
Laser Guide

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About this guide

Welcome to the laser guide! This document contains contains an overview of everything you need to get started with the fantastic art of laser cutting and engraving. In the following pages you will find instructions on how to use a subset of the features our laser and the associated software packages have to offer.

Please take care when operating the laser. Not only is it a very expensive piece of machinery, but it is difficult to service. If you follow the instructions within, everybody will be able to enjoy the laser, and downtime will be minimal.

The laser is also a potentially dangerous machine as it essentially ignites tiny controlled fires indoors. Just as you would not leave a fire unattended, do not leave this laser unattended. In addition, please read all of the notes, as there are several operating details that can help reduce the risk of mishap.

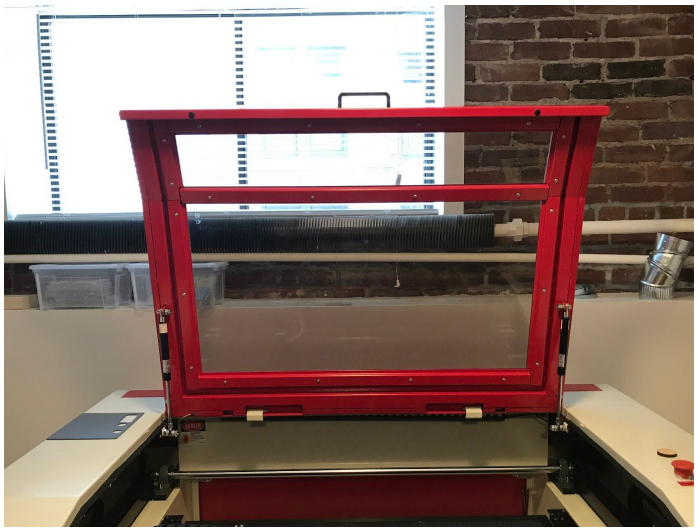
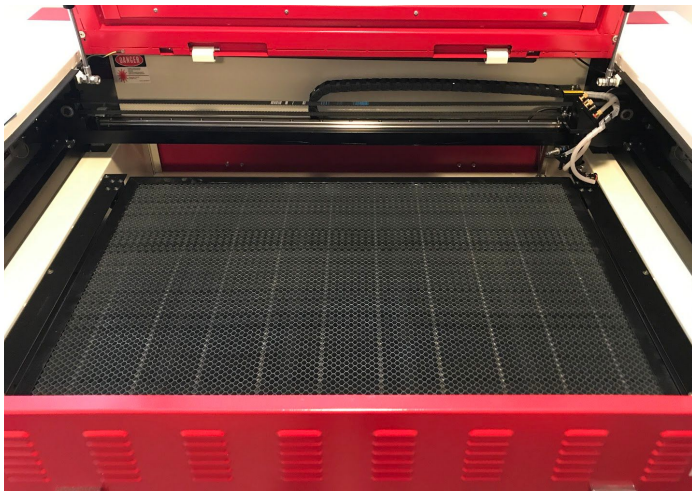
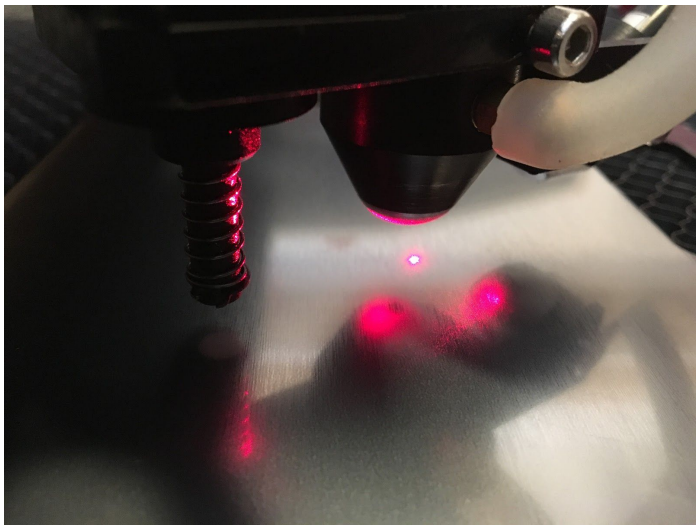
Finally, this is a living document, so if you are experimenting with new techniques or software packages, and discover something that works well, please let us know. We would love to share your discovery with the community!

Enjoy!

Laser Operation

Glossary

Operator pad Used to controls movement of the laser head and worktable. Selects, modifies, and executes jobs.	
Laser & power indicator lights The power indicator will illuminate when the key is in the ON position. The laser light will flash whenever the laser fires.	

Main lid MUST be closed in order to complete a job. If it is open, the laser head will move, but the laser will not fire.	
Work table A permeable surface that allows a powerful vacuum underneath to suck away debris and fumes while materials are cut and engraved.	
Laser head An extremely sensitive **and fragile** lens that focuses the laser to enable precision cutting and engraving.	

Chiller Ensures that water-cooled laser does not overheat during operation by keeping the water as cold as possible.	
On/Off Controls The “Emergency Stop” button can be hit to immediately power down the machine. The On/Off switch must be engaged in the “ON” position for the laser to function	

Materials

Acceptable Materials

Natural Materials ● Rock ● Brick ● Stone ● Marble ● Granite ● Glass ● Etc...	Synthetic Polymers ● Acrylic ● Styrofoam ● Styrene ● ABS (Warning - Cutting leaves bad smell) ● Plexiglass (engrave only - produces noxious gas) ● Polycarbonate (engrave only - produces noxious gas) ● Etc…
Organic Materials ● Wood ● Leather ● Plants ● Fruit ● Vegetables ● Sea shells ● Etc..	Cloths ● Jeans ● Cotton ● Silk ● Nylon ● Dacron ● Etc..

Metals - NOTE This laser is not intended to cut or mark metal.

- Stainless Steel with flat side (engraving only)
- Ferrous materials (engraving only)

Common Settings for Engraving and Cutting

It is difficult to know what settings we should use to engrave every material due to the expected / acceptable quality and material properties. These settings should be used as guidelines. Be sure to test materials before beginning a cut or engraving.

Material	Mode	% Pwr	Speed (mm/s)	Scan Gap (mm)	Thickness	Passes	Notes
Glass	Engrave	12	350	.055	any	1	Use lowest power setting with thin scan gap. Keep glass cold with cold air, wet paper, or other coatings.
Wood	Engrave	14	350	.085	any	1	May experiment with masking tape to prevent sap from becoming hazy.
Basswood	Cut	50	15	NA	1/8 inch	1	Use lowest power with highest speed to completely cut material.
Balsa Wood	Cut	50	45	NA	1/8 inch	1	Use lowest power with highest speed to completely cut material.
Birch Plate	Cut	52	12	NA	1/8 inchh	1	Use lowest power with highest speed to completely cut material.
Birch Plywood	Cut	70	10	NA	3/16 inch	1	Use lowest power with highest speed to completely cut material.
Plywood-RC Aircraft	Cut	50	45	NA	3/16 inch	1	Quality of cut depends on wood density, glue content and humidity.
Acrylic	Cut	55	12	NA	1/4 inch	1+	Don’t move too slow or acrylic will cause surrounding areas to sag or catch on fire
Acrylic	Engrave	55	300	.065	any	1	Hard/brittle acrylic will engrave better.
Acrylic - Mirrored	Cut	40	15	NA	1/8 inch	2	Use first pass to get nearly through mirror backing. Use second pass to finish cut.
Granite	Engrave	85	150	.085	any	1	Use high powers to engrave at slowest speeds. May rub high contrast paints into the cracks, then wipe off … to make the image POP into view.
Romark	Engrave	12	325	.100	any	1	Use scan gap thick enough to prevent plastic from rolling into globs. Use only enough air to get into the desired color plastic.
Plexi-Glass	Cut	50	12	NA	Varies (⅛ inch)	1	Cut fast and hard. Make sure to get fumes out of work area fast. Do not breathe the fumes.
Styrofoam - Closed Cell	Cut	12	45	NA	Varies	1	Use long focal length lens. Use lots of air for cooling the Styrofoam. Cut in thin layers, glue layers together.
Styrofoam -	Cut	12	25	NA	Varies	1	Use long focal length lens. Use

Open Cell (squishy)							lots of air assist to keep cool.
Brick	Cut	70	35	NA	any	1	Use minimal air. Engrave with target slightly out of focus. Needs to be “engravable brick” to turn the sand into glass.
Mirror (Back)	Engrave	45	325	.085	any	1	Laser power effects the paint and heat transfers to copper /silver film layers. The laser continues to scar the glass.
Leather	Engrave	45	325	.085	any	1	Set Scan-Gap for resolution that you need for your design projects.
Leather	Cut	70	12	NA	1/16 inch	1	Use lowest power with highest speeds to completely cut through the material. Higher speeds may be obtained by also increasing power
Anodized Aluminum	Engrave	25	325	.065	any	1	Set Scan-Gap for resolution that you need for your design projects. Aluminum can take a high resolution. Power settings vary for color.
Powder Coated Metal	Engrave	25	325	.085	any	1	Set Scan-Gap for resolution that you need for your design projects. Don’t try to engrave all the way thru. Exposed metal may tarnish or rust.
Cermark	Engrave	50	300	.070	any	1+	Too high of power will damage the Cermark. Too low power will not heat Cermark to stick to the material. The glass/metal/ceramic must be warm.

Startup

The Laser machine is expected to be powered off. The key switch is in the “OFF” position and the Emergency Stop button is pressed down.

1. Open the main lid.
    a. Check if there is any damage from a previous user.
    b. Make sure that there isn't a cat or other animal that found a temporary place to sleep.
    c. Remove all materials on worktable. Check the position of the table, laser head, and materials. Ensure that there are no obstructions that will damage the laser head. The laser head may automatically traverse the table upon startup, and a head collision will damage the machine.

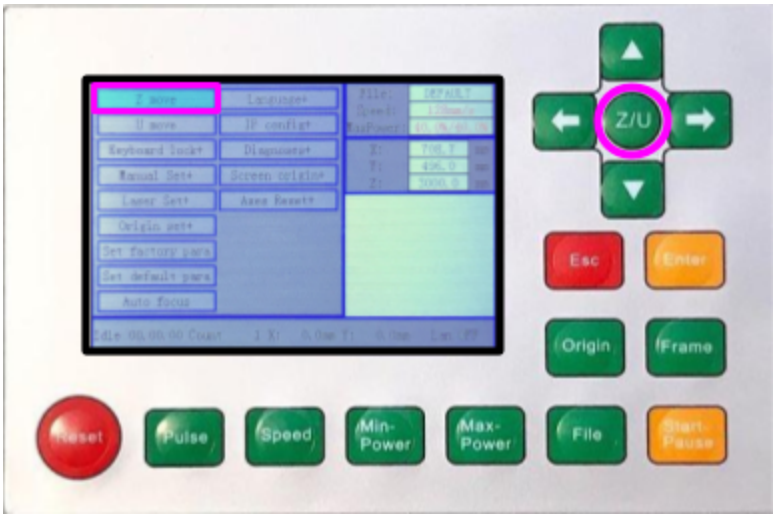
2. Release the Emergency Stop Button by twisting the button. The button should pop up. The Emergency Stop Button must be in the “UP” position in order to power on the machine.

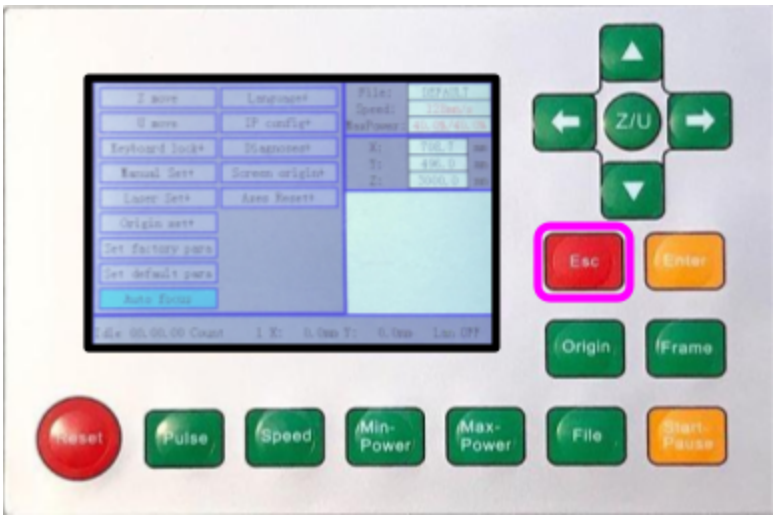
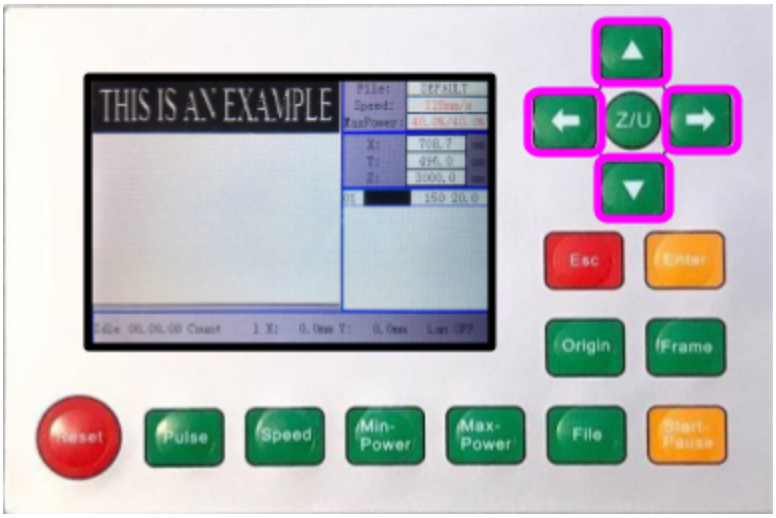
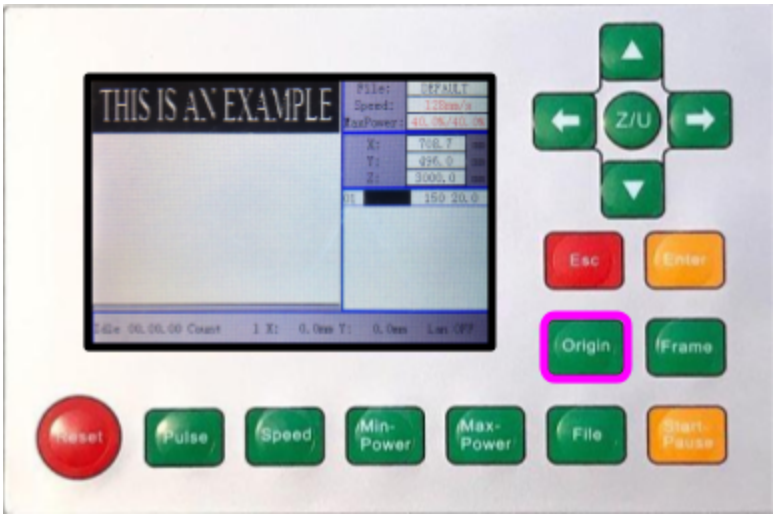
3. Turn the key to the “ON” position to power on the laser
    a. Note: The laser machine will take several seconds to completely power on. There are normal sounds, alarms, and boot screens that occur.

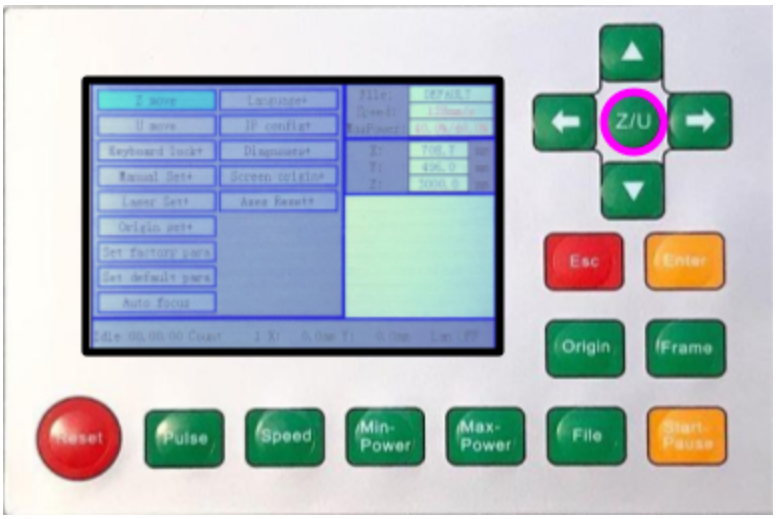
4. You are now ready to start a job

If the operator pad takes more than 15 seconds to completely turn on, then it might have a communications problem with the main motion controller.

Performing a Job

Follow the correct startup procedure to turn on the laser Getting Started	
Press the Z/U button. Make sure Z move is highlighted on the screen	
Press the RIGHT ARROW button to move the worktable down. Lower the worktable to provide ample clearance between laser head and all materials on worktable	

Press ESC to return to the home screen.	
Follow the steps in [Downloading a file]() to download your job to the laser machine.	
Aligning Ensure that there are no objects that might block or hit the laser head.	
Using the ARROW KEYS, move the laser head until it is above your material.	
Press the ORIGIN button to set the starting point for your job.	

Press the FRAME button. The laser will rapidly trace the perimeter of your job. Ensure the frame is entirely above your material, otherwise repeat steps 5 and 6 until a you are satisfied with the location of your job.	
Focusing	
To auto focus, press Z/U to open the menu.	
Select the Auto focus option and press ENTER. The worktable will rise to meet your material. When operation completes, the menu will close.	

Go!	
Press START-PAUSE to begin the job	

Things that can go wrong

Head crash

A head crash occurs when the laser head collides with anything in its path. This may cause severe damage to the laser lens, autofocus, mirrors, and motors. The laser is not smart, and will continue its trajectory regardless of obstacles.

Preventative measures

1. Do not put material on the worktable until the startup sequence is complete
2. Lower the worktable when traversing the bay
3. Use the FRAME button before the AUTOFOCUS button. The anchor point for the job may not be attached to the origin
4. Make sure materials are uniform in height.

If it happens

1. Hit the EMERGENCY STOP button as soon as possible, ideally before the collision occurs. Always be vigilant when the laser head is in motion
2. Turn the key to the OFF position. DO NOT open the lid or attempt to move materials. Seek help

Fire

If improper power and speed settings or materials are used, the laser may ignite a fire. The air system is intended to prevent small flames associated with normal operation, but you may need to manually extinguish larger flames and fires

Preventative measures

1. Only use pre-approved materials from reliable sources.
2. Check the common settings for engraving and cutting section to determine proper operation settings.
3. If you choose to experiment with your own, change settings in small increments
4. Make sure that flammable materials (sap, stickers, paper backing) are removed before cutting and engraving
5. Ensure that all fire extinguishing materials are on hand whenever the laser is in operation

Extinguishing hierarchy

0. Hit the EMERGENCY STOP button. If fire extinguishes, keep the lid closed to allow smoke to vent
1. Blow / fan out
2. Smother with fire cloth
3. Spray water squirt bottle
4. Spray non-corrosive fire retardant

⚠ Using a fire extinguisher is a last resort as it will destroy the machine. Only use this if you are alone in the building and the whole place is burning down.

Breaking the worktable limit

If a job is started too close to the edge of the worktable, the machine may attempt to process it off of the worktable, causing the laser to cut itself.

Prevention

1. Use the FRAME button before processing any job. Always check your frame and origin one more time than you think you need to!
2. Ensure that the job position is set to ANCHOR in RDWorks. See downloading files to the laser for more information

If it happens

0. Hit the EMERGENCY STOP button
1. Report any damage to a shop attendant

Fumes

Many materials emit fumes during cutting and engraving. The laser has a high powered exhaust system that contains smoke and gaseous fumes. Large and/or long jobs may overload the filtration system and leak fumes into the room.

Prevention

1. Ensure the exhaust system is running whenever the laser is in operation. If it appears to be disabled, make sure the socket switch is engaged.
2. Only cut approved materials. See the acceptable acceptable materials list for more information.
3. If you are cutting a material that may emit fumes, wait 30 seconds before opening the door.

If fumes fill the room

1. Stop all jobs using the START / PAUSE button. DO NOT it the EMERGENCY STOP button as the ventilation system will also shut down
2. Leave the room and close the door behind you
3. Immediately report fumes to a shop attendant

Shutdown

1. Turn the key switch to “OFF” position **or** press the “Emergency Stop” button
2. Ensure that the key switch and “Emergency Stop” button are both in the “OFF” and “Down” positions, respectively, before leaving the laser station

- Do not leave the machine unattended while the laser is active.
- Do not turn the power off and on quickly. The rush of electrical current can damage the power supplies.

Troubleshooting

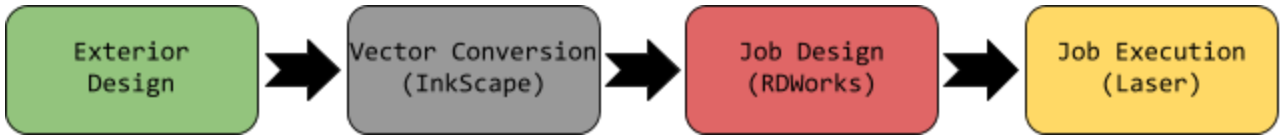
- If laser head traces job pattern but does not fire, ensure that the laser power switch is engaged and the lid is fully closed

- If you find that a new project isn't working correctly, then try to run a project that you have confidence as working correctly.

- Do not immediately blame the laser machine. The laser machine could malfunction for the following reasons:
    - The laser machine has a bad communication with the computer,
    - The AC voltage is wrong or fluctuating,
    - The laser machine has encountered a power spike.
    - The laser machine was recently moved and the frame is slightly twisted,
    - The laser beam alignment is incorrect,
    - The lenses or mirrors are dirty (carbon dust, sap, acrylic fumes, glass dust, oil, water vapor)
    - The laser power is diminished because the mirrors are oxidized.

Software

Workflow Overview



The workflow is broken up into several stages

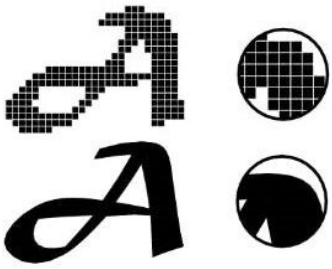
1. Exterior design - You can use any tool to design a project. Your design can start as a png, jpg,gif etc. Really anything that can be imported into Inkscape
   a. Programs : any
   b. Input formats : any
   c. Output formats : many

2. Vector conversion - We use Inkscape because it is a free, open source program that can export to Desktop Cutting Plotter format (.dxf). Adobe Illustrator, Inkscape's expensive sibling, and the Illustrator file format (.ai), works as well.
   a. Programs : Inkscape, Adobe Illustrator
   b. Input formats : many
   c. Output format : dxf, (.ai)
      - (RDWorks can accept many file formats but we find dxf works the best. Look through the RDWorks import drop down menu of compatible file types if you wish to experiment. Note that some file types are bitmap types, and will not support cutting etching etc.

3. Job design - RDWorks is the software that converts our vectors into cuts and engravings. It communicates directly with the laser, and supplies settings to the machine. RDWorks has a minimal design interface for touch ups and simple jobs like text or polygons.
   a. Program : RDWorks
   b. Input format : dxf, (.ai)
   c. Output format : rld

Inkscape

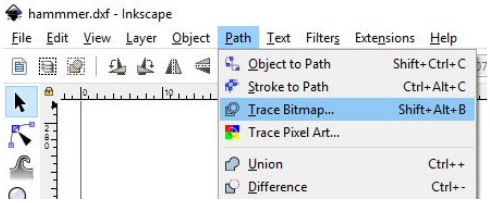
Rasterized/Bitmapped Images vs Vector Art

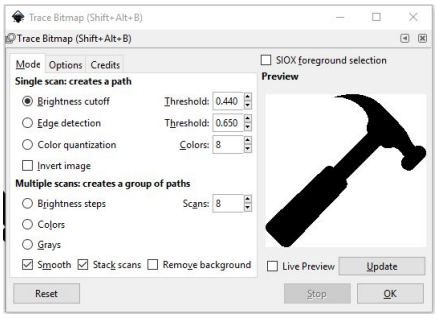


There are two types of images that we deal with in the laser workflow. The first image is created by organizing pixels in rows and columns called “rasters”. These images are great for use on websites, but start to lose quality when stretched or shrunk. Furthermore, RDWorks and the Laser machine need to read images as a series of lines. That’s where Vector Art comes in. Vector Art is a way of interpreting images as lines and polygons. It is a great way to ensure high-quality images at any size.

Creating Vector Art from an Image

1. Download an image (or export it from your illustration software), as a PNG, GIF, JPEG, or other bitmapped format.
2. Open Inkscape and select File>Import to bring your image into the application.
3. Click on your image and select Path>Trace Bitmap.
4. Adjust the settings under “single scan” in the dialogue box that appears. For colorless images, selecting the “brightness cutoff” with a ~.5 threshold should be sufficient. If parts of the image seem to be getting excluded in the preview, increase the threshold.
5. Press OK, and then close out the dialogue box by clicking the X at the top.
6. You now have two images, the vector graphic and the original raster. The vector drawing is on top, so click and drag to move it away from the raster image. If it is not obvious which image is which, zoom in on an edge. The vector art will be clear, while the bitmapped image seems fuzzy in comparison. Delete the original bitmapped image.





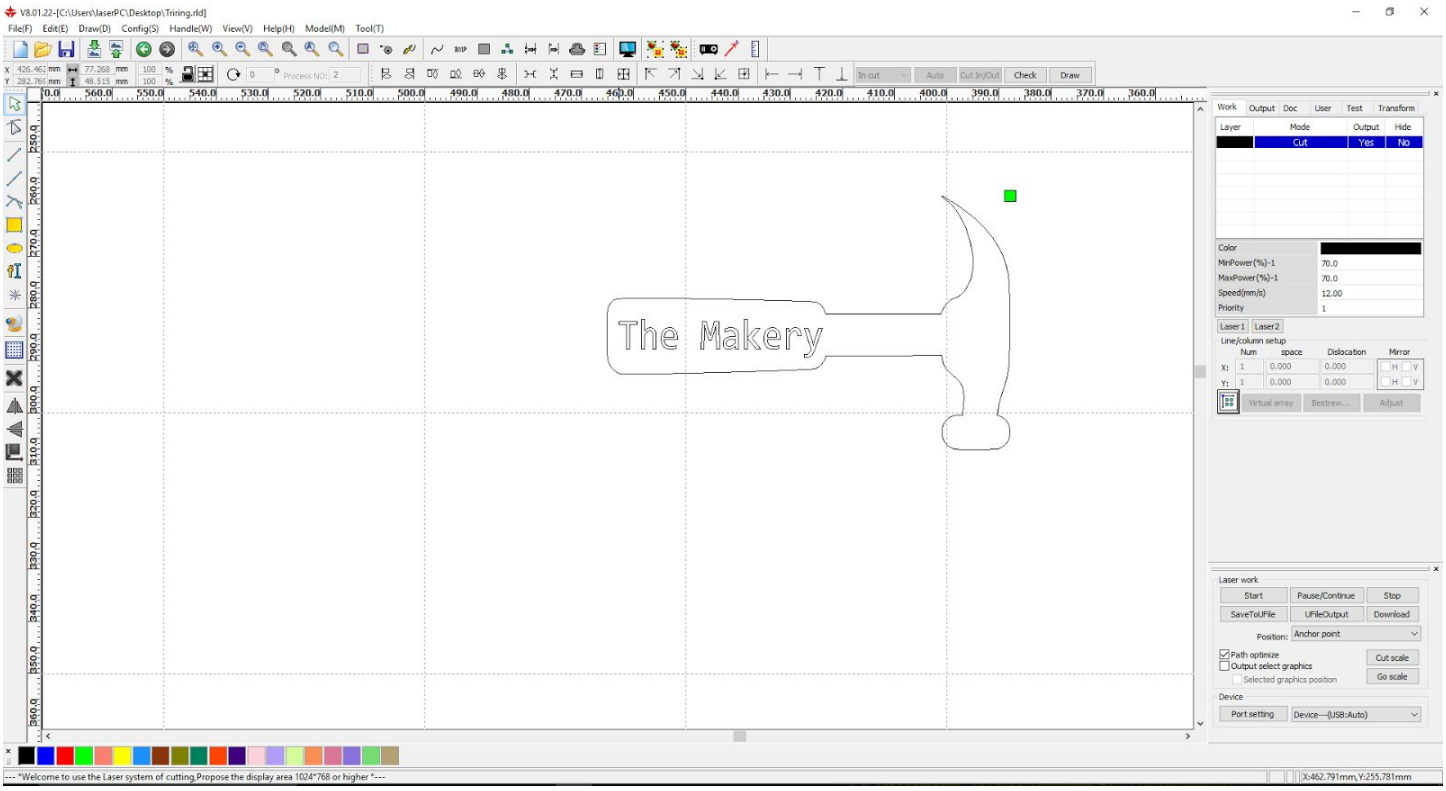
Exporting to RDWorks

In order for RDWorks to see your beautiful, hi-res vector graphic as such, you need to save it in the proper format. Choose File>Save As, and select “Desktop Cutting Plotter (.dxf)” from the file type dropdown menu.

RDWorks

Laser Control

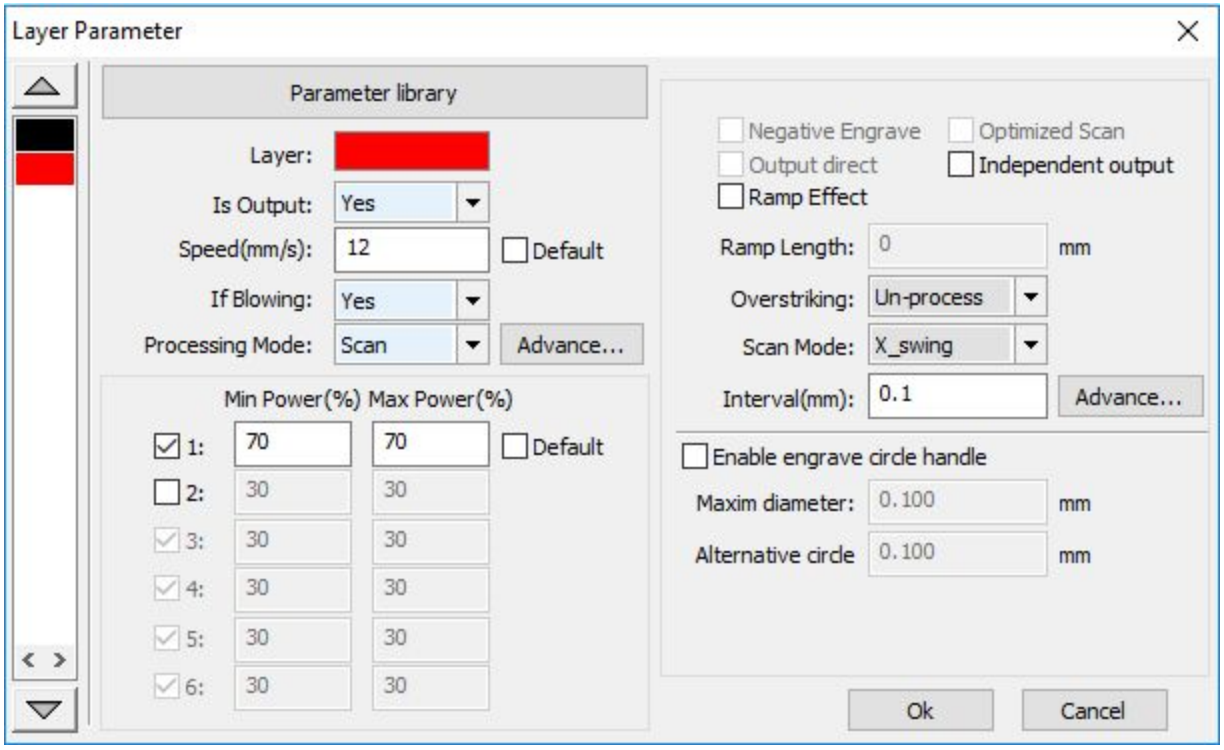
Layers



RDWorks uses color coded layers to structure a laser job. To add a line or object to a layer, highlight it, and click on one of the colors at the bottom right. You will notice that the laser control panel in the upper right will update. Each layers has many parameters that you will need to adjust.

Layer Parameters

Once you have a design with layers, it is time to tell the laser how to process each layer. Click on the laser control panel in the upper right to open the following menu



General

The general settings we will adjust are:

- Processing mode
  - SCAN - The laser head will pass back and forth between the lines as if it were a printer. This mode is used for engraving. If you wish to set a layer to scan, all shapes must enclose area, and the scan function will etch the interior area. It is good practice to check the image on the laser control pad to verify the processing mode was interpreted as intended. See downloading files to machine for details
  - CUT - The laser will trace the lines using a constant beam
- Min/max power
  - Power determines how much energy the laser transfers to your material. Power values are given in percentages.
  - Min and Max power should be set to the same values
  - Set the power according to the material you are cutting, and the processing mode you selected. See common settings for engraving and cutting for recommended settings.
  - Remember that power values are specific to this laser and its wattage. If you are researching power settings, be sure to reference machine make and wattage.

- Speed
  - Speed is measured in mm/s (millimeters per second), and it determines how fast the laser head passes over your material. In general, engraving is done at high speed (100 - 350) and cutting is done at low speeds (10 - 100)

Scan Settings

Interval

- The interval is the distance between each pass of the laser across the engraving area. Intervals are generally between .1 mm and .05, although you may use larger intervals if you wish to create a lattice effect

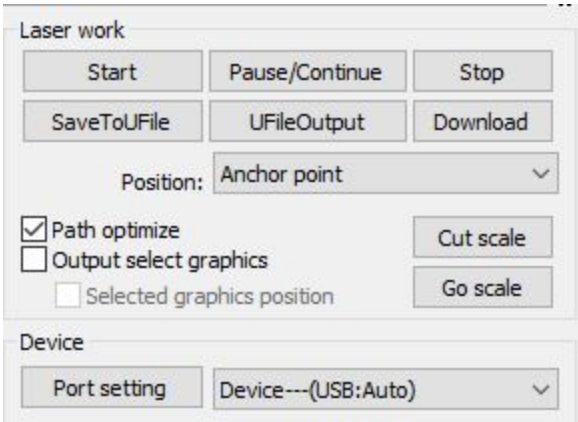
Previewing Your Job

If you select the preview icon from the top palette, a job preview will open in a new window. From this screen you can view total job time, light time and cut parameters, and you can simulate the job in real time or at an accelerated pace.

TIPS: When preparing for a complex project, this feature is useful for planning. If you are cutting on surfaces that will drop out from your material, you may want to first simulate the job to ensure that cuts that will move your material are executed in the proper order.

Downloading Files to Laser Machine

Once you are satisfied with your design, and all layers are properly configured, press the download button on the right hand panel near the bottom of the screen.



IMPORTANT: Ensure that the position is set to anchor point. This ensures that the laser executes the job at the user-set origin. We prefer to operate the laser in this way as it is less error prone

IMPORTANT: Do not operate the laser using the START button in RDWorks. We prefer that the laser is operated from the control panel as it is less prone to user error

Design

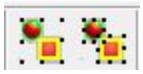
Built-in Design Tools

RDWorks has a limited design palette so we recommend using Inkscape if your project requires a more robust set of design tools. RDWorks is useful for adding text, and basic shapes to your project.

Text

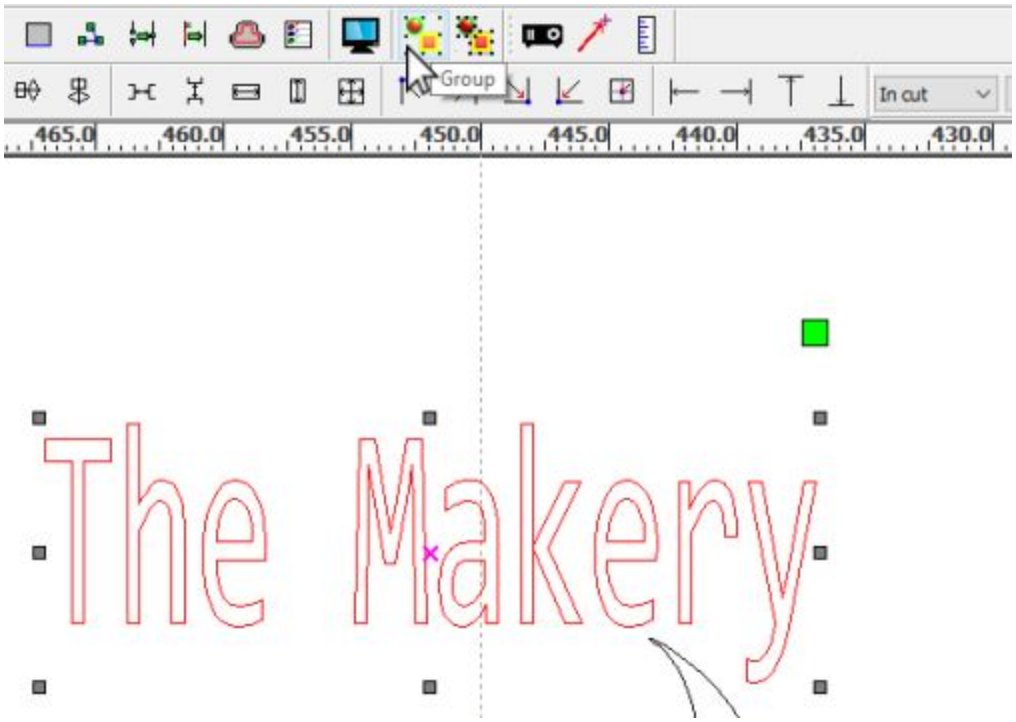
Use the “fI” button on the left palette to add text. Select a TrueType font and set parameters.

Grouping



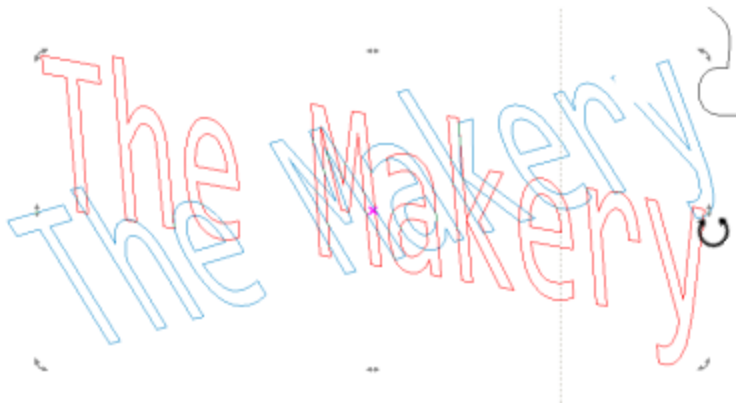
You may wish to group and ungroup objects to edit individual paths. As an example, text is created as a grouped object. If you wish to change an individual letter, you will need to ungroup the object

- To ungroup an object, highlight it and select ungroup from the top palette
- To group an object, highlight or select all desired components (ctrl+shift+click) and click the group button from the top palette.



Moving, resizing, rotating, slanting

- Move: Click and drag the pink “X” in the center of the object highlight
- Resize: click and drag one of the 8 grey boxes on the periphery of the the object highlight
- Rotate & slant: Double click on the object. Use corner arrows to rotate, and edge arrows to slant. NOTE: When text objects are double clicked, the text preferences pane opens. To rotate or slant text, you must first ungroup and regroup the text object to remove its custom properties



Importing Designs

For complex designs, you will most likely want to import files into RDWorks. To do so, choose file>import and select a .dxf file. Feel free to browse the drop down menu and import other supported files types such as .ai (Adobe Illustrator) or .plt (AutoCAD).

REMEMBER: If you wish to cut or engrave, you must import vector based design files