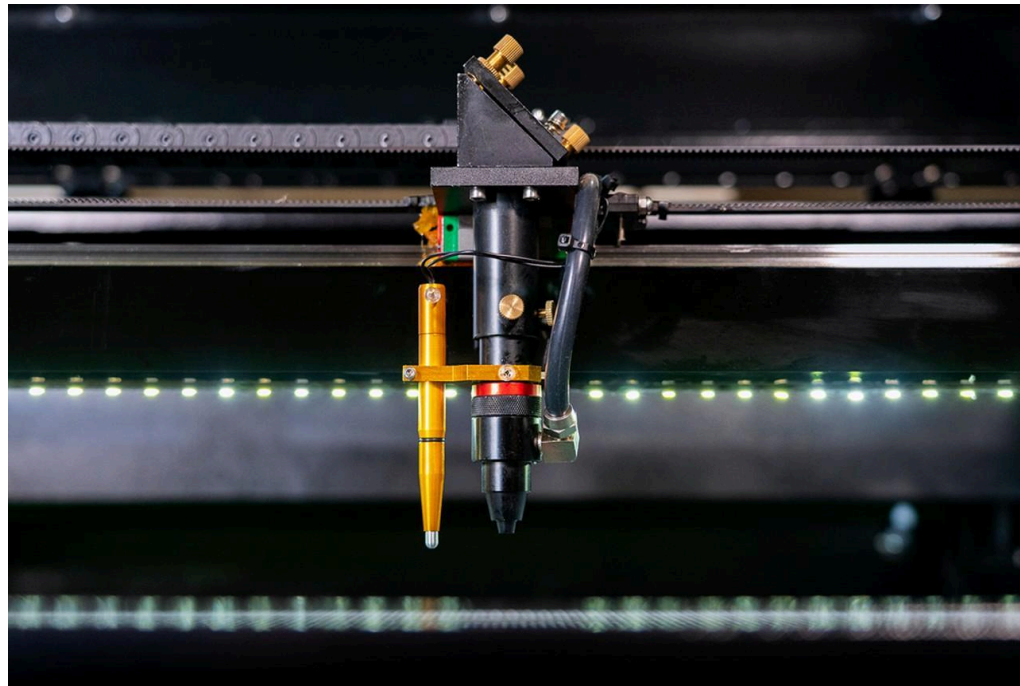
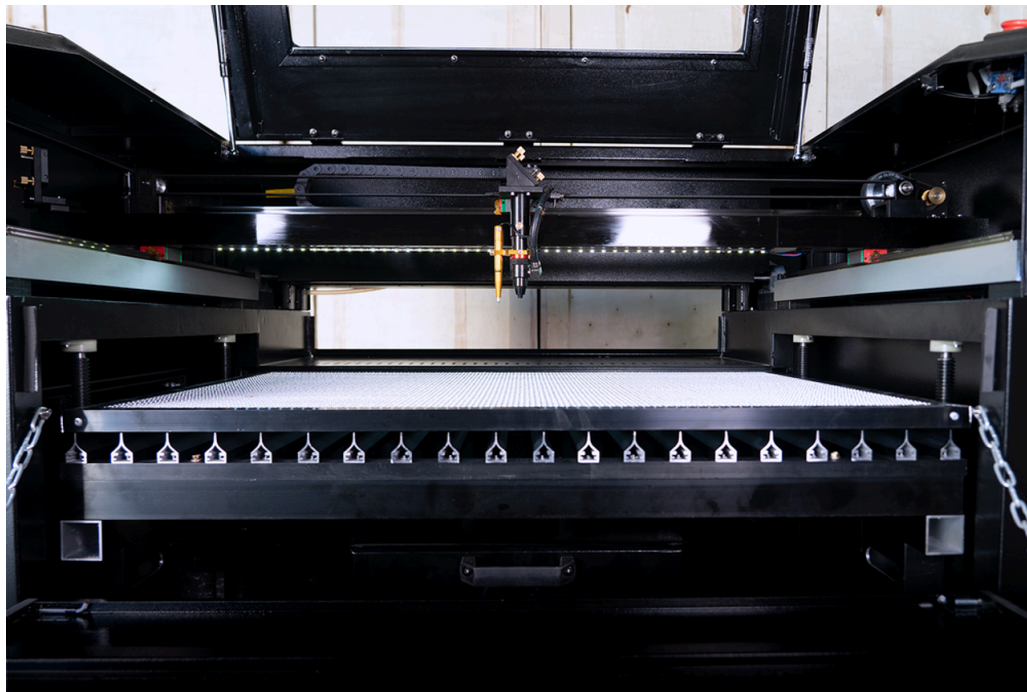
- Full Spectrum Laser 120W CO2 – <https://www.fslaser.com/ps36/>
- Full Spectrum Forum - <https://www.fullspectrumengineering.com/forums/index.php>
- LightBurn Forum - <https://forum.lightburnsoftware.com/>
- Ruida Controller - <https://www.ruidacontroller.com/rdc6445s/>
- Thingiverse - <https://www.thingiverse.com>



Full Spectrum Laser 120W - CO2 Laser Cutter



Bed size: Left to right = 900mm (3'), Front to back = 600mm (2')



Materials we cannot Laser cut

We do not or cannot cut the following materials:

UNSAFE - NEVER CUT THESE MATERIALS

MATERIAL	DANGER!	Cause/Consequence
PVC (Poly Vinyl Chloride), vinyl, pleather, and artificial leather	Emits pure chlorine gas when cut!	Do not cut this material as it will ruin the optics, cause the metal of the machine to corrode, and ruin the motion control system.
Thick (>1mm) Polycarbonate/Lexan	Cut very poorly, discolors, and catches fire	Polycarbonate strongly absorbs infrared radiation from a CO2 laser, so it is very ineffective for cutting.
ABS	Emits cyanide gas and tends to melt	ABS doesn't cut well. It melts leaving gooey deposits, tends to catch fire, and toxic fumes.
HDPE/milk bottle plastic	Catches fire and melts	It melts. It gets gooey. Do not use it.
Polystyrene Foam	Catches fire	It catches fire, melts, and only thin pieces can be cut. This is the #1 material that causes laser fires!!!
Polypropylene Foam	Catches fire	It melts, catches fire, and the melted drops continue to burn and turn into rock-hard drips and pebbles.
Fiberglass	Emits fumes	It is a mix of two materials that cannot be cut. Glass (etch, no cut) and epoxy resin (fumes)
Coated Carbon Fiber	Emits noxious fumes	A mix of two materials. A thin carbon fiber mat can be cut, with some fraying - but not when coated.

Materials we can Laser cut

We can laser cut plastics, wood, rubbers, foams, and papers if they do not contain chlorine.

SAFE MATERIALS TO LASER CUT

The laser can cut or etch. The materials that laser can cut materials like wood, paper, cork, and some kinds of plastics. Etching can be done on anything, wood, cardboard, aluminum, stainless steel, plastic, marble, stone, tile, and glass.

Material	Max thickness	Notes	WARNINGS!
Many woods	1/4"	Avoid oily/resinous woods	Be careful cutting oily or very resinous woods as they may catch fire.
Plywood / Composite woods	1/4"	These contain glue and may not laser cut as well as solid wood.	Harmful fumes from cutting through unknown glues.
MDF / Engineered woods	1/4"	These are okay but may char when cut.	Use the compressed air and vent fumes properly.
Paper, card stock	thin	It cuts well and quickly.	Make sure to wait for a while to get the burned smell to vent.
Cardboard, carton	thicker	Cuts well but may catch fire.	Watch for fire.
Cork	1/4"	Cuts nicely. Engineered cork has a lot of glue in it and may not be cut as well.	Avoid thicker cork.
Acrylic, Lucite, Plexiglass, PMMA	1/2"	Cuts extremely well leaving a beautifully polished edge.	Can cut thicker by going slowly.
Acetal Copolymer Delrin (POM)	1/4"	Acetal tends to work better. Great for gears! It comes in many colors and hardness.	Can catch fire & flames are colorless Should use compressed air. Produces formaldehyde gas so leave inside cutter to degas for a few minutes.

Kapton tape (Polyimide)	1/16"	Works well, in thin sheets and strips like tape.	
Mylar	1/16"	Works well if thin. Thick mylar warps, bubbles, and curls	Gold-coated mylar will not work.
Solid Styrene	1/16"	Smokes a lot when cut but can be cut.	Keep it thin.
Dapron foam	1/4"	1/4" cuts nicely, with a smooth edge.	Must be constantly monitored.
Gator foam		Foam core gets burned and eaten faster than top and bottom hard paper.	Not a fantastic thing to cut, but it can be cut if watched.
Cloth/felt/hemp		They all cut well.	Not plastic-coated or impregnated cloth!
Leather/Suede	1/8"	Leather is hard to cut, but can be if it is thin	Genuine leather only! Not 'pleather' or other imitations!
Magnetic Sheet		Cuts beautifully	
Non-chlorine containing rubber		Fine for cutting.	Beware of chlorine-containing rubber!
Teflon (PTFE)	thin	Cuts OK in thin sheets	
Carbon fiber mats		Can be cut very slowly.	You must not cut carbon fiber that has been coated!!
Coroplast ('corrugated plastic')	1/4"	Difficult because of the vertical strips.	Use multiple passes to cut through

Materials we can Laser Etch or Engrave

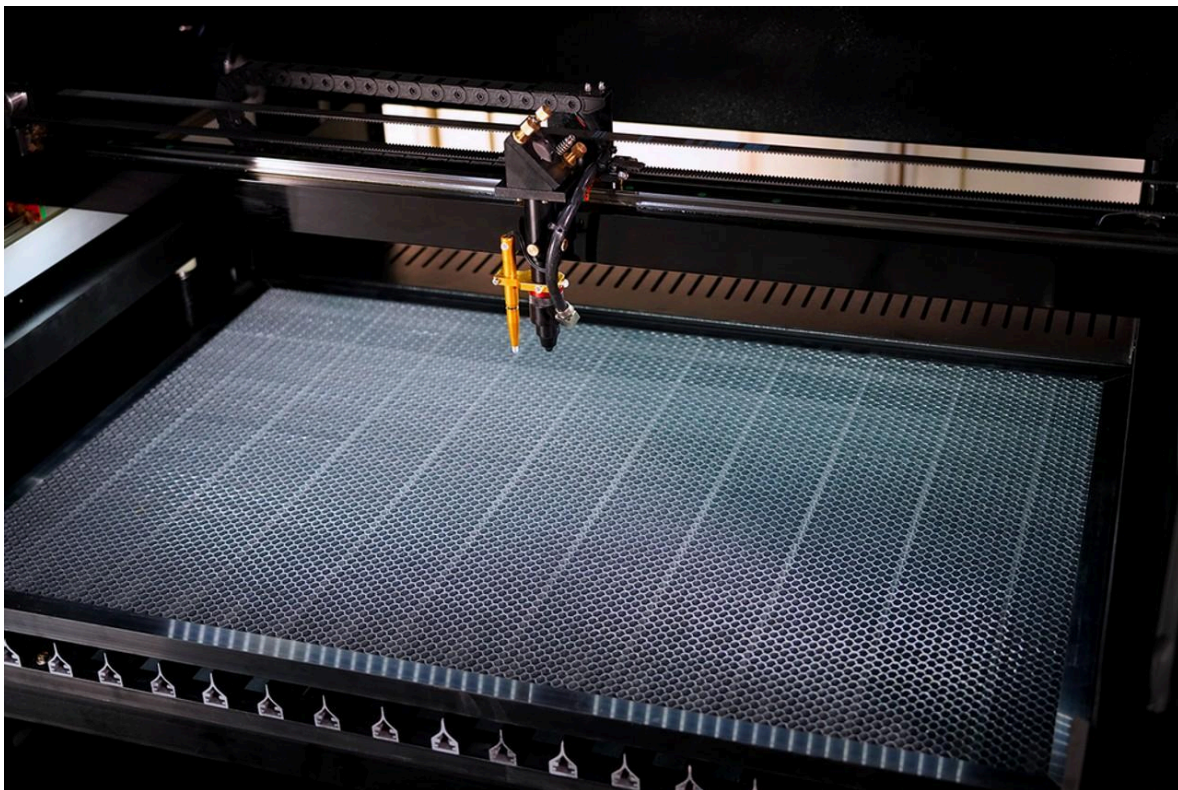
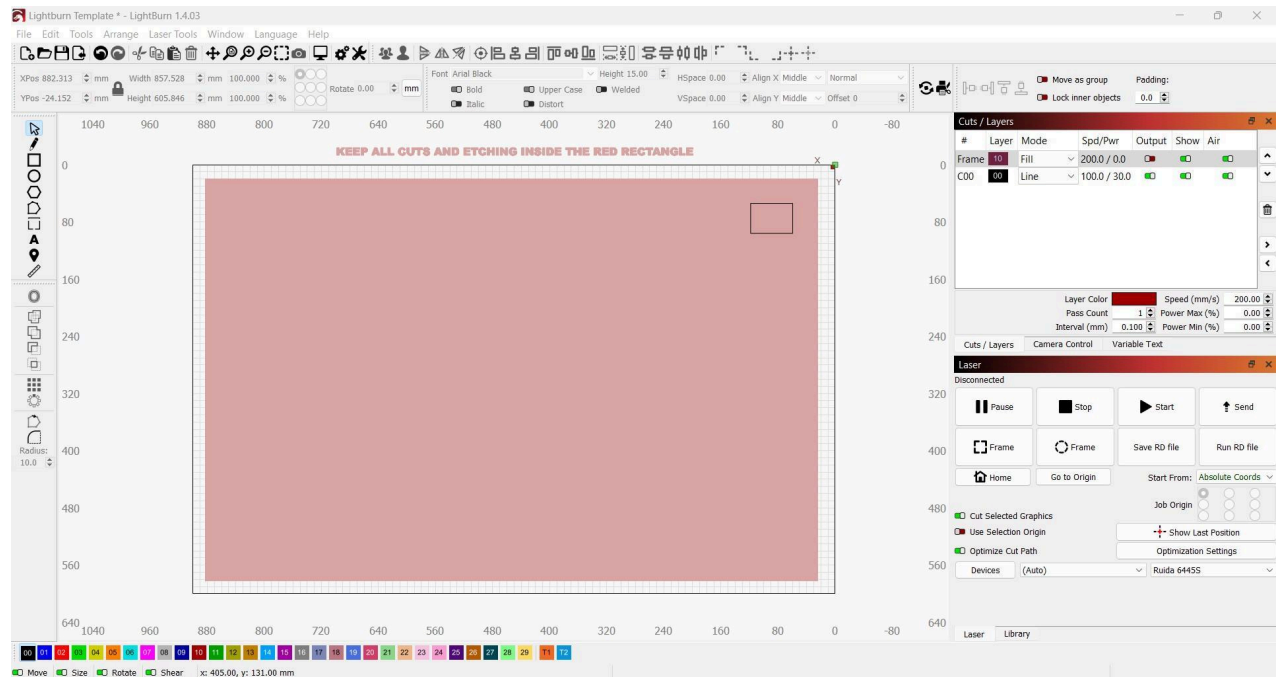
All the above "cuttable" materials can be etched, in some cases very deeply.

SAFE MATERIALS TO LASER ETCH

In addition, we can etch:

Material	Notes	WARNINGS!
Glass	Green seems to work best...looks sandblasted.	Flat Glass can be engraved. Round or cylindrical items need a rotary unit.
Ceramic tile		
Anodized aluminum	Vaporizes the anodization away.	
Painted/coated metals	Vaporize the paint away.	
Stone, Marble, Granite, and Soapstone	Creates a white "textured" look when etched.	100% power, 50% speed, or less works well for etching.

SOFTWARE: Lightburn running the DLP Ruida controller over USB





Part 1: Safety – From the Full Spectrum Laser User’s Manual

Overview

Please carefully read all instructions before attempting to operate the laser. **Never operate or test the laser without the water pump activated** or with anything other than pure distilled water as a coolant. Never attempt to operate the laser with the lid open or attempt to override the magnetic lid interlock switch. Please inspect the laser tube carefully for any shipping damage and contact us immediately via email if there are any issues. **Know your marshals.**

Laser Safety

The output of the CO2 engraving laser is fully contained in a Class 1 enclosure during normal operation. The laser cabinet has a safety interlock switch that deactivates the laser if the door is opened during operation, and no special precautions are necessary to operate the high-power laser safely. However, the output beam of the Alignment Laser (visible red diode laser) is accessible to the operator during normal operation, giving the total system an overall rating of Class 3R. While this device employs the same technology as a handheld laser pointer, it is potentially hazardous if its beam is directed into the eye.

General Operation Precautions

The laser operator should observe the following:

- NEVER operate the machine with any of the panels removed. Be aware that removal of any portion of the cabinet will expose a Class 4 laser system and increase the risk of injury and/or fire. PERSONAL INJURY AND FIRE RISKS ARE ESPECIALLY PRONOUNCED IF THE MACHINE IS OPERATED WITH THE BOTTOM PANEL REMOVED. Remember that the CO₂ laser beam is invisible!
- NEVER engrave or cut any material containing PVC or vinyl. These materials (along with other chlorine/chloride-containing materials) produce a corrosive vapor that is extremely harmful to humans and will destroy your machine. *Your warranty will be void if your machine is damaged by corrosion from engraving or cutting PVC or vinyl.*
- NEVER engrave or cut any unknown material. The vaporization/melting of many materials, including but not limited to PVC and polycarbonates, can give off hazardous fumes. Please refer to the MSDS sheet from the material manufacturer to determine the response of any work material to extreme heat (burning/fire hazard).
- NEVER operate your machine unattended. There is a significant risk of fire if the machine is set improperly, or if the machine experiences a mechanical or electrical failure while operating.
- ALWAYS use the air assist, especially during vector cutting. Vector cutting movements are slow and apply an extremely large amount of heat to the workpiece. This buildup of heat can cause a significant fire risk.
- DO NOT disassemble the machine or remove any of its protective covers while the unit is plugged in.
- DO NOT defeat the door interlock.



- DO NOT look into the beam of the Alignment Laser (visible red diode laser)
- DO NOT operate the Alignment Laser without the focus lens in place. The unfocused beam can be reflected out of the chassis.
- NEVER operate the machine without a properly operating ventilation system. Most materials produce an irritating smoke when engraved. Some materials, including paint, varnish, composition board and plastics, produce harmful compounds if concentrated.

Electrical Safety

The AC input power to the Full Spectrum HL40-5g is potentially lethal and is on the far right within the cabinet.

- DO NOT open any of the machine's access panels while the unit is plugged in. Opening a panel may expose the operator to the unit's AC input power.
- DO NOT make or break any electrical connections to the system while the unit is turned on.
- DO NOT access the electronics area with hands or tools unless the unit is disconnected from power.

The power supply is capable of outputting DC 20,000V at up to 20mA—always make sure to give the supply capacitors adequate time to discharge before accessing the electronics area. This power is also provided to the discharge terminals on the laser tube itself. Your laser shipped with silicone terminal covers that prevent access to bare wiring—notify Full Spectrum Laser support and immediately cease operations if these covers ever slip and expose bare wire. [4]

Fire Safety

Laser cutting and engraving systems represent a significant fire hazard due to the extremely high temperatures generated by the laser beam. While most cutting and engraving operations aim to vaporize material without burning, most materials capable of being cut or engraved are inherently combustible and can easily ignite. Usually this is a small flame of burning material coming from the cutting zone which self-extinguishes due to the air assist or de-powering of the beam. However, the flame can propagate and set fire to the machine and threaten its surroundings.

Experience shows that vector cutting with the laser has the most potential to create an open flame. Acrylic in all its different forms is especially flammable when vector cutting with the laser. Please also be aware that stacking materials (especially organic materials such as paper) can lead to an increased risk of flame propagation or workpiece ignition. Please read the following warnings and recommendations and follow them closely!

- NEVER leave the laser system unattended during operation.



- KEEP the area around the machine clean and free of clutter, combustible materials, explosives, or volatile solvents such as acetone, alcohol, or gasoline.
- ALWAYS keep a properly maintained and inspected fire extinguisher on hand. Full Spectrum recommends a Halogen fire extinguisher or a multi-purpose dry chemical fire extinguisher. Halogen extinguishers are more expensive than dry chemical extinguishers but offer certain advantages should you ever need to use an extinguisher. The Halogen extinguisher discharges a clean, easily removable substance that is not harmful to the mechanics or wiring of the laser system. The dry chemical extinguisher discharges a sticky, corrosive powder that is difficult to clean up.
- ALWAYS use air assist when vector cutting.
- Be Careful when vector cutting. Many materials have the potential to burst suddenly into flames – even materials that may be familiar to the user. Always monitor the machine when it is operating.
- KEEP The Laser System Clean – A buildup of cutting and engraving residue and debris is dangerous and can create a fire hazard. Keep your laser system clean and free of debris. Regularly remove the cutting grid to clean any small pieces that have gotten stuck or fallen through.



Robot Garden Specific Laser Usage

1. When in doubt, ask a Marshal (info@robotgarden.org, 925-290-8260).
2. Understand the LASER and read the user's manual thoroughly.
3. Turn **ON** the **Main Power Switch** above the Laser Cutter on the wall.
4. Ensure the **Exhaust Fan** is running properly.
5. Ensure that the **Compressor and Water Pump** are functioning, water is flowing through the unit, and air is at the nozzle of the laser head.
6. Ensure that the power plugs and surge protectors are properly fitted, and power is flowing to the unit.
7. Turn the key to **Power ON** the Laser Cutter.
8. Ensure the LCD displays the boot parameters and IP of the unit.
9. If the LCD is not ON, Twist the **E-stop** to start the unit.
10. **Focus the laser head** and make sure the Z value is within the limit.
11. Ensure that the **Material** being cut/engraved **is approved** for the system. (Refer to pages 4-7)
12. Ensure the PC is running, that the LightBurn software is running, and that you have a good connection to the cutter.
13. The laser should be focused for the thickness of the material used. Get a Marshal to walk you through the procedure of focusing.
14. Import your work or vector drawing as a .dxf or .svg file, and for engraving import your image file. (jpg, .bmp, or .png).
 - Note: Alternatively, you can create the design in Lightburn. Explore the introduction video on this page <https://forum.lightburnsoftware.com/t/first-time-users-welcome/18>
15. Select the cutting setting from the Materials Library (lower right tab).
16. Verify the "User Selected Origin" is Off.
17. Position your material and drive the laser to the top right corner of the desired cut area.
18. Conduct the "Frame" test to verify you will stay on the material.
19. Engrave or cut your material.
 - Note: Conduct a "Material Test" if the Library setting is not adequate to cut your materials. Get a Marshal to walk you through the procedure of Material Test.
20. Save your work to the user folder.
21. When done, turn **OFF the Power key** on the laser cutter and the **Main Switch**.
22. **DO NOT leave the system while it is running.** It is normal to see flashes and or flame with some materials and how you are using the system. But if it gets out of hand, hit the E-STOP, grab a spray bottle, and put it out. If necessary, grab a fire extinguisher to put out the flames
23. Contact a Marshal (info@robotgarden.org, 925-290-8260) if there are any issues.

