zamia

OPERATORS MANUAL

N10 CO_2 RF LASER

www.sptlaser.net

CONTENT

Chapter 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

Version

This manual is for operation of N10(i) CO_2 RF Laser. Read it carefully before you use and operate N10(i), and the lastest version of this manual will be updated at www.sptlaser.net.

Model

N10 and N10i are air-cooled design, all the parameters are the same except for the difference on the output power and wavelength.

The same information is abbreviated as N10. For detailed product information, please refer to this manual.

1.2 Warranty Service

Warranty information

This is to certify that N10(i) CO_2 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 maintanence. 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 N10(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 as below 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 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 orignal packing of N10(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

N10 (i) CO_2 RF laser is used for laser cutting, laser marking, plastic welding, and 3D laser printing.

N10(i) requires DC power input, a DC power supply with 30V/7A 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 1.5mm and smaller than 2mm, with good insulation. Single piece of cable shall be no more than 4m.

N10(i) is designed with air cooling, there must be fans mounted to take away the heat of laser during operation to prevent the N10 from unstable working performance and damages caused by overheating. It requires 2 fans at least with a speed no less than 250CFM(around 7.1m^3/m).

Qualified Ventilation: If the ventilation is proper, the temperature rise of N10 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 65 °C.

When the N10 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 conditionor if necessary. Cut the power of laser and stop cooling if the laser is not operated

for a long time. When the laser works 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 needs to blow air to the laser.

1.5 Packing list

N10 CO_2 RF laser x1

DB15 connector 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.

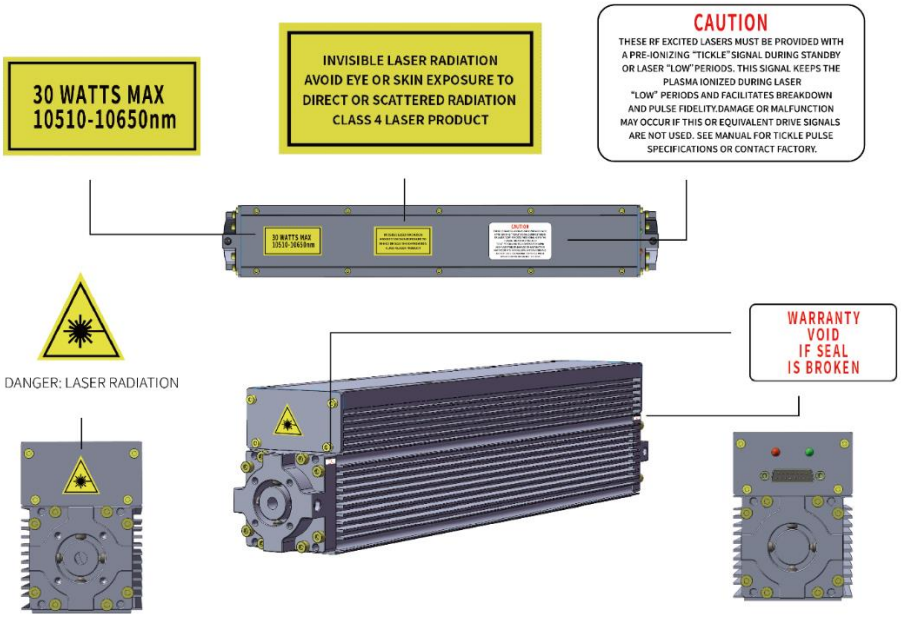
Please look up the alerts and warning labels in this manual.

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 5 hazard labels on N10 CO_2 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 disassemble and modification on laser fails the warranty.

7. Keep the laser working in good ventilation condition. 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

CO_2 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 quality beam and stable power;
- Suitable for a variety of industrial environments, can last for up to 20,000 hours

3.2 Applications & materials

Applications

N10 CO_2 RF laser can be used for, laser cutting, laser marking, plastic welding, 3D printing.

Materials

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

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

3.3 Parameters and Operation requirements

Dimension and weight

Dimension (mm)	440×71×100.5mm
Packing Dimension (L*W*H)	555x295x185mm
Net Weight	4.0Kg

Technical parameters

MODEL	N10	N10i
Excitation Mode	RF-Excited	
RF Frequency	48MHz	
Laser Resonator	Waveguide	
Wavelength	10.6μm	9.3μm
Average Power	12W	10W
Laser Output Power Range	0-12W	0-10W
Beam Quality(M^2)	<1.2	
PWM Duty Cycle	0%-100%	

Modulation Frequency	0-20kHz	
Power Stability	⩽±10%	
Beam Size (1/ e^2)	3.5±0.2mm	3.5±0.2mm
Beam Divergence (Full Angle)	4±0.5mrad	
Beam Ellipticity	0.85 - 1.1	
Extinction ratio	50:1 minimμm	
Range of Wavelength	10.57-10.63μm	9.27-9.33μm
Working Voltage	30VDC±2VDC	
Max. Working Current	7A	

3.4 Operation mode

N10 CO_2 RF laser can be operated in two mode, they are CW mode and Gated CW mode.

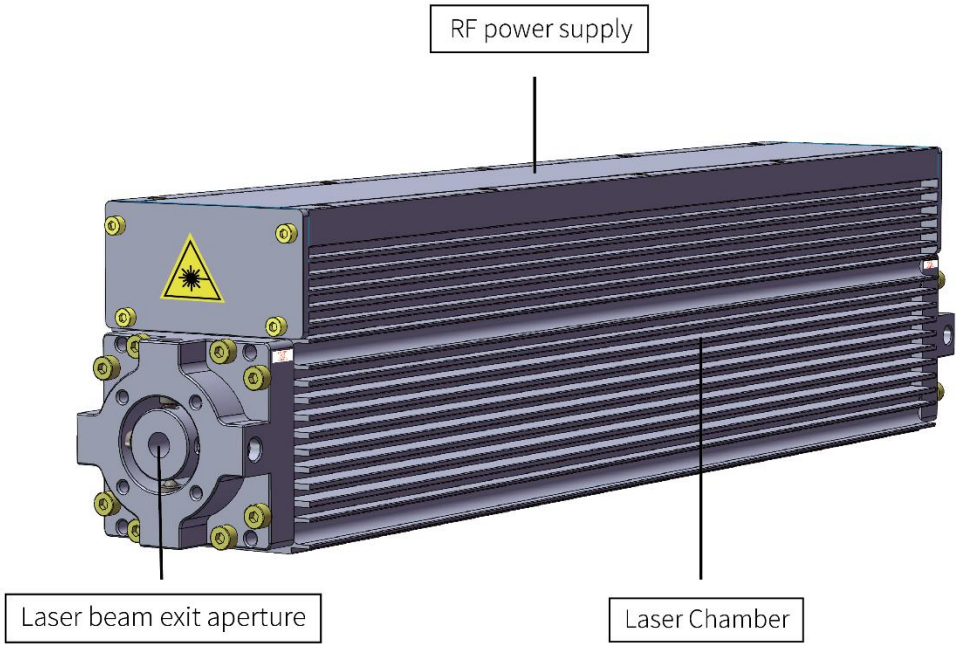
CW mode

In CW mode, the RF power supply works in continuous mode and outputs continuous laser. The TTL signal (pin 14, DB15) should be continuously high level. In this mode, the laser outputs its 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 signal (pin 14, DB15) is changed to a pulse waveform, and the N10 outputs pulse laser accordingly. (The CW mode is actually a pulse waveform with a 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 1μs, and the pulse repetition frequency should not be higher than 20kHz; and the duty cycle can be from 0 to 100% without limitation.

3.5 Product Structure



N10 CO_2 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.

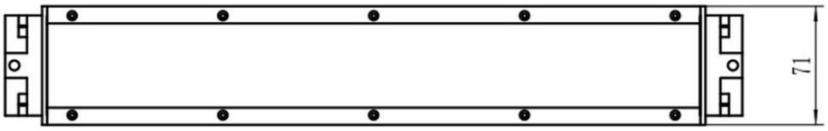
The design of laser chamber inside enables the laser to output with stable power and perfect laser spot mode to reach its maximum power output.

Radio frequency (RF) amplifier

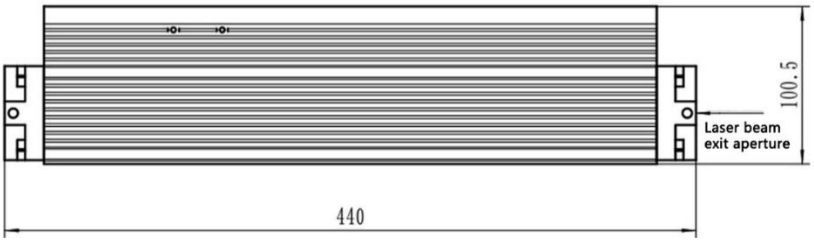
The RF amplifier supplies pulsed RF power to excite and ionize the laser gas in the resonator. The ON/OFF and output power of the laser can be controlled with external PWM signal.

Chapter 4 Mounting Instructions

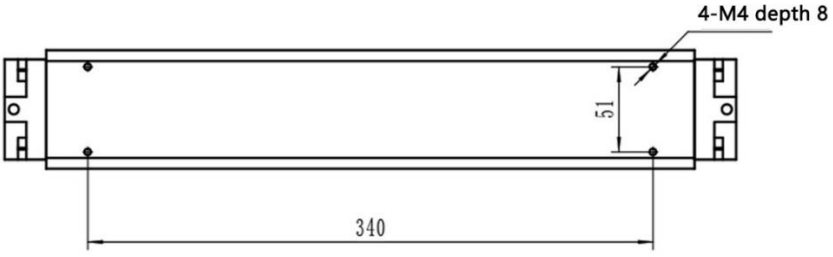
4.1 The outline & mounting of N10 (i)



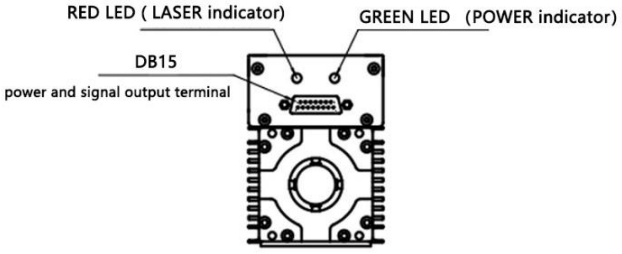
N10 top view



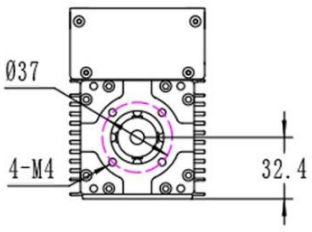
N10 front view



N10 bottom view



N10 left view



N10 right view

*Laser beam of N10 CO_2 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.

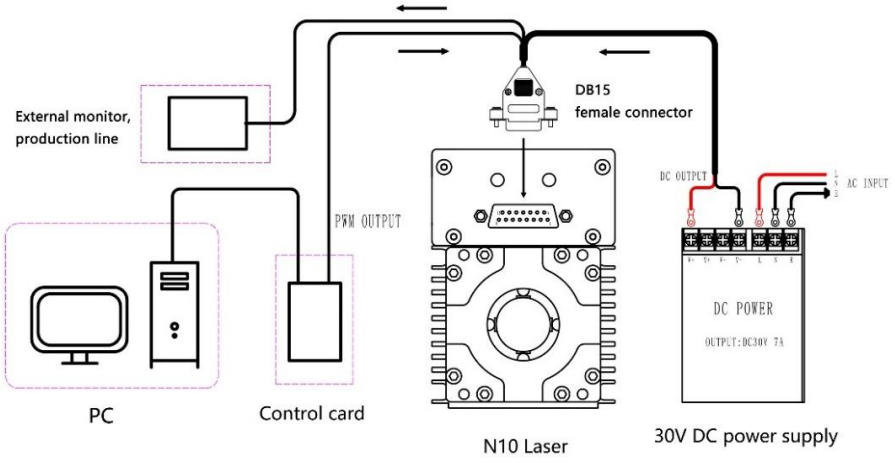
4.2 Operation Environment

Requirements:

Temperature	5~40 °C
Humidity	⩽95%
Altitude	⩽2000m

4.3 Wiring Instructions

Please follow the diagram as below to do the wiring when you use N10 CO_2 RF laser tube for the first time. For more detailed wiring info, please look up from other chapters in the manual.



N10 wiring diagram

4.4 DC cable

N10 CO_2 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 > 1.5mm and <2mm. The DC cable shall be no longer than 4m. Check the input voltage to laser and make sure it is 30V 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 power supply output requirements

Voltage	30VDC±2VDC
Average current	7A
Max. current	10A (Maintain 1/3ms)
Ripple and noise	<1% peak value

Suggestion: better choose 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 infects 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, sametime, the voltage output of DC power supply increases in a moment. If the voltage goes up to be more than 36V, 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 15V, 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 100μs.)

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

3. 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 definition of DB15 connector. “+30VDC” is anode on RF, connect to “V+” on DC power supply, and “+30VDC RETURN” is cathode on RF, 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 N10.

7. Screw the male and female connectors when connecting the DB15 plug-ins of the laser 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.

Cooling Fan

N10(i) is designed with air cooling, there must be fans mounted to take away the heat of laser during operation to prevent the N10 from unstable working performance and damages caused by overheating. It requires 2 fans at least with a speed no less than 250CFM(around 7.1m^3/m).

Install the same quantity fans symmetrically on both sides of the laser, and the distance between the fan and the laser shall be no more than 1cm. To ensure the laser is well cooled, airflow from the fan has to be blowed vertically into the heat sink on both sides of the laser.

If the laser is mounted in a sealed shell, please install ventilation fan or make exhaust holes on the shell to take the heat away. Otherwise the laser can’ t run normally if it is operated under high temperature for a long time.

Qualified Ventilation: If the ventilation is proper, the temperature rise of N10 shall be ⩽20 °C during operation compare to when it is in OFF state. The ambient temperature should be within 5~40 °C, and the maximum temperature of the laser surface should be less than 65 °C.

4.7 Control Signals

The N10 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 N10 RF laser to grasp the working status.

Material and tool requirements

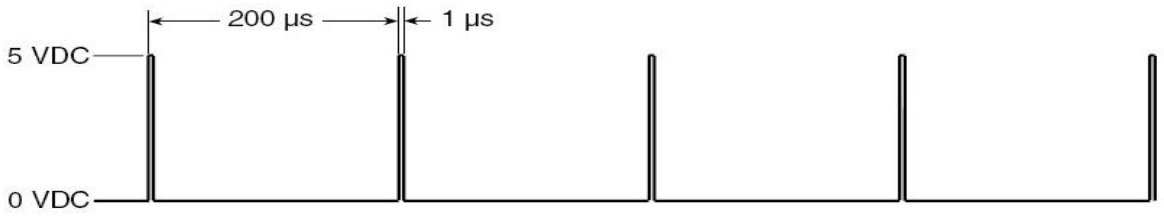
TTL Logic generator	Adjustable frequency and duty cycle
Oscilloscope	Oscilloscope bandwidth is decided according to the modulation frequency required by the operator

Control signals requirements

The control signal must be a TTL level signal

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: The internal chip does not provide a pre-ionization signal. It requires the external control board to give N10 laser a pre-ionization signal (5kHz, 1μs, 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 processs performance.



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

When the signal cable is connected to the N10 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 N10 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 and 1000μs.

The modulation signal should be a pure TTL level signal. 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 N10 laser.

* To protect control signal to N10 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 N10 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 N10 CO_2 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 N10 CO_2 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 N_2 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 subtance 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.

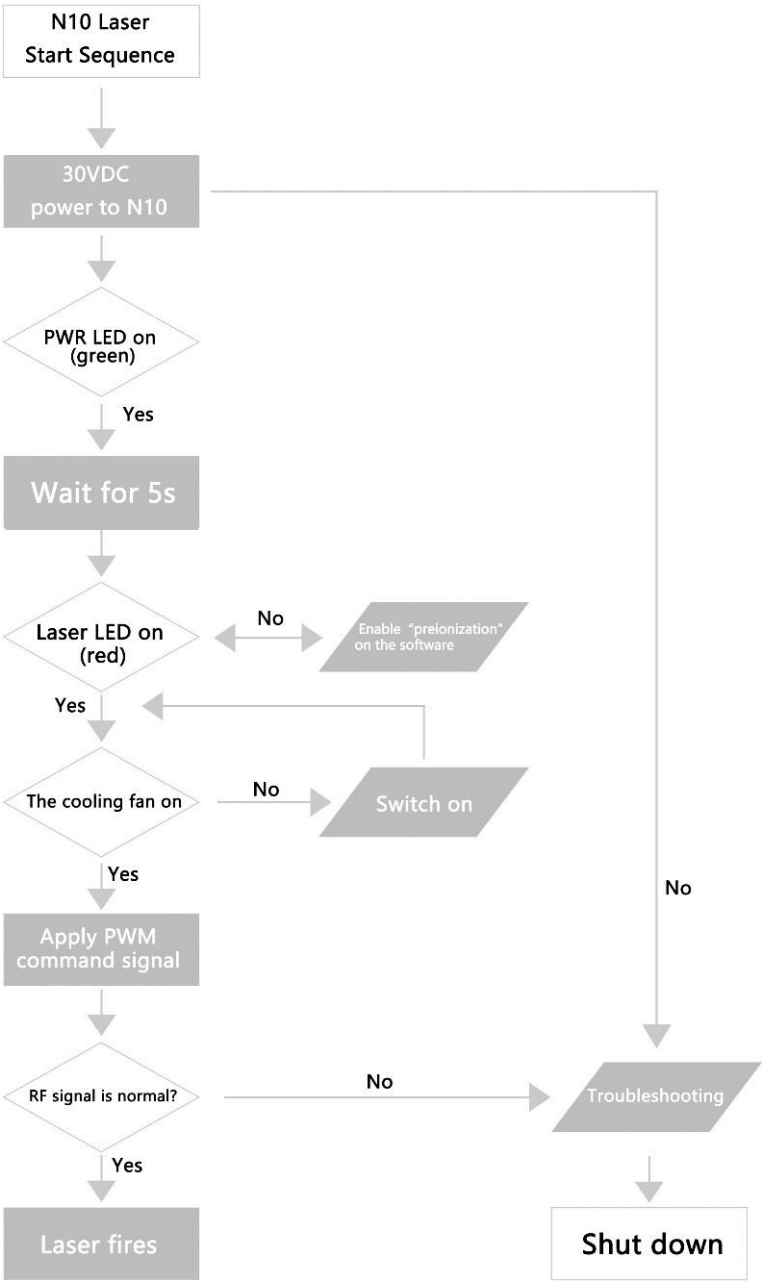
4.9 Fixing

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 N10 CO_2 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



Note: When you shut down the system, please keep the cooling fan running for 5mins after the laser stops firing. Dust are 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 30VDC power and the control signal through the DB15 connector on the laser to make the laser work.

Preparations

1. Power supply（30V，more than 210W output）

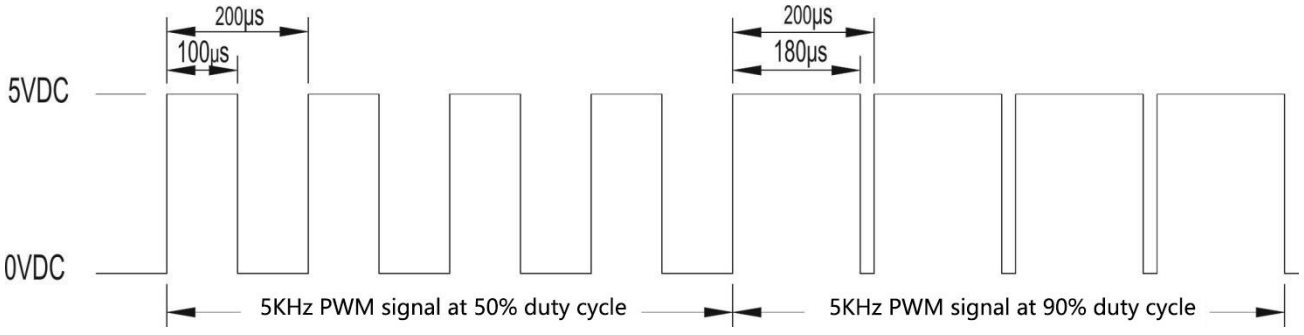
2. Fixing bracket (firm and flexible)

3. TTL Signal generator (Modulation frequency: 0~20kHz, duty cycle: 0~100% adjustable)

5.3 Control Terminal

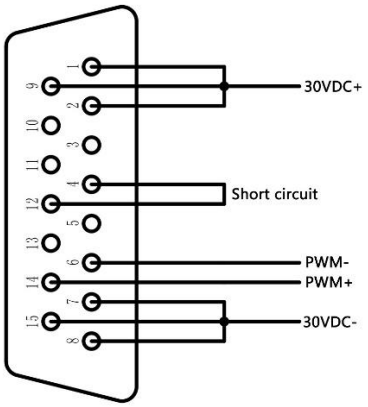
The N10 CO_2 laser is controlled by an external modulation signal, the signal input to and output from the laser is a TTL logic. The ON/OFF and output power of the laser can be controlled by the ON/OFF and the duty cycle of the modulation signal. At the same time, there is also a rich detection and feedback 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 signal 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 DB15 Connector

The operation of the N10 CO_2 laser is easy, please refer to the definition of DB15 connector as below.



N10 wiring instructions

When powering to the laser, short circuit pin 1,2,9 to "30VDC+", and short circuit pin 7,8,15 to "30VDC-" on DC power supply, to protect the pins from being burnt because of the heat caused by excessive current! Please check the DB15 connector definition for other functions wiring.

DB15 connector description

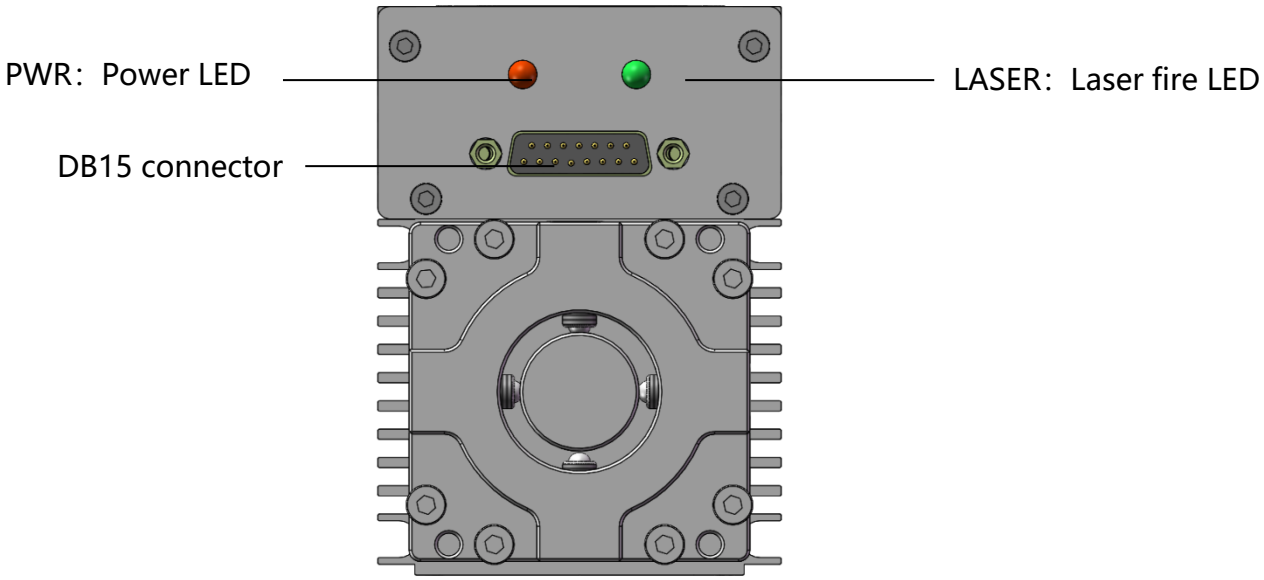
PIN No.	Signal	Definition
1、2、9	VDC+30V INPUT	Input +30VD
7、8、15	VDC+30V RETURN	Input+30VDC return
3	Fault Shutdown Output	There is or was internal circuit failure (>65°C ±2°C), overvoltage or undervoltage fault, when it happens, the low level effective signal (refer to pin 2 or pin 4) is converted from +15V (normal operation) to 0 VDC
4	Remote Interlock Input input TTL logic; 0= Enable Laser Control, 1=Laser Control Disabled	Input this pin TTL logic low, the laser is enabled, and then the laser fires when input TTL high at pin 14

5	+5VDC OUTPUT output TTL logic high	Output current 170mA, maximum 5.4VDC
6	Signal Ground	Signal Ground
10	Output temperature alarm	In case of pre-shutdown temperature warning (when the laser temperature reaches 54 ° C ± 2 ° C), the low level is valid, the signal is converted from + 15 V (normal operation) to 0 VDC, and the low level is maintained until the temperature drops by 2 ° C. Using this output to inform the user that increase the need of laser cooling or realize the risk of turning off the laser.
11	REMOTE PWR LED OUTPUT	Maximum output voltage 2.8 VDC, 20mA
12	Signal Ground	Signal Ground
13	REMOTE LASE LED OUTPUT	Maximum output voltage 2.8 VDC, 20mA
14	Input TTL logic; 1=RF ON, 0=RF OFF; 1kΩ impedance	The pin 4 should be at logic low first and then logic high to make laser fire.
1. All the interface signals shall be connected to the one same ground. 2. Pin 3 and pin 10 are low level valid outputs. Specification: off: + 15 VDC, 5 mA to 3 kohm. On: < 1 VDC, absorb 100 mA. 4. Pins 11 and 13 can be directly connected to the positive of the LED or LED input optical isolator without the limit of external current device. Connect the LED negative to pin 12. 5.The output of pin 13 (remote laser LED output) is a pulse width modulation (PWM) signal based on the PWM command input signal, which is not a steady-state (on / off) output.		

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 & indicators



Controls and indicators of N10 CO_2 laser

Indicators instructions

LED	Instructions	Remarks
PWR (Green)	ON, the laser is ready	OFF, RF power fault.
LASER (Red)	ON, input PWM signal to laser, laser fires.	ON, input PWM signal after the laser is connected to power for 5s, the bigger the duty cycle, the lighter the LED.

*Please refer to Section 5.4 for details of the DB15 connector

5.6 Start-up and pulse operation

Before the operation of N10, please confirm the following items again:

1. The output voltage of DC power supply meets the working voltage required by N10 laser;

2. TTL control signal 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 N10 CO_2 laser is properly powered with 30VDC, the POWER LED (green) is ON, wait for 5s, and the LASER LED shall be ON with faint light (If there is no faint light from LASER LED, please check if the external control can supply preionization signal or if click “preionization” in the software).

Giving PWM signal and the laser fires immediately. The higher the PWM signal duty cycle, the stronger the laser output power, and the lighter the LASER LED.

If the laser works in a high humidity environment, please check if there is condensation on the surface of the N10 CO_2 laser output window lens. If there is condensation, it means the environment is too moist 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.

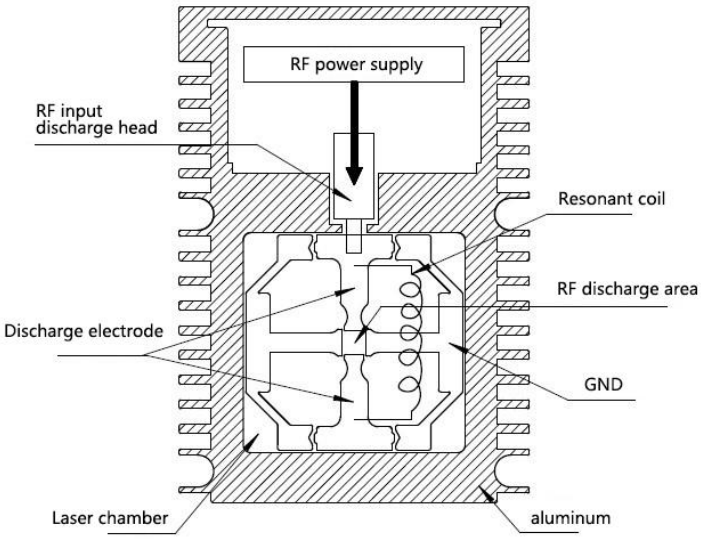
5.7 Laser Operation Safety Tips

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

N10 is a RF-Excited CO_2 laser with waveguide optical resonator, which is excited with RF power supply as pump source to discharge the optical resonator. There are two pieces of adjustable optics mounted on ends of the resonator (1pc on each end), one of them is a full mirror with curvature and the other one is a lens with certain transmittance. The space between two optics is a plasma tube excited by RF which is combined with is discharge electrodes, ground electrode and resonant coil, its structure is as below picture. The upside and downside discharge electrodes and ground electrodes on both ends are assembled into a square discharge area in a certain way. The size of discharge area varis from laser to laser, it is generally around 5mm. The two discharge electrodes are connected by resonant coil, achieve 48MHz RF frequency by adjusting resonant coil to match the frequency of RF power supply.

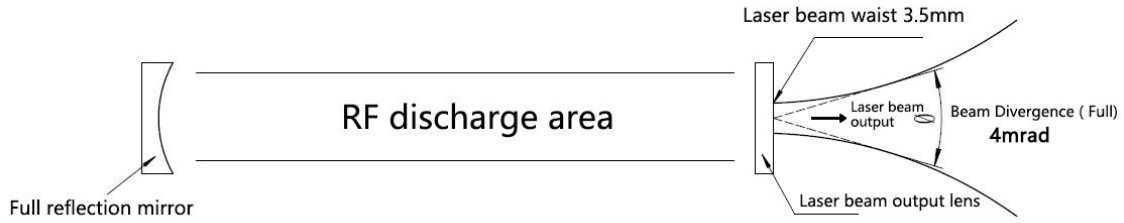


6.2 Pre-ionization

Input RF power to ionize the CO_2 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.

6.3 Laser beam

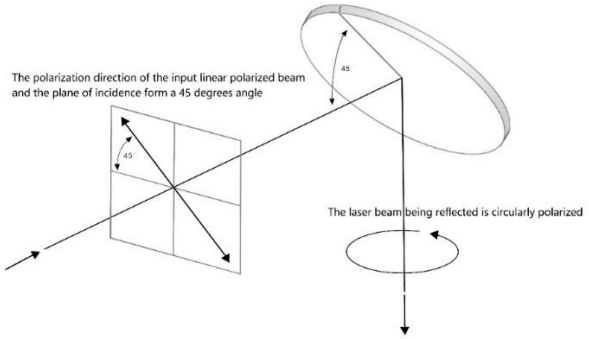
The laser beam is in square shape at the laser beam exit and it turns into round shape at longer distance (about 0.6m or longer distance away from the laser beam exit), close to Gaussian beam. The mode factor (M^2) generated by the structure and optical components in the optical resonator is ＜1.2. You can see from the picture as below, the laser beam waist is 3.5mm at the laser aperture, and the divergence angle (full) is 4mrad (4mrad means the laser beam waist increases 4mm 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 N10 CO_2 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 N10 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 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.

6.6 RF power supply

N10 CO_2 laser generates a 48MHz RF signal from a self-excited oscillation circuit, and generates a high-power RF output through a power amplifier circuit. The RF power supply is powered by a 30V DC power supply, and the laser output power is controlled by a PWM signal.

The RF power supply provides laser status indications, to see if it works (green LED ON), laser fires (red LED on), and other signals like temperature and voltage are feedback to the external indicating device through the output terminal (DB15 connector) to check the laser working status.

6.7 Modulation signal and PWM method

The N10 CO_2 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 N10 CO_2 laser, the maximum duty cycle is 100%.

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

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

Formula description

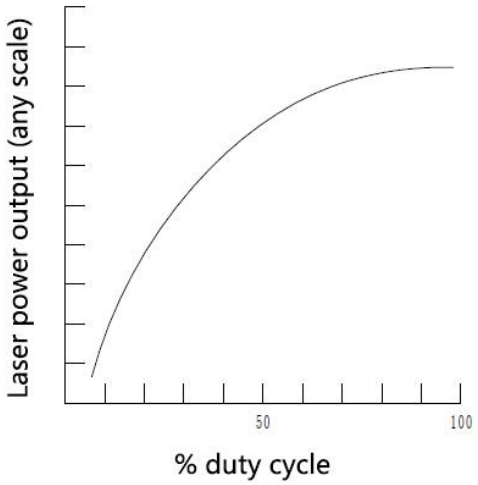
W	Modulation pulse width in μs
Q	Modulation frequency in kHz

For example, 5kHz frequency, duty cycle is 60%, according to the above formula, calculate W = 60% * 1000/5 = 120μs.

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 recommend 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 N10 CO_2 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 device and disconnect the power firstly. It is recommended to use a wet cloth to clean the laser shell. Water can't goes into the laser which can cause damage to it.

Maintanence 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 Q&A

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

A: Yes, The N10 CO_2 RF laser requires the pre-ionization signal from an external control system, and the pre-ionization signal parameters are 5kHz, 1μs, or 1kHz, 5μs.

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 lens 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.