



BD04K SERIES

4KW Auto-Focusing Tube Laser Cutting Heads-User Manual

Thank you for choosing our product!

This manual explains in detail how to use the BD04K laser cutting head, including installation, setup, operation, and service. You can consult us directly for more details.

Please read this manual carefully before your actual use to help you effectively understand this laser head.

The products may continue to be renewed. We apologize for the inconvenience caused by the information difference between the product the manual indicates and the actual product you get.

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Content

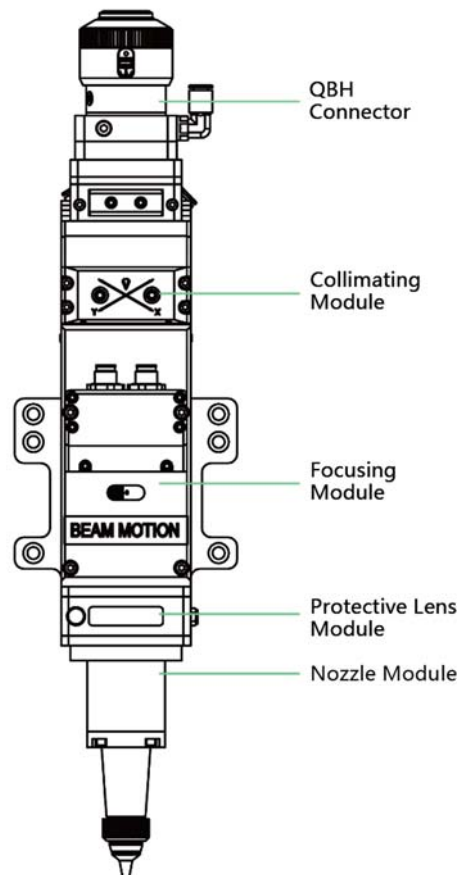
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1 Summary

This manual includes the general description, basic installation, factory settings, operation and maintenance services, and other aspects of the BD04K series products, which have too many optical and mechanical customization configurations, so only the main parts will be introduced in this manual.

The BD04K series laser heads are auto-focusing tube laser cutting heads for fiber laser, which were released by Switzerland RAYTOOLS AG in 2021. The products are equipped with external servo motor drive units, which use a linear mechanism to drive the focusing lens to change position in the range of about 30 mm automatically. Users can use the program settings to achieve continuous adjustment of the focus position to complete the rapid perforation of thick plates and automatic cutting of different material thicknesses of plates. The products can be equipped with D30 composite lens groups to integrate the beam. Diversified interface configurations can be adapted to a variety of fiber lasers. The optimized optical and water-cooled design allows the laser heads to work under high power for a long time continuously and steadily.



1.1 Product Features

- Optimized optical configuration and smooth and efficient airflow design;
- Automatic focusing range + 12 ~ -12mm, adjustment accuracy 0.05mm;
- Equipped with D30 composite lens groups, the maximum fiber power is up to 4KW;
- Maximum acceleration of focus lens driver is 10m/s², maximum speed is 6m/min;
- The drawer-type of lens mount makes the replacement of protective lenses more quickly and easily;
- Large clear aperture lenses are used for beam collimating and focusing to obtain the best optical quality and cutting effect;
- With QBH, G5 and other fiber interfaces, it can be adapted to various fiber lasers.

1.2 Structure and Function

As shown in Figure 1, the laser head consists of five basic units: collimating water cooling module, collimating centering module, focusing driver module, protective lens module and nozzle module.

- Collimating water cooling module: Can cool the collimating centering module;
- Collimating centering module: Can collimate the incident laser into a parallel beam and adjust the beam spot from the center of the nozzles;
- Focusing driver module: The collimating beam is focused into a small beam spot which has high power density, and the focus position is adjusted by the driver automatically;
- Protective lens module: The protective lens protects the focusing lens from damage by returning slag and prolongs the service life of the focusing lens;
- Nozzle module: guide the focus beam to workpiece and generate high velocity jet cutting to achieve high quality cutting.

2 Mechanical Installation

2.1 Mounting Holes

The size of the mounting holes and position of the BD04K tube laser cutting head are shown in Figure 2.1. To ensure high-quality cutting, we recommend that you install the laser head vertically into the processing area and lock it into place.



Note: The z-axis motor slide plate (for fixing the laser head) and machine tool must be fully grounded to make sure they are properly grounded.

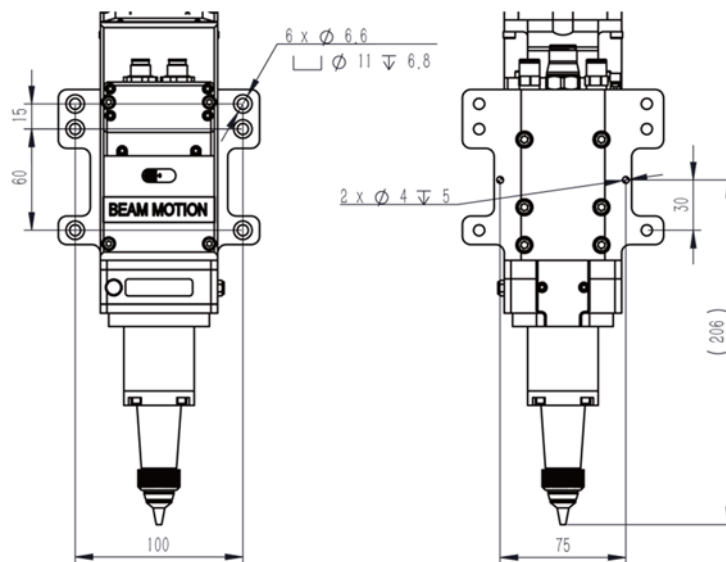


Figure 2.1 – Mounting Holes

2.2 Connecting Gas and Water

2.2.1 Connecting the Cooling Water System

The BD04K laser head has an integrated water-cooling design. You can choose any connector on the water circuit as an inlet or outlet. It is important to note that when the laser power is greater than 500W, we recommend you enable water cooling. As you can see from Figure 2.2, the position and quantity of the water connectors are listed, and Table 2.2 shows the recommended water flow rate.

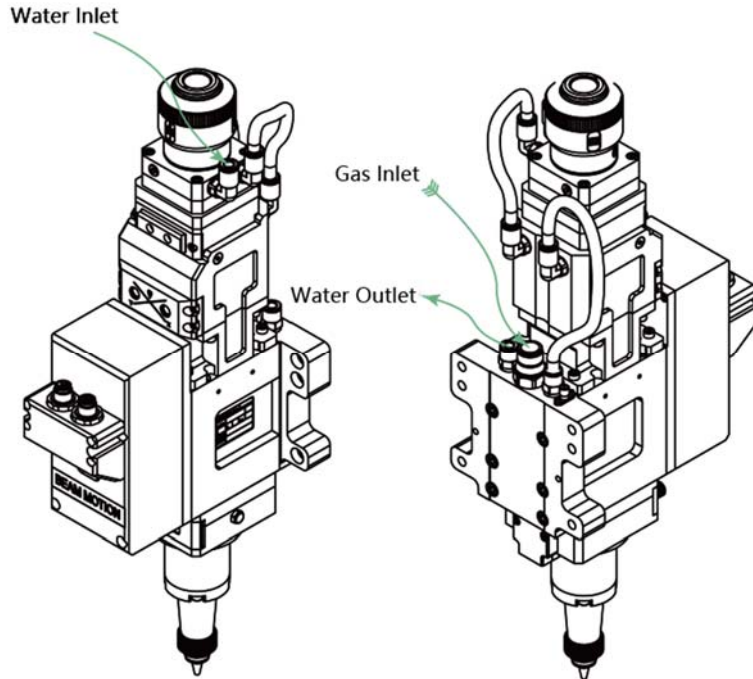


Figure 2.2 – Water cooling circuit and gas circuit

Outer Diameter of Water Connector	6mm
Min. flow rate	1.8L / min (0.48gpm)
Entry pressure	170-520kPa (30-60 psi)
Entry temperature	≥ room temperature / > dew point
Hardness (relative to CaCO3)	<250mg/liter
PH range	6 to 8
Max. size of solid particles	200 microns

Table 2.2 – Basic technical requirements of water cooling

This cooling water system is closed-loop cooling water system. You can use an external free water supply by following to the requirements listed above.

2.2.2 Connecting the Auxiliary Gas System

The impurities in cutting gas such as hydrocarbons and water vapor can damage the lens and cause laser power fluctuation as well as inconsistencies between the sections of the workpiece. The table below shows the recommended cutting gas specifications. The higher the purity of the gas, the better the quality of the cutting sections.

Gas	Purity	Permitted water vapor (ppm)	Permitted hydrocarbon (ppm)
Oxygen	99.95%	<5 ppm	<1 ppm
Nitrogen	99.99%	<5 ppm	<1 ppm
Argon	99.998%	<5 ppm	<1 ppm
Helium	99.998%	<5 ppm	<1 ppm
Auxiliary Gas Pipe Diameter (Outer Diameter)			10mm

Impurities can be filtered out in gas supply pipes, but oxygen and water vapor can permeate beam paths through non-metallic materials, which is the source of dust and hydrocarbons. We therefore recommend that you only use stainless steel fittings. At the same time, filters must be used to remove a minimum of 0.01micron particle.

It is recommended to use a pressure gauge with a stainless-steel diaphragm. If a rubber diaphragm is used, hydrocarbons will be generated due to aging and other factors.



Note: To avoid any gas path block (which may cause damage to the cutting head and result in low-quality cutting), please do not replace the gas connector arbitrarily. Using sealing tape or sealing material to seal the fittings is not permitted!

2.3 Cable Connection

This section only introduces the cable connection of the cutting head. For wiring diagram from laser head to CNC (I/O) or height sensor kit, please refer to the relevant manuals.

2.3.1 Connecting Cables to Laser Head

Connect the 8-pin connector (on laser head) with power limit cable; connect the 12-pin connector (on laser head) with encoder cable (as shown in Figure 2.3). After reserving a suitable length, insert the cables into the machine tool cable crawler groove and fix them properly.

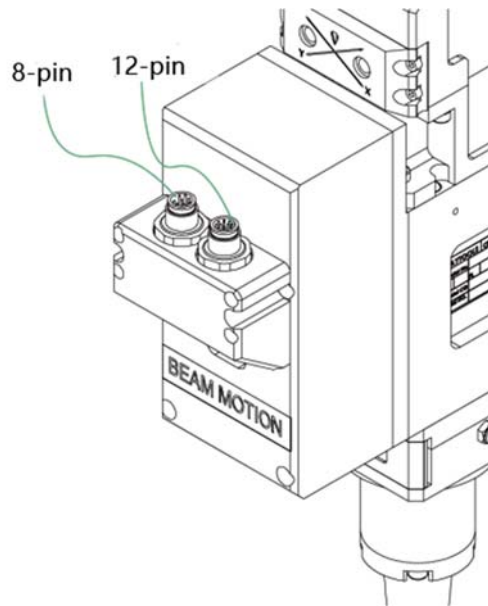


Figure 2.3 – Connecting cables to laser head

2.3.2 Connecting Cables to Servo Driver

Connect the power limit cable and encoder cable to the corresponding interfaces on driver according to the cable definition (see the cable).

Note: The limit sensor is in low-level normally closed output mode (the sensor outputs a low-level signal when it is not triggered); if necessary, you need to install a relay for conversion.



Note: All cables should be connected in the power-off state, and the power-on debugging can be performed after the cable connection is checked.

2.4 Fiber Connector Introduction

BD04K is suitable for most industrial laser fiber. It is equipped with a collimating lens assembly.

The connecting part between the fiber end and the laser head is called the fiber connector. The commonly used fiber connector is QBH, and each fiber connector has its own unique fixing method. Please refer to the relevant introduction for the use of fiber connectors. Figure 2.4 shows the mounting interface of the QBH connector.



Warning: The optics must be kept clean and all dirt must be removed before connecting. To prevent any falling dust or dirt getting into the fiber connector accidentally, we recommend that you connect the laser fiber when optics are in horizontal place.

2.5 Connect the Laser Fiber to the Laser Head and Do Direction Adjustment

In this section, the connection method between fiber laser and laser head will be introduced by combining the case of QBH connector.

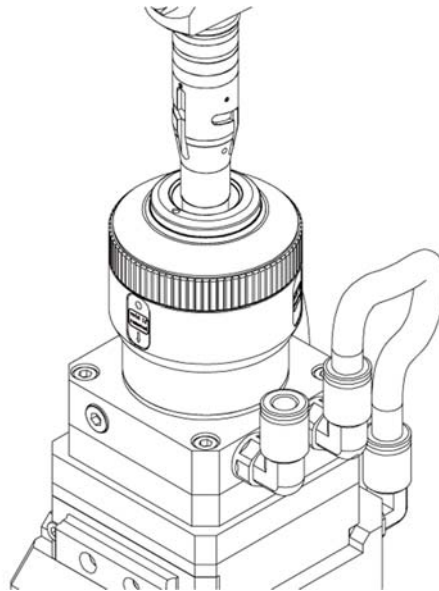


Figure 2.4 - Installation: Laser fiber (e.g., QBH connector)

First, align the red point at the end of the QBH connector with the red point of the handwheel; then remove QBH protective cap from the QBH connector. Make sure that the red mark of fiber output end is aligned to QBH red mark, insert the fiber interface straight to bottom; Then turn the QBH handwheel clockwise. It is in place when you hear the "Da" sound, then pull the handwheel up and turn clockwise again. (See Figure 2.4).

When the laser fiber is inserted into the QBH connector, the red point on fiber is too far away from the red point on laser head interface, causing an out of alignment insertion. You can refer to the steps below to adjust the position of QBH connector on laser head to solve the problem.

As shown in Fig. 2.4, loosen the 4 locking screws of the part with a wrench, rotate the QBH connector, then tighten the locking screws after the red mark is in place.

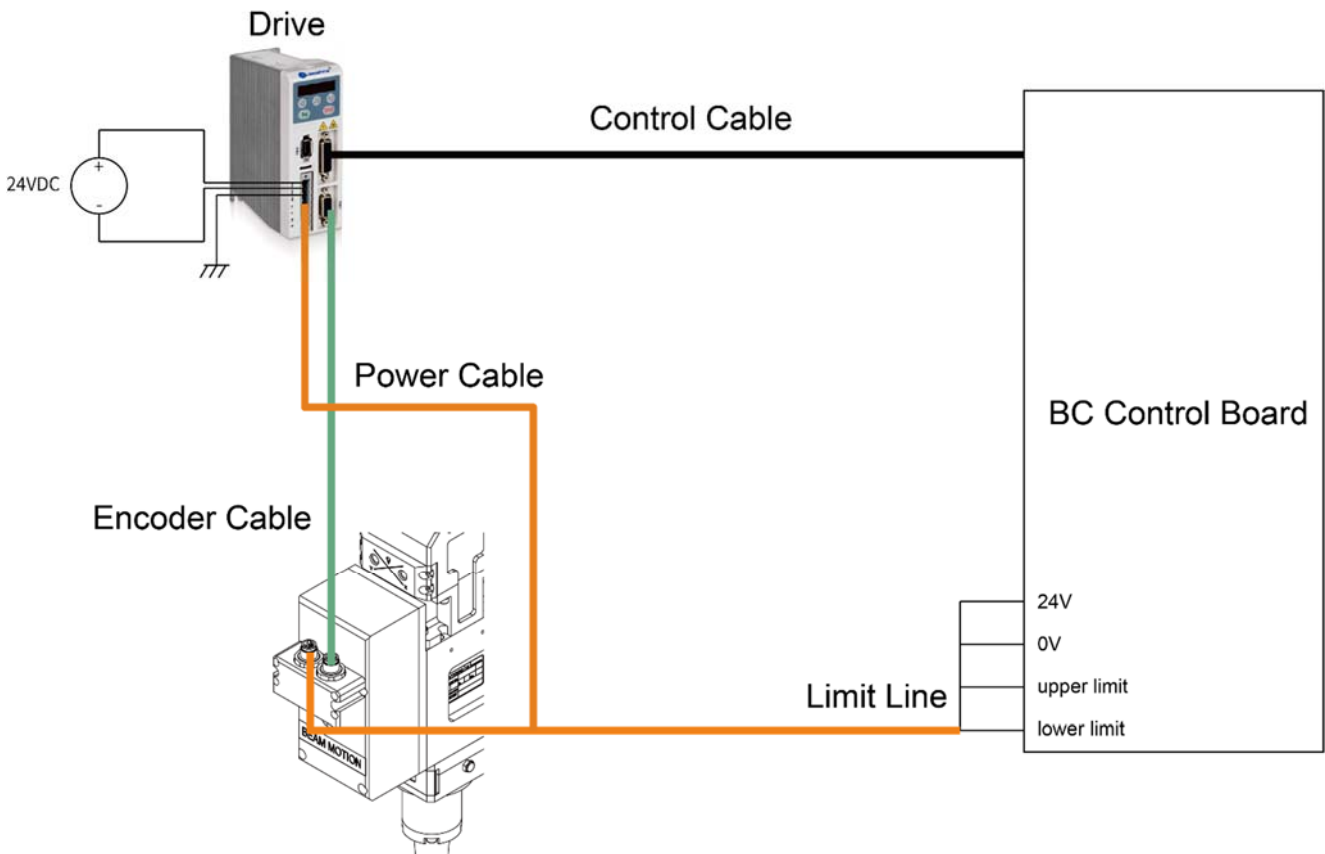
3 System Installation and Commission

3.1 Auto-Focus by Pulse(for FSCUT Controller)

3.1.1 Wiring

Driver + Stepper Motor:

The motor is mixed stepper motor, which needs to connect 24V, 0V and earth to the Vdc, GND and PE of the driver respectively. A+, A-, B+, B- are the power lines of the stepper motor. Please follow the line label instructions (24V power supply is provided by customer).



Limit signal:

white	red	pink	blue
+24V	0V	upper limit	lower limit

Note: The limit sensor is active low, and the signal is normally closed. It continuously outputs a 0V signal when it is not triggered.

3.1.2 Software Settings

- Open the platform configuration tool and enter the value shown in Figure 3.1.
- Set parameters as in Figure 3.1(only for reference).
- Save the parameters and enter the interface.

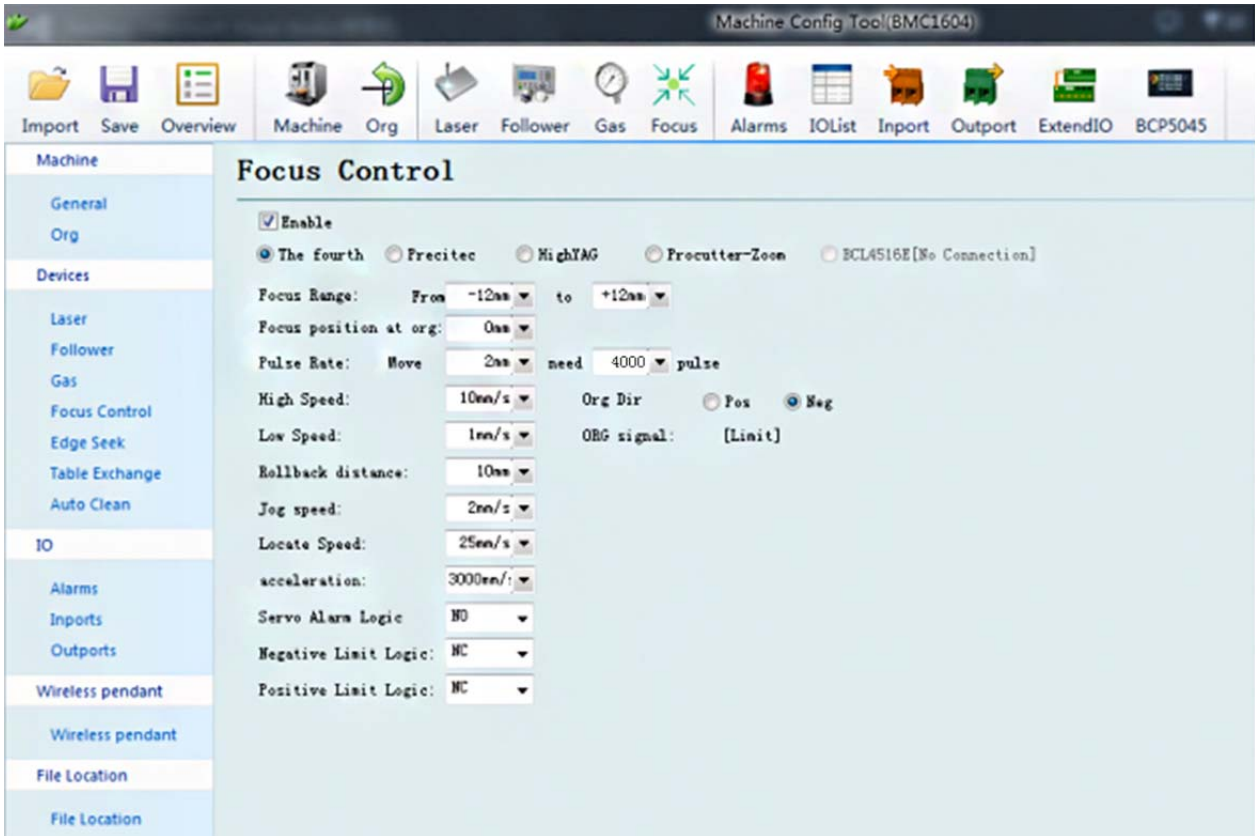


Figure 3.1 - Platform Configuration Tool

3.1.3 Interface Operation

1. Jog the J axis, check if the action is normal (distance " pitch " and direction), 0 scale move up to J+.
2. Move the J axis slowly to make it reach the upper and lower travel limits, and check whether the direction and limit signals are normal.
3. Click the zero-returning icon. The J axis moves downward and returns to zero again when reaching the lower travel limit. At this time, the zero-point position coincides with the zero-focus position, and the zero-returning is completed.

Note:

1. Click +, the lens holder moves upwards to reach the upper travel limit, click -, the lens holder moves downwards to reach the lower travel limit.

2. The direction of backing to origin is negative, and take lower limit as a sampling signal.
3. Pitch 2mm, 4000 pulses one turn.
4. Recommended to set the positioning speed to 50-100mm/s.



Figure 3.2 - Operation interface

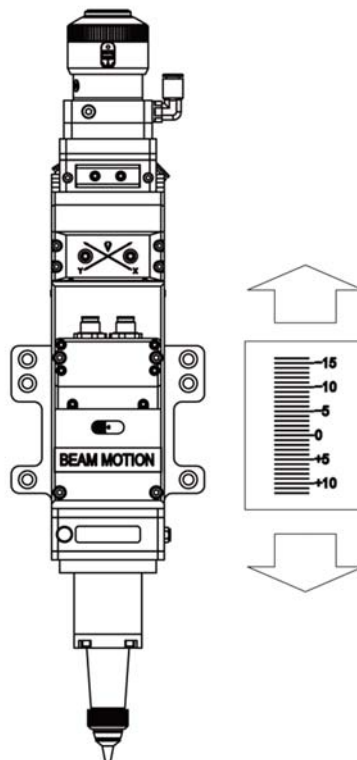


Figure 3.3 — Limit positions diagram

3.2 Auto-Focus by 0-10V(with F050)

3.2.1 Interface Description of F050

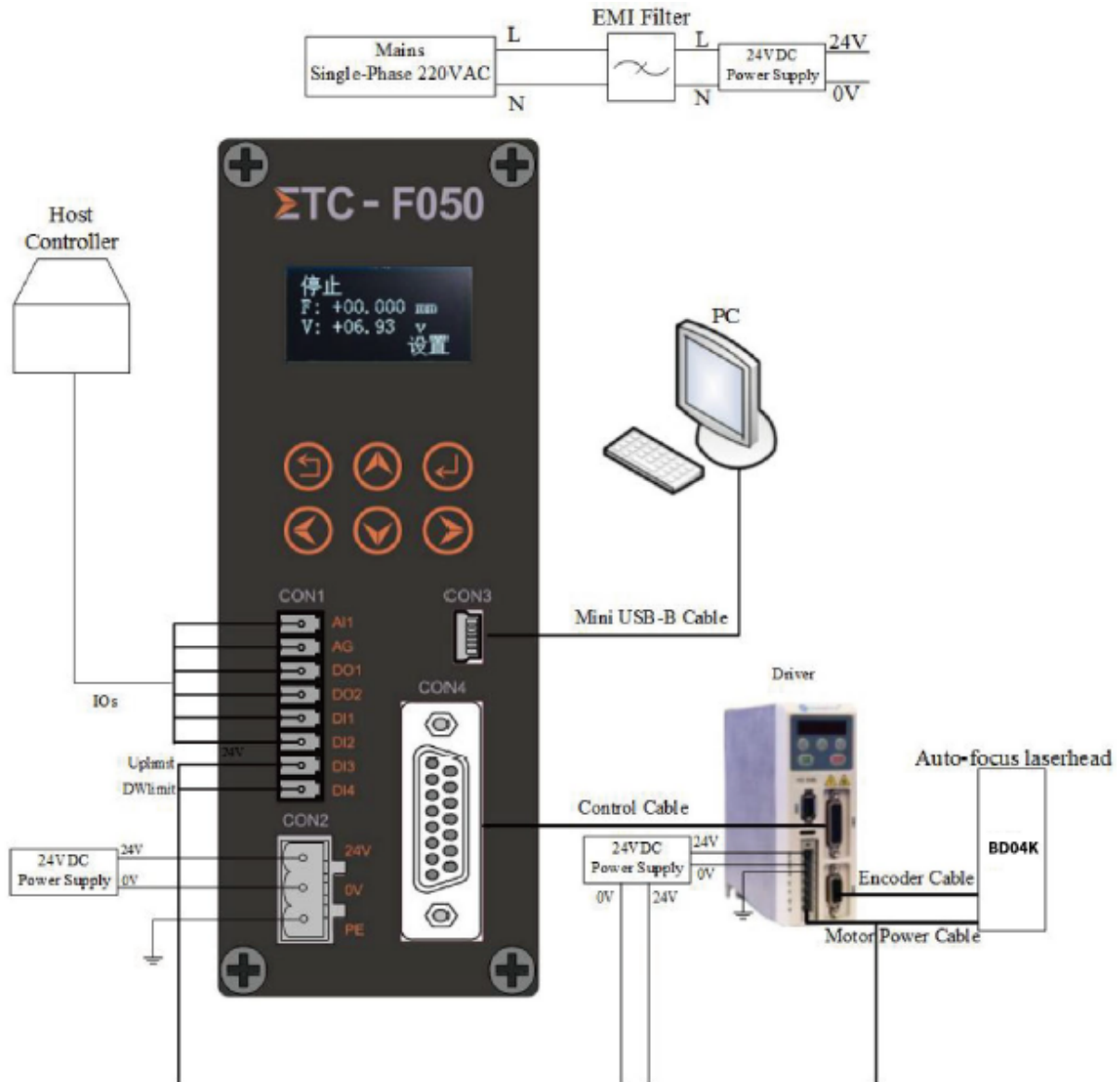
Connector	Function	Pin	Description	Remark
CON1	I/O Interface	VF	focus setting	0-10V to focus position setting
		AG	analog ground	analog signal ground
		ALM	alarm output	0V: normal 24V: abnormal
		INP	focus-reached	0V: focus-unreached 24V: focus-reached
		EN	focus enabling	0V: focus enabling 24V: focus disabling
		HOME	zero position homing	0V: home disabling 24V: home enabling
		L-UP	upper limit	0V: triggered upper limit signal 24V: untriggered upper limit signal
		L-DW	lower limit	0V: triggered lower limit signal 24V: untriggered lower limit signal
CON2	24V power supply	24V		24V to power supply
		0V		0V to power supply
		PE		ground
CON3	For firmware updating			
CON4	Interface to connect drive			



Note: Only use F050 when the CNC controller provides an analog signal for auto-focus. Do not need F050 when the CNC controller provides pulse for auto-focus. Please refer to chapter 3.2.2 for more information about F050.

3.2.2 Wiring

The following diagram shows how to do cable connection of F050. For detailed information, please refer to the separate manual of F050.

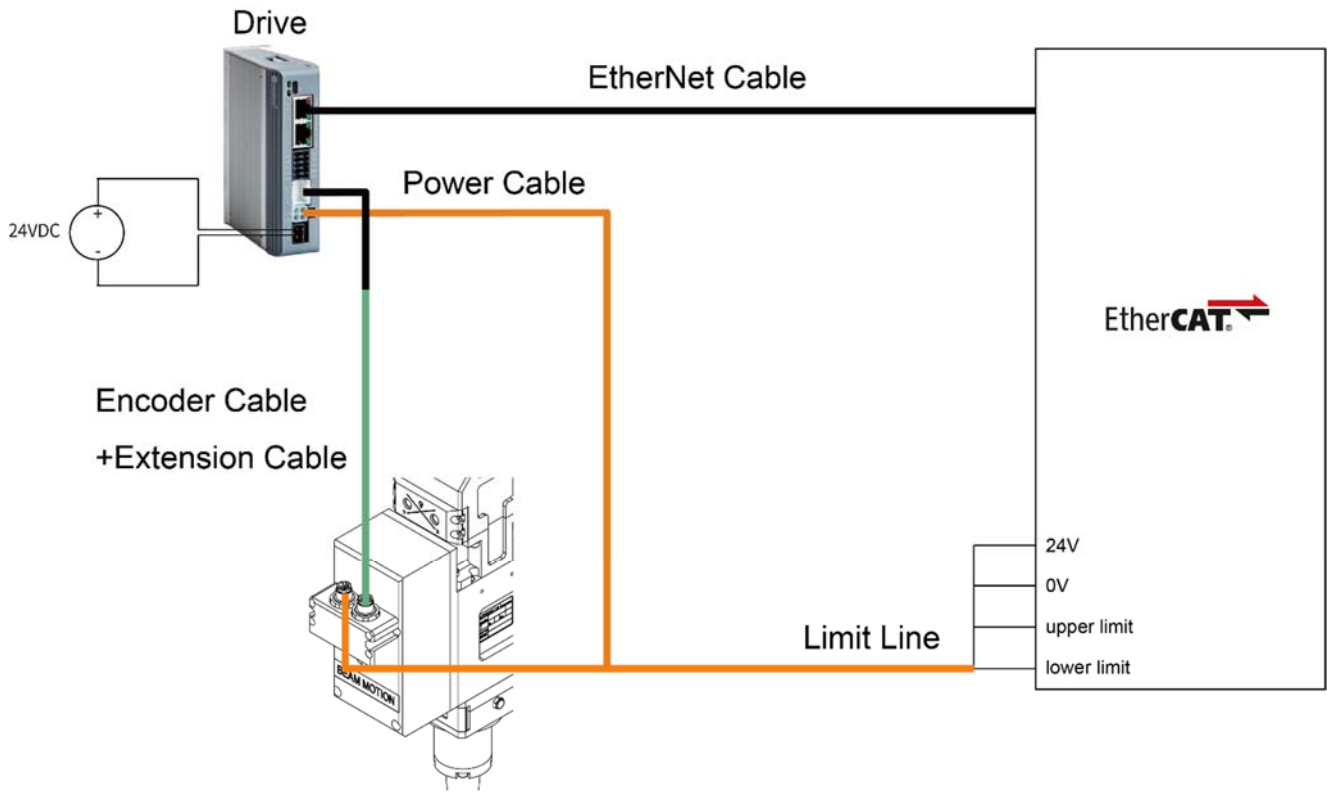


3.3 Auto-Focus by EtherCAT

3.3.1 Wiring

Driver + Stepper Motor:

The motor is mixed stepper motor, which needs to connect 24V, 0V and earth to the Vdc, GND and PE of the driver respectively. A+, A-, B+, B- are the power lines of the stepper motor. Please follow the line label instructions (24V power supply is provided by customer).



4 Beam Adjustments and Focusing

4.1 Adjusting the Laser Beam (QBH interface)

The cutting quality depends largely on whether the lens is centered or not. If not, the laser beam may fall on nozzle inside to produce high temperature deformation. Lens centering operation should be carried out when nozzle is replaced or the cutting quality is decreased.

Lens centering of the BD04K laser head can be done by adjusting the position of the collimating mirror in the X-Y direction. The X-Y adjusting screws are shown in Figure 4.1. An inner hexagon spanner can be used to loosen or screw the adjusting screws until the laser beam is in the middle of the nozzle opening. Tape dotting method is commonly used here:

- Take a piece of transparent tape and stick it directly below the center tip of the nozzle;
- Turn on the red guiding beam of fiber laser to observe the relative positions between nozzle tip center and red beam. Adjust the red beam spot to the center of the nozzle opening by adjusting the X-Y screws;

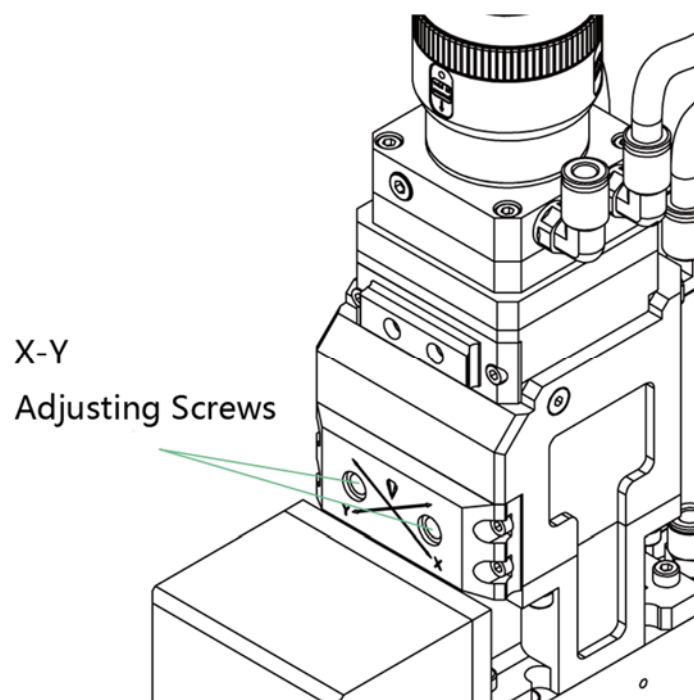


Figure 4.1 - Beam centering

- Next, enable the laser source and set the laser power to the range of 80w-100w to dot manually; Take the tape off to check whether the hole is in the middle of the nozzle opening;

- Repeat the above steps until you find the best centering position. Basically, this beam centering operation requires several adjustments.

4.2 Focus Position Adjustment

The BD04K is an auto-focus laser cutting head, but manual dotting must be taken into consideration when carrying out any adjustments (factory setting performing, lens replacement, laser source replacement, etc.). This is to find the correct focus position.

Pls do as follows to dot manually.

- Adjust the laser head scale to the max. value and set the laser power range to 80w-100w.
- Enable the laser to dot on the textured paper in a movement of 0.5mm (as small as possible) per time.
- Performing several dotting until find the smallest hole, this is happened when the focus is exactly at the nozzle tip. Now we find the zero-focus position.

5 Maintenance

5.1 Cleaning the Lens

Regular maintenance of the lens is required considering the processing technology of laser cutting. We recommend that you clean the protective lens once a week. The protective lens holder has a drawer structure to facilitate lens maintenance. (Figure 5.1)

Lens cleaning:

- a. Tools: dust-proof gloves or fingerstall, long fiber cotton stick, ethanol, rubber gas blower.
- b. Cleaning instruction:
 - Put your thumb and index finger with fingerstall;
 - Soak the cotton stick in ethanol for a while;
 - Hold the slide edge of the lens with thumb and index finger gently. (Note: do not touch the lens surface in case stain);
 - Hold the lens in front of your eyes with your finger and use the cotton stick to clean the lens in a single direction, from left to right, from bottom to top, (do not wipe back and forth so as to avoid secondary pollution of the lens). Then blow away the dirt with clean air (both surfaces should be cleaned). After cleaning, make sure that there is no residual: detergent, absorbent cotton, foreign objects, and impurities.

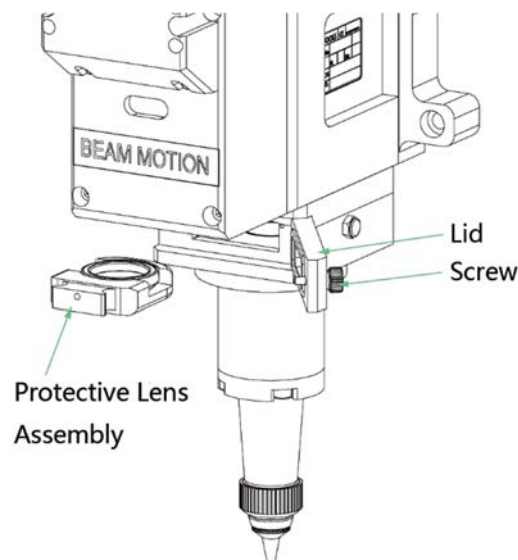


Figure 5.1 - Remove the protective lens

5.2 Replacing Lens

Maintenance and replacement work of lens must be carried out in a clean workplace, and dust-proof gloves or fingerstalls must be worn when replacing the lenses.

5.2.1 Replacing Middle/Bottom Protective Lens

The protective lens is a wearing part and needs to be replaced when damaged.

- As shown in Figure 5.2, open the lid to pull out cover glass holder by pinching 2 edges of drawer holder.
- Carefully lift off the clamping ring and remove the protective lens with fingerstall;
- Clean the protective lens, lens holder and seal ring. The seal ring should be replaced if it is damaged;
- Install the cleaned protective lens (Regardless of the front or back surface) into the lens holder;
- Install the clamping ring;
- Insert the lens holder to the laser head put the lid back, then fasten the screw.

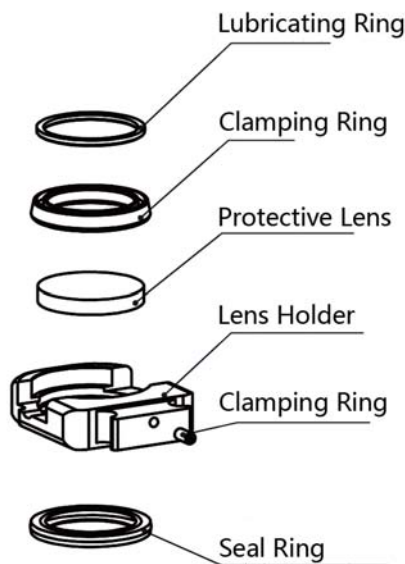


Figure 5.2 – Bottom Protective Lens Assembly Structure

5.2.2 Replacing the Upper Protective Lens

The upper protective lens is a wearing part and needs to be replaced when damaged.

- Undo the screws on the lens holder with 3mm inner hexagon spanner (as shown in figure 5.3);
- Pull out the lens holder by pinching the two edges, use a textured paper to seal the opening to prevent the falling dust;
- Removing the protective lens by putting your fingers with fingerstalls;
- Clean the protective lens, lens holder and seal ring. The seal ring should be replaced if it is damaged;
- Install the clean(new) protective glass (Regardless of the front or back surface) into the lens holder;
- Re-install the seal ring;
- Insert the lens holder to the laser head and tighten the locking screw.

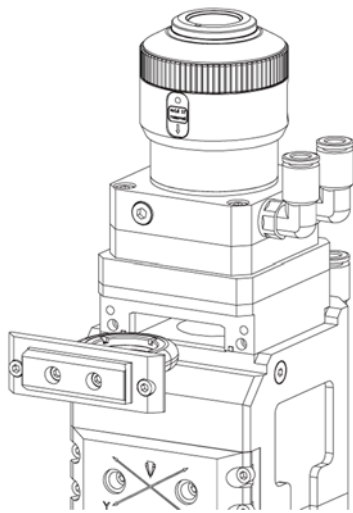


Figure 5.3 – Remove the upper protective lens holder

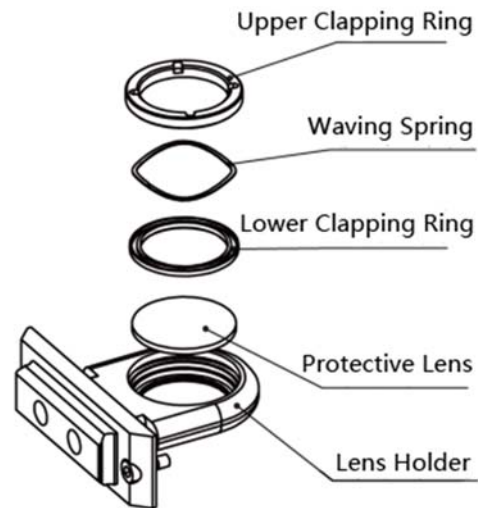


Figure 5.4 – Upper protective lens assembly structure



Note: Do not pull out the edge of seal ring directly as it can damage the seal ring.

5.2.3 Replacing the Collimating Lens

To replace the collimating lens, please do as follows.

- Take the laser head to a clean workplace and clean up the covering dust on the surface of laser head;
- Undo the screws on the collimating lens assembly with 3mm inner hexagon spanner (as shown in figure 5.5);

- Take out the collimating lens assembly, and use a lens tool to remove the pressing ring and collimating lens;
- Clean or replace the collimating lens;
- Reassemble the collimating lens assembly in order (see Figure 5.6), pay attention to tighten the pressing ring properly, and re-screw it into the collimating lens assembly;
- Tighten the bolts of collimating lens assembly firmly;
- Check whether the focus position is in the center of the nozzle hole before use. If not, carry out beam centering again.

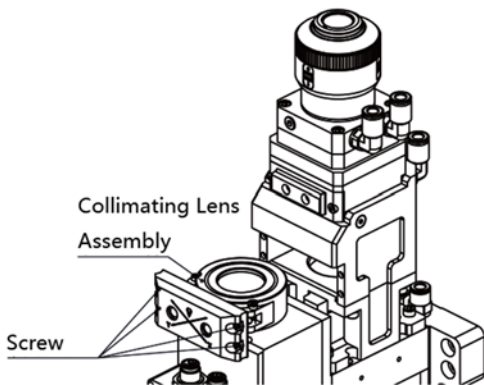


Figure 5.5 – Remove Collimating Lens Assembly

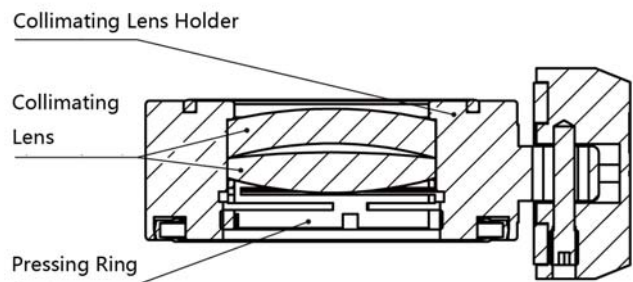


Figure 5.6 – Collimating Lens Assembly Structure

5.2.4 Replacing the Focusing Lens

To replacing the focusing lens, please do as follows.

- Take the laser head to a clean workplace and make sure that the laser head surface is clean;
- Place the laser head horizontally, and remove the locking screws from bottom to top (see Figure 5.7);

- As shown in Figure 5.8, use a lens tool to remove the focusing lens holder, and take off the pressing ring and focusing lens;

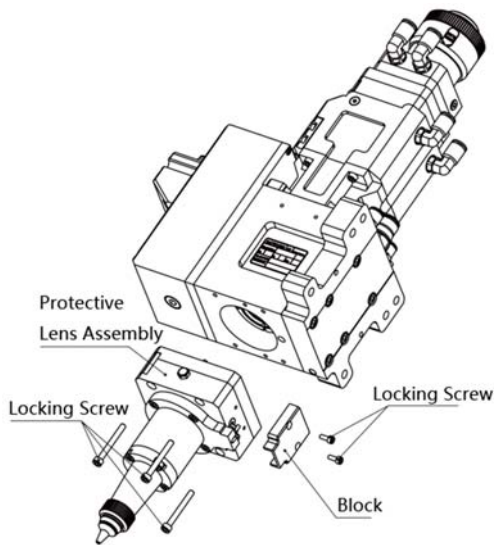


Figure 5.7 – Remove the screws

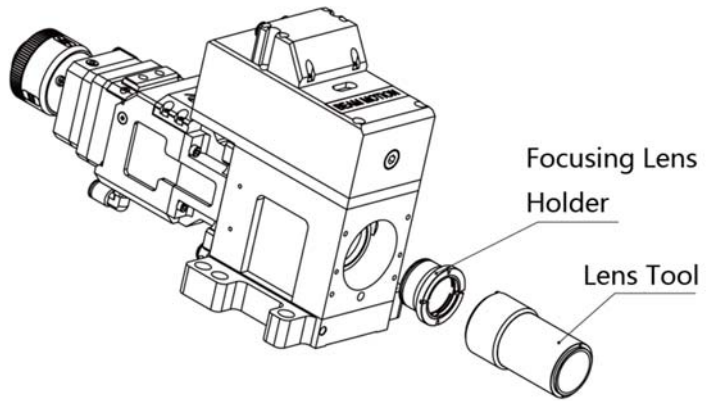


Figure 5.8 – Remove Focusing Lens Assembly

- Clean or replace the focusing lens;
- Carefully place the focusing lens and the pressing ring back into the lens holder (see figure 5.9), and tighten the pressing ring properly;

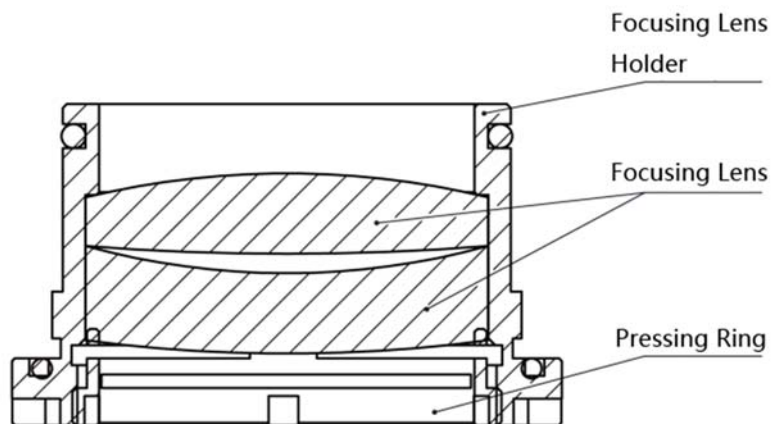


Figure 5.9 - Schematic diagram of focusing lens installation

- Install the focusing lens assembly into cutting head and tighten screws;
- Assemble the laser head according to Figure 5.7, and tighten the screws;
- Check whether the focus position is in the center of the nozzle hole before use. If not, carry out beam centering again.

5.3 Replacing the Nozzle Connector

During the laser cutting, the laser head will inevitably be hit. So, you need to replace the nozzle connector if necessary.

5.3.1 Replacement of Ceramic Part

- Unscrew the nozzle;
- Press the ceramic part to make it fixed and not oblique and then screw off the locking nut;
- Align the pin hole of the new ceramic part to 2 locating pins and press the ceramic part by hand to screw on the locking nut;
- Screw on the nozzle and tighten it properly.

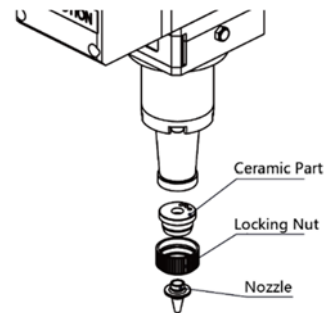


Figure 5.10 - Replace the Ceramic Part

5.3.2 Replacing the Nozzle

- Unscrew the nozzle;
- Put on a new nozzle and tighten it properly;
- Do capacitance calibration once again after replacing the nozzle or ceramic part.

5.4 Error Analysis and Diagnostics of Driver

5.4.1 Driver Failure Analysis

The initial interface of the servo is displayed when the motor is powered on.

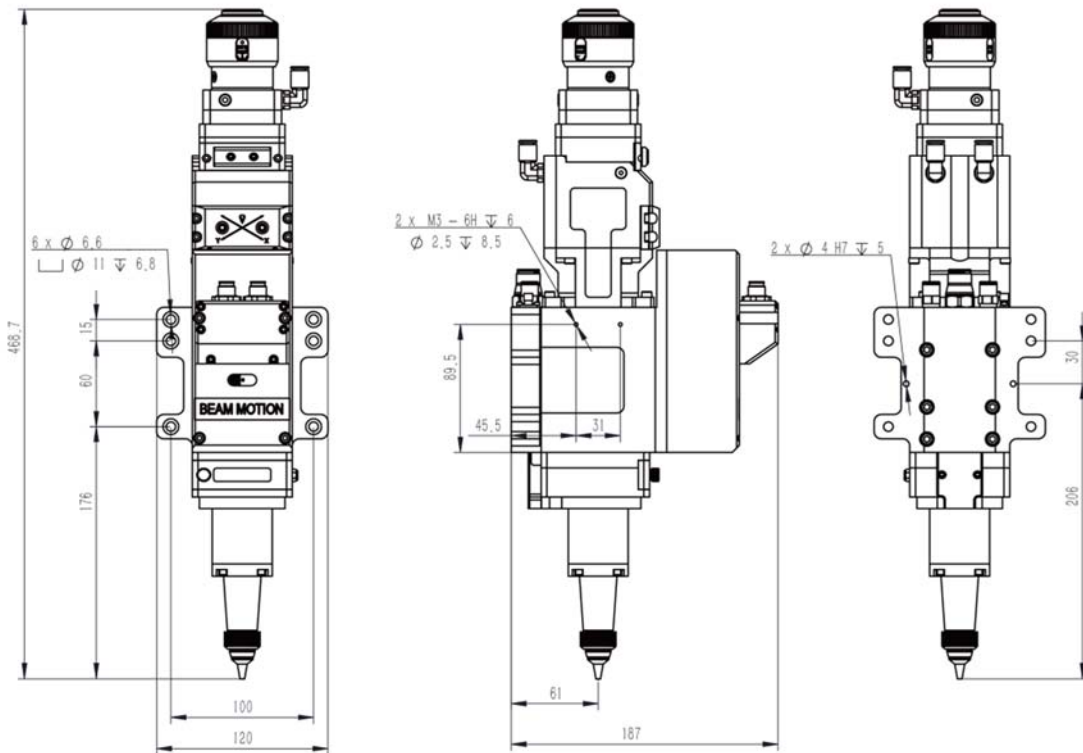
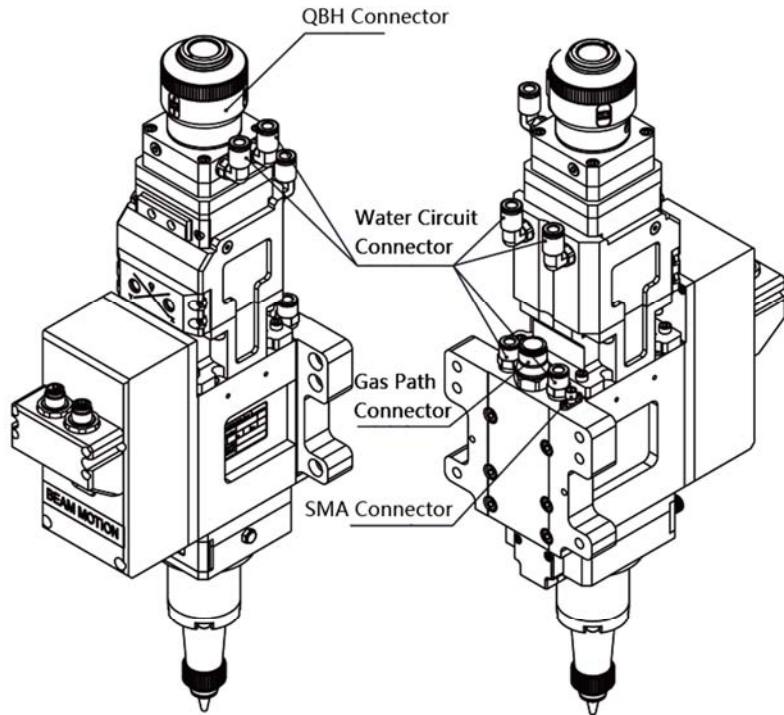
The display of L__0 means that the difference between the given pulse and the feedback pulse is 0.

LED Display	Meaning	Remark
	Low Level	
	High Level	
	Position Error	Difference of given pluse and feedback pulse

- If the motor is moving normally, this value will change in real time according to the position of the motor, and the value will be 0 after the motor is stable; it means that the wiring is correct and the server is working properly;
- If this value stays same at 0, and the motor does not move; it means the servo has not received the given pulse, and it is necessary to check whether the control cable is in good contact;
- If this value keeps increasing or decreasing, and the motor does not move, it means that the servo has received the given pulse but has not received the feedback pulse from the motor. It is necessary to check whether the power cable and the encoder cable are in good contact. Or whether the motor reaches upper and lower limits so that the motor cannot move;
- When the value increases to 6000 or decreases to -6000, the servo will trigger protection and go to error. The interface will show Er_020. When the driver fails, the driver will stop and prompt the corresponding error code. The error can be cleared only by restarting the driver.

6 Mechanical and Optical Overview

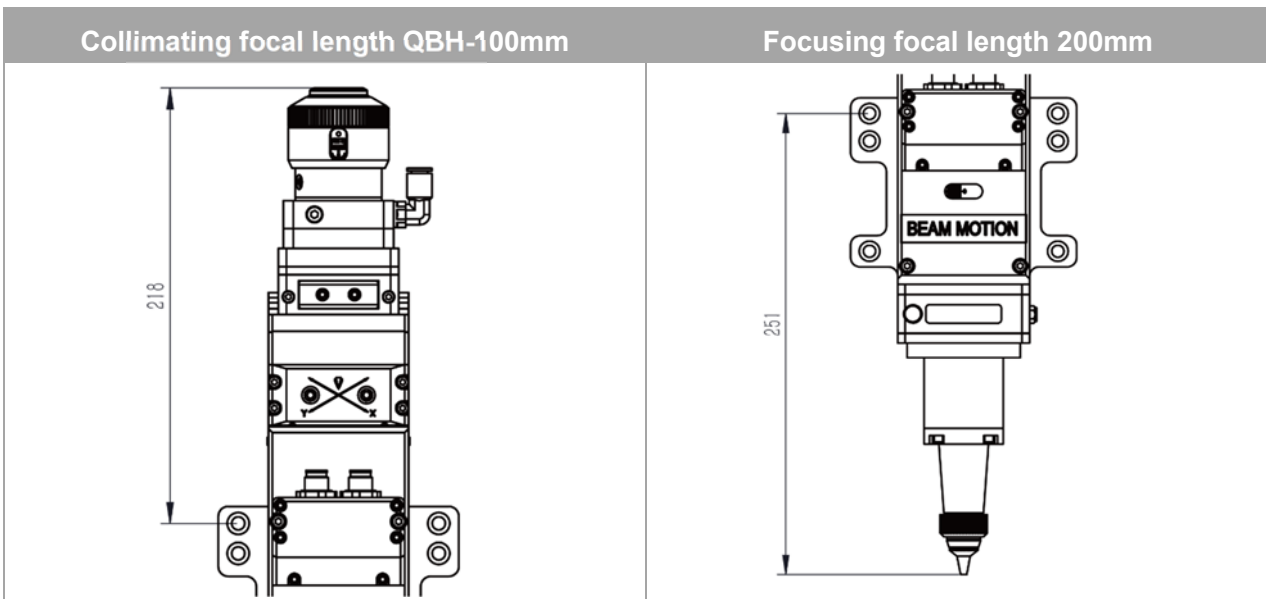
6.1 Mechanical Dimension



CL/mm	100	75
FL/mm	200	
H/mm	468.7	

6.2 Schematic Diagram of Cutting Head Configuration

6.2.1 Focal Length



6.3 Part No. of Spare Parts

6.3.1 Fiber Connector

Fiber Connector	Part. No
QBH (standard)	211FIA3003

6.3.2 Collimating / Focusing Lens

Lens Specifications	Part No.
Collimating lens, biconvex, F100	110255AACBHE0231
Collimating lens, meniscus, F100	110255AAFBHE0232
Focusing lens, biconvex, F200	110255AACBHE0233
Focusing lens, meniscus, F200	110255AAFBHE0234

6.3.3 Protective Lens

Protective Lens Specifications	Part No.
D24.9 x 1.5 (top)	211LCG0020
D27.9 x 4.1 (middle)	211LCG0037
D27.9 x 4.1 (bottom)	211LCG0037

6.3.4 Nozzles

Name	Specification	Part No.
Single Nozzle	1.0mm	120GJT0910
	1.2mm	120GJT0912
	1.5mm	120GJT0915
	2.0mm	120GJT0920
	2.5mm	120GJT0925
	3.0mm	120GJT0930
	3.5mm	120GJT0935
	4.0mm	120GJT0940
Double Nozzle	0.8mm	120GJT0208
	1.0mm	120GJT0210
	1.2mm	120GJT0212
	1.5mm	120GJT0215
	2.0mm	120GJT0220
	2.5mm	120GJT0225
	3.0mm	120GJT0230
	3.5mm	120GJT0235
	4.0mm	120GJT0240

6.3.5 Cables

Name	Length	Part No.
Encoder cable	15M	ELN0A3315M00029B
	20M	ELN0A3320M00048B
	30 M	ELN0A3330M00053B

Power cable	15M	ELN0NA3215M00028B
	20M	ELN0NA3220M00049B
	30 M	ELN0NA3230M00055B
Control cable—For FSCUT Position Mode	2.0M	ELNAB102M00045
EtherNet cable	0.5M	3570050025
Extension cable(for encoder cable)	0.5M	3620030013

6.3.6 Ceramic Part and TTW Cable

Name	Part No.
Ceramic part M8	120515093A
TTW cable	211TTW9002