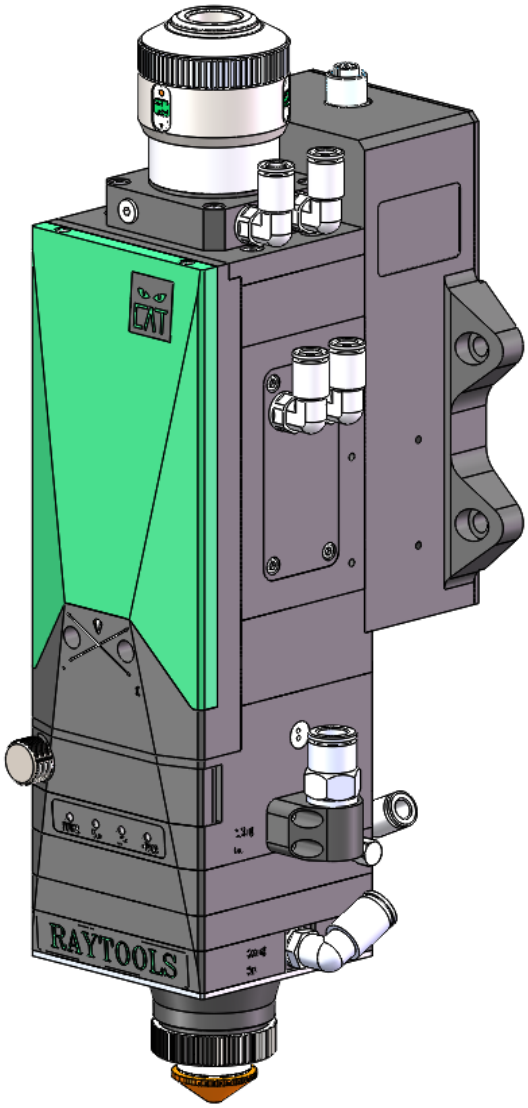
RAYTOOLS

BS04K CAT SERIES

4kW Auto-Focus Smart Laser Cutting Head - User Manual



Document History

Edit date	Version	Topic, revision, action taken
2024/9/6	V1.0	First edition

Thank you for choosing our product!

This manual describes the installation and commissioning of laser cutting head in details 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.

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If you find any errors in this 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.

Raytools AG

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Disclaimer

- We reserve the right to change the design in order to improve the quality or expand the application or comply to manufacturing workmanship.
- We will not bear any responsibility for losses and accidents caused by wrong operation or improper handling of our products.
- Dismantling of 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 us or the 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 & accident prevention and have received equipment operation guidance.
- Read and understand basic safety instructions and operations.
- You must have studied the relevant regulations and safety instructions and understand the possible hazards.
- Comply with relevant regulations and implement corresponding protective measures.

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Safety Instructions

Prevent Electric Shock

- Parts of the laser head such as 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 under the laser head.
- Repair and maintenance work can only be carried out after the power is turned off.
- Do not exceed the specified maximum pressure.
- It must be ensured that 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 protective eyeglasses that meet the requirements of safety standards IEC 60825-1.

Prevent Waterway Corrosion

- In order 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 in order to prevent personnel from being harmed by noise when the cutting air pressure is high.

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.

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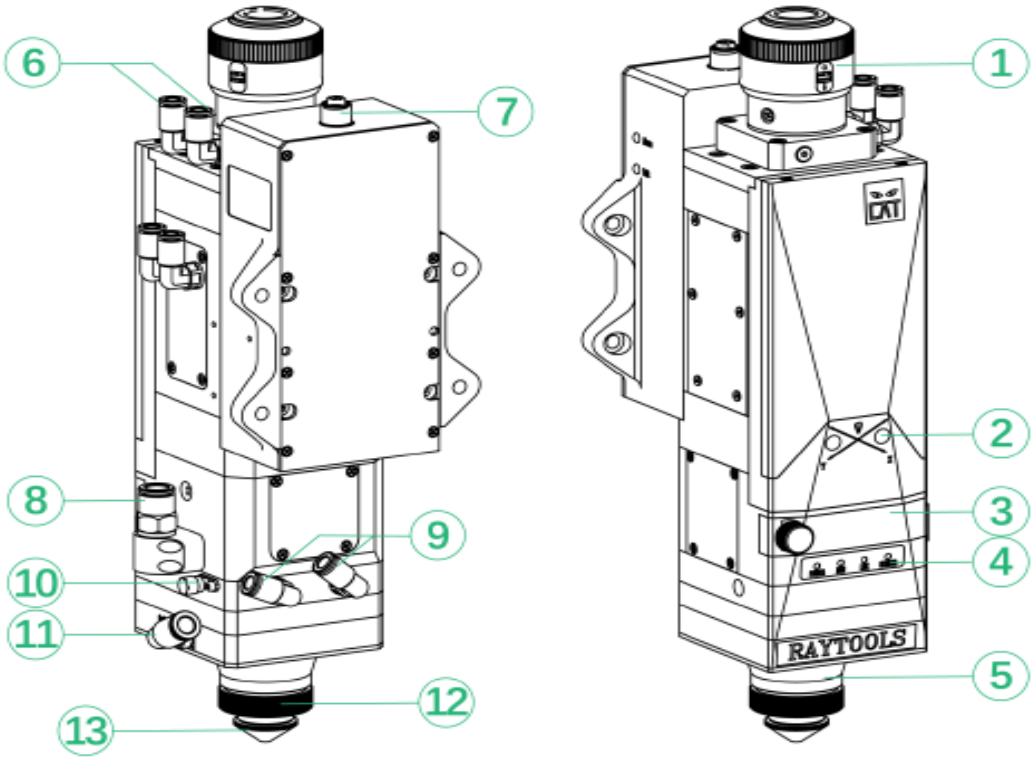
1 Product Summary

1.1 Structure (with QBH Interface)



1 Fiber Interface (QBH)

2 Collimation Module/XY Alignment

3 Bottom 1 Cover Glass Assy

4 LED

5 TRA (Nozzle Assy)

6 Water Cooling Interface (□6)

7 Control Interface

8 Cutting Gas Interface (□10)

9 Water Cooling Interface (□6)

10 Preamplifier Interface

11 Nozzle Cooling Gas Interface (□8)

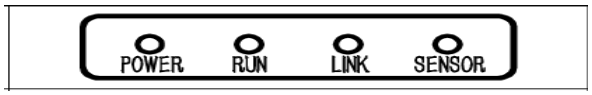
12 Retainer Ring

13 Ceramic Body & Nozzle

1.2 Monitor

- Focus lens temperature
- Top 1/bottom 1 cover glass temperature
- Stray beam of bottom 1 cover glass
- Dew point temperature and humidity
- Signal of bottom 1 cover glass ready status and side collision
- Cutting gas pressure and cavity pressure
- TTA (built-in capacitance amplifier) temperature and capacitance
- Input focus and output focus
- Firmware version and FPGA version

1.3 LED



LED Status Definition (from left to right)

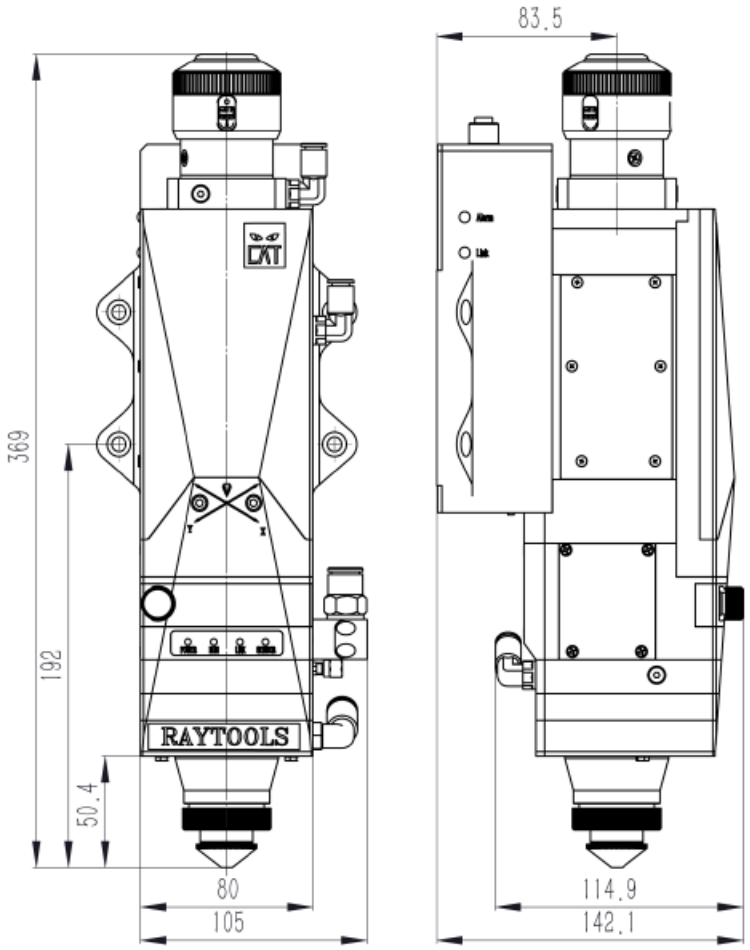
LED No.	LED Status	Status Definition
LED 1 (POWER)	Green on	Power normal
	Red on	Power abnormal
	Light off	Power disconnected
LED 2 (RUN)	Green on	Motor normal
	Green blink	Motor disabled
	Red on	Motor fault
LED 3 (LINK)	Green on	Normal EtherCAT communication
	Green blink	Master PC configuration error
	Red on	Communication error/Firmware upgrading
	Light off	EtherCAT disconnected
LED 4 (SENSEOR)	Green on	Sensors running normally
	Green blink	Sensor precaution
	Red blink	Sensor alarm
	Light off	Sensor offline or error

1.4 Technical Datasheet

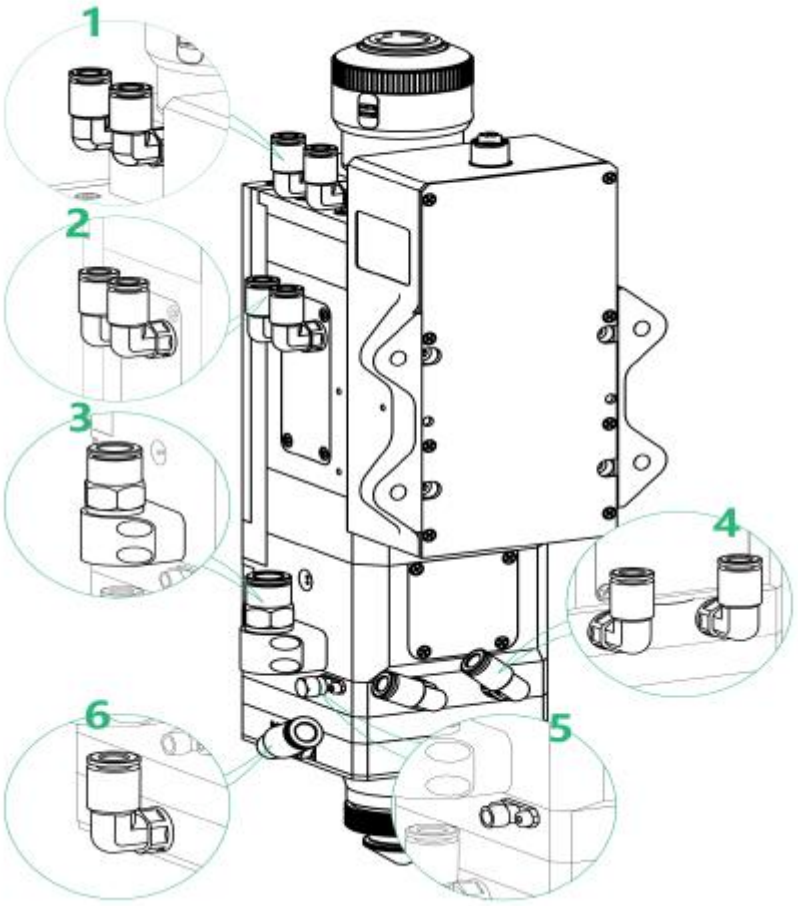
Model	BS04K CAT
Wavelength	1064nm
Fiber Interface	QBH
Power Rating	4kW
Collimation Length (fC)	100mm
Focusing Length (fF)	150mm
NA max	0.13
Auto Focus Range	-17mm…+17mm
Beam Alignment Range	-1.5mm…+1.5mm
Mounting Size of Cutting Head	4xM6
Mounting Size of Preamplifier	4xM3
Cutting Gas	⌀10, max. 25bar
Nozzle Cooling Gas	⌀8, max. 5bar
Water Cooling	⌀6, max. 5bar, min. 1.5L/min
Operating Voltage	24V±10%, min. 3A
I/O Interface (8-Pin)	Output current must be less than 30mA
Operating Temperature	5℃～55℃
Humidity	30％～95％, without condensing
Weight	about 5kg

1.5 Mechanical Size

Optical Configuration: 100:150



1.6 Physical Interface



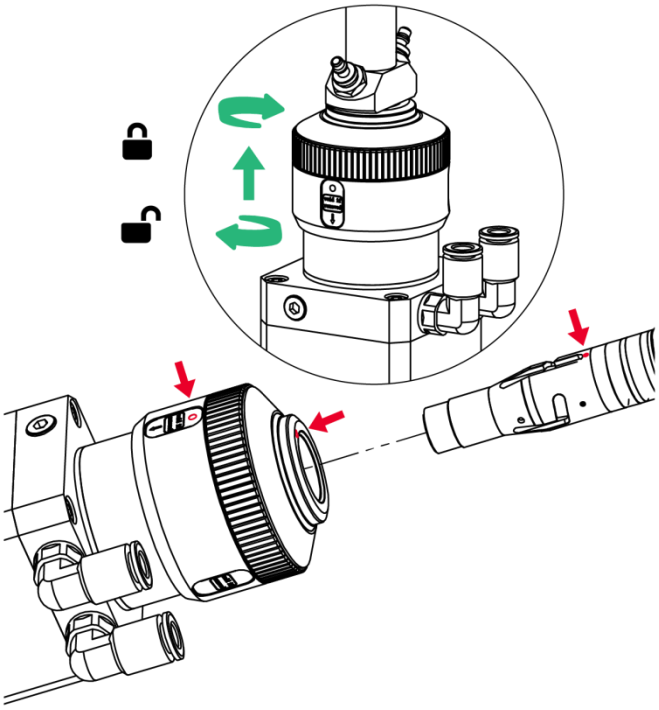
No. 1	Cooling water (⌀6)	No. 4	Cooling water (⌀6)
No. 2	Cooling water (⌀6)	No. 5	Preamplifier (SMA)
No. 3	Cutting gas (⌀10)	No. 6	Nozzle cooling gas (⌀8)

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 surface of the lens. Upper limit in the fiber before fixing the laser head.

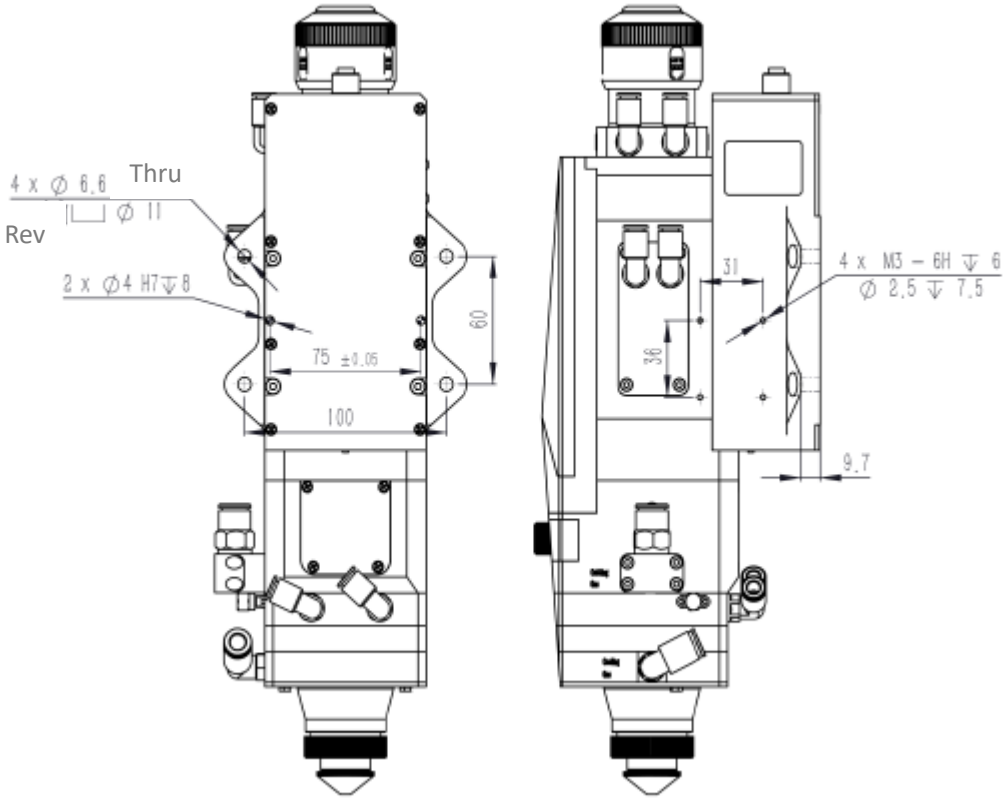
QBH Fiber Insertion



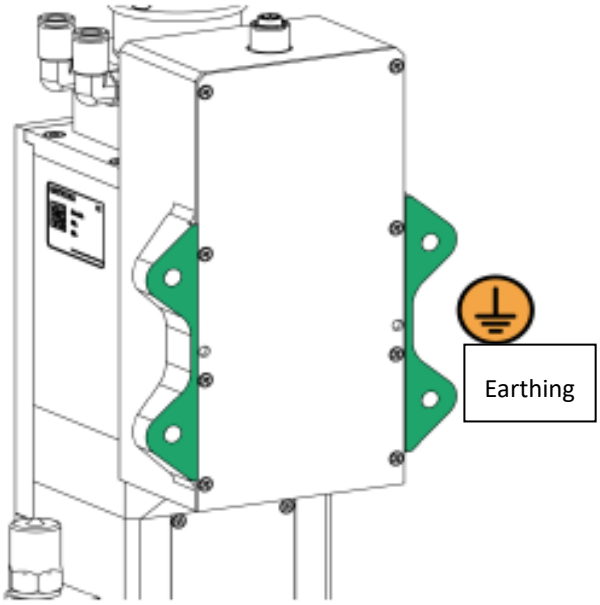
- Align the red point at the end of the QBH interface to the red point of the handwheel.
- Remove QBH dustproof cover.
- Align the red mark of male fiber end to red mark on female QBH of cutting head when you insert the fiber end straightly to bottom of QBH interface of cutting head.
- Turn the QBH handwheel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

2.2 Mounting of Laser Cutting Head

The mounting of laser cutting head to machine tool is shown as below. Customers are advised to Install the laser head perpendicular to the bed surface as requested and make sure the laser head is locked, which is one of the premises to ensure the stable cutting.



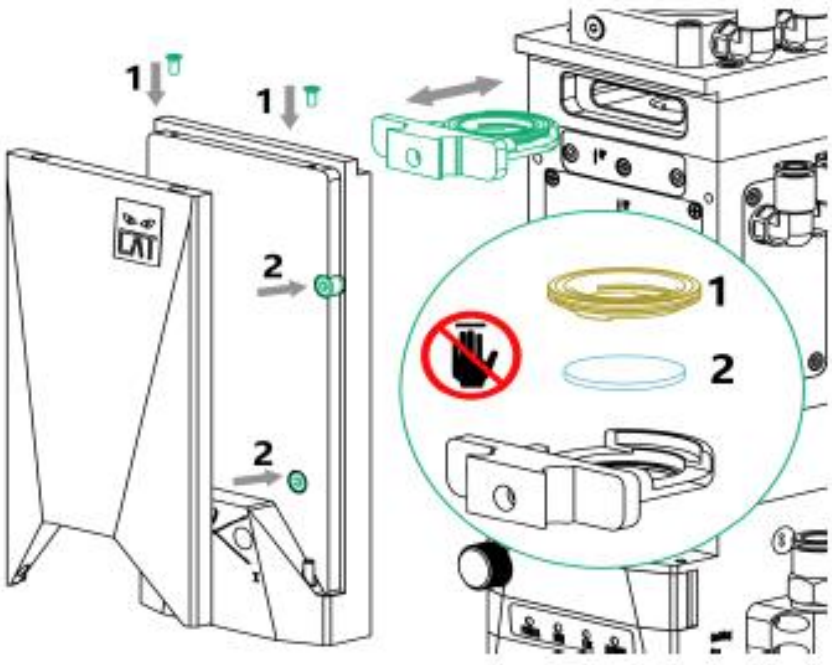
2.3 Earthing of Laser Cutting Head



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

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

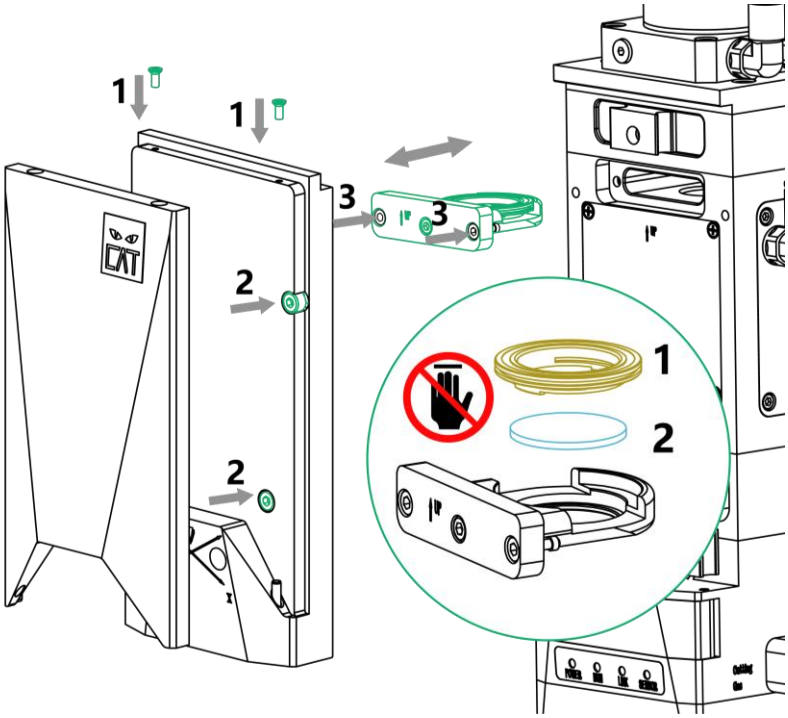
Maintenance or Repair shall be implemented at dust free workstation.



- As shown above, loose the bolts (1 &2) 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.
- 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.

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

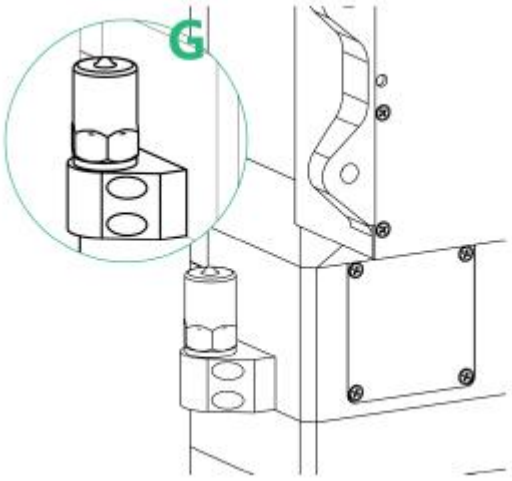
2.5 Inspection of Top 2 Cover Glass



- As shown above, loose the 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.
- 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.

2.6 Connection of Cooling Water and Assist Gas

2.6.1 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.

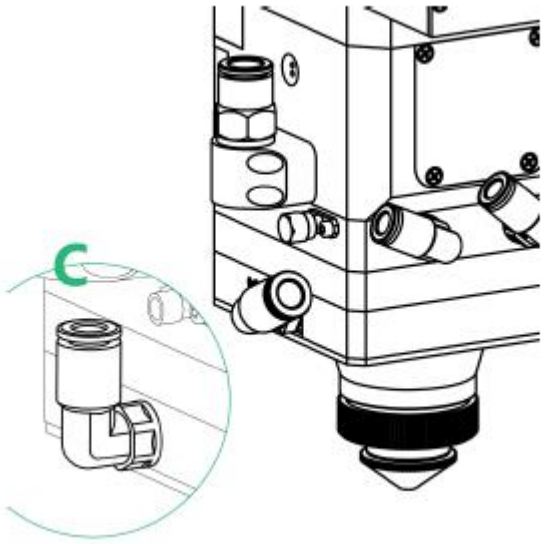
Impurity can be filtered out in gas supply tube, but Oxygen and water vapor can permeate light path through nonmetal materials, which is the source of the appearance of dust and hydrocarbon. Stainless steel fittings are recommended, at the same time must use filters which can remove a minimum of 0.01 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	99.5%	<5 ppm	<1 ppm
Nitrogen	99.95%	<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 also damage the cutting head.

2.6.2Connection of Nozzle Cooling Gas

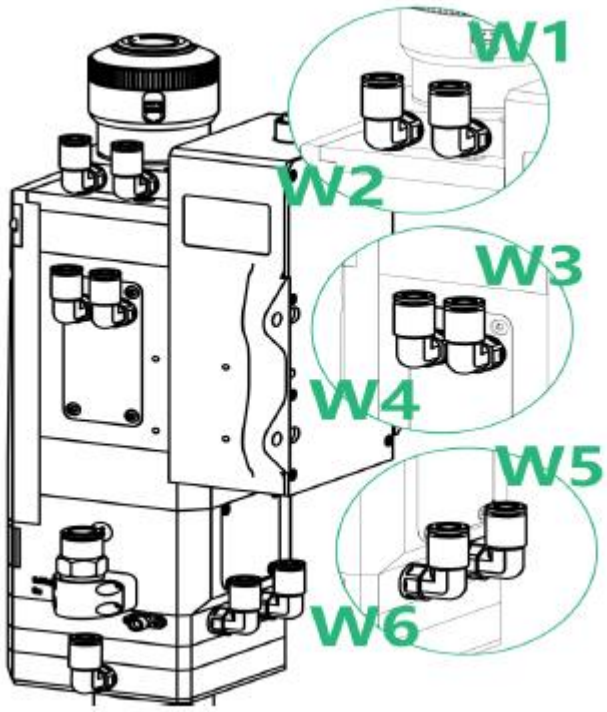


Dried N2 or fine filtered air is recommended and the O2 is prohibited for nozzle cooling.

Gas type	N2 or Air (dried and fine filtered)
Gas pressure	Max. 5bar (0.5MPa)
Gas interface	⌀8 (C)

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 also damage the cutting head.

2.6.3 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 specification of cooling water and the connection are suggested below.

Cooling pipeline of the fiber interface: W1, W2

Outer diameter of water hose	⌀6mm
Minimum flow speed	1.5 l/min
Entry pressure	170-520kPa
Entry temperature	≥room temperature /＞dew point
Hardness (relative to CaCO3)	＜250mg/liter
PH range	6 to 8
Particle size allowed	Diameter less than 200 microns

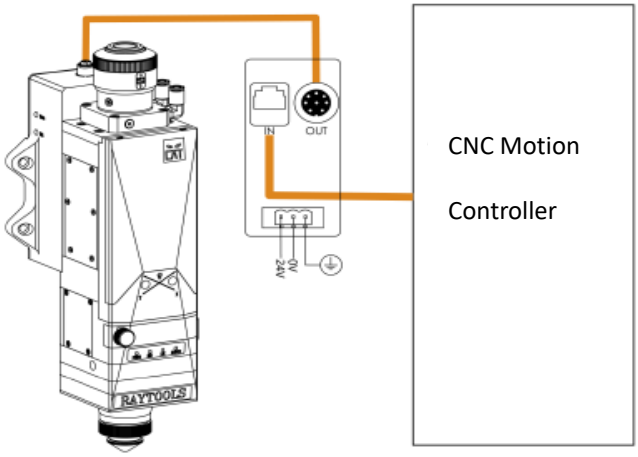
To avoid corrosion, it is a must to comply with the related instructions and maintenance interval of the equipment, manufacturer and the cooling water device.

3 System Installation and Commissioning

EPOE24

Description:

Item	Item	Definition
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	Earthing



Note:

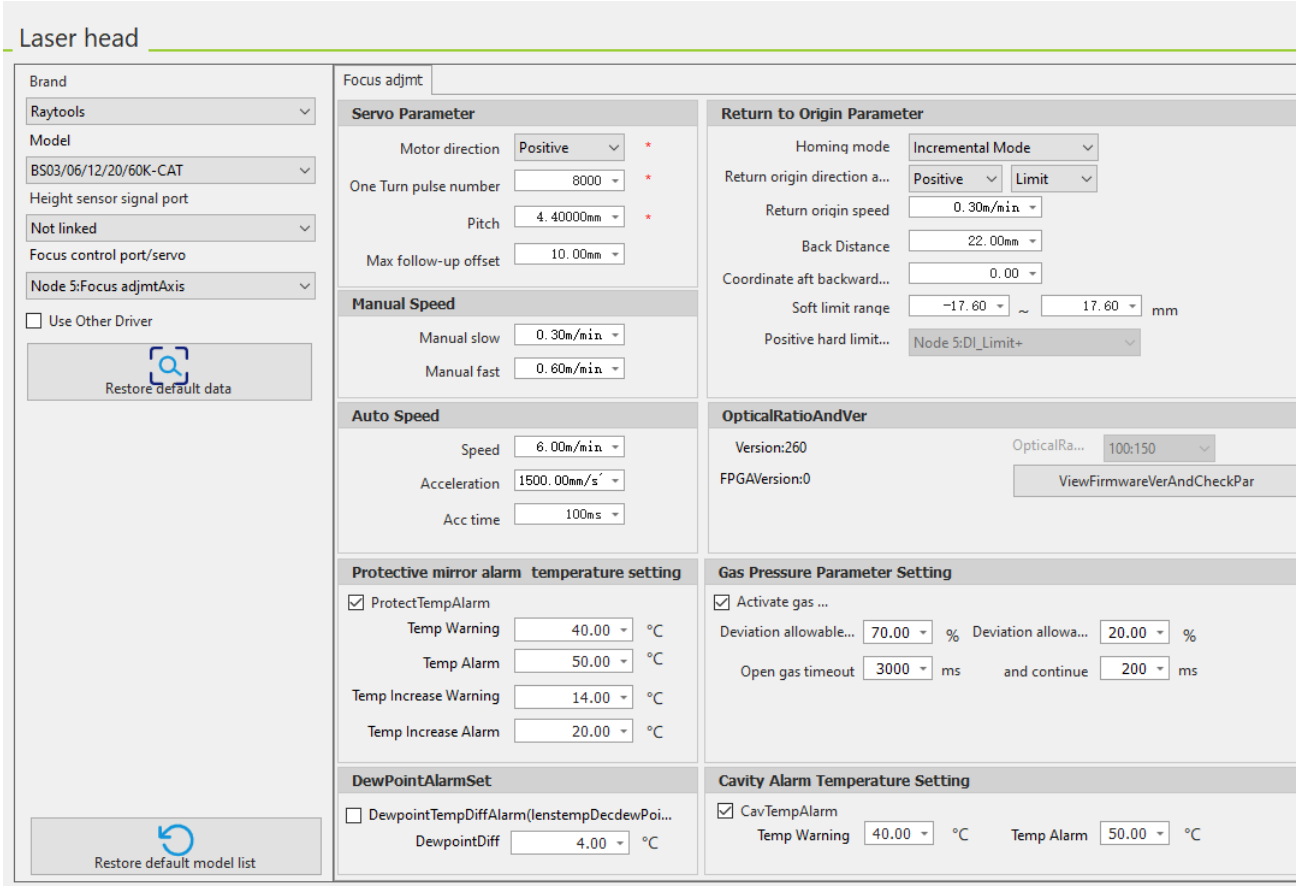
1. Connect 24V to IO (EP0E24).

2. Wiring according to the above graphic.

3. Configure and commission the system according to the system instruction

Optical configuration: **100:150**

Raytools system setting:



The connections and settings may differ from one CNC control system to another.

Once the setting is modified, the corresponding wiring method may need to be changed.

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 nozzle center. 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 -1mm to +1mm.
- Tear off the tape and check the shooting hole position in tape.
- Repeat the above steps to find out relatively centered position.

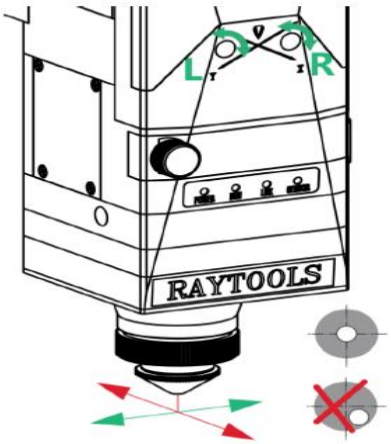


Figure 4.1— Beam Adjustment

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 collimation 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:

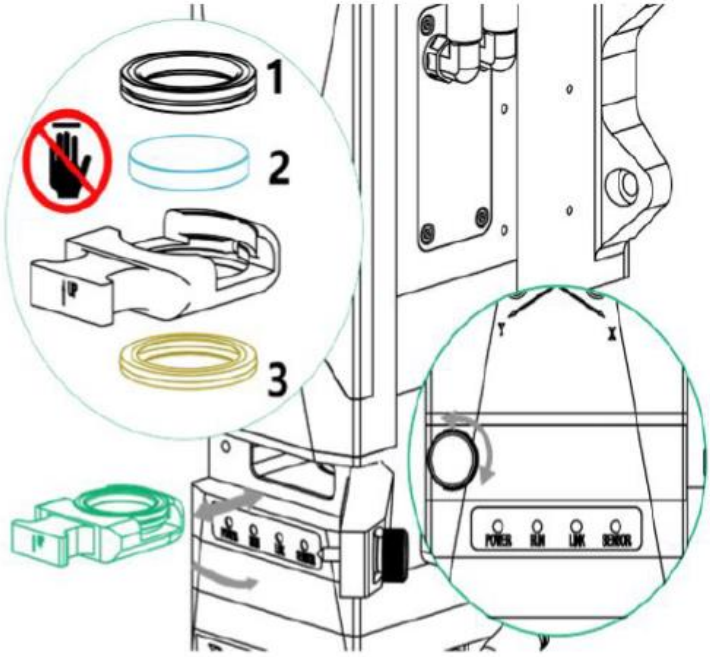
- To put fingertip onto left thumb and index finger.
- Spray absolute ethanol onto the polyester swab.
- Hold the edge of the lens with left thumb and index finger gently. (note: avoid touching the surface of the lens by fingertip in case of trace)
- Hold the lens to face eyes by left hand and hold the 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 Bottom 1 and 2 Cover Glass/Protection Glass

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

5.2.1 Removal and Installation of Bottom 1 Cover Glass/Protection Glass

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



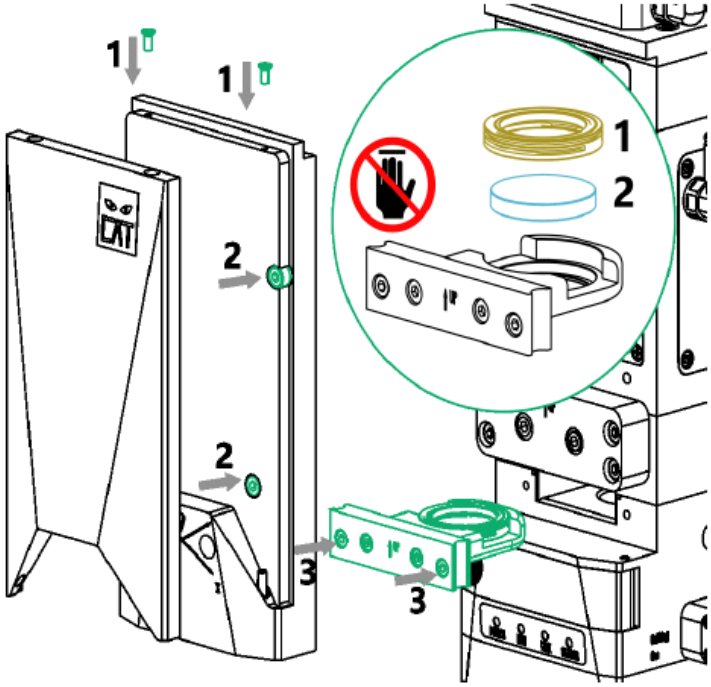
- As shown above, loose the bolt, take off the glass cover and pull out the glass holder by pinching 2 edges of drawer type holder.
- Close the cover panel immediately.
- Remove the pressing ring (1) and cover glass (2) after wearing fingertips.
- Clean the cover glass holder and seal ring (3). The elastic 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.

Please wear the clean gloves or fingertips.

5.2.2 Removal and Installation of Bottom 2 Cover Glass/Protection Glass

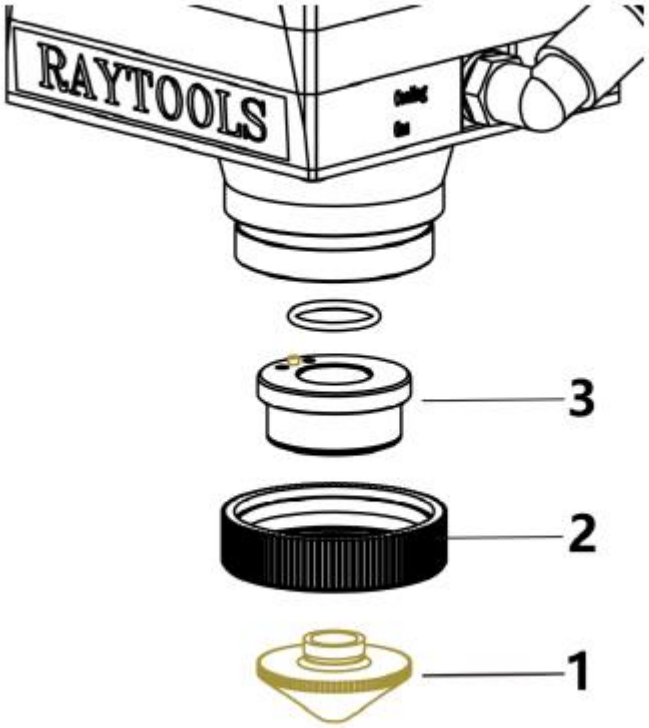
The cover glass is wearing part which needs to be replaced once it is damaged.



- As shown above, loose the bolts (1&2&3) 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.
- 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.

Please wear the clean gloves or fingertips.

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 retainer ring (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 retainer ring (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 ceramic body by hand (without tools) otherwise it could damage the ceramic body.

ⓘ Keep the contact surface of all parts clean.