Product User Manuals

PLH3D-6W Series Laser Heads User Manual

Opt Lasers GRAV

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PLH3D-6W Series Product Description

PLH3D-6W Series laser head engraves and cuts plastics, woods, cardboard and textiles, engraves anodized Aluminum, and marks stainless steel and Titanium. It can be controlled by nearly all CNC machines and 3D printers. It is universally mountable and can replace CO2 lasers in many applications.

This compact and lightweight laser head requires no additional cooling. The laser head's body both directs air from the fan to remove smoke and functions as an efficient heat sink. The machined 6000-Series Aluminum housing keeps the laser head both low-weight and conducts heat away from the laser diode to maintain its lifetime while allowing it to be operated at high power.

PLH3D-6W Series laser head has a device to protect it from overheating to maintain the semiconductor laser's lifetime. It automatically shuts off when the housing temperature exceeds 47° C (116°F) and resumes operation when it reaches 40°C (103°F). In addition, the unit's laser driver is integrated directly into the laser head. This greatly increases the maximum modulation frequency and allows longer cables to be used.

The laser head includes High-Efficiency Mounted Aspheric lens and High-Resolution Triplet lens. We recommend using High-Resolution Triplet lens with pre-set focus, it is most optimized solution for engraving in many applications. The focal length of the laser head is adjustable with installed lens. For more detail information of focal spot displacement range see technical data (page 6).

PLH3D-6W Series can engrave on most types of wood, as well as create 3D images. Woods include, Birch and Pine plywood, Balsa, hardwood and MDF. Its light can also cut most low-density woods. The laser head can cut an assortment of textiles. These include white cotton, denim, felt, Cordura™, 2 and 3-way stretch fabrics and many types of nylon. It can be done without penetrating the protection layer when one is used, such as in the embroidery industry. Many textiles can also be written on with the appropriate settings.

Its blue light allows to engrave metal, such as: black anodized Aluminum, wrought Iron, and marks Titanium and stainless steel; plastic cutting, such as: ABS, Acrylic (black, green, red), Polypropylene, Polyamides, as well as latex, Neoprene and other compositions of rubber. The laser head can also write on many of these materials. It can cut or engrave brown (vegetable tanned) full-grain leather and black full-grain leather.

PLH3D-6W Series Technical Data

Basic Specifications	PLH3D-6W	PLH3D-6W-XF	PLH3D-6W-LC	PLH3D-6W-µSpot
Laser Diode Optical Power[1]	6 W	6 W	6 W	6 W
Dimensions of Laser Head (L x W x H)	40 x 55 x 69 mm (1.6 x 1.7 x 2.7 in.)	40 x 54 x 78 mm (1.6 x 1.7 x 3.1 in.)	40 x 54 x 86.5 mm (1.6 x 1.7 x 3.4 in.)	40 x 54 x 86.5 mm (1.6 x 1.7 x 3.4 in.)
Weight of Laser Head, Typ.	190 g (6.7 oz.)	210 g (7.4 oz.)	275 g (9.7 oz.)	275 g (9.7 oz.)
Flow Rate of Fan	17 m^3/h (10 CFM)	43 m^3/h (25 CFM)	N/A	43 m^3/h (25 CFM)
Fan Noise	23 dBA	58 dBA	N/A	58 dBA
Mounting Hole Pattern	4 Holes, 24x15 mm (0.94 x 0.59 in.)	4 Holes, 24x15 mm (0.94 x 0.59 in.)	4 Holes, 24x15 mm (0.94 x 0.59 in.)	4 Holes, 24x15 mm (0.94 x 0.59 in.)
Mounting Hole Type	M3 x 0.5 x 4.5 mm	M3 x 0.5 x 4.5 mm	M3 x 0.5 x 4.5 mm	M3 x 0.5 x 4.5 mm
Ambient Temperature Range (Operating)	0°C to 40°C (32°F to 104°F)	0°C to 45°C (32 °F to 113°F)	0°C to 45°C (32 °F to 113°F)	0°C to 45°C (32 °F to 113°F)

[1]Since the working distance and lens choice can both have a slight effect on the amount of power from the laser head, it is difficult to specify an exact power value.

Elec. Specifications	PLH3D-6W	PLH3D-6W-XF	PLH3D-6W-LC	PLH3D-6W-µSpot
Modulation Input 1	Analog/TTL/PWM 0 – 5 V	Analog/TTL/PWM 0 – 5 V / 0 -10V	Analog/TTL/PWM 0 – 5 V / 0 -10V	Analog/TTL/PWM 0 – 5 V / 0 -10V
Modulation Input 2[1]	TTL/PWM 0 – 24 V	TTL/PWM 0 – 24 V	TTL/PWM 0 – 24 V	TTL/PWM 0 – 24 V
Recommended PWM Base Frequency	5 – 10 kHz	5 – 10 kHz	5 – 10 kHz	5 – 10 kHz
Max. Modulation Bandwidth	30 kHz	30 kHz	30 kHz	30 kHz
Input Impedance of Mod. In. 1 and 2	>1 k-Ω	>1 k-Ω	>1 k-Ω	>1 k-Ω
Power Supply Unit Voltage[2]	12 – 24 V	12 – 24 V	12 – 24 V	12 – 24 V
12 V PSU Min. Current	2.0 A	2.5 A	2.0 A	2.5 A
24 V PSU Min. Current	1.10 A	1.25 A	1.0 A	1.25 A
Cable Length, Typ.	14 cm (5.5 in.)	14 cm (5.5 in.)	N/A	14 cm (5.5 in.)
Wire Area (Gauge)	0.34 mm^2 (22 AWG)	0.34 mm^2 (22 AWG)	N/A	0.34 mm^2 (22 AWG)
Max. Power Consumption	25 W	30 W	24 W	30 W

"Laser Off" state is <2 V. "Laser On" state is 3 – 24V.

[2] To use a PSU with voltage outside of this range, see the available accessories on our website. We also offer a 12V power supply.

Optical Specifications, PLH3D-Series[1]	High-Resolution Lens[2]	High-Efficiency Lens[3]	µSpot Lens
Recommended Working Distance[4]	20 – 120 mm	25 – 80 mm	60.0 mm
Beam Spot Width	0.1 mm	0.15 mm	<0.10 mm
Beam Spot Height	0.1 – 0.5 mm	0.2 – 0.6 mm	<0.15 mm
Example Focused Beam Spot Size, d = 80 mm (3.2")	0.1 x 0.3 mm (0.004" x 0.012")	0.15 x 0.6 mm (0.006" x 0.024")	N/A
Example Focused Beam Spot Size, d = 50 mm (2")	0.1 x 0.2 mm (0.004" x 0.008")	0.15 x 0.5 mm (0.006" x 0.020")	N/A

[1] Specifications customizable for OEM customers on request.

[2] The High-Resolution Lens is a triplet (three-element) lens, f = 8 mm. This lens is recommended for applications requiring a more circular beam spot, higher power density or medium to long working distance.

[3] The High Efficiency Lens is an aspheric lens, f = 4 mm. This lens is recommended for applications requiring a higher power when it is practical to use a shorter working distance.

[4] Working distance is adjustable. The focused beam spot size depends on focal distance; shorter focal distance results in a smaller focused beam spot size

General Laser Safety Warnings and Cautions

Only person with specialized training and appropriate laser safety knowledge can use and maintain the laser head. The laser head operator must be aware of laser radiation hazard.
While laser head is operating protection Laser Glasses designed for 190 – 540 nm (OD 7+) should be used. Make sure that all personnel in the same room worn protection glasses.
Eye exposure to the direct or diffusely reflected laser beam is a hazard. The laser head beam may cause permanent eye damage.
Skin exposure to the laser beam is a hazard. The laser beam may cause serious skin burns. Laser beam may easily burn cloth.
It is possible to get serious injury while using this product or being in the vicinity of an individual using it. Improper use of the laser head can result in injury or death.
Flammable substances exposure to the laser beam may pose fire hazard. The laser head operation in an explosive atmosphere may be dangerous. The working area must be well ventilated. During the operation laser beam may ignite gases or flammable liquids.
Before making any adjustments, changing accessories or performing maintenance, the laser should be powered off and disconnected from the power supply and CNC main board.
The laser head must be properly mounted to a rigid body such that it cannot be moved unintentionally. Unintentional move of the laser head is dangerous.
The unauthorized personnel must have no access to the system into which the laser head is integrated. The laser head must be stored out of the reach of children. Untrained persons are not allowed to operate, maintain and observe operation of the laser head.
Specular reflection materials should not be placed in front of operating lasers head. Remember, diffused reflection of the laser beam is uncontrolled and may pose hazard to eye.
Appropriate shielding should be used around the system into which the laser head is integrated. The system in which laser head is used must be equipped with key switch and safety interlock.

Responsibility of use or misuse belongs to the end user. Tomorrow's System and its affiliates accept no responsibility for use or misuse by the user. If you may not be able to use this product properly, we recommend that you do not begin use or cease use immediately.

Electrical Information

Pinout

Important: PLH3D-6W-Series engraving laser head should be powered from a high-quality power supply without anything else connected. Please note: connecting the laser head to the same power supply unit as a stepper motor or any other high-impedance equipment is not recommended. Doing so may cause damage to the laser diode.

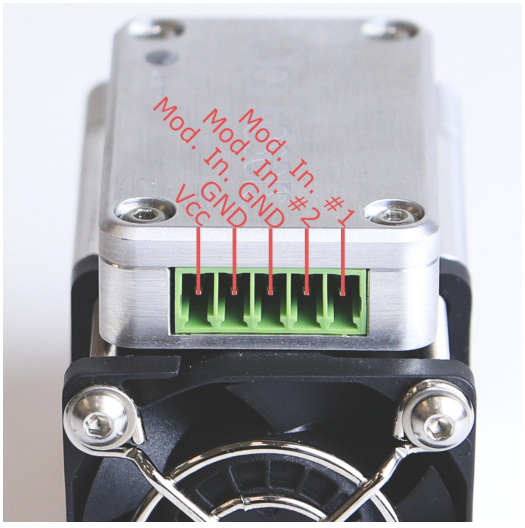
PLH3D-6W Series laser head has the terminal with following inputs:

Electrical Connections					
Pin	**Function**	**PLH3D-6W-XF**	**PLH3D-6W**	**PLH3D-6W-LC**	**PLH3D-6W-µSpot**
1	Modulation Input 1 Analog	✓	✓	✓	✓
2	Modulation Input 2 TTL/PWM	✓	✓	✓	✓
3	Signal GND	✓	✓	✓	✓
4	Vcc GND	✓	✓	✓	✓
5	Vcc	✓	✓	✓	✓

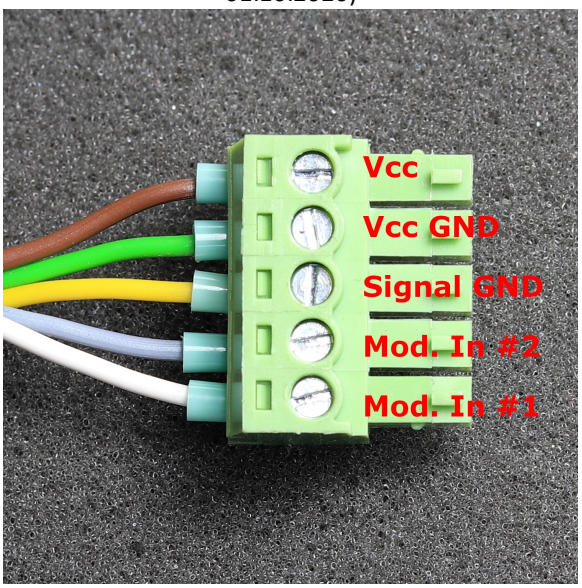
Pin #5 and Pin #4 are responsible for the power supply line of the laser head, they must be connected to positive and negative terminals of the power supply respectively. Pin #1 and Pin #3 are responsible for Modulation Input #1. Pin #2 and Pin #3 are responsible for Modulation Input #2. Note: Modulation Input #1 and Modulation Input #2 have a common ground.

Important: Do not connect both Modulation Input #1 and Modulation Input #2 at the same time. Doing so may result in malfunction of the laser head.

PLH3D-6W-Series Laser Head Pinout:



Cable pinout for PLH3D-6W-Hobby and other pigtailed PLH3D-6W-Series engraving laser heads (sold before 01.10.2020)



Modulation Functionality

Engraving laser heads	Modulation Input 1	Modulation Input 2
PLH3D-6W Series	0 – 5 V Analog Signal 0 – 5 V TTL/PWM Signal	0 – 5 V TTL/PWM Signal 0 – 10 V TTL/PWM Signal 0 – 24 V TTL/PWM Signal

Modulation Input #1:
Modulation Input #1 accepts Analog, Pulse-Width Modulation (PWM) and Transistor-Transistor Logic (TTL) signals. The operating range of Modulation Input 1 is 0 – 5 V. If it is connected to a signal with slightly higher voltage, e.g., 0 – 10 V, only the 0 – 5 V portion of the signal will affect the power. Voltage connected to this input should not exceed 10 V.

Modulation Input #2:
Modulation Input #2 accepts PWM or TTL signals. Examples of compatible control signal ranges are: 0 – 5 V, 0 – 10 V and 0 – 24 V. For control via PWM, we recommend using a base frequency of 5,000 – 10,000 Hz. While frequencies such as 1,000 Hz will also work, higher frequencies typically produce better grayscale images. Duty cycle % will correspond to the optical output power %.

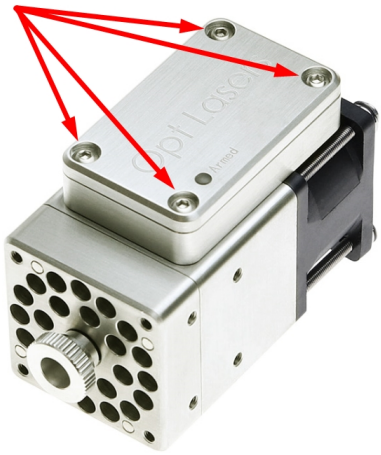
Specification of Modulation Input #2 are following:

Parameter	Test condition @ Ta = 25°C	Min. Voltage	Typ. Voltage	Max. Voltage	Units
High level input voltage	Vcc = 12V Vcc = 24V	2.5	-	-	V
Low level input voltage	Vcc = 12V Vcc = 24v	-	-	1.0	V

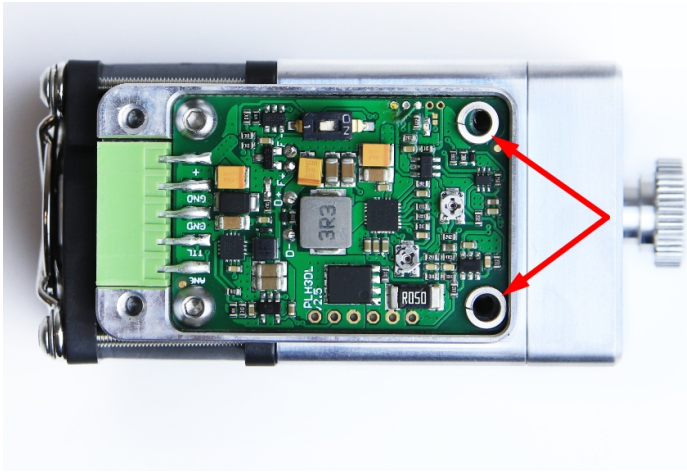
How to change voltage range for Modulation Input #1 from 0 - 5V to 0 - 10V

With the new generation of laser diode driver for PLH3D-6W-Series user can change the voltage range which is acceptable by Modulation Input #1. Here is a quick guide on how to do it.

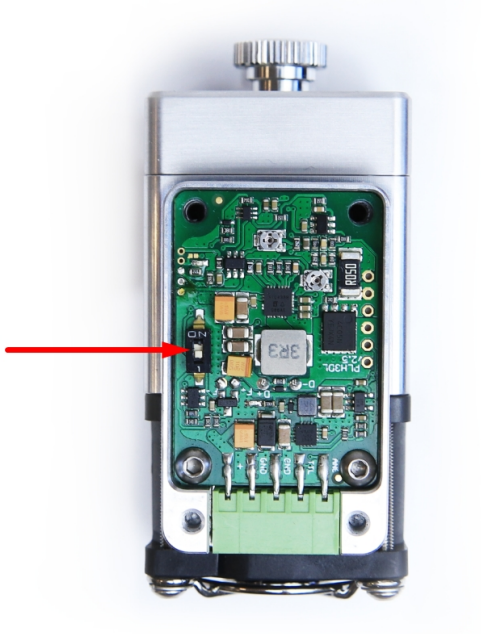
1. Disconnect the laser head from any power supply and modulation signals.
2. Use a 2.0mm Allen (hex) key to unscrew 4 screws located in the corners. See image below for the reference.



3. Remove the driver cover. Important: be careful, inside you will find 2 split washers (AKA spring washer or single coil washer) don't lose them. They must be placed at the same position while assembling everything back.



4. Use a small flat screwdriver to move the switch into second position (marked "ON"). See image for the reference. Now the laser head's Modulation Input #1 accepts voltage range 0 - 10V.



5. Assemble everything in reverse order. Important: center the split washers before assembling the top cover. The screw should go through the split washer.

Electronics Compatibility with CNC Machines

All CNC machines are using a control signal to manage the spindle rotation speed. Hence, PLH3D-6W Series laser heads can be controlled by any CNC controller. This feature makes our laser heads universal.

A CNC controller outputs a signal in the form of an Analog, PWM or TTL signal. This signal is used for modulation of the spindle speed. The same CNC output signal which is used for spindle speed modulation can be connected to appropriate input of the laser head. Further, modulation of the laser head power can be controlled in the same way as spindle speed is, i.e. changing spindle speed in G-code “S0-S255”.

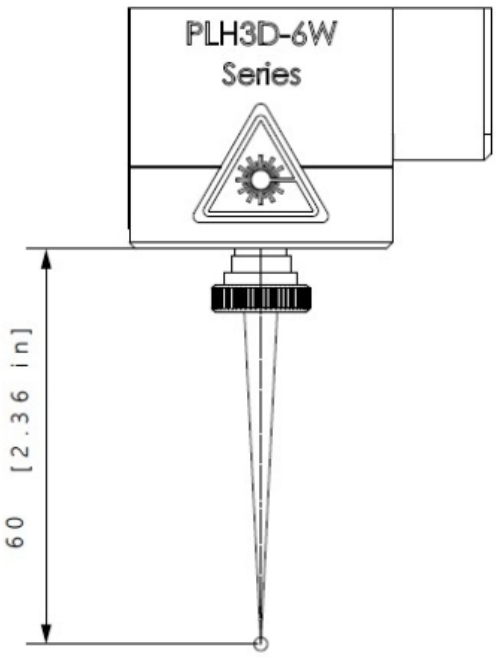
Note: It is important to ensure that the spindle signal is switched off (no voltage output) while the CNC machine is in idle.

Connections for Common CNC Machines

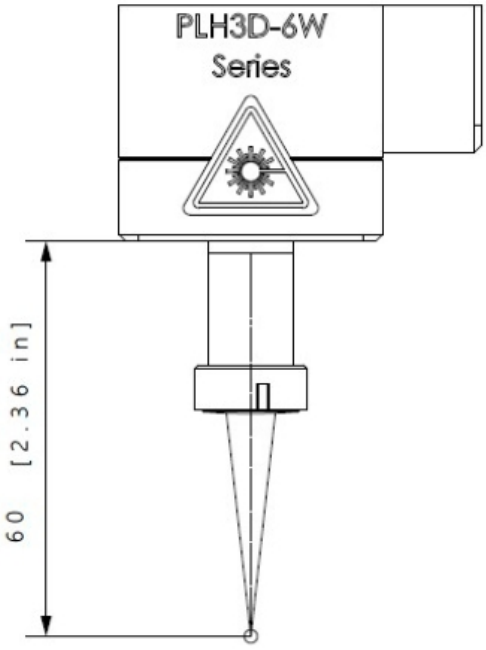
CNC Name	Connection	Type of control	PLH3D-6W Input
STEPCRAFT CNC	DB15 connector PIN 7	PWM	Pin #2
	DB15 connector PIN 2	GND	Pin #3
X – CARVE	“Spindle (PWM)”	PWM	Pin #2
	“GND”	GND	Pin #3
CNC xPRO V3 Controller	~D11 Variable Spindle PWM	PWM	Pin #2
	“GND”	GND	Pin #3
CNC Shark	“Spindle Terminal”	PWM	Pin #2
	“GND”	GND	Pin #3
Legacy Maverick CNC	PIN 17	PWM	Pin #2
	GND	GND	Pin #3
CNC USB Controller Mk3/4	Mk3 OUTPUT Connector, Pin 1,2 or 6	PWM	Pin #2
	Mk3 OUTPUT Connector, Pin GND	GND	Pin #3

Factory Set Focus Distance

The PLH3D-6W Series laser head ships with the High-Resolution Triplet lens installed and adjusted to focus at 60.0 mm (measured from the front-face surface of the laser head to engraving plane). This focal distance has well-optimized focal spot size to output light power ratio which is suitable for many engraving and cutting applications. We recommend keeping the focal distance of the laser set to the default of 60.0 mm as a starting point.



the Beam Cone Shape of the PLH3D-6W-XF Laser Head



the Beam Cone Shape of the PLH3D-6W-µSpot Laser Head

Mount the laser head on the CNC machine with front side (side on which lens is installed) pointing towards engraving material. Note: Make sure that the laser head is in stable position and does not move under influence of external forces. Engraving material should be at stable position as well, it should not move during engraving. Using your CNC machine, set laser head position at 60 mm measuring from the front side of the laser head to engraving material. Hint: Use a caliper or 60mm long piece of material to measure precisely the distance. After setting the position zero the Z-axis on the CNC machine and use the laser in XY plane without changing the Z value.

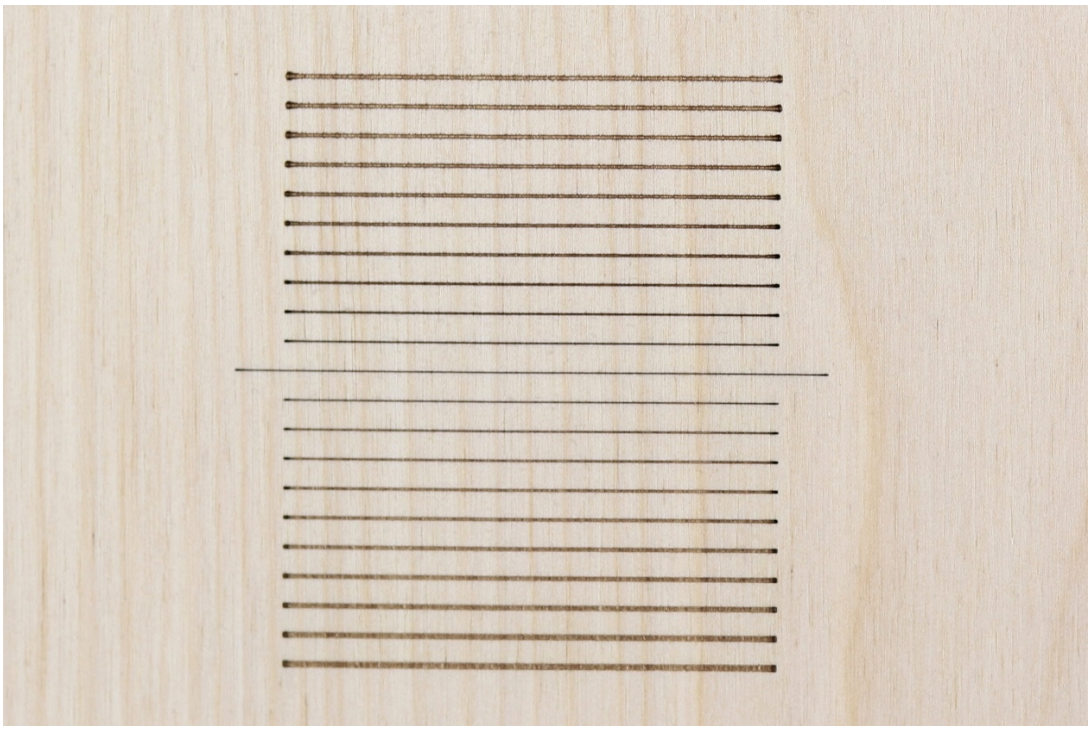
Setting the Working Distance

Some engraving applications may require small focus spot, i.e. high-resolution engraving, detailed engraving. PLH3D-6W Series laser head has adjustable focal length and exchangeable lens. This future allows it to fulfill broad range of engraving applications. Shorter focal length of the laser head produces a smaller beam spot (higher power density).
You can adjust focus spot distance from the front of the laser head by rotating the lens clockwise or counterclockwise. Note: it is necessary to ensure that the mounted lens is sufficiently deep inside the laser head, so the lens does not move before powering on the unit.

Once you changed the position of the lens use your CNC machine to find where is the focus spot. Using the methods described above calibrate the laser head position.

- **Coarse adjustment:**

a. Set current position as a zero position in your CNC software.
b. Engrave “zero position” line on the engraving material. Hint: make this line longer compares to the next engraved line, it’s going to be easier to find “zero line”.
c. Engrave (on the engraving material) 10 lines with step 1 mm in the positive direction of Z-axis and 3 mm step in X-axis.
d. Go back to zero position.
e. Engrave (on the engraving material) 10 lines with step 1 mm in the negative direction of Z-axis. and 3 mm step in X-axis.
f. Inspect engraved lines, find the thinnest engraved line.
g. Count how many lines away is the thinnest line from “zero line”, and in which direction it is placed. Let’s consider case when the thinnest line is located 5 lines from zero line and in positive direction of X-axis. In such a case calibration parameter is +5mm.
h. In the CNC software, move “zero position” of the laser head by calibration parameter.

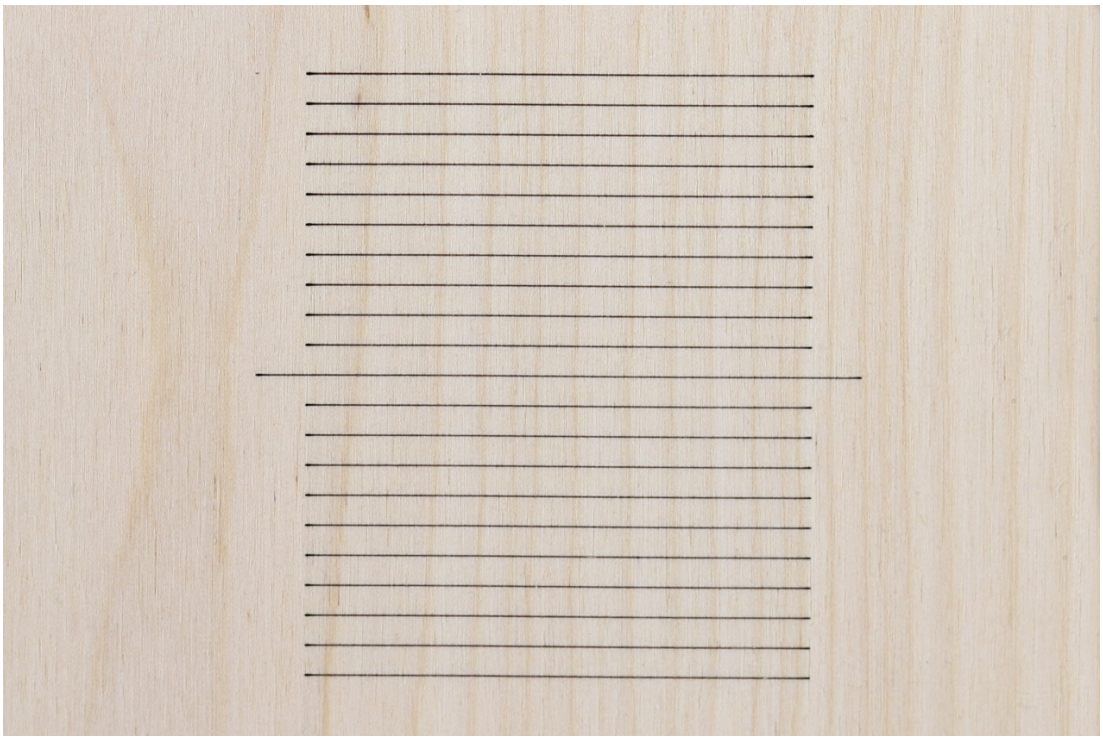


- **Fine adjustment:**

To obtain the highest power density, which results in the better engraving performance, we recommend making fine adjustments to the distance of the laser head and the engraving material. This adjustment should be done after performing coarse adjustment.

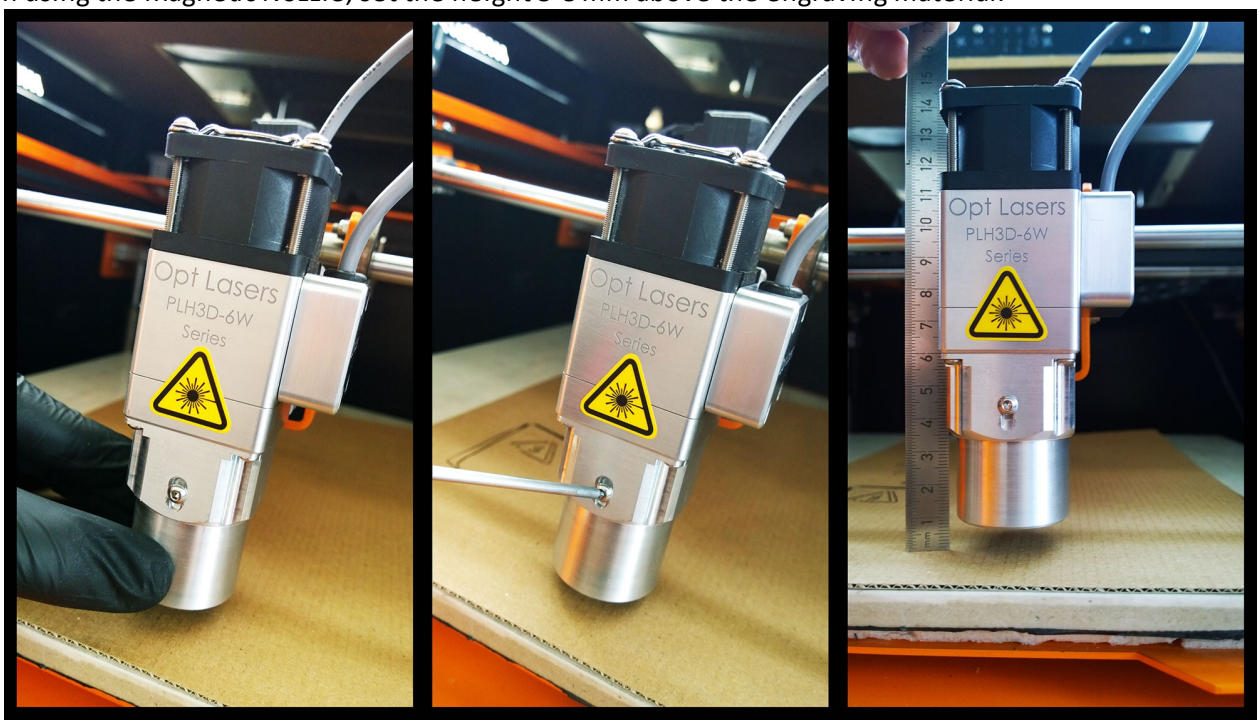
The process is similar to the coarse adjustment process expect steps in Z-axis, they are smaller to make adjustment precise.

a. Set laser head at a zero position, which must be calibrated by know.
b. Engrave “zero position” line on the engraving material. Hint: make this line longer compares to the next engraved line, it’s going to be easier to find “zero line”.
c. Engrave (on the engraving material) 10 lines with step 0.1mm in the positive direction of Z-axis and 3 mm step in X-axis. We recommend engraving lines with 50mm length, it is easier for eye to compare thickness of a line on longer range.
d. Go back to “zero position”.
e. Engrave (on the engraving material) 10 lines with step 0.1 mm in the negative direction of Z-axis. and 3 mm step in X-axis.
f. Inspect engraved lines, find the thinnest engraved line.
g. Count how many lines away is the thinnest line from “zero line”, and in which direction it is placed. Let’s consider case when the thinnest line is located 2 lines from zero line and in negative direction of X-axis. In such a case calibration parameter is -0.2 mm.
h. In the CNC software, move “zero position” of the laser head by calibration parameter.



Nozzle height adjustment

1. When using the Magnetic Nozzle, set the height 5-8 mm above the engraving material.



Choice of Lens

High-Resolution Three-Element and High-Efficiency Aspheric Lens are included with each of our PLH3D-6W Series laser engravers.

1. *Factory aligned High-Resolution Mounted Tripled Lens*

The High-Resolution Mounted Triplet Lens has a relatively long effective focal length (EFL) of 8 mm, which allows it to focus laser light to a small spot. All 6 lens surfaces are coated with anti-reflection (AR) coating centered at 450 nm.

It is usually preferred for engraving a thinner line, cutting a thicker material due to the reduced convergence and divergence, or when a longer distance between the laser head and the plane of the object to be engraved is necessary.

2. *High-Efficiency Mounted Aspheric Lens*

The High-Efficiency Mounted Aspheric lens is designed to obtain as much as possible power from the laser diode. Its short effective focal length (EFL) of 4 mm make a variety of working distances possible but makes the focus spot almost twice bigger compared to Triplet Lens. This lens should be used for engraving thick lines on wood or plastic where the low-quality engraving is acceptable.

High-Resolution Mounted Triplet Lens (Left)
and High-Efficiency Mounted Aspheric Lens (Right)

Maintenance

1. ***Lens***

We recommend inspecting cleanest of the lens surface before starting engraving. It is easy to clean the front surface of the lens if it becomes dirty when engraving, which may be done with Isopropyl Alcohol (IPA) and an optical wipe. However, in some cases, it can be necessary to replace the lens. It is recommended to purchase an extra lens with PLH3D-Series laser heads if they will be used in an environment where dust, smoke or oil are generated.

2. ***Fan and Laser Head Body***

Regular maintenance of the laser head cleanest positively affects its lifetime, in some cases it may prevent from damaging the lens. Ventilation openings and fan must be kept clean and free of foreign matter. Remember to close the lens while cleaning laser head, for this we recommend using Kapton tape. We recommend using compressed air for cleaning ventilations channels or cotton swab (cotton buds) with Isopropyl Alcohol.