

Multi-Mode Continuous Wave Fiber Laser User Guide RFL-C2200

TABLE OF CONTENTS

1 Safety Information.....	1
1.1 Symbols Used in this User Guide.....	1
1.2 Laser Classification.....	1
1.3 Optical Safety.....	2
1.4 Electrical Safety.....	2
1.5 Other Safety Rules.....	3
2 Product Description.....	4
2.1 Features.....	4
2.2 Package Contents.....	4
2.3 Unpacking and Inspection.....	4
2.4 Operation Environment.....	5
2.5 Announcements.....	6
2.6 Specifications.....	1
3 Installation.....	1
3.1 Dimensions.....	1
3.2 Installation Procedures.....	1
3.3 Cooling Requirements.....	1
4 Using the Product.....	1
4.1 Front Panel.....	1
4.2 Rear Panel.....	2
4.3 Power Connection.....	4
4.4 Control Wire Definitions.....	5
4.5 Control Modes.....	8
4.6 Entering a Control Mode.....	9
4.7 Hyper Terminal Mode.....	10
4.8 RS-232 Mode.....	18
4.9 AD Mode.....	21
5 Warranty, Return and Maintenance.....	24
5.1 General Warranty.....	24
5.2 Limitations of Warranty.....	24
5.3 Service and Repair.....	25

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

	WARNING: Refers to a potential personal hazard.
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	CAUTION: Refers to a potential product hazard.
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1.2 Laser Classification

This model 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 2200 W. Direct or indirect exposure to this level of light intensity may cause damage to the eye or skin. Despite the radiation being invisible, the beam may cause irreversible damage to the retina and/or cornea. Appropriate and approved laser safety goggles must be worn all the time while the laser is operational.

	<p>WARNING: You must use appropriate laser safety goggles when operating this device. The laser safety goggle is selected according to the range of wavelengths emitted from this product. The end user must ensure that the laser safety goggles used protects against light emitted by the device over its entire range of wavelengths: 900nm~1100nm. Please verify that the personal protective equipment (e.g. enclosures, viewing windows or view-ports, goggles, etc.) being utilized is adequate for the output power and wavelength range.</p>
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1.3 Optical Safety

Any dust on the end of the QBH optical cable 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>
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1.4 Electrical Safety

- (1) Make sure the 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 can result in personal injury.</p>
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- (2) Make sure that the correct voltage of the AC power source is used.

	<p>CAUTION: Failure to use the correct voltage could damage the product.</p>
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- (3) There are no operator serviceable parts inside. To prevent electrical shock, do not try to remove covers. Any tampering with the product will void the warranty.

1.5 Other Safety Rules

- (1) Never look into the laser output head 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) Do not remove the covers of the laser, or the warranty will be voided. All maintenance must be performed in Raycus or by qualified Raycus personnel.

Product Description

1.6 Features

Raycus CW fiber laser is designed for industrial and scientific research applications with high pump conversion efficiency, low power consumption and excellent beam quality. It is compact and ready to use. It can be used as a stand-alone unit or easily integrated into user's machines.

Main Features:

- High beam quality
- Fiber delivery
- Reliable, long lifetime
- High wall-plug efficiency
- Compatible control interface

Applications:

- Cutting
- Welding
- Scientific research

1.7 Package Contents

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

1.8 Unpacking and Inspection

Your Raycus CW fiber laser is shipped in a package designed to provide maximum protection. Upon delivery, please inspect all packages 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 taking the unit out of the packing case to ensure that the fiber optic cable is not snagged and damaged. A comprehensive packing list is sent with the laser. 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 evidence 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 are precise optic instrument, any vibration, twist or excessive bend will damage the instrument.</p>
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1.9 Operation Environment

The operation voltage for the product: 380VAC \pm 10%, 50/60Hz, three phase with neutral line.

Warning:

- (1) Make sure the instrument is properly grounded before you use it.
- (2) There are no user serviceable parts, equipment or assemblies inside the product. All service and maintenance shall be performed by qualified Raycus personnel. In order to prevent electric shock, please do not break the seal or uncover the cap. Failure to comply with this instruction will void the warranty.
- (3) The output terminal of the laser is connected to an optic delivery cable. Please inspect the output head carefully for dust or other contamination. Use appropriate lens paper to clean it if necessary.
- (4) Failure to follow the instructions may cause malfunction and damage to the device.
- (5) It is not allowed to install the output head when the laser is in operation.

- (6) Do not look into the output head directly. Wear appropriate safety goggles all the time when operating the laser.

1.10 Announcements

Please make sure that the correct voltage of AC power source is used. Failure to connect power source correctly will damage the device. Use of controls or adjustments other than those specified herein may result in hazardous radiation and damage to the laser. It is critical to keep the lens clean. Please cap the output terminal when it is not in use. Do not touch the output lens. If necessary, you can use appropriate lens paper and alcohol to clean the lens. Failure to follow the specified instructions may result in the loss of laser power. Such loss is not covered under warranty.

1.11 Specifications

The specifications are listed in the following table.

Table 1: Product Specifications

Model	RFL-C2200	
Optical Characteristics		Test Conditions
Nominal Output Power(W)	2200	
Operation Mode	CW/Modulated	
Polarization State	Random	
Output Power Tunability (%)	10~100	
Emission Wavelength(nm)	1080±10	Nominal Output Power
Output Power Instability	≤5%	Nominal Output Power; Time Interval: 5hrs; Ambient Temp.: 25°C
Modulation Frequency(Hz)	50~5k	Nominal Output Power
Red Guide Laser Power (mW)	0.5~1	
Output Terminal	QBH	
Beam Quality (BPP, mm•mrad)	≤5	Nominal Output Power
Fiber Core Diameter(μm)	100	
Delivery Cable Length(m)	15	
Min. Fiber Cable Bend Radius(mm)	300	
Electrical Characteristics		
Power Supply	AC 380V±10%, 50/60Hz, Three Phase with Neutral Line	
Max. Power Consumption(kW)	8.8	
Control Mode	Hyper Terminal/RS-232/AD	
Other Characteristics		
Dimensions(W×D×H)	650×900×980	
Weight(kg)	<150	With the air conditioner
Operating Ambient Temperature(°C)	10~40	
Humidity (%)	<70	
Storage Temperature(°C)	-10~60	
Cooling Method	Water	

2 Installation

2.1 Dimensions

Figure 1 shows dimensions of the product.

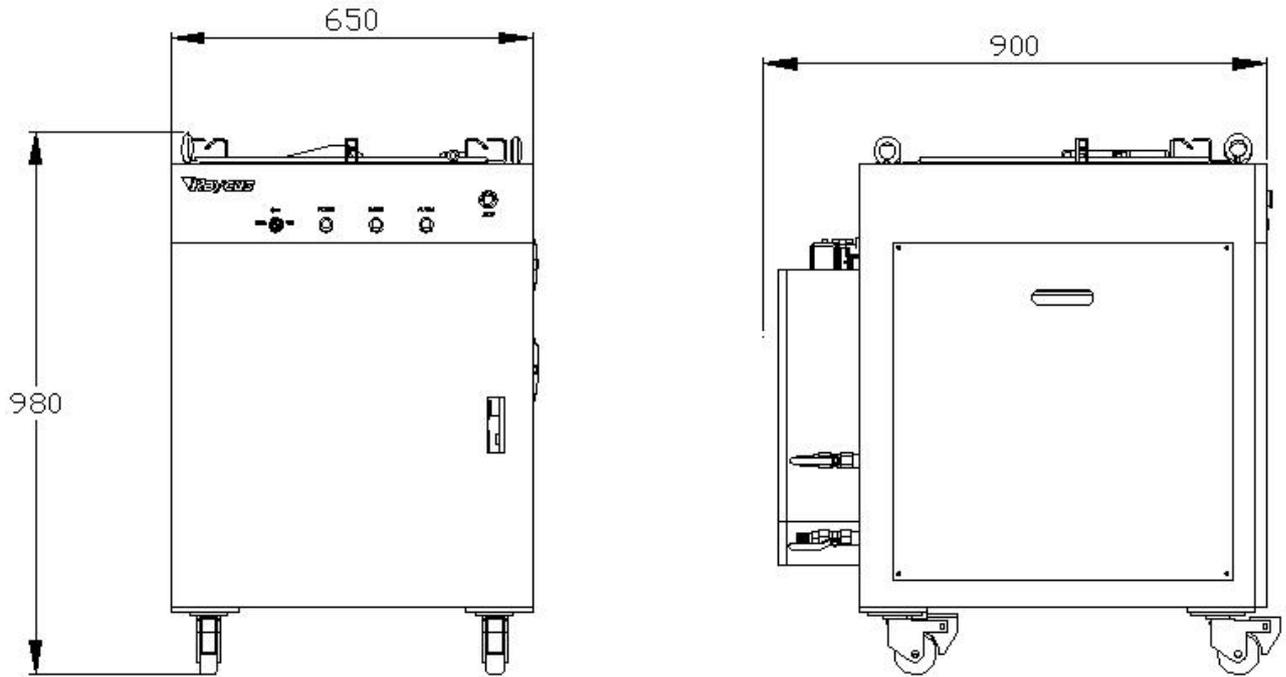


Figure 1: Dimensions of the Laser (unit: mm)

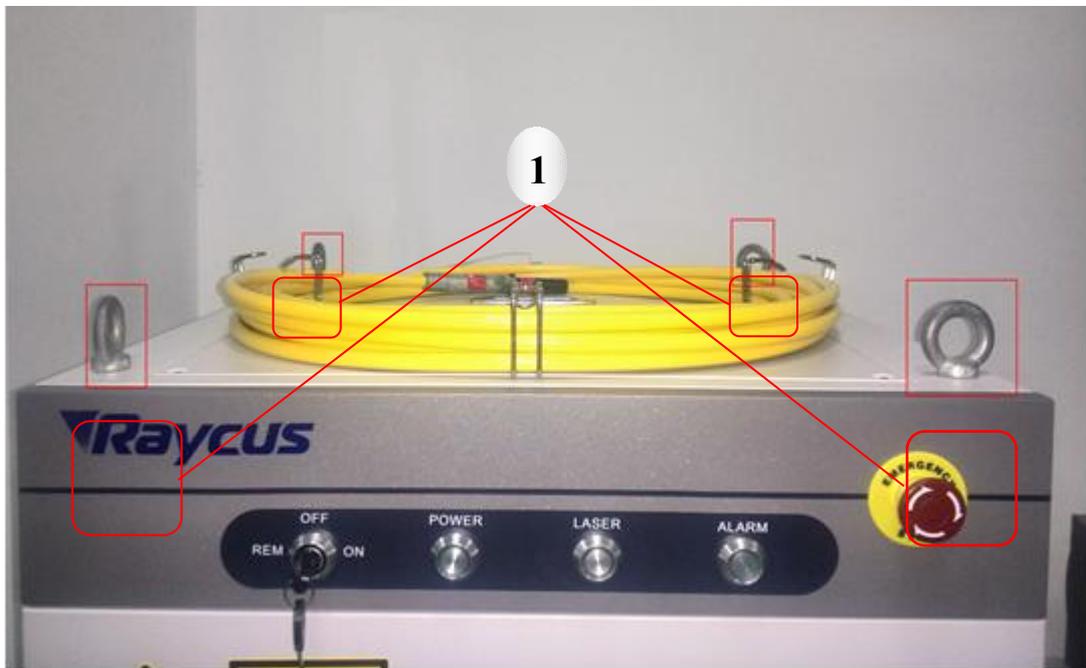
Note: The two interlock pins on the output terminal must be shorted before the laser is turned on. Usually there are shorted contacts in the processing head, please check the head to ensure that.

2.2 Installation Procedures

- (1) Check if the power supply has the correct voltage ($380\text{VAC}\pm 10\%$, 50/60Hz), and the earth line is connected reliably.
- (2) Place the laser firmly on the desirable position.
- (3) Fix the casters at the bottom side of the laser.

- (4) Check the output head and clean it if necessary. This procedure must be performed by Raycus personnel or person authorized by Raycus.
- (5) Connect the power cable and control cable to the Fiber Laser when power supply is OFF.
- (6) Insert the water tube into the inlet and outlet.
- (7) The optic fiber cable must not be bent with the radius less than 30 cm during transportation, storage and when in use.

There are four swinging rings on the top of the product and four casters on the bottom, with which you can lift or move the product. The rings and casters are shown in Figure 2.



1. Swinging rings



2. Casters

Figure 2: The Swinging Rings and Casters

	<p>CAUTION: All the cables can only be connected when power supply is off. Hot plug may damage the laser.</p>
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	<p>CAUTION: Ensure that there are no fiber bends with radius less than 30 cm. Avoid excessive twisting and tight bends during the robotic arm movements. Tight bends will damage the laser system.</p>
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2.3 Cooling Requirements

Table 2: Cooling Requirements

Parameter	Unit	Value
Cooling Capability	kW	≥ 7
Minimum Flow	L/min	25
Maximum Inlet Pressure	Bar	7
Pipe Inner Diameter	mm	16

Water temperature setting:

Summer (ambient temperature higher than 30°C): $29 \pm 0.5^\circ\text{C}$;

Winter (ambient temperature lower than 30°C): $25 \pm 0.5^\circ\text{C}$.

Purified water should be used. In order to prevent mildew growing, we recommend to add alcohol about 10% of total volume. The cooling system should equip with filter. Check and clean the filter every six months.

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 , you must use chiller with both heating and cooling functions, and keep it in full-time operation.

When connecting to the laser for the first time, ensure that the flow and return connections are correct.

If you will not use the laser for a long time, water should be emptied from the laser, and then block inlet and outlet. Failure to do so may lead to permanent equipment damage.



CAUTION: Please set the water temperature in strict accordance with the requirements above. Too low temperature may lead to condensation in the Laser module and the output head. This can cause serious damage to the equipment.



CAUTION: The cooling system should be turned on 1 min earlier before the laser is turned on. Check any water leakage and make sure that the water temperature reach the set point before you start the laser.

3 Using the Product

3.1 Front Panel

Figure 3 shows the front panel.

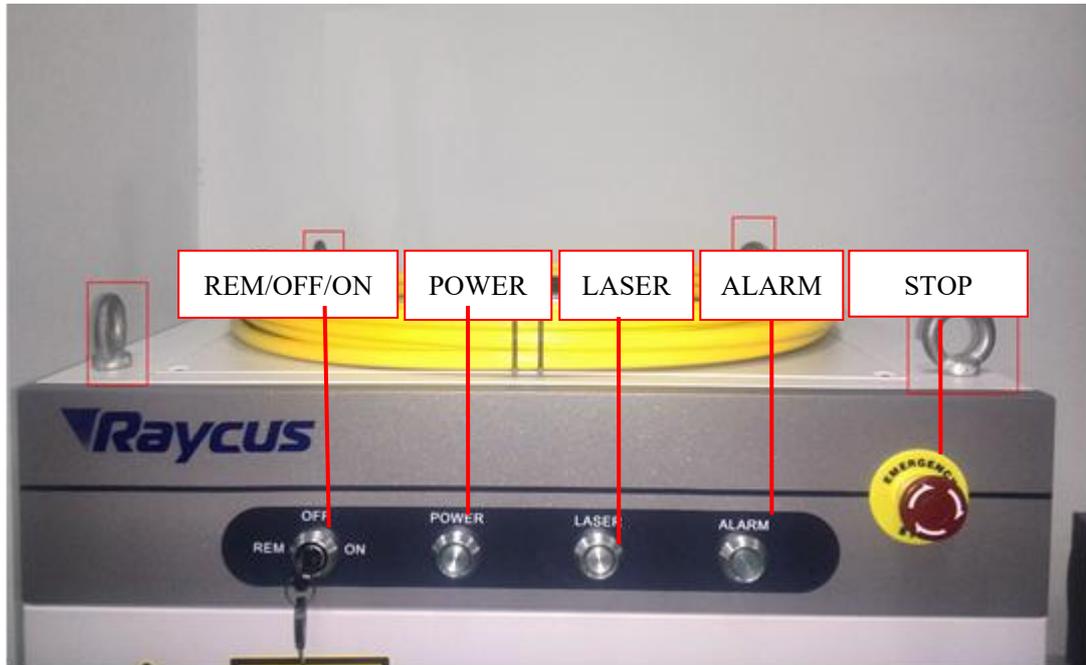


Figure 3: Front Panel View

REM/OFF/ON: Key switch, the power switch of the laser. Insert the key (Item 7 in Figure 3); 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 in the “CONTROL” cable. You can refer to **4.6 Entering a Control Mode** for more details.

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

LASER: Laser emission button, it’s a button with a red indicator. In hyper terminal mode and AD mode, when this button is pressed down, the product is ready to emit laser, and the LED illuminates. Press again will release the button, and disable the laser emission. It is also for shifting

the laser and red guide laser. When laser emission is enabled, the red guide laser is off; when the laser emission is disabled, the red guide laser is on.

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

STOP: Press it down to stop the laser immediately, turn it clockwise to release. But the laser cannot start before it's powered on (use the key switch) for a second time.

INDICATION LAMPS: Laser state indicator, green indicates that power supply is on, red indicates that laser is emitting and orange indicates laser failure.

3.2 Rear Panel

Figure 4 shows the rear panel.

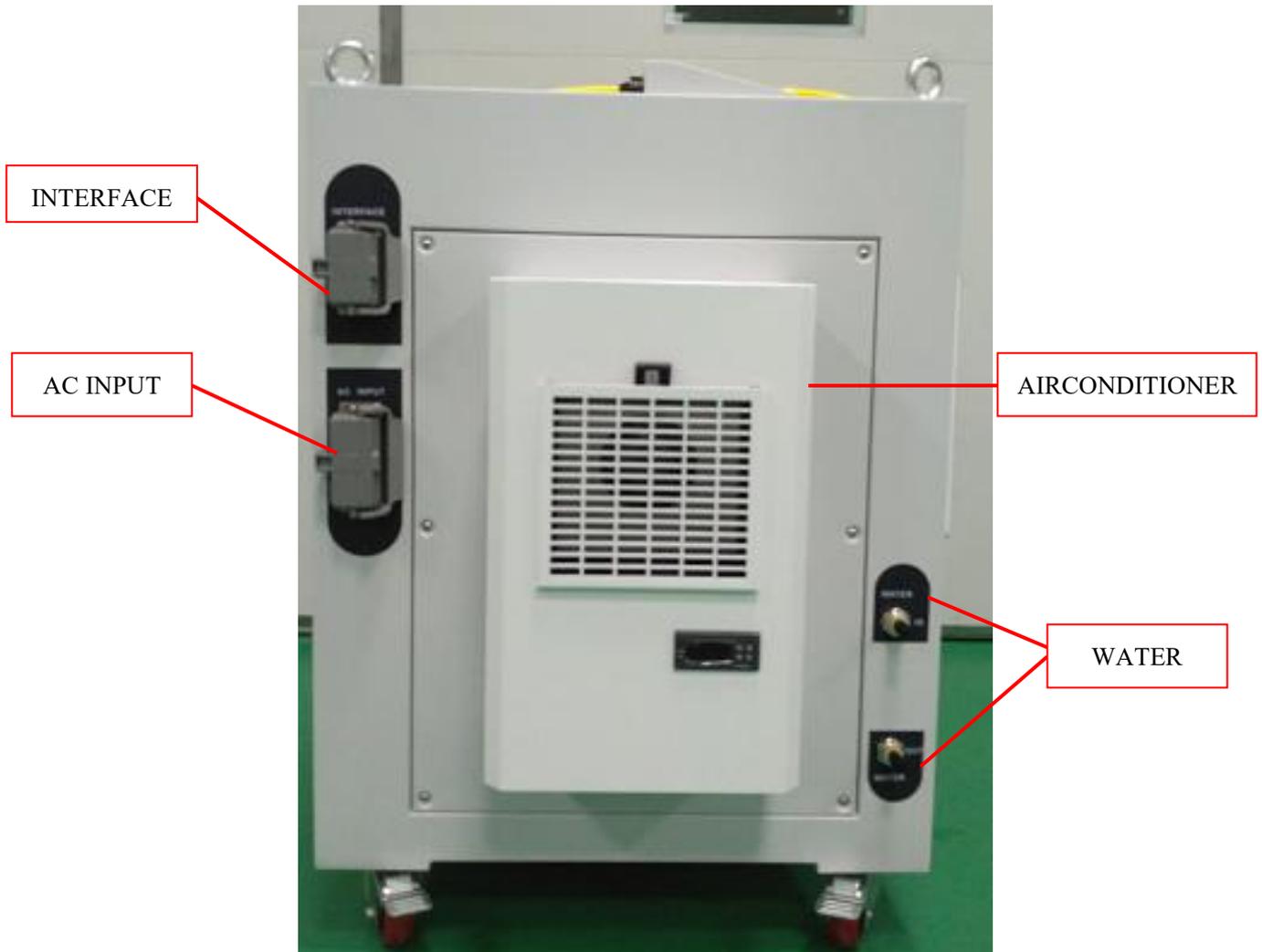


Figure 4: Rear Panel View

AC INPUT: The socket for supply input that can be only mated with the plug on the power cord we provided. The socket has housing with a cover and a lever. You can cap the socket with the cover, and then lock the cover with the lever.

INTERFACE: This interface is for all the control signals, including remote laser control, remote control mode setting, ready, analog control, modulation, interlock, RS-232, etc. The interface also has housing with a cover and a lever to protect it.

WATER: Pagoda joint pipe connectors, the inlet and outlet for cooling water flow in and return, compatible with 19 mm (Inner Diameter) water pipe.

AIRCONDITIONER: The air conditioner automatically turns on when the key on the front panel is turned to “ON” or “REM” .

CIRCUIT BREAKER: A circuit breaker is on the side near the rear panel, shown in Figure 5 (Item 5). It is the main switch of the laser.



Figure 5: The Circuit Breaker

3.3 Power Connection

	<p>CAUTION: Before connect the product to AC power; you must check up that the AC supply you will apply is in accordance with the specifications provided in Table 1.</p>
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A power cord is provided in the package, as in Figure 6.



Figure 6: The Power Cord of the Laser

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 insert it, lock it with the lever (Figure 7).

The other end of the power cord is stripped off and each wire is crimped with a “pin-type cable connector” . There are five wires labeled L1, L2, L3, N and PE, respectively. You should connect the wires to the AC power supply according to the labels in Table 3:

Table 3: Power Cord Definition

Label	Color	Description
L1	Red	Phase Line
L2	Yellow	Phase Line
L3	Blue	Phase Line
N	Black	Neutral
PE	Green & Yellow	Protective Earth

The length of the power cord is 5 meters, and the conductor sectional area for each wire is 2.5 mm².



1. Protective cap; 2. Lever; 3. Plug; 4. Socket

Figure 7: Lock the Plug of the Power Cord with the Lever

3.4 Control Wire Definitions

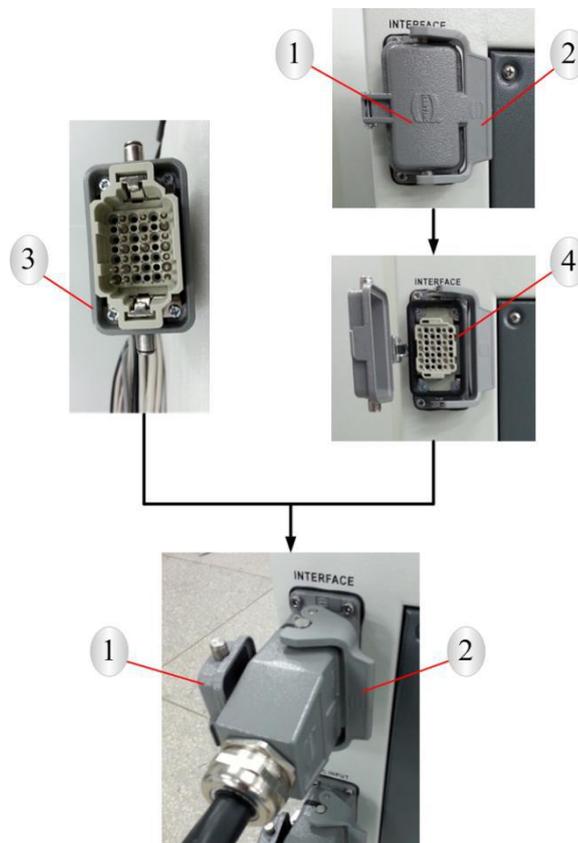
All the control signals are integrated in the “INTERFACE” on the rear panel (Figure 4).

We provide a cable for the “INTERFACE”, as shown in Figure 8.



Figure 8: The Cable for the INTERFACE

Insert the plug into the “INTERFACE”, and lock it with the lever, as shown in Figure 9, when you are ready to use the product.



1. Protective cap; 2. Lever; 3. Plug; 4. Socket

Figure 9: Lock the Plug of the Cable for INTERFACE with the lever

The control cable for the “INTERFACE” is actually 6 cables, they are for different purpose.

The control wire definitions are in the following table.

Table 4 Control Wire Definitions

Cable Name	NUM	Label	Color	Description	Note
CONTROL	6	LAS_C	White	Remote emission control, 24V level. When the level is high, the laser emission is enabled. The function is the same as the “LASER” button on the front panel. “LASER” and “LAS_C” can’t work simultaneously. If you use “LASER”, left “LAS_C” disconnected; if you use “LAS_C”, keep the “LASER” button up.	“CONTROL” is relative to “EGND”
	7	AD/RS	Green	Remote control mode setting. When 24V is applied, the remote control mode is set to AD mode; when this wire is left disconnected or set to a low level, the remote control mode is set to RS-232 mode. Refer to 4.6Entering a Control Mode for details.	
	8	RDY	Black	System ready. When system check is finished, this signal is sent to indicate the system is ready for operation. It is 24V level, active high.	
	9	EGND	Blue	External ground	
	20	EVCC	Red	External power supply, 24V level	
	24	S_ERR	Purple	System error, 24V level, active high. The signal is coincident with the ‘ALARM’ indication on the front panel.	
	\	PE	\	Protective earth, connected to the shielding net of the cable.	
RS-422	11	T+	White	This cable is reserved for RS-422 control.	\
	12	T-	Brown		
	13	R-	Yellow		
	14	R+	Green		
	\	PE	\	Protective earth, connected to the shielding net of the cable.	
AD	22	0-10V	Red	Analog signal, setting the output power in AD mode. Do not apply voltage signal higher than 10V.	This cable is for analog signal input only.
	25	AGND	Black	Analog ground	
	\	PE	\	Protective earth, connected to the shielding net of the cable.	

MODULATION	36	MOD+	Red	The cable is for modulation signal input, 24V level.	\
	37	MOD-	Black		
	\	PE	\	Protective earth, connected to the shielding net of the cable.	
INTERLOCK	38	ITL_A	Red	Interlock	Make sure that the interlock is shorted before turn on the laser.
	39	ITL_B	Black		
RS-232	40	RX	Red	Connect to the RX of upper computer.	The cable is for RS-232 and Hyper terminal control.
	41	TX	Yellow	Connect to the TX of upper computer.	
	42	GND	Blue	Ground of the RS-232 interface.	
	\	PE	\	Protective earth, connected to the shielding net of the cable.	

	<p>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.</p>
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3.5 Control Modes

There are two different modes of laser emission: CW and pulsed. In the CW mode, the laser emits continuously, and you can set the output power by percentage of output power. In the pulse mode, the laser emits in a waveform of pulses.

We provide three modes to control the product: HyperTerminal, RS-232 and AD. The hyper terminal mode is a local control mode; RS-232 and AD mode are remote control modes. In the HyperTerminal mode and RS-232 mode, you can set all the parameters in the CW or pulse mode, but in the AD mode, the output power is controlled by analog signal, and the emission is controlled by remote modulation signal.

We have sensor to monitor the operation conditions of the laser, if any abnormal condition occurs, the laser will be stopped, and error information will be sent out from the RS-232 port. The control system in the laser also records the errors, which will be shown in the system self-check in hyper terminal mode. Refer to **4.7.3Operation in Hyper Terminal Mode** for details.

3.6 Entering a Control Mode

The following diagram shows the process of entering a certain control mode.

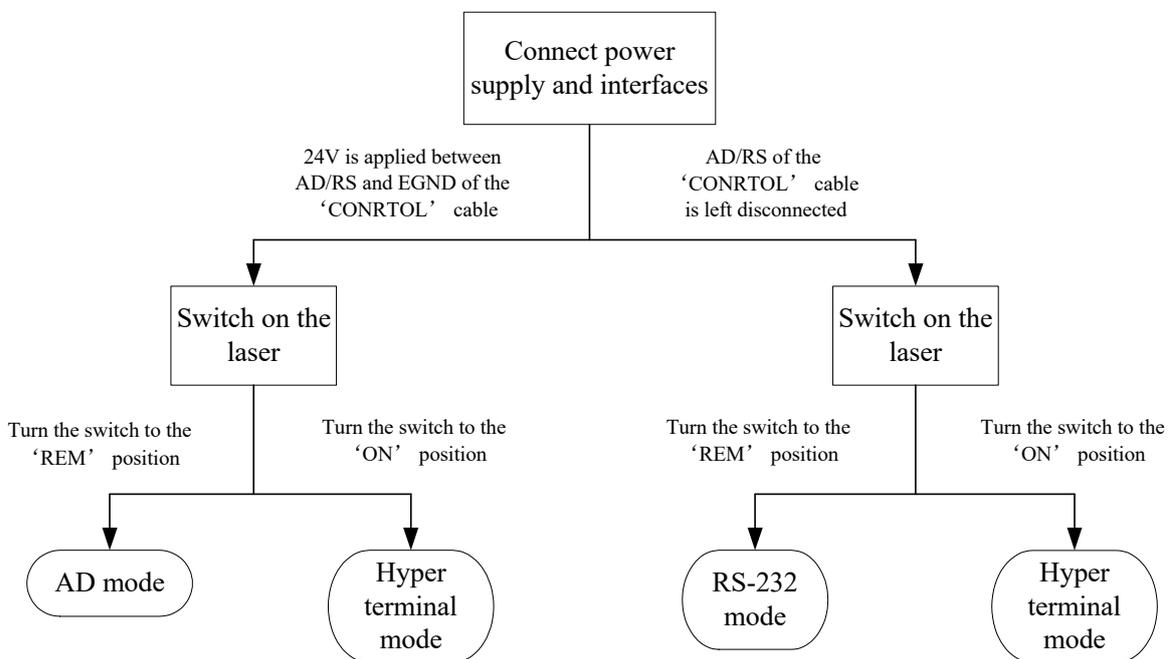


Figure 20: The Process of Entering Different Control Modes

If you want to enter hyper terminal mode, you must turn the key to the “ON” position; if you want to enter a remote control mode, you must turn the key to the “REM” position. Whether you enter AD mode or RS-232 mode depends on 24V is applied to PIN7 and PIN9 of the “CTRL-INTERFACE” or not.

3.7 Hyper Terminal Mode

Hyper terminal mode is a local control mode. Hyper terminal is a communication tool in Windows system, so make sure your PC operation system is Windows. In hyper terminal mode, operation parameters can be set, and errors can be displayed and cleared.

3.7.1 Wiring in Hyper Terminal Mode

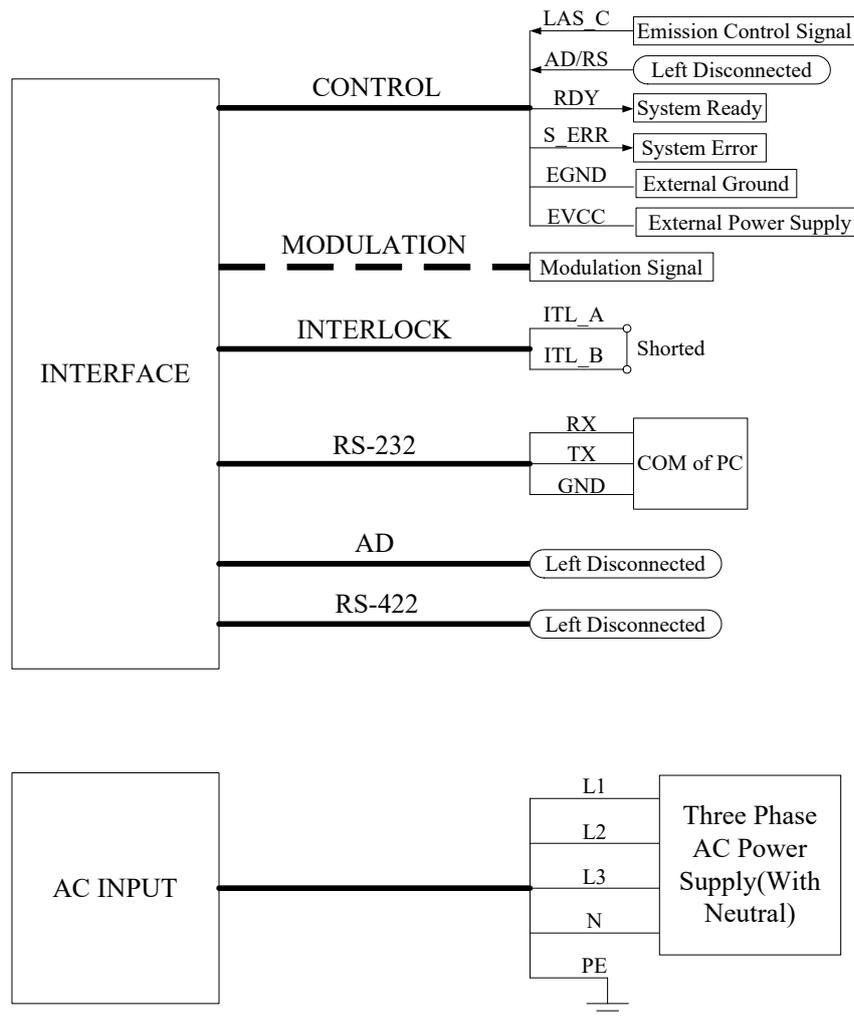


Figure 31: Wiring in Hyper Terminal Mode

The wiring in hyper terminal mode is in Figure 31. The “CONTROL” cable is for different purposes. “LAS_C” is for remote emission control, “AD/RS” is for control mode setting, “RDY” is a flag for system self-check accomplishment. “S_ERR” is for system error report. “EVCC” is 24V external power supply. All the signals in the “CONTROL” cable are 24V level, and are

relative to “EGND”. If you don’t use remote emission control, left “LAS_C” disconnected. The “MODULATION” cable need to be connected when the laser emission is controlled by remote modulation signal, otherwise can be left disconnected. The “RX” and “TX” of the “RS-232” cable should be connected to the “RX” and “TX” of the PC, respectively. “AD” and “RS-422” should be left disconnected. The PE of the cable for “INTERFACE” is not shown in Figure 3, but we recommend you to connect all the PE wires to the protective earth.

3.7.2 Hyper Terminal Setup

Follow the instructions to setup hyper terminal:

- (1) In Windows system, click as follows: START→Accessories→Communication→Hyper Terminal;
- (2) A dialog will pop up, to recommend Hyper Terminal as the default telnet program, choose “Yes”;
- (3) Hyper terminal will start, type in any name for “New Connection”, then click “OK”;
- (4) Choose the COM you connected with the RS-232 cable, then click “OK”;
- (5) Set up communication protocol: Baud rate-9600, Data Bits-8, Parity-None, Stop bits-1, Flow Control-None. Then click “OK”;

Now the hyper terminal setup is finished.

3.7.3 Operation in Hyper Terminal Mode

Before you start the laser, check the wiring, cooling connection and the most important, the delivery cable and optic output terminal are OK. Make sure that the interlock is shorted, and the laser emission button is up (emission disabled). Then start the chiller.

Turn the key to the “ON” position to start the laser, and the system start self-check. If the process of system self-check is normal, the following information will be displayed in the hyper terminal:

Welcome to use Raycus fiber laser

The Model is RFL-CXXX/X/X/X(the model name of the laser)

Checking RS-232 connection.....

RS-232 connected.....

System is doing self-check, please wait.....

Interlock is ok.....

.....

The laser emission is disabled.....

Checking temperature.....

Module 1 temperature 1=XX °C OK

Module 1 temperature 2=XX °C OK

Module 1 temperature 3=XX °C OK

Module 1 temperature 4=XX °C OK

Module 2 temperature 1=XX °C OK

Module 2 temperature 2=XX °C OK

Module 2 temperature 3=XX °C OK

Module 2 temperature 4=XX °C OK

Module 3 temperature 1=XX °C OK

Module 3 temperature 2=XX °C OK

Module 3 temperature 3=XX °C OK

Module 3 temperature 4=XX °C OK

Module 4 temperature 1=XX °C OK

Module 4 temperature 2=XX °C OK

Module 4 temperature 3=XX °C OK

Module 4 temperature 4=XX °C OK

Module 5 temperature 1=XX °C OK

```
Module 5 temperature 2=XX °C OK
Module 5 temperature 3=XX °C OK
Module 5 temperature 4=XX °C OK
System has started, please wait.....
```

The hyper terminal shows the system self-check process-check RS-232 connection, interlock, laser emission status, and system temperature. While doing temperature checking, hyper terminal will show the temperature on different test points.

If “Interlock error, please power off the laser and check interlock” is presented, please follow the instructions to power off the laser, short the interlock, and then start the product again.

```
Checking RS-232 connection.....
RS-232 connected.....
System is doing self-check, please wait.....
Interlock error, please power off the laser and check interlock
```

If “Laser emission is not disabled, please power off the laser and check if LASER button on the front panel is pressed down” is present in the self-check process, please follow the instructions to check the laser emission button on the front panel, press it to release, and then restart the product with the key. Laser emission must be disabled on system start-up.

```
Checking RS-232 connection.....
RS-232 connected.....
System is doing self-check, please wait.....
Interlock is OK.....
Laser emission is not disabled, please power off the laser and check if LASER button on the front panel is pressed down.....
```

When “System has started, please wait.....” is presented, self-check is passed, “RDY” signal is sent, and error records will be presented, followed by an instruction to press “U” on the keyboard in 3 seconds.

Err1 record: 0

->Module 1 T1 High temperature record: 0

->Module 1 T1 Low temperature record: 0

->Module 1 T2 High temperature record: 0

->Module 1 T2 Low temperature record: 0

->Module 1 T3 High temperature record: 0

->Module 1 T3 Low temperature record: 0

->Module 1 T4 High temperature record: 0

->Module 1 T4 Low temperature record: 0

->Module 2 T1 High temperature record: 0

->Module 2 T1 Low temperature record: 0

->Module 2 T2 High temperature record: 0

->Module 2 T2 Low temperature record: 0

->Module 2 T3 High temperature record: 0

->Module 2 T3 Low temperature record: 0

->Module 2 T4 High temperature record: 0

->Module 2 T4 Low temperature record: 0

->Module 3 T1 High temperature record: 0

->Module 3 T1 Low temperature record: 0

->Module 3 T2 High temperature record: 0

->Module 3 T2 Low temperature record: 0

->Module 3 T3 High temperature record: 0

->Module 3 T3 Low temperature record: 0

->Module 3 T4 High temperature record: 0

->Module 3 T4 Low temperature record: 0

->Module 4 T1 High temperature record: 0

->Module 4 T1 Low temperature record: 0
->Module 4 T2 High temperature record: 0
->Module 4 T2 Low temperature record: 0
->Module 4 T3 High temperature record: 0
->Module 4 T3 Low temperature record: 0
->Module 4 T4 High temperature record: 0
->Module 4 T4 Low temperature record: 0
->Module 5 T1 High temperature record: 0
->Module 5 T1 Low temperature record: 0
->Module 5 T2 High temperature record: 0
->Module 5 T2 Low temperature record: 0
->Module 5 T3 High temperature record: 0
->Module 5 T3 Low temperature record: 0
->Module 5 T4 High temperature record: 0
->Module 5 T4 Low temperature record: 0
Err2 record: 0
Err3 record: 0
Err4 record: 0
->Module 1 Err4 record: 0
->Module 2 Err4 record: 0
->Module 3 Err4 record: 0
->Module 4 Err4 record: 0
->Module 5 Err4 record: 0
Err5 record: 0
Err6 record: 0
-> Module 1 Err6 record: 0

-> Module 2 Err6 record: 0
-> Module 3 Err6 record: 0
-> Module 4 Err6 record: 0
-> Module 5 Err6 record: 0
Err7 record: 0
Err8 record: 0
Err9 record: 0
Press 'U' in 3 seconds to enter UI

Err1 to Err9 are different errors like output power error, over temperature error, etc. Only the times of occurrence is displayed. Follow the instruction to press “U” to enter user interface (UI).

After you enter the UI, press “Enter”, and the following options will be displayed:

You have entered UI, press 'Enter'.....
Welcome to use Raycus fiber laser
Please choose the operation mode:
1-> CW mode
2->Pulse mode
3->CW mode with remote modulation
4->Pulse mode with remote modulation
5->Clear errors
6->Save system configurations
7->Return

You can choose the operation mode by pressing corresponding number on the keyboard.

❖ CW mode

Press “1” in the mode selection page, you will enter “CW mode”. In this mode, the laser emission is continuous, so just one parameter needs to be set—percentage of output power.

The present operation mode is CW mode

Please set percentage of output power (MIN=0, MAX=100), press 'Enter' to confirm:

Then type a number between 10 and 100, with minimum increment of 1, then press "Enter".

For example, type "20" and enter, the output power will be set to approximate 20%.

Please set percentage of output power (MIN=0, MAX=100), press 'Enter' to confirm:20

Press '7' to return to previous menu, press 'Enter' to reset

If you don't input anything, the system will accept 0 as the default, which means that if you press "Enter" without no value typed in, the percentage of output power will be set to 0%.

When the percentage of output power is set and laser emission is enabled ("LASER" on front panel is pressed down or "LAS_C" is high), the laser emits. The "MODULATION" cable is disconnected in this mode.

You can press "Enter" again to set another value for percentage of power, or press "7" to return to previous menu to choose another operation mode.

❖ Pulse mode

Press "2" in the mode selection page, you will enter "Pulse mode". You should provide 3 parameters for this operation-repetition frequency, duty cycle and percentage of output power.

For example, set the repetition frequency to 2kHz, duty cycle to 50% and percentage of output power to 60%.

The present operation mode is pulse mode

Please set repetition frequency (MIN=50, MAX=5000), press 'Enter' to confirm: 5000

Please set duty cycle (MIN=0, MAX=100), press 'Enter' to confirm: 50

Please set percentage of output (MIN=0, MAX=100), press 'Enter' to confirm:60

Press '7' to return to previous menu, press 'Enter' to reset

The repetition frequency is between 50Hz and 5 kHz, but you must input a number between 50 and 5000, so for 5 kHz, input 5000;

Duty cycle is between 0% and 100%, for 50%, type in 50;

For 60% output power, type in 60.

If you input a value out of the range specified in the brackets, the system will instruct you again to input a legal value. Just follow the instructions.

When the parameters are set and laser emission is enabled (“LASER” on front panel is pressed down or “LAS_C” is high), the laser emits sequence of pulses you have customized. The “MODULATION” cable is also left disconnected in this mode.

❖ **CW mode with remote modulation and Pulse mode with remote modulation**

Press “3” in the mode selection page to enter “CW mode with remote modulation”, and press “4” to enter “Pulse mode with remote modulation”. In these two operation modes, the parameter settings are no different from “CW mode” and “Pulse mode”. Only one more emission condition is added-remote modulation signal. So you must connect the “MODULATION” cable to remote modulation signal. Notice that the modulation signal is 24V level, and active high.

When the parameters are set, laser emission is enabled (“LASER” on front panel is pressed down or remote emission control is sent from “LAS_C”), and the remote modulation signal inputs from “MODULATION”, the laser emits.

❖ **Clear errors**

Press “5” in the mode selection page will clear error records. Then press “7” to return.

Error records are cleared Press ‘7’ to return to previous menu

❖ **Save system configurations**

This operation is for Raycus personnel only.

3.8 RS-232 Mode

RS-232 mode is a remote control mode. In this mode, we have a protocol for communication between the laser and the upper computer, and you can set emission parameters and return errors. Notice that the “LASER” button or “LAS_C” is of no use in this mode, but make sure to keep the button up and left “LAS_C” disconnected.

3.8.1 Wiring in RS-232 Mode

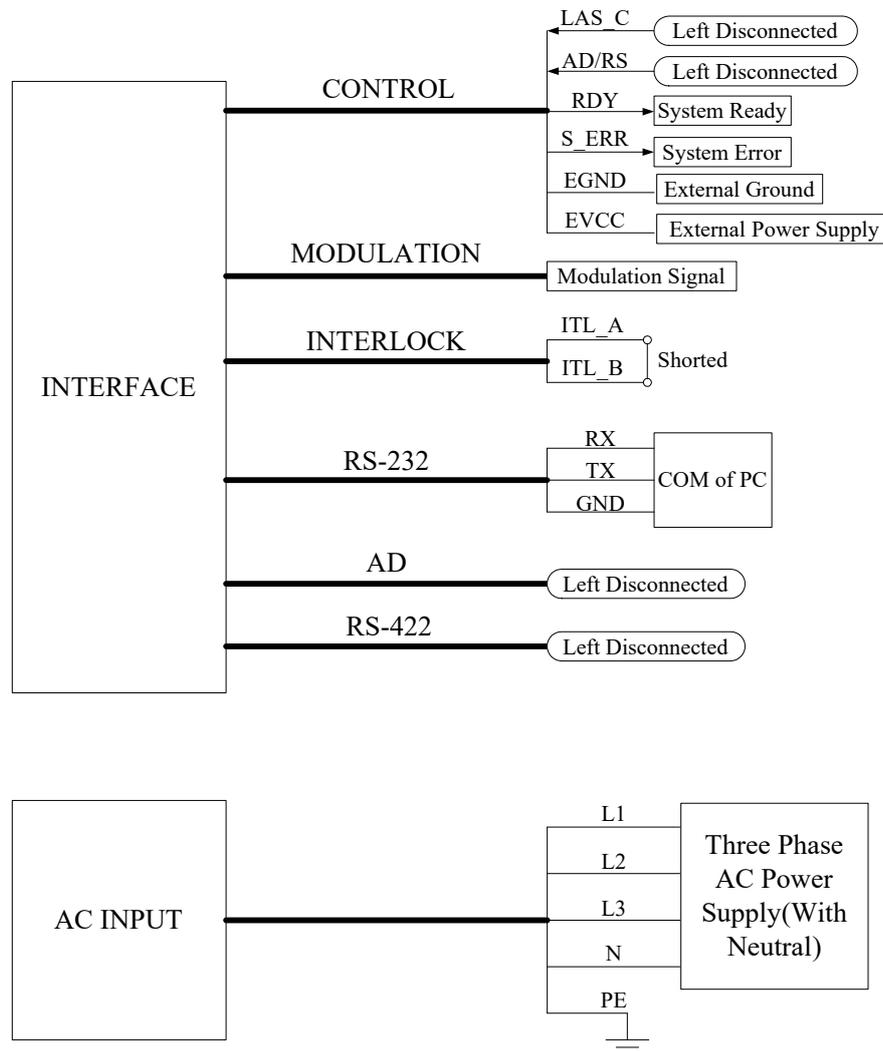


Figure 42: Wiring in RS-232 Mode

The wiring in RS-232 mode is similar to the wiring in hyper terminal mode. The differences are: you have to connect the “MODULATION” cable, and “LAS_C” must be left disconnected.

3.8.2 The Communication Protocol

The protocol is presented in the table below:

Table 5: The Communication Protocol for RS-232 Mode

Code	Description	Example
1B4F0D	Emission On	Sent: 1B4F0D Response: 54530D
1B530D	Emission Off	Sent: 1B530D Response: 54530D
1B4350XX0D	Set the operation to CW mode, XX is the percentage of output power, ranging from 0 to 64, and it's hexadecimal.	Sent:1B4350320D Response: 54530D Set the operation to CW mode, percentage of output power is 50%.
1B46XXXX44##50&&0D	Set the operation in pulse mode. XXXX-repetition frequency, 32~C350; ##-duty cycle, 0~64; &&-percentage of output power, 0~64; All parameters are in hexadecimal.	Sent:1B461388443C50500D ; Response: 54530D; Set the operation in pulse mode, Repetition frequency-5kHz, Duty cycle-60%, Percentage of output power-80%.
54530D	Response after code is received.	\
54 45 31 0D	Report Error 1	\
54 45 32 0D	Report Error 2	\
54 45 33 0D	Report Error 3	\
54 45 34 0D	Report Error 4	\
54 45 35 0D	Report Error 5	\
54 45 36 0D	Report Error 6	\
54 45 37 0D	Report Error 7	\
54 45 38 0D	Report Error 8	\
54 45 39 0D	Report Error 9	\
54 45 40 0D	Report Error 10	\

3.8.3 The Operation in RS-232 Mode

Before you start the laser, check the wiring, cooling connection and the most important, the delivery cable and optic output terminal are OK. Make sure that the interlock is shorted, and the laser emission button is up (emission disabled). Then start the chiller.

Turn the key to “REM” position to start the laser, and system start self-check. If the interlock is not shorted or the “LASER” button is pressed down, the system self-check cannot pass. In this condition, you must power off the laser, and deal with the problem, then start the laser again.

The system self-checks will pass in about 30 seconds, then “RDY” signal will be sent. After that, you can send codes from the upper computer. In RS-232 mode, the laser emits on conditions that the “Emission On” code (1B4F0D) is received, operation parameters are set and remote modulation signal inputs from the “MODULATION” cable.

In RS-232 mode, you can still use hyper terminal to monitor the status of the laser. All you have to do is to start windows hyper terminal, and configure it as stated in 4.7.2Hyper Terminal Setup. But you can’t set operation parameters from hyper terminal when the control mode is RS-232.

3.9 AD Mode

AD mode is also remote control mode. In AD mode, the output power is set by analog signal, and pulse mode is not available in this control mode.

3.9.1 Wiring in AD Mode

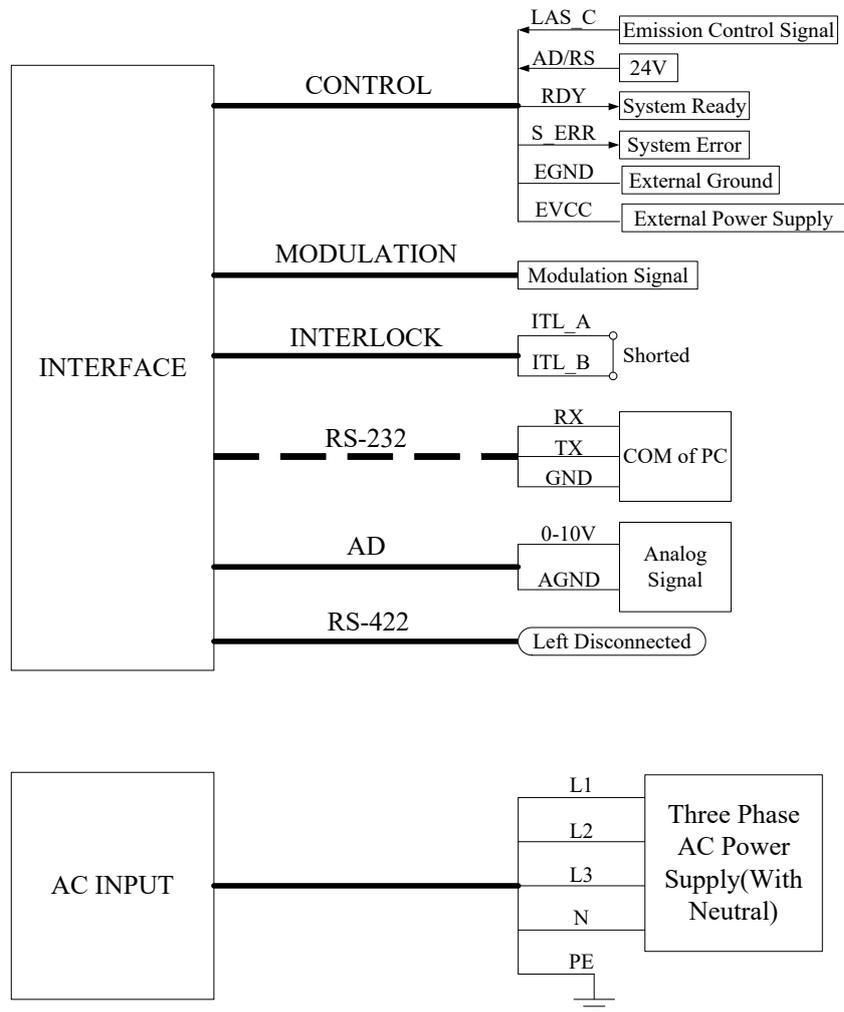


Figure 53: Wiring in AD Mode

The wiring in AD mode is shown in Figure 53. There is an important difference in the “CONTROL” cable connection: 24V must be applied between “AD/RS” and “EGND”. If you don’t use remote emission control, left “LAS_C” disconnected. The “MODULATION” and “INTERLOCK” cable connection are same as wiring in hyper terminal and RS-232 mode. If you want to monitor the system status in hyper terminal, you can still connect the “RS-232” cable to PC. The analog signal is input from “AD” cable.

3.9.2 The Operation in AD Mode

Before you start the laser, check the wiring, cooling connection and the most important, the delivery cable and optic output terminal are OK. Make sure that the interlock is shorted, and the laser emission button is up (emission disabled). Then start the chiller.

Turn the key to “REM” position to start the laser, and system start self-check. If the interlock is not shorted or the “LASER” button is pressed down, the system self-check cannot pass. In this condition, you must power off the laser, and deal with the problem, then start the laser again.

The system self-checks will pass in about 30 seconds, then “RDY” signal will be sent. After that, the laser is ready to receive analog signal, and you can press down “LASER” button to enable the laser emission.

In AD mode, the laser emits on conditions that “LASER” button is pressed down or “LAS_C” is high, analog signal is received and remote modulation signal inputs from the “MODULATION” cable.

You can still use hyper terminal to monitor the status of the laser. All you have to do is to connect the “RS-232” cable to your PC, then start windows hyper terminal, and configure it as stated in 4.7.2Hyper Terminal Setup. But you can’t set operation parameters from hyper terminal when the control mode is AD.

	CAUTION: Please ensure that the analog signal DO NOT exceed 10V.
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4 Warranty, Return and Maintenance

4.1 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.

4.2 Limitations of Warranty

The warranty does not cover the maintenance or reimbursement of our product of which the problem results from tampering, disassembling, misuse, accident, modification, unsuitable physical or operating environment, improper maintenance, damages due to excessive use or not following the instructions caused by those who are not from Raycus. 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 31days after the defect is discovered. This warranty does not involve any other party, including specified buyer, end-user or customer and any parts, equipment or other products produced by other companies.



WARNING: It is the customer's responsibility to understand and follow operating instructions in this User Guide. Accessories and fiber connectors are not covered by this warranty.

4.3 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.
- 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 anytime 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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