

USER MANUAL

Laser cleaning

LC-CLEAN 300W

MANUFACTURER:

LASERCOMERCIAL ENTERPRISE

B67583120

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LEGAL NOTICES

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CHAPTER 0 - PREFACE

This manual must be read and complied with by all persons who are in the controlled laser area.

All users must review the entire user guide and receive full training by authorized personnel before using the device.

The original language of this manual is Spanish.

RECIPIENTS AND GENERAL INFORMATION

This guide is intended for all owners and operators of the LC-CLEAN 300W device, as well as all persons working in and around the laser equipment when it is in use.

All users of this product must be trained in laser safety, and must follow all safety instructions and warnings in the user guide, safety labels on the EQUIPMENT, and all applicable safety rules, laws, and regulations. The following standards and directives have been taken into account in the preparation of this manual and may be consulted for a better understanding of the content:

- UNE-EN 60825-1:2015 Safety of laser products - Part 1: Equipment classification and requirements.
- UNE-EN 60825-4:2006 Safety of laser products - Part 4: Laser radiation protection systems.
- IEC / TR 60825-14:2004 Safety of Laser products – Part 14: A user's guide
- EN ISO 11553-1:2020 Safety of machinery - Laser processing machines - Part 1: General safety requirements
- UNE-EN 12254:2010 Screens for laser workstations - Safety requirements and testing.
- UNE-EN 207:2018 Personal eye protection equipment - Filters and eye protection against laser radiation (laser protection glasses).
- Directive 2006/25/EC of the European Parliament and of the Council of 5 April 2006 on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation).
- Royal Decree RD 486/2010, of April 23, on the protection of the health and safety of workers against risks related to exposure to artificial optical radiation. BOE No. 99 04/24/2010.

ANSI Z136.9:2013 American National Standard for Safe Use of Lasers in Manufacturing Environments.

**SYMBOLS, WARNINGS AND CATEGORIZATION USED IN THIS MANUAL**

SIGNAGE AND/OR SYMBOL	EXPLANATION
 <u>DANGER</u>	This concept and signage indicates an important danger to be taken into account. If this danger is not avoided, it can cause death or serious injury.
	This sign indicates 'WARNING' and is accompanied by an important explanation for the safety and use of the equipment by the user.
 IMPORTANT	This signage is accompanied by an explanation that requires special attention since it is prominent.

CHAPTER 1 - SUMMARY



1.1 INTRODUCTION

This manual contains all the necessary information related to the LC-CLEAN 300W Laser Cleaning Equipment, and has been produced by LC LASERS. This is a guide compiled with experience and dedication to facilitate the understanding and use of the LC-CLEAN 300W Laser Cleaning Equipment by the end user. In order to make continued and long-lasting use of the equipment, the person or persons who are going to operate the LC-CLEAN 300W Laser Cleaning Equipment must be familiar with its installation, operation, maintenance and safety systems.

Very important: Read the entire manual before using the LC-CLEAN 300W laser cleaning equipment. Keep the manual with the machine. If the equipment is sold or transferred to third parties, provide the user manual.

Before installation and use, read and follow the instructions in this user manual. Damage to persons and/or property may result from failure to follow the instructions given below.

The operation of the system is only permitted with equipment and spare parts supplied or included in the manufacturer's parts list. Any type of deliberate modification by the user without consulting the manufacturer may pose a risk to the health of people using the machine.

The equipment must be handled by personnel trained and authorized by the user company.

The machine complies with all established safety regulations. However, dangers may arise if the machine is operated by untrained personnel, used incorrectly or used for purposes other than those for which it was specifically manufactured. This chapter provides an overview of all important safety considerations necessary to optimize safety and ensure the safe and trouble-free operation of the machine.

Other chapters in this manual also contain specific safety instructions.

Signs, labels and pictograms attached to the machine must remain visible and must not be removed.

1.2 REFERENCES

The following standards and directives have been taken into account in the preparation of this manual, which can be consulted for a better understanding of the content:

- UNE-EN 60825-1:2015 Safety of laser products - Part 1: Equipment classification and requirements.
- UNE-EN 60825-4:2006 Safety of laser products - Part 4: Laser radiation protection systems.
- IEC / TR 60825-14:2004 Safety of Laser products – Part 14: A user's guide
- EN ISO 11553-1:2020 Safety of machinery - Laser processing machines - Part 1: General safety requirements



- UNE-EN 12254:2010 Screens for laser workstations - Safety requirements and testing.
- UNE-EN 207:2018 Personal eye protection equipment - Filters and eye protection against laser radiation (laser protection glasses).
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- ANSI Z136.9:2013 American National Standard for Safe Use of Lasers in Manufacturing Environments.

1.3 TYPES OF USE

1.3.1 INTENDED USE

The laser cleaning It is increasingly present in different industries and jobs. Some of the laser cleaning applications are the following:

- Removing paint from aircraft and vehicles
- Cleaning walls or exteriors of some buildings
- Cleaning in the electronics industry
- Cleaning of welds
- Preparation of materials to be welded
- Partial removal of layers of paint or coatings
- Cleaning industrial parts or belts and meshes with accumulated dirt
- Rust removal from metals

This laser equipment is specifically manufactured to work with its built-in software and the uses prepared for this machine, it should be taken into account:

- a) Clean suitable materials with the appropriate parameters required
- b) The laser cleaning machine must be used and handled by personnel who are familiar with the equipment, its use and operation.
- c) Failure to comply with or omit the instructions and warnings contained in this instruction manual excludes any liability on the part of LC LASERS, the equipment manufacturer.
- d) All safety precautions included in this manual must be used.



To work with other materials or special alloys not specified in the above list, consult LC technical service for your safety.

1.3.2 UNINTENDED USE (FORESEEABLE MISUSE)



Under no circumstances should the laser cleaning machine be used for any purpose other than cleaning materials indicated and suitable for laser cleaning.

As indicated in the previous points, the type of cleaning to be performed can be chosen, but not for any other purpose. The user of the laser cleaning machine is obliged to use the indicated PPE to make proper use of the machine as intended.



Under no circumstances should you work or be near the laser machine without appropriate laser protection glasses.

Under no circumstances should the laser cleaning machine be used to work on objects that may injure people or animals or damage buildings, valuable objects or similar.

Under no circumstances should the laser gun be pointed at living beings, delicate materials, structures, buildings, electrical material, electrical appliances, electrical installations, vehicles, cars or any other object that is outside the scope of the cleaning work itself. These actions may result in serious accidents to people, animals and valuable installations. LC is exempt from any liability and legal, criminal or administrative repercussions arising from the misuse of the laser cleaning machine not provided for in this manual.

Examples of product misuse include:

1. Working without following the safety measures specifically explained in this guide.
2. The use of this product by persons not trained in any area.
3. Inadequate protective measures in the workplace. Key protective measures include: (1) Establishing a controlled laser zone with restricted entry via interlock; (2) providing PPE to ALL workers within the controlled laser zone (e.g., laser safety glasses, and appropriate filters, and appropriate clothing and gloves for clean-up work).
4. Unauthorized modification or conversion of the product by the user or other personnel without the express written permission of LC.



5. Intentionally disabling or bypassing the product's safety systems.
6. Using parts and consumables (other than PPE that meets safety requirements) from other manufacturers (e.g. protective window, nozzle tips, etc.) that do not meet the minimum requirements.
7. Use this product to clean parts containing materials other than those described in section 1.2.1.
8. Removing or rendering illegible safety labels and hazard warnings.
9. Holding parts with your hand or in any way that the cleaning head points towards parts of a person's body.
10. Use of this product by any person in a residential area.
11. Cleaning in containers containing flammable, combustible or unknown materials.
12. Use the laser equipment for work other than cleaning.

1.4 CERTIFICATION

LC Lasers certifies that the LC CLEAN 300W laser cleaning equipment has been inspected and tested by authorized personnel.

LC CLEAN 300W has passed LC quality control before the laser equipment is shipped to the customer. This quality control has the comprehensive review of:

- Internal components of the equipment.
- Conductivity.
- Testing of equipment and proper operation.
- Exterior aesthetics of the equipment.
- Spare parts.

Below you will find the CE marking for this product, as well as the declaration of conformity for the LC CLEAN 300W equipment.



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Máquina

Limpieza láser

Modelo

LC-CLEAN P 300W

Código producto

LC-LL300W

Año de fabricación

2025

Fuente de alimentación

230

V**Laser power**

300

W



Declaración CE de Conformidad

Nosotros **Laser Comercial Enterprise**
C/ Tomas Viladomiu, 61
08650 - Sallent
(Barcelona)



declaramos, bajo nuestra única responsabilidad, que la instalación:

Denominación genérica: Limpieza láser
Marca: LASER COMERCIAL ENTERPRISE
Modelo: LC – GL140 / GL200 / LC-CLEAN 300W / LC-GL500
Código de producto: LC-GL 140W / LC-GL 200W / LC-CLEAN 300W / LC-GL 500W
Año de expedición: 2021

clasificada como máquina, según la directiva 2006/42/CE - *Directiva de Máquinas*,

y a la que se refiere esta declaración, se adapta a lo reflejado en las siguientes normas o documentos normativos, entre otros:

EN ISO 12100:2012 - Seguridad de las máquinas. Principios generales para el diseño. Evaluación del riesgo y reducción del riesgo.
EN 60204-1:2007 - Equipo eléctrico de las máquinas. Parte 1: Requisitos. Generales
EN ISO 14120:2016 - Seguridad de las máquinas. Resguardos. Requisitos generales para el diseño y construcción de resguardos fijos y móviles.
EN ISO 14119:2014 - Dispositivos de enclavamiento asociados a resguardos. Principios para el diseño y la selección
EN ISO 13857:2008 - Distancias de seguridad para impedir que se alcancen zonas peligrosas con los miembros superiores e inferiores
EN ISO 13850:2007 - Parada de emergencia. Principios para el diseño.
EN 50081-2:1993 - Compatibilidad electromagnética. Norma Genérica de emisión. Parte 2: Entorno industrial
EN ISO 13849-1:2009/AC - Seguridad de máquinas. Partes de los sistemas de mando relativas a la seguridad. Parte 1: Principios generales para el diseño.
EN 13849-2:2013 - Seguridad de máquinas. Partes de los sistemas de mando relativas a la seguridad. Parte 2: Validación.
EN 13732-1:2008 - Ergonomía del ambiente térmico. Métodos para evaluación respuesta humana a contacto con superficies. Superficies calientes.
EN 1837:1999+A1 - Seguridad de las máquinas. Iluminación integrada en las máquinas
EN 61310-2:1995 - Seguridad máquinas. Indicación, marcado y maniobra. Requisitos para el marcado.
EN 61310-3:1999 - Seguridad máquinas. Indicación, marcado y maniobra. Requisitos para la localización y funcionamiento de actuadores.
EN 60825-1:2015 - Seguridad de productos láser. Parte 1: Clasificación de los equipos y requisitos.
EN 60825-4:2007 - Seguridad de productos láser. Parte 4: Sistemas de protección frente a la radiación láser.

El producto descrito es conforme con las siguientes Directivas Europeas:

2014/35/UE Directiva de Baja Tensión

2014/30/UE Directiva de Compatibilidad Electromagnética

2006/42/CE Directiva de Máquinas

La propia empresa arriba indicada se encargará de recopilar el Expediente Técnico de Construcción bajo requerimiento motivado de las autoridades nacionales competentes, según se indica en el Anexo II 1.A apartado II de la citada Directiva 2006/42/CE.

Sallent,
16 de FEBRERO de 2021
(Lugar y fecha de la exposición)

Ferran Sardans
Director Técnico
(Nombre y firma)



Esta declaración de conformidad sigue la normativa europea EN ISO/IEC 17050-1 Declaración de conformidad del proveedor. Parte 1: Requisitos generales



CHAPTER 2 - LASER SAFETY INFORMATION

To ensure safe operation and optimal performance of your laser cleaning equipment and associated peripherals, follow all warnings in the product user guide.

Safety precautions must be observed during all phases of operation, maintenance and service.

It is essential to read the entire manual before using the LC-CLEAN 300W laser cleaning equipment. Keep the manual with the machine. In case of sale or transfer of the equipment to third parties, provide the user manual.

Before installation and use, read and follow the instructions in this user manual. Damage to persons and/or property may result from failure to follow the instructions given below.

The operation of the system is only permitted with equipment and spare parts supplied or included in the manufacturer's parts list. Any type of deliberate modification by the user without consulting the manufacturer may pose a risk to the health of people using the machine.

The equipment must be handled by personnel trained and authorized by the user company.

Users of this equipment must follow these recommendations and apply proper laser safety practices at all times and during all work involving this equipment.

All servicing and maintenance operations must be carried out by qualified personnel only.

2.1 SYMBOLS AND WARNINGS IN THIS MANUAL

In CHAPTER 0, symbols and words used in this manual to indicate important concepts and/or explanations are specified. They are designed to draw your attention to any hazards or important information. These standardized signal words will identify important hazards and warnings.

Safety warning messages will appear in this user guide whenever hazards or risky situations may occur. They will alert the user to direct and indirect dangers related to the use of the product and associated peripherals, and will contain general rules of conduct.

For your safety, it is important to read and fully understand the meaning of these signal words and symbols. Follow all safety warnings and proceed with caution to avoid accidents, personal injury and property damage.



2.2 TYPES OF LASER

The laser class is the first piece of information that indicates the danger of the laser. This information is easily accessible. It is mentioned on the laser device as well as in its operating instructions. It is a regulatory and normative obligation for the manufacturer.

These classes, which are 8, can be summarized as follows (1; 1M; 1C; 2; 2M; 3R; 3B; 4).

CLASS	RISKS
1	The device is safe to use, including direct viewing for a long period of time, even when using optical viewing devices.
1M	Non-laser beam, including direct viewing for long periods of time (with the naked eye); viewing through an optical instrument may be dangerous (the letter "M" stands for "magnifying optical viewing instruments")
1C*	Without ocular risk, the ELV for skin (or other non-ocular tissues) may be exceeded in case of interactional exposure (the letter "C" derives from the term "contact", deduced from the mode of operation).
2	Safe** for momentary exposures (0.25 s), valid only for the wavelength range of 400-00 nm.
2M	Safe ** for a short period of time; possible injury if viewed with an optical instrument.
3R	Laser exceeding the maximum permissible exposure (MPE) for direct viewing in the beam (the letter "R" comes from the term "reduced requirements")
3B	Dangerous if exposed to direct beam, regardless of duration of exposure. Diffuse reflections are usually safe, but EMP can be overcome when using an optical viewing instrument. Also, there is a risk of fire from the direct beam (the letter "B" is historical as it comes from the first classification).
4	Dangerous direct vision, dangerous skin exposure, dangerous diffuse reflection and high risk of fire, also due to diffuse reflection.



* This class concerns direct applications with intentional exposure to radiation to the skin or internal body tissues in medical, diagnostic, therapeutic or cosmetic procedures. The laser radiation emitted may be Class 3R, 3B or 4, but the technical characteristics of the device prevent eye exposure (the beam may be Class 3R or 4 only if the applicator is in contact with the skin, or very close to the skin or internal body tissues), thus reducing the hazard class to Class 1. By extension, the requirements of this class can be applied to laser equipment developed, for example in biomedical research at the CNRS.

** The concept of "safety" is linked to the absence of injuries. However, these rays can cause intense and painful glare.

2.3 LASER CLASSIFICATION

The laser cleaning equipment is a Class 4 (USA: Class IV) laser system identified according to DIN EN 60825-1.

To avoid eye irritation during operation, the operator should NEVER look directly into the laser source and should wear eye protection glasses.

Class 4 (US: Class IV)

High power lasers (visible or invisible) are considered to present an acute potential hazard to eyes and skin under both direct (intrabeam) and scattered (diffuse) conditions. Also consider potential hazards for fire (ignition) and byproduct emissions from target or process materials.

It is the responsibility of the machine operator to take appropriate measures to eliminate hazards such as fire or explosion through the laser beam.

When working with Class 4 lasers (US: Class IV), follow these precautions:

- e) According to BGV B 2 "Laser emission", a trained laser safety officer must be appointed to assess potential hazards and ensure that appropriate control measures are implemented.
- f) The laser-controlled area must be marked with appropriate warning signs or warning lights.
- g) The laser-controlled area will be defined to contain the laser radiation.
- h) It must also be protected against unauthorized access.
- i) The operator of Class 4 laser systems must always wear appropriate safety glasses.
- j) An indicator (typically a light) to provide a warning of laser emission before and during the emission time.

**DANGER****CLASS 4 INVISIBLE LASER RADIATION**

Serious and permanent eye damage from reflected or scattered radiation.

Precautions:

- If the system can be active (key switch on), laser protection glasses must be worn within the protected laser area.
- Once work has stopped and before leaving the controlled laser area, the laser device operator must: (1) turn the key switch to the OFF position and (2) remove the key and store it in a safe place. This will prevent unauthorized and untrained personnel from using the laser device.

The LC CLEAN 300W has a red pointer on the head to help focus the beam. This red pointer is a class 3R laser.

All lasers must be classified according to their output power or energy and the laser wavelength. This device is classified as a high power laser instrument with the laser classification for each laser type specified below.

	Main fiber laser (used for cleaning)	Laser indicator (helps with positioning prior to work)
Laser Classification	Class 4	Class 3R
Wavelength	1070 nm	600 to 700nm
Laser radiation emitted	Invisible (Infrared)	Visible (Red)
Average power	300w	20mW
Peak power	85kW	20mW

**DANGER****CLASS 4 INVISIBLE LASER RADIATION - HAZARDS TO EYES AND SKIN**

This level of light can cause serious damage to the eyes and skin.

Precautions:





-
- Because of these risks, a qualified laser safety officer must be present to ensure a safe working environment.
 - If the system can be switched on, laser protection glasses must be worn within the controlled laser area.
 - Appropriate laser safety guards, safeguards and procedures must be present while the laser device is in operation.
 - The laser operator must wear all recommended PPE, including: (1) Specified laser protective eyewear. Additional PPE intended to protect the skin includes flame-, heat-, and arc-resistant protective gloves, clothing, and aprons.
-

**DANGER****CLASS 3R VISIBLE LASER RADIATION.**

- **Avoid exposing your eyes to this laser.**
 - **Avoid looking directly into the laser beam or with optical instruments.**
-

2.3.1 LASER PARAMETERS

A laser is a device that produces a special form of light. A conventional light source, such as a light bulb, produces a diffuse form of light containing a wide range of wavelengths. A laser produces a much more structured light. Laser radiation is extremely bright (several orders of magnitude greater than the light we receive from the sun), has a high degree of purity (it can be thought of as a single wavelength), and is usually emitted in a very narrow beam.

The divergence of a typical laser beam is only 1 mrad, i.e. the beam will spread out only 10 cm after travelling 100 m. These properties make laser radiation suitable for cleaning use in a variety of applications:

restoration, rust removal, grease cleaning, among other options. The purity of the beam allows for the selective removal of unwanted material, while its low divergence and high brightness allow the beam energy to be conducted through a lens and focused to achieve the power and energy density necessary to remove material impurities from a surface.

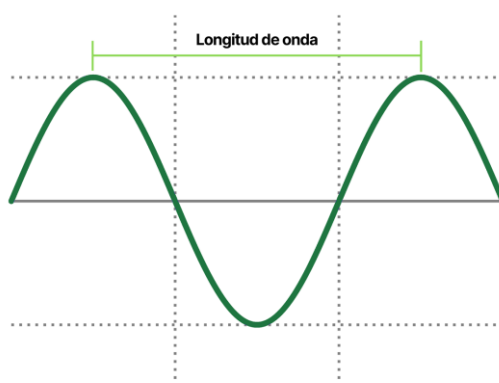
The term LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Lasers are devices that produce a very special form of light, very dense in energy. There is a whole range of lasers used in sectors as varied as industry, surgery, telecommunications, construction, etc. Closer to home, there are "scanners" in the grocery store, compact disc players, etc.



Wavelength: Laser light is a form of energy that behaves, for all practical purposes, like a wave. The wavelength is the distance between two peaks.

Laser radiation wavelengths are usually expressed in nanometers (nm). One nanometer is one millionth of a millimeter or 10^{-9} meters or 0.000000001 meters. The wavelengths of light emitted by different types of lasers range from 190 nm to 10,600 nm.

The wavelength of laser radiation from cleaning equipment is typically 1064nm.



Power: The power of a laser, concentrated in a small area, may be sufficient to cut metal. In other cases, the power is so low that there is no risk to the eyes or skin.

In practice:

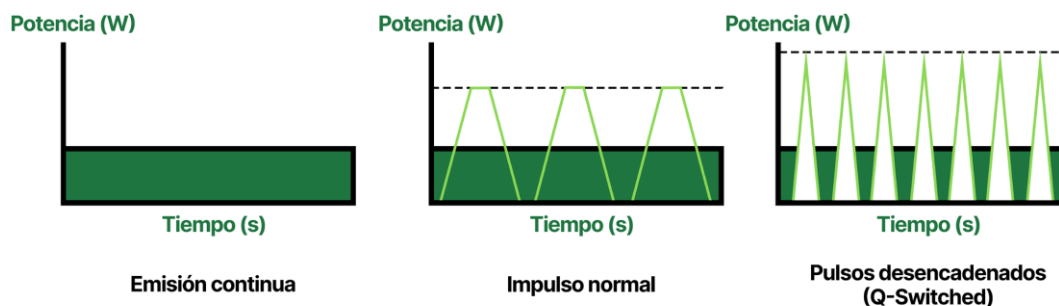
- k) For a pulsed laser, the amount of energy in joules (J) that can be released per pulse is given. Power can also be quantified by taking into account the duration of a pulse. Power is expressed in watts, which corresponds to 1 J/s.
- l) For a continuous-emitting laser, its emission power is given in watts (W). The output power of continuous-wave lasers can vary from a fraction of a milliwatt to several kilowatts.

However, with the same average power, the peak power of a single pulse at the output of a Q-switched laser can reach gigawatts (10^9 W) or even terawatts (10^{12} W) in some laser types. These high powers correspond to an energy released in a very short time.

Tiempo: Duración de un impulso

Área verde oscuro: Potencia media

Línea discontinua: Nivel de potencia máxima





Type of issue:

Laser radiation can be emitted in a pulsed or continuous form. A laser can emit light either continuously or in a pulsed form, depending on the nature of the pump source. If the pump source provides energy in a short burst (rather than continuously), the resulting emission is a pulse of light.

- Pulses. The duration of pulses varies from a few femtoseconds (10⁻¹⁵ s) to several tens of milliseconds. These pulses occur at very variable rates, from a few pulses per hour to several hundred per second. They can be of three types: normal, Q-switched or mode-locked.
- Continuous emission. A laser is said to emit continuously if the duration of the emission exceeds 0.25 seconds, which is the time of the eyelid closing reflex (palpebral reflex). When the eye is exposed to intense light, the eyelid has the reflex of closing to protect the eye.

2.4 RISKS AND RISK FACTORS AND SAFETY SIGNS ON LASER EQUIPMENT

As stated in the previous section, there are several risks and risk factors in the LC LASERS manual laser cleaning system:

EYE HAZARDS

The eye is an extremely sensitive and important part of the body. The eye's great ability to collect and focus light means that it is vulnerable to laser-induced damage.

Damage can occur at all wavelengths, although the area of tissue affected depends on the wavelength. Laser radiation emitted in the visible (400 - 700 nm) and near-infrared (700 - 1400 nm) spectral regions pose the greatest risk, as the light is efficiently transmitted through the ocular fluid and concentrated on a very small spot on the retina at the back of the eye. This wavelength range is known as the retina's risk region.

This high concentration of energy can be enough to permanently damage the retina. This damage can be especially severe if it occurs in the central region (fovea) of the retina, which contains an especially high concentration of light sensors. The damage can severely impair vision in that eye. Unfortunately, most accidents occur with the observer looking in the direction from which the laser



beam has traveled, so the damage and therefore eye damage is most likely to occur in this critical region.

Laser radiation of short wavelengths (<300 nm) in the ultraviolet and long wavelengths in the far infrared (>3000 nm) are absorbed in the front of the eye, which can damage the cornea. Laser radiation in the mid-infrared (1400 - 3000 nm) and near-ultraviolet (300 - 400 nm) is absorbed primarily by the lens, which can lead to cataract formation.

Even brief exposures to a high-intensity laser beam can cause damage.

SKIN DANGERS

Laser radiation can also cause skin damage, although the dangers to the skin are generally considered less serious than those to the eyes. The area of skin affected will depend on the wavelength of the laser beam. Visible and near-infrared radiation (400 -1400 nm) are able to penetrate the epidermis (50 -150 µm from the surface) and dermis (1 - 4 mm), while far-ultraviolet and far-infrared radiation are strongly absorbed in the stratum corneum (8-20 µm). Potential effects of skin irradiation by a laser beam are summarized in the table.

Standard: UNE-EN 60825-1:2015

LC CLEAN is a class 4 laser product



ELECTRICAL RISK

Given by manipulation of the power circuit, which should only be accessed by authorized maintenance personnel using specific safety measures related to



electrical risk and/or due to deficiencies in the insulation of the flexible cables or connections to the machine's network.

To reduce the risk of electrical shock, do not open the door used to store the electrical circuit, as there are no parts inside that the user should manipulate. In the event of a fault, disconnect the machine and notify a person in charge or authorized to contact the specialized technical service.

To avoid indirect contact, make sure that there is a suitable ground connection and that the housing is in perfect condition. It is necessary to make sure that the chassis of the LC-CLEAN 300W laser cleaning equipment is connected to the ground connection.

Do not use gas, flammable liquid or electrical conduits for grounding.

Direct electrical contact may occur in the power circuit due to insulation deficiencies in the flexible cables or connections to the mains or the machine..

Indirect electrical contact may occur with the machine casing due to a voltage fault or a faulty ground connection.

LASER RADIATION

Observation into the class 4 laser beam and skin exposure are dangerous, as is observation of diffuse reflections.



IMPORTANT NOTE: The use of protective glasses is mandatory both when using the machine and when remaining in the area of use given the risks described above.

PROJECTIONS AND BURNS

Eye splashes and burns can be caused by micro-sprays of material particles released from very thick layers being cleaned. Take the necessary measures to protect your eyes and skin.

Risk of burns or skin injuries. To minimize the risk, it is recommended to use appropriate clothing of appropriate length for the activity being carried out, such as cotton safety clothing that completely covers the operator's arms and torso.

EXPLOSION AND FIRE

It can be caused by working in flammable environments or inside containers that have held flammable liquids or by working with containers that have held flammable products. To avoid or minimize the risk, the material must be checked before starting the activity with the laser equipment.



INHALATION OF CONTAMINANTS

Risk of inhalation of contaminants produced by cleaning processes that produce smoke. To minimise or avoid the risk, optimum ventilation of the premises is recommended, together with localised extraction or, failing that, confinement of the process. If the first method is not sufficient and isolation of the process cannot be carried out, individual protection of the worker's respiratory tract must be used as a supplement.

HITS OR FALLS

Risk of impacts/cuts against moving and immovable objects of the equipment, such as the casing or other parts of the machine.

Risk of falling objects during handling, proper use of the hose and gun is recommended during use.

Risk of falling at the same level, it is recommended to keep the work area tidy and clean to avoid falls caused by moving parts of the equipment such as the hose.

ACOUSTIC RISKS

There are three sources of noise in laser cleaning workplaces:

- m) The laser system itself.
- n) The smoke extraction device.
- o) The laser cleaning process. The rapid ejection of material from a surface during laser cleaning causes the generation of sound waves, which propagate away from the surface and are heard as a "popping" sound.

The long-term effects of joint exposure to the three noise sources have not been investigated by any institution at either European or global level. However, the noise levels of the laser system itself are not very high, and the smoke extraction device will depend on the equipment used.



Risk of incorrect actions by untrained persons!

Improper use of the machine may result in injury and/or damage to the machine and to third parties.

It is necessary to inform the personnel and users who are going to use the equipment about the operation of the machine and any other risks.

Consult official regulations on the operation of machines and accident prevention regulations.

**Risk resulting from missing, faulty or incorrect safety installations and machine components!**

Defective or missing safety installations and machine components can result in death, injury and/or damage to the machine.

Carefully check that the safety installations and machine components are functioning correctly and do not exhibit any faults or abnormal behaviour.

The actions specified for each fault must be taken immediately if parts are faulty or defective.

**Risk of incorrect operation (especially during setup)!**

Setting up and operating the machine with limited knowledge of its function may result in injury and/or damage to the machine and/or third parties.

It is necessary to read the operating and safety instructions carefully before starting the machine and beginning any type of work.

**Risk of incorrect use of the equipment by unauthorized persons and/or persons without adequate knowledge!**

Setting up and operating the machine with limited knowledge of its function may result in injury and/or damage to the machine and/or others.

It is important to never leave the machine unattended while it is in operation.

Turn off the machine with the main switch when not in use and when work is finished.

**Risk posed by lack of machine signage!**

Making incorrect assumptions can lead to the risk of the machine being operated incorrectly.

Machine and workspace signage must be used correctly.

**Risk of irreparable damage!**

Any non-repairable fault may damage the machine. In this case, it is necessary to shut down the machine properly and call customer service.

**Risk arising from the use of inferior quality spare parts or those from other manufacturers.**

The use of inferior quality spare parts or those from other manufacturers compromises the safety of the machine and invalidates the Declaration of Conformity (CE) supplied with it.

Wear parts or damaged mechanical, safety or electrical components must be replaced with original spare parts, consult your supplier.

**Risk due to lack of protective equipment!**

It is mandatory to wear appropriate work clothing.

It is mandatory to wear high power laser protection safety glasses (Class 4 / US: Class IV).

Depending on the materials you are working with, it is necessary to use an appropriate extraction system. There are some materials that emit harmful fumes when cleaned with a laser.

**Risk posed by laser marking reaction products!**

A suitable extraction system must be used in laser marking due to the possible generation of gases, fumes and any other partially toxic by-products.

In individual cases, the reaction products may consist of static dust. If it enters any electrical system, it may cause short circuits resulting in personal injury and material damage.

**Risk posed by flammable or explosive materials!**

Class 4 laser radiation can ignite materials or cause explosions. Among other things, you must ensure that:

The parameters are selected so that the material does not overheat.

The system is monitored if necessary

Dust is extracted safely

There is no accumulation of flammable waste or remnants in the workspace.



2.4.1 HAZARDS DURING THE CLEANING PROCESS: GASES, SMOKE AND DUST

Laser cleaning may involve the generation of fumes and the emission of other substances into the air caused by the very process of evaporating impurities from a surface. These residues consist primarily of substrate material. In addition, small amounts of compounds that were not part of the original material, gases generated by the thermal cracking of organic substances and their combustion by the laser. These laser-generated air pollutants are known to create unpleasant odors and visible smoke.

Depending on the materials being cleaned and the parameters selected, laser cleaning may generate gases, fumes, aerosols or dust.

The toxicity of such fumes and residues depends on the material or dirt involved.

These potentially harmful fumes should be removed from the breathing zone by extraction if high concentrations of fumes exist for a prolonged period of time.

The operator is responsible for ensuring that an adequate extraction system is in place and that relevant guidelines are followed to protect people and the environment.

VDI guideline 2262 1... 3 "Air in the workplace" provides, among other things, additional remarks.

The operator must also ensure that gases, fumes or dust do not settle on the lens of the laser gun. Any dirt that accumulates on the lens can cause loss of performance, material damage, poor marking results and damage to the device. Contact your service center for a replacement if it is damaged.

In a very specific example, recent research has shown that in a 50m² workshop with a 4m height and no air exchange, 10 minutes of laser cleaning of limestone was sufficient to reach the maximum permissible workplace concentration (MPCC) of respirable quartz dust.

Another study, also conducted indoors, showed that the residues emitted from the removal of sulfation scale by laser cleaning included a significant proportion of particles with diameters equal to or less than 3 µm. These small particles can penetrate the lungs to the alveoli and are potentially harmful by solubilizing their alkaline and metal salt compounds.

It is sometimes difficult to determine the actual danger of the fumes generated because the exact composition of the layer of dirt being removed is often unknown.

In any case, the risk of smoke generation is solved with a properly functioning smoke extractor and ventilation of the work space once the work day is over. In addition, the use of a mask during cleaning work is highly recommended. In some cases, the use of



masks and/or ventilation systems may be mandatory. **air-supplied respiratory protection.**

2.5 PREVENTION AND SAFETY SYSTEMS

There are different prevention and safety systems that will make the handling and operation of the LC-CLEAN 300W Laser cleaning equipment much safer and will minimize the risks during its use.

The laser cleaning machine has the following safety features:

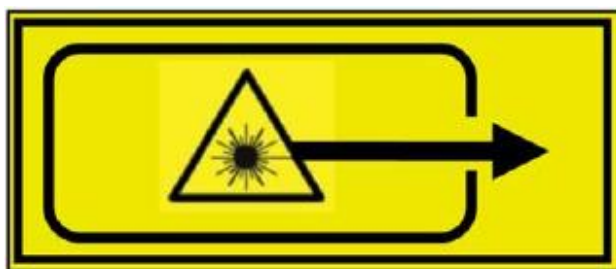
- Machine on/off key;
- Laser on/off key;
- Emergency stop button;
- Emissions notification screen and notice.
- Adequate signage
- Creating a safe workspace

2.5.1 SAFETY SIGNAGE ON LASER EQUIPMENT AND LABELING

The UNE-EN 60825-1 standard requires that each laser product must carry labels to warn about the class, beam emission aperture, characteristics and dangers of exposure to laser radiation generated by the specific product.

In addition to the identification and laser classification labels on the LC CLEAN 300W machine, the following are found:

- A label indicating the laser beam exit, i.e. on the cleaning torch with an arrow pointing towards the tip:



- A label indicating the characteristics of the laser emission (wavelength and maximum power), the danger of exposure to visible and invisible radiation of Class 4.



In addition, the following signs may appear on the equipment or in certain work areas around it. Their meaning is indicated below:



SAFETY GLASSES.

Mandatory eye protection.

Pictogram according to EN 61310 Indication, marking and manoeuvring.

Part 1: Specifications for visual, audible and tactile signals, Section 7.



GLOVES.

Mandatory hand protection against burns.

Pictogram according to EN 61310 Indication, marking and manoeuvring.

Part 1: Specifications for visual, audible and tactile signals, Section 7.



FACE SHIELDS.

Mandatory face protection.

Pictogram according to EN 61310 Indication, marking and manoeuvring.

Part 1: Specifications for visual, audible and tactile signals, Section 7.



WARNING! RISK OF ELECTRICAL CONTACT.

Work on the electrical installation must be carried out exclusively by qualified personnel authorised by the company and in compliance with safety regulations.

Pictogram according to EN 61310 Indication, marking and manoeuvring.

Part 1: Specifications for visual, audible and tactile signals, Section 7.

WARNING! LASER RADIATION RISK



Work with the laser machine must be carried out exclusively by qualified personnel authorized by the company and in compliance with safety regulations.

Pictogram according to the specific standard on laser radiation EN 60825-1.



WARNING! GENERAL DANGER.

General indication of caution due to a hazard that will be defined in the area where the sign is placed.

Pictogram according to EN 61310 Indication, marking and manoeuvring.

Part 1: Specifications for visual, audible and tactile signals, Section 7.

2.5.2 CREATION OF THE LASER ROOM

Most laser cleaning systems produce a divergent laser beam. As the laser beam moves away from the system, it will eventually spread out to a point where it can be considered safe, meaning too weak to harm the eye. This distance is called the Nominal Eye Hazard Distance (NOHD or DNRO). The NOHD depends on the characteristics of the laser cleaning system being used, including wavelength, pulse length, pulse energy, and beam divergence.

Laser cleaning must be carried out within a controlled area, within which the laser beam is confined.

- Adequate warning signs and a warning light (activated when the laser is in operation) must be clearly visible in the work space and upon entering the work area.



- It is also optional to incorporate an acoustic signal that is activated when the laser is fired.
- Interlocks must be installed at access points to the controlled area so that the laser system will turn off when someone enters the area.

When setting up a controlled zone (whether within a large studio or outdoors), the path of a laser beam escaping the zone (if a ceiling has not been included) should always be considered: there may be specular reflective surfaces (e.g. shiny metal pipes) above the work area or windows on the upper floors of a neighbouring building directly in the line of sight.

In such cases, there is a possibility that people outside the controlled area may be inadvertently exposed to hazardous radiation, so a roof must be provided (of course, this may also be necessary outside to provide protection from the weather). On scaffolding, any gaps between the scaffolding boards must be secured if work is carried out above or below the laser cleaning area.

- Particles and fumes generated by the cleaning process must be aspirated at source.

This room may consist of a room or an area delimited by fixed or mobile partitions (cabin, protective enclosure, etc.). It is considered an area with access reserved for personnel authorized by the person in charge of the unit.

Signaling of the controlled laser room:

There must be adequate signage indicating the presence of a laser and its level of risk. This signage must be clearly visible and legible at all entrances to the premises. It includes:

- The "laser hazard" pictogram.

A warning light, flashing or not, placed in a visible place, is recommended to warn of the activation of a laser in the room. It may be supplemented by the emission of an acoustic signal. If an installation has several class 3B or 4 lasers, the warning light must be activated as soon as one of the sources (including the supply capacitor) is supplied with power. Wherever possible, it is recommended that the indicator light be linked to the laser power supply. These lights can also be replaced by light boxes (or light columns). These are made up of several lights and provide more precise information on the nature of the risk depending on the use of the laser. The meaning of each colour on the display panel* must be specified and it is advisable to harmonise it for the entire unit.

In summary, the following should be taken into account when creating a safe space:



- a) Luminous signs
- b) Access control to the laser cleaning area
- c) Smoke and particle extractor
- d) Good lighting and ventilation in the work area
- e) Cover glass windows and similar
- f) Interlock switch for access to controlled work areas
- g) PPE required

2.5.3 RISK ASSESSMENT AND DESIGNATION OF RESPONSIBLE PARTIES

The workplace risk assessment should identify all hazards, establish the conditions under which they may exist and identify the level of risk to which people may be exposed. Appropriate safety controls can then be put in place to reduce the level of risk to an acceptable level. Both the risk assessment and the safety controls should be documented. There should be a formal written framework within which the organization manages laser safety.

To ensure a safe working environment and to be aware of all the hazards and safety measures to be taken, it is useful to appoint a Laser Security Officer (LSO). This person must assume administrative responsibility for laser safety on behalf of the employer and ensure compliance with safe working procedures.

The role of the laser safety officer is to:

- Ensure appropriate control measures.
- Periodic monitoring of laser risks.
- The effectiveness of the control measures applied.
- Maintaining the workspace and equipment.

The employer retains overall responsibility for laser safety. The employer must ensure that the LSO has the knowledge and skills to perform his or her role effectively.

The LSO may need to use a Laser Protection Assessor (LPA) in certain situations. The Laser Safety Assessor, for example, must establish appropriate safety controls when working conditions differ in any way from the normal situation.

The LSO's role should also include specific approval of control measures. This is especially important in the case of outdoor installations, where the safety installation will be temporary and conditions may be very different from ideal conditions. The LSO must inspect and approve (or, if necessary, require changes and additions to) such installations before they can be used. This approval should be documented to show what conditions are being met when working with laser cleaning equipment.



2.5.4 ADMINISTRATIVE CONTROLS

Administrative controls involve keeping track of and monitoring who uses the laser cleaning system and how it is used.

The procedural aspects of administrative controls, i.e. "local rules", are extremely important as they set the organizational framework within which the laser will be used. A vital part of laser safety is awareness of the hazards and understanding of the procedures in place to reduce the risk of injury to an acceptably low level.

It is essential to restrict the use of a laser cleaning system to personnel who have received training in the safe use of lasers.

2.5.5 GENERALITIES

Power supply circuit

The power cables must be of the appropriate section to avoid overheating.

Its insulation will be sufficient for a nominal voltage < 1000 V.

The connection terminals of the LC-CLEAN laser cleaning equipment and the plug pins must be properly insulated.

Light radiations

Class 4 laser products must not be used without first carrying out a risk assessment to identify hazardous situations and assess the expected level of laser exposure, as specified in Section 4 of Directive 2006/25/EC on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation). It will also serve as a basis for determining the control and protection measures necessary to ensure safe operation.

The following factors will be taken into account in this assessment:

- Characteristics of the area or areas to be cleaned with laser.
- Process control.
- Manual operations.
- Clamping and positioning of parts.
- Beam output considerations: structural integrity of components, means to maintain the state of optical components, means to maintain beam alignment, etc.
- Situation and location of workers during laser cleaning.
- Environmental factors.
- Geometry, composition and surface finish of the piece or pieces to be worked.



IMPORTANT INFORMATION NOTE: When working with highly reflective materials, the bounce light can conserve quite a bit of energy in the first part of the bounce. It is recommended to take extreme care with your hands to avoid skin burns and not to touch the parts being worked on immediately after laser cleaning them, but to wait a reasonable amount of time.

Trained and specialized LC LASERS personnel will inform the user of this risk assessment.

As a general rule, safe work spaces must be defined. Depending on the risk assessment carried out, one of the following options or a combination of them will be chosen:

1. Install the cleaning equipment inside a controlled area, i.e. an enclosure with fixed walls and ceiling and an access door with safety switches to prevent access by third parties. Access will be restricted to authorized personnel.
2. Use screens to separate workstations to protect other workers from direct and indirect laser radiation. The material should be opaque, preferably made of solid metal sheet and non-reflective surfaces. It is also possible to use robust translucent material, which should be selected based on the optical protection properties suitable for the wavelength and power of the laser source. The bottom should be at least 50 cm from the floor to facilitate ventilation. Signs should be posted with the words: DANGER, LASER RADIATION RISK.



Regardless of the solution adopted, the use of approved laser protection glasses is mandatory for the operator handling the laser cleaning equipment and for any other person observing the work.

There are two types of radiation generated during laser cleaning:

- Direct radiation is the radiation emitted by the gun or torch and which cleans the material. This radiation can cause serious burns in direct contact with the skin and eyes.
- Indirect radiation is produced by the rebound and/or reflection of the light emitted by the gun or torch. This light has a specific wavelength, between 1060-nm and 1080nm. This wavelength is covered by the special glass used in protective glasses.

Projections and burns

It is recommended to use cotton safety clothing that completely covers the operator's arms and torso to adequately protect the skin. The user must use protective glasses and face shields, which, in addition to protecting from radiation, also protect against micro projections from the cleaning process.



Protection against toxic fumes and vapours resulting from the cleaning process

Use a smoke and vapour extraction system, properly located near the cleaning area, and must evacuate said smoke and vapours outside the work area, ensuring a renewal of clean air.

Ventilate the workspace regularly when the laser cleaning equipment is not in use.



If the material to be cleaned generates a lot of fumes due to its composition (galvanized, aluminized or other treatments), it will be mandatory to incorporate a fume and vapor extraction system or, failing that, respiratory protection equipment with air supply.

Grounding

The installation of the grounding sockets must be done according to the manufacturer's instructions.

It is necessary to ensure that the chassis of the laser cleaning equipment is connected to the ground.

Do not use gas, flammable liquid or electrical conduits for grounding.

2.5.6 RESPONSIBILITIES OF THE PERSONS WHO OPERATE THE MACHINE AND ITS USERS

Keep this manual near the machine's work area so that it is accessible at all times to all persons working on the machine.

The user must ensure that the machine is only operated under perfect safety and maintenance conditions.

You should always have a fire extinguisher on hand, as the laser beam can ignite flammable materials.

Do not store any flammable materials inside or near the device. In particular, any waste materials produced must be removed to avoid the risk of fire.

The operator must ensure cleanliness and accessibility in and around the machine by following appropriate instructions and controls.

The machine must only be operated by trained and authorized personnel.

For all activities relating to installation, assembly, start-up, operation, modifications of operating conditions and methods, maintenance, inspection and repair, the shutdown procedures that may be provided in the Operation Manual must be observed or contact the specialized technical service.



It is the operator's duty to check the machine for externally visible damage and defects before starting work, and to immediately report any changes that appear (including behavior during operation) that affect safety.

Setup, re-equipment, workpiece change, maintenance and repair activities should only be performed with the equipment switched off, by trained personnel.

First of all, no safety components may be removed or disabled (here we already emphasize the imminent dangers, e.g. severe burns, loss of eyesight). If it is necessary to remove safety components during repair and service, the replacement of safety components must be carried out immediately after completion of service and repair activities.

Working methods that affect the safety of the machine are not permitted.

It is absolutely prohibited for anyone who is under the influence of drugs, alcohol or medications that alter a person's reaction to operate or work with the machine.

The scopes of competence for the various activities within the scope of machine operation must be clearly defined and observed, so that unclear questions of competence do not arise from a safety perspective. This applies in particular to activities on electrical equipment, which should only be carried out by specialised experts.

- a) Follow safety instructions to avoid personal injury and property damage while working on and with the machine.
- b) Failure to follow these instructions may result in personal injury and damage or destruction of the machine.
- c) Failure to heed the safety advice and instructions given in this manual will release the manufacturer and its authorized representatives from any liability and claims.

2.6 WARNINGS DURING WORKING WITH LASER CLEANING



The laser beam must never be directed at people or animals!

Never attempt to modify or remove the safety devices or laser head cover!

Never attempt to modify or disassemble the laser and do not attempt to operate a system that has been modified or disassembled.

The use of this machine for any purpose other than that for which it was manufactured: cleaning materials using a laser is prohibited.



Exposure to hazardous radiation may result from the use of operating or adjusting equipment other than that described herein, and if different operating methods are used.

- The workplace should be well lit. This allows the conservator to see the work properly (especially if wearing tinted eye protection), move freely around the work area and see other hazards such as trailing cables. Ideally, the walls surrounding the workplace should be light-coloured and reflect light diffusely.
- The work area must be well ventilated.
- Specularly reflective surfaces should be removed from the work area to reduce the possibility of glare. Tools around the work space that may have shiny surfaces should be covered with anti-reflective tape.
- Care must be taken when wearing jewelry during laser cleaning operations.
- If the boundaries of the controlled area contain windows, these should be covered with a material that is opaque to the laser radiation being used (glass transmits most wavelengths used in laser cleaning very well).
- Attention should also be paid to the number of people present in the controlled area. Ideally, only one laser should be used at a time and no other work should be carried out while the laser is in use.
- If more than one laser cleaning system needs to be used simultaneously, a controlled zone must be created for each laser.

2.7 PROHIBITIONS



Cleaning work with the LC-CLEAN 300W laser cleaning equipment must not be carried out near areas where degreasing operations are being carried out, as gases hazardous to health may be produced.



Work inside containers, tanks or barrels will also not be permitted until they have been completely cleaned and degassed with steam.



It is prohibited to carry out any type of cleaning without the necessary protective equipment.



Never use the LC-CLEAN 300W laser cleaning equipment outside the materials to be cleaned.



It is prohibited to store or operate near corrosive or flammable materials.

2.8 PPE'S



There are different Personal Protective Equipment (PPE) for the operator of the LC-CLEAN 300W Laser cleaning equipment:

- Eye protection: the PROTECTIVE GLASSES supplied with the LC-CLEAN 300W laser cleaning equipment or approved laser protection glasses must be used without exception. In the event of an accident due to the NON-use of said protective glasses, LC LASERS is exempt from any legal or judicial liability arising from said injury.

The LC-CLEAN 300W Laser cleaning equipment comes with two pairs of protective glasses with different opacities, so that the operator can choose the one that is most comfortable when working.

The glasses to be used must comply with the specifications and marking according to standard EN 207: filters and eye protectors against laser radiation.

It is important to use the PPE appropriate for the workplace. It is recommended to work with work clothes and safety boots, for greater comfort and safety when working with the machine.

2.9 TECHNICAL DATA OF THE MACHINE

Major

Model	LC-CLEAN 300W
Product reference	LC-LL300W
Electricity consumption	<1500 W
Voltage	230VAC
Power stability (2 hours)	<1.5%
Power stability (24 hours)	<2%
Dimensions approx.	250x400x700 mm
Approx. weight	<40kg
Hose length	5m approx.

Laser data

Model	L300W-V.1
Product reference	CL2-L300W-V.1-10mJ
Laser power	Pm 300W Pp <100kW
Laser type	Pulsed fiber laser
Consumption	<1200W
Voltage	48V
Maximum power consumption	<25A
Wavelength	1064nm



Power instability	<5%
Power range	1-100%
Frequency range	1-3000kHz
Laser efficiency	34%
Start time	10 μ s
Gun connection type	QCS
Fiber length	5 m
Pulse width	13-500 ns
Anti-Reflex protection	Yes
Weight	25 kg
Dimensions	340x265x100 mm
Working temperature	0~40°C
Ambient humidity	10-90%
Refrigeration system	Air cooling
Storage temperature	-10-60°C
Laser Class	4 (IEC 60825-1)
Pointer power	1mW
Pointer class	2M (IEC 60825-1)

2.10 TRAINING

Article 6 of Directive 2006/25/EC on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation) requires that workers exposed to risks from artificial optical radiation receive information and training, especially workers using class 3B and class 4 laser products. Training shall include:

- The measures taken.
- Exposure limit values and associated potential risks.
- The results of the evaluations, measurements and/or calculations of the levels of exposure to artificial optical radiation carried out, as well as explanations of their meaning and potential risks.
- How to detect and report adverse health effects resulting from exposure.
- The circumstances in which workers have the right to health surveillance.
- Safe work practices to minimize risks from exposure.
- Correct use of appropriate personal protective equipment.

2.11 REGULATIONS



The above provisions are subject to the obligations laid down in Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery and amending Directive 95/16/EC and Directive 2006/25/EC on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation).

In addition to the European regulations UNE EN 60825-1 and UNE EN 60825-4 regarding the safety and classification of laser types, UNE-EN 208 of 2010 and UNE-EN 207 of 2018 regarding the eye protection essential for the use of the equipment.



CHAPTER 3 - LASER CLEANING

3.1 DESCRIPTION

LC LASERS manual laser cleaning is a revolutionary and innovative technology in the world of metal cleaning.

The LC-CLEAN 300W laser cleaning equipment allows for very fine cleaning without excessive heating and without any deformation of the materials.

The operation of the LC-CLEAN 300W laser cleaning equipment is extremely simple: it does not require a high technical level on the part of the operator, and it cleans a wide variety of materials using the same technique, simply by changing the equipment parameters.

The power and precision offered by the LC LASERS manual laser cleaning system allows us to clean at high speeds, depending on the power of the equipment and the coating to be removed.

3.2 DIFFERENCES, ADVANTAGES AND DISADVANTAGES WITH RESPECT TO SHOT BLASTING

Shot blasting is a cleaning technique that removes dirt by the impact of abrasive particles propelled towards metallic and non-metallic surfaces. Through this process, visible dirt such as rust, corrosion, paint, dust, carbon and other residues can be removed.

3.2.1 ADVANTAGES OF SHOT BLASTING CLEANING

- It requires a relatively low initial cost.
- Technique that does not involve chemical substances.
- Technology well known in the market.

3.2.2 DISADVANTAGES OF SHOT BLASTING CLEANING

- It is not effective in removing large scale dirt.
- High consumption of abrasive products.
- Great fatigue for the operator, as the equipment can be annoying.
- Need for a safety suit and cabin.
- High energy consumption.
- Exterior cleaning not recommended.



- Noisy.

However, in recent years, a new technique has burst into the sector with great force, laser cleaning. This is the most innovative technology in the area of cleaning rust and other substances and offers many advantages over other more traditional techniques such as shot blasting.

Today, the cleaning market has evolved, but many of the techniques used are still outdated, as they use manual processes combined with aggressive chemicals that damage the material to be cleaned. In addition, some techniques such as shot blasting have some drawbacks such as, for example, the need for a large workforce in the different stages of the manual process. With the laser equipment we achieve great advantages such as very rapid preparation of the cleaning process.

Some research has shown that time is reduced by up to 20 times compared to other cleaning systems. Laser cleaning equipment has high speed, dry cleaning and is also environmentally friendly.

3.3 APPLICATIONS OF LASER CLEANING

Laser cleaning is the latest development in laser technology for deep, effective and successful cleaning. Traditional industrial cleaning methods often require tedious processes, present dangers and limitations, and are environmentally polluting. Laser cleaning machines can be used to clean paint, heavy soiling, remove rust and corrosion, and more. Let's learn about laser cleaning applications and how laser cleaning equipment works.

It is increasingly present in different industries and jobs. We will highlight some applications of laser cleaning:

- Removing paint from aircraft and vehicles
- Cleaning walls or exteriors of some buildings
- Cleaning in the electronics industry
- Cleaning of welds
- Preparation of materials to be welded
- Partial removal of layers of paint or coatings
- Cleaning industrial parts or belts and meshes with accumulated dirt
- Rust removal from metals



CHAPTER 4 – MAIN COMPONENTS

4.1 LASER RESONATOR

The laser resonator is the key component that produces the laser beam. This beam of light is then directed towards the cleaning gun by a flexible hose containing a fiber optic cable, which efficiently transports the laser energy.

This resonator is pulsed, meaning the laser is emitted in rapid pulses rather than a constant stream of energy. The equipment is designed to deliver an average power of 300W, ensuring consistent and effective performance during use. In addition, it features a peak power of up to 100kW, allowing the laser to reach extremely high intensity in short bursts, ideal for precise and powerful cleaning applications.

4.2 LASER GUN

The laser gun functions as the main head of the cleaning system, being the work tool that the operator uses to direct and manipulate the laser towards the surface to be cleaned. This gun allows precise and effective control of the laser beam, which facilitates the execution of cleaning on specific materials or surfaces.

The laser cleaning gun features some essential consumables, such as lenses, which are key components in focusing the laser beam correctly. To ensure optimal performance, it is essential that the gun is kept in good condition and cleaned regularly. This is especially important to prevent dust, dirt, or other contaminants from affecting the gun's internal components, which could lead to damage to the lenses or affect the accuracy of the laser beam.



CHAPTER 5 – USE OF EQUIPMENT

This chapter details the first steps to take when you receive your new LC-CLEAN 300W laser cleaning equipment and how to use it. Follow these instructions carefully to start up the equipment for the first time and keep this manual handy for future reference related to its maintenance and operation.

5.1 ELECTRICAL CONNECTION

All LC-CLEAN laser cleaning equipment has a power cable coming out from the back.

The 300W unit operates on a 16A single-phase socket. A power cable is included with the unit, with a head that fits into the socket on the back of the LC-CLEAN 300W laser cleaning unit.

5.2 ON AND OFF

5.2.1 IGNITION

To properly operate the equipment LC-CLEAN laser cleaning 300W must follow the following steps:

1. Properly connect the equipment to the power supply by plugging the cable into a compatible socket.
2. Turn the emergency switch clockwise to deactivate it (mushroom).
3. Turn the ignition switch key clockwise.

5.2.2 SHUTDOWN

To proceed to turn off the LC-CLEAN 300W laser cleaning equipment, we must follow the previous steps in reverse:

1. Turn the key counterclockwise.
2. Press the emergency switch (mushroom).



5.3 CONTROL PANEL

Heteam controlLC-CLEAN 300W laser cleaning is carried out using a touch screen located on the front of the equipment, so it does not require any computer or external accessory for its control.

5.3.1 START OF THE SOFTWARE

Once the equipment is turned on correctly, the following login screen will appear:



Two boxes can be selected:

- 1- Cleaning: Start screen to enable laser cleaning (Default password – 1)
- 2- Configuration: Allows you to make internal configurations (Default password – 6)



5.4 CLEANING

In this menu we can access to perform the cleaning



5.4.1 CLEAN

To perform the equipment cleaning process, follow these steps:

1. **Click on Preview:** Start preview to check system status.
2. **Press on Laser:** Activate the laser to prepare the equipment.
3. **Press Ready:** Confirm that the equipment is ready to operate.
4. **Remove the lens cap from the gun:** Make sure the lens is uncovered and ready for shooting.
5. **Put on personal protective equipment (PPE):** Make sure you are wearing all the safety elements necessary to operate the equipment safely.
6. **Press the trigger button twice:** Do this with a 1 second interval between each press to start cleaning.

Optional note:

- You can press the AIR button to activate a digital output that would turn on the air pump. However, this feature is currently disabled.

5.4.2 OSCILLATION

Here we find different forms of cleaning. Each of these forms has different configurations depending on the typology.

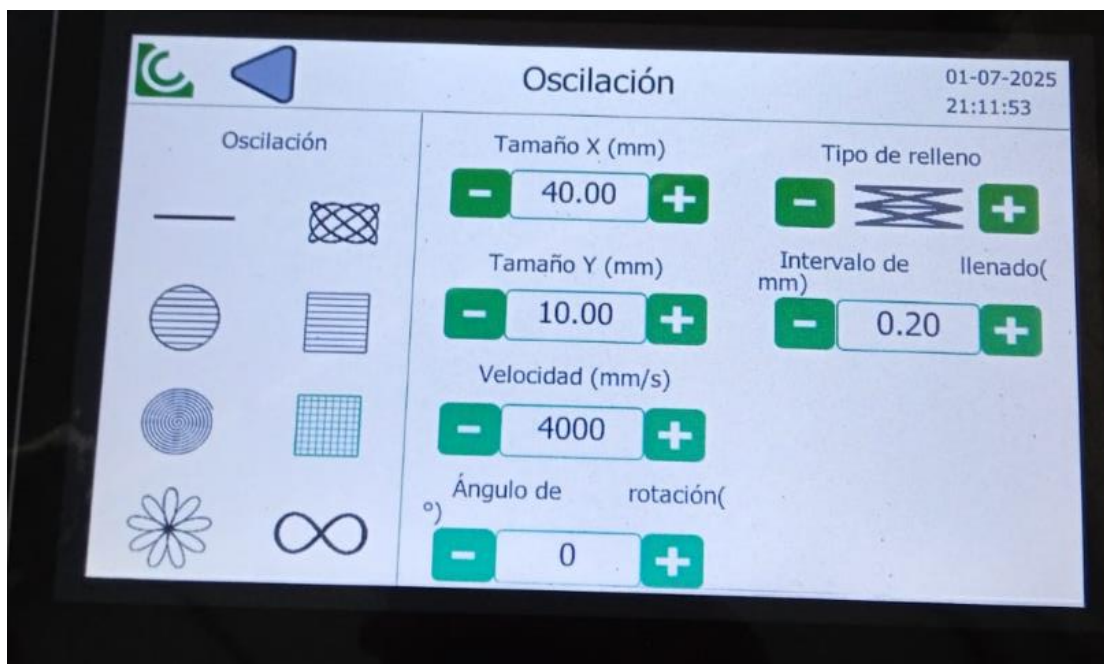


Figure Configuration

Each figure has particular characteristics that can be adjusted according to its typology. Configurable parameters include:

- **Size on X axis:** Modify the horizontal dimension of the figure.
- **Size on Y axis:** Adjust the vertical dimension of the figure.
- **Movement speed:** Regulate how fast the system moves.
- **Rotation angles:** Set the angular orientation of the figure.
- **Fillings:** Customize the fill level as needed.
- **Types of filling:** Choose from different available fill styles.
- **Other additional parameters:** According to the specific needs of each figure.

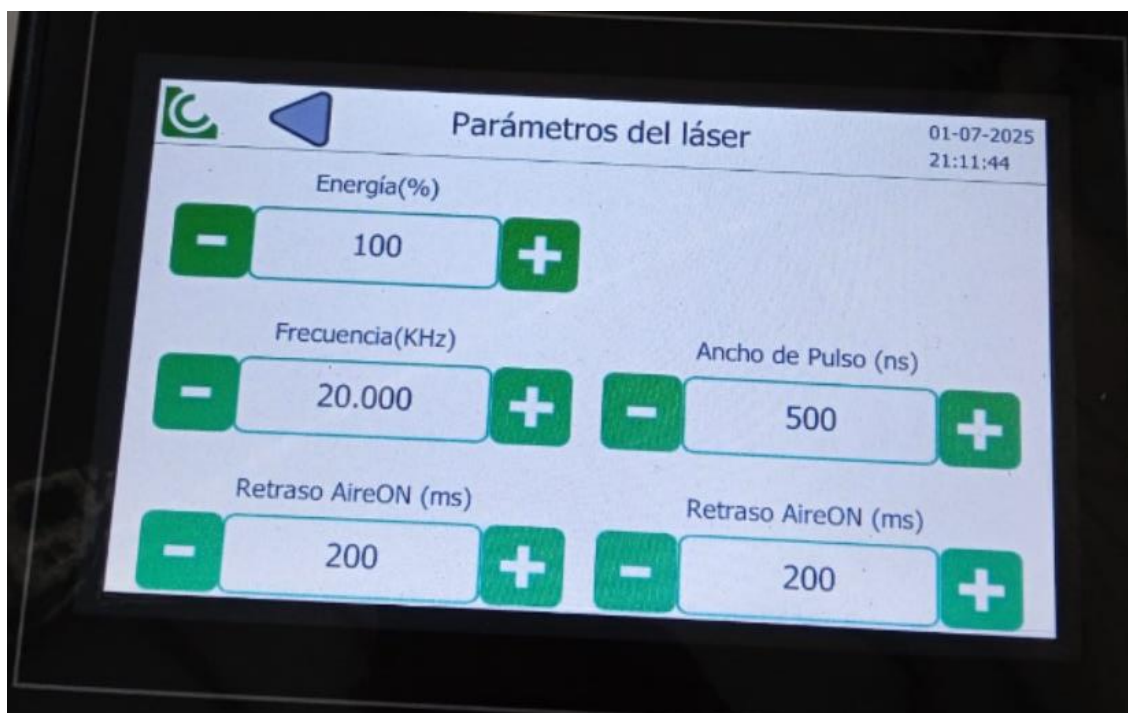
To view the adjustments made or check the settings, return to the previous menu and press the Preview option.

5.4.3 POWER

Laser Configuration Elements

The following adjustable parameters are available to customize the operation of the laser cleaning equipment:

1. **Power (0-100%):** Regulates the output power of the laser.
2. **Frequency (0-250 kHz):** Adjusts the laser output frequency.
3. **Pulse width (10-500 ns):** Define the pulse width as needed.
4. **Pre air (ms):** Sets the air output time before triggering.
5. **Post air (ms):** Sets the air output time after triggering.



Important Note:

In pulsed laser cleaning equipment, the values for frequency and pulse width are not completely independent. The laser operation automatically adjusts to protect itself and prevent irreparable damage at certain combinations of these values.

For example, selecting a lower frequency will automatically reduce the laser power to prevent overload. Specific values and their limitations are detailed in the table below.

PULSE WIDTH (ns)	MINIMUM FREQUENCY (kHz)
13	250
20	170
30	120
45	80
60	70
80	55
100	50
150	34
200	30
250	25
350	22
500	20



5.5 CONFIGURATION



CONFIGURACIÓN

30-10-2024
00:00:00



CORREGIR



I/O



TEMPERATURA



USUARIOS



OTROS



VERSIONES



RAMPA
DE POTENCIA



PARÁMETROS
DINÁMICOS

The laser cleaning equipment has several adjustable parameters to customize its operation. However, some functions are restricted and require the supervision of a specialized technician for adjustment.

1. **Point position correction:** Adjust the position of the point to ensure that it is as centered as possible (IMPORTANT).
2. **Digital inputs and outputs (I/O):** Configure digital inputs and outputs for specific integrations.
3. **Temperature:** Monitors the temperature status of both the gun and the laser.
4. **User control:** Manage user permissions and access.
5. **Other settings:** Additional device-specific settings.
6. **Versions:** Check the version of the installed software.
7. **Power ramp:** Allows generating power ramps for specific applications.
8. **Dynamic parameters:** Adjust advanced parameters to optimize performance.



5.5.1 CORRECT



Pointer and Lens Settings

This screen allows you to adjust the centering of the red pointer and select the lens type. Depending on the lens used, it is necessary to change the model (e.g. F210). You can check the lens model on the lens outline.

The “ADJUSTMENT” section is restricted and should only be modified under the supervision of a qualified technician. Incorrect adjustments could cause the laser to fire inside the gun, which could result in irreparable damage.

5.5.2 I/O



Configuring Digital Inputs and Outputs

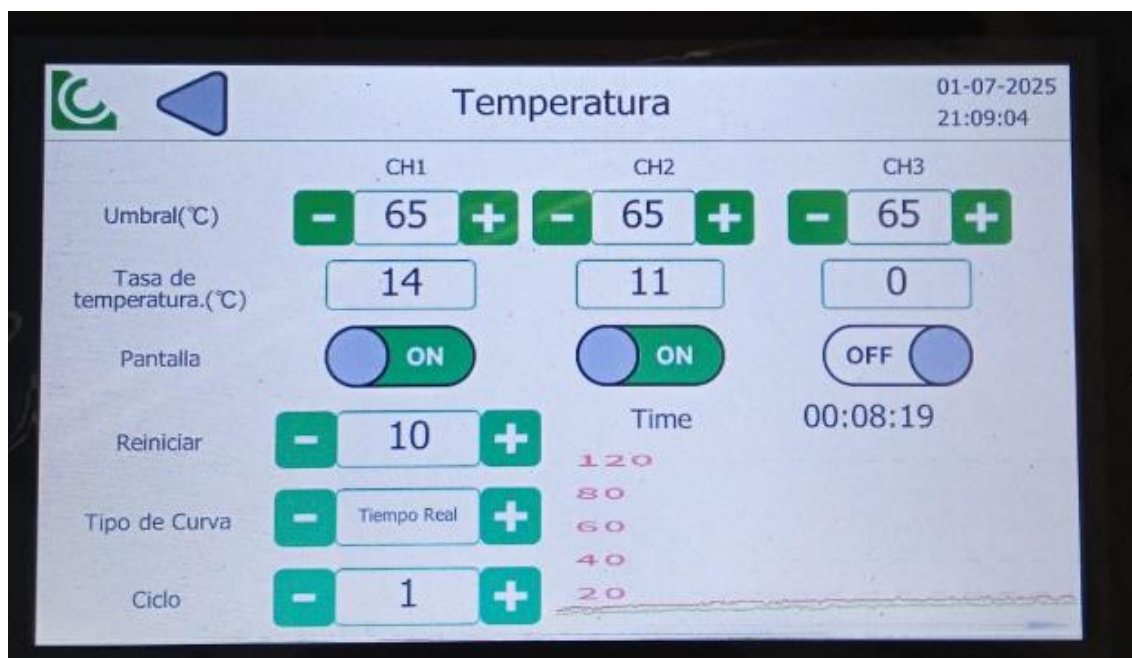


In this section, digital inputs and outputs can be configured for various system applications. These settings allow integration with other devices or systems, optimizing the use of the equipment for specific tasks.

It is important to note that incorrect settings could affect the performance of the equipment or even cause damage to components. It is therefore recommended not to modify these settings without the supervision and advice of a qualified technician. Incorrect settings could alter the interaction between the equipment and other connected systems, which could compromise the safety and proper operation of the laser.

If you are unsure how to make these adjustments, always consult a qualified technician to avoid problems and ensure maximum equipment performance.

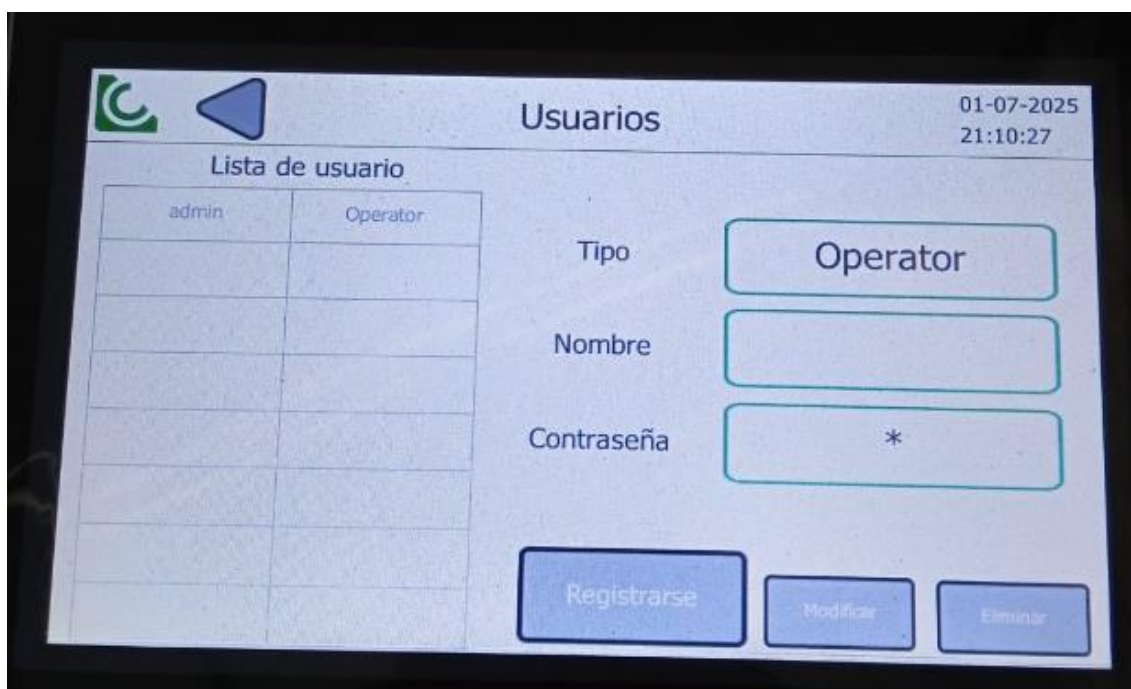
5.5.3 TEMPERATURE



On this screen, it is possible to monitor the temperature of the laser and other critical components of the equipment. This function allows you to check the thermal status of the elements and ensure that they operate within safe ranges, avoiding overheating that could damage the system or affect its performance.



5.5.4 USERS



User Management

In this section, you can change and assign permissions to different users of the system. There are two types of users with different access levels:

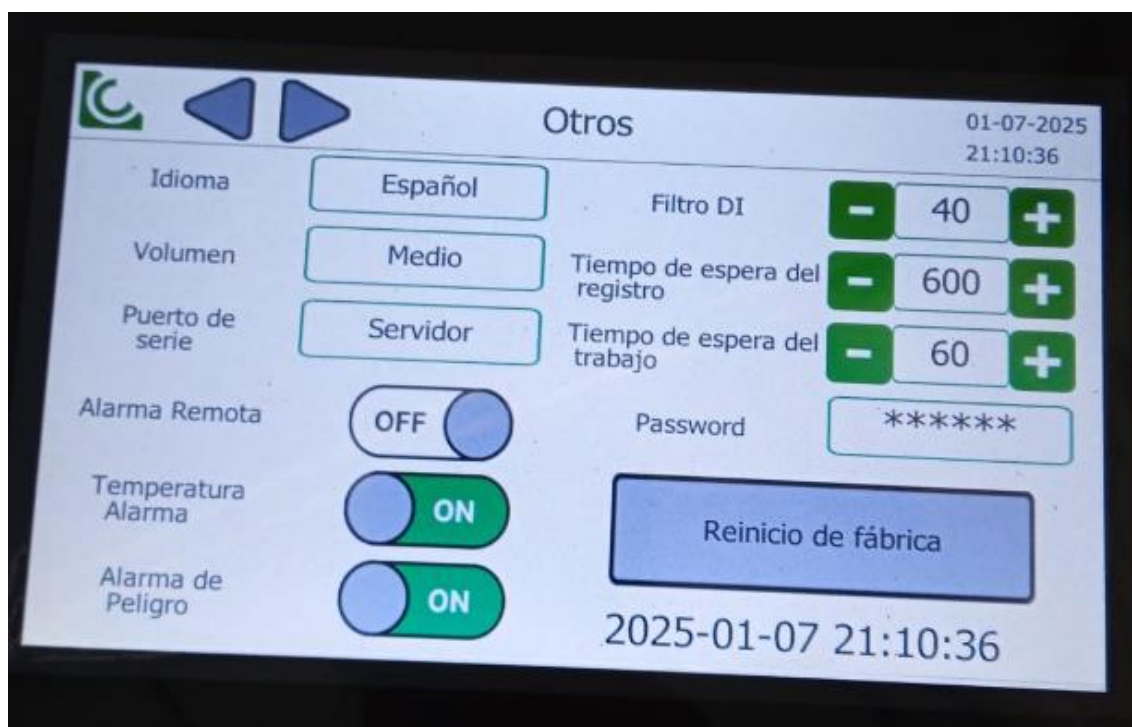
- **Operator:** Basic user, with limited permissions, suitable only for performing cleaning tasks.
- **Administrator:** Advanced user, with access to settings and the ability to modify system parameters.

Additionally, the following action buttons are available:

- **Register:** To save a new user with the corresponding permissions.
- **Modify:** To update the settings of an existing user.
- **Eliminate:** To remove a user from the system.



5.5.5 OTHERS



System Configuration

In this section, various control system settings can be adjusted, such as:

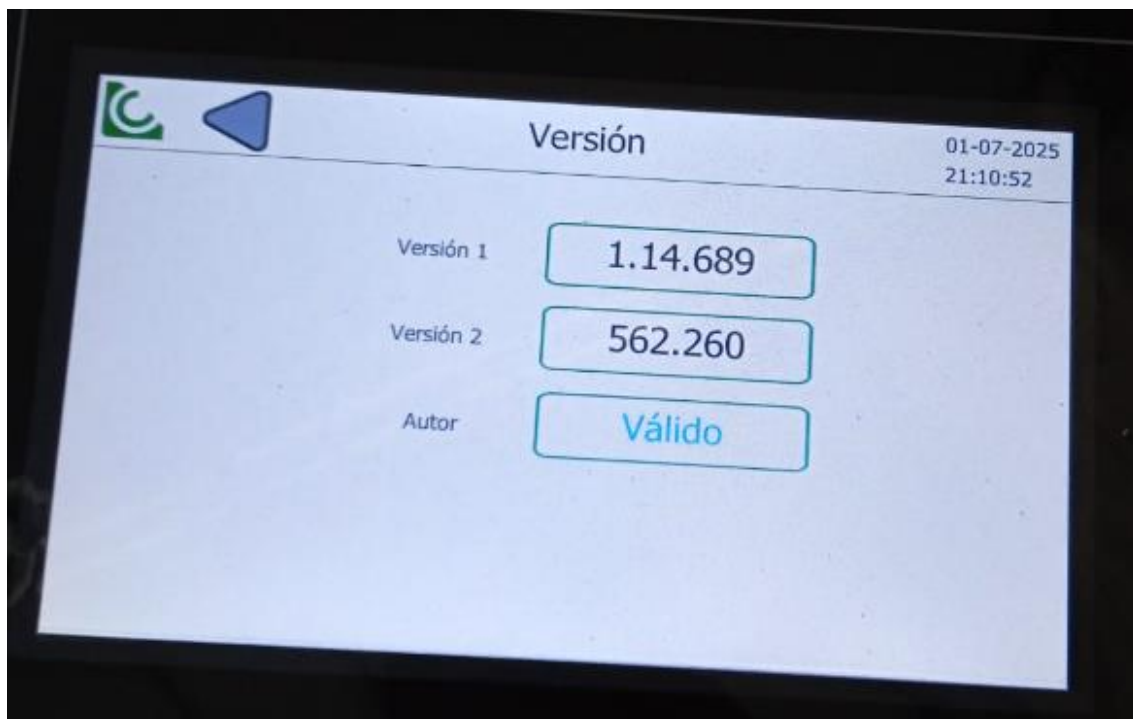
- **Language:** Allows you to change the language of the control system to adapt it to the user's needs.
- **Volume:** Adjust the volume of the display or system notifications.
- **Remote alarm:** Enables external alarms for alerts outside the system.
- **Alarm temperature:** Set an alert if the temperature of the device exceeds the safe limit. It is recommended to leave this option ON by default.
- **Danger alarm:** Activates an internal alarm that warns of possible failures or dangerous conditions of the equipment. It is recommended to leave this option ON by default.

Important note:

It is recommended not to modify the other elements, since these may alter internal configurations of the system and affect its proper functioning.



5.5.6 VERSIONS



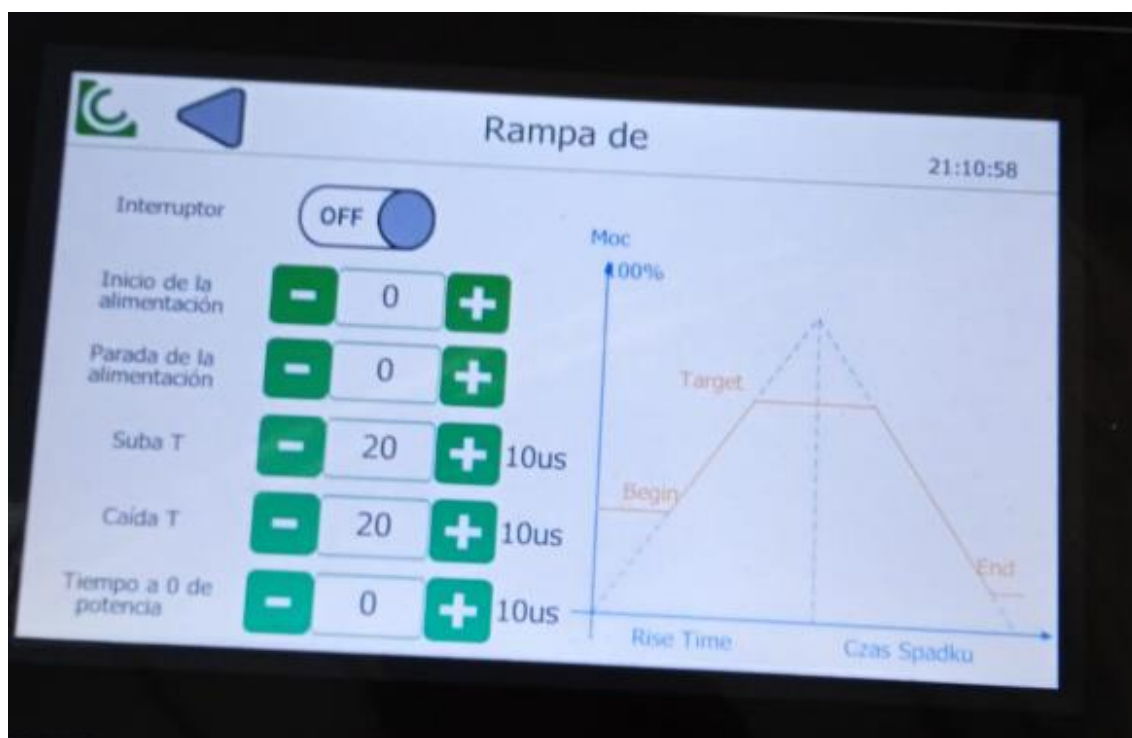
Software and Gun Version

In this section, you can check the software version and the gun version. In addition, the system indicates whether these versions are valid or require an update.

- **Software version:** Displays the current version of the software installed on the system.
- **Pistol version:** Reports the firmware version of the connected gun.
- **Status of validity:** The author or system indicates whether the version is valid and up-to-date. If not, an update will be recommended.



5.5.7 POWER RAMP



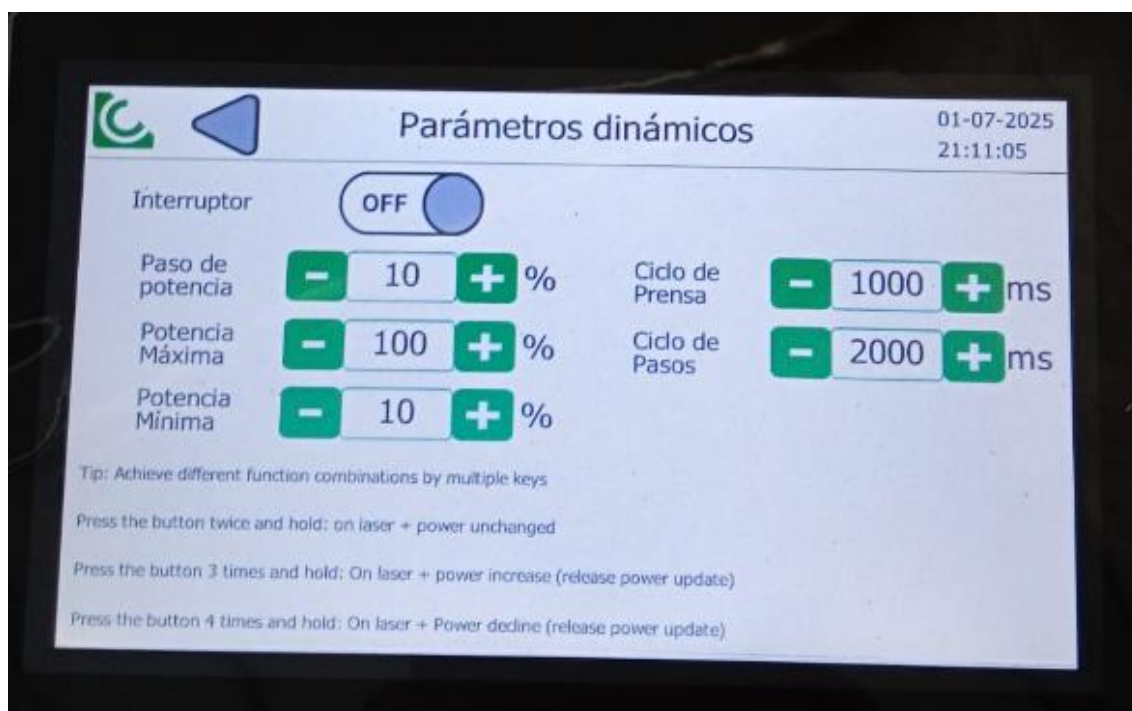
Entrance and exit ramps

In this section, ramps can be set up to gradually adjust the laser parameters. These ramps allow for a smooth transition in values, improving control and accuracy during the cleaning process.

- **Entrance ramp:** Adjusts the progressive acceleration of the parameters at the beginning of the process.
- **Exit ramp:** Controls the gradual deceleration at the end of the process, avoiding abrupt changes that may affect performance.



5.5.8 DYNAMIC PARAMETERS



Advanced Features

In this section, you will find more advanced settings that allow you to adjust critical parameters of the laser system. These options are designed to provide more precise control over the performance of the equipment and to protect it from possible failures. Available functions include:

- **Power limitation:** Allows you to set a maximum power limit to avoid overloading or damaging the laser.
- **Power step cycles:** Set the cycles of gradual increase or decrease of power during the cleaning process. This helps to optimize efficiency and protect the equipment.
- **Activating or deactivating the emission of the laser beam:** Allows you to control when the laser emission is activated or deactivated, which can be useful for security operations or when the laser needs to be temporarily disabled.



5.9 GUN FUNCTION AND OPERATION

The gun incorporated in LC-CLEAN laser cleaning equipment is one of the most advanced in its sector, standing out for several advantages over its competitors.

Among the most outstanding features are:

- **Ergonomic design:** Allows comfortable use for long periods, reducing operator fatigue.
- **Ease of use:** Its intuitive interface makes it easy to use, even for users with little experience.
- **Robustness of components:** Made with high quality materials, ensuring durability and resistance in demanding conditions.
- **Practicality of adjustment:** Controls and adjustments are quick and easy to perform, optimizing operating time.
- **Versatility:** Adaptable to a variety of applications and work environments, increasing its effectiveness in different cleaning tasks.

5.9.1 GALVANOMETRICAL SYSTEM

Inside the gun outlet is the Galvanometer, a system of motorized mirrors that allows the laser beam to be redirected according to the shape selected on the control screen. Depending on the chosen configuration, the mirrors will move in one way or another to meet the desired specifications in the cleaning process.

INFORMATION NOTE:

Access to the galvanometer is restricted and is covered by the gun's warranty. It must not be tampered with under any circumstances to avoid invalidating the warranty or damaging internal components.

5.9.2 LENS

Located just after the lens protector, the focusing lens is responsible for concentrating the light beam coming from the resonator. This F-Theta type lens has the ability to focus the beam on a specific plane, which optimizes the cleaning process.

There are different types of lenses with different focal lengths. In general, the shorter the focal length, the more concentrated the beam is, allowing for greater precision. However, it is important to note that higher concentration does not always translate into faster cleaning, as other process factors also influence efficiency.



5.9.3 LENS PROTECTOR

The lens protector is the only consumable part of the LC-CLEAN 300W laser cleaning equipment. As its name suggests, it is specifically designed to allow the laser beam to pass through, protecting the lens from possible damage.

This protector acts as a barrier against pitting and damage caused by laser rebound or refraction, as well as to prevent microprojections from settling on the lens, which could affect its performance.

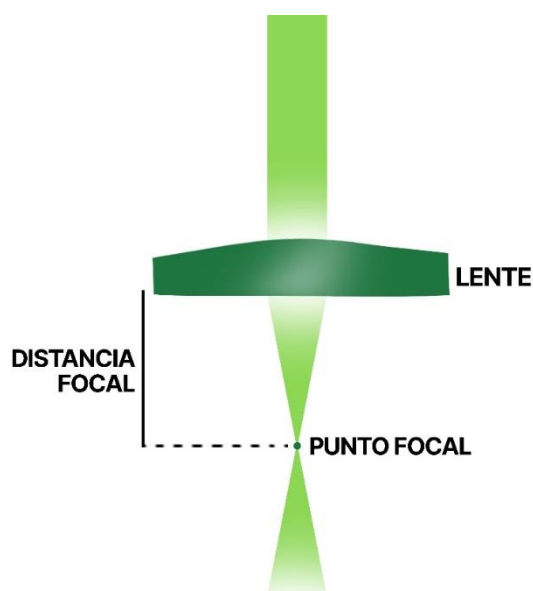
It is essential to keep the lens protector clean and in good condition at all times. It is recommended to check it periodically and replace it when necessary to ensure optimal operation and prevent damage to internal components.

5.9.4 FOCAL LENGTH

As mentioned above, the laser beam exits the optical fiber in a uniform and parallel manner. The lens' function is to concentrate this beam into a very small, "hourglass" shaped spot.

The central point of this "hourglass" is where most of the laser beam's energy is concentrated. To ensure maximum efficiency, the focal length must be manually adjusted while the laser is in operation, so that the central point of the beam is located on the surface of the material to be treated.

To facilitate this adjustment, the equipment has two red pointers, specifically designed to help triangulate the distance and ensure that the concentration point is correctly located on the material during work.



The focal length is fixed and varies depending on the type of lens used. Fortunately, finding it is a simple process. To do this, simply pull the trigger of the laser gun and gradually move it to different distances from the material you want to clean. The goal is



to locate the point of greatest intensity, which corresponds to the area of maximum concentration of laser beam energy.

This setting is key to achieving the best results during the cleaning process as it ensures that energy is applied efficiently and accurately.

5.9.5 PARAMETERING

1. Power:

- Recommendation: It will depend on the type of material to be cleaned and the layer of contaminant to be removed.
- For harder materials or stubborn contaminants (rust, thick paint), higher power (70-100%) is recommended.
- For delicate materials or lighter contaminants (dirt, dust), lower power is recommended (30-60%).

Recommended value: Start with 50-60% for standard cleaning, adjusting based on material type and cleaning efficiency.

2. Frequency:

- Frequency is related to the number of pulses per second.
- For tough materials (such as rust or thick layers of paint), a lower frequency is ideal, as the laser energy is concentrated in a shorter time.
- For more fragile materials or to obtain faster cleaning, a higher frequency is recommended, to provide more pulses per second and a higher work rate.

Recommended value: Between 20-50 kHz for harder materials, and between 50-100 kHz for softer materials or more efficient cleaning.

3. Pulse Width:

- The pulse width determines how long each laser pulse lasts.
- For hard surface cleaning, it is recommended to use a shorter pulse width, allowing for faster and more effective action without damaging the material.
- For softer surfaces or more delicate work, using a larger pulse width may be helpful to avoid overloading energy into the material.

Recommended value: Start with a range of 150-300 ns for efficient cleaning, adjusting according to the material.

4. Line Width:

- The line width defines the width of the area that is cleaned in each pass of the laser.
- For quick cleaning of large surfaces, a larger line width is ideal.



- For more detailed work or cleaning small areas, a narrower line width is better as it allows you to be more precise.

Recommended value: Between 40-60 mm for standard jobs, adjusting according to the type of material and the area you need to cover.

5. Movement Speed:

- The movement speed should be adjusted according to the power, frequency and type of material.
- For harder materials or thicker contaminants, a lower travel speed is recommended to ensure the laser has enough time to act on the material.
- For softer materials or light cleaning, a higher speed is suitable as it reduces working time without compromising effectiveness.

Recommended value: For hard or thick materials, start with a speed of 10,000-20,000 mm/s, and for softer materials or faster cleaning, use speeds of 20,000-30,000 mm/s.

Summary of Recommended Initial Values:

- **Power:** 50-60%
- **Frequency:** 20-50 kHz (harder materials) / 50-100 kHz (softer materials)
- **Pulse width:** 150-300 ns
- **Line width:** 40-60 mm
- **Movement speed:** 10,000-20,000 mm/s (harder materials) / 20,000-30,000 mm/s (softer materials)

Additional Tips:

- Always perform initial tests on a small section of the material to adjust parameters as needed.
- Keep in mind that the type of material (metal, paint, rust, etc.) will greatly influence how the parameters will affect cleaning.
- The temperature of the material is also relevant, as a hot material may react differently than a cold material.



CHAPTER 6 - EQUIPMENT MAINTENANCE

The LC-CLEAN 300W laser cleaning equipment requires regular and periodic maintenance to ensure its correct operation and prolong its useful life.

If you need to perform maintenance, repair or inspection, follow these steps:

1. **Turn off the equipment** and be sure to remove the key.
2. **Press the emergency switch** to disable any system function.
3. **Turn off the main switch**, located at the rear of the machine, to completely disconnect the power.

Once maintenance is completed, before putting the equipment back into operation, be sure to:

- **Tighten all screws correctly** to ensure that the parts are securely fastened.
- **Verify that the security systems** are operational and functioning properly.

6.1 REPLACING THE LENS PROTECTOR

To replace the gun lens guard, follow these steps:

1. **Loosen the circular thread** from the protective window and remove the lens protector drawer. The lens protector is located right where the lens is, being the first layer of protection for it.
2. **Remove the lens protector** damaged or dirty and replace it with a new one. Be sure not to touch the surface of the protector with your fingers to avoid getting it dirty.
3. Once the new lens protector is placed in the pressure frame, place it in its correct position and tighten the circular thread that holds it firmly.
4. **Reinstall the lens drawer** in place inside the gun.

6.2 INSPECTION OF THE GUN CONNECTOR

It is essential to regularly check that the fiber connector is properly secured. Make sure that it is not loose or mispositioned, as this could affect system performance. Also, avoid excessive bending of the fiber cable, maintaining a bend radius greater than 60° to prevent damage to the optical fiber.



6.3 PISTOL

The cleaning gun must always be kept clean to avoid possible damage to its optical components. It is important to ensure that it is handled correctly, avoiding falls and knocks that may affect its operation.

The connecting hose between the gun and the body of the equipment must also be treated with care. It must never be stepped on by people or, especially, by moving machinery, as this could cause damage to the optical fibre and affect the performance of the equipment.

6.4 PERIODIC INSPECTIONS

To ensure the correct operation of the LC-CLEAN 300W laser cleaning equipment, periodic inspections are essential. The recommended tasks are as follows:

- **Daily inspection of lens protector:** Check that the guard is free of contamination or marks. If it is dirty or contaminated, replace it promptly.
- **Weekly inspection of the gun connector:** Make sure the gun connector is properly connected and shows no signs of wear or damage.
- **Review of the gun or torch:** Check that there are no water leaks at any joints. If any leaks are detected, take the necessary steps to correct them and prevent damage.



CHAPTER 7 - ERRORS AND PROCEDURES

7.1 INTRODUCTION

The LC-CLEAN 300W laser cleaning equipment uses cutting-edge technology. However, due to its operation and characteristics, occasional errors may occur. The most common problems and recommended procedures for solving them are described below.

7.2 COMMON ERRORS AND PROCEDURE

If the LC-CLEAN laser cleaning equipment exhibits abnormal behavior, please follow the steps below, performing a cleaning test after each step, in the strict order listed:

1. **Inspection of the lens protector:** Check if it is dirty or contaminated. If necessary, clean the guard.
2. **Inspection of the lens:** Examine the lens for pitting or damage. If necessary, replace the lens.

7.3 OTHER ERRORS AND PROCEDURE

The chiller and laser resonator are equipped with several safety sensors that detect anomalies. If any problems are detected, an alarm will be triggered and the equipment will be blocked to prevent damage.



CHAPTER 8 - WARRANTY AND CONDITIONS

8.1 WARRANTIES

The LC-CLEAN 300W laser cleaning equipment is covered by a warranty. The warranty conditions are as follows:

- **2 year warranty** for the equipment in general and its main components (resonator, mechanical parts and connections).
- **1 year warranty** for the electrical part cleaning gun (Optical type consumables are not included), the control system and the entire electrical section.
- **Consumables** such as lenses, lens protectors, among others, are not subject to warranty.

8.2 CONDITIONS AND RESPONSIBILITY

The warranty on components is subject to proper use and correct operation of the equipment. Any indication of misuse will result in non-compliance with the warranty conditions, and the repair or replacement of components will be the responsibility of the customer.

Specific conditions:

a) During the warranty period, we will provide the defective components free of charge, provided that they meet the warranty conditions. However, the transportation cost of out-of-warranty products is not covered.

b) Users must use the equipment in accordance with the instructions for use to ensure its integrity. The company will not be responsible for the warranty in the following cases, and may exercise legal rights as appropriate:

- Using the equipment in inappropriate location, temperature or environmental conditions, despite the manufacturer's recommendations.
- **Equipment Modification** without prior authorization, or the use of spare parts, components or peripherals that are not supplied by our company.
- Failure to comply with established operational and maintenance requirements.
- Damage caused during transportation of the equipment.

c) Without affecting the characteristics of the product, we reserve the right to change the specifications or shape of the products without prior notice.



d) Our only legal obligation is related to the sale of the product itself, its quality and performance, as well as the warranty. We do not assume any additional liability, whether direct or indirect, or for misuse or damage to third parties.

8.3 PROCEDURE

If your equipment presents any error or fault, contact your official distributor directly. A technician will be contacted to make the relevant checks and, if necessary, proceed to activate the guarantee.