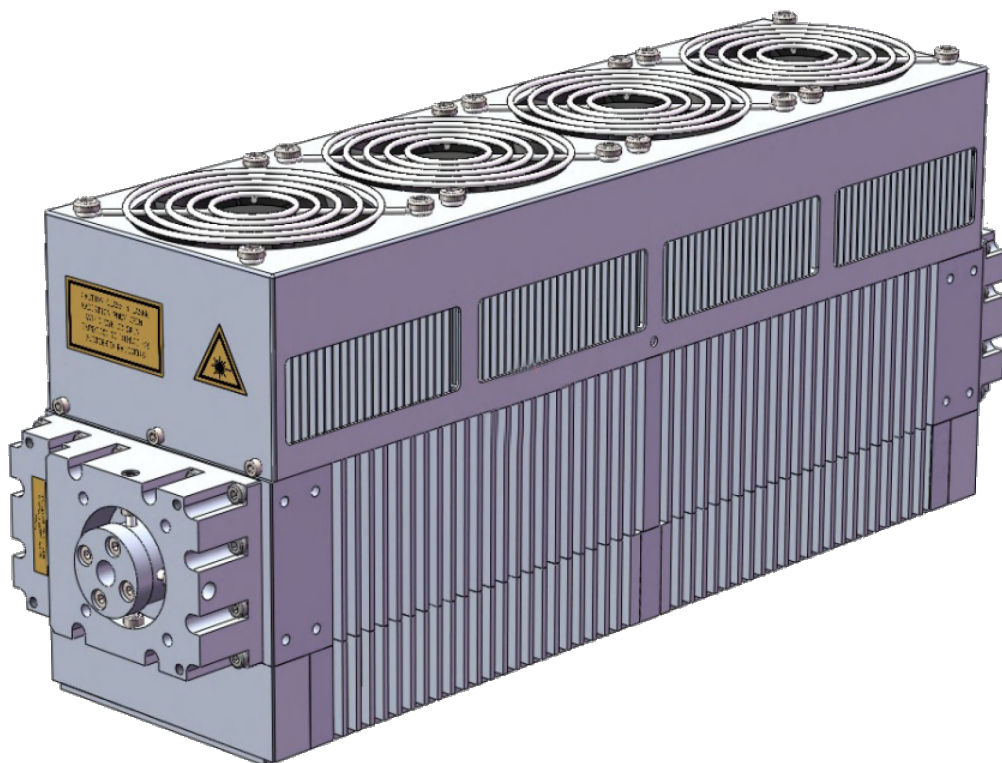




OPERATORS MANUAL

ET-SERIES CO₂ RF LASER



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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-ENET-26.07 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.

Version

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

Model

ET-series include ET-60A, ET-80A. For detailed product information and parameters, please refer to this manual.

1.2 Warranty Information

This is to certify that ET-series 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 ET-series, 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 external impact
7. Warranty void if seal broken

Contact

Email for support: support@laserwd.com

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

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

We request you to keep the original packing of ET-Series, to prevent any damage to the laser in storage and shipping.

For more info, please look up in this manual.

1.4 Basic Description

ET-series CO₂ RF laser is used for laser cutting, drilling, marking on non-metallic materials.

When ET-series CO₂ laser runs in an environment of high humidity, it is necessary to check if there is dew condensation on the surface and window lens of the laser. If so, it means that the ambient humidity is too high. If necessary, please install an air conditioner to reduce the ambient humidity. When the laser does not work for long, the power supply to the laser should be cut off and the heat dissipation should be stopped. When it is used in the case of heavy dust, it is necessary to conduct dust prevention. The light path should be sealed at the joint of each interface, and rubber rings should be used.

ET-series CO₂ RF excited laser dissipates heat by air cooling, and the laser has its own cooling fan. If there is a lot of dust in the ambient air, it is necessary to add a sealed enclosure outside the laser, and a fan should be added to the enclosure (with a filter screen on the enclosure) to force the air to circulate. The filter screen should be cleaned regularly, otherwise it will lead to poor heat dissipation, leading to power attenuation and even damage of the laser!

1.5 Packing list

ET-Series RF CO₂ Laser ---1pcs

DB9 male connector----1pcs

Test report ----1pcs

Quick Mounting Instruction ----1pcs

Packing list paper ----1pcs

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.

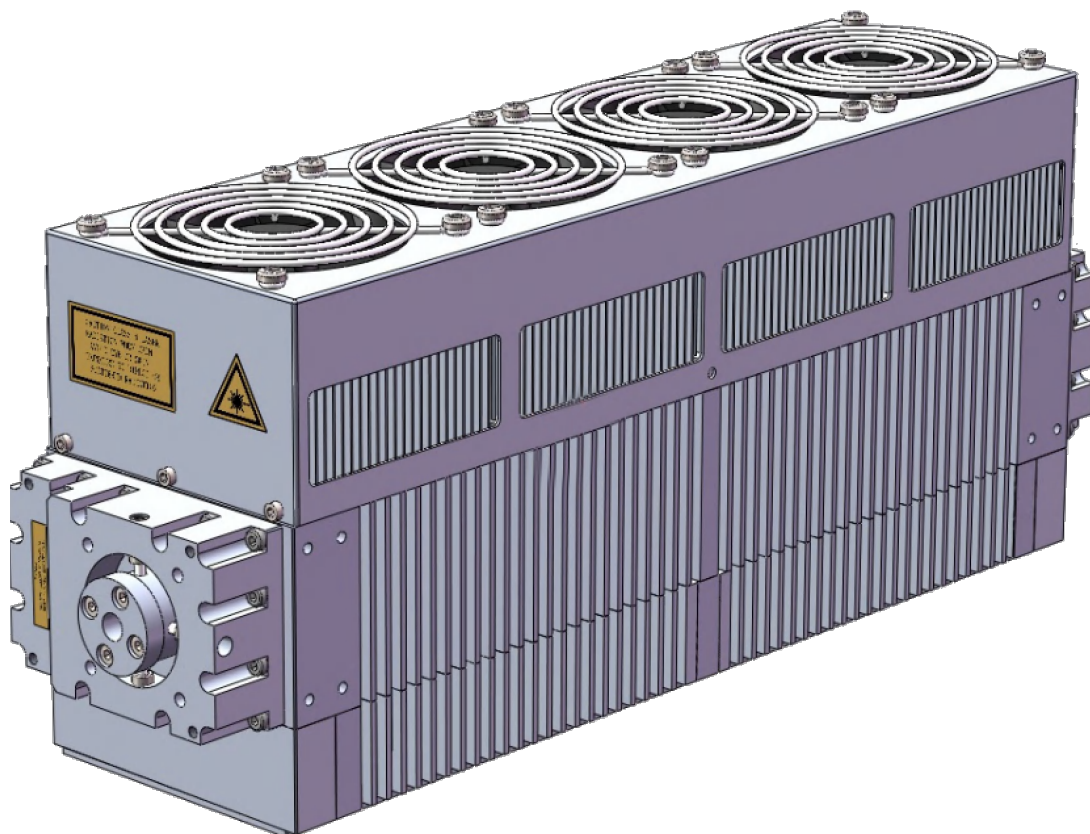
Because direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam. Do not allow the laser beam to contact a person, this product emits invisible laser beam which can burn the human tissues seriously. And any use of 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 3 hazard labels on ET-serise CO₂ laser, please check the info as below to know where they are located.



2.3 Operation instructions

1. Always wear laser goggles 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

Emergency stop

Use under emergency to stop laser by cutting the power.

Set up warning signs and control areas

Set up warning signs and blockers in the same area as an exposed laser beam.

Fire extinguisher

CO₂ or dry powder fire extinguisher shall be kept nearby where the laser is installed.

Chapter 3 Product Introduction

3.1 Brief

Output with circularly symmetric near TEM00 mode Gaussian beam;

Ê All-metal structure with sealed off design, maintenance free;

Ê RF power supply and cavity integrated package, appearance simplicity & easy to be integrated;

Ê Compact structure, high-grade dust-proof design, suitable for a variety of industrial environments.

3.2 Applications

Applications

ET-Series CO₂ RF laser is suitable for laser cutting, laser marking, plastic welding, and 3D printing.

3.3 Parameters& Operation Requirements

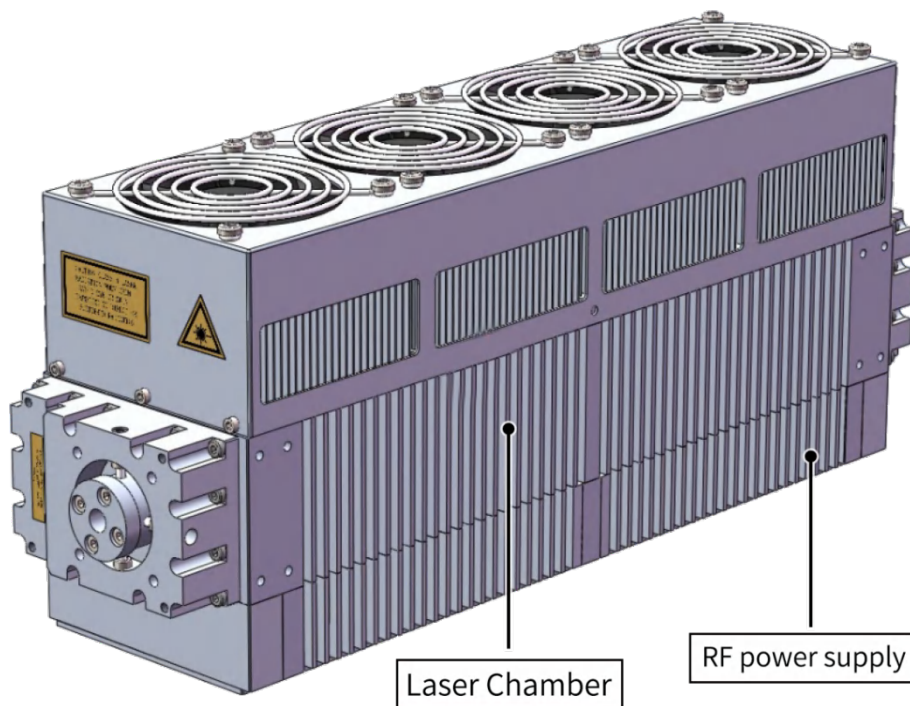
Parameters

Model	ET-60A	ET-80A
Pump Method	RF-Excited	
RF Frequency	81.36MHz	
Wavelength	10.6μm	
Average Power	60W	80W
Output power range	1~60W	1~80W
Beam Quality(M ²)	<1.2	
PWM Duty Cycle	1~100% (output stable at >4%)	
Modulation	0~50kHz	
Power stability	≤±7%	
Beam diameter (1/e ²)	2.1±0.3mm	
Beam Divergence (full)	≤7.5mrad	≤8.0mrad
Beam Ellipticity	<1.2	
Polarization	Linearly polarized,parallel to the base	
Range of Wavelength	10.3~10.8μm	
Dimensions	402.5mm*100mm*160mm	525.6mm*100mm*172mm
Weight	7.5kg	11.2kg
Input	48VDC±0.5VDC/15A	48VDC±0.5VDC/25A (Max. current)
Cooling	air-cooled	
Environmental Temperature	5~35°C (41~95°F)	
Humidity	≤95%, No condensation	

3.4 Product Structure

ET-Series 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.

· ET-Series Product Structure



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 wave guide surface of optical resonator.

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

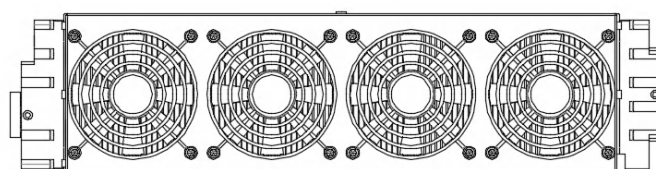
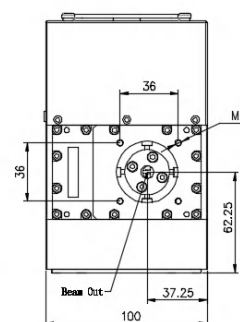
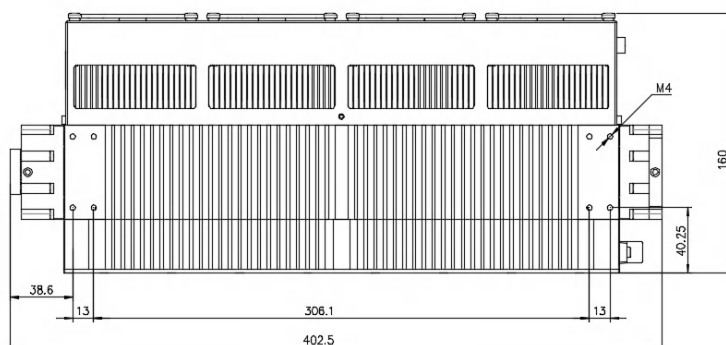
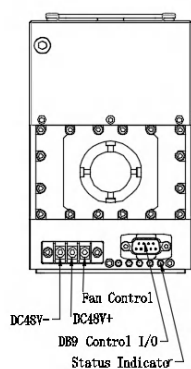
RF power supply

The RF power supply supplies pulsed RF power to excite and ionize the laser gas in the resonator. The pulse width and period of the laser can be controlled with external modulation signal.

Chapter 4 Mounting Instructions

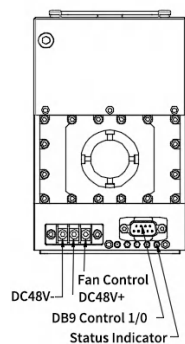
4.1. The Outline & Mounting of ET-Series

· ET-60A

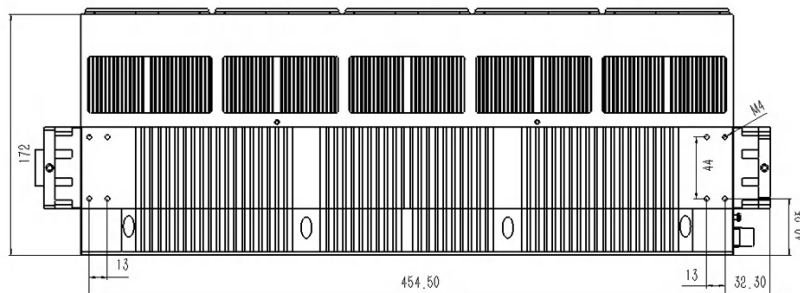


· ET-80A

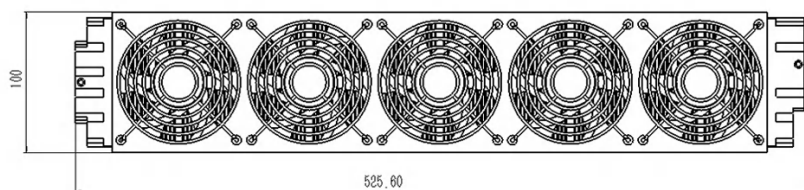
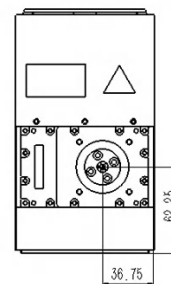
Back View



Side View



Front View



Top View

4.2 Operation Environment

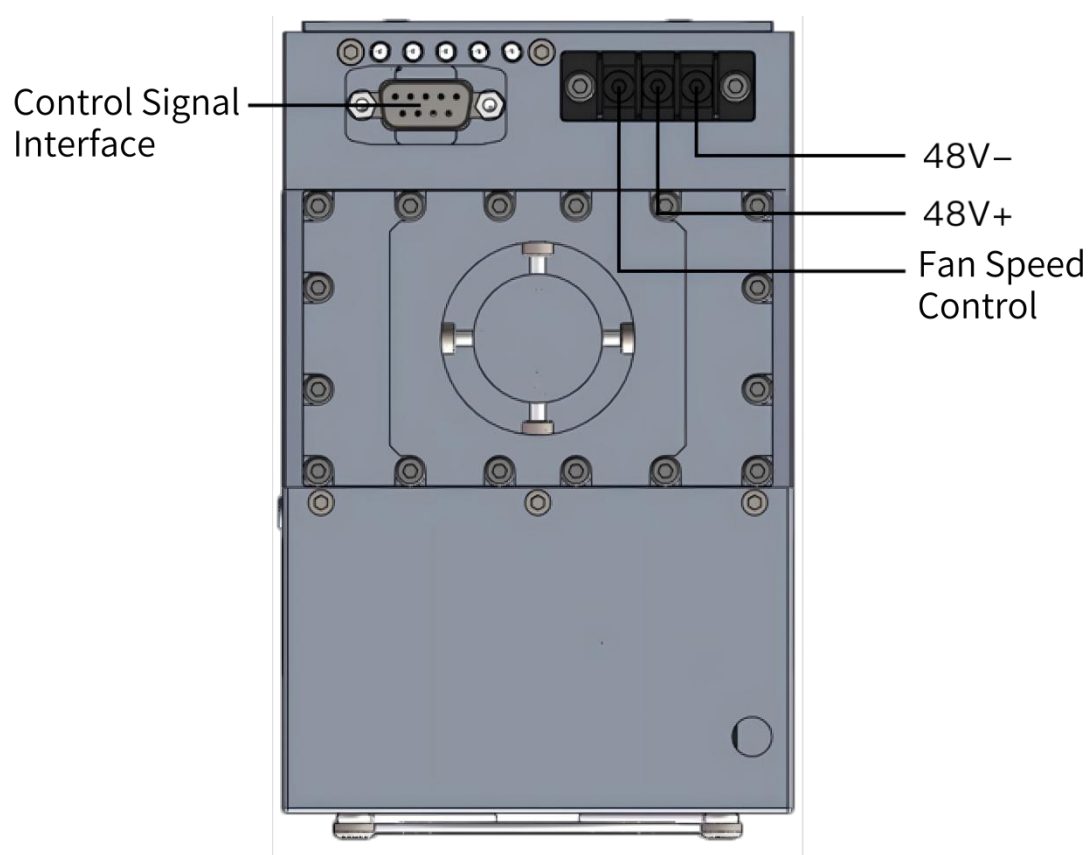
Requirements:

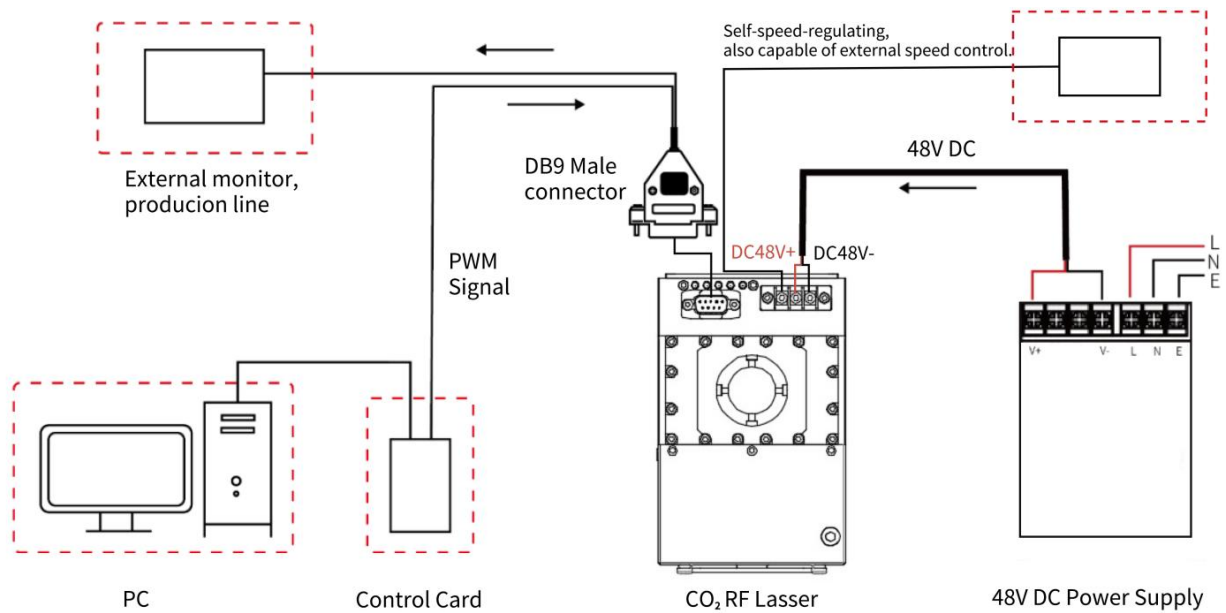
Temperature	5~35°C (41~95°F)
Humidity (no condensation)	<95%
Altitude	≤2000m

4.3 Wiring Diagram

Please follow the diagram as below to do the wiring when you use ET-Series CO₂ RF laser for the first time. For more detailed wiring info, please look up from Chapter 5, section 5.4.

ET-Series Wiring Diagram





4.4 DC Cable

ET-Series CO₂ laser works with DC power, a DC power supply with $48V \pm 0.5V$ output is recommended. The DC cable must be multiple twisted wires with reliable insulation performance, and the thickness of its conductive core shall be $>4 \text{ mm}^2$ and $<6 \text{ mm}^2$. The DC cable shall be no longer than 4m. If the power cord is longer than 4m, thicken the wire appropriately and be sure to fix it firmly, and check the input voltage to laser, make sure it is 48V.

Keep the wiring of the control cable away from the electrical appliances and cables with high voltage, high current and electromagnetic radiation to prevent the laser control signal from being interfered.

The multiple relationship between the current-carrying capacity of the insulated wire and the cross-section.

The unit of the wire is mm^2 , divided into two types: copper core wire and aluminum core wire, copper core wire is generally used.

Common wire section (mm^2):

1、 1.5、 2.5、 4、 6、 10、 16、 25、 35、 50、 70、 95、 120、 150、 185

Load current value of wire specified in GB4706.1-1992/1998

1mm²(6A~8A)..

1.5 mm² (8A~ 15A)..

2.5 mm² (16A~25A)..

4 mm² (25A~32A)..

6 mm² (32A~ 40A)..

For a wire of 1.5, 2.5, 4, 6, 10mm² the cross-sectional area can be multiplied by 5.

For a 16, 25mm² can be multiplied by 4.

For a 35, 50mm² can be multiplied by 3.

For a 70, 95mm² can be multiplied by 2.5.

For a 120, 150, 185mm² can be multiplied by 2.

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. DC cable

DC Input of ET-Series

Model	ET-60A	ET-80A
Max. current	18A	30A
Voltage	DC48V±0.5V	DC48V±0.5V
Continuous working current	≤18A	≤30A

Operation precautions

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.

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 100 μ s if the start pulse width of laser is 300 μ s.)

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 3m.

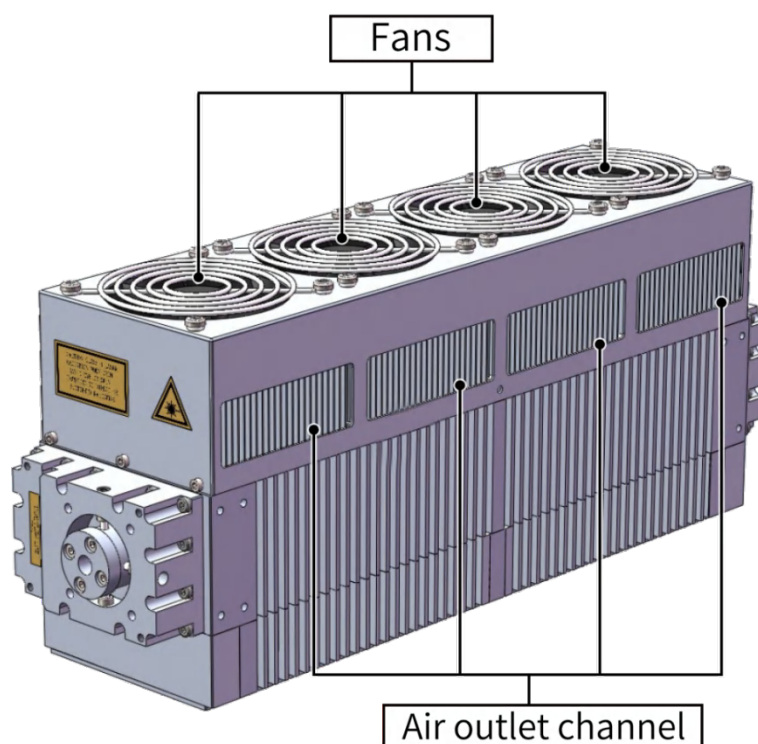
1. An over voltage protection circuit between DC power supply and RF power supply is required to avoid laser damage due to excessive voltage fluctuations.
2. Connect the power supply according to the labels located at the back side of the laser. "+" is anode on RF power supply, connect to "V+" on DC 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.
3. The laser shell and DC power supply must be correctly grounded. The laser can be damaged because of not grounded or excessive noise from incorrect grounding.
4. 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 ET-Series.
5. Do not apply too much strength when connecting the cable to electrodes on the laser. Too much strength can do irrecoverable damage to the RF amplifier in the laser.

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.

ET-series CO₂ laser uses air-cooled heat dissipation. Driven by fans, air enters the laser air channel and flows out near the front and rear end plates of the laser. The laser is cooled by a constant flow of air. Therefore, when the laser is running, do not block the fans and the laser air outlet channel. Ensure that the fans and air outlet are unobstructed and there is at least 6cm gap to smooth the cooling air flow.

The fans speed is automatically adjusted according to the laser temperature. The rotating speed of the laser is low in standby mode and the speed is high when the laser is working at high power. It is a normal phenomenon that the fans sounds different when working at different duty cycles.



4.7 Control signals

The ET-Series laser operation is controlled with external command signal, and requires working enable signal, working modulation signal and an external safety lock device, which can monitor the output signal of ET-Series CO₂ laser to know the working status.

Material and tool requirements

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

Command signals requirements of ET-Series

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.

The internal chip has a built-in pre-ionization signal. When powered on, the gas inside the laser is in a pre-ionized state. Upon receiving the light-emission signal, the laser will generate laser output immediately. If an external control card provides the pre-ionization signal, the recommended parameters for the pre-ionization signal are as follows: 5 kHz, duty cycle 1%–1.5%. At this time, the laser emission status indicator will be constantly on.

- The command signal pin must be always in a controllable state.

When the signal cable is connected to the ET-Series 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.

- **Command signal -- TTL logic**
- The duty cycle of the modulation signal must be selected according to different

lasers. The high-level pulse width should be $>3\mu\text{s}$.

- The modulation signal should be a pure TTL logic. Excessive interference (voltage fluctuation), voltage jump, and voltage spikes in the control signal will cause damage to the internal control circuit board and RF amplifier of the ET-Series laser.

4.8 External Laser Path Protection

The laser exit aperture of ET-Series 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 ET-Series 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 / 9.3 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 ET-Series 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 must 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 anti-reflective 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 ET-Serie 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 Operation Preparations

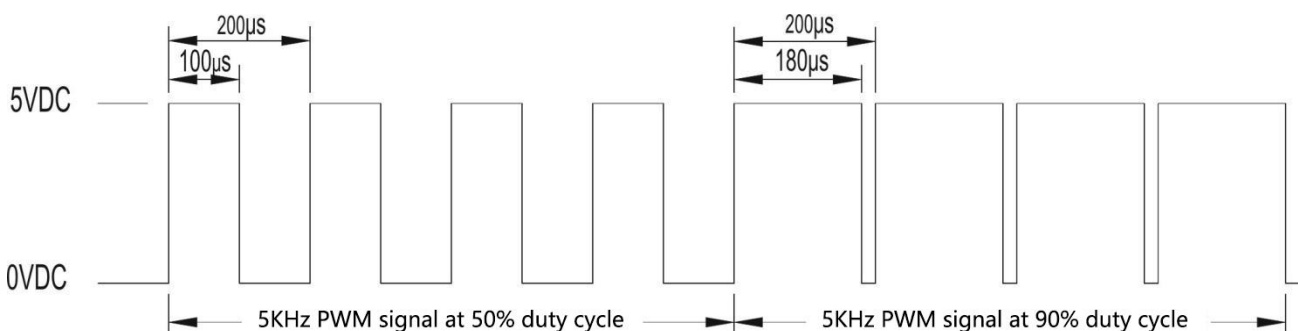
Apply the 48V DC power and the command signal through the DB15 connector on the laser to make the laser fire.

1. DC power supply (48V, output more than 1500W)
2. Fixing bracket (strong and flexible)
3. TTL logic generator (Modulation frequency: 0~100KHz, duty cycle: 0~100% adjustable)

5.2 Control terminal

The ET-Serie 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.

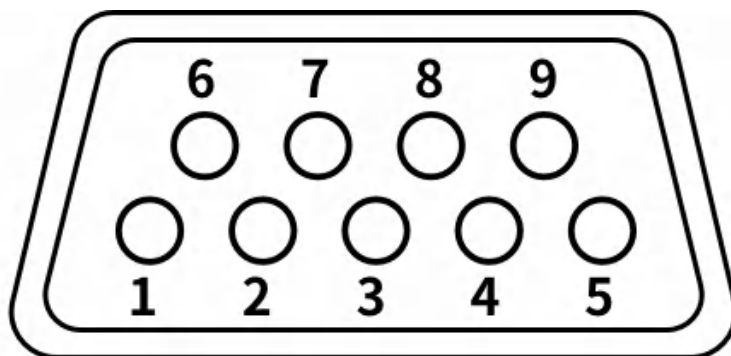
Note: The waveform shown below is a typical 0-5V TTL logic with adjustable duty cycle (or pulse width) and frequency:



5.3 Control Signal Interface

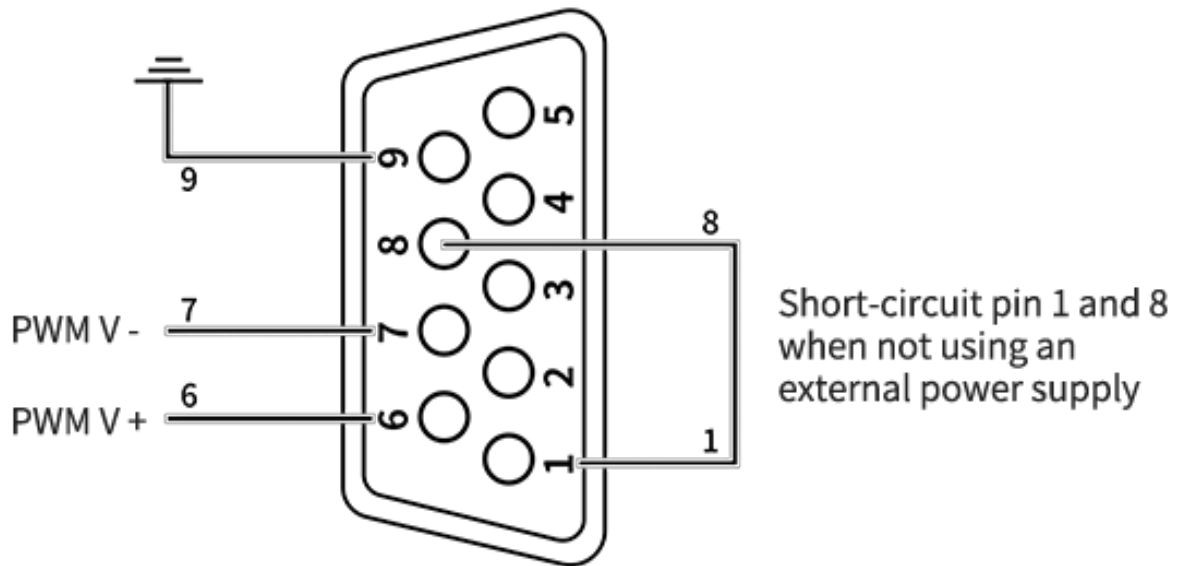
The ET series CO₂ RF laser comes a DB9 female connector as the laser interface. The PWM signal is input through the DB9 interface, to control the laser output.

The definition of DB9 connector

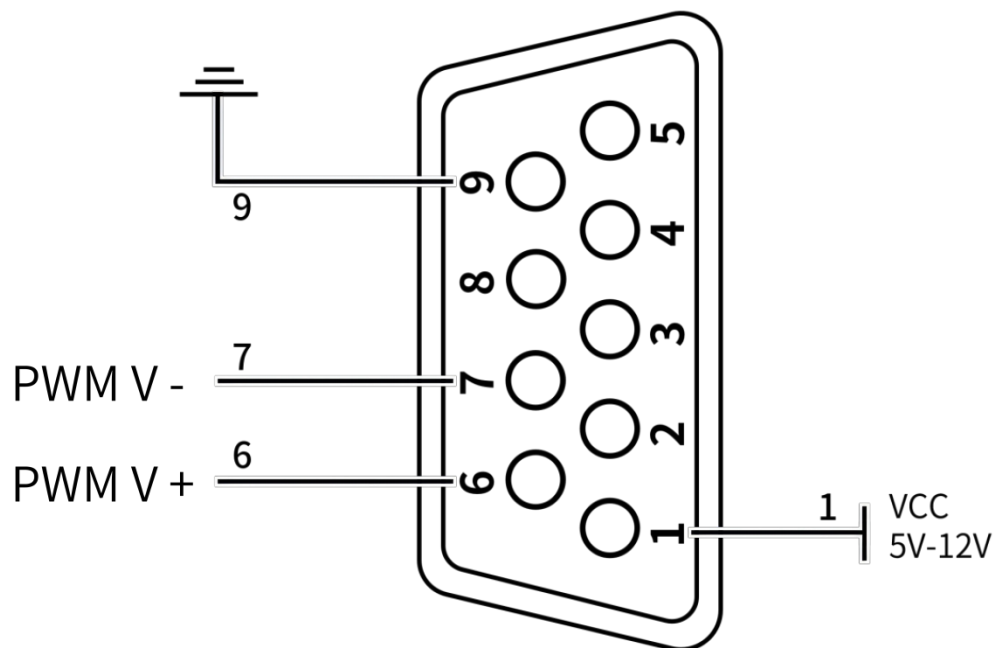


Pin	Function	Description
Pin1	Enable Signal	High level effective (DC 5V - 12V). The laser enters a 23-second preparation time before it can emit light. The return pin is Pin 9.
Pin2	Fault Output	Normally outputs 5V. Outputs 0V when a fault is detected. ^①
Pin3	Ready Signal	Outputs 5V when the laser is ready. Outputs 0V during power-on pre-ionization and fault conditions. ^②
Pin4	Undefined	Undefined
Pin5	Fault Indicator Signal	Connects to the fault indicator LED signal on the light board. The high level is 5V. ^③
Pin6	Light Emission Signal Positive	Light emission signal (PWM), high level effective
Pin7	Light Emission Signal Negative	
Pin8	5V Output	Can be used for external power supply with a current capacity of 200mA
Pin9	Return Pin	

Wiring (When enable is not driven by external power)



Wiring (When enabled by external power supply)



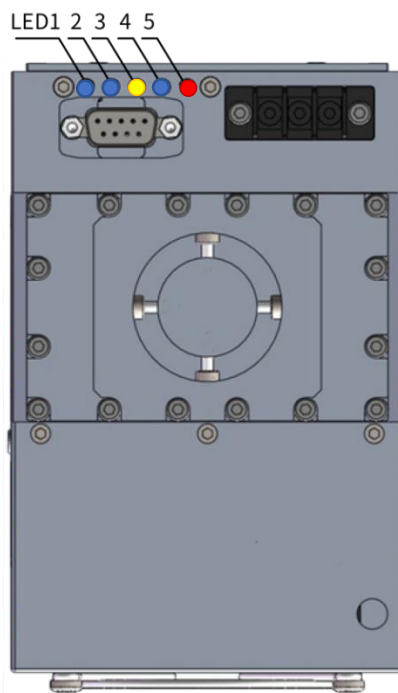
Input signal

The ET-Serie CO₂ laser control signal is TTL logic, which is input through the DB9connector, the corresponding pins are pin6 and pin7. Pin 6 is logic high and pin 7 is logic low. The level on pin 6 is 3.3~5V and 0~0.3V on pin 7.

Output signal

The ET-Serie CO₂ laser output signal and alarm signal are displayed through the indicators on the panel.

5.4 Control & Indicators



Definition of LED:

LED Indicators		
NO.	Color	Function
LED1	Blue	Always OFF
LED2	Blue	OFF: No fault Flashing 1time, OFF 1s: The power supply voltage is less than 46V. Flashing 2 times, OFF 1s: The power supply voltage is more than 50V. Flashing 3 times, OFF 1s: The temperature of the RF amplifier is more than 80°C Flashing 4 times, OFF 1s: The RF V+ feedback faulty Flashing 5 times, OFF 1s: The RF V- feedback faulty Flashing Quickly: Power Overload Alarm
LED3	Yellow	Always ON: The laser is ready. Flashing: The laser self-check or faulty, check with LED2.
LED4	Blue	Always ON: Connected to the external enable signal OFF: Not connected to the external enable signal
LED5	Red	Always ON: The laser is firing. OFF: The laser stops firing.

5.5 Start-up and pulse mode

Before operating the ET-Series CO₂ laser, please confirm the following items again:

1. The output voltage of DC power supply meets the working voltage required by ET-Series;
2. TTL control logic meets the laser operation requirements;
3. Power terminals and signal connectors are well connected;
4. The dust proof plug attached on the laser beam exit aperture is removed;
5. Protections to the laser and the personnel who are in the laser operation area are well done.

Check the equipment ventilation: The air exhausted from the laser outlet shall not directly return to the air inlet. And the temperature at the air inlet shall be equal to or lower than the ambient temperature.

When the ET-Series CO₂ laser is properly powered with 48V DC, check if the fan works OK, and then wait for 23s. Input PWM command signal and the laser fires immediately. The higher the PWM signal duty cycle, the stronger the laser output power.

The emitted laser is invisible, it can cause personnel injury, before power up, protections to the laser and the personnel who are in the laser operation area are well done.

ET-Series uses air-cooled heat dissipation, the ambient temperature will affect the normal operation of laser. ET-Series CO₂ laser working temperature is 5~35°C. If the temperature is lower than this range, it will be difficult to ionize the laser during initial power-on, which will affect the RF power supply. If above this temperature range, the laser is unable to dissipate heat effectively, can not work normally, and even cause damage to electronic components. In general, the temperature increases by 1 , and the output power of the laser decreases by 1%.

Keep the connectors of external optical path well sealed with rubber ring if the laser works in dusty environment. If necessary, please blow air into the laser ambient, using high-purity nitrogen or clean, filtered air free of water, oil and dust, to prevent damage to the laser output optics and the RF power supply.

5.6 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!

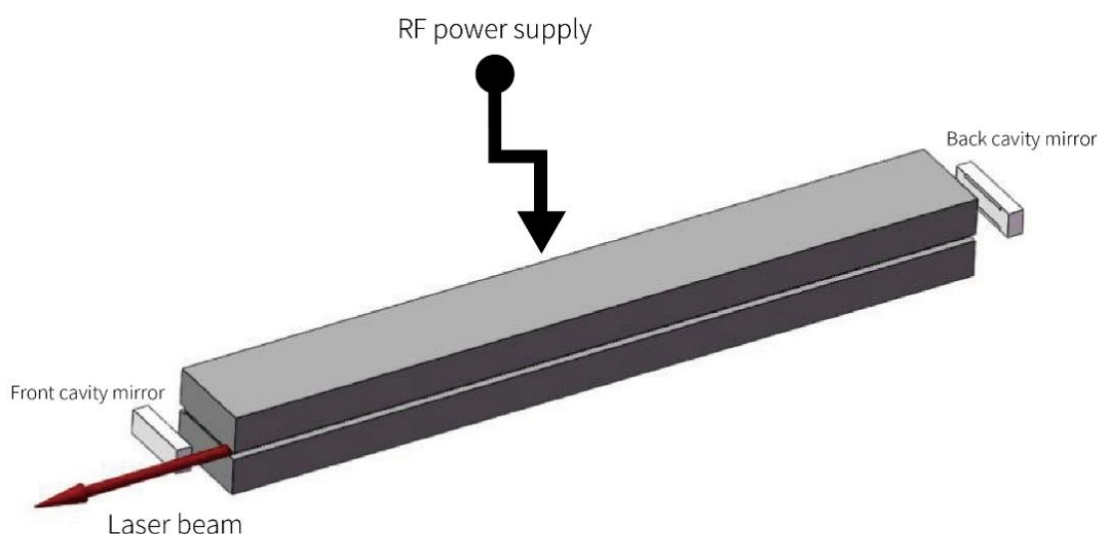
Chapter 6 Technical Reference

6.1 Optical resonator

The ET series is a RF-excited, diffusion-cooled slab waveguide CO₂ laser that uses an RF power supply as the pump source. Two rectangular metal slabs are placed in parallel with a gap of approximately several millimeters between them; the gap varies with different laser models. One slab is grounded via the metal housing and is referred to as the negative electrode slab. The other is connected to the RF power supply through an RF feedthrough and is referred to as the positive electrode slab. Two total reflectors are mounted at both ends of the metal slabs to form the laser resonator for laser output extraction.

The positive and negative electrode slabs and laser cavity mirrors are installed inside a sealed metal chamber, typically made of aluminum alloy. The laser working gas, positive and negative electrode slabs, and laser cavity mirrors are hermetically sealed within the metal housing. The RF power supply is coupled into the electrode slabs via a dedicated feedthrough, ionizing the working gas between the electrodes to generate gain medium. Laser output is extracted through the cavity mirrors mounted at both ends of the slabs, and the laser beam exits through a window on the sealed chamber. The window is sealed with an anti-reflection coated ZnSe lens, which enables highly efficient laser energy output while providing stable, reliable high-vacuum sealing.

ET-Serie CO₂ laser principal diagram



*The V+ V- inductance coils are not shown in the figure.

6.2 Cooling

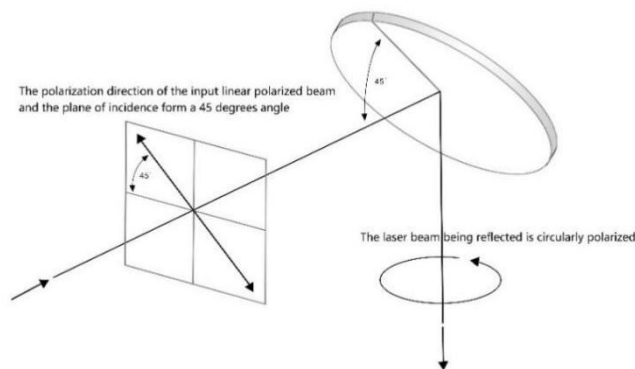
Input RF power to ionize the CO₂ gas mixture to generate laser, meanwhile, around 80% of the RF power is converted into heat left in the discharge area. The heat spreads to the surface of the laser through its metal plates and is taken away by the running coolant in the plates (water-cooled) or fans (air-cooled) to ensure the working stability of laser.

6.3 Polarization

The discharge area of the ET-Serie CO₂ laser is parallel to the base, it is linearly polarized beam and vertical to the base. If circularly polarized beam is required, can apply a phase delay device in the optical path, like phase delay mirror.

6.4 Back-reflected beam isolation principle

It requires a retro-reflective beam isolator mounted in the external optical path if ET-Serie 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 beam and completely reflects S-beam, 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 beam P is reflected by the high reflective material, it passes through the phase delay mirror twice to become beam S. When it enters the Brewster window, it cannot be transmitted and totally reflected, and then cannot return to the ET-Series 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 degrees on the machine and then focused by laser 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 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

The ET-Serie CO₂ laser is driven by 81.36MHz RF power supply which is powered by a 48V DC power supply, and the laser output power is decided by the external PWM signal given to RF power supply. 81.36MHz RF signal generated from a crystal oscillator, and it finally outputs as high power RF output through the amplification circuit.

The status of LED indicators on RF power supply can help to tell the laser state, such as its work condition, temperature, cooling flow, voltage, etc. It helps operators to learn the laser conditions from the indicators.

6.7 Modulation signal & PWM method

The laser output power is decided by the external PWM signal. The laser generates corresponding laser pulse output according to the pulse width and frequency of the command signal which controls ON/ OFF of RF power supply. The maximum duty cycle of ET-Series is 100%.

$$W = \frac{\text{Duty Cycle} * 1000}{Q}$$

Formula description:

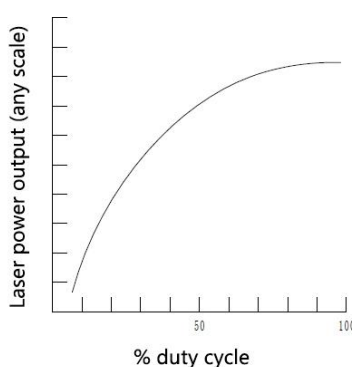
W	Modulation pulse width, in μs
Q	Modulation frequency, in KHz

E.g., with 5KHz frequency and 60% duty cycle, according to the formula above, $W = 60\% * 1000 / 5 = 120\mu\text{s}$.

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.

95% is recommended as the maximum duty cycle 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 is close to its power saturation, the PWM duty cycle produces a non-linear power function, which flattens out when the duty cycle is about 95%. If keep running at 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 ET-Series CO₂ laser comes with a sealed maintenance free design, only regular inspection and cleaning of optics are required. Dust and cotton fiber 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 maintenance

To ensure the long-term stable operation of the laser, in addition to strictly complying with the installation requirements in the user manual, regular inspection and maintenance of the laser's operating environment are also required. Before operation, please turn off the equipment and disconnect the power supply.

Check whether there is any condensation on the laser housing. If so, reduce the humidity of the environment where the laser is located.

Check whether the wiring of the laser is secure. If loose, tighten it properly.

Check whether the laser housing is properly grounded, and ensure reliable grounding.

Check whether there is dust on the laser surface. If so, wipe the housing with alcohol.

Check whether there is dust on the cooling fan. Wipe it or clean it with a high-pressure air gun.

After completing the above inspections, power on the laser and check whether the fan rotates normally and whether there is vibration. If vibration occurs, check and tighten the screws on the fan cover.

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. Remove 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:

Materials	Requirements
Gloves	No dust
Nitrogen	>99.9%
Alcohol	Spectral Grade
Acetone	Spectral Grade

Chapter 8 Q&A

1. **Q: Why does the laser take some time to fire after getting command signal when it's powered on?**

A: To extend the service life of ET-Series CO₂ laser, the internal chip is set with a 23s delay. To preheat the laser gas mixture in the optical resonator during the delay to prevent the RF power supply from being overloaded instantly.

2. **2.Q: Is external pre-ionization signal required to be given to the laser before it fires?**

A: The laser has a built-in pre-ionization signal. When powered on, the gas inside the laser is in a pre-ionized state. Upon receiving the laser emission signal, the laser will generate laser output immediately.

If an external control card provides the pre-ionization signal, the recommended parameters are as follows: 5 kHz, duty cycle 1%–2%. At this time, the laser emission status indicator will be constantly on.

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

A: The laser beam exit aperture has to be sealed to prevent any possible contamination to the lens. Handle it gently to protect the laser from any accidental impact.

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

A: The ambient temperature should be maintained at 5°C~35°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 ensure no condensation on the laser. The environmental pH value is neutral.

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

A: The laser beam exit lens can be wiped. Wipe it gently with special lens cleaning paper dipped in alcohol after blowing away the bigger contaminants on it. If the lens surface is seriously contaminated and damaged, do not run the laser, avoid completely lens burnt, end in more damage.

6. 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.

7. 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 shall be checked:

1. Check if the size and the aperture of optics in the external optical path 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.

8. Q: What to do when the laser power output 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.

9. Q: There are many sealing labels attached on the laser, what are they for?

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