

zamia

OPERATORS MANUAL

Q150 CO₂ RF LASER



CONTENT

Chaper 1 Introduction	1
1.1 Trademark, Copyright, Version and Model.....	1
1.2 Warranty Information.....	2
1.3 Unpacking/packing, storage/shipping, mounting, connecting, cooling.....	3
1.4 Basic description.....	3
1.5 Packing list.....	3
Chapter 2 Safety instructions and precautions.....	4
2.1 Summary.....	4
2.2 Warning Labels and locations.....	5
2.3 Operation instructions.....	5
2.4 Safety precautions.....	6
Chapter 3 Product Introduction	7
3.1 Brief.....	7
3.2 Applications and materials	7
3.3 Parameters and working requirements	8
3.4 Product Structure	9
Chapter 4 Mounting Instructions.....	10
4.1 The outline and mounting of Q150(i).....	10
4.2 Working Environment.....	10
4.3 DB25 Connector	11
4.4 DC cable.....	13
4.5 Power system	13
4.6 Cooling.....	15
4.7 Control Signals.....	16
4.8 External Laser Path Protection	18



4.9 Fixing.....	19
4.10 Cooling protection.....	19
Chapter 5 Control and Operation	20
5.1 Operation Flow Chart.....	20
5.2 Preperation.....	21
5.3 Terminals.....	21
5.4 Control signal interface description.....	22
5.5 Control and indicators.....	25
5.6 Start up & Pulse mode	26
5.7 Safety tips.....	26
Chapter 6 Technical Reference.....	27
6.1 Optical resonator	27
6.2 Cooling.....	28
6.3 Beam Shaping.....	28
6.4 Polarization	29
6.5 Back-reflected beam isolation principle.....	29
6.6 External optical path and attentions	30
6.7 RF POWER SUPPLY.....	31
6.8 Cooling and setting coolant temperature.....	31
6.9 Modulation signal and pulse width modulation method.....	32
6.10 Laser Marking	32
Chapter 7 Maintenance.....	33
Chapter 8 Questions and Answers.....	34

Chaper 1 Introduction

1.1 Trademark, Copyright, Version and 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-EQ150-22.02 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 Q150(i) CO₂ RF Laser. Read it carefully before you use and operate Q150(i), and the latest version of this manual will be updated at www.sptlaser.net.

Model

There is only difference on wavelength and power between Q150 and Q150i, other parameters are the same. Q150 is mostly used for instruction in the manual.



1.2 Warranty Information

This is to certify that Q150(i) CO₂ laser is guaranteed by SPT Laser co.,ltd to be free of all defects in quality for a period of 26 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 stroage or damage.

If, within warranty, any defect in materials and workmanship of your Q150(i) , 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 casued by force majeure

Contact info

Email for support: 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 Q150(i), to prevent any damage to the laser in storage and shipping. For more info, please look up in this manual.

1.4 Basic description

Q150 CO₂ laser is used for cutting, drilling and marking on non-metal materials.

Q150(i) requires DC power input, a DC power supply with 48V/50A 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 5mm and smaller than 6mm, with good insulation. Single piece of cable shall be no more than 4m.

Q150 is cooled with coolant, and the cooling pipe has to be ID8mm and OD10mm, each single pipe is required to be less than 4m. Please use high purity nitrogen or filtered clean air without water, oil and dust if need to blow air to the laser.

The test report shows the parameters of Q150(i) tested before being packed, it can be found in the carton.

1.5 Packing list

Q150 CO₂ Laser ----1set

Test Report -----1pc

DB connector -----1pc

Acrylic template burnt by laser ----1pc

Chapter 2 Safety instructions and precautions

2.1 Summary

According to Chinese national standard, GB7247.1-2001 (IEC60825-1:1993) , this product is class 4 laser. It can cause personel 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 personel safety prior to shipping, mounting, and maintenance. Incorrect operation can cause damage to laser.

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

DANGEROUS This Class 4 CO₂ 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.

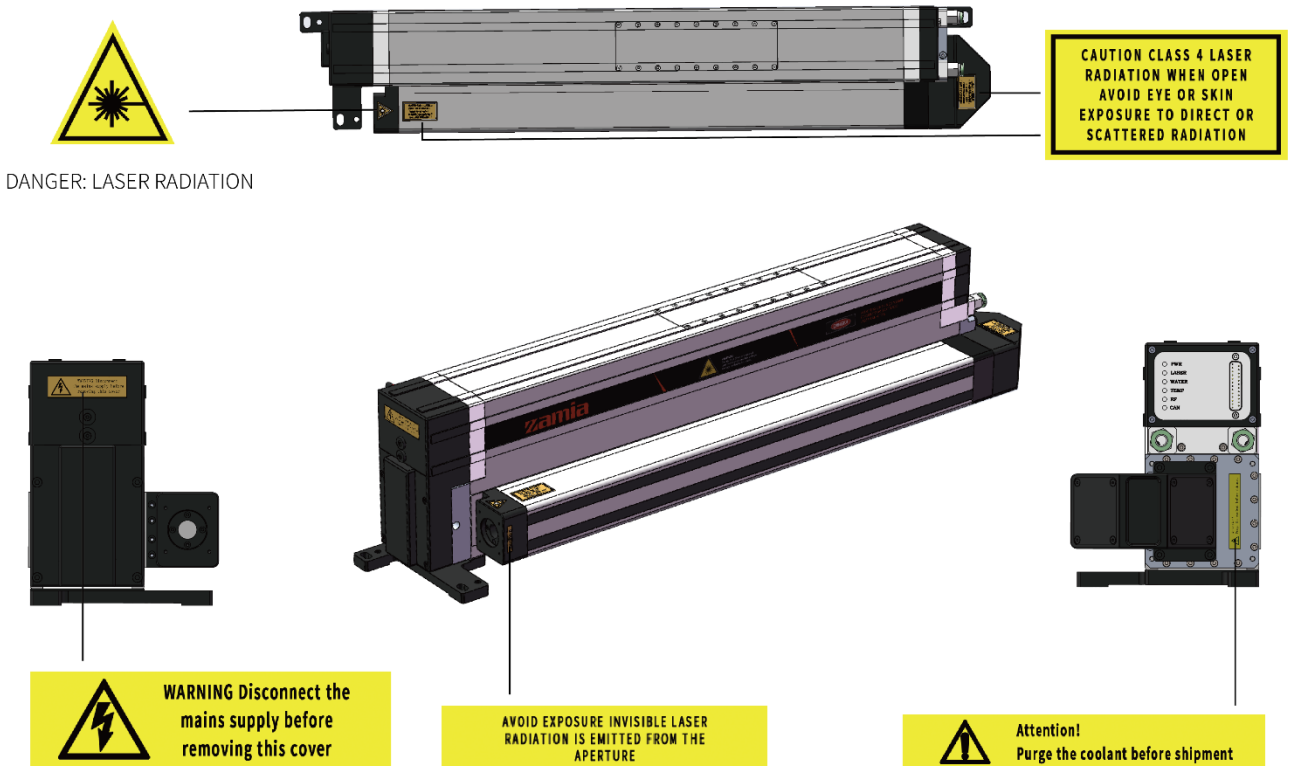
Warning Poisonous and harmful dust or gas may be generated during laser processing, effective exhaust or ventilation conditions are necessary for operators' safety.

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



2.2 Warning Labels and locations

There are totally 5 hazard labels on Q150 CO₂ laser, please check the info as below to know where they are located.



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 disassembly and modification on laser fails the warranty.
6. Keep the laser working in good ventilation condition place. Too much heat in laser can cause damage.

2.4 Safety precautions

1. Emergency stop

Used 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

- Integrated with laser beam shaping system, output with circularly symmetric near TEM00 mode Gaussian beam;
- All-metal structure with sealed off design, maintenance free;
- RF power supply and cavity integrated package, appearance simplicity & easy to be integrated;
- Compact structure, high-grade dust-proof design, suitable for a variety of industrial environments;
- CAN bus, external pulse dual working mode.

3.2 Applications and materials

Applications

Q150 CO₂ RF Laser is suitable for laser marking, laser cutting, laser welding and 3D laser printing.

Materials

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

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



3.3 Parameters and working requirements

Demension and weight

Demension (L*W*H)	853×151.7×196.4mm
Packing demension(L*W*H)	308x955x260mm
Net Weight	22.5Kg

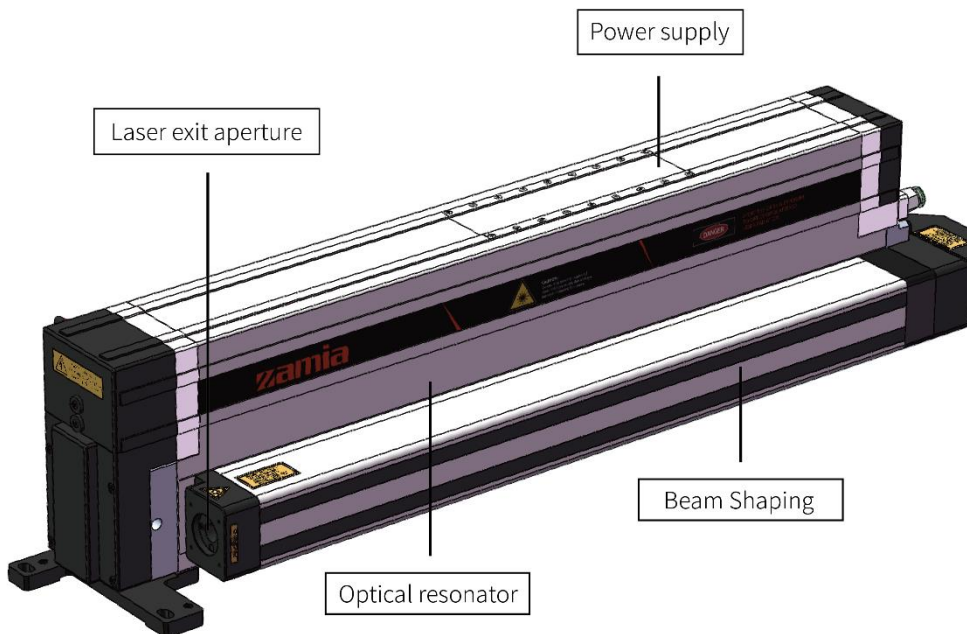
Technical parameter

Model	Q-150	Q-150i
Excitation Mode	RF-Excited	
RF Frequency	81.36MHz	
Laser Resonator	Slab-Waveguide	
Wavelength	10.6μm	9.3μm
Average Power	150W	140W
Laser Output Power Range	5 - 150W	5 - 140W
Beam Quality (M ²)	<1.5	
Max. Peak Power	375W	350W
Min. Pulse Period	20μs (equivalent 50KHz)	
Min. Pulse Width	3μs	
Pulse Rise/Fall Time	<60μs	
Modulation Pulse Width Range	3 - 1000 μs	
Modulation Frequency	0.8 - 50KHz	
Power Stability	≤ ±7%	



Beam Size (1/ e ²)	7.0±0.5mm	6.5±0.5mm
Beam Divergence (Full Angle)	<1.5mrad	
Beam Ellipticity	0.83 - 1.2	
Polarization (Parallel to the base)	Linear>100:1	
Wavelength Range	10.3-10.8µm	9.2-9.4µm

3.4 Product Structure



Q150 CO₂ RF LASER is combined with an aluminium and two independent units, upside is RF and downside is laser 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 with stable power and perfect laser spot mode to reach its maximum power output.

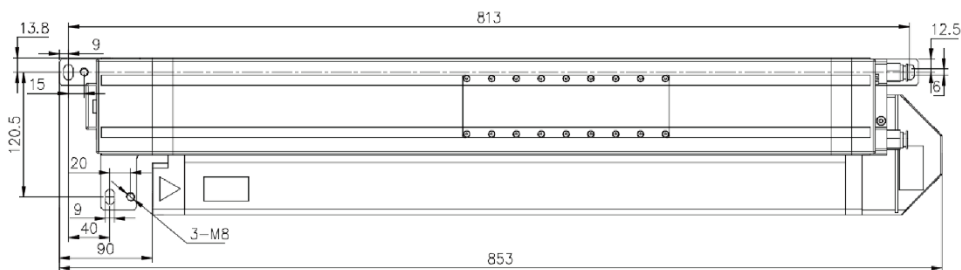


RF power supply

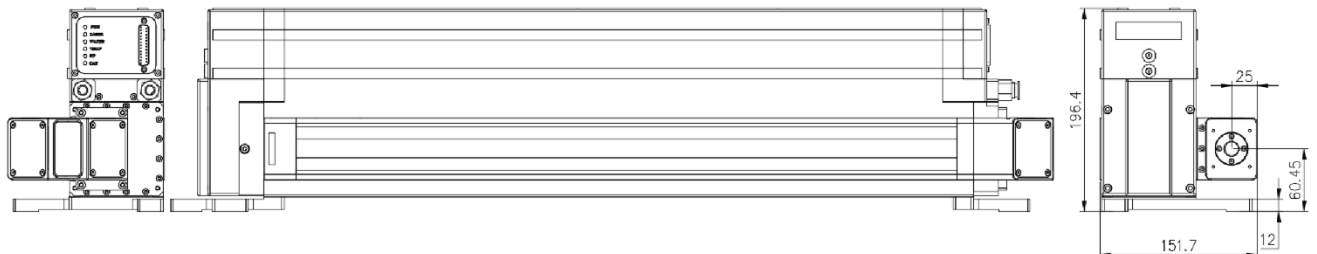
The RF power supply provides pulsed RF power to excite the working gas in the resonator. The modulation pulse width and pulse period of laser output can be controlled by external control signal.

Chapter 4 Mounting Instructions

4.1 The outline and mounting of Q150(i)



Top View



Back View

Side View

Front View

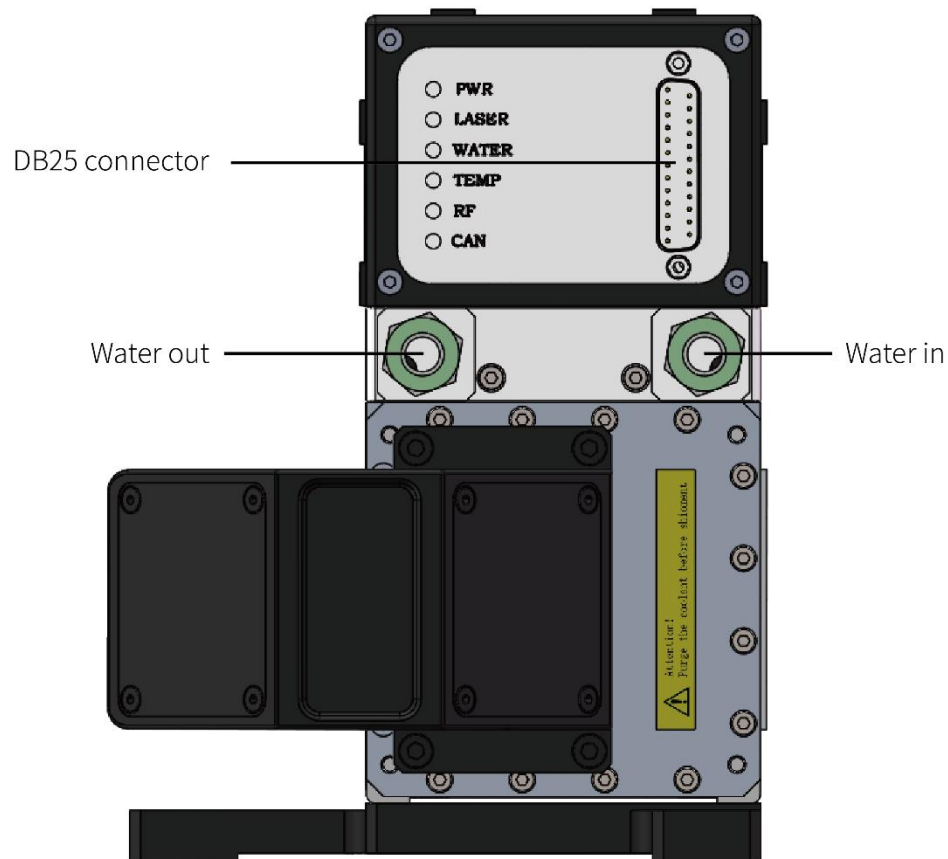
4.2 Working Environment

Requirements

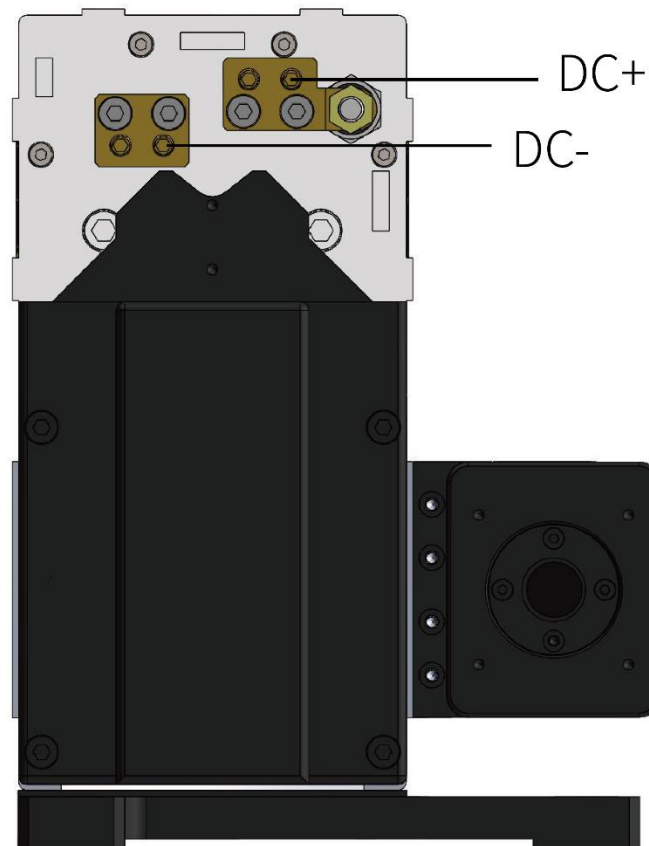
Temperature	5~40°C
Humidity (no condensation)	≤95%
Altitude	≤2000m

4.3 DB25 Connector

Please follow the diagram as below to do the wiring when you use Q150 CO₂ RF laser for the first time. For more detailed wiring info, please look up from other chapters in the manual.

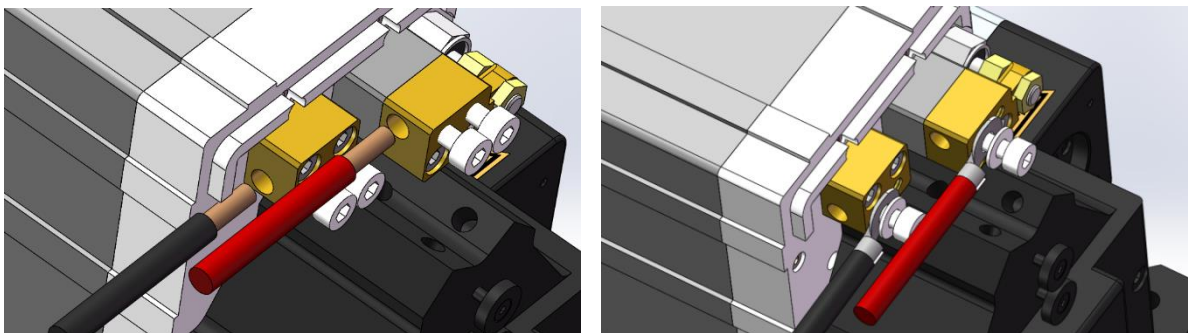


Recommend to use a pipe with ID8mm and OD10mm to connect the water in and out directly.



View of power terminals as above is after removing the cover. Please put the cover back after connecting the cables.

Wiring options



- ① Plug the cable directly and tighten it with screw.
- ② Place the wiring ring onto the bolt and lock it with screw.

***Cable in black is cathode, cable in red is anode.**



Connectors on the Laser

DB25 connector	Connect it properly according to definition of each pin to control laser output.
Water in	Coolant in
Water out	Coolant out
DC+	Connect to DC48+
DC-	Connect to DC48V-

4.4 DC cable

Q150 CO₂ RF laser works with DC power. The DC cable must be multiple twisted wires with reliable insulation performance, and the thickness of its conductive core shall be $>5\text{mm}$ and $<6\text{mm}$. The DC cable shall be no more than 4m. Check the input voltage to laser and make sure it is 48V if the cable is more than 4m.

The signal cable must be kept away from any electrical appliances and cables with high voltage, or high current and electromagnetic radiation. Ensure the laser control signals will not be disturbed.

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

Peak current	100A
Voltage	DC48V±0.5V
Continuous working current	≤50A

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, sometime, 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 it is less than 43V, the laser doesn't work normally.

The peak voltage of DC power supply shouldn't last more than 10μs, 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 100μs if the start pulse width of laser is 300μs.)

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.

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

3. Connect the power supply properly according to the label info on each terminal of the laser. “+” is anode on RF power supply, connected to V+ on DC power supply, and “-” is cathode on RF, connected to V- on DC power supply. Maximum length of cable connecting DC power and RF on the laser is 4m, and twist the cable into a single strand to reduce the mutual inductance between the terminals.



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

5.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 laser.

6.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.

Cooling path

Cooling for Q150 CO₂ laser requires coolant. A pipe with ID8mm and OD10mm is the right choice, and it has to be no more than 4m long. Water pipe made of materials with high stability like stainless steel, copper alloy or non – transparent plastic is recommended.

Filter is required in the cooling path. Some chillers come with filter, if not, please attach external filter to it. 100micron filter element is recommended.

Please replace the filter cartridge every 3 months to ensure the quality of coolant.



Cooling requirements

Max. Heat Load	2.5KW
Pump Flow	>5.7l/min
Coolant temperature	21~25°C
Coolant Temperature precision	±1°C
Coolant	Corrosion resistant pure water
Water Pressure	105KPa (@5.7l/min)
(Maximum static water pressure)	827KPa

Coolant

Antifreeze and other additives can be added into the cooling water, but can't be anything corrosive or which can seriously affect the water flow speed. Demineralized water, deionized water or distilled water are recommended to be used as coolant.

Coolant requirements

Electrical conductivity	<1000μS/cm
Hardness	<10 ppm
pH Value	7-8.5
Bacteria levels	<1000 cfu/ml

***The cooling water temperature should be kept above the dew point to avoid the cooling water forming condensation inside the laser.**

4.7 Control Signals

Laser operation is controlled with external command signals. Need to apply working enable signal, working modulation signal and external safety locking device to the laser. Monitor the output signal of the laser to know well of its working state.

Materials and requirements

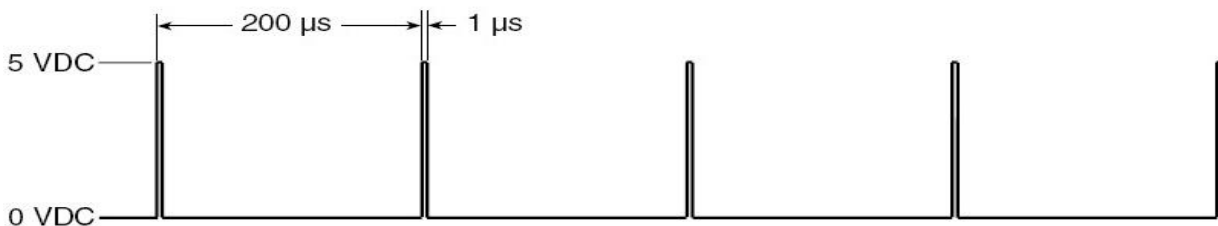
TTL	Frequency adjustable TTL signal source
Oscilloscope	Oscilloscope bandwidth is decided according to the modulation frequency required by the operator

Command signal requirements of Q150(i)

Command signal must be TTL Level

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 does not provide a pre-ionization signal. It requires the external control board to give Q150 laser a pre-ionization signal (5KHz, 1 μ s, as chart below), to make the gas mixture in the optical resonator be in the pre-ionization state. And then it only requires a small pulse signal input to make the laser fire immediately. If there is no pre-ionization signal given, the laser power output will be unstable, which affects the process performance.**



- **The command signal pin must be in a controllable state all the time.**

When the signal cable is connected to the Q150 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 differential signal, otherwise the laser is easily damaged due to excessive common-mode interference voltage.**
- **The duty cycle of the modulated signal must be selected according to different lasers, and the pulse width of the high level should be within 3 μ s~ 1000 μ s.**



- **The modulation signal should be a pure TTL level signal. Excessive interference (voltage fluctuation), voltage jump, and voltage spike in the control signal will cause damage to the internal control circuit board and RF amplifier of Q150 laser.**

4.8 External Laser Path Protection

The output window of the laser is very sensitive. The particles and moisture attached to the lens will cause fatal damage to the window. Good external optical path sealing 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 Q150 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 Q150 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 Q150 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.

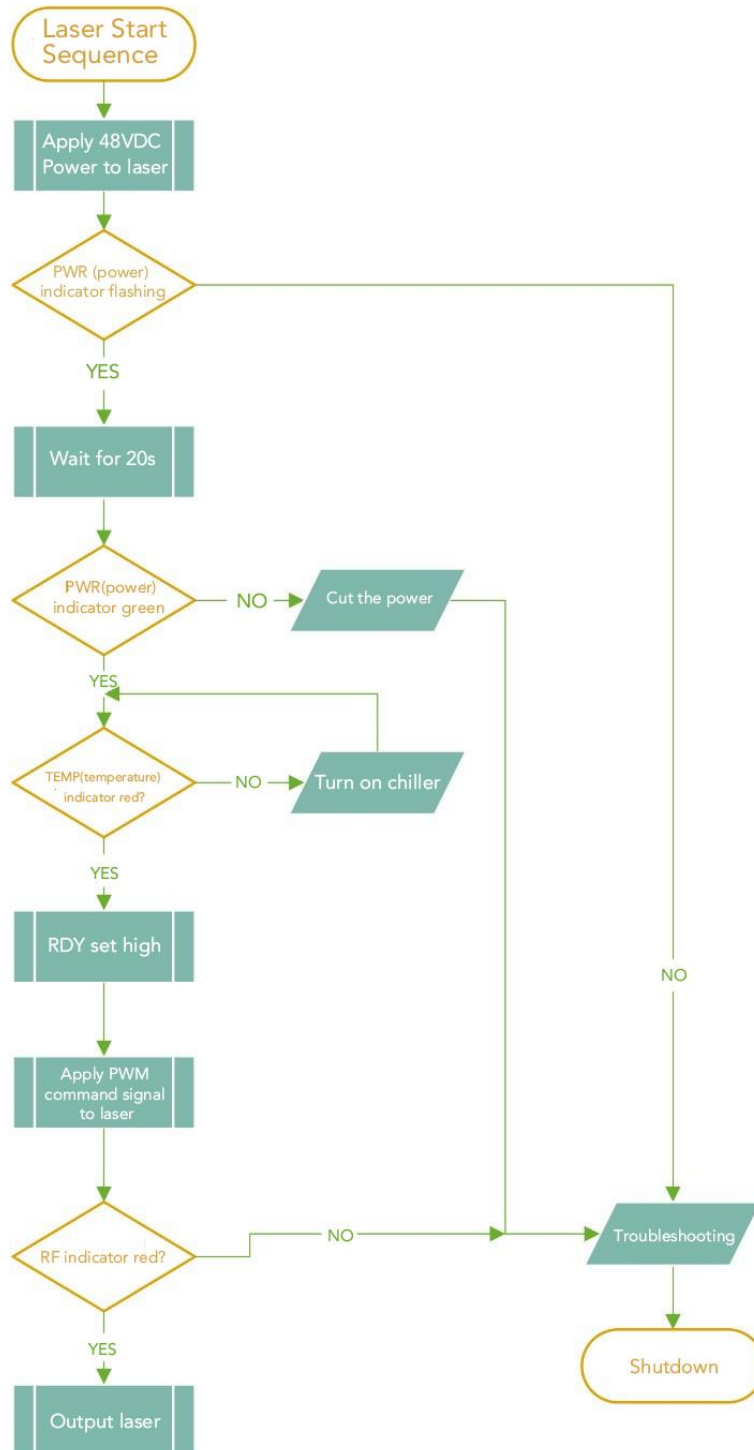
4.10 Cooling protection

There is no flow switch in Q150 laser, but it has the function of receiving and processing external flow switch signals. Follow the instructions below to connect the flow switch signal to the corresponding pin.



Chapter 5 Control and Operation

5.1 Operation Flow Chart



Q150 CO₂ LASER BRIEF OPERATION FLOW CHART

5.2 Preperation

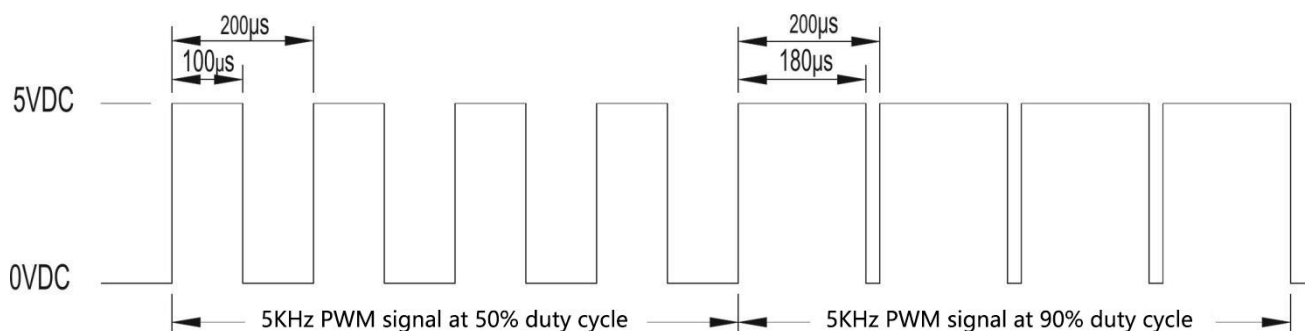
Only need to switch on the 48V DC power supply and apply the control signal through the DB25 connector on the laser to make the laser work.

1. DC power supply (48V, more than 2400W)
2. Fixing bracket (firm and flexible)
3. TTL signal generator (modulation frequency: 1~100KHz, duty cycle: 0~60% adjustable)

5.3 Terminals

The Q150 CO₂ laser is controlled by an external modulation signal, the signal input to and output from the laser is a TTL level signal. 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 signal generator and other control and detection devices.

Note: The waveform displayed in the figure below is a typical 0-5V TTL signal. The duty cycle (or pulse width) and the frequency are adjustable:

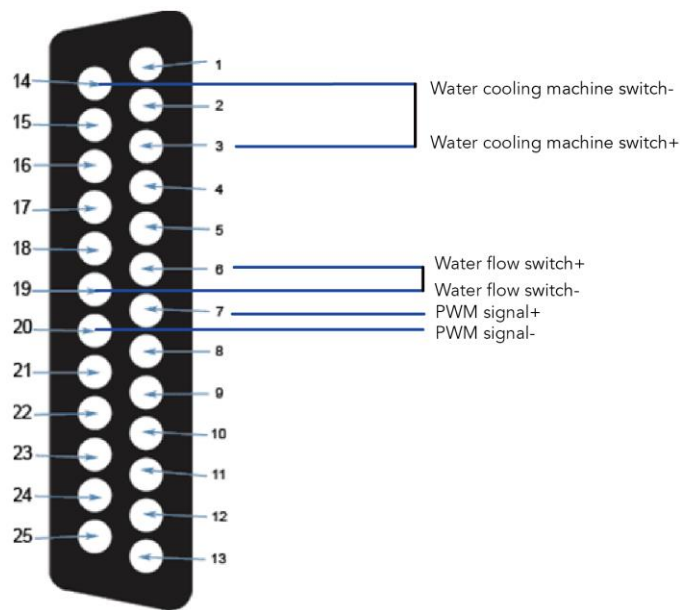




5.4 Control signal interface description

There is a 25-pin DB25 female connector on Q150 CO₂ laser as the interface. Through this DB25 interface, the differential signal is input to control the laser output, and the state feedback signal of the laser can also be received from it to link the production line.

The DB25 connector:



DB25 connector

As the photo shows, what needs for laser working:

1. Water cooking machine's switch signal (when Pin3 and Pin14/15 in short-circuit)
2. Water flow switch signal (Pin6 and Pin19 in short-circuit)
3. PWM signal (Pin7 and Pin20)

There is no water flow switch in the internal of the laser, but it has the function of receive and deal with the signal of the water flow switch external. To use the laser, each signal line should be connect to the corresponding Pin follow the instruction, or it will cause irreversible damage.



The pins of DB25 connector

Pin	Function	
1	Positive analog Voltage output signal	Analog output signal Shows the positive voltage from the RF amplifier to the laser, full scale value is +5V
2	Reflection analog Voltage output signal	Analog output signal The laser tube voltage feedback, full scale value is +5V
3	Input start signal	Connect this Pin to PWM return to start the RF amplifier. This is Pin is also for Remote Interlock(External Safety Interlock).
9/13/22/25	--	Not Enabled
5(+),18(-)	Modulation test Output signal	Differential output signal Generate a modulation signal with a pulse width of 100μs and a pulse period of 1000μs, which is used as the input modulation signal in the test mode.
6(+),19(-)	Flow protection, switching value input	Connect the water flow switch. After the two pins are short circuited and connected, the laser works.
7(+),20(-)	Modulation input	Differential input signal To control the laser output, the pulse width (period) must be within 10μs ~ 998μs and the duty cycle is no more than 60%.
8(+),21(-)	PWM Return	The differential signal does not change when the RF amplifier is modulated, which means that the RF tube cable or connector is damaged
16(+),22(-)	Command Advance	When the RF amplifier modulates, the state of the differential signal changes. If this signal state does not change, the RF amplifier is in an abnormal state.
10(+),23(-)	Duty Cycle Limit	The differential signal state changes if the duty cycle is more than 60% or the pulse width of modulated signal is more than 1mS.



11(+),24(-)	Voltage standing wave ratio limit	Under normal conditions, the differential signal will not change, and it will only be turned on when the laser tube has an error that will lead to the disharmony between the laser tube and the RF amplifier
12	Test Start	Connect the test modulation signal to the PWM return
14.15.16	PWM Return	1.2.3 Refer to Pin 1, 2, 3
4(+),17(-)	Over Temperature	When the coolant temperature is more than 50°C, the differential signal changes. Please restart the laser when the coolant temperature is less than 40°C after shutdown.

*** 1. All differential input signals $0.2V < V_H - V_L < 5V$ are logic 1, and $-5V < V_H - V_L < -0.2V$ is logic 0, which is an indeterminate state outside this interval;**

2. Differential inputs cannot use negative input ground, otherwise the laser can not work normally.

Signal Input

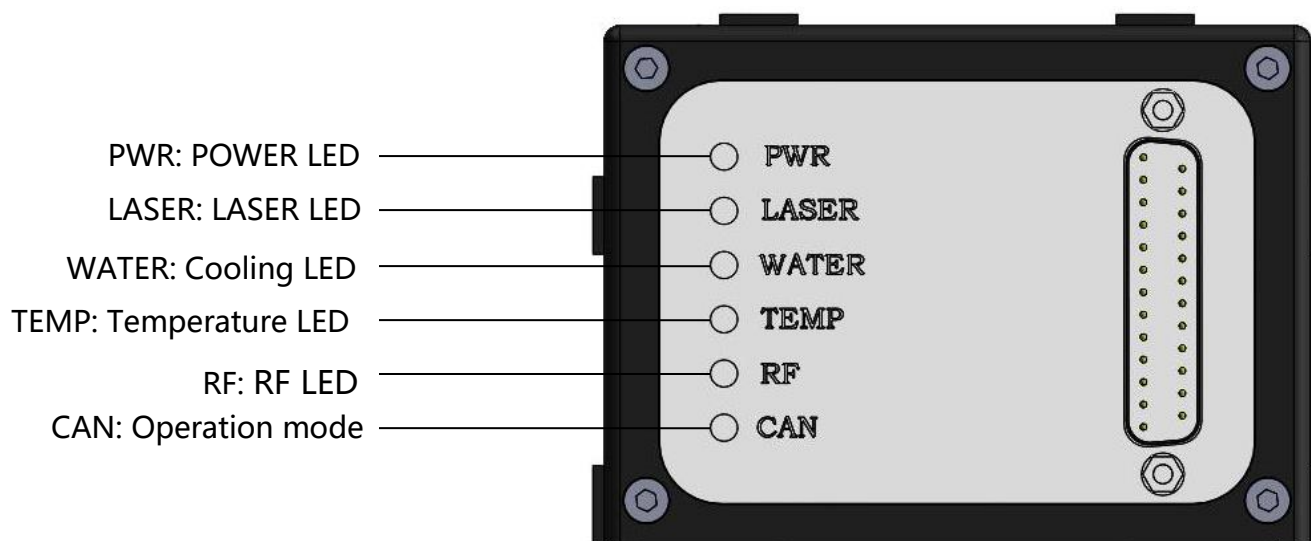
The command signal of Q150 CO₂ laser is differential signal which input via DB25 connector and the corresponding pins are pin 7 and pin 20. Pin 7 is high level, and pin 20 is low level. Input value on pin 7 is 3.3~5V, and it is 0~0.3V on pin 20.

Output Signal

The output signal of Q150 CO₂ laser are working status and alarming which are shown from the indicators on panel. The 2 kinds of signals output via DB25 connector, the correspondence of pin and signal, please look up in the instruction of DB25. Check the laser working status and alarming from the instruction of Q150 indicators.



5.5 Control and indicators



Indicators

LED	Normal	Abnormal
PWR	It blinks for 20 seconds when it is turned on, and then turns on. Indicates that the laser is in working state	
LASER	Light up means PWM signal is applied, Laser light	
WATER Red (Cooling alarm)	OFF	ON, Water cooling failure, please check the water flow
TEMP Red (Temperature alarm)	OFF	ON, Abnormal laser temperature
RF	OFF	ON, Abnormal RF signal
CAN Yellow (Operation mode)	OFF	ON, In CAN bus working mode

5.6 Start up & Pulse mode

The Q150 CO₂ RF laser is properly powered with a DC 48V voltage. After being powered on, the laser fires in pulse mode immediately when it gets PWM command signal. Since the CO₂ laser is invisible and can be absorbed by human tissues to cause injury, please ensure protections to the laser and the personnel who are in the laser operation area are well done before the laser operation.

The Q150 CO₂ needs to be cooled with coolant (water). The proper water temperature and water flow are critical for the laser operation. If the coolant temperature is more than 25°C or the flow rate is very low which is not enough for cooling, the performance of laser can be degraded and the electronic components in the laser can be damaged.

If the Q150 CO₂ laser works in a high humidity environment, please check if there is condensation on the surface of the Q150 co2 laser output window lens. Please turn off the laser and stop the cooling if there is condensation. Do not cool the laser for long time when it doesn't work. Keep the connectors of external optical path well sealed with rubber ring if the laser works in dusty environment.

5.7 Safety tips

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

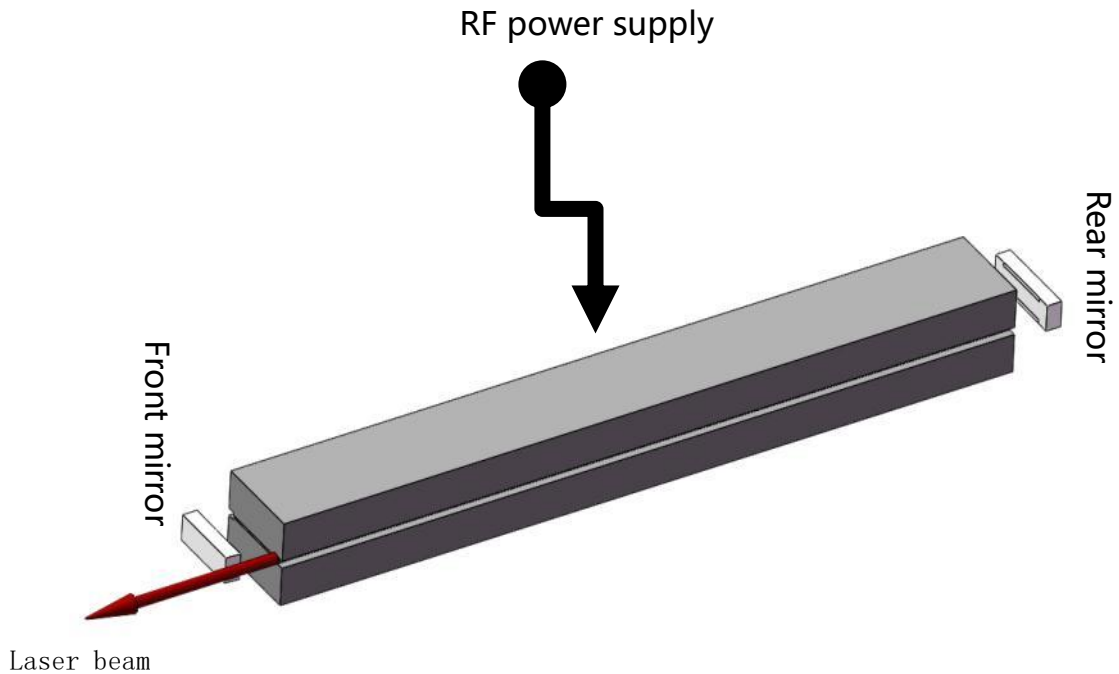
Chapter 6 Technical Reference

6.1 Optical resonator

Q150 is a RF excited CO₂ laser with Slab-Waveguid optical resonator, RF power supply works as its pump source. 2pcs of rectangle metal slats are placed in parallel with a gap around several mm, and the width of gap is different from lasers to lasers. One of the slat is grounded through the laser shell, called negative plate, and the other one is connected to RF power supply with laser feed-in components, called positive plate. Two pieces of full-reflection mirror are mounted on ends of these two metal slats, all of them constitute the optical resonator which is used to generate the laser beam.

The electrodes and optics are mounted in a sealed off metal chamber, and the chamber is generally made of aluminum alloy materials. The gas mixture, electrodes and cavity mirrors are sealed off in the metal chamber. Internal RF power supply imports RF power to the electrodes with special feeder to ionize the gas mixture into gaining media. Laser beam is generated by the two optical mirrors fastened on the ends of electrodes, and exits from the output window on the sealed chamber. The output window is sealed with a ZnSe lens with reflection reducing coating, it can enhance both the power of laser output and the stability of the high vacuum seal. There is cooling path in both electrodes to take away the heat during process. And the design of cooling path in positive electrode needs to ensure the electrode is insulated from the laser chamber and the coolant flows smoothly.

Q150 LASER WORKING PRINCIPLE



*** The cooling path and inductance coil for conjuncting two electrodes are not displayed in the diagram**

6.2 Cooling

The input RF power ionizes the CO₂ gas mixture to generate laser beam, meanwhile, about 80% RF power is converted into heat accumulated in the discharge area. The heat accumulated in the discharge area is directly transmitted to the electrodes and taken away by the coolant in the electrodes to promise the stability of the laser power output.

6.3 Beam Shaping

The asymmetry in X and Y directions of Q150 optical resonator decides that the generated laser beam is also unsymmetric when it exits from the optical resonator. The output laser beam is elliptical spot. The size of spot and beam divergence angle are different in X and Y

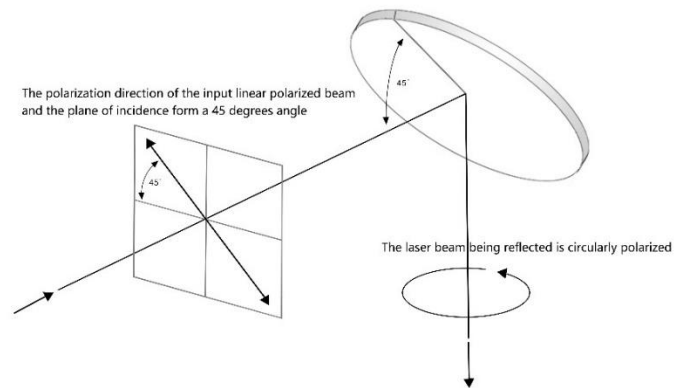
directions, and there is side-lobe interference in X direction. Firstly, the laser beam is converted into round shape after a cylindrical lens, and then being focused. The side-lobe interference is eliminated with a spatial filter at the laser beam focus and then align the laser beam. After all the process, the laser beam is shaped into a TEM00 beam.

6.4 Polarization

The discharge area of Q150 CO₂ laser is parallel to the laser base and the output laser beam is linearly polarized. Its polarization direction is also parallel to the base. If requires a circularly polarized laser beam, can add a phase delay device such as phase delay mirrors to the optical path to achieve it.

6.5 Back-reflected beam isolation principle

It requires a retro-reflective beam isolator mounted in the external optical path to stop the reflected laser beam if Q150 is used for processing high-reflective materials. The logic is: the laser beam comes through a optical component which is totally transparent to P polarized light and S polarized light is totally reflected by it, an optic like Brewster window. After that, the laser beam reaches to a phase delay device (E.g. 45 degree phase delay mirror), and then it reaches to the process material through focusing optic. The P polarized beam turns into S polarized beam after being reflected by high reflection materials and 2 times by phase delay mirrors, and the S polarized beam can't pass through Brewster window, it will be totally reflected, can't go back to the laser.



45° Phase delay mirror principle diagram

6.6 External optical path and 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 angle 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.

6.7 RF POWER SUPPLY

Q150 CO₂ Laser is driven by a 81.36MHz RF power supply which is powered by a 48V DC power supply and output PWM signal to control the laser power output. The RF power supply generates a 81.36MHz RF signal from a crystal oscillator and the signal turns into high RF power output to resonator through the power amplification circuit.

The status of LED indicators on RF power supply can tell the laser state, such as its work condition, temperature, cooling flow, voltage, etc.

6.8 Cooling and setting coolant temperature

Proper cooling is vital for Q150 co2 laser to work normally. Most of the RF power is converted into heat which has to be taken away by matchable cooling system to the laser. According to different temperature and humidity in working environments, the coolant temperature setting range is 21~25°C and the flow has to be 5.8L/min at least.

Please refer to the temperature and humidity in working environments when setting coolant temperature, in case condensation on the laser. Condensation on the laser can cause irreversible damage to the laser and affect its service life. Coolant temperature has to be higher than the dew point of the air. If the coolant temperature is more than 25°C, the heat generated in the discharge area cannot be effectively taken away, which will cause laser power decrease and increase the risk of RF power supply failure.

Must use deionized pure water as coolant. Tap water can cause fouling in cooling path and corrode it, which can cause fatal damage to lasers.

Do not run the laser in freezing temperature. There may be ice crystals in coolant which can damage the cooling path in Q150 and affect its lifetime. In the storage of Q150, the coolant in its cooling path has to be drained, in case it corrodes the cooling path, or breaks it in freezing environment to cause damage to the laser.

6.9 Modulation signal and pulse width modulation method

The laser output power is decided by the external PWM signal. According to the pulse width and frequency of the signal for laser output to control ON/ OFF of RF power supply to obtain the corresponding laser pulse output. The maximum duty cycle of Q150 is 60%. The relationship between Q-switching frequency and pulse width is as follows:

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

Formula description:

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

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

6.10 Laser Marking

When modulating laser power, input PWM signal to control the laser pulse width and laser pulse frequency. In the process of some materials, better processing results can be achieved with certain laser frequency and pulse.

Chapter 7 Maintenance

If damage on optics of the laser found, please contact SPT LASER for after-sale service.

The Q150 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 maintenance

Please turn off the laser and cut the power. Stop the chiller and check if the coolant is pollution-free and there is no impurities, and replace the coolant regularly on time. Check if the coolant temperature matches the ambient temperature, and there should be no condensation on the laser. Check if there is dust on the laser chamber and clean it with a damp cloth. Ensure no water enters the laser, which can cause damage to it.

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.

Materials Requirements

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

Chapter 8 Questions and Answers

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

A: In order to increase the service life of the Q150 CO₂ RF laser, the internal chip is set with a 40s delay. Preheat the working gas in the cavity during the delay to prevent the RF power supply from being overloaded instantly.

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

A: Q150 CO₂ RF laser has a pre-ionization circuit module, so the user does not need to give the rf co2 laser tube additional pre-ionization signals.

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 ambient 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: The laser exit lens can be wiped. Wipe gently with special lens-cleaning paper dipped in alcohol after blowing away the bigger contaminations on it. If the optic is polluted and damaged seriously, please do not run the laser to avoid the optics being burnt.



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

- 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.