LFS–AM–T43 Live Focus System (Analog type)
Operation Manual

Model: LFS – AM – T43
Motion controller Version: RDC633XM-V6.32.6x
MetalCut Software Version: V1.00.13

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Safety

Live Focus System (LFS) is applied in laser processing machine. Laser protection is CLASS3 and CLASS4.

Please reference to GB7247.1-2001 and take some safety protection measures.

The following should be executed:

- Operation persons should wear protection glasses.
- Connected to the ground. A valid connection to ground should be done and the resistance should be less than 1 ohm. CNC machine tools, LFS, sensor shell and support plate should be stable grounding.
- Please do not try to disassemble the parts of LFS. Otherwise, the LFS will be fault.
- Laser beam nozzle and the LFS sensor are integrated design. When the LFS is working, please do not touch the sensor. Otherwise will cause damage to your body.
- When cutting glossy surface metal, please notice the reflect laser beams from the metal surface. Some protection measure should be taken to avoid the body to be damaged. Preventive measures should be taken and operate carefully, to prevent burn out parts by laser beam off center axis.
- Keep the sensor and nozzle clean. Avoid the cooling water, condensed water or other foreign matter flowing into sensor; otherwise the sensor will be fault. The laser power and other controllers should meet the EMC standard and should be connect to the ground reliably.
- Sensors and electrical cabinet parts must be grounding as requirements. Processed metal artifacts should be reliable grounding.
## Version Notes

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.2</td>
<td>2013/11/01</td>
<td>LFS manual</td>
</tr>
<tr>
<td>V1.8</td>
<td>2014/3/4</td>
<td>Correct the electric connections</td>
</tr>
</tbody>
</table>
Chapter 1 System Introduction

LFS-AM-T43 is working together with RDC633XM metal and nonmetal mixed cutting control system. Structure diagram is as shown in picture 1-1. The system mainly includes the following parts:

- motion controller, operation panel, and software
- LFS controller and sensor
- Laser head, step motor driver or servo motor, etc.
- Relay and gas valve of auxiliary gas switch
- Limit switches
- Origin switch (optional)
- Manual switch

Motion control system is mainly responsible for the whole metal cutting movement control, and external accessories motion control. LFS controls the laser head moving up and down automatically according to the focus distance from nozzle to metal surface, to ensure it is always focus on a fixed distance. Laser head is used to install the focus lens (long-focal length and short focal length), protect lens and air/water cooling systems. Auxiliary gases generally choose O2, N2, etc., which is depending on the laser types. The control card automatically controls the auxiliary gas by switches. Limit switch signal connected to the LFS to protect the motor movement, installed or not installed according to the requirements of the system. The origin switch is connected to the RDC633XM, when switching to manual operation, which is used to control the laser cutting head back to the origin which controlled by Z axis. The manual switch provides manual mode and auto mode for switchover. When in manual mode, the cutting head movement controlled by Z axis of the direction key control of control card; when in automatic mode, the cutting head movement is controlled by the LFS.

The computer controls RDC633XM and LFS-AM-T43 through running MetalCut mixed cutting software. The computer uses USB interface to connect the two modules. When running RDC633XM, control the LFS-AM-T43 system in real-time, and control the cutting head up and down according to the concave and convex extent of the metal surface.
Workflow of the mixed laser cutting system is as follows:

(1) **Power on Reset**

When power on reset, users can set RDC633XM to enable or prohibit the XYZ axis whether reset. The Z axis motor is controlled by the LFS and RDC633XM dual control. For the LFS, when initial power on, working in manual state, the Z axis motor controlled by card. If the user has enabled the Z axis power on reset, so the Z axis will execute reset operation when power on. The direction of the reset is negative limit direction, at this time must install the negative limit over the cutting head.

Limit switch is usually mechanical contact switch, and has normally open contact and normally close contact, normally open contacts connected to limit input terminal of the LFS, normally closed contacts connected to the limit input of RDC633XM. The upper limit of LFS and negative limit of RDC633XM are actually connected to the same limit switch normally open and normally closed contacts.

Then, if you enabled power on reset, the RDC633XM card will begin to lift the cutting head reset when power on, and meanwhile the X/Y-axis begin to reset operation.

(2) **Initial Tuning**

Before starting work, firstly, it must be LFS and amplifier tuning work to ensure that when the distance from the nozzle to metal plate is 1.1 mm, the analog voltage output of the amplifier is 5.5 V~6V. Then perform homing operation, to find the focus position exactly.
(3) Start a work  
When started working, the LFS drives the cutting head moving down, until reaching to the focus point, blowing auxiliary gas and punching hole, and a primitive cutting is executed, the auxiliary gas is closed. The laser head raises up to a position and jump to another primitive to start a new laser cutting process. When all the primitives are cut off, the laser head will be raised up to the highest position.

(4) Pause/continue  
When paused, controller will close blowing and rose up the laser head to the fixed position. When continue, the head position will not move (at high position) if the system is paused during following laser cutting state, system will move the head down to the focus position firstly and then cutting if it was paused in laser cutting processing.

(5) LFS test  
When installed, first of all, test the LFS and controller matching whether correct. Because there is difference between motor driver DIR signal and the motor actual moving direction, which will cause the moving direction reverse, so, before start working, the positive direction of LFS and cutting head moving positive direction should be matched.

Therefore, there is a test button on the operation panel of RDC633XM controller. When the RDC633XM is in idle and standby status, press button on the panel, the laser head should moving down, and blowing action started. Then press “,” again, laser head will be raise up and blowing stopped. If the control process is correct, then the system can work normally.
Chapter 2  Live Focus Controller

2.1 LFS Structure Diagrams

![LFS Structure Diagrams](image)

Picture2-1:  Structure Diagram of the LFS controller

2.2 Interface Description

2.2.1 CN1 is the analog amplifier interface.

Including non-contact capacitive sensor detection input interface, and temperature compensation input interface.

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>VCC</td>
<td>Amplifier power source</td>
<td>+12V output, drive ability above 200mA</td>
</tr>
<tr>
<td>PIN2</td>
<td>ALM</td>
<td>Crash alarm output</td>
<td>Output 0V when there is no alarm. Output 24V when there is alarm.</td>
</tr>
<tr>
<td>PIN3</td>
<td>CT</td>
<td>Capacitive sensor input</td>
<td>Input: 0~10V</td>
</tr>
<tr>
<td>PIN4</td>
<td>Ain</td>
<td>Analog detection input</td>
<td>Input: 0~5V</td>
</tr>
<tr>
<td>PIN5</td>
<td>NTC</td>
<td>Temperature detection input</td>
<td>Users temperature detection</td>
</tr>
<tr>
<td>PIN6</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
</tr>
</tbody>
</table>

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2.2.2 CN2 power input interface.

The LFS power input is +24V.

**Sheet 2-2 CN2 Interface Definition**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>+24V</td>
<td>LFS power source</td>
<td>+24V output, drive ability above 2A</td>
</tr>
<tr>
<td>PIN2</td>
<td>GND</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>PIN3</td>
<td>PGND</td>
<td>External shielded grounding</td>
<td>Generally connect to ground</td>
</tr>
</tbody>
</table>

2.2.3 CN3 Communication input & output Interface

**Sheet 2-3 CN3 Interface Definition**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>trace</td>
<td>Trace signal Input</td>
<td>When low level, the LFS will control the laser head to trace down. When high level or open, the LFS will rise up with laser head. The input interface receives the tracing signal from the motion controller.</td>
</tr>
<tr>
<td>PIN2</td>
<td>punch</td>
<td>Perforation signal input</td>
<td>Receives the perforation signal from the motion controller. The signal from motion controller, high level (+24V), which means the system is working.</td>
</tr>
<tr>
<td>PIN3</td>
<td>wrkOk</td>
<td>Working status indicator</td>
<td>Working status signal input. The signal comes from the motion controller, to indicate the current work finish or not. When finished, the LFS will move to the highest point.</td>
</tr>
<tr>
<td>PIN4</td>
<td>UpOk</td>
<td>Rising up in-position status</td>
<td></td>
</tr>
<tr>
<td>PIN5</td>
<td>DnOk</td>
<td>Going down in-position status</td>
<td></td>
</tr>
<tr>
<td>PIN6</td>
<td>AlmOut</td>
<td>Crash alarm output</td>
<td>When the laser head crash into the metal plate, the alarm signal output is 24V.</td>
</tr>
</tbody>
</table>
2.2.4 CN4 External Input Interface

### Sheet 2-4 CN4 Interface Definition

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>Lmt+</td>
<td>Upper limit switch input</td>
<td>Upper limit switch input. The NC contact of mechanical switch, one connects to ground and the other connects to the input pin. The polarity of the limit switch is negative, low level is effective.</td>
</tr>
<tr>
<td>PIN2</td>
<td>Lmt-</td>
<td>Lower limit switch input</td>
<td>Lower limit switch input. The NC contact of mechanical switch, one connects to ground and the other connects to the input pin. The polarity of the limit switch is negative, low level is effective.</td>
</tr>
<tr>
<td>PIN3</td>
<td>EmStp</td>
<td>Emergency stop input</td>
<td>Stop the LFS and send the protection signal to motion controller and stop the controller synchronously.</td>
</tr>
<tr>
<td>PIN4</td>
<td>FocSwt</td>
<td>Auto-searching focus input</td>
<td>Execute search focus point automatically. The following condition should be noticed: 1. Laser head is ready and not in the tracing status. 2. The system is idle 3. The motion controller is high level and idle.</td>
</tr>
<tr>
<td>PIN5</td>
<td>ModeSwt</td>
<td>Manual /Auto mode switch input</td>
<td>When 24V or open, the LFS is in the manual mode. Under the mode, the Z-axis motor is controlled by Z-axis control signal of the motion controller RDC633XM. When connecting to GND, 0V, the LFS is working in auto mode. The LFS controls the Z-axis motor.</td>
</tr>
<tr>
<td>PIN6</td>
<td>GND</td>
<td>GND</td>
<td></td>
</tr>
</tbody>
</table>

2.2.5 CN5 External output interface.

### Sheet 2-5 CN5 Interface Definition

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>LowO2</td>
<td>Low pressure O2 control</td>
<td>To control the relay to control the</td>
</tr>
</tbody>
</table>
## 2.2.6 CN6 External output interface

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>LMT+_OUT</td>
<td>Upper limit signal output</td>
<td>Low level output when triggered, when don’t trigger, high level output.</td>
</tr>
<tr>
<td>PIN2</td>
<td>LMT-_OUT</td>
<td>Lower limit signal output</td>
<td>Low level output when triggered, when don’t trigger, high level output.</td>
</tr>
<tr>
<td>PIN3</td>
<td>OUT0</td>
<td>Air switch controls signal output</td>
<td>To control the electromagnetic valve</td>
</tr>
<tr>
<td>PIN4</td>
<td>OUT1</td>
<td>RESERVED</td>
<td>Can control relay directly</td>
</tr>
<tr>
<td>PIN5</td>
<td>GND</td>
<td>GND</td>
<td></td>
</tr>
</tbody>
</table>

## 2.2.7 MOTOR Control Interface

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>DEFINITION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN1</td>
<td>GND</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>PIN2</td>
<td>ALM</td>
<td>Servo alarm INPUT</td>
<td>When 0V, servo alarm invalid.</td>
</tr>
<tr>
<td>PIN3</td>
<td>SON</td>
<td>Servo on output</td>
<td>When 0V, servo working</td>
</tr>
<tr>
<td>PIN4</td>
<td>A-</td>
<td>Encoder A-</td>
<td>Encoder input</td>
</tr>
<tr>
<td>PIN5</td>
<td>B-</td>
<td>Encoder B-</td>
<td>Encoder input</td>
</tr>
<tr>
<td>PIN6</td>
<td>C-</td>
<td>Encoder C-</td>
<td>Encoder input</td>
</tr>
<tr>
<td>PIN7</td>
<td>+5V</td>
<td>+5V output</td>
<td></td>
</tr>
</tbody>
</table>
2.2.8 SENSOR Motor Control Interface

The sensor interface is full-digital sensor data communication interface.

2.3 Indicator Description

<table>
<thead>
<tr>
<th>NAME</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVCC</td>
<td>24V power light</td>
</tr>
<tr>
<td>AlmOut</td>
<td>Crash alarm signal output, 24V output when crashed; Otherwise, 0V.</td>
</tr>
<tr>
<td>DnOk</td>
<td>Going down in-position output</td>
</tr>
<tr>
<td>UpOk</td>
<td>Rising up in-position output</td>
</tr>
<tr>
<td>WrkOk</td>
<td>Working condition input, the light turns off when finished, and turn on when in working.</td>
</tr>
<tr>
<td>Punch</td>
<td>Cutting indicator</td>
</tr>
<tr>
<td>Trace</td>
<td>Tracing signal input, the light turns on when tracing control, and turns off when rise up.</td>
</tr>
<tr>
<td>ModeSwt</td>
<td>Reserved</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>FocSwt</td>
<td>Reserved</td>
</tr>
<tr>
<td>EmStp</td>
<td>Emergency stop switch input, valid when connect to GND, and invalid when it is in air. The light turns on when press, and off when loosen.</td>
</tr>
<tr>
<td>Lmt-</td>
<td>connect to normally open contact, triggered when closed, the light turns on</td>
</tr>
<tr>
<td>Lmt+</td>
<td>connect to normally open contact, triggered when closed, the light turns on</td>
</tr>
<tr>
<td>Fault</td>
<td>System fault indicator, the light turns on when errors happened.</td>
</tr>
<tr>
<td>WrkSts</td>
<td>System working status output instruction, the light turns on the system working, and turns off when stopped.</td>
</tr>
<tr>
<td>ModeOut</td>
<td>Reserved</td>
</tr>
<tr>
<td>HighO2</td>
<td>High oxygen pressure output indicator, the light turns on when the relay working</td>
</tr>
<tr>
<td>LowO2</td>
<td>Low oxygen pressure output indicator, the light turns on when the relay working</td>
</tr>
<tr>
<td>Out</td>
<td>Reserved output</td>
</tr>
<tr>
<td>Air</td>
<td>Compressed air control output instruction, the light turns on when the relay working</td>
</tr>
<tr>
<td>LmtNO</td>
<td>Lower limit output instruction</td>
</tr>
<tr>
<td>LmtPO</td>
<td>Upper limit output instruction</td>
</tr>
<tr>
<td>Clr</td>
<td>Servo alarm clear output, using for servo driving, the light turns on when clearing.</td>
</tr>
<tr>
<td>SMode</td>
<td>Servo mode switch output status, using for servo driving, the light off when in position mode, the light on when in speed mode.</td>
</tr>
<tr>
<td>Alm</td>
<td>Servo alarm input, the light turns on when ALM working.</td>
</tr>
<tr>
<td>Son</td>
<td>Servo enable output status</td>
</tr>
<tr>
<td>DIR</td>
<td>Direction signal output instructions</td>
</tr>
<tr>
<td>PULSE</td>
<td>Pulse signal output instructions</td>
</tr>
<tr>
<td>System</td>
<td>System status instruction</td>
</tr>
<tr>
<td>Run</td>
<td>System running instruction</td>
</tr>
<tr>
<td>CRASH</td>
<td>Crash alarm instruction</td>
</tr>
<tr>
<td>Sts</td>
<td>Digital sensor status indicator</td>
</tr>
</tbody>
</table>
Chapter 3  Sensor and Amplifier

Capacitive sensor and amplifier are shown in below Picture 3-1, capacitive sensor and laser head integrated together and connected with amplifier through RF cable.

![Picture 3-1 capacitive sensor and amplifier](image)

3.1 Function

Capacitance sensor coordinates with many kinds of capacitive sensing heads, which can measure the physical quantities for relative capacitance change (distance, pressure, temperature, thickness, level, etc.) and adjust the sensitivity or measuring range. When sensing head touched with the measuring object, indicator lights flash (red light), and give crash alarm signal (+ 24V). Crashing signal occurred when the distance is less than 0.1 mm between head and the object to be measured. When the amplifier red indicator light turns on, the signal output is 24V, output 0V when there is no crashing occurs.

3.2 Working Principle

The capacitance sensor is to transform the capacitance change into electrical signal when the capacitive sensing head is working, to achieve the measurement of physical quantities (distance, pressure, temperature, thickness, level, etc.) by signal amplification, demodulation and filtering processing.

3.3 Technical Parameters

1. Power supply voltage: DC 24V ± 20%, ≥0.5 A, ripple wave noise < 100mVp-p
2. Interval setting range: 0.1⋯10 mm (diameter of the nozzle port is φ 5)
3. Measurement repeat accuracy: < ±0.05 mm
4. Temperature drift is less than 0.01 mm
5. Response time: < 2ms
5 core Ф 9 aviation connection plug provides power input and output;

Main electrical cabinet dimension: 43mm (length) x 50mm (width) x 20mm (height)

Working environment:
- Electrical cabinet working temperature: -40 ℃...60 ℃;
- Relative humidity < 80%;
- No strong electromagnetic interference;

Alarm protection and status output.

NOTICE:
Sensor measuring range is already set as 0.2~10mm before leaving factory.
Focus position defaults to 1.1 mm.
Chapter 4  LFS Controller

4.1 Function Description

LFS-AM-T43 LFS live focus control system is developed by RuiDa technology especially for metal and non-metal mixed cutting system, which uses all-digital control circuit and advanced software control algorithm, to achieve Z-axis focus control automatically and accurately.

Main functions:
- Can control step motor and servo motor, speed up to 200 mm/s.
- Crash alarm protection, double protections for LFS controller and RDC633XM
- Search the focus automatically
- Rising up and moving down speed can be set by software
- 3 rising position points, height can be set by user independently
- Special technology for punching, makes the system more stable
- Controller and LFS high-speed communication, no waiting time, improve the efficiency greatly
- Control the large torque stepper motor, can improve the response speed
- Optimized auxiliary gas blowing control which reduced the gas loss effectively. Dual-channel gas control output and applied to switching between metal cutting and non-metal cutting
- Upper/lower limit protection
- Manual/automatic switching function
- Software integrated LFS controller panel, to configure parameters more easily
- Set focus position by software.
- Temperature compensation function, ensuring the focus position keeps no drift if the cutting-head working for a long time.

4.2 Diagram of Connection

Connection between RDC633XM control card and LFS_AP01 is as shown in Picture 4-1.

Accessories listed as follow:
(1) RDC633XM and operation panel
(2) LFS_AP01 live focus controller
(3) Manual/Automatic mode switch
(4) 24V DC power supply, supply for board, height controller as well as external relay
(5) 36V DC power supply, supply for stepper motor drives independently
(6) 24V DC relay *4 pcs, one for controlling the pulse switching, the other two for control the AC electron magnetic valve of external blowing, the last one is for switching the motor control.
(7) Magnetic valve, magnetic valve, compressed air oxygen magnetic valve (low pressure and
(8) 2 pcs limit switches, with normally open and normally close contacts, connected to limit input of LFS controller to protect the Z axis; connect to RDC633XM to reset the adjustable axis. Installation position refer to Picture4-1
Picture 4-1 Connection Electrical Diagram under delayed-mode
Chapter 5  LFS Controller Working Process

5.1 Installation

Firstly, install capacitive sensor and amplifier correctly. Amplifier should be installed in one side of the cutting-head, and ensure BNC head connected with capacitance sensors reliably.

Then, connect the output signal of sensor amplifier to the interface of LFS controller. The connecting cable between sensor amplifier and LFS controller should be not too long, the standard cable length provided by RuiDa technology is 10 meters, if the user's machine do not need so long, to ensure the control precision they can remove part of it properly. Sensor amplifier should be installed near the head which is recommended, and to ensure that shielded cable connected between sensor and the amplifier is not affected by stress.

Finally, connect LFS and RDC633XM correctly according to the wiring instructions after the connection between LFS and controller.

5.2 System Running Test

The power indicator on the sensor amplifier will be on after the system “power on”, alarm indicator will not light, and touch the nozzle with a metal plate, crash indicator on the amplifier will be on. So that means the amplifier works normally.

Notice:

The initial parameter setting must be carried out before any operation. Setting principle is: first, the cutting head moves to the position where 1.1 mm distances from the metal plate. The method is: By default, switch to automatic mode, press homing focus button, the cutting head moving down; during moving down, switch to manual mode, the cutting head rising to the position of 1.1 mm away from metal plate, measuring the voltage between pin 1 and pin 32 in CON3 of EPLC, if the voltage is too high or too low, can adjust the potentiometer on amplifier to 6.0V. Then the system initial parameter setting is finished. Switch to automatic mode; carry out the auto-searching focus function again, after this step, the cutting-head stopped at the peak, and then all settings finished.

Before system test, should set the manual control parameter and Z-axis parameter reasonably.
The Z-axis parameter setting of "manufacturer parameter" of RDC633XM as follows:
  Direction polarity: positive
  Key motion direction: positive
  Step length: according to the screw lead and motor subdivision calculation (must set up the Z-axis step length correctly)
When finished, under manual mode, pressing Z+, the motor will rise up; pressing Z-, the laser
head will move down (Important: please make sure of this!!)

If move to opposite direction, you can exchange each other for A+ and A- motor wiring directly, which will change the rotating polarity of motor.

Notice:

If the user uses hard limit, and the limit switch connect to the normally closed contact, you should set the polarity of hard limit as positive, otherwise it will cause the Z-axis can't move manually. In addition, if the user set the Z-axis power on but not reset, so should set a larger value for the breadth of Z-axis; if set the Z-axis “start up” but not reset, XY finished resetting, the operation panel will display the current coordinate is 3000mm; if set “start up” and reset, operation panel will display 0, the breadth setting could be set as normal.

The system focus position defaults to 1.1mm. Jump height is 10mm, crash alarm height is 20mm, and work-finished height is 40 mm.

Motor pulse count is set to 4000 pulses/roll, the lead screw is 4 mm.

(1) Before power on, please make sure that the limit switch connects to Z-axis, and normally open contact of mechanical switch already connects to the limit input of LFS, and its normally-closed contact already connects to limit input of RDC633XM controller, the upper limit of LFS corresponding to the negative limit of RDC633XM controller. In addition, confirm the switch be “Manual mode”

(2) Set the step as 0.001 mm/pulse when screw lead is 4 mm and motor PPR is 4000. The parameter should be modified according to different configuration.

(3) RDC633XM power on, if Z-axis power on and reset, Z-axis will reset and rise up until touch the upper limit switch, so a reset operation is completed. Reset finished, the coordinate is 0. If the power on but does not reset, the XY-axis reset but Z-axis keeps still when power on.

(4) When the XY-axis reset, if user installed Z-axis limit switch on the uplift direction, you can carry on a reset operation, Z-axis move to negative limit direction. The reset point position is the original position of Z-axis. You can control Z-axis motion by press Z+,Z- on the operation interface by this time.

(5) Set up the working area of Z-axis according to Z-axis stroke, so make sure there is no crash when Z-axis in manual mode because of the working area limited.

(6) Do one Z-axis reset process independently, Z-axis can reset correctly. When finished, move Z-axis to proper position manually.

If Z-axis limit switch is not installed or limit signal does not connect to Z axis limit input of RDC633XG, then Z-axis can’t reset, which will lead to crash.

(7) Switch to automatic mode, the LFS begin to control the motor of cutting head.

(8) Must do initial tuning of the amplifier before debugging LFS control, that means cutting head moves down to the position which the distance from nozzle to metal plate is 1.1mm, adjust the amplifier output voltage is 6V.

(9) Must do auto-searching focus operation (Note 2) after initial tuning by press the
"auto-search focus" button which uses normally open mode. After press the button, laser cutting head moves down to the metal surface slowly until touch the surface slightly, then move to the focus position reversely and move away from metal surface after stopped about 1s and stay at the highest point of LFS.

(10) The LFS controller is in standby state after auto-searching the focus.

(11) Press button " ." on the panel, the cutting head will move down and tracing, focus position is 1.1 mm. Press the button "." again, the head rises up to 10 mm, this position is the uplifting height for LFS controller during cutting.

(12) If the focus position is incorrect after testing, you can re-set the focus position by the software.

All above steps have been finished, the LFS can work normally.

Note1:
If Z axis power on reset is not executed, press Z+ and Z-, the Z-axis will be move as well, but the Z-axis motion will not be limited by working area. If Z-axis does not reset, the initial coordinate position is defaulted to 3000mm. So the Z- stroke is 3000mm, but the stroke of Z+ is limited by the machine work area.

Note2: An auto-searching operation must be executed under the following conditions:
(1) Power on for the first time after machine assembled
(2) Laser head has been working for a long time or metal dregs on the nozzle or ablation.
(3) Changed the parts of the LFS, such as nozzle, sensor, amplifier etc
(4) LFS motor fault occurs after the cable disconnection
(5) Significant changes have taken place in external environment temperature and humidity

5.3 Auto-searching Focus

The LFS controller can search focus position automatically. When the system is idle, pressing the “auto-searching focus position” button, an automatically searching focus point is executed. LFS controller will control the laser head to move down to the metal surface slowly. When the distance between nozzle and the metal surface is less than 0.1 mm, the crash alarm indicator led will be turn on and the LFS will stop the motion of the laser head. Then move to the reverse direction to reach to the focus point. Staying about 1 second and move to the highest point fast. So the LFS is ready.

Auto-searching focus function includes auto-searching surface and move to the focus position automatically. This function mainly used in the movement caused by change of working time and temperature.

During auto-searching process, the LFS will not response any commands from external until finish the process; meanwhile the focus position is revised.

5.4 Focus Setting

The focus position can be set up by the software RD_Tracer. The focus position height is from
0.5mm to 4mm. When the focus position has been set up, the machine must carry out one auto-searching process, and then this focus position will be effective. The auto-searching focus point operation must be executed for every time when revised.

5.5 System Running

Before LFS running, the parameter of RDC633XM must be set up correctly. The details as follows:

5.5.1 Manufacture parameters

The tracing control parameters include rise-up-in-position detection and move-down-in-position detection, showed in Picture 5-1, and the LFS type is “common”.

![Vendor tools](image)

Picture 5-1 LFS Control Parameter Configuration

5.5.2 Process parameters setting

Process parameters include punching parameters setting and micro-linking parameters. As shown in Picture 5-2.
RDC633XM controller supports continuous punching mode and pulse punching mode, punching mode can be set up in the user parameters.

If the pulse punching enable is banned, the current punching mode is continuous punch; the laser will be emitted continuously for a period of time at the first point and then began to cut. The punching time is decided by the following factor: the times of first point punching (n) and single punching time (Ton).

Punching time = n*Ton

The punching time is generally set as 1, single punching time is the punch time which needed.

Pulse punching mode is always applied to the thick metal plate cutting and scribing. If the pulse punching mode is permitted, as the following picture shows: the times of first point punching is 4, single punching time is Ton, and the punching pause time is Toff.

The manufacture parameters, user parameters and process parameters are set up, so that the machine can start to cut normally. Special remarks: Please set up the punching power independently when punching, which can be set according to process requirement by users.

The layer parameter contains automatic judgment of micro-linking settings and the max. micro-linking distance. If using the automatic judgment of micro-linking and set the maximum micro-linking distance (supposed to 2mm), laser head will not rise up when the jump length is below the maximum micro-linking distance; on the contrary, the laser head will rise and start cutting, which can improve the cutting efficiency.
5.6 LFS Control Interface

LFS controller Parameters is setting up by USB. Please install the USB drivers correctly, the EPLC driver will be showed in Device Manager in the windows operation system.

After installing the USB driver, the LFS software should be installed. The software named RD_Tracer in the CD. The interface of the software is shown as picture 5-3. After installation, the LFS parameter settings as follow: open software initially → press “Open USB” → press "read parameters". If does not open USB or open USB failed, you cannot read and write parameters. Only reading parameters completed, write parameters button is valid, the user can write parameters. Click “Open USB” which displays the interface as Picture5-3. If there is no error, which means the LFS and the PC communicated successfully. Click on the "Read" to get the parameters of the LFS controller. Click "Write" to write parameters to LFS memory.

Note:
Make sure the LFS is idle (the laser cutting finished or paused), and then switch to Manual mode; finally, read or write operation is permitted.

Parameters including:

- Controls parameter (Filter parameter 1, Filter parameter2, Filter parameter3);
The initial value is defaulted as 100.0.0.0.0 (Do not recommend to modify). The parameters will affect the sensibility of live focus control. If improper setting, the LFS will be vibrating and shaking.

- **Height for jump**
  When starting a cutting task, laser head will jump from a vector to another vector. The height is the rising up height when jumping. Usually the value is set to be less than 10mm, default as 10 mm.

- **Height for crash alarm**
  When the laser head has crashed to the metal surface, the LFS will rise up the laser head to prevent the laser head from damage. The rising up height is the value. 20mm is the default value.

- **Height for finishing work**
  When cutting finished, the laser head should stay a higher position. The value is 40mm in default.

- **Focus position**
  Focus position is the height from the metal surface to the nozzle.

- **LFS step distance**
  There are two methods to set up the proper step distance:
  1. Calculation: if the screw pitch is 5mm, the subdivs of stepper motor is 4000, so step distance is 5/4000=0.00125 mm/pulse.
  2. Measurement: switch to Manual mode, measuring Z-axis of RDC633XM, moving a distance on Z-axis, then measure the actual distance of the movement, calculated by PC software, then set the value as step distance parameter through LFS setting software.

- **Maximum Velocity**
  The parameter is the maximum velocity of the frequency of the LFS when Z-axis doing tracing movement during motion control. If the step motor lose step, the value should be decreased.

- **Auto-searching focus velocity**
  During auto-searching focus point, the laser head moves down to metal surface with this velocity. The value is generally from 1mm/s to 5mm/s. 3mm/s is the default value.

- **Motor polarity**
  The parameter is to set up the motor moving direction. When the laser cutting head rises up during auto-searching focus, the parameter should be modified to ensure that that laser head move down to the metal surface. The default motor polarity is negative. There is another way to modify the polarity. To exchange the polarity of motor phase winding, that is, the A+ and A- can be exchanged to change the moving direction.

- **Limit enable and the limit switch polarity**
  There are negative and positive limit inputs for protecting laser head during motion. If the limit is enabled and limit polarity correctly, the LFS will protect the laser head automatically. During tracing, the laser cutting head touched the lower limit; the laser head will rise up to a
safe position. During rising up, if the upper limit is touched, the motor will stop motion immediately.

If the limit switch is normally open, one terminal connects to GND, the other terminal connects to limit input of LFS, so limit polarity should be set to negative.

Once the limit triggered, the DrProc PIN of RDC633XM is valid, the system will stop XY-axis movement, and the operation panel will display the warning of “the machine is protected”.

Notice: There are interfaces to connect upper limit and lower limit of LFS adjustment axis. The LFS can protect the cutting head in manual mode automatically, to use mechanical switch to be installed as limit switch generally which with normally open and normally closed contactors. The NO contactor connects to LFS limit input. And the NC contactor connects to Z-axis limit input of RDC633XM, and enable the hard limit protect, so the laser cutting head on the Z axis can be protected completely.

- Crash alarm

If crash alarm is enabled, laser head will rise up to a safety height when the laser head touches the metal surface. If the cash alarm is banned, the crash alarm input will be neglected.

When crash alarm happened, the machine should stop motion. So the crash alarm signal should connect to machine protect input on the RDC633XM. So when the crash alarm happened, the protection is valid and RDC633XM will stop the motion and give the information to the panel which displays “machine is protected”.

In order to realize the function, the parameter in the vendor parameter should be set, which shown as the following picture.
- **Blowing Channels**
  The LFS supplies 2 channels IO to control auxiliary gas relay. One is for O2 control in metal cutting; the other is for auxiliary compressed gas control in non-metal cutting.

  The parameter is 1, only one channel blowing signal is available, that is O2 control channel. When cutting non-metal in Manual mode, 1\textsuperscript{st} channel output relay closed, compressed gas will blowing; when switch to metal cutting in Auto mode, 1\textsuperscript{st} output relay switch controlled by LFS.

  The parameter is 2, the 2\textsuperscript{nd} channel relay closed to control the compressed air valve conducting when non-metal cutting in Manual mode. When switch to metal cutting in Auto mode, the LFS will close the 2\textsuperscript{nd} channel control output firstly, to make the 1\textsuperscript{st} channel output under control.

- **Low Pressure Punching**
  This option is used to set whether to do low pressure oxygen punching operation or not. If “YES”, the block will automatically control low pressure oxygen output in laser punching process, in order to prevent the cutting small graphics of the blasting hole. In the normal cutting, switch to the high pressure oxygen status automatically. If you want to achieve this function, the output of the oxygen tank must be two channels, a channel to increase the pressure of reducing valve of low pressure oxygen output, the other channel for normal oxygen output, at the same time the two channels are controlled by independent solenoid valves.

  Open the interface, firstly, click "open USB", if the USB connection is correct, only "read parameters" button is enabled, the user can read parameters. Only read the parameters, "write parameters" has been enabled. See picture 5-4.
Once the system is properly connected, you can press the "read parameters" to get the inside parameters of LFS. If need to modify a certain parameter, then click directly on the entry, you should click "write parameters" when finished modify. When the progress bar disappears, the parameters are written into system. The setting parameters have a size limit, too large and too small parameter will automatically be forbidden, so please set up reasonable parameters.

**NOTICE:**

- During LFS motion & auto-searching focus process, the writing and reading parameter are forbidden. Before reading and writing parameters, the manual/automatic switch should be set to be manual mode. When finished parameter reading and writing, switch to automatic mode.

- During LFS motion, auto-searching focus cannot work.

- If the focus position is modified with RD_Tracer, auto-searching must be executed to take effect.
Chapter 6  Wiring Diagram

6.1 Cutting head drive motor control circuit diagram

Cutting head driving motor is used to drive the laser head moving up and down. Mixed cutting system can apply to metal and non-metal cutting. Z-axis motor is controlled by ePLC when metal cutting. For non-metal cutting, Z-axis motor is controlled by RDC633XM. There is a relay to switch the signals between LFS and RDC633XM. The cutting head control signal comes from ePLC when metal cutting, and when cutting non-metal the control signal from Z-axis of RDC633XM.

The manual/auto switch relay is controlled by CN5 (ModOut) of ePLC. The output is controlled by the input CN4-PIN5. When it connects to OGROUND, which is valid for metal cutting. When it is NC, which is valid for non-metal cutting. The diagram is shown as Picture 6-1.

![Motor wiring diagram](image)

**Notes:**
The selection of motor control parameters:
- Motor model: 42HS08 (v2.0)
- Driver model: DM556 (customized)
- PPR: 4000 pulse/rt
- Peak current: 2.1A; average current: 1.5A
- The dial-up switch is set as follows; the red part is dial-up position:
6.2 Auxiliary gas control diagram

The auxiliary gas of mixed cutting system includes: 1. Blowing compressed air when cutting non-metal materials; 2. Blowing O2 when cutting metal materials.

When execute a non-metal cutting task, the operation mode should be switched to manual mode firstly. So the compressed air channel is enabled and the O2 valve is shut off. When start cutting, the compressed air electro-magnetic valve is opened. When finished cutting, the valve will be shut off. When execute metal cutting, the LFS has two IO to control the 2 electro-magnetic valves. One is for low pressure O2 and the other is for high pressure O2.

**CN5-PIN1 connects to low pressure gas relay for punching, CN5-PIN2 connects to high pressure gas relay for cutting.**

*If only choose 1 channel O2, cutting and punching use the same gas pressure, and connect the electromagnetic valves to CN5-PIN2. And the auxiliary gas should be set to be 1 and the low pressure punch enable should be set to NO, shown as below:*

The auxiliary gas control table is shown as follows:

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>value</th>
<th>mode</th>
<th>air</th>
<th>High pressure O2</th>
<th>Low pressure O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary gas</td>
<td>1</td>
<td>Manual</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>NO</td>
<td>AUTO</td>
<td>O2 high pressure is valid when punching and cutting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary gas</td>
<td>1</td>
<td>MANU</td>
<td>CLOSE</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>YES</td>
<td>Manual</td>
<td>O2 high pressure is open when cutting O2 low pressure is open when punching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary gas</td>
<td>2</td>
<td>Manual</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>NO</td>
<td>AUTO</td>
<td>O2 high pressure is open during punching and cutting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary gas</td>
<td>2</td>
<td>Manual</td>
<td>OPEN</td>
<td>CLOSE</td>
<td>CLOSE</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>YES</td>
<td>AUTO</td>
<td>O2 high pressure is open when cutting O2 low pressure is open when punching</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There are 2 methods to handle the auxiliary gas.

**Method 1:**

**Parameter configuration:**

- **Auxiliary gas channels:** 2
- **Low pressure punch gas enable:** yes, and increase one low pressure control relay

Compressed air conducts through the electromagnetic valve and the main gas circuit. Oxygen channel was divided into two branches, one is high pressure oxygen channel, the other is low pressure oxygen channel, and the two channels connect through the electromagnetic valve and the main gas circuit respectively.

When cutting non-metal, air channel conducted, the two electromagnetic valves of oxygen closed at the same time. When cutting metal, shut off the air channel, and the oxygen channels connected to the main gas circuit, the controller switching between high pressure and low pressure oxygen automatically according to the cutting and punching operation.

Note: air channel conduction and shut-off can be manual switch valve, also can through the electromagnetic valve, using manual rotary switch valve, which can save a relay and a electromagnetic valve, save hardware cost.

When auto/manual switch is set to manual mode, it is for non-metal cutting mode, high pressure O2 controls CN5-PIN2 (HignO2), low pressure O2 controls CN5-PIN1 (LowO2), high level output, the connected relay is switch off, O2 control valve closed. Then compressed air controls CN6-PIN3 (OUT0) will output low level, the connected relay is closed, compressed air output to tee joint. Compressed air blows into the laser head for non-metal cutting.

When automatic/manual switch is set to automatic mode, it is for metal cutting mode, CN6-PIN3 (OUT0) output high level, the relay is switch off, compressed air control valve closed, then the high & low pressure O2 electromagnetic valve under control, when punching, the CN5-PIN2 (HignO2) high pressure valve closed, CN5-PIN1 (LowO2) is open; when punching finished, low pressure O2 valve CN5-PIN1 (LowO2) closed, high pressure O2 CN5-PIN2 (HignO2) open, and start to cut.
The parameter for Method 1 is shown as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>value</th>
<th>mode</th>
<th>air</th>
<th>O2 high pressure</th>
<th>O2 low pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary gas</td>
<td>2</td>
<td>Manual</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>NO</td>
<td>Auto</td>
<td>O2 high pressure is open when punching and cutting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary gas</td>
<td>2</td>
<td>Manual</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>YES</td>
<td>Auto</td>
<td>O2 high pressure is open when cutting</td>
<td>O2 low pressure is open when punching</td>
<td></td>
</tr>
</tbody>
</table>

**Method 2:**

Method 2 is simple and economical, as shown in the Figure 6-3 below. Auxiliary air only uses 2 valves. Gas supply must be replaced manually in the switch process of metal cutting and non-metal cutting. Gas pipeline must connect to compressed air manually for non-metal cutting. And gas pipeline must connect to oxygen pipeline manually for metal cutting.

When switching to automatic mode to cut metal, O2 gas is controlled by LFS controller. O2 is closed when the laser head rising up. The O2 will blow when the laser head move down to the focus position. When punching, the O2 switch to high pressure automatically until finished task.

While switching to manual mode to cut non-metal, CON0-PIN10 (OUT2), CN0-PIN 12 (OUT4) output in vain, the 2 valves are closed, the main gas circuit connects to compressed air.
Switching from manual mode to automatic mode, must connect the O2 channel with gas supply, the switchover controlled by EPLC.

![Diagram showing gas control system](image)

**Picture 6-3 Auxiliary gas control wiring diagram (Method 2)**

The parameter for the Method 2 is shown as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>value</th>
<th>mode</th>
<th>air</th>
<th>O2 high pressure</th>
<th>O2 low pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary gas</td>
<td>1</td>
<td>Manual</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>NO</td>
<td>Auto</td>
<td>O2 high pressure is open during Punching and cutting</td>
<td>O2 low pressure is open during punching</td>
<td></td>
</tr>
<tr>
<td>Auxiliary gas</td>
<td>1</td>
<td>Manual</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Punch gas enable</td>
<td>YES</td>
<td>Auto</td>
<td>O2 high pressure is open during cutting</td>
<td>O2 low pressure is open during punching</td>
<td></td>
</tr>
</tbody>
</table>
6.3 Manual/Automatic Mode Circuit & Auto-searching Focus Circuit

6.3.1 Manual/automatic mode switchover

This is for non-metal and metal mode switch control. Manual mode is for non-metal cutting mode, Automatic mode is for metal cutting mode.

The manual/automatic switch should choose locked switch with good quality. When in manual mode, the laser head is controlled by Z-axis of RDC633XM. Press Z+ and Z- to move the laser head. When in automatic mode, the laser head is controlled by the LFS, which adjust the position of the cutting head automatically according to the sensing detection of the height of metal plate surface to make the focus position of the cutting head at a fixed altitude all the time.

Auxiliary gas control is different for manual mode and automatic mode.

![Manual/automatic switch properties](image)

<table>
<thead>
<tr>
<th>Manual/automatic mode switchover</th>
<th>LFS-CN4 PIN5 ModeSwit</th>
<th>LFS-CN4 PIN6 GND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-searching focus button</td>
<td>LFS-CN4 PIN4 FocSwt</td>
<td>LFS-CN4 PIN6 GND</td>
</tr>
</tbody>
</table>

Picture 6-4 Manual switch and auto-searching focus diagram

*NOTICE:* Manual mode is for non-metal cutting and automatic mode is for metal cutting.

6.3.2 Auto-searching Focus Control

The auto-searching button is for the laser head to find the focus point. When power on for the first installation or replaced some parts of LFS, the auto-searching process should be executed.

The auto-searching focus is the switch without self-lock. The LFS just capture button touch point contact, will perform auto-searching focus operation: cutting head move down at a slower speed (touch plate speed can be set up, it is recommended that at a relatively low speed), until touch the panel, and then back to the focus position and the highest position.

6.4 Live Focusing Control Diagram

The LFS control circuit is mainly to complete the connection between the LFS and control card. After connected, control card can communicate with LFS actively, so as to control the cutting head automatically.
The wiring diagram between LFS and the RDC633XM, see Picture 6-5.

**Notice:** Yellow shaded part, if uses the delay mode, there is no need to connect. If uses in-position mode, you must connect it.

### 6.5 Limit and Alarm Diagram

When laser head touches the upper limit, the laser head will stop motion immediately. If the laser head touches the lower limit, the laser head will rise up to a safe position away from the metal plate.

The limit switch connects to normally open contact. See Picture6-6:

**NOTICE:**

Limit input can be enabled or disabled. When limit is disabled, the laser head will neglects the status of the limits. The laser head will not be protected.
The above wiring diagram means the limit switch is valid when it connects to ground. So in the RD_Tracer, the polarity of active level of the limit switch must be set to be negative.

System defaults limit switch level to low level effectively, normally open contact of mechanical switch connects to limit input of LFS, and set the limit for negative polarity.

In addition, Z-axis controls cutting head in manual mode, so it must add limit protection. The normally closed contact of mechanical switch connects to Z-axis limit of RDC633XM, making the hard limit protection. At this time must modify the limit to positive polarity. After connecting the limit of Z-axis in manual mode, you can perform reset operation of Z-axis.

### 6.6 Sensor and amplifier diagram

The power for amplifier is +24VDC, which can be connected to sensor of LFS directly. When power on, the power supply indicator turns on. See as picture 6-7

The detection range of display window is 0 ~ 10, normal work is usually between 5 ~ 9. the display window is 0 when crashed. Connection between sensor amplifier and LFS controller as shown below:
6.7 Controller, LFS and Amplifier Power Circuit

The power for LFS, amplifier and RDC633XM is 24VDC. The power for motor driver is 36VDC.

6.8 Matters need attention for System installation

When install the amplifier to the laser head, the shell of amplifier must be conducted with sensor shell and in conducting state. See picture 6-10.

Due to the cutting head surface with oxidation treatment, which may cause external contact resistance of the amplifier and cutting head is very big, and so that cannot be shared ground. So when installing amplifier, try to remove the blue oxide layer of installation position to contact ground reliable.

In addition, for the placement of the metal plate cutting, cutting plate should contact the machine effectively, the impedance is zero. The metal plate cannot be N.C.. Otherwise it will affect the detection
effect of capacitance sensor.

Notes: Recommending that use a wire to connect the shell of amplifier to the machine!
Chapter 7  Usual Fault & Disposing Method

The LFS system has high precision capacitive sensor with high sensitivity, which is a sophisticated sensing and detection system, the surrounding environment of temperature and humidity has a certain influence on the performance of the sensor, especially the humidity, which will influence on the capacitive sensor greatly. So must ensure the sensor part of cutting head is dry, no moisture.

<table>
<thead>
<tr>
<th>Common Fault Phenomenon</th>
<th>Reason</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press “Auto-searching focus “button, laser cutting head moving down slowly, when touch the metal plate stay on the focus position. No need to rise up.</td>
<td>1. The step motor loses steps.</td>
<td>1. Decrease the rising velocity, testing at speed with 20mm/s.</td>
</tr>
<tr>
<td></td>
<td>2. DIR signal of motor control is not connected.</td>
<td>2. Check the electrical wire is connected correctly</td>
</tr>
<tr>
<td>Auto-searching focus is right, but press test button “.”, the laser cutting head moves down very slowly</td>
<td>1. The problem of detection sensitivity of sensor.</td>
<td>Switch to Manual mode, press “Auto-searching focus “button, the laser cutting head moves down and touch the metal plate and then rise up to focus position. Make sure the distance between the nozzle and the metal plate is 1.1mm, rotating the potentiometer on the LFS amplifier to be 5~6V.</td>
</tr>
<tr>
<td>Auto-searching focus is right. Press “.”, the laser head does not move down. Press “.” again, the laser head rise up. Press again and again, the laser cutting head always rise up</td>
<td>Detection sensitivity of sensor is over range.</td>
<td>Test focus position (1.1mm), rotating the potentiometer on the LFS amplifier to be 5~6V.</td>
</tr>
<tr>
<td>When power on, the laser head rising up all the time, switch to the manual mode, which can control the motor. When switch to auto-mode again, the laser head rise up again.</td>
<td>Lower limit signal is always valid and triggered all the time or the crash alarm is always valid and triggered all the time.</td>
<td>Firstly disable the crash alarm and limit alarm by RD_Tracer. If the fault disappeared, please check the limit and crash alarm. To make sure that the polarity matches the limit switch.</td>
</tr>
<tr>
<td>Laser cutting head cannot work normally, sometimes can move down, and sometimes cannot.</td>
<td>Wiring error or sensor damaged.</td>
<td></td>
</tr>
<tr>
<td>Laser cutting head cannot work normally, the work led indicator</td>
<td>The machine does not contact to ground reliable.</td>
<td>Please make sure that the machine has a good connection to ground.</td>
</tr>
</tbody>
</table>
### Laser Cutting Head Movement Issues

<table>
<thead>
<tr>
<th>Issue Description</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser cutting head tracing the focus but vibration is serious</td>
<td>Wrong grounding mode.</td>
<td>Make sure that the aluminum shell of amplifier and cutting head is well connected to the machine body.</td>
</tr>
<tr>
<td>Laser head no movement, but motor works.</td>
<td>The step motor loses steps.</td>
<td>Reduce the maximum speed properly and test again.</td>
</tr>
<tr>
<td>Pressing auto-searching focus button, laser cutting head rising up with velocity</td>
<td>Motor polarity setting is wrong</td>
<td>Change the polarity of the motor direction via RD_Tracer.</td>
</tr>
<tr>
<td>When in Auto-searching focus processing or tracing, laser cutting head moves down</td>
<td>1. Sensor or amplifier fault</td>
<td>Firstly, contact the cutting head with a metal object, observe the crash alarm indicator light and the amplifier indicator will be on.</td>
</tr>
<tr>
<td>1. Crash alarm wiring wrong</td>
<td>2. Crash alarm wiring wrong</td>
<td>If turn on, it’s not sensor problem. If turn off, it’s the sensor problem.</td>
</tr>
<tr>
<td>3. Detected metal plate does not connect to grounding and machine very well</td>
<td></td>
<td>Then, check the wiring and grounding problem.</td>
</tr>
<tr>
<td>After connected, pressing “Auto-searching focus” button, laser head rises up all</td>
<td>Wrong motor polarity setting</td>
<td>If in auto-searching focus process, the cutting head motion direction and the touch panel in the opposite direction, need to modify</td>
</tr>
<tr>
<td>the time</td>
<td></td>
<td>the motor polarity. The Parameter settings please refer to the LFS parameters setting in the software.</td>
</tr>
<tr>
<td>After long time working, cutting head vibration is serious when tracing</td>
<td>Capacitance sensor parameters changed. Need to recalibrate capacitance sensor and amplifier.</td>
<td>After working for long hours, the cutting head nozzle is dirty and capacitance sensor's structure has changed, causing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the characteristics of capacitance sensor has changed, which will cause this kind of situation, at this point you need to do</td>
</tr>
<tr>
<td></td>
<td></td>
<td>original calibration. That means, keep away from metal plate at 1.1 mm (the cutting head in a stable state), to adjust</td>
</tr>
<tr>
<td></td>
<td></td>
<td>potentiometer knobs on the amplifier, observe the display window, set as 5 V~ 6 V, and then finish one auto-searching focus process</td>
</tr>
<tr>
<td>Switch to manual mode, pressing Z+ and Z-, the motor does not move</td>
<td>1. Relay does not work</td>
<td>1. Press the selector switch; observe the relay contact is correct and, if</td>
</tr>
<tr>
<td></td>
<td>2. Z-axis hard limit enable</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>move</th>
<th>or the polarity setting is wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3. Z-axis working area setting is too small</td>
</tr>
<tr>
<td></td>
<td>4. Z-axis motion mode setting is inching mode, and the inching distance is too small</td>
</tr>
<tr>
<td></td>
<td>the contact point switchover is normal, that shows the switching function is normal.</td>
</tr>
<tr>
<td></td>
<td>2. Testing enabled hard limit, if ok, which means the limit polarity is incorrect.</td>
</tr>
<tr>
<td></td>
<td>3. Z-axis working area can be set a larger value, such as 10000.</td>
</tr>
<tr>
<td></td>
<td>4. Set up the motion mode as continuous motion (the inching distance is 0), to test the motion whether normal or not.</td>
</tr>
</tbody>
</table>
Chapter 8  Man-machine Operation Panel

8.1 Operation panel Introduction

Touch screen is mainly used for displaying working status and setting parameters of the LFS. When the system working normally, touch screen displays the main screen, which shows the system status, alarm status, focus position, tracing velocity and other information. On the main screen, press “Menu” button to set parameters and management. “Reset” button can do reset operation of the laser cutting head when tracing closed. In addition to the “Menu”, “Reset” button, other displaying on the main screen is status or information display, which cannot be operated. See Figure 8-1.

Figure 8-1 Main screen

8.2 Operation panel Connection

LFS interface as Figure 8-2 shown.

```
<table>
<thead>
<tr>
<th></th>
<th>TXD</th>
<th>RXD</th>
<th>GND</th>
<th>VCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>
```

Figure 8-2 LFS interface
Touch screen interface shown in Figure 8-3.

<table>
<thead>
<tr>
<th>GND</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>TXD</td>
<td>T</td>
</tr>
<tr>
<td>RXD</td>
<td>R</td>
</tr>
<tr>
<td>VCC</td>
<td>V</td>
</tr>
</tbody>
</table>

Figure 8-3 Touch screen interface

The data exchange between LFS controller and touch screen via serial communication, LFS controller RXD pin connected to touch screen TXD pin. LFS controller TXD pin connected to touch screen RXD pin. GND pin connected to GND pin. VCC pin connected to VCC pin, other pins no need to connect. It has been equipped with the connection cable, the standard cable length is 1.5 m.

LFS controller and touch screen has been connected properly; touch screen will enter into the main screen when power on. If an error occurs, it says "unable to connect", user need to check the wiring connection.

8.3 Operation Introduction

1) Function Buttons
   ◆ Menu
      Press this button to enter into the menu, to modify the LFS parameters.
   ◆ Reset
      When the follow disable, press this button which can reset the laser cutting head.

2) System status display
   System status display including: the follow Enable/Disable, collision protection Enable/Disable, limit protection Enable/Disable, status of the laser head and alarm status.
   Cutting head status: including Idle, Alarm Elevation, Down, Rising, Resetting and Auto-searching Focus, the status will be changed depending on the state of the system.
   Alarm status: including normal system, upper limit triggered, lower limit triggered, reset error, crash alarm and other errors.
      ◆ Normal: display the system is in “normal operation”;
      ◆ Upper Limit Triggered: the limit is enable when the upper limit switch is triggered, it will display “the upper limit triggered”;
      ◆ Lower Limit Triggered: the limit is enable when the lower limit switch is triggered, it will display “the lower limit triggered”;
      ◆ Reset Error: when resetting error, it will show “reset error”.
      ◆ Crash Alarm: The crash alarm is enabled when the laser head touched the metal plate. Crash warning will be displayed;
      ◆ Multiple Errors: When there are more than two kinds of errors, it displays "ERR: NUM", 
NUM is number, means the error code. Multiple error code binary as shown in Picture 8-1, such as: NUM = 10, which means there is Reset Error (error code BIT3 is 1), Upper Limit Triggered (error code BIT1 is 1).

<table>
<thead>
<tr>
<th>BIT4</th>
<th>BIT3</th>
<th>BIT2</th>
<th>BIT1</th>
<th>BIT0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Picture 8-1 multiple error code binary sheet

1: error happened.
0: normal.

The users can find out the responding error status according to the above values multiple errors in binary code as Picture 8-2 showed.

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Error Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIT4</td>
<td>Collision Alarm</td>
</tr>
<tr>
<td>BIT3</td>
<td>Reset Error</td>
</tr>
<tr>
<td>BIT2</td>
<td>Lower Limit Trigger</td>
</tr>
<tr>
<td>BIT1</td>
<td>Upper Limit Trigger</td>
</tr>
<tr>
<td>BIT0</td>
<td>System Error</td>
</tr>
</tbody>
</table>

Picture 8-2 multiple error code

3) Menu

Press "Menu" button on the main screen, entering to menu UI, user can modify the parameters of the LFS and manage it. Menu UI including: filter parameter, height parameter, motion parameter, system parameter and parameter management. Menu UI refer to Picture 8-4.

8.4 Parameter Setting

After modifying parameters, user needs to press the "Write parameter "will be effective, otherwise it will be invalid. If user is not sure whether the current value is valid, user can press the "Read parameter "to read parameters of the controller.

There are two ways to set parameters, one is the data input, the other is the drop-down icon. If drop-down icon, then click the drop-down icon, it will pop up options, and then select the corresponding
parameter. If there is no drop-down icon, which means that the parameters are entered by keyboard through clicking the shaded area which will pop up the keyboard. In the data entry process, if the data input error, user can press the "←" key to delete the data, user can also press the "ESC" to cancel the data input. When data entry is completed, press "Enter" to confirm, so data entered. After all the data setting finished, press the "write parameter" to make all parameters are valid. All parameters have a setting range, if out of the setting range; it will be unable to complete the data entry.

Parameter settings include: Filter Parameter, Height Parameter, Motion Parameter, and System Parameter.

8.4.1 Filter Parameter

![Picture 8-5 Filter parameter](image)


- **Filter Parameter 1:**
  System filter parameters, do not recommend users to modify. Change these parameters, if set incorrectly can lead to vibrating and shaking. Parameters setting range: 10 to 300, the default setting is 100.

- **Filter Parameter 2:**
  System filter parameters, do not recommend users to modify. Change these parameters, if set incorrectly can lead to vibrating and shaking. Parameter setting range: 0 to 10, the default setting is 0.

- **Filter Parameter 3:**
  System filter parameters, do not recommend users to modify. Change these parameters, if set incorrectly can lead to vibrating and shaking. Parameter setting range: 0 to 10, the default setting is 0.

- **Alarm Filter:**
  For adjusting the alarm filter, the parameter should not be set too large, which will cause the laser cutting head cannot rise up in time when collision warning; On the contrary, too small filter time will lead to false alarms caused by cutting spray residue. Parameter setting range: 5
8.4.2 Height Parameter

Height Parameter includes: G0 Height, Alarm Height, Finish Height and Focus Position. Height Parameter is as Picture 8-6 shown.

- **G0 Height:**
  The height is the rising up height when start cutting. Usually the value is set to be 10mm, can be set as the actual situation. Parameter setting range of 0 to 45, the default setting is 10mm.

- **Alarm Height:**
  When the laser head has crashed to the metal surface, the LFS will rise up the laser head to prevent the laser cutting head from damage. The rising up height is the value. Parameter setting range: 0 to 45, the default setting is 20mm.

- **Finish height:**
  When all the work has been finished, the laser head should stay a higher position. So user can set the height according his need. Parameter setting range: 0 to 45, the default setting is 20mm.

- **Focus Position:**
  Focus position is the height from the metal surface to the nozzle. Usually the value is set to be 1mm. Parameter setting range: 0 to 5, the default setting is 1mm.
8.4.3 Motion Parameter

Motion parameter includes: Jump Speed, Follow Speed, Focus Speed, Step Length and Motor Polarity. Motion parameter as Picture 8-7 showed.

- **Jump Speed:**
  
  When starting a cutting task, laser cutting head rises up speed. The parameters need to be set according to user needs. Parameter setting range: 1 to 200, the default setting is 60 mm/s.

- **Follow Speed:**
  
  Follow speed is the maximum tracing speed of Z-axis. When he motor losing steps, user can reduce the parameter. Parameter setting range: 1 to 200, the default setting is 60 mm/s.

- **Focus Speed:**
  
  During Auto-searching focus point, the laser cutting head moves down to metal surface at this speed. The speed should not be set too fast, too fast can cause touch metal and a greater focus position deviation. Parameter setting range: 1 to 5, the default setting is 3 mm/s.

- **Step Length:**
  
  The step length is the ratio of the PPR. Parameter setting range: 0.0001 to 0.01, the default setting is 0.001 mm/s.

- **Motor Polarity:**
  
  The parameter is to set up the motor moving direction. When the laser cutting head rises up during auto-searching focus, the parameter should be modified to ensure that that laser head move down to the metal surface. The default motor polarity is negative. There is another way to modify the polarity. To exchange the polarity of motor phase winding, that is, the A+ and A- can be exchanged to change the moving direction.
8.4.4 System Parameter

System parameter includes: Limit Polarity, Limit Enable, Alarm Enable, Auxiliary Gas and Punch Enable. System parameter as Picture 8-8 showed.

- **Limit Polarity:**
  There are negative and positive limit inputs for protecting laser head during motion. If the limit is enabled and limit polarity is set correctly, the LFS will protect the laser head. During live focusing, the laser head touch the down limit; the laser head will rise up to a safe position. During rising up, if the upper limit is touched, the motor will stop motion immediately.

  If the limit switch is normally open, one terminal connects to GND. Another terminal connects to limit input of LFS. The parameter named limit polarity should be set to be negative. We recommend that user select mechanical switch to be installed as limit switch. The switches have normally open and normally closed contactors. The NO contactor is connected to LFS limit input and the NC contactors connect to Z axis limit input of RDC633XM. So the laser head on the Z axis can be protected completely whatever the Z axis motor are controlled by LFS or RDC633XM.

  So the limit protection function should be enabled. If the normally close contactor is connected to RDC633XM, then the limiter polarity should be set to positive. Or the Z motor cannot move by the Z+ and Z- because the hardware limit is triggered. The default limit polarity is negative.

- **Limit Enable:**
  If the limit is enabled and limit triggered, the LFS will protect the laser head automatically, otherwise there is not protect and the limit status will be displayed on the main screen. The default limit enabled.

- **Alarm Enable:**
  If crash alarm is enabled, laser head will rise up to a safety height when the laser head touches the metal surface. If the crash alarm is banned, the crash alarm input will be neglected. When crash alarm happened, the machine should stop motion. So the crash alarm signal should connect to machine protect input on the RDC633XM. So when the
crash alarm happened, the protection is valid and RDC633XM will stop the motion and give the information to the panel which displays “machine is protected”. The default alarm enabled.

**Auxiliary Gas:**

The LFS supplies 2 channels IO to control auxiliary gas relay. One is for O2 control in metal cutting; the other is for auxiliary compressed gas control in non-metal cutting.

The parameter is 1, only one channel blowing signal is available, that is O2 control channel. When cutting non-metal in Manual mode, 1\(^{st}\) channel output relay closed, compressed gas will blowing; when switch to metal cutting in Auto mode, 1\(^{st}\) output relay switch controlled by LFS.

The parameter is 2, the 2\(^{nd}\) channel relay closed to control the compressed air valve conducting when non-metal cutting in Manual mode. When switch to metal cutting in Auto mode, the LFS will close the 2\(^{nd}\) channel control output firstly, to make the 1\(^{st}\) channel output under control.

**Punch Enable:**

This option is used to set whether to do low pressure oxygen punching operation or not. If “YES”, the block will automatically control low pressure oxygen output in laser punching process, in order to prevent the cutting small graphics of the blasting hole. In the normal cutting, switch to the high pressure oxygen status automatically. If you want to achieve this function, the output of the oxygen tank must be two channels, a channel to increase the pressure of reducing valve of low pressure oxygen output, the other channel for normal oxygen output, at the same time the two channels are controlled by independent solenoid valves. The default punch enabled.

8.4.5 Parameter Management

Parameter Management is mainly used to save and restore user parameters, including: Filter Parameter, Height Parameter, Motion Parameter and System Parameter. User can save the current parameter values as default and restore the default value for the user parameter. Parameter Management is shown in Picture 8-9. It requires administration authority and only six-password input correctly then start to operate. According to the actual situation to set up the controller parameters, you can save the current parameters as the factory values, in order to facilitate restore management. In restoring the factory, will take the last factory value as user parameters. If before restoring parameters without saving parameters as factory value, it will restore the default value as user parameters. Parameter management as below Picture 8-9 showed.
Picture 8-9 Parameter Management

6 digits initial passwords can be obtained through the factory, the user can modify the password, please keep in mind the passwords after modified, otherwise you will be unable to use parameter management to save and restore the factory values.

8.5 Matters Need Attention

- Prohibition of press two or more buttons at the same time;
- When user press the button, note the intensity and speed of press;
- Do not modify user parameter in motion.
- In starting up status, clicking untouched area of the touch screen (button area) more than 20 times quickly within 4 seconds then entering into calibration model. Before leaving factory has been carried out calibration, there is no need to calibrate.

Steps as follows:
1) Clicking untouched area of the touch screen (button area) more than 20 times quickly within 4 seconds;
2) Buzzer buzzes for 1 second, stopping click when hearing it;
3) In calibration mode, touch the screen designated location as the cross line pointed.
4) Calibration finished.
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