Instructions for Adding Endurance 15-Watt DUOS Laser Beam DIY Upgrade Kit

to Inventables X-Carve CNC

3D Printing and Assembling Custom XYZ Linear Translation Table Mount and X-Carve Mount and

Extending Wiring for

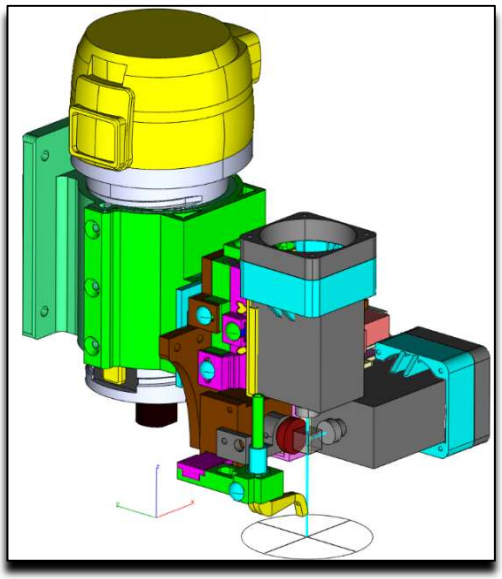
Endurance 15-Watt DUOS Laser Beam DIY Upgrade Kit

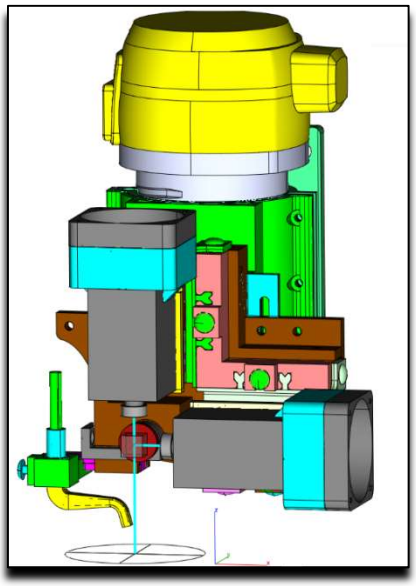
(AKA "Endurance 15-Watt DUOS Laser Beam DIY Upgrade Kit Customization for X-Carve CNC")

by

Reginald A. Jones

04/08/2021





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1 Copyright Notice

2 Legal Disclaimer

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The Class 4 lasers used in this system can cause significant eye injury. Always use appropriate protective goggles when operating the lasers. See Laser Safety Facts at https://www.lasersafetyfacts.com/4/ for further information.

3 Introduction

This document describes how to 3D print and assemble the custom XYZ translation table mount and X-Carve Dewalt spindle mount parts designed by Reginald A. Jones to use with the Endurance 15-watt DUOS Laser Beam DIY Upgrade Kit, in place of the laser mount parts supplied in the original kit by Endurance. It also describes how to align and focus the lasers and how to extend the wiring provided in the kit to allow the laser controllers to be placed in a convenient location in the machining workspace.

The goal of the design effort was to provide a quicker, easier, and more precise method for aligning the dual lasers at the focal depth (which turns out to be at about 2.5 inches). Several design iterations and improvements were made while prototyping to assure tight sliding fits between the slots and rails of the linear translation mechanisms. Also, position lock tabs were added to the design to lock the translation tables in their aligned positions and to ensure the rigidity of the assembly.

Parts were printed on a Prusa MK3S+ 3D printer using Prusa PLA at 0.1 mm layer height. Most parts require the use of supports when printing. Instructions for printing each part are provided in this document as well as the required parts list.

The mechanism works by allowing the end user to turn drive screws to make minute adjustments for each laser in the X,Y and Z directions to align the dual laser beams. Subsequent versions may fix the horizontal laser and only provide translation in X, Y and Z for the vertical laser (as providing XYZ translation for both lasers is redundant if the horizontal laser is always correctly position by default).

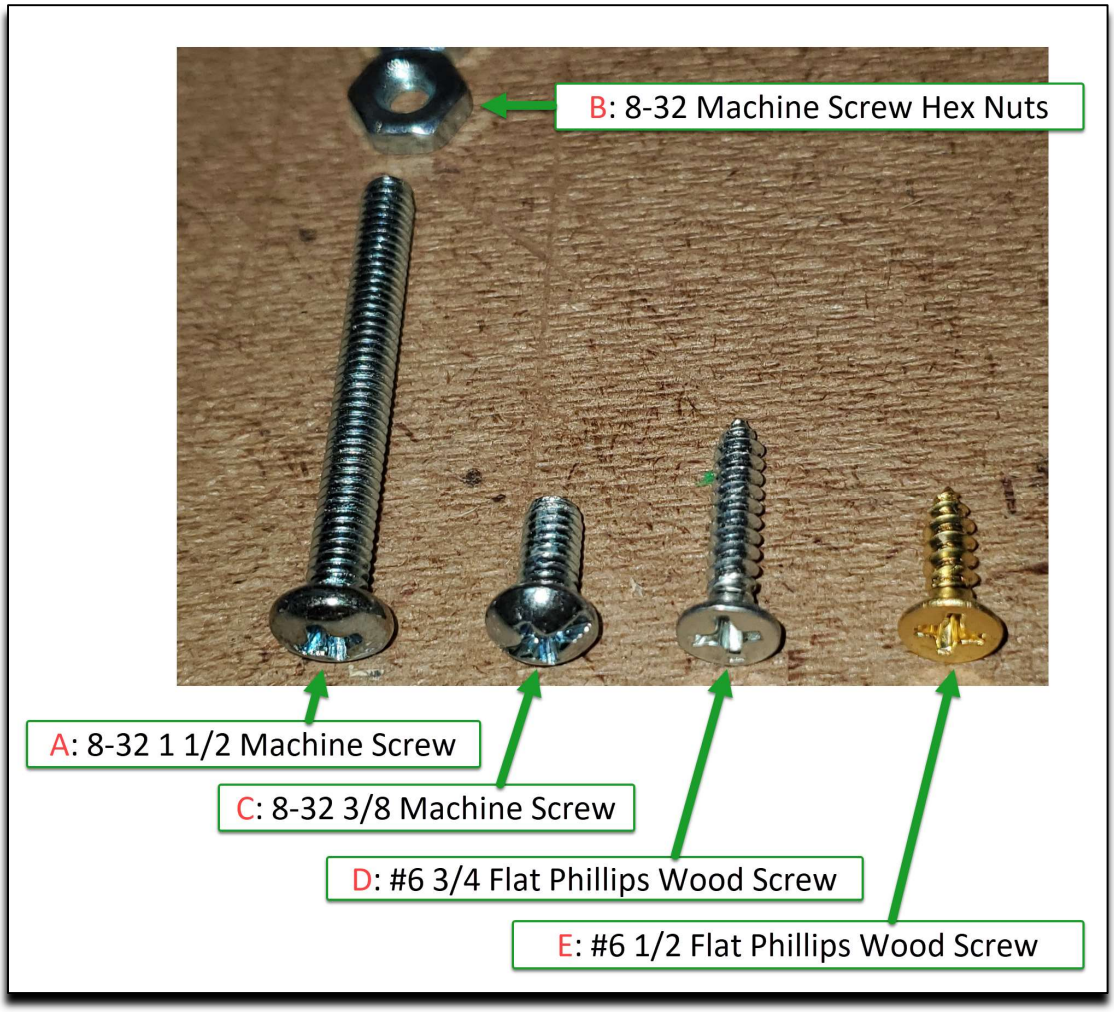
I extended the original DUOS wiring between the laser controllers and the lasers by approximately 6 feet to allow placement of the controllers at the desired location in my X-Carve environment.

The completed prototype assembly was mounted on the X-Carve and initially tested on 2/19/2021. I was able to quickly align and focus the lasers as I had hoped, attaining a very fine focal point at depth of 2 15/32 inches from the bottom of the vertical laser focal ring to the top of the material surface.

Initial beam quality test results were excellent as well as initial cutting tests. Test results are in the Appendix.

4 Custom Duos Mount Hardware List

Ref	Part	QTY	Purpose(s)
A	8-32 1 1/2 Machine Screw	6	Drive Screw that translates Translation Table
B	8-32 SAE 304 Machine Screw Hex Nuts	6 12	Drive Nut that translates Translation Table as Drive Screw turned Locks position of Translation Table Drive Screw (2 on each Drive Screw) in the Drive Screw Holder
C	8-32 3/8 Machine Screw	8 1	Locks Translation Table position using Position Lock Tabs Locks position of Air Assist Air Line Holder
D	#6 3/4 Flat Phillips Wood Screw	3	Attaches In_Out_Slots to Mount_Base from bottom
E	#6 1/2 Flat Phillips Wood Screw	2	Attaches In_Out_Slots to Mount_Base at Mount_Base L-bracket
	White Lithium Grease	1	Lubricant for Translation Table rails and slots, Drive Screws and Drive Screw Holder

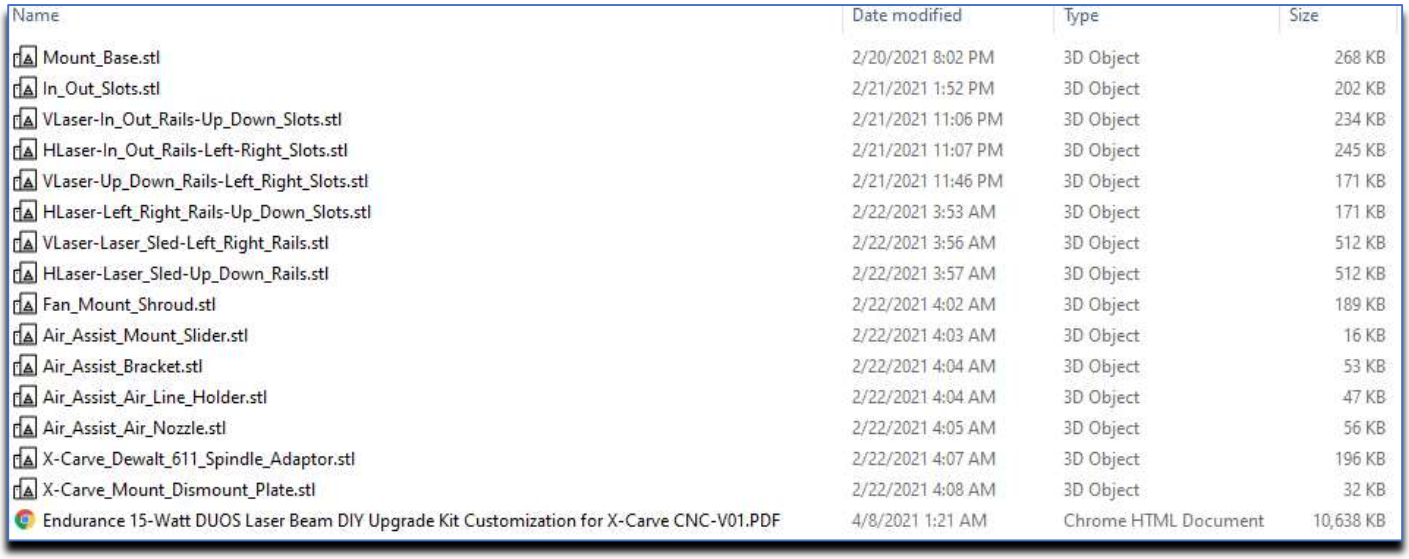


5 3D Printing and Post Processing STL Files

Unzip the files in **Endurance 15-Watt DUOS Laser Beam DIY Upgrade Kit Customization for X-Carve CNC-V01.zip** to the desired directory.

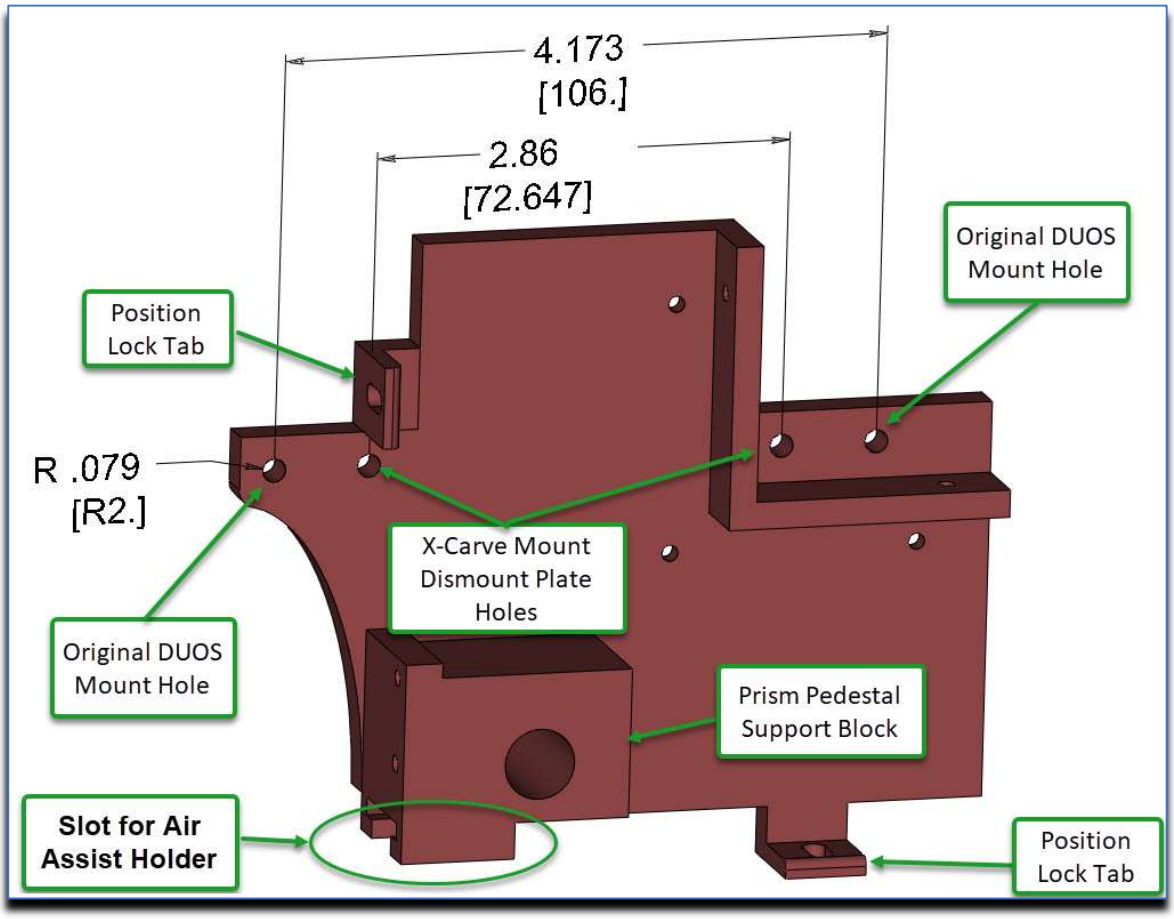
Follow instructions below to print and post process and follow the subsequent assembly instructions.

Note: A non-trivial amount of effort is required to remove supports. Make sure that you remove cleanly, especially around rails, slots, Drive Screw Holder and Drive Nut Holder areas. A little un-removed support residue will cause Drive Screws not to fit or turn properly or Drive Nuts not to fit flush in Drive Nut Holder.



Name	Date modified	Type	Size
Mount_Base.stl	2/20/2021 8:02 PM	3D Object	268 KB
In_Out_Slots.stl	2/21/2021 1:52 PM	3D Object	202 KB
VLaser-In_Out_Rails-Up_Down_Slots.stl	2/21/2021 11:06 PM	3D Object	234 KB
HLaser-In_Out_Rails-Left-Right_Slots.stl	2/21/2021 11:07 PM	3D Object	245 KB
VLaser-Up_Down_Rails-Left_Right_Slots.stl	2/21/2021 11:46 PM	3D Object	171 KB
HLaser-Left_Right_Rails-Up_Down_Slots.stl	2/22/2021 3:53 AM	3D Object	171 KB
VLaser-Laser_Sled-Left_Right_Rails.stl	2/22/2021 3:56 AM	3D Object	512 KB
HLaser-Laser_Sled-Up_Down_Rails.stl	2/22/2021 3:57 AM	3D Object	512 KB
Fan_Mount_Shroud.stl	2/22/2021 4:02 AM	3D Object	189 KB
Air_Assist_Mount_Slider.stl	2/22/2021 4:03 AM	3D Object	16 KB
Air_Assist_Bracket.stl	2/22/2021 4:04 AM	3D Object	53 KB
Air_Assist_Air_Line_Holder.stl	2/22/2021 4:04 AM	3D Object	47 KB
Air_Assist_Air_Nozzle.stl	2/22/2021 4:05 AM	3D Object	56 KB
X-Carve_Dewalt_611_Spindle_Adaptor.stl	2/22/2021 4:07 AM	3D Object	196 KB
X-Carve_Mount_Dismount_Plate.stl	2/22/2021 4:08 AM	3D Object	32 KB
Endurance 15-Watt DUOS Laser Beam DIY Upgrade Kit Customization for X-Carve CNC-V01.PDF	4/8/2021 1:21 AM	Chrome HTML Document	10,638 KB

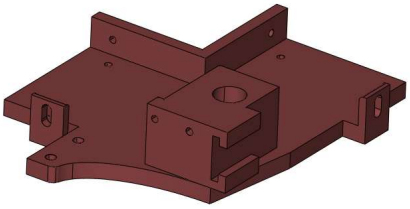
5.1 Mount Base



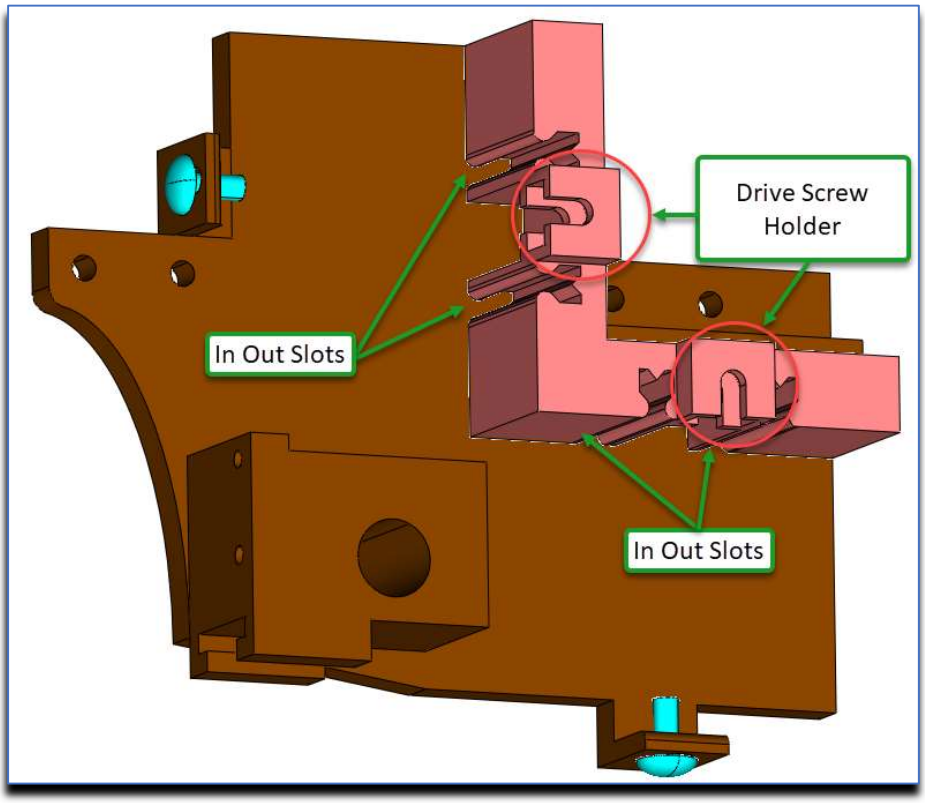
This part replaces the original DUOS base supplied by Endurance. The only parts form the original DUOS shipment that are reused are the mount for the PRISM (and its screw) and the aluminum shield for the horizontal laser and its screw.

Note: The inner set of dimensioned holes are for the custom X-Carve mount. The outer set match the original DUOS mount supplied by Endurance. Translation table filenames are named to describe motion relative to the mounted assembly – In Out(Y) (i.e., back and forth), Up Down (Z), Left Right (X).

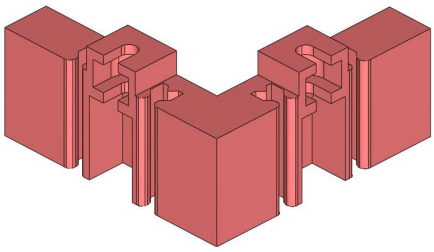
3D Printing Configuration/Instructions

Setting	Value	Notes
Filename	**Mount_Base.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	Prusa Slicer adds supports for the vertical holes
Print Orientation	As Shown	
Post Processing		Remove supports.

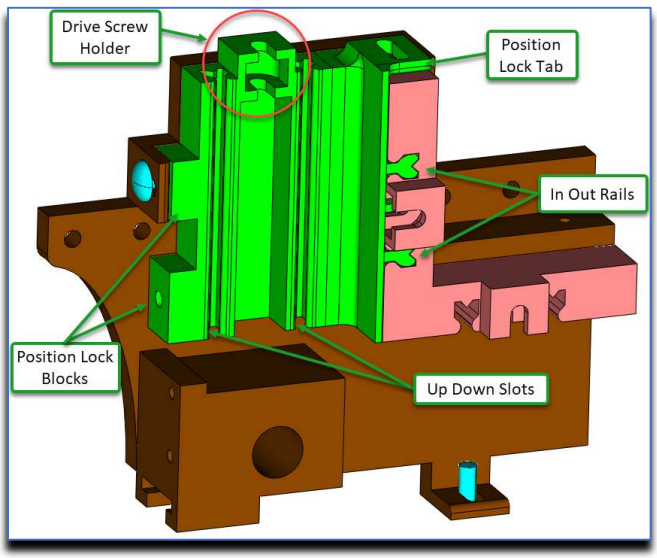
5.2 In Out Slots

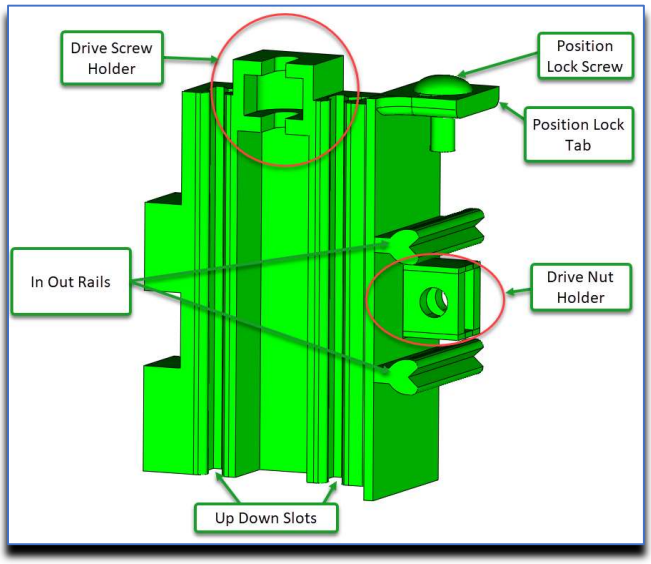


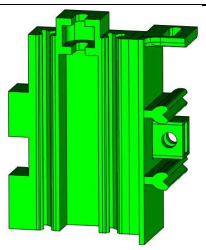
3D Printing Configuration/Instructions

Setting	Value	Notes
Filename	**In_Out_Slots.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Remove supports. • Make sure Drive Screw Holder area is completely clear of support material. Tolernances are tight.

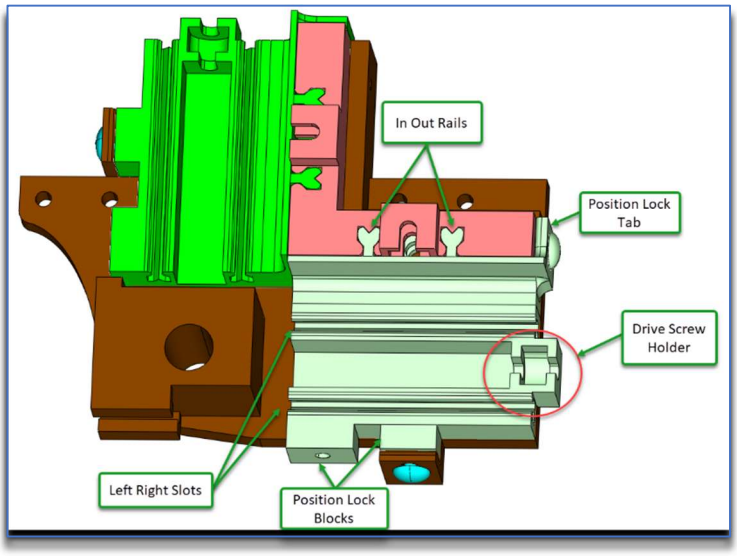
5.3 VLaser In Out Rails-Up Down Slots

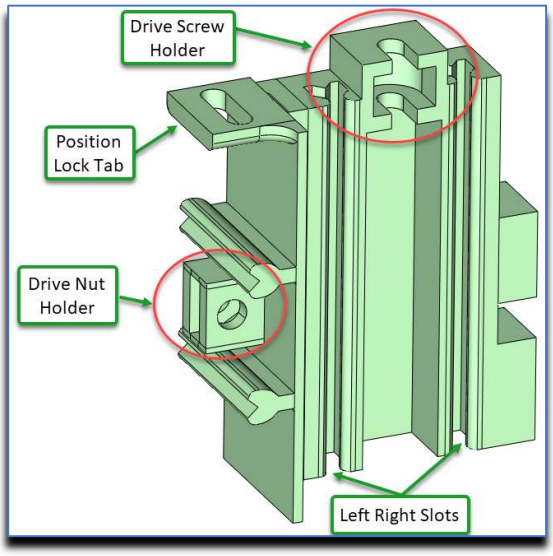


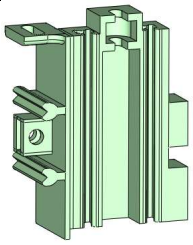


Setting	Value	Notes
Filename	**VLaser-In_Out_Rails-Up_Down_Slots.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Screw Holder and Drive Nut Holdler areas are completely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtain in **In_Out_Slots.stl** slots when grease applied.

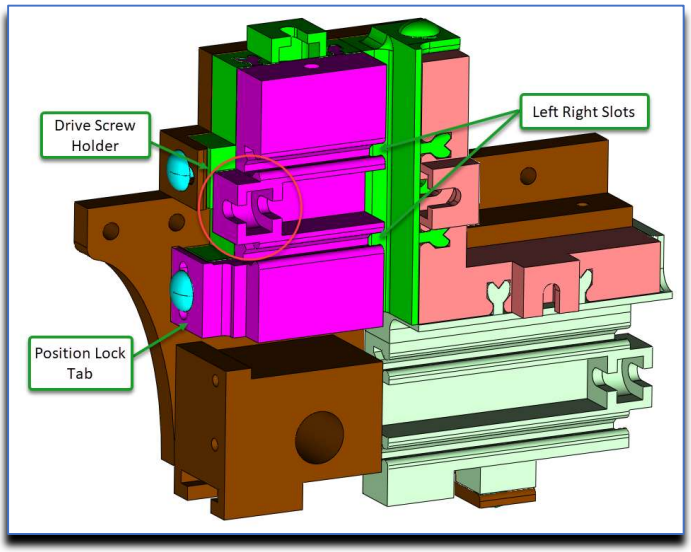
5.4 HLaser-In Out Rails-Left Right Slots

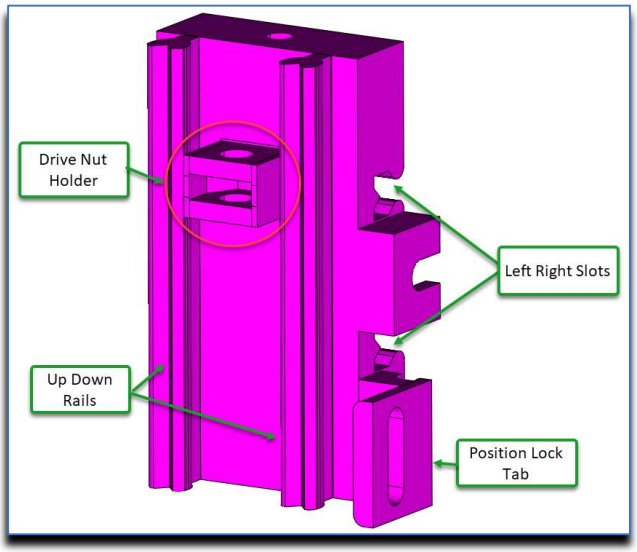


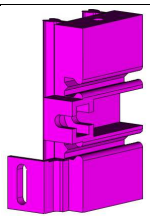


Setting	Value	Notes
Filename	**HLaser-In_Out_Rails-Left_Right_Slots.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Screw Holder and Drive Nut Holdler areas arecompletely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtained in **In_Out_Slots.stl** slots when grease applied.

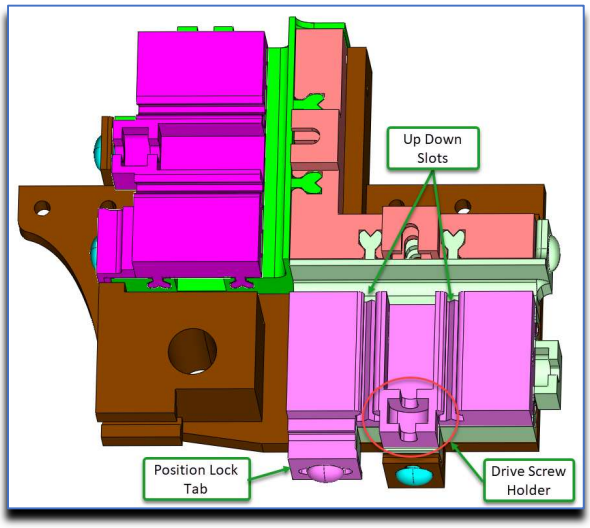
5.5 VLaser-Up Down Rails-Left Right Slots

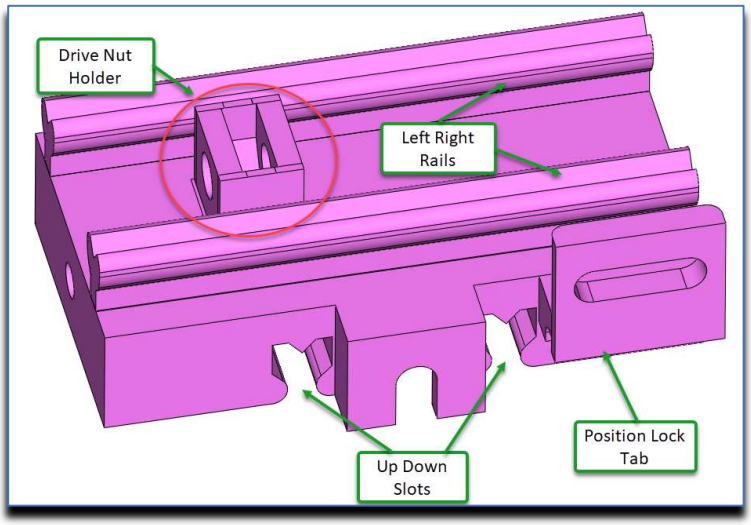


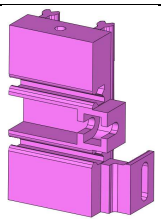


Setting	Value	Notes
Filename	**VLaser-Up_Down_Rails-Left_Right_Slots.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Screw Holder and Drive Nut Holdler areas are completely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtained in **VLaser-In_Out_Rails-Up_Down_Slots.stl** slots when grease applied.

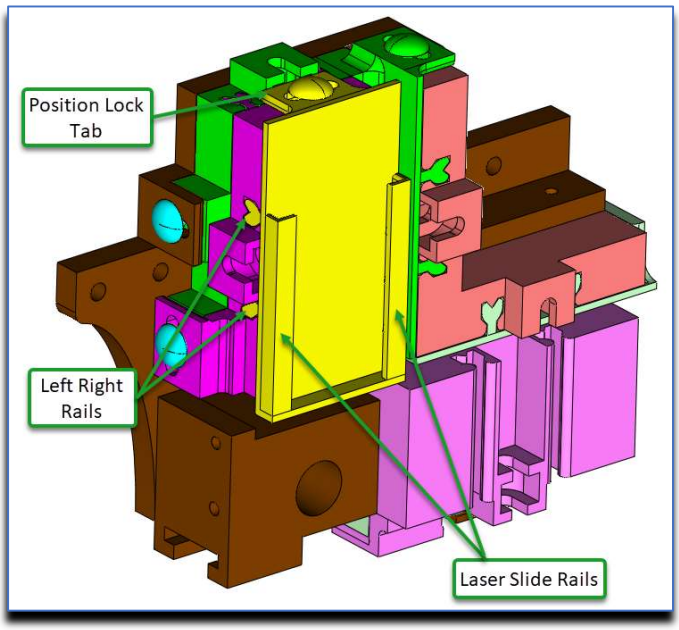
5.6 HLaser-Left Right Rails-Up Down Slots

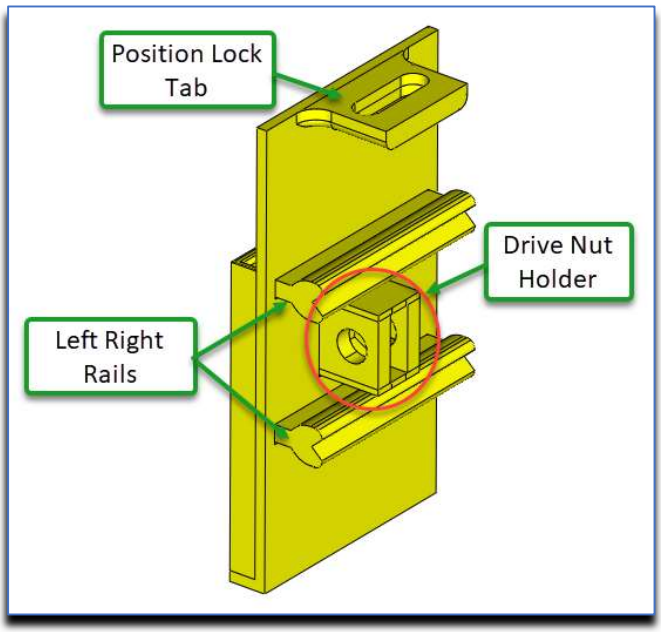


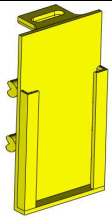


Setting	Value	Notes
Filename	**HLaser-Left_Right_Rails-Up_Down_Slots.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Screw Holder and Drive Nut Holdler areas are completely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtained in **HLaser-In_Out_Rails-Left_Right_Slots.stl** slots when grease applied.

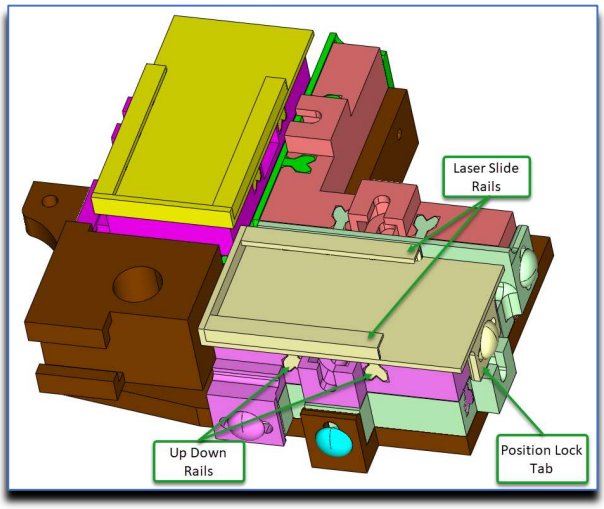
5.7 VLaser-Laser Sled-Left Right Rails

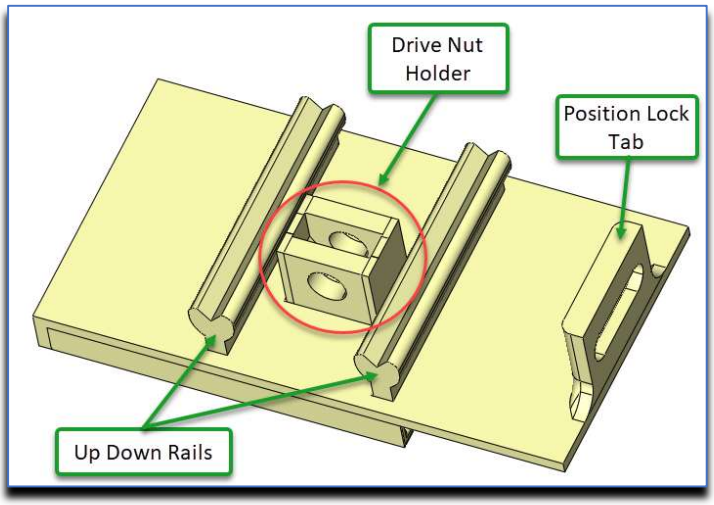


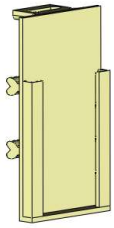


Setting	Value	Notes
Filename	**VLaser-Laser_Sled-Left_Right_Rails.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Nut Holdler area is completely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtained **VLaser-Up_Down_Rails-Left_Right_Slots.stl** slots when grease applied.

5.8 HLaser-Laser Sled-Up Down Rails

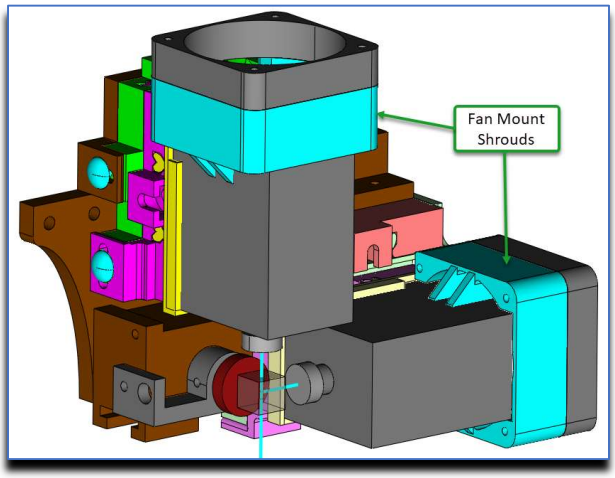


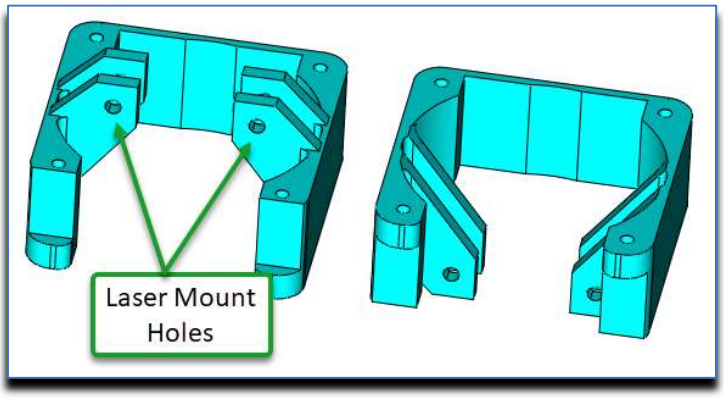


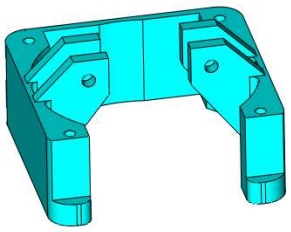
Setting	Value	Notes
Filename	**HLaser-Laser_Sled-Up_Down_Rails.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Make sure Drive Nut Holdler area is completely clear of support material. Tolernances are tight. • Sand rails so that tight sliding fit obtained **VLaser-Up_Down_Rails-Left_Right_Slots.stl** slots when grease applied.

5.9 Fan Mount Shroud

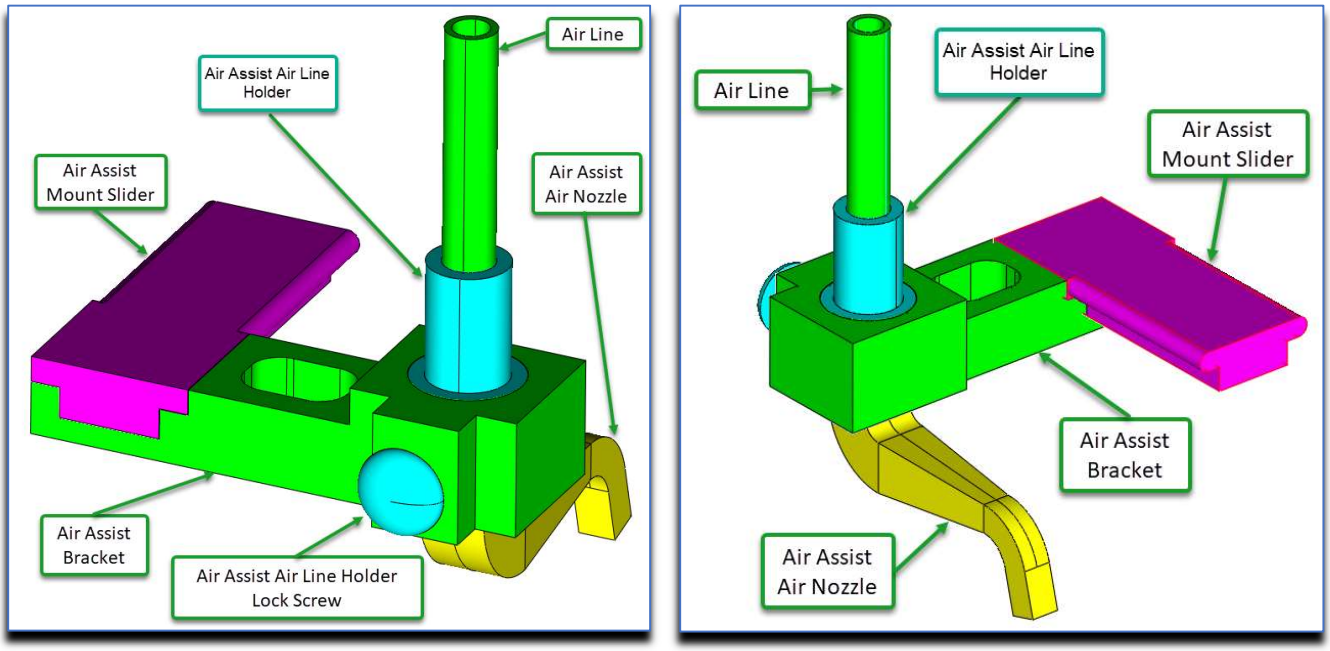
This fan shroud replaces the original shroud supplied by Endurance. Can print both at same time.

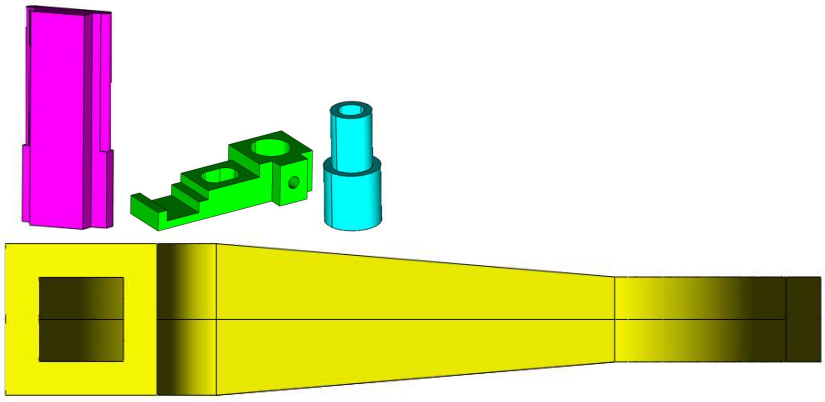




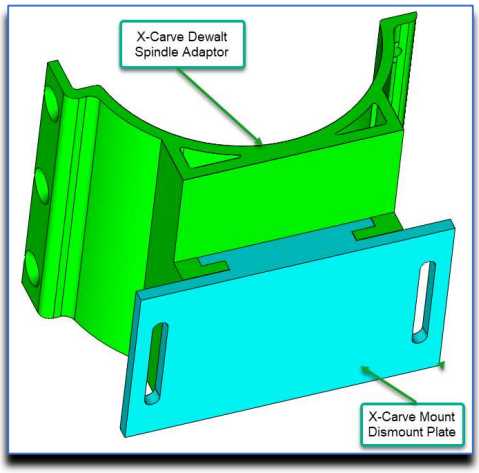
Setting	Value	Notes
Filename	**Fan_Mount_Shroud.stl**	Mounts using back screws on the laser heat sink.
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports.

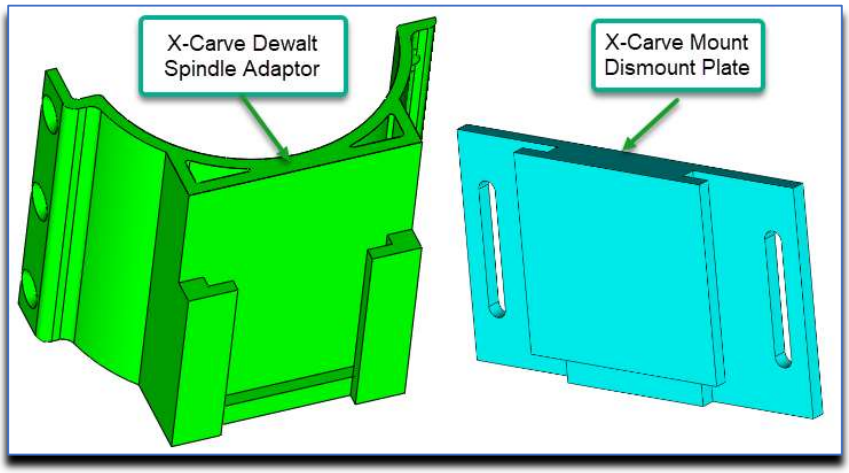
5.10 Air Assist Parts

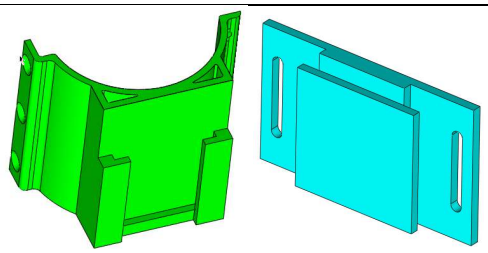


Setting	Value	Notes
Filename(s)	**A: Air_Assist_Mount_Slider.stl** **B: Air_Assist_Bracket.stl** **C: Air_Assist_Air_Line_Holder.stl** **D: Air_Assit_Air_Nozzle.stl**	
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	As Noted	No supports on A. Everywhere on B. None on C. As described below on D.
Print Orientation	As Shown	 Print **Air_Assist_Air_Nozzle.stl** as shown with supports underneath only. As oriented, the 3D printer will correctly bridge the hollow channel running through the nozzle.
Post Processing		• Thoroughly remove all supports. • Glue Air_Assist_Mount_Slider.stl to Air_Assist_Bracket.stl (with CA or whatever you have that glues plastic)

5.11 X-Carve Dewalt 611 Spindle Adaptor and X-Carve Mount Dismount Plate





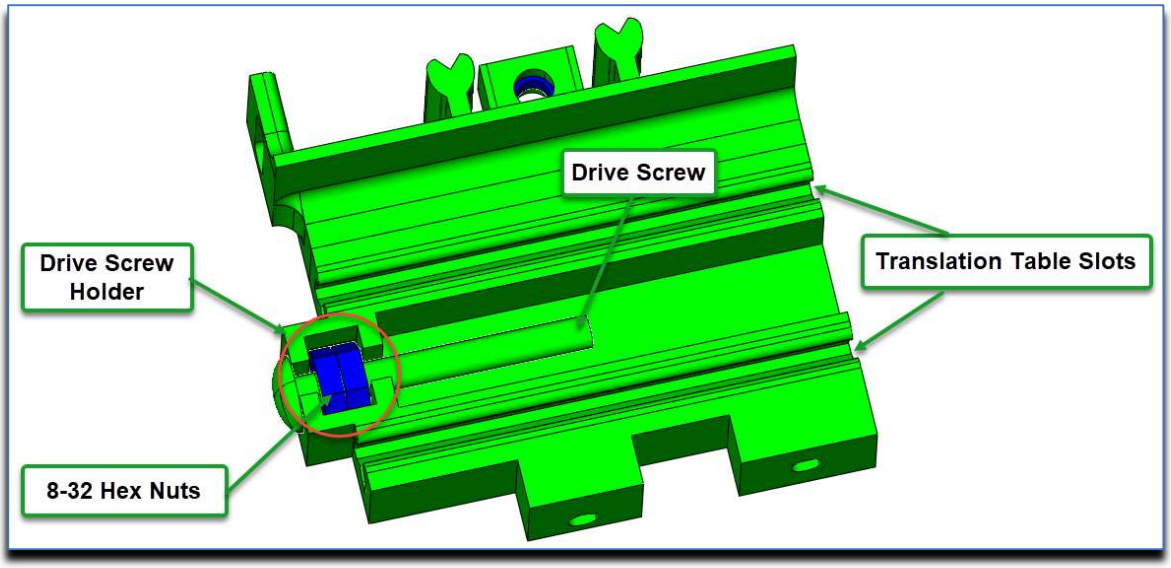
Setting	Value	Notes
Filename(s)	**A: X-Carve_Dewalt_611_Spindle_Adaptor.stl** **B: X-Carve_Mount_Dismount_Plate.stl**	Supports not needed
Material	PLA	PLA used for prototype. Use stronger material such as PETG for final.
Layer Height	0.1mm	
Infill	15%	Will increase for final version (to 20% or more)
Perimeters	2	
Supports	Everywhere	
Print Orientation	As Shown	
Post Processing		• Thoroughly remove all supports. • Sand B: X-Carve_Mount_Dismount_Plate.stl rails as needed for tight sliding but on and off removable fit with A. Parts where very tight after printing. Required a lot of sanding sliding parts in and out to get desired sliding. There should be no motion between parts when they are completely mated.

6 Assembly Instructions

6.1 Drive Screw Assembly

The **Drive Screws** rotate in the **Drive Screw Holder** pulling or pushing a **Drive Nut** located in the **Drive Nut Holder** attached to a mating translation table. Two hex nuts are used to lock the position of the Drive Screw in the Drive Screw Holder. Perform the following for all 6 Drive Screws in all Drive Screw Boxes used in the assembly:

1. Clear out all support material from the Drive Screw holder.
2. Position an initial hex nut near the top of the Drive Screw.
3. Place those parts all the way down in the Drive Screw Holder and adjust the hex nut to obtain a fit against the outside end of the Drive Screw Holder that allows the Drive screw to turn with a little effort.
4. Remove the Drive Screw and hex nut from the Drive Screw Holder and add a 2nd hex nut to the Drive Screw that buts up against the initial hex nut making sure you keep the initial hex nut in its current position.
5. While maintaining the position of the initial hex nut, tighten (with as much force as you can muster) the 2nd hex nut and the initial hex nut together on the Drive Screw so that they are both locked in position of the Drive Screw.
6. Apply grease (preferably white lithium grease (or another grease that won't drip when the assembly is in operation) to the surfaces of the Drive Screw Box.
7. Press the Drive Screw with the locked hex nuts into the Drive Screw Holder.
8. Place a hard flat tool over the Drive Screw in Drive Screw Holder and press down while turning the Drive Screw to ensure that it turns properly and is seated all the way down in the Drive Screw Holder.

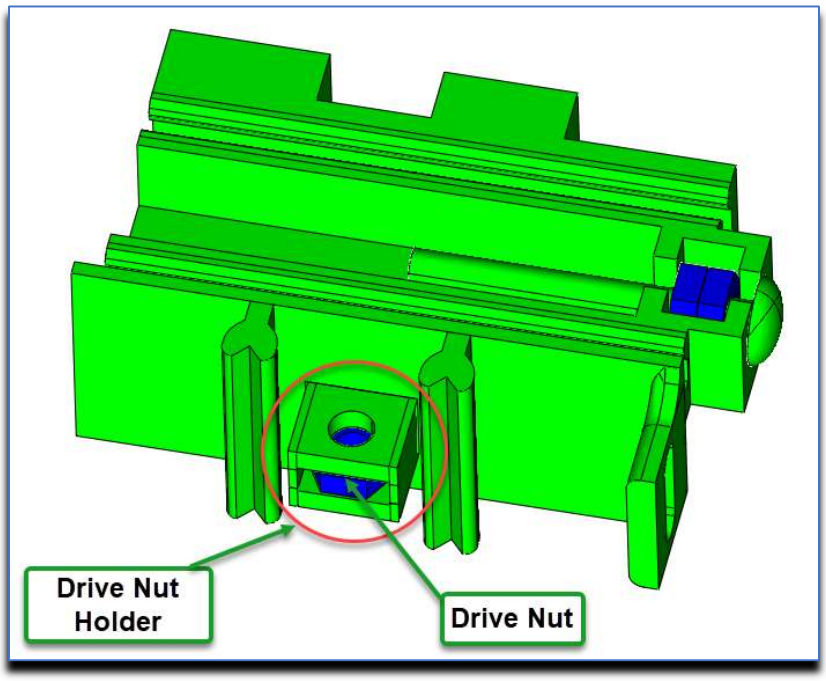


Note: Two of the six 8-32 1 1/2 Drive Screws need to be shortened to a length of 1 15/64". They are the Drive Screws that are used in **In_Out_Slots.stl.** The length of the other four Drive Screws remains unchanged at 1 1/2".

6.2 Drive Nut Assembly

The **Drive Nut** is housed in the **Drive Nut Holder** of a driven translation table. The Drive Nut Holder is sized to perfectly fit a standard 8-32 hex nut. The following instructions apply for all 6 Drive Nuts used in the assembly:

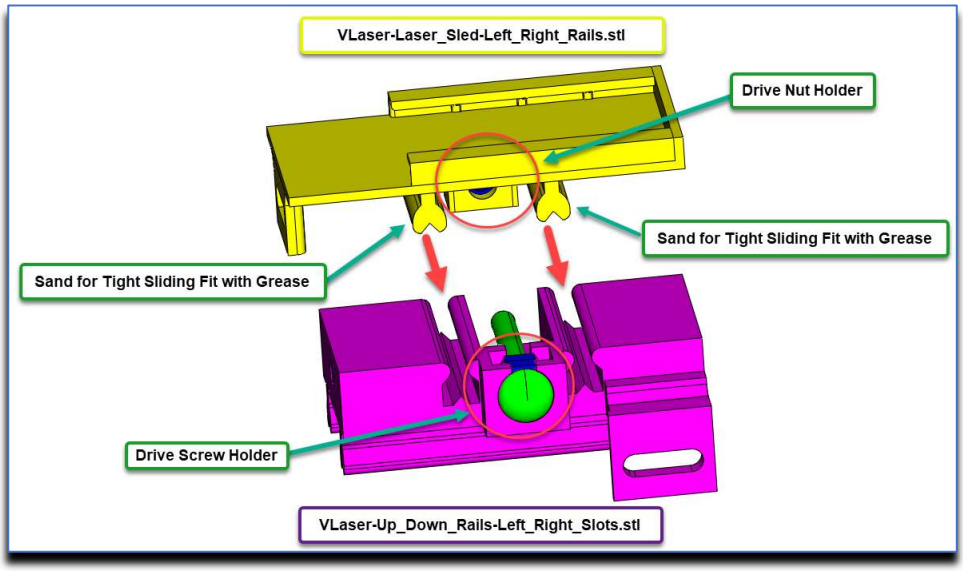
1. Clear out all support material from the Drive Screw Holder.
2. Insert an 8-32 hex nut into the Drive Nut Holder.
   The top of the hex nut must be flush with the Drive Nut Holder.
   If the Drive Nut does not go in properly, double check to make sure you cleared all support material.
   It's a press fit. So, recommend holding end of hex nut with plyers while inserting into Drive Nut Holder.

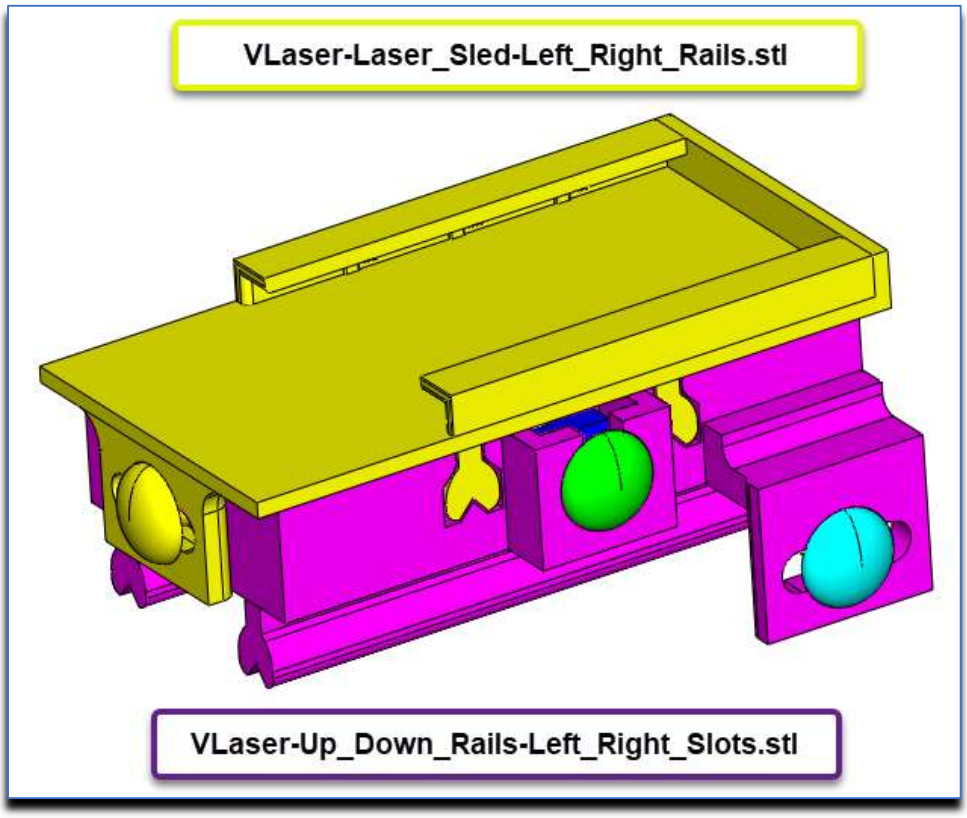


Note: Check the uniformity of the shape of each Drive Nut prior to installing in the Drive Nut Holder. I encountered some Drive Nuts that were irregularly shaped (e.g., non-uniform thickness), that caused the Drive Nut not to fit in the Drive Nut Holder.

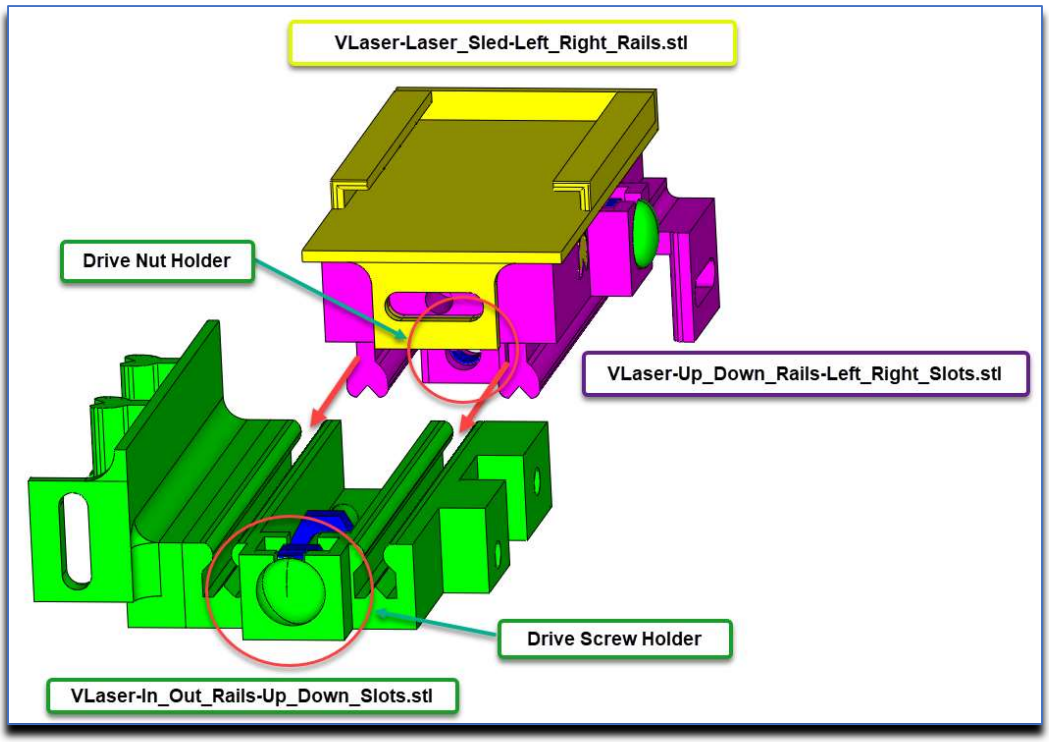
6.3 Vertical Translation Table Assembly

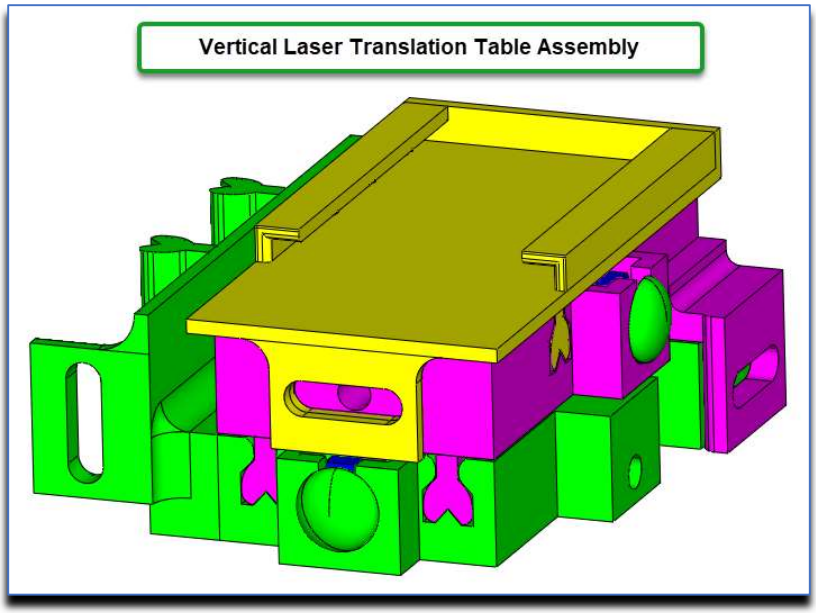
1. Ensure Drive Screw and Drive Nuts our properly mounted in the parts shown.
2. Align the slots and rails and insert the rails into the slots until the Drive Screw hits and aligns with the Drive Nut.
3. Turn the Drive Screw clockwise to move the translation table toward the Drive Screw Holder until the translation table is centered over the part doing the driving.

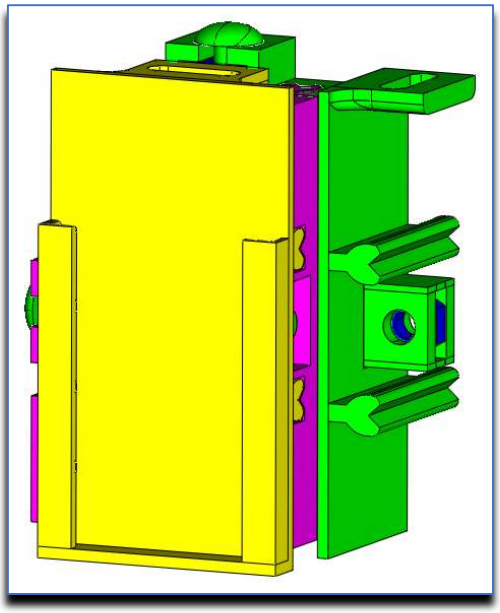




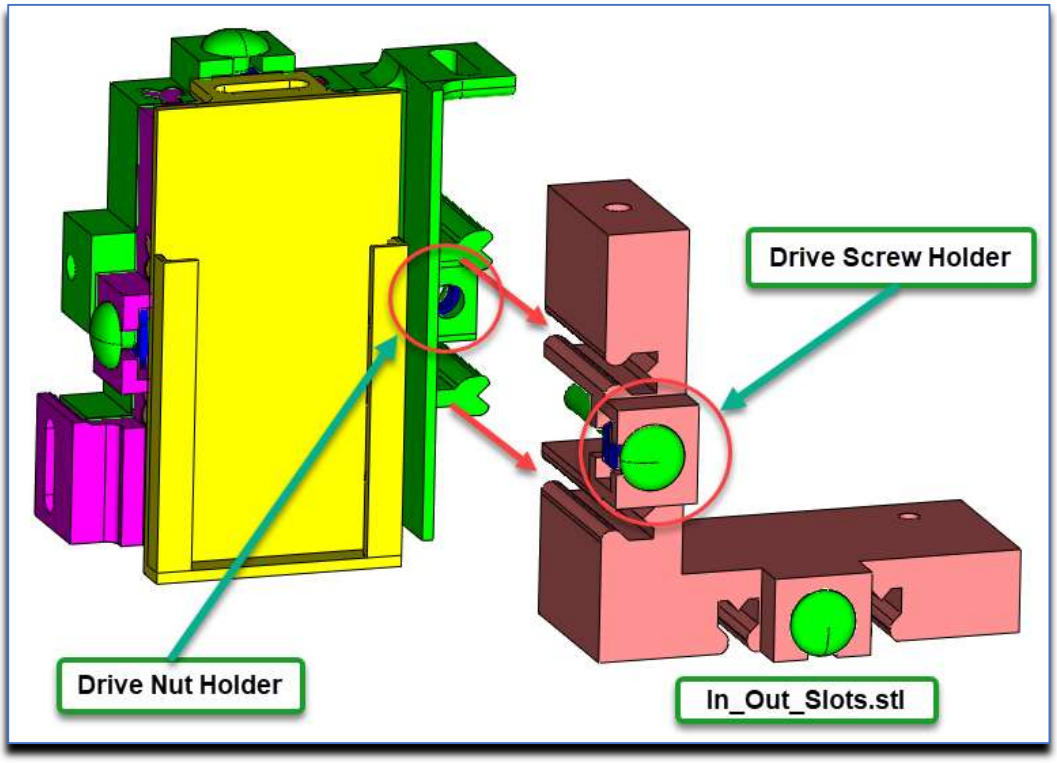
4. Ensure Drive Screw and Drive Nuts are properly mounted in the parts shown.
5. Align the slots and rails and insert the rails into the slots until the Drive Screw hits and aligns with the Drive Nut.
6. Turn the Drive Screw clockwise to move the translation table toward the Drive Screw Holder until the translation table is centered over the part doing the driving.

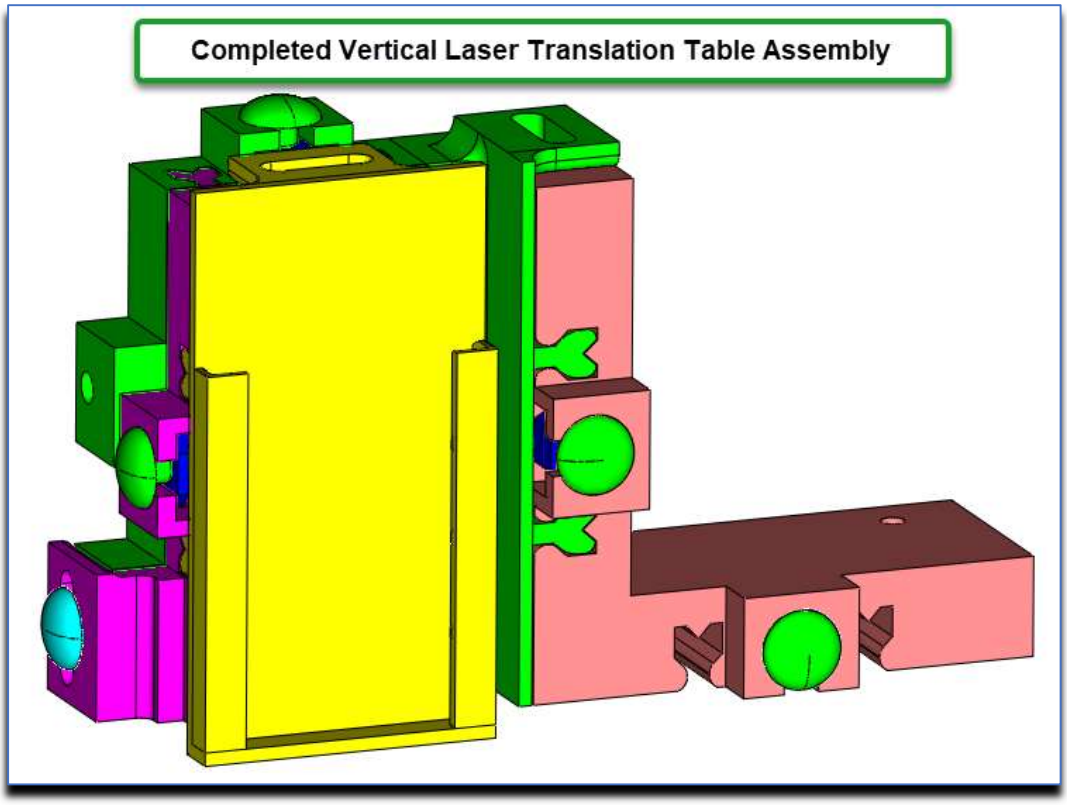






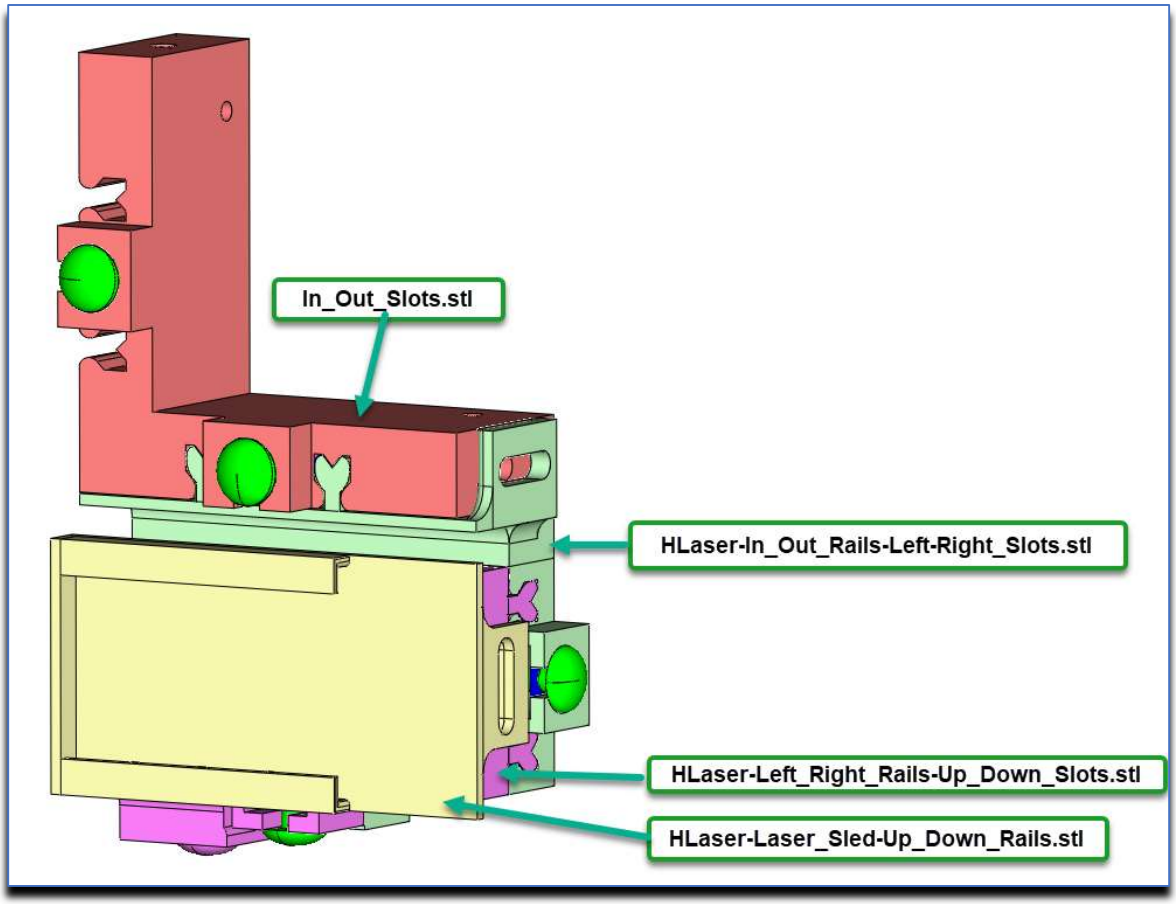
7. Ensure Drive Screw and Drive Nuts are properly mounted in the parts shown.
8. Align the slots and rails and insert the rails into the slots until the Drive Screw hits and aligns with the Drive Nut.
9. Turn the Drive Screw clockwise to move the translation table toward the Drive Screw Holder until the translation table is centered over the part doing the driving.





6.4 Horizontal Translation Table Assembly

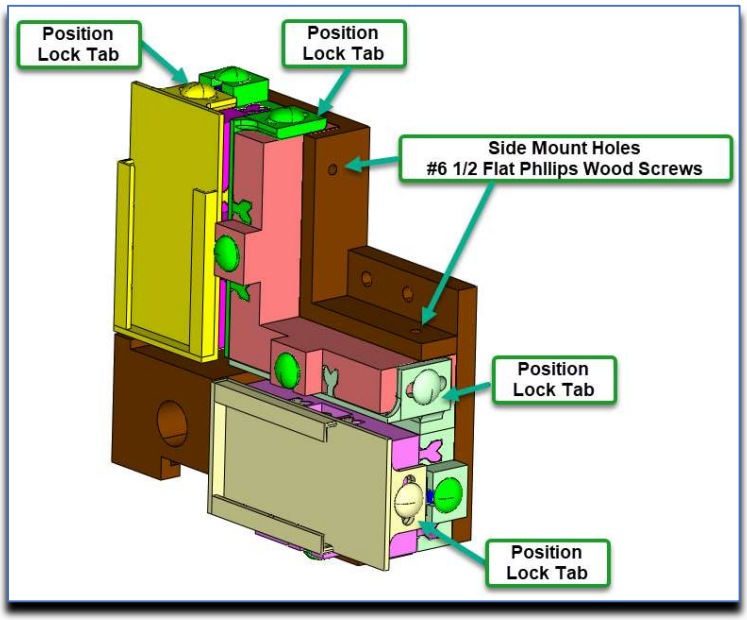
1. Complete the horizontal laser translation table assembly by repeat the instructions for assembling the vertical laser translation tables using the parts for the horizontal laser assembly:
   - HLaser-Laser_Sled-Up_Down_Rails.stl
   - HLaser-Left_Right_Rails-Up_Down_Slots.stl
   - HLaser-In_Out_Rails-Left-Right_Slots.stl
   - In_Out_Slots.stl (horizontal portion)



6.5 Translation Tables Attachment to Mount Base

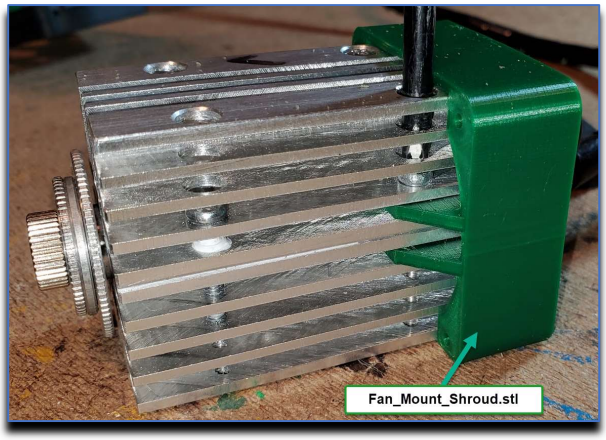
1. Mount the Translation Tables Assembly to Mount_Base.stl in the holes provided as shown below. Ensure that the back flat head Philips wood screws are flush with the back of the Mount_Base back surface after screwing in.

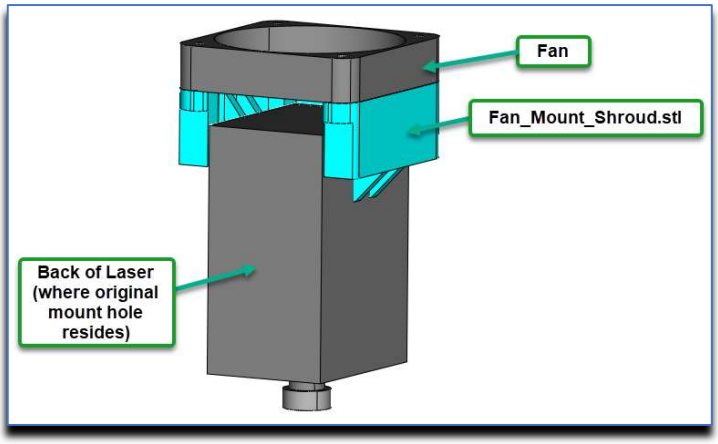
2. Self-tap the #8-32 3/8 machine screws into the holes provided behind each Position Lock Tab. There are 8 tabs.
3. Do not screw the machine screws all the way down until the lasers have been aligned and focused with the whole assembly in place in its final destination (CNC machine, 3D printer).



6.6 Mounting Fan Mount Shrouds on Laser Heatsinks

1. Remove the back screw only from each laser heatsink.
2. Attach 3D print of Fan_Mount_Shroud.stl at the back of each laser using the holes provided, ensuring that the open side of the Fan Mount Shroud is oriented toward the back of the laser as shown.

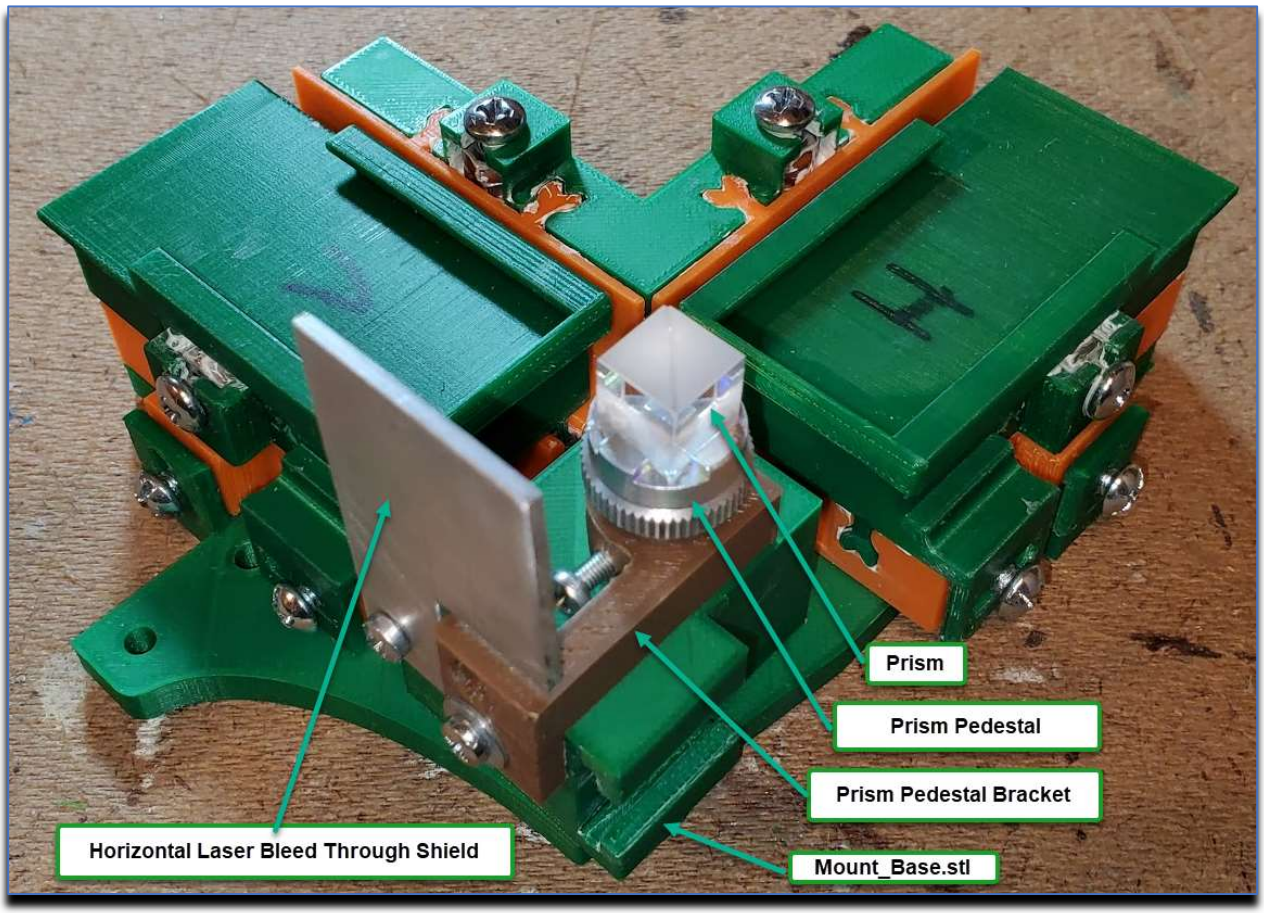




3. Attach the Laser Cooling Fan to the Fan Mount Shroud (if you are ready to test).

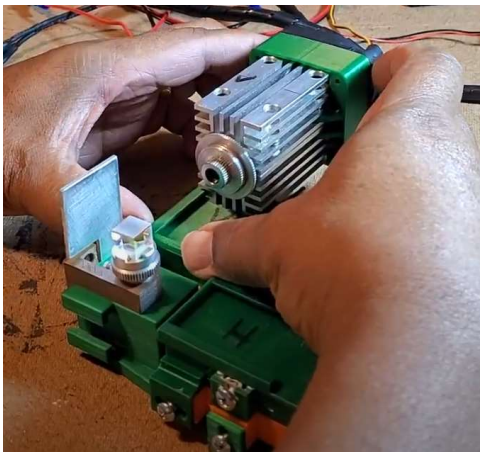
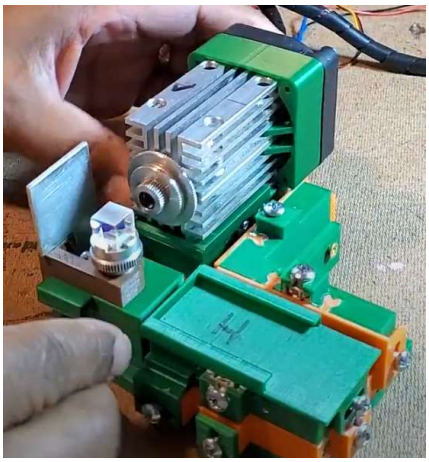
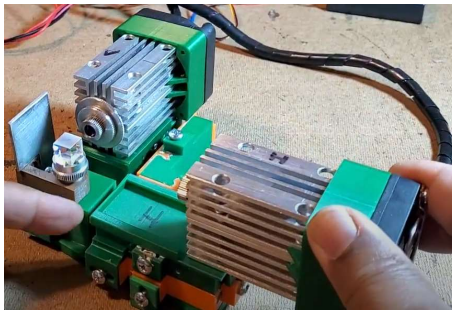
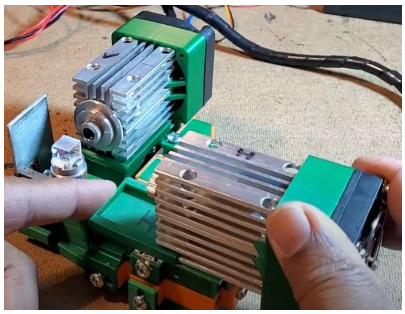
6.7 Mounting Prism Pedestal Bracket and Horizontal Laser Bleed Through Shield

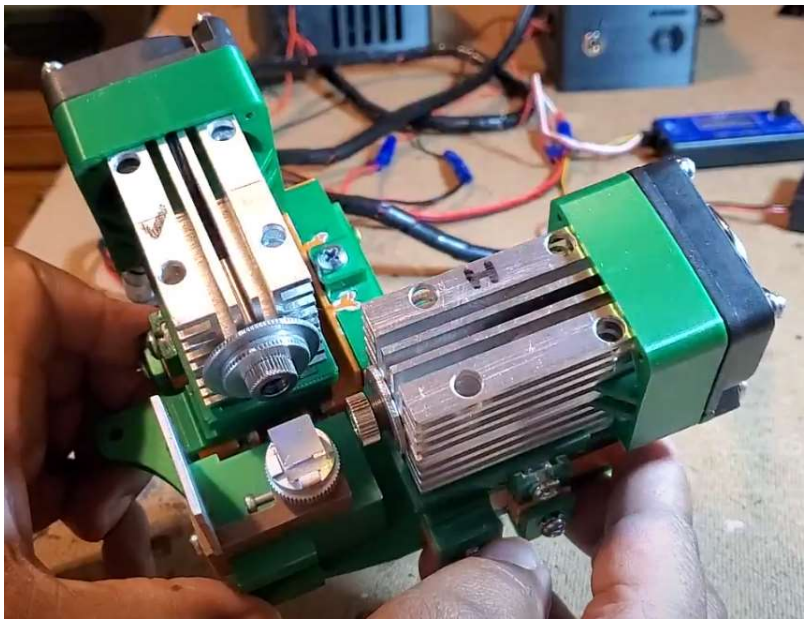
1. Mount the Prism Pedestal Bracket (and Prism Pedestal and Prism) and the Horizontal laser Bleed Through Plate to Mount_Base.stl.



6.8 Mounting Lasers onto Laser Sled

1. Remove the original Endurance-supplied mount bolt from the bottom of each laser.
2. Orient the laser so that its bottom faces the top of the Laser Sled.
3. Align the laser with the Laser Sled and slowly apply force to slide the laser forward on the sled until it can no longer be moved forward. The Laser Sleds are designed for a very tight press fit with the lasers. Three likely imperceptible protrusions exist on either side of the sled slide path to increase friction. Be careful. Recommend testing the fit of the laser with the sled parts right after they are printed. Ensure that you can get the sleds on and off.
4. Use the Drive Screws to position all of the translation tables in their centered, un-adjusted positions, after sliding the lasers into position.



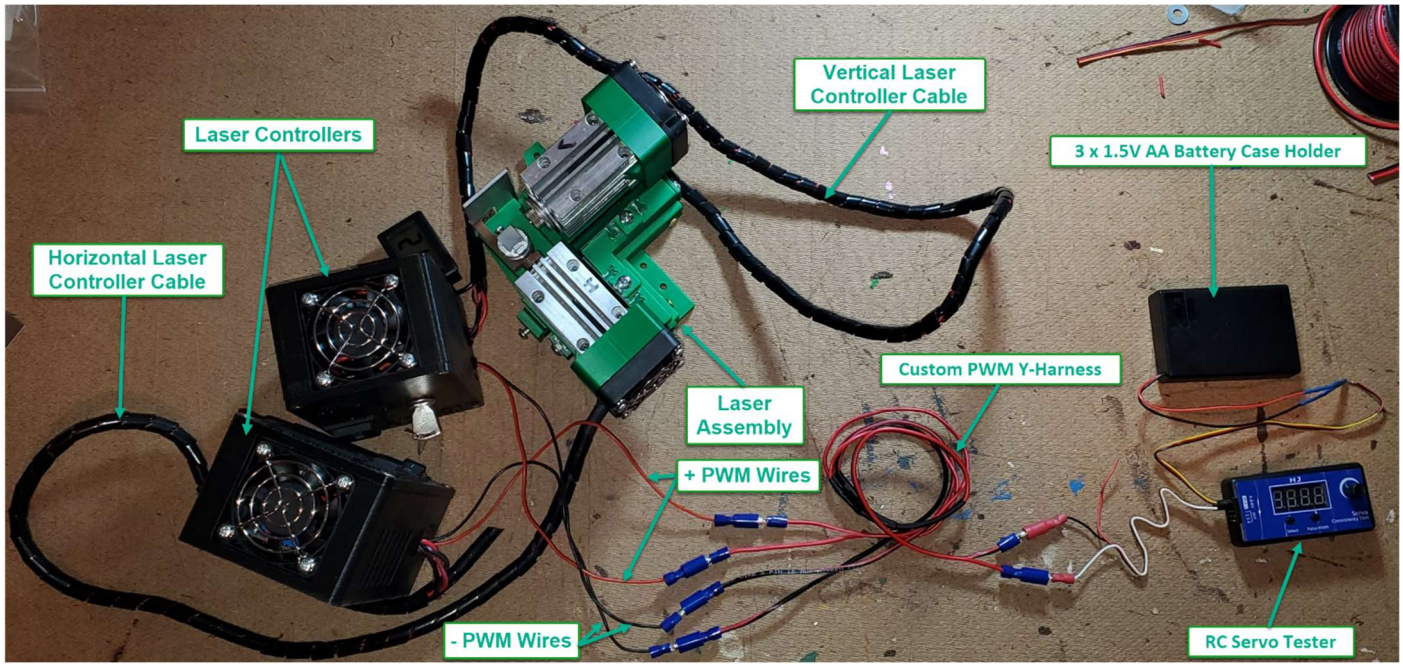
7 Initial Laser Testing, Alignment and Focusing

7.1 Test Setup

To verify that the DUOS Kit worked properly out of the box and to make it easy to align and focus the lasers, I created a test stand shown below and I acquired a **scissor stand** to enable easy laser focusing and alignment.

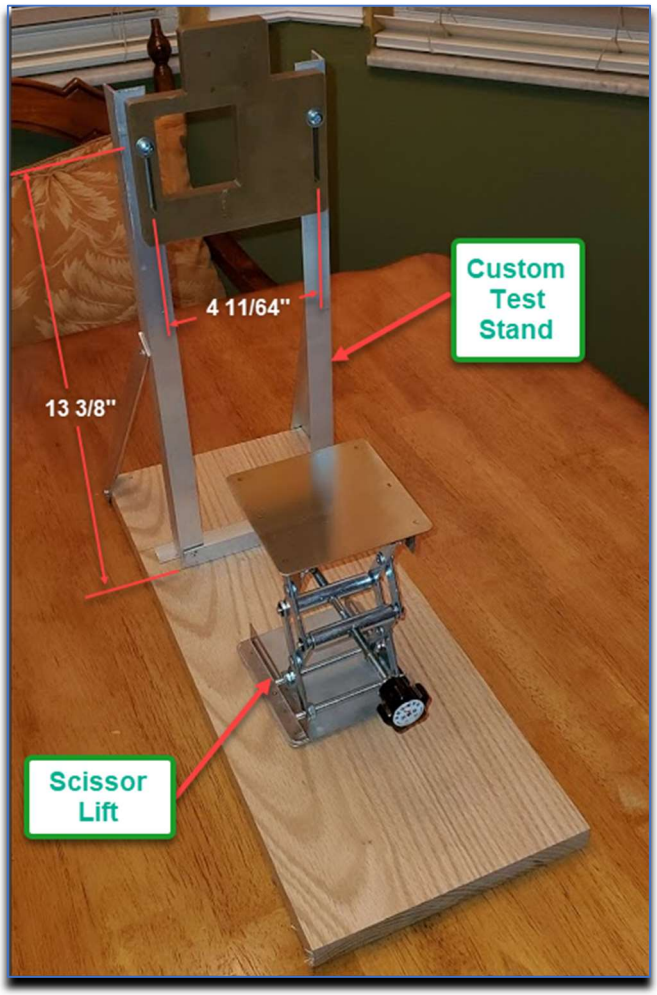
I used an **RC Servo tester** to provide the Pulse Width Modulation (**PWM**) signal to specify the laser power.

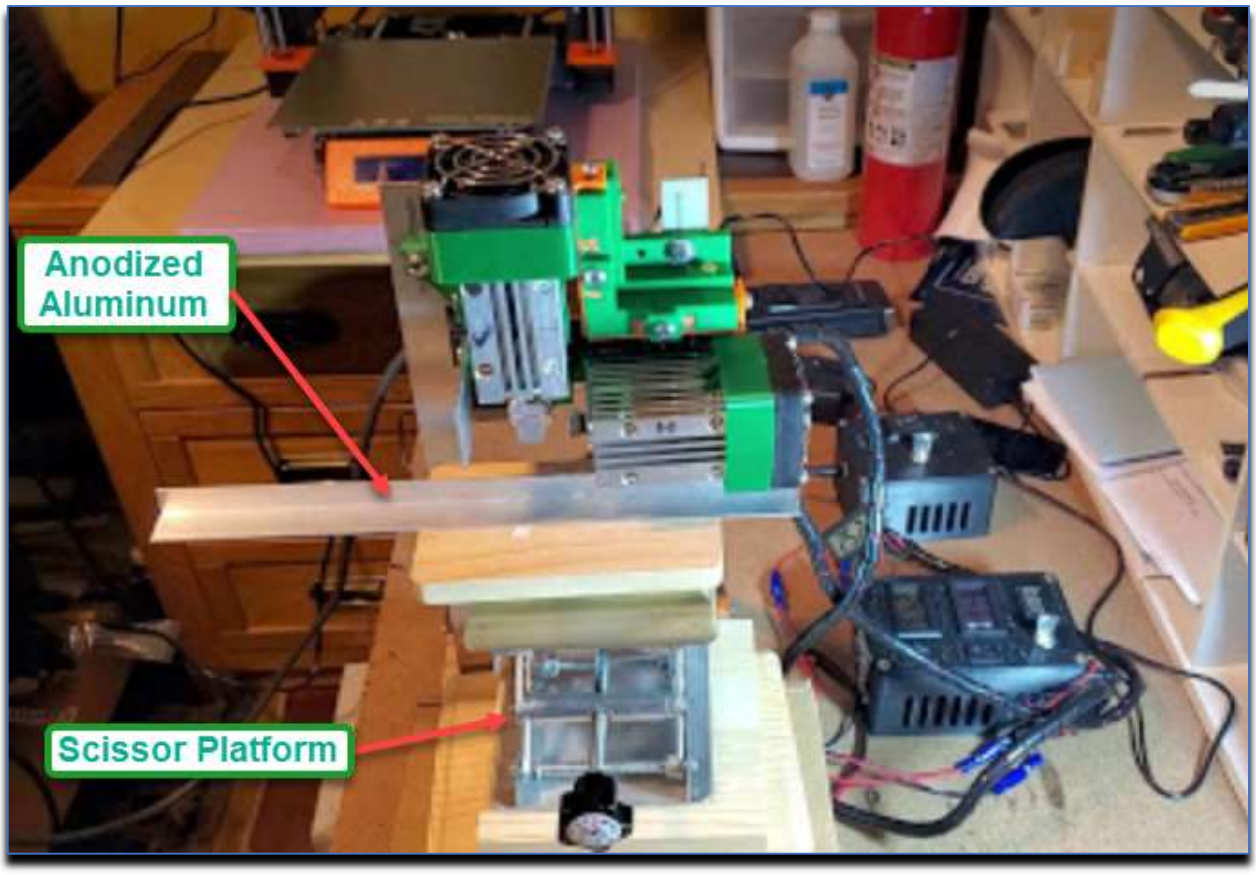
1. Create a **Y-harness** as shown in the picture below long enough to position the laser controllers at the desired location in your environment. I made my harness length 18 to 24 inches to ensure that the harness was long enough to reach the PWM output of my X-Carve controller.
2. Split off the PWM signal wires coming from the X-Carve Controller and add connectors to allow connection with the PWM Y-harness created above.
3. Mount the laser assembly on the test stand.



7.2 Initial Focusing

1. Put on your laser goggles. Then turn on both DUOS lasers.
2. Set the laser power level with the RC Servo Tester so that the laser beams become visible.
3. Move the black card supplied in the in the Endurance DUOS kit, or better, a piece of anodized aluminum up and down by hand to determine the laser focal depth (as measured from the bottom of the vertical laser focal ring (which for me was around 2.5 inches).
4. Set the RC Servo Tester Power to zero to power off the laser. Turn off the lasers.
5. Position the anodized aluminum on the scissor stand below the laser path.
6. Raise or lower the scissor stand so that the anodized aluminum is positioned near the initially determined focal depth.
7. Put on your laser goggles. Then turn on the horizontal DUOS laser only.
8. Set the laser power level with the RC Servo tester so that the horizontal laser beam becomes visible.
9. Raise or lower the scissor stand to bring the horizontal laser into tight focus.
10. Turn off the horizontal laser. Then turn on the vertical laser.
11. If the vertical laser dot is not as tightly focused as the horizontal laser, adjust the focal ring on the vertical laser to achieve the same dot size as the horizontal laser. (In practice, I did not have to modify the focal ring to fine tune focus on either of the lasers. Their out-of-the-box positions were maintained.)





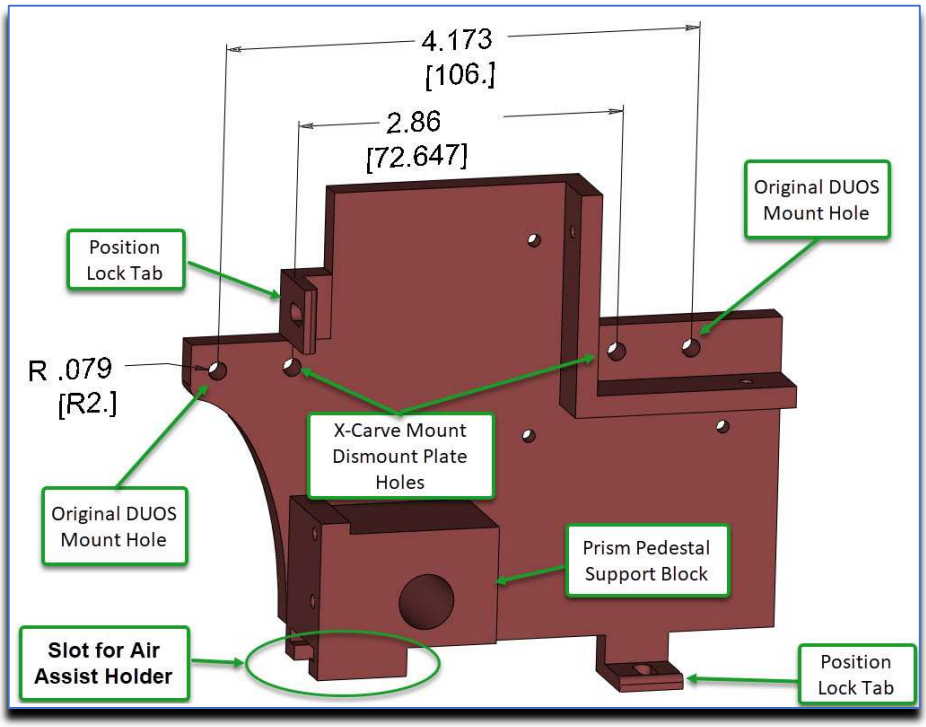
7.3 Initial Alignment

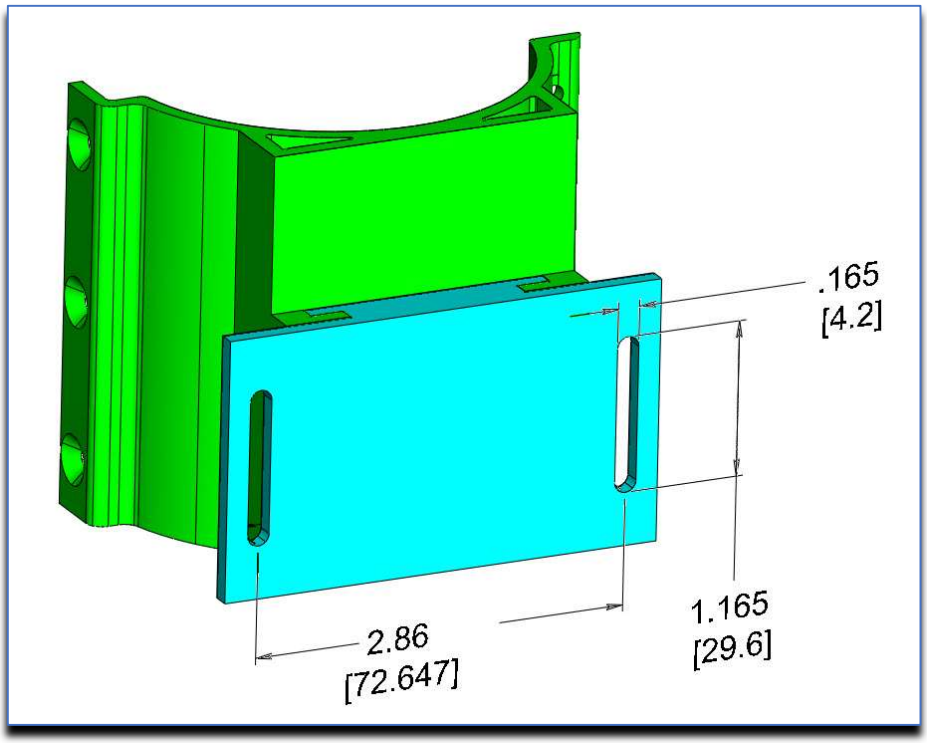
The custom laser alignment mechanism works by allowing the end user to turn **Drive Screws** to make minute adjustments for each laser in the X, Y and Z directions to perfectly align the dual laser beams. Since the lasers were already individually focused according to the instructions in the previous sections, you should only need to fine tune the **In and Out** and **Left and Right** Drive Screws of the **vertical laser**, and/or the **Up and Down** and In and **Out Drive** Screws of the **horizontal laser**.

1. Put on your laser goggles. Then turn on both DUOS lasers.
2. Set the laser power level with the RC Servo Tester so that the laser beams become visible.
3. Adjust the **In and Out** and **Left and Right** Drive Screws of the **vertical laser**, and/or the **Up and Down** and **In and Out** Drive Screws of the **horizontal laser** to align the laser dots so that they form the smallest perceptible dot.
   Note: I turned off the lights and used a magnifying glass to ensure I had the best alignment.
4. Set the RC Servo Tester Power to zero to power off the laser. Turn off the lasers.
5. Screw down the **Position Lock Tabs** on the horizontal laser only to fix the position of the horizontal laser. It will be easier to make any final alignments on just the vertical laser after extending the controller wires and mounting the laser assembly on the X-Carve .
6. Put on your laser goggles. Then turn on both DUOS lasers.
7. Set the laser power level with the RC Servo Tester so that the laser beams become visible.
8. Ensure that both lasers are still aligned. Adjust the position of the vertical laser if necessary. Do not tighten Position Lock Tabs of the vertical laser at this time.

8 Mounting the Translation Table Assembly on Your End Device

The mount parts described (and/or provided) are for mounting the DUOS lasers on my 1000mm X-Carve CNC. However, the outer holes on Mount_Base.stl match the holes on the original base supplied for the DUOS by Endurance. If you need a custom mount and are not able to obtain or create one yourself, contact me (reginaldajones7@gmail.com) to discuss creating a custom mount for you.





Note: The inner set of dimensioned holes are for the custom X-Carve mount. The outer set match the original DUOS mount supplied by Endurance.

9 DUOS Wiring Extension

Below is a diagram showing how I extended wires (+ - Laser Power, + - Cooling Fan Power, and + - Thermal Probes for each laser), on the original DUOS kit to allow placement of the laser controllers in the desired location in my X-Carve operating environment. Approximately 6 feet was added to the initial wiring along with connectors that allow the laser assembly to be completely disconnected and dismounted from the X-Carve when not in use (i.e., when performing milling jobs on X-Carve).

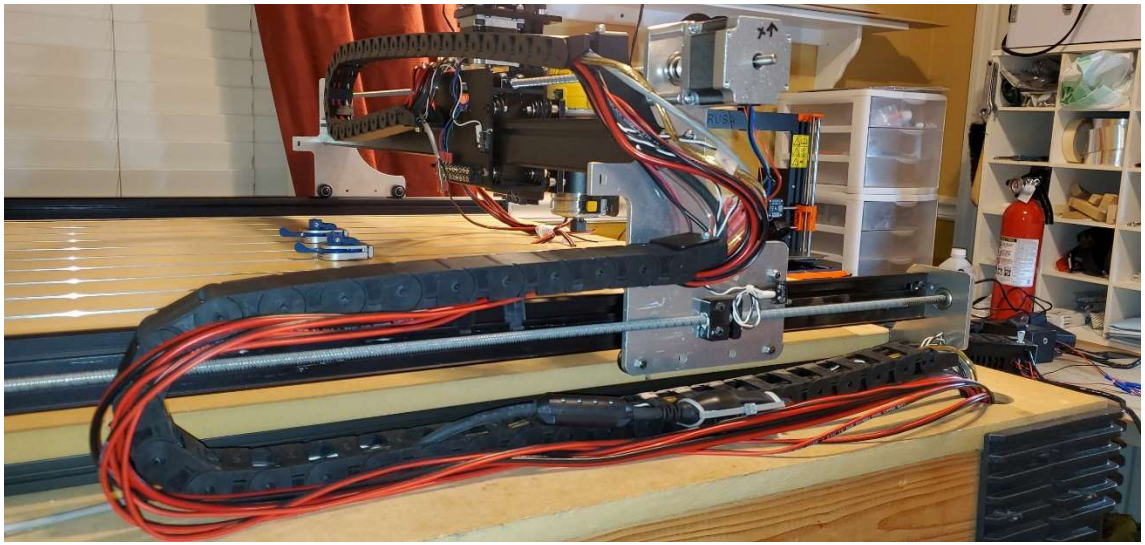
I chose connectors to accommodate the various wire gages that come with the DUOS. I recommend sticking with the wire gauges shown, especially the AWG 12 wires used to extend the laser power wires, (as I consulted with George Formitchev on the best wire gauge to use). Feel free to use different connectors. I use the AWG bullet connectors and the XT-60 connectors for my RC aircraft hobby. So, I had some of those connectors on hand.

Space was getting tight in my X-Carve drag chain after adding the laser power and cooling fan wire extensions. So, I chose to use a single RJ11 phone cord containing 4 wires for the Thermal Probe wire extensions, splitting off at the beginning and ending of the RJ11 extension. (This is shown as 2 separate pairs of wires in the diagram. However, just 1 RJ11 phone line was threaded through drag chains).

The procedure I used to extend the Duos controller wires follows. Your environment may differ from mine. So, modify steps accordingly.

9.1 Wire Extension Length Determination

1. Mount the laser assembly on the X-Carve using the 3D printed custom mounts.
2. Cut the wires leading from each laser controller to the lasers in half.
3. Place the laser controllers in their permanent location in the X-Carve environment.
4. Measure the **wire extension length** as the distance from where wires will connect to the mounted laser assembly through the drag chains to the location in the X-Carve environment where the laser control boxes are placed plus an extra 18 inches to this distance for safety (or service loops).



Wire Extension Length Determination

9.2 Laser Power Wire Extension

5. Measure and cut to the **wire extension length** (as determined above) 2 pairs of + - (red, black) **AWG 12 wire** for **vertical and horizontal Laser Power**.
6. Thread both pairs of wires through the drag chains.
7. Label the beginning and end of the wires to designate one red, black pair for the vertical laser and the other for the horizontal laser. Check continuity to be sure the wires are labeled correctly.
8. Strip wires appropriately and add the **AWG 12-10** and **XT-60 connectors** as shown in the diagram. (You could use AWG 12-10 connectors in place of the XT-60 connectors for all of the laser power connections).

9.3 Laser Cooling Fan Wire Extension

9. Measure and cut to the **wire extension length** 2 pairs of + - (red, black) **AWG 18** wire for each **laser cooling fan**.
10. Thread both pairs of wires through the drag chains.
11. Label the beginning and end of the wires to designate one red, black pair for **the vertical laser cooling fan** and the other pair for **the horizontal laser cooling fan**. Check continuity to be sure the wires are labeled correctly.
12. Strip wires appropriately and add the **AWG-22-16** connectors as shown in the diagram.

9.4 Laser Thermal Probe Wire Extension

13. Cut then ends off of each of 2 **RJ11 Telephone Line Cord Phone Extensions** (RJ11 phone wires) at a length of 7 inches back from each male connector.
14. Measure and cut to the **wire extension length** one of the remaining RJ11 phone wires.
15. Thread the RJ11 phone wire through the drag chains.
16. Remove 6 inches of the outside phone wire cover from each end of the RJ11 phone wire, exposing the 4 individual wires.
17. Separate the 2 halves of 4 RJ11 inline couplers and cut the 4 wires that join the halves to make the length of the wires emanating from one the halves as long as possible. (Toss the other halves).
18. Designate the red (+) and black (-) wires in the RJ11 phone wire for the **horizontal laser Thermal Probe** and the yellow (+) and green (-) wires for the **vertical laser Thermal Probe**.
19. Splice on connectors as shown in the wiring diagram. I had to modify the pin placement in the RJ11 inline couplers to ensure that the correct wires matched when the male RJ11 connectors are inserted into the female couplers.
20. Label the beginning and end of the wires to designate horizonal and vertical thermal probes. Check continuity be sure the wires are labeled correctly.

Note: If you have room in your drag chain, it might be simpler to run separate wires for the horizontal and vertical thermal probe wires.

Endurance Duos 15 Watt DIY Kit Wiring

04/07/2021

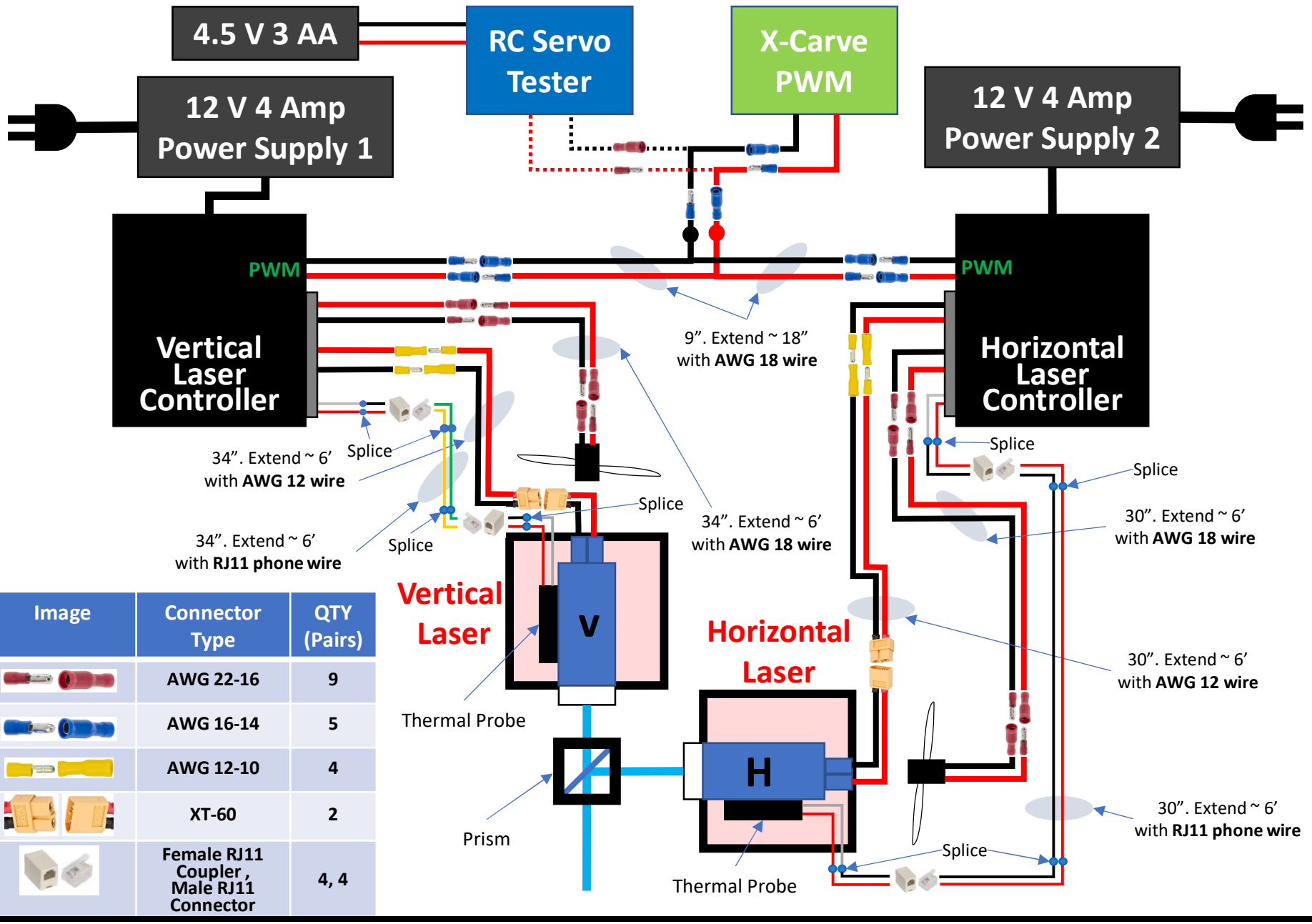
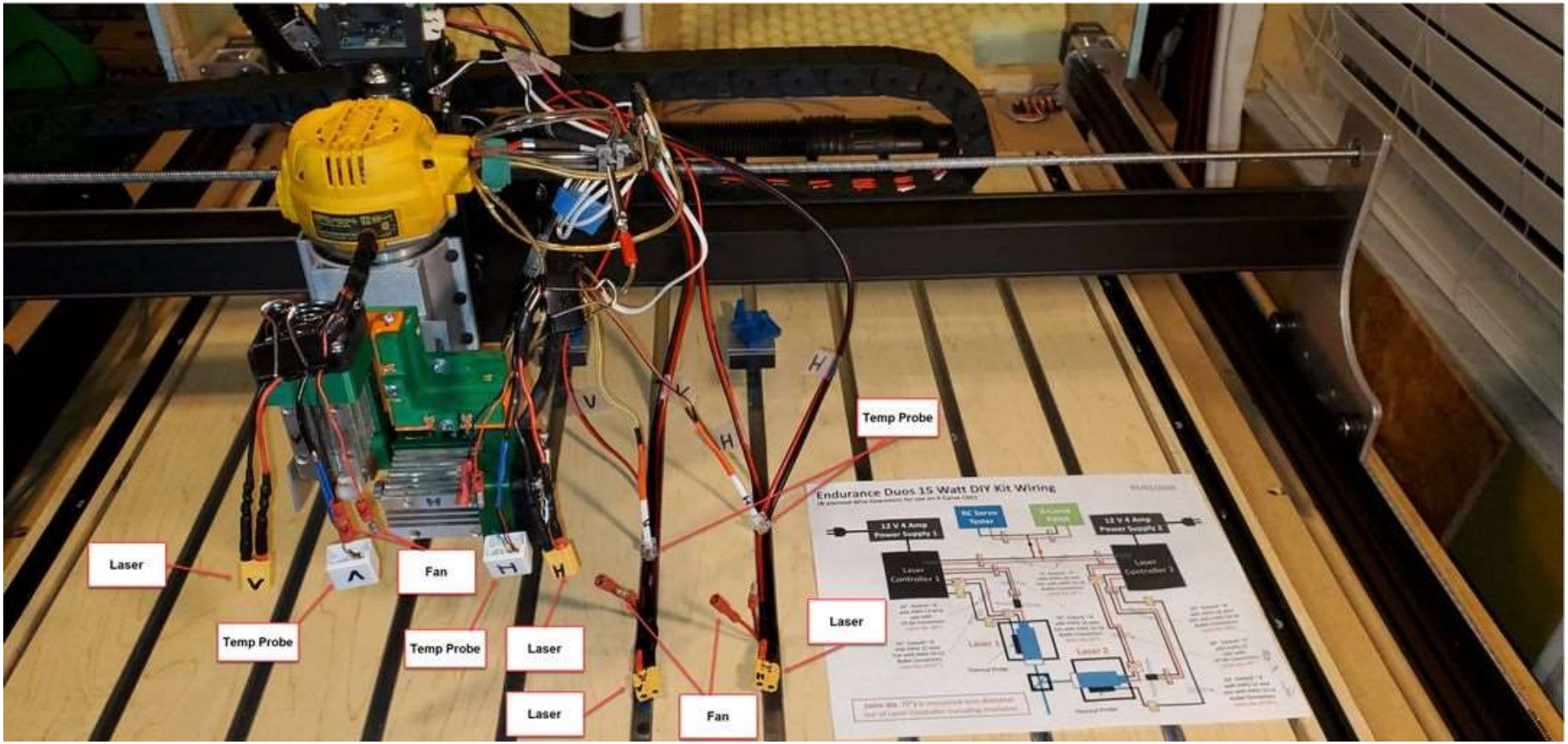
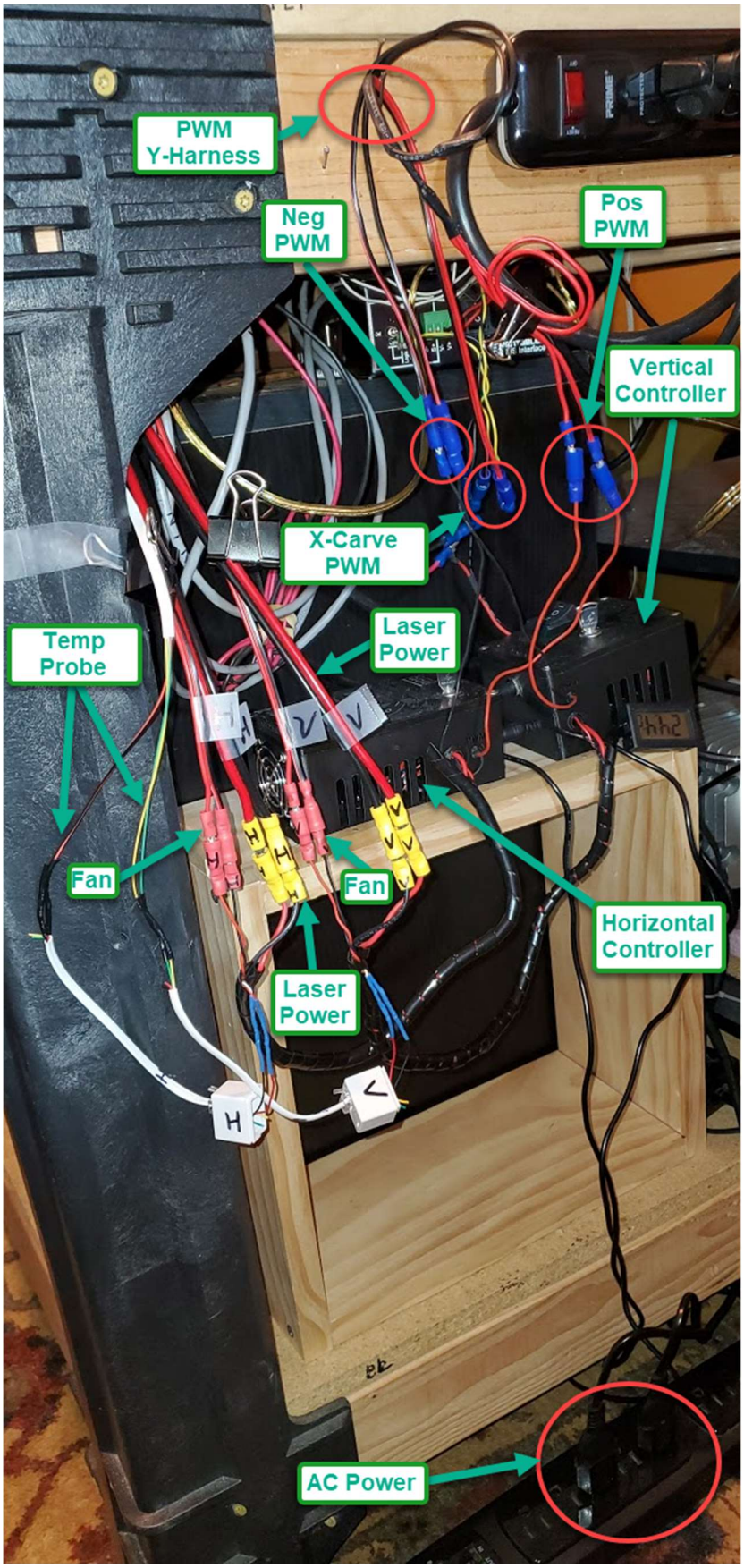


Image	Connector Type	QTY (Pairs)
	AWG 22-16	9
	AWG 16-14	5
	AWG 12-10	4
	XT-60	2
	Female RJ11 Coupler , Male RJ11 Connector	4, 4



Wiring at Lasers



Wiring at Laser Controller

10 Final Focusing and Alignment

1. Once all of the wires have been extended and connectors added, make all of the connections, continuing to use the RC Servo tester to provide the PWM signal to the lasers.
2. Place a piece of anodized aluminum under the laser at the focal depth previously determined using test stand by adjusting the Z-height of the laser using the X-Carve and by using the scissor lift.

Final Focusing and Alignment

3. Put on your laser goggles. Then turn on both lasers.
4. Set the laser power level with the RC Servo tester so that the laser beams become visible.
5. Repeat the initial focusing and alignment instructions from sections 7.2 Initial Focusing and 7.3 Initial Alignment, if the lasers are out of focus or are no longer aligned. Power off the lasers and the RC Servo tester.
6. Screw down the **Position Lock Tabs** on the vertical laser to fix the position of the vertical laser.

7. Connect the PWM signal wires from the X-Carve controller to the PWM Y-harness.
8. Test the Duos lasers using laser driver software.
   I use Vectric VCarve Pro cam software for laser cutting and etching and LaserGRBL to dither images and export associated Gcode. I use Universal Gcode Sender Platform to send Gcode to the X-Carve.

11 Appendix 1: Parts / Hardware List

Parts below are those that I ordered (from Amazon). Parts without a link listed below were obtained at local hardware store.

Part	Link	Image	# Needed
#8-32 SAE 304 Machine Screw Hex Nuts	100 Qty 8-32 SAE 304 Stainless Steel Machine Screw Hex Nuts (SNG578)		18
#8-32 1 ½ Pan Head Phillips Machine Screws	The Hillman Group 92132 8-32-Inch x 1-1/2-Inch Pan Head Phillips Machine Screw, 100-Pack		6
#8-32 3/8 Pan Head Phillips Machine Screw			9
#6 3/4 Flat Phillips Wood Screw			3
#6 1/2 Flat Phillips Wood Screw			2
White Lithium Grease	Lucas Oil 10533 White Lithium Grease - 8 oz. Squeeze Tube		1
Scissor Stand	WISAMIC Lab Jack 4x4 inches, Lab Jack Scissor Stand Platform, Stainless Steel Laboratory Jack Lift		1
Servo Tester	Globact RC Digital Servo Tester/ESC Consistency Tester for RC Helicopter Airplane Car		1
3 x 1.5 V AA Battery Case Holder	Onwon 6 Pieces 3 Slots x 1.5V AA Battery Case Holder Battery Spring Clip Storage Box Wire Leads with On/Off Switch		1
12 AWG Wire Red & Black - 25 Feet	GS Power 12 AWG (American Wire Gauge) Flexible OFC Zip Cord Speaker Cable for Car Stereo Amplifier Remote Automotive Trailer Harness Hookup Wiring | 25 ft Red & 25' Black Bonded – Pure Copper		1

Part	Link	Image	# Needed
18 AWG Wire Red & Black - 40 Feet	TYUMEN 40 Feet 18 AWG Gauge 2 Conductor Stranded Red Black Car Home Stereo Speaker Audio Cable Electrical Hookup Wire - 99.95% Oxygen Free Copper Wires		1
RJ11 Telephone Line Cord Phone Extension – 9.98 Feet	RJ11 6P2C Telephone Line Cord Phone Extension Straight Cable Wire 6p2c Pin Plug Male to Male Plug Modular Landline Cable Fax Modem, 3M/ 9.8 feet Long White (2 of Pack)		2
RJ11 Inline Coupler	RJ11 6P4C Inline Coupler, Uvital Modular Female to Female Straight Telephone Extension Cable Cord Coupler Adapter Jack White(**2 Pack**)		4
AWG 22-16 Bullet Connectors	Wire Connectors Red PVC Insulated Copper Core Quick Splice Bullet Butt Terminals		9 pair
AWG 16-14 Bullet Connectors	AIRIC 100pcs Bullet Connectors Male/Female Kits 16-14AWG Wire Connectors Blue PVC Insulated Copper Core Quick Splice Bullet Butt Terminals		5 pair
AWG 12-10 Bullet Connectors	Hilitchi 50Pcs 12-10 Gauge Insulated Male / 50Pcs Female Bullet Quick Splice Wire Terminals Wire Crimp Connectors Set (12-10AWG Total 100Pcs)		4 pair
XT-60 Connectors	3 Pairs XT60 XT-60 XT60H Plug Male and Female Connector with Sheath Housing Cover with 120mm 12AWG Silicon Wire for RC Lipo Battery FPV Racing Drone		2 pair

12 Appendix 2: Initial Test Results

I extended the original DUOS wiring between the laser controllers and the lasers (about 18”) by approximately 6 feet to allow placement of the controllers at the desired location in my X-Carve environment. See the diagram below.

The completed prototype assembly was mounted on the X-Carve and initially tested on 2/19/2021. I was able to quickly align and focus the lasers as I had hoped, attaining a very fine focal point at 2 15/16 inches from the bottom of the vertical laser focal ring.

Initial beam quality test results were excellent as well as initial cutting tests. See below.

Date: 02/17/2021

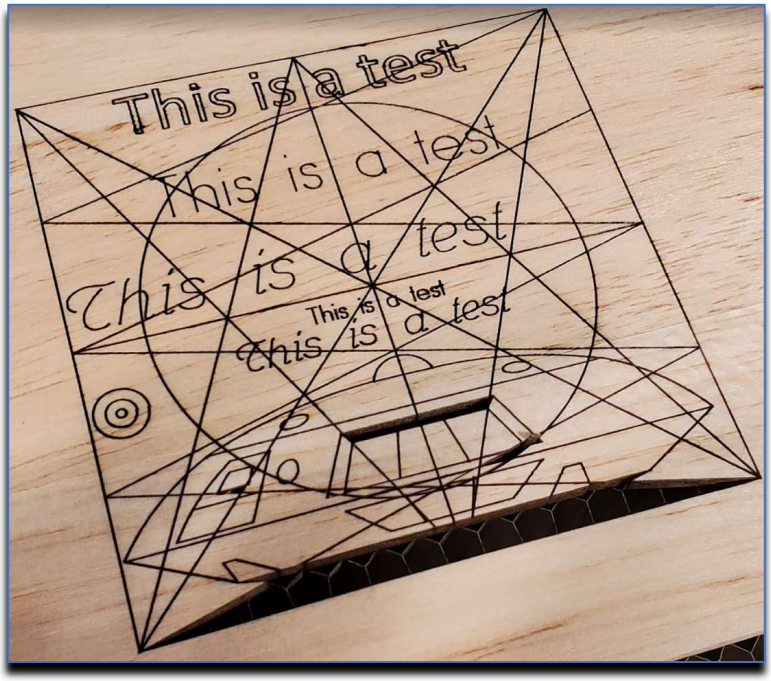
Finished wiring and connections for my Duos 15 Watt DIY Laser Kit with custom XYZ linear translation tables to simplify laser alignment and custom mounts for my X-Carve CNC.

I also performed the 1st precision test of the Duos on the X-Carve. Test was run on 1/8 inch balsa at 50% laser power with feed rate of 40 inches/min and air assist. This is the exact same test I run with my JTech 3.8 watt laser. I'm extremely happy with the results - nice tight burn. There are minor jaggies when there was a sharp change in direction on some of he text. But I got those same jaggies with the lighter 3.8 watt Jtech (can be mitigated by slowing acceleration and feed rated) I honestly thought there would be more jaggies but it appears as though the lock down tabs are doing the job.

I was pleasantly surprised to see some complete burn through the 1/8 inch balsa at 50% power. So I would not expect to have any issues cutting my planned kits in 1 pass at say 75% power - TBD).

Once I completed the wiring, I realigned the lasers by turning the positioning screws and locked the table in place with the locking tabs and screws. I'm ecstatic over these 1st results!!!!!!

Thank you, George Formitchev, for making the Duos Kit available (especially at the rate I got it during the special 2020 Xmas offer!!!!).



Date: 02/19/2021

1st Cut Tests (with air assist) of dense 1/8" Balsa Using Duos 15 Watt DIY Kit. Almost through cut with 1 pass at 90% power with FR of 15 ipm. Complete Through cut with 2 passes at 70% power with FR of 15 ipm.

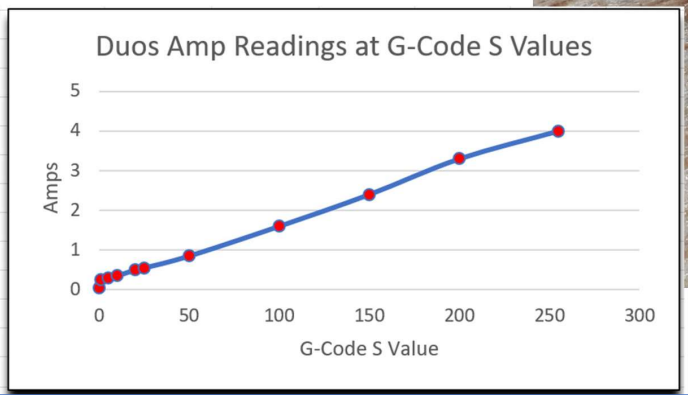
Would have taken 15 passes with JTech 3.8 watt laser (and air assist).

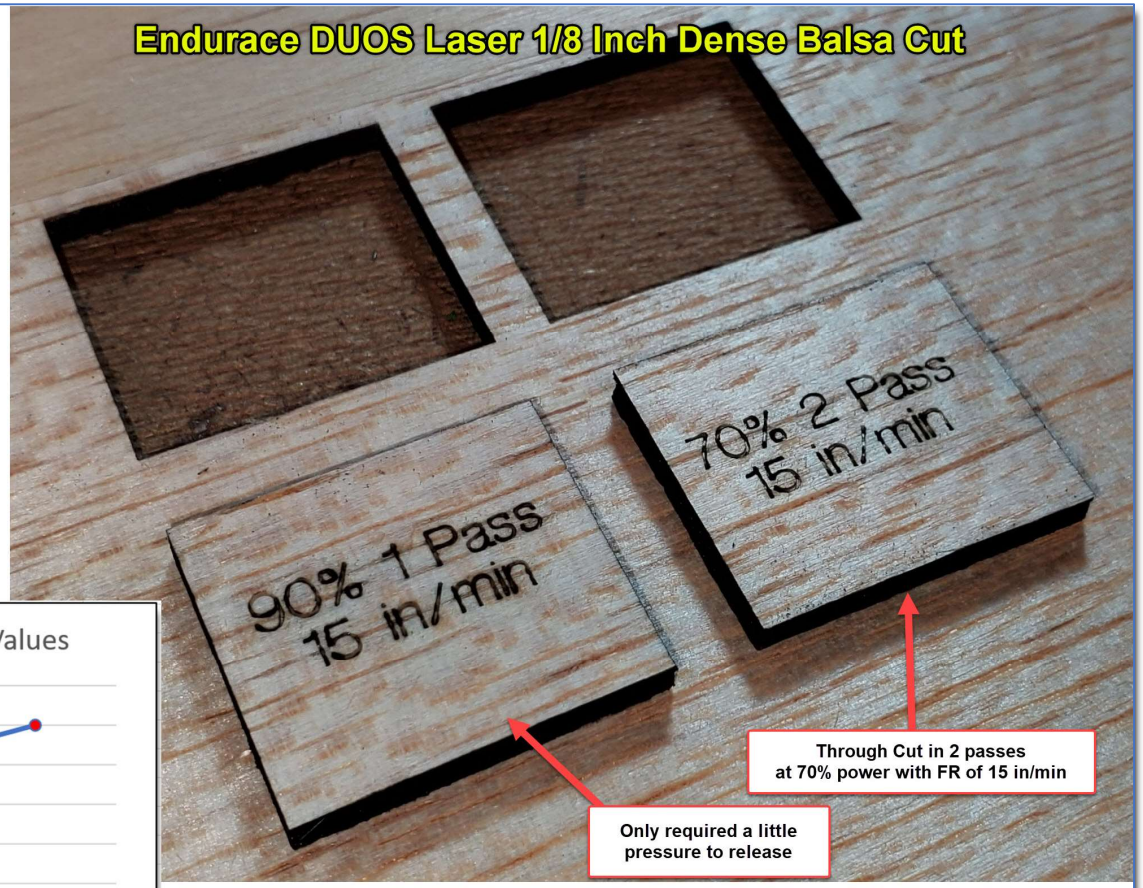
I'm extremely happy with the power increase and laser dot size. Appears to be just as tight as my single 3.8 watt JTech Photonics laser.

Will cut kit plane as next test.

Tool #	Power %	G-Code S Value	Notes
0	0%	0	
	1%	2	
1	5%	12	Light line on balsa
1	10%	25	Medium line on balsa
	15%	38	
2	20%	51	Dark line on balsa
	25%	63	
3	30%	76	
	35%	89	
4	40%	102	
	45%	114	
5	50%	127	
	55%	140	
6	60%	153	
	65%	165	
7	70%	178	Through Cut 1/8 Dense Balsa in 2 Passes
	75%	191	
8	80%	204	
	85%	216	
9	90%	229	98% Through Cut 1/8 Dense Balsa in 1 Pass
	95%	242	
10	100%	255	

Gcode S	Laser Amps
0	0.05
1	0.25
5	0.3
10	0.35
20	0.5
25	0.55
50	0.85
100	1.6
150	2.4
200	3.3
255	4

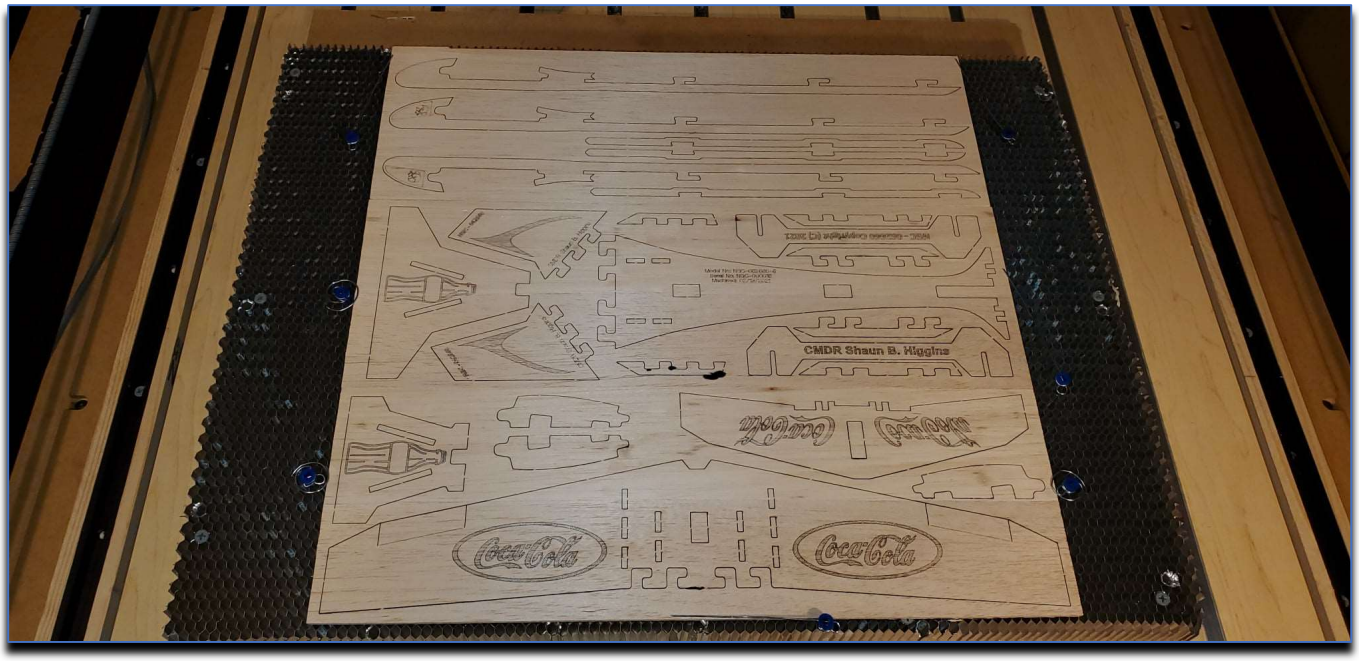


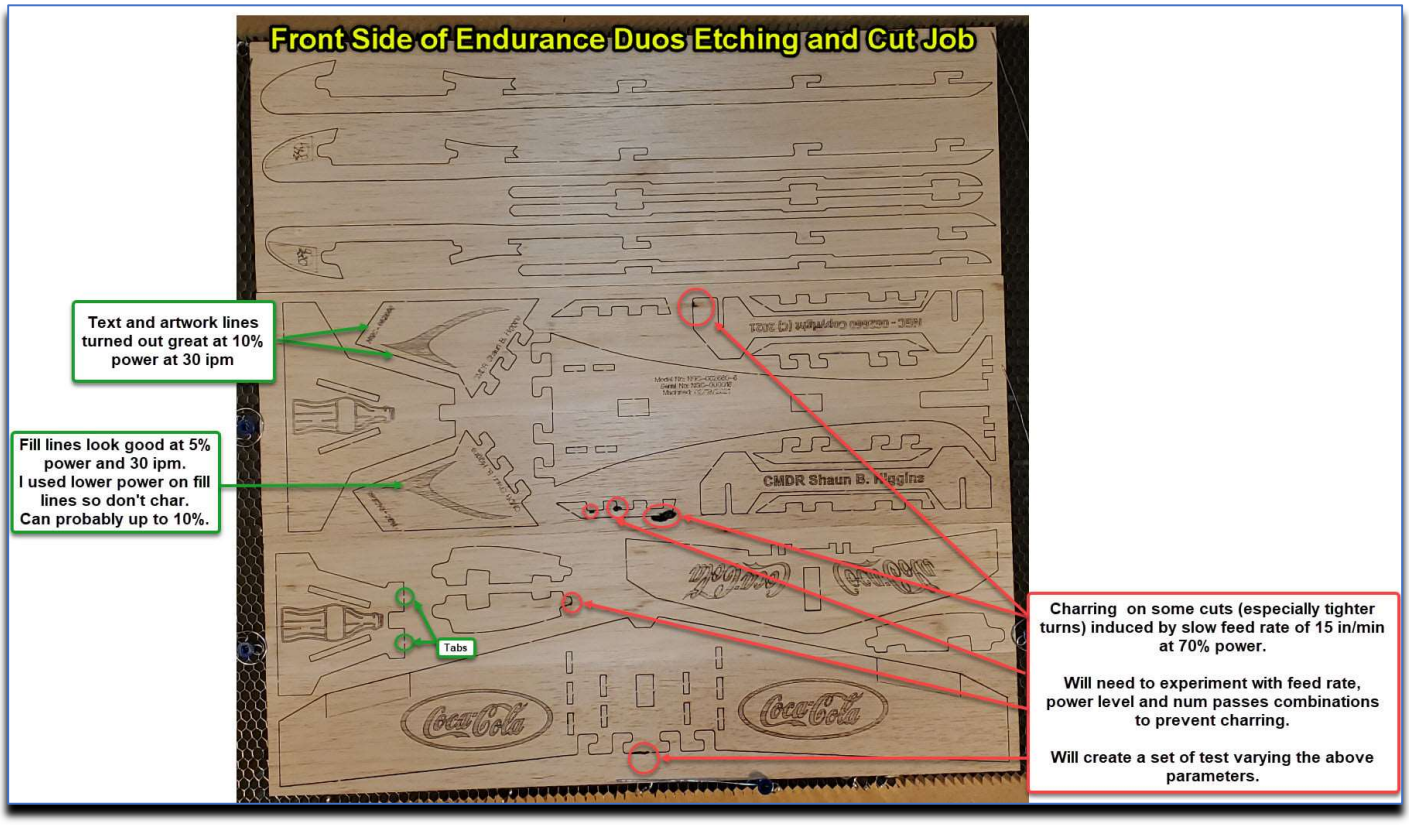


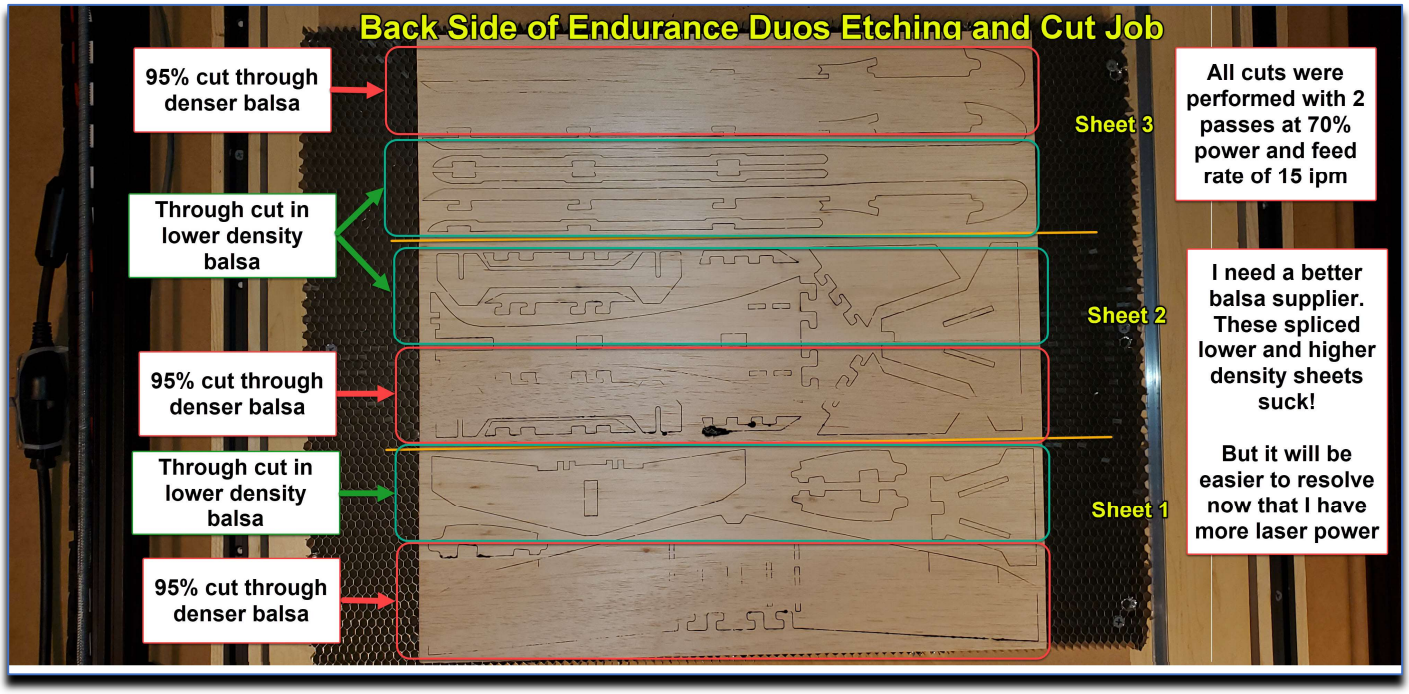
Date: 02/20/2021:

Here are the results of the 1st cut and etch job for a balsa plane kit (I designed) using the Endurance Duos 15 Watt DIY Laser Kit. All cuts were performed with 2 passes at 70% power and 15 in/min. Art work was performed at 10% power at 30 ipm. Fill lines were performed at 5% power at 30 ipm - turned out a little light on the fills. Will increase to 10%.

Summary: Duos working great! I just need to dial in the combination of power, feed rate and passes that will always result in a through cut accounting for the varying density of balsa on any given sheet and prevents the charring induced by using air assist.



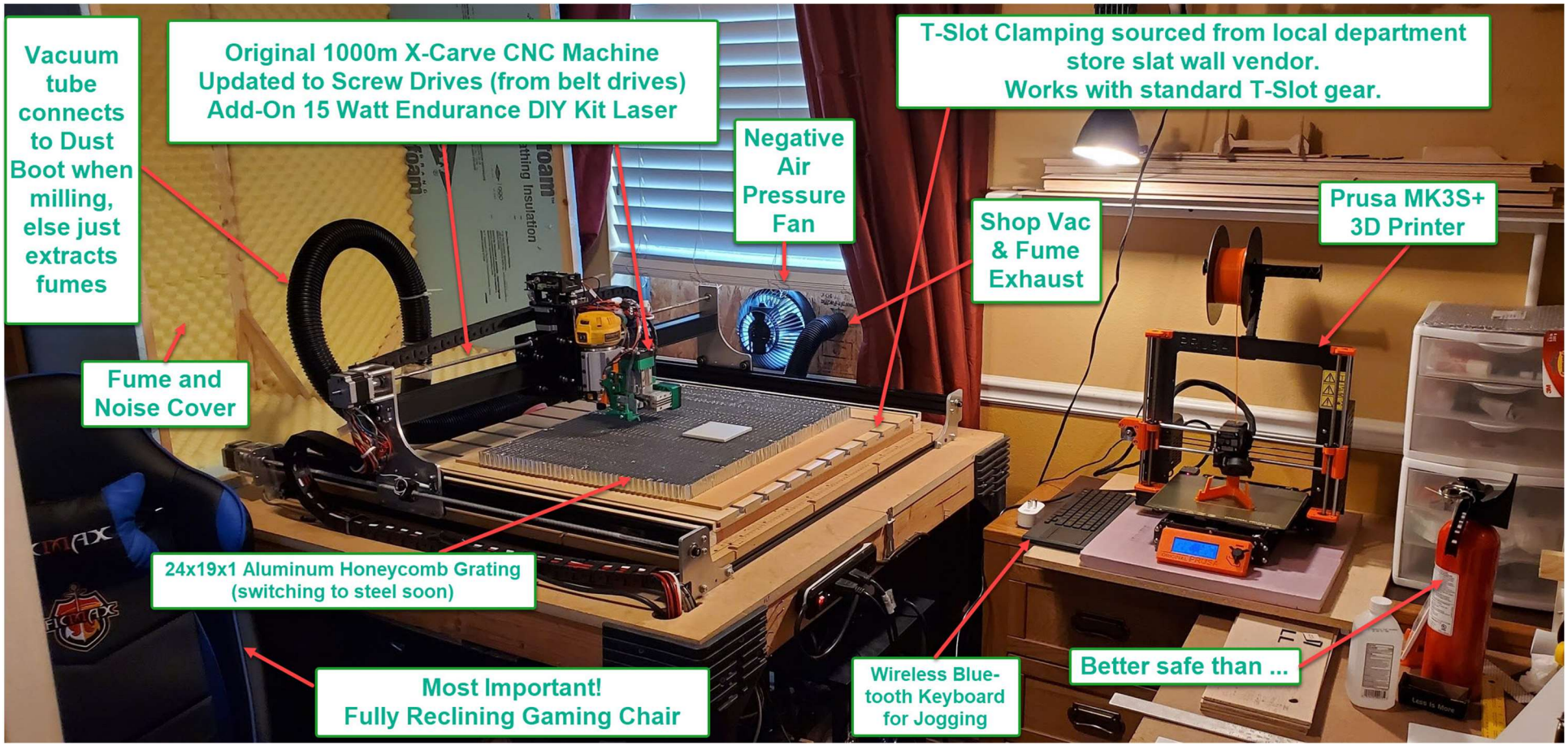




6x6 and 4x4 White Tile Etchings

01. Endurance Duos 15 Watt DIY Kit
02. Power settings: 50%
03. Feed Rate settings: 1200 mm/min
04. Filter: Jarvis dither
05. Laser time: 1 hr 52 min (for 6x6 tile)
06. Number of Dpi: 200
07. Laser software: LaserGrbl
08. Used paint: Rust-Oleum Painter's Touch 2X ULTRA COVER PAINT+PRIMER Gloss Almond
09. Type of lasering: Diode
10. Ceramic Tile Size : 6x6 and 4x4
11. Universal Gcode Sender Platform to burn

Completed X-Carve DUOS Laser Environment



X-Carve CNC Laser and Machining Environment