



# BM111 SERIES

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3KW Auto-Focusing Laser Cutting Heads User Manual

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<b>Version:</b>	<b>V1.0</b>
<b>Date:</b>	2017/12/22

Historical Version:

Historical Version	Date of Release	Brief description of alteration	Editor	Date of Edit	Reviewer	Date of Review
V1.0	2017/12/22	Establish BM111 User Manual	Luyuan	2017/12/19	Alex Li	2017/12/22

Thank you for choosing our products!

This manual makes a detail introduction about the use of BM111 series auto-focusing laser cutting heads, including installation, operation and maintenance instructions etc. If you have other things need to know, please contact us directly.

Please read the manual carefully before using the series cutting heads. This will help you use it better.

Due to the continuous updating of product features, please note the product you have received may differ in some aspects from the illustrations in this manual. We apologize for the inconvenience to you.

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# 1 Introduction

This manual includes the general description, basic installation, factory settings, operation and maintenance services and other aspects of BM111 series products, which have too many optical and mechanical customization configurations, so only the main parts will be introduced in this manual.

The BM111 series laser heads are auto-focusing cutting heads for fiber laser, which are released by Switzerland RAYTOOLS AG in 2017. The products are equipped with internal servo motor drive units, which use the linear mechanism to drive the focusing lens to change position in the range of about 22mm 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 thickness, material 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, optimized optical and water-cooled design allows the laser heads work under high power for a long time continuously and steadily.

## 1.1 Product Features

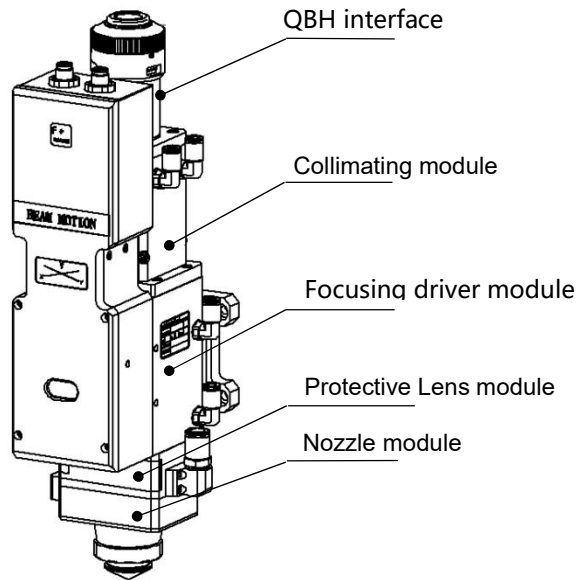
- Optimized optical configuration and smooth and efficient airflow design;
- Automatic focusing range + 10 ~ -12mm, adjustment accuracy 0.05mm;
- Equipped with D30 composite lens groups, the maximum fiber power is up to 3KW;
- Maximum acceleration of focus lens driver  $10\text{m} / \text{s}^2$ , maximum speed 10m / min;
- The drawer-type of lens mount makes the replacement of protective lens more quickly and easier;
- The composite lens groups are used for beam collimating 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, focusing driver module, protective lens module and nozzle module.

- Collimating module: Can collimate the incident laser into a parallel beam and adjust the beam spot from the center of the nozzle;

- 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 driving device automatically;
- Protective lens module: The protective lens protects the focusing lens from damage by the returning 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.



**Fig 1 - laser head structure**

## 2 Product Configuration

### 2.1 Configuration Type

Code	Fiber interface type	Collimating lens type	Focus lens type
BM111A01A	QBH	100YYH	125YYH
BM111A02A	QBH	100YYH	155YYH

### 2.2 Packing List

Name	Quantity
Laser cutting head	1
Driver	1
Controller	1
Power cable	1
Encoder cable	1
Control cable	1

**Note:** The above form is only for standard factory configuration.

## 2.3 Cutting Head Shape

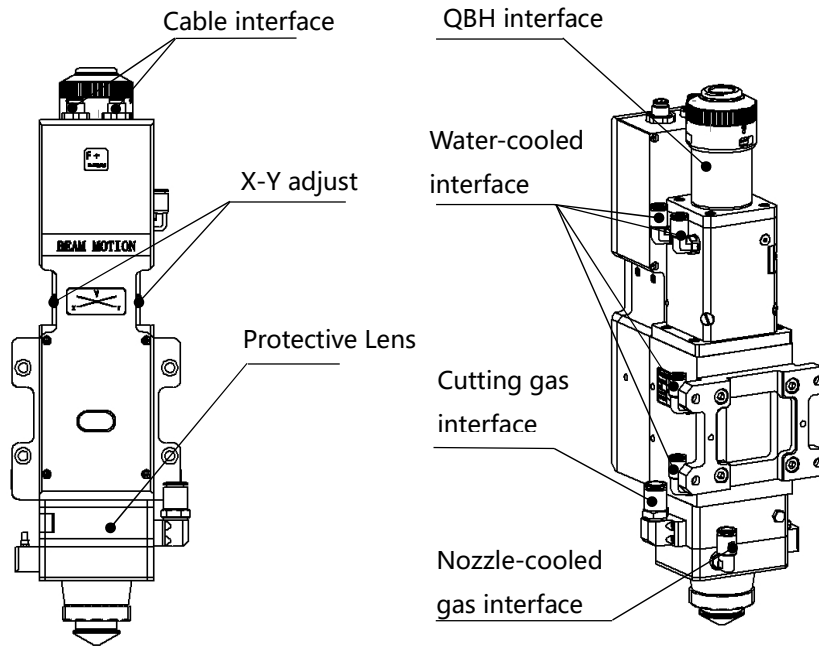
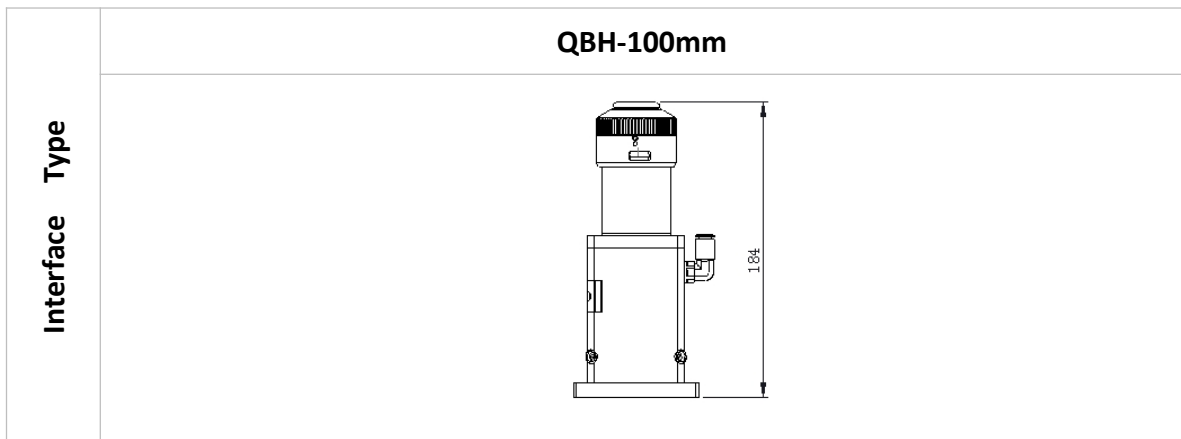


Fig 2.1 – Cutting head shape of BM111

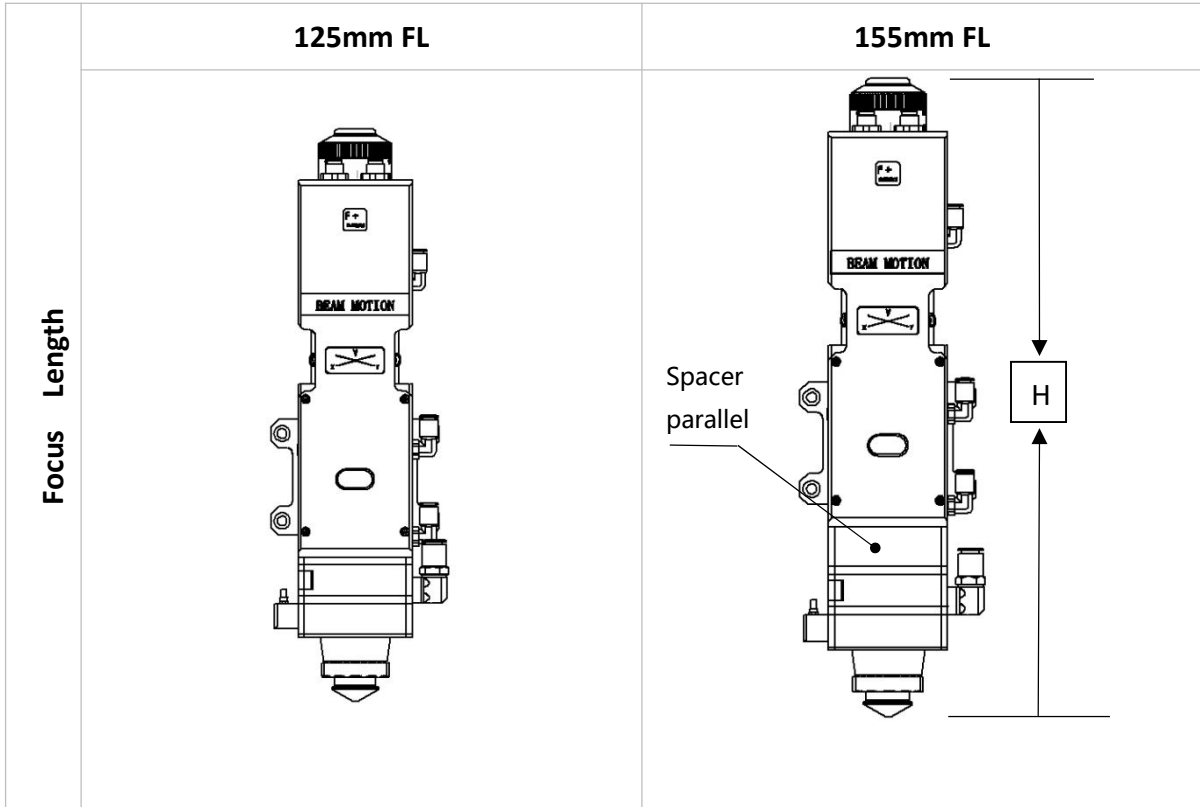
## 2.4 Cutting Head Configuration Diagram

### 2.4.1 Interface Type





## 2.4.2 Focus length

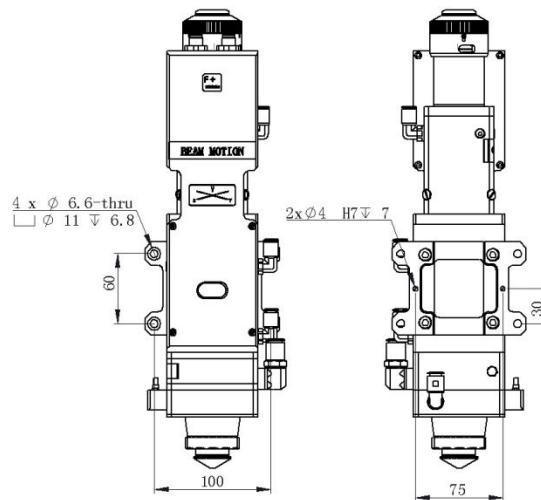


MODE	BM111001A	BM111002A
dCL/mm	100	
FL/mm	125	155
H/mm	393	417.8
Weight/KG	6.28	6.3

## 3 Mechanical Installation

### 3.1 Mounting Holes

The mounting holes size and position of the BM111 laser cutting head are shown in Figure 3.1, which can be used to fix the laser head and machine tool. We strongly recommend customers to install the laser head perpendicular to the process material surface as requested and make sure the laser head is locked, this is one of the preconditions to ensure the follow-up stable cutting effect.



**Fig 3.1 - mounting holes position**



**Note:** The Z-axis motor slide plate for fixing the laser cutting head should be connected with machine tools and make sure there is a good grounding.

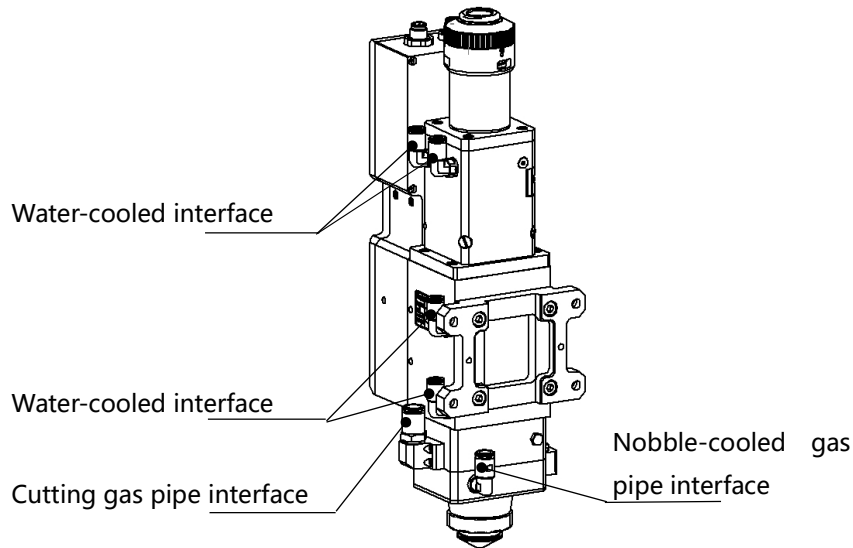
### 3.2 Connection of Water Pipe and Gas Pipe

#### 3.2.1 Water-cooled interface

BM111 laser cutting head has 2 sets of water-cooled channels, the 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, we recommend users to use water-cooled. As you can see from Figure 3.2, the position and quantity of the water interfaces, and the table below details the recommended water flow rate.

The design of this water-cooled interface is closed loop water-cooled system, and it also can be

used equipped with external water supplied, the precondition is to meet the requirements in the list.



**Fig 3.2 - position of water pipe and gas pipe interfaces**

<b>Cooling water pipe diameter(outside diameter)</b>	6mm
<b>Minimum flow speed</b>	1.8 l/min(0.48gpm)
<b>Entry pressure</b>	170-520kPa(30-60 psi)
<b>Entry temperature</b>	≥room temperature / > dew point
<b>Hardness (relative to CaCO3)</b>	< 250mg/liter
<b>PH range</b>	6 to 8
<b>Particles size available</b>	Diameter less than 200 microns

### 3.2.2 Assist gas interface

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 work piece. The following table is the recommended cutting gas specifications. The higher the purity of the gas, the better the quality of the cutting section.

Impurities can be filtered out in gas supply tube, but Oxygen and water vapor can permeate light path through non-metallic materials, which is the source of the appearance of dust and hydrocarbons. Stainless steel fittings are recommended, at the same time customers must use

filters which can remove a minimum of 0.01 micron particle to purify.

We recommend customers to use the pressure gauges with stainless steel diaphragm. Industrial pressure gauges suck in air. Rubber diaphragm produces hydrocarbons by aging or other factors.

About the nozzle cooling gas, Nitrogen or finely filtered air is recommended. The pressure should be less than 10 bar. Do not use oxygen as a cooling gas.

Cutting 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

Tracheal tube diameter specification	
Cutting gas pipe diameter ( outside diameter )	10mm
Cooling gas pipe diameter ( outside diameter )	8mm



**Note:** Gas interfaces can not 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.

## 3.3 Connection of Cutting Head Cable

### 3.3.1 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.

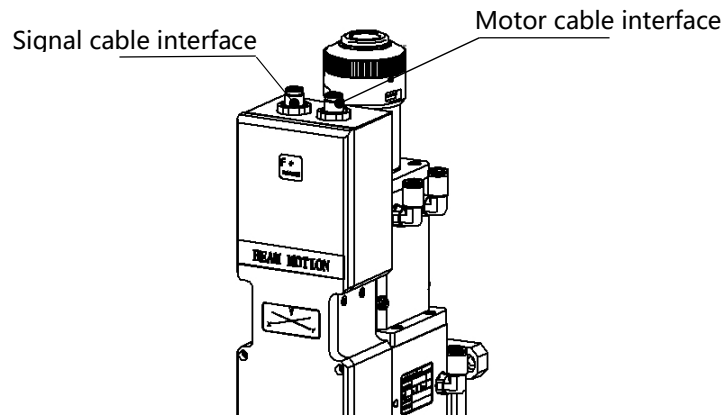


Fig 3.3 - cable interface of laser cutting head

### 3.3.2 Connection of Cable and Driver

Connect motor power cable and signal cable with the corresponding interfaces of driver according to the definition in cable sleeve. **(Note: The low level output of the limiting sensor is normally closed output mode.)**



**Note:** All wiring is in the state of power-off, and the power can be debugged after inspection.

### 3.4 Fiber Input Interface

BM111 is suitable for most industrial fiber lasers. It is equipped with collimating lens assembly.

The connection between the end of the fiber and the cutting head is called fiber interface. Commonly used fiber connectors include QBH, QD and so on, and every fiber interface has its unique fixation method. Please refer to corresponding instruction of fiber interface. Figure 5 shows the installation interface of QBH connector.



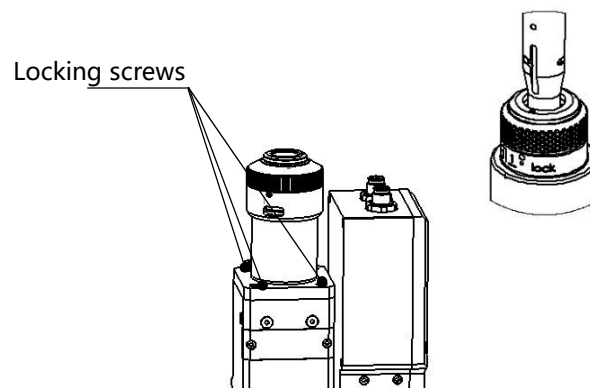
**Note:** The optical devices must be kept clean and all dust must be removed before use. If the optical fiber is vertically inserted in the laser head, the laser head must be rotated 90 degrees to the horizontal level and then inserted the optical fiber in it to prevent dust from entering the interface and falling on the surface of the lens. Insert the optical fiber before fixing the laser head.

## 3.5 Fiber Insertion and Interface Direction Adjustment

In this section, an optical fiber insertion method is described in conjunction with QBH connector.

First, align the red point at the end of the QBH connector with the red point of the handwheel; then remove QBH dust proof cover ,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 3.4 )

When the fiber interface insert 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, users can refer to these steps below to adjust the position of fiber interface on laser head for solving the problem. As shown in Fig. 3.4, loosen the 4 locking screws of the part with a wrench, rotate the QBH interface , then tighten the locking screws after the red mark is in place.



**Fig 3.4 - Schematic diagram of fiber interface insert in QBH connector**

## 4 ETC\_F100 Installation

### 4.1 Interface and Signal

#### 1.Interface

Interface	Description
CON1	DB15 female connector, the interface to connect servo driver.
CON2	Interface to connect external IO devices.
CON3	Interface to 24V DC power supply.
CON4	Interface to connect external IO devices.

#### 2.Signal

##### Pin signals of the CON1 Interface:

Pin	Description
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)

**Pin signals of the CON2 Interface:**

Pin	Description
N/A	/
N/A	/
Alarm output	When an abnormal alarm occurs, a high level signal is output, normally high impedance state
Zero returning	Input signal calibration
Analog Ground	Analog signal common ground, analog signals include: focus set input, focus feedback output
Focus set input	The input signal of setting the focus height, analog.
Focus feedback output	Output the current focus height, analog.
Clasp brake +	Brake signal cable of the brake function motor, the negative pole is connected to the negative pole of the power supply. ETC-F100 comes with internal relay, which can be connected with brake cable directly

**Note:** "N / A" is an interface without definition, please leave it blank.

**Pin signals of the CON4 Interface:**

Pin	Description
Quick stop input	In emergency, press the emergency button to achieve emergency stop, OUT_Servo_DA output 24V
N/A	/
Focusing in	Output 24V after the focus reaches the setting height.



place	
N/A	/
N/A	/
Focusing enables	High-level control focus on, low-level control focus off
Lower limit	The lower limit of the input signal, active low
Upper limit	The upper limit of the input signal, active low

**Note:**

**"N / A" is an interface without definition, please leave it blank.**

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

To adapt the external circuit, there is a jumper cap inside the ETC\_F100 to select the active-low or active-high input signal. The output signal is selected active low or active high. To change the signal level, contact us to change it.

## 4.2 Wiring

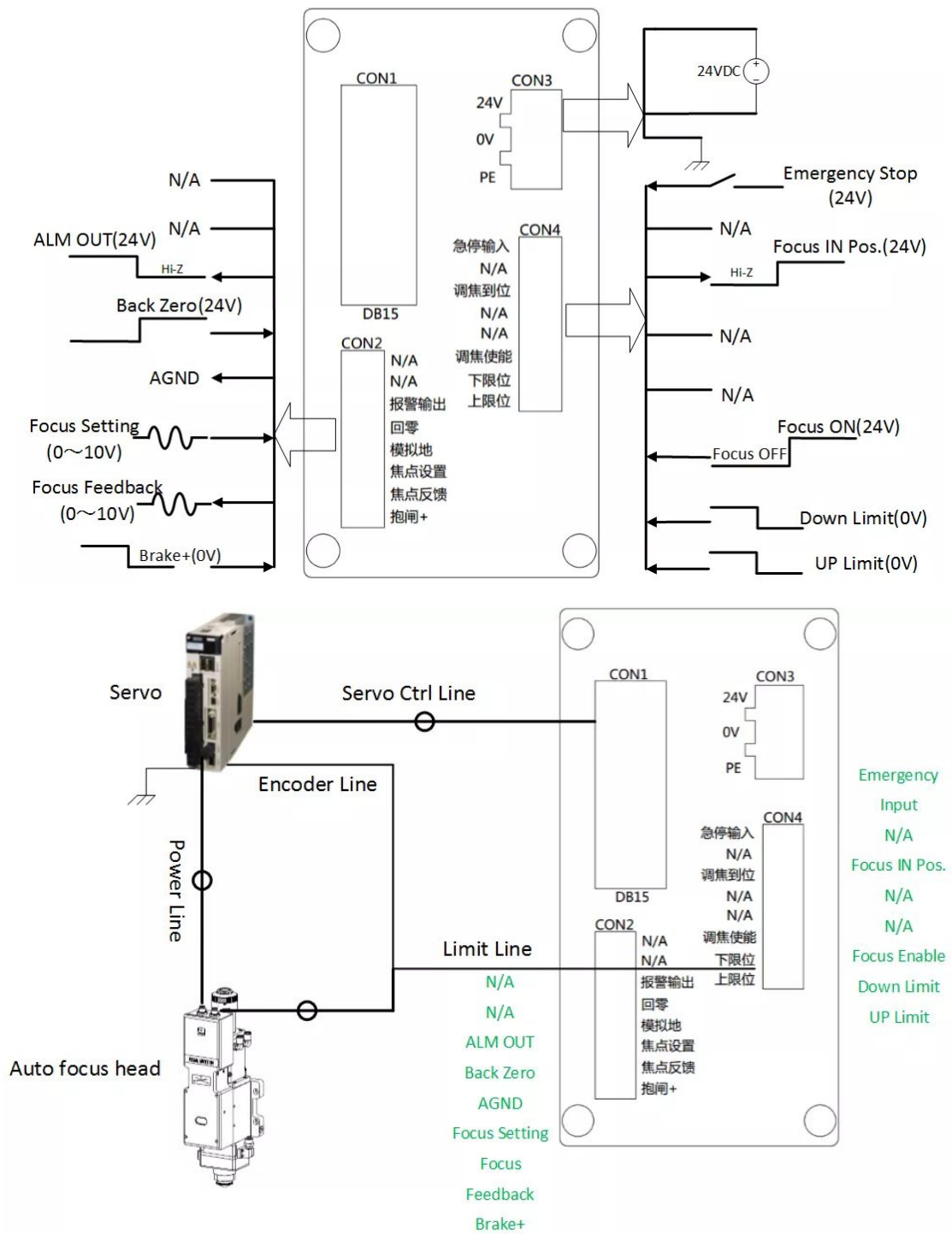


Fig 4.1 - ETC\_F100 Wiring Instructions

## 4.3 ETC\_F100 Dimensions

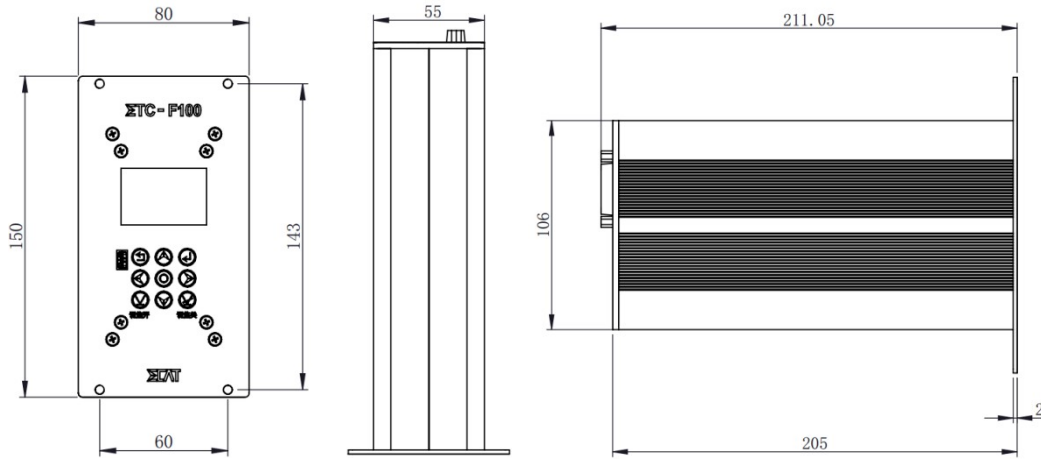


Fig 4.2 - ETC\_F100 Dimensions (Unit: mm)

## 5 Adjustment of Beam Center and Focus Position

### 5.1 Beam Center Position Adjustment (QBH interface)

Cutting quality in a great extent depends on whether the beam spot is in the center of nozzle or not. If the beam spot is not in the center, the laser beam may hit the nozzle or inner wall of the laser head, that leads to produce high temperature deformation. Beam center position adjustment should be considered when nozzle is replaced or the cutting quality is decreased.

Beam center position adjustment of the laser cutting head can be finished by adjusting Collimating lens, X-Y direction. The adjusting screws are located on the top of the cutting head as shown in Figure 5.1. By using inner hexagon spanner users can loosen or tighten the adjusting screw until the beam spot is located in the center of nozzle. Make sure the laser beam output from the center of nozzle. A method commonly used, tape dotting method:

- Pick a scotch tape, flatten it, and stick it to the nozzle end face.
- Open the inner guiding red light of the laser. Finding and observing the position that the red light on the scotch tape relative to nozzle center;
- open and adjust laser generator at the range of 80W-100W ,then laser dotting.
- Tear off the tape and check the hole is in the center of the nozzle or not;
- Repeat the above steps until the beam spot is in the center of the nozzle .

This center adjustment requires a series of steps, which is the basic operation of general laser adjustment.

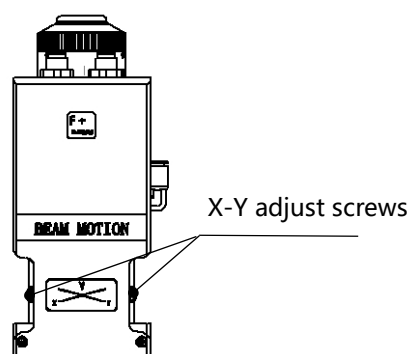


Fig 5.1 - QBH interface beam centering

## 5.2 Beam Focus position Adjustment

Even BM111 is equipped with automated focusing system, it still need dot manually to re-determine the focus position when users replace the lens or lasers. For details about operating system parameters, please refer to the system instructions.

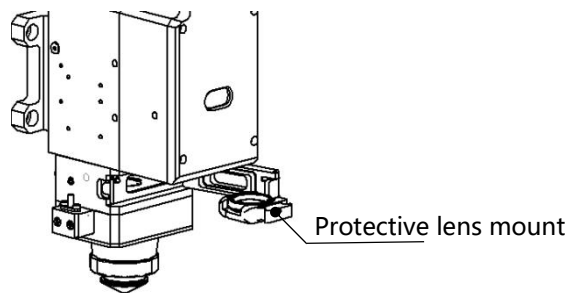
Manual dotting can refer to the following steps:

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), activate the laser to make a hole in the textured paper;
3. Dotting several times, finally compare and find out the scale corresponding to the smallest hole, which is the zero focus position, that is, the focus spot is just at the end of the nozzle end face.

## 6 Maintenance

### 6.1 Cleaning Lens

It's necessary to maintain lens regularly because of the characteristic of laser cutting process. Once a week cleaning the protective lens is recommended. The collimating lens and focusing lens need to be cleaned once every 2~3 month. In order to facilitate the maintenance of the protective lens, the protective lens mount adopts a drawer type structure.(Fig6.1)



**Fig 6.1 - Replace the protective lens**

#### Lens cleaning

Tools: Dust-proof gloves or finger sleeves, polyester fibers cotton stick, ethanol, rubber gas blowing.

#### Cleaning instruction:

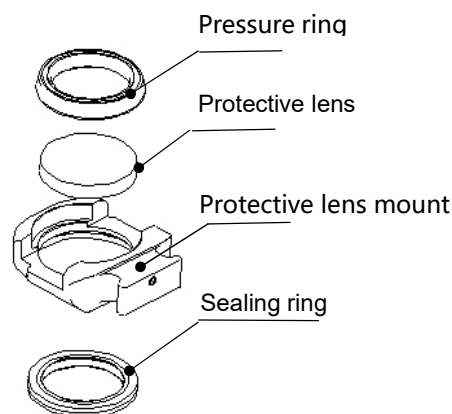
1. The left thumb and forefinger wear the finger sleeves;
2. Spray ethanol onto the polyester fibers cotton stick;
3. Hold the slide edge of the lens with left thumb and forefinger gently.(note: avoid the fingertip touching the surface of the lens)
4. Put the lens in front of eyes, hold the polyester fibers cotton stick with the right 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, to avoid secondary lens pollution)and use rubber gas blowing to sway the surface of the lens. Both sides should be cleaned. After cleaning, make sure that there are no residues: detergent, absorbent cotton, foreign matter and impurities.

### 6.2 Removal and Installation of Lens

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

## 6.2.1 Removal and Installation of Protective Lens

- The protective lens is a fragile part and needs to be replaced after damage.
- As shown in Figure 6.1, loosen two locking screws, hold the two sides of the drawer type lens mount and pull out the protective lens mount.
- Remove the pressure ring of the protective lens, remove the lens after wearing finger sleeves.
- Clean the lens, lens mount and sealing ring. The elastic sealing ring should be replaced if damaged.
- Install the new cleaned lens (Regardless of the front or back side) into the drawer type lens mount.
- Put the pressure ring of the protective lens back.
- Insert the protective lens mount back to the laser cutting head and tighten the locking screws.



**Fig 6.2 - Protective lens mount structure**

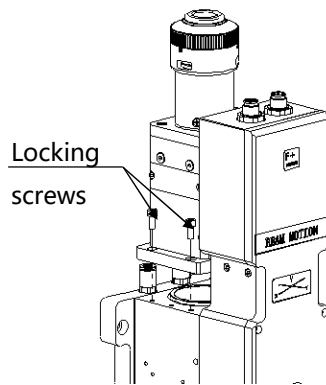


**Note:** Do not directly pull the edge of the elastic sealing ring out so that it is easy to damage.

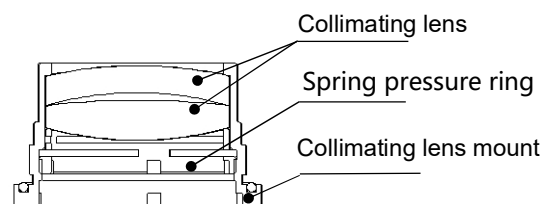
## 6.2.2 Removal and Installation of Collimating Lens

- The procedures for removing and installing collimating lens are as follows.
- Remove the laser head and move to a clean place. Clean all dust on the laser head surface;

- Use a 3mm inner hexagon spanner loosen the screws of collimating components( as shown in figure 6.3), and seal the part(connected to collimating components) with Crepe Paper to prevent dust from falling inside the laser head.
- Unscrew the collimating lens mount and remove the spring pressure ring and the collimating lens with the lens removing tool;
- Clean or replace the collimating lens.
- As shown in figure 6.4, reassemble the collimating lens components in sequence. Note that the spring pressure ring is tightened properly and re-screwed into the collimating component.
- Tighten the locking screws of collimating component.
- Check the focus position is at the center of the nozzle or not before using, if not , the position should be reset.



**Fig 6.3 - Remove the collimating component**



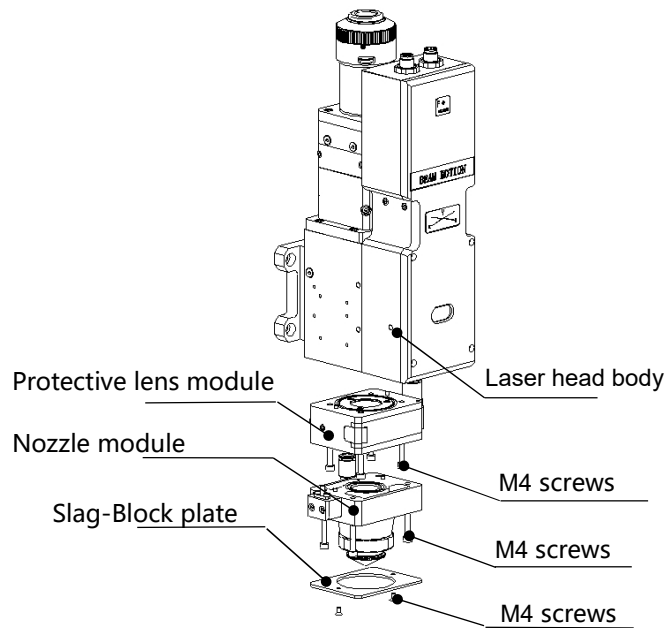
**Fig 6.4 - Collimating lens installation diagram**

### 6.2.3 Removal and Installation of Focusing Lens

Removal and installation of focus lens refer to the steps as follows:

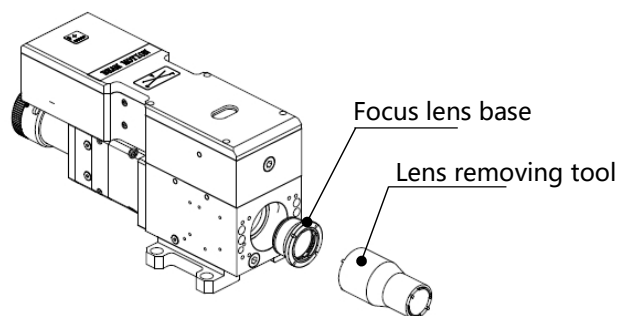
- Remove the laser head and move to a clean place. Clean all dust on the laser head surface.
- Place the laser head horizontally. As shown in Figure 6.5, remove the locking screws from bottom to top.





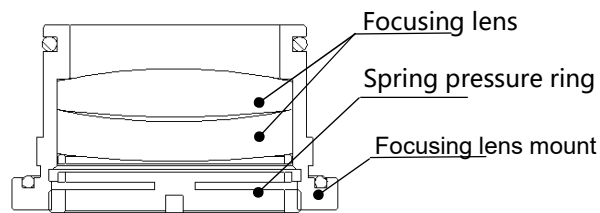
**Fig 6.5 - Remove the protective lens and the nozzle component**

- As shown in figure 6.6, use a lens removing tool to remove the focus lens mount.



**Fig 6.6 - Remove and install the focusing lens**

- Remove the spring pressure ring and focusing lens with a lens removing tool.
- Replace or clean the focusing lens.
- As the direction shown in figure 6.7, put the focusing lens and the spring pressure ring in the lens mount carefully and tighten the pressure ring properly.



**Fig 6.7 - Focus lens installation diagram**

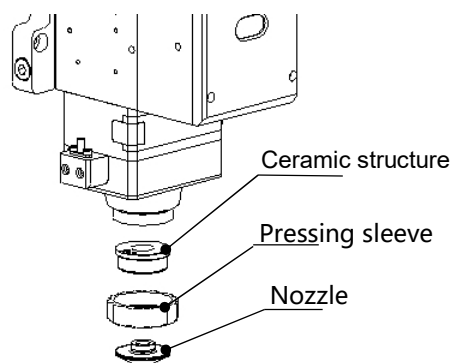
- Turn the focusing lens back into the focusing lens mount and tighten it.
- As the sequence shown in figure 1.1, reassemble and tighten the screws.
- Check the focus position is at the center of nozzle or not. If not, you need to refer to the 3.1 step to reset the operation.

## 6.3 Replace Nozzle Connection Assembly

During the laser cutting, the laser head will inevitably be hit, so users need to replace the nozzle connector.

### 6.3.1 Replace Ceramic Structure

- Unscrew the nozzle.
- Hand pressing the ceramic structure so that it is not skewed, and then unscrew the pressure sleeve.
- Align the pinhole of the new ceramic structure with the 2 locating pins and press the ceramic structure by hand, then screw the pressure sleeve.
- Screw the nozzle and tighten it properly.



**Fig 6.8 - Replace nozzle connector**

### 6.3.2 Replace Nozzle

- Screw the nozzle;
- Replace the new nozzle and re-tighten it properly.
- Once the nozzle or ceramic structure has to be replaced, it must be re-capacitance calibration.

## 6.4 Fault Analysis of ETC\_F100

### 6.4.1 Alarm Information

ETC-F100 may generate the following alarm information:

#### 1. Upper and lower limit alarm

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

- Limit signal is not connected to the ETC-F100;
- Limit the sensor is obscured by unknown objects;
- Limit sensor installed improperly (this possibility is extremely small);
- The limit signal is disturbed. At this time, the corresponding limit signal may flicker in the function test, especially after the motor is enabled. The ETC-F100 and the 24VDC limit signal can be independently powered A power filter is needed for the 220V AC of the Servo driver, and to ensure that the ground wire grounding well.

#### 2. “Zero returning” Alarm

After the system is powered off and restarted, the controller needs to go back to zero to establish a reference coordinate system. If there is no back to zero, the panel will prompt " Zero returning ", It can be solved by the following methods:

- Perform a zero return operation through the ETC-F100.
- Select “Yes” and save it in the “power-on Reset” , and it will automatically return to zero after power-on again.
- High level can be input through “Zero returning” interface to realize backing to zero.

#### 3. “Exceeding z-axis stroke” Alarm

This alarm is generated when the actual Z-axis coordinate exceeds the Z-axis travel. When this

alarm occurs, please note:

- 1) Z-axis travel setting is appropriate;
- 2) Whether the location of dial overtravel.

#### 4. “Servo Alarm”

Under normal circumstances, when the drive alarm, “Servo Alarm” will be displayed by ETC-F100. If the drive is normal, and the ETC-F100 displays the “Servo Alarm”, it may be caused by the following conditions:

- Servo driver wiring is incorrect;
- External interference.

### 6.4.2 Common Problems Analysis

#### 1. “Servo Calibration” process terminated abnormally

- 1) dial in the upper limit

When the dial is in the upper limit position, this error occurs when servo calibration is performed.

- 2) dial position near the upper limit

The dial position near the upper limit (about 1mm), this error will occur in servo calibration.

In this condition, please move the dial to the middle of the stroke (more than 1mm), and then take the servo calibration.

#### 2. The screen is abnormal displayed

The external interference may cause the screen to display abnormally, please reboot the ETC-F100 when this abnormality occurs.

#### 3. Z-axis coordinate offset

Under the static state, the Z axis coordinate keeps changing slowly, in this condition, the servo calibration can be restarted.

#### 4. Input signal jitter or invalid

If the input signal is Jittering or invalid, 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 high effective input signal, 24V can be directly connected to the corresponding input port,

if the corresponding number is inverted, then the board is normal;

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

After ensure the board 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 in common ground with the ETC-F100 power supply and then remove the interference and test again.

If the number is not inverted, please check the input signal is valid or not.