Fully automatic paper super labeling machine Hardware User's Manual

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I. Introduction

How to use this manual

The user manual provides information on how to use and maintain the craft marking system.

All information in this manual is based on long-term experience and process accumulation. It is important to strictly follow these instructions, especially when maintaining and repairing the system. Please follow all clauses in this manual to avoid invalidating the warranty. If you wish to perform procedures not described in this manual, please contact our customer service center and obtain permission.

Laser safety and compliance standards

This marking machine is designed in accordance with the 'GB7247.1-2001: Safety of Laser Products-Part 1: Classification, Requirements, and User Guide' and 'GB2894-2008: Guidelines for the Use of Safety Markings' issued by China in 2001. It also aligns with the U.S. Food and Drug Administration's (FDA) standards for laser products,' 21 CFR 1440.10 and 1040.11 '. The European standard can be found in' UNIEN60825-4 1998. CEI'. As a Chinese laser device, it complies with the aforementioned standards, which require manufacturers to provide information on the laser radiation status. The machine must be equipped with anti-laser radiation devices, and employees must be aware of the potential dangers from improper use of the system. The laser system of this marking machine includes a Class 4 laser, which complies with EN-60825-1 (12CFR 1440.10). Every component of the machine, including the control panel, input alarm signals, protection, laser output indicator lights, identity labels, and CE certification, adheres to the above laser safety standards. In addition to the laser safety specifications mentioned above, other preventive measures must also be implemented during the operation of the laser equipment.

To avoid exposure to direct or reflected laser beams, take all precautions and follow all instructions.

To avoid eye injury during use and maintenance of the equipment, please wear a protective cover.

Laser radiation to the skin can cause varying degrees of burns.

Safety measures for equipment

In order to ensure the safe operation of equipment and the personal safety of operators, our company has taken the following safety measures:

1. The equipment is made of all metal.
2. The equipment is equipped with a safety lock (the host power supply opens the lock, and the computer host opens the lock).
3. Emergency stop switch.
4. Status indicator light.
5. Overhead keyboard console.
6. Safety signs.

System Introduction

brief introduction

The system uses a 10640nm carbon dioxide laser, which can meet the requirements of different applications: marking, engraving, cutting, color removal, paint layer treatment, material micro-heat treatment and so on.

Laser processes can be used to fix workbenches and production lines to suit the characteristics of the system.

The equipment is made of aluminum type structure, and the latest drive control is used to achieve stable quality in the whole working area. The laser optical path change is driven by two galvanometer motors (XY), and the third axis is driven by the pre-scanning focusing system to adjust the focusing distance widely.

When repairing the equipment, it is necessary to match the laser with the marking head to avoid the correction of the optical path.

The 3d dynamic dotting machine can adjust different working areas and different power configurations.

This device is a level 4 safety system. For more information, please refer to Chapter (Chapter 10).

Features of this equipment

The following are the main features of 3D dynamics:

1. Average nominal power: ≥ 250 W (coherent J2) and ≥ 350 W (coherent J3)
2. Standard working range: 300*300mm ~600*700mm (the size can be adjusted)
3. Working area beam focal length: working area 300*300mm (f=300mm) ~600*800mm (f=800mm)

supply electricity

Single-phase voltage AC220V (or three-phase AC380V), frequency 50Hz (or 60Hz), maximum working current 35A (coherent J2)

40A (coherent J25) and 45A (coherent J3).

technical parameter

The imported radio frequency laser with a wavelength of 10640nm is adopted, which has good optical mode and small divergence Angle.

High speed large inertia CTI galvanometer of the United States. It uses a 50mm large spot mirror.

The workbench area is large to meet the convenience of operation.

Working environmental conditions

Ensure that the equipment is used in accordance with the following environmental conditions to prevent adverse effects on the performance and function of the equipment. Otherwise, the equipment may be damaged or even cause accidents resulting in personal injury and property damage.

1. This equipment can only be used indoors, not installed outdoors or in the following environment.

a) Directly exposed to the thermal radiation environment of the heating equipment.
b) An environment with liquid splashes or oily air.
c) An environment exposed to direct sunlight.
d) An environment with dust or corrosive gases (sulfur and ammonia).

e) An environment with drastic temperature changes.

f) An environment that freezes and condenses.

g) An environment with vibration and strong impact.

2. Use and store the equipment within the rated temperature and humidity range. Humidity is less than or equal to 80%, temperature is 5℃~30℃.

3. Use the equipment within the rated power supply range. The voltage fluctuation range is ±5%, and the frequency is 50Hz (or 60Hz). (If the voltage and frequency are not correct, a voltage regulator and frequency converter must be installed).

Weight and size of the system (J3) (standard models are as follows, different from modified machines)

Light path system weight: 110Kg size: 1380 x 545 x 345mm Light path system weight: 110Kg size: 1380 x 545 x 345mm

Cooling system weight: 87Kg size: 670 x 470 x 890mm Cooling system weight: 87Kg size: 670 x 470 x 890mm

Adsorption workbench weight: 20Kg size: 846 x 846 x 46mm Adsorption workbench weight: 20Kg size: 846 x 846 x 46mm

Total weight: 1200Kg size: 2400 x 2300 x 2150mm Total weight of equipment: 1200Kg size: 2400 x 2300 x 2150mm

initial inspection

1. Random instructions
2. Customer's optional accessories

Transportation and installation

The room where it was installed

At least 3x3M2 of flat space, (see chapter 2 for indoor environment and working environment regulation)

Unloading operation

- Personnel with operational skills.
- Pay attention to personal safety and property safety during unloading. Wear safety helmet, protective gloves and work shoes when necessary.

Outer packing inspection

Whether the packing box is intact, damaged, and whether there are traces of being opened. Whether the packing box is inverted, damp or soaked by water.

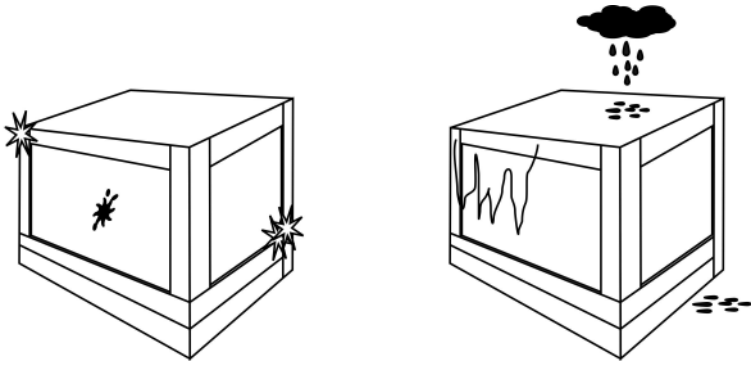


Figure 3.3 Damage or dampness of the outer packing

Open and pack

Use two layers of packaging

- Protective film packaging
- Wooden packing

If the equipment is packed with wood, please open it with appropriate tools.

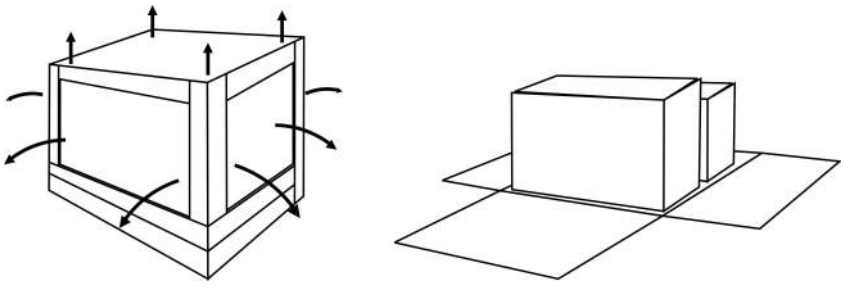


Figure 3.4 Unboxing illustration

Note: Do not press your hands and feet during unloading and unpacking. Also be careful of the nails on top of the wooden box.

Installation (This work must be done by a qualified person)

1. First install the main frame, find out 6 main support columns of the frame in the packaging bag and the corner code and screws to fix the frame.

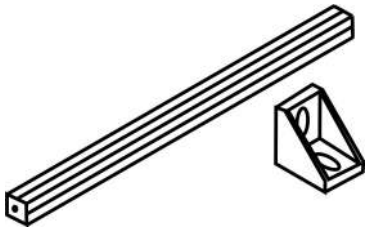


Figure 3.5.a, support bar and corner code

2. Install according to the drawing size. In the process of installation, first install the corner code and screws under the support column. Note: do not fix the screws too tight, so that they can be moved by hand. Install according to the drawing size. In the process of installation, first install the corner code and screws under the support column. Note: do not fix the screws too tight, so that they can be moved by hand.
3. Remove the packaging film of the light fixture, and slowly lift the light fixture to the 6 support columns with a forklift or manpower. Position it according to the drawings, and install the corner code and screws. Remove the packaging film of the light fixture, and slowly lift the light fixture to the 6 support columns with a forklift or manpower. Position it according to the drawings, and install the corner code and screws.
4. After the good position, lock all the support column screws. Finally, adjust the machine feet to the horizontal standard and lock them.
5. During the installation process, be sure to protect the vibration lens part.

Power and terminal connections

1. Set up the main cabinet and indoor water circulation system according to the drawings.
2. Connect the power supply and data lines between the chassis and the cabinet.
3. Cut the binding strap, unscrew the PG60 connector nut first, then pass the tube head and all wires through the large hole behind the main cabinet, and finally screw back the nut. Find the 25-pin housing in the random file box, and install the housing on the PIN25 pin D head.
4. Connect the galvo power plug and tighten the nut.
5. Connect the laser power supply plug.
6. Connect the water circulation main power plug, protection control line plug, and water circulation to the outdoor unit power plug.
7. Remove the LCD display packaging box and install the base. Place it on the main electrical control cabinet, adjust the viewing position and connect it to the VGA terminal of the computer host in the main electrical control cabinet, and connect the power cable.
8. Connect the main power line. Locate the main power line and ground wire in the cabinet, and connect them to the voltage stabilizer or user air switch according to their polarity. (The equipment is powered using a three-phase five-wire system, which includes 3 live wires, 1 neutral wire, and 1 ground wire. Follow the wire labels: U, V, W represent live wires, N represents the neutral wire, and double-colored wires represent the ground wire. Note: Ensure that the grounding is reliable.)
9. Connect the cooling water pipe. Connect the inlet and outlet water pipes correctly, and lock each water pipe firmly. Ensure that each water pipe is not squeezed or bent.

How to use the tank temperature control panel

Turn on the power switch of the water circulation cooling system

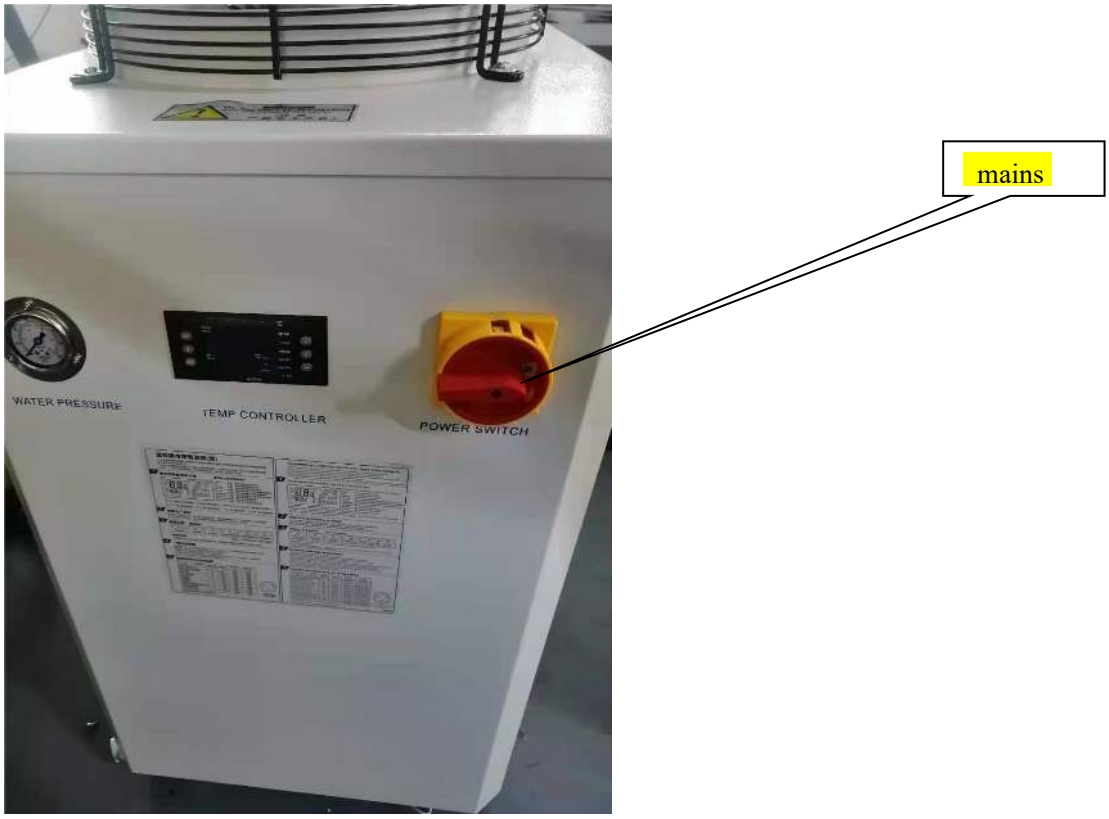


Figure 3.7 Water cycle temperature controller

Operation method of water tank thermostat panel:

Hold down the ▲ key and press the SET key for five seconds. The upper display window will show 00, and the lower display window will show PAS. At this point, press the ▲▼ key to select the preset password (factory preset is 8). Press the SET key once more to enter the parameter setting mode, where the display changes to F0. After entering the parameter setting mode, use the left and right ◤◥ keys to cycle through and change the parameter settings. Press ▲▼ to modify the value of a specific parameter. Press the RST key at any time to save the changes, exit the parameter setting mode, return to the temperature display, and run according to the new parameters. Note: The control mode must be set to intelligent mode, which is parameter setting option F3 control mode selection 1. Parameter setting options: F8 sets the maximum water temperature to 28 degrees, and F9 sets the minimum water temperature to 26 degrees.

Fill the water

1. This system must use pure water as cooling water. Before filling water, check whether the drain valve is closed.
2. Open the cover of the indoor water cooling system and the water tank, then pour bottled purified water into the tank. During this process, be careful not to splash water out, as there are electrical circuits inside the machine that could cause leakage or damage. After turning on the system, some water will be used in the water circulation path, so once the water level stabilizes, add more water until it reaches about 40mm above the top edge of the stainless steel tank.

Appendix dew point temperature table

Table 3.6

Relative humidity (%)

ambient temperature (℉)(℃)	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**
60 (16)				32	36	39	41	44	46	48	50	53	54	55	57	59
				0	**2**	**4**	**5**	**7**	**8**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
65 (18)			33	37	40	43	46	48	51	53	55	57	59	60	62	64
			1	**3**	**4**	**6**	**8**	**9**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
70 (21)		33	37	41	45	48	51	53	56	58	60	62	64	65	67	69
		1	**3**	**5**	**7**	**9**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**21**
75 (24)		37	42	46	49	52	55	58	60	62	65	67	68	70	72	73
		3	**6**	**8**	**9**	**11**	**13**	**14**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
80 (27)	35	41	46	50	54	57	60	62	65	67	69	71	73	75	77	78
	2	**5**	**8**	**10**	**12**	**14**	**16**	**17**	**18**	**19**	**21**	**22**	**23**	**24**	**25**	**26**
85 (29)	40	45	50	54	58	61	64	67	70	72	74	76	78	80	82	83
	4	**7**	**10**	**12**	**14**	**16**	**18**	**19**	**21**	**22**	**23**	**24**	**26**	**27**	**28**	**28**
90 (32)	44	50	54	59	62	66	69	72	74	77	79	81	83	85	87	88
	7	**10**	**12**	**15**	**17**	**19**	**21**	**22**	**23**	**25**	**26**	**27**	**28**	**29**	**31**	**31**

95	(35)	48	54	59	63	67	70	73	76	79	81	84	86	88	90	92	93
		9	**12**	**15**	**17**	**19**	**21**	**23**	**24**	**26**	**27**	**29**	**30**	**31**	**32**	**33**	**34**
100	(38)	52	58	63	68	71	75	78	81	84	86	88	91	93	95	97	98
		11	**14**	**17**	**20**	**22**	**24**	**26**	**27**	**29**	**30**	**31**	**33**	**34**	**35**	**36**	**37**

In the environmental temperature column, you can find the temperature corresponding to your local area, expressed in Fahrenheit or Celsius (with Celsius in bold). The value where the air temperature and relative humidity intersect is the dew point temperature (the temperature at which condensation begins) in Fahrenheit or Celsius. The cooling system's temperature setting must be higher than the dew point temperature. For example, if the air temperature is 85℉ (29℃) and the relative humidity is 60%, the dew point temperature would be 70℉ (21℃). Therefore, the cooling system's temperature setting should be set above 72℉ (22℃) to prevent condensation inside the laser, which could damage the laser.

4. Know the equipment

4.1 Composition of equipment

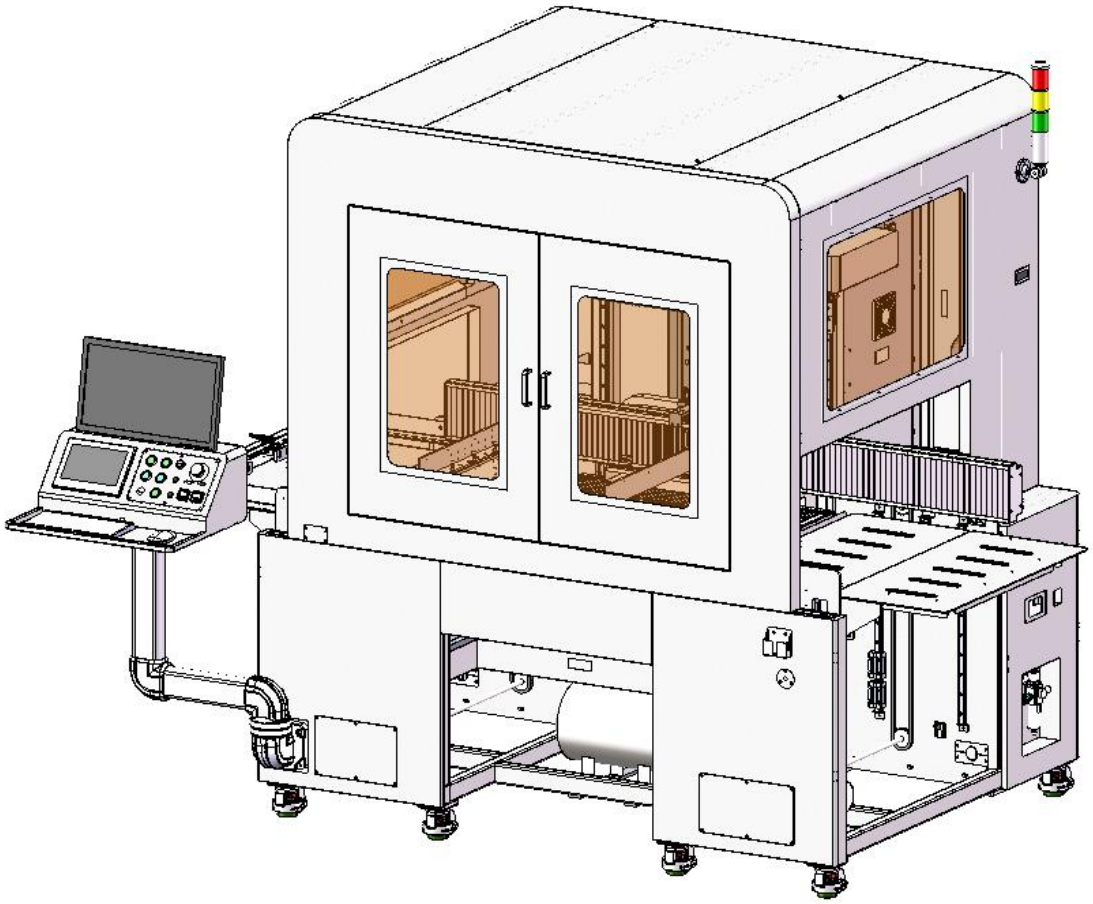


Figure 4.1 Equipment diagram

4.2 Introduction of connecting connections and plugs

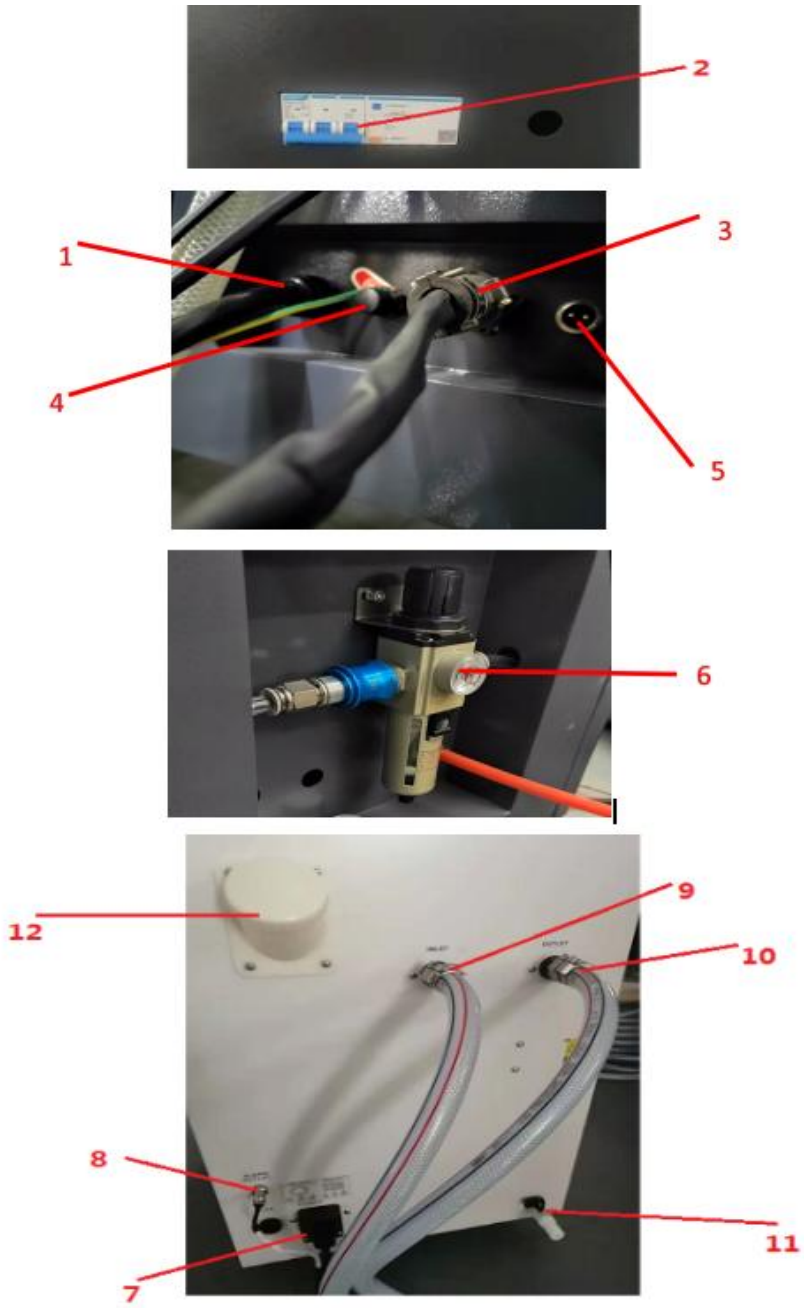


Figure 4.2 Intent of external connection ports of the device

Description of each connection port:

1. Equipment total power cable interface
2. Main switch of the equipment
3. Laser chiller interface (output from the equipment)

4. Ground station
5. Pedal interface
6. Intake valve
7. AC power supply interface of laser chiller
8. Laser chiller flow switch interface
9. Water inlet of laser chiller
10. Water outlet of laser chiller
11. Discharge port of laser water cooler
12. Laser water cooler filling port

4.3 Electronic control box and computer

The panel of the electronic control box is shown in Figure 4.3.a:

Figure 4.3.a Control panel

1. Emergency stop: emergency stop switch, this switch presses the main circuit power off.
2. Key: Used to open the device control power supply.
3. Start: Start the power supply of the laser chiller.
4. Shaking mirror: Shaking mirror power switch.
5. Laser: laser power switch.
6. Computer: Computer start switch.
7. Elevate: Control the power switch of the motor.
8. Red light: Red light indicates the light control switch.
9. USB: external USB interface.
10. Alarm: sound and light alarm lamp.
11. Operation: Start button for loading and unloading.

The interface on the back of the computer host is shown in Figure 4.3.b:

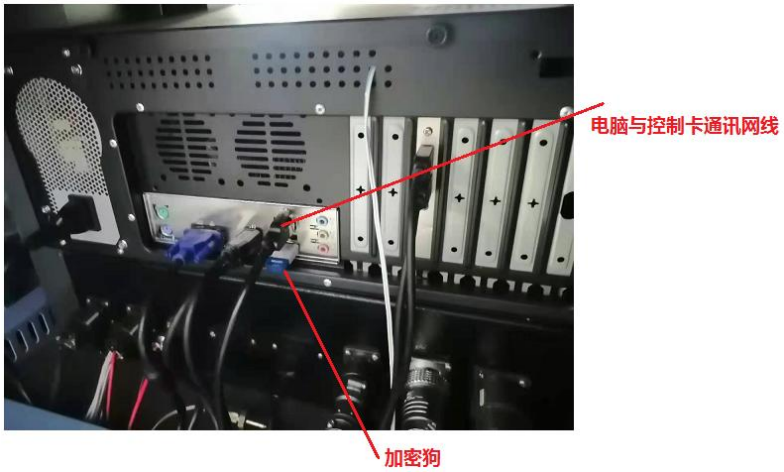


Figure 4.3.b Back of computer host

The sampling table is shown in Figure 4.3.c:

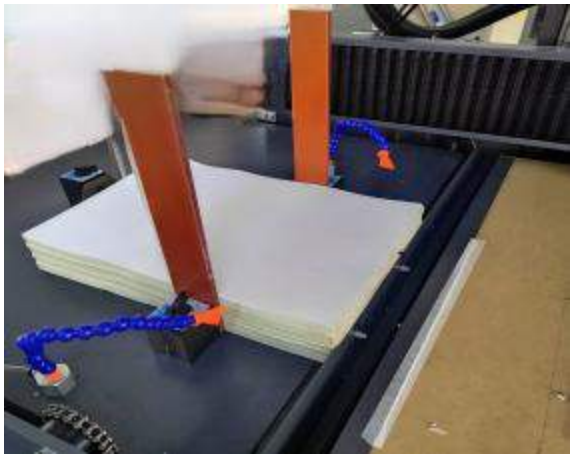


Figure 4.3.c Material platform

The receiving platform is shown in Figure 4.3.d:

Figure 4.3.d Material receiving table

The charging vacuum generator is shown in Figure 4.3.e:

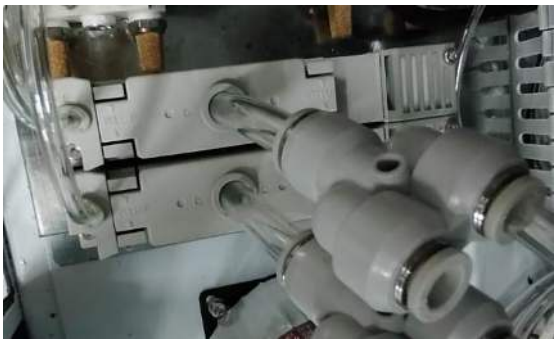


Figure 4.3.e Charging material vacuum generator

The light fixture seat lifting control button is shown in Figure 4.3.f:

Figure 4.3.f Light stand lifting control button

4.4 Input and output signals

Control card diagram and related interface definition:

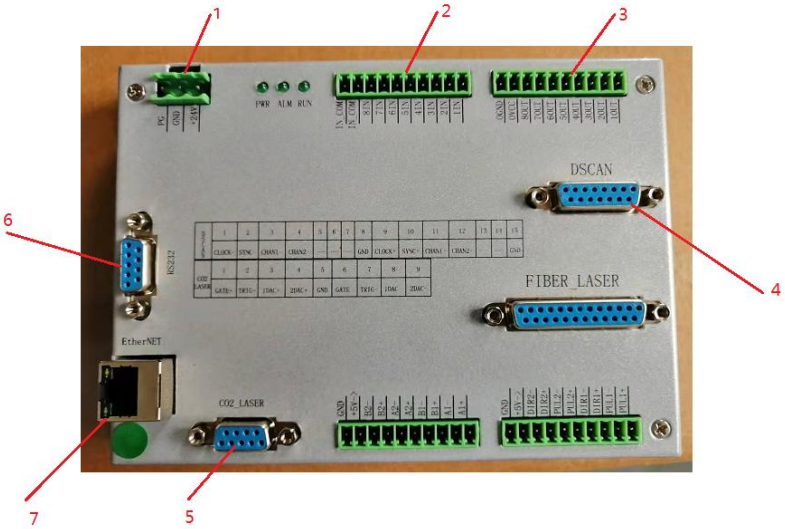


Table 4.4 PCI6408 (TE3000) General pin definition

number	Interface definition	interface specification
1	24V	Control card is powered by 24V
2	1IN、2IN	Flymark interface, pedal signal interface
3	OUT	Output port for marking completion signal
4	DSCAN	XY axis galvanometer signal interface
5	CO2-LASER	Laser signal interface
6	RS232	Z axis dynamic group signal interface
7	EtherNET	Computer host and control card communication network cable interface

4.5 Optical path diagram

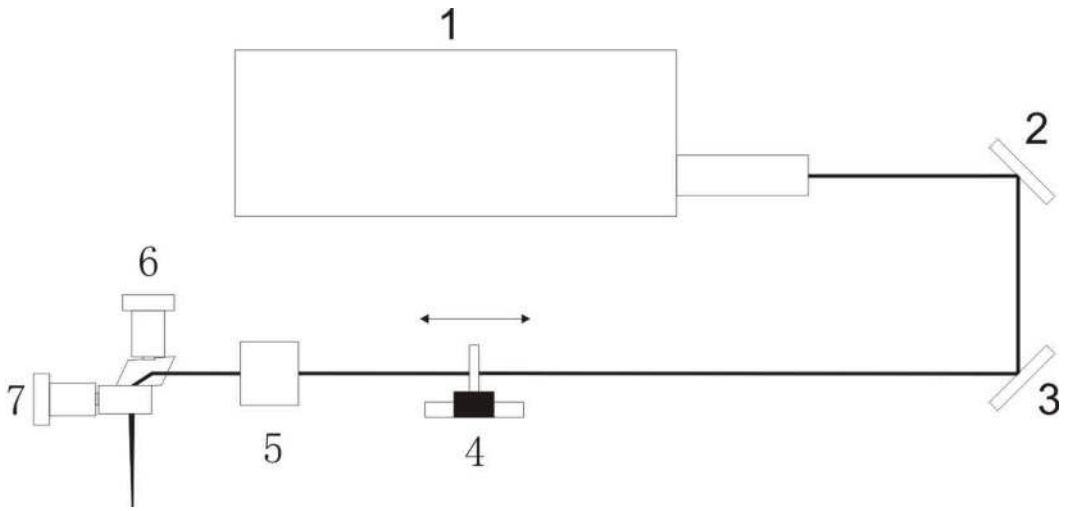


Figure 4.5 Schematic diagram of optical path

1. laser
2. 45-degree mirror lens
3. 45-degree mirror lens
4. Dynamic lens sets
5. The focus mirror

6. X axis motor and mirror
7. Y-axis galvanometer motor and mirror

5. Start up and shutdown

When the equipment is installed for the first time, attention should be paid to whether the waterway and circuit connection method are correct.

5.1 Start up

1. ON/OFF: the general power switch of the dotting machine.
2. Key: used to open the control power supply of the dotting machine. (At this time, the red alarm light is on)
3. RUN: The main power supply of the dotting machine starts, press the RUN switch, and the water circulation is normal after a few seconds (at this time, the alarm light is green)
4. SCAN: The galvanometer power switch is turned on. Wait for about one minute before proceeding to the next step.
5. LASER: Laser power switch.
6. Start the exhaust system.
7. The equipment is started.
8. Emergency stop: This is an emergency stop switch, which cuts off the main circuit when pressed.

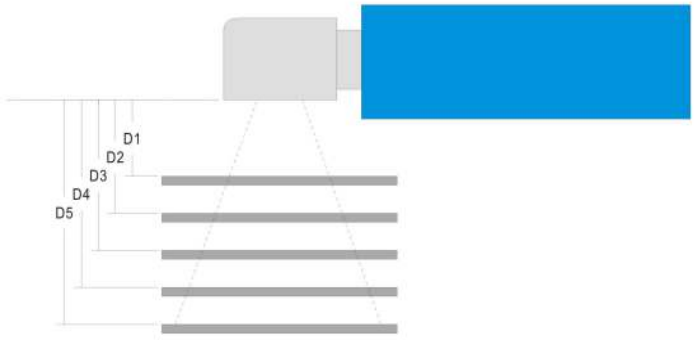
5.2 Shutdown

1. Close the LASER switch (laser power supply switch).
2. Close the SCAN switch (lens power switch).
3. Close the key master control lock and take out the key for safekeeping.
4. Exit the marking software and computer system, lock the main door and take out the key for safekeeping.
5. Close the ON/OFF switch of the total power supply to OFF.
6. Close the exhaust system.
7. The device is closed.

Sixth, working area and focal length adjustment

6.1 Adjustment of working area

We need to choose different working areas to meet the requirements of the processing process. The following figure shows the adjustment parameters and methods for each area.



DI~D5 represents the vertical distance between the vibration lens and the stage, and the corresponding parameters behind it represent the maximum working range of the scale mark at the corresponding distance.
D1=300mm is used for marking patterns and characters within the size of 300x300mm (more detailed marking)
D2=400mm is used for marking patterns and characters within the size of 400 x 400mm.
D3=500mm is used for marking patterns and characters within the size of 500 x 500mm.
D4=600mm is used for marking patterns and text within the 600 x 600mm format (lining and cutting)
D5=800mm is used for marking patterns and characters within the size of 600 x 800mm.

When adjusting the lifting platform, ensure that your stainless steel ruler is perpendicular to the vibration lens and that the readings are accurate. After setting up the lifting platform, mark the largest square frame on the relative amplitude and use the ruler to check if this frame matches the dimensions shown on the computer screen. If the marked frame is smaller than expected, it indicates that the distance is too close; if it is larger, it suggests that the distance is too far. Adjust the lifting handle of the workbench slightly until the dimensions match. (For focal length adjustment, see Chapter 6.2) For example, if you draw a 400x400mm square in the computer, the laser will also mark a 400x400mm square on the workbench.

Note: When adjusting the working area, the background parameters of the computer should be set at the same time. See the software manual for the setting method.

6.2 Adjustment of focal length

After adjusting the working area, create a 10x10mm square in the drawing area of the marking software. Set the energy value to 15%, and mark continuously on A4 white paper (for software usage, refer to the software manual). It is recommended that professional machine operators adjust the focus. Note: The focus decreases

when turning clockwise and increases when turning counterclockwise. Repeatedly adjust the focus knob to quickly find the optimal laser focus. The best focus is when the laser line is the thinnest and the sound is clearest. After adjusting the focus, make sure to lock the focus wheel and inform others not to move it again.

Rotate the focal length clockwise to go down, and rotate the focal length counterclockwise to go up

Maintenance of equipment

7.1 Optical Devices

First, use lens paper dipped in alcohol to clean the outer surface of the plano lens, and then carefully remove the plano lens and clean the inner surface. Finally, use cotton swabs dipped in alcohol to clean the X/Y mirrors and focusing mirrors. Open the sealing tube of the dynamic group optical path and clean the dynamic lenses.

7.2 Workbench and adsorption workbench

Clean the surface and internal debris and oil layer of the workbench and adsorption table egg tray regularly. Do not knock during the cleaning process. When cleaning the inside, remove the pressure strip screws on three sides of the adsorption table, take out the egg tray and clean it with professional cleaning agent (Lanweibao).

7.3 Fan and smoke exhaust pipe

Open the fan side cover screw regularly, clean the dust on the fan turbine and inside with a brush and small knife, and cover the fan side plate after cleaning, and tighten all screws. Remove the air pipe joint, blow away the internal dust with a high-pressure air gun, and reinstall it.

7.4 Computer host and software

Clean the computer power supply, CPU fan dust and circuit board dust regularly. Make file data copies and virus scans for the computer regularly.

7.5 Power system

Voltage fluctuation range ±5%. Do not dial and answer mobile phones, walkie-talkies and other high-intensity electromagnetic wave radiation near the vibration lens. Ground resistance should not be greater than 0.5Ω.

7.6 Water circulation system

Keep the water circulation system ventilated, check the water level and water quality regularly, and replace the filter and circulating water regularly.

In the case of extremely low temperature, antifreeze should be added or the circulating water should be discharged after each use to prevent the equipment from freezing.

Common faults and solutions

(When performing any check, please turn off all power supplies of the device first)

8.1 No response when starting up

1. Check the voltage of the total power input and make sure it is normal.
2. Check whether the emergency stop EMERGENCY STOP switch is pressed, otherwise reset the emergency stop switch.
3. Whether the water circulation system is normal, check whether the waterway is kept unblocked.
4. Whether the panel's main power OFF/ON switch is in the ON position.

8.2 No laser output or weak laser output

1. Check to see if the software is displaying the marking (in red) and check that the pedal switch is working properly.
2. Whether the duty cycle is set properly in the software parameters, and the parameters are set properly. (Please read the software manual for setting the software parameters).
3. **Check whether the surface of the mirror is clean, otherwise please clean the mirror according to 7.1 Optical Maintenance instructions. If the mirror is not cleaned or the film falls off, please contact our**

customer service center for replacement.

4. **Check whether there is PWM signal on RS232 port, Pin 2 and Pin 5 of Db9 hole of marking control card. Otherwise, please contact our customer service center.**

IX. Warning and risk

All measures in this chapter are designed to prevent bodily and environmental harm from improper handling during machine operation or maintenance. The company does not assume responsibility for injuries resulting from the improper use of procedures or lack of prior written authorization. The machine should be operated and maintained by a person familiar with laser safety and incident protocols. The machine is equipped with warning signals to alert operators.

High  **voltage (visible at energized electrical and electronic components)**

General  **hazard (visible at the parts most in need of attention)**

Laser  **radiation is dangerous**

Fire ( **visible on the laser assembly)**

These warning signs can be seen in the most necessary places and are also shown in this instruction with the same meaning.

9.1 Power hazards

When using and maintaining this equipment, please carefully follow the following steps:

1. Before starting, make sure that the cover and protective cover of the electronic component are not removed.
2. Do not touch or place metal objects in the above places when the equipment is running.
3. When maintaining, turn off the machine and wait for several minutes before removing the cover and protective cover of the electronic component because residual voltage may occur.
4. Not all of the electronic components in a device operate at the same voltage, and the following voltages are also used.

230V AC		48V DC	5V DC
power supply		100w-200w-300w laser	Input/output circuit

circuit		power supply	

9.2 Laser risk

The pulses and frequencies generated at the laser output end are harmful to the human body, so avoid radiation to the eyes and skin. In some specific cases, scattered radiation can also damage the eyes.

Please pay special attention to the fact that the laser produced by the equipment is invisible and harmful to human body.

This laser equipment is a class 4 laser product and complies with industrial safety standards. The responsibility for protection of the laser must be stated in writing. Any operator using this equipment must understand the risks arising from improper operation.

The following are the current laser safety standards:

- GB2894-2008 Guidelines for Safety Signs and Their Use
- Safety of GB7247.1-2001 Laser Products Part 1: Equipment Classification, Requirements and User Guide

9.3 Protection against laser radiation

The laser produced by the device produces high energy and high density invisible radiation. This radiation can seriously damage skin tissue, such as burns of varying degrees.

The UNI-EN 209 standard specifies the maximum energy that the cornea can tolerate. Depending on whether the laser is continuous or pulsed, this limit is reflected in the pulse output energy and frequency regulations. All personnel operating or maintaining the equipment must wear protective glasses that meet the standards, even when the equipment is not equipped with protective measures. Only individuals familiar with lasers are permitted to enter the equipment's working area.

The equipment working area shall be equipped with standard warning signs. According to GB2894-2008 Guidelines for Safety Signs and Their Use, the hazards of laser radiation can be classified as follows according to the mode of radiation:

1. Direct radiation
2. Scattered radiation
3. Direct or scattered radiation after focusing by optical accessories

9.4 Smoke generated during laser processing

The smoke produced by the processing material at or out of focus on the laser focal length depends on the substance contained, the environment of the laser processing, and the melting, vaporization, and combustion caused by the thermoacoustic effect. The steam produced during the laser processing process may contain substances harmful to human health.

The chemical composition of the harmful substance depends on the processing material. Before installing the smoke emission device to the equipment, the smoke should be analyzed.

The resulting smoke can affect the equipment: it will increase the maintenance workload of the equipment and damage the optical accessories of the equipment.

If you want to process materials that produce smoke, such as plastic, it is necessary to install a smoke emission device on the equipment.

The smoke and steam generated can damage the equipment; problems caused by improper use are not covered by warranty.

9.5 Combustible materials

When using laser to process combustible materials, fire may start. Operators must pay attention at all times and fire extinguishers must be available near the equipment.

9.6 Laser protective goggles

Protective goggles worn during operation. The laser protective glasses must have the CE mark.

"GB7247.1-2001 Safety of Laser Products Part 1: Equipment Classification, Requirements and User Guide" or higher quality level with CE certification.

Protective goggles can prevent reflected or scattered radiation.

Fourteen categories of laser product standards

The following content is excerpted from the mandatory enforcement standard of our country, "GB7247.1-2001 Safety of Laser Products-Part 1: Equipment Classification, Requirements, and User Guide." This guide serves as a user manual for our company's laser equipment, providing a reference for understanding laser safety standards. It is an appendix to this manual and does not modify the current standard "GB7247.1-2001 Safety of Laser Products-Part 1: Equipment Classification, Requirements, and User Guide."

10.1 Laser radiation affects biological tissue

Because of laser alignment, laser radiation is different from other radiation. Laser alignment, with high energy or high power, causes a large amount of energy to be transmitted to biological tissue.

Biofouling, which absorbs the laser, is the main cause of damage.

The principle can be divided into:

- Thermal action
- A brief thermoacoustic effect

- photochemical process

The differences are determined by the physical parameters of the laser source, such as the wavelength of the radiation, pulse width, and the size of the image formed during radiation and energy release (when optical lenses are present). Generally, if the energy reaches a certain threshold, the primary damage process depends on the pulse duration: exposure times in the nanosecond range can cause brief acoustic phenomena, those between nanoseconds and 100 microseconds can lead to transient thermal acoustic effects, and continuous radiation over 100 microseconds to several seconds can result in thermal effects.

The absorption of radiation is carried out by atoms or molecules, which is closely related to the wavelength. When a sufficient amount of radiation is absorbed, the kinetic energy of the molecules increases, leading to an increase in temperature. Most injuries caused by lasers are due to the heating or heat absorption of skin tissue. The thermal damage is limited to the area around the region where the laser energy is absorbed, primarily concentrated at the center of the laser beam. Cells in this area may experience burning symptoms, and the primary cause of tissue damage is the destruction of cellular proteins. As previously mentioned, the continuous damage to tissues is mainly due to the duration of the laser radiation exposure and the laser pulse cycle. Due to the heat's conductivity, when the laser is directly irradiated to the tissue with continuous or long pulses, the area of high temperature gradually expands.

Because a large number of cells are overheated, the expansion of thermal effect causes the damaged area to increase, which is the thermal damage caused by continuous or long pulse laser radiation to the tissue.

Because it absorbs radiation at specific wavelengths, the damage is made worse.

Because the radiation area is in an excited state, special chemical reactions will occur. Reducing the radiation reduces this situation. Due to the combination of various triggering methods, peak power short pulse lasers (such as Q-switched lasers) can damage human tissue.

The time it takes for biological tissue to absorb energy is extremely short, producing intense radiation.

The temperature of the irradiated tissue rises so rapidly that the liquid components of the cells are rapidly converted into gas, and this rapid conversion causes the cells to burst or rupture.

Temporary compression occurs, resulting in the formation of an annular blast zone at the point of burning.

The human skin is exposed to laser radiation. The effects are determined by the physical properties of light, as the body has a self-repairing ability. However, the human eye can absorb certain wavelengths of light or transmit it to the nervous system. Nevertheless, the eye can suffer permanent damage due to the limited regenerative capacity of nerve fibers. Even minor injuries outside this range can be permanent.

The hazards of excessive exposure to different wavelengths are summarized in Table 10.1, divided into skin and eye injuries.

Table 10.1

(area coverage)	eye	skin
(ultraviolet rays , C) 180-280nm	keratitis	Accelerate aging
ultraviolet rays B 280-315nm	keratitis	(Increased pigmentation)
ultraviolet rays A 315-400 nm	Photochemical cataracts	change colour

(Visible reflection) 400-780nm	(Photodynamic and thermal damage to the retina)	(sensitivity response)
(Infrared emission A) 780-1400nm	(Cataracts, retinal burns)	(Skin burns)
infrared ray B 1400-3000 nm	(Slight inflammation, cataracts, corneal burning)	(Skin burns)
infrared ray C3000nm-1mm	(Only corneal burns)	(Skin burns)

Visible lasers near the infrared are a real threat to the eyes. At these wavelengths, the lens is transparent, and the laser beam can easily reach the internal nerve tissue. The relationship between the pupil's surface and the retina image results in increased radiation. In fact, the light entering the pupil focuses on a single point on the retina. The pupil has a variable width, but its diameter does not exceed 7MM (the maximum dilation in young people). Considering the energy concentrated by the lens, this increases the radiation from the cornea and the retina between 2X10 and 5X10. For example, the YAG laser has a wavelength of 1064nm. To avoid damage, the light energy on the skin must be 10 times greater than that on the eye.

10.2 Classification and hazard level of laser

I class

It includes lasers or laser systems, which are essentially safe or, in other words, not dangerous. Because they are designed with fixed protective devices or internal safety measures, direct and prolonged observation is no longer dangerous.

II class

It involves a laser source or a low-power radiation system (with continuous output below 1 mW) in the visible spectrum (400 to 700 nanometers). Direct exposure to light should be avoided. A brief, accidental exposure of less than 0.25 seconds is not considered dangerous. This is similar to the human instinctive reflex (the eyelid reflex). For prolonged exposure (over 0.25 seconds), a protective eye shield should be worn.

Class III 3A:

It is dangerous to look directly at a beam of light with optical instruments (telescope or astronomical telescope). In the wavelength range, the protection of the naked eye against accidental exposure (less than 0.25 seconds) is ensured by the eyelid's self-defense response.

Class III 3B:

Direct exposure to Class IIIB lasers is very dangerous, even in accidental exposure, goggles are required. Exposure to radiation and visible spectral regions are not considered dangerous under the following conditions.

a) The minimum distance of the observed object is 13CM
b) The maximum time to look at the object is 10 seconds

The emission level of the laser, where the emission level exceeds (LEA) the limit recognized by five times, is considered a VI class laser.

VI class

Each higher radiation emitted by a class 3B laser is considered a Class 4 laser system. In this case, the only scattered light that is exposed to is dangerous and can damage eyes, skin and cause fires. Eye protection is required for all operations on this type of laser or laser system.

10.3 Summary of safety measures

These are not only safety measures, but also control devices used by users according to the level of the laser. The laser manufacturer has classified the equipment, and this dangerous information and label can be found in the equipment or instructions.

When installing class 4 laser equipment (this is the use of a laser source with the highest level of potential hazard to humans), users of such laser systems must entrust a laser expert or a trained technician who is not only familiar with laser safety measures, but also knows how to take precautions to avoid accidents.

Whenever possible, protective devices must be used and it is important to understand that the equipment must be placed in a location that avoids accidental radiation leaks and is below hazardous levels. Warning signs must be placed where the machine is located (i.e., next to the lid of the machine).

The main purpose of safety measures is to reduce the level of laser radiation hazard or further the possibility of danger.

If there is any replacement that affects the laser performance, please notify our customer service center in writing and request to reclassify the laser system.

10.4 Warning and marking

(Warning sign at the position of the shaking lens)

If it is launched onto a reflective material, in this case the warning light indicates that the laser is on. The laser also needs protection.

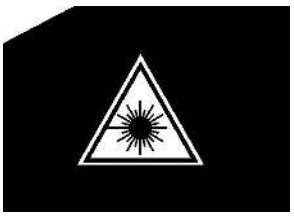


Figure 10.4 Warning signs at the location of the vibration lens

10.5, mirror reflection

Avoid unexpected laser radiation mirror reflection. The figure below shows the dispersion or transfer of radiation.

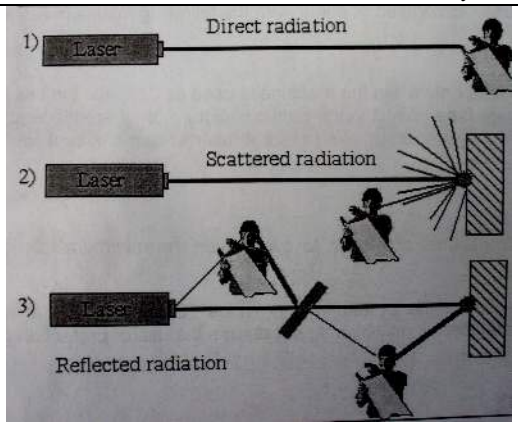


Figure 10.5 Mirror reflection

10.6, eye protection

When using class 4 lasers, always wear goggles.

10.7, safety training

Laser machines can be dangerous not only to users but also to those who approach the machine. Because of these dangers, only properly trained personnel are permitted to use laser systems. Our company can provide the appropriate training. The training includes:

1. Understand the workflow.
2. Understand the process of controlling hazards and warning signs.
3. Safety and protection guidelines.
4. How to determine an emergency.
5. The physical effects of lasers on the eyes and skin.
6. What are the potential hazards if not done correctly.

10.8 Hazards caused by laser operation

1. Air pollution: toxic smoke and gas produced during the processing of raw materials. (usually harmful gases are produced when raw materials are burned)
2. Side radiation: Laser processing produces the emission of laser light (similar to an oxyhydrogen flame)
3. Current hazards: Laser equipment should meet the low load standard.
4. Fire hazard: When processing flammable materials, the most likely fire hazard is generated. When cutting fragile materials, be careful to prevent the throwing of fragments, even from a distance. Please refer to the user manual, accidental fire can be completely avoided.

10.9 Risk control devices and specifications

1. Safety cover device:

The optical path protection device complies with the laser safety standard. The working area should also have a safety device to prevent accidental leakage of the laser in front, and fire protection devices should be arranged.

The penetration time of the safety devices must be detailed and the integrity of these safety devices must be checked.

2. Warning signs:

Are warning signs and delayed launch devices installed on the equipment, or is the equipment protected, or are the warning signs not obvious? Are visual and auditory warning signs installed to show some external equipment that the laser emits to the outside?

3. Temporary management of laser area signal lights:

Warning signs must be placed in temporarily managed laser areas, such as during facility maintenance or faulty machines.

4. Personal protection:

When following the instructions on how to use the machine, the need for personal protection should be reduced to a minimum.

5. Visibility of employee operations during work:

The operator must observe the laser processing material from one position and be close to the control panel and emergency switch.