

编号 RFL-C100~RFL-C2000S

密级

阶段标记

页数 46

名称 **RFL-C100~RFL-C2000S**

连续光纤激光器英文说明书

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Continuous-Wave Fiber Laser User Guide

RFL-C100~RFL-C2000S

Wuhan Raycus Fiber Laser Technologies Co., Ltd.

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1 Safety Information

Thank you for choosing Raycus fiber laser. This User Guide provides important safety, operation, warranty and other information. Please read it carefully before you use this product. In order to ensure safe operation and optimal performance of the product, please follow the warnings, cautions, operating procedures and other instructions accordingly.

1.1 Symbols Used in this User Guide

	<p>WARNING: Refers to a potential hazard that may leads to a personal injury or death.</p>
	<p>CAUTION: Refers to potential a hazard that may leads to a minor personal injury or product damage.</p>

1.2 Laser Classification

This series of lasers are classified as a high power Class 4 laser instrument according to the European Community standards EN 60825-1, clause 9. This product emits invisible laser radiation at or around a wavelength of 1080 nm, and the total light power radiated from the optical output is greater than 100W~2000W (depending on model). Direct or indirect exposure of this level of light intensity may cause damage to the eyes or skin. Despite the radiation being invisible, the beam may cause irreversible damage to the retina and/or cornea. Appropriate and approved laser safety eyewear must be worn all the time while the laser is operating.

	<p>WARNING: You must use appropriate laser safety eyewear when this device is operating. The laser safety eyewear is selected according to the range of wavelengths emitted from this product. The end user must ensure that the laser safety eyewear being used protects against light emitted by the device over its entire range of wavelengths. Please verify that the personal protective equipment (e.g. enclosures, viewing windows or viewports, eyewear, etc.) being utilized is adequate for the output power and wavelength ranges listed on the product.</p>
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1.3 Safety Labels

The position of the safety labels on products varies depending on the model of the continuous-wave fiber laser, as shown in Figure 1 and Figure 2:

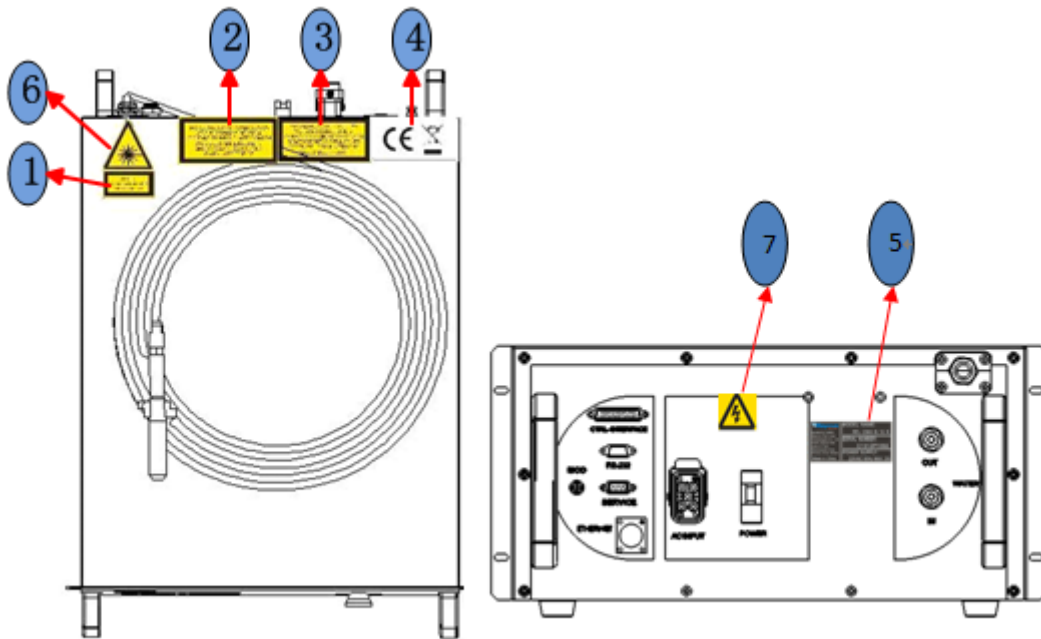


Figure 1: Safety Label Locations of RFL-C100~C1000

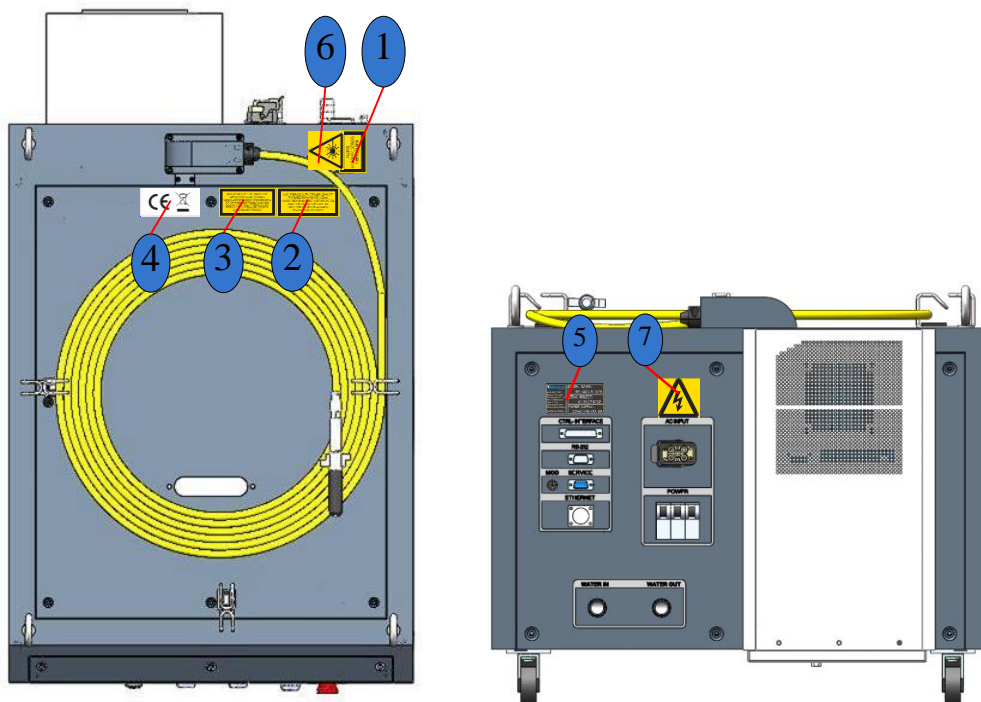


Figure 2: Safety Label Locations of RFL-C1500S/2000S

These safety labels include warning labels, apertures through which laser radiation is emitted and labels of certification and identification, etc. Specifications of these labels are as follows:


Table 1: Specifications of Safety Labels

	<p>(Take 500W for example)</p>	
<p>1.Aperture Label</p>	<p>2.Class 4 Laser Product</p>	<p>3.Class 2M Laser Product Label for Guide Laser</p>
<p>4. CE Compliance</p>	<p>5. Identification Plate</p>	<p>6.Laser Radiation Hazard Label</p>

		
7.Electrical Hazard		


1.4 Optical Safety

Any dust on the end of the collimator assembly can burn the lens and damage the laser.


	<p>CAUTION: If the output of the device is delivered through a lens with an anti-reflection coating, make sure that the lens is of good quality and clean.</p>
---	---

1.5 Electrical Safety

(1) Make sure your product is grounded through the PE line of the AC power cord. The grounding must be firm and reliable.

	<p>WARNING: Any interruption from the protective earth will electrify the enclosure, which may result in personal injury.</p>
---	--

(2) Make sure that the correct voltage of the AC power source is used.

	<p>CAUTION: Failure to connect the correct voltage could damage the product.</p>
---	---

1.6 Other Safety Rules

- (1) Never look directly into the laser output port when power is supplied to the laser.
- (2) Avoid using the laser in a dim or darkened environment.
- (3) If this device is used in a manner not specified in this document, the protection provided by the device may be impaired and the warranty will be voided.

(4) There are no operator serviceable parts inside, and all maintenance must be performed in Raycus or by qualified Raycus personnel. Do not try to remove covers, or electrical shock may be caused, and warranty will be void.

2 Product Description

2.1 Features

Compared with traditional lasers, Raycus CW fiber laser has higher efficiency electric-optical conversion, lower power consumption and excellent beam quality. The fiber laser is compact and ready to use. It can be used as a stand-alone unit or easily inserted into user's apparatus.

Main Features:

- Excellent beam quality
- High quality fiber output
- High Power Stability
- Output power continuously adjustable, fast switching response
- Maintenance free operation
- High efficiency of electric-optical conversion
- Convenient control interface
- Fast modulation

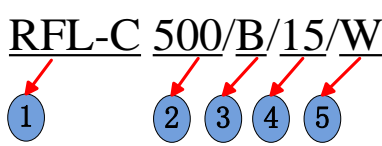
Applications:

- Cutting, Welding
- 3D Printing
- Scientific research

2.2 Model Configuration

The series of Raycus continuous-wave fiber laser include 100W, 200W, 300W, 400W, 500W, 600W, 700W, 750W, 1000W, 1500W and 2000W, and the model designation codes are illustrated in the following table:

Table 2 Model Names and Designation Codes

	
1	RFL-C series, continuous-wave (CW) fiber laser
2	Power in watts: 100--100W 200L--170W 200--200W 300L--250W 300--300W 500--500W 750--750W 1000--1000W 1500S--1500W 2000S--2000W
3	Wavelength: B--1080nm
4	Length of delivery cable in meter, including 15m and 20m, and other length can be customized
5	Cooling method: W-- water cooling A-- air cooling
<p>Note: No air conditioner in this laser series except the RFL-C1500S/C2000S.</p>	

Usually we omit the suffix and present the model name as RFL-C200, RFL-C300, etc. However, you can find the complete model name on the identification plate.

2.3 Package Contents

Please refer to the packing list accompanying the shipment to check actual items included.


2.4 Unpacking and Inspection

Raycus CW fiber laser is shipped in a package designed to provide maximum protection. Upon delivery, please inspect all packaging for evidence of mishandling or damage. If you find

any evidence of mishandling, please save the damaged material and contact the shipping agent and Raycus immediately.

Remove all the contents from the packing case. Take extra care when removing the unit out of the packing case to ensure that the fiber optic cable is not twisted, hauled or damaged. A comprehensive packing list is included with the system documentation. Check all items against the list and contact Raycus immediately if there is any missing item or evident damage to the unit. DO NOT attempt to install or operate the laser, if there is any evident or suspected damage to the unit.

It is recommended to keep the packing materials, as they will be necessary if you ever need to ship the unit back for service at a later date.

	<p>CAUTION: The fiber optic cable and output head is precise optic instrument, any vibration or impact to the output head, and twist or excessive bend to the cable will damage the instrument.</p>
--	--

2.5 Operation Environment

The basic operation conditions are listed in the table below:

Table 3 Basic Operation Conditions for the Laser

Laser (W)	100	200L	200	300L	300	500	750	1000	1500S	2000S
Power Source(V)	220±10% V AC 50/60Hz							380±10% V AC 50/60Hz		
Power Capacity (kW)	0.4	0.8	0.8	1.2	1.2	2.0	3.0	4.0	5.0	6.5
Installation Environment	Flat with no vibration and shock									
Ambient Temperature (°C)	10~40									
Relative Humidity (%)	<70									

Warning:

- 1) Ensure reliable grounded before using the laser.
- 2) The laser output is connected to the output cable. Please check the laser output carefully to prevent dust or other contamination. Use special paper when cleaning the laser output lens.

3) If the laser is used in accordance without the method specified in this manual, the laser may be in abnormal working state and cause damage.

4) It is strictly forbidden to install the laser output when the laser is in operation.

5) Do not look directly into the laser output. Be sure to wear protective glasses when operating the laser.


	<ul style="list-style-type: none"> ◆ Do not expose this product to high humidity (>95%) ◆ Do not let this product work below the ambient dew point temperature
---	---

Table 4 The Constant Dew Point Table

AMBIENT DEW POINT									
Room Temperature (°C)	Maximum Relative humidity								
	20%	30%	40%	50%	60%	70%	80%	90%	95%
20	-3.5	2	6	9	12	14.5	16.5	18	19
25	0.5	6	10.5	14	16.5	19	21	23	24
30	4.6	10.5	15	18.5	21.5	24	26	28	29
35	8.5	15	19.5	23	26	28.5	31	33	34
40	13	20	24	27.5	31	33.5	36	38	39
Laser operating temperature range									

2.6 Precautions for Use

(1) Before supplying the power to the device, make sure that the correct voltage of the AC power source is used (See Table 3 for the laser model and corresponding input voltage). Failure to connect power source correctly will damage the device;

(2) Failure to follow the instructions may cause malfunction and damage to the device, such damage is not covered by warranty.

(3) It is very important to ensure the cleanness of the calibrated laser output head, otherwise it will cause irreparable damage to the laser.

(4) Please inspect the output head carefully for dust or other contaminations. Use appropriate lens paper to clean it if necessary. Do not touch the output lens at any time; as well as remember to cap the output head when it is not in use, and make sure the cap is clean;

(5) Failure to follow the specified instructions may result in the loss of laser power, and such loss will not be covered by the warranty.

2.7 Specifications

The specifications are listed in the following table

Table 5 Product Specifications

Model	C100	C200L	C200	C300L	C300	C500	C750	C1000	C1500	C2000	Test Conditions
Optical Characteristics											
Nominal Output Power(W)	100	170	200	250	300	500	750	1000	1500	2000	
Operation Mode	CW/Modulated										
Polarization State	Random										
Output Power Tunability(%)	10~100										
Emission Wavelength(nm)	1080±5										Nominal Output Power
Output Power Instability	±1.5										Nominal Output Power; Duration: 5hrs; Ambient Temp.: 25°C
Modulation Frequency(Hz)	50~50,000										Nominal Output Power
Red Guide Laser Power(mW)	0.1~1										
Optical Output Characteristics of QBH head											
Beam Quality	$M^2 \leq 1.3$						BPP <2.3 (mm ×mrad)			Nominal Output Power	
Core Fiber(μm)	25						50(25, 100, 200 optional)				
Delivery Cable Length(m)	15						20				
Electrical Characteristics											
Power Supply	220±10% V AC, 50/60Hz						380±10% V AC, 50/60Hz				
Numerical Aperture (NA)	0.11						0.2				
Max. Power Consumption(W)	400	800	800	1000	1000	2000	3000	4000	5000	6500	
Control Mode	RS-232/AD/Ethernet										
Other Characteristics											
Dimensions(W×H×D)	485×237×663(include. handles)						485×237	520×620×986			

		×763(include. handles)	(include. handles)	
Weight(kg)	<50		<80	
Operating Ambient Temperature(°C)	10~40			
Humidity (%)	<70			
Storage Temperature(°C)	-10~60			
Cooling Method	Water Cooling			

3 Installation

3.1 Dimensions

The dimensions of Raycus CW fiber laser is divided into three types according to the laser model, among which RFL-C100 ~ RFL-C750 laser dimension is the first type, RFL-1000 laser dimension is the second type, RFL-C1500S and RFL-C2000S laser dimension is the third type.

3.1.1 Dimension of RFL-C100~RFL-C750

Figure 3 shows dimensions of RFL-C100 ~ RFL-C750 (take RFL-C750 for example, other models in the series have the same dimensions).

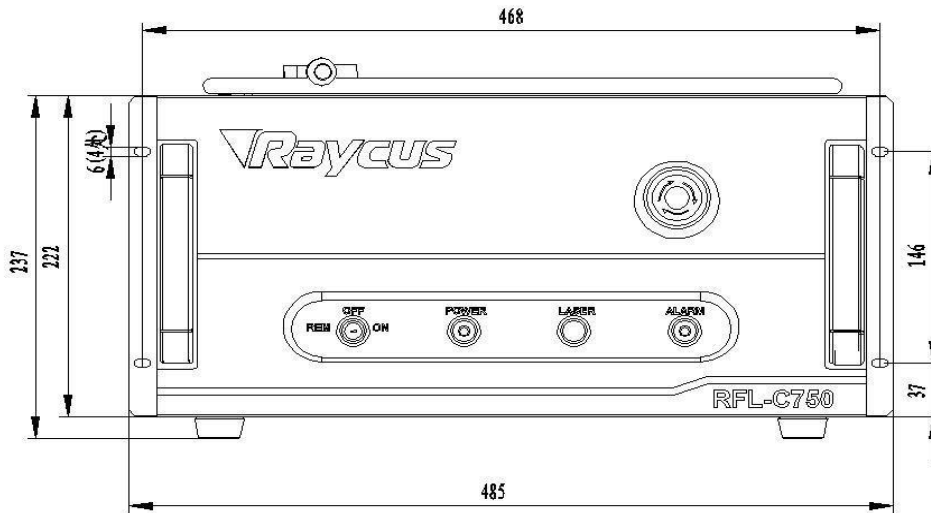


Figure 3 (a) Front panel view of RFL-C100 ~ RFL-C750 (unit: mm)

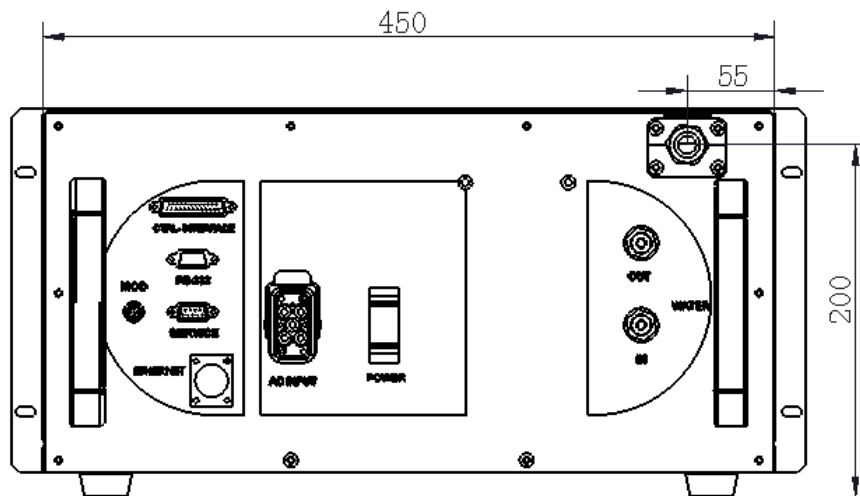


Figure 3 (b) Rear panel view of RFL-C100 ~ RFL-C750 (unit: mm)

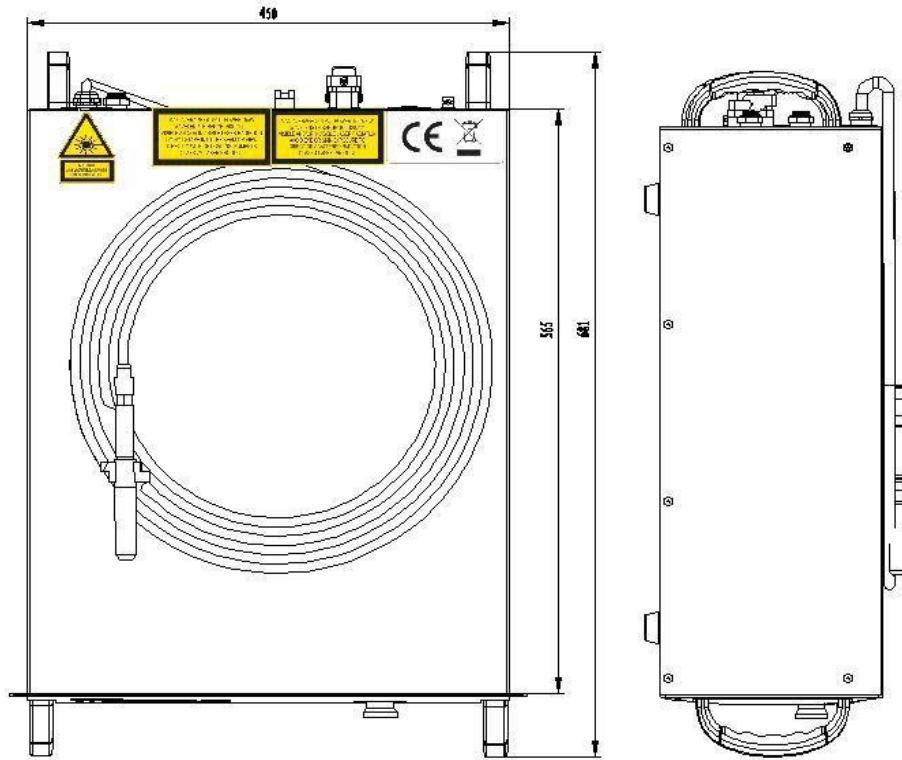


Figure 3 (c) Top and Side view of RFL-C100 ~ RFL-C750 (unit: mm)

3.1.2 Dimension of RFL-C1000

Figure 4 shows dimensions of RFL-C1000.

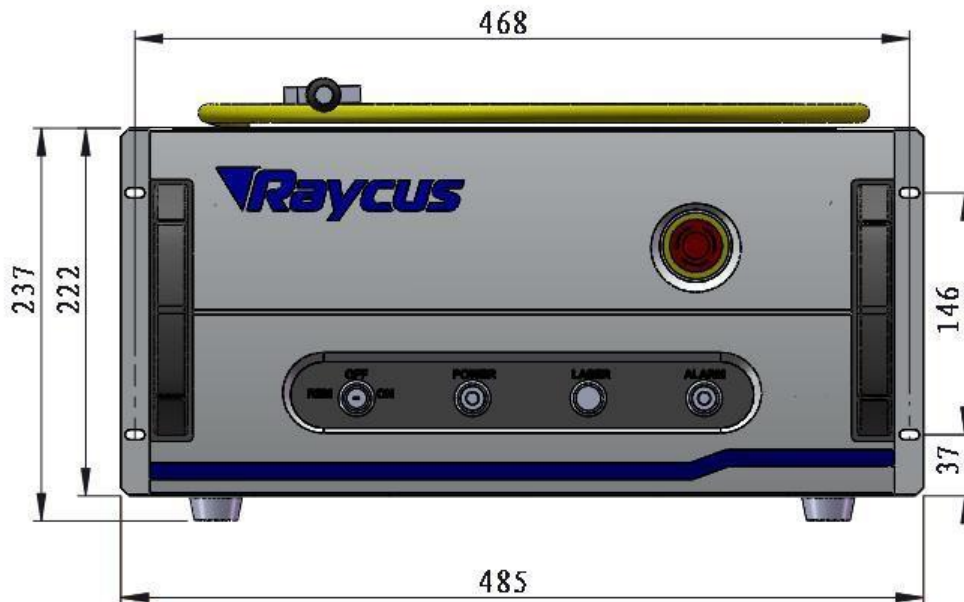


Figure 4 (a) Front panel view of RFL-C1000 (unit: mm)

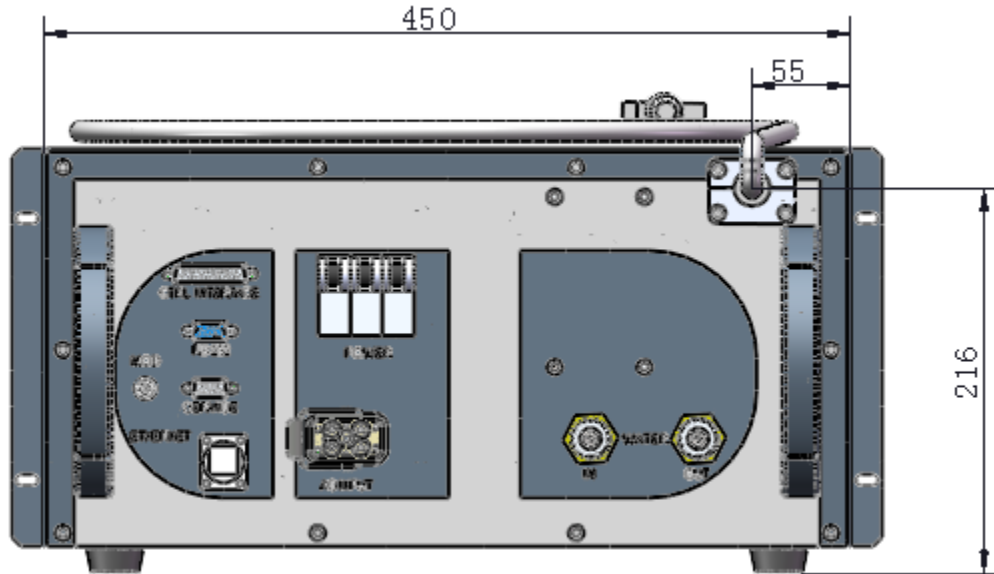


Figure 4 (b) Rear panel view of RFL-C1000 (unit: mm)

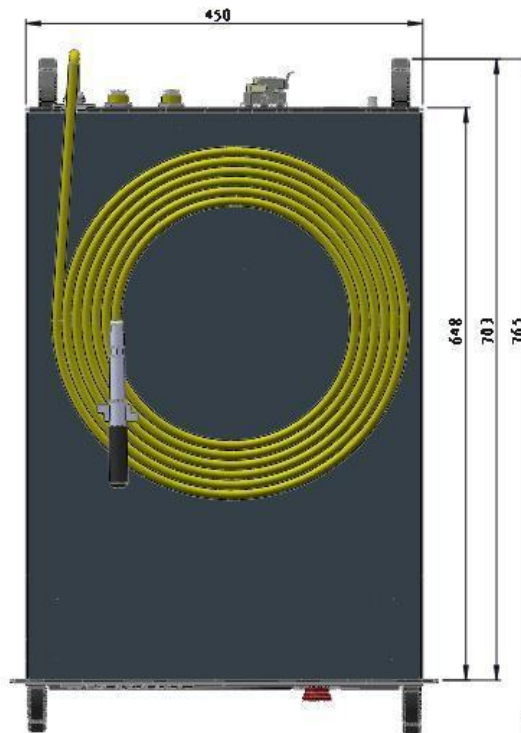


Figure 4 (c) Top and Side view of RFL-C1000 (unit: mm)

3.1.3 Dimension of RFL-C1500S/C2000S

Figure 5 shows dimensions of RFL-C1500S/C2000S (take RFL-C2000S for example, RFL-C1500S has the same dimensions).

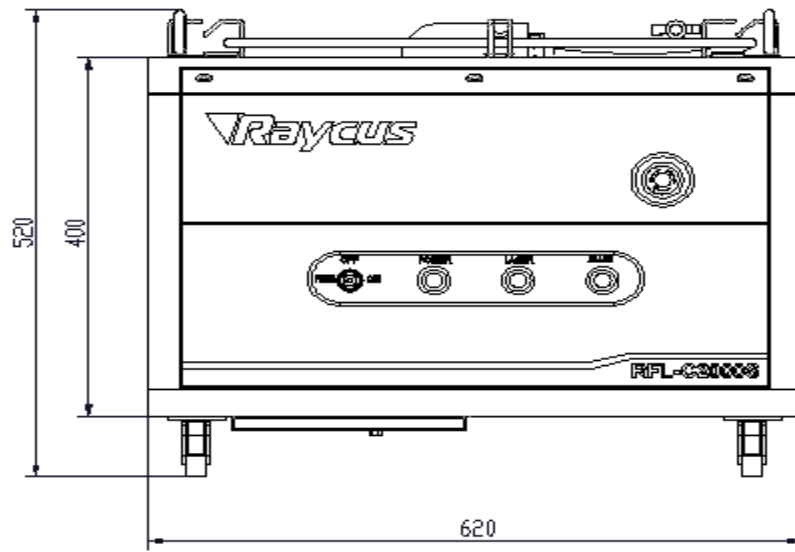


Figure 5 (a) Front panel view of RFL-C1500S/C2000S (unit: mm)

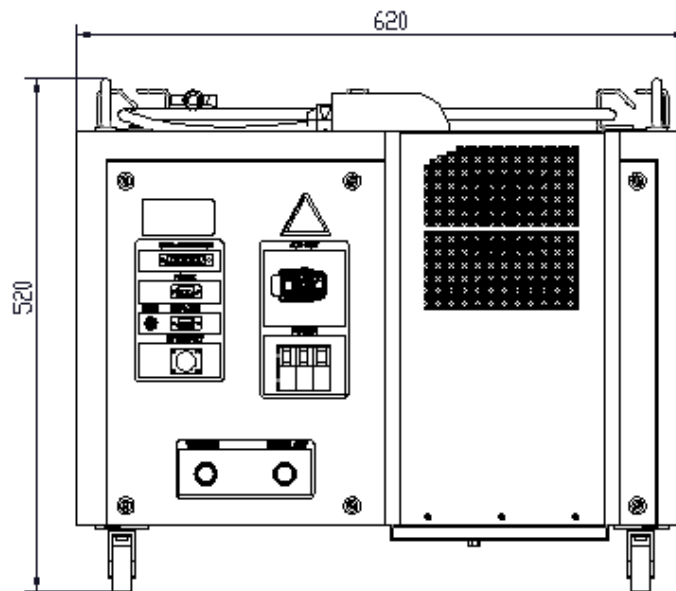


Figure 5 (b) Rear panel view of RFL-C1500S/C2000S (unit: mm)

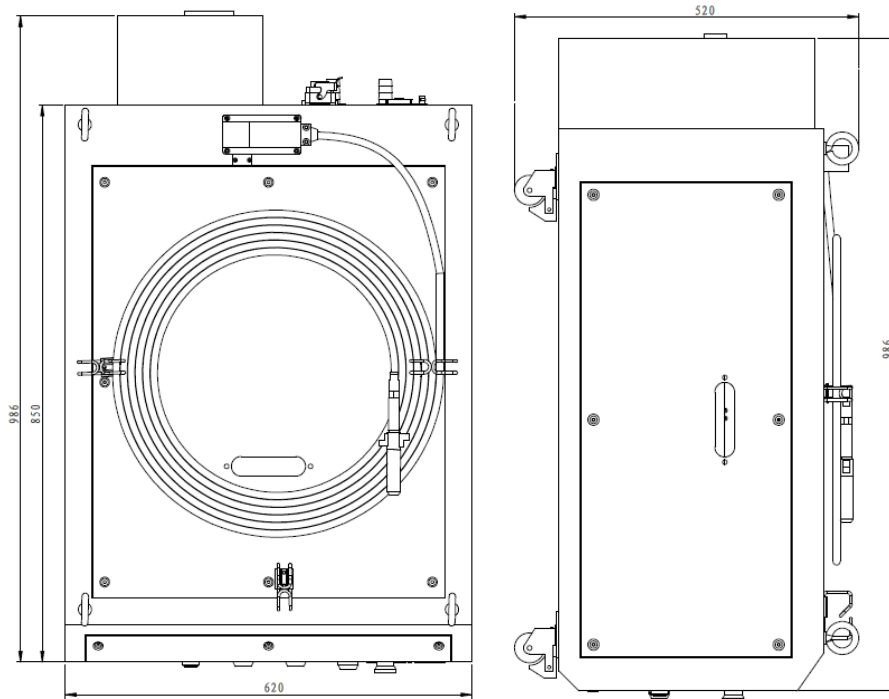


Figure 5 (c) Top and Side view of RFL-C1500S/C2000S (unit: mm)

3.2 Output Cables and installation

Raycus CW fiber laser uses different laser output cables according to the laser model.

3.2.1 Output Cable of RFL-C100~RFL-C1000

The laser output cable of RFL-C100~RFL-C1000 is a self-made QBH output cable (optional QCS output head). The specific appearance dimensions are shown in Figure 6, Figure 7 below:

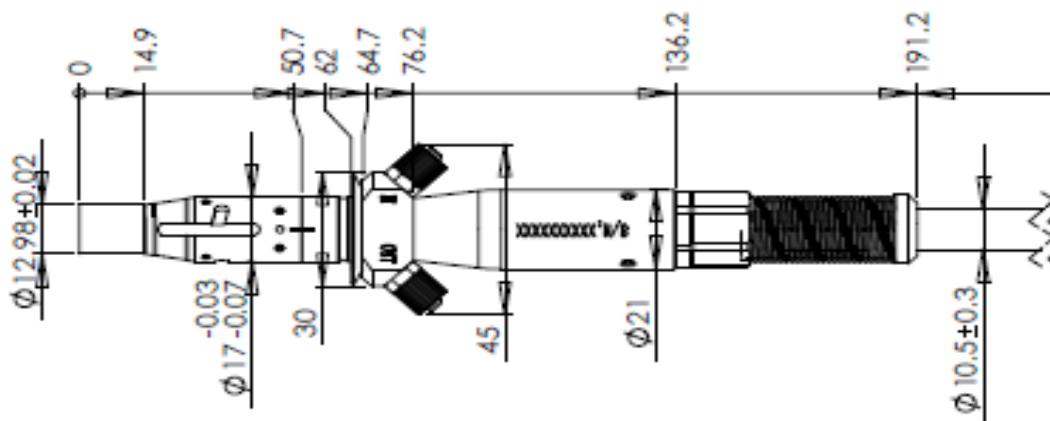


Figure 6 QBH Output Cable (unit: mm)

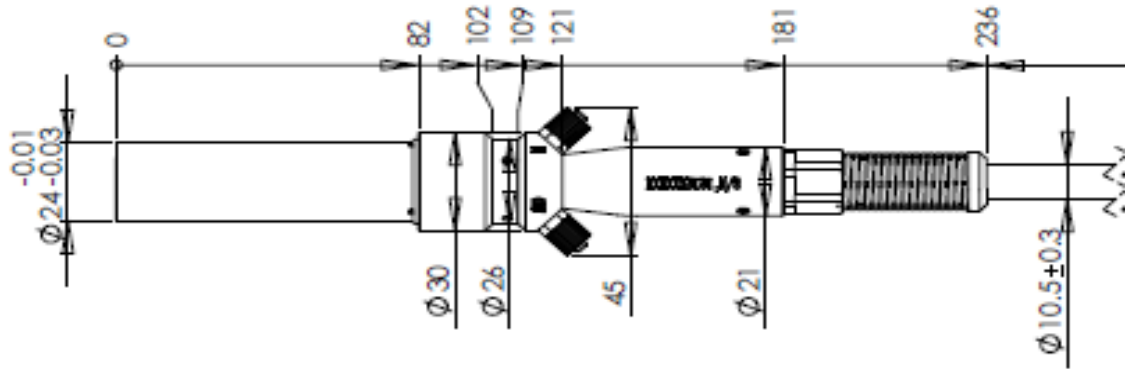


Figure 7 QCS Output Cable (unit: mm)

3.2.2 Output Cable of RFL-C1500S/C2000S

The laser output cable of RFL-C1500S/C2000S is a self-made QBH output cable. The specific appearance dimensions are shown in Figure 6 above

	<p>CAUTION:</p> <ul style="list-style-type: none"> ◆ For QBH output cable, there are two interlock pins on the output head, which must be shorted before the laser is turned on. Usually there are shorted in the processing head, please check the head to ensure that. ◆ Inspect the output lens before install the output head to the processing head. Clean the output lens if necessary. ◆ It is strictly prohibited to disassemble the output head for Non-Raycus Personnel, or the warranty is void.
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3.3 Cooling Requirements

Table 6 Cooling Requirements

Model(RFL-C)	100	200L	200	300L	300	500	750	1000	1500S	2000S
Cooling Capability (W)	>300	>600	>600	>900	>900	>1500	>2300	>3000	>4500	>6000
Minimum Flow (L/min)	8								15	
Maximum Pressure (Bar)	7								7	
Pipe Outside Diameter (mm)	10							12	19	
Water temperature of cooling system (°C)	25 (±1°C)									

1) The water temperature setting of cooling system:

- summer (Ambient temperature is higher than 30°C) $29 \pm 0.5^{\circ}\text{C}$ (RFL-C100~RFL-C1000)
- summer (Ambient temperature is higher than 30°C) $25 \pm 0.5^{\circ}\text{C}$ (RFL-C1500S/C2000S)
- winter (Ambient humidity temperature is lower than 30°C) $25 \pm 0.5^{\circ}\text{C}$

2) Coolant requirements:

- The cooling water is pure water. It is recommended to use pure drinking water.
- In order to prevent mould growing that may lead to pipe blockage, we recommend to add alcohol about 10% of the total volume.
 - If the product is used in an environment that ambient temperature is between -10°C and 0°C , we recommend to use 30% alcohol, and replace it every two months.
 - If the product is used in an environment that ambient temperature is below -10°C , please to use dual-system chillers (with heating function) and ensure uninterrupted operation of the cooling system.


3) Requirements for output cable cooling system:


- Rate of liquid flow: 1.7-2.0 L/min;
- Pressure of liquid flow: < 0.6 mPa at the inflow;
- Type of liquid exchange junction: SMC MS-5H-6;
- Type of tube: outer diameter $\phi 6$; inner diameter $\phi 4$;
- Direction of cooling liquid: unidirectional; connect the tube with the water-pipe strictly according to direction shown on the layer of the tube;
 - Type of liquid: de-ionized water, condensed water, pure water;
 - PH value of liquid: 5.5 - 9;
 - Filter is needed for the cooling system, and the size of the solid residual practicals should be within 100um;
 - Maximum temperature of liquid: 45°C ;
 - Minimum temperature of liquid: greater than the saturated dew-point 5°C ;

- Additive to the liquid: satisfies the requirements of PH value and size of solid residual practicals as above;
- Radius of the bending of the armored pipe: off-work state (i.e. transportation and reservation): minimum radius of bending ≥ 20 cm; in-work state: minimum radius of bending ≥ 30 cm;
- Long-term vibration < 2 G; Impact action < 10 G.

4) Other requirements for chiller:

- When starting the cooling system for the first time, check the entire water system and the joint for water leakage. The external water pipe must be installed and connected according to the inlet (IN) and outlet (OUT) by the laser. Otherwise, the laser may not work properly.
- If you will not use the laser for a long time, water must be emptied from the product, and then both the inlet and outlet must be blocked with the nuts we provide. Failure to do so may lead to permanent equipment damage.

	<p>CAUTION: Please set the water temperature in strictly accordance with the requirements above. Too low temperature may lead to condensation on the laser module and the output cable. This can cause serious damage to the equipment.</p>
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	<p>CAUTION: Make sure that the water temperature reaches the set point and the cooling system is working well before you start the laser.</p> <p style="text-align: center;"> [summer: $29 \pm 0.5^{\circ}\text{C}$ (RFL-C100~RFL-C1000) ; $25 \pm 0.5^{\circ}\text{C}$ (RFL-C1500S/C2000S) ; winter: $25 \pm 0.5^{\circ}\text{C}$] </p>
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3.4 Installation Procedure

- (1) Place the product in an appropriate position, immobilize it if necessary;
- (2) Check if the power supply has the correct voltage (See Table 5 for the laser model and corresponding input voltage), and the earth line is connected, make sure it is firm and reliable;
- (3) Connect the power cable and control cable to the product when power supply is OFF;
- (4) Insert the water pipes into the inlet and outlet;


(5) Check the output head and clean it if necessary. This procedure must be performed by Raycus personnel or person authorized by Raycus. Make sure the environment is clean, or the output cable may be contaminated.


(6) Prevent the delivery cable from treading, pinching or excessive bending during installation;


(7) During the installation and disassembly process, please take care to gently put the laser output head, do not be shocked.

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

(9) The minimum bending radius of the output fiber cable of the laser should not be less than 20 cm under the non-working conditions, and the minimum bending radius should not be less than 30 cm when the laser is working.

	<p>CAUTION:</p> <ul style="list-style-type: none">◆ All the cables can only be connected when power supply is OFF. Hot plug may damage the laser.
---	--

	<p>CAUTION:</p> <ul style="list-style-type: none">◆ The laser output optical cable should be kept as natural as possible and not be distorted.◆ The too small bending radius of the output fiber cable will damage the laser.
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	<p>CAUTION:</p> <ul style="list-style-type: none">◆ Make sure the aperture and the cavity of the processing head is clean;◆ Keep the protective cap properly, prevent it from contamination; Or the aperture will be contaminated when capped.
---	--

4 Using the Product



Raycus CW fiber laser has stopped using the HyperTerminal, so the HyperTerminal will not work when the laser is powered on. Please log in to the official website of Raycus to download the latest PC software and the relevant manual.

<http://www.raycuslaser.com/index.php/index-show-tid-53.html>

4.1 Front Panel

The front panel style of Raycus CW fiber laser is divided into two types according to the laser model, among which RFL-C100~RFL-C1000 laser front panel style is the first type, RFL - C1500S/C2000S laser front panel style is the second type, as shown in the following:

Figure 8 shows the front panel of RFL-C100~RFL-C1000 (take RFL-C750 for example, other models in the series have the same front panel):

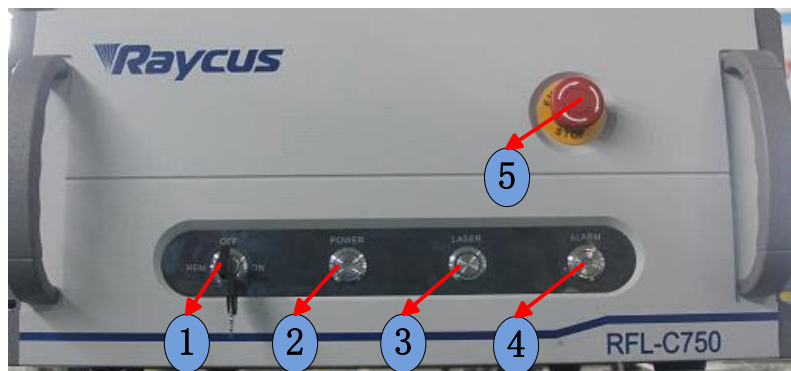


Figure 8 Front Panel View of RFL-C100~RFL-C1000

Figure 9 shows the front panel of RFL-C1500S/C2000S (take RFL-C2000S for example, RFL-C1500S has the same front panel)

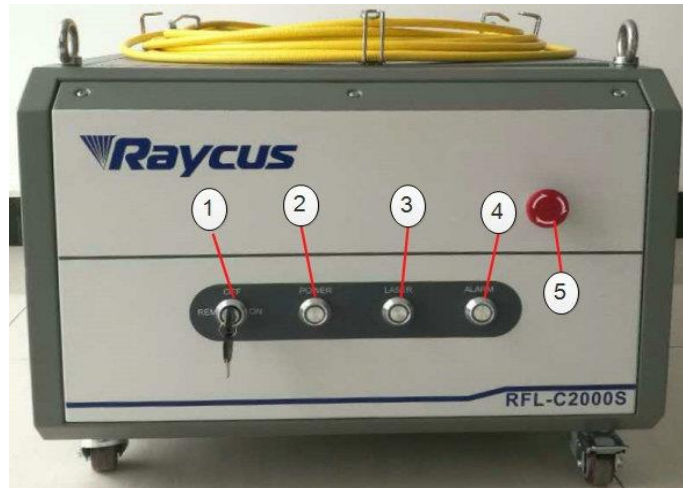


Figure 9 Front Panel View of RFL-C1500S/C2000S

1. **REM/OFF/ON:** Key switch, the power switch of the laser. Insert the key (**Item 6** in Figure 8(9)); either turn the key clockwise to the 'ON' position or counterclockwise to 'REM' position will power on the laser. Then the laser will enter a control mode depending on your previous setup on the 'CTRL-INTERFACE'. You can refer to [4.6 Control Mode](#) for more details.

2. **POWER:** Power Indicator, indicates that the power is switched on, when the green LED illumines.

3. **LASER:** Laser emission button, it's a button with an annular LED indicator (red color). The product is ready to emit laser and the red light turned off, when this button is pressed down. Press again will release the button, and disable the laser emission.

4. **ALARM:** Alarm indicator, indicates a fault condition, when the yellow LED illumines.

5. **EMERGENCY STOP:** Press it down to stop the laser immediately. Turn it clockwise to release, but the laser cannot start before it's powered on with key switch for a second time.

4.2 Rear Panel

The rear panel style of Raycus CW fiber laser is divided into three types according to the laser model, among which RFL-C100~RFL-C750 laser front panel style is the first type, RFL-C1000 laser front panel style is the second type, RFL - C1500S/C2000S laser front panel style is the third type, as shown in the following:

Figure 10 shows the rear panel of RFL-C100~RFL-C750 (take RFL-C750 for example, other models in the series have the same rear panel):

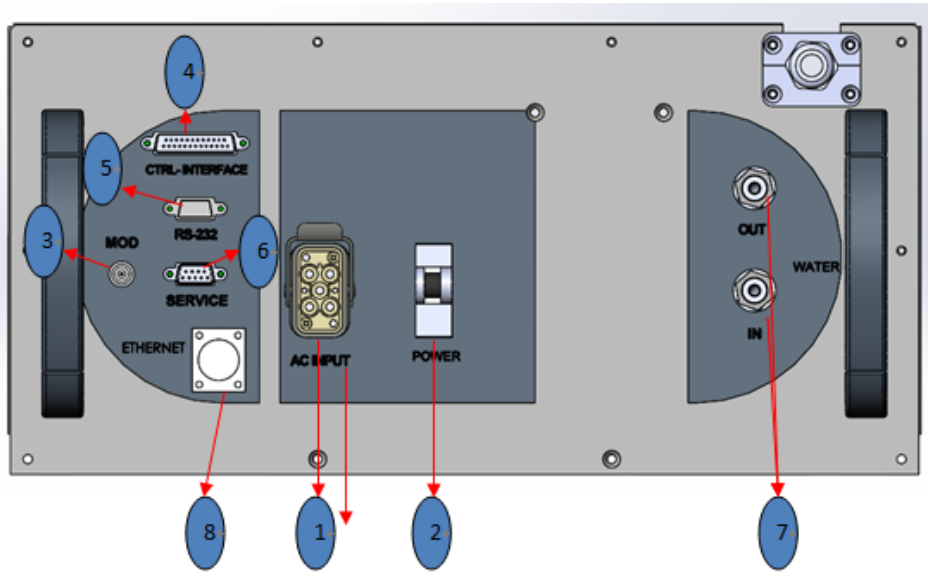


Figure 10 Rear Panel View of RFL-C100~RFL-C750

Figure 11 shows the rear panel of RFL-C1000:

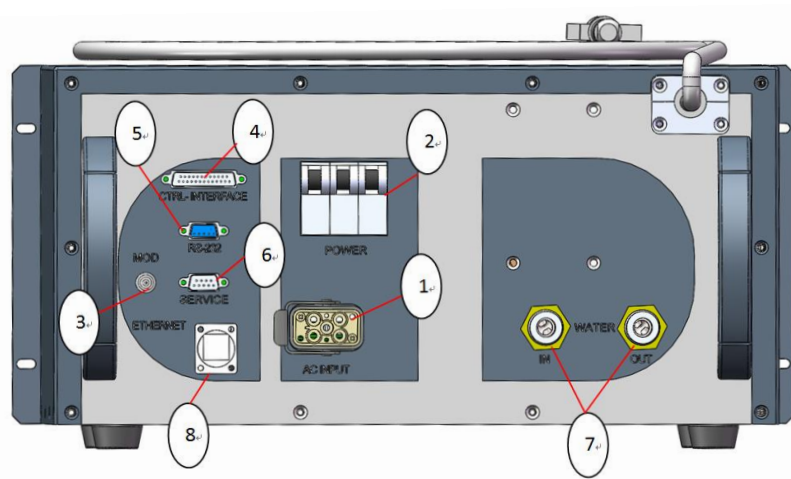


Figure 11: Rear Panel View of RFL-C1000

Figure 12 shows the rear panel of RFL-C1500S/C2000S (take RFL-C2000S for example, RFL-C1500S has the same rear panel):

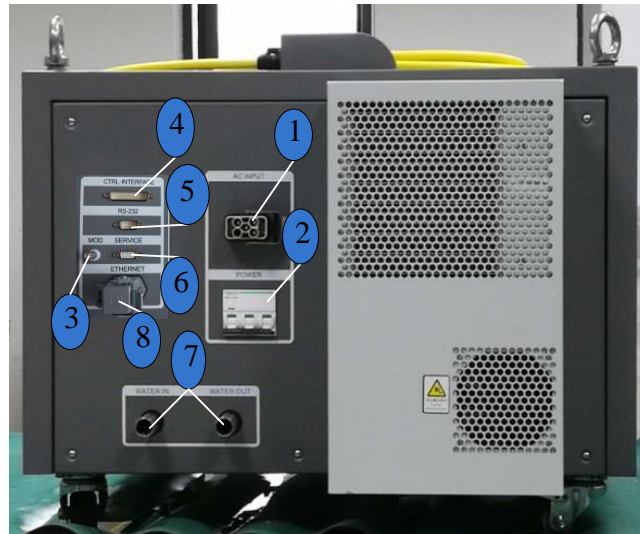


Figure 12 Rear Panel View of RFL-C1500S/C2000S

- 1. AC INPUT:** The socket for supply source input that can only be mated with the plug on the power cord we provided.
- 2. POWER:** Air switch to control the switching of AC.
- 3. MOD:** Modulation input, a signal for switching the laser on and off in remote control modes. The control signal should be able to apply current over 20mA, and the voltage should be 24V.
- 4. CTRL-INTERFACE:** Control interface, this interface is a male DB25 connector and it's multi-functional. The end users can set the control mode and input analog control signal with the interface, as well as get the fault signal from it.
- 5. RS-232:** RS-232 serial port, Provide remote control and alarm information storage for the laser. Raycus provides a matching RS-232 serial communication cable.
- 6. SERVICE:** Provide external functions of the customer. For details, please refer to [4.4 Interface and Definition](#).
- 7. WATER:** Pipe connectors, the inlet and outlet for cooling water to flow in and return. (See Table 6 for the laser model and corresponding water pipe size for cooling system requirements).

8. **ETHERNET:** Ethernet interface. Provide remote control and alarm information storage for the laser.

4.3 Power Connection

	<p>CAUTION: Before connecting the product to AC supply source, you must check up that the AC supply you will apply is in accordance with the specifications provided in Table 3 or Table 5.</p>
--	--

Table 7 Power Connection Requirements

Model	RFL-C100~RFL-C750	RFL-C1000~RFL-C2000S
Supply Source	220±10% V AC 50/60Hz	380±10% V AC 50/60Hz
Power Cord		
One End of Power Cord	Three wires labeled L, N and PE.	Four wires labeled L1, L2, L3 and PE.
Sign Description	L -> Phase Line N -> Neutral PE -> Protective Earth	L1, L2, L3 -> Phase Line PE -> Protective Earth
Note	One end of the power cord is a plug, insert it into the socket 'AC INPUT' on the rear panel. Notice that the plug is wrong-side preventing. After inserting it, lock it with the lever.	

4.4 Interface Definitions

4.4.1 SERIVCE Security interface

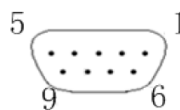


Figure 13 SERIVCE Security interface


Each pin is defined as shown in Table 8 below.

Table 8 SERVICE definition

PIN	Name	Function	Voltage	min	max
1	PowerA	Remote switch (key), passive contact, can't be connected to external voltage or ground	24V		1A
2	PowerB				
6	InterLock+	Passive contact, can't be connected to external voltage or ground. Short the pin 6 and 7 before emission laser	5V		20mA
7	InterLock-				

Other pins are empty.

- The SERVICE connector is a female DB9 interface. If PIN 6-7 are disconnected, the laser will immediately stop working, and the laser Ready signal will go low.
- The laser has pre-shortened the 6 and 7 pins before shipment. If it is not connected, the InterLock error will be displayed after the laser is powered on.

	<p>CAUTION: The interlock cannot be connected to active signal, or error will be caused, or even the product may be damaged.</p>
---	---

4.4.2 Modulation Input

The 24V modulation signal should be applied to the connector as in Figure 14. A cable is provided for the connector, which is shown in Figure 15. The MOD modulation signal description is shown in Table 9, and the internal circuit of the modulation signal is as shown in Figure 16.

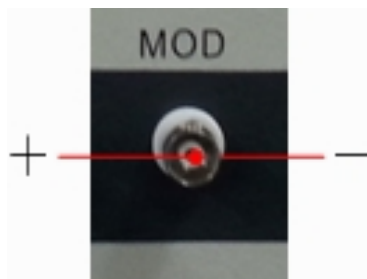


Figure 14 Modulation Input

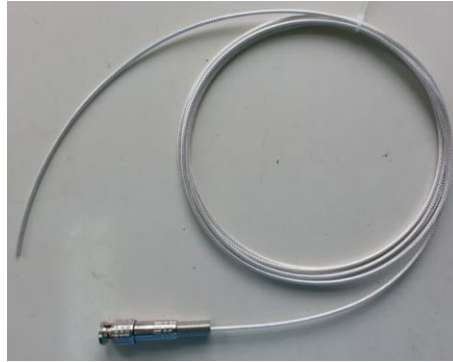


Figure 15 MOD Cable-The Cable for Modulation Signal

	<p>The modulation signal cable core is positive (24V) and the external metal mesh is negative (GND). Before the modulated signal is connected to the laser, please check the level.。</p>
--	--

Table 9 MOD definition

Name	OUT/IN	Function	Level	Example	min	max
MOD	Input	External signal	24V	24V	15V	28V
				0V	0V	3V

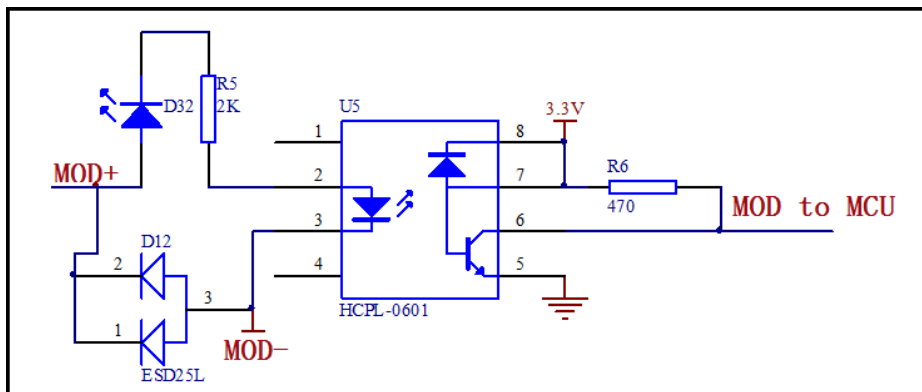


Figure 16 The internal circuit of the modulation signal

4.4.3 Control Interface

The pin number of ‘CTRL-INTERFACE’ is shown in Figure 17:

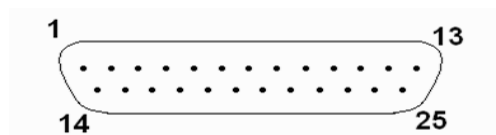


Figure 17 Pin Number of control Interface

The definitions of the control interface are as follows:

Table 10 Control Interface Definitions

PIN	Name	In/Out	Function	Typical Voltage	Min	Max	Current	Response Time	
6	LASER EN	Input	Enable signal	Enable	24V	15V	28V	<8mA	100ms
				Disable	0V	0V	3V		
7	ADEN	Output	External AD model enable	Enable	24V	15V	28V	<8mA	100ms
				Disable	0V	0V	3V		
8	Laser Ready	Output	Ready signal	Ready	24V			<100mA	100ms
				Not Ready	0V				
9	EXGND		Reference GND of pin 6,7,8,20,24						
20	EXVCC		24V (power for PIN8 and PIN24)	24V	20V	28V	<500mA		
22	Analog	Input	Analog Voltage Signal		0V	10V	<10mA	200us	
23	Laser Power	Output	Power indication		0V	5V	<20mA	20us	
24	Alarm	Output	Error Signal	Error	24V			<100mA	100ms
				Normal	0V				
25	AGND		GND of PIN20、PIN23						
other	NC		None						

CAUTION:

- ◆ Please check the control voltage level and ensure that the level is in accordance with the requirements. Over voltage and voltage ripple may damage the product.
- ◆ Make sure that the analog voltage signal does not exceed 10V, otherwise the product may be damaged.

1) PIN6 and PIN7 internal circuit

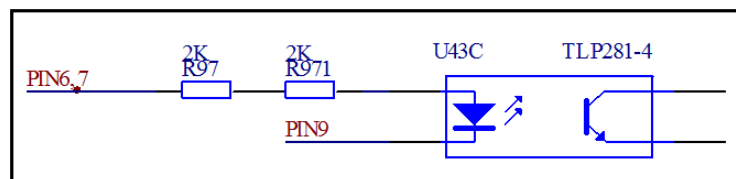


Figure 18 PIN6、PIN7internal circuit

2) PIN8 and PIN24 internal circuit

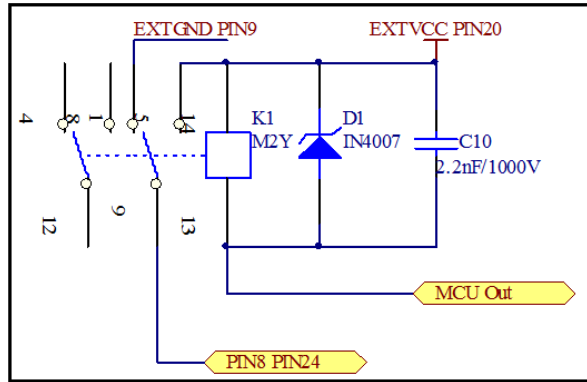


Figure 19 PIN8 and PIN24 internal circuit

3) PIN22 internal circuit

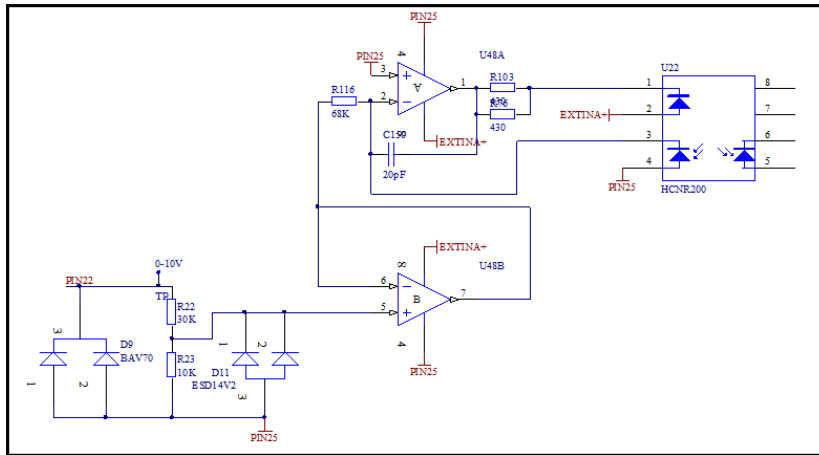


Figure 20 PIN22 internal circuit

4) PIN23 internal circuit

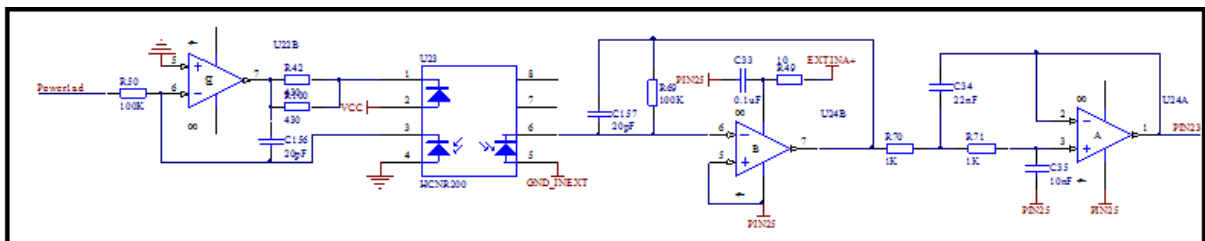


Figure 21 PIN32 internal circuit

4.4.4 RS-232 Serial Port

Figure 22 shows the pin number of RS-232 serial port.

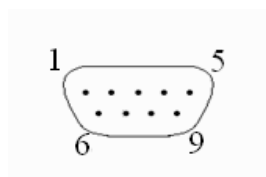


Figure 22 Pin Number of RS-232 Serial Port

And the definitions of the pins are in the following table:

Table 11 RS-232 Serial Port Definitions

PIN	DESCRIPTION
2	RX
3	TX
5	GND
Others	NONE

A three-lines (RxD, TxD, GND) interface is used. For detail commands and description please see the introduction of PC software or ask Raycus to get the Communication protocol.

The specific parameters of the RS-232 control interface are set as follows:

Table 12 RS-232 Interface parameters

PARAMETER	Values
baud rate:	9,600
Data bit:	8
Stop bit:	1
polarity:	NC
flow control:	NC

Figure 23 shows the RS-232 serial cable.



Figure 23 RS-232 Cable

4.4.5 TCP/IP Interface Configuration

The default IP address of this product is 192.168.0.10, only supports UDP communication. The laser listens for connection on port is 8098, and the command must be sent in a single data string.

Table 13 The pins definition of Ethernet interface

PIN	FUNCTION	DESCRIPTION
1	TX+	TRANSMIT+
2	TX-	TRANSMIT-
3	RX+	RECEIVE+
4	N/C	NONE
5	N/C	NONE
6	RX-	RECEIVE-
7	N/C	NONE
8	N/C	NONE

For better communication stability, recommend to use this interface first.

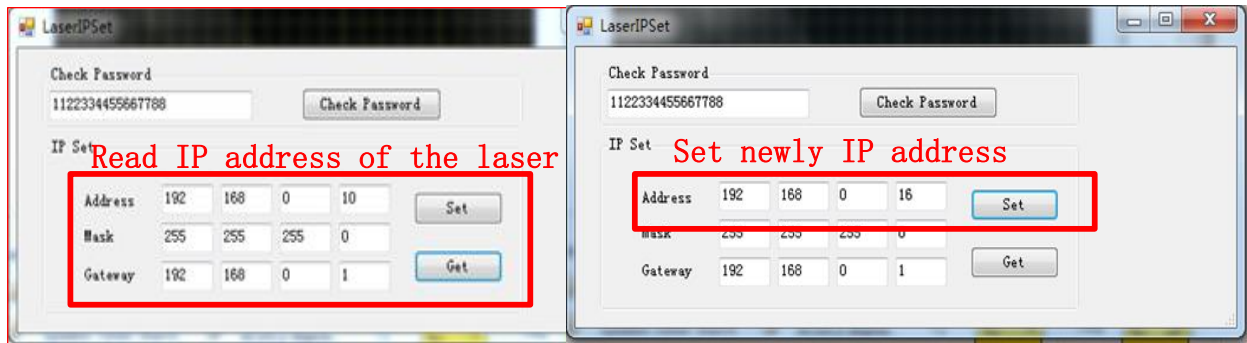
The steps of Ethernet connection:

Step 1: Open the Raycus PC software, click "Session→RS232 (or Ethernet)" to make the PC communicate with the laser, and then click "Tool→Laser IP Set" to enter the laser IP address setting;

Step 2: The default password is "1122334455667788". After the verification is passed, read or set the new laser IP address.

Step 3: If you use the Raycus PC software to control the laser, you need to find the folder where the PC software is located, open the laser configuration file "config.xml", and write the newly laser IP address. If you do not use Raycus software, please go to the step 4;

Step 4: Configure TCP/IP, select "Use the following IP address:", manually assign an IP address, and the IP address of the PC must be in the same network segment as the laser IP address, and assign a subnet mask address. The default is 255.255.255.0, click the "OK" button to confirm the settings and exit.



If you do not use Raycus software, please go to the step 4

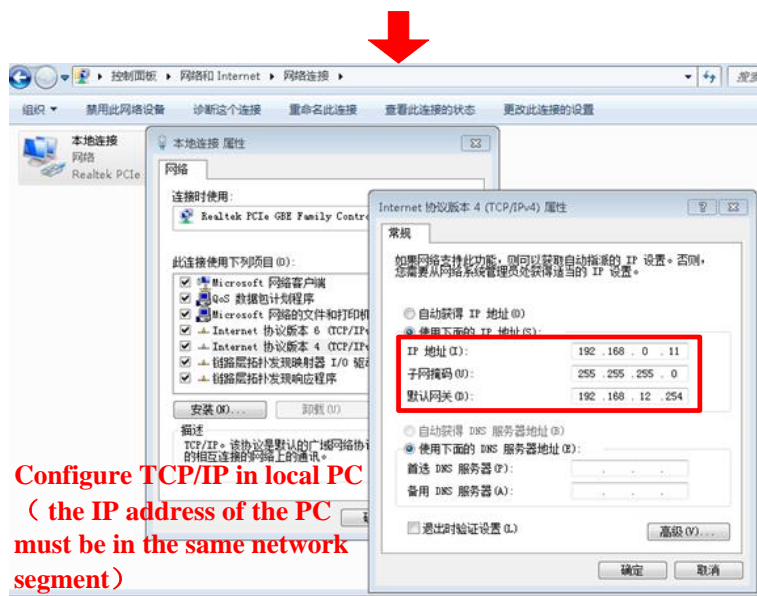
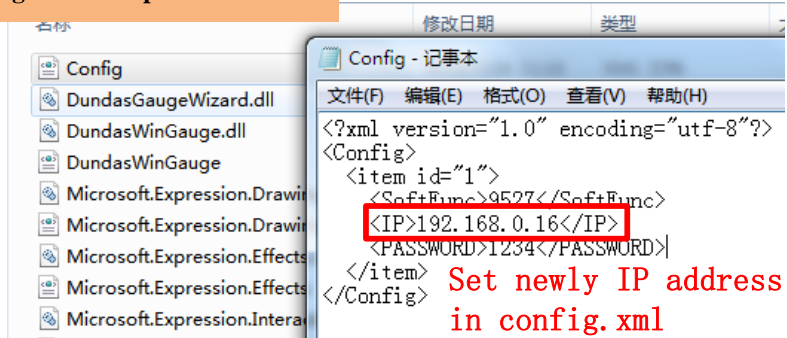


Figure 24 The Steps of Ethernet Connection

4.5 Steps Of Installation

- 1) Carefully remove the laser from the box, move to the installing position, and lock the casters;
- 2) Remove the output cable protective cap and check the output lens for dust with strong light and clean it if necessary, then cover the output cable protective cap;

3) Install the output cable on the processing equipment according to the actual situation (install the output head cooling water pipe at the same time), pay attention to the output cable and head, then remove the protective cap and confirm that the output lens is clean and install the output head.;

4) Connect cooling water pipe;

5) Connect the control line and power according to the control mode.

4.6 Steps Of Starting

Make sure the air switch is OFF and the emergency stop button (EMERGENCE STOP) on the front panel of the laser has been pressed down. All electrical connections must be finished before the laser is powered up;

1) Make sure that the pins 6 and 7 of DB9 SERVICE interface are closed;

2) Turn on the chiller and check leakage. If there is no water leakage, turn off the chiller and wait for the laser to turn on.

3) Turn on the air switch and release the emergency stop switch.

Note: RFL-C1500S/2000S has an air conditioner and it starts to run as the emergency stop switch is released. In order to avoid damage the laser caused by condensation when the working temperature and relative humidity of the laser are in the dew point area [*the blue area in Table 4*], for RFL-C1500S/2000S please wait for the air conditioner to run for 30 minutes before operate the laser later ,and for RFL-C100~ RFL-C1000 please improve the working environment.

4) Let the chiller work;

Turn on the key switch and start the laser.

4.7 Control Modes

4.7.1 Wiring in different modes

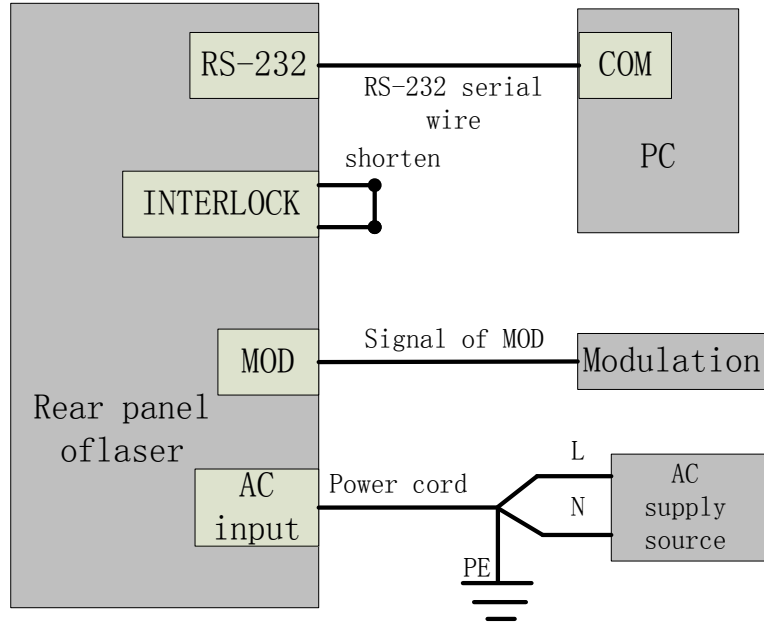


Figure 25 Wiring in RS-232 mode

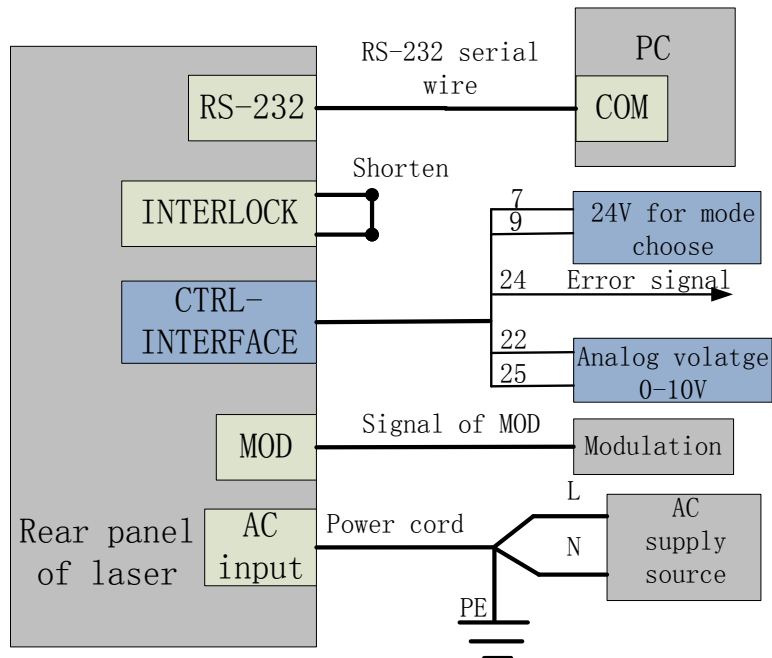


Figure 26 Wiring in AD mode

4.7.2 Internal control mode

5) Turn the key switch to the “ON” position and the “Power” indicator on the front panel light on;

6) Waiting for 10s until the internal main control board circuit initialization is completed;

7) Set the power of the laser (the power is set by 0-10V analog single when the AD mode is enabled, and the power is set by the PC software when the AD mode is disabled.) ;

8) Press the “Laser” button (enable hardware emission)on the front panel;

9) Send the start or stop emitting command to control the emission via RS-232.

See 4.8 to get the process of laser shutting down.

4.7.3 External control mode

Modulation Mode: When the duty cycle of the internal pulse is set to 100%, the laser operates in external modulation mode. The laser is controlled by the user's "modulation" signal provided by the external MOD interface. For the time sequence diagram, see [4.7.5 Control sequence diagram]

Gate Mode: When the duty cycle of the internal pulse is less than 100%, the laser operates in Gate mode. The laser is controlled by the MOD signal and internal frequency. MOD signal is used to start and stop internal pulse signal. For the time sequence diagram, see [4.7.5 Control sequence diagram]

The laser operates on external modulation mode by default.

5) Turn the key switch to the “REM” position (or turn the key switch to OFF, short the SERVICE interface PIN 1, 2) and the “Power” indicator on the front panel light on;

6) Wait for 10s until the internal main control board circuit initialization is completed.

7) Set the power of the laser (the power is set by 0-10V analog single when the AD mode is enabled, and the power is set by the PC software when the AD mode is off.) ;

8) Give the emission enable signal in one of the following ways:

- Press the “Laser” button (enable hardware emission) on the front panel;

- PIN 7-9 of the DB25 control interface is applied to 24V (enable hardware emission);
- Send the start or stop emitting command (enable hardware emission) to control the emission by the PC software;

9) The laser is controlled by the user's "modulation" signal provided by the external MOD interface

See 4.8 to get the process of laser shutting down.

4.7.4 AD mode

When PIN 7-9 of the DB25 control interface is applied to 24V, the laser enters the external AD mode, and the power of the laser is controlled by the voltage obtained by PIN 22-25 of the DB25 interface connector (1V-10% power, 10V-100% power).

When PIN 7-9 of the DB25 control interface is applied to 0V or left floating, the power of the laser is set by serial port or Ethernet.

4.7.5 Control sequence diagram

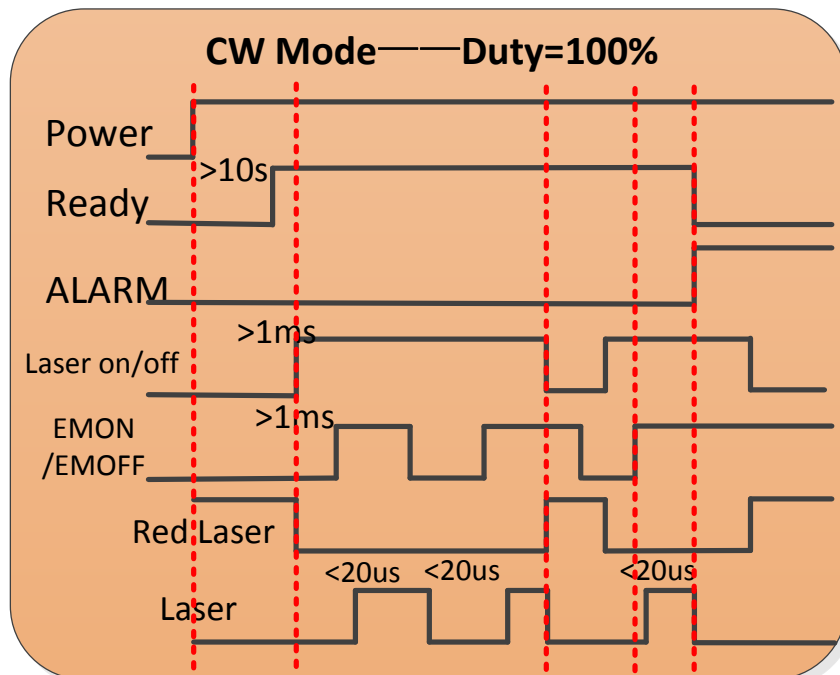


Figure 27 Control sequence diagram of CW mode

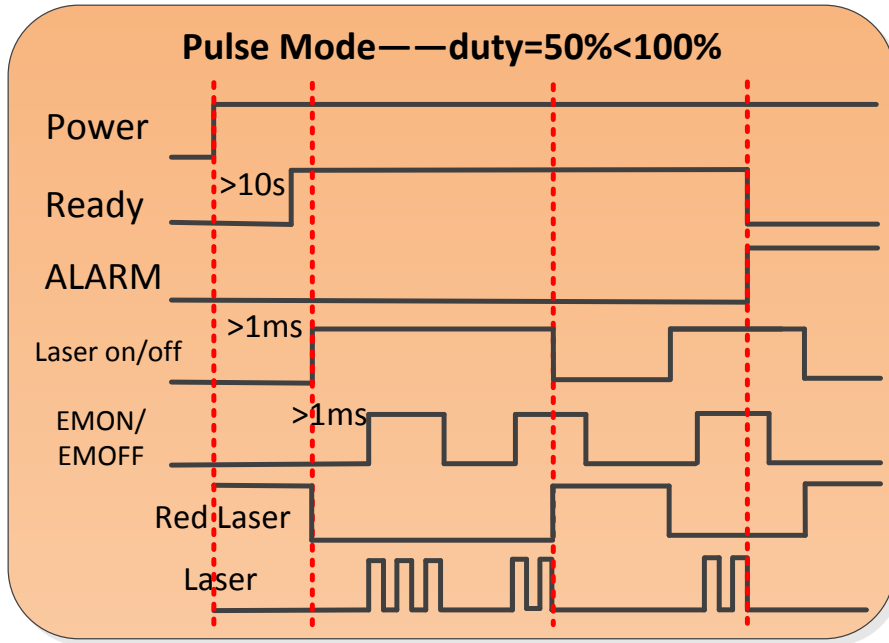


Figure 28 Control sequence diagram of Pulse mode

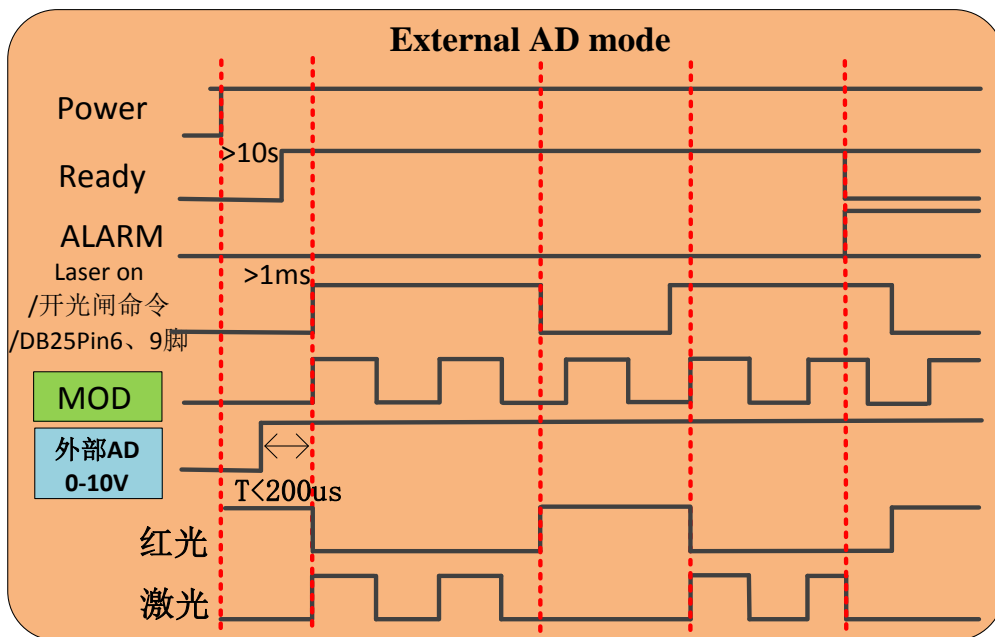


Figure 29 Control sequence diagram of External AD mode

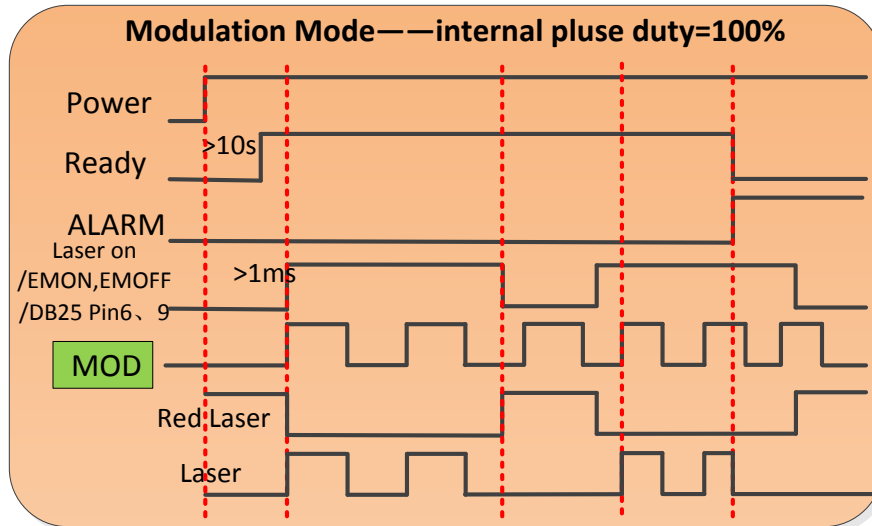


Figure 30 Control sequence diagram of Modulation mode

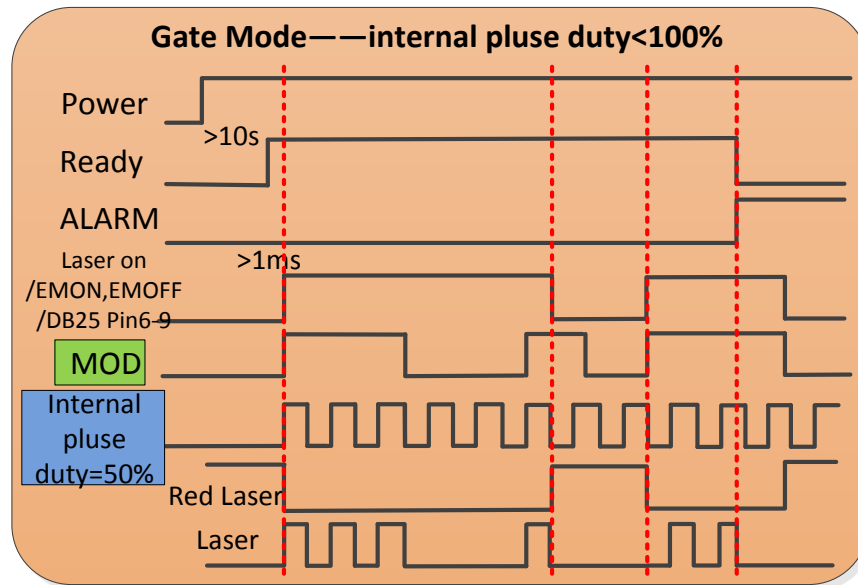


Figure 31 Control sequence diagram of Gate mode

4.7.6 Red light to control

Turn the key switch to the "REM" or "ON" position and power up the laser, "POWER" green indicator light is on and the red guide light is output. The red guide light is off when "LASER" button in front panel is pressed or command "EMON" is sent via RS-232, while the red light is on when "LASER" is released or command "EMOFF" is sent via RS-232.



CAUTION: The red light and the laser emission cannot be output at the same time. If there is no red light output, please check if the "LASER" button is released and command "EMOFF" is sent.

4.8 Steps of shutting down

Please turn off the laser in the order below:

- 1) Turn off the emission;
- 2) Turn the key switch to the "OFF" position and release "LASER" button;
- 3) Turn off the chiller;
- 4) If the product have air conditioner please waiting 10 minutes for the air conditioner to continue working. If the laser does not have air conditioner, please ignore this step;
- 5) Disconnect the air switch;
- 6) Cover the output head protection cap;

5 Alarms and Solutions

5.1 Alarms Display

When the laser establishes communication with the client software, all alarm states of the laser can be displayed on the client software homepage, as shown in Figure 32(Download the PC software and software manual, please log in to Raycus official website)

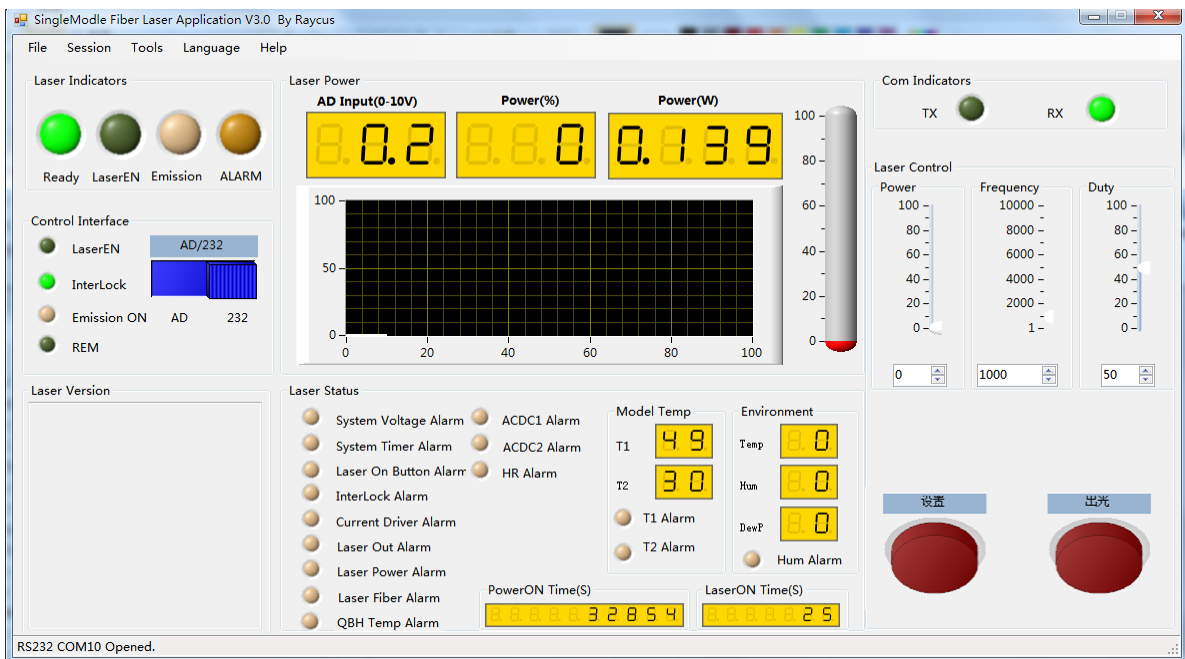


Figure 32 The homepage of PC software

If any alarm occurs (except for Interlock alarm) when the laser is running, the homepage will display the alarm that occurs, and the ALARM light (yellow) on the front panel of the laser will light up, the laser will stop emitting and lock.

When the Interlock is abnormal, the output of Ready signal is low, and the Interlock state is abnormal in the software homepage, but the laser is not locked, and the ALARM light (yellow) is not lit. The output of Ready signal is on high level when the Interlock is normal.

5.2 Alarm solutions

The instructions and solutions of alarms are as follows:

Table 14 Instructions and solutions for alarms of laser

Alarm name	Alarm instructions and solutions
System Timer Alarm	<p>Instruction: The internal clock of laser is abnormal.</p> <p>Solution: If it displays this alarm, please contact Raycus.</p>
Laser On Button Alarm	<p>Instruction: This alarm occurs when the “LASER” button on the front panel of the laser has been pressed before the laser was powered on.</p> <p>Solution: Please power off the laser and pop up the ”LASER” button. Re-power the laser and check if the alarm is released. If this alarm continues to occur, please contact Raycus.</p>
InterLock Alarm	<p>Instruction: Occurs when the InterLock is disconnected.</p> <p>Solution: Short the InterLock pins and restart the laser to try. If this error continues to occur, please contact Raycus.</p>
Current Driver Alarm	<p>Instruction: Current Driver Alarm, this error occurs when the constant current driver board inside the laser is abnormal.</p> <p>Solution: Restart the laser, If this error continues to occur, please contact Raycus</p>
Laser Out Alarm	<p>Instruction: 1. Laser Out Alarm immediately occurs when the laser is powered.</p> <p>Solution: The laser will autolock after two times of this error occurs successive, please contact Raycus</p> <p>2. The laser will get this error when it does not emit with correct settings.</p> <p>Solution: Close the shutter and pop up the “LASER” button on the front panel of the laser to check if the red guide light is output normally when it isn’t emitting. If there is no red guide light, please stop using the laser immediately and contact Raycus. If the red guide light output normally, please restart the laser to try, if the alarm continues to occur, please contact Raycus.</p>
Laser Power Alarm	<p>Instruction: The alarm is generated when the emission of the laser cannot reach the set value. Power error occurs only when the laser is emitting.</p>

	<p>Solution: Restart the laser, if this error continues to occur, please contact Raycus.</p>
ACDC1 Alarm	<p>Instruction: ACDC1 Error, failure of the laser power supply or sudden power failure of the power supply system may cause an alarm.</p> <p>Solution: Check if the input AC voltage is normal. Restart the laser, if this error continues to occur, please contact Raycus.</p>
ACDC2 Alarm	<p>Instruction: ACDC1 Error, Over current or overvoltage inside the laser may generate this error.</p> <p>Solution: Check if the input AC voltage is normal. Restart the laser, if this error continues to occur, please contact Raycus.</p>
T1/T2 Alarm	<p>Instruction: Low temperature/high temperature alarm of the laser. The sensor in the laser detects an abnormal temperature inside the laser. A high-temperature / low-temperature error occurs when the temperature at the monitoring point exceeds the set upper / lower limit.</p> <p>Solution: High temperature alarm, please check if the water-cooling system is normally working, the water temperature is set correctly, and the water connection is correct. When the water cooling system works normally and the water temperature drops below 30 °C, restart the laser. If the alarm continues, please contact Raycus.</p> <p>Low temperature alarm, please check if the actual water temperature of the water is too low. In addition, a low ambient temperature may also cause a low temperature alarm when the laser is cold. Please wait until the water temperature of the water rises above 10 °C. If the alarm continues, please contact Raycus.</p>
Hum Alarm	<p>Instruction: The Hum Alarm of the laser, the internal temperature of the laser detects that the current water-cooled plate temperature is lower than the internal dew point temperature, and there is a risk of condensation.</p> <p>Solution: Immediately stop using the laser. For RFL-C100~RFL-C1000, please improve the working environment and after the ambient temperature is lower than internal temperature of the laser, restart the laser (advice to configure alone Air-conditioned room for the laser). For RFL-C100~RFL-C1000, please wait</p>

	for the air conditioner to run for 30 minutes before restart the laser. If the alarm continues to occur, please contact Raycus.
--	---

In addition to the above, if there are any questions or errors in using of the laser, you can contact Raycus to get help.

6 Warranty, Return and Maintenance


6.1 General Warranty

Raycus warrants that all Raycus fiber laser products are conformed to applicable product specifications under normal use and are free from defects in materials and workmanship. The warranties start on the date of shipment from Raycus for a period of time as set forth in the applicable purchase contracts or product specifications. Raycus has the right to choose to repair or replace any product that proves to be defective in materials and workmanship selectively during the warranty period. Only products with particular defects are under warranty. Raycus reserves the right to issue a credit note for any defective products produced in normal conditions.

6.2 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 caused by those who are not from Raycus due to excessive use or not following the instructions. Customer has the responsibility to understand and follow this instruction to use the device. Any damage caused by fault operating is not warranted. Accessories and fiber connectors are excluded from this warranty.

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

	<p>WARNING: It is the customer's responsibility to understand and follow operating instructions in this User Guide and specifications prior to operation-failure to do so may void this warranty. Accessories and fiber connectors are not covered by this warranty.</p>
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6.3 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.
- 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, please notify the carrier in document immediately.

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

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

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