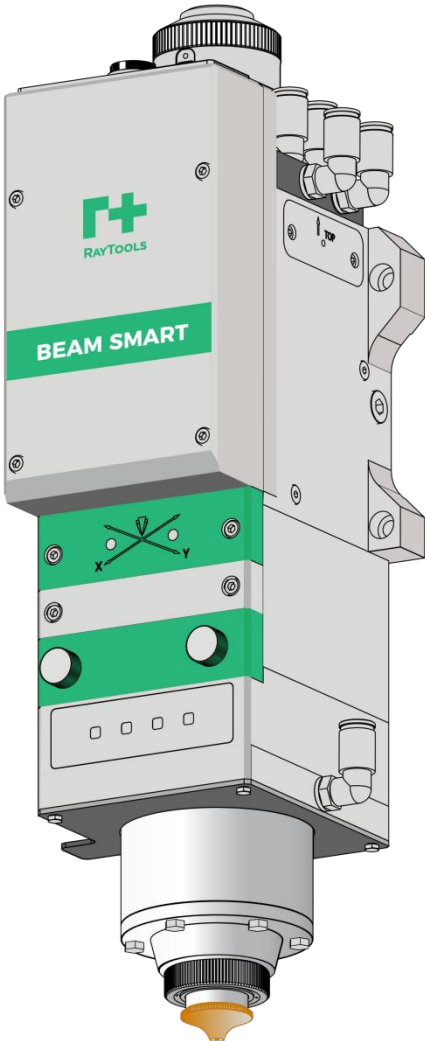


RAYTOOLS

BS06K SERIES

6kW All-In-One Smart Laser Cutting Head - User Manual



Document History

Edit date	Version	Topic, revision, action taken
2022/4/7	V1.0	First edition

Thank you for purchasing this product from *Raytools*!

This manual describes the installation and commissioning of the laser cutting head in detail so that you can use this product quickly. You can consult us directly for more details.

Due to the continuous updating of product functions, the product you receive may differ from the introduction in this manual in some aspects.

We reserve all rights in this document including the issued patents and other registered commercial ownership related to this document. It is strictly prohibited to use this document improperly especially to copy and disseminate it to third parties.

If there are any errors in the document, please inform us as soon as possible. The data contained in this manual is only used to describe the product and shall not be regarded as a statement of security interest.

For the benefit of our customers, we will constantly try to ensure that the products we develop comply with the latest technology.

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Disclaimer

- We reserve the right to change the design to improve the quality or expand the application or comply with manufacturing techniques.
- We will not bear any responsibility for losses and accidents caused by wrong operation or improper handling of our products.
- Dismantling of the product will lose all warranty claims excluding the normal replacement of worn parts and components required for maintenance or commissioning operations.
- Unauthorized modification of products or use of non-original spare parts will directly lead to the invalidation of warranty and liability exemption.
- It is recommended to only use the spare parts provided by us or submit them to our designated professional team for installation.

Use Regulations

- Ensure that the product is used in a dry environment.
- Ensure that the product is used in the environment required by EMC standards.
- The product is only allowed to run within the parameters specified in the technical data.

Personnel Responsibilities

- Be familiar with the basic provisions of work safety and accident prevention, having received equipment operation guidance.
- Read and understand basic safety instructions and operations.
- Must have studied the relevant regulations and safety instructions and understand the possible hazards.
- Comply with relevant regulations and implement corresponding protective measures.

Safety Instructions

Prevent Electric Shock



- Parts of the laser head such as the nozzle, sensor, sensor interface, and attached fasteners may not be fully protected by the ground wire due to function fault. These parts may have low voltage. When installing electrical equipment, please pay attention to taking anti electric shock measures for relevant personnel.



- Note that the equipment shall be grounded as specified.

Guard against Danger

- Never put your hands or other body parts under the laser head.
- Repair and maintenance can only be carried out after power off.
- Do not exceed the specified maximum pressure.
- Must ensure the laser head is in normal condition at all times.
- All fasteners such as bolts and nuts must be tightened.



Laser Caution

- Avoid direct laser radiation or scattering to the skin.
- Do not stare at the laser beam even when wearing optical equipment.
- Use special laser goggles that meet the requirements of related safety standards IEC 60825-1.

Prevent Water Circuit Corrosion

- To avoid corrosion, use the specified coolant and comply with relevant requirements and specified maintenance intervals.

Noise Prevention

- The corresponding measures shall be specified or explained and observed to prevent personnel from being harmed by noise.

Storage and Transportation

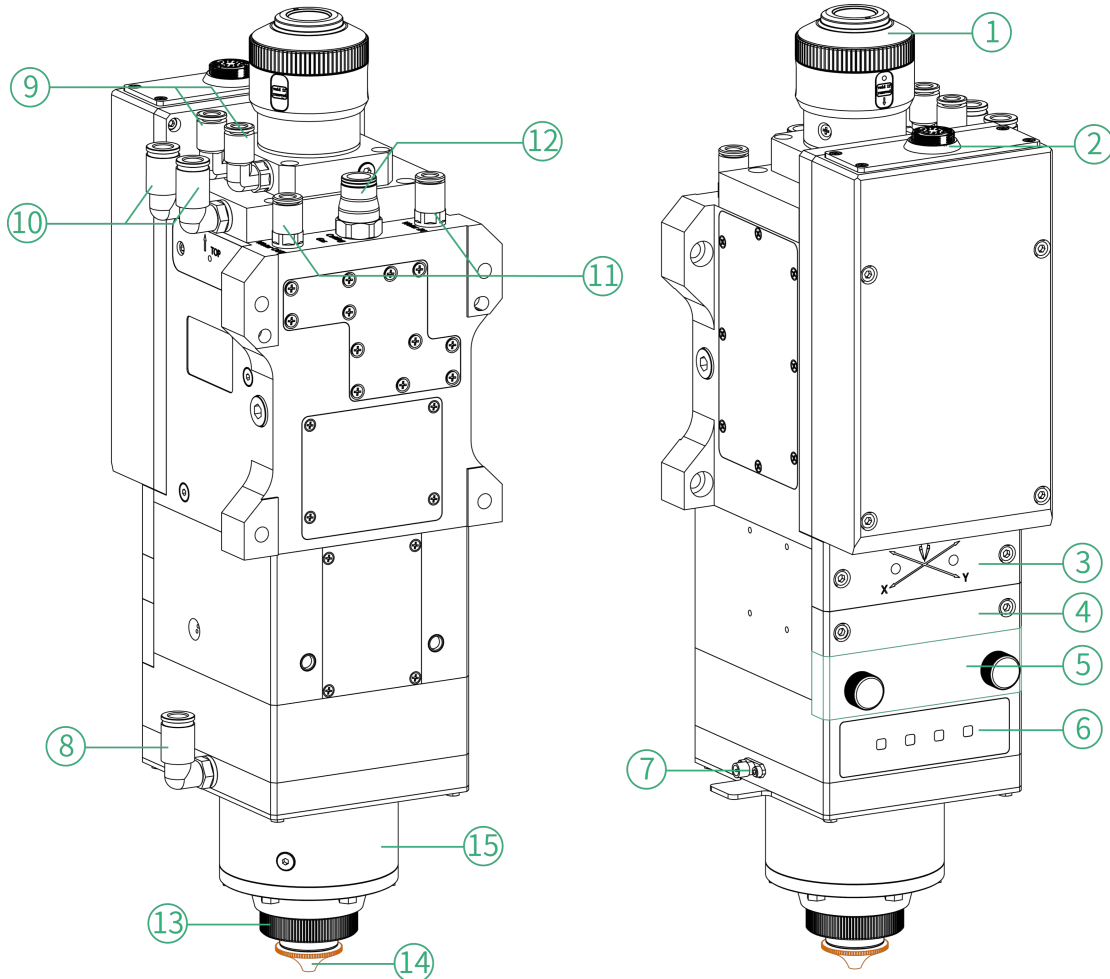
- Observe the storage temperature range allowed by the technical data.
- Take reasonable measures to prevent fire, vibration, or impact.
- Do not store in or near the magnetic field.

Contents

1 Product Summary	1
1.1 Structure (with QBH Interface)	1
1.2 Functions	2
1.3 Technical Data	4
1.4 Mechanical Size (CL100mm/FL200mm)	5
1.5 Physical Interface	6
2 Mechanical Installation	7
2.1 Fiber Insertion	7
2.2 Mounting of Laser Cutting Head	9
2.3 Earthing of Laser Cutting Head	10
2.4 Inspection of Top Cover Glass (1 st Installation/Replacement of Fiber)	11
2.5 Connection of Cooling Water and Assist Gas	12
3 System Installation and Commissioning	15
3.1 Auto Focus by 0-10V Analog	15
3.2 Auto Focus by EtherCAT	17
3.3 Mobile APP Configuration and Connection	18
4 Beam Alignment and Zero Focus Correction	19
4.1 Beam Alignment	19
4.2 Set Focus Correction Position	20
5 Maintenance	21
5.1 Cleaning Lens	21
5.2 Removal and Installation of Lenses	22
5.3 Replace Ceramic Body and Nozzle	24

1 Product Summary

1.1 Structure (with QBH Interface)



1 Fiber Interface

2 Control Interface

3 Focus Module (XY Alignment)

4 Middle Cover Glass Assy

5 Bottom Cover Glass Assy

6 LED

7 Pre-amplifier Interface

8 Nozzle Cooling Gas Interface ($\Phi 8$)

9 Water Cooling Interface ($\Phi 6$)

10 & 11 Water Cooling Interface ($\Phi 6$)

12 Cutting Gas Interface ($\Phi 10$)

13 Retainer Ring

14 Ceramic Body & Nozzle

15 TRA (Nozzle Assy)

1.2 Functions

1.2.1 Height Follow

The laser head equips with a capacitive sensor, which ensures that the distance between the nozzle and the workpiece remains constant during cutting (as long as the workpiece surface is not heavily bulged).

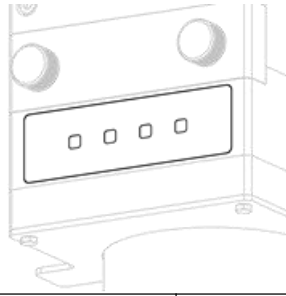
1.2.2 Protection and Monitoring

- Laser head gravity detection
- Cutting gas pressure detection
- Bottom cover glass ready detection
- Temperature detection of bottom cover glass
- Temperature detection of top cover glass
- Cavity gas pressure detection
- Cavity temperature detection

1.2.3 Smart Monitoring

- Compatible with PC
- Compatible with Android

1.2.4 LED Indicator



LED Status Definition (from left to right):

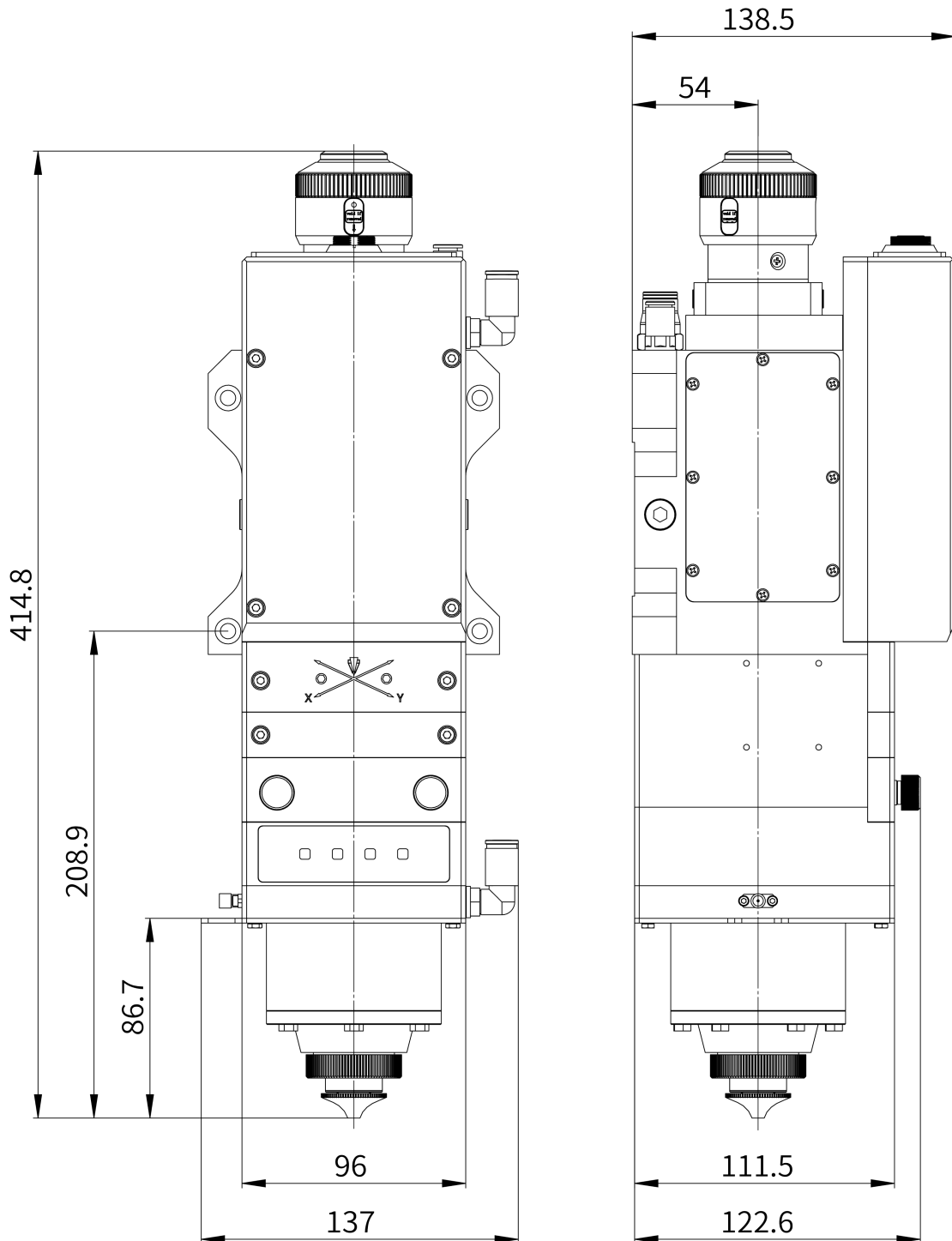
LED No.	LED Status	Status Definition
LED 1	Green on	Running normally
	Green blinks	Focus motor homing
	Red on	Communication error (connection issue of master card and WIFI card)
	Red blinks	Motor fault
	Red/Green blink once alternately	Limit sensor error of screw rod
	Red/Green blink twice alternately	Focus homing failed
	Red twice/Green once blink alternately	WIFI card fault
LED 2	Green on	Running normally
	Red on	Overheating of top cover glass
	Red blinks	Overheating of focus lens
	Red/Green blink once alternately	Temperature sensor fault of top cover glass
	Red twice/Green once blink alternately	Temperature sensor fault of focus lens
LED 3	Green on	Running normally
	Red on	Overheating of bottom cover glass
	Red blinks	Bottom cover glass not ready for operation
	Red/Green blink once alternately	Temperature sensor fault of bottom cover glass
	Red twice/Green once blink alternately	Gas pressure sensor fault
LED 4	Green on	Running normally
	Red on	Overheating of cavity
	Red blinks	Detected cavity pressure indicates gas leakage from focus lens holder
	Red/Green blink alternately	Temperature sensor fault of cavity
	Red twice/Green once blink alternately	Pressure sensor fault of cavity

1.3 Technical Data

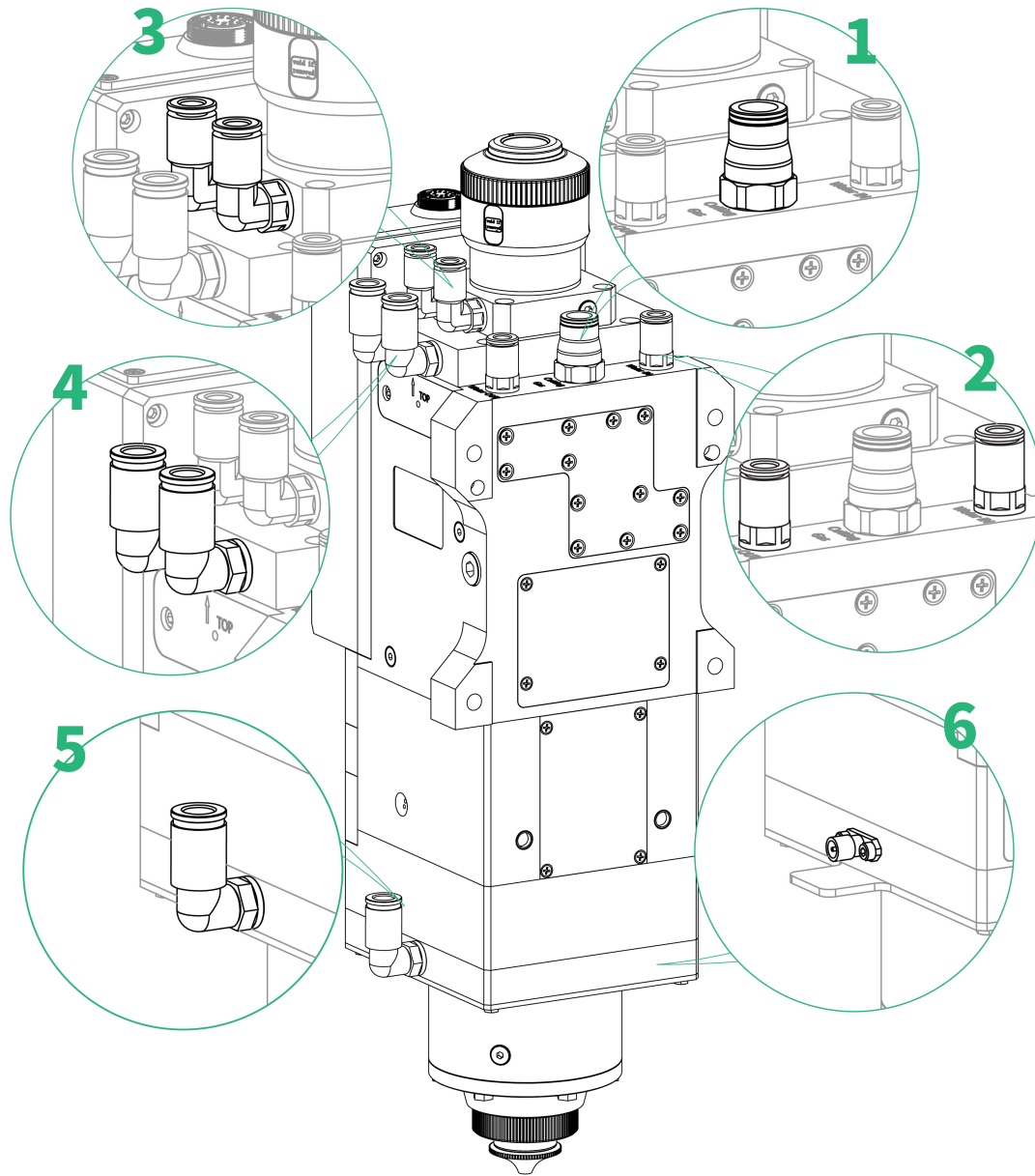
Model	BS06K
Wavelength	1080nm
Fiber Interface	QBH/G5
Power Rating	6kW
Optical Configuration	
- Collimation Length (fC)	100mm
- Focusing Length (fF)	200mm
NA	0.13
Auto Focus Range (Vertical)	-52...+32mm
Beam Alignment Range	-1.5mm...+1.5mm
Installation - Screw QTY and Size	
Mounting Plate	4xM6.6
Preamplifier	4xM3
Cutting Gas	Φ10, max. 25bar
Nozzle Cooling Gas	Φ8, max. 5bar
Water Cooling	Φ6, max. 5bar, min. 1.5L/min
Operating Voltage	24V±10%, max. 4A
I/O Interface (19-Pin)	Output current must be less than 30mA
Operating Temperature	5°C ~ 55°C
Humidity	30% ~ 95%, without condensing
Weight	6.5kg ~ 7.0kg

1.4 Mechanical Size (CL100mm/FL200mm)

Optical Configuration:100:200



1.5 Physical Interface



No. 1	Cutting gas ($\Phi 10$)	No. 4	Cooling water ($\Phi 6$)
No. 2	Cooling water ($\Phi 6$)	No. 5	Nozzle cooling gas ($\Phi 8$)
No. 3	Cooling water ($\Phi 6$)	No. 6	Preamplifier (SMA)

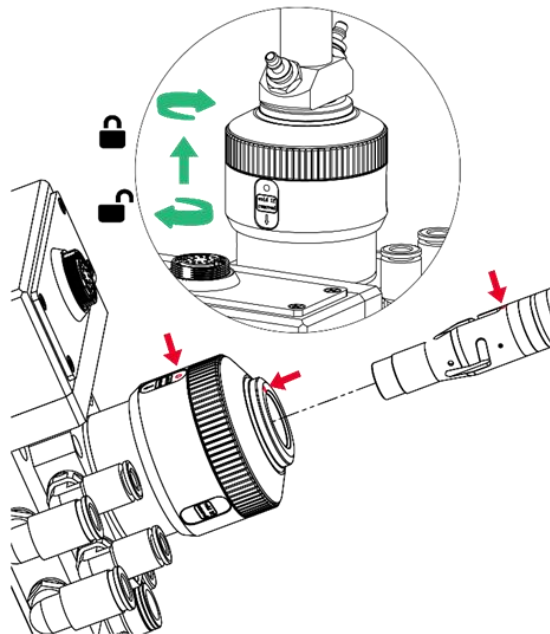
2 Mechanical Installation

2.1 Fiber Insertion



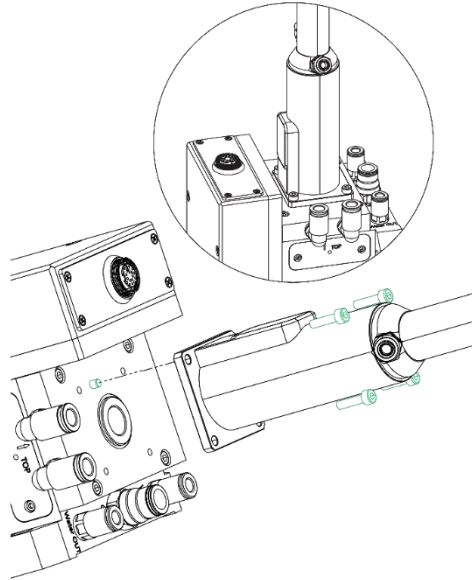
WARNING: The optical components must be dust free and all dusts must be cleaned before use. The fiber shall be horizontally inserted into fiber interface to prevent dust from entering the interface and falling on the lens. Clean the upside of the fiber before inserting into the laser head.

2.1.1 QBH Fiber Insertion



- Align the red point at the end of the QBH interface to the red point of the handwheel.
- Remove QBH dustproof cover.
- Align the red mark of fiber end to red mark on QBH of cutting head. Then insert the fiber straightly to the bottom of the QBH interface.
- Turn the QBH handwheel clockwise. It is in place when you hear the "Da" voice, then pull the handwheel up and turn clockwise to end.

2.1.2 G5 Fiber Insertion



- Remove the dust cover of G5 adaptor.
- Align the locating pin holes of the fiber end and the laser head.
- Lock the fiber end and the laser head with locking screws tightened to the corresponding screw holes.
- Shake the fiber gently after locked, to confirm it is tightened prior to use.

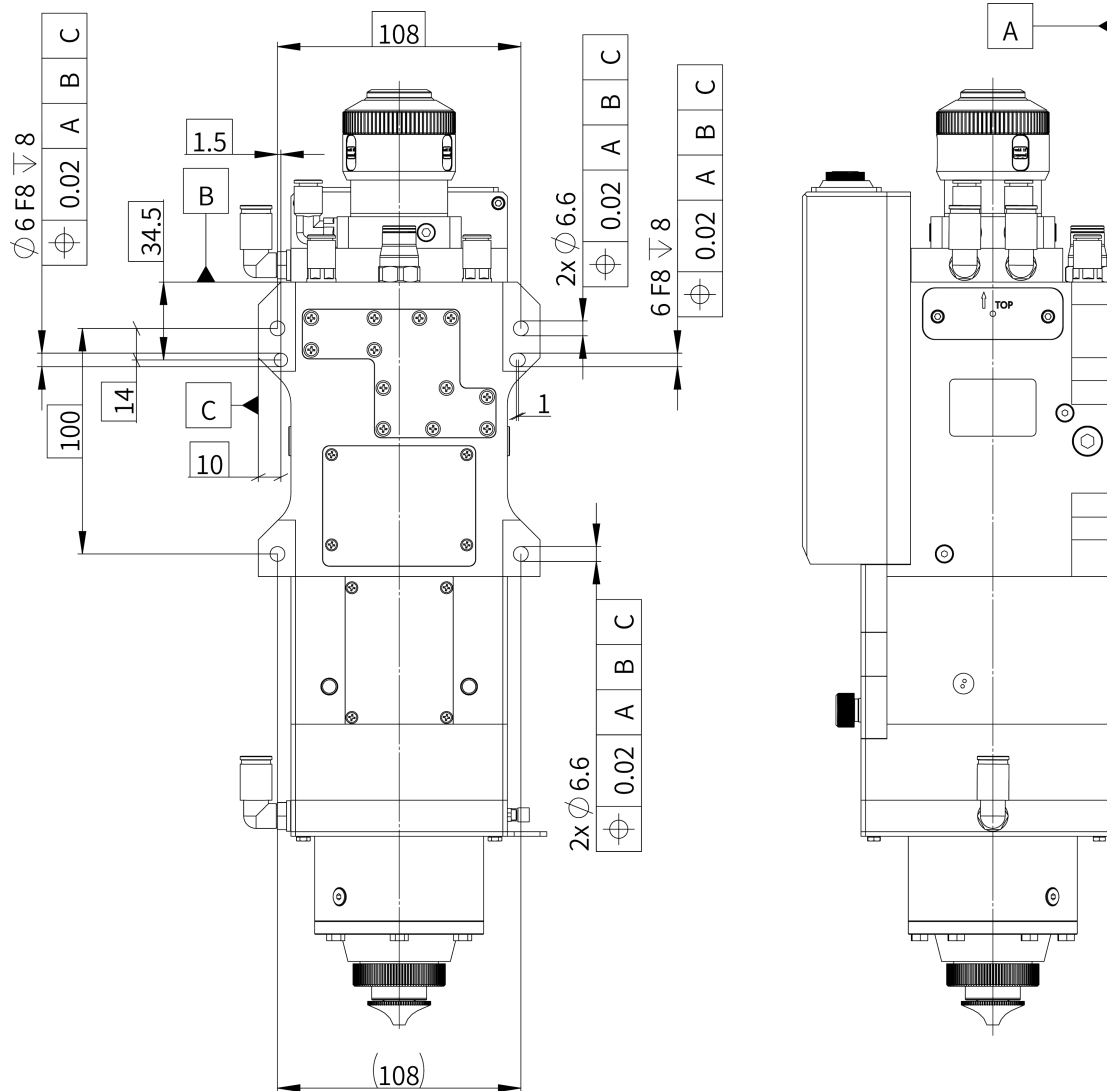


It is recommended to use textured tape to seal the connection of female and male fiber interface after the installation is finished in order to prevent from dust as much as possible in critical dusty environment.

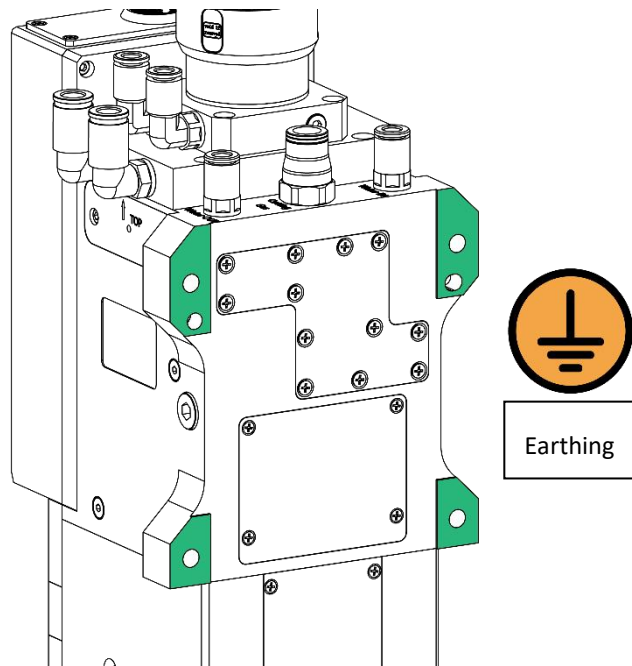
2.2 Mounting of Laser Cutting Head

The mounting of laser cutting head to machine tool is shown as below.

It is advised to install the laser head perpendicular to the machine surface as requested and make sure the laser head is locked, which is one of the premises to ensure the stable cutting effect.



2.3 Earthing of Laser Cutting Head

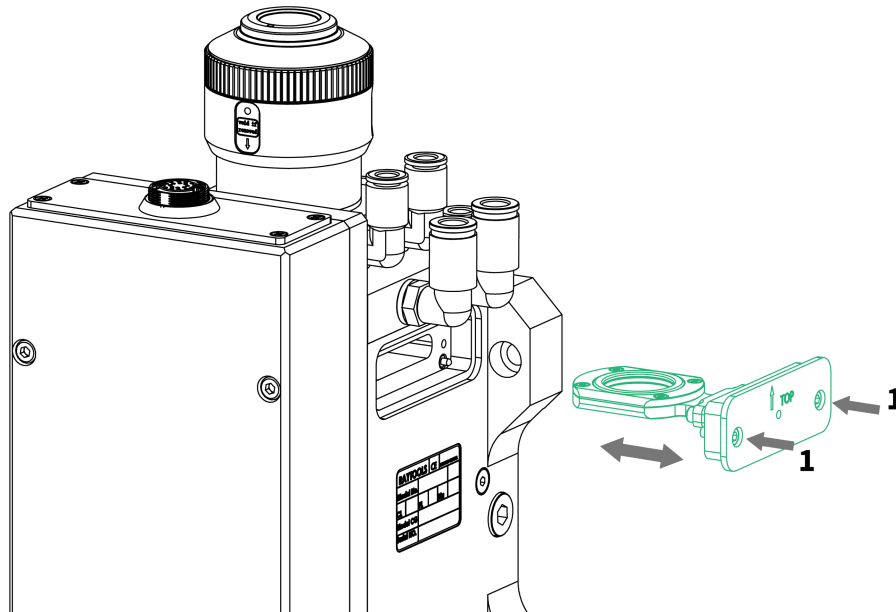


The shaking or vibration of cutting head due to incorrect earthing could cause damage to sensor mechanism and machine.

2.4 Inspection of Top Cover Glass (1st Installation/Replacement of Fiber)



Maintenance or repair shall be implemented at dust free workstation.



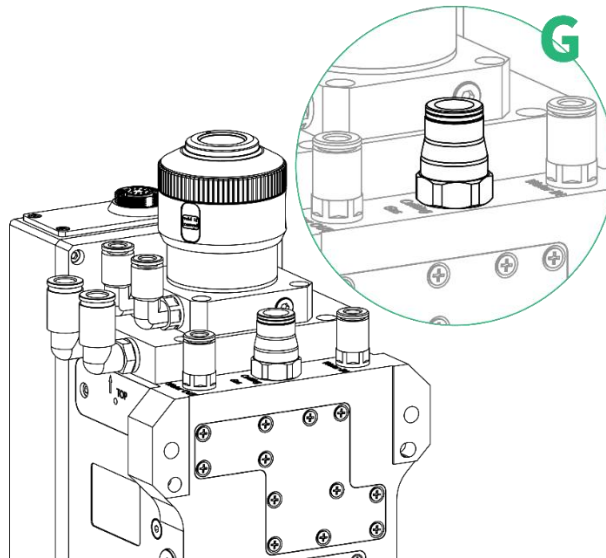
- Loose bolts (item 1) and pull out the glass holder until you see the complete cover glass.
- Seal the openings of cutting head by textured tape immediately.
- Check if the top cover glass is clean. If not, blow the cover glass by clean compressed air until it is clean.



The cover glass shall be replaced if it cannot be cleaned or a damage happens.

2.5 Connection of Cooling Water and Assist Gas

2.5.1 Connection of Cutting Gas



The impurity in cutting gas such as hydrocarbon and steam will damage the lens and cause cutting power fluctuation as well as inconsistencies between the sections of the work piece. The table below is the recommended cutting gas specification. The higher the purity of the gas, the better the quality of the cutting section.

Impurity can be filtered out in gas supply tube, but Oxygen and water vapor can permeate light path through nonmetal materials, which is the source of the appearance of dust and hydrocarbon. Stainless steel fittings are recommended, at the same time must use filters which can remove a minimum of 0.01 micron particle to purify.

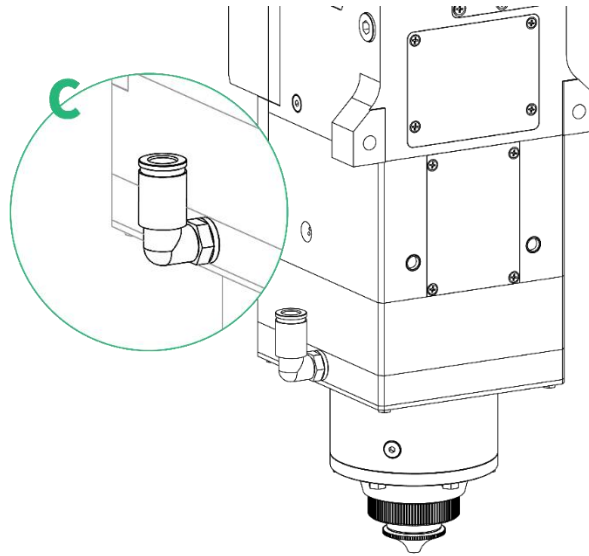
A pressure gauge with a stainless steel diaphragm is recommended. Industrial pressure gauges suck in air. Rubber diaphragm produce hydrocarbon by aging or other factors.

Gas	Purity	Maximum content of water vapor	Maximum content of hydrocarbon
Oxygen	>99.95%	<5 ppm	<1 ppm
Nitrogen	>99.99%	<5 ppm	<1 ppm
Diameter of cutting gas pipe (Outer diameter)	10mm (G)		
Gas Pressure	Max. 25bar (2.5MPa)		



CAUTION: Gas interface cannot be replaced arbitrarily especially do not use PTFE TAPE. Otherwise the gas path will be blocked and cannot do normal cutting which will damage cutting head at the same time.

2.5.2 Connection of Nozzle Cooling Gas



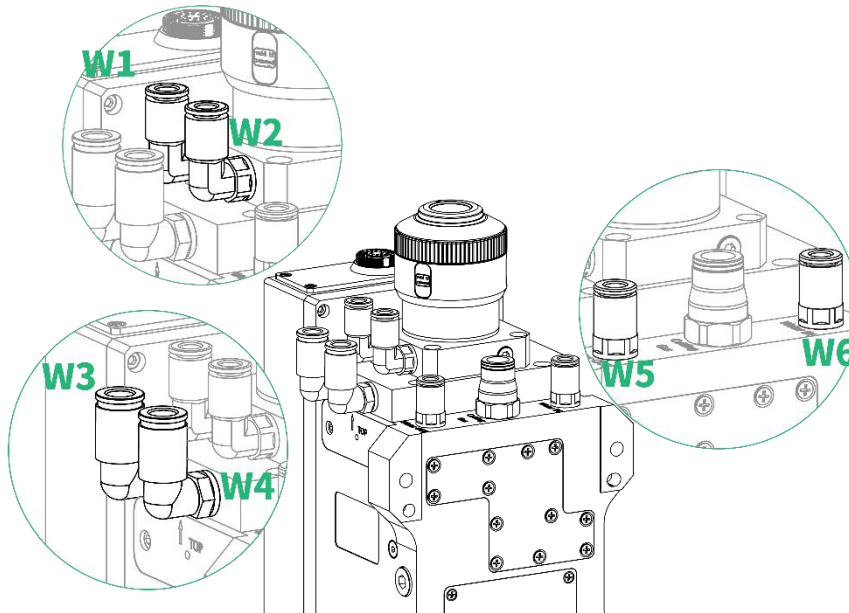
Dried N2 or fine filtered air is recommended for nozzle cooling. The O2 is prohibited for nozzle cooling.

Gas type	N2 or Air (dried and fine filtered)
Gas pressure	Max. 5bar (0.5MPa)
Gas interface	Ø8



CAUTION: Gas interface cannot be replaced arbitrarily especially do not use PTFE TAPE. Otherwise the gas path will be blocked and cannot do normal cutting which will damage cutting head at the same time.

2.5.3 Connection of Cooling Water



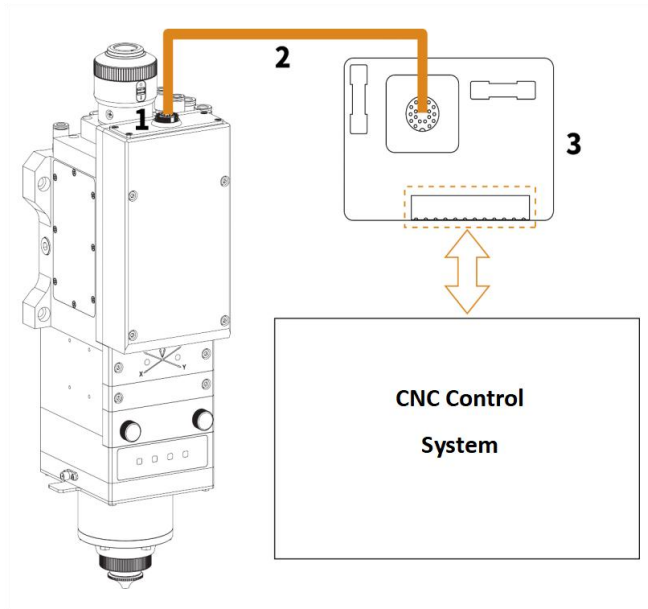
It is important to note that when the laser power is greater than 500W. It is recommended to use water cooling. The recommended water flow is suggested as below.

- Connect the cooling water to the $\Phi 6$ interface.
- Cooling pipeline of **fiber interface**: W1, W2, **collimation module**: W3, W4, **machine**: W5, W6

Outer diameter of water hose	6 mm
Minimum flow speed	1.5 l/min
Entry pressure	170-520 kPa (30-60 psi)
Entry temperature	\geq room temperature />dew point
Hardness (relative to CaCO ₃)	<250 mg/l
PH range	6 to 8
Particle size allowed	Diameter <200 microns

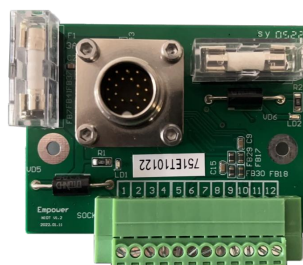
3 System Installation and Commissioning

3.1 Auto Focus by 0-10V Analog



- Connect ①the interface of laser head with ③I/O-CAN board by ②the control cable
- Connect all necessary I/O interface of laser head with CNC
- Connect 24V power supply to the I/O-CAN board
- Complete configuration and commissioning according to the system instruction

Note: FSCUT motion control system usually gets a 0.3V cutoff voltage and the corresponding voltage range comes to be 0.3V-9.7V.

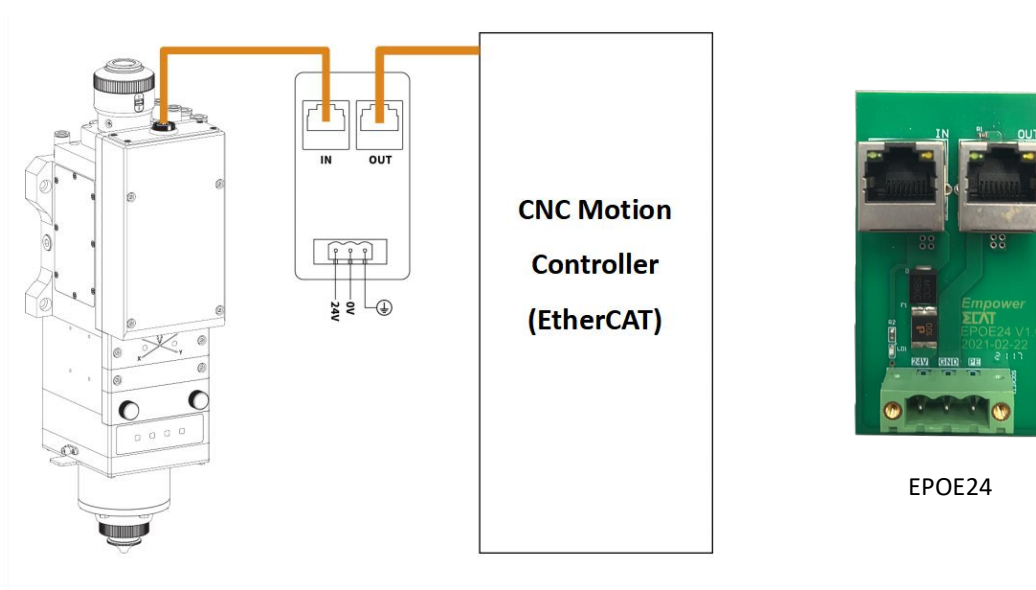


I/O-CAN Board

I/O-CAN Definition

Pin No.	Item	Definition
1	Power supply 24V	24V to power supply
2	Power supply 0V	0V to power supply
3	I/O 24V	24V to I/O
4	I/O 0V	0V to I/O
5	-	Preserved
6	-	Preserved
7	Input-Home	24V (Uperedge): Home enable Else: Home disable
8	Input-Focus	24V (Uperedge): Focus enable Else: Focus disable
9	Output-Alarm	Floating: Alarm 24V: no alarm
10	Output-Focus reached	24V: Focus reached Floating: Focus unreached
11	Input-Analog +	0.3V-9.7V Auto focus
12	Input-Analog -	

3.2 Auto Focus by EtherCAT



- Connect 24V power supply to the I/O board (EPOE24)
- Connect by network cable as shown above
- Complete configuration and commissioning according to the system instruction

EPOE24 Definition

No.	Definition	Remark
IN	Input-Interface	Signal input
OUT	Output-Interface	Signal output
24V	Power supply 24V	24V to power supply
GND	Power supply 0V	0V to power supply
PE	Earthing	For earthing

3.3 Mobile APP Configuration and Connection

- Start the app and operate connection according to the instruction.
- Set by manual input base on actual needs.

Examples as below:

Item	Remark	Set Value
Zero Focus Offset	To correct according to actual zero focus position	
Alarm Temp-Top Cover Glass	Alarm threshold 45°C	45°C
Alarm Temp-Bottom Cover Glass	Alarm threshold 45°C	45°C
Alarm Temp- Focus Lens	Alarm threshold 45°C	45°C
Alarm Temp- Cavity	Alarm threshold 45°C	45°C
Alarm Pressure-Cavity	Alarm threshold 1.5 bar	

4 Beam Alignment and Zero Focus Correction

4.1 Beam Alignment

Cutting quality in a great extent depends on whether the lens is in the middle. If the lens is not in the middle, the laser beam may contact with nozzle or inner wall to produce high temperature deformation. Lens alignment operation should be considered when nozzle is replaced or the cutting quality declines.

Lens alignment of laser cutting head can be finished by adjusting focus lens, X-Y direction. The X/Y adjusting knob is located above bottom cover glass as shown below. Adjusting the 2 knobs until the beam is located in the middle of nozzle. Make sure the laser beam output from the center of nozzle. A method commonly used is tape dotting method as below:

- Fix the cutting head with a big size nozzle (tip size shall be larger than beam size) or adjust to nearly zero focus.
- Pick a scotch tape, flatten it and stick it to the nozzle tip.
- Open the red light of the laser. Find and observe the position of red light in the scotch tape.
- Shoot laser at low power to check beam penetration size. Beam penetration shall be circle and located in the nozzle tip center.
- Adjust the 2 X/Y adjusting knobs to get beam aligned. The max X/Y adjusting range is roughly from -1.5mm to +1.5mm.
- Tear off the tape and check the shooting hole position in tape.
- Repeat the above steps to find out relatively centered position.

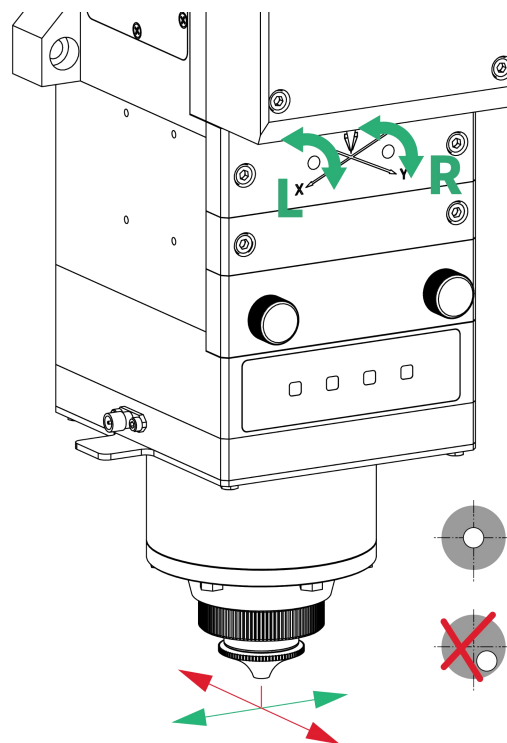
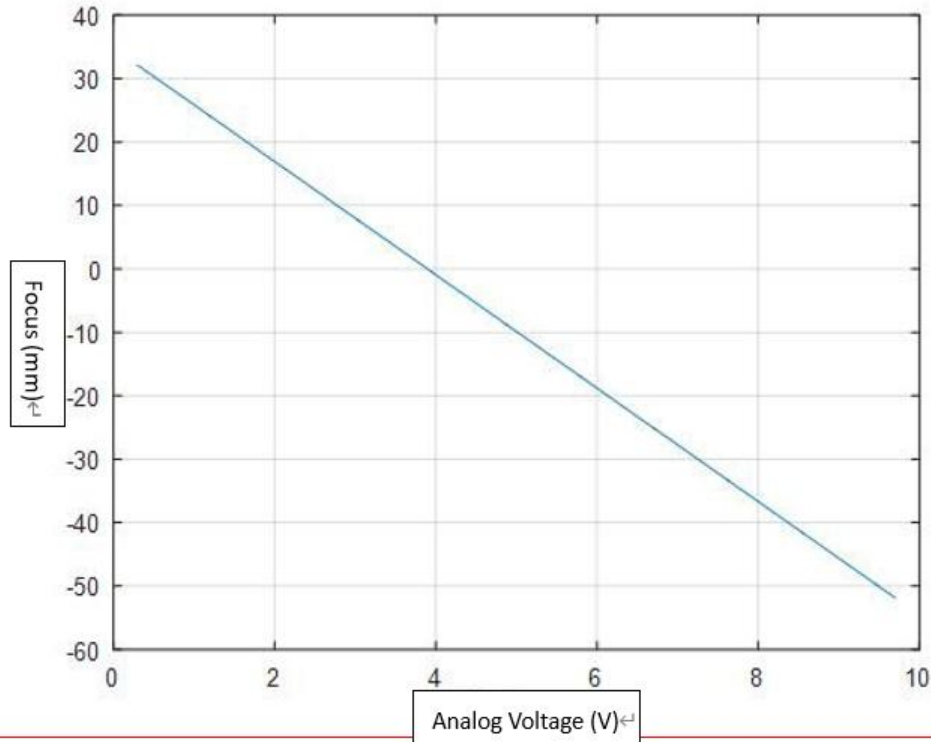


Figure 4.1— Beam Adjustment

4.2 Set Focus Correction Position

Focus & Voltage Curve



Note:

1. CL100mm/FL200mm: 0.3V corresponds to +32mm. 9.7V corresponds to -52mm.
2. CL100mm/FL150mm: 0.3V corresponds to +16mm. 9.7V corresponds to -26mm.
3. Mechanical and optical manufacturing tolerance, matching tolerance between imaging proportion of optical component and optical fiber will have other effects on the actual focus position.
4. Adjust the focus offset according to the actual situation.

5 Maintenance

5.1 Cleaning Lens

It's necessary to maintain lenses regularly because of the characteristic of laser cutting process. Cleaning to the cover glass once a week is recommended. The collimating lenses and focusing lenses are recommended to be cleaned once every 2~3 months. In order to facilitate the maintenance of the cover glass, the cover glass holder adopts a drawer type structure.

Tools: Dust-proof gloves or fingertip, polyester swab, absolute ethanol, rubber gas blow (purely compressed air).

Cleaning instruction:

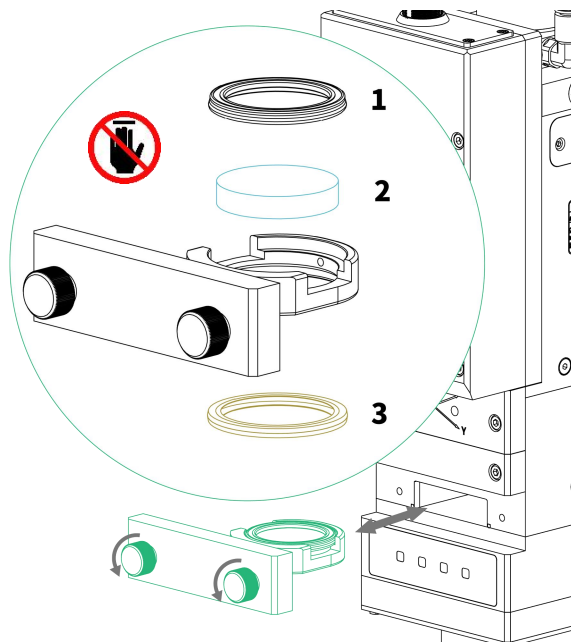
- To put fingertip onto left thumb and index finger.
- Spray absolute ethanol onto the polyester swab.
- Hold the edge of the lens with left thumb and index finger gently. (note: avoid touching the surface of the lens by fingertip in case of trace)
- Hold the lens to face eyes by left hand and hold the polyester swab by right hand. Wipe the lens gently in single direction, from bottom to top or from left to right (Should not wipe back and forth in case of secondary pollution to lens) and use rubber blow (purely compressed air) to blow the surface of the lens. Both surfaces should be cleaned. After cleaning, make sure that there is no residual like detergent, floating ash, foreign matters and impurities.

5.2 Removal and Installation of Lenses

The whole process needs to be completed in a dust free room. Wear dust-proof gloves or fingertips when removing or installing the lenses.

5.2.1 Removal and Installation of Bottom Cover Glass/Protection Glass

The cover glass is wearing part which needs to be replaced once it is damaged.



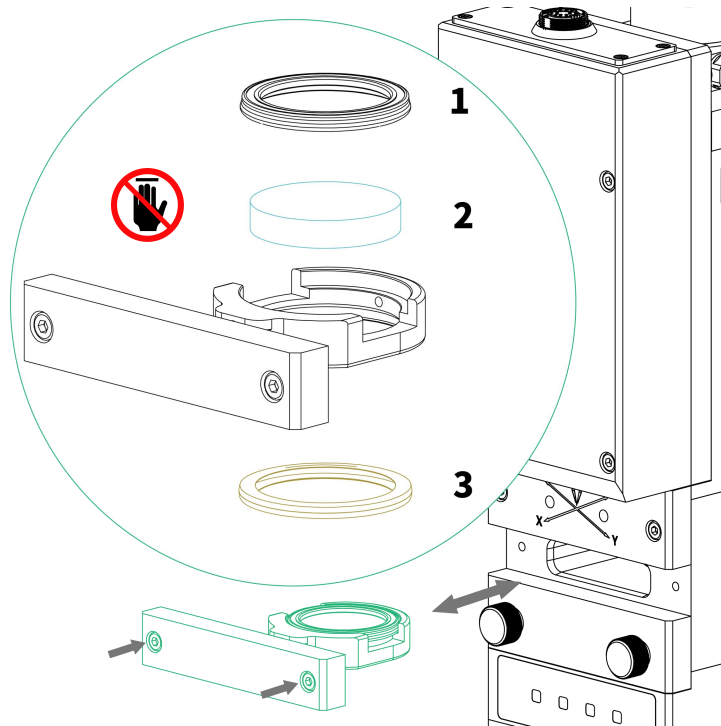
- As shown above, loose the 2 bolts to pull out cover glass holder by pinching 2 edges of drawer type holder.
- Seal the mounting openings by textured tape immediately.
- Remove the pressing ring (1) and cover glass (2) after wearing fingertips
- Clean the cover glass holder and seal ring (3). The elastic seal ring (3) should be replaced if it is damaged.
- Install the cleaned or new cover glass (regardless of the front or back surface) into the holder of cover glass.
- Install the pressing ring.
- Insert the cover glass holder back to the laser head and tighten the bolts.



It is not allowed to pull out the edge of seal ring directly as it is very easy to damage the seal ring.

5.2.2 Removal and Installation of Middle Cover Glass/Protection Glass

The cover glass is wearing part which needs to be replaced once it is damaged.

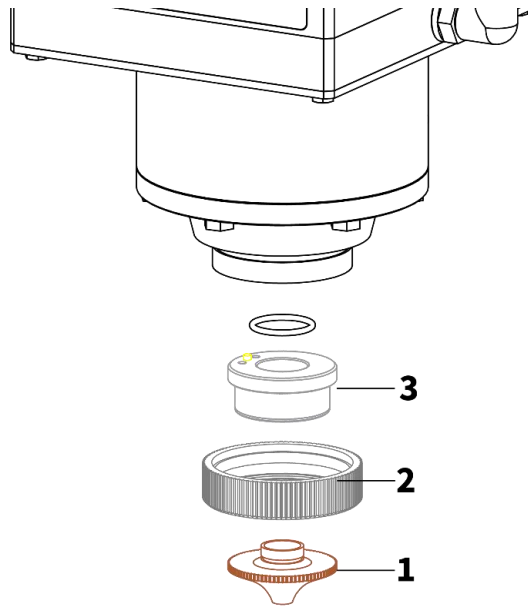


- As shown above, loose the 2 bolts to pull out cover glass holder by pinching 2 edges of drawer type holder.
- Seal the mounting openings by textured tape immediately.
- Remove the pressing ring (1) and cover glass (2) after wearing fingertips
- Clean the cover glass holder and seal ring (3). The elastic seal ring (3) should be replaced if it is damaged.
- Install the cleaned or new cover glass (regardless of the front or back surface) into the holder of cover glass.
- Install the pressing ring.
- Insert the cover glass holder back to the laser head and tighten the bolts.



It is not allowed to pull out the edge of seal ring directly as it is very easy to damage the seal ring.

5.3 Replace Ceramic Body and Nozzle



The nozzle is required to be replaced if it gets crash or damaged by laser beam. The dirt on ceramic body is required to be cleaned or to replace the ceramic body if it gets crash.

- Unscrew the nozzle (1).
- Press the ceramic body (3) upward by hand to make it fixed without deflection and then unscrew the lock nut (2).
- Align the pin hole of the new ceramic body with the locating pin. Press the ceramic body (3) upward by hand and tighten the lock nut (2).
- Screw the new nozzle (1) and get it properly tightened.
- Do the capacitance calibration once again after replacing the nozzle or ceramic body.



Only tighten the nozzle and lock nut by hand (without tools) otherwise it could damage the ceramic body.



Keep the contact surface of all parts clean.