# MAKO

CO2 LASER



# LASER CUTTER USER MANUAL

# INKSMITH

Mako 60W Laser Cutter User Manual - 2023.06.07

# WARNINGS

**InkSmith Ltd.**
180 St. Leger Street,
Kitchener, Ontario
N2H 4M5

1-844-465-7684
tech@inksmith.ca
www.inksmith.ca

InkSmith cannot be held responsible for any direct or indirect damages, which result from using or working with the products electrical circuits or software described herein. The apparatus must be used only by trained and skilled personnel. This Operation Manual must be read and followed prior to operating the laser machine.

Furthermore, InkSmith reserves the right to change or alter any product described herein without prior notice.

In case of failure, please check the device first according to section 6.1 Tips for Troubleshooting. If unsuccessful, please note all data of the device (year of manufacture, software version, etc.) and call us from a telephone next to the switched on device.

For queries or technical problems please contact InkSmith directly at the above address.

# TABLE OF CONTENTS

# 1.0 MACHINE OVERVIEW

## 1.1 GENERAL ACKNOWLEDGMENTS

Please read and follow this Operation Manual carefully before installation and operation of the laser cutting machine. Damage to persons and/or material can result from not following the Operation Manual. Operation of the machine is only permitted with consumables listed in the Approved Materials lists.

It is extremely important that the laser cutter is only operated after the machine has be properly adjusted. Use of the laser cutter with unapproved materials is not recommended. The manufacturer does not admit liability for damage to personnel and/or equipment resulting from such use.

The laser cutting machine must only be operated, maintained and repaired, by personnel that are familiar and trained as well, with the correct operation and dangers of the machine.

Failure to follow the operation, maintenance and repair instructions described in this Operation Manual excludes any liability of the manufacturer if a defect occurs.

Please note, when processing conductive materials, conductive dust or particles in the air might damage electrical components and lead to short circuits. Please note, such use is not covered in the machine warranty.

Please retain a copy of this manual for reference.

# 1.0 MACHINE OVERVIEW

## 1.2 TECHNICAL SPECIFICATIONS

| Technical Specifications | |
|---|---|
| Model | Mako 60W |
| Price | $8,299.00 |
| Workspace | 500mm x 300 mm |
| Laser Power | 60 Watt |
| Laser Type | CO2 Sealed Glass Tube, 10.6 μm |
| Cooling Type | Water Cooling |
| Engraving Speed | 100-200mm/sec |
| Cutting Speed | 50-100mm/sec |
| Laser Optical Control | (0-100% set by software) |
| Min. Engraving Size | English letter: 1mm x 1mm |
| Max Scanning Precision | 4000DPI |
| Locating Precision | ≤+ 0.01mm |
| Controlling Software | DSP Control System |
| Graphical Format Supported | AI, DST, PLT, DXF, DWG, LAS, etc. |
| Compatible Software | Autocad, Coreldraw, Photoshop, Lightburn, Tajima, etc. |
| Colour Separation | Yes |
| Drive System | High-precision 3-Phase Stepper Motor |
| Power Supply | AC110V/220V+10%, 50HZ/60HZ |
| Working Environment | Temperature: 0 - 45°, • Humidity 5 - 95% |
| Optional Spare Parts | Honeycomb Worktable, Rotary Device, Auto-focus device |
| Air Filtration Unit | Optional Unit, if required +$1999.99 |
| Stand | Optional, if required + $599.99 |

# 1.0 MACHINE OVERVIEW

## 1.3 MACHINE INFO

The Mako Laser Cutters are a series of high precision laser cutting machines capable of delivering professional results quickly and efficiently. The Mako Laser Cutters are able to cut and engrave on a variety of materials including wood, cardboard, fabric, leather, and acrylic.

Warning labels about your specific machine can be found on the laser cutting machine. Please do not change or remove the Equipment Name Plate from the machine.

# 2.0 SAFETY

## 2.1 GENERAL SAFETY

All persons involved in the installation, set-up, operation, maintenance of the machine, must have read and understood the Operation Manual and specifically the "Safety" section. It is recommended that organizations generate an internal qualification process for operating the laser cutting machine. Personnel who complete laser safety training should be recognized with written proof of qualification (see section 6.2).

To ensure the safety of all operators and performance of the laser cutting machine, only those individuals who have read this Operation Manual may operate the laser cutting machine.

**Safety Information for Operating Personnel**

1.  All persons involved in the installation, set-up, operation, maintenance of the machine, must have read and understood the Operation Manual.
2.  Machine operators must ensure no unauthorized individuals install, set-up, operate, maintain and/or repair the laser cutting machine.
3.  It is the duty of the operator to check the machine before operation and to immediately report defects that may affect the safety of the machine.
4.  The operator must ensure that the machine is only operated in perfect working condition.
5.  Modifying or removing safety components of the laser machine will void the machine warranty and may result in undue risk for the operator.
6.  If the removal of safety components is required during the repair or service of the machine, the replacement of the safety components must be performed immediately after completion of the service and repair activities.
7.  Preparation, retooling, maintenance and repair activities must only be performed with equipment switched off, by trained personnel.
8.  It is forbidden to perform unauthorized modifications or changes to the machine.

# 2.0 SAFETY

## 2.2 LASER SAFETY PRECAUTIONS

The Mako Laser Cutter contains a powerful $CO_2$ laser tube, which is used to cut, etch and engrave materials on its cutting bed. Once focused, our lowest wattage laser, has sufficient power to vaporize up to 6mm of plywood in a single pass. Our laser cutters are very powerful machines and should be treated as such.

For this reason, there are interlocks in place to prevent injury by shutting off the power to the laser whenever the interlocking cover is in the open position. With the cover closed, the machine is considered a class 1 laser, as any active beam is fully enclosed. This is a classification that requires no special safety considerations.

**WARNING: It is not only dangerous and irresponsible to over-ride or undermine a safety interlock system, it is also an offense under the Occupational Health and Safety Act.**

While the laser cutter's power is 100% contained within the machine during normal usage, it is possible, through the use of keys that open access panels on the side of the machine, for users to become exposed to the laser beam or radiation scattered from it. Your laser cutter's keys should be kept in a secure location during normal laser use and should never be accessed by untrained personnel.

As with all types of radiation, the extent of damage to human tissue is a result of the wavelength, the flux (the amount of radiation impacting each square meter of tissue) and the duration of the exposure. It is impossible to visually detect, and thereby limit, exposure of infrared radiation as it is invisible to the human eye. As such, the first indication of exposure to a $CO_2$ laser beam would be the identification of damaged tissues. Should this tissue be a cornea or retina, the damage could be permanent and debilitating.

Any potential of damage to tissue is 0% when operating the laser cutter as it is intended to be used. Risk is only from improper use, such as if the laser cutter is operating while the interlockign door is open, if the interlock switch or key on the main door is damaged or disabled, if the safety interlock system has been illegally overridden, or if the access panels on the side of the machine are open while operating.

The beam should never be operated while the interlocking door is open, or if the interlock switch or key on the main door is damaged or disabled in any way.

# 2.0 SAFETY

**Laser Safety Information**

- The Mako 60W conforms to the **ANSI+Z136.1-2014** standard. It has a fully enclosed beam path, lockouts on all access panels, and the labeling indicates the relevant safety warnings. Please note that improper operation of the device can override the status of safety and can cause the emission of harmful radiation.
- This laser system contains a carbon dioxide ($CO_2$) laser source of class 4 that emits intensive and invisible laser radiation. Without safety precautions the direct radiation or even diffuse reflected radiation is dangerous.
- Without safety precautions, the following risks exist with exposure to laser radiation:
    - Eyes: Burns to the retina from NIR (Near Infra Red) LASER
    - Burns to the cornea from CO2 Laser
    - Skin: All types of burns
    - Clothing: Danger of fire
- Never try to modify or disassemble the laser on your own and do not try to start a system that has been modified or disassembled.
- **Dangerous radiation exposure can result if the use of operation or adjustment of equipment other than is anything that described here, and/or if different operational methods are performed.**
- Dangerous radiation exposure can result from the use of prohibited materials such as:
    - blank or polished metals
    - metals with very high reflectivity like copper, brass, gold, sand silver
    - any materials with highly reflecting coatings
- Other highly reflecting materials, especially in combination with high laser power, low processing speed and/or work pieces with curved or inclined surfaces, might reflect laser radiation towards the protection cover. With a very low probability this protection cover could be damaged if the reflected radiation is FOCUSED onto the surface of the protection cover. Therefore visual inspection for point-like defects on the protection cover should be done if the aforementioned conditions occur.
- If you detect such damages on the protection cover, immediately turn off the laser machine and contact InkSmith to request a new protection cover.

# 2.0 SAFETY

## 2.3 OPERATIONAL SAFETY

No special personal protective equipment is required to operate the laser cutter. The laser cutter's beam is fully enclosed, and it's ventilation system protects users from smoke and vapours created during the machine's operation

It is mandatory to have a fire extinguisher nearby at all times during operations, and that all operations are performed under the direct supervision of a person trained in Fire Safety and the use of fire extinguishers.

Although it is not required, your organization may suggest the use of safety glasses during operation of the laser cutter.

Regardless of safety glasses use, do not stare directly at the bright light produced from the laser beam when interacting with the materials it is cutting or etching.

The red dot pointer is a low power visible light laser that can be on even when the loading door is open. Never point the red dot pointer directly at any person's eyes. Be aware of potential surface reflections. A risk of fire is always present when the machine is cutting or etching on combustible materials. Never operate the laser cutter without direct supervision of a trained person.

A tiny flame is normal for some materials during laser operations. Any flame that continues to burn after the laser has moved positions is an indication that the material is on fire. Such a situation must be addressed immediately. Very small flames can be extinguised by blowing them out like a candle, or by smothering with a suitable material. If a flame gets larger than the size of your fist, If a flame gets larger than the size of your fist, immediately notify the nearest supervisor. If a fire extinguisher is required, all other lab personnel must immediately evacuate the building and the nearest pull station must be activated.

**WARNING: Supervisors must stay alert and aware of the machine and operating environment, and refrain from distractions like mobile device usage. A fire in the machine will not make a sound to alert attention, supervisors must keep a regular light of sight to observe any potential fires. Due to the inward-drawing ventilation, there will also be no smell of smoke to indicate a fire. If a fire builds to the point where it ignites wiring, paint or plastic in the laser cutter before it is put out, it poses an extreme danger to the operator and the entire building.**

**DANGER: Only trained and qualified personnel are allowed to operate the laser cutter.**

# 2.0 SAFETY

## 2.4 APPROVED/NOT APPROVED MATERIALS

Never use the laser cutter on materials that are not on the approved list for cutting,etching,engraving. Toxic fumes and/or risk of fire may result. The use of not approved materials may result in toxic fumes and/or a fire.

**Approved Materials:**
- Acrylic
    - Cast–good for engraving
    - Extruded–good for cutting, less expensive
- Aeroply/Birchply
- Basswood
- Brown Cardboard
- Cloth
- Natural fibers– good for cutting, but will scorch on edges
- Synthetic fibers– good for cutting, but only on non-chlorinated fibers; be aware that edges will self-seal
- Corian
- Cork
- Delrin (Seal Press)
- Leather
- Mat Board (used as border on pictures, thin card board)
- Melamine plastic
- Micro surfaced rubber Stamps
- Natural Wood – up to 1∕2"
- MDF that is free from Formaldehyde
- Paper
- Plywood – up to 12 mm
- Silicone Sheet

**NOT Approved Materials:**
- ABS
- Crystal
- Glass
- Metal or Composites thereof
- Marble
- MDF that is manufactured using Formaldehyde (if uncertain, assume that the material contains formaldehyde)
- Teflon
- Polyurethane
- Polystyrene and Styrofoam
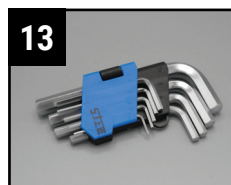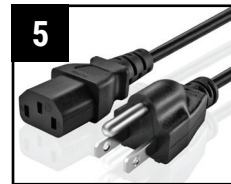- PVC
- Polyurethane and Polyurethane Foams

# 3.0 INITIAL SETUP

## 3.1 WHAT'S INCLUDED

1. Mako Laser Cutter
2. CO2 Tube
3. Exhaust Hose
4. Hose Clamps
5. Power Cables and Adapters
6. Triangle Key
7. USB Cable
8. Ethernet Cable
9. USB Drive
10. Accessories
11. Gold Pins
12. Water Chiller Valve
13. Allen Keys
14. Housing Keys (80W 100W)

**Optional**
15. Air Filtration

# 3.0 INITIAL SETUP

## 3.2 LOCATION CONSIDERATIONS

Before you install the Mako Laser, it is important to select an appropriate location. To determine the best location, please follow the guidelines listed below:

- Avoid locations where the machine may be exposed to high temperatures, dust, and high humidity. The humidity must not exceed 70% and the temperature must not be close to the dew point. Select a location where the room temperature is between 15 °C and 25 °C (59° – 77° F).
- Avoid locations where the machine may be exposed to mechanical shocks.
- Select a location with good air circulation and, if available, close to ventilation. Avoid locations with poor air circulation.
- Avoid higher ambient temperatures and a strong exposure of the machine to the sun. Use window coverings, if required.
- Select a location close to ventilation (if available).
- Select a location that is less than 2.5 meters away from your computer (max. cable length to avoid disturbing interferences).
- Select a table or surface that is able to the handle the weight of the laser.
- Choose a location where you are able to have access to all sides of the laser.

## 3.3 ELECTRICAL REQUIREMENTS

Make sure that your electrical outlet is capable of providing the proper voltage, frequency and amperage that the laser system requires. It is highly recommended that you use a surge suppression plug to protect your computer equipment. Machines made for Canada are all 110V 60Hz.

The maximum current draw will depend on the machine model and laser tube power.
- **40W** tube machine 6.4A
- **60W** tube machine 7.3A
- **80W** tube machine 8.2A
- **100W** tube machine 10A

*DAMAGES FROM AN INADEQUATE OR INAPPROPRIATE POWER SOURCE ARE NOT COVERED UNDER WARRANTY. IT IS YOUR RESPONSIBILITY TO PROVIDE A SUITABLE ELECTRICAL SUPPLY.*
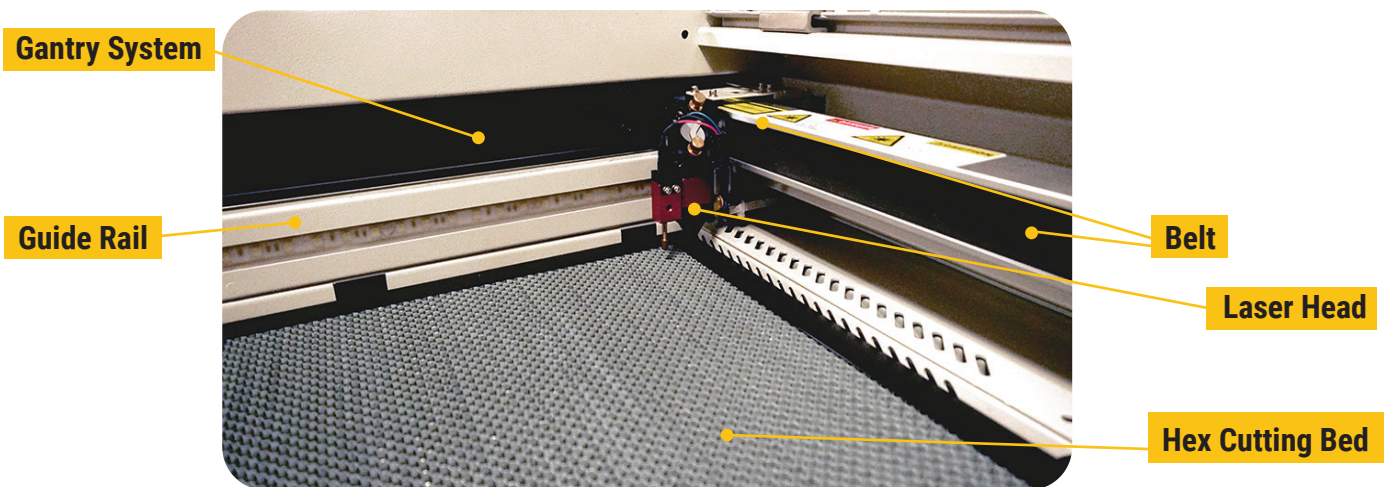
## 3.4 EXHAUST REQUIREMENTS

Please refer to the specific exhaust requirements found in the operation manual included with your air filtration unit. If you are not using a separate air filtration unit it is suggested that the Mako Laser be filtered using flexible aluminum duct piping into an existing exhaust ventilation unit. You can connect to your buildings HVAC system using the flexible aluminum duct piping included in the crate of your laser cutting machine.

# 3.0 INITIAL SETUP

## 3.5 MAKO LASER DIAGRAM

**Protective Cover**

**Control Panel**

**Optical Path Checking Panel**

**Water Cooler**

**Emergency Stop Button**

**Gantry System**

**Guide Rail**

**Belt**

**Laser Head**

**Hex Cutting Bed**

# 3.0 INITIAL SETUP

### 3.6 CONNECTING AIR FILTRATION TO AN STSTEM

Start by plugging in your Mako Laser Cutter into a suitable power outlet (as outlined in section 3.3 ELECTRICAL REQUIREMENTS).

**Option 1 - Connect to the Mako Laser Cutter Air Filtration System**

Follow the specific instructions included with your Mako Laser Cutter Air Filtration System to install it on your laser machine. To access the instructions please click the link here.

**Option 2 - Mako Laser Cutter Air Filtration System**

Alternatively, you can connect your Mako Laser Cutter to your building's existing HVAC system. To do so, use the flexible aluminum hose included with your Mako Laser Cutter, and pipe it into an existing vent. We recommend securing the connection points with tin tape to ensure that no fumes escape.

# 4.0 OPERATION

## 4.1 POWERING ON

1. Before powering on the Mako Laser ensure that the protective cover is closed.
2. Verify the safety Emergency Stop is not engaged (if it is, rotate it clockwise until it extends to the non-engaged position).
3. Flip the main power switch on the right side of the machine to the on position, if you are using a 80w and 100w the main power switch will be the key slot on the right side.

**Transferring Files to the Mako Laser Cutter**

• Insert the USB stick into the lower port of the two USB ports on the back side of the Mako Laser Cutter.
• On the control panel of the laser, press the "file" button. The files currently stored in the internal memory in the laser will be displayed in a box with a series of smaller boxes to the right.
• Use the white arrow keys on the keypad to navigate over to the smaller boxes then navigate down until you reach the box called "UDisk+".
• Press the "Enter" button on the keypad. The display will refresh with an empty window on the left and a new group of boxes on the right.
• Select "Read UDisk File". The left window will populate with the names of all of the laser files stored in the parent directory of the USB stick.
• Use the arrow keys to highlight the file you want to use.
• Use the left and right arrow keys to toggle back to the boxes on the right side of the screen.
• Navigate down to "Copy to Memory" and highlight it. Press the "Enter" button.
• Press the "ESC" button on the interface twice. This will exit the machine from file displaying mode.
• Press the "File" button once more.
• The file that was copied will now be displayed in the list of files in the box at the left of the display screen. Use the curser to scroll up or down until the file that is needed is highlighted.
• Press the "Enter" button. The file is now in the active memory of the machine and is ready to run.

There are a limited number of file names which can be displayed on the screen at one time, so other files in the laser cutter's memory may only become visible when the curser keys are used to scroll up or down through the list.

The menu option displayed on the screen will cycle from the bottom. It is not necessary to reverse scrolling direction – the list will simply loop. Do not leave too many files loaded in the machine at one time. It will slow the process of file selection and may completely fill the limited memory space of the onboard computer. To delete files, select them in the left window then navigate in the right boxes to highlight the "Delete" option. Then press Enter.

# 4.0 OPERATION

## 4.2 CALIBRATING THE MAKO LASER CUTTER

The gantry system is made up of the motors and linear rails that allow for the laser head to travel during operation. It's important to make sure that all body parts are out of the travel path of any moving parts. Once the machine is powered on, use the direction keys on the keypad to move the laser head around. It should do so relatively quietly, and at the same rate in all directions. If this is not the case, proceed to Troubleshooting before moving on to the next steps.

# 4.0 OPERATION

**Testing the Laser Tube**

Ensure that the flow of water within the laser tube is in the high to low voltage direction. The water will be flowing from left to right you (from the end with the red connector to the end with the black connector). You will be able some flow in the middle of the laser tube. Only look while the laser is not being fired.

**Debugging the Light Path**

The light path of the laser tube is calibrated during the manufacturing process, however it's a good idea to recalibrate the laser after transportation to ensure the safety performance of the machine.

The optical system of the laser cutter consists of a laser $CO_2$ tube, three reflection mirrors, 1 focus lens, a laser head and red dot position system. Please refer to the diagram below.



**First Reflection Mirror**

**Red Dot Position System**

**CO2 Laser Tube**

**Second Reflection Mirror**

**Third Reflection Mirror**

**Laser Head**

**Focusing Lens**
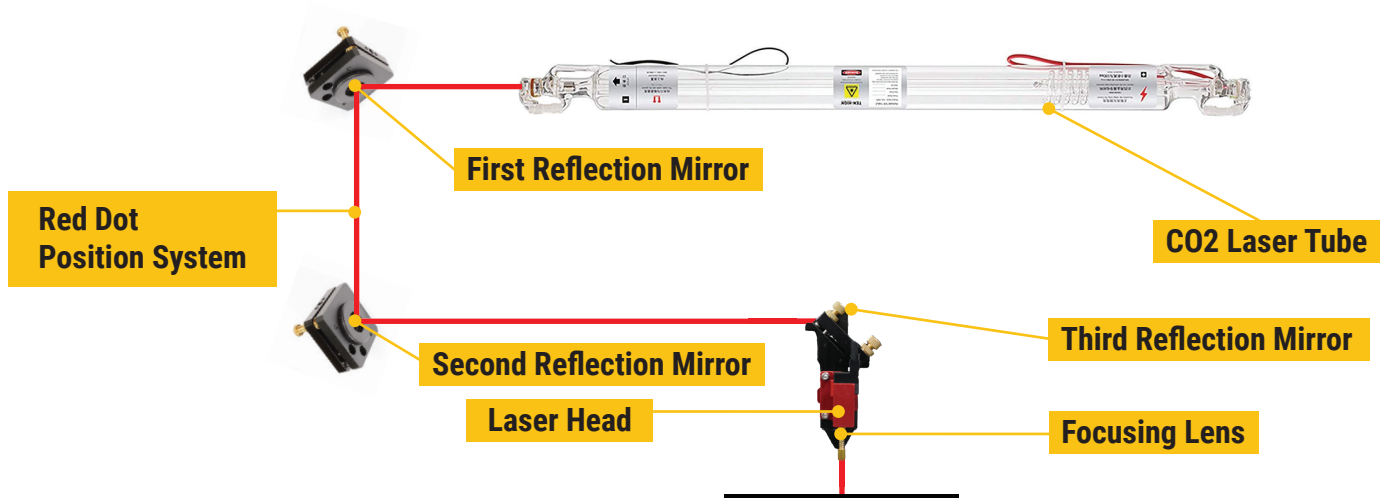
The Mako Laser cutter works by shooting a beam of light from the laser tube, which is then reflected and by the first, second, and third mirrors. After reflecting off of the third mirror the light beam is shot through the focus lens and reaches the work table.

It's through the process of reflecting and focusing that we're able to achieve the best cutting and engraving results. If the light path isn't properly calibrated, it may damage the laser tube, reflectors, lens or result in poor cutting and engraving outcomes. Please calibrate the laser tube using the following three steps:
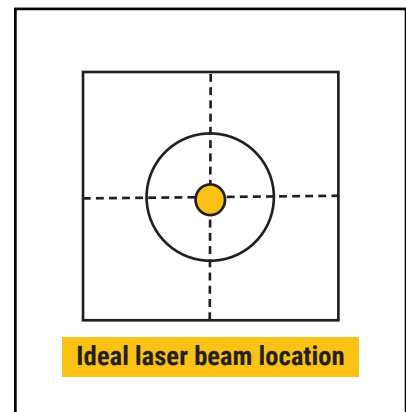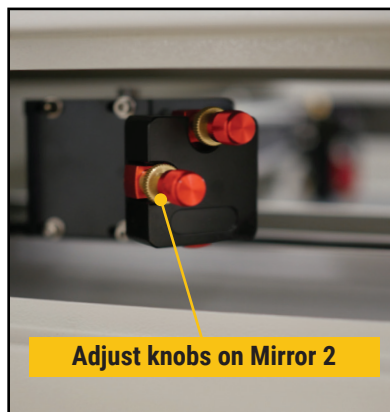
# 4.0 OPERATION

**STEP ONE: Mirror 1 Adjustments**

Open the machine lid and move the gantry system to the front of the machine. Use the Housing Keys to open the side panel of the machine to access the laser mirrors. To align the reflection of Mirror 1, place a small amount on masking tape over the aperture of Mirror 2. With the cover and side panel closed, use the pulse button on the control panel to send a beam of light from the laser. After a quick pulse, open the lid and side panel to examine the location of the laser pulse on the tape of Mirror 2. Use the knobs on Mirror 1 to make small adjustment as needed in order to align the laser beam according to the diagram below.



**Tape on Mirror 2**



Vertical Angle Adjuster

Horizontal Angle Adjuster

**Adjust knobs on Mirror 1**



**Ideal laser beam location**
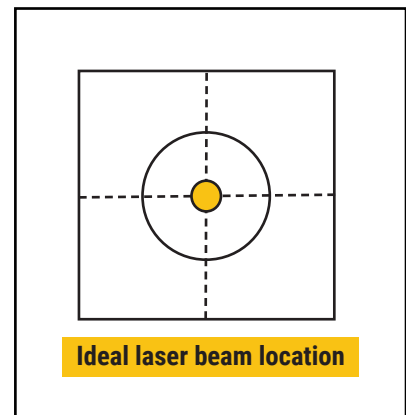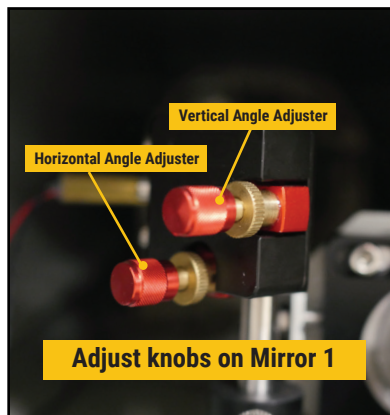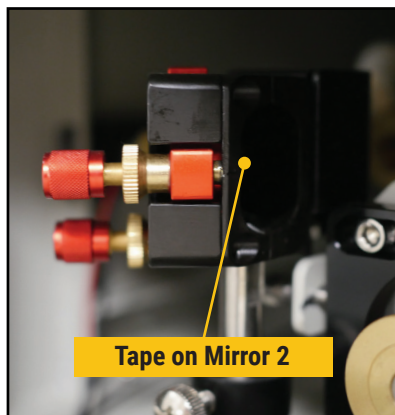
**STEP TWO: Mirror 2 Adjustments**

To align the reflection of Mirror 2, repeat the previous steps but place the masking tape on Mirror 3. Adjust the knobs on Mirror 2 as necessary in order to align the laser beam according to the diagram below.



**Tape on Mirror 3**



**Adjust knobs on Mirror 2**



**Ideal laser beam location**

# 4.0 OPERATION

**STEP THREE: Mirror 3 Adjustments**

To align the reflection of Mirror 3 you will again use the masking tape, but place it on the bottom of the metal laser nozzle. Adjust the knobs on the top of the laser head accordingly to align with the diagram pictured below.

It is important to ensure all three mirrors on the laser machine are adjusted accordingly in order to ensure optimal machine performance and the life of the laser tube.


Tape on Laser Nozzle


Adjust knobs


Ideal laser beam location
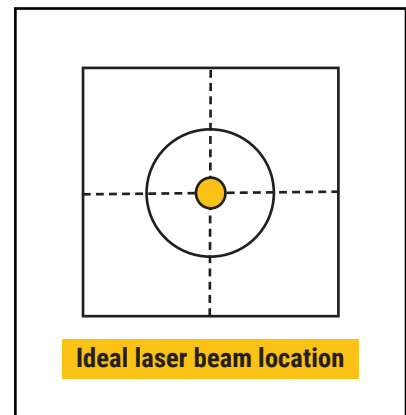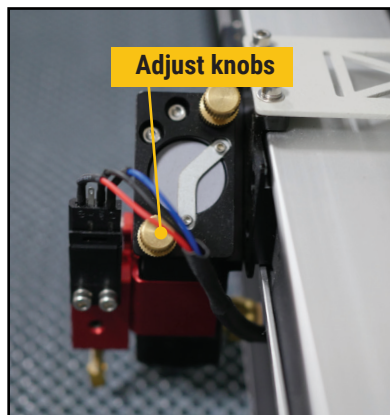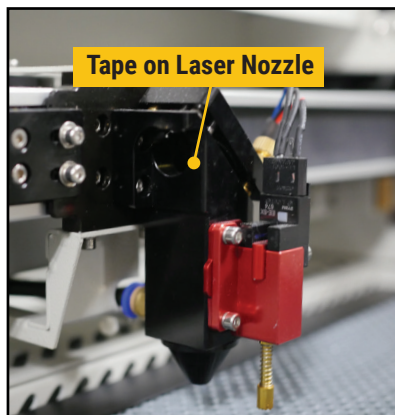
# 4.3 SETTING UP LIGHTBURN SOFTWARE

LightBurn is layout, editing, and control software for your laser cutter. With LightBurn you can:

- Import artwork in a variety of formats
- Arrange, edit create new vector shapes
- Apply settings like power, speed, number of passes, cut order, brightness & contrast, dithering mode, and much more

**WARNING! If a file is prepared using a table size setting larger than your bed size, it may cause the axis to attempt to travel beyond their physical limitations, resulting in damage to the machine.**

**Minimum Computer System Requirements**

LightBurn will run on Windows 7.0 or later, 32 or 64 bit, MacOS 10.11 or later, or 64 bit Linux. LightBurn does not require a powerful computer for most work, although if your designs contain a lot of images, more memory is helpful.

# 4.0 OPERATION

**Installation**

**Download**

Download the latest release version that matches your computer.

- Windows 64-bit
- Windows 32-bit
- Mac OSX
- Linux 64-bit

**Windows Installation**
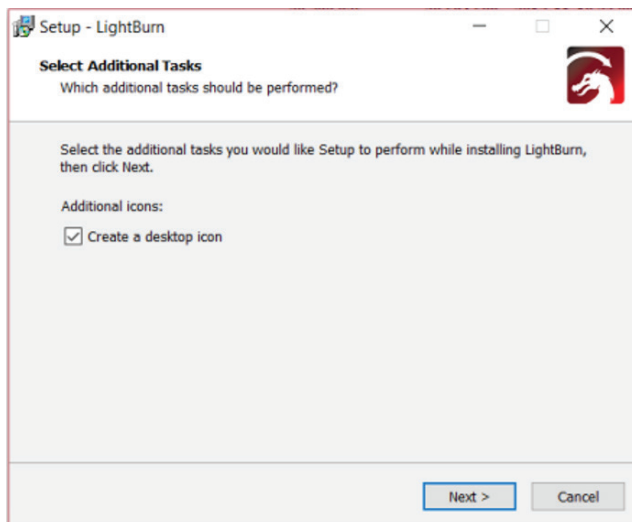


1. Launch the installer executable

2. Windows may ask if you trust the software, as LightBurn is not currently digitally signed

3. Select if you would like to create a desktop icon

4. Click Install

5. Click Finish

That's it! Locate the LightBurn icon to launch the program

**Mac/OSX Installation**

1. Download the Mac/OSX version

2. Double-click the .zip file to extract the DMG (disk-image) file

3. Double-click the LightBurn.dmg file to mount it

4. Drag the LightBurn application into your applications folder

5. Launch LightBurn from the launcher as normal

6. You can now eject the DMG file (drag it to the trash bin)

# 4.0 OPERATION

**Linux Installation**

1. Open a terminal and run the following command: sudo adduser $USER dialout && sudo adduser $USER tty

2. **IMPORTANT!** Log out and log back in (this refreshes the permissions we just added)

3. Download the Linux 64-bit version, either the .run file or the .7z file and follow the appropriate steps below:  .run installer

4. Open your terminal and cd to the directory you downloaded the file to. 5. Run bash ./LightBurn-Linux64-v*.run

6. It will not automatically install and great a program listing in your desktop environment. .7z installer

7. Extract the folder wherever you want Lightburn to exist

8. Right click AppRun > Properties > Permissions > 'Allow executing file as program' 6. Double click AppRun inside your Lightburn folder.

**Activating LightBurn**



If you've never used LightBurn before, you'll be shown the License and Trial page first. Here you can either enter and activate a license key if you have one, or you can activate a free 30 day trial by clicking "Activate Trial".
If you do have a license key, be sure to enter it exactly, including the dashes, then click the 'Activate License' button. We recommend just copying the key and pasting it into the License Key box. You can purchase a License Key through Inksmith.

You can get back to this screen in LightBurn at any time by going to the menu and clicking Help > License Management.
Once you have activated your license or the trial, click 'OK'

The next thing you'll see is the 'General Usage Notes' page - this is a brief help page just to get you going. You can get back to it any time in the Help menu, under Help > Quick Help and Notes. Click OK.
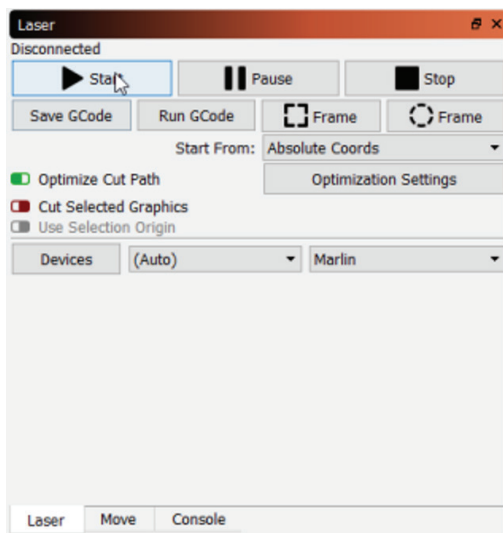
# 4.0 OPERATION

**Device Setup**

If you've never run LightBurn, the first thing you need to do is set up your machine layout (work area size and zero / origin) in the settings, and then add your device type in the devices box. If you have more than one type of laser / device, you can add more than one and choose a default. At present, the layout and page size aren't associated with the device, but this will be changed to that in the future.

If you've never used LightBurn before, you'll also need to tell LightBurn a couple of thing about your hardware to get started.



1. In the lower-right of the display is a box called "Laser" - on the bottom of it is a button called "Devices". Click it.
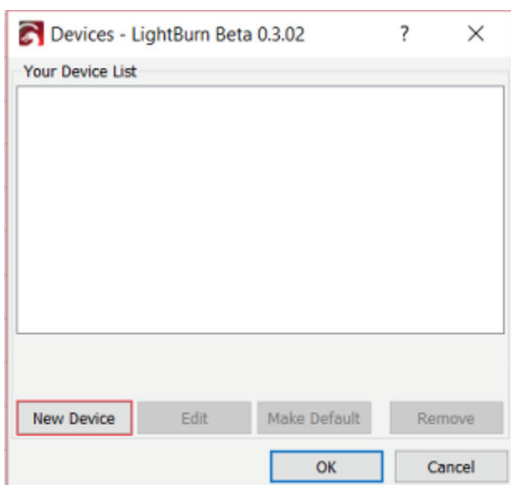


2. Click the "New Device" button (highlighted in red, on the left):
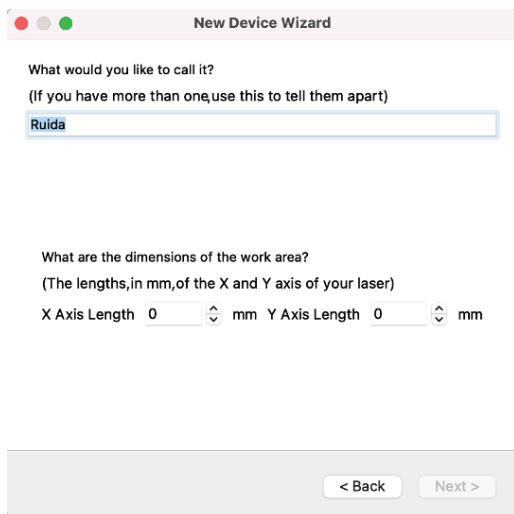
# 4.0 OPERATION
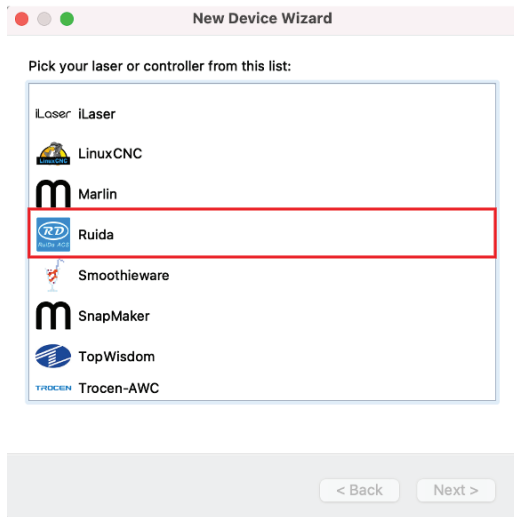
3. Choose the Ruida Laser . Don't worry if you have more than one laser. Start with one for now, and add the others later.
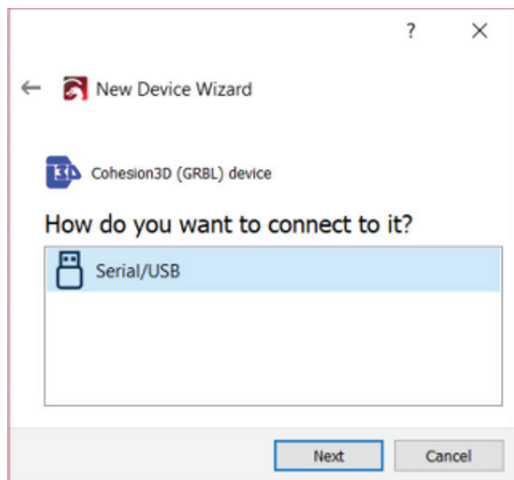
4. Choose your connection method. Serial/USB, Network, etc...

5. Choose a distinct name and set your machine bed size for X and Y.

Below, we've provided the appropriate X and Y positions for each laser wattage of the Mako Laser Cutter:
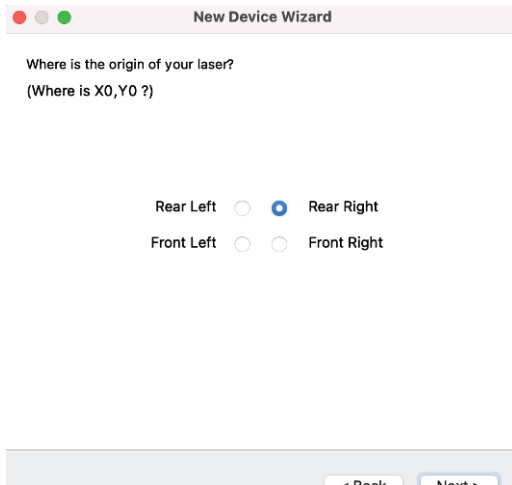**40W** - X Length = 500mm, Y Length = 300mm
**60W** - X Length = 500mm, Y Length = 300mm
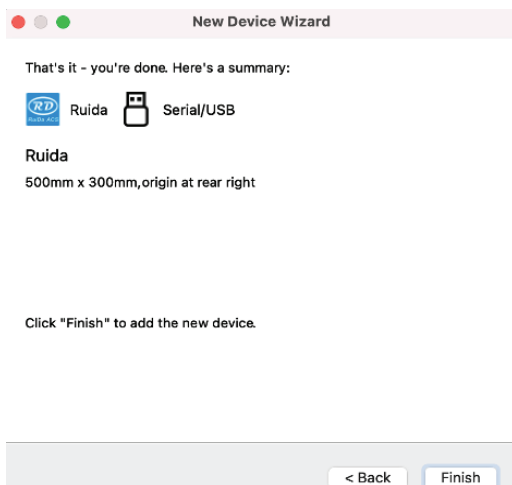**80W** - X Length = 700mm, Y Length = 450mm
**100W** - X Length = 900mm, Y Length = 600mm

# 4.0 OPERATION



6. Choose the X0,Y0 origin point that matches your machine. All machines have the orgin point X0,Y0.



7. Click "Finish" to save your laser setup.

If your laser is connected to the computer, LightBurn will try to establish communication. For some systems this will *home* the laser, for others it will simply show "Ready" in the status box at the top of the laser tab, or the bottom status bar, depending on your system.

If you are adding multiple devices, repeat the steps above for each Mako Laser Cutter. When you are done, you can set the default connection by clicking on the name in the device list and clicking the "Make Default" button.

You may also edit or remove devices by clicking the device and choosing the appropriate button.

# 4.0 OPERATION

**Making a Simple Project**

We're going to go step-by-step through creating a small, simple project in LightBurn, to show you how to use a few of the basic editing tools, and give you a feel for how things work.

Before you start, make sure you have a laser set up in LightBurn (see device setup).

This project will be a simple name tag, cut out around the letters, ideally made from thin wood or acrylic, but a piece of cardboard will also work for this project.

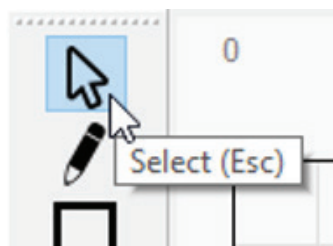**Adding text to your file in LightBurn**
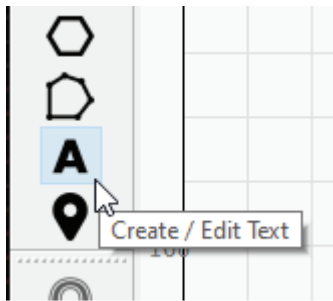


With LightBurn running, and an empty project, click the "Create Text" button. It normally lives along the left side of the main window.



Next, click the mouse somewhere in the middle of the "Edit" window (the workspace) to get a cursor, then type your name.
Click the 'Select' tool button on the top left of the edit window, or press 'Esc' twice (once to finish entering text, and again to exit text entry and go back to selection mode).



Click the "Selec'" tool button on the top left of the edit window, or press "'Esc" twice (once to finish entering text, and again to "exit text entry" and go back to selection mode).

# 4.0 OPERATION

When you finish the text, you'll see an entry appear in the "Cuts / Layers" list on the upper left of the display. This is the "layer" that your text is on, and it holds the settings that will be sent to the laser for all the objects on this layer:
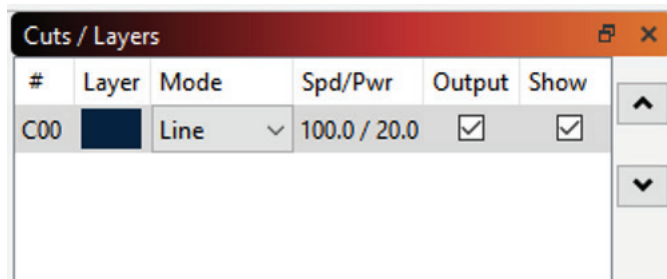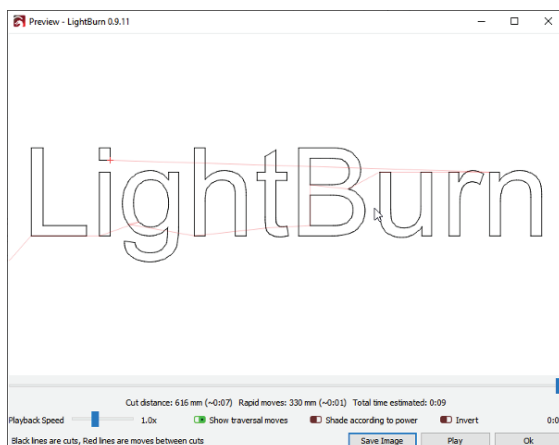


This tells us that the shapes on this layer will be drawn as lines, with 100 mm/sec speed, and 20% power. Depending on your settings, the speed might be different.

**Previewing**
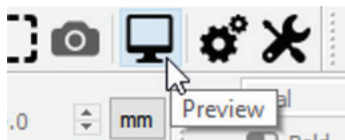


To see how the laser will run your project, click the "Preview" button in the middle of the main toolbar.

The preview window will pop up, showing the completed job, like this:



The lighter red lines are showing the laser moving between the shapes (traversal moves), and the black lines are where the laser will burn. Click the "Play" button and you can watch a simulation of how the laser will run the job. You can also grab the slider and drag it around to see the cut at different points in time. Spot checking the output like this is a good habit to get into, because you'll likely spot mistakes before you burn the project for real, saving time and material. Click the "Ok" button to close the preview.

# 4.0 OPERATION

**Changing text properties**
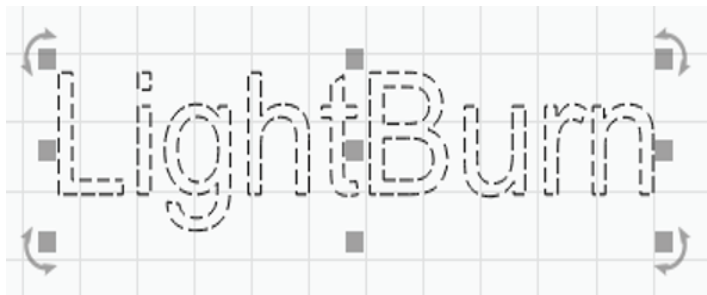


Make sure you're still in "Selection" mode - the "Select" tool should be highlighted. Click the name, or click and drag a rectangle around it to select it. When it's selected, it will be drawn as animated dashes instead of solid lines, and handles will appear around the selection to let you change the size, position, or orientation.

The options in the Text Toolbar at the top will activate, like this:
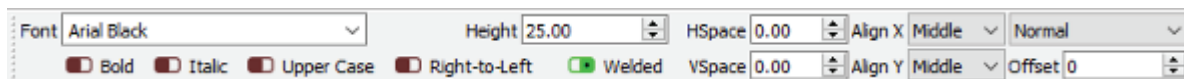


Click the drop down for the font, and change it to anything you'd like. While you are choosing your font, the changes will be displayed in real time in the edit window. You can change the height, make it bold or italic, and adjust spacing here too.

**Undo / Redo**

If you make a change you don't like, you can undo it by clicking the "Undo" button on the toolbar (or pressing "Ctrl+Z", or "Edit" > "Undo in the menu"). If you decide you liked it after all, you can also "Redo" ("Ctrl+Shift+Z"). "Undo" and "Redo" in LightBurn are unlimited, the undo system doesn't reset unless you create a new file or close the program.

**Changing the Layer settings**

Rather than outline the text, we're going to change it to be solid filled. In the "Cuts / Layers" window, click "Line' and change it to 'Fill", like this:
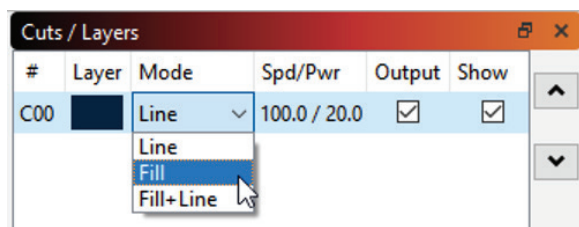


You'll notice that the display in the edit window hasn't changed, but if you run the preview again, it looks quite different. By default, the view in LightBurn shows outlines only, not fills, because it's much faster, and it prevents things from being hidden behind solid shapes that might still be run on the laser.
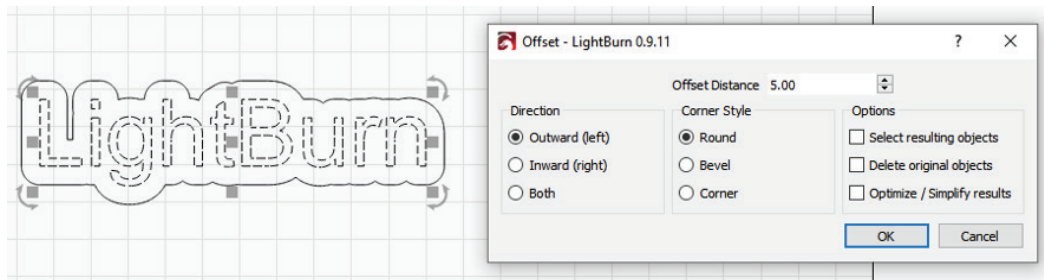
30

# 4.0 OPERATION

**Adding an outline: The Offset tool**
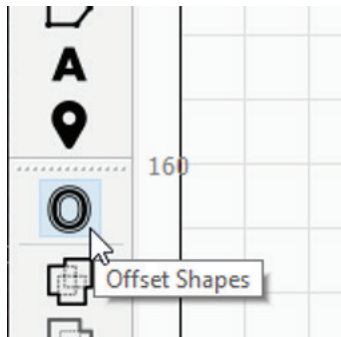


With the text selected, click the "Offset" button on the left toolbar, shown on the left:

The Offset options window will appear, and you should see something like this:



The Offset tool creates a new shape by outlining the shapes in your selection at a given distance, either inward, outward, or both, and merging the result. If you point the mouse at the "Offset Distance" value, you can scroll the mouse wheel to change the number and watch the result change in real time. You can also click the box and enter your desired number as well.

Make the "Offset Distance" value large enough so that there are no internal gaps in the outline. Notice the gap above between the "L" and the "i" is gone in the version below:
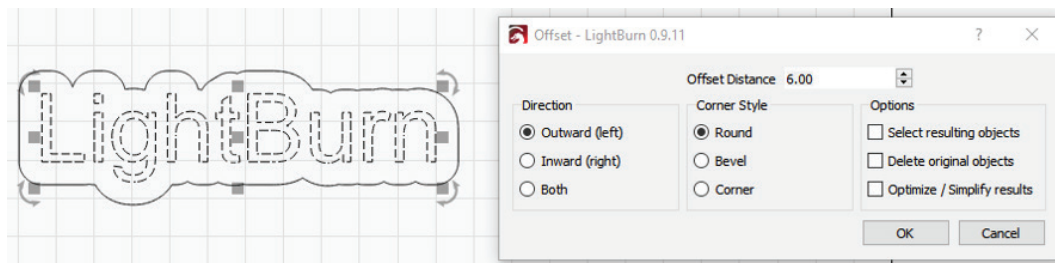


When you're happy with the result, click "OK".

# 4.0 OPERATION

**Changing Layers**

Now, use the left mouse button to click the new outline you just made, so it is the only thing selected, like this:



Then, click the "Red" square in the color palette at the bottom of the display:
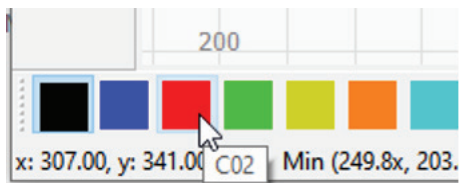


The outline will turn red, and you should see two entries in your "Cuts / Layers" list, like this:



The first layer (C00) is black and is the fill for your text. The second layer (C02) is red and is the outline cut.

# 4.0 OPERATION

**Speed and Power**

This next part may be tricky, so please read carefully. Speed and power settings vary quite a bit between lasers, and LightBurn supports a lot of different types of machines. It also depends on the type of material you're using - cutting through 1/8" basswood uses much less power than cutting through 1/4" plywood or acrylic. This next section assumes 1/8" (3mm) plywood.

To begin with, click the black color entry in the "Cuts / Layers" window. Below the list of layers you'll see the "Cut Info" window, containing something like this:

For the text, you want enough power to engrave into the material you're using, but not too deep.
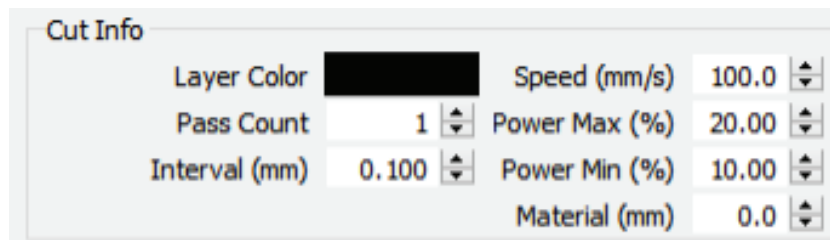


All models of the Mako Laser Cutter use a $CO_2$ laser. As such use 200 mm/sec, 15% power (as both the "Power Max" and "Power Min") and leave everything else.

Note this is a rough starting point, and you will probably need to change this later.

Now, click the red entry in the "Cuts / Layers" window. This is going to be what cuts through the material to cut out the shape. Cutting requires more power and much less speed.

Set 15 mm/sec, 75% power (again for both max and min power)

# 4.0 OPERATION

Again, note that these are starting points and may need to be adjusted.

Open the "Preview" window again ("Alt+P", or click the "Preview" button), then drag the progress slider from left to right to watch how the laser hear will run. You'll see the text engrave first, followed by the outline cut. If you don't see those things, check the settings again, and verify that you have the first layer (black) set to "Fill", and the second layer (red) set to "Line".

**Positioning the Job on the Laser**

When sending this to the laser, there are a couple of different ways that it can be positioned, and the one you choose may depend on the kind of hardware you have. We recommend that in the 'start from' menu you use the absolute cords.

Absolute Cords: Will cut the object in the position on the grid that you have chosen.
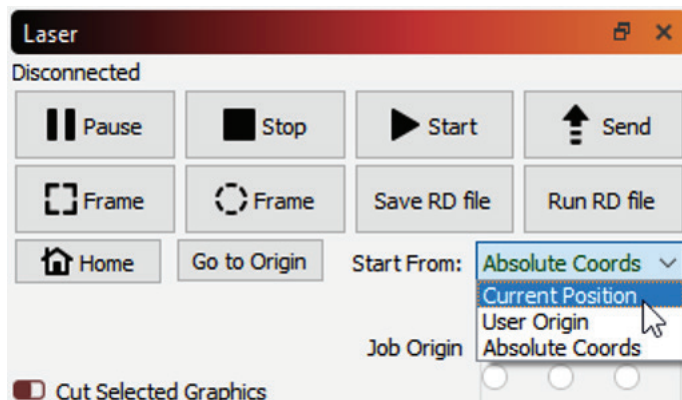


User Origin: Will cut the object wherever you set origin to. Which should be set up to the top right (X0, Y0).

Currently Position: Will cut the object where the laser is currently positioned on the bed.

In the Laser window, which is in the lower-right of the main window by default, look for the 'Start From' drop down box, and choose 'Current Position' or 'Absolute Coords'.

In the Laser window, which is in the lower-right of the main window by default, look for the 'Start From' drop down box, and choose 'Absolute Coords'.

# 4.0 OPERATION

If you used 'Current Position' mode, you'll see the 9-dot "Job Origin" control under it activate, and you should see a green square on your design in the same spot indicated by Job Origin control, like this:
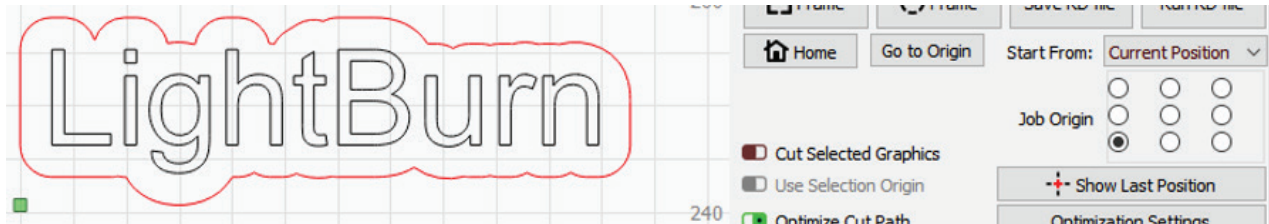


In the above image, the Job Origin is set to the lower-left, and that's where the green origin square is on the design. That green square represents the position of the laser before you start the job, so the design is going to end up above and to the right of wherever the laser is when we press Start.

Put a piece of material in the bed of the laser, and use the arrow keys on the laser controller to move the head of the laser to the lower-left corner of the material

When you think it's lined up, press the button labeled 'Frame'. The head of the laser will move in a rectangle around where the job will go. If you need to adjust anything, do so, then Frame again.

When everything is lined up, close the lid on the laser, then press the Start button.

If anything goes wrong, hit the stop button to abort the job, but if not, let it finish. When it completes, have a look at how things ended up - if the engraving of the name is too deep or too dark, you can increase the speed or reduce the power (or both). If the cut didn't go all the way through, reduce the speed or increase the power (or both).

# 4.0 OPERATION

**Results and Next Steps**

When it's done, hopefully it looks like something like this:



**Tracing an image in LightBurn**

To start, import an image object into LightBurn, select it, then choose Tools > Trace Image from the menu (or press "Alt-T"). You can also select an image, then right-click and choose "Trace Image" from the pop-up menu.
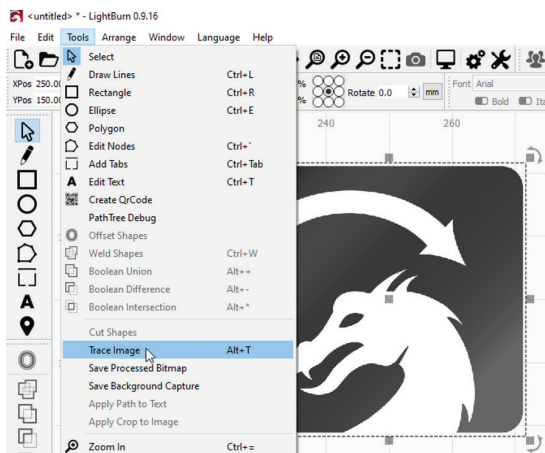


You'll be presented with the "Trace Image" dialog, with your image showing in the window, as shown on the right.
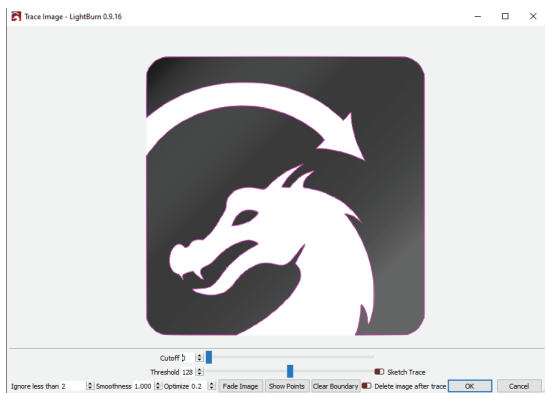


In this image, the purple lines are the vectors that Light-Burn has produced from the image being traced. If you want to be able to see them more clearly, click the "Fade Image" button, and the image will dim. You can also zoom and pan using the same controls as the preview window (mouse wheel to zoom, and click-drag the view with either left or middle mouse).

# 4.0 OPERATION

## Controls

The preview window can be panned and zoomed just like the edit window, using the middle mouse button to pan and the mouse wheel to zoom. Double-clicking the middle mouse button resets the view.

The "Cutoff" slider controls the lower end of the range of values that LightBurn will outline with vectors, and the "Threshold" slider sets the upper end. The default is 0 to 128, which traces around all values in the range of 0 to 128 brightness, excluding lighter values in the range of 129 to 255 brightness.

By adjusting these two controls, it is possible to trace around a narrow range of the image.
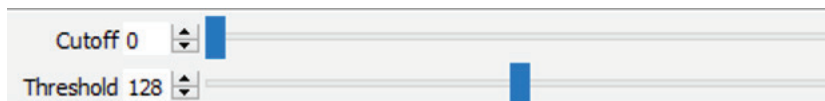


## SELECTION RANGE

By clicking and dragging within the trace window you can specify a portion of the image you would like to trace. Once the area is defined, you can grab and drag a corner of it to adjust, or just single-click to reset it.
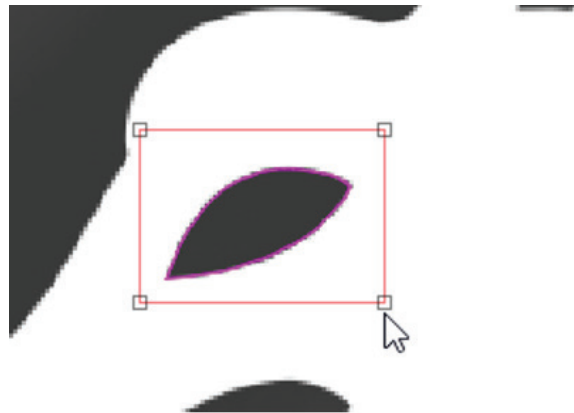


## IGNORE LESS THAN

This setting tells the vectorizer to ignore anything smaller than this many pixels in area. If you are trying to vectorize a noisy image, increasing this may help.

# 4.0 OPERATION

**SMOOTHNESS**

Bitmap images are made of pixels, and pixels are rectangles. Image tracing tries to infer shapes from these arrangements of rectangles, and has to smooth out the results or everything would just look like stairs. Part of the process is trying to recover smooth shapes from jagged lines, and this number controls how aggressive the smoothing is. A value of 1.333 is the maximum, and will make almost everything into curves. A value of 0.0 will produce all straight lines. The difference is shown above on the right.

Notice in the left image, with a "Smoothness" of zero, the area highlighted in red is made of several line segments, whereas the same area in the right image is a continuous curve. The area shown in blue is also sharp in the left image, but with the "Smoothness" value set to maximum, the image at right shows how even sharp corners become smoothed, and this is rarely desired. The default value of 1.0 is a good mix between producing smooth curves while still maintaining sharp corners.

**OPTIMIZE**

After generating lines and curves, the image trace feature will attempt to merge similar lines and curves together to reduce the node count of the result. The "Optimize" parameter controls how aggressive this is. 0 means no merging. The default of 0.2 is a nice balance between accuracy of the result and node count.

**FADE IMAGE**

The "Fade Image" function, dims the image to make it easier to see the resulting vector shapes.

**SHOW POINTS**

The "Show Points" function enables the display of the points (nodes) of the resulting vector trace. Enabling this is useful when you are tuning the Optimize parameter to see the resulting points.

# 4.0 OPERATION

## 4.3 CONTROL PANEL NAVIGATION
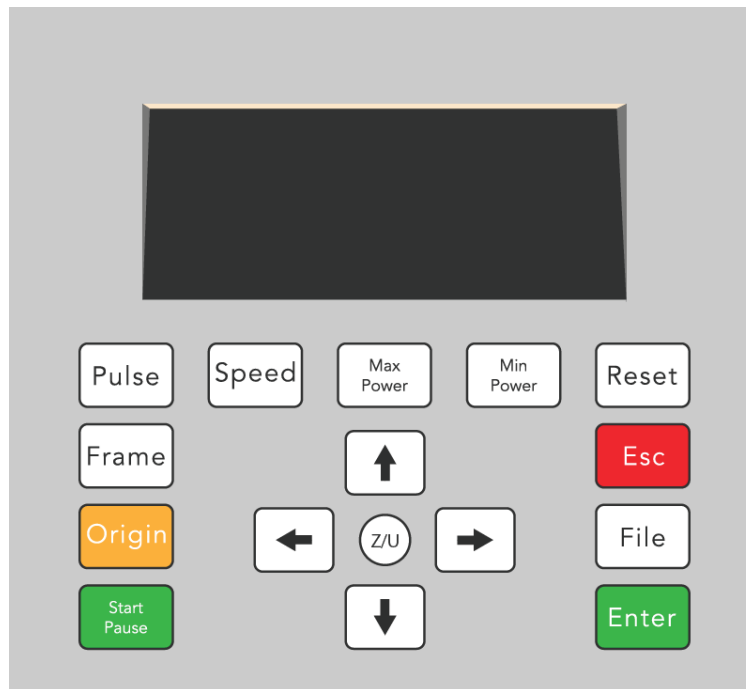


The **Reset button** will reset the laser head back to the last set X,Y coordinates if the laser head has been moved.

The **Pulse button** will temporarily activate the laser and create a short burst of laser power. Holding down the Pulse button and using the arrow keys to navigate the laser head Pulse will allow you to make cuts freehand without a .dxf file.

The **Speed button** allows you to change the speed at which the laser cuts. This is useful because different thicknesses of materials need deeper cuts. Deeper cuts need to have a slower speed. To change the speed at which the laser moves, press the Speed button, then use the Min-Power and Max-Power buttons to adjust the speed accordingly. Press the Enter button to confirm.

The **Min-Power button** is used to set the minimum power that the laser will output. This is useful for when you are working with engraving and need a variety of powers for the Min-Power different depths engraving.

# 4.0 OPERATION

**Max Power**

The **Max-Power button** is used to set the maximum power that the laser will output. This is useful for when you are working with engraving and need a variety of powers for the Max-Power different depths engraving.
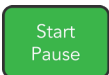
**File**

The **File button** pulls up all the available files and file folders on the laser machine. Use this button to find and select the files that you would like to cut, etch, engrave. To move through these files use the arrow buttons and press Enter to select a file.

**Start Pause**

The **Start-Pause button** is used to start a file or to pause a file during operation. Start Pause

**Origin**

The **Origin button** is used to set particular X and Y coordinates. This can be done by using the arrow buttons to move the laser head to where you want it, and then pressing Origin. This origin position is the exact position from which the laser will start cutting. This can "Origin" be useful if you have an odd sized piece of material from which you would still like to cut  from. The origin can be located anywhere on the bed's surface.

**Frame**

The **Frame button** allows you to see whether or not the piece you want to cut will fit on the amount of material you have. When pressing Frame, the laser head will show you the exact rectangular size of the file. You can do this before starting the file, to see if you have a large enough material surface.

**Esc**

Pressing the **Esc (Escape) button** will allow you to exit, or cancel the current operation. This is useful if you would like to cancel the current cut, engraving job before it starts.

**Enter**

Use the **Enter button** button to select files, variables, folders, etc.

**Z/U**

The **Z/U button** will bring up all the sub menus, such as how to raise and lower the bed. This is needed to properly position the bed depending on the material you are using.
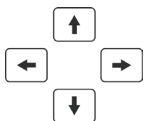
The **Arrow buttons** are used to navigate through the various menus and settings.

# 4.0 OPERATION

## 4.4 PREPARING FILES FOR PRINT

**Laser Cutting**
The first step to preparing a laser cut part is to prepare the CAD file that will create the shape that is to be cut out on the laser.

**Drawing CAD Files for Laser Cutting**
Laser cut CAD files are simple, 2D line drawings that represent the outline of the parts you want to create from stock materials. The final product will have a thickness that is predetermined by the thickness of the stock material you are cutting.

*Note: For materials that need to interlock, it is a good practice to measure the thickness of the material prior to designing as the nominal thickness does not always exactly match the measured thickness.*

Any part that exceeds the size of your cutting bed will need to be broken into sections to cut.

When drawing parts for laser, keep in mind that the kerf (amount of material lost to the cut) is approximately the thickness of a piece of paper. Therefore, any designs that have lines closer together than the kerf will result in a larger hole, rather than two individual cuts.

Another design consideration is whether the parts should immediately fall free, or should remain in the stock wood held by small tabs. A small number of large parts can be removed more conveniently if designed to fall out, however a large number of smaller parts can be problematic if they fall from the sheet during cutting process. Parts that fall out can require access to the trap underneath the cutting table. Alternately, if the parts are designed to remain tabbed into the stock materials, the parts are easy to remove from the laser cutter and are protected by the stock wood during storage and shipping. These tabs are easily created by cutting small gaps along the cut lines in strategic places. The thicker the material, the smaller these tabs need to be.

# 4.0 OPERATION

## 4.5 PREPARING THE MACHINE FOR WORK

**Powering the Machine On**

Before powering on the machine ensure that the protective cover is closed. Verify the safety Emergency Stop is not engaged (if it is, rotate it clockwise and it will extend to the non-engaged position). Flip the main power switch on the side of the machine or turn the key if you are operating an 80 or 100w laser.

**Transferring Files to the Laser Cutter**
- Insert the USB stick into the lower of the two USB ports on the right side of the laser cutter.
- On the control panel of the laser, press the "file" button. The files currently stored in the internal memory in the laser will be displayed in a box with a series of smaller boxes to the right
- Use the white arrow keys on the keypad to navigate over to the smaller boxes and navigate down until you reach the box called "UDisk+"
- Press the "Enter" button on the keypad.
- The display will refresh with an empty window on the left and a new group of boxes on the right. Select "Read UDisk File". The left window will populate with the names of all of the laser files stored in the parent directory of the USB stick.• Use the arrow keys to highlight the file you want to use.
- Use the left and right arrow keys to toggle back to the boxes on the right side of the screen. Navigate down to "Copy to Memory" and highlight it. Press the "Enter" button.• Press the "ESC" button on the interface twice. This will exit the machine from file displaying mode.
- Press the "File" button once more. The file that was copied will now be displayed in the list of files in the box at the left of the display screen. Use the curser to scroll up or down until the file that is needed is highlighted.
- Press "Enter" – the file is now in the active memory of the machine and is ready to run.

*Note: There is a limited number of file names which can be displayed on the screen at one time, so other files in memory may only become visible when the curser keys are used to scroll up or down through the list. The menu option displayed on the screen will cycle from the bottom. It is not necessary to reverse scrolling direction – the list will simply loop. Caution: Do not leave too many files loaded in the machine at one time. It will slow the process of file selection and may completely fill the limited memory space of the on-board computer. To delete files, select them in the left window then navigate in the right boxes to highlight the "Delete" option. Then press "Enter".*

# 5.0 MAINTENANCE

## 5.1 MACHINE CLEANING

To ensure the safety and performance of your Mako Laser, it is important to perform cleaning and maintenance on a regular basis. The Mako Laser Cutter should always be kept in an environment that is between 18°C and 30°C. Please also be mindful of the amount of dust and air pollution in the operating environment as this can affect the various electronic parts of the machine. Power off machine before cleaning.

**General Cleaning Tips**

1. The cutting bed and interior of the machine should always be kept clean and free of scraps or other material. Loose material scraps can interfere with the gantry system or other moving parts in the machine.
2. The top surface of the machine should never be used as a table or working surface. The acrylic machine cover should be free to open and close at all times.
3. Warm water and a sponge can be used to remove any charred markings on the work table. It is not recommend that any cleaning products be used on the machine, especially those that contain flammable substances.
4. The lenses and mirrors on the machine may need to be cleaned periodically. To do this, use a small amount of glass cleaner on white paper towel to gently wipe the surface. **PLEASE NOTE: After using glass cleaner on the machine, you MUST wait at least an hour before operating the machine.** This is because the flammable alcohol substance found in glass cleaner must be fully dried before being exposed to the laser beam.

**Changing Water**

The temperature, quality, and age of the water used will directly affect the lifespan of the laser tube. It is recommended that only distilled, room temperature water is used for the machine. Water that has sat too long, is too warm, or is un-distilled will negatively impact the quality, results and lifespan of the Mako Laser Cutter.

The water cooling system is built in for this machine. We suggest changing the water and cleaning the water tank every six months. Begin by removing the water tank, to do this you will have to unscrew the two bolts beside the water tank, and then pull the water tank out. Here, you'll find the water outlet, unscrew the cap of the outlet. Next, empty out the old water and rinse the tank with fresh water to clean it. With the old water removed, you can now fasten the cap of the water outlet, place the water tank back, and fill up the water tank with new distilled water.

# 5.0 MAINTENANCE

**Cleaning The Lens and Mirrors**

If you find your laser is cutting poorly the lenses and mirrors may need to be cleaned. If the mirrors or lenses become smudge or dirty the laser beam will have a difficult time transmitting through the glass. Follow the steps below to properly clean your Mako Laser Cutter's lenses and mirrors:

1. Soak a cotton swab (for lenses) or tissue (for mirrors) in Isopropyl (rubbing alcohol).
2. Rub the cotton swab or tissue on lens until all the debris and dust is gone.
3. You may need to do this several times.
4. Make sure all debris and dust is gone and the lenses and mirrors is fully dry beforeusing the laser cutter again.
5. Any debris or dust left on the lens surface will be baked on if not cleaned off before using the laser.

**WARNING: After using glass cleaner on the machine, you MUST wait at least one hour or more before operating the machine.** This is because the flammable alcohol substance found in glass cleaner must be fully dried before being exposed to the laser beam.

**Gantry Maintenance**

After extended use of the laser it is not uncommon for the gantry system to accumulate dust and debris. It is suggest that you clean the gantry system in your machine once to twice a month. Ensuring it is clean will allow the gantry system to move freely, resulting in higher precision and performance. To do this, turn off the machine and use a dry cloth to remove any excess dust or debris on the rails.

# 5.0 MAINTENANCE

## Guide Rails Cleaning

The guide rails, which are covered by a metal protective cover, will occasionally need to be cleaned and lubricated. To clean the guide rails on the Gantry system, wipe them down with paper towel (no solvents) and lubricate them with a few drops of shredder performance oil. Move the laser head back and forth several times to ensure the oil is evenly distributed.



Guide Rails
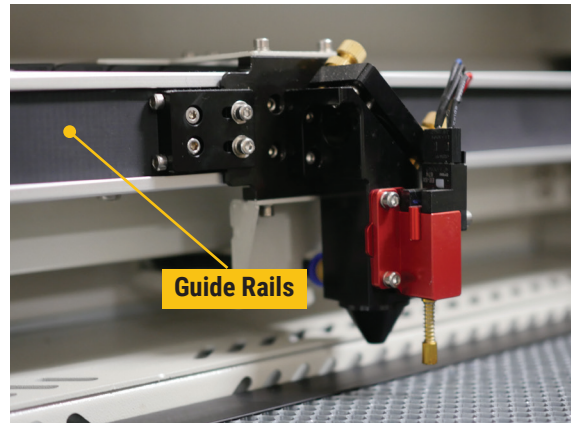
## 5.2 MAINTENANCE SCHEDULE

Below is our recommended maintenance schedule for each part to help ensure the safety, performance, and longevity of your Mako Laser Cutter.

| | DAILY | WEEKLY | MONTHLY | ANNUALLY |
|---|---|---|---|---|
| **MIRROR 1** | | Check/Clean | | |
| **MIRROR 2** | | Check/Clean | | |
| **MIRROR 3** | Check/Clean | | | |
| **LENS** | Check/Clean | | | |
| **TABLE** | As Needed | | | |
| **WATER COOLING UNIT** | | | Check/Replace Water | |
| **ENTIRE WORKING AREA** | | As Needed | | |
| **BELTS** | | | | As Needed |
| **TUBE** | | | As Needed | |
| **LINEAR RAILS** | | | As Needed | |
| **AIR NOZZLE** | | As Needed | | |
| **INTERNAL MEMORY** | | | | As Needed |

# 6.0 ADDITIONAL INFO

## 6.1 TIPS FOR TROUBLESHOOTING

**If the machine does not turn on:**
•    Check to see that the machine and all the components are connected .

**If the machine loses cutting power:**
•    Calibrate the laser tube as per the instructions in section 4.2.
•    Turn off the machine, unplug it and check the CO2 laser tube for defects.

**If the machine does not cut all the way through the material after the first pass:**
•    Do not move material at all or change the origin location. Restart the cut job immediately after the first one is finished.
•    Increase the power on the next cut file (keep record for commonly used materials). Note: When the laser cuts completely through a material, smoke can usually be seen coming through the bottom of the bed. ISmoke will be visible through the cracks of the fresh cut material when looking through the cutting bed's holes. If no smoke can be seen coming throught he  bottom, a few more rounds of cutting may be necessary.

**Mako Laser Cutter Tricks**
•    If you are not sure if the cut file will fit on the material you have on the bed, press "frame" button and it will outline a rectangular area representing how large the cut will be.
•    Make sure to always use the "Z auto level" before each cut to ensure that laser will cut properly.
•    When using the keypad to select files, the ENTER button does not need to be pushed, the item you wish to select only needs to be highlighted.

# 6.0 ADDITIONAL INFO

**6.2 TRAINING COMPLETION FORM**

**Employee/Trainee:**

**Trainer:**

**Date of Training:**

The above mentioned employee/trainee received instruction on the operation of the Mako Laser Cutter. The following topics were covered turning the training:

- Machine Overview
- General Safety
- Laser Safety Precautions
- Operational Safety
- Approved/Not Approved Materials
- Powering ON/OFF the laser machine
- Debugging the Light Path
- Control System Navigation
- Preparing Files for Print
- Preparing the Machine for Work
- Machine Cleaning
- Maintenance Schedule
- Tips for Troubleshooting

**Signature of Trainer**                          **Signature of Trainee**

# 6.0 ADDITIONAL INFO

## 6.3 TECHNICAL SUPPORT CONTACT

If you are having issues operating your laser machine and have gone through the Tips for Troubleshooting section in this manual please contact our Technical Support line.

**InkSmith Technical Support**

Phone: 1-844-465-7684 ext.4
E-mail: tech@inksmith.ca
www.inksmith.ca

**Technical Support Hours:**

Monday-Friday
9:00am-5:00pm EST

*NOTE:* For complex problems please provide photograph or video evidence via email (tech@inksmith.ca) in order to help us better diagnose your issue.

# MAKO
CO2 LASER

## QUESTIONS?

tech@inksmith.ca
1-844-465-7684 ext.4

**www.inksmith.ca**

INKSMITH