MUSE
MOPA
USER MANUAL

Full Spectrum
LASER

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Fire Warning

Fire Warning

Laser cutting and engraving systems can present a significant fire hazard due to the extremely high temperatures generated when the laser beam is in use.

Some material are extremely flammable, catching fire quite easily and damaging the machine and its surroundings.

Vector Cutting has been proven to have the most potential for igniting material, however fires can be started when performing Raster Engraving if negligent.

Please read the following warnings and recommendations before using your machine. These instructions should be followed closely at all times.

- **Always keep a properly maintained and inspected 5lbs. or larger fire extinguisher on hand.** We recommend a Halogen or multipurpose dry chemical fire extinguisher.
- **Always keep the area around the machine clean and free of clutter.**
- **Never store any flammable materials in or near the machine.**
- **Never stack materials near or in your work area.**
- **Never operate your machine unattended.**

Materials

Below is a small list of materials usable with the MOPA Galvo.

Material	Raster	Vector
Aluminum	✓	✓
Nickel	✓	✓
Copper	✓	✓
Titanum	✓	✓
Leather	✓	✓
Rubber	✓	✓
Stone	✓	✓

Introduction

Thank you for purchasing your new Muse Master Oscillator Power Amplifier(MOPA) Galvo. Our high quality products will provide years of service simply by following proper usage and upkeep. With proper usage and upkeep your machine will be a key part in any design work.

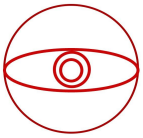
This user manual will guide you through the safety guidelines and operation of your machine. We recommend that you familiarize yourself with this manual before using your laser engraver. Remember to be safe and have fun!

For more information and product selection, please visit www.fslaser.com

Safety Symbols & Meanings

This icon warns of potential fire hazards and fire risks.

Warning about power surges and electrical risks.



This icon indicates potential eye damage.

Warning about glass or cutting hazards.

This icon warns of potential risks of chemical inhalation.

Important information to keep in mind when running you laser.

Section I. Safety

Setup Precautions

Follow all safety protocols and procedures before operating any machinery. It is the responsibility of the operator to ensure all safety precautions are correctly followed, and that the machine is properly assembled and in working order.

- **Always inspect your machine for damage or breakage before each use.**
- **Do not operate machinery that is damaged or defective in any way.**
- **Always have a clean, level, and open work space to unbox and place your laser system.**
- **Never modify, disassemble, or in any way alter the construction of the laser and never start up a system that has been modified or disassembled.**
- **Keep your laser system clean.**
- **Do not disassemble the machine or remove any of its protective covers.**
- **Always have a first-aid kit designed for the initial treatment of burns and smoke inhalation.**
- **Never operate the machine with any of the panels removed.**
- **Never place hands or fingers into moving parts such as the Z-stage.**

Safety During Operation

The output of the fiber engraving laser is fully contained in a Class 3 enclosure during normal operation. However, the output beam is accessible to the operator during normal operation, giving the total system an overall rating of Class 3B. Class 3 lasers have minimal safety concerns when used properly and handled with care. The laser system is designated as Class 3B due to the fact that safety glasses must be used when observing the laser engraving process. We recommend following these Safety Guidelines:

- **Keep your workspace clean.**
- **Never engrave or cut any unknown material.**
- **Never leave the laser system unattended during operation.**

Section I. Safety

Electrical Safety

The power supply is capable of releasing a current up to 9 Amps. This power is sent to the discharge terminals on the machine itself. In order to prevent access to bare wiring your laser shipped with silicone terminal covers. Please notify Full Spectrum Laser support and immediately cease operations if the covers ever slip and expose bare wire.

Note: When performing any replacement procedures, make sure the machine is off for at least an hour.

- **Do not open any of the machine's access panels while the unit is plugged in.**
- **Never make or break any electrical connections to the system while the unit is turned on.**
- **Never access any electrical areas with hands or tools unless the unit is disconnected from the power for at least one hour.**
- **Never replace the installed amp fuse with one of a higher rating.**
- **POWER ON/OFF is controlled by the switch at the back of the machine, with (-) being on and (o) being off.**
- **In case of a blown fuse always contact Technical Support before replacing anything.**

Compliance Statement:

The standard for laser safety is the American Standard for the Safe Use of Lasers, Z136.12000. Developed by the American National Standards Institute (ANSI) it is the basis for many federal regulations and Occupational Safety and Health Administration (OSHA) guidelines for laser and laser system manufacturers. It contains detailed information concerning the proper installation and use of laser systems. While the ANSI standard is not a law, its recommendations, including warning signage, training, and the designation of a laser safety officer, may be mandatory under local regulations. It is the operator's responsibility to ensure that the installation and operation of the Full Spectrum Desktop Laser System are performed following applicable laws. Copies of ANSI Standard Z136.12000 are available from:

LASER INSTITUTE OF AMERICA 12424 RESEARCH PARKWAY, SUITE 125 ORLANDO, FL 32826 (407) 3801553.

Section I. Safety

The following diagrams will help you locate all of the machines components.

Laser head Assembly

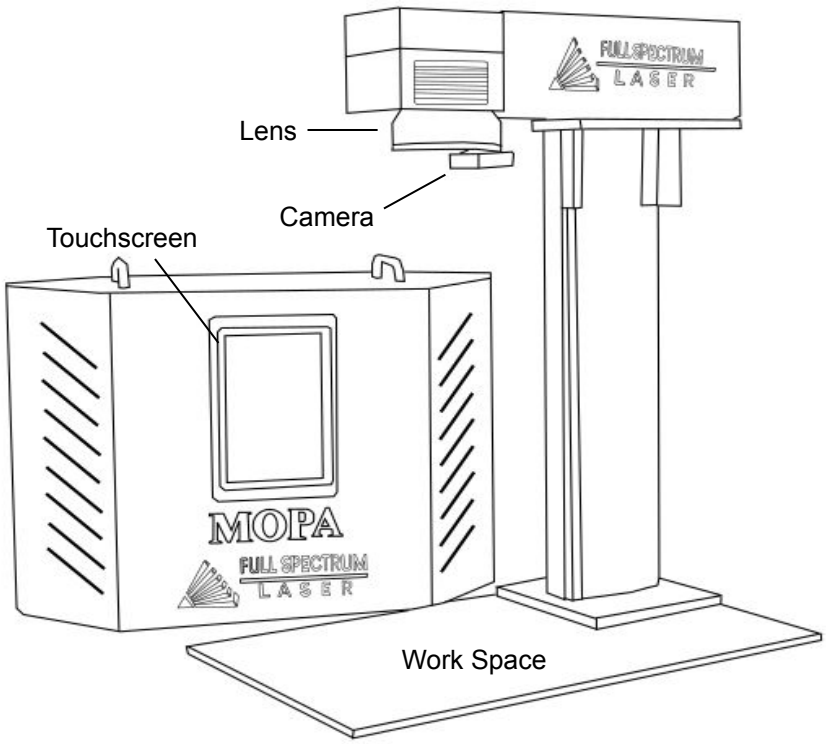


Fig. 1

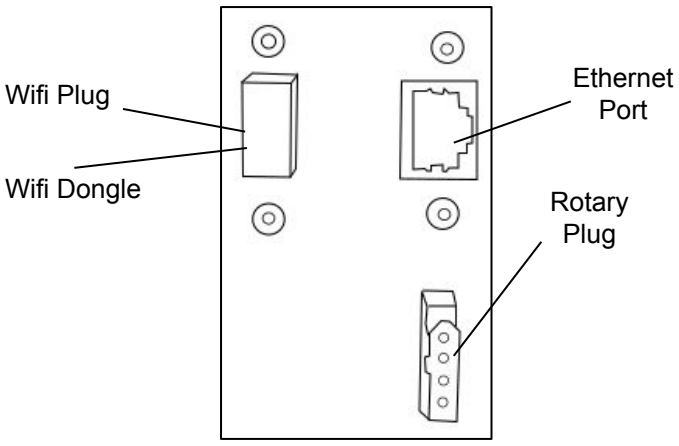


Fig. 2

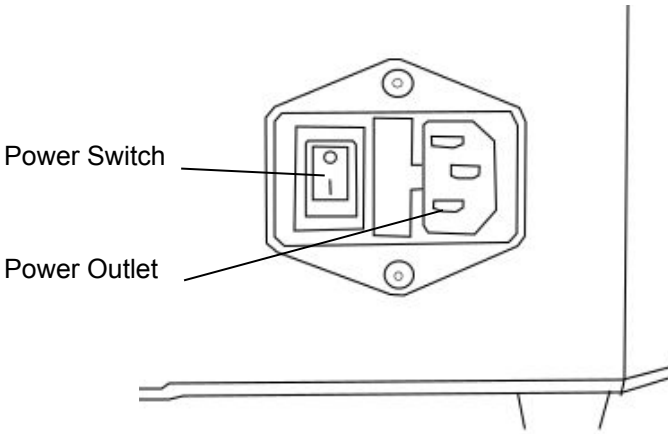


Fig. 3

Section I. Safety

Section Review:

Do's:

- **Remember to make sure your work area is nice an clean.**
- **Always keep an eye on your machine.**
- **Always inspect your machine for damage or breakage before each use.**
- **Keep your laser system clean.**
- **Always keep a Halogen or multipurpose dry chemical fire extinguisher on hand.**
- **Always have a first-aid kit designed for the initial treatment of burns and smoke inhalation.**

Don'ts:

- **Do not stack items on or near your work area.**
- **Do not leave your machine unattended.**
- **Never operate the machine with any of the panels removed.**
- **Never access any electrical areas with hands or tools unless the unit is disconnected from the power for at least one hour.**
- **Never place hands or fingers into moving parts such as cooling fans.**
- **Never operate the machine without a properly operating ventilation system.**

Section II. Unboxing & Assembly

The MOPA Galvo has a weight of 130 lbs. At least two people are needed to lift and unbox the machine. **Do Not Lift The Box Alone.**

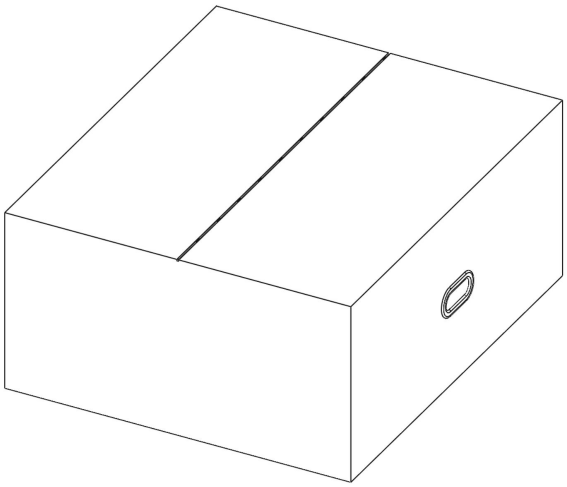


Fig. 4

Unboxing Steps

Follow these instructions for best results:

1. **Prepare Work Space:** You will need an open, level work space to place your laser cutter. A sturdy table with room for the machine (25.5" x 13" x 23.5 for the machine + 18.5" x 8" x 16.5" for the workspace) is recommended. Be sure the table is free of clutter and can support a minimum of 400lbs (the machine itself weighs 130 lbs).

2. **Place Box:** Place your box on or near your table before opening it, using either a pair of scissors or a box cutter.

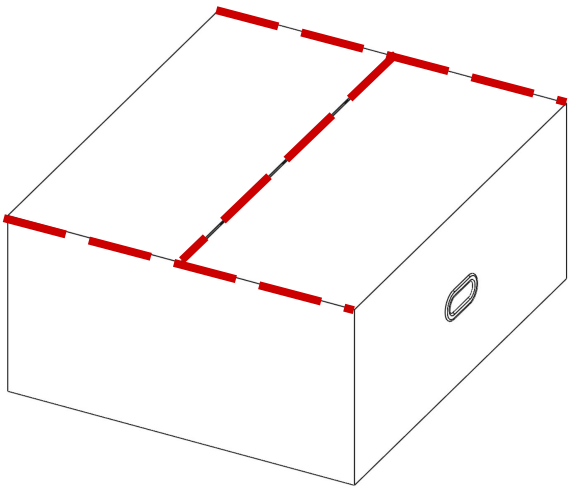


Fig. 5

Section II. Unboxing & Assembly

3. Remove the Top Layer of Foam.

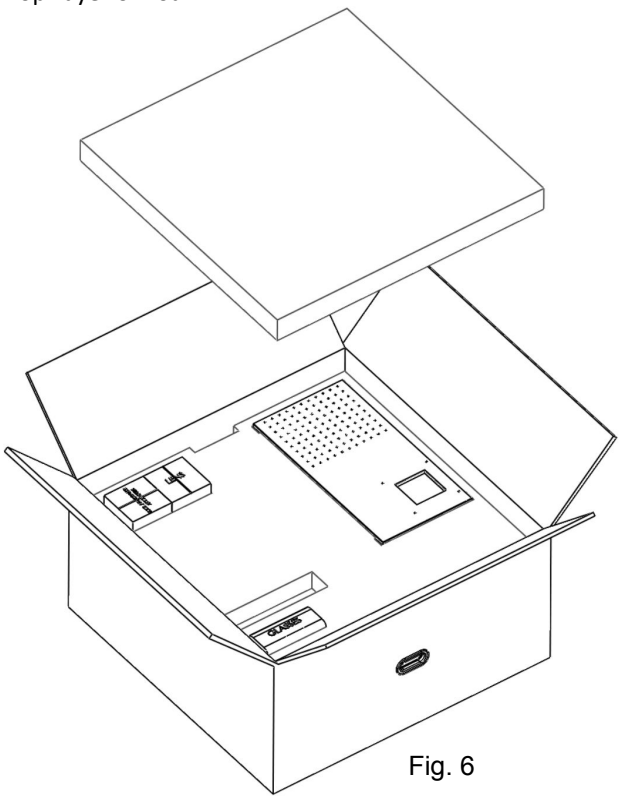


Fig. 6

4. Remove the stage base, power cord, and accessories from the packaging.

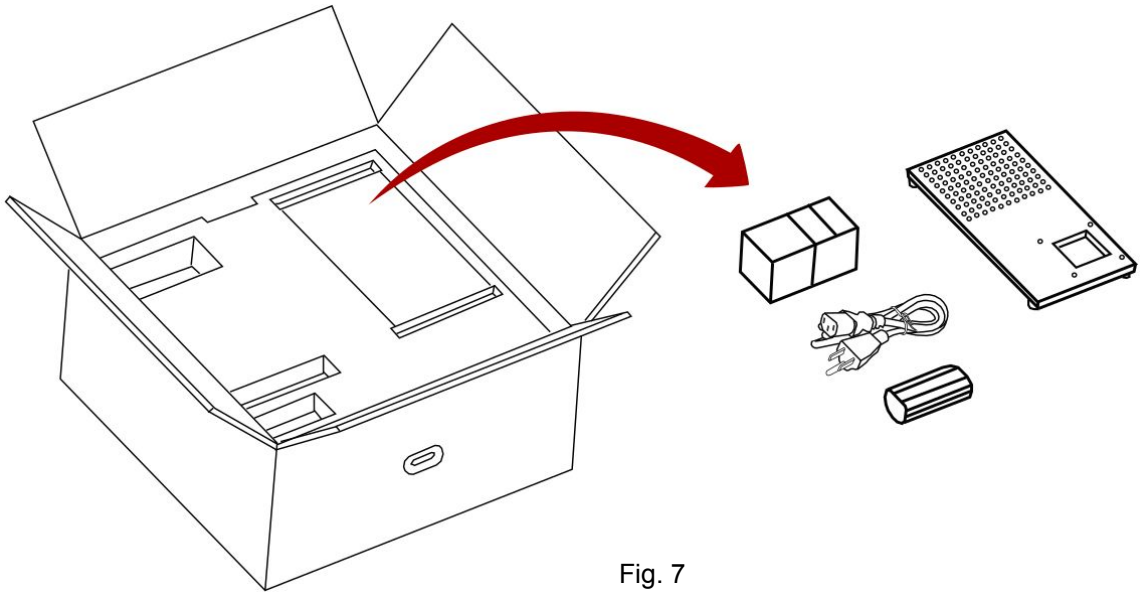


Fig. 7

Section II. Unboxing & Assembly

5. Remove the Second Layer of Foam.

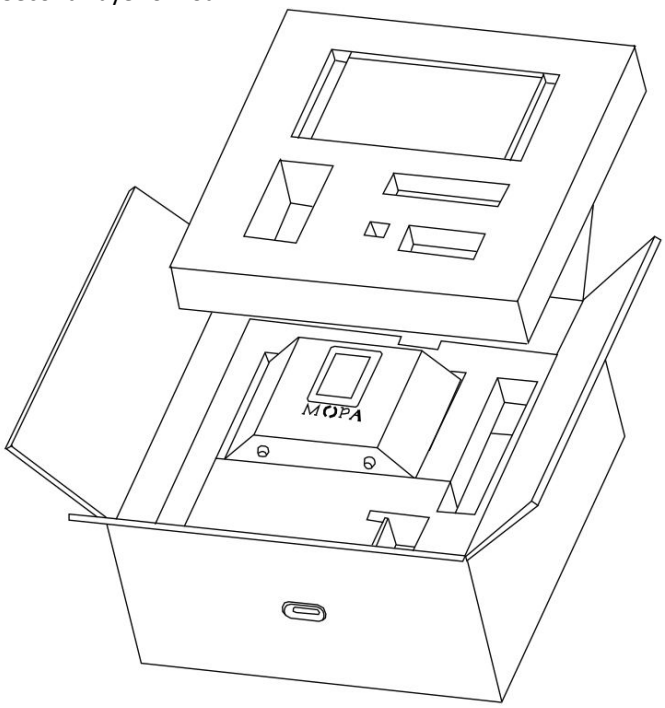


Fig. 8

6. Remove the Foam under the main unit.

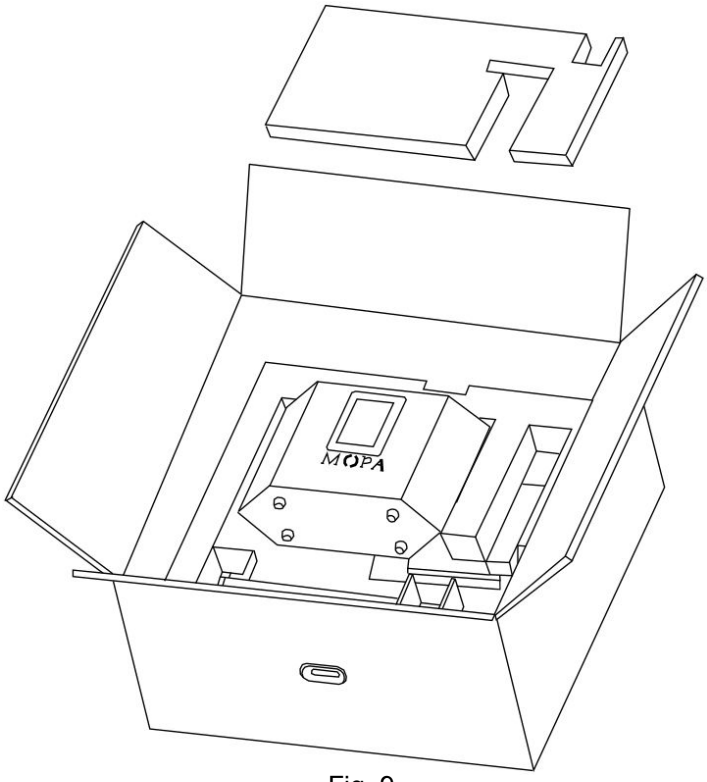


Fig. 9

Section II. Unboxing & Assembly

7. Remove the Main Unit, Z-stage and Isolator from the Foam.

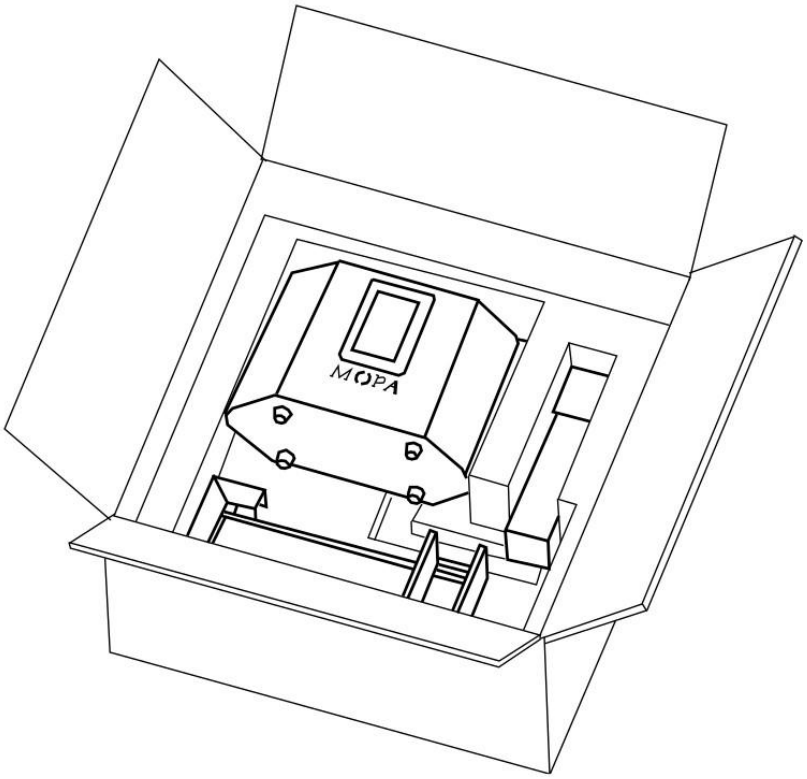


Fig. 10

Section II. Unboxing & Assembly

Assembly Instructions:

1. To assemble your new MOPA Z-stage you will need:
   4 - M6 x16 screw and a M5 Hex Key

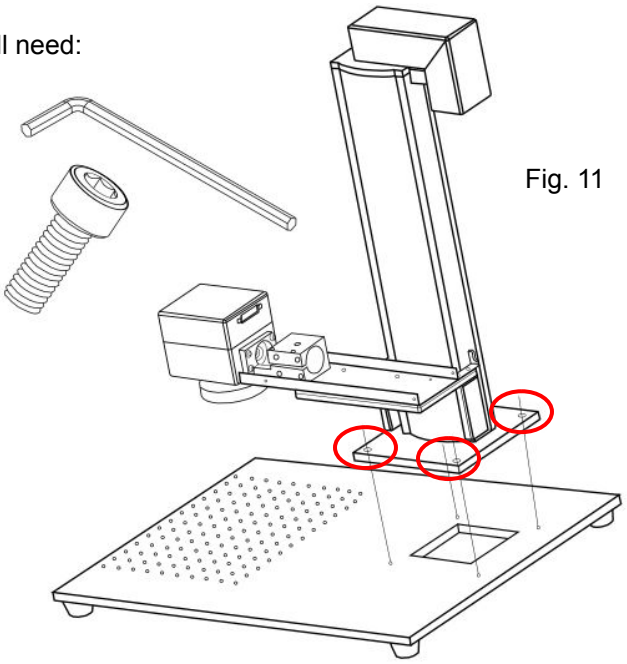
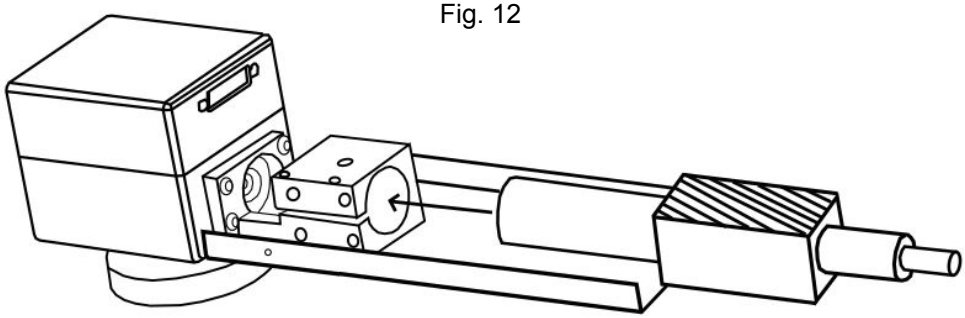


Fig. 11

2. Use the M6 screws to fasten the base to the stage. (See Fig.11)

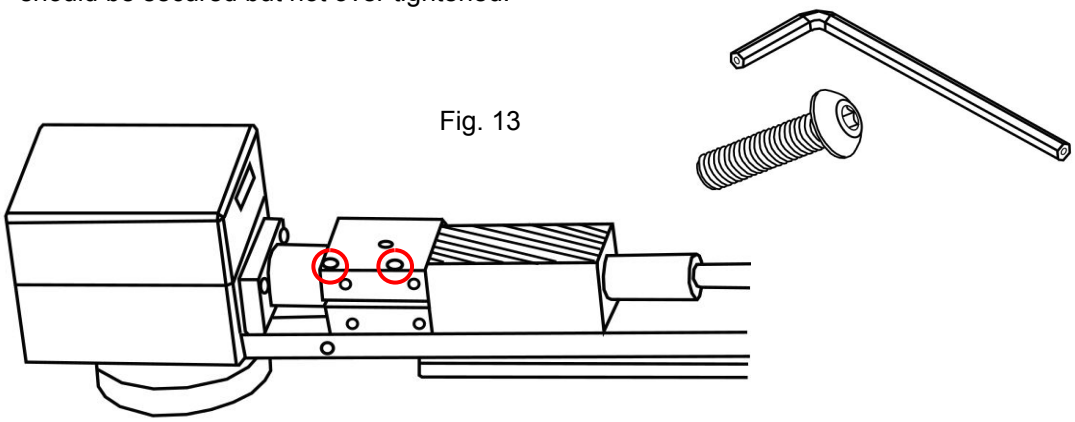
3. Locate the Isolator and slide it into the laser mount.

Fig. 12



4. Once the isolator is in place secure it with a M4 hex key using the M5x30 screws provided. The isolator should be secured but not over tightened.

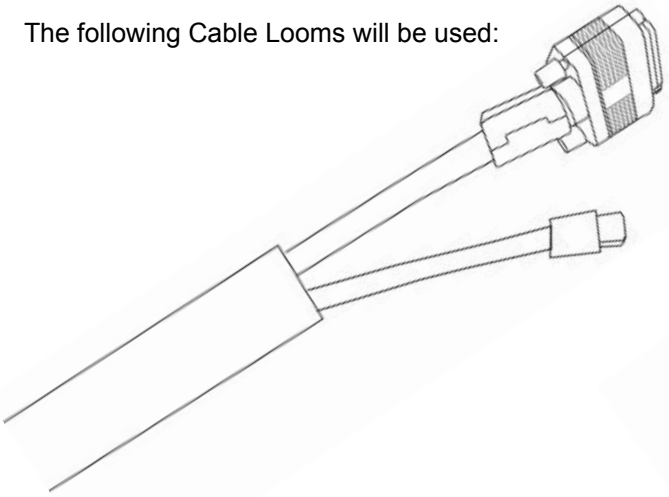
Fig. 13



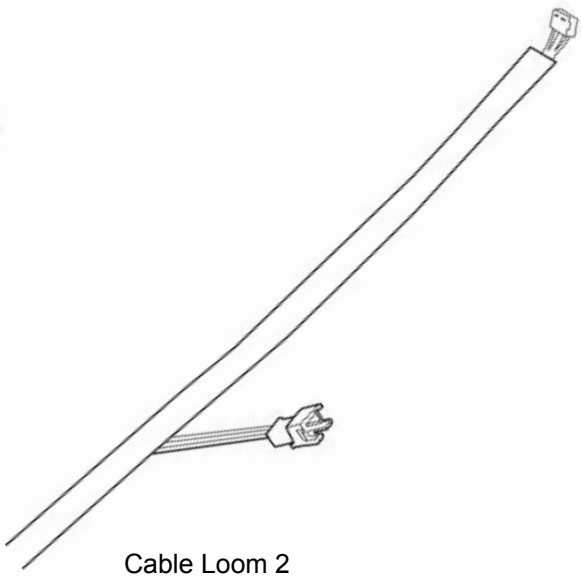
Section II. Unboxing & Assembly

Cable Connections:

The following Cable Looms will be used:



Cable Loom 1



Cable Loom 2

1. Grab Cable 1 and connect the VGA cable onto the port on the back of the scan head(see Fig 4).

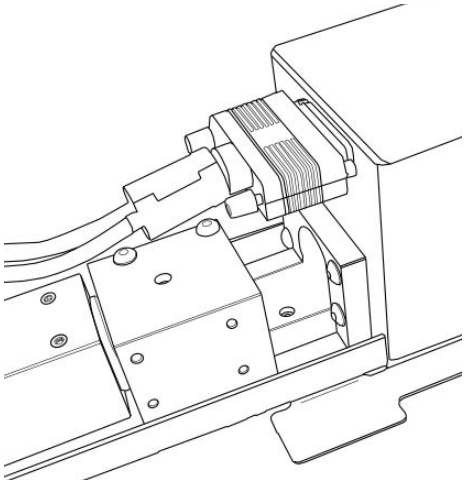


Fig. 14

2. Find the Type C cable in the loom and run it through the opening before connecting to the camera.

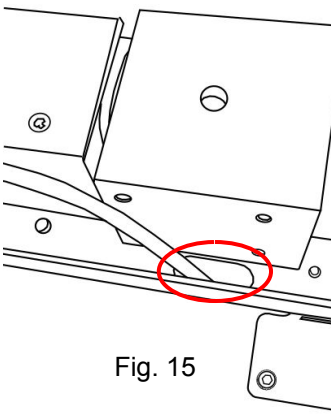


Fig. 15

Note: If you have trouble reaching any cable you can open the loom to pull out the cables.

Section II. Unboxing & Assembly

3. Take Cable Loom 2 and connect the 3 pin to the cable hanging near the motor. Make sure the pins are oriented correctly.

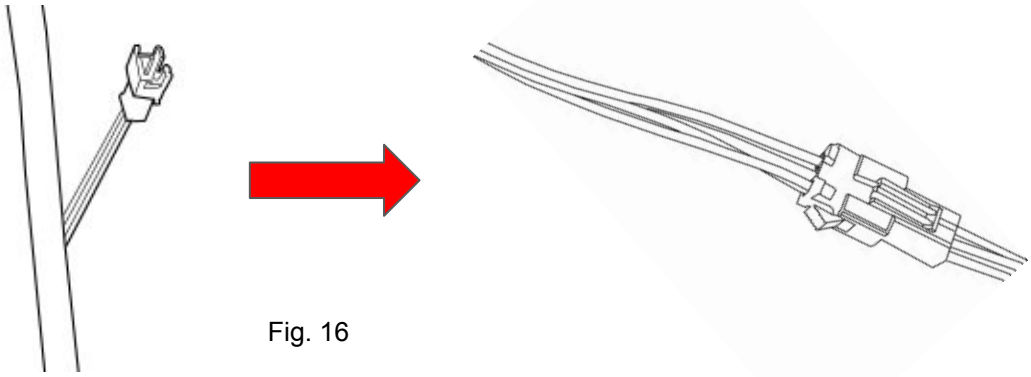


Fig. 16

4. Plug the remaining 4 pin cable connector and plug it into the motor.

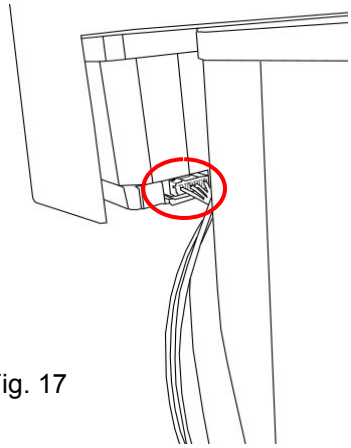
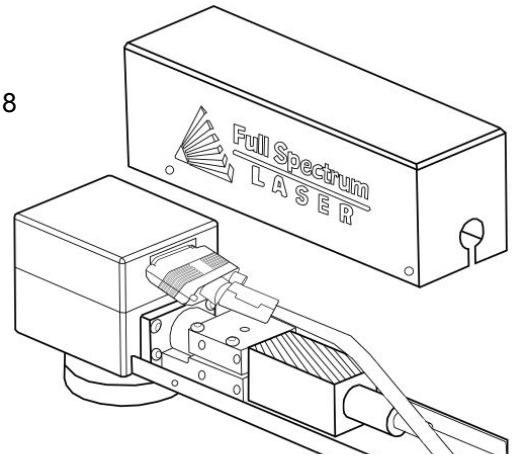


Fig. 17

5. Lastly install the Coverhead using four M4x8 screws that screw into the inner plate. Make sure you run all the cables coming out of the scan head assembly through the back opening.

Fig. 18



Section II. Unboxing & Assembly

Section Review:

Do's:

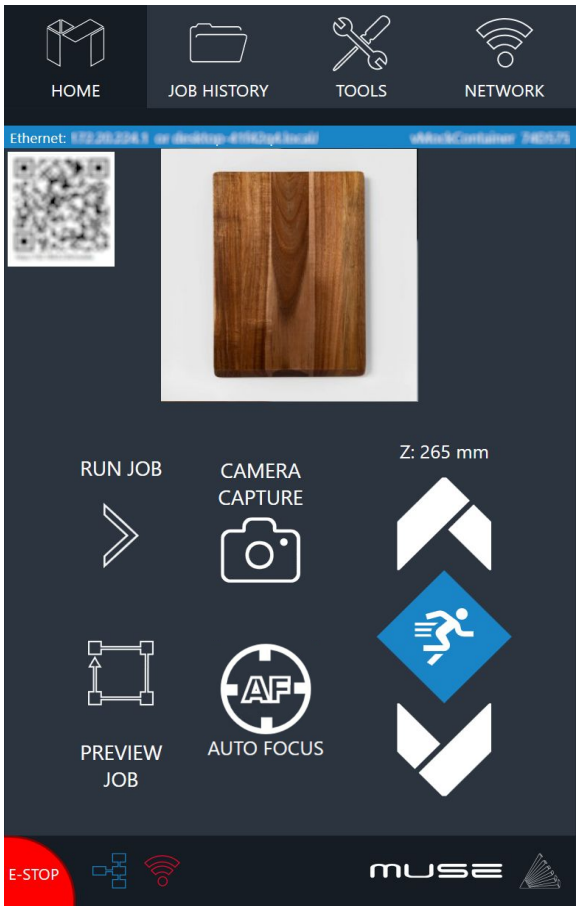
- **Remember to lift the box with at least two people.**
- **Remove all items from the box before starting the assembly process.**
- **Make sure all your connections are secure before starting your machine.**

Don'ts:

- **Do not lift your machine by yourself.**
- **Do not try to lift heavy parts by yourself. Make sure you have someone ready to help.**

Section III. Touchscreen Interface

The touchscreen that comes on your MOPA allows you to control the basic functions of your laser without needing a computer. Jobs are accessible through the touchscreen once loaded in from the RE3 interface.

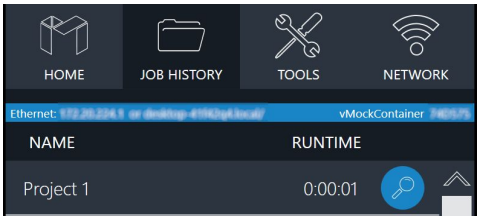


Home

The Home screen contains the devices IP address, the QR Code for RE3 and controls for the laser head.

Job History

The Job History icon allows the user to access previous projects. Selecting the File allows the user to view and re-run it.
No internet is needed to run the file saved here.



Tools

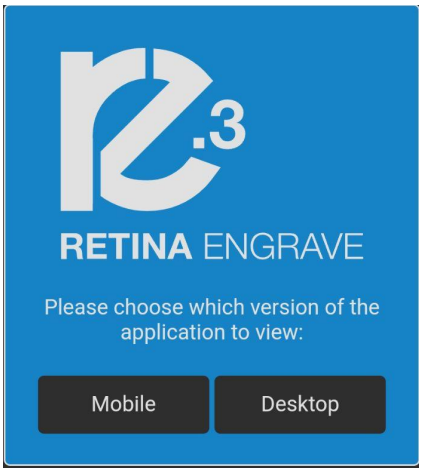
The tools icon allows the user to check and adjust the machine settings, enable rotary attachments, home the laser, and get information about the machine.

Network ⇨ Wi-Fi

Allows the user to connect to the Wi-Fi.

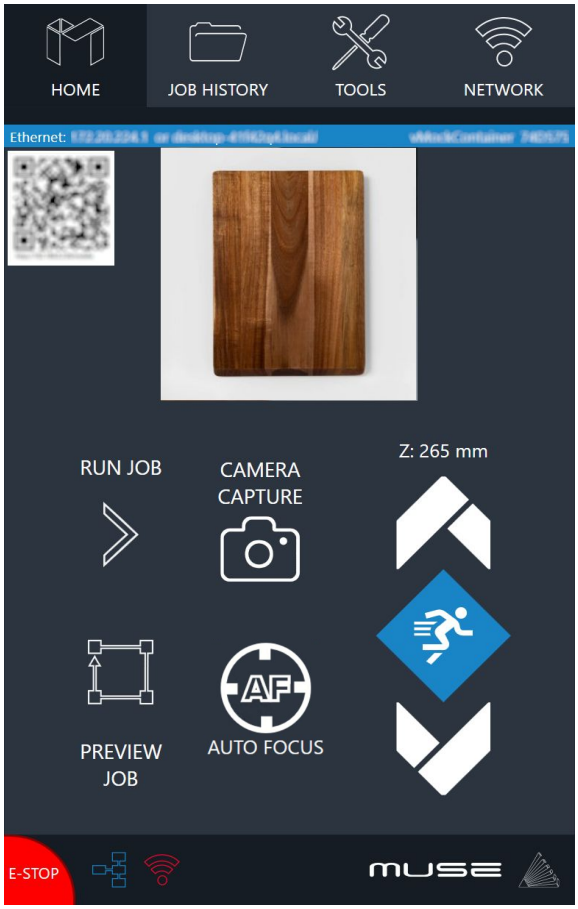
Mobile Version

A mobile version is available by scanning the QR Code or by inputting the device's IP address into your phone's web browser. (See Connect to Software for more information)



Section III. Touchscreen Interface

Machine Indicators:



Wired IP Indicator:

The IP indicator shows if the machine is connected to an ethernet cable.

Connected

Not Connected

Wi-Fi Indicator:

The Wi-Fi indicator will indicate if the machine is connected to the Wi-Fi.

Connected

Not Connected

AutoFocus Icon:

The Autofocus icon automatically moves your machines Z-stage to the height needed to perform an engraving. (Needs QR card to work.)

Camera Capture Icon:

The Camera Capture icon takes images of the workspace.

Movement Controls:

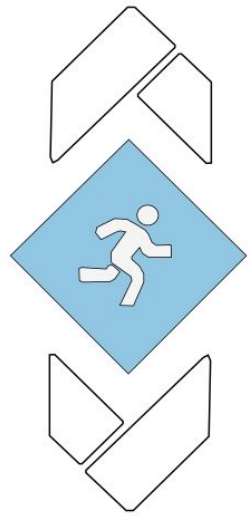
The laser hade can be moved up and down according to the speed settings.

Section III. Touchscreen Interface

Speed Indicators:

Your machine has 3 speed setting that can be change by selecting the icon on the touchscreen or from RE3.

Running Icon: The machines default speed and the fastest speed.
Used for fast movement across the work area



Jogging Icon: The second speed, also known as the intermediate speed.
Used for normal adjustments before running a job

Walking Icon: The final and slowest speed.
Used for small adjustments.

Section III. Touchscreen Interface

Section Review:

Do's:

- **Have your QR card on your material for autofocusing.**
- **Remember to adjust the jog speed by selecting the diamond icon.**
- **Make sure your machine is connected to the internet before starting any jobs.**

Don'ts:

- **Do not adjust the jogging speed while the machine is moving.**

Section IV. Internet Connection

The MOPA Galvo software is browser-based, meaning no download is required. RetinaEngrave v3.0 (RE3) is locally hosted on the machine's internal computer so it will function even without an internet connection. Using any computer, only an internet browser (such as Google Chrome) is needed to access RE3. There are three methods of connecting to the internet. The method chosen will depend on you or on the location of the machine.

Connect Via Router (Recommended):

Connecting the MOPA Galvo to the router is the most reliable way to establish a link to RE3.

1. The MOPA comes with an ethernet cable(see Fig. 19).

Fig. 19

2. Connect the cable to the ethernet ports on both devices(see Fig. 20).

Note: Ethernet port looks the same on all devices

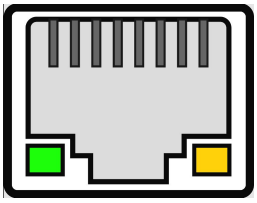


Fig. 20

Connect to Wi-Fi:

1. Your machine should come with a device called a dongle attached to the usb port. This device enables your machine to connect to the wifi. Make sure that it is there and connected.

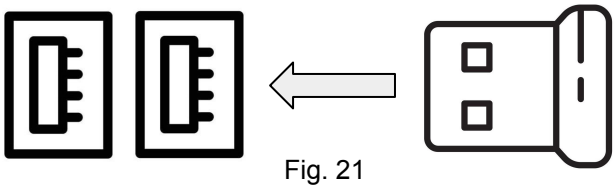
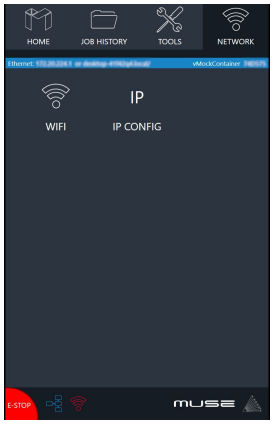


Fig. 21

2. Select the Network button on the top right of the Touchscreen.

3. Select WiFi and look for your network. Select it and enter your password



Connect Directly to Computer:

Connecting the MOPA and the computer should only be done if the previous two options are not possible. The MOPA can connect to the computer via ethernet cable.

Note: The location of the ethernet port varies on computer models. Some computers may not have an ethernet connection and may need an ethernet adapter.

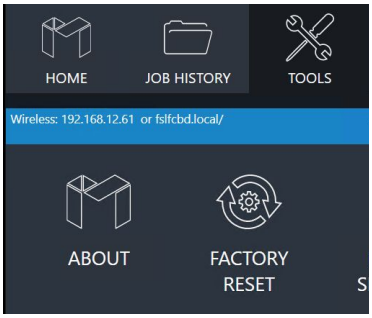
Section IV. Internet Connection

Software Connection

RetinaEngrave v3.0 (RE3) is a combination of a print driver and control software that communicates with, downloads jobs to, and controls the laser system. There is no download required for RetinaEngrave v3.0. With a local connection (achievable with Wi-Fi or the included Ethernet cable) your MOPA will link with the software's IP address

1. **Turn On MOPA: Turning on your MOPA will automatically boot up your Muse Touchscreen interface.** Allow 30 seconds or so for the machine and touch screen to boot up.

2. **Locate the IP Address in the blue line under the Home icon.** Alternatively, you can find the IP Address of the machine by tapping Tools -> About. The address will be listed there. This IP Address is of the network you connected the machine to. Wireless and Wired connections will have different IP Addresses.



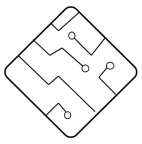
3. **Type IP Into Browser**(Google Chrome is preferred). This will link you to the RetinaEngrave v3.0 (RE3) interface. You now have full access to the software. There is no need to install or download anything. You must, however, keep a local connection, either through Wi-Fi or the Ethernet cable.

Using QR Code:

Another method is to use the QR code which is visible in the Home and About sections.

1.Take a picture of the QR code with your camera or use a QR code reader.

2. A link will appear that can be selected.



Your machine comes installed with the latest version of RetinaEngrave v3.0. It will only be updated by support. You will know the machine is updating when the interior lights of the MOPA turn off. **Do not turn off your machine until the update to complete and the machine lights will turn back on.**

The laser must be powered on when operating the software or when connecting the laser via the Ethernet cable. You will need uninterrupted Network access for this process.

Section IV. Internet Connection

Section Review:

Do's:

- **Make sure your machine is connected to the internet before you attempt your first project.**
- **Remember to let your machine fully boot up before attempting to enter RE3.**

Don'ts:

- **Do not take off the Wi-Fi Dongle.**
- **Do not connect the machine to your computer's ethernet port unless the other two options have already been run.**
- **Do not attempt to enter RE3 if the machine is off. It will not load.**

Section V. Focusing Your Laser

Focusing must be done each time a new material is selected or when restarting your machine.

Auto-focus:

Your Galvo came with a black anodized QR card that can be placed on top of your material under the laser head (see Fig. 22).

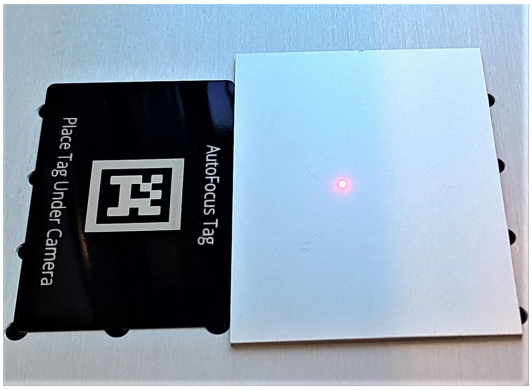


Fig. 22

Note: Make sure the QR code is visible on the camera during focusing.

2. In RE3, go to the top right section of your browser and locate the jog Controls.(See Fig. 23)

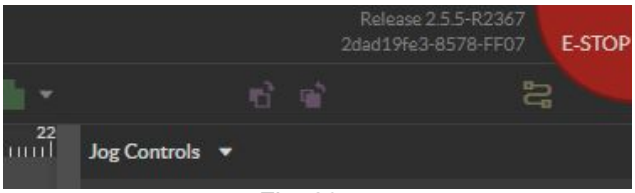


Fig. 23

3. Select the Jog Control arrow to open menu and select the **Z** autofocus button.(See Fig. 24)

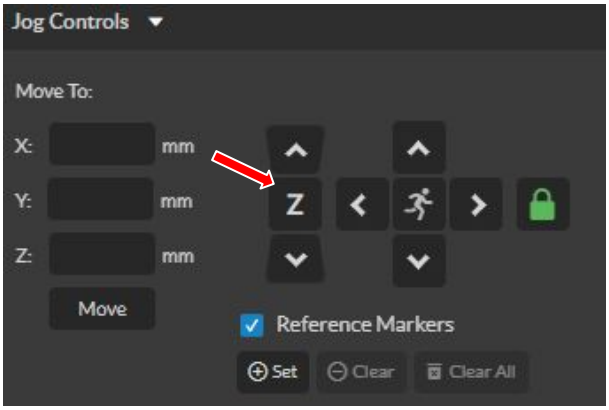


Fig. 24

4. The lens will move into ideal position for the selected material

Section V. Focusing Your Laser

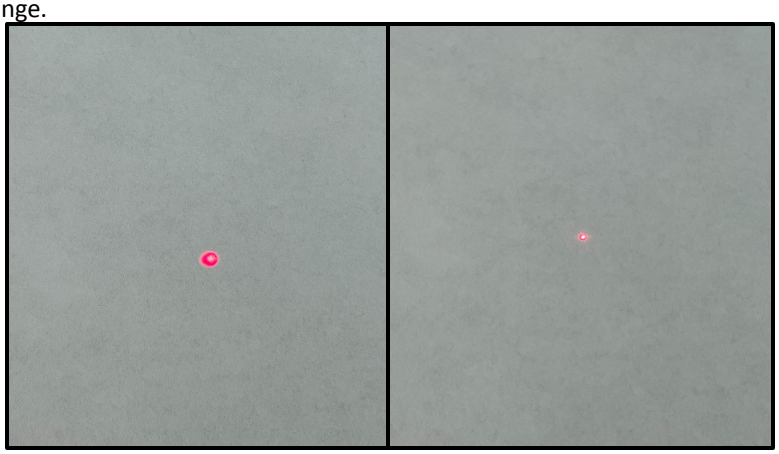
Manual Focus:

If one loses the QR card or simply chose not to use it, then they will have to focus the laser head manually. The appropriate engraving distance is determined by the lenses focal length. Below is a chart of our lenses and their required distance.

Lens Focal Length	Distance from Material
163mm	203mm
254mm	294mm
330mm	370mm
420mm	460mm

Please keep in mind that the numbers are for the distance from the lens to the object, not the lens to the workspace. If switching to a larger object then the stage needs to be adjusted accordingly.

Another thing to keep in mind when doing manual adjustments is to keep an eye on the red diode. When the laser turns on and starts to home the red diode is large and fuzzy. As the laser head moves down the stage the red diode becomes smaller and more focused. When the diode looks clearest you can run the focusing test to make sure it is within range.



Laser Focus Test

Once your machine is in the appropriate height we need to run the focus test.

1. Place an anodized card above the selected material. You can use the back of your focusing card if needed.

2. Select the laser focus icon.(See Fig.25)

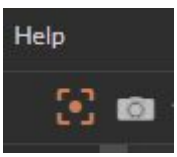


Fig.25

Section V. Focusing Your Laser

3. Make sure the appropriate lens size is selected before hitting the generate test pattern option.

WARNING!! This will fire the laser! Make sure you are at least 12 inches away from the laser if you are not wearing safety glasses.

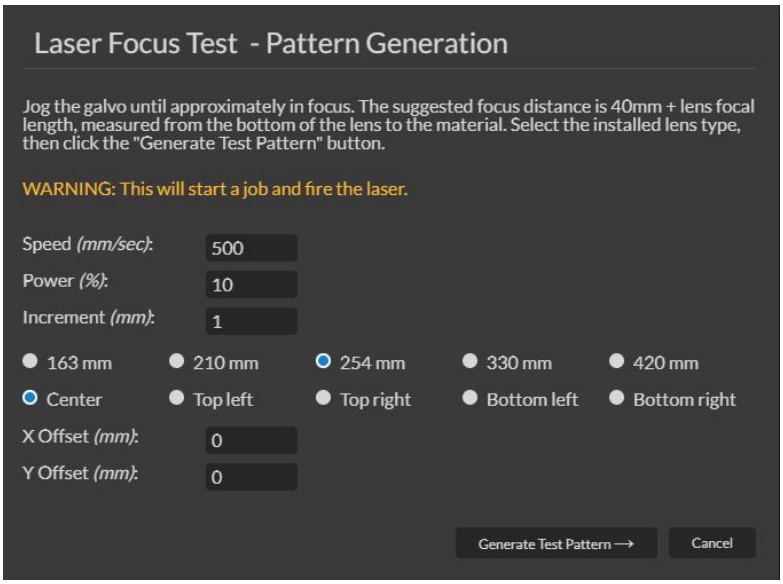


Fig. 26

4. The laser will produce a grid of marks from A - H vertically and numbers 1-6 horizontally.(See Fig.27)

Fig. 27

Note: The marking in the focus test are in millimeters and may require some means of magnification.

5. Choose the 2 most visibly similar blocks and input them into the Pattern Selection then select “Focus Job Result”, and then done.

Example: In this picture 3F and 4D are visibly similar so they can be chosen.

Note: If focus test does not produce the grid then it may need to be re-focused.

Section V. Focusing Your Laser

Section Review:

Do's:

- **Have a ruler ready for manual focusing.**
- **Make sure your QR card is visible on the camera when auto-focusing.**
- **Perform a focus test before each job to ensure a high quality engraving.**

Don'ts:

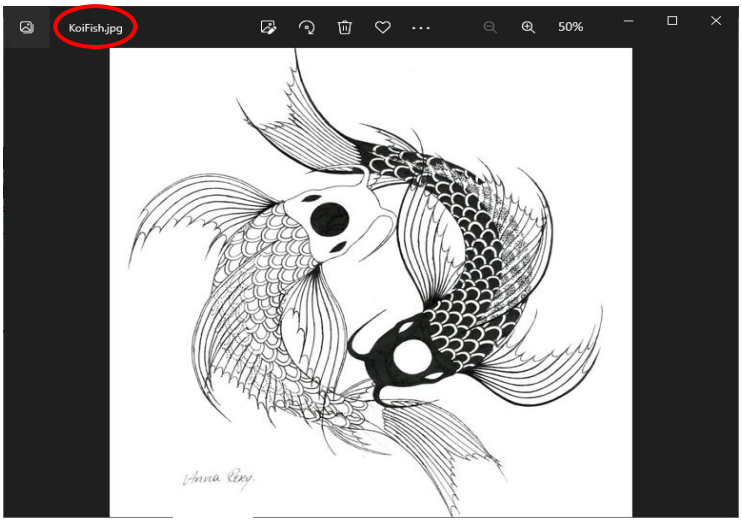
- **Do not run a job without focusing your laser.**
- **Do not run a job without performing a Focus Test.**

Section VI. Operations

This section will guide you through using your MOPA Galvo. To get started, it is important to understand the meanings of "Vector Cutting" and "Raster Engraving" and their associated file types.

Vector Cutting	Raster Engraving
Vectors use mathematical formulas to create paths that form a shape.	Rasters are make of white and colored pixels. The colored pixels are what is engraved.
Used for creating signs & logos	Used for creating surface marking & engravings
Vectors are found in PDF, SVG,DXF, and AI files.	Rasters are found in JPEG, PNG, BMO, and TIF files
PDF is preferred.	JPEG is preferred.

RE3 is compatible with: AI, BMP, PNG, PDF, JPG, TIF, DXF, SVG, and RE3 files. When importing images the resolution for the preview image will be at 100 dpi but the resolution of the actual image will be 500 dpi.



The file type of an image can be viewed by opening it or by looking at the properties/details section.

Creating a Design

You may decide that instead of just importing a picture you want to make one. When creating a design in design software, we recommend using a software you are familiar with. RE3 can work with a variety of file types but we recommend saving your files as a pdf, svg , or jpeg. PDF and SVG files contain both raster and vector data, making them the most suitable for both engraving and cutting. JPEG is the most suitable for rastering.

Beside the file types there are two things to keep in mind when designing:

1. Line thickness- When designing an image for RE3 the lines in the drawing should be a decent thickness. If the lines are too thin, then RE3 will have trouble reading them.

2. Coloring- When importing an image it is important to keep in mind the lasers function in two ways: on and off. The laser will fire when it reads a shaded image and stop when it doesn't. For that reason, when an image is imported it is converted into a grayscale image. This also means that any colors chosen will vanish. To compensate, you can make the image monochrome or cut out their designs one aspect at a time for easier customization.

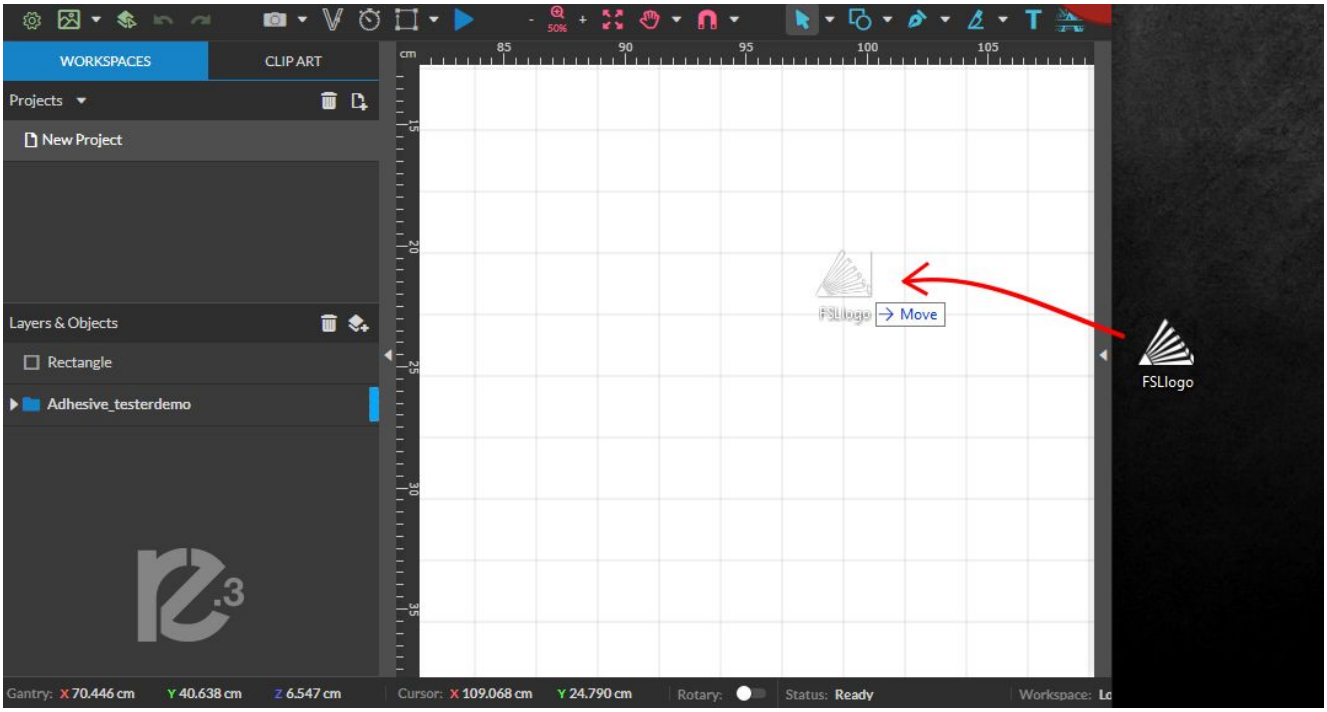
3. File Size- Files larger than 30 MB may slow down the machine. Vector files are typically harder to run than rasters.

Section VI. Operations

Mouse Controls:

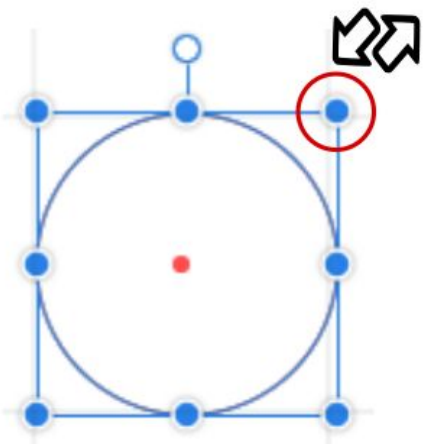
1. **Drag ‘n Drop:** Click and hold a design file, it will become highlighted letting you know it can then be dragged. Drag it into the workspace and a “move” prompt will appear below the object showing it can be dropped into the workspace. Release the file and it will be imported into RE3. Once uploaded, you can freely move the design within the workspace.

Importing Images:

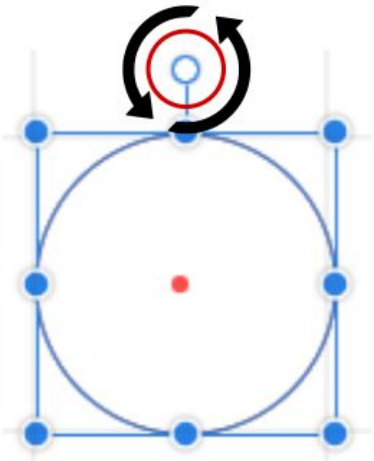


2. **Resize / Rotate:** Clicking on the object with your mouse will highlight the border in blue. The adjusters for size and orientation will become visible. We can use the mouse to manipulate the object’s size by expanding or constricting the square adjusters on each edge (see Resize) or rotate the object using the rotation node usually located above the object (see Rotate).

Resize



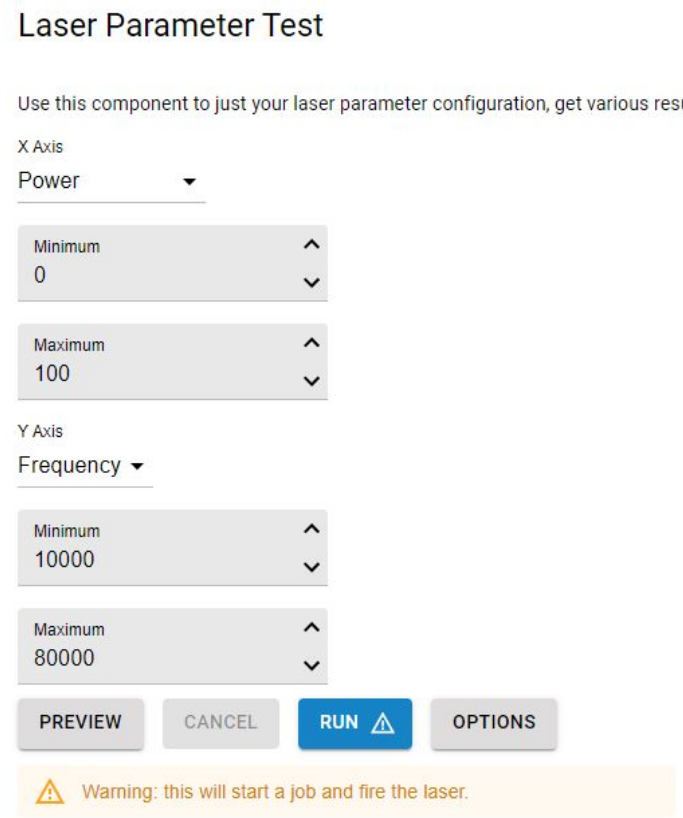
Rotate

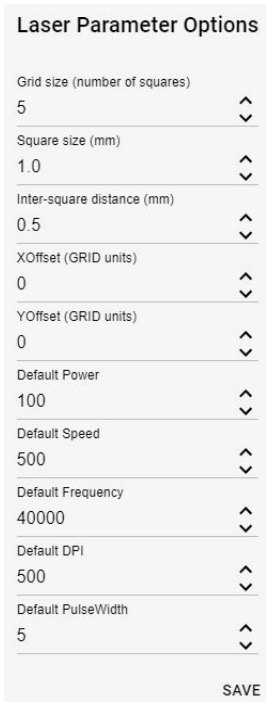


Section VI. Operations

Laser Parameter Test

If your not sure what types of settings you want to use for your materials, then try using the **Laser Parameter Test** under the Laser Tools page. The Parameters Test will form a graph to test the two parameters chosen at their minimum and maximum, which spaces in between that depend on the grid size. This means that the larger the grid size the easier it is to narrow down your selection. The parameters you can test are: Power, Speed, Frequency, DPI, and Pulse Width. PulseWidth is a Parameter only use in MOPA machines. **E**nter the Setup page by going to the Machine name, going to Diagnostics and selecting Galvo Calibration. Then select the Parameters tab.





Selecting the Options button will open the Options window. Here you will adjust the grid settings, such as the grid size, square size, and default settings.

Section VI. Operations

Section Review:

Do's:

- **PDF is preferred for Vectors, while JPEG is preferred for Rasters.**
- **Remember when preparing your own design to use thicker lines.**
- **Remember that previews are seen in 200 DPI but are imported as 500 DPI.**
- **Remember that importing files larger than 30MB can slow down your machine.**

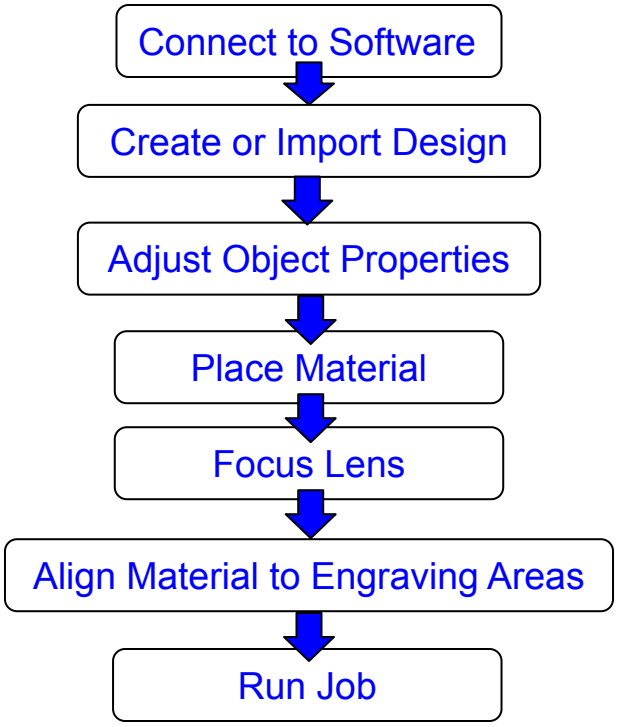
Don'ts:

- **Do not use thin lines when making a design as it could get cut.**
- **Do not perform a Parameters Test if you do not have multiple material samples. We recommend getting a different sample before continuing.**

Section VII. Retina Engrave V3

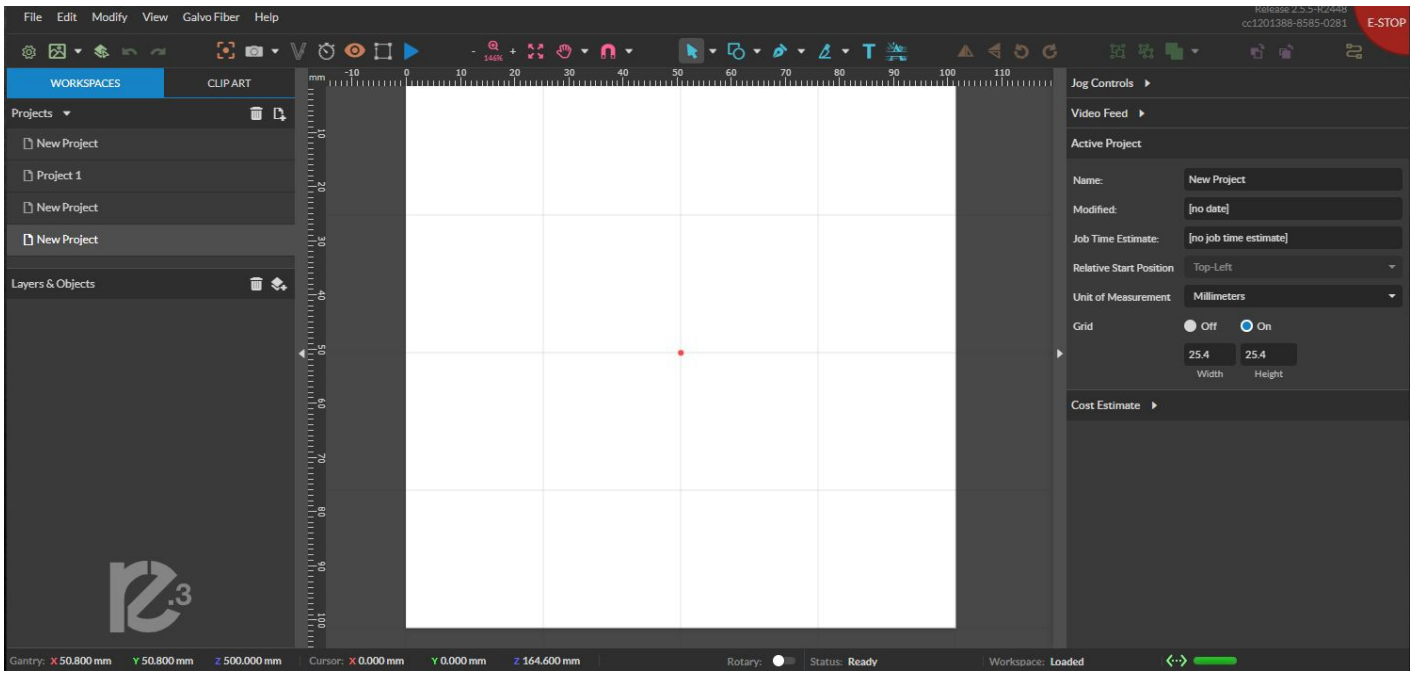
Starting on RE3

Using your new machine for the first time can seem intimidating but we've worked to make this guide as clear as possible regarding our software. We have broken down the entire process into 7 steps.



Before starting your project, make sure that the all your accessories are properly connected and functional.

1. **Entering RE3.**
   Enter RE3 if you have not already done so. Below is a picture of how RE3 should look once loaded.



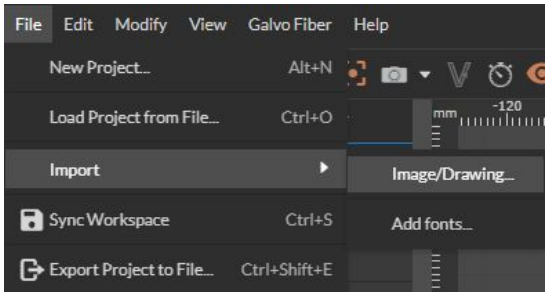
Section VII. Retina Engrave V3

2. Import Design

Select the file you wish to engrave via your editing software or an image saved on your computer.

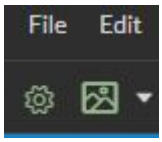
It can be place into RE3 using three methods:

-It can be imported by going to the File->Import->Image



-It can be "dragged" into your RE3 workspace using your mouse(Drag 'n Drop).

-It can be placed using the photo icon.



The Arrow next to the photo icon is for selecting the properties you wish to import. If you wish to be asked when importing the image, then do not save any setting.

3. Adjust Object Properties

Modify the image in RE3 using the right toolbar. The main things you'll be adjusting are the size, power, and speed.

The size can be adjusted individually by using the Width/Height bars or together by selecting the white oval. When the white oval is on (see left), then the width and height will change proportional to each other.

The Power of the machine will depend on the wattage chosen. The settings are set in terms of percentage with 100% being full power. If you purchases a laser of 50W or higher we recommend performing your first engraving below 50% and then adjusting based on results.

Frequency should be adjusted by minor increment to minimize fire risk.

4. Place Material

Prepare the material you wish to engrave. If the material you are working with is new to you or untested, make sure you have enough material to test with to ensure your settings are correct before marking the final part/design.

Section VII. Retina Engrave V3

5.Focus Lens

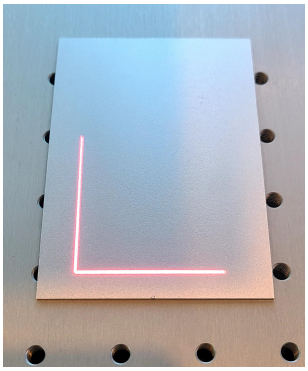
Your MOPA must be focused before starting a job. The MOPA comes with an autofocus feature in RE3 and on the touchscreen.

NOTE: The focus distance number set in the RE3 interface is machine relative. It signifies the distance away from home needed to engrave.

6. Align your design with your material.

This can be done by using the perimeter icon to preview the area where the laser will engrave.

You can use the camera capture option for help better aligning your design. You should still make sure to check the engraving perimeter before running your project.



Once adjusted to ensure your design is engraved in the desired area, you should make sure the material does not move from the workspace. This can be done by weighing down the material using an object that will not interfere with the engraving, such as jig, fixture, putty, or tape.

7. Once the picture is aligned run the job.

You can start the job by selecting the play button.

While the job is running you should not look directly at the engraving process unless you have on safety glasses. Instead, the project can be viewed from the Video Feed or Touchscreen.

Once the marking is complete, do not move the part until you are sure that it has the desired look, as re-aligning becomes significantly difficult.

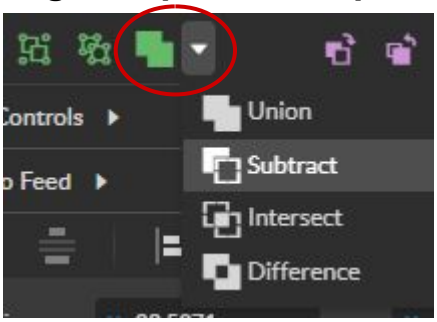
Once completed, wipe your part clean of any dust or residue resulting from the engraving process.

Congratulations!! You have made your first engraving on RE3. It's an exciting process to engrave material to your liking. Sometimes a little trial and error is needed to see what designs go well in what ways. The following pages will provide more information on how to use RE3 for more detailed and precise engravings.

Section VII. Retina Engrave V3

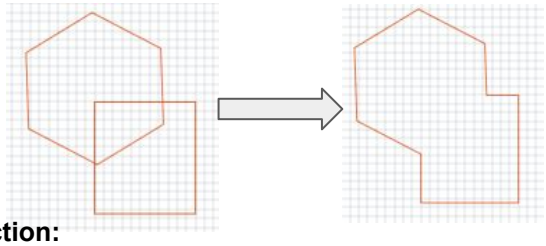
Here is other information that will be useful when performing your first jobs on RE3.

Creating and Manipulating Compound Shapes & Objects

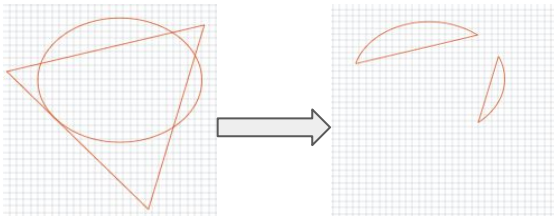


These functions are available in the Grouping section of the toolbar (see above). Compound Shapes & Objects Operators can combine and modify shapes and objects to create unique compound shapes and objects with these functions:

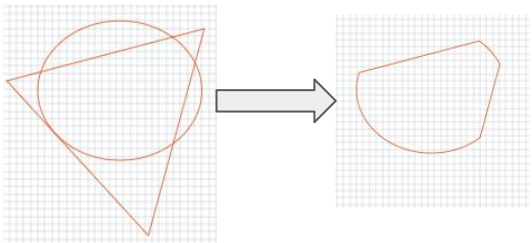
Union:



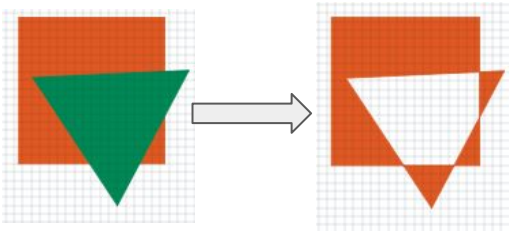
Subtract:



Intersection:



Difference:



Split Selection (Shift+Ctrl+G): Split up a previously created compound shape(s) or object(s) that has been combined with other shapes. Select the compound shape and choose Split Selection. The different objects are split back up into individual layers that can be moved independently.

Infill:

Before:

After:

Infills are mainly used when one wants to engrave words or shapes into an object.Once the infill is placed it can be rasterized for engraving. If the shape is something you want to cut out, then the infill is not needed.

Section VII. Retina Engrave V3

Passes:

Passes are typically used for different things in rastered material, than in vectored.

Vector Passes

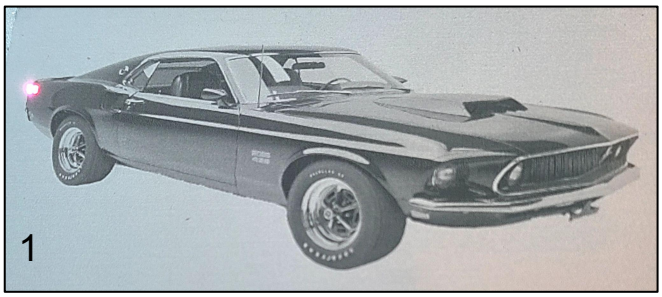
In vectors, multiple passes are done to cut through thicker material. Sometimes, such as when cutting wood, a single cut is not enough therefore we can program multiple passes to ensure we cut through our material.

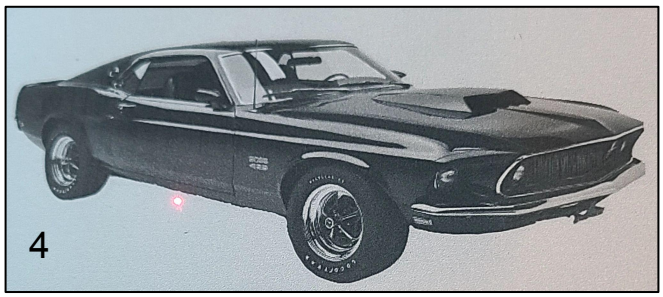
Note: Certain material will need more passes than others and may result in some charring around the edges.

Raster Passes

In rastered images passes are done to add more depth into a picture. Multiple passes are mainly done to add more details to you design.

Below will be an image done on a Fiber Galvo to show the difference multiple passes will have on an image.





The Final Pass (pass 4) is far more detailed than the first pass. The final product looks much closer to the original than the other one. However, one should keep in mind that the more passes you add, then the longer it will take the job to be completed. This job has 4 passes programmed, therefore the time was 4 time longer than doing 1 pass .

Note: Different materials may not need to perform multiple passes. It depends on user preference if an image should be engraved multiple times or not.

For a more detailed and in-depth look into RE3, please use the RE3 Guide, which can be found at https://fslaser.com/resources/ .

Section VII. Retina Engrave V3

Section Review:

Do's:

- **Remember there are three methods to importing a file. If one does not seem to be working for you, then try the others.**
- **Remember to use the Perimeter and/or Camera Capture options to align your design with your materials.**
- **Remember that compound objects are made using the Grouping section.**
- **Remember to adjust your object properties before running your project.**
- **Remember that infills are used to fill in vector objects for engraving.**
- **The laser can be stopped or pause using various methods, find the one that works best for you.**

Don'ts:

- **Do not select any options on the photo icon if you want to be asked each time.**
- **Do not run a project if your material is not secure. Brace it in some way before continuing.**
- **Do not run multiple vector passes on something you don't want to cut.**

Section VIII. Lens Replacement & Calibration

Lens Removal and Replacement:

If you wish to change the lens, the machine must be calibrated again. Ensure lenses are probably stored with appropriate lens caps and are not cross threaded when mounting.

1. Ensure laser head is in a reachable position to remove lens.

2. Remove any objects or work pieces from underneath the lens work area.

3. Place the lens cap onto your lens to protect the lens from potential damage.

4. Carefully twist counter-clockwise to loosen the lens.
   Try to avoid damaging the camera or camera shutter located on the side of the scanhead.

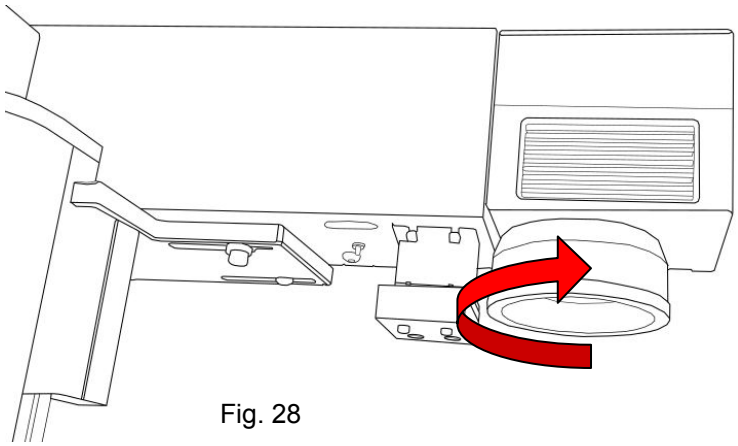


Fig. 28

Avoid touching the glass surface of the lens to prevent scratches. The lens collar may come loose with the lens,if that occurs remove both together and separate once dismounted.

5. Replace the collar to the scanhead before inserting a new lens.

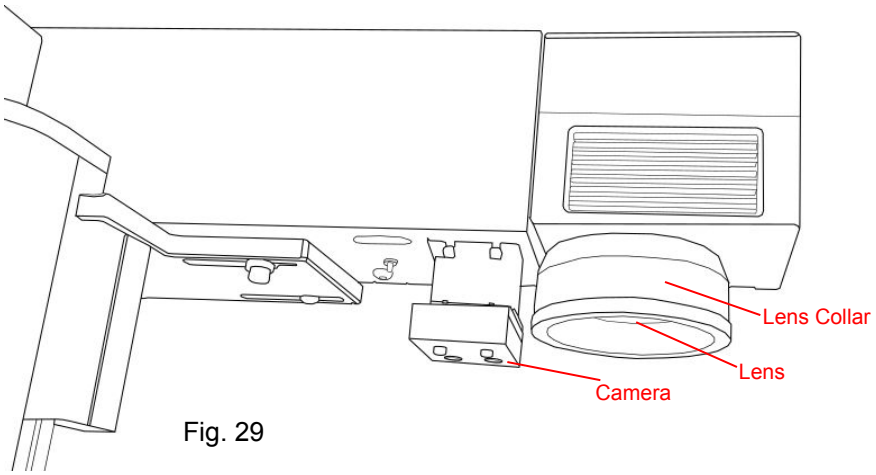


Fig. 29

7. Remove top and bottom protective lens caps and screw new lens into collar on scan head.
   DO NOT OVERTIGHTEN LENS!!

8. Wipe down the glass surfaces with optical lens wipes if you notice smudges, fingerprints or other contaminants.

Section VIII. Lens Replacement & Calibration

Lens Calibration:

Calibration should be performed if:

1. The camera is changed or manipulated.
2. The lenses are removed, replaced, or changed.
3. Focusing accuracy has degraded and the laser is not marking.

Warning!! Calibration cannot be done in Rotary Mode.

Preparation:

Before performing a lens calibration the focusing card must be within the view of the camera and outside of the work area to perform the calibration properly. The size of the work area is determined by the lens used (refer to the chart below).

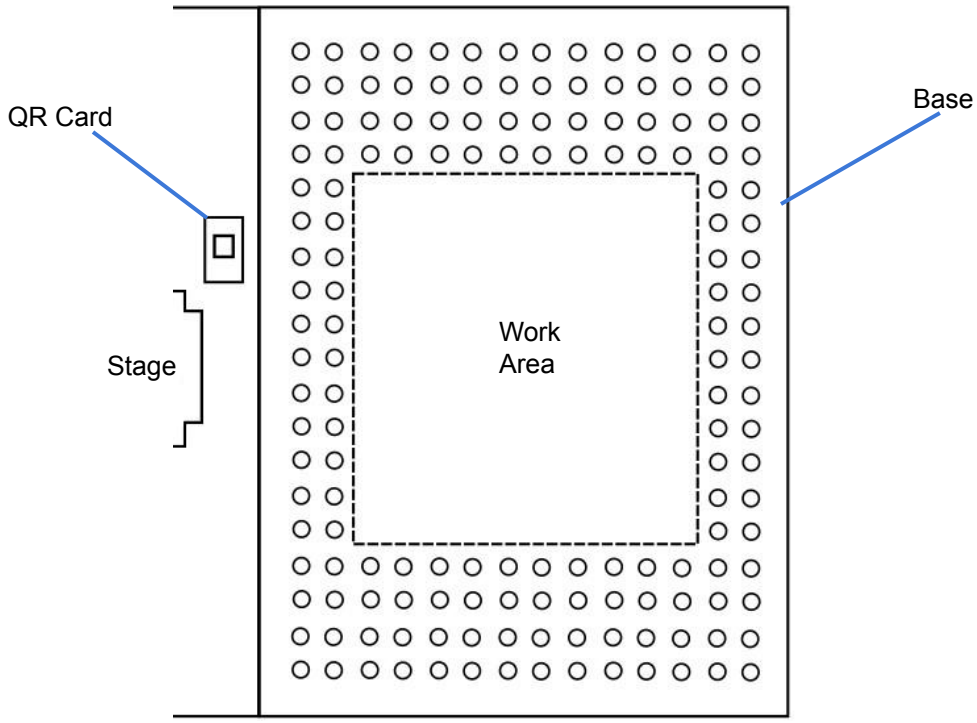


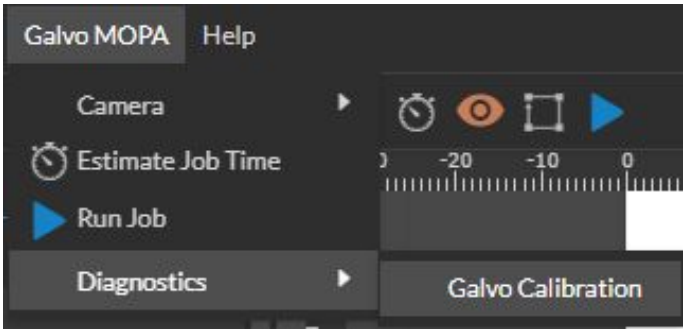
Fig. 30

Lens Size(mm)	Working Area Approx. (mm)
163	110X110
210	140X140
254	175X175
330	220X220
420	300X300

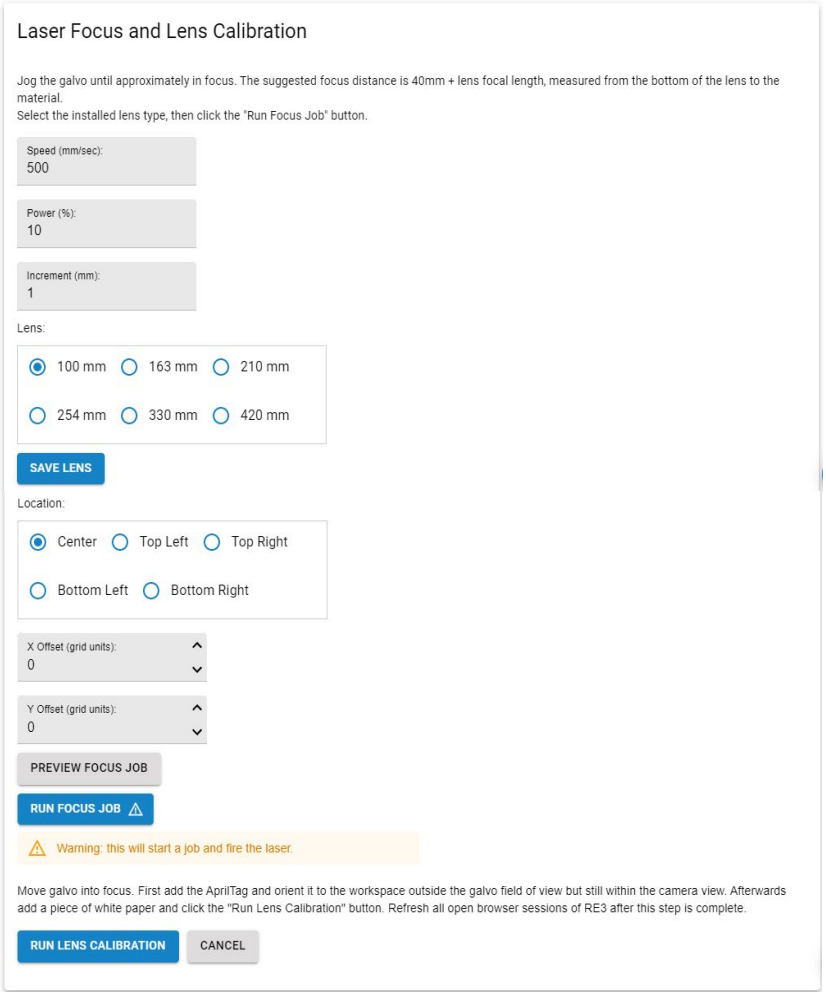
Section VIII. Lens Replacement & Calibration

Lens Calibration:

We recommend going to the "Laser Tools" page to perform the following adjustment. The page can be accessed by going to the Machine name, going to Diagnostics and selecting Galvo Calibration.



1. Once the Laser Tools page is loaded locate the **Laser Focus and Lens Calibration** section.



For a MOPA machine the power should be set to 100%

Make sure that the correct lens size is saved in the lens section. If the wrong lens setting is saved then all of the following calibration will have to be re-done.

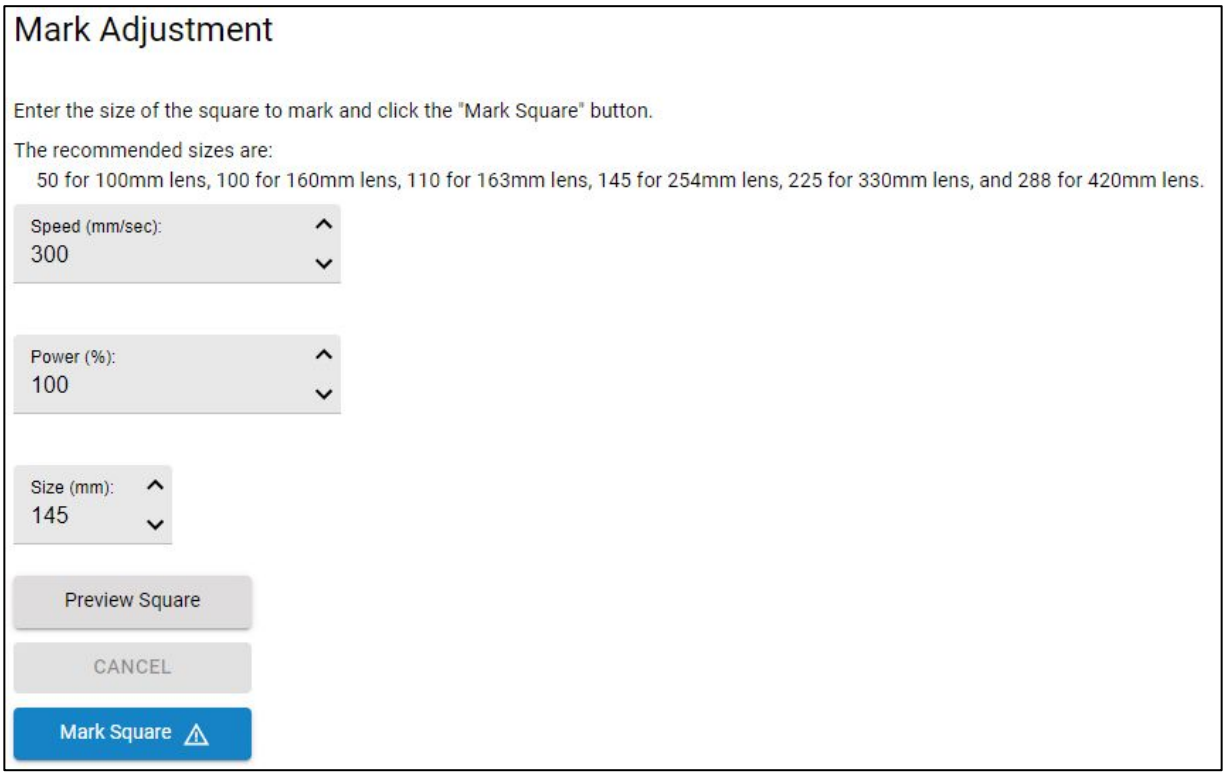
2. Select **Run Lens Calibration**.

   The red diode will disappear indicating that the calibration is starting. The camera will slowly turn off, then the diode will reappear and scan the work area. After the calibration is finished you will be given a pass or fail.

If your test fails it could be because your work area may be too bright. You may want to close any open blinds or turn off a light before retrying. Another reason could be that your work area is too dark. You may want to try laying a white piece of paper under the laser diode to improve visibility.

3. When the machine is successfully calibrated to the lens we need to perform mark and preview adjustments so that the laser properly engraves in it's new work area.

Mark Adjustment:



1. Run the mark adjustment to verify that the lens calibration process was successful.

2. The speed and power don't need to be changed but the size does. The size refers to the size of the square that will be made it's value depends on the lens size you are using.

3. Place a flat piece of test material under the laser for marking.

   Preview the square before proceeding to ensure only test material is marked.

4. Select “Mark Square”.

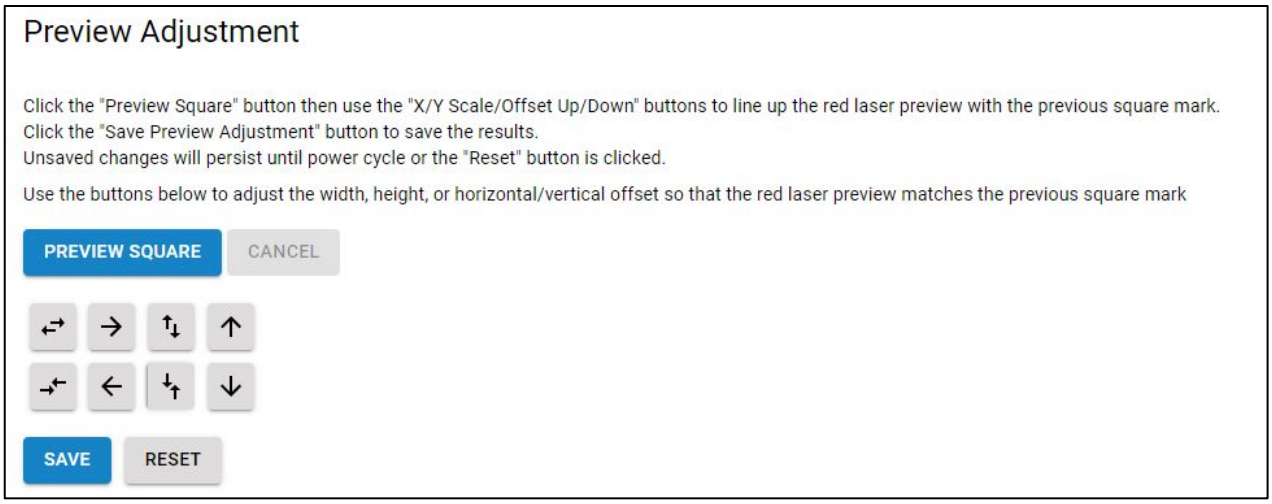
5. Measure the marked square. It should be the size chosen before. If the lens calibration was not done correctly then it will be off by approximately 2mm. Re-run the lens calibration and then redo the lens adjustment.

   Please note that the top left corner of the square is cut off intentionally.

6. Select “Save Mark Adjustment”

Preview Adjustment:

1. Once the mark adjustment is correct. Mark a new square using the Mark Square button.
2. Without moving the part you just engraved, press “Preview Square”.
3. Use the adjustment buttons so that the tracing done by the red dot perfectly overlaps the marked square.
4. Select “Save Preview Adjustment”.



Section VIII. Lens Replacement & Calibration

Section Review:

Do's:

- **When removing the lens make sure to avoid hitting the camera.**
- **The lens collar can be easily removed and replaced.**
- **Make sure the QR card is within the cameras view before performing the lens calibration.**
- **Have test material prepared for the mark and preview adjustment.**

Don'ts:

- **Do not start your lens calibration without the QR Card present.**
- **Do not perform the Mark or Preview Adjustment without the QR Card present.**

Section IX. Camera Functions

As Intel's most compact RealSense camera, the D405 is a short-range stereo camera that operates at an ideal range of 7 to 50cm. By combining RGB sensory data with image processing software to provide sub-millimeter resolution and accuracy. This camera is also equipped with a minimum object detection down to 0.1mm at 7cm.

Camera Capture:

1. Enter RE3.
2. Place material in the laser bed.
3. Select the Camera Icon on RE3 or from the touchscreen. The workspace will be captured.

The Workspace can be cleared on RE3 using the arrow.

4. Align design to material. Run perimeter to double check your position.
5. You can now adjust your settings to run your job.

Camera Calibration:

Your camera is calibrated before shipping. The Camera Calibration should only be done when the camera has been replaced or when instructed to do so by a support representative.

Preparation:

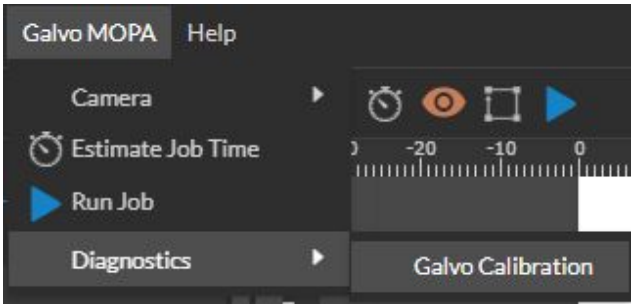
Before performing camera functions the focusing card must be within the view of the camera and outside of the work area to perform the calibration properly. The size of the work area is determined by the lens used (refer to the chart below).

Lens Size(mm)	Working Area Approx. (mm)
163	110X110
210	140X140
254	175X175
330	220X220
420	300X300

Section IX. Camera Functions

Procedure:

1. **Enter the Laser Tools Page.** This can be done by going to the Machine name, Diagnostics and then selecting Galvo Calibration or by inputting: ID address /setup and then Setup.

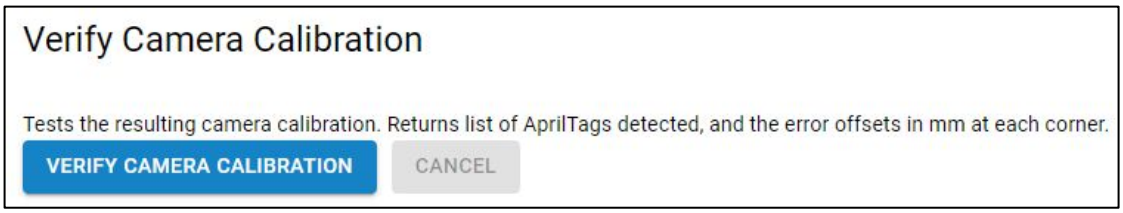


2. Lay out about 1 to 2 sheets of letter sized paper centered under the red dot. Ensure these sheets are flat and smooth to produce the best calibration.

3. Make sure your Galvo is focused if you have not already done so.

4. Then go to the "Laser Tools Tab" and select "Run Lens Calibration" if you have not already done so.
   Refer to Lens Calibration on pg 39.

5. After, it passed go to **Verify Camera Calibration** and select the verify camera calibration option.



Focus Tag Calibration:

There may be times when the Focus Tag is damaged or is not read properly. It may be fixed by calibrating the focus tag.

Make sure your machine is within focus before starting calibration. Write down the Z- stages coordinates to ensure calibration is done correctly.

1. Enter the **Laser Tools** page. Look for the **Tag Autofocus Calibration** section.

2. Place the Focus tag in the center of the work space.

3. Select the **Take Snapshot** button to perform a camera capture. The Focus Tag should appear in the screen with a red box above the Tag. The Red box signifies that the Tag was detected. If the box does not appear then the Tag may be damaged.

Section IX. Camera Functions

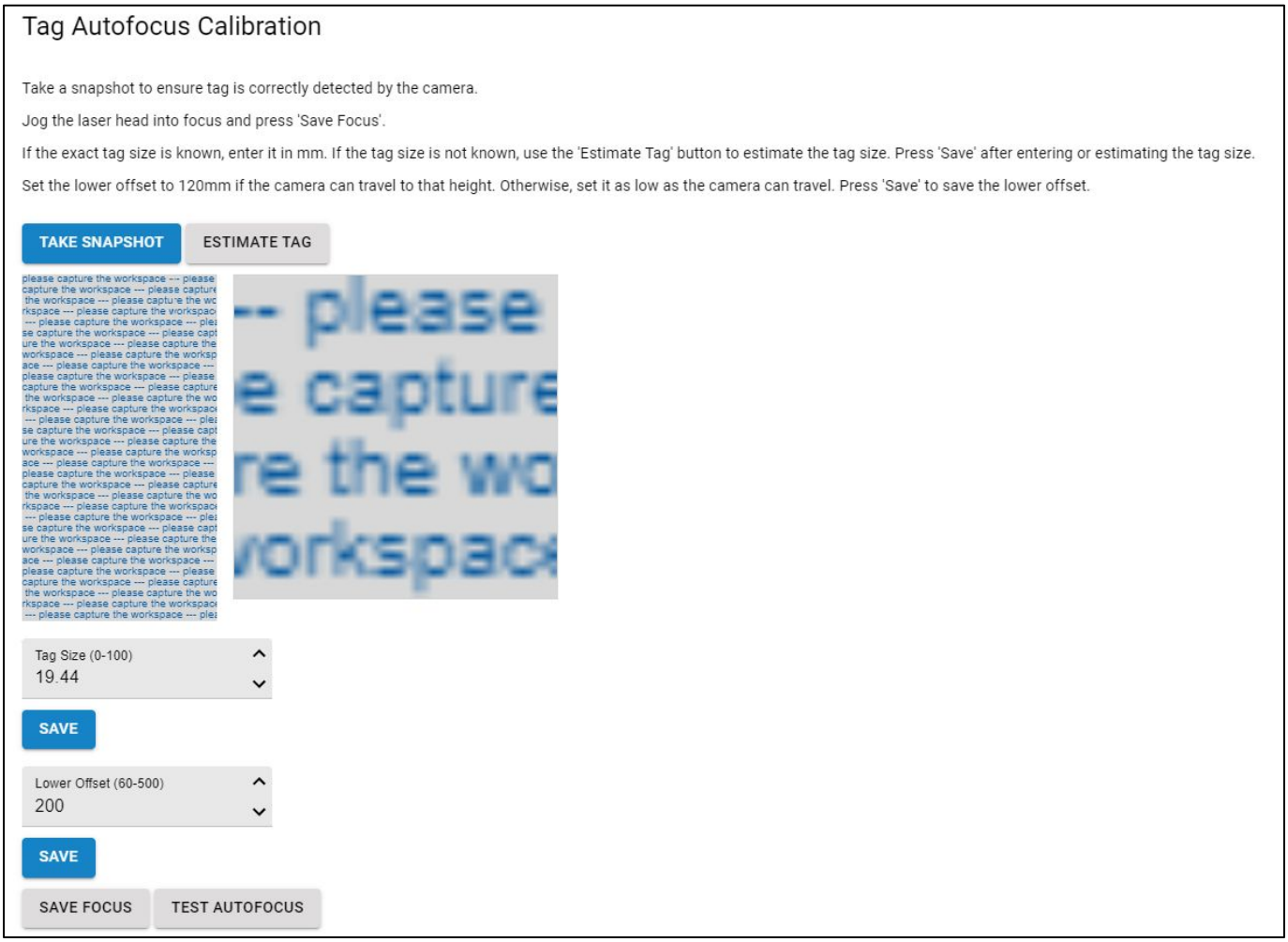
4. The tag size should always be saved as 19.44. Having the incorrect number would result in focusing issues.

5. Set the lower offset for your stage. We recommend starting at 120 and adjusting from there.

6. By saving the focus the machine will move to the lower offset. If the lower offset is set too low it will hit zero and return to the previous location. The lower offset should be set as close to the bottom as possible for the most accuracy.

7. Once the focus is saved move the stage from it's position and test the autofocus. If done correctly the stage will return to it's previous focus location.

If you're having issues with the tag calibration please contact technical support for assistance (Refer to pg 54).



Section IX. Camera Functions

Section Review:

Do's:

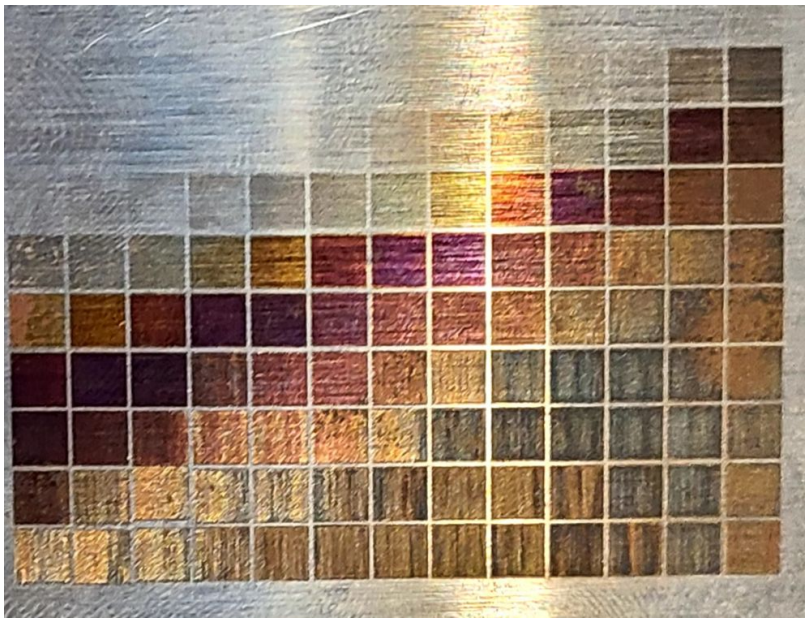
- **Make sure the QR card is within the cameras view before performing the camera calibration.**

Don'ts:

- **Do not start your Camera Calibration without the QR Card present.**

Section X. Color Engraving

Color Engraving Overview



MOPA machines are called that because they contain both a master oscillator to produce a beam and an optical amplifier to increase its power output. This causes Master Oscillator Power Amplifier or MOPA machines to have greater power and faster speed than a traditional fiber laser. This system also has the added feature of having an adjustable pulse width. The ability to adjust all of these setting is what gives MOPA lasers the means to engrave color. However, certain conditions must be fulfilled in order to engrave in color.

1. **Material**
   MOPA systems can only engrave color in material made of stainless steel or titanium alloy. This is because the process of marking the material will cause a chemical reaction that will anneal or alter the properties of the metal. The chemical reaction is what creates the color in the material.

2. **Machine Properties**
   The coloring process can be affected by many factors such as: the laser source, the lens used and the focus distance. This is important to keep in mind since even similar models can produce different shades of color.

3. **Engraving Parameters**
   The hatching type, the pulse width, the frequency, the line spacing and the power are adjusted according to the type of color ones trying to engrave.

4. **Only vector objects can be engraved in color.** That is because the infill will play an important part in engraving. Bi-directional or Optimization Two-Way hatching are mainly used for color engraving. If you wanted to use a rasterized image then the tracing parameters will need to be used.

5. **Do not engrave in high power.** The material will not engrave color properly or at all if the material gets too hot.

In the following pages we will explain in more detail how these properties can affect color engraving.

Section X. Color Engraving

Color Engraving Parameters:

Frequency:

Fiber lasers work by emitting light in fixed intervals. By increasing the frequency the intervals are shortened. This causes the laser to be fired with greater power and subsequently makes darker engraving. However, if the frequency is too high certain material can potentially catch fire. However, for stainless steel we have to worry about a different effect.

By increasing the frequency of the laser machine the stainless steel will be heated up fairly quickly. This can affect the color engraving process. If the material is too hot it will not engrave in color. There is an on the off chance that it will engrave in color however the color will look different once the material cools down.

Hatching and Line Spacing:

Hatching types, or infills as we like to call them, is the pattern in which your engraving is done. As mentioned before Bi-directional or Optimization Two-Way hatching are used for color engraving. The way the pattern is engraved depends on the line spacing. The larger the spacing the less the object is filled in. Since we're trying to engrave colors we want to have a small infill. The ideal spacing for colored engraving is .001-.005. It's important to keep in mind that simply by changing the line spacing the colors can be different.

Focus Distance:

Fiber and MOPA lasers work by emitting two beams of light that will burn the material when they converge. For that reason these laser systems must be in focus to engrave. The focus distance is within a few millimeters, meaning if you switched from a 1mm stainless steel sample to a 2mm sample your material will still engrave without having to refocus.

This become important in color engraving because it means you can raise and lower your laser head to help get different coloring. Let's say you get a blue marking but your aiming for purple, you can try lowering the stage to get a hotter etch and could end up with a shade closer to purple.

Levelness:

You should always make sure your object is level to ensure proper engraving. Engraving in color simply adds another reason as to why to do so. As stated above, raising and lowering the laser head can change the colors. The same can apply to an unleveled object. One end of the object will have a different shaping than the other.

Rainbow Engraving:

Rainbow Engravings are engraving that slowly change color as engraved. These types of engraving can be done in both Fiber and MOPA lasers. These engraving are done in a higher line spacing of .02, a medium-low to medium speed, and medium to medium-high power, such as 45 to 70%.

Remember that this is just a General Guideline for you to help better understand how complicated engraving in color is. It's up to you to find out what method works best for your needs.

Troubleshooting & Applications

Troubleshooting:

A large amount of problems customers face centers around laser focusing. These lasers must be with its focus range to function properly. Being outside of focus will yield no mark at all. Before calling tech support, please verify that you are in focus using the black card provided. (Refer to Focusing section on pg 24.)

Issue	Possible Solution
Laser Won't Mark	• Make sure your machine is focused. If the machine is off in height by a few millimeters it will not engrave. Make sure to refocus your laser head after changing to a new material. • Verify that the material used if receptive to 1064 nanometer wavelengths.
I can't get the marks I want	• Make sure the material is usable. Some material are not meant to be cut with the Galvo. • Try some of the setting ideas mentioned in the marking applications. We have a raster and vector materials tests on our website to help you find the types of engraving you want. Visit https://fslaser.com/material-test/ for the files.
My engraving lacks depth	• May need to increase the power and/or lower the speed. • Multiple passes can add more depth. • A smaller lens can be used to engrave in more detail. • The laser may engrave even it it's not fully focused. Make sure to perform the laser focus test each time you change to a new material.
I'm having trouble focusing my laser.	• If auto-focusing with the QR tag, then make sure that the QR tag is visible in the camera throughout the process. If the QR tag get cut off from the screen, then the machine will not focus. • One can always try the manual focus. **Refer to the Focusing section on page 24.**
The Mark Adjustment square looks wobbly.	• If the camera calibration was done on a wrinkled, bumpy, or slanted surface, then the calibration will be off. • Make sure the camera is calibrated on a flat, smooth, and leveled surface.
The marking are not coming out even.	• If the material your engraving on is not flat or leveled then the material will engrave unevenly. We suggest getting something to make the engraving surface leveled beforehand.

Troubleshooting & Applications

Mark Applications:

One should keep in mind that every material will react differently based on the settings used. Materials can have different grades or alloys which will affect the engraving process. It is up to the user to determine their application and the best process for their needs. Many factors are involved when using the Galvo laser, such as speed, power, frequency, lens size, the power source (20W or 50W), focusing and material grade. This is a general list to give an idea of how one can go about getting the engraving desired.

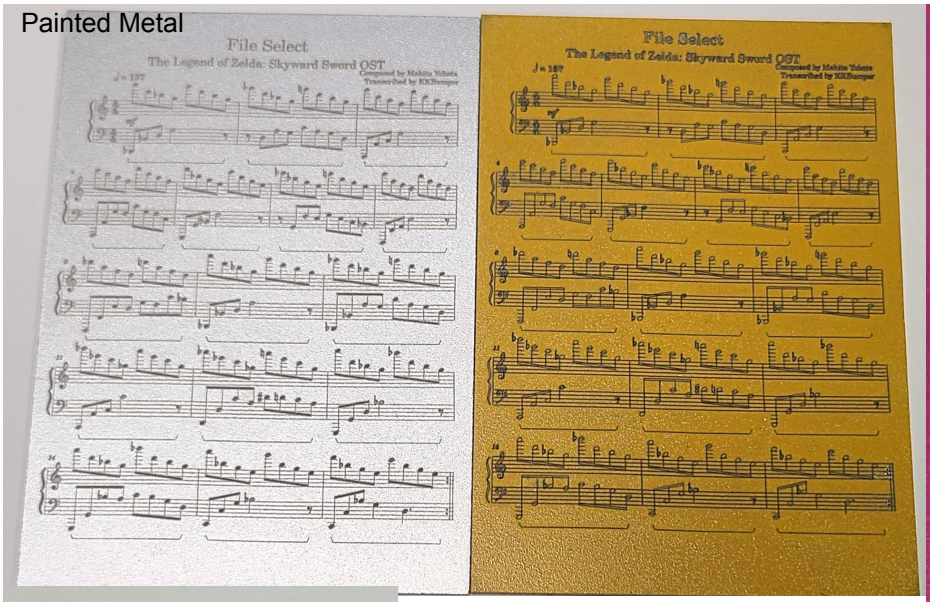
Marking Types	Methods Used
Deeper Engraving on steel	● High Power, Medium Speed, 25-50 passes ● Multiple passes can be programed. ● Low khz
Surface Marking	● 20W- High power & Low Speed ● 50W- High power & Low Speed ● 4-8mm in/out of focus
Thin Cuts	● High Power & Medium Speed ● Use wobble amplitude .1 and spacing .05 ● Low khz
Marking black acrylic (Bleaching the surface)	● Low Power, Low Speed & Low DPI
Annealing	● High Power, Low Speed & unfocused by 4-8mm ● Multiple passes ● Mid range khz

Troubleshooting & Applications

Examples

With your new laser engraver, the sky's the limit. All you need to worry about is your own imagination. In order to help spark it we picked some projects others made to help show you the potential of your MOPA.

Painted Metal



Purple
Anodized Card

Tumbler

Tin

Glass

Warranty

Full Spectrum Laser will replace or repair any defective parts free of charge within the first 30 days. Ground shipping is free with overnight shipping available at extra charge.

Full Spectrum Laser will replace or repair any defective part within the warranty period free of charge but shipping charges are the responsibility of the customer. Warranty includes parts and labor only. Shipping of defective and replacement components is excluded.

The customer may arrange their own shipping. Parts can be dropped off at our warehouse free of charge.

All defective parts must be returned to Full Spectrum Laser for evaluation before replacements are issued, unless otherwise authorized. The warranty is valid for normal use only and excludes uses not stated in manual. Parts damaged by fires are considered user error if the machine is left unattended. Always stand next to the machine with a fire extinguisher and be ready to turn it off in case of an emergency. Never operate the machine unattended.

Our lasers have a 30-day full warranty and include a 1-year extended warranty. The 1-year extended warranty excludes shipping and consumable items. All electronic items (control cards, power supplies, motors) and most mechanical items are covered under the extended warranty unless damaged by abuse. Fire damage is not covered under the warranty. Consumables not covered include, but are not limited to, rubber parts (such as tubing, belts, plastic wheels, lenses, mirrors, other optics, and laser tubes).

The original purchaser may transfer the balance of the warranty to anyone free of charge provided we are notified in writing within 30 days.After 30 days, we will only provide warranty and tech support services to the original purchaser unless a warranty transfer fee is paid.

Warranty will remain valid if product is sold. However, the buyer must request RMAs and repairs from the original purchaser unless a warranty transfer fee is paid.

NOTE: Full Spectrum Laser DOES NOT offer warranties or customer support for 3rd Party parts, including replacement laser tubes, as it may not be compatible with Full Spectrum Laser machines and can cause damage to your laser system.

Visit https://laser101.fslaser.com/support for most current warranty postings.

Customer Support

For a list of Frequently Asked Question and a series of help guides, visit us at our Help Center .

We offer a variety of free projects to help you get started, just check out our Free Projects page.

For more information on laser engraving, check out our Blog .

Financing:
We work to provide a perfect option for any budget.

For more information contact sales:

M-F 8AM-5PM PST
sales@fslaser.com
702-802-3101

Technical Support:
Are you having an issue not found in the Help Center?

Contact support:

M-F 8AM-5PM PST
support@fslaser.com
702-802-3103

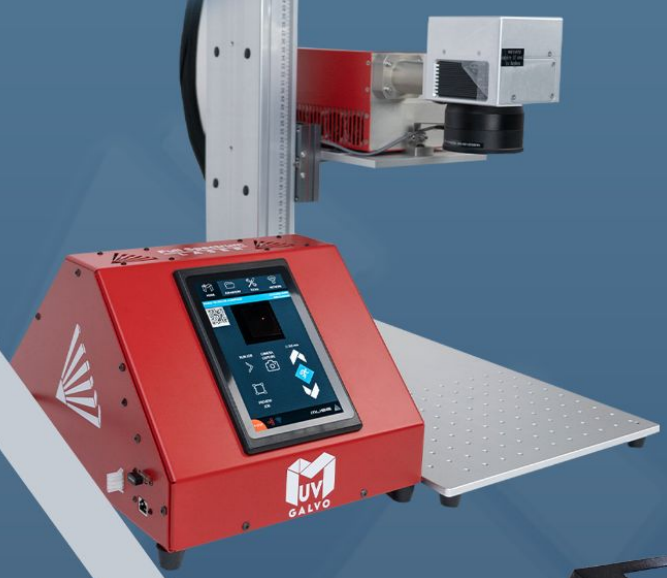
Contact Information:

Phone: (702) 802 - 3100
Fax: (702) 987 - 0150

6216 S Sandhill Rd.
Las Vegas, NV 89120

Sign into our website to check your order status or email us.

Shipping: shipping@fslaser.com
Accounting: accounting@fslaser.com



READY TO UPGRADE ?

Have you gotten the most out of your desktop laser? Have you hit the limits of your output quotas and want to see how the professionals do it? Step up to Professional Grade with P-Series and the Muse Titan by Full Spectrum Laser.

Our P-Series and Muse Titan take your production to the next level. Industrial grade components give you faster movement, better precision and increased laser power. All P-Series and Muse Titans come with our RetinaEngrave software,Motorized Z-stage, AutoFocus, Knife Edge and Honeycomb tables.

Do you have a more specific marking and or engraving application? Something to engrave the smallest of details? Look no further than the Muse Fiber Galvo and the UV Galvo. These machines are designed to capture and engrave extreme details on metal and other special materials.

Full Spectrum
LASER

JOIN THE FULL SPECTRUM LASER COMMUNITY

FULL SPECTRUM LASER INVITES YOU TO JOIN OUR COMMUNITY OF HOBBY MAKERS AND PROFESSIONAL MANUFACTURERS THROUGH OUR SOCIAL MEDIA CHANNELS (FACEBOOK, INSTAGRAM, TWITTER, YOUTUBE) WE ALWAYS HAVE SOMETHING POSITIVE TO SAY ABOUT HOBBY MAKER CULTURE OR THE INDUSTRY WE WORK IN. YOU CAN FOLLOW US AS WE CROSS THE COUNTRY GOING TO CONVENTIONS AND MAKER EVENTS OR JUST CHECK OUT ALL THE AWESOME STUFF WE MAKE. BEST OF ALL, WE OFFER ALL THOSE DESIGNS FOR ALL THOSE PROJECTS WE MAKE WITH OUR LASER CUTTERS FOR FREE. JOIN OUR COMMUNITY AND SEE WHAT ALL THE EXCITEMENT IS ABOUT

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- WWW.INSTAGRAM.COM/FULLSPECTRUMLASER
- WWW.TWITTER.COM/FULLSPECLASER
- WWW.YOUTUBE.COM/FULLSPECTRUMLASERS

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