



CO₂ RF LASER OPERATORS MANUAL

N30



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Chapter 1 Introduction

1.1 Trademark, copyright, version, model

Trademark

ZAMIA® is registered trademark of SPT LASER co.,ltd., all the other ZAMIA trademarks are the property of their respective owners.

Copyright

This is the SPTOM-EN30-20.01 version, all rights reserved by SPT LASER. Reprint and copy of this manual, including versions in other languages are forbidden without written authorization from SPT LASER company.

This manual is for operation of N30 series CO₂ RF Laser. Read it carefully before you use and operate N30, and the latest version of this manual will be updated at www.sptlaser.net.

Model

N30A is designed with air-cooling, and N30L is cooled with coolant. N30iA is air-cooled at 9.3μm and N30il is water-cooled model at 9.3μm. All the parameters are the same except for the difference on the output power and wavelength.

Where the information is the same, all the models are referred to as N30. For detailed product information, please refer to this manual.



1.2 Warranty Service

Warranty information

This is to certify that N30 CO₂ laser is guaranteed by SPT Laser co.,ltd. to be free of all defects in quality for a period of 24 months from the date of purchase. The warranty does not apply to any defect caused by misuse (including environmental factors), accident and improper maintenance. We request that you examine every shipment of 7 days after receipt and inform SPT LASER co.,ltd. of any storage or damage.

If, within warranty, any defect in materials and workmanship of your N30, please contact SPT LASER co.,ltd. When contacting for support, please provide the date of purchase, model, serial number and brief description of the problem. And keep all the labels on the laser complete.

The situations are not applied to the warranty:

1. Man-made sabotage
2. Warranty expired
3. No product info label and valid invoice, or the sealed
4. Any damage caused by improper maintenance, mounting, adjustment and misuse
5. Parts removal and repair without authorization of SPT LASER co.,ltd.
6. Damage caused by force majeure

Contact Info

Email for after-sale service: support@laserwd.com

For more info, please check at www.sptlaser.net



1.3 Unpacking / packing, storage / shipping, mounting, connecting, cooling

We request you to keep the original packing of N30, to prevent any damage to the laser in storage and shipping. For more info, please look up in this manual.

1.4 Basic Description

N30 CO₂ RF laser can be applied to laser cutting, drilling, marking non-metallic materials and medical cosmetology.

N30 requires DC power input, a DC power supply with 48V/12.5A output is recommended. The cable connects the laser and DC power directly has to be multiple twisted flexible wire, the wire core has to be bigger than 3mm and smaller than 4mm, with good insulation. Single piece of cable shall be no more than 4m.

N30A CO₂ laser is designed with air-cooling, there are fans mounted on it to take away the heat of laser during operation. There must be 6cm space reserved on three sides of the fans to ensure ventilation (no less than 6m³/m).

Qualified Ventilation: If the ventilation is proper, the temperature rise of N30A shall be ≤ 20 °C during operation compare to when it is in OFF state. The ambient temperature should be within 5 ~ 45 °C, and the maximum temperature of the laser surface should be less than 60 °C.

N30L CO₂ laser is cooled with coolant. It must work with chiller to take away the heat of laser during operation to prevent the laser from unstable working performance and damages caused by overheating.

When the N30 CO₂ laser works in a high humidity environment, pay attention to the surface of the laser and its window lens to check if there is condensation. If it happens, it



says the ambient humidity is too high, reduce it with air conditioner. If necessary. Cut the power of laser and stop cooling if the laser doesn't work for a long time. When the laser works in a dusty environment, it needs to be protected from dust, seal connections of the optical path with rubber rings.

Please use high-purity nitrogen or filtered clean air without water, oil and dust if needed to blow air to the laser.

1.5 Packing list

N30 CO₂ RF laser x1

1.5m long network cable x1

Test report x1

Simple wiring instructions x1

Chapter 2 Safety Instructions & Precautions

2.1 Summary

According to Chinese national standard, GB7247.1-2001 (IEC60825-1:1993), this product is class 4 laser. It can cause personnel injury and fire due to its refraction, reflection, diffuse reflection, please always be careful!

Read the entire manual and follow its instruction to make sure the correct operation of laser and personnel safety prior to shipping, mounting, and maintenance. Incorrect operation can cause damage to laser.

Please look up the alerts and hazard labels in this manual.



DANGEROUS This Class 4 laser product emits invisible infrared laser radiation. Because direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam. Do not allow the laser beam to contact a person, this product emits invisible laser beam which can burn the human tissues seriously. And any use of laser in explosive environments is banned.

WARNING Poisonous and harmful dust or gas may be generated during laser processing, effective exhaust or ventilation conditions are necessary for operators' safety.

ATTENTION Please go through and follow the guide in the manual on shipping, mounting, operation and maintenance of laser, incorrect operation can do harm to laser.

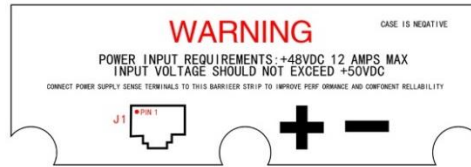


2.2 Hazard Labels

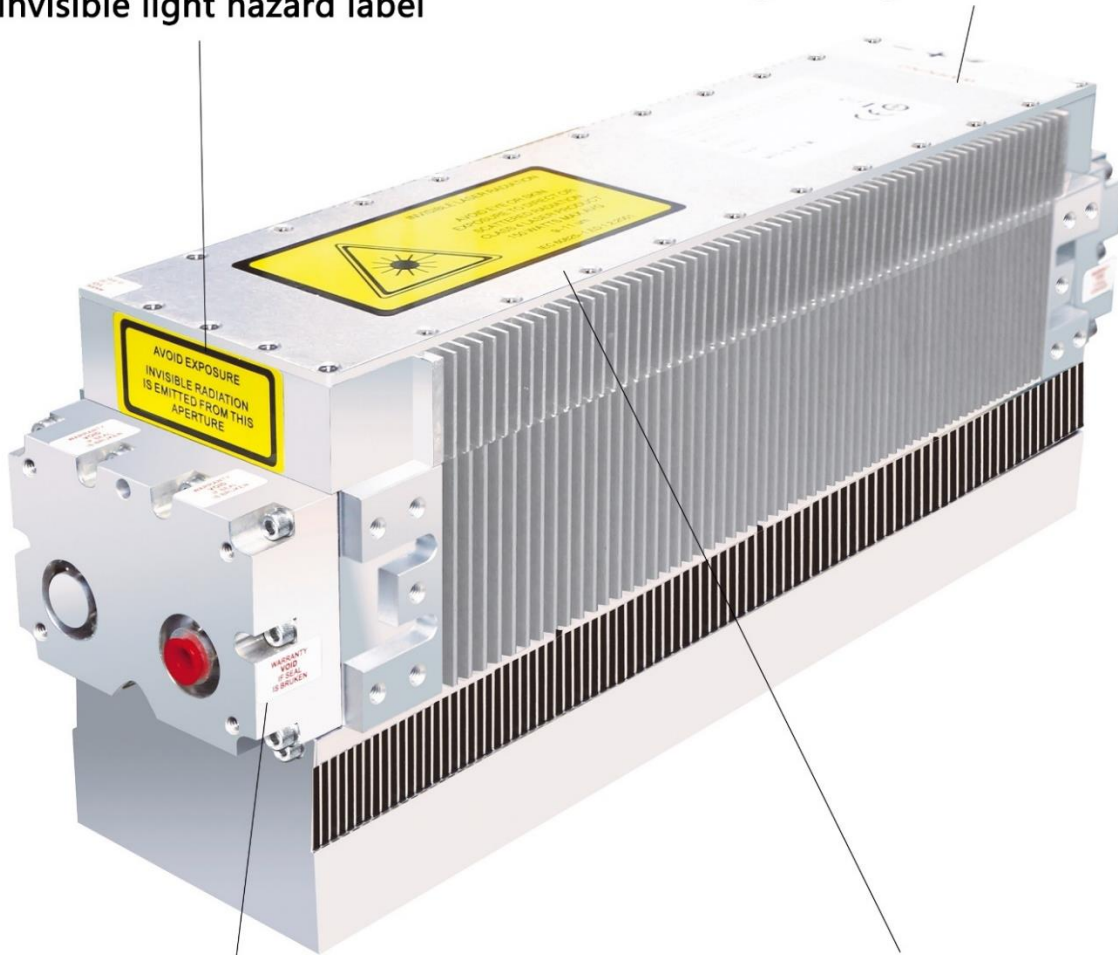
There are totally 4 hazard labels on N30 CO₂ laser, please check the info as below to know where they are located.



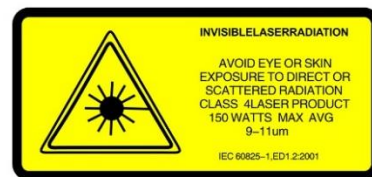
Warning:
Invisible light hazard label



Warning: Voltage hazard label



Note: do not disassemble



Danger: laser radiation



2.3 Operation instructions

1. Always wear eye protection to avoid any damage from laser.
2. Avoid any contact to combustible materials or humans from laser beam, it is capable of seriously burning human tissue.
3. Do not process on any high reflection material, any reflect or diffuse laser radiation can cause damage to devices and personnel.
4. Do not use any organic materials and metals as laser beam blocker. Organic matter burns or melts easily, and metal reflects the laser radiation.
5. Any personal disassemble and modification on laser fails the warranty.
6. Keep the laser working in good ventilation condition. Too much heat in laser can cause damage.

2.4 Safety precautions

1. Emergency stop
Use under emergency to stop laser by cutting the power.
2. Set up warning signs and control areas
Set up warning signs and blockers in the same area as an exposed laser beam.
3. Fire extinguisher
CO₂ or dry powder fire extinguisher shall be kept nearby where the laser is installed



Chapter 3 Product Introduction

3.1 Brief

- RF power supply and cavity integrated package, appearance simplicity & easy to be integrated ;
- All-metal structure with sealed off design, maintenance free ;
- High photoelectric conversion efficiency and fast modulation response;
- Output excellent laser beam and stable power;
- Suitable for a variety of industrial environments, can last for up to 20,000 hours.

3.2 Applications & materials

Applications

N30 CO₂ RF laser can be used for medical cosmetology, laser cutting, laser marking, plastic welding, and 3D printing.

Materials

Processing of leather, wood, plastic and other non-metal materials.

Processing of special materials, such as ABS, Teflon, asbestos, rubber, etc

Medically can be used for spot removing.

3.3 Parameters & Operation requirements

Technical Parameters:

MODEL	N30A/N30L	N30iA/N30iL
Pump Method	RF-Excited	
RF Frequency	100MHz	
Laser Resonator	Waveguide	
Wavelength	10.6μm	9.3μm



Average Power	30W	25W
Output Power Range	0-30W	0-25W
Beam Quality(M ²)	<1.2	
Pulse Rise/ fall time	<100us	
PWM Duty Cycle	0%-100%	
Modulation Frequency	0 to 25kHz	
Power stability	≤±5%	
Beam diameter(1/ e ²)	1.8±0.2mm	1.8±0.2mm
Beam Divergence (Full)	7.5±0.5mrad	
Beam Ellipticity	0.9 to 1.1	
Polarization	Linear>100:1	
Range of Wavelength	10.55-10.63μm	9.27-9.33μm
Input Voltage	48VDC±2VDC	
Max. Input current	12A	
Dimensions (mm)	N30A/N30iA 357×91.5×140mm N30L/N30iL (water-cooled) 382×91.5×102.9mm	
Packaging size (mm)	N30A/N30L 600x270x200mm	
Weight	N30A (air cooling) 6.6Kg N30L (water-cooled) 6.2Kg	

3.4 Operation mode

N30 CO₂ RF laser can be operated in two modes, they are CW mode and Gated CW mode.

CW mode

In CW mode, the RF power supply works in continuous mode and outputs continuous laser. TTL logic (pin 1 of RJ45) should be high. In the CW mode, the laser outputs the maximum power, and the power is not adjustable.

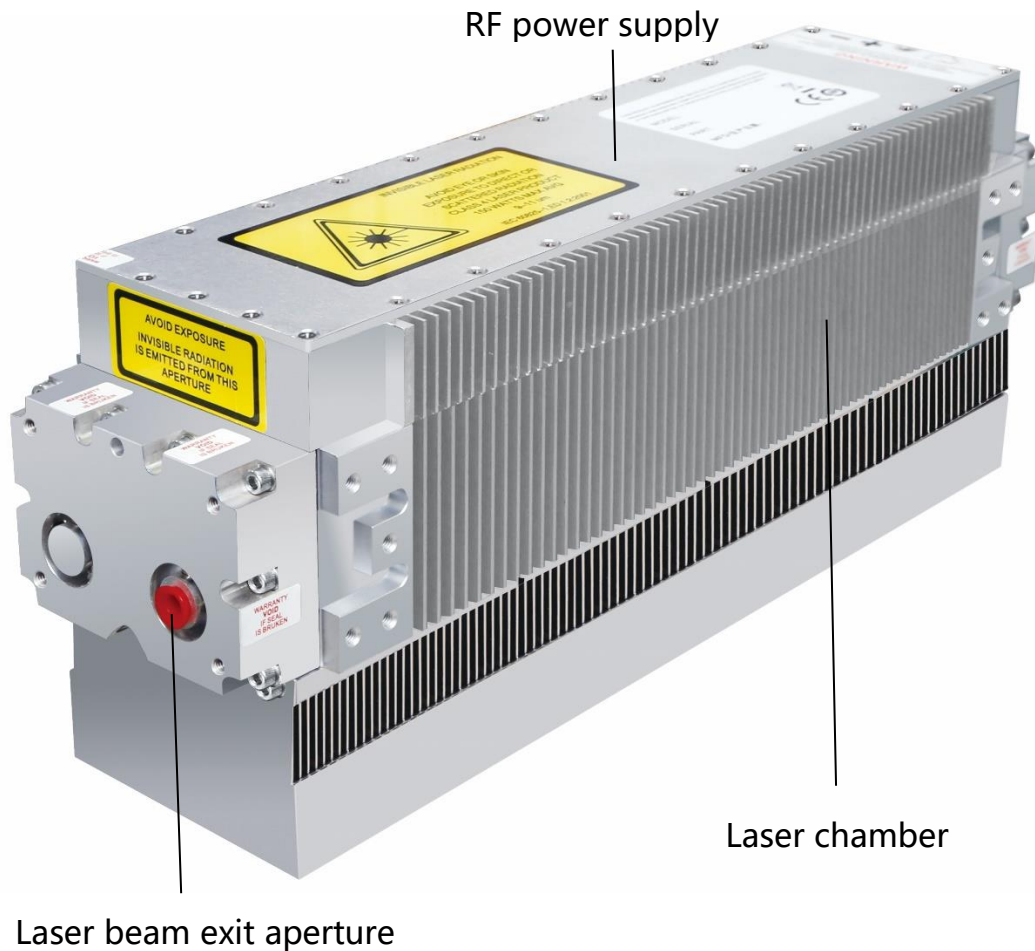
Gated CW mode

Compared with CW mode, other command states are the same, except that the TTL logic (pin 1, RJ45) is changed to a pulse waveform, and the N30 outputs pulse laser accordingly.



(The CW mode is actually a pulse waveform at 100% duty cycle). The laser pulse peak power is the peak power of the laser runs in CW mode. Recommend to run it with a pulse width which is not less than $1\mu s$, and the pulse repetition frequency should not be higher than 25kHz; and the duty cycle can be from 0 to 100% without limitation.

3.5 Product structure



N30 CO₂ RF laser is covered with an all-aluminum case, structure inside are two independent parts, the upside part is the RF power supply and the downside one is the laser optical resonator.

Laser Chamber

Laser chamber is a full sealed metal structure with high heat conductivity which



ensures good thermal stability of laser. There are discharge electrodes to excite the laser gas in the resonator, and their discharge surfaces are the waveguide surface of optical resonator.

The design of laser chamber inside enables the laser to output stable power and perfect laser spot mode to reach its maximum output power.

Radio frequency (RF) amplifier

The RF amplifier supplies pulse RF power to excite and ionize the laser gas in the resonator. The ON/OFF and output power of the laser can be controlled with external PWM signal.

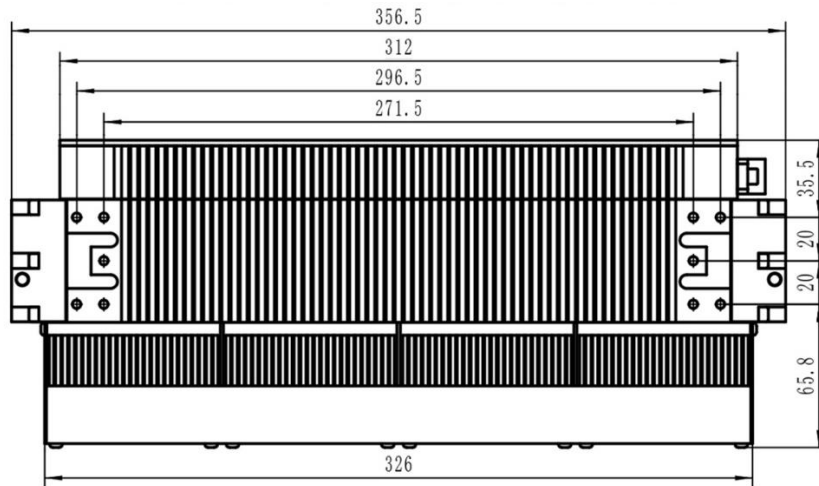
Chapter 4 Mounting Instructions

4.1 The outline and mounting of N30

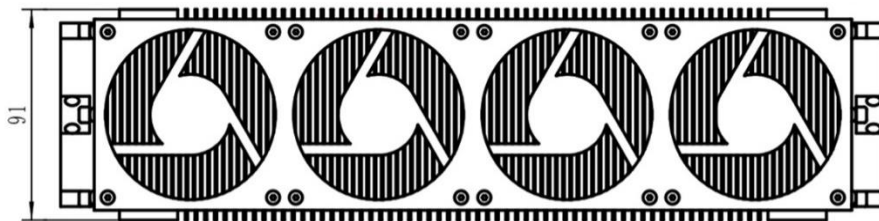
N30A CO₂ Laser



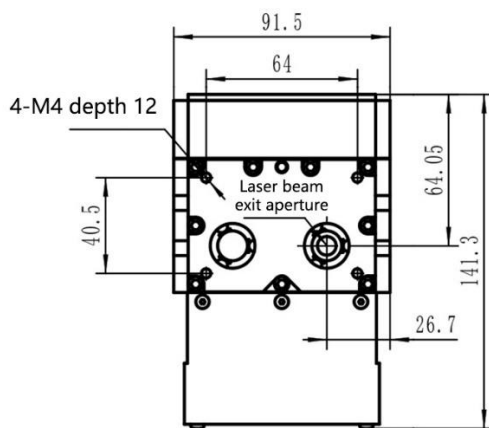
N30A (air-cooled) top view



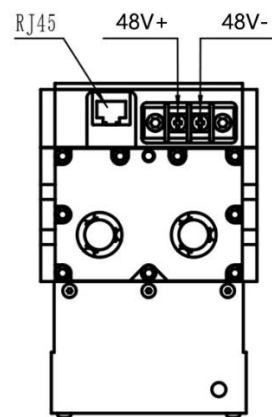
N30A (air-cooled) front view



N30A (air-cooled) bottom view



N30A (air-cooled) left view

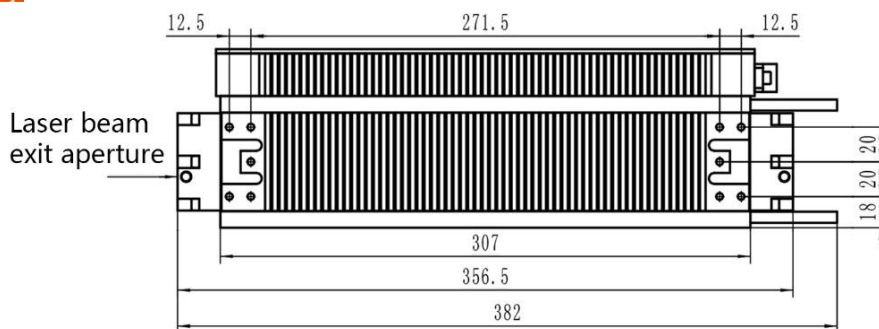


N30A (air-cooled) right view

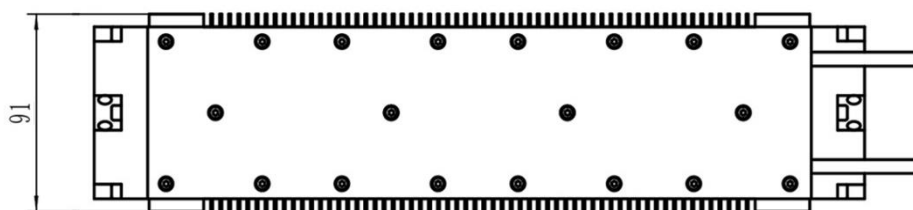
N30L CO₂ Laser:



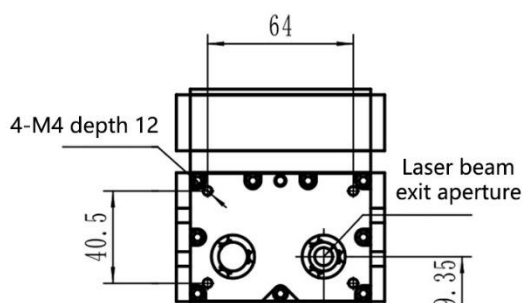
N30L (water-cooled) top view



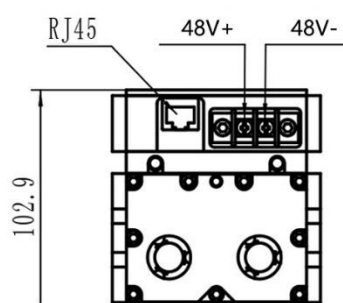
N30L (water-cooled) front view



N30L (water-cooled) bottom view



N30L (water-cooled) left view



N30L (water-cooled) right view

*Laser beam of N30 CO₂ RF Laser tube exits from its front laser exit aperture.

Do not mount the external optical path to the laser exit aperture holder in case the external mechanical stress affects to the optical resonator of the laser.

4.2 Operation Environment

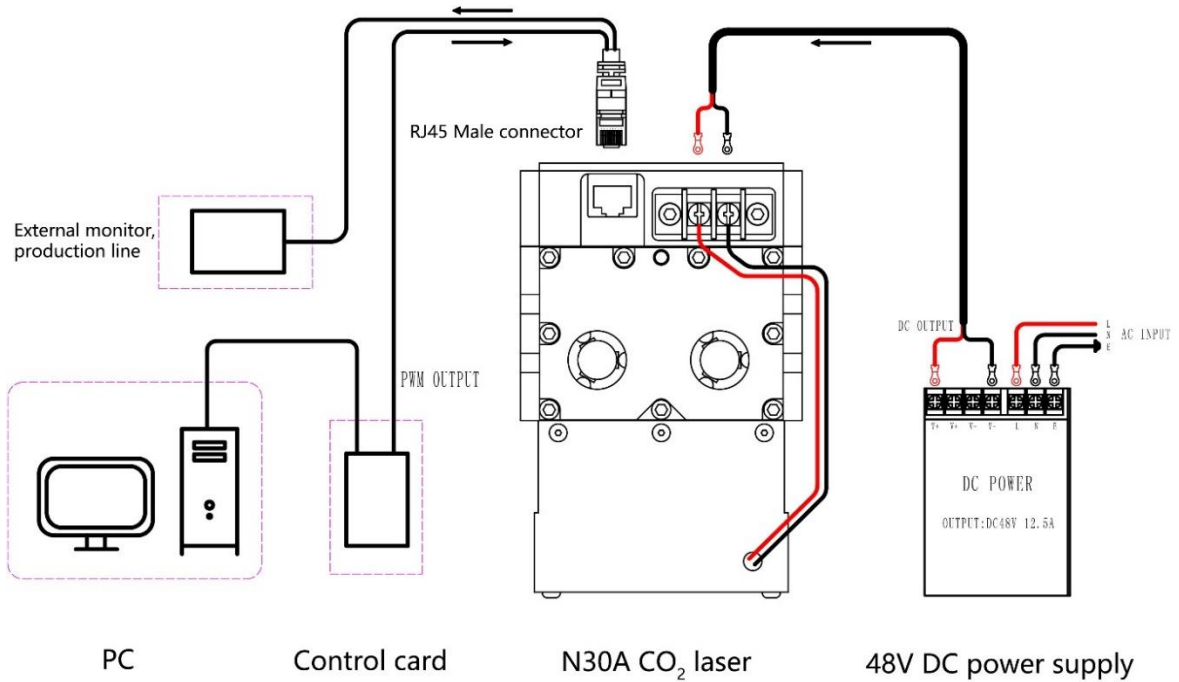
Requirements:

Temperature	0~45°C
Humidity	≤95%
Altitude	≤2000m

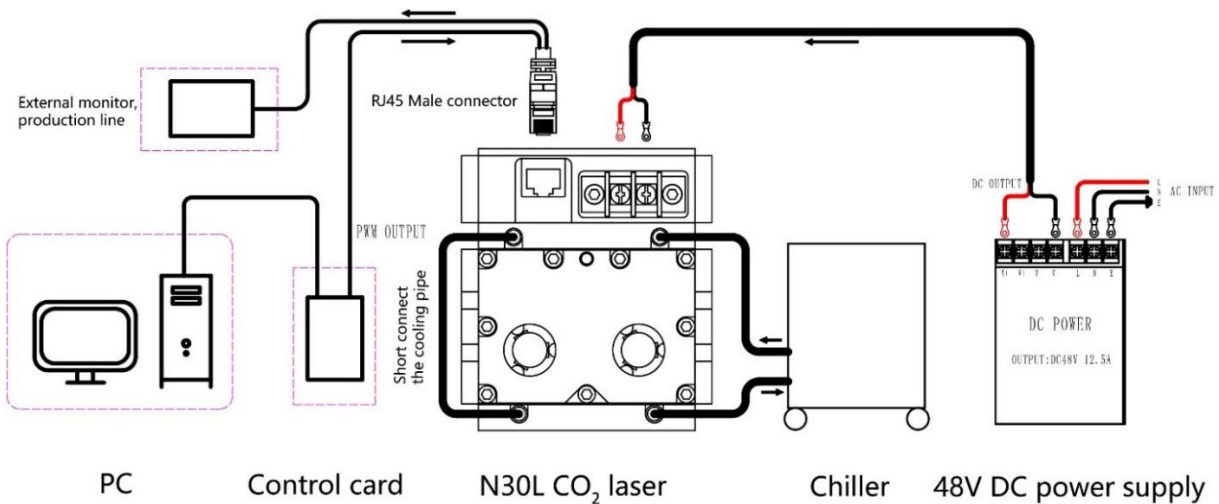


4.3 Wiring Instructions

Please follow the diagram as below to do the wiring when you use N30 CO₂ RF laser tube for the first time. For more detailed wiring info, please look up from other chapters in the manual.



N30A (air-cooled) wiring diagram



N30L (water-cooled) wiring diagram



4.4 DC cable

N30 CO₂ RF laser works with DC power supply. The DC cable must be multiple twisted wires with reliable insulation performance, and the thickness of its conductive core shall be > 3mm and <4mm. The DC cable shall be no longer than 4m. Check the input voltage to laser and make sure it is 48V if the cable is longer than 4m.

4.5 Power System

Choose external power supply which meets all the requirements to ensure the laser works smoothly. The internal power system of the laser is with high-frequency and high-power, an unqualified external power source can cause damage to the internal power system.

Materials and Tools required

1. DC power supply;
2. Cable;
3. Multimeter;
4. Oscilloscope;
5. Power cable.

DC Output Requirements

Voltage	48VDC±2%
Average current	12A
Max. current	18A(Maintain 1ms)
Ripple and noise	<1%Peak value

Suggestion: strongly recommend the DC power supply with feedback control, which can feed back the voltage from ends of the load to the power supply that the power supply can adjust the output voltage accordingly in real time.

Operation precautions

1. DC power supply must come with good instantaneous current and voltage adjustment capability. Peak current required by laser affects the working life of



DC power supply directly. When laser stops firing, the current load on DC power supply drops from high value to near 0 suddenly, same time, the voltage output of DC power supply increases in a moment. If the voltage goes up to be more than 53V, it can cause damage to the power transistor in RF amplifier, which will end up to laser power drop or laser damage.

2. The laser requires high peak current from DC power supply when it fires. In the case of high load current, the voltage output of DC power supply drops, but it shouldn't drop too much. If the voltage is less than 43V, the laser doesn't work normally. The peak voltage of DC power supply shouldn't last more than 10 μ s, and duration of DC power supply peak current should be 1/3 of the laser start pulse width. (E.g. The DC power supply peak current should last more than 300 μ s if the start pulse width of laser is 300 μ s.)

3. Connect V- (output) on DC power supply to ground. And also connect the cathode on laser to ground if the cable for connecting laser and DC power supply is longer than 4m.

An over voltage protection circuit between DC power supply and RF power supply is required to avoid laser damage due to excessive voltage fluctuations.

4. Connect the power supply according to the labels located at the back side of the laser. "+" is anode on RF power supply, connect to "V+" on DC power supply, and "-" is cathode on RF power supply, connect to "V-" on DC power supply. Maximum length of cable connecting DC power and RF on laser is 4m, and twist the cable into a single strand to reduce the mutual inductance between the terminals.

5. Make sure the laser shell and DC power supply are well grounded. The laser can be damaged because of not grounded or excessive noise from incorrect grounding.



6. DC power supply test. Firstly, test the DC power supply with multimeter (to check voltage) and oscilloscope (to check ripple) under no-load conditions, and test (use a multimeter, oscilloscope, and ammeter) it again with a laser load(full laser power output), to ascertain each value (voltage and current) of the power supply output parameters meets the demand of N30.

Make sure the RJ45 connector is totally plugged in and the screws on positive pole and negative electrode tightened to avoid the failure of the laser due to poor contact.

4.6 Cooling

The photoelectric conversion rate of the laser is 10% only, which means only 10% of the electric power input is converted into laser power output, and the remaining power is basically converted into heat. And the heat has to be taken away, otherwise it will be accumulated and increase internal temperature of the laser which will cause damage to components in the laser in the end. The heat generated in N30 series CO₂ laser is taken away by external cooling system.

Air cooling

The N30A CO₂ Laser comes with fans and there has to be 6cm space left between the fans and other objects on each side during mounting. If the laser is covered with a shell, there should be holes or external fans mounted on the shell to ensure proper ventilation (air flow is $\geq 6\text{m}^3/\text{m}$). If the laser works in a dusty environment, attach a strainer and fans onto the shell. The strainer has to be cleaned regularly. (If the operation environment is extremely dusty, please choose N30L instead.)

Qualified Ventilation: If the ventilation is proper, the temperature rise of N30 shall be $\leq 20^\circ\text{C}$ during operation compare to when it is in OFF state. The ambient temperature should be within $5 \sim 45^\circ\text{C}$, and the maximum temperature of the laser surface should be less than 65°C .



Water cooling

N30L CO₂ laser is cooled with coolant.

Coolant requirements:

Water flow at the water outlet on laser (minimum)	5.7L / min
Coolant temperature	10°C-35°C
Water pressure (at water inlet on the laser)	205-520 kPa
Cooling water hardness (equivalent to CaCO ₃)	<250mg/l
Pressure difference	Min170kPa
Heat capacity	2.5kW
pH value	5 to 9
Particle size	Diameter ≤200μm

Chiller requirements

1. Cooling capacity $\geq 2.5\text{KW}$;
2. Chiller lift $\geq 21\text{m}$.

Rated flow of chiller is the water flow without load which is not the actual flow when it works with laser. To ensure the chiller meets demand of the laser (flow at water outlet on the laser has to be $\geq 5.7\text{L/m}$), so the lift of chiller has to be considered about as well.

3. The pipe used as cooling path shall be as big as possible. If need to transfer the bigger pipe into a smaller one to match the water inlet/ outlet of the laser, the smaller pipe should be as short as possible.

Coolant temperature setting

There are electronic components, RF power units and optics in the laser, all of them are very sensitive to condensation. If there is condensation on the surface of any of



them, it can cause components damage, poor output (power and laser beam mode) of the laser, even the laser can be destroyed. To ensure the laser works normally during operation, the coolant temperature needs to be set properly.

The two factors need to be considered about when setting coolant temperature:

1. Air temperature
2. Relative Humidity

If the laser works in an environment with air conditioning, the coolant temperature can be set at 25°C, and the final value is up to the Air temperature Relative Humidity in the area where your laser is operated. Generally recommend to set the coolant temperature close to the air temperature (within $\pm 2^{\circ}\text{C}$).

Coolant temperature setting (based on Air temperature and Max. Relative humidity) for reference ($^{\circ}\text{C}$):

Air temperature ($^{\circ}\text{C}$)	Max. Relative Humidity (%)							
	30%	40%	50%	60%	70%	80%	90%	95%
5	20	20	20	20	20	20	20	20
10	20	20	20	20	20	20	20	20
15	20	20	20	20	20	20	20	20
20	20	20	20	20	25	25	25	25
25	25	25	25	25	30	30	30	30
30	30	30	30	30	35	35	35	35
35	35	35	35	35	35	35	35	35
40	35	35	35	35	N/A	N/A	N/A	N/A

1. Values given in the chart as above are for reference only, please match the Air Temperature and Max. Relative Humidity in the area where your laser is operating.
2. N/A: the laser can't be operated in this area due to condensation.



Chart explanation The first column in the chart is the real air temperature and the first row is the Max. relative humidity. Values in the column are the cooling temperature setting for reference. For example, if the air temperature is 26°C and the Max. relative humidity is 80%, then the coolant temperature shall be set at 30°C.

Note: please dry the laser if it needs to be stored, shipped or not being operated for a long time. Water left in the laser can cause damage to it.

4.7 Control signals

The N30 laser is controlled with an external input control signal, and requires working enable signal, working modulation signal and an external safety lock device, which can monitor the output signal of N30 CO₂ laser to know the working status.

Material and tool requirements

TTL Logic Generator	Adjustable frequency and duty cycle
Oscilloscope	Oscilloscope bandwidth is decided according to the modulation frequency required by the operator

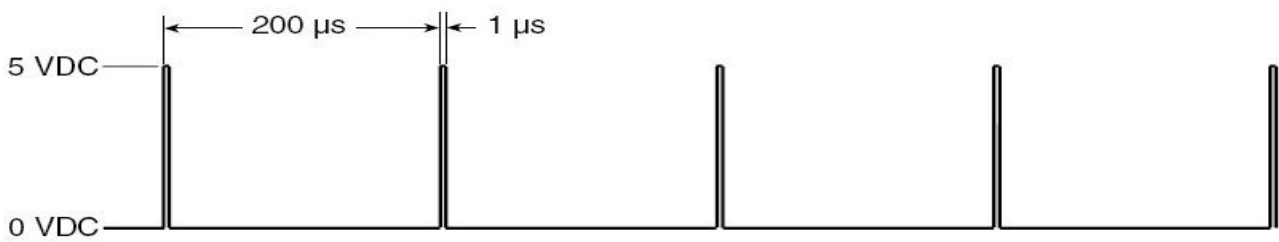
Control signals requirements

The control signal must be TTL logic.

There is around 50mA current sink at laser control terminal when it is powered on, so the command signal must come with sufficient drive capability to avoid big changes in the TTL control signal level. The high level of the control signal should not differ too much when it is with and without load. E.g if the high level control signal is 5V under no-load running, then it is better maintained at 4.5V and above when it is loaded.

Note: There is a 42s delay in the initial setting of N30 CO₂ laser which is given by the chip in the laser. During the delay, provide pre-ionization signal to the chip to make the gas mixture in the laser to be in preionized state. And then apply a small pulse signal that the laser fires immediately when the delay is over.

If the operator doesn't want the delay, then need to provide a pre-ionization signal (5kHz, 1µs, refer to the chart as below) to the laser from external control system. If there is no pre-ionization signal, the laser can't work stably.



- **The state of the control signal pins must always be in a controllable state.**

*When the signal cable is connected to the N30 laser, the signal of each pin on the connector must be in a controllable state at all times. If the pins are in the high-impedance floating state that uncontrollable level signals can occur.

- **The modulation signal must be a differential signal, otherwise the N30 laser is easily damaged due to excessive common-mode interference voltage.**
- **The duty cycle of the modulation signal must be selected according to different lasers. The high-level pulse width should be between 3μs ~ 1000μs.**
- **The modulation signal should be a pure TTL logic. Excessive interference (voltage fluctuation), voltage transitions, and voltage spikes in the control signal will cause damage to the internal control circuit board and RF amplifier of the N30 laser.**

*To protect control signal to N30 laser from being interfered, please keep the cable away from electrical appliances and cables which come with high voltage, large current, and electromagnetic wave radiation.

4.8 Optical Path protection

The output window lens of N30 CO₂ laser is very sensitive. The particles and moisture attached to the lens can cause fatal damage to it. Well-sealed external optical path can prolong the service life of the laser and reduce the failure rate of the laser.

The problems that can happen to the front output window lens during the operation of the laser:



If the N30 CO₂ laser works in a dusty environment, or the environment is oily, colloidal particles, etc., the output window lens of the laser can be contaminated (dust, oil, water, etc.) very possibly. If the lens is contaminated, the coating on its surface can be burnt by high density laser power, which can cause its laser output power reduced and the spot mode deteriorated.

If the material processed comes with a plane (metal, etc.) with high reflectivity to 10.6 μm wavelength, the laser exit window can be penetrated by the retro-reflected laser power due to the back reflection. If the working table of the laser processing system is an even metal plat (such as an aluminum plate), the front output window of the N30 CO₂ laser can be burnt out due to backward reflection.

To avoid the possible problems above, need to take the following measures:

If the equipment works in an environment full dust, oily particles, colloidal particles and other adherent pollutants, the front output window of the laser should be sealed.

The external optical path has to be well sealed, and blow N₂ to the optical path if necessary. If the whole optical path cannot be fully sealed, please install a protective lens at where is not less than 10cm away from the laser output window, and the protective lens must be antireflective on both sides.

If there is metal or other substance plane which has high reflectivity to the laser wavelength on the processing materials, please install retro-reflection isolator to avoid damage to the front output window of the laser caused by retro-reflection. If the working table of laser system is a flat metal plate, choose a honeycomb processing platform instead of a flat one to avoid back reflection.

4.9 Fixing

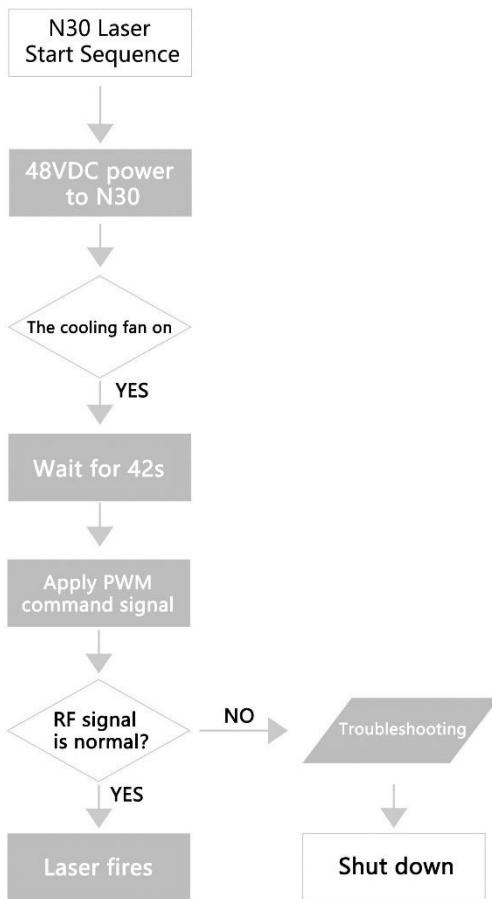
The laser can be mounted at any angle. If the laser is mounted with output window upside, must apply protection to the laser output window in case it is burnt out due to dust particles attached on it.



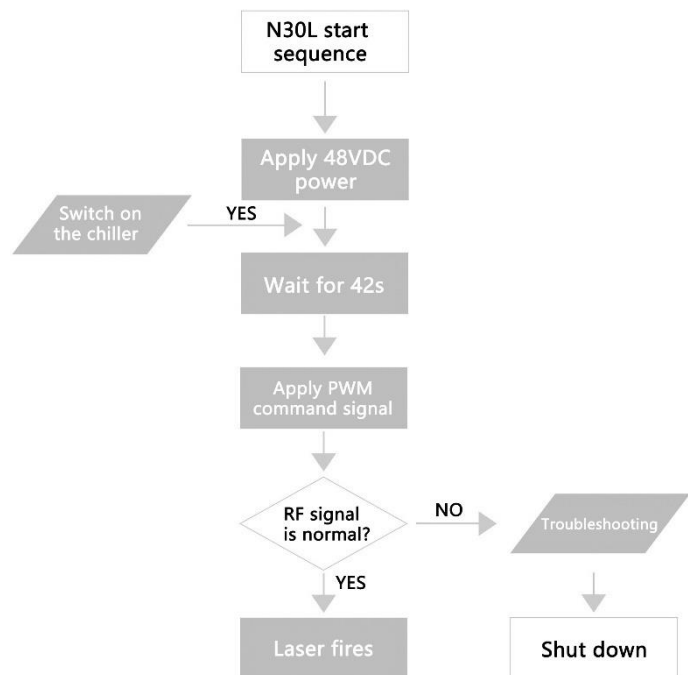
Avoid subjecting the laser cavity to strong external distortions in the mounting of N30 CO₂ laser. Long time last strong distortion can deform the cavity of the laser and cause the laser to detune, which can cause issues like the laser power decrease, the laser spot mode deterioration, and even the laser can't fire.

Chapter 5 Control & Operation

5.1 Operational Flowchart



N30A (air-cooled) operational flowchart



N30L (water-cooled) operational flowchart

Note: When you shut down the system, please keep the cooling fan running for 5mins after the N30A laser stops firing. Dust is very easily absorbed to the high-temperature laser, which can affect the cooling of the laser.



5.2 Operation Preparations

Only need to apply the 48VDC power and the control signal through the RJ45 connector on the laser to make the laser work.

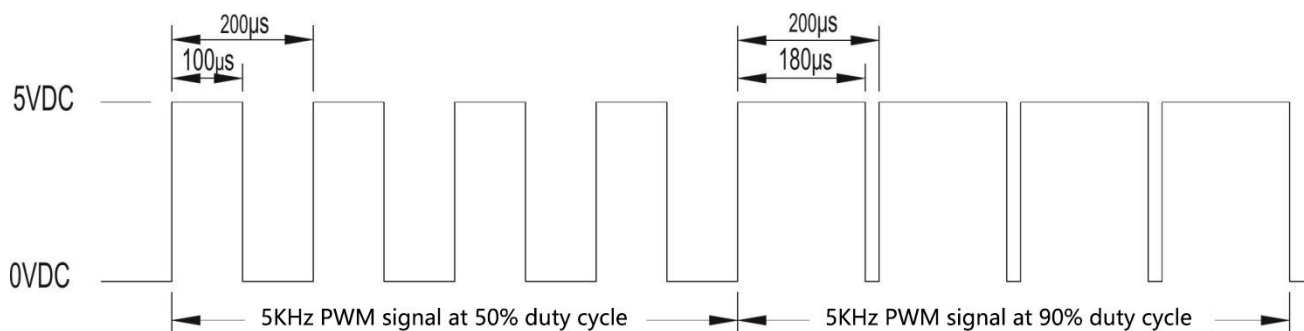
Preparations

1. DC power supply (48V, output more than 600W)
2. Fixing bracket (firm and flexible)
3. TTL logic generator (Modulation frequency: 0~25kHz, duty cycle: 0~100% adjustable)

5.3 Control terminal

The N30 CO₂ laser is controlled by an external modulation signal, the signal input to and output from the laser is a TTL logic. The ON/OFF and output power of the laser can be controlled by the ON/OFF and the duty cycle of the modulation signal. At the same time, there is also a rich detection and feedback signal interface on the laser to help the operator to tell the working state of the laser. The operator needs to prepare a differential linear drive module which is to provide the drive signal to the laser, TTL logic generator and other control and detection devices.

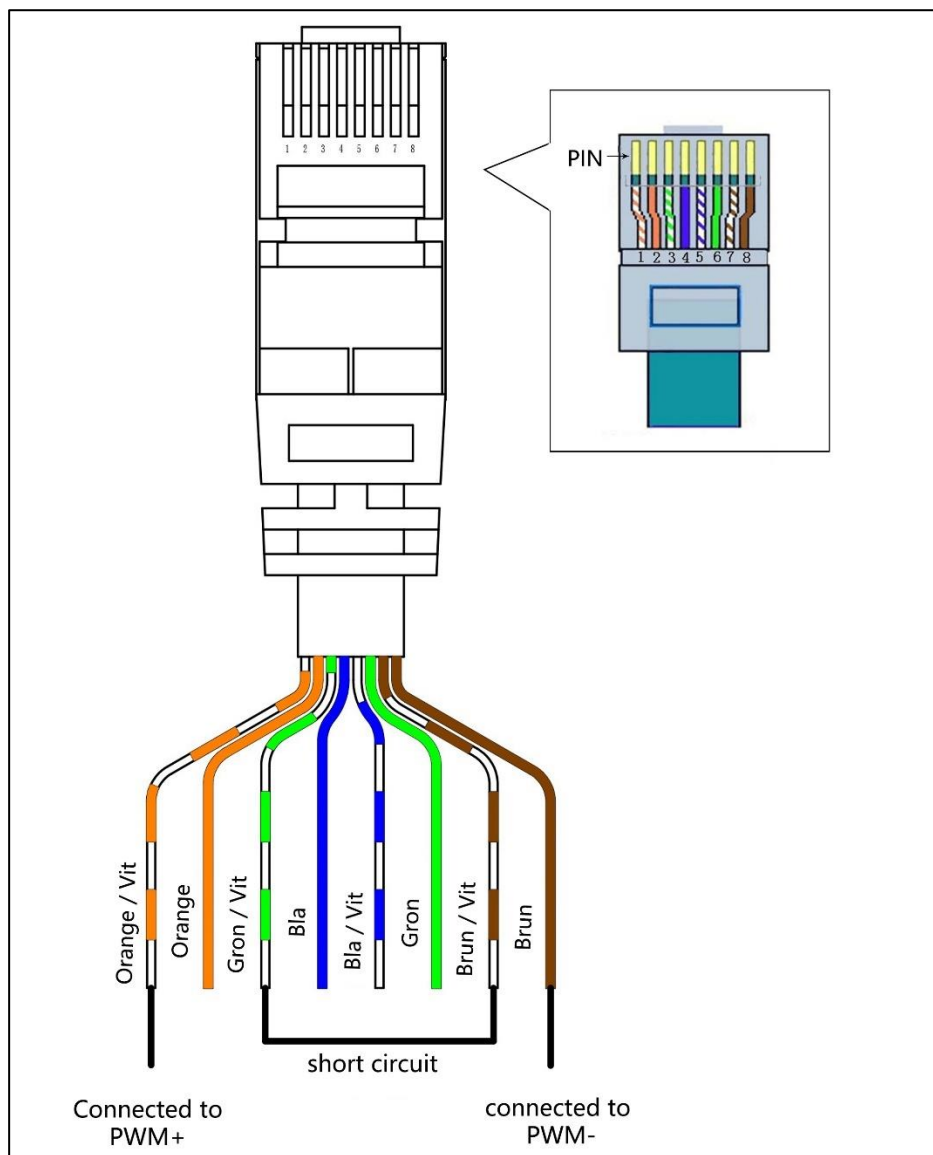
Note: The waveform shown below is a typical 0-5V TTL logic with adjustable duty cycle (or pulse width) and adjustable frequency:





5.4 RJ45 Connector

The operation of the N30 CO₂ laser is easy, please refer to the definition of RJ45 connector as below.



N30 simple wiring diagram

* Corresponding to pins 1-8 from left to right. For more wiring options for different functions, please refer to the connector definition.



RJ45 interface definition description on the laser:

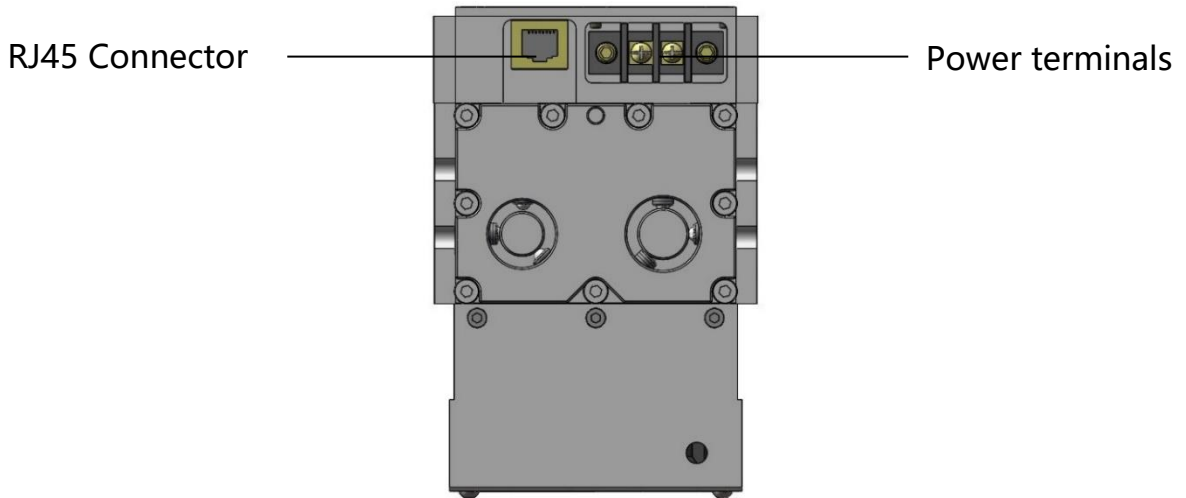
PIN No.	Signal description	Description
1	TTL logic input Input TTL logic; 1=RF ON, 0=RF OFF; input 1kΩ impedance	Pin 7 is set at logic high first, and then set this pin at logic high to generate laser.
2	Output +15VDC±0.5VDC, 250mA.	Parameters for reference to check RF power supply. If the voltage is not in the listed range, the laser needs maintenance.
3	LASER OK TTL logic output; 1=LASER OK, 0=laser fault	During the pre-ionization process after the laser is powered with DC 48V, this pin is at logic low; please input TTL logic when this pin is at high logic.
4	Temperature OK Output TTL logic; 1=temperature OK, 0=temperature Fault	When the laser temperature exceeds 65°C, “temperature fault” alerts and output logic low. The laser stops automatically.
5	Voltage OK TTL logic output; 1=voltage OK, 0= voltage Fault	When the DC power supply output voltage exceeds 55V, error report, output logic low.
6	GND	Internal ZAMIA use; must be grounded by OEM.
7	Control Enable Input TTL logic; 1=laser control enabled, 0=laser control disabled	When this pin is at logic high, the laser is enabled; and then input logic high to pin 1, the laser can fire.
8	Logic ground for all interface signals (customer)	
All the interface signals are connected to the same GROUND		
The connector used is RJ-45 type.		

Attention

1. Place a power meter, or something else that can obstruct the laser beam in front of the laser aperture to avoid accidental injury during operation.
2. Please find the requirements for laser control and test in the manual.



5.5 Controls and indicators



N30 control interface and power terminals

Control connector and power terminals description:

Item	Description	Remarks
Power terminals	Power the laser through it	Terminal block screws: SM4x0.7 Positive and negative screw model: M4x0.7
RJ45 Connector	Control signal I/O interface	Strongly recommend to use shielded CAT5E network cable

*Please refer to Section 5.4 for details of the RJ45 connector

5.6 Start-up and pulse operation

Before operating the N30 CO₂ laser, please confirm the following items again:

1. The output voltage of DC power supply meets the working voltage required by N30 laser;
2. TTL control logic meets the laser operation requirements;
3. Power terminals and signal connectors are in good contact;
4. The dustproof plug attached on the laser output window is removed;
5. Protections to the laser and the personnel who are in the laser operation area are well done.



When the N30 CO₂ laser is properly powered with 48VDC, check if the fan or the chiller works OK, and then wait for 42s (please give preionization signal to the laser if the customer doesn't want the 42s delay). Input PWM command signal and the laser fires immediately. The higher the PWM signal duty cycle, the stronger the laser output power.

If the laser works in a high humidity environment, please check if there is condensation on the surface of the N30 CO₂ laser output window lens. If there is condensation, it means the environment humidity is too high and please use air-conditioner if necessary. If the laser does not work for a long time, please cut the power to the laser and stop cooling. Keep the connectors of external optical path well sealed with rubber ring if the laser works in dusty environment.

5.7 Laser Operation Safety Tips

This product is class IV laser. It can cause personnel injury and fire due to its diffuse reflection, please always be careful!

Do safety precautions according to this manual.

Chapter 6 Technical Reference

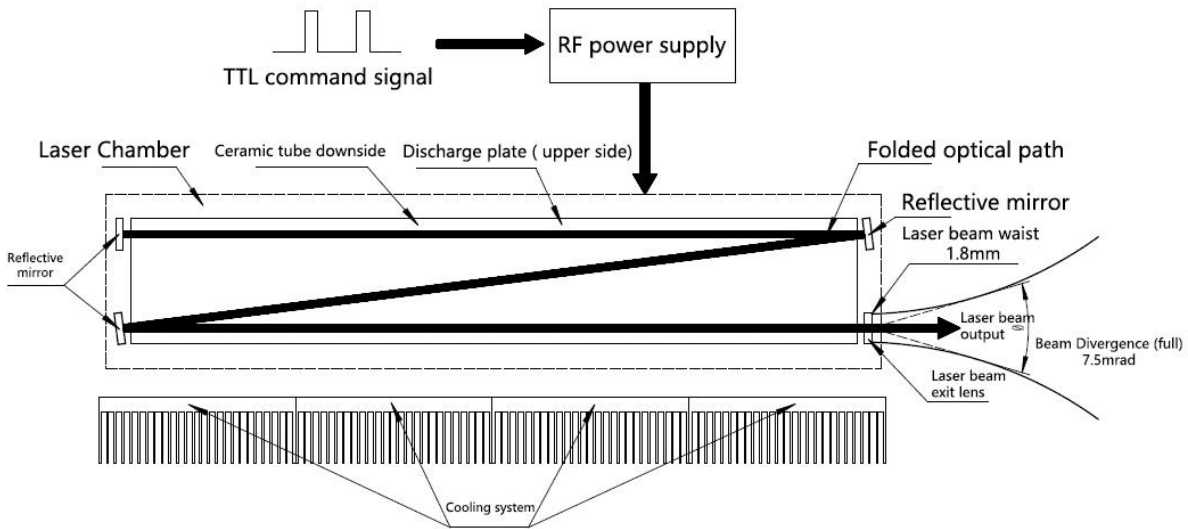
6.1 Optical resonator

N30 is a RF-Excited CO₂ laser with waveguide optical resonator, which is excited with RF power supply as pump source to discharge the optical resonator. There are four pieces of adjustable optics mounted on ends of the resonator, three of them are full reflection mirrors and one is optical lens with certain transmittance, and they form a folded optical resonator in a "Z" shape. In the optical resonator, there is a plasma tube excited by radio frequency which is composed of a discharge plate and a ceramic plate, its mechanical structure is shown as below.

The discharge plate is processed into a specific shape, so that the resonance frequency of the optical resonator can be 100MHz which matches the operating



frequency of the RF power supply. And there is laser guiding path processed on the ceramic plate in “Z” shape.



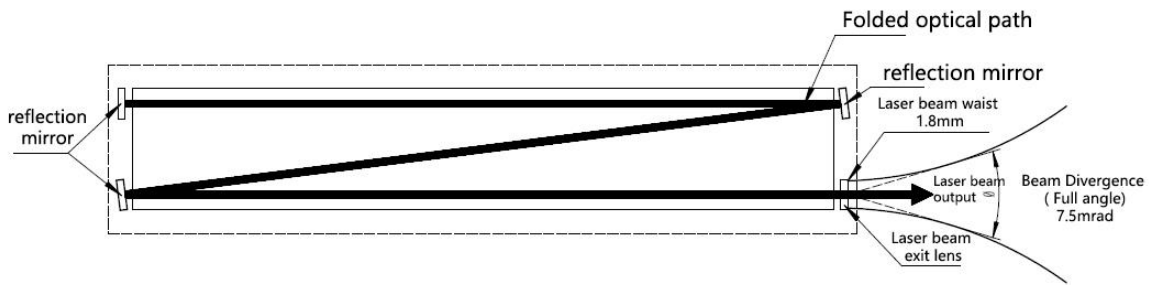
6.2 Pre-ionization

Input RF power to ionize the CO₂ gas mixture to generate laser, meanwhile, around 80% of the RF power is converted into heat left in the discharge area. The heat spreads to the surface of the laser through its metal shell and is taken away by the cooling fan or water cooling plate.

6.3 Laser beam

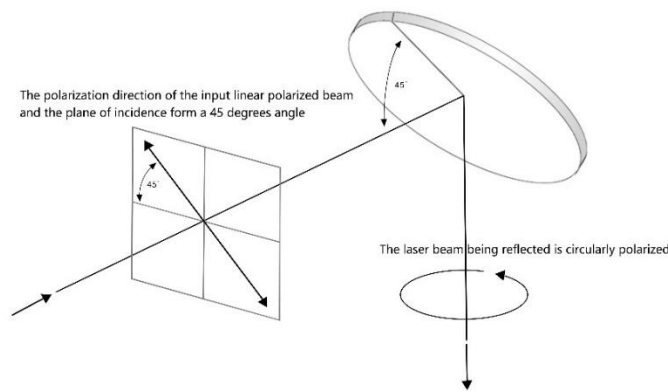
The laser beam is in round-like shape at the laser beam exit aperture and turns into round at longer distance (around $\geq 0.3\text{m}$ away from the laser beam exit) which is in Gaussian-like shape. The mode factor (M^2) generated by the structure and optical components in the optical resonator is < 1.2 . You can see from the picture as below, the laser beam waist is 1.8mm at the laser aperture, and the

divergence angle (full) is 7.5mrad (7.5mrad means the laser beam waist increases 7.5mm when the distance from the laser aperture increases 1m.)



6.4 Back-reflected beam isolation principle

It requires a retro-reflective beam isolator mounted in the external optical path if N30 CO₂ laser is applied to process high reflective materials. The principle is as follows: The laser beam is incident on a device that completely transmits P-polarized light and completely reflects S-light, such as a Brewster window, incident on a 45-degree phase delay device, like 45-degree phase retarder, incident on a focus lens to do laser process. After the P light is reflected by the high reflective material, it passes through the phase delay mirror twice to become S light. When it enters the Brewster window, it cannot be transmitted and totally reflected, and then cannot return to the N30 RF laser. The unidirectional optical path transmission device composed of Brewster window and 45-degree phase delay mirror is a kind of beam isolator.



45° Phase delay mirror principle diagram

6.5 External optical path & attentions

Generally in the laser process, the laser beam is expanded and then focused before it



reaches the processing materials. On the laser cutting machines, the laser beam is reflected by 3pcs of full reflectors which are mounted in 45 degree on the machine and then focused by lens to reach the material. On laser marking machines, the laser beam passes the beam expander firstly, and then reflected by the X Y mirrors in the galvo, finally reaches to the material after being focused by the F-theta lens to achieve high precision process in small field.

Good exhausting is required in the process area to protect the lens from harm of smoke from processing. The external optical path from beam exit aperture to focusing optic on machines shall be well sealed, blow clean air or nitrogen to the optical path if necessary.

Pay attention to each every component in the optical path during mounting and tuning, there shall be no contaminant on any of them and do not apply too much mechanical stress to it.

6.6 RF power supply

N30 CO₂ laser generates a 100MHz RF signal with a crystal oscillator, and generates a high-power RF output through a power amplifier circuit. The RF power supply is powered by a 48V DC power supply, and the laser output power is controlled by a PWM signal.

The RF power supply provides laser status indications. Help customer to tell the working status, temperature and power supply voltage test, etc by sending feedback signal through output terminal (RJ45) to the external control system.



6.7 Modulation signal & PWM method

The N30 CO₂ laser receives external PWM signals to modulate the output laser power. The RF power supply is ON/OFF according to the pulse width and frequency of the command signal to have the corresponding laser pulse output. For N30 CO₂ laser, the maximum duty cycle is 100%.

The relationship between Q-switched frequency and pulse width is as follow

$$W = \frac{\text{duty cycle} * 1000}{Q}$$

Formula description

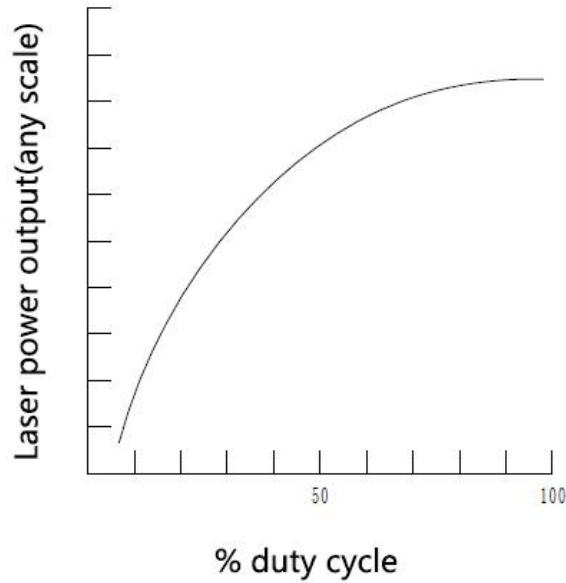
W	Modulation pulse width in μs
Q	Modulation frequency in kHz

For example, 5kHz frequency, duty cycle is 60%, according to the above formula, calculate $W = 60\% * 1000/5 = 120\mu\text{s}$.

6.8 Marking & engraving

Input PWM signal to modulate the laser pulse width and laser pulse frequency for modulating the laser output power. In some materials processing, better processing results can be achieved with certain laser frequency and pulse.

When choosing the PWM signal duty cycle, 95% duty cycle is recommended as the maximum value, because the laser output power is hardly increased between 95% and 100% PWM duty cycle (as shown in the figure below). When the laser power saturation is approached, the PWM duty cycle produces a non-linear power function, which flattens out when the duty cycle is about 95%. If you keep using 100% duty cycle, it increases the power consumption and 5% thermal load.



Chapter 7 Maintenance

If damage on optics of the laser found, please contact SPT LASER for after-sale service. The N30 CO₂ laser comes with a sealed maintenance free design, only regular inspection and cleaning of optics are required. Dust and cotton fibre are the common contaminants on optics of the laser which can cause laser beam absorption and scattering, which can cause permanent damage to optics in extreme cases. And permanent damage to the laser is also possible if the optics are removed improperly.

Regular external maintenance

Please turn off the device and disconnect the power. It is recommended to use a wet cloth to clean the laser shell, do not let water into the laser to avoid damage to the laser.

Maintenance of Laser optics and external optics

Please turn off the equipment and cut the power, stop the chiller, and seal the external optical path of the laser processing equipment. Take off the lens with gloves, put it on the non-woven fabric or special lens cleaning cloth. Use cleaning cloth dipped Alcohol or acetone to clean the lens and can only move in one direction. Do not reuse the used lens cleaning cloth. If the laser is used in a dusty environment, please blow it with filtered clean air or high-purity nitrogen firstly.



Maintenance materials requirements:

Material	Requirements
Gloves	Without dust
Nitrogen	>99.9%
Alcohol	Spectral Grade
Acetone	Spectral Grade

Chapter 8 Q&A

Q: Why do we need to wait for some time before inputting PWM signal to the laser after switching on the system?

A: To extend the service life of N30 CO₂ laser, the internal chip is set with 42s delay. During the delay, the laser gas mixture in the optical resonator is preheated to prevent the RF power supply from being overloaded instantly

Q: What matters during the storage and shipping of the laser?

A: The laser exit window has to be sealed to prevent any possible contamination to it. Handle lightly to protect the laser from any accidental impact.

Q: What are the requirements for the operation environment of the laser?

A: The air temperature should be maintained at 5 °C ~ 40 °C. External dust protection is necessary if the laser runs in dusty fields where the laser exit window is easy to be burnt. The humidity has to be within recommended range to condensation on the laser. The environmental pH value is neutral.

Q: How to clean output window of the laser if it is contaminated? Can do it with a cotton swab?

A: Do not wipe it with a cotton swab which can damage the lens. If there is only a small amount of particles attached to the output window and its coating is not burned out, please blow it with 99.95% pure nitrogen.



Q: If the size of the laser spot is known, how to decide the size of the optics in the external optical path?

A: The size of the optics in the external laser path shall be 1.5 to 2 times of the actual spot size.

Q: Power at the laser exit is strong, but it is very low on processing materials, what would be the reasons?

A: Generally, there is high laser power loss in the external optical path, the following points should be checked:

1. Check if the optics in the external optical path and the clear aperture are big enough;
2. Check if the optics in external optical path quality is reliable (the wastage of single optic shall be no more than 3%);
3. Check if there is contamination or damage on the optics in the external optical path;
4. Check if the alignment of external optical path is properly done.

Q: What to do when the laser power is low or unstable during operation?

- A:**
1. Test if the voltage of DC power supply connected to the laser is normal or not with a multimeter;
 2. Test if the command signal to the laser is normal or not with an oscilloscope.

Q: What are the sealing labels on the laser for?

A: If the sealing label is damaged, the warranty of the laser fails.