User Manual of Metal Laser Cutting Machine

Introductions to installation, commissioning and operation

Jinan Bodor Laser Corporation Limited

CONTENTS

Foreword

Thanks for your choice of our products. Complete after-sales and solutions will be provided for you. Please keep the Manual and other annexes properly for your better operation.

The Manual describes safety matters, operating principle, transportation and storage, installation method, operation and application, troubleshooting, maintenance and service, etc of the product. The Manual is applicable to standard configuration of our company's products; please read over detail files attached for some component items.

Please read this Manual carefully before installation and utilization if you use this product for the first time.

For quickly effective use of the product, the operating personnel should:

I. Be familiar with some professional computer knowledge and be able to use relevant authoring and mapping software, including SolidWorks, AutoCAD, etc.

II. Have some knowledge in optics and maintenance and repair related to electromechanical equipment.

III. Recognize whether you are familiar with operational process of equipment and could be able to operate according to the process before starting.

Due to unceasing update of product functions, your product received may be slightly different from the description in the Manual. Therefore, we hereby apologize for this.

If any better suggestions or questions, please log in our website www.bodor.com to leave a message or call our 24-h hotline 400-991-7771 for consultation freely.

Chapter I Equipment Acceptance and Placement

1.1 Equipment acceptance and inspection

1.1.1 Notes for unpacking

Please check whether the outer package of the machine has any damage after receiving the product. The machine packaged with wooden case is labeled with shockproof and inclination-proof marks as shown in Figure 1-1. In case the crystal tube on DAMAGE X (shockproof) label turns red, it indicates that the machine has suffered from shock during the transportation or handling; in case the window of TILT XTR (inclination-proof) label turns red, it indicates that the machine has suffered from inclination during transportation or handling. As shown in Comparative Figure 1-2, the normal labels are as shown in upper figures, and the ones when crystal tube and window turn red are as shown in lower figures. In case the crystal tube or window turns red or the outer package has obvious damage, please contact the insurance company or our company to negotiate the follow-up matters.

The equipment packaged with wooden package, the straps shall be removed firstly, and the wooden plates shall be removed from top to bottom to avoid any damage to the equipment in the case. No sharp objects can be used to gash the protective film package of the equipment to avoid any surface scratch and damage of electrical circuit, and the company will not bear any liabilities for the damage caused by the customer.

Figure 1-1 Shockproof and Inclination-proof Labels

Figure 1-2 Changes of the Labels before and after Shock and Inclination

Notes: In general, the laser source is placed in the wooden case, and it is necessary to unpack the wooden case carefully and especially not to damage the fiber-optic cable. In order to better protect the lathe bed, the envelope shall not be opened before determining the placement position.

1.1.2 Inspection contents

Please confirm whether the product you received is the one you bought, check whether the product has any damage during the transportation confirm whether the components are complete and free of any damage.

In case of transportation damage, product model unconformity or accessory missing, please contact with our company timely.

1.2 Installation requirements and notes

1.2.1 Ground requirements

1. The equipment installation foundation shall be flat, and the altitude difference of such components as lathe bed, water chiller, control cabinet, automatic loading device or tooling feeding

platform (for robot), and laser source (cabinet-type) shall not exceed 10mm.

2. The concrete thickness of the overall installation surface shall not lower than 200mm, the compression strength shall not smaller than 30N/mm^2 and the load shall be more than 30KN/m^2.

3. The overall installation surface of lathe bed shall be composed of flat continued bottom plate located within the scope of supporting point. The new-made bottom plate/pressing plate shall be free from dents or cracks in drying conditions. It is not allowed that the travel range of laser beam on the lens are more than 0.5mm due to the inclination of lathe bed.

1.2.2 Environmental requirements

1. Ambient temperature and humidity requirements

The equipment shall be operated under dry and well ventilated, and the ambient temperature shall be between +4℃ and +33℃. It is suggested that the customer provides an operation environment with constant temperature and humidity for the equipment, if applicable. The ambient temperature shall not lowered below +4℃ when the equipment is in shutdown condition. Notes: The heat distortion resulted from direct sunlight at one side and downcast air at the other side shall be avoided (for example, if the equipment is installed at the window position, shutters can be adopted to avoid such conditions).

2. External air

In order not to influence the cutting quality, it is a must to ensure that no grain or matter able to absorb rays with wave length of 1.064um exists around the machine, such as the steam containing solvent emitted in painting or steam released from the oil removal device.

3. Cooling of control system

The cooling of control system is completed by the internal air circulation inside the control system shell, which can ensure that the electrical parts will not be polluted by the dust and dirt to the maximum extent. The wet room is not suitable for the operation of control system, the wet environment may result in corrosion of contact points between the contactor and relay.

4. Vibration requirement

In order to keep the optimum operating performance, please ensure that the equipment is not under the influence of external force around the equipment. The external forces effecting the equipment operation include: fork lift truck, land carrier vehicle, etc.; directly installing or dismantling other machine beside the equipment; machines causing vibration beside the equipment, such as punching machine, bending machine and sheet metal cutting machine.

1.3 Placement of components

It is necessary to plan the placement position of water chiller, control cabinet,laser source, lathe bed or gantry beam (for robot) and other parts, the placement position rules of different machines are basically same, which can be referred to at the layout of various model in the first volume of the Manual.

1.3.1 Lathe bed

The placement position of lathe bed shall be firstly confirmed, a fork lift truck or other tools can be used to lift the lathe bed about 80cm to install the base angle. It is necessary to ensure that the lathe bed is placed at the position planned well (Figure 1-3), then the envelope of lathe bed shall be removed, and the removed packaging materials shall be placed at the position named by the customer on site and timely cleaned. The nuts at base angle shall be adjusted separately (Figure 1-4),

the level gauge or level bar can be used to adjust the level of lathe bed platform.

In case such devices as exchange platform, outer cover, pipe cutting and automatic feeding exist outside the lathe bed, the principles from large to small and from interior to exterior shall be observed, and each component shall be connected well after placed well.

Figure 1-3 Machine Lathe Bed (with envelope)

Figure 1-4 Base Angle

RC series manipulator cutting machine shall be carried with a crane, and a rope can be tied on the lifting bolt of the device as shown in Figure 1-5. Please note that the load of the crane and lift rope shall be larger than 300kg.

Methods and notes for transportation and handling:

1. No one is allowed to climb or stand on or put heavy object on the package box.

2. No one is allowed to drag or move the product by cable connected to the product.

3. It is strictly prohibited to collide or scratch the panel and display.

4. The product package box shall be free of moisture, long-term sunlight exposure or rain.

5. The manipulator shall be carefully suspended or lifted during installation and any collision is prohibited. The wire rope is not allowed to touch the equipment and otherwise, soft object shall be used for separation.

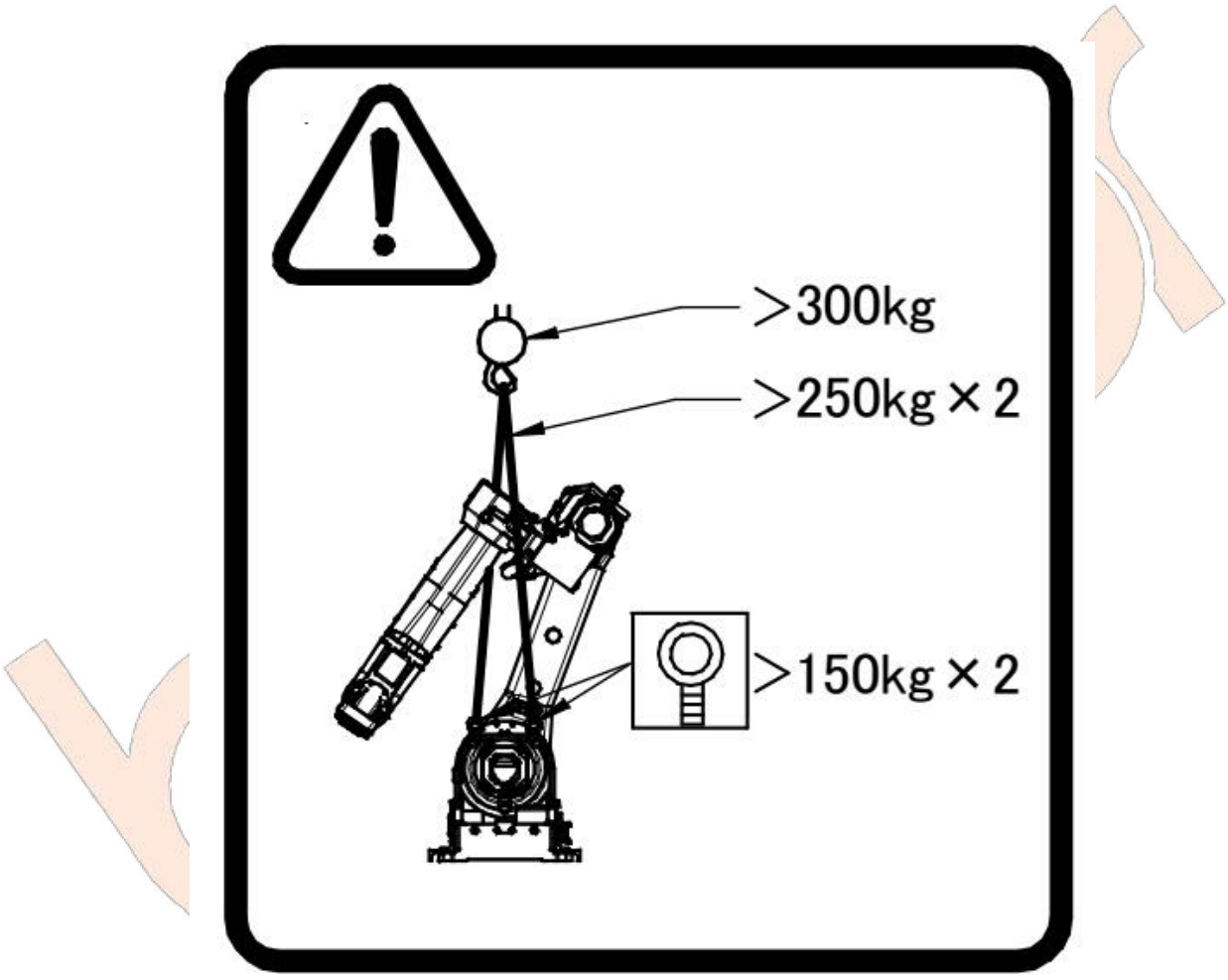

Figure 1-5 Hoisting Schematic Drawing for RC Series Manipulator Cutting Machine

1.3.2 Water chiller

The water chiller is equipped with wheel, thus it can be moved to proper position after filling water at a broad place; it is recommended to be placed at the right diagonal back of the lathe bed (the user is in front of the machine).

Notes: 1. It is strictly prohibited to install the unit at a non-ventilated closed room, the distance from top of the unit shall be at least 2.5m to other objects to ensure the flow and unblocked air; meanwhile, the distance from the water chiller shall be at least 1.5m to other objects around it to ensure that the hot wind from the water chiller will not flow back to the air-inlet surface of the water

chiller. 2. The water chiller is filled with purified water, distilled water or deionized water, and no corrosive liquid, anti-freezing solution or turbid (with filiform, flocculent or granular suspended solids) water or water with undesirable odor can inject into the water chiller. 3. Any unnecessary contact (such as hands) with the water shall be avoided when filling water, and all auxiliary equipment for water injection, such as pump and hose shall be only used for this water chiller. 4. It is recommended to replace the water in water chiller at two - three months.

Figure 1-6 Water Chiller

1.3.3 Laser source

The volumes of laser source will be different due to different powers, and the laser source with power lower than 1000W can be put into the control cabinet (Figure 1-7, Figure 1-8, Figure 1-9). In case the power of laser source exceeds 1000W, it will be made into cabinet body with wheels, which cannot be accommodated in the control cabinet, and will be placed at the middle position at right side of lathe bed.

I3 and I5 series are equipped with small cabinet, and the power of laser source is quite small in general, thus the laser source can be put at the exclusive setting position in the cabinet (Figure 1-9).

The model of RC robot is quite special, the power of its laser source is lower than 1000W, and the laser source can be put at the exclusive setting position in the cabinet (similar to Figure 1-7, Figure 1-8 and Figure 1-9).

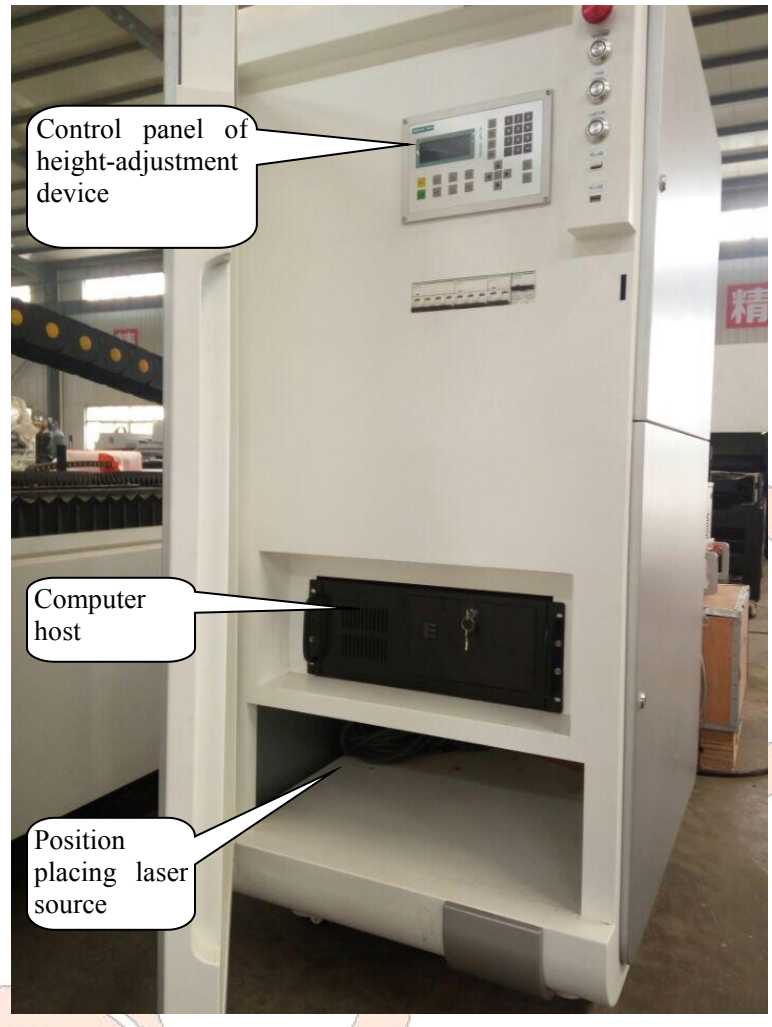

Figure 1-7 Open the Front Door of Control Cabinet

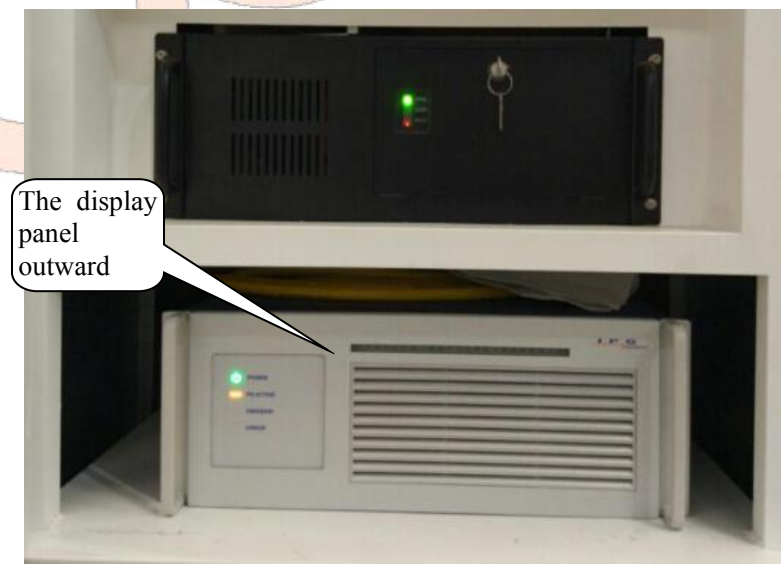

Figure 1-8 Setting Schematic Diagram of laser source

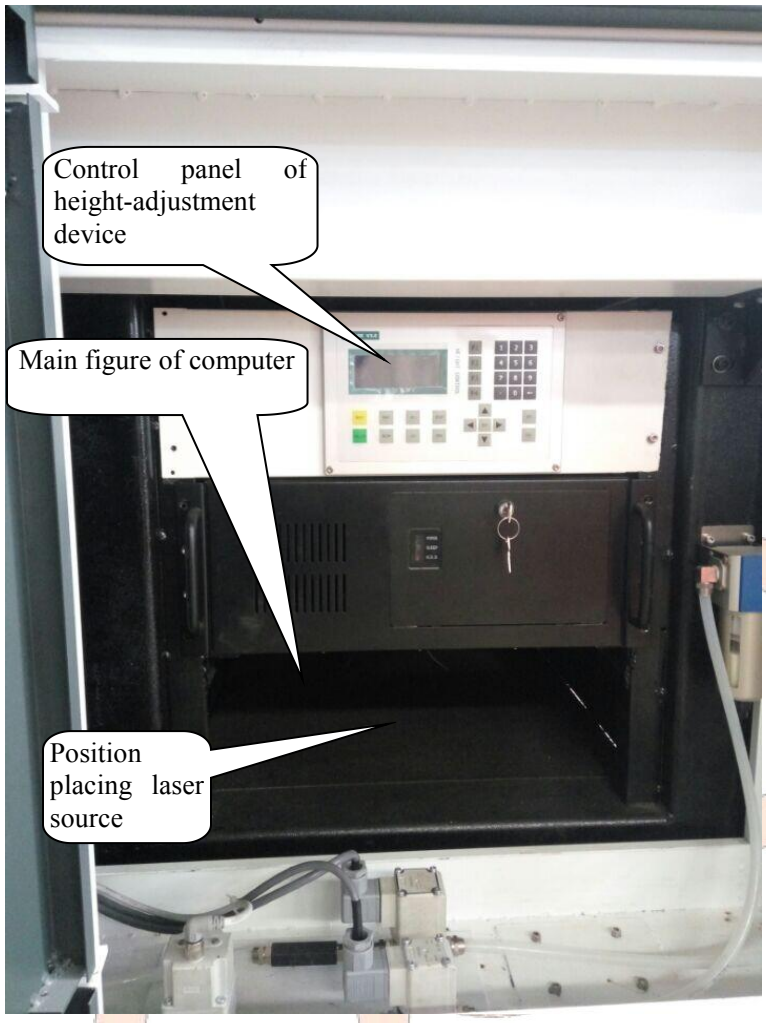

Figure 1-9 Setting Position of I3 and I5 Series laser source

1.3.4 Control cabinet

In case the laser source can be put in the control cabinet, the laser source shall be put at the exclusive position at a broad place, and then the optical fiber and wire shall be lightly put on the main body. Then the control cabinet shall be pushed to the right front side of the lathe bed.

1.3.5 Fan

The fan is used to remove the smoke generated, the interface of fan duct can be seen when opening the upper cover of the lathe bed; the other end of the pipe is connected with the fan, a gas outlet pipe will be equipped with the fan, by which, the fan installation can be completed, and the fan can be set flexibly if the pipe length allows.

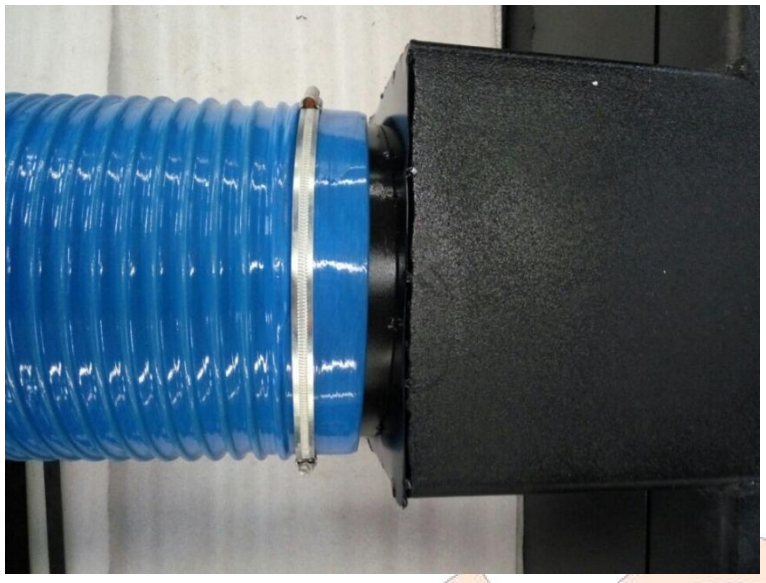

Figure 1-10 Interface for Installing Fan at Back of Lathe Bed

1.4 Installation introduction of pipe cutting machine

The pipe cutting machines produced by our company are equipped with various types, the holding devices are also provided with multiple configurations. In terms of plate and tube machine, the user shall keep the parallelism, perpendicularity and flatness of pipes and laser cutting heads to ensure an optimum working performance, the operation of which is quite complex, thus the operator shall be equipped with a strong operation ability. For the installation and commissioning, it is strongly suggested that the operating personnel can come to the factory for learning or ask for site assistance from the customer service staff of our company. The installation of general pipe machine is similar to that of plate mangle, please refer to the previous chapter.

Chapter II Connection of Pipeline, Line and Other Components

2.1 Gas circuit connection and gas requirements

2.1.1 Gas circuit connection

Two white gas lines will be introduced from the lathe bed, one for nitrogen connection, and one for oxygen connection. A nitrogen gauge can be used to connect the nitrogen line with device providing nitrogen (air); an oxygen gauge can be used to connect the oxygen line with the device providing oxygen (Figure 2-1).

RC robot series can only by equipped with oxygen circuit;

gas cylinder is the easiest method supplying assisted gas, but numerous manual works are demanded when the consumption is large. Do not fully exhaust the gas cylinder at work; when returning the gas cylinder, the residual pressure in the cylinder shall be at least once larger than the air pressure. The cutting operation shall stopped when replace the gas cylinder to cut off the air current. Liquid storage tanks will be selected based on the processing conditions, which is the easiest and most economical air supplying method.

2.1.2 Specifications and requirements for assisted gas

Assisted gas	Purity	Main applied sheet metal
Oxygen (O_2)	99.95%	Carbon steel
Nitrogen (N_2)	99.95%	Stainless steel
Air	Clean (free of water, oil and other impurities)	Thin carbon steel and thin stainless steel

Variables related to the assisted gas: nozzle diameter, assisted gas pressure, laser cutting time, etc., the actual gas consumption quantity will be calculated based on the actual gas utilization factor.

Notes: 1. Due to different state and region standards, the standard nitrogen gauge and oxygen provided by our company may be failed to be connected to your gas supply device, for which, the user can purchase nitrogen gauge and oxygen at local. 2. The temperature of used gas shall not exceed 50℃. 3. In principle, in case of any problem concerning gas, please contact the gas supplier. 4. In case the gas supply position is quite far, the gas circuit and electrical cable shall not be laid at the same pipeline, and the gas shall be separately introduced to the machine tool joint. 5. Special professional personnel shall be provided for the operation, gas exhaust shall be conducted for the first time to ensure that the pipe can be connected to the machine tool after cleaning.

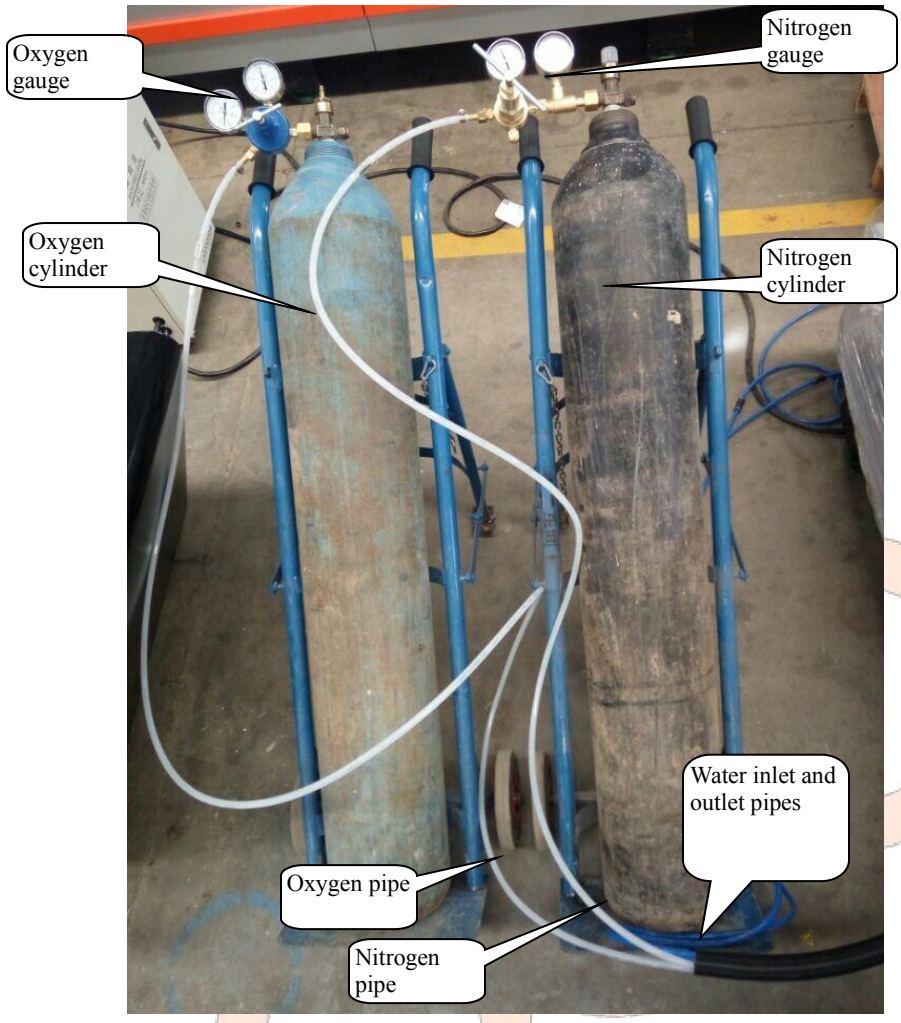

Figure 2-1 Example for Connection of Gas Supply Device

Pneumatic butt material device is equipped with sheet metal cutting machine (a dyad can be seen after opening the cover as shown in Figure 2-2); other pneumatic device can be special model, thus it is recommended that the compressed air can be adopted.

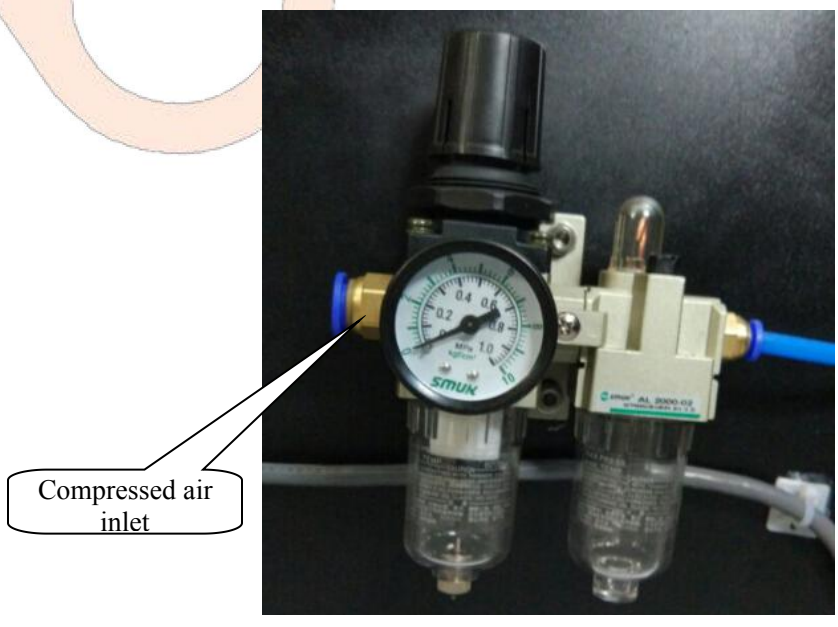

Figure 2-2 Connection of Pneumatic Actuator

2.2 Connection of water circuit and water chiller

HP and LP water circuits are output from the water chiller. The LP water circuit (two blue pipes to the lathe bed, as shown in Figure 2-1) flow to the fiber pigtail and cutting head, the water inlet and outlet directions shall be noted, the water shall flow through fiber pigtail can then the laser cutting head. The LP water circuit flows (Figure 2-3) to the laser source, the water circuit connection modes will be different according to the brands and types of the laser source, and the waterway flow direction and label shall be noted to ensure correct connection of the water pipe attached to the machine.

For example: As shown in Figure 2-3, OUTLET(L) interface at left side of water chiller shall be connected to the WATER IN interface at right side of laser source, and the INLET(L) interface of the water chiller shall be connected to the WATER OUT interface to ensure the circulation and flow of water.

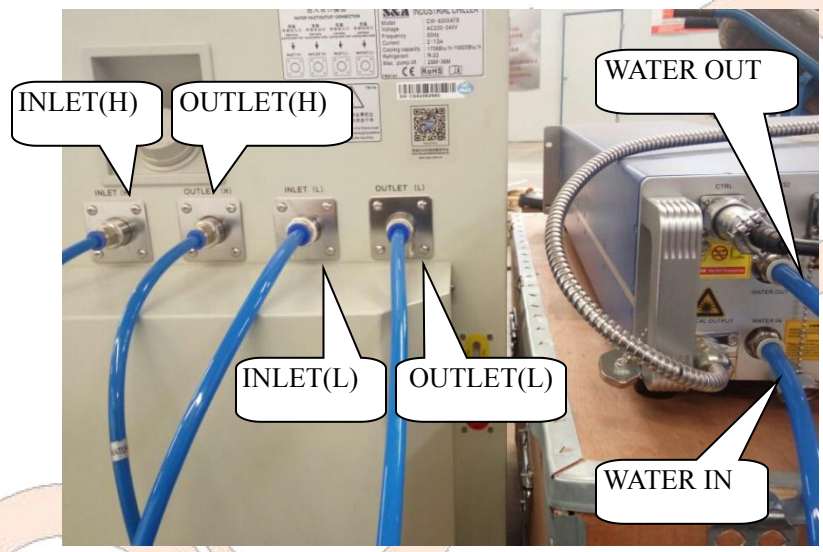

Figure 2-3 Example for Connection between Water Chiller and laser source

2.3 Circuit connection

The machine is composed of multiple parts, and all parts shall be ensured correct connection. Electrical schematic diagram in the first volume of the Manual can be referred to for the connection method.

2.3.1 Water chiller

In the control cabinet, the connection position for water chiller power line and laser source power line (Figure 2-4), and the fire line, zero line and grounding line shall be connected and fixed firmly.

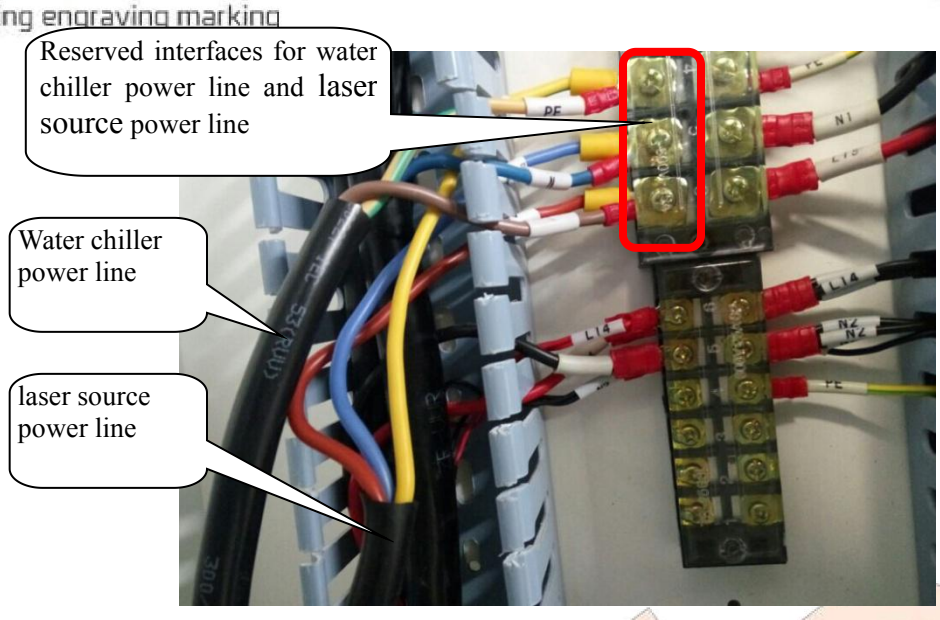

Figure 2-4 Example for Connection between Water Chiller Power Line and laser source Power Line

If the machine uses a laser source with a larger power, the cooling capacity of water chiller will increase, for which, the three-phase power supply will be provided. Connection shall be conducted separately, the phase sequence shall be noted, and in case of any wrong phase sequence, the water chiller will alarm and fail to start.

One signal line from water chiller of part model will be connected to the laser source, if any, the connection shall be connected based on label.

2.3.2 Laser source and laser cutting head

Same as water chiller in principle (Figure 2-4), the fire line, zero line and grounding line of the laser source shall be connected in the control cabinet.

Three-phase power supply shall be provided if the laser source has a larger power, and the leading line shall be introduced separately. laser sources with different brands or models will be different in phase sequence; in case the phase sequence is wrong, the fiber sequence will alarm and cannot be opened.

It is necessary to introduce signal line from the laser source to connect to the control card, the connection lines of laser sources with different brands and models will be different in number, and the reserved interface in the control cabinet shall be found and connected according to line No. In case of any problem in connection, connection diagram in the first volume of Manual can be referred to, and the customer can also contact our company directly. Examples for signal line connection of laser source are as shown in Figure 2-5 and Figure 2-6.

One signal line will be introduced from the laser source of some models of water chiller to detect whether the water chiller is opened; in case of any line, the connection shall be conducted according to label.

Figure 2-5 Example for Connection of laser source Signal Line 1

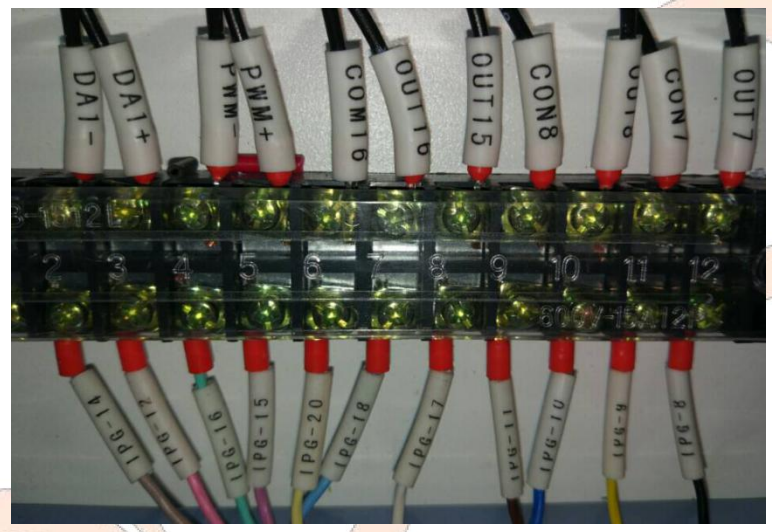

Figure 2-6 Example for Connection of laser source Signal Line 2

The optical cable of laser source shall pass through the tank chain carefully, plugged the fiber pigtail into the laser cutting head and fixed at Z axis. The water pipe, gas line, amplifier and sensing line will be installed after fixing the laser cutting head, and the detailed operation video can be referred to in other materials attached with the machine. The operation procedures are briefly shown as follows:

1.Remove all the cover plates of tank chains.

2.Release all optical cables of the laser source to remove the torsion.

3.Thread the fiber pigtail into the hole of control cabinet and set the optical cable into the tank chain to ensure that the fiber pigtail can elicit from the shield of laser cutting head 300mm-400mm.

4.The fiber pigtail will be plugged into the laser cutting head. (See below for the detailed procedures)

5.Fix the laser cutting head at Z axis.

6.Install the water pipe, gas line, amplifier and sensing line based on label No., as shown in Figure 2-7.

7.Install the cover plate of tank chain.

8.Recover the excessive optical cable and put it on the laser source shell.

Figure 2-7 Example for Installation of Fiber Cutting Head

Notes: The end face of the fiber pigtail shall be clean before plugging. Special microscope components can be used to observe the end face of fiber pigtail, special compressed air and special cleaning agent (isopropyl alcohol) as well as special cotton swab and special lens paper for cleaning tools are used to clean the dust and other dirt. It is strictly prohibited to excessively bend the optical cable of the laser to prevent from breaking off the glass fiber inside the optical cable. The optical cable shall not be exposed to prevent from trample.

A. Operation sequence for plugging the fiber pigtail into the laser cutting head:

Place the fiber pigtail horizontally, take off the black dust cover, and align the golden marked point with the red marked point on the laser cutting head chuck and plug it into the bottom. Turn the nut towards the left according to the procedures marked (2 1) on the laser cutting head chuck, lift it and turn it towards to the left to complete the fixation and fastening procedures.

B. Operation sequence for taking the fiber pigtail from the laser cutting head:

The procedures for taking off the fiber pigtail is in contrast with installation procedures, i.e., turn the

nut of laser cutting head chuck towards the right, pull it down, turn it towards the right, at that time, the fiber pigtail is in free state and can be taken off from the laser cutting head chuck.

After separating the fiber pigtail from the laser cutting head, dust covers shall be adopted to cover the them separately to avoid dust intrusion.

Please pay attention to distinguish the water pipe and gas line. In general, the white hard pipe is the gas line and the white pipe and blue pipe are water pipe. The water pipe connection methods of different types of laser source will be different, and the connection shall be conducted based on label.

2.3.3 Control cabinet

In order to ensure normal operation of the machine, multiple lines of control cabinet shall be introduced, such as the aforesaid power line of water chiller, power line of laser source and signal line of laser source. Control cabinet shall also be introduced for many other lines (Figure 2-7); port inserting is adopted for some lines and some lines are directly connected to the electric parts in the control cabinet; all lines are marked with labels, and the connection shall be conducted based on the label. In case of any connection problem, please refer to the connection diagram in the first volume of the Manual.

Figure 2-7 Example for Line Introduction of Control Cabinet

2.3.4 Fan

In the control cabinet, connection position for fan power line is also reserved near the laser source power line and water chiller power line. The positions marked with U1, V1 and W1 labels will be connected with U1, V1 and W1 positions on the fan as shown in Figure 2-8; in case of any motor inversion, it represents a wrong phase sequence, for which, the phase sequence connection shall be replaced after cutting off the power.

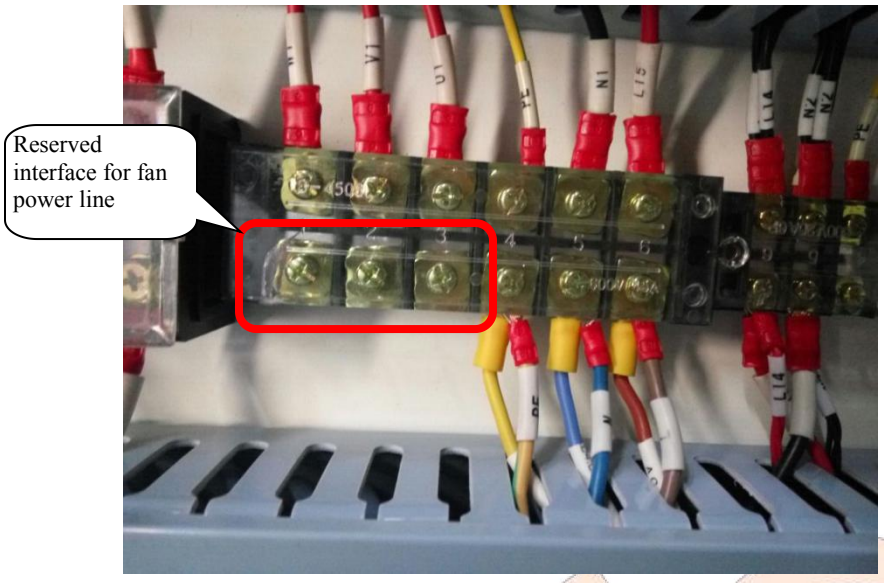

Figure 2-8 Connection Position for Fan Power Line

2.3.5 Connection of other circuits

Specially customized machine may be equipped with some additional functions to ensure its normal functions, for which, the connections are also needed, such lines are also marked with labels, and the connection shall be conducted according to the labels. In case of any connection question, please contact our company.

2.3.6 Circuit connection of main power of the machine

It is necessary to ensure that the machine can be powered on only after all the pipes, lines and components are connected.

In addition to I series, the main power line of the machine is a five-core cable (Figure 2-9), including the black grounding line, blue zero line and phase lines in other three colors (yellow, green and red). The main power line of I series is a three-core cable, including fire line, zero line and grounding line. All cables are marked with labels, please conduct the connection based on line No.

Figure 2-9 Main Power Line

2.3.7 Notes for electricity safety

It is necessary to ensure that the voltage of all equipment complies with the machine requirements, the power line is firmly fixed with the short circuit switch to avoid the equipment damage resulted from the power phase shortage.

The shell of each equipment shall be grounded to avoid the static electricity damaging the equipment electrical components, as well as prevent personal injury on operating personnel in case of electric leakage resulted from circuit damage.

The power shall be cut off and the operator shall wait for a period of time when maintaining and replacing the electrical component, and hot line work is strictly prohibited.

The dust on circuit breaker, transformer and connection plate shall be cleaned regularly to prevent the current from breaking through the dust and resulting in equipment damage.

The power supply shall be cut off after completing the work.

Chapter III Start-up Test Run

3.1 Knowing various switches on the machine

The switch is set on the control cabinet as shown in Figure 3-1, the appearances of which may be different due to different batches, and functions are shown briefly as follows:

Main switch of the machine: When the main switch is closed after connecting the machine power line properly, other switches can work corresponsively.

Switch of water chiller and laser source: After the switch of water chiller and laser source are closed, the water chiller and laser source will be prepared to work.

Computer switch: The control panel of height-adjustment device will light on after closing the switch, and the computer controlling the machine will start by clicking the start-up key on the computer host.

Control panel of height-adjustment device: It is used to calibrate the sheet metal to stabilize the cutting procedures, and this panel shall be displayed at the control software.

Emergency button: The machine will stop operating by pressing this button in process of movement to prevent danger happening. For safer operation, there is another emergency button at the bottom right of the displayer, and in normal operation, the two emergency buttons shall be in non-pressed button.

Switch of servo drive: Each axis of the machine will be prepared to work when this switch is closed.

USB port: USB port introduced from the computer host can facilitate the connecting with U-disk and other equipment.

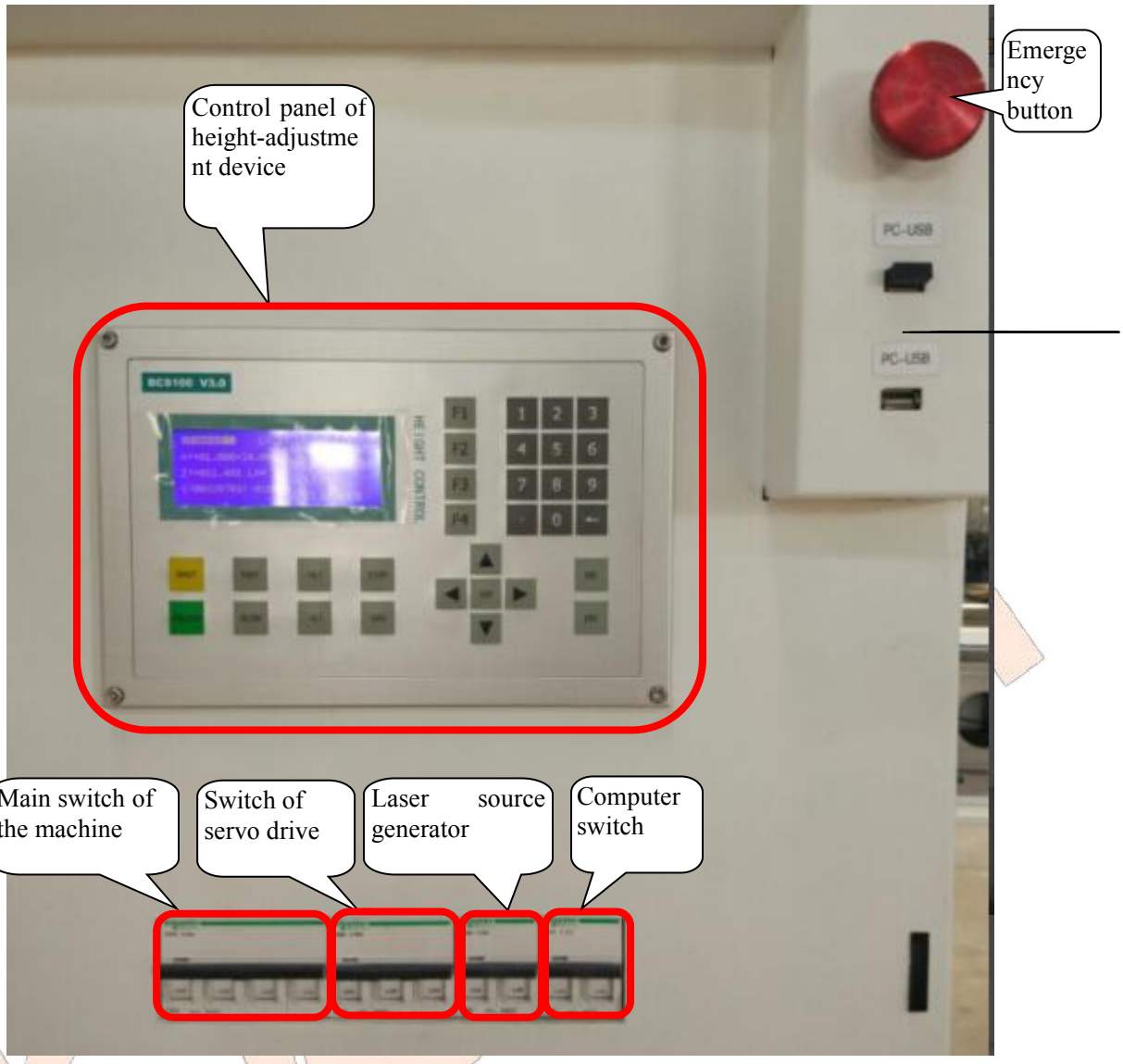

Figure 3-1 Schematic Diagram of Each Switch of Control Cabinet

Other switches are integrated to the software, which can be operated in CNC tab, and the display will be different of different models of machine. as shown in Figure 3-2.

Ejector: Action of pneumatic actuator and roller lifted for facilitating loading are controlled by the switch of butt material device.

Fans: Fan switch, click it to start the fan and enable the smoke evacuation and dedusting function.

Key and Laser on are used for the operation of laser source, which will be described below.

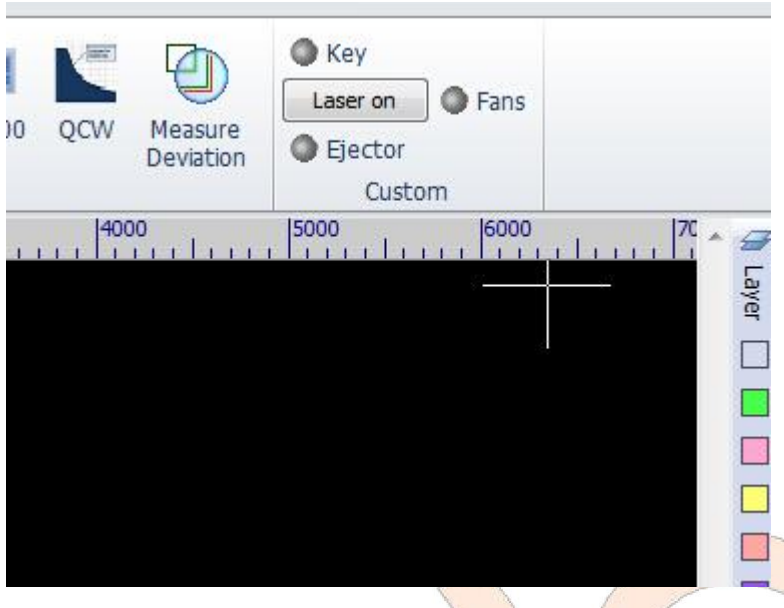

Figure 3-2 Buttons of CNC Tab

Notes: In case the line, gas circuit and water circuit are not connected or not connected properly, the above mentioned switches may be not functioning. In addition, the machine is equipped with remote control handle, and the key functions are shown as follows.

3.2 Checking whether the moving components operate normally

Please ensure that connections of water circuit, gas circuit and electric circuit are completed and its tightening ring, connector, terminal, switches are connected firmly and reliably. Close the main switch of the machine, then close the computer switch, click the start-up button on the computer host to start the machine, press the switch button on the servo drive (or close the servo drive switch on the control cabinet), open the software controlling the machine (in case of any prompt of returning origin, please cancel). Test whether the machine can move dolly and normally and whether Z axis can move vertically and normally as shown in Figure 3-3. For pipe cutting machine, the rotation of pipe clamping part shall also be tested. In case the machine is provided with other additional functions, the test shall also be conducted.

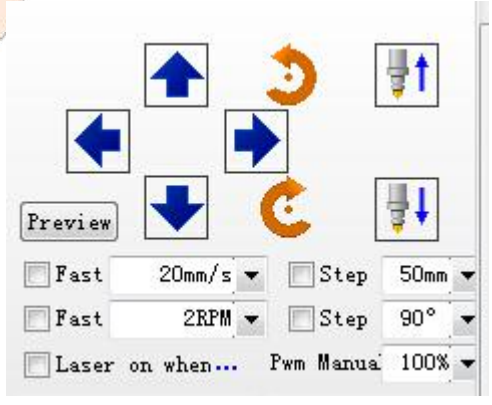

Figure 3-3 Position Controlling Action in the Software

In case of any alarm concerning Z axis at the software interface, it shall be solved by calibration, and the calibration method can be referred to in Section 4.3.

I series machines or machines with outer cover are provided with cover opening protection function,

and the action test shall be conducted after making sure that the upper cover and outer shield are closed.

In case of any other alarm, please find the position may have problems according to the alarm content, and in case of failure to solve it, please contact our company.

After all actions are normal, click Go Origin on CNC tab to conduct one operation of returning to origin; or re-start the software, in case of prompt of returning origin, please click "OK".

3.3 Checking the water circuit

Close the switch of water chiller and laser source on the control cabinet, turn on the switch button of the water chiller (due to different models of water chiller, it may need to click the start button on the panel after turning on the panel). At that time, the water chiller will start to work, each interface of the whole water circuit shall be viewed, and in case of any water leakage, the water chiller shall be closed immediately, and then the position leaking water shall be repaired. The test shall be conducted after repair, until the water leakage is stopped.

3.4 Checking the gas circuit

Firstly, make sure that there is relative gas in the gas supply device, and check whether each gas circuit and interface are connected. Open the switch of gas supply device, turn on the switches on the oxygen gauge and nitrogen gauge respectively. It is suggested to rotate the oxygen gauge between 0.3-1.0Mpa and rotate the nitrogen gauge between 1.5-2.7Mpa; in case of any gas leakage voice, it is necessary to find the position and solve the gas leakage phenomenon.

After ensuring no gas leakage, click "Puff" in the operation software to view whether there is any gas release and then click "Puff" to view whether the gas release is stopped as shown in Figure 3-4. Replace another gas (button at right side of "Puff"), click "Puff" to view whether there is any gas release and then click "Puff" to view whether the gas is stopped. Any abnormity shall be resolved.

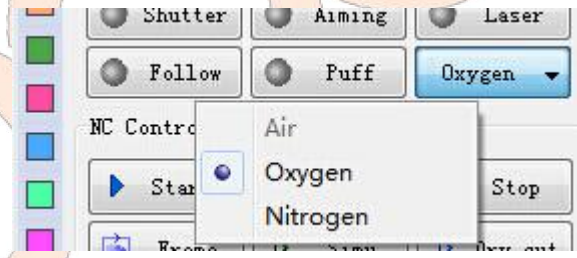

Figure 3-4 Position Testing Gas in Software

After connecting compressed air to the dyad (a dyad can be seen after opening the back cover, as shown in Figure 2-2), and press the butt material button (or butt material button at the CNC interface) to test the butt material device of sheet metal cutting machine. In case the machine is equipped with other pneumatic actuator, it shall be tested together.

3.5 Laser generation

In general, water chiller shall be started firstly and then the laser source shall be started. When the water chiller and laser source are prepared to work, turn on the switch button on the water chiller, and after the water is normally supplied, turn on the key switch and button switch of the laser source. Please note the following points for alarm: 1. When the water temperature is low, the laser source shall be turned on after the water temperature is up to 20℃. 2. Due to different models of water chiller, it may need to click the start button on the panel after turning on the panel to start the water chiller. 3. The operation methods will be different due to different powers, brands and types of laser source. For example, there is no button on 500W-1000W IPG laser source, its key switch and switch

button are integrated to the operation software. Furthermore, it is necessary to firstly open the key switch of laser source or rotate the handle switch for the laser source with larger power to enable the dehumidification device of laser source to work for ten minutes, and then open the water chiller to operate it to a certain temperature, then enable the laser source to make laser generation.

In case IPG laser source under 1000W is adopted, click the CNC tab before laser generation, then click "Key" (at this time, the POWER instruction light on the laser source panel will be on), click "Laser on" after three seconds (at this time, PS ACTIVE indicator light on the laser source panel will be on), click "Aiming", you will find the indicator red light under the cutting head nozzle. At this time, click "Laser" button, laser will be released under the nozzle (meanwhile, EMISSION indicator and laser generation indicator light on the laser source panel will be on), as shown in following figures.

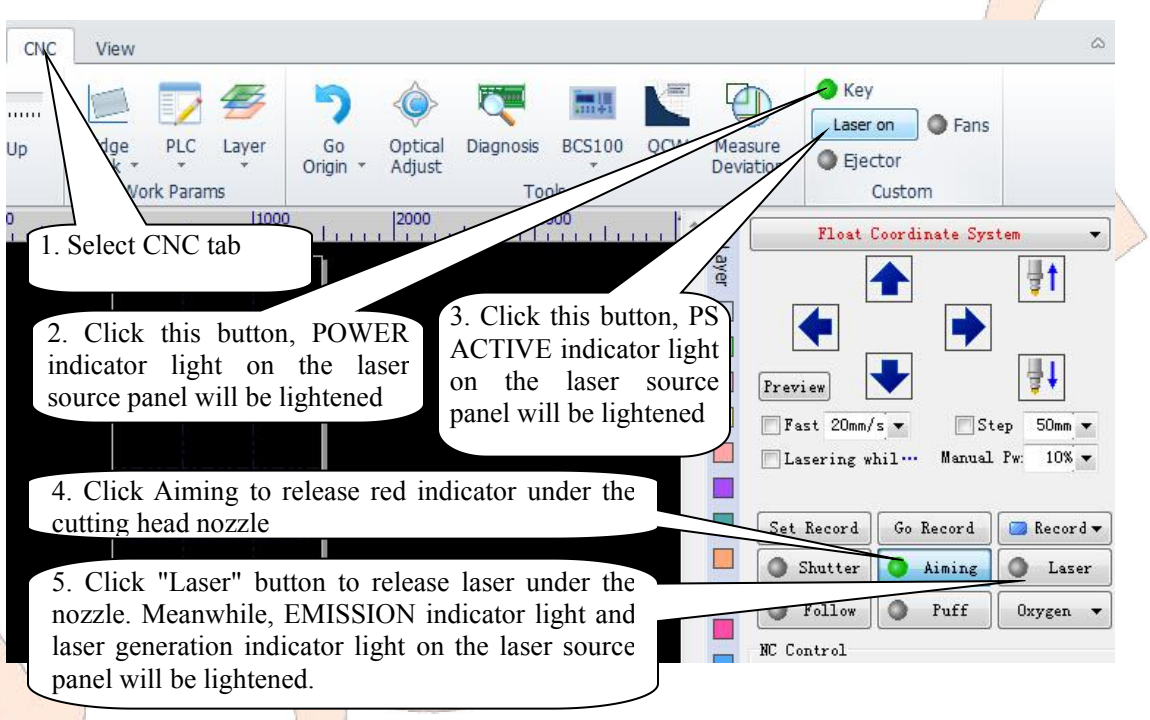

Figure 3-5 Position Controlling Laser in the Software

Figure 3-6 IPG laser source Panel

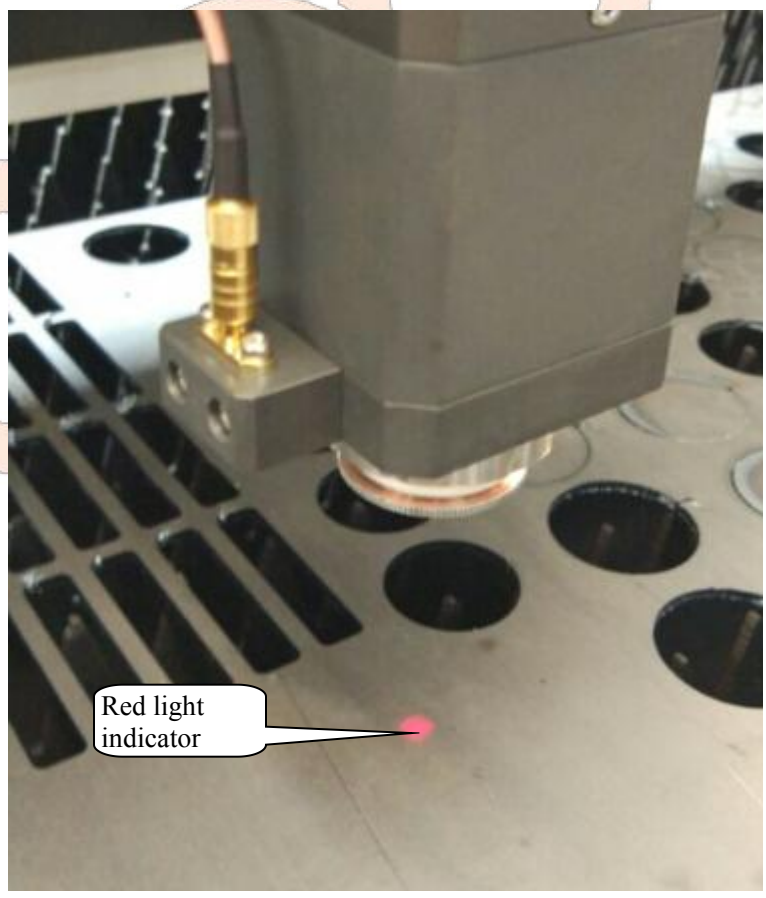

Figure 3-7 Red Light Release under the Laser Cutting Head

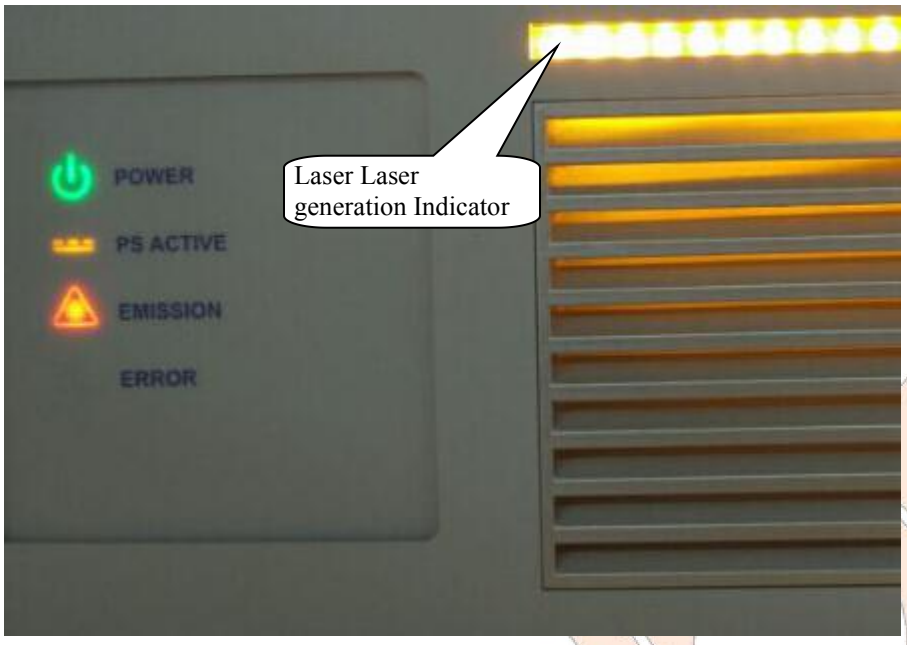

Figure 3-8 Panel Display in IPG laser source Laser generation

Notes: The laser source laser generation method is similar to laser sources of other brands and models, and some of them are easier. For example, it needs to wait for a few seconds after turning on the key switch of MAX laser source under 1000W and then click START; in case of any red instructor release, "Laser" button shall be clicked in the software and the laser will be released under nozzle. Furthermore, for some laser sources, after turning on the key switch (or turning the key switch to REM position) and clicking START (or not to click), it is necessary to click "Shttur" in the software and then click Aiming and Laser buttons.

Due to various brands and models of laser source, other operations will not list in details, in case of any unknown issues, please contact our company.

3.6 Start-up and shut-down procedures

This chapter introduces preparatory works before the operation, the start-up procedure of each component does not have any strict requirements, and the recommended procedures are: host and operation software → gas supply device → water chiller → laser source.

The recommended machine shutdown procedures are:

1. Close the gas supply device after completing the processing, and click "Puff" separately to release the gas from the gas line.

2. Paste adhesive tapes under the cutting head nozzle to avoid the dust in the air entering the cutting head.

3. Move X axis and Y axis to the middle of machine tool to prevent drive shaft from affecting the cutting precision due to the gravity deformation.

4. Turn off the switch on the laser and then cut off the power supply.

5. Turn off the switch on the water chiller and then cut off the power supply.

6. Close the control software and shut the computer host down.

7. View the surrounding environment conditions of the machine tool to check whether there is kindling or high temperature object to prevent from fire and eliminate the safety danger.

Chapter IV Operation Steps for Sheet Metal Processing

4.1 Laser cutting process principle

Laser cutting is an advanced cutting process widely used in the material processing. Laser beam with high energy density is adopted as "cutting tool" to conduct hot cutting process on the materials. Laser cutting technology is adopted to cut various metals, non-metal sheet and composite materials, which is widely used in various field.

4.1.1 Laser cutting principle

Laser cutting refers to using the focused laser beam radiating the work piece to melt, carburate and ablate the materials or enable the materials to reach fire point, and meanwhile, high-speed stream with same axis as the light beam is adopted to remove the molten material and achieve the cutting works. Laser cutting is one of heat cutting methods.

4.1.2 Main mode of laser cutting

1. Laser-melting cutting

Laser-melting cutting refers to using the laser heating to melt the metal materials, and jetting the non-oxidizing gas (N2, Air, etc.) through the nozzle with same axis as the light beam and eliminating the liquid metal depending on the strong pressure to form a kerf.

2. Laser oxygen cutting

The principles of laser oxygen cutting is similar to oxyacetylene cutting, for which, the laser is used as the preheated heating source, and oxygen and other active gases can be used as assisted gas. On one hand, the ejected gas will oxidize with metal, releasing abundant oxidation heat; On the other hand, the melted oxide and the melt will be blown out from the reaction area, and the kerf will be formed in the metal.

Laser oxygen cutting is mainly used for metal materials easily oxidized, such as carbon steel. It can also be used for processing such materials as stainless steel, but it will result in a black and rough cross section, and the cost of which is lower than that of inert gas.

4.1.3 Features of laser cutting

The laser cutting features quick cutting speed and high quality compared with other cutting methods, which can be summarized as follows:

1. The laser cutting can achieve a good cutting quality due to its small laser spot, high quality density and quick cutting speed.

2. The incision is narrow, both sides of the kerf is in parallel with proper perpendicularity over the surface, and the size precision of cutting parts is high. The cutting surface is smooth, clean and nice-looking, even it can be the last processing procedure without any machining, and the parts can

be used directly.

3. The heat affected zone width of the material is small after laser cutting, the material performance near the cutting position will be hardly affected, and the work piece will have small deformation and high cutting precision.

4. Quick cutting speed and high work efficiency.

5. In non-contact cutting, the nozzle will not contact the work piece when conduct the laser cutting, the tool wearing can hardly exist.

4.1.4 Process analysis of laser cutting

Laser cutting is a process combined melting with vaporization, and there are factors affecting the cutting quality; in addition to the process parameters of the machine tool and process materials, other factors are summarized as follows:

1.For selection of internal and external cutting, the internal or external hole position of the sheet metal will be determined according to the actual condition.

2.Selection of line leading mode, angle and length.

3.The material use ratio and proper setting of part distance and sheet metal spacing from heat effect.

4.The selection of processing route by heat deformation shall be taken into consideration.

5.Proper application of micro circular arc chamfering.

The experience shall be concluded based on actual production conditions and the optimum process shall be selected based on the work pieces and parts processed.

4.2 Dimming at the nozzle

4.2.1 Nozzle action

The air flow condition will be different based on different nozzle design, which will affect the cutting quality directly. The main functions of nozzle include:

1. Avoiding such sundries as cutting fused stains bouncing upwards and entering the cutting head to damage the lens.

2. The nozzle can ensure that the ejected gas is more concentrated, and can control the area and size of gas diffusion to make a higher quality.

4.2.2 Influence from nozzle on cutting quality and nozzle selection

1. Relations between nozzle and cutting quality: The cutting quality will be affected when the nozzle has any deformation or residue. Therefore, the nozzle shall be placed carefully without bumping; The residue on nozzle shall timely cleaned. A higher precision requirement is necessary for nozzle manufacturing, and the nozzle shall be replaced timely due to poor quality resulted from the nozzle quality in itself.

2. Selection of nozzle

In general, when the nozzle diameter is small, the gas velocity is high, and the molten materials eliminating ability is strong, suitable for thin plate cutting, by which, the fine cutting section can be achieved. When the nozzle diameter is large, the gas velocity is low and the molten materials eliminating ability is poor, suitable for cutting thick plate with a low speed. In case a nozzle with a larger hole diameter is used to cut the thin sheet rapidly, the residue produced may be spattered

upwards, damaging the protection lens.

In addition, the nozzle can be divided into composite and single-layer nozzles (as shown in Figure 4-1), and the composite nozzle is generally used to cut the carbon steel and the single-layer nozzle is used to cut the stainless steel.

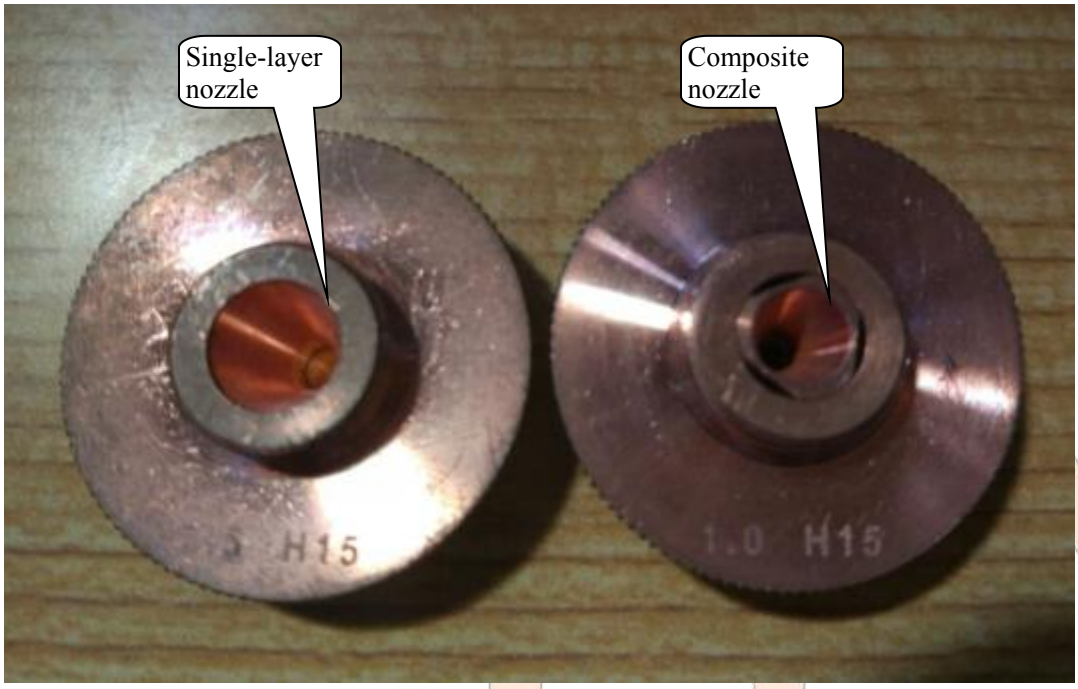

Figure 4-1 Single-layer Nozzle and Composite Nozzle

4.2.3 Concentric adjustment of laser and nozzle

The procedures for adjusting the laser passing through the nozzle center:

1. Open the software, move the cross beam and laser cutting head to proper position.

2. Paste the cellulose tape evenly to the end face of the nozzle with your thumb (as shown in Figure 4-2).

3. Set proper power in the software (about 10%), click "Laser" (or "Laser" button on the handle), the icon "⊙" will be displayed on the tape, take off the cellulose tape and note not to rotate its relative position. In case the light spot is not in the nozzle center, it is necessary to adjust knob on top of the cutting head to ensure the light spot is at the nozzle center. Repeat the above action until the hole in cellophane tape by laser overlaps with the nozzle center.

When the nozzle center is not concentric with the center of the laser, the impacts on cutting quality include: 1. Affecting the cutting section, the ejecting assisted gas will cause uneven gas, and inconformity qualities around the cutting section, even irregular cutting. 2. Affecting angle quality, partial over-melted phenomenon will occur when cutting small work pieces with sharp angle or small angle, cutting plate; sharp corners may not be achieved when cutting the thick plate. 3. In case the perforation is not stable, over-melted phenomenon may occur when perforating the thick plate and the time perforation time is hard to control. The concentricity of nozzle center and the laser is one of the important factors of cutting quality, especially cutting the thick work piece, its effect is even greater. Thus the concentricity of nozzle center and laser shall be adjusted to achieve better

cutting section.

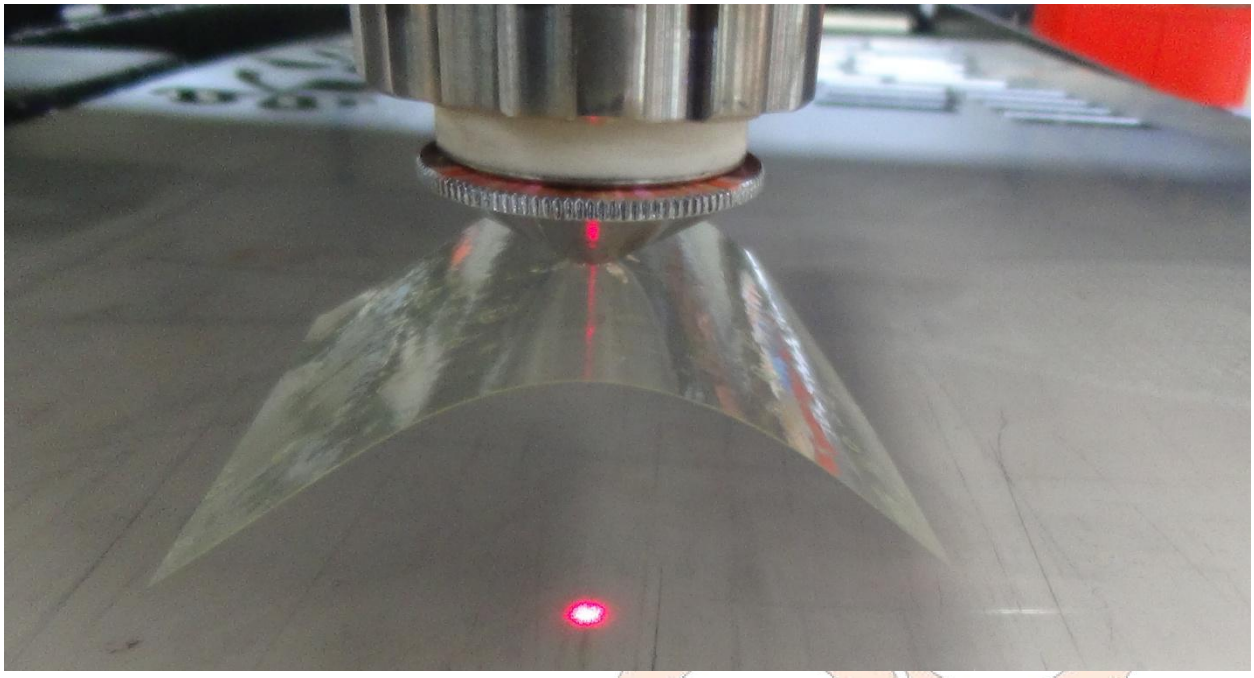

Figure 4-2 Schematic Diagram of Dimming Method

4.2.4 Adjustment of light beam focus

During the laser cutting, the relative location of beam focus and cutting sheet metal surface has a large effect on cutting quality, and it is very important to adjust the focus position. This laser cutting machine is equipped with automatic following adjustment device with high precision; the numerical control system will automatically adjust the distance of the end face under the nozzle from the sheet metal when changing the plate height to ensure the constant height from the nozzle to the plate surface and constant position of the focus.

The precise screw lift focus box will be adopted for focusing mechanism of focus lens to realize the focus adjustment, featuring self-locking capability and fine focusing function.

Focusing hand wheel is equipped with focusing module, 20 halving tick marks are made along the peripheral direction (as shown in Figure 4-3), the focus lens will lift or decline for 0.05mm for one tick mark rotation, and the focusing lens will lift or decline 1mm vertically when rotate one circle. 0 scale is located near the nozzle, -5 means that the focus will stick 5mm out from the nozzle, and +5 means that the focus retracted 5mm at the focus.

Figure 4-3 Focusing Device of Laser Head

The relation between focus position and cutting materials and sections is listed in the following table

Name and location of focus	Cutting material and section features
Zero focus: laser focus is located on the upper surface of the sheet metal	It is used in sheet cutting. The upper cutting surface is smooth and lower surface is not smooth.
Positive focus: laser focus is located on the upper surface of the sheet metal	Operation method of the carbon steel plate. The focus is on the surface, thus the smooth surface range is quite large, the kerf is wider than the kerf of zero focal length, the gas flow is quite large in cutting and the perforation time is longer than that of zero focus.
Negative focus: laser focus is located below the upper surface of the sheet metal	Application of stainless steel, copper plate and aluminium plate. HP nitrogen is used to cutting the stainless steel to facilitate the molten slag protection section, and the kerf will be widened with the work piece thickening.

4.3 Calibration

Place the sheet metal on the cutting table, move the cutting head above the sheet metal by software and handle operation, select CNC tab to click BCS100 icon, and click [F1]CALIBRATE with a mouse at the dialog box, and then click [2]CAPACITANCE CALIBRATION as shown in Figure 4-4. Click the down arrow to move the laser head to the position about 5mm-10mm above the sheet metal, and click Enter as shown in Figure 4-5; click to store after completing the calibration

(stability and smoothness are above Good), click to store it and close BCS100 interface after the calibration. Click "Follow" and test whether the following is normal.

Figure 4-4 Initial Calibration Interface

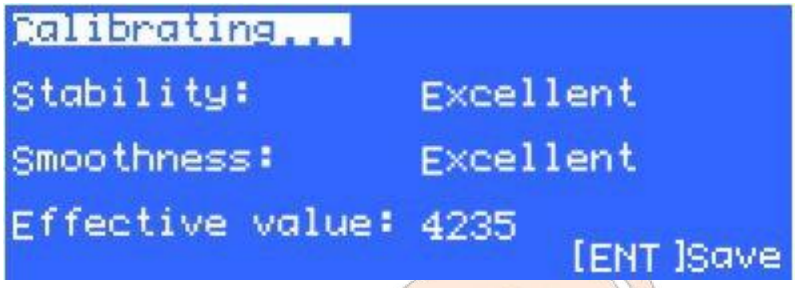

Figure 4-5 Calibration Interface

It is suggested to conduct a calibration operation after each start-up and sheet metal replacement.

4.4 Cutting process

4.4.1 Drawing or importing the graphic data

Cyp cut is equipped with easy drawing functions, which requires that the operating personnel shall be equipped with drawing ability, which will not be stated repeatedly. In addition to the build-in functions, files in such forms as dxf, ai and plt can be imported into the software, as shown in following figure.

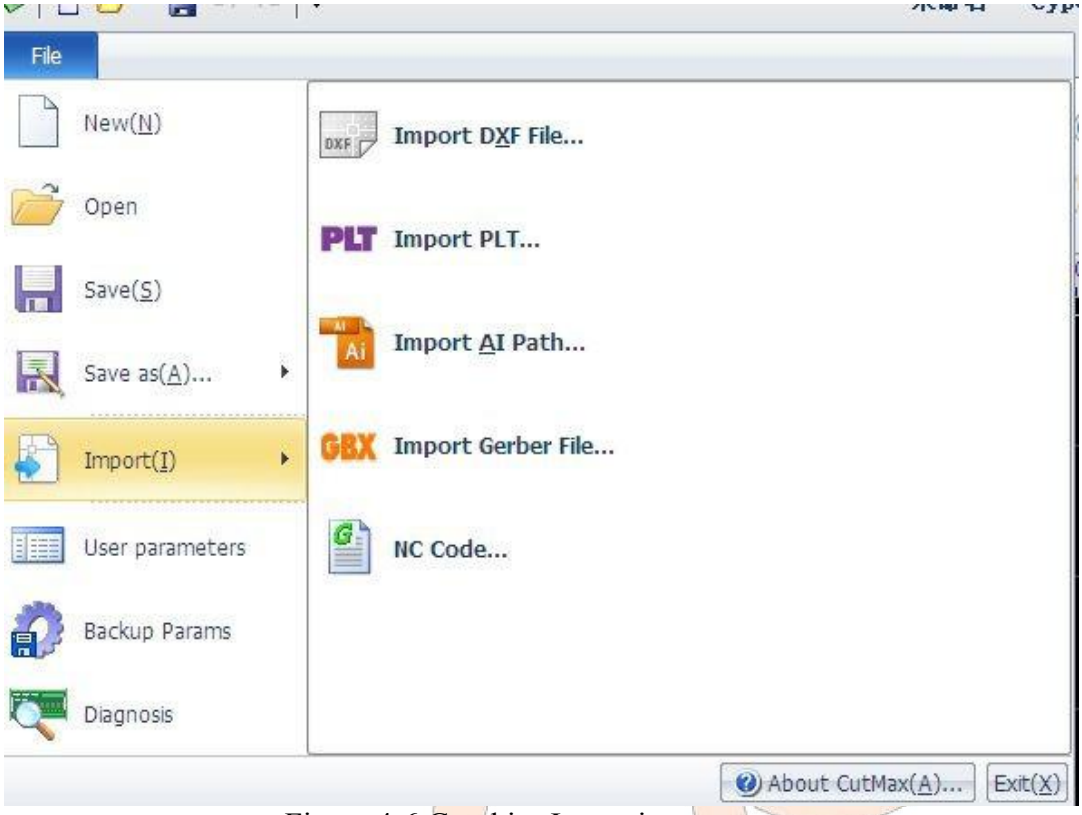

Figure 4-6 Graphics Importing

4.4.2 Checking the graphics

After drawing and introducing the graphics, please check whether the graphics have any error or whether there is any unnecessary graphics. Draw tab (Figure 4-7) is provided with consolidation and connection line, repetition removal line, small graphics removal and other operations, in case the graphics are complex, please try to use such functions. Sometimes, the graphics imported may have size error, thus it is also to check whether its size is wrong, if any, please correct it.

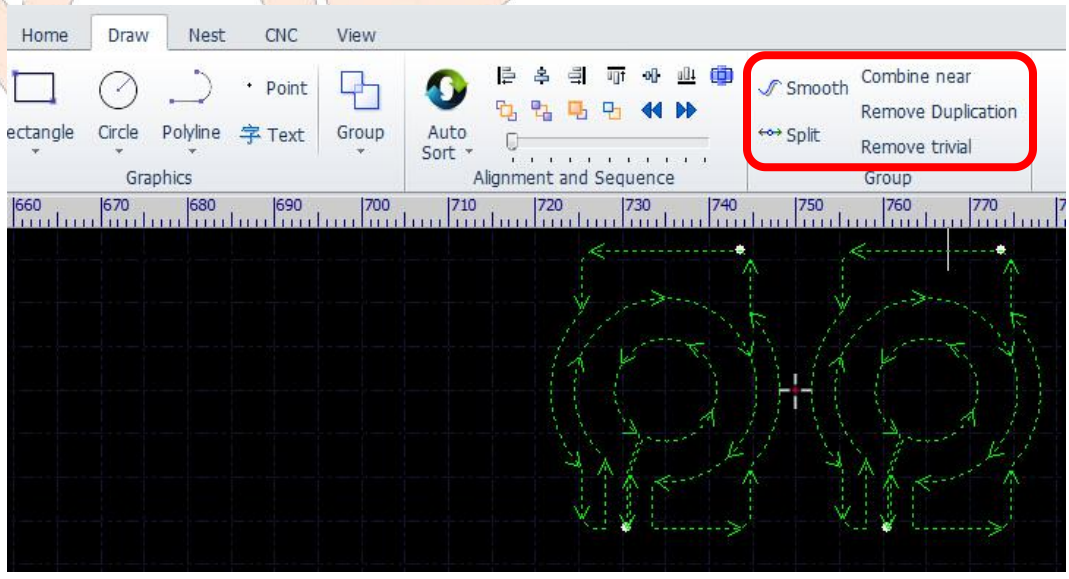

Figure 4-7 Checking Whether the Graphics Are Correct

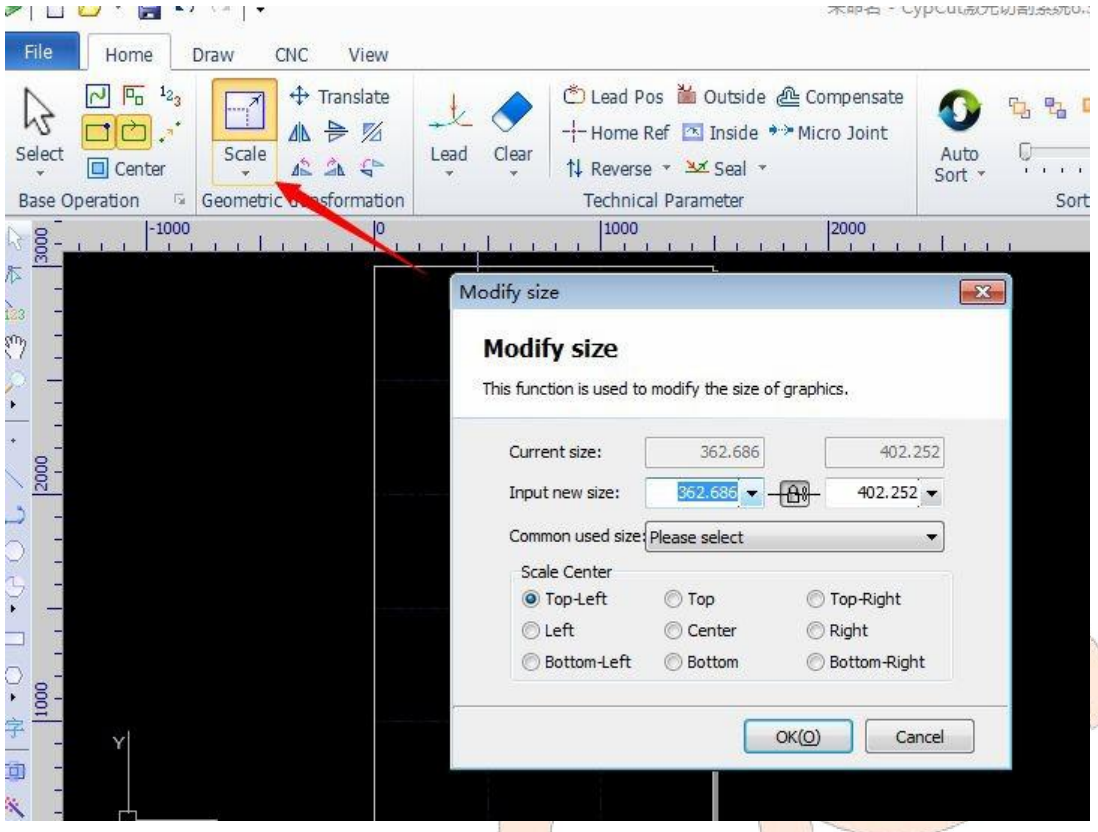

Figure 4-8 Checking Graphics Size

4.4.3 Setting process parameters

1. Setting lead-in and lead-out lines

It is suggested only to set lead-in line. In case that you are not satisfied with lead-in line automatically set, please click Outer or innter to change its lead-in direction after selecting the closed line. Click Lead Pos, and click proper position to change its cutting start point. Click Reverse to change its processing direction.

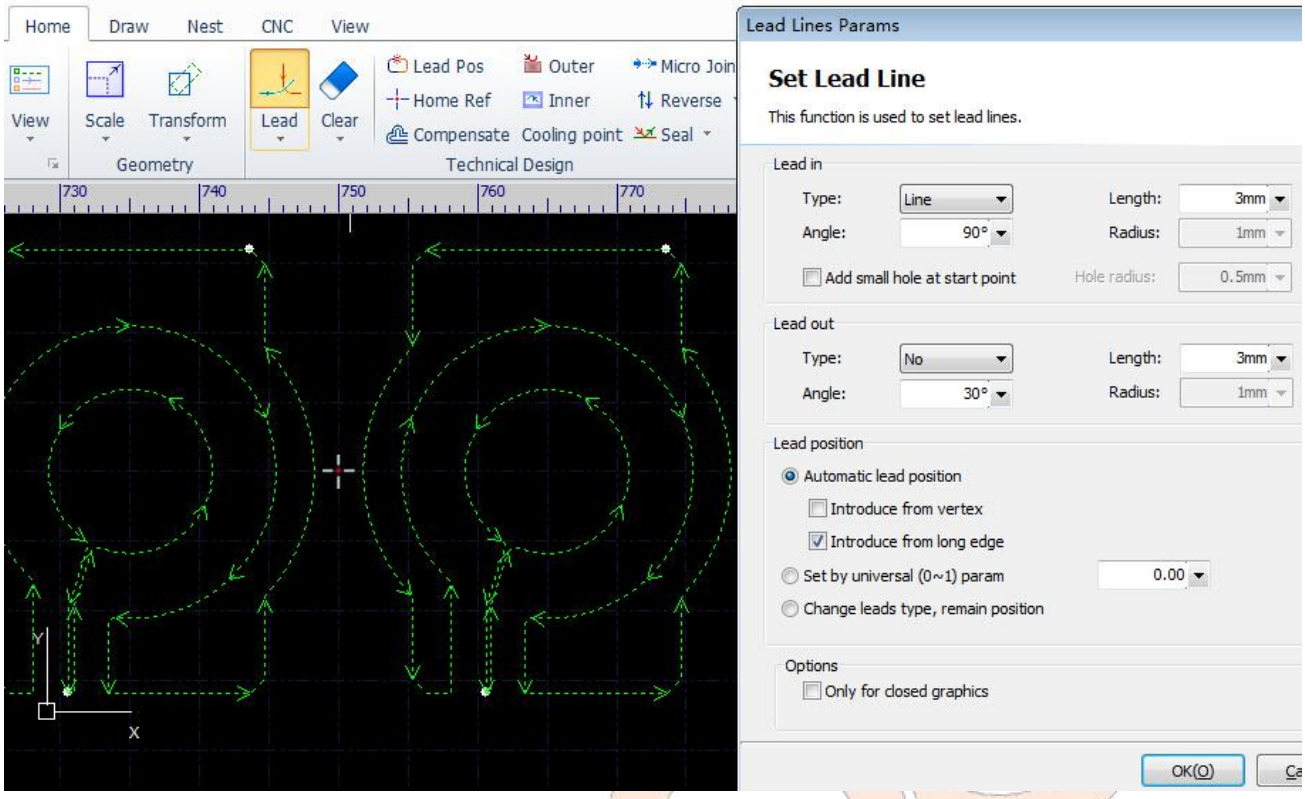

Figure 4-9 Lead-in Line Setting

2. Sorting

When the graphics is complex, it is suggested to click O-icon after selecting one ordering rule and then conduct sorting. Click "Simu" to simulate the cutting route in the software, if the route procedures are not proper, please change the sorting rules.

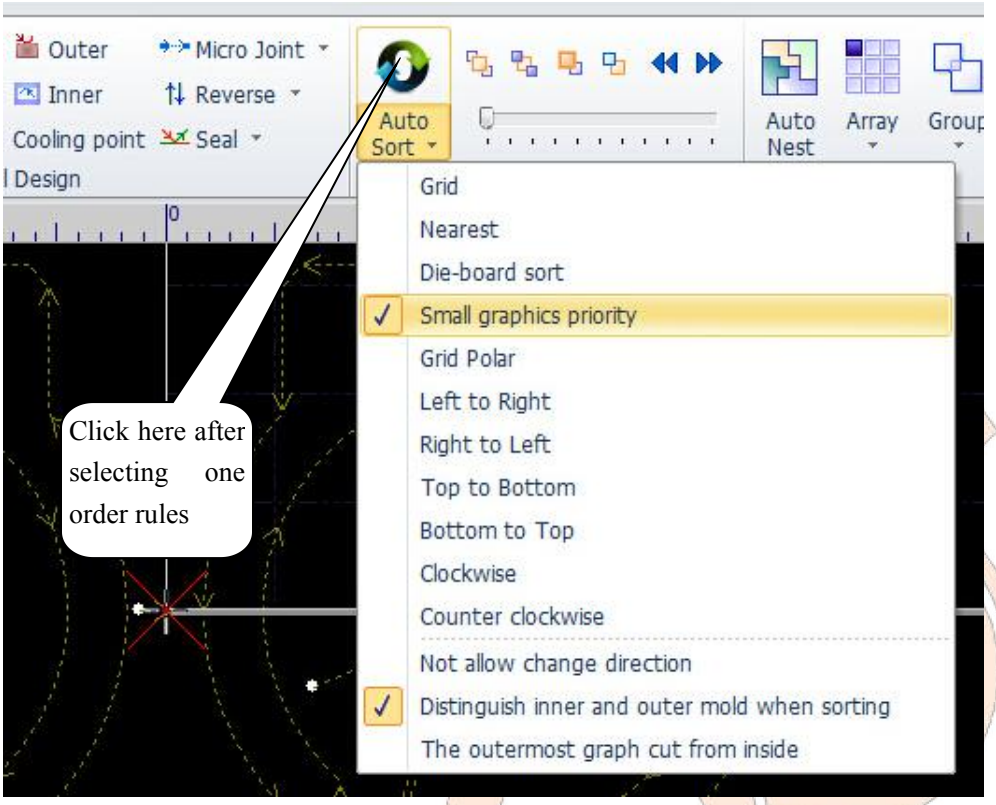

Figure 4-10 Sorting Method

3. Setting cutting parameters

Click "layer", and setting proper cutting parameters at the popping dialog box. Several sets of cutting parameters are saved in the machine when shipping by our company, click "Load" and select proper item to call the parameters. The parameters called are only for reference, and the operating personnel shall conduct tests based on actual condition to achieve more proper parameters.

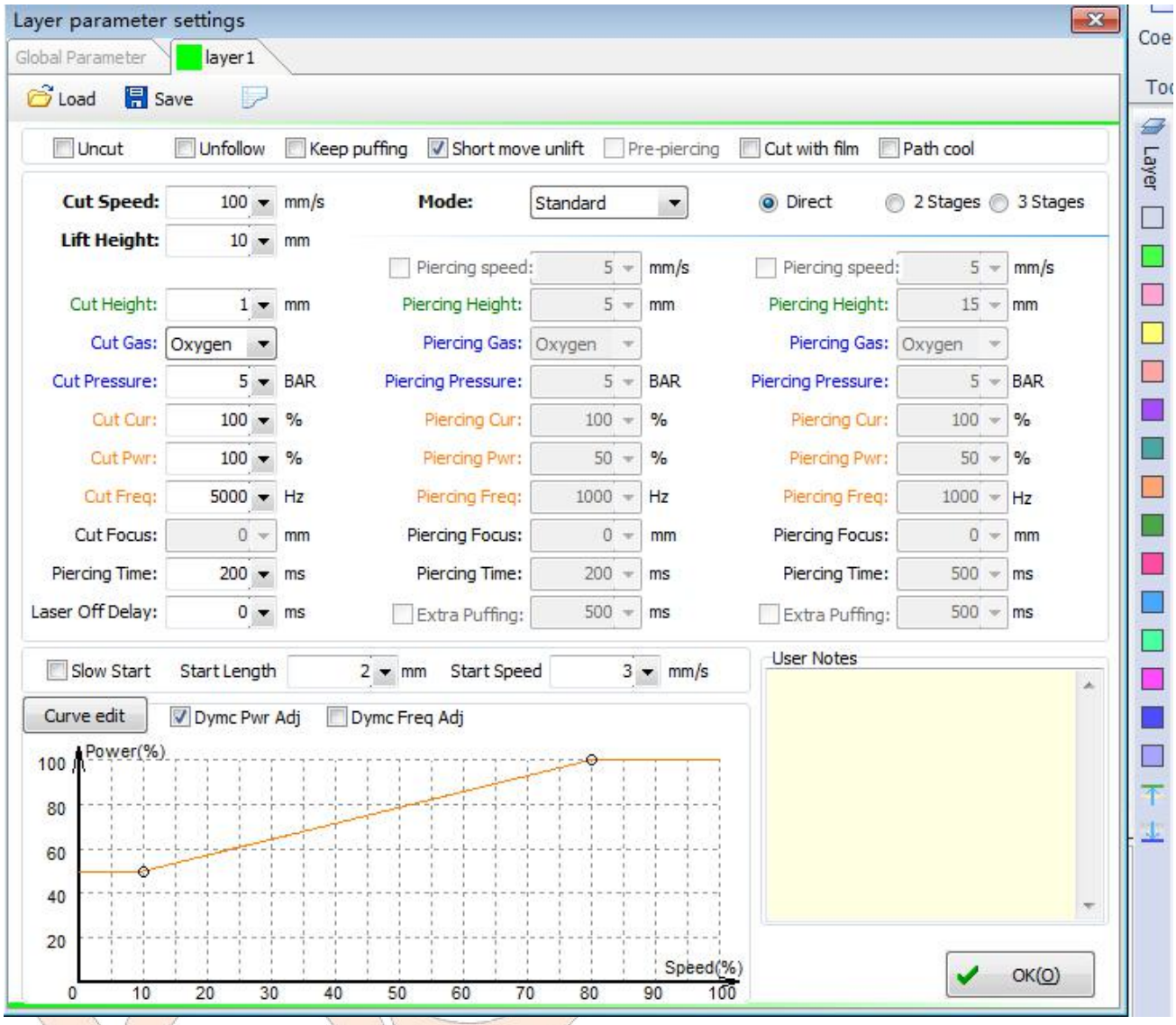

Figure 4-11 Parameter Setting Interface

4. Focal length adjustment

Adjust the focal length based on material thickness, as shown in Section 4.2.4 and the following figure.

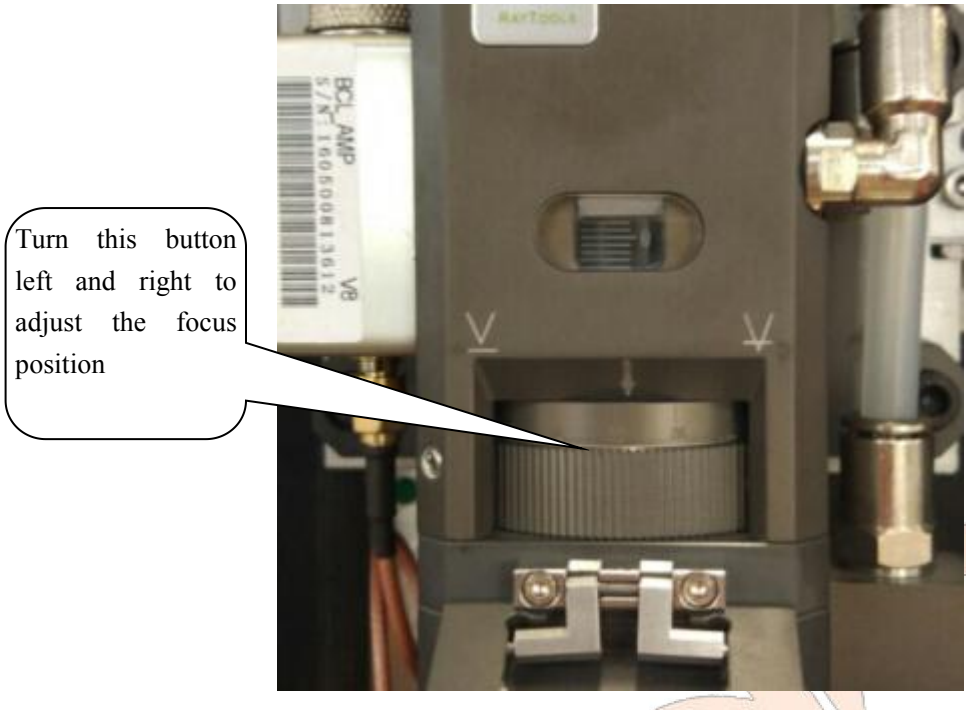

Figure 4-12 Setting Proper Focal Length

5. Select the proper position and move it along the frame

Click "Home Ref", and select the proper laser head stop position. Move the laser cutting head to proper position, click "Frame" and test whether the test from is correct. Click "Dry cut" and the machine will conduct dry running without laser generation cutting, and it is not a must to press this button to save time.

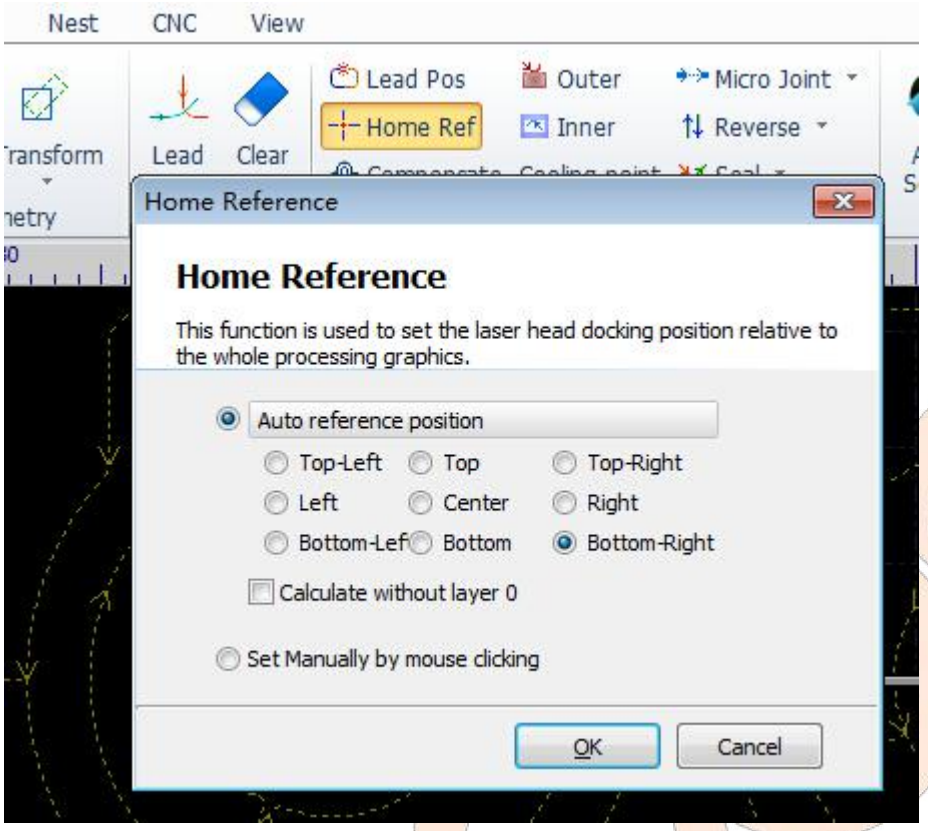

Figure 4-13 Setting Stop Position of Laser Head

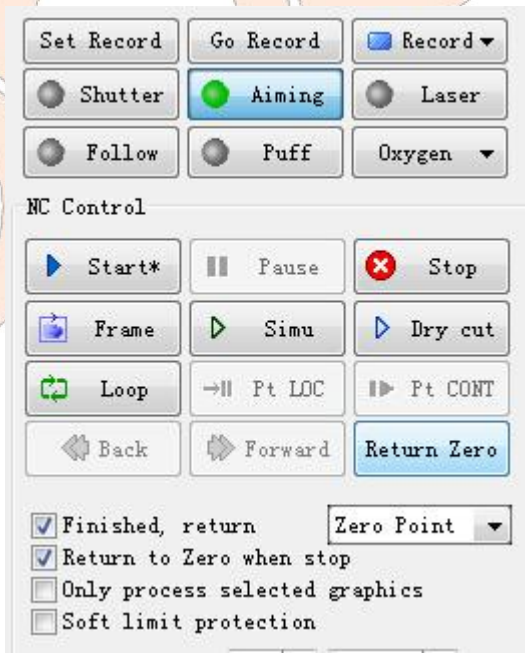

Figure 4-14 Motion Control Panel

Notes: Before starting processing, it is necessary to determine that the work piece graphics can be operated within the scope of sheet metal to prevent the laser cutting head lowers outside the sheet metal, bump to the blade and result in laser cutting damage after starting the cutting work.

6. Cutting

Click "Follow" and "Puff", test whether the following and blowing are normal and click "Start" to start the cutting work after ensure the safety. Please note not to be scalded when viewing whether cutting sample parts meet the requirements.

Notes: The operating personnel can find the optimum parameters (velocity, air pressure, focal length, etc.) through multiple tests, improving the work piece quality and work efficiency. It is suggested to save the found parameters, record the focal length when naming and the same parameters can be called for used when processing the same materials next time. The operation software is equipped with stronger function, the capable operating personnel can conduct self-exploration ensuring the safety, making your work more efficient.

4.4.4 Factors influencing cutting principles

1. The distance from nozzle to work piece is as shown in Figure 4-15; too short distance will result in collision of sheet metal and nozzle, and too long distance will result in gas diffusion, causing many residues at the cutting bottom surface.

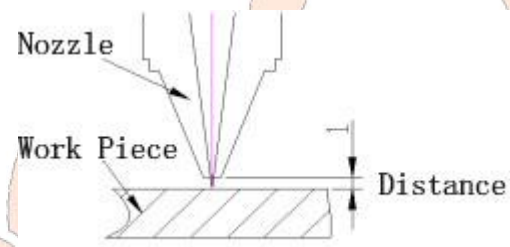

Figure 4-15 Distance Schematic Diagram of Nozzle and Work Piece

The distance from the nozzle to the work piece can be set in 

layer interface, and distance between 0.5-1.5mm is recommended.

2. Cutting speed

The feed speed can be judged from the cutting spark, the sparks will be diffused downwards in normal cutting, and when the speed is too high, the sparks will be banked; In case the sparks are not diffused, but gathered together, it indicates that the feeding speed is too low. As shown in Figure 4-16, the cutting surface of a cutting speed will present a stable line, and no residue will be generated at bottom half.

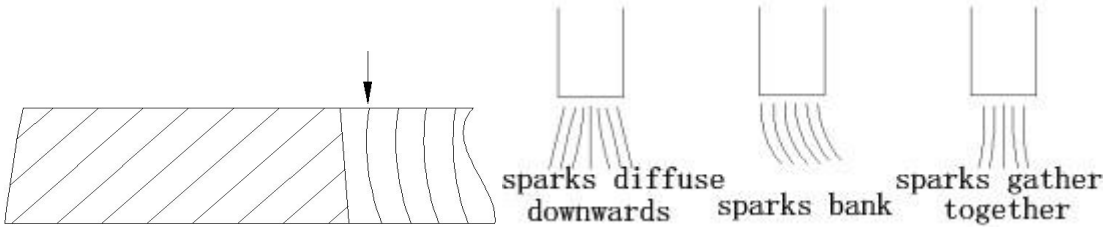

Figure 4-16 Cutting Section Schematic and Cutting Spark Effect Diagram

Influence of too high speed on cutting quality: 1. May give rise to cutting failure with sparks all around. 2. Some areas can be cut off while others cannot. 3. The cutting section is rough. 4. Many residues. It is shown in Figure 4-17.

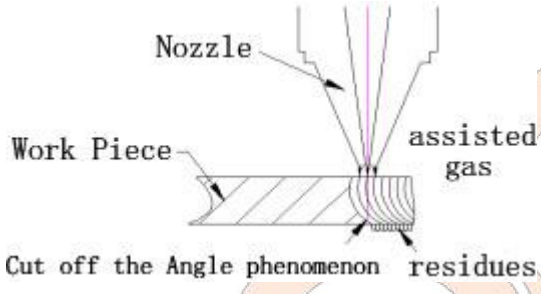

Figure 4-17 Cutting Effect Diagram

Influence of too low speed on cutting quality: 1. May lead to over-melted sheet metal and rougher cutting fracture surface. 2. The kerf will be wider to lower the cutting precision, and the small rounded corner or sharp corners may be melted. 3. Low cutting efficiency influences production capacity.

3. Gas and pressure

The assisted gas will be different in laser cutting based on the different materials. The functions of assisted gas mainly include: helping to combust, heat dissipation, blowing off the molten stains generated during cutting, preventing the residue popping upwards to entering the nozzle and protecting focusing lens. When cutting pressure is insufficient, the cutting speed cannot be lifted, effecting production efficiency, generating more residues and affecting the cutting quality. Rough carbon steel section and wide kerf will be generated when the assisted gas pressure is too high; At the same time, the partial cutting section will be melted and the cutting quality will be affected.

In case the gas pressure for perforation, the laser will be hard to pass the sheet metal and the perforation time will be longer, causing lower production rate. Two high gas pressure will result in spark flying, the protection lens will be damaged, the breakthrough point will be over melted and the hole will be too large, affecting the cutting quality.

In general, the nitrogen is used to cut stainless steel, and oxygen is used to cut the carbon steel. The nitrogen pressure shall be increased for thicker material when cutting the stainless steel. The oxygen pressure shall be lower for thicker material when cutting the carbon steel.

Therefore, assisted gas selection and pressure setting for laser cutting shall be adjusted according to

actual conditions, and other parameters will be supported to ensure an optimum cutting effect.

4. Laser cutting power

The laser power also has effect on the quality of laser cutting, and 100% of cutting power is used to ensure a rapid cutting speed and work efficiency.

4.5 Introduction to remote control handle

For more convenient machine control, remote control handle is supported as shown in Figure 4-18, the key functions will be introduced one by one as follows.

Start: Start to work.

Pause: In case the machine is working or dry running, this key can be used to pause the operation. Click Start to continue to operate the machine.

Trace: It is similar to the Dry cut button functions at the software interface to enable the machine to be dry running without laser generation cutting.

Stop: In case the machine is working or dry running, this key can be used to stop the operation. Click Start to continue to start the machine again.

Figure 4-18 Remote Control Handle

Gas: It is similar to the puff button function in software interface, used to test whether the air blowing is normal.

Follow: Please ensure there is metal material under the laser head, this key can be used to open the following function of the laser cutting head.

Shutter: It is similar to Shutter key functions in the software.

Laser: When setting proper power in the software interface, the key can be clicked for laser generation. It is mainly used for dimming.

Back: click the key to move backward some distance after the machine stops. And then click Start, the machine can continue to move backward from the position.

Edge Seek: refer to automatic tracing-edge. If the sheet metal is put at a tilt when cutting plate, the control system can calculate its offset angle to use the materials effectively; if the operation is in mistake, it may damage the laser cutting head, so it is recommended to operate after correct setting in the software. First press the Fast key and then click Edge Seek when cutting pipe to seek the middle position of the pipe.

Zero: it is related to the "Home Ref" in the software interface, after setting the stop position of laser cutting head, click the key to make laser head return to the previous position in case the laser cutting head is moved (i.e. the stop position of laser cutting).

Forward: click the key to advance some distance after the machine stops. And then click Start, the machine can continue to move forward from the position.

Motion control area: control the side-to-side movement of X axis, front and back movement of Y axis, up and down movement of laser cutting head and anticlockwise or clockwise rotation of rotation axis.

Box: its function is same as that of Frame button in the software interface, and it shall operate one circle along the graphics frame to define the operating range.

Fast: first press the key and then click a certain key within the motion control area to make the axis move quickly. Its movement speed is the added speed when fast movement in the motion control area of the software interface, for example: 

Step: first press the key and then click a certain key within the motion control area to make the axis move step by step. Its step-by-step distance is the added distance when step-by-step movement in the motion control area of the software interface, for example: 

Notes: During the equipment processing, operating personnel shall hold the operation handle in hand all the time, not put the handle aside so that the operating personnel can press the key of "pause" or "stop" in emergency situation and it can avoid the unnecessary damage for operating

personnel and equipment.

Chapter V Introduction to Pipe Processing

5.1 Rotation center record

Similar to the sheet metal cutting, calibration is required for the pipe cutting, however, after completing the calibration, the automatic tracing-edge operation shall be operated and it can be completed by clicking "Edge Seek" on remote control handle. After completing the automatic tracing-edge operation, click "Save Rotate Center" in software to record the center position, as shown in Figure 5-1.

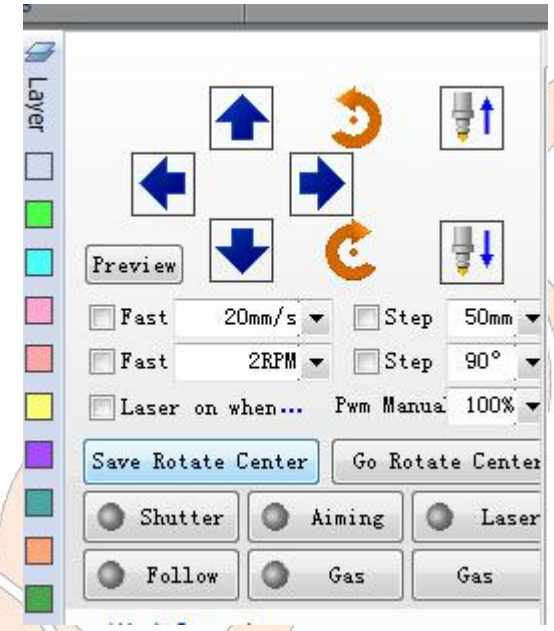

Figure 5-1 Rotation Center Record

5.2 Opening the graphics

Click OPEN to select the graph to be opened and Cyp tube supports 3D files in form of IGS. It shall select the proper tensile direction when opening the graph and select the outer wall contour line, as shown in Figure 5-2.

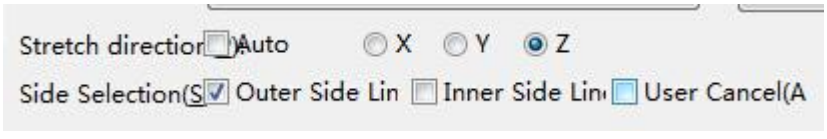

Figure 5-2 Select Proper Tensile Direction

5.3 Appropriate stop position selection

Under the tab of Home, click Home ref and select a proper stop position in the dialog box and it is recommended to select the farthest or nearest end, as shown in Figure 5-3.

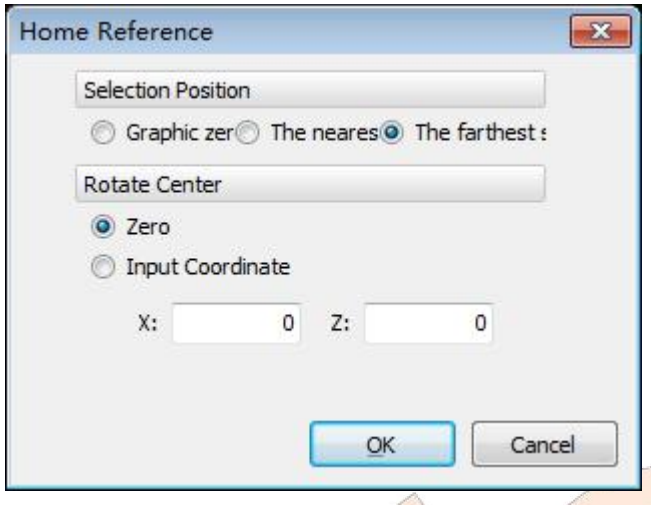

Figure 5-3 Appropriate Stop Position Selection

5.4 Other operations

Other operations are similar to these of the part of sheet metal processing and please refer to Section 4.4. For the installation and commissioning, it is strongly suggested that the operating personnel can come to the factory for learning or ask for assistance to your factory from the customer service staff of our company.

Chapter VI Basic Control Operation and Programming of RC Robot

6.1 Teach pendant

6.1.1 Keys of teach pendant

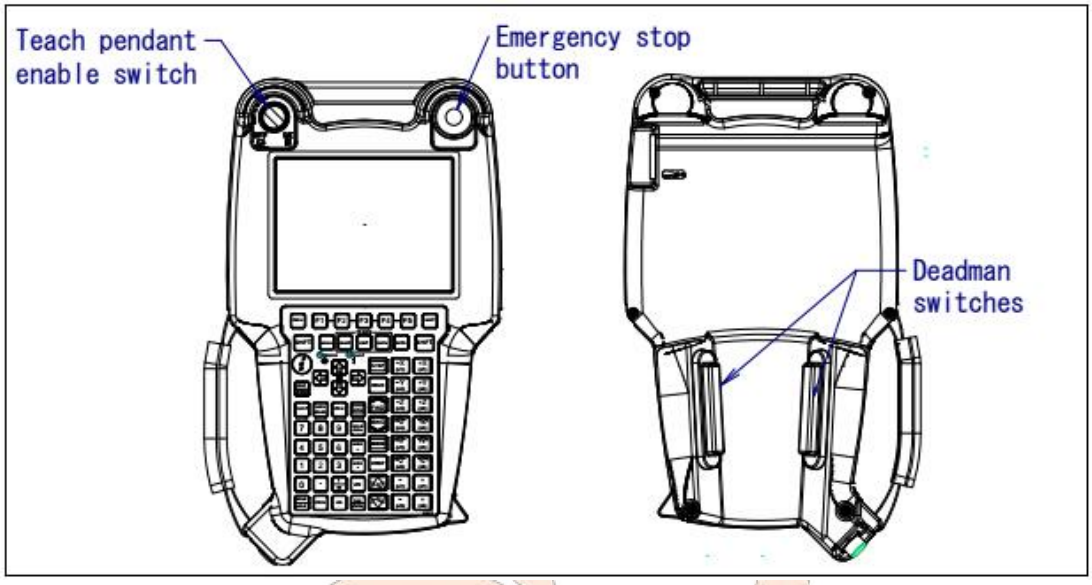

Figure 6-1 Switch of Teach Pendant

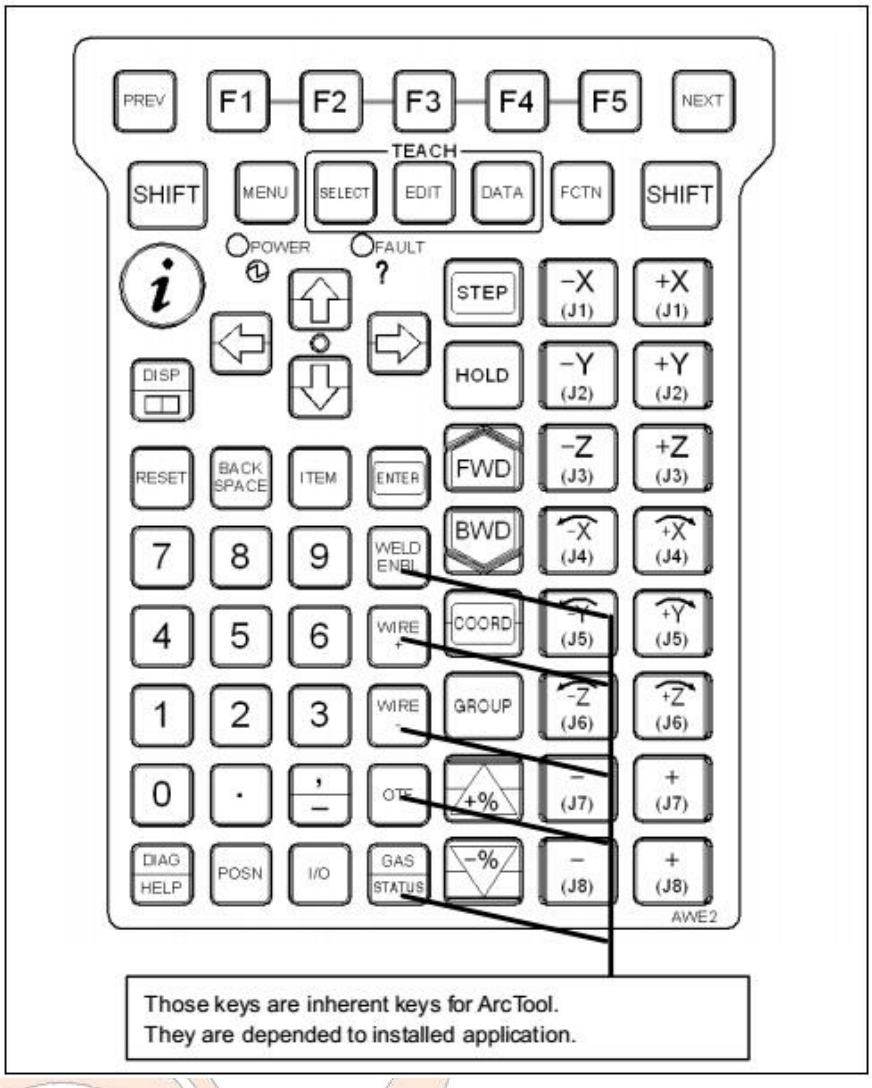

Figure 6-2 Key Switch of Teach Pendant

F1, F2, F3, F4, F5: Function key is used to select the function key menu in the last line of image.

NEXT: Page key is used to switch the function key menu to the next page.
MENU: Menu key is used to display the image menu.
FCTN: Auxiliary key is used to display the auxiliary menus.
SELECT: Overview key is used to display the overview image of the program.
EDIT: Edit key is used to display the edit image of the program.
DATA: Data key is used to display the data image.
TOOL: TOOL1 and TOOL2 keys are used to display the images of tool 1 and tool 2.
SET UP: Setting key is used to display the setting image.
STATUS: Status display key is used to display the status image.
I/O: Input/output is used to display the I/O image.
POSN: Position display key is used to display the current position of the image.
DISP: Move the image of operation object.
DIAG/HELP: Move to the prompt image when pressing alone. Move to the alarm image when pressing with SHIFT.
COORD: Types of manual coordinate system switching, following switches can be operated

in turn: joint, manual, world, tool, user, joint.

FWD/BWD: It can start the program when pressing with SHIFT at the same time (forward/backward).

HOLD: It is used to interrupt the execution of program.

STEP: It is used to test the switching of intermittent operation and continuous operation in the process of operation.

PREV: Return key is used to display the status of returning to the tightening state. It will not return to the status display of previous tightening state under some conditions as per the operation.

BACKSPACE: Cancel key is used to delete a character or digital before the cursor position.

6.1.2 State display of teach pendant

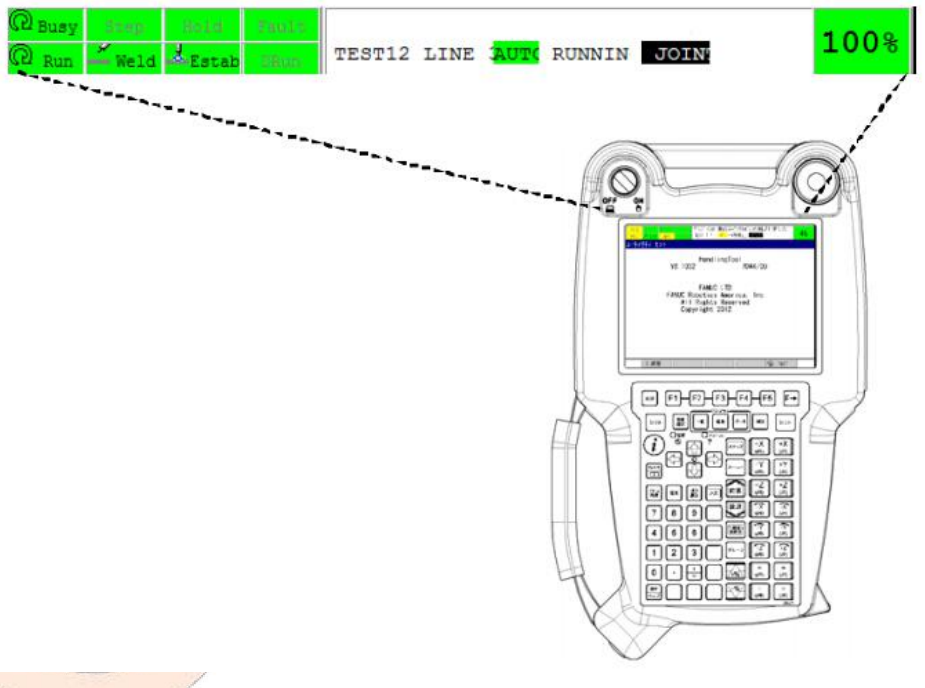

Figure 6-3 State display of Teach Pendant

Processing: it represents that robot is doing a certain operation.

Single section: it represents that it is in the operation mode of single operation.

Pause: it represents that the HOLD key is pressed or HOLD signal is input.

Abnormal: it represents there is an abnormal condition.

Implementation: it represents that the program is in implementation state.

I/0: it is the inherent LED of application program.

Running: it is the inherent LED of application program.

Test run: it is the inherent LED of application program.

6.2 Program composition

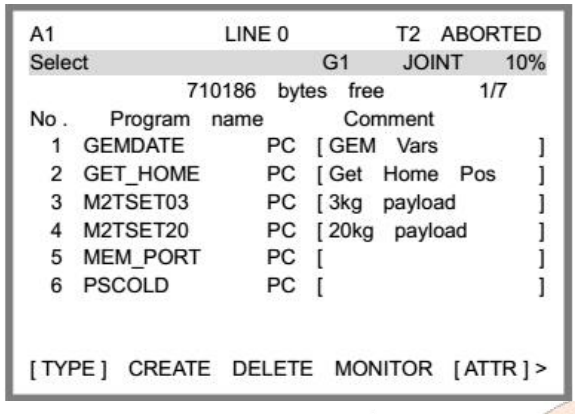

Figure 6-4 Overview Image of Program

Figure 6-5 Program Editing Screen

6.3 Program name

Different programs are distinguished based on different program names, which are as long as 1-8 bytes and must be unique.

Numbers, English capital and lowercase letters as well as underlines can be used as program names, while such symbols as @, ￥, % and # are not supported.

Programs must be named in a way that can indicate the purposes and functions of the programs. The program of fixed fire laser may, for example, be named "DIANSHE" (the Chinese phonetic alphabets of "fixed fire"), so the general function of this program can be known rapidly in the future process of using.

The names below may not be used as program names:

COM1, COM2, COM3, COM4……
CON,PRN,AUX,NUL ……
LPT1, LPT2, LPT3……

Programs adopted with RSR must be named in the form of "RSRnnnn", where "nnnn" refers to 4 digits, such as RSR0001. Otherwise, the program will not perform.

6.4 Type of actions

The robot can perform 4 types of actions: 1. J joint action: a type of joint action that excludes trajectory control or postural control. 2. L linear action: a type of linear action that includes rotary movement and performs trajectory control or postural control. 3. C circular action. 4. A C circular action.

6.4.1 Joint action J

Action is the basic move method to move the robot to a specified location. The robot will accelerate along all the axes at the same time, move at the teaching speed and then stop after deceleration. The movement paths are usually nonlinear ones, the type of action will be recorded when the end point is taught, and the postures of the tool are uncontrolled in the movement.

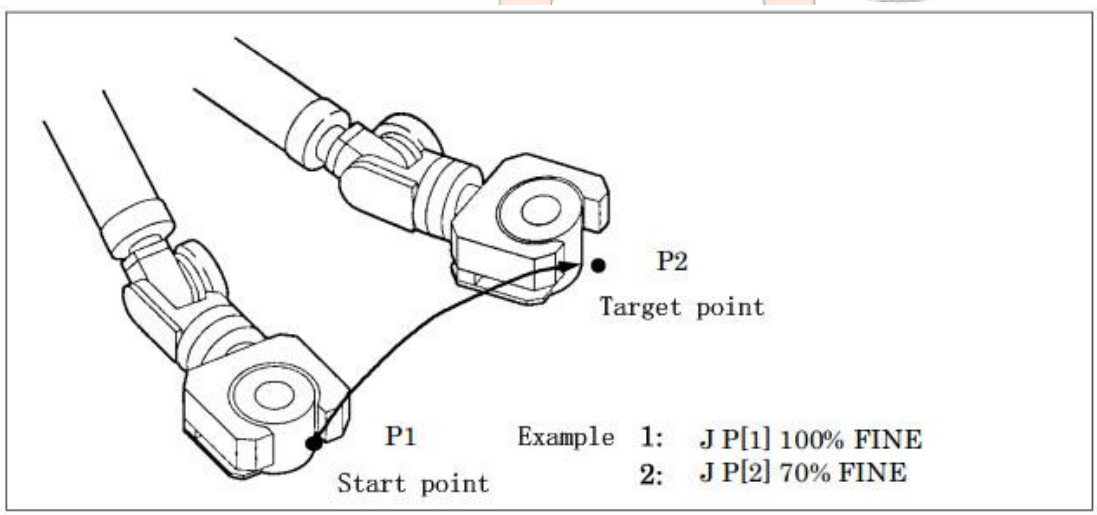

Figure 6-6 Joint Action

1: J P[1] 100% FINE

2: J P[2] 70% FINE

6.4.2 Linear action L

Linear action, as a kind of move method, means that the motion trail from the start point of an action to the end point of the action is controlled in a linear mode, and the type of action will be recorded when the end point is taught. The postures of the tool in the movement will be controlled after those

at the start point and target point are divided.

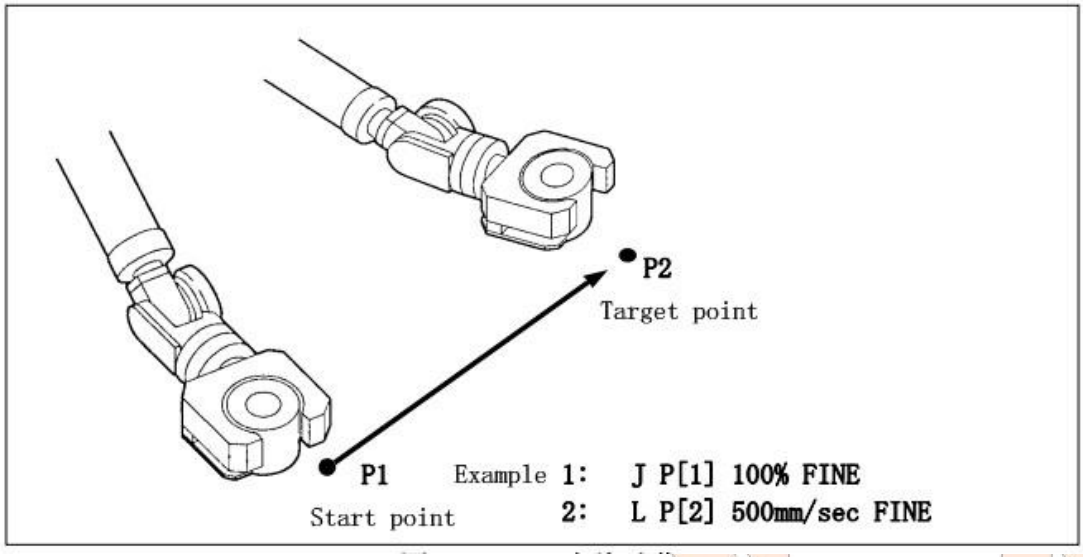

Figure 6-7 Linear Action

1: J P[1] 100% FINE

2: L P[2] 500mm/sec FINE

6.4.3 Circular action C

Circular action, as a kind of move method, means that the motion trail of the tool center point will be controlled in a circular mode from the start point of an action to the end point through the pathway point. It will provide teaching for the pathway point and target point in one instruction, and will control the postures of the tool in the movement after dividing the postures at the start point, pathway point and target point.

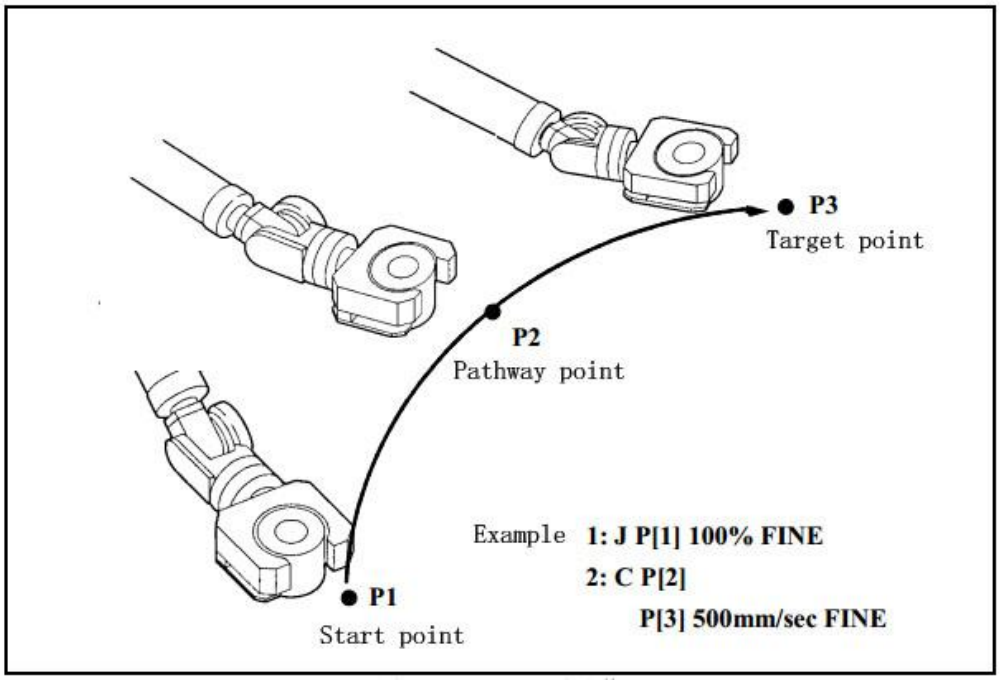

Figure 6-8 Circular Action

1：J P[1] 100% FINE

2：C P[2]

P[3] 500mm/sec FINE

6.4.4 C circular action A

Under the instruction of circular action, two positions, i.e., the pathway point and end point, need to be taught in one line, while under the instruction of C circular action, only one position needs to be taught in one line, and a circular action will be executed when the circular arcs created by 3 continuous C circular action instructions are linked.

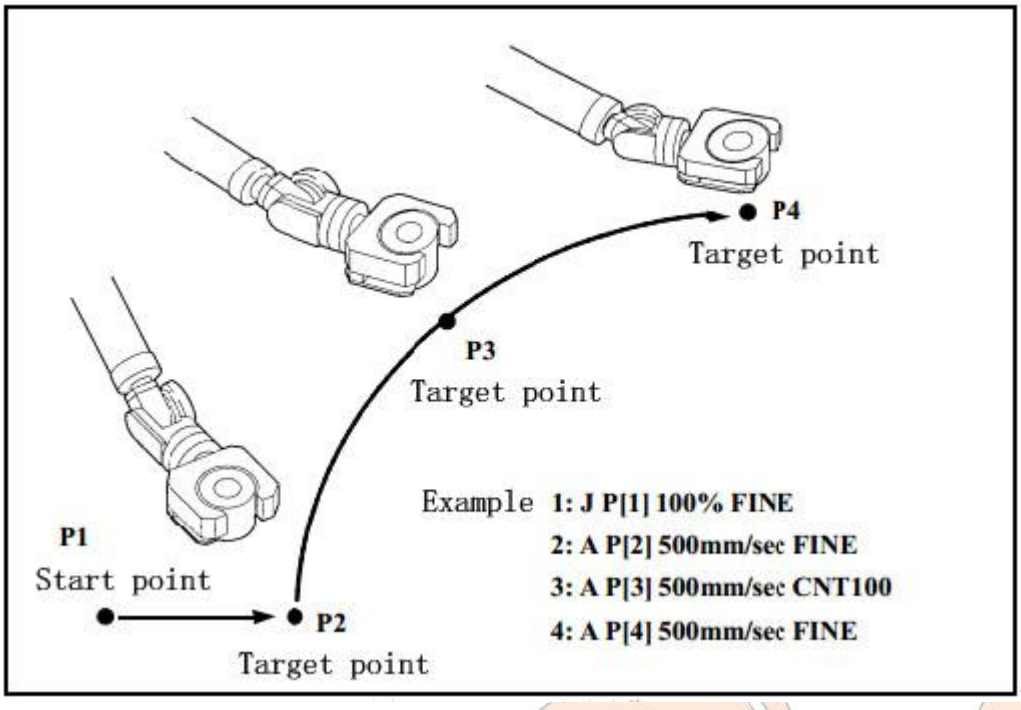

Figure 6-9 C Circular Action

1: J P[1] 100% FINE

2: A P[2] 500mm/sec FINE

3: A P[3] 500mm/sec CNT100

4: A P[4] 500mm/sec FINE

6.5. Program establishment

6.5.1 Program creation

Press SELECT, choose F2 "Create" and then a program record image will pop out.

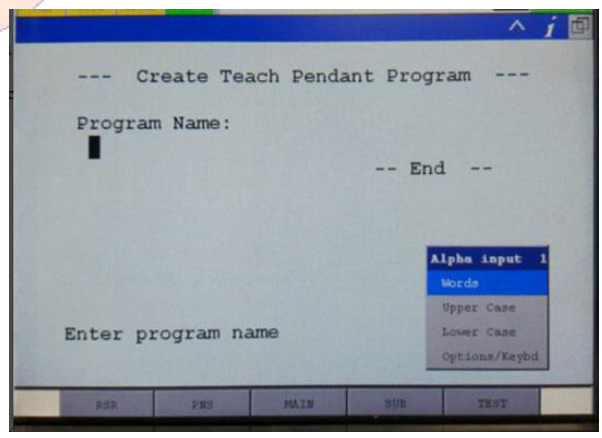

Figure 6-10 Program Record Image

Click RSR and then enter a new file name, when "Up" and "Down" can be clicked to select to enter capital and lowercase letters. Press ENTER after the program name is entered.

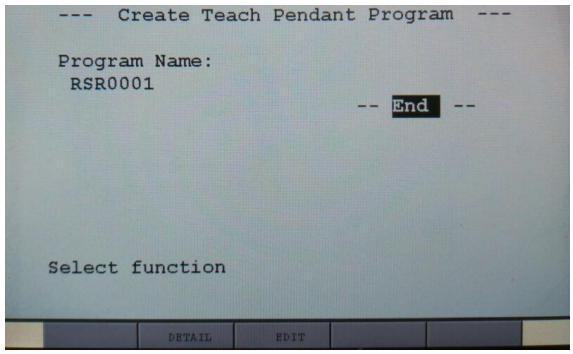

Figure 6-11 Program Creation

6.5.2 Program execution

The program can be started in the following three methods:

Press SHIFT+FWD/SHIFT+BWD on the TP

Press the start button on the operation panel

Peripheral equipment

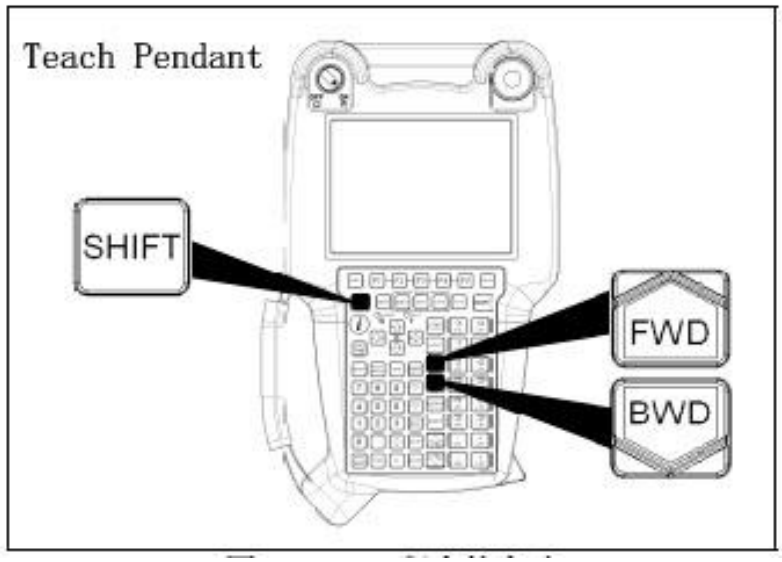

Figure 6-12 TP Operation for Program Start

6.5.3 Positioning type

FINE positioning type: According to FINE positioning type, the robot will stop (be positioned) at the target position before moving towards the next target position.

CNT positioning type: According to CNT positioning type, the robot will move close to the target position but won't stop at it. Instead, it will act at the next target position.

The close degree of the robot to the target position will be defined by a number from 0 to 100.

In the case of 0, the robot will act in the position closest to the target position, but will not be positioned at the target position before starting the next action. In the case of 100, the robot will not decelerate near the target position. Instead, it will start actions towards the next point through the point that is the farthest away from the target position.

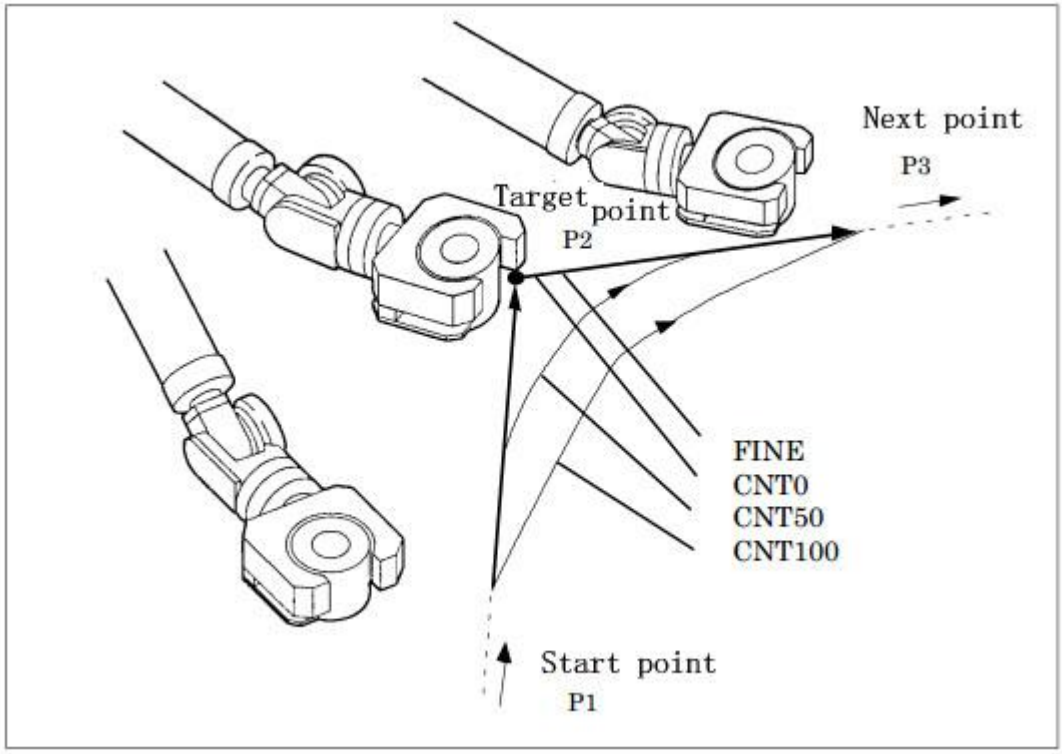

Figure 6-13 Comparison of Positioning Types

Chapter VII Operation Notes, Maintenance, Service and Troubleshooting

7.1 General notes

In the above introduction, matters that need to be noticed have already been mentioned, please read carefully. And matters not mentioned are added as below:

1. Operating personnel must abide by the safe operation rules of laser cutting machine strictly.

2. Operating personnel need to look up all the manuals supplied with the machine or be trained by the customer service staff of our company in order to be familiar with equipment structure and performance and master the knowledge related to the operating system.

3. Labor protection articles need to be worn according to the rules; protective eyeglasses in conformity with provisions must be worn near the laser beam.

4. A material may not be processed until that whether it can be adopted with laser radiation or heating is made clear in order to avoid the potential hazards to produce smoke and steam.

5. The operating personnel may not leave his/her post or ask others to operate the machine arbitrarily once the machine starts operation.

6. Fire extinguishers shall be placed in a place where they are available conveniently. The laser and optical gate may be turned off in the case of no processing. Paper, cloth or other inflammables may not be placed near the laser beam without protection.

7. In case of any abnormity during processing, it's necessary to shut down the machine and clear troubles timely or report to supervisors.

8. Keep the laser, lathe bed and the surrounding area clean, tidy, orderly and greaseless, and work pieces, sheet metals and wastes piled up according to the rules.

9. When adopted, the gas cylinders shall be prevented from pressing the wires, water pipes and gas lines in order to prevent the occurrence of electric leakage, water leakage and gas leakage. Gas cylinders shall be adopted and transported in accordance with gas cylinder supervision regulations. Gas cylinders are prohibited from being exposed to the sun or placed near heat sources. To open the cylinder valve, the operating personnel must stand at the side of the cylinder mouth.

10. It's necessary to check the water level of water chiller when it is powered on, and it is strictly prohibited to power on the water chiller when there is no water or the water level is too low in order to protect the water cooling device from damage. It is strictly prohibited to squeeze or tread the water inlet and outlet pipeline of water chiller in order to keep water circuits smooth.

11. As the wavelength of the laser produced by the product is 1064nm, human skin will be burnt when exposed to laser radiation and the retina will be impaired severely in case the laser beam is watched for a long time, operating personnel must wear 1064nm protective eyeglasses.

12. As a lot of smoke will be produced when the device is used to cut certain sheet metals, the air duct of fan shall be led to the outside or additional air cleaning units may be equipped. Besides, operating personnel shall wear dust masks to avoid the occurrence of occupational diseases.

13. When the machine keeps off for a long time at a temperature lower than 0℃, the cooling water in the water chiller, laser and water pipes shall be drained off in order to prevent the equipment and pipelines from damage caused by cooling water if it is frozen in the condition of too low temperature.

14. The protection lenses in the laser cutting head shall be checked once per day. When the collimating lens or focus lens needs to be dismantled, the dismantlement process shall be recorded, and special attention shall be paid to the installation direction of the lens, which may not be installed wrongly.

7.2 Introduction to water chiller temperature settings

The current water chillers of our company can adjust water temperature automatically according to temperature and humidity, and generally, they can be used normally **without any setting to be changed.**

As to laser sources whose power is equal to or lower than 1000W, it is recommended to supply water for a period of time (10-20min or so) before turning on the laser source, which has the following advantages: 1. In case of low temperature, water temperature can rise when the water cycles for a period of time, which does good for the normal operation of laser source. 2. In case of high humidity, the water supplied at first may dew inside the machine, but the water chiller will adjust to the proper water temperature automatically after the water cycles for a period of time, then the dewing phenomenon can be eliminated.

As the laser source above 1000W is equipped with dehumidification devices itself, it can reduce the humidity inside the laser source and then reduce the dew point. All laser source manufacturers require to power on the laser source firstly, and water will be supplied after dehumidification device operates for a period of time.

According to the test of multiple different types of water chillers that are used currently, in the automatic temperature control conditions, the water temperature of low-temperature water is about 5℃ higher than the dew point, while that of high-temperature water is about 10℃ higher than the dew point. **If your water chiller is not adopted with the standard configuration of our company or you need to set the water temperature yourself due to special reasons, we suggest that the water temperature of low-temperature water is set to be about 5℃ higher than the dew point, while that of high-temperature water is set to be about 10℃ higher than the dew point.**

What is dew point? What is the relationship between it and the temperature and humidity?

Dew formation refers to the phenomenon that there would be condensate water on the surface of one object when the surface temperature of the object is lower than the surrounding air temperature. (There is dew outside of the beverage bottle that is taken out from the refrigerator just, which is dew formation phenomenon. If there is dew formation phenomenon inside the laser source or at the fiber pigtail, irreparable damage may be caused.) Dew point refers to the temperature of one object when dew starts to form there, which is related to both temperature and humidity, and details are shown in the table on the next page.

For examples, if the temperature is 25℃ and humidity is 50%, the dew point would be 14℃ according to the table, that is, in the environment where the temperature is 25℃ and humidity is 50%, the water temperature of water chiller should exceed 14℃ in order to ensure that the equipment needs to cooling will not form dew. At this time, we suggest that the water temperature of low-temperature water is set to be 19℃ and that of high-temperature water is to be 24℃ if you need to set them yourself.

But dew point can change too easily and dew can be formed in case of any carelessness in the setting of water temperature, so the water chiller is suggested working in the automatic temperature

control mode, that is, do not change any setting of the water chiller. The best conditions for the machine to run is the environment with constant temperature and humidity.

If the temperature of the environment where the equipment locates is lower than 0℃, the water chiller is suggested running all the day. Otherwise, the water in the water chiller, laser source, laser cutting head and pipeline shall be drained totally after the equipment is tuned off in order to protect the components from damage caused by freezing. Water chiller and laser source can also be provided with attemperators, while the water in the laser cutting head and pipeline that are difficult to be provided with attemperators shall be drained.

Comparison Table of Ambient Temperature, Relative Humidity and Dew Point														
Relative humidity Ψ (%)	95	90	85	80	75	70	65	60	55	50	45	40	35	30
Ambient 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

7.3 Maintenance and service

In order to ensure the normal operation of laser cutting machine, the equipment needs to be maintained daily. As the whole machine tool is composed of extremely precise components, care must be taken during routing maintenance and operation procedures of all parts must be followed strictly. Besides, the maintenance shall be made by specially-assigned persons and rough operation is prohibited in order to avoid any damage to components.

7.3.1 General standards

The precondition to keep the quality of machine tool is to make professional lubrication with the most suitable lubricant, which can avoid operation troubles and their consequences.

Prior to putting into operation: The machine tool must be lubricated seriously according to the lubrication instruction before being put into operation. If the machine tool is not used for a long time (such as ocean shipping), the lubrication condition of the whole machine tool must be checked.

The oil filler and discharge outlet may not be opened exceeding the schedule time and shall be kept clean.

Only the cloth without fiber flock can be used to wipe the oil groove and lubricating points; waste wool, kerosene or gasoline may not be used. Instead, main shaft lube oil in the thin liquid state ("jet lubricating oil") shall be used.

The synthetic lubricating oil may not be mixed with mineral oil or the synthetic oil produced by other manufacturers, including the synthetic oil with the same features produced by other manufacturers.

Waste oil can only be drained in the warming up state of turbine.

The harmless treatment of waste oil shall be paid attention to specially.

Notes of clean: The whole equipment shall be cleaned comprehensively within the specified time interval. Clear dirt can be scrubbed or gettered by industrial vacuum cleaner.

Safety notices: The machine tool shall be turned off with the master switch in case of maintenance. Safety requirements shall be followed strictly in order to avoid accidents.

The maintenance spare parts that users shall prepare usually are as below:

Acetone: a bottle of 500ml with a purity of 99.5％ and water less than 0.3％.

Pledget: 5 packages.

Alcohol: 500ml, with a purity of more than 99.5％.

Lens paper: 5 books.

Blowing balloon 1

Dropper needle: 1 (for medical purposes).

Organic glass: 200×300×20.

Ink stone (red): 1 piece.

Cotton swab: 2 packages.

Multimeter: 1.

7.3.2 Routing maintenance and service of peripheral equipment

Please refer to the corresponding operating instructions for the routing maintenance of water chilling machine, laser source and other peripheral equipment, and the following is just a general description.

1. Maintenance and service of water chiller

The maintenance and service have been mentioned above when the water chiller is introduced, which will not be narrated here. The routing maintenance of all kinds of water chillers shall be conducted according to their corresponding maintenance instructions, and the following is the maintenance instructions of a certain water chiller, which can serve as reference.

Maintenance period	Content of maintenance	Goal of maintenance
Every day	1. Check whether the temperature of water chilling machine is set normally (set temperature 20±1℃)	Ensure that the temperature of cooling water supplied for laser is normal
	2. Check whether the sealing of the water circuit of water chilling machine, water temperature and water pressure meet the requirements	Ensure the normal operation of equipment and prevent water leakage
	3. Keep the working environment of water chilling machine dry, clean and draughty	Do good for the excellent operation of water chilling machine
Every month	1. The dirt on the surface of the water chilling machine shall be cleared with mild detergent or high quality soaps instead of benzene, acids, abrasive powder, steel brush or hot water	Keep the surface of the water chilling machine clean
	2. Check whether the condenser is blocked by dirt and clear the dirt on the condenser with compressed air or brush.	Ensure the normal operation of condenser
	3. Clean the air filter net: a. Open the panel of the unit that holds the air filter net, pull it up and draw it out. b. The dust on the filter net can be cleared with vacuum cleaner, air gun and brush. The filter net shall be shaken to dry before reinstalled if it is moist after cleaning. c. Cleaning period: once a fortnight. Please make cleaning occasionally in case of serious dirt.	Prevent poor heat dissipation from resulting in bad refrigeration and burning out the water pump and compressor
	4. Check the water quality of the water tank and follow up	Only good water quality can ensure the normal operation of laser
	5. Check whether there is water leakage phenomenon in the pipeline of the water chilling machine.	Ensure that the water chilling machine is free from water leakage phenomenon
Every 3 months	1. Check the electrical components (such as switches and connection terminals) and wipe them with cloth	Keep the surface of the electrical parts of the water chilling machine clean in order to prolong the service life

	2. Replace the circulating water (distilled water) and wash the water tank and metal filter net. In case a ROFIN laser is equipped, the cooling water can be replaced every half year after corrosion inhibitor is added; in case a PRC laser is equipped, the cooling water can be replaced every half year after propylene glycol is added.	Ensure the normal operation of laser
★★★ Notes: The following are necessary to be done in case of stopping for a long time: a. Place the water chilling machine and water pipes in a place far away from dust. b. Pull the power line away from the socket and wipe it clean; c. Wash the body of the unit: Prevent water from being splashed on the electronic components when washing the inside of the unit; d. Drain all the water in the laser, cutting head and water chiller.		

2. Maintenance and service of laser and fiber pigtail

As the key equipment of laser cutting machine, laser provides laser cutting machine with light sources for cutting. In order to keep your laser cutting machine working normally in a high quality, ensure the reliable operation of your laser and prolong its service life, you are reminded of checking and maintaining your laser.

laser source can be free from maintenance basically. Besides to keep the surroundings clean, the daily work is to observe whether the cooling water and voltage are normal, and please contact us in case of any abnormity.

7.3.3 Maintenance and service of lens

As at the lower of the centering module, the protection lens is easy to be polluted by smoke and dust, so it is suggested cleaning once every day before starting to work. The first is to loosen the screws of the drawer of protection lens completely, hold the both sides of the drawer of protection lens box with thumb and forefinger to pull out the drawer slowly and be careful not to lose the seal rings at the top and bottom sides of the drawer; the next is to seal the drawer mouth with gummed paper to prevent focus lens from dust pollution. The protection lens is a plane mirror, and the seal rings and protection lens can be pulled away through pressing the lens. During installation, the lens shall be placed before seal rings are pressed.

The collimating lens and focus lens are inside of the fiber cutting head, the disassembly sequence shall be recorded in case of disassembly to ensure the veracity of reinstallation.

1. Notes for the use of lenses

Don't touch the optical surfaces of focus lens, protection lens and QBH head directly with hand in order to prevent the lens surfaces from scratch or corrosion. Please clean the lenses in case of any grease or dust on the surfaces as it can affect the use of lenses seriously. It is strictly prohibited to wash the optical lens surfaces with water or cleanser essence, as the surfaces of lenses are plated

with a special layer of membrane, which will be damaged if the lenses are washed with them. Please don't place the lenses in the damp place, otherwise, the lens surfaces will be aged. Don't use too much pressure when installing or replacing the reflector, focus lens and protection lens, otherwise, the lenses may be deformed, which will influence the quality of light beam.

2. Methods to install or replace optical lenses

It's necessary to wear clean clothes, clean hands with soap or cleanser essence and wear light, thin and clean white gloves before installing or replacing optical lenses. It is strictly prohibited to touch the lenses with any part of the hand. Hold the lenses from the side and don't touch the coating surfaces of lenses directly when taking them.

Don't blow with mouth facing the lenses when assembling them. Please place the lenses on a clean table steadily with several pieces of lens professional paper lying under them. Try to be careful when taking lenses to avoid bruise and fall, and never exert any force on their coating surfaces. The bases where the lenses are installed shall be clean and the dust and dirt inside the bases shall be cleared with clean air gun before the lenses are placed into the bases gently.

When installing lenses into bases, it is forbidden to fix the lenses with too strong force in order to avoid lens deformation and the further influence in the quality of light beam.

3. Lens cleaning steps

The cleaning method varies from lens to lens. Lens with plane surface and without base shall be cleaned with lens paper; lens with curved surface or base shall be cleaned with cotton swab. The specific steps are as follows:

Steps to clean the lens with lens paper: blow off the dust on the surface of lens with clean air gun; clean the surface of lens with alcohol or lens paper, during which, it's necessary to place the bright and clean side of the lens paper on the surface of lens, drop 2-3 drops of high pure alcohol or acetone and then draw out the lens paper horizontally towards the direction of the operating personnel. The above actions shall be repeated for several times until the lens surface is clean. No pressure may be exerted on the lens paper in order to avoid scratch. If the lens surface is very dirty, the lens paper can be folded for 2-3 times and the above steps shall be repeated until the lens surface is clean. It is prohibited to drag dry lens paper on the lens surface.

Steps to clean the lens with cotton swabs: blow off the dust on the surface of lens with air gun firstly, then remove the dirt with a clean cotton swab; use a new cotton swab stained with high pure alcohol or acetone to make movement along the circumference from the center of the lens to wash the lens and replace to use another clean cotton swab when the circumference washing is finished every time. Repeat the above operation until the lens is clean. Observe the washed lens until there is no dirt or spot on its surface. Install the washed lens into the lens base according to the above method. Second-hand cotton swabs are prohibited to be used for the operation.

In case of chippings difficult to remove on the lens surface, the surface can be blown with rubber air blower. Both sides need to be cleaned, after which, another confirmation shall be made to ensure there is no of the following residual: detergent, pledget, foreign matter and impurities. The lens may not be exposed to air after cleaning, which shall be installed soonest or stored in a clean sealed container temporarily.

4. Storage of optical lens

The proper storage of optical lens could maintain the good quality of the lens. The temperature of storage environment is 10-30℃, and the lens may not be placed in the freezing chamber or similar environment, or else condensation and frost would be caused when it is taken out, which would damage the lens easily. The temperature of storage environment may not exceed 30℃, or else the coating film on the lens surface may be impacted. The lens shall be stored in a box in a non-vibrating environment, or else the lens could be easily deformed, thus influencing its use performance.

5. Replacement of quick-wear components

The nozzle at the lower of the cutting head is easy to break down due to the worst service conditions, which can be contrarotated to screw off in order to be replaced with a new one. After replacement, it's necessary to screw it off and make another capacitance calibration. In case of replacing a new ceramic body assembly, the two gauge piles must be aligned with the locating holes of the inductive seat, the ceramic body shall be laid flat and righted before tightening the clamping rings, and the nozzle will be screwed when the ceramic body is compressed. Failing to meet the above installation requirements may damage the parts of inductive seat module and hinder the normal operation of the system.

7.3.4 Maintenance and service when long-term parking

In case the machine tool is to be parked and not to be used for a long time, please smear all the moving components of the machine tool with grease and package them with anti-embroidered paper. For other parts, it's necessary to check whether there is rust formation, exercise rust removing and rust-proof treatment for rusty parts (dust-proof covers can be added if possible), and clean and check the machine tool regularly.

The lubrication of gear rack: use antirust agent (such as WD-40) to clear the gear rack and use hand spraying grease (such as dinosaur 192) to lubricate gear rack evenly.

The lubrication of linear slide rail: use grease gun (such as R-301) to inject the lithium base grease (such as MP-3) into the centralized lubrication seat.

If the linear slide rail fails to be lubricated properly, the friction in the rolling parts will increase, and the long-term use in the above condition will become the main reason for lifespan shortening.

The lubricating grease for linear slide rail and sprocket chain is lithium base grease, and Jinguan Lithium Base Grease MP-3 is recommended. And grease gun will be used to inject the lithium base grease into the sliding block. Beside, due to structure requirements, the linear guideway is sealed in the bellow of dust-proof cover secondarily, when the grease gun is used for lubrication, it's necessary to open the bellow of the dust-proof cover before injecting grease.

7.3.5 Analysis on and inspection of common problems

Alarm position	Alarm name	Alarm reason and inspection method
Follower Alarm	Capacity diminish	1. Nozzle is failed to be installed.
		2. Ceramic ring is loose
		3. There is something wrong with the connection,
	Capacity large	There is something wrong with the calibration, which shall be made again
	Servo alarm	1. The servo of Z axis is not on
		2. There is something wrong with the servo connection, and please check all the servo plugs.
	Z+ Limit reached	Z+limit is triggered
	Z- Capacity large	Z-limit is triggered
Communication timeout		1. The network cable is not connected well
		2. The IP of height-adjustment device is reset.
		3 The height-adjustment device is not on
Servo alarm	Alarm code: 910, 710, 720	1. The servo is not on
		2. There is something wrong with the servo connection, and please check all servo plugs.
Limit alarm	Y+ Limit	1. The limit is triggered.
	Y-Limit	2. The limit is touched by something
	X+ Limit	3. There is something wrong with the limit, which needs to be replaced
	X- Limit	4. There is something wrong with the pinboard
The cutting effects become worse suddenly.		1. No calibration is made after material replacement
		2. The nozzle is unclear or damaged
		3. The assisted gas pressure is insufficient
		4. The lens is polluted or damaged

Annex: Cutting Speed Parameter List

Material	Thickness(mm)	500W	1000W	1500W	2000W	3000W	4000W
		The best cutting speed m/min	The best cutting speed m/min	The best cutting speed m/min	The best cutting speed m/min	The best cutting speed m/min	The best cutting speed m/min
Carbon steel (O_2)	1	10	14	20	24	30	35
	2	4.5	7	9	12	18	24
	3	2.1	3.3	3.5	3.8	4	6
	4	1.5	2.2	3	3.1	3.5	5
	5	0.1	1.8	2.5	2.7	3	4
	6	0.9	1.5	2	2.1	2.5	2.5
	8		1	1.5	1.5	1.9	1.9
	10		0.8	1.2	1.3	1.3	1.3
	12			0.8	0.9	1.2	1.2
	16				0.6	0.8	0.8
	20					0.7	0.7
	22						
	24						
Stainless steel (Air)	1	9	14	20	25	30	35
	2	3	5	8	13	20	24
	3	1	3	4	5.4	11	13
	4		1.5	3	3.3	8	11
	5		1	1.5	2.4	5	7.5
	6			1	1.3	3	5
	8				1	1.7	3.5
	10					1	2
	12					0.6	1.5
	14						1
	16						0.6
Aluminum	1	4.8	9	18	21	24	27

plate	2	1	3.6	7	9	14	17
	3		1	2	6	8.5	12
	4			1	3.2	5	8
	5				1.5	3.5	5.2
	6				0.6	2.2	3
	8					1	1.5
	10						0.5
Copper plate	1	4.8	9	18	25	28	30
	2	0.6	3	6	8	15	17
	3		0.6	1.8	2.4	3.6	12
	4			0.6	0.9	1.5	8
	5				0.8	3.2	5
	6				0.6	2.2	3
Notes: Data in this list are for reference only as they can vary among different laser sources, different batches of materials, different batches of gas, different optical lens and so on.							

After-sale warranty of Laser Machines

First of all, thank you very much for purchasing a Bodor product. In order to guarantee the smooth processing of after-sales service, we will make the following announcements:

General principles

1. We are responsible for the maintenance of facilities which are within the Warranty conditions.

2. Users must keep the machine's integrity and independence during operation. In the following situation, our company will not take any direct, indirect or joint liability. Futhermore, if any equipment is damaged or there are any losses in either economic or reputation to our company due to the following situation, we, Bodor company, reserve the right to investigate any legal liability.

1) Using the equipment in an environment that it was not designed for..

2) Altering the machines privately, including, adding parts, reducing parts, dismounting, using another brand's parts, etc.

3) Human damage or doing operations and maintenance without following the requirements in the instructions.

4) Damage caused by movement or transportation.

On condition of not influencing the machine's performance, our company reserves the right to change the product's specifications and name the products before informing the customer.

Our company is responsible for the quality and performance of the machine we sell. However, we are not responsible for other indirect obligations and responsibilities.

Detailed Principles

Equipment Warranty: 3 years. Calculated from the production date in machine’s nameplate.
Specific details are as below:

1.Laser module Warranty:

(1) Fiber module's warranty：2 years normally；3 years on 2KW and above it

(2) CO2 tubes:

RF Tube's warranty: 1 year；

Glass Tube's warranty: RECI tube: 10 months ,40w tube: 4 months ..

(P.S. Laser module's warranty date calculated from the production date in laser module tag)

2.The warranty does not include consumable parts, such as glass mirrors, belts, switches, gas nozzles ,foots/wheels, keys/press boards, etc.

3.Warranty of peripheral devices (if the machine has them):

Warranty of peripheral devices is 1 year, calculated from the production date in the device's tag. Maintained by device's manufacturers as standard,Our company assist maintenance. Peripheral devices including water-chillers, fans, air pumps, water pumps etc.(If the machine has them).

Accessories repair and shipping cost

Within the warranty period:

For free repair or replacement of accessories, the buyer should bear the shipping costs from their local place to our company if it needs to tested, repaired or replaced.

If the failure cause by the parts'quality after testing(non human factors and use environment etc.), it will be repaired or replaced free of charge, and Bodor company will bear the return shipping cost. If the failure doesn't cause by the parts'quality, the buyer should pay the repair fees and round-trip shipping cost.

P.S. The repaired parts should be returned to our factory. if the buyer is in arrears of spare parts, Bodor company will cancel the warranty terms of the machine).

Outside the warranty period:

The buyer should paid for repairs and round-trip shipping.

Door to Door Service Policies

Bodor supplies door to door services all over the world. Charging standards and service

processes are as below:

(A). Charging standards:

1. Technician visa fees, domestic travel expenses (including transportation cost occurred during handling documents);

2. Training and maintenance fees: $200/day/person （take the time of landing and starting off of plane in customer's country as standard） ;

3. International round-trip tickets (reserved and paid by the buyer, and supply the e-ticket information to our company);

4. Abroad accommodation(arranged and paid by the buyer)

(B).Overseas training/maintenance processes:

1. Bodor company will calculate the fees of item 1 and item 2 above, and then inform the buyer. After the buyer pays the fees, Bodor company will arrange for the technician to apply for a visa.

2. We will inform the buyer after the technician gets the visa. The buyer should supply the round-trip ticket information mentioned above in item 3, and arrange accommodation from item 4 after the technician arrives.

3. Only after getting the approval of Bodor company, the buyer can apply for an extension for the training and maintenance.The buyers should pay for the"extend training and maintenance service fees"before the start of the extend service.

Postscript

Our company reserves the final interpretation right for the Manual and we will make our best effort to ensure the accuracy of it. Due to the limited knowledge of the author, the Manual may contain mistake(s) or omission(s). We will not be obliged to consequences of any form caused by such mistake(s) or omission(s). Our company will not be obliged to any direct, indirect, special, attached or relevant damage or responsibility caused by improper use of the Manual or the product. We welcome the criticism and correction from extensive users and peers.

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