OWNER'S MANUAL

HL40-5g

HOBBY ADVANCED LASER

R3.4 – 11 April 2013

(This Page Intentionally Left Blank)

Table of Contents

Table of Figures

(This Page Intentionally Left Blank)

Fire Warning

Laser cutting and engraving systems represent a significant fire hazard due to the extremely high temperatures generated by the laser beam. While the objective of most cutting and engraving operations is to vaporize material without burning, it is easy to ignite a flame. Most materials capable of being cut or engraved are inherently combustible and can easily ignite setting fire to the machine and threatening its surroundings.

Experience shows that vector cutting with the laser has the most potential to create an open flame. Acrylic in all its different forms has been shown to be especially flammable when vector cutting with the laser. Please also be aware that stacking materials (especially organic materials such as paper) can lead to increased risk of flame propagation or work piece ignition.

Please read the following warnings and recommendations and follow them closely at all times!

- *NEVER* leave the laser system unattended during operation.
- *KEEP* the area around the machine clean and free of clutter, combustible materials, explosives, or volatile solvents such as acetone, alcohol, or gasoline.
- *ALWAYS* keep a properly maintained and inspected fire extinguisher on hand. Full Spectrum recommends a Halogen fire extinguisher or a multi-purpose dry chemical fire extinguisher. The Halogen extinguishers are more expensive than a dry chemical, but offer certain advantages should you ever need to use an extinguisher. The Halogen extinguisher discharges a clean, easily removable substance that is not harmful to the mechanics or wiring of the laser system. The dry chemical extinguisher discharges a sticky, corrosive powder that is very difficult to clean up.
- *ALWAYS* use air assist when vector cutting.
- *BE CAREFUL* when vector cutting. Many materials have the potential to burst suddenly into flames – even materials that may be very familiar to the user. Always monitor the machine when it is operating.
- *KEEP YOUR LASER SYSTEM CLEAN* – A build up of cutting and engraving residue and debris is dangerous and can create a fire hazard. Keep your laser system clean and free of debris. Regularly remove the cutting grid to clean any small pieces that have gotten stuck or fallen through.

Introduction

Thank you for your purchase of a Full Spectrum Laser HL40-5g "Hobby Advanced" Laser System. It is our wish that this product adds value to your business or hobby activities for years to come. Please take time to read this manual in its entirety to safely use your laser to its full potential.

In order to safely setup and use your laser, you should read at least the first seven parts of this manual

Icons Used in This Manual

This icon marks Warnings and Cautions. Please pay special attention to information associated with this icon.

The fire warning icon calls attention to fire risks that are present while operating the laser.
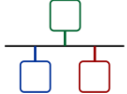
Indicates information related to connecting your laser to your computer using an Ethernet connection.

Indicates a useful tip or information that will help you operate more efficiently.

Part 1: Safety

Overview

Please carefully read all instructions before attempting to operate the laser. Never operate or test the laser without the water pump activated or with anything other than pure distilled water as a coolant. Never attempt to operate the laser with the lid open or attempt to override the magnetic lid interlock switch. Please inspect the laser tube carefully for any shipping damage and contact us immediately via email if there are any issues—please include your unit's serial number and photos of the problem.

Laser Safety

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

General Operation Precautions

The laser operator should observe the following:

- NEVER operate the machine with any of the panels removed. Be aware that removal of any portion of the cabinet will expose a Class 4 laser system and greatly increase the risk of injury and/or fire. PERSONAL INJURY AND FIRE RISKS ARE ESPECIALLY PRONOUNCED IF THE MACHINE IS OPERATED WITH THE BOTTOM PANEL REMOVED. Remember that the CO_2 laser beam is invisible!
- NEVER engrave or cut any material containing PVC or vinyl. These materials (along with other chlorine/chloride containing materials) produce a corrosive vapor that is extremely harmful to humans and will destroy your machine. *Your warranty will be void if your machine is damaged by corrosion from engraving or cutting PVC or vinyl.*
- NEVER engrave or cut any unknown material. The vaporization/melting of many materials, including but not limited to PVC and polycarbonates, can give off hazardous fumes. Please refer to the MSDS sheet from the material manufacturer to determine the response of any work material to extreme heat (burning/fire hazard).

- NEVER operate your machine unattended. There is a significant risk of fire if the machine is set improperly, or if the machine should experience a mechanical or electrical failure while operating.
- ALWAYS use the air assist, especially while vector cutting. Vector cutting movements are relatively slow and apply an extremely large amount of heat to the work piece. This buildup of heat can cause a significant fire risk.
- DO NOT disassemble the machine or remove any of its protective covers while the unit is plugged in.
- DO NOT defeat the door interlock.
- DO NOT look into the beam of the Alignment Laser (visible red diode laser)
- DO NOT operate the Alignment Laser without the focus lens in place. The unfocused beam can be reflected out of the chassis.
- NEVER operate the machine without a properly operating ventilation system. Most materials produce an irritating smoke when engraved. Some materials, including but not limited to paint, varnish, composition board and plastics, produce compounds that can be harmful if concentrated.

Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The standard reference for laser safety is the American Standard for the Safe Use of Lasers, Z136.1-2000, developed by the American National Standards Institute (ANSI). This reference is the basis for many of the federal regulations for laser and laser system manufacturers, and for the Occupational Safety and Health Administration (OSHA) laser safety guidelines. It contains detailed information concerning proper installation and use of laser systems. While the ANSI standard itself does not have the force of law, its recommendations, including warning signage, training, and the designation of a laser safety officer, may be compulsory under local workplace regulations when operating laser systems above Class I. It is the operator's responsibility to ensure that the installation and operation of the Full Spectrum Laser Hobby Advanced Laser System is performed in accordance with all applicable laws. Copies of ANSI Standard Z136.1-2000 are available from:

Laser Institute of America

12424 Research Parkway, Suite 125

Orlando, FL 32826

(407) 380-1553

Electrical Safety

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

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

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

Fire Safety

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

Experience shows that vector cutting with the laser has the most potential to create an open flame. Acrylic in all its different forms has been shown to be especially flammable when vector cutting with the laser. Please also be aware that stacking materials (especially organic materials such as paper) can lead to increased risk of flame propagation or work piece ignition.

Please read the following warnings and recommendations and follow them closely at all times!

- *NEVER* leave the laser system unattended during operation.
- *KEEP* the area around the machine clean and free of clutter, combustible materials, explosives, or volatile solvents such as acetone, alcohol, or gasoline.
- *ALWAYS* keep a properly maintained and inspected fire extinguisher on hand. Full Spectrum recommends a Halogen fire extinguisher or a multi-purpose dry chemical fire extinguisher. Halogen extinguishers are more expensive than a dry chemical, but offer certain advantages should you ever need to use an extinguisher. The Halogen extinguisher discharges a clean, easily removable substance that is not harmful to the mechanics or wiring of the laser system. The dry chemical extinguisher discharges a sticky, corrosive powder that is very difficult to clean up.
- *ALWAYS* use air assist when vector cutting.
- *BE CAREFUL* when vector cutting. Many materials have the potential to burst suddenly into flames – even materials that may be very familiar to the user. Always monitor the machine when it is operating.
- *KEEP YOUR LASER SYSTEM CLEAN* – A build up of cutting and engraving residue and debris is dangerous and can create a fire hazard. Keep your laser system clean and free of debris. Regularly remove the cutting grid to clean any small pieces that have gotten stuck or fallen through.

Compliance Statement

The Full Spectrum Laser HL40-5g "Hobby Advanced" Laser System is a class 3R laser product, as defined in International Standard IEC 60825-1.

The Full Spectrum HL40-5g complies with 21 CFR 1040.10 and 1040.11, the Federal Performance Standards for Light-Emitting Products, except for deviations pursuant to Laser Notice No. 50, dated July 16, 2001. The Center for Devices and Radiological Health of the US FDA issued Laser Notice No. 50 to permit manufacturers to classify and manufacture their products in accordance with the International Standard.

21 CFR 1040 and IEC 60825-1 require that certification, identification and warning labels be placed on laser products. Reproductions of the labels found on the Full Spectrum Hobby Advanced Laser System follow, with locations specified:

1. Certification/Identification Label. This sticker is located on the rear of the machine. Any updates to the information (date of manufacture and manufacturer address) are added as adhesive overlays.

Full Spectrum Laser LLC
7310 Smoke Ranch Rd., Unit D
Las Vegas, NV 89128 USA

Authorized Representative:

Model Number: HL40-5g-110
Serial Number: HL40-5g-00000
Date of Manufacture: July 2012

Class 3R Laser Product

This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001

This product complies with IEC 60825-1: 2001

Mass: 30kg MAX

Warning Label. This label is located on the rear of the machine, above the Certification Label.

3. Explanatory Label. This label identifies the classification of the HL40-5g in accordance with IEC 60825-1. It is located on the rear of the machine, next to the Warning Label.

LASER RADIATION
AVOID DIRECT EYE EXPOSURE
CLASS 3R LASER PRODUCT

5mW CW MAXIMUM 400 - 700nm
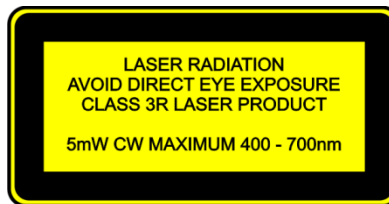
4. Non-interlocked Protective Housing Safety Labels (5).

Two exterior labels located on left and bottom panels. Two interior labels located on the bottom of the power supply and the side optics riser #1 so that the labels are visible when the covers have been removed. One label located on the right tube access panel.

CAUTION - CLASS 4 VISIBLE AND
INVISIBLE LASER RADIATION
WHEN OPEN

AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
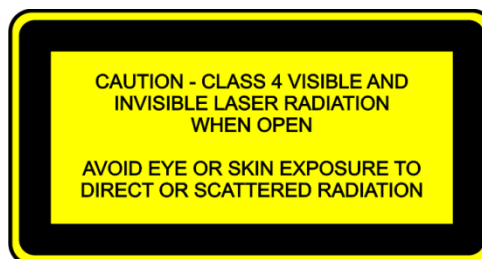
5.   Defeatably-interlocked Protective Housing Safety Label. This label is located on the machine's cabinet door, in the lower right-hand corner.

CAUTION - CLASS 4 VISIBLE AND INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED

AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION
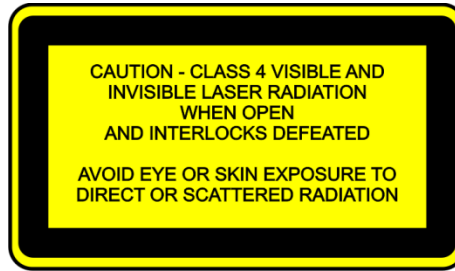
6.   Aperture Safety Label (2). This label is located on the left slider of the Y gantry and on the main aperture of the laser tube.

LASER APERTURE

7.   Electrical Safety Label. This label is located on the right panel of the machine.

DANGER

HIGH VOLTAGE INSIDE CABINET

DISCONNECT POWER BEFORE OPENING PANEL
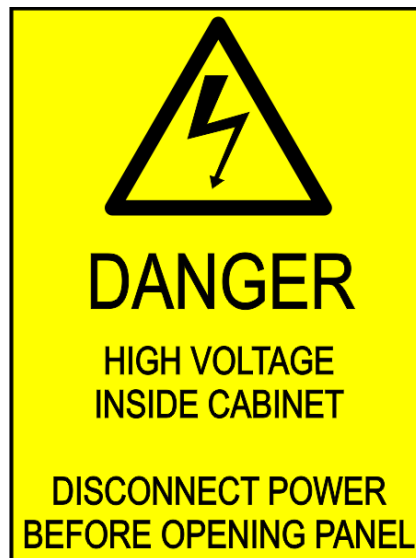
8. Fire Warning Label

This fire hazard label is located on the right side of the top panel of your laser system:

DANGER

FIRE HAZARD

**DO NOT OPERATE
MACHINE UNATTENDED**

USE EXTREME CAUTION WHEN
CUTTING FLAMMABLE MATERIALS
SUCH AS WOOD OR ACRYLIC.

A PROPERLY MAINTAINED FIRE
EXTINGUISHER SHOULD BE KEPT
NEAR THE MACHINE AT ALL
TIMES. FULL SPECTRUM LASER
RECOMMENDS A CO_2 FIRE
EXTINGUISHER.

Part 2: Getting Started

Setting Up Your Laser System

Setup of the Hobby Advanced laser usually takes less than 30 minutes, but there are a few things you will need to take care of before it arrives:

- Purchase distilled water for cooling the laser. Your laser comes with a pump and tubing for circulating the water through the tube and back into a reservoir. *Please make sure to only use distilled water—neither filtered nor de-ionized water will work and tap water will cause deposits that can destroy your tube and void the warranty.*
- Purchase a container to act as a reservoir for the distilled water. Be sure to check the container regularly to ensure that the water remains clean and deep enough to cover the pump.
- If you did not purchase an exhaust system from Full Spectrum, you will need to purchase and install one. *You may need a contractor to install the exhaust. This must be done **prior** to installation of the laser system.*

Once your laser has arrived, you will need to do the following to set up your machine:

- Remove the laser and accessories from the box
- Connect the exhaust, cooling and air assist systems
- **Remove the zip ties (3) that secure the drive belts during shipping**
- **Remove the zip tie that secures the laser head**
- Connect electrical power
- Connect the laser to your computer using an Ethernet cable
- Install the latest version of RetinaEngrave (download information can be found in the shipping box)

Notes:

- Please do not throw away the laser's box and packaging, you may need it later.

Parts and Accessories

Your laser shipped with the following included parts and accessories:

Table 1 - Included Accessories

	Description	**Quantity**
1.	Laser engraving machine	1
2.	Software Download Sheet and QuickStart Guide	1
3.	Water pump	1
4.	Water pump connection hose	2
5.	Honeycomb cutting table	1
6.	Power cable	1
7.	Ethernet cable	1
8.	2in lens focus gauge (1.32in)	1
9.	Eccentric wheel and 4mm nut adjustment tool	2
10.	2mm hex key	1
11.	2.5mm hex key	1
12.	M3 Thumbscrew	2
13.	M3 Fender Washer	2
14.	M3 tooth lock washer	1
15.	Focus Lens Assembly	1

Attaching the Focus Lens Assembly

The focus lens assembly (1) is pre-installed at the factory. It attaches to the focus head using one M3 thumbscrew and two M3 spring washers. Attach the air assist tube to the push-to-connect connector (2) once the head has been secured. Run a job with the laser OFF to verify the air tube will not interfere with the beam path or rub against the X rail while engraving.

1
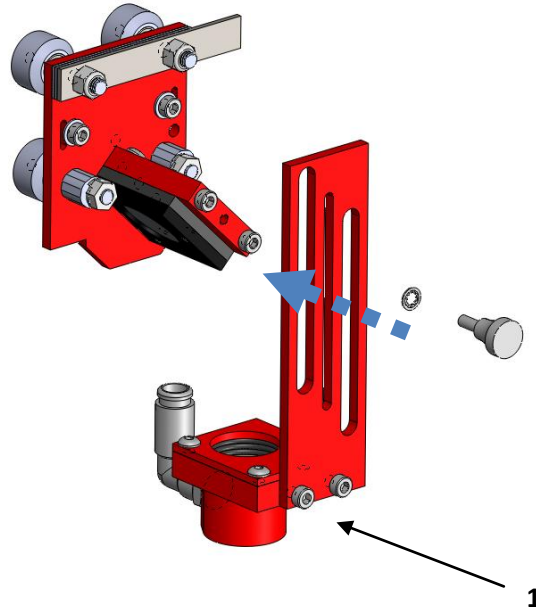
Figure 1 - Focus Lens Attachment

2
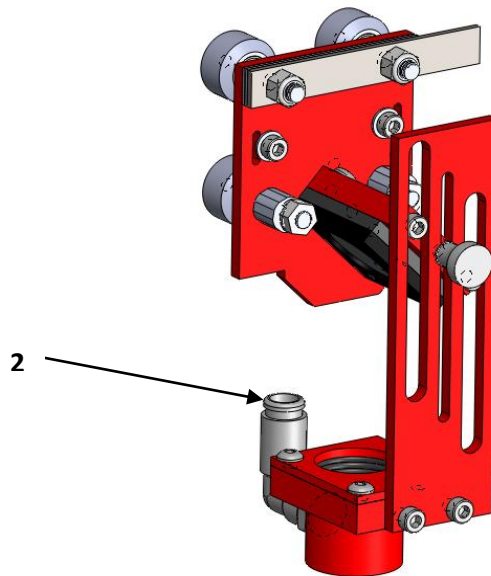
Figure 2 - Air Assist Attachment

[11]

Connecting the Exhaust

It is mandatory that an exhaust blower is connected and operating whenever you run a job on your laser. The exhaust blower removes smoke and fumes from the case and exhausts them to the outside of the building. You should never operate your laser without a working exhaust. Full Spectrum recommends exhaust systems capable of 60-100CFM. Keep in mind that exhaust systems with high flow rates may require fixtures for thin materials.

Caution – It is important that either rigid or flexible metal ducting be used in the exhaust system. Any type of "soft" ducting is potentially flammable and should be avoided.

In the United States flexible aluminum ducting can be acquired from the following locations:

- Your local hardware store
- McMaster-Carr http://www.mcmaster.com/

Supplier	Size	Part Number	Cost
McMaster	4in ID	55335K42	$7.75/ea (26" compressed, 7' extended)

Exhaust Blower Connection

You will find a 4" (100mm) exhaust flange with the accessories for your laser. The flange must be attached to the rear of the Hobby Advanced chassis in order to connect an exhaust blower.
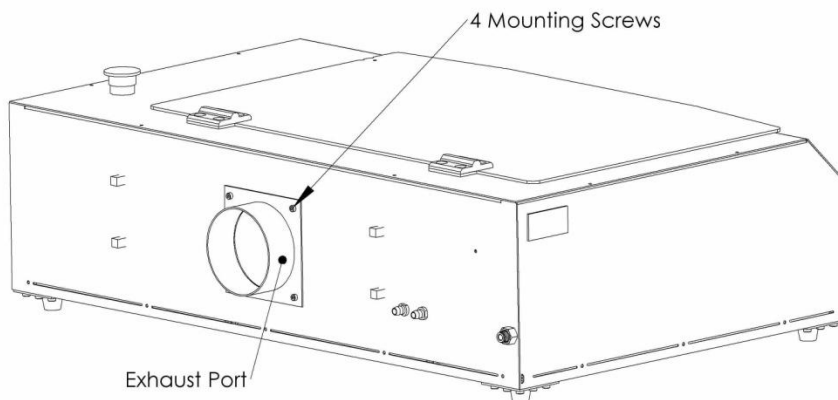
Figure 3 - Exhaust Blower Connection

Secure the exhaust port using the included screws and nuts.

Once the exhaust flange is installed, use flexible metal tubing to connect the laser system to the exhaust system. Check your system for leaks—most can be remedied with duct tape. Please be aware that the protective housing is not designed to be air-tight; the front grill is designed to allow an exhaust system to draw fresh air through the work area.

Connecting the Water Pump and Air Assist Compressor

Your HL40-5g laser uses a water-cooled continuous beam CO_2 laser tube. The tube requires a flow of room-temperature water to regulate the temperature of the resonance chamber. Your purchase includes a water pump for cooling the laser tube. A low-flow air compressor for vector cutting gas assist is available as an optional accessory.

NEVER FIRE THE LASER WITHOUT A CORRECTLY CONNECTED AND POWERED WATER PUMP. FIRING THE LASER WITHOUT TURNING THE PUMP ON OR, WORSE, WITH NO WATER IN THE SYSTEM, WILL SEVERLY DEGRADE OR DESTROY YOUR LASER TUBE AND VOID YOUR WARRANTY.

Please make sure that there are no air bubbles inside of the water jacket of the laser tube. Air bubbles can create local hotspots in the resonance chamber and reduce the lifetime of your tube. If present, water bubbles typically migrate to the electrodes on either end of the tube. You should visually inspect the laser tube to make sure that bubbles are not present; slightly tilting the laser while powering on the circulation pump is usually sufficient to remove bubbles.
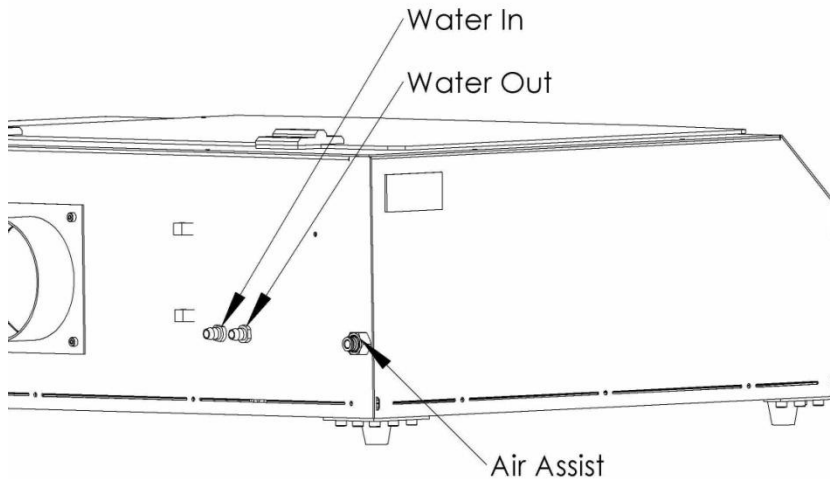
Figure 4 - Air and Water Connections

The tube is cooled by a circulation pump. The pump must be submerged in a container of distilled water (distilled water is available from any grocery chain—most customers use a 5gal paint bucket as the reservoir) with one of the two provided silicone tubes being connected from its output to the **Water Inlet** fitting. The other tube is connected to the **Water Outlet** fitting and is left to drain back into the reservoir.

The water inlet and outlet are the two barbed connectors on the rear of the laser to the right of the exhaust flange. The left one is the water inlet and the right is the water outlet.

Air is used as a pressurized gas to assist in cutting and engraving operations. The pressurized air is critical to safe and efficient cutting operations as it not only helps cut through material more quickly, but also helps prevent the formation of flames.

On the far right side of the machine is a push-to-connect fitting for the air assist input. Simply push the included ¼" plastic tube into the connector (press on the plastic flange while pulling on

the tube to remove it). Make sure that the other end of the tube is connected to the air compressor.

Third-Party Air Assist Systems

If you choose to attach your laser to a 3rd party air compressor, make sure to use at least one stage of air drying and air cleaning (5 micron filter recommended) and limit the input pressure to no more than 30psi. Low-quality compressed air can damage your focus lens.

Connecting Electrical Power

The Full Spectrum Hobby Advanced Laser System and available accessories are configured to accept 110VAC at 60Hz. 220VAC units connect to power through an included converter (single-phase 220VAC).

The electrical cord is found among the accessories. The power cord plugs into a C14 power receptacle located on the right side of the machine in the lower rear. The laser system itself draws approximately W of power and can be run off of most circuits without modification. However please be aware that the accessories will increase the circuit load; the most significant power draw usually comes from the blower/exhaust system. Consult the manufacturer's information and manual for the operating parameters of your exhaust system.

Notes:

- **Power On/Off**: the laser's power is controlled by the large red button (e-stop) located on the top of the case in the far right. This is a normally-open twist to release button. To power the laser down, simply press the button down until it locks. To power the laser up, twist the button clockwise according to the indicating arrows on the surface of the button.
- The laser system is equipped with a fuse on the power inlet to protect the machine from surges or short circuits. The fuse is user-changeable (machine ships with 10A fuse installed).
- **In case of a blown fuse**: determine the cause of the overload before replacement to protect the machine from damage.
- **Caution**: do not replace the installed 10 amp fuse with a fuse of a higher rating. This will void your warranty and the electronics will not be adequately protected from surges or short circuits.

Part 3: Connecting the Laser to Your Computer

All Full Spectrum Laser Systems are designed to be used with either 32 or 64 bit versions of Windows 7. Full Spectrum Laser recommends a system with the following minimum specifications:

Intel® Core™ or AMD Athlon™ II processor

Microsoft® Windows® 7 64-bit with Service Pack 1

6GB of RAM

The Hobby Advanced can connect to your computer via either Ethernet or USB (but not both simultaneously). Full Spectrum includes an Ethernet cable in the laser accessories and recommends the use of Ethernet cables as USB is more prone to electrical interference.

Your laser must be connected to your computer in order to download jobs. The laser can store jobs in its onboard memory while powered, however loss of power will cause stored jobs to be lost. If you purchase and install a mini-SD card, you can download jobs to your laser and run them without a computer attached (however you will not be able to alter the job settings from the laser control panel). Because an SD card is not volatile memory, jobs are stored between power cycles.

Notes:

Ethernet

- If your laser is located more than 6ft from your computer, you will need to use the Ethernet connection.
- Connecting via Ethernet while the power is on requires you to power cycle your machine in order to obtain an IP address.

Part 4: Installing the Full Spectrum RetinaEngrave3D Software and Drivers

Overview

RetinaEngrave 3D is the combination print driver and control software that communicates with, downloads jobs to and controls the laser system. It is available on the Full Spectrum downloads page. Your username and password can be found on the information sheet included with your laser's accessories. Installation is quick and easy: just download the latest software package, extract the .zip file, run the executable installer and follow the on-screen prompts.

RetinaEngrave3D Installation Procedure

1. Follow the instructions on the included software download sheep to login and download the latest version of RetinaEngrave (.zip archive of several files)
2. Extract the installation executable (current version as of this writing: "RetinaEngrave3D-4.32.9122.exe") to a folder of your choice
3. Run the executable. Make sure to allow access to the internet and allow the program to make changes to the hard drive

4. Follow the on-screen instructions:

5. Read and agree to the software license agreement:
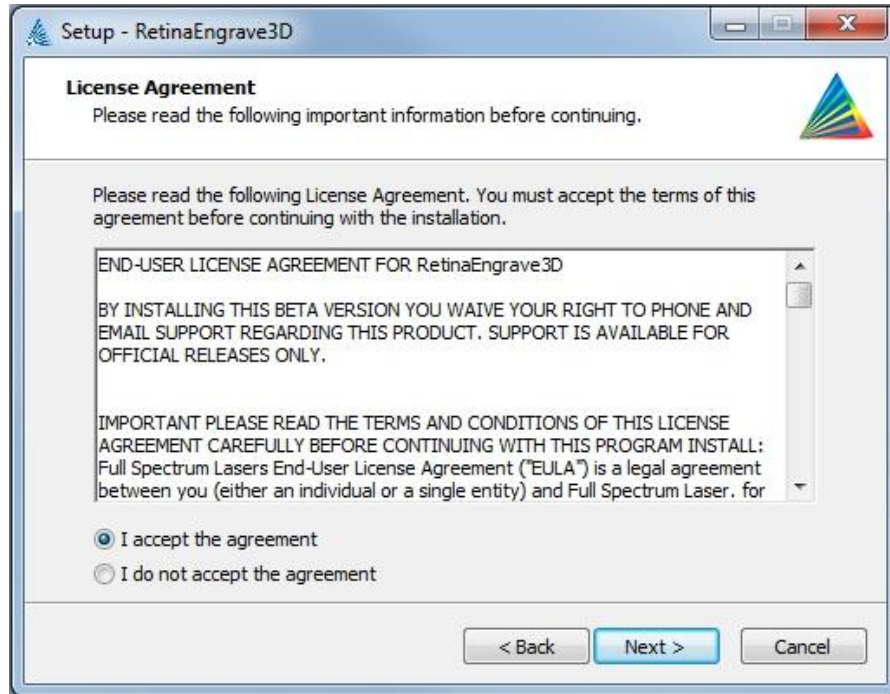
6. Select a destination folder for the program and its components
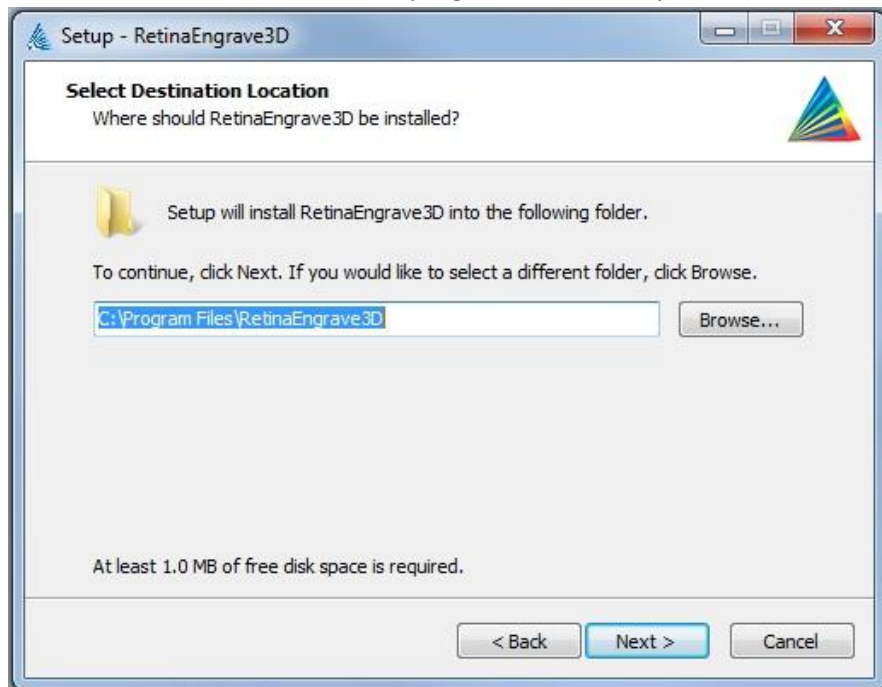
7. Select the type of installation you would like. The **Full Installation** is recommended.
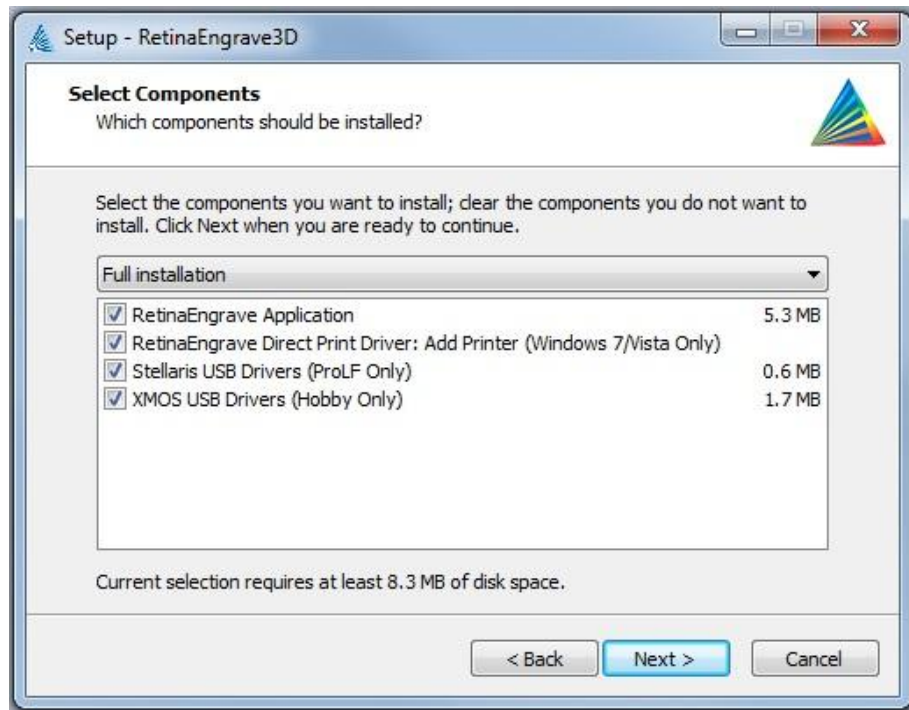
8. The installation can take several minutes to complete. Once it is finished you will be able to open RetinaEngrave and make simple designs or start printing to the software directly from other applications.
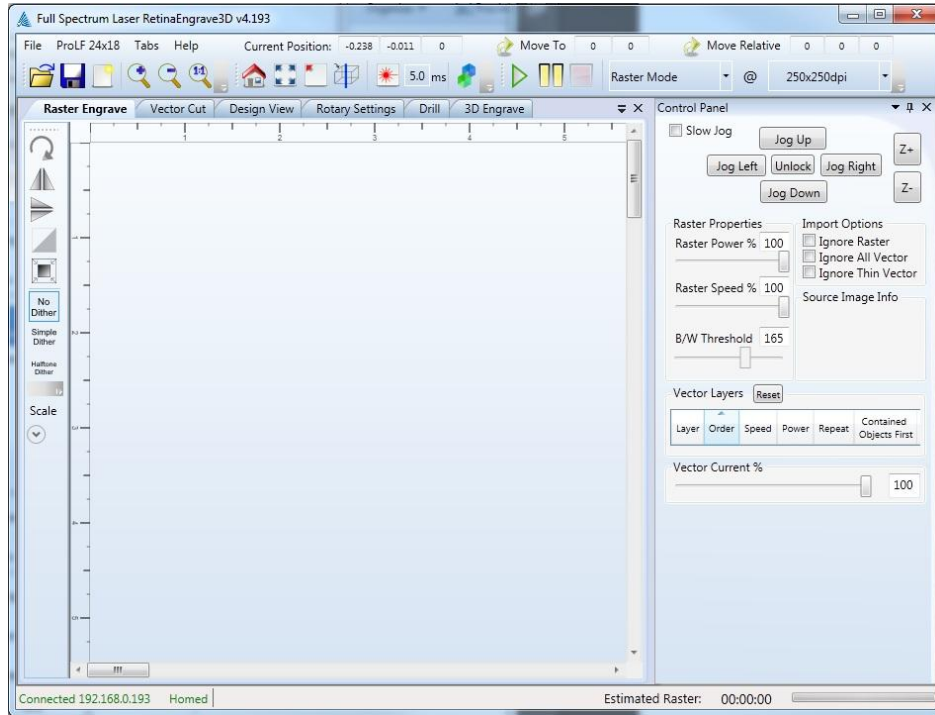
RetinaEngrave3D and Network Connectivity

Please note that in order for your laser to connect to RetinaEngrave3D, RetinaEngrave **must** have networking privileges. You may have to modify the permissions of RE3D in your antivirus software and/or your Windows security settings to give it explicit permission to access the network and internet.

Part 5: Control Panel Interface

Overview

Your Hobby Laser system is powered by our advanced 3D PRO controller, which can perform basic functions (alignment and test) without requiring a PC connection. Installation of a microSD card will allow you to permanently store jobs created in our RetinaEngrave software on your laser and thus free up your PC for more important tasks (like surfing the internet).

Once you have prepared a job in RetinaEngrave, you can start the job immediately or download the job to the onboard memory of the laser. To run a downloaded job, there is an additional step of loading the job in the controller's memory before pressing "go". This is done using the LCD touch panel:

1. Press the **Mode Select** button (**FS/Z**) until the MODE field reads "FF".
2. The SELECTION field should read "filename.bin", where "filename" is the name of the job file you loaded.
3. Press the Start/Cancel button (button 6) to load the job.
4. Press the Start/Cancel button again to run the job.

The LCD touch panel also allows you to control the basic functions of your laser without needing to connect a PC. This is very convenient during alignment and testing procedures.

Notes:

Ethernet
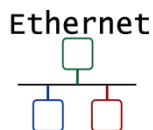
- If the laser system does not find a DHCP server while booting, it will assign itself an IP address. This address is displayed on the screen after boot—the self-assigned IP does not change between power cycles.
- The panel uses capacitive sensing which requires contact with skin to operate.
- The panel is quite sensitive and can often sense changes through thin fabrics (a cotton shirt). Please take note of this and avoid leaning on the panel during maintenance.
- The control panel interface is mode-based, meaning that each button's function depends on the currently-selected mode.

Panel and Display

Figure 5 – Control Panel

The LCD screen has two lines and gives operations information in four fields:

- The **SELECTION** field is located on the top line and gives information on the current operation mode of the laser
- The **MODE** field is located on the far left of the lower line and tells the operator the current mode
- The **POWER** field displays the laser power on a scale of 0-255. During a job you can adjust from 0-255 on the fly using the up and down arrows. It is located to the right of the MODE field.
- The **ADDRESS** field displays the last 3 digits of the IP address with a character prefix. A prefix of **A** means that the laser did not find a DHCP server on its network and self-assigned an IP addres. The **D** prefix means the laser found a DHCP server.
- The **POWER** field displays the laser current in mA, or "LOff" for current less than 1mA. Sometimes this field will display 1.1mA even when the tube is off; in general, anything less than 2mA is considered off.

Button Functions

Panel function buttons are numbered 1-6 starting from the left. Jog buttons (arrow pad) continue the numbering from 7 starting at 12 o'clock and counting up counterclockwise. Typically the icons on the top line are active during Fast XY Jog (Mode 0). The icons on the bottom are typically active during Alignment (Mode 2).

[21]

During Setup

1. **FS/Z (Mode Select)**
   a. Toggles between modes
   b. Fast XY Jog (Mode 0) -> Slow XY Jog (Mode 1) -> Alignment (Mode 2) -> File Select (Mode 3) -> Factory Reset (Mode 4)

2. **Lock/Unlock**
   a. Locks or unlocks the drive motors. System cannot jog or test fire while unlocked, but laser head can be positioned by hand.

3. **Home**
   a. If in Fast XY (Mode 0) or Slow XY (Mode 1) the machine will home itself and remember the position.

4. **Return/Test Fire**
   a. In Fast XY (Mode 0) or Slow XY (Mode 1) the laser will move to the previously saved job start position.
   b. In Alignment (Mode 2) this button fires a short-duration pulse designed to mark thermal paper.

5. **Run Perimeter**
   a. In Fast XY (Mode 0) the bounding perimeter of the job will be shown quickly (RetinaEngrave software must be started/loaded with a job for this function to be active).
   b. In Slow XY (Mode 1) the bounding perimeter of the job will be shown slowly.

6. **Start/Cancel**
   a. In any menu mode (File Select or Factory Reset) this button will select the option displayed in the SELECTION field.
   b. Cancels a move operation (homing, autofocus or a running job).
   c. In Fast/Slow XY, with the laser UNLOCKED, this fires a higher-power test pulse.
   d. In Fast/Slow XY, pressing this button after the laser homes will rapidly move the head to the upper left corner of the workspace.

7. **Jog Buttons (4)**
   a. In Fast or Slow XY (Modes 0 and 1), the buttons move the laser head left/right and front/back.
   b. In File Select (Mode 3) the up and down buttons scroll through the loaded jobs.

During a Job

1. Only the **Lock/Unlock** and C**ancel** buttons function. All other function buttons are disabled.
   a. **Lock/Unlock** pauses/resumes the job.
   b. **Cancel** cancels the job.
2. **Up/Down** Jog buttons allow you to adjust the job power on the fly. Scale is from 0 (no power) to 255 (full power).

Modes

Fast XY Jog (Mode 0) and Slow XY Jog (Mode 1)

Use the jog buttons to move the laser head. Press the home button to index the laser head.

Alignment (Mode 2)

Use this mode during tube testing and mirror alignment. The test fire button fires a short-duration laser pulse that will mark thermal paper. Use the jog buttons while the motors are locked to jog the head. Unlock the motors to move the head by hand. The test fire function is enabled while the motors are unlocked. The test pulse will not fire with the magnetic safety interlock open.

File Select (Mode 3)

Navigate through *.bin* job files that are loaded on a microSD card (not included). Use the up and down jog buttons to scroll through the list and press the **Start** button to load the job. Press the **Start** button a second time to run the job.

Factory Reset Mode (Mode 4)

Use this mode to reset the laser's IP address settings to the factory defaults. Useful if you assign a static IP but can no longer connect.

Notes:

- The Hobby Laser controller has 2 hard stops and 2 soft stops on the limits of the axes. Soft stops prevent the motion system from attempting to move beyond its mechanical limits, but require a reference in order to work: the laser **must** be homed in order for the soft stops to function properly.

Part 6: RetinaEngrave3D Pro Activation

Overview

If you are a new customer, your laser's control card is shipped with an 80-hour temporary usage authorization. If you are an existing customer, this information will apply if you update your software—after the update you will have 80 hours to activate your card. The 80 hours are only counted while the laser is ON. During the temporary usage period you must connect your laser to your PC while it is connected to the internet and validate your card. Control card activation is a one-time process. This section will walk you through the validation process.

Validation Walkthrough for New Customers

1. Connect your laser to your computer (either directly or over the network).
2. Make sure that your PC has a working internet connection.
3. Turn on your laser.
4. Start RetinaEngrave.
5. RetinaEngrave will automatically attempt to connect to your laser. Alternately, you can manually select or enter its IP address.
6. Once the laser has successfully connected to RetinaEngrave a popup will appear informing you that your card is temporarily activated, the amount of hours remaining and will ask you to validate your card.
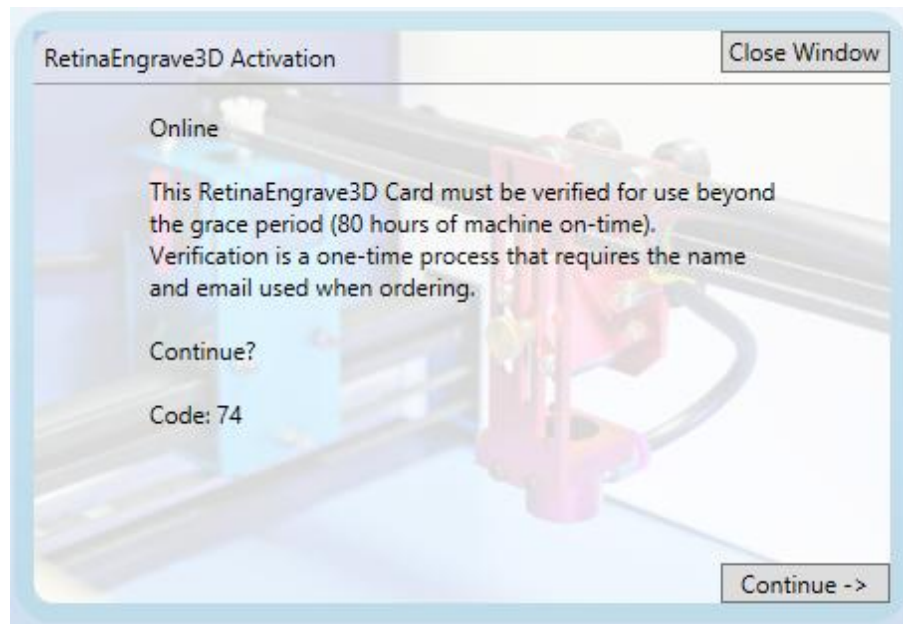
Figure 6 - RetinaEngrave3D Activation Popup

7. Click "Continue ->" to proceed to the validation information screen.

8. Fill out the fields on the validation screen with the requested information. This information should match or be close to the information you supplied with your order. If it is not, we may need to request clarification from you. Fields with a * are required.
    a. Your order number (optional; 3 or 9 digits, emailed to you from GoogleCheckout).
    b. Contact person/company (first and last name).
    c. Contact email (this should be one that is regularly checked)
    d. Comments field (optional; you can use this to provide extra information, such as a phone number). Anything you enter into this field will be attached to the record in our database and will be viewed when we process your validation. This field is also used for communications during the validation process.

Figure 7 - RetinaEngrave3D Validation Form

9. Once you have entered the information, hit "send".
10. The information will be sent to us for comparison against your order info.

[25]
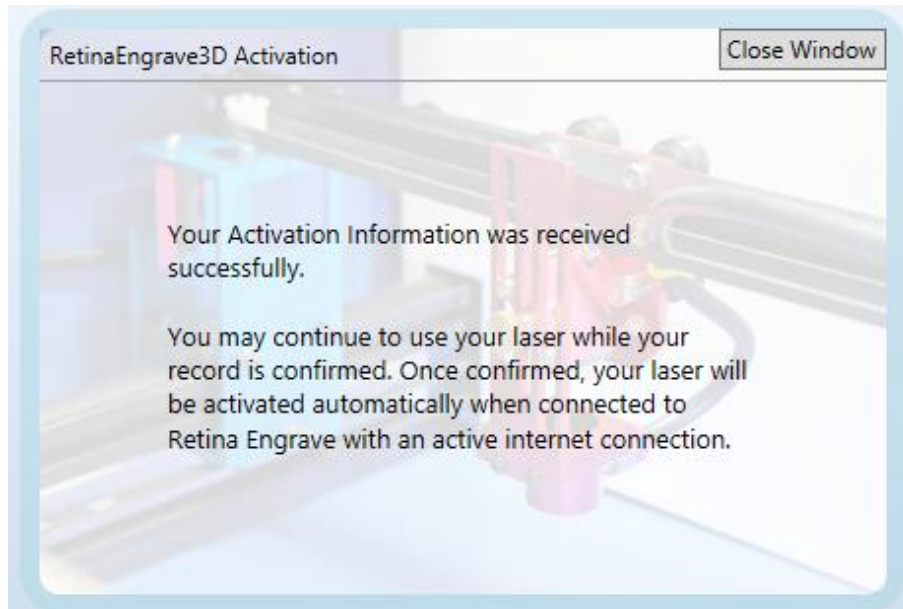
Figure 8 - Validation Information Receipt Acknowledgment

11. Once your information has been received, you will see the popup in Figure 8 .
12. Once we have verified your information, we will update the record in the database.
13. The next time your laser is connected to RetinaEngrave and the Internet, it will retrieve the updated record info and your card will be activated.

Validation Walkthrough for Existing Customers (software upgrade)

1. Download the latest version of RetinaEngrave and extract the .zip archive to a location on your PC.
2. You may or may not be required to update your laser's firmware—open the extracted folder and read any documents (Text, PDF, Word) found there for installation information. Follow those instructions first (load firmwares using your **current** version of RE3D).
3. Run the RetinaEngrave executable installer.
4. Follow the steps in the previous section: **Validation Walkthrough for New Customers**

Offline Validation Procedure

1. If you are unable to connect to your laser and the internet at the same time you will need to perform the following steps to activate your unit.
2. Connect your PC to your laser via Ethernet.
3. Start RetinaEngrave3D and ensure that you have a connection with your unit.
4. Navigate to the Help menu, and select "Create Profile Offline"
5. Again, navigate to the Help menu, and select "Save Profile to File"

6. Choose a location to save your laser's profile.
7. Connect your PC to the internet and log in to your email account.
8. Attach the laser profile file to a new email and send to activation@fullspectrumlaser.com
9. We will verify that your information matches the purchase, or send you an email if we need more information.
10. Once your profile has been verified, we will email you an activated profile.
11. Download the activated profile.
12. Start RetinaEngrave.
13. You can drag the activated profile into the workspace, or use the Help menu -> "Open Profile From File".
14. Your laser is now activated.
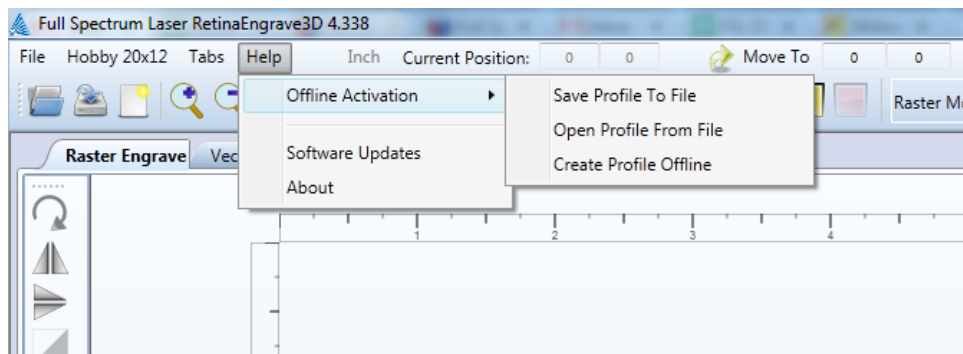
Figure 9 - Help Menu for Offline Activation

Validation Incomplete – More Information Required

If the information that you supplied during the activation process does not match any of our records, we will update your status and the next time that you open RetinaEngrave3D a popup (Figure 10) will appear notifying you that more/corrected information is required.

Figure 10 - Incomplete Validation Popup

1. Pressing "Continue ->" will take you to the validation form (Figure 7) that you submitted, with the information you supplied pre-populated.
2. The "Comment" field is used for communications between you and our support staff. We use it to provide clarification on the reasons for requesting more or updated info.
3. Based on the feedback from our staff, update the Validation form and click "Send Activation".
4. If the update was successful, the popup in Figure 11 will appear. If you attempted to re-submit without updating your information, you will receive an error message.
5. Once we have received and verified your information, we will update your record and your laser will be activated the next time that it is connected to your PC and the internet.

Notes:

- If you experience difficulties or errors with the validation process, please contact support via email and include your unit's serial number and your order number (if possible).

Figure 11 - Information Update Successful Popup

Part 7: Quick Start and Setup

Overview

Now that you have set up your laser and accessories and have installed the control software, the next step is to ensure that your laser is working properly. The tube test and mirror alignment procedures should take less than 30 minutes and will ensure that your laser is performing optimally. Your laser's main power is controlled by the twist-release switch on the top of the case.

The first thing we are going to verify is that your laser tube did not crack during shipping. This should take less than 2 minutes. The second test will check the mirror alignment and if necessary, adjust the mirrors so they are once again aligned. The laser's mirrors are aligned during assembly at our location, however shipping subjects the laser system to a great deal of vibration which can cause the mirrors to vibrate slightly out of alignment.

These tests require the following tools and materials:

- Scissors or small wire cutters (for removing axis zip ties).
- Thermal paper. This is the same paper that receipts are printed on. Used receipts work.
- Masking/painters tape. For taping the thermal paper to mirrors and apertures.
- 2mm hex key. For adjusting mirror angles. Included in accessories.
- 2.5mm hex key. For adjusting mirror mounts and angles. Included in accessories.

Before we begin testing the laser, we need to free the motion system from its shipping restraints and remove the accessories from the work area. The accessories are zip-tied to the front beam attenuator—cut the zip tie and remove the accessories. The motion system is restrained by 6 zip ties: one on the X axis drive belt, two on each Y axis drive belt and two securing the head slider. Carefully cut the zip ties, avoiding damage to the drive belts. The focusing sub-assembly is also restrained by zip ties; they must be cut in order to perform alignment.
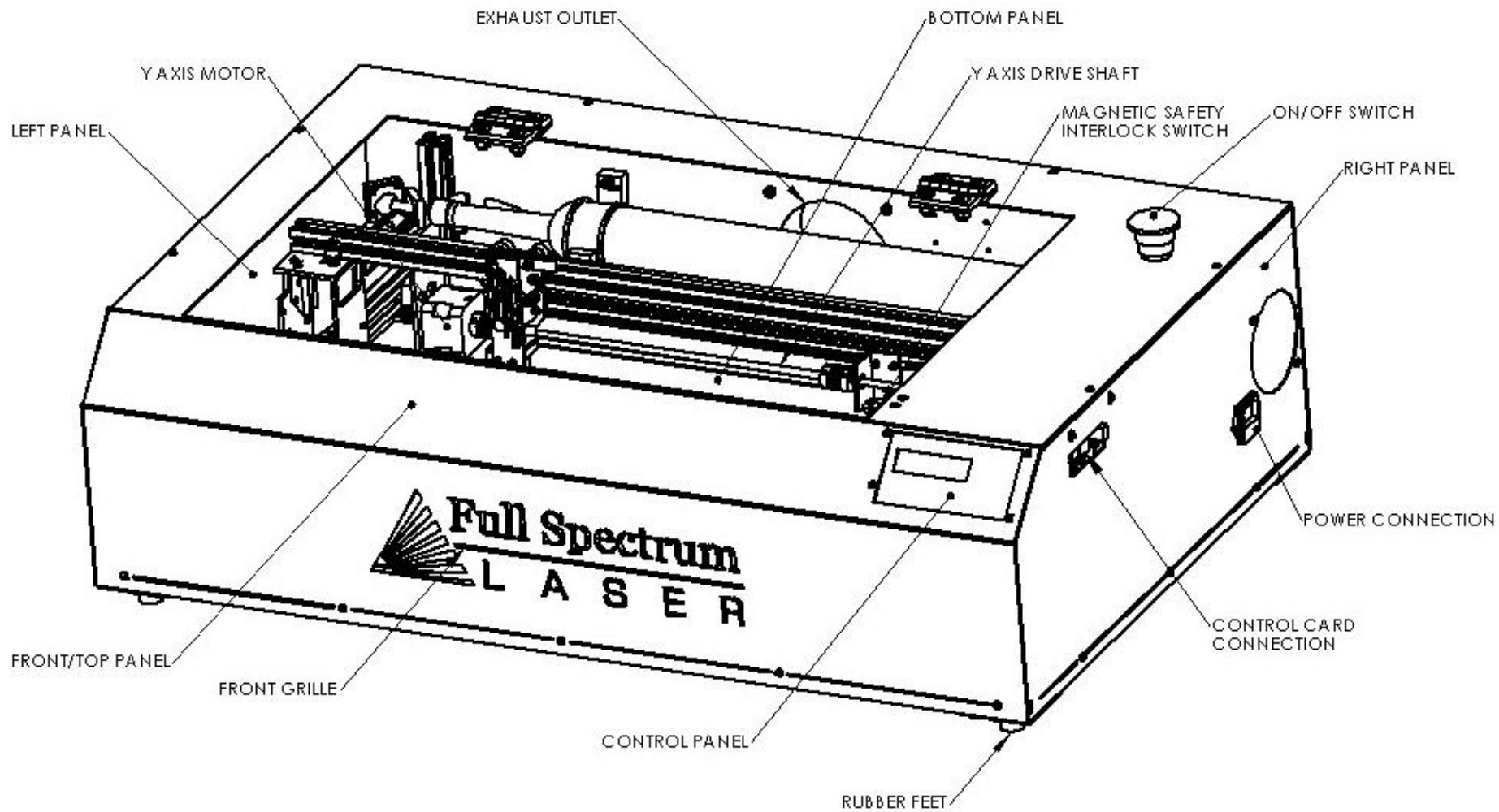
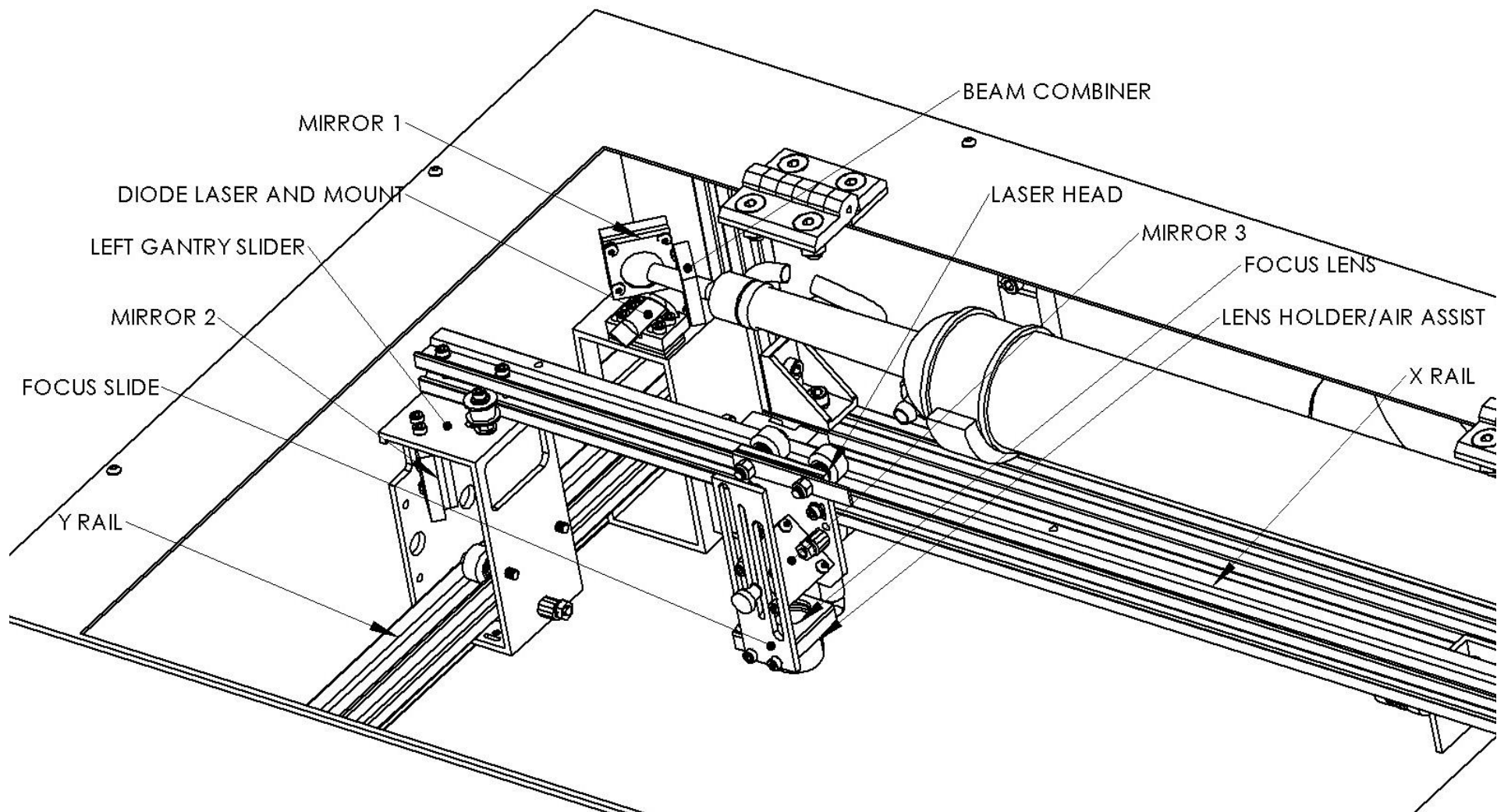**Figure 12 – Exterior Component Description**

[31]

Figure 13 - Optics and Motion Components

[32]

Laser Tube Test

In this test we are going to tape a piece of thermal paper between the laser tube aperture and the beam combiner aperture and then test fire the tube.

1. Make sure that the proper accessories are attached and engaged (water pump)
2. Open the work area cover.
3. Take a piece of thermal paper and tape between the Beam Combiner and mirror 1 with the sensitive (shiny) side facing the laser tube output. Alignment is not critical, but make sure that there is a large enough white space that can capture the beam output; the beam is approximately 5mm in diameter and will exit from the center of the tube.
4. Close the cover.
5. Place the laser into test fire mode (**FS/Z** button, toggle until menu reads "Align Mode".
6. Press the **Test Fire** button.
7. A circular black mark with diffuse edges should appear on the thermal paper. If there is interference, the mark will be occluded and/or have a very sharp edge. If this is the case, your tube is working but has come out of alignment.

You should hear a 'click' and/or see a plasma arc inside the tube (may require more than one button press). The click is from the power supply switching rapidly on then off for the test pulse. If you observe either of these actions but no mark on the thermal paper, the paper was most likely reversed or incorrectly placed. If you do not mark the paper and are not observing a noise during a test fire attempt, it is possible that the cover interlock was not properly engaged; try shifting the cover or magnet closer to the sensor. If these solutions do not solve the problem, please contact technical support at support@fullspectrumlaser.com

Mirror Alignment

Your laser was aligned during assembly and test in Las Vegas—the CO_2 beam and Alignment Laser beams were matched to follow the same path through the mirrors and fire down the center of the focusing head. However, shipping is a high-vibration environment and it is sometimes necessary to re-align mirrors. Before we go through a full re-alignment process, let's check and see what the current alignment is:

Alignment Test

1. Take a piece of thermal paper and place it above the lens on the focusing head, covering the aperture. Tape two edges so that the paper will stay relatively taut over the hole. Press your finger firmly along the edge of the aperture to make a mark on the thermal paper to show the aperture's outline.
2. Jog the laser to the upper left corner.

3. Close the lid and test fire.
4. Observe the location of the mark on the thermal paper.
5. Jog the gantry halfway along the Y axis towards the lower (front) left corner. Test fire and observe the mark
6. Jog the gantry the remainder of the way along the Y axis and test fire at the lower left corner and observe.
7. The burn mark should be relatively close to the center and should not "walk" after jogging the laser head.

If there was a great deal of variation in the location of the burn marks (more than 2mm of drift) you will need to align your laser. We recommend first aligning the invisible cutting beam with the visible Alignment Beam—this saves a great deal of time lost in opening and closing the lid for safe access while firing the laser. The procedure for this is the following:

Alignment Procedure

The New 5th Generation Hobby laser has an integrated beam combiner which greatly simplifies beam alignment. The general procedure is to first align the red beam with the invisible beam then use the red beam as the primary indicator for alignment.

1. Put a piece of thermal paper on mirror #1.
2. Press the UNLOCK button on the laser control panel. In the unlocked state, you can move the laser head around by hand and fire test dots using the TEST FIRE button.
3. Close the lid then press the TEST FIRE button on the laser control panel. A black dot should appear on the mirror. Check that this dot is round and not clipped. You may need to press the test fire button several times to get a dot. In the unlikely case the dot is still clipped after multiple test fires, the tube may be sitting at an angle causing it to hit the beam combiner. Adjust one of the clamps of the laser tube to move the tube down so it is not clipped by the beam combiner. This should not happen normally unless you changed the tube so contact FSL tech support for more details.

Not Clipped
ok

Mirror
outline
Laser fire
dot

Clipped by
beam combiner
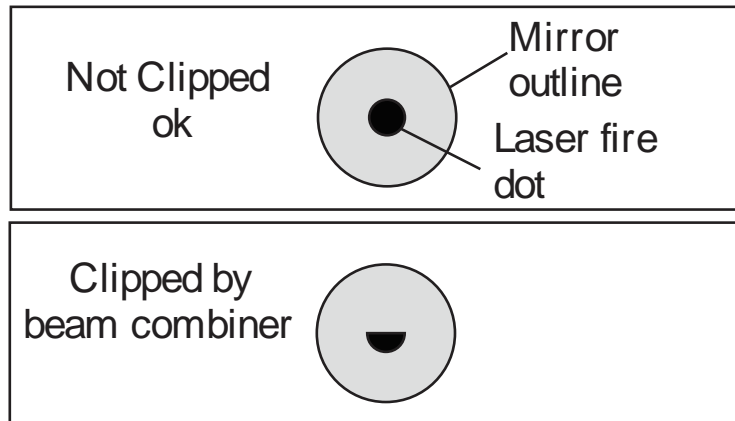
4. Move the X gantry (the long black bar) down to the lowest Y position as shown in the following picture. Put a piece of thermal paper on location #2. Fire a test pulse and observe where the black dot appears on the thermal paper.

5. Without moving the gantry and without touching any of the mirrors, adjust the red dot pointer so that the red dot overlaps with the black dot. Do this by adjusting the screws that hold the red laser in place.
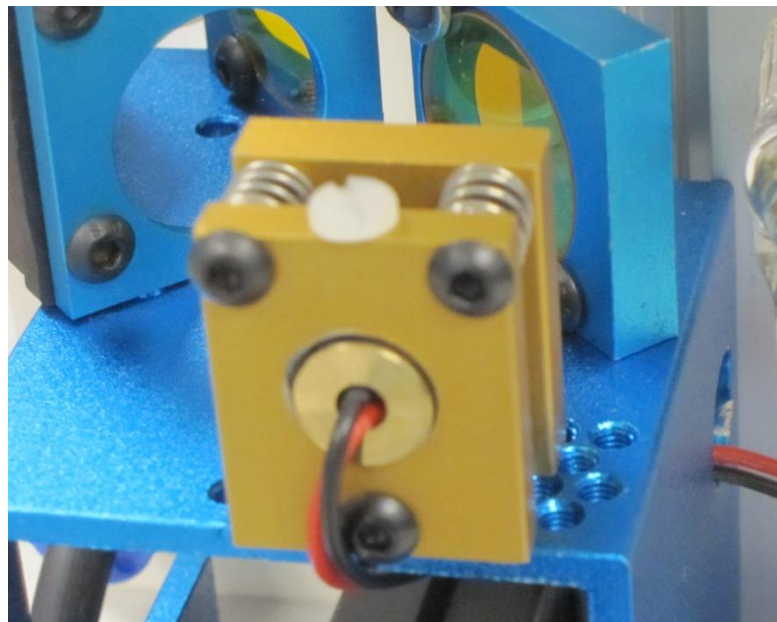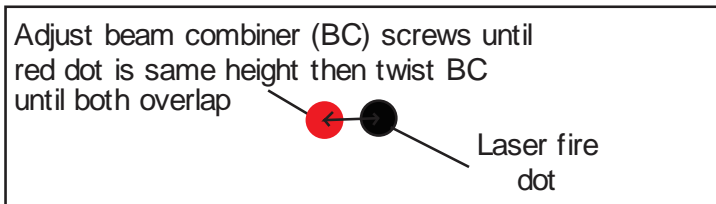
Figure 14 - Revision 2 Diode Mount

6. Once the red dot overlaps with the black dot, the red is travelling along the same path as the invisible laser beam and can be used to align the rest of the laser instead of relying on the invisible black dot.

[35]

Adjust beam combiner (BC) screws until red dot is same height then twist BC until both overlap
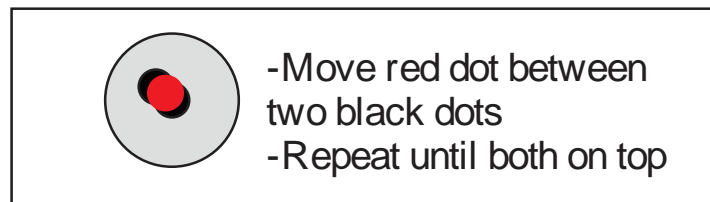
Laser fire dot

7. Move the X gantry to the top Y position. Fire another black dot onto the thermal paper. You should now have two black dots (one from the upper Y position and one from lower Y position). Move the X gantry up and down and verify that the red dot tracks from one black dot to the other black dot.

8. Move the X gantry to the lowest Y position. The red dot should now overlap with one of the black dots. Adjust mirror #1 until the red dot is in the middle of the two black dots.

Laser fire dot from bottom Y

Adjust mirror until red dot between

Laser fire dot from top Y
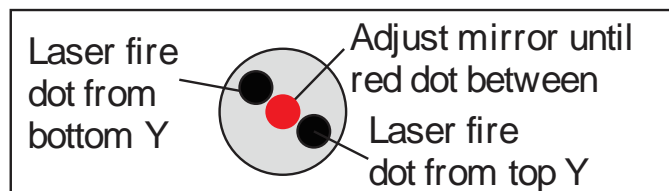
9. Use a fresh piece of thermal paper and fire a test dot with the X gantry still in the lowest Y position. Move the X gantry to the top position and fire another test dot. Now the two black dots should be closer together than in step #6.

10. Move the X gantry back to the lowest Y position. Now adjust the red dot until it moves to the center of the two black dots.

11. Repeat the process of firing two black dots on the top and on the bottom Y positions and adjusting mirror #1 to move the red dot to the center of the two black dots until the two black dots from the top and bottom Y positions are centered on top of each other.

The idea is that when the laser is not aligned, you will have two black dots from the test fires in the top and bottom positions. The red laser pointer is aligned with the invisible laser pointer so gives you immediate feedback on the mirror adjustment. By adjusting it into the middle of the two black dots, you are splitting the error difference. Usually after 1 or 2 iterations, the black dots will be exactly on top and this axis is aligned. The goal is to have the two black dots overlap exactly. **It is not necessary that the dots be in the center of the mirror but they should be somewhere on the mirror.** Mirror #1 is now aligned.

Adjust mirror until red dot between

Black dots are closer

-Move red dot between two black dots
-Repeat until both on top
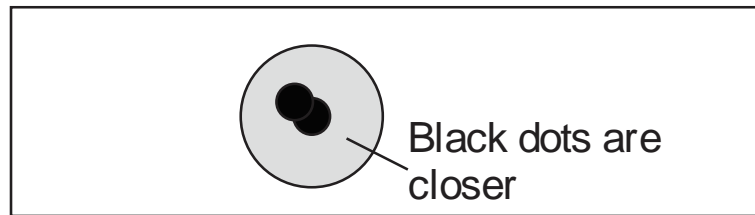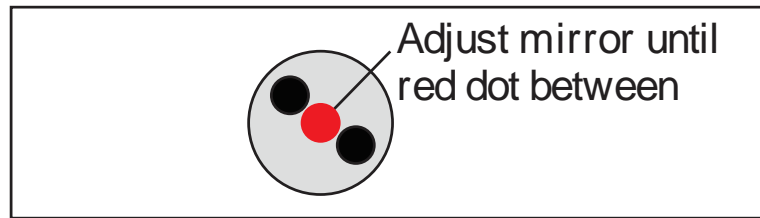
12. Once the mirror #1 is aligned, we will adjust mirror #2. Put a piece of thermal paper on mirror #3. Using the red dot, adjust the mirror until the red laser is somewhere on the mirror.

13. Move the laserhead to the far right position. Fire a test dot here producing a black dot. The red and black dot may be off slightly because the distance travelled by the laser beams is longer so any small errors are amplified. Without touching any of the mirrors, adjust the red dot to overlap with the black dot through the screws on the red laser diode mount or twisting the red laser diode mount.

14. Put on a new piece of thermal paper. Move the laserhead to the far left and fire a black dot. Move the laserhead to the far right and fire a second black dot.

15. Now you should have two black dots on the thermal paper and the red dot. Verify as you move from the left side to the right side that the red pointer tracks between the two black dots.

16. Move the laserhead to the far right. The red laser dot should overlap with one of the black dots. Adjusting only mirror #2, move the red dot between the two black dots.

Laser fire dot from far right

Adjust mirror until red dot between

Laser fire dot from far left
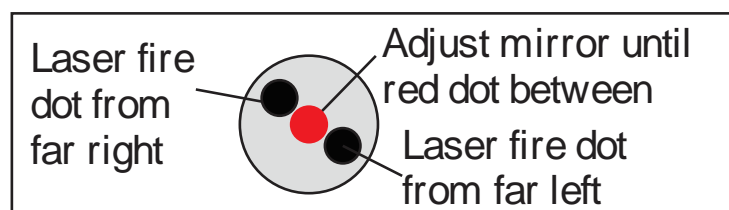
17. Replace with a new piece of thermal paper and fire dots in the far left and far right positions. Again move to the far right position then adjust the red dot between the two black dots. Repeat until the two black dots are exactly on top of each other. Mirror #2 is now aligned.
18. Once mirror #2 is aligned, put a piece of thermal paper on top of the lens. Adjust the screws on mirror #3 until the red dot is in the center of the lens. Fire a black dot into the thermal paper.
19. Move the laser head around and verify the red dot does not move away from the black dot anywhere on the laser bed. The closer you get the dots stationary, the better aligned the laser will be. You can fire black dots at the 4 corners of the laser bed and verify none of them are more than 2mm away from each other.
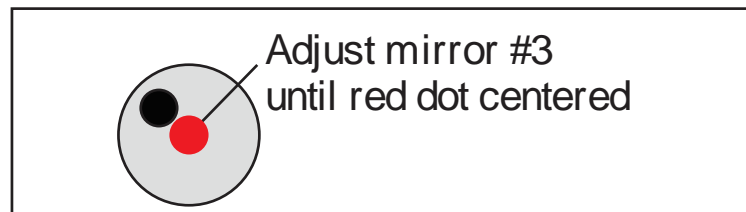
Congratulations, your laser is now aligned!

Focusing

Focusing the Hobby Advanced Laser is quick and easy. Your laser included a billet sized for the included 2-inch focal length lens. To focus for engraving or cutting, simply place the billet on the top of the engraving plane and then release the locking mechanism on the focus head until the air assist nozzle rests on top of the billet. Then re-tighten the sliding head and remove the billet from the work piece.

Laser Head Adjustment

Proper laser head adjustment is critical for high accuracy. The two upper wheels of the laser head have fixed axles and the two bottom wheels are mounted through eccentric spacers. When the eccentric spacers are turned, they tighten the bottom wheels against the underside of the black X axis rail. Too much tension and the wheels can bind up when doing high speed raster or rapid moves. Too little tension and you can see some slop in the cutting. Two special wrenches are included to adjust the wheels.

Eccentric shaft Adjustment Instructions
1. Adjusting the eccentric shafts is done by first loosening the locking nut which is pressed against the spring washer and the eccentric shaft. Use one of the included adjustment wrenches to hold the eccentric spacer in place while using the second to loosen the nut.

2. With the locking nut loosened, you can use one wrench to turn the eccentric shaft.
   a. Depending on the initial location of the eccentric, a clockwise turn can either tighten or loosen the wheel.
3. Remember to use the two wrenches to retighten the locking nut after you are happy with the eccentric nut position.

Proper Wheel Tension Instructions

The proper tension should be tested as follows:

1. Unlock the motors or turn off the machine. Grip the laser head with one hand. You should be able to turn each of the wheels relatively freely with the other hand even with the laser head held in one place. If you can't turn each wheel without moving the laser head, likely the tension is too high and one or both eccentric wheels need to be loosened.
2. Let the laser head go. Turn each of the wheels and the laser head should move. If the wheels are freewheeling then the tension is too low and the eccentrics should be tightened.
3. Check if there is any front to back tolerance in the laser head assembly. This can be tested by gently twisting the laser head about the Z and X axes of the machine. There should be minimal wobble to ensure the laser head doesn't move when the laser head rapidly changes direction. A small amount of looseness on the head is required for proper operation.

[39]

Ideally the wheels should be tight enough so if they rotate then they move the head but not tight enough that they introduce too much friction. The above wheel test is an excellent test of balance between these two.

Belt Tension

The belts of your laser should be relatively tight and have no sag; you should be able to pluck any of the belts and it should vibrate back to stiffness. Ideal belt tension is achieved by applying moderate to high pressure with one's hands to the idler pulley—no extra leverage is needed. The X idler pulley is held in place with an M4 hex nut and can be adjusted with the included eccentric adjustment key. The Y idlers are mounted on two L-shaped brackets and held with two M4 cap screws. The M4 cap screws require a 3mm hex key to adjust.
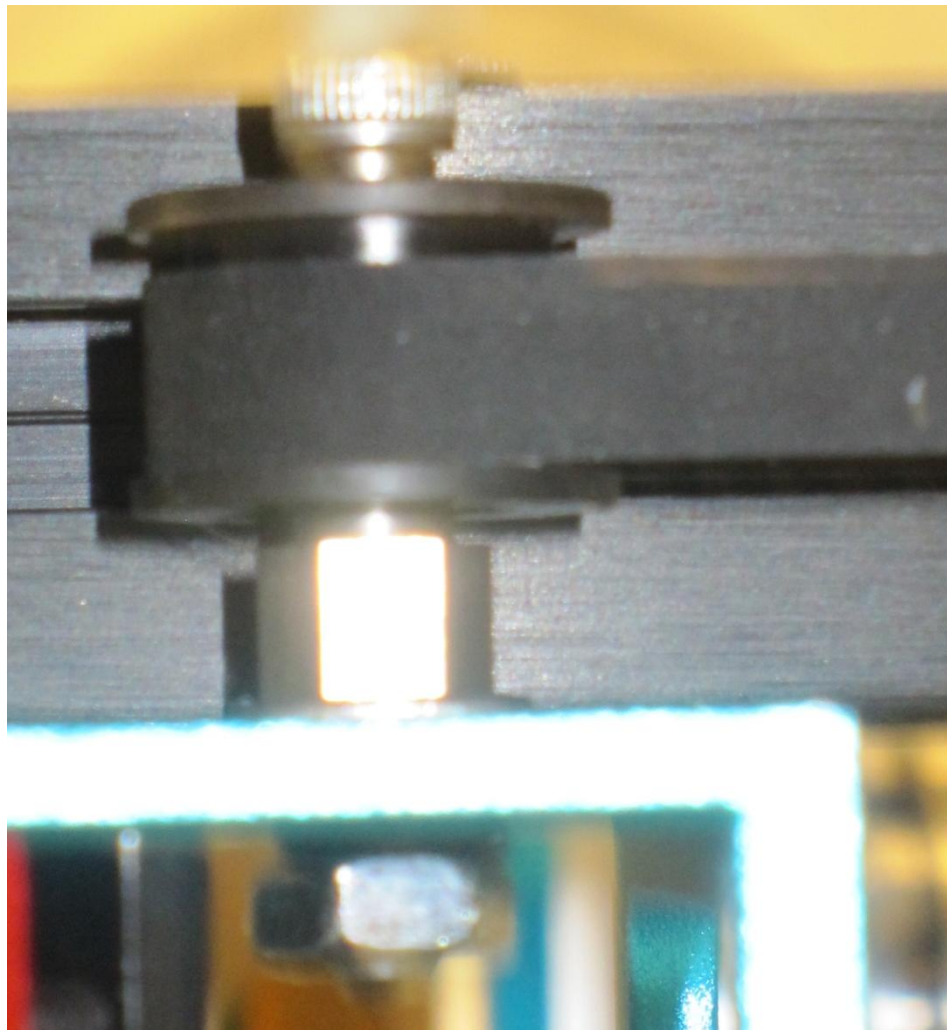
Figure 16 - Detail of X Idler/Tensioner
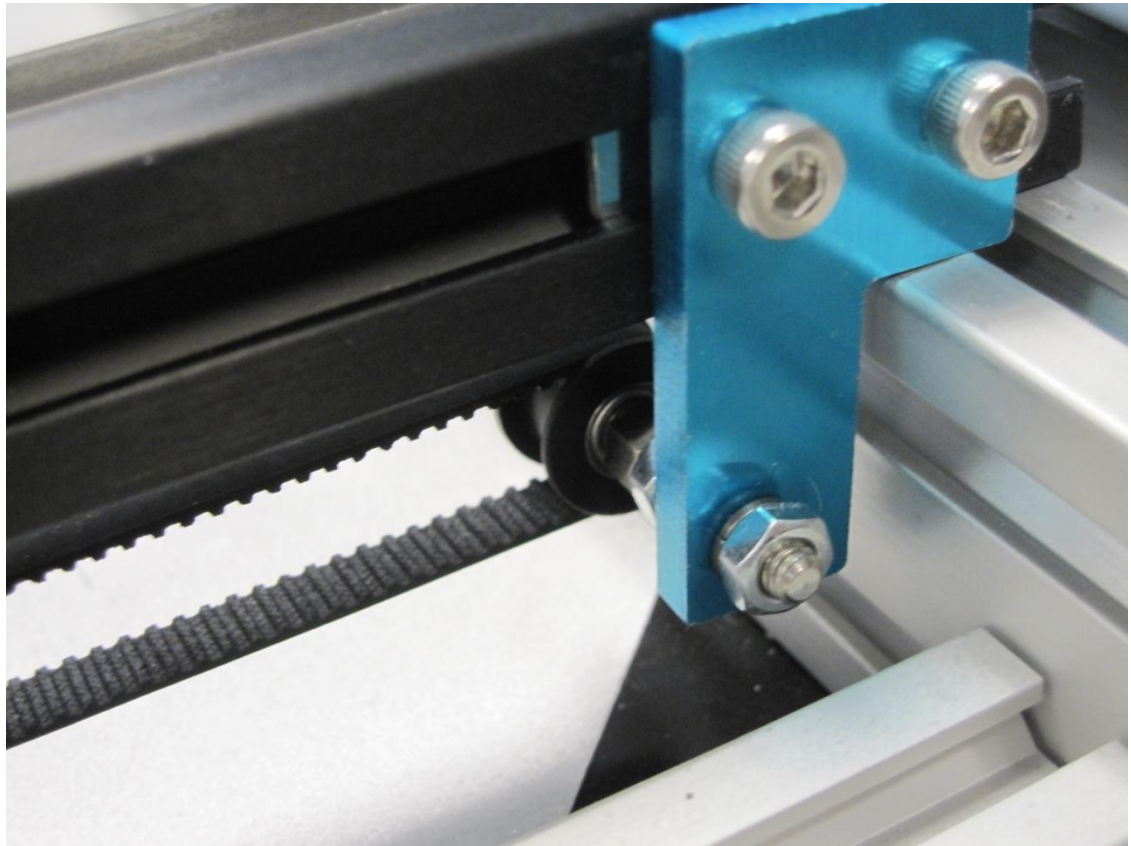
Figure 17 - Detail of Y Idler/Tensioner

Quick Start

Your Full Spectrum laser system is ready to use if you have read the manual to this point and followed all of the foregoing instructions. Please remember to use caution while operating the laser and make sure that all accessories are functioning properly before running any job. The following instructions provide a general workflow for taking an original design and turning it into a laser cut part:

1. Create your artwork/design in the software program of your choice (e.g. CorelDraw) or use the *Design View* tab of RetinaEngrave.
1. Turn on the machine and accessories and wait for it to find an IP.
2. Once the machine has an IP (approx. 30s), launch RetinaEngrave.
3. Place your piece of sample material on the honeycomb.
4. Focus the laser head onto the sample piece.
5. Close the cover.
6. From CorelDraw, call up the print menu.
7. Select the "Full Spectrum Engineering" Driver.

8. If the "Pre-flight check" fails, check that both your document page size and printer page size match the size of the work area, and that no artwork Is outside the boundaries of the page.
9. Once the pre-flight check is clear, continue printing to the software.
10. Your design will be loaded and then rendered by RetinaEngrave under the default raster tab.
11. Once you have set the power levels and layer ordering to your liking, you can run the job. If you plan to run it often, you can save the project file to a location on your hard drive.

Part 8: Software Interface

Overview

RetinaEngrave3D is the combination control software, electronics and print driver that allows you to create jobs and download them to your laser system. The full control package for your laser has four parts:

- RetinaEngrave3D print driver
- RetinaEngrave3D job software
- FSL LCD Capacitive Touch Control Panel
- RetinaEngrave3D PRO laser controller

A typical job starts with the creation of a design in your favored software. Once you are satisfied with your work, open RetinaEngrave3D then your design program's print dialog. Select the "Full Spectrum Engineering Print Driver", make sure that the "Preflight Check" tab is not giving any warnings then click on the "Print" button. Your job is parsed by RetinaEngrave and will appear in the RetinaEngrave software under the currently selected mode tab. Now you are able to review your design, make adjustments and choose the laser settings for running the job. You can start the job immediately or download the job to the onboard memory of the RetinaEngrave controller (if you have installed a microSD card). To run a downloaded job, there is an additional step of loading the job in the controller's memory before pressing "go". This is done using the LCD touch panel.

RetinaEngrave is a powerful program with an easy to use interface. It features standard keyboard shortcuts, which come in especially handy if you have a wireless micro-keyboard.

Notes:

- The software instructions in this manual are current for **Version 4.339**
- Hovering the pointer over any button will give you its name and shortcut key.
- RetinaEngrave, like the laser itself, is mode-based. Please note the type of job you wish to run (Engraving, Cutting, Design, etc) is determined by the currently-selected tab above the Job View.
- The control panel determines important job settings and allows you to move the laser head. Keep in mind that each section of the control panel only applies to its corresponding Job View tab (eg Vector Properties only affect the job in the Vector Cut tab.

Using RetinaEngrave

General Usage

Open RetinaEngrave by double-clicking the desktop icon or selecting it from the program menu.

The program must be open at the time of printing from your design software in order to capture the print stream. Alternately, you can print to an XPS print file while RetinaEngrave is not running and open this XPS file at a later time to print.

The first time that you open RetinaEngrave, you will be asked to select your laser from a popup menu. It is **extremely** important that you choose the correct laser: **Generation 5 Hobby 20x12"**. Choosing the wrong laser will cause communication errors and the laser tube will fire continuously. If you select the wrong laser, use the Laser menu and select "Change Laser" to select the proper unit.

If the connection dialog (lower left of RetinaEngrave) shows the laser as disconnected, make sure the Ethernet cable is plugged in and power cycle the laser. If there is still a connection issue, go to the laser menu and manually enter the IP Address displayed on the control panel after boot.

Print from any application and select the "Full Spectrum Engineering Driver" as the printer

Vector mode will only capture Vector output. Vector mode has been tested with many different vector programs such as CorelDraw X5, AutoCad 2011,Inkscape, Adobe Illustrator, Draftsight and more as shown in our demo videos. However, if you have problems vector printing to RetinaEngrave, use CorelDraw X5. Read the tips on our forums for how to import most file types such as DXF files into CorelDraw. Raster mode should print from any program.

Select the Mode tab – Vector Cut or Raster Engrave

Click on the mode tab that corresponds to the type of job you would like to perform. For engraving, keep in mind that engraved areas should be black. For cutting, colors (Blk, Red, Grn, Blue, Magenta, Cyan, Yellow) correspond to individual paths and settings. Use the Control Panel to adjust to power and speed of the job.

Press the "Go" button to start cutting

This downloads the job to the laser's temporary memory and starts it. The cutting happens in the background. While every effort is made to efficiently multi-thread the process, avoid memory-intensive tasks while cutting because the trajectories are calculated on the fly by the software. Also monitor the progress of the cut on the lower right hand corner.

Vector Mode

RetinaEngrave generates vector information from *.xps* files directly. RetinaEngrave is capable of recognizing up to 7 layers of vector information based on line color; Cut+Engrave operations reserve Black for engraving. All other file types must be opened in their native application or CorelDraw and sent through the Windows print dialog. Alternatively, print to the "XPS Document Writer" and open the resulting *.xps* within RetinaEngrave.

Raster Mode

RetinaEngrave can open *.xps* files and various image formats to generate Raster images for engraving. However, RetinaEngrave handles 1-bit bitmaps differently from other formats as it does not rescale a 1-bit bitmap. In 1-bit mode, 1 pixel = 1/1000 of an inch or 1/500 or 1/250 depending on the selected output resolution. If the pixel is black it will fire the laser, otherwise it does not fire. 1-bit bitmaps produce the most predictable output. Other image formats are opened with best-effort conversion and up-scaling. You can generate your own 1-bit dithered images for grayscale effects. There is a tutorial on using Adobe Photoshop to generate 1-bit bitmaps on the Full Spectrum Laser forums.

Adjust the threshold to include or exclude portions of the drawing in Raster mode

When working with a grayscale image, adjust the threshold up or down to alter which portions of the image you wish to engrave.

Raster resolution

DPI (Dots Per Inch) is a measure of the pixel density of an engrave. For example, 1000x1000 DPI corresponds to 1000 left to right sweeps per vertical inch of an image. Higher DPI settings will engrave more deeply as the average laser on time per unit area is higher. Engraving at 250dpi will be 4x faster than 1000dpi. We have found that 250DPI works well for most block/vector engraves and 500DPI works well for image engraving.

Notes:

- The **job origin** in RetinaEngrave is the upper-left of your design.
- RetinaEngrave does not use a fixed index system: the **job origin** is the **current position** of the laser head, wherever it happens to be. Make sure to position the head such that your job fits into the workspace and onto your work piece.

Automatic White Space Cropping

RetinaEngrave automatically crops white space from the page. This allows the use of programs like MS Word where you cannot set the exact position of the output easily on the page. To prevent cropping, draw a colored rectangle (yellow recommended) around your objects at the desired output size. In **Raster Mode**, use the **Threshold** button to fade brightly colored lines. In **Vector Mode**, set the **Repeats** of the yellow layer to 0 to ignore this line. In Figure 7 there is a yellow box drawn around the items. When this image is printed, it is cropped to the yellow box outline and the size is 6.71"x3.48". In Figure 8 the yellow box is omitted. The image is cropped to the extents of the non-zero pixels and produces an image that is 4.77"x1.22".

This feature is particularly useful when trying to align the drawing on existing material. For example, if you have a 4"x6" wood plaque that you want to engrave, measure the size of the plaque then draw a 4"x6" yellow box this size in your drawing. Put the text inside this box. Set the position of the laser to the top left hand corner of the wood plaque and press **Start** and it will raster the same size and location on the plaque as you have laid out in the drawing.
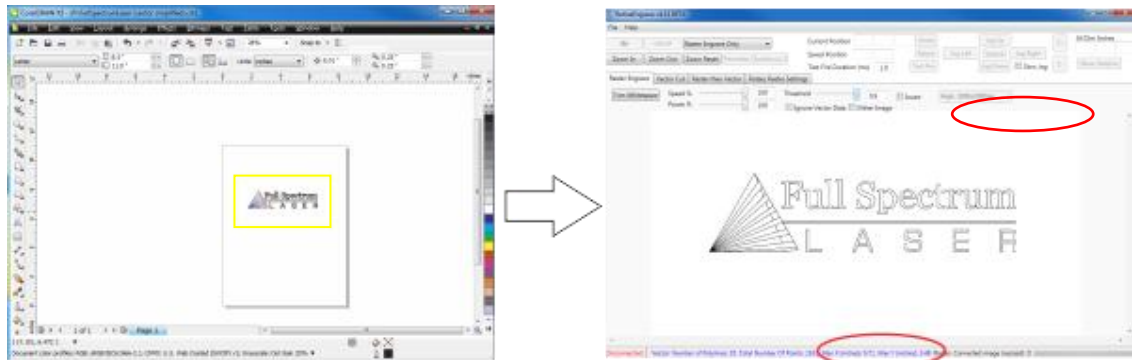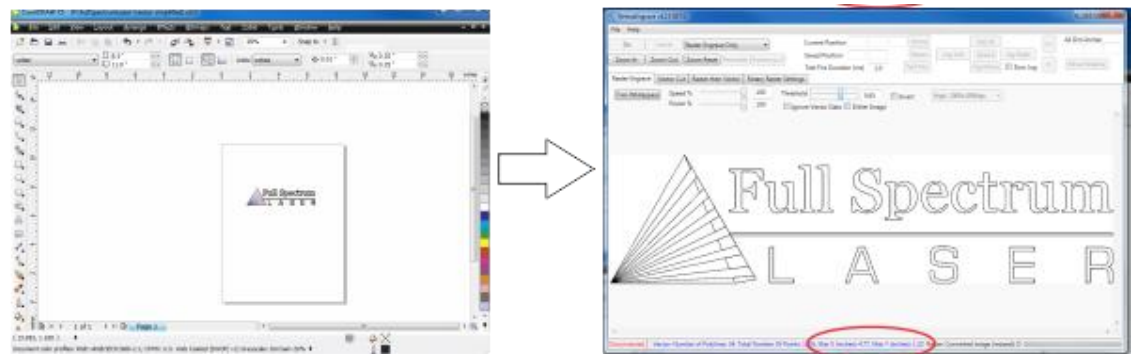

Figure 18 - Outline Cropping

Figure 19 – Standard Cropping

[46]

Printing Size

The paper size within the printing options must match the work area of the laser you are printing to. This is done at time of printing and is independent of the software you are printing from. RetinaEngrave automatically crops all whitespace from the image so the first non-white pixel is at position (0,0) in the top left.
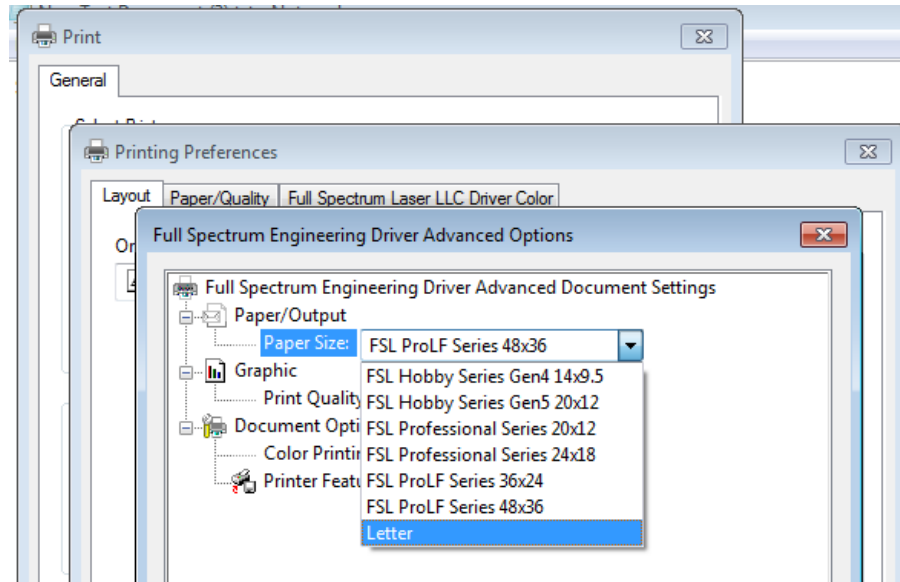

Figure 20 –FSL Printer Driver Work Area Selection

To Change the Paper Size:

- Select *Preferences->Advanced* and change the paper size.

Description of Major Interface Features

Please note that certain advanced features require attachment upgrades to the laser (notably Z axis, autofocus and rotary functions).

In this section you will be introduced to the major interface features of RetinaEngrave. We will go through the interface one line at a time from left to right and start at the top (Figure 21). Shortcut keys are bracketed **[]**.

The Workspace

The workspace is a preview of your current job.

Line 1

File menu

The File menu allows the user to open up files to engrave. RetinaEngrave supports drag and drop of *.xps* files for vector cutting and standard image file types (*.bmp, .jpg, .png, .tiff)* for raster engraving. Other file types must be printed to the Full Spectrum Engineering Driver or saved as *.xps* documents.

The file menu also allows a user to load or save a project and settings.

The options sub-menu allows you to save your workspace window setup, set the PC to audibly alert when a job is completed, enable or disable the keyboard shortcuts, load the last-saved project on startup or log output for troubleshooting.

Laser menu

The Laser menu provides options related to the laser unit configuration and communications. It will allow you to select the type of laser you are connected to, manually reconnect to the laser or manually set the connection IP address.

The Laser menu also allows you to save the current job and settings as a *.bin* file onto a MicroSD card (when the card is loaded onto the laser).

The laser Card Commands sub-menu should only be accessed by direct request and under supervision of Full Spectrum Laser support staff.

Tabs menu

The tabs menu allows you to show the 3D engrave tab or Control Panel.

Help menu

The help menu offers options to inform you about the version of RetinaEngrave you are using, an Activation menu (future functionality), and Troubleshooting and Update fields which will open the FSL website in your default browser.

Current Position

Shows the laser's current absolute position from the origin (home; upper right), it is reset to 0,0 when the laser is homed. The right field is the X coordinate, the left field the Y coordinate.

Move To

The text fields show the saved position read from the controller. The fields are editable, allowing you to move to a manually entered location. Pressing the **Move To** button will first move the laser head to the home switches for reference then rapidly move to the position in the text boxes.

Press the **Home** button to move the laser head to the origin. The laser will measure the distance it takes to reach the limit switches and enter the X and Y values into the **Move To** fields. It will then set the **Current Position** boxes to 0,0.

Move Relative

These fields command a move by the specified amounts along X and Y using the current position as the origin. Combine with the **Home** button to move to fixture points or between fixture points.

Line 2
Open File [CTRL+O]

Open compatible file types (.xps, .bmp, .set, .bin).

Save Project [CTRL+S]

Save your current project and settings as a *.set* file.

Clear Workspace

Clear the workspace of the current job.

Zoom In [+], Zoom Out [-], 1:1 Zoom

The zoom buttons control the workspace view of the Engrave and Cut tabs. The **1:1 Zoom** button restores the default zoom level.

Home [H]

Move the laser head to the origin (upper right of the work area). The laser should be homed after startup or RetinaEngrave will present a bounds alarm when you attempt to run a job. RetinaEngrave has a built-in bounds checker to make sure that your design fits within the workspace.

Perimeter [J]

The perimeter function will run the laser head in a box that bounds the limits of your design.

Perimeter Steps [P]

Each button press steps through one side of the perimeter bounding box.

Laser Head Positioning (Advanced Users)

The default job origin is located at the upper left of your design (0,0 in the workspace) and referenced from the <u>current</u> location of the laser head in the work envelope. The Laser Head Positioning button opens a dialog box that allows you to change the default job origin between the center of the job or the upper left (2 radio buttons in top menu division). The lower division of the Laser Head Positioning dialog box contains 9 radio buttons that allow you to preview job perimeter positions (you cannot set them as work origins). Keep in mind that the job origin setting is reset to default when RetinaEngrave is closed.

Estimate Job Time

This button calculates the job time based on the current speed settings. The resulting estimate can be found in the lower right hand corner of RetinaEngrave.

Test Fire [F] and Test Fire Duration field

Pressing this button causes the tube to fire for the amount of time (in milliseconds) listed in the duration field. Default value is 5.0ms—this works well for marking thermal paper without burning through. Remember to close the lid or the tube will not fire.

Rotary Engrave Tab

Displays the 3D engrave tab.

Start Job [G]

Press the **Start** button to start the job with the current settings. The job origin is by default located at the upper left of your design and is indexed from the current location of the laser head. For example, if you are vector cutting a 3in square, the laser will fire and move 3in to the right, then 3in forward (down), then 3in left and finally 3in up back to the starting position of the laser head.

The **Start** button will be grayed out and not selectable whenever the laser is disconnected.

Pause [SPACEBAR]

Pressing the space key will pause and up-pause the in-progress job.

Cancel

Immediately ends the in-progress job and returns to the job origin.

Mode-select menu

This drop-down menu allows you to select between several modes: **Raster** and **Vector** modes open their respective tabs, **Raster then Vector** will first run the job in the raster tab (black pixels) and then run the job in the vector tab.

The S**imulate Vector** modes create a red-dot overlay in the workspace that follows the path of your vector lines at some multiple of the currently selected speed (eg 100% speed at 0.5x runs at equivalent of 50% speed).

Resolution menu

Drop-down menu where you can select the DPI of the current job. Only used in Raster mode.

Control Panel

The control panel contains 5 sections: **Jog**, **Raster Properties, Import Options, Source Image Info** and **Vector Layers**.

The **Jog** section allows you to move the laser head using either the buttons or the keyboard arrow keys. Selecting the slow jog checkbox jogs the motion system at half of normal speed. The Lock/Unlock button allows you to unlock the motors to move the laser head by hand—the motors must be locked in order to run a job or jog.

The **Raster Properties** section allows you to set the power and speed of a raster job, as well as the B/W threshold for a grayscale image.

Import Options allow you to set conditions under which the print stream from Windows is captured. Ignoring raster data is useful if you are working with large or complex files and only causes RetinaEngrave to only render outlines of filled sections. Ignoring vector data is useful

when engraving images. Ignoring thin vectors will ignore small lines within a factor set by the tolerance field.

The **Vector Layers** section controls the layer order, speed, power and number of repeats for each layer. As discussed in the *General Usage* sub-section, vector layers are based on one of 7 colors. The **Contained Objects First** checkbox determines the order of cutting within a particular layer.
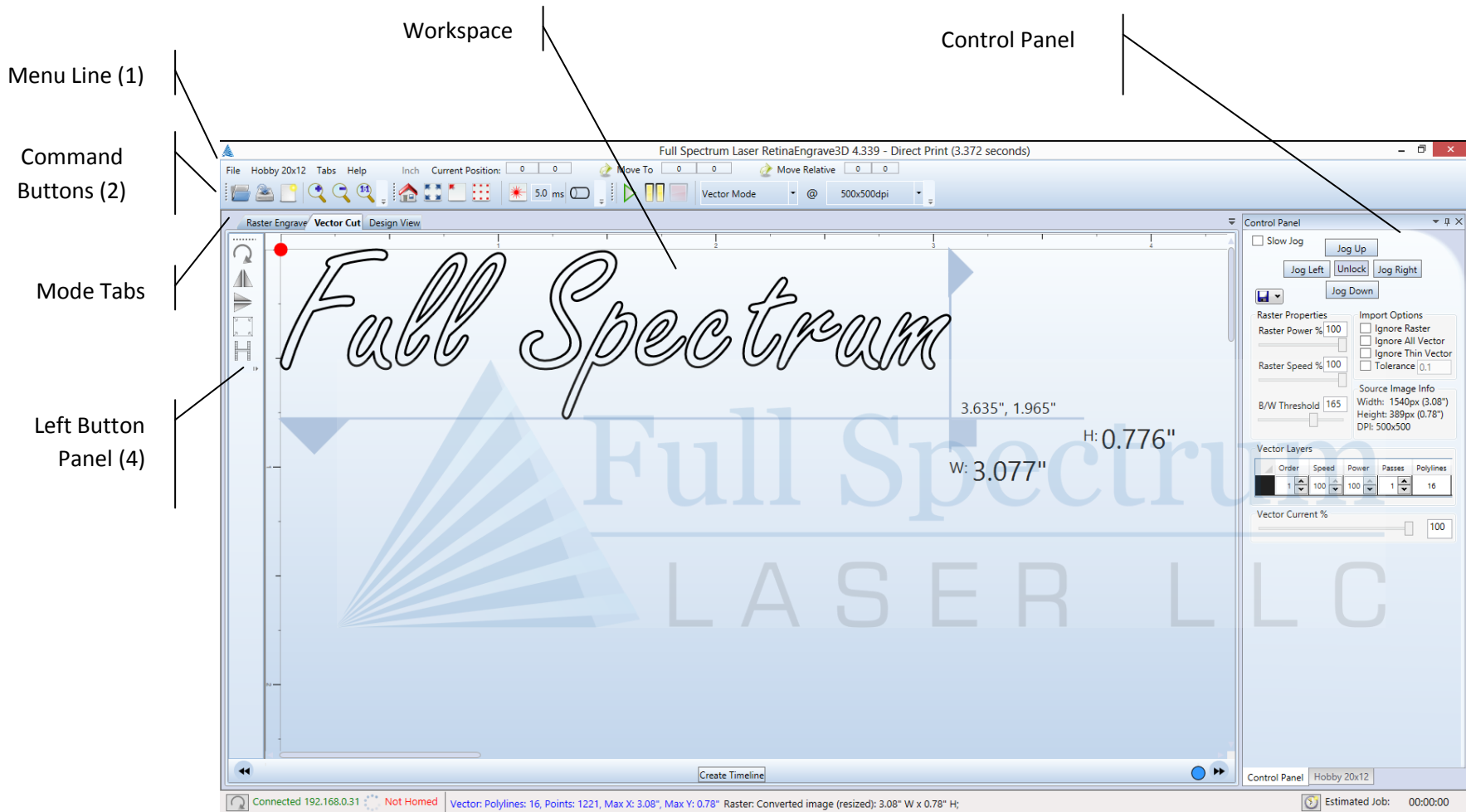
Menu Line (1)

Command
Buttons (2)

Workspace

Control Panel

Mode Tabs

Left Button
Panel (4)

Full Spectrum

Figure 21 - RetinaEngrave3D Interface

Customizing the Interface

The user interface for RetinaEngrave3D is built around several tabs relating to functionality (Raster Engrave, Vector Cut, etc). These tabs can be dragged to change their order or location in the program window. You can organize your workspace using the auto-size function (Figure 22) or leave the tab dialog window floating. The auto-size function will snap the dragged tab to a preset location in the program window. The default tab location is reached by dragging to the center of the auto-size overlay. Keep in mind that the **Start** button will always start a job using the data in the active tab.
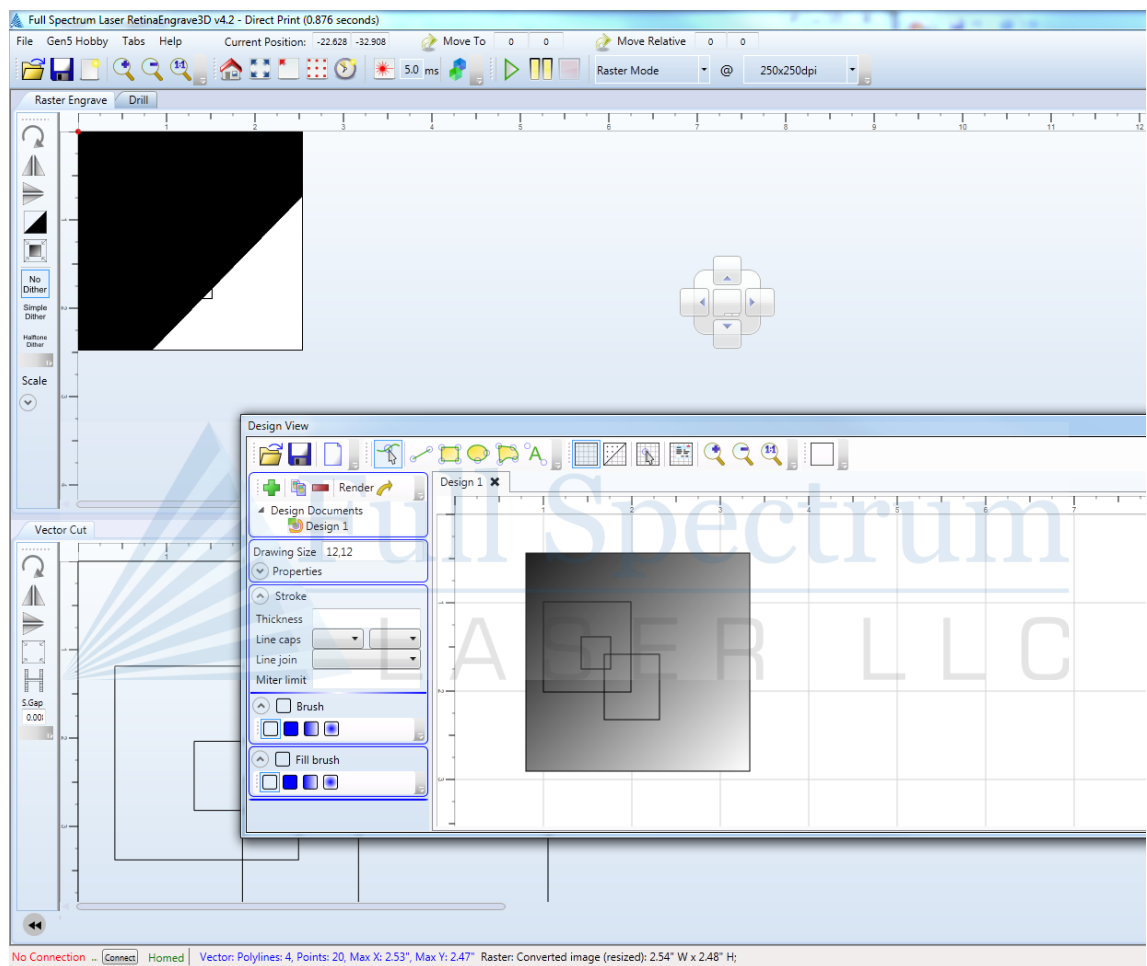
Figure 22 - Customizing the RetinaEngrave3D Interface

Part 9: Engraving

Overview

Your Full Spectrum Laser Hobby Advanced Laser System has several advanced functions that make it easy to bring your designs from your PC into the real world. Engraving is the process by which complex designs are etched into a work piece or a work piece is marked using an additive coating such as Thermark™. Engraving can range from a simple surface mark all the way through deep material removal. Engraving is differentiated from cutting in that cutting is the process of burning a closed contour completely through a work piece. The most common type of engraving is known as "Raster Engraving" or "Rastering", because the laser fires individual pulses corresponding to pixels in an image. When the laser is operating in raster mode the head moves rapidly from left to right and slowly top to bottom, engraving your image pixel by pixel and line by line. You can also engrave images in vector mode (Part 9), by setting the power such that you score the work piece without cutting through.

Engraving works with both vector and pixel-based source files, allowing you to engrave anything from a simple block logo all the way through high-resolution photographs. The proceeding sections will introduce you to engraving with RetinaEngrave3D.

Raster Engrave Tab

Select this tab before hitting the **Start** button to Raster Engrave only If your image looks cut off or cropped, be sure to read *Part 7: Working with Projects Larger than 8.5"x11"* to learn how to change the paper size in your program. Please refer to Figure 21 for a visual representation of the Raster Engrave interface.

Left Button Panel (Top to Bottom)

Rotate Image 90 Degrees

Each button press will rotate the image 90 degree clockwise.

Mirror Image Vertically

Mirrors the current image about a vertical centerline.

Mirror Image Horizontally

Mirrors the current image about a horizontal centerline.

Invert Image

Reverses the black and white pixels of the image. Useful for engraving on coated materials.

Trim Whitespace

Use this button to automatically remove additional whitespace in the image after using the **Threshold** slider. Usage of this button is not recommended; instead, adjust your design in its native drawing software to remove items you don't want to show up on the output before printing. RetinaEngrave automatically removes whitespace for all non-zero pixels.

No Dither

When **No Dither** is selected, RetinaEngrave will use the threshold slider value to compute a grayscale cutoff. Any grays below the threshold will be black and any above will be white.

Simple Dither

Dithering a color or grayscale image will produce a pattern of black pixels that approximates the original gradients. Dithering applies a computed dot density of on/off pixels to the image to create a grayscale effect. The quality of the dithered image preview in the workspace often looks poor—however, the actual output engrave quality will be much higher. Dithered images simulate true grayscale by averaging pixel density to achieve an optical effect closely approximating the original image. Selecting this button has no effect on images that are 1-bit or black/white already.

Halftone Dither

Like the **Simple Dither** button, this button dithers the image in the workspace but uses a different algorithm. Certain images and work materials will often respond better to one algorithm or another.

Scale Image

The **Scale** dropdown allows you to scale a design before engraving. Set the scale factor in the field and apply it using the set scale button.

Raster Properties and Import Options (Control Panel)
Raster Power %

This field and slider allow you to set the firing current as a percentage of the maximum as set in the configuration file. Laser tubes have a minimum activation current; setting this value too low will result in the laser not firing. Keep this in mind when setting power below 10%.

Raster Speed %

Set the engraving speed as a percentage of the maximum. Maximum speed is set in the *config.xml* file. The raster routine in v4 is optimized so it only rasters non-whitespace and minimizes the acceleration distance. If you set the speed % very low such as 1% then the laser head does not need much acceleration distance. Total time to engrave = (acceleration time + raster time). Since acceleration time is also lower the total time is not linearly related to the speed %. However, the energy/heat applied to the material is linear according to the speed %. For deeper engraving use a slower speed.

Black/White Threshold

Adjust this slider to fade in or fade out portions of any image that is not black/white. Your computer graphics card must be fast enough to use the slider in real-time to see the updates. This has no effect on 1-bit bitmaps or black and white images. If you have a computer with a slow graphics card, set the threshold using the textbox and enter the values manually.

Ignore All Vector

 Checking this box will only import raster data and ignore vector data. When processing a print job, RetinaEngrave attempts to sort all the vectors for the fastest cut times. A drawing containing millions of points or vectors will take up a large amount of memory and CPU which can cause a major slowdown in performance. Ignoring the vector data will also allow faster print jobs if only raster is required.

DPI Selection

Full Spectrum Laser recommends settings of 250x250dpi for most applications; text as small as 4pt can be engraved at 500dpi with excellent readability. Typically, 1000dpi is only used special cases. The dpi setting also affects the delivered power density, as higher dpi settings correspond to a higher number of pulses per square inch. It is also important to note that due to the focused beam spot size (0.002-0.005in) there will be pixel overlap at higher dpi settings. This leads to a blending effect in the overlapped areas, which will lead to a darker engrave result on particular materials (woods).

The dpi settings affect the print processing resolution. The maximum printing resolution is set in the configuration file and displayed in the control panel in the **Source Image Info** box. The final resolution is set to the maximum of the configuration file setting and the dpi selected from the dropdown menu. The default setting is 250dpi. By selecting 1000dpi before printing, the laser will import at 250dpi then upscale the image using a bi-cubic interpolation to 1000dpi.

RetinaEngrave stores the source image in memory and converts it to grayscale before dithering. Due to the large number of pixels in a 1000dpi image (1 million pixels per square inch) your computer may run out of memory. Computers with less available memory should select 250dpi before printing because even at an input resolution of 500dpi the memory requirements can be high.

Important Note: Positioning When Raster Engraving

When you raster an image, the laser head accelerates to the desired speed over some at the default job origin—if you are using a changed origin, for example a center origin, the laser head will still move to the upper left corner before beginning the job.

Because of the acceleration and deceleration distances, some jobs will require a 1in buffer on the left and right sides to avoid crashing the laser head.

Getting Better Raster Results

A laser has two states: on and off. Every black pixel or "laser dot" is the result of the laser turning on and firing at a particular location. This location is controlled by the input image, which can be thought of as a "map" of on and off pixels. The question is how do we give RetinaEngrave the best "map" of these laser dots to accurately represent the original image?

Your source image is processed several times between sending it to the Windows XPS Image Writer (printer) and final laser processing of the work piece. The first alteration of the source image occurs when the image is sent from the print stream into RetinaEngrave. If the printer

DPI is set differently from the software DPI, the source image must be up-sampled to the native DPI of the laser; up-sampling is necessary to keep the output image dimensions (in inches) the same as the source image dimensions. This process generates new pixels; unfortunately there are mathematical constraints on the sampling process so it is imperfect.

In order to avoid introduction of error through up-sampling, the source image must be a 1-bit image. 1-bit images are an exact "map"; all pixels are either on (black) or off (white). The best results are achieved by creating/converting a source image in a dedicated editing program with DPI settings that match the native DPI of the laser (1000dpi).

In the case of non 1-bit *.bmp* images (greyscale/color), dimensions are set on import using the page size in the print driver dialog box. Changing the DPI setting results in a different number of pixels in the same space, without changing the dimensions of the image. This procedure results in lower output quality that is not true to the source image. Multi-bit images that are not evenly divisible by the native laser DPI (250/500/1000) should always be direct printed instead of dragged and dropped, and should be rastered at the same resolution as they were printed. The case study in the following section examines the results of various import methods.

Source Type	Import method	Notes
1bit BMP	Drag and Drop, File-Open	Pixels are divided by laser dpi (1000 for hobby). 1000=1 inch. DPI box changes DIMENSIONS of output by skipping lines. Output is always true to source. It is not recommended to Direct Print 1-bit images
Color/Greyscale BMP	Direct Print	Always Direct Print non 1bit images as they are sampled at a rate proportional to laser output resolution, resulting in better quality output. For best output, Raster at the same DPI as the source image
XPS file containing images	Drag and Drop, File-Open, Direct Print	For best output, Raster at the import DPI

Table 2 - Summary of Best Practices for Image Formats

Case Study: The Effects of Up-scaling Following Direct Print

We have generated a small 50x50 pixel box. In the following illustration, the center box is the original size. This is direct printed using "Half Page" format from Windows Picture Viewer. Figure 23 is the actual size of what is generated from Direct Print. Figure 24 is the result of a Direct Print at 250dpi. Observe the rounded edges due to the drastic increase in size.
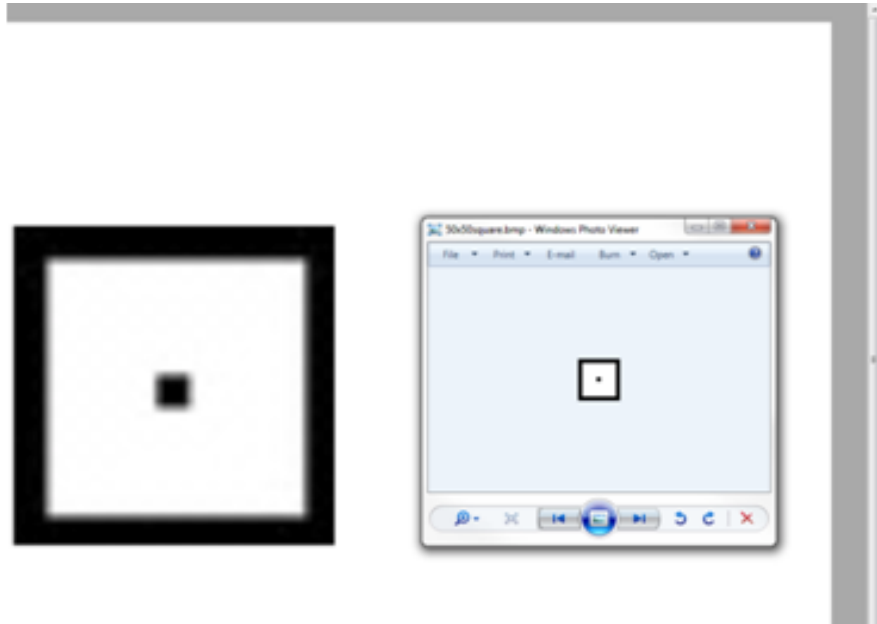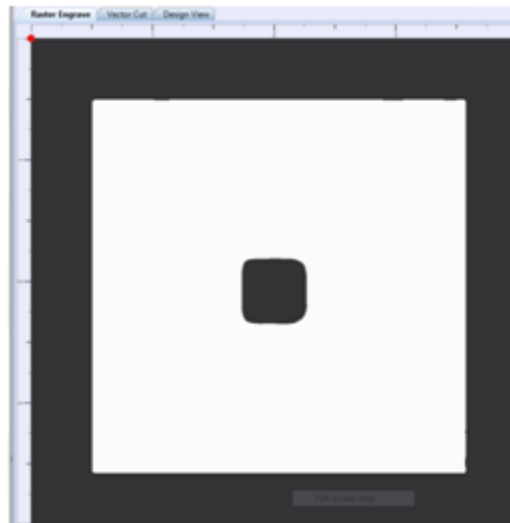

Figure 23 - Direct Print Source

Figure 24 – Direct Print at 250dpi

[60]

If we select 1000dpi within RetinaEngrave and then Raster, we get surprising results. The right image in Figure 25 is the actual output that is sent to the laser, including the anomalies along the edge. This is the result of direct printing from a small source to a large output and rastering at a much higher DPI than the project was direct printed at (1000 vs 250).
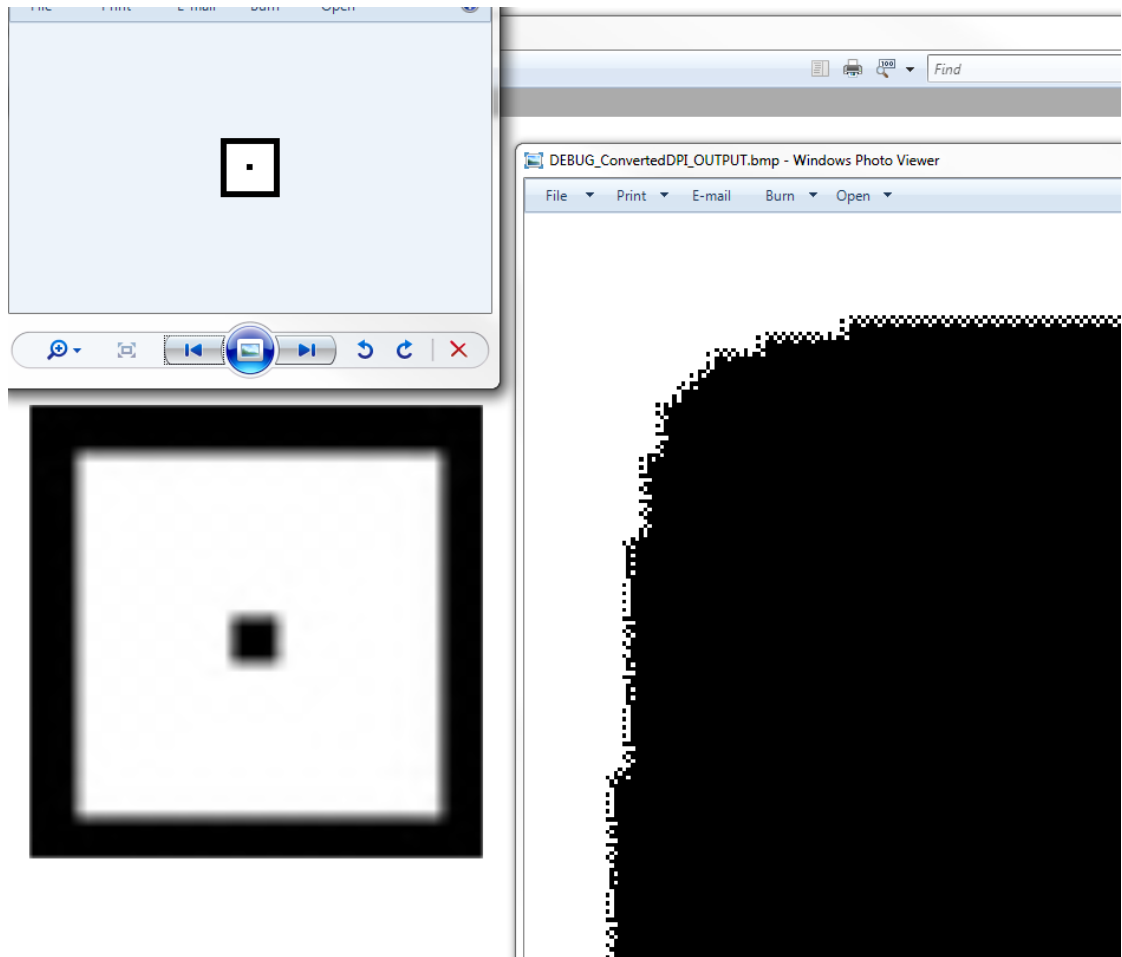
Figure 25 – 1000dpi Output from 250dpi Print

In Figure 26 we take the corner of the same project and output it at 500dpi instead of 1000. The effects are still visible although not as severe as using a 1000dpi output.
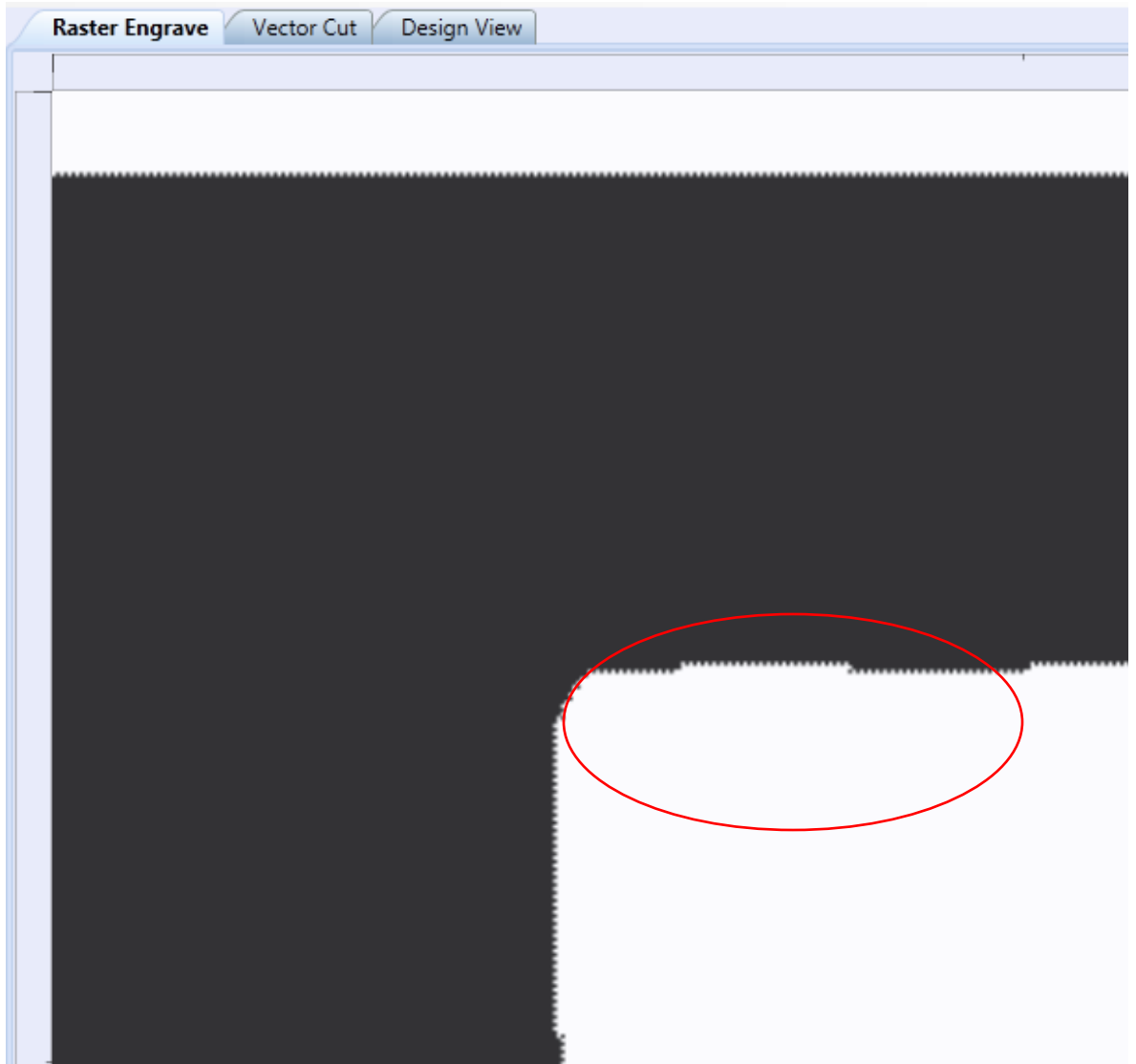
Figure 26 – 500dpi Output from 250dpi Source

Figure 27 shows a Direct Print at 500dpi with output at 250dpi.
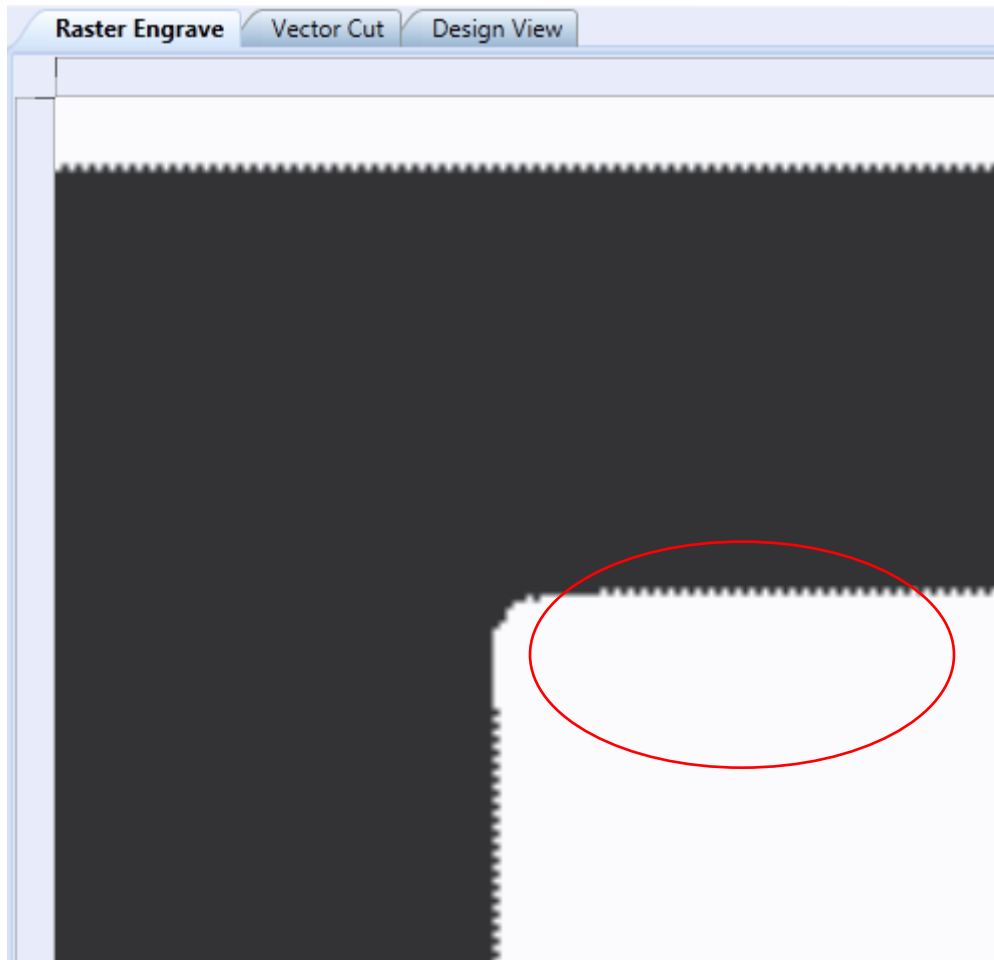
Figure 27 – 250dpi Output from 500dpi Source

When we print at 250dpi and output at 250dpi, we find the best results because import and output DPI are identical (Figure 28). The software must up-sample to 1000dpi in order to lase, resulting in an image ¼ the size of the original. In order to output at the same dimensions as the source, the software skips 4 lines for every line of output on the Y-Axis. In this way, no scaling is required and no anomalies are introduced as pixels need not be generated before output.
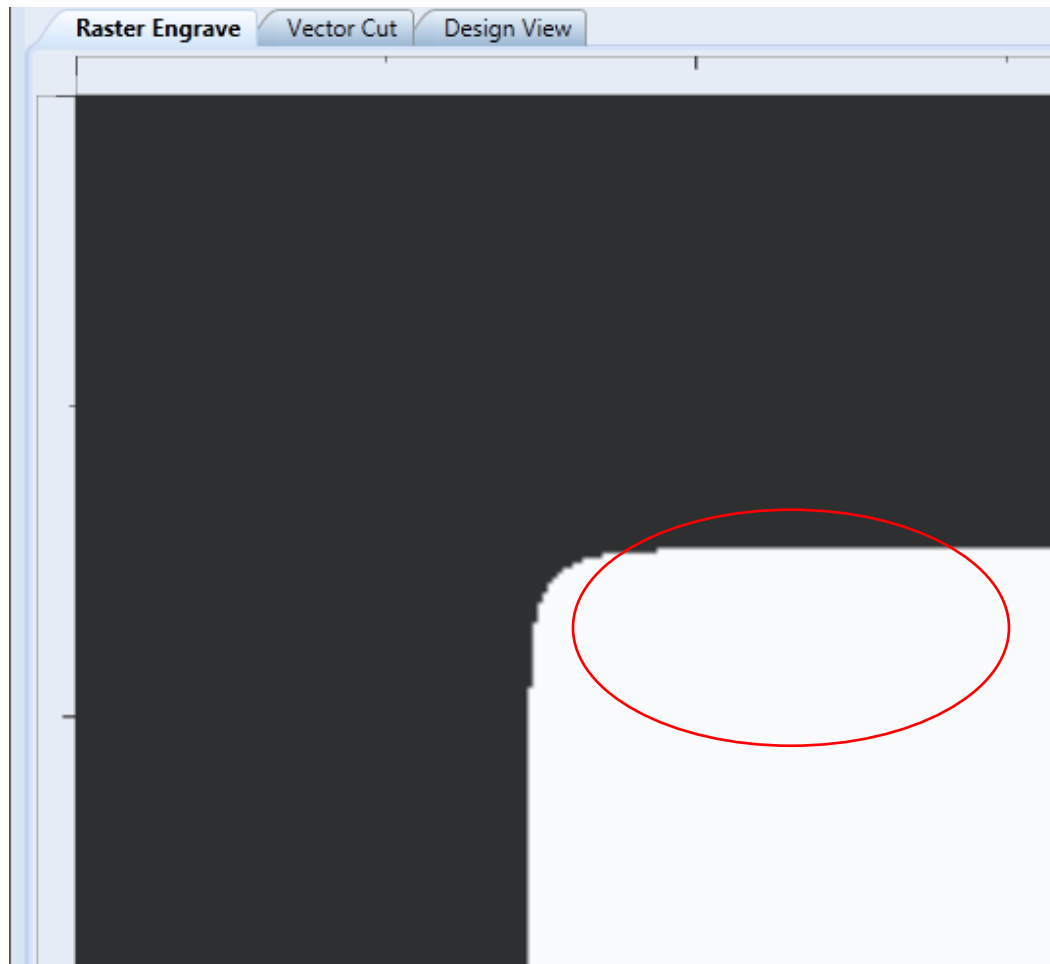
Figure 28 – 250dpi Output from 250dpi Source

Part 10: Cutting

Overview

In Vector Cut mode, RetinaEngrave receives information from the print stream and interprets it as a series of paths for the laser head to follow. In order for the print stream to have vector information, the file being printed must be a vector file. RetinaEngrave is capable of following complex contour paths created in any vector drawing program, however certain programs and formats are more reliable than others. Full Spectrum Laser carries out unit testing using CorelDraw X5 and recommends that Hobby Advanced owners use this program. If you use different design software and run into a problem with the print interface, we recommend printing to the XPS Document Image Writer or saving as a PDF. PDF files save vector information and are the best way to carry artwork from a non-compatible operating system (Mac or Linux) onto your Windows 7 PC. Limited testing has been carried out with CorelDraw X6 and it appears to be a good choice as well. Other popular packages include Adobe Illustrator, Inkscape and Google's free online vector drawing application. Additionally, most CAD packages are able to output drawings in a vector format for printing; Autodesk 123D is particularly interesting for its cost (free) and built-in 3D slicing capabilities.

Notes:

- The Microsoft XPS Document Writer creates images so that they will print exactly as they appear on your screen. Any program that is vector based will have its information embedded as vector paths (CorelDraw, MS Word, CAD programs, etc) and should work with the Vector Cut functionality of RetinaEngrave3D.

Vector Cut Tab

Select this tab before hitting the **Start** button to cut the paths displayed in the work area. If your image looks cut off or cropped, be sure to read *Part 7: Working with Projects Larger than 8.5"x11"* to learn how to change the paper size in your program.
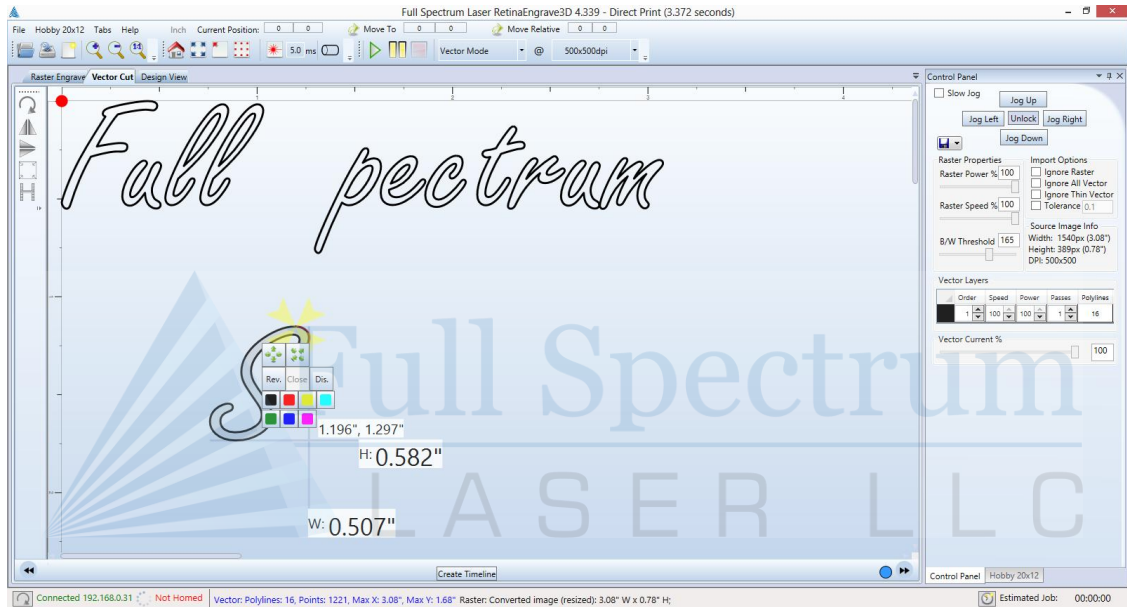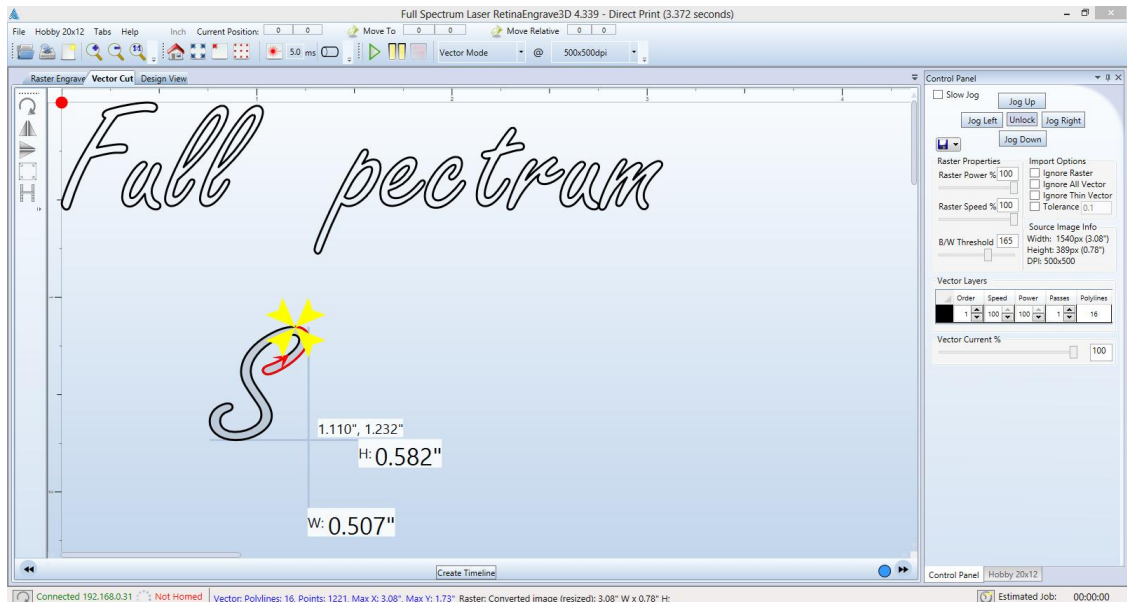

Figure 29 – Vector Engrave Interface

Figure 30 - Vector Cut Path Selection

Left Button Panel (Top to Bottom)

Rotate Vector 90 Degrees

Each button press will rotate the design 90 degree clockwise.

Mirror Vector Vertically

Mirrors the current vector drawing about a vertical centerline.

Mirror Vector Horizontally

Mirrors the current design about a horizontal centerline.

Resize Vector According to Input Values

This button will bring up a dialog box allowing you to change the size of the vector image in the workspace by setting specific X and Y dimensions. It does not preserve scale.

Horizontal Vector Hatching

This button and corresponding parameter box automatically fill closed contours with a horizontal hatch pattern, with the gap between horizontal scan lines (in inches) determined by the input in the parameter box. This is a useful function for engraving deeply into an object—with the proper settings it will remove material much more quickly than in Engraving mode. Be aware that due to the scan gap being non-zero the bottom surface might not be smooth.

Vector Layers, Vector Current % and Import Options

Ignore Raster

Select this option to speed up processing of large vector files on computers with limited memory. Raster data is memory intensive for large drawings at the highest resolutions and is unneeded if only vector cutting is required.

Vector Current %

Total power is determined by a combination of delivered current and voltage to the laser tube. The current is directly regulated while voltage is controlled by PWM (Pulse Width Modulation). PWM is a technique whereby an average voltage is delivered in a series of pulses per unit time. In Vector mode you can control both the PWM frequency (power) as well as the delivered current (Vector Current %). In Raster mode, the output is pulsed based on the speed and pixel pattern, so only current control is available (Raster Power %).

Vector Layers

RetinaEngrave automatically separates vector drawings into layers by color. Each layer can specify different properties. The **Reset Layer Properties** button will reset the Vector Layers table to the default values.

- Layer: The designated color of the layer
- Order: Layers are cut in order from 1 to 7
- Speed: Sets the speed of the layer as a percentage of the maximum value.
- Power %: Sets the PWM frequency. PWM power control is very fine. Setting it to 0.5% will mark but not cut through paper.
- Repeat: Set the number of repeats of the layer at the chosen power and speed settings. Set to 0 to ignore the layer.

Designating Layers

Designating a color to objects/ layers you want to vector cut enables you to take advantage of RetinaEngrave3D's ability to specify cutting order, cut speed, laser power and number of repeats for each layer.

RetinaEngrave supports up to seven standard color layers for maximum program compatibility: **Black**, **Blue**, **Red**, **Magenta**, **Green**, **Cyan**, and **Yellow** from the RGB color palette.

RetinaEngrave uses a best guess color round off routine when a color is not a standard RGB color. Avoid **Black** whenever possible because this is the default color RetinaEngrave uses whenever it cannot figure out what color it should be. By avoiding **Black**, you will have more control.

Workspace Tools

Use the drag handles located on the edges of your design to resize the image. The extension lines display the width and height of the bounding box that encloses the image. Dragging the square handle will preserve the design's scale. The small field located on along the height extension line gives the current X and Y workspace coordinates of the mouse.

Hovering the mouse over a vector object (poly line) will cause it to highlight. You can right-click the mouse to disable that object in the current job and right-click again to re-enable.
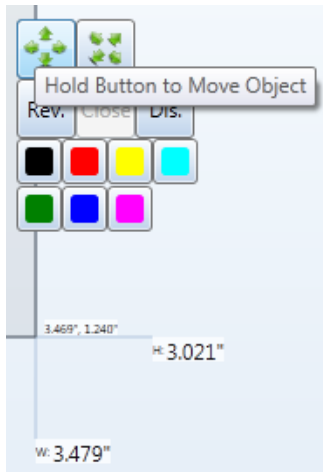
Clicking on a poly line will bring up the workspace editor. You can move, scale or disable it; assign it to a layer using the colored buttons; reverse the direction of the path; or close small gaps between the ends of an un-closed poly line (for advanced users).

Part 11: Advanced Functions

Overview

The following sections introduce you to the advanced capabilities of RetinaEngrave3D. Some of these capabilities are only possible with the purchase of extra attachments (rotary engraving). Please make sure that you are familiar with the previous sections of this manual before working with the advanced functions.

- Combined Engraving and Cutting allows you to set up a job to engrave a design and then cut a pattern
- The Rotary Engraving tab is the interface for setting up a raster job to be engraved on the outside of a cylindrical object (requires rotary attachment)
- The 3D Engraving tab allows you to take a grayscale image and set up a job that will convert it into an automatic series of layers to achieve a 3D effect

Engrave then Cut

RetinaEngrave3D supports engraving and cutting in the same job. In this section we describe the process of using CorelDraw X5 to properly prepare your image before direct printing to RetinaEngrave

1. Designate either yellow or cyan to the layers you want to vector and designate black to the layers you want to raster.
2. In our example image we want to
   a. Engrave the text and the four corner objects in raster mode by changing them to black.
   b. Cut the middle object and the outside border in vector mode by changing them to yellow or cyan.
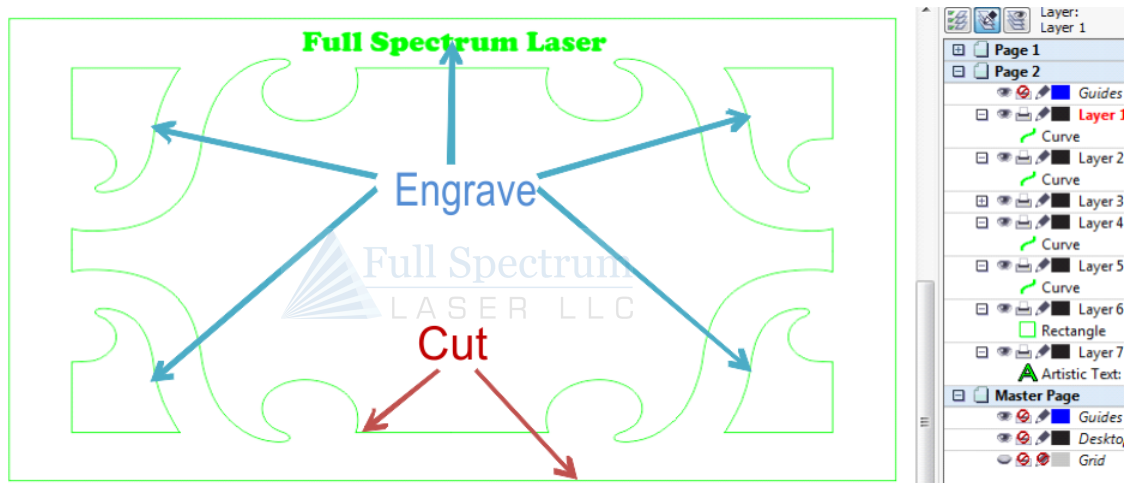
Figure 31 - Engrave/Cut Example Source
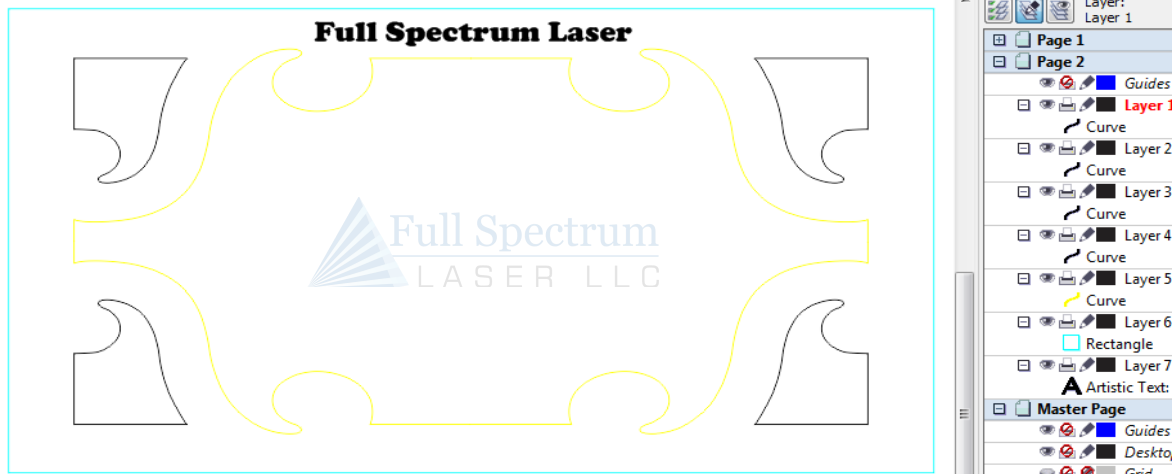
Figure 32 - Engrave/Cut Ready for Direct Printing

Make sure that any text that is "Artistic Text" in CorelDraw X5 has a Hairline outline applied.

1. Verify that RetinaEngrave is running in the background.
2. File → Print using the Direct Print Driver.
3. Switch the current program view to RetinaEngrave.
4. Use the mode select drop-down menu to choose **Raster then Vector** mode.
5. Adjust the slider on the the threshold setting to fade out/in objects. RetinaEngrave will only raster what is visible on the screen. Adjusting the slider to the left will fade out objects, while sliding to the right will fade in objects. You can also adjust the threshold by manually typing a value into the box next to the threshold slider between 0.000 and 1 and then left clicking on the image. The maximum threshold value of 1 will make the image solid black and should not be used. For optimal results first adjust the threshold almost all the way to the right to a value of 0.999.

In Raster mode all objects will show as black. The objects designated as yellow or cyan in CorelDraw X5 will fade out before the objects that were designated as black will fade out.

6. Slowly adjust the threshold setting to the left until the vector objects that you previously designated yellow and/or cyan in CorelDraw X5 completely fade out, leaving only the black raster objects visible.In our example image we found that a threshold setting of 0.96 made the center yellow vector object completely fade out. The cyan vector border has not faded out and further threshold adjustment is needed.

[72]
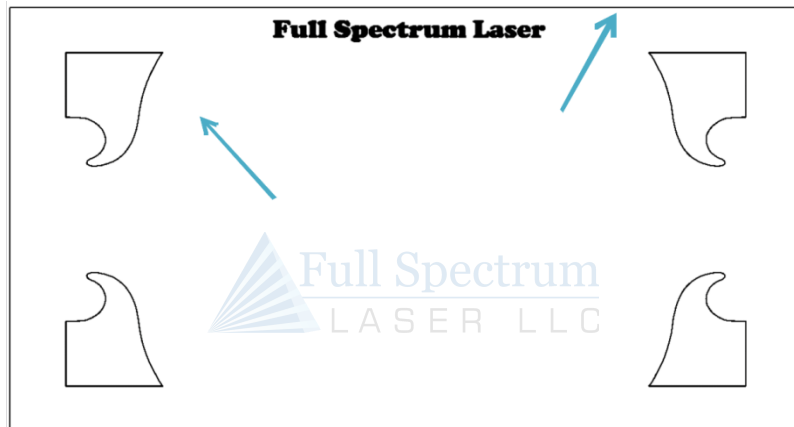
Figure 33 – Yellow Layer Removed After Threshold

7. Further adjustment of the threshold to the left to a value of 0.9 makes the cyan vector border completely fade out. The threshold for our example image is now properly adjusted leaving only the black objects that we want to raster engrave visible. The end goal when adjusting threshold value is to adjust the threshold to the left just enough to make the yellow/cyan objects fade out while leaving the black raster objects highly visible for optimal detail raster engravings.Threshold settings for your particular image could vary from our example image settings.
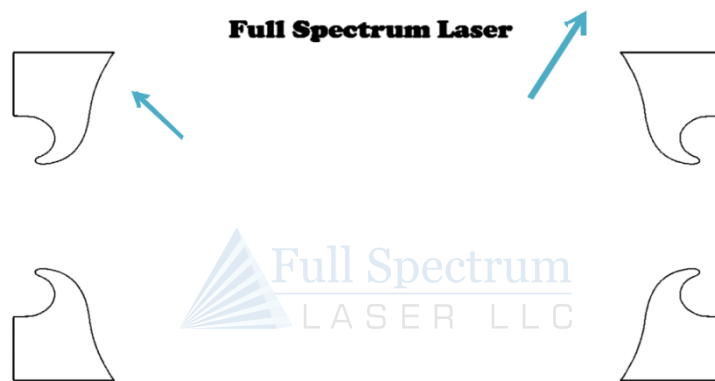
Figure 34 - Cyan Layer Removed After Threshold

8. Adjust the Speed % and DPI to your desired settings.
9. Left Click on the **Start** button to engrave your material.

When the raster engrave process is complete **DO NOT** move your material inside the laser cabinet. Both Raster Engrave mode and Vector Cut mode use the same job origin. As long as the material has not been moved between the raster engrave process and vector cut process the image will line up correctly on your material after finishing the vector cutting process.

Rotary Engraving

If you have purchased a Hobby Advanced Rotary Attachment, the following instructions explain how to set up a job for rotary engraving/cutting. Setup and installation information for the rotary attachment is found in **Appendix B** of this manual.

1. Turn your laser **Off** and then follow the instructions in **Appendix B** to connect the Rotary Attachment.
2. Turn your laser on and connect to it with RetinaEngrave3D.
3. Click on the **Rotary** button (Figure 35)
4. Click the **Enable Rotary** checkbox.
5. **Steps per Inch** is pre-set—do not modify.
6. **X Sweeps per Inch** is automatically set based on the DPI settings.
7. Test your job at 0 power to make sure there is no slippage; increasing the value of the **Y-Axis Speed Divisor** will help eliminate slippage.
8. Click on the **Start** button to rotary engrave.
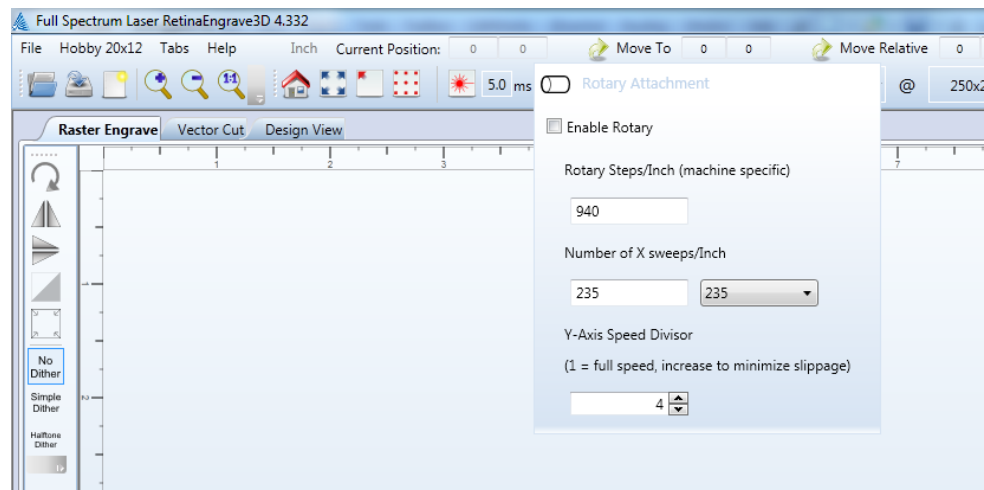
Figure 35 - Rotary Engrave Menu

3D Engraving

RetinaEngrave3D allows 3D engraving from grayscale images by automatically separating an image into layers and allowing those layers to be run as independent raster jobs.

1. Load a grayscale image and then open the **3D Engrave** tab.
2. Using the slider or data field, choose the number of frames that you wish to engrave.
3. Right-click on the **Auto Generate Frames** button.

Your job is broken into a series of frames using the currently-selected **Raster Properties**. Each frame auto-thresholds your image by pixel darkness based on the number of frames that you chose. You are then able to do the following:

- Select separate power and speed settings for each frame
- Copy or delete frames
- Drag frames to re-order them
- Adjust the threshold of each frame (high, low and range)
- Set the Z axis offset of each frame (only works with a powered Z table)

You can clear the workspace using the **Clear Frames** button or **Start 3D Engrave** to begin the job. Keep in mind that 3D engraving works as a series of individual raster jobs for each frame; as such jobs with more frames can take a long time to complete.
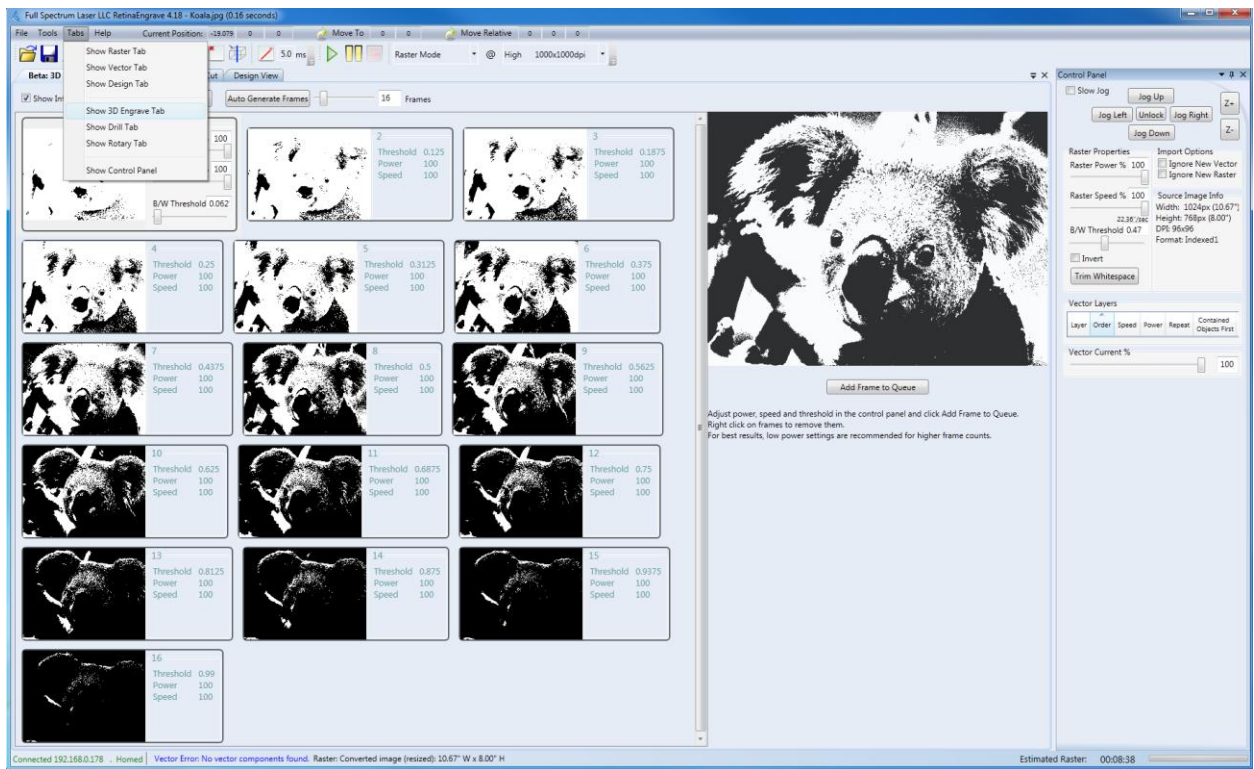
Figure 36 - 3D Engrave Tab

[75]

3D Engraving Example

Figure 37 and Figure 38 show an example grayscale input file and the result with the following settings:

- 40 layers
- 100% speed
- Approximately 70% power

This engrave took about 1hr with overall dimensions of 3.854in x 3.625in. The source file is available at the following link (http://tinyurl.com/fsl3dacrylic). Photos and laser settings courtesy of Bevan Camp.

Figure 37 - Example Grayscale Input File
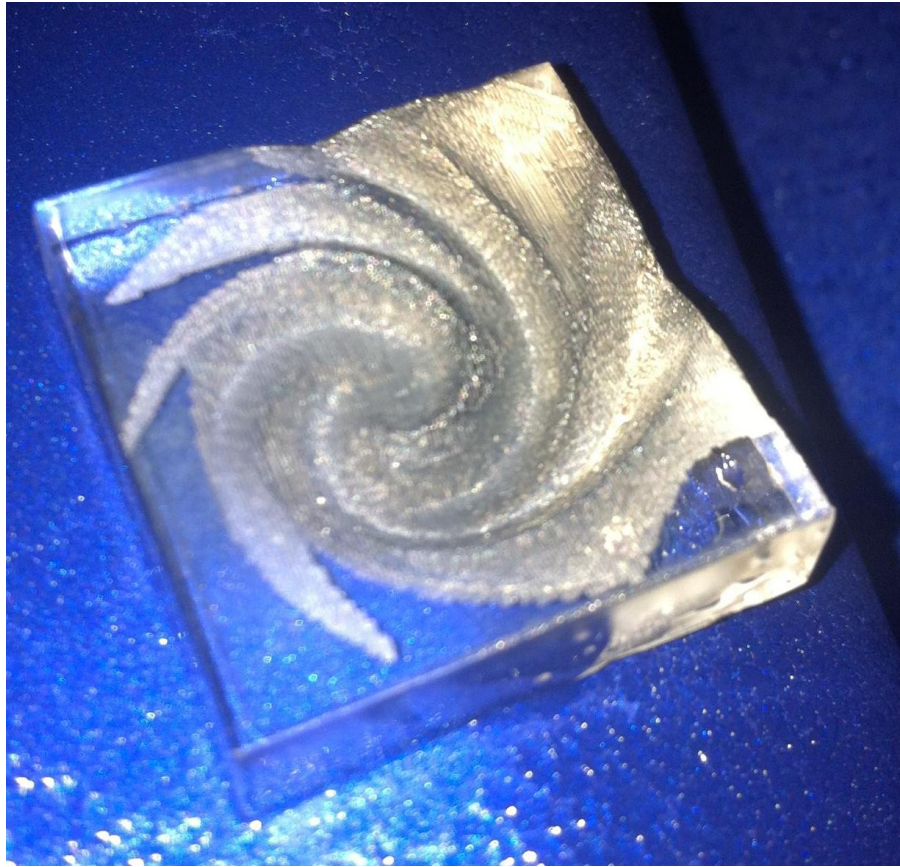
Figure 38 - Example 3D Engraving Result

Part 12: The Design Tab

Overview

The Design Tab provides basic drawing tools for creating simple designs within RetinaEngrave. The tools allow you to draw open or closed contours, complex paths, shapes and text with a variety of fill options. The Design Tab is project-based, with each project having one or more designs. Once you have a design, you select it and render it to one of the mode tabs.

Please note that the Design Tab is not meant to replace a dedicated drawing/design package—it exists as an internal tool for quick tests and is released as-is. If you are having a problem with the output of the design tab, please use a standard program such as CorelDraw to create your work and report any software issues to support@fslaser.com.

Design Tab Functionality

Line 1

Open, Save and **New Project** buttons

These buttons allow you to load a saved project, save your current project or open a new project. Opening a new project removes any unsaved data in the document design window.

Edit Shape

Select shapes or points and edit their information (color, thickness, fill, etc).

New Line

Add a new point to point line. Drag the end handles to change length or use the **Shape Properties** box (bottom of **Shape Properties Panel**) to set start and end points.

New Rectangle

Draw a rectangle. Use the handles to change proportions or the properties panel to adjust width and height (units are inches) as well as corner radii. Use the **Stroke** properties to adjust corner joint type.

New Ellipse

Draw an ellipse. Use the properties panel to change the X and Y radii (**units are pixels**).

New Path

Create a new spline path. Select one of the end points to bring up the **Shape Properties** box and add/remove points and adjust line tangency.

New Text

Place text in the design area.

Toggle Grid

Changes the visibility of the drawing grid in the design area.

Toggle Points

Changes the grid format from lines to points

Toggle Snap-to-Grid

Enable or disable snap functionality with drawing points

Grid Options

This popup menu controls grid display and parameters. The **Grid Width** and **Snap Grid Width** fields can be altered to suit your preferences; units are in inches.

Zoom Buttons

Adjust the zoom level of the design area.

Shape Properties Panel (Left Side)

New Drawing, Copy Drawing and **Delete Drawing**

These buttons allow you to create a new drawing, delete a drawing or copy the current drawing.

Design Selection Menu

This drop-down list allows you to select which drawing to make active via a left double-click. You can also select the tab of the drawing you would like to work on in the design area.

Drawing Properties

Set the total work area drawing size units in inches).

Stroke Properties

Control the stroke thickness (pixels), end point shape, joint behavior and miter behavior.

Brush Properties

Control the color and fill style of the brush. Allows you to create and specify gradients.

Fill Properties

Specify the properties of a closed shape

Shape Properties

Control the properties of the currently selected shape. Set exact size of features.
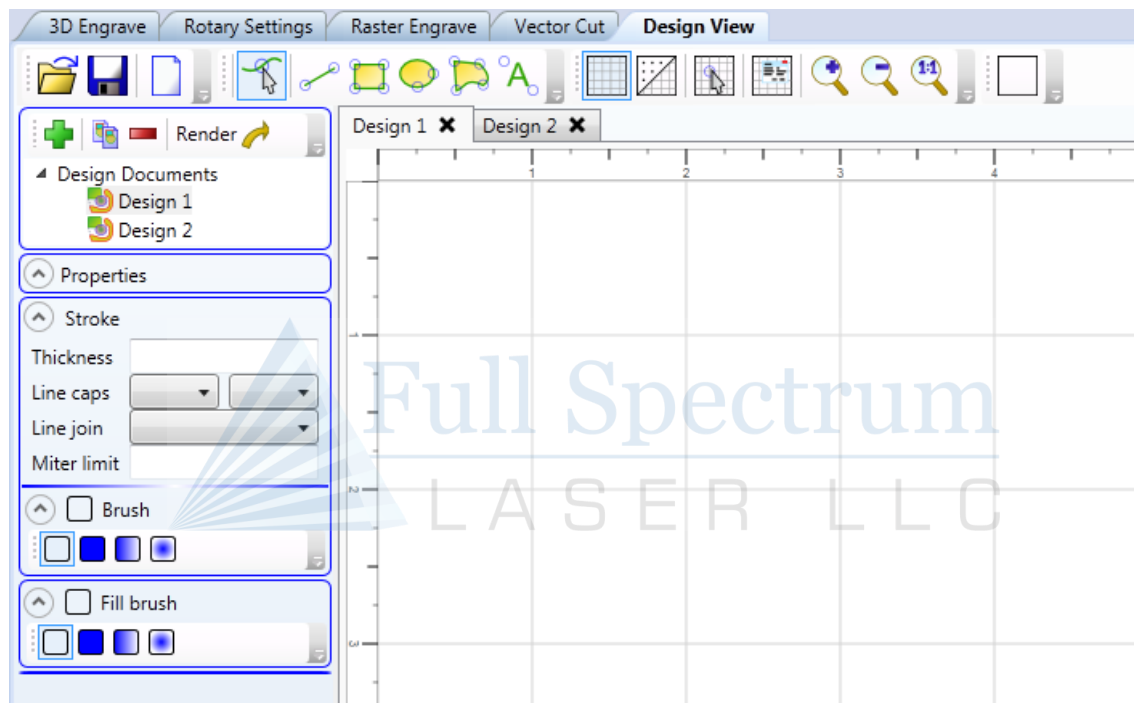
Figure 39 - Design Tab Interface

(This Page Intentionally Left Blank)

Appendix A: Preparing a Print Job with CorelDraw X5

Overview

Appendix A covers the creation of an example job using CorelDraw X5. It demonstrates several steps that are important to properly prepare your job for printing to the laser.

Converting Curves to Hairlines

In vector mode, lines should be reduced to the minimum thickness allowable by the drawing program. In CorelDraw X5, these are known as *hairlines*. If lines are not reduced to hairlines, RetinaEngrave3D may trace the boundary of the line instead following the center of the line during vector cutting.

1. Left Click: Edit -> Select All -> Objects. This will select all objects.
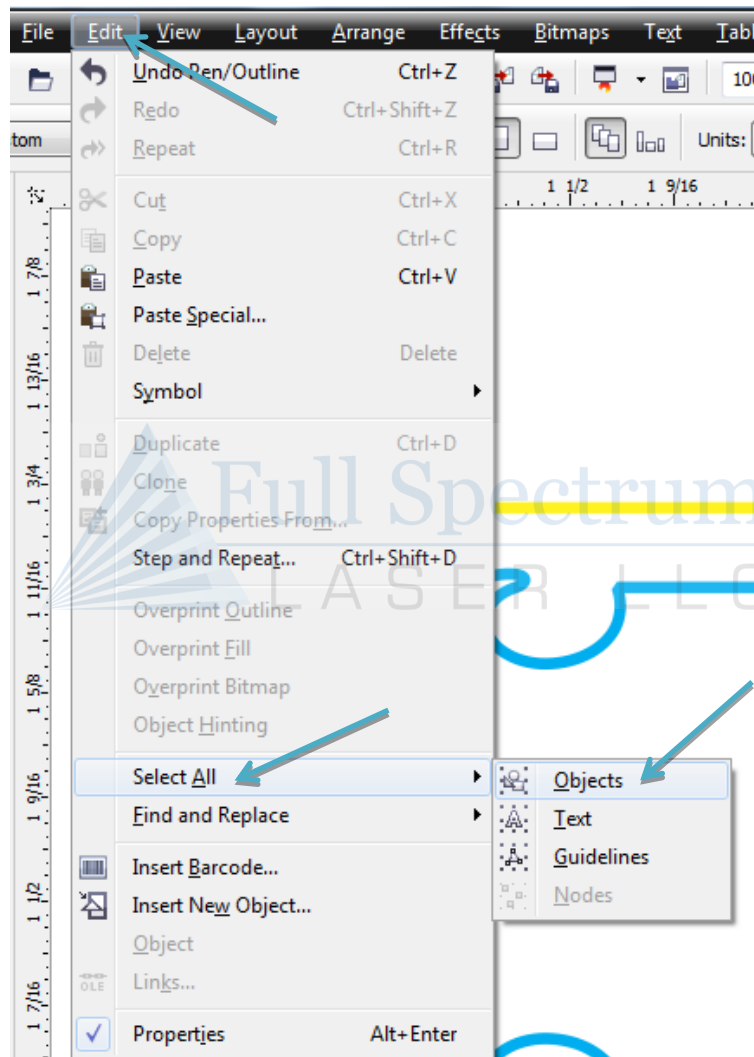
Figure 40 - Select All Objects, CorelDraw

[82]

2. Left Click: Outline Pen Tool -> Hairline Outline.   This will change the width of all lines to Hairline.
3. In this example object our line width is 0.5 pt
4. After applying Hairline Outline our line width is now Hairline (thinnest possible)
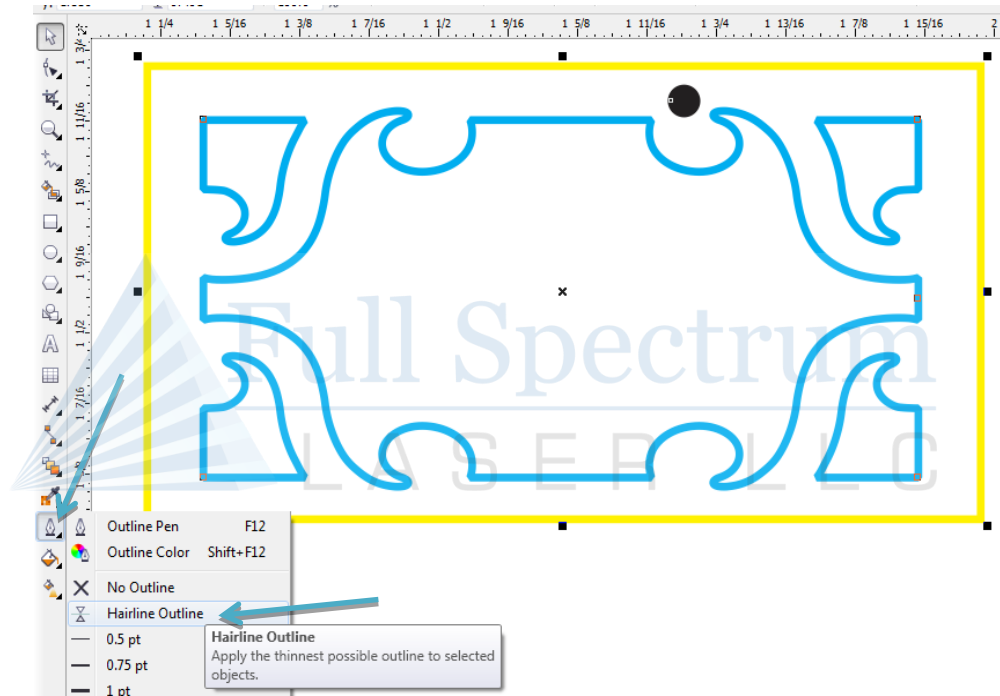
Figure 41 – Convert Objects to Hairline, CorelDraw

Joining Curves

For predictable output, vector drawing segments should be closed as much as possible. Many times vector drawings (in particular DXF files) may have small breaks that will confuse the RetinaEngrave print driver.

CorelDraw X5 has a great command: Arrange ->Join Curves. This will join touching lines into a closed path suitable for laser cutting. In this example our object is 1" width by 0.282" height.

At 500% zoom the object appears to have all lines connected. However at 6400% zoom on the bottom left corner of the same object we can see that some of the lines are merely touching and are not connected
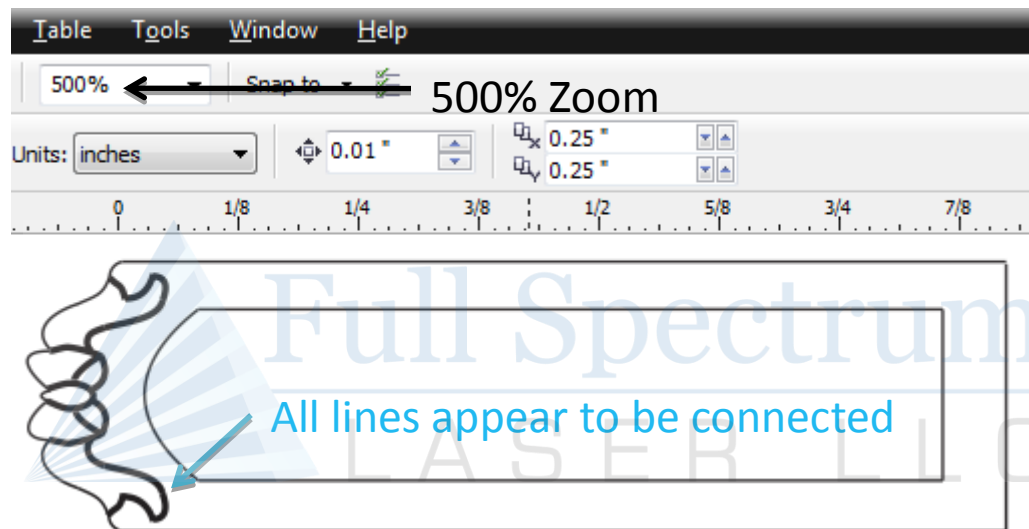
Figure 42 - Example Drawing at 500% Zoom
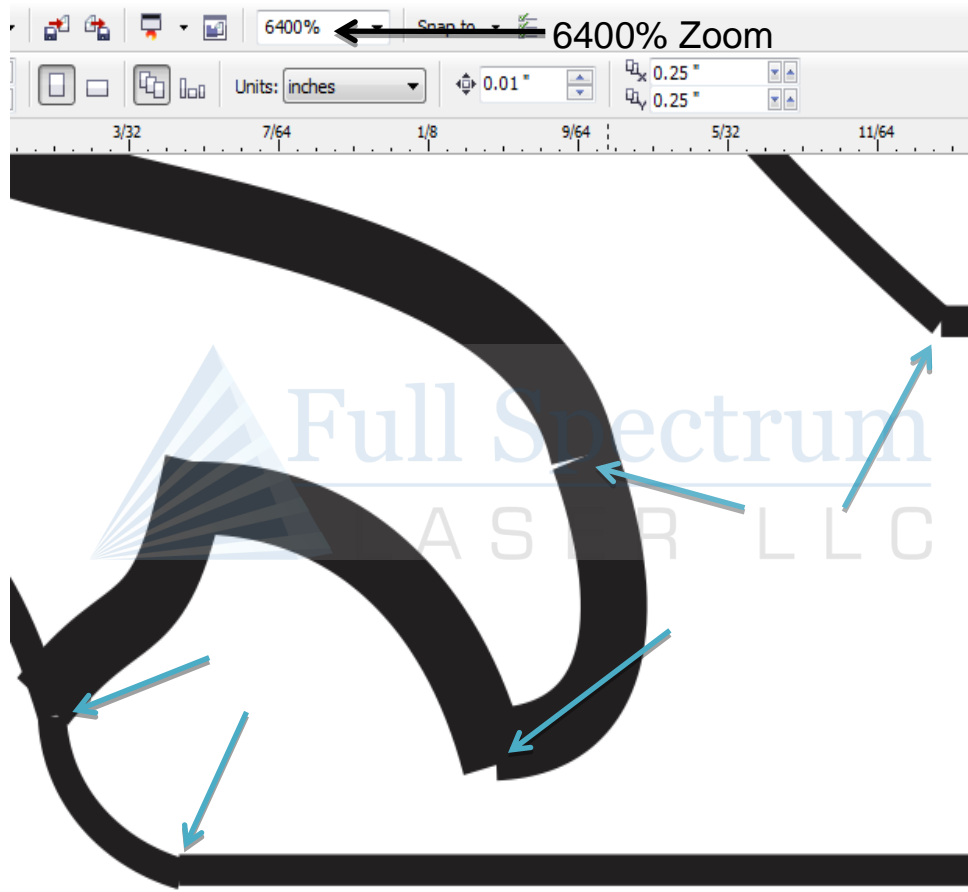
Figure 43 - Example Drawing at 6400% Zoom

We want these lines to be continuous, so we will use the join curves command:

1. Select all objects you want to correct. Left Click on Arrange/Join Curves.
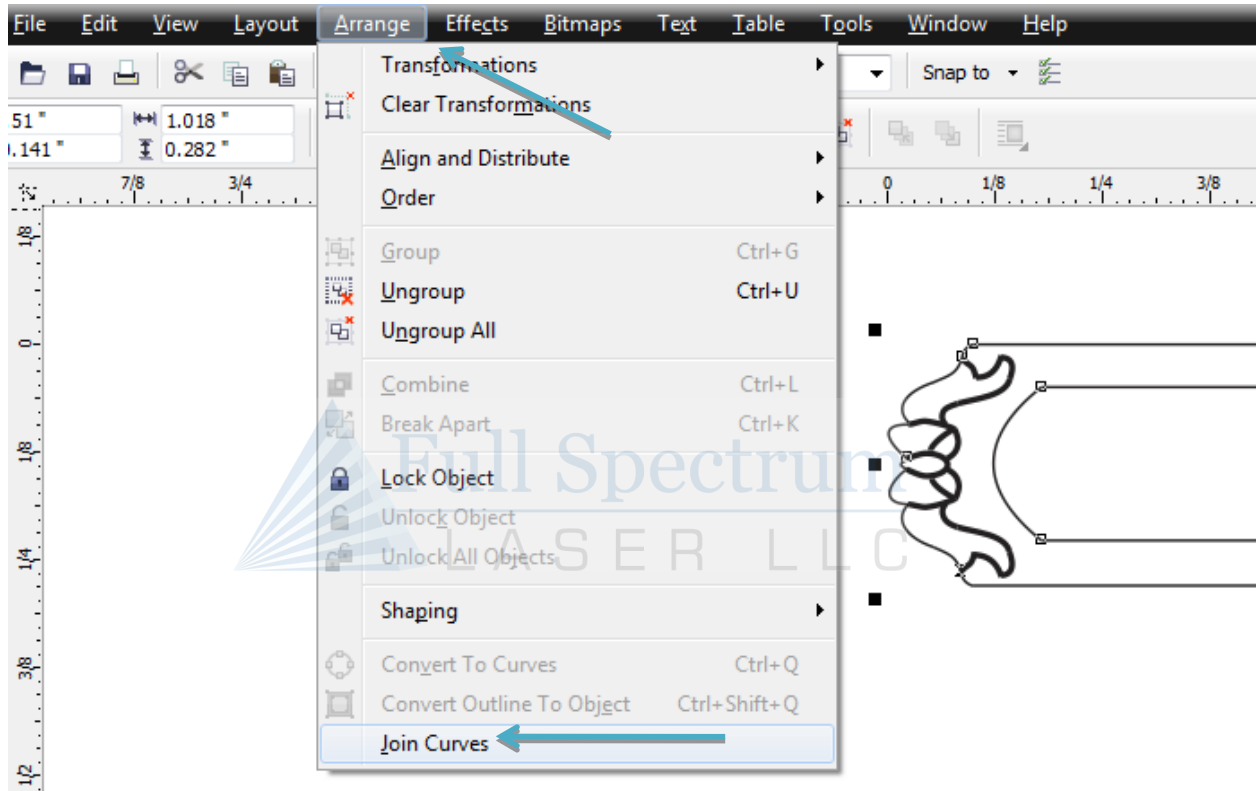
2. The Join Curves window will appear on the right side of your screen. Click Apply.
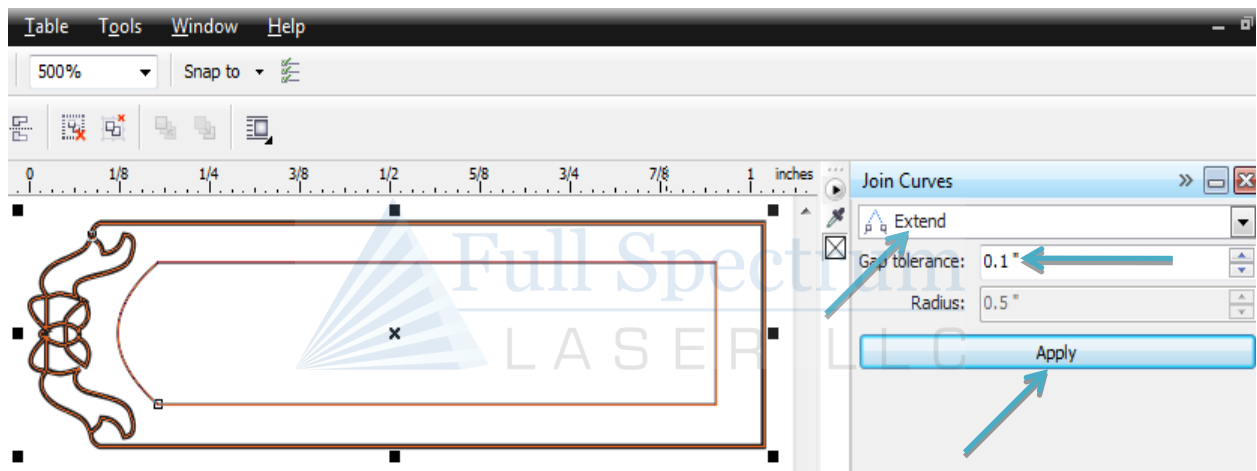
The default settings of Extend and Gap tolerance 0.1" should be sufficient for most users.

Here is the same object at 6400% zoom -all lines are now connected and we have a closed path.
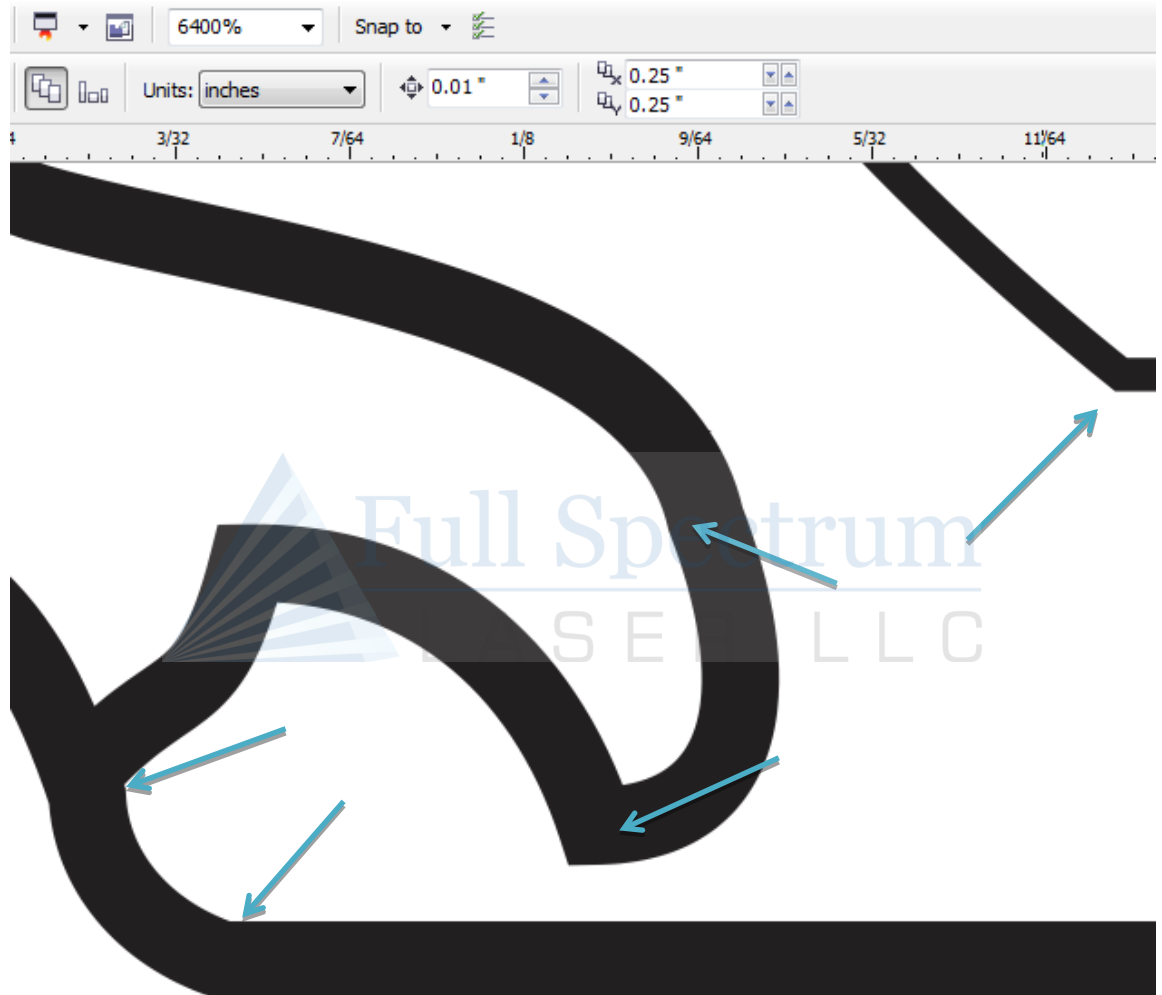
Figure 44 - Example Drawing at 6400% Zoom, After Processing

Designating Colors to Layers, CorelDraw

Designating a color to objects/ layers you want to vector cut enables you to take advantage of RetinaEngrave3D's ability to specify cutting order, cut speed, laser power and number of repeats for each layer.

RetinaEngrave supports up to seven standard color layers for maximum program compatibility: Black, Blue, Red, Magenta, Green, Cyan, and Yellow from the RGB color palette.

Always assign the **outline stroke** (the object border) the desired color and not the fill of the object. Always use an empty fill when possible.

1. Open your *.cdr* vector format file in CorelDraw X5.
2. Make sure you have the Object Manager window open by **Left Clicking**: Tools, Object Manager
3. **Right click** on the object in the Object manager that you want to designate a color to.
4. **Left click** on "Properties" in the pop-up window
5. In the Object Properties window **Left Click** on the Outline Pen tab.
6. In the Outline Pen properties window **Left Click** on the down arrow next to "Color:" to change the outline color of the currently selected objects to one of the seven supported colors.

In Figure 36 we have changed the outline color of one object to blue. It is possible to have more than one object the same color. In our example image all objects that have a black outline would be considered to be on the **Black** layer in RetinaEngrave and the single object with the blue outline would be considered to be on the **Blue** layer.

Repeat steps 3 through 6 as necessary to change the outline color of objects, specifying one of the supported colors for each layer of objects up to a maximum of seven.
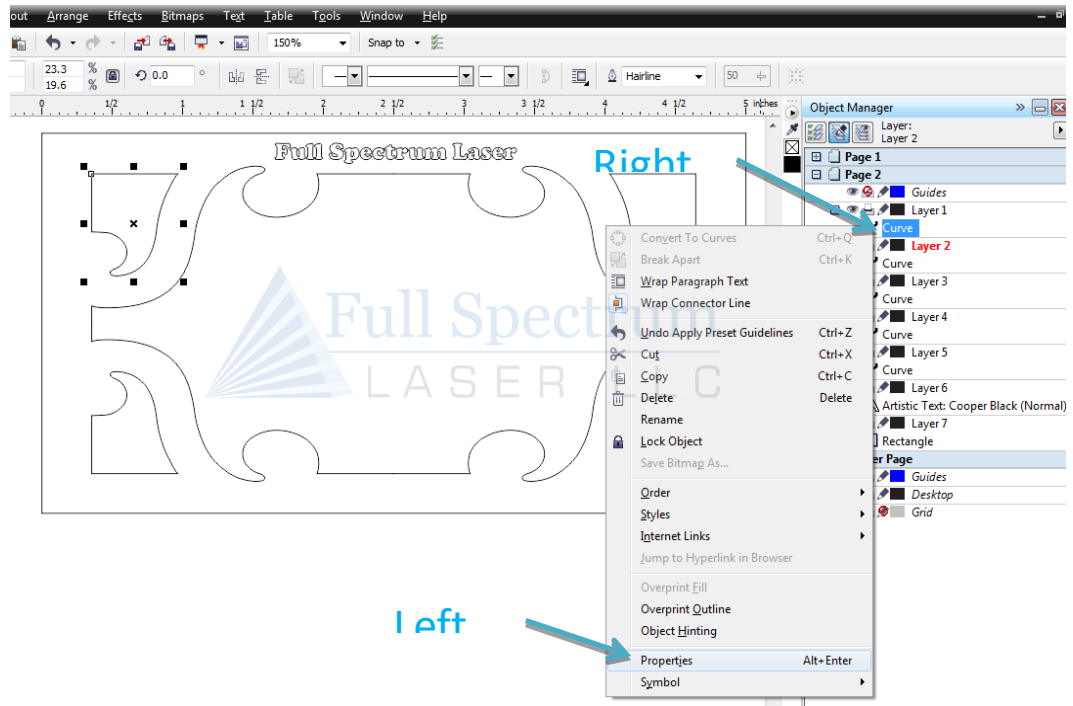
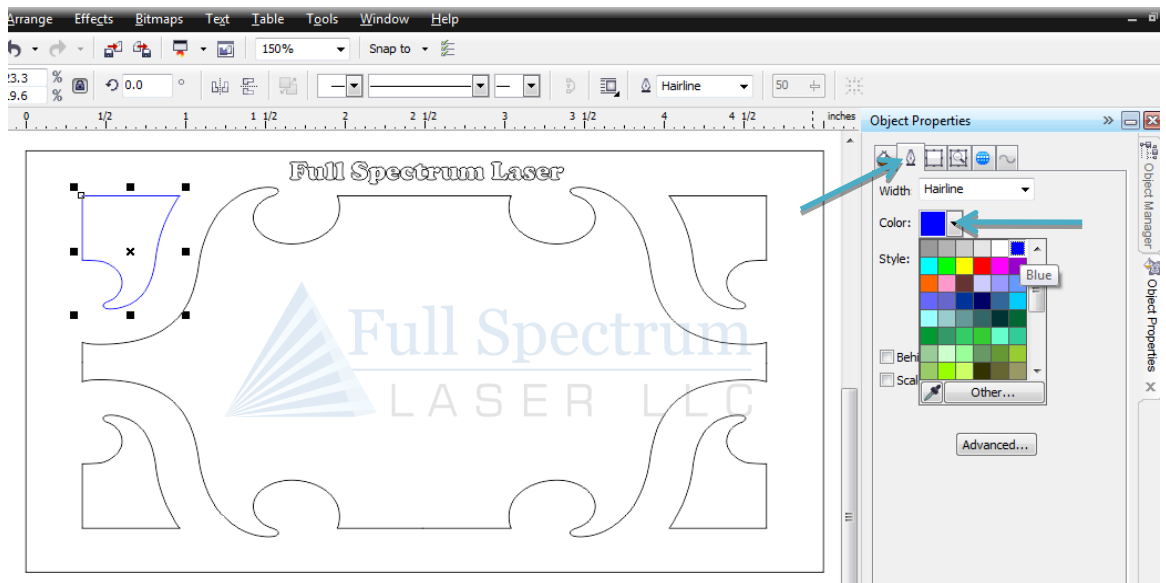**Figure 45 - Designating Object Color, CorelDraw**
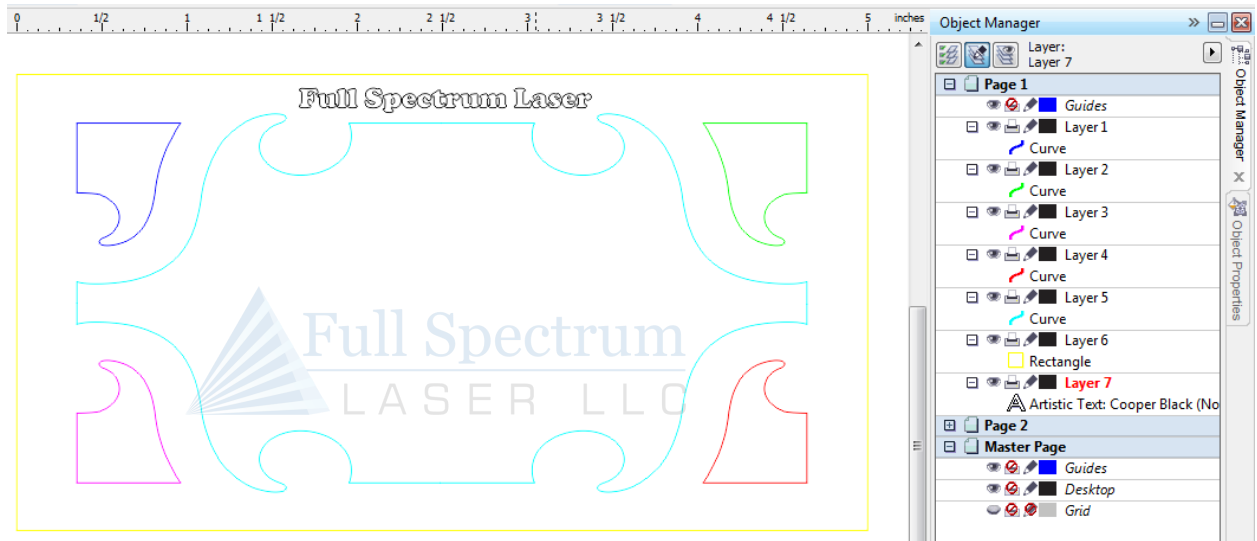

Figure 46 - Colored Segment, CorelDraw

Figure 47 - Seven Object Layers, CorelDraw

Appendix B: Rotary Attachment Setup and Installation

Overview

Thank you for purchasing the Full Spectrum Laser Hobby Advanced Rotary Attachment. The rotary attachment is capable of engraving on objects from 0.25in diameter. This Appendix explains the typical install method of the rotary attachment into a 5th Generation Hobby Laser (HL40-5g Hobby Advanced). Once you have unpacked your rotary attachment, you will need to connect it to your laser's RetinaEngrave PRO controller before running any jobs.

Rotary Attachment Installation

Once you have unpacked your rotary attachment, begin the installation process by placing it into the work area of your laser (Figure 48 - Rotary Attachment). The rotary attachment is a friction-wheel type—objects rest on two driven and two idling wheels and are turned to engrave an image onto the surface of a cylindrical object. Because some small objects are very light, **the rotary attachment has two hold-down plates to force light objects into contact with the drive wheels**.

Figure 48 - Rotary Attachment

[91]
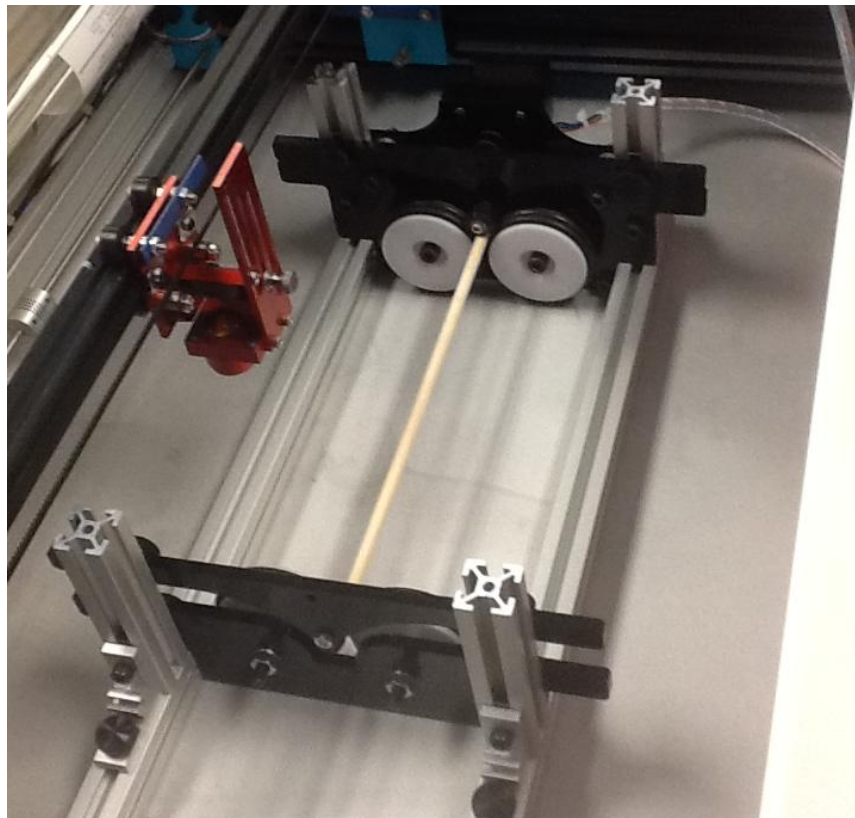
The rotary attachment works by translating Y motion along a cylindrical surface. With the laser off, place the rotary attachment into your laser's work area, and disconnect the Y motor from the RetinaEngrave PRO control card and connect the rotary attachment motor in its place. Note the orientation of the connector and the wiring (Figure 49 – Rotary Attachment Motor Connection), this orientation should be maintained when connecting the rotary attachment to the control card.
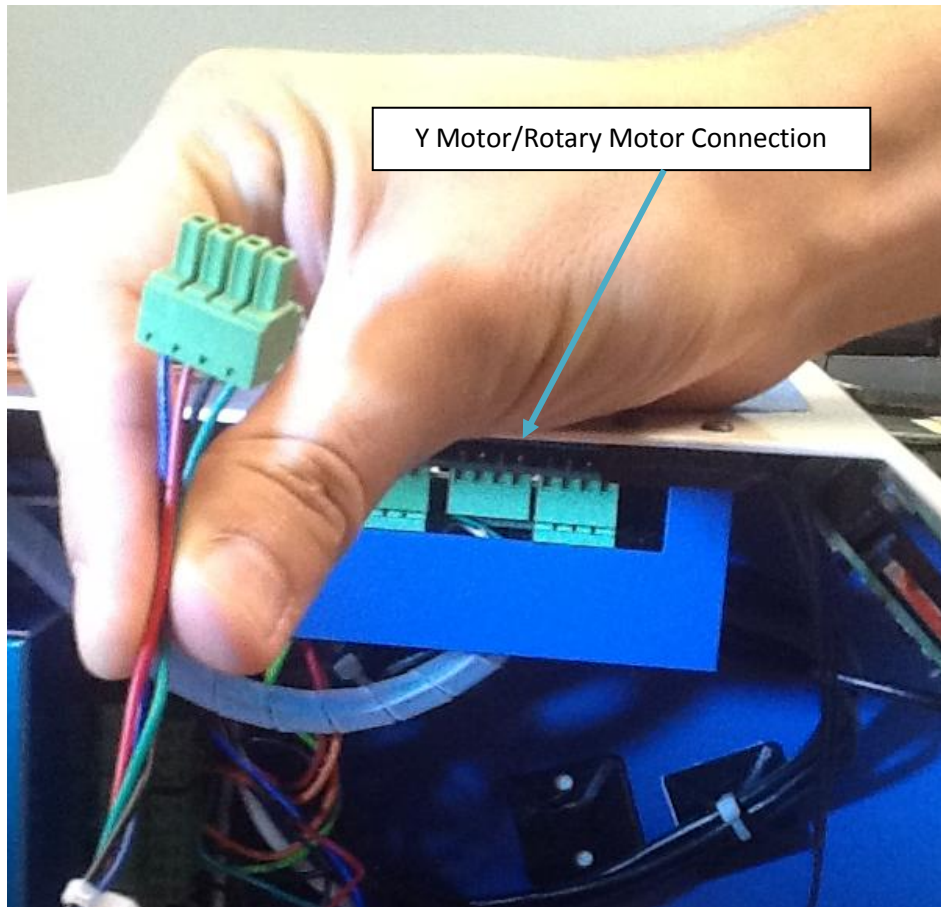

Figure 49 – Rotary Attachment Motor Connection

Once you have connected your rotary attachment, you can activate your laser and move the rotary attachment and laser head into a position to engrave on your work piece. The red dot should be in the same vertical (X-Z) plane as the center axis of the work piece.

Keep in mind that Y axis motion is now sent to the rotary, so you may need to unlock the laser head and move the gantry by hand.

[92]

Using the Rotary Attachment

The rotary attachment is designed to be used within the laser case, however its maximum engraving diameter can be increased by modifying your laser system's bottom panel. Please be aware that any system modifications must be performed by an authorized technician and in accordance with all applicable state and federal laws.

Aligning Your Rotary Attachment

The best way to align your rotary attachment with the laser head is to build a jig that uses the frame as a reference. A quick procedure to visually align the rotary attachment follows.

1. Focus the laser head onto the rear frame member of the rotary attachment on the far left (Figure 50).
2. Slide the laser head to the right, keeping the red dot in the same relative position on the rotary frame member as you go (Figure 51 and Figure 52).
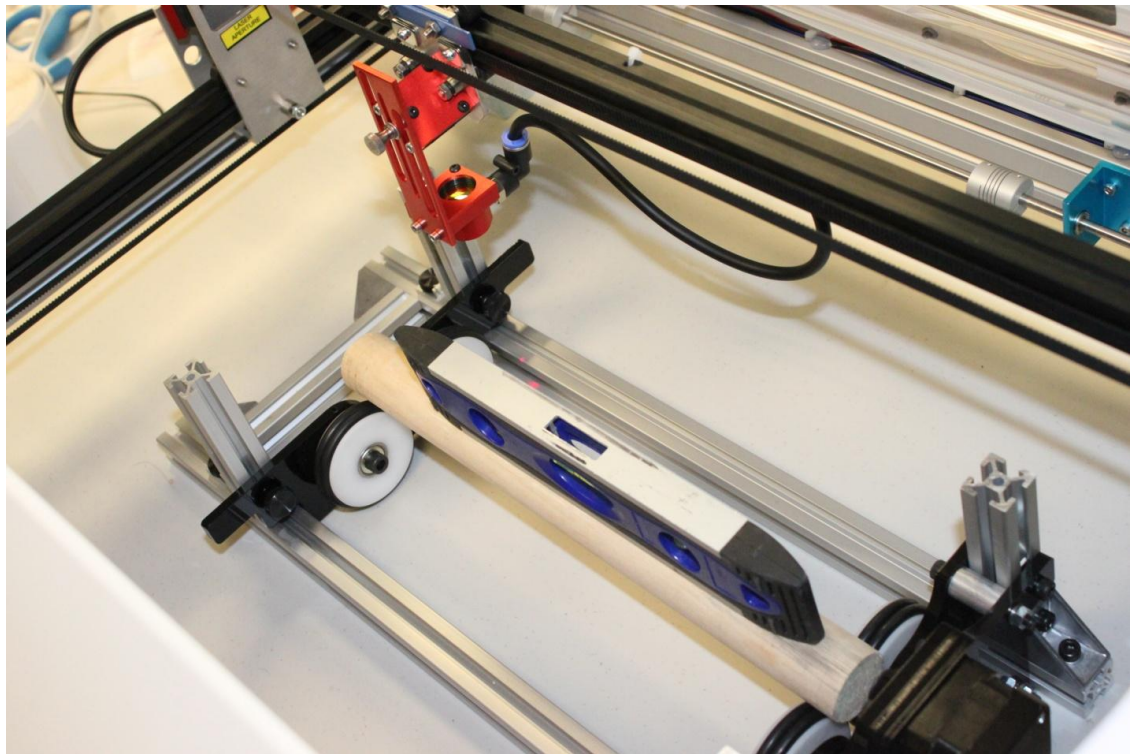
Figure 50 - Rotary Visual Alignment Step 1
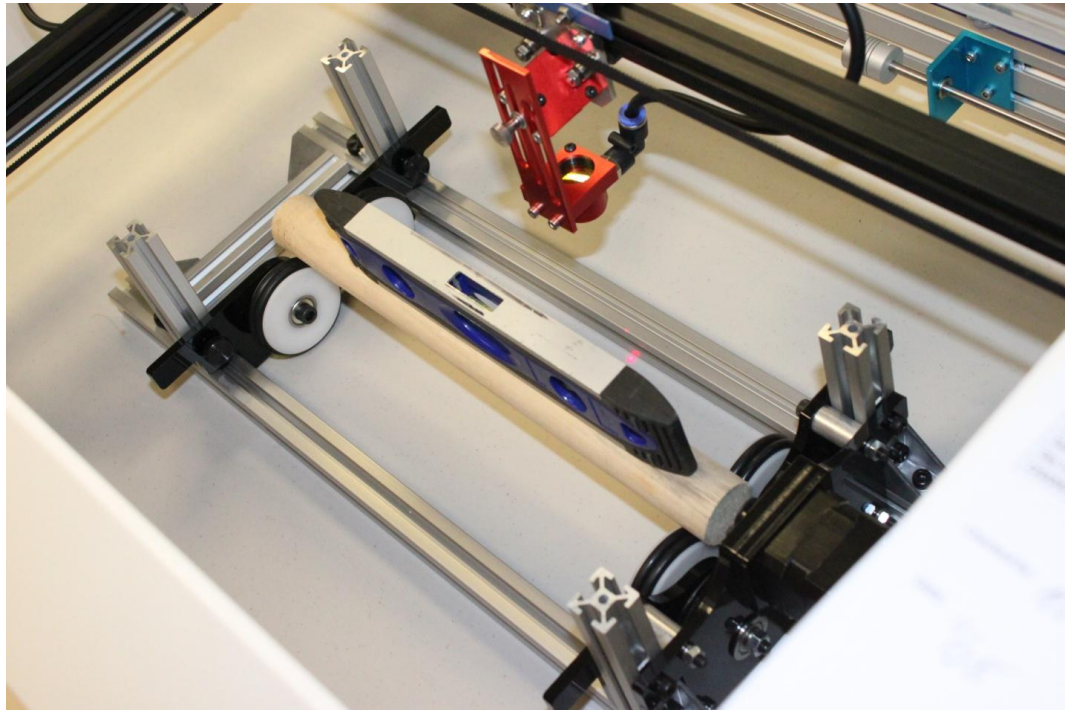
Figure 51 - Rotary Alignment Step 2
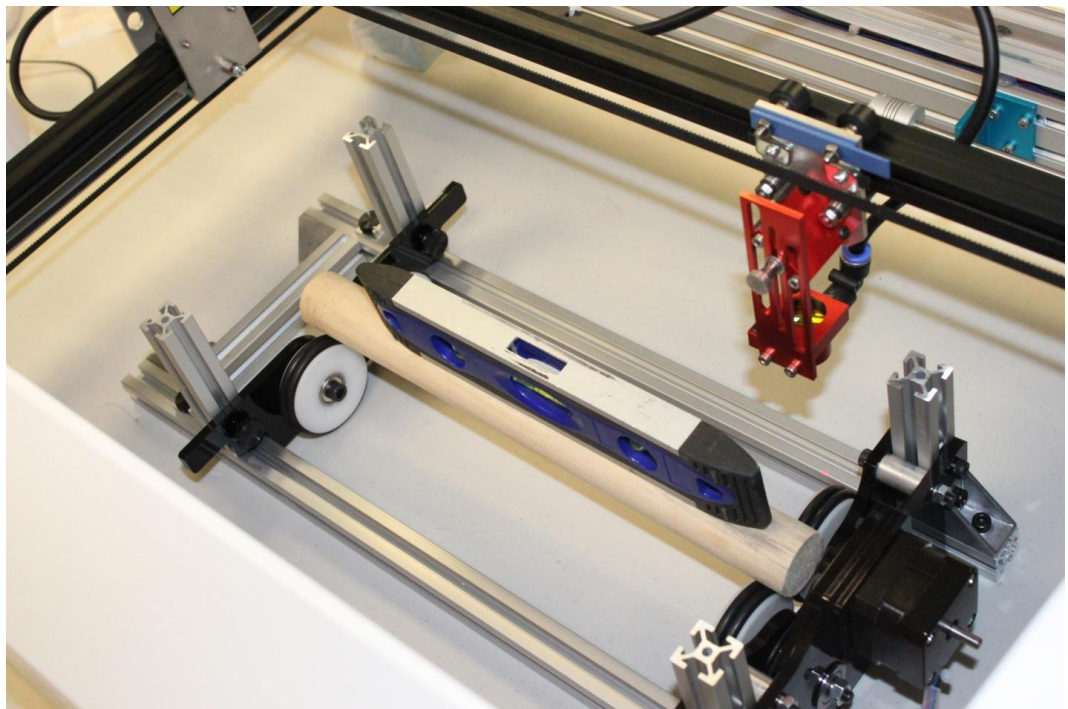
Figure 52 - Rotary Alignment Step 3

Focusing Your Rotary Attachment and Leveling the Work Piece

Rotary engraving should be carried out along the topmost portion of your circular work piece co-planar with the work piece axis. Focus the laser with the included billet. It is important that your work piece be level along its length—a small carpenter's level is very helpful. The following figures (Figure 53, Figure 54 and Figure 55) illustrate the steps.
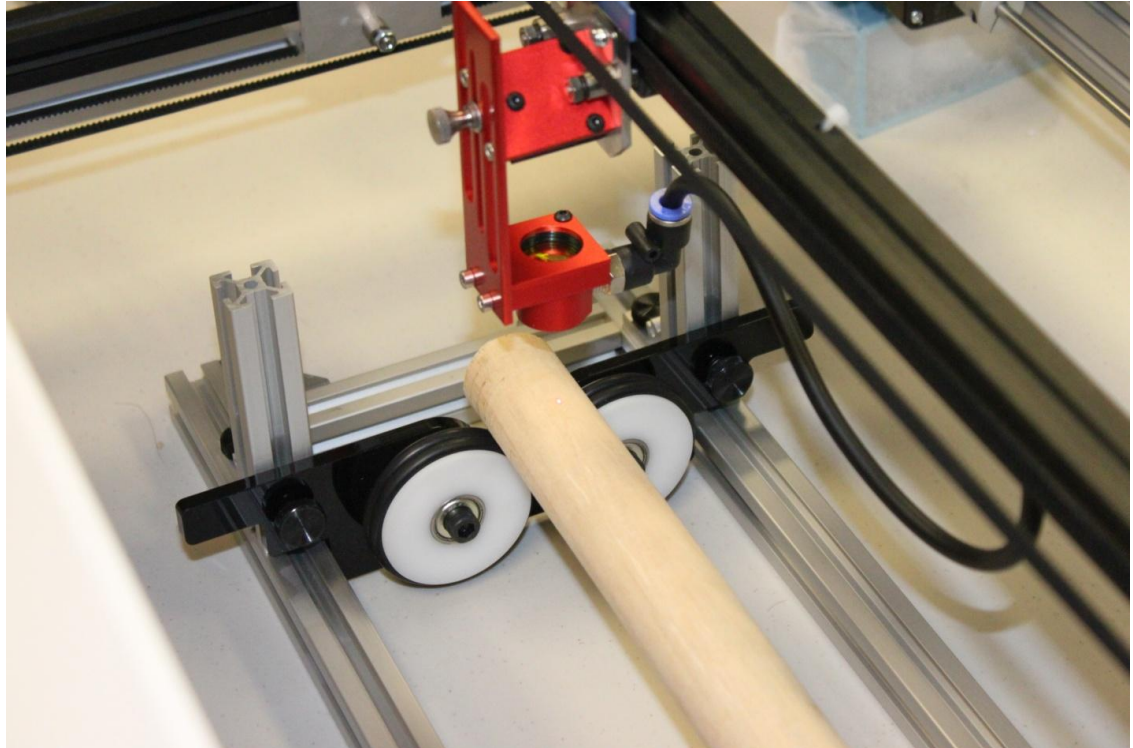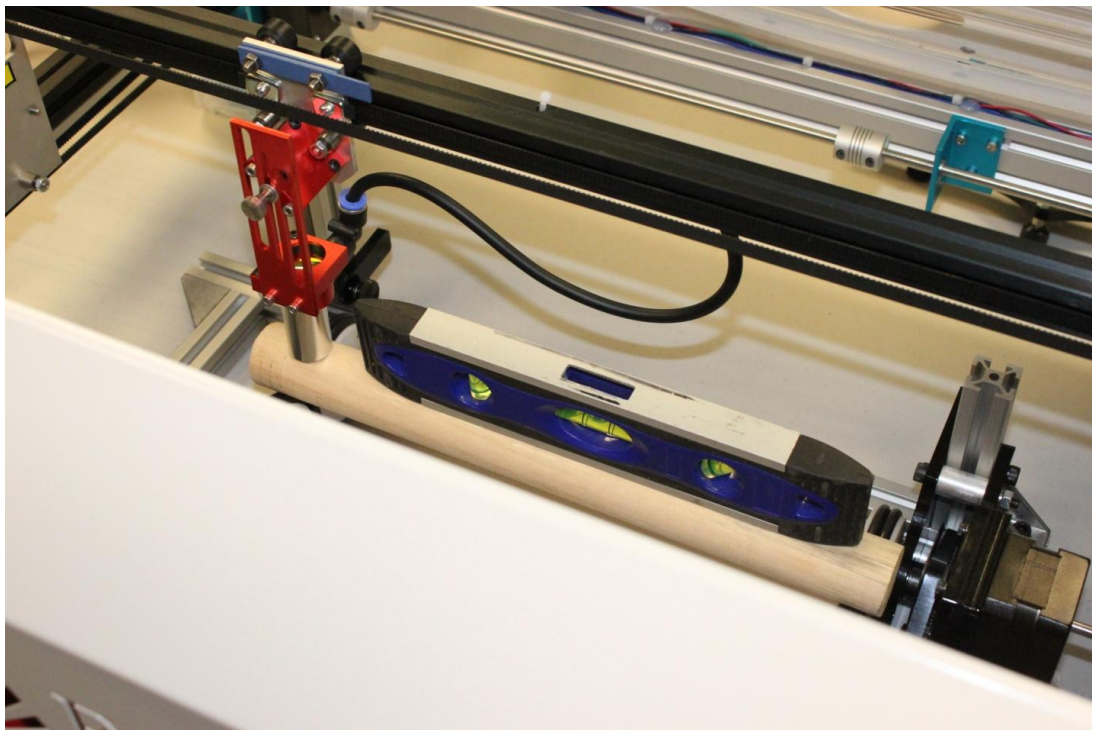

Figure 53 - Red Dot Aligned on Work Piece
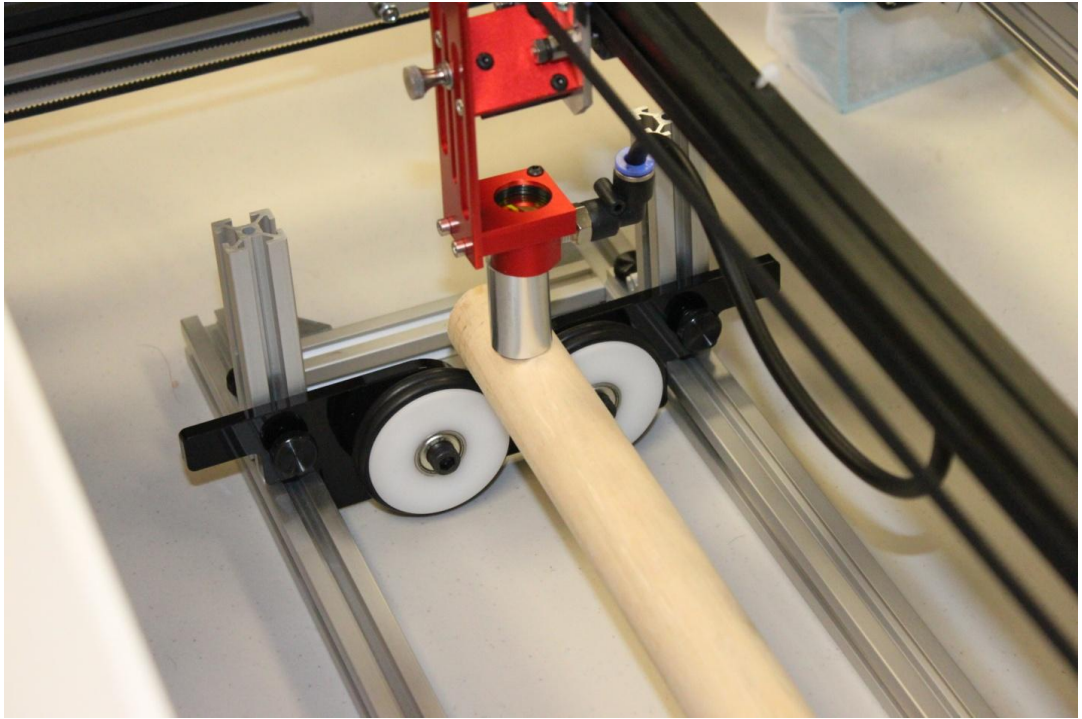
Figure 54 - Laser Head Focused
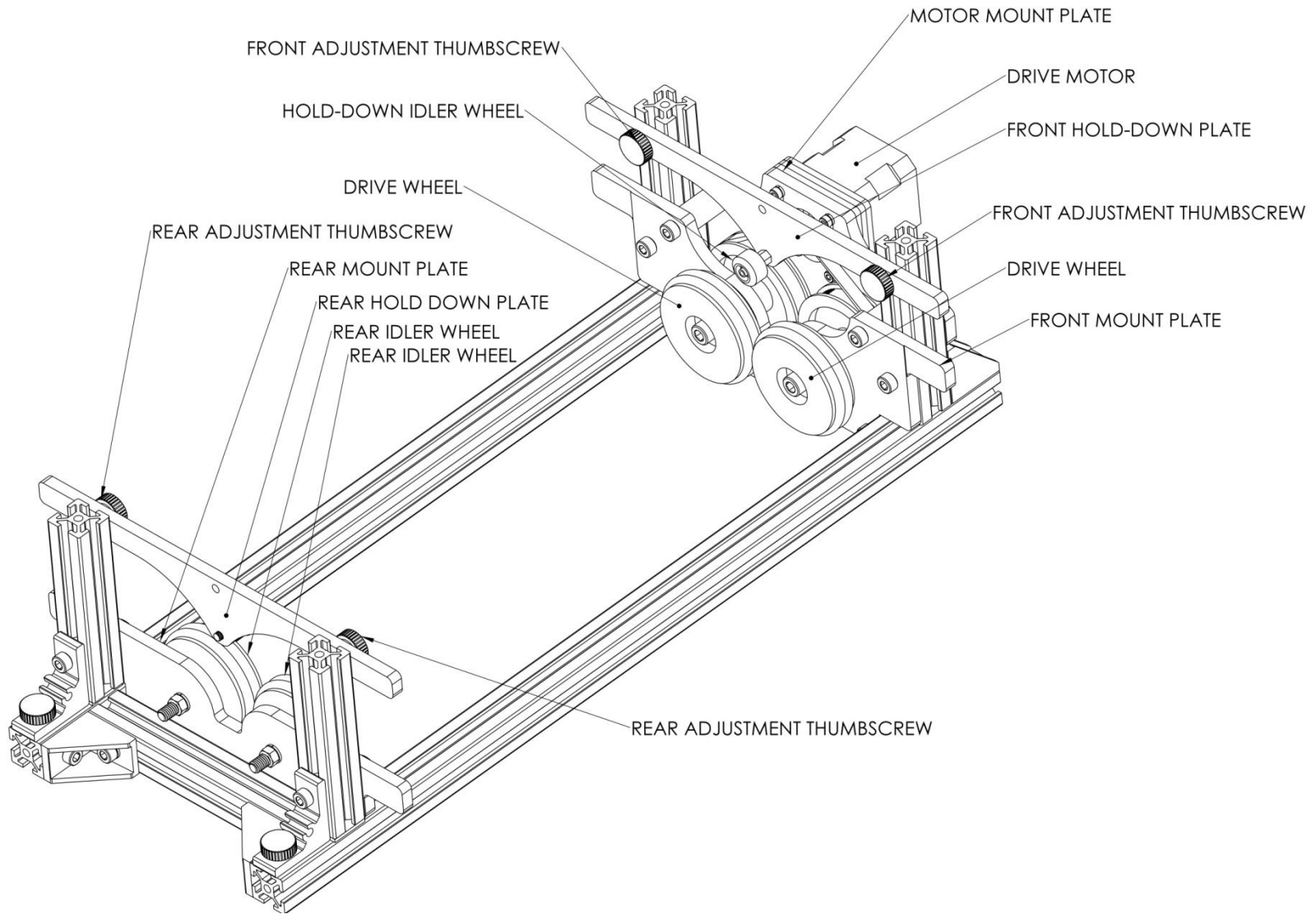

Figure 55 - Laser Focused and Work Piece Leveled

FRONT ADJUSTMENT THUMBSCREW

HOLD-DOWN IDLER WHEEL

DRIVE WHEEL

REAR ADJUSTMENT THUMBSCREW

REAR MOUNT PLATE

REAR HOLD DOWN PLATE

REAR IDLER WHEEL

REAR IDLER WHEEL

MOTOR MOUNT PLATE

DRIVE MOTOR

FRONT HOLD-DOWN PLATE

FRONT ADJUSTMENT THUMBSCREW

DRIVE WHEEL

FRONT MOUNT PLATE

REAR ADJUSTMENT THUMBSCREW

Figure 56 – Rotary Component Description

[97]

Appendix C: Warranty Statement

Please note that the most current warranty agreement can be found at http://fslaser.com/service-and-support.

Within the first 30 days, Full Spectrum Laser will replace or repair any defective parts free of charge and pay for ground shipping of parts. Overnight shipping is available at extra charge.

Outside the first 30 days, 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. The warranty includes parts and labor only. Shipping of defective and replacement components is excluded by the warranty. The customer may arrange their own shipping or drop parts off to exchange parts at our warehouse free of charge. Typically Full Spectrum Laser has most replacement parts on hand for immediate shipment of under warranty parts.

All defective parts must be returned to Full Spectrum Laser postage paid for evaluation before replacements are issued unless otherwise authorized. The warranty is valid for normal use only and excludes Acts of God, user error and use outside of normal parameters. Parts damaged by fires are considered user error if the machine is left unattended. Just like operating a household gas stove, always stand next to the machine with a fire extinguisher and be ready to turn it off in case of a fire and never operate the machine unattended.

Prior to 8/7/2012, the extended warranty was charged separately and the Hobby Lasers had a 60 day base warranty on all items excluding shipping unless an extended warranty was purchased.

After 8/7/2012, the Hobby lasers have a 60 day warranty on all items and a free extended limited 1 year warranty which excludes consumable items/shipping included in their price.

The limited warranty excludes shipping and consumables and other normal wear and tear items. All electronic items (control cards, power supplies, motors) and most mechanical items are covered under the extended warranty unless damaged by abuse/fires. Consumables not covered include, but are not limited to, rubber parts such as tubing, belts, plastic wheels, lenses, mirrors, other optics, and laser tubes.

Within the first 30 days the original purchaser may transfer the balance of your warranty to anyone else free of charge provided you notify us in writing. Outside of the first 30 days, we will only provide warranty and tech support services to the original purchaser unless a warranty transfer fee is paid as there is a cost involved with initial tech support of new users and accounting fees. If you sell your machine, the warranty remains valid but the buyer must arrange with the original purchaser to request RMAs and send in the machine for repairs unless a warranty transfer fee is paid.
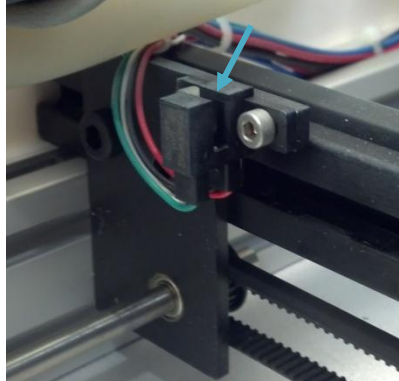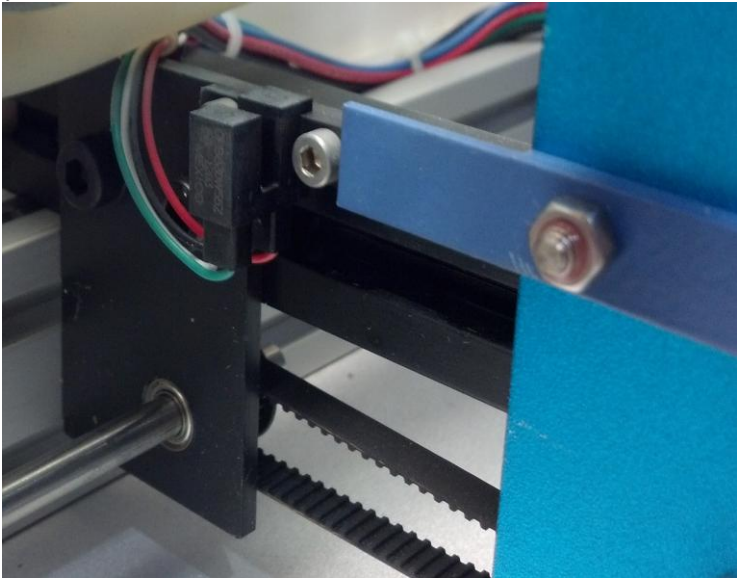
Appendix D: Troubleshooting

This Appendix is a quick troubleshooting reference to assist with common problems. Please contact support if your issue is not mentioned here or if the recommended solution(s) do not solve your problem.

For the purposes of quick and easy troubleshooting, Full Spectrum Laser recommends that customers possess or have access to one of the following in the location they have placed their laser:
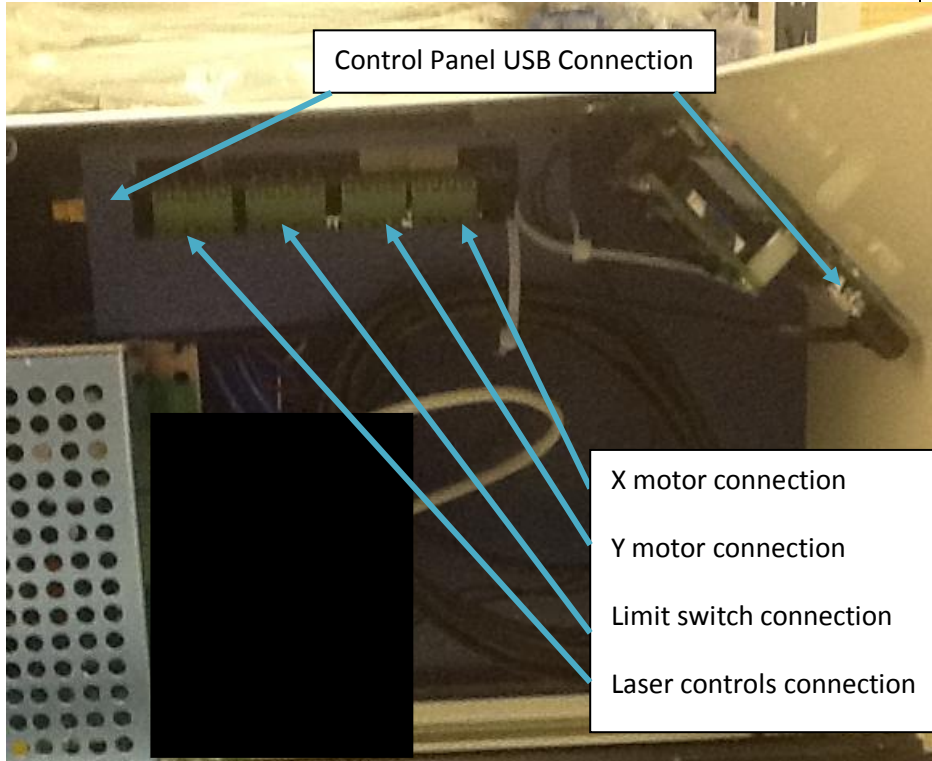
- Digital still camera
- Web camera and videoconferencing software such as skype (internet access required)

These tools are extremely helpful for diagnosing problems, as they allow us to quickly gather important information on the state of your laser.

	Description of the Problem	Recommended Solution
1.	Front Panel does not turn on	Check that the internal USB connection between the Control Card and the Control Panel is in place. If the USB cable is connected, check that the Control Card is receiving power. The green LED on the Ethernet port will be lit if the Card has Power. If the Ethernet LED is not lit, verify that the laser is plugged in and the power is ON (E-stop is unlocked). If the laser is plugged in and power switch (E-stop) is ON, check that the power supply is receiving power (green LED on main board is lit). If power supply LED is receiving power, check connections between laser and power supply. If connections are good (no loose connectors or wires) and foregoing tests passed, please contact support.
2.	Laser does not fire	Make sure that the cover of your laser is closed during jobs or test fires. Check that the magnet wires are connected to the terminals on the power supply.
3.	Laser head skips during raster	This issue is usually caused by over-tightening the adjustment spacers on the lower part of the laser head. Try loosening the cams and testing a raster job at 0% power. The adjustment spacers should be tight enough to restrict the laser head from moving more than a very small amount but the laser head should be movable without too much effort by hand (test this with the laser off or motors unlocked). Laser head adjustment tutorial: http://www.youtube.com/watch?v=Pd6eY97JSkM&feature=youtu.be

		Laser unable to HOME The laser attempts to home but crashes before tripping the optical interrupt. Usually along the Y axis.	This problem is caused by the Y axis interrupter "flag" and optical limit switch "interrupt" moving from the nominal mounting positions. 1) Using a business card or small piece of paper, home the laser and interrupt the problem axis. Motion along that axis should cease. If it continues to move, the problem is likely electrical—please contact support. 2) If the axis stops moving, the issue is mechanical. 3) Loosen the 2 M3 screws that secure the optical interrupt and slide it towards the front of the laser. You can also loosen the two M4 nuts that hold the flag in place and slide the flag towards the interrupt. Be sure that you do not unscrew the wheel axles.
4.			
5.		Red diode laser OFF	Check that the plugs on the power supply are connected, as it is possible they came loose during shipping.

6.	Laser pauses during a job Random Pausing or other button pushes (panel led lights green randomly). The laser stops movement during a job and displays a "*Paused*" message on the touch panel and/or the *Pause* button in RetinaEngrave is grayed out, without the user having commanded a pause.	This occurs due to the sensitivity of the front capacitive touch panel combined with ElectroMagnetic Interference (EMI) caused by a poor connection to the tube electrodes. Tests: 1) Unplug the short USB cable going to the panel—this should fix the issue and the job should complete normally. You can run any job as normal with the panel disconnected using the computer to control the laser. 2) Reconnect the panel and open the lid and run the job. The laser will not fire with the lid open. The job should complete normally without ever pausing. This indicates a bad ground connection; ground is located on the left side of the laser tube (nearest the emission aperture). Resolution: Clean the electrode and rewrap the ground wire on the laser tube (see Appendix F – Tube replacement) Shifting of the connection during shipping can sometimes cause a loose connection to the ground wire. The voltage on this wire is less than 0.1V and it must make tight contact with the electrode or else there can be unpredictable EMI behavior. Remove the wire, sand the surface of the electrode and rewrap the wire on the post. We recommend a few layers of teflon tape to hold down the wire to the post. The post is very delicate and we do not recommend attempting to solder to it as solder doesn't hold and we also don't recommend crimping to it to prevent breakage of the surrounding glass. Wrapping the wire + wrapping with teflon tape to hold it down is the best way to install it. It is not necessary to insulate this low voltage wire. Previously, tubes were wrapped and insulated on both sides but only the Red high voltage wire **MUST** be insulated.
7.	Laser head crashes during a job	In either Raster or Vector mode, the laser must first be **Homed** for the soft limits to work properly. In **Raster** mode, the laser requires an acceleration and deceleration distance that varies with the S**peed %**; lower speeds require a shorter acceleration/deceleration distance. This issue is only apparent on jobs that take up the full work area or are run close to the edge.
8.	PC does not connect to Laser	Verify that your internet connection is properly configured for DHCP. You must reset the laser after connecting the Ethernet cable. On some PCs it is not possible to browse the internet over WiFi and connect to the laser via Ethernet at the same time.

9.	Engraved lines are diffuse; cutting fails even at high power	Check that your laser is in focus.
		    1. Rest the included focus billet on top of your work piece.
		    2. Loosen the lens slide so the output nozzle rests on the focus billet.
		    3. Retighten the slide.

|		
10.	Motors do not jog	Verify that the motors are connected to the control card. Control Panel USB Connection X motor connection Y motor connection Limit switch connection Laser controls connection
11.	Vector cut rectangles are out of square (lines are straight, but angles are wrong)	This problem is usually caused by a loose rear coupler or an uneven belt (after a Y-axis crash or skip). Re-squaring the Y axis is not difficult, but it is very helpful to have an extra pair of hands. 1. Using the 2mm hex key, loosen the motor flex coupling (2 screws) 2. Make sure that the middle flex coupling is tight (avoid putting pressure on the Y shafts) 3. Take two known-length standards of equal size (1-2-3 blocks work well) and place them at the front of the machine on either Y-rail, flush with the interior wall of the top panel. 4. Slide the gantry forward so that both left and right risers are in contact with the blocks. 5. Maintaining forward pressure on both sides of the gantry, re-tighten the motor flex coupling.

12.	Gantry jams/skips during Y moves	This is usually caused by the Y axis eccentric cams being over-tightened. The normal motion along the Y axis should be smooth and not require too much force when the laser is off or unlocked. Slowly move the Y axis from the rear of the laser to the front. If you feel bumps or sticking points, the eccentric cams are over-tightened. Loosen the cams until the Y motion is smooth. The wheels of risers 2 (left slider) and 3 (right slider) should be contacting the Y rails in the following manner: • Eccentric wheels should have good contact with bottom channel • One of the upper, fixed wheels on <u>each</u> side should have good contact with the upper channel • One of the upper, fixed wheels on <u>each</u> side will be free-wheeling or have low-contact with the upper channel
13.	Vector cut lines are not straight	This problem is usually caused by a mis-adjusted laser head. Please follow the instructions in the **Laser Head Adjustment** section of **Part 7** of this manual, or watch the following video tutorial: http://www.youtube.com/watch?v=Pd6eY97JSkM&feature=youtu.be
14.	Air hose drags on work piece or coils into beam path	1. Slide the laser head to the far right of the work area and drop the focus slide to its lowest point. 2. Remove the air hose from the connector on the laser head. 3. Make sure the air hose is straight and free from kinds or bends. 4. Replace the air hose into the connector, giving it a slight counter-clockwise twist so the hose is suspended in the air behind the laser head. 5. Slide the head from right to left and make sure that the hose does not interfere with the beam path or work piece.
15.	Laser will not run jobs or jog after a software update OR The following popup appears in the connection box: Firmware Update Or	This occurs if a firmware update was incomplete. Make sure that you loaded BOTH the XMOS and Stellaris firmwares.
16.	Other cutting or engraving issues	Assuming that your laser tube is firing, perform the following checks: 1) Clean mirrors, lens and beam combiner with a lens wipe. 2) Make sure that your laser is in focus. 3) Check that your lens is correctly oriented inside the holder (convex side up). 4) If these checks do not help solve your issue, please contact technical support (M-F, 9am-6pm PST: support@fslaser.com)

Appendix E: Power Supply Connections

CONNECTIONS FROM TOP TO BOTTOM
TERMINAL CONFIGURATION:
4-6-4

CONNECTOR CONFIGURATION:
4-6-4

CONNECTOR CONFIGURATION:
3-5-4

CONNECTOR A

EMPTY

CONNECTOR A

VACANT

CONNECTOR B

EMPTY

CONNECTOR B

VACANT

CONNECTOR C

CONNECTOR C
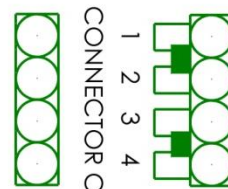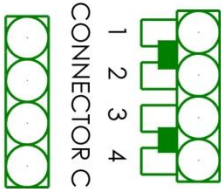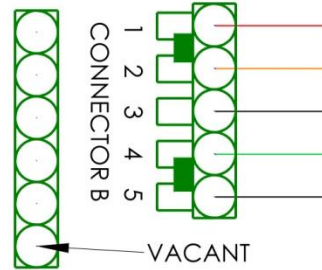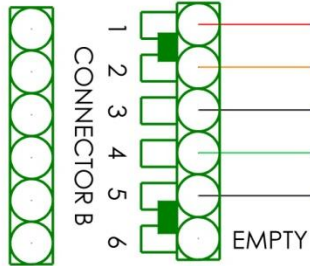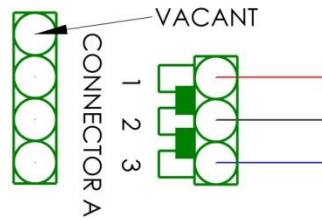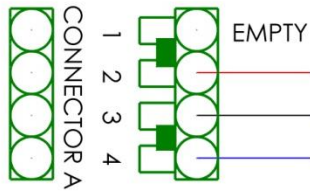
	NAME	SIGNATURE	DATE		FINISH:		DEBUR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
DRAWN								TITLE:		
CHK'D										
APPV'D								POWER SUPPLY CONNECTIONS		
MFG										
Q.A				MATERIAL:				DWG NO. 120100-01		A4
				WEIGHT:				SCALE:1:1	SHEET 1 OF 1	

Appendix F: Laser Tube Replacement

Overview

This Appendix provides procedures and a walkthrough to replace the laser tube on your Hobby Advanced Laser. Please carefully read all instructions before beginning the replacement procedure as there are several critical steps which must be properly followed to avoid breaking the laser tube. The included pictures show how to properly connect wires to the tube's electrodes and secure the connections.

Required Parts and Tools:

- FSL 40W replacement tube (Part Number: 420153-01)
- Wrench (for M5 hex nuts)
- Scissors/wire cutters
- Large zip ties
- 2mm hex key for removing back panel of laser (included with accessories)
- 6.5mm ID silicone tubing (included with FSL replacement tube)
- RTV Silicone Adhesive Sealant (available at your local hardware store)
- Teflon/PTFE tape (at least 2 10in lengths). Also called plumber's tape; blue PTFE tape is ideal (available at your local hardware store).

Warnings

- Pulling on the tube wires will break your laser tube at the neck
- The water connections are very fragile, DO NOT pull or force the connection tubes—gently work the tubes off of the connectors.
- The capacitors in the power supply retain power even after turning the laser off. To ensure your safety, turn off the laser, remove the power cord and wait at least 1 hour before accessing the power supply.

Replacement Procedure

Switching the Tube

1. Power off and unplug your unit. Wait at least 1 hour for capacitors to discharge.
2. Disconnect water from rear connectors. Use the small piece of tubing that shipped with your laser to shunt the two water bulkheads together.
3. If necessary, move your laser so that you have at least 1ft of table working space to access the rear of the unit. You will be removing the rear panel to access the tube.
4. Using a wrench, remove the 4 M5 hex nuts from the posts on the rear of the laser
5. Using a 2mm hex key, unscrew the 5 lower M3 6mm button head socket screws and 2 upper M3 6mm button head socket screws.
6. Carefully remove the rear panel and lay flat on your work surface.

7. Carefully remove the silicone sealant and tubing to expose the **BLUE** ground wire (located at the tube aperture).
8. Unwrap the **BLUE** ground wire from the tube terminal.
9. Hold the **BLUE** ground wire about 8 inches from the exposed end. Move the exposed end to the **RED** POWER terminal. If there is any residual voltage in the capacitors, there will be a spark as it grounds to the **BLUE** wire. DO NOT hold the blue wire near the exposed end while doing this. NEVER perform this procedure while the laser's power cord is connected. The waiting period should have dissipated any residual charge, but take extreme care during this procedure.
10. Carefully remove the silicone sealant and tubing to expose the **RED** power wire (located at the rear of the tube).
11. Unwrap the **RED** power wire from the tube terminal.
12. Remove the two water tubes from the inner bulkheads.
13. Remove the water tubes from the laser glass bulkheads—please exercise caution as using to too much force can break the bulkheads and prevent a sharp glass hazard (and will also make your tube unusable).
14. Remove the laser tube mounts from the panel. Not the orientation of the tube relative to the holders.
15. Remove the mounting U-bolts from the rubber tube holders.
16. Remove the tube from the rubber holders.
17. Set aside the old tube.
18. Place the new tube into the rubber holders in approximately the same orientation as the old tube.
19. Attach the U-bolts to the rubber holders and place the tube back onto the rear panel.
20. Exercising caution, thread the M5 hex nuts onto the U-bolt posts and make snug (but not yet tight) with the rear panel.
21. Carefully attach the water tubes to the proper laser connection bulkheads. Make sure that the water tube routing and locations match the original configuration

Connecting the Tube to the Power Supply

1. Straighten the exposed wire on the red lead. Twist the wires together.
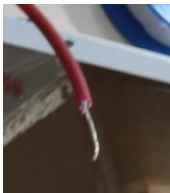
2. Slide one piece of silicone tubing onto the red lead (Figure 57).
3. Wrap the exposed portion of the red lead **tightly** and **securely** around the positive electrode—reflector end, opposite the aperture (Figure 58 and Figure 59).
4. Thread Teflon tape around the neck of the laser tube (Figure 60).
5. Tightly wrap one end of the Teflon tape several times around the electrode (Figure 61 through Figure 63).
6. Bring the opposite side of the Teflon tape around the neck of the laser tube and around the inside of the electrode (Figure 64).
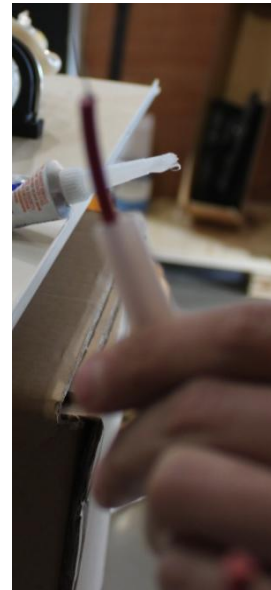7. Wrap the Teflon tape tightly around the electrode (Figure 65).

Figure 57

8. Knot the Teflon tape tightly around the electrode (Figure 66 and Figure 67). Repeat. Trim Teflon tape.
9. Slide the silicone tubing onto the electrode (Figure 68).
10. Fill the silicone tubing with silicone sealant (Figure 69)Figure 68.
11. Allow the silicone to dry (Figure 70).
12. Repeat steps 1 through 8 for the **BLUE** ground wire that attaches to the electrode nearest the tube aperture; it is not necessary to insulate the ground wire with silicone tubing or sealant.
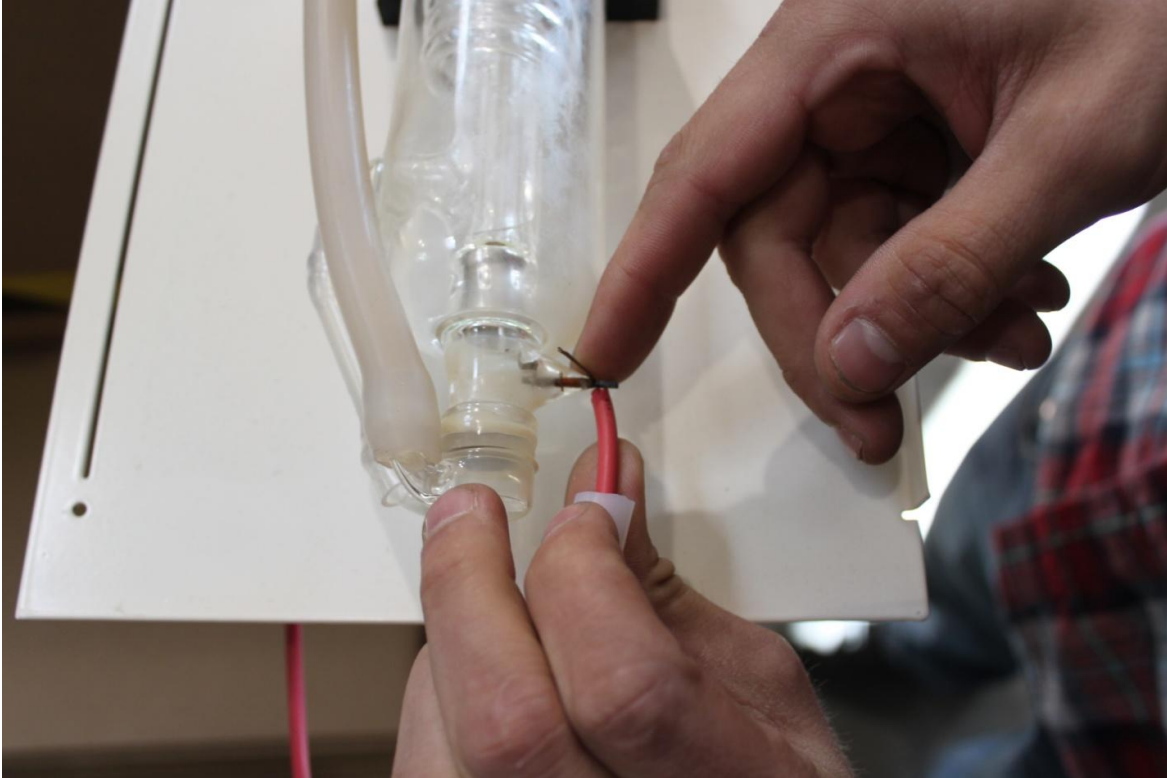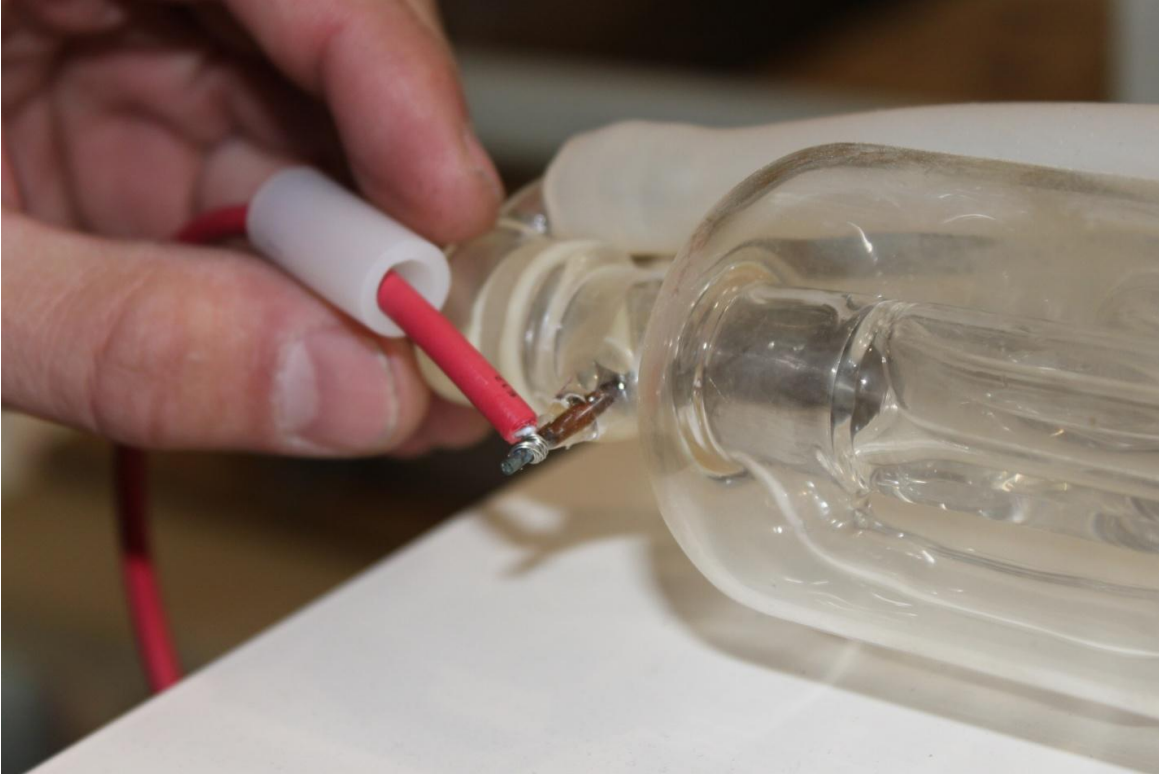

Figure 58

Figure 59

Figure 60

Figure 61

Figure 62

[109]
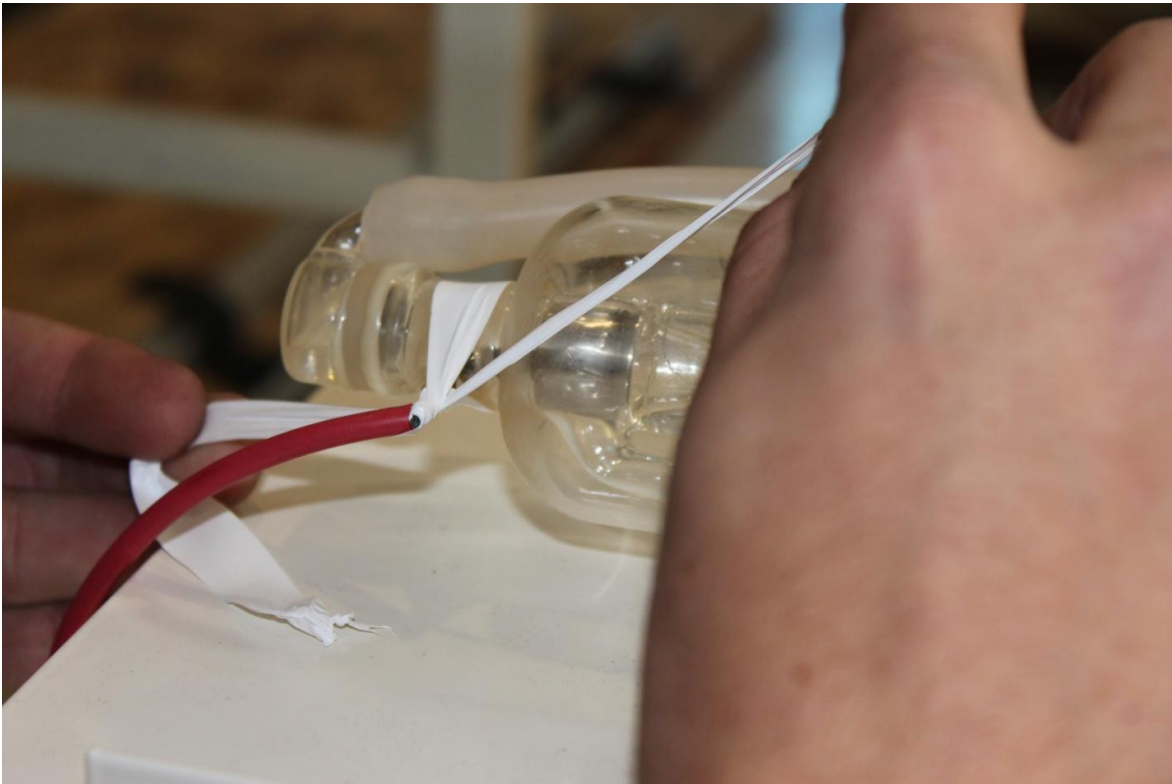
Figure 63

Figure 64
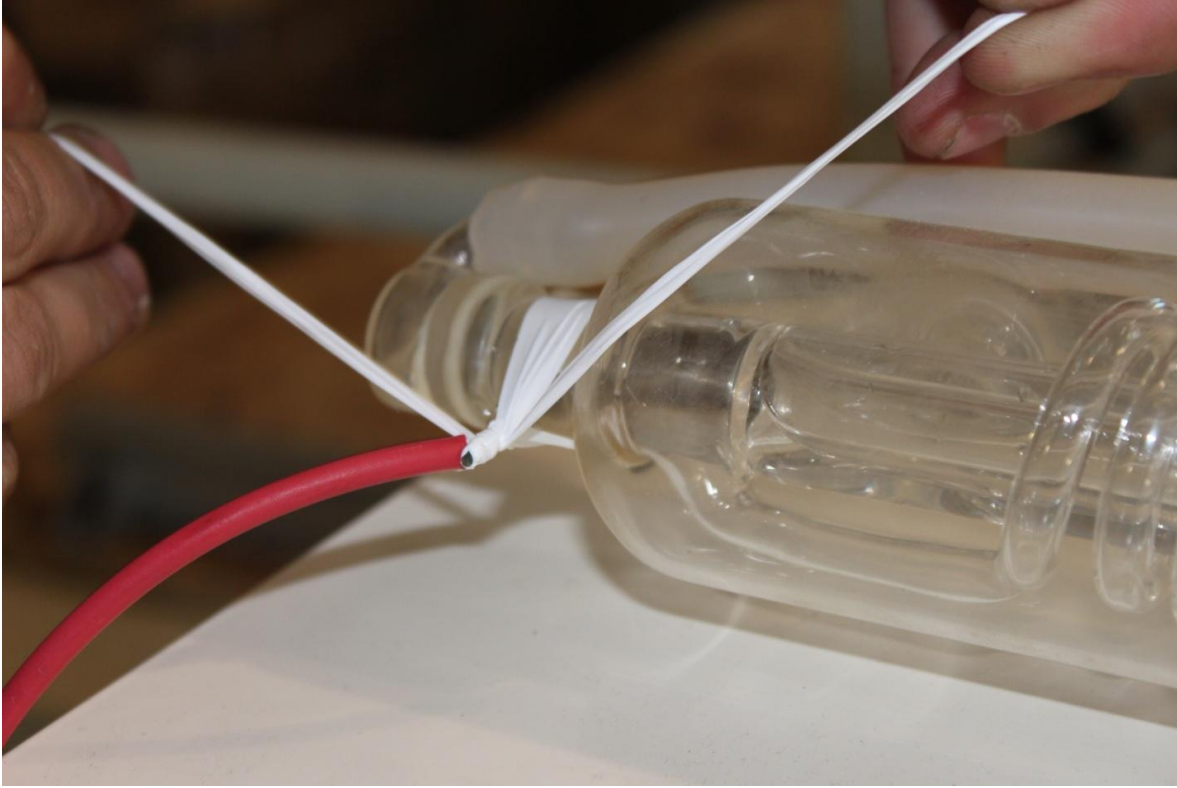
Figure 65

Figure 66

[111]
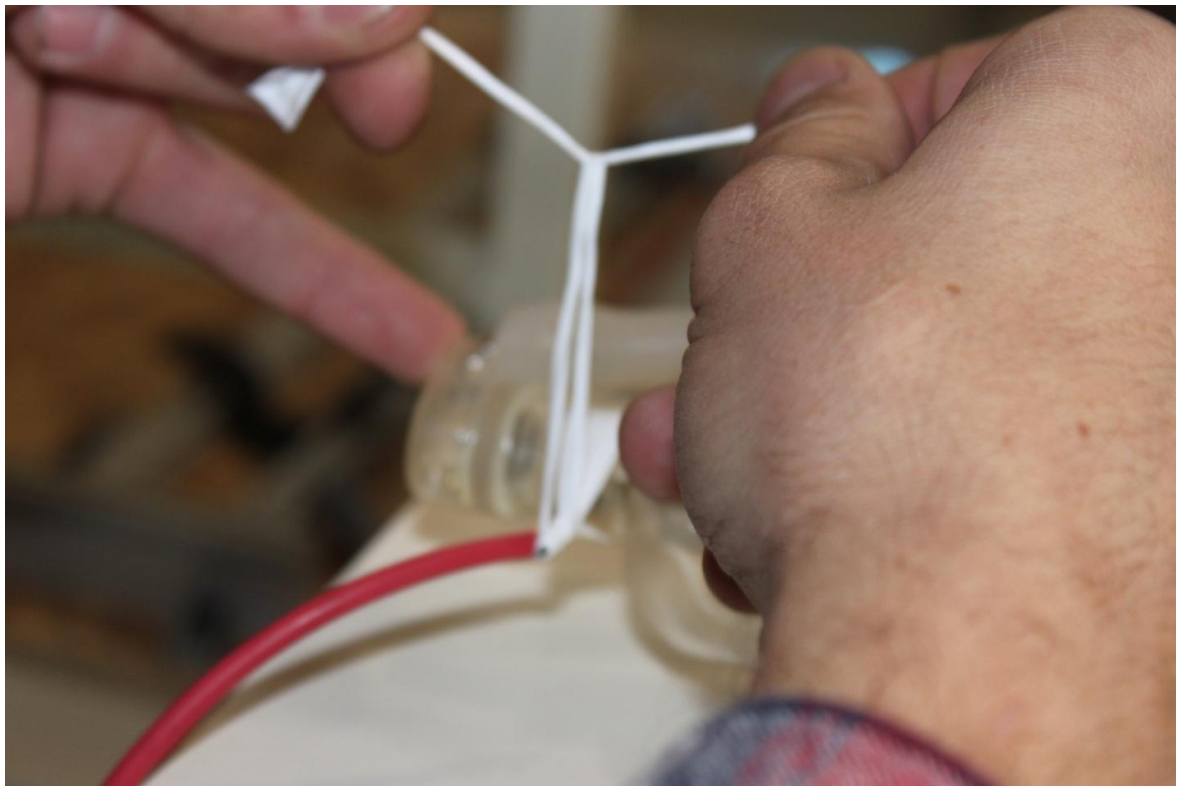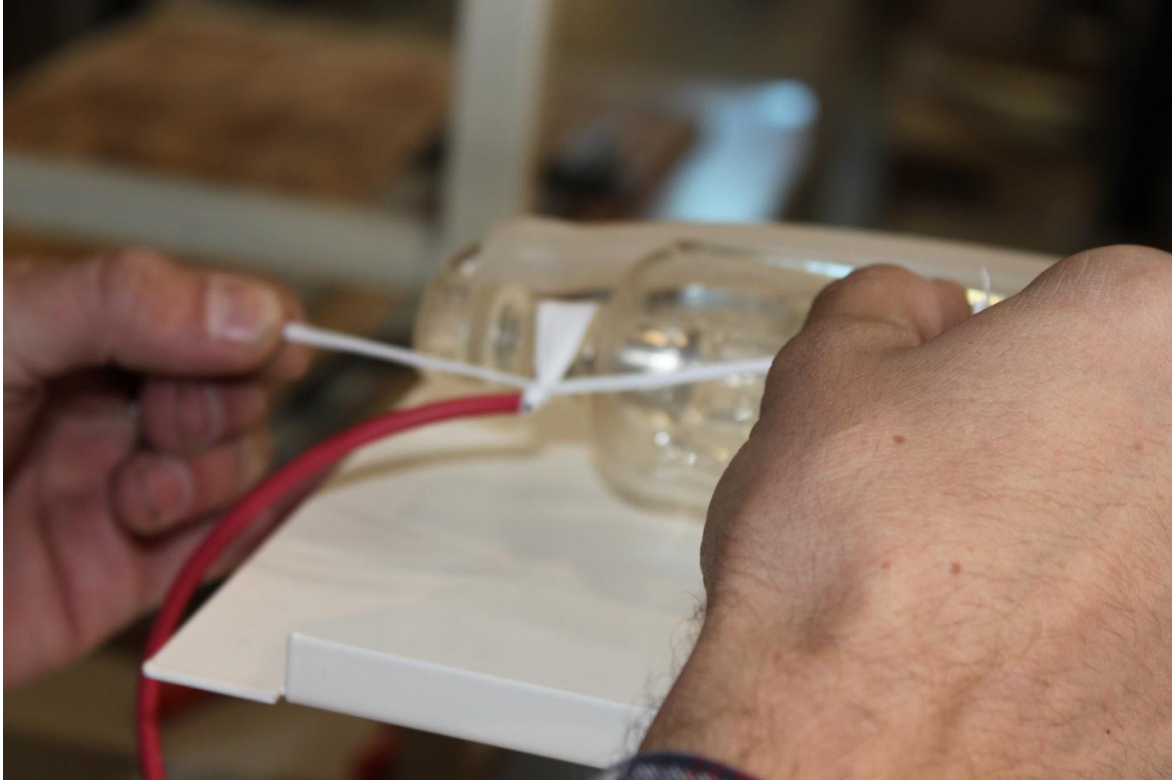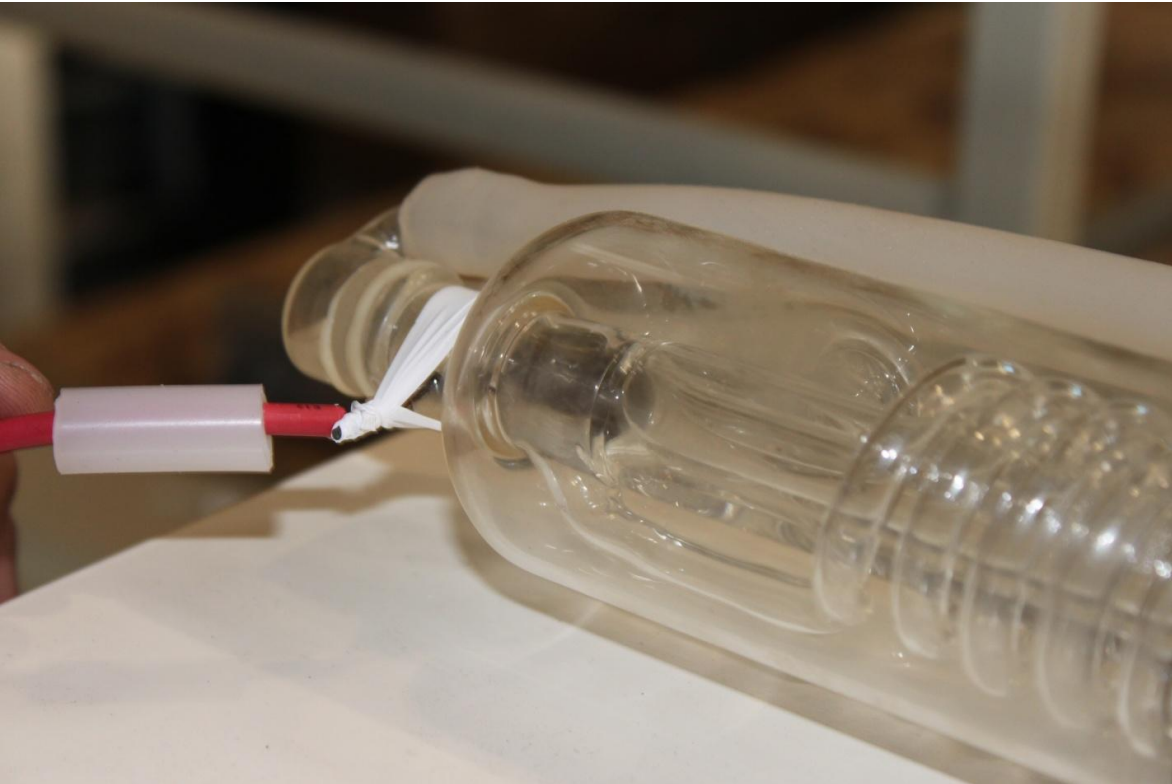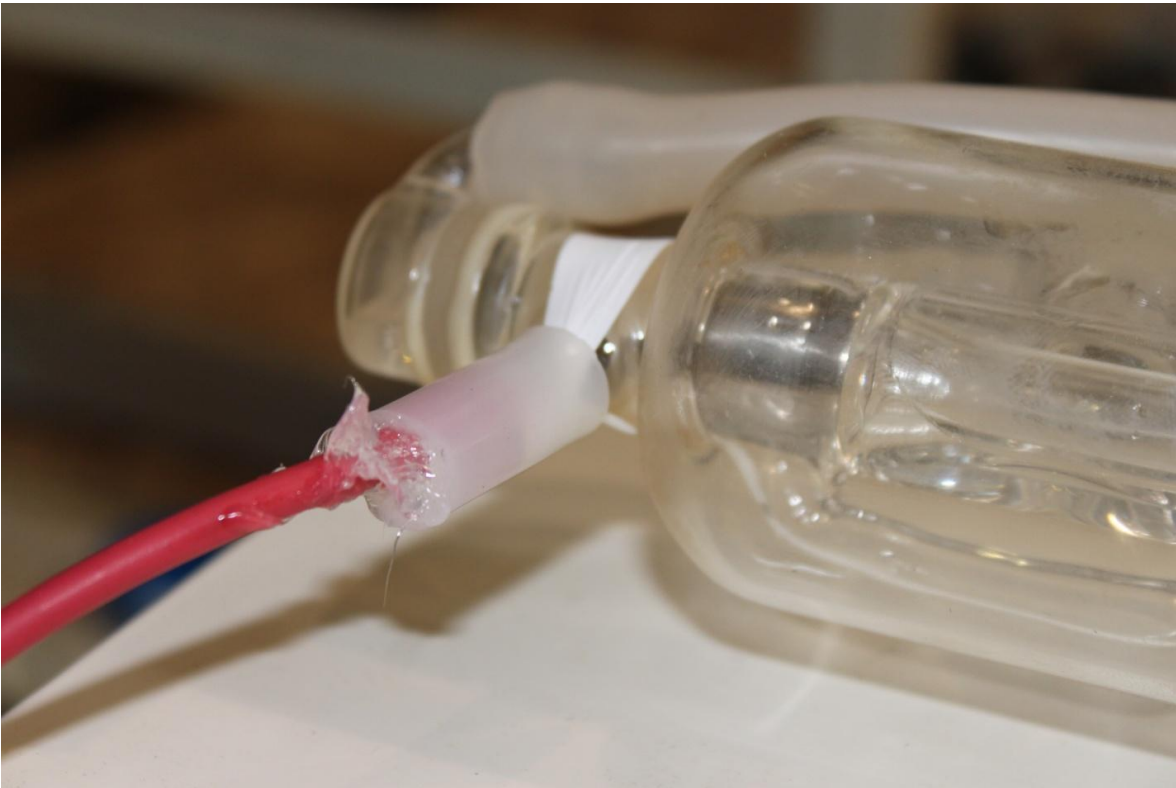
Figure 67

Figure 68

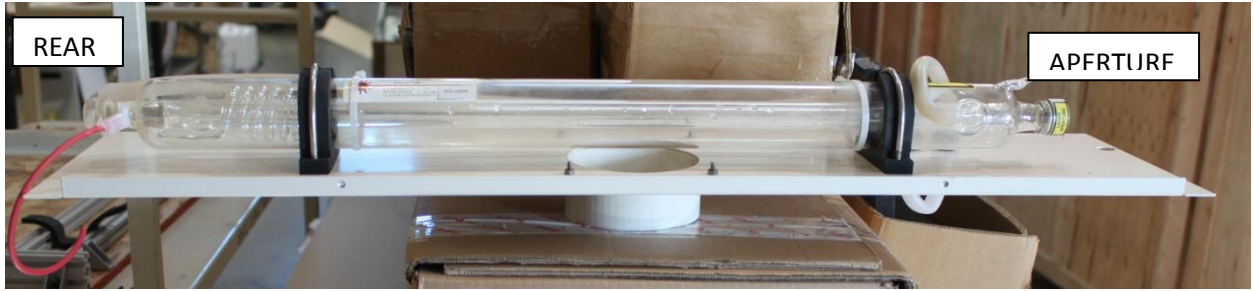Figure 69

Figure 70

[113]

Figure 71 – Tube Wire Orientation Reference

Appendix G: Power Supply Replacement

Overview

This Appendix provides procedures and a walkthrough to replace the Power Supply on your Hobby Advanced Laser. Please carefully read all instructions before beginning the replacement procedure as there are several critical steps which must be properly followed to avoid breaking the laser tube. This appendix also references procedures found in **Appendix E: Laser Tube Replacement**.

Required Parts and Tools

- Replacement Power Supply Unit (PSU)
- 3mm hex key (a ball-end 3mm hex driver is very helpful)

Warnings

- Pulling on the tube wires will break your laser tube at the neck
- The capacitors in the power supply retain power even after turning the laser off. To ensure your safety, turn off the laser, remove the power cord and wait at least 1 hour before accessing the power supply.

Replacement Procedure

1. Disconnect the laser power cord.
2. Wait 1 hour.
3. Disconnect the 3 green PSU board connectors.
4. Using the 3mm hex key, remove the 2x M3-6 socket head cap screws that secure the PSU to the frame. These screws are secured with threadlocker and may require some strength to remove.
5. Slide the PSU towards the front of the laser.
6. Disconnect the **RED** wire from the laser tube (consult **Appendix E: Laser Tube Replacement**).
7. Remove the old power supply.
8. Place the new power supply into the unit
9. Follow the instructions in **Appendix E: Laser Tube Replacement** to re-connect the **RED** wire to the tube.
10. Mount the power supply to the frame using the 2x M3-6 socket head cap screws.

Appendix H: Belt Installation Instructions

Overview

The belts on your laser system are a consumable item and will eventually stretch beyond a usable length or break. You can contact Full Spectrum Laser support for replacements or purchase them from various suppliers. The belts are 6mm wide fiberglass-reinforced neoprene MXL timing belts—1/4in wide MXL timing belts will also work. SDP-SI (https://sdp-si.com/eStore/) sells open-ended 1/4in wide MXL belts by the foot (PN: *A 6Z16-C025*). The Y belts are approximately 34in in length, and the X belt is approximately 49in in length.

Required Tools:

- 2mm Hex key (included with accessories)
- 2.5mm Hex key (included with accessories)
- Scissors

Procedures

1. The M3 retaining screws on the gantry can be difficult to access without removing the bottom of the laser casing. For this reason, you should contact a trained technician to perform Y belt replacements.
   a. Make sure that your laser is disconnected from power for at least 1hr prior to the technician's arrival.
   b. Disconnect water and other connections as the laser will be turned upside down
2. Loosen or remove the M3 retaining screws and washers so that the old belt can be removed and discarded.
3. Run each end of the new belt through the mounting slot with the teeth on the inside of the closed loop (see Figure 72 and Figure 75).
   a. The ends of the belt should protrude by approximately 3 teeth (6mm) through the slot.
   b. Make sure that the belt forms a flat, closed loop.
4. Tighten the M3 screws to secure and retain the belt (Figure 72 and Figure 74). Starting the thread with your fingers can speed the process up.
5. Loosen the idler pulley mount
6. Once the belt has been installed on the riser, loop over the drive and idler pulleys.
7. Tension the belt by pulling on the Y idler pulley mount (Figure 75) with your hand. Moderate to strong force is recommended.
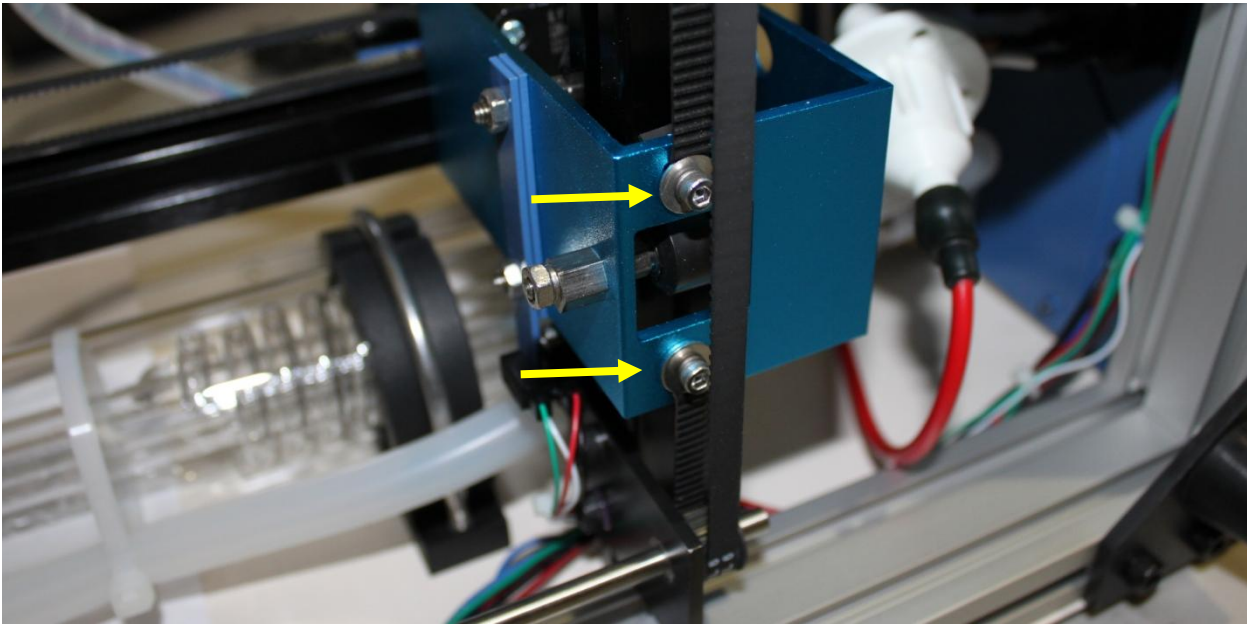8. To re-align the Y gantry, follow the procedures in Appendix D, Item 10.
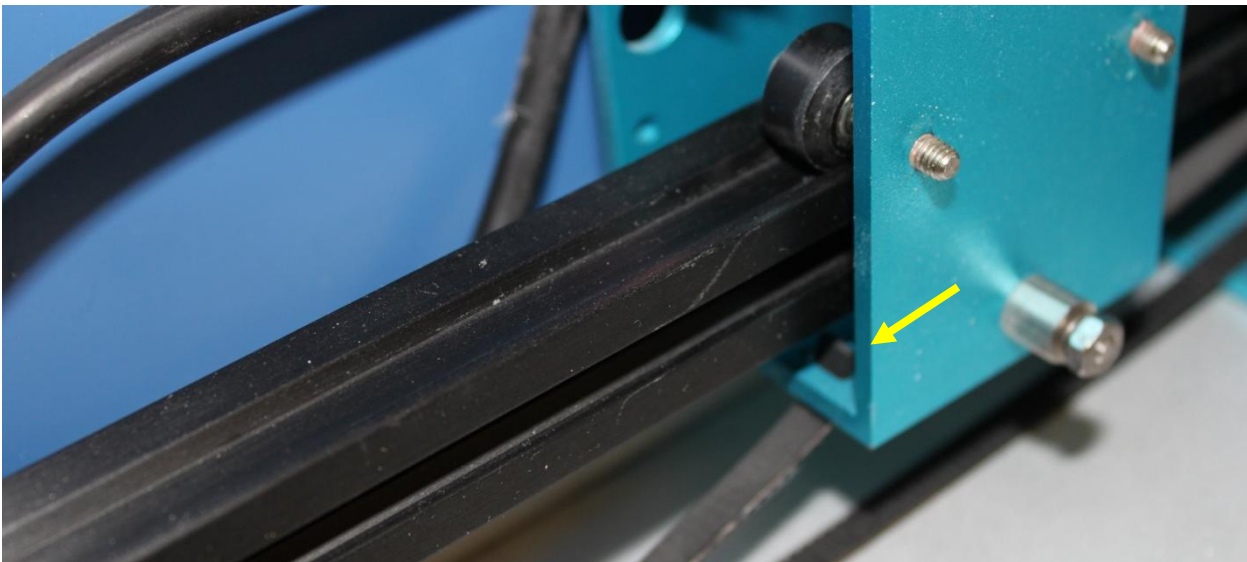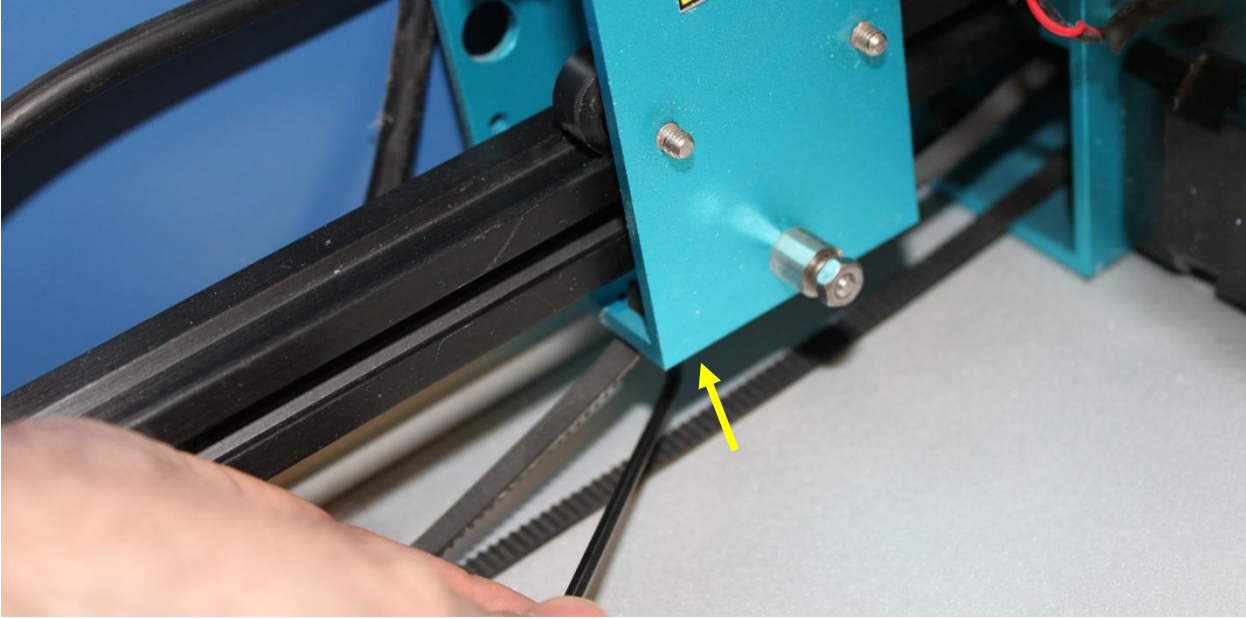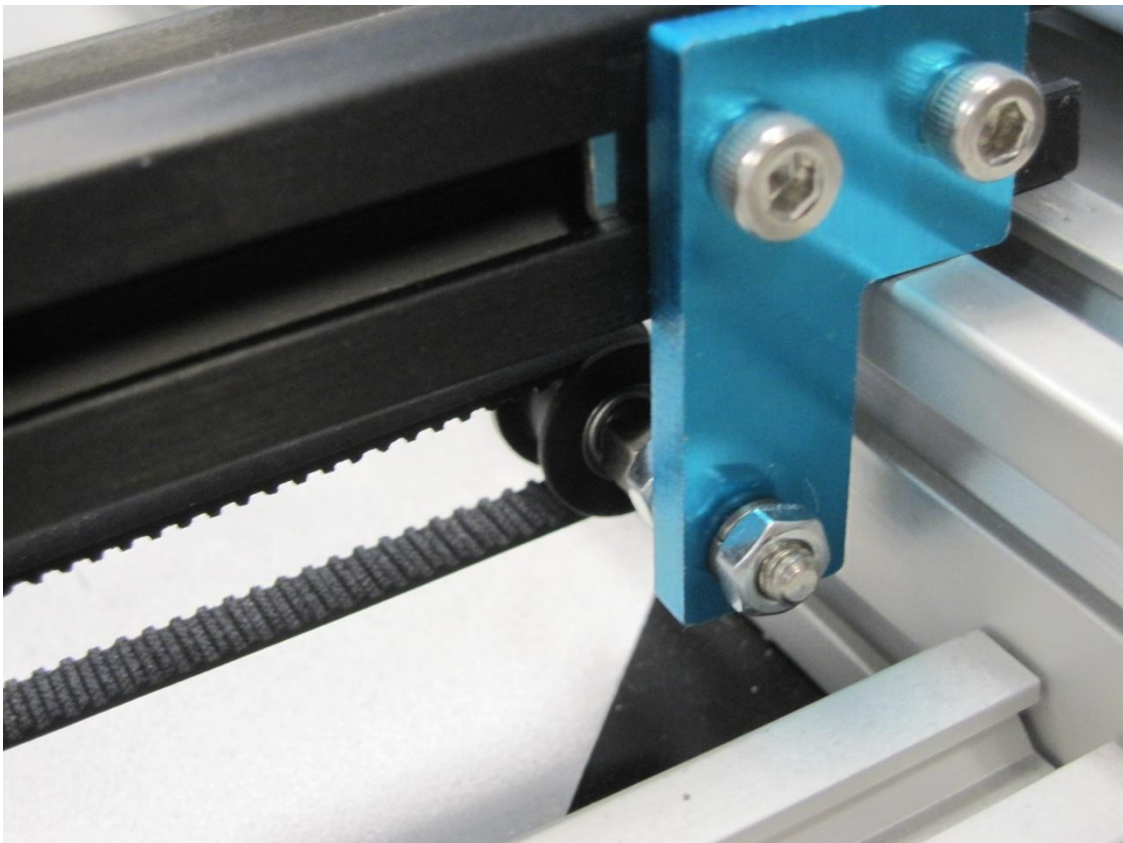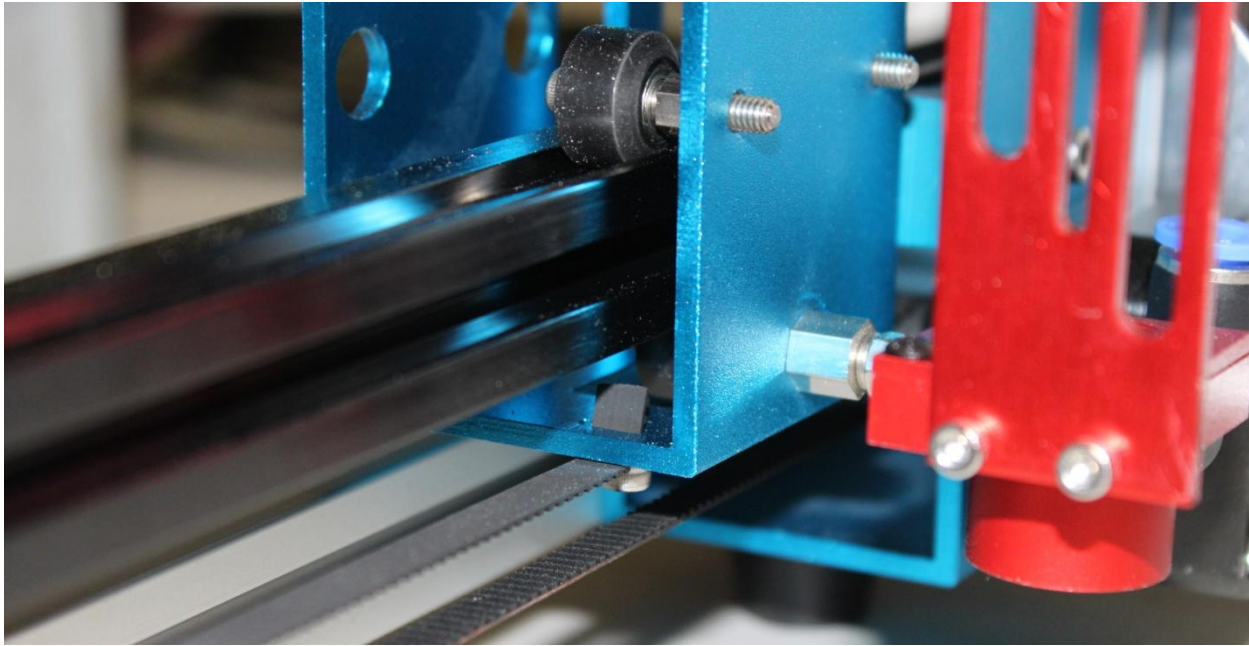
Figures

Figure 72

Figure 73

Figure 74

Figure 75

Figure 76