User Manual

MF44 Professional Laser Cutting Machine

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Intellectual Property Notice

All intellectual property rights related to this equipment and its software are the exclusive property of **Mintech Inc.** Any unauthorized reproduction, modification, or use is strictly prohibited.

Important Notice

1. Operational Risk

This fiber laser cutting machine is intended for use **only by properly trained personnel**. Operators must thoroughly read and understand all contents of this manual and strictly follow all operating instructions and safety guidelines.
Mintech Inc. shall not be held responsible for any damage or malfunction resulting from improper operation, unauthorized modification or repair, or failure to perform routine maintenance as outlined in this manual.

2. Limitation of Liability

Mintech Inc. is **not liable for any indirect, special, incidental, or consequential damages**, including but not limited to loss of production, loss of profit, or data loss, resulting from the use of this equipment.

3. Scope of Application

The information in this manual applies **only to the specified model(s)** of Mintech fiber laser cutting machines. Any unauthorized alterations or modifications to the equipment will **void the warranty**.

4. Technical Data & Information

The technical data and product information in this manual are **subject to change without notice** as part of Mintech's ongoing product development and improvement process.

We hope this manual provides valuable guidance for the **safe and effective operation** of your fiber laser cutting machine.
If you have any questions or require further technical support, please do not hesitate to contact **Mintech Customer Support**.

Thank you for choosing Mintech. We are committed to providing you with quality products and exceptional service.

Table of Contents

Chapter 5 – Operating Instructions

Chapter 6 – Maintenance and Care

Chapter 1 – Safety and Regulations

1.1 Safety Standards and Guidelines

Applicable U.S. Standards:

This equipment is designed and manufactured in accordance with relevant U.S. safety regulations, including but not limited to:

- **ANSI Z136.1** – Safe Use of Lasers
- **NFPA 79** – Electrical Standard for Industrial Machinery
- **OSHA 29 CFR 1910.147** – The Control of Hazardous Energy (Lockout/Tagout)

⚠**Note:**

Operators must comply with all **federal, state, and local safety regulations**, as well as workplace-specific safety and accident prevention protocols.

To ensure the **safe operation of the fiber laser cutting machine** and to prevent injury or equipment damage, please observe the following key safety principles:

✅**Always maintain a high level of safety awareness** during operation.

✅**Conduct regular safety training** and ensure all personnel are properly trained and authorized.

✅ Operators must understand all potential hazards and follow safety

procedures outlined in this manual.

✅ Follow **lockout/tagout procedures** during maintenance or repair.

✅ Ensure proper use of **personal protective equipment (PPE)**, such as laser safety glasses, gloves, and protective clothing.

By following strict safety protocols and responsible operation, you can effectively reduce the risk of accidents and ensure both **operator safety and reliable machine performance**.

1.2 Hazards of Laser Operation

1.2.1 Laser Radiation Hazards

- **Direct Exposure:** Fiber laser beams have extremely high energy density and can cause **serious injury to eyes and skin**. Operators must wear **ANSI Z136.1-compliant laser safety glasses**, and the laser beam must be confined within a **sealed or enclosed area** during operation.
- **Reflected Radiation:** Reflections from shiny or metallic surfaces can scatter the laser beam and pose significant risks. Avoid using high-reflectivity materials near the laser path, and always use **protective barriers and enclosures**.
- **Safety Measures:**
    - Install proper **laser shielding or enclosures**.

- Limit access to the laser operating area to **authorized personnel only**.
- Display clear **laser hazard warning signs** at all entry points as required by **OSHA and ANSI standards**.

1.2.2 Electrical Hazards

- **High Voltage Components:** The laser cutting machine operates on **high-voltage power**, posing a risk of electric shock. Only **qualified electricians or trained service personnel** should perform installation or maintenance.
- **Wiring and Connections:** Regularly inspect all **cables and terminals** for wear, damage, or looseness. Never operate the machine in **wet or damp conditions**.
- **Emergency Shutdown:** Ensure all operators know the location of the **emergency stop button** and understand proper **lockout/tagout (LOTO)** procedures in case of electrical failure.

1.2.3 Mechanical Hazards

- **Moving Components:** The machine’s table and gantry may **move rapidly during operation**. Never reach into the machine while it is powered on or in motion.

- **Clamping Mechanisms:** Always ensure workpieces are **securely clamped** to prevent shifting or ejection during cutting.
- **Maintenance Safety:** Power off the machine completely before performing any maintenance. Wait until **all moving parts have fully stopped** before accessing the machine.

1.2.4 Fire and Explosion Hazards

- **Flammable Materials:** Laser processing generates **extreme heat**, which can ignite flammable materials. Keep the **work area free of combustible items**, and equip the site with **appropriate fire extinguishers** (e.g., CO_2 or dry chemical).
- **Ventilation and Fume Extraction:** Ensure **proper ventilation and active exhaust systems** are functioning to remove smoke, dust, and fumes generated during cutting, reducing the risk of fire or respiratory hazards.
- **Operating Procedures:** Never operate the machine beyond its rated capacity or without proper cooling. Overheating may lead to **fire or system failure**.

1.2.5 Noise and Vibration Hazards

- **Noise Control:** Fiber laser machines may generate **high noise levels**, especially during high-power or piercing operations.

Operators should wear **hearing protection (earplugs or earmuffs)** in accordance with **OSHA 29 CFR 1910.95**.

- **Vibration Impact:** Excessive vibration may affect **cutting accuracy** and long-term machine health. Ensure the machine is installed on a **stable foundation**, and periodically check for loose components.

1.2.6 Chemical Hazards

- **Toxic Fumes:** Cutting certain materials, such as **plastics or coated metals**, can release hazardous gases. Ensure **adequate ventilation** or use a **dedicated fume extraction system**.
- **Cleaning Agents and Lubricants:** Use chemicals in accordance with the **manufacturer's SDS (Safety Data Sheet)**. Wear **chemical-resistant gloves and safety goggles** to avoid skin contact and inhalation of vapors.
- **Waste Disposal:** Collect and dispose of cutting waste and residues in accordance with **EPA and local environmental regulations** to avoid pollution and chemical hazards.

Before operating the fiber laser cutting machine, it is essential to **carefully read all safety information** provided in this manual and **pay close attention to the safety warning labels** affixed to the machine. These labels are

designed to alert operators to potential hazards and provide critical safety guidance.

Ensure that all safety labels are **intact, clearly visible, and remain in their original positions**. If any label is found to be **damaged, faded, or missing**, it must be **replaced immediately**. New labels should be affixed **exactly in their original locations—do not remove, relocate, or alter** any safety label without authorization.

Some labels may include signal words such as **“DANGER”** or **“WARNING”** to indicate **high-risk areas** or operations that could result in **serious injury**.

Safety labels are typically located near critical hazard zones, including:

- Laser emission ports
- Moving components (e.g., gantry, worktable)
- Cutting head and surrounding area
- High-voltage or high-temperature components

Operators must strictly follow all label instructions, **avoid direct contact with hazardous areas**, and **wear appropriate personal protective equipment (PPE)** at all times to ensure safe operation.

1.3.1 Types of Safety Labels

Label	Color	Description
DANGER	Red background with white text	Indicates **immediate danger** that will result in serious injury or death if not avoided. Used near high-voltage zones or laser beam exits.
WARNING	Orange background with black text	Indicates a **potential hazard** that could result in serious injury or death. Commonly used near hot surfaces or moving parts.
CAUTION	Yellow background with black text	Indicates a **minor hazard** that may cause slight injury or equipment damage.
NOTICE	Blue background with white text	Provides **important operational information**. Not a safety alert.
PPE	Blue text and white image	Indicates required **Personal Protective Equipment (PPE)** such as goggles, gloves, or hearing protection.

1.3.1 Icons and descriptions

	Safety glasses must be worn.
	Warning:Laser Radiation
	Please read the user manual before operating the machine
	Caution: keep hands away to avoid injury
	This machine may produce toxic fumes/particles

	Caution: Class 2M Laser Radiation When Open. Do Not Stare Into the Beam or View Directly With Optical Instruments.
	DANGER – Class 4 Laser Radiation When Open. Avoid Eye or Skin Exposure to Direct or Scattered Radiation.
	Danger:Electric Shock
	Warning: Risk of injury from Moving Parts
	Keep away while the machine is in operation
	Operation and maintenance of this equipment must be performed by authorized professionals only
	Safety goggles must be worn when operating the machine
	Warning: Do not touch the machine during operation

1.4 Operational Safety

Improper use or operation of the machine beyond its intended purpose may lead to:

- Personal injury to operators.
- Damage to the machine or surrounding property.
- Adverse impact on machine performance and reliability.

1.4.1 Machine Usage Requirements

This machine is intended for **industrial use only**. Installation, operation, and maintenance must comply with **manufacturer instructions** and **local regulations**.
Permitted uses include laser cutting of **metal sheets** and, where applicable, **metal profiles**.

The following actions are **strictly prohibited**:

- Unauthorized modifications or alterations.
- Operating methods that compromise safety.
- Cutting of:
    - Plastics (especially chlorine-based like PVC)
    - Wood
    - Boards coated with PVC film
    - Magnesium or other flammable metals

Disclaimer:
Any other usage shall be deemed **unauthorized**. Mintech is **not liable** for damages resulting from such use. **Warranty will be void**.

1.4.2 Authorized Personnel

Only **trained and authorized personnel** are permitted to operate, configure, or service the machine.

Authorized personnel may perform:

- Transporting and positioning the machine.
- Operating laser, pneumatic, hydraulic, and electrical systems.
- Disassembling or moving machine components.

1.4.3 Safety Precautions

- Ensure proper lighting in the operating area for visibility and safety.
- Always check the surroundings before powering on to avoid accidental injury.
- All personnel near the laser must wear **1064nm laser safety goggles**. Never look directly at the laser beam.

- Protective enclosures must be used to contain the laser beam. The laser should **shut off automatically** when safety doors are opened.
- Disable the servo system before entering the machine area. Always **remove the key switch** when not in use.
- Cutting heads and parts may remain hot. Allow to cool before contact.
- Do not cut materials of unknown composition or flammability.
- Perform a test cut for new materials to confirm settings.
- Operators must **remain on-site** during cutting. Pause or power down if stepping away.
- Do not modify parameters during operation without proper validation.

1.5 Hazards

1.5.1 Laser Classification (ANSI Z136.1 Compliant)

Laser devices are classified based on their potential hazards to eyes and skin. The U.S. follows the ANSI Z136.1 standard, as summarized below:

Laser Class	Description
Class 1	Safe under all normal usage. No protective measures required.
Class 1M	Safe to the unaided eye, but hazardous when viewed with optical instruments.
Class 2	Visible lasers (<1mW). Blink reflex provides natural protection.
Class 2M	Same as Class 2, but hazardous with optical aids.
Class 3R	Potential eye hazard (<5mW). Avoid direct eye exposure.
Class 4	High power (>500mW). Severe risk to eyes and skin. May cause fire. Requires full safety protocols.

1.5.2 Laser Classification of This Machine

This machine is classified as a **Class 4 laser system**, the highest and most hazardous classification under ANSI Z136.1. Class 4 lasers emit high-power beams capable of causing **serious or permanent eye and skin injuries** and may also pose **fire hazards**.

Due to the high-powered laser beam used for cutting metals and other materials, strict safety measures must be followed to reduce operational risks:

✅ **Safety protection devices**

- Fully enclosed protective covers must be installed to prevent beam exposure.

✅ **Automatic interlocking system**

- Interlock systems must deactivate the laser when the enclosure is opened.

✅ **Emergency stop device**

- Emergency stop buttons must be accessible for immediate shutdown if needed.

✅ **Personal protective equipment （PPE）**

- Operators must wear **certified laser safety goggles** appropriate for the laser wavelength.

✅ **Operating procedures and authorization**

- Only **trained and authorized personnel** may operate this machine under defined safety protocols.

⚠ WARNING:

Failure to follow safety measures may result in **permanent eye damage, skin burns, or fire hazards**. Always ensure all safety mechanisms are in place and functional.

1.5.3 Overview of Residual Risks

Despite the equipment being equipped with safety devices and structural design, some unavoidable residual risks remain. The following lists typical hazards and recommended safety measures for operators:

Risk Category	Hazard Source	Hazard Type	Recommended Measures
Mechanical Risks	X, Y, Z axis movement	Crushing or impact	Avoid getting close to moving parts
Mechanical Risks	Sharp work piece edges	Cutting injury	Wear gloves and protective clothing； Use tools to remove parts
Mechanical Risks	Protruding parts	Entanglement or	Mark hazard zones clearly

Risk Category	Hazard Source	Hazard Type	Recommended Measures
		interference	
Mechanical Risks	High-pressure cutting gas	Gas ejection injury	Only trained personnel replace tanks; wear goggles
Electrical Risks	Live electrical components	Electric shock (fatal)	Power off before service; no unauthorized wiring
Thermal Hazards	Molten slag splashes	Burns	Keep distance; wear fire-resistant gear
Thermal Hazards	Contact with hot parts	Contact burn	Wait until fully cooled
Thermal Hazards	Oxygen leak ignition	Fire or explosion	Install proper extinguishers; Inspect gas lines regularly
Radiation Hazards	Plasma or laser light	Eye injury	Wear laser safety goggles; Follow local laser safety laws
Material Hazards	Cutting gases, dust, aerosols	Inhalation or skin exposure	MSDS / Ensure ventilation; follow MSDS and manual guidance
Fire hazard	Fire and Explosion	Dust collector or cutting area	Install extinguishers: dry powder (Class A/B/C); Follow fire codes

Chapter 2: Product Overview

2.1 Key Components of the Laser Cutting Machine

A laser cutting machine consists of several key modules that work together to ensure efficient, stable, and high-precision cutting operations.

2.1.1 Machine Bed

The machine bed provides structural support, typically constructed from heavy-duty welded steel with stress relief and heat treatment for enhanced rigidity and vibration resistance.

2.1.2 Gantry

The gantry supports and moves the cutting head along the X-axis. It is often made of aerospace-grade aluminum for strength and lightweight performance, enabling high-speed precision movement.

2.1.3 Control System

The control system acts as the brain of the machine, coordinating the laser, motion, and automation. It features functions like path optimization, real-time monitoring, and remote diagnostics.

2.1.4 Laser Source

The fiber laser source is the energy core, offering high photoelectric conversion efficiency and low maintenance, suitable for a wide range of metal materials.

2.1.5 Cutting Head

The cutting head focuses the laser beam on the material, featuring auto-focus and height-sensing systems for optimal quality across varying material thicknesses.

2.1.6 Cooling System

An industrial-grade chiller provides precise cooling to the laser source and optics, preventing overheating and ensuring continuous operation.

2.1.7 Pneumatic System

The pneumatic system delivers assist gases (oxygen, nitrogen, or air) to the cutting area. Gas type, purity, and pressure significantly affect cutting performance.

2.1.8 Water Circuit System

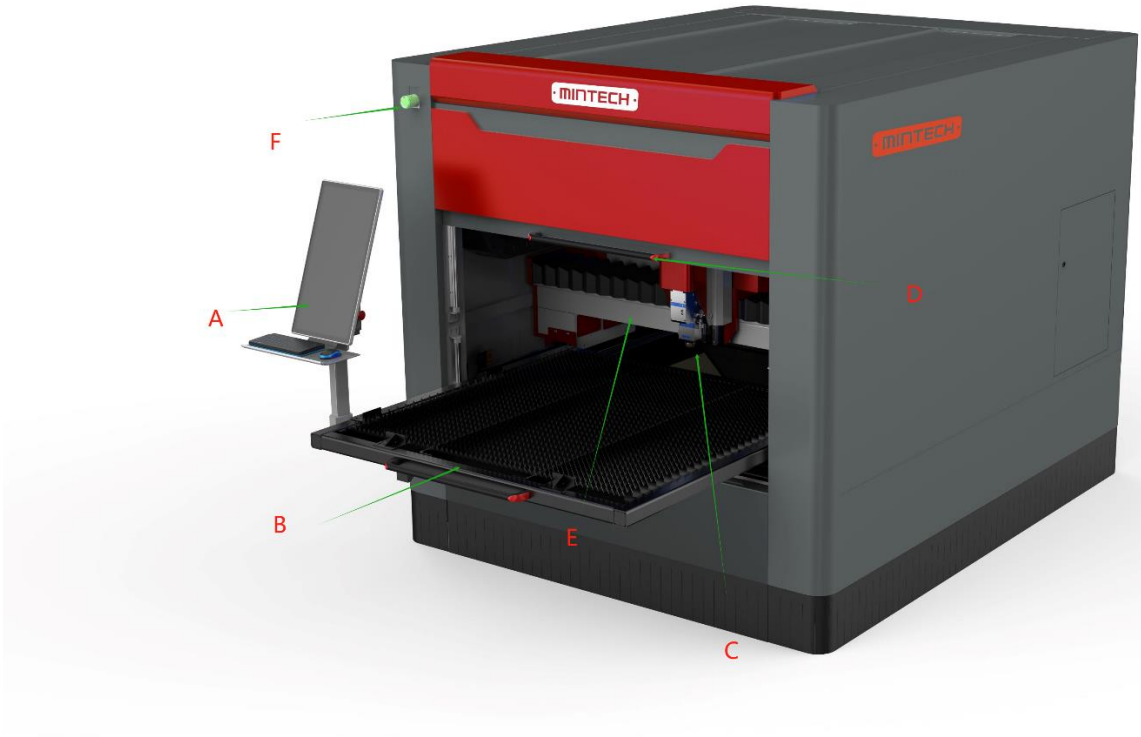
The water circuit supplies coolant to the laser source and optics. It includes a primary loop for the laser and a secondary loop for fiber connectors and lenses.

2.1.9 Dust Extraction System

Industrial dust collectors or fume extractors remove particles and fumes generated during cutting, maintaining a clean and safe working environment.

2.2 Machine Appearance Overview

Machine front side



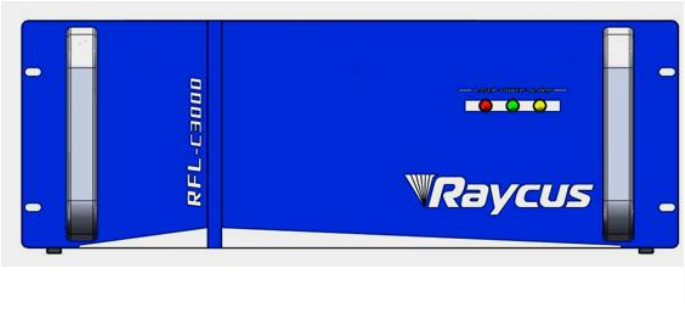
A	Integrated HMI / Operator Console
B	Pull-Out Worktable / Drawer Table
C	Laser Cutting Head / Focusing Assembly
D	Vertical Sliding Safety Door
E	Moving Gantry / Crossbeam Assembly
F	Status Indicator Light / Signal Light

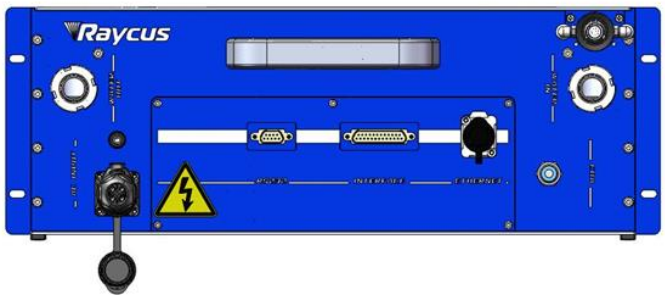
Machine back side

G	Electrical Control Cabinet / Power Cabinet
H	Rear Safety Access Door
I	Laser Source Installation Area
J	Power & Pneumatic Interface
K	Fume Exhaust Port / Dust Outlet
L	Left Maintenance Access Door

2.2.1 Raycus Laser Panel Description

The Raycus laser panel integrates power, control, alarm, water cooling, and communication ports for comprehensive laser operation and status monitoring.





◆ Panel Indicator & Port Functions

POWER	POWER Indicator	Red light indicates that the laser is powered on.
LASER	LASER Output Indicator	Green light indicates the laser is actively emitting.
ALARM	ALARM Indicator	Yellow light indicates a fault or warning has occurred.
AC INPUT	AC INPUT Socket	Connect with specified AC input per model, equipped with circuit breaker.
CTRL-INTERFACE	CTRL-INTERFACE (DB-25)	Multifunctional control port: mode selection, analog input, modulation & alarm.
RS232	RS232 Port	Serial interface for remote control and fault logging.
WATER	WATER Inlet/Outlet	Water ports for chiller connection. Use proper PU tube per model spec.
ETHERNET	ETHERNET Port	Ethernet port for remote access and alarm information transmission.
CDA	CDA Input	Clean Dry Air input to prevent internal condensation and ensure reliability.

◆ Laser Remote Monitoring Instructions

The laser can be remotely monitored via computer using either of the following connection methods:

1. **RS-232 Serial Mode**

   Use the provided RS-232 cable and select the corresponding COM port for access.

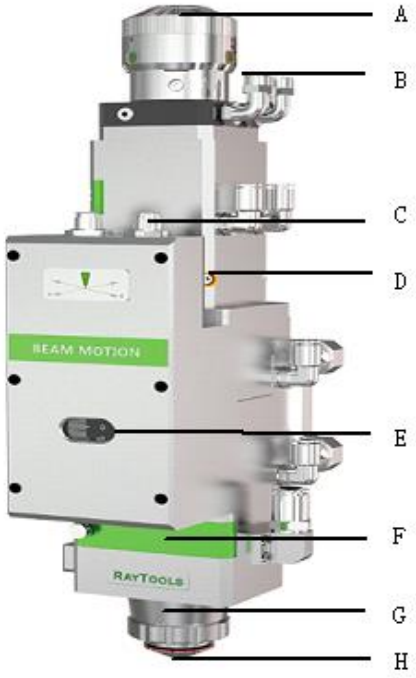
2. **Ethernet Mode**

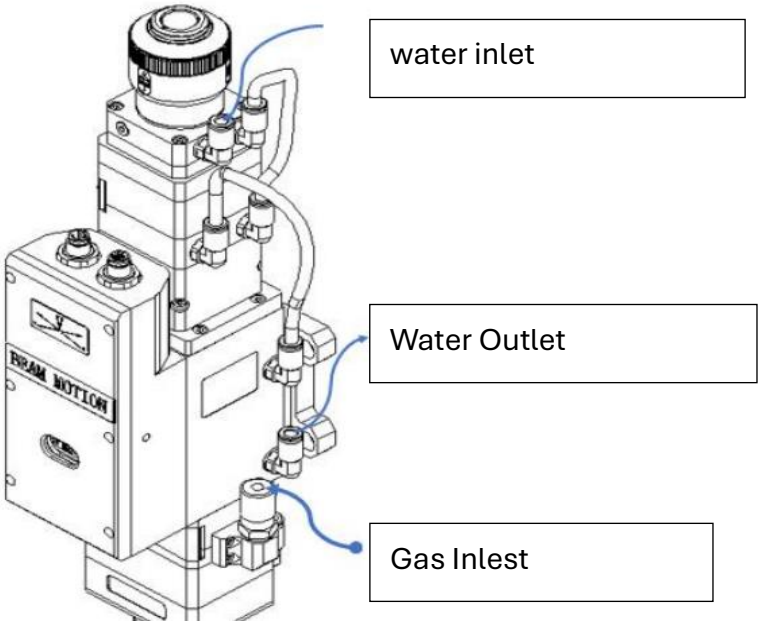
   Configure the IP addresses as follows to enable access via Ethernet:

   - **Laser IP Address**： 192.168.0.178
   - **Computer IP Address**： 192.168.0.180

After successful connection, click “Login” to access the laser monitoring dashboard for real-time data and control.

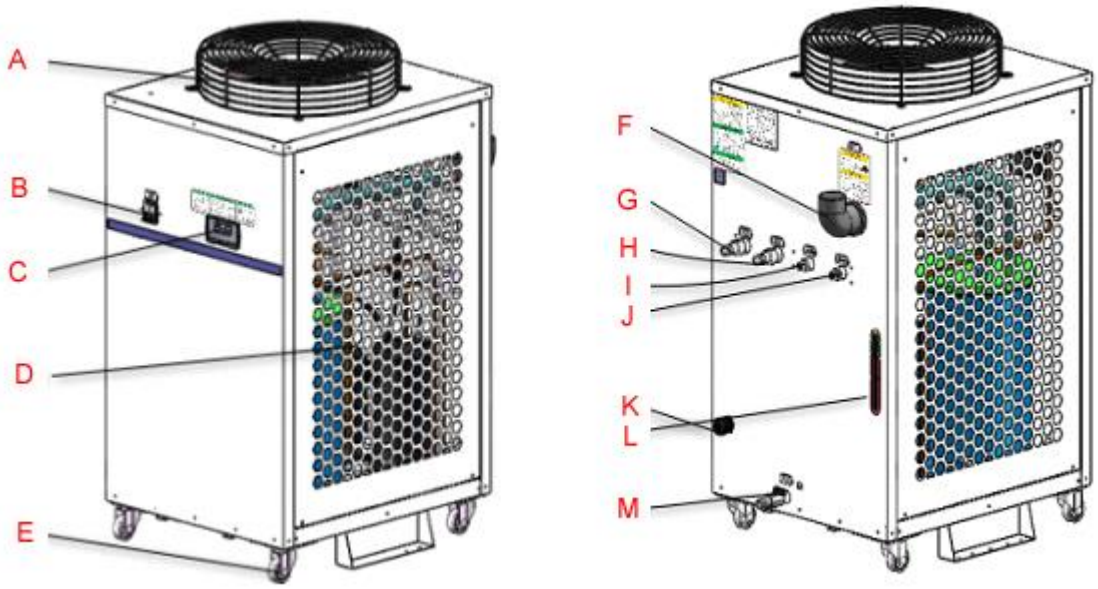
2.2.2 CNC Cutting Head





A	QBH Connector	E	Scale Viewing Window
B	Water Cooling Port	F	Protective Lens Drawer (Lower)
C	Aviation Connector	G	Sensor Module
D	Centering Adjustment Knob	H	Nozzle

2.2.3 Chiller



A	Exhaust Vent
B	Circuit Breaker
C	Controller
D	Air Inlet
E	Caster Wheels
F	Water Filling Port
G	Low-Temperature Water Outlet
H	Low-Temperature Water Inlet
I	High-Temperature Water Outlet
J	High-Temperature Water Inlet
K	Power Cable Outlet
L	Water Level Indicator
M	Drain Port

Temperature Control Panel Instructions

Normal water set temperature = [Low-temperature water set value] + [F01 ambient offset].
To adjust the normal temperature, you must modify the factory parameter **F01**.

How to adjust:
On the temperature display screen, press and hold **<▲> + <▼>** for 5 seconds to enter **factory parameter setting mode**.
Do **not** modify factory settings without approval from the chiller manufacturer.
Once inside, use <▲> or <▼> to change the parameter values.
If no input is detected for 5 seconds, or if <▲> + <▼> is pressed again, the system will **automatically save and exit** (the display will blink while saving).

2.2.4 Product Specifications

Item	Specification	
Model	MF44	
Laser Power	3000W Fiber Laser Output Power	
Working Area	X/Y Axis: 1300mm / 1300mm	
Z-Axis Travel	100mm	
Positioning Accuracy (X/Y)	±0.03mm	
Repeatability (X/Y)	±0.03mm	
Ambient Temperature	+10 to 35°C	
Dimensions	Length: 2777mm	
	Width: 2151mm	
	Machine Height: 2040mm	
Approx. Weight	1501kg	
Electrical Specs	AC380V / 50/60Hz	
IP Rating	IP54	
Cutting Capacity (Flat Sheet)		
Mild Steel (O_2)	1–14mm	1–14mm Carbon Steel with Oxygen
Stainless Steel (N_2)	1–6mm	1–6mm Stainless Steel with Nitrogen

Chapter 3 Installation Instructions

3.1. Unpacking Precautions

When unpacking the laser cutting machine, please follow the guidelines below to ensure the safety and integrity of the equipment:

- **Packaging Removal**:

  If the equipment is packed in a wooden crate, please follow the instructions displayed on the exterior of the crate when unpacking to prevent damage to the equipment during the process. For equipment wrapped in protective film, avoid using sharp tools to directly cut through the packaging material, so as to prevent scratching the equipment's surface or damaging the protective conduits for electrical installations.

- **Inspection Items**:

  - **Confirm Equipment Model**:

    Upon unboxing, immediately verify that the model of the received equipment matches the product you purchased, ensuring that the device meets the requirements of your order.

  - **Check for Transport Damage**:

    Conduct a comprehensive inspection of the equipment to verify whether any damage or anomalies occurred during transit.

  - **Verify Accessories Completeness**:

    Based on the accompanying checklist, verify that all parts and accessories are present and complete, and inspect them for any damage, paying particular attention to the integrity and functional condition of critical components.

- **Handling Anomalies**:

  If you discover any issues—such as an incorrect device model, missing accessories, or transit damage—please contact our After-Sales Service Department or service provider as soon as possible to ensure the timely handling and resolution of these matters.

- **Other Considerations**:

- **Photograph for Records**: We recommend taking photos during the unboxing process to serve as documentation for addressing any potential issues later.
- **Prompt Inspection**: It is recommended to complete the above checks as soon as possible after unboxing to ensure the integrity and proper functioning of the device.

3.2. Installation Precautions

The proper installation of a laser cutting machine is crucial to ensuring the equipment operates correctly. Please strictly adhere to the following requirements:

3.2.1. Installation Site Requirements

- **Flooring Requirements**:
  - **Levelness**: The floor surface must be kept level; within the footprint of the laser cutting machine's foundation, the height variation shall not exceed ±10 mm. Furthermore, the foundation must be capable of withstanding a load of over 20 tons to ensure that equipment operation remains free from errors caused by foundation-related issues.
- **Space Layout**:
  - **Distance from Walls**: A minimum clearance of 60 inch should be maintained between the laser and the wall, and the distance between the chiller and the laser should not exceed 400 inch, to ensure smooth connection of the cooling pipes.
  - **Operating Space**: An operating clearance of at least 50 inch should be reserved around the equipment to facilitate routine maintenance and personnel access.
- **Vibration Control**: The laser cutting machine should be installed on a vibration-free floor, and its use in conjunction with equipment that generates impact or vibration should be avoided.
- **Safety Environment**: Avoid installing the laser cutting machine in flammable or explosive environments; keep the area surrounding the equipment free from open flames and electric welding operations.

3.2.2. Environmental Requirements

- **Temperature Control**:
  - **Operating Temperature**: The ambient temperature should be maintained between 15°C and 30°C to prevent excessively high or low temperatures from affecting equipment performance.

- **High-Temperature Operation**: During the summer, if the ambient temperature exceeds 35°C, it is recommended to implement appropriate cooling measures to prevent the laser from overheating.
- **Low Temperature Operation**: During winter, if the temperature drops below 10°C, the equipment's water-cooling system must be kept running continuously or antifreeze added to prevent freezing and subsequent damage.

- **Humidity Requirements**:
  - **Relative Humidity**: The ambient relative humidity should be maintained between 30% and 70%. Excessively high humidity may cause internal electrical components to become damp, thereby reducing the stability of the laser; conversely, excessively low humidity may lead to the accumulation of static electricity, potentially damaging electronic components.
- **Cleanliness Requirements**:
  - **Air Quality**: The operating environment should be kept clean, avoiding the presence of excessive airborne dust, oil mist, or other contaminants. These particles can compromise the cleanliness of optical components and degrade beam quality.
  - **Avoid Pollution Sources**: Avoid installing the device in locations where fumes from painting, solvents, or degreasing processes are present, as these fumes may absorb laser radiation and affect laser performance.
- **Airflow Control**:
  - **Avoid Strong Airflows**: Strong airflow or unidirectional winds should be avoided in the vicinity of the equipment to prevent air currents from interfering with the optical path system or the moving components of the machine tool.
  - **Prevent Direct Sunlight**: If the device is installed near a window, curtains or blinds must be installed to prevent direct sunlight.
- **Ventilation Requirements**:
  - **Ventilation System**: Factory workshops should be equipped with an effective ventilation system to ensure air circulation, while avoiding direct airflow toward the laser cutting machine.

- **Smoke and Dust Exhaust**: The smoke, dust, and harmful gases generated during the cutting process must be promptly extracted via an exhaust system to safeguard the health of operators and maintain the cleanliness of the equipment's interior.

3.2.3 Electrical Requirements

To ensure stable operation and safe use of the equipment, power connection for the laser cutting machine must comply with the following requirements:

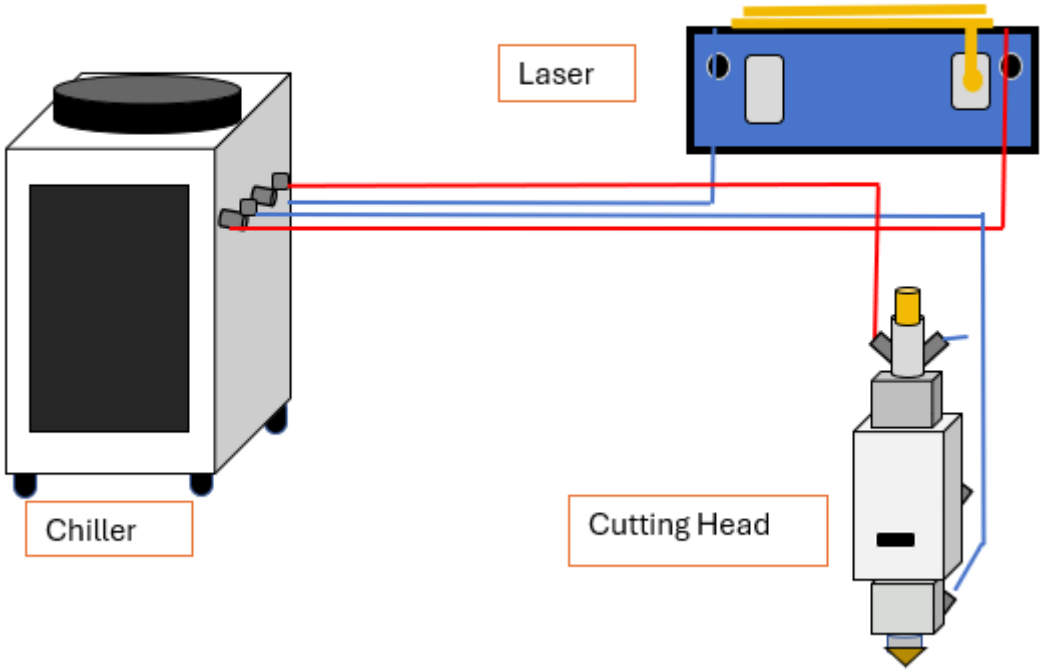
- **Power Input**
  Power supply must be **three-phase five-wire, AC380V ±5%, 60Hz**, with a **voltage stabilizer** to protect the system from voltage fluctuations.
- **Grounding Protection**
  A reliable grounding system is essential, with ground rods at least **6.56 foot deep** and **resistance ≤ 0.5Ω**, to prevent static electricity risks.

Table 3-1 Electrical Specifications

Item	Specification	Description
Power Type	3-Phase 5-Wire	Standard industrial power
Operating Voltage	AC380V ±5% / AC380V ±5%	Voltage stability required
Frequency	60Hz	
Cable Material	Copper	High conductivity recommended
Cable Size	8–10 mm^2/10-8AWG	Depending on power rating
Voltage Stabilizer Capacity	50–80KVA	Depending on model setup

3.2.4 Water Connection

To ensure stable and efficient operation of the laser source and cutting head, the water cooling system must be properly installed and maintained as described below.



System Structure

The cooling system of this equipment comprises two circuits:

- **Primary Circuit**: Provide cooling water for the laser.
- **Optical Path Circuit**: Provides cooling water for optical components such as QBH connectors and collimators.

Water Filling Procedure

1. Open the chiller's water inlet valve and add water to the tank.
2. The water level should be maintained 30–50 mm below the top rim of the water tank to prevent overflow.
3. Use purified or distilled water when adding water; the use of tap water is strictly prohibited to prevent the formation of limescale.
4. When adding water for the first time, or when powering on again after a prolonged period of disuse:
    - The water pump's air vent valve must be opened to release air, in order to prevent damage to the pump.

- Simultaneously adjust the opening degrees of all valves within the water circulation system.
- During subsequent operation, please avoid frequently adjusting the valves.

Open the **inlet valve**, fill the tank with **purified or distilled water**, and maintain the water level **30–50mm below the tank top**.
Before first startup, make sure to **bleed air from the water pump** and adjust all valve openings properly.

Chiller Operation

Once the water temperature reaches the set value, the chiller will automatically maintain a constant water temperature, and the water pump will continue to operate to ensure a stable circulation of cooling water.

Only after the **coolant temperature and water pressure differential** meet the laser's required specifications should the **laser be powered on**.

Recommended Temperature Settings

Circuit	Summer (>35°C)	Winter (10–20°C)
Primary	27°C	24°C
Optics	30°C	28°C

Antifreeze Precautions

- If the operating environment temperature falls below 0°C (32°F), it is recommended to use antifreeze specifically designed for laser equipment.
- Antifreeze should possess the following characteristics:

Requirement	Description
Excellent Anti-freeze Performance	Ensure Safe Operation at Low Temperatures
Corrosion Resistance	Preventing Corrosion of Piping and Lasers
Rubber Compatibility	No swelling or damage to seals
Stability	Does not spoil for a long time

Requirement	Description
Low-temperature fluidity	Maintain normal circulation efficiency.

Please do not mix antifreeze from different brands or models to avoid chemical reactions.

Periodic Maintenance Recommendations

- It is recommended to replace the cooling water every 1–2 months to keep the system clean.
- Regularly inspect water quality and filter cartridges to prevent impurities from clogging the cooling channels.
- Before winter or a prolonged shutdown, please thoroughly drain the water lines or add antifreeze.

Replace coolant every **1 to 2 months**, clean filters regularly, and ensure all hoses are free from blockage. Always drain or protect the system in cold seasons.

3.2.5 Gas Supply Requirements

During operation, laser cutting machines require various types of auxiliary gases to meet the cutting requirements of different materials. The following provides detailed gas requirements and important considerations:

Gas Types

- **High-Purity Oxygen**
  Used for carbon steel cutting to enhance cutting speed and edge quality.
- **High-Purity Nitrogen**
  Used for cutting stainless steel, aluminum, etc., to prevent edge oxidation or discoloration.
- **Compressed Air**
  A cost-effective option for low-precision cutting or rough processing, suitable for aluminum and mild steel.

Gas Supply Methods

- **Cylinder or Cylinder Manifold**
  Easy to use, suitable for small to medium-scale use. Oxygen/Nitrogen purity should be ≥99.7%.
- **Liquid Oxygen Supply**
  - Pressure Requirements： about 1 MPa ≈ 145 psi
  - Gas Purity： ≥99.9%
  - Vaporizer Gas Supply Capacity： ≥50 m^3/h （about 1765 ft^3/h）
    Supply pressure ~145 psi, purity ≥99.9%, vaporizer capacity ≥1765 ft^3/h.
- **Liquid Nitrogen Supply**
  - Pressure Requirements： 2–3 MPa ≈ 290–435 psi
  - Gas Purity： ≥99.99%
  - Vaporizer Gas Supply Capacity： ≥100 m^3/h （约 3530 ft^3/h）
    Supply pressure 290–435 psi, purity ≥99.99%, vaporizer capacity ≥3530 ft^3/h.

Important Notes

- *Gas flow will interrupt during cylinder replacement – plan accordingly.*
- *Use clean tubing with no oil, grease, or moisture.*
- *Do not clean hoses with solvents; do not use lubricants when connecting hoses.*
- *Maintenance must be performed in a clean environment.*
- *Install pressure regulators between the gas source and the machine.*

Pressure Regulator Requirements

- **Oxygen Regulator**： The output pressure range should reach 0.1–1.5 MPa （≈ 14.5–217 psi）
- **Nitrogen Regulator**： The output pressure range should reach 2–3 MPa （≈ 290–435 psi）
- **When the air-blowing function is active within the cutting software, the system air pressure must not drop below 0.3–0.4 MPa (≈ 43.5–58 psi); excessive pressure drop will compromise cutting quality.** When the "blow" function is activated, gas pressure should not drop below 43.5–58 psi to avoid performance loss.

Air Supply Requirements for Laser Cutting with Compressed Air

When using air as an assist gas for laser cutting, the air supply system must meet the following requirements:

Air Compressor System

- **Type:**
  Screw-type air compressor is recommended.
- **Working Pressure:**
  2.5 MPa ≈ **362.6 psi**
  The output pressure should reach 2.5 MPa (362.6 psi).
- **Air Flow Rate:**
  ≥ 2.0 m^3/min ≈ **70.6 CFM**
  Minimum exhaust volume should be 2.0 m^3/min (70.6 CFM).

Air Quality Control

- **Filtration System:**
  At least 3–5 stages of air filtration based on onsite conditions.
- **Refrigerated Air Dryer:**
  Capacity should be no less than 3.8 m^3/min (134.2 CFM).
- **Adsorption Dryer:** *For enhanced moisture removal.*

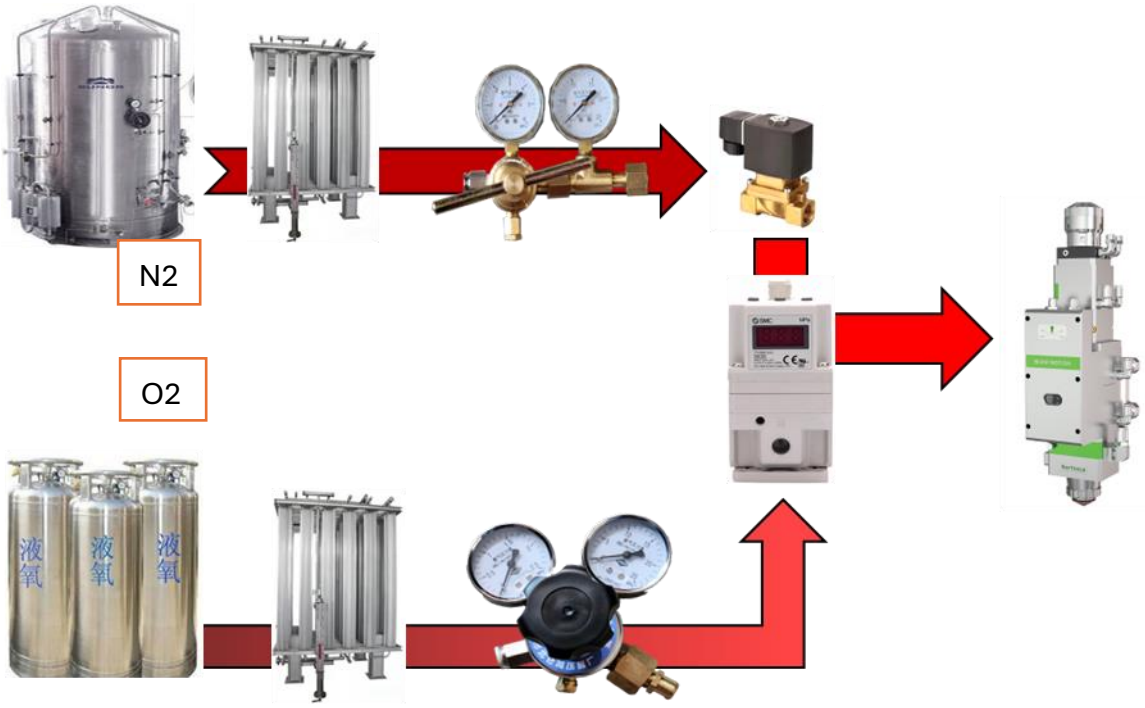
Air Storage Tank

- **Tank Capacity:**
  1.2 m^3 ≈ **42.4 cubic feet**
  To stabilize airflow and pressure during operation.

Integrated System (Optional)

An optional integrated air compression system—specifically designed for fiber laser cutting machines—is available; it integrates compression, air storage, filtration, and drying functions to simplify installation and ensure air quality.

Air Line Connection Inspection



Before operating the laser cutting machine, thoroughly inspect the air line system to ensure stable and reliable gas supply.

Key Inspection Points:

- **Hose Connection:**
  Ensure all air hoses are securely connected with no looseness or leaks.

- **Pressure Monitoring:** *Check the gas pressure gauge before each use to confirm sufficient working pressure.*

Important Notes:

Oil & Moisture Contamination:
Compressed air often contains oil mist and moisture. Inadequate filtration may severely damage the cutting head and pneumatic components. Such damage is not covered under warranty and is the user's responsibility.

Gas Flow vs. Material Thickness:
Gas consumption varies based on material thickness. Adjust pressure and flow accordingly for optimal performance.

Safe Handling:
Use oxygen, nitrogen, and other gases with caution. Keep gas supply systems away from open flames or welding operations to prevent fire or explosion hazards.

3.2.6 Cleaning Consumables Requirements

To ensure stable machine operation and precise cutting performance, the following cleaning materials are recommended for routine maintenance:

a) Anhydrous Ethanol (or Isopropyl Alcohol)

- Purity Requirements： ≥99.7%

- Application: Primarily used for cleaning optical components of laser cutting machines, such as protective lenses and collimating lenses.

- Usage Instructions: Apply a small amount of alcohol to a specialized lens tissue or a lint-free cotton swab, then gently wipe the lens surface to avoid leaving scratches or residue. Do not use low-quality cleaning fluids or those containing impurities, as this may contaminate or damage the lens.

b) Masking Tape

- Width Recommendations： about 50mm

- Application: Used to seal external gaps in the laser cutting head, preventing dust from entering the cutting head or internal optical components, thereby safeguarding the cleanliness of the equipment.

- Usage: Wrap the masking tape around the seams of the cutting head housing; specifically, apply it after replacing lenses or performing maintenance to provide protective coverage.

c) Transparent Adhesive Tape

- Purpose: Used to detect and adjust the centering of the laser beam through the nozzle to ensure cutting accuracy.
- How to use: Place a small piece of tape under the nozzle, fire a low-power laser pulse, and observe the burn mark. Adjust the nozzle or beam path accordingly until the laser is centered.

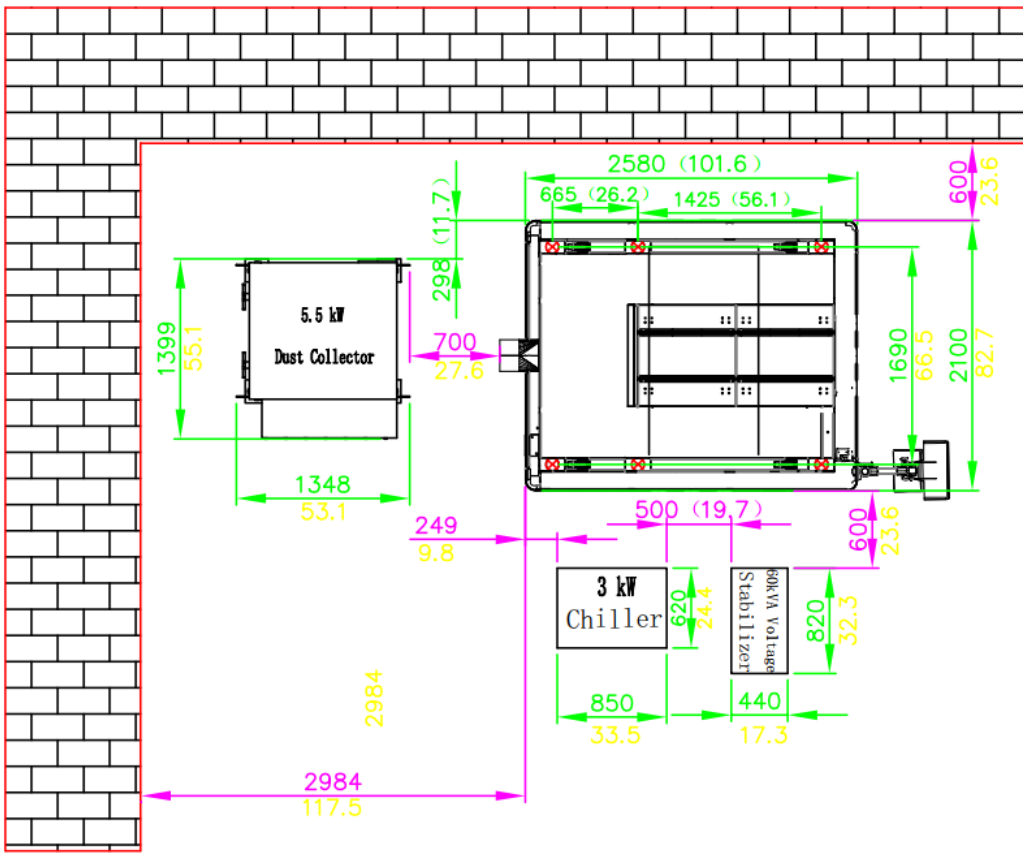
3.2.7. Machine Bed Installation

Before installation, carefully consider the equipment's footprint and the space required for operation and maintenance.

The complete machine system includes: Fume extractor, voltage stabilizer, industrial chiller, and integrated air compressor.

Floor space (L × W):6000 × 4000 mm (236" × 157")

To ensure safe operation, routine maintenance, and proper ventilation, it is recommended to reserve **at least 600mm (24“)** of clearance around the machine.



1. Handling & Unloading Method

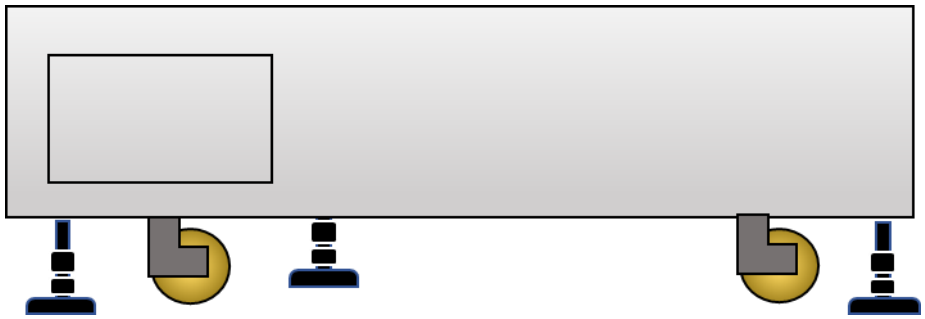
Use a forklift with a **rated capacity exceeding 4500 lbs (approximately 2 metric tons)** to **safely unload the machine from the wooden or metal pallet to the ground**.

After unloading, install **swivel caster wheels** and **screw-adjustable leveling feet** at the base of the machine to facilitate positioning and leveling.

2. Adjust the machine level

1） **Leveling the Machine**

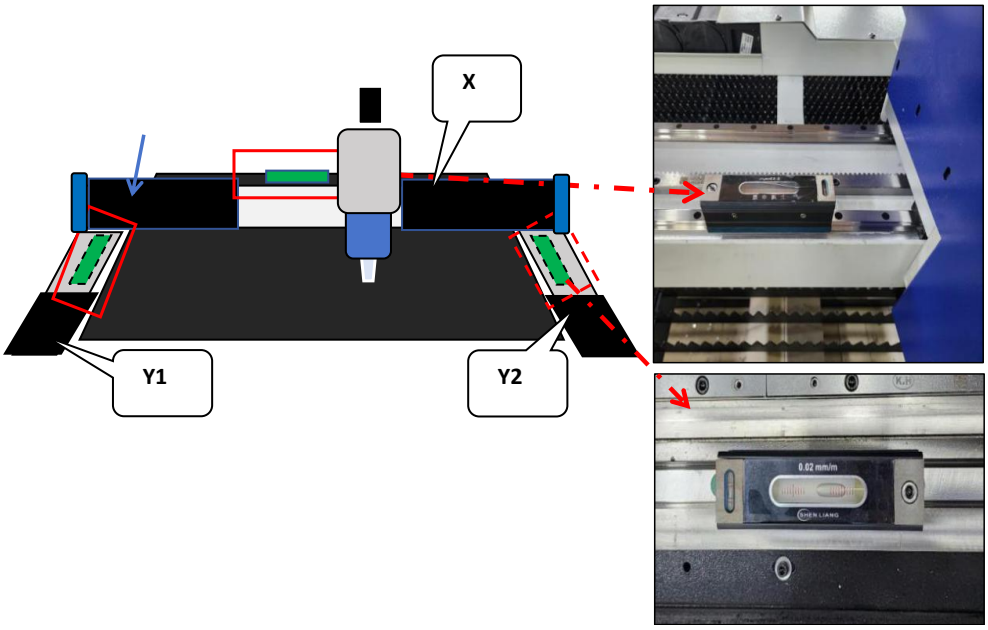
After moving the machine to its designated installation location, adjust the height of the leveling screws on the adjustable feet to slightly lift the machine until the caster wheels are completely off the ground. This prevents any movement and ensures the equipment is securely positioned for further installation and leveling.



2） Open the front protective door of the machine and move the beam to the center position. Loosen the screws of the XY-axis protective covers and remove the covers. Then place the level on the surface of the guide rail.

3） Leveling the Y1 Axis

Start by leveling the Y1 axis. Clean the guide rail and the base of the level gauge thoroughly with a clean cloth. Place the level gauge on the guide rail and observe the position of the bubble. If the bubble shifts to the left, the left side is too high and needs to be lowered. Use an adjustable wrench (300 mm or larger) to adjust the leveling screw nut on the left foot until the bubble is centered.



4) Leveling the X Axis

Next, level the X axis. Place the level gauge horizontally on an open section of the guide rail and observe the direction in which the bubble shifts. Adjust the corresponding leveling screw using the same method as for the Y1 axis to achieve a balanced level.

After leveling, lower all the remaining unused leveling screws to the bottom, and raise the movable nuts to the top. Use two adjustable wrenches to firmly lock the bottom and top nuts together, ensuring equipment stability.

3. Check the Laser Source, Cutting Head, and Install the Chiller

1) If the laser source is pre-installed within the machine, inspect it thoroughly after long-distance transportation to ensure that it has not shifted and that the fiber cable is not pinched or damaged.

If the laser source is shipped separately, verify that the outer packaging is intact. After unpacking, inspect the unit for any visible damage or deformation, and ensure that all accessories are included.

2） Chiller Water Pipe Connection Instructions

Connect the "Normal Temperature Return" port on the chiller to the corresponding "Normal Temperature Outlet" port to form a complete loop—this circuit should be connected to the cutting head for cooling.

Similarly, connect the "Low Temperature Return" to the "Low Temperature Outlet" for the laser source cooling system.

Ensure all water lines are securely connected and matched to the correct ports to maintain optimal cooling performance.

3） Laser Cutting Head Inspection & Installation

If the cutting head is pre-installed on the machine, remove the Z-axis protective cover and check whether the mounting screws are properly tightened and the cutting head is securely positioned.
If the cutting head was shipped separately, carefully inspect the exterior for any signs of damage such as dents or scratches. Then follow the installation instructions to mount the head in place, ensuring a firm and flush connection. Finally, connect the air supply and water cooling lines to the corresponding ports on the cutting head. Make sure all connections are secure and aligned according to the labels to prevent leaks or misoperation.

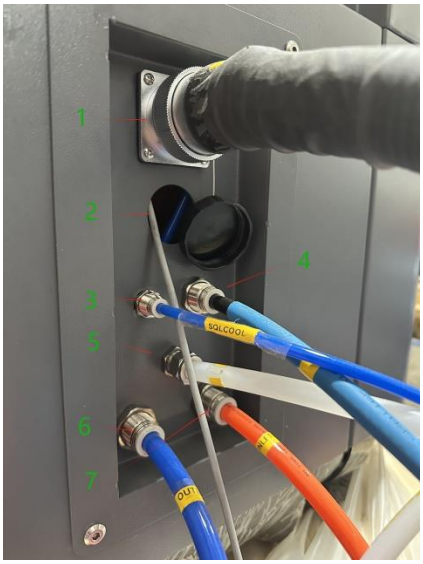
4） Rear-side Utility Connection Instructions

According to the diagram, connect the following pipelines to the designated ports located at the lower right rear of the

machine. Ensure each line is securely attached and correctly matched:

1. **Main Power Cable** – Connect to the machine's power input terminal.
2. **Laser Power Cable** – Connect to the dedicated laser power input.
3. **Oxygen Supply Line** – Used for carbon steel cutting, connect to the "O2" labeled port.
4. **Nitrogen Supply Line** – Used for stainless steel and aluminum cutting, connect to the "N2" labeled port.
5. **Air Cooling Line** – For additional cooling during cutting, connect to the "Air" labeled port.
6. **Cooling Water Inlet** – Connect the water supply line from the chiller to the "Inlet" port.
7. **Cooling Water Outlet** – Connect the return water line from the laser/cutting head to the "Outlet" port.

Always double-check that each connection matches its label and usecase to avoid operational issues or equipment damage.



3.2.8 Electrical Connection

1. Check whether the main power circuit breaker and each branch circuit breaker operate sensitively.

2. Verify that the equipment's power wiring is correctly connected.

3. Ensure that the main power circuit breaker and branch circuit breakers (e.g., main unit, laser, air compressor) meet the capacity requirements as indicated in the schematics.

4. Confirm that the power lines are properly grounded.

5. Inspect all high-voltage wire terminals (especially the input and output points of the power transformer) to ensure reliable and secure connections; verify that all plugs and sockets are firmly connected.

Warning: The power lines must be reliably grounded. Otherwise, signals within the machine's electrical cabinet may be interfered with, and leakage could pose a danger.

Gas Line Connection

Connect the nitrogen/air pipe, oxygen pipe, and coolinggas pipe to the gas meter. The pressure requirements are as follows:

- Nitrogen pressure: 2.0–3.0 MPa (approximately 290–435 psi)
- Oxygen pressure: 0.8–1.0 MPa (approximately 116–145 psi)
- Cooling gas pressure: 0.5 MPa (approximately 72.5 psi)

Note：

- When replacing gas cylinders or cylinder groups, gas flow will be interrupted.
- Pipes must be clean, free from oil, grease, and dust.
- Do not use solvents to clean hoses.
- Do not use lubricants when connecting hoses.
- All maintenance work must be conducted under extremely clean conditions.
- A pressure-reducing valve must be installed at the gas source between the cylinder and the machine.

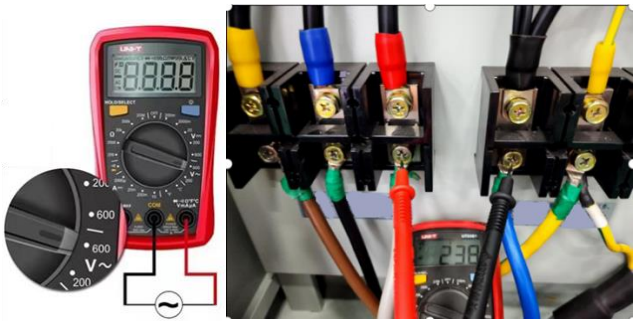
Chapter 4: Equipment Commissioning

4.1 Initial Power-On and Debugging Steps

4.1.1 Verify Power Connection and Power Supply Compliance

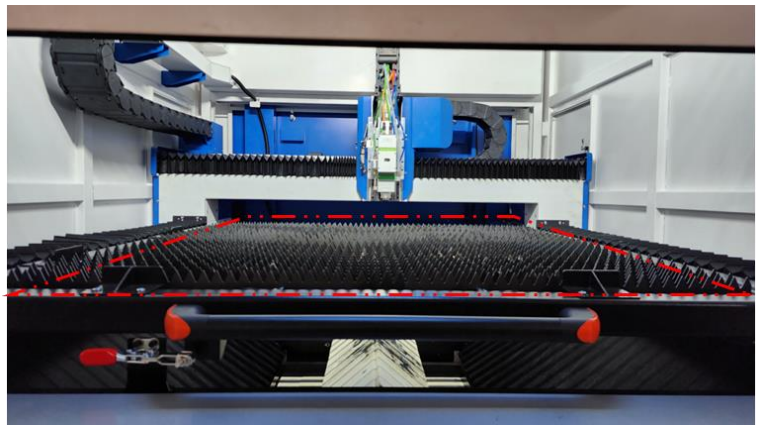
Ensure that the main power and all subsystem connections (laser source, chiller, air compressor) are correct and properly grounded.
Also confirm that the facility's power supply meets requirements: 208–240V, 3-phase AC, 60Hz.

Once all checks are complete, switch on each subsystem breaker inside the electrical cabinet one by one, then turn on the main power switch. The system will then enter standby mode.



4.1.2 Ensure Clean Worktable Surface

Make sure the working table is clean and free of tools, debris, or leftover materials that could interfere with the cutting head's movement.



4.1.3 Check Cooling System

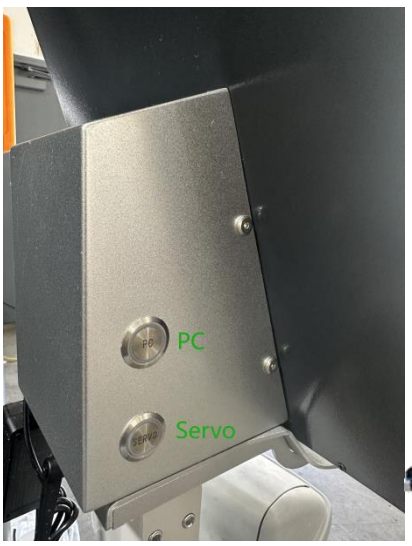
Ensure the chiller's inlet and outlet pipes are properly connected and that the water level in the tank is appropriate. Only use purified or distilled water as the coolant.
Recommended temperature range: 26°C to 28°C (78.8°F to 82.4°F) to ensure optimal cooling performance and protect laser components.

4.1.4 Verify Control System

Power on the control system and ensure the touch screen and HMI function properly, with the software running as expected.

Power On the Control System

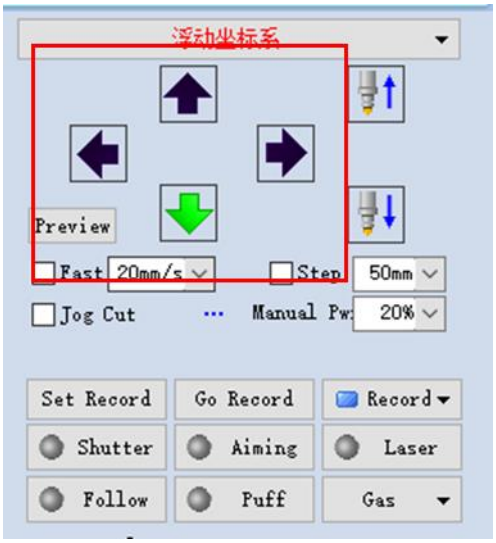
Turn on the control computer by pressing the "PC" button located at the back of the control screen. Wait for the system to fully boot.
Once the system is ready, press the "Servo" button on the control interface to activate the machine's drive system and enable axis motion.



Start Cutting Software and Check Axis Movement

On the control screen, launch the cutting software “CypCut” or “CypWell”.
Navigate to the **Axis Control Panel**, then manually jog the **X, Y, and Z axes** one by one. Observe their

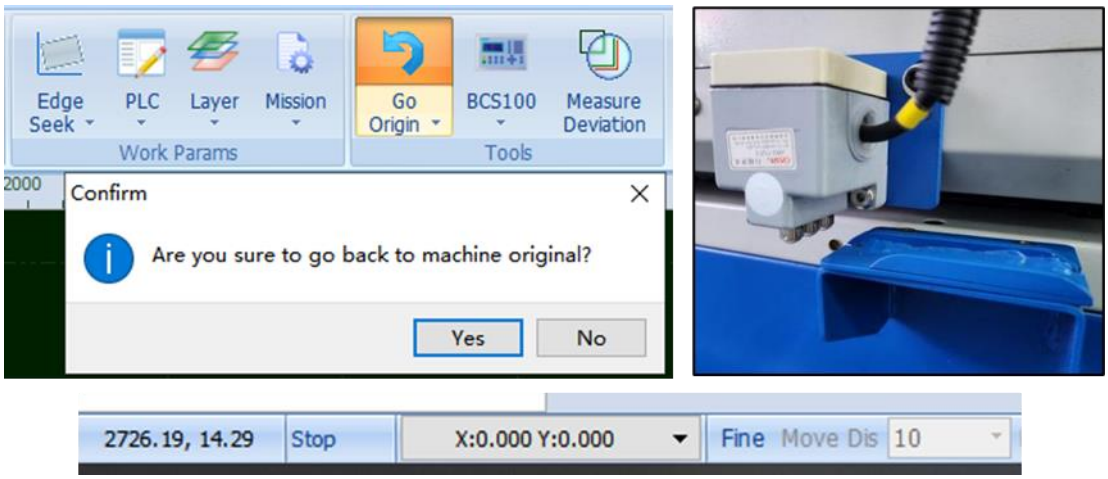
motion to ensure smooth, accurate movement without unusual noise or jamming, confirming proper motor and drive system function.



Homing Setup and Limit Switch Check

Before initial homing, inspect the home and limit switches on the X, Y, and Z axes to ensure they are secure and undamaged.
Once confirmed, perform **single-axis homing** one at a time.

We recommend testing each axis separately in the following order: **X** → **Y** → **Z**, ensuring that each limit switch is functioning correctly and position feedback is accurate.



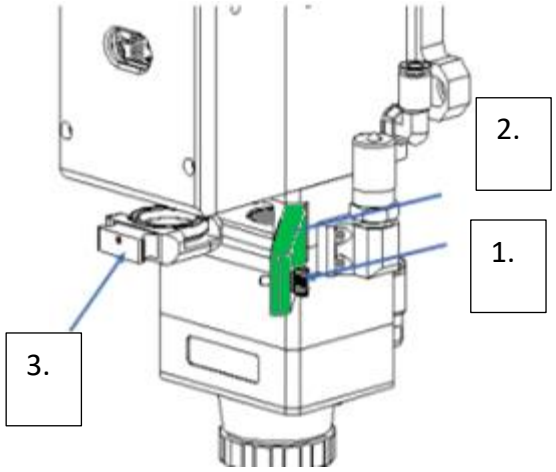
4.1.5 Inspect Laser Source and Cutting Head

Make sure the laser source and cutting head are securely installed, cables and hoses are intact, and the optical area of the head is clean.

Cutting Head Inspection

Before initial commissioning or routine maintenance, carefully **inspect and clean the protective lens of the cutting head** to ensure optimal laser transmission and cutting performance.
Any dust or debris on the lens can degrade cut quality or damage optical components.

⚠**Important:** Do **not disassemble the protective lens in dusty environments**. Ensure the workspace is clean to avoid contamination or damage to the cutting head's sealing structure.

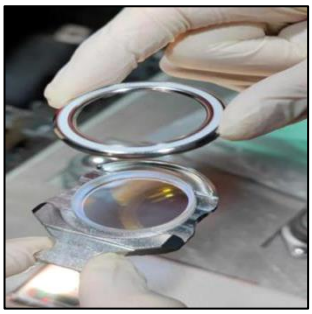
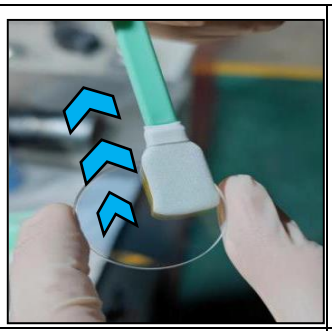
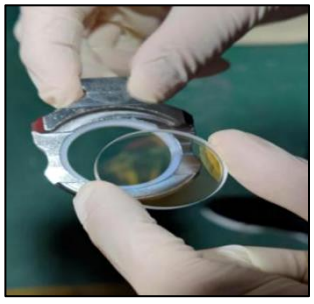


Protective Lens Removal Procedure

1. **Loosen the locking bolt** – Use the appropriate tool to loosen the locking bolt located at the bottom of the cutting head.
2. **Open the protective lens cover** – Gently pull down the cover plate to expose the lens compartment.
3. **Remove the protective lens** – Carefully take out the lens using clean gloves or tweezers. **Avoid touching the optical surface.**
4. **Close the cover** – After removal, close the cover plate and ensure it is properly seated.

⚠ Ensure the workspace is clean during removal. Use proper tools and wear protective gear.

Protective lens cleaning

			
Put on lint-free gloves and remove the retaining ring	Spray a small amount of high-purity alcohol anto clean cotton swab	Shake off any excess alcohol from the cotton swan and wipe the lens in one direction	Inspect the lens under a light source to ensure it is free of smudges or residue,then carefully

			reinstall it into the lens mount.
Install the retaining ring, insert the assembly into the cutting head, close the protective lens cover, and seal it with masking tape to prevent dust contamination.			

How to Check If the Laser Beam is Centered in the Nozzle

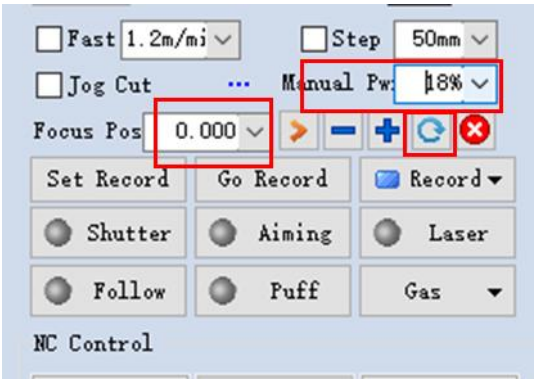
Steps：

1. **Apply Tape**
   Place a small piece of clear tape or masking tape over the nozzle opening.

2. **Fire a Low-Power Pulse**

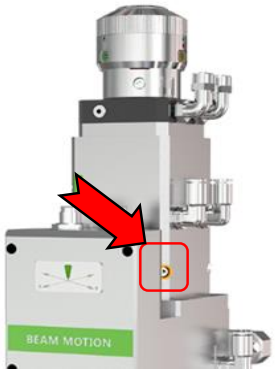
   Set the laser to low power test mode and fire a single pulse to leave a burn mark on the tape.

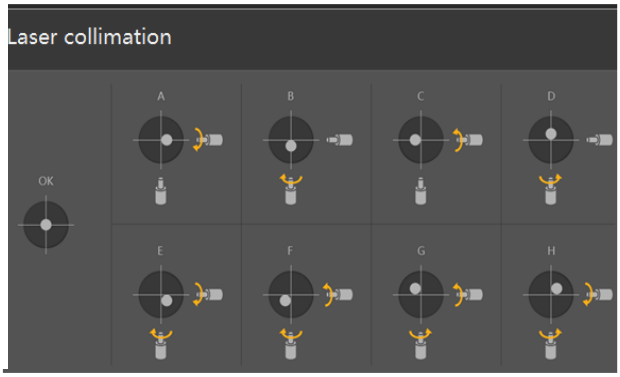
   On the operation interface, check whether the Focus Position is set to "0". If not, use the "+" or "−" buttons to adjust it to "0", then press the confirm button to save the setting.
   Next, go to the "Manual Operation" page and set the Laser Output Power to 18%.

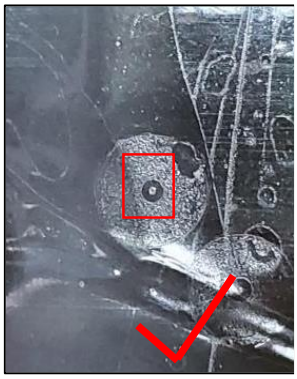


3. **Inspect the Burn Mark**
   Check if the laser burn mark is centered in the nozzle opening. If off-center, the beam is misaligned.

Use the handheld controller provided with the machine (see later section for details) to pulse the laser and remove the tape from the nozzle. Observe the burned laser spot. If the spot is unclear, slightly increase the laser power; if the spot is too large, reduce the power accordingly. Repeat the process to check whether the laser spot is centered. If it's off-center, fine-tune the X and Y adjustment screws on the cutting head until the laser spot is aligned with the center of the nozzle, as illustrated.



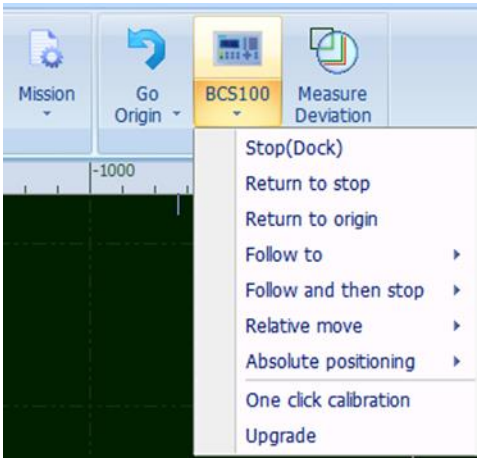




Note: Do not place your hand under the nozzle when activating the laser to avoid burns. Also, do not place any material beneath the nozzle during this process.

4.1.6 Z-Axis Height System Calibration（One Click Calibration）

After the machine returns to its origin, manually move the cutting head above a **flat, uncut steel plate** to ensure accurate calibration.
Then, go to the **"NC" (Numerical Control)** tab on the control interface, click the **"BCS100"** dropdown menu, and select the **"One Click Calibration"** option.
The system will automatically calibrate the reference distance between the nozzle and the material surface, enabling precise capacitive height sensing for stable and reliable cutting performance.



4.1.8 Gas Pressure Check and Purge Test

Check the readings on the oxygen and nitrogen pressure gauges:

- Oxygen pressure should reach 1 MPa
- Nitrogen pressure should reach 2 MPa

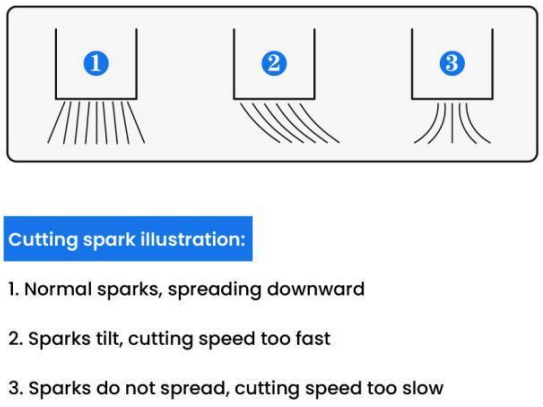
Once the gas pressures are confirmed to be within the correct range, switch to the corresponding gas type in the control system software.
Then, use either the handheld controller or the software interface to perform the "Purge" operation.
Observe the nozzle at the cutting head to ensure a steady gas flow is being released, verifying that the gas lines are properly connected.

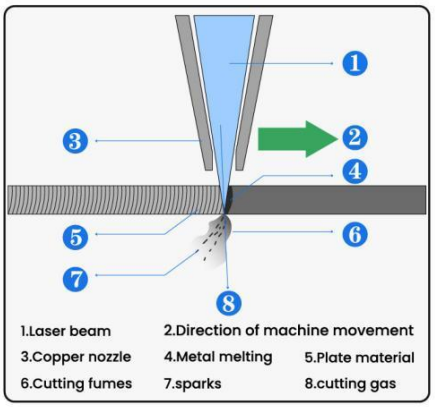
4.1.9 Provide Operation Manual and Training

Deliver a complete user manual and safety guide, and conduct necessary pre-operation training for all personnel.

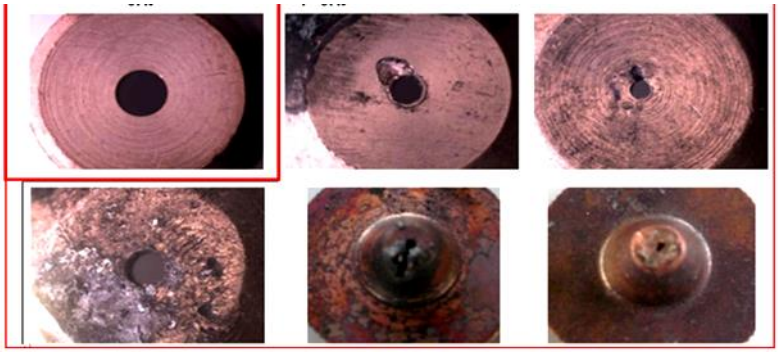
4.2 Laser Cutting Principles and Process Tuning

Laser cutting is a thermal cutting process based on a high-energy-density laser beam. The focused high-power laser irradiates the surface of the work piece, causing the local material to rapidly melt, vaporize, ablate, or ignite. A high-speed coaxial assist gas then blows the molten material out of the kerf, achieving precise and efficient separation of the material.

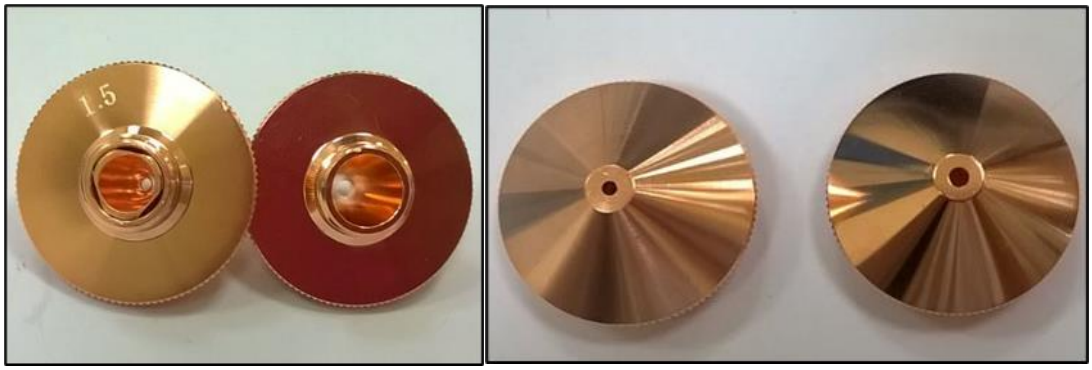




4.2.1 Nozzle Type Selection and Status Determination



Regularly inspect the nozzle tip to ensure the center hole is not worn or deformed. An irregular or non-circular orifice can cause laser beam deviation and affect cutting accuracy.
If slag or metallic debris is found on the contact surface of the nozzle, it may lead to cutting head instability or abnormal height sensing during operation.
One-sided dross buildup on the work piece is often a sign of a damaged or misaligned nozzle.
Additionally, if the nozzle shows signs of discoloration or burning, it should be replaced immediately to maintain optimal cutting performance and system reliability.



Double Layer1.5 Single Layer Single Layer 2.0 Single Layer

3000W Laser Nozzle Selection Guide

Oxygen Cutting for Mild Steel (Recommended: Double-layer Nozzles):

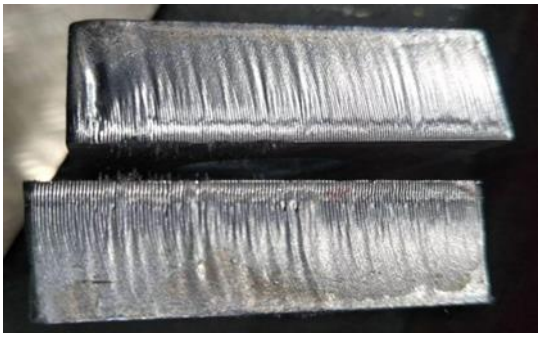
- 1–12mm thickness: Use double-layer Ø1.2mm nozzle
- 14–18mm thickness: Use double-layer Ø1.2mm or Ø1.4mm (model ST1.2 / ST1.4)
- 20–22mm thickness: Use double-layer Ø1.4mm or Ø1.6mm (model ST1.4 / ST1.6)

Nitrogen Cutting for Stainless Steel (Recommended: Single-layer Nozzles):

- Below 6mm thickness: Use single-layer Ø3.0mm nozzle
- 8–12mm thickness: Use single-layer Ø5.0mm nozzle
- 14–20mm and above: Use single-layer Ø5.0–8.0mm nozzle (adjust as needed based on cutting performance)

4.4.1 Cutting Process Optimization

- The cut surface exhibits coarse ripples, lacks perpendicularity, and features roughness and slag adhesion at the bottom (as shown in the figure):



Possible Causes and Recommendations:

1. Incorrect nozzle selection (nozzle orifice size is too large)

    - An excessively large nozzle orifice results in dispersed airflow and reduced concentration of the gas column, preventing the effective expulsion of slag from the cutting.

    - At the same time, the risk of misalignment between the laser beam and the gas flow increases, resulting in uneven cutting edges.

    Recommendation: Depending on the sheet thickness and the gas being used (oxygen/nitrogen), switch to a suitable nozzle with a smaller aperture (e.g., for carbon steel < 10 mm, a Ø1.0–1.2 mm nozzle may be used).
    At the same time, the risk of misalignment between the laser beam and the gas flow increases, resulting in uneven cutting edges.

2. Focus position mismatch (improper focus setting)

    - A focus set too low—or positioned within the lower section of the material—results in uneven energy concentration, causing the upper cut to be clean while the lower cut remains rough.

    - Insufficient defocusing can also result in non-perpendicular cuts and residual slag.

Recommendation: Continue to increase the positive defocus amount (i.e., raise the focal point slightly, bringing it closer to the upper surface of the work piece) to ensure a more uniform distribution of laser energy throughout the entire cutting thickness.

3. Cutting speed is too slow

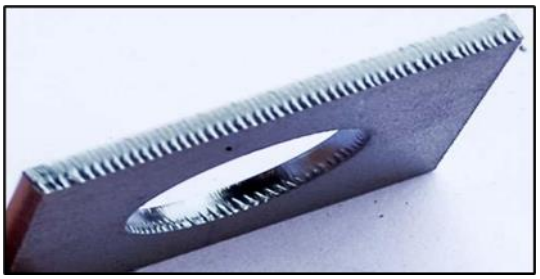
    - The laser dwells at a single location for too long, resulting in excessive heat accumulation; consequently, the molten material is not blown away in a timely manner, leading to exacerbated ripple formation and severe dross adhesion.

    - Moving too slowly can also easily lead to edge overheating or scorching.

Recommendation: Consider slightly increasing the cutting speed—particularly when penetration is good—by gradually

accelerating until the ripple pattern becomes finer and dross accumulation is reduced.

- The upper section of the cut surface is relatively neat, while the lower section exhibits regular ripples or even slight burrs; the overall surface lacks smoothness and may show signs of localized overheating.



Causes and Corresponding Solutions

1. Nozzle selection is oversized.

- Problem Symptoms:
  An excessively large nozzle diameter causes the airflow to diverge, preventing it from effectively concentrating to expel molten slag in a timely manner; this compromises the cleanliness of the cut knife, and is particularly detrimental to the quality of the cut in the lower section.

- Solution:
  Replace the nozzle with a smaller-diameter one that matches the plate thickness and gas pressure. At the same time, check the nozzle for wear or eccentricity to ensure that the laser beam and gas flow are coaxial.

2. The focus position is incorrect (needs to add positive defocusing).

- Problem Symptoms:
  An excessively deep focal point (negative focus) causes laser energy to concentrate in the lower section of the material; this results in insufficient melting of the upper section and excessive melting of the lower section, thereby generating ripples and burrs.

- Solution:
  Appropriately increase the positive defocus value (shift the focal point upward, closer to the upper surface of the work piece). We recommend attempting fine-tuning: starting from the current focal position, adjust in increments of +0.3 mm to +0.5 mm until the cut cross-section shows improvement.

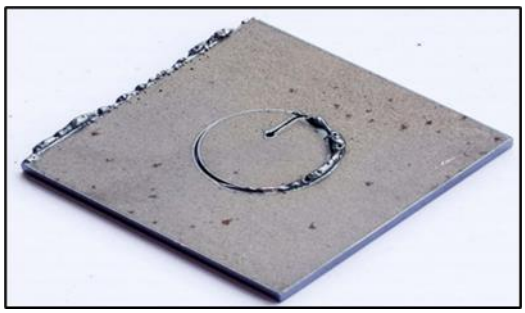
3. Slow cutting speed, high gas pressure

- Problem Symptoms:
  Excessively low speed leads to heat accumulation, resulting in coarse, heat-affected surface patterns;

conversely, excessively high air pressure may cause airflow disturbances, causing slag to be impacted and rebound.

- Solution:
  To appropriately increase the cutting speed, start from the current speed and perform test cuts by increasing it by 5–10% at a time. Reduce the gas pressure to a more reasonable range—for example:
    - Recommended oxygen pressure for cutting carbon steel: 0.8–1.0 MPa.
    - For nitrogen cutting of stainless steel, a pressure of 1.5–2.5 MPa is recommended (depending on thickness).

- The cutting path did not cut through completely; the cut edge retains a significant amount of slag, and the cutting line is interrupted or distorted.



Analysis of Root Causes and Corresponding Solutions:

1. Cutting speed is too fast.

- Problem Description:
  The dwell time of the laser beam on the material is insufficient, resulting in incomplete melting of the metal, failure to cut through, or the formation of residue.
- Solution:
  Reduce the cutting speed to allow the laser sufficient time to act upon the material surface, thereby completing the melting and vaporization processes. Adjustments can be made in stages—reducing the speed by 10–15% each time—while observing the resulting changes in penetration and cut surface finish.

2. Focus mismatch (too high or too low)

- Problem Description:
  The focal point deviates from the actual thickness range of the material; consequently, the laser energy is not concentrated at the cutting plane, resulting in localized incomplete cuts or dross formation.
- Solution:
  Reset the focal position; it is recommended to position the focus approximately 0 to +1 mm below the upper surface of the material (positive defocus).
  If an autofocus system is in use, verify whether it has been calibrated or is experiencing interference.

Consider performing test cuts: conduct a series of consecutive test cuts at various focal positions (e.g., -1 mm, 0 mm, +1 mm) to facilitate comparative analysis.

3. Damaged copper nozzle or optical path misalignment

- Problem Description:
  Wear, deformation, or misalignment of the copper nozzle causes the laser beam to deviate from the nozzle's center; airflow deflection can also compromise cutting stability.
- Solution:
  When installing a new nozzle, it is recommended to use a double-layer nozzle (e.g., Ø1.2 mm or Ø1.4 mm) that is appropriate for the material thickness.
  Re-perform the alignment calibration between the nozzle and the laser beam (this can be verified using either the marking method or the piercing method).
  Inspect and clean all optical lenses; pay particular attention to the protective lens to check for any signs of ablation or contamination.

- **Rough cut surface, with severely charred and blackened edges.**

1. Cutting speed is too slow.

- Problem Symptoms:
  The laser dwelt on the material for an excessive duration, leading to heat accumulation that caused the metal edges to melt excessively; this resulted in extensive edge burning, irregular ripples, and severe dross adhesion.
- Solution:
  Incrementally increase the cutting speed—preferably by 10–15% at a time—until a reduction in slag and a finer kerf are observed.
  Ensure that the piercing process is complete before initiating the cut to prevent overheating of the edges.

2. Protect the lens from contamination (dirt or burns)

- Problem Symptoms:
  Lens contamination can lead to the attenuation or scattering of laser energy, preventing the beam from focusing accurately; this results in degraded cutting performance—or even issues such as scorched edges and a failure to penetrate the material.
- Solution:
  Inspect and clean the protective lens; replace it if necessary.

The lens must be kept clean and free of oil, dust, and water stains.

Use high-quality lenses and perform regular maintenance.

3. Assist gas is impure or pressure is too high.

- Problem Symptoms:

  Insufficient gas purity (i.e., the presence of impurities in the oxygen) leads to unstable oxidation reactions, resulting in burnt edges, the formation of oxide layers, and slag adhering to the cut walls.

  Conversely, when the gas pressure is excessively high, increased airflow turbulence causes molten material to splatter and results in a rough cut surface.

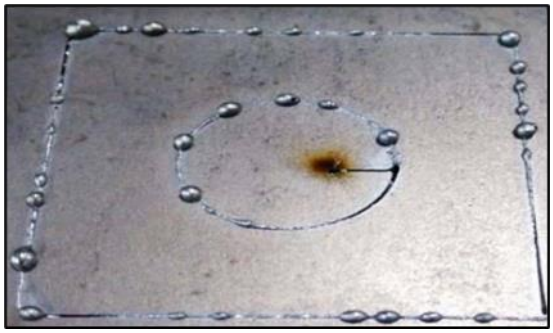
- Solution:

  Switch to high-purity gases (Oxygen ≥ 99.5%, Nitrogen ≥ 99.99%).

  Optimize gas pressure parameters; avoid blindly increasing pressure.

  - Oxygen cutting of carbon steel: 0.8–1.0 MPa is recommended.
  - Nitrogen cutting of stainless steel: 1.5–2.5 MPa (depending on material thickness).

- **The cut did not fully penetrate the material; a significant amount of molten metal beads appeared around the cutting line, and the cut itself was discontinuous and incomplete, indicating unstable cutting performance.**



1. Excessive Cutting Speed

• Symptoms: The laser dwell time on the material is insufficient to fully melt the material; specifically, it fails to achieve timely penetration at fillets or corners.

• Consequences: Incomplete cuts, dross accumulation, unclosed cut edges, and prominent burn marks.

• Solution: Reduce the cutting speed. It is recommended to decrease the current speed by 10–20%, and specifically to implement a "corner slowdown" strategy in corner regions.

2. Auxiliary gas pressure is too low.

- Symptom: Although the laser melts the material, the airflow is insufficient to expel the molten metal from the kerf.
- Result: Formation of excessive melt beads, accumulation of slag, and defective or adhering edges along the cut.
- Solution:

- Increase gas pressure (for carbon steel cutting, oxygen pressure of ≥0.8–1.0 MPa and nitrogen pressure of ≥1.5 MPa are recommended).
- Inspect the gas lines to ensure they are unobstructed, verify that the pressure regulator is functioning correctly, and confirm that the gas purity is ≥99.5% (for oxygen) or ≥99.99% (for nitrogen).

3. Incorrect Focus Setting

• Symptoms: The laser energy fails to concentrate at the appropriate depth within the material for cutting, resulting in incomplete piercing and uneven cut edges.

• Consequences: Focus set too high → Incomplete penetration; Focus set too low → Severe dross accumulation at the bottom of the cut.

• Solution:

- Reset the focus to the correct position; it is recommended to position the focal point within the upper-to-middle section of the material thickness (Positive Focus: 0 to +1 mm).
- If using an auto-focus cutting head, verify that the focus offset function is operating correctly or determine if calibration is required.

• Unsuccessful or Poor Perforation Results: Prior to laser cutting, the laser beam must first create a hole in the material—a step known as "perforation." Particularly when cutting carbon steel, the perforation process has a significant impact on both the subsequent cutting quality and the lifespan of the laser head.

Key Control Points During Piercing:

1. Do not position the laser head too close during piercing: It is recommended to maintain a distance of no less than 10 mm between the laser head and the workpiece surface; this prevents molten metal splatter from ricocheting back and damaging the lens.

2. Ensure gas pressure is not too low: The gas pressure used for piercing must be at least 0.6 bar; insufficient pressure increases the risk of "blowouts" or back-splatter.
3. Monitor the piercing process closely and stop immediately if issues arise:
    - If the hole fails to pierce through the material, or if a "blowout" occurs, stop the operation immediately.
    - Do not attempt to force the cutting process to continue; doing so risks molten metal splatter ricocheting back and burning out the laser head's protective lens.
    - You should readjust the piercing parameters before attempting to pierce again.
4. Laser power must not be set too high: particularly when utilizing "single-stage piercing" (fast piercing), setting the power too high can easily lead to piercing explosions.
5. Adjust Air Pressure When Changing Nozzles: When switching to a nozzle of a different diameter, the air pressure must be adjusted accordingly to prevent poor piercing results caused by airflow mismatch.
6. The longer the piercing duration, the more the power output should be appropriately reduced.
    - If the laser dwells at a single point for an extended period, the power output must not be set too high; otherwise, it risks burning through the material or causing blowouts.
    - If the power output is high, the piercing time must be correspondingly shortened.

Observations and Parameter Adjustment Suggestions for the Piercing Phase

During the piercing process, one should closely observe at which stage the "blowout" occurs: if the first stage remains stable but a blowout occurs during the second stage, this indicates that the blowout may be attributed to improper parameter settings in the second stage.

At this stage, particular attention should be paid to examining the following factors:

- Is the air pressure in the second stage too high?
- Is the laser power set too high?
- Is the duty cycle too high?
- Is the focus too off (too much positive or negative focus)?
- Is the dwell time excessively long?

Key Control Points During Piercing:

1. Maintain a safe distance between the laser head and the material:
   The laser head should not be too close to the sheet. A minimum distance of 10 mm is recommended to prevent molten metal from splashing back and damaging the protective lens.
2. Ensure sufficient gas pressure:
   The piercing assist gas pressure should be at least 0.6 bar. Low pressure increases the risk of blowouts or slag rebound.
3. Closely monitor the piercing process — stop immediately if abnormalities occur:
    - If the laser fails to penetrate the material or a blowout occurs, stop the process immediately.

    - Do not proceed with cutting after a failed piercing, as molten metal may reflect and damage the protective lens.
    - Re-evaluate and adjust the piercing parameters before retrying.
4. Avoid excessive laser power:

   Especially during single-stage (quick) piercing, excessive power can lead to violent blowouts.
5. Adjust gas pressure when changing nozzles:

   If the nozzle diameter is changed, the gas pressure must be adjusted accordingly to ensure proper gas flow and avoid piercing defects.
6. Balance power and piercing duration:
    - If the laser stays on a single point for a long time, the power should be reduced to prevent burning or blowouts.
    - Conversely, if higher power is required, the piercing time should be shortened appropriately.

Piercing Stage Monitoring & Parameter Adjustment Suggestions

During the piercing process, it's essential to observe at which stage blowouts occur.

If the first stage completes successfully but blowouts happen in the second stage, this likely indicates parameter issues specific to the second stage.

Key factors to check include:

- Is the gas pressure in the second stage too high?
- Is the laser power set too high?
- Is the duty cycle too aggressive?
- Is the focus position too far off (either overly positive or negative)?
- Is the piercing dwell time too long?

  Adjustment Recommendations:
- Try reducing the duty cycle or shortening the dwell time in the second stage to minimize the risk of blowouts.

Stainless Steel Cutting Process Description

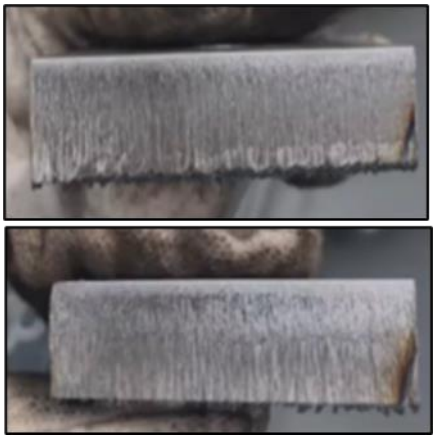
• The cut surface exhibits distinct, layered ripples—particularly in the lower section, where a sense of "fracturing" is evident. This suggests that the cutting process was accompanied by blue light and plasma effects; the cut face is

generally uneven, characterized by a coarse texture, and indicates poor airflow purging.

1. Excessive negative focus value → Leads to plasma effect and severe delamination
    - Cause: When the negative focus value is set too high (the focus is too deep into the material), the laser energy cannot be stably focused within the material thickness, easily causing plasma (blue light) interference. The laser beam is diffused and reflected, resulting in delamination, roughness, or even uneven ablation of the cut surface.
    - Solution:
        - Reduce the negative focus value and adjust the focus position back to the upper-middle part of the material thickness to avoid energy delamination caused by an excessively deep focus.
        - Recommended adjustment range: Increase the current value by 0.5–1 mm (e.g., if currently -2.5 mm, try changing it to -1.5 mm).
2. Nozzle orifice too small → Unstable airflow, rough cut
    - Explanation of Cause: A nozzle that is too small restricts gas flow; this results in a high auxiliary gas ejection velocity but a limited coverage area, preventing the formation of a stable airflow channel. Consequently, slag accumulates, the cut surface becomes disturbed, and the edges turn out rough.
    - Solution:
        - Replace with a larger diameter nozzle (e.g., Ø1.4~1.6mm) that is suitable for the current material thickness and air pressure.
        - Ensure that the nozzle is undamaged, free of eccentricity, and concentric with the laser spot.
3. Excessive pneumatic feed disturbs the molten zone, resulting in the formation of melt ripples.
    - Explanation of Cause: Excessive auxiliary gas pressure leads to unstable molten metal ejection, causing severe disturbance to the cut surface—specifically, the appearance of a wavy structure along the lower edge of the kerf characterized by "bulges" or a "stepped" texture.
    - Solution:
        - Reduce the gas pressure to a suitable range; for nitrogen cutting of stainless steel, 1.5–2.5 MPa is recommended (depending on thickness).

- At the same time, confirm whether the airflow is stable and whether there is any pulsation (such as a faulty pressure regulating valve).

- **The cut surface is inconsistent, with finer texture in the upper half and obvious coarse, stringy lines in the lower half. There is slag or dross buildup at the lower edge, and some areas are charred (blackened). The cut is not perpendicular enough and has poor surface finish.**



1. **Incorrect Nozzle Selection (Orifice Too Small)**

- **Impact:** A nozzle with too small an orifice produces a narrow gas jet with excessively high velocity but limited coverage. This prevents effective removal of molten metal, especially in the lower section of the material, leading to slag buildup.
- **Symptoms:** Noticeable string-like textures in the lower half, presence of slag, and irregular patterns caused by poor airflow.
- **Solutions:**
  - Replace the nozzle with a larger orifice size appropriate for the material thickness (e.g., for 8–12 mm carbon steel, use Ø1.4–1.6 mm double-layer nozzle).
  - Check for nozzle eccentricity or blockage to ensure the gas jet is coaxial with the laser beam.

2. Improper Focus Position (Insufficient Negative Focus)

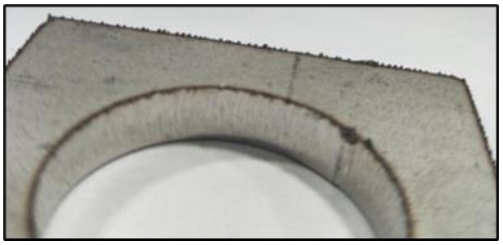
- **Impact:** If the focus does not penetrate deep enough into the material, laser energy concentrates on the surface or upper section, causing insufficient melting in the lower half.
- **Symptoms:** Fine texture in the upper cut surface but rough, slag-laden lower section—indicating uneven penetration through the full thickness.
- **Solutions:**
  - Increase the negative focus value (move the focal point deeper into the material).
  - Adjust in increments of 0.3–0.5 mm. For example, if currently at –1 mm, try –1.5 mm or –2 mm.

- Focus adjustments should be coordinated with material thickness, nozzle size, and gas pressure.

3. Insufficient Assist Gas Pressure

- **Impact:** Low gas pressure results in poor slag removal, especially in the lower cutting zone, causing slag buildup and burnt edges. In severe cases, the cut may fail to penetrate.
- **Symptoms:** Slag accumulation, darkened edges, or rough lines at the bottom of the cut—classic signs of inadequate airflow unable to expel molten material.
- **Solutions:**
  - Increase gas pressure to recommended levels:
    - **Oxygen for carbon steel:** ≥0.8–1.2 MPa
    - **Nitrogen for stainless steel:** ≥1.5–2.5 MPa (depending on thickness)
  - Check gas supply stability and ensure regulators and filters are not clogged.

• The cut edges of the stainless steel exhibit prominent burrs and serrations; the kerf is not sufficiently smooth, and the edges appear darkened or even scorched. Overall, the cut lines look rough, indicating poor quality.



1. Nozzle Orifice Too Small — Insufficient Gas Flow

- **Impact:** A small-diameter copper nozzle produces a limited gas outlet area and insufficient flow, making it difficult to remove molten slag and burrs. This issue becomes more pronounced when cutting thicker plates or when gas pressure is low.
- **Solutions:**
  - Replace with a larger-diameter nozzle suitable for the current material thickness and gas pressure (e.g., Ø1.4 mm–1.6 mm).
  - Check for nozzle wear or blockage to ensure the airflow is unobstructed and coaxial with the laser beam.
  - Use appropriate gas pressure to ensure the airflow is strong enough to expel molten material.

2. Focus Position Too High (Focus Too Close to the Material Surface)

- **Impact:** When the focus is set too high, laser energy concentrates mainly on the upper surface of the material. The lower section does not melt sufficiently, resulting in burrs and non-vertical cut edges.
- **Solutions:**
  - Lower the focus position (increase negative focal offset) so the laser energy penetrates into the middle and lower sections of the material.

- Recommended adjustment range: gradually shift from 0 mm (zero focus) to –0.5 mm, –1.0 mm, and compare test cuts.

3. Cutting Speed Too Slow

- **Impact:** If the cutting speed is too slow, the laser dwells on the material for too long, causing excessive heat buildup. This leads to over-melting or burning at the edges, increasing burrs and surface roughness.
- **Solutions:**
  - Increase the cutting speed appropriately (e.g., by 10–15%) to reduce excess heat.
  - This adjustment is especially effective for thin sheets or low-power cutting conditions.

- **Key Points for Stainless Steel Perforating Operations**

1. Pay Attention to the Piercing Method

- Stainless steel piercing behaves differently from carbon steel. With high-power lasers, improper piercing can easily burn or contaminate the protective lens of the cutting head.
- It is recommended to select the appropriate piercing mode (such as single-stage or two-stage piercing) based on material thickness.

2. Maintain Proper Piercing Height and Gas Pressure

- The distance between the laser head and the material surface should be **no less than 10 mm** to prevent molten slag from rebounding and damaging the lens.
- Piercing gas pressure should be **no lower than 2 bar**. If the pressure is too low, slag cannot be expelled effectively, increasing the risk of lens damage.

3. Use “Two-Stage Piercing” for Thick Plates

- For thicker stainless steel plates (e.g., **>6 mm**), two-stage piercing is recommended. This method gradually reduces power or frequency in two steps, resulting in more stable piercing and less slag.

4. High-Frequency Piercing Produces a Cleaner Result

- During piercing, use high-frequency pulsed laser bursts to achieve rapid penetration. This minimizes repeated heating and reduces slag formation.

5. Use the “Slag Removal” Function for Cleaner Surfaces

- After piercing, stainless steel surfaces often retain slag. Enabling the control system’s **slag-removal function** allows the laser to automatically sweep the surface once after piercing, cleaning residual molten material.

Chapter 5: Operating Instructions

Operation Panel Overview

The operating unit of the professional cutting machine comprises the machine tool's main control panel and a handheld pendant. The functions of the main control panel and the handheld pendant are described separately below.

Machine Tool Main Operation Panel

The structural layout of the main control panel is illustrated in the figure below. Its primary function is to facilitate emergency stops, power-on/power-off operations, and motion control for the equipment. From left to right, the components are: the main power switch, servo power switch, emergency stop button, and USB port.

Handheld Enclosure

The Manual Pulse Generator features flexible extensibility, allowing it to be extended directly to the operating terminal. It connects to the controller via a wireless signal. The two primary functions commonly performed by the Manual Pulse Generator are as follows: separate cutting operations and adjusting the origin point of the cutting program.

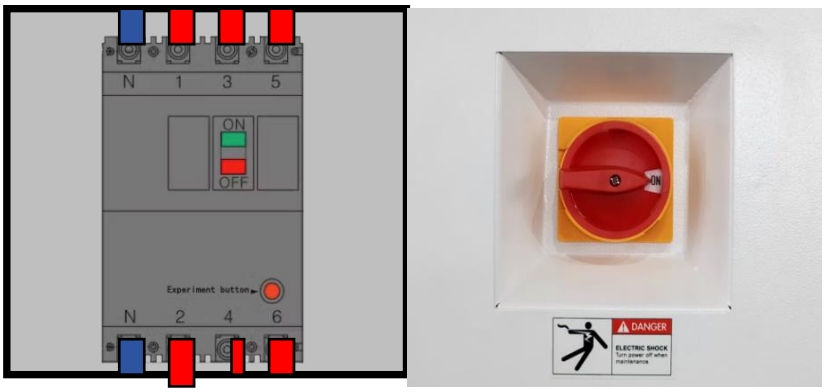
Table5-1

Button	Function	Button	Function	Photo
Start/ Continue	Start cutting, or resume after pausing.	Pause	Pause cutting	
Dry Run	Move the cutting head along the programmed path (without laser)	Stop	Stop cutting	
Gas / On-Off	Cutting gas on/off	Follow / On-Off	Height-following on/off	
Shutter / On-Off	Laser on/off	Red Light / On-Off	Red light Switch	
Breakpoint Positioning	Return to the position where Stop was pressed	Laser Spot Shot	Press once to fire a single laser pulse	
Backward	Move the cutting head backward (only during pause)	Forward	Move the cutting head forward (only during pause)	
Edge Finding	Detect the angle/position of the work piece	Fn	Function key	

Frame Walk	Move the cutting head along the outer contour of the shape	Home	Return to the starting point	
Fast Move	Hold together with direction keys (X/Y/Z) for fast movement	Step Move	Hold together with direction keys (X/Y/Z) to move by preset step distance	
	Rotate counterclockwise		Rotate clockwise	
→	Move right	←	Move left	
↑	Move forward	↓	Move backward	
Z↓	The cutting head moves downward.	Z↑	The cutting head moves upward.	
K	Customizable Keys	**FN+K**	Customizable Keys	

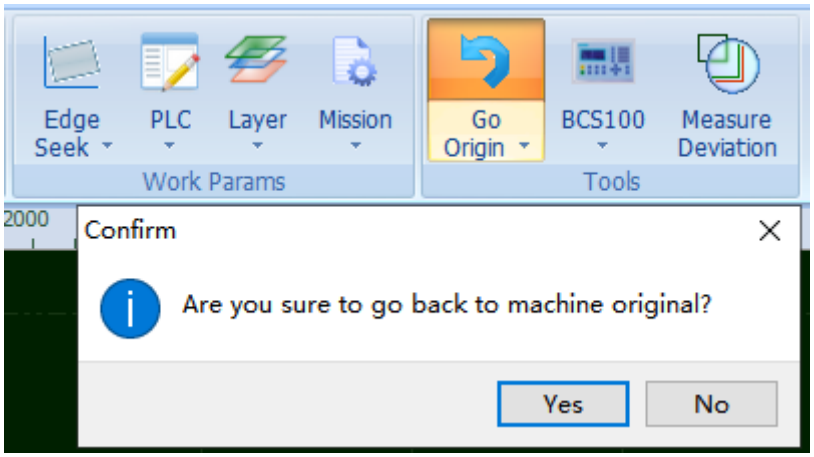
Overall Power-On Sequence

(1) Turn on the main power cabinet supply and the machine tool's main power switch.



(2) Pull up the Emergency Stop knob, then press the "PC" button (Machine Control System); wait for the control system to initialize.

(3) Click the "SERVO" button to launch the cutting software. Once the software has started, check the machine tool for any debris; then, click "CNC" and execute the "Go origin" operation.



(4) Switch on the laser power supply and the chiller power supply. Allow the chiller to run for 5–10 minutes until the water temperature reaches above 20°C, then check the chiller's operating status to ensure the water level is normal.

(5) Based on the specific gas required for cutting, verify that the pressure at the gas valve is within the normal range. Open the gas regulator valve and check that the pressure of the auxiliary cutting gas is normal. Use the handheld controller to initiate a gas purge to ensure proper gas flow.

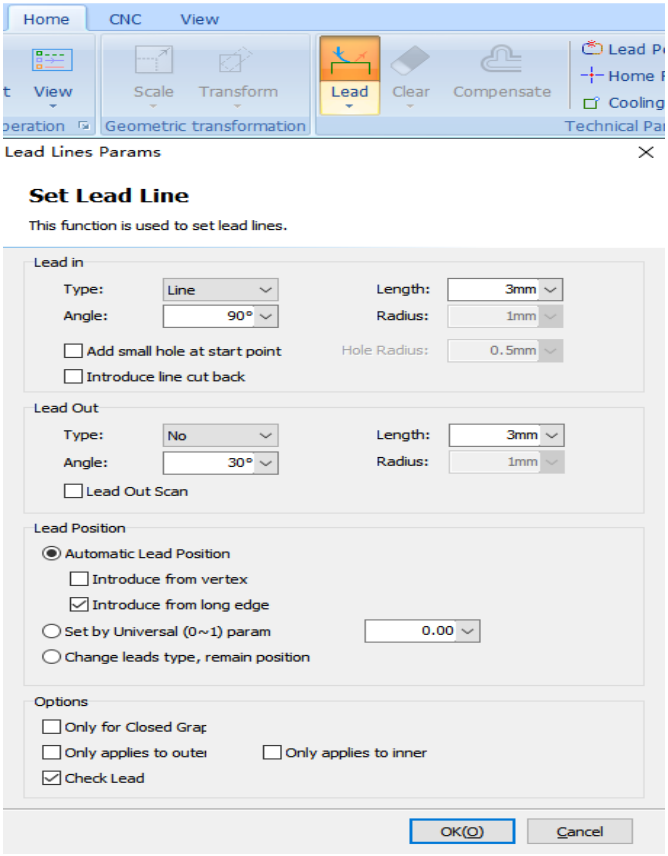
Commonly Used Features

Leader Lines

When adding lead-ins, the outer contour utilizes a "positive cut" (introduced from the outside), while the inner contour utilizes a "negative cut" (introduced from the inside). To manually configure the positive or negative cut settings, select the desired geometry, then click the "Outer/Inner" button located on the standard toolbar.

Automatic Leader Lines

Select the graphic for which you wish to configure lead lines, then click the "Lead" icon located on the Standard toolbar. In the window that appears, set the parameters for the lead lines, as shown in the figure below:



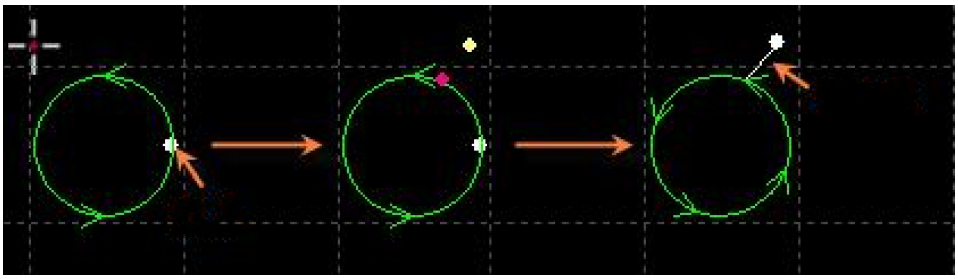
1）Lead-in/Lead-out Check: When a lead line intersects with the cutting contour (indicating the lead line is too long), the lead line length is automatically reduced to prevent it from damaging the contour.

2）Distinguishing Between Outer and Inner Contours: The software distinguishes between outer and inner contours based on their nesting relationships. The outermost layer constitutes the outer contour; the layer immediately beneath it is an inner contour; the layer beneath that is an outer contour; and so on. Any unclosed shape cannot form a distinct layer.

Manually Set Lead-in Lines

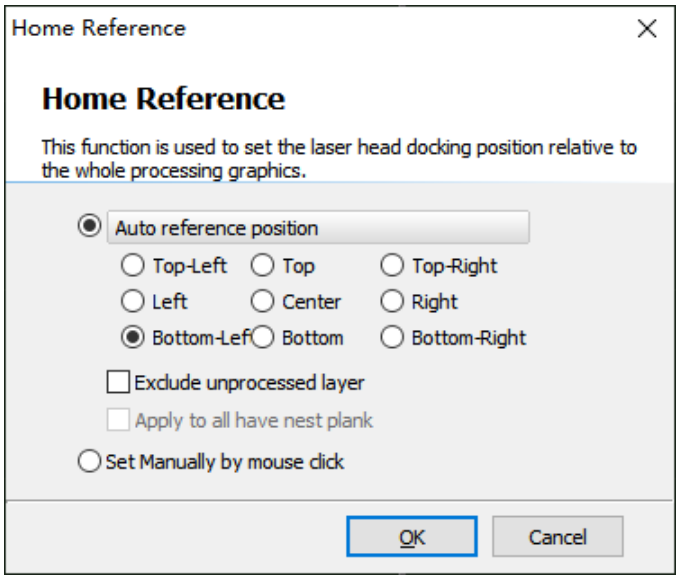
1）Manual Start Point：

Click the starting point "Lead pos," then click the graphic contour to complete the manual starting point operation. As shown in the figure below:



Docking

Set the relative position between the cutting head and the graphic; it is recommended to select the bottom-left corner. Click the "Dock" button under the "Common" tab to open the parameter dialog box. Once the parameters have been configured, click "OK" within the dialog box to finalize the modification of the docking point. (Note: The "Follow Graphic" docking feature—which determines whether the cutting head tracks the graphic—can be enabled or disabled within the "Advanced" section of the Configuration Tools.) See the figure below:

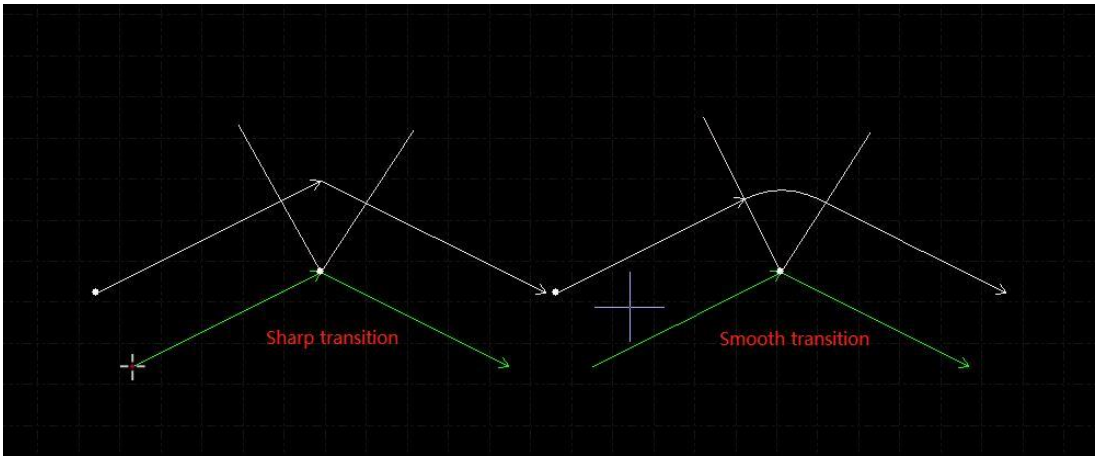


Compensate

Select the graphic requiring compensation, then click the " " button on the toolbar to apply kerf compensation. The kerf width should be determined by measuring the actual cutting results. The compensated cutting path is displayed in white on the drawing board; during processing, it is this compensated path—rather than the original graphic—that will be executed. The original graphic, though

displayed on the drawing board for operational convenience, will not be processed.

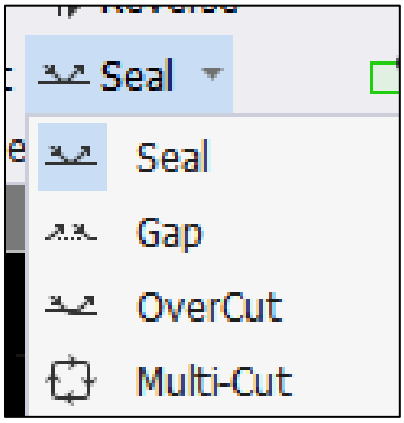
The direction of the kerf compensation can be selected manually or determined automatically based on whether the cut is internal (female) or external (male)—specifically, by offsetting the inner contour inward and the outer contour outward. During kerf compensation, you can choose whether the corners transition as fillets or right angles, as illustrated in the figure below:



In the diagram, the green line represents the original figure, the white line represents the compensated path, and the pale yellow line represents the perpendicular drawn from the corner of the original figure. As illustrated, applying compensation on both sides of the perpendicular ensures that the edges of the cutting kerf align with the original figure; however, a transition is required at the corners. Typically, a rounded-corner transition ensures that the cutting kerf edges remain aligned with the original figure throughout the transition process, resulting in smoother operation. To remove compensation, select the specific graphic requiring un-compensation, then click the "Clear" button and choose "Remove Compensation," or simply select the "Remove Compensation" button located within the Kerf Compensation section.

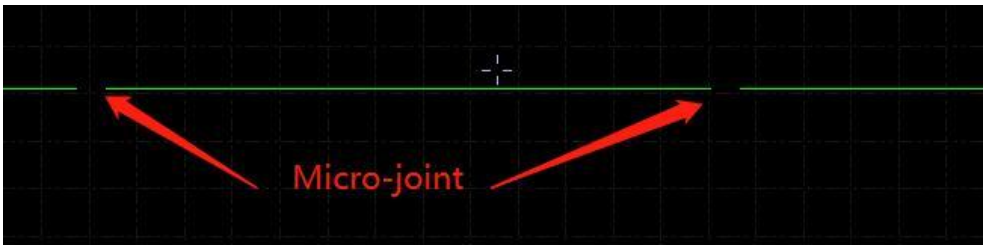
Overshoot, Gap, Closure, and Multiple Turns

Under the "Process Settings" section of the main menu bar, there are four selectable buttons used to configure Sealing, Notches, Overcuts, and Multiple Passes, respectively. To make a setting, simply select the desired graphic and then click the corresponding button. Note that any adjustments made to the "Notch/Overcut" dimensions will only apply to subsequent notch or overcut operations; the dimensions of any notches or overcuts that have already been configured will remain unchanged.

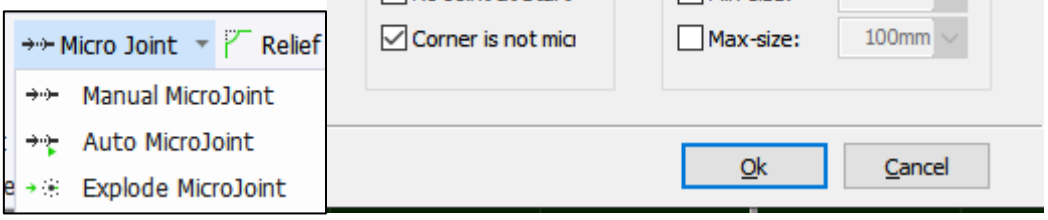


Micro-joints

Micro-joints are used to insert a small, uncut connection within a cutting path, thereby preventing the part from warping or lifting after the cutting process is complete. When the laser reaches this specific point, it will shut off; whether the assist gas and height-following system also deactivate is determined by the parameters configured for short-distance rapid traverses during cutting. On the drawing canvas, a micro-joint is visually represented as a small gap, as shown in the figure below:

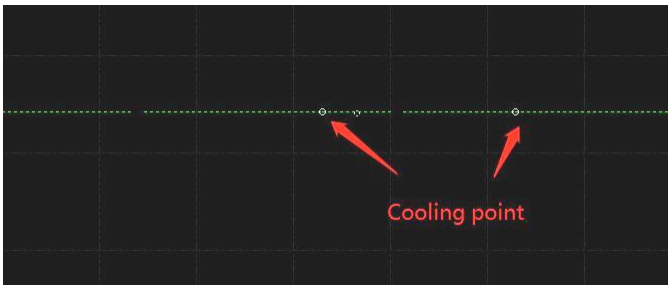


Click the button located beneath the small triangle to the right of the "Micro-link" button. Configure the parameters in the dialog box that appears, then click OK. You can choose to apply micro-links either by quantity—for example, adding 10 micro-links to each shape—or by distance—for example, inserting one micro-link every 100 mm.

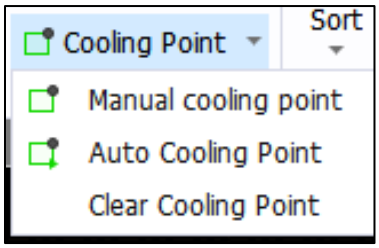


Cooling Point

Click the "Micro-Joint" button located on the standard toolbar, then click at the desired position on the graphic to place a cooling point. When the cutting process reaches a cooling point, the laser will automatically shut off; it will then pause to blow air—based on the cooling point settings defined in the global parameters—before reactivating the laser to resume normal cutting. Cooling points appear on the drawing canvas as solid white dots, as shown in the figure below:



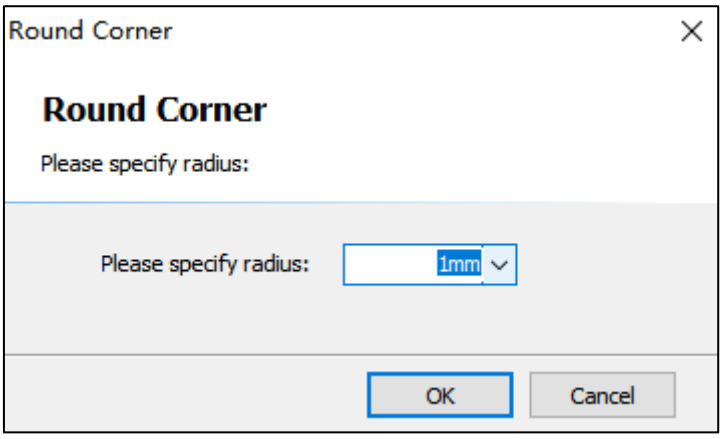
Click the small triangle to the right of the "Cooling Point" button, then select "Automatic Cooling Point." Set the parameters in the dialog box that appears, and click "OK." The locations where cooling points can be automatically added include injection points and sharp corners.



Fillet

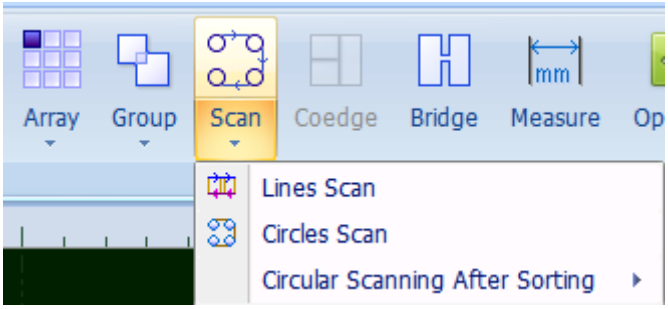
Click the "Fillet" button on the toolbar to open the dialog box; enter the desired fillet radius value, then click OK. Next, edit the right angles of the figure.

:


Round Corner
Round Corner
Please specify radius:
Please specify radius:
1mm
OK
Cancel

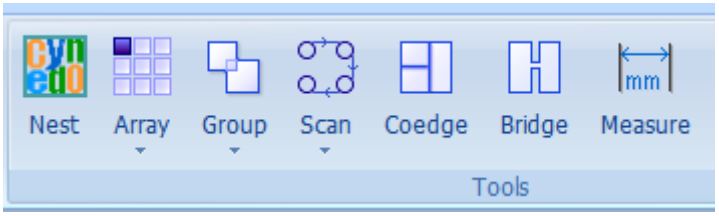
Flying Cut

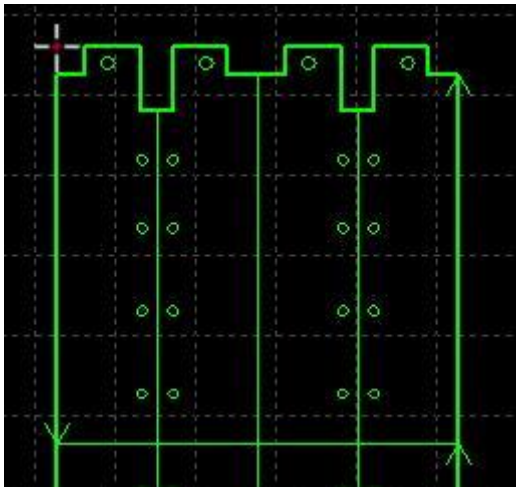
Prior to performing fly-cutting, it is recommended that users first sort the graphics intended for this operation; this step optimizes the scanning and cutting path, thereby saving idle travel time. Click the "Fly-cut" button located on the standard toolbar (Note: When the graphics within a regular array consist entirely of circles, this button functions as "Circular Arc Fly-cutting"), or select the "Linear Fly-cutting" option from the drop-down menu, to access the Linear Fly-cutting Parameter Settings interface.



Common Edge

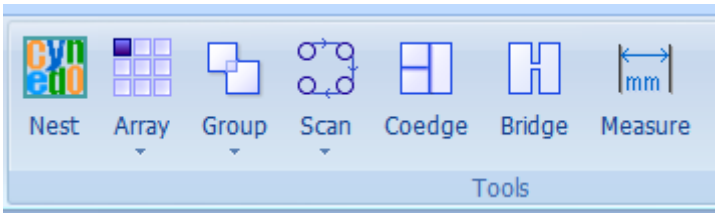
Merging workpieces that share identical boundaries—allowing them to share a single common edge—can significantly reduce machining length and boost efficiency. To utilize this feature, select two or more shapes intended to share an edge, then click the "Common Edge" button on the toolbar. CypWell will then attempt to merge the selected shapes along a common edge; if the selected shapes do not meet the necessary criteria for edge sharing, a notification message will appear in the "Drawing" window located at the bottom-left corner of the interface.

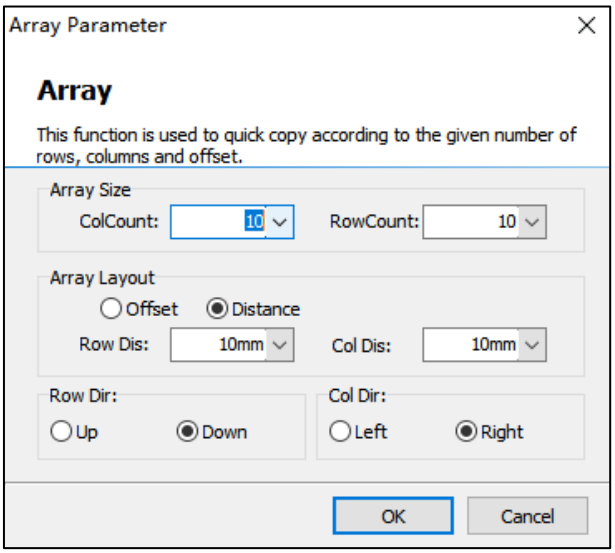




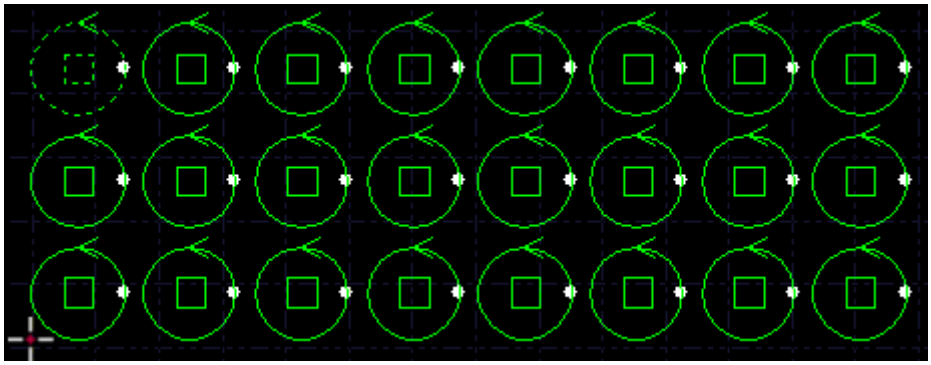
Array

Click the "Array" button, or select "Rectangular Array" from the "Array" drop-down menu; the parameter interface shown in the figure below will appear:





By simply configuring the number of rows, columns, offset, and direction, you can quickly duplicate the selected graphic, as shown in the figure below:

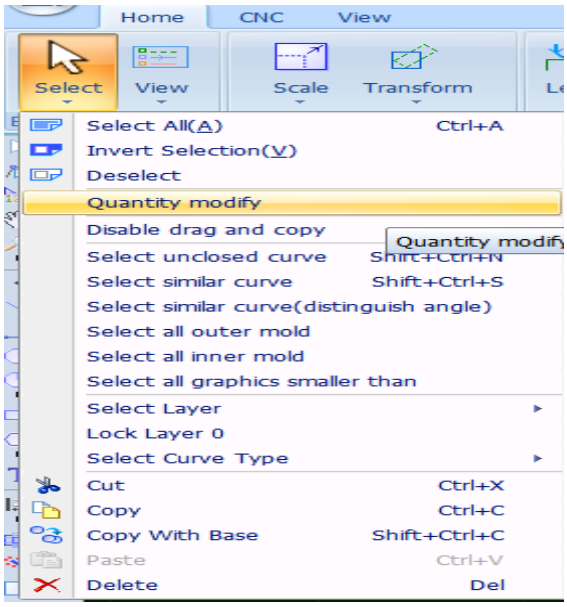


Batch Modify

For process modifications involving similar shapes, the "Batch Modify" function can be utilized to enhance drafting efficiency. The figure below serves as an example:

CypWell Laser Cutting Control Software 32

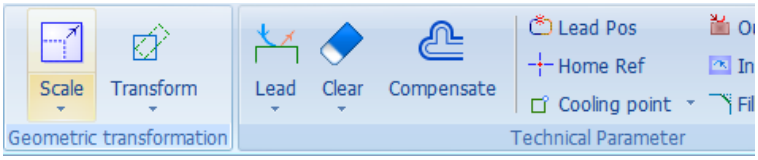
After selecting the graphics, enter the batch modification interface; once the leaders are configured, the changes will be applied simultaneously to both graphics.



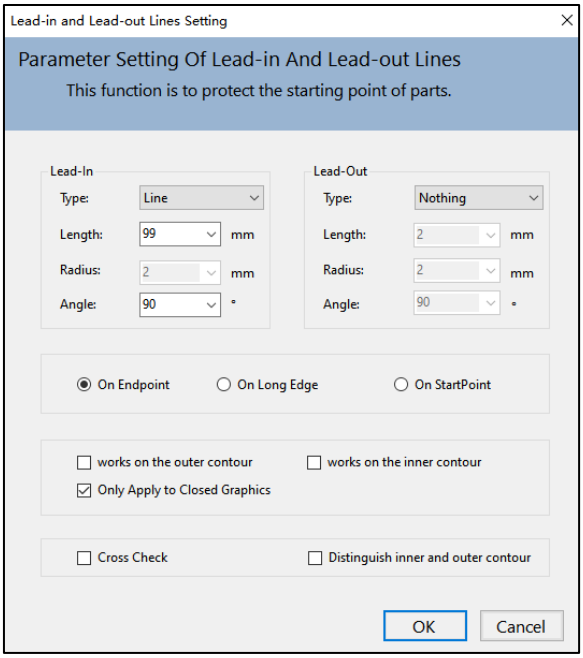
Cutting Steps

Step 1: Open the cutting software "Cyp Well," click "File," and select the graphic you wish to cut.

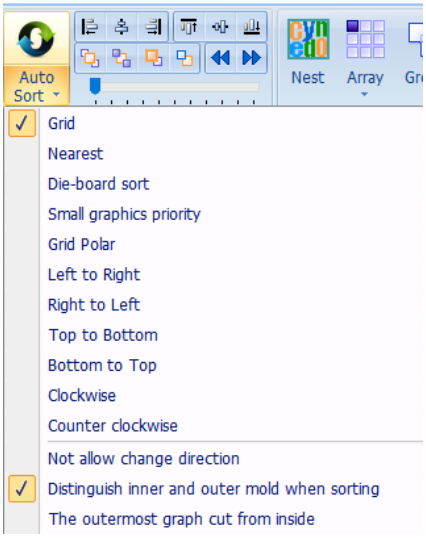
Step 2: Add a Leader Line. Select the graphic, then click "Lead"



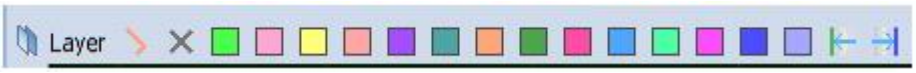
Set the type to a straight line with a length of 5 mm (this value can be adjusted as needed), keeping the angle unchanged. For the leader line, select "None." The leader position can be set to originate from the longer side (i.e., drawn from the edge of the graphic); then, click "OK." If, after adding the leader, it extends beyond the boundaries of the graphic, click "Negative Cut" or "Positive Cut" to adjust the leader's position.



Step 3: Select the shapes and click "Sort" to open the sorting dialog box. Customize the sorting criteria, then click "OK" to automatically determine the order of the two shapes.



Step 4: Click "Layer" to load the parameters corresponding to the specific sheet thickness. Verify the corresponding copper nozzle size, click "OK," and replace the nozzle on the cutting head.



Step 5: After replacing the copper nozzle, perform a capacitance calibration.

Step 6: Click to select either Oxygen or Nitrogen, then click "Blow" to verify that gas is being emitted.

Step 7: Select the desired cutting pattern, move the cutting head to the starting position, and click "Trace Border" to visualize the area the pattern occupies.

Step 8: Once everything is confirmed to be correct, click "Start" to begin processing. (Note: First-time users should hold the handheld controller with their finger positioned over the Pause button, ready to immediately press Pause/Stop should any issues arise.)

Shutdown Procedure

(1) Once cutting is complete and no further cutting is required, press the Emergency Stop button on the control console → Turn off the laser switch → Turn off the chiller switch.

(2) Close all gas cylinders and valves. Use the software to initiate a "purge" cycle to release residual gas from the pipelines, then turn off the air compressor and the air dryer.

(3) Turn off the servo button on the control console; save all cutting parameters and current cutting/processing tasks.

(4) Exit the cutting software → Perform a standard Windows shutdown → Press the computer power button.

(5) Switch off the main power "circuit breaker" on the electrical cabinet.

☞ Please strictly adhere to the operational steps outlined above; this ensures the proper functioning of the equipment and helps prevent malfunctions and safety hazards.

☞ In the event of adverse environmental conditions—such as extremely low temperatures—or other special circumstances, you must consult a service engineer.

Maintenance and Upkeep

Overview

To ensure the proper operation of the laser cutting machine, regular maintenance and upkeep of the equipment are essential. Since the entire machine tool is assembled from high-precision components, extreme care must be exercised during routine maintenance. All procedures must be strictly followed in accordance with the specific operating protocols for each section of the machine. Furthermore, maintenance should be performed exclusively by designated personnel; rough handling is strictly prohibited to prevent damage to the components. Power to the machine must be switched off during all maintenance operations.

Spare Parts Users Should Keep on Hand

A. Isopropyl Alcohol: 99.7% purity (water content < 0.3%); 500ml bottle.

B. Lint-free Cotton Swabs: 1 pack (100 swabs/pack).

C. Alcohol: 500ml; purity > 99.5%.

D. Lens Cleaning Paper: 1 booklet.

E. Compressed Air: 1 canister.

F. Rust Remover: 1 bottle.

G. All-purpose Cleaner: 1 bottle.

H. Multimeter: 1 unit.

Equipment Maintenance

Maintenance of the Pneumatic System

Daily check the air lines for any leaks; verify that the drain valves on the air compressor, air receiver, air dryer, and filters are draining properly, and ensure that all drainage functions are normal.

Maintenance of the Water System

Table 6-1

Machine Name: Chiller		
Maintenance Period	**Maintenance and Servicing Scope**	**Maintenance Objectives**
Daily	1. Check whether the chiller temperature setting is normal (set temperature: 20°C–22°C).	Ensure that the temperature of the cooling water supplied to the laser is normal.
	2. Check the chiller's water circuit seals, water temperature, and water pressure to ensure they meet requirements.	Ensure the equipment operates normally and prevent water leakage.
	3. Keep the chiller's operating environment dry, clean, and well-ventilated.	Conducive to the proper operation of the chiller.
	4. Observe the liquid level indicator tube located at the front of the chiller to ensure that the water level inside the tank is above 90% of the tank's height.	Preventing the water pump from burning out due to dry running.
	5. Ensure that the water tank cover mounting screws are tightened, and that the water tank filler cap is securely screwed on.	Prevent dust and debris from the environment from entering the water tank.
Monthly	1. Use a cleaning agent or high-quality soap to remove dirt from the surface of the chiller. Do not use benzene-based substances, acids, abrasive powders, steel brushes, hot water, or similar items for cleaning.	Ensure the surface of the chiller is clean.
	2. Open the chiller cabinet door panel and use a high-pressure air gun to blow out the fins of the condenser radiator, removing any dust adhering to them.	To prevent poor cooling caused by inadequate heat dissipation, which could lead to the burnout of the water pump and compressor.
	3. Use a high-pressure air gun or a cleaning cloth to clean the water pump's heat sink fins and other components; use the high-pressure air gun to blow away dust from the cooling fan located behind the water pump, as well as any debris inside the computer case.	Prevents poor heat dissipation and extends the service life of all components.
	4. Inspect water tank water quality and follow up.	Good water quality is essential to ensure the proper operation of the laser.
	5. Check the chiller piping for any signs of water leakage.	Ensure that the chiller is free of water leaks.
Every three months	1. Inspect electrical components (such as terminal blocks, switches, etc.) and perform dust removal.	Ensure the surfaces of the chiller's electrical components

		remain clean to extend its service life.
	2. Replace the circulating water (distilled water).	Prevents impurities in the water from clogging the circulating water system, thereby severely compromising cutting performance or even burning out optical components.
	3. Clean the filter. (Note: Use high-pressure water to clean the filter; please exercise caution during the cleaning process.)	Prevent the filter from clogging and failing to function properly.
	4. Cleaning the Chiller Water Tank	Prevents impurities in the water tank from entering the water circulation system.

Precautions:

a. Before adding water, ensure that the chiller is powered off and that the drain valve located at the bottom of the unit is closed. If visible impurities or foreign objects are present in the water tank, do not proceed immediately with adding water; instead, clean the tank thoroughly before refilling.

b. When adding water, exercise caution to prevent spillage onto the exterior of the chiller, which could lead to surface corrosion or contamination of the surrounding environment.

c. Use high-pressure water to clean the filter; please handle with care during the cleaning process.

d. Strictly avoid operating or storing the chiller in environments where the ambient temperature falls below 5°C or exceeds 40°C.

e. During operation, ensure that the chiller remains properly ventilated: maintain a clearance of at least 1000 mm free of obstructions on both the top (air outlet) and the side (air inlet) of the unit.

f. The water hoses connecting the chiller to the cutting machine should typically have a single-run length of 10 meters; the maximum length must not exceed 25 meters.

Maintenance of Dust Extraction and Removal Systems

The dust extraction and removal system serves as an auxiliary component of the laser cutting machine. Its primary function is to promptly and effectively extract the dust generated during the laser cutting process, thereby protecting the machine tool's critical precision components from dust contamination while simultaneously safeguarding the workshop environment. Maintenance of the dust extraction system should be performed in accordance with the maintenance guidelines for the extraction fan; furthermore, the details of each maintenance operation must be meticulously recorded in the Maintenance Log (Table 6-2).

Machine Name: Exhaust Fan		
Maintenance Period	**Maintenance and Servicing Scope**	**Maintenance Objectives**
Daily	Remove stains and dirt from the surface of the exhaust fan.	Keep the exterior of the exhaust fan clean.
Every 7 days	Clean the inside of the exhaust fan	Ensures smooth ventilation and effective performance.

Note: The dust extraction system is an optional accessory. Equipment equipped with a dust extraction system requires this maintenance procedure.

Voltage Stabilizer Maintenance

A voltage regulator is a power supply circuit or device designed to automatically adjust output voltage. Its primary function is to stabilize a power supply voltage—which may be subject to significant fluctuations or fail to meet the specific requirements of connected equipment—within a designated set range, thereby enabling various circuits and electrical devices to operate normally at their rated working voltages. In the context of a laser cutting machine, the voltage regulator serves primarily to provide the laser source with a stable working voltage that meets all necessary specifications, thereby preventing damage to the laser or other electrical components caused by voltage instability or non-compliant voltage levels. The use of a voltage regulator is of paramount importance in a laser cutting machine; consequently, its proper maintenance and upkeep are absolutely essential. Please refer to Table 6-3 below for specific maintenance procedures, strictly adhering to the instructions provided, and ensure that a record is kept of every maintenance operation performed.

Table 6-3

Machine Name: Voltage Stabilizer		
Maintenance Period	**Maintenance and Servicing Scope**	**Maintenance Objectives**
Daily	1. Check whether the load current is within the permissible range.	Ensure the machine operates normally.
	2. Remove stains and dirt from the machine's surface.	Ensure the machine surface is clean.
	3. Check the stability of the three-phase voltage.	Ensure a stable power supply to the machine tool and laser.

Monthly	1. Thoroughly clean all components of the voltage stabilizer—particularly the brushes, the exposed parts of the contact voltage regulator, the brush sliding rails, and the variable-speed transmission components -using gasoline and a cotton cloth to wash and wipe them dry.	Ensures effective heat dissipation for components, extending their service life.
	2. Replace worn or damaged carbon brushes.	Ensure the stability of the three-phase voltage.
	3. Adjust the clearance of the screw; a slight amount of play is sufficient.	Ensure the machine operates normally.
★★★Precautions: a. If the input voltage remains within the permissible range but the output voltage becomes unstable, an immediate inspection must be performed. b. The voltage regulator should be installed in a clean, dry, cool, and well-ventilated location to prevent overheating during operation. Important Note: Although this unit is designed to operate in ambient temperatures up to 40°C, prolonged exposure to such high temperatures can cause alterations in semiconductor components, potentially resulting in permanent damage and reduced reliability. For safety and optimal performance, it is recommended to operate the unit within an ambient temperature of 25°C. c. All maintenance and servicing procedures must be performed only after the power supply has been completely disconnected.		

Note: Voltage stabilizers are configured based on power requirements; equipment equipped with a voltage stabilizer requires this specific maintenance procedure.

Laser Maintenance

Specific maintenance procedures for the laser unit should be performed in accordance with the instruction manual provided for the selected laser model.

A）Anti-freeze

In operating environments prone to frequent power outages—or where daily draining of the cooling fluid is not feasible—the use of antifreeze is mandatory. The base fluid of antifreeze typically consists of a mixture of alcohols and water; it is required to possess a high boiling point and flash point, high specific heat capacity and thermal conductivity, low viscosity at low temperatures, resistance to foaming, and non-corrosive properties toward metal components, rubber hoses, and similar materials. When selecting or formulating an antifreeze solution, its freezing point should be at least 5°C lower than the lowest ambient temperature of the operating environment. It is recommended to use specialized antifreeze products from professional brands:

We recommend the CLARIANT brand, which offers two specific models suitable for use in laser systems:

1) Antifrogen® N: Ethylene Glycol–Water based (Industrial grade; toxic to humans).

2) Antifrogen® L: Propylene Glycol–Water based (Food grade; non-toxic to humans).

Note: No antifreeze solution can serve as a complete substitute for deionized water, nor should it be used continuously throughout the entire year. The volume of antifreeze used should constitute between 10% and 20% of the total tank capacity, and must not exceed 20%. Once the winter season has passed, the cooling lines must be thoroughly flushed with deionized water or purified water, after which deionized water or purified water should be reinstated as the primary cooling fluid.B)

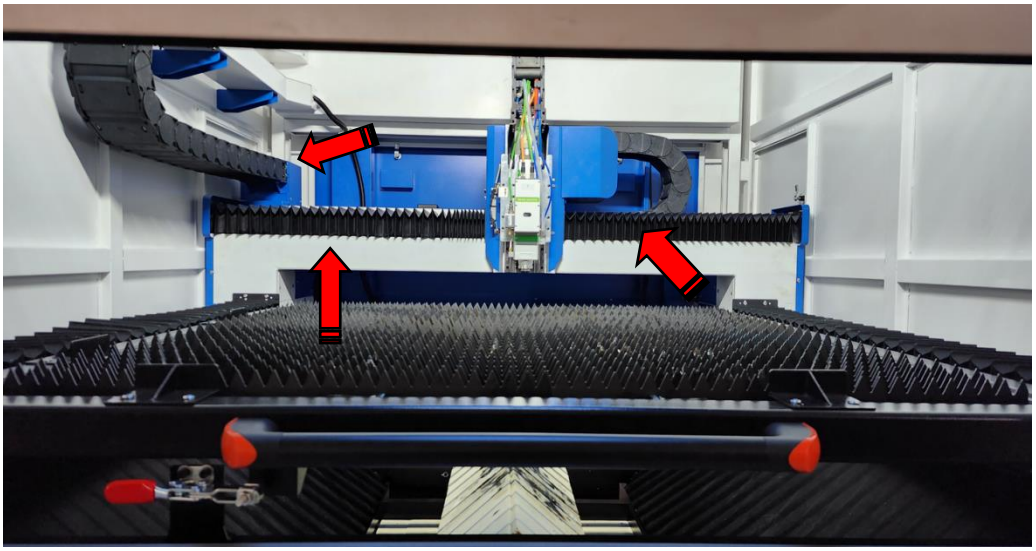
B) Anti-condensation

- Since lasers impose stringent requirements on their operating environment, special maintenance measures are necessary during the summer season to ensure their protection. These measures aim to prevent condensation—which can occur due to significant temperature differentials between the laser and the external environment—and thereby avoid potential damage to the laser unit. The following maintenance procedures should be strictly observed during summer operation:
- Dedicate a separate, air-conditioned room specifically for the laser unit to optimize its external operating environment, ensuring it operates within a dry, temperature-controlled setting.
- It is recommended that customers acquire a temperature and humidity monitor and place it inside the laser's air-conditioned room to continuously track the internal environmental conditions.
- Adjust the chiller settings according to the ambient temperature: set the high-temperature limit to 28–32°C and the low-temperature limit to 25–29°C.
- Strictly adhere to the prescribed power-on and power-off sequence for the fiber laser machine.
    - **Power-On Sequence**
        (1) Turn on the laser's main power switch, and allow the cabinet air conditioner or dehumidifier to run for at least 30 minutes;
        (2) 30 minutes after turning on the laser, turn on the chiller's power switch.

    - **Shutdown Sequence**
        (1) Turn off the chiller power switch;
        (2) Turn off the laser power switch.

Main Machine Tool Maintenance

Cutting operations generate smoke and dust; to ensure the long-term stability of the machine, internal maintenance is essential. The machine tool should undergo a monthly cleaning of the dust covers, sheet metal components, and beam sections. (Perform this operation with the power switched off.)

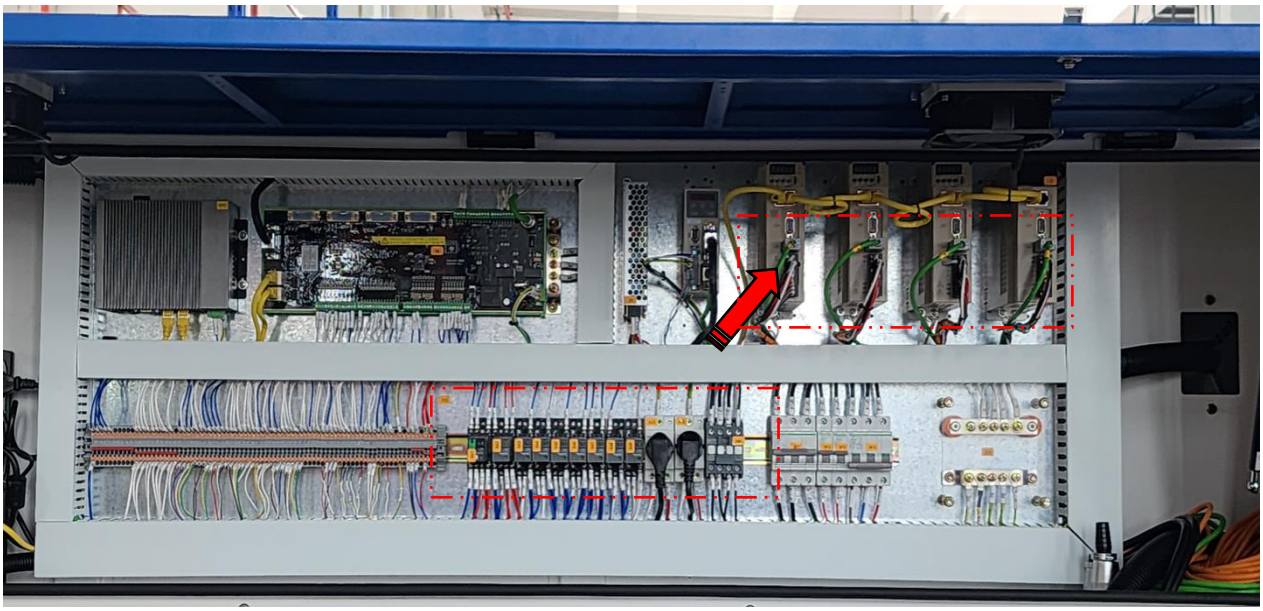


Z-Axis Cover Front Door

Check that the Z-axis cover mounting screws are securely tightened to prevent loosening and potential collisions during high-speed operation.

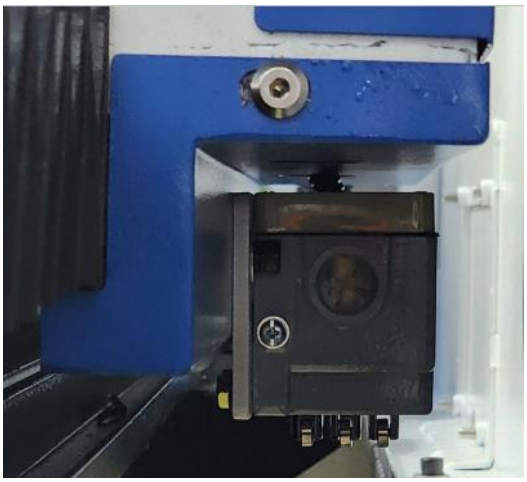
The electrical control cabinet is neat and tidy.

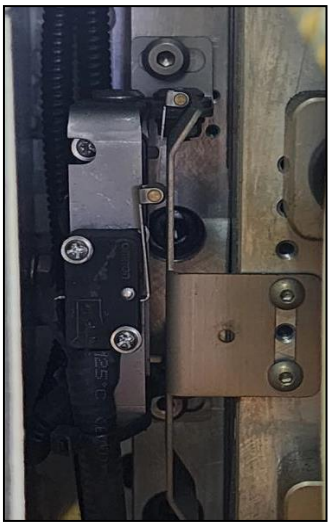
Over time, a significant amount of dust will accumulate inside the electrical cabinet. Use a clean cloth to wipe down the cabinet components on a monthly basis, and inspect the wiring every three months to check for any loose connections. Ensure that all plug-in connectors are thoroughly checked. (This procedure must be performed with the power disconnected.)



Limit Switch Cleaning

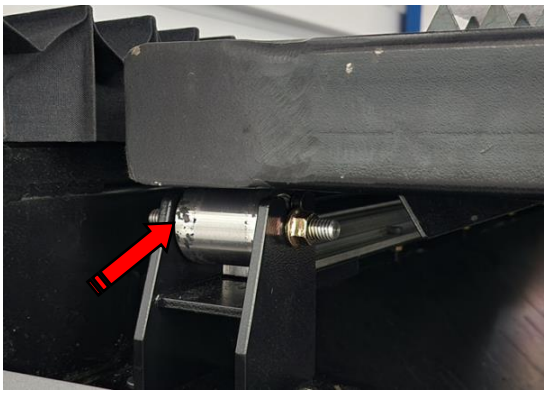
Conduct a monthly inspection to verify the proper functioning of the X and Y axes, as well as the safety limit switches. Check the computer monitor to ensure that no alarms are triggered by the touch sensors. Clean the sensors with a clean cloth to prevent dust accumulation over time, which could lead to reduced sensitivity.





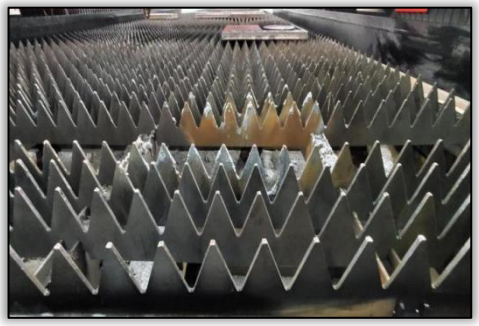
Platform Guide Rail Cleaning

To ensure the normal and stable operation of the machinery—and thereby guarantee the quality of the processed products—diligent daily maintenance of the pulleys and cylindrical guide rails must be performed.



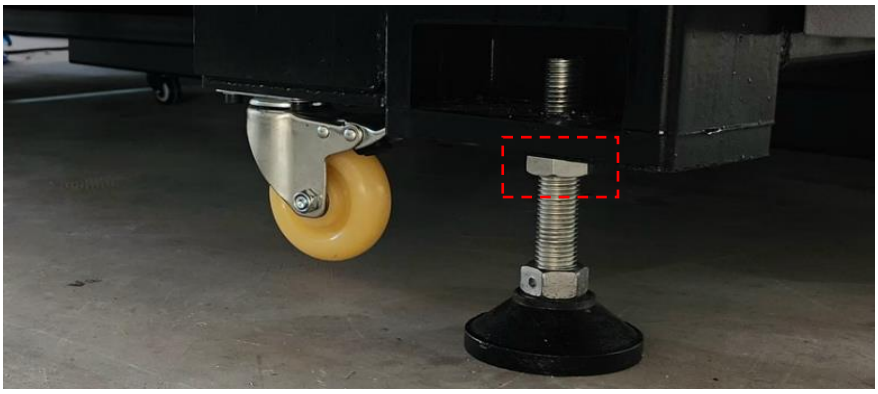
Rack

Prolonged use inevitably leads to wear and damage to the gear racks; this can result in unevenness when positioning sheet materials, and a reduction in the rack's support height may trigger a "lower limit" alarm during cutting operations. Severe damage to the gear racks compromises cutting quality, often manifesting as slag accumulation on one side of the cut edge. Any gear racks found to be severely damaged must be replaced.



Inspection of Machine Tool Leveling Feet

Every three months, inspect all leveling feet on the machine tool to ensure they are secure. Check the nuts on the leveling feet for looseness by attempting to turn them; if any are loose, tighten them using an adjustable wrench.

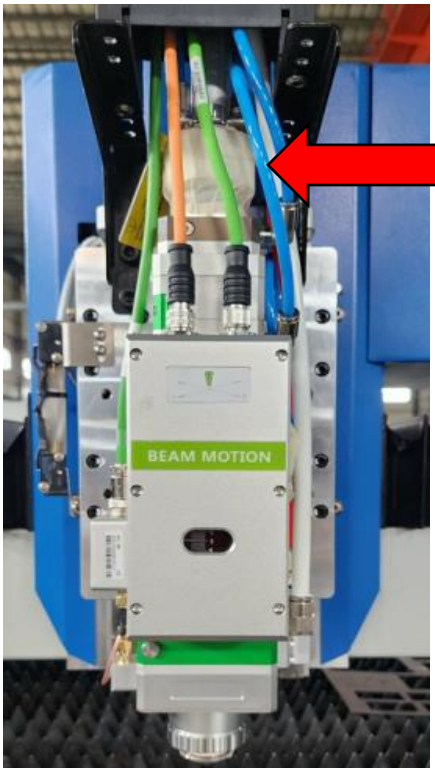


Material Cart Cleaning

To prevent the waste drawer from becoming jammed—a situation that can arise from an excessive accumulation of waste material over extended periods of cutting—please clear the waste from the drawer at the end of each day's cutting operations and verify that the rollers are functioning correctly.

Cutting Head

Clean the exterior of the cutting head daily. After extended periods of cutting, wipe it down thoroughly with a clean cloth, then wrap the cutting head with masking tape to prevent discoloration caused by smoke and dust. Wipe the QBH (fiber optic interface) and wiring ports on the cutting head with a clean cloth before covering them with masking tape. For the protective cover of the lower protective lens, ensure the masking tape is replaced frequently to maintain cleanliness, thereby preventing dust ingress when changing the lens.



Wipe the surface clean with a cloth, then replace the old masking tape with a fresh layer.

Chiller Maintenance Requirements

◆ Recommended Ambient Temperature: 0–45°C

◆ Recommended Ambient Humidity: ≤80% RH

◆ Use softened water, such as purified water, distilled water, deionized water, or high-purity water.

◆ Strictly prohibit the use of spring water, mineral water, oily liquids, liquids containing solid particles, or liquids corrosive to metals.

◆ Recommended Antifreeze Ratio: ≤30% Ethylene Glycol (to be added during winter to prevent the circulating water from freezing).

◆ Periodically remove and clean the dust filter screens, and use a compressed air gun to blow away accumulated dust from the internal condenser (perform at least once a week or more frequently; the dust filter screens must not be left removed for extended periods).

◆ Given that fiber laser chillers often operate in harsh environments, regular maintenance is essential to ensure optimal performance and extend the equipment's service life. Maintenance should be performed weekly and includes—but is not limited to—the following tasks:

◆ Inspect the condenser; check the air ducts for obstructions caused by foreign objects; and verify that airflow intake and exhaust around the unit remain unobstructed.

◆ Clean the condenser and the dust filter screens.

◆ Inspect the cooling medium (water) for foreign objects or signs of microbial growth. Generally, the cooling medium should be replaced every 15–20 days; the replacement medium must be purified water, distilled water, or high-purity water.

◆ Check water circuit connections for looseness and inspect the water pump for leaks.

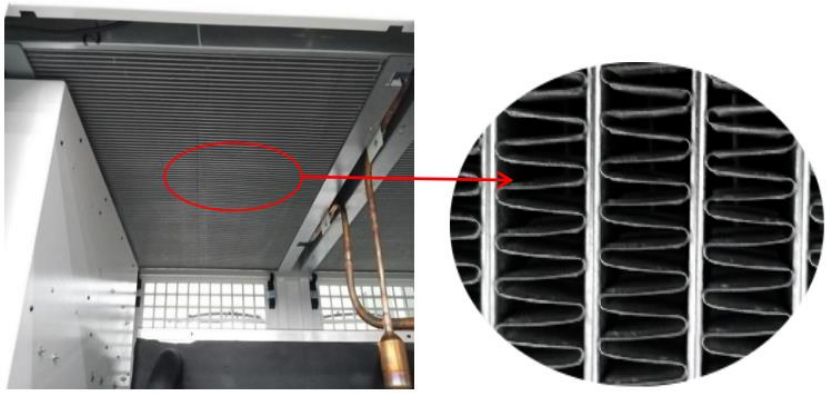
◆ Inspect the water tank and clean out any accumulated sediment or dirt from the interior.

◆ Periodically clean the filters within the equipment's water circuit (typically once every 7–10 days). The two common filter types used by this company are: the Y-type filter (positioned at the water pump's intake or the equipment's water outlet) and the built-in stainless steel filter (located inside the water tank).

◆ Test the insulation resistance; the insulation resistance value must be ≥5 MΩ.

◆ Perform dust removal and cleaning of the equipment's condenser and dust filter screens approximately every 15 days.

Winter Maintenance



Add antifreeze

If the ambient temperature at night drops below 2°C, it is recommended that customers either keep the equipment running continuously or add antifreeze. The volume ratio of ethylene glycol should be selected based on Table 1, ensuring that the resulting freezing point is approximately 5°C lower than the ambient temperature of the equipment's operating environment. Once the daily average temperature rises above 5°C, replace the water containing antifreeze with softened water.

Suggestion:

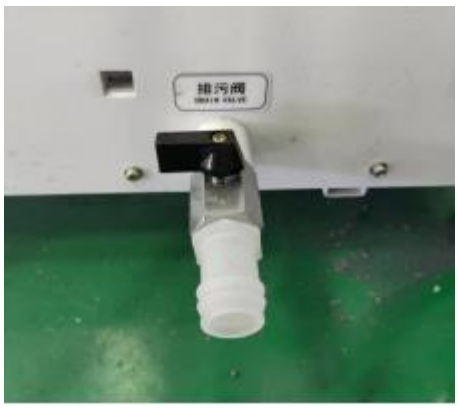
For the water chiller, add a professional-grade antifreeze—such as Clariant's Antifrogen N—at a mixing ratio of 3:7 (3 parts antifreeze to 7 parts water). Once added, this solution prevents freezing down to -20°C. If temperatures are expected to drop below this range, please consult the water chiller supplier to confirm the appropriate antifreeze ratio.

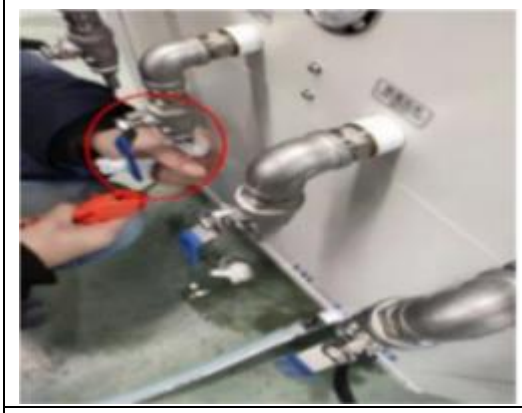
If professional-grade antifreeze is difficult to procure, a large-format automotive antifreeze—such as Shell OAT 45°C—may be used as an alternative.

Note: No antifreeze can serve as a complete substitute for deionized water, nor should it be used continuously throughout the entire year. Once the winter season has passed, the piping system must be flushed using deionized or distilled water, after which deionized or distilled water should be reinstated as the primary coolant. Whenever feasible, we recommend optimizing the operating environment—specifically by ensuring the water chiller remains powered on continuously—or, alternatively, by selecting the antifreeze product shown in the image on the right.

Equipment Drainage

If the chiller is to remain out of service for an extended period, it is recommended to drain the water stored within the unit. This measure prevents the water from freezing—should ambient temperatures drop below 0°C—thereby eliminating the potential risk of internal piping or components sustaining damage due to freezing. To prevent the stored water from freezing, the following drainage guidelines have been established: Table 6-4.

	
Step 1: Open the drain valve to completely drain the interior of the water tank.	Step 2: Use a hose to bypass the normal-temperature water outlet and the normal-temperature water inlet. (For return lines equipped with a ball valve, simply close the ball valve.)
	
Step 3: Insert an air gun into the outlet of the low-temperature water pipe, and hold a cleaning towel against the pipe opening (to prevent air leakage during the blowing process). Activate the air gun and blow for approximately 85 seconds to completely purge any residual water from the pipe, continuing until no water is discharged from the outlet.	Step 4: Insert an air gun into the opening of the low-temperature return water pipe, and use a clean towel to seal the opening (to prevent air leakage during the blowing process). Activate the air gun and blow for approximately 85 seconds to completely purge any residual water from the pipe, continuing until no water is discharged from the outlet.

	
Step 5: Remove the connection pipes for the normal-temperature outlet and return (or open the ball valves for the normal-temperature outlet and return).	Step 6: Insert an air gun into the outlet of the room-temperature water pipe while holding a cleaning towel against the opening. Open the outlet of the low-temperature water pipe, then activate the air gun to blow air for approximately 85 seconds to purge any residual water from the piping, continuing until no water is discharged from either the drainage port or the low-temperature water outlet.
	
Step 7: Insert an air gun into the opening of the room-temperature return water pipe. While holding a clean towel against this opening, open the low-temperature return water pipe opening. Activate the air gun and blow air for approximately 85 seconds to purge any residual water from the pipe, continuing until no water is discharged from either the drainage outlet or the low-temperature return water pipe opening.	Step 8: Insert an air gun into the water tank, activate it to blow air for approximately 60 seconds, and purge any residual water from the tubing until no water is discharged from the drain outlet or the low-temperature return port. (For handheld welding units, use a clean towel inserted into the tank to absorb and remove any residual water remaining at the bottom.)
Step 9: Unscrew the water pump's drain plug to discharge any residual water from inside the pump, ensuring it is completely drained.	

Cleaning the Built-in Water Tank Filter

Cleaning the Water Tank Bottom Suction Filter：

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Open the side door of the chiller; as shown in the figure below, you will see the equipment's water tank.</td><td>After opening the top cover of the water tank, you will see the water intake filter located at the bottom of the tank (as shown in the figure above).</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Rotate the bottom intake filter counter-clockwise to remove it; then, use an air gun to blow air through the filter screen to thoroughly clear away any accumulated dirt and impurities.</td></tr>
</table>

Cleaning of Y-Strainers

Table 6-5

Open the side door of the chiller; as shown in the figure below, you will see the unit's Y-type water filter.

Using an adjustable wrench, unscrew the hexagonal nut at the bottom of the Y-strainer in a counter-clockwise direction. (Note: This requires two adjustable wrenches—use the left wrench to hold the assembly steady by pulling upwards, while using the right wrench to unscrew the nut downwards in a counter-clockwise motion.) Once removed, the internal filter screen of the Y-strainer will be exposed.

Simply use an air gun to blow away and clean the dirt and impurities from the internal filter screen of the Y-type water filter.

Chapter 6 Maintenance and Upkeep

Overview

To ensure the proper operation of the laser cutting machine, routine care and maintenance of the equipment are essential. As the entire machine tool is assembled from high-precision components, extreme caution must be exercised during routine maintenance. All procedures must be strictly followed in accordance with the specific operating guidelines for each component, and maintenance tasks should be performed exclusively by designated personnel. Rough handling is strictly prohibited to prevent damage to the machine's components. The power supply must be disconnected during all maintenance operations.

Spare Parts Users Should Keep on Hand

A. Isopropyl Alcohol: 99.7% purity (water content < 0.3%); 500ml bottle.

B. Lint-free Cotton Swabs: 1 pack (100 swabs/pack).

C. Alcohol: 500ml; purity > 99.5%.

D. Lens Cleaning Paper: 1 booklet.

E. Compressed Air: 1 canister.

F. Rust Remover: 1 bottle.

G. All-purpose Cleaner: 1 bottle.

H. Multimeter: 1 unit.

Equipment Maintenance

Maintenance of the Pneumatic System

Daily checks should be performed on the pneumatic lines to detect any signs of leakage. Verify that the drain valves on the air compressor, air storage tank, air dryer, and filters are functioning correctly and draining properly.

Maintenance of the Water Cooling System

Machine Name: Chiller		
Maintenance Period	Maintenance and Servicing Scope	Maintenance Objectives
Daily	1. Check whether the chiller temperature setting is normal (set temperature: 20°C–22°C).	Ensure that the temperature of the cooling water supplied to the laser is normal.

	2. Check the chiller's water circuit seals, water temperature, and water pressure to ensure they meet requirements.	Ensure the equipment operates normally and prevent water leakage.
	3. Keep the chiller's operating environment dry, clean, and well-ventilated.	Conducive to the proper operation of the chiller.
	4. Observe the liquid level indicator tube located at the front of the chiller to ensure that the water level inside the tank is above 90% of the tank's height.	Preventing the water pump from burning out due to dry running.
	5. Ensure that the water tank cover mounting screws are tightened, and that the water tank filler cap is securely screwed on.	Prevent dust and debris from the environment from entering the water tank.
Monthly	1. Use a cleaning agent or high-quality soap to remove dirt from the surface of the chiller. Do not use benzene-based substances, acids, abrasive powders, steel brushes, hot water, or similar items for cleaning.	Ensure the surface of the chiller is clean.
	2. Open the chiller cabinet door panel and use a high-pressure air gun to blow out the fins of the condenser radiator, removing any dust adhering to them.	To prevent poor cooling caused by inadequate heat dissipation, which could lead to the burnout of the water pump and compressor.
	3. Use a high-pressure air gun or a cleaning cloth to clean the water pump's heat sink fins and other components; use the high-pressure air gun to blow away dust from the cooling fan located behind the water pump, as well as any debris inside the computer case.	Prevents poor heat dissipation and extends the service life of all components.
	4. Inspect water tank water quality and follow up.	Good water quality is essential to ensure the proper operation of the laser.
	5. Check the chiller piping for any signs of water leakage.	Ensure that the chiller is free of water leaks.
Every three months	1. Inspect electrical components (such as terminal blocks, switches, etc.) and perform dust removal.	Ensure the surfaces of the chiller's electrical components remain clean to extend its service life.
	2. Replace the circulating water (distilled water).	Prevents impurities in the water from clogging the circulating water system, thereby severely compromising cutting performance or even burning out optical components.
	3. Clean the filter. (Note: Use high-pressure water to clean the filter; please exercise caution during the	Prevent the filter from clogging and failing to function properly.

	cleaning process.)	
	4. Cleaning the Chiller Water Tank	Prevents impurities in the water tank from entering the water circulation system.

Precautions:

a. Before adding water, ensure that the chiller is powered off and that the drain valve located at the bottom of the unit is closed. If visible impurities or foreign objects are present in the water tank, do not proceed immediately with adding water; instead, clean the tank thoroughly before refilling.

b. When adding water, exercise caution to prevent spillage onto the exterior of the chiller, which could lead to surface corrosion or contamination of the surrounding environment.

c. Use high-pressure water to clean the filter; please handle with care during the cleaning process.

d. Strictly avoid operating or storing the chiller in environments where the ambient temperature falls below 5°C or exceeds 40°C.

e. During operation, ensure that the chiller remains properly ventilated: maintain a clearance of at least 1000 mm free of obstructions on both the top (air outlet) and the side (air inlet) of the unit.

f. The water hoses connecting the chiller to the cutting machine should typically have a single-run length of 10 meters; the maximum length must not exceed 25 meters.

Maintenance of Dust Extraction and Removal Systems

The dust extraction and removal system serves as an auxiliary component of a laser cutting machine. Its primary function is to promptly and effectively extract the dust generated during the laser cutting process, thereby protecting the machine tool's critical precision components from dust contamination while simultaneously safeguarding the workshop environment. Maintenance of the dust extraction system should be conducted in accordance with the maintenance guidelines for the extraction fan, and the details of each maintenance operation must be meticulously recorded in the maintenance log:

Machine Name: Exhaust Fan		
Maintenance Period	Maintenance and Servicing Scope	Maintenance Objectives
Daily	Remove stains and dirt from the surface of the exhaust fan.	Keep the exterior of the exhaust fan clean.
Every 7 days	Clean the inside of the exhaust fan	Ensures smooth ventilation and effective performance.

Note: The dust extraction system is an optional accessory. Equipment equipped with a dust extraction system requires this maintenance procedure.

Voltage Stabilizer Maintenance

A voltage regulator is a power supply circuit or device designed to automatically adjust output voltage. Its primary function is to stabilize a power supply voltage—which may be subject to significant fluctuations or fail to meet the specific requirements of connected equipment—within a designated set range, thereby enabling various circuits and electrical devices to operate normally at their rated working voltages. In the context of a laser cutting machine, the voltage regulator serves primarily to provide the laser source with a stable working voltage that meets all necessary specifications, thereby preventing damage to the laser or other electrical components caused by voltage instability or non-compliance. The use of a voltage regulator is of paramount importance in a laser cutting machine; consequently, its proper maintenance and upkeep are absolutely essential. Please refer to the table below for specific maintenance procedures, strictly adhere to the instructions provided, and maintain a detailed record of every maintenance operation performed.

Machine Name: Voltage Stabilizer		
Maintenance Period	Maintenance and Servicing Scope	Maintenance Objectives
Daily	1. Check whether the load current is within the permissible range.	Ensure the machine operates normally.
	2. Remove stains and dirt from the machine's surface.	Ensure the machine surface is clean.
	3. Check the stability of the three-phase voltage.	Ensure a stable power supply to the machine tool and laser.
Monthly	1. Thoroughly clean all components of the voltage stabilizer—particularly the brushes, the exposed parts of the contact voltage regulator, the brush sliding rails, and the variable-speed transmission components—using gasoline and a cotton cloth to wash and wipe them dry;	Ensures effective heat dissipation for components, extending their service life.
	2. Replace worn or damaged carbon brushes.	Ensure the stability of the three-phase voltage.
	3. Adjust the clearance of the screw; a slight amount of play is sufficient.	Ensure the machine operates normally.
Precautions: a. Ensure that the input voltage remains within the permissible range; if the output voltage becomes unstable, immediately inspect the unit. b. The voltage regulator should be installed in a clean, dry, cool, and well-ventilated location to prevent overheating during operation. Important Note: Although this unit may be installed at		

ambient room temperature... While the device can withstand an ambient temperature of 40°C, prolonged exposure to such high temperatures can induce changes in semiconductor components, resulting in permanent damage and reduced reliability. For safety reasons, it is recommended to operate the device within an ambient temperature of 25°C.

c. Maintenance and servicing must be performed with the power supply disconnected.

Note: Voltage stabilizers are configured based on power capacity; equipment equipped with a voltage stabilizer requires this maintenance procedure.

Laser Maintenance

Specific maintenance procedures for the laser unit should be guided primarily by the instructions provided in the manufacturer's manual for the selected laser model.

A) Freeze Protection

In operating environments prone to frequent power outages—or where daily draining of the coolant is not feasible—the use of antifreeze is mandatory. The base fluid of antifreeze typically consists of a mixture of alcohols and water; it is required to possess a high boiling point and flash point, high specific heat capacity and thermal conductivity, low viscosity at low temperatures, resistance to foaming, and non-corrosive properties toward metal components, rubber hoses, and similar materials. When selecting or formulating an antifreeze solution, its freezing point must be at least 5°C lower than the lowest ambient temperature of the operating environment. It is recommended to use specialized antifreeze products from professional brands:

We recommend the CLARIANT brand, which offers two specific models suitable for use in laser systems:

1) Antifrogen® N: Ethylene Glycol–Water based (Industrial grade; toxic to humans)

2) Antifrogen® L: Propylene Glycol–Water based (Food grade; non-toxic to humans)

Note: No antifreeze solution can serve as a complete substitute for deionized water, nor should it be used continuously throughout the entire year. The volume of antifreeze used should constitute between 10% and 20% of the total tank capacity, and must not exceed 20%. Once the winter season has passed, the cooling lines must be thoroughly flushed with deionized water or purified water, and the system should revert to using deionized water or purified water as the primary coolant.

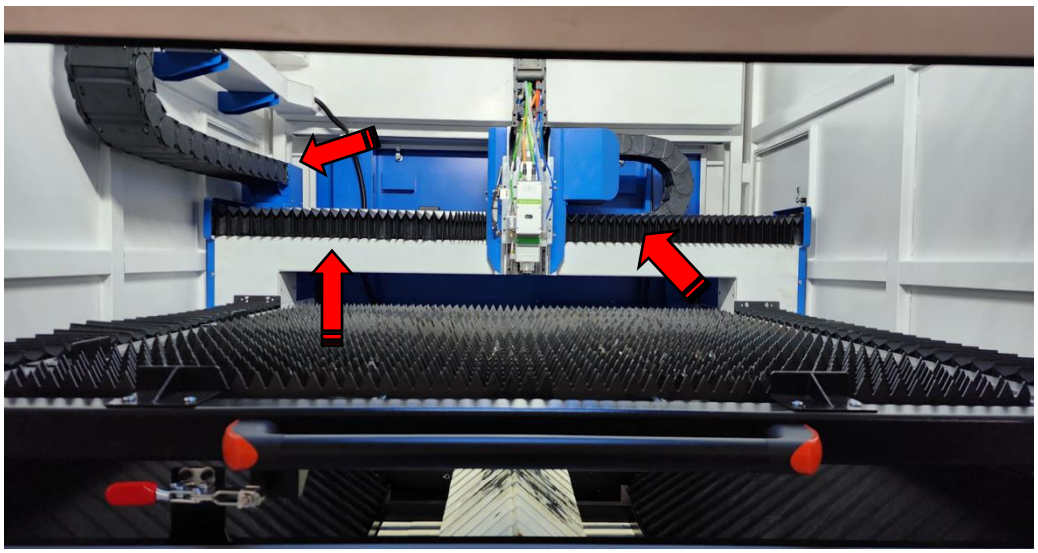
B）Condensation Prevention

Given the stringent environmental requirements for laser systems, special precautions must be taken during the summer months to protect the laser unit. To prevent damage caused by condensation—which results from significant temperature differentials between the laser and its external environment—the following maintenance measures are essential for summer operation:

- Dedicate a separate, air-conditioned room specifically for the laser unit to optimize its external operating environment, ensuring the laser operates within a dry, temperature-controlled setting.
- It is recommended that customers acquire a temperature and humidity monitor and place it inside the laser's air-conditioned room to continuously track the environmental conditions.
- Adjust the chiller temperature settings according to the ambient temperature: set the upper limit (high temperature) to 28–32°C and the lower limit (low temperature) to 25–29°C.
- Strictly adhere to the prescribed power-on and power-off sequences for the fiber laser system.
    - Power-On Sequence
        (1) Turn on the main power switch for the laser unit, allowing the cabinet air conditioner or dehumidifier to run for at least 30 minutes.
        (2) Approximately 30 minutes after powering on the laser unit, turn on the power switch for the chiller.
    - Power-Off Sequence
        (1) Turn off the power switch for the chiller.
        (2) Turn off the main power switch for the laser unit.

Main Machine Tool Maintenance

Cutting operations generate smoke and dust; to ensure the long-term stability of the machine, internal maintenance is essential. The machine tool should undergo a monthly cleaning of the dust covers, sheet metal components, and beam sections. (Perform this operation with the power switched off.)



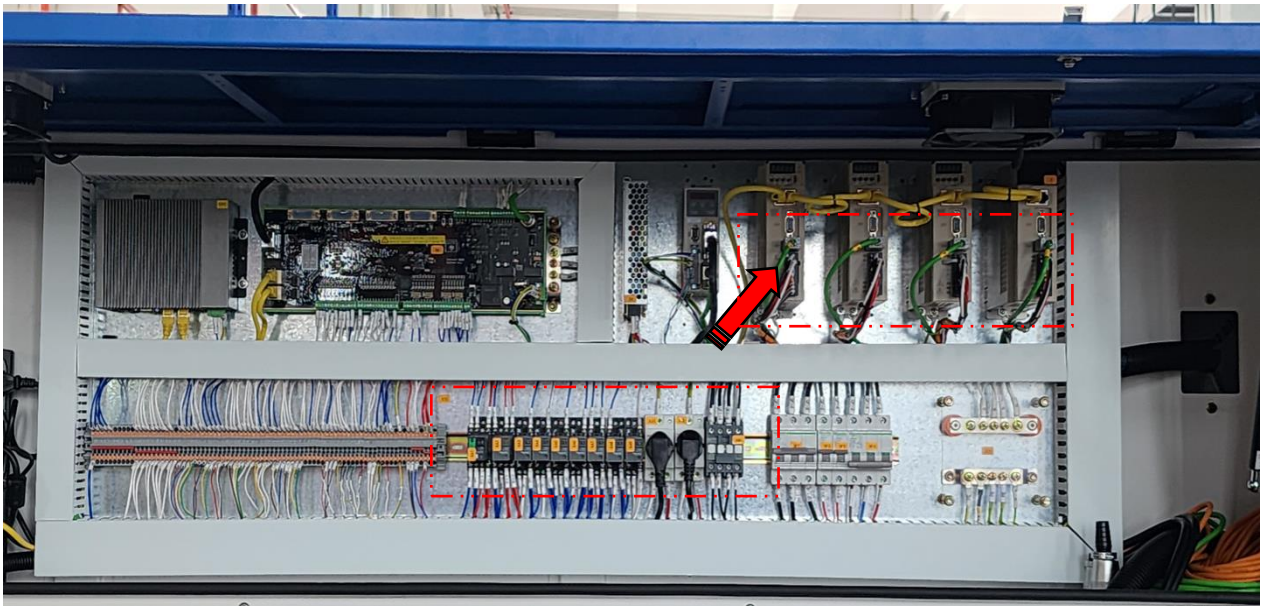
Z-Axis Cover Front Door

Check that the Z-axis cover mounting screws are securely tightened to prevent loosening and potential collisions during high-speed operation.


DANGER
CRUSH
BEAM MOTION

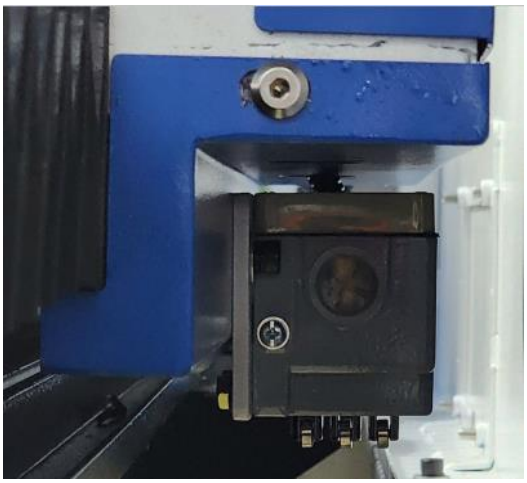
The electrical control cabinet is neat and tidy.

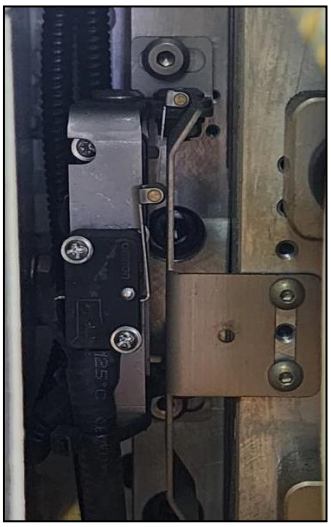
Over time, dust will accumulate inside the electrical cabinet. Clean the cabinet components with a clean cloth monthly, and check for loose wiring every three months. Thoroughly inspect all plug-in connectors. (Power must be disconnected before operation.)



Limit Switch Cleaning

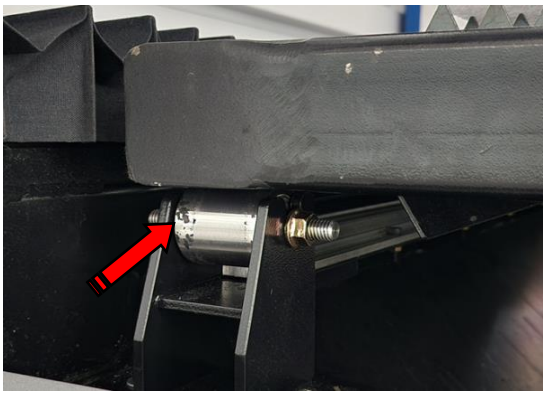
Conduct a monthly inspection to verify the proper functioning of the X and Y axes, as well as the safety limit switches. Check the computer monitor to ensure that no alarms are triggered by the touch sensors. Clean the sensors with a clean cloth to prevent dust accumulation over time, which could lead to reduced sensitivity.

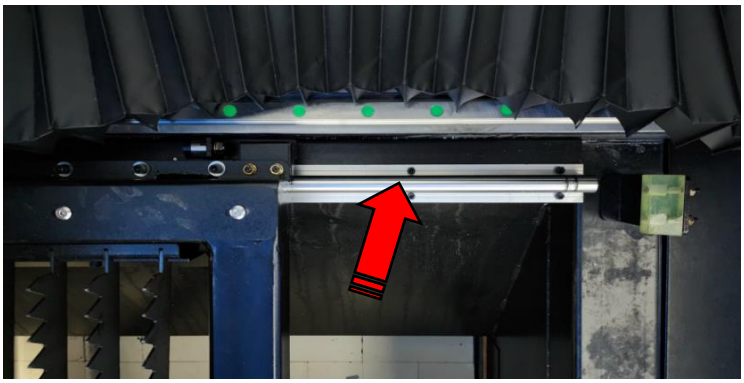




Platform Guide Rail Cleaning

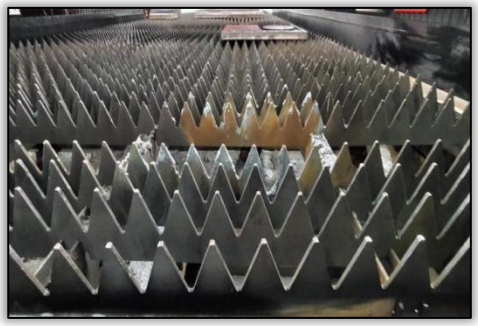
To ensure the normal and stable operation of the machinery—and thereby guarantee the quality of the processed products—diligent daily maintenance of the pulleys and cylindrical guide rails must be performed.





Rack

Prolonged use of the rack system for cutting inevitably leads to wear and damage; this can result in unevenness when positioning sheet materials, and a reduction in the rack's support height may trigger a "lower limit" alarm during cutting operations. In cases of severe rack damage, the cutting quality is compromised, often manifesting as slag accumulation on one side of the cut edge. Any rack components found to be severely damaged must be replaced.



Inspection of Machine Tool Leveling Feet

Every three months, inspect all leveling feet on the machine tool to ensure they are secure. Check the nuts on the leveling feet for looseness by attempting to turn them; if any are loose, tighten them using an adjustable wrench.

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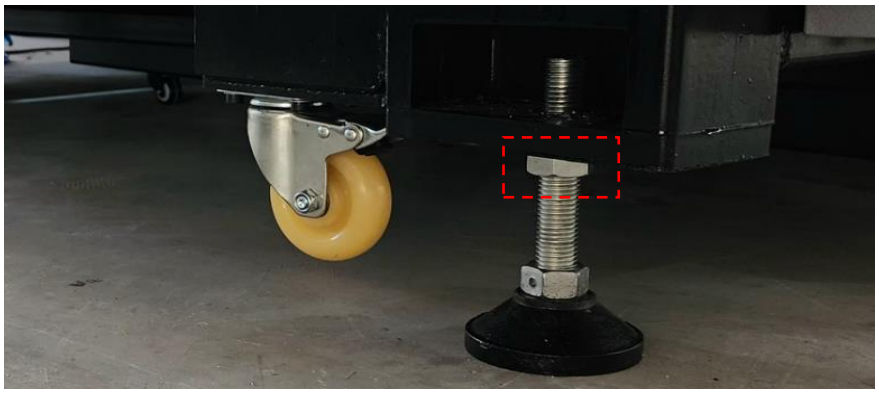


Material Cart Cleaning

To prevent the waste drawer from becoming jammed—a situation that can arise from an excessive accumulation of waste material over extended periods of cutting—please clear the waste from the drawer at the end of each day's cutting operations and verify that the rollers are functioning correctly.

Cutting Head

Clean the exterior of the cutting head daily. After extended periods of cutting, wipe it down thoroughly with a clean cloth, then wrap the cutting head in masking tape to prevent discoloration caused by smoke and dust. Wipe the QBH (fiber optic interface) and wiring ports on the cutting head with a clean cloth, and then cover them with masking tape. Regarding the protective cover for the lower protective lens, ensure that the masking tape is replaced frequently to maintain cleanliness, thereby preventing dust ingress when changing the lens.

Wipe the surface clean with a cloth, then replace the old masking tape with a fresh layer.

Chiller Maintenance Requirements

◆ Recommended Ambient Temperature: 0–45°C

◆ Recommended Ambient Humidity: ≤80% RH

◆ Use softened water, such as purified water, distilled water, deionized water, or high-purity water.

◆ Strictly prohibit the use of spring water, mineral water, oily liquids, liquids containing solid particles, or liquids corrosive to metals.

◆ Recommended Antifreeze Ratio: ≤30% Ethylene Glycol (to be added during winter to prevent the circulating water from freezing).

◆ Periodically remove and clean the dust filter screens, and use a compressed air gun to blow away accumulated dust from the internal condenser (perform at least once a week or more frequently; the dust filter screens must not be left removed for extended periods).

◆ Given that fiber laser chillers often operate in harsh environments, regular maintenance is essential to ensure optimal performance and extend the equipment's service life. Maintenance should be performed weekly and includes—but is not limited to—the following tasks:

◆ Inspect the condenser; check the air ducts for obstructions caused by foreign objects; and verify that airflow intake and exhaust around the unit remain unobstructed.

◆ Clean the condenser and the dust filter screens.

◆ Inspect the cooling medium for foreign objects or signs of microbial growth. Generally, the cooling medium should be replaced every 15–20 days; the replacement medium must be purified water, distilled water, or high-purity water.

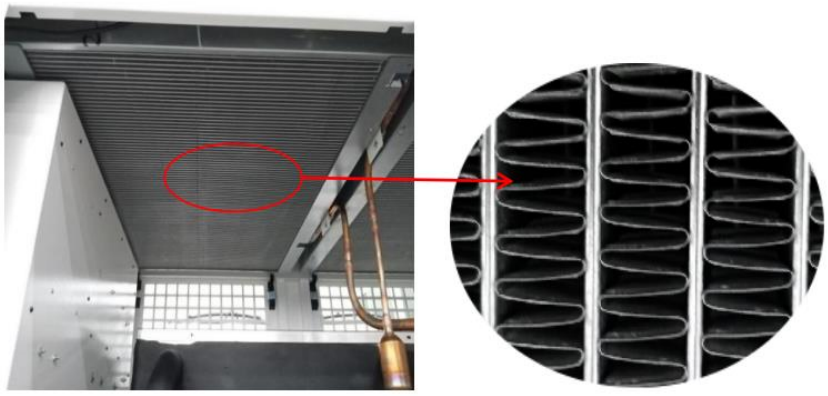
◆ Check water circuit connections for looseness and inspect the water pump for leaks.

◆ Inspect the water tank and clean out any accumulated sediment or dirt from the interior.

◆ Periodically clean the filters within the equipment's water circuit (typically once every 7–10 days). The two common filter types used by this company are the Y-type filter (positioned at the water pump's intake or the equipment's water outlet) and the built-in stainless steel filter (located inside the water tank).

◆ Test the insulation resistance; the insulation resistance value should be ≥5 MΩ.

◆ Perform dust removal and cleaning of the equipment's condenser and dust filter screens approximately every 15 days.



Winter Maintenance

Add antifreeze

If the ambient temperature at night drops below 2°C, it is recommended that customers either keep the equipment running continuously or add antifreeze. The volume ratio of ethylene glycol should be selected based on Table 1, ensuring that the resulting freezing point is approximately 5°C lower than the ambient temperature of the equipment's operating environment. Once the daily average temperature rises above 5°C, replace the water containing antifreeze with softened water.

Suggestion:

When adding antifreeze to the water chiller, use a specialized brand—such as Clariant's Antifrogen N—at a mixing ratio of 3:7 (3 parts antifreeze to 7 parts water). Once added, this mixture provides protection against freezing down to -20°C. If ambient temperatures are expected to fall below this range, please consult your water chiller supplier to confirm the appropriate antifreeze ratio.

If specialized brands are difficult to procure, you may instead use a large-format automotive antifreeze, such as Shell OAT -45°C.

Note: No antifreeze product can serve as a complete substitute for deionized water, nor should it be used continuously throughout the entire year. Once the winter season has passed, you must flush the internal piping with deionized or distilled water and revert to using deionized or distilled water as the primary coolant. Whenever feasible, we recommend optimizing the operating environment—specifically by keeping the water chiller powered on continuously—to avoid the need for antifreeze; alternatively, you may opt to use the specific antifreeze product illustrated in the image on the right.

Equipment Drainage

If the water chiller is to remain out of service for an extended period, it is strongly recommended that you drain the water stored within the unit. This precaution prevents the internal water supply from freezing—a risk that arises when ambient temperatures drop below 0°C—thereby eliminating the potential hazard of frozen-induced damage to the internal piping or components. To safeguard against the freezing of the chiller's internal water supply, the following drainage procedures have been established:

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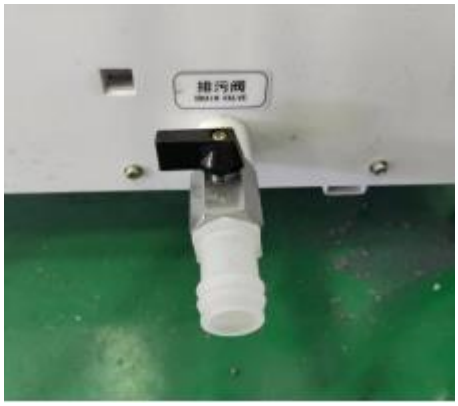	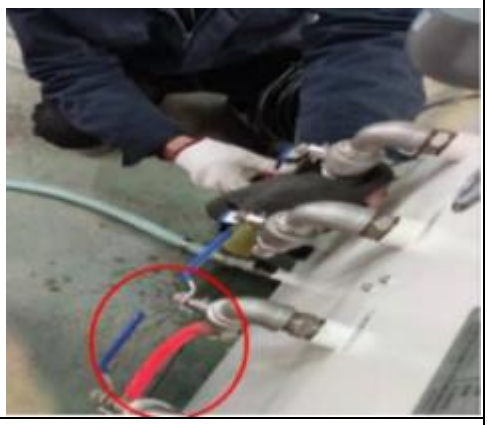
Step 1: Open the drain valve to completely drain the interior of the water tank.	Step 2: Use a hose to bypass the normal-temperature water outlet and the normal-temperature water inlet. (For return lines equipped with a ball valve, simply close the ball valve.)
	
Step 3: Insert an air gun into the outlet of the low-temperature water pipe, and hold a cleaning towel against the opening (to prevent air leakage during the blowing process). Activate the air gun and blow for approximately 85 seconds to completely purge any residual water from the pipe, continuing until no water is discharged from the outlet.	Step 4: Insert an air gun into the opening of the low-temperature return water pipe, and use a clean towel to seal the opening (to prevent air leakage during the blowing process). Activate the air gun and blow for approximately 85 seconds to completely purge any residual water from the pipe, continuing until no water is discharged from the outlet.

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Step 5: Remove the connection pipes for the normal-temperature outlet and return (or open the ball valves for the normal-temperature outlet and return).	Step 6: Insert an air gun into the outlet of the room-temperature water pipe while holding a cleaning towel against the opening. Open the outlet of the low-temperature water pipe, then activate the air gun to blow air for approximately 85 seconds to purge any residual water from the piping, continuing until no water is discharged from either the drainage port or the low-temperature water outlet.
	
Step 7: Insert an air gun into the opening of the room-temperature return water pipe. While holding a clean towel against this opening, open the low-temperature return water pipe opening. Activate the air gun and blow air for approximately 85 seconds to purge any residual water from the pipe, continuing until no water is discharged from either the drainage outlet or the low-temperature return water pipe opening.	Step 8: Insert an air gun into the water tank, activate it to blow air for approximately 60 seconds, and purge any residual water from the tubing until no water is discharged from the drain outlet or the low-temperature return port. (For handheld welding units, use a clean towel inserted into the tank to absorb and remove any residual water remaining at the bottom.)

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Step 9: Unscrew the water pump's drain plug to discharge any residual water from inside the pump, ensuring it is completely drained.

Cleaning the Built-in Water Tank Filter

Cleaning the Water Tank Bottom Suction Filter：

Open the side door of the chiller; as shown in the figure below, you will see the equipment's water tank.

After opening the top cover of the water tank, you will see the water intake filter located at the bottom of the tank (as shown in the figure above).

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Rotate the bottom intake filter counter-clockwise to remove it; then, use an air gun to blow air through the filter screen to thoroughly clear away any accumulated dirt and impurities.

Cleaning of Y-Strainers

Open the side door of the chiller; as shown in the figure below, you will see the equipment's Y-type water filter.

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Using an adjustable wrench, unscrew the hexagonal nut at the bottom of the Y-strainer in a counter-clockwise direction. (Note: This requires two adjustable wrenches—use the left wrench to hold the assembly steady by pulling upwards, while using the right wrench to unscrew the nut downwards in a counter-clockwise motion.) Once removed, the internal filter screen of the Y-strainer will be exposed.	Simply use an air gun to blow away and clean the dirt and impurities from the internal filter screen of the Y-type water filter.

Chapter 7: Troubleshooting

Fault Analysis and Troubleshooting Methods

Cutting Machine Tool Fault Analysis

Anomaly / Fault	Reason	Solution
Power is on, but the power indicator light is not lit.	No external power supply	Switch on the power at the main power supply or the circuit breaker distribution box.
	The main power contactor is faulty.	Replace the contactor or check the wiring.
	The main power switch, key switch, or emergency stop button has poor contact or is damaged.	If necessary, replace the damaged switch or the switch wiring.

No auxiliary gas output during part machining.	Insufficient air pressure	Check air line pressure.
	Damaged solenoid valve or wiring	Inspect the solenoid valve electrical wiring and the solenoid valve.
Abnormal noise occurs during shaft operation.	The shaft's moving parts lack lubricant.	Check the fluid level of the central lubrication pump; add lubricant if necessary.
	There is interference between the moving parts and the stationary parts.	Verify the safety of the moving parts' travel paths.
The cut graphics do not match the dimensions on the drawings.	Program Input Error	Inspection Procedure Based on Drawings
	Impact on Positioning Accuracy	Check machine tool precision, and verify the software and servo motor pulse equivalents.

Laser Power Supply Fault Analysis

Anomaly / Fault	Reason	Solution
The laser power supply is not working, and the panel indicator light is off.	Abnormal power input; loose plug.	Replace the plug.
	Power not connected.	Check the power supply connections for each phase.
Power input is normal, but the main circuit is not functioning.	Is the water circulation functioning properly?	Turn on the circulating water.
	Are the emergency stop and key functioning properly?	Restore to normal position
The cut gap is too wide.	The focus is not set correctly.	Refocus

Cooling System Fault Analysis

Anomaly / Fault	Reason	Solution
No display after powering on.	Power supply phase loss or low voltage	Supply power as required.

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	Thermostat failure	Check the thermostat according to the configuration procedure, and replace it if necessary.
The compressor fails to start or shuts down abruptly during operation (Overload indicator lit).	Improper Low-Pressure Control Settings	Reset Low-Pressure Threshold
	High-pressure controller activated (possibly due to extremely high ambient temperature)	Identify the cause, resolve the issue, and then reset the button.
	Refrigeration piping lockage or leakage	Please have a professional handle this.
	Pressure controller correctly configured; protection activated.	Low-Pressure Protection: Refrigerant shortage. Check for leaks; after repairing the leak, add refrigerant. High-Pressure Protection: Dirty condenser or faulty condenser fan. After resolving the issue, press the red button on the pressure switch to reset.
	Thermostat failure	Repair or replace the thermostat.
Compressor Frosting	The temperature setting is too low, or the thermostat is faulty.	Adjust the temperature or replace the thermostat.
	The expansion valve is open too wide; the system contains an excessive amount of refrigerant; or the expansion valve's thermal bulb is improperly positioned or not securely fastened.	Adjust the valve opening, discharge the excess refrigerant, and re-wrap the thermal bulb as required.
	The evaporator is dirty, resulting in low heat exchange efficiency.	Clean the evaporator.
During operation, the indicator light illuminates and the buzzer sounds an alarm.	Insufficient water flow; flow switch activated.	Has the water pump been drained?
	Water filter clogged	Clean the water filter.
Insufficient Cooling Capacity	The expansion valve is opening too wide or too narrowly.	Adjust the expansion valve.

	Refrigerant shortage or excess	Adjust to a reasonable value.
	The system contains a significant amount of air.	Re-evacuate and recharge with refrigerant.
	Refrigeration piping clogged by dirt	Identify the cause and resolve the fault.
	Scaling on the Water Side of the Evaporator (Including Plate-Type)	Clean the evaporator.
	Clean the evaporator.	Clean the evaporator.
	Condenser Fan Failure	Repair or Replace Fan
	Refrigerant Leak	Check for leaks, repair them, and then add refrigerant.
During operation, the water level indicator lights up and the buzzer sounds an alarm.	Water tank level is low.	Drink enough water.
	Water level probe improperly positioned or float stuck.	Adjust the probe and float.
	Thermostat Troubleshooting and Repair	Or replace the thermostat.
Exhaust temperature is too high.	The condenser is dirty, and the fan airflow is insufficient.	Clean the condenser; inspect or replace the fan.
	The refrigeration system contains an excessive amount of air.	Re-evacuate and recharge with refrigerant.
	Damage to the insulation layer of the low-temperature pipe	Repair the insulation layer.
	The heat load is excessive, exceeding design specifications.	Configure and use in accordance with design requirements.
	Ambient temperature is extremely high.	Improve the operating environment
Insufficient pump flow	Pump flow passage partially clogged	Clean the water pump, water filter, and piping
	Pump impeller damaged	Replace the impeller

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	Flow resistance is excessive, and the total head exceeds the pump's rated value.	Identify the cause, adjust the piping, or replace the pump.

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