

Continuous-Wave Fiber Laser User Guide

RFL-C40000~80000M

Wuhan Raycus Fiber Laser Technologies Co., Ltd.

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1 Safety Information

Thank you for choosing Raycus Fiber Laser. This user manual provides you with important safety, operation, maintenance and other relevant information. Please read the manual carefully before using this product. To ensure safe operation and optimum product operation, please observe the following cautions and warnings as well as other information within this manual.


1.1 Safety Labels

The detailed description of safety signs is as follows.

	WARNING: Describes a hazard that leads to severe injury or death to people.
	CAUTION: Describes a hazard that leads to general injury to people or damages to product.

1.2 Laser Safety Grade

According to European Standard EN 60825-1, Clause 9 and Chinese Standard GB 7247.1-2012 Safety of Laser Products Part 1: Equipment Classification Requirements, this series of lasers are Class 4 laser instruments. The product emits laser radiation at a wavelength of 1080 nm or around 1080 nm. Direct or Indirect exposure to high power laser radiation causes damage to the eye or skin. Although the radiant laser is not visible, the beam will cause irreparable damage to the retina or cornea, so appropriate and certified laser safety glasses must be worn throughout the laser emitting.

	WARNING: Users must use appropriate laser goggles when operating this device. The laser goggles should be selected according to the range of wavelength emitted from this product. Users must ensure that the protect range of laser goggles over the entire range of laser wavelengths. Please DO NOT directly view the laser output head when laser emitting.
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1.3 Safety Labels

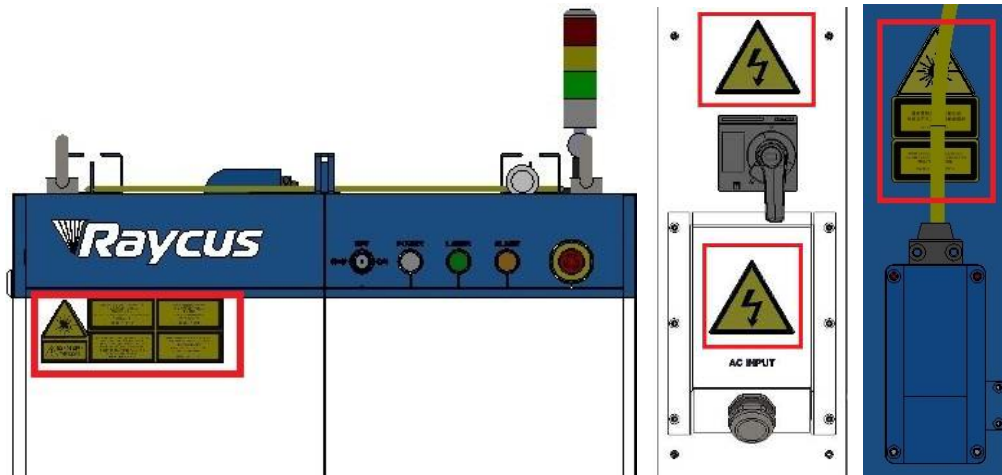


Figure 1 Safety Label Locations of CW fiber laser


Laser safety signs include: safety warning, laser output head warning, product certification, product nameplate, etc. The detailed explanation of safety signs is as follows:

Table 1 Safety Label

<div data-bbox="183 1030 485 1176" data-label="Image"> </div> <p data-bbox="284 1198 384 1232">English</p> <div data-bbox="183 1232 485 1377" data-label="Image"> </div> <p data-bbox="284 1400 384 1433">Chinese</p>	<div data-bbox="638 1041 933 1187" data-label="Image"> </div> <p data-bbox="646 1198 909 1232">English (40000W)</p> <div data-bbox="638 1232 933 1377" data-label="Image"> </div> <p data-bbox="646 1388 909 1422">Chinese (40000W)</p>	<div data-bbox="1093 1041 1396 1187" data-label="Image"> </div> <p data-bbox="1189 1198 1292 1232">English</p> <div data-bbox="1093 1232 1396 1377" data-label="Image"> </div> <p data-bbox="1189 1388 1292 1422">Chinese</p>
<p>1: Laser Emit Head</p>	<p>2: Type 4 Laser Product</p>	<p>3: Class 2 Laser Product Label-5mW Red Laser</p>
<div data-bbox="194 1563 470 1704" data-label="Image"> </div>	<div data-bbox="609 1541 960 1727" data-label="Image"> </div>	<div data-bbox="1168 1570 1321 1697" data-label="Image"> </div>
<p>4: CE Authentication</p>	<p>5: ID Label (40000W)</p>	<p>6: Laser Radiation Hazard</p>
<div data-bbox="266 1814 399 1942" data-label="Image"> </div>		
<p>7: Electrical Hazard</p>		


1.4 Optical Safety

Any dust on the end of the collimator assembly can damage the crystal of output head or the entire laser.


	<p>CAUTION:DO NOT emit when the protective cap is not removed, otherwise the lens or crystal will be damaged.</p>
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1.5 Electrical Safety

- a) Ensure that the PE line is effectively grounded, and the installation environment is safe and reliable.

	<p>WARNING: The disconnection of the product grounding will electrify the enclosure, which may result in personal injury to the operator.</p>
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- b) Please ensure that all interface signals (including GND) of external devices connected to the laser are well insulated from PE, otherwise it may cause abnormalities in laser signal acquisition and transmission.
- c) Ensure that the AC voltage is supplied normally.

	<p>CAUTION: Wrong wiring mode or power supply voltage will cause an unrecoverable damage to the laser device.</p>
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1.6 Other Safety Rules

- a) Do not view the laser output head directly when laser is emitting.
- b) Do not use fiber lasers in dark or dim environments.
- c) If this device is used in a manner not specified in this document, the protection provided by the device may be impaired and the warranty will be voided.
- d) It is forbidden to manually operate the laser cable head/cutting head when the green light of the laser tricolor light is on;
- e) There are no user serviceable parts, equipment or assemblies inside the product. All service and maintenance shall be performed conducted by a certified Raycus engineer. In

order to prevent electric shock, please do not break the seal or uncover the shield. Failure to comply with this instruction will be treated as invalid warranty.

2 Product Description

2.1 Features

Fiber lasers are more compact and ready to use than conventional laser structures, with higher electrical and optical conversion efficiency, lower power consumption and better beam quality. Thanks to its flexible laser output, it can be easily integrated with system equipment.

Main Features:

- High beam quality
- High reliable
- Free-maintenance operation
- High electro-optical conversion efficiency
- Convenient control menu
- Fast modulation

Applications:

- Industrial cutting and welding
- Scientific research

2.2 Package Parts

Please refer to package accessories in the packing box.

2.3 Unpacking and Inspection

Through the specially designed packaging materials and cabinets, Raycus ensures that the lasers are fully protected during transportation. Nevertheless, in order to prevent unpredictable situations during transportation, the users still need to carefully check whether the package is correctly placed before unpacking, and there is no damage from phenomenon such as collision, cracking and flooding on the outside of the box. Once you find that there is an abnormality in the external cabinet, please inform Raycus Company in time to deal with it as soon as possible.

Please double check if each listed content is inside the package; and contact Raycus as soon as possible if there are any issues.

Take extra care when removing the unit from the package and make sure that the fiber optic cable stays away from any possible collision and vibration. Please DO NOT distort, bend or pull the output cable when unpacking the device; and avoid any collision to the head of laser output.



CAUTION: The fiber optic cable and output head are precise optic instrument, ANY vibration or impact to the output head, and twist or excessive bend to the cable will damage the instrument.

2.4 Operating environment

The operation conditions are listed as the Table 2.

Table 2 The operation environment conditions for the laser

Type		RFL-C40000M	RFL-C60000M	RFL-C80000M	
Supply voltage (V)		Three-phase four-wire system AC 323V~AC 437V, 50/60Hz (including PE)			
Power supply capacity (kVA)		> 140	> 210	> 280	
Water cooling parameter	Refrigeration capacity (kW)	> 80	> 120	> 160	
	Water cooling flow (L/min)	TOP (L/min)	> 125	> 210	> 300
		Bottom (L/min)	> 165	> 245	> 268
	Pressure fall	TOP (bar)	> 1.4	> 0.9	> 1.1
		Bottom (bar)	> 1.5	> 1.0	> 0.9
Placement environment		Flat ground, no vibration and shock			
Ambient Temperature		10°C~40°C			
Operating Relative Humidity		< 70%			
Store Temperature		-10°C~60°C			
Store Humidity		< 90%			
Cooling		Water cooling, Cooling water temperature 22±1°C			

Precautions for laser operating environment:

- a) Make sure the product is properly grounded before use.
- b) Requirements for vibration and shock in the operating environment of the laser : Long-term vibration should be less than 2G, and shock should be less than 10G;
- c) The laser output head is connected with fiber optic cable. Please inspect the output head carefully for dust or other contaminations. Use appropriate lens paper to clean it if necessary.

- d) Customers can select a water chiller with the corresponding cooling capacity based on the product power at their site. The cooling capacity of the water chiller is determined when the ambient temperature is 40°C and the water supply temperature is 22°C.

Failure to follow the instructions when operating the laser may cause malfunction and damage:

- a) High humidity air and condensation can accelerate the aging of electrical components, and even cause electrical malfunctions such as component damage, short circuits, open circuits, etc., leading to laser startup trips, false alarms from the laser, and circuit board burnout.
- b) If condensation forms on the lens or bare fiber, it can reflect or refract laser light and absorb laser energy, causing damage to optical components.
- c) Condensation on the laser can cause the cabinet to rust and accelerate the corrosion of the water-cooled board.

It is advisable to avoid operating the laser in a condensation-prone environment. To minimize the risk of condensation on the laser, reduce product failure rates, and extend its service life, it is strongly recommended to equip the laser with an air-conditioned room (it is strictly prohibited to place the water chiller inside the air-conditioned room). The size of the air-conditioned room should ensure proper heat dissipation for the laser's air conditioning system (maintaining a distance of $\geq 0.5\text{m}$ from the air conditioning vents), while also facilitating maintenance and repair of the laser. The comparison table of ambient temperature, relative humidity, and dew point is shown in Table 2.

Tips: Install the laser in an air-conditioned environment for longer life and better performance.



	<ul style="list-style-type: none"> ◆ Do not expose this product to high humidity (humidity > 90%). ◆ Do not operate this product at temperatures below the ambient dew point (as shown in Table 2)
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Table 2: Comparison Table of Constant Dew Point under Ambient Temperature and Relative Humidity

Ambient temperature (°C)	Maximum relative humidity								
	20%	30%	40%	50%	60%	70%	80%	90%	95%
20	-3.5	2	6	9	12	14.5	16.5	18	19
25	0.5	6	10.5	14	16.5	19	21	23	24

30	4.6	10.5	15	18.5	21.5	24	26	28	29
35	8.5	15	19.5	23	26	28.5	31	33	34
40	13	20	24	27.5	31	33.5	36	38	39

	<p>◆ Green zone: The dew point temperature is 22°C lower than the cooling water temperature of the laser, which falls within the safe range;</p> <p>◆ Red zone: The dew point temperature is higher than 22°C, which exceeds the cooling water temperature of the laser by 22°C. Condensation will occur, and measures must be taken before use.</p> <p>Measure 1: Inject compressed dry air through the CDA interface;</p> <p>Measure 2: Install cabinet air conditioning to reduce the ambient temperature.</p>
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2.5 Attentions

- The output laser is collimated by the collimating lens, it is important to keep the collimating lens clean, otherwise it will damage the device.
- Please cap the output head when it is not in use. Do not touch the output lens at any time. Use appropriate lens paper to clean it if necessary.
- Safety keep the cap when using the laser. To avoid dust, make sure the opening direction of the cap is put down.
- Failure to follow the instructions may cause laser power loss, such loss is not covered by warranty.

2.6 Features

Table 3: Product technical data sheet

Product Specifications				
Optical properties				Test Conditions
Type	RFL-C40000M	RFL-C60000M	RFL-C80000M	
Output Power(kW)	40	60	80	/
Operation Mode	CW/Modulated			/
Polarization State	Random			/
Output Power Tunability (%)	10%~100%			/
Emission Wavelength	1080nm±5nm			Rated output power

Output Power Unstability	Short time ($\leq 2h$) : $\pm 1\%$ Long time ($> 8h$) : $\pm 1.5\%$			Rated output power; continuous running time: more
Modulation Frequency (Hz)	50Hz~2kHz			Rated output power
Red Guide Laser Power	1~1.5mW			/
Fiber output Type	QP	HQP		/
Beam Quality (BPP, mm•mrad)	3.5~4.3	5.5~6.5	5.5~7.5	Rated output power
Fiber core diameter(μm)	100	150	180	customizable
Delivery Cable Length	30m	28m		customizable
Electrical characteristics				
Operating Voltage	Three-phase four-wire system AC323V~AC437V、50/60Hz (including PE)			/
Maximum power Consumption	120 kW	180 kW	240 kW	/
Control Method	Hardwire+Analog Control/LIN Communication Control/RS232 Communication Control			/
Other characteristics				
Dimension(W×H×D) (mm)	1145×1700×1410	1850×1730×1410	2045×1580×1340	Includes casters and rings, does not include
Weight (kg)	1100	1650	1750	include air conditioning
Product Specifications				
Optical properties				Test Conditions
Type	RFL-C40000M	RFL-C60000M	RFL-C80000M	
Output Power(L-W)	40	60	80	/
Operation Mode	CW/Modulated			/

3 Installation

3.1 Dimensions

The main body dimensions of RFL-C40000M-CE CW fiber laser are shown in Figure 1(a).

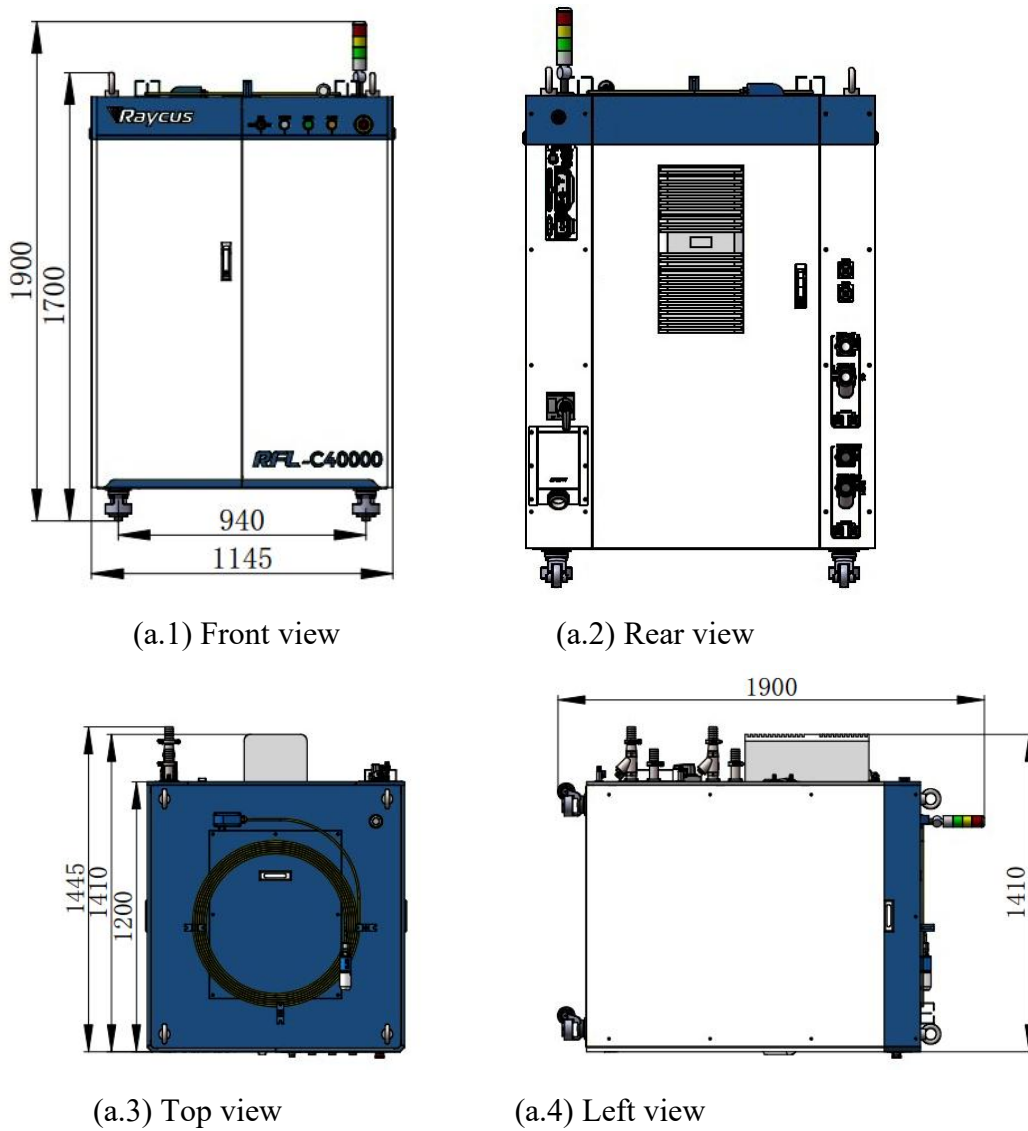
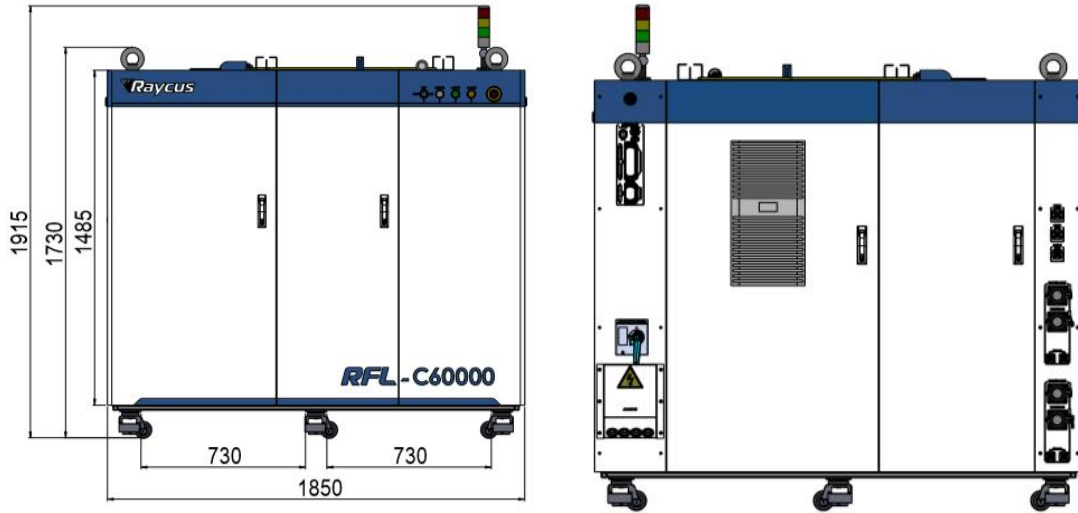


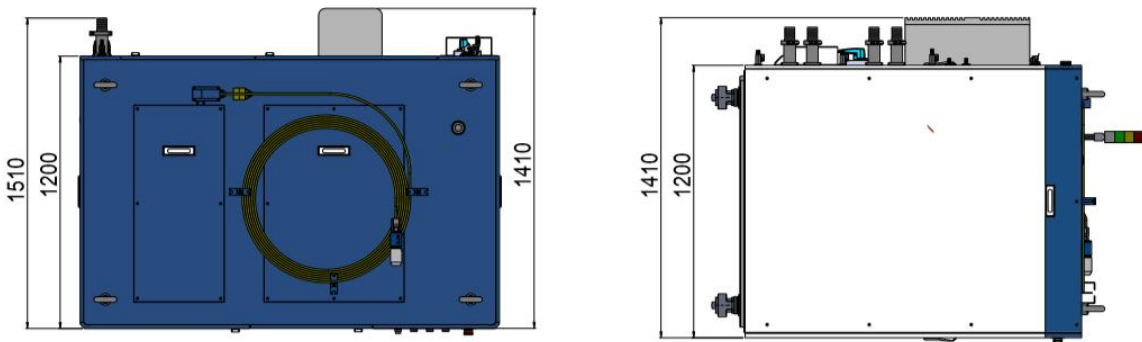
Figure1 The dimensions of RFL-C40000M-CE CW fiber laser

The structure size of RFL-40000M-CE laser is 1145×1700×1410mm (width×height×depth; including casters and rings, without warning light); RFL-C40000M-CE laser weighs less than 1100kg.

The main body dimensions of RFL-C60000M-CE CW fiber laser are shown in Figure 2(a).



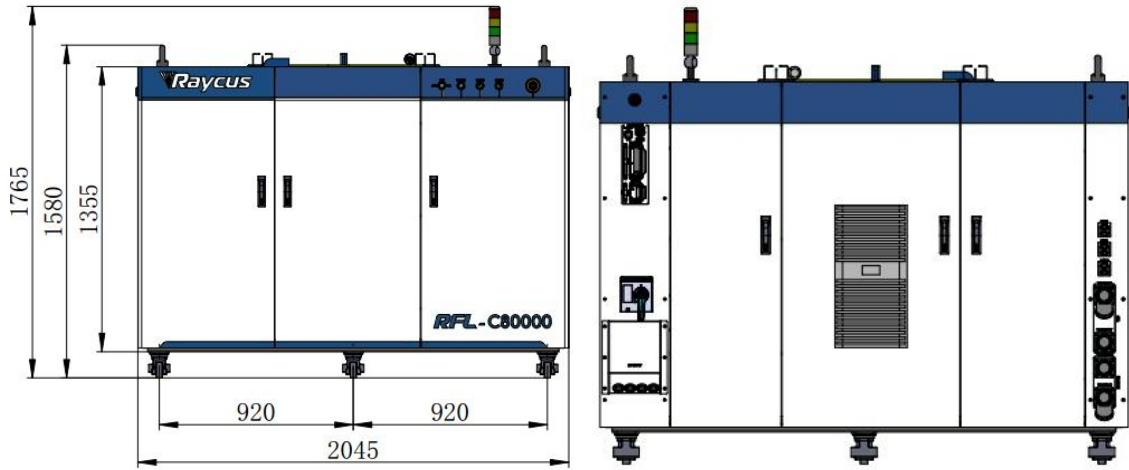
a) Front view and rear view



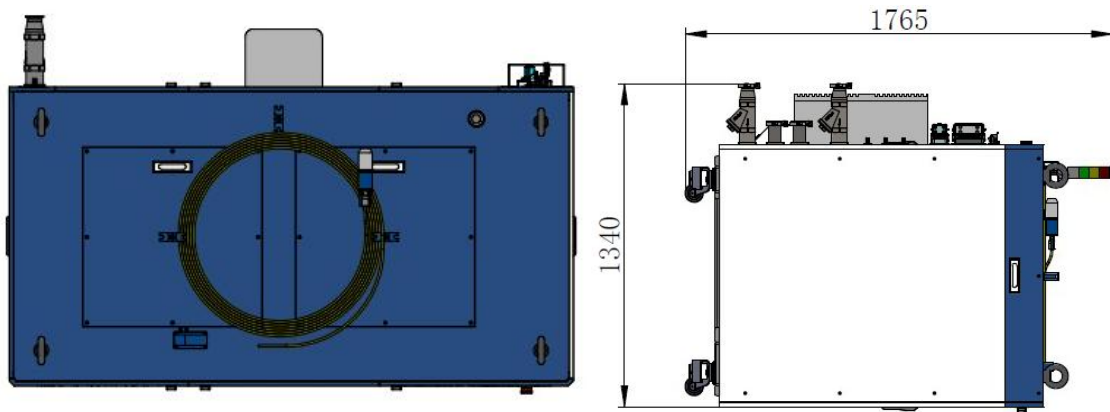
b) Top view and side view

Figure2 The dimensions of RFL-C60000M-CE CW fiber laser

The structure size of RFL-C60000M-CE laser is 1850×1730×1410mm (width×height×depth; including casters and rings, without warning light); RFL-C60000M-CE laser weighs less than 1650kg.



a) Front view and rear view



b) Top view and side view

Figure3 The dimensions of RFL-C80000M-CE CW fiber laser

The structure size of RFL-C80000M-CE laser is 2045×1580×1340mm (width×height×depth; including casters and rings, without warning light); RFL-C80000M-CE laser weighs less than 1750kg.

3.2 Size and installation of output optical cable

CW fiber laser uses the RFL-QP output optical cable, and the external dimensions of the output optical cable head are shown in Figure 4.

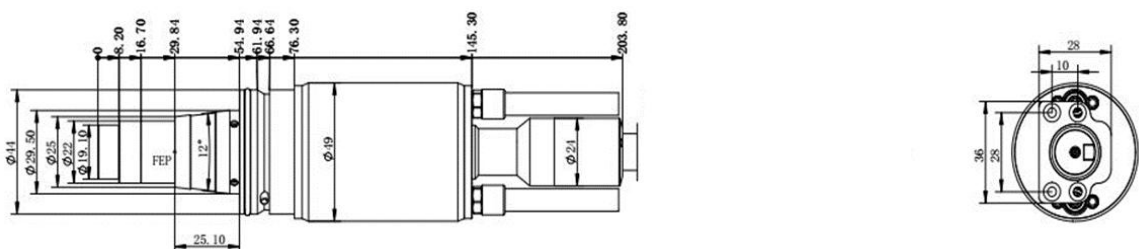
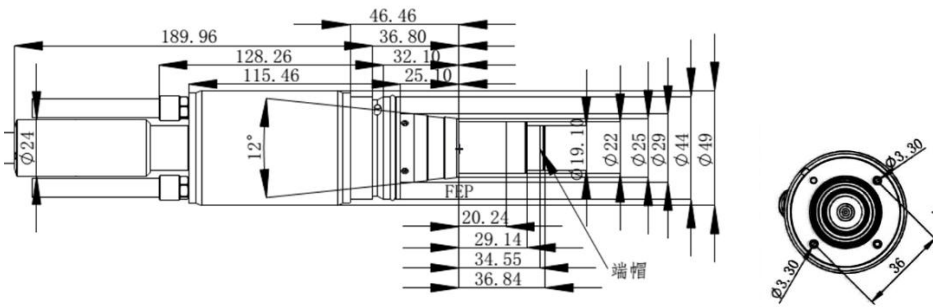


Figure 4 External dimensions of the output optical cable head



RFL-HQP External dimensions of the output optical cable head (RFL-C60000)

Figure 5 External dimensions of the output optical cable head

Note: The dimensions in the above diagram are in the unit of millimeter (mm).

Before the laser works, make sure that the two copper contacts (Interlock pins) on the output head are shorted, otherwise the laser will not work properly. Before installing the output cable into the processing head, the lens of the output cable must be inspected. If the output cable lens is dirty, the lens must be cleaned. It is forbidden to disassemble the output lens by anyone other than staff in Raycus, otherwise the warranty will be invalidated.

3.3 Cooling system requirements and installation

The laser cooling system mainly consists of a low-temperature water circuit and a room temperature water circuit. The cooling system requirements are:

- a) The water quality requirements for the cooling system are shown in Table 5;

Table 5 Requirements for Cooling Water Quality

No.	Items	Reference Standard
1	Type of cooling water:	deionized water/distilled water/ultrapure water
2	PH	6.0-8.0
3	Conductivity/TDS	<15 μ S/cm / <30mg/L
4	Residual chlorine content	none
5	Turbidity (insoluble particulate matter)	<1NTU (visually none)

- b) In order to prevent the water in the water cooler from growing mold and causing pipeline blockage, it is recommended to add alcohol when filling pure water, and the amount of alcohol added is 5%~10% of pure water;

- c) When the ambient temperature is below 0°C, the cooling system is prone to freezing, which can cause damage to the laser. It is recommended to use a suitable antifreeze solution (Clariant laser antifreeze is recommended) when the ambient temperature is below 5°C. The concentration of the antifreeze should not be too high, as it may affect the system's heat dissipation. The antifreeze should be replaced every two months, and the antifreeze ratio is shown in Table 6.

Table 6 The antifreeze ratio

No.	Anti-freezing temperature range (°C)	Mixing ratio (anti-freezing fluid stock solution: deionized water/purified water)
1	-36~-45	6:4
2	-26~-35	5:5
3	-16~-25	4:6
4	-6~-15	3:7
5	-2~-5	2:8

- d) Antifreeze is corrosive. Therefore, once the weather turns warm (when the ambient temperature consistently remains above 10°C), it is recommended to promptly clean the cooling system and replace the cooling water with industrial alcohol solution.
- e) If the laser is to be transported or not used for more than a week, the internal cooling water should be drained, and clean compressed air with a pressure of less than 0.7 MPa should be used to blow out the residual water inside the device (including the laser and chiller). Failure to do so may cause irreversible damage to the laser water circuit system (such as corrosion, blockage, or freezing);
- f) For low-temperature water circuits of lasers with different power levels, use rubber hoses of corresponding specifications to connect the pipelines according to the method shown in the diagram. After installing the rubber hoses into the pagoda, use clamps of corresponding specifications to tighten them (the tightening process of the clamp should be fast at first and then slow down as it approaches the set torque value, until the torque reaches the required torque. Then, leave it for 30 minutes, and tighten it again to the set torque. The tightening torque for the steel band clamp in Figure 9 is 6NM, and the tightening torque for the strong clamp in Figure 10 is 8NM);



Figure 9 Steel band clamp

Figure 10 Strong clamp

g) The cooling water connection for the RFL-C40000M lasers is shown in Figure 12, and the cooling water connection for the RFL-C60000M/80000M lasers is shown in Figure 13. The direction of the arrow indicates the direction of water flow.

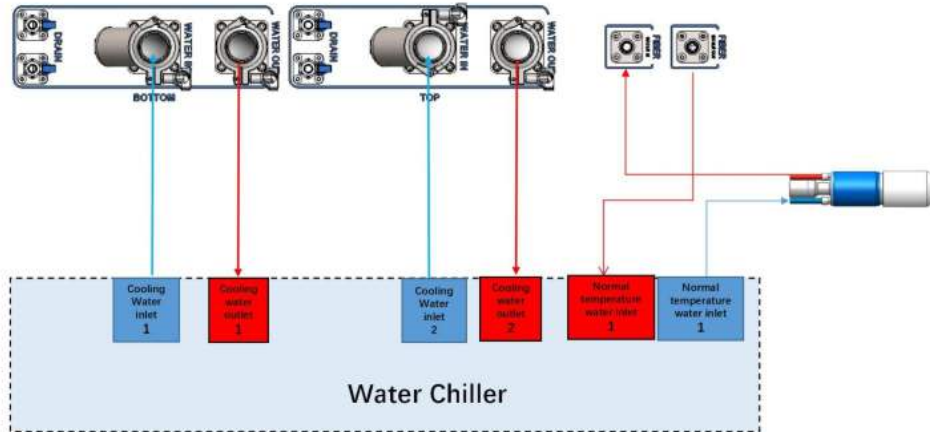


Figure 12 Schematic diagram of the cooling system connection for the RFL-C40000M

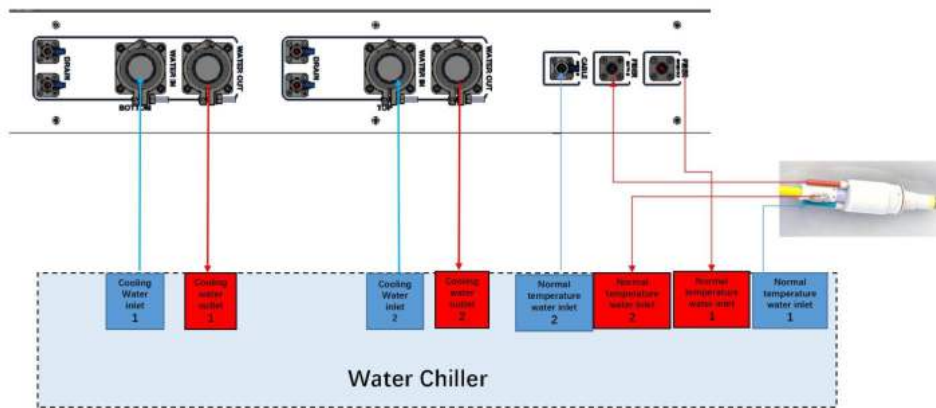


Figure 13 Schematic diagram of the cooling system connection for RFL-C60000M/80000M

The above suggested connection method is only for customer reference. When there are accessory devices on the actual cutting head, please connect according to the actual situation, but it is necessary to ensure that the laser accurately monitors the flow of the optical cable head.


Water cooling requirements for output optical cables:

- a) Water flow requirements: The water flow rate of the QP/HQP output optical cable should be greater than 3.0L/min, and for the armored part of the 60000M/80000M product optical

- cable, the water flow rate should be greater than 0.5L/min;
- b) Water cooling pressure: inlet pressure ranging from 0.4 to 0.6 MPa;
- c) Type of inlet and outlet connectors: QP/HQP Optical cable output end: $\phi 8$ quick-connect connector, shipped with $\phi 8$ red and blue water tube; 60000M/80000M product optical cable armor part shipped with $\phi 6$ red water tube and $\phi 6$ quick-connect connector; rear panel of the entire machine has a $\phi 13$ pagoda head, shipped with $\phi 13$ red and blue water tube and hose clamp;
- d) The water chiller needs to be equipped with a filter element that filters particles with a size of less than 100um. The filter element should be cleaned once a month;
- e) Maximum cooling water temperature: 35°C; minimum cooling water temperature: 5°C above the saturation dew point temperature;
- f) Additives in cooling water: Meet the above requirements for pH value and solid particle size;

Other requirements for the cooling system:

When starting the cooling system for the first time, check the entire water circuit system and connectors for any signs of water leakage;

	<ul style="list-style-type: none"> a) Before starting the laser, ensure that the cooling system is functioning properly and the water temperature reaches a suitable level; b) Unsuitable cooling water can easily cause corrosion and blockage of the laser's water channel, resulting in the product being unable to dissipate heat and function properly. c) Failure to add antifreeze or incorrect proportion of antifreeze added can cause damage to the laser
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3.4 Installation precautions

Precautions for laser installation:

- a) Place the laser horizontally in a suitable position and make necessary fixations;
- b) Connect the power cord and control cable of the laser properly when it is not powered on;
- c) Connect the cooling system to the laser and the output optical cable head according to the inlet and outlet water identification;
- d) Please check the laser output head and ensure it is clean before installing it into the equipment;
- e) During the installation of output optical cables, do not step on, squeeze, or excessively bend the protective sleeve to avoid damaging the optical fibers;
- f) During the installation of optical cable output heads, ensure the cleanliness of the

surrounding environment (avoid using electric fans to cool down during hot summer days, as this can cause excessive dust in the air);

- g) When the transmission optical cable of the laser is in non-working states such as transportation and storage, its minimum bending diameter should not be less than 20cm. When the laser is emitting light, the minimum bending diameter should not be less than 30cm;
- h) Customers can utilize the bottom rollers to transport or move the product. Before moving the laser, please ensure that the support blocks of the leveling casters are lifted off the ground. Once the laser is positioned, adjust the support blocks to make them contact the ground to prevent the laser from shifting. The horizontal adjustment rollers at the bottom of the laser are shown in Figure 14;
- i) During transportation, it is recommended to use our original packaging box for the laser. If the original packaging box is not feasible, the design of the transportation packaging can be completed under the guidance of our technical staff.

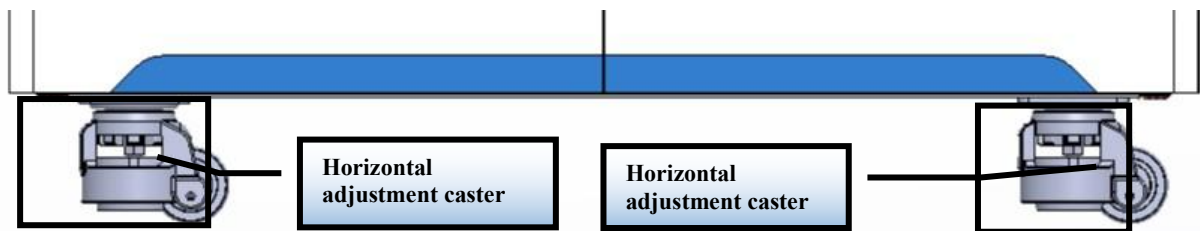





Figure 14: Horizontal adjustment casters at the bottom of the laser

	<p>CAUTION:</p> <ul style="list-style-type: none"> (1) All control line connections for the laser should be made in a non-powered state. (2) Installing control lines while powered on may cause damage to the laser.
	<p>CAUTION:</p> <ul style="list-style-type: none"> (1) The placement of the laser output cable should be as natural as possible, and the output cable should not be twisted; (2) If the coil diameter of the output optical cable is too small, it will damage the laser.
	<p>CAUTION:</p> <ul style="list-style-type: none"> (1) In the process of installation and disassembly, please handle the laser output head gently, and avoid vibration; (2) Before assembling the laser output head, ensure that the optical lens and cutting head cavity are clean and free of pollution.

3.5 Protective End Cap of Output Cable and Using Description

3.5.1 Types of Protective End Caps and Factory Status

The output cable model used by the multi-module high-power fiber laser is QP/HQP output cable. There are two types of protective end caps included with the machine, as shown in Figure 15.

Type A end cap: It is assembled onto the output optical cable at the factory, and equipped with a protective window plate to ensure the cleanliness of the end cap (also known as the crystal) during transportation.

Type B end cap: Attached to the packaging accessories, it is generally packaged in a laminated box. The end cap does not have a protective window sheet, which is used to prevent the end cap from being damaged when loading and cutting the optical cable (or welding the head).

Table 7: Instructions for Using the Protective End Cap of Output Optical Cable

Model	Optical cable model	Type of end cap at factory delivery	Type of end cap used
RFL-C40000M	QP	Type A End Cap (with protective window)	Type B End Cap (without protective window)
RFL-C60000~80000M	HQP	Type A End Cap (with protective window)	Type B End Cap (without protective window)

Note: According to the difference of the protective end cap of the cable in the actual use of the customer, some models need to replace the protective end cap. Please refer to the "Cleaning Instructions for the Output Optical Cable Before Installation" to clean the output optical cable and the protective end cap.

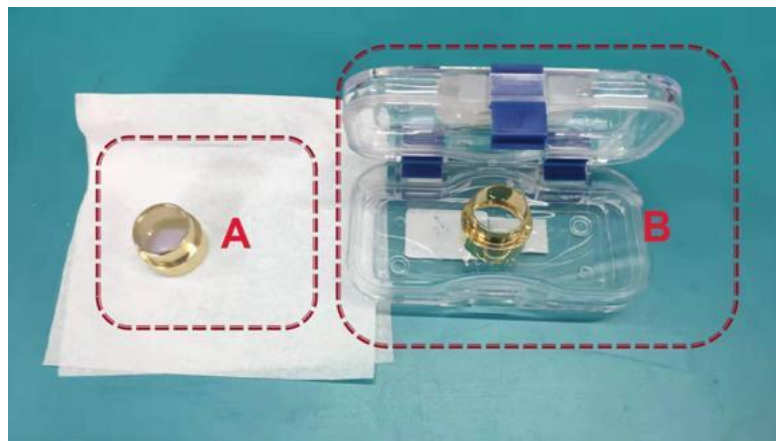


Figure 15 Optical Cable Protection End Cap Diagram

3.5.2 Pre-installation Cleaning Instructions for Output Cables

It is prohibited to perform manual operations on the laser cable head/cutting head when the green light of the laser's three-color indicator is illuminated;

Cleaning steps for output optical cables:

a) Preparation tools

Cleaning agent: absolute ethanol, or isopropyl alcohol.

Cleaning tools: cleaning cotton swabs, dust-free paper, compressed air bottles, etc.

b) Steps

Clean workbench should be turned on for at least 5 minutes, and the output optical cable should be taken out of the black packaging box, as Figure 6. The outer surface of the shell shall be blown with compressed air bottle for preliminary cleaning



Figure 16: Output optical cable placed in the packaging box

1) Place the output optical cable in a clean workbench;

The following operations need to be carried out in a clean workbench. If the operation is not carried out in a clean environment, it will cause great risk to the output optical cable; operators need to wear finger cots to operate.



Figure 17: Output optical cable placed in a clean workbench with ventilation turned on

2) Remove the white dust cap and place it face down on new lint-free paper.

The dust-free paper is for one-time use, and there is a risk of dust falling if it is used multiple times.



Figure 18 Output optical cable with white dust cover removed

- 3) Use a cotton swab and anhydrous ethanol to clean the metal casing of the optical cable, then remove the end cap (with protective window) attached to the optical cable, and place it on a clean paper .



Figure 19: Removing the A-type end cap from the optical cable

- 4) Check the cleanliness of the end caps in this state. If the cleanliness is not enough, please clean the end caps.
- 5) Please refer to the cleaning method: <http://www.raycuslaser.com/view/1852.html>
- 6) Reference video: <https://mp.weixin.qq.com/s/hRXrPkb8DAYvDYegSWwYLg>

Note: The end cap cleaning is generally performed by our professional staff. If the customer needs to operate it by himself, we need to go through the relevant training of our staff and obtain the relevant qualifications before the above operations can be carried out. If the operation method is improper, it will cause irreversible and serious damage to the output optical cable during use. After ensuring the cleanliness, inst

After ensuring the cleanliness, install the B- type end cap. During the installation process, there will be resistance when screwed to the bottom, which is a normal phenomenon. It is necessary to ensure that there is no gap between the end cap and the main body sleeve. And

then check the finish and cleanliness of the end cap's glossy surface, as Figure 9 shown. Then connect the fiber optic cable output head to the cutting head (or welding head) with the B-type end cap installed. This operation needs to ensure the cleanliness of the inner and outer surfaces of the cutting head (or welding head) connector.

Note: The connection with the cutting head (or welding head) still needs to be carried out in a clean workbench, and it is necessary to check the cleanliness and smoothness of the relevant components of the cutting head (or welding head) itself.

Keep the corresponding accessories as Figure 10 shown in order to facilitate the re-transportation of the laser or output cable.

Note: The fiber optic cable must be loaded with Type A end caps each time it is transported. That is, every time the output optical cable is unloaded from the cutting head and needs to be transported, the end cap of type B must be replaced with the end cap of type A, and the white dust cover must be covered, and finally put into a black box for transport.



Figure 20 Accessories that customers need to keep: black protective box, white dust cover, type A end cover

4 Using the Product



Please log in to the official website of Raycus to download the new PC software and the PC software user manual. Website: <http://www.raycuslaser.com>

4.1 Front Panel

Figure 21 shows the front panel.

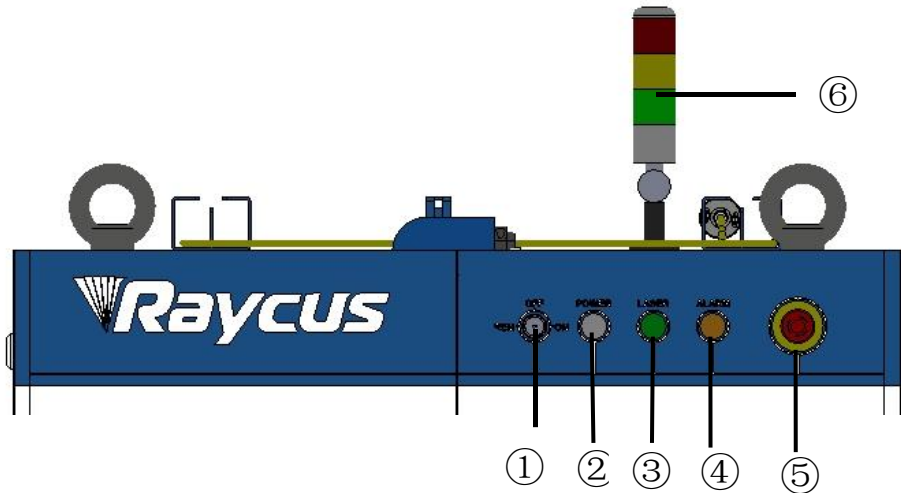


Figure 21

Note: ①-REM/OFF/ON ②-POWER ③-LASER

④-ALARM ⑤-STOP ⑥-INDICATOR LIGHT

REM/OFF/ON: The key switch, the main control switch of the laser. Insert the key and turn it to the "ON" position, the main control part of the laser is powered on, and the POWER light is on; Rotate to the "REM" position, you need to close the 8 and 9 pins of the XP2 interface on the rear panel to realize remote power-on, and rotate to REM to activate the hard-wired control mode of the laser.

POWER: Control power indicator, when the white indicator light is on, it means the main control system is on.

LASER: The power button of the laser main power supply has a green light indicator function. After the laser main control system is powered on and all INTERLOCKS are detected as normal, press this button, the laser main power supply is powered on, and the button lights up after the main power supply is powered on.

ALARM: INTERLOCK alarm indication, the ALARM indicator lights up during the power-on self-check on the control panel. After the self-inspection is completed, all INTERLOCK interfaces are normally closed, and the ALARM indicator is off. During the operation of the laser, if any INTERLOCK is disconnected and the laser preparation is not completed, the indicator light will be on.

STOP: Emergency stop button, press to turn off the main power of the laser immediately; turn the button clockwise to release the button, and press the LASER button again to start the main power of the laser.

INDICATOR LIGHT: After the main power supply of the laser is powered on, the green indicator light is on when the laser is Ready; when the laser is emitting light, the red indicator light is on; when the laser has a fault, the yellow indicator light is on, accompanied by an alarm sound.

4.2 Rear Panel

Figure 22 shows the rear panel.

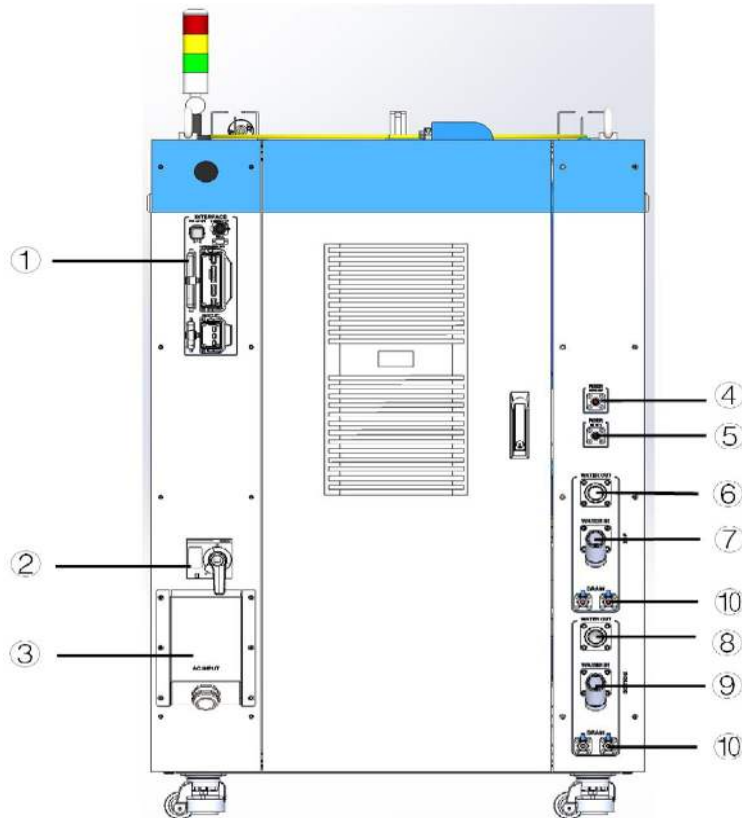


Figure 22 Rear panel diagram of laser

①-INTERFACE ②-CIRCUIT BREAKER ③-AC INPUT ④-FIBER WATER OUT ⑤-FIBER WATER IN ⑥-TOP WATER OUT ⑦-TOP WATER IN ⑧-BOTTOM WATER OUT ⑨-BOTTOM WATER IN ⑩-DRAIN

① -INTERFACE : This interface provides all control signals, including: RS232 communication, laser on/off control, laser remote control mode selection, analog control, modulation signal, Interlock interface, etc. This socket comes with a protective cover and a lock. When you are not using the product, you can cover the power input socket with the protective cover and lock it with the lock.

②-**BREAKER**: The circuit breaker (air switch) on the rear panel of the laser is the main power switch of the laser.

③-**AC INPUT**: The power input socket must be matched with the plug provided by us. This socket comes with a protective cover and a lock. When you are not using the product, you can cover the power input socket with the protective cover and lock it with the lock.

④- **FIBER WATER OUT**: Output optical cable water outlet, this interface is connected to the output optical cable water inlet, connected to the $\phi 13$ inner diameter water pipe.

⑤- **FIBER WATER IN**: Output optical cable water inlet interface, this interface is connected to the water outlet of the normal temperature water of the water cooler, and connected to the $\phi 13$ inner diameter water pipe.

⑥- **TOP WATER OUT**: The water outlet on the top of the laser is connected to the water inlet of the water chiller. RFL-C40000M is connected to a water pipe with an inner diameter of $\phi 38$, RFL-C60000M is connected to a water pipe with an inner diameter of $\phi 45$, and RFL-C80000M is connected to a water pipe with an inner diameter of $\phi 51$.

⑦- **TOP WATER IN**: The water inlet on the top of the laser is connected to the cooling water outlet of the water chiller. RFL-C40000M is connected to a water pipe with an inner diameter of $\phi 38$, RFL-C60000M is connected to a water pipe with an inner diameter of $\phi 45$, and RFL-C80000M is connected to a water pipe with an inner diameter of $\phi 51$.

⑧-**Bottom Water Outlet**: The water outlet at the bottom of the laser is connected to the cooling water return inlet of the water chiller. RFL-C40000M is connected to a water pipe with an inner diameter of $\phi 38$, RFL-C60000M is connected to a water pipe with an inner diameter of $\phi 45$, and RFL-C80000M is connected to a water pipe with an inner diameter of $\phi 51$.

⑨- **Bottom Water Inlet**: The water inlet at the bottom of the laser is connected to the cooling water outlet of the water chiller. RFL-C40000M is connected to a water pipe with an inner diameter of $\phi 38$, RFL-C60000M is connected to a water pipe with an inner diameter of $\phi 45$, and RFL-C80000M is connected to a water pipe with an inner diameter of $\phi 51$.

⑩-**DRAIN**: Laser drain port, connect to a water pipe with an inner diameter of $\phi 10$.


4.3 Power Connection

The definition and parameter requirements of AC INPUTline interface are shown in Table 8.

Table 8 The definition and parameter requirements of AC INPUTline

Interface definition	Identification	Wire diameter			
		RFL-C40000M	RFL-C60000M	RFL-C80000M	Colour
AC380V-L1	L1	50	120	185	Brown
AC380V-L2	L2	50	120	185	Gray
AC380V-L3	L3	50	120	185	Black
安全地	PE	25	95	185	Kelly

The standard length of the power cord provided by Raycus is 15m.

	<p>a) Before connecting to the AC power supply, please verify whether the provided AC power supply meets the specifications listed in Table 1;</p> <p>b) Incorrect wiring will cause damage to the laser. Therefore, before powering on the laser, please check whether the power cord is connected correctly.</p> <p>c) The laser operates with a high current. Please spread out the cables and avoid stacking them, to prevent heating of the cables due to prolonged operation.</p>
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4.4 Control Interface Definition

This type of laser does not provide a control signal line, except a control signal connector. The appearance of the joint is shown in Figure 23

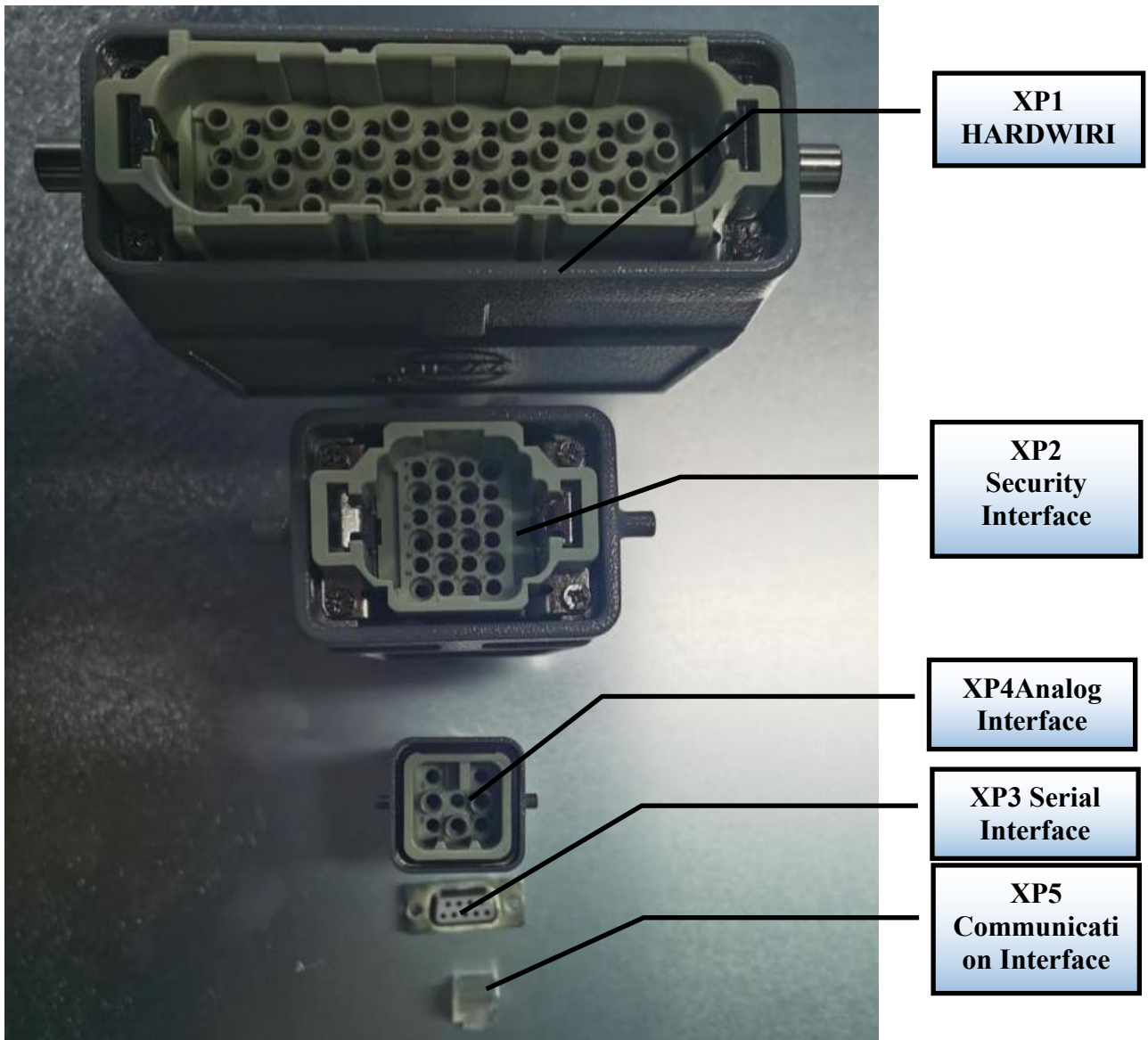


Figure 23 Control signal line

4.4.1 Control interface definition

The 24-pin safety interface has remote control system power-on, remote main power supply power-on, and active and passive outputs for some lasers. Detailed interface definitions are provided in Table 9

Table 9 Definition of XP2 safety interface

Pin No.	Type	Description
1	MOD+	Output control, voltage input signal; laser ON: 4V~30V; laser OFF: -3V~2V; Maximum modulation frequency: 5kHz;.
2	MOD-	
3	OUT(FET S pole)	Laser output indication, MOS pipe D, S output; current<0.5A. $V_{DS}<30V$. passive signal.

4	OUT(FET D pole)	
5	OUT	Connect the negative pole of the external laser-emitting indicator, current < 100mA
6	OUT	Connect the negative pole of the external power-on indicator, current < 100mA
7	OUT(24V)	Connect the positive pole of the external laser-emitting indicator; active signal, current < 400mA
8	IN	On REM mode, the main control board is powered on when pin-8 and pin-9 are closed; 24V active contact output, no external voltage or grounding.
9	IN	
10	24V OUT	Connect the positive pole of the external power-on indicator; active signal, current < 400mA
11	OUT	Emergency output 1 on the front panel, relay output contact, passive contact, current < 100mA, voltage < 30V; If the current panel stop pressed, pin-11 and pin-14 are open, or else close.
14	OUT	
12	OUT	Emergency output 2 on the front panel, relay output contact, passive contact, current < 100mA, voltage < 30V; If the current panel stop pressed, pin-12 and pin-13 are open, or else close.
13	OUT	
15	OUT(FET S pole)	Main power supply power on output indication, MOS pipe D, S output current < 0.5A, $V_{DS} < 30V$, passive signal.
16	OUT(FET D pole)	
17	IN	Interlock1 input, the pin-17 and pin-20 should be closed normally; active contacts, no external voltage or grounding.
20	IN	
18	IN	Interlock2 input, the pin-18 and pin-19 should be closed normally; active contacts, no external voltage or grounding.
19	IN	
21	IN	Close the pin-21 and pin-22 to start the main power supply remotely. (The function is the same as the LASER button on the front panel.) active contacts, no external voltage or grounding.
22	IN	
23	OUT	Pin-23 and pin-24 indicate the laser key switch status: Opened - the laser key switch is in the OFF position; Closed - The laser key switch is in the ON or REM position. Passive contact, external voltage signal, the voltage is less than 30V, and the current is less than 1A.
24	OUT	

a) MOD signal

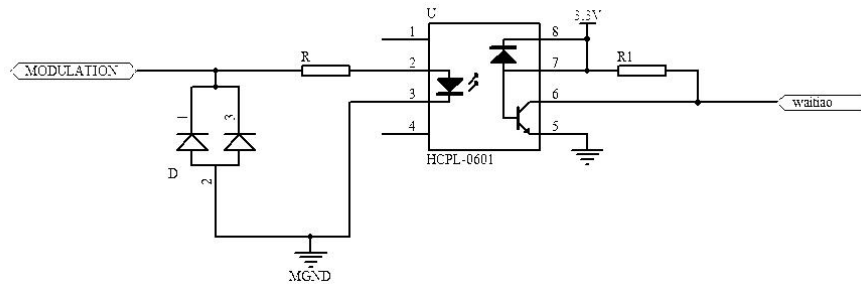


Figure 24: MOD Signal Circuit Diagram

This signal requires a voltage >18V and does not allow reverse polarity.

b) Passive light-emitting indicator and main power-on indicator

The 3/4 light output indication of XP2, and 15/16 is the output indication for the main power being on. The internal circuit diagram is shown in Figure 25:

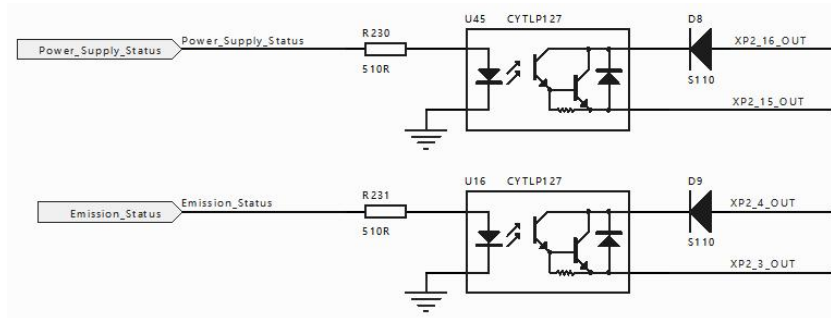


Figure 25 Circuit diagram of light output and main power on indication

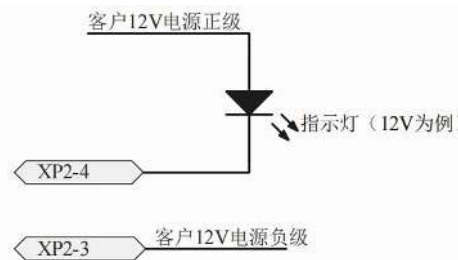


Figure 26 Recommended wiring diagram for light output indication (taking 12V as an example)

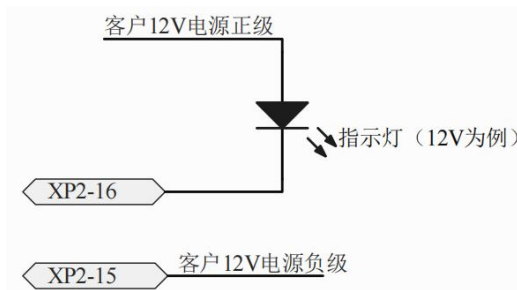


Figure 27 Recommended wiring diagram for indicating that the main power supply is powered on (taking 12V as an example)

c) Active light indicator and a main power-on indicator

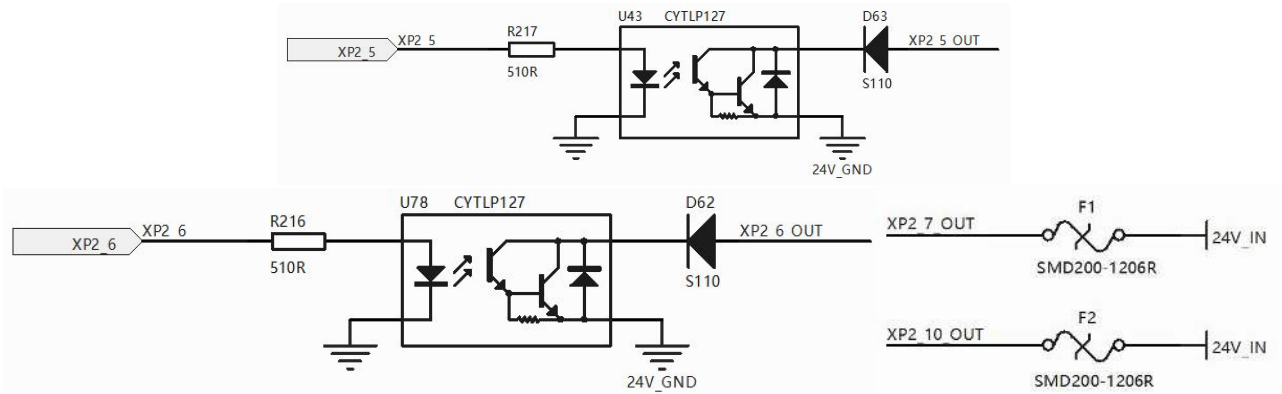


Figure 28 Circuit diagram with active light indication and main power-on indication

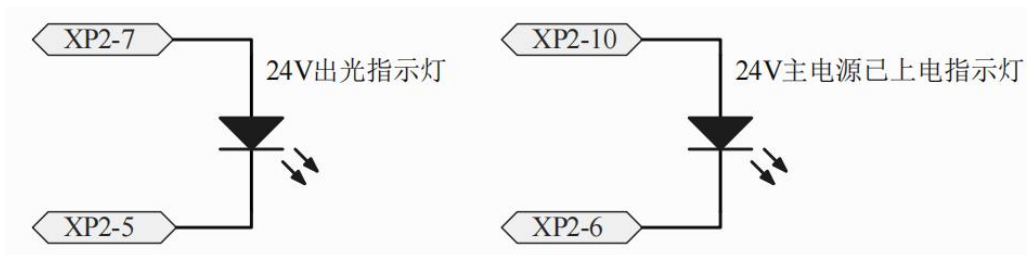


Figure 29 Recommended wiring diagram for active light output indication and main power supply powered-on indication

d) Power on the remote control board

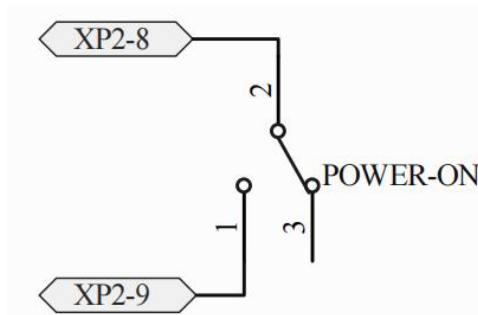


Figure 30 Recommended wiring diagram for powering up the remote control board

When the laser key switch is set to REM mode, the main control board's pins 8/9 must be short-circuited before powering on.

e) Power on the remote main power supply

This signal is used to power up the main power supply through the XP2 interface.

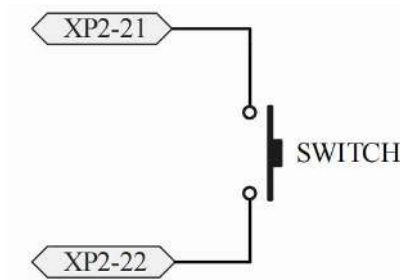


Figure 31 Wiring diagram for remote main power supply power-up of XP2

- f) The control board has been powered on and is outputting
This signal is a relay output. After the main control board is powered on, the relay engages, causing the passive contact to close, without distinction between positive and negative pole s. It is externally connected to a voltage signal with a voltage less than 30V and a current less than 1A.

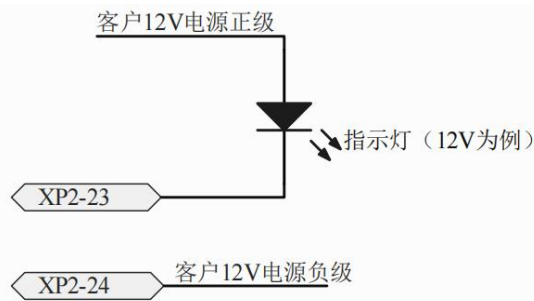


Figure 32 Recommended wiring diagram for powering up the XP2 remote control board

4.4.2 HARDWIRING XP1

64 pin hardwire interface, control signal input and output interface of laser in remote mode. Input high level is greater than 18V valid, input low level is less than 3V valid. Specific interface definitions are shown in Table 7 below.

Table 7 XP1 hardwire interface definition

	Interface Definition		Type	Description
	Pin No.	Pin Definition		
XP1	A1	Laser request signal	Input signal	Laser request signal, only after this bit is valid will the laser receive other XP1 hard-wired interface input commands.
	A2	Programming mode start-up execution	Input signal	The programming mode is initiated by the rising edge and terminated by the falling edge. The program number is determined by A8 to A14. In REM mode, if the program number is 0000000 and A6 is high, the laser power is set by an external analog quantity; if the program number is 0000000 and A6 is low, the laser power is set by the Raycus;

A3	Enabling Internal patter	Input signal	High level enables PC software control function.
A4	Reset signal	Input signal	Active on rising edge; to clear laser alarm bit; effective high-level time at least 1 ms.
A5	Red light indicator	Input signal	The guide led light indicator is on when A5 is high.
A6	Simulation control enabling energy	Input signal	When A6 is high, the analog input signal is enabled. The program number Program Number is required to be set to 0, or A8~A14 are all low (non-programming mode).
A7	Stop programming Mode	Input signal	In programming mode, program execution is terminated immediately when A7 is high.
A8~A14	Set program Number	Input signal	Hardwired address for selecting a stored program number. A8 is the lowest bit and A14 is the highest bit.
A15	synchronous input	Input signal	Synchronous input signal, used with the program command WAIT in programming mode.
A16	COM	Reference ground	Reference ground for all input signals of XP1.
C1	Laser-driven power supply	Input signal	The rising edge turns on the main power, and the falling edge turns off the main power.
B1	The laser is ready	Output signal	The laser is ready to emit laser light when B1 is high.
B2	Laser output	Output signal	The laser is emitting light when B2 is high.
B3	The laser operates in internal mode	Output signal	The laser works in the internal control mode when B3 is high. In this mode, the laser can be controlled by communication.
B4	Laser anomalies	Output signal	The laser is abnormal when B4 is high.
B5	Laser red light indication	Output signal	The laser is emitting guide light when B5 is high.
B6	AD mode	Output signal	The laser works in the AD mode when B6 is high.
B7	Feedback signal of A1	Output signal	The laser has received the A1 signal when B7 is high.
B8	Main power supply of laser	Output signal	The main power of laser is on when B8 is high.
B9	Program running	Output signal	Laser program is running when B9 is high.
B10	Program ending	Output signal	Laser program is ended when B10 is high. B10 clears when the A2 is invalid.

	B11	Abnormal Wave Mode Termination	Output signal	Laser program is ended abnormally when B11 is high. B11 can be cleared when the A4 is high.
	B12	Synchronous output	Output signal	Sync signal output in programming mode.
	B13	Warning output	Output signal	Laser is warning when B13 is high.
	B14	Not connect		
	B15	External power supply (Positive pole)	Input signal	The 24 V input voltage, power supply of all XP1 output signal. Only when B15 and B16 access 24 V power, output signal is effective.
	B16	External power (Negative pole)	Input signal	

4.4.3 RS232 XP3

The 9-pin serial interface RS232 is used for the communication between the laser and the Raycus software. It can be used to communicate with the Raycus software or the software of the Raycus software which integrates the communication protocol of Raycus. The definition is as follows.

Table 8 RS232 serial interface definition

Pin No.	Type	Description
2	IN	RXD, serial receiving pin of laser
3	OUT	TXD, serial transmitting pin of laser
5	COM	GND, signal ground

Baud rate: 9600, Data bits: 8, Stop bits: 1, No parity and no flow control

4.4.4 AnalogXP4

The analog interface, an 8-core Harting interface, is used to control the output power of the laser by analog in AD mode, and can also monitor the output light and power feedback signals of the laser. The interface definition is shown in Table 12 below.

Table 12 XP4 analog interface definition

Pin No.	Type	Description
1	IN	0V~10 V analog signal, laser power control signal in AD mode , 0V~10 V corresponding to 0%~100% output power
2	AGND	Analog signal ground
3	OUT	Power amplifier voltage output. 0 V: 0% laser power output;
4	Reference	Reference ground for power amplifier voltage
5	OUT	High back-amplification voltage (reserve, no use)
6	Reference	Reference ground for high backup voltage (reserve, no use)

4.4.5 ETHERNET Interface TCP/IP

Table 13 XP5 communication interface definition

Pin No.	Function	Description
1	TX+	Data transmission+
2	TX-	Data transmission-
3	RX+	Data acceptance+
4	N/C	Not connect
5	N/C	Not connect
6	RX-	Data acceptance-
7	N/C	Not connect
8	N/C	Not connect

The Ethernet port configuration is as follows:

- Default IP address of the laser : 192.168.0.10;
- Laser port: 10001.
- Laser communication protocol (network port & serial port)

All commands and return values in this protocol are composed of ASCII characters. When entering, please pay attention to the following points:

- a) Commands generally consist of 3 or 4 letters, and sometimes numerical values are attached;
- b) All commands and return values end with the "Enter" character (CR, 0x0D, \r). If this product receives a string containing a "Enter" character but the command is invalid, it will return to the "Command Err!\r";
- c) For ease of identification, all commands are written in uppercase letters, but in reality, this product does not distinguish between uppercase and lowercase letters. To facilitate identification, a space is added between the command and the parameter;
- d) This product will send a return value for every command received. The return value generally includes the command content itself. If the returned content contains numerical values or error types, a colon (":") will be used to separate the returned command content from the numerical values or error types.

The specific protocol content and command examples of this product are shown in Table 14

Table 14

Comman	Description	Command example
ABF	Aiming Beam OFF –Turn off red	Send: ‘ABF\r’ Return: ‘ABF\r’
ABN	Aiming Beam ON – Turn on red	Send: ‘ABN\r’ Return: ‘ABN\r’
DEABC	Disable External Aiming Beam Control	Send: ‘DEABC\r’ Return: ‘DEABC\r’

EEABC	Enable External Aiming Beam Control	Send: 'EEABC\r' Return: 'EEABC\r'
DEC	Disable External Control	Send: 'DEC\r' Return: 'DEC\r'
EEC	Enable External Control	Send: 'EEC\r' Return: 'EEC\r'
DLE	Disable Hardware Emission Control	Send: 'DLE\r' Return: 'DLE\r'
ELE	Enable Hardware Emission Control	Send: 'ELE\r' Return: 'ELE\r'
EM OFF	Stop Emission	Send: 'EMOFF\r' Return: 'EMOFF\r'
EMON	Start Emission	Send: 'EMON\r' Return: 'EMON\r'
MPWR OFF	Main Power OFF	Send: 'MPWROFF\r' Return: 'MPWROFF\r'
MPWR ON	Main Power ON	Send: 'MPWRON\r' Return: 'MPWRON\r'
SPW	Set Pulse Width	Send: 'SPW 100\r' Return: 'SPW:100\r' (Set pulse width as 100ms) Other return values: 'ERR: input Err\r' (Input pulse width <0.0001) 'ERR: Out of Range\r' (Over maximum pulse width) 'ERR: Duty Cycle too High\r' 'ERR: Duty Cycle too Low\r' 'SPW:100, Duty=100%\r'
SPRR	Set Pulse Repetition Rate	Send: 'SPRR 1000\r' Return: 'SPRR: 1000\r' 'ERR: input Err\r' 'ERR: Out of Range\r' 'ERR: Duty Cycle too High\r' 'ERR: Duty Cycle too Low\r' 'SPW: 100, Duty=100%\r'
SDC	Set Diode Current (%) The set value must be less than 100% and above the minimum current setting value, which can be set to 0. If the set value is greater than 100, the default is input 100.	Send: 'SDC 100\r' Return: 'SDC: 100\r' Other return values: 'ERR: Input Err\r' 'Laser is worked in AD Mode\r'
RCS	Read Current Set point	Send: 'RCS\r' Return: 'RCS: 56.7\r' (The current set value is 56.7 %)

RPRR	Read Pulse Repetition Rate (Hz)	Send: 'RPRR\r' Return: 'RPRR:10\r' (Repeat frequency is 10Hz)
RBT	Read Board Temperature	Send: 'RBT\r' Return: 'RBT:36.6\r'
RPW	Read Pulse Width (ms)	Send: 'RPW\r' Return: 'RPW:5.5\r' (pulse width is 5.5ms)
RCT	Read Laser Temperature	Send: 'RCT\r' Return: 'RCT:34.5\r'
PERR	Reset Errors	Send: 'PERR\r' Return: 'PERR\r'
SUT	Set Up Time (ms)	Send: 'SUT 50\r' Return: 'SUT:50\r'
SDT	Set Down Time (ms)	Send: 'SDT 50\r' Return: 'SDT:50\r'
RUT	Read Up Time (ms)	Send: 'RUT \r' Return: 'RUT:50\r'
RDT	Read Down Time(ms)	Send: 'RDT \r' Return: 'RDT:50\r'
PSRT	Program Start	Send: 'PSRT 1\r' Return: 'PSRT:1\r'
PSTP	Program Stop	Send: 'PSTP\r' Return: 'PSTP\r'
ECM	Enable Calibration Mode –Power linear correction mode (in this mode, the external analog is corrected and output after filtering, so the response time of AD analog is larger than that of through mode)	Send: 'ECM \r' Return: 'ECM\r'
DCM	Disable Calibration Mode (AD analog response time is less than 100 us in this mode)	Send: 'DCM\r' Return: 'DCM\r'
Others	Command Error	Send: 'BGM\r' Return: 'Command Err!\r'
STA	Read Device Status – Read the product status. A return value of 32-Bit digital information. The meaning of each Bit is as follows (undefined or 'reserved' Bit negligible):	Send: 'STA' Return: 'STA:4100' returned value 4100(Decimal) can be converted to 0 x1004 (hexadecimal), and then converted to binary to see that Bits 2 and 12

Bit 0	Normal operation
	Authorization time
Bit 1	Normal
	Temperature too high
Bit 2	Emission off
	Emission on or in preparation
Bit 3	No high reflection
	High reflection Abnormal
Bit 4	External AD mode=off
	External AD mode=on
Bit 5	Power Correction Mode=off
	Power Correction Mode=on
Bit 6	Normal
	Sub-controlling communication abnormal
Bit 7	Normal
	Sub-module abnormal
Bit 8	Guide red light=off
	Guide red light=on
Bit 9	The laser is not ready
	The laser is ready
Bit 10	QCW mode=off
	QCW mode=on
Bit 11	Module Main Power=off
	Module Main Power=on
Bit 12	Modulation mode=off
	Modulation mode=on
Bit 13	Normal
	Leakage sensors 1 leaking
Bit 14	Normal
	Leakage sensors 2 leaking
Bit 15	No laser
	Laser is power on
Bit 16	Gate mode=off
	Gate mode=on

Bit 17	AC input normal
	AC input abnormal
Bit 18	External Emission control=off
	External Emission control=on
Bit 19	Normal
	Laser fault
Bit 20	Slow up slow down mode off
	Slow up slow down mode on
Bit 21	A laser operates in ON" mode
	A laser operates in REM" mode
Bit 22	Wave mode off
	Wave mode on
Bit 23	Surge protector normal
	Serge protector failure
Bit 24	Normal
	Low temperature fault
Bit 25	Normal
	Humidity alarm
Bit 26	Normal
	Water flow meter 1 Flow Alarm
Bit 27	Red light internal control
	Red Light External Control
Bit 28	Normal
	Water flow meter 2 Flow Alarm
Bit 29	Normal
	Module locked
Bit 30	Optical circuit safety interlock normal
	Optical circuit safety interlock abnormal
Bit 31	Normal
	High average power

4.5 Installation sequence of the laser

- a) Carefully take out the laser and move it to the installation position;
- b) Remove the protective cap from the optical cable output end, use strong light to check if there is dust on the output end lens. If there is, clean it before use, and then replace the protective cap on the output end;
- c) Install the output optical cable on the processing equipment according to the actual situation (also install the cooling water pipe for the output head). Ensure the output optical cable is neatly arranged and the output head is well protected. Remove the protective cap, reconfirm whether the output end lens is clean, and then install the output head;
- d) Connect the cooling system, water inlet filter assembly, and laser cooling water pipe;
- e) Connect the control circuit and power supply according to the external control mode.

4.6 Start operation sequence

- a) Turn on the water chiller, check whether the water pipe is leaking. If not, turn off the water chiller and proceed with the electrical connection;
- b) Ensure that the circuit breaker is in the OFF state, and the emergency stop button on the front panel of the laser has been pressed; all electrical connections must be completed before powering on the laser;
- c) Confirm that the three-phase electrical wiring is correct and the power supply meets the specifications of the power supply section;
- d) Close the circuit breaker on the rear panel and release the emergency stop switch on the front panel of the laser. Turn on the key switch. If the laser gives a temperature and humidity alarm, turn off the key switch. After the air conditioner has been working for 10 minutes, turn on the key switch again. If the laser gives a temperature and humidity alarm, turn off the key switch again. After the air conditioner has been working for another 10 minutes, if the laser does not give a temperature and humidity alarm when the key switch is turned on, turn off the key switch and turn on the water chiller. Ensure that all doors of the laser are closed, the optical cable output head is inserted into the cutting head (or corresponding equipment), and all safety circuit interfaces are closed;
- e) Select the desired control mode, turn on the key switch, activate the main power supply, turn off the red light, and wait for the laser to be ready. When the green light of the three-color light above the machine illuminates, it indicates that the laser is ready to emit light.

4.7 The instructions of Raycus software

Raycus Laser has developed a dedicated laser monitoring software, which enables human-machine interaction through the software to read and set laser parameters as well as control functions. The interface displayed by the software is divided according to functional categories, including laser management platform, working mode, language selection, about, authorization, main status interface, circuit status interface, module enable interface, interface interface, alarm interface, module parameter interface, programming mode interface, log interface, etc.

4.7.1 Laser management software

Raycus Laser provides laser management software, through which functions such as searching for lasers and configuring parameters can be performed. Turn on the laser by opening the knob on the rear panel of the laser and rotating the laser key to ON or REM. Power on the laser. Open the laser management software and click "Search for Devices" to search for the laser.

In the laser management software, configure the laser IP address, subnet mask, and default gateway through "Parameter Configuration", as shown in Figure 33. Once the IP address is confirmed, you can connect to the laser, and the successful connection is shown in Figure 34. The factory default IP address of the Raycus laser is 192.168.0.10. After completing the laser IP address configuration, click to open the software and enter the Raycus host computer interface.

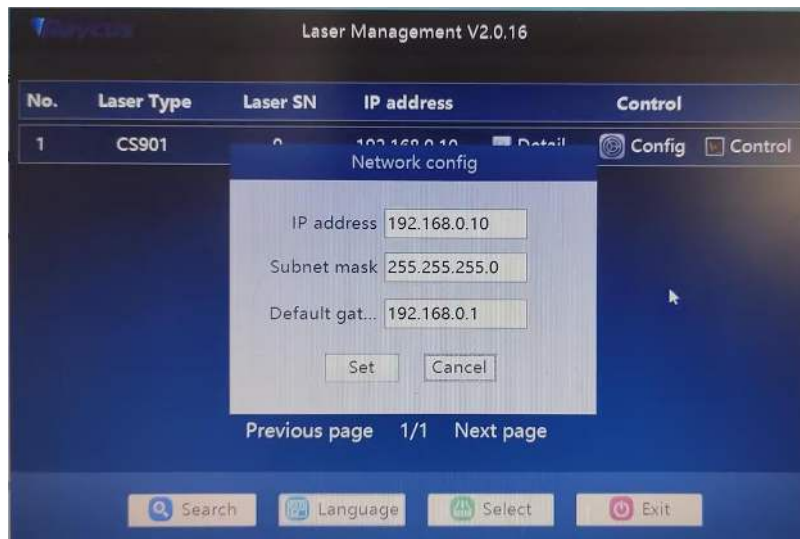


Figure 33 Raycus Laser Management Platform Configuring IP Address

4.7.2 Usage of the Raycus software

The main interface of the Raycus software display is shown in Figure 35.

Basic usage method of Raycus laser Raycus software:

- Click "Mode", select "Control Mode", and click "OK" to enter the control mode;
- Click "Power on main power OFF" to power on the main power supply of the laser. This button changes to "Power on main power ON", and the "Power" indicator in the main status bar is lit;

- c) Click the red light ON button to turn off the red light and wait for the laser preparation to complete. After the laser preparation is completed, the "Ready" indicator in the main status bar will be lit;
- d) Set "Power [%]" or "Power [W]", set "Frequency" and "Duty Cycle", and click "Set";
- e) Click "Laser Emission ON", the laser emits light, and the "Emission" indicator in the main status bar is lit;
- f) If it is necessary to set the output optical power to a ramp up or ramp down mode, you can set the "Power ramp up time" and "Power ramp down time" in the "Laser" area, and click "Set" to enter the power ramp up or ramp down mode for the laser;
- g) If you need to edit the optical power waveform yourself, you can refer to Section 8.13 of this operating instruction to edit the waveform, set the "Program Number" in the "Laser" area, enter the programming mode, and click "Laser Emission ON" to output the laser according to the edited waveform.

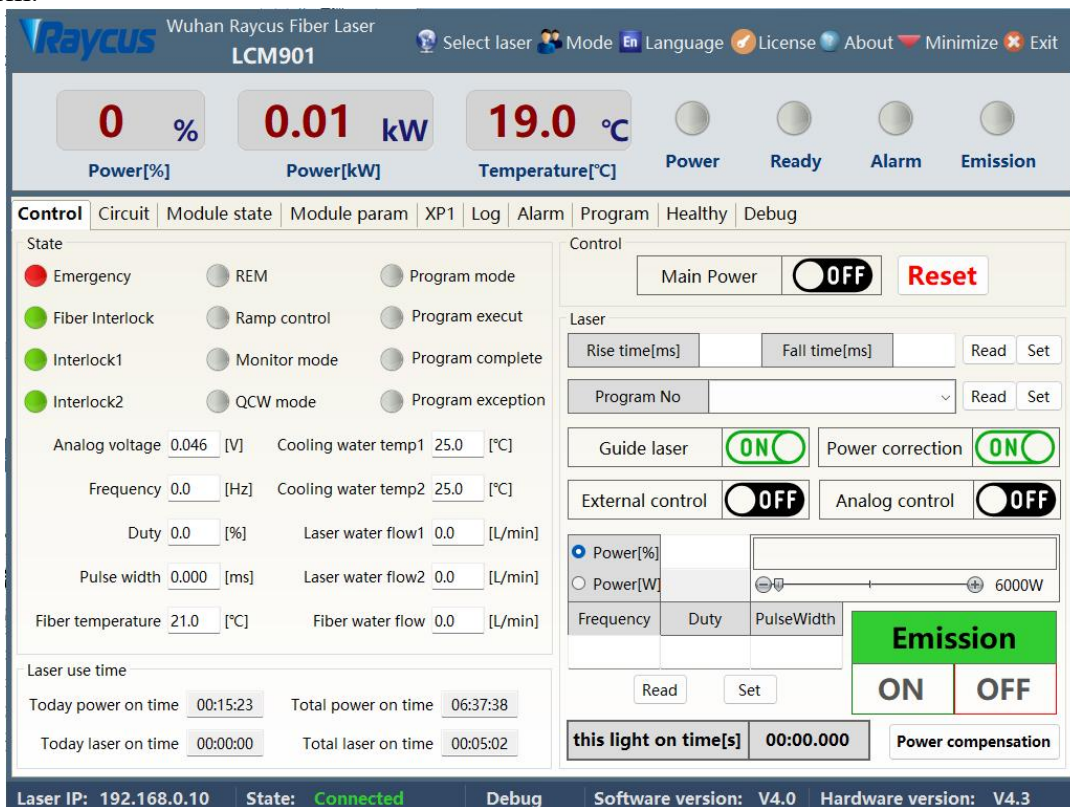


Figure 35 The main interface of the Raycus software

4.7.3 Selection of working mode for Raycus software

The laser operation mode is set through the Raycus software, and its operation menu is shown in Figure 36. The definitions of various modes are shown in Table 15. When the display programming mode is selected, the waveform editing menu will be displayed on the software.

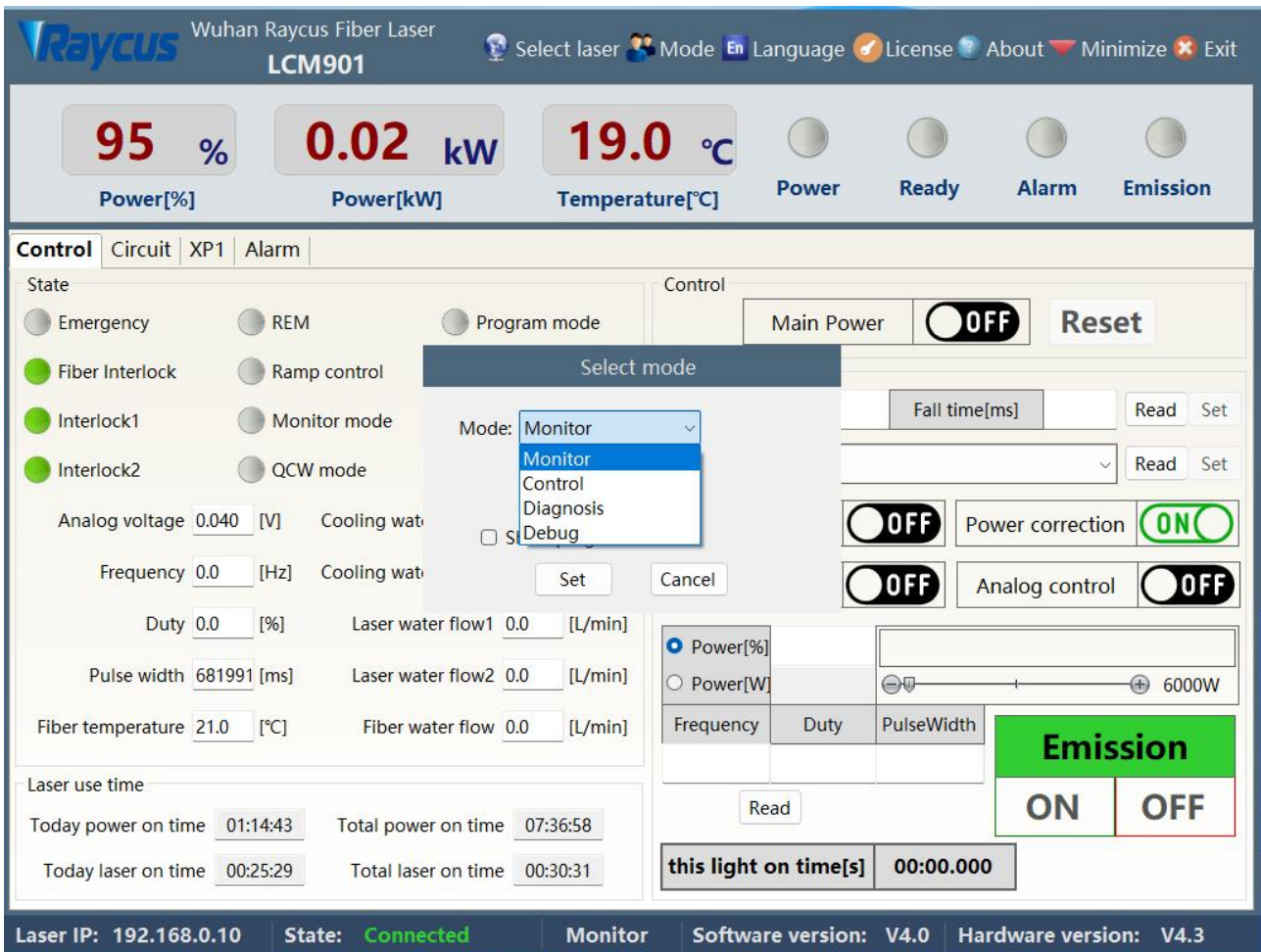


Figure 36 Display menu for laser operation mode selection display area

Table 15 Laser operating modes and their meanings

Mode selection	Meaning of mode selection mode
Observing Mode	This mode provides the most concise software menu
Control Mode	This mode enables the upper computer to control buttons, and users can use this mode to control the laser
Diagnostic Mode	This mode displays all the states and parameters of the laser for easy diagnosis of the laser
Debug Mode	can modify the parameters of the laser (it is necessary to verify the laser

4.7.4 Language Selection

The laser language selection operation menu is shown in Figure 37. Currently, only Simplified Chinese and English languages are supported. After clicking to set the language, you need to reopen the Raycus software before the settings will take effect.

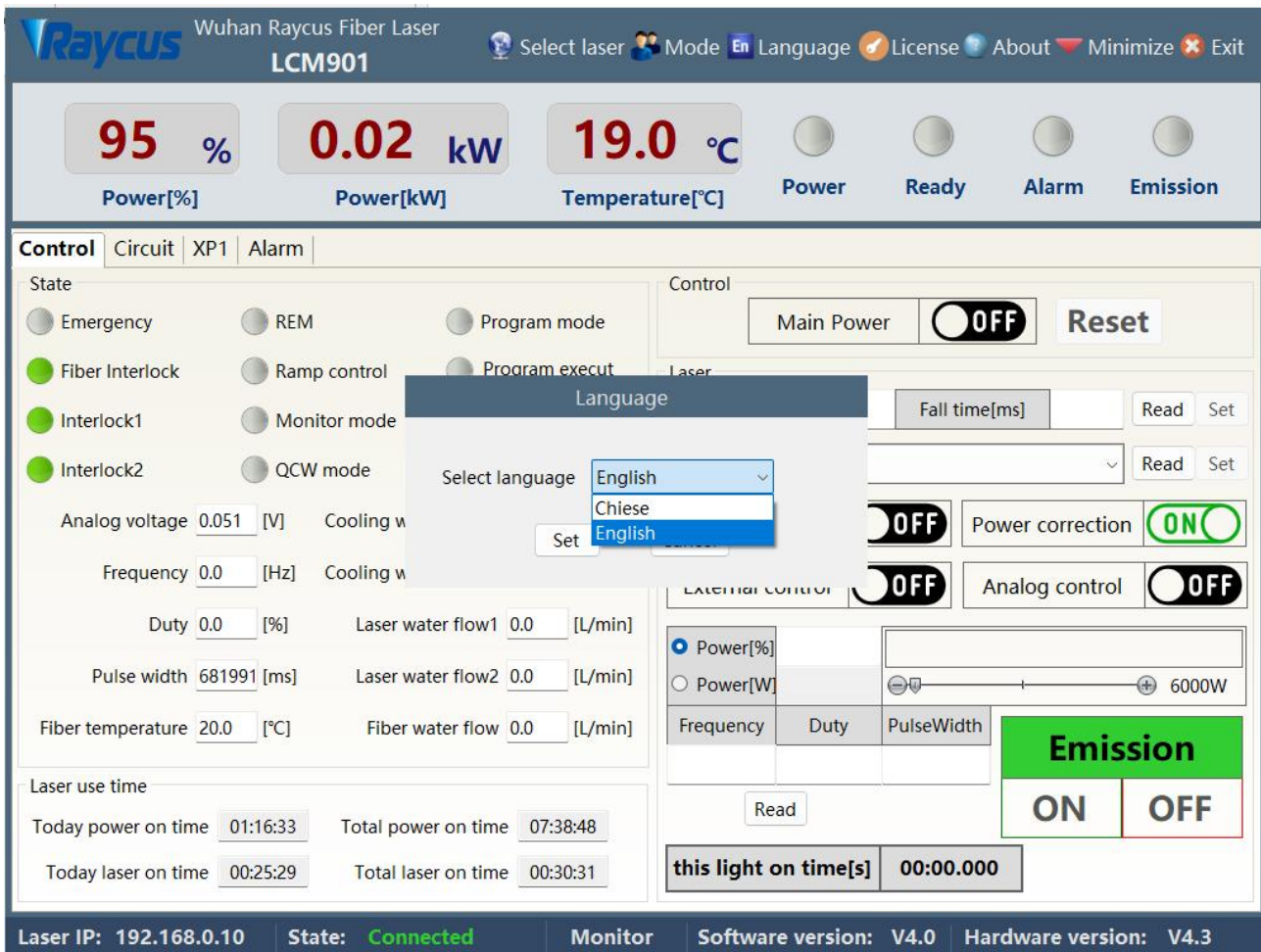


Figure 28 Laser Language Selection Operation menu

4.7.5 About

Information such as laser factory time, model, laser serial number, master serial number, key version number, and system information can be queried in the "About" item of the Raycus software. The specific display menu is shown in Figure 38.

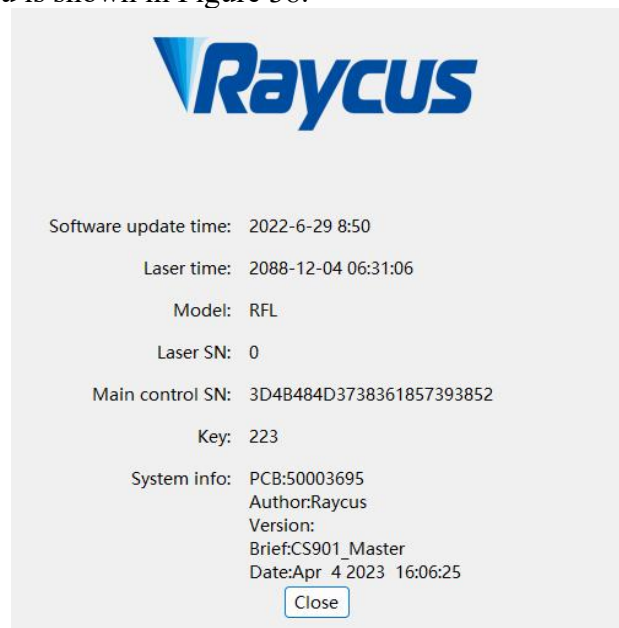


Figure 38 Laser related information query menu

4.7.7 Main status display area

The main status display area of the laser is shown in Figure 40, and the display content is shown in Table 16.



Figure 40 Schematic diagram of the main display area of the laser

Table 16 Display Contents and Meaning of the Main Display Area of the Laser

Display Content	Meaning
Output power [%]	real-time display of the currently set power percentage
Output power [W]	Displays the average output power of the current laser in real-time
Laser temperature(°C)	Real time display of the current laser water cooled plate
The Power indicator	indicates the current status of the main power supply: green - the main power supply is powered on gray - the main power supply is not powered on
The Ready indicator	indicates the Ready status of the current laser: green - the laser is ready to output laser light; Grey - laser is not ready
The Alarm indicator	indicates the current alarm status of the laser: yellow - the laser is abnormal, Grey - no abnormality in the laser
The Emission indicator	indicates the current output state of the laser: red - the laser is outputting laser light, Grey - laser not outputting laser light

4.7.7.1 Laser working status display area

The laser operation status display area is shown in Figure 41, and the display content is shown in Table 17.

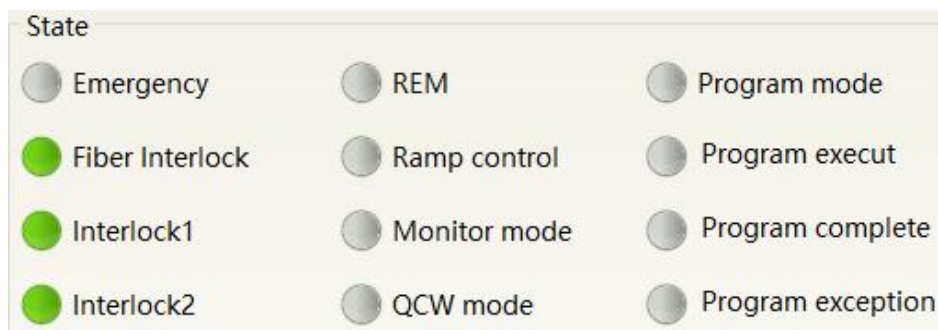


Figure 41 Schematic diagram of laser operation status display area

Table 17 Contents and meanings displayed in the main display area of the laser

Display	Meaning
Emergency stop	red - indicates that the emergency stop button on the front panel of the laser is pressed; Grey - indicates that the emergency stop button on the front panel of the laser has been reset
The status of output optical cable interlock	green - the interlock contact on the output optical cable head is closed; Grey - The Interlock contact on the output cable head is open
InterLock1 closed	green - the 17 and 20 pins on the XP2 safety interface are closed Grey - pins 17 and 20 on the XP2 safety interface are disconnected
InterLock2 closed	green - pins 18 and 19 on the XP2 safety interface are closed Grey - pins 18 and 19 on the XP2 safety interface are disconnected
REM	green - the laser operates in REM mode Grey - laser operates in ON
Power ramp up ramp down mode	green - the laser is operating in power ramp up ramp down mode Grey - the laser is not operating in power ramp up ramp down mode
Monitoring mode	green - The upper computer software is in monitoring mode and can only view laser status information, and cannot perform any control on the laser. This mode is activated when the 10001 port of the laser is used by the customer. Grey - upper computer software running in normal mode
QCW mode	green - the laser is operating in QCW mode Grey - laser operating in continuous mode
Programming mode	green - the laser is running in programming mode, and the program number is not 0; Grey - The laser is not running in programming mode and the program number is 0
Executing	green - the laser is executing a program in programming mode Grey - The laser is not in programming mode or the program in programming mode is not being executed
Execution Complete	Green - Laser execution completes the program in programming mode Grey - The laser is not in programming mode or the program has not
Execution abnormal	red - The laser is in programming mode and the execution program is abnormally interrupted Grey - The laser is not in programming mode or the laser is in programming mode and in a normal state

4.7.7.2 Display area for accumulated working time of laser

The display menu of laser cumulative working time is shown in Figure 28. It can display the cumulative startup time, cumulative laser output time, today's startup time, and today's light output time of the current laser, in units of hours, minutes, and seconds.



Figure 42 Display menu for accumulated working time of laser

4.7.7.3 Laser power on, mode selection, light output control area

The display area for laser power on, mode selection, and light output control is shown in Figure 43, and the display content is shown in Table 18

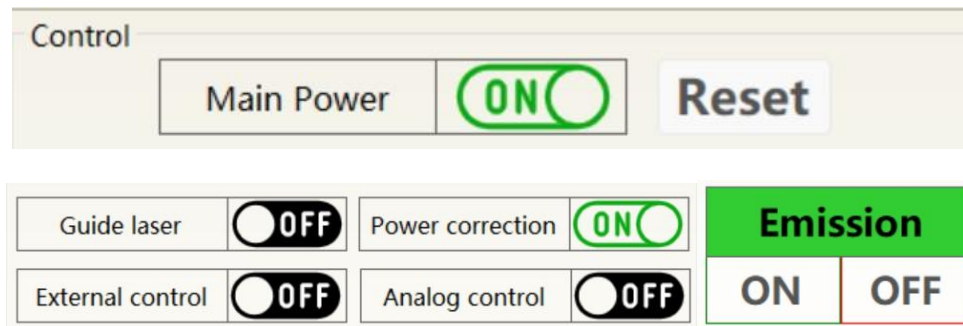


Figure 43 Display area for laser power on, mode selection, and light output control

Table 18 Display content and meaning of laser power on, mode selection, and light output control display

Display	Meaning
Main power on button	Click ON to power on the main power supply; Click OFF to power off the main power supply
Reset	clears the current laser alarm
Red light	Click ON to turn on red light; Click OFF to turn off the red light
power correction	Click ON to activate the laser power correction mode; Click OFF to turn off the laser power correction mode;
External control mode	Click ON to activate laser external control; Click OFF to turn off the laser external control; Automatic memory of mode power failure
AD mode	Click ON in to activate AD analog mode; Click OFF to turn off the AD analog mode;
Laser emission	Output laser
Laser emission	Turn off the laser

4.7.7.4 Slow rise and slow fall parameter area

The display menu of the laser power ramp up ramp down parameter setting area is shown in Figure 44. Click Read Parameters to read the power rise and fall times stored in the laser. Click Set Parameters to set a new power up and down time. When the rise and fall times are all set to 0, the power ramp up and ramp down function is automatically turned off; When one is not 0, the ramp up or ramp down function is automatically turned on, and the "ramp up environment mode" indicator in the status area is lit.

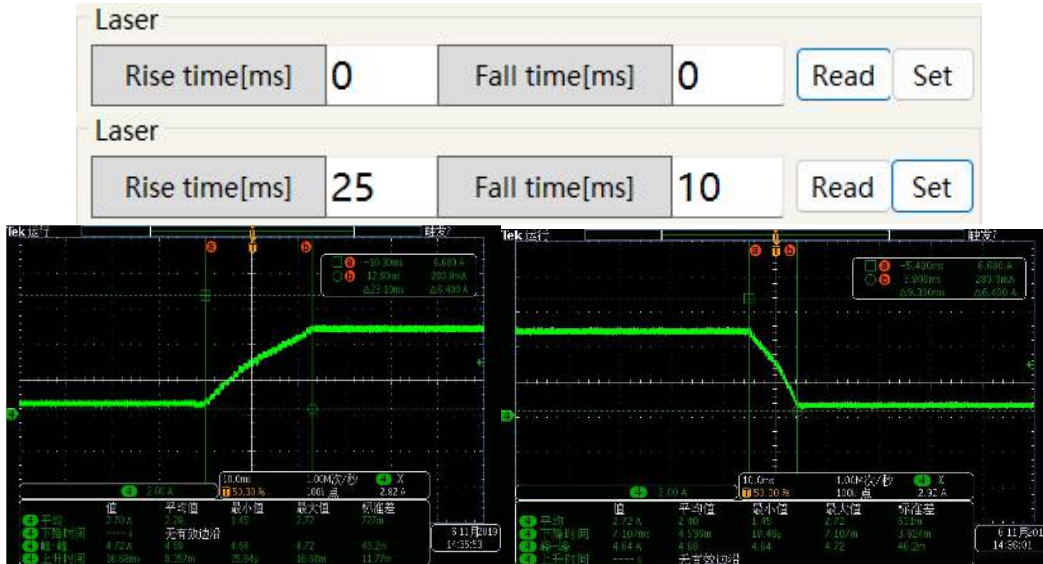


Figure 44 Display menu and measured waveform of power ramp up and ramp down setting area

4.7.7.5 Programming mode test area

The laser programming mode display menu is shown in Figure 45, where the program is written and written to the laser (see Section 8.13 of this description for specific methods); In this interface, select the program number, click Settings, and the "Program Mode" indicator in the status area will light up. Click "Laser Emission ON", and the "Executing" indicator in the status area will light up. After the program execution is completed, the "Executing Completed" indicator in the status area will light up. During the execution process, click "Laser Emission OFF", and the "Executing Abnormality" indicator in the status area will light up.

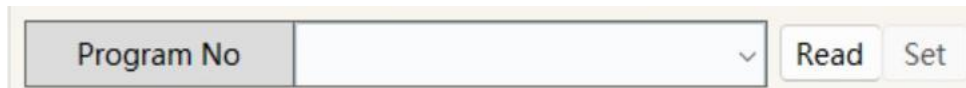


Figure 45 Laser Programming Mode Test Area Display menu

4.7.7.6 Output parameter reading and setting area

The display menu of the laser output parameter setting area is shown in Figure 46. The light output parameter setting is invalid when the AD mode is turned on.

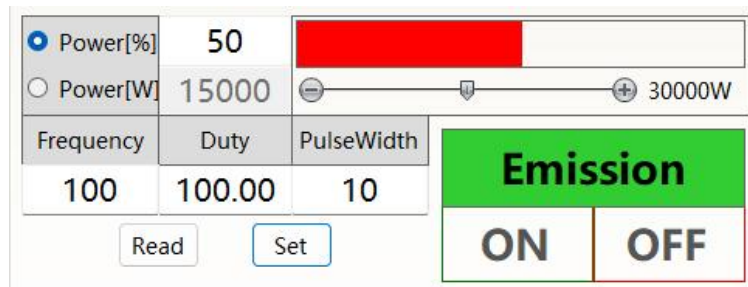


Figure 46 Display menu of light output parameter setting area

4.7.8 Laser circuit status display area

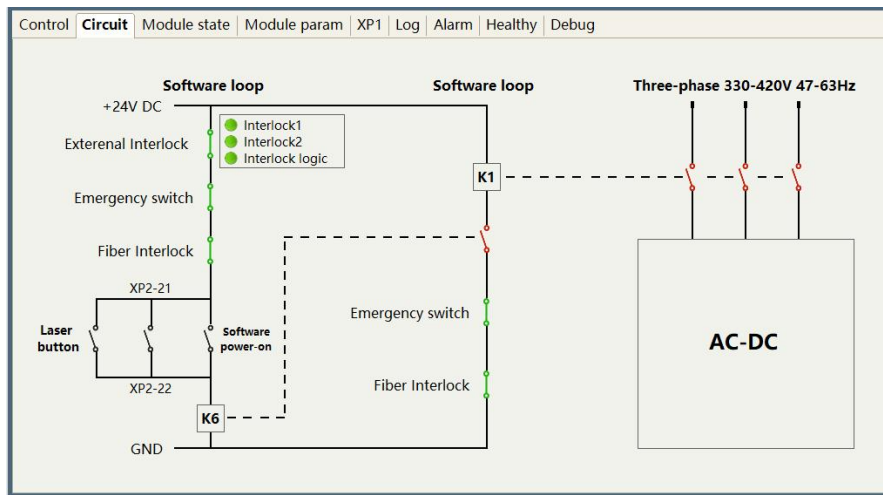


Figure 47 Laser Circuit Status Display menu

The laser circuit display area is shown in Figure 47. According to this state diagram, the laser safety circuit status can be checked.

4.7.9 Laser module enable display area

The display menu of the laser module enabling display area is shown in Figure 48. The green indicator light indicates that the "ON" check box is selected, indicating the module actually running in the current laser.

Module state			Module param		XP1	Log	Alarm	Healthy	Debug					
Module	State	Alarm	Module	State	Alarm	Enable	Temp1	Temp2	Module	State	Alarm	Enable	Temp1	Temp2
Master module	<input type="radio"/>	<input type="radio"/>	Optical module1	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	20.0	20.0	Optical module11	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
Bundle module	<input checked="" type="radio"/>	<input type="radio"/>	Optical module2	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	20.0	20.0	Optical module12	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
Dehumidity module	<input type="radio"/>	<input type="radio"/>	Optical module3	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>	-5.0	-5.0	Optical module13	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
			Optical module10	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-	Optical module14	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
			Optical module9	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-	Optical module15	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
			Optical module8	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-	Optical module16	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-
			Optical module7	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-						
			Optical module6	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-						
			Optical module5	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-						
			Optical module4	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	-	-						

Read Set

Figure 48 Display menu of laser parameter display area

4.7.10 XP1 Interface Status Indication

The laser interface status indication menu is shown in Figure 49, which displays the input and output status of the XP1 interface on the rear panel for easy viewing of interface status information.

The screenshot displays the XP1 interface status menu. At the top, it shows the Raycus logo and the model number LCM901. Below this, there are several key indicators: Power [%] at 20%, Power [kW] at 0.00, and Temperature [°C] at 255.0. There are also status icons for Power (green), Ready (grey), Alarm (yellow), and Emission (grey). The main area is divided into 'Input signal' and 'Output signal' sections, each with a list of 15 items, each accompanied by a radio button. The status of these signals is indicated by the color of the radio button (green for active, grey for inactive). At the bottom, there is a status bar showing 'Laser IP: 192.168.0.10', 'State: Connected', 'Monitor', 'Software version: V4.0', and 'Hardware version: V4.3'.

Figure 49 Interface Status Indication menu in Diagnostic Mode

4.7.11 Alarm Type Display Area

The display menu of the laser alarm type display area is shown in Figure 50. This menu displays the current laser alarm reason.

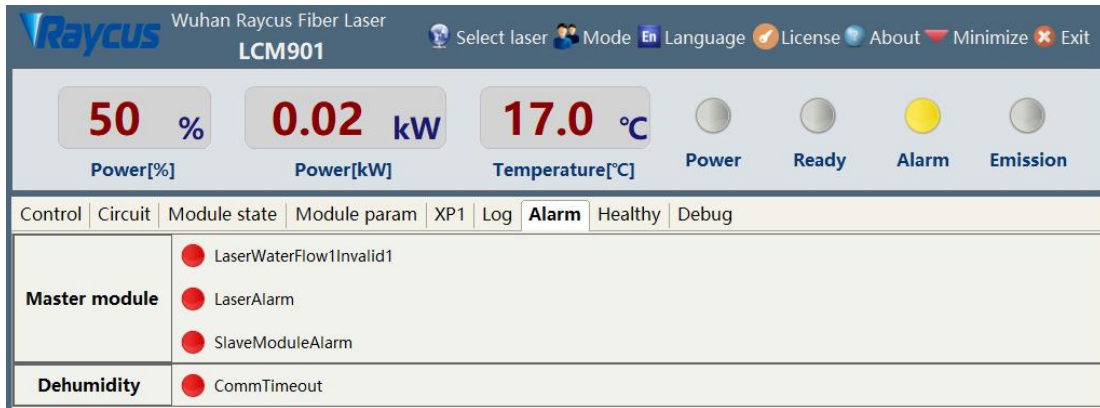


Figure 50 Display menu of laser alarm type display area

4.7.12 Module parameters (in diagnostic mode)

The laser enters diagnostic mode to activate the module parameter menu. The laser module parameter query menu is shown in Figure 51. This menu is for parameter query in diagnostic mode, and its data is convenient for our technical personnel to analyze the cause of laser abnormalities.

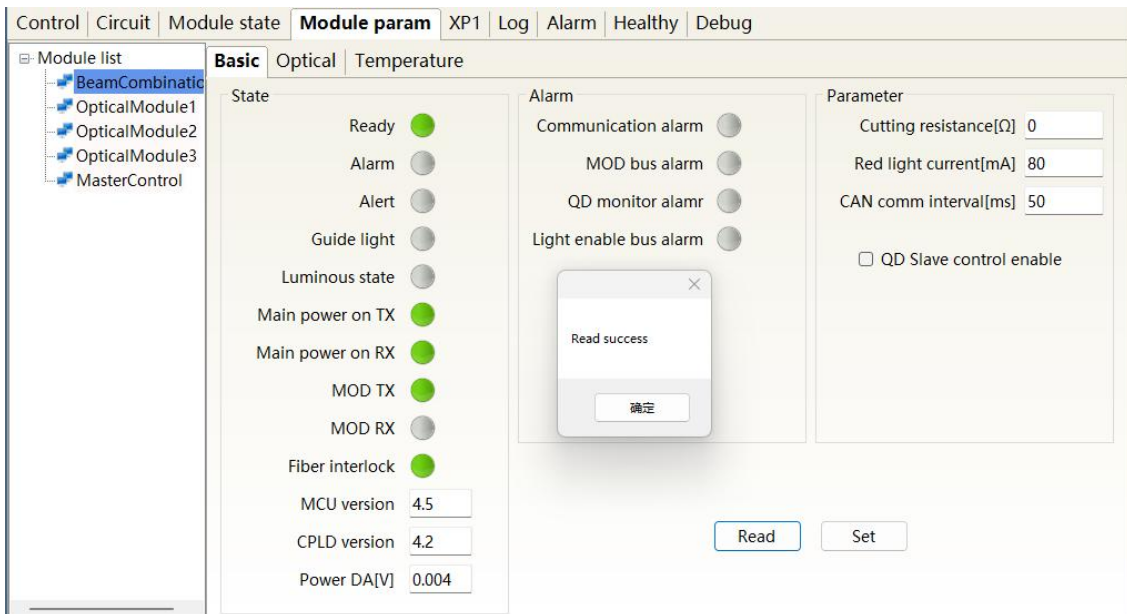


Figure 51 Module Parameter Query menu in Diagnostic Mode

4.7.13 Programming mode (waveform editing)

When selecting the laser operation mode, tick "Display Programming Mode" in any mode, as shown in Figure 52. The "Program Settings" interface can be activated. The laser conversion setting menu is shown in Figure 53.

No	Parameter	Type
1	STOP	No parameter
2	SPT	Time[ms] <input type="text"/> Power[W] <input type="text"/>
3	SPR	Speed[W/ms] <input type="text"/> Power[W] <input type="text"/>
4	WAIT	Type <input type="text"/> Time[ms] <input type="text"/>
5	GOTO	Line <input type="text"/> Type <input type="text"/> Num <input type="text"/>
6	OUT	Type <input type="text"/>
7	EXTPOWER	Mode <input type="text"/>

Figure 52 Programming menu in waveform editing mode

4.7.13.1 Viewing the number of waveform bars inside the current laser

The operation menu for viewing the number of waveform bars stored inside the current laser is shown in Figure 53. Click the "Refresh Program List" button, and the software will automatically list the number of saved waveform bars. Green indicates that this bar already has programs, and white indicates that this bar is empty.

No	Parameter	Type
1	STOP	No parameter
2	SPT	Time[ms] <input type="text"/> Power[W] <input type="text"/>
3	SPR	Speed[W/ms] <input type="text"/> Power[W] <input type="text"/>
4	WAIT	Type <input type="text"/>
5	GOTO	Line <input type="text"/> Type <input type="text"/> Num <input type="text"/>
6	OUT	Type <input type="text"/>
7	EXTPOWER	Mode <input type="text"/>

Figure 53 Operation menu for viewing the number of waveform stored inside the current laser

4.7.13.2 Viewing Waveform Content

The operation menu for viewing the waveform content in the current laser waveform mode is shown in Figure 54. With the left mouse button, click the waveform number to be read, and the program will automatically list the original waveform list.

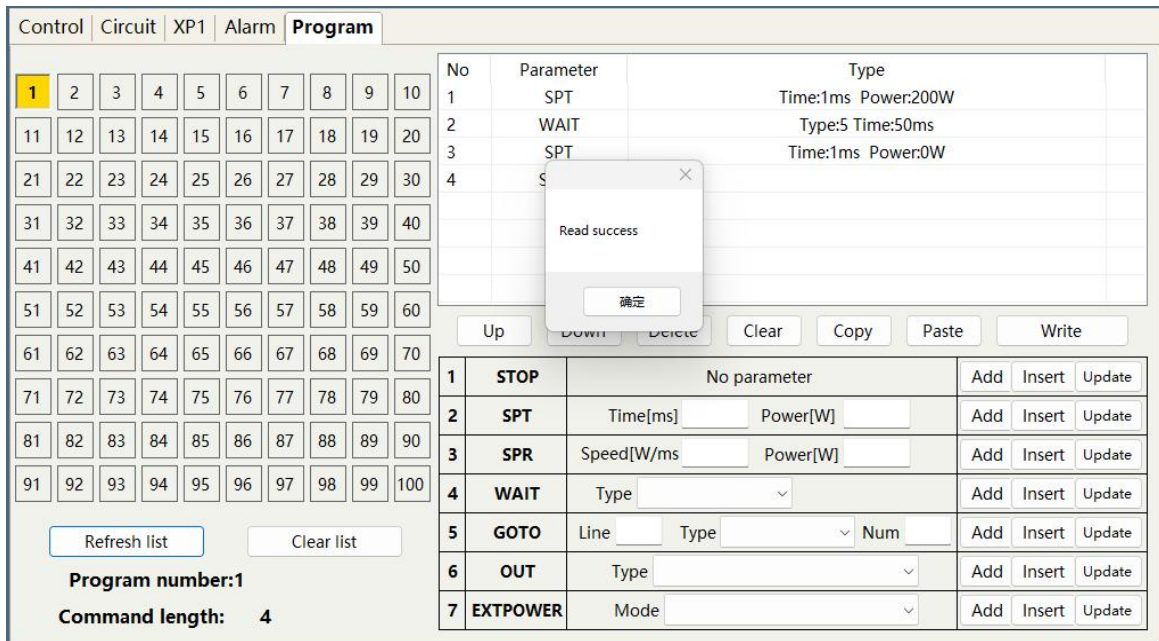


Figure 54 Operation menu for viewing the waveform content in the current laser waveform mode

4.7.13.3 Clear All Waveforms

The operation menu for clearing all waveforms stored in the current laser waveform mode is shown in Figure 55. Click "Clear Program List" and the software will clear all waveforms stored inside the current laser.

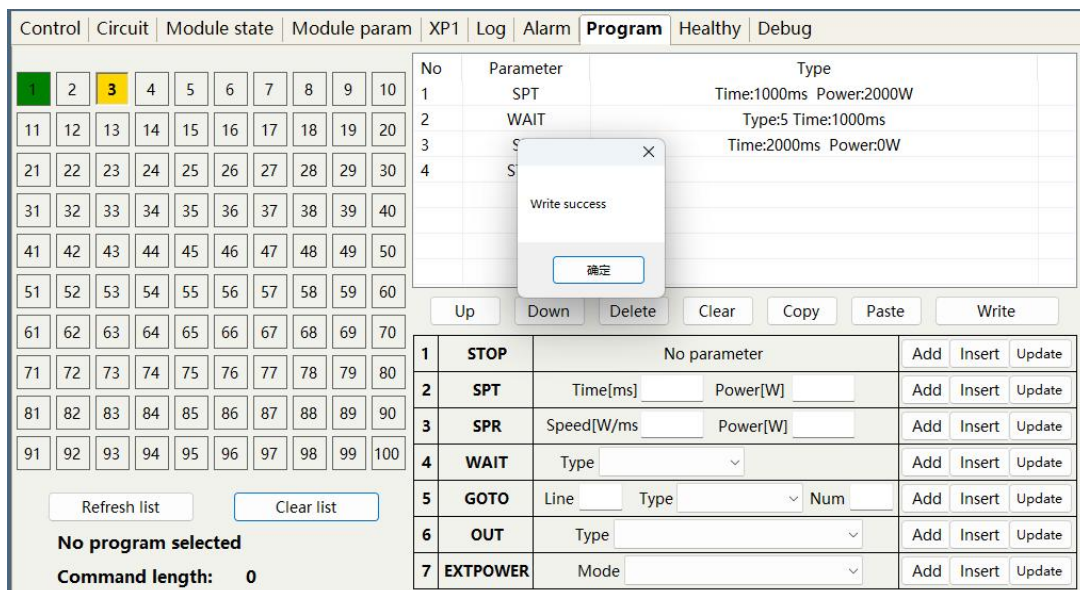
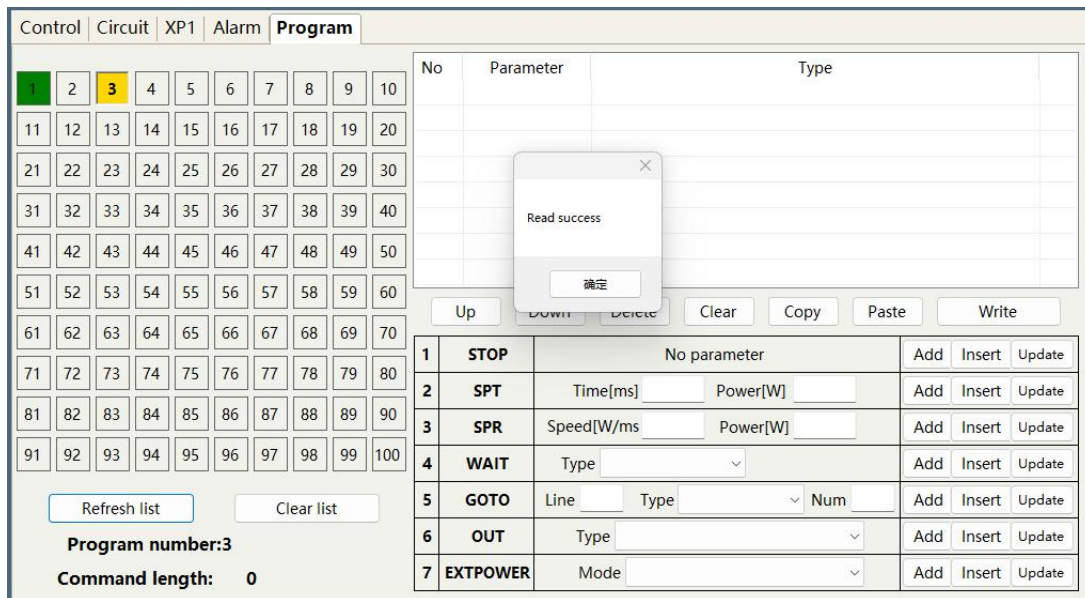


Figure 55 Operation menu for clearing all waveforms stored in the current laser waveform mode

4.7.13.4 Editing Waveforms

The steps of waveform editing when the laser is operating in waveform mode are shown in Figure 49. Step 1: Left click on the pre edited waveform number; Step 2: Select a command under the command type, enter the parameters of the command, and click "Add". The previous command immediately appears in the program list on the left; Step 3: After editing all the commands, click "Write to Laser"; Step 4: Click "Refresh Program List" again, and the new waveform number will turn green, indicating successful writing. Note: The last command of the program must be STOP.



a) Select a pre edited waveform number

No	Parameter	Type	

Up Down Delete Clear Copy Paste Write

1	STOP	No parameter	Add Insert Update
2	SPT	Time[ms] 1000 Power[W] 2000	Add Insert Update
3	SPR	Speed[W/ms] _____ Power[W] _____	Add Insert Update
4	WAIT	Type _____ Time[ms] _____	Add Insert Update
5	GOTO	Line _____ Type _____ Num _____	Add Insert Update
6	OUT	Type _____	Add Insert Update
7	EXTPOWER	Mode _____	Add Insert Update

No	Parameter	Type	
1	SPT	Time:1000ms Power:2000W	

Up Down Delete Clear Copy Paste Write

1	STOP	No parameter	Add Insert Update
2	SPT	Time[ms] _____ Power[W] _____	Add Insert Update
3	SPR	Speed[W/ms] _____ Power[W] _____	Add Insert Update
4	WAIT	Type _____ Time[ms] _____	Add Insert Update
5	GOTO	Line _____ Type _____ Num _____	Add Insert Update
6	OUT	Type _____	Add Insert Update
7	EXTPOWER	Mode _____	Add Insert Update

b) Add Command Type

Control Circuit Module state Module param XP1 Log Alarm **Program** Healthy Debug

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Refresh list Clear list

No program selected
Command length: 0

No	Parameter	Type	
1	SPT	Time:1000ms Power:2000W	
2	WAIT	Type:5 Time:1000ms	
3	SPT	Time:2000ms Power:2000W	
4	STOP		

Up Down Delete Clear Copy Paste Write

No	Parameter	Type	
1	STOP	No parameter	Add Insert Update
2	SPT	Time[ms] Power[W]	Add Insert Update
3	SPR	Speed[W/ms] Power[W]	Add Insert Update
4	WAIT	Type	Add Insert Update
5	GOTO	Line Type Num	Add Insert Update
6	OUT	Type	Add Insert Update
7	EXTPOWER	Mode	Add Insert Update

Write success

确定

Control Circuit Module state Module param XP1 Log Alarm **Program** Healthy Debug

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Refresh list Clear list

No program selected
Command length: 0

No	Parameter	Type	
1	SPT	Time:1000ms Power:2000W	
2	WAIT	Type:5 Time:1000ms	
3	SPT	Time:2000ms Power:2000W	
4	STOP		

Up Down Delete Clear Copy Paste Write

No	Parameter	Type	
1	STOP	No parameter	Add Insert Update
2	SPT	Time[ms] Power[W]	Add Insert Update
3	SPR	Speed[W/ms] Power[W]	Add Insert Update
4	WAIT	Type	Add Insert Update
5	GOTO	Line Type Num	Add Insert Update
6	OUT	Type	Add Insert Update
7	EXTPOWER	Mode	Add Insert Update

Write success

确定

c) Write commands to the laser

The screenshot shows the 'Program' tab of the software interface. On the left is a 10x10 grid of buttons numbered 1 to 100. Button 3 is highlighted in yellow. To the right of the grid is a table with columns 'No', 'Parameter', and 'Type'. Below the table are buttons for 'Up', 'Down', 'Delete', 'Clear', 'Copy', 'Paste', and 'Write'. A 'Read success' dialog box is open over the table, with a '确定' (OK) button. Below the grid are 'Refresh list' and 'Clear list' buttons, and text indicating 'Program number:3' and 'Command length: 4'. At the bottom right, there is a table with 7 rows of command parameters and their respective 'Add', 'Insert', and 'Update' actions.

No	Parameter	Type
1	SPT	Time:1000ms Power:2000W
2	WAIT	Type:5 Time:1000ms
3	SPT	Time:2000ms Power:2000W
4	STOP	

1	STOP	No parameter	Add	Insert	Update
2	SPT	Time[ms] <input type="text"/> Power[W] <input type="text"/>	Add	Insert	Update
3	SPR	Speed[W/ms] <input type="text"/> Power[W] <input type="text"/>	Add	Insert	Update
4	WAIT	Type <input type="text"/>	Add	Insert	Update
5	GOTO	Line <input type="text"/> Type <input type="text"/> Num <input type="text"/>	Add	Insert	Update
6	OUT	Type <input type="text"/>	Add	Insert	Update
7	EXTPOWER	Mode <input type="text"/>	Add	Insert	Update

d) Check whether the command was successfully written

Figure 56 Schematic diagram of waveform editing operation in waveform mode

4.7.13.5 Command Interpretation

The meaning of all commands and commands during laser operation is shown in Table 19.

Table 19 Commands and their meanings during laser operation

Command Code (1 byte)		Parameter 1 (2 bytes)		Parameter 2 (4 bytes)		Description
1	Stop	/		/		Stop has no command to end without a program, and the last
2	SPT	0~65000 (ms)		0~65000(W)		takes time for parameter 1 to change power to parameter 2
3	SPR	0~65000 (W/ms)		0~65000(W)		Change the power to parameter 2 at the power change
4	WAIT	1	WAIT 1 waiting for synchronization signal low level	/		
		2	Wait for synchronization	/		
		3	Waiting for the rising edge of the synchronization signal	/		
		4	Wait for the synchronization signal to fall along the space	/		
		5	Waiting time	0~65000ms(int)		
5	GOTO	0~99	line	-1	When the synchronization signal is low	the jump condition is met, and the jump is to another line number
		0~99	line	-2	Jump when sync signal is high	Jump to other line numbers when conditions are met
		0~99	line	0~1000000	Number of times to jump to this line number	Number of times to cycle to this line number
6	OUT	1	SO	1	Output synchronization signal low level	

				2	Output synchronization signal high level	
7	EXT Power	1	0~10V			
		2				

4.7.14 Log

4.7.14.1 Search for fault records

The interface for displaying the laser's operation log is shown in Figure 57. To query the laser's operation log, simply select the time period you wish to query and click "Search".

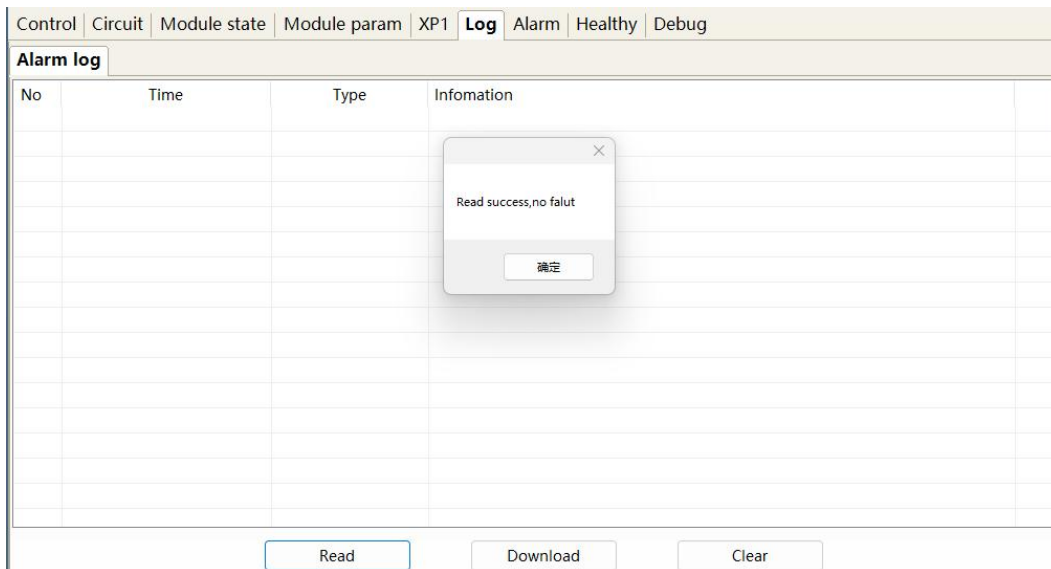


Figure 57: Laser Work Log Display Interface

4.7.14.2 Download Historical Fault Records

The download interface for historical fault records is shown in Figure 58. The saved path for the fault information file is /Raycus > FiberLaerManagement > Log_LCM800 > Alarm.

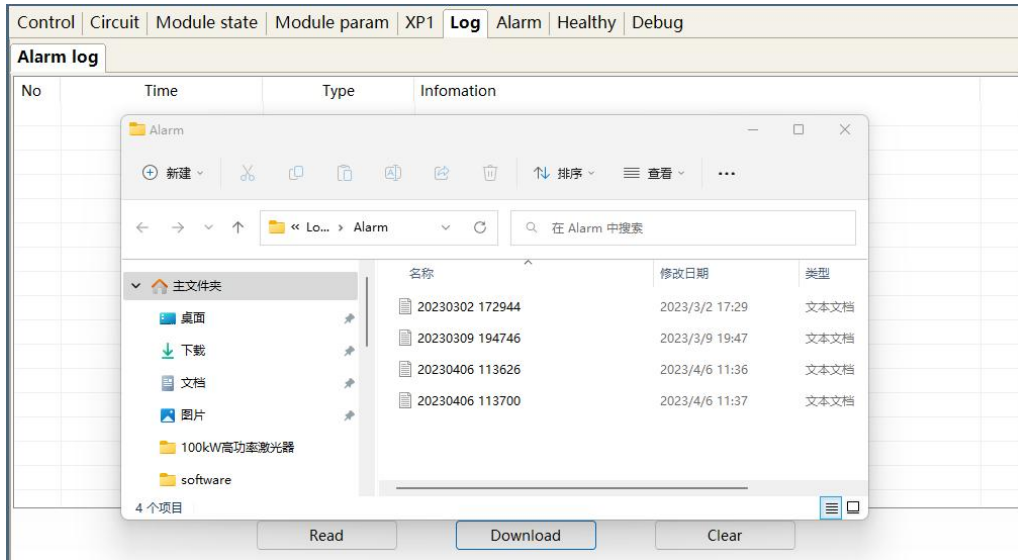


Figure 58 Download menu of laser history fault record

4.8 Control Mode Selection

The Raycus high-power CW laser has two control modes: namely ON mode and REM mode. Users can select the mode to be entered through the key on the front panel.

Table 20 Function of ON and REM mode

	AD Mode	External control	programming mode	Power	Laser ON and OFF	Red laser
ON Mode	close①	close②	-	communication(13)	communication (11)	communication (12)
	Enable③	close②	-	XP4-1/2 pin pressure	communication (11)	communication (12)
	close①	Enable④	-	communication (13)	XP2-1/2 pin level	communication (12)
	Enable③	Enable④	-	XP4-1/2 pin pressure	XP2-1/2 pin level	communication (12)
REM Mode	close⑤	close⑥	close⑦	communication (13)	communication (11)	communication (12)
	Enable⑧	close⑥	close⑦	XP4-1/2 pin pressure	communication (11)	XP1-A1/A5 is high level
	close⑤	Enable⑨	close⑦	communication (13)	XP1-A1 laser request is high XP1-A2 laser emission enable is high XP2-1/2 input MOD signal	XP1-A1/A5 is high level
	Enable⑧	Enable⑨	close⑦	XP4-1/2 pin pressure	XP1-A1 laser request is high XP1-A2 laser emission enable is	XP1-A1/A5 is high level

					high XP2-1/2 input MOD signal	
	close⑤	Enable⑨	Enable⑩	determined by programming command	XP1-A1 laser request is high XP1-A2 high level indicates operating program	XP1-A1/A5 is high level

- ① Send "DEC" by communication, or click button of Analog Control on the PC software;
- ② Send "DLE" by communication, or click button of External Control on the PC software;
- ③ Send "EEC" by communication, or click button of Analog Control on the PC software;
- ④ Send "ELE" by communication, or click button of External Control on the PC software;
- ⑤ XP1-A1 is high level, XP1-A6 is low level or suspending;
- ⑥ XP1-A1 is high level, XP1-A3 is high level;
- ⑦ XP1-A1 is high level, XP1-A8~A14 is all low level or suspending;
- ⑧ XP1-A1 is high level, XP1-A6 is high level;
- ⑨ XP1-A1 is high level, XP1-A3 is low level or suspending;
- ⑩ XP1-A1 is high level, XP1-A8~A14 is not all low level;
- ⑪ Emit laser: Send "EMON" by communication, or click button of Emission "ON" on the PC software
Turn off the laser: Send "EMOFF" by communication, or click button of Emission "OFF" on the PC software;
- ⑫ Emit red light: Send "ABN" by communication, or click button Guide laser "ON" on the PC software
Turn off red light: Send "ABF" by communication, or click button of Guide laser "OFF" on the PC software;
- ⑬ The communication sends "SDC XX" to set the power percentage, XX represents the power percentage, or click button Power\Duty cycle\Frequency\Pulse width and then click the button of Set on the PC software.

4.8.1 ON Mode

In the On mode, the user can send commands to set different working mode through PC software or direct communication. After the laser is powered on again, the mode before power failure will be memorized.

4.8.1.1 AD Enable Mode

When AD mode is enabled, the laser power is determined by the analog voltage of pin 1 and pin 2 of XP4. If the AD mode is not enabled, the laser power can be set through the PC software or send the "SDC XX" command.

4.8.1.2 Emission External Control Enable

When the emission external control is enabled, the laser emission is determined by the level difference between the pins of MOD+ and MOD- in the XP2 port; if the emission external control is not enabled, the laser emission or shutdown are determined by the emit button on the PC software. Also, you can send “EMON” command to turn laser emission on, and send “EMOFF” command to turn laser emission off.

4.8.1.3 Guide Laser (Red Guide Beam) Control

ONIn “ON” mode guide laser can only be turned on/off by using PC software, or by sending command of “ABN” (on) / “ABF” (off).

The red light module inside the laser works through communication, so there is a time delay of at least 10ms for the opening and closing of red light;

When the red light is on, the laser cannot be set to “Ready”. Only after the red light is turned off the laser can be set to “Ready”. (This limit can be changed, please contact Raycus Engineer).

4.8.1.4 Programming Mode

In “ON” mode, when the current program number of the laser is not 0, the laser runs in the “Programming” mode. Please use the Raycus software to edit the waveform and select the pre-run program number.

When the laser is in the internal control mode:

Send the “EMON” command or press the button of Emission “ON” button, the laser will start to run the program,

Send the “EMOFF” command or press the button of Emission “OFF” button can terminate the laser emission at any time;

When the laser is in the external control mode, the rising edge of MOD starts to operate the program, and the falling edge of MOD can terminate the program at any time.

4.8.2 REM Mode

4.8.2.1 AD Enable Mode

When both A1 and A6 of XP1 are set high, A8~A14 are set low, the laser operates in AD mode, and the current laser power is determined by the analog voltage of pin 1 and pin 2 of XP4; When A6 of XP1 is set low or suspended, the current laser power is set by sending "SDC XX" command through PC software or communication

4.8.2.2 Emission External Control

When both A1 and A3 of XP1 are set high, the laser is in the internal control mode, and the laser emission is controlled by the “light on button” by PC software or through communication

sending "EMON" to emit light, and "EMOFF" to control the light off; When A1 of XP1 is set high, A3 is suspended or set low, the laser is in the external control mode, the output light is determined by the TTL level of the MOD signals(pin1 and pin2 of XP2) and A2 of XP1.

4.8.2.3 Red Light Control

When both A1 and A3 of XP1 are set high, the laser is in the red light internal control mode, and the red light is controlled by the PC software red light button or through communication by sending "ABN" or "ABF" command to control the ON/OFF of the red light; When A1 of XP1 is set high, and A3 is suspended or set low, the laser is in external control mode, and the red light is controlled by A5 of XP1.

The red-light module in the laser works by means of communication, so there is a time delay of at least 10ms when the red light is turned on and off.

When the red light is on, the laser cannot be set to Ready. Only after the red light is turned off the laser can be set to "Ready". (This limit can be changed, please contact Raycus Engineer).

4.8.2.4 Programming Mode

When A1 of XP1 is set high and A8-A14 is not 0, the laser is in "Programming Mode". At this time, the laser emission is controlled by A2 of XP1, and the laser emission waveform is determined by the edited waveform.

4.9 Laser Wiring Diagram and Operation Steps

4.9.1 Internal Control in ON Mode

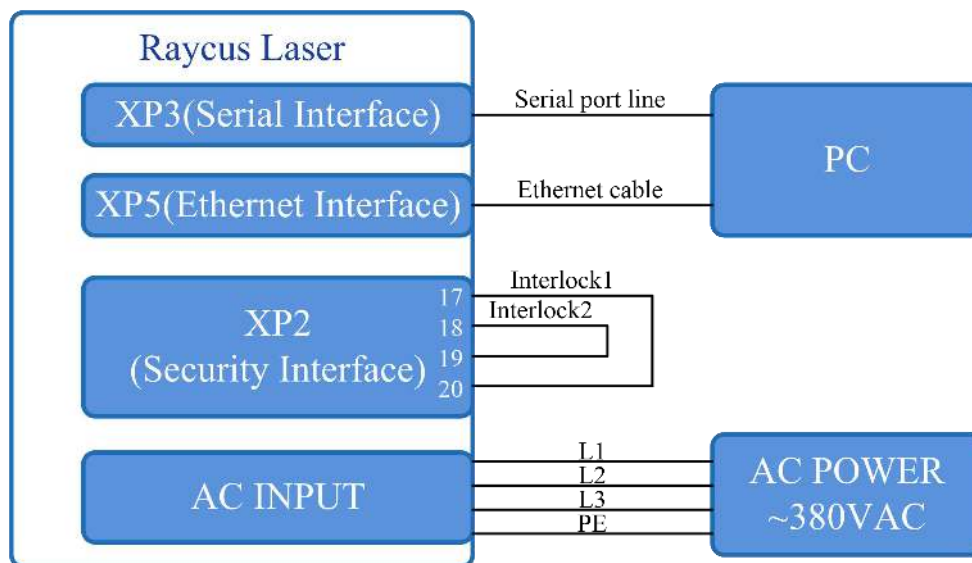


Figure 60 Software mode wiring diagram when key switch at "ON" position

Operations Steps

- a) Turn the knob switch on the rear panel to“ON”
- b) Turn the key switch to“ON”
- c) Open the Raycus software
- d) Click the guide laser “ON” button to view the guide laser
- e) Turn off “AD” mode and turn off external control mode (this mode can be memorized when power off)
- f) Click the main power “ON”
- g) Waiting for “Ready”
- h) Set laser emission parameters
- i) Click the laser “ON”.

4.9.2 Laser Operating in External Control Mode

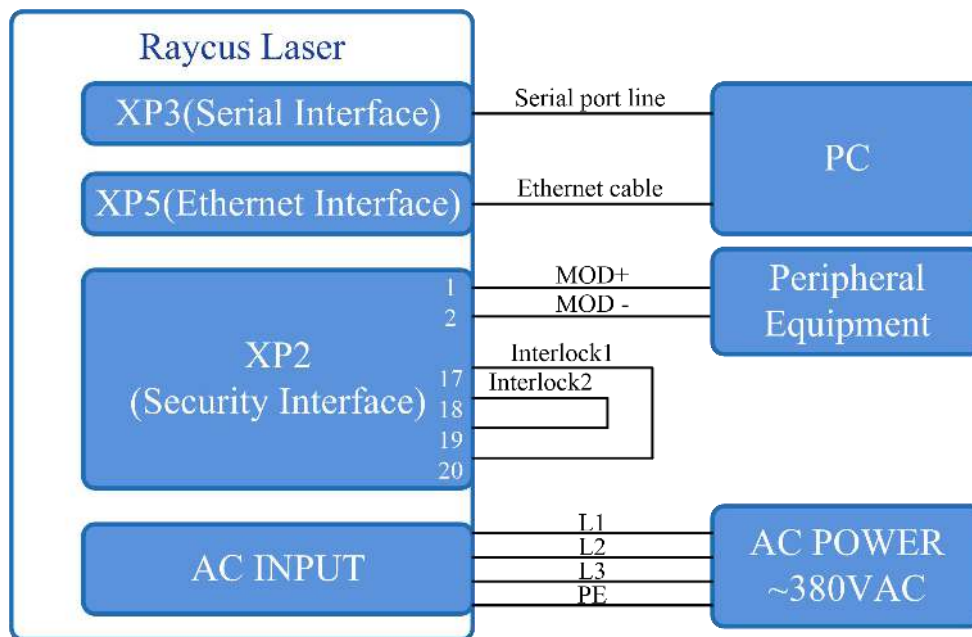


Figure 61 The wiring diagram of laser operating in external control mode

Operations Steps

- a) Turn the knob switch on the rear panel to“ON”
- b) Turn the key switch to“ON”
- c) Open the Raycus software
- d) Click the guide laser “ON” button to view the guide laser
- e) Turn off “AD” mode and turn on “External Control” mode (this mode can be memorized after

- power off)
- f) Click the main power “ON”
- g) Waiting for “Ready”
- h) Set the percentage of laser emission power
- i) Turn on the laser through the high level output by MOD signal

4.9.3 In ON Mode, the Laser Emission Power is Externally Controlled by Analog Signal

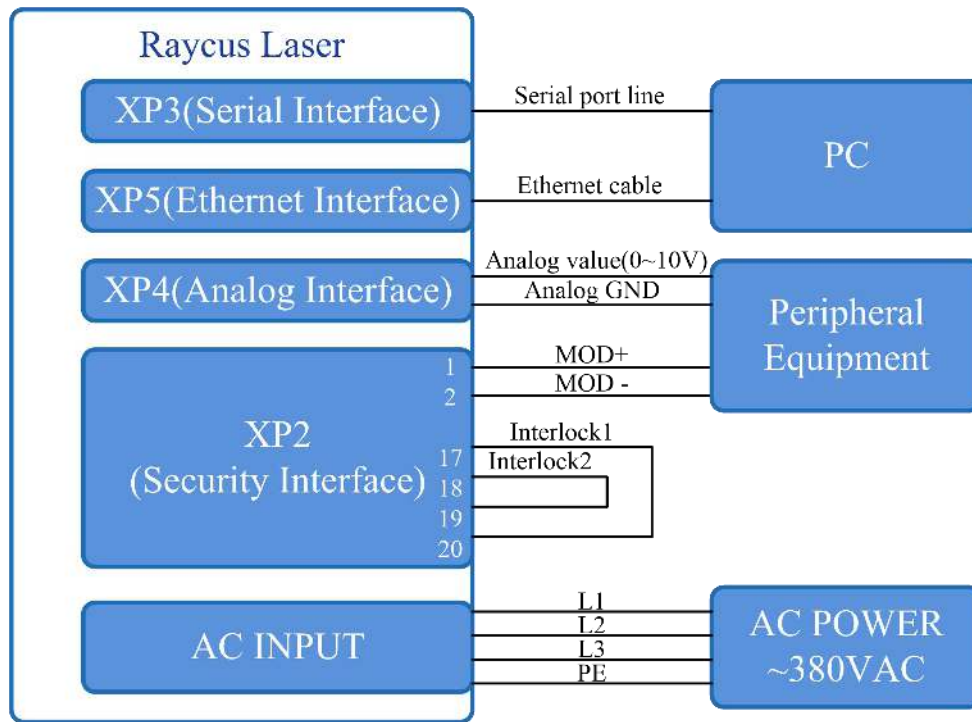


Figure 62 In ON mode, the wiring diagram of the power and laser emission controlled by analog signal

Operations Steps

- a) Turn the knob switch on the rear panel to “ON”
- b) Turn the key switch to “ON”
- c) Open the Raycus software
- d) Click the guide laser “ON” button to view the guide laser
- e) Turn on the “AD” mode and turn on “External Control” mode (this mode can be memorized after power off)
- f) Click the main power “ON”
- g) Waiting for “Ready”
- h) The control board card outputs power analog and emit control signal.

4.9.4 Laser Operating in External Control Programming Mode

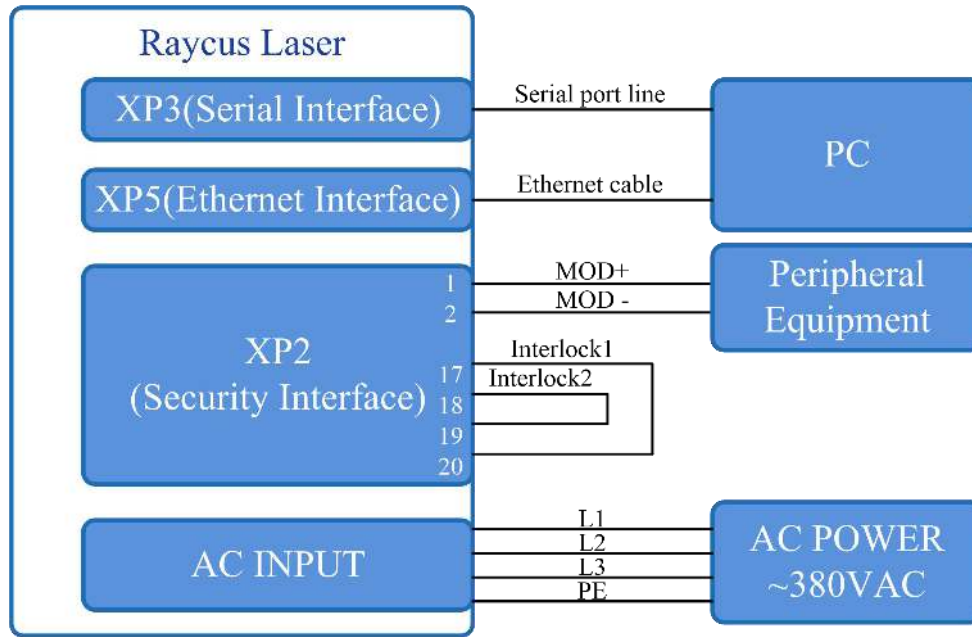


Figure 63 Wiring diagram of external control laser emission in programming mode, in ON mode

Operations Steps

- a) Turn the knob switch on the rear panel to “ON”
- b) Turn the key switch to “ON”
- c) Open the Raycus software
- d) Click the guide laser “ON” button to view the guide laser
- e) Click the main power “ON”
- f) Waiting for “Ready”
- g) Set the pre-executed waveform number (the program number is greater than 0)
- a) Start waveform at the rising edge of MOD signal.

NOTE:

The high-level time of MOD must be greater than the program running time. If MOD gives a falling edge in advance, the Raycus software will display that the laser program is abnormally terminated.

4.9.5 Set the Power Analog Quantity in REM Mode to Control the Laser Emission

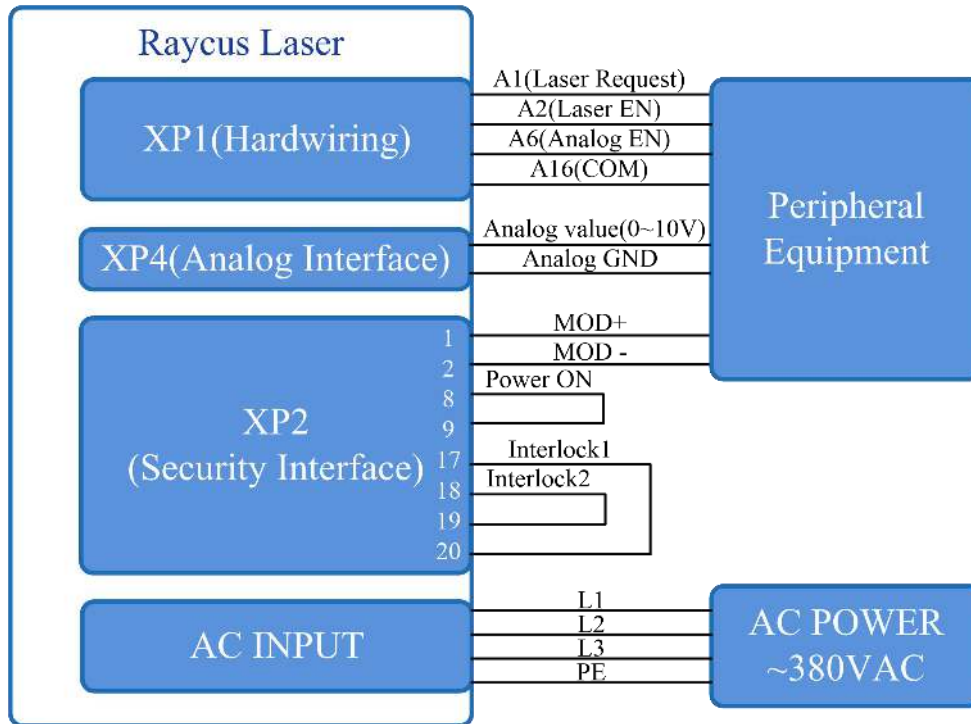


Figure 64 REM mode power and laser emission are externally controlled wiring diagram

Operations Steps

- Turn the knob switch on the rear panel to “ON”
- Turn the key switch to “REM”
- Short-circuit pin 8/9 on XP2
- XP1-A1 connects to 24V, XP1-A6 connects to 24V
- Connect XP1-A5 to 24V and turn on the guide laser; after checking the optics, connect XP1-A5 to 0V and turn off the guide laser
- XP1-C1 is connected to 24V, and the main power is turned on (operator can also directly press the LASER button, or clicks the main power “ON” on the Raycus software)
- Waiting for “Ready”
- XP1-A2 connects to 24V, and the control board outputs analog and MOD signals

4.9.6 Power Communication Setting in REM

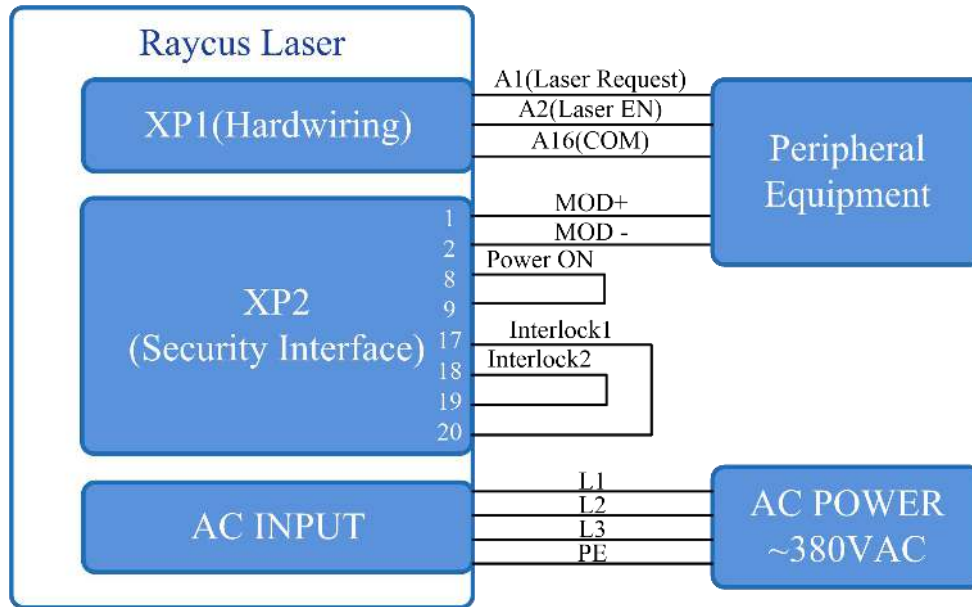


Figure 65 Wiring diagram of power internal control and laser emission external

Operations Steps:

- a) Turn the knob switch on the rear panel to “ON”
- b) Turn the key switch to “REM”
- c) Short-circuit pin 8/9 on XP2
- d) XP1-A1 connects to 24V
- e) Connect XP1-A5 to 24V and turn on the guide laser; after checking the optics, connect XP1-A5 to 0V and turn off the guide laser
- f) XP1-C1 is connected to 24V, and the main power is turned on (users can also directly press the “LASER” button, or clicks the main power “ON” on the Raycus software)
- g) Waiting for “Ready”
- h) The Raycus software sets the power, XP1-A2 is connected to 24V, and the control board card outputs MOD signal

4.9.7 Programming Mode in REM Mode

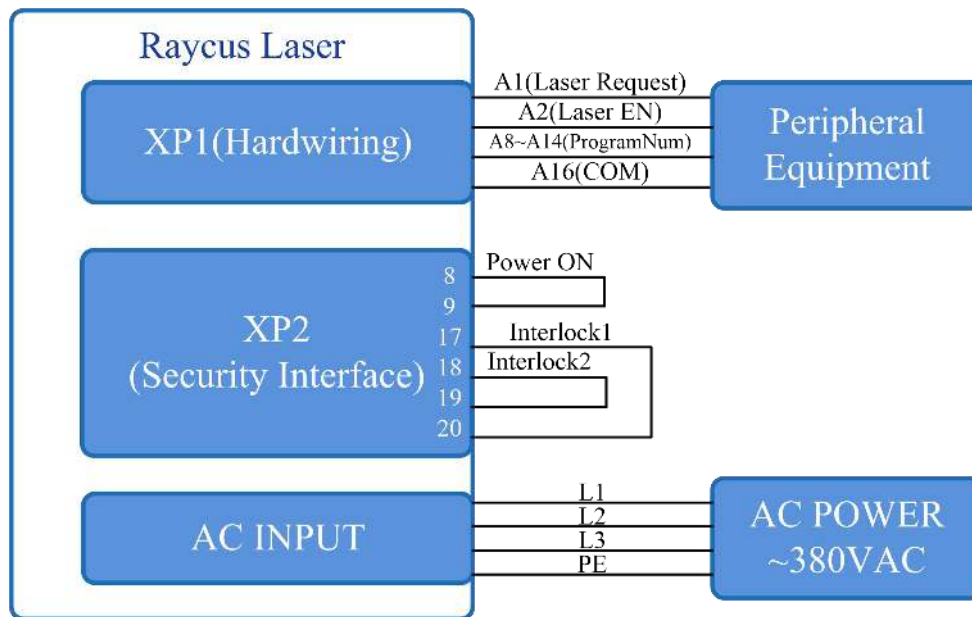


Figure 66 Wiring diagram of programming mode in REM Mode

Operations Steps:

- Turn the knob switch on the rear panel to “ON”
- Turn the key switch to “REM”
- Short-circuit pin 8/9 on XP2
- XP1-A1 connects to 24V
- Connect XP1-A5 to 24V and turn on the guide laser; after checking the optics, connect XP1-A5 to 0V and turn off the guide laser
- XP1-C1 is connected to 24V, and the main power is turned on (users can also directly press the “LASER” button, or clicks the main power “ON” on the Raycus software)
- Waiting for “Ready”
- XP1-(A8-14) select the number of the pre-executed program, set XP1-A2 high to start executing the program.

4.10 Shut Down operation sequence

Please shut down the laser according to the following operational sequence:

- Shut off the laser emission;
- Disconnect the air switch;
- Shut down the chiller;
- Put on the protective cap of the output connector.

5 Alarm Solutions

The instructions and solutions of alarms are as follows::

Alarm name	Alarm instructions and solutions
<p>T1/T2 Alarm (Low temperature alarm and high temperature alarm)</p>	<p>Alarm instructions: The laser triggers low/high temperature alarms when the internal sensor detects abnormal temperature within the laser. A high temperature alarm is triggered when the temperature at the monitoring point exceeds the set upper limit, while a low temperature alarm is triggered when it falls below the set lower limit.</p> <p>Possible solutions: In case of a high temperature alarm, please check whether the water cooling system is properly turned on, whether the water temperature setting is correct, whether the chiller is working normally, and whether there are any abnormalities in the water circuit connection. When the water cooling system is working normally and the water temperature drops below 30°C, restart the laser and try again. In case of a low temperature alarm, please check whether the actual water temperature of the chiller is too low. Additionally, an excessively low ambient temperature may also cause a low temperature alarm when the laser is started in the cold state. If any of the above conditions exist, you need to wait until the water temperature of the chiller rises above 10°C before restarting the laser for a try.</p>
<p>Hum Alarm (Dew alarm)</p>	<p>Alarm instructions: The laser has detected a dew point temperature inside the laser device that is below 22°C, indicating a risk of condensation.</p> <p>Possible solutions: Immediately stop using the laser. Keep the laser powered on and water flowing. At this time, the internal dehumidifier of the laser will work. Wait for 10-15 minutes and reset the laser status. Alternatively, improve the working environment of the laser to keep the ambient temperature lower than the internal temperature of the laser. It is recommended to configure an independent air-conditioned room for the laser.</p>
<p>LaserWaterflow (Laser water flow alarm)</p>	<p>Alarm instructions: The laser has triggered a water flow alarm, indicating that the internal detection system has detected that the current water flow rate is below the required value, posing a safety risk.</p> <p>Possible solutions: Immediately stop using the laser. Please follow the laser operation requirements in [Section 3.3: Installation and Requirements for the Cooling System], check the output model and working status of the laser water chiller, and clean the laser water inlet filter assembly. It is recommended to regularly clean the water chiller and water inlet filter assembly, and replace the cooling water.</p>
<p>ScatteredLight Alarm (Scattered light alarm)</p>	<p>Alarm instructions: Scattered light alarm: When the internal ambient light intensity of the laser exceeds the set value, a scattered light alarm is triggered, and the laser's light emission function is locked (unlockable). The scattered light alarm only occurs when the laser is emitting light</p> <p>Possible solutions: Restart the laser, check the status of the guide light indicator on the laser, read the scattered light monitoring voltage value through the "slave module" of the host computer, and contact Raycus.</p>

<p>Laser Power Alarm (Power alarm)</p>	<p>Alarm instructions: Power alarm is triggered when the output power of the laser fails to reach the set value. The power alarm only occurs when the laser is emitting light.</p> <p>Possible solutions: Check the guide light status indicated by the laser and contact Raycus.</p>
<p>ACDC Alarm (Power alarm)</p>	<p>Alarm instructions: The laser power supply alarms may be triggered by the failure of the laser power supply or sudden power outage and restart of the power supply system.</p> <p>Possible solutions: Check whether the input AC voltage is normal. If it is normal, restart the laser to try. If the alarm continues to occur, please contact Raycus.</p>
<p>Current Driver Alarm (Alarm from current drive board)</p>	<p>Alarm instructions: The current drive board alarms when the internal constant current drive board of the laser is abnormal.</p> <p>Possible solutions: Restart the laser for a try. If the alarm continues to occur, please contact Raycus.</p>

6 Laser Maintenance

6.1 Air Conditioning Maintenance

Regularly check and clean the dust filter on the air conditioning panel to prevent the dust filter from blocking the air inlet and affecting the cooling effect of the air conditioner. The dust cover of the air conditioning panel is shown in Figure 67. Regularly check the condensation water drainage pipe at the bottom of the air conditioner to prevent blockage and affect the drainage of condensation water. The condensation water drainage pipe of the air conditioner is shown in Figure 68.



Figure 67: Dust Cover for Air Conditioner Panel



Figure 68: Condensate Drain Pipe of Air Conditioner

6.2 Drainage of Laser

When storing/transporting/not using the laser for more than 1 week, the cooling water inside the laser should be drained. The specific operation is as follows:

- a) Remove the connecting hose between the laser and the water chiller to naturally drain the internal cooling water from the laser;

- b) Connect one end of the rubber hose to the water inlet of the laser (the hose should be clamped securely to the water inlet using a clamp), and connect the other end to the compressed air supply port, with a gas flow meter connected in series between them;
- c) Use a rubber hose to connect the water outlet of the laser to the sewage pool;
- d) Slowly open the ball valve at the compressed air supply port to introduce a sufficient flow rate (Q) of compressed air into the laser (A), and maintain the flow for (t) minutes. This can essentially drain the cooling water from the laser. Table 22 lists the compressed air flow rates for draining water corresponding to different lasers, as well as the dimensions of the connecting rubber hoses.

Table 22: Compressed Air Flow Demand for Drainage and Connection Rubber
Hose Size for Different Lasers

Laser Mode	Compressed air flow rate Q(L/min)	Ventilation time t(min)	Air supply pressure(MPa)	Rubber hose size (mm)
40000M	≥900	≥5	≤0.7	Φ38 (Two inlets and two outlets)
60000M				Φ45 (Two inlets and two outlets)
80000M				Φ51 (Two inlets and two outlets)

7 Warranty, Repair and Return

7.1 General Warranty

After all the lasers manufactured according to the standard or non-standard model production documents are shipped, Raycus guarantees the products with material and technical problems and guarantees that they meet the specifications under normal use.

Raycus has the right to selectively repair or replace any product that has a material or technical problem during the warranty period. All products repaired or replaced during the warranty period only provide free warranty services for products with special problems. Raycus reserves the right to collect payment for products that have problems under normal use.

7.2 Limitations of Warranty

The warranty does not cover the maintenance or reimbursement of our product of which the problem results from tampering, disassembling, misuse, accident, modification, unsuitable physical or operating environment, improper maintenance, damages due to excessive use or not following the instructions caused by those who are not from Raycus. The customer has the responsibility to understand and follow this instruction to use the device. Any damage caused by fault operating is not warranted. Accessories and fiber connectors are excluded from this warranty.

According to the warranty, client should inform us within 31 days after the defect is discovered. This warranty does not involve any other party, including specified buyer, end-user or customer and any parts, equipment or other products produced by other companies.



WARNING: It is the customer's responsibility to understand and follow operating instructions in this User Guide and specifications prior to operation-failure to do so may void this warranty. Accessories and fiber connectors are not covered by this warranty.

7.3 Technical support and product maintenance

- This product does not have any built-in components that can be maintained by the user, so all repairs should be carried out by Raycus technical personnel.
- If any alarms occur during the use of the product, promptly notify Raycus technical personnel and proceed with troubleshooting.
- All repaired or replaced products must be placed in the original packaging box provided by Raycus; otherwise, Raycus reserves the right not to provide free maintenance for any product damage caused by this.
- When you receive Raycus products, please promptly check whether the products are intact. If there are any abnormalities, please contact the carrier or Raycus company in a timely manner.

Raycus reserve the right to make changes in design or constructions of any of our products at any time without incurring any obligation to make changes or install the same on units previously purchased.

All the items within warranty and service above provided by Raycus are for uses' reference; formal contents about warranty and service are subject to the contract.

Information contained in this document is subject to change without notice.

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