



BM114S SERIES

6KW Auto-Focusing Laser Cutting Head- User Manual

RAYTOOLS
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Email: sales@raytools.net

Add: EMMENTALSTRASSE 96 CH-3414 OBERBURG, SWITZERLAND



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Thank you for choosing our product!

This manual makes a detail introduction about the use of BM114S laser cutting head, including installation, setup, operation and service etc. Please directly contact us if you have other things to know.

Please read these instructions carefully before use the series cutting head and relative equipments. This will help you to use it better.

Because the product keeps renewing, please note the product you receive may differ slightly from the illustrations in this manual in some aspects. We apologize for your inconvenience here.

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1 Summary

This manual covers the general description of BM114S series products, including the basic installation, factory settings, operation, use and maintenance services and other aspects. The specific Optical mechanical customization configurations are too much, so only the main unit parts will be introduced in this manual.

The BM114S series is an automatic focusing fiber cutting head released by Swiss RAYTOOLS AG in 2018. The product is equipped with internal servo motor and internal driver units, which can drive the focus lamp to change position automatically in the range of about 25mm by linear mechanism. Users can continuously focus through setting program to finish the rapid perforation of thick plates and the automatic cutting of plates of varies thickness and material. The product can be equipped with D37 composite lens group to integrate the beam, a variety of interface settings, so that it can be used with a variety of fiber lasers; optimized optical and water-cooled design allows the laser head work under high power steadily for a long time.

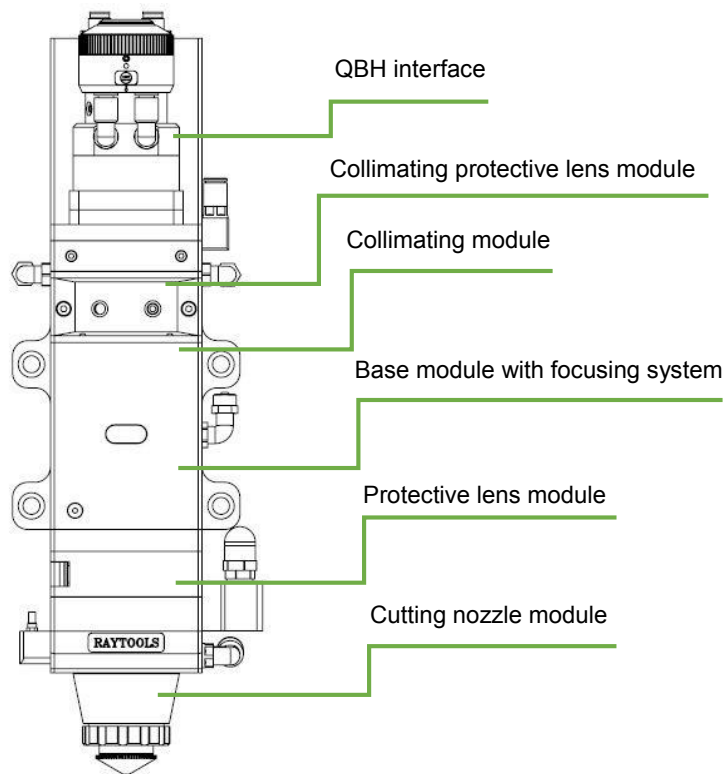


Fig 1 - laser head structure

1.1 Product Advantages

- Optimized optical configuration and smooth and efficient airflow design;
- Automatic focusing range + 10 ~ -15mm, adjustment accuracy 0.05mm;
- Equipped with D37 composite lens, the maximum fiber input power can carry 6KW;
- Maximum acceleration of focus lens driver 10m / s², maximum speed 10m / min;
- The drawer type lens holder make the replacement of protective lens more quickly and easier
- The composite lenses were used for collimation and focusing to obtain the best optical quality and cutting effect;
- Equipped with QBH, QD and other fiber interfaces can match with various fiber lasers.

1.2 Structure & Function

As shown in Figure 1, the laser head consists of four basic units, such as collimating module CM, focusing driving module, protective lens module and nozzle module.

- Collimating module: The collimation function of the optical fiber is collimated after the incident laser is collimated into a parallel beam and the function of tuning;
- Focusing driving module: The collimated beam is focused into a concentrator beam with high power density, and the focus position is automatically adjusted by the driving device;
- Protective lens module: the protective lens protects the focusing lens from damage by returning the slag and prolongs the service life of the focusing lens;
- Nozzle module: Guide the focus beam to the work piece and produce high velocity jet cutting to achieve high quality cutting

2 Machinery Installation

2.1 Mounting

BM114S laser machining head and the fixed mounting hole size and position of the machine tool are shown in Figure 3.1. Customers are advised to Install the laser head perpendicular to the machined surface as requested and make sure the laser head is locked, which is one of the premises to ensure the follow up sable cutting effect.



CAUTION: The Z-axis sliding base for fixing laser processing head should be connected with machine tools and keep a good grounding.

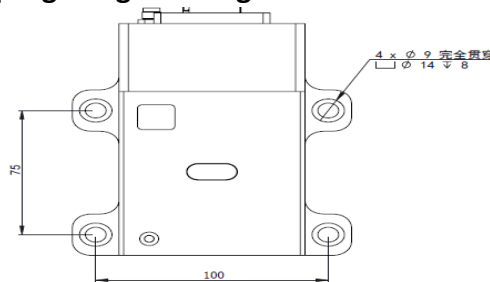


Figure 3.1 — Mounting

2.2 Connection of Water Pipe and Gas Pipe

2.2.1 Water-cooled interface

BM114S laser processing head has 3 sets of water-cooled channels which direction of water entry and exit can be arranged arbitrarily. It is important to note that when the laser power is greater than 500 watt, it is recommended to use water-cooled.as you can see from Figure 3.2, the position and amount of the water interface, and the right table details the recommended flow velocity.

The design of this water-cooled interface is closed loop water-cooled system, and it also can be used equipped with external water supplied but subjected to the requirements of the list.

Outer diameter of water pipe caliber	6mm
Minimum flow speed	1.8 l/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
Particles size available	Diameter less than 200 microns

2.2.2 Assist gas interface

The impurity in assist 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 firm below is the recommended auxiliary 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

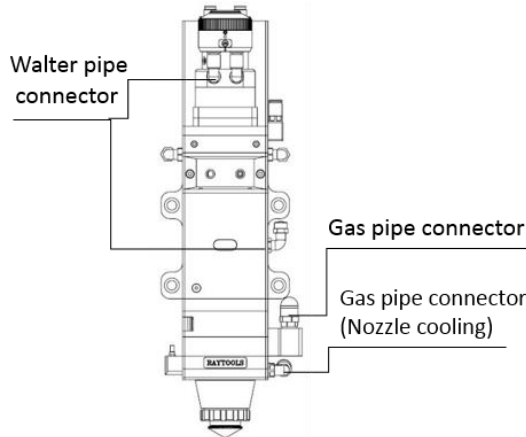


Figure3.2 — Water pipe, Gas pipe

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
argon	99.998%	<5 ppm	<1 ppm
helium	99.998%	<5 ppm	<1 ppm
Diameter of auxiliary gas pipe (Outer diameter)		10mm	
Diameter of cooled gas pipe (Outer diameter)		8mm	



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

2.3 Connection of Cutting Head Cable

This paper mainly introduces the connection between the cable and the cutting head. The control section of the driver and the connection refer to the wiring diagram of each series of system.

2.3.1 Connection of Cutting Head and Cable

Connect the corresponding connector of cutting head with motor power cable, encoder cable, sensor cable respectively (as shown in figure 3.3). After the proper length is reserved, the cable is inserted into the track groove of the machine tool and fixed.

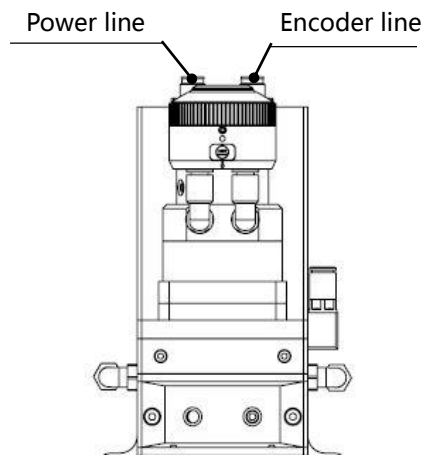


Figure 3.3 — Cable interface of laser head

2.3.2 Cable connection and drive connection

Connect motor power wire and encoder wire with the corresponding interface of driver according to the definition in cable sleeve.

CAUTION: The output signal of limiting sensor is NPN-NC;

CAUTION: All wiring is in the state of power failure, and the power can be debugged after inspection



2.4 Fiber Input Interface

BM114S is suitable for most industrial laser generators. It is equipped with collimator.

The connection between the end of the fiber and the cutting head is called fiber interface. Commonly used fiber connectors include QBH, QD, etc, and every fiber interface has its unique fixation method. Please refer to corresponding instruction of fiber interface. Figure 3.4 shows the installation interface of QBH connector.



WARNING: The optical devices must be kept clean and all dust must be removed before use. If the laser head is vertically inserted in the optical fiber, the laser head must be rotated 90 degrees to the horizontal level and then inserted into the optical fiber 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.

2.5 Fiber Insertion and Interface Direction Adjustment

In this paper, an optical fiber insertion method is described in conjunction with a QBH joint.

First, align the red point at the end of the QBH interface with the red point of the handwheel; then remove QBH dust proof cover and the red mark of fiber output end is aligned QBH red mark and insert straight to bottom; Then turn the QBH handwheel clockwise. It is in place when you hear the "Da" voice, then pull the handwheel up and turn clockwise again. (see Figure 3.4)

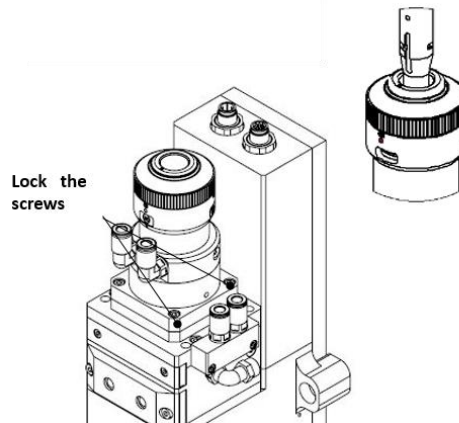


Figure 3.4 — Diagram of inserting fiber at the QBH interface

When the fiber connector is inserted into the interface, if the red dot on fiber is too far away from the red dot on laser head interface, causing an out of alignment insertion, you can refer to steps below to adjust the position of fiber interface on laser head for solving the problem. As shown in Fig. 3.4, unscrew the 4 locking screws of the position of the part icon with a wrench, rotate the QBH interface and screw the locking screws after the red mark is in place.

3 System Installation Commissioning

3.1 ETC_F100 Installation

3.1.1 Interface & Signal

Interface	Descriptions
CON1	DB15 female connector, interface to servo driver.
CON2	Interface for connecting external IO devices.
CON3	Interface to 24V DC power supply.
CON4	Interface for connecting external IO devices.

Pins of CON1 :

Pin	Descriptions
1	OUT_Servo_DA (Drive speed command)
2	Servo_TGON (Drive brake signal)
3	Servo_CLR (Drive alarm clear signal)
4	Servo_OS (Drive zero speed clamp, used to control motor lock shaft)
5	PGND (Power ground)
6	E1_A_N (Encoder A negative)
7	E1_B_N (Encoder B negative)
8	E1_C_N (Encoder C negative)
9	AGND (Analog ground)
10	Servo_ALM (Drive alarm signal)
11	Servo_SON (Drive enable signal)
12	VDD_24V (Power supply)
13	E1_A_P (Encoder A positive)
14	E1_B_P (Encoder B positive)
15	E1_C_P (Encoder C positive)

Pins of CON2 :

Pin	Descriptions
N/A	/
N/A	/
Alarm out	When alarm occurs, a high level signal is output, normally is high impedance state.
Home	Homing input signal, active high.
AGND	Common ground of analog signals, analog signals include: focus set input, focus feedback output.
Focus set	The input signal of focus setting, is analog.
Focus Feedback	Output the position of current focus, is analog.
Brake+	This signal is not connected (motor without brake)

Note : N / A is an undefined interface, please leave it blank.

Pins of CON4 :

Pin	Descriptions
Emergency Stop	When the accident occurs, press the emergency stop button to achieve emergency stop, 24V effective.
N/A	/
Focus IN Pos.	Output 24V when focus in position.
N/A	/
N/A	/
Focus Enable	High-level control focus on, low-level control focus off.
Down limit	The input signal of down limit, NPN.
Up limit	The input signal of up limit, NPN.

Note: N / A is an undefined interface, please leave it blank.

The above table shows only for factory default settings for the ETC-F100 controller.

3.1.2 Wiring

The motor is an ac servo motor, which is connected with 220V AC L and N at the driver terminals L1, L2, L1C and L2C. Details of connection method as shown in figure 4.1

Limit signal: the limit diagram is shown in figure 4.2.

Brown	White & Brown	Green	White & Green
+24V	0V	Up limit	Low limit

Note: the limit sensor is NPN-NC and it continuously outputs 0V signal when it is not triggered.

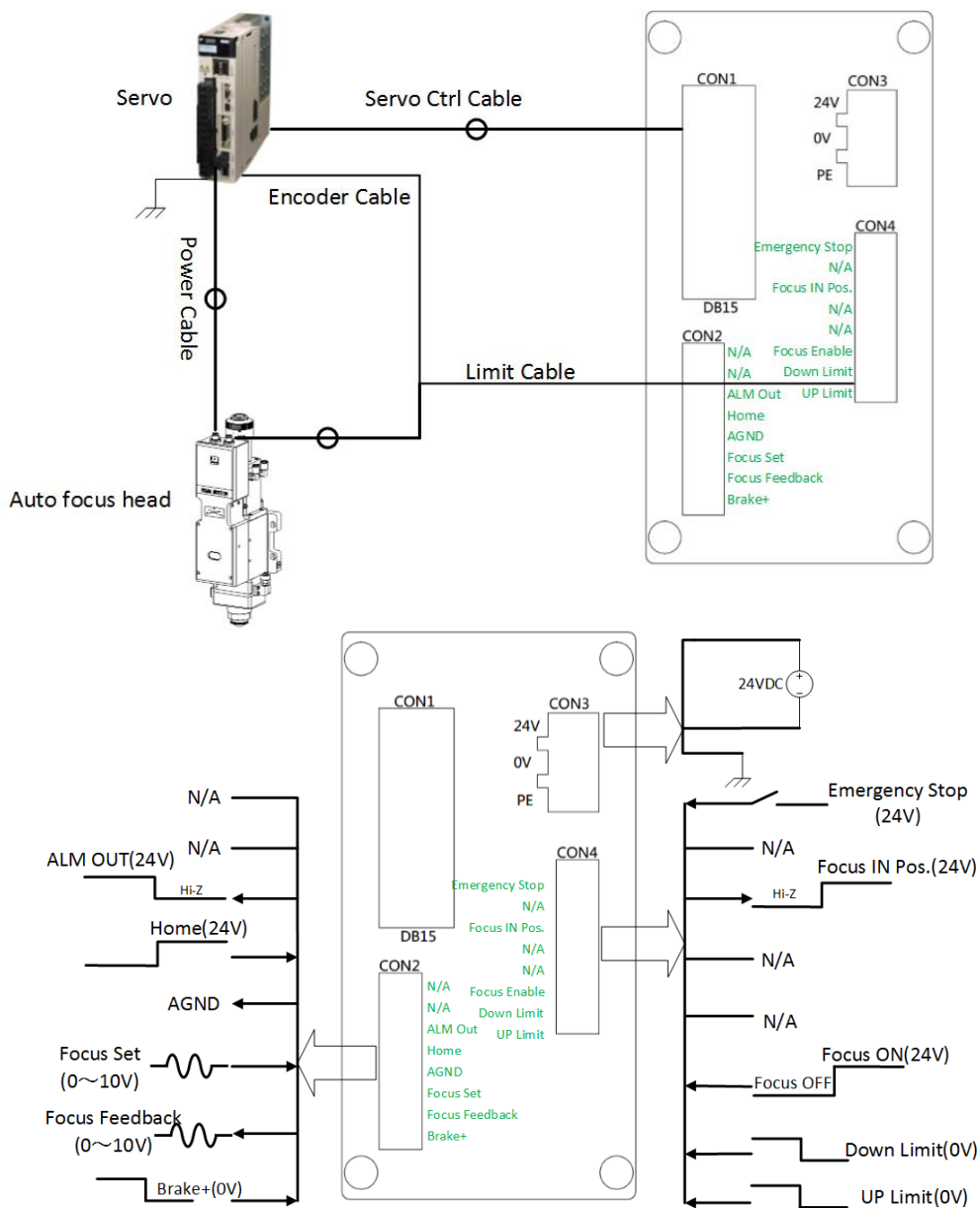


Figure 4.1—ETC_F100 Wiring instruction

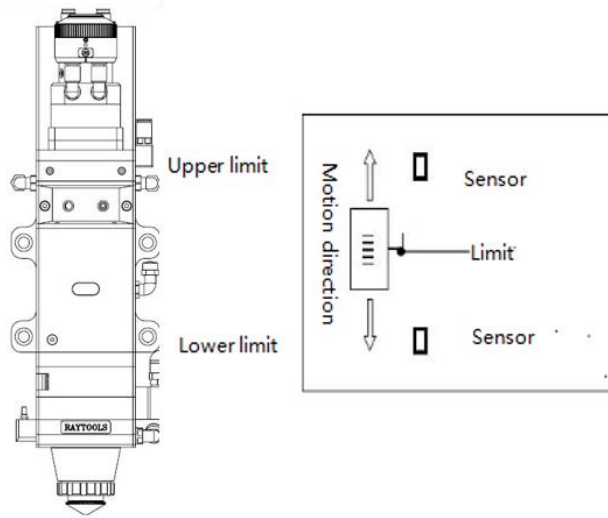
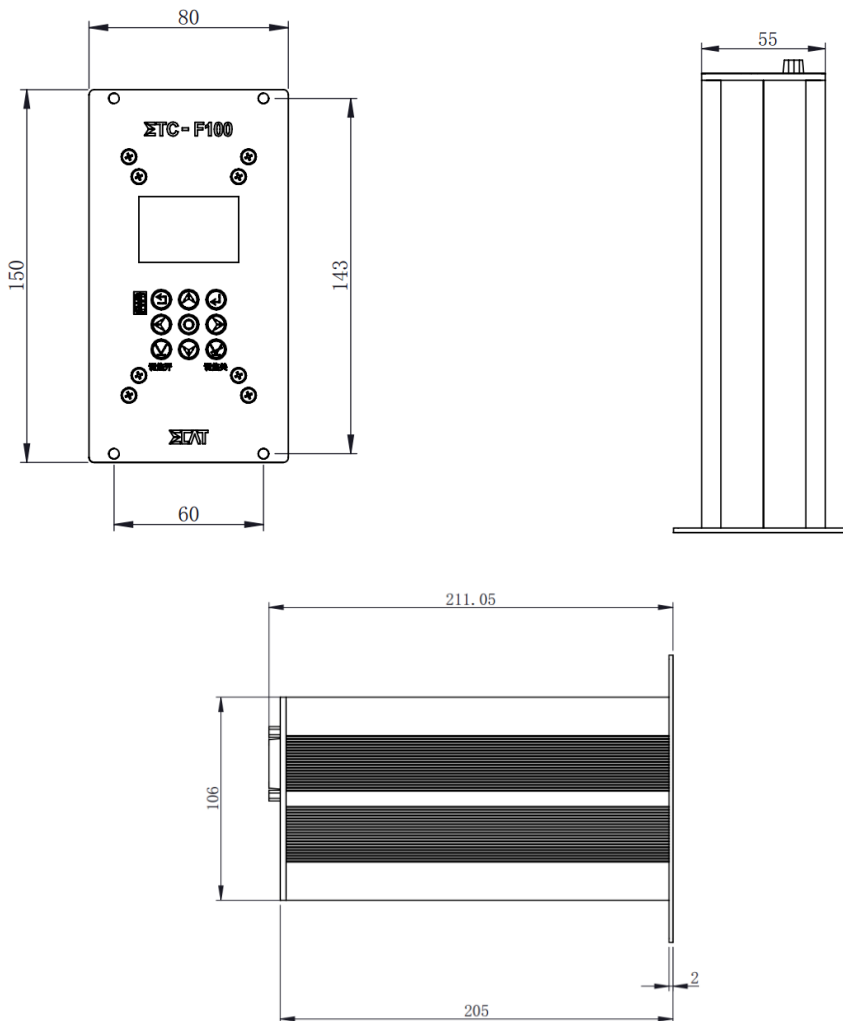


Figure 4.2—limit diagram

3.1.3 Dimension of ETC_F100



1.1 Figure 4.3 —Overall size of ETC-F100 controller (unit: mm)

3.1.4 Dimension of Drive

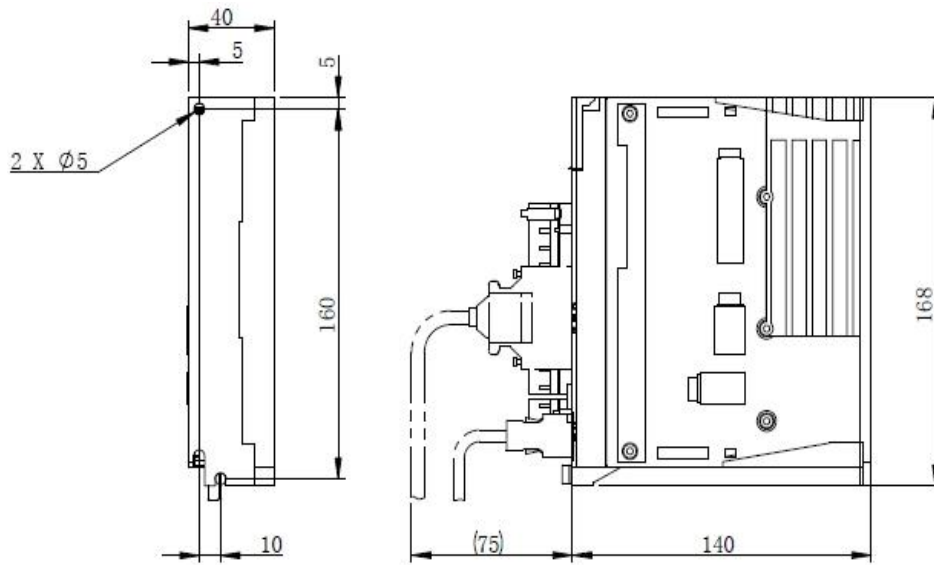


Figure4.4 —Overall size of drive (unit: mm)

3.2 FSCUT (BC) with position mode

3.2.1 Wiring

The motor is AC servo motor, which should connect the end of the drive L1, L2 , L1C and L2C to AC 220V L and N. Please refer to figure 4.5 for the wiring connection mode and figure 4.4 for the driver installation size

Limit signal: As shown in figure 4.2

Brown	White & Brown	Green	White & Green
+24V	0V	Up limit	Low limit

Note: The limit sensor is NPN-NC and it continuously outputs 0V signal when it is not triggered.

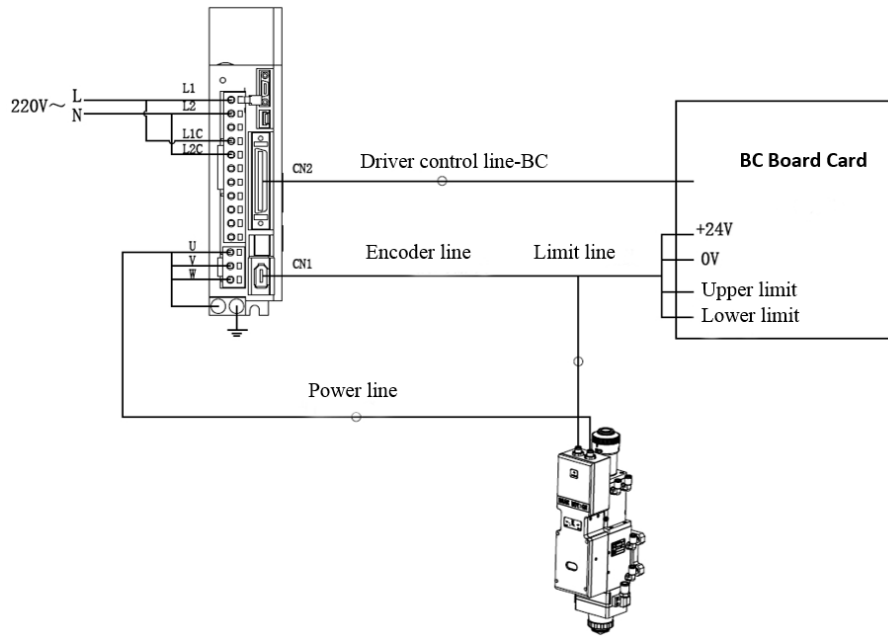


Figure4.5 — Position loop FSCUT wiring diagram

Open the platform configuration tool, enter the value shown in Figure 4.6

1. Set parameter as the figure (only for reference).
2. Select J axis for detection, open loop and initiate enable to travel and detect the encoder in (-14mm~+10mm) to determine the encoder direction.
3. Save the parameters and enter the interface

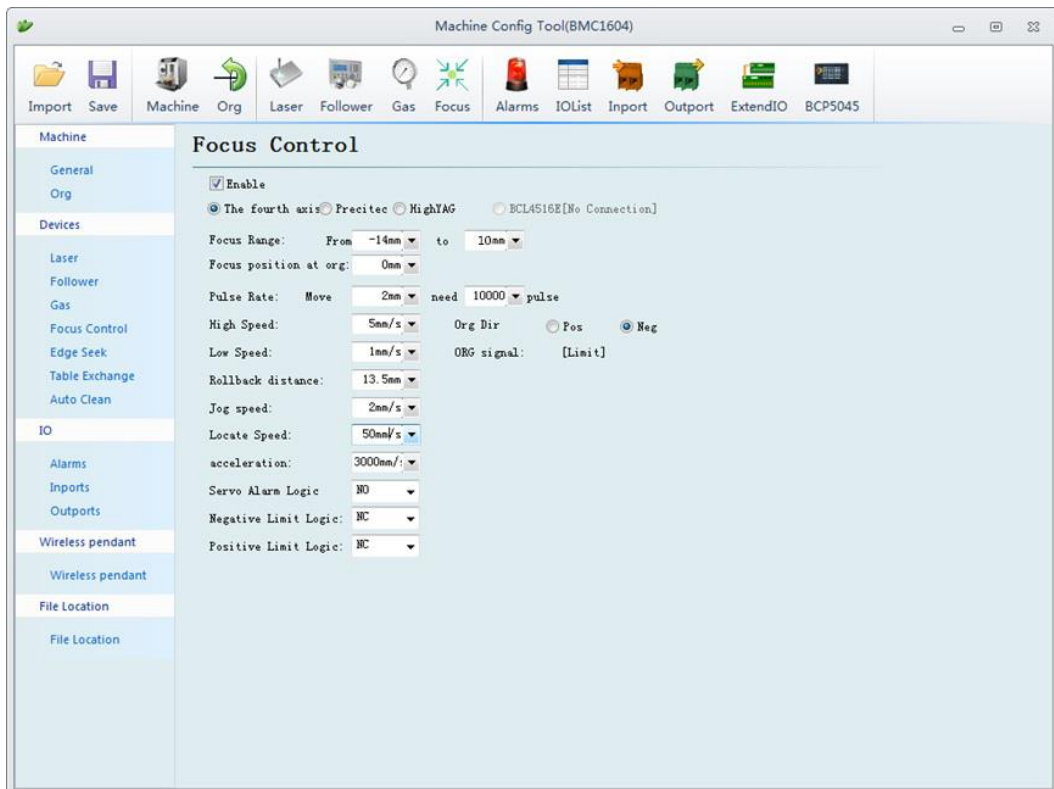


Figure 4.6 — Platform configuration tools

3.2.2 Interface Operation

1. Move J axis to check if the action is normal (“thread pitch” and direction), J+ indicates scale 0+.
2. Slowly moving the J axis so that it meets the positive and negative limit, check whether the direction and limit signal are normal or not.
3. By click homing icon, J axis moves to negative direction and do 2nd homing when touches negative limit. In this case the position of zero point coincides with zero focal position. The homing is finished.

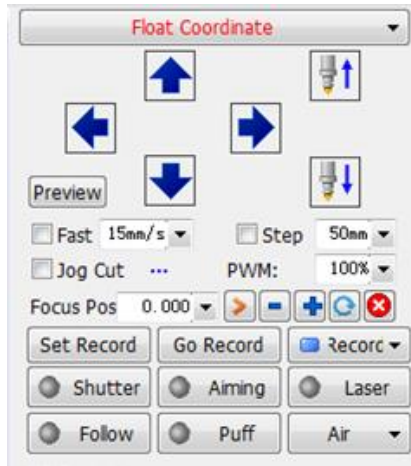


Figure 4.7— Operation

Note:

1. Click+, the lens holder moves upward. When it touches positive limit, click -, then lens holder moves downward to the negative limit.
2. The direction of origin is negative, and take lower limit as a sampling signal.
3. Pitch 2mm, 10000 pulses per turn
4. Positioning speed is recommended 50-100mm/s.

3.3 FSCUT (BC) with velocity mode

3.3.1 Wiring

1. The motor is AC servo motor, which should connect the end of the drive L1, L2 , L1C and L2C to AC 220V L and N. Please refer to figure 4.8 for the wiring connection mode and figure 4.4 for the driver installation size
2. Limit Signal: As shown in figure 4.1

Brown	White & Brown	Green	White & Green
+24V	0V	Up limit	Low limit

Note: The limit sensor is NPN-NC and it continuously outputs 0V signal when it is not triggered.

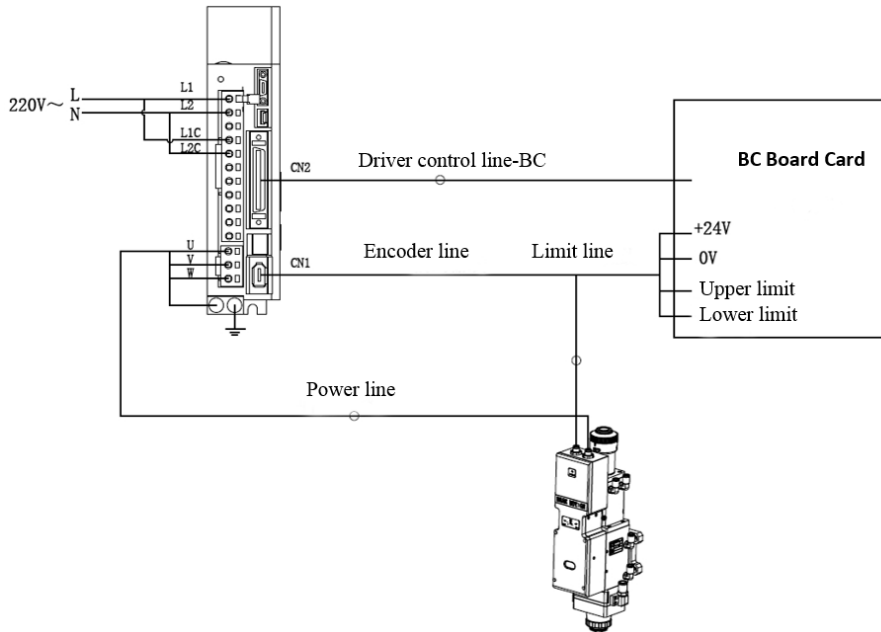


Figure 4.8 — Velocity loop - FSCUT wiring diagram

3.3.2 Software settings

The axis parameter settings are shown in Figure 4.9. (only for reference)

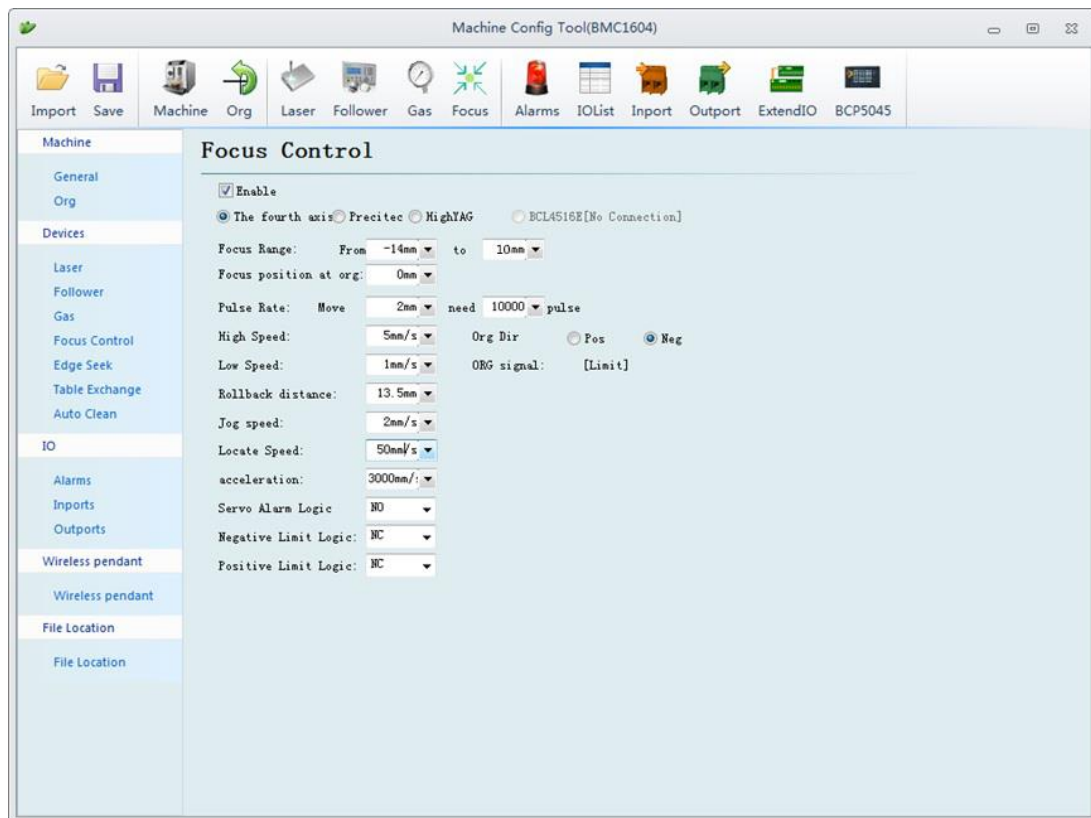


Figure 4.9— Platform configuration

Entry J axis detection, “closed loop and initiate enable”. Move J axis to see whether the action is normal. Scale 0+ indicates J+. Check encoder and speed.

3.3.3 Interface Operation

1. Move J axis to check if the action is normal (“thread pitch” and direction), J+ indicates scale 0+.
2. Slowly moving the J axis so that it meets the positive and negative limit, check whether the direction and limit signal are normal or not.
3. By click homing icon, J axis moves to negative direction and do 2nd homing when touches negative limit. In this case the position of zero point coincides with zero focal position. The homing is finished.

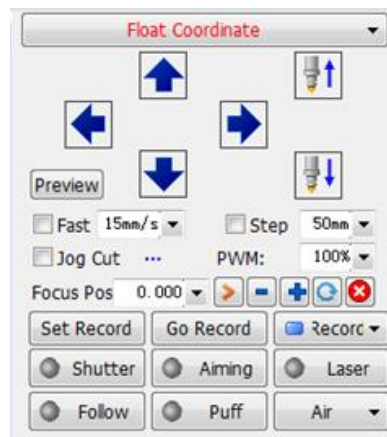


Figure 4.10— Operation interface

Note:

1. Click+, the lens holder moves upward. When it touches positive limit, click -, then lens holder moves downward to the negative limit.
2. The direction of origin is negative, and take lower limit as a sampling signal.
3. Pitch 2mm, 10000 pulses per turn.
4. Positioning speed is recommended 50-100mm/s.

4 Beam Adjustments and Focusing

4.1 Beam Adjustments (QBH interface)

Cutting quality in a great extent depend 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 centering operation should be considered when nozzle is replaced or the cutting quality is decreased.

Lens centering of laser cutting head can be finished by adjusting Collimating mirror, X-Y direction. The adjusting screw is located on the top of the cutting head as shown in Figure 5.1.

By using inner hexagon spanner can loosen or screw the adjusting screw 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 tape dotting method:

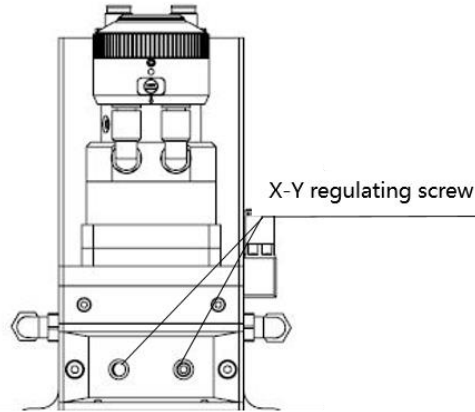


Figure 5.1 — Beam center regulation

Pick a scotch tape, flatten it, and attach it to the center of nozzle which directly below the hole end face;

Open the inner guiding red light of the laser. Find and observe the position of nozzle center that the red light in the scotch tape relative to;

Next open and adjust laser generator at the range of 80W-100W and dot manually.

Tear off the tape and check the hole in the center of the nozzle;

Repeat the above steps to find the optimum relative nozzle center position of the beam;

This adjustment requires a series of adjustments, which is the basic operation of general laser tuning.

4.2 The Focus Position Adjustment

BM114S is equipped with automated focusing system. But it still need dot manually to redecide the focus position when it reset of replacement of lenses, lasers. For details about operating system parameters, please refer to the system instructions.

Manual focus can refer to the following steps:

1. The laser head scale is displayed to the maximum, and the laser power range is set to 80-100w;
2. Then, within each moving 0.5mm (as small as possible), open a laser hole on the textured paper;
3. Drilling several times, finally compare and find out the scale corresponding to the smallest hole is zero coke, that is, the focus is just at the end of the nozzle section.

5 Maintenance

5.1 Cleaning Lens

It's necessary to maintain lenses regularly because of the characteristic of laser cutting process. Once a week cleaning the protective lenses is recommended. The collimating lenses and focusing lenses are recommended to clean once every 2~3 months. In order to facilitate the maintenance of the protective lens, the protective lens holder adopts a drawer type structure. (Figure 6.1)

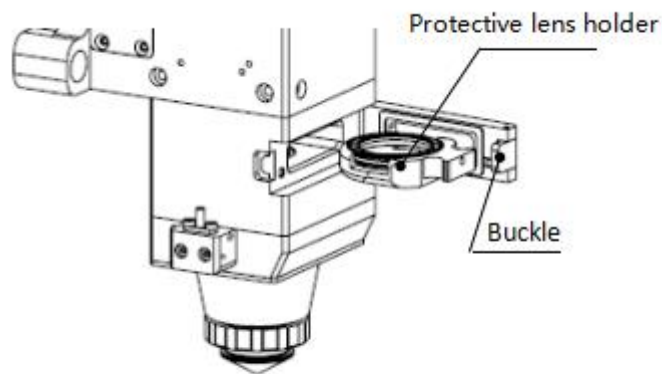


Figure 6.1 — Take out protective lens

Lens cleaning

a. Tools: Dust-proof gloves or finger stall, long fiber cotton stick, ethanol, rubber gas blowing.

b. Cleaning instruction:

1. The left thumb and index finger with fingertip;
2. Spray ethanol onto the absorbent cotton stick
3. Hold the slide edge of the lens with left thumb and index finger gently.(note: avoid the fingertip touching the surface of the lens)
4. Put the lens facing to eyes, hold the absorbent cotton stick with the left hand. Wipe the lens gently in single direction, from bottom to top or from left to right, (Should not be able to wipe back and forth, so as not to secondary pollution of the lens) and use rubber blowing to sway the surface of the lens. Both sides should be cleaned. After cleaning, make sure that there is no residual: detergent, absorbent cotton, foreign matter and impurities.

5.2 Removal and Installation of Lenses

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

5.2.1 Removal and Installation of Collimating Protective Lenses

The protective lens is a fragile part and need to be replaced after damage.

- As shown in Figure 6.1, open the buckle, open the cover of protective lens, pinch the two sides of the drawer-type lens holder and pull out the base of protective lens;
- Remove the pressure washer of the protective lens , remove the lens after wearing fingertips
- Clean the lens, lens holder and seal ring. The elastic seal ring should be replaced if damaged.
- Install the new cleaned lens (Regardless of the positive or negative side) into the drawer type lens holder.
- Put the pressure washer of the protective lens back.
- Insert the protective lens holder back to the laser processing head, cover the lid of the protective lens and fasten the buckle.

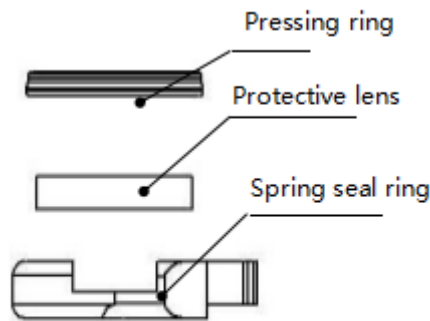


Figure 6.2 — Structure of protective lens

5.2.2 Removal and Installation of Collimating Lenses

The collimating protective lenses are a fragile part and need to be replaced after damage.

- Use a 2.5mm inner hexagon spanner to unscrew the screw of collimating protective lens (as shown in figure 6.3);

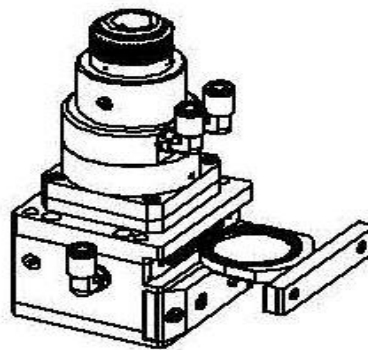


Figure 6.3 — Take out collimating protective lens

- Remove the gland of collimating protective lens, pinch the two sides of the drawer-type

- lens holder and pull out the base of protective lens;
- Seal the part connected with the components of collimating protective lens with textured paper so as to prevent the entry of dust;
- Wear the fingerstall and take out the lens;
- Clean the lenses, lens holder and seal rings, for example, replace a new one for the damaged elastic seal ring;
- Install the new lens (regardless of the front and back sides) wiped clean into the drawer-type lens holder;
- Re-install the seal ring;
- Re-insert the collimating protective lens holder to the laser processing head, cover the lid of collimating protective lens and tighten the locking screw.



Note: It is not allowed to directly pull out of the edge of the elastic seal ring, which will damage the elastic seal ring very easily.

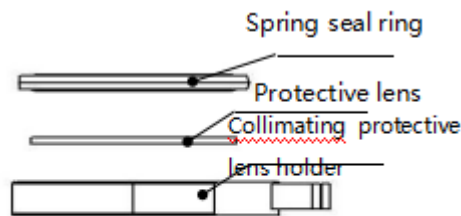


Figure 6.4 — Structure of collimating protective lens

5.2.3 Removal and Installation of Collimating Lenses

- Removal and installation of collimating lenses refer to the following steps:
- Remove the laser head and move to a clean place. Clean all dust on the laser head surface;
- Use a 3mm internal hexagonal wrench to unscrew the locking screws of the collimating components (as shown in Figure 6.5), seal the part connected with the components of collimating components with textured paper so as to prevent the entry of dust;
- Screw out the collimating lens holder, and remove the spring compression ring and collimator lens with the lens-removing tools;
- Replace or clean the collimating lenses.
- As shown in Figure 6.6, reassemble the components of collimating lens in order, pay attention to screw the spring compression ring appropriately with force, and re-screw it into the collimating components;
- Lock the screws of the collimating components;
- Check whether the focus position is in the center of the nozzle hole before use, if it is not in the center, it is necessary to carry out center-regulating operation again.

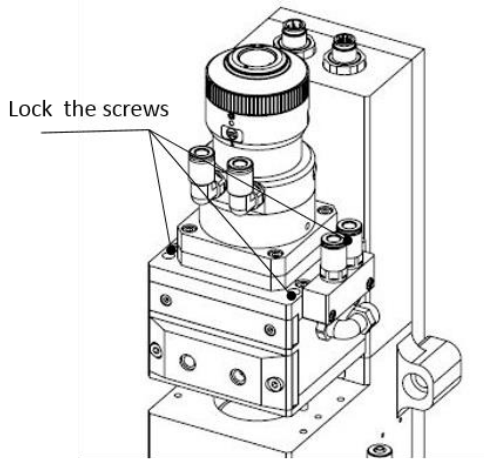


Figure 6.5 — Dismantle collimating component

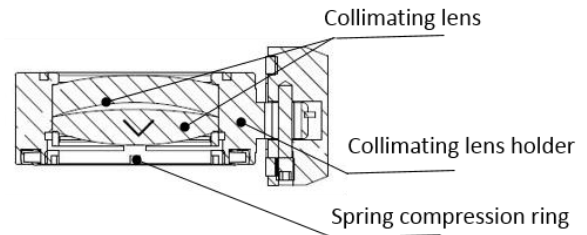


Figure 6.6 — Installation diagram of collimating lens

5.2.4 Removal and Installation of Focus Lenses

- Removal and installation of focus lenses refer to the following steps:
- Remove the laser head and move to a clean place. Clean all dust on the laser head surface;
- Place the laser head horizontally. As shown in Figure 6.7, remove the locking screws from bottom to top;

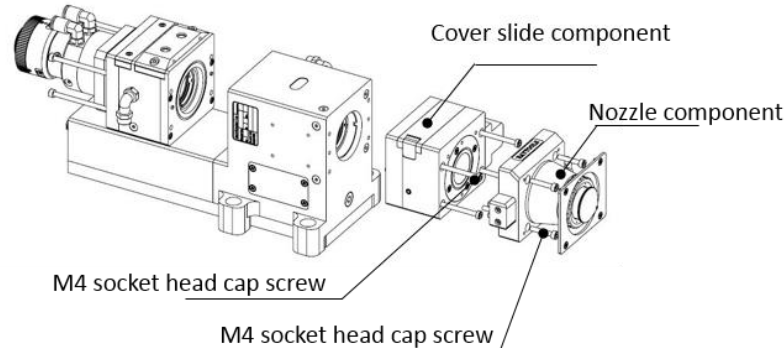


Figure 6.7 — Framing

- As shown in figure 6.8, use a lens-taking tool to remove the focus lens holder;
- Remove the spring pressure washer and lens with a lens taking tool;
- Replace or clean the focus lens.
- As the direction (arrow) shown in figure 6.9, put the focusing lens and the spring pressure washer in the lens holder carefully and tighten the pressure washer properly;
- Spin the focus lens holder back to focus lens barrel and tighten it;
- As the sequence shown in figure 6.7, reassemble and lock the screw.
- Check if the focus position is at the center of nozzle. If not, you need to refer to the 3.1 step to reset the operation.

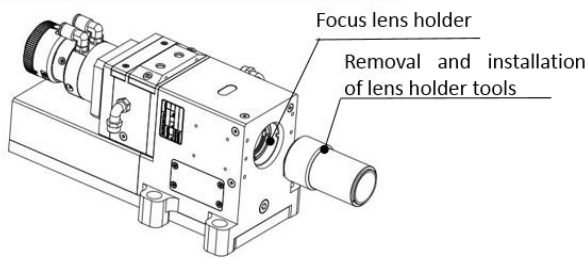


Figure 6.8 — Removal and installation of lens

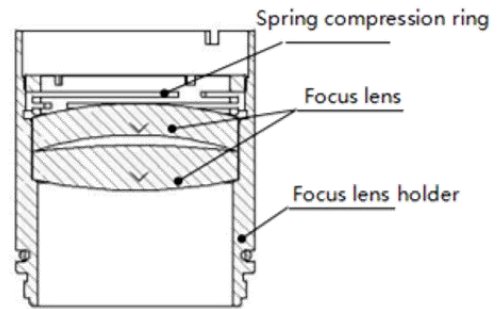


Figure 6.9 — Installation diagram of focus lens

5.3 Replace Nozzle Connector

In the laser cutting process, the laser head will inevitably be hit, so it is necessary to replace the nozzle connectors.

5.3.1 Replace Ceramic Body

- Unscrew the nozzle;
- Press the ceramic body with hands, make it fixed and not oblique, and then screw off the pressing sleeve;
- Align the pin hole of the new ceramic body with 2 locating pins, press the ceramic body with the hand and screw on the pressuring sleeve;
- Screw on the nozzle and tighten it with appropriate strength.

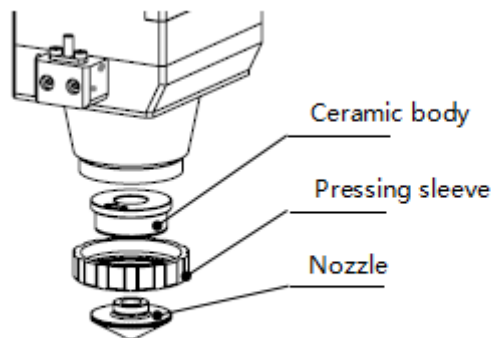


Figure 7.0 — Replace the nozzle connector

5.3.2 Replace Nozzle

- Unscrew the nozzle
- Replace with a new nozzle, and re-tighten it with appropriate force.
- Do the capacitance calibration once again after replacing the nozzle or ceramic body.

5.4 Troubleshooting of Driver

5.4.1 Alarm information

These following alarm information may happen on ETC_F100 :

1、Up or Down Limit Alarm

This alarm is generated when the system detects a sensor signal of the Z-axis up limit or down limit. If not meet the requirements, please reset the sensor position. If the alarm is always displayed, please check:

1. Limit signal is not connected to the ETC-F100;
2. Whether the sensor is obscured by unknown objects; ;
3. Limit sensor installed improperly (this possibility is minimal);
4. The limit signal is disturbed. At this time, the corresponding limit signal may flicker in the function test, especially after the machine tool is enabled. The ETC-F100 and the 24VDC limit signal can be independently powered. Add a filter for 220V AC power supply of the Servo drive, and ensure good grounding.

2、Home first

After the system is powered on, the controller needs to home to establish a coordinate system. If do not home, the screen will display "Home First" Can be solved by the following methods: :

1. Control by keyboard of the ETC_F100 .
2. Select "Yes" and save in the "Auto Homing" menu.
3. By the interface of "Home".

3、Exceed Z-axis Travel

This alarm is generated when the actual Z-axis coordinate exceeds Z-axis travel distance or less than 0. When this alarm occurs, please note:

1. Whether Z-axis travel settings are appropriate;
2. Whether the position of dial over travelled.

4、Servo Alarm

Under normal circumstances, when the servo alarms, “servo alarm will be displayed. If the drive is normal, an alarm is displayed, it may be caused by the following conditions:

1. Incorrect wiring of servo drive ;
2. External interference.

5.5 Common Problem Analysis

5.5.1 Servo calibration process terminated abnormally

- 1 Up limit triggered by dial

This error occurs when servo calibration is executed when the up limit triggered by dial.

- 2 The dial position is near the up limit.

The dial position near the up limit (about 1mm), this situation will occur when servo calibrating. In the event of the above problems, please jog the focus to the middle of the stroke (more than 1mm), and then execute servo calibration.

5.5.2 The screen is abnormally displayed

External interference may cause the screen to display abnormally. Please reboot the ETC-F100 when this abnormality occurs.

5.5.3 Z-axis coordinate drift

In the static state, the Z-axis coordinate changes continuously and slowly, at this moment, the servo calibration should be carried out.

5.5.4 Input signal jitter or invalid

If the input signal is invalid or jittered, enter the I / O port detection interface of the function test, directly connect 24V (Active-high) or 0V (Active-low) of the 24V DC power supply to the corresponding input port, and observe whether the corresponding number is inverted:

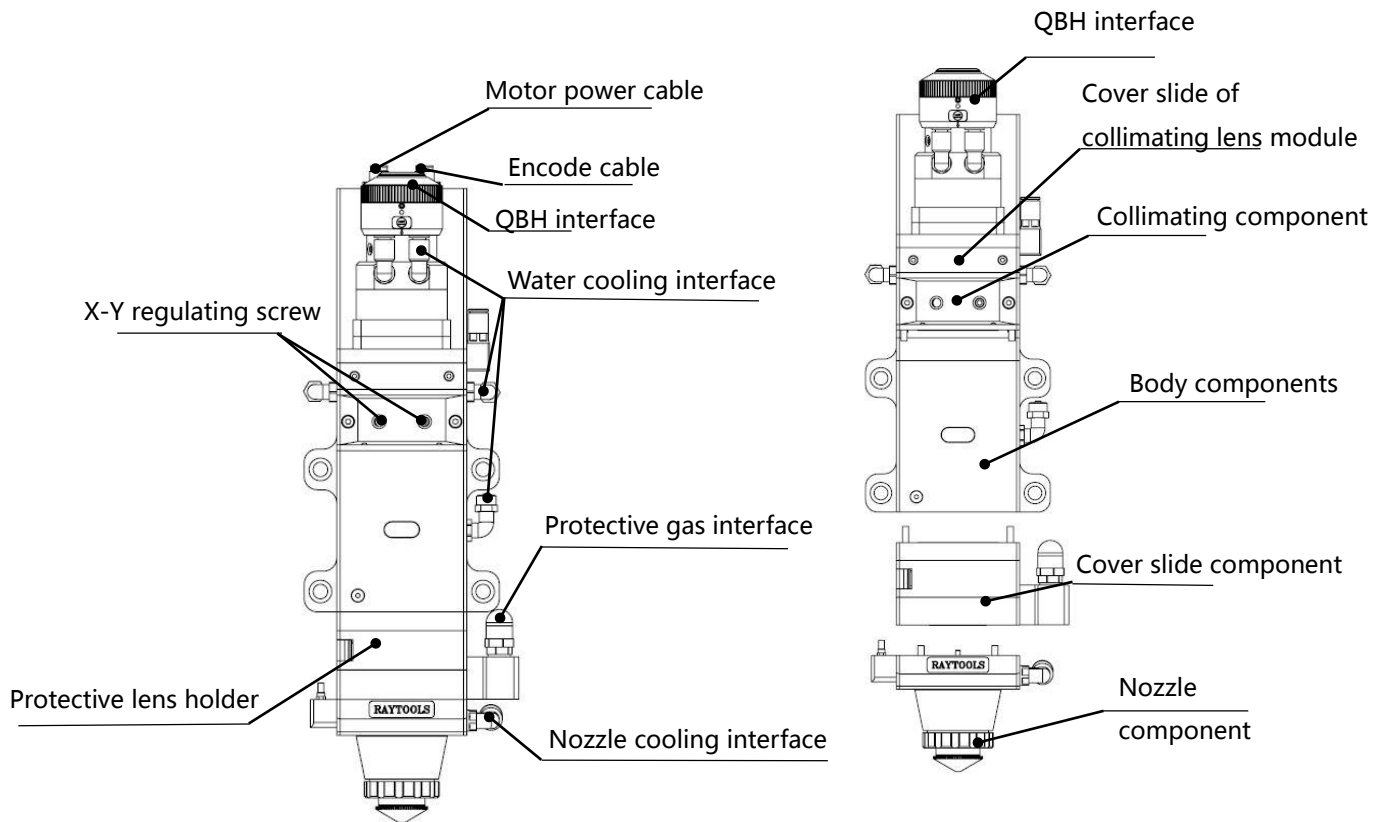
For active-high input signal, 24V can be directly connected to the corresponding input port, if the corresponding number is inverted, then the hardware is normal.

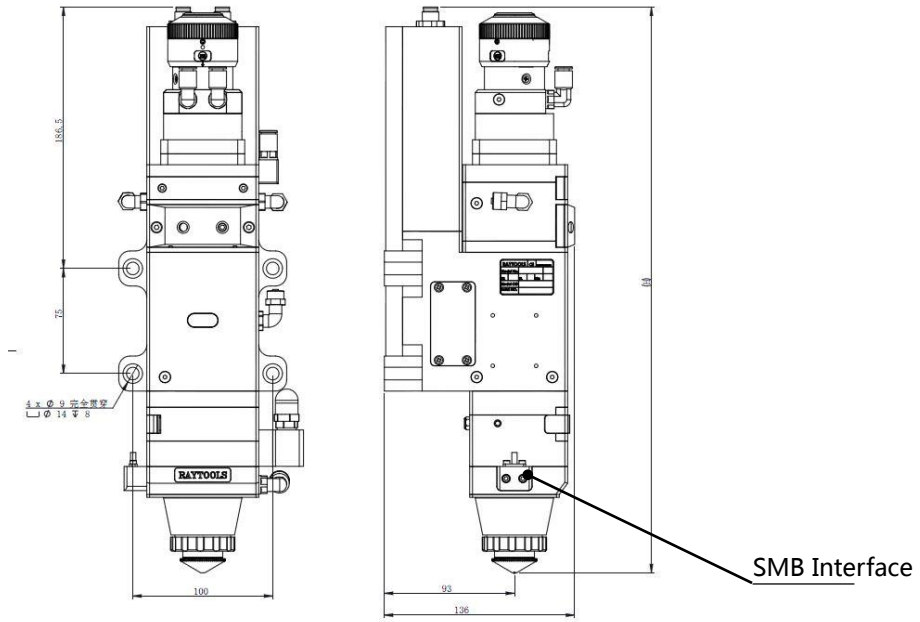
For active-low input signal, 0V can be directly connected to the corresponding input port, if the corresponding number is inverted, then the hardware is normal.

After ensuring the hardware is normal, access the input signal. If the number is jittering, the input signal may be unstable. Please make sure that the 24V power of the input signal is common with the ETC-F100 power supply. Please exclude the external interference and test again. If the number is not inverted, please check whether the input signal is valid.

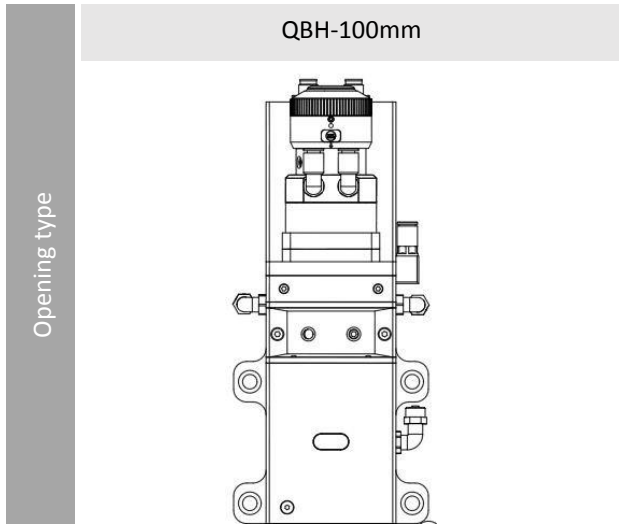
6 Mechanical and Optical Configurations Diagram

6.1 Cutting Head Shape





CL/mm		100	
FL/mm		150	200
H/mm	QBH	403	440



6.1.1 Focus length

