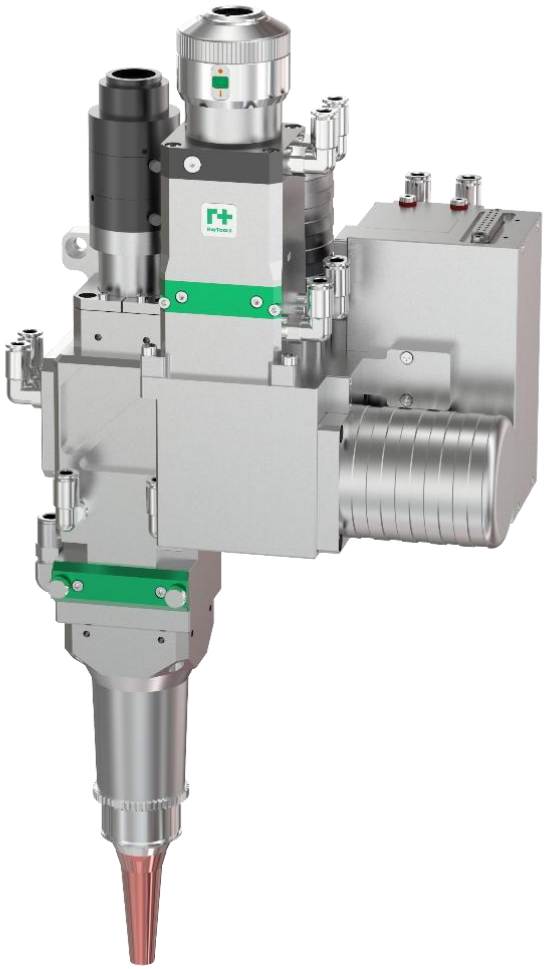
RAYTOOLS

BF3304F SERIES

4kW Wobble Laser Welding Head - User Manual



Original Version

Document History

Edit date	Version	Topic, revision, action taken
2023/2/21	V1.0	First edition

Thank you for choosing our product!

This manual describes the installation and commissioning of laser welding 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.

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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1 Summary

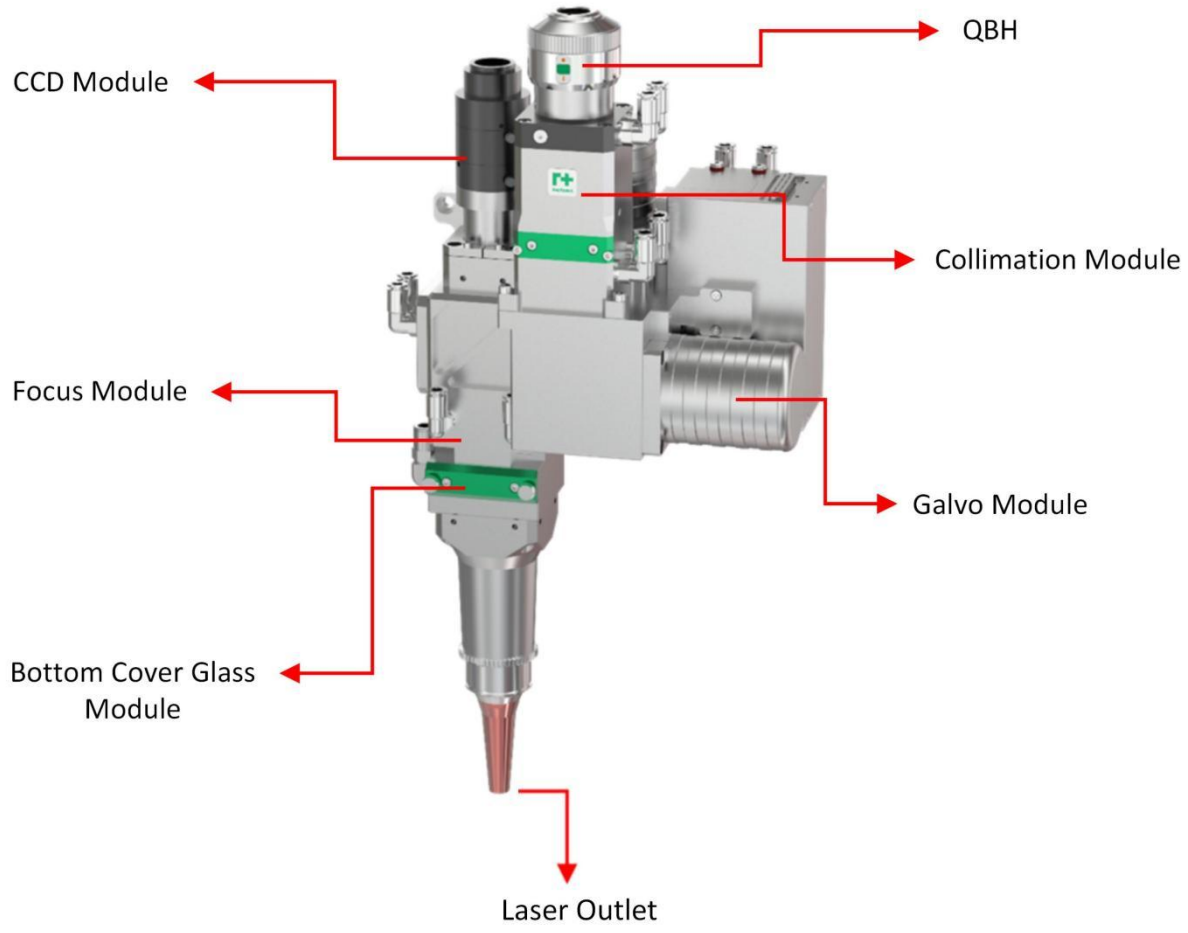
The manual contains the installation, factory settings, operation and use, and maintenance of the BF3304F series products. Since there are many optical and mechanical configurations and customization, the manual describes its main modules and components.

The BF3304 is suitable for medium power welding, increasing the melt width, reducing the porosity and improving the surface quality by scanning. With rich scanning graphics, scanning welding supports circular, linear, C shaped, and S shape, etc.

It also has rich module options, which can be adapted to the paraxial light source for TCP calibration, the paraxial blue point light source for CCD image illumination, the position sensor for position tracking, the temperature sensor for high-quality welding effect, and the wire feeder for wire filling welding. All make it easy to realize automatic welding.

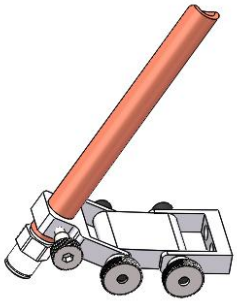
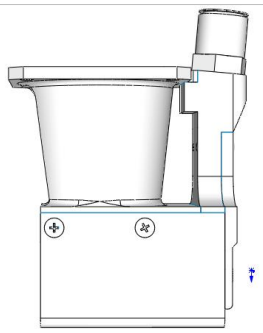
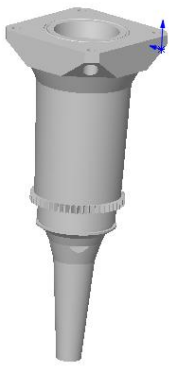
The optimized optical design ensures high-speed and high-quality laser welding; smooth and efficient structure design leads to good melt pool protection; water cooling for both collimation and focus modules gives the laser head a long stable operation and extended lifespan.

1.1 Structure (with QBH Interface)



1.2 Bill of Material

S/N	Item	QTY	Image for reference
1	Laser welding head	1	
2	Motion control card	1	
3	±15V power supply (Optional)	1	

4	High-flexible galvo signal cable (5m)	1	
5	High-flexible galvo signal cable (10m, optional)	1	
6	Side blow nozzle assembly (Optional)	1	
7	Air knife (Optional)	1	
8	Coaxial nozzle assembly (Optional)	1	

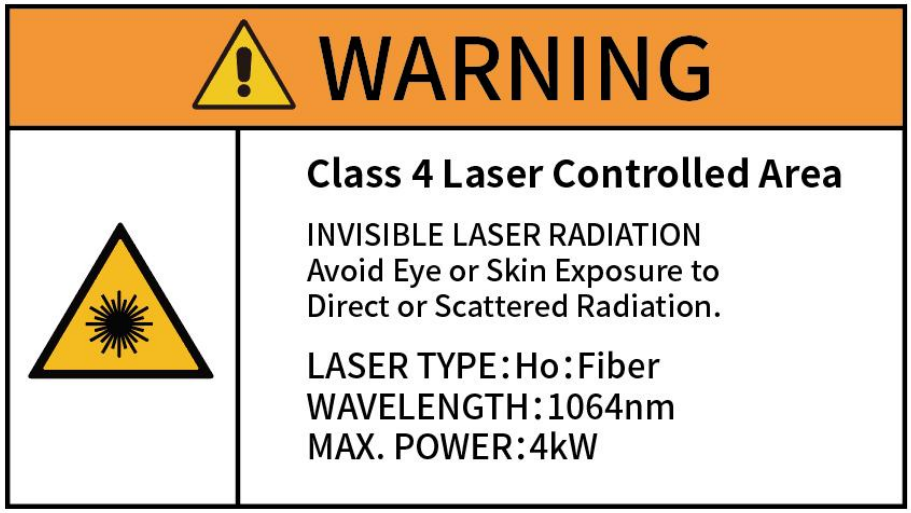
Note: The above form is only for the standard factory configuration.

1.3 Technical Datasheet

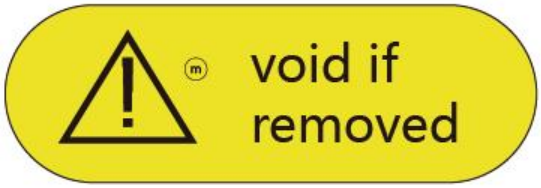
Model	BF3304F
Wavelength	1064nm
Power	4kW
NA	(Fc100)max.0.14, (Fc150)max.0.09
Fiber connector	QBH，QD
Clear aperture	∅ 28mm
Collimation length	100mm, 150mm
Focus length	200mm, 250mm, 300mm, 400mm
Top cover glass	∅ 37mm*1.6mm
Bottom cover glass	∅ 37mm*7mm
CCD module	C/CS

1.4 Label

You may see the following labels on the laser welding head:



The warning label is on the laser and indicates the laser power and wavelength.

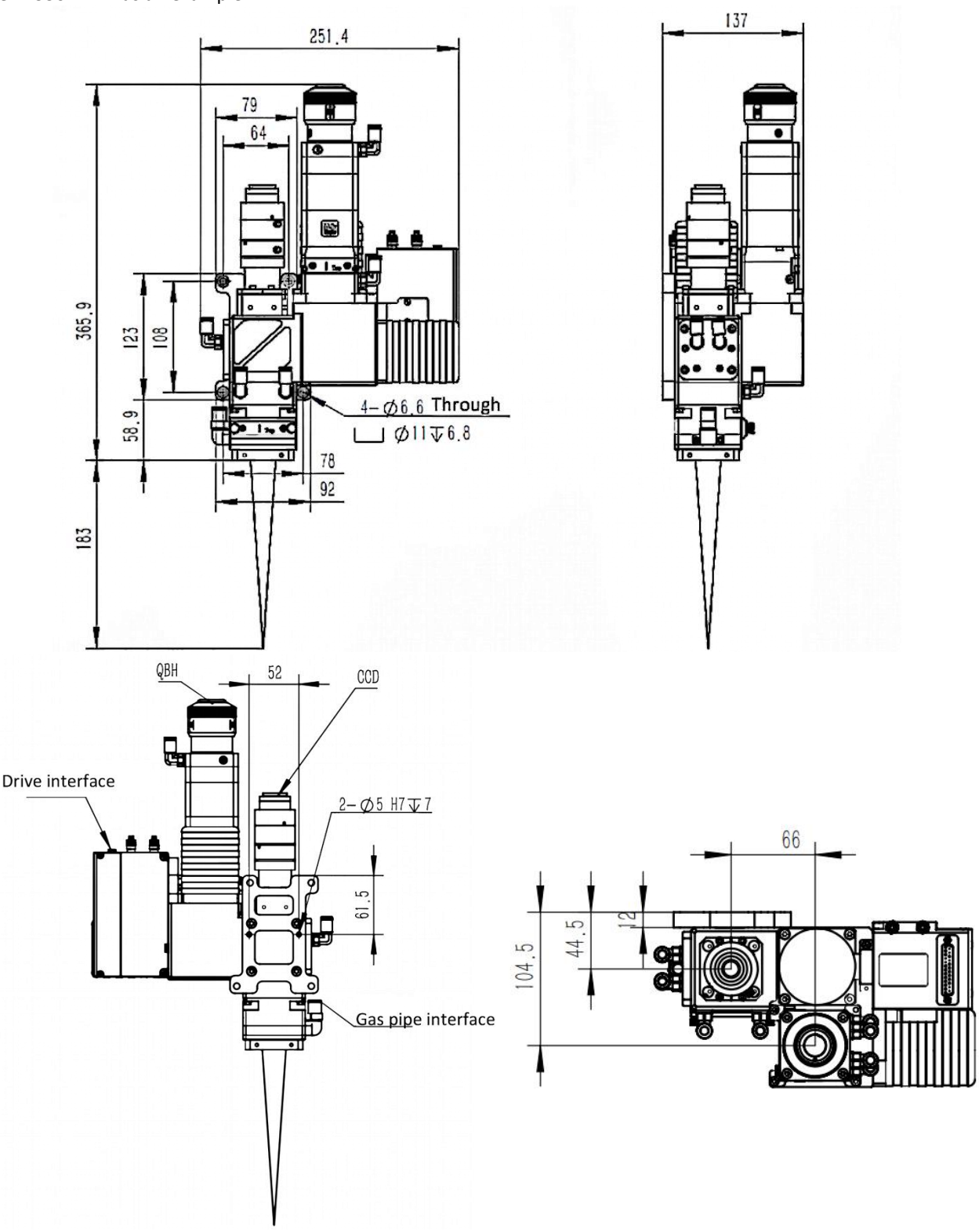


The caution sign on the left indicates to keep the laser cavity clean. The other on the right indicates that the removal of the label leads to the warranty void.

2 Mechanical Installation

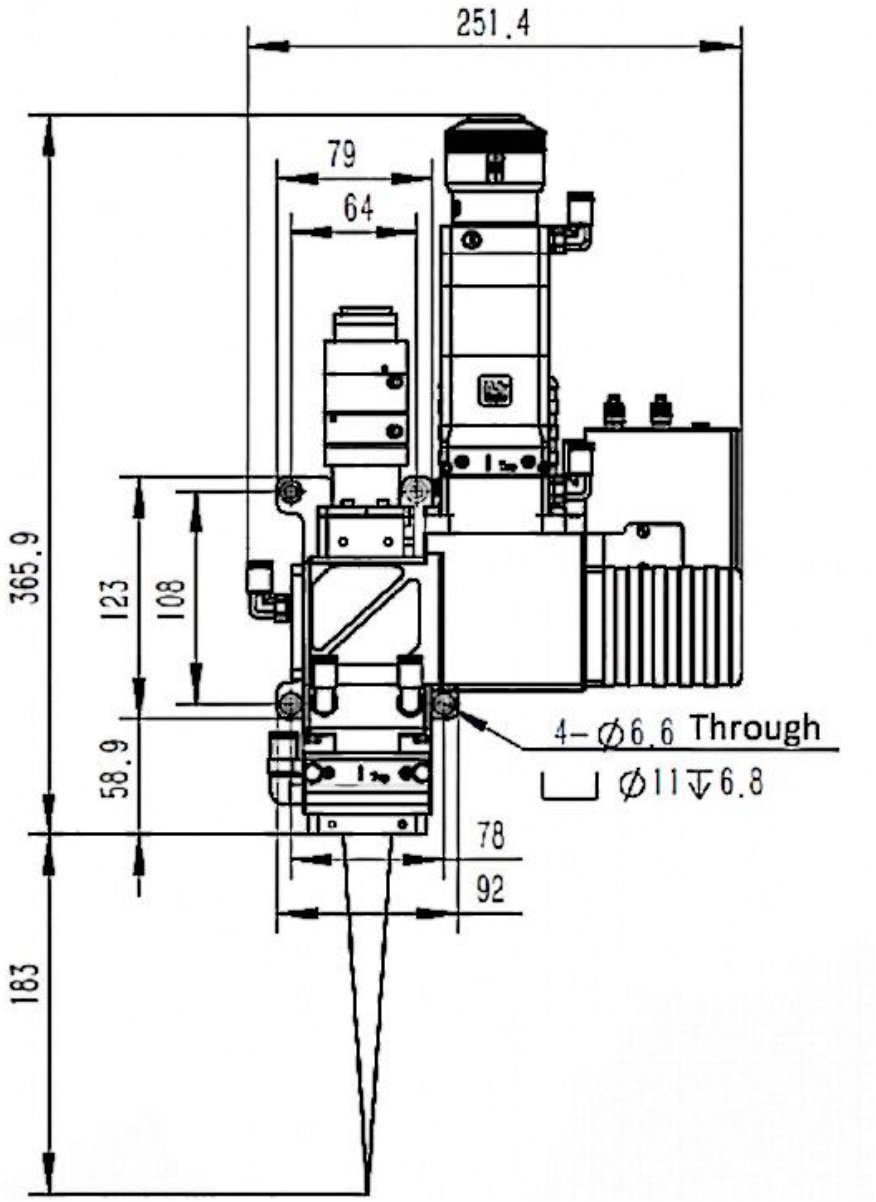
2.1 Mechanical Size and Mounting Holes

Take BF3304F1F4 as an example:



2.2 Working Distance

Take BF3304F1F4 as an example:



Notice:

- The workpiece surface shall be paralleled to the reference level of welding head, otherwise, it will cause graphic deformity.
- The working distance for reference from welding head to the workpiece surface is 183±2.5mm as a standard configuration. Meanwhile, the accurate working distance shall be determined by actual spark and sound.

2.3 Fiber Insertion

1

Remove the dust cover.

2

Align the red point on QBH to the red point of the fiber.

3

Insert the fiber after alignment.

4

Rotate the QBH screw cap in marked direction to complete 1st locking. Afterward, pull the cap outward and rotate it in marked direction to complete 2nd locking.

5

Complete the fiber insertion.

6

Restore the dust cover.

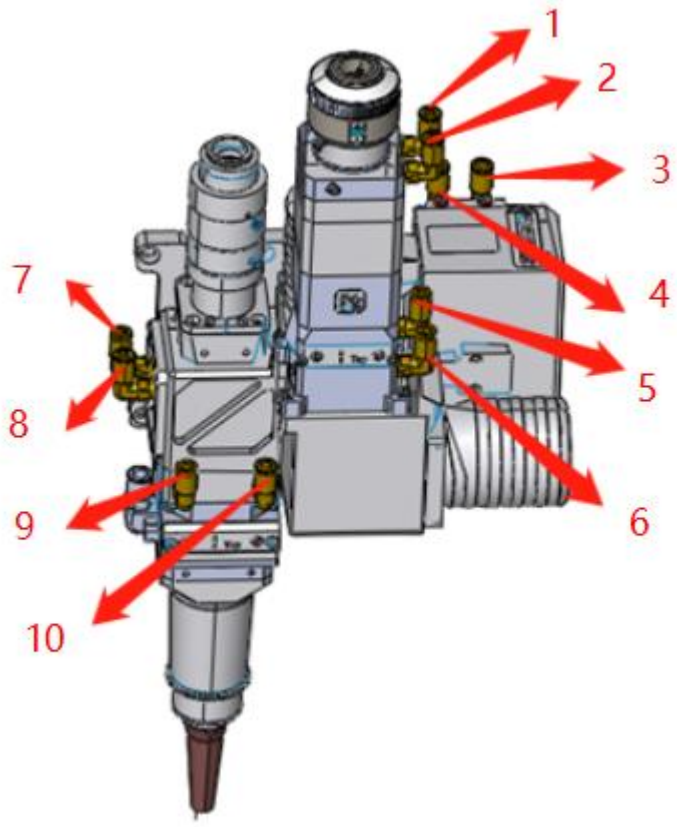
Notes:

- Fiber shall be inserted or pulled out in horizontal direction to prevent dust from dropping into the welding head.
- Fiber end shall be dust free or cleaned before insertion into welding head.
- Fiber and welding head shall be held firmly during insertion to prevent damage to the fiber end.
- QBH shall be locked firmly after fiber insertion in case of looseness when used.

2.4 Connection of Water & Gas Circuit

2.4.1 Cooling Water

Take BF3304F1F4 as an example:



Connection of Water Circuit

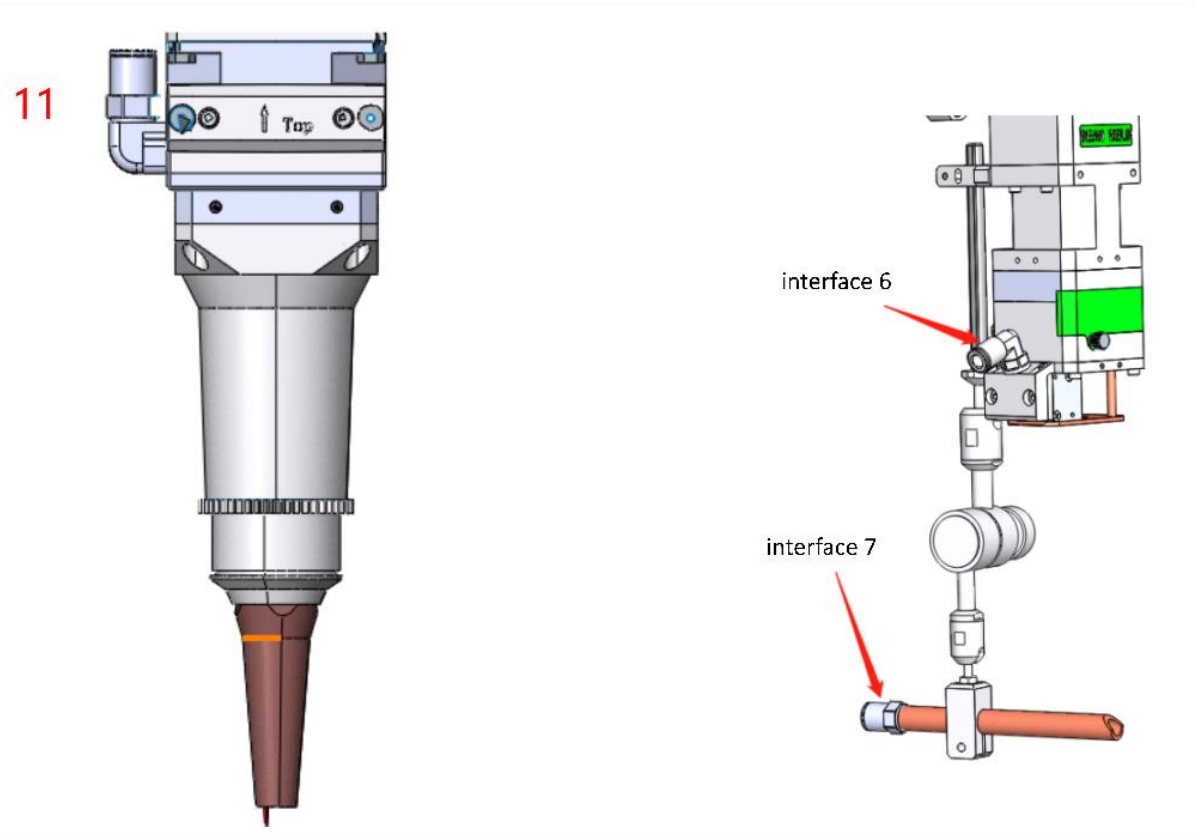
- Connect 2-3-4-5-6-7-8-9 interfaces by ∅ 6mm pipe to form a water-cooling circuit, which has been completed as a factory setting.
- Interface 1: water inlet
- Interface 10: water outlet

Specification

Outer diameter of water hose	∅ 6mm
Minimum flow speed	1.8 l/min (0.48gpm)
Entry pressure	≈0.4Mpa
Entry temperature	≥room temperature /＞dew point
Hardness (relative to CaCO3)	＜250mg/liter
PH range	6 to 8 (deionized or distilled water)
Particle size allowed	Diameter less than 200 microns

2.4.2 Assist Gas

Take BF3304F1F4 as an example:



Connection of Gas Circuit
Coaxial Nozzle: connect interface 11 with inert protective gas.
Air Knife + Side Blow Nozzle:
Connect interface 6 with gas for air knife, 4-6 bar clean compressed air.
Connect interface 7 with inert protective gas.

Specification

Gas	Purity	Maximum content of water vapor	Maximum content of hydrocarbon
Oxygen	≥99.95%	<5 ppm	<1 ppm
Nitrogen	≥99.995%	<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)		Ø 6mm	

3 System Installation and Commissioning

3.1 Interface for Wiring

Interface of Motion Control Card

1. Power Supply Interface (J1)
The interface is used for power supply of motion control card and galvo.

Pin No.	Name	Definition
1	+15V	+15V Input
2	GND	GND
3	-15V	-15V Input

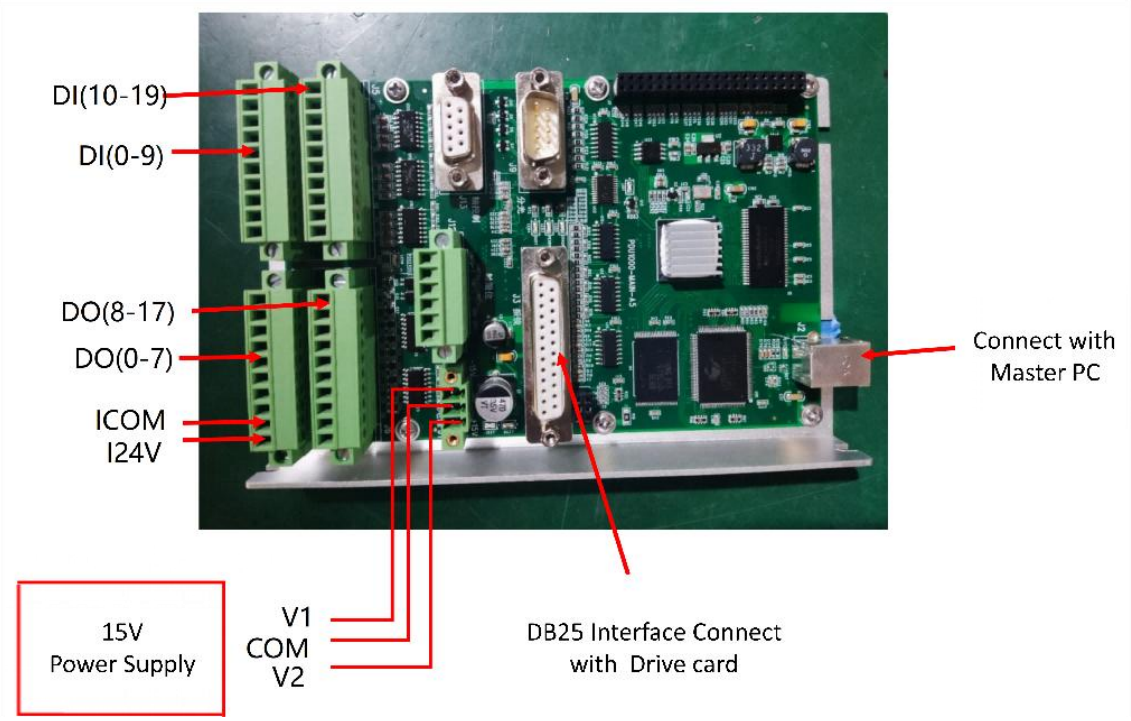
2. Signal Interface (J2)
As an USB2.0 interface, it is used for the communication between the motion control card and the master PC.

3. Galvo Commands (J3)
DB25 female interface: control signal and power supply of the galvo system.

Pin No.	Signal	Definition		Pin No.	Signal	Definition
1	Clk-	Clock -		14	Clk+	Clock +
2	Sync-	Synchronizing -		15	Sync+	Synchronizing +
3	X_data-	X galvo -		16	X_data+	X galvo +
4	Y_data-	Y galvo -		17	Y_data+	Y galvo +
5	X_fb-	X galvo feedback -		18	X_fb+	X galvo feedback +
6	Y_fb-	Y galvo feedback -		19	Y_fb+	Y galvo feedback +
9/10/22	+15V	Galvo power supply +15V		11/23/24	GND	GND
12/13/25	-15V	Galvo power supply -15V		7/8/20/21	NC	Spare

3.2 Diagram and I/O-CAN Definition

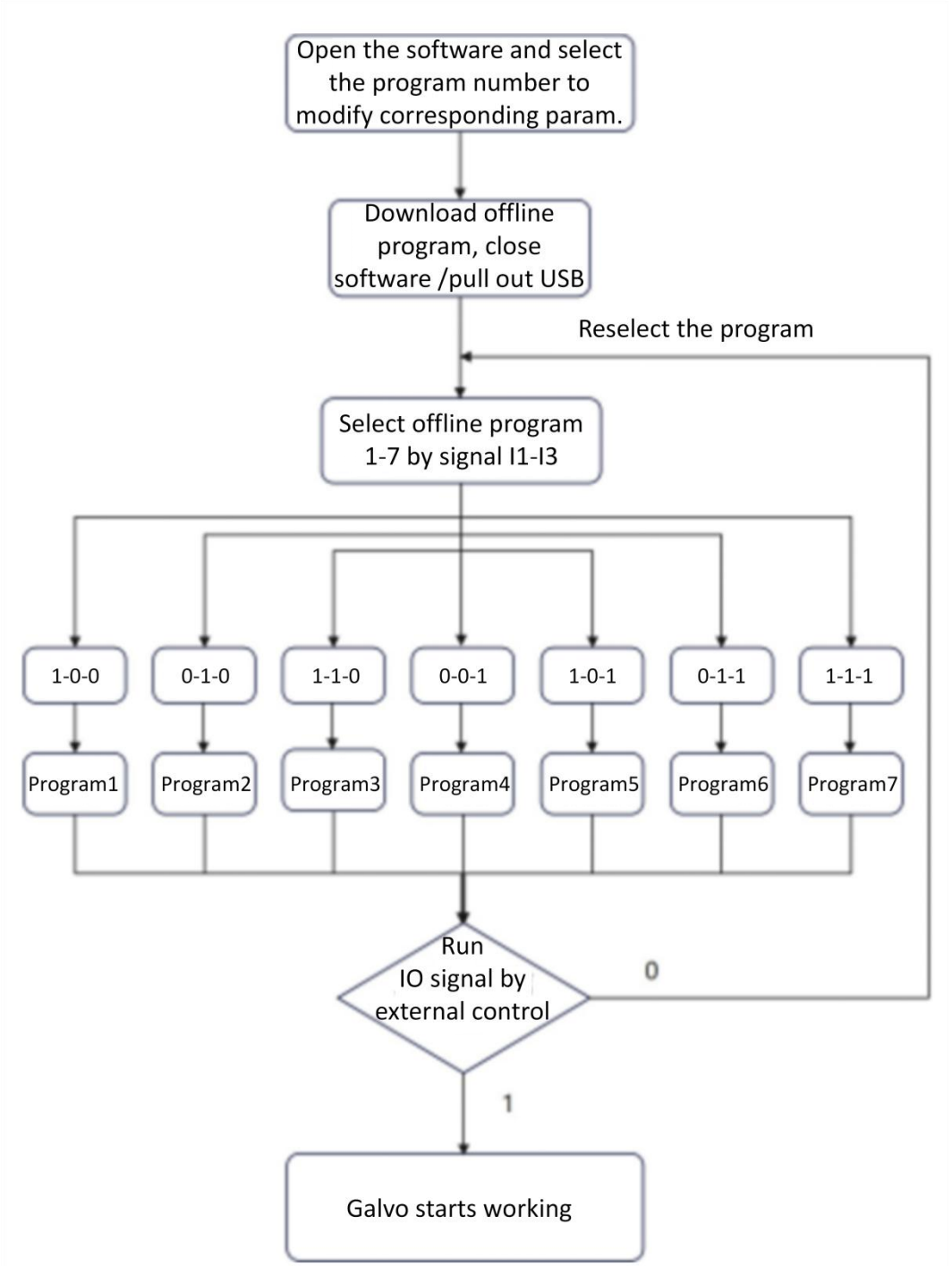
3.2.1 Wiring Diagram



3.2.2 I/O-CAN Definition

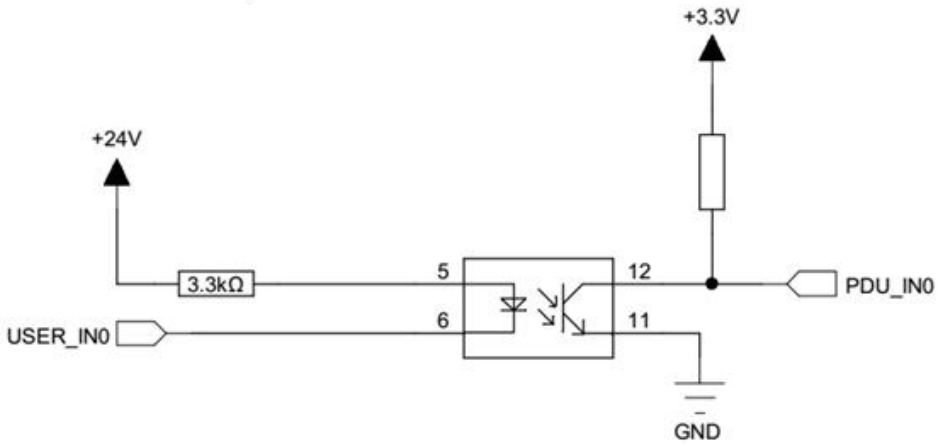
Signal	Type	IO No.	Definition	Signal Type
Running	Output	Out0	Running status	NPN
Error	Output	Out2	Running error of motion card	NPN
STOP	Input	I19	Emergency stop	NPN
Run	Input	I0	Triggered offline mode	NPN
DocApply	Input	I1~I3	Select offline program	NPN
I24V	Input	I24	I/O power supply	NPN
ICOM	Input	ICOM	I/O GND	NPN

IN3	IN2	IN1	Program No.
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7



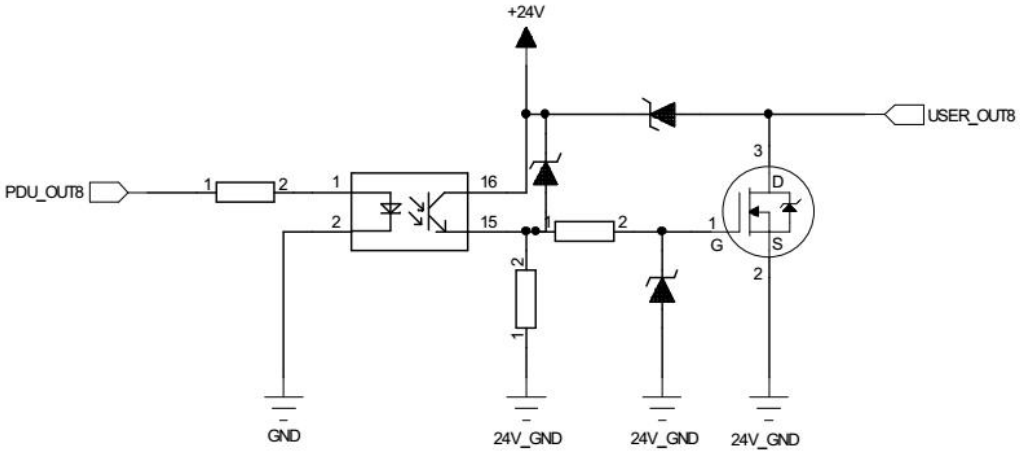
1. Signal I1-I3 and external operation signal are effective for low-level input.
2. External operation signal inputs and the galvo starts working. External operation signal stops and the galvo ceases.
3. When the external operation signal is turned off, the modification of offline program takes effect.

General I/O Input Circuit Diagram is shown as below:



The current shall be more than 2.5mA under NPN in order to safeguard the signal communication (VCC-VinL>8V). The VinL shall be less than 15V if the power supply is 24V.
The current shall be less than 0.25mA under PNP in order to safeguard signal communication (VCC-VinH<0.8V). The VinH shall be more than 23.2V if the power supply is 24V.

O0-O7 is 500mA output with circuit diagram as shown below:



3.3 System Debugging by Internal Control

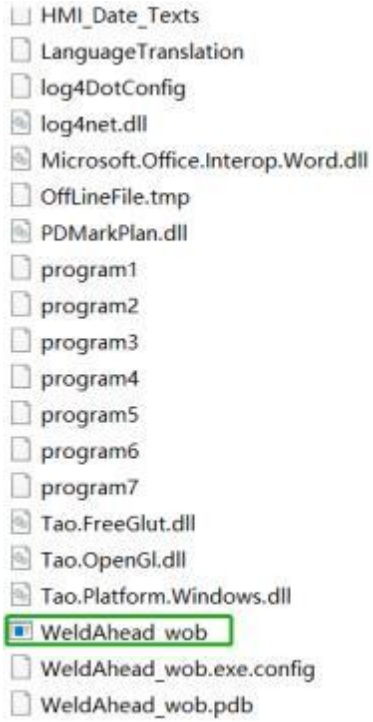
3.3.1 Communication Setting

Confirm system 64-bit or 32-bit to select driver.

1. Open the software in the folder.
2. Connect the motion control card to the master PC.
3. Run the X64 or X86/EXE to install the driver directly.

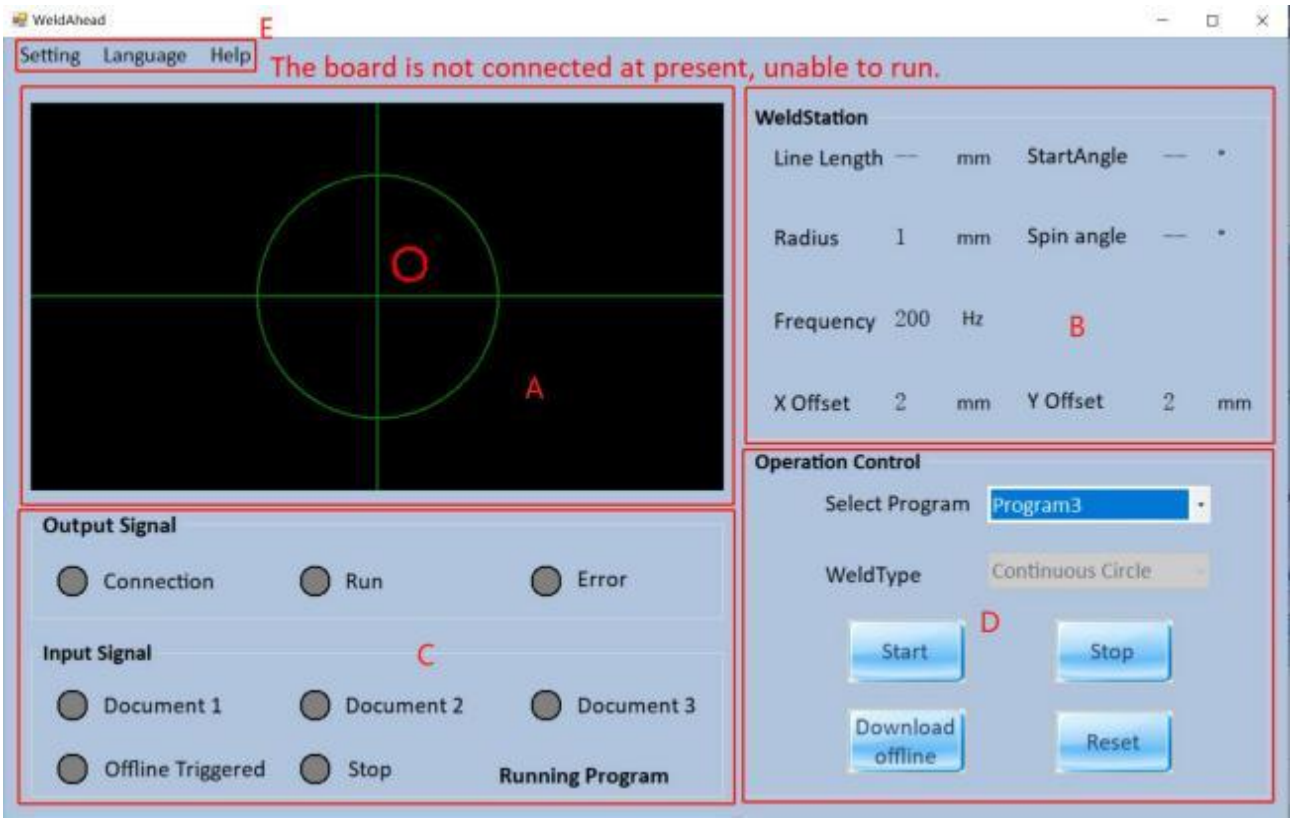
3.3.2 Startup

Open the folder: WOB and double-click on Debug. Select the software.
(BF330 Software----Debug----WeldAhead_wob)



3.3.3 Interface Introduction

Main Interface



A. Welding Path Preview: to observe the set moving path.

B. Welding Status: to observe the set parameters.

C. System Status: to monitor the I/O signal status.

D. Operation Control : to select program number and buttons like “Start”, “Stop”, “Download offline” and “Reset”.

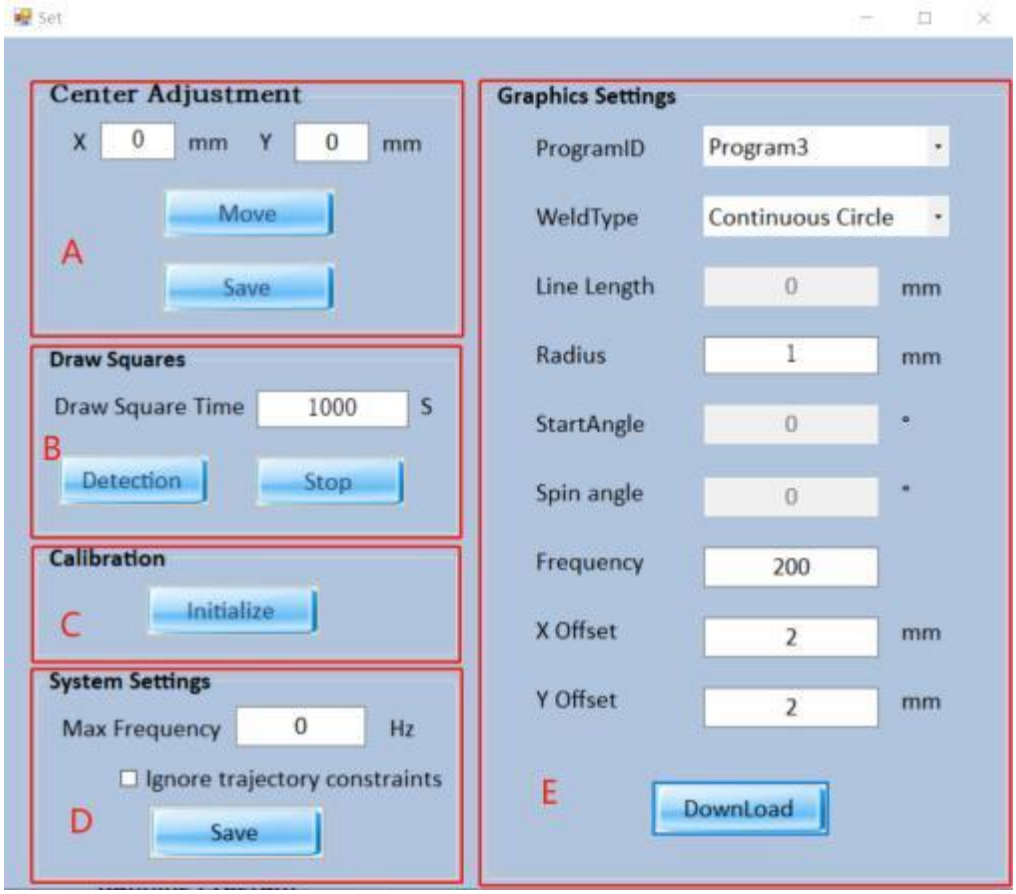
Start: activate galvo system to run set path.
Stop: stop the control of motion card.

Download offline: download all paths into the motion card.
Note: The downloaded paths will overlap the early downloaded and current paths. Ensure all set paths correct prior to download. The download may take some time and please keep patient.

Reset: clear the alarm when the error occurs to motion card.
Note: further operation is prohibited before the alarm is cleared by reset.

E. Menu: to set path parameters, do the calibration, select the language, and search for help.

Parameter Setting Interface



A. Center Adjustment: set the graphic center and laser beam alignment.

- Adjust the red light to the center of air knife by adjusting X/Y value.
- Click “Move” to get beam spot reaching X/Y location .
- Click “Save” to record the center coordinate.

B. Draw Square Detection: adjust the graphic size at focus point and calibrate the graphics size.

- Click the “Detection” button by red beam after the focus point is determined. It will draw a square.
- Check if it is a 4x4mm square. If not, to measure square size and fill the values (Length-X, Width-Y, with accuracy 0.1mm) into the auto calibration and save it.
- Draw square again to confirm if it is correct.

C. Calibration: clear the setting from center adjustment and draw square detection. Initialize to default calibration data.

D. System Setting

- Max Frequency: to set the max frequency as per required path to avoid position offset alarm.
- Ignore trajectory constraints: default path cannot be more than a circle with radius 5mm. If it is ticked, this limit(constraint) could be ignored.

E. Graphic Setting

- Program ID: set parameter ID. 7 ID could be set.
- Weld Type: set wobbling path, including continuous line, continuous circle, continuous 8 shape, continuous C type, continuous S type and continuous square type.

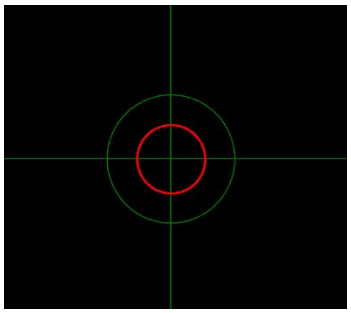
3.3.4 Welding Type and Parameter Setting

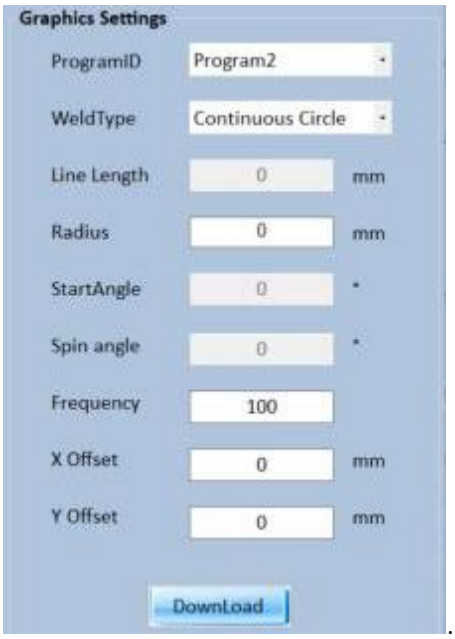
1. Continuous Circle

Set the diameter, frequency and X/Y offset (the offset adjustment is to modify the position of circle center).

- Diameter: max. 10mm
- Relation between max. Frequency and Diameter: Frequency ≤ 2800÷Diameter÷π

Click “download” after the setting is completed.



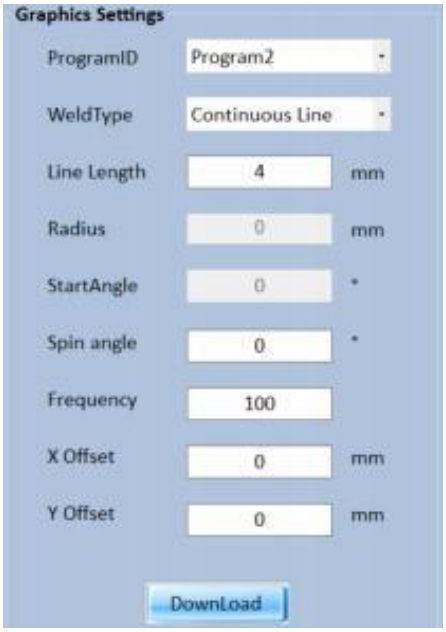


2. Continuous Line

Set the line length, frequency, spin angle and X/Y offset.

- Line length: max. 10mm
- X/Y Offset Range: ±5mm (modify according to the requirement)
- Relation between Frequency and max. Length: Frequency ≤ 2800÷Line length÷2

Click “download” after the setting is completed.

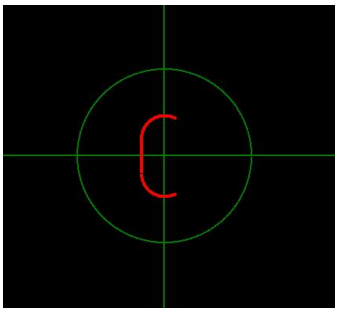


3. Continuous C Shape

Set the line length, diameter, frequency, spin angle and X/Y offset.

- Sum of Arc Length and Diameter: max. 10mm
- X/Y Offset Range: ±5mm (modify according to the requirement)

Click “download” after the setting is completed.

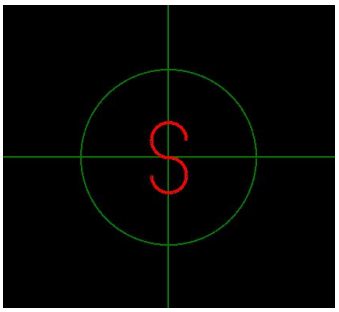


4. S Shape

Set the radius, frequency, spin angle and X/Y offset.

- Arc Diameter: max. 5mm
- X/Y Offset Range: ±5mm (modify according to the requirement)

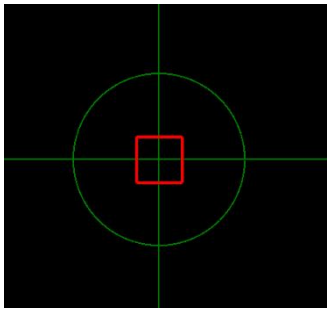
Click “download” after the setting is completed.

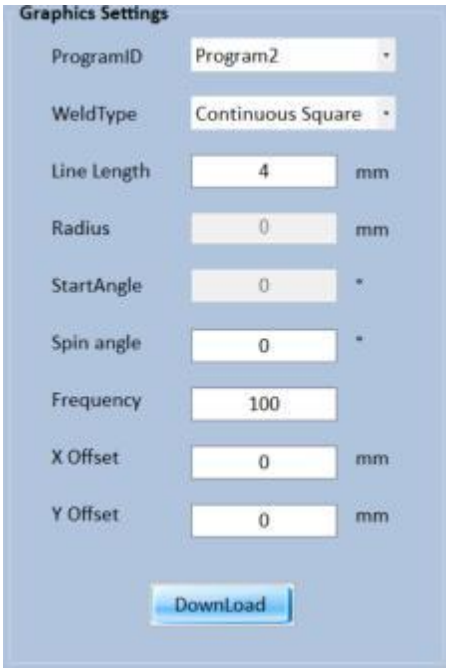


5. Continuous Square

- Set the line length, spin angle, frequency and X/Y offset.
- Line Length: max. 10mm
- X/Y Offset Range: ±5mm (modify according to the requirement)

Click “download” after the setting is completed.



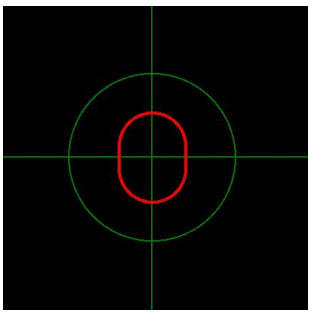


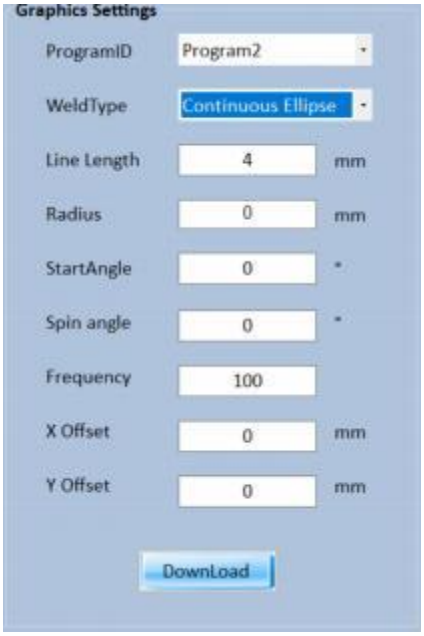
6. Continuous Ellipse

Set line length, radius, start angle, spin angle, X/Y offset and frequency.

- Line Length: max. 10mm
- Arc Length: max. 5mm
- X/Y Offset Range: ±5mm (modify according to the requirement)

Click “download” after the setting is completed.



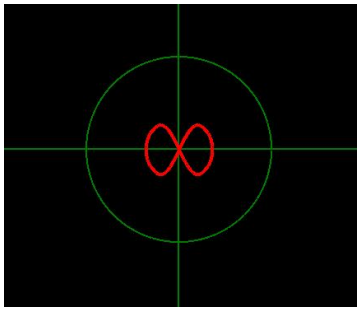


7. Continuous 8 Shape

Set arc radius, frequency, spin angle and X/Y offset.

- Arc Radius: max. 5mm
- X/Y Offset Range: ±5mm

Click “download” after the setting is completed.



3.4 Internal and External Control Mode

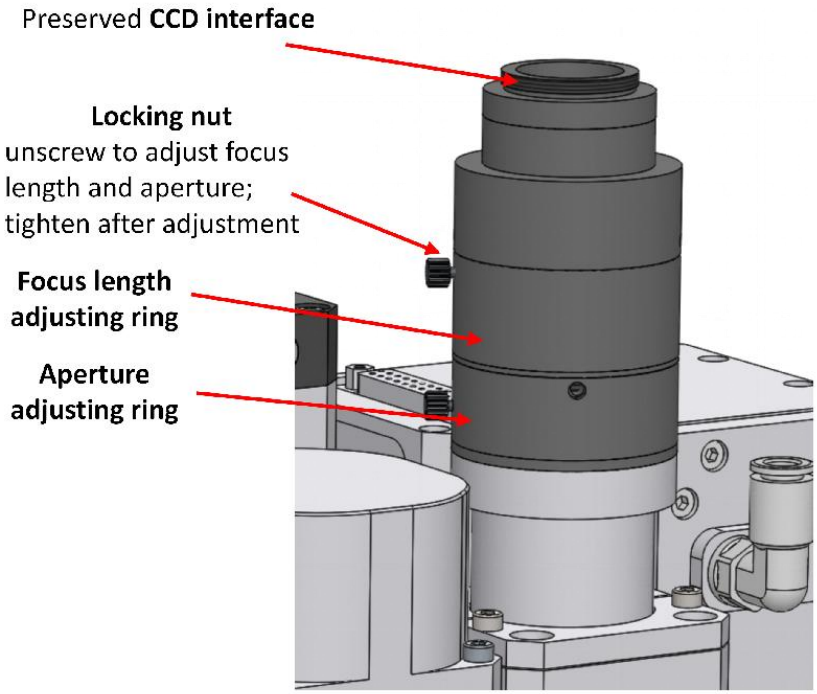
Internal Control
Control the laser head by BF330 software. Select program 1-7 and click “Start” and “Stop”.

External Control
Download offline will download program 1 to 7. Ensure the correct path before download.
Offline running can be used after downloading offline.
Offline program could be selected by I1 to I3. The offline shall be triggered after the offline program is selected. While offline program is running, it is invalid to change unless it is stopped and select a new offline program to start a new offline running.
If not input program selection signal, it will trigger program 0 to do homing.

Notice: When using external control offline, trigger program 0 and select other offline programs after turning off program 0.

3.5 CCD Module

Mounting and Adjustment



(CCD camera is not in standard supply scope but is optional to users.)

Steps of CCD adjustment:

1. Put the workpiece that need to be observed at the focus point and power on welding head to complete homing. Then turn on the auxiliary light source.
2. Loose the locking nut before adjusting focus length and aperture.
3. Adjust aperture adjusting ring to get proper image brightness.
4. Adjust the ring of focus length to get clear image.
5. Fasten the locking nut after completing the focus length and aperture adjustment.
6. Adjust the nut of image position to locate the image in screen center.

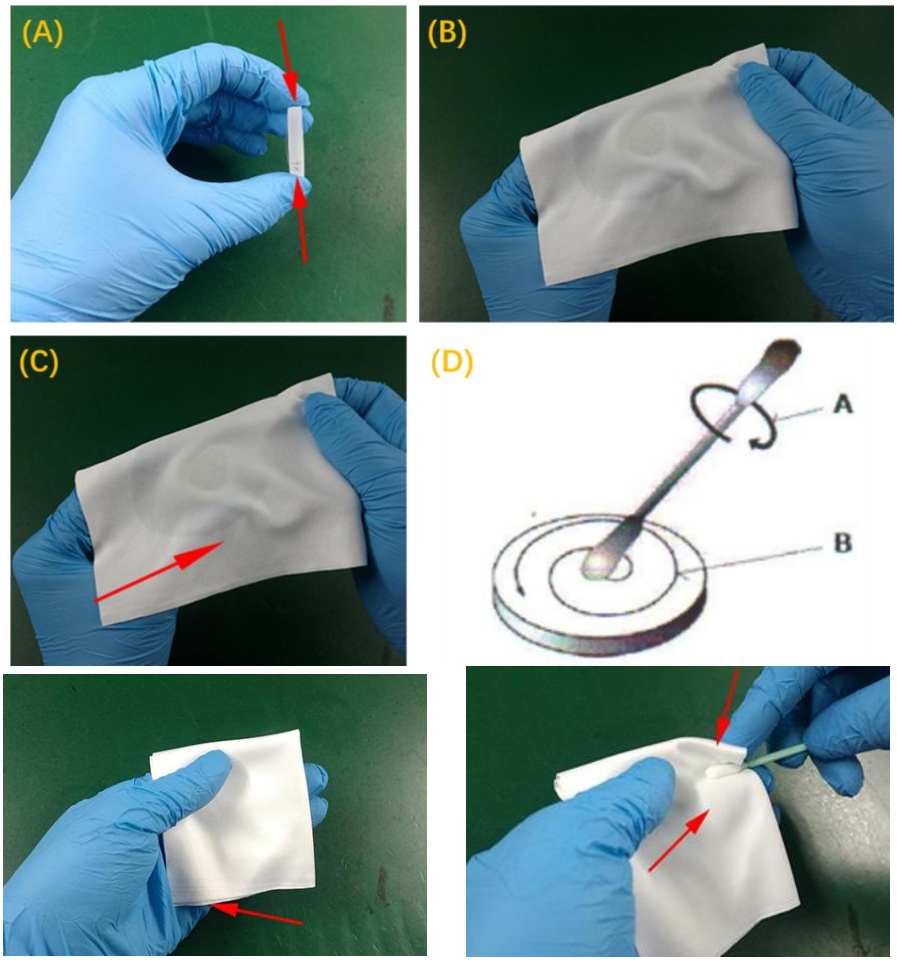
Attention: 2 opposite nuts shall be adjusted simultaneously in same direction to adjust the image position.

4 Maintenance

4.1 Cover Glass Cleaning

The cover glass should be cleaned regularly according to the steps shown below:

1. Take the side face of the glass with gloves, refer to figure (A). Do not touch the top and bottom surfaces with fingers;
2. Put the cleanroom wiper on the glass, and use 2-3 drops of lens cleaner, as shown in figure (B);
3. Slowly drag the cleanroom wiper horizontally and ensure no mark. Then, the glass will be clean. This step can be repeated till it is clean. Every time use a new piece of cleanroom wiper. Refer to figure (C);
4. With serious stains, a cleaning swab will be needed. Spray the lens cleaner on the swab, and then use it to clean the glass. Move the cleaning swab from the inside, anticlockwise, in a circular motion, with gentle force on the glass surface. Rotate the swab along the vertical axis gently to ensure the effect. Refer to figure (D).



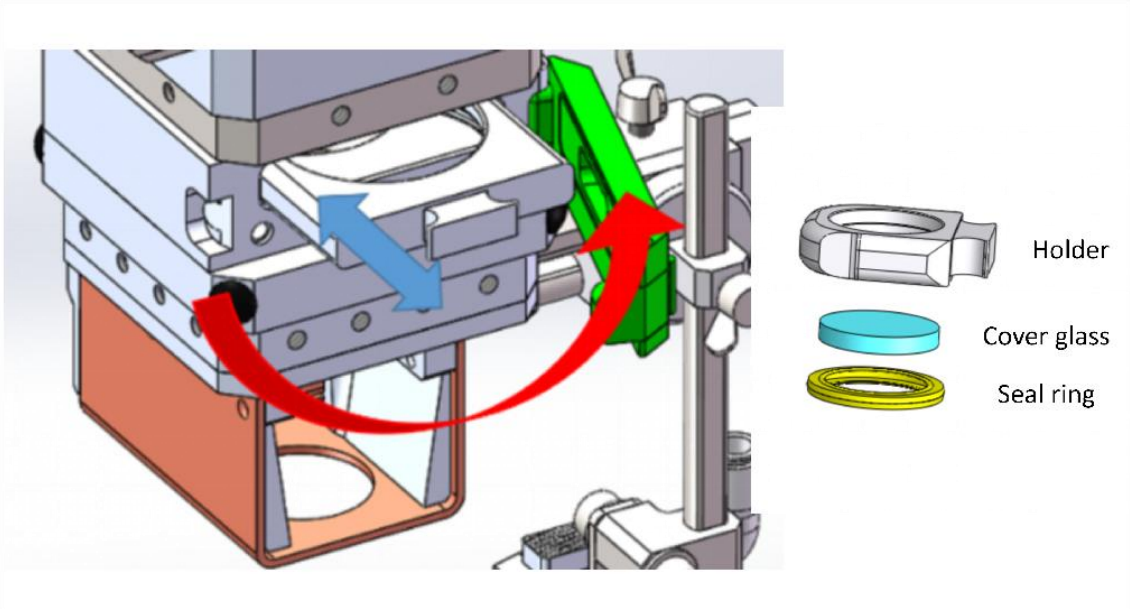
5. With serious contamination, use the cleanroom wiper and fold it twice.Spray the cleaner at the right-angle position after folding. Hold the lens with no contact with the top and bottom surfaces, and take the cleanroom wiper. Press the side with lens cleaner against the lens surface and gently press the other side with the forefinger. Gently and firmly turn the cleanroom wiper clockwise along the surface of the lens.

4.2 Cover Glass: Assembly and Disassembly

Steps are shown in figure 3-1:

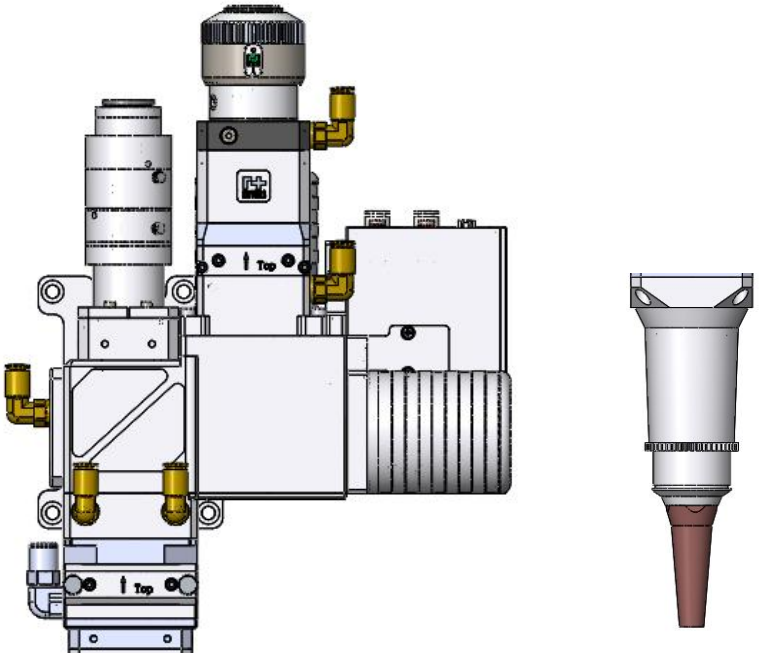
1. Loosen screws;
2. Pull out the cover glass holder;
3. Press the glass with fingers and push out the lens from the holder at the side without the seal ring;
4. Install the cover glass back into its holder;
5. Seal the cover glass with the seal ring;
6. Replace the cover glass holder;
7. Tighten screws.

Caution: Do not take out the seal ring on the cover glass with fingernails or any hard tool, which will cause gas leakage and serious damage to the lenses. Place the seal ring properly to guarantee its use.



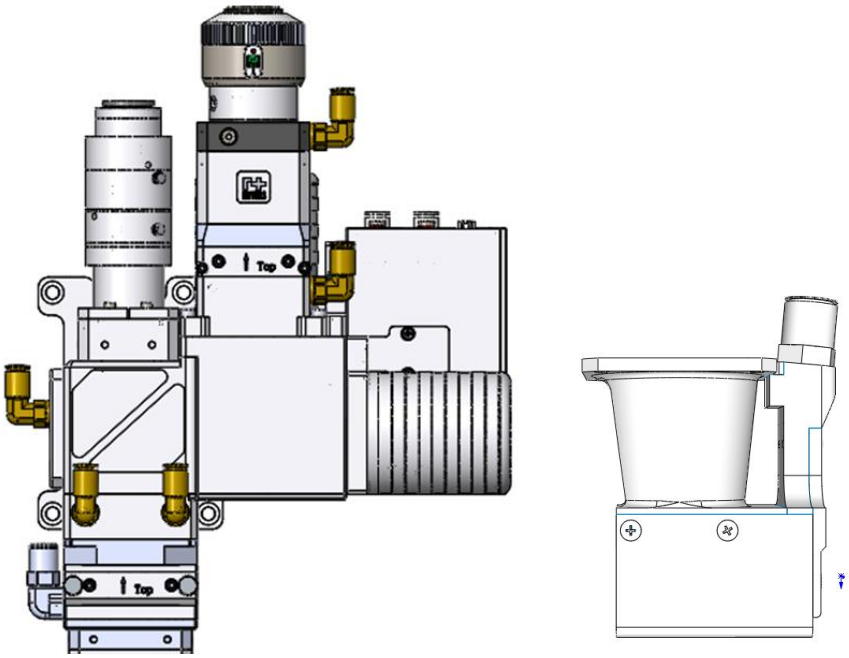
4.3 Installation of Coaxial Nozzle & Air Knife

4.3.1 Coaxial Nozzle



The coaxial nozzle is to be mounted by 4 inner hex screws (M3x10) .

4.3.2 Air Knife



The air knife is to be mounted by 4 stainless steel external hex bolt (M3x10).

4.4 Consumables: Material Code

4.4.1 Cover Glass

Laser head	Size	Material code
BF3304F1F4	D37mmx1.6mm (Top)	211LCG0045
BF3304F1F4	D37mmx7mm (Bottom)	211LCG0078

4.4.2 Nozzle

Laser head	Type	Material code
BF3304F1F4	Coaxial nozzle	120AJ1604A

4.4.3 Seal Ring

Laser head	Type	Material code
BF3304F1F4	Bottom cover glass	1021M21210058