Profeta®
南京前知科技

IE150

User Manual

Version: Profeta-IE150-V1.2-2023-03-17-EN

Nanjing Profeta Intelligent Technology Co., Ltd.

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1 Overview

1.1 Scope of use

As an essential part of the IE150 laser mould system, this manual is used to explain the matters attention should be paid to when using the machine:

- Ensuring that all employees are aware of the safety precautions.
- Operating the machine safely under any conditions;
- Installing the machine correctly;
- Knowing about the operation and limitations of the machine in detail before operating the machine;
- Maintaining the machine correctly and safely;
- Disassembling machines in safe conditions and in compliance with local occupational health and environmental regulations.

Notice!

To use the machine, the managers of the company's departments are required to supervise the use of the machine in accordance with the local laws and regulations in force.

Before operating the machine, you must read the manual carefully.

Please read this manual carefully to learn how to operate the machine correctly and safely so that you can use the product safely, efficiently and economically.

This manual assumes that the plant where the machine is installed and used complies with the current occupational health, safety and environmental regulations. The pictures, documents and statements herein contain the manufacturer's confidential technical information, and the manufacture of this machine and its components is not permitted under any circumstances without authorization.

1.2 How to read the operation manual

This manual is divided into several independent chapters, each with

detailed instructions for specific operations (installation, use, maintenance). The safety operations and skills in these areas are explained and described in detail.

The order of the chapters is based on the logical sequence of machine use.

The operation manual includes a cover, a table of contents and a series of chapters.

The first page of this manual contains the model number of the machine, the version of this manual and a picture of the type of machine described to help the reader quickly identify the machine and its manual.

Figure number

All pictures are numbered in numerical order.

The style of picture numbering is as follows: **Figure 1**

Table numbering:

All tables are numbered in numerical order.

The style of table numbering is as follows: **Table 1**

Units of measurement:

The units of measurement used herein are based on the international System of Units **(SI).**

1.3 Storage of User Manual

The user manual should be properly stored in a clean and good environment.

Do not remove, tear up or modify the contents of the manual without permission.

The manual shall be stored in a location closest to the machine and protected from moisture and heat so that it is ready for use.

The manufacturer can provide additional copies of the user manual upon request.

1.4 Update of the User Manual

The manufacturer reserves the right to modify the machine and its design without notifying the customer and without updating the manuals already delivered to the user.

If the improvement made by the manufacturer to the machine installed at the customer's site requires modification of some chapters of the manual, the manufacturer must send the revised new version of the manual to the customer. The user should use the latest version of the manual provided by the manufacturer.

1.5 Intended users

This manual is written for the operator of the machine.

Operator

Workers responsible for installing, operating, commissioning, maintaining, cleaning, repairing or moving machine.

Requirements for users

This is an industrial machine, so the user should be a professional with relevant skills. Specifically, persons who meet the following conditions:

- Reaching the legal age;
- Trained in machine operation and maintenance;
- Being physically and mentally healthy and able to perform tasks of some technical difficulty;
- Being recognized by the enterprise to be able to perform the work;
- Being familiar with emergency measures;
- Being familiar with relevant laws and regulations;
- Being in good command of the operational steps and rules set by the manufacturer;

This manual is not intended for use by any third parties and is only

authorized for use in the customer's company.

2 General information

2.1 Name and address of manufacturer

Name of manufacturer: Nanjing Profeta Intelligent Technology Co., Ltd.

Address of manufacturer: 12 Mozhou East Road, Jiangning District, Nanjing

E-mail: support@profeta.cn

URL: http://www.profeta.cn

2.2 Name and nameplate of machine

The name of this machine is Intelligent & Expert (IE150-HⅡ), and the nameplate example is shown in Figure 1.

Figure 1

2.3 Statement

The machine is designed and manufactured in accordance with current national laws and regulations and relevant guidelines.

2.4 Safety standards

The design and manufacture of this machine are carried out in strict accordance with the China’s safety standards and meet the requirements of current laws and regulations.

2.5 After-sales service

When the machine is sold, there will be a warranty card with warranty conditions on it. If the machine fails within the valid warranty, the manufacturer will repair or replace the defective part after proper inspection of the machine.

The manufacturer shall not be responsible for the consequences of unauthorized modification of the machine or change of parts by the user.

When the machine fails, users are advised to contact our after-sales service department in time, please do not repair and change it by yourself.

2.6 Customer’s preparations

Unless otherwise agreed in the contract, the following preparations are usually required at the customer's expense:

- Prepare relevant work sites and air sources in advance (see 4.3.1 "Installation preparation" and 4.5.2 "Pneumatic connection" for specific requirements);
- Prepare power supply equipment for the machine (including the grounding system) according to relevant local laws and regulations;
- Separate a machine installation area (see 4.3.1 "Installation preparation" for specific requirements) suitable for the use of Class 4 laser;

- Provide air conditioning system to meet the temperature and humidity requirements for equipment storage and normal operation (see section 5.4 "Installation environment" for specific requirements).

2.7 Responsibility

The manufacturer shall not be responsible for any problems due to the user's failure to follow the instructions provided in the operation manual.

If you have any questions after reading the following, contact the manufacturer directly.

3 Safety

3.1 General safety instructions

Please read the instructions provided in the user manual carefully and follow them strictly before commissioning the machine.

In designing the machine, the manufacturer provides various safety mechanisms to ensure the safety and reliability of the machine.

To ensure the safe and correct use of the machine, the following information is provided in the necessary sections of each chapter:

- Minimum skill level of the operator;
- Number of operators required;
- Status of machine;
- Residual risk;
- Personal protective equipment required or recommended;
- Prevention of human error.

The following shall be strictly observed

To ensure a safer use of the machine, the user can use additional protection measures on his own depending on the situation. Of course, nothing the user does should be contrary to the contents herein.

For example, operators should pay close attention to the dressing during operation:

- Do not wear loose clothing that could get caught in the machine;
- Do not wear ties, or pendants;
- Do not wear large necklaces and bracelets to avoid getting your hands or head caught in the machine due to these accessories.

In any circumstances, users must strictly implement the following:

- It is forbidden to install inoperative safety devices on the machine;
- Keep the electrical distribution cabinets closed;
- Only maintenance electricians are allowed to open the electrical distribution cabinet after disconnecting the power supply. To ensure

that the individual components are fully discharged, it is necessary to wait at least 5 minutes after turning off the power connection;

- Do not modify any part of the machine for any reason. If the machine is damaged due to failure to follow this guideline, the manufacturer shall not be liable for any consequences arising therefrom;
- Please use a dry cloth to clean the machine's housing, control panel, etc.

Notice!

The manufacturer shall not be liable for any injury to the user caused by the machine if:

- Use of the machine by employees without proper training;
- Misuse of the machine;
- Defects in the power supply system;
- Incorrect installation;
- Insufficient daily maintenance;
- Unauthorized modification of the machine;
- Use of non-original parts or parts of unspecified type;
- Failure to follow the instructions in this manual;
- The use of the machine does not meet the requirements of current laws and regulations;
- Natural disasters;

General rules

The instructions in the manual shall be followed for the use of moving parts.

Any safety devices installed on moving parts to prevent accidents and ensure safety shall not be modified or removed, they shall be properly maintained.

Any defects or malfunctions in moving parts shall be reported promptly to the supervisor or directly to the supplier.

Checking and testing

Checking and testing of the machine shall be carried out according to the instructions herein.

The manufacturer shall not be responsible for accidents caused by failure to replace worn or failed parts in a timely manner.

The testing, which shall be performed by skilled operators, is divided into an appearance test and a functional test, aiming at ensuring the safe operation of the machine.

Testing contains the following:

- Testing of the load-bearing structure, and there shall be no cracks, damage, deformation, corrosion, wear, etc.;
- Testing all mechanical components;
- Testing all safety devices installed on the machine;
- Checking all dowels and bolted connections;
- Testing the functionality of the machine;
- Testing the status of the machine;
- Testing the air pressure and the air tightness of the machine;

The test results shall be strictly documented to make reasonable and clear guidance for subsequent repairs.

WARNING!

If any abnormalities are found with the machine, they must be completely resolved before the machine can be operated, and maintenance personnel must document the completion of the repair and ensure that the problem is fully resolved before the machine is authorized for use.

If the person performing the test finds cracks or abnormalities, the manufacturer of the machine must be notified immediately. In the event of a machine failure, be sure to stop the machine and have it properly inspected and repaired. Check for extraneous objects between machine parts and make sure nothing remains between moving parts after repairing.

Ensure that the machine is operated under maximum safety conditions and prohibit anyone from performing the following operations:

- tamper with any part of the machine;
- leave moving parts unattended;
- use the machine under imperfect working conditions;
- manually operate moving parts in the event of a power failure.

3.2 Situations where the use of the machine is prohibited

The machine shall not be used in the following cases:

- uses other than those specified herein;
- in the environments with explosive or corrosive atmospheres, or environments where high concentrations of dust or oily substances are suspended in the air;
- in the event of fire;
- in the event of flammable and explosive materials;
- safety devices are not installed or operating.

3.3 Double protection

The safety warning and the safety switch are interlocked so that the machine will only start running when the safety warning is off.

WARNING!

The user shall be fully responsible for the operation of the machine in the presence of a safety warning, and the manufacturer shall not be responsible for any property damage or personal injury caused by the user himself.

3.4 Safety devices

The following are the safety devices installed on the machine:

Components	Function	Location	Picture
Red mushroom button	Emergency stop	Control panel	
Main power switch	Power supply for electrical equipment	Back of the cabinet	
Chamber's safety-door lock	Safety-door switch	Chamber door	

Table 1

3.5 Signs

The following warning symbols have been posted on the equipment:

Danger sign

- Sign 1 Danger! Laser;
- Sign 2 Danger High Voltage;

Figure 2

Mandatory signs:

- Sign3 Must wear protective shoes;
- Sign4 Must wear protective clothes;

- Sign5 Must wear protective gloves;
- Sign6 Must wear protective glasses;
- Sign7 Must wear dustproof mask.

Figure 3

Prohibition signs:

- Sign 8 No burning;

Figure 4

3.6 Hazards associated with the use of laser systems

3.6.1 Laser classification

Class 1: No biological hazard. Any beam that may be viewed is shielded, and the laser system is interlocked when the laser is exposed.

Class 2: Output power is 1 mW. Will not burn the skin or cause a fire. Since eye reflection can prevent some eye damage, these lasers are not considered dangerous optical devices. (For example, when encountering bright light, your eyes will blink automatically, or your head will turn to avoid these strong lights, this is the so-called reflection behavior or reflection time. Such laser products will not cause damage to the eyes during this time. Nevertheless, one would not want to stare at it for a prolonged period of time).

Class 3A: Output power is 1 mW to 5 mW. Will not burn the skin. Under certain conditions, such lasers can cause blindness and other damage to the eyes.

Class 3B: Output power is 5 mW to 500 mW. At higher power, these laser products can scorch the skin. This kind of laser product is clearly defined as harmful to the eyes, especially at higher power, damage will be caused to the eyes.

Class 4: Output power is more than 500 mW. This kind of laser products will definitely cause eye damage. Just as it burns skin and ignites clothing, laser can ignite other materials.

3.6.2 General safety measures and precautions

When owning and operating lasers, the following general precautions must be taken:

Class 1: No biological hazard, no measures required.

Class 2: Will not burn the skin or cause a fire. Since eye reflection can prevent some eye damage, these lasers are not considered dangerous optical devices.

Class 3A: Laser emission indicator indicates whether the laser is working or not;

- The power key switch should be used to prevent unauthorized use by others;
- There should be a hazard label attached.

Class 3B:

- A power key switch is used to prevent unauthorized use by others; laser emission indicator indicates whether the laser is working or not.
- There is a 3 to 5 second delay after turning on the power to allow the operator to leave the beam path;
- Equipped with an emergency stop switch;
- Turn off the laser beam at any time;
- A red danger label must be attached to the laser.

Class 4:

- Equipped with a power key switch to prevent unauthorized use by others; equipped with a safety device to prevent the protective cover of the system from being opened during work;
- Equipped with a laser emission indicator to indicate whether the laser is working or not;
- Equipped with an emergency stop switch to cut off the laser beam at any time;
- A red danger label must be attached to the laser. This kind of laser reflected beam is as dangerous as the main beam.

3.6.3 Personal protective device for laser system

All personnel who may be exposed to Class 3 or Class 4 lasers are required to wear personal protective equipment, especially safety goggles.

Check the safety condition and usage occasion of each pair of safety goggles and the corresponding class of laser to ensure that the safety goggles match the class of the laser.

3.7 Residual risks

In standard operating mode, be aware of the following residual risks:

3.7.1 Risks arising from the use of inert gases in the chamber

This equipment requires the use of inert gases in the chamber. These gases (N2 or Ar) are not inherently toxic or hazardous in the traditional sense, however, because they are colorless and odorless, they cannot be detected when their concentration increases, which in turn causes the oxygen concentration in the air to decrease, leading to suffocation of workers. The following table illustrates the effects of reduced oxygen concentration in the air on the human body.

Oxygen concentration (%)	Possible effect on personnel
20.9	No effect
19.0	No negative physiological effects in the short term
16.0	Elevated heart rate and respiratory rate, declined concentration and reasoning skills, along with decreased coordination of the limbs.
14.0	Fatigue, sudden emotional change, uncoordinated limb movement, decreased judgment
12.5	Unclear mind, poor coordination and high respiratory rate may cause damage to the heart and cause nausea and vomiting.
＜10	Immobility, loss of consciousness, convulsions and even malfunctions

Table 2 Effects of hypoxia on health

The Occupational Safety and Health Administration (OSHA), an American health and safety government agency, sets an oxygen concentration of 19.5%-23% for a safe environment. When the oxygen concentration falls below 16%, the brain sends a signal to the respiratory control center, asking it to breathe faster. When the oxygen concentration is reduced, the symptoms will worsen. When the concentration is between 4-6%, people will become unconscious within 40 seconds. In this case, oxygen must be provided for a short period of time if you want to survive. However, even after recovery, the victim is at risk of cardiac arrest afterwards.

Therefore, there are serious risks in the following cases:

- Loss of and/or damage to the equipment's gas lines;
- Insufficient ventilation and oxygen exchange in the equipment installation room;
- The device is leaking air for unseen reasons.

WARNING!

Provide proper ventilation and air exchange as required by the machine environment.

WARNING!

Oxygen sensors with display and alarm systems are required to be installed in the machine room.

WARNING!

After each operation, part of the inert gas stays in the chamber of the machine. Beware of suffocation! Open the chamber door, and access it after sufficient ventilation.

3.7.2 Risks associated with equipment handling parts

- Machining parts can also be dangerous. The degree of danger they generate is related to the size of the machined part;
- Angular parts have sharp edges, having a risk of injury to personnel. Need to wear personal protective equipment;
- There is a risk of burns on the processed hot parts. Wear protective gloves; use auxiliary tools to remove parts; avoid direct contact with hot surfaces.

3.7.3 Risks associated with dangerous goods

The preparation process produces fumes and particles (see 3.8). These products are usually drawn into the filter element by the circulation system of the equipment.

WARNING!

If the circulation system is not functioning, this can lead to the possible inhalation of harmful gases and dangerous particles into the respiratory tract.

3.8 Toxic gases formed by laser processing

The laser radiation produced by the machine can melt, burn or vaporize almost any material.

In the process of laser processing metal materials, dust, atomic chemicals and toxic gases will be produced, which do great harm to the health of operators and the optical system of laser devices.

WARNING!

In the process of laser processing special metals, carcinogens may be produced. Users are advised to verify the presence of such potentially harmful substances in the processed materials.

The user must independently and safely test the safety of the material, and if necessary, take appropriate precautions to protect the safety of the operator.

Protective measures:

Laser protection usually takes corresponding protective measures for laser source, operator and working environment respectively. Specific measures include safety management, safety education, engineering protection, personal protection and medical supervision.

- Safety management: Formulate safe operation procedures for laser, strictly classify and define laser products, and provide users with guidelines for safe use guidelines, etc.
- Safety education: Conduct safety education and training for personnel exposed to lasers.
- Engineering protection: Remove flammable substances and mirror reflectors from the laser light path, set up danger signs, and set up necessary alarm devices in the workplace, etc.
- Personal protection: Provide laser protective goggles, dustproof masks and other protective equipment for personnel exposed to lasers.
- Medical Supervision: carry out regular physical examination for operators when necessary.

3.9 Safety specifications for metal additive manufacturing

3.9.1 Safety specification for powder storage

1) Metal powder is flammable and explosive, so it must be sealed and kept away from fire sources and direct sunlight. It is advisable to store

in a dry environment at room temperature. A D-type fire extinguisher should be equipped to prevent emergencies.

2) If the powder is not stored properly and the fluidity is affected by moisture, the powder can be dried in a vacuum drying oven, cooled to room temperature and sieved again to restore its fluidity.

3.9.2 Personal safety protection

Fine metal powder easy to cause harm to human health. For the sake of operational safety and health, it is recommended to do the following protection in any case of contact with powder:

1) Wear plastic gloves to prevent contact with powder;
2) Wear a dustproof mask with a protection level of N95 or higher.
3) Wear dustproof and anti-static work clothes;
4) When performing equipment maintenance and powder sieving operations, wear safety helmets and safety goggles.

3.9.3 Preparation before processing

1) Before processing, the plate must be smoothed with a grinder to obtain the best powder spreading effect and make the first layer more firmly bonded;
2) For equipment using titanium powder, high-purity Ar with a purity of not less than 99.99% must be used as the shielding gas. If N2 is introduced, spontaneous combustion or explosion may occur. (Titanium burns in pure nitrogen);
3) For equipment using cobalt chromium powder, N2 or Ar with a purity of not less than 99.99% can be used;
4) The room where the metal 3D printer is placed should be equipped with air conditioner with constant temperature and humidity function to control the temperature at 15~30℃ and the relative humidity at 45%~65%RH to ensure a suitable ambient temperature , air

circulation and dryness.

3.9.4 Treatment after processing

1) For equipment equipped with Protector of Gas System – Titanium (PGS-Ti), after processing, it needs to cool down for 10-20 minutes before using the powder cleaning device to clean it. When using the powder cleaning device, pay attention to controlling the oxygen content within 2%. When the oxygen content continues to rise, the protective gas should be replenished in time, and it is prohibited to use the powder cleaning device under the condition that the oxygen content exceeds the standard. Prevent the powder from being oxidized or spontaneously ignited under the condition of high oxygen content during high-speed movement;
2) The residual powder that is difficult to clean in the chamber must be removed with an explosion-proof vacuum cleaner filled with water inside. If an ordinary vacuum cleaner is used, it is prone to explosion;
3) The black smoke left on the sidewalls after processing can only be wiped with a wet paper towel, and vacuuming is prohibited.
4) In order to ensure the purity of the powder and improve the processing quality, it is recommended that the used powder be sieved through an automatic sieving system after each moulding to remove impurities and large particles from the powder.
5) There will be residual stress in the parts after laser processing. If the parts are cut directly from the plate, they will be easily deformed. Therefore, it is recommended to anneal the moulded parts together with the plate in an atmospheric furnace or vacuum furnace with argon gas after processing in order to obtain better mechanical properties.
6) When replacing the filter element of which the service life is over, the explosion-proof filter barrel must be filled with protective gas. Before removing it, use the manual valve to close the air inlet and outlet. After

removing it, fill it with water and let it stand for 48 hours before cleaning. The used filter elements need to be placed in anti-static garbage bags.

3.9.5 Other precautions

1) When using bottled argon gas, the argon cylinder needs to be fixed in a cool, ventilated place, away from heat sources, open flames and direct sunlight. When using bottled liquid argon, in addition to the requirements for argon cylinders, frostbite should also be prevented;
2) Smoking and open flames are strictly prohibited in the workplace.

4 Installation

4.1 Transportation and placement

The equipment can be transported using general means of transport capable of supporting its weight and volume; as the equipment is supplied fully assembled, it just needs to be placed where it is to be used.

The machine for transporting the equipment needs two supports to safely lift and transport the equipment, so as to prevent the equipment from tilting during transportation, which will lead to deformation of part of the structure under stress and affect the processing accuracy, and the transport machine is shown in Figure 5

Figure 5

When the equipment is placed in the place where it is to be used, be sure to measure the dimensions of all aspects of the equipment and the space occupied by each external device of the equipment in advance to ensure that there is enough space for each device to be placed and to avoid stacking the devices due to insufficient space.

Safety guidelines in transportation:

When unloading the equipment from the transport machine and moving it to the place of use, the following safety guidelines shall be strictly observed:

- After lifting the equipment, be sure to pay close attention to the surrounding facilities to avoid the equipment being hit by other equipment or objects around.
- In order to be more stable, safe and not to block the line of sight during the

movement of the equipment, the moving height of the equipment must be lowered as much as possible.

- In order to avoid disintegration or imbalance when the equipment is moved, all movable parts or parts that cannot fully bear their own weight alone must be safely and securely fastened to the equipment.
- The manufacturer is not responsible for any damage or breakage of the equipment caused by improper methods or personal errors during the movement of the equipment after the user has confirmed receipt of the equipment.

4.2 Storage

If the equipment is not used, the equipment needs to be placed in accordance with the following precautions:

- Place the equipment in an enclosed area.
- Protect the equipment from any collision and crushing.
- Protect the equipment from any heat or humidity.

4.3 Preparations

4.3.1 Preparations for installation

Before installing the equipment, it is necessary to prepare enough space for use according to the dimension of the equipment and the selected lifting machine.

The placement of the equipment must be handled according to ergonomics, and the working position must be safe and reliable. In order to operate the equipment more conveniently and handle the processing materials, an additional space of at least 1m must be reserved, so as to facilitate maintenance and adjustment operations.

4.3.2 Power system preparations

The power system that provides power to the equipment must have an

electrician to connect these electrical components according to the wiring diagram, and must comply with current regulatory rules and technical standards regarding work safety and electrical system safety.

In order to comply with current regulations for a safe workplace, be sure to provide proper safety equipment when operating the machine, so as to ensure the safety of employees and machines.

WARNING!

The manufacturer shall not be responsible for the consequences caused by the user's failure to operate the machine in accordance with the above rules.

Users must take the above preparations seriously, and the manufacturer shall not be responsible for any accidents caused by the user's failure to connect these electrical components correctly.

4.4 Placement

When installing the equipment in the workshop, the user must take into account all the external dimensions of the machine, the connections and the buffer zones.

The buffer zone is used to store materials, maintain the machine and ventilate the area, so these factors must be taken into account, as well as the necessary operating space for the operator to operate the machine.

4.5 Connection

Manufacturer's technical staff: In order to deal with the intricacies of special situations or to respond to technical problems raised by the user, the manufacturer will provide appropriate technical staff to assist the user with relevant mechanical or electrical or electronic or software expertises.

4.5.1 Electrical connection

The internal connections of the equipment are made by the

manufacturer's technical engineers, while the electrical connections between the equipment and the user's electrical distribution lines are carried out by the user's qualified personnel, so as not to cause electrical failures of the machine due to faulty line connections.

Ensure that electrical equipment fully complies with GB 50054-2011. The power supply must be able to provide the maximum input power required by the equipment. The user must provide cut-off switches suitable for the power supply to the equipment and effective protection against indirect contact/overload currents.

When connecting electrical devices, check the following:

- The voltage and frequency of the power supply must be strictly limited, because incorrect power supply voltage may cause serious damage to the machine.
- The main distribution network is fitted with a suitable earthing system.

Be very careful when connecting the power supply. The power supply must be cut off and fully comply with safety requirements. The power supply can only be carried out after proper grounding operation, and the power supply connection should be connected with the cable provided by the manufacturer.

4.5.2 Pneumatic connection

The nitrogen or argon supply circuit provided by the customer must be able to provide a pressure of at least 6 bar.

4.6 Preliminary testing

Before receiving the machine, it shall be the user's responsibility to check whether there is any obvious damage caused by overturning or tipping during transportation. In case of any damage, the user shall immediately notify the carrier and contact the supplier to explain the situation.

Before starting the equipment each time, the following procedures shall be performed:

- Check all security systems;
- Check the protective devices and signs.

Before starting the equipment, a series of checks and tests must be carried out to avoid errors or accidents during the start-up phase:

- Check the machine for damage during the installation phase;
- Carefully check the integrity of electrical switchboards, control panels, cables and conduits;
- Check that all external power connections are normal;
- If necessary, check that all moving parts are free to move and rotate.

5 Machine description

5.1 Working principle

The basic principle of this machine is: according to the three-dimensional data of the part, slice to generate multiple layers, each layer generates a laser scanning path, and finally the machine controls the laser scanning and stacks layer by layer. With the faster scanning of the laser, the metal melt pool undergoes a rapid solidification process to produce a dense, fine-grained structure, which gives the moulded part excellent mechanical properties.

The specific moulding process in the equipment: before the laser beam starts scanning, the powder coating device pushes the metal powder onto the plate of the mould cylinder, and then the laser beam melts the powder on the plate according to the filling contour line of the current layer to process the current layer , then the mould cylinder is lowered by a distance of the layer thickness, the powder supply cylinder is raised by a distance of certain thickness, and the powder coating device coats metal powder on the processed current layer. The equipment loads the data of the next layer of contour for processing, and so on layer by layer until the entire part is processed. The entire processing is carried out in a chamber protected by inert gases, so as to avoid the reaction of the metal with other gases at high temperatures.

Figure 6

5.2 Intended use

This machine uses selective laser melting technology to manufacture products, and the equipment, in the set process and atmosphere protection environment, controls the powder selectively melted layer by layer by laser program. Other uses are not consistent with the set use, you need to contact the manufacturer to obtain permission to use, and obtain additional information on the manufacturer's use guidance.

WARNING!

- **The machine may only process metal powders (hereafter referred to as materials) supplied or authorized by the manufacturer; any unauthorized materials shall not be used.**

- **Operators may inhale metal powder or have skin contact with metal powder when adding materials, removing material and cleaning up the machine. Therefore, the operator must wear protective clothing, gloves, dustproof masks, and completely sealed glasses when working**.
- **Except for the operator, no one is allowed to approach the machine. If anyone else is near the machine, shut down all operations immediately and ask to stay away from the operating area.**

5.3 Level of laser system

The laser system of this machine is a Level 4.

5.4 Installation environment

The machine must be installed inside the plant with adequate lighting, good ventilation and a solid level ground.

The machine can operate in the following environments:

- Temperature: +15°C ~ + 30°C;
- Relative humidity: less than 75% and no condensation.

Therefore, an air-conditioned environment is required in case there is a need to reduce humidity.

WARNING!

This machine cannot be used in explosive, corrosive or dusty environments.

The use of this machine is prohibited in the following environments:

- High dust concentration;
- Corrosive environment;
- Fire risk;
- Explosive atmosphere.

5.5 Lighting

The light intensity of the room where the machine is installed must comply with the existing local regulations. Under any conditions, every area of the room should have good visibility and no reflection hazard. The every buttons on the control panel must be easy to distinguish, especially the emergency button must be clearly visible.

The machine is equipped with internal lighting, however, there is no external lighting. The working environment needs to be equipped with comprehensive lighting with a brightness of at least 200 Lux, so as to ensure that every point of the machine is clearly visible.

5.6 Vibration

Please make sure the foot installation is adjusted reliably to ensure the stability of the equipment, so as to reduce the vibration of the machine during operation.

5.7 Technical data

- Laser level: Level 4
- Machine dimension: 1070*670*1750mm (length*width*height)
- Mould size: Φ158*70mm
- Machine weight: 500kg
- Power supply: AC220V, 16A
- Frequency: 50/60HZ
- Grounded or not: Grounded
- Power consumption 3.5KW
- Laser: 300 W fiber laser *2 or 200 W fiber laser *2
- Spot diameter: 40~60um;
- Gas shield: nitrogen/argon <5L/min;

- Applicable materials: cobalt-chromium alloy, pure titanium, TC4;
- Applicable scenarios: crowns & bridges, removable partial denture, orthodontic band, functional appliances, implant surgical guides, teeth preparation guides, etc.;
- Ambient temperature limit: +15~+30℃;

5.8 Main components

The machine can be divided into the following main parts:

- Electrical switchboards and assemblies;
- Laser A, Laser B;
- Oxygen content sensor 1, oxygen content sensor 2;
- Industrial Personal Computer, operating panels, software;
- Gas circulation and conditioning components;
- Mechanical part.

5.9 Power distribution cabinet door locks and buttons

See Figure 7 for power distribution cabinet door locks and buttons.

Figure 7

5.10 Shielding gases

Shielding gas (Nitrogen/Argon) is required for the machine to work. The shielding gas circulates inside the machine.

5.11 Standard supplies for the machine

The following are standard supplies:

- User manual;
- Auxiliary tools and consumables are shown in Table 3.

Auxiliary tools	Allen wrench, brush, powder shovel, height gauge
Consumables	Scraper, plate, felt ring, O-ring, small filter element, large filter element, KF flange seal

Table 3

5.12 Electromagnetic environment

The machine must be operated in an appropriate electromagnetic environment, its internal radiation and immunity are elaborated by the following harmonized standards:

GB 17799.2-2012 Electromagnetic compatibility
Generic standards – Immunity test in industrial environments
GB 17799.4-2012 Electromagnetic compatibility
Generic standards – Emission in industrial zone environments
GB 17625.1-2012 Electromagnetic compatibility

Limit value Harmonic current emission limit (equipment input current ≤ 16A per item)

5.13 Security measures set by the manufacturer

5.13.1 Safety instructions

The machine is composed of a fully enclosed bottom fixture and a safety door. The safety door is protected and controlled by the whole control system.

Protection from laser radiation: To avoid reflection of laser beam during processing, the chamber is installed with laser radiation-proof glass.

Prevention of glove box impact: In order to avoid abnormal glove box impact during processing, the glove box is installed with a safety door lock, and the glove box should be locked when operating during processing.

Laser on limit: The laser beam can only be turned on when the safety door is closed.

Prohibited operations:

- If the safety door is opened, stop operating the machine immediately.
- It is forbidden to look at the top of the machine during operation.

5.13.2 Main power switch

The main power switch is located at the rear of the machine, see Figure 8.

Horizontal: the machine is switched off and the power supply is cut off.

Vertical: Power on.

Figure 8

5.13.3 Emergency stop button

The emergency stop button is located on the front of the machine (see Figure 9), and the following consequences will occur after being pressed:

- Turn off the laser;
- Shut down the gas circulation system;
- Shut down the cooling system;
- Stop the motion mechanism.

Figure 9

5.13.4 Gas circulation system of the chamber

There is a large amount of inert gas in the chamber of the machine, which is enclosed in a circuit; and there is a device for filtering dust and impurities inside the circuit, which is an interchangeable filter element filter in shape.

WARNING!

Exposure to metal powders is harmful, mainly to the respiratory system, eyes, and skin.

5.13.5 Layout and description of the working chamber

The layout of the working chamber is shown in Figure 10.

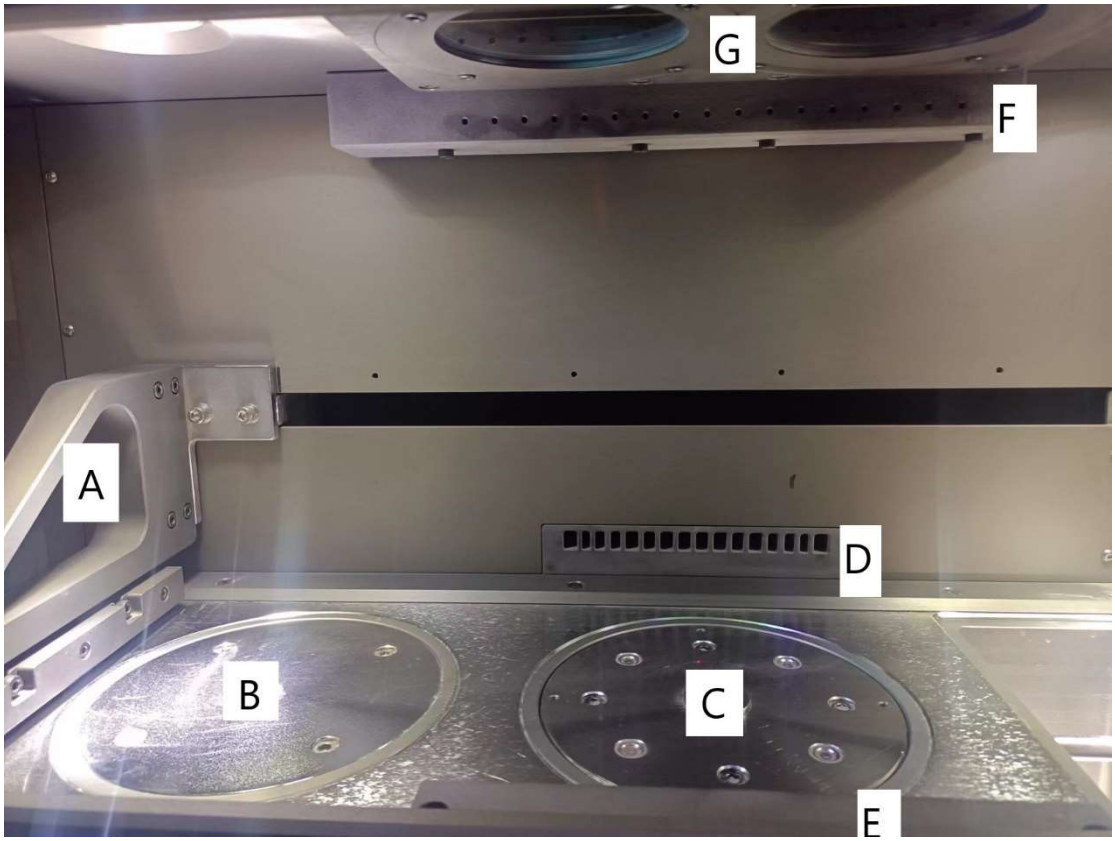

Figure 10

A) Powder coating device;

B) Powder supply device;

C) Mould device;

D) Lower air outlet;

E) Air inlet;

F) Upper air outlet;

G) Protective glass.

The layout below the mould is shown in Figure 11.

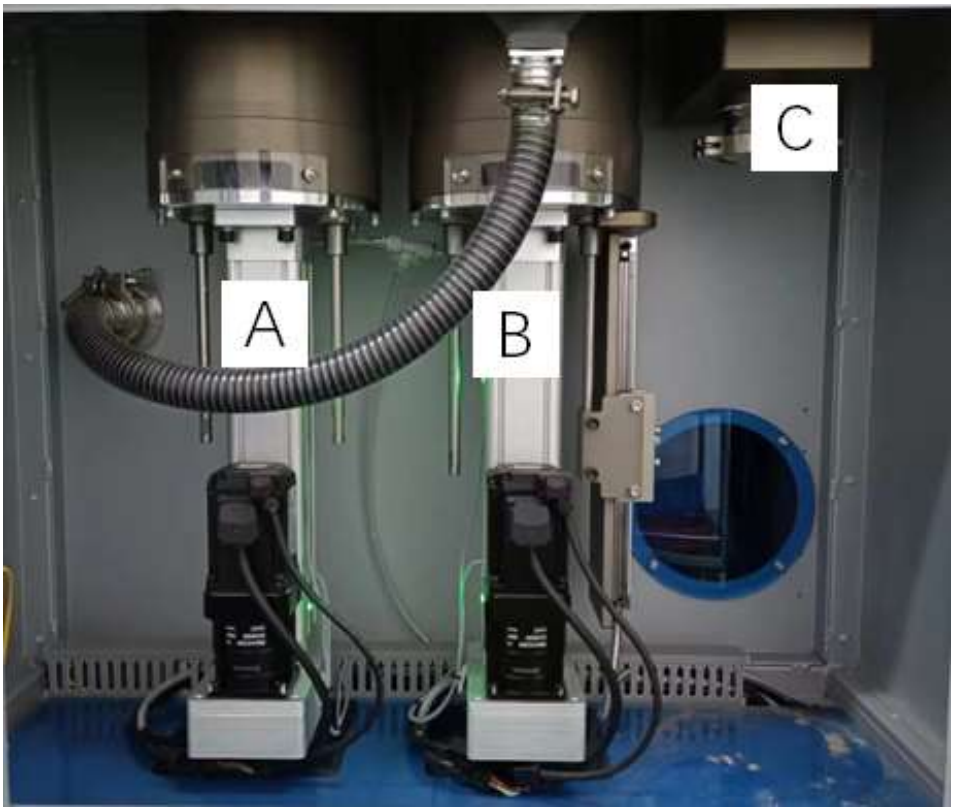

Figure 11

A) Electric powder supply cylinder;

B) Electric mould cylinder;

C) Powder collecting box.

6 Use of machines and software

6.1 Warnings

Safety warning!

Staff engaged in the cleaning of machine's chamber and the use of metal powders must be equipped with safety operating equipment (according to the safety level of the material), which includes: fully sealed glasses, face shield with breathing filter, and safety gloves.

Software use warning!

Operators must be proficient in the basic operation of the Windows operating system.

6.2 Safety check before starting the machine

Before the machine is delivered to the customer, it is carefully tested and trial-run by the manufacturer to ensure the perfect operation of all components. However, the safety instructions in Chapter 3 must be strictly enforced prior to start-up.

6.3 Starting the machine

After powering on the machine, the entire part should be thoroughly and carefully inspected to ensure that there are no people or objects in the area that would prevent the machine from operating properly, and that no objects have been left in the work area.

Check the safety of the machine and reset it if necessary, especially the following:

- Whether the emergency stop button works;
- Whether the protective safety door lock works;
- Check whether the glove box equipped with the chamber door is damaged or leaked.

WARNING!

Use a laser with a protective switch and absolutely prohibit tampering with the laser settings.

6.4 Control panel

The control panel is shown in Figure 12.

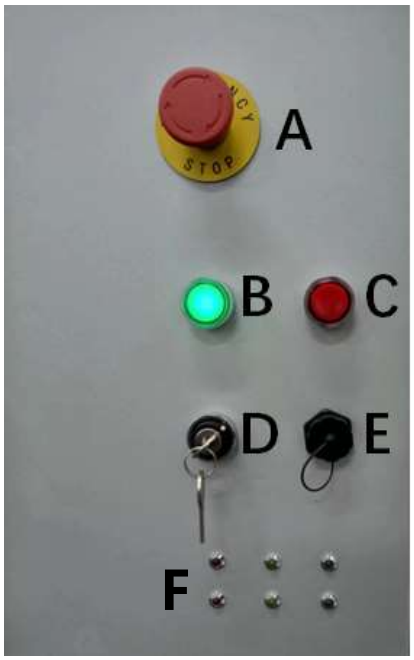

Figure 12

A) Emergency stop button;

B) On button;

C) Off button;

D) Start key;

E) USB interface;

F) Laser on indicator.

6.5 Equipment control software

The equipment control software (mould system) is mainly composed of printing, printing preparation, and real-time monitoring, which is used to control the equipment hardware to perform 3D printing production according to the slice data.

6.5.1 Print screen

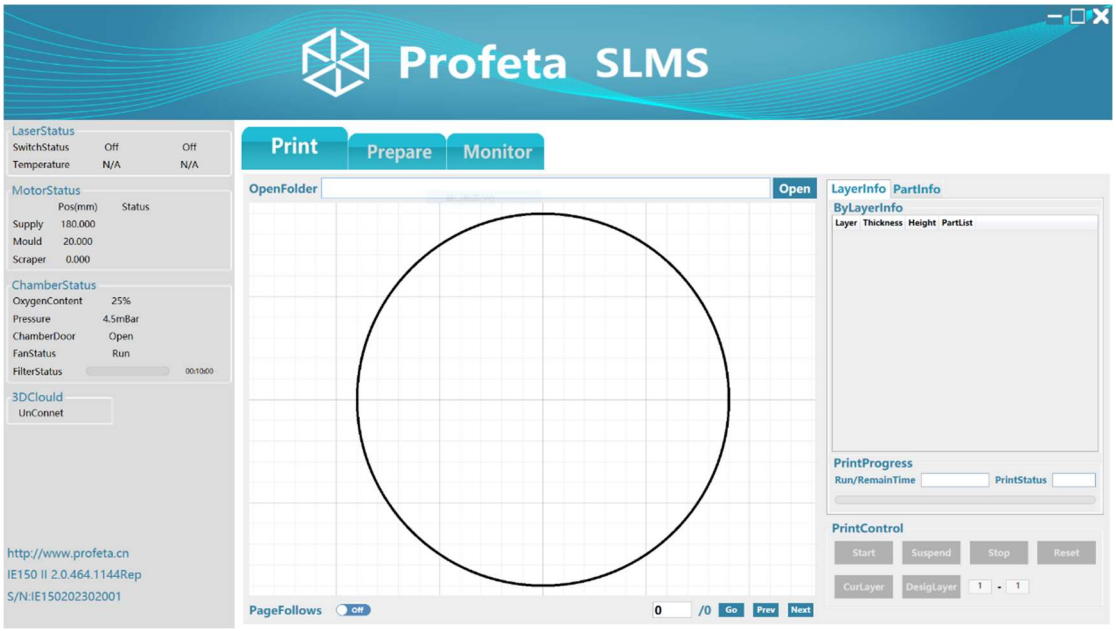

Figure 13

Equipment status monitoring area

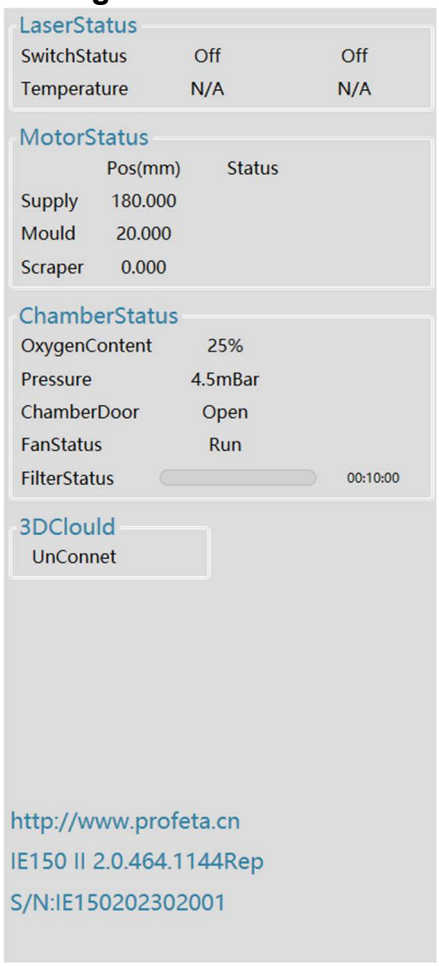

Figure 14

- **LaserStatus**

SwitchStatus: record information on the current operating status of the laser. Its status includes:

"On" - the laser is currently running;

"Off" - the laser is currently stopped;

Temperature: record information on the current temperature of the laser;

- **MotorStatus**

Supply: record information on the current position of the powder supply piston;

Mould: record information on the current position of the mould piston;

Scraper: record information on the current position of the scraper;

- **ChamberStatus**

OxygenContent: record information on the current oxygen content from the oxygen content sensor in the chamber, where two oxygen content sensors are

currently installed;

Pressure: record information on the current air pressure of the chamber;

ChamberDoor: record information on the status of the chamber door lock, its status includes:

"Closed and locked" - the door is closed and locked;

"Closed and unlocked" - the door is closed but not locked;

"Open" ---- chamber door is open;

"Status Abnormal" - reading error of chamber door status information

FanStatus: record the fan status

FilterStatus: record the usage of the filter element

Software version and other information

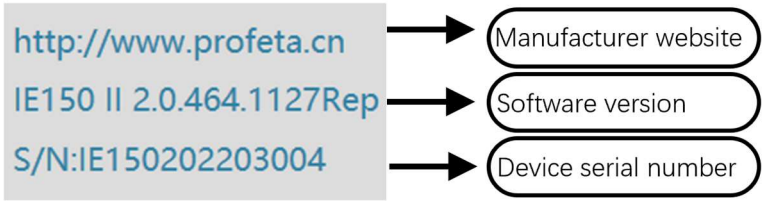

Figure 15

Print monitoring area

1) File loading area

Figure 16

Open: browse the print file (loads the entire folder);

The print file path is displayed in the box;

2) Print layer information

a. Print file layer-by-layer information

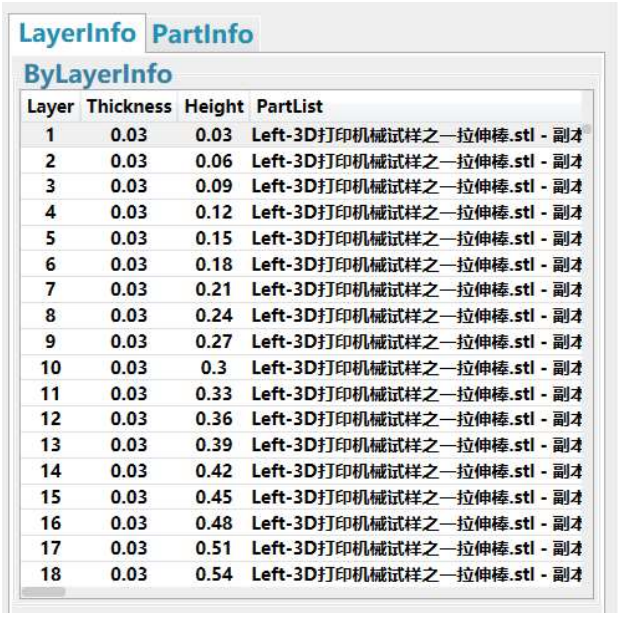

Figure 17

Layer: print file data layer by layer display

Thickness: the thickness of each layer of powder coated

Height: the height from the first layer to current layer

Partlist: the file name for the printing of current layer

b. Part Information

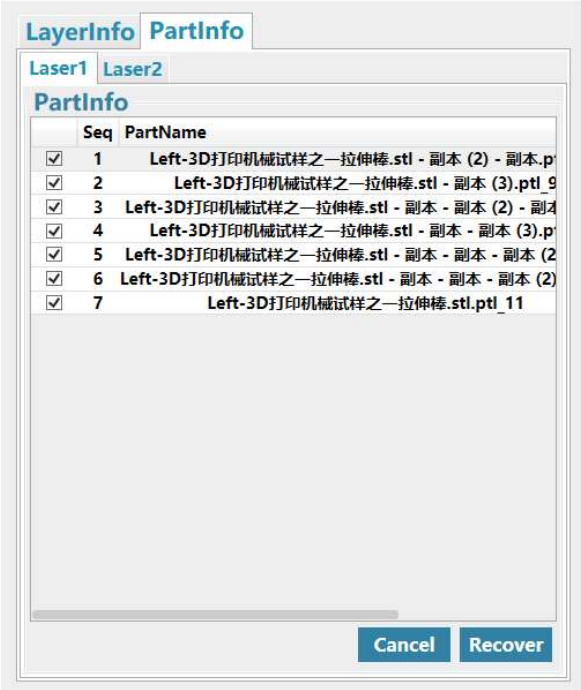

Figure 18

PartInfo: separately display the specific information of the laser 1/2 printed part, including the file name, layer thickness and maximum height of the part;

Cancel: after selecting a part, click to cancel printing, the checkmark in front of the part will disappear, the area of the part on the preview screen will be grayed out, and this part will not be printed in this printing;

Recover: select the part that has been canceled printing, click to resume printing, the area of the part on the preview screen will return to color, and the part will return to the normal printing state;

c. Print file illustration

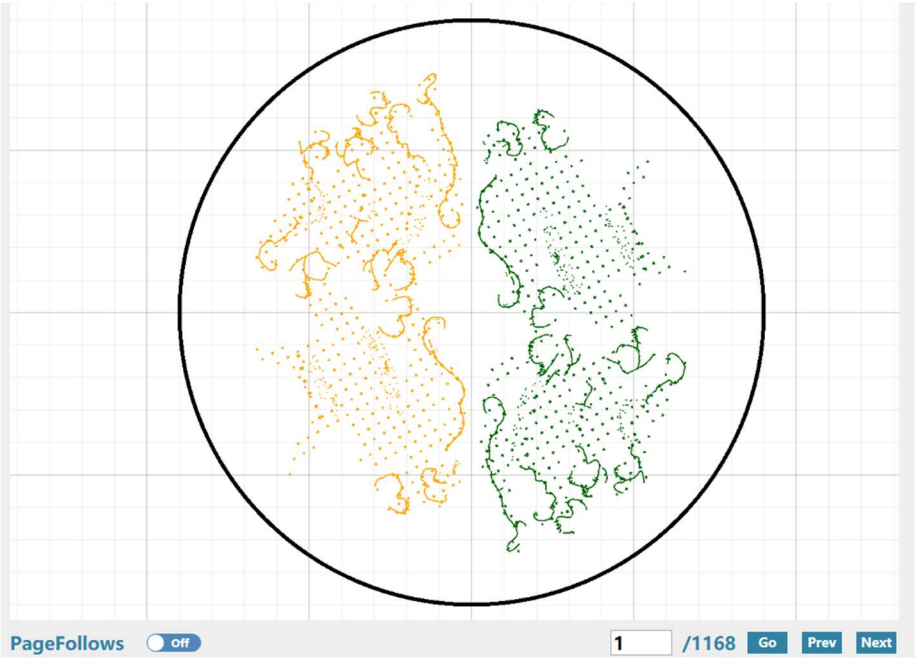

Figure 19

PageFollows: after page following is enabled, the part shape of the current printing layer will be displayed in real time in the print preview box;

Go: jump to any layer;

Prev: jump to previous layer

Next: jump to next layer

The circular area in the middle is the print preview interface, showing the shape of the current layer of the print;

3) Printing progress

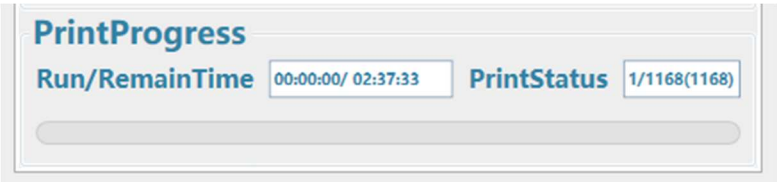

Figure 20

Run/RemainTime: display the run time/remaining time;

PrintStatus: display the running nodes of the printer before printing: gas filling, laser starting;

The number of layers printed/the total number of slice layers in the print file is displayed during printing;

“Printing completed” is displayed after printing is completed;

Below is the printing progress bar, showing the current total printing progress;

4) Print control

Figure 21

Start: start the file printing task.

This operation is available under the following conditions:

1. The file is loaded successfully;

2. The printing task is suspended.

This action is not available under the following conditions:

1. The print file is not loaded or fails to load;

2. The printing task is in progress;

3. The device reset button is lit but not clicked.

Suspend: suspend the file printing task.

This operation is available under the following conditions: a printing task is in progress;

This action is not available under the following conditions:

1. There is no printing task currently;

2. The reset button is lit but not clicked.

Stop: stop the file printing task.

This operation is available under the following conditions:

1. The printing task is in progress;

2. The printing task is suspended.

This action is not available under the following conditions:

1. There is no printing task currently;

2. The reset button is lit but not clicked.

Reset: reset the printer status.

This operation is available under the following conditions:

1. After the emergency stop button is pressed;

2. The actions of scraper, powder supply cylinder and mould cylinder have timed out;

3. When the laser reports an error.

This action is not available under the following conditions:

1. Failure to press the emergency stop;

2. The actions of scraper, powder supply cylinder and mould cylinder have not timed out;

3. When the laser does not report an error.

CurLayer: the layer currently displayed in the print preview box

This operation is available under the following conditions:

1. The file is loaded successfully;

This action is not available under the following conditions:

1. The print file is not loaded or fails to load;
2. The printing task is in progress;
3. The device reset button is lit but not clicked.

DesigLayer: print the layer specified in the text box (start layer - end layer)

This operation is available under the following conditions:

1. The file is loaded successfully;
2. The emergency stop is not pressed, the actions of scraper, powder supply cylinder and mould cylinder have not timed out, and the laser does not report any error.

This action is not available under the following conditions:

1. The print file is not loaded or fails to load;
2. The printing task is in progress;
3. The device reset button is lit but not clicked.

6.5.2 Print preparation screen

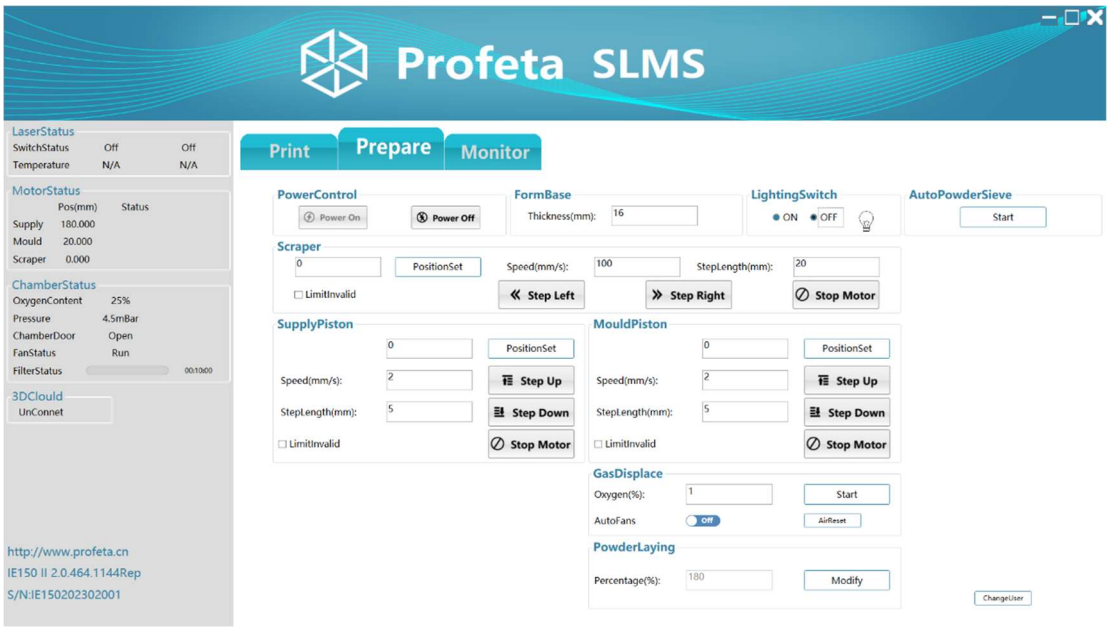

Figure 22

Control equipment power supply

Figure 23

Power On: the equipment is powered on. After power on, the button is grayed out;

Power Off: the equipment is powered off. After power off, the button is grayed out.

Lighting switch

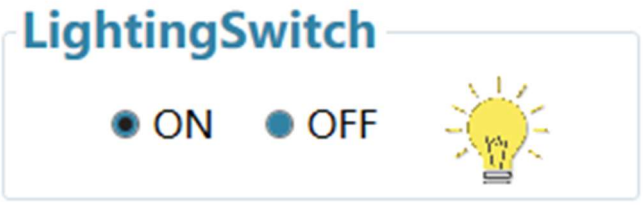

Figure 24

ON: turn on the chamber lighting;

OFF: turn off the chamber lighting;

On the right is a lighting diagram of the chamber, which will change with the lighting turning on and off;

Scraper

Figure 25

PositionSet: control the scraper to move to the specified position;

Step Left: control the scraper to move to the left, and move by one step at the specified moving speed for each operation;

Step Right: control the scraper to move to the right, and move by one step at the specified moving speed for each operation;

Stop Motor: make the scraper stop moving immediately;

Speed: specify the moving speed of the scraper, unit: mm/s;

StepLength: specify the distance that the scraper moves each time, unit: mm;

LimitInvalid: release the soft limit of the scraper;

Powder supply piston

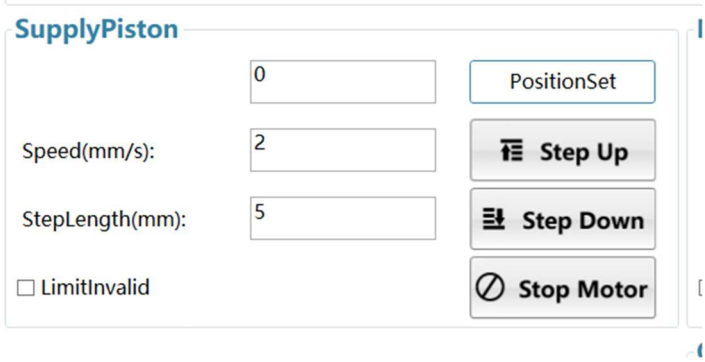

Figure 26

PositionSet: control the powder supply cylinder to move to the specified position;

Step Up: control the powder supply cylinder to move upward, and move by one step at the specified moving speed for each operation;

Step Down: control the powder supply cylinder to move down, and move by one step at the specified moving speed for each operation;

Stop Motor: make the powder supply cylinder stop moving immediately;

Speed: specify the moving speed of the powder supply cylinder, unit: mm/s;

StepLength: specify the distance that the powder supply cylinder moves each time, unit: mm;

LimitInvalid: release the soft limit of the powder supply cylinder;

Mould cylinder piston

Figure 27

PositionSet: control the mould cylinder to move to the specified position;

Step Up: control the mould cylinder to move upward, and move by one step at the specified moving speed for each operation;

Step Down: control the mould cylinder to move down, and move by one step at the specified moving speed for each operation;

Stop Motor: make the mould cylinder stop moving immediately;

Speed: specify the moving speed of the mould cylinder, unit: mm/s;

StepLength: specify the distance that the mould cylinder moves each time, unit: mm;

LimitInvalid: release the soft limit of the mould cylinder;

Gas shield

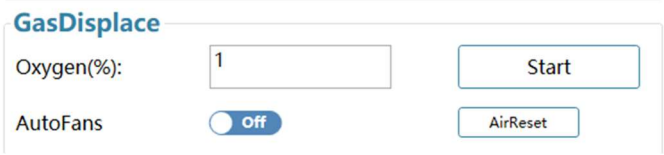

Figure 28

OXygen: after setting the oxygen content, click Start, the equipment will start gas filling, and stop gas filling when the oxygen content drops to the set value;

AutoFans: After enabling "AutoFans", the fan starts automatically when the oxygen content drops to a certain value;

AirReset: close all valves and fans;

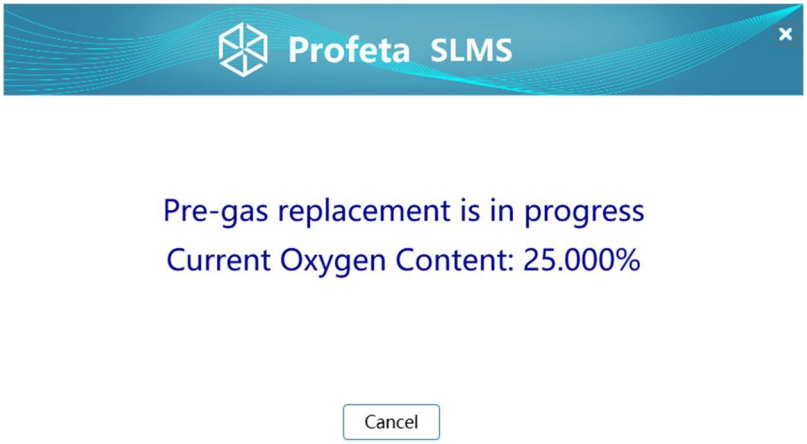

Figure 29

Cancel: click to stop the replacement;

Power coating ratio

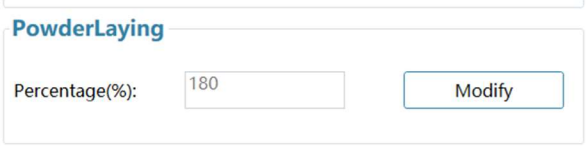

Figure 30

Percentage: click Modify Settings to set the powder coating ratio during printing, and then click Save Settings (the button will change to Save Settings after clicking Modify Settings), which can be modified before printing and during printing (limit is 100 to 400);

Change User

Figure 31

Click Change User to pop up the login interface, and you can switch between User and Supervisor interfaces (switching during printing will not affect printing)

Powder recovery

Figure 32

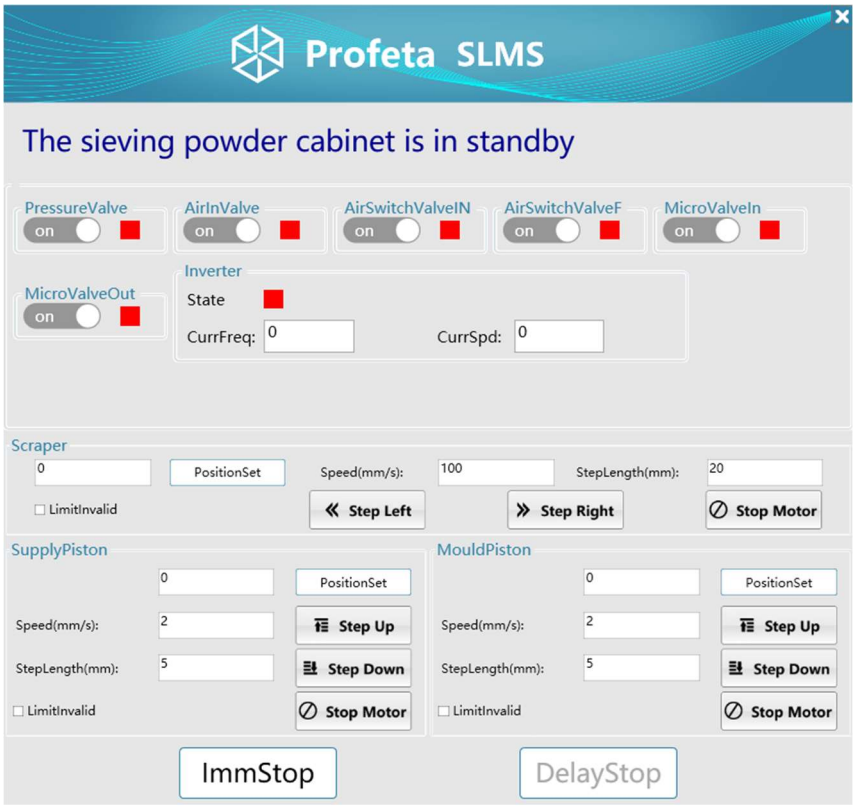

Figure 33

ImmStop: stop the sieving process immediately

DelayStop: stop the sieving process after a period of delay

6.5.3 Real-time monitoring

Figure 34

The air pressure and PLC program version in the chamber can be monitored in real time.

6.5.4 Data processing monitoring in the machine chamber

The data on the frequency of the fan and the oxygen content are crucial for the working (laser melting) process of the machine. The following is a description of these data:

- "Oxygen Content": refers to the content of oxygen in the chamber. Under normal circumstances and normal environment, oxygen in the air accounts for 20%. In order to prevent the oxidation of the melt pool during the printing process, the machine needs to work in an oxygen-free environment. Based on this, the machine must be shielded with an appropriate gas depending on the material, so that the oxygen content reaches the set value of the user.
- "Fan Frequency": corresponding to the wind field in the chamber and the wind speed on the moulding plane. During the working process of the machine, in order to prevent dust from causing rough prints and prevent powder from being blown away by excessive wind speed, it is

necessary to set the corresponding fan frequency according to different materials and different shielding gases, so as to ensure the quality of prints.

7 Maintenance

7.1 Maintenance personnel

Maintenance repairman: Under normal circumstances, he is competent to operate the machine, to debug the machine in manual mode, and to adjust, maintain and repair mechanical parts. **Maintenance repairman generally cannot work on live electrical systems.**

Maintenance electrician: under normal circumstances, he is competent to operate the machine, and can use corresponding protection measures to perform power adjustment, maintenance and repair in normal mode. **Maintenance electricians can work in live electrical panels and junction boxes.**

Manufacturer's technicians: in agreement with the user, qualified technicians provided by the manufacturer perform complex procedures in specific cases. Manufacturer's technicians may have relevant mechanical / electrical / electronic / software expertise.

7.2 Safety warnings for maintenance

These operations include inspection, maintenance and repair. It is recommended that, after each operation, a detailed record be kept for reference in subsequent operations.

For any defect in this machine, the user shall immediately report to the manufacturer, and immediately stop the machine and disconnect the power until it is repaired.

Before carrying out any test, maintenance and repair on the inside of the machine:

- Remove the processing platform;
- clean up the work area;
- shut off the supply of inert gas;
- Replace defective parts with original parts only, as these parts have

the same mechanical, electrical, physical and chemical properties as the original parts, otherwise it will affect the overall performance of the machine.

WARNING! Electrical risk!

During the test, cleaning, maintenance, and mechanical, electrical and electronic repairs of the machine, the machine may have residual power.

- Any work on electrical switchboards and electrical systems must be done by qualified personnel (maintenance electricians);
- Electrical maintenance work in the electrical system must be completely de-energized. Turn off the main power to prevent any electric shock;
- Before carrying out any maintenance work, the residual electric energy must be safely removed, and appropriate measures shall be taken according to the instructions of the designated personnel;
- In any case, the maintenance electrician should ensure that no residual voltage exists between the electrical switchboard and the electrical components of the machine. Even with the main power supply and all electrical switches turned off, there are times when life-threatening voltages are present.

WARNING! Danger of suffocation!

Toxic gases or inert gases (such as colorless and odorless nitrogen or argon) may escape from the machine

- Check inert gas piping and connections for leaks.

Before carrying out any installation, adjustment or repair work, the following operations shall be carried out on the gas circuit:

- shut off the supply of inert gas;
- Checking that the ventilation around the machine is good before working on it;
- Always follow the safety requirements for the use of inert gases and

operate them correctly according to the operation manual.

After the processing is completed, some inert gas remains inside the machine's chamber. There may be a danger of suffocation near the machine's chamber.

- First of all, open the chamber for ventilation;

Before starting work (testing, cleaning, maintenance, repair), disconnect all power supplies using the main power switch and lock it to prevent any accidental opening and hang a suitable reminder.

Caution! Risk of breakage!

When moving disassembled machine parts (e.g. scrapers, mould plates) or after repair work, care must be taken to prevent parts from falling out. In order to prevent damage to objects and personal injury.

Gloves and safety shoes must be worn.

Caution! Danger of heat!

The entire workflow involves the use of a laser, making the inner surfaces of the chamber very hot, so:

- Always wait for the temperature to drop below 40℃ before performing any testing, cleaning, maintenance or repair work.
- Must wear protective clothes;

If the control loop is obstructed, an overheating hazard will occur.

Caution!

The sharp corners of mechanical parts are prone to scratches, so protective clothing, gloves and safety shoes are a must.

Caution! Risk of property damage!

Insufficient or improper maintenance can lead to costly repairs and prolonged downtime. The service life of the machine depends on regular maintenance, so regular maintenance is necessary (**see 7.7 Routine Maintenance for the specific maintenance intervals**).

In addition to cleaning the laser protection lens, the user should leave

other maintenance work on the laser part to the manufacturer's professionals.

WARNING! Wear protection!

When handling metal powders, a protective mask must be worn!

Use securely closed safety goggles to avoid eye damage when handling powder or sieving powder!

Safety gloves, safety shoes and all protective equipment must be used, otherwise there is a risk of skin damage!

- Inhalation of metal powder should be avoided under all circumstances.
- When cleaning the chamber, powder supply cylinder, mould cylinder and replacing the filter element, be sure to minimize the diffusion of powder;
- Strictly follow the safety requirements for the use of metal powder provided by the supplier;
- When the pipeline is damaged or the interface is not properly sealed, leakage of inert gas may occur.

7.3 Machine insulation

Before starting any maintenance or repair work, the main power switch must be disconnected and locked out to disconnect power to the machine.

WARNING!

The following operations must be completed before maintaining the machine:

- Maintenance work on the machine should only be carried out with all electrical systems completely shut down.
- Before starting to clean out the chamber, make sure the workplace has good ventilation.
- Before cleaning and maintaining the chamber, open the chamber door to release the inert gas inside.

7.4 Special protection

Before maintaining and repairing the machine, the following recommendations should be followed:

- Always place the "Under Maintenance" sign in an easily visible area before starting maintenance on the machine;
- For electrical or circuit repair, always use insulated tools;
- Do not use flammable and soluble materials;
- Do not dispose of mechanical grease and refrigerants as if they were household waste;
- Do not dispose of metal powder and residual materials from processing as if they were household waste;
- Use appropriate aids when touching or taking higher parts in the machine;
- Please do not climb on the machine;
- When work is done, check for loose cable connections, restore removed guards or signage, and ensure they are placed in the appropriate area.

WARNING!

The manufacturer shall not be responsible for any damages arising from failure to follow the above listed contents.

7.5 Cleanup

Before performing cleanup, be sure to complete the following:

- The main power supply must be turned off and be sure to use the sign "Maintenance in progress, do not close the switch" as a reminder.
- Under no circumstances is it allowed to use flammable, soluble and corrosive detergents to clean the machine.
- Be sure to store and handle materials carefully.

7.5.1 Cleaning the chamber

After printing, the printing screen will display "Printing finished", at this time, the chamber door can be opened for cleaning.

- **Cleaning inside the chamber:**

  (1) Use a brush to clean the soot and dust from the air inlet in the chamber to the powder recovery tank (equipment equipped with an automatic sieving system, use the automatic powder sieving system to clean the soot and dust from the air inlet);

  (2) Click the "Print Preparation" tab, adjust the mould plate to a horizontal surface, and use a brush to clean the metal powder on the mould plate to the powder recovery tank;

  (3) Set the position of the mould cylinder to "0", and use a brush to clean the powder on the mould plate to the powder recovery tank (in case of a titanium equipment, it is necessary to clean the powder in the bolt holes of the plate to the powder recovery tank, and use a blow bag to remove remaining powder in the bolt hole);

  (4) Remove the plate (in case of a titanium equipment, use an Allen wrench to take out the 4 retaining bolts), pour the residual powder on the plate into the recovery tank, take out the plate, and clean up the residual powder on the mould mounting plate;

  (5) Take out an empty plate, clean the surface, and place it on the mould mounting plate (in case of a titanium equipment, align the four screw holes of the empty plate with the four screw holes of the mould mounting plate, and tighten the four retaining bolts with an Allen wrench), and the new plate is installed successfully.

- **Cleaning the protective glass:**

Wear protective equipment for eyes, skin, hands and respiratory system in accordance with Section 7.2.

1. Prepare lens wiping materials and anhydrous ethanol;
2. Open the protective door of the machine chamber, and make sure that the laser protection glass is above the chamber;

3. Use the materials specified in the user manual to clean the lens of the protective glass. If necessary, use anhydrous ethanol to moisten the lens and remove stubborn dirt;
4. Close the work door.

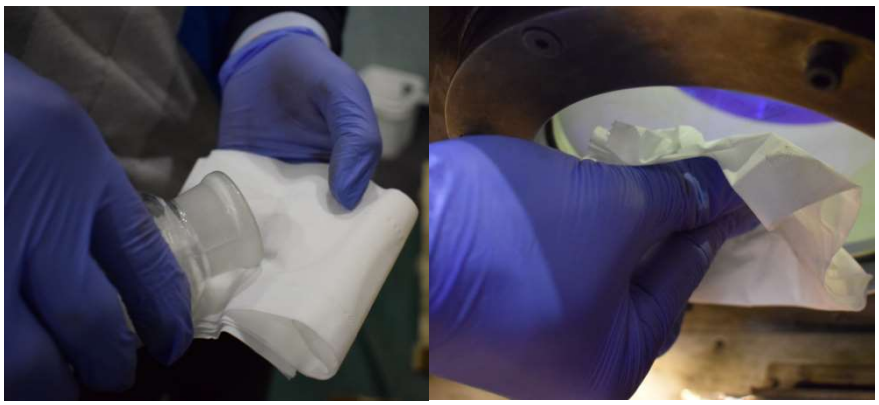

Figure 35

- **Cleaning of the chamber door:** use a paper towel that does not drop dust or non-greasy cotton to wipe the chamber door and the sealing strip to remove smoke and dust, and then use a paper towel or non-greasy cotton moistened with anhydrous ethanol to remove the grease and dust from the chamber door and the sealing strip.

7.5.2 Replacing filter element

WARNING!

Wear protective equipment!

Wear respiratory protection as required in section 7.2, and ensuring eyes, hands and skin are in safe protective equipment.

WARNING!

Potentially explosive atmosphere! Risk of dust explosion when using powder filters.

WARNING!

Beware of injuries and damage to property and the environment!

WARNING!

Metal powders, powder filters and their packaging must never be thrown into water, earth or the environment.

These materials must be collected, transfered and received in suitable containers for special waste disposal according to the current regulations of the country where they are located.

WARNING!

When the software shows that it is time to change the filter element or replace different powders, the filter element must be changed.

Please follow the instructions below to replace the filter element in the filter. The manufacturer is not responsible for any damage incurred if the following instructions are not followed.

- Close the manual valves on the two air pipes of the filter tank (the large filter tank is in a closed state), as shown in the figure (it is closed when the manual lever is perpendicular to the air pipe);

Figure 36

- Remove the clamp between the two valves and take out the filter tank;

Figure 37

- Open the side manual valve, fill tap water into the filter tank until the water overflows, and then close the manual valve;
- Open manual valve at the top, fill tap water into the filter tank until the water overflows, and then close the manual valve;
- Lay the filter tank down, let the outside of the large filter element fully contact with the water, and let the filter tank stand for a day; The next day, open the manual valve on the side, drain the water, then fill it with enough water again, and let it stand for 2 days (the filter element printed with cobalt chrome powder only needs to soak for 2 hours to proceed to the next step; for filter element printed with pure titanium or titanium alloy powder, please strictly follow the above procedures before proceeding to the next step);
- Remove the clamp and take out the large filter element;

- Unscrew the filter element retainer (the black part in the picture below), and remove the filter element;

Figure 38

- Put the filter element into an anti-static bag for centralized treatment (you can put some water in the anti-static bag in advance);
- To install a new filter element, the filter element must be pressed tightly during installation to avoid poor filtering effect during use;
- Reinstall the filter tank and clean the inside of it, dry the filter tank with kitchen paper, and then put the filter element back into the filter tank. At this step, pay attention to the installation of the filter tank end cover gasket, you can properly apply grease to assist the installation; if not installed properly, it will make the end face extrusion damage, resulting in problems with air tightness.
- Open the manual valve.

WARNING!

Never use any type of vacuum cleaner to clean the canister, the manufacturer will not be responsible for any damages incurred if this

rule is not followed.

7.5.3 Replacing the small filter element

WARNING!

Under no circumstances should metal powder or smoke be poured directly into trash bins or sewers. They must be packed in anti-static bags and disposed of in accordance with relevant regulations.

Before replacing the filter element, the equipment needs to stand for at least 24 hours.

1) Loosen the clamp;

Figure 39

2) The small filter element can be unscrewed directly, and then replaced with a new one. The old filter element can be soaked in water and put into an anti-static bag (if the printing material is pure titanium or TC4, special attention should be paid to prevent possible static electricity and sparks).

7.5.4 Cleaning the exterior paneling of the machine

When the machine's chamber door is opened, some metal dust may be released onto the machine's exterior paneling. Operators should therefore

wear appropriate protective clothing.

WARNING!

Wear protective equipment for eyes, skin, hands and respiratory system in accordance with Section 7.2.

The exterior of the machine needs to be cleaned with a clean disposable rag, and the used waste rag should be disposed of reasonably according to the guidelines for safe use of materials.

7.6 Lubrication

Regular lubrication of the machine's moving parts (chains, gears and sliders) can prolong the service life of these parts.

The regular maintenance plan is explained in detail in section 7.7. To ensure that the machine is working in good condition, the maintenance schedule must be strictly implemented.

7.7 Routine maintenance

7.7.1 General instructions for use

The emergency stop button of the machine should be tested every month. This test is carried out when the machine is idling to verify whether the emergency stop button is working normally.

In the event of an accident, professional staff should be arranged to investigate and find out the cause of the failure, or inform the manufacturer directly.

The glove device shall be checked and cleaned on a regular basis to ensure that it is not damaged, and shall not come into contact with sharp tools or corrosive liquids.

Check the continuity of the circuit every other year, and test its continuity according to the standard.

This machine has been designed to minimize routine servicing, however, it is the user's responsibility to assess its general condition and determine its suitability for service.

If the machine is not in the best condition, it is recommended to stop operation and start maintenance to ensure maximum efficiency.

Check all the components that make up the machine to ensure that no part is deformed and failed.

For all maintenance work that does not require power, be sure to turn off the main power switch.

WARNING!

Always disconnect the main power supply before carrying out maintenance work.

Be sure to wear personal protective equipment:

- Protective mask for the respiratory system (to prevent inhalation of powder);
- Safety glasses;
- Protective gloves;
- Non-slip shoes;
- Appropriate protective clothing.

7.7.2 Maintenance plan

The operator must maintain the machine on time and sequentially according to the following requirements.

The manufacturer shall not be responsible for the damage caused by the user's failure to maintain the machine in accordance with the requirement in the plan.

Even if the following operations are simple, they must be performed by qualified personnel.

Routine maintenance arrangements include: test, check and intervention, these operations are to prevent machine downtime or failure, the following

factors should be systematically controlled:

- Condition of machine lubrication;
- Condition of worn parts.

Maintenance	Frequency	Machine status
Inert gas: check damage and leaks in pipes	Daily	Non-operating state
Before any operation: check the pressure of the inert gas	Daily	Non-operating state
Remove metal powder and any remaining objects from the machine	Daily	Non-operating state
Cleaning the protective glass in the chamber	Daily	Non-operating state
Cleaning inside the chamber	Daily	Non-operating state
Check the glove box	Daily	Non-operating state
Ensure that all safety devices are fully functional	Daily	Non-operating state
Check the quality of powder coating	Before each print	Non-operating state
Cleaning the filter element	Every 200 hours	Non-operating state
Lubricate moving parts	Every 6 months	Operation status
Check the necessary connections	Every 6 months	Power Off status
Check the integrity of electrical equipment	Annually	Power Off status
Check the oxygen content sensor	Every 6 months	Power Off status

Table 4

7.8 Special maintenance

If special maintenance, replacement, overhaul, calibration, cleaning of optical parts or repair work is required, the manufacturer must be contacted for

technical support service.

WARNING!

Beware of the sharp edges of machine parts!

- Be sure to provide protective clothing for the safety of the operator.

WARNING!

Beware of smash injuries caused by dislodged machine parts!

When unloading or reassembling large parts of the machine, be sure to fix them securely to the equipment that lifts them.

- Safety shoes must be worn.

WARNING!

Pay attention to the safety of property and working environment!

- After the work is finished, check whether all threaded connections are firmly connected.
- Any broken or failed parts must be replaced with original parts.
- The warehouse should always be equipped with frequently changed parts, such as printing plates, laser protection lenses and smoke filter elements.

7.9 Troubleshooting

For any defects in the machine (deviations from those stated in the manual), please contact the manufacturer directly.

Note that it is necessary to completely restart the machine in an emergency. On the contrary, if you want to continue the operation after the machine has abnormal conditions, you only need to eliminate the reasons and continue to perform normal procedures.

The following table (Table 5) lists possible fault warnings and solutions:

Air tightness related:		
Phenomenon:	Possible causes:	Solutions:
Gas filling timeout	1. The gas cylinder itself leaks 2. The chamber door is not cleaned 3. The set screw for chamber door hinge is loose 4. Unreliable pipe joints 5. The filter tank seal is not installed in place or is crushed 6. Cylinder's O-ring has not been replaced for a long time, resulting in cylinder leakage 7. The filter element is not cleaned, resulting in excessive pressure in the chamber, the pressure relief valve is thereby open 8. There is an air leakage point in the equipment	1. You can hear obvious air leakage sound when you get close to it, replace the gas cylinder 2. Clean up with paper towel moistened with anhydrous ethanol 3. Tighten with an Allen wrench, the strength should not be too large 4. Check the joints and re-install if there is a problem 5. Remove and reinstall, if damaged, replace with a new sealing strip 6. Replace new O-rings regularly 7. Clean the filter element 8. Fill the chamber with hydrogen and nitrogen mixture, and then use a hydrogen detection instrument to detect whether there is an air leak point, and detect it when the fan is started and stopped.
Oxygen content does not go down / there is a pause in the printing	1. Small flow rate adjustment is unreasonable, the pressure in the chamber is very small during the printing process, and the	1. The air intake flow rate is normally 3L/min, and the outlet air flow rate is adjusted to keep the pressure in the chamber at about 4mBar 2. Adjust the pressure reducing

process	pressure reducing valve adjustment pressure is too small, failing to meet the requirements of gas replenishment 2. Failure to replace the filter element on time; if the filter element is not replaced for a long time, it will affect the gas circulation 3. The purity of the nitrogen generator is not enough 4. Oxygen content sensor failure 5. The filter element is not installed properly, resulting in air leakage	valve, the first level is 0.2, the second level is 0.1 3. Regularly replace the filter element as required 4. Check the nitrogen generator or air compressor 5. Contact the supplier to replace the oxygen content sensor 6. Install the filter element and tighten it to avoid air leakage
Oxygen content, the maximum and minimum values are wrong, and the change value is wrong	Zero calibration is wrong	Re-calibrate the zero
The air pressure of the equipment during printing is continuously higher than 25mbr	1. The small flow outlet valve failure, cannot open 2. Small flow intake flow is too large 3. No air coming out of the air pipe even if it is cut, and the outlet pipe with small flow rate is bent 4. Small flow outlet air adjustment is too small	1. Replace the small flow outlet valve 2. Turn down the small flow air intake 3. Straighten out the outlet pipe 4. On the premise of ensuring that the oxygen content does not rise, increase the air outlet to reduce air pressure, and the small flow marbles will fall back
Mechanical related:		
Phenomenon:	Possible causes:	Solutions:
Limit trigger	1. The limit switch is loose and shifted	1. Move the limit switch to the correct position and retighten it

	2. False alarm 3. The limit switch is damaged (remove the limit switch, if it is always off, it means it is damaged)	2. Move the motion mechanism in the opposite direction, and then reset the fault 3. Contact the supplier to replace the limit switch
Stuck cylinder (piston cannot move)	The inside of the piston cylinder has not been cleaned for a long time, resulting in a lot of powder accumulation. After being damp, the powder agglomerates, causing the piston to get stuck and unable to move	1. If the speed is slowed down and the moving step is small, the piston can move. Raise the piston to the position where the O-ring can be replaced, then clean the periphery of the piston with a vacuum cleaner, let the piston go down, and then clean the inside of the piston cylinder; 2. The piston is completely stuck and cannot move. Loosen the felt ring pressure plate and try to move the piston. If it can be moved, follow the first method; if it still cannot be moved, you need to remove the pressure plate and the felt ring, and then try to move it. If it still cannot be moved, you need to remove the connecting bolts of the piston, guide rod and electric cylinder, use special tools to manually remove the piston, and finally clean the piston and piston cylinder.
	The piston fastening bolts are loose, causing the piston to tilt during movement	1. Remove the pressure plate and felt ring 2. Remove the connecting bolts of the piston, guide rod and electric cylinder, manually take out the piston with a special tool, polish the cylinder body with sandpaper and reinstall the piston
The mould cylinder cannot be lowered after being lifted up, the mould fault is	The felt ring and upper plate are not installed properly, causing it to get stuck	Remove and reinstall in place

reported, and the servo reports an error		
Positioning timeout and secondary positioning often occur during printing	1. The fixing screw on the grating ruler is not tightened 2. The cylinder block is stuck, and the O-ring type is not suitable	1. Tighten all the screws that fix the grating ruler 2. Clean the cylinder and replace the appropriate O-ring
Laser related:		
Phenomenon:	Possible causes:	Solutions:
Laser does not emit light	1. The emergency stop button of the laser is touched 2. The scraper is not in place during printing 3. The wiring is loose or Harting head shortening 4. Control software or controller problems 5. The temperature is too low/high	1. Pull out the emergency stop button 2. Check whether the scraper is in the set position 3. Check the wiring and Harting head 4. Restart the software or controller 5. Turn on the air conditioner to make the room temperature reach 22℃, and turn on the water cooler at the same time to make the water temperature reach 20℃ before starting
Galvanometer scanner does not work	1. Abnormal power supply 2. The galvanometer scanner motor is damaged	1. Check the power supply 2. Replace the galvanometer scanner
Inaccurate laser calibration	Excessive scanner error	Calibration is successful after replacing the scanner
One laser does not emit light during dual laser equipment printing	Poor QBH contact	Use the manufacturer's version of software to shield the QBH alarm.
IPG lasers often have a	Unplug the laser network cable and ping the IP	1. Disable wired network connections to the company's

laser start error as soon as they start printing	address of the laser, and successful ping indicates an IP conflict	intranet. 2. if only connected to the wireless network, you need to unplug the wireless network card or forbid the connection of the wireless network that causes IP conflict;
The IPC is stuck during printing, and the laser 1 keeps emitting light at one point.	After replacing the IPC, it still appears to be stuck. After replacing the control card, the stuck did not occur again. It is analyzed that there is a problem with the control card that causes the IPC to be stuck.	Contact the manufacturer to replace the RTC control card
Laser start failed	1. Air switch is closed 2. The emergency stop button of the laser is pressed 3. The laser's power key switch is in the Off position 4. The communication line is not plugged in properly 5. The mould system checks the laser model and cooling method selection error	1. Open air switch 2. Pull out the emergency stop button 3. Turn the power key to the On position 4. Plug in the communication line 5. Use Producer to log in to the mould system to select the correct laser model and cooling method
Electrical related:		
Phenomenon:	Possible causes:	Solutions:
Inaccurate positioning of mould cylinder	1. The RS485 communication line is loose 2. The grating ruler fails 3. The grating ruler is loosely installed 4. Piston ring mounting screws are loose	1. Check the RS485 communication line 2. Contact the supplier to replace the grating ruler 3. Check the installation of the grating ruler 4. Check the piston ring mounting screws
Alarm for positioning timeout of the mould cylinder	The connector between the motor and the reducer is loose	Tighten the connector

during printing		
When printing, the red light and yellow light are on when the laser is started, and the green light is not on, and then a laser start error is reported! After a few more attempts, the yellow light does not come on	Observe that the two points A31.Q8.4 and A31.Q8.3 of the PLC module have output, but the coils of relay KA15 and KA16 are not powered, and it is judged that the relay is damaged	Contact the supplier to replace the relay
After the whole machine is powered off, the mould cylinder does not move when the breakpoint is printed	PLC moulding speed lost after power off	In the print preparation screen, manually move the mould cylinder once
Print quality related:		
Phenomenon:	Possible causes:	Solutions:
Poor print quality, rough surface, obvious lines	Filter element is clogged	Observe whether there is obvious smoke and dust during the printing process
	Poor quality of powder coating	Observe whether the powder is evenly and flatly coated over the entire printing tray after coating the powder and whether there are wavy patterns.
	Powder is damp	In the process of powder coating, the powder forms lumps, a large

		number of obvious scratches and pits. The powder is dried in a drying oven, and the powder is dried before use.
	The fan does not start	1. Check whether the fan stops 2. Check whether there is a problem with the fan control circuit 3. Check whether the inverter has an alarm
Sieving related:		
Phenomenon:	Possible causes:	Solutions:
The sieving apparatus sprays powder, but does not sieve	1. Too much powder is put 2. The sieve is not cleaned	1. The powder in the recovery tank is sieved in batches, and the powder put into each sieve should not exceed 1/2 of the sieve plate or 1-2kg, that is, the powder in the recovery tank is sieved in 2-3 times; 2. Clean the sieve after each sieving, and use a vacuum cleaner to remove the particles in the mesh after brushing;
At the end of automatic sieving and powder suction, the air pressure in the chamber shows below -20mbar, and the chamber door is not easy to open.	After the mechanical structure is modified, the negative pressure is very large after the powder suction is completed.	Fasten the gloves, turn off the powder suction, and click the inflatable protection for 2 seconds to solve the problem。
Unable to suck powder, sucking speed is low	1. The frequency of powder sucking is too small 2. The pipe sucks in foreign objects such as screws, which will get stuck in the powder suction valve	1. Change the powder suction frequency to 50Hz 2. Check whether foreign objects are sucked into the powder suction pipe

IPC related:		
Phenomenon:	Possible causes:	Solutions:
The computer cannot start up, the host green light is on, but the red light is off	Host motherboard burned out	Remove the hard drive to back up data, and replace the host.
Wireless network and wired network cannot be accessed	The wireless network is disabled. Check the wired network, the PLC communication IP is wrong.	1. Enable the wireless network 2. Set the PLC communication IP to the correct one, and the light will be emitted normally 3. Disable the wired network and enable it again to restore normal connection.
It shows that the signal line is not connected	Check the line is not damaged, and it is analyzed that there is a problem with the drivers	Back to normal after updating the driver
The mouse is not sensitive and the movement is uncontrollable	The bluetooth adapter is directly plugged into the host, and the electromagnetic interference is large, so it cannot be used; plugged into the extension cable inside the device, some devices are not flexible, and it can be used normally when plugged into the front panel.	You can plug the Bluetooth adapter into the extension cable or the front panel

Mould system related:		
Phenomenon:	Possible causes:	Solutions:
When starting the mould system, the display remains on the "logging in..." page; checking the log shows	Communication IP has been tampered with	Set the network IP connected to the switch to 200.100.2.198.

PLC connection failure		
The control circuit of the mould system is not powered on, the mould cylinder and the powder supply cylinder report the upper limit, but the actual position is not at the upper limit	The local connection of the PLC communication is disabled, causing problems in the communication between the PLC and the IPC	Enable local connection and restore PLC communication
The mould system cannot be started	1. The network port of the switch is broken 2. The CT5 driver is not installed	1. Change the communication line to a normal network port 2. Uninstalling the driver, and then reinstall the RTC5 Driver folder driver. If this doesn't work, restart the computer to install the driver automatically
The desktop shortcut of the mould system disappears, and the programs in the original folder disappear	1. Deleted by anti-virus software 2. Windows firewall and security center are not disabled 3. The mould system folder is not added to the Windows system's antivirus exclusions	1. Uninstall the antivirus software 2. Disable the Windows firewall and security center 3. Add the mould system folder to the Windows system's antivirus scanning exclusions
During printing, the scraper waits for a long time at the waiting position or on the right side, resulting in too long powder coating time	The computer is connected to an unstable or very slow network, and frequent requests to connect to 3D Cloud result in this problem.	Change to a stable network or completely disconnect from the network

Mould system reports valve abnormality	May be abnormal communication with PLC	After re-inserting the network cable of the switch, the whole machine restarts
Mould system reports PLC connection abnormality	1. The network cable of the switch is not plugged in properly 2.Wrong IP address setting	1. Re-plug the network cable of the switch 2. Contact the manufacturer to check the PLC address
Mould system operation lag	1. Wrong IP address setting for oxygen content 2. Oxygen content sensor or collector damaged	Contact the supplier to check

Table 5

7.10 Work record

Date	Problem	Causes	Repair operations	Signature

Table 6

8 Assistance and spare parts

8.1 Assistance

The manufacturer can provide more information about the use, maintenance or installation of the machine.

When asking for information, the user should list references and instructions in this manual using the clearest terms possible.

8.2 Spare parts

For any spare parts required, please contact the manufacturer directly.

WARNING!

Always use original accessories.

The manufacturer shall not be responsible for machine breakage, malfunctions as well as personal and property damage caused by failure to use original accessories.

In order to facilitate the management of spare parts, the manufacturer shall provide the following modules, which can quickly find the required parts. Again, users should not use non-original accessories. In addition, if you use non-original accessories, even if the machine is within the warranty period, you will not be able to enjoy the manufacturer's warranty service. If you need accessories, just fill in the form according to the following requirements and send it to the manufacturer.

In order to avoid unnecessary trouble and facilitate the information exchange between customers and manufacturers, it is recommended to fill in the form as carefully as possible according to the format requirements of the attachment. Then send the completed form to the manufacturer.

When you need to order accessories, in order for you to communicate with our technical staff more conveniently, please follow the following procedures to fill in the form:

a) Please indicate what components have failed;
b) Tell the manufacturer where the failed part is located in the machine;
c) Contact the manufacturer and describe the type of damaged part;
d) Fill in the form below to order accessories.

Spare Parts Request Form

Machine Information	
Machine name:	
Model:	
Serial number:	

Table 7

List the accessories to be ordered:

Part name	Part description	Quantity

Table 8

9 Additional instructions

9.1 Waste disposal

The user shall be responsible for the reasonable disposal of the waste generated during the machine production in accordance with the current laws and regulations of the country, and the waste dust, lubricating oil and replaced parts must also be reasonably and legally disposed of in strict accordance with the current laws and regulations.

9.2 Decommissioning and disassembly

After the machine reaches its service life, it needs to be decommissioned. In order to further dispose of the machine reasonably and effectively classify the waste parts, it is necessary to disassemble the machine. The disassembled machine is basically divided into three types of parts: plastic, metal and electronic components, and the parts must be classified according to current legal regulations.

9.2.1 Breakdown and treatment

The manufacturer recommends entrusting the dismantling and disposal of the machine to professional technical service providers and waste disposal companies.

9.2.2 Preparation for breakdown

- Remove any dirt, especially powder, as these may endanger human health during disassembly;
- Fence off an area for disassembly and storage of disassembled items;
- The main power supply to the machine must be disconnected;
- If there are gas supply equipment, disconnect these equipment in advance;
- Release pressure from pressure components;

- Wait at least an hour to allow the voltage inside the machine to fully drain and the components to cool before it is safe to touch any component in the machine.

9.2.3 List of hazardous substances

After disassembling the machine, the disposal of the following hazardous substances shall comply with the current laws and regulations of the place where the machine is used.

Hazardous substances	**Structural components existed**
Arsenic trioxide	Electronic components
Lubricant	Slider and motion mechanism
Filter element	Dust filter unit
Metal powder	Dust filter unit
Battery	Electrical switchboards, control systems

Table 9

9.3 Safe working procedures

Educate and inform employees of proper operating procedures:

- Use the machine safely;
- Emergency measures.

10 Machine warranty and after-sales service

10.1 Machine warranty

The machine warranty (including the key core components: laser, galvanometer scanner): non-human failure during the warranty period shall enjoy free maintenance by the manufacturer.

10.2 Precautions

- The temperature of the equipment storage environment needs to be maintained at 15℃~35℃, and equipment damage caused by low temperature is not covered by the warranty;
- When the optical lenses of the equipment need to be maintained every six months, they need to be thoroughly cleaned. Burnout due to improper maintenance and dust accumulation in the lenses shall not be covered by the warranty.

11 Attachment

11.1 Attachment information

Warranty card

Manufacturer: Nanjing Profeta Intelligent Technology Co., Ltd.

Machine:

Model:

Serial number:

This warranty card is only applicable to customers who operate in strict accordance with this operating manual during the warranty period. During the warranty period, for any failure of the machine or the defect and failure of parts, the manufacturer will provide free maintenance of the machine and replacement of parts. The manufacturer has the right to take back the parts replaced by the manufacturer. Before the machine is sold, the manufacturer must guarantee that the machine and machine parts are intact, and the manufacturer shall bear all responsibilities for the failure of the machine before it is sold.

The user's use of the material shall not be covered by this warranty, and the user shall be responsible for any problems caused by the customer's misuse of the material in the course of use. For machine maintenance and parts replacement beyond the warranty period, the customer shall pay a certain fee according to the relevant cost guidelines.

Legal representative:

Manufacturer Name: Nanjing Profeta Intelligent Technology Co., Ltd.

Manufacturer Address: No. 12, Mozhou East Road, Jiangning District, Nanjing, P.R. China