Guide of Laser Cutting Machine

Introduce i Series of Products, Quickly Master the Method of Use

Preface

Thank you for purchasing the laser cutting machine of Jinan Bodor Laser Co., Ltd. We will serve you sincerely. If you are using our product for the first time, please carefully read this Guide before installation and use.

Statement

It means that the user does not raise any objections to our shipping list if the user requires our installation and debugging service.

All of the following documents include work security tips, which are of great significance to avoid hazardous situations. During operation, please strictly comply with the rules of operation, and read the sections of safety before use.

If you have any questions or better suggestions, please visit our website www.bodor.com to leave a message or call the 24-hour free phone 400-166-1119 for consultation.

Directory

Safety Notes

This Chapter explains the concept of safety, and indicates the measures that should be taken to avoid possible risks. The “Overview of Other Risks” includes the measures taken by users to avoid other risks.

Tip: Users must comply with the existing regulations of safety and accident prevention of each nation, as well as the safety regulations of each province and region.

Warning signs and danger signs:

Some actions may cause dangers during operation. Job description usually follows warning signs in the Instructions. Danger signs are set on the machine tool.

Warning signs include the following warnings:

Danger: Indicates there is severe harm. If it is not avoided, it may cause death or serious injury!!!

Anti-electric Shock Label

The personnel are warned that there is strong electricity here. Please pay attention to preventing the electric shock.

Warning: Indicates there is likely to cause dangerous situations. If it is not avoided, it may cause serious personal injury or great loss!

Crush Warning Label

The personnel are warned of preventing the crush.

Label of Preventing User from Plugging Fiber

The personnel are warned of prohibiting from plugging the fiber.

Label of No Permission of Forklift

The personnel are warned of not permitting the forklift.

Shipping Mark

Keep Upright Label

Please pay attention to this label on arrival and confirm that if the equipment is placed upside down.

Anti-reverse Label

Please pay attention to this label on arrival and confirm that if the equipment is seriously reversed or dumped.

Tip: Indicates there is likely to cause dangerous situations. If it is not avoided, it may cause minor injury or slight property loss!

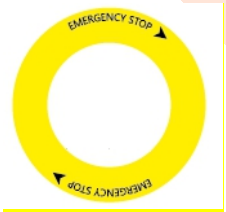
Label of Paying Attention to the Forklift

The personnel are warned to pay attention to the forklift here.

Hoisting Label

The personnel are warned to pay attention to the hoisting location of the crane.

Emergency Stop Label



The personnel are warned to pay attention to the emergency stop button here.

Label of Removing the Shipping Block and Rust Prevention Oil

The personnel are warned that it is required to remove the rust prevention oil, shipping block and hoisting ring before using.

No Unpacking Label

The personnel are warned of not packing the boxes.

I. Overview

Operators must carefully read this Chapter to understand the safety measures and requirements of the machine tools, and comply with relevant safety precautions before operation and routine maintenance of the machine tools.

Laser processing equipment and its operation shall accord with two national standards, i.e. GB7247.1-2001 l Radiation Safety of Laser Products, Equipment Classification, Requirements and Users Guide and GB/T10320-2011 Electrical Safety of Laser Equipment and Installations.

II. Safety of Equipment Operation

In the process of equipment use, operators must strictly comply with the safety guidelines involved in this Chapter. Improper or non-conforming use of the equipment may cause the following dangers:

A: To endanger personal safety.

B: To damage the equipment and other property safety of users.

C: To affect effective work of the equipment.

2.1 Please use it according to the regulations

The equipment is used by users only in the industry sector. Users must comply with the equipment installation, operation and transport conditions specified by Bodor Laser, and carry out maintenance work. Furthermore, its installation and operation must also comply with the existing regulations of user's country and region. Users can implement laser cutting

of metal plates or pipes by using the equipment. It is strictly forbidden that users modify and refit the equipment; it is strictly forbidden to carry out operations which may affect the safety of machine tools; it is strictly forbidden to cut plastics, wood, and plates with PVC film and magnesium.

Disclaimer: Except for these provisions, any other operations are deemed as non-conforming use, and Bodor Laser shall be not liable for any losses herein incurred, in particular, property damage, personal injury and production loss. Such risks shall be fully borne by users.

2.2 Personnel Qualification

Only authorized and trained personnel can carry out operation, debugging and maintenance of the equipment. The trained personnel can carry out normal cutting work on the laser cutting machine; transport, install and disassemble machine tools; maintain and repair the equipment.

2.3 Danger

2.3.1 Overview of Laser Class

Laser equipment is broken down into different laser classes according to the European standard EN 60825-1.And laser class indicates the hazard level of laser beam irradiated.

Laser Class	Description
1	Laser beams available are not dangerous under predictable proper conditions.

2	The wave length of laser beams available is within the visible spectrum range (400nm-700nm). Short-time exposure (less than 0.25s) does not damage the eyes. For other rays beyond the wave length range of 400-700nm which meet Class 1 conditions, generally can protect the eyes by keeping away from laser beams or closing eyes.
3B	Laser beams available are harmful to the eyes and skin as well. It is very dangerous to look straight at rays of a 3B laser. Exceeding the maximum allowable radiation value, rays from the 3B laser source may cause damage to the skin.
4	Rays available are extremely harmful to the eyes and skin, and even diffused rays also cause damage. And rays may cause a fire and explosion hazard. For a Class 4 laser device, safety measures must be taken: The most important is to fully protect the eyes. Under normal circumstances, the power intensity of a Class 4 laser device is enough to burn the skin, cause a fire and ionize the atmosphere when focusing. Therefore, a series of other security measures should be taken.

Operation mode of laser cutting machine

Operation Mode	Description	State	Laser Class
Normal operation mode	Normal operation mode refers to the operation of the equipment within the range of all functions, including the maintenance work described in the operation guide.	Machine tools are controlled by program or manually. Personnel are outside the danger zone.	1
Maintenance and debug mode	Maintenance and debug mode refers to the state of machine tools during maintenance and debugging.	When the equipment is in an abnormal state or needs to be maintained.	4

2.3.2 Danger of Laser Rays

Danger

When the equipment is running, laser rays belong to invisible light with high energy!

It may cause severe burns to the skin and damage the eyes. The impact on vision may result in visual impairment and even blindness!

→ During maintenance, all jobs should be carried out only by specially-trained maintenance personnel or professionals.

→ If debugging is required when the laser source is working, operators must wear the laser protective glasses.

→ Dangerous areas should be protected with protective materials when necessary, such as steel plates or movable PC partition.

→ Pay attention to danger signs and warning icons.

Warning

Laser rays may hurt the eyes! Do not look straight at rays!

If you look at the processing position for a long time, visible rays may cause damage to the operator. Especially, plasma produced during high-speed cutting process or manufacturing of galvanized steel plate, titanium, aluminum and high-quality steel, produces bright light, which may cause permanent damage to the retina.

Warning

Secondary rays in the laser cutting process are dangerous! High-intensive visible rays may cause permanent damage to the retina!

→ Do not look straight at the machining position without taking protective measures.

→ Wear laser protective glasses when necessary.

2.3.3 Fire Danger

For the purpose of fire protection of machine tools, the following fire extinguishers should be prepared:

• Dry powder fire extinguishers, aiming at a fire caused by hot residue which is generated during laser processing.

• CO_2 fire extinguisher, aiming at a fire due to other causes.

Tips

To prevent fire, explosion and other disasters, there should be no flammable and explosive products such as gasoline and styrofoam within 2 meters around the laser cutting machine due to the risk of reflection during laser cutting. Any losses caused thereby, especially property damage, personal injury, production losses and other risks, shall be solely borne by the user.

In the working area of machine tools or when raw material is replaced, burning object is prohibited!

→ Do not throw burning object, such as cigarette, into the working area of machine tools.

→ The dust control unit must have worked for a period of time before the replacement of aluminum/aluminum alloy with other metal material (vice versa), and it is better to clear up filter elements inside the smoke purifier(if equipped) . Each kind of

material uses dedicated filter elements when conditions permit.

→ Carry out routine maintenance of the fan (or your extra smoke purifier).

2.3.4 High Voltage Risk

Voltage can cause life danger if the operation does not accord with the regulations!

→ Do not bridge the safety circuit.

→ Do not use it in the explosive dangerous environment.

Danger

Live part is still dangerously charged after cutting off power supply!

→ Do not touch the components with a warning sign.

→ Take measures to prevent machine tools from being reconnected accidentally.

→ Await discharge time.

2.4 Precautions

2.4.1 Pay attention to warning signs and danger signs.

Some jobs may cause danger during operation. Job description follows warning signs in the Instructions. Danger signs are set on the machine tool.

2.4.2 Personnel training.

Before working with the machine tool, the user must meet the following criteria:

• Take professional training

• Understand possible risks and protective measures

• Prepare personal protective devices

• Prepare personal protective devices worn by operators (e.g. gloves, protective shoes,

goggles, etc.)

• Assign personnel to be in charge of safety, operation, maintenance and repair, commissioning.

• Read the Equipment Guide completely. Suggestion: Obtain the written confirmation of the operator.

• Know about the protective measures against rays:

- Enable the operator to understand the operational process of the equipment.

- Properly use ray protective devices, for example, wear laser protective goggles.

- Learn about emergency treatment.

• High-temperature workpieces have to be taken out with appropriate tools.

2.4.3 Abide by the precautions of operating machine tools

Check dangerous areas and safety devices.

• The operator must confirm that no one is in the dangerous area before starting the machine tool.

• The operator can operate the machine tool only after confirming safety condition. Safety devices shall not be disassembled or shut down unless maintenance and repair are carried out. Maintenance personnel must remount safety devices to make it in service after maintenance.

• The customer shall not dismantle or discard protective devices and protective functions of the equipment itself without permission, failing which any losses caused thereby, especially property damage, personal injury, production losses and other risks, shall be solely borne by the user.

The user must operate the equipment according to the regulations.

• The user must ensure that the machine tool is installed according to the installation drawings and conditions.

• The user must ensure that only authorized personnel can work on the machine tool.

• The user or his or her authorized personnel must operate the machine tool under normal conditions.

• The user must ensure that the work site of the machine tool is clean and orderly according to relevant regulations and check.

Operators

• The operator must immediately report all the changes in the machine tool (including operational performance) to the leader. The machine tool must be checked at least once a day to see if there is a visible defect or damage.

Follow the shutdown procedure

• The operator must comply with the specified shutdown procedure after all jobs are finished (e.g. settings and maintenance).

Turn off the water-cooling machine in case of emergency.

• Immediately turn off the water-cooling machine in case of major failure in the water-cooling machine (such as leakage of coolant circulation loop).

The user must take the following measures.

• Make professionals check the water-cooling machine, laser source and other peripheral equipment regularly.

• Record the equipment usage (recommended)

2.4.4 When workpieces have sharp edges

Warning

The sharp edges of workpieces may be dangerous! Please wear personal protective devices!

2.4.5 The electric control cabinet may be dangerous

The electric control cabinet can be opened only by personnel with professional electrical skills or trained by Bodor.

Danger

High voltage may cause damage to human body!

→ Keep the electric control cabinet closed.

→ Before the electric control cabinet is opened every time: Turn off the machine tool, and await at least 5 minutes.

Tip

The surface of newly-cut workpiece is very hot, so be careful of burning!

2.4.6 The dedusting system must work normally.

Smoke and dust which are generally produced during processing may damage human tissues and organs. The user must assess the risks arising from material processing, and prepare necessary countermeasures.

Warning

- **Harmful gas and particles may enter the respiratory tract during laser processing.**
- **Work only when the dedusting system runs normally.**

Dust, aerosols and gases

The following harmful substances are discharged during laser processing of metal. Please ensure that the dedusting system can run normally.

• Dust of particle size > 1μm

• Aerosol of particle size < 1μm

• Harmful gases

Dangerous substances generated by cutting oil

• If metal material is treated with cutting oil, it will produce organic compounds (liquid or gaseous substances) during laser cutting process. Please take effective protective measures.

Dangerous substances produced by polyethylene coating

• In order to protect the surface, some materials are coated with polyethylene. The polyethylene coating will be vaporized during laser cutting process. Organic compounds (such as alkanes) that are produced in this process may cause injury. Please take effective protective measures.

2.4.7 Use of spare parts, accessories and running materials

Use of spare parts and accessories.

• It is forbidden to use the equipment or accessories unauthorized by Bodor Laser, since they are without Bodor's certification program (hereinafter referred to as "Outsourcing Parts"). The installation or use of outsourcing parts may cause damage to the machine tool, and be likely to cause unpredictable danger.

Disclaimer

The losses incurred by use of outsourcing parts or improper installation and replacement of spare parts or accessories authorized by Bodor are not within the scope of Bodor Laser's liability.

Guide of Complete Machine Assembly and Disassembly

Important notes

The guide of complete machine assembly and disassembly includes preparation and all other information for placement and use of the machine tool before use.

Tip

i series are the equipment with multiple models for cutting metal materials with laser, and it is not allowed to use the i series to cut non-metal materials (e.g. glass, acrylic, wood, etc.).

Tip

All the conditions described in this Chapter must be met before the arrival of the machine tool. Otherwise, the Bodor Laser's After-sales Service Department will not provide any services before the machine tool is put into operation. Please make all the preparations in advance according to the following work plans.

Tip

Before the equipment officially runs, the machine tool should be operated only by personnel authorized by Bodor Laser or by Bodor Laser's after-sales service personnel.

Tip

The initial debugging and running of the machine tool should be carried out only by Bodor Laser's debugging service personnel or customer service commissioners.

Include:

• Place, calibrate, level correction and fix the machine tool.

• Add the coolant.

• Connect the machine tool to the supply system (except the power source).

• Perform functional testing.

• Instruct the operators.

• The customer shall contact the customer service staff of Bodor to guide the move and disassembly of the equipment if the customer has this demand. Our company will not be responsible for the warranty if the equipment cannot work or does not work normally because it has not been moved or disassembled privately by the customer without contacting the customer service staff of Bodor.

Tips

Lubricating oil shall be added in the case of transporting machine tools by air. We draw the customer's attention to follow the guide of maintenance for regular maintenance. Our company will not be responsible for the problems caused by the failure of maintenance!

Tip

Ensure that the amount of lubricant is normal when the machine tool is running, and check it regularly.

I. Preparedness Plan

The preparedness plan provides the preparedness scheme required by the customer before the arrival of the equipment. See relevant chapters of the guide of complete machine assembly and disassembly for details. The time planning is for reference only, and the details are subject to the actual order.

Before the arrival of the equipment	Main points of the plan	Measures
10th week before the arrival of the equipment	Installation site	• Determine the installation site of the machine tool, and at the same time consider the site requirements according to the site layout drawing. • Check ground conditions: - Ground quality - Flatness - Gap • Pay attention to machine weight and size. • Check climatic conditions: - Room temperature. - External air purity. • Check transport routes: - Doorway size - Height of breast beam - Height of cable rack - Switchyard around the corner, etc.
8th week before the arrival of the equipment	Personnel and training	• Appoint a person in charge of transfer and preparation of the machine tool. • Assign operating personnel, maintenance personnel and programming personnel. • Agree on the training period of professionals.
4th week before the arrival of the equipment	Power supply	• Install the electrical interface at the installation site. • Prepare standard wiring and circuit

		protection according to the regulations.
4th week before the arrival of the equipment	Air compressor (only when prepared by the customer)	• Install the compressed air feeder at the installation site
2nd week before the arrival of the equipment	Running materials	• Nitrogen, • Oxygen • Cooling water • Compressed air (optional)

1.1 Installation Conditions

Requirements for ground

• The ground of equipment installation should be flat, the flatness be within ±5mm, and the concrete thickness of the entire installation surface be not less than 200mm.

Requirements for space

• The distance between left side and rear side of the machine tool and the workshop wall should be more than 1,200mm; the distance from the laser to the wall should be more than 1,000mm.

• In order to prevent the occurrence of a fire, the processing site should be equipped with appropriate fire extinguishers, and fire-fighting access should be set aside.

Tip

For i series products, the foundation needs to be made pursuant to the requirements of foundation drawings (see the Annex Foundation Drawings for i Series Products). Bodor shall not be responsible for poor cutting accuracy of the equipment, ripples generated by cutting parts, waves and other phenomena due to the customer's failure to make the foundation according to the requirements.

Requirements for environment

• The operation environment for the equipment should be kept dry and well ventilated at an ambient temperature of 0℃~40℃ and a relative humidity of below 95% RH (without freezing or condensation). As each electrical component may be below an average altitude of 2000 meters, any customer with capability is recommended to provide the equipment with a constant temperature and humidity environment. The ambient temperature at the installation site should not be below + 4 ° C when the equipment is off. Note: any thermal deformation caused by direct sunlight on one side or air inflow on one side should be avoided (e.g. If the equipment is installed at a position near the window, an blind may be installed to avoid such case).

• The core parts of the machine tool, including the control unit, servo unit, monitor and control panel, have certain requirements for the environment. Protect the machine tool against interference from electromagnetic wave, for example, electric-arc welding and discharge machine may affect normal operation of the machine tool.

• In order to ensure cutting quality, it is necessary to ensure that there are no particles or substances which can absorb the ray with a wavelength of 1.064um around the machine, such as solvent vapor that is emitted during paint spraying or steam from a deoiler.

• In the electric control cabinet, the user shall neither connect external wires and sockets nor connect electric drills, angle grinders, etc. into the electric control cabinet, failing which Bodor shall not be liable for the damage to the components caused thereby.

1.2 Power Supply

Quality of power supply

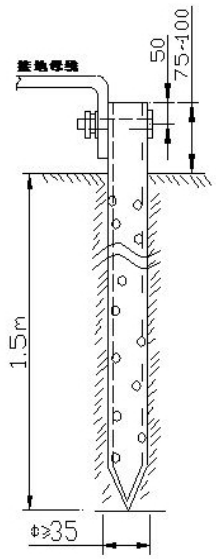
•Degree of three-phase unbalance <2.5%, line voltage fluctuation <5%.

• If the quality of power supply does not meet the said configuration, a voltage stabilizer shall be added to ensure normal operation of the equipment. failing which any losses caused by the quality of power supply, especially property damage, personal injury, production losses and other risks, shall be solely borne by the user, for which Bodor shall not be liable.

Ground protection

Grounding points of machine tool: 1. the machine tool is separately grounded; 2. The electric control cabinet is separately grounded; 3. The peripheral equipment is separately grounded (laser, water cooler, transformer, voltage stabilizer, fan, smoke purifier, etc.)；grounding resistance < 4 Ω as required.

The grounding device should be made of steel, such as steel pipes with a diameter of 50mm or angle steels with a size of 50mm × 50mm × 5mm.Both the steel pipe and the angle steel should be installed on grounding body vertically. In the meanwhile, appropriate salt water should be poured to ensure a good grounding effect. Copper core cables greater than or equal to 10 square meters should be used as outgoing lines, which will be connected to the grounding body through M12 bolts. The connection part of such bolts should be repainted with anticorrosive paint.



接地极与接地母线焊栓连接方式

The grounding part of the electrical equipment shall be connected to the grounding trunk line with a separate grounding wire.

In a grounding system, the grounding resistance should be less than or equal to 4Ω, and the repeated grounding resistance should be less than or equal to 10Ω.

A regular test should be carried out for the grounding resistance (on a quarterly basis). In case of any resistance exceeding standard, the cause should be found with rectifying immediately.

The transformer/voltage stabilizer configured in the equipment is only used for this equipment, and do not use external power supply for other equipment.

Disclaimer: Any operation other than those regulated herein shall be considered as non-compliant use; any losses caused thereby, especially property damage, personal injury, production losses and other risks, shall be solely borne by the user, for which Bodor shall not be liable.

1.3 Running Materials

The gas quality should meet ISO 8573-1: 2010; the level of solid particles, water and oil should reach Level 2, Level 4 and Level 3 respectively.

Nitrogen: its purity should be 99.9% as a minimum for cutting stainless steel, and its concentration should be <100ppm.

Oxygen: its purity should be 99.9% as a minimum for cutting carbon steel, and its concentration should be <100ppm.

Compressed air: It is required to be clean without any impurities such as water, oil. Where conditions permit, it can be used for thin carbon steel, thin stainless steel, etc. (All key parameters of the air compressor should not be less than the following standards: please use screw-type air compressor as much as possible, of which the volume flow is related to the laser power. The maximum operating pressure is ≥1.6mpa, the pressure dew point temperature is 2 ~ 8 ℃, the filtering accuracy is 0.01μm, and the oil content at air outlet is≤0.003ppm).

Disclaimer: machine tool pipelines, gas valves and cutting heads will be irreversibly contaminated if oxygen, nitrogen and compressed air below the above requirements are used. Bodor shall not be responsible for warranting the losses, costs and expenses caused thereby, which shall be assumed by the customer.

Lubricating oil: any lubricating oil (Grade 120) meeting the total standards may be used.

Cooling water: high-quality pure water, distilled water or deionized water without any mineral substance is required to be used as cooling circulating water.

II. Transport and Handling

2.1 Requirements for Transport

• The laser cutting machine should be firmly fixed in transit to prevent damage. The packed product should be able to be transported to any place on the secondary road. During long-distance transportation (including sea transport, rail transport, road transport, etc.), the machine shall not be loaded in the open trunk or in the cabin, not allowed to be transported together with the inflammables, explosives, corrosives and other dangerous goods. It is not allowed to get wet due to rain, snow and liquid substances. Mechanical collision or damage is not allowed.The electrical equipment should be designed to withstand storage and transportation temperatures from -25 ° C to 55 ° C. Under the highest storage and transportation temperature of 70 ° C, it should not be operated for more than 24 hours in a short period. Appropriate methods should be provided to protect cargos from excessive moisture, sway, crush and mechanical shock during carrying.

2.2 Requirements for Handling

• All hauling operations should be carried out in accordance with transport regulations.

• The machine tool shall not be placed on the ground without floor tiles; otherwise, the bottom of each component will be damaged! The base plate of the machine tool must be 100mm or more above from the ground, and such a distance must be also maintained when the machine tool is transported to the installation site.

• The ground conditions of the installation site must meet the requirements of installation conditions. The user must provide the conditions for installation according to the

layout drawing before the machine tool arrives.

• When the equipment reaches the customer, the load capacity of lifting equipment required by unloading and transferring depends on the type of the product purchased by the customer.

• When the equipment is delivered to the customer, each tool for unloading, unpacking and positioning the equipment should be selected according to the operating instructions for site installation of corresponding equipment model of Bodor Laser i Series in a strict manner. Besides, all operation should also be subject to the operating instructions for site installation of corresponding equipment model of Bodor Laser i Series.

2.3 Handling Tools

• Any auxiliary equipment, such as forklifts, hoists, cranes, should be selected in accordance with the operating instructions for site installation of corresponding equipment model of Bodor Laser P Series once the equipment is delivered. Only the hoisting ring posted hoisting label can be used for hoists and cranes. When using a forklift, attention should be paid to keep away from any damageable part (such as sheet metal parts), so as to protect the equipment from any damage caused by the forklift. For equipment with long overall length, uneven center of gravity and easy tipping, any forklift is strictly prohibited for handing.

-If possible, forklifts and cranes are preferred to unload and transfer the equipment and its accessories to a designated location.

-In the event that there is no crane in the plant or the tonnage of a crane fails to meet

requirements, please use forklifts and cranes together for unloading. Additionally, appropriate transfer equipment and appropriate loading methods should be applied to carry the laser cutting machine and its accessories to a designated location.

- In case of a small plant without any crane, Method I: the equipment can be first unloaded outside the plant by a hoist, a forklift or double forklift and then transferred. The lower part of the front of the equipment bed should be placed on a handing tank and the rear part should be carried by the forklift to a designed location.

- In case of a small plant without any crane, Method II: the equipment can be first unloaded outside the plant by a hoist, a forklift or double forklift and then transferred. The lower part of the four corners of the front and back of the equipment bed should be placed on a handing tank and may be moved by a crowbar to a designed location.

Warning

The equipment should be hoisted and handled by a professional transport company. If the customer needs to handle and hoist the equipment on his or her own, personnel in charge should receive professional training as well. If the customer changes the hoisting mode, Bodor Laser will not be liable for damage to the equipment and personal injury.

2.4 Hoisting Position and Forklifting Point of the Lathe Bed

The following sketches are slightly different from each other according to different equipment, only for reference.

Fig.1.1

For bare machine of i3 linear Series, it is not allowed to be hoisted and only forklifts can be used for carrying through forking its side. The forking position with 700mm at side can be forked and carried by the forklift, as shown in Figure 1.1.

Disclaimer: please unload as per our requirements, failing which we will not assume any responsibility therefrom.

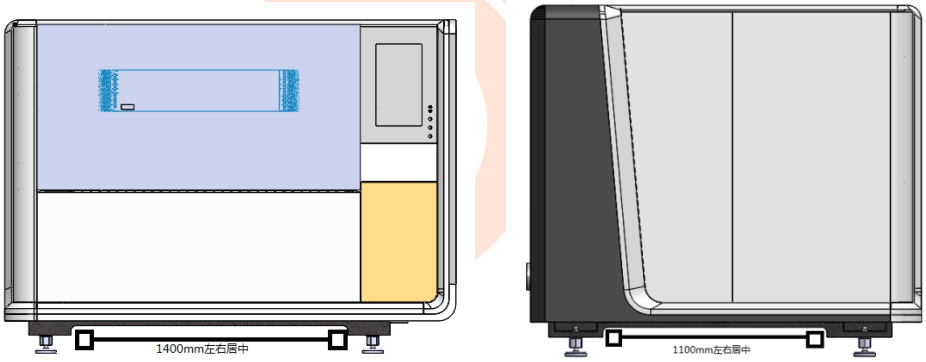


Fig.1.2

For bare machine of i5 Series, it is not allowed to be hoisted and only forklifts can be used for carrying. The forking position with 1400 mm between front and back as well as the forking position with 1100 mm at side can be forked and carried by the forklift, as shown in Figure 1.2.

Disclaimer: please unload as per our requirements, failing which we will not assume any responsibility therefrom.

2.5 Storage Conditions, Storage Period and Precautions

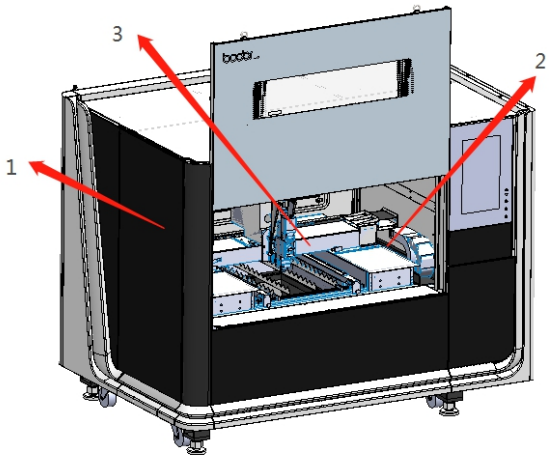
For a plant where the laser cutting machine is stored, its ambient temperature should be-10℃～40℃ and its relative humidity should be 45%～85%. It is not allowed to store any harmful gases, flammables, explosive products and corrosive chemicals. Any cooling water in the machine should be exhausted. In addition, there should be no strong mechanical vibration, impact and strong magnetic field interference. The host equipment and packaging box should be placed off the ground at least 100 mm. It is forbidden to store in the open air. In any case, the storage period should not exceed six months, otherwise a full inspection is required. The equipment can only be used after passing the inspection.

Installation and Debugging Guide

I. Brief Introduction to the Structure

1.1 Composition of Complete Machine

The schematic diagram for the whole equipment of i Series is shown in Figure 2.1（a）、（b）.



1. Outer enclosure　2. Bed　3. Dual drive module

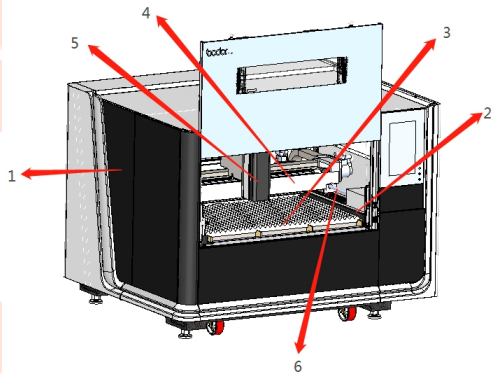


Fig.2.1

1. Outer enclosure　2. Bed　3. Work table　4. Beam　5. Z-axis　6. Drive

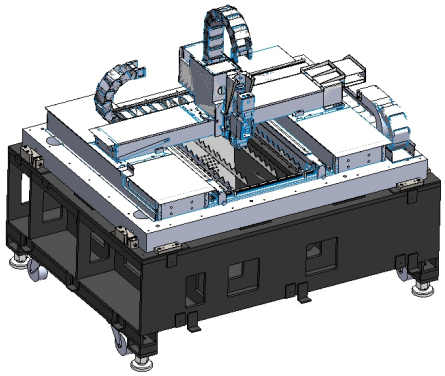
1.2 Introduction to Important Components

(1) Outer Enclosure

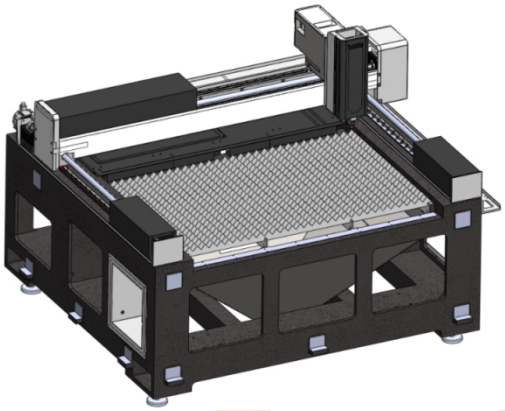
As shown in No. 1 of Figure 2.1（a）、（b）, the outer enclosure is divided into front, back, left, and right part, which are respectively welded in a whole with sheet metal and profiles. Each part is bolted in a firm and reliable manner. Tempered glass is attached to the outer part between the front and left sheet metal structures, achieving a more beautiful appearance. For the front door, the structure of electronically controlled vertical lift door is adopted with one-button for opening and closing. Besides, detection switches of deceleration and stop are equipped to ensure higher safety performance. A touch screen is adopted as the display screen with high sensitivity and good visual and operating feel. The outer enclosure and the main body of the equipment are bolted for overall shipment, which is not required to be reassembled by customers on site. There is a visible window on the front cover to facilitate operators in observing of the cutting process. A laser protective glass is attached to the inside of such window, effectively protecting operators' vision from damaging of laser during cutting.

(2) Lathe Bed

The whole structure of lathe bed is shown in Fig. 2.2（a）、（b）.



（a）



（b）

Fig.2.2

The bed of i3 linear model is made from plates through welding as a whole. Internal stress is eliminated by heat treatment after welding, which greatly reduces the deformation of the bed after installation and improves the comprehensive mechanical performance of the bed.

The beds of i5 model and i7 model are made from cast iron. Compared with the profile welded bed, the cast iron welded bed has a more reasonable structure with less internal stress, lower thermal sensitivity, better stability and shock resistance. It is the best choice to achieve higher machining accuracy.

The dimensions of the bed rail mounting surface, the motor seat mounting surface and

the beam mounting surface are completed in a single set-up for improving the processing accuracy and ensuring high cutting accuracy.

(3) Working table

Processing size

i3linear：600*600mm；i5：1500*1000mm；i7：3000*1500mm.

Structure of working table

As shown in No. 3 of Figure 2.1, a pneumatic fixture table is used for i3 linear model, in which the plates are fixed by a pneumatic fixture. In this way, any thin plate can be processed（The thickness of the clamping is 0.8-6mm）. For work table of i5 model, it can be standardly fixed table or non-standardly pneumatic table （The thickness of the clamping is 0.8-5mm）, mainly depending on the choice of customers at their needs. The cutting thickness of the plate can be selected from a wider range. For i7 model, the cutter table is designed as a pull-out type in order to facilitate feeding and ensure the safety of the operator due to its larger processing format. Plates may be directly placed on the table by a user with lifting appliance and pushed to a designed position for cutting. It is easy to operate and any thicker plate can be cut successfully.

(4) Beam device

As shown in No. 4 of Figure 2.1, the beam is made of reinforced aluminum alloy through welding as a whole, to which the strength requirements are satisfied after heat treatment and other processes. In the meanwhile, lightweight design is adopted for the beam to increase cutting speed.

(5) Z-axis device

As shown in No. 5 in Figure 2.1, the Z-axis device is the part that realizes the lifting movement of the cutting head. The lifting movement of the cutting head is controlled by the numerical control system, the motor drives the ball screw, and the laser head is connected to the plate to reciprocate. . The photoelectric switch is used to control the stroke at both upper and lower ends. Both the ball screw and the linear guide are made of high quality products to ensure the accuracy of the transmission.

(6) Drive device

As shown in No. 6 of Figure 2.1, for i3 linear model, the X-axis / Y-axis is driven by a precision linear motor and the Z-axis is driven by a linear module. For i5 model, the X-axis / Y-axis is driven by ball screws of servo motors and the Z-axis is driven by a linear module. For i7 model, the X-axis / Y-axis is driven by racks and pinions of servo motors and the Z-axis is driven by ball screws of servo motors. All the three axes are strictly matched and debugged to ensure high speed, accuracy and stability of movement of each axis.

1.3 Introduction to Each Functional System.

Dedusting system

The laser cutting machine is configured with the dust collection system, and the dust collection pipeline in lathe bed body , air duct with a large diameter and high power fan are used to effectively inhale dust generated during laser cutting process, and to collect emissions, ensuring the health of the operator.

Air circuit system

The air circuit part of the laser cutting machine is divided into two types, cutting air

circuit and working air circuit. The cutting air circuit is used to supply low-pressure oxygen and high-pressure nitrogen for cutting. The working air circuit is used to supply compressed air for pneumatic unit. All gases should be dry and clean, with high purity and have no oil.

The main function of oxygen is to cut ordinary carbon steel, and that of nitrogen is to cut non-ferrous metals such as stainless steel and alloy steel. The use of different cutting gases depends on different materials.

Lubricating system

The centralized lubricating system is used to automatically supply oil for sliding block, ensuring the precision of the transmission system, improving the service life of linear guide rail.

Cooling system

The waterway system of the laser cutting machine adopts the dual temperature water-cooling machine. One way is used to cool the laser, and the other is to cool the cutting head.

II. Equipment Installation and Connection

2.1 Inspection and Acceptance after the Arrival of the Equipment.

• Inspection and acceptance of goods in the container: Check whether the packaging of the host equipment in the container is damaged before unloading. If there is damage, the recipient should take pictures in the container **(Photos should be clear).**

• Check whether the marks of anti-inversion and anti-collision on the packing cases are abnormal (normally, they are colorless; abnormally, they are red), as shown in the figure 2.3.

If those marks are found to be abnormal, the recipient should take pictures in the container **(Photos should be clear).**

Fig2.3

• In case of abnormal marks, keep well the packing cases and clear photos of the damaged location. If the mode of transportation is air transport, check and confirm whether the equipment is damaged or not on site. Sign to receive after checking there is no damage. If there is any breakage, please reject it and contact us. If the packing cases of the equipment for sea or land transportation are damaged or the marks of inversion and anti-collision are abnormal, the recipient should take pictures and continue to unpack for check; if the equipment is damaged, the recipient should immediately report to the insurance company specified on the policy and protect the scene. Meanwhile, the recipient needs to contact our customer service staff at the same time so as to determine the solution.

2.2 Specification and Requirements for Packaging Removal

• Remove the packing tape if the equipment is packed in a wooden case, and remove the wooden board in order from top to bottom so as not to cause damage to the equipment in the case. Do not open with a sharp object if the equipment is wrapped with a protective film to avoid scratches on the surface of the equipment and damages to all kinds of electrical and air pipes. The Company shall not replace the equipment damaged by the customer.

• When taking delivery, the optical fiber devices are usually placed in the wooden cases, therefore, carefully unpack the wooden cases, especially, do not to damage fiber cable; in order to better protect the equipment, the packing film on the equipment should not be opened before the location is determined.

2.3 Circuit Connection

• The machine is composed of multiple parts, and each part should be electrified. Please make sure that the circuit of each part is connected correctly. Incorrect connection may cause damage to the equipment.

Connection to the Power Bus of the Equipment.

• The machine's power bus duct is a five-core cable, and its connection to the electric cabinet of lathe bed adopts air plug (see the figure below), thus facilitating the customer's installation and connection. If the voltage at the place of customer is three-phase 380V, it can be directly connected to the main switch, if not, a transformer should be added so as to change voltage into 380V, and the other end of the power bus duct is connected to the output end of the transformer so as to supply power for the electric control cabinet.

• There is single-phase power for I series, so please refer to the circuit drawing when wiring.

• Make sure that all pipelines, lines and parts are connected well before supplying power for the machine.

Connection between peripheral equipment and the electric cabinet.

• In order to make the machine run normally, it is necessary to introduce multiple lines

into the control cabinet, such as the power cord of draught fan, that of water-cooling machine, that of optical fiber device and signal line. In addition, many other lines also need to be introduced into the control cabinet. Some lines are inserted mutually through ports, and some need to directly access to electrical parts in the control cabinet. Make sure the lines are connected according to their serial number. If you have questions about wiring, please check the wiring diagram in the attached specification.

Safety Precautions for Electricity Use

• Make sure that voltage of all equipment meets the requirements of the machine, and that the power cord and the circuit breaker are securely connected so as to avoid damage to the equipment caused by lack phase.

• The shell of each equipment must be grounded to avoid damage to electrical components of the equipment caused by static, and to avoid injury to the operator caused by circuit failure and electric leakage.

• When replacing electrical components, cut off power, and wait for a period of time before operation. Live-wire work is strictly prohibited. Regularly remove dust on the circuit breaker, transformer and wiring board to prevent current from breaking through dust, which may cause damage to the equipment.

• Turn off the power after completion of work.

2.4 Connection to Gas Circuit

• Two air pipes extend from the lathe bed. One is used to connect nitrogen (compressed air or nitrogen is used while cutting), and the other is used to connect oxygen. Connect the

nitrogen pipe to the nitrogen supply unit through the nitrogen gauge, and connect the oxygen pipe to the oxygen supply unit through the oxygen gauge.

• Refer to the schematic diagram of gas circuit in the standard file for details.

• Refer to the requirements in the running materials for gas specification.

• Attention points of gas circuit installation

- Gas purity may affect the speed and effect of cutting, and high-purity gas may bring high speed and better effect.

- For different countries or regions have different standards, our standard configuration of nitrogen and oxygen gauges may be unable to connect to your gas supply device; under such situations, please purchase nitrogen and oxygen gauges separately in the local market.

- The temperature of the supplied gas should be not over 50℃;

- In principle, it is recommended to keep in contact with gas suppliers in the issues of gas supply;

- If gas source is farther away, it is strictly prohibited to lay down gas pipes and cable in the same pipeline, and gas pipes are separately connected to the joint of the machine tool;

- Installation of gas pipes requires professional installation personnel, and the initial installation requires air exhaust. Make sure that the pipes are clean before connection to the machine tool.

2.5 Connection to Waterway

• The water cooling machine outputs two waterways, high-pressure waterway and low-pressure waterway. The high-pressure water flows to the optical fiber plug and the

cutting head. Pay attention to the direction of water inlet and outlet, make water first flow through the optical fiber plug and then through the laser cutting head. Low-pressure water flows to the optical fiber devices. Due to different brand of optical fiber device, the type of waterway connection may be different, and the specification of joint pipe also may be different. Please recognize the flow direction and mark number of waterway, and correctly connect to the waterway with water pipes which are attached to the machine.

•Refer to the waterway schematic diagram in the standard files for details.

• Attention points of waterway installation

- Non-mineral purified water, distilled water or deionized water is added to the water-cooling machine, and it is forbidden to add corrosive liquids or water with impurities.

- When adding water, avoid unnecessary contact with water (for example, touch water by hand). All auxiliary equipment such as pumps and hoses should be used only for this water cooling machine.

- Before turning on the water-cooling machine, check its water level, and it is strictly prohibited to turn on the water-cooling machine if there is no water or water level is too low, in order to avoid damage to the water-cooling machine. It is strictly prohibited to squeeze and tread on inlet or outlet pipes of the water-cooling machine in order to keep the waterway unimpeded.

- At a temperature of below 0℃, in case of long-time downtime, discharge cooling water from the water-cooled machine, laser and water pipes in order to prevent cooling water from freezing due to low temperature, which may cause damage to the equipment and pipeline.

- It is recommended to completely replace water in the water-cooling machine every two to three months.

III. Equipment Startup and Debugging

Warning

After the acceptance of the machine, the user must remove the packing film, and remove anti-rust oil on the surface of guide rail and the rack surface with pure cotton cloth which had been dipped in kerosene, after that, the machine can work normally.

Note: Before the machine is electrified, please check and confirm that connection to the power cord of the equipment meets the requirements, wiring is firm, the overall equipment is well installed, and with no foreign objects or no barriers in the direction of each motion axis. After checking, it is permitted to start up the machine for power supply.

3.1 Boot procedures

1.1. The main switch is installed in the rearmost end of the equipment. Please turn on the main switch (as shown in Fig. 2.4) to electrify the equipment and insert lever drive and keyboard mouse receiver in USB interface.

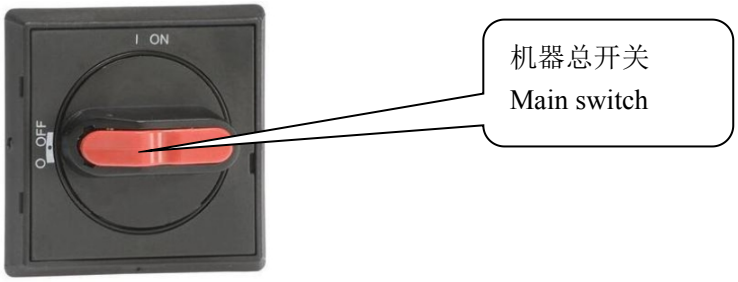


Fig. 2.4

2. Turn on the switch of control circuit and button of industrial personal computer, then, turn on the drive switch to power on the servo drive (see Figure 2.5).

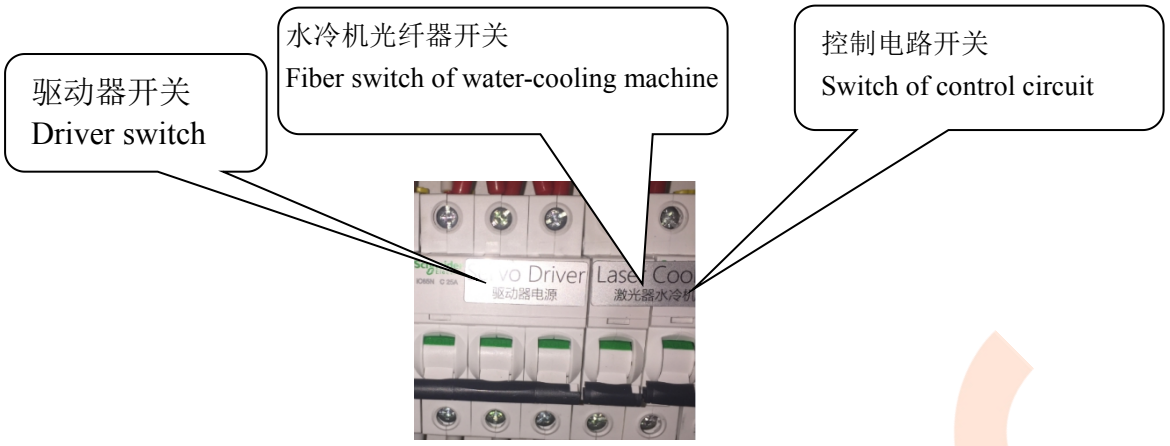


Fig. 2.5

3. Click  to start the software.

4. Unlock the scram button and rotate right to open the scram button  on the displayer.

3.2 Inspection of Waterways

Turn on the brake of the water-cooling machine optical fiber device on the control cabinet, and then turn on the switch knob of the water-cooled machine, (due to different model of the water-cooling machine, after turning on the knob, you may need to click the "Start" button on the panel again.) At this time, the water-cooling machine starts to run, check each interface of the entire waterways. If water leakage is found, immediately turn off the water cooler, and then repair the place where there is water leakage. After repair, retest to ensure there is no water leakage.

3.3 Inspection of Gas Circuit

First of all, make sure that there is gas in your gas supply device, and check each gas

circuit and interface to see if they are connected. Turn on the switch of each gas supply device, and turn on the switch on the oxygen gauge and the nitrogen gauge respectively. It is recommended to rotate the switch of the oxygen gauge to 0.3-1.0Mpa and that of the nitrogen gauge to 1.0-2.5Mpa, if the sound of air leakage is heard, search for its position, and solve the problem of air leakage.Provided that a pneumatic fixture is selected, it is required to press tighten and release button of the fixture on the operation interface after connecting to the compressed air to check whether the pneumatic device of the fixture is operating properly.

After making sure that there is no air leakage, as shown in the figure 2.6, click “N2” or “Air/O2” in the operational software to see if air is out, and then click “N2” or “Air/O2” to see if gas is off. If there is something unusual, it needs to be solved.

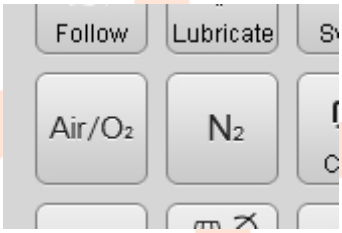


Fig.2.6

3.4 Motor Unit Test

Open the software (after opening the software, the prompt of returning to the original point will pop up, please click the “Close” button). Find out the software movement control button (as shown in the figure 2.7), check if the movement mechanism (X, Y, Z axis, etc.) can normally run at a low speed, and move to the limit switch to test if all limit switches are valid.(If the machine has additional functions, make the corresponding tests)

If there is an alarm in the z-axis direction at the top of the software interface, it needs to be solved through calibration. If there is any other alarm, please check the alarm content and find the possible problem. If it cannot be solved, please contact us. When all the movements become normal, click “Go Home” in the “Processing” menu bar tabs, and return to the original point; or restart the software, and click on “All Axes” when the prompt of returning to the original point pop up.

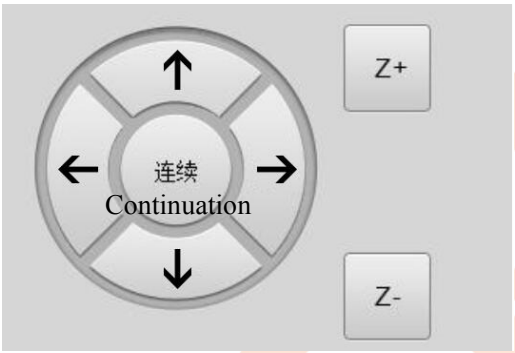


Fig.2.7

3.5 Test of Light Emission

According to the power-on procedure on the laser source, turn on the laser control, click the bursting button 

to test the emission of laser light, and make sure that before testing the water-cooling machine is turned on , and oxygen and nitrogen can be normally blew off.

In general, turn on the water-cooling machine, and then open the optical fiber device. Namely, when the water-cooling machine and the fiber optic device are on standby, turn on the switch knob of the water-cooling machine, and then turn on the key switch and switch button of the optical fiber device when water supply becomes normal. However, attention should be paid to the following points: 1. When water temperature is lower, after it rises to

20℃, open the optical fiber device. 2. Due to different models of the water cooling machine, after turning on the knob, click the "Start" button on the panel again to start the water-cooling machine. 3. Due to different power, brand and model of the optical fiber device, the operating method is a bit different. For example, there is no button on the 500W-1,000W IPG optical fiber device, and its key switch and switch button are integrated into the operational software. While, for the high-power optical fiber device, open the key switch of the optical fiber device or turn on the handle switch, and then make the dehumidification device of the optical fiber device run for ten minutes, after that, turn on the water-cooling machine and make its running temperature up to a certain degree, and then make the optical fiber device emit light.

For example, for the Maxphotonics fiber optic devices with power of less than 1000W, turn on the key switch of the optical fiber device, after waiting for a few seconds, click "START" to output red light as instructed; after that, click on the "Shutter" button in the software, and then click the "Bursting" nozzle to emit laser light. For example, turn on the key switch of some fiber-optic devices (or rotate the key switch to "REM" location), click "START" (or don't click it), and then click "Shutter" in the software, and then click the "Aiming" and "Laser" buttons.

Due to multiple brands and models of the fiber optic device, other detailed operations are not listed any more, if you have any questions, please contact us.

3.6 Turning off the Machine Tool

First of all, exit from the software. Click the computer shutdown button 

, after

the computer is completely shut down, reset the key switch, and rotate the red knob switch to OFF.

3.7 Summary

This Chapter introduces the preparatory work before starting work. There are no strict requirements for the boot sequence of various parts, so it is recommended that the boot sequence is as follows: Host machine and operational software → Gas supply device → Water-cooling machine→ Optical fiber device

Tips Shutdown sequence

1. After completing the cutting process, click “N2” or “Air\O2” to release gas in each pipe, and close the gas supply device.

2. Use the adhesive tape under the nozzle of the cutting head to prevent dust from entering the cutting head.

3. Move the X-axis and Y-axis to the middle of the machine tool in order to avoid the deformation of transmission shaft caused by self-weight, affecting the cutting precision.

4. Turn off the switch on the laser source to disconnect power supply.

5. Turn off the switch on the water-cooling machine to disconnect power supply.

6. Turn off the control software, and shut down the host computer.

7. Make an inspection tour of the surrounding environment of the machine tool to check whether there is a tinder or high-temperature object, so as to avoid a fire and eliminate potential safety hazards.

Equipment Operating Instruction

Warning: Please carefully read <<the *Safety* sections>>before operating the equipment to ensure the safety of operators.

I. Basic Knowledge of Laser Machining

1.1 Laser Machining Principle

Laser cutting is an advanced and relatively widely-applied cutting technology in material machining. It is a machining method, in which laser beams with high-energy density are used as the "Cutting Tool" to make thermal cutting of materials. The laser cutting technology can be used to cut all kinds of metal, non-metal plates and composite materials, and widely applied in all fields.

Laser cutting means that the focused laser beam is used to irradiate workpieces, so that the irradiated materials can rapidly melt, evaporate, ablate or reach the ignition point; at the same time, with the aid of high-speed airflow with the same axis as beam light, wipe off molten substances to realize workpiece cutting. Laser cutting is one of the thermal cutting methods.

1.2 Main Methods of Laser Machining

1) Laser fusion cutting

Laser fusion cutting means that metal materials are molten through laser heating, non-oxidizing gas is injected through the nozzle with the same axis a beam light (N2, Air,

etc.), and then liquid metal is eliminated by means of great pressure of gas, ultimately, kerf is formed.

Laser fusion cutting is mainly used to cut non-oxidizing materials or active metals, such as stainless steel, titanium, aluminum, alloys, etc.

2) Laser oxygen cutting.

The principle of laser oxygen cutting is similar to that of oxyacetylene cutting, namely, laser is used as the preheating source, and oxygen and other active gases as the cutting gas. On the one hand, the emitted gas has an oxidation reaction with the metal, releasing a mass of oxidation heat; on the other hand, the molten oxide and the melt are blown out of the reaction area, and form a kerf in the metal.

Laser oxygen cutting is mainly used for carbon steel and other easily-oxidized metal materials, which is also used for machining the materials such as stainless steel. However, the cross section is dark and rough, and its cost is lower than that of inert gas cutting.

Tips

The i series products are the equipment for cutting metal materials with a laser. The i series products shall not be used for cutting non-metals (e.g. glass, acrylic materials, wood, etc.)!

1.3 Focal Position

Relative to the surface of machined materials, after laser beam focusing, the place where the focal point is located is called the focal position. The focal position determines beam diameter, power density and kerf shape on the surface of the workpiece. In the process

of laser cutting, the relative position of beam focus and cutting board surface has a great influence on the quality of cutting, so it is very important to correctly adjust the focal position. This laser cutting machine is configured with high-precision automatic following control device. When the height of the plate is changed, the numerical control system can automatically adjust the distance between the nozzle and the plate so as to maintain constant height from the nozzle to the plate surface, to ensure the stability of the focal position.

The focusing mechanism of focus lens is to pull the focusing box with precision screws so as to realize focusing, with good self-locking performance and fine focusing function.

The following table shows the relationship of focal position, the cutting materials and cross section.

Name and Focal Position	Cutting Materials and Cross-section Characteristics
Zero focus: The laser focus is on the plate surface.	It is used for thin plate cutting. At this point, the maximum capability density, the minimum beam diameter and the narrowest kerf can be obtained on the material surface.
Positive focus: the laser focus is above the plate surface.	It is used for laser oxygen cutting. The focus is on the surface, the focal position is enlarged, and the kerf is increased accordingly.
Negative focus: the laser focus is below the plate surface.	It is used for laser fusion cutting. The focus is inside the material, the focal position is reduced, and the kerf is increased accordingly.

1.4 Nozzle

1.4.1 Functions of the Nozzle

Due to different nozzle design, the flow of air stream is different, which directly affects

the quality of cutting. The main functions of the nozzle include:

1) Prevent sundries during cutting and melting from bouncing upwards the cutting head, which may damage the lens.

2) The nozzle can make the jetted gas more concentrated, control the area and size of gas diffusion, thus making the quality of cutting better.

1.4.2 Influence of the Nozzle on the Quality of Cutting and Selection of the Nozzle

1) Relationship of the nozzle and the quality of cutting: The quality of cutting can be affected by the deformation of the nozzle or the residue on the nozzle. Therefore, the nozzle should be carefully placed and should not be collided. Residue on the nozzle should be timely cleaned. High precision is required during manufacturing the nozzle, if the cutting quality is poor because of the poor quality of nozzle, please timely replace the nozzle.

2) Selection of the nozzle.

In general, when the nozzle diameter is small, the airflow speed is fast, the nozzle has a strong ability to remove the molten material, suitable for cutting the thin plate, and the fine cutting surface can be obtained; when the nozzle diameter is large, the airflow speed is slow, the nozzle has a poor ability to remove the molten material, suitable for slowly cutting the thick plate. If the nozzle with a large aperture is used to rapidly cut the thin plate, the residue generated may splash up, causing damage to the protective glasses.

In addition, the nozzle is also divided into two types, i.e. a composite type and a single-layer type (see the figure 3.1). Generally speaking, the composite nozzle is used to cut carbon steel, and the single-layer nozzle is used to cut stainless steel.

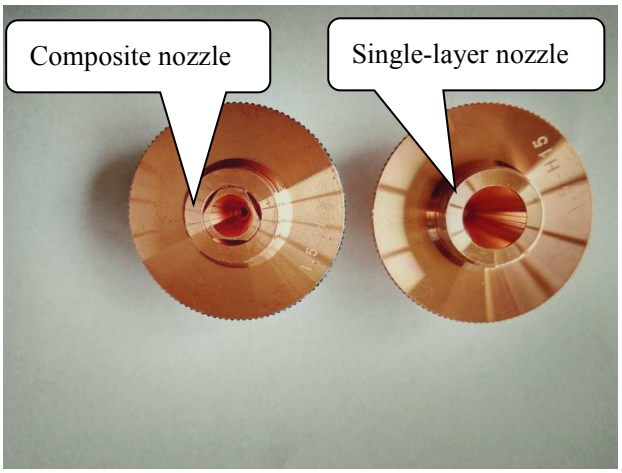


Fig.3.1

Material Specification	Material Thickness	Nozzle Type	Nozzle Specification.
Cs	Less than 10mm	Composite nozzle	Φ1.2/Φ1.0
	12--18mm		Φ1.5
	Than20mm		Φ2.0 or above
Ss	1	Single-layer nozzle	Φ1.0
	2--3		Φ1.5
	3--5		Φ2.0
	More than 5mm		Φ3.0 or above
Affected by materials、gases for machining and laser power, the data in this table may be different, so these data are for reference only! We recommend that you purchase our special nozzles because the nozzles of different manufacturers have a greater impact on the cutting effect.			

1.5 Dimming (Coaxial Laser)

Steps for adjusting the laser light to pass through the nozzle center are as follows:

1) Open the software, move the beam and the laser cutting head to the appropriate position.

2) Evenly apply the transparent adhesive tape to the end face of the nozzle (see the figure 3.2).

3) Set in the appropriate power (80-100W) in the software, click on the "Laser" (or "Laser" button on the handle), the "⊙" icon may appear on the tape, take down the transparent adhesive tape, and be careful not to rotate its relative position. If no light spot ejected is in the nozzle center, it is necessary to adjust the knob on the upper of the cutting head so as to make light spots in the nozzle center. Repeat the above action until the aperture on the transparent adhesive tape ejected by the laser coincides with the nozzle center.

When the nozzle center is not coaxial with the laser center, the effects on the quality of cutting, are as follows:

1. Affecting the cutting cross-section. When the cutting gas is ejected, uneven gas volume may cause inconsistent quality around the cutting cross section, and even abnormal cutting.

2. Affecting the quality of sharp angles. When cutting the workpiece with a sharp or a smaller angle, it is easy to produce partial super-perfusion. When cutting the thick plate, sharp corners cannot be cut.

3. If perforation is unstable, perforation of the thick plate may cause super-perfusion, and penetration time is not easy to master. The concentricity of the nozzle center and the laser is one of the important factors to decide the quality of cutting, especially, the thicker the workpiece is, the greater the effect. Therefore, it is necessary to adjust the concentricity of the nozzle center and the laser, thus getting a better cutting cross-section.

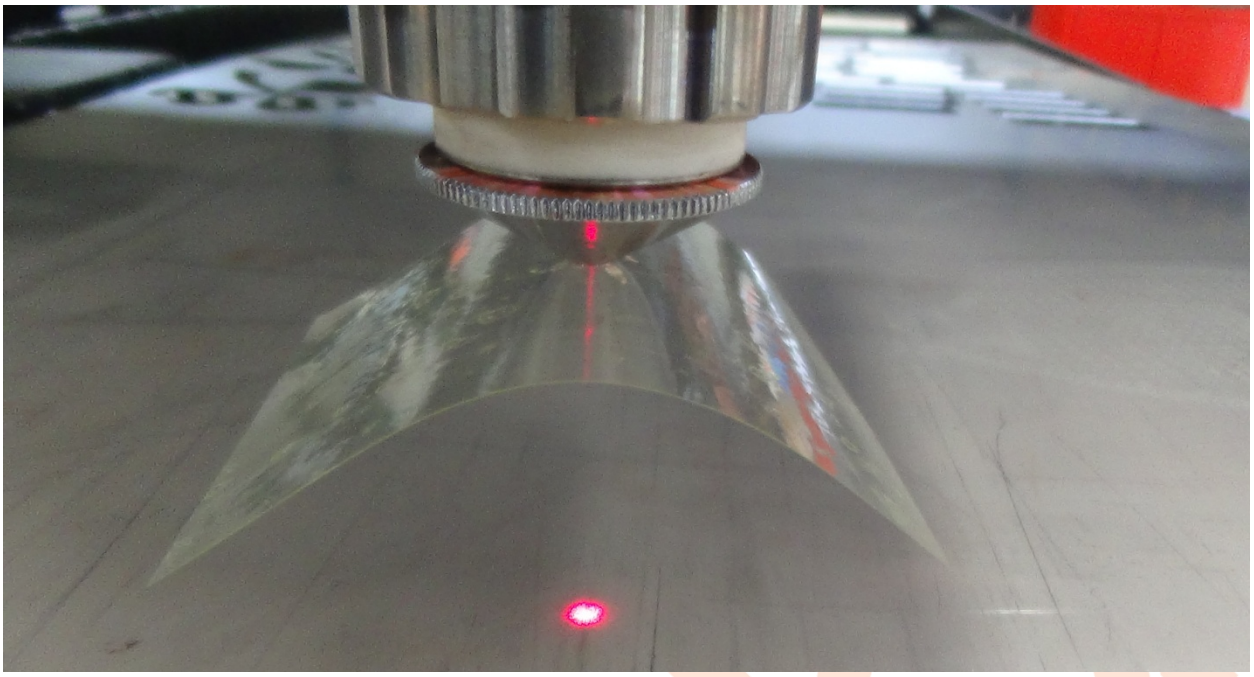


Fig.3.2

Warning: it must be operated by a single person to prevent accidents. It is strictly prohibited to operate by two or more people at the same time!

1.6 Calibration

Place the plate on the cutting table, move the cutting head above the plate through the software or by controlling the handle, select the left toolbar, click the icon  in the dialog box, as shown in the figure 3.3. Click the Z Down Arrow on the Z Axes to move the laser head to the location about 5mm-10mm above the plate. Click the calibration button to complete the calibration, and close the interface. Click “Follow” to test whether the follow-up is normal.

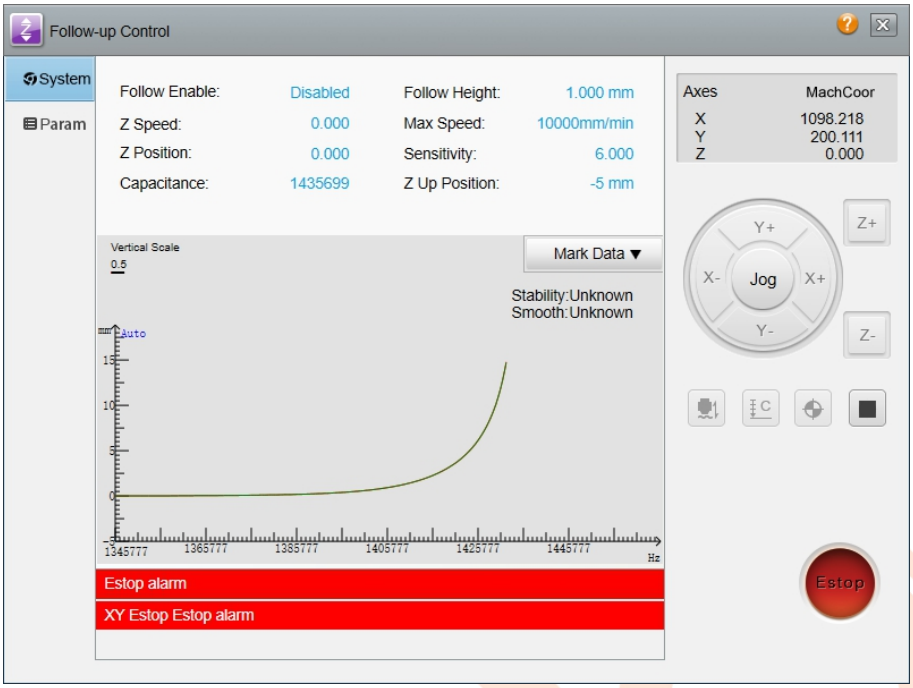


Fig.3.3

Note: The indicators calibrated through the above two parameters must be “Medium” at least; otherwise, the quality of cutting may be affected. The ideal conditions for these two indicators are “Excellent” or “Good”. If the result is dissatisfactory, recalibration is required. It is recommended to conduct a calibration after starting up or replacing the plate.

1.7 Factors Affecting the Cutting Technology

（1）Impact of cutting plates

In order to ensure normal laser processing, the plates used shall meet the following conditions because different types of plates of different quality have a great influence on the quality of laser cutting:

Q235A, Q235B, 201, 304, as main materials, are used for conventional laser cutting plates. Plates shall comply with Cold-rolled Steel Plate and Steel Strip Sze, Shape, Weight and Tolerance (GB 708-1988), Stainless Steel Cold-rolled Steel Plate and Steel Strip (GBT

3280-2015), together with valid Product Quality Certificate. Products manufactured by large steel plants such as China Baowu Iron and Steel Group Co., Ltd., Jinan Iron and Steel Group, Anshan Iron and Steel Group Corporation and China Shougang Group are preferred. The cutting quality will be reduced if the plates produced by local small steel mills are used, thereby increasing the difficulty of debugging.

The surface of plate should be smooth and free from bumps, scratches, distortions and other surface defects. The corroded (single) surface shall be evenly distributed with less than 15% of the single-side area. You should wipe the rusted area with cotton yarn so see that the color of light rust becomes lighter (namely, the rust is floating on the surface); otherwise, it is not suitable for laser cutting plate. The scale cinder area should be evenly distributed and less than 15% of the single-side area. Otherwise, it is not suitable for laser cutting plate.

（2）Cutting Height

As shown in the figure 3.4, if the distance between the nozzle and the workpiece is too short, it may cause the collision of the plate and the nozzle; if the distance is too long, it may cause gas diffusion, causing more residues on the cutting bottom.

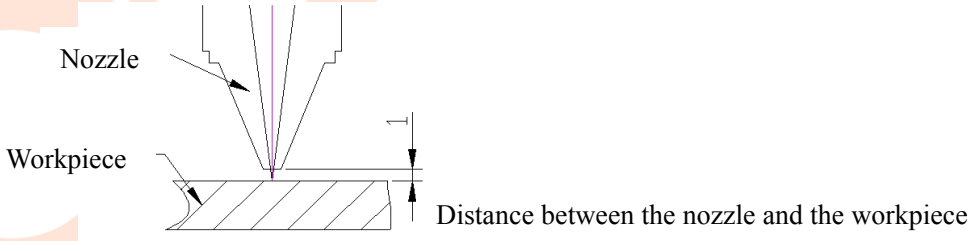


Fig.3.4

The distance between the nozzle and the workpiece can be set at the “Technology” interface, and the recommended distance is between 0.5-1.5mm.

（3）Cutting Speed

The speed of feeding can be judged from the cutting spark. Under the condition of normal cutting, the spark is diffused from top to bottom, and when the spark is tilted, the speed of feeding is too fast; if the spark is not diffused but condensed, the speed of feeding is too slow. The figure 3.5 shows the appropriate cutting speed, the cutting surface shows a smooth line, and no slag comes from the lower part.

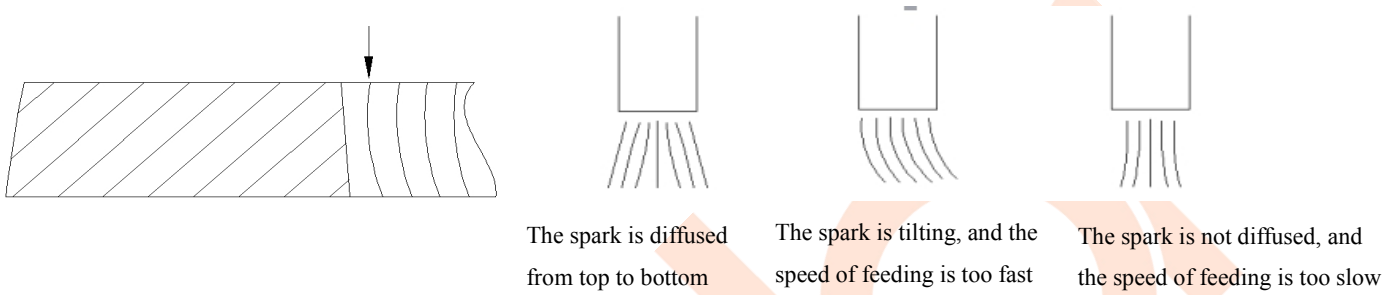


Fig.3.5

In case of poor quality of cutting, it is recommended to carry out a general inspection first, of which the content and sequence are as follows:

1) Cutting height (it is recommended that the actual cutting height is between 0.5 and 1.5mm): If the actual cutting height is not accurate, the calibration should be carried out.

2) Nozzle: Check the type and size of the nozzle to see if it is used correctly. If it is correct, check whether the nozzle is damaged, and the roundness is normal.

3) It is recommended to conduct an optical center inspection of the nozzle with a diameter of 1.0, and the focus should be between -1 to 1 while inspecting the optical center. In this way, small light points are easy to be observed.

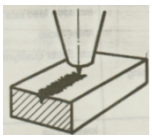
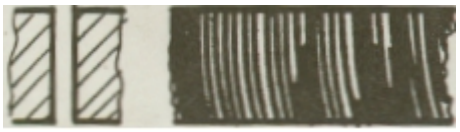
4) Protective lens: Check whether the lens is clean, and confirm there are no water, no oil and no slag on the lens. Sometimes the protective lens may be fogged due to weather or too cold auxiliary gas.

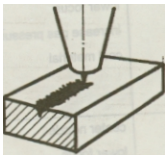
5) Check whether the focus is set correctly.

6) Modify the cutting parameters.

After checking the above six items, if no problems, modify the parameters according to the phenomenon.

Structural steel: Cutting with O_2		
Defects	Possible Cause	Solutions
There is no burr, and the drawn wire is consistent. 	Power is proper The cutting speed is proper	
The drawn wire at the bottom has a large deflection and the bottom kerf is wider. 	The cutting speed is too high Cutting power is too low Air pressure is too low The focus is too high	Reduce the cutting speed Increase cutting power Increase air pressure Lower the focus
Burrs at the bottom surface are similar to slag, and like droplet and easy to remove. 	The cutting speed is too high Air pressure is too low The focus is too high	Reduce the cutting speed Increase air pressure Lower the focus
Connected metal burrs can be removed as a whole piece. 	The focus is too high	Lower the focus
Metal burrs at the bottom surface are difficult to remove. 	The cutting speed is too high Air pressure is too low Gas is not pure The focus is too high	Reduce the cutting speed Increase air pressure Use purer gas Lower the focus

Burrs are only on one side. 	Coaxial laser is not correct. The opening of the nozzle has defects.	Align coaxial laser Replace the nozzle
Materials are discharged from above. 	Power is too low The cutting speed is too high	Increase the power Reduce the cutting speed
The surface of cutting is not precise. 	Air pressure is too high The nozzle is damaged. The nozzle diameter is too large.	Reduce air pressure Replace the nozzle Install an appropriate nozzle
Stainless steel: Cutting with N_2 high pressure.		
Defects	Possible Cause	Solutions
Regular small droplet-like burrs are produced 	The focus is too low The cutting speed is too high	Raise the focus Reduce the cutting speed
Irregular long filamentous burrs are produced on both sides, and the surface of large plate discolors. 	The cutting speed is too low The focus is too high Air pressure is too low The material is too hot	Increase the cutting speed Lower the focus Increase air pressure Cool the material
Irregular long burrs are produced on the cutting edge. 	Coaxial laser is not correct. The focus is too high Air pressure is too low The cutting speed is too low	Align coaxial Laser Lower the focus Increase air pressure Increase the cutting speed
The cutting edge becomes yellow	Nitrogen contains oxygen impurities.	Use high-quality nitrogen

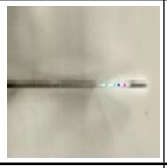
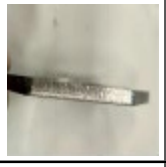
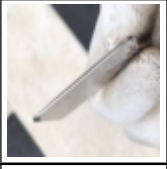
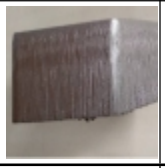
Light beam is diffused at the beginning.	The acceleration is too high The focus is too low The molten material cannot be discharged	Reduce the acceleration Raise the focus Pass through a circular hole
The kerf is rough	The nozzle is damaged. The lens is dirty	Replace the nozzle Clean the lens, and replace it if necessary.
The material is discharged from above. 	The power is too low The cutting speed is too fast Air pressure is too high	Increase the power Reduce the cutting speed Reduce air pressure

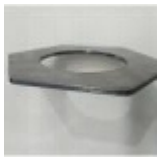
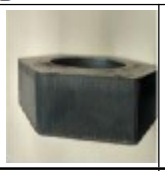
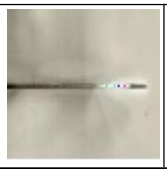
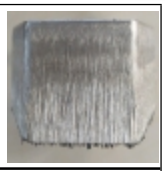
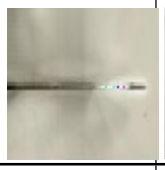
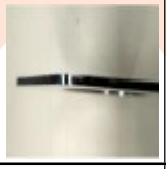
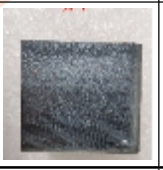
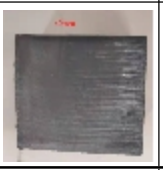
5）Check whether the focus is set correctly.

6）Modify cutting parameters

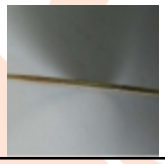
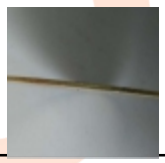
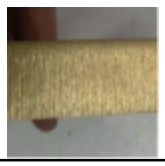
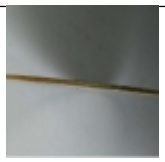
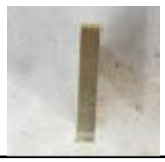
After checking the above six items and there is no problem, then modify the parameters according to the phenomenon.

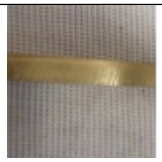
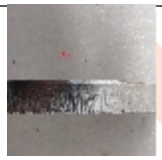
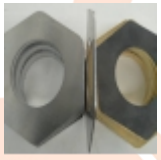
（4）Corresponding plate cutting effect of each power section:

Power		Carbon steel（Q235A）			Stainless steel		
4KW	Thickness（mm）	1	10	20	1	3	12
	Result						
6KW	Thickness（mm）	1	14	20	1	12	20
	Result						
8KW	Thickness（mm）	1	16	25	1	14	25

	Result						
10KW	Thickness（mm）	1	6	10	1	4	8
	Result						
	Thickness（mm）	16	20	30	14	20	25
	Result						
12KW	Thickness（mm）	1	8	14	1	6	12
	Result						
	Thickness（mm）	18	20	30	16	20	30
	Result						
15KW	Thickness（mm）	1	8	14	1	6	14
	Result						
	Thickness（mm）	20	30	40	20	30	40
	Result						
20KW	Thickness（mm）	1	10	16	1	10	16

	Result						
	Thickness（mm）	20	30	40	20	30	40
	Result						

Power		Aluminum		Brass	
4KW	Thickness（mm）	1	12	1	8
	Result				
6KW	Thickness（mm）	1	20	1	12
	Result				
8KW	Thickness（mm）	1	25	1	16
	Result				
10KW	Thickness（mm）	1	6	1	6
	Result				
	Thickness（mm）	20	30	10	16
	Result				

12KW	Thickness（mm）	1	8	1	6
	Result				
	Thickness（mm）	20	30	10	18
	Result				
15KW	Thickness（mm）	1	10	1	6
	Result				
	Thickness（mm）	20	30	14	18
	Result				
20KW	Thickness（mm）	1	14	1	10
	Result				
	Thickness（mm）	20	30	14	18
	Result				

Note: this parameter is for reference only, which cannot be used as the basis for acceptance or quality traceability because different conditions on the site (plate quality, gas quality, etc.) influence a lot. It is the responsibility of Bodor for the final explanation!

1. The cutting effect is subject to different fiber optics, material quality, gas, optical lenses, cutting graphics, etc., in which case it is necessary to be adjusted according to the site conditions; (the plate model used for this parameter: Q235 for carbon steel, 201 for stainless steel, 5# for aluminum, H6 of copper, and the plate thickness of the theoretical thickness, but the actual thickness is slightly smaller than 0.2 ~ 0.5mm).

2. The cutting accuracy is affected by the quality of different material types and material surface, and installation status of machine tool. As a result, we recommend that when cutting precision workpieces, the cutting speed is reduced with the recommended speed below 12m/min.

3. Requirements for cutting gas: nitrogen (purity ≧ 99.99%), oxygen (purity ≧ 99.9%) for cutting.

4. At the time of cutting highly reflective materials such as copper and aluminum, attentions should be paid to adjust the process, during which the limit thickness is not recommended for continuous and long-term processing. MAX Laser can cut highly reflective materials under normal cutting conditions; but we do not recommend long-term cutting.

5. The operating environment is 10° C ~ 35° C with the relative humidity of below 35%; there shall be no large-scale electrical equipment in the surrounding area without electromagnetic interference; power quality: three-phase unbalance <2.5%, line voltage fluctuation <5% ;

Tips: (1) We recommend that the layout spacing is≧0.8 times the thickness of the plate to avoid thermal deformation and poor cutting.

(2) As an intensive cutting in a small area, this processing method will cause damage to

the tool bed and the worktable, which is not covered by the product warranty;

(3) The thermal deformation of plate will affect the final straightness when cutting the plates in a long-stroke and continuous manner (single cutting straight line> 2m), which is not covered by the product warranty.

II. Application of External Functions of the Equipment

2.1 USB Interface

The production system is not directly connected to the machine tool, but data can be transmitted via the USB interface, and the wireless key mouse receiver is also inserted into the USB interface to realize wireless operation  .

2.2 Return to Zero

After the machine tool is electrified, in order to make the equipment safely move within the stroke, carry out return-to-zero operation first, open the software, and press the return-to-zero button 

on the software interface to make the X, Y, Z axes return to zero automatically.

2.3 Draught Fan Startup

The draught fan automatically starts, and does not need human control. When the laser head emits light, if the cutting head is in a set area, the draught fan will automatically start dedusting, please note that all axes must return to zero before cutting.

2.4 Automatic Focusing

Some laser heads come with the function of automatic focusing, if you want to use this function, open the software, and click a layer 图层 on its left to set the focus height 切割焦点: 0 mm . When cutting, it quickly moves to the set focus, then start cutting.

III. Machining Process

3.1 Importing the Graphics

Bodorpro2.0 software has a simple drawing function, which requires the operator to have a certain ability of drawing, which will not be repeated. In addition to its built-in drawing function, the software can import files in such formats as dxf, ai and plt, as shown in the figure3.6.

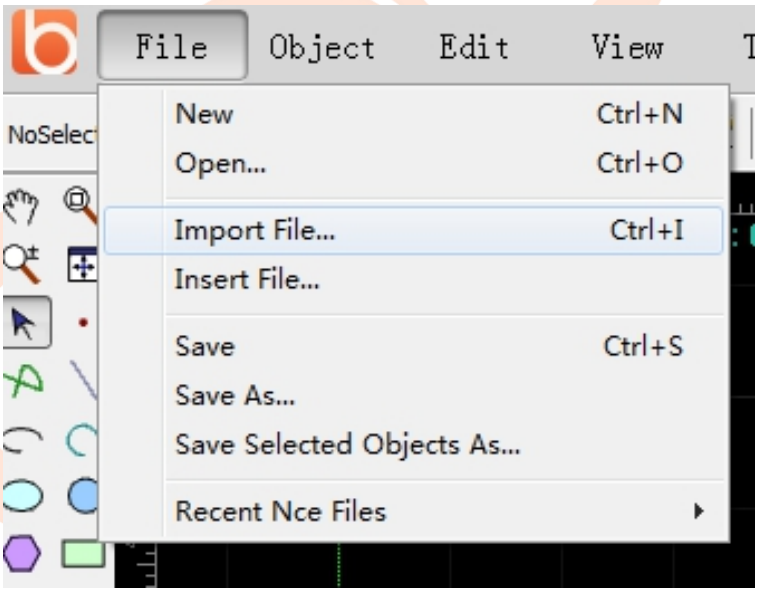


Fig.3.6

3.2 Preprocessing

When importing graphics, Bodorpro2.0 can automatically remove tiny graphics and repeated lines, merge connected lines, as well as level, sort and break up, so in a general case, you do not need other treatments before beginning to set process parameters. If the automatic processing process cannot meet your requirements, and you need to manually optimize the graphics, you can open the menu “Object”- “Graphics Preprocessing” button.

3.3 Technology Processing

1. Differentiate internal and external molds: When opening DXF and other external files, Bodorpro2.0 can automatically differentiate internal and external molds. When the lead line is added, the external mold belongs to Yang cutting, leading-in from the external, and the internal mold belongs to Yin cutting, leading-in from the internal. When manually setting the Yin and Yang cutting, please select the graphics to be set, and then click the “ Unfill/Fill ” button on the “Technology” menu bar.

2. Lead-in/out line: Select the graphics that needs to set lead-in/out line, then click the Lead Line icon on the “Technology” menu bar, and set the parameters of lead-in/out line in the pop-up window, as shown in the figure 3.7:

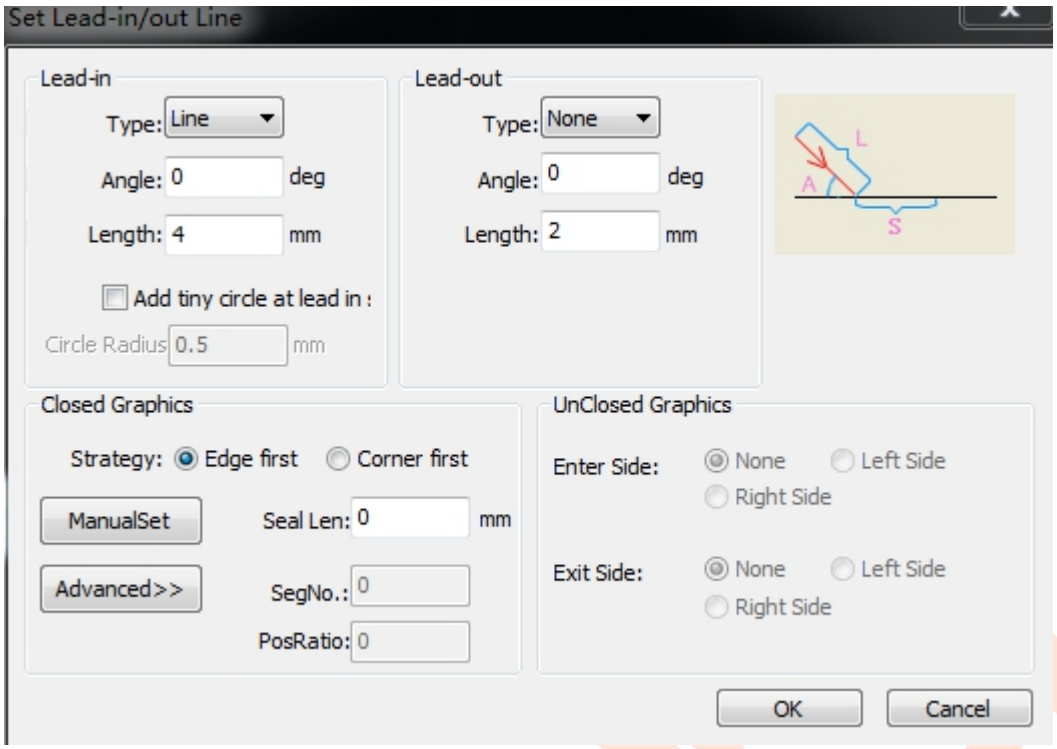


Fig.3.7

If you are dissatisfied with automatic settings of lead-in/out line, select the closed line, and then click the Start Cut Point button on the toolbar to manually modify the lead-in line.

3. Kerf Compensation:

Select the graphics to be compensated, and then click the Set Kerf Compensation button on the "Technology" menu bar to complete kerf compensation.

The width of kerf should be measured according to the actual cutting results, and the compensation track is indicated by white on the drawing board. During processing, the compensation track is running; the original image compensated is not processed, but only displayed on the drawing board for easy operation. The direction of kerf compensation can be selected by hand, or be automatically judged according to the Yang and Yin cutting, and the inner mold is shrunk and the outer mold is expanded.

3.4 Sorting

If the graphics is more complex, click the Mach Order button on the "Technology" menu bar to sort in rows. After sorting, click "Simu" button to simulate the cutting path in the software. And the machine does not run, if the path sequence is found unreasonable, the sorting rules will be changed again.

3.5 Settings of Cutting Parameters

Click "Layer" to set the appropriate cutting parameters in the pop-up dialog box. Our machine has several sets of cutting parameters while delivering. Click "Import" to select the appropriate entries to call. The parameters that are called are for reference only, and the more appropriate parameters need to be tested by the operator according to the actual situations.as shown in the figure 3.8

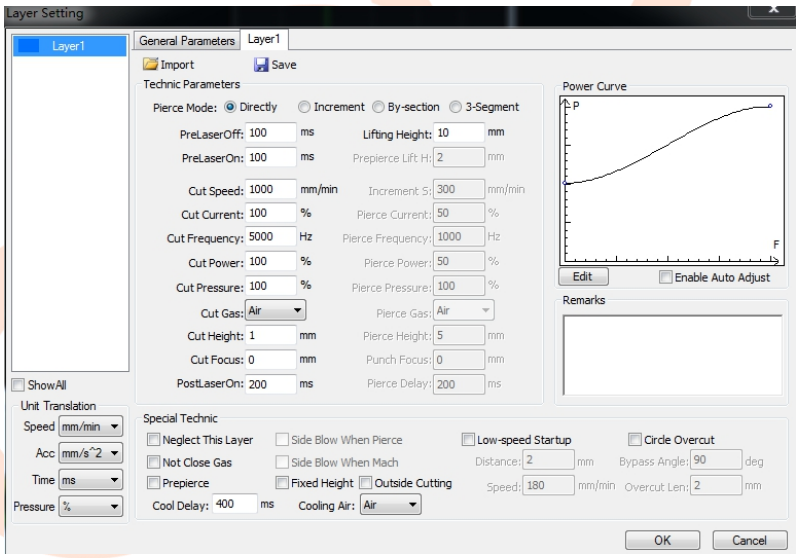


Fig.3.8

3.6 Adjusting the Focal Length

According to the thickness of the material, adjust the focal length. See Section 1.3.

3.7 Selecting the Appropriate Position, and Following the Frame

Move the laser cutting head to the appropriate position, click Set Zero, and then click Frame Check to test whether the running frame is correct(fig.3.9). If you click “Dry Run”, the machine will run empty and not emit light for cutting. To save time, need not to click this button.

Fig.3.9

Note: Before machining, it is necessary to confirm that the workpiece graphics can safely run within the range of the plate. Prevent the laser cutting head from falling outside the plate after cutting starts, which may cause damage to the laser cutting head.

3.8 Cutting

Click “Follow” and “Puff” respectively, and then test whether the follow and blowing is normal. After ensuring safety, click “Set Zero” “Start” for cutting. Check whether the cutting sample meets the requirements, and beware of scalding.

Note: The operator can find the optimal parameters (speed, air pressure, focal length,

etc.) through multiple tests, which can improve the quality and efficiency of the workpieces. It is recommended to save the found parameters, and record the data of focal length when naming, thus calling the parameters directly when the same material is processed the next time. In addition, the operational software also has more powerful features that enable the operator to explore in a safe manner and make your work more efficient.

IV. Brief Introduction to Remote Control Handle

In order to control the machine conveniently, the machine is equipped with remote control handle, and the key functions are introduced below.

Sketch of some buttons

No.	Picture	Name	Function	No.	Picture	Name	Function
1		Air blowing	Check whether the air channel is unblocked	14		Z-axis positive direction	Z-axis moves in positive direction
2		Brust	Check whether there is laser emission	15		Step	A axis will be moved in an incremental manner and it can switch between continue mode and step mode
3		Servo	Check the calibration effect of laser head	16		Back up	Back to the previous cutting mode
4		Set Zero	Set part origin	17		Z-axis negative direction	Z-axis moves in negative direction
5		Frame Check	Check the maximum overall dimensions of the graph	18		W-axis negative direction	W-axis moves in negative direction

6		Start	Start running under automatic condition	**19**		W-axis positive direction	W-axis moves in positive direction
7		Resume	Cut from the breakpoint	**20**		Edge-finding	Find the edge of plates and pipes
8		Y-axis positive direction	Y-axis moves in positive direction	**21**		Emergency Stop	Stop motion of the axis in emergency
9		Suspend	The operating process is temporarily stopped	A		High Speed Light	It lights when press the button of high speed
10		X-axis negative direction	X-axis moves in negative direction	B		Step Light	It lights when press the button of stepping
11		X-axis positive direction	X-axis moves in positive direction	C		Alarm Light	it lights when the system alarms
12		High Speed	A axis will be moved at high speed	D		Power Light	
13		Y-axis negative direction	Y-axis moves in negative direction				

 Attention

1) Calibration combination key: Press and hold  , and then press  to start the calibration function.

2) Manual high speed combination key: In the continuous manual mode, press and hold  and any direction key.

Instructions of Equipment Maintenance and Repair

Professional maintenance is the prerequisite for maintaining machine tools; it can effectively avoid running faults and the consequences incurred.

Danger

Conducting the maintenance work when the machine tool is connected, there may be life dangerous!

- If no other clear instructions, turn off and lock the main switch, and pull out the key.
- Strictly abide by the safety regulations.

Before putting into operation

• Before the machine tool is put into operation, the machine must be lubricated carefully according to the lubrication chart. For export products by sea or other means of transport, it is necessary to clean up 204-1 replacing-type anti-rust oil before the equipment is put into operation, and check the lubrication condition of the entire machine tool at the same time. When necessary, completely remove all lubricating points and the concretionary lubricants in the pipeline.

Precautions for cleaning operation

- Regularly clean the equipment.
- Sweep away big dirt or clean it with an industrial vacuum cleaner.

Precautions for lubrication

The lubrication of the machine tool shall be carried out according to the lubrication chart and maintenance instructions. In addition, attention should be paid to the following points:

- The inlet and outlet should be kept clean, and opening time not exceed the time required.
- Waste oil can be eliminated only in the state of equipment warm-up.
- Only wiping rag without fiber flock and diluent lubricant for guide rail can be used to clean the lubrication part; it is not allowed to use waste wool and benzene-contained liquid for cleaning.
- Synthetic lubricants shall not be mixed with mineral oils or synthetic lubricants produced by other manufacturers (even homogeneous synthetic lubricants).
- Properly dispose waste oil.

Qualifications of maintenance personnel

All maintenance work should be carried out only by personnel who have received maintenance training and have relevant knowledge.

In addition to the above qualifications, specific maintenance work (e.g. in the high-frequency generator area) also requires vocational training or further study in the field of electronic technology.

Furthermore, professionals are required to be authorized to engage in electronic technical work for this equipment (Refer to the regulations of VBG4 for authorizing special operation electricians). Besides, the existing regulations of each country are also applicable.

I. Maintenance overview

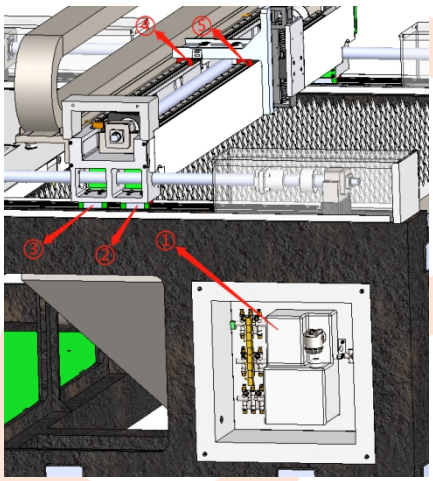
1.1 Main maintenance list

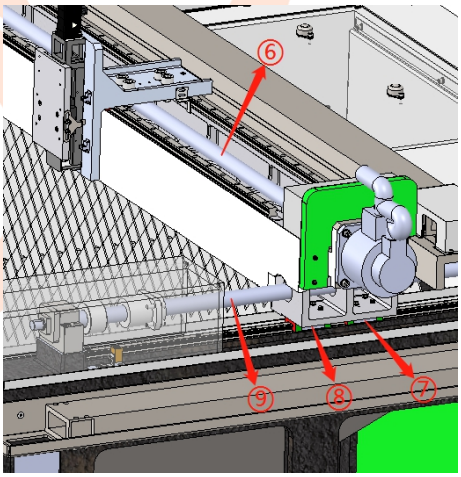
Period/running hours	Maintenance position	Maintenance work
8h	Slag and dust cleanup in the X/ Y-directional dustcloth.	Check and clean up the slag and dust from X/Y-directional dustcloth.
8h	Slag and dust collector--dust car	Check and clean up the slag and dust collection vessel--dust car and clean up
8h	Slag and dust cleanup in the X-axle guard plate	Clean up slag and dust from X-axle guard plate
40h	Inspection of pneumatic elements and pipelines in the pneumatic system	Check the pneumatic elements and pipeline in the pneumatic system
40h	Inspection of air circuit elements and pipeline in the air source	Check the air circuit elements and pipeline in the air source
40h	Inspection of circulating water pipeline	Check the circulating water pipeline.
100h	Oiling and cleaning of automatic lubricating container	Check the oil mass of automatic lubricating container, supplement the oil, check and clean the oil circuit.
500h	Cleanout of filter screen of water-cooling machine	Clean up and clean out the filter screen of water-cooling machine
1000h	Change oil and clean the automatic lubricating container	Clean up the interior and exterior of automatic lubricating container and change the new lubricating oil.
2000h	Clean and oil the Z-axle guideway and ballscrew, tidy the Z-axle guideway and slide block up, then, add the lubricating	Check and clean up Z-axle guideway, slide block and ballscrew, add the lubricating grease on Z-axle slide block and oil the

	grease.	ballscrew.
2000h	Cleaning and oiling of X and Y-axle guideway and ballscrew	Check the cleaning and oiling of X and Y-axle guideway and ballscrew
Every 6 months	Cooling device	Replace the cooling water (cleaning cycle)

For single class operating:	
8 running hours	Every day
40 running hours	Every week
100 running hours	Every 14 days
500 running hours	Every season
1000 running hours	Every half a year
2000 running hours	Every year
5000 running hours	Every 2.5 years
15000 running hours	Every 7.5 years
Every 6 months	Not subject to running hours and six months after
Every 2 years	Irrelevant to running hours and two years after
Every 3 years	Irrelevant to running hours and three years after

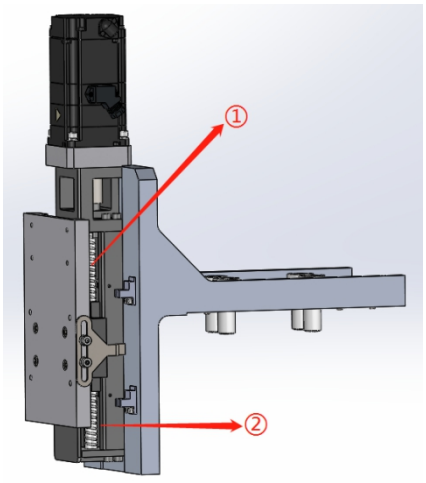
1.2 Lubrication





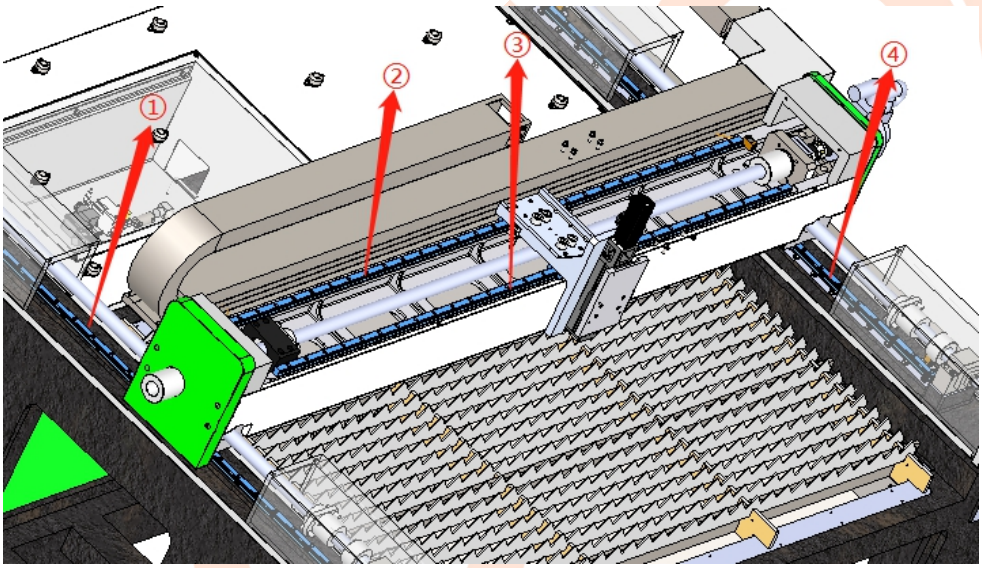
①Automatic lubricating pump ②Guideway slide block 1 on the left side of X axle ③Guideway slide block 2 on the right side of X axle ④Guideway slide block 1 above Y axle ⑤Guideway slide block 2 above Y axle ⑥Guide screw on Y axle ⑦Guideway slide block 2 on the left side of Y axle ⑧Guideway slide block 1 on the right side of Y axle ⑨Guide screw on X axle(two pieces)

Lubrication Overview Figure I



①Lead screws on Z axle ②Slide block on Z axle

Lubrication Overview Figure II



①Guideway 1 on X axle ②Guideway 1 on Y axle ③Guideway 2 on Y axle ④Guideway 2 on X axle

Lubrication Overview Figure III

Lubrication Overview Table

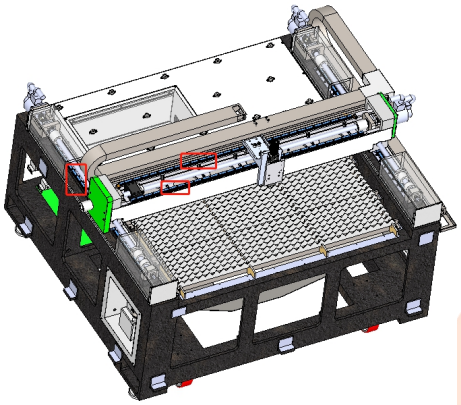
Lubricant Part	Dosage	Recommended lubricants	Logo	Viscosity and Consistency	Order No.
X-axis guide slider	0.3ml/time and each time/ 12min	32# machine guide slider oil	Shell	Motion viscosity 32	.....
Y-axis guide slider	0.3ml/time and each time/ 12min	32# machine guide slider oil	Shell	Motion viscosity 32	.....

Z-axis guide slider	25g/time and 200h/time	0# lithium base grease	Sinolube	Motion viscosity 68	.....
Z-axis ball screw	10g/time and 200h/ time	0# lithium base grease	Sinolube	Motion viscosity 68	.....
X-axis/ Y-axis ball screw	0.3ml/ time and each time/12min	46# machine guide slider oil	Shell	Motion viscosity 46	.....

Prompt:

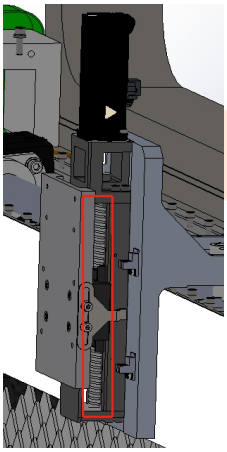
We recommend using the listed lubricants or lubricating oils with the same quality which can be proved produced by other mineral oil companies.

Maintenance point 1.2.1



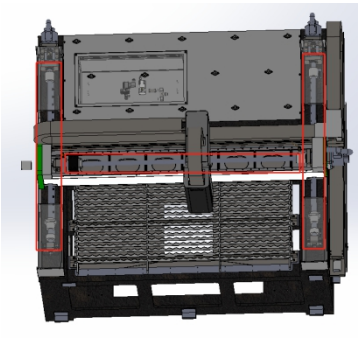
Job nature: **Lubrication**
Make lubrication in the motion process of X and Y axle guideway
Interval: 0.3ml/time, Once/4h
Tools/materials: 32# guideway oil
Job contents: Visual observation on the lubricating oil mass of X and Y-axle guideway, in case of any adjustment, please contact with Bond engineer.

Maintenance 1.2.2



Job nature: **Lubrication/cleaning**
Clean Z-axle guideway, slide block and ballscrew; grease the guideway slide block and add guideway oil on the ballscrew
Interval: Once/year
Tools/materials: Cleaning cloth, oil gun, grease gun, 46# guideway oil and 0# lithium base grease
Job contents: Remove the hood components, use cleaning cloth to clean the linear guideway, slide block and ballscrew, oil the ballscrew and use grease gun to grease the guideway slide block

Maintenance 1.2.3



Job nature: **Lubrication/ cleaning**

Clean the X/Y-axle ballscrew and add the guideway oil on the ballscrew

Interval: Once/year

Tools/materials: Cleaning cloth, oil gun, 46# guideway oil and 0# lithium base grease

Job contents: Remove the hood components and use cleaning cloth to clean and oil the ballscrew

Maintenance 1.2.4

Job Nature：**Clean/Refueling/Oil Change**

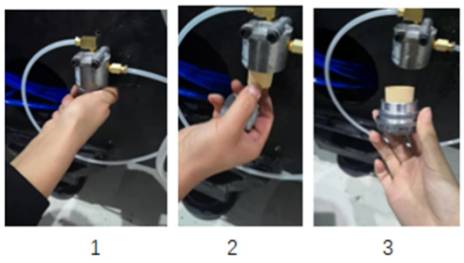
Cleaning, refueling and oil change of automatic lubrication pump

Interval: refuel once 14 days, change oil once every half a year

Tools/Materials: Cleaning cloth, funnel, refueling barrel; No. 32 guide oil

Job Description: regular cleaning and refueling; regular oil changes. Attentions should be paid to ensure that the inside and outside of the container are clean at the time of changing oil.

Maintenance 1.2.5



Job Nature：Clean

Regular cleaning of the filter element in the oil filter

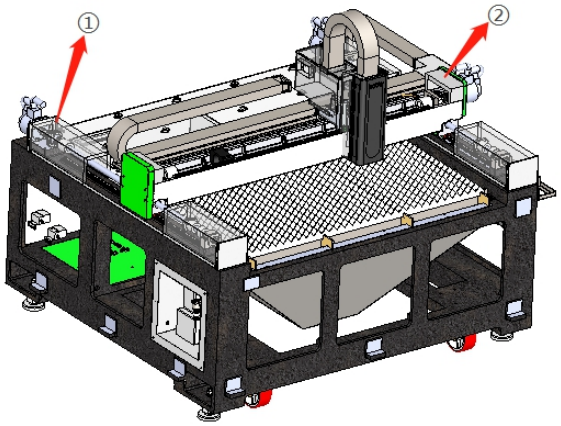
Interval: once every half a year

Tools/Materials: cleaning cloth, air gun

Job Description: unscrew the filter base to remove the filter element, clean the filter element with an air gun, after which reinstall it and tighten the base.

1.3 Mechanical Part

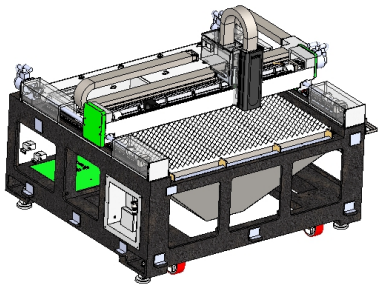
1.3.1 Overview



①Dustcloth in X direction ②Dustcloth in Y direction

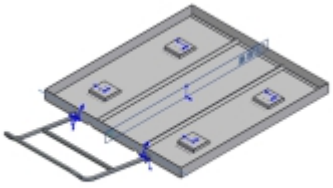
1.3.2 Maintenance guideline

Maintenance point 3.2.1



Job nature: **Cleaning**
Slag and dust cleanup on X-directional dustcloth
Interval: Once/day
Tools/materials: Air gun and pump
Job contents: Clean up slag and dust from X-directional dustcloth at regular intervals

Maintenance point 3.2.2



Job Nature：**Clean**
Check slag and dust collection container--waste truck and clean it
Interval: once a day
Tools/Materials: cleaning tools
Job Description: check the slag and dust collection container--waste truck and clean it up at regular intervals

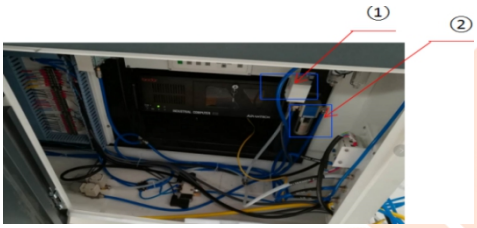
1.4 Air source part

1.4.1 Overview

气源部分概览图示（一）

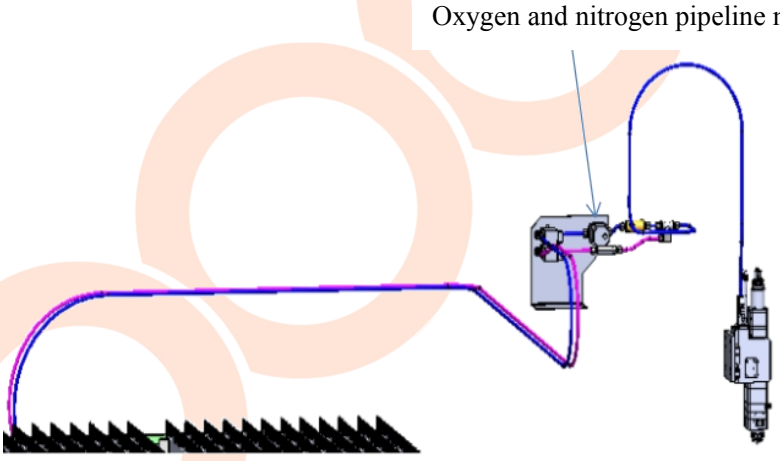
Oxygen meter Nitrogen meter

Air Source Overview Figure (I)



①Pressure switch ②Filter

Air Source Overview Figure II

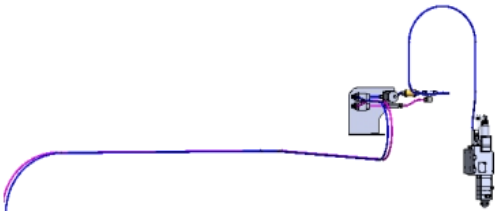


气源部分概览图示（三）

Sketch of the overview of the air source section (iii)

1.4.2 Maintenance Instructions

Maintenance of gas circuit elements and pipeline of the gas source section



Job nature: **Cleaning/Checking**

Check gas source, gas circuit components, pipeline, etc.

Interval: once/week

Tools/Materials: Cleaning cloth, air gun, air pump.

Job description: Remove the table blind, clean up the filter, pressure switch and nitrogen & oxygen pipeline module, observe air pressure stability of nitrogen gauge and oxygen gauge, and check whether there is air leakage in air duct.

1.4.3 Cleaning of Filter

1 2 3 4

Job Nature: Replace

Regular replacement of the filter element in the filter

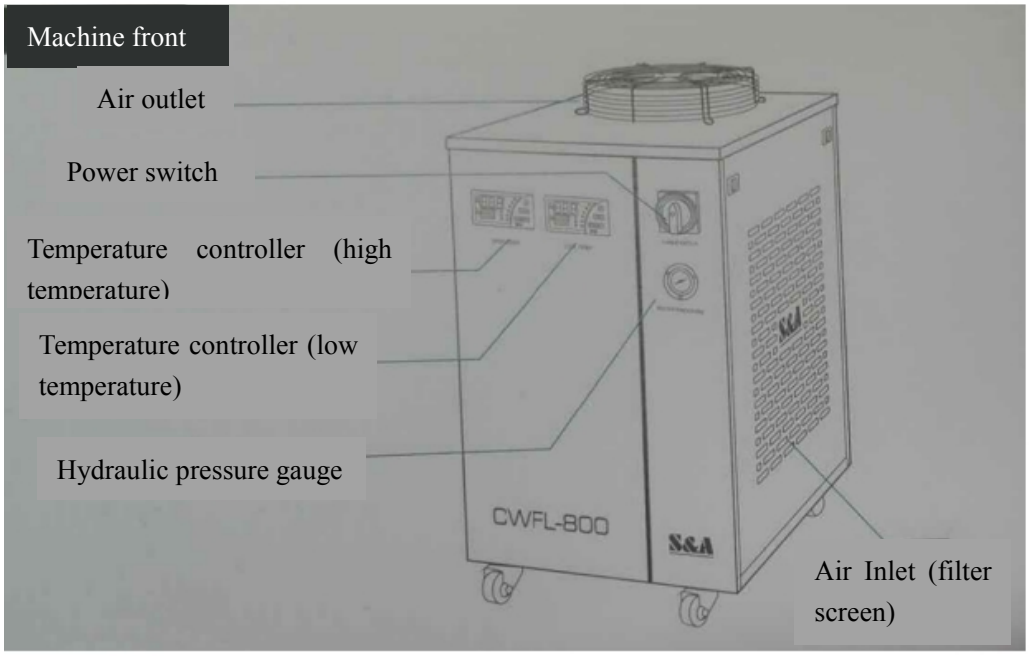
Interval: once a year

Tools/Materials: cleaning cloth, inner hexagonal handle, filter element

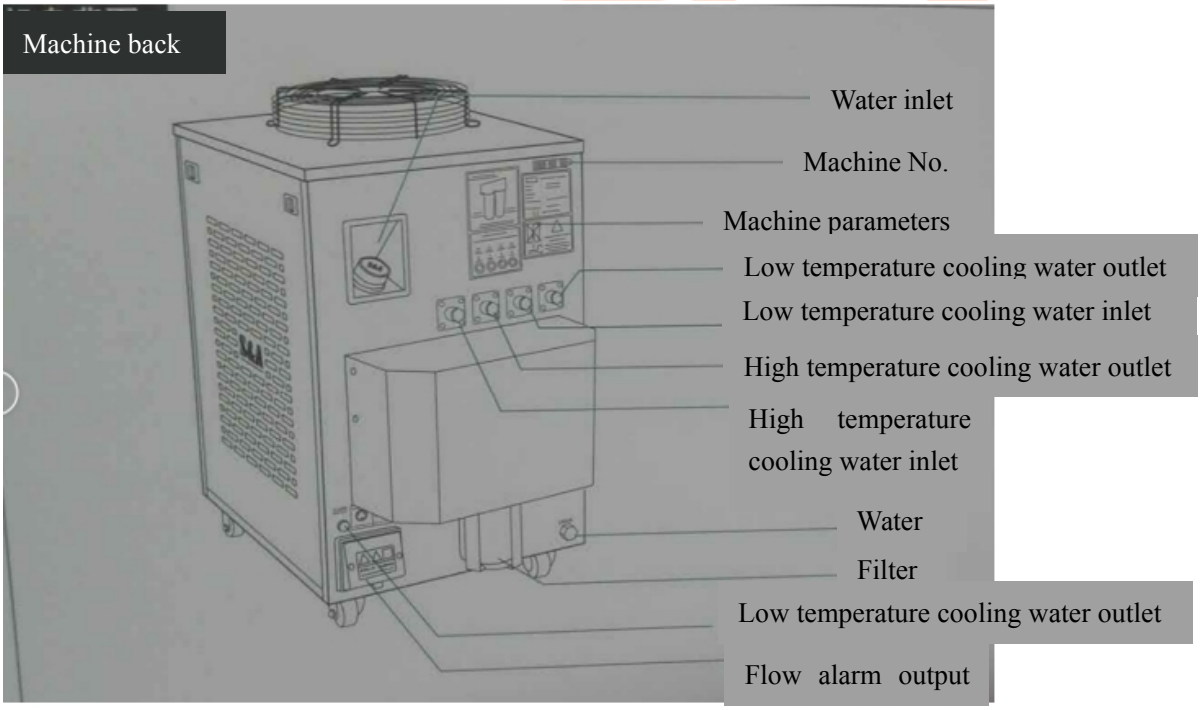
Job Description: disassemble the filter to remove the filter element from the filter and replace it with a new one.

1.5 Cooling Water Circulation Loop

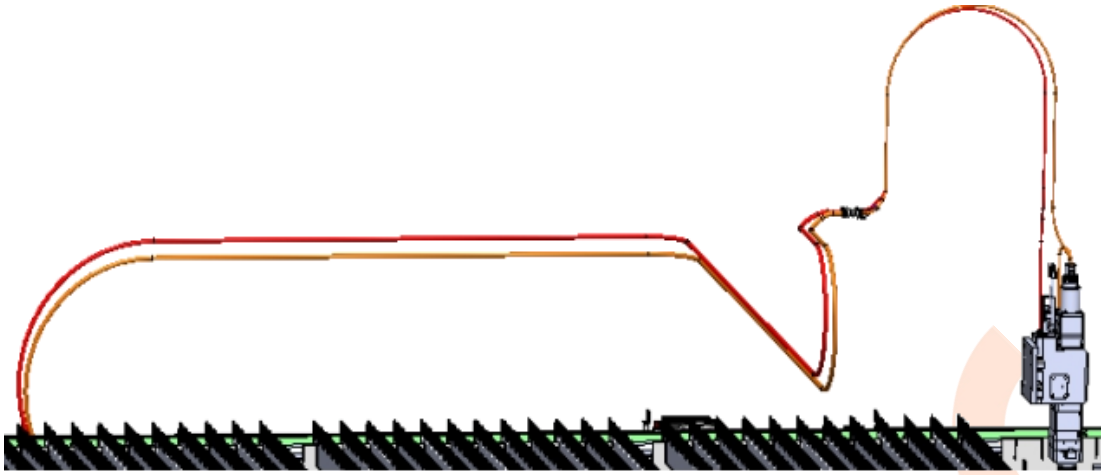
1.5.1 Overview



Sketch of the overview of the cooling-water circulation loop (i)



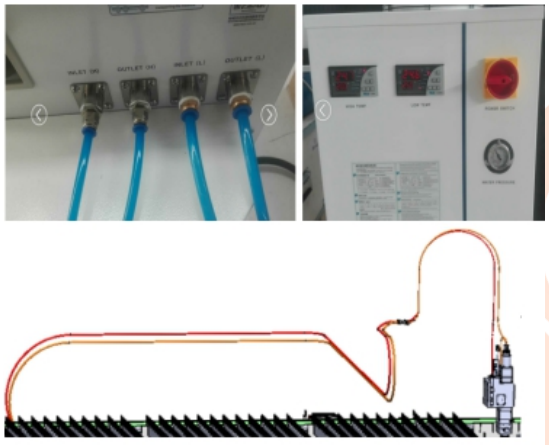
Sketch of the overview of the cooling-water circulation loop (ii)



Sketch of the overview of the cooling-water circulation loop (iii)

1.5.2 Maintenance Instructions

Maintenance Points 5.2.1

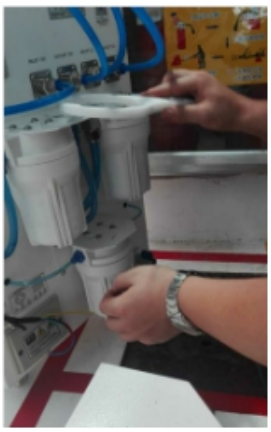


Job nature: **Check**
Check the circulating water loop pipeline, etc.
Interval: once/week
Tools/Materials: Observation.
Job description: Open the table blind to remove the motor cover blind, and open the head shell to check the overall circulating water route, and to make sure no water leakage in water pipe.

Maintenance Points 5.2.2

Job nature: **Cleaning and washing**
Clean up the filter screen of the water-cooling machine (both sides)
Interval: once/quarter
Tools/Materials: Water pipe, cleaning tools, cleaning cloth
Job description: Press the filter screen "Jaw" of the water-cooling machine, remove the filter screen, and then clean up the filter screen with clean water.

Maintenance Points 5.2.3



Job nature: **Replace cooling water**
Completely discharge cooling water in the filter, and then add new cooling water.
Interval: once/every six months
Tools/Materials: Cleaning cloth, screwdriver, purified water
Job description: Remove the rear downside "Cover" of the water-cooling machine, open the "Water Outlet", unscrew the "Filter", completely discharge cooling water in the filter; completely discharge cooling water in the water-cooling machine inner, and then add cooling water in the "Water Inlet" according to water level displayed on the water gauge.

II. Common Problem Solving Handbook

2.1 The details of common fault alarm and handling method are shown in the table below.

Alarm Position	Alarm Name	Alarm Causes and Inspection Methods
Floating Head Alarm	Decrease in Body Capacitance	1. The nozzle is not installed
		2. Ceramic ring is loosened
		3. There are problems with wiring
	Unusually increase in Capacitance	There are problems with calibration, so re-calibration is required.
	Servo alarm	1. Z-axis servo is not opened.
		2. There are problems with servo connection, so please check all the servo plugs.
	Upper Limit is Effective	Z-axis upper limit trigger
	Lower Limit is Effective	Z-axis lower limit trigger
Network Timeout		1. Network cable is not connected.
		2. Reset the height controller IP.
		3. The height controller is not opened.
Servo Drivers Alarm	Alarm Code: 910, 710, 720	1. The servo is not opened.
		2. There are problems with servo connection, so please check all the servo plugs.
Limit Alarm	Y+ Limit	1. Limit trigger
	Y-Limit	2. There is something touching the limit.
	X+ Limit	3. There are problems with the limit, so replacement is required.
	X- Limit	4. The pin board is faulty
The cutting effect suddenly becomes worse		1. No calibration is made after replacement of the material.
		2. The nozzle is not clean or damaged.
		3. Cutting air pressure is insufficient.
		4. The lens are polluted or damaged

2.2 The details of common cutting faults and solving methods are shown in the table below.

Phenomenon	Possible Cause	Solutions
There is waviness during cutting	The shim plate of the machine tool is suspended. Whether the locking cylinder locks the table.	Adjust the shim plate of the machine tool. Check the pressure value of compressed air.

Cutting precision is not stable	The laser head is not installed vertically. The laser head is not firmly installed.	Detect the verticality of the laser head with a special level gauge. Check mounting screws of the laser head.
There is big diagonal error.	X-axis is not vertical to the Y-axis.	Adjust the verticality of X, Y-axis.
There are edge angles during cutting.	After long-time running, the gear and gear mesh become larger.	Readjust the engagement.

Warning

If any abnormal reaction occurs in the equipment, please press the emergency stop button. At this time, only personnel trained by Bodor can operate the equipment, please do not handle it without authorization in order not to cause greater losses. Please contact Bodor customer service for assistance as soon as possible. Bodor Laser shall have the right to request liability exemption for serious consequences caused by any illegal operation.

2.3 Dew Point Table of the Water-cooling Machine

Dew point temperature refers to the temperature when air is cooled to saturation without changing moisture content and air pressure. Evocatively, the temperature at which water vapor in air becomes dew point is called dew point temperature. Please avoid the temperature of water-cooling machine near dew point; otherwise, the equipment may be damaged.

Comparison Table of Environment Temperature, Relative Humidity and Dew Point														
Relative Humidity Ψ (%)	95	90	85	80	75	70	65	60	55	50	45	40	35	30
Environment Temperature Ta (℃)	Dew Point Td (℃)													
10	9.2	8.4	7.6	6.7	5.8	4.8	3.6	2.5	1.5	0	-1.3	-0.3	-5	-7
11	10.2	9.4	8.6	7.7	6.7	5.8	4.8	3.5	2.5	1	-0.5	-2	-4	-6.5
12	11.2	10.9	9.5	8.7	7.7	6.7	5.5	4.4	3.3	2	0.5	-1	-3	-5
13	12.2	11.4	10.5	9.6	8.7	7.7	6.6	5.3	4.1	2.8	1.4	-0.2	-2	-4.5
14	13.2	12.4	11.5	10.6	9.6	8.6	7.5	6.4	5.1	3.5	2.2	0.7	-1	-3.2
15	14.2	13.4	12.5	11.6	10.6	9.6	8.4	7.3	6	4.6	3.1	1.5	-0.3	-2.3
16	15.2	14.3	13.4	12.6	11.6	10.6	9.5	8.3	7	5.6	4	2.4	0.5	-1.3
17	16.2	15.3	14.5	13.5	12.5	11.5	10.2	9.2	8	6.5	5	3.2	1.5	-0.5
18	17.2	16.4	15.4	14.5	13.5	12.5	11.3	10.2	9	7.4	5.8	4	2.3	0.2
19	18.2	17.3	16.5	15.4	14.5	13.4	12.2	11	9.8	8.4	6.8	5	3.2	1
20	19.2	18.3	17.4	16.5	15.4	14.4	13.2	12	10.7	9.4	7.8	6	4	2
21	20.2	19.3	18.4	17.4	16.4	15.3	14.2	12.9	11.7	10.2	8.6	7	5	2.8
22	21.2	20.3	19.4	18.4	17.3	16.3	15.2	13.8	12.5	11	9.5	7.8	5.8	3.5
23	22.2	21.3	20.4	19.4	18.4	17.3	16.2	14.8	13.5	12	10.4	8.7	6.8	4.4
24	23.1	22.3	21.4	20.4	19.3	18.2	17	15.8	14.5	13	11.4	9.7	7.7	5.3
25	23.9	23.2	22.3	21.3	20.3	19.1	18	16.8	15.4	14	12.3	10.5	8.6	6.2
26	25.1	24.2	23.3	22.3	21.2	20.1	19	17.7	16.3	14.8	13.2	11.4	9.4	7
27	26.1	25.2	24.3	23.2	22.2	21.1	19.9	18.7	17.3	15.8	14	12.2	10.3	8
28	27.1	26.2	25.2	24.2	23.1	22	20.9	19.6	18.1	16.7	15	13.2	11.2	8.8
29	28.1	27.2	26.2	25.2	24.1	23	21.3	20.5	19.2	17.6	15.9	14	12	9.7
30	29.1	28.2	27.2	26.2	25.1	23.9	22.8	21.4	20	18.5	16.8	15	12.9	10.5

31	30.1	29.2	28.2	26.9	26	24.8	23.7	22.4	20.9	19.4	17.8	15.9	13.7	11.4
32	31.1	30.1	29.2	28.1	27	25.8	24.6	23.3	21.9	20.3	18.6	16.8	14.7	12.2
33	32.1	31.1	30.1	29	28	26.8	25.6	24.2	22.9	21.3	19.6	17.6	15.6	13
34	33.1	32.1	31.1	29.5	29	27.7	26.5	25.2	23.8	22.2	20.5	18.6	16.5	13.9
35	34.1	33.1	32.1	31	29.9	28.7	27.5	26.2	24.6	23.1	21.4	19.5	17.4	14.9
36	35.18	34.05	33.1	32	30.9	29.7	28.4	27	25.7	24	22.2	20.3	18.1	15.7
37	36.2	35.2	34.05	33	31.8	30.7	29.5	27.9	26.5	24.9	23.2	21.2	19.2	16.6
38	36.95	36	35.06	33.9	32.7	31.5	30.3	28.9	27.4	25.8	23.9	22	19.9	17.5
39		36.8	36.2	34.9	33.8	32.5	31.2	29.8	28.3	26.6	24.9	23	20.8	18.1
40			36.8	35.8	34.7	33.5	32.1	30.7	29.2	27.6	25.8	23.8	21.6	19.2

Appendixes

Following Files List
Warranty Card

Equipment Parameter Configuration Table

Laser Cutting Process Parameter Reference Table

List of Vulnerable Parts		
S/N	**Name**	**Remark**
1	Transmission fiber	
2	Optical lens	
3	Sammer sealing	
4	Ceramic body	
5	Nozzle	
6	Gas nozzle of cutting head faucet	
7	RF cable	
8	Filter elements and filter components	
9	Blade holder, blade, anti-burn component	
10	Mouse and keyboard	
11	Dust cover	
12	Handle	
13	Various cables and all crystals	

Following Files List

Lists of Following Files		
Item	**Specific content**	**Notes**
1. Software	System software Bodorpro	Following with device
2. Machine parameters	Cutting parameters	Export data after testing device
	Platform configuration parameters	
3. Servo driver parameters	X axle servo driver parameters	
	Y axle servo driver parameters	
	Z axle servo driver parameters	
4. Device operation instructions	Device installation guide PPT version(add move notice)	
	Product manual	
	Device test and software operation manual	
	Standard file	Waterway schematic, electric schematic, lubrication schematic, packing layout, hoisting schematic, foundation drawing, site layout, vulnerable parts drawing
5. Peripheral equipment	Fiber optic instruction	
	Height controller instruction	
	Laser head instruction(empower, Bodor Genius, etc.)	
	Water cooler instruction	
6.Test drawing	Cutting test graphic	
	Artware graphic	
7.Software apk	PDF Reader, WinRAR, WPS (English version)	Choose Chinese version if you are in China, English version for overseas clients.

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助力中国智造

To Drive Intelligent Manufacturing in China

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Website: www.bodor.com