RFL-QCW450/4500 quasi-continuous fiber laser

operating instruction

Wuhan Ruike Fiber Laser Technology Co., LTD. WuhanRaycusFiberLaserTechnologiesCo.

company introduction

Wuhan Raycus Fiber Laser Technology Co., Ltd. (hereinafter referred to as "Raycus Laser ", stock code: 300747) is a national key high-tech enterprise under the Torch Program, specializing in the research, development, production, and sales of fiber lasers and their key components and materials. The company boasts a national key innovation team for high-power fiber lasers and a national-local joint engineering research center for fiber laser technology. It is a globally influential supplier of fiber laser R&D, production, and services, with vertical integration capabilities from materials to devices and complete machines. The company's main business includes providing various fiber laser products and application solutions to laser manufacturing equipment integrators, as well as offering technical research and development services and customized products.

The company's main products include pulsed fiber lasers ranging from 10W to 2,000W; continuous fiber lasers from 10W to 120,000W; quasi-continuous fiber lasers from 75W to 450 W; and direct semiconductor lasers from 80W to 8,000W. These products are widely used in laser manufacturing applications such as marking, cutting, welding, cladding, cleaning, and additive manufacturing. In the field of ultrafast lasers, the main products include nanosecond lasers from 10W to 20W, picosecond infrared lasers from 2W to 100W, picosecond green lasers from 5W to 50W, picosecond ultraviolet lasers from 5W to 30W, and femtosecond lasers from 1W to 20W. These products are extensively applied in laser manufacturing processes such as display and panel glass cutting, automotive glass cutting, FPC cover film cutting, 5G LCP cutting, OLED flexible display material cutting, LED and crystal wafer cutting, and semiconductor chip cutting.

As a leading domestic fiber laser manufacturer, Ruike Laser has seized the opportunities presented by industry development. The company leverages its vertical integration advantages in the industrial chain, technological strengths, and brand reputation. By actively implementing quality improvement projects to ensure product quality, enhancing cost control, improving overall operational efficiency, continuously increasing R&D investment, and advancing the automation of smart factories, Ruike Laser has solidified its leading position in the domestic laser market. The company is actively expanding into high-power and ultrafast laser segments, further opening up growth prospects. Its high-power laser technology has reached international leading standards, gradually replacing products from major overseas laser manufacturers in the domestic market, with overall sales maintaining a growth trend. In the ultrafast laser sector, market sales are steadily increasing, and product technology continues to improve, which will inject momentum into the company's business performance.

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catalogue

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1 security information

Thank you for choosing Ruike Fiber Laser. This user manual provides important information on safety, operation, maintenance, and other aspects. Therefore, please read this user manual carefully before using the product. To ensure safe operation and optimal performance of the product, please follow the precautions and warnings as well as other information in this manual.

1.1 safety signs

	◆ It may cause serious personal injury or even endanger life safety.
	◆ May cause general personal injury or damage to products and equipment.

1.2 Laser safety rating

According to European standard EN 60825-1, clause 9, this series of lasers falls under Class 4 laser instruments. The product emits laser radiation with wavelengths around 1080nm, and the peak power of the laser emitted from the output head exceeds 4500W, with an average power greater than 450W. Direct or indirect exposure to such light intensity can cause damage to the eyes or skin. Although the radiation is invisible, the beam can still cause irreversible damage to the retina or cornea. Appropriate and certified laser protective glasses must be worn throughout the operation of the laser.

	◆ When operating this product, ensure that you wear laser safety goggles throughout the process. Laser safety goggles have selective protection against specific wavelengths of laser light, so please choose goggles that match the laser output wavelength of this product. Even when wearing

	laser safety goggles, it is strictly prohibited to directly view the output head while the laser is powered on (regardless of whether it is emitting light).

1.3 safety signs

Raycus The safety label of continuous fiber laser is shown in Figure 1:

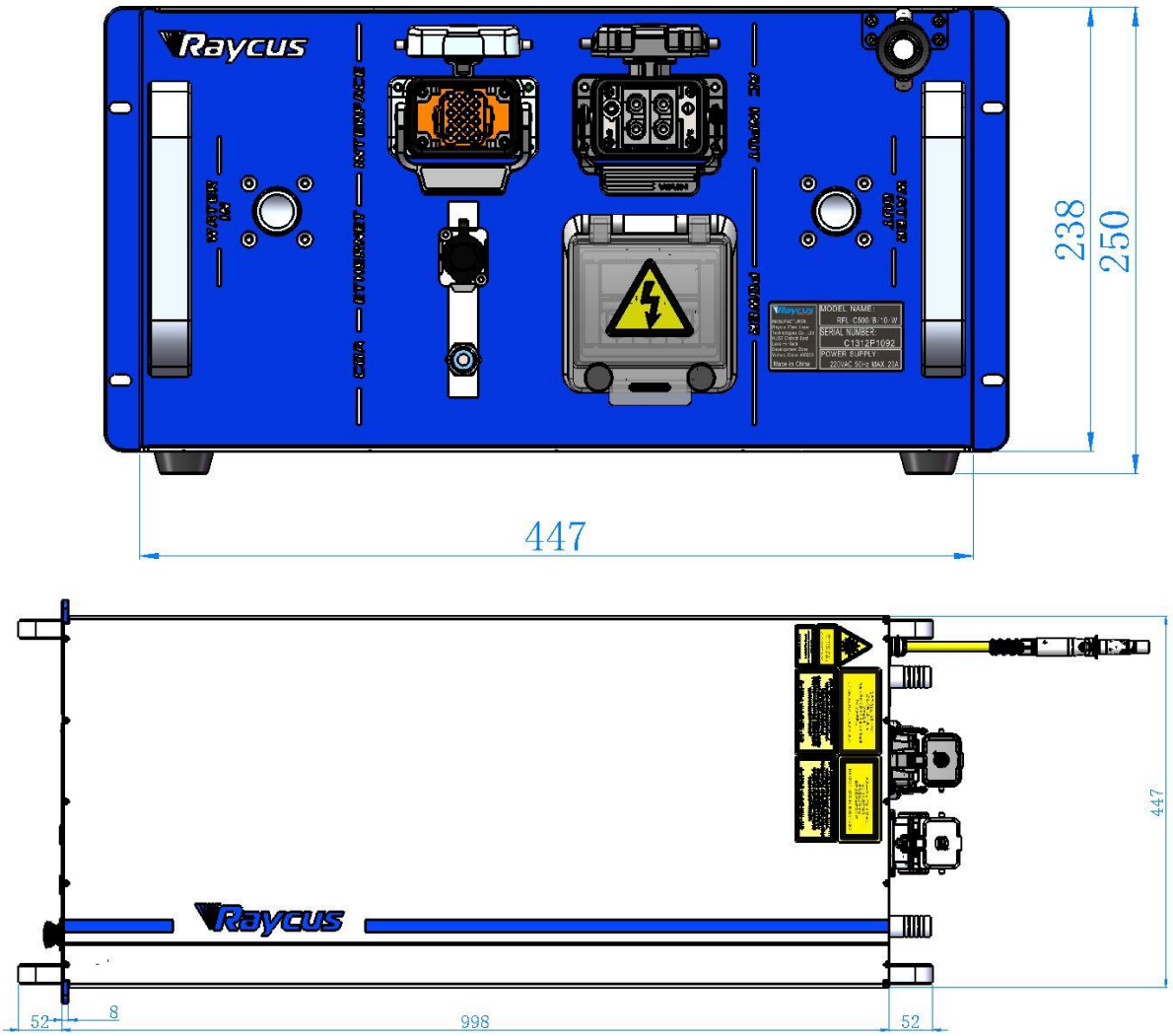
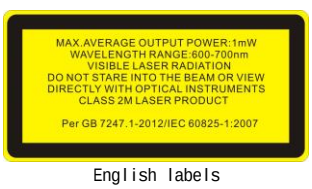


Figure 1 RFL-QCW450/4500 safety mark

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

Table 1 Safety signs

 English labels 	 English label (500W as an example) 	 English labels 

Chinese labels	Chinese label (500W as an example)	Chinese labels
1: Laser output head warning	2: 4 types of laser products	3: 2M class laser pr-oduct identification -1mW red light
		
4: CE certification	5: Product nameplate	6: Laser radiation hazard
		
7: Strong electric danger		

1.4 Optical safety

If there is dust on the laser output head, it will cause the lens to burn out when the light is emitted.

	◆ Do not output laser without opening the laser output head protection cap, otherwise it will cause the laser output lens or crystal burn.

1.5 Electrical safety

1) Please ground the laser through the PE line in the power cord, and ensure that the grounding is firm and reliable.

	◆ The disconnection of the laser ground will cause the laser housing to be charged, which may lead to personal injury of the operator.

2) Ensure that the AC voltage supply is normal.

	◆ Incorrect wiring or power supply voltage can cause irreparable damage to the laser.

1.6 Other safety precautions

1) Do not look directly at the laser output head while the laser is running.

2) Do not use fiber laser in dim or dark environment.

3) Please follow the laser user manual to operate the laser, otherwise any damage to the laser will not be covered by warranty.

4) The laser does not have built-in accessories and all repairs should be carried out by Ruike personnel. To prevent electric shock, do not damage the label or remove the lid. Otherwise, any damage to the laser will not be covered by warranty.

2 product presentation

2.1 product features

Compared with traditional lasers, fiber laser has higher photoelectric conversion efficiency, lower power consumption and higher beam quality. Fiber laser is compact and can be used at any time. Due to its flexible laser output mode, it can be easily integrated with system equipment.

main features:

- The beam quality is excellent
- high reliability
- High power stability
- Replace lamp pump laser
- Pulse and continuous working modes
- High peak power
- High electro-optical conversion efficiency
- Maintenance free operation

Main application fields:

- Cutting of 3C materials
- Spot welding, seam welding, micro welding, precision welding
- Ceramic cutting, ceramic drawing
- Battery tab welding

2.2 container loading list

Please refer to the packing list in the packing case.

2.3 Unbox and check

Ruike Company ensures that the laser is fully protected during transportation through specially designed packaging materials and boxes. Nevertheless, to prevent unforeseen situations during tra-

nsit, users still need to carefully check whether the box is correctly placed and if there is any damage to the exterior of the box before opening it

Damage or phenomena such as collision, cracking and water immersion. If any abnormality is found in the external housing, please notify Ruike Company in time for early treatment.

After unpacking, please check whether the packing list is consistent with the actual items. If you have any questions, please contact Ruike Company in time.

When taking out the laser, you should pay attention to avoid collisions or violent vibrations of the laser. When taking out the coiled laser output cable, you should pay special attention to not twisting, bending or pulling the laser output cable, and at the same time, avoid collisions and vibrations of the laser output head.

	◆ The laser output cable is a precision optical device. Twisting or over-bending the output cable, vibration and impact on the laser output head will cause irreparable damage to the laser.

2.4 Java runtime environment Java

The basic operating environment of the laser is as follows:

Table 2 Operating environment of the laser

Model	RFL-QCW450/4500
Service voltage (V)	380±10%V AC 50/60Hz
Power supply capacity (W)	>2500
Placement environment	Flat, no vibration and impact
Working environment temperature ( )	10～40
Work environment humidity (%)	30~70

warn:

1) Make sure the laser is reliably grounded before use.

2) The laser output head is connected to the output optical cable. Please check the laser output head carefully when

using it to prevent dust or other contamination. Use special lens paper to clean the laser output head.

3) If the laser is not used in accordance with the methods specified in this manual, the laser may be in an abnormal working state and cause damage.

4) When the laser is in operation, it is strictly prohibited to install the laser output head.

5) Do not look directly at the laser output head. Wear a laser protection eye when operating the laser.

◆ Do not expose this product to high humidity (humidity> 95%).

◆ Do not allow the product to operate at temperatures below the ambient dew point (see Table 3).

Table 3 Comparison of constant dew point at ambient temperature and relative humidity

Constant dew point table at ambient temperature and relative humidity									
Ambient temperature	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
			Laser operating temperature range						

◆ Green area: the condensation point temperature is lower than the laser cooling water temperature of 22 , which belongs to the safe range;

◆ Red area: If the dew point temperature is higher than 22 and exceeds the laser cooling water temperature of 22 , condensation will definitely occur. Measures must be taken before use.

Measure 1, see section 4.2 for access to clean dry air from CDA to reduce relative humidity;

Measure 2, install cabinet air conditioning to reduce the ambient temperature.

2.5 matters need attention

1) Before the laser is connected to the AC power supply, make sure that the correct input voltage is connected. The wrong input power will cause irreparable damage to the laser.

2) Failure to use the laser in accordance with the control or adjustment methods specified in this manual may cause damage.

3) It is important to keep the laser output head clean after calibration, otherwise it will cause irreparable damage to the laser.

4) Cover the output head with a protective cap when not using the laser; do not touch the lens of the output head; if necessary, clean the lens of the output head with special lens paper and alcohol.

5) Loss of optical power may be due to failure to operate in accordance with the above specifications, and such loss will not be covered by warranty.

2.6 product property

Table 4 Product technical parameters

Model	RFL-QCW450/4500	Testing environment
Optical characteristics		
Work pattern	Continuous/modulation	
Polarization direction	Stochastic	
Maximum average power (W)	450 (Continuous/pulse mode)	Continuous mode: 100% power Pulse mode: frequency 10Hz, duty cycle 10%, power 100%
Maximum peak power (W)	4500	Frequency 10Hz, duty cycle 10%, power 100%
Maximum single pulse energy (J)	45	Frequency 10Hz, duty cycle 10%, power 100%
Pulse length (ms)	0.05~50	
Power regulation range (%)	10~100	
Central wavelength (nm)	1080±5	Output rating
Output power instability (%)	±1.5	Output rating Continuous running time: 5h Working temperature: 22±1
Modulating frequency (Hz)	0~5,000	Minimum pulse width is greater than or equal to 50us
Red light indicates output power (mW)	0.5~1	
Optical cable output characteristics		
Beam quality BPP (mm* mrad)	1.5-2	Output rating
Fiber core diameter (μm)	50	Customizable core diameter
Output cable length (m)	10	Customizable length
Electrical properties		
Working voltage	380±10% Vac、50/60Hz	
Maximum power consumption (W)	2500	
Control method	RS-232/AD/Ethernet	
Other features		
Overall dimensions (W x H x D) (mm)	1102 x 447 x 250 (including handle)	
Weight (kg)	<90	
Working environment temperature range ( )	10~40	
The humidity range of the working environment is (%)	30~70	
Storage temperature ( )	-10~60	

Cooling-down method	Hydrocooling	

3 install

3.1 Overall size drawing

Figure 2 shows the appearance size of RFL-QCW450/4500 laser.

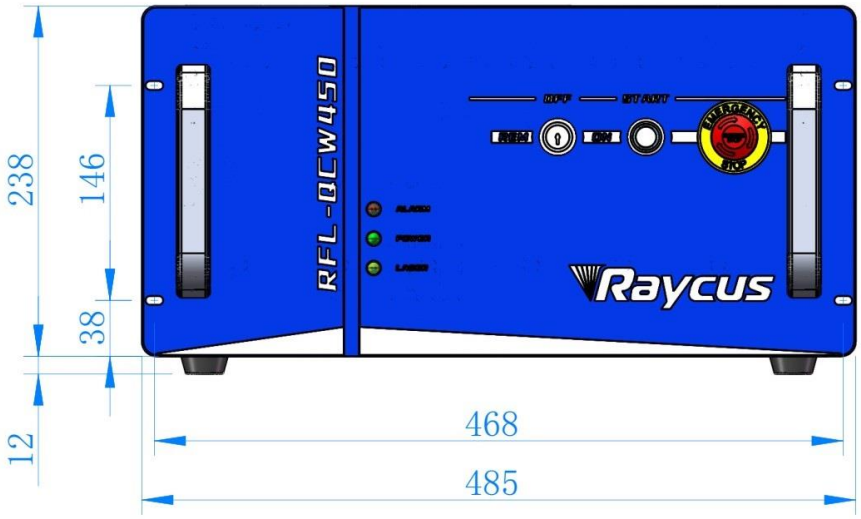


Figure 2 (a) Front view (unit: mm)

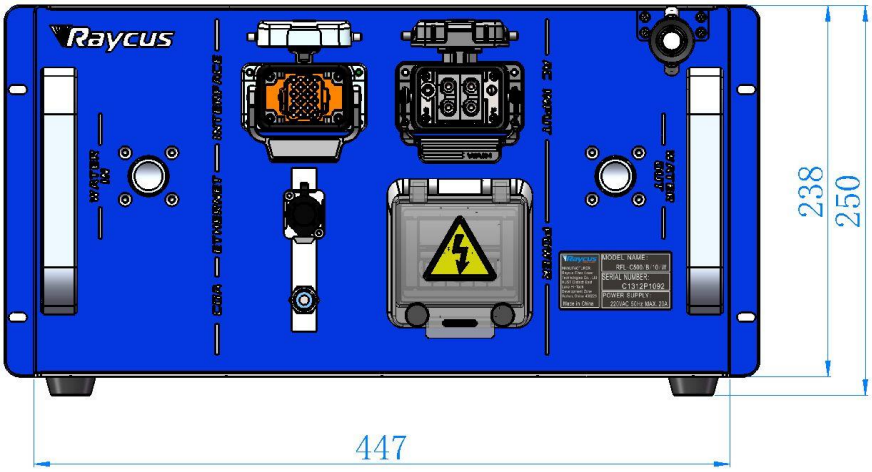


Figure 2 (b) Rear view (unit: mm)

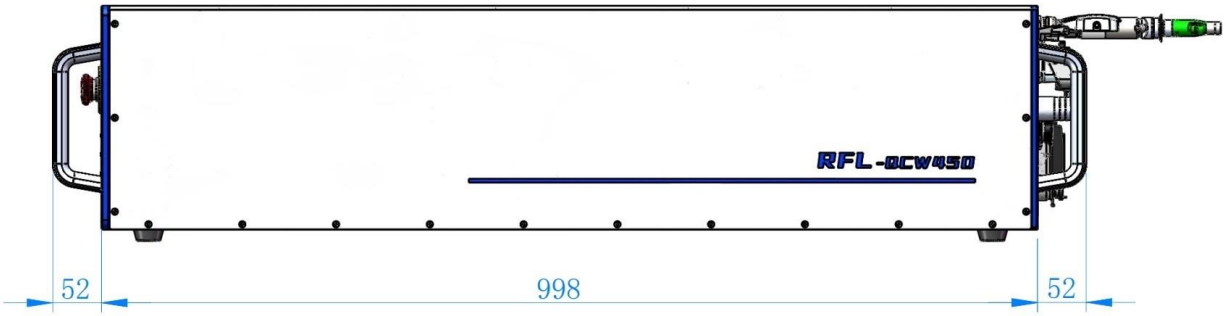


Figure 2 (c) Top view, side view (unit: mm)

3.2 Output cable size and installation

The output cable of the continuous fiber laser Raycus RFL-QCW 450/4500 is a standard QBH interface. The specific appearance size is shown in Figure 3. There are differences in the size of the protective end cap between the output cable of other models and this model. The protective end cap of this model is extended.

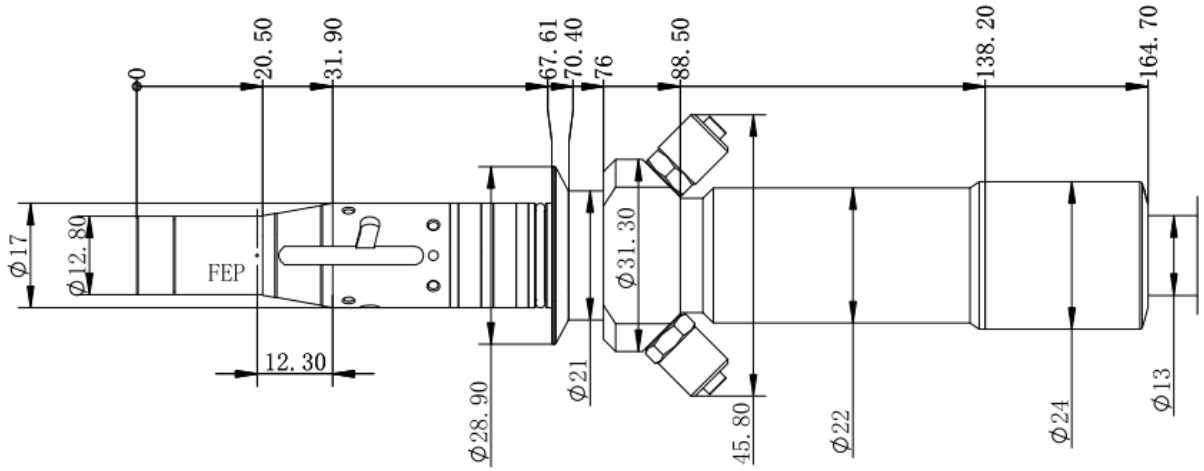


Figure 3 QBH output optical cable size diagram (unit: mm)

	◆ Before installing the output cable into the processing head, the lens of the output cable must be checked. If the lens of the output cable is found to be dirty, the lens must be cleaned. ◆ It is strictly prohibited for personnel other than Ruike Company to disassemble the output head lens, otherwise the warranty will expire.

3.3 Cooling system installation and requirements

Table 5 Cooling system requirements

Model	RFL-QCW450/4500
Refrigerating output W	>2000
Minimum flow rate L/min	30
Maximum input pressure Bar	7
Inner diameter of pipe mm	25
Cooling system water temperature ( )	22±1℃

1) Cooling system water temperature setting:

22±1℃

2) **Cooling system filter access requirements:**

When the water quality of the laser cooling system is poor (contains more impurities), it is easy to cause water blockage in the laser water circuit, which will trigger flow alarm or high temperature alarm, resulting in laser shutdown. In severe cases, it will lead to the scrapping of the laser water circuit. Therefore, RFL-QCW450/4500 laser is equipped with an inlet water filter assembly, as shown in Figure 4.

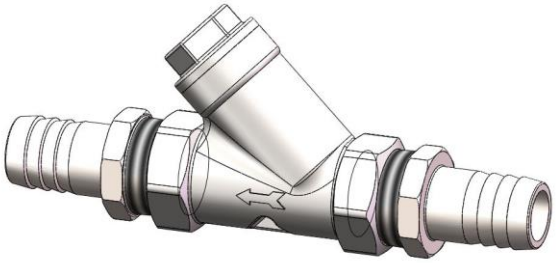


Figure 4 Water intake filter assembly

When the laser is installed and used, connect the inlet filter assembly to the outlet of the customer's on-site cooling water system according to the water flow direction indicated by the arrow in Figure 4, and then connect the inlet filter assembly to the inlet of RFL-QCW450/4500 laser as shown in Figure 5.

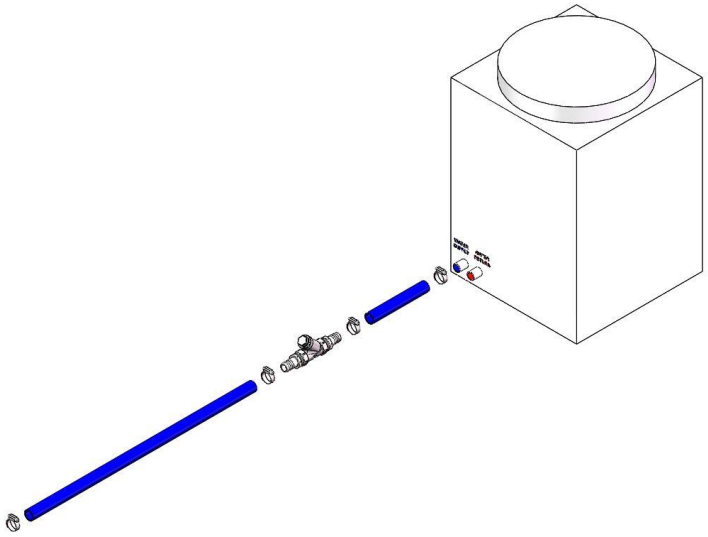


Figure 5 Schematic diagram of the inlet filter assembly connected to the water cooling system

During the use of the laser, please clean the Y-type filter of the inlet water filter component regularly according to the water quality of the cooling water system (open the nut cover of the Y-type filter, take out the filter screen, clean it and put it back, and then tighten the nut cover). It is recommended that the cleaning frequency should not be less than once a week.

3) Coolant requirements:

- The cooling water is made of pure water. It is recommended to use drinking pure water.

- In order to prevent the growth of mold in the water in the chiller from causing blockage of the pipeline, it is recommended to add ethanol when adding pure water, and the volume ratio of ethanol is 10%.
- When the ambient temperature around the device is between -10 and 0 , an ethanol solution with a volume ratio of 30% must be used and replaced every two months.
- When the ambient temperature around the equipment is lower than-10 , a dual system (with heating function at the same time) chiller must be used to ensure uninterrupted operation of the cooling system.

4) Requirements for water cooling of output optical cable:

- Water cooling flow: 1.7-2.0L/min.
- Water cooling pressure: inlet less than 0.6Mpa.
- Type of inlet and outlet joint: SMC MS-5H-6.
- Pipe type: outer diameter 6, inner diameter 4.
- Cooling water direction: unidirectional, strictly connect the water pipe according to the inlet and outlet direction marked on the shell.
- Cooling water quality: deionized water, distilled water, pure water.
- Cooling water PH: 5.5-9.
- The water cooling machine should be equipped with filter element, which filters particles smaller than 100um.
- Maximum cooling water temperature: 45 .
- Minimum cooling water temperature: greater than the saturation condensation point temperature 5 .
- Additives in cooling water: meet the above PH value and

solid particle size requirements.

- Armored tube bending radius: in non-working conditions such as transportation and storage, the minimum bending diameter shall not be less than 20cm. In the state of laser emission, the minimum bending diameter shall not be less than 30cm.
- Long-term vibration, less than 2G; impact, less than 10G.

5) Other requirements for cooling system:

- When starting the cooling system for the first time, check whether there is any leakage in the entire water system and joints. The external water pipe must be installed and connected according to the inlet (IN) and outlet (OUT) marked by the laser, otherwise the laser may not work properly.

- If the laser is not used for a long time, the cooling water inside the cooling system and the laser should be emptied, otherwise it will cause irreparable damage to the laser.

	◆ Please set the water temperature of the cooling system correctly. If the water temperature is set too high, the laser will not work properly; if the water temperature is set too low, condensation will occur inside the laser or in the laser output optical cable, resulting in irreparable damage to the laser. ◆ Please clean the water inlet filter assembly in time. When the water inlet filter assembly is blocked, it will cause laser flow alarm or high temperature alarm.

	◆ Before starting the laser, it is necessary to ensure that the cooling system works properly and the water temperature reaches the suitable temperature. [Summer: 22±1 ; Winter: 22±1]

3.4 Installation precautions

1) Place the laser horizontally in the appropriate position and secure it as necessary.

2) Before energizing the laser, please check whether the power supply voltage of the laser is stable (see Table 4 Product Technical Parameters for the laser model and corresponding power supply voltage) and whether the grounding wire is good.

3) Connect all power lines and control lines of the laser in a non-electric state.

4) Connect the cooling system to the laser and output cable according to the inlet and outlet signs.

5) Please check the laser output head and do the necessary

cleaning, then install it into the equipment. If you find that there is dust or foreign matter on the laser output head that cannot be cleaned up, please contact Ruike Company in time, and do not continue to install and operate the laser for the time being.

6) Do not step on, squeeze or bend the yellow/metal armored protective tube during installation and output of optical cable to avoid damage to the fiber.

7) During installation and disassembly, please take care to handle the laser output cable gently and do not be subjected to vibration.

8) Ensure that the surrounding environment is clean during the installation of laser output cable and output head, otherwise it may pollute the output head (do not use fans to avoid dust).

9) The minimum bending diameter of the output optical cable of the laser shall not be less than 20cm in non-working conditions such as transportation and storage; and shall not be less than 30 cm in light-emitting conditions.

	◆ All control lines of the laser should be connected in a non-powered state. Power installation of control lines may cause damage to the laser.

	◆ The placement of laser output cable must be kept as natural as possible, and twisting of the output cable is prohibited. ◆ The winding diameter of the output cable is too small to cause damage to the laser.

	◆ Before the laser output cable assembly, it must be ensured that the lens and cutting head cavity is clean and free from pollution. ◆ Take good care of the output head protection cap to prevent contamination; otherwise, indirect contamination will be caused to the output head when the protection cap is put on.

4 Product use

Please use the new version of the upper computer software and the upper computer software user manual.

4.1 front panel

Figure 6 shows the front panel style of the RFL-QCW450/4500 laser:

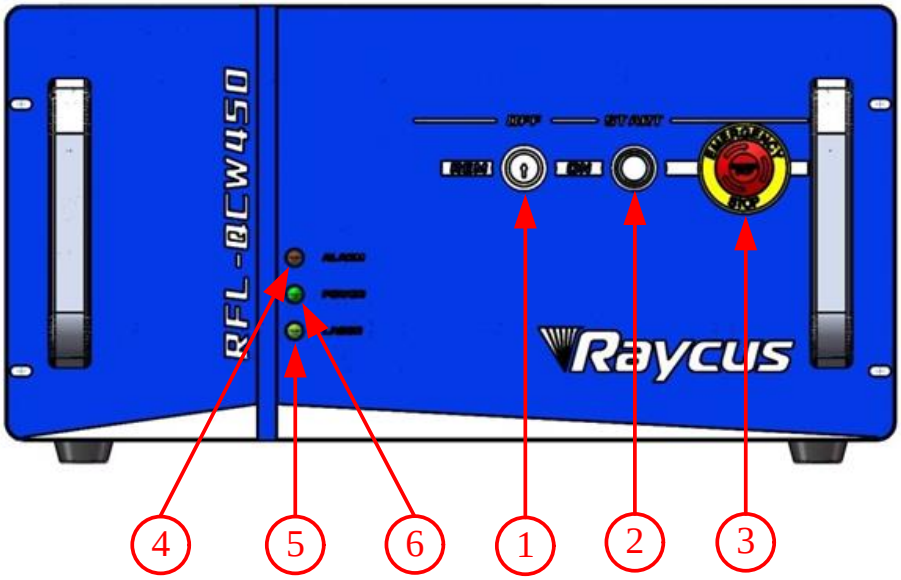


Figure 6 RFL-QCW450/4500 laser front panel

1. REM/OFF/ON: Key switch, the power switch for the laser control system. Insert the key and rotate it to the "ON" position or the "REM" position (requires shorting terminals 7, 8, and 9 of the control interface). This will turn on the power to the control system. The laser will then enter the corresponding control mode based on the pre-set "CTRL-INTERFACE" and subsequent operations. For more detailed information, refer to [4.8 Control Modes].

2. START: Main power start button, press the button to light up the green light, and the main power of the laser enters the READY state.

3. EMERGENCY STOP: Press to immediately shut down the laser and lock it. Rotate clockwise to release the button and return to normal operation.

4. Alarm: alarm indicator, when the yellow light is on, it means that the machine has an alarm.

5. LASER: Light output indicator light, laser light output Laser red light on.

6. POWER: Control the power indicator light. When the white light is on, the control system is turned on.

4.2 back panel

Figure 7 shows the back panel style of RFL-QCW450/4500 laser:

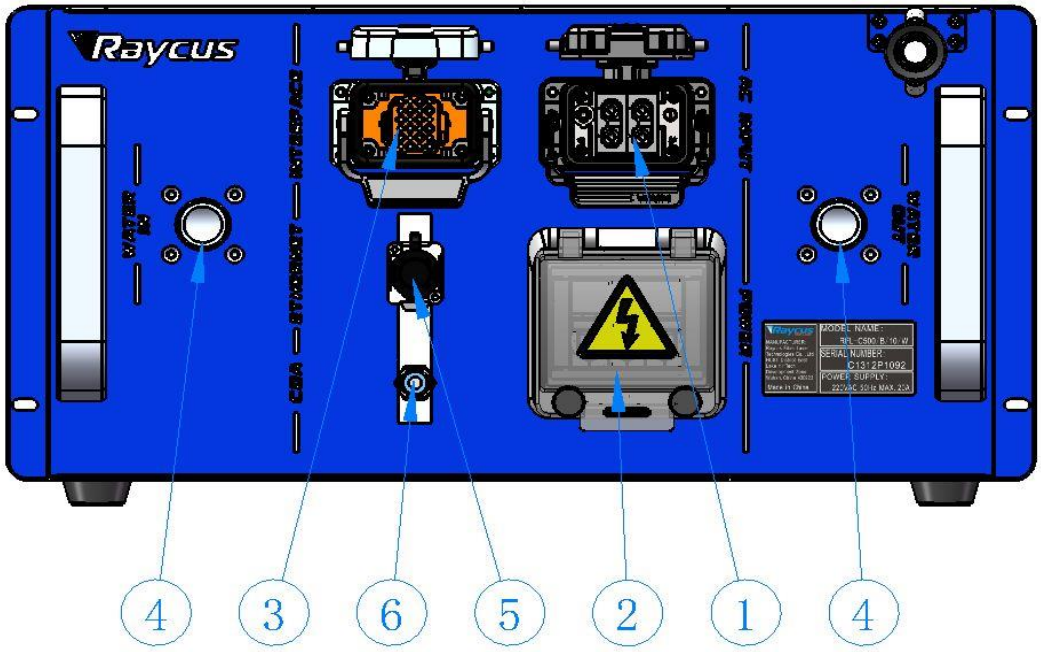


Figure 7 RFL-QCW450/4500 laser back panel

1. AC INPUT: Power input socket. The input voltage corresponding to the laser model must be connected according to the input voltage (see Table 4 Product Technical Parameters for the laser model and corresponding input voltage). The matching plug provided by Ruike must be used.

2. POWER: Air switch, control the on and off of AC current.

3. CTRL-INTERFACE: control interface, CTRL-INTERFACE interface (24 pins), multi-function multiplexing port, user can set control mode, input analog voltage signal, modulate 24V signal, and also alarm signal output interface.

4. WATER: The water pipe interface is connected to the inlet and outlet of cooling water respectively. Please connect the PU pipe with corresponding outer diameter according to the laser model (see Table 5 for the requirements of cooling system for the laser model and corresponding water pipe size).

5. ETHERNET: Ethernet interface. Provides remote control of the laser and storage of alarm information.

6. CDA: Clean dry air interface, which is connected to clean dry air to prevent condensation of laser.

How to use CDA:

1) When the CDA provided by the customer is used, the CDA needs to be dried and cooled by a refrigerated dryer, and then filtered by 5um and 0.3um particle filters respectively, and 0.1um oil mist filter, and the temperature is in the range of 5-40℃, the highest dew point is 0℃ (it is recommended that the compressed air temperature is less than the cooling water temperature by 5℃), the pressure is less than 0.1MPa, the flow rate is set at 10 LPM, and the pipe diameter of the interface is 6mm;

2) When using the CDA filter component provided by Ruike, the compressed air input should be dried and cooled by a cold dryer, the pressure is less than 0.8MPa, and the pipe diameter of the interface is 6mm;

3) Before starting the machine, ventilation should be started for 30min. When the temperature is lower than 10℃ and the humidity is lower than 50% in winter, ventilation can be stopped.

4.3 Power connection

	◆ Before connecting to the AC power supply, please check whether the laser model and the provided AC power supply are consistent with those listed in Table 2 or Table 4.

Table 6 Power connection requirements

Model	RFL-QCW 450/4500
Power Supply Voltage	380±10% V AC 50/60Hz
Power line	

At the end of the power cable	Four wires with a wire diameter of 4mm2 are marked L1, L2, L3 and PE respectively
Instructions for use	L1, L2, L3->phase line PE->protective earth wire
Remarks	The plug at the end of the power cord is inserted into the socket marked "AC INPUT" on the back panel. Note that the plug has a reverse connection function, and lock it after plugging in.

4.4 Control interface definition and connection

4.4.1 Control interface definition

Use the CTRL-INTERFACE interface (24 pins) for control. The specific interface is defined as follows:

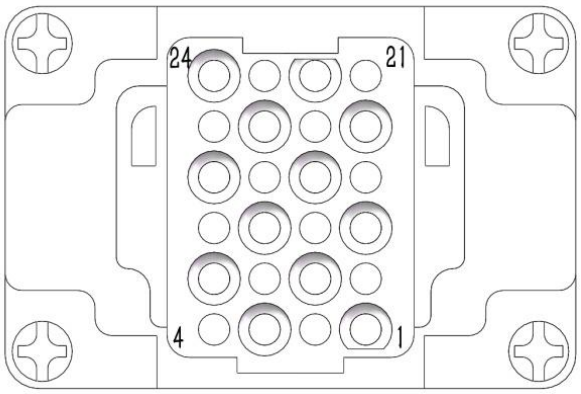


Figure 8 Schematic diagram of CTRL-INTERFACE interface

Table 7 Laser control 24 Pin interface definition

Pin	Signal name	Signal type	Signal level	Drive Ability	Typical response	Description
1	Interlocking passage 1A	Close the touch Type in	24Vdc	<1A	<500ms	Based on "EN 954-1" or "ISO 13849-1" Cat.3PLd "No external voltage or grounding shall be connected to the passive contact."
2	Interlocking passage 2A					
3	Interlocked passage 2B					
4	Interlocking passage 1B					
5	RS232Tx				120ms	Data transmission
6	RS232Rx					Data acceptance
7	RS232Com	Return to end				RS-232 Return end
8	Remote key switch	Close the touch Type in	24Vdc		20s	In REM mode, the internal main control board is powered on. The passive contact shall not be connected to external voltage or ground.
9						
10	Remote start button	Instantaneous closed contact input	24Vdc		1s	In the remote mode, start the laser pump main power supply. The passive cont-
11						

12	Current control analog input	Analog input	1-10 Vdc	1 mA	100μs	Current shall not be connected to external voltage or grounded. Analog input: 1-10 VDC = 10 -100% current
13	Power monitoring analog output	Analog output	0-8Vdc	11m A	20μs	Analog output 0-8VDC=0-Pnom
14	Simulate the ground	Return to the end				12 / 13, the common ground of feet
15	Modulate +	Digital input	5-24Vdc	6 mA	20μs	5-24VDC input
16	Modulate-	Return to the end				15 The return end of the foot
17	Guide red light control	Digital input	5-24Vdc	6 mA	120ms	In the remote mode, the rising edge is valid
18	Laser enabled	Digital transmission	5-	6 mA	120ms	In the remote mode, there is an upward edge

		Enter	24Vdc			Effect
19	Laser alarm	Numeric output	24Vdc	100mA	120ms	High level = alarm state
20	Digital ground	Return to the end				17 / 18 / 19 / 21 / 22 / 23 / 24 Public ground for feet
21	Error reset	Digital input	5-24Vdc	6 mA	120ms	Rising edge reset (resettable alarm)
22	The laser is ready	Numeric output	24Vdc	100mA	120ms	High level = laser is ready
23	The main power supply has started	Numeric output	24Vdc	100mA	120ms	High level = main power supply has been started
24	Laser shot	Numeric output	24Vdc	100mA	100us	High level = laser is being fired

◆ Check the level of the control signal to ensure that it meets the requirements. Voltage exceeding or fluctuating may damage the laser.

InterLock interface is 24-pin 1, 4 and 2, 3. If these two pins are disconnected, the laser will immediately interrupt the light output, the laser Ready signal output becomes low level, and the laser displays InterLock alarm.

◆ The Interlock interface shall not be connected to active signals, otherwise the interface will be damaged and the laser will alarm

4.4.2 Ethernet TCP/IP interface Settings

The default IP address of this machine is 192.168.0.10, and only supports UDP communication. The communication port is 8098. Commands must be sent in a single packet to send a single data string.

Table 8 Ethernet interface pin definitions

Pin	Function	Description
1	TX+	Data transmission +
2	TX-	Data transmission-
3	RX+	Data accepta-

		nce +
4	N/C	Connectionless
5	N/C	Connectionless

6	RX-	Data acceptance-
7	N/C	Connectionless
8	N/C	Connectionless

If conditions permit, please use this interface first to obtain better communication stability. The laser and computer should be in the same LAN.

Table 9 IP address of the laser

The default IP address of the laser	
IP address IP address	192.168.0.10
Subnet mask subnetmask	255.255.255.0

IP configure:

① Open "Local Connections" on your computer and click "Properties";

② Select "Internet protocol version 4 (TCP/IP 4);

③ Click the Properties button;

④ Select "Use the following IP address:" to manually assign an IP address;

⑤ Assign the IP address to 192.168.0.x (x cannot be 10, because 192.168.0.10 has been assigned to the laser), and then assign the subnet mask address, which is 255.255.255.0 by default;

⑥ Click the "OK" button to confirm the setting and exit. See Figure 9 for details.

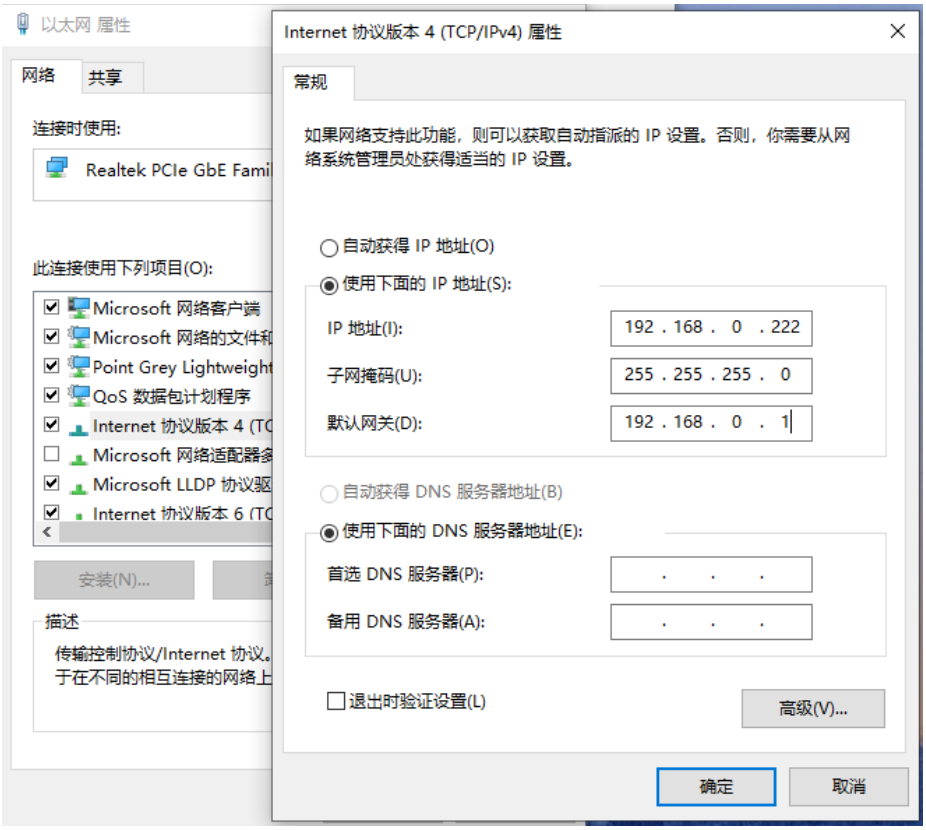


Figure 9 PC IP Settings

After the IP setting is completed, open the upper computer. In the corresponding text box on the upper computer interface, the connection status is displayed: connected, indicating that the microcontroller program runs normally and the communication connection is normal. The display interface is shown in Figure 10 below.

Figure 10 The communication connection is normally displayed on the

main interface

4.5 Order of laser installation

1) Carefully remove the laser and move it to the installation position;
2) Remove the optical cable output head protection cap, use strong light to check whether there is dust on the output end lens, if so, clean it first before use, and then cover the output head protection cap;
3) Install the output optical cable on the processing equipment according to the actual situation (install the cooling water pipe of the output head at the same time), pay attention to tidy up the output optical cable and protect the output head. Remove the protective cap, confirm whether the output end lens is clean again, and then install the output head;
4) Connect the cooling system, water inlet filter assembly and laser cooling water pipe;
5) Connect the control line and power supply according to the control mode.

4.6 Start the operation sequence

Make sure the air switch is off and the stop button (STOP) on the laser panel has been pressed. All electrical connections must be completed before the laser is powered on;

1) Ensure that the 24-pin Interlock foot is closed;
2) Turn on the chiller, check whether the water pipe is leaking, if not, turn off the chiller and wait for the laser to open;
3) Close the rear panel air switch, release the front panel emergency stop switch;

4) Turn on the chiller;

5) Turn on the key switch and start the laser.

4.7 Laser host function

RFL-QCW450/4500, the upper-level software communicates with the main control board via UDP during operation. Through background programs running on the software and human-machine interaction operations, it achieves reading and setting laser parameters as well as control functions. The interface displayed by the software is divided according to functional categories, including control, alarm, about, language selection, authorization, mode selection, and other pages.

Figure 11 Upper computer control interface

4.7.2 Control interface

The control interface is the content displayed on the first page after opening the upper computer software, which includes the most commonly used status signals, laser parameter Settings and related functions for controlling the laser.

Power on the main power supply: Turn on or turn off the main power supply. After turning on and off the main power supply, the software shows the change of the main power supply status.

Control laser abnormal reset: Click the reset button to issue the laser abnormal reset command.

Control red light: Red light is turned on or off in the internal control state of red light. After turning on and off the red light, the software changes the red light status.

Control red light external control: Turn on or off the red light external control, and the software will change the state of the red light external control after turning on or off the red light external control. If the current state is red light external control, disable the button to control the red light.

Reading and setting the slow rise and slow fall parameters: The time of slow rise and slow fall can be set separately. It can only be set as an integer in the range [0,61000].

Reading and Setting Program Number: The program number is displayed in a drop-down box. When you click on the drop-down box, it loads the program number saved on the main control board, showing only valid program numbers. By default, "Unset" is added, corresponding to the program number "0". When you click to read, the current program number is read from the main control board. If the read program number is "0",

It displays "Not Set," otherwise it shows the read program number. When setting, if "Not Set" is selected, the program number will be set to "0," indicating that the program mode is not currently in use; otherwise, it will be set to the currently selected program number. When opening the software, it automatically reads and displays the program number set on the current main control board.

Control of Light Output Parameters: The light output parameters include power, frequency, pulse width, and duty cycle. Communication between the software and the main control board only requires setting the power, frequency, and pulse width. The duty cycle can be calculated from the pulse width and frequency, and similarly, the pulse width can be calculated from the duty cycle and frequency. During software operation, modifying the frequency and duty cycle will simultaneously adjust the pulse width, and vice versa. The light output power can only be set as an integer within the range of [0,100], the frequency can be set as a decimal within the range of [0, 1000], and the duty cycle can also be set as a decimal within the range of [0,100].

Control of light output mode: Light output related modes include AD mode, external enable, and QCW mode. Each mode can be controlled to turn on and off separately, and the current status of each mode can be displayed. When AD mode is turned on, the light output power is controlled by an external analog signal.

Control of light emission: control the opening or closing of laser emission or laser enable. Only when the laser has a preparation signal can it be controlled normally, otherwise the button to open and close the laser is disabled.

Status Display: Includes the most commonly used laser status

such as emergency stop, laser enablement, normal Interlock logic, Interlock1 closed, Interlock2 closed, power ramp-up and ramp-down, program mode, program execution in progress, program execution complete, and program execution exception, as well as data on internal environmental temperature, internal environmental humidity, dew point, external 0-10V, output light frequency, duty cycle of output light, pulse width of output light, laser water flow rate, and output optical fiber water flow rate.

Laser usage time display: including today's start time, today's light output time, cumulative start time, cumulative light output time.

4.7.3 Log interface

The log page displays all alarm fault information of the current laser.

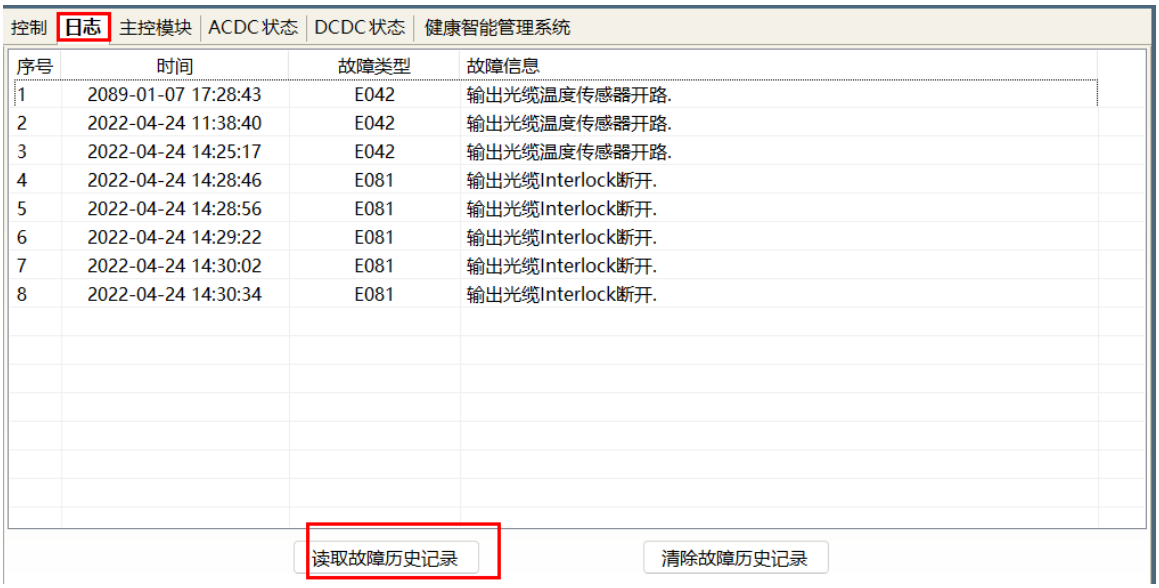


Figure 12 Log interface of the upper computer

4.7.4 about

The laser time, model, serial number, master control serial number, key version number and system information are displayed in the interface. When the about interface is opened, the upper computer software reads from the master control module once.

Figure 13. About the interface

4.7.5 Choose a language

In the language interface selection, you can set the language used by the software. After selecting the language and clicking OK, you do not need to restart the software. The content displayed in the software will be automatically converted into the language, and the current selected language will be saved to the configura-

tion file. When starting the software next time, the display will be according to the last set language.

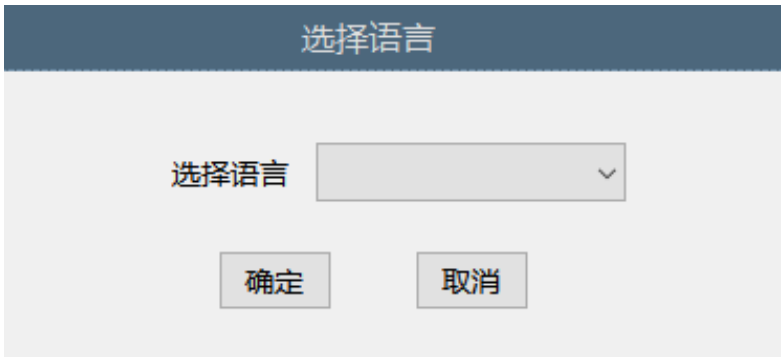


Figure 14 Select the language interface

4.7.6 empower

The authorization interface is used to control the time-limited locking of the laser. When the authorization interface is opened, it loads the machine code once, the laser locking time, and the locking time. The laser locking time is a time-limited lock for integrators by Raycus, while the locking time is a time-limited lock for end customers by the integrator. On the authorization interface, only Raycus' authorization code can be set. The function of calculating the authorization code is implemented on the server and is independent of the upper-level software. The authorization code used by the integrator can be generated on the authorization interface.

Figure 15 Authorization interface

4.7.7 mode selection

Mode selection is used to select the mode of the current software, including observation mode, control mode, diagnosis mode and debugging mode.

Observation mode: When the software is opened, the observation mode is selected by default, and the user interface displays the most commonly used mode

And the information that you care about, to avoid too much information to interfere with the user, the observation mode does not need a password to use.

Control mode: The control mode is based on the observation mode and adds the function of an operable control interface. A password is required to enter the control mode. The initial password is 81338818 (the password can be modified).

Debug mode: Debug mode is based on the diagnostic mode, and adds a parameter setting interface. It is an encrypted mode that can only be entered by Ruike debugging engineers.

Diagnostic Mode: When the laser fails and requires remote diagnosis by after-sales service, or when integrators need to understand more status information about the laser, they can enter diagnostic mode. Diagnostic mode adds status information for the main control module, ACDC module, and DCDC module on top of observation mode. Access to diagnostic mode requires a password; the initial password is 81338818 (the password can be changed).

4.7.8 Main control module

The master module contains all the status of the master module, power monitoring, temperature monitoring, water flow monitoring, power correction, optical monitoring, QCW parameters and system parameters.

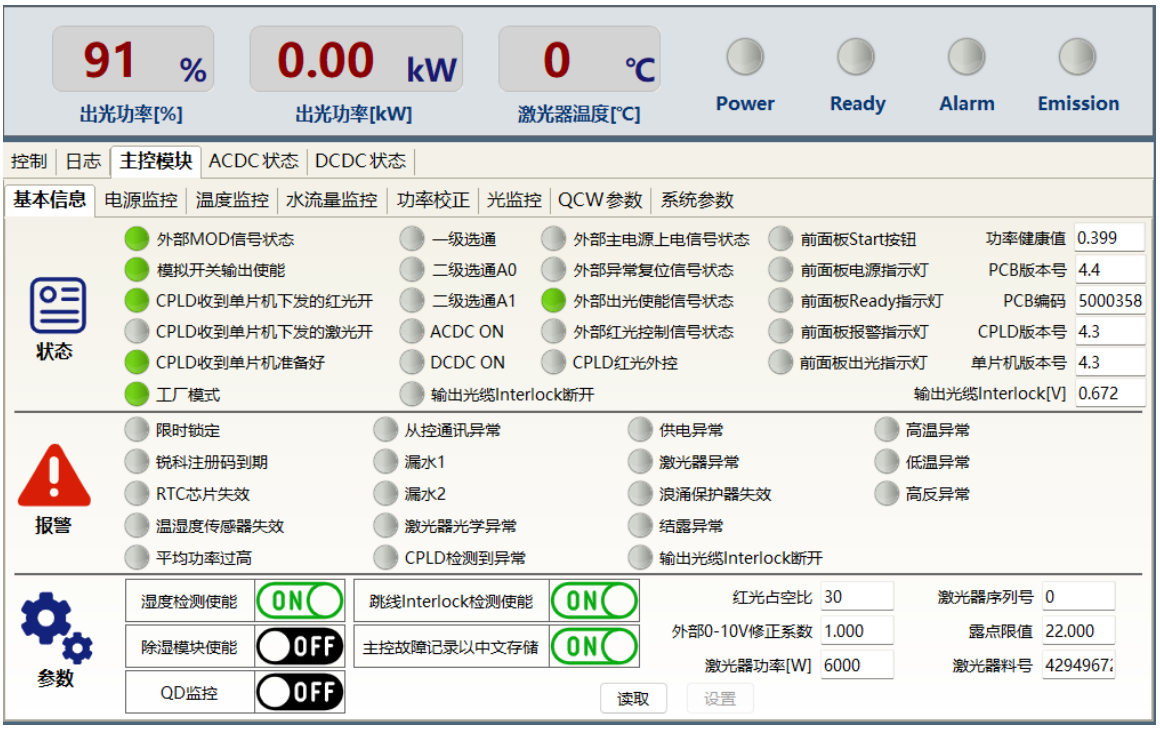


Figure 16 Main control module status information interface

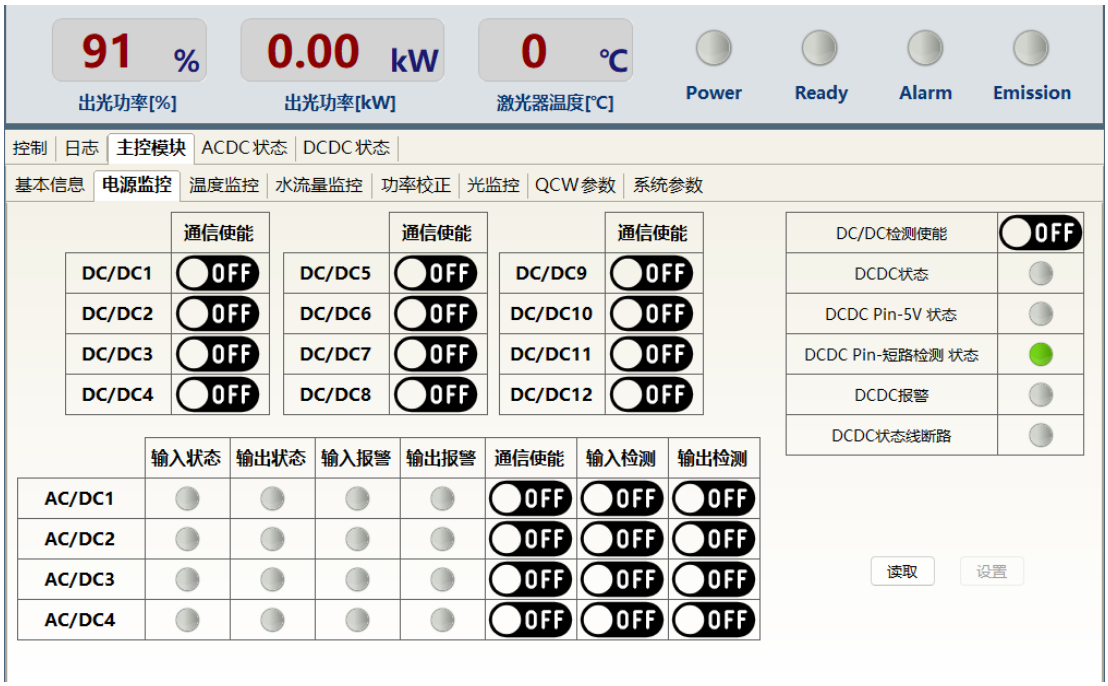


Figure 17 Power monitoring interface of the main control module

Connect to the network through the system parameter interface of the main control module:

AP mode: The laser is a WiFi hotspot (the name and password of the hotspot can be configured). After the mobile phone connects to the laser WiFi hotspot, the real-time status of the laser can be viewed by using the mobile APP of Ruike;

STA mode: The laser can automatically connect to the mobile phone hotspot or wireless router (the hotspot name and password can be configured). The laser establishes a connection with the cloud server of Ruike through WiFi and sends real-time data, which can realize remote viewing and parameter setting functions.

Figure 18 Main control module system parameter interface

4.7.10 ACDC module

The ACDC module page contains the status information of the ACDC module and supports up to 4 ACDC modules.

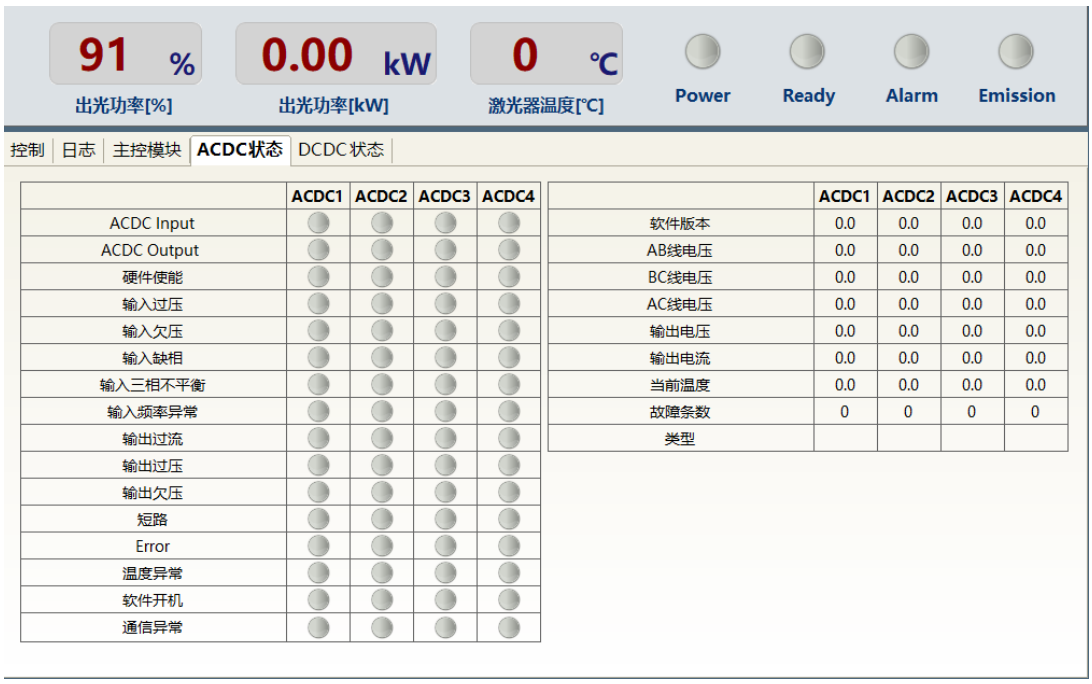


Figure 19 ACDC, module interface

4.7.11 DCDC module

The DCDC module page contains the relevant status information of the DCDC module, and supports up to 12 DCDC modules.

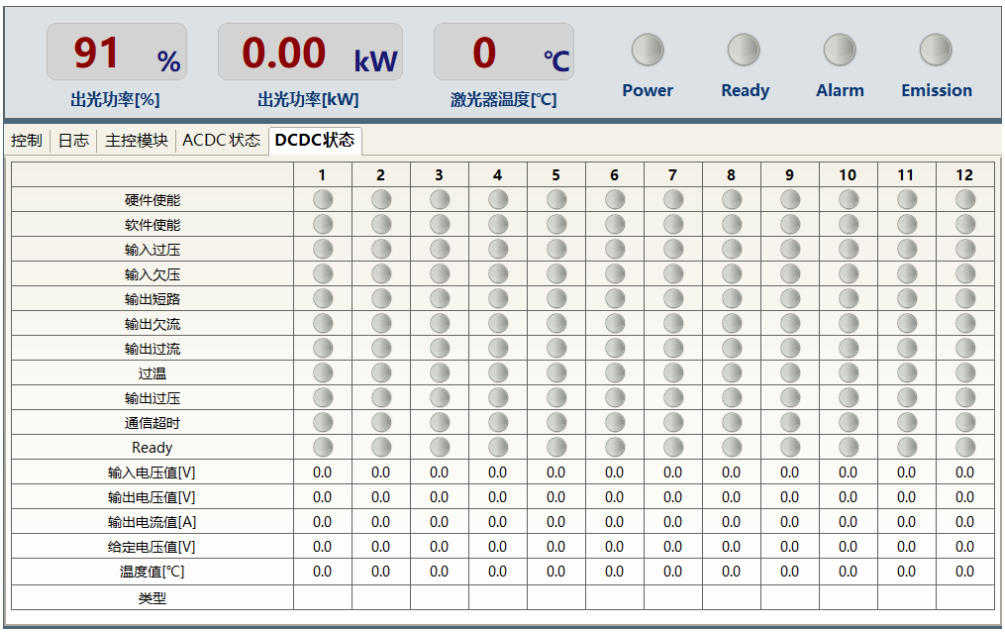


Figure 20 DCDC, module interface

4.8 Laser operating mode

There are three main working modes of laser, continuous (CW), pulse (Pulse). The main differences and characteristics between pulse mode (QCW mode), continuous mode and waveform mode are as follows:

The maximum peak power in pulse mode (4500W) is much higher than that in continuous mode (450W).

In pulse mode, the maximum pulse width and the maximum duty cycle are limited to a certain range (see Figure 21, Pulse Mode Operating Range).

In continuous mode, the maximum pulse width and the maximum duty cycle are not limited.

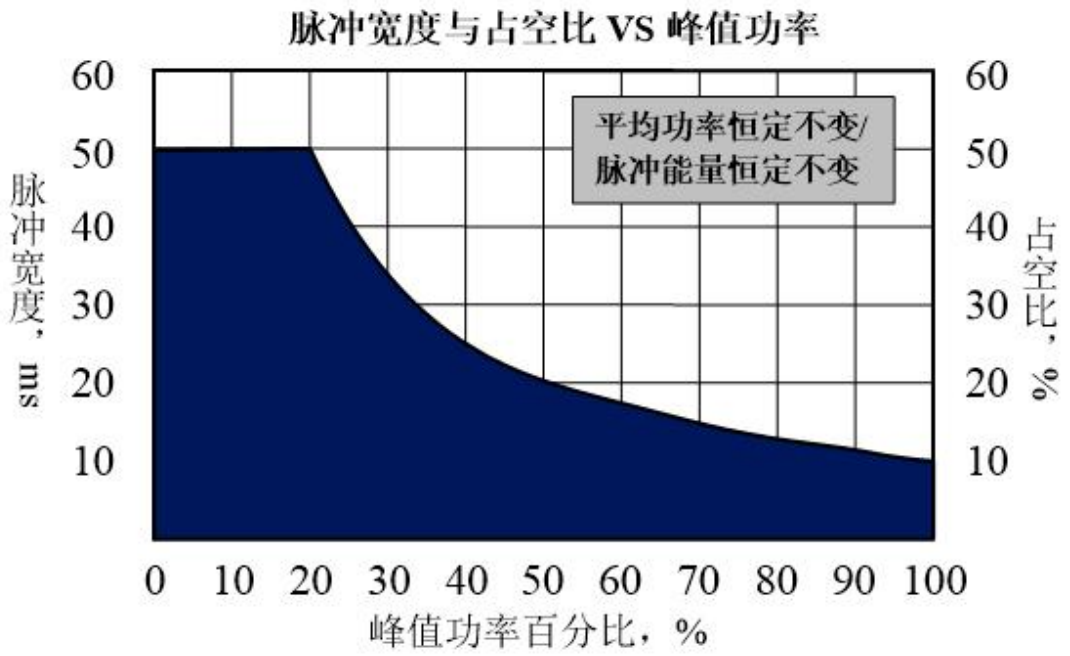


Figure 21 Pulse mode operating range

4.9 Control mode selection

The laser has two control modes: ON mode and REM mode. Users can select the desired mode through the key on the front panel. Both the ON mode and REM mode allow the laser to operate in continuous or pulsed (QCW) modes. In ON mode (laser test mode),

only power percentage, red light control, output control, and off light can be set. In REM mode, options include AD mode, external enable, and red light external control.

4.8.1 REM

mode AD

mode

AD pattern	Laser power

ON	INTERFACE 24 The analog voltage of pin 12 and 14 is 0~10V 0V——0% 10——100%
OFF	The upper computer sets the power percentage

Red light out control

Red light external control	
ON	The 17 feet of the INTERFACE: —— turns on the red light on the rising edge; —— turns off the red light on the falling edge.
OFF	Upper computer software: Red light ON—— Turn on the red light; Red light OFF—— Turn off the red light.

External enablement

External enablement	Laser enabled
ON	INTERFACE 24 Rising edge of pin 18 and 21
OFF	The laser enable ON/OFF is performed by the upper computer software

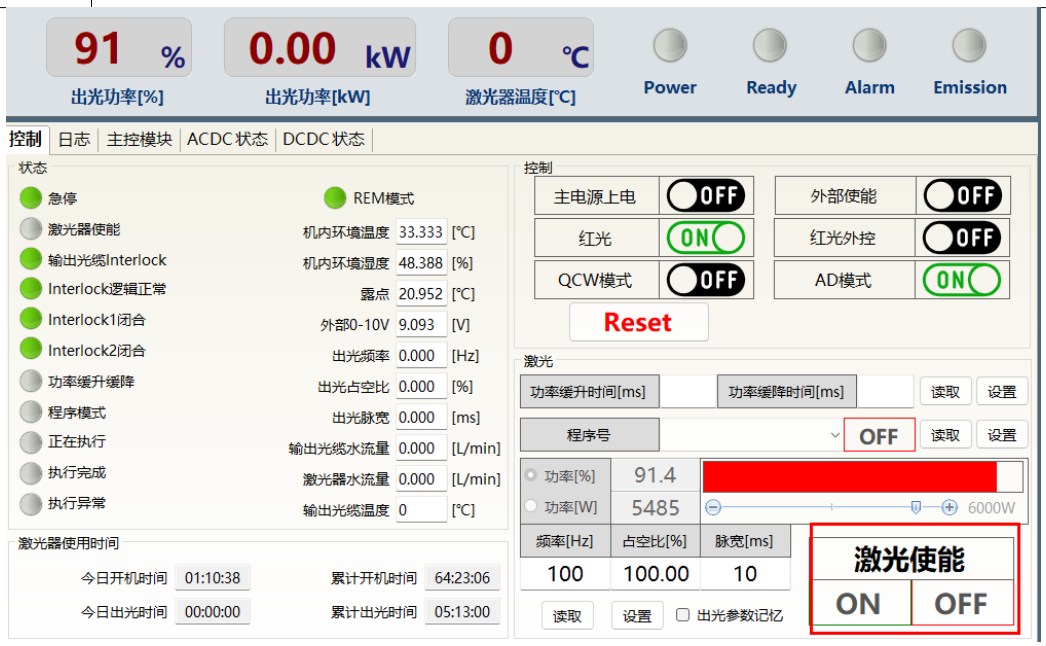


Figure 22 Laser enabled interface

4.8.2 Control mode

wiring diagram

4.8.2.1 Internal

control in ON mode

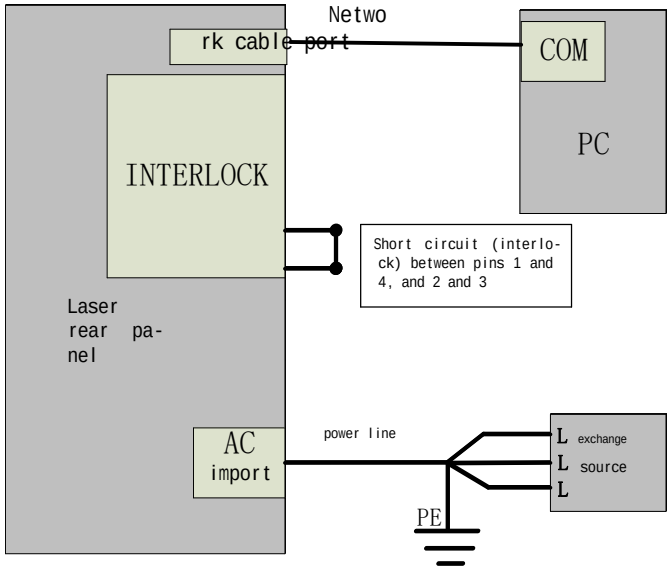


Figure 23 Internal control wiring diagram under the "ON" software mode of the key switch

method of operation:

- Pull up the front panel ESTOP knob;
- The key switch is turned on;
- Open the upper computer software;
- Click the Red Light ON button to view the red light;
- Click the main power ON;
- Wait Ready;
- Setting the light emission parameters;
- Click Laser ON.

4.8.2.2REM Set power communication parameters in mode and enable upper computer software

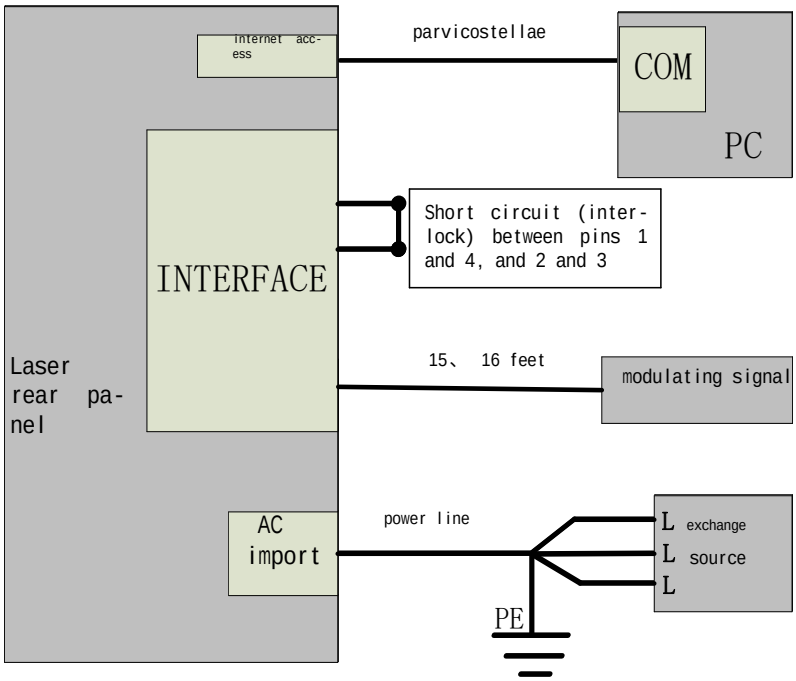


Figure 24 Power internal control and light output external control in REM mode, and wiring diagram of upper computer software enabling

method of operation:

- Pull up the front panel ESTOP knob;
- The key switch is turned to REM;
- Short circuit the 8 and 9 pins on the INTERFACE 24 needle (power on the control board);
- Open the upper computer software;
- Click the Red Light ON button to view the red light;
- Close AD mode, close external enablement;
- Click the main power ON;
- Wait Ready;
- Click the laser enable ON button on the upper computer software;
- Set the percentage of light output power;
- When the internal output frequency of the laser needs to be set, the emission frequency/duty cycle/pulse width should be configured; (the emission is determined by the modulation signal on pin 15.16 and the emission frequency and duty cycle set by the upper-level software); when the internal output frequency of the laser does not need to be set, the

default parameter is a frequency of 100Hz and a duty cycle of 100%.

- 15 and 16 foot modulation signal output high level to turn on the laser.

4.8.2.3REM Set power communication parameters in mode and enable externally

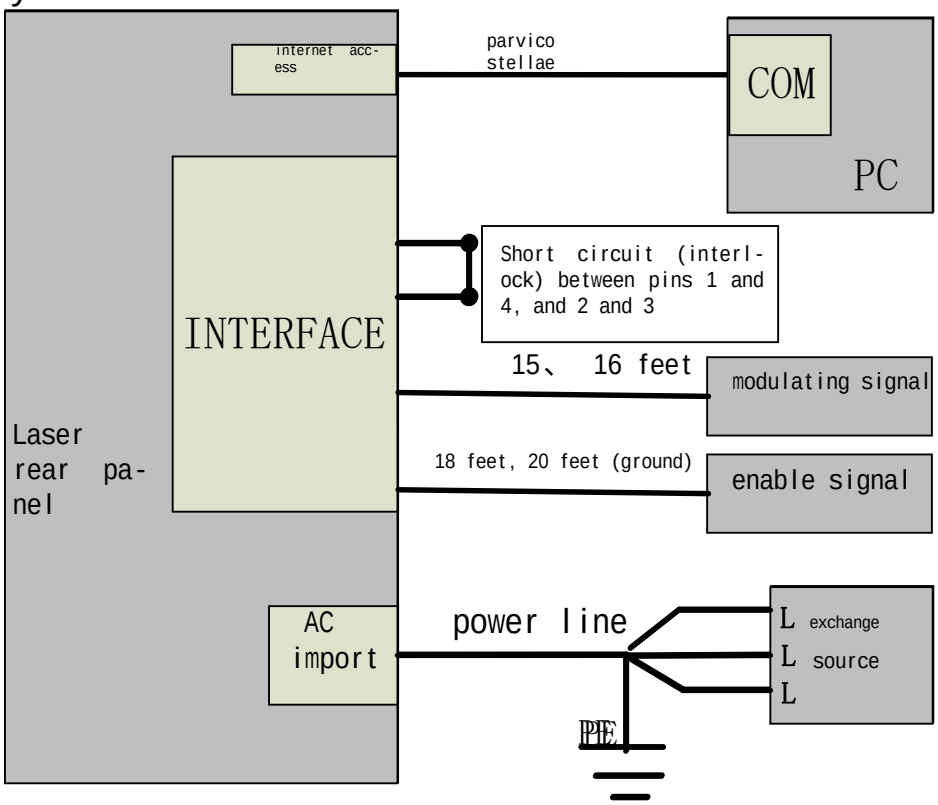


Figure 25 Power internal control and light output external control in REM mode, external enable wiring diagram

method of operation:

- Pull up the front panel ESTOP knob;
- The key switch is turned to REM;
- Short circuit the 8 and 9 pins on the INTERFACE 24 needle (power on the control board);
- Open the upper computer software;
- Click the Red Light ON button to view the red light;
- Close AD mode and open external enablement;
- Click the main power ON;
- Wait Ready;
- INTERFACE 24 On the needle, 18 feet input rising edge;
- Set the percentage of light output power;
- When the internal output frequency of the laser needs to be set, the emission frequency/duty cycle/pulse width should be set; (the emission is determined by the modulation signal on pin 15.16 and the emission frequency and duty

cycle set by the upper-level software); when the internal output frequency of the laser does not need to be set, the default parameter is set to a frequency of

100Hz, duty cycle 100%.

- 15 and 16 foot modulation signal output high level to turn on the laser.

4.8.2.4REM Power analog setting mode is set in the mode, and the upper computer software enables it

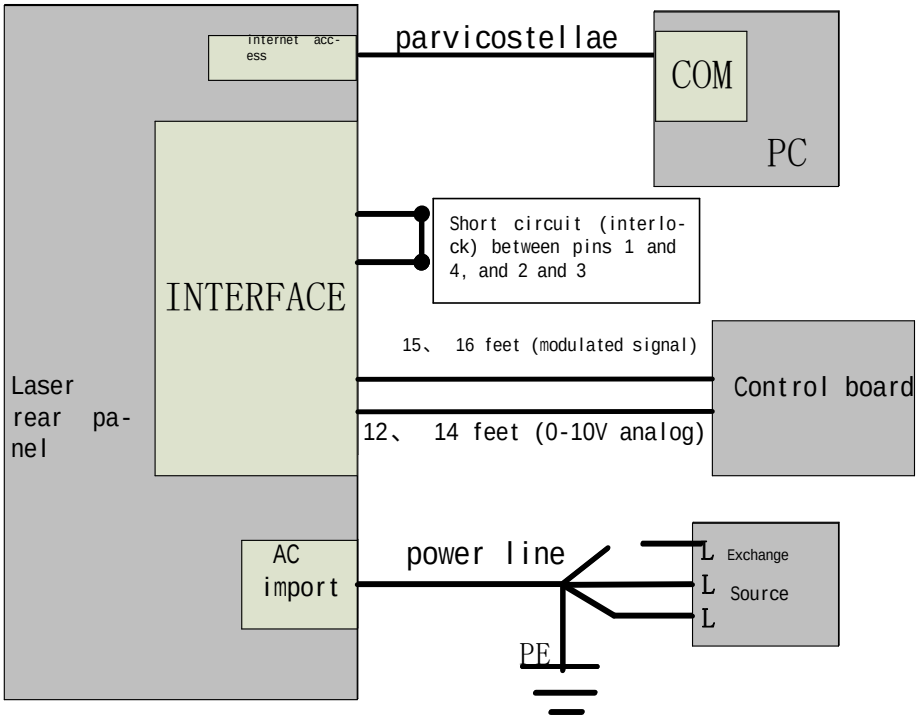


Figure 26 Power and light output are externally controlled in REM mode. The operation method of the upper computer software enabling wiring diagram is as follows:

- Pull up the front panel ESTOP knob;
- The key switch is turned to REM;
- Short circuit the 8 and 9 pins on the INTERFACE 24 needle (power on the control board);
- Open the upper computer software;
- Click the Red Light ON button to view the red light;
- Open AD mode and turn off external enablement;
- Click the main power ON;
- Wait Ready;
- The upper computer software clicks the laser enable ON;
- When the internal output frequency of the laser needs to be

set, the emission frequency/duty cycle/pulse width should be set; (the emission is determined by the modulation signal on pin 15.16 and the emission frequency and duty cycle set by the upper-level software); when the internal output frequency of the laser does not need to be set, the default parameter is set to a frequency of

100Hz, duty cycle 100%.

- The control board outputs analog quantities (12,14 pins) and light output signals (15,16 pins).

4.8.2.5REM Power analog setting mode is set in the mode under which external enable is enabled

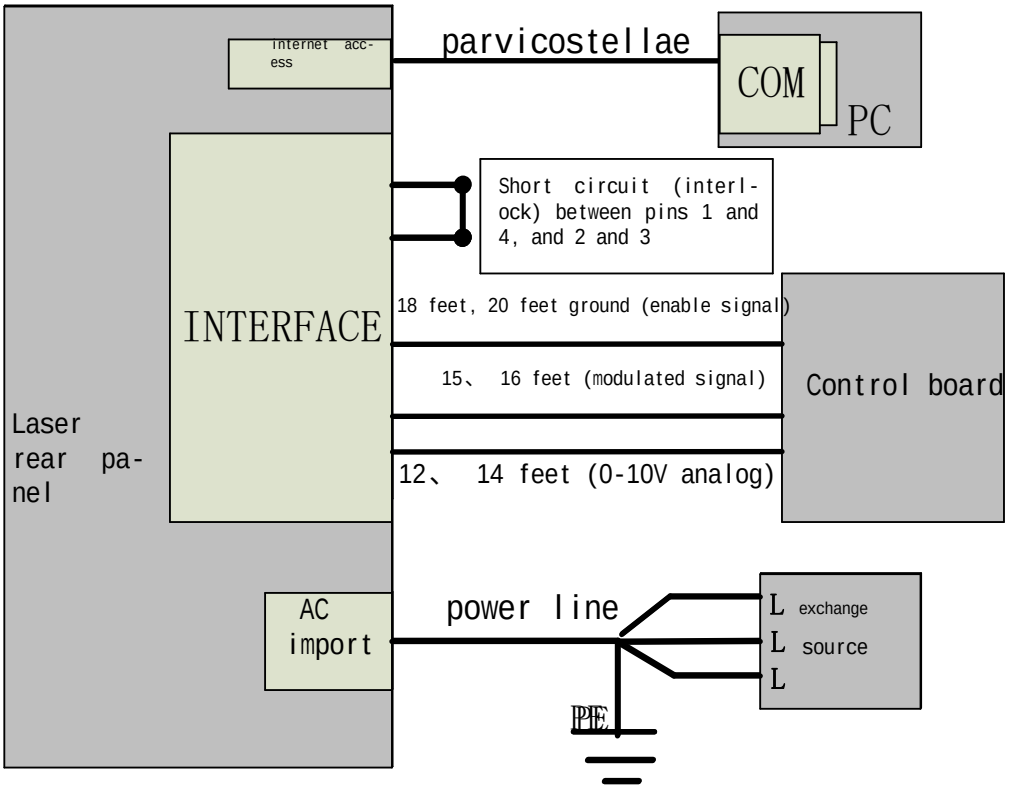


Figure 27 Power, light output and enable are all externally controlled wiring diagram in REM mode Operation method:

- Pull up the front panel ESTOP knob;
- The key switch is turned to REM;
- Short circuit the 8 and 9 pins on the INTERFACE 24 needle (power on the control board);
- Open the upper computer software;
- Click the Red Light ON button to view the red light;
- Open AD mode and open external enablement;
- Click the main power ON;
- Wait Ready;
- INTERFACE 24 On the needle, 18 feet input rising edge;
- When the duty cycle of the internal output frequency of the

laser is required, the light emission frequency/duty cycle/ pulse width is set; (the light emission is determined by the modulation signal at pin 15.16 and the light emission frequency and duty cycle set by the upper computer software

); When the internal output frequency of the laser is not required, the default setting parameter is a frequency of 100Hz and a duty cycle of 100%.

- The control board outputs analog quantities (12,14 pins) and light output signals (15,16 pins).

4.10 Laser timing diagram

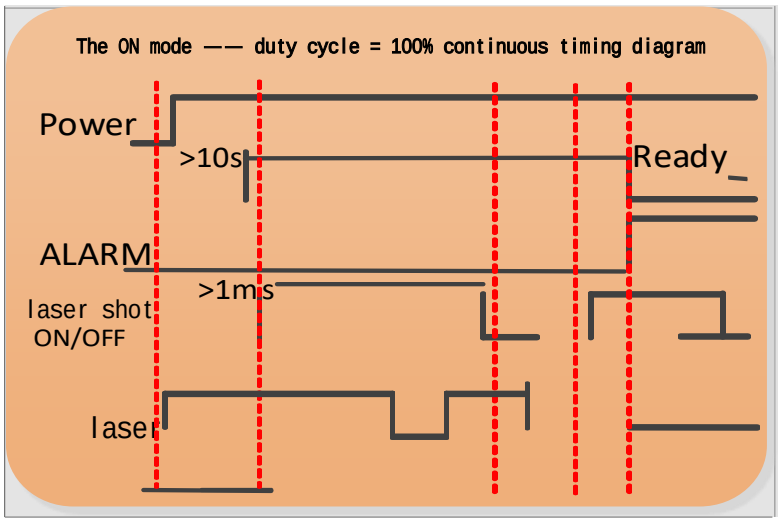


Figure 28 Timing diagram of control in ON mode

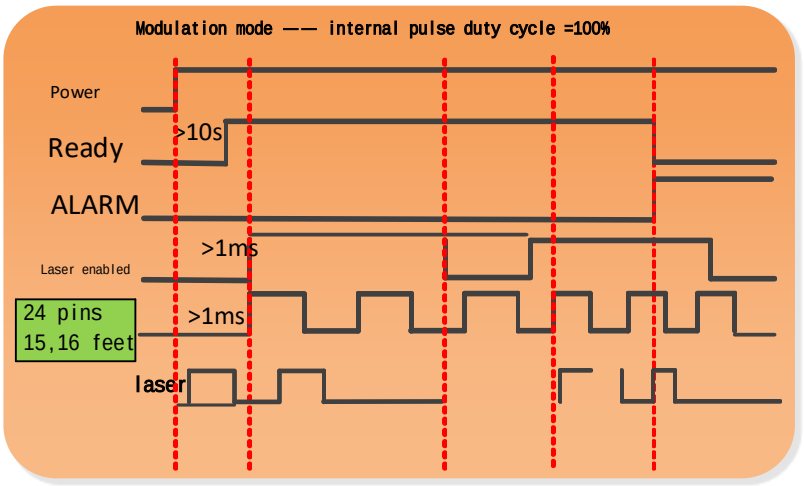


Figure 29 Schematic diagram of external modulation mode control under key "REM"

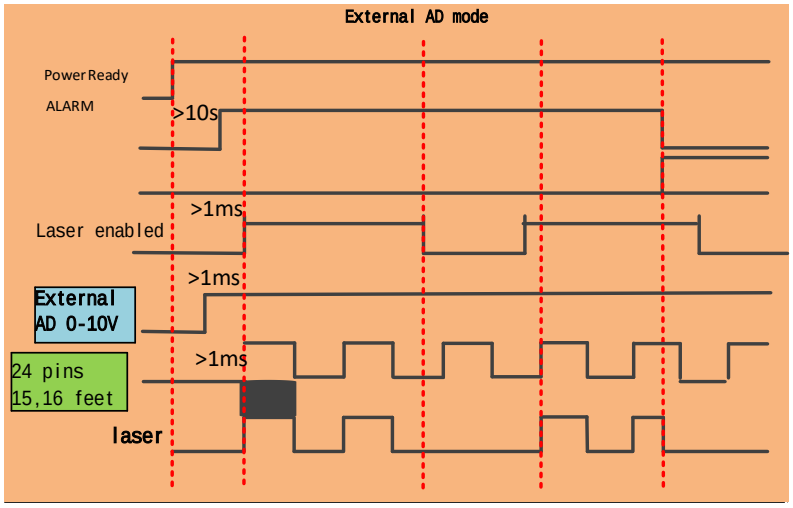


Figure 30 Schematic diagram of external AD mode control under key "REM"

4.11 Modulated signal control

The modulation operating frequency range of RFL-QCW450/4500 laser is 1-5000Hz, and the minimum output pulse width of the laser is required to be greater than or equal to 160us. The reference values of laser frequency and duty cycle setting are shown in Table 10.

Table 10 Reference values for laser frequency and duty cycle Settings

frequency Pulse width duty cycle	95%	90%	80%	70%	65%	60%	55%	50%	45%	40%	35%	30%	25%	20%	15%	10%		
5000Hz	190us	180us	160us															
4500Hz		200us	177us															
4000Hz			200us	175us	162us													
3500Hz				200us	185us	170us												
3000Hz						200us	183us	166us										
2500Hz								200us	180us	160us								
2000Hz										200us	175us							
1500Hz												200us	166us					
1000Hz														200us				
500Hz															300us	200us		

4.12 Close the operation sequence

Please follow the following sequence to turn off the laser:

1) Turn off the laser output;

2) Turn off the key switch (turn the key to OFF) and bounce the "START" button;

3) Turn off the chiller;

4) Disconnect the air switch;

5) Cover the output head with a protective cap.

5 Common alarm logs and handling measures

5.1 The log shows

Connect the computer and open the upper-level software. After establishing normal communication between the laser and the client software, all alarm statuses of the laser can be displayed on the upper-level software interface, as shown in Figure 31. When there are abnormalities in the internal temperature, power, scattered light, power supply operation, condensation, or flow rate of the laser, an alarm will occur.

Figure 31 Main interface of the upper computer software

When the laser is running, any alarm occurs (except Interlock abnormal), the upper computer software interface will also display the alarm that occurs, and at the same time, the ALARM alarm light (yellow) on the front panel of the laser will be lit, and the laser will stop emitting light and lock.

Interlock After the abnormality, the laser output Ready signal is low level, and at the same time, the upper computer software interface prompts Interlock abnormality, but the laser does not lock, and ALARM alarm light (yellow) does not light up. Interlock After the normality, the laser immediately outputs Ready signal is high level.

5.2 Alarm log processing

The typical laser alarm description and possible solutions are as follows:

Table 11 Laser alarm description and possible solutions

Name of the alarm	Alarm description and solution measures
T1/T2 Alarm (temperature alarm —— low temperature alarm and High temperature alarm)	**Alarm description:** The laser low temperature/high temperature alarm occurs when the sensor inside the laser detects abnormal temperature inside the laser. When the temperature of the monitoring point exceeds the set upper limit, a high temperature alarm is generated; when the temperature exceeds the set lower limit, a low temperature alarm is generated. **Possible solutions:** In case of high temperature alarm, please check whether the water cooling system is normally opened, whether the water temperature setting is correct, whether the chiller is working normally, and whether there is any abnormality in the water connection. When the water cooling system works normally and the water temperature drops below 30℃, restart the laser to try. In case of low temperature alarm, please check whether the actual water temperature of the chiller is too low.

	In addition, low ambient temperature may also cause low temperature alarm when the laser is started in cold machine state. If any of the above situations occur, you should wait until the water temperature of the chiller rises to more than 10℃ before restarting the laser for trial.
Hum Alarm (Retraction alarm)	**Alarm description:** Condensation alarm inside the laser. The condensation risk exists when the dew point temperature inside the laser is detected to be <22℃. **Possible solutions:** Immediately stop using the laser. Please introduce cold dry air from the CDA interface according to the operation requirements to discharge the humid air in the cabinet, or improve the working environment of the laser, so that the ambient temperature is lower than the internal temperature of the laser. It is recommended to configure a separate air-conditioned room for the laser.

Laser Water Flow (laser water flow alarm)	**Alarm description:** Laser water flow alarm, the laser internal detection of the current water flow is lower than the required value, there is a safety risk. **Possible solutions:** Immediately stop using the laser. Please check the output model and working status of the laser water cooler according to the laser operation requirements in section [3.3 Installation and Requirements of Cooling System], and clean the laser inlet water filter assembly. It is recommended to clean the water cooler and inlet water filter assembly regularly and replace the cooling water.
Scattered Light Alarm (scattered light alarm)	**Alarm description:** Scattered light alarm: when the ambient light intensity inside the laser exceeds the set value, the scattered light alarm is generated and the laser output function is locked (cannot be unlocked). The scattered light alarm only occurs when the laser is in the output state. **Possible solutions:** Restart the laser, check the red light state of the laser, read the scattered light monitoring voltage value through the "slave module" of the upper computer, and contact Ruike.
Laser Power Alarm (Power alarm)	**Alarm description:** Power alarm, when the output power of the laser cannot reach the set value, a power alarm is generated. The power alarm only occurs when the laser is in the light state. **Possible solutions:** Check the laser indicator for red light status and contact Ruike.
ACDC Alarm (POWER alarm)	**Alarm description:** The laser power supply alarm may be generated when the laser power supply fails or the power supply system is suddenly disconnected and restarted. **Possible solutions:** Check whether the input AC voltage is normal. Restart the laser and try when it is normal. If the alarm continues to occur, please contact Ruike.
Current Dri-	**Alarm description:** The alarm occurs when the constant current drive board

ver Alarm (Current dr-ive board alarm)	inside the laser is abnormal. Possible solutions: Restart the laser for a try, and contact Raycus if the alarm continues to occur.

In addition to the above, if you have any questions or alarms during the use of the laser, you can contact Raytech for help.

6 Quality assurance and repair, return process

6.1 General warranty

After all products manufactured according to order or specification are shipped, Ruikeo provides warranty for products with material and technical problems and guarantees that they meet specifications under normal use.

Ruike has the right to selectively repair or replace any products with material or technical problems during the warranty period. All products repaired or replaced during the warranty period are guaranteed free of charge only for those products with special problems. Ruike reserves the right to collect payment for products with problems under normal use.

6.2 The limitation of warranty

Damages to products and their components (including optical fibers) caused by tampering, opening, disassembly, misinstallation, or modification by non-Ruike personnel; or damages due to misuse, negligence, or accidents; or damage resulting from use beyond specifications, incorrect installation and maintenance, abuse, or failure to follow the information and warnings in the user manual are not covered under warranty. Customers are responsible for understanding and operating according to the instructions in the user manual and operating procedures. Damage caused by incorrect operation is not covered under warranty, and accessories and optical fibers are not covered under warranty.

Within the warranty period, the Buyer must submit a written request within 31 days from the date of discovery of the product problem. The warranty does not involve third parties (including

the specified buyer, end user or customer, and does not include parts, equipment or other products not manufactured by Raytech).

	◆ The customer is responsible for understanding and operating according to the instructions in the user manual and operation specifications. The damage caused by incorrect operation is not covered by warranty, and accessories and optical fiber parts are not covered by warranty.

6.3 Technical support and product maintenance

➢ There are no built-in maintenance parts for users, so all repairs should be carried out by Ruike technicians.

➢ If any alarm occurs during the use of the product, you should notify the technical personnel of Ruike in time and deal with the troubleshooting.

➢ All repair or replacement products must be placed in the original packaging box provided by Ruike. Otherwise, Ruike will have the right to refuse free repair for any damage caused thereby.

➢ When you receive the Ruike product, please check whether the product is intact and undamaged in time. If there is any abnormal situation, please contact the carrier or Ruike company in time.

Ruike will continue to develop new products. The product information listed in the manual may change without notice. All technical parameters are subject to the terms of the contract.

The above warranty and service terms of the products are for users' reference only. The formal service and warranty contents shall be subject to the agreement in the contract.