USER MANUAL

LC-WELD SMART

MANUFACTURER
LASERCOMMERCIAL ENTERPRISE
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(BARCELONA) SPAIN

LC Lasers

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LEGAL NOTICES

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CHAPTER 0 - PREFACE

This manual must be read and complied with by all persons 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.

ADRESSEES

This guide is intended for all owners and operators of the LC-WELD device, as well as all persons working in and around the laser equipment when it is in use. The use of this product should be limited to fully trained industrial, professional, technical or commercial operators who are responsible for welding in industrial and non-industrial installations for commercial purposes.

All users of this product must be trained in laser safety and welding and must follow all instructions and safety warnings in the user guide, the safety labels on the EQUIPMENT and all applicable safety standards, 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 contents:

- 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. Laser processing machines. Part 1: General safety requirements.
- UNE-EN 12254:2010 Screens for workstations with lasers. Safety requirements and tests.
- UNE-EN 207:2018 Personal eye protection equipment. Filters and eye protection against laser radiation (laser safety goggles).
- 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 23 April, on the protection of the health and safety of workers against risks related to exposure to artificial optical radiation. BOE nº 99 24/04/2010.

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

SYMBOLS AND WARNINGS USED IN THIS MANUAL

SIGNAGE AND/OR SYMBOL	EXPLANATION
DANGER	This concept and signage indicate an important hazard to be aware of. Failure to avoid this hazard can result in fatalities, serious injuries.
	This 'WARNING' sign 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 should be given special attention as it is highlighted.

´

CHAPTER 1 – GENERAL INFORMATION

1.1 INTRODUCTION

LC presents the LC-WELD SMART laser welding device, which consists of a fibre laser source and a cooler, a laser gun and a housing with a 10 inch display. This manual contains all necessary information related to the LC-WELD SMART laser welding equipment and has been compiled by LC Lasers. This is a guide compiled with experience and dedication to facilitate the understanding and use of the LC-WELD SMART laser welding equipment by the end user. In order to make continued and lasting use of the equipment, the person(s) who will be operating the LC-WELD SMART laser welding equipment must be familiar with the installation, operation, maintenance and safety systems of the equipment.

The fiber laser source provides up to 1500W maximum output power at an infrared wavelength of 1070 nm.

These operating instructions indicate the safe and proper handling of the machine described in detail in the following chapters. The safety instructions given throughout this manual as well as the general instructions for machine operation must be observed. The accident prevention measures and general safety regulations at the workplace and at the workstations associated with this equipment must also be observed.

The LC-WELD SMART laser device has been tried and tested with special attention to handling and safety. By following the safety regulations, this user guide and applying proper safety practices when operating the laser, LC-WELD SMART is a safe and reliable device.

Before starting any work on the machine, the operator must have read these operating instructions, especially the chapter on basic safety instructions.

Due to its special characteristics, laser light poses different safety risks than light from other sources. Laser radiation can be hazardous to eyes and skin if the irradiance of directly propagated, specularly reflected or even scattered laser radiation is sufficiently high. All laser operators and persons in the vicinity of the laser when in use must be aware of the hazards and wear all recommended personal protective equipment. They should also follow all safety procedures provided and recommended during the use of the equipment.

To ensure safe operation and optimum product performance, follow all instructions in this guide and adhere to all safety and related warnings.

In this manual we will refer to the LC-WELD SMART laser welding machine as "welding machine", "laser machine", "laser welding machine", "LC-WELD SMART", "laser welding equipment" and derivatives of all these options.

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 workstations with lasers. Safety requirements and tests.
- UNE-EN 207:2018 Personal eye protection equipment. Filters and eye protection against laser radiation (laser safety goggles).
- 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 23 April, on the protection of the health and safety of workers against risks related to exposure to artificial optical radiation. BOE nº 99 24/04/2010.
- ANSI Z136.9:2013 American National Standard for Safe Use of Lasers in Manufacturing Environments.

These standards and directives are essential to ensure the safety and health of those who work with laser equipment. They provide specific guidelines and requirements for the safe management of risks associated with laser radiation and artificial optical radiation. Compliance is essential for the safe operation of the LC-WELD SMART laser welder.

1.3 TYPES OF USE

1.3.1 INTENDED USE

The LC-WELD system has been designed exclusively for use by fully trained industrial, professional, technical or commercial operators who are responsible for welding in industrial and non-industrial installations for commercial purposes. Following the steps and instructions in this manual regarding the use and operation of the laser machine is the only intended use of the laser welding machine. It is only intended for use for its primary function: metal welding work using a laser beam.

No one other than the operator of the laser device should be in the laser controlled area while the equipment is in use. Ideally, the operator should be able to be observed and monitored by personnel outside the controlled laser area by means of cameras. If any person is inside the controlled laser area, he/she must wear appropriate PPE.

The intended use of this product is limited to the processing of metallic materials such as stainless steel, galvanised steel, mild steel, aluminium and copper:

- Metal fabrication and processing.
- Metallurgy applications.
- Bodywork and similar.
- Construction.
- Maintenance and repair of various materials.
- Transport.
- Metal furniture.
- Aerospace.

The following materials are suitable for welding with LC-WELD equipment:

- Stainless steel.
- Aluminium.
- Titanium.
- Galvanised steel.
- Carbon steel.

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

1.3.2 UNINTENDED USE (FORESEEABLE MISUSE)

Under no circumstances shall the laser welding machine be used for any purpose other than welding the materials specified and suitable for laser welding.

As indicated in the previous points, the type of welding to be carried out can be selected and the nozzles of the laser welding gun can be exchanged for this purpose, but not for any other purpose. The user of the laser welding machine is obliged to use the specified PPE for the intended use of the machine.

Under no circumstances work or be near the laser machine without the appropriate laser safety goggles.

Under no circumstances may the laser welding machine be used to work on objects that could injure people or animals or damage buildings, valuables or similar objects.

Under no circumstances should the laser gun be pointed at living beings, sensitive materials, structures, constructions, electrical equipment, electrical apparatus, electrical installations, vehicles, automobiles or other objects that are far away from the actual welding work. Such actions may result in serious accidents to persons, animals and valuable installations. LC is exempt from any legal, penal or administrative liability and repercussions resulting from the misuse of the laser welding machine not foreseen in this manual.

Under no circumstances should the filler wire be used for any purpose other than to feed material during welding. It is important not to touch this wire under any circumstances once the machine is running.

Examples of product misuse include the following:

1. Work without following the safety measures specifically explained in this guide.
2. Use of this product by untrained persons in any area.
3. Inadequate protective measures in the workplace. Key protective measures include: (1) Establish a controlled laser zone with restricted entry by interlocking; (2) provide PPE to ALL workers within the controlled laser zone (e.g. laser safety goggles, welding mask and appropriate filters, and clothing and gloves suitable for welding work).
4. Unauthorised modification or conversion of the product by the user or other personnel without the express written authorisation of LC.
5. Intentionally disabling or bypassing product safety systems.

6. Use parts and consumables (other than PPE meeting safety requirements) from other manufacturers (e.g. protective window, nozzle tips, etc.) that do not meet the minimum requirements.
7. Use this product for welding parts containing materials other than those described in section 1.2.1.
8. Remove or render illegible safety labelling and hazard warnings.
9. Holding parts by hand or in any manner in which the welding head points in the direction of parts of a person's body.
10. The use of this product by any person in a residential area.
11. Welding on containers containing flammable, combustible or unknown materials.
12. Use laser equipment for non-welding work.

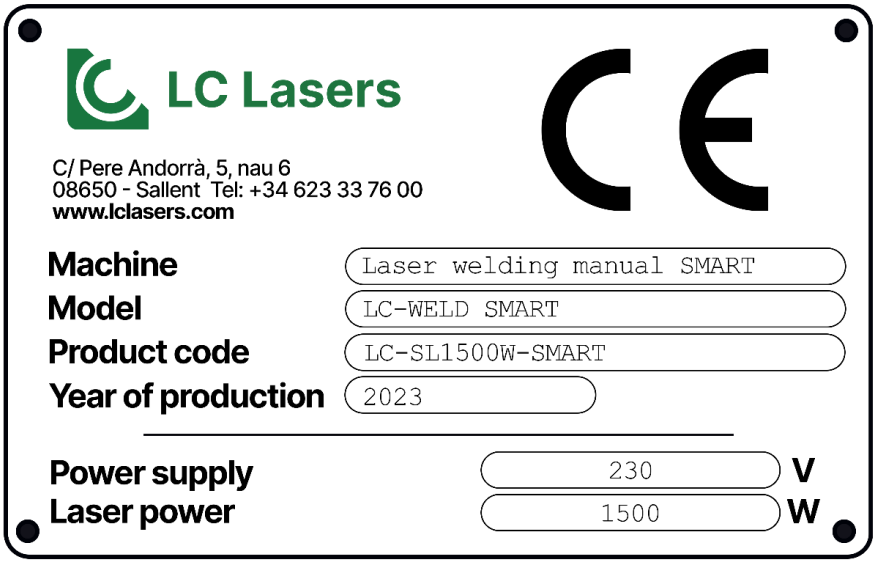
1.4 CE CERTIFICATION

LC Lasers certifies that the LC WELD SMART laser welding equipment has been inspected and tested by authorised personnel. LC WELD SMART has passed the LC quality control prior to shipment of the laser device to the customer. This quality control has been thoroughly checked by:

- Internal components of the equipment.
- Conductivity.
- Testing of equipment and proper functioning.
- External aesthetics of the equipment.
- Spare parts.

Below is the CE marking for this product.

1.4.1 CE MARKING



1.5 DECLARATION OF CONFORMITY

LC Lasers

Declaración CE de Conformidad

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

declaramos, bajo nuestra única responsabilidad, que la instalación:

Denominación genérica:	Soldadura láser
Marca:	LC LASERS
Modelo:	LC – WELD SMART
Año de expedición:	2023

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 ISO 11553:2020 - Seguridad de las máquinas. Máquinas de procesamiento láser. Parte 1: Requisitos generales de seguridad.
EN ISO 11553:2020 - Seguridad de las máquinas. Máquinas de procesamiento láser. Parte 2: Requisitos generales de seguridad.
EN ISO 12254:2010 – Pantallas para puestos de trabajo con láseres. Requisitos de seguridad y ensayos.
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 B de la citada Directiva 2006/42/CE.

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

Sallent,
5 de septiembre del 2023
(Lugar y fecha de la exposición)

Ferran Sardans
Director técnico
(Nombre y firma)

LC Lasers
Lasercomercial Enterprise NIF:B67583120
C/ Tomás Viladomiu 61, 08650 Sallent (Barcelona)

CHAPTER 2 - SAFETY INFORMATION

To ensure safe operation and optimum performance of the laser welding 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-WELD SMART laser welding unit. Keep the manual with the machine; if the equipment is sold or passed on to third parties, provide the user manual.

Before installation and use, read and follow the instructions in these operating instructions. Damage to persons and/or property can result if the following instructions are not followed.

Operation of the system is only permitted with equipment and spare parts supplied or included in the manufacturer's parts, any kind of deliberate modification by the user without consulting the manufacturer may pose a risk to the health of persons using the machine.

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

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

All set-up and maintenance operations must only be carried out by qualified personnel.

2.1 SYMBOLS AND WARNINGS IN THIS MANUAL

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

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

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 CLASSIFICATION OF THE LASER PRODUCT

The harmonised standard UNE-EN 60825-1:2015 establishes different classes of laser products according to their ability to cause damage to biological tissues, especially the eye and the skin. These classes are established from Class 1 to Class 4:

- Class 1 is the only class that is safe under all conditions (in use and in case of failure), because access to laser radiation exceeding the radiation exposure limit values is not possible.
- Class 4 is the highest class, and in case of exposure to laser radiation always involves damage to the eye as well as to the skin and both direct and reflected or diffuse exposure. In addition, Class 4 presents a fire hazard due to ignition of flammable materials.

Section 5.2 of UNE-EN 60825-1:2015 states that measurement of laser radiation levels may be necessary to classify a laser product. Measurements are unnecessary when the physical characteristics and limitations of the laser source clearly place the laser product or installation in a particular class.

In this case, the machine integrates a high-power Class 4 laser product. Furthermore, the aim is to use the laser beam of the generator for metal welding. During the intended operation the laser beam must therefore be accessible:

The LC WELD is a Class 4 laser product.

DANGER

INVISIBLE CLASS 4 LASER RADIATION

Severe and permanent eye damage from reflected or scattered radiation.

Cautions:

- If the system can be active (key switch on), it is necessary to wear laser goggles inside the laser area.
- After stopping work and before leaving the controlled laser area, the operator of the laser device must: (1) turn the key switch to the OFF position and (2) remove the key and store it in a safe place. This prevents unauthorised and untrained personnel from using the laser device.

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

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

	Main fibre laser (used for welding)	Laser pointer (aids positioning prior to work)

Laser classification	Class 4	Class 3R
Wavelength	1070 nm	600 to 700nm
Emitted laser radiation	Invisible (Infrared)	Visible (Red)
Average power	1500w	20mW
Peak power	1500W	20mW

DANGER

INVISIBLE CLASS 4 LASER RADIATION - EYE AND SKIN HAZARDS

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

Precautions:

- Due to these risks, a qualified laser safety officer must be present to ensure a safe working environment.
- If the system may be switched on, it is necessary to wear laser safety goggles within the controlled laser area.
- While the laser device is in operation, appropriate safeguards, guards and laser safety procedures shall be in place.
- The laser operator should wear all recommended PPE, including: (1) specified laser goggles and (2) welding helmet with appropriate filters.
- Additional PPE intended to protect the skin includes gloves, protective clothing and aprons resistant to fire, heat and electric arc.

DANGER

CLASS 3R VISIBLE LASER RADIATION.

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

2.2.1 CLASSIFICATION OF LASER PRODUCTS

CLASS	DANGER
1	The device is safe to use, including direct viewing over a long period of time, even when using optical observation devices.
1M	Non-laser beam, including direct vision for a long time (naked eye); seeing through an optical instrument can be dangerous (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" is derived from the term "contact", deduced from the mode of operation).
2	Secure ** for momentary exposures (0.25 s), valid only for the wavelength range 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 beam viewing (the letter "R" is derived from the term "reduced requirements")
3B	Hazardous if exposed to direct beam, regardless of exposure duration. Diffuse reflections are normally safe, but the EMP may be exceeded when using an optical viewing instrument. In addition, 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 fire hazard, also due to diffuse reflection.
* This class refers to direct applications with intentional radiation exposure to the skin or internal body tissues in medical, diagnostic, therapeutic or cosmetic procedures. The emitted laser radiation may be Class 3R, 3B or 4, but the technical characteristics of the device prevent ocular exposure (the beam may be Class 3R or 4, but the technical characteristics of the device prevent ocular exposure (the beam may be only if the applicator is in contact with the skin, or in close proximity 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 "safe" is linked to the absence of injury. However, these rays can cause intense and painful glare.	

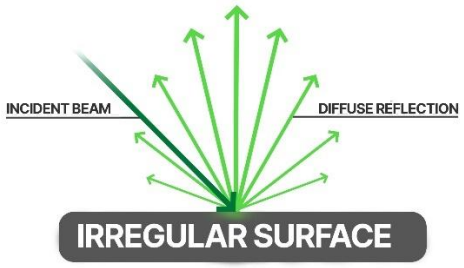
2.2.1 LASER RADIATION AND SAFETY RISKS

When working with laser welding equipment, both diffuse and specular laser emissions can be produced by diffuse reflection. By testing different materials, it has been determined which types of reflections are produced in each case (see ANNEX 2),

To carry out the measurements of the diffuse laser radiation emissions in the different materials that can be welded with the LC WELD machine, the power meter has been positioned at a distance of ~150 mm from the welding point and the angle has been

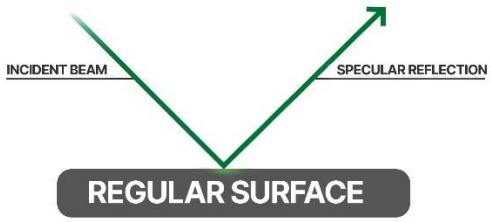
varied to maximise the laser power detected. Below is a table with the power values obtained for each material. It can be noted, especially in the case of aluminium which was analysed for two incident laser power values, that the diffuse emission is more important for a lower incident power. This is due to the fact that the laser induces a drastic change of the irradiated area which affects its ability to reflect the laser. Diffuse laser emission values as a function of the welded material:

Material	Incident power	Diffuse power
Aluminium	75%=1400W	50mW
Aluminium	35%=700W	200mW
Iron	35%=700W	40mW
Stainless Steel	35%=700W	20-40mW



Diffuse reflection of a laser beam

As far as specular reflection is concerned, it depends in particular on the reflectivity of the welded material. When the laser is incident on a material, it generates a beam directed in the opposite direction and at the same angle as the incident beam with respect to the plane of the welded part.



Specular reflection

There is a big difference in the behaviour of the materials:

- Aluminium has a higher reflectivity, especially for an incident laser power of 1 kW. Comparing the incident laser power and the reflected part results in a reflectance factor of 5%. The reflected laser power decreases with increasing

incident power on the material. As in the case of diffuse reflection, this behaviour is due to the fact that increasing the laser power on the material induces changes in the impacted area which can influence the reflected part of the power.

- The same behaviour is observed with iron, although in this case, the reflectance factor is much lower (~ 2%),
- Finally, stainless steel has a constant reflectance (~ 2%) independent of the incident laser power.

2.2.1.1 SECONDARY RADIATION RISK

Welders who are exposed to invisible UV light without proper protection can suffer permanent eye damage. Even brief exposure to invisible UV light during welding can cause blurred vision, burning, tearing, pain and eye irritation (feeling of sand in the eye).

	DANGER	**Visible and invisible light radiation produced during welding** The interaction between high-power laser beams and the target materials being welded can create plasmas that produce UV and "blue light" emissions that can cause conjunctivitis, photochemical damage to the retina and sunburn-like reactions on the skin.

2.3 SECURITY INDICATORS

The laser resonator has an "emission on" status light located on the front panel of the unit. When this status light comes on (during welding or cleaning), it means that the laser emission has been initiated by the operator controls on the manual welding head.

	DANGER	**DANGER WHEN THE POWER SUPPLY IS SWITCHED ON!** The laser device is in a hazardous state and all precautions must be taken as if the laser were ready to emit.

All necessary precautions should be taken.

The laser welding equipment has indicators to announce the laser emission. On the welding screen under the WORK option, a green indicator is visible when the laser is in emission.

Outside the controlled laser area, light signals can be reproduced to indicate when the equipment is switched on for work, when it is switched off and when the laser is in emission, with a traffic-light type light.

2.4 SAFETY GOGGLES AND MASK

2.4.1 SAFETY GLASSES

Laser safety goggles, as PPE, must be CE-certified in accordance with the European standard *EN207: Personal eye protection equipment. Filters and eye protectors against laser radiation* must also meet the following requirements:

- Provide a level of protection appropriate to the characteristics of the laser used (wavelength, power, mode of operation, etc.),

According to the characteristics of the source integrated in the welding equipment and the measurements studied, **the minimum protection level required is DLB6 at the wavelength of 1060-1070 nm.**

The selection of appropriate **laser safety glasses** requires the end user to accurately identify the range of wavelengths emitted by this product and the Predictable Exposure Limits (PEL). All laser safety glasses have energy-absorbing filters. Laser safety glasses are usually thicker.

The protection level of the goggles must ensure that, in the worst case, what the filter can transmit must be less than the EMP value. The goggles must be suitable for the wavelength of the laser we are working with.

Review the product safety labelling and verify that the personal protective equipment (i.e. goggles, enclosures, viewing windows or peepholes, etc.) being used is suitable for the output power and wavelength ranges. Decisions regarding safety glasses should also take into account possible secondary radiation risks due to radiation from the welding process and UV radiation.

Protective eyewear is based on the use of filters that can transmit or attenuate a certain wavelength of light, partially or completely. The optical density (OD) of a filter is a measure of this attenuation of the energy passing through the filter.

The higher the OD value, the higher the attenuation and the higher the protection value (more light of a certain wavelength is filtered out). In addition, the protective goggles must offer sufficient resistance against LEP (i.e. they must withstand a direct laser impact for at least 5 seconds according to EN 207).

Below is an example photo of the glasses delivered with the equipment:

Gafas de protección láser STARLIGHT X2, Filtro: 0206

The CE of the glasses delivered with the LC-WELD SMART equipment:

EU-Konformitätserklärung

PROTECT LASERSCHUTZ GMBH

Der Hersteller

PROTECT-Laserschutz GmbH
Mühlhofer Hauptstraße 7
90453 Nürnberg

erklärt in seiner alleinigen Verantwortung hiermit, dass die nachstehenden Produkte

Artikel-Nr.	Filter	Gestell	Gestellfarbe
000-K0206-GLAD-20	0206	GLADIATOR	silber
000-K0206-OVSP-02	0206	OVERSPEC II	weiß
000-K0206-OVSP-20	0206	OVERSPEC II	silber
000-K0206-RETR-21	0206	RETRO	titan
000-K0206-SPEC-02	0206	SPECTOR	weiß
000-K0206-SPEC-20	0206	SPECTOR	silber
000-K0206-STAR-X-01	0206	STARLIGHT-EXTRA	schwarz

im Einklang mit der Verordnung (EU) 2016/425 des Europäischen Parlaments über persönliche Schutzausrüstungen und zur Aufhebung der Richtlinie 89/686/EWG und entsprechen der nationalen Norm, mit der die harmonisierte Norm EN 207: 20 09 + AC: 2011 + EN 207:2017 umgesetzt wird, sowie der Richtlinie über die allgemeine Produktsicherheit: 2001/95/EG stehen.

Die notifizierte Stelle DIN CERTCO Gesellschaft für Konformitätsbewertung mbH, Notified Body 0196, hat die EU-Baumusterprüfungen durchgeführt und die EU-Baumusterprüfbescheinigungen C5083PF/R0 (Tragekörper OVERSPEC II)); C5822PF/R0 (Tragekörper SPECTOR)) ausgestellt.

Die notifizierte Stelle ECS GmbH – European Certification Service, Notified Body 1883, hat die EU-Baumusterprüfungen durchgeführt und die EU-Baumusterprüfbescheinigungen (C1548.5PF (Filter 0206)); (C863.5PF (Tragekörper GLADIATOR)); (C7002.5PF (Tragekörper RETRO)); (C2334.1PF (Tragekörper STARLIGHT-Extra)); (C1168.4PF (Tragekörper UNIVERSAL unkaschiert)) ausgestellt.

Petra Fröbel
Geschäftsleitung PROTECT-Laserschutz GmbH
Nürnberg, 05.12.2019

Rüdiger Fröbel
Geschäftsleitung PROTECT-Laserschutz GmbH
Nürnberg, 05.12.2019

DANGER

EYE HAZARD DURING LASER WELDING WORK

Risk of permanent eye damage and impairment of vision due to reflected and scattered invisible class 4 laser beam reflections. Risk of eye damage as a result of exposure to UV light, heat and sparks produced during processing of the material.

Cautions:

- Operators must wear the specified laser safety goggles in combination with the specified welding mask when the device is in operation.
- Laser goggles alone do not provide sufficient eye protection when using laser welding equipment, it is necessary to use the welding mask to adequately protect from UV rays.

LC provides a pair of laser safety goggles with the LC WELD equipment.

- All persons present in the controlled laser area, whether they are working with the machine or are present as observers, must wear appropriate laser safety goggles.
- It is recommended to minimise the number of people present in the controlled laser area.
- Before entering the controlled laser area, all persons must properly don PPE.
- Do not use with laser safety glasses other than those indicated in this guide.

DANGER

INCORRECT OR DAMAGED LASER SAFETY GOGGLES

Severe and permanent eye damage and impaired vision may occur.

Precautions:

- Before using laser safety goggles, all personnel should check the labelling on the goggles and confirm that they comply with the OD or LB rating (depending on the user's country), identified earlier in this section.
- **The goggles must protect for the wavelength used in the laser equipment.**
- Before use, laser safety goggles should be inspected for cracks, discolouration, damage to the coating, marks or cracks.
- **Under no circumstances should damaged glasses be used.**

Also check the mechanical integrity of the mount.

- **If the condition of the laser safety goggles is suspect, that pair should be discarded and replaced.**

2.4.2 WELDING MASK

A suitable welding mask must be worn to provide adequate protection from the UV light produced during the welding process.

Ultraviolet light protection screen, with a grade 3 according to regulations:

- *EN 166: Personal eye protection.*
- *EN 169 Personal eye protection - Filters for welding and related techniques - Permeation properties and recommended use.*

It is **MANDATORY to wear** a welding or oxy-fuel welding type protective shield.

2.5 PPE CLOTHING

Refer to section 2.7.6 for information related to skin hazards. The skin of unprotected personnel may be exposed to extremely hazardous levels of laser radiation, UV radiation and blue light related to the welding process itself, as well as to burns due to hot parts.

To protect against skin hazards, the operator of the hand-held laser device must wear flame-, heat-, and arc-resistant gloves, clothing, hats, and aprons while the device is in operation.

In addition to eye protection, there is a variety of Personal Protective Equipment (PPE) for the operator of the LC-WELD SMART laser welding equipment:

Skin protection (clothing): one upper piece of special welding flame-retardant cotton.

Class 1 protective clothing is for protection against less hazardous welding techniques and situations, which produce lower levels of molten metal splashes and radiant heat.

- *UNE-EN ISO 13668:2013 Protective clothing. General requirements*.
- *UNE-EN ISO 11611:2015: "Protective clothing used during welding and allied processes*".

These garments are designed to protect the wearer's body, including hoods, aprons, sleeves, and gaiters and excluding the hands. This standard does not cover requirements for foot, hand, face and eye protectors. For adequate protection against the risks to which welders may be exposed, additional PPE covered by other standards should be used to protect the head, face, hands and feet.

If a suit is required, these will consist of:

- A single garment (gown or overalls).

- A two-piece suit, consisting of jacket and trousers. The jacket must be of sufficient length to overlap the top of the trousers.

Flame retardant gloves: It is important to use welding gloves when working with the laser welding machine. It should be a type B welding glove, recommended for TIG. Characteristics: Category II PPE, according to Standards:

- *EN 388:2016 (gloves for protection against mechanical hazards)*
- *EN 420:2003+A1:2009 (General Requirements for protective gloves)*
- *EN 407:2004 (Protective gloves against thermal hazards)*
- *EN 12477:2001+A1:2005 (Protective gloves for welders)*

IMPORTANT

The gloves have good resistance to the heat generated by welding activities, with a comfortable inner lining for the wearer. In addition, they should be comfortable and flexible to work with ease.

2.6 LASER TECHNICAL DATA AND SAFETY RISKS

Knowing the details of the laser provides relevant information to make a good choice of PPE and to understand the risk factors related to this equipment. The Laser Safety Officer (LSO) of the workplace has to identify the maximum permissible exposure and hazard distances to determine which PPE and safety procedures are necessary.

Technical data of the laser resonator:

Model	**L1500W-V2.06**
Product reference	L1500W-V2.06-50µm
Laser Power	1500W
Laser Type	CW HPP
Consumption	<3800W
Voltage	220-240VAC
Wavelength	1070nm ±10
Power range	1-100%
Frequency range	<50 kHz
Laser Efficiency	42%

Start time	10 µs
Type of connection	QBH
Fibre length	10m
Need for refrigeration	2,2kW Q
Weight	20kg
Dimensions	435x339x100mm
Laser Class	4 (IEC 60825-1)
Red laser pointer power	1mW

The European 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), and its transposition into Spanish law by Royal Decree 486/2010 (article 6), in the assessment of the risks of exposure to laser radiation, the exposure levels of workers must be compared with the exposure limit values. The methodology applied in the assessment, measurement and/or calculations shall be in accordance with the International Electrotechnical Commission (IEC) standards for laser radiation, i.e. the UNE-EN 60825 series of standards.

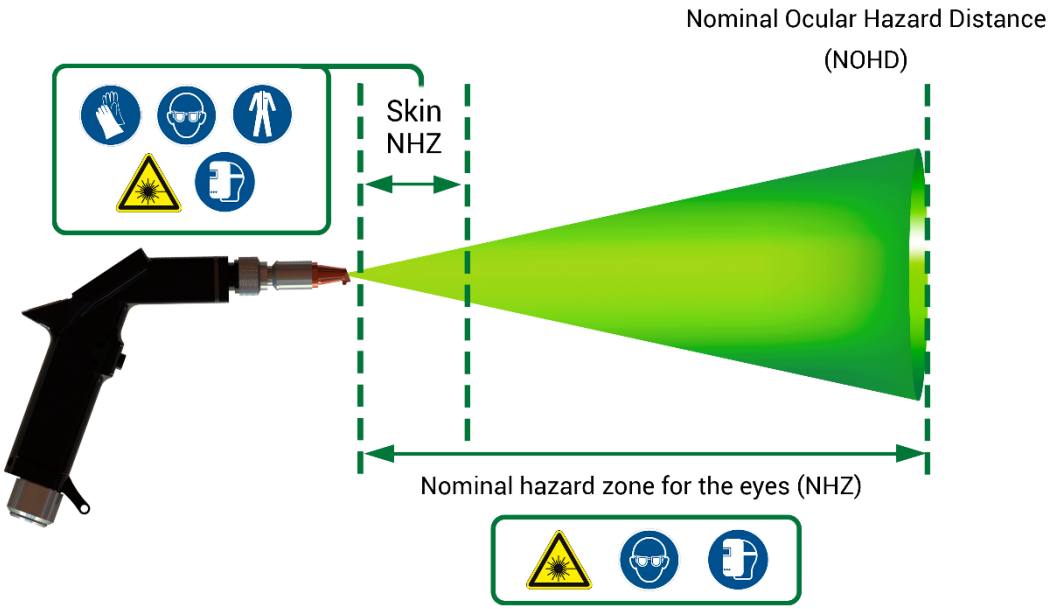
Laser safety terms and definitions

- **Maximum Permissible Exposure:** Maximum Permissible Exposure (MPE) is the level of laser radiation to which people can be exposed under normal circumstances without suffering adverse effects. The MPE is the irradiance or radiant exposure that can be incident on the eye (or skin) without causing injury or adverse biological changes to the eye or skin. The MPE is the highest power (in W/cm2) or energy density (in J/cm2) of a light source that is considered safe. The MPE varies depending on the wavelength of the laser, the energy involved and the duration of exposure. The MPE is a necessary parameter for determining the appropriate optical density (OD) and nominal danger zone (NDZ). Note that there is a different MPE value for eyes and skin. In the EU: See Directive 2006/25/EC and TROS Laser radiation.

- **Nominal eye risk distance (DNRO):** The DNRO is the distance from the laser aperture (or equipment reference point) to the position at which the irradiance (E) is equal to the EMP. DNRO is the distance along the axis of the unobstructed beam of a laser to the human eye beyond which the irradiance or radiant exposure during normal operation is not expected to exceed the MPE. At distances greater than the DNRO, the laser beam intensity is not hazardous in the case of unshielded vision or exposure. The calculation of the DNRO depends on the characteristics of the laser beam, such as output power, beam diameter and beam divergence. The DNRO is usually much larger than the largest dimension of its working area.

- **Nominal Hazard Distance (NHA):** The NHA describes the space within which the level of direct, reflected or scattered radiation during operation exceeds the applicable MPE. Exposure levels beyond the NPZ boundary are below the applicable MPE. If you are within the NPZ, you are at risk of exposure above the MPE and should therefore wear PPE.

- **Optical density**: OD is a measure of the attenuation of laser radiation through a material. This value is mainly used in the specifications of laser safety glasses and viewing windows. The higher the OD, the greater the attenuation of laser radiation. The OD is used in the determination of the appropriate laser eye protection.



2.6.1 MAXIMUM PERMISSIBLE EXPOSURE (MPE)

The value of the MPE to be considered for the source incorporated in the LC WELD welding equipment is that established in the UNE-EN 60825-1 standard for a point source with laser emission in continuous mode and in the infrared band (1050 - 1400 nm). EMP eye = 50 W/m² for the eyes and EMP skin = 10 kW/m² for the skin.

The following table presents a comparison of the accessible emission of the laser source at a distance of 450 mm from the exit of the welding torch with the EMP values (eye and skin). It is worth mentioning the following comparison of the accessible emission with the EMP values:

Parameter and symbol	Laser under analysis
Average power P_0	2 000 W
Wavelength λ	1060 - 1070 nm
Accessible emission @ 450 mm, E	9.71 MW/ m²
EMP for the eyes, EMPocular	50 W/ m²
Excessive EMP for the eyes	194 200
EMP for skin, EMPskin	10 kW/ m²
Excessive EMP for the skin	971

2.6.2 NOMINAL EYE RISK DISTANCE (DNRO)

The parameter that best illustrates the risk of exposure to laser radiation is the nominal eye risk distance (DNRO).

The three types of laser radiation exposures that can be anticipated or given are direct exposure or indirect exposures to diffuse reflection or specular reflection.

The values of the DNROs are 281, 63 and 3.5 m for direct exposure, specular reflection and diffuse reflection, respectively. These distances indicate the danger zones for eye damage in case of exposure to the laser incorporated in the LC WELD machine, hence the need to implement adequate (collective and individual) protection systems. The results of the DNROs analysis applied to the LC WELD laser welding machine are summarized in the table below:

Parameter and symbol	Value
Average power, P0	2 000 W
EMP ocular	50 W/ m²
Lens focal length, f	150 mm
Beam diameter over lens, d63	3.8 mm
Direct exposure, DNROdir	281 m
Specular exposure, DNROesp	63 m
Diffuse exposure, DNRodif	3,5 m

These values were analysed with a 2kW laser source and the reference point is the focal point, i.e. the tip of the welding torch.

From this analysis, we conclude that the use of appropriate PPE (explained in point 4.7) is essential for the safety of the user as well as the working environment, since in case of direct exposure to the laser without appropriate PPE, serious damage can occur.

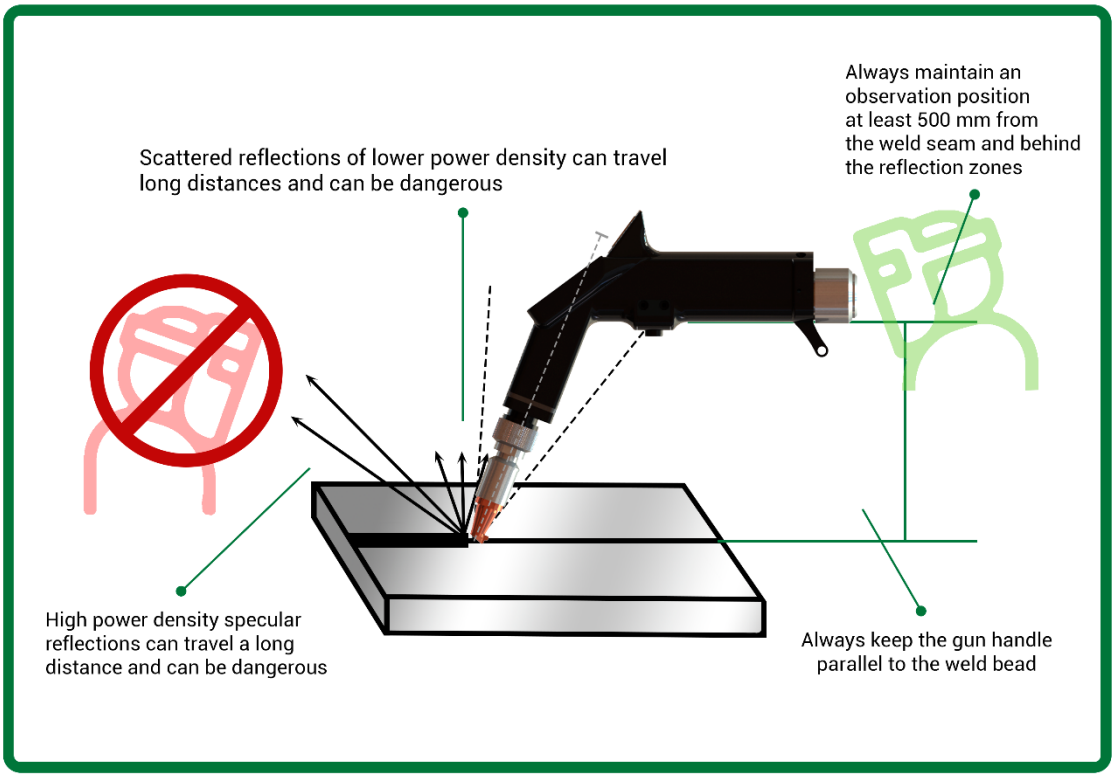
2.6.3 REFLECTED BEAM HAZARD

- **Take care to avoid/minimise specular reflections. The primary laser of this product emits invisible laser radiation, corresponding to laser class 4, at or around a wavelength of 1060-1070 nm (infrared).**
- In addition, the laser guide (red pointer) of this product emits visible laser radiation, corresponding to laser class 3R.

As explained in section 2.2.1, multiple laser beams at different angles can be produced when working with laser equipment. These are specular reflections.

Laser welding systems can create specular reflections due to the interaction of the laser beam and the parts being processed. Although these secondary beams may be less powerful than the total power emitted by the laser, the intensity can be great enough to cause damage to the eyes and skin, as well as to the materials surrounding the laser.

The angle of the welding gun must be taken into account to avoid dangerous reflections.


Always maintain an observation position at least 500 mm from the weld seam and behind the reflection zones
Scattered reflections of lower power density can travel long distances and can be dangerous
High power density specular reflections can travel a long distance and can be dangerous
Always keep the gun handle parallel to the weld bead

DANGER

Laser beams can reflect off multiple surfaces. Be aware of the possibility of multiple reflections during welding. **The gun must always be in the correct position to avoid dangerous reflections**.

2.6.4 LIGHT RADIATION AND RADIATION PROTECTION

The performance requirement of a laser radiation protection system, according to UNE-EN 60825-4, is to ensure that in case of exposure of its front surface in accordance with the predictable exposure limit (PEL), the laser radiation accessible on its rear side does not exceed the Class 1 accessible emission limit at any time during the maintenance control interval.

The LEP value must be assessed by considering the worst-case or reasonably foreseeable combination of all parameters of incidence of the laser beam on the protection. This is normally given by a direct incidence of the laser beam on the protection.

The control or maintenance inspection intervals specified according to UNE-EN 60825-4 are the durations mentioned above, which must be adapted to the use of each laser processing system or machine. For example, for a laser system under continuous observation, a laser radiation protection system endurance duration of 10 s is required.

In the case of the LC WELD hand-held laser welding machine, a direct impact on a safety shield is impossible during its intended operation. Such a situation can only occur in the case of gross negligence, where the operator voluntarily directs the torch towards the shielding. However, the materials chosen as the basis for possible protective screens were irradiated in this configuration.

In a collaboration between LC and PROCARELIGHT SL (an expert company in laser safety), several materials were validated according to the UNE-EN 60825-4 standard for use in the manufacture of covers or screens for protection against laser radiation, i.e. the risk analyses and tests required by this harmonised standard on protection systems were carried out.

As the welding process with the LC WELD machine is only carried out under continuous observation, all materials that exceed a direct laser exposure duration of 10s are valid as protective systems. All samples were irradiated until perforation. The materials tested and the duration withstood by each of them are:

- A 2 mm thick aluminium sheet showed a direct exposure duration of more than 2 min.
- A 1.5 mm thick aluminium sheet withstood direct laser exposure for 50 seconds.
- A steel plate (2 mm thick) withstood direct exposure to laser radiation for more than 10 s, but less than 20 s.

- The same behaviour as the steel sample was observed with a 2 mm thick iron plate.

2.6.4.1 RISK ASSESSMENT FOR LASER PRODUCTS CLASS 4

Class 4 laser products must not be used without first carrying out a risk assessment to identify hazardous situations and assess the foreseeable level of exposure to the laser, as referred to in paragraph 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 shall also serve as a basis for determining the control and protective measures necessary to ensure safe operation.

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

- Characteristics of the area(s) intended for laser welding.
- Process control.
- Manual operations.
- Clamping and positioning of parts.
- Beam output considerations: structural integrity of components, means of maintaining the condition of optical components, means of maintaining beam alignment, etc.
- Location and position of workers during laser welding.
- Environmental factors.
- Geometry, composition and surface finish of the part or parts to be worked on.

As explained above, when working with highly reflective materials, the bounce light can conserve quite a lot of energy in the first part of the bounce, it is recommended to take extreme precautions with the hands to avoid skin burns.

2.6.5 ULTRAVIOLET LIGHT

As this is welding work, there are some risks similar to traditional welding to be aware of. Although much less than with traditional welding systems, during laser welding, intense visible radiation or ultraviolet (UV) light can be produced. Ultraviolet (UV) light, which is invisible, can damage the skin and eyes. For this reason, appropriate face protection (welding mask, specified in the section on PPE) must be worn.

2.7 ANALYSIS OF RISKS AND RISK FACTORS

2.7.1 EYE HAZARD

NEVER look directly into a laser opening (such as the output fibre, or the welding head) while the unit is on. The operator must turn the unit off and disconnect power to perform any maintenance action involving the fibre cable or fibre output head.

It is mandatory to always wear laser safety goggles specific to the laser equipment used.

Ensure that all personal protective equipment (PPE) is suitable for the output power and wavelength range listed on the laser safety labels affixed to the product.

-NEVER look directly into the output port when supplying power to the laser.

-Avoid placing the laser and all optical components at eye level.

-Avoid using the laser in a dark environment.

-Use closed enclosures for the laser beam.

-Always turn the key to the "OFF" position when working with the output (e.g. when mounting the laser head on a device, etc.).

As an additional precaution, disconnect the power supply to the equipment.

Highly reflective metals, such as aluminium, may cause some of the beam energy to be reflected at the welding site and require additional precautions.

- Specular reflections can also pose a hazard to the operator if any part of the beam is reflected from several surfaces.
- Take precautions to understand the expected specular reflection cone for each processed part and do not attempt to view the part or place any part of the body within the expected specular reflection cone.

Operators and observers must also be aware of reflections at all times. Further reflections are likely to occur if the laser parameters are not adjusted correctly to achieve fusion of the target part.

2.7.2 SKIN HAZARD

Welding and cleaning process - UV radiation

Skin damage due to exposure to UV radiation produced during the welding (or cleaning) process.

Cautions:

- It is compulsory to wear the appropriate PPE while using the equipment.
- The required PPE includes: (1) welding helmet over specified laser safety goggles, (2) flame, heat and arc resistant gloves, (3) sturdy clothing suitable for welding.

DANGER

Welding process - High temperature

Severe skin burn from contact with a hot surface or from exposure to thermal radiation or hot particles.

Cautions:

- Appropriate PPE must be worn during welding operations.
- The required PPE includes: (1) welding helmet over specified laser safety goggles, (2) flame, heat and arc resistant gloves, (3) sturdy clothing suitable for welding.
- Avoid touching the welded part or the nozzle tip of the welding head or the tube with unprotected skin immediately and shortly after laser emission.

Exposure to ultraviolet light can cause skin burns (similar to sunburn) and this can increase the user's risk of skin cancer and accelerate skin ageing.

Depending on the intensity of the infrared light, skin lesions may include thermal burns or excessive skin dryness.

Sparks generated during the welding process can also cause burns.

The laser welding process itself transfers a significant amount of energy and heat onto a material. The parts worked on with the laser equipment may be at high temperature

even after the work is completed. Likewise, the nozzle, tube and other parts of the laser gun may be hot during use. Be sure to use the appropriate PPE to protect yourself from burns, such as gloves and appropriate clothing.

It is essential to take precautions to avoid skin damage by wearing clothing suitable for work with laser welding equipment, resistant to fire, heat and electric arc. Clothing must be sufficiently resistant to UV radiation.

2.7.3 IN-PROCESS HAZARDS

During the laser welding process, various hazards can occur when working with materials of different characteristics. The laser reacts with the material and can generate vapours, fumes, sparks and various particles. These fumes and particles can be a hazard.

DANGER	**Welding process - Fumes and Particulates** **Damage to body tissues or organs from exposure to fumes and other by-products generated by the welding process.** **Cautions:** - The user must take measurements according to the material of the workpiece to be welded. - During welding, keep your head away from the fumes. - Always keep in an area with adequate ventilation. - Hazardous and toxic fumes, vapours and particles must be captured and expelled from the work area by means of an extraction system. - Ensure that the work surface is well ventilated. The opening of the collection unit should be located as close as possible to the process area. - PPE (respiratory protection) must be worn if the released hazardous substances cannot be extracted close to the process.
	It is advisable to use a fume and vapour extraction system, suitably located close to the welding area, and should exhaust fumes and vapours out of the work area, ensuring a renewal of clean air. If the material to be welded generates a lot of fumes due to its composition (galvanised, aluminised or other treatments), it will be compulsory to incorporate a fume and vapour extraction system or, failing that, respiratory protection equipment with air supply.

Fumes generated by the welding process may contain components that are harmful to health. It can adversely affect the lungs, heart and central nervous system.

When the laser interacts with target materials such as plastics, metals or composites, the target material may start to vapourise. Often the fumes and mists are not visible, but they are highly toxic and pose a serious health hazard.

UV emissions during the welding process can react with oxygen and nitrogen in the air to form ozone and nitrogen oxides which, in high concentrations, can be lethal.

DANGER

Risk of asphyxiation in poorly ventilated confined spaces

Gases used in the welding process itself, such as argon or nitrogen, can accumulate in the environment.

Dangerous concentrations of toxic fumes and gases can build up very quickly and cause unconsciousness and death by asphyxiation.

Cautions:

- Carry out routine air monitoring to determine the levels of hazardous fumes in the area where the laser equipment is operated.
- In confined spaces and other circumstances, the use of a respirator may also be necessary.

It is recommended that a risk assessment for welding dust, particles and fumes be carried out to ensure the proper disposal of the residues caused by the welding process itself.

The owner of the laser, before starting to work with the laser, must:

- Be familiar with the material to be worked on and its possible reactions with the laser beam.
- Read and follow the safety data and warning labels on all materials and accessories used in the work.
- Employ appropriate measures to prevent and control the risk; such measures will normally require the removal of fumes from the process area to the outside and appropriate purification before exhaust gases are released back into the atmosphere away from personnel;
- Inform, instruct and train operators on the risks and precautions to be taken;
- Where necessary, control the exposure of operators and carry out an appropriate form of health surveillance in compliance with local regulations.

During the welding process itself, projections of micro-particles can occur which can cause burns.

It is recommended to use cotton safety clothing that completely covers the operator's arms and torso to adequately protect the skin. The welder must wear protective goggles and face shields. As well as special welding gloves (TIG type gloves are recommended), which in addition to protecting against radiation, also protect against micro-projections from the welding process.

2.7.3.1 FIRE HAZARD

There are two types of fire extinguishers that must be available near the laser area.

1. The ABC dry chemical extinguisher is a good general-purpose extinguisher that should be readily available. This type of extinguisher is suitable for:

- Fires of solid materials, generally of an organic nature - the combustion of which results in the formation of embers - such as wood, paper and textiles.
- Fires due to flammable liquids.
- Electrical fires.

2. A Class D dry powder extinguisher shall also be provided. This type of extinguisher is suitable for combustible metal fires.

Consult national legislation and legal obligations at work for specific characteristics of fire extinguishers.

DANGER

The laser can ignite solvents, gases and combustible materials.

Laser light can ignite volatile substances such as alcohol, gasoline, ether and other flammable solvents and gases (e.g. MAPP gas), causing a fire or explosion.

Precautions:

Exposure to solvents and other flammable materials and gases must be avoided and taken into account when installing and using this device.

- **Do not weld combustible and flammable materials (e.g. magnesium).**
- Whenever possible, combustible and flammable materials should be completely removed from the laser area.

DANGER

Welding and laser cleaning can cause a fire or explosion!

The heat and sparks produced during operation of the system can cause the system to cause a fire or explosion.

Precautions:

- Laser welding should only be carried out if the area is free of combustible materials.
- Never weld on containers containing flammable or combustible material.
- If you do not know the contents of a container, you should assume that it is flammable or combustible.
- Fire extinguishers should be close by and accessible to personnel, who should be trained in their use.

2.7.4 SAFETY OF GAS CYLINDERS

The LC-WELD laser welding equipment requires gas for a good weld finish, as in other fusion metal joining techniques and methods.

The placement and arrangement of gas cylinders must be taken into account.

Cylinders can explode or be damaged if placed incorrectly or close to the welding area, which can cause accidents and material damage. Falling or overturning of the cylinder can also cause damage and accidents.

Cautions:

- Cylinders must be positioned so that they are protected and placed in such a way that they cannot be knocked over.
- Cylinders must be kept away from sparks, heat sources or possible flames, as well as from the deflection of the laser beam.
- The cylinder must be stored in an upright position and secured to a fixed support.

It is necessary to have operational regulators in good condition that are suitable for the gas and pressure required. All hoses and couplings must also be suitable for the application and maintained in good working order.

2.7.5 RISK ANALYSIS OF LC-WELD EQUIPMENT

On the following pages, the risk assessment relating to the machine is attached, taking into account the UNE-EN ISO 11553-1 standard. The legend used in the risk assessment in the different phases of the life cycle and the different states of the machine is as follows:

LIFE CYCLE PHASES OF THE MACHINE	
A	Transport
B	Assembly and installation
C	Commissioning
D	Regulating, Learning / Programming and/or Process Change
E	Operation
F	Cleaning, Maintenance
G	Troubleshooting / Troubleshooting
H	Dismantling / Decommissioning
MACHINE STATES	
Machine error condition	
a)	The variation of a characteristic or a dimension of the processed material or workpiece

b)	The failure of one (or more) of its components or of its functions
c)	External disturbances (e.g. electromagnetic interference, shocks, vibrations)
d)	A design error or deficiency (e.g. programme errors)
e)	Disruption of its power supply
f)	Surrounding conditions (e.g. damaged ground surface)
Human error condition	
a)	Loss of control of the machine by the operator (mainly for portable machines or mobile machines).
b)	Reflex behaviour of a person in case of malfunction, incident or failure during the use of the machine
c)	Behaviour that results from a lack of concentration or attention
d)	Behaviour resulting from the application of the "law of least effort" when performing a task.
e)	Behaviour resulting from pressures to keep the machine running under all circumstances.
f)	Behaviour of some people (e.g. children, people with disabilities, people with disabilities)

Risk Assestment	Made by	Procarelight
	device type	Welding
	System	LC-WELD handheld laser welding

Nº	Machine life cycles	Posible states ISO 12100															Brief description	Protection target	Solution/measures to take	Standards and directives to apply	indications/criteria for PEM and inspection
		Machine error condition							Human error condition												
	A B C D E F G H	a	b	c	d	e	f		a	b	c	d	e	f							
1	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming E= Operation F= Cleaning, Maintenance G= Fault search/detection	X	X								X	X	X	X			Hazards produced by Radiation: Exposure to direct laser beam or specular reflections produced by parts of the machine	Avoid eye or skin injuries to people working near the machine	1- Only authorized personnel with adequate training should intervene. 2- They must use the appropriate PPE and in good condition (certified glasses according to EN207 and appropriate clothing)	Directive 2006/25/EC UNE-EN ISO 11553-1 EN-IEC 60825-1 TR/IEC 60825-14 EN 207	1- Verify the correct condition of the protective glasses 2- Verify that the LB protection indexes of the glasses are correct 3- It is necessary for maintenance personnel to have adequate training
2	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming F= Cleaning, Maintenance G= Fault search/detection	X	X								X	X	X	X			Hazards produced by radiation: - Exposure to the direct laser beam that passes through the interior of the head or to specular reflections produced by tools or parts of the machine when the protections are removed	Avoid eye or skin injuries to people working near the machine	1- Warn through warning labels (visible when removing the protections) of the presence of the invisible beam. 2- Only qualified personnel with adequate training should intervene. 3- They must use the appropriate PPE and in good condition (certified glasses according to EN 207 and appropriate clothing)	Directive 2006/25/EC UNE-EN ISO 11553-1 EN-IEC 60825-1 TR/IEC 60825-14 EN 207	1- Verify the correct condition of the protective glasses 2- Verify that the LB protection indexes of the glasses are correct 3- Verify that maintenance personnel have adequate training
3	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming F= Cleaning, Maintenance G= Fault search/detection	X	X								X	X	X	X			Hazards produced by radiation: - Ignition - Burst - Emission of pollutants from materials used in maintenance and interposed in the path of the laser beam	Avoid collateral risks to people working on the machine and to the machine itself	1- Do not put materials of any kind in the path of the laser beam (invisible) 2- Training of the personnel that will intervene in these operations 3- Warning of maintenance instructions	Directive 2006/25/EC TR/IEC 60825-14	1- Verify maintenance instructions 2- Verify that maintenance personnel have adequate training
4	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming E= Operation F= Cleaning, Maintenance G= Fault search/detection		X		X						X	X	X	X			Electrical hazards	Avoid risks of electric shocks during operations on the Machine	1- Only qualified personnel with adequate training should intervene 2- They must use the appropriate PPE and tools and in good condition	UNE-EN ISO 11553-1	1- Verify the correct state of electrical insulation 2- Verify that maintenance personnel have adequate training
5	E= Operation																Hazards resulting from the interaction of the beam with the material: - Generation of toxic, allergic, carcinogenic materials, heavy metals, etc. in material processing	Avoid inhalation or contact with the skin of particles that can cause damage	1- Only qualified personnel with adequate training should intervene 2- Installation of a suitable suction system 3- They must use the appropriate PPE and in good condition	UNE-EN ISO 11553-1	1- It is necessary for the staff to have adequate training 2- Verify the correct operation of the suction system 3- Verify the correct state of the PPE
6	E= Operation																Hazards resulting from the interaction of the laser beam with the material: - Smoke and vapor emissions	Avoid inhalation of fumes and vapors	1- Only qualified personnel with adequate training should intervene 2- Installation of a suitable suction system 3- They must use the appropriate PPE and in good condition	UNE-EN ISO 11553-1	1- It is necessary for the staff to have adequate training 2- Verify the correct operation of the suction system 3- Verify the correct state of the PPE
7	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming E= Operation F= Cleaning, Maintenance G= Fault search/detection	X	X			X					X	X	X	X			Hazards resulting from the interaction of the laser beam with the material: - Ignition. In the processing of plastics, wood or combustible materials	Avoid the flame	1- Only qualified personnel with adequate training should intervene 2- Have an automatic extinguishing system 3- In the absence of an automatic extinguishing system, do not leave the machine unattended at any time and have a fire extinguisher nearby	UNE-EN ISO 11553-1	1- It is necessary for the staff to have adequate training 2- Verify the correct operation of the extinguishing system
8	B= Assembly and installation C= Commissioning D= Adjustment, Learning, Programming F= Cleaning, Maintenance G= Fault search/detection																Dangers generated by neglecting ergonomic principles in the design of the workplace	Avoid fatigue or injury due to improper posture or movement	1- Adapt the work space and the necessary ergonomic elements	UNE-EN ISO 11553-1	1- Check the workspace and ergonomic elements

ELECTRICAL RISK

Caused by tampering with the power supply circuit, which should only be accessed by authorised maintenance personnel using the specific safety measures related to the electrical risk and/or by deficiencies in the insulation of the flexible cables or mains connections of the machine.

To reduce the electrical risk, do not open the door used to store the electrical circuit, as there are no parts inside for the user to handle. In the event of a fault, switch off the

machine and notify a responsible or authorised person so that they can contact the specialised technical service.

To avoid indirect contact, make sure that there is a proper ground connection and that the housing is in perfect condition. Make sure that the chassis of the LCWELD laser welding device is connected to the ground.

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

Direct electrical contact can occur in the supply circuit due to insufficient insulation of flexible cables or connections to the mains or to the machine.

Indirect electrical contact can occur with the machine casing due to a voltage or grounding fault.

PROJECTIONS AND BURNS

Eye projections and burns can be caused by micro projections of particles due to the welding itself and the parts being welded. Take the necessary measures to protect eyesight and skin.

Risk of burns or skin lesions. To minimise the risk, the use of protective gloves and close-fitting clothing of a suitable length for the activity being carried out is recommended, being cotton safety clothing that completely covers the arms and torso of the operator.

EXPLOSION AND FIRE

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

INHALATION OF POLLUTANTS

Risk of inhalation of contaminants produced by metal welding. To minimise or avoid the risk, optimal ventilation of the room 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 is not possible, individual protection of the worker's respiratory tract must be used in addition.

KNOCKS OR FALLS

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

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

Risk of falling to the same level, it is recommended to maintain order and cleanliness in the work area to avoid falls caused by moving parts of the equipment such as the hose.

WELDING WIRE ENTRAPMENT

It is compulsory to keep the feeder door closed at all times, except when operating the welding wire, in which case it must always be done with the equipment stopped and not in operation.

2.8 SAFETY MARKINGS ON LASER EQUIPMENT AND LABELLING

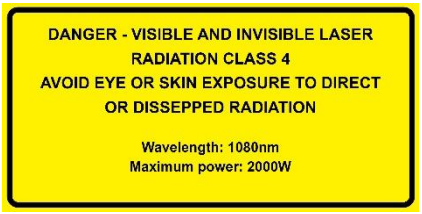
The safety label placard, which is placed on the device, provides information about the risks of laser radiation that are present in your particular device.

This product has the required safety labels located on the outside of the device case in several places. These include warning labels indicating removable or displaceable protective housings, openings through which laser radiation is emitted, and certification and identification labels.

The following is the meaning of the labels on the product and their location on the equipment.

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

In addition to the laser identification and sorting labels on the LC WELD machine, there are the following labels:

	A label indicating the output of the laser beam, i.e. on the welding torch with an arrow pointing towards the tip.
	A label indicating the characteristics of the laser emission (wavelength and maximum power), the hazard from exposure to visible and invisible Class 4 radiation.

	Laser radiation hazard label. Can be found alone or combined with other symbols.
	SAFETY GOGGLES. Compulsory eye protection. Pictogram according to EN 61310 Indication, marking and operation. Part 1: Specifications for visual, audible and tactile signals, Paragraph 7.
	GLOVES. Mandatory hand protection against burns. Pictogram according to EN 61310 Indication, marking and operation. Part 1: Specifications for visual, audible and tactile signals, Paragraph 7.
	FACE SHIELDS. Mandatory face protection. Pictogram according to EN 61310 Indication, marking and operation. Part 1: Specifications for visual, audible and tactile signals, Paragraph 7.
	PROTECTIVE CLOTHING Mandatory protective clothing in the work area. Pictogram according to EN ISO7010.
	WARNING! RISK OF ELECTRICAL CONTACT. Work on the electrical installation must only be carried out by qualified personnel authorised by the company and in compliance with safety regulations. Pictogram according to EN 61310 Indication, marking and operation. Part 1: Specifications for visual, audible and tactile signals, Paragraph 7.
	WARNING! RISK OF LASER RADIATION Work on the laser machine may only be carried out by qualified personnel authorised by the company and in compliance with safety regulations.

	Pictogram according to the specific laser radiation standard EN 60825-1.
	WARNING! GENERAL DANGER. General indication of caution due to a hazard which shall be defined in the area where the sign is placed. *Pictogram according to EN 61310 Indication, marking and operation.* *Part 1: Specifications for visual, audible and tactile signals, Paragraph 7.*
	HANDLING WITH GLOVES IS PROHIBITED Indicates the prohibition of handling certain items with gloves. In the case of LC WELD SMART, this refers to a task with the feeder. Pictogram according to ***UNE 81-501/81 on safety signs at workplaces.***
	Risk of entrapment. Indicates the risk of entrapment of certain components. Pictogram according to EN-ISO 7010 Standard

DANGER

Risk of injury due to illegible or missing labels!

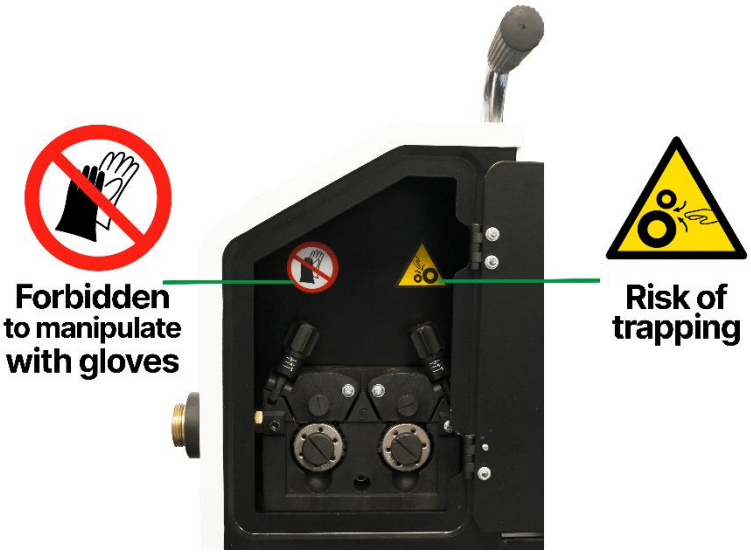
Over time, labels can become damaged, soiled and become difficult to identify or unreadable. If the labels cannot be read clearly, hazards or necessary operating information cannot be recognised. This can lead to accidents and/or serious injury to the user of the equipment.

Cautions:

- Always keep labels in good condition so that they remain legible.
- Never remove a label affixed to the equipment.
- If any label is damaged, illegible or missing, please contact the service department of your dealer.

Location and meaning of safety labels on LC-WELD SMART equipment:

On the inside of the yarn winder we find the following information stickers:



2.8.1 REGULATORY COMPLIANCE

Standard	Title / Description
Directives:	
2014/35/EU	The Low Voltage Directive covers all electrical equipment and components designed for use with a voltage rating between 50 and 1000 V for alternating current (AC) and between 75 and 1500 V for direct current (DC). It provides the essential (safety) requirements to be met by the electrical equipment and components covered by it, and describes the conformity assessment procedure to be applied by the manufacturer to ensure compliance with the essential requirements.
2014/30/EU	The EMC Directive aims to ensure that all electrical and electronic equipment minimises the emission of electromagnetic interference that may influence other equipment. The directive also requires equipment to be able to withstand disturbances from other equipment.
2006/42/EC	The Machinery Directive is an EU directive on machinery and certain parts of machinery. Mandatory health and safety specifications are combined with voluntary harmonised standards. Its main objective is to guarantee a common safety level for machinery placed on the market or put into service in all member states and to ensure its free movement within the EU.
Laser safety	
IEC 60825-1 (EU)	Safety of laser products. Part 1: Equipment classification and requirements
CDRH 21 CFR 1040.10 **(United States)**	Code of Federal Regulations (CFR). Title 21. Food and Drugs - Chapter I. Food and Drug Administration - Department of Health and Human Services - Subchapter J. Radiological Health - Part 1040. Standards for Performance for light emitting products - Section 1040.10. Laser products
ISO 11553-2	Safety of machinery. Laser processing machines - Safety - Part 2: Safety requirements for hand-held laser processing devices Part 2: Safety requirements for hand-held laser processing devices.
EN 207	Personal eye protection equipment. Filters and eye protectors against laser radiation (laser safety goggles).

2.9 WORKPLACE

The LC-WELD device is a CLASS 4 laser device and it is therefore mandatory to work with the device in a safe workplace. The risk assessment is to be carried out by personnel trained and specialised by LC in the assessment of laser workplaces. Safe working areas must be marked out.

2.9.1 SECURITY OF THE ENVIRONMENT

The LC-WELD SMART is prepared to work and be operated in:

- Interior space
- I work without rain or water.
- Ambient air temperature 5 to 35 °C.
- Relative humidity between 10 and 90 %.
- Overvoltage category II.
- See product specifications for additional information.

This equipment is not suitable for use where unprotected persons or children may be present. Keep away from sources of shock or vibration.

- Ensure that all personal protective equipment (PPE) is suitable for the output power and wavelength range listed on the laser safety labels attached to it.
- Inattentive or careless actions and operation may cause injury to the operator due to reflected or scattered laser radiation.
- Do not expose the device to a high humidity environment (>90 % humidity).
- The laser device is water-cooled. Operation at higher temperatures will accelerate ageing and may decrease performance. If the device overheats, do not use it and call for technical support.

2.9.1.1 NOISE LEVEL AND DECLARATION

Declaration of noise emission levels	
Machine: LC-WELD laser welding	Operating conditions Emission sound power measurements of the equipment without welding. Welding pressure measurements of a metal part for 30 seconds at 1 metre from the welding point.
Equivalent continuous A-weighted sound pressure level at the workstation in dB(A).	84

Maximum instantaneous C-weighted sound pressure level at the workstation in dB(C).	97
Sound power level emitted by the machine, A-weighted, in dB(A).	67
Reporting constants, background noise (K1A) and local environment correction for power (K2A) and sound pressure (K3A) in dB.	K_{1A} = 1.7 K_{2A} = 0.8 K_{3A} = 0,3
Values determined according to the basic acoustic standards UNE-EN ISO 11202:2010 and UNE-EN ISO 3746:2010.	

The values quoted are noise emission levels and are not necessarily safe sound levels for work. Although there is a correlation between emission levels and exposure, this cannot be used reliably to determine whether additional precautions are necessary.

Factors influencing the actual exposure levels for personnel include the characteristics of the workspace, noise from other sources, etc. i.e. the number of machines and other adjacent processes.

Also, the permissible exposure levels may vary from country to country. This information, in any case, allows the user of the machine to make a better assessment of the hazard and risk.

2.9.2 ESTABLISHMENT OF A CONTROLLED LASER AREA

In many jurisdictions, laser safety regulations require the appointment of a Laser Safety Officer (LSO) in each company or institution where laser equipment is used.

The employer is primarily responsible for compliance and adherence to laser safety standards, but may delegate responsibilities or tasks. The key points in establishing the controlled laser area are the determination of the maximum foreseeable irradiance to which personnel may be exposed and then the design of the PPE and shielding of the laser area.

Suitable enclosures must be used to ensure a safe working area for the laser. This includes, among other things, laser safety signs, interlocks, adequate warning devices and training/safety procedures. Do not operate with the welding head at eye level.

- The primary laser of this product is class 4. Therefore, it is mandatory to appoint a site RSL:

In Germany: According to the OStrV, the designation of an RSL at the workplace is mandatory when workers use or are exposed to laser products of class 3R, 3B and 4.

In the United States: According to ANSI Z136.1, the designation of an RSL in the workplace is mandatory when workers use or are exposed to Class 3B and Class 4 laser products.

Although not mandatory in our jurisdiction, it is advisable to assign a laser safety officer.

- The laser safety officer, together with the distributor of the equipment can work to establish the laser controlled area, to protect all persons who may be in the vicinity of the operating laser equipment.
- Use the laser only in a controlled laser area with controlled access.
- A recommended option is to carry out administrative controls, i.e. to keep a record of all persons entering and leaving the controlled laser area, as well as all persons who have been trained to work with lasers.
- It must be ensured that the laser is in a controlled area where the beam cannot escape either explicitly or accidentally. Any barrier used in the LLZ must be made of a laser-resistant material that can withstand both direct and diffuse beams.

In the EU: see EN 60825-4.

- Outside the controlled laser area, there must be appropriate signs indicating when laser work is in progress. In addition, there must be appropriate warning and hazard signs, informing of potential hazards.

In the EU, the marking of the laser zone is mandatory according to EN 60825-1.

- Restrict access to the CFZ to only those persons who are trained in laser safety while operating the hand-held laser device.

Post a sign with the names of all persons authorised to work within the laser working area.

2.9.3 SAFE WORKING SPACE: CONTROLLED LASER AREA

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

- A movable wall or partition is an integral part of the means of prevention and should only be moved for planned operations with compensatory measures if necessary.
- A laser device can be installed in an enclosure acting as collective protective equipment.

Safe working spaces must be identified. Depending on the risk assessment carried out, one or a combination of the following options shall be chosen:

1. Install welding equipment inside a controlled area, i.e. an enclosure with fixed walls and ceiling and access door with safety switches to prevent access by third parties or unauthorised persons. Access shall be restricted to authorised personnel. In addition, a light signal external to the area may be used to indicate when laser work is in progress.
2. Use screens separating workstations to protect other workers from direct and indirect laser light radiation. The material of these screens must comply with the following characteristics:
    - These partitions must be at least 2 metres high.
    - This area must be enclosed in such a way that no laser or light emission to the outside can occur.
    - It should be a well-ventilated area with a fume extraction system if necessary.
    - One of these partitions will act as a door, so it must be movable, without losing the watertightness of the whole.
    - It is not necessary to close the ceiling, as long as we do not have other people working in an area or on a higher level with direct contact to the laser welding equipment.
    - The material of such partitions can be made of:
        - 2 mm aluminium (preferably)
        - 1.5 mm aluminium.
        - 2 mm carbon steel.
        - Aluminium and rock wool sandwich panel.

    - It is advisable to paint these screens black to avoid reflection of the material itself.
    - It is recommended that the minimum working space be 3 x 3 metres.
    - On the outside it shall be indicated that laser work is carried out indoors, with appropriate safety signs.
    - Access by unauthorised persons shall be prohibited. It is recommended to have a control of the persons who have access to the controlled laser area.

	The characteristics of this demarcated area are indispensable for a safe working space once the hazards and risks outlined above are known.

DANGER	**Under no circumstances may anyone enter the work area without the appropriate safety PPE.** **Irrespective of the solution adopted, the use of approved laser safety goggles by the operator of laser welding equipment is mandatory.**

Other recommended security measures:

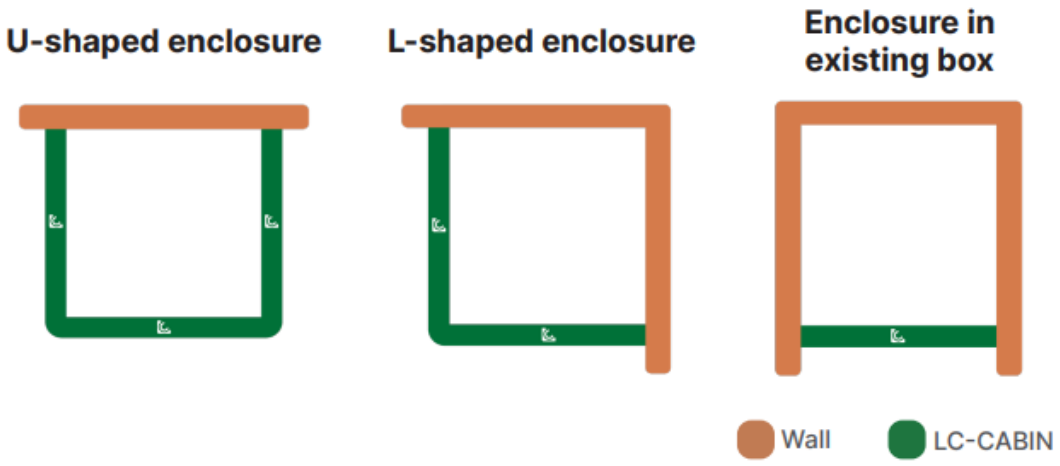
- System using light signals on the outside of the enclosure, to know whether the laser is emitting or not.
- Power cut-off system in case of accidental opening of the door, with consequent interruption of the laser emission.
- Acoustic warning to know when a person wants to enter the enclosure and to be able to control the laser emission from the inside.

It is mandatory to work in a controlled area in order to work safely. Under no circumstances shall there be any unauthorised persons inside the welding area.

Regarding the configuration of the welding space:

- In a space without walls, with an enclosure of 4 partitions in the shape of a square or rectangle.
- In a space with a wall, with an enclosure of 3 U-shaped partitions, taking advantage of the wall.
- In a space with two walls, with an enclosure of 2 L-shaped partitions, taking advantage of the two walls.
- In an existing box with three walls, enclosure with 1 partition and door.

Examples of enclosures for a laser safety zone with LC-CABIN:



Example of LC-CABIN enclosure with traffic lights outside:

	DANGER	**The configuration of the controlled area and the position of the movable partitions shall be determined by the results of the risk assessment carried out before the equipment is put into operation.**

When working with gas, it is strictly forbidden to approach with a flame, produce sparks or smoke in the vicinity of a workplace where gas may normally or accidentally be present in the atmosphere. It is forbidden to search for gas leaks with a flame; soapy water or other suitable detector must be used for this operation.

Good lighting is recommended for welding work. In general, a minimum illumination of 100-200 lux should be provided for operations without high visual requirements and from 300-500 lux if there are medium visual requirements such as precision or adjustment work, plus lux if high visual requirements are needed.

The slope of the ground must be a maximum of 7% to guarantee the stability of the equipment. In any case, it is recommended to work on a completely flat ground, without irregularities or slope.

Under no circumstances may the equipment be placed on top of other objects, such as pallets, tables, lifts, etc.

2.9.4 LASER SAFETY OFFICER (LSO)

In some jurisdictions it is mandatory to establish a laser safety officer, although not mandatory in some countries, it is always recommended. The workplace Laser Safety Officer (LSO) will need to identify the maximum permissible exposure and hazard distances to determine what PPE, guards and other safety procedures are necessary to safely operate the product within the laser controlled area (LCA). The manager may also establish administrative controls and access restrictions to the area where the laser equipment is operated.

2.10 ELECTRICAL SAFETY

DANGER

Electrical voltage! Danger to life through direct or indirect contact with live (live) parts.

Cautions:

- **Only trained and authorised personnel may have access to the inside of the equipment for repairs.**
- **To avoid electric shock, do not remove the covers.**
- Any tampering with the product will void the warranty.

DANGER

The input voltage to the laser welding unit is potentially lethal!

Cautions:

- **All electrical cables and connections should be treated as if they were at a harmful voltage level.**
- All parts of the power cable, connector or housing of the device must be considered hazardous.

IMPORTANT

All electrical and welding gas connections must be connected before applying power to the unit.

- In addition, and where applicable, all connections must be secured with screws to ensure proper operation.

Inadequate grounding and AC voltage To ensure electrical safety:

Cautions:

The device must be properly grounded through the protective earth conductor of the AC power cable. Any type of interruption of the protective earth conductor from the protective earth terminal can lead to personal injury.

Before powering the device, make sure that the voltage of the AC power supply is appropriate. Failure to use the correct voltage may result in damage to the device. Refer to your specific model markings for proper power connection.

2.11 PREVENTION AND SAFETY SYSTEMS

There are different prevention and safety systems that will make the handling and operation of the LC-WELD laser welding machine much safer and will minimise the risks during use. The LC-WELD machine is equipped with the technical safety elements required by the UNE-EN 60825-1 standard.

2.11.1 POWER SUPPLY CIRCUIT

Power supply cables must be of adequate cross-section to prevent overheating. Their insulation must be sufficient for a rated voltage > 1000 V. The connection terminals of the LC-WELD laser welding device and the plug pins must be adequately insulated.

2.11.2 "GROUND" CLAMP AND CONTROLS

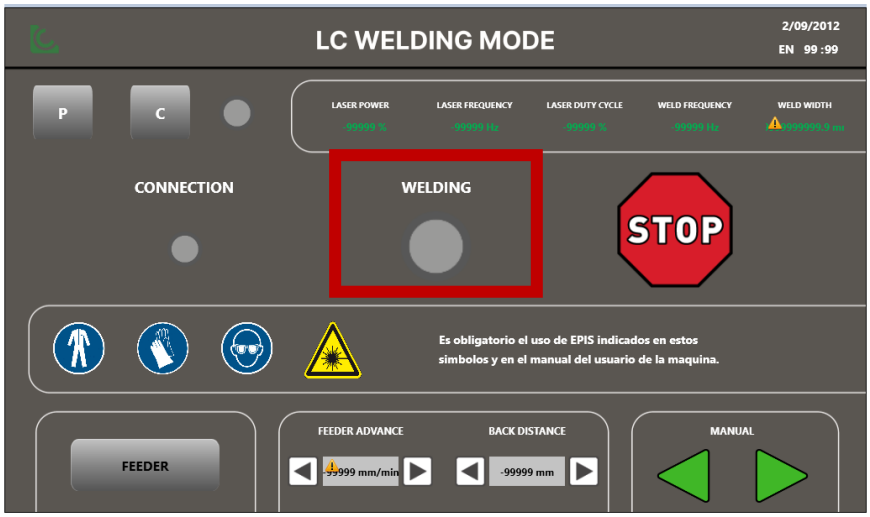
The LC-WELD SMART laser welding device is equipped with a clamp that is very similar to what is known as a "ground". However, this clamp does not constitute a "ground" as such: it is simply a safety system that prevents the LC-WELD SMART laser welding device from operating if the gun or torch is not in contact with the work table or the workpiece, in order to avoid injuries and physical burns due to direct contact with the laser beam emitted by the gun.

The mass is important and of mandatory use. In addition, the output of the laser beam is only possible when a button on the top of the welding torch handle is pressed.

2.11.3 LASER EMISSION WARNINGS

There are laser emission warnings, located at different points on the laser welding equipment.

On the laser welding screen, when working, (within the WORK and WELDING SCREEN function), there is an alarm. When it is red, it indicates laser emission, e.g.:



The same warnings can be reproduced at the access points to the working areas with the equipment, for example, by installing traffic-light type warning lights. These warnings can be placed both outside the controlled laser area and inside, to indicate the laser emission. In the same way, they can be complemented with door sensor systems, so that when the door is opened unexpectedly, the laser automatically stops emitting.

2.11.4 GROUNDING

The installation of the grounding sockets must be carried out according to the manufacturer's instructions. It must be ensured that the chassis of the LC-WELD laser welding equipment is connected to the grounding system.

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

2.11.5 ELECTRICAL PROTECTION MAGNETOTHERMALS

The equipment has two protections against overcurrents (magnetothermal) F1 and F2 located in the main electrical panel.

The protection system will be activated in the case of a general overcurrent or in the control circuit.

2.12 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. The training shall include:

- The measures taken.
- General explanation of exposure limit values and associated potential risks.
- The results of assessments, measurements and/or calculations of the levels of exposure to artificial optical radiation carried out, as well as explanations of their significance and potential risks.
- How to detect adverse health effects due to exposure and how to report them.
- The circumstances in which workers are entitled to health surveillance.
- Safe working practices to minimize risks from exposure.
- The correct use of appropriate personal protective equipment.

If there is and/or is compulsory the figure of a laser safety officer who knows all the PPE and safety rules of the machine.

2.13 GENERAL SAFETY INSTRUCTIONS

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

If this laser welding equipment is used in a manner not specified herein, the protection provided by the device may be impaired and the warranty will be void.

Do not use nozzles, spare parts and consumables from other suppliers.

The fibre cable of the LC WELD device connected to the gun using spare parts from other suppliers may cause the safety functions of the device to malfunction. This may also damage the equipment and increase the risk of injury due to laser irradiation.

Precautions:

- Connect the fibre only to an approved welding head supplied by LC or an official distributor.
- Do not connect other devices to the laser welder head connections on the rear panel other than the supplied cable and head.
- Do not use nozzles, spare parts or similar from other suppliers, it may cause the equipment to malfunction.

2.14 PROHIBITIONS

Welding work with the LC-WELD SMART laser welding device must not be carried out in the vicinity of degreasing operations, as this may result in the production of fumes hazardous to health.

Welding shall also not be permitted inside containers, tanks or casks until they have been thoroughly cleaned and degassed with steam.

It is forbidden to carry out any kind of welding without the necessary protective equipment.

	Never use the LC-WELD laser welding equipment outside the materials to be welded.
	It is prohibited to store or operate near corrosive or flammable materials.
	It is forbidden to use the gun with the dough in the gun itself.
	It is forbidden to use the equipment without specific training.

CHAPTER 3 - LASER WELDING

3.1 DESCRIPTION

LC Lasers manual laser welding is a revolutionary and innovative system in the world of metal welding.

The LC-WELD SMART belongs to the latest range of laser welding equipment, a complete and easy to use device, which allows very fine welds to be made without excessive heat input or deformation of the materials. We can ensure complete penetration in the materials and thicknesses indicated.

The operability of the LC-WELD SMART laser welding machine does not require a high level of technical expertise on the part of the operator. It allows us to weld a wide variety of materials using the same technique, simply by configuring the machine's parameters.

The power and precision offered by LC Lasers' manual laser welding system allows welding at high speeds, depending on the power of the equipment and the thickness of the material to be welded.

This technology also gives the option of welding with or without material input, depending on the weld preparation and the desired finish.

3.2 DIFFERENCES, ADVANTAGES AND DISADVANTAGES COMPARED TO OTHER WELDING TYPES

LC Lasers differ significantly from conventional welding for several reasons. Firstly, it does not use an electric arc like conventional welding, such as ELECTRODE, MIG-MAG (continuous wire) or TIG, but a very powerful and focused light (laser beam). This allows it to affect the material to be welded in a different way: it only heats the material where the light hits, unlike the electric arc.

This produces very thin welds with excellent depth and penetration and virtually no spatter without excessive filler, which reduces polishing time considerably and allows deep, strong welds to be made without overheating the material, resulting in a significant reduction in deformation, especially of thin materials.

Unlike other methods and technologies, LC laser welding allows the equipment to be configured to always achieve the same result: the welding is controlled by the machine, not the operator. The welding speed can therefore be selected with the welding wire feeder once the parameters have been set.

Although the gun and torch are designed to be as ergonomic as possible, the flexibility of the hose and the robustness of the gun require proper preparation for welding, including tooling, positioners or tackers, among others.

3.3 LASER WELDING APPLICATIONS

LC Lasers handheld laser welding is suitable for a wide range of applications offering innovative results and finishes in the metal industry:

- The LC-WELD SMART manual laser welding machine is specially designed for linear welding, with or without input, of sheet thicknesses between 0.5mm and 5mm, and of materials such as carbon steel, stainless steel, aluminium, titanium, among others.

- Laser welding revolutionises welding thanks to its speed, ease of use and other advantages. It is a device that aims for maximum efficiency and allows you to optimise your production system.

3.4 INTENDED USE OF THE LASER WELDING MACHINE

Following the steps and instructions in the above points concerning the operation of the laser machine is the only intended use of the laser welding machine. It is only intended to be used for its primary function: metal welding work using a laser beam.

Under no circumstances may the laser welding machine be used for any purpose other than welding the materials specified and suitable for laser welding. See in this manual which materials can be welded with the laser welding machine.

As indicated in the previous points, the type of welding to be carried out can be selected and the nozzles of the laser welding gun can be interchanged for this purpose, but not for any other purpose. The user of the laser welding machine is obliged to use the specified PPE for the intended use of the machine.

Under no circumstances work or be near the laser machine without the appropriate laser safety goggles.

Under no circumstances may the laser welding machine be used to work on objects that could injure people or animals or damage buildings, valuables or similar objects.

Under no circumstances should the laser gun be pointed at living beings, delicate materials, structures, constructions, electrical equipment, electrical appliances, electrical installations, vehicles, automobiles or other objects that are far away from the welding work itself, as these actions can result in serious accidents to people, animals and valuable installations. LC is exempt from any legal, penal or administrative liability and repercussions resulting from the misuse of the laser welding machine not foreseen in this manual.

Under no circumstances should the filler wire be used for any purpose other than to feed material during welding. It is important not to touch this wire under any circumstances once the machine is running.

3.4.1 MATERIALS SUITABLE FOR LASER WELDING

The materials suitable for welding by the LC-WELD SMART hand-held laser welding machine are as follows:

- Stainless steel
- Aluminium
- Titanium
- Galvanised steel
- Carbon Steel

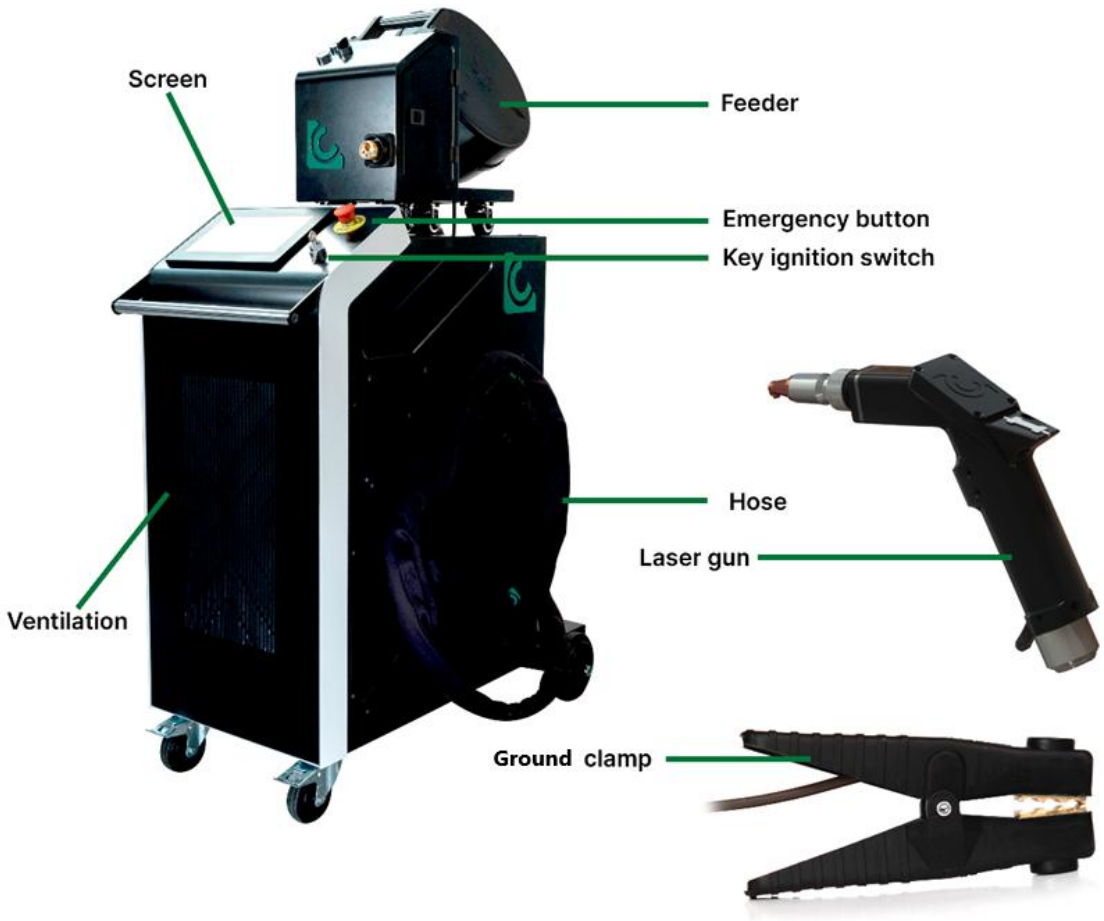
To work other materials or special alloys not specified in the above list, please consult LC technical service for your safety.

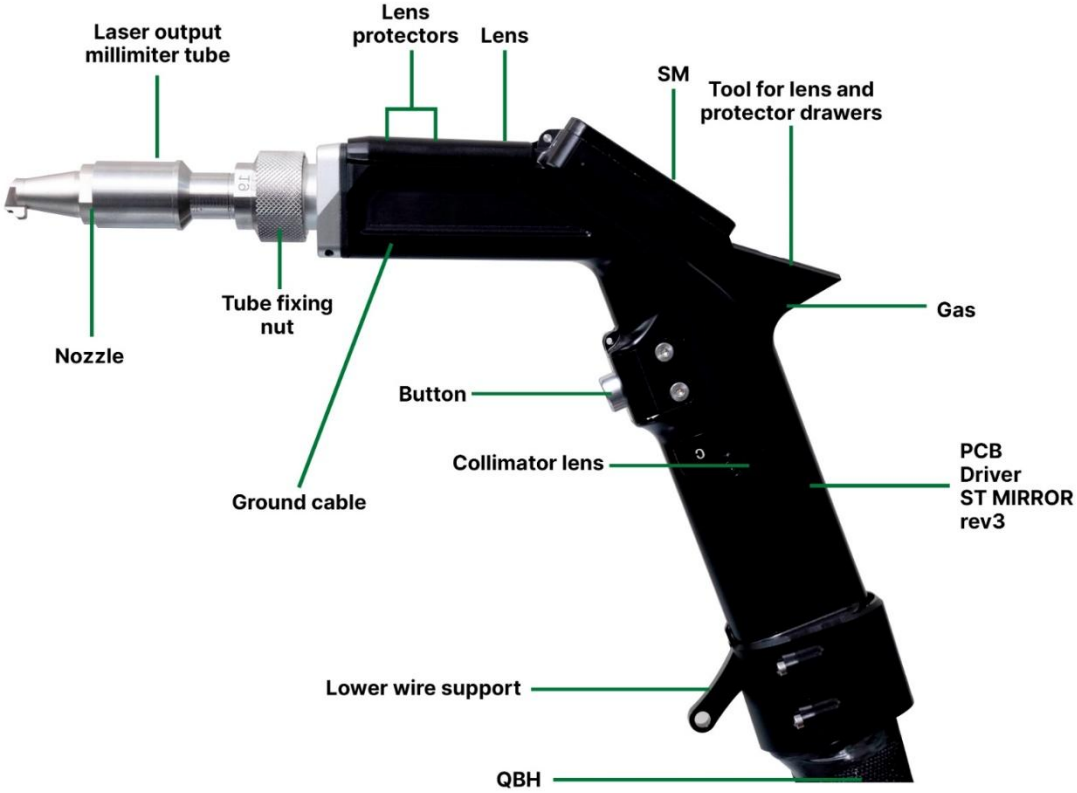
IMPORTANT

Welding not suitable for class 6XXX aluminum

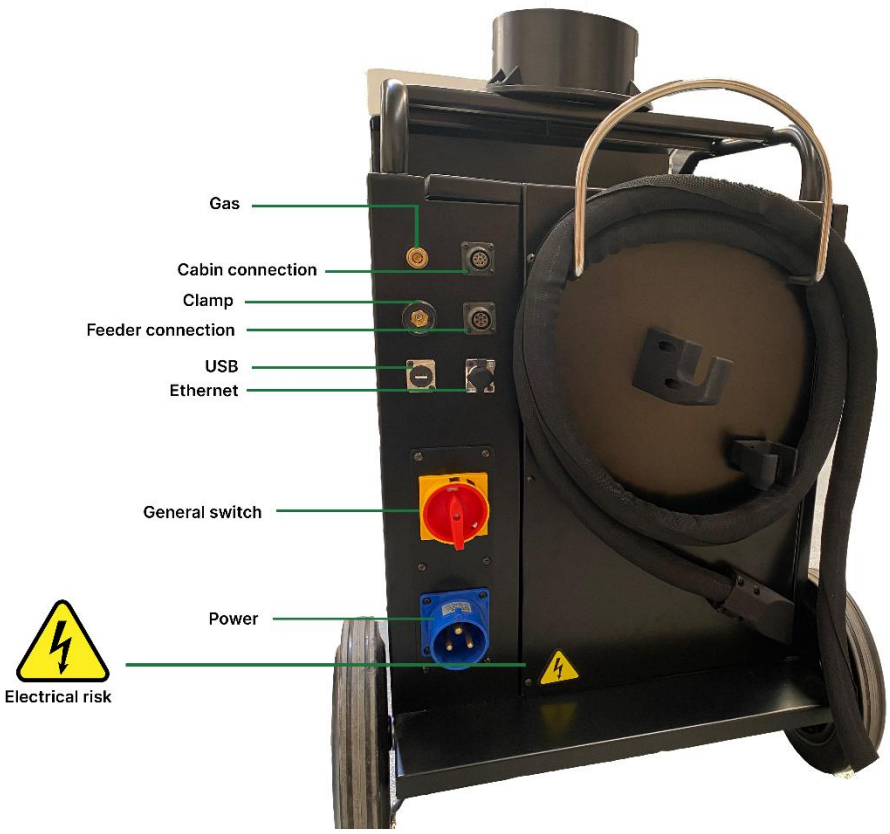
CHAPTER 4 - LASER WELDING EQUIPMENT

4.1 EQUIPMENT COMPONENTS





4.1.1 OVERVIEW OF THE REAR OF THE EQUIPMENT



4.1.2 LASER RESONATOR

The laser resonator produces the laser beam, which is directed to the gun by means of a flex with a fibre optic cable.

The fiber laser generator data sheet is included in ANNEX 1, together with the optical specifications of the fibre output.

4.1.3 CHILLER OR COOLER

The "Chiller" or refrigerator is used to cool the Laser resonator and the gun or torch, to maintain a stable temperature in both, since the energy produced releases notable amounts of heat. **The laser system already has its own cooling system using R32 type gas.**

4.1.4 FEEDER

The feeder accessory is a removable device that is supplied with LC-WELD SMART. The feeder is attached to the gun by means of a fitting that connects the wire rope to a metal tube and to the gun. It can be regulated from the same screen, activating and deactivating the feeder and controlling the parameters.

It is compulsory to keep the feeder door closed at all times, except when operating the welding wire, in which case it must always be done with the equipment stopped and not in operation.

When the laser welding equipment is working with the feeder, the side door of the feeder, where the rollers and the filler wire are located, shall remain locked, if available. It is strictly forbidden to open and access the inside of the feeder while the equipment is working.

Dual Contribution Model

The double filler winder is a system designed to simultaneously feed **two filler wires** into the melt pool during laser welding. Unlike the single filler system, which supplies a single thread, this new technology allows for greater flexibility in the management of the filler material.

The wires can be of the same type or different alloys, and their feed can be configured **synchronously or independently**, depending on the needs of the process.

4.1.5 DISPLAY

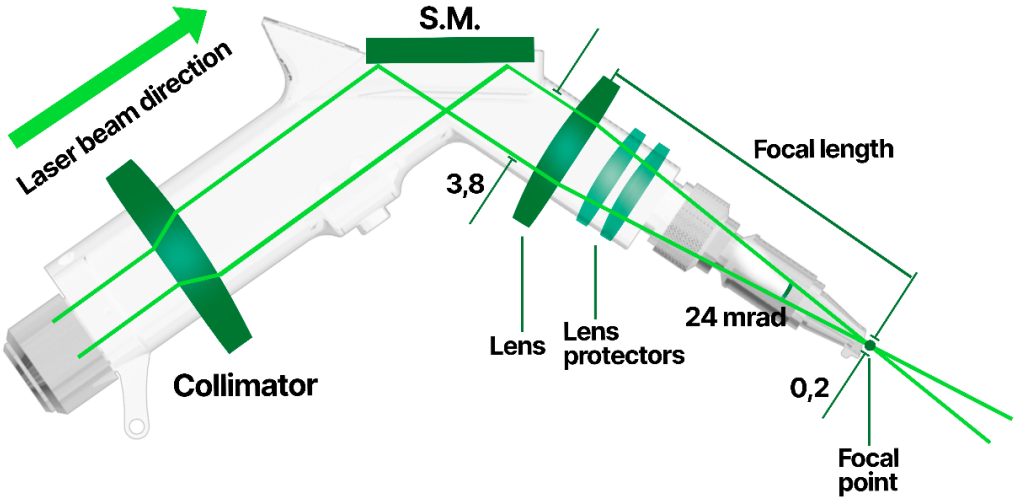
The LC-WELD laser welding machine's display allows easy and practical operation of the machine's parameters, simplifying its options as much as possible without reducing its capabilities. It is organised in a menu of functions explained in the SOFTWARE chapter.

4.1.6 GUN

The gun or torch incorporated in the LC-WELD laser welding equipment is of high quality.

In this drawing, the optical path of the laser beam inside the gun and to the focal point is simplified.

The laser beam passes through the collimating lens to STABILISE its diameter before the Steering Mirror (SM). After the mirror, the beam is directed towards the focusing lens which focuses the beam at the tip of the gun, GETTING THE FOCAL POINT. After the focal lens, the gun has two lens protectors that protect the lens from dust or external substances.



Steering mirrors in laser welding are used to direct and focus the laser beam to the precise welding location. This method offers the possibility of high precision and detailed control over the welding process. Steering mirrors allow precise manipulation of the laser beam, which is crucial for achieving high quality weld joints. They can direct the laser to specific areas and make fine adjustments to ensure correct penetration and weld formation.

They also allow rapid changes in beam direction, which increases the speed of the welding process and improves productivity.

During the intended operation of the LC WELD device, the only possible opening of the laser beam is at the tip of the welding gun.

4.1.7. CONNECTION POINTS

The connection points at the back of the machine are described below.

Connection point	Function
GAS	Gas inlet connection for gun operation.
CABIN	Connection to the welding cabin security system.
CLAMP	Ground clamp cable connection.
FEEDER	Wire feeder connection
USB	Connection for machine SW update tasks
ETHERNET	Ethernet connection only for technical assistance tasks.

4.2 TECHNICAL DATA

4.2.1 DATA LASER WELDING EQUIPMENT

Model	LC-WELD SMART
Product reference	LC-SL1500W-SMART
Laser power	1500w
Electricity consumption	<4200W
Voltage	220-240VAC
Wavelength	1070nm ±10
Frequency range	<20 kHz
Power stability (2 hours)	<2%
Power stability (24 Hours)	<3.5%
Laser Efficiency	36%
Laser Class	4 (IEC 60825-1)
Weight	<80kg
Hose length	8m Aprox
Measurements Approx.	400x640x950 mm

4.2.2 FEEDER DATA

Model	LC-FEEDER SMART	LC-FEEDER DA 1500W
Product reference	LC-FEED-SMART-V1.07	LC-WELD DOBLE ARRASTRE 1500W
Consumption	<120W	<65W
Tension	24Vdc	24Vdc
Output Speed	100rpm	100rpm
Measurement	240x420x520mm	340x500x460mm
Weight	<12kg	<15kg
Engine Type	DC PWM	
Others Engine	Includes Encoder	
Control System	CANBUS	

4.2.3 LASER DATA

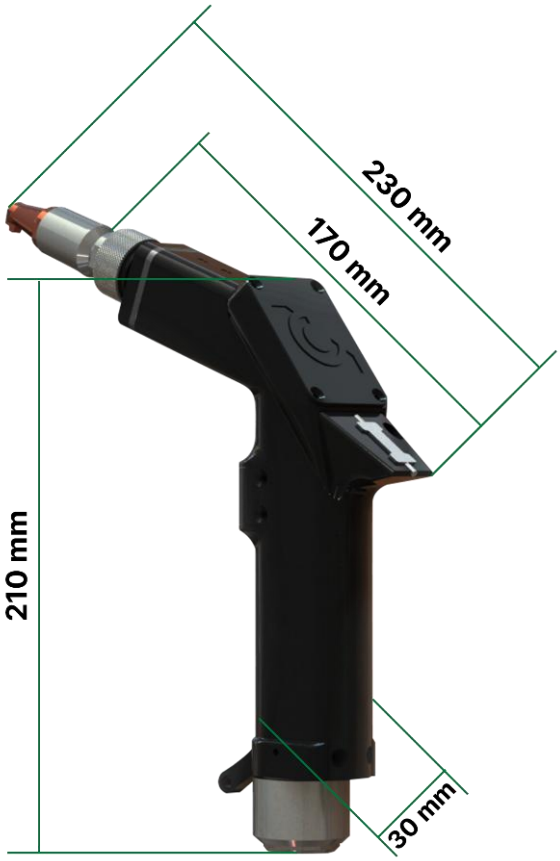
Model	L1500W-V5.1
Product reference	L1500W-V5.1-50µm
Laser Power	≤1500W
Laser Type	CW HPP
Consumption	<3800W
Voltage	220-240VAC | 50 Hz

Maximum energy consumption	20 A
Wavelength	1070nm ±10
Power instability	<3,5%
Power range	1-100%
Frequency range	<20 kHz
Laser Efficiency	36%
Start time	10 µs
Type of connection	QBH
Fibre length	10m
Output fibre diameter	25 µm
Weight	40kg
Dimensions	560x339x423mm
Ambient temperature	5~40°C
Ambient humidity	10-90%
Need for refrigeration	Yes
Cooling method	Gas cooling (gas type R32)
Storage temperature	-10-50°C
Laser Class	4 (IEC 60825-1)
Pointer power	1mW
Pointer class	2M (IEC 60825-1)

4.2.4 DATA GUN

Model	LC-WELD GUN SM
Material	Aluminium/Stainless Steel
Product reference	LCWELD GUN SM V 4.4
Weight	670g
Measures	230x210x30mm
Focal lens type	F150 λ=1060-1080nm
Lens protector type	99.999% T λ=1060-1080
Type of collimating lens	F=50C λ=1060-1080nm
Connection	QBH
System	Steering mirror (S.M.)
No. of lenses	1
No. of lens protectors	2
No. of collimating lens	1
Compatible equipment	LC WELD SMART& LC WELD SMART

Driver	LC_FMR-20_DRIVER_Rev5
Maximum power equipment	<2000W
Feeding	24V
Communication	CANBUS



CHAPTER 5 - PACKAGING AND DELIVERY

In this section, we inform you about the packaging and delivery process of the LC WELD SMART manual laser welding equipment. Knowing this information will help to avoid any kind of inconvenience with the delivery of the package.

5.1 CONTENTS OF THE SHIPMENT OF THE LC-WELD SMARTEQUIPMENT

LC REFERENCE	DESCRIPTION	IMAGE
LC-WELD PRO	LC-WELD SMART MACHINE	
LC-FEEDER	WIRE FEEDER	
10402-00018	POWER SUPPLY CABLE	
10301-00014	GAS TUBE	
10103-00033	QUICK CONNECTOR GAS	
10701-00014	THREAD FEED WIRE (0.8-1.6mm)	

10401-00026	FEEDER CONNECTION CABLE	
10901-00063	GUN SUPPORT	
10701-00090	Rollers AL 0,8-1,6 SF	
10701-00089	Rollers HI 0,8-1,0 SF	
10701-00092	Rollers AL 1,2-1,6 SF	
10701-00091	Rollers HI 1,2-1,6 SF	
11101-00015	USB driver	
22001-00014, 22001-00035, 22001-00056, 22001-00077, 22001-00098	LC-WELD SMART PRINTED MANUAL (depending on language)	
22001-00115, 22001-00042, 22001-00021, 22001-00063, 22001-00084, 22001-00105	PRINTED SAFETY BROCHURE (depending on language)	
55001-00018	PROTECTIVE GLASSES	

10103-00030	GROUND WITH CABLE AND CONNECTOR	

ACCESSORY BOX:

10901-00168	WELDING PIPE	
11201-00089	M5X16 DIN912 x2	
11201-00167	M3X6 DIN912 x2	
10901-00071	Brass tube	
10901-00086	Sirga Ring	
10901-00041	Rope support	
10203-00010	Straight female straight metal cable fitting	
10901-00100	Lower towline support	
10901-00092	Welding pipe fixing thread	

10901-00169	Tool for lens boxes and protectors	
10901-00110	FE Nozzle Closed 0,8" nozzle	
10901-00111	Nozzle FE Closed 1,0" input	
10901-00112	Nozzle FE Closed 1.2" (1.2")	
10901-00113	Nozzle FE Closed 1,6" nozzle	
10901-00114	Nozzle AL Open 0,8" input	
10901-00115	Nozzle AL Open 1.0" input	
10901-00116	Nozzle AL Open 1,2" input	
10901-00117	Nozzle AL Open 1,6" input	

10901-00118	Short inner SA nozzle	
10901-00119	Long outer SA nozzle	
10901-00205	Double thread input nozzle 1.2mm (for Double Feeder)	
10901-00206	Double thread input nozzle 1.6mm (For Double Feeder)	
10901-00207	Double contribution lower tow support (For Double Feeder)	
10901-00024	BRASS NOZZLE 0,8	
10901-00021	BRASS NOZZLE 1,0	
10901-00022	BRASS NOZZLE 1,2	
10901-00023	BRASS NOZZLE 1,6	
11001-00003	LENS PROTECTORS D18X3mm (x10)	
11001-00002	Lens F 150 0.4mm LO: 1060-1080 nm	

Keys of the equipment

IMPORTANT	**In the event of an incident, you must inform the carrier immediately, providing a list of all incidents encountered.** We recommend that you send photographs of the condition of the package to your LC Lasers technical and/or sales contact in order to resolve the issue and find a solution.

5.2 DELIVERY

All LC-WELD laser welding equipment is rigorously manufactured, checked, tested and approved by our technical and engineering staff prior to delivery: our strict quality control enables us to ship 100% operational and ready-to-work equipment. Ensuring that only qualified and fit-for-purpose laser equipment can be delivered.

On the other hand, it is always recommended to unpack the package very carefully, in order to reduce the possibility of any damage to the equipment. In section 5.4 a series of instructions for a correct unpacking of the package is provided.

Check the box for any damage due to careless handling or blows during transport.

5.3 INSPECTION ON DELIVERY

The package to be delivered is labelled with safety information for both the carrier and the recipient, but this does not necessarily guarantee correct handling. Check the outside of the box for obvious damage during transport.

IMPORTANT

Cautions:

- **It is of utmost importance that, as soon as we receive the package, we check whether the box or the laser equipment is damaged.**
- If you discover damage to the case or the laser machine during inspection, take photographs of the damaged parts.

5.4 UNPACKING THE PACKAGE

The use of a pallet truck is recommended for moving the machine to the place where it is to be unpacked. Always place the machine on a flat and stable surface.

IMPORTANT

When unpacking the package, our technical team always recommends using the right tools and personal protective equipment (PPE). In this way, we can guarantee a correct unpacking of the laser machine.

Overweight Injury Warnings

In order to avoid physical injury, never attempt to transport the package individually. The laser machine must be carried by at least two people.

Manual transport of the machine should be limited to a minimum time and distance. If long distance transport is required, material handling equipment should be used.

A list of product components is given in section 5.1. Check that all items are inside the box.

IMPORTANT

If any component or material from the list provided is missing, please contact LC Lasers. Under no circumstances should you attempt to operate the equipment if you notice any damage or malfunction or if any item is missing.

It is recommended to keep all packaging for any future storage or transport needs.

CHAPTER 6 - INSTALLATION

The laser welding machine is likely to be used most often by the welder, who has to perform welding as a large part of his job. It is also possible that a distributor or dealer will use the machine to demonstrate its operation to a third party.

Whatever the case may be, the operating steps described in this manual must be followed. This chapter details the first steps to be taken when you receive your new LC-WELD laser welding equipment. Please follow these instructions carefully when starting up the device for the first time and keep this manual handy for future reference regarding maintenance and operation of the device.

6.1 CAUTIONS

IMPORTANT

Damage to the welding system - incorrect voltage!

Before connecting the power supply, make sure that the voltage and wiring are correct!

Precautions:

- **Please refer to the specifications for the appropriate power supply requirements and/or consult LC technical service or an official distributor.**
- Make sure that the input voltage is equal to the level indicated in the specification (see section 6.1).

IMPORTANT

Use only in an environment with sufficient airflow to allow for the specified heat load produced during the intended operation of the equipment.

6.2 PREPARATION OF EQUIPMENT

When the equipment is received, it is important not to carry out any action without having read this manual carefully. In case of initial doubts, contact your technical service.

The following sections specify the different preparations necessary for the correct functioning and operation of the equipment.

6.2.1 ENVIRONMENTAL CONDITIONS

The equipment must be in an environment with a **reasonable temperature.** The suitable temperature range is **between 10ºC and 33ºC.**

6.2.2 ELECTRICAL CONNECTION

To make the connection to the electrical power supply, a 32 A single-phase electrical panel connector is supplied with the equipment. This connector must be connected as follows:

L1=Line voltage > L2/N=Neutral connection > PE=Grounding

Connect the equipment to the power supply with the cable provided with the equipment. Make sure that all connections are securely fastened, and that no connectors are loose.

Finally, operate the rear disconnector and switch on the machine normally.

IMPORTANT

Damage to the welding system - incorrect voltage!

Before connecting the power supply, make sure that the voltage and wiring are correct!

Precautions:

- **Please refer to the specifications for the appropriate power supply requirements and/or consult LC technical service or an official distributor.**
- **Make sure that the input voltage is equal to the level indicated in the specification (see section 6.1).**

6.2.3 GAS CONNECTION

The LC-WELD SMART laser welding machine requires gas for a good weld finish, as in other fusion metal joining techniques and methods.

The gas also protects some of the optical elements of the gun, so an internal sensor system **will not allow work to be carried out** if the equipment is not connected to a **pressurised gas system**.

The gases admitted for welding shall be high purity inert gases such as:

- Technical Argon.
- Nitrogen or Technical scourge.

The gas inlet is located at the rear of the unit, and the connection is made by means of a quick connector connected at the other end to the gas bottle with regulator or to the gas supply system if one is available.

The FLOW rate of gas supplied in welding is usually between **18L/min and 22 L/min**, the flow rate being variable to adapt it to the different types of work carried out.

IMPORTANT	**It is important to ALWAYS open the shielding gas supply before starting to work with the LC-WELD SMART laser welding device. Otherwise the control software itself will not allow work, as it will not detect any pressure in the system.**
DANGER	Positioning and fixing gas cylinders Gas cylinders can explode if damaged or placed near the welding area, causing injury and property damage. Injury and damage may also occur if the cylinder tips over. Precautions: - Gas cylinders must be protected and located in areas where they cannot be knocked or damaged. - Place them away from sources of heat, sparks or flames, as well as from the reflection of the laser beam. - The cylinder must be stored in an upright position and secured on a fixed support.

6.2.4 SAFETY, CAB AND SEMAPHORE

There are different safety systems on the LC-WELD SMART laser welding machine, such as the ground clamp and the LC-CABIN safety cabin system.

The ground clamp must ALWAYS be connected to the work table or, failing that, to the workpiece if it is too large to be placed on the table or if it has non-conductive parts. Details of its operation will be given later in this manual.

Connect the ground clamp to the welding table or to the workpiece to be worked on.

For safety and regulatory reasons, the LC-WELD SMARTdevice must be associated with a security locking system, to which the device must be connected.

This system should incorporate, at a minimum:

- Cabin made of suitable material.
- A system of sensors on the door(s), intended to interrupt the operation of the equipment if one or more doors are opened during the use of the equipment.
- An external traffic light, intended to indicate the status of the equipment inside the cab.
- In some territories, it is necessary to use door locking systems.

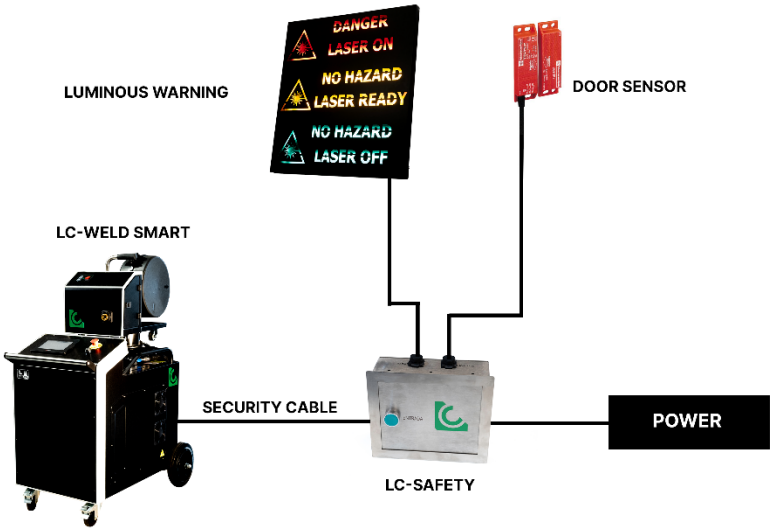
For the connection of the security system, cabin and traffic light, the connector located in the rear part will be used and the cable provided with the cabin will be connected to it. This cable is responsible for communicating the equipment with the control board of the car, and controls everything related to safety, both the door closing sensors and the traffic light.

NOTE: *The equipment will not allow work if the safety system is not connected to an LC-CABIN cabin. In case of non-installation of a safety system with LC-CABIN cabin, consult your dealer.*

6.2.4.1 LC WELD SMART CONNECTION TO THE LC SAFETY SYSTEM

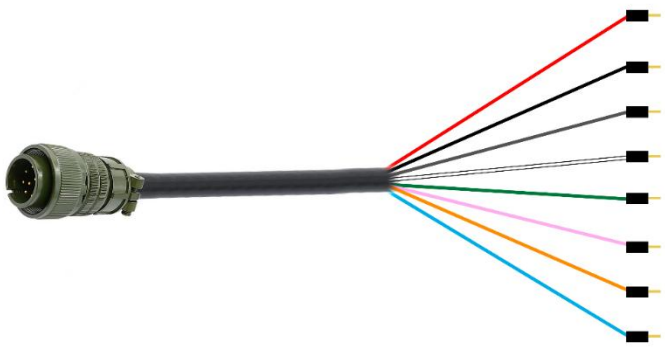
The LC SAFETY system is LC Lasers' own system for connecting the LC WELD SMART to an LC CABIN. LC SAFETY provides a safe and simple connection between the laser welding unit, the external traffic light and the cabin door sensor to prevent unexpected openings when the laser is active. The LC CABIN offers to form a laser safety zone to work safely with the equipment.

The following diagram summarizes the connection between the LC WELD SMART and the LC CABIN via the LC SAFETY system:



6.2.4.2 LC WELD SMART CONNECTION TO AN EXTERNAL SYSTEM

To connect to a system other than LC SAFETY itself, the following pin diagram must be followed:



PIN	LABEL NAME	COLOUR	SIGNAL
1	+24V	Web	24V SUPPLY
2	GND	Black	GND
3	+ITLK	Grey	ITLK +
4	RESET	White	RESET
5	L_RD	Green	LIGHT RED 24V
6	L_GN	Pink	LIGHT GREEN 24V
7	L_OG	Orange	LIGHT ORANGE 24V
8	AUX	Blue	RESERVE

- Pin 3 and 2 are for the door sensor.
- Pins 2, 5, 6, 7 are for the traffic light.
- Pin 4 is RESET FUNCTION.

6.2.5 CHILLING SYSTEM

The LC-WELD SMART manual laser welding equipment is gas cooled with gas type R32. The laser system already has autonomous temperature control.

If the device overheats, discontinue use and contact the Technical Assistance Service of your official distributor.

6.2.6 AIR OUTLET

At the front and rear are the cooling outlets of the equipment; it is recommended that the equipment is not too close to a wall or a surface that impedes good ventilation.

IMPORTANT	**Once the equipment is ready for welding and/or transport is not required, it is essential and mandatory to brake the wheels by using the brakes on the wheels.**

CHAPTER 7 - USE OF EQUIPMENT

Any user of the LC-WELD SMART equipment must follow the operating and safety steps described in this manual. The operating instructions are essential for the proper use and maintenance of the equipment.

Before using the equipment, as mentioned in the previous chapter, it is necessary to carry out all the necessary checks, summarised below:

- When the equipment is received, it is important not to carry out any action without having read this manual carefully. In case of initial doubts, contact the technical service.

- The equipment should be in an environment with a **reasonable temperature**, suitable temperatures would be **between 10ºC and 33ºC**.

- Properly connect the equipment to **the mains power supply** with the specified parameters.

- Properly connect the equipment to **a gas bottle or gas supply system** at the indicated flow rate (18-22 L/min).

- Properly connect **the ground clamp to the** work table or the workpiece to be worked on.

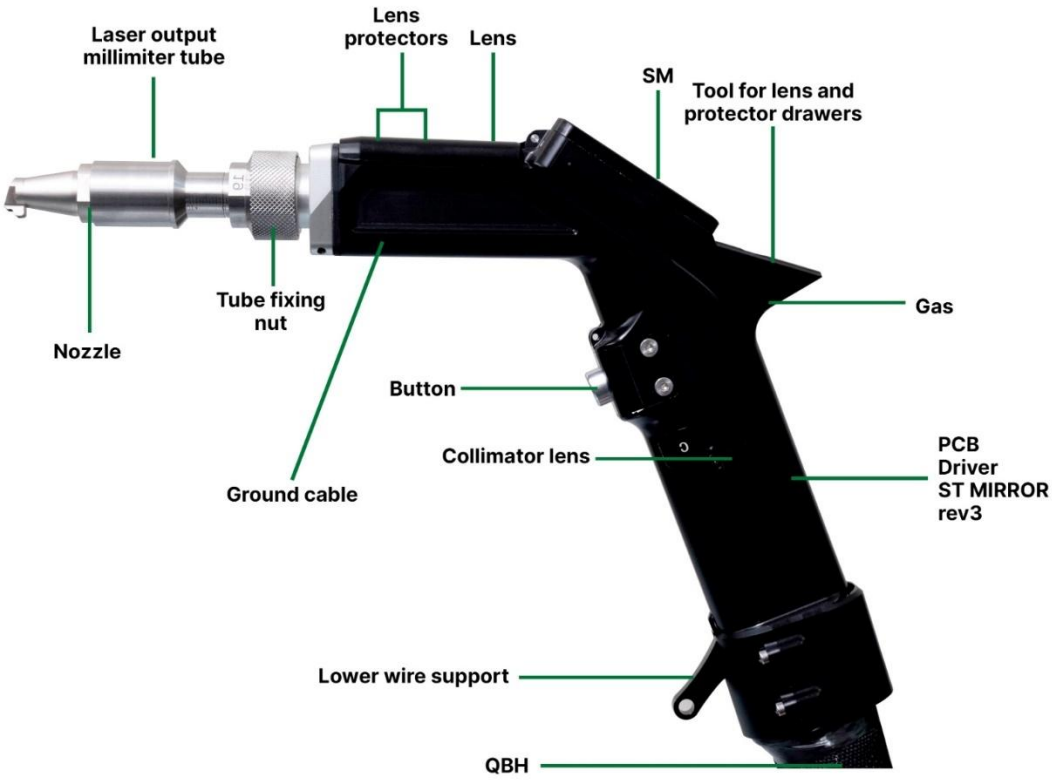
- Properly connect the equipment to the **LC-CABIN security system.**

- Make sure that the upper part where the equipment is ventilated is not obstructed and the ventilation system works correctly.

- Once the equipment is prepared for welding or its transportation is not required, the wheels must be blocked using the brakes on them.

This chapter details the different components of the equipment, as well as their function and use.

7.1 GUN: PARTS, COMPONENTS AND OPERATION



To remove the lens protectors, lens and collimator lens, the gun incorporates a tool. This supplied tool located on the back of the laser gun is equipped with a threaded section and another allen type. One m2.5 threaded end to remove the optical drawers, and two others with a 1.5mm and 2mm Allen type tip to release the retaining ring from the protectors or the lens.

In case this part is lost or missing, the following tools can be used:

- Screw with M2.5 thread
- Allen of M1.5 and M2

7.1.1 "GROUND" CLAMP

The LC-WELD SMART laser welding unit incorporates a direct contact safety system, similar to the ground clamp used in electric arc welding systems.

However, this clamp is not a mass as such: it does not cause an electric arc, as the LC-WELD SMART laser welding system melts the material by light incision, not by electric arc.

This clamp provides one of the main safety systems incorporated in the LC-WELD laser welding equipment, as the control system does NOT allow the equipment to operate if the welding gun or the welding wire is not in contact with the material to be welded.

The ground clamp must ALWAYS be connected to the workbench or, failing that, to the workpiece if it is too large to be placed on the workbench or has non-conductive parts.

For this purpose, it must be ensured that the welding table to be used or the surface on which the clamp is placed is metallic and conductive, in order to facilitate the correct connection between the clamp and the gun.

The "ground" clamp is connected to the equipment by means of a suitably labelled connector on the rear.

Reference Code No. (10103-00030)

7.1.2 QBH

The QBH is the system used to connect the fibre optic head coming out of the laser resonator to the gun. It is a special connector, and must always be properly connected, otherwise the control software will trigger an alarm and will not allow the LC-WELD laser welding equipment to operate.

To connect it correctly, a specific sequence of movements must be carried out (see chapter 11 of MAINTENANCE).

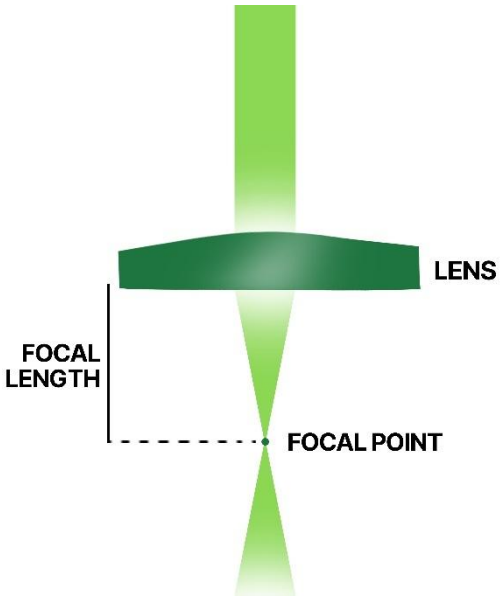
7.1.3 STEERING MIRROR SYSTEM

The new technology developed by LC Lasers, the Steering Mirror (SM), consists of a mirror that oscillates between the various axes by means of magnets to guide the laser beam outwards and perform laser welding.

INFORMATIVE NOTE: Access to the SM system **is subject to the guarantee of the gun**, and it is therefore **forbidden to** manipulate this access without the authorization of LC Lasers technical service.

7.1.4 FOCAL LENS

Located before the lens protector, its function is to concentrate the light beam coming from the collimator in an "hourglass" shape.



The focal point is the place where the power of the laser beam is most concentrated, and therefore the optimum point for welding. Therefore: always make sure that the point of incision of the laser in the material coincides with the focal point, for maximum effectiveness of the laser beam.

To find the focal length see POINT 7.5 .

The lens is housed inside a drawer on the top of the gun, marked with a letter L.

Use the tool supplied with the gun to loosen the drawer. If this part is lost or missing, the following tools can be used:

- Screw with M2.5 thread
- Allen of M1.5 and M2

The drawer that houses the lens is secured with a stud bolt inside, which holds the protector in place, and features a hole that makes it easy to engage and disengage the drawer. To remove the drawers, use the threaded part of the tool to pull them out. Carefully remove the drawer from the hole and, using the tool provided, unscrew the stud bolt. This will release the lens from the drawer, allowing you to change the lens. To change the lens, the metal ring above the lens must also be removed.

Once you have placed the new guard on the drawer, replace the ring and fix it again with the stud bolt. Place the drawer back into its corresponding hole and fit it into the gun. The drawers have a magnet part which makes them easier to fix.

LC reference code: 11001-00002

7.1.5 SIRGA

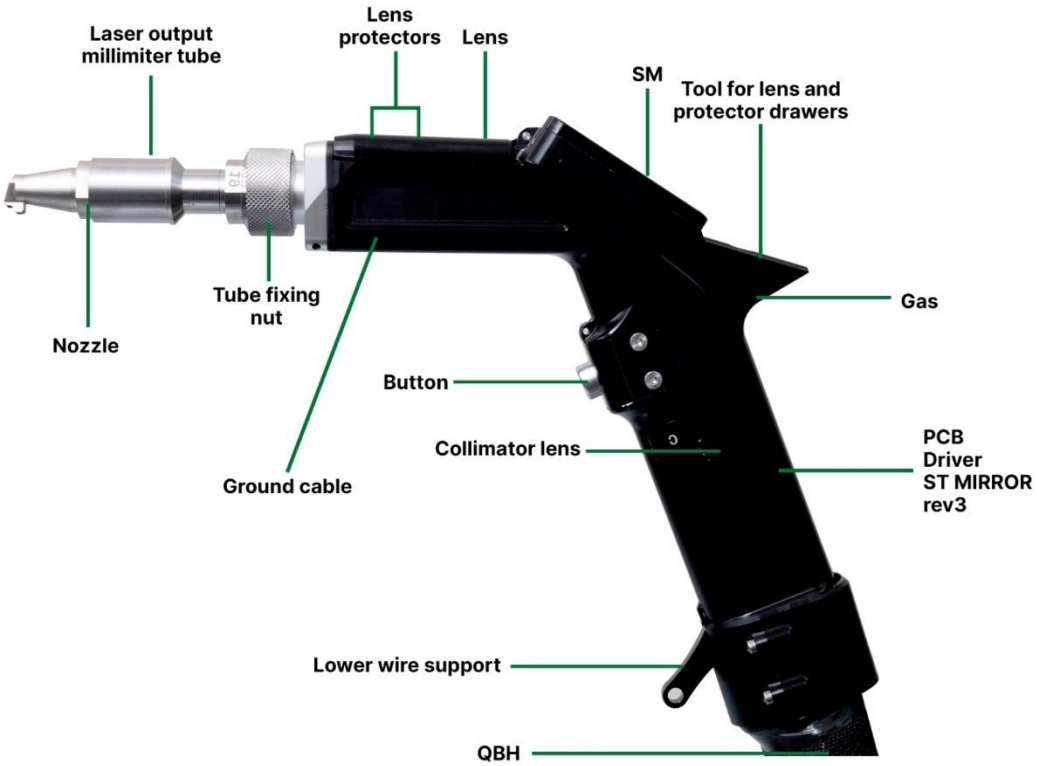
The wire guide line, coming from the feeder, consists of a rubber sheath and a *graphite* line inside.

At the end, the rope should protrude about 20cm more than the rubber sheath.

For wire-feed welding, the wire rope must be attached to the wire-feed fitting supplied by LC in the enclosed accessory box.

7.1.6 LENS PROTECTORS

Lens protectors are one of the consumable parts of the LC-WELD laser welding equipment. There are two lens protectors housed in two drawers on the top of the gun.



The protectors are housed in the two drawers marked with the letter P.

This shield, as its name suggests, is specially designed to allow the laser beam to pass outwards and not inwards, when it comes from bounce or refraction.

This protects the lens from possible pitting and damage caused by rebound or refraction and also from possible micro projections that could settle on the lens itself.

The lens protector should always be kept as clean as possible, checked periodically and replaced if necessary.

The lens protectors for this gun are located in two removable drawers on the top of the gun.

Reference Code No. 11001-00003.

Use the tool supplied with the gun to loosen the drawer. If this part is lost or not available, the following tools can be used:

- Screw with M2.5 thread
- Allen M1.5 and M2

The drawer that houses the protectors is secured with a stud screw inside, which holds the protector in place, and has a hole that makes it easy to attach and detach the drawer. To remove the drawers, use the threaded part of the tool to remove them. Carefully remove the drawer from the hole and, using the tool provided, unscrew the stud screw. This will release the lens protector from the drawer, allowing you to make the change. To change the protector, you must also remove the metal ring placed on top of the protector.

Once you have placed the new protector in the drawer, replace the ring and secure it again with the stud screw. Place the drawer back into its corresponding hole and attach it to the gun. The drawers have a magnet part that makes them easy to fix.

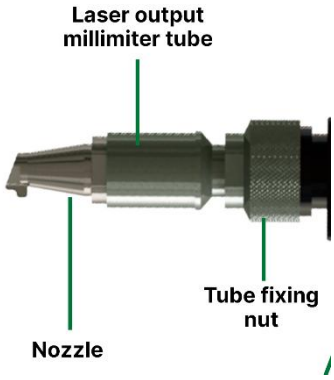
7.1.7 GAS IN THE GUN

The gas enters at the rear of the gun where the driver is located and through a fitting it reaches the tip of the gun to supply gas for welding.

7.1.8 WELDING PIPE

This is the metal tube marked with millimeters. This tube allows the laser beam and shielding gas to exit and also houses the nozzle at the outermost end of the tube.

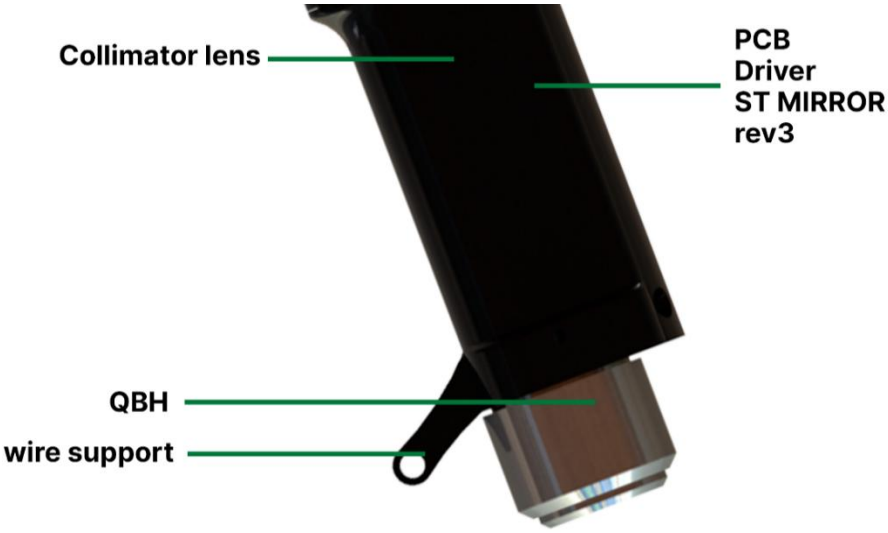
The tube is equipped with a threaded fastening for easy removal and fixing.



The millimetre markings on the tube will help to find the focal length of our laser welding equipment (SEE ITEM 7.5).

7.1.9 COLLIMATOR LENS

In the pistol grip there is a drawer with the collimator lens. This lens concentrates the laser beam coming from the source to the focal lens of the gun.



The collimator lens is fitted inside the next drawer with the letter C that is fixed with a screw:

This lens is surrounded by a metal ring as the lens protector and the lens.

7.1.10 NOZZLES

The nozzles are the element that will provide direct contact with the welding material or filler wire.

They are considered as positioners, as they provide comfort and the correct positioning of the gun in different types of welding, with or without material contribution (welding wire).

The material of these nozzles is copper with a nickel plating to ensure maximum strength and durability.

There are different shapes, which are divided into nozzles for work **WITH** material **supply** and nozzles for work **WITHOUT** material **supply:**

7.1.10.1 GROOVED NOZZLES FOR WELDING WITH MATERIAL SUPPLY

There are 4 sizes for the 4 welding wire diameters compatible with the LC-WELD laser welding equipment: 0.8mm, 1mm, 1.2mm and 1.6mm. See point 9.2 for 'Choice of welding nozzles'.

LC reference codes:

10901-00110	Nozzle FE Closed 0,8" nozzle	
10901-00111	Nozzle FE Closed 1,0" input	
10901-00112	Nozzle FE Closed 1.2" (1.2")	
10901-00113	Nozzle FE Closed 1,6" nozzle	
10901-00114	Nozzle AL Open 0,8" input	
10901-00115	Nozzle AL Open 1.0" input	
10901-00116	Nozzle AL Open 1,2" input	

10901-00117	Nozzle AL Open 1.6" input	
10901-00205	Double thread input nozzle 1.2mm	
10901-00206	Double thread input nozzle 1.6mm	

These nozzles have a machined channel through which the wire will be guided in the direction of the laser beam, thus favoring the rigidity and centering of the wire. Each size has a channel of a different width for the different wire diameters allowed.

7.1.10.2 NOZZLES FOR WORK WITHOUT MATERIAL INPUT:

- **Short fork for flat welds and inside corners without material input.**

Its design facilitates the work on butt welds. The space in the middle facilitates the passage of any welding points made for the first clamping of the workpiece in its optimum position.

It usually requires a guide to make welds as straight as possible.

- **Long fork for welding outside corners without material input.**

Its design makes it easy to work on outside corner welds.

The larger space between the two tips allows the corner to pass optimally inside the nozzle, making it easier to position in this type of welding.

10901-00118	Short inner SA nozzle	
10901-00119	Long outer SA nozzle	

7.1.9.3 NOZZLES FOR CLEANING

With the same welding equipment, laser cleaning work can be carried out.

To carry out laser cleaning work, we must use the part of the software prepared to configure the cleaning parameters (see point 8.4.1.1.1 CLEANING AND POINT).

The nozzles to be used for laser cleaning work are the SHORT INSIDE SA NOZZLE (10901-00118).

7.2 ROLLERS

The welding wire feeder has different types of rollers:

For aluminium :

NAME	LC REFERENCE	REPRESENTATIVE PICTURE
Rollers AL 0,8-1,6 SF	10701-00090	
Rollers AL 1,2-1,6 SF	10701-00089	

For ferritics:

NAME	LC REFERENCE	REPRESENTATIVE PICTURE
Rollers HI 0,8-1,0 SF	10701-00092	
Rollers HI 1,2-1,6 SF	10701-00091	

7.3 SWITCHING THE EQUIPMENT ON AND OFF

In order to switch on the LC-WELD SMART laser welding device correctly, the following steps must be followed:

1. Make sure that all connections have been made for proper installation (see Chapter 6):
   a) Electrical connection
   b) Connection to gas supply
   c) Connection of the ground clamp
   d) Connection of the safety system LC-CABIN
2. Make sure that the doors of the LC-CABIN are properly closed and secured.
3. Make sure that the red emergency switch is not tripped. If it is tripped, turn it clockwise to release it.
4. Activate the disconnector located at the rear of the equipment by turning it clockwise.
5. Turn the key switch on the front of the unit clockwise to the ON position.
6. The display will become active. Wait for the CPU of the system controller to become fully active (approximately 50 seconds).
7. Enter your username and password to access the equipment control system.
8. Once in the options menu, select 'START'. Activate the chiller and the laser resonator.
9. As soon as the green "system ready" indicator appears, the device is ready for use.

!	IMPORTANT	**Before switching on the equipment, make sure that the emergency switch (mushroom) is released, otherwise the equipment will not switch on.**
!	IMPORTANT	Before operating the LC-WELD laser welding equipment, we must wait for the control software to indicate that the system is ready by means of the "system ready" indicator.
⚠	**DANGER**	All electrical connections must be connected before applying power to the unit.
⚠	**DANGER**	Ensure that all persons around operating laser equipment wear personal protective equipment (PPE) while in use. This includes specified laser safety glasses, mask, gloves, welding clothing. - Ensure that all power is removed from the laser when handling the fibre cable. The minimum bend radius allowed is 150mm.

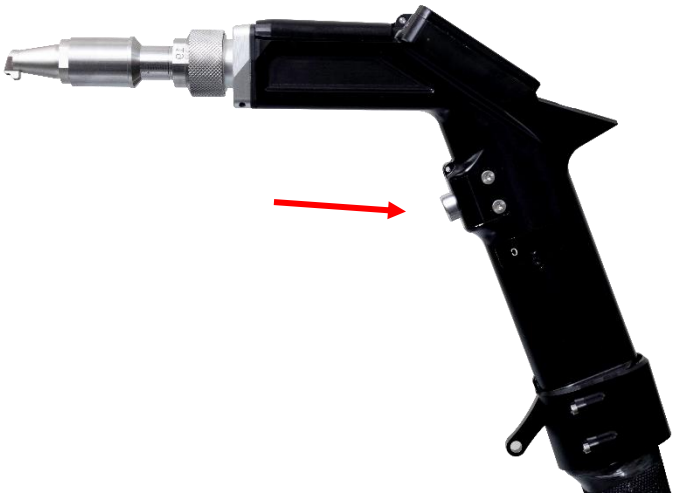
To switch off the LC-WELD SMART laser welding device, simply follow the above steps in reverse order:

1. Turn the key anticlockwise.
2. Deactivate the disconnector at the rear of the unit by turning it anticlockwise.
3. Shut off the gas system to avoid possible leaks.

7.4 SWITCHING THE GUN ON AND OFF

The laser gun is activated with the button on the top of the gun handle (trigger). When the trigger is pulled, if everything is in proper working order and the tip of the gun is in contact with the workpiece or welding material, the laser beam will be emitted to work.

It is intended to be activated with the gun held firmly in the preferred hand and by pressing with the index finger. Ignition will not occur if the gun is not in contact with the material.

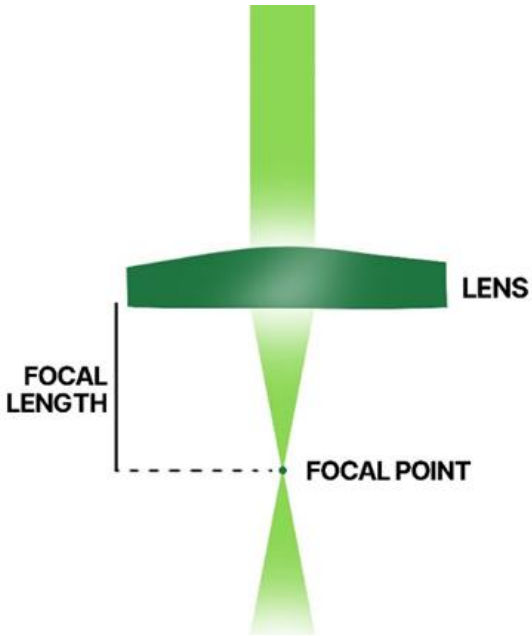


DANGER	**It is forbidden to operate the gun without being in contact with the material or the welding table.** **It is TOTALLY FORBIDDEN to use the mass directly in the welding gun.** **In welding mode, without making contact with the ground, if the trigger is pressed, the welding wire will come out at the programmed welding speed.** **Precautions:** - **Correct use of the dough is mandatory.** - **The gun must never be operated if it is not in contact with the material.**
DANGER	It is mandatory to aim the gun correctly in the direction of the material to be processed. Never point the gun in the direction of people, objects and/or animals.

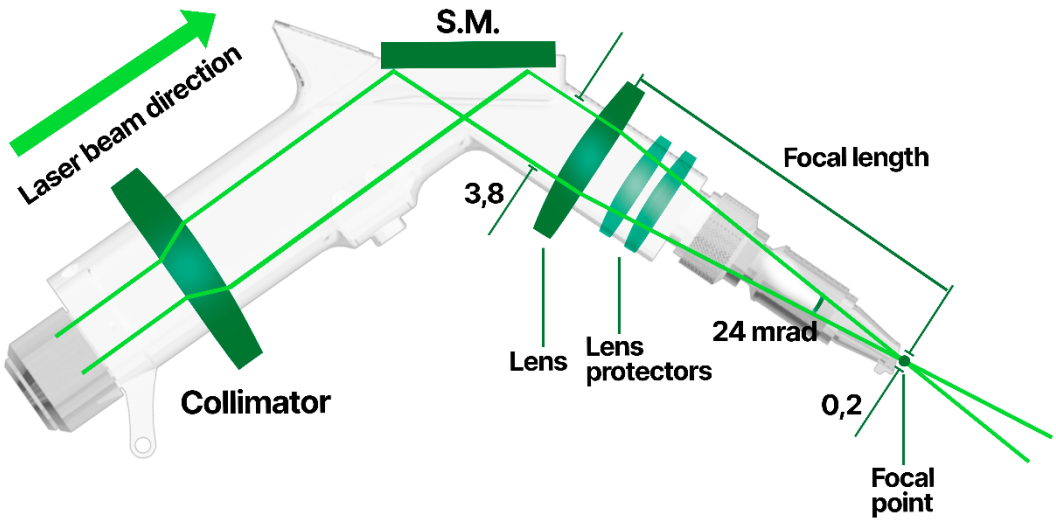
7.5 FOCAL LENGTH

As previously mentioned, the laser beam emerges from the collimator as a uniform, parallel beam. The main function of the lens is to concentrate this beam into a tiny spot, similar to the shape of an hourglass.

The center point of this 'hourglass' pattern is where the beam energy is maximally concentrated. Adjusting the laser and gas output tube is essential to ensure that this point coincides with the welding point, thus guaranteeing optimum energy input for the welding process. The welding distance (DS) indicates at which point the laser output tube should be adjusted as detailed below.

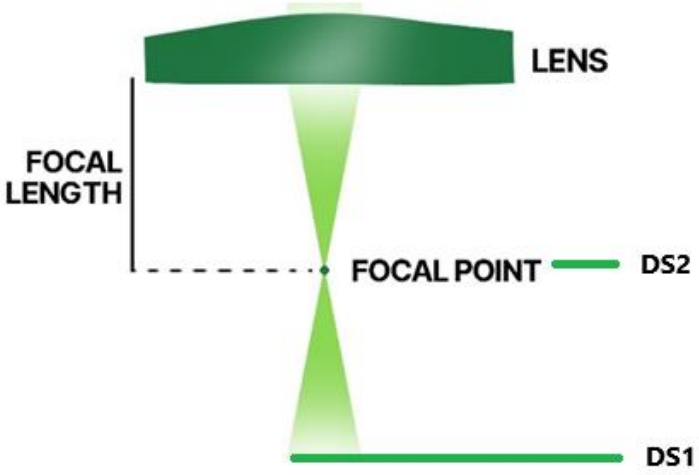


The focal length, which determines this welding point, is usually located at approximately + or - 150 mm from the lens, although this measurement may vary.

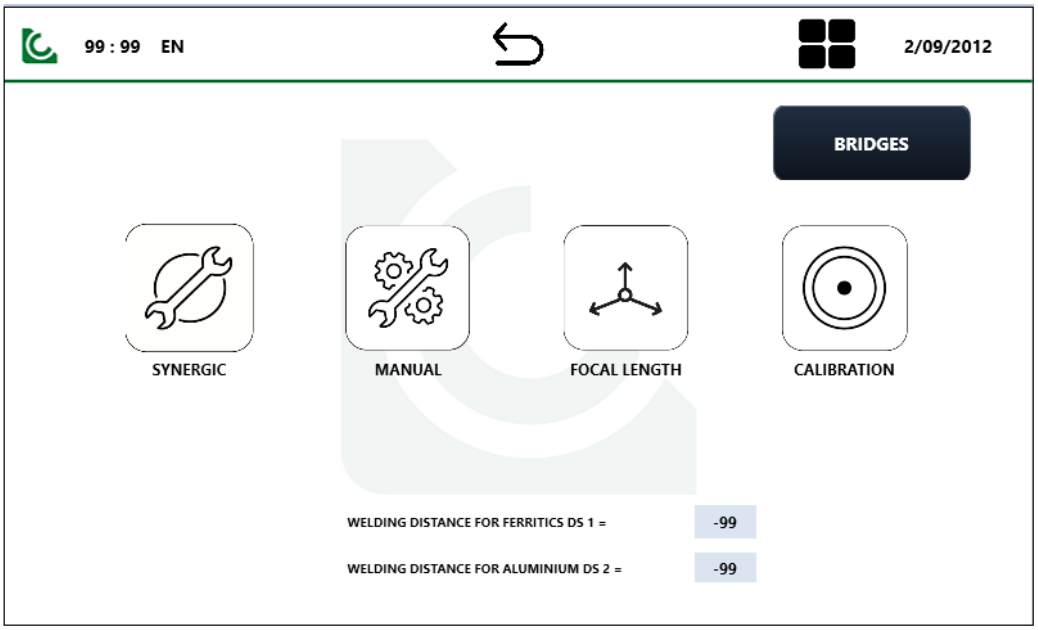


For a good welding job, two WELDING DISTANCE values have been defined:

- **DS1** – Welding distance for FERRITIC materials (approx. FOCAL LENGTH +8mm)
- **DS2** – Welding distance for ALUMINUM (similar to FOCAL LENGTH)



Each of our equipment includes a quality control certificate that details the two factory welding distances DS1 and DS2 obtained during said control. These are included in the equipment's own SW on the JOBs screen.



This focal length shall be adjusted only by using the measuring scale engraved on the threaded tube of the gun tip.

The different nozzles have been designed to maintain the correct distance and adjust to the set focal length. Once the focal length has been defined, the nozzles can be

interchanged according to the type of work to be carried out, without the need to make additional adjustments in relation to the focal length.

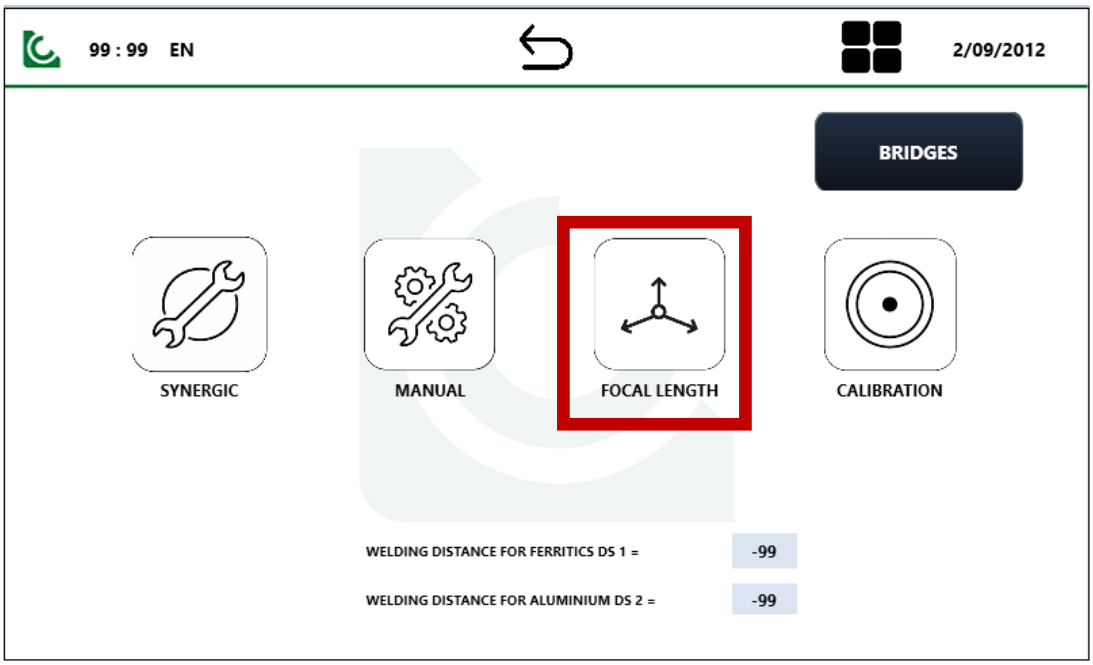
IMPORTANT	**It is important to note that the focal length may change over time due to various factors. If a change in focal length is detected or difficulties in finding the focal length are encountered, it is essential to contact the Technical Support Service of the official distributor.**

7.5.1 CALCULATION OF THE FOCAL LENGTH

Since the focal length can vary, it is essential to have an easy and objective method to find it. To do so, follow the steps described below and use the tools designed for this purpose:

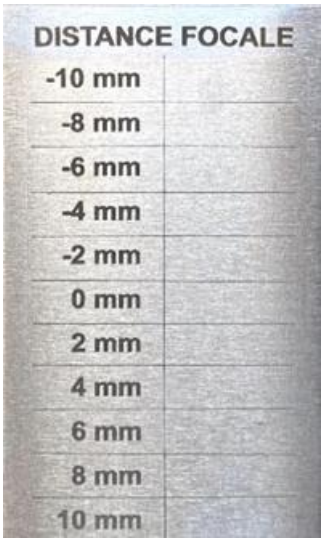
- Focal length functionality of our equipment.
- Sample tube.

Step 1: Access the specific functionality for the calculation of the focal length. It is located in the WORK menú.



Step 2: Prepare the test pieces intended for calculating the focal length or, failing that, a 1.5mm thick aluminum plate on which the laser can be shot. In this way, the correct laser beam power at the appropriate focal length can be checked and found. On this plate the different points will be made at different length settings (-10mm to +10mm) and then the power of the laser will be checked.

DISTANCE FOCALE	
-10 mm	
-8 mm	
-6 mm	
-4 mm	
-2 mm	
0 mm	
2 mm	
4 mm	
6 mm	
8 mm	
10 mm	

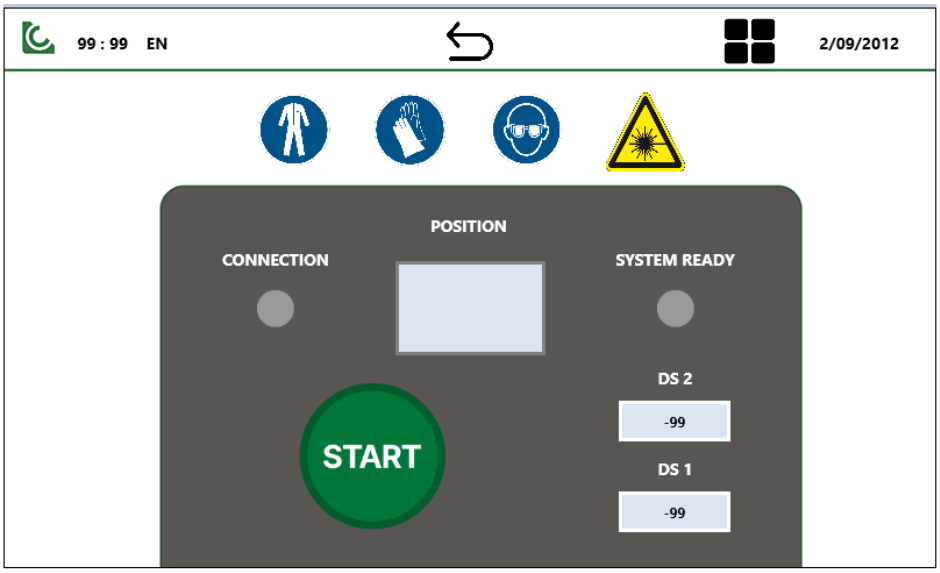


IMPORTANT **It is essential to use an ALUMINIUM sample for the calculation of the focal length, as this material provides more reliable results due to its properties.**

Step 3: Once you are ready to weld, start the procedure through the program by pressing the START button on the screen.

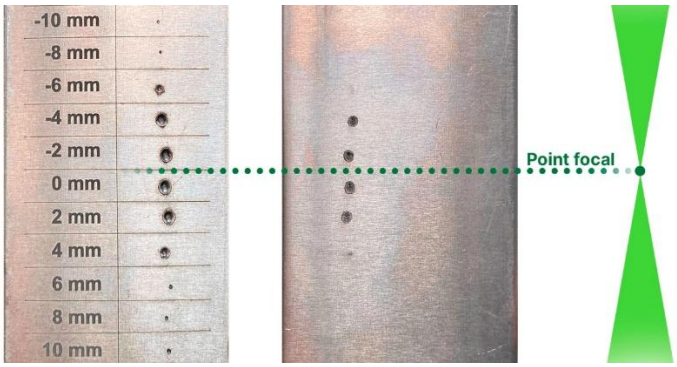
The procedure shall consist of a series of **predefined shots at different focal positions**.

The equipment will indicate on the square of the screen the position of the threaded tube (-10mm, -8mm, etc) which the user must adjust before each shot in an aluminum piece.



When all is ready, fire in the appropriate box of the flask being used.

Once the procedure is completed, a shot scale will be obtained which will facilitate the deduction of the focal length. This will be achieved by observing and analysing the results obtained as can be seen in the example below:



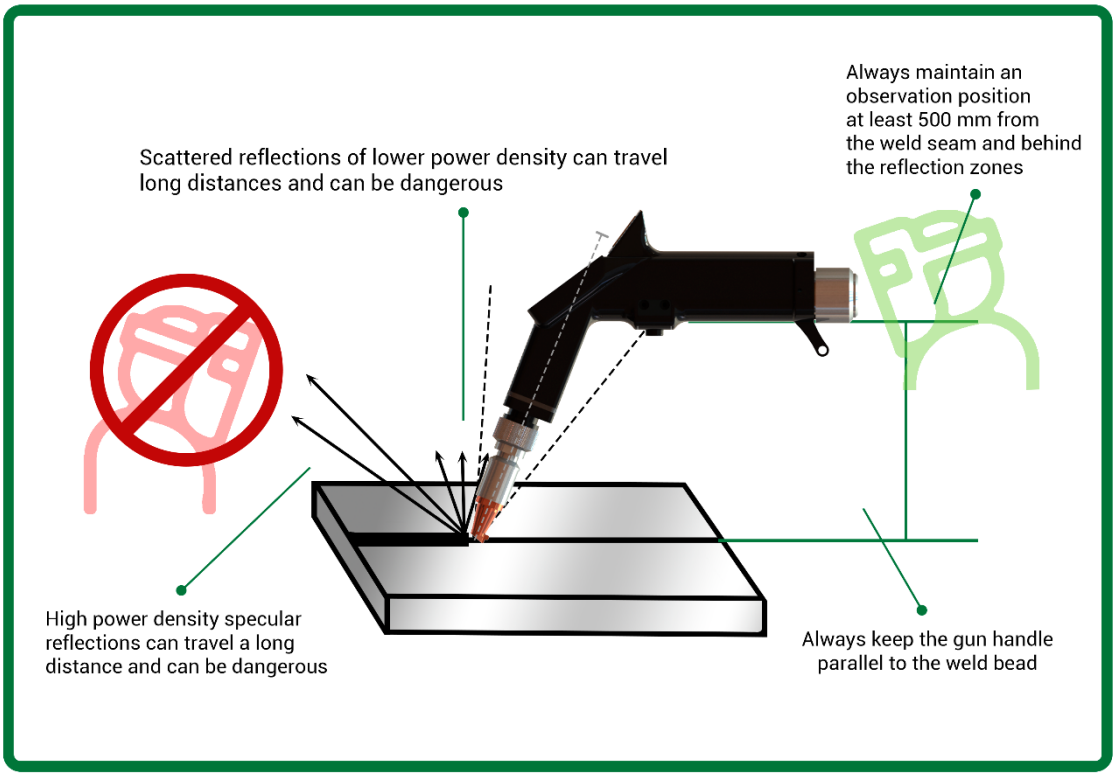
Step 4: Once the optimal focal length has been determined through the procedure described above, the values DS2 (focal length value) and DS1 (focal length value +8mm) can be entered into the focal length screen.

This step will ensure that the welding is done accurately and effectively, making the most of the focal length settings for optimal results.

With this focal length system, the focal length will not vary when changing nozzles since the shape of the nozzles has been adapted to do so. The configuration allows the nozzles to be replaced depending on the type of welding to be carried out without changing the position of the laser output tube because the dimensions of the nozzles automatically compensate for this variation, allowing you to always work with the correct focal length.

7.6 POSITIONING

In order to weld correctly with the LC-WELD laser welding equipment, we must maintain a specific position in relation to the area to be welded.



For flat welds, the gun handle must be kept parallel to the weld bead to prevent the laser beam from bouncing back into the laser and gas outlet tube, which could damage the lens protector and the different optical elements of the gun.

For welding inside corners, the gun must be kept parallel to the weld bead, but the position must also be maintained at 45º to the horizontal axis.

For welds in external corners, the principle is the same: and also, always seek to impact half of the angle described by the two parts.

IMPORTANT	**It is recommended to keep the handle flat and parallel to the material for proper welding.**
IMPORTANT	It is VERY IMPORTANT to maintain the position throughout the welding process, taking care NOT to VARY the angle or direction of the gun, so as not to adversely affect the result.

7.7 WELDING

The LC-WELD SMART laser welding unit can weld with or without material input. When welding WITH welding material, the welding is carried out with standard welding wire of the desired material (see section 3.4.1).

In the case of NO filler welds, the surfaces to be welded are melted so that they are joined together without the addition of extra material.

7.7.1 WELDING WITH FILLING MATERIAL

In welding WITH filling material, the surfaces to be welded are melted together and material is added to fill small gaps or spaces.

There are only two types of nozzles available for the welding with filler wire, for welding in all positions and for welding in the outside corner. There are 4 different sizes of nozzles to choose from, one for each wire diameter, 0.8, 1, 1.2, 1.6. The nozzles are grooved nozzles, and the groove is used to guide the wire towards the centre of the laser beam.

The final quality of the laser weld depends significantly on an adequate wire thrust. The particularity of this method is that the gun directs and defines the welding speed, generating regular and precise beads.

Problems with wire feed can result in no wire feed or irregular movements, causing defective and unaesthetic welds.

These problems often occur with specific materials such as aluminum and 1.6 mm ferritic materials over long distances or in awkward positions.

7.7.1.1 THREAD SETTINGS

In order to operate the LC-WELD SMART laser welding machine with material feed, a welding nozzle must first be installed, choosing a size that is compatible with the diameter of the welding wire to be used.

The nozzle must be positioned with the channel at the bottom, where the welding wire will exit, in order to guide it correctly.

7.7.1.2 INSTALLATION AND CONNECTION OF THE WIRE FEEDER

To use the wire feeder supplied with the LC-WELD laser welding equipment, the wire rope must first be installed.

The wire rope has a standard MIG-MAG type wire feeder connector at one end. This connector must be inserted in the correct position (front of the wire feeder) and screwed in completely.

To connect the feeder to the equipment, simply connect the cable provided from the back of the feeder to the back of the equipment.

To finish, place the spool of welding wire on the feeder shaft, tighten the spool clamp, take the tip of the wire and feed it through the wire guide into the rollers. Make sure that

the wire passes through all tubes and holes. When the end of the thread is already inside the towline, lower and lock the pressers, adjusting the pressure if necessary (recommended pressure = 2).

Make sure that the feeder switch is in the ON position (I), and the equipment is switched on and with an active user.

By pressing the button " ▲ " continuously, the wire will advance rapidly. Keep it pressed until the welding wire comes out of the tip of the wire rope.

Once the thread comes out of the end of the hose, insert it into the pipe of the fitting until the hose is fixed with the quick release coupling.

IMPORTANT	**If you place the wire rope in the hose before the wire is completely passed through, the wire may get caught in the metal tip, in which case the welding wire may wrinkle at the feeder outlet.**
IMPORTANT	It is compulsory to change the thread spool and/or the rollers with the machine OFF.

7.7.1.3 CONNECTING THE FEEDER TO THE GUN

In order to connect the wire feeder to the gun, the line supplied with the equipment must be connected to the power supply by means of a quick-connect fitting.

Once the welding wire has been inserted, a metal tip compatible with the wire diameter chosen must be selected and screwed onto the tip of the feed pipe.

The welding fixture is attached to the gun by fitting it to the outside of the laser and gas outlet tube by means of a snap ring and tightening it with a hexagonal screw.

7.7.1.4 STEP-BY-STEP THREAD ADJUSTMENTS

The thread pusher system basically consists of 4 parts which we will describe below:

- **Coil**
- **Motor**: consists of 4 drive rollers for aluminium and 2 for other materials, with an encoder that adjusts the power to maintain the set speed.
- **Sleeve**: allows the thread to be guided to the gun.

- **Gun application**: This system allows the wire to be guided and acts as a junction between the sheath and the welding nozzle channel.

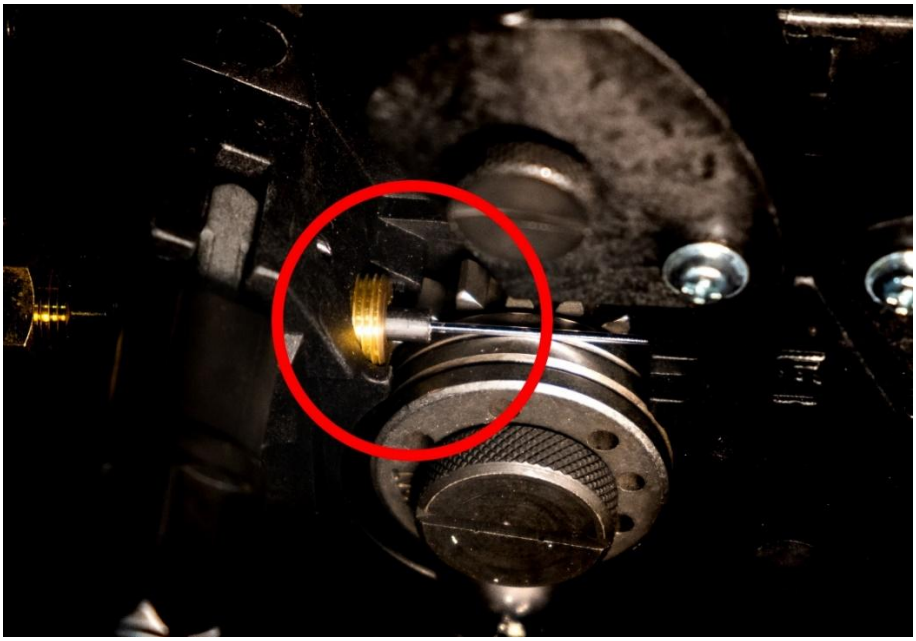
The method for adjusting and/or verifying step-by-step all components of the thread-pusher system is as follows:

1- **Motor:** the correct roller pressure is 2, and this should be sufficient for any material and with a maximum length of 4 metres.

It is not possible to have any thread rubbing problems before this element.

!	IMPORTANT	**It is essential to assemble the aluminum kit with the 4 traction rollers to guarantee a good push of the aluminum wire.**

2- **Sleeve:** Visual check of the yarn sleeve, which should be visible from the inside of the winder and should be as close as possible to the rollers (without rubbing against them).



	IMPORTANT	**In case of any problems with the thread's contribution, this is a key inspection point that will allow us to easily rule out problems.**

It is not recommended in any case to exceed a distance of 4 metres (and it is recommended to reduce this distance if using wires with a diameter of 1 mm or less).

The inside of the sheath may not have any problems with the wire, although the wire may rub more or less on the inside of the sheath depending on its diameter, the length of the wire and the welding positions.

3- **Spray gun application:** this is the part where there are usually the most problems with rubbing and which requires the most precision in the adjustment.

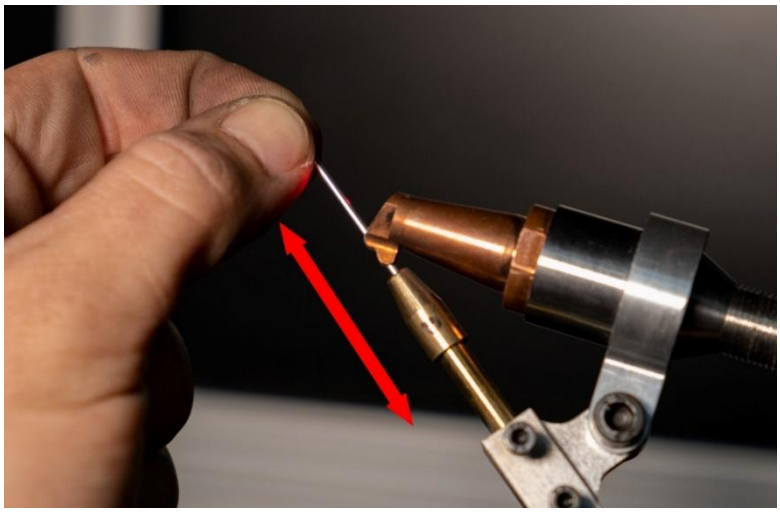
The appliqué must be correctly adjusted to allow the thread to pass through the channel without excessive rubbing. As a check, the thread should be parallel to the channel, otherwise the thread will rub excessively against the inlet or outlet edges of the channel and this may cause thrust problems.

To adjust this fixture, loosen the large screw on the side of the fixture, put the gun in a comfortable position that allows you to see the position of the thread at the same time, adjust/move the fixture and tighten the screw.

This is usually done with the gun face up on a table, and if there is no table at the welding site between the legs face up.

Once we have correctly positioned the applique and the thread is correctly centred in the channel, we can proceed to tighten the screw again and make a final check to make sure that the thread is correctly adjusted.

The thread should be easy to move with the fingers and if not, it should be re-tightened.



IMPORTANT

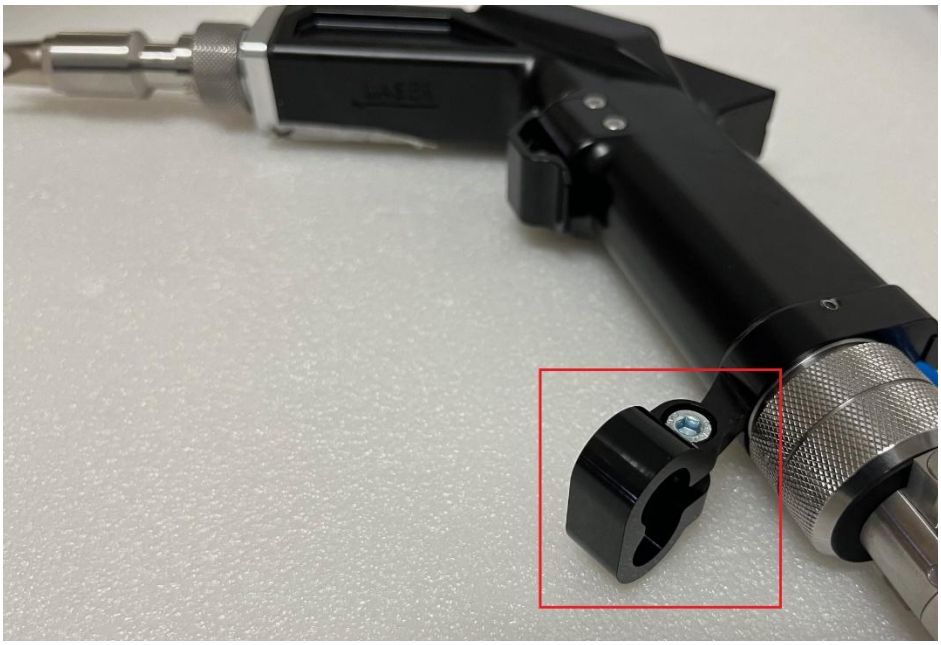
Performing this check regularly is key to ensuring good wire pull. Remember that wire rubbing may depend on the welding position, and the wire may be hot during welding!

For the DOUBLE TRACK model:

The included cable [10401-00026] is the same as the one used with the single feeder. The same **connection cable** can be replaced or used.

Gun Preparation:

- Replace the "Lower tow support" with the double contribution "[10901-00207]".



- **Assemble the "Double Filler Nozzle** [10901-00205]" with the " Brass Tow Guide Tube [10901-00071]" and "Quick Tow Fitting [10203-00010]". Replace the nozzle on the LC-HEAD.

- Place the two spools of thread in their compartment and put the **set of pulleys** according to the **size and thread material.**
- **Connect the two towlinks** on the side of the scart connector, start the machine and using the forward/reverse buttons on the feeder, **pass the wire** until it **protrudes 15-20cm from the towpath.**
- Thread the thread through the nozzle tubes. When inserting the **second** thread into the nozzle it can offer resistance or jam, that is why **we recommend passing the thread before fixing the towpath** with the "Quick Rope Fitting [10203-00010]"
- Check that the **laser pointer** is in the middle of the two wires. **It must be centered.**
- At this point the machine is ready to run on double wire. At the parameter level, it is advisable to **slightly increase the laser power** compared to the single-wire parameters.

In conclusion, these are the important points of this process:

- **Recommended roller pressure**: 2
- In case of aluminium, use U-grooved rollers and connection kit with upper drive rollers.
- **Visual inspection of the sheath**: the yarn sheath should be visible coming out of the rope inside the winder: this will allow us in case of problems to make a quick visual inspection and rule out some problems.
- **Precise adjustment of the thread passage through the feed nozzle channel and subsequent verification after adjustment**

7.7.1.5 OPERATION

To operate the LC-WELD laser welding equipment with wire feed, you must centre the wire and nozzle, and ensure that the wire is seated in the existing channel in the nozzle.

The thread must be cut so that the tip coincides with the red pointer and, if this does not coincide exactly with the thread, move the pointer with the target located on the parameterisation screen by pressing the icon and moving the pointer sideways to make them coincide.

DANGER

Never shoot WITHOUT THE PRESENCE OF THE RED DOT.

Once these steps are completed, the gun is ready for operation.

When welding with filler, we must ensure that the tip of the welding wire makes contact with the welding shaft, but not the nozzle or the welding wire outlet tube.

The ideal positioning of the gun must be observed (section 7.6).

Once correctly positioned, press the gun power button (trigger).

When the equipment starts welding, you will notice that the wire, as it exits the wire feeder and feed tube, **pushes** the gun backwards. It is **VERY IMPORTANT to** follow this push while pressing lightly in the direction of the welding axis to ensure a uniform result.

IMPORTANT

Unlike other conventional types of welding, with LC-WELD SMART manual laser welding, it is the machine that controls the welding, not the operator: with the same set-up, if the position and thrust tracking requirements are met, anyone can weld the same weld bead, regardless of the welder's technique or experience.

7.7.1.6 FEEDER CONFIGURATION TIPS AND PARAMETERS

Manual laser welding WITH wire feed is very easy to operate, just follow some of the tips below:

- To end a welding seam, a specific gesture must be made, raising or lowering the gun, depending on the type of work carried out, a few thousandths of a second after releasing the gun activation button (trigger), to prevent the wire from sticking to the gun.
- If the welding wire sticks to the welding bead, simply focus the red pointer on the tip of the welding wire and fire a short shot while pulling the gun.
- Apply light pressure in the direction of the welding shaft to guide the wire into position and force it to push the weld.
- It is recommended to make use of the 'Burn Out' parameter.

7.7.1.7 TROUBLESHOOTING THREAD THRUST PROBLEMS

Wire guide exit cover:

The occurrence of this problem probably indicates significant fretting somewhere in the system that has not been resolved. In attempting to remedy this, the increased pressure on the pusher rollers may have caused other problems. In addition, it is possible that it is the result of an incorrect fit in the part that holds the thread sheath to the towline.

Presence of aluminium dust as the wire advances:

This phenomenon indicates excessive friction between the yarn and the nozzle, usually caused by an incorrect angle of the yarn to the nozzle channel.

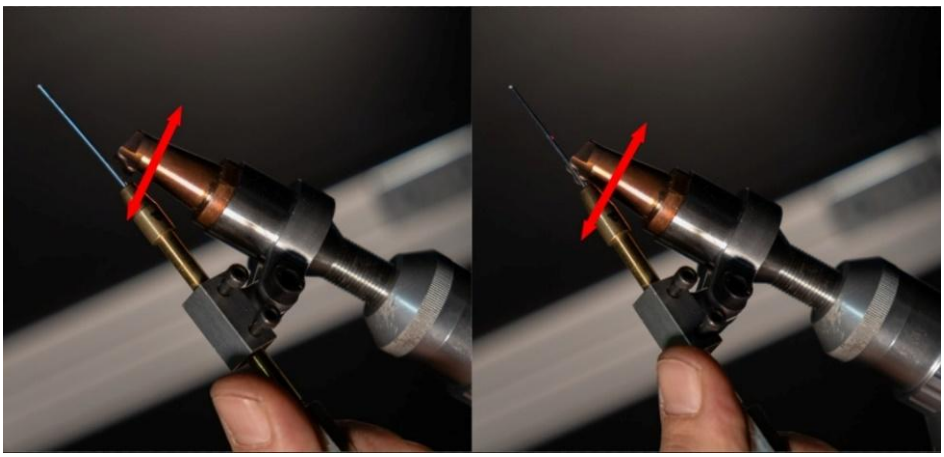
Thread feed problems:

If the thread does not advance correctly, there are a number of steps to follow to identify the source of the problem:

- verify that the pusher rollers do not slip and are able to push the yarn properly
- Check that there is no excessive friction in the passage of the wire through the welding nozzle channel.
- Make sure that the thread sheath has not come out of the line.
- If all these factors are correct, check the welding positions to avoid excessive wire friction on the sleeve.

Thread stuck when tightening the applique

If the wire sticks when tightening the clamp screw, it is likely that by over-tightening, the wire is crushed excessively against the welding nozzle channel. To remedy this, either loosen the wire slightly by hand or readjust the clamp by loosening and retightening the screw with the appropriate tool.



IMPORTANT	**The position of the appliqué must be firm so as not to impair the completion of the weld when attempting to exit the weld.**
IMPORTANT	If a good thrust is not achieved, and always as a last resort, nozzles with a larger diameter than the thread used can be used.
IMPORTANT	**Working with 0.8 mm aluminium wire can be problematic: it is advisable to shorten the length of the line as much as possible and to adapt a sheath for a better experience.**

7.7.2 WELDING WITHOUT MATERIAL SUPPLY

In fillerless welding, the surfaces to be welded are melted so that they are joined together without adding any extra material. For this type of welding, the parts must be very well positioned: they must touch each other perfectly and not leave any empty space.

7.7.2.1 NOZZLES AND THEIR APPLICATION

The LC-WELD laser welding unit has several nozzles as described above:

- Short fork for flat welds without material input.

  Its design makes it easy to work on butt welds. The space in the middle facilitates the passage of any welding points made for the first clamping of the workpiece in its optimum position.

  It usually requires a guide to make welds as straight as possible.

- Long fork for welding outside corners without material input.
  Its design makes it easy to work on outside corner welds.

The larger space between the two tips allows the corner to pass optimally through the inside of the nozzle, making it easier to position in this type of welding.

7.7.2.2 ADJUSTMENT

For non-contributory welding, the equipment must be properly prepared:

- Remove the appliqué for the yarn supply.
- Change the nozzle to a nozzle for non-additive welding, depending on the work to be carried out.
- Adjust the focal length if necessary, threading the tube in or out as appropriate (see section 7.5).
- Position the nozzle and then lock the rotation of the tube with the locknut on the laser and gas outlet tube itself.

7.7.2.3 OPERATION

To operate the LC-WELD laser welding equipment for welding without material input, simply ensure that the nozzle is in contact with the material or parts to be welded, and press the activation button. Remember the positioning of the gun: always maintain an inclination of +/- 60°, to avoid direct bouncing of the laser beam into the laser and gas outlet tube, which could quickly damage the lens protector.

7.7.2.4 TIPS AND PARAMETERS

The LC-WELD laser welding machine requires a constant welding speed:

We advise you to first choose a speed at which you are comfortable to move steadily, and then set the parameters for power, frequency and so on to suit the chosen speed.

You can also modulate the thickness of the weld seam, if you wish, via the parameterization screen, using the "gauge width" tab.

By maintaining a stable position and speed, a high uniformity of results can be ensured.

CHAPTER 8 - SOFTWARE

The LC WELD SMART software is specifically designed by LC to work with manual laser welding.

The LC-WELD SMART laser welding equipment software allows, among other functions:

- Parameterize the equipment in different ways.
- Create different levels of users and permissions.
- Create welding profiles.
- Create and execute jobs (tasks).
- Control all elements of the equipment from a single screen.

The operation of the software, its different functionalities and programming are explained in detail below.

8.1 STARTING THE SOFTWARE

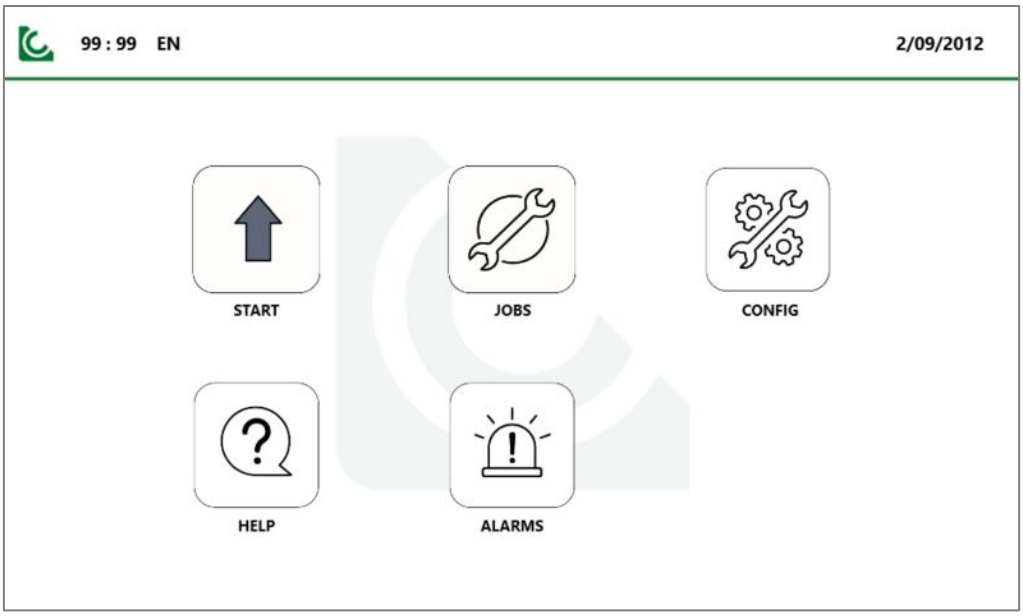
Once the equipment is turned on correctly (see section 7.3), the main menu will appear directly.

8.2 MAIN MENU

The main screen of the software is a general menu of functionalities.

The total functionalities available in the main menu are:

- START
- JOBS
- CONFIG
- HELP
- ALARMS

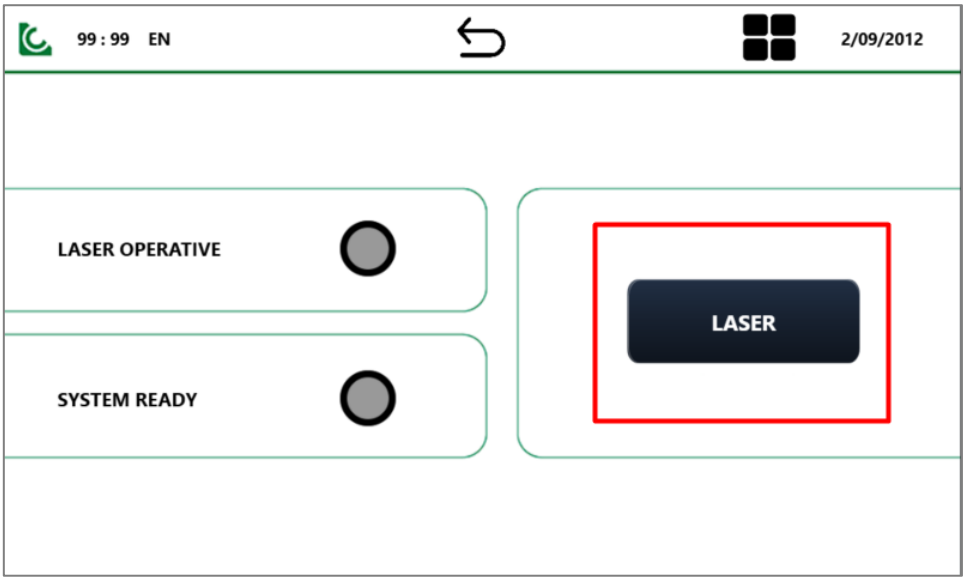


8.3 START

The first menu item is START.

This screen is the only way to activate the laser resonator and the cooler. It is necessary to activate both options to start operating the equipment.

To activate the laser resonator, the BUTTON on the right side of the screen must be selected.



As soon as both the cooler and the laser resonator are activated, the current temperature of the cooling system will be displayed on the right-hand side of the screen.

SYSTEM READY

The "SYSTEM READY" indicator indicates when the system is **ready** to start working. When **everything is correct** (resonator is ok, gas is open and the safety system is correctly activated), the **"SYSTEM READY" indicator** will turn **green.**

The "System Ready" indicator is present on various screens of the software.

IMPORTANT	**If the equipment is outside the established temperature ranges, the system does not detect the presence of pressurized gas, or the LC-CABIN security system (optional) is not correctly closed and activated, the "SYSTEM READY" indicator will not be displayed. will turn green, so the system would not be ready to operate.**

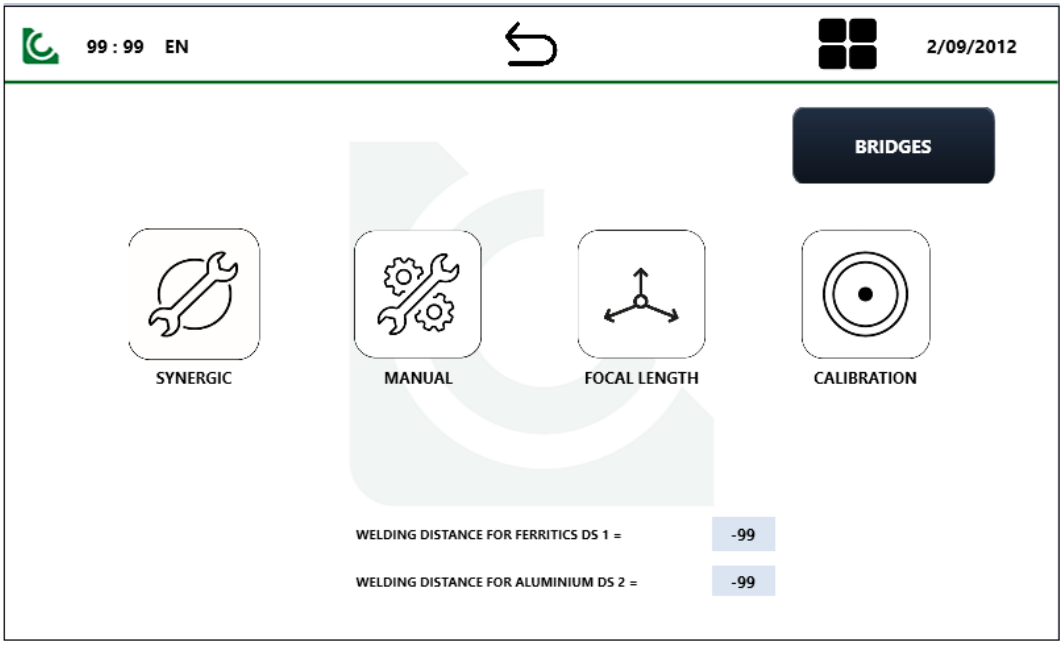
8.4 JOBS

The second option on the main menu is JOBS

In the JOBS menu there are two job functionalities:

- SYNERGIC
- MANUAL

In addition, it has the CALIBRATION and FOCAL DISTANCE functions.

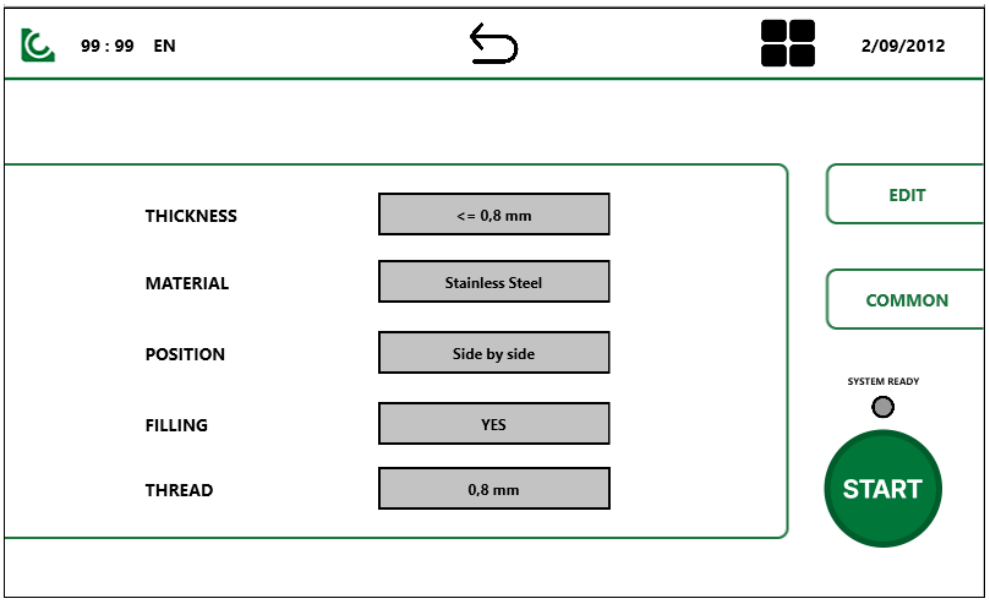


8.4.1 SYNERGIC

The "SYNERGIC" option allows you to work with previously configured parameters in a synergic way.

Once inside the "SYNERGIC" mode, a menu with several options will appear:

- THICKNESS
- MATERIAL
- POSITION
- CONTRIBUTION
- THREAD (SUBJECT TO "CONTRIBUTION")



Using the different options, the characteristics of the welding to be carried out must be chosen. With this information, the system automatically configures the necessary parameters.

Parameters to be selected and their meaning:

THICKNESS (WIDTH)	This is the thickness of the sheet to be welded. The options allow you to select different mm depending on the thickness to be worked. **AVAILABLE OPTIONS: 0.8 - 1 - 1.2 - 1.5 - 2 - 3 and 4.** All expressed in millimetres (mm).
MATERIAL	Material of the sheet metal to be worked. **AVAILABLE OPTIONS: Carbon steel, stainless steel, titanium, galvanized and aluminum.**

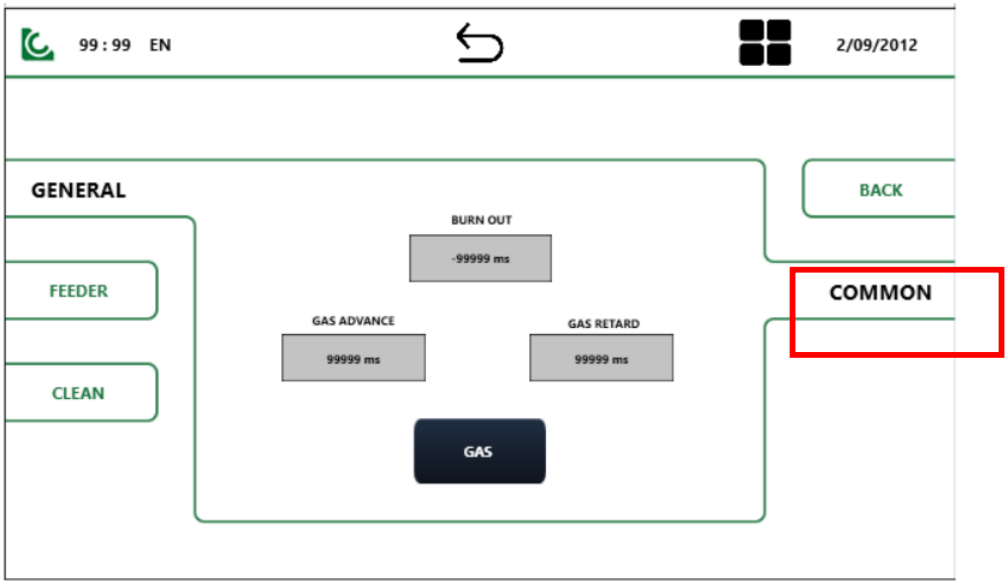
POSITION	Position in which the welding is to be carried out. Distinction is made between "butt" welds and other positions (OTHERS). Butt" welds shall be considered as **full penetration.**
FILLING	You can select whether the welding is to be carried out WITH or WITHOUT wire input. **OPTIONS AVAILABLE: YES, NO** Select YES to work with input, select NO to work without input.
THREAD	This option will only be available if the previous option is affirmative, i.e. the welding WITH wire input option has been selected. In this option the diameter of the thread to be used is determined. The options are subject to the thickness of the sheet: the use of a wire with a diameter **greater than** the **thickness of the** selected **sheet is never** permitted. 4 diameters can be selected: 0'8/1/1'2/1'6 mm

Once all the options have been configured, simply press the "**START**" icon to enter the welding screen (See section 8.4.3).

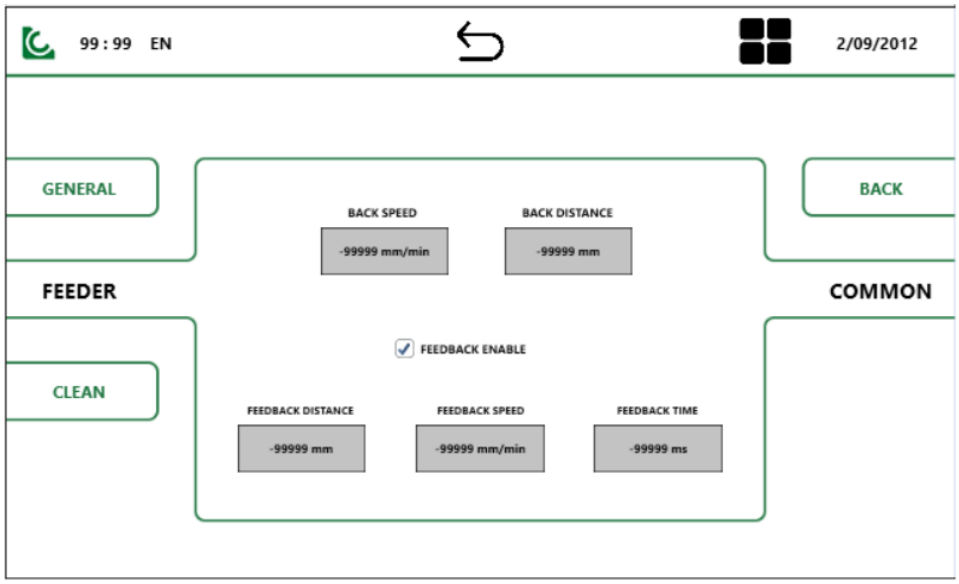
Within this same "SYNERGIC" menu, on the left-hand side, there are three options: EDIT and COMMON.

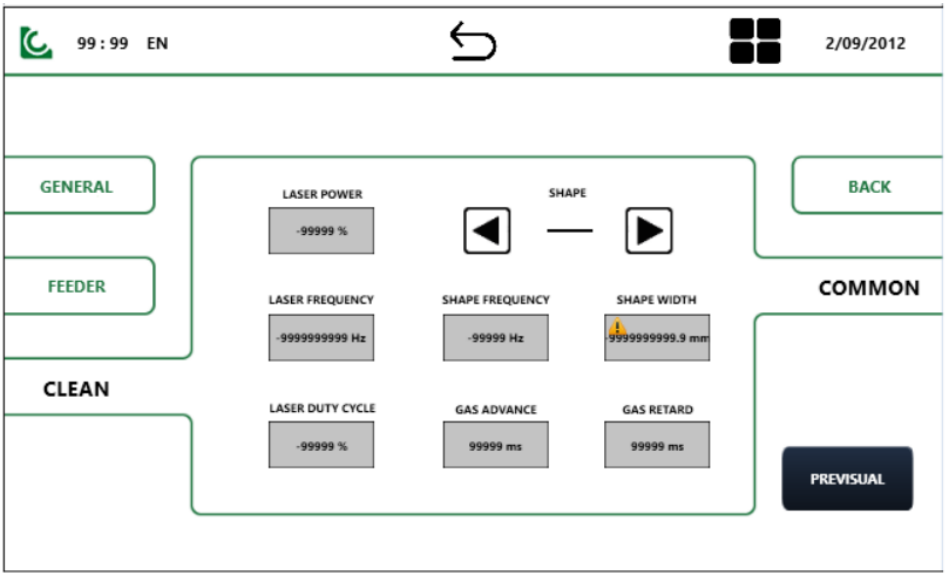
On the **COMMON** screen you can view the following welding parameters grouped into: GENERAL, FEEDER and CLEANING.

Below are the parameters included in each function in the menu on the left:



The "**GAS**" option is a manual activation of the solenoid valve, intended to purge the gas system.





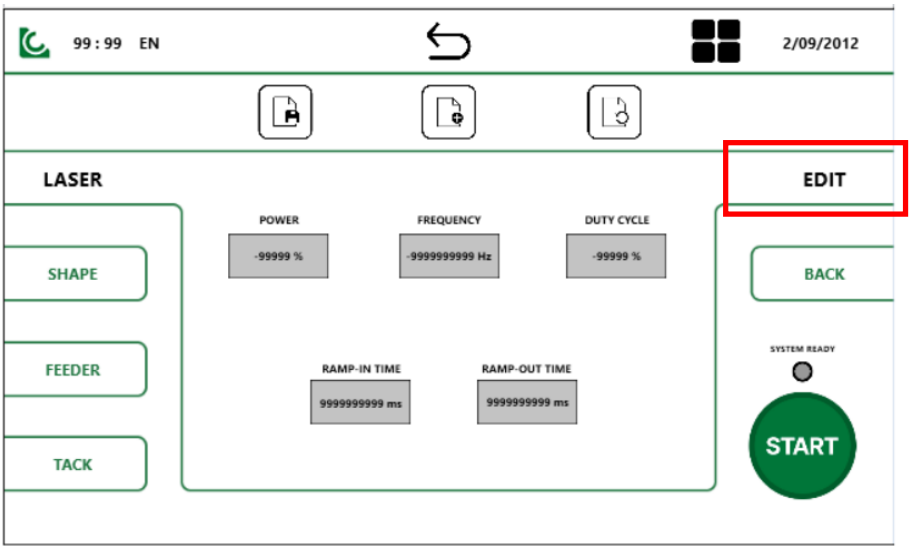
The "**PREVISUAL**" option is used to preview the weld shape (LINE), intended to check the width of the weld.

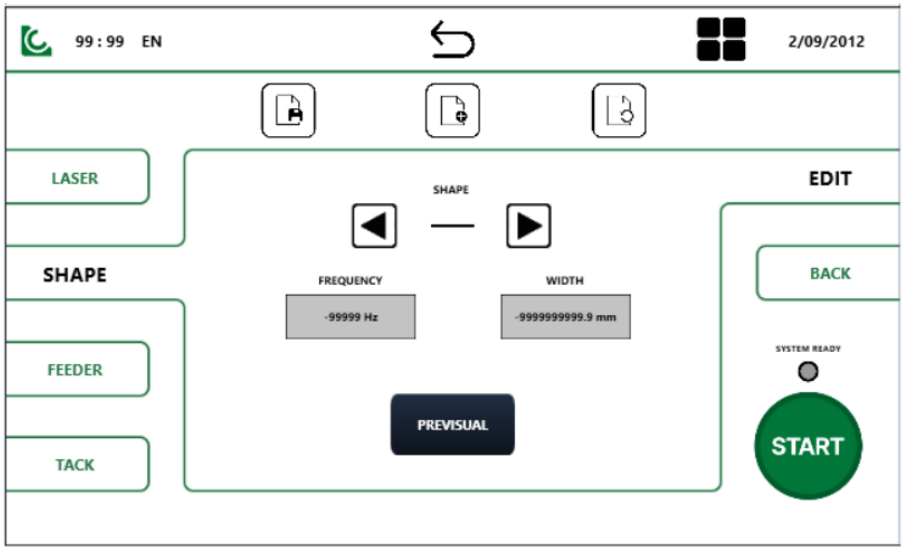
See section 8.4.2.3 for a detailed explanation of the CLEANING parameters.

Using the **EDIT** option, the following preset parameters can be viewed and configured when selecting the SYNERGIC options:

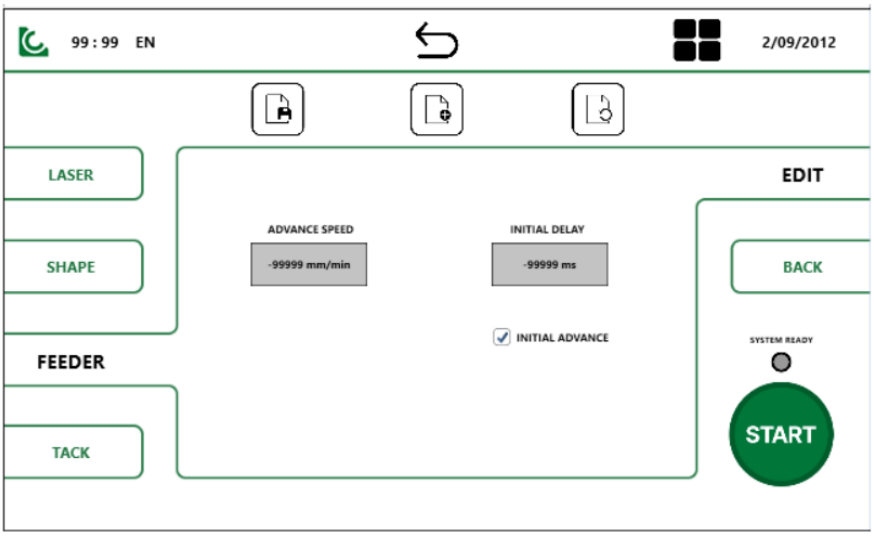
- LASER: power, frequency, duty cycle, start/end ramp time
- SHAPE: shape, frequency, width and PREVISUAL
- FEEDER: forward speed, delay.
- TACK

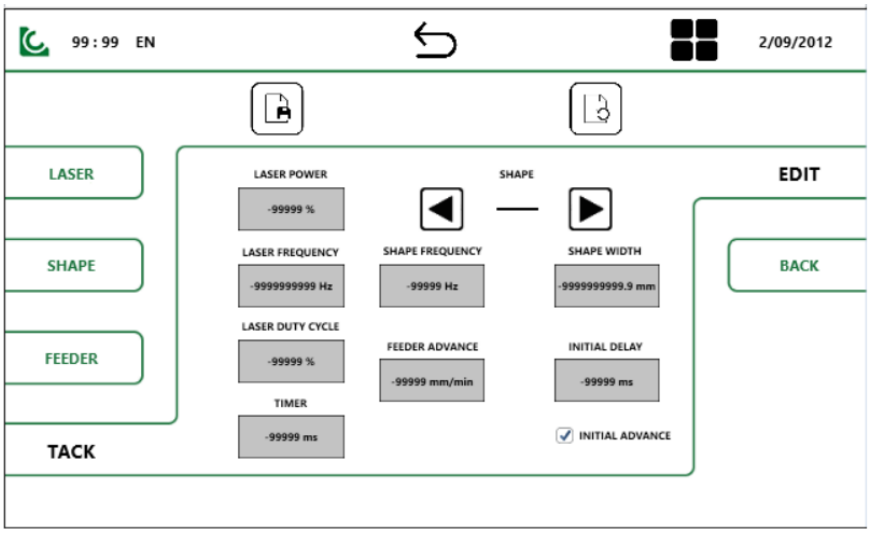
Below are the parameters included in each function in the menu on the left:





The "**PREVISUAL**" option is used to preview the weld shape (LINE), intended to check the width of the weld.

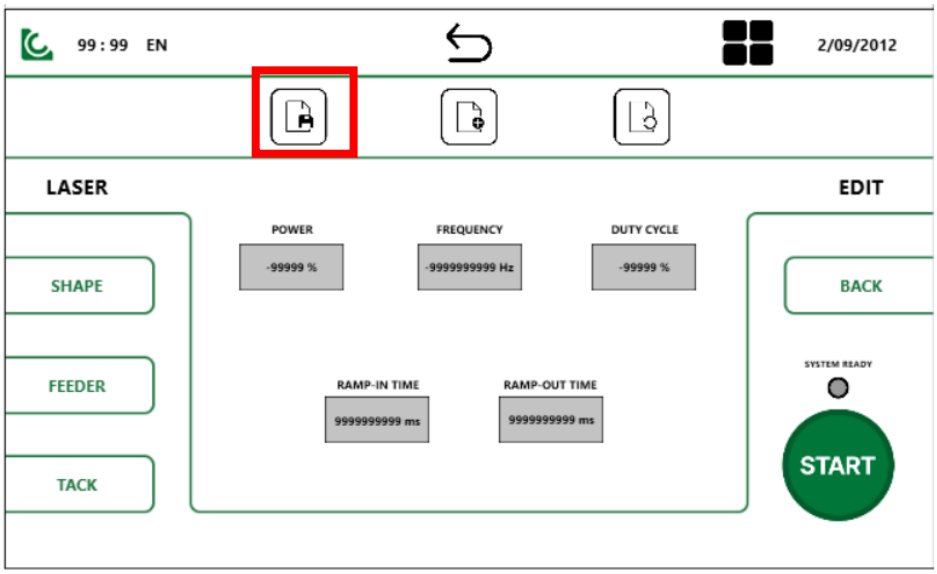




Refer to section 8.4.2.3 for detailed explanation of TACK parameters.

These options are the same as those on the existing screen in the "MANUAL" work menu (see section 8.4.2).

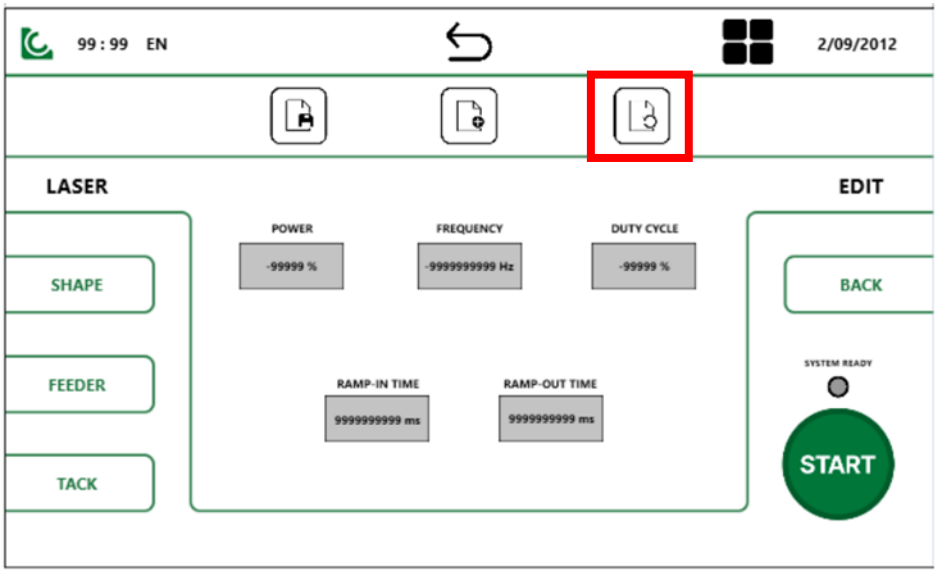
From this editing screen it is possible to modify the parameters proposed by the program, so that the results can be further refined depending on the desired finish. Once the parameters have been modified to the user's liking, press SAVE:



In this case, these parameters will be saved corresponding to the combination of options chosen on the first screen of SYNERGIC mode.

The next time **this same combination of options** is chosen, the modified parameters previously saved will be configured using the EDIT menu.

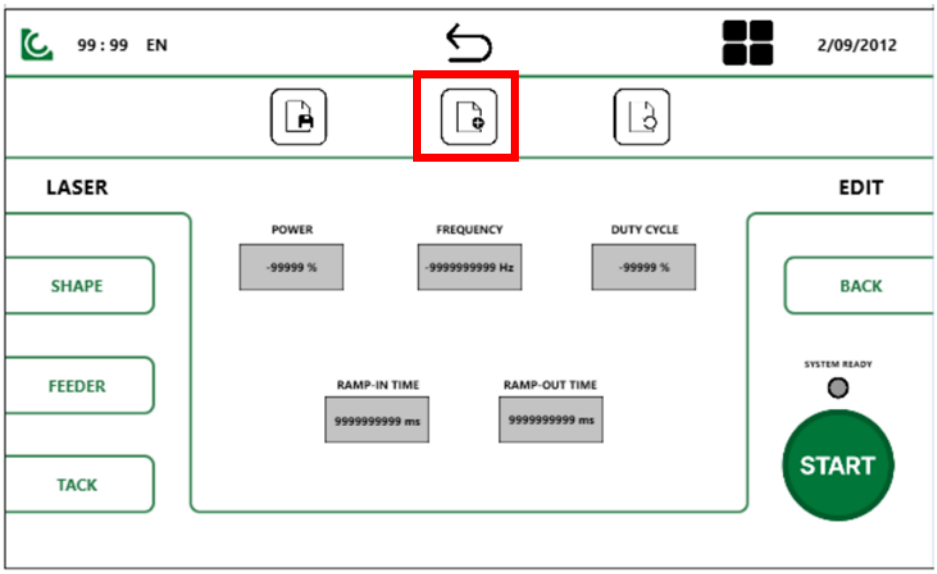
Within the EDIT screen, the possibility of returning to the factory parameters is offered by pressing this icon:



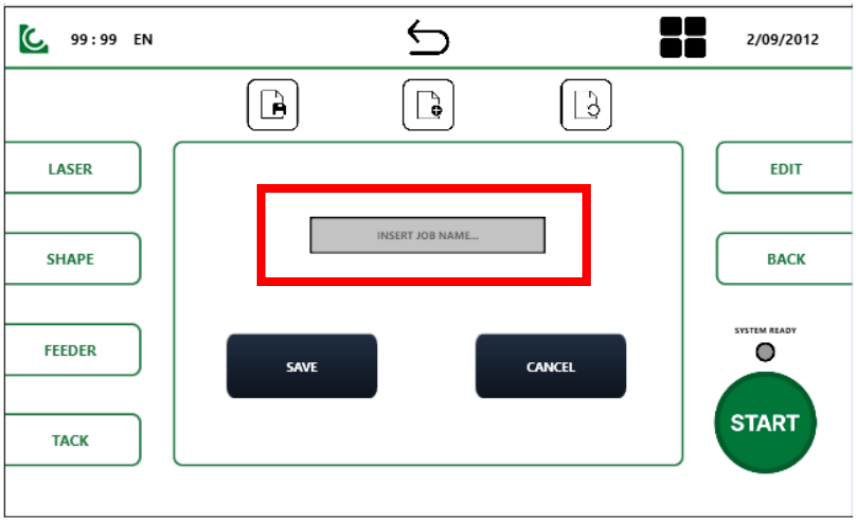
In this way, the default parameters are restored.

As in the rest of the screens, by means of the START option, the welding screen will be accessed to start working.

Within the SINERGIC-EDIT screen, parameters can be saved to create profiles for the advanced mode:

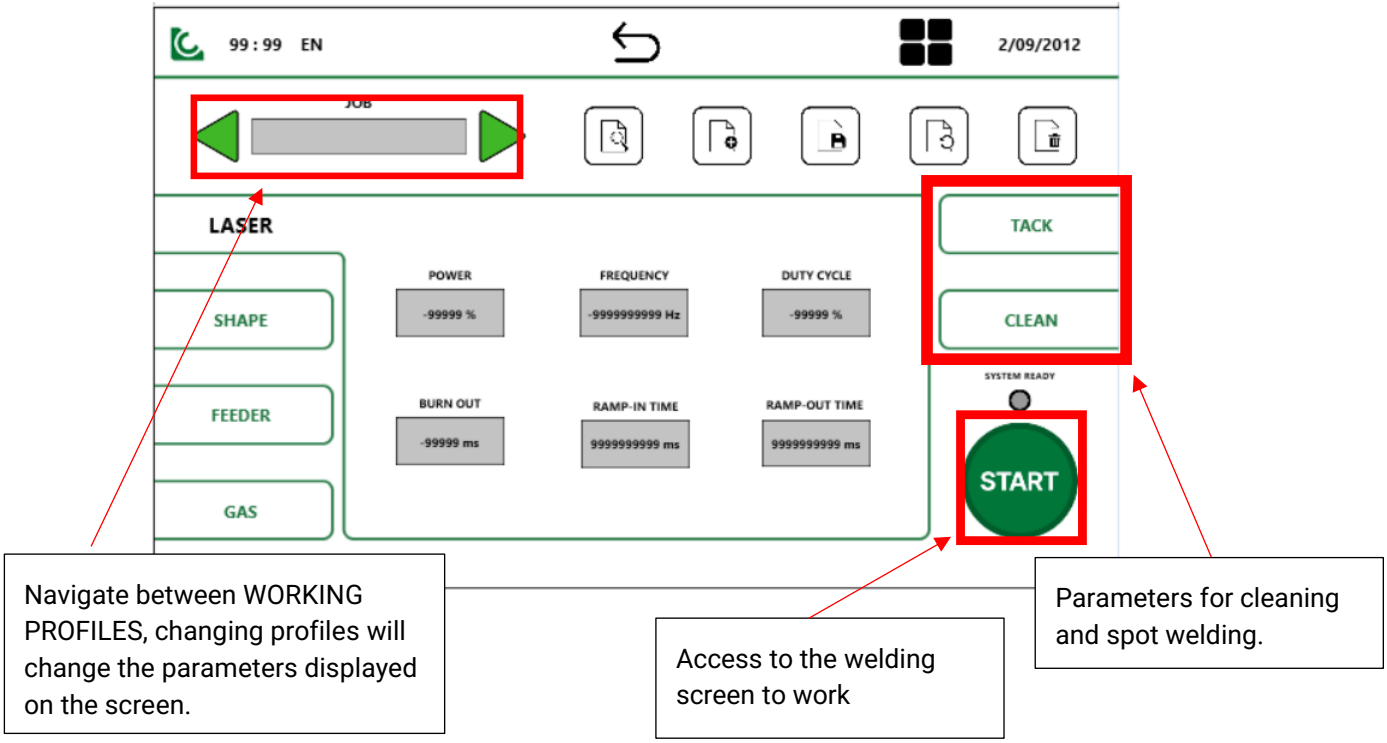


In this screen, a work profile name can be inserted to save the selected parameters.



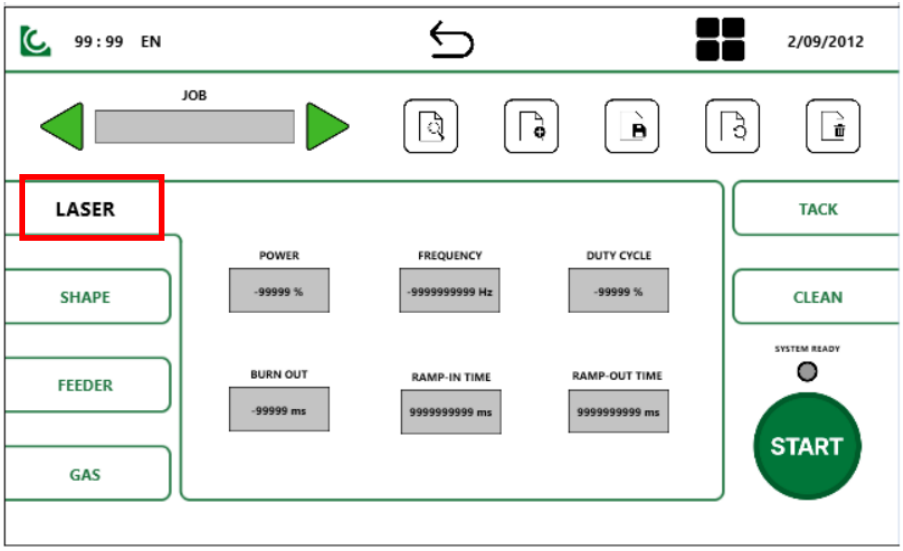
8.4.2 MANUAL WORK

By means of this work mode, the user can work with total freedom of parameterisation. This option allows the user to create new WORK PROFILES, edit existing ones, work with the desired WORK PROFILE or with freedom of parameterisation.

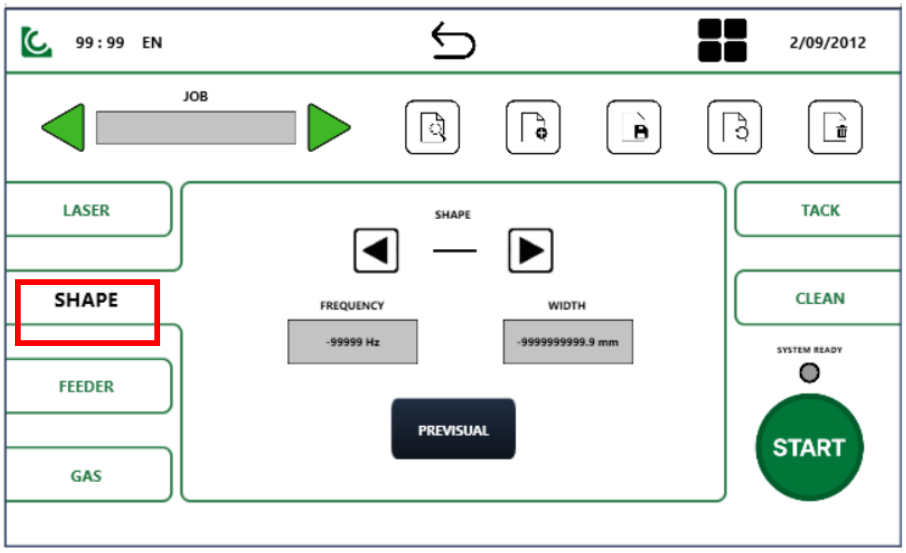


Once in "MANUAL" mode, a menu with several options for parameterizing welding operations will appear on the left side of the screen. These are grouped into LASER, SHAPE, FEEDER and GAS.

Below there is an explanation of the parameters that can be found:



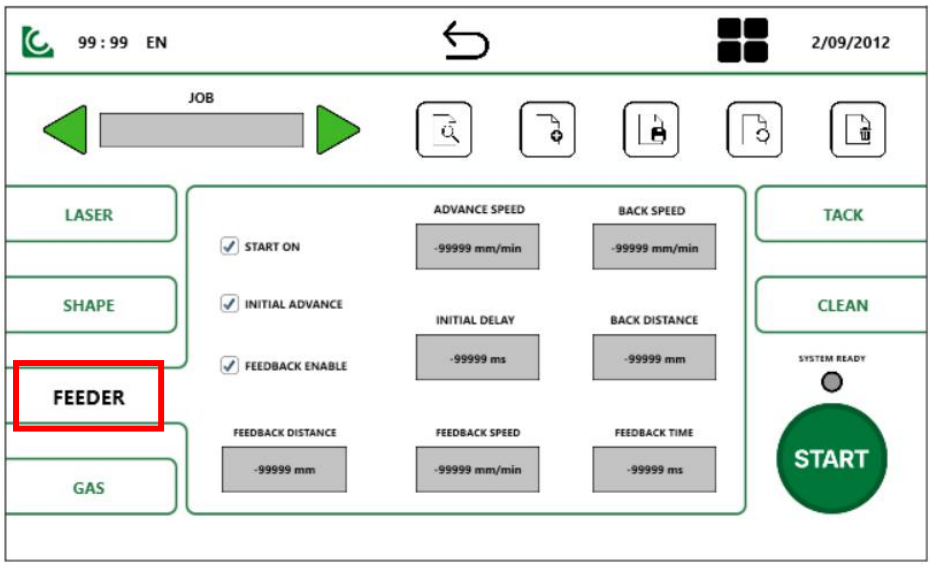
LASER	
LASER POWER	Laser power delivered to the weld. It is expressed as a **percentage (%).** **Power** is one of the parameters that will most determine the penetration of the weld.
LASER FREQUENCY	Laser beam emission frequency. It is expressed in Hertz (Hz). The frequency is determined by the material to be welded: • Ferritic materials: 20,000Hz • Aluminium: 50 Hz
LASER DUTY CYCLE	**The amount of time** within one Hertz of laser emission in which the **resonator emits** laser radiation. It is expressed as a **percentage (%).** The **duty cycle** is determined by the material to be welded: • **Ferritic materials:** 80%. • **Aluminium:** 100%.
BURN OUT (LASER OUTPUT)	This parameter allows the parameterisation of the feeder shutdown separately from the laser shutdown, i.e. the wire feed is terminated first and then the laser beam is switched off. It allows you to configure how long it will take for the laser beam to switch off after the wire feed has been switched off. It is expressed in **milliseconds (ms).** This parameter is used to achieve a better welding output. The **recommended** programming **time** is around **500 ms.** **THIS PARAMETER IS COMPARABLE TO BURNBACK**
RAMP START TIME **RAMP ENDING TIME**	These two parameters indicate the time of progressive increase (START) or reduction (END) of the laser power. **IMPORTANT: if working with thread feed, only the start ramp is operational, not the end ramp.**



SHAPE

SHAPE S.M.	**Shape** to be drawn by the galvanometric mirror system of the gun during welding. This parameter could be equated to the **weld combing** performed in conventional welding.
FREQUENCY S.M.	**Frequency** at which the **motors are** to move. It is expressed in **Hertz (Hz).** In simplified terms, this is the **speed** at which the weld is to be **combed.**
LINE WIDTH	**Size or width** of the galvo shape. It is expressed in **millimetres (mm).**

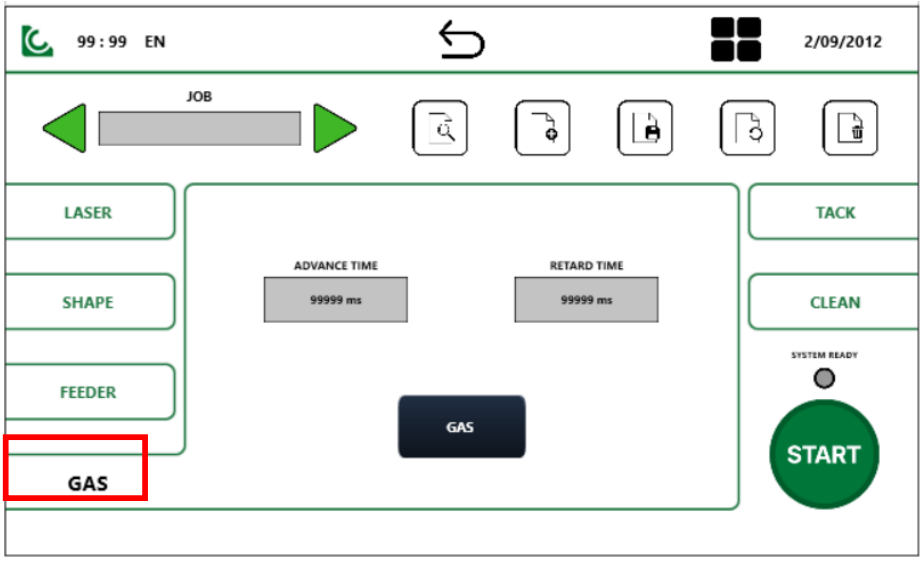
The "**PREVISUAL**" option is used to preview the weld shape (LINE), designed to check its width.



FEEDER

FEEDER ADVANCE	**Speed at** which the welding **wire** will advance **during welding.** It is expressed in **millimetres per minute (mm/min).** IMPORTANT — **It should be remembered that the wire feed speed (FEEDER ADVANCE) shall be the welding feed speed, as explained in section "7.6.1.5 Operation" of this manual.**
FEEDER BACK	**Speed** at which the welding **wire** will go **backwards as** soon as the welding is **completed.** It is expressed in **millimetres per minute (mm/min).**
RETARDATION	Time it takes for the supply thread to come out after activating the laser.
DISTANCE BACK	**Distance** that the wire will **move back as** soon as the weld is **completed.** It is expressed in **millimetres (mm).**
RETURN DISTANCE	Length of feed wire returned at the end of the welding job
RETURN SPEED	Speed at which the feed wire returns at the end of the welding job
RETURN TIME	Waiting time before the wire returns at the end of the welding job

FEEDER SELECTOR (WIRE FEEDER)	Activation or non-activation of the wire feed within the welding profile. • If the **box does NOT** have a **tick (✓), the wire** feed motor **will NOT be activated** at any time **during the job.** If the **YES box** contains a **tick (✓), YES will activate** the **wire** feed motor **during the job.**
DELAY AND FORWARD SELECTOR	This parameter can be divided into two functions: • If the **"ADVANCE"** selector **does NOT have a "tick".** (✓): During the **programmed time,** the **laser** beam **will be emitted** but the **feeder** motor will **not be activated.** This **function** is intended to **preheat** some materials before starting the **weld** bead. • If the **"ADVANCE"** selector **DOES have a "tick".** (✓ **):** During the programmed time, the Feeder motor will be activated but no Laser beam will be emitted.



GAS

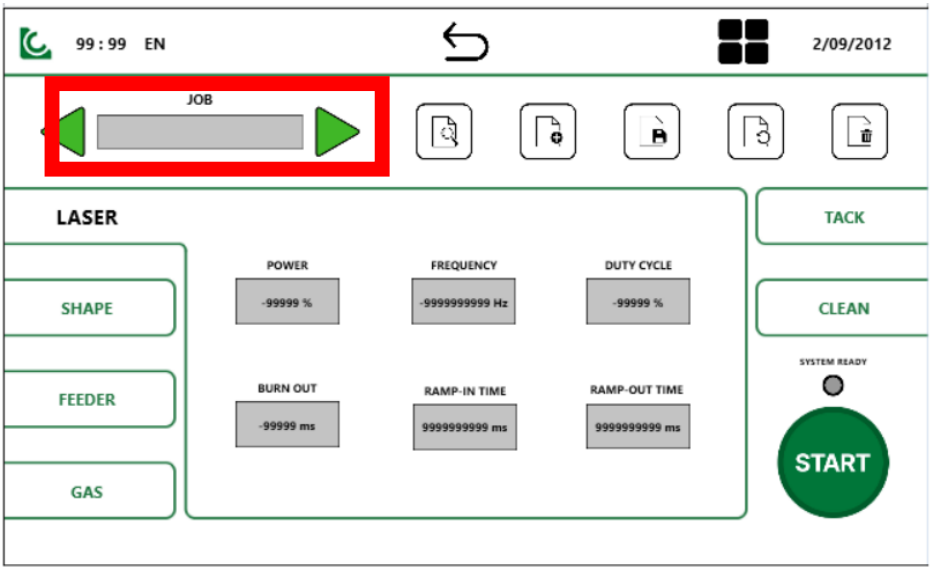
GAS ADVANCE	**Pre-blowing of** shielding **gas** prior to welding, intended to **remove the air** surrounding the **welding** shaft. It is expressed in **milliseconds (ms).**
GAS OUTPUT	**Post** work **gas emission**, intended to **protect the cooling of** the **weld**. It is expressed in **milliseconds (ms).**

The "**GAS**" option allows manual activation of the solenoid valve, designed to purge the gas system.

Once the desired parameters have been selected, using the START button, we can access the welding screen to start working.

8.4.2.1 SELECTION OF WELDING PROFILE

In the 'WELDING PROFILE' option we can select work profiles (groups of saved parameters) and edit them if required or work directly with the WELDING PROFILES already created. Automatically, the equipment comes from the factory with a 'default' WELDING PROFILE with generic parameters.



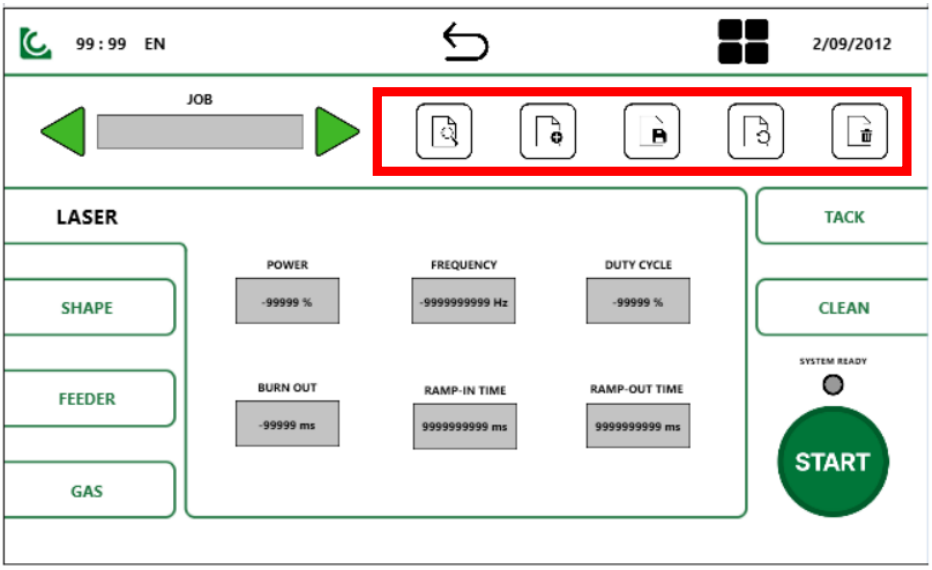
To view the existing JOB PROFILES we can navigate using the arrows at the top of the screen. By changing the JOB PROFILE, the parameters associated with each profile will be automatically loaded.

If you want to view the list of all the WELDING PROFILES saved, you can navigate using the arrows, or select the three lines, which give access to the menu on the left side of the screen and select the search option.

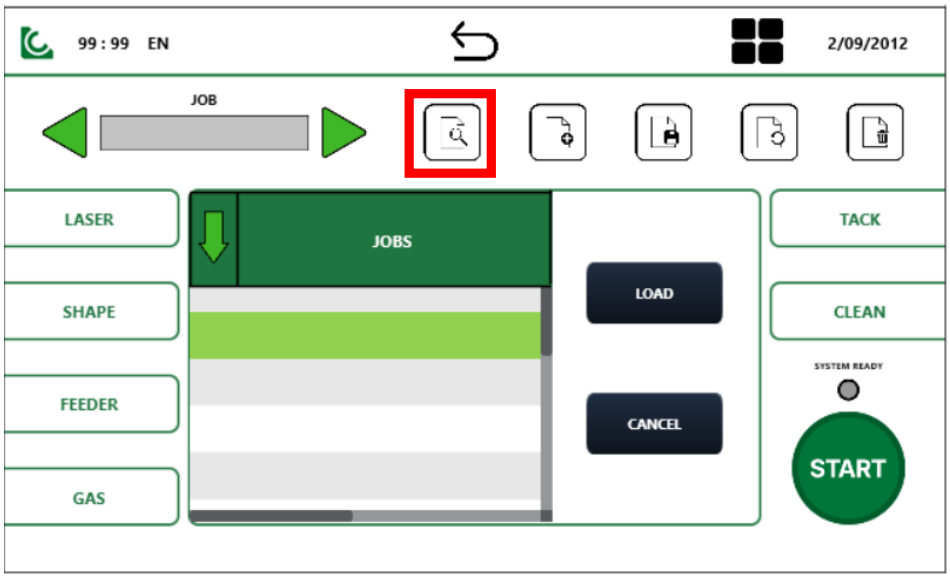
8.4.2.2 SEARCHING, CREATING, SAVING AND EDITING EXISTING WELDING PROFILES

From the option WORK-MANUAL you can **search, create, save, edit and delete** WELDING PROFILES.

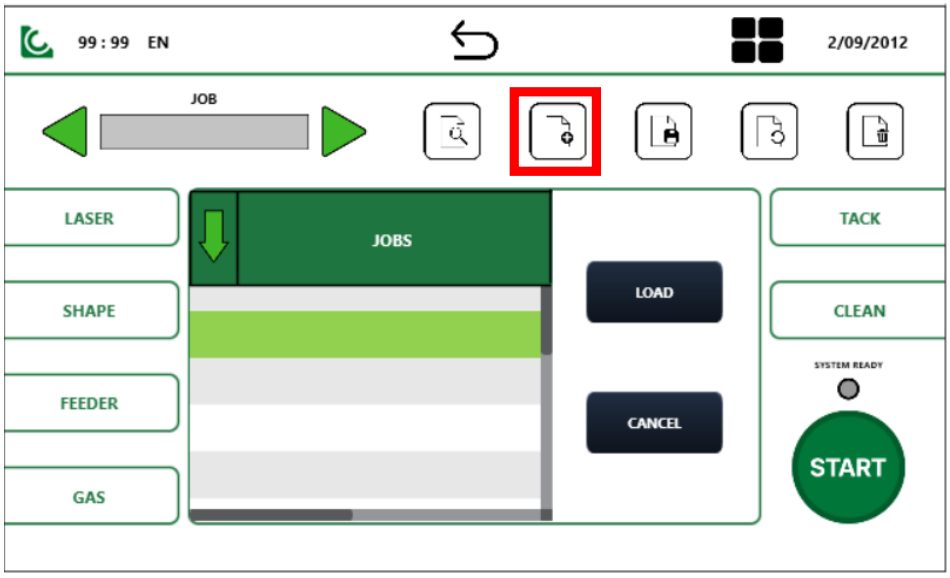
These different options are located at the top of the screen and allow you to manage the 'WELDING PROFILES', that is, a group of parameters selected and saved with a specific name or reference.



The magnifying glass allows you to search within a list of saved WELDING PROFILES. The list will appear on the right side of the screen.



The + symbol allows you to create a new WELDING PROFILE by editing all the parameters again and giving it a new name.



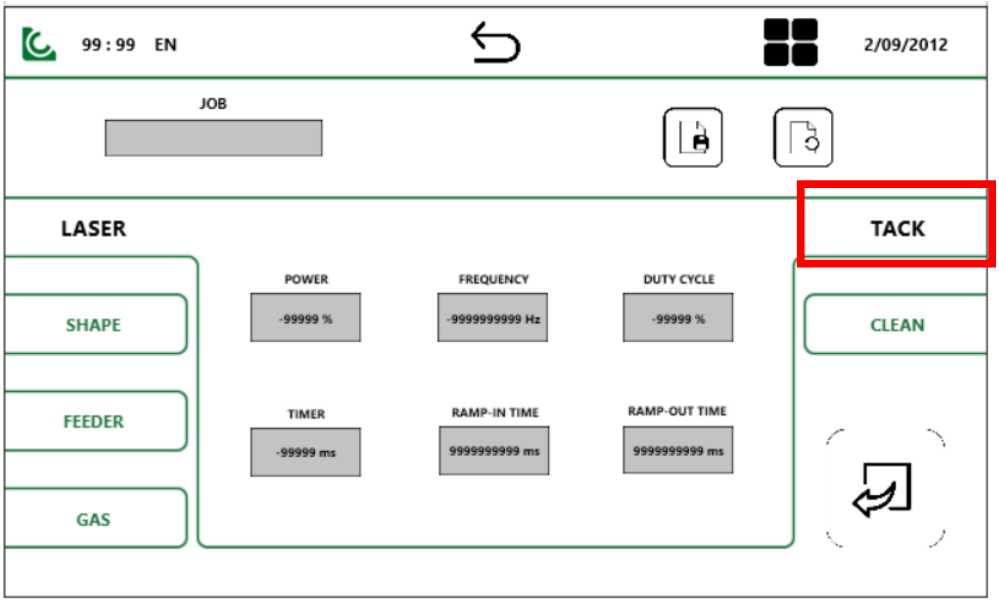
	Once the desired parameters have been selected, it is necessary to click on the save icon, otherwise, if the profile is changed or the menu is exited without saving the changes, the changes will not be saved associated with the profile in question.
	This option allows the user to revert to the last saved parameters.
	Pressing this icon removes the selected WELDING PROFILE.

8.4.2.3 CLEAN AND TACK – MANUAL

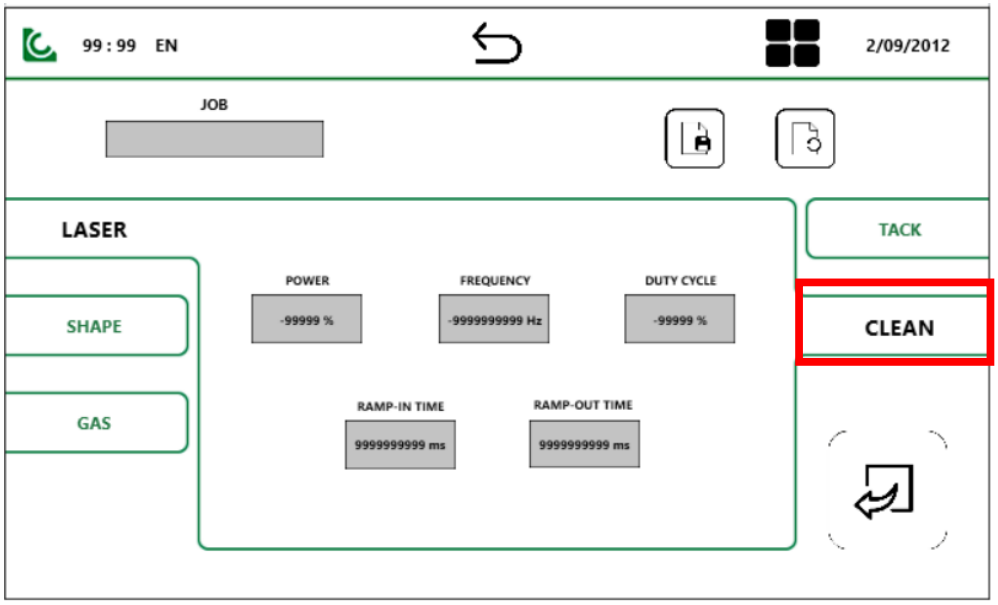
Starting from the MANUAL WORK, you can perform tacking and cleaning tasks on the welds, using the CLEAN and TACK options.

Selecting these options in the "LC WELD MODE" welding screen changes the displayed equipment parameters to adapt them to cleaning and spotting tasks.

From the MANUAL screen and selecting CLEAN or TACK, some base parameters appear that can be edited to work. The MANUAL option allows you to edit and save the TACK and CLEAN parameters.



For the TACK function, the parameters related to LASER, SHAPE, FEEDER and GAS can be selected.

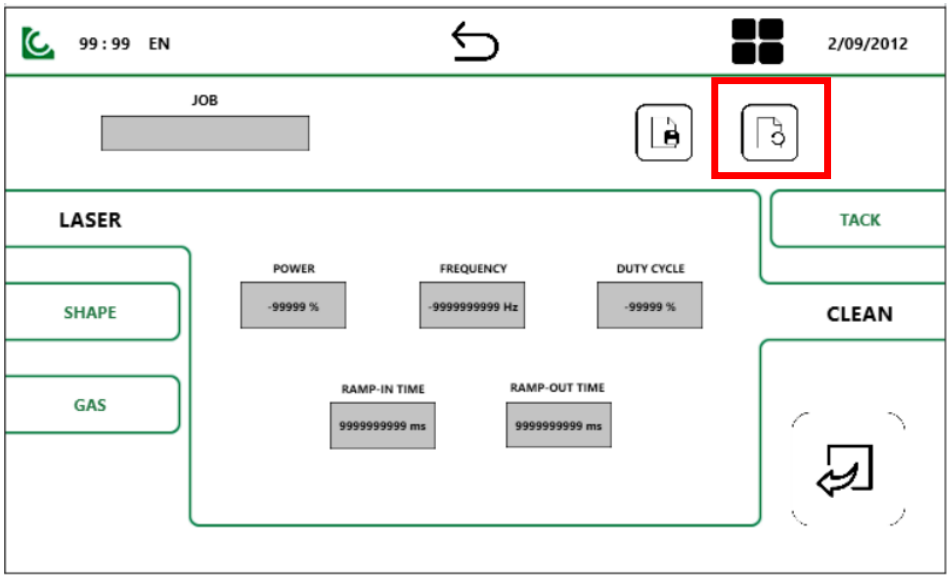


For the CLEANING function, the parameters related to LASER, SHAPE and GAS can be selected.

Depending on the parameters entered in this screen, **if the TACK parameters are edited and saved, they will be directly related to the combination of options entered in this first SINERGIC work screen.**

In the case of CLEAN, the saved parameters are general for all combinations. It is not possible, in SINERGIC mode, to save a modification of the CLEANING parameters

Using the 'RESET' option you can recover the factory parameters.



8.4.3 WELDING SCREEN

In order to be able to work, the welding screen must be accessed via the 'START' icon that appears in the different work modes (BASIC, ADVANCED or JOBS).

To access this screen, the "SYSTEM READY" indicator must be green, otherwise the programme will not allow access to the welding screen.

This screen is different from the rest because it is **black**.

If the ground connection is correct and the system does not emit any incidence alarm (adequate cooling temperature, laser without incidences), the equipment will allow the user to carry out welding.

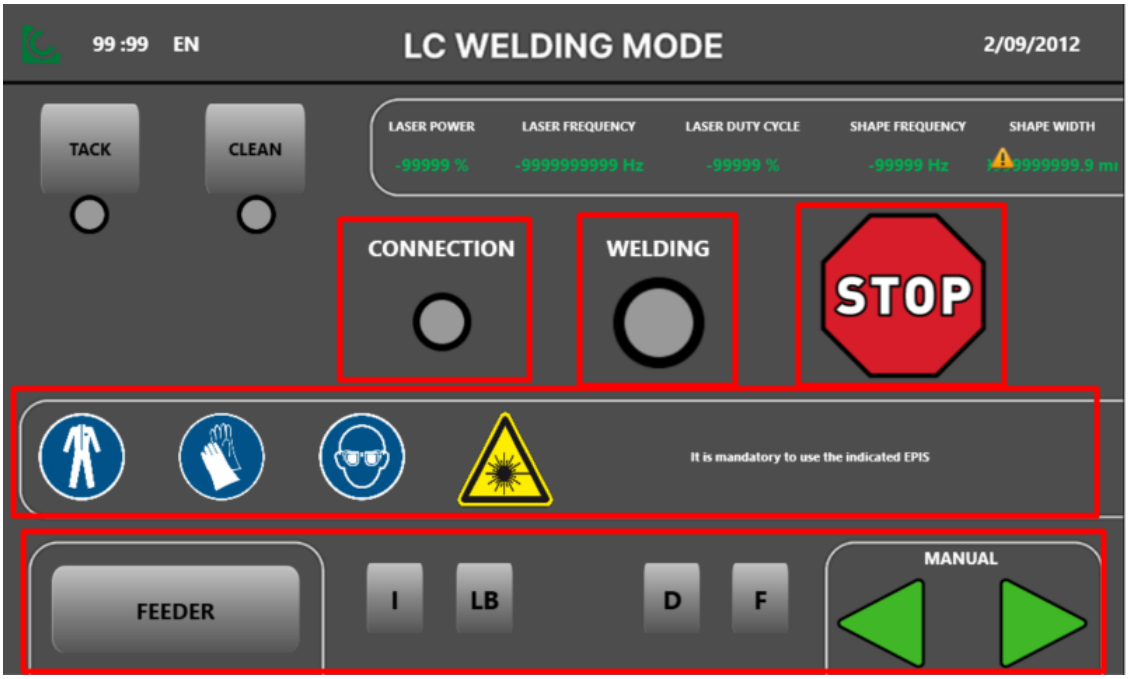
IMPORTANT	**It should be noted that if the equipment has any incident or alarm activated (SEE SECTION 8.9 - ALARMS) or the system is not ready (SYSTEM READY) the programme will not allow access to the welding screen to work.**

Inside the welding screen:

- The "CONNECTION" indicator shows whether the necessary contact of the gun with the table and CLAMP is being made correctly.
- The 'WELD' indicator in the centre of the display indicates when the laser is emitting.
  If it is GREEN, the laser is in emission and poses a risk to unprotected persons.

As discussed elsewhere, this signal can be reproduced outside the cab, e.g. at traffic lights.

- The 'STOP' button allows you to exit the welding mode and return to the previous screen.
- The 'FEEDER' button is used to activate or deactivate the wire feeder. When activated, new commands for controlling the feeder parameters will appear on the screen. With the options 'FEEDER FORWARD' and 'DISTANCE BACK' you can fine-tune the setting of the wire feeder to work in the desired way.
  With the arrows on the right-hand side "MANUAL" the thread can be manually moved forwards or backwards.
- In the central part of the welding screen there is a section reminding of the necessary PPE and the obligatory nature of its use by the worker.



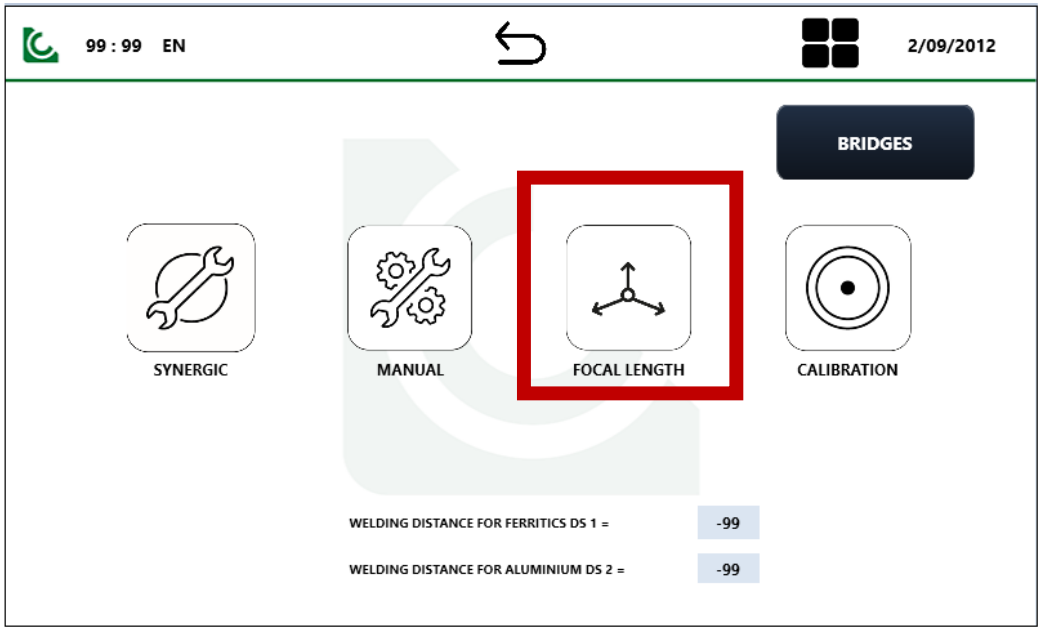
At the top, you can see some parameters related to welding:

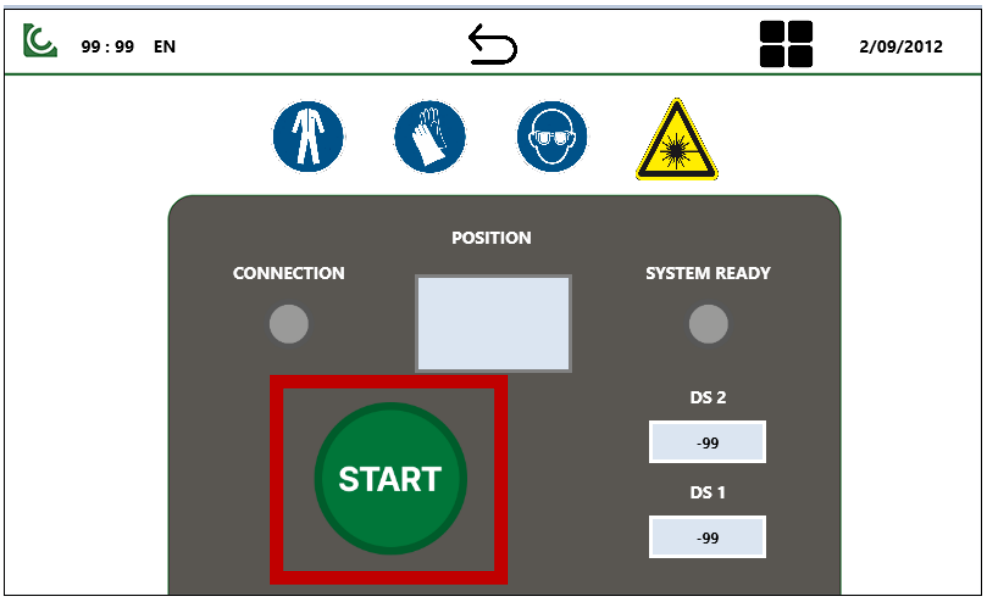
- LASER POWER
- LASER FREQUENCY
- LASER DUTY CYCLE
- FREQUENCY
- LINE WIDTH

8.4.4 FOCAL LENGTH SCREEN

Within the work menu there is the 'Focal Length' functionality.

This option allows us to configure the focal length of our equipment.





Through the START button we can start shooting every XX mm to find the welding distances DS1 and DS2.

The 'POSITION' square indicates the position of the threaded tube (-10mm, -8mm, -6mm, etc.) that the user must adjust before each shot.

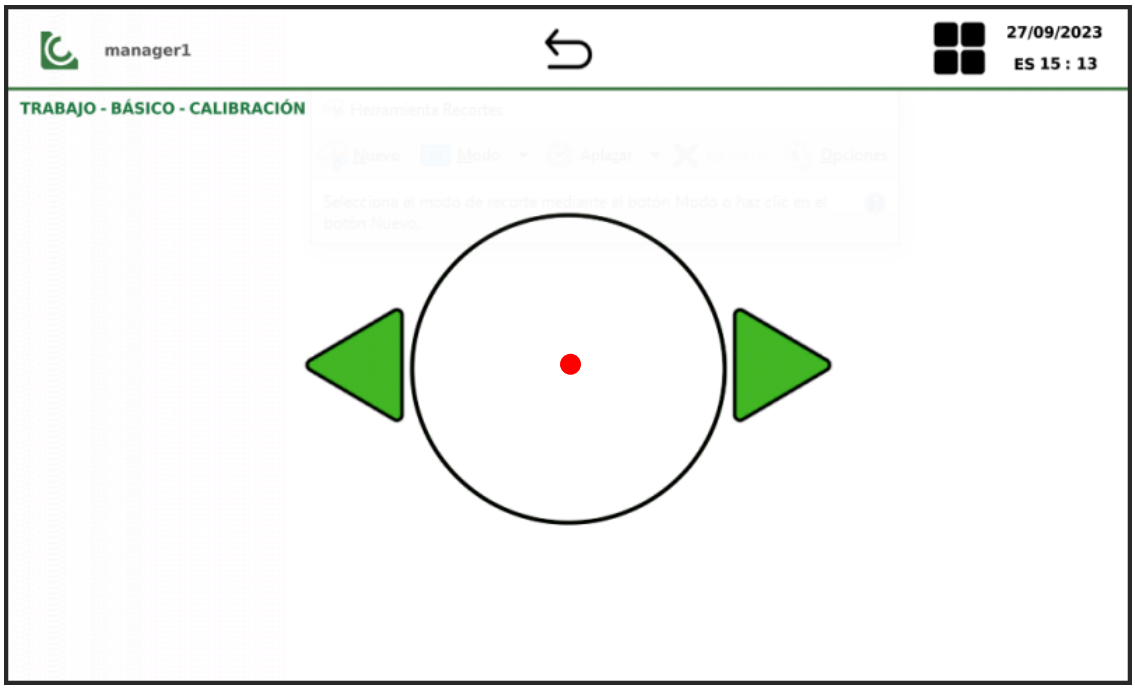
See POINT 7.5 for a detailed explanation of how to configure the focal length.

8.4.5 CALIBRATION SCREEN

Using the CALIBRATION screen you can center the red pointer on the inner diameter of the gun tube, as well as center it with the filler wire.

Pressing the icon will open the following screen, allowing the user to move the red pointer from side to side to properly center it:

Red pointer centering screen:



	IMPORTANT	**The red pointer should always be centered on the gun's outlet tube, regardless of position on the screen. To calibrate the center of the tube with the center of the screen, contact the SAT of your official distributor.**
		If you cannot center the red dot through the calibration screen, contact your technical service.

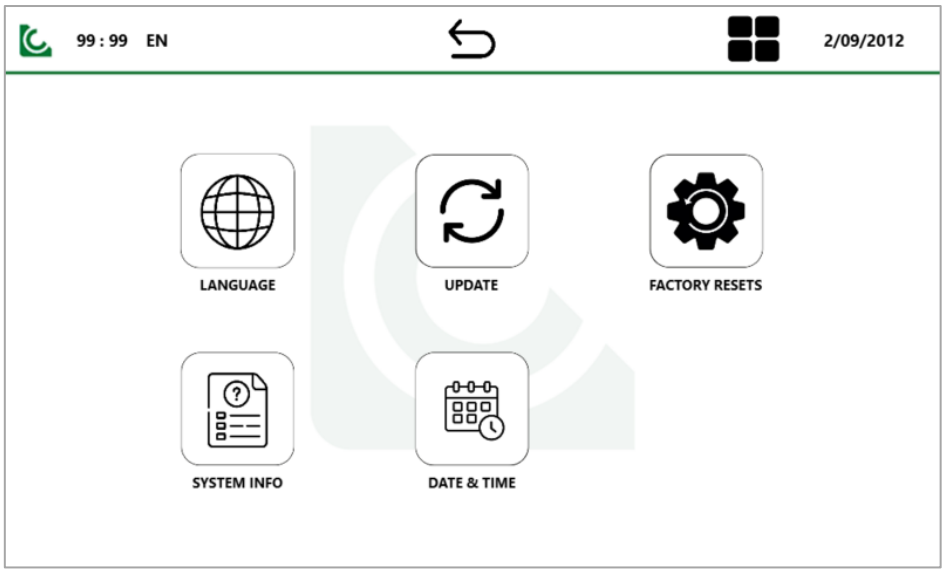
8.5 CONFIGURATION

CONFIG

In the 'CONFIG' option you can access the configuration submenu, to edit the general configuration of the equipment and to access various information about the equipment.

The options available in the "CONFIGURATION" menu are as follows:

- LANGUAGE
- FACTORY RESETS
- SYSTEM INFO
- UPDATE
- DATE & TIME



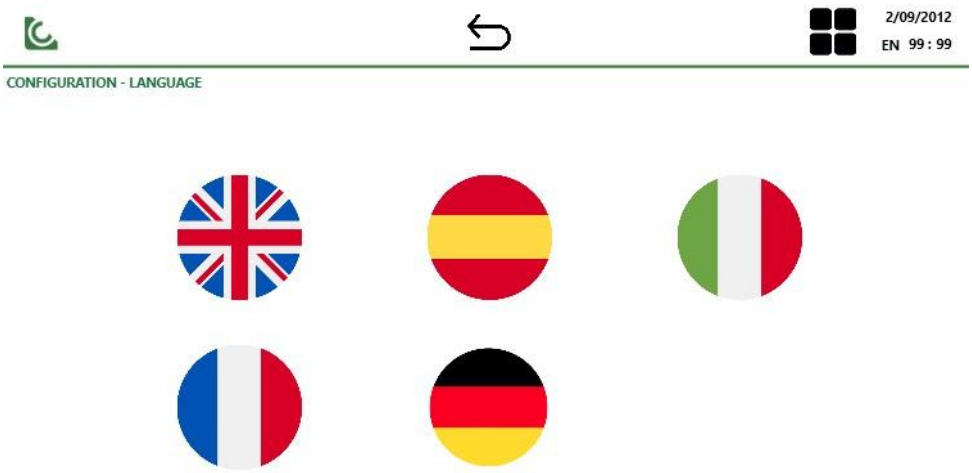
8.5.1 LANGUAGE

Click on the "LANGUAGE" icon to access the different languages available.

- Languages available: English, French, Italian, Portuguese, Spanish, French, Italian, Portuguese, English

Simply click on the icon of the desired language and then press the "back" button

. The system will have changed the language in all fields.

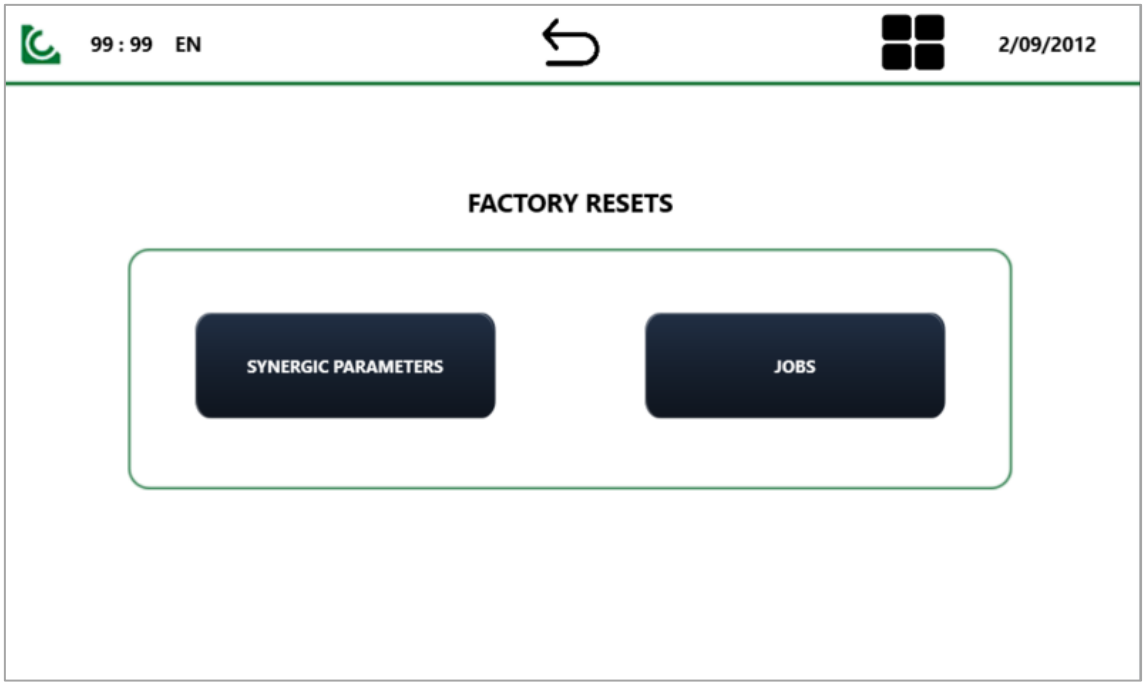


A

8.5.2 FACTORY RESETS

In the 'FACTORY RESETS' option, ADMIN and MANAGER users are given the option to reset the equipment parameters to the factory settings in different fields:

- WORK PROFILES: Allows you to delete all WORK PROFILES created in ADVANCED work mode.
- BASIC: Allows ALL basic parameters modified at any time to be returned to their factory settings.

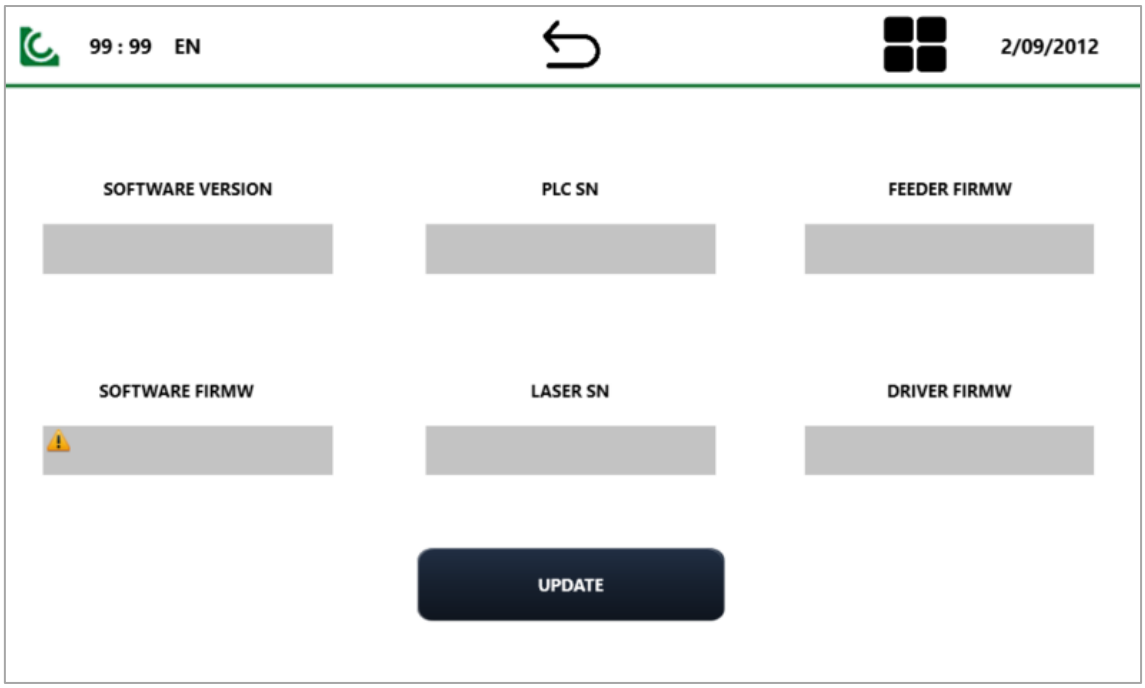


8.5.3 SYSTEM INFO

The SYSTEM INFO section is only visible to the administrator user.

Various information about the equipment's internal control system appears in SYSTEM INFO.

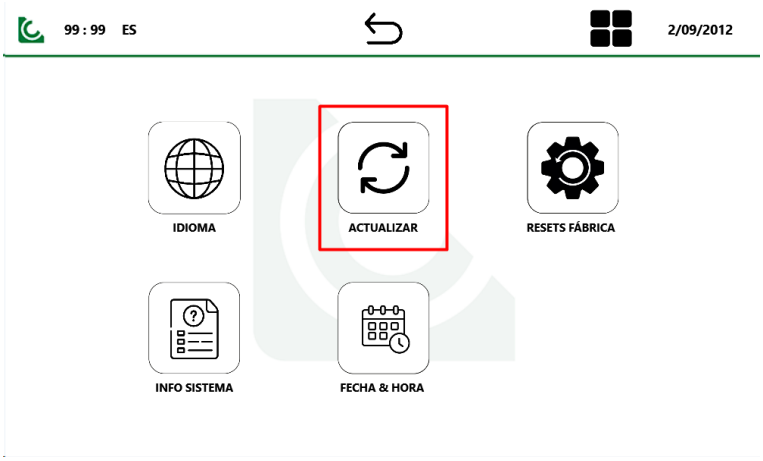
In the event of a breakdown or malfunction of the system, the Technical Assistance Service may require information from this section.



8.5.4 UPDATE

The UPDATE menu allows the user to choose between:

- Update the team's internal software to incorporate improvements in the program.
- Update user support documentation (videos, manuals, questions)



The updates will basically consist of 3 stages:

- USB preparation
- USB connection
- Automatic update process

1- USB preparation

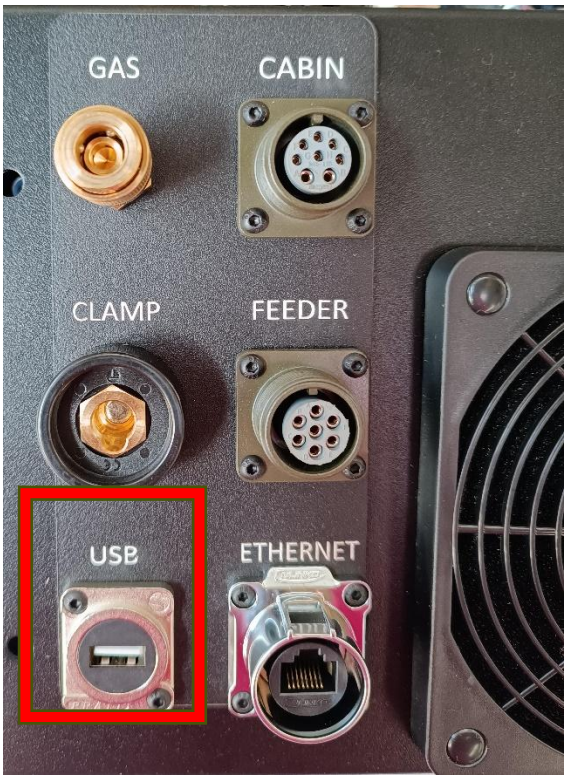
The information necessary for the update will be sent via "WeTransfer" or another similar service. You will receive the information compressed in a file called "uni.zip", which you must unzip in the root of the USB following these stepssos:

Nombre	Fecha de modificación	Tipo	Tamaño
CE	07/11/2023 12:09	Carpeta de archivos	
GAR	07/11/2023 12:09	Carpeta de archivos	
MAN	07/11/2023 12:08	Carpeta de archivos	
VID	09/11/2023 11:39	Carpeta de archivos	
uni.zip	17/11/2023 10:00	Archivo WinRAR Z...	570.492 KB

IMPORTANT **Do not modify, move or delete files in these folders, or change folder or file names to ensure a smooth update.**

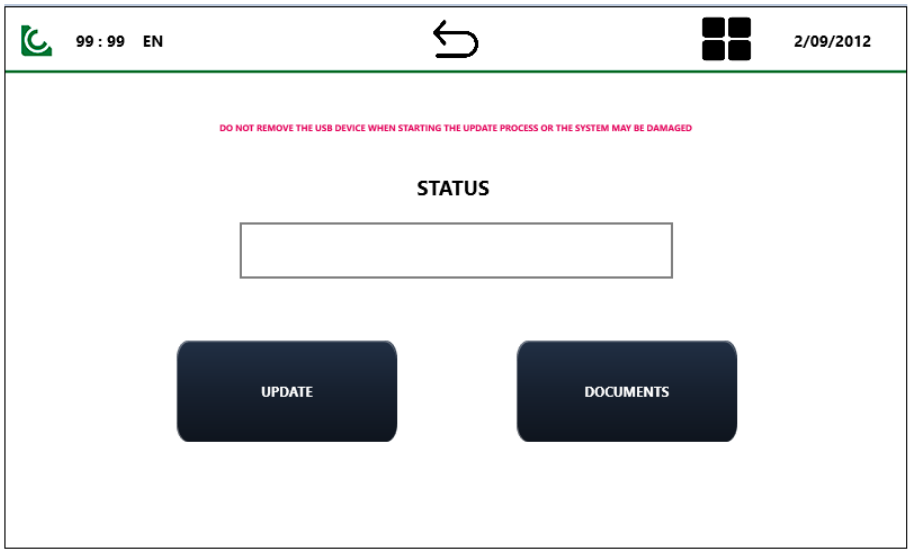
2- USB connection to the machine

The update is carried out using a file contained on a USB stick (pen drive), which must be inserted into the USB slot located on the back of the device.



3- Automatic update process

select the "UPDATE" icon on the system or media and wait for the system to complete the entire process.

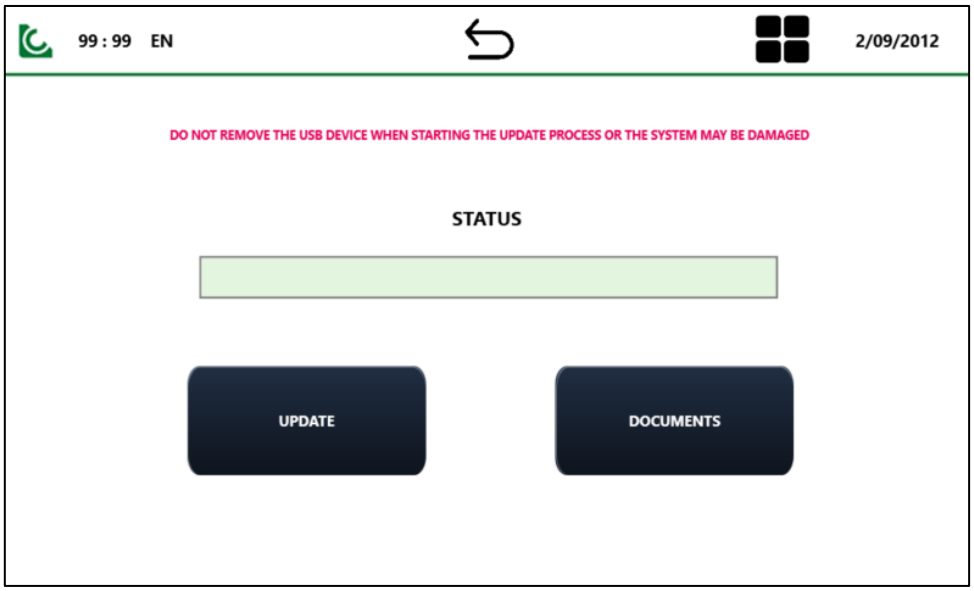


IMPORTANT	**It is crucial to wait for the machine to reboot on its own after the update. Do not interrupt the process, remove the USB or cut off the power under any circumstances.**

If you have an older version of the software, it is necessary to update it to access the standard screen and select the option to update media (manuals, videos, etc.). This update process is divided into two steps:

The update will be done in two steps:

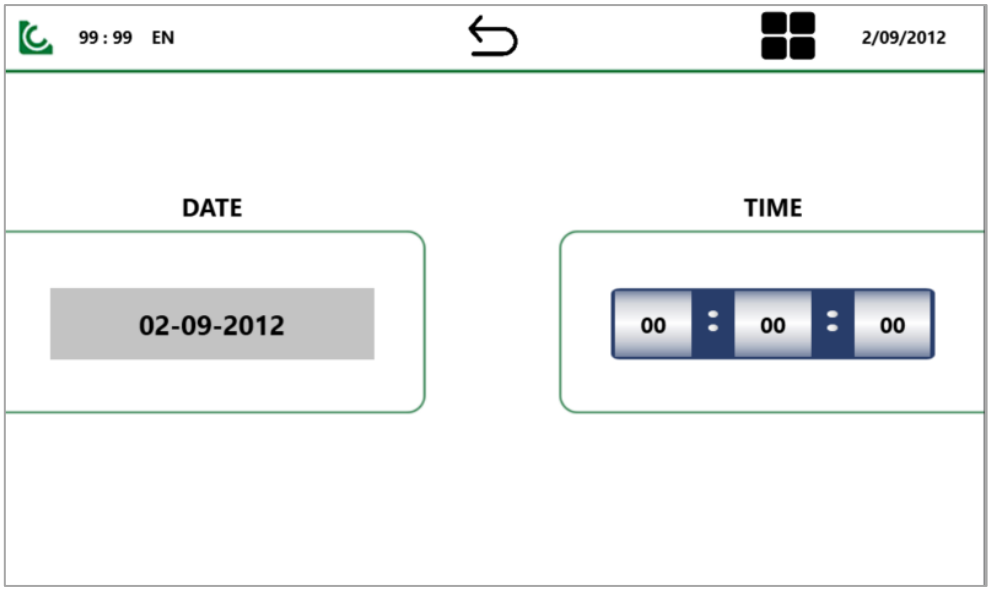
a. Update
b. Afterwards it will only be necessary to Update Media



IMPORTANT **If any part of the process is interrupted, please contact your nearest technical service.**

8.5.4 DATE & HOUR

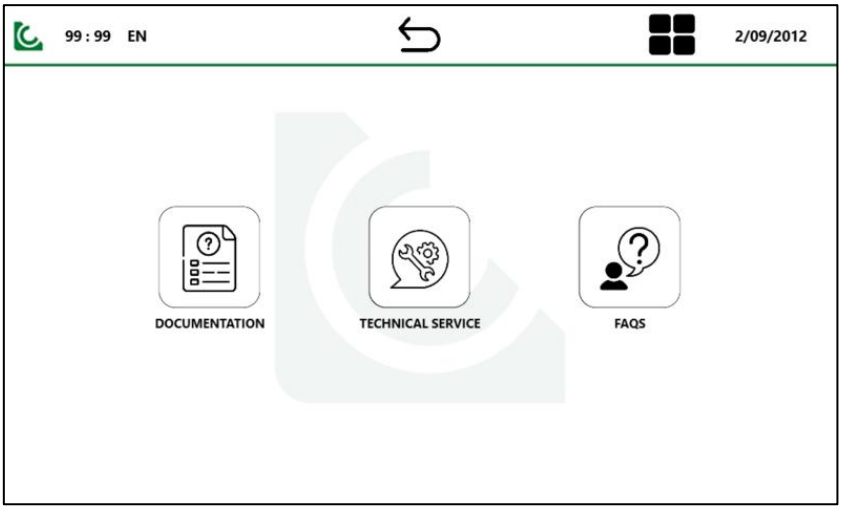
From this screen you can manually edit the machine's date and time parameters.



8.6 HELP

In the 'Help' menu there are different options:

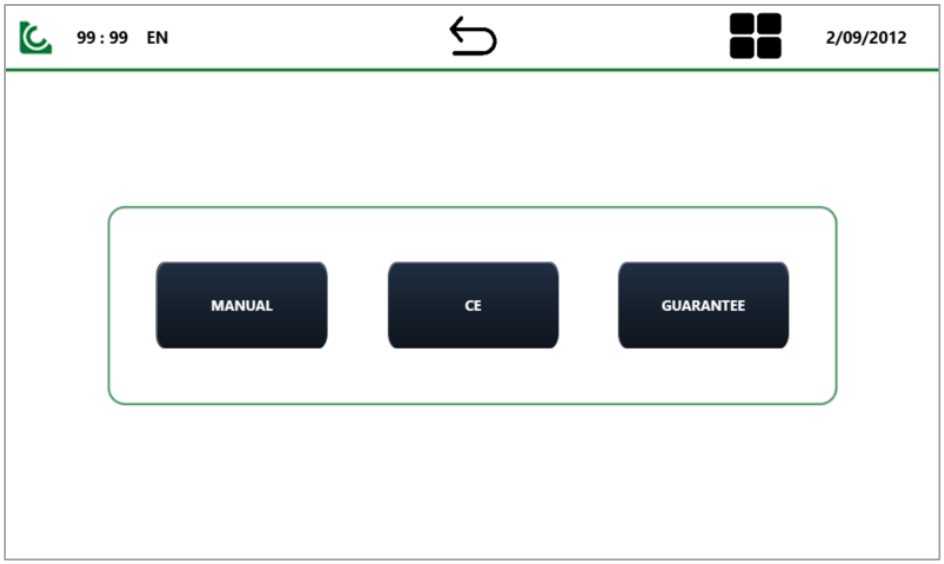
- Documentation
- Technical service
- FAQS



8.6.1 DOCUMENTATION

By pressing the "DOCUMENTATION" icon you can access a series of digital documents related to the LC-WELD SMART equipment:

- User manual
- CE declaration of conformity
- Guarantee



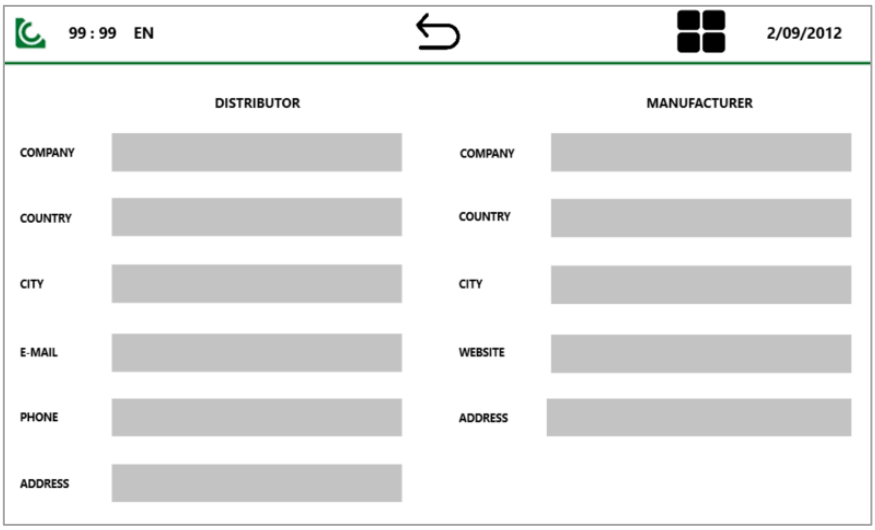
8.6.2 TECHNICAL SERVICE

By pressing the "TECHNICAL SERVICE" icon you can access two lists of information:

- Official Distributor

- LC Lasers

These listings contain contact information for both entities.



8.6.3 FAQS

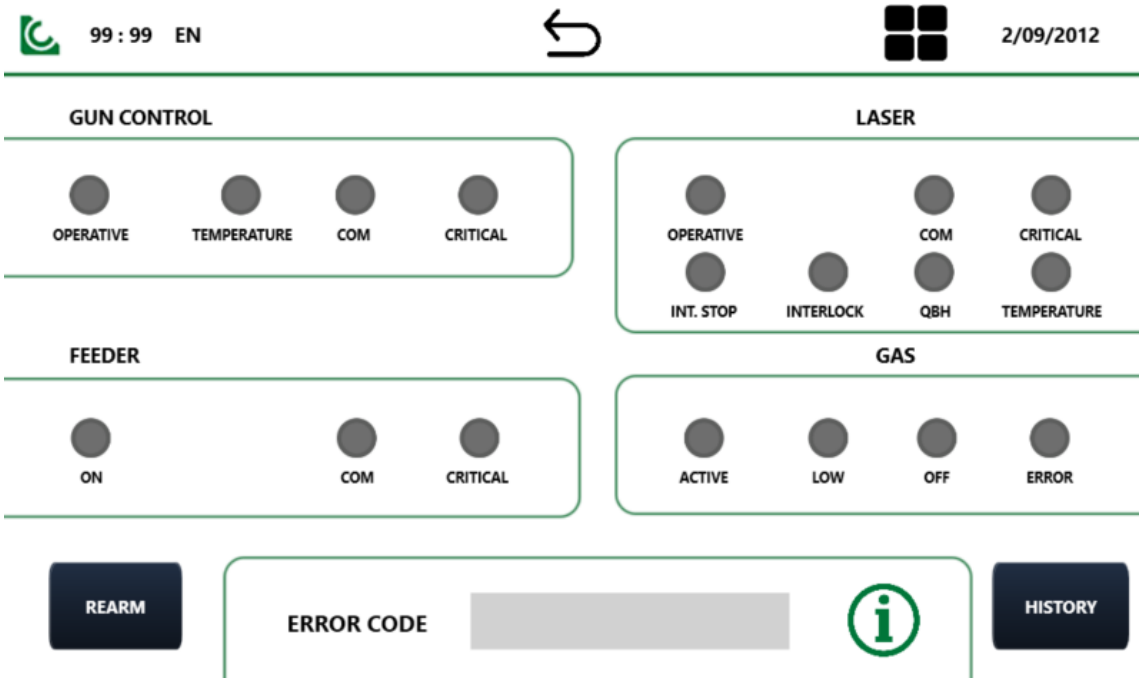
This screen details the most common cases of machine failure and the steps to follow in each of them.

8.7 ALARMS

The "ALARMS" section allows ALL users to view the overall status of the entire system, showing the active and inactive alarms of the system.

There are alarm indicators in different fields:

- GUN Control
- Chiller
- Feeder
- Laser
- Gas



- **GUN CONTROL:** This section shows the alarms related to the general electronic control board of the equipment.
- **CHILLER:** This section shows the status of the chiller control board.

- **FEEDER:** This section shows the status of the wire feeder control board.
- **LASER:** The LASER section displays various information on the status of the laser resonator.
- **GAS:** Finally, the GAS section shows information about the gas circuit.

***All the information present on this screen may be required by the Technical Assistance service to perform remote diagnoses.**

In certain cases, the registered error code is also displayed.

As soon as certain errors appear, they can be quickly corrected and, in some cases, the system must be RESET.

In this case a letter "R" will appear in a box. Simply press it to reset the system.

To view more information about alarm type codes, press the button .

CHAPTER 9 - WELDING PARAMETERS

LC-WELD SMART machines incorporate an advanced system for selecting the appropriate welding parameters for each material and thickness.

Even so, it is interesting and necessary to know how the different variables in the "MANUAL" parameter table behave, as the operator must be able to modify the parameters proposed by the synergic system and adapt them to his needs in order to fine-tune the results as much as possible.

In that sense, this chapter will be divided into 3 parts:

- Use of the LC-WELD SMART synergy system.
- Explanation of the behaviour of the different existing parameters.
- Tables of indicative parameters separated by materials.

9.1 - LC-WELD SMART EQUIPMENT PARAMETERS

As mentioned above (Chapter 8 - Software), the LC-WELD SMART laser welding machines incorporate a parameter selection system, accessible from the two possible job types: "SYNERGIC" and "MANUAL".

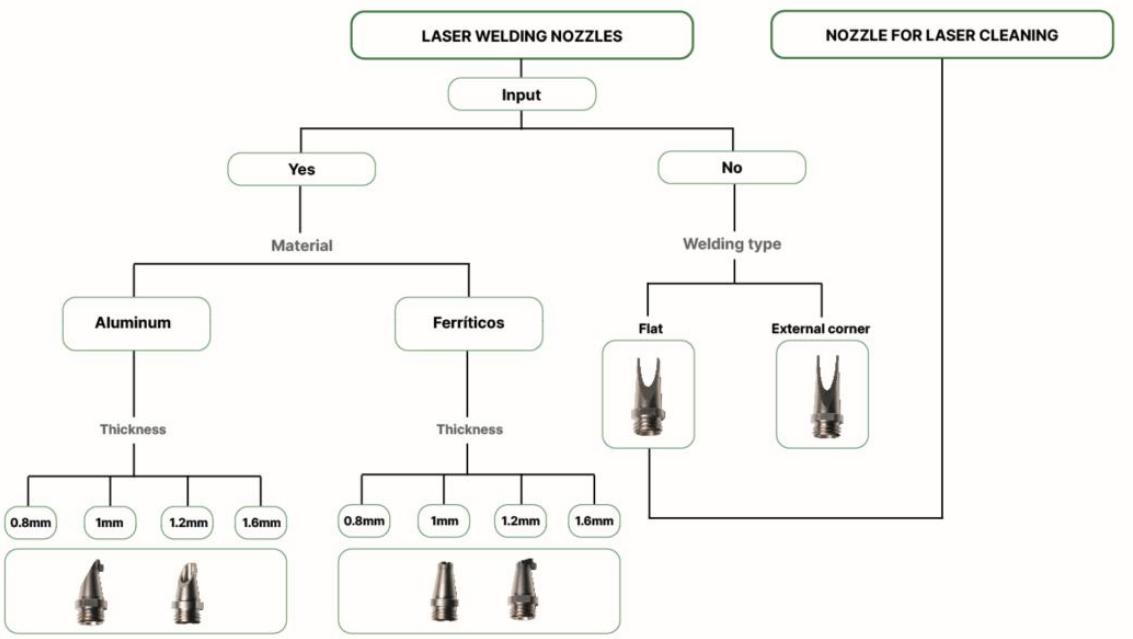
Once in the "SYNERGIC - EDIT" or "MANUAL" mode, a menu with various parameterization options will appear:

PARAMETERS	Unit	Min - Max	EXPLANATION
LASER POWER	%	5-100	Laser power delivered to the weld. It is expressed as a **percentage (%).** **Power** is one of the most important parameters determining weld penetration.
LASER FREQUENCY	Hz	10-50.000	Laser beam emission frequency. It is expressed in Hertz (Hz). The frequency is determined by the material to be welded: • Ferritic materials: 20,000Hz • Aluminium: 50 Hz
LASER DUTY CYCLE (LASER DUTY CYCLE)	%	15-99	**The amount of time** within one Hertz of laser emission in which the **resonator emits** laser radiation. It is expressed as a **percentage (%).**

			The **duty cycle** is determined by the material to be welded: • **Ferritic materials:** 80%. • **Aluminium:** 100%.
SHAPE	-	Two options: vertical and horizontal	**Shape** to be drawn by the S.M. system of the gun during welding. This parameter could be equated to the **weld combing** performed in conventional welding.
SHAPE FREQUENCY	Hz	1-100	**Frequency** at which the S.M. system will move**.** It is expressed in **Her (Hz).** In simplified terms, this is the **speed** at which the weld is to be **combed.**
WIDTH	ms	0,1-4,5 CLEAN: 0,1-5	**Size or width** that the **LINE is** going to have. It is expressed in **millimetres (mm).**
FEEDER ADVANCE (FEEDER ADVANCE)	mm/min	200-12500	**Speed at** which the welding **wire** will advance **during welding.** It is expressed in **millimetres per minute (mm/min).**
FEEDER BACK (FEEDER BACK)	mm/min	200-12500	**Speed** at which the welding **wire** will go **backwards as** soon as the welding is **completed.** It is expressed in **millimetres per minute (mm/min).** This parameter is **closely linked to the** parameter **"BACK DISTANCE".**
BACK DISTANCE	mm	0-10mm (inc. 1mm)	**Distance** that the wire will **move back as** soon as the weld is **completed.** It is expressed in **millimetres (mm).** This parameter, as explained above, is **closely linked** to **"FEEDER BACK"**.
BURN OUT (LASER OUTPUT)	ms	0-2000	This parameter allows us to parameterise separately the switching off of the feeder and the switching off of the laser, i.e. the wire feed is finished first and then the laser beam is switched off. It allows us to configure the programmed time it will take for the laser beam to switch off after the wire feed has been switched off. It is expressed in **milliseconds (ms).** This parameter is used to achieve a better welding output. The **recommended** programming **time** is around **500 ms.**
RAMP START TIME	ms	0-5000	These two parameters indicate the time of progressive increase (START) or reduction (END) of the laser power.
RAMP FINISH TIME	ms	0-5000	

			IMPORTANT: if working with thread feed, only the start ramp is operational, not the end ramp.
RETURN DISTANCE	mm	0-30	Length of feed wire returned at the end of the welding job
RETURN SPEED	mm/min	200-12500	Speed at which the feed wire returns at the end of the welding job
RETURN TIME	ms	1-3000	Waiting time before the wire returns at the end of the welding job
GAS ADVANCE (GAS FEED)	ms	5-300	**Pre-emission of pre-work** shielding **gas**, intended to **remove the air** surrounding the **welding** shaft. It is expressed in **milliseconds (ms).**
GAS RETARD (GAS OUTPUT)	ms	5-300	**Post** work **gas emission**, intended to **protect the cooling of** the **weld**. It is expressed in **milliseconds (ms).**
DELAY AND SELECTOR ADVANCE	ms	0-3000	This parameter can be divided into two functions: • If the "**ADVANCE**" selector **does NOT have a "tick".** (✓): During the **programmed time,** the **laser** beam **will be emitted** but the **feeder** motor will **not be activated.** This **function** is intended to **preheat** some materials before starting the **weld** bead. • If the "**ADVANCE**" selector **DOES have a "tick".** (✓**):** During the programmed time, the Feeder motor will be activated but no Laser beam will be emitted.
FEEDER SELECTOR (WIRE FEEDER)	NA	NA	Activation or non-activation of the wire feed within the welding profile. • If the **box does NOT** have a **tick (✓), the wire** feed motor **will NOT be activated** at any time **during the job.** • If the **YES box** contains a **tick (✓), YES will activate** the **wire** feed motor **during the job.**

9.2 CHOICE OF WELDING NOZZLES AND CLEANLINESS


LASER WELDING NOZZLES
NOZZLE FOR LASER CLEANING
Input
Yes
No
Material
Welding type
Aluminum
Ferríticos
Flat
External corner
Thickness
Thickness
0.8mm
1mm
1.2mm
1.6mm
0.8mm
1mm
1.2mm
1.6mm

CHAPTER 10 - MAINTENANCE

The LC-WELD SMART laser welding equipment requires regular maintenance to ensure proper operation.

The different operations related to maintenance are detailed below:

- Transport and storage
- Precautions to be taken
- Periodicity of the different maintenance tasks

10.1 TRANSPORT AND STORAGE

The different components of the equipment must be stored and kept properly after use:

- **Hose:** It must be coiled in the existing side fittings on the equipment.
- **Gun: it** must be properly fitted into the holder specifically designated for it on the side of the equipment.
- **Feeder or wire feeder:** It must be stored on top of the equipment on the pivoting support specifically designated for it, with the towline attached to the hose or properly coiled, without disturbing the passage or potentially causing accidents. All doors and/or covers must be properly closed and secured.

To prevent it from tipping over during transport, it is recommended to move the LC-WELD SMART Laser welding unit carefully by pushing on the horizontal bar at the front of the unit.

The equipment must always be moved using the wheels.

Under no circumstances should any attempt be made to lift the equipment manually: serious accidents and/or injuries may occur.

If it is essential to lift the equipment, forklift trucks or similar must be used, with appropriate safety measures in place.

The person in charge of operating/driving the forklift must be in possession of a valid forklift licence.

- It is advisable to wear safety footwear and appropriate work clothing to protect users' feet and prevent accidents to the skin and the rest of the body.
- The body posture should be appropriate without putting too much strain on the back.
  In case of injury and/or discomfort to any part of the body, refrain from dragging and/or moving the equipment.
  The equipment must be stored in a cool and dry place, free from agents and objects that could damage the materials and/or components.

IMPORTANT

It is important to apply the brakes once the equipment has been transported and is in a safe place.

It is mandatory to activate the brakes during use of the equipment and in storage: otherwise serious accidents may occur.

10.2 PRECAUTIONS

The following precautions can be taken into account in general for all LC WELD SMART models.

General maintenance precautions

For maintenance, repair and inspection, it is essential to **switch off the equipment**, remove the key and press the **emergency stop** switch.

Welding Gun Maintenance Precautions

Under **no circumstances should the** gun be serviced when the equipment is **switched on**, unless expressly instructed to do so by an authorised Service Centre.

The equipment **must be switched off,** to avoid possible damage or accidents.

Precautions when handling fiber laser cable.

Incorrect handling of the laser fibre cable can damage it and cause **serious problems and** malfunctions in the operation of the equipment. Avoid bending, **dragging or placing excessive weight** on the fibre cable. Do not bend more than 150 mm in diameter.

Precautions when handling the different optical elements

Any **scratches or dirt** on any of the **optical elements of the** gun can **degrade** the laser welding process.

For this reason, appropriate measures must be taken to handle any of the optical elements correctly, such as working in a **dust-free environment** and **wearing nitrile gloves** so as not to leave any greasy residue on the optics.

Precautions when returning to work after maintenance

Once the maintenance work has been completed and **before using the equipment**, check that all **screws are tight**, all **connections are correct** and that the **safety systems are working properly.**

10.3 PERIODIC REVIEWS

To ensure the proper functioning of the LC-WELD SMART laser welding equipment, a number of periodic inspections must be carried out. These will be divided into:

- Daily Reviews
- Weekly Reviews

10.3.1 DAILY REVIEWS

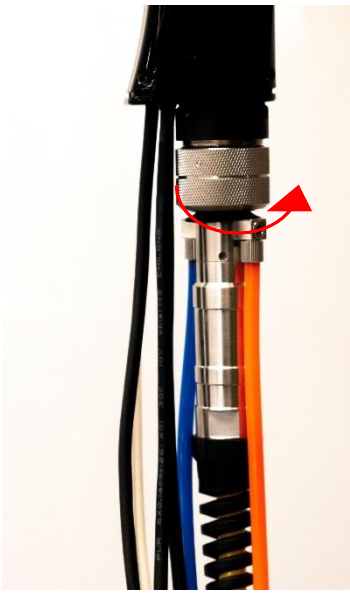
- **CLEANING THE GUN: Every day at the end of each shift**, the gun must be cleaned **with a cloth** (either cotton or microfibre) and a **NON-AGRGRESSIVE** cleaning product (such as glass cleaner), to remove **the dust and** surface **dirt** accumulated on the gun. While cleaning, it is advisable to check that the gun does not leak water from any joint. Clean the welding tube, check the state of the nozzles and clean the front of the gun (estimated time 5 minutes).

- **CLEANING THE LASER AND GAS EXIT TUBE: Every day at the end of each shift**, the **laser and gas exit tube** of the gun must be cleaned to remove any

micro projections that may have become embedded in the nozzle and/or the tube. This must be done with **a circular metal brush** with a diameter of Ø8mm. This operation must be carried out **by extracting the tube** from the gun, unscrewing it after unblocking the locking nut (estimated time 5 minutes).

- **CHECKING THE QBH:** While performing the daily cleaning of the gun, it is advisable to check the condition of the QBH, making sure that it is not loose or unscrewed. It must be firmly attached to the gun and its threaded part turned as far as possible to the right.

Reference photo:



10.3.2 WEEKLY REVIEWS

- **GENERAL CLEANING OF EQUIPMENT: In** addition to the daily checks, **every Friday at the end of the last shift the** equipment has to be cleaned in a general way:
  - Clean the side filters to remove accumulated dust.
  - Clean the top tray of the equipment to remove accumulated dust (clean with a cotton or microfibre cloth and a non-aggressive cleaning product such as glass cleaner if necessary).
  - Clean the equipment hose to remove accumulated dirt and dust.

    (estimated time 15 minutes)

IMPORTANT **Cleaning should always be carried out with the equipment switched off and the wheel brakes applied.**

- **WIRING CHECK: In** addition to the daily checks, **every Friday at the end of the last shift,** all equipment wiring must be checked to ensure that it is in optimum condition and that there are no defects:
    - Power supply cable.
    - Ground cable and clamp.
    - Gas pipe.
    - Gun hose.

CHAPTER 11 - DIAGNOSIS AND TROUBLESHOOTING

The LC-WELD SMART laser welding machines work with highly advanced technologies.

However, like any industrial equipment, LC-WELD SMART laser welding machines are not exempt from **minor faults and problems** that need to be diagnosed and repaired.

This chapter provides details on how to diagnose these minor faults and/or problems and how to solve them.

11.1 DIAGNOSTIC PREMISES

The following are the main premises to be taken into account when diagnosing errors in our LC-WELD devices:

11.1.1 RULE FUNDAMENTAL

One of the **most important things** to **understand and keep in mind** is that the **red pointer** indicates the **path the laser beam will follow** when it is triggered.

If you do not see the red pointer on the gun output when switching on the equipment, the cooler and the laser, there are 2 options:

- The laser source is switched off or suffers from a problem and/or malfunction.
- The laser beam (red pointer) is deflected or interrupted, which means that there is an error or malfunction in the optical system, either at the level of dirt/pitting in one of the optical elements or at the level of the S.M. system (the beam is being abnormally directed).

If the laser is deflected or interrupted and the trigger of the welding gun is pulled, it is impossible to know where it will therefore be directed:

WARNING: Never fire unless you can see the red pointer on the pistol's trigger guard.

When the red pointer is not present at the tube outlet, it is **imperative to** find the cause **before attempting to weld.**

ATTENTION: Attempting to weld or fire the laser without the presence of the red dot will be considered negligent and the repair will be considered out of warranty.

11.1.2 SEPARATION BETWEEN EQUIPMENT AND GUN

The first step that can be taken in diagnosing a fault is very easy:

We can be **100% sure** that the Laser resonators that equip our machines are specially programmed to **only allow a** light beam **to be fired** if the **resonator is** in **PERFECT INTERNAL CONDITION**, so we can draw the **following conclusion:**

***IF THE EQUIPMENT EMITS A LASER BEAM (AND AN ALARM IS NOT EMITTED FROM THE CONTROL PANEL IMMEDIATELY AFTERWARDS), ALTHOUGH PRACTICALLY ALL THE POWER IS LOST, WE ARE DEALING WITH AN OPTICAL TYPE ERROR).**

This means, in short, that the **resonator can only fire well**, so any **electrical and/or resonator errors will be** automatically **ruled out if a shot is fired at** the right time, and the **focus will be** 100% on the **optical system** of the equipment (gun and fibre head).

If, on the other hand, the equipment does **not behave normally** when attempting to weld (the resonator does not fire, the beam does not move normally, the wire does not come out, etc...) attention shall be drawn to the **electrical, electronic and control system of the equipment**.

11.1.3 DO NOT INSIST

As soon as an **error** appears **in the optics of the** LC-WELD SMART hand-held laser welding units, the most frequently observed **characteristic is the loss of power of the unit during operation.**

The most common mistake made by users of LC-WELD SMART equipment is to **insist on welding**, even going so far as to **increase the percentage of power in an** attempt to make the equipment weld better. This practice can only **further damage the** optics of the gun or the welding head, **making the repair more expensive.**

Therefore, **the most appropriate reaction** to an **eventual loss of power** will be to **check the optical elements one by one in the** order detailed later in this document.

11.1.4 STATE OF THE OPTICS

!	IMPORTANT	**Before proceeding to inspect any of the equipment's optical elements, review the manufacturer's WARRANTY conditions and recommendations for use.**

When an optical error is found, the optical system shall be checked.

This means checking the condition of each of the optical elements of the gun and/or the fibre head, and their condition must be **absolutely perfect.**

If we find any **smudges, shadows, or marks** on the surface of any of the **optical elements**, there is a very high percentage of probability that this element is **irreparably damaged**.

Attempts can be made to clean the surface of the optical elements with **microfibre cloths** or **special optical swabs** and **isopropyl alcohol**, but **there is no guarantee** that such cleaning will solve the problem since, as already mentioned, there is a very high probability of **irreparable damage**.

Optics can be checked in **two ways:**

- Counter reflex
- Against the light

Checking **against reflection** simply means looking for the reflection of any light (window, fluorescent, etc...) in the plane of the optical element and checking the perfect condition of the element.

The **backlight** check involves looking through the optical element against any light that is not excessively strong (preferably outdoor or ambient light) and checking that there is no damage to the element.

11.1.5 ORDER OF VERIFICATION

As soon as an **optical error** appears with an **apparent loss of power**, the optics of the gun should be **checked** based on the **probability of damage** to the individual elements of the gun and/or fibre head.

But first **of all**, it must be ensured that it is an optical problem, so the **check** will be carried out **strictly in the following order:**

1. Verification of the red pointer (sharp and centred).
2. Verification of focal length (Quality Control Certificate).
3. Checking the threaded pipe and nozzle (Cleaning).
4. Inspection of lens protector(s).
5. Lens inspection.
6. Inspection of the collimator lens

11.2 INSPECTIONS OF THE OPTICAL SYSTEM

		Before proceeding to inspect any of the equipment's optical elements, review the manufacturer's WARRANTY conditions and recommendations for use.
!	IMPORTANTE	**The rest of the optical elements of the system (steering mirror system, collimator and fibre head) are for the exclusive use of the Authorised Technical Assistance Service.** **Any unauthorised tampering will automatically void the warranty on the gun and, if applicable, on the equipment**

- **INSPECTION OF THE LENS PROTECTOR**:
  - Use the tool supplied with the gun to loosen the lens protector drawer.
  - Carefully remove the drawer.
  - Inspect the lens protector against backlight and glare.
  - There are two lens protectors, check both carefully.

- **LENS INSPECTION**:
  - Use the tool supplied with the gun to loosen the lens barrel.
  - Release the shield block with an Allen key, and loosen the ground cable with an Allen key.
  - Remove the protector block carefully to prevent the lens protector from falling off.
  - Remove the thermal bridge with an Allen key.

- Once the thermal bridge has been removed, **visually check** the condition of the lens, focusing with a torch or light source if necessary, to look for any damage to the lens.

11.3 REPLACEMENTS IN THE OPTICAL SYSTEM

IMPORTANT	**Before proceeding to inspect any of the equipment's optical elements, review the manufacturer's WARRANTY conditions and recommendations for use.**

IMPORTANT!!!	**ATTENTION!!! Any operation related to the optics of the gun must be carried out in an environment FREE OF SUSPENSION DUST, to avoid possible contamination of the optical elements exposed during the operation.**

11.3.1 LENS PROTECTOR REPLACEMENT

To change the lens protector, the following steps must be followed:

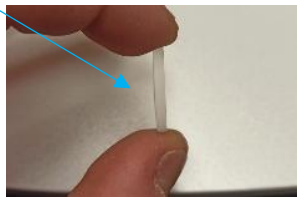
- Loosen the lens protector housing from the threaded part using the tool provided with the gun. If this part is lost or missing, the following tools can be used:
  - Screw with M2.5 thread
  - Allen of M1.5 and M2
- Carefully remove the drawer of the lens protector.
- Loosen the stud bolt securing the guard to the drawer with the tool supplied with the gun.
- Remove the ring placed on top of the protector.
- Remove the damaged lens protector by dropping it on your hand and discard it.
- Replace the lens protector with a new one, always holding it by the edge to avoid soiling the lens surface.
- Replace the ring.
- Carry out the process in reverse, fixing the lens protector with the stud bolt, placing the drawer back into the hole.

11.3.2 LENS REPLACEMENT

To replace the focal lens, the following steps must be followed:

- Loosen the lens protector housing from the threaded part using the tool provided with the gun. If this part is lost or missing, the following tools can be used:
    - Screw with M2.5 thread
    - Allen of M1.5 and M2
    -
- Carefully remove the lens drawer
- Loosen the stud bolt that secures the focal lens in the drawer with the tool provided with the gun.
- Remove the ring on top of the lens.
- Remove the damaged lens by dropping it on your hand and discard it.
- Replace the lens with a new one, always holding it by the edge to avoid soiling the lens surface.
- The new lens must **ALWAYS** be fitted **WITH THE CONVEXED PART INWARD OF THE GUN**.

CONVEX PART OF THE LENS



- Carry out the process in reverse, placing the ring on top of the lens, fixing the lens with the stud bolt in the drawer, placing the drawer and fixing it on the gun.

11.3.3 NOZZLE REPLACEMENT

1. Remove the nozzle from the laser and gas outlet tube by turning it counterclockwise.
2. Tighten the new nozzle clockwise onto the laser and gas outlet tube.

11.4 ERRORS AND MALFUNCTIONS

In the following, different possible faults and malfunctions in the LC-WELD SMART laser welding equipment are detailed, which will be divided into two main sections:

- Errors and malfunctions in the equipment.
- Errors and anomalies in welding.

11.4.1 EQUIPMENT FAULTS AND MALFUNCTIONS

11.4.1.1 THE PISTOL DOES NOT FIRE

- Check if the red pointer is visible.
- Check that the laser source is switched on ("START" submenu).
- Screen in welding mode ("WORK" submenu, green "START" button, screen with black background).
- CONNECTION" indicator lit (green).
- WELDING" indicator lit (green).
- Check that no alarm signal is emitted ("ALARMS" submenu).
- Check the button on the gun:
    - Check cable connections in the hose.

11.4.1.2 RED POINTER IS NOT VISIBLE

- Check that the laser source is switched on ("START" submenu).
- Check that no alarm signal is emitted ("ALARMS" submenu).
- Check if the lens protector is dirty.
- Check if the lens is dirty.
- Remove the laser head with the laser OFF.
    - (Case 1) The red pointer is visible so the collimator may be dirty or damaged.
    - (Case 2) The red pointer looks bad so the laser head may be damaged.
    - (Case 3) The red pointer is visible. The collimator and head are in very good condition, it could be a problem in the STEERING MIRROR system (contact the service department).
    - (Case 4) The red pointer is not visible - Contact the Service team.

11.4.1.3 THE RED POINTER IS VISIBLE, BUT I CAN'T CENTRE IT.

- Check the centring of the pointer using the "Work profile" screen. Pressing the icon will open the centring screen.
- If it is not possible to centre the pointer correctly, please contact the Technical Service team.

11.4.1.4 ANY ALARM IS ACTIVATED

- Using the ALARMS submenu, detect which alarm it is.
- Please contact the Technical Service team.

12.4.1.5 THE LASER RESONATOR DOES NOT SWITCH ON

- Check that no alarm signal is emitted ("ALARMS" submenu).
- Please contact the Technical Service team.

12.4.1.6 RED POINTER DOES NOT MOVE WHEN SOLDERING

- CONNECTION" indicator lit (green).
- WELDING" indicator lit (green).
- Check cable connections in the hose.
- Please contact the Technical Service team.

12.4.1.7 THREAD DOES NOT DRAG WHEN FIRING

- Display in welding mode ("WORK" submenu, green "START" button, display with black background).
- Feeder mode activated on welding screen.
- Check the roller locking system on the feeder motor.
- Please contact the Technical Service team.

12.4.1.8 SOLENOID VALVE DOES NOT ACTUATE WHEN TRIPPING

- Check that no alarm signal is emitted ("ALARMS" submenu).
- Press GAS on the parameterisation screen and check if E.V. is switched on.
    - Ignition - Check the welding parameters and the condition of the gas cylinder as well as the flow rate of the regulator.
    - No power on: check the power supply to the electrical panel.

- Please contact the Technical Service team.

12.4.1.9 VERY HOT OR BUBBLY LASER HOSE

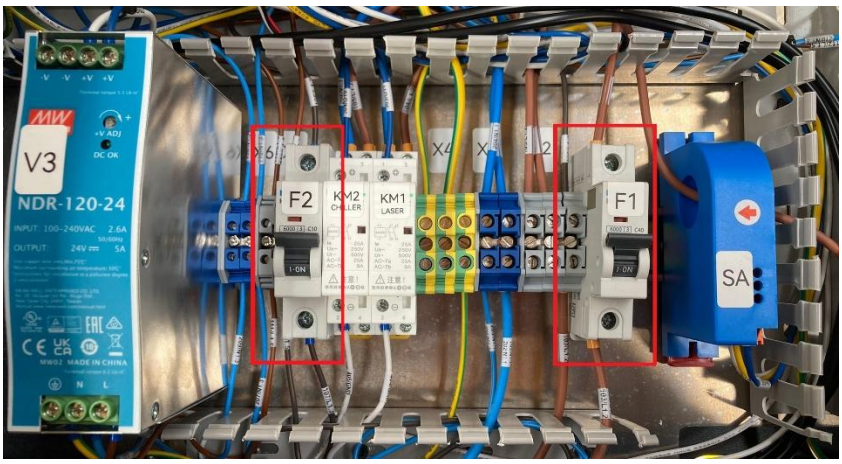
- Broken laser fibre - Replace.
- Please contact the Technical Service team.

11.4.1.10 THE MACHINE DOES NOT TURN ON

- Overvoltage. For these cases, the equipment has two magneto-thermal circuit breakers to protect both the internal electrical circuit and the user.

- To reset the system, open the side cover indicated in the image by removing the screws:

Once the cover is open, check that the F1 and F2 magneto-thermal switches have tripped and reset them.



11.4.2 WELDING ERRORS AND ANOMALIES

11.4.2.1 WHEN WELDING THE PIPE BURNS VERY MUCH

- The beam may be touching the tube: check the centring of the red pointer.
- Check the focal length. if it is not found, there is a problem with the optics (see chapter 12.2).

11.4.2.2.2 THE WELD IS NOT REGULAR

- Check the parameters on the work profile screen.
- Check the focal length.
- Check the centring of the red pointer.
- Check the welding position.
- Check that the welding wire comes out correctly and stably.
- Check that the feeder motor provides a constant wire feed.
- Possible presence of moisture in the welding wire.
- Check the optical system (see chapter 12.2).

11.4.2.3 THE WELDING LOSES POWER

- Optical problem, check optical section (see chapter 12.2).

11.4.2.4 LENS PROTECTORS BREAK TOO OFTEN

- Check that the nozzle and tube are not dirty.
- Check the humidity of the gas.
- Check that the gas pressure is adequate (18-22L/min).
- Check that the gas cylinder is not at the end of its capacity.
- Check that gas is flowing steadily out of the regulator.
- Check that the material to be welded is not very dirty. If it is dirty, it is recommended to clean it with acetone to remove greasy residues.
- The gas flow rate can be slightly increased (2-4L/min more).
- Check the welding position (+/- 55°).

11.4.2.5 WELDING ON ALUMINIUM: THE TUBE GETS VERY HOT

- This is normal due to the higher reflectivity of aluminium; keep an eye on the position.

11.4.2.6 NORMAL WELDING NOISE IS NOT HEARD DURING WELDING

- The problem could be the focal length, which can change over time.

- Check the optical section (see chapter 12.2).

11.4.2.7 LENS OR LENS PROTECTOR FOGS UP

- Possible condensing environment (high humidity), however, check the optics in general (see chapter 12.2).

11.4.2.8 PISTOL GRIP BECOMES HOT

- Check the output of the red pointer.
- Check the laser head.
- Check the collimator.
- Please contact the Technical Service team.

11.4.2.9 MY EYES ITCH WHEN SOLDERING

- Use a welding fume extractor.
- Wear suitable, approved and well-maintained protective goggles and face shield.

11.5 SERVICE AND ASSISTANCE

As LC Lasers' hand-held laser welding technology is a highly innovative technology, it is not uncommon for questions to arise regarding safety, use of PPE, set-up, operation, installation and maintenance of the LC-WELD SMART equipment.

Most of them can be easily solved by reading this instruction and safety manual carefully.

If you have any questions or technical problems, please contact the Technical Assistance Service of your official distributor.

11.6 FAILURES

In the event of a malfunction of the LC-WELD SMART laser welding device, the user can only follow the instructions given in the previous points.

In the event of a fault outside the points indicated above, call directly to the Technical Assistance Service of your official distributor to solve the problem, without carrying out any action other than those described above, leaving the equipment duly switched off, disconnected and stored to avoid damage to third parties.

IMPORTANT

Under no circumstances open the side covers or carry out any operation on the rest of the equipment that has not been described in this manual. In case of doubt, contact the Technical Assistance Service of your official distributor.

12.7 ACCIDENTS

In the event of an accident with the LC-WELD SMART Laser Welding Unit, a distinction must be made between:

- **Property damage** accidents**.**
- Accidents involving **personal injury.**
    - **Skin** damage**.**
    - **Eye** damage**.**

Call the emergency service and contact the relevant authorities in case of personal injury or physical damage.

CHAPTER 12 - DISMANTLING THE WELDING DEVICE

12.1 LASER WELDING EQUIPMENT DISMANTLING PROCESS

For dismantling laser welding equipment, LC Lasers provides you with a number of tips and instructions to make the dismantling process quicker and easier.

1. Disconnect the gas supply to the laser welding machine.
2. Turn the switch to the OFF position and remove the key. Then put it in a plastic bag and attach it to the front of the device.
3. Disconnect all power cables from the laser welding equipment.
4. At the rear of the welding equipment, disconnect the flexible hose from the gas inlet connection. This is the gas line from the installation that enters the system.
5. Cover the welding head carefully with plastic and bubble wrap.
6. Carefully roll and wrap the hose and place it next to the welding head on top of the device.
7. This will complete the disassembly procedure.

WEEE Directive for environmentally safe disposal.

Improper disposal leads to pollution and contamination of the environment.

Precautions:

- Electronic devices must be disposed of in accordance with regional directives on waste electrical and electronic equipment (WEEE), such as directive 2012/19/EU.
- Do not dispose of this product with unsorted municipal waste. At the end of its useful life, this product should be sent to separate collection facilities for recovery and recycling.
- **Please contact customer service for more information on the decommissioning of this product.**

By properly recycling electrical and electronic equipment, users can ensure **environmentally** sound treatment and disposal of waste to reduce potential environmental or health risks that may occur as a result of improper disposal.

CHAPTER 13 – ANNEXES

ANNEX 1 - LASER SOURCE CHARACTERISTICS

OPTICAL SPECIFICATION	**Output Power (W)**	≤1500
	Operating Mode	CW
	Polarization	Random
	Power Range (%)	1 – 100%
	Central Wavelength (nm)	1070 ±10
	Power Instability (%)	<2,5
	Max. Modulation Frequency (kHz)	<20
	Red point Laser power (mW)	1
	Beam Delivery Optics	QBH
	Output Fiber Diameter (µm)	50
	Delivery Fiber Length (m)	10-15m
ELECTRIC SPECIFICATION	**Operating Voltage (VAC)**	AC 220V 50/60Hz
	Max Power Consumption (A)	≤20
OTHER SPECIFICATION	**Dimensions W×H×D (mm)**	5605X339X423
	Weight (kg)	25
	Ambient Temperature (℃)	5~40
	Ambient Humidity (%)	10-90
	Cooling Method	Gas cooling
	QBH Cooling Temperature (℃)	Gas circulation
	Storage temperature(℃)	-10-50

ANNEX 2 - DIRECT, DIFFUSE AND/OR SPECULAR EXPOSURE

To carry out the laser radiation measurements and the assessment of the machine envelope, an instrument from the manufacturer OPHIR was used. The instrument consists of a power meter (or probe) and a reader (or display). As power meters, the thermal probe was used:

- model 3A, low power and high sensitivity,

The measuring probes are connected to the reader (of the Laser-Star model).

In laser welding, marking and/or cutting processes it can be assumed that most of the energy is absorbed by the material and the transmission is zero. However, there is always a part of the reflected energy to which a reflectance factor can be associated . The part of the reflected energy can be of two types:

- Diffuse reflection, whereby the laser beam loses its directivity and its energy is transmitted in all directions in the space around the process zone. From a laser radiation exposure point of view, this is the shortest range. In the worst case, 100% of the incident energy can be considered to be reflected as scattered light, i.e. a reflectance equal to 1.

- Specular reflection, where a beam incident on a material is simply deflected in a direction opposite to the incidence at the same angle to the plane of the processed material and maintains its directivity. From the point of view of exposure to laser radiation, it is just as dangerous as direct exposure. The UNE-EN 60825-4 standard suggests that it should be assessed by testing.

The expressions used to quantify reflections may vary depending on the configuration of the laser system.