Raycus XZ Series High Power Continuous Wave Fiber Laser User Guide

Applicable:			
	RFL-C3000XZ	RFL-C4000XZ	RFL-C6000XZ
	RFL-C8000XZ	RFL-C10000XZ	RFL-C12000XZ

Wuhan Raycus Fiber Laser Technologies Co., Ltd.

Vol. 2.5

CONTENT

Figure List

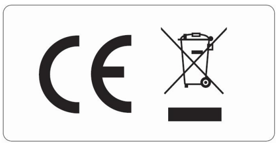
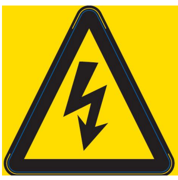
Table List

1 Safety Information

Thank you for choosing Raycus Fiber Laser Products, hereinafter refers as the Product/Products or Lasers/Laser. This users' manual provides you with important safety, operation, maintenance, and other relevant information. Please read the manual carefully before using the 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 SECURITY LABEL

	**WARNING**: May cause serious injury to the person or even endanger the safety of life.
	**CAUTION**: May cause general injury to the person or damage to products or equipment.

 English label  Chinese label	 English label (12000W as example)  Chinese label (12000W as example)	 English label  Chinese label
1. Laser Emission Aperture	**2. Class 4 Laser Product**	**3. Class 2M laser Product – 1 mW Guide laser**
		
4. CE Certification	**5. Product Nameplate (12000W as an example)**	**6. Laser Radiation Hazard**
		
7. Electrical Hazard		

1.2 Laser Safety Grade

According to European Standard EN 60825-1, Clause 9, this series of laser products are Class 4 laser products. This product emits laser radiation at a wavelength of 1080 nm or around 1080 nm, and the average laser power of the products listing in this User Guide radiated from the fiber delivery cable is ranged from 3000W to 12000W (depending on the product model). Either directly or indirectly being exposed to high power laser radiation will bring permanent damage to the eye or skin. Even though the radiant laser is not visible at the wavelength of about 1080nm, 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 wear 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. It is forbidden to watch the laser fiber delivery connector during laser emission.

1.3 Optical Safety

The dust on the end of the fiber delivery connector may bring damage to the lens or the entire laser device.

	**CAUTION: DO NOT** emit the laser when the black plastic protective cap is not removed, otherwise the lens or the crystal will be damaged.

1.4 Electrical Safety

1) Ensure that the product is effectively grounded, and the installation environment is safe and reliable.

	**WARNING:** The disconnection of the product grounding will cause the product shell to become electrified, which may result in personal injury to the operator.

2) Ensure that the AC voltage is supplied normally.

	**CAUTION:** Wrong wiring mode or power supply voltage will cause an irrecoverable damage to the laser device.

1.5 Other Safety Guidelines

1) **DO NOT** watch the fiber delivery connector of the product directly by anytime when the product is powered on.
2) **DO NOT** use the product in a dark or dim place.
3) If the product is used in a manner not specified in this document, the resulted impairment to the laser will not be covered by the warranty.
4) There are no user serviceable parts, equipment, or assemblies inside the product. All service and maintenance shall be performed and conducted by the Raycus engineer or authorized personnel. In order to prevent electric shock, **DO NOT** break the seal or remove the shell. Failure to comply with this instruction and the resulted impairment to the laser will not be covered by the warranty.

2 Product Description

2.1 Features

Fiber lasers are compact and ready to use in comparison with conventional laser products, featuring higher electrical to optical conversion efficiencies, lower power consumption and better beam quality. Furthermore, thanks to its flexible laser emission design by using a shielded optical fiber, it can be easily and safely integrated into a varies of laser application systems.

Main features:

- High beam quality;
- High reliability;
- Maintenance-free operation;
- High electrical-optical efficiency;
- Convenient control interface;
- Fast modulation.

Typical Applications:

- Industrial metal cutting and welding;
- Scientific research.

2.2 Package Parts

Please refer to the enclosed Package Parts List to cross check what accessories should be contained 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 the transportation. Nevertheless, in order to prevent any unpredictable situation during transportation, the users still need to carefully check whether the package is correctly handled before unpacking, and whether there is any damage or suspicious appearance such as collision, crack or water stain on the outside of the box. Once users find that there is an abnormality in the external cabinet, please inform Raycus at once.

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

Take extra care when removing the product from the package and try to make the fiber delivery cable with its connector staying away from collision and vibration. Please **DO NOT** distort, bend, or pull the delivery cable when unpacking the device; and avoid any collision to the quartz or protective cap of laser emission.

CAUTION: The fiber delivery cable and its connector are precise optic instrument, any vibration or impact to the fiber delivery cable or connector, twist or excessive bend will damage the product.

2.4 Operation Environment

The required operation conditions are listed as in the Table 1:

Table 1 Operation conditions for the laser

Model	**C3000Z**	**C4000XZ**	**C6000XZ**	**C8000XZ**	**C10000XZ**	**C12000XZ**
Supply Voltage	Three-phase four-wire, AC 323V~AC 437V, 50/60Hz (with PE)					
Power Supply Capacity	＞15 kVA	> 18 kVA	> 25 kVA	> 35 kVA	> 45 kVA	> 50 kVA
Water Cooling Flow	＞35 L/min	> 35 L/min	> 52 L/min	> 64 L/min	> 79 L/min	> 94 L/min
Installation Environment	Flat, no vibration nor impact					
Ambient Temperature	10℃ ~ 40 ℃					
Relative Humidity	＜ 70%					

1) Make sure the product is properly grounded before use.
2) The fiber delivery cable connector is well connected with the fiber optic cable (delivery cable). Please inspect the fiber delivery cable connector carefully for dust or other contaminations. Use appropriate lens cleaning paper to remove the dust before laser emission.
3) Failure to follow the instructions when using the laser may cause malfunction or damage.
4) **DO NOT** install the fiber delivery cable connector during laser emission.
5) **DO NOT** watch the fiber delivery cable connector lens directly if the laser is powered on. **MUST** wear the appropriate protective goggles all the time when operating the laser.

TIPS:

Install the laser in an air-conditioned environment will offer the product to benefit a longer life and better performance.

2.5 Attentions

1) Make sure that the mail power supply of AC 380V correctly connected. Wrong connection will damage the product.

2) It is important to keep the fiber delivery cable connector clean, otherwise it will damage the product.

3) Please cap the fiber delivery cable connector when it is not in use. **DO NOT** touch the top lens of the connector at any time. Use appropriate lens cleaning paper to clean it when any dust or dirt is noticed.

4) Keep the cap safety in the storage box when using the product. To avoid dust inside the cap that may pollute the lens of the connector, make sure the opening direction of the cap is put down.

5) Failure to follow those above instructions may cause laser power loss, such loss will not be covered by warranty.

2.6 Specifications

Table 2 Product specifications

Optical Characteristics							
Product	**C3000XZ**	**C4000XZ**	**C6000XZ**	**C8000XZ**	**C10000XZ**	**C12000XZ**	**Remark**
Emission Power	3 kW	4 kW	6 kW	8 kW	10 kW	12 kW	/
Operation Mode	Continuous Wave / Modulated						/
Polarization	Random						/
Emission Power Range	10% ~ 100 %						/
Emission Wavelength	1080 ± 5 nm						Nominal Emission Power
Emission Power Instability	≤± 1.5 %						Nominal Emission Power; Duration: >5hrs; Ambient Temp.: 24±1℃
Modulation Frequency	50～5k Hz			50～2k Hz			Nominal Emission Power
Red Guide Laser Power	0.5～1 mW						/
Fiber delivery cable connector	RFL-HQBH			RFL-QD			/
Beam Quality (BPP)	⩽ 4 mm·mrad						Nominal Emission Power
Fiber Core Diameter	100 μm						Customizable
Fiber Delivery Cable Length	20 meters						Customizable
Electrical Characteristics							
Operating Voltage	Three-phase four-wire system AC 340V ~ 420V, 50/60Hz (with PE)						/

Max. Power Consumption	9 kW	11.5 kW	17.5 kW	23 kW	28.5 kW	34.5 kW	/
Way to Control	Serial Communication / AD						/
Other Characteristics							
Dimension W×H×D (mm)	670×990×1160		900×960×1160		1200×960×1160		Includes casters and rings, without warning lights
Weight	< 250 kg	< 280 kg	< 360 kg	< 400 kg	< 450 kg	< 500 kg	Air conditioning included
Operating Ambient Temperature	10 ~ 40 °C						/
Humidity	＜ 70 %						/
Storage Temperature	-10 ~ 60 °C						/
Cooling Method	Water Cooling						/

3 Installation

3.1 Dimensions

The mechanical dimensions of RFL-C3000XZ/C4000XZ/C6000XZ/C8000XZ/C10000XZ/ C12000XZ are shown as follow:

1) The dimensions of the RFL-C3000XZ/C4000XZ are shown in Figure 1 (taking RFL-C4000XZ as an example).

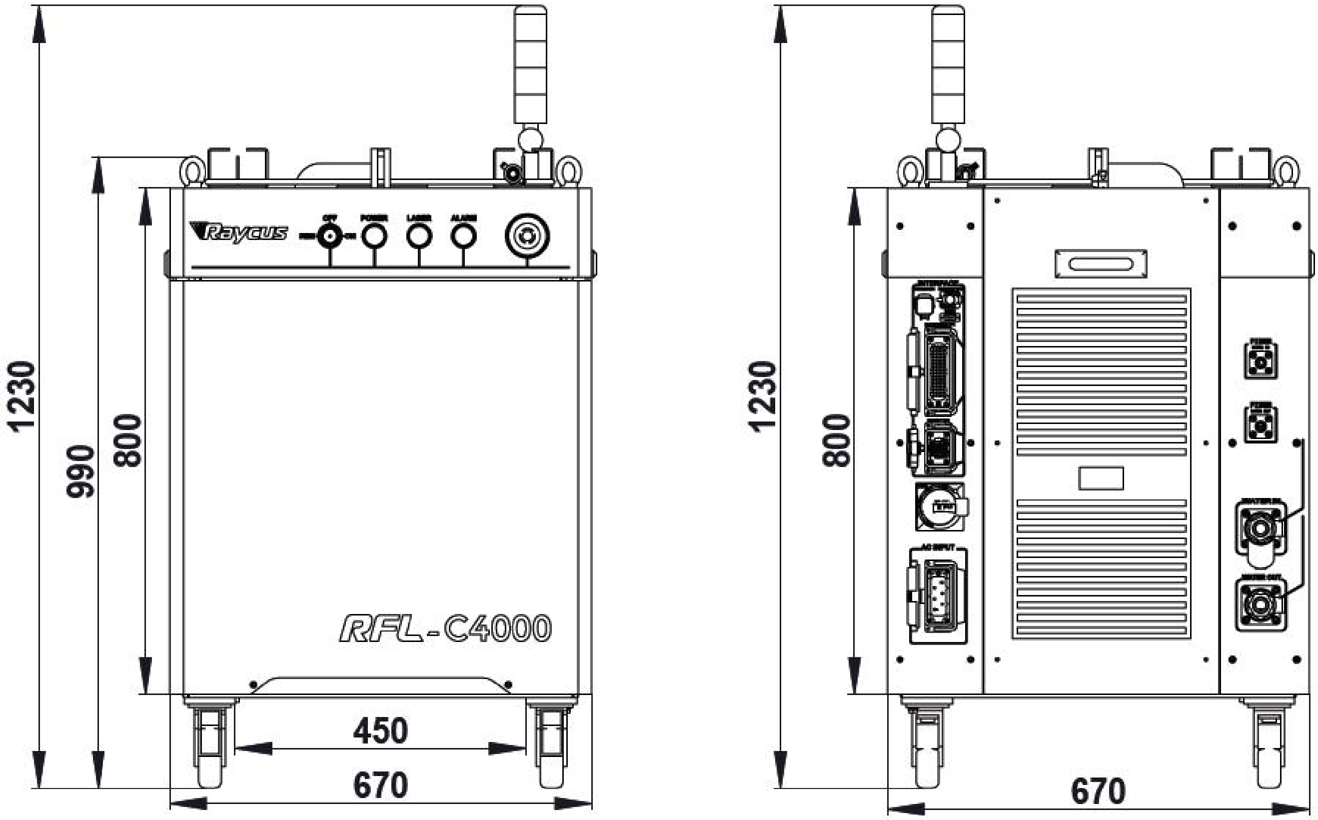


Figure 1.a - Front and rear view

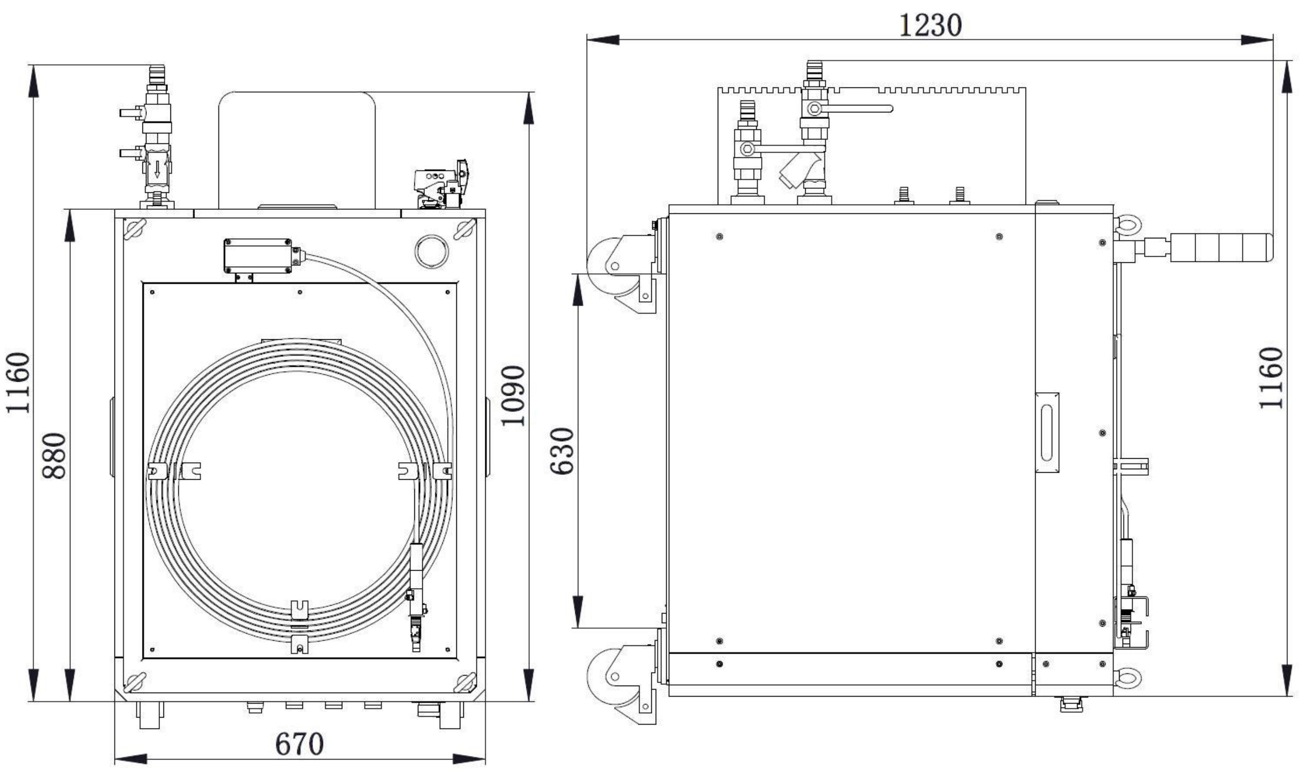


Figure 1.b - Top and left side view of the product

Figure 1 Dimensions of RFL-C3000XZ/C4000XZ

Those two models of RFL-C3000XZ and C4000XZ share a same cabinet, henceforth the same dimensions of 670 × 990 × 1160mm (width × depth × height, including casters and rings, excluding the stats lamps), and the weight is about 250 kg for RFL-C3000XZ, and about 280 kg for RFL-C4000XZ.

2) The dimensions of the RFL-C6000XZ and C8000XZ are shown in Figure 2 (taking RFL-C8000XZ as an example)

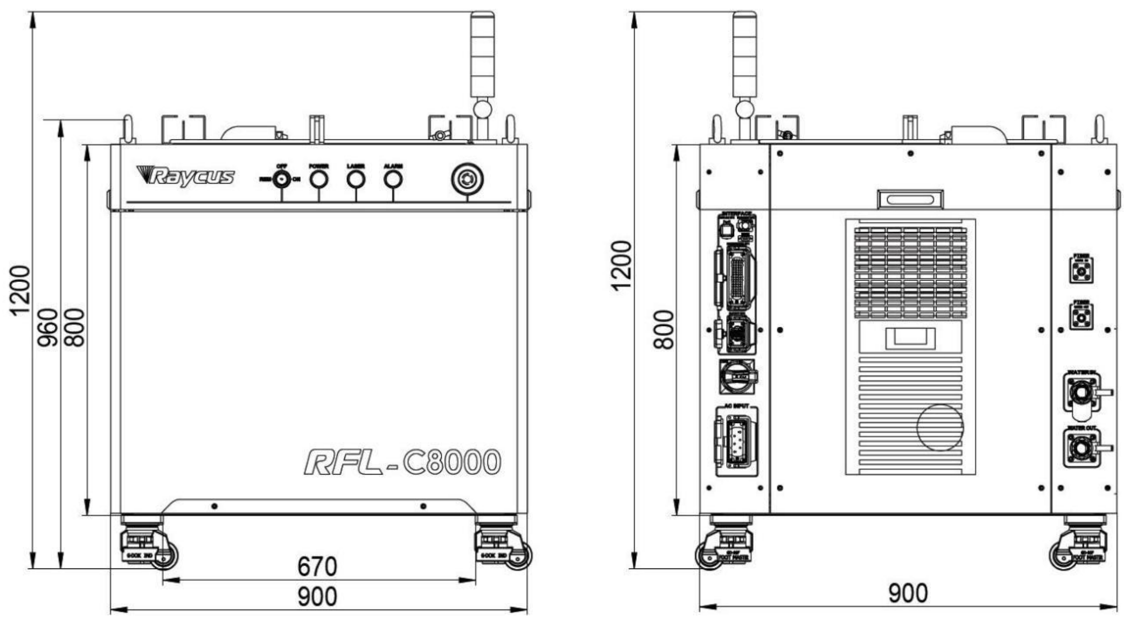


Figure 2.a - Front and rear view

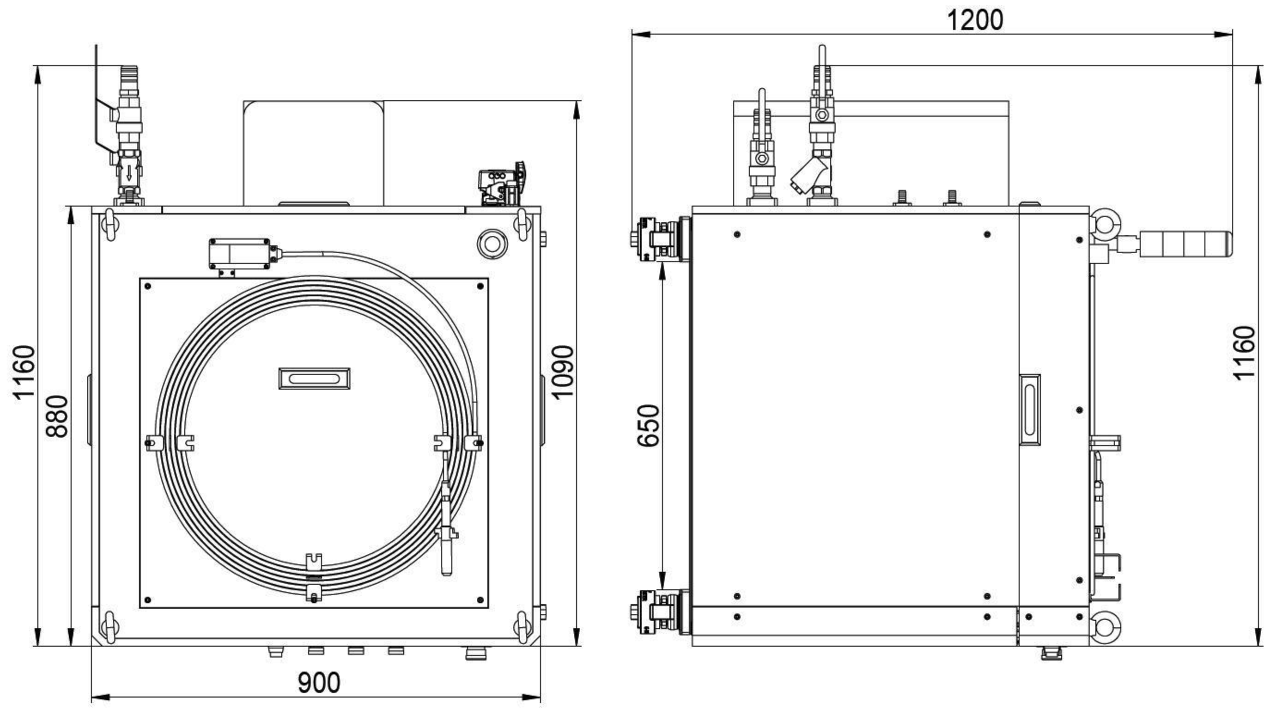


Figure 2.b -Top and left side view

Figure 2 Dimensions of RFL-C6000XZ/8000XZ

RFL-C6000XZ and C8000XZ share a same cabinet, and henceforth the same dimensions of 900 × 960 × 1160 mm (width × depth × height, casters and rings, excluding alarm lights), and the weight is about 360 kg for RFL-C6000XZ and 400 kg for RFL-C8000XZ.

3) dimensions of the RFL-C10000XZ/C12000XZ are shown in Figure 3 (taking RFL-C12000XZ as an example)

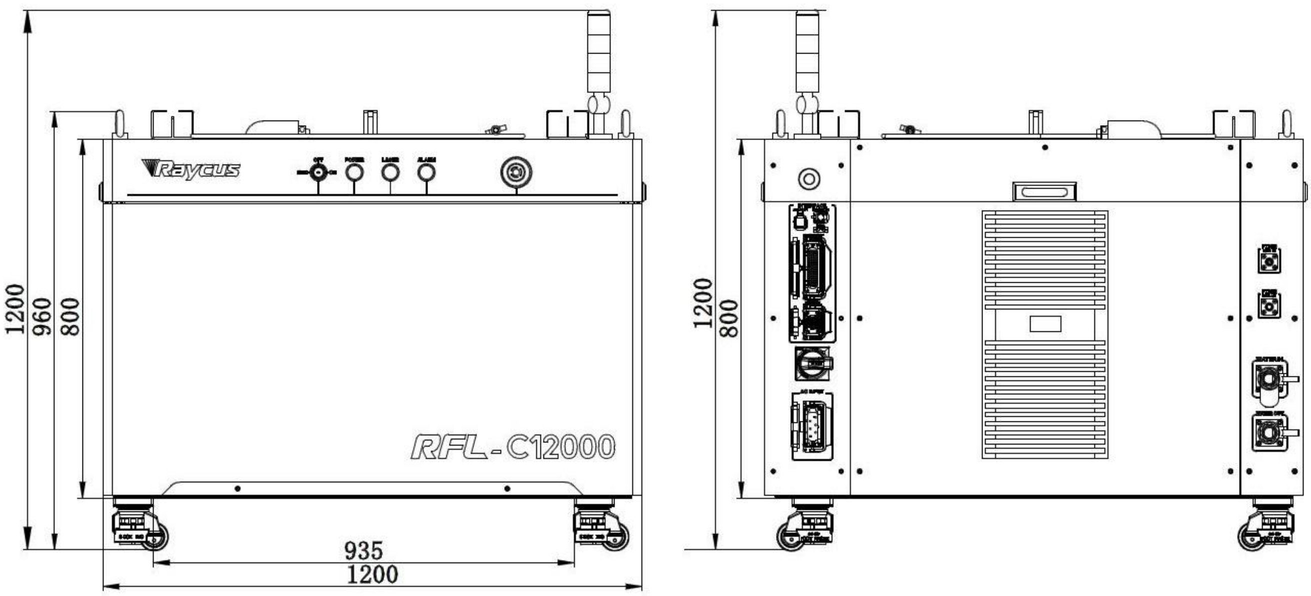


Figure 3.a - Front and rear view

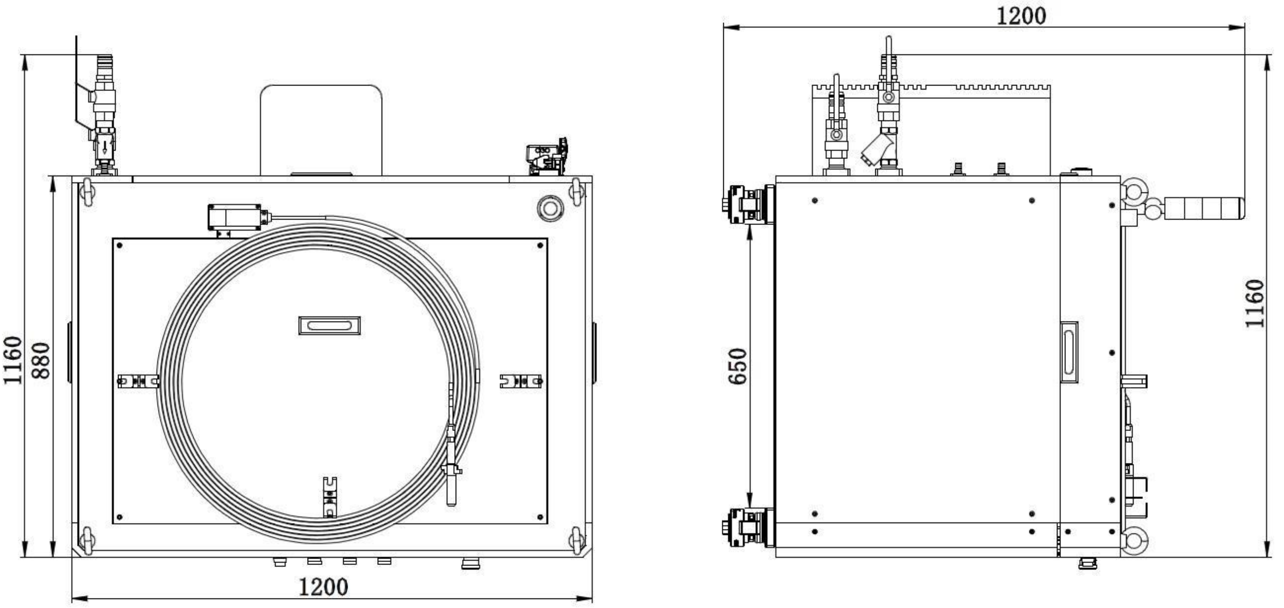


Figure 3.b - Top and left side view

Figure 3 Dimensions of RFL-C10000XZ/12000XZ

Those two models of RFL-C10000XZ and C12000XZ share a same set of cabinet, and henceforth the same dimensions of 1200 × 960 × 1160 mm (width × depth × height, including casters and rings, excluding alarm lights); The weight is about 450 kg for RFL-C10000XZ and 500 kg for RFL-C12000XZ.

The type and dimensions of RFL-C3000XZ/C4000XZ/C6000XZ/C8000XZ/C10000XZ/C12000XZ's fiber delivery cable and cable connector are as follows:

1) RFL-C3000XZ/C4000XZ/C6000XZ uses the RFL-HQBH model cable connector, and the external dimensions of the cable connector are shown in Figure 4:

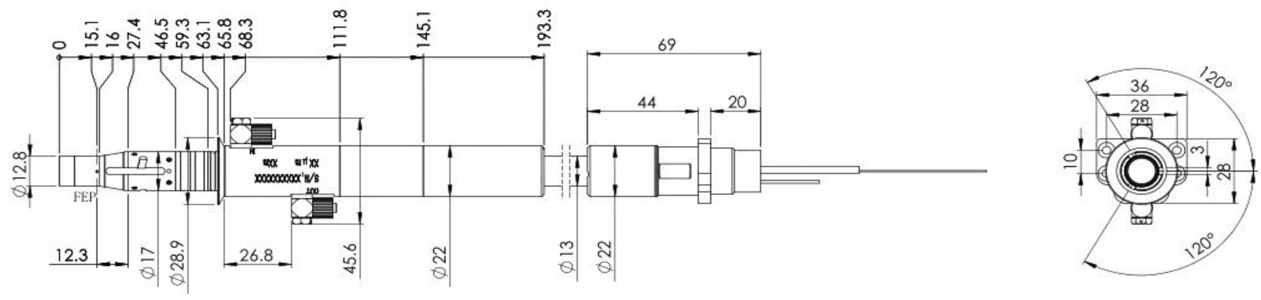


Figure 4 External dimensions of the RFL-HQBH fiber delivery cable connector

2) RFL-C8000XZ/C10000XZ/C12000XZ uses the RFL-QD model cable connector, and the external dimensions of the output optical cable connector are shown in Figure 5:

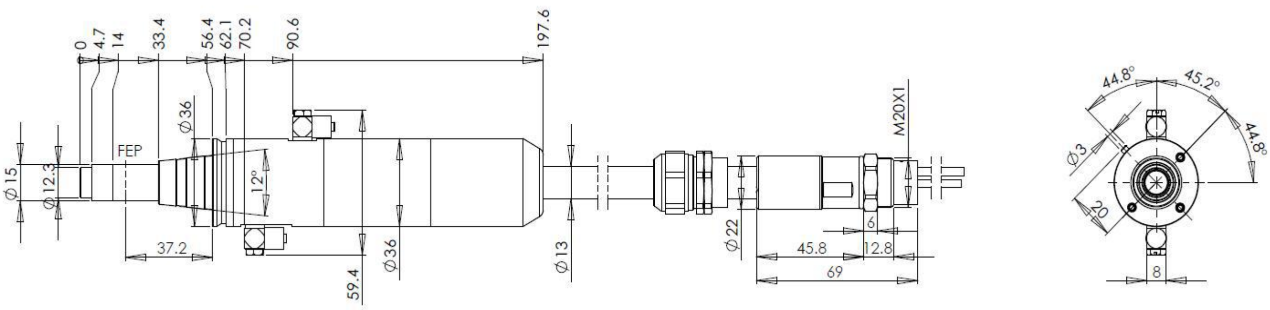


Figure 5 External dimensions of the RFL-QD fiber delivery cable connector

NOTE:

1) The dimensions in the above figures are in the unit of mini-meter (mm).
2) Before the laser is powered on, make sure that the two copper contacts (interlock pins) on the fiber connector are shorted well, otherwise the laser will not work properly.
3) Before installing the fiber delivery cable connector into the laser processing head, the lens of the fiber delivery cable must be inspected carefully.
4) If the fiber delivery cable lens is dirty, the lens must be cleaned well. It is forbidden to disassemble the protective lens by anyone other than staff of Raycus or Raycus authorized personnel, otherwise the warranty will be invalidated.

3.2 Installation Requirements

1) Place the laser horizontally in a suitable position and fix it as necessary;
2) Before the laser is powered on, check if the power supply has the correct voltage (AC 323V ~ 437V, 50/60Hz, see Table 2 Product Technical Data Sheet for details), and the grounding line (PE) shall be well grounded all time during powering on;
3) Connect the power cable and control cable to the product when power supply is OFF;
4) Connect the cooling system to the laser and output optical cable connector according to the water inlet and outlet signs;
5) Please check the laser fiber delivery connector and make sure to clean it before installing it in the equipment;
6) **DO NOT** step on, squeeze, or excessively bend the protective tube during the installation of the output optical cable to avoid damage to the optical fiber;
7) In the process of installing the fiber delivery connector, ensure the cleanliness of the surrounding environment (**DO NOT** use electric fans to dissipate heat when it is hot in summer to avoid large dust in the air);
8) The minimum bending diameter of the laser transmission cable in non-working conditions such as transportation and storage shall not be less than 20 cm. When the laser is emitting, the minimum bending diameter shall not be less than 30 cm;

9) Users can use the four rings on the top of the product to carry the product or the four casters at bottom to move it. As Figure 6, and **MUST** check that the rings are firmly installed and that the casters are fully active before lifting the laser.

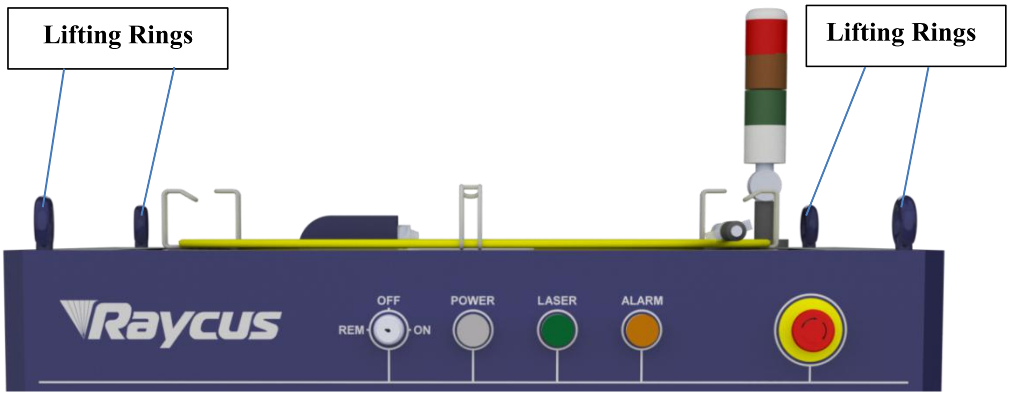


Figure 6.a - Lifting Rings (RFL-C6000XZ/C8000XZ as an example)

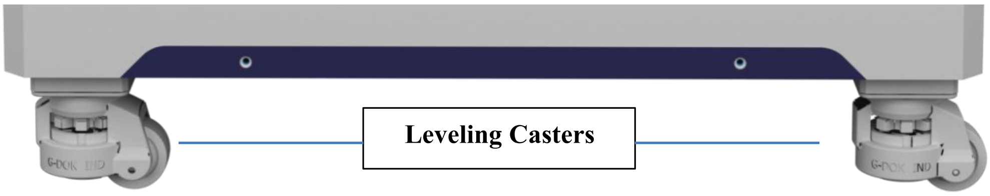


Figure 6.b - Leveling casters (RFL-C6000XZ/C8000XZ as an example)

Figure 6 Product top lifting rings and bottom level adjustment casters

CAUTION: All the cables can only be connected when power supply is off. Hot plug may damage the device.

CAUTION:

(1) The placement of the laser delivery cable should be as natural as possible, and the delivery cable should not be twisted;
(2) If the coil diameter of the delivery optical cable is too small, it will damage the laser.

CAUTION:

(1) In the process of installation and disassembly, please handle the laser fiber delivery connector gently, and **DO NOT** subject it to vibration;

(2) Before installing the laser fiber delivery connector, ensure that the optical lens and laser processing head cavity are clean and free of pollution.

3.3 Cooling Requirements

Table 3 Water cooling requirements

Model	C3000XZ	C4000XZ	C6000XZ	C8000XZ	C10000XZ	C12000XZ
Cooling Capacity	≥ 6 kW	≥ 8 kW	≥ 12 kW	≥ 16 kW	≥ 20 kW	≥ 24 kW
Min. Flow Rate	＞35 L/min	＞52 L/min	＞64 L/min	＞79 L/min	＞94 L/min	＞112 L/min
Max. Input Pressure	4 ~ 6 Bar					
Hose Inner Diameter	Φ25 mm			Φ32 mm		

Cooling system water temperature setting: 24 ± 1°C.

3.3.1 Requirements for Cooling Water:

1) The cooling water uses the pure water, may use the drinking pure water.
2) In order to prevent the growth of mold that may lead to water blockage of the product, adding alcohol solution to about 10% portion of the total volume is recommended.
3) If ambient temperature is between -10℃ and 0℃, it is recommended to use the 30% portion volume alcohol, and replace it by every 2 months entirely.
4) If the ambient temperature is below -10℃, the cooling system (chiller) with both heating and cooling functions must be activated, and shall keep it in full-time operation by 24 hours to avoid the fiber delivery cable connector and modules inside the product that containing the always waterways from freezing.

3.3.2 Requirements for Delivery Cable Cooling System:

1) Water flow requirements:
   a) RFL-HQBH model fiber delivery cable: 1.5L~2.0 L/min
   b) RFL-QD model fiber delivery cable: 2.5~3.0 L/min.
2) Pressure of liquid flow: < 0.6 MPa at the inflow.
3) Type of liquid exchange junction: Two-Touch Fitting M5 to ϕ6 mm.
4) Type of tube: outer diameter ϕ6 mm; inner diameter ϕ4 mm.
5) Direction of cooling liquid: unidirectional; connect the tube with the water-pipe strictly according to direction shown on the layer of the tube.
6) Type of liquid: de-ionized water, condensed water, purified water; it is recommended to replace the coolant once a month, not exceeding two months at most.
7) PH value of liquid: 5.5 ~ 9.
8) Filter element/cartridge is needed for the cooling system, and the size of the solid residual particles should be ≤ 100 μm; replace the filter element/cartridge once a month.

9) Maximum temperature of liquid: 45 ℃.

10) Minimum temperature of liquid: 5 ℃ above the saturated dew-point.

11) Additive to the liquid: satisfies the requirements of PH value and size of solid residual particles as above.

12) Radius of the bending of the armored pipe: off-work state (i.e., transportation and reservation): minimum radius of bending ≥ 15 cm; in-work state: minimum radius of bending ≥ 20 cm.

13) Long-term vibration < 2 G; Impact < 10 G.

3.3.3 Other Requirements:

1) When initiating the cooling system before using the product each time, check the entire water system and joints to prevent the water leakage. The external water pipe must be installed and connected according to the water inlet (IN) and water outlet (OUT) identified on the rear panel of the product. Otherwise, the product may not work properly.

2) If the product is not used for a long time, the cooling water inside the cooling system and the product should be drained totally, and then both the inlet and outlet must be covered with proper caps. Otherwise, the product may be damaged due to the frozen.

3) Please use compressed gas below 0.5 MPa when draining the water from the product. Failure to do so may cause permanent and irrecoverable damage to the cooling system.

CAUTION:

(1) Set the water temperature of the cooling system correctly according to the ambient temperature. If the water temperature was set too high, it will result in the product de-functioning. If the water temperature was set too low, it will cause condensation inside the product or the laser fiber delivery cable, which will cause damage to the product as well;

(2) Before turning on the product, the cooling system must be working properly and the water temperature should be suitable for the temperature.

4 Using the Product

Please visit Raycus official website to download the latest Raycus Laser Control Software and its user manual as well. Website: http://www.raycuslaser.com

4.1 Front Panel

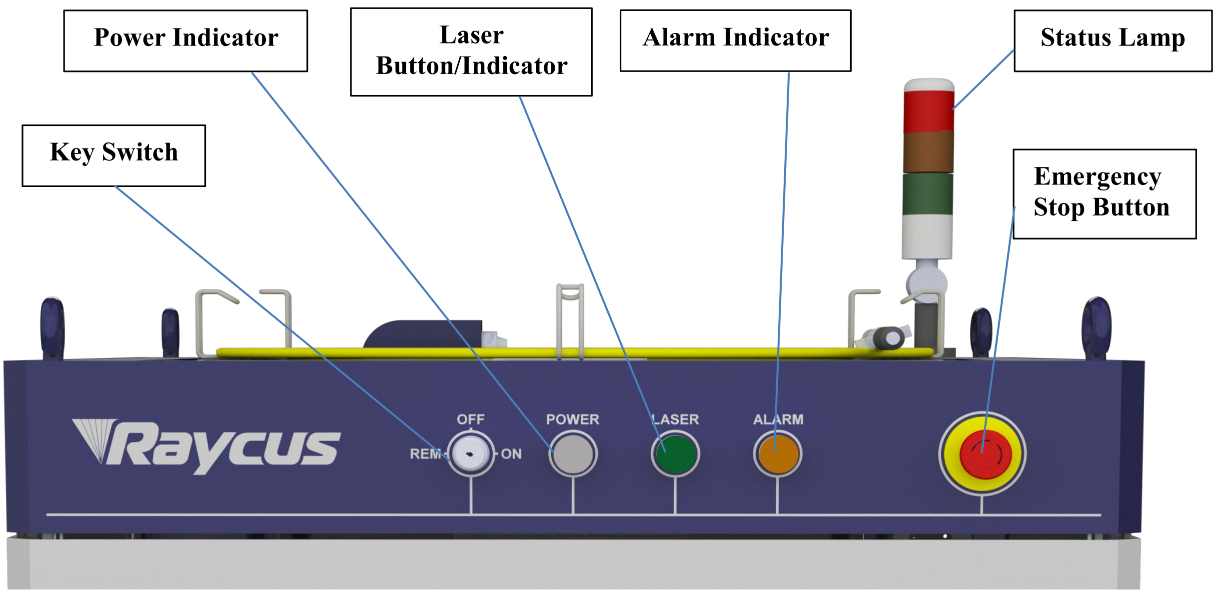


Figure 7 Front panel

4.1.1 REM/OFF/ON (Key Switch)

The main power switch of the product, to be operated with a key (enclosed as a standard accessory).

a) Insert the key and turn clockwise to the "ON" position, the main control part of laser source is powered on and the Power Indicator (White) lights on.

b) Or turn counterclockwise to "REM" position, and short-connect the Pin 8 and Pin 9 of XP1 Port to work in "REMOTE" mode. And Hardwire control mode is also accessed with key at "REM" position.

4.1.2 POWER Indicator (White)

When main control system is powered on, this indicator will illuminate white.

4.1.3 LASER Button/Indicator (Green)

When main control system is powered on (Power Indicator illuminates white) and all Interlock ports are connected properly, press this button to power on the main power module of laser source and this indicator will illuminate green.

4.1.4 ALARM Indicator

INTERLOCK alarm indicator. This indictor will illuminate Yellow during the control board powering-on and self-check processes. When the self-check is done and all INTERLOCK ports are working properly this indicator will turn off. When the laser source is in work, any INTERLOCK malfunction will bring this indicator to illuminate again.

4.1.5 EMERGENCY STOP Button

Press down to turn the laser off immediately in emergent situations. Turn it clockwise to release the button (recover to the normal position). Then use the key to turn the laser back on after the emergency is lifted.

4.1.6 Status Lamp

When the laser key switch hits “ON” or “REM”, the green light is on. The red indicator is on when the laser is emitting. When the fault occurs, the yellow indicator light is on, accompanied by a siren sound. (Note: some certain client-customized version of XZ series product may have different definitions for each colored indicator of the status lamp).

4.2 Rear Panel

4.2.1 AC Input

The socket for mains in. Please use only the enclosed power cord provided by Raycus. The socket features a protective cover and a lock. Please use the protective cover and lock when not using the product.

4.2.2 INTERFACES

Control interface panel, including HARDWIRING XP1, SAFETY XP2, RS232, ANALOG XP4, ETHERNET XP5 interfaces. This control panel provides all control input signals and feedback output signals, including: RS232 communication, network port communication, laser on/off control, laser remote control mode selection, analog control, modulation signal, Interlock interface, laser emission power feedback signal, etc., Refer to Table 5, Table 6, Table 7, Table 8 and Table 9 for control line definitions. This socket comes with a protective cover and the lock. When users are not using the product, users shall cover the power input socket with the protective cover and lock it with the lock.

4.2.3 WATER Inlet/Outlet for Delivery Cable Connector and Laser Source

Pagoda type water tube connector. The inlet and outlet are used for inflow and outflow of cooling water. The rear views of other higher power models are shown below for reference. Except for the differences in dimensions of the cabinet, the layout of sockets and water connections are the same as 4000W model.

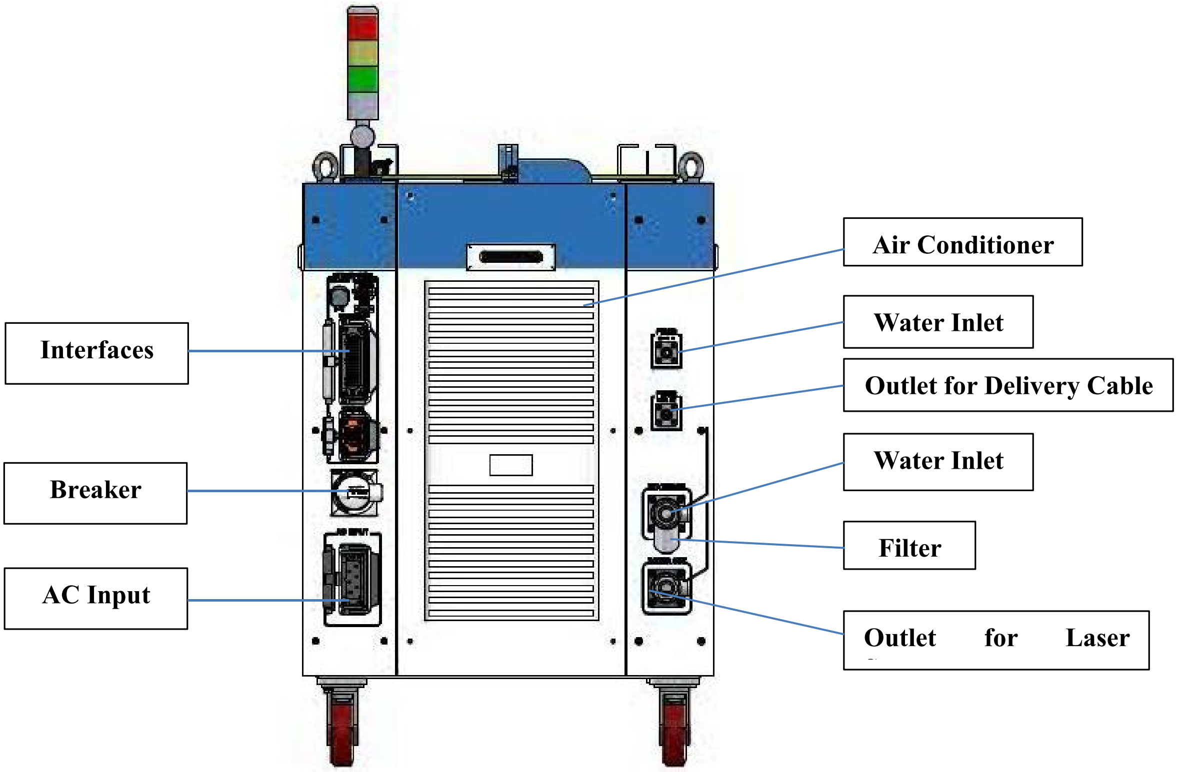
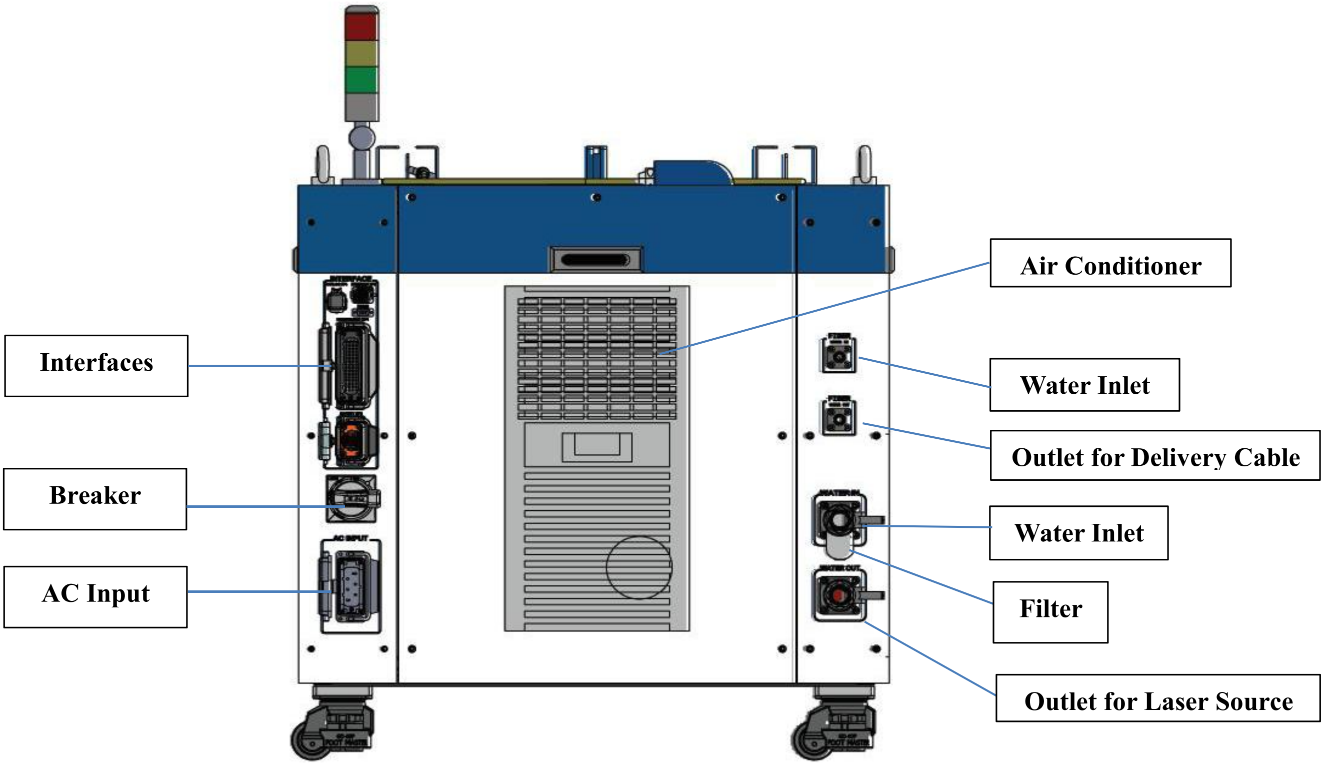


Figure 8.a - Rear panel (RFL-C3000XZ/C4000XZ)



Picture 8.b - Rear view of RFL-C6000XZ/C8000XZ

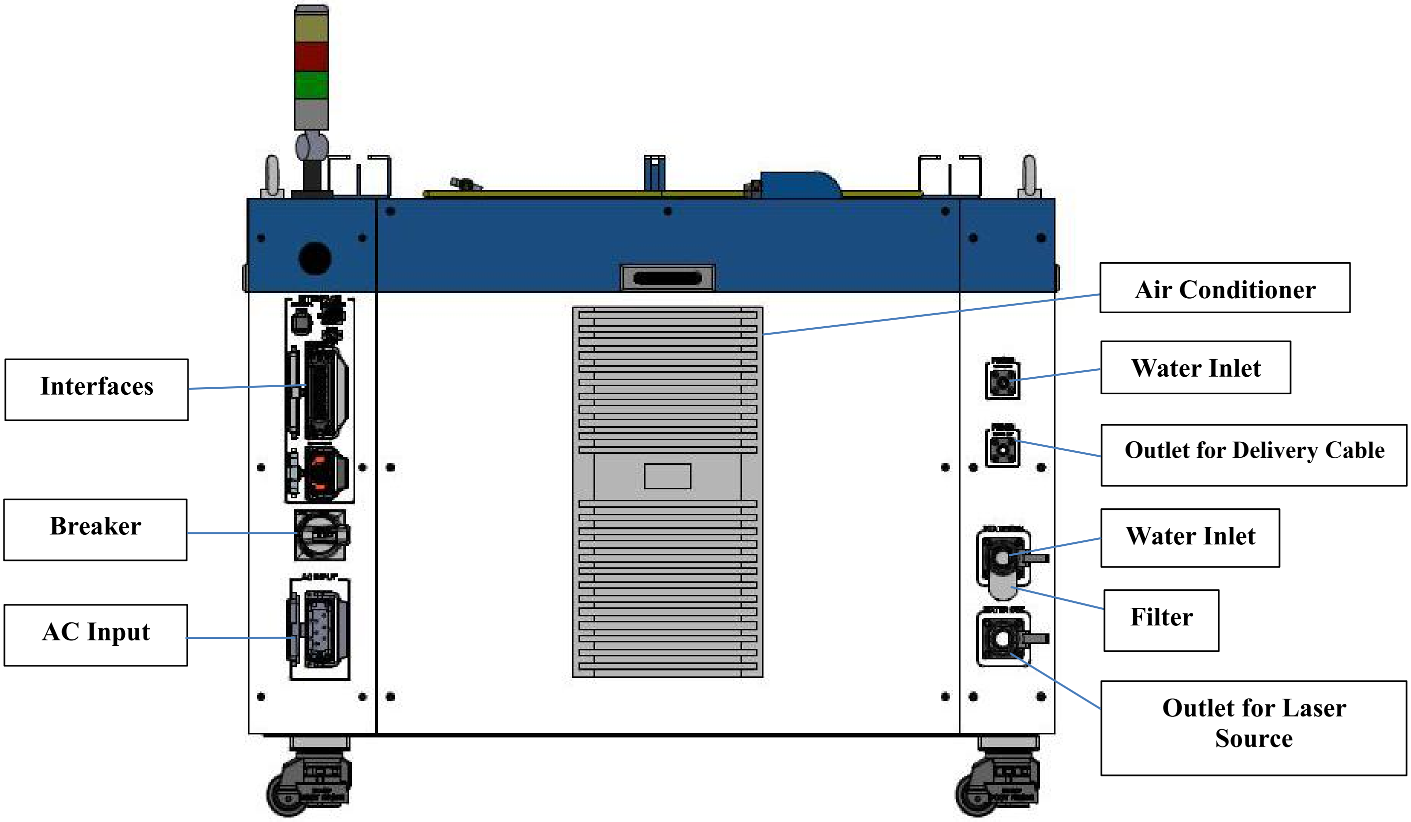


Figure 8.c - Rear view of RFL-C10000XZ/C12000XZ

Figure 8 View of RFL-C3000XZ - C12000XZ

4.3 Power Connection

	**CAUTION:** (1) Before connecting the product to AC power, users must check that the AC supply is applied in accordance with the specifications provided in Table 1. (2) Incorrect connection of the power cable will damage the product. Please carefully check both the power cable and the control cable are correctly and firmly connected before usage.

8A power cord is enclosed in the accessory package, as Figure 9

a) C3000XZ/4000XZ b) C6000XZ power cord c) C8000XZ/C10000XZ/C12000XZ

Figure 9 Power cords of different models

Insert the plug at the end of the power cord into the "AC INPUT" socket on the rear panel. Notice that the plug is wrong-side proofing. After insertion, lock it with the latch. As Figure 10.

a) C3000XZ/4000XZ b) C6000XZ c) C8000XZ/C10000XZ/C12000XZ

Figure 10 Power cord plug and socket

RFL-C3000XZ/C4000XZ models use four-core power cable. RFL-C6000XZ/C8000XZ/C10000XZ/ C12000XZ models use seven-core power cable. AC interface definition and requirements are shown in Table 4.

Table 4 Definition and parameter requirements of AC interface

RFL-C3000XZ/C4000XZ Power Connector Pin Definitions and Parameters				
Pin Number	**Definition**	**ID**	**Diameter**	**Color**
1	AC380V-L1	L1	$6mm^2$	Brown
3	AC380V-L2	L2	$6mm^2$	Black
5	AC380V-L3	L3	$6mm^2$	Grey
6	Protective Earth	PE	$6mm^2$	Yellow/Green
2, 4, 6, 8	/	None	/	/
RFL-C6000XZ Power Connector Pin Definitions and Parameters				
1, 2	AC380V-L1	L1	$4mm^2/4mm^2$	Brown
3, 4	AC380V-L2	L2	$4mm^2/4mm^2$	Black
5, 6	AC380V-L3	L3	$4mm^2/4mm^2$	Grey
7	Protective Earth	PE	$4mm^2$	Yellow/Green
8	/	/	/	/
RFL-C8000XZ/C10000XZ/C12000XZ Power Connector Pin Definitions and Parameters				
1, 2	AC380V-L1	L1	$6mm^2/6mm^2$	Yellow
3, 4	AC380V-L2	L2	$6mm^2/6mm^2$	Green
5, 6	AC380V-L3	L3	$6mm^2/6mm^2$	Red
7	Protective Earth	PE	$6mm^2$	Yellow/Green
8	/	None	/	/

Standard Power cord length is 8 m for RFL-C3000XZ/C4000XZ models, and 15 m for RFL-C6000XZ/C8000XZ/C10000XZ/C12000XZ models.

NOTE:

The appearance of the AC input connector used in RFL-C6000XZ is the same as that used in RFL-C8000XZ/C10000XZ/C12000XZ models, only the pin (male pin, female core) and core module are changed, the pin is replaced with rated current of 40A, and the core module is replaced accordingly.

4.4 Control Interface Definition

The laser source comes with control signal connectors, but without control signal cables. The connectors are shown in Figure 11.

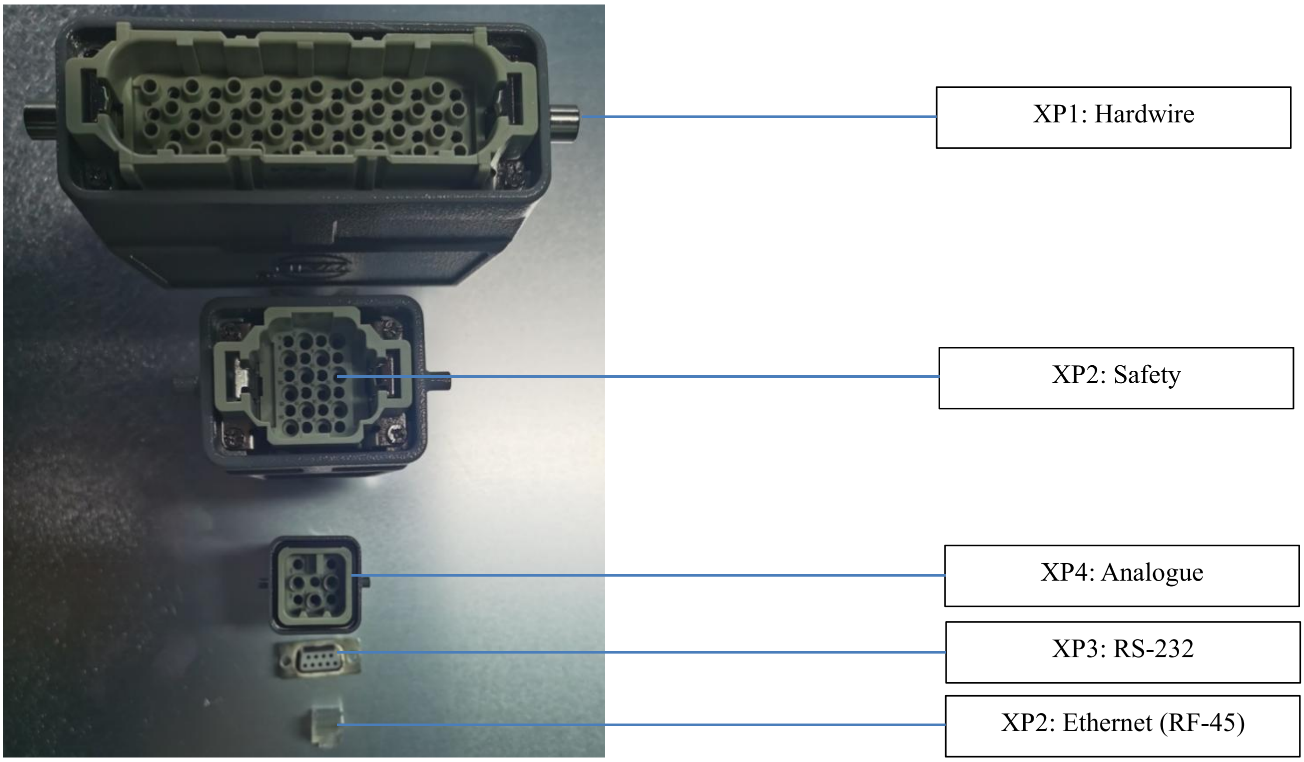


Figure 11 Control signal connectors

4.4.1 Safety XP2 24 Pin Interface

The 24-pin hard wire interface, with remote control system power-on, remote main power power-on, and active and passive output of some lasers. Detailed interface definitions are shown below:

Table 5 Safety XP2 24 pin interface definition

No.	Type	Description
1	MOD+	Laser emission control, voltage input; Fiber Laser ON：4～30 V; Fiber Laser OFF：-3～2 V; Maximum modulation frequency：5 kHz.
2	MOD-	
3	OUT (FET S pole)	Laser emission indicator, MOSFET D pole, S pole output; electric current ＜1A，Vds＜30V Passive Signal
4	OUT (FET D pole)	
5	OUT	Laser emission warning light negative，electric current＜100mA
6	OUT	The main power supply is energized to the negative of the warning lamp，electric current＜100 mA
7	OUT (24V)	The laser emission and the main power supply are energized to the positive pole of the warning light，electric current＜400mA
8	IN	During REM mode, the remote main control board is powered on, 24V active contact input, and external voltage or grounding is not allowed； When pin 8 and 9 are closed, the main control board will be powered on.
9	IN	
10	24V OUT	The laser emission and the main power supply are energized to the positive pole of the warning light，electric current＜400mA.
11	OUT	Front panel emergency stop output 1, relay contact output, passive contact，electric current＜100mA，voltage＜30V;
14	OUT	

		After pressing the current panel emergency stop, 11, 14 open circuit, otherwise for short circuit.
12	OUT	Front panel emergency stop output 2, relay contact output, passive contact, electric current＜100mA, voltage＜30V; After pressing the current panel emergency stop, 12, 13 open circuit, otherwise for short circuit.
13	OUT	
15	OUT (FET S pole)	The main power supply has been switched on for output indication, MOSFET D and S poles output; electric current < 0.5A, voltage < 60V.
16	OUT (FET D pole)	
17	IN	Interlock1 input, active contact, normal short connection 17, 20, no external voltage or grounding.
20	IN	
18	IN	Interlock2 input, active contact, normally short connection 18, 19, no external voltage or grounding.
19	IN	
21	IN	When the remote main power is powered on, it is same with the function of the Power button on the front panel. When Pins 21 and 22 are closed, the main power supply is started. The active outlet points can't not be externally voltage or grounded.
22	IN	
23	OUT	The laser has been energized and output; OFF - 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, voltage less than 30V, electric current less than 1A.
24	OUT	

1) Mode Signal

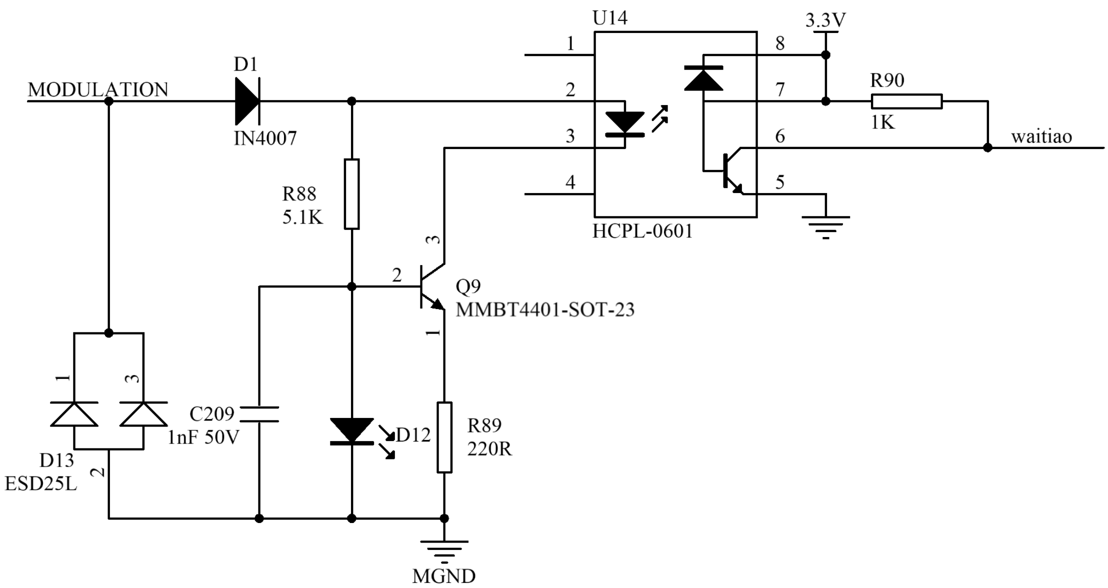


Figure 12 Mod signal schematic diagram

This signal is 5/24V compatible, and reverse connection is not allowed.

When the key switch is turned to "ON" and the laser works in the external laser control mode, the MOD is used to control the laser emission and turn off;

When the key switch is turned to "REM" and the laser is working in the external laser control mode, MOD and XP1-A2 (at this time the A2 position light enable signal) are united to control the emission and turn off of the laser (in REM mode, the laser can only be controlled by A2, need to be customized).

2) Passive Laser-Emitting Indication and Main Power-On Indication

XP2's 3/4 laser emission indication, 15/16 is the main power supply output indication, the internal circuit diagram is shown in Figure 13.

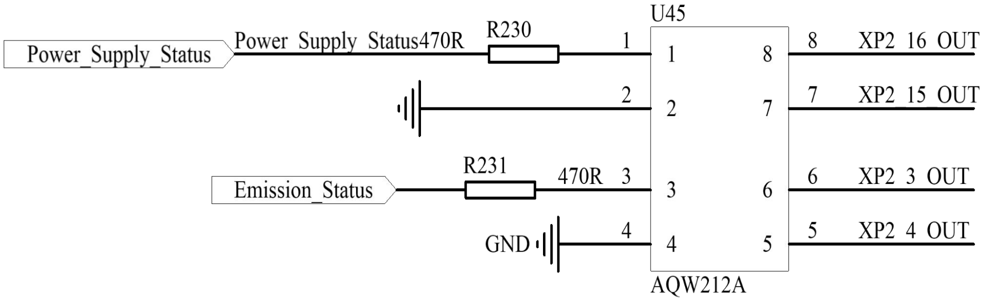


Figure 13 Internal schematic diagram

Recommended wiring diagram (12V has been taken as an example)

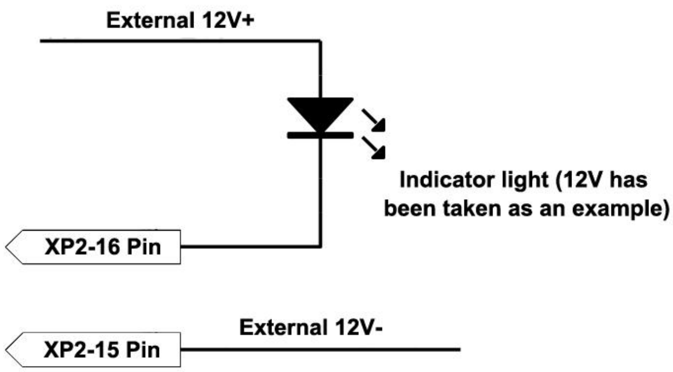


Figure 14 Recommended wiring diagram

3) Active Light Indicator and Main Power on Indicator

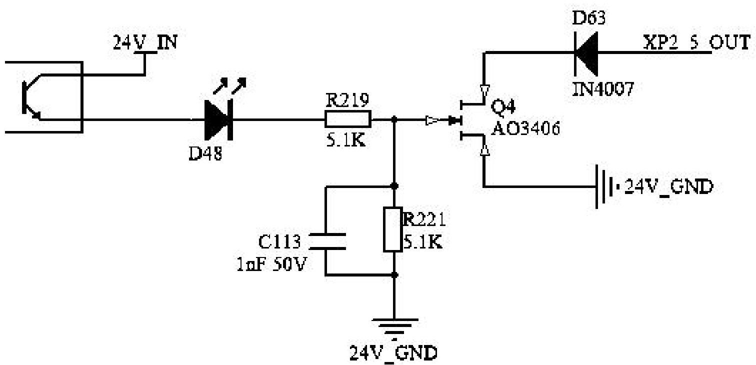


Figure 15 Internal circuit diagram

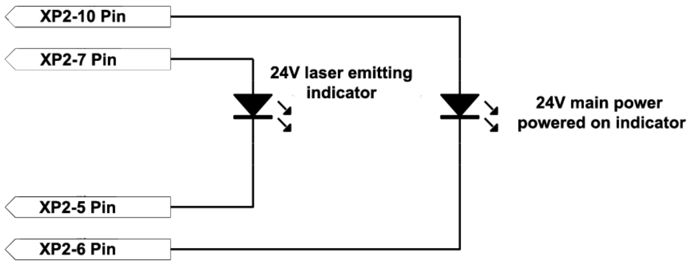


Figure 16 Recommend wiring diagram

4) Power On the Remote-Control Board

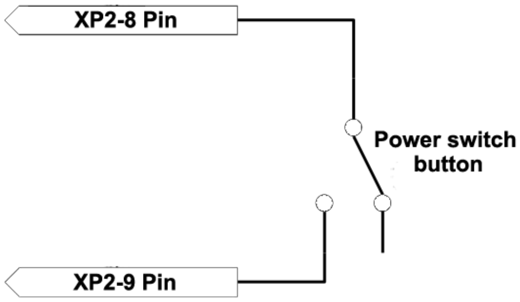


Figure 17 Recommended wiring diagram

When the laser key switch on "REM", it must be short-connected to the 8/9 pin main control board to power on.

5) Remote Main Power Supply

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

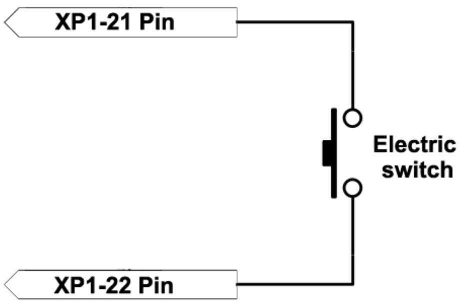


Figure 18 XP2 Remote main power supply wiring diagram

6) The Control Board is Powered on And Output

This signal is a relay output, and the relay is closed after the main control board is powered on.

4.4.2 Hardwire XP1

64 pin hard wire interface, featuring the control signal input and output for the laser working in remote mode. Detailed interface definitions are shown in Table 6 below:

Table 6 XP1 Hardwire interface definition

Pin		**Type**	**Descriptions**
Pin No.	Pin Name		
A1	Laser request	Input	Input signal and request laser, laser will receive other commands only after this bit is valid
A2	Programming mode execution	Input	Rising edge will initiate the laser source to emit laser power according to the pre-downloaded programming commands. Program number is determined by Pin A8~A14. 1) if the program number is 0000000 and Pin A6 is high, the laser power is set by AD analog value; 2) if the program number is 0000000 and Pin A6 is low, the laser power is set by Raycus Laser Control System (Raycus House-made Software); 3) if the program number is 0000000 and Pin A6 is low and A3 is high, the laser emission is controlled by Raycus Laser Control System (Raycus House-made Software)
A3	Internal model	Input	High level enables the Raycus Laser Control System
A4	Reset	Input	Effective high level and clear the laser alarm bit, the effective high-level time will last at least 1 ms
A5	Guide laser	Input	Valid until guide laser on.
A6	Analog control	Input	Input signal, it is valid after be able to simulate the input signal (Program num = 0000000)
A7	Stop editing	Input	Stop editing immediately once in high level.
A8	Program number selects address	Input	Input signal, low level
A9~A14	Program number selects address1-6	Input	Input signal, high bits 1 ~ 6s, select program number
A15	Synchronization	Input	Backup
A16	COM	The reference for all signals	/
C1	The laser drive power on	Input	Input signal, rising edge to turn on the main power, falling edge to turn off the main power.
C2	Null	/	/
C3~C6	Optical gate selection	Input	Input signal:C3is low level, C6 is high level; 0000 - Optical Gate closed 0001 - Optical Gate 1 is open 0010 - Optical Gate 2 is open 0011- Optical Gate 3 is open **(Only working for laser source featuring Optical Gate function, and as standby for normal models.)**
C7	Currently reserved (intended as an enabling signal in QCW mode)	Input	Input signal, enabling QCW mode **(Only working for laser source featuring QCW mode)**
C8~C16	/	/	Backup

B1	Laser ready	Output	Indicate that the laser is ready for emission.
B2	Laser emitting	Output	Indicate that the laser is emitting.
B3	Internal mode Indicator	Output	Indicate that the laser is working in Internal mode.
B4	Abnormal	Output	Indicate that the laser is in abnormal condition.
B5	Guide laser indicator	Output	Indicate that the laser guide laser is on.
B6	AD mode	Output	Indicate that the laser is working in AD mode.
B7	Laser receiving request signal	Output	Indicate that the laser receives Request Signal (Pin A1).
B8	Main power on	Output	Indicate the main power is on.
B9	Waveform mode Indicator	Output	Indicate that the laser is working in Waveform mode.
B10	Waveform mode execution finished	Output	Indicate that the Waveform mode is successfully done. Invalid pin A2 will reset this pin.
B11	Waveform mode abnormally finished	Output	Indicate that the Waveform mode is abnormally finished. Reset (Pin A4) will reset this pin.
B12	Synchronization signal output	Output	High level valid, low level invalid
B13	Alarm	Output	Indicate that the laser is having alarms.
B14	Backup	/	/
B15	External power source +	/	External power source of 24V. All output pins are effective when Pin B15 and B16 are connected with 24V external power source.
B16	External power source -	/	
D1~D4	Working optical gate indicator	Output	Indicating the current working Optical Gate: 0000- Optical Gate disabled 0001-Optical Gate 1 is working 0010-Optical Gate 2 is working 0011-Optical Gate 3 is working D1 low level， D4 high level (Only working for laser source featuring Optical Gate, **and as standby for normal models**)
D5	Cooler warning	Output	Warning for the current cooling water temperature.
D6	Cooler alarm	Output	Alarm for the current cooling water temperature.
D7	QCW mode	Output	Indicate the laser source is working in QCW mode **(Only for model featuring QCW function)**
D8~D11	Hardware address	Output	Coding-Cable function 0000- Laser source number 0 0001- Laser source number 1 D8 low level， D11 high level
D12~D16	Backup	/	/

4.4.3 XP3 RS232 Interface

The 9-pin serial interface is used for the communication between the laser and the Raycus Laser Control System. The definitions are shown in Table 7 as follows:

Table 7 XP3 serial interface definitions

Pin no.	Type	Description
2	IN	RXD, Serial port receiving pin of the laser
3	OUT	TXD, Serial port transmitting pin of the laser
5	COM	GND, Serial port common end

4.4.4 XP4 Analog Interface

The 8-Core Harting port analog interface, is used to control the emission power of the laser by analog in AD mode, and can also monitor the output laser and power feedback signals of the laser. The interface definition is shown in Table 8 below:

Table 8 XP4 analog interface definitions

Pin No.	Type	Description
1	IN	0~10 V analog signal, laser power control signal in AD mode ,0-10 V corresponding to 0-100% emission power
2	AGND	Analog Signal location
3	OUT	Power amplifier voltage output; 0 V: 0% laser power output, 8 V: 100% laser power output
4	Reference	Reference for power amplifier voltage
5	OUT	High reflection amplification voltage (reserve for standby, not have yet)
6	Reference	Reference for High reflection Voltage

4.4.5 XP5 Ethernet Interface

The interface definition is shown in Table 9 below:

Table 9 XP5 communication interface definition

Pin No.	Function	Description
1	TX+	Data transmission+
2	TX-	Data transmission-
3	RX+	Data acceptance+
4	N/C	No connection
5	N/C	No connection
6	RX-	Data acceptance-
7	N/C	No connection
8	N/C	No connection

4.5 Interlocking

Raycus XZ series models are designed with an interlocking function, which is a two-channel mechanism with output monitoring and manual/automatic reset.

When the safety interlocking circuit is open, the safety circuit will disconnect the power of the optical module and then stop the laser emission. To restart the main power supply, users must close both interlocking channels (24-Pin interface: Pin 17 and Pin 18 short-connected, Pin 19 and Pin 20 pins short-connected). Otherwise, the main power will be turned off and the laser cannot be turned on.

If the interlock is shorted/closed (the "Emergency Stop" button is also released) and there is no error alarm, press the "Start" (LASER) button to restart the main power supply, and the "main power has been started" pin of the external interface will have a high level.

When the safety interlocking circuit is open or the error is detected, the main power supply of the optical module will be turned off, and the "main power supply has been started" signal of the interface will become low level. The detected "error state" is latched and the on-board relay opens the manual reset loop with monitoring until the error is cleared, thus preventing the laser from being restarted.

If errors such as short circuit between interlocking channels or short circuit of start (LASER) button are detected, the safety interlocking loop cannot be reset before the error is cleared.

4.6 Schematic Diagram of the Laser Electrical Circuit

The schematic diagram of the laser is as Figure 19:

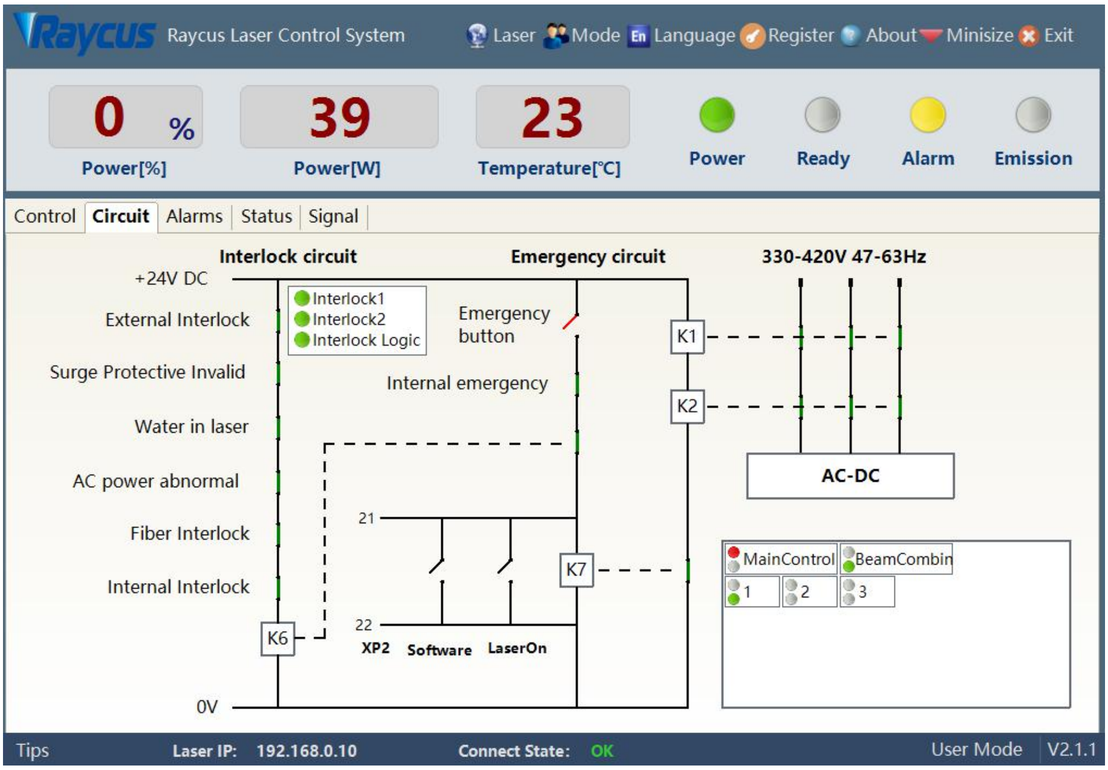


Figure 19 Schematic diagram of the laser electrical circuit

4.7 Operation Start-ups Sequences

1) Turn on the water cooler, check whether the water pipe is leaking. Turn off the water cooler and connect electrically.
2) Make sure the circuit breaker is in “OFF” position and the “Emergence Stop” button of the front panel is pressed down. All electrical connections must be completed before the laser is powered on;
3) Confirm that the three-phase electrical connection is correct and the power supply meets the specifications, turn on the water cooler.
4) Close the rear panel circuit breaker, release the laser front panel emergency stop switch; ensure that all laser doors are closed, optical cable fiber delivery connector has been inserted into the laser processing head (or corresponding equipment), all interlock interfaces have been closed;
5) Select the required control mode according to 1.4 “control mode”, turn on the key switch, start the main power supply waiting for the laser to be “Ready” state. When the laser is ready, the tricolor status lamp on the top the laser lights green, representing that the laser is ready for emitting the laser beam.

NOTE:

1) Raycus high power continuous wave lasers are equipped with relative individual backpack air conditioner, turn on the switch, the air conditioning will then begin to work.
2) When the working environment temperature and relative humidity of the laser are in the dew point area (Blue), please let the air conditioner work for 30 minutes before operating the laser.

5 Control Mode Selection

Raycus high power continuous lasers provide two control modes, ON Mode and REM Mode, respectively. Users can choose their needed mode by turning the key on the front panel to the corresponding position. The specific operation is as Table 10.

Table 10 Control modes and their subsequent operating methods

	AD mode	Output remote control	Programming mode	Power	Laser emission and shutdown	Red guide beam
ON Mode	Close ①	Close ②	-	Communication ⑬	Communication ⑪	Communication ⑫
	Enable ③	Close ②	-	XP4-1/2 Foot voltage	Communication ⑪	Communication ⑫
	Close ①	Enable ④	-	Communication ⑬	XP2-1/2Foot level status	Communication ⑫
	Enable ③	Enable ④	-	XP4-1/2Foot voltage	XP2-1/2Foot level status	Communication ⑫
REM Mode	Close ⑤	Close ⑥	Close ⑦	Communication ⑬	Communication ⑪	Communication ⑫
	Enable ⑧	Close ⑥	Close ⑦	XP4-1/2Foot voltage	Communication ⑪	XP1-A1/A5 high
	Close ⑤	Enable ⑨	Close ⑦	Communication ⑬	XP1-A1 Laser request high XP1-A2 Laser emission energy XP2-1/2 input MOD signal	XP1-A1/A5 high
	Enable⑧	Enable ⑨	Close ⑦	XP4-1/2Foot voltage	XP1-A1 Laser request high XP1-A2 Laser emission energy XP2-1、2 input MOD signal	XP1-A1/A5 high
	Close ⑤	Enable ⑨	Enable ⑩	By programming instruction	XP1-A1 Laser request high XP1-A2 Upward initiation of implementation procedures	XP1-A1/A5 high

Note：①～⑬ operating methods:
① Send “DEC” ; ② Send “DLE”; ③ Send “EEC”; ④ Send “ELE”; ⑤ XP1-A1 high, XP1-A6 low or suspended; ⑥ XP1-A1 high, XP1-A3 high; ⑦ XP1-A1 high, XP1-A8~A14 low or suspended; ⑧ XP1-A1 high, XP1-A6 high; ⑨ XP1-A1 high, XP1-A3 low or suspended; ⑩ XP1-A1 high, XP1-A8~A14 low; ⑪ Communication sends “EMON” to emit laser beam, send “EMOFF” turn off laser; The communication sends “ABN” output guide laser, send “ABF” turn off guide laser; ⑬ The communication sends “SDC XX” sets the power percentage, XX represents the power percentage.

① Send "DEC" through communication, or click the 

button on the host computer software;

② The communication sends "DLE", or the host computer software clicks the 

button ;

③ The communication sends "EEC", or the host computer software clicks the 

button;

④ The communication sends "ELE", or the host computer software clicks the 

button;

⑤ XP1-A1 is high level, XP1-A6 is low level or floating;

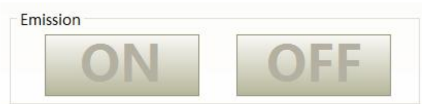
⑥ XP1-A1 is high level, XP1-A3 is high level;

⑦ XP1-A1 is high level, XP1-A8~A14 are low level or floating;

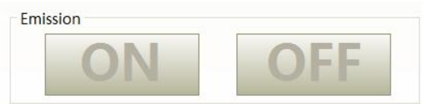
⑧ XP1-A1 is high level, XP1-A6 is high level

⑨ XP1-A1 is high level, XP1-A3 is low level or floating

⑩ XP1-A1 is high level, not all XP1-A8~A14 are low level;

⑪ Communication send "EMON" or the host computer software click the 

"ON" button to emitting the laser;

⑫ The communication sends "EMOFF" or the host computer software clicks the 

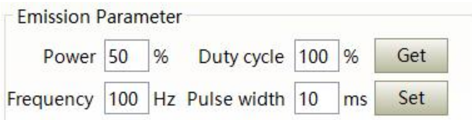
"OFF" button to turn off the laser;

⑬ The communication sends "ABN" or the host computer software clicks the 

button to output guide laser ;

⑭ Communication send "ABF" or the host computer software click the 

button to turn off the guide laser;

⑮ Communication sends "SDC XX" to set the power percentage, XX represents the power percentage, or the host computer software clicks the 

button;

5.1 ON Mode

In "ON" mode, users can set different operating modes by using the Raycus Laser Control System (RLCS) or using a direct communication command method, which can be memorized by the laser source even after powering off.

5.1.1 AD Mode Enable

When the AD mode is enabled, the power of the laser is determined by the analog voltage of 1 or 2 feet of the XP4; if the AD mode is not enabled, the power of the laser can be set by the Raycus Laser Control System or by sending the "SDC 80" command.

5.1.2 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+, MOD- in the XP2 port; if the emission external control is not enabled, the laser emission and shutdown are determined by the output button in the Raycus Laser Control System, or send "EMON" command to turn laser emission on, and send "EMOFF" command to turn laser emission off.

5.1.3 Guide laser (Red Guide Beam) Control

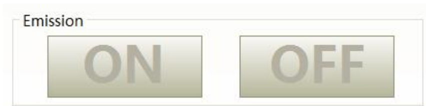
In "ON" mode guide laser can only be turned on/off by using Raycus Laser Control System, or by sending command of "ABN" (on) / "ABF" (off).

When the guide laser is turned on, the laser will turn off the "Ready" signal, and the green indicator of "Status Lamp" will turn off. When the guide laser is turned off, the laser "Ready" signal will resume immediately, and the green indicator of "Status Lamp" will be lit on.

5.1.4 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 Host Computer Software to edit the waveform and select the pre-run program number.

When the laser is in the internal control mode, press the 

"ON" button, or send the "EMON" command, the laser will start to run the program, send "EMOFF" or press the 

"OFF" button can terminate the laser emission at any time;

When the laser is in "External Control" mode, the rising edge of MOD starts the program to start execution, and the falling edge of MOD can terminate the program at any time.

5.1.5 AD Mode

When A1 and A6 of XP1 are set high at the same time, the laser runs into the AD mode, and the current laser emission power is determined by the relative analog voltage of Pin 1 and Pin 2 of XP4; when A6 of XP1 is set low or floating, when the emission power of the laser passes through the Host Computer Software or communication send “SDC 80” command to set.

5.2 REM Mode

5.2.1 AD Mode

When the Pin A1 and Pin A6 of the XP1 port are both set high, the laser runs into the “AD” mode, and the current laser emission power is determined by the analog voltage of Pin 1 and Pin 2 of the XP4 port.

When the Pin A6 of the XP1 port is set low or suspended, the laser emission power is set by the Raycus Laser Control System or by sending command (“SDC80”) directly.

5.2.2 External Control

When XP1's A1 and A3 are both set high, the laser is in the Internal Control mode, the laser is controlled by the Host Computer Software on button or the communication sends “EMON” to control the laser emission, “EMOFF” controls the laser emission off; when XP1's A1 is high, A3 is suspended or set low, the laser is in external control mode, and the laser emission is determined by the high and low levels of XP1's A2 and XP2-1, 2 pin MOD signal together.

5.2.3 Guide laser Control

When both A1 and A3 of XP1 are set high, the laser is in the guide laser internal control mode, and the guide laser is controlled by the guide laser button of the Host Computer Software or the communication sending “ABN” and “ABF”; when A1 of XP1 is set high, A3 is suspended or set low, the laser is in external control mode, and the guide laser is controlled by A5 of XP1.

The guide laser component of the product works by means of communication, so there is a time delay of at least 10 ms when the guide laser is turned on and off;

When the guide laser is turned on, the laser cannot be set to “Ready”. Only when the guide laser is turned off, the laser beam with a wavelength about 1080nm is then allowed to set to the “Ready” condition (if this limit needs to be changed, please contact Raycus regarding the users’ specific need).

5.2.4 Programming Mode

When XP1's A1 is set high and A8-A14 is not 0, the laser is in “Programming” mode. At this time, the laser emission is controlled by XP1's A2, and the laser emission waveform is determined by the edited waveform.

6 Laser Wiring Mode and Operation Steps

6.1 Internal Control in ON Mode

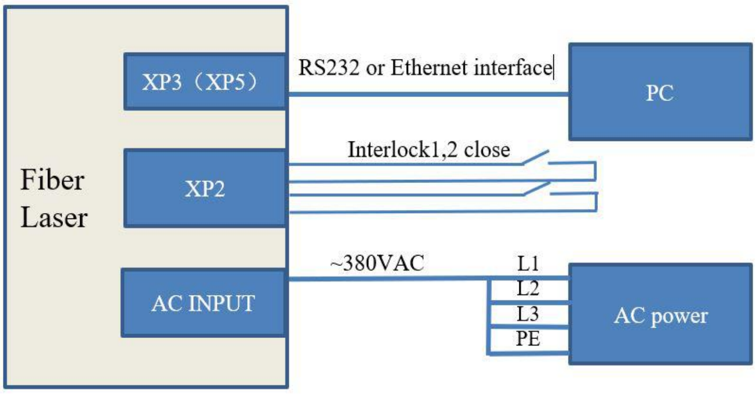


Figure 20 Key switch at “ON” position software mode wiring diagram

Operation method:

1) Turn the knob switch on the rear panel to “ON”;
2) Turn the key switch to “ON”;
3) Open the Raycus Laser Control System;
4) Click the guide laser “ON” button to view the guide laser;
5) Turn off “AD” mode and turn off external control mode; (this mode can be memorized when power off)
6) Click the main power “ON”;
7) Waiting for “Ready”;
8) Set laser emission parameters;
9) Click the laser “ON”.

6.2 Laser Operating in External Control Mode

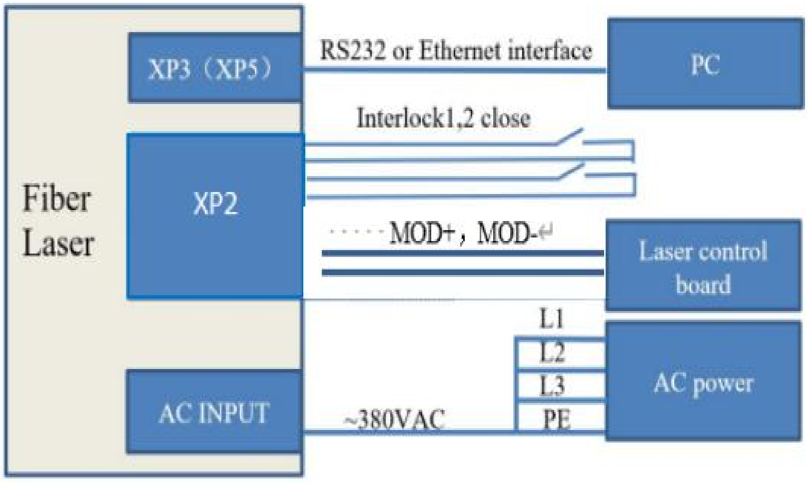


Figure 21 Wiring diagram of power internal and external control of laser emission by MODE

Operation method:

1) Turn the knob switch on the rear panel to “ON”;
2) Turn the key switch to “ON”;
3) Open the Raycus Laser Control System;
4) Click the guide laser “ON” button to view the guide laser;
5) Turn off “AD” mode and turn on “External Control” mode; (this mode can be memorized after power off)
6) Click the main power “ON”;
7) Waiting for “Ready”;
8) Set the percentage of laser emission power;
9) MOD signal output high level to turn on the laser.

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

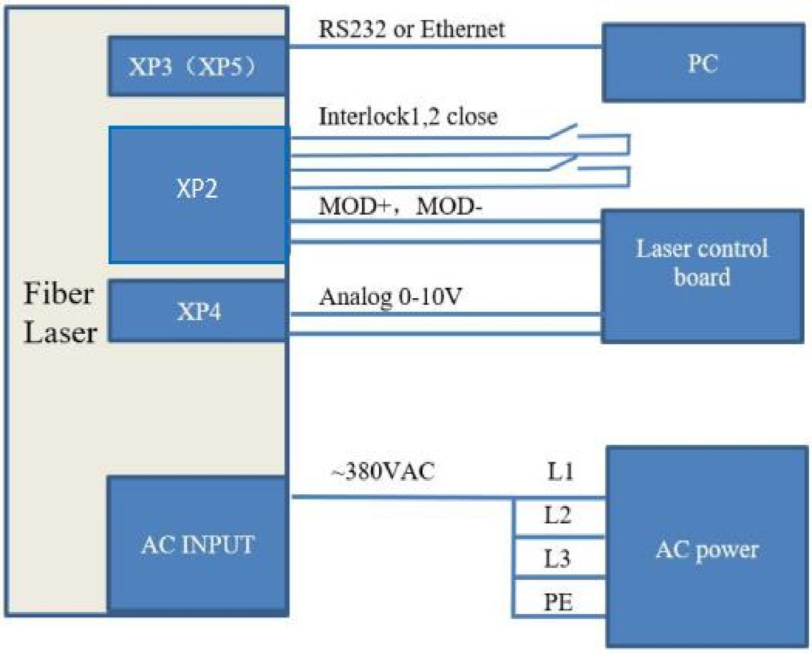


Figure 22 In ON mode, the power and laser emission controlled by analog wiring diagram

Operation method:

1) Turn the knob switch on the rear panel to “ON”;
2) Turn the key switch to “ON”;
3) Open the Raycus Laser Control System;
4) Click the guide laser “ON” button to view the guide laser;
5) Turn on the “AD” mode and turn on the external control mode; (this mode can be memorized after power off)
6) Click the main power “ON”;
7) Waiting for “Ready”;
8) The control board card outputs analog quantity and light signal.

6.4 Laser Operating in Programming Mode

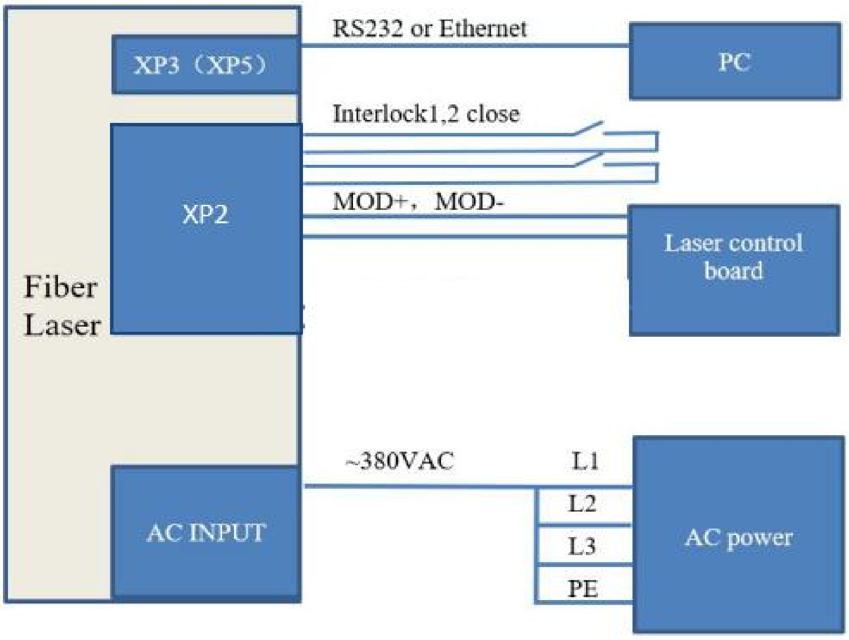


Figure 23 Wiring diagram of external control laser emission in programming mode, in ON mode

Operation method:

1) Turn the knob switch on the rear panel to “ON”;
2) Turn the key switch to “ON”;
3) Open the Raycus Laser Control System;
4) Click the guide laser “ON” button to view the guide laser;
5) Click the main power “ON”;
6) Waiting for “Ready”;
7) Set the pre-executed waveform number (the program number is greater than 0);
8) 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 Laser Control System will display that the laser program is abnormally terminated.

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

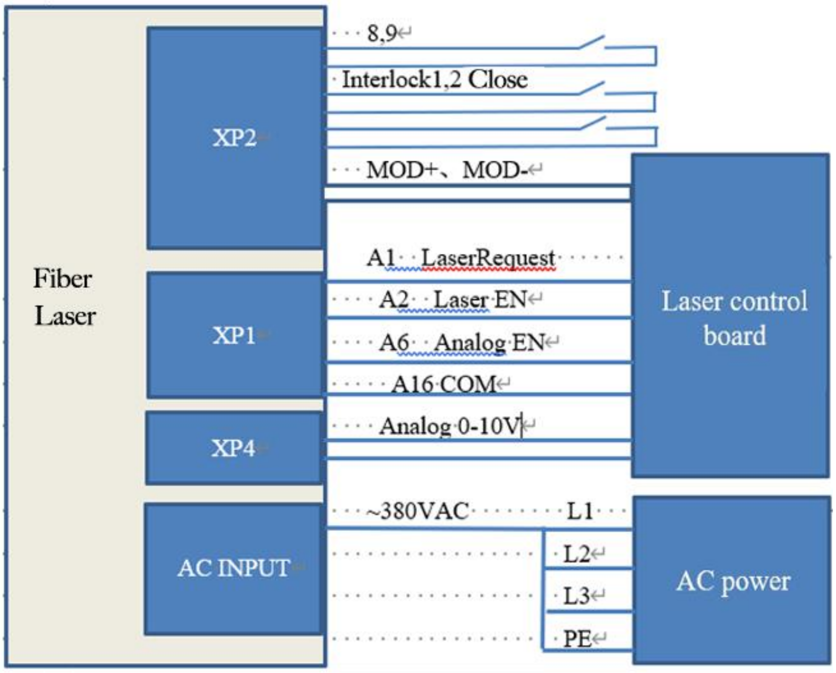


Figure 24 REM mode power and laser emission are externally controlled wiring diagram

Operation method:

1) Turn the knob switch on the rear panel to “ON”;
2) Turn the key switch to “REM”;
3) Short-circuit pin 8/9 on XP2;
4) XP1-A1 connects to 24V, XP1-A6 connects to 24V;
5) 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;
6) XP1-C1 is connected to 24V, and the main power is turned on (users can also directly press the LASER button, or the host computer software clicks the main power “ON”);
7) Waiting for “Ready”;
8) XP1-A2 connects to 24V, and the control board outputs analog and MOD signals.

Figure 68 Interface of empty all waveform stored in the current laser waveform mode

8.13.4 Edit Waveform

Waveform editing when the laser is working in waveform mode is shown as Figure 69 ~ 73.

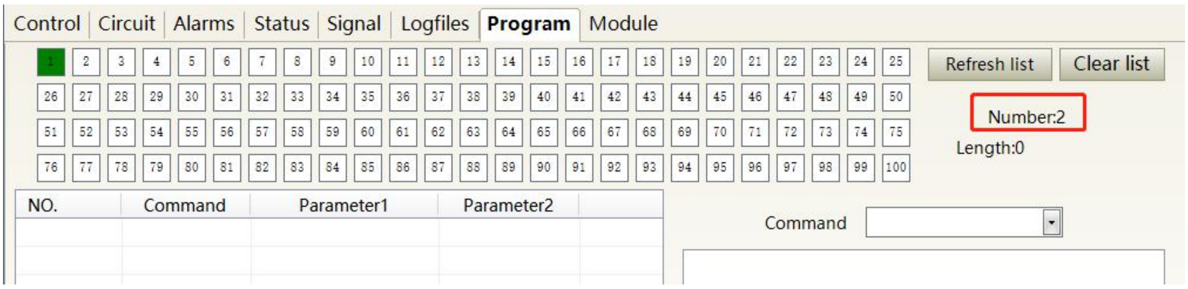


Figure 69 Step 1: Left click the pre-edited waveform number

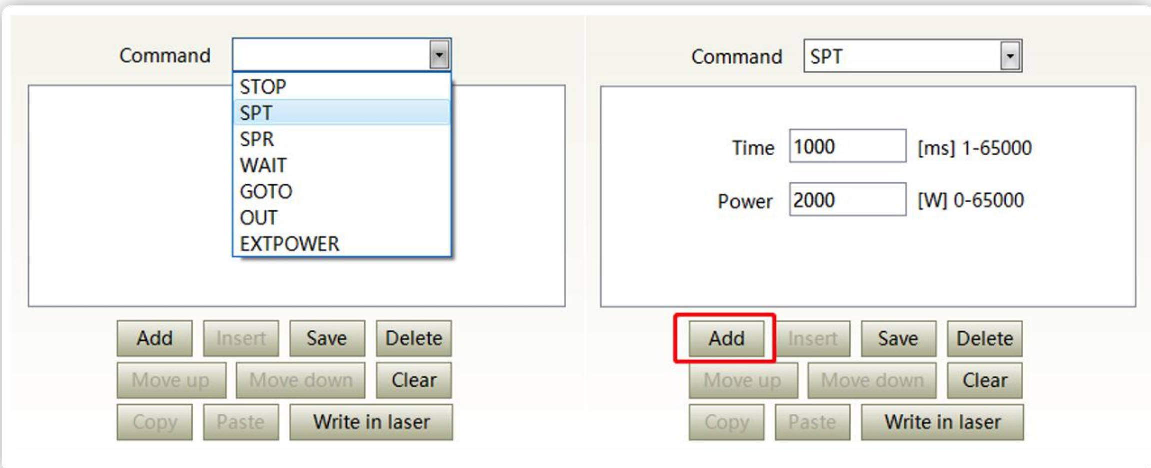


Figure 70 Step 2: Select the command under the command type, click “Add”

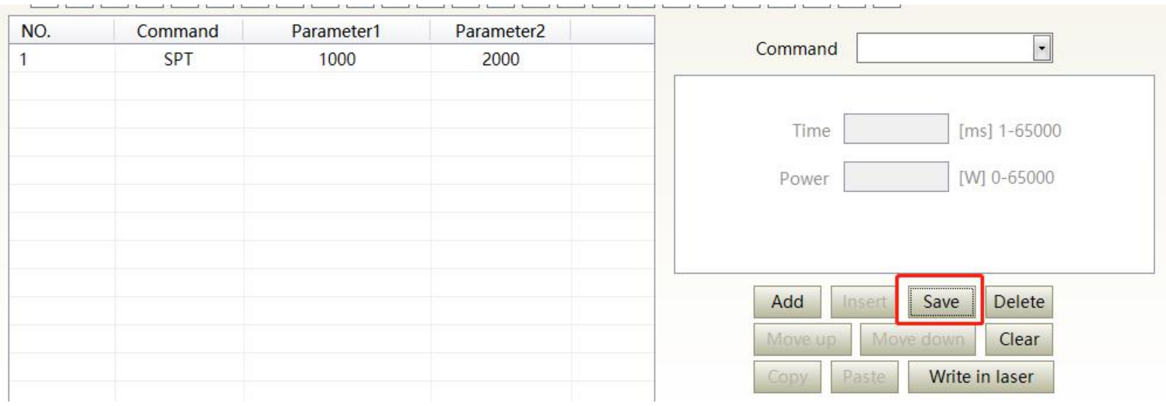


Figure 71 Step 3: Enter the parameters and click "Save"

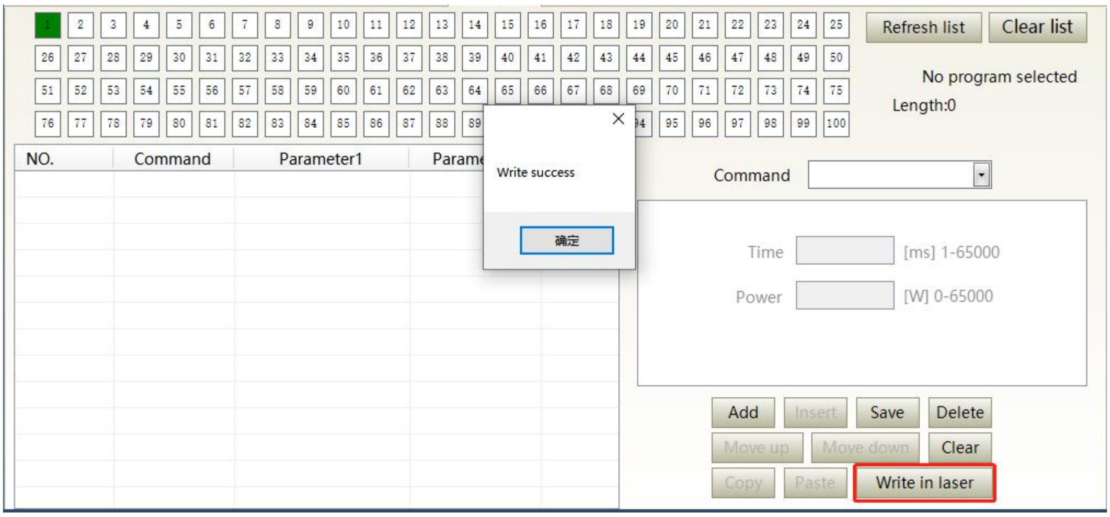


Figure 72 Step 4: After editing all commands, click "Write Laser"

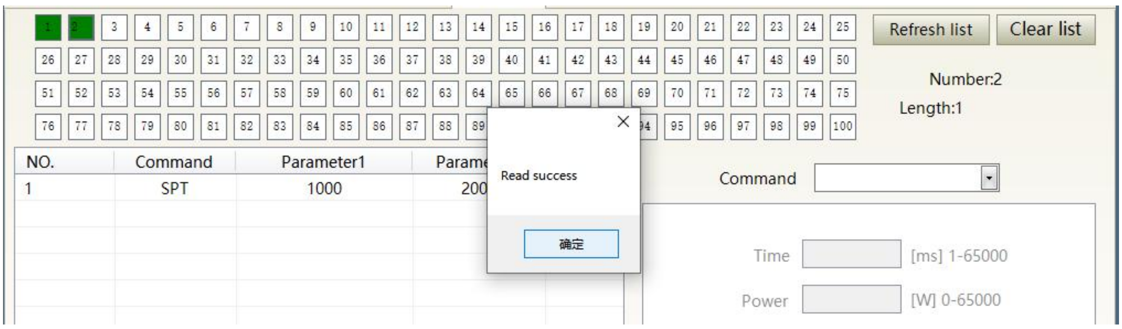


Figure 73 Step 5: New waveform number will turn green when users re-click the "Refresher List"

8.13.5 Command Explanations

Table 16 Command explanations in laser working status

Code (1 Byte)		Parameter1(2 bytes)	Parameter 2 (4 bytes)	Note
1	Stop	none	none	The program end command. the last command must be this command.

2	SPT	0～65000 (ms)		0～65000 W		Change power to 2 in time 1
3	SPR	0～65000 (W/ms)		0～65000 W		Change power to 2 in power change ratio 1
4	WAIT	1	Wait for sync signal low level	Null		
		2	Wait for sync signal high level	Null		
		3	Wait for sync signal rising	Null		
		4	Wait for sync signal dropping	Null		
		5	Wait	0～65000 ms (int)		
5	GOTO	0～99	line	-1	Switch at low sync signal	Jump to different line when comply
		0～99	line	-2	Switch at high sync signal	Jump to different line when comply
		0～99	line	0～1000000	Switch at waiting time due	Jump to different line when comply
6	OUT	1	SO	1	sync signal low level output	
				2	sync signal high level output	
7	EXT Power	1	0～10 V			
		2				

9 Warranty, Repair and Return

9.1 General Warranty

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.

9.2 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 users have 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 30 natural days after the defect is discovered. This warranty does not involve any other party, including specified buyer, end-users and any parts, equipment or other products produced by other companies.

	WARNING: It is the users' 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.

9.3 Service and Repair

DO NOT open the device. There are no user serviceable parts, equipment, or assemblies for user in this product. All service and maintenance shall be performed by qualified Raycus personnel or the parties that authorized by Raycus.

Please contact Raycus as soon as possible when problems under warranty about maintenance happened to the product.

The product returned with permission should be placed in a suitable container.

If any damage happened to the product when receiving the goods, please notify the carrier in written format immediately.

NOTE:

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

All the items within the warranty and service clauses specified as above and to be provided by Raycus are for users' reference only; the formal contents about warranty and service are subject to the contract to be signed between Raycus and its users.

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