

1<sup>ST</sup> VERSION | 2020

# FIBER LASER MARKING MACHINE OPERATION MANUAL

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PLS READ CAREFULLY BEFORE INSTALLATION & USING



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## **SECTION ONE: GENERAL SUMMERY**

### **1.1 BRIEF INTRODUCTION OF FIBER LASER MARKING MACHINE**

The laser-marking machine uses its fiber laser source to output laser, and then through the high speed scanning galvanometer system, it can be used to print permanent marks on the surface of various materials. The efficiency of optical conversion in fiber laser marking is up to 70%.

The effects of marking is

1. To expose deep matter through the evaporation of surface matter, or
2. To engrave traces through the chemical and physical changes of surface matter caused by laser energy, or
3. To burn out some substances by laser energy, and to display the patterns and characters needed to etch.

MAIN COMPONENTS: fiber laser source, galvanometer (marking head), software control card, control box and cabinet, flat work platform placing work pieces.

### **1.2 WORK PRINCIPLES OF FIBER LASER MARKING MACHINE**

The fiber laser marking machine generates laser by laser source, outputs laser by optical fiber, and then marks on work pieces by cooperating with optical high-speed scanning galvanometer. The core component is fiber laser source.

Fiber laser source adopts rare earth elements as gain medium. Due to the fact that the fiber core in fiber laser source is very slender, under the action of pump light, it is easy to form high power density in fiber, resulting in pump level "population inversion". Therefore, when a positive feedback loop is properly added to form a resonator, a laser oscillation can be formed. In addition, because the fiber matrix has a wide fluorescence spectrum, fiber lasers are generally made to be adjustable , that is, its wavelength can be regulated within a certain range, and several colors of some materials can be marked while marking.

### **1.3 Main features of fiber laser marking machine :**

1. Fiber laser marking machine uses fiber laser source. The life span can reach 100 thousand hours. Its superior performance ranks ahead in the world.

The beam quality is high, which is the fundamental mode laser(TEM00), and the focal spot diameter is less than 20um. The divergence angle is the 1/4 of a semiconductor pumped laser.

The single line is narrower, especially suitable for fine and precise marking.

1. It has small volume, small power consumption, and the whole machine consumes less than 500W. The built-in air-cooling mode has substituted the bulky heavy water cooling unit, which occupies smaller floor area and allows more convenient installation. It really achieves both energy saving and portability.
2. High electro-optic conversion efficiency, Simple and easy to use, without optical adjustment or maintenance, compact structure, high system integration and less fault.
- 3.No maintenance, long service life and suitable for fierce work environment.
4. The processing speed is 2-3 times higher than that of the traditional marking machine. Optical scanning galvanometer, high laser repetition rate, high working speed without distortion
5. The fiber laser source is equipped with optical isolator, which effectively shields the reflected light. It can mark on high reflective materials such as gold, silver, copper, aluminum and silicon. It does not need to deviate from the center of the field lens, which greatly expands its application area. And for different metal materials, the operation of adjusting the frequency and energy can mark out a certain color.
6. Marking software is powerful which is compatible with Coreldraw, AutoCAD and other software files; support PLT, PCX, DXF, BMP and etc.; SHX, TTF font can be used directly; support automatic encoding and can print serial number, batch number, date, bar codes, two-dimensional code, automatic jump numbers and etc.; USB interface output control.

## **SECTION TWO: SAFTY PROTECTION IN EQUIPMENT OPERATION**

### **2.1 Conventional safety instructions**

The specially designed fiber laser marking machine helps reduce the occurrence of accidental events exposed to dangerous radiation.

#### **WARNING**

▲ The operation, adjustment, or control that does not comply with the instructions of this manual may lead to dangerous radiation. Therefore, it is necessary to be fully familiar with all safety requirements and operation steps prior to operation and maintenance of the system.

▲ Provided that the damage to the equipment due to failure of complying with the instructions of this manual in operation, adjustment or control, it would not be within warranty coverage. If any instructions not clear or not mentioned herein while operating the machine, please kindly contact with Sundor service line 0086-18500183888.

In order to ensure safe operation and optical performance of the machine, please follow the following cautions and warnings.

Warning: Please must ensure the connection of the safe grounding wire while using the laser machine.

Caution: Please must ensure that the input is 220V AC before electrifying the laser machine. Please be noted that wrong voltage input may cause damage to the equipment.

## **2.2 Laser source safety type**

The laser source applied in the fiber laser marking machine belongs to safety class IV. If use improperly, it will cause harm to the human body. Users should take protective measures according to the requirements of this manual.

The laser wavelength of the laser source is 1064nm. The maximum power rate is not more than 20W.

Avoid direct exposure of eyes or skin to laser radiation.

Do not try to open the device. Its maintenance or service can only be completed through Sundor's authorized engineer.

- **The harms of laser**

Laser output is invisible infrared light. Even if it deviates from the focal distance, it may cause grade III burning.

The output of the device consists of both visible and invisible radiation. It's harmful for people's eyes.

- **Explosion and fire risk**

The fiber laser marking machine is not suitable for use in neither flammable and explosive situations nor the environment with volatile solvents such as alcohol, gasoline, etc.

## **2.5 Electrical safety**

The fiber laser marking machine should not be dismantled at will because there is high pressure inside possible to cause harm to human body. In case of work failure, only the professional and technical engineer can open the machine.

## **2.6 Warning marks and labels in workroom**

In the workroom of fiber laser marking machine, warning label "Beware laser" should be marked in its prominent position.

## Section Three: Laser Source Introduction

### 3.1 Overview of laser theory

When some materials are stimulated, its atoms or molecules are distributed more at high energy level than that of low energy level, so that the material can radiate with the corresponding frequency of energy level difference. English word "laser" - is acronym for light amplification by stimulated emission of radiation. The laser is composed of a working medium and a pump source enclosed in the pump chamber. The pump source pumps the working medium from the energy ground state to the excited state. If "population inversion" happens between two excited levels, stimulated radiation (i.e., photons) is formed. The photons are amplified by resonance and reflected back and forth in the optical cavity. Some of amplified electromagnetic radiation output forms laser.

Compared with other light sources, laser has the characteristics of good monochromatic, good coherence, good directivity and high brightness.

#### 1. Good monochromatic

The light emitted by ordinary light source includes a wide wavelength range, i.e. wide spectra line, as the sun light contains all wavelengths of visible light, but laser is single wavelength whose spectral line width is very narrow usually from hundreds of nanometers to several micrometers. Compared with ordinary light, its spectral line width is narrower by several orders of magnitude.

- Good coherence

The amplitude of the superimposed laser beam is stable. In a long time, the phase relation of the light wave remains unchanged. This cannot be achieved by any other light source.

- Good directivity

The light emitted by ordinary light source diverges in all directions whose beam divergence is large. But laser's divergence angle is quite small, which is usually a few milliradians.

- High brightness

Laser beam can focus through an optical system (such as a lens) onto a very small area, which makes laser have very high brightness.

### 3.2 General Introduction of Laser Source

The working medium of a laser source can be gas, liquid, or solid. The working medium of

most gas laser sources consists of atoms, molecules, or a mixture of both. The working medium of a solid-state laser source consists of atoms or ions doped in some crystals. The working medium of liquid laser source consists of molecules that originate from large molecular mass dissolved in the liquid.

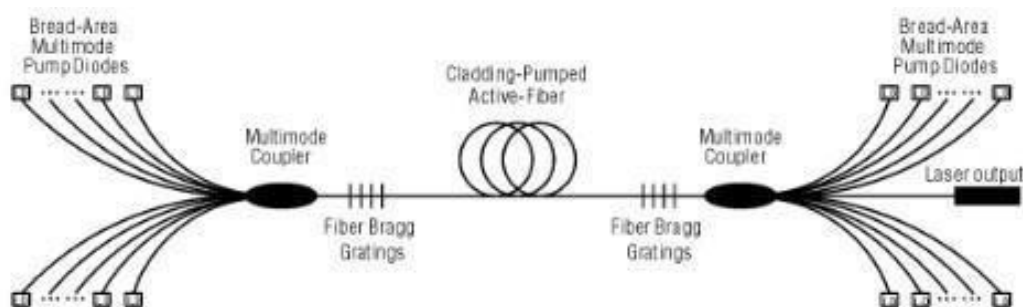
Under specific pumping conditions, all of these working mediums can achieve "particle population inversion" and produce laser at a certain wavelength.

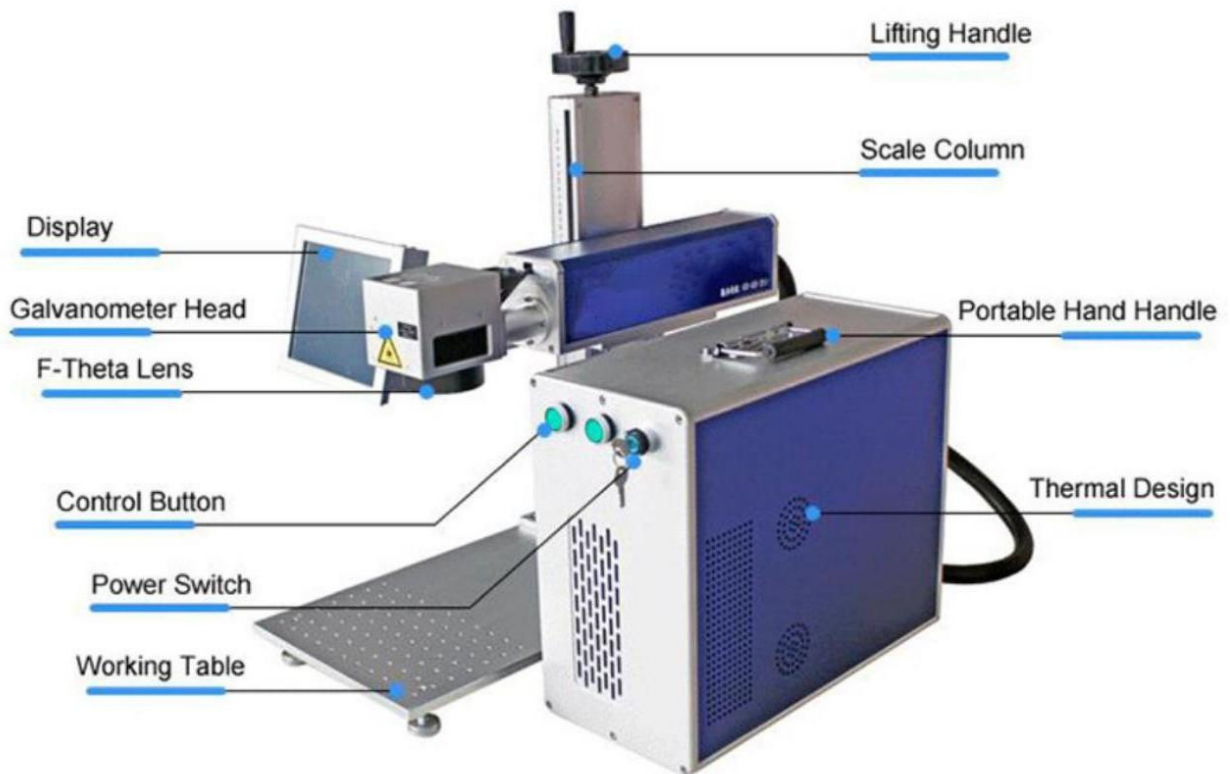
The fiber laser marking machine adopts the most advanced pulse fiber laser source in the world.

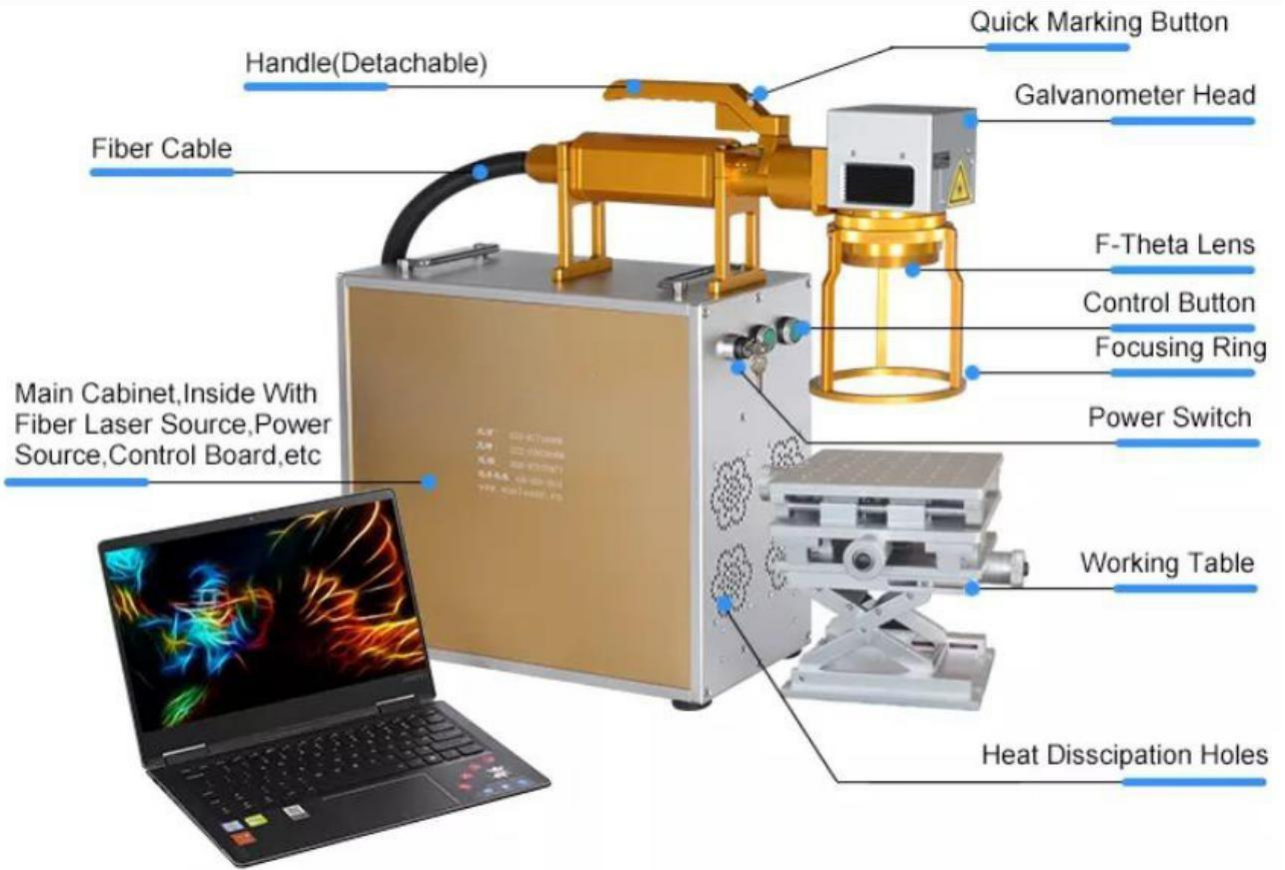
Fiber laser source is developed on the basis of fiber amplifier. Fiber amplifier uses optical fiber doped with rare earth elements together with a proper feedback mechanism to form fiber laser source. The optical fiber doped with rare earth elements act as the gain medium of the fiber laser. There is a very thin fiber core in fiber laser source. The pump's function in the fiber makes it easy to form high power density that causes population inversion of working material energy level. In addition, fiber grating is used as the resonant cavity of the fiber lasersource.

Fork typed cladding fiber is made with a special process. Multimode pump light enters from the fork into the optical fiber and pumps light for the single-mode fiber core doped with rare earth element (e.g., Yb). Every time when the pumping light passes cross the single-mode fiber core, the atomic of rare earth elements pump to upper level and then spontaneous radiation is formed through the transitions. Due to frequency selective effect of fiber grating arranged in the optical fiber, the spontaneous radiation of specific wavelengths are amplified and finally generate laser. If doped with different rare earth elements in cladding fiber materials such as erbium, thulium, praseodymium, ytterbium or other rare earth elements, there will be many different wavelengths of fiber laser source.

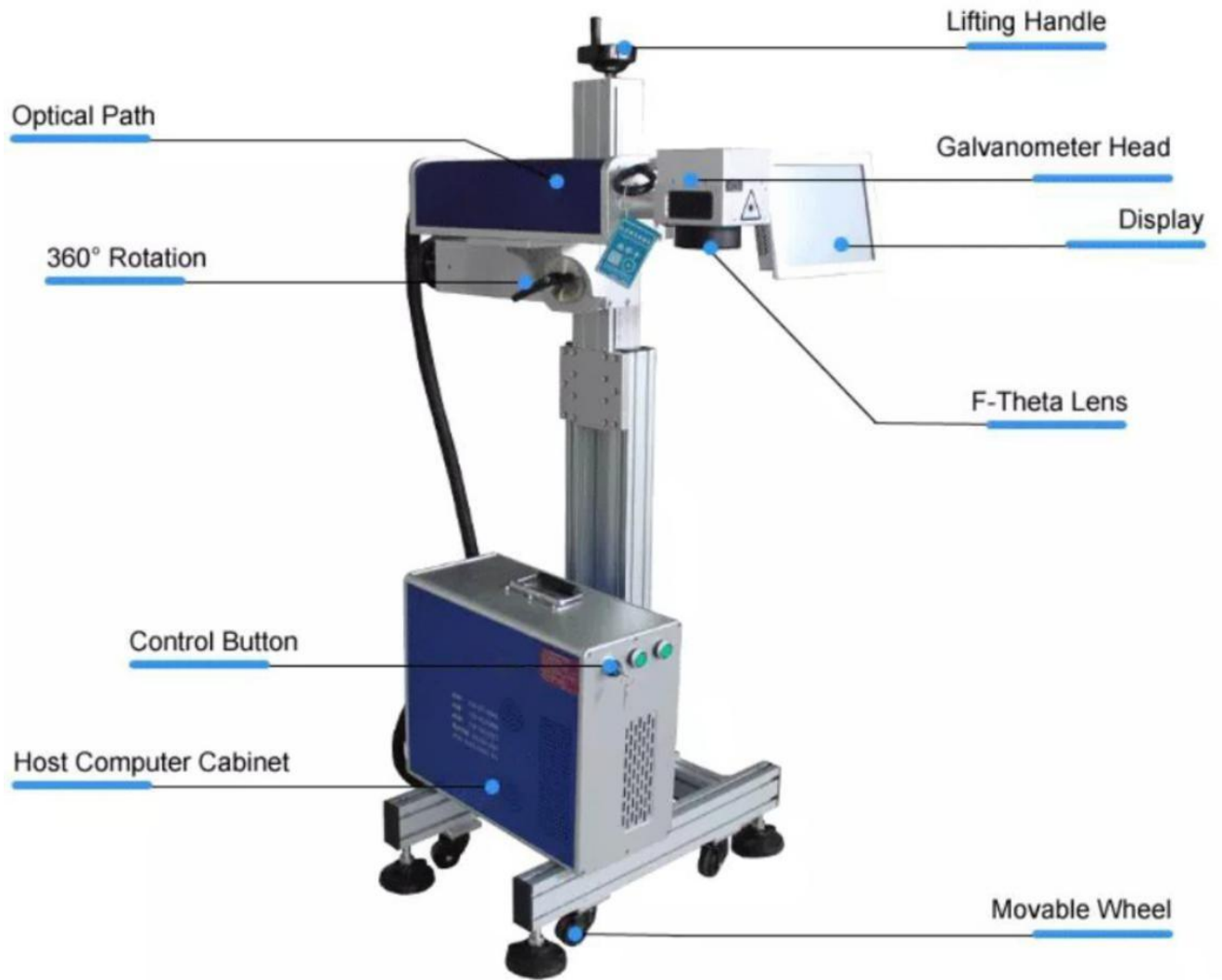
High power laser output can be obtained by coupling multiple laser diodes to cladding fiber by using cladding and parallel pumping technology. Its basic principles as shown in the below diagram:









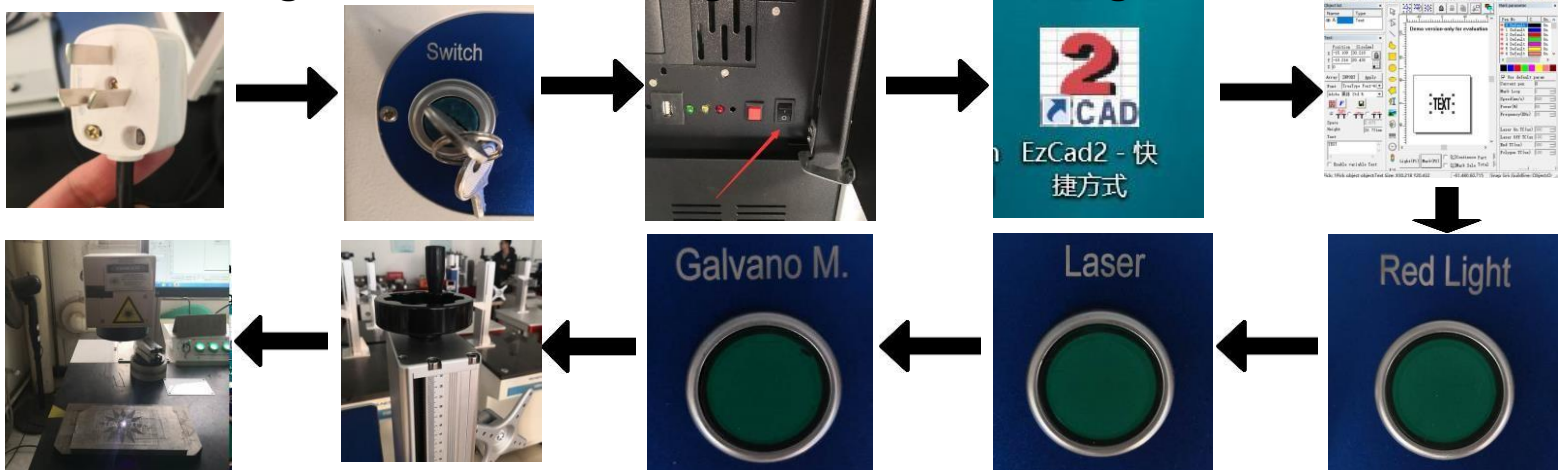




**Using Steps:**

- To Connect 220V/110V, 50HZ/60HZ electricity
- To Turn on Power Switch
- To Turn on Computer
- To Open EZCAD Marking Software in Computer
- To Type into words / text or insert drawing into software
- To Switch on Red Light to adjust the marking area in products
- To Turn on Laser
- To Turn on Galvanometer
- To adjust the focusing distance with up/down of lifting handle

**10.To get the exact focusing and do the marking work.**



## Section Four: Software Introduction and Setup

### 4.1 This software has the following main functions :

- Graphic patterns available to be processed by free design
  - Support TrueType font, JSF font, SHX font, dot matrix font (DMF), one dimensional bar code and two-dimensional bar code.
  - Flexible variable text processing. Real-time processing for characters or letters. Can read and write text files and Excel files directly and dynamically.
  - The text data can be read directly through serial interface.
  - Text data can be read directly through network port.
  - The function of automatically splitting the text can adapt to the complex processing situation.
  - The powerful node editing and graphic editing function can be used for curve welding, cutting and intersection operation.
1. Support up to 256 pens (layers) and can set different processing parameters for different objects
    - Compatible with common used image formats (BMP, JPG, GIF, TGA, PNG, TIF and etc.)
    - Compatible with common used vector graphics (AI, DXF, DST, PLT and etc.)
    - Commonly used image-processing functions (gray scale conversion, black-and-white image conversion, node processing, etc.). Can be processed with 256 levels of gray scale image processing
  2. Strong filling function, supporting ring shape filling
  3. Multiple control objects, users can freely control the interaction between the system and the external devices
    - Directly support G3 fiber laser source of SPI and the latest IPG\_YLP fiber laser source.
    - Support dynamic focusing (3 axis processing system)
    - A kind of open multilingual support function that can easily support the languages of all countries in the world

### 4.2 Interface description

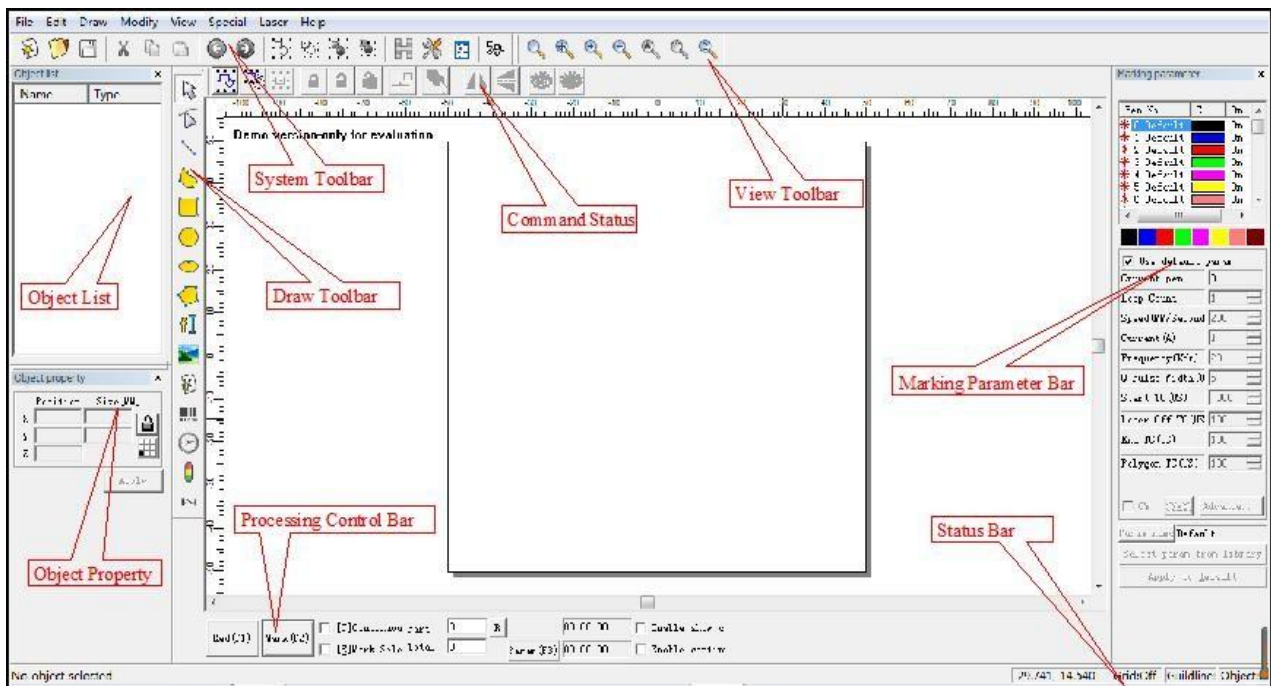
#### 2 Starting interface

When the program starts running, the startup interface is displayed (Figure 1-1), and the program initializes the operation in the back-end.

Home screen (Figure 1-2)



### 4.3 Parameter Adjustment (Figure 1-3)



The parameters to be adjusted: speed, power, and frequency

Speed: 1 - 12000mm/s (to be adjusted according to requested marking effects, slow down the speed while requesting depth or black color effect)

Power rate: 1% - 100% (the greater the percentage of the power rate, the deeper the marking depth, but for brand new machine, it is not encouraged to use 100% power rate directly at initial period).

Frequency: 20 - 100KHz (small frequency for marking depth effect), better default setting 20KHz

The reference range of in practical use for 20W laser marking machine: (Specific effects are subject to actual testing)	
Metal parts (steel / copper / aluminum) deep marking:	Speed: 100-300 Power rate: 60-90
Metal parts (steel / copper / aluminum) light marking:	Speed: 600-1500 Power rate: 20-40
Some non-metals (PVC/ABS)	Speed: 800-1500 Power rate: 1-30

**Please refer to Operation Manual of Software for more details.**

The practical operation of fiber laser marking machine:

2. The operator must be familiar with the basic knowledge of the machine tool's structure, performance, operating system, the function of each component, and usage.
3. Ensure power supply to be plugged in properly before the operation.
4. Switches: after checking the power supply, open the control switch; switch on the computer and every switch (laser source, Galvanometer, red light). Check whether all switches are in good order.
5. Edition: open the marking software, edit the content of marking; after editing, the marking content will be placed in the center position.
6. Marking operation:
  - (1) Put the work piece on the worktable.
  - (2) Testing operation: Before marking the work pieces, put an aluminum foil (a kind of meta sheet) above the marking position of the work piece, find out the focus and test the marking effect, after fixing the focus, put away the aluminum foil.
  - (3) Red light preview: Ensure red light in the correct marking position, if not, use keyboard ( up down left and right ) to control the movement of red frame, until fix the correct marking position (Note: only minor adjustment for red light, in case of much deviation from the marking position, please manually move the work piece position);
  - (4) Start marking operation after finding out the right position.
  - (5) Do not put hand at the focus point of marking.
  - (6) In case of marking machine being malfunction or abnormal, report the fault to maintenance personnel timely and fill out the daily maintenance records.
  - (7) After ending the marking work, clean the marking powder remains on the worktable and wipe equipment.

## **Section Five: Maintenance**

The fiber laser marking machine is mainly composed of electronic devices, precision instruments and optical devices. It has high requirements for the working environment and daily maintenance.

### **5.1 Precautions for the maintenance of the machine:**

1. Fiber laser source is the core component of the fiber laser marking machine. It is necessary to prevent the fiber from breaking off.
2. After finishing marking work, switch off the power supply of both the marking machine and the computer.
3. Keep the computer of the fiber laser marking machine to switch on/off in normal way to avoid the damage of hard disk and the loss of file.
4. If this machine is not in working status, cover the field lens to prevent dust pollution for optical lenses.
5. When the machine works, the circuit is in a high voltage state. Do not try to repair it at the state of powering on unless it is a professional person so as to avoid the electric

shock accident.

6. The power supply should be cut off immediately once there is any failure of the machine.
7. If the equipment is used for a long time, the dust in the air is adsorbed on the surface of lower end of lens. It may reduce power rate and influence marking effect. And what's worse is, it may cause optical lenses burst due to over temperature in the endothermic process. Therefore, when the marking effect is not good, it should be carefully checked on the surface of the focus lens to see if it has been contaminated.
8. In the working process, it is not allowed to move the marking machine in order to avoid damage to the machine.
9. Do not cover or heap other items on the marking machine so as not to affect its heat dissipation.
10. If the voltage is unstable, please install voltage regulator so as not to affect the marking effect.
11. Protection against moisture and water.
12. **Must install grounding wire.**

## 5.2 Common fault and elimination methods

For use or other reasons, the fiber laser marking machine may appear some fault(s).

For your timely diagnosing and solving some simple faults, we list some possible faults and the methods to solve for your reference as below.

Srl.No.	Common Faults	Fault Causes	Solutions
1	Power light indicator does not light.	No mains supply	
		Power line not connected	Connect power line
		Broken power indicator	Change the indicator
2	Laser indicator does not light.	Broken laser indicator	Change the indicator
3	Laser indicator lights but no laser output	The lens cover of the field lens is not removed off	Remove the lens cover
		Setting up too small power rate percentage	Raise the power rate percentage
4	Laser indicator does not light and no laser output	Signal connection line is not well connected	Reconnect the signal line
5	Laser output available but laser indicator does not light	Broken laser indicator	Change the indicator
		Loose weld laser	Weld the laser

		indicator	indicator properly again
6	Uneven marking lines	Work piece is not in focal plane	Place the work piece within the circle of focal plane
7	The marked words and graphics, some are clear, some not	The marking surface is not parallel to the field lens	Leveling off the marking surface