



BD04K SERIES

4KW Auto Focus Tube Cutting Head-User Manual



Document History

Edit date	Version	Topic, revision, action taken
2020/11/16	V1.0	First edition
2023/11/20	V2.0	Configuration update

Thank you for choosing our product!

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

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

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

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

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Disclaimer

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

Use Regulations

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

Personnel Responsibilities

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

Safety Instructions

Prevent Electric Shock

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

Guard against Danger

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



Laser Caution

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

Prevent Waterway Corrosion

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

Noise Prevention

- The corresponding measures shall be specified or explained and observed in order to prevent personnel from being harmed by noise when the cutting air pressure is high.

Storage and Transportation

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

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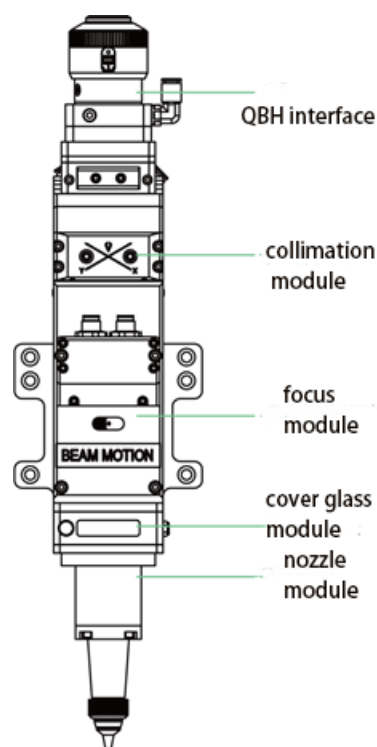
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1 Introduction

This manual includes basic installation, factory settings, operation and maintenance services and other details about BD04K SERIES products. But only the main parts will be introduced here, as there are too many types of optical and mechanical customization configurations.

Released by RAYTOOLS in 2021, BD04K SERIES auto focus tube cutting heads are equipped with servo motor outside and drive units inside, supporting to move focus lens within 30mm automatically through the linear mechanism. And users can set program to do continuous adjustment of the focus position, so as to perforate thick sheets and auto cut sheets with different thickness and material.

BD04K SERIES products adopt D30 compound lens assembly for beam integration while applying QBH interface with fiber laser. Based on optimized optical and water-cooled design, laser heads can run stably with high power for a long time.



1.1 Features

- Optimized optical configuration & smooth and efficient flow design.
- Auto focus range: +12 ~ -12mm; adjustment accuracy: 0.05mm.
- D30 compound lens; max fiber input power: 4KW.
- Max. acceleration of drive of focus lens: 10m/s^2 ; max. speed: 6m/min.
- Drawer type lens holder, fast and convenient to replace cover glass.
- Compound lens at collimation lens and focus lens, maximizing optical quality and cutting efficiency.
- QBH interface, compatible with different fiber laser.

1.2 Structure & Function

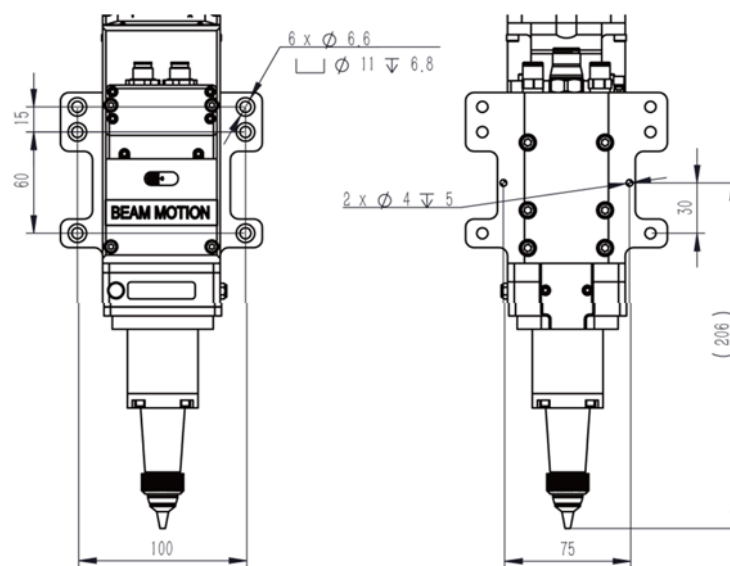
The laser head includes five basic units:

- Collimating module/water cooling: water cooling for collimating alignment module.
- Collimating module/alignment: collimate the laser into a parallel beam and align it.
- Focus module/drive: focus the collimated beam into high-power density convergent beam and auto adjust focus position through drive unit.
- Cover glass module: protect focus lens from damage by the returning slag and prolong its lifespan.
- Nozzle module: lead convergent beam to processing workpiece and produce high-speed airflow jet for high-quality cutting.

2 Mechanical Installation

2.1 Mounting of Laser Cutting Head

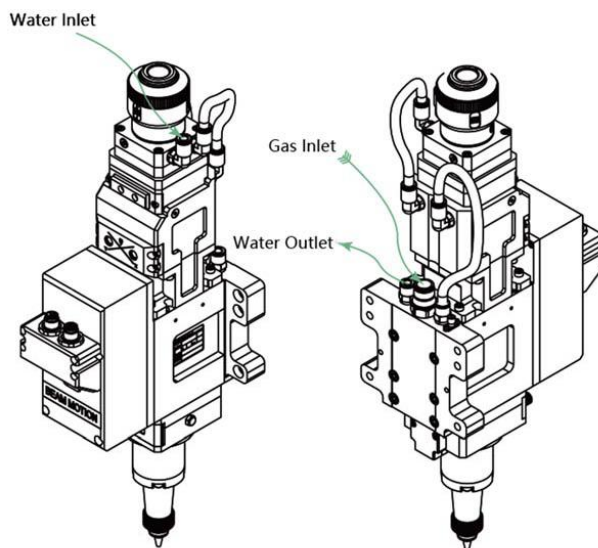
The mounting of laser cutting head to machine tool is shown as below. Customers are advised to install the laser head perpendicular to the bed surface as requested and make sure the laser head is locked, which is one of the premises to ensure the stable cutting.



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

2.2 Connection of Cooling Water and Assist Gas

2.2.1 Connection of Cooling Water



When the laser power is greater than 500W, it is recommended to use water cooling.

The recommended water flow is suggested below.

Outer diameter of water hose	ø6mm
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 CaCO ₃)	<250mg/liter
PH range	6 to 8
Particle size allowed	Diameter less than 200 microns



The water cooling interface, with closed loop system design, can work in external free water supply if meeting above requirements of water flow.

2.2.2 Connection of Cutting Gas

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 0.01micron particle to purify.

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

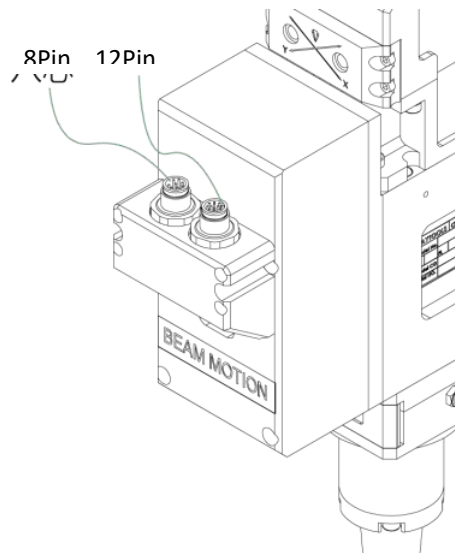
Gas	Purity	Maximum content of water vapor	Maximum content of hydrocarbon
oxygen	99.95%	<5 ppm	<1 ppm
nitrogen	99.99%	<5 ppm	<1 ppm
argon	99.998%	<5 ppm	<1 ppm
helium	99.998%	<5 ppm	<1 ppm
Diameter of cutting gas pipe (Outer diameter)			10mm



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

2.3 Connection of Cutting Head Cable

Connect the 8-pin power limit cable and the 12-pin encoding cable to the corresponding connectors on the cutting head, as shown below. Then thread the cables into the machine's cable track grooves and fix cables after reserving a proper length.



Connect the 8-pin power limit cable and the 12-pin encoding cable to the corresponding connectors on the driver. For detailed wiring of driver and limit sensor, please refer to attachment. **Note:** The output mode of limit sensor is NC and NPN active (outputs NPN signal when don't trigger the sensor); Please install a relay for conversion according to actual need.



CAUTION: The wiring must be done when the power is off.

2.4 Fiber Input Interface

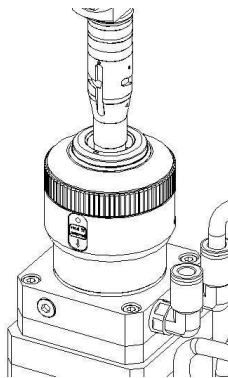
BD04K SERIES products, with collimating lens assembly, can work with most of fiber lasers in the market.

Fiber interface means the connection between the tip of the fiber and the cutting head. Common fiber interface includes QBH type, and every fiber interface is different to fix. Please refer to corresponding instruction of fiber interface.



The optical components must be dust free and all dusts must be cleaned before use. The fiber shall be horizontally inserted into fiber interface to prevent dust from entering the interface and falling on the surface of the lens. Upper limit in the fiber before fixing the laser head.

2.5 QBH Fiber Insertion



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

If the angle between the red dot on the fiber and the red dot on the laser head interface is too far apart when inserting the fiber connector into the interface, and can't align insert, you can refer to the following steps to adjust the position of the fiber optic interface on the laser head.

- use a wrench to loosen the 4 screws on the below picture
- rotate the QBH connector to make red marks in place
- tighten the locking screws.

3 System Installation and Commissioning

3.1 Focusing Controller (ETC-F050)

3.1.1 Connector Definition

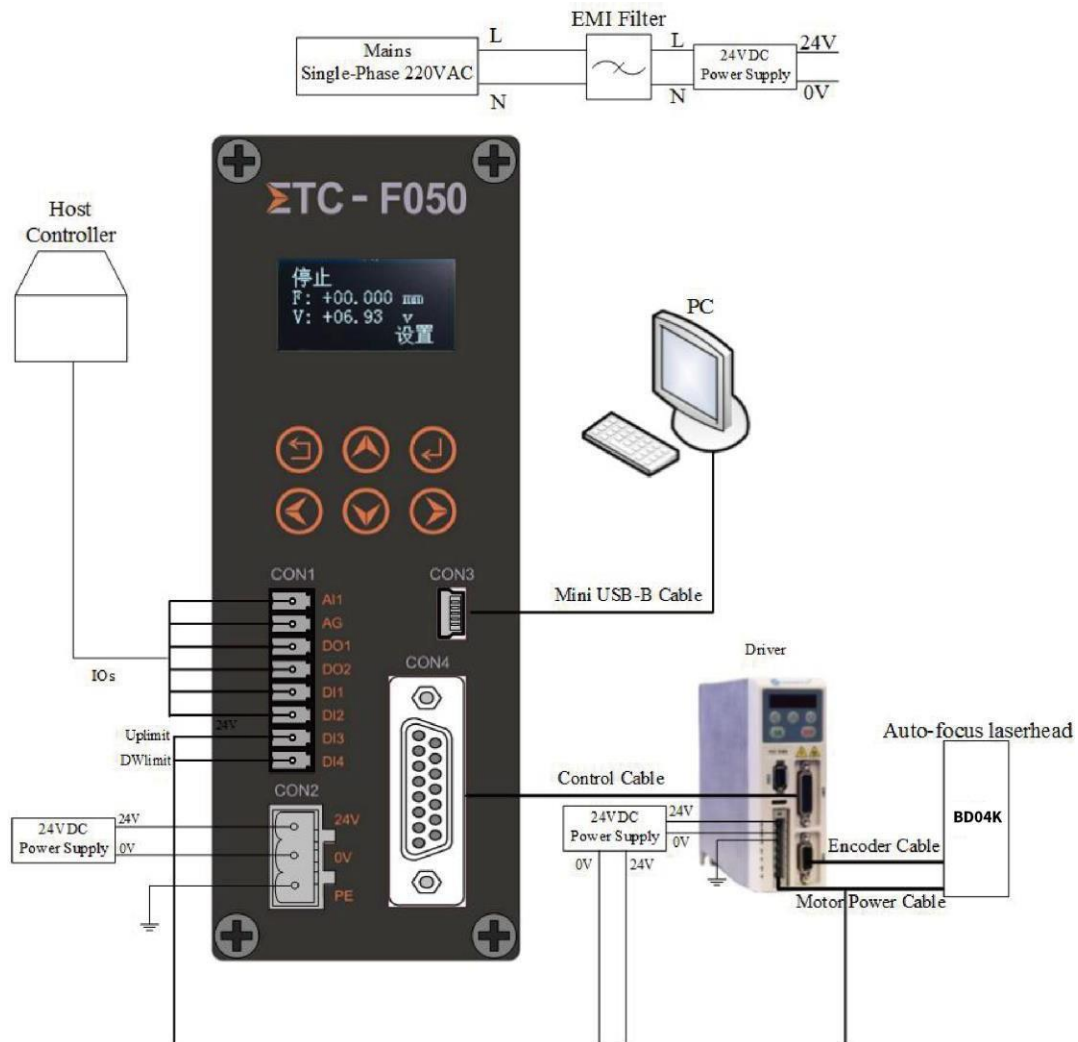
Connector	Function	Pin	Description	Remark
CON1	I/O signal interface	VF	Focus setting	0~10V, input voltage of focus position
		AG	Analog ground	Analog signal earthing
		ALM	Alarm output	0V - normal, 24V-abnormal
		INP	Focusing in place	0V - not reaching the position of focus setting; 24V - reaching the position of focus setting
		EN	Focusing enable	0V –focusing OFF, 24V –focusing ON
		HOME	Return to zero point	0V – invalid input of home signal; 24V - valid input of home signal
		L-UP	Upper limit	0V- trigger upper limit signal; 24V - untrigger upper limit signal
		L-DW	Lower limit	0V- trigger lower limit signal; 24V - untrigger lower limit signal
CON2	24V DC power interface	24V		Power input 24V
		0V		Power input 0V
		PE		Earthing
CON3	For firmware upgrade			
CON4	Driver interface			



ETC-F050 is available for CNC systems with analog control. For system with focus control, the controller is not necessary.

3.1.2 Wiring

Graphic here is only for reference, and more information can be found in ETC-F050 User Manual.

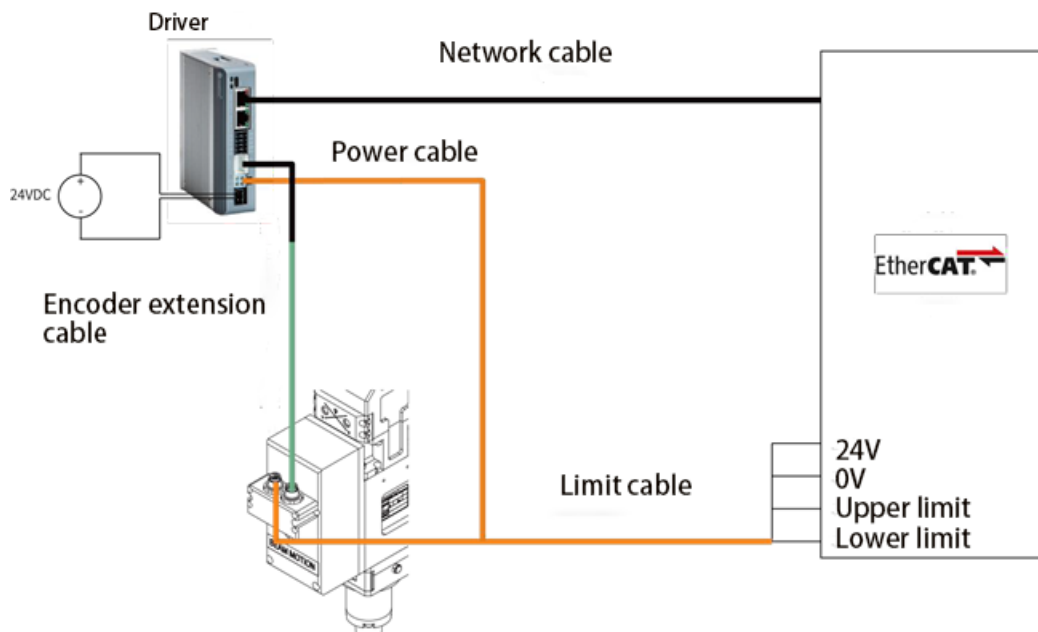


3.2 EtherCAT Control

3.2.1 Wiring

Driver + step motor

- Use hybrid step motor.
- The Vdc, GND and PE shall be connected to 24V, 0V and earthing respectively.
- A+, A-, B+ and B- are power cables of step motor, and should be wired as below:
- 24V power supply should be customer-provided.



Limit signal:

White	Red	Pink	Blue
+24V	0V	Upper limit	Lower limit



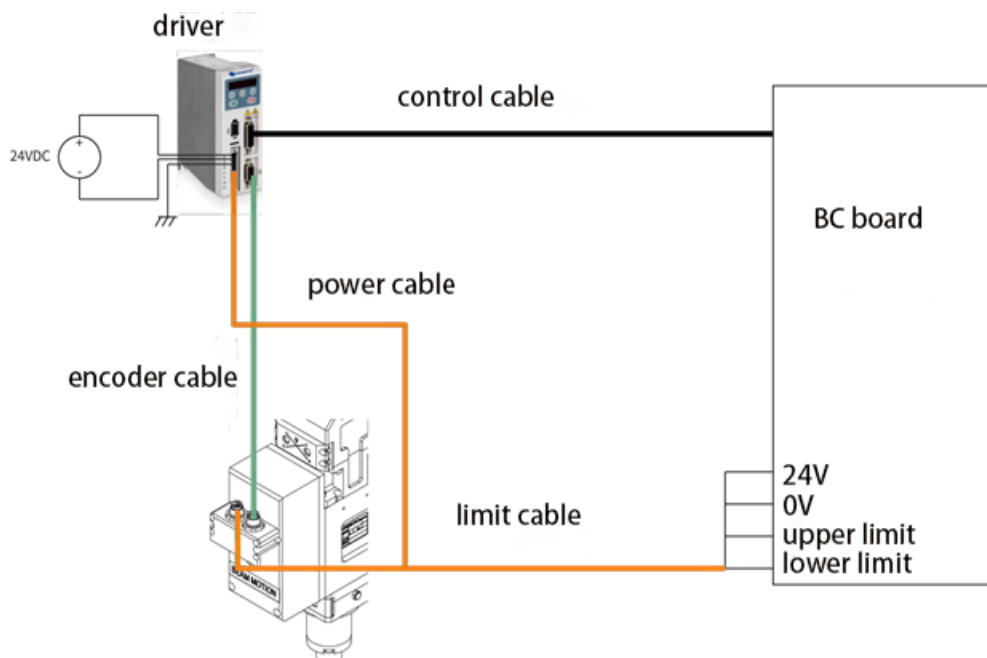
The limit sensor is NPN-NC and it continuously outputs 0V signal when it is not triggered.

3.3 Non-EtherCAT Positioning-Loop-BC

3.3.1 Wiring

Driver + step motor

- Use hybrid step motor.
- The Vdc, GND and PE shall be connected to 24V, 0V and earthing respectively.
- A+, A-, B+ and B- are power cables of step motor, and should be wired as below:
- 24V power supply should be customer-provided.



Limit signal:

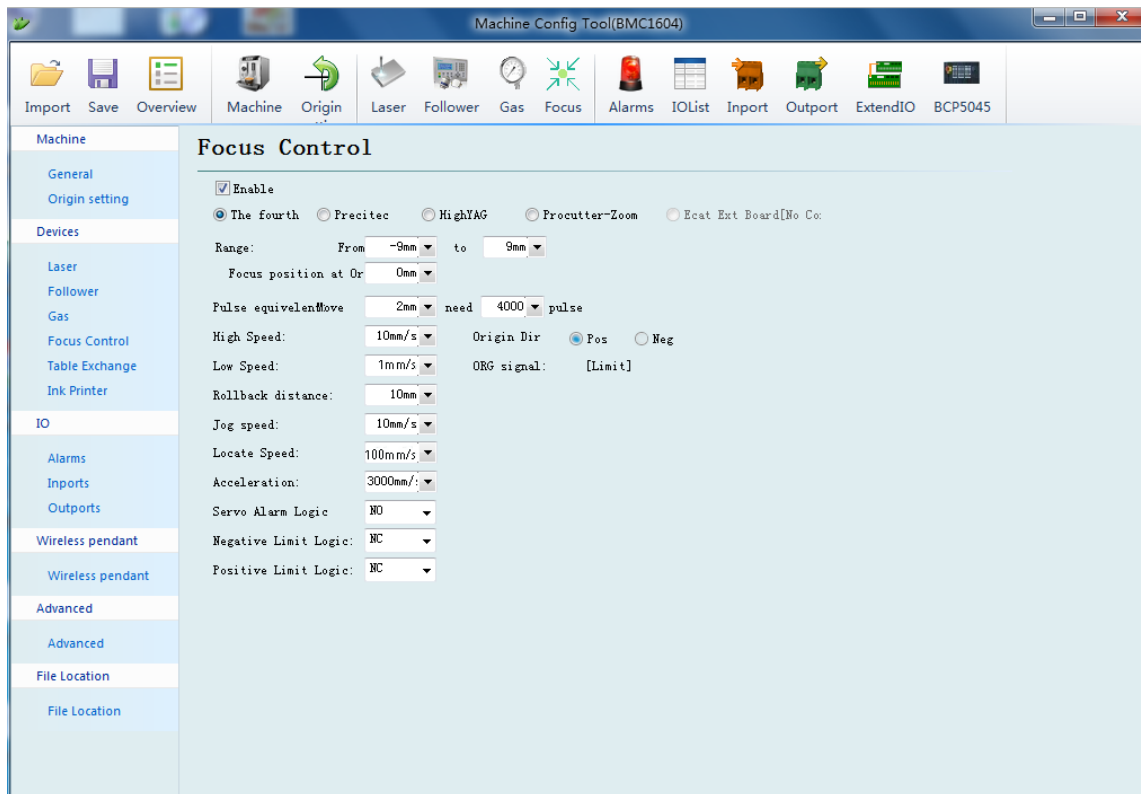
White	Red	Pink	Blue
+24V	0V	Upper limit	Lower limit



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

3.3.2 Software Setting

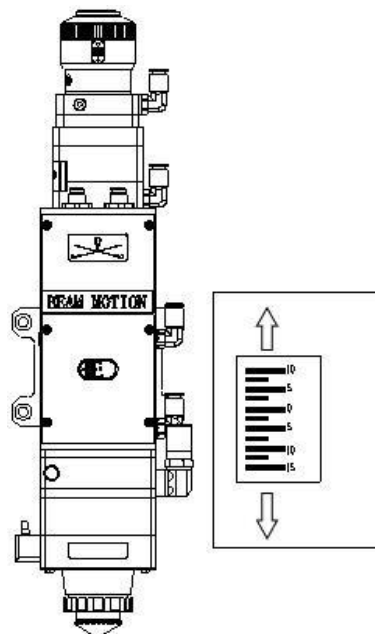
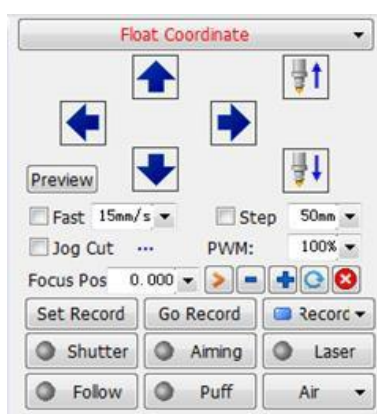
Open Machine Config. Tool and input following parameters:



If the driver is EtherCAT, please set Pulse No. as 10000.

3.3.3 Interface Operation

- Move J axis to check if the action is normal (“thread pitch” and direction), J+ indicates scale 0 up.
- Move J axis slowly to touch the positive and negative limit, and check if the direction and limit signal are normal.
- Click , J axis moves to negative direction and do 2nd homing when touching negative limit. Then the position of zero point coincides with zero focal position and homing is finished.

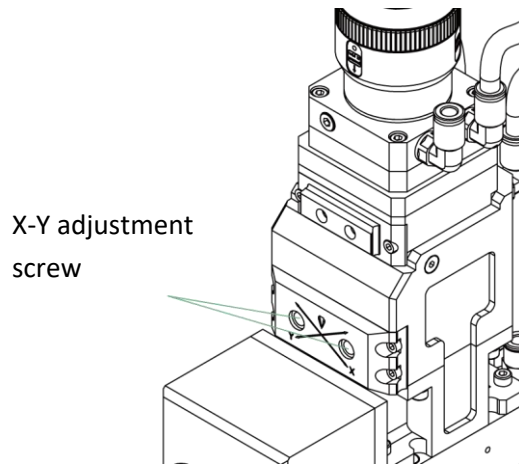


Note:

- Click +, lens holder moves upward to positive limit; click -, lens holder moves downward to negative limit.
- The homing direction is negative, and take lower limit as a sampling signal.
- Pitch: 2mm; pulse/circle: 4000
- Recommended positioning speed: 50-100mm/s.

4 Beam Alignment and Zero Focus Correction

4.1 Beam Alignment (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 below. 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 as below:

- Pick a scotch tape, flatten it and stick it to the nozzle tip.
- Open the red light of the laser. Find and observe the position of red light in the scotch tape.
- Adjust the 2 X/Y adjusting knobs to get beam aligned.
- Open laser and adjust laser power within 80W-100W and dot manually.
- Tear off the tape and check the shooting hole position in tape.
- Repeat the above steps to find out relatively centered position.

4.2 Zero Focus Correction

Laser cutting head is equipped with automated focusing system. But it is required to dot manually to redefine the zero focus position when it is initially set or lenses and lasers are replaced. For details about operating system parameters, please refer to the system instructions. Manual dot can refer to the following steps:

1. Attach one textured tape on nozzle tip. Set laser power to 80-100W.
 2. While moving each 0.5mm focus (as small as possible), shot a hole on the textured tape.
 3. Dotting several times to find out the focus corresponding to the smallest hole which is supposed to be real zero focus.
- The zero focus is just at the tip of the nozzle.

5 Maintenance

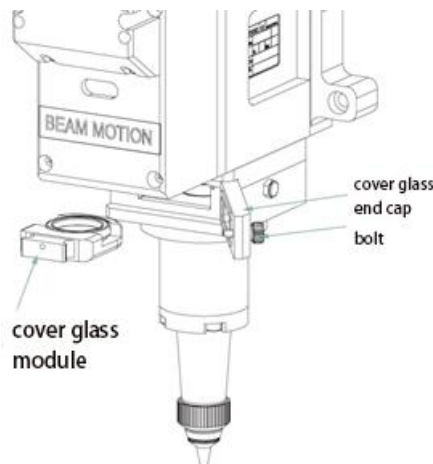
5.1 Cleaning Lens

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

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

Cleaning instruction:

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

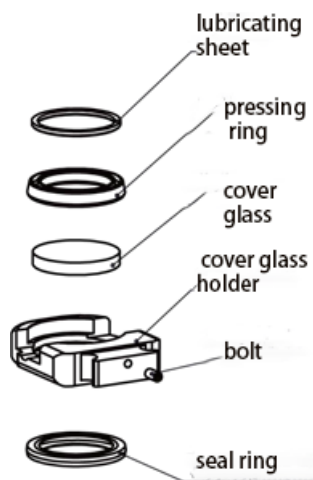


5.2 Removal and Installation of Lenses

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

5.2.1 Removal and Installation of Cover Glass

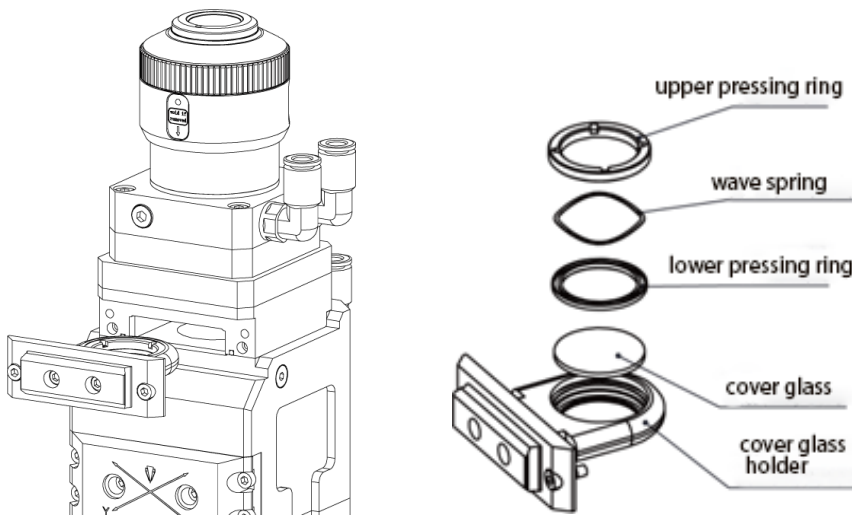
The cover glass is wearing part which needs to be replaced once it is damaged.



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

5.2.2 Removal and Installation of Middle Cover Glass/ Protection Glass

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



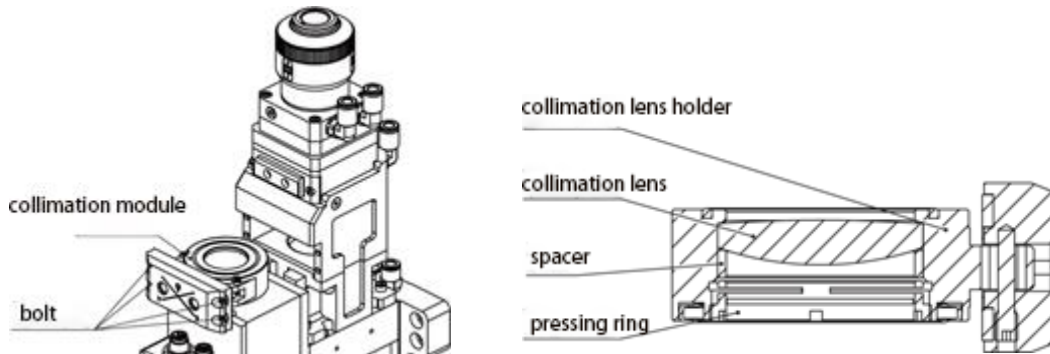
As shown above, loose the bolts to pull out cover glass holder by pinching 2 edges of drawer type holder.

- Seal the mounting openings by textured tape immediately.
- Remove the pressing ring and cover glass after wearing fingertips.
- Clean the cover glass holder and seal ring. The elastic seal ring should be replaced if it is damaged.
- Install the cleaned or new cover glass (regardless of the front or back surface) into the holder of cover glass.
- Install the pressing ring.
- Insert the cover glass holder back to the laser head and tighten the bolts.



It is not allowed to pull out the edge of seal ring directly as it is very easy to damage the seal ring.
Please wear the clean gloves or fingertips.

5.2.3 Removal and Installation of Collimation Lens

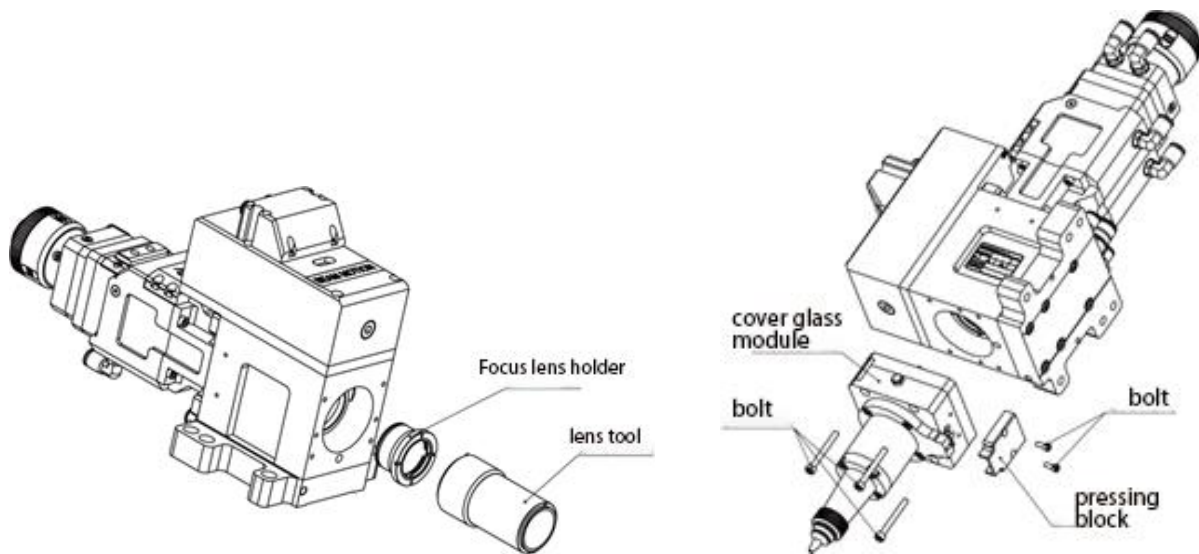


- Remove the laser head and move to a dust free room.
- Clean all dusts on the laser head surface.
- Loosen the bolts to pull out the whole assembly.
- Seal the mounting openings by textured tape immediately.
- Move the assembly. Remove the pressing ring and collimation lenses with a lens tool.
- Replace or clean the collimation lenses.
- Mount the assembly back to the cutting head and tighten the bolts.



Check if the beam is aligned. If not, please do the alignment as per chapter 4.1.

5.2.4 Removal and Installation of Focus Lens

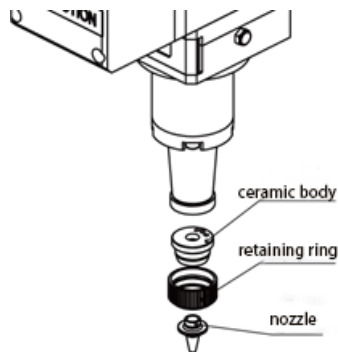


- Clean all dusts on the laser head surface.
- Loosen the 2 bolts as above to pull out focus lens holder.
- Seal the focus lens and mounting openings by textured tape immediately.
- Move the focus lens holder to a dust free room and loosen the bolts. Remove pressing ring and focus lenses in sequence.
- Replace or clean the focus lenses.
- Put focus lenses and pressing ring into the lens holder. Tighten it by bolts.
- Insert the focus lens holder into the cutting head and tighten the bolts.



Check if the beam is aligned. If not, please do the alignment as per chapter 4.1.

5.3 Replace Ceramic Body and Nozzle



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

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

5.4 Common Fault and Alarm of Drive

5.4.1 Fault Analysis

When the motor is power on and servo LED displays L____0, the follow error is 0.

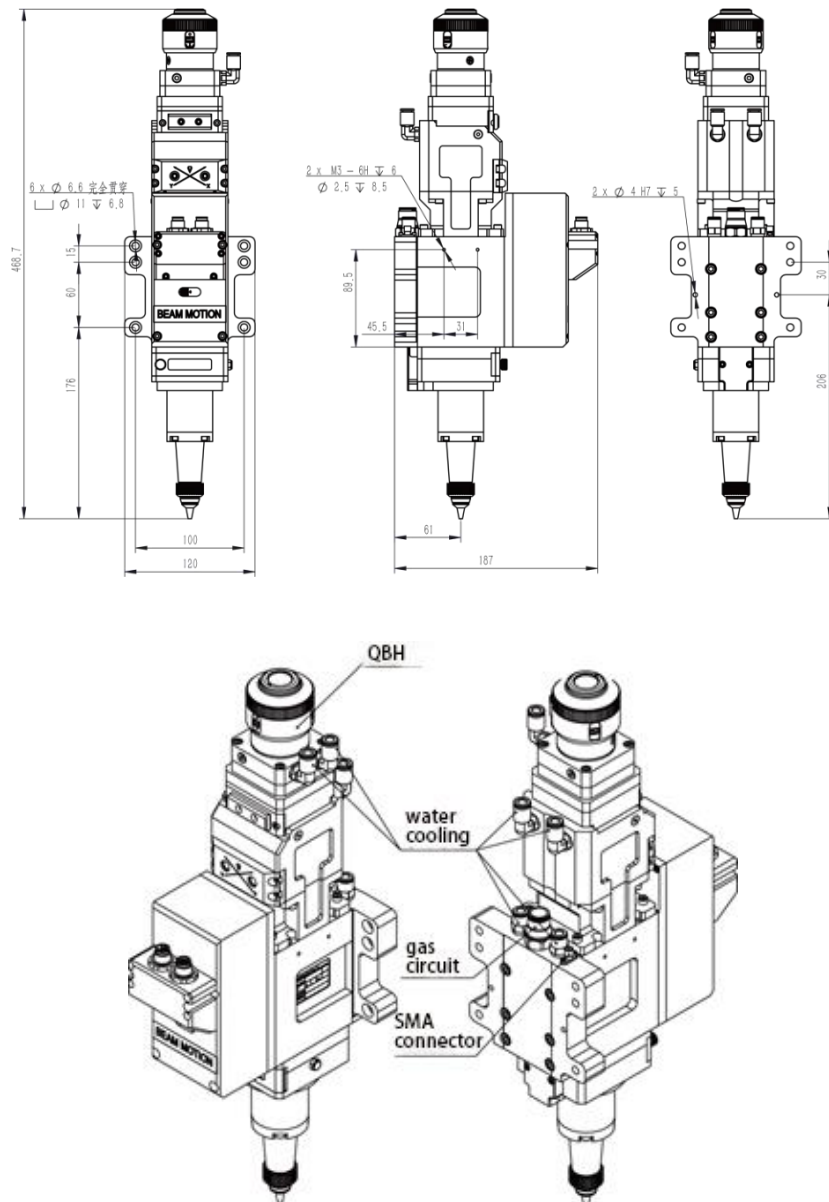
LED	Definition	Remark
	LSB	
	MSB	
	position error	following error

When the driver controls movement value of the motor:

1. If the motor moves normally, the value will change in real time according to the motor position and will be 0 when the motor is running stably; The wiring is correct, and the servo works normally;
2. This value keeps 0, and the motor does not move, which means the servo does not receive the given pulse. Please check whether the control cable is in good contact.
3. This value is increasing or decreasing, and the motor does not move, which means the servo receives the given pulse but without feedback pulse from the motor. Please check whether the power cable and encoder are in good contact, or whether the motor is at the top of the upper and lower limit affecting motor motion;
4. When the value increases to 6000 or decreases to -6000, the servo will open out of tolerance protection and the interface display Er_020; when the drive fails, the drive will shut down, and prompt corresponding fault code. Please power off and power on again to clear the fault.

6 Mechanical and Optical Config.

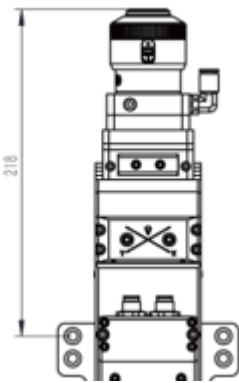
6.1 Physical Structure



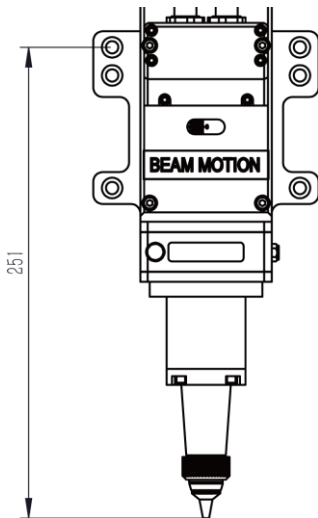
CL/mm		100			75	
FL/mm		-	-	200	-	-
H/mm				468.7		

6.2 Optical Configuration

6.2.1 Collimation Length

Collimation Length	QBH-100	
		

6.2.2 Focus Length

Focus Length		200mm.FL
		

6.3 Config.

6.3.1 Fiber Interface

Fiber Interface	Product ID
QBH (standard)	211FIA3003

6.3.2 Collimation/ Focus lens

Item	Product ID
F100 meniscus lens	110255AAFBHE0232
F100 biconvex lens	110255AACBHE0231
F200 meniscus lens	110255AAFBHE0234
F200 biconvex lens	110255AACBHE0233

6.3.3 Cover Glass

Specification	Product ID
D24.9 x 1.5 (top)	211LCG0020
D27.9 x 4.1 (middle)	211LCG0037
D27.9 x 4.1 (bottom)	211LCG0037

6.3.4 Cable

Specification		Product ID
Encoder Cable	15M	3570040076
	20M	3570040077
	30M	3570040078
Power Cable	15M	3570030145
	20M	3570030146
	30M	3570030147
Fscut positioning loop- Leadshine control cable	2.0M	ELNAB102M00045

6.3.5 Nozzle & Ceramic Body

Nozzle	3D Single layer M11-Φ1.2	120GJT1112
	3D Single layer M11-Φ1.3	120GJT1113
	3D Single layer M11-Φ1.4	120GJT1114
	3D Single layer M11-Φ1.6	120GJT1116
	3D Single layer M11-Φ1.8	120GJT1118
	3D Single layer M11-Φ2.0	120GJT1120
	3D Single layer M11-Φ3.0	120GJT1130
	3D Single layer M11-Φ4.0	120GJT1140
	3D Single layer M11-Φ5.0	120GJT1150
	3D Double layers M11-Φ1.2	120GJT1412
	3D Double layers M11-Φ1.3	120GJT1413
	3D Double layers M11-Φ1.4	120GJT1414
	3D Double layers M11-Φ1.6	120GJT1416
	3D Single layer M11-Φ1.8	120GJT1418
	3D Single layer M8-Φ1.2	120GJT0112
	3D Single layer M8-Φ1.3	120GJT0113
	3D Single layer M8-Φ1.4	120GJT0114
	3D Single layer M8-Φ1.6	120GJT0116
	3D Single layer M8-Φ1.8	120GJT0118
	3D Single layer M8-Φ2.0	120GJT0120
	3D Single layer M8-Φ3.0	120GJT0130
	3D Single layer M8-Φ4.0	120GJT0140
	3D Single layer M8-Φ5.0	120GJT0150
Ceramic Body	M8	120515093A
	M11	120515092A