LightWELD® Series
Handheld Laser Welding System
Original Operating Manual
(for use in European Economic Area)

Includes the LightWELD® XC Model
Welding and Cleaning System

Document Number: **DOCCHUGMPSEN0018 | Rev:2**
Date: **02/06/2023 | DCO: D5712**

Important Safety Information

This operating manual must be read before using the LightWELD® device.

The information and instruction in this operating manual can not substitute a comprehensive work place and work process related hazard and risk assessment. Depending on the results of this hazard and risk assessment further protective means or further PPE must be applied or the working place or working process must be revised for safe operations of your application.

Laser Radiation

Exposure to laser light can inflict severe retina and/or cornea injuries leading to permanent eye damage and may cause skin damage. Some laser light, including the welding (or cleaning) beam (1070 nm), is invisible. Safety protocols must be followed to prevent accidental exposure to invisible, direct and reflected beams. The system must only be operated in a Laser Controlled Area (LCA).

Eye Damage

Only one person is allowed to be in the Laser Controlled Area while the device is in operation. The person in the Laser Controlled Area must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing, to protect against eye damage from any reflected or scattered laser beams as well as welding bright light, ultraviolet (UV) light, heat and sparks. Sleeves and collars should be buttoned at all times.

The combination of appropriate laser safety glasses and LightWELD helmet will provide sufficient protection against eye damage. Ideally the person in the Laser Controlled Area can be observed and monitored, by personnel outside the Laser Controlled Area, using camera technology.

IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.

If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

* As defined by ANSI and EN 60825-1, a Laser Controlled Area is “a laser use area where the occupancy and activity of those within is controlled and supervised. This area may be defined by walls, barriers or other means. Within this area, potentially hazardous beam exposure is possible.” Laser controlled areas are generally enclosed areas capable of absorbing stray laser energy and equipped with a safety interlock to the laser to prevent unauthorized access while laser is in use.

Skin Hazard

Exposure to infrared (IR) and ultraviolet (UV) light radiation as well as heat and sparks can cause serious injury to the skin. The person in the Laser Controlled Area must wear all appropriate personal protective equipment (PPE), including protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.

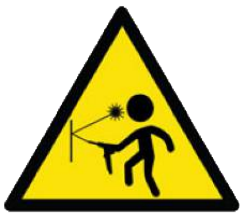
Depending on the intensity of the IR light, skin injuries may also include thermal burns or excessive dry skin. Exposure to UV light may cause sunburn and will increase a welder's risk of skin cancer and accelerated signs of skin aging. Welding sparks may also cause burns as well as contacting to hot surface or exposure to thermal radiation or hot particles. Avoid touching the welded part or the weld head nozzle tip and/or tube, with unprotected skin, immediately and shortly after laser emission.

Ideally the person in the Laser Controlled Area can be observed and monitored, by personnel outside the Laser Controlled Area, using camera technology.

IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.

If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

Laser beam can penetrate through metal parts to objects or persons on the other side. Never hold parts for processing in a position where laser penetration of the metal may result in a hazard.



Reflected Beam Hazard

Highly reflective metals such as aluminum and stainless steel may cause reflection of the laser energy away from the target weld site to the laser source or surrounding area and may present a hazard. Stray reflections may also damage materials, components or equipment nearby to the laser processing area.

Only one person is allowed to be in Laser Controlled Area while the device is in operation. The person in the Laser Controlled Area must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing, to protect against eye damage from any reflected or scattered laser beams as well as welding bright light, ultraviolet (UV) light, heat and sparks. Sleeves and collars should be buttoned at all times.

Ideally the person in the Laser Controlled Area can be observed and monitored, by personnel outside the Laser Controlled Area, using camera technology.

Fume Hazards

Welding “smoke” from interaction of the laser beam with target materials can be comprised of very fine particles, which are toxic and can damage the lungs, heart, kidneys and central nervous system. Inhalation exposure is the primary hazard from the welding fumes or the hazardous materials released except if one is from welding splatters and burns caused by them.

During welding, always keep your head away from fumes. Always weld in an area with adequate ventilation and use a fume extraction system to remove vapors, particles, and hazardous debris from the welding processing area.

Other Hazards

Laser radiation (both reflected and scattered), and heat and sparks produced during laser material processing can start a fire or cause an explosion in combustible or flammable materials in the Laser Controlled Area.

Laser welding and cleaning should only be performed in an area free of combustible or flammable materials. Never weld or clean parts on containers that have flammable or combustible material. If the contents of a container are unknown, you should assume that they are flammable or combustible. Flammable materials must be removed from the Laser Controlled Area before the Operator initiates handheld laser device operation. Remember to check the opposite side of the weld object’s seam to confirm there are no flammable materials on that side (some laser light can pass through the seam to the opposite side).

Gas cylinders must be stored only in areas where they cannot be struck by welding beams, sparks or laser beam deflections. Working regulators suitable for proper storage and pressure regulation of any gases are required. All hoses and fittings must also be suitable for the gas types and pressures used in the welding application.

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Preface

Ensure you read and understand this manual in its entirety and familiarize yourself with the operating and maintenance instructions before you use the product.

IPG strongly recommends that all operators of the product read and pay particular attention to all safety information contained herein prior to operating the product.

NOTICE

This operating manual should stay with the product to provide you and all future operators, users, and owners of the product with important operating, safety and other information. It should be referred to regularly.

For product technical assistance, contact IPG Service.

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Audience

This manual is intended for all owners and operators of the LightWELD device, as well as all persons working in the vicinity of the product when it is in use.

Use of this product should be limited to fully trained industrial, professional or commercial operators who are responsible for welding in industrial installations for commercial purposes.

All users of this product should be trained in both welding and laser safety, and must follow all instructions and safety warnings in the operating manual, safety labels on the LightWELD device, and all applicable safety standards, laws and regulations, including:

- EN 60825-1:2014 - Safety of Laser Products - Part 1: Equipment classification and requirements.
- EN 60825-4 - Safety of Laser Products - Part 4: Laser Guards
- 2006/25/EC - Artificial Optical Radiation.
- EN ISO 11553-2 - Safety of machinery - Laser processing machines - Part 2: Safety requirements for hand-held laser processing devices. Standard is found at:
  - https://www.iso.org/home.html
- **In Germany**: TRGS 900 and TRGS 910 (exposure limit values for hazardous substances). Standards can be found through the website:
  - https://www.baua.de/DE/Home/Home_node.html

We strongly recommend that all operators obtain appropriate laser safety training before operating this product. For laser training resources refer to Safety, Training, and Standards Resources [▷ 67] in this manual.

The LHW-Series is not intended for use in residential settings or by untrained operators in any setting.

Note

The language of the original instructions is English.

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1 Overview

1.1 Introduction

IPG Photonics introduces the LightWELD® series fiber laser system that consists of a compact weld control unit and an ergonomic, lightweight handheld weld head with built-in beam wobble functionality. The fiber laser source provides up to 1500 W maximum output power at 1070 nm infrared wavelength. Select stored program modes enable up to 2500 W of High Peak Power for additional capability.

The LightWELD® XC series fiber laser systems provide all the same welding capabilities as the LightWELD series system but with added cleaning functionality with an adjustable width up to 15 mm when operating in laser cleaning mode.

The new cleaning mode is used to remove oils, rust, contaminants and coatings before welding, and remove soot, debris and discoloration after welding. This will improve the visual appearance of the weld joint without the time and expense of abrasives and chemicals.

The IPG fiber laser welding system has been designed and tested with safety in mind. By following this User's Guide and applying sound laser safety practices, it can be a safe and reliable device.

Because of its special characteristics, laser light poses safety hazards different than light from other sources. Laser radiation may be dangerous for the eye and also for the skin if the irradiance of directly propagated, specularly reflected or even scattered radiation is high enough. All laser operators and persons in the vicinity of the laser when the laser is in use must be aware of the hazards and wear all recommended personal protective equipment and must follow all safety procedures provided / recommended during equipment use.

In order to ensure the safe operation and optimal performance of the product, please follow all instructions in this guide and adhere to all safety and related warnings.

These safety precautions must be observed during all phases of operation, maintenance, and repair of this instrument.

Operators are urged to adhere to these recommendations and to apply sound laser safety practices at all times. Furthermore, operators should review all safety guidelines and requirements for welding.

1.2 Types of Use

1.2.1 Intended Use

Use of this product should be limited to fully trained industrial, professional or commercial operators who are responsible for welding in industrial installations for commercial purposes.

Only the Operator of the laser device should be in the Laser Controlled Area while the equipment is being used. Ideally the Operator can be observed and monitored, by personnel outside the Laser Controlled Area, using camera technology.

All LightWELD series models are used for welding and brazing applications.

In addition, the following models can also be used for pre and post cleaning of the welding part surface:

- LightWELD XC

Product intended use is limited to metals materials processing such as: stainless steel, galvanized steel, mild steel, and aluminum.

- Metal Fabrication Shops
- Auto Body Applications
- Construction and piping
- Maintenance and Repair
- Aerospace and Transportation
- Farm, Furniture and Appliances

1.2.2 Non-Intended Use

Use of this product should be limited to fully trained industrial, professional or commercial operators who are responsible for welding in industrial installations for commercial purposes.

Use of this product should be limited to fully trained industrial, professional or commercial operators who are responsible for welding in industrial installations for commercial purposes. The device is to be used exclusively in the intended operation according to Intended Use [▸ 21].

All users of this product should be trained in both welding and laser safety, and must follow all instructions and safety warnings in the operating manual. All applicable safety standards, laws, directives and regulations must be applied and fulfilled.

Examples of product misuse include the following:

1. Use of this product by untrained persons.

2. Inadequate safeguards at the working site. Key safeguards include:
   - Establishing a Laser Controlled Area with an interlocked entrance
   - Providing PPE for the Operator within the laser controlled area (e.g. laser safety glasses, welding helmet with adequate filters and face protection, laser and heat-resistant clothes, gloves and apron
3. Unauthorized modification or conversion of the product by the user or other personnel without the express written permission of IPG Photonics.
4. Intentionally disabling or by-passing product safety systems.
5. Using parts and consumables (other than PPE that meets safety requirements) from other manufacturers (e.g. protective window, nozzle tips, etc) which do not meet minimum requirements.
6. Using this product to weld parts that contain materials other than those described in Intended Use [▶ 21].
7. Removing or defacing safety labeling and hazard notices.
8. Holding parts in hand or in any manner where the weld head is pointed in the direction of any individual's body parts.
9. Use of this product by any individual in residential area.
10. Welding on containers that contain flammable, combustible or unknown materials.

1.3 Target Groups

This manual for the product LightWELD has been created by IPG Photonics for the operating and maintenance personnel of the product owner.

1.4 Personnel Qualifications

The areas of responsibility, ensuring the necessary competence and supervision of personnel must be precisely regulated by the product owner.

The personnel assigned to install, operate, and maintain the product must have the corresponding qualifications for performing this work. Any lack of knowledge on the part of the personnel must be corrected through training and instruction.

1.4.1 Professional Qualification

Professional qualifications are a necessary prerequisite for certain work on the product. Depending on the respective work, the corresponding product-specific qualification is also required.

Electrician

Electrical specialists include professionally trained personnel with the appropriate knowledge and experience. They are permitted to carry out electro-technical work, to assess it and recognize any potential hazards involved.

Laser Safety Officer

Laser Safety Officer include professionally trained personnel with the appropriate experience and qualification. They are responsible for conformance and enforcement of laser safety regulations. Successful participation in the training must be confirmed by an examination certificate. For further information please follow the local regulations.

1.4.2 Product Specific Qualification

Product-specific qualifications are obtained during training and instruction on the product. Depending on the product-specific qualification acquired, personnel are divided into the following groups:

Operating Personnel

The operating personnel was trained and instructed in the safe operation of the product.

The operating personnel may only:

- Perform welds using preset programs
- Perform cleaning using preset programs

Advanced Operating Personnel

The advanced operating personnel may

- Create User Mode recipes (welding/cleaning programs)
- Adjust preset welding and cleaning programs
- Select and install the weld head nozzle tip and tube
- Set up global device parameters

Maintenance Personnel

The maintenance personnel is made up of staff who have the corresponding professional and product-specific qualifications to perform the tasks listed below.

The maintenance personnel are trained in the maintenance of the product by IPG or another responsible IPG subsidiary or authorized to carry out the maintenance work, insofar as this is not carried out by employees of IPG.

The following tasks are performed by the maintenance personnel:

- Assembly and installation
  - Setting up the Laser Controlled Area
  - Set up and install the product
  - Run lines and fibers to the product
  - Connect the product (the power supply must be connected by an electrician)
  - Decommission the product
- Maintenance Work
  - Replace protective window
  - Clean the fiber cable terminator (quartz block of the fiber connector)
  - Replace the weld head
- Troubleshooting
  - Run diagnostics
  - Troubleshooting as described in the manual (refer to: Troubleshooting [▶ 170])

1.4.3 Overview Task / Qualification

Task	Chapter in the Manual	Qualification
Operating Laser Welder Device: • Welding and cleaning using preset programs	System Startup [▶ 101] System Shutdown [▶ 104] Quick Start Welding Using Preset Programs [▶ 129] Quick Start Cleaning Using Preset Programs [▶ 132]	Operating Personnel
Operating Front Panel Controls: • Set up laser power, wobble frequency, wobble length • Select and use program mode recipe • Set up global device parameters	Rotary Control Knobs [▶ 106] Program Mode Recipe Selection Buttons [▶ 108] Device Front Panel Setup Mode [▶ 110]	Advanced Operating Personnel
Operating Laser Welder: • Select and install weld head nozzle tip and tube	Weld Head Nozzle Tip and Tube [▶ 124]	Advanced Operating Personnel
Setting program recipes and parameters	Program Recipes and Parameters [▶ 136]	Advanced Operating Personnel
Setting up • Global device parameters • Program recipes and parameters	Computer Connection to Device [▶ 146]	Advanced Operating Personnel

Task	Chapter in the Manual	Qualification
Installing Welding Device: • Connect customer interface • Connect electrical power	Precautions [▶ 87] Air Flow and Installation Clearances [▶ 88] Connect Workpiece Clamp Cable [▶ 88] Connect Welding Gas [▶ 89] Connect Weld Head Cable [▶ 90] Customer Interface Connections [▶ 90] Connect Electrical Power [▶ 92] Laser Controlled Area Door Interlock Example [▶ 95] System Startup [▶ 101] System Shutdown [▶ 104]	Maintenance Personnel + Electrician
Establish a Laser Controlled Area	Establish a Laser Controlled Area [▶ 61]	Maintenance Personnel + Laser Safety Engineer
Identify and clear errors	Troubleshooting [▶ 170]	Maintenance Personnel
Decommissioning Welder Device	Decommissioning Welder Device [▶ 176]	Maintenance Personnel
Maintenance Work	IPG Weld Head Maintenance [▶ 177] Replacing the Weld Head [▶ 180] Connect/Disconnect Fiber Output [▶ 182] Output Termination Cleaning Procedures [▶ 187]	Maintenance Personnel

Table 1: Overview Task Qualification Title

1.5 Certification

IPG certifies that this instrument has been thoroughly tested and inspected. It was found to meet published specifications prior to shipping.

The product has been CE certified. Certification is indicated by the presence of the CE Mark on the Identification label in Safety Label Description and Location [▶ 44]. Relevant compliance standards are listed in Regulatory Compliance [▶ 47].

1.6 Model Naming Convention

IPG offers several LightWELD models. This guide is designed to provide complete instructions for all model types. Therefore, specific difference in models is noted where applicable. The figure below illustrates the model designation methodology.

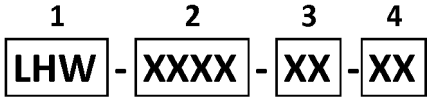


Figure 1: Laser Handheld Welder Model Designation

1 LHW is Laser Hand Welder

2 Average Output Power in Watts

3 Alphanumeric characters that indicate the model type or blank

Blank (for LightWELD model)

XC (for LightWELD XC model)

4 Fiber Length in meters

1.6.1 Models Covered

LightWELD® device models covered by this document include:

- LHW-1500-05
- LHW-1500-10
- LHW-1500-XC-05
- LHW-1500-XC-10

2 Safety and Compliance Information

2.1 Safety Information and Conventions

To ensure the safe operation and optimal performance of the LightWELD device and associated peripherals, follow all warnings in the product operating manual. The information and instruction in this operating manual can not substitute a comprehensive work place and work process related hazard and risk assessment. Depending on the results of this hazard and risk assessment further protective means or further PPE must be applied or the working place or working process must be revised for safe operations of your application.

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

Operators must adhere to these recommendations and apply sound laser safety practices at all times. There are no user serviceable parts, equipment or assemblies associated with this product, except as indicated in Maintenance [▷ 177]. All internal service and maintenance should only be performed by qualified IPG personnel, except as noted in Maintenance [▷ 177].

2.2 Safety Signal Words and Symbols

Safety warning notes throughout this user guide are introduced with specific signal words (e.g. **DANGER**, **WARNING**, **CAUTION** and **NOTICE**) and supplementary safety symbols. They are designed to call your attention to any hazards or important information. These standardized signal words will identify levels of hazards and risks for injury or property damages.

Refer to Signal Words Used in this User Guide [▷ 29] for the list of signal words and their meanings.

Refer to Safety Symbols Used in this User Guide [▷ 30] for a list of all the symbols and their meanings.

Safety warning messages will appear in this user guide wherever hazards or hazardous situations can occur. They will alert the user to direct and indirect hazards concerning the use of the product and associated peripherals, and contain general rules of behavior.

Safety warning messages will (1) identify what the hazard is, (2) specify what the consequences will be if the hazard is not avoided and (3) specify what precautions should be taken.

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 damage to property.

An example of a safety warning note is shown here.

⚠ DANGER

CLASS 4 LASER RADIATION

Severe and permanent eye damage from reflected or scattered radiation.

⇨ Protective laser eyewear must be worn inside the laser area if the system can be active (Keyswitch turned ON).

Signal Word[1]	Explanation
⚠DANGER	This signal word indicates an immediate danger. If this danger is not avoided, this will lead to death or severe injuries.
⚠WARNING	This signal word indicates a possible danger. If this danger is not avoided, this could lead to death or severe injuries.
⚠CAUTION	This signal word indicates a possible dangerous situation. If this dangerous situation is not avoided, this could lead to light or moderate injuries.
NOTICE	If this notice is not heeded, there is a risk of damage to the product, or other property damage or environmental damage.
IMPORTANT	This signal word indicates important information or recommendations concerning the subject under discussion (not hazard related). Do not overlook this information.

Table 2: Signal Words Used in this User Guide

[1] Do not proceed until you fully understand and meet all the required conditions.

Symbols	Explanation
WARNING HAZARD SYMBOLS:	
	ELECTRICAL HAZARD Indicates presence of dangerous voltages that may be of sufficient magnitude to constitute a risk of electric shock in certain conditions.
	LASER RADIATION HAZARD Indicates a danger of exposure to hazardous invisible and visible laser radiation.
	OPTICAL RADIATION HAZARD Indicates that operator must take precautions to avoid injury to eyes and skin from optical radiation (such as UV, visible or IR) that is produced during laser processing.
	CAUTION HAZARD SYMBOL General purpose hazard symbol to call your attention to a particular hazard.
	LASER CONTROLLED AREA SYMBOL This symbol is used to illustrate that the product must only be operated within a Laser Controlled Area where the occupancy and activity of those within is controlled and supervised. Within this area, potentially hazardous beam exposure is possible. Laser controlled areas are generally enclosed areas capable of absorbing stray laser energy and equipped with safety interlock to the laser to prevent unauthorized access while the laser is in use. The interlocks would automatically shut down the laser emission if someone opens the door to enter the laser area unexpectedly. Laser welding and cleaning within this controlled area protects personnel outside from hazardous exposure. The laser operator is the only person that is allowed in the Laser Controlled Area while the device is in operation. The operator must be wearing all laser safety PPE. All other personnel must remain outside. Ideally the laser operator can be observed and monitored from outside the laser area room using camera technology.
	DIRECT AND REFLECTED LASER BEAM HAZARD Symbol illustration shows a reflected laser beam from the part surface that is directed towards the operator's head/body. This symbol was created to warn of a potential eye or skin hazard due to direct or reflected laser beams during welding (or cleaning). Personnel must wear protective equipment and clothing. The laser operator must consider cone of reflection and maintain proper position during operation to ensure no part of their head or body intersects with the reflection zone.
	DIRECT BEAM POINTING IS PROHIBITED Symbol illustration shows the handheld weld head being pointed towards person's head. Symbol warns user to NEVER look directly into the output weld head or point the handheld weld head at others. This is extremely dangerous, even when wearing full eye protection.

Symbols	Explanation
	FIRE HAZARD Symbol indicates a possible fire hazard. Operators must take precautions to avoid causing a fire by igniting flammable material.
	HOT SURFACE HAZARD Symbol indicates hot surface during welding. To avoid possible burns protective gloves and clothing should be worn.
	GAS CYLINDER HAZARD Symbol indicates exploding pressurized cylinder. The gas cylinder must be protected from high temperatures, sparks, and flames. Cylinder should be secured to prevent it from tipping over.
	FUME INHALATION HAZARD Symbol indicates a inhalation health hazard. Personnel should take precautions to protect themselves from being exposed to hazardous and toxic fumes produced during welding.
	WARNING ASPHYXIATING ATMOSPHERE HAZARD Symbol indicates a build up of toxic gases and fumes that can cause unconsciousness, asphyxiation or death.
	HEAVY WEIGHT HAZARD Symbol warns that physical injuries are possible when attempting to carry the welding unit alone. Please note that welding unit weighs approximately 50 kg (110 lb).
MANDATORY SYMBOLS:	
	NOTICE SYMBOL Symbol is used in conjunction with the NOTICE signal word. Notices are related to various kinds of property damages. Ensure you do not overlook this information.
	WEAR LASER PROTECTIVE EYEWEAR Symbol indicates that personnel must wear laser safety eyewear (PPE) to protect against laser radiation hazards.
	WEAR WELDING MASK / HELMET This symbol indicates that personnel must wear a welding mask / helmet to protect their eyes and head. There may be hot flying particles, intense light and UV radiation from welding activity.
	WEAR PROTECTIVE GLOVES Symbol indicates that personnel must wear laser-resistant and heat-resistant protective gloves.fire and heat resistant, and arc resistant gloves.

Symbols	Explanation
	WEAR PROTECTIVE CLOTHING Symbol indicates that personnel must wear laser-resistant and heat-resistant protective clothing.fire and heat resistant, and arc resistant clothing.
	WEAR PROTECTIVE APRON Symbol indicates that personnel must wear laser-resistant and heat-resistant protective apron.fire and heat resistant, and arc resistant apron.
	WEAR RESPIRATORY PROTECTION Symbol indicates that respiratory protection must be worn.
	MUST SECURE GAS CYLINDERS Symbol indicates that all gas cylinders must be secured upright to prevent them from tipping over and to avoid flammable or explosive vapors being released.
	READ USER GUIDE INSTRUCTIONS Symbol indicates that personnel must read safety and operational instructions in this user guide.

Table 3: Safety Symbols Used in this User Guide

2.3 Laser Safety Information

2.3.1 Key Control

The keyswitch, on the front panel of the device, limits access to the laser device and can prevent an unauthorized user from turning the laser device on. In order for the laser to operate, the key must be inserted into the keyswitch and turned to the 1 (ON) position (refer to Weld Unit Front View [▶ 73]). Once turned to the ON position the key cannot be removed until turned OFF.

When the Operator of the laser device stops working and prior to leaving the Laser Controlled Area, the Operator must: (1) turn keyswitch to OFF, and (2) remove the key and store it in a secure location. This prevents unauthorized and untrained personnel from using the laser device.

2.3.2 Emission-ON Safety Indicators

The laser device is equipped with an Emission-On status indicator light located on the front panel of the unit (refer to Weld Unit Front View [▶ 73]). When this status indicator light turns on (during welding or cleaning), it means that laser emission was initiated by the operator controls on the handheld weld head.

The handheld laser weld head which can be 5 to 10 meters (16 to 32 feet) away from the unit front panel display, has an additional emission ON status indicator light on the weld head itself that will be lit red while laser emission is turned ON (refer to Weld Head [▶ 76] and Warning and Status Lights [▶ 123]).

⚠ DANGER

DANGER WHEN POWER SUPPLY (PS) IS ACTIVATED

The laser device is in a danger state and all precautions must be taken as if the laser is ready to emit.

⇨ The signals *Power Supply Enabled* and *Switch Enabled* on the 12-pin Interface Connector should be used for a laser radiation emission warning device.

The power supply that controls emission has two enables. One is called Power Supply Enable and the other is called Switch Enable.

On the 12-pin interface connector, pins 5,6 (Signal *Power Supply Enabled*) and 7,8 (Signal *Switch Enabled*) can be used to control an external warning device according to the requirements of EN 60825-1. The warning device shall warn that the laser is powered on, ready and capable of emitting. Full precautions must be taken.

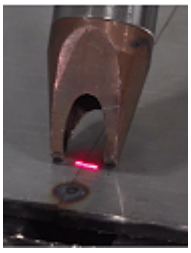
2.3.3 Laser Classification

This device is classified as a high power laser instrument with laser classification for each laser type identified in Laser Classification Information [▶ 34].

This product emits two types of laser radiation output!

Primary Laser: This is the material processing laser (Class 4, high power fiber laser) which is used for welding and cleaning). The emitted laser output is INVISIBLE.

Guide Laser: The guide laser (Class 2M) emits a VISIBLE red output beam that is used by the operator as a visual aid when positioning the weld head nozzle onto the parts prior to starting the welding (or cleaning) process. Picture below shows the red guide beam over the seam of the two plates prior to welding.



Characteristic	Primary Laser [2] Fiber laser used for welding / cleaning	Guide Laser [3] For positioning weld head nozzle
Laser Classification	Class 4 (per IEC 60825-1)	Class 2M (per IEC 60825-1)
Wavelength	1070 nm	600 to 700 nm
Laser Radiation Emitted	INVISIBLE (IR)	VISIBLE (Red)
Average Power	[1] greater than 1500 W	1 mW
Peak Power	[1] greater than 2500 W	1 mW

Table 4: Laser Classification Information

[1] Primary Laser: Total light power radiated from the optical output is greater than 1500 W average and greater than 2500 W peak per optical output port, depending on the model. Please refer to the product specification for the specific performance characteristics of your device.

[2] Primary Laser: Class 4 high power lasers present the most serious of all laser hazards. **Diffuse and specular beam reflections can inflict severe retina and/or cornea injuries leading to severe and permanent eye damage. Class 4 laser beams are also a potential skin hazard and fire hazard as well.** Take precautions to prevent accidental exposure to both direct and reflected beams and also against diffusely scattered radiation.

3 Guide Laser: **Eye exposure should be avoided. Do not stare into beam or view directly with optical instruments.**

⚠ DANGER

Class 4 Invisible Laser Radiation - Eye and Skin Hazards

This level of light may cause severe damage to the eyes and skin.

- ⇨ Due to these risks a qualified laser safety officer should be present to ensure a safe working environment. Refer to Establish a Laser Controlled Area [▶ 61] for information on establishing a Laser Controlled Area (LCA).
- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat resistant clothing. Sleeves and collars should be buttoned at all times. For more information, please refer to sections:
  - ⇨ Laser Safety Eyewear and Welding Helmet [▶ 36], Secondary Radiation Hazard [▶ 49], Protective Eyewear for Laser Welding and Cleaning [▶ 49], and Skin Hazard [▶ 51].
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

⚠ WARNING

Use of controls, adjustments or performance of procedures other than those set forth in this User Guide

May result in exposure to hazardous radiation.

2.3.4 Laser Safety Eyewear and Welding Helmet

Laser Safety Eyewear Standards:

Laser safety PPE must conform to the legislative requirements dependent on the location of the laser installation.

⇨ Refer to: (1) Regulation (EU) 2016/425 on personal protective equipment; and also (2) EN 207 Personal eye-protection equipment - Filters and eye protectors against laser radiation (laser eye-protectors).

The selection of appropriate laser safety eyewear requires the end user to accurately identify the range of wavelengths emitted from this product and the Foreseeable Exposure Limits (FEL). Please review the safety labeling on the product and verify that the personal protective equipment (i.e. eyewear, enclosures, viewing windows, or viewports, etc.) being utilized is adequate for the output power and wavelength ranges. Decisions on safety eyewear must also take into account any secondary radiation hazards due to the welding (or cleaning) process radiation and UV radiation (refer to Secondary Radiation Hazard [▶ 49]).

Protective eyewear is made possible with the use of filters which can transmit or attenuate a particular wavelength of light, partially or completely. The Optical Density (OD) of a filter is a measure of this attenuation of energy passing through the filter. The higher the OD value, the higher the attenuation and the lower the transmittance and the greater the protection value (more of the light of a particular wavelength is being filtered). In addition, the protective eyewear must provide a sufficient resistance against the FEL (i.e. it must withstand a direct hit from the laser for at least 5 second according to EN 207).

⚠ DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

- ⇨ IPG is providing one pair of laser safety glasses and IPG LightWELD helmet with the unit. This safety equipment must be worn by the Operator of the laser device.
- ⇨ Additional laser safety glasses and IPG LightWELD helmets are available for purchase. Refer to List of Available Accessories [▷ 71] for list of part numbers.
- ⇨ IPG recommends to use laser safety glasses in combination with IPG LightWELD helmet (refer to List of Available Accessories [▷ 71]).
- ⇨ All laser PPE must be CE marked.
- ⇨ The protection level LB depends on the laser operating mode D, I.
- ⇨ The letter "D" denotes a CW laser having a pulse length of >0.25 s.
- ⇨ The letter "I" denotes a pulsed laser, having a pulse length between 1 µs and 0.25 s.
- ⇨ The LB rating specifies the damage threshold of the filter material at maximum power or energy density.
- ⇨ If you have any questions on interpreting the protection ratings marked on your PPE, contact your employer's site Laser Safety Officer for assistance or further training.

⚠ DANGER

Incorrect or Damaged Laser Safety Glasses and Welding Helmet

Severe and permanent eye damage and vision impairment can occur.

- ⇨ Before using a pair of laser safety glasses and a welding helmet, all personnel must check the labeling and confirm that they meet the required LB rating.
- ⇨ Prior to use, the filters of the laser safety glasses and the welding helmet should be inspected to check for any cracking, discoloration, coating damage, pitting, and crazing. Also check the mechanical integrity of the frame.
- ⇨ If the condition of the PPE is suspect, it should be discarded and replaced.

Whether the laser is used in a new installation or to retrofit an existing system, the end user is solely responsible for determining the suitability of all personal protective equipment. There are several laser safety equipment suppliers in both Europe and the US that offer materials or equipment (refer to Laser Safety Equipment Suppliers [▷ 39]).

Item	Organization[1]	Website
European Union: [2]		
1	Laservision	https://www.uvex-laservision.de/
2	Protect Laserschutz	https://protect-laserschutz.de/
3	Laser 2000	https://www.laser2000.de/
4	Spetec	https://www.spetec.de/
United States: [2]		
5	Laservision USA	https://lasersafety.com
6	Kentek Corporation	https://kenteklaserstore.com https://www.kenteklaserstore.com/lightweld-class-4-laser-safety?utm_source=pd
7	Rockwell Laser Industries	https://rli.com

Table 5: Laser Safety Equipment Suppliers

[1] IPG provides the names of these providers solely as a convenience and does not endorse or recommend any of them, or their products or services. IPG assumes no liability for their recommendations, products or services.

[2] This list is not necessarily complete.

2.3.5 Laser and Heat Resistant Clothing PPE

Refer to Skin Hazard [▶ 51] for skin hazard related information. Unprotected skin of personnel may be exposed to extremely hazardous levels of the laser radiation, UV and blue light process related radiation and burns due to hot parts.

To protect against skin hazards, the Operator of the handheld laser device must wear laser-resistant and heat resistant gloves, clothing, caps and apron while the device is in operation. See Laser and Heat Protective Clothing Suppliers [▶ 40] for recommended supplier.

Protective gloves must resist against laser radiation of 1070 nm before exceeding the maximum permissible exposure skin value. Protective gloves must be suitable for use according to the welding protection standard EN ISO 11611. They must also be suitable for use according to heat and flame protection standard EN ISO 11612.

Item	Organization[1]	Website
European Union: [2]		
1	Protect Laserschutz	https://protect-laserschutz.de
2	Jutec	https://jutec.com

Table 6: Laser and Heat Protective Clothing Suppliers

2.3.6 Laser Technical Data and Safety Hazard Calculations

Relevant laser specifications for the product are indicated in Laser Technical Data [▶ 40].

Characteristic	LightWELD LightWELD XC
Operating Mode	CW[1] or HPP[2]
Wavelength	1070 nm
Maximum Average Power (in CW Mode)	1650 W
Maximum Pulse Energy (in HPP Mode)	13.75 J
Pulse Duration (in HPP Mode)	5 ms
Beam Divergence[3]	45.3 mrad

Table 7: Laser Technical Data

[1] Continuous Wave (CW): Laser emits a continuous and steady emission output (i.e. emission is not pulsed). The optical power is constant with time.

[2] High Peak Power (HPP): HPP laser mode enables a CW laser to operate in pulsed mode but with an increased peak power compared to the average power in CW mode.

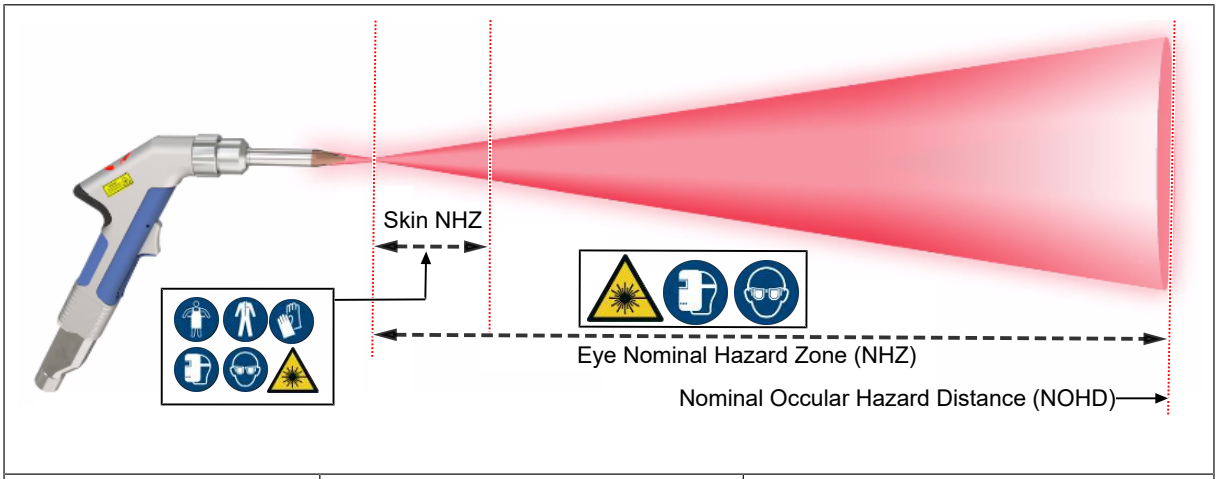
[3] Related to 63% of the total power.

The site Laser Safety Officer (LSO) will need to identify the maximum permissible exposure and the hazard distances in order to determine what PPE, guards and other safety procedures are required to be able to safely operate the product within the Laser Controlled Area (LCA).

- Refer to Laser Safety Terms and Definitions [▶ 41] for listing of key laser safety terms and their definitions.
- Refer to Laser Safety Hazard Calculations [▶ 42] for calculated MPE's, NOHD and NHZ. There are separate values specified for eye and for skin.
- Refer to Directive 2006/25/EC and EN 60825-1.

Laser Safety Terms	Definitions for Laser Safety Terms
Maximum Permissible Exposure (MPE)	The MPE is the irradiance or radiant exposure that may be incident upon the eye (or the skin) without causing injury or adverse biological changes in the eye or skin. MPE is the highest power (in W/cm^2) or highest energy density (in J/cm^2) of a light source that is considered to be safe. The MPE varies by wavelength of the laser, the energy involved, and the duration of exposure. MPE is a necessary parameter in determining the appropriate optical density (OD) and Nominal Hazard Zone (NHZ). Please note there is a separate MPE value for eyes and for skin. Please reference Directive 2006/25/EC and TROS Laser Radiation.
Nominal Hazard Zone (NHZ)	The NHZ describes the space within which the level of direct, reflected or scattered radiation during operation exceeds the applicable MPE. Exposure levels beyond the boundary of the NHZ are below the applicable MPE. If you are within the NHZ you are at risk of an exposure above the MPE and must be wearing PPE.
Nominal Ocular Hazard Distance (NOHD)	The NOHD, sometimes referred to as the Nominal Hazard Distance, is the distance along the axis of the unobstructed beam from 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 NOHD the intensity from the laser beam is not hazardous for unaided viewing or exposure. The NOHD calculation depends on the beam characteristics of the laser such as the output power, beam diameter and beam divergence. The NOHD is usually much greater than the largest dimension of your work area.
Optical Density (OD)	The OD is a measure of the attenuation of laser radiation through a material. This value is primarily used in laser safety eyewear and viewing window specifications. The higher the OD the greater the attenuation of the laser radiation will be. The OD is used in the determination of the appropriate laser eye protection.

Table 8: Laser Safety Terms and Definitions



MODEL NAME	EYE HAZARD CALCULATIONS	SKIN HAZARD CALCULATIONS
LightWELD	CW Mode: 144 meters (473 feet) HPP Mode: 151 meters (495 feet)	CW Mode: 11 meters (36 feet) HPP Mode: 6 meters (20 feet)
LightWELD XC	CW Mode: 144 meters (473 feet) HPP Mode: 151 meters (495 feet)	CW Mode: 11 meters (36 feet) HPP Mode: 6 meters (20 feet)

Table 9: Laser Safety Hazard Calculations

2.3.7 Device Safety Label Locations

The safety label banner which is affixed on the device, provides information on the laser radiation hazards that are present in your particular device.

The IPG safety label and the information listed on the safety label will vary based on the output power(s), wavelength(s), and other performance characteristics. It is important to review the labels affixed to the product for specific information about your laser device.

This product has the required safety labels located on the outside of the device enclosure at various locations. These include warning labels indicating removable or displaceable protective housings, apertures through which laser radiation is emitted and labels of certification and identification.

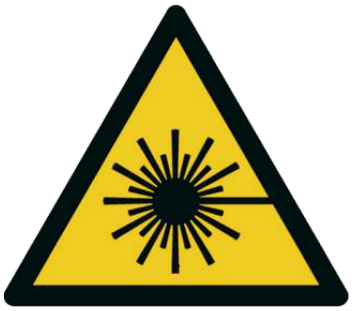
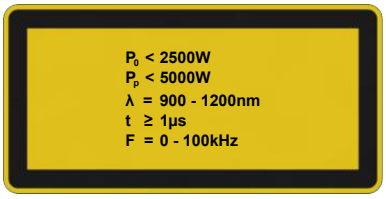
See Safety Label Description and Location [▷ 44] description of all safety labels and their placement on the product.

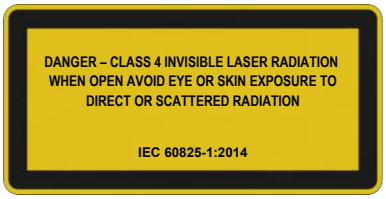
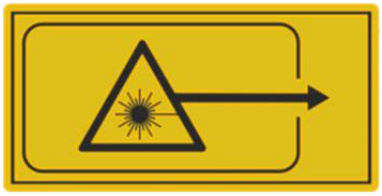
Figure 2: Laser Safety Explanation Label

1	Valid for High Power Fiber Laser	2	Valid for Red Guide Laser
3	Valid for High Power Fiber Laser		

1. Identification Plate Label

Rear panel of the device. (Products Made in the US) - See Label Placement - Device Rear and Side Panels [▷ 46].

2. Laser Radiation Hazard Label	3. Primary Laser – Class 4 Laser Information Label	4. Primary Laser– Class 4 Warning Label
		
Located near output aperture or exit point from the enclosure: (1) rear panel of the device, (2) top of weld head, (3) base of fiber cable output connector. See Label Placement - Device Rear and Side Panels [▷ 46] and Label Placement - Weld Head [▷ 47].	Identifies the output power, peak power, pulse duration, pulse repetition rate and wavelength range for the primary fiber laser used for material processing. Located on rear panel of the device. See Label Placement - Device Rear and Side Panels [▷ 46].	Identifies Laser Classification for the primary fiber laser used for material processing. Located on rear panel of the device. See Label Placement - Device Rear and Side Panels [▷ 46].

5. Red Guide Laser–Class 2M Information and Warning Label	6. Panel Label	7. Aperture Exposure Label – Weld Head
		
Combination label for guide laser used for positioning weld head nozzle on part. This label identifies the output power and wavelength range. It also specifies the classification and warning. Located on rear panel of the device. See Label Placement - Device Rear and Side Panels [▸ 46].	Located on device side panels near bottom. See Label Placement - Device Rear and Side Panels [▸ 46].	Located near output aperture of the weld head. The label is also placed at the base of the fiber cable output connector. See Label Placement - Weld Head [▸ 47].
8. Electric Hazard Label	**9. Caution Label**	**10. Safety Label – QR Code**
		
Located on rear panel near AC receptacle. See Label Placement - Device Rear and Side Panels [▸ 46].	Consult accompanying documentation. Located on rear panel near AC receptacle. See Label Placement - Device Rear and Side Panels [▸ 46].	Scan QR code to access online product safety content, etc. Label also specifies the support phone number. In the EU please contact +49 2736 4420 8217, IPGL-LSS-Support@ipgphotonics.com Label is located on bottom left corner of front panel. See Label Placement - Device Rear and Side Panels [▸ 46].

8. Patent List Label		
This device is covered by US patents: 7,893,901 — 8,068,705 8,724,218 — 8,160,415 9,213,135 — 8,948,218 10,615,570 — 9,647,410 and other US & International patents pending 63/002,915 — 63/089,113 63/069,816 — 29/756,161 CMUS0009286XXXXU Rev A List of patents that are applicable to this device. Label is located next to the identification label on the rear panel. See Label Placement - Device Rear and Side Panels [▷ 46].		

Table 10: Safety Label Description and Location

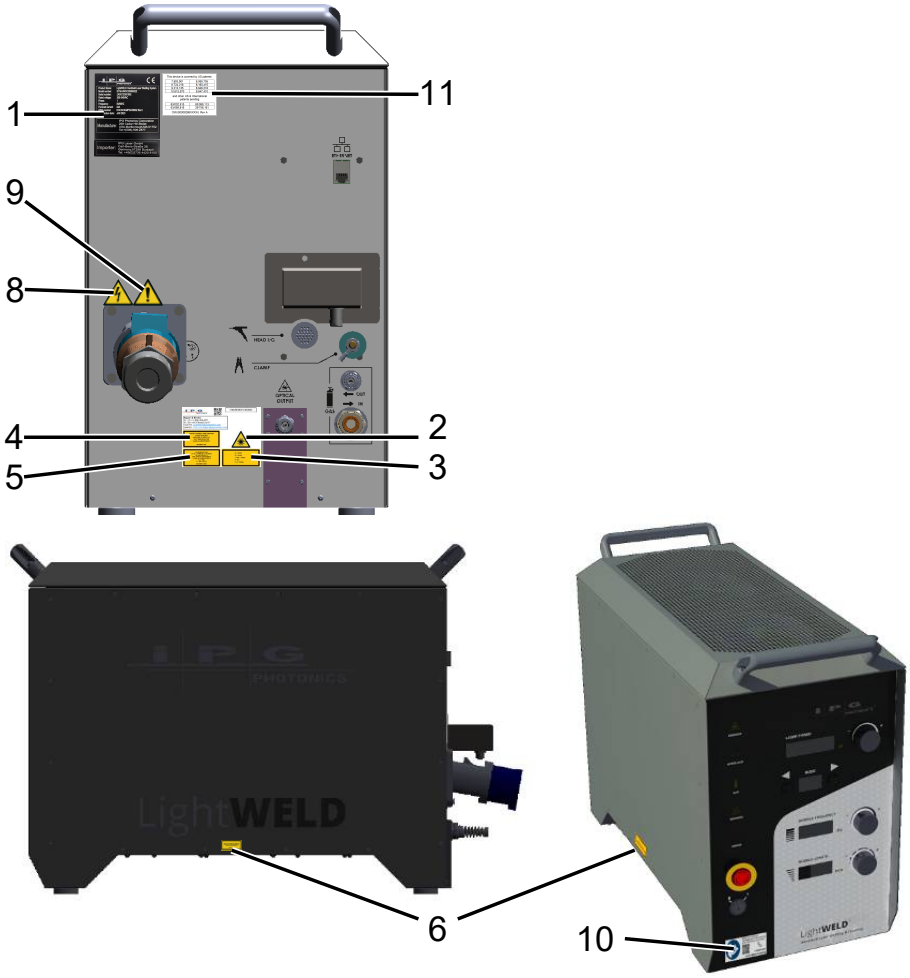


Figure 3: Label Placement - Device Rear and Side Panels

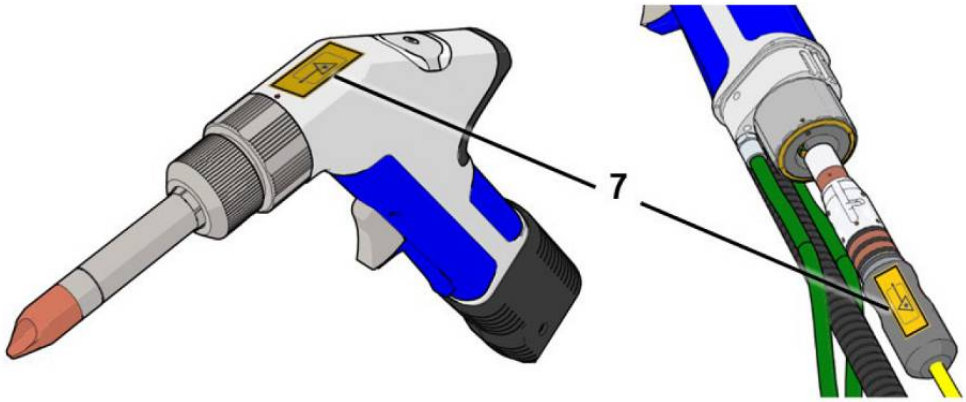


Figure 4: Label Placement - Weld Head

2.4 Regulatory Compliance

The LightWELD product is designed and engineered with important safety features and performance and complies with applicable standards and specifications in accordance with relevant directives and regulations.

Standard	Title / Description
Directives:	
2014/35/EU	The Low Voltage Directive covers all electrical equipment and components designed for use with a voltage rating of 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 that electrical equipment and components covered by it must comply with, and it outlines the conformity assessment procedure the manufacturer must apply in order to ensure compliance with the essential requirements.
2006/42/EC	The Machinery Directive is an EU directive concerning machinery and certain parts of machinery. Mandatory specifications in health and safety are combined with voluntary harmonized standards. Its main intent is to ensure a common safety level in machinery placed on the market or put in service in all member states and to ensure freedom of movement within the EU.
2014/30/EU	The EMC Directive aims to ensure that any electrical and electronic equipment minimizes the emission of electromagnetic interference that may influence other equipment. The directive also requires equipment to be able to resist the disturbance of other equipment.
Electromagnetic Compatibility (Emissions and Immunity)	
EN 61326-1 (EU)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General Requirements

Standard	Title / Description
EN 61326-3-1 (EU)	Electrical equipment for measurement, control and laboratory use – EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications
EN 61000-6-2 (EU)	Electromagnetic Compatibility (EMC) - Part 6-2: Generic Standards - Immunity Standard for Industrial Environments
EN 61000-6-4	Electromagnetic Compatibility (EMC) - Part 6-4: Generic Standards - Emission Standard for Industrial Environments
Electrical Safety:	
EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
Laser Safety:	
EN 60825-1	Safety of Laser Products - Part 1: Equipment Classification and Requirements
EN 60825-4	Safety of Laser Products - Part 4: Laser guards
EN ISO 11553-2	Safety of machinery - Laser processing machines - Part 2: Safety requirements for hand-held laser processing devices
TROS (Germany)	Technical Rule for Occupational Safety and Health Ordinance on Artificial Optical Radiation - TROS Laser Radiation
Functional Safety:	
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN ISO 13849-2	Safety of machinery - Safety-related parts of control systems - Part 2: Validation
Hazardous Substances:	
TRGS 560 (Germany)	Technical Rules for Hazardous Substances TRGS 560 “Air recirculation for activities involving carcinogenic, mutagenic and fertility-endangering dust”
GefStoffV (Germany)	Ordinance on Hazardous Substances

Table 11: Listing of Regulations

2.5 Important Operation Safety Information

2.5.1 Secondary Radiation Hazard

⚠ WARNING

Visible and Invisible Light Radiation Produced During Device Operation

The interaction between high power laser beams and target materials being welded may create plasmas that produce UV emissions and “blue light” which may cause conjunctivitis, photochemical damage to the retina and/or sunburn-like reaction to the skin.

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, eye pain and irritation (feeling of sand in your eye).

2.5.2 Protective Eyewear for Laser Welding and Cleaning

For laser welding, it is not sufficient to wear PPE that only protects against the laser’s IR wavelength. The selection of PPE should also take into account the secondary radiation hazards as well. Refer to Secondary Radiation Hazard [▷ 49] as well.

⚠ DANGER

Eye Hazards During LightWELD Device Operation

Risk of permanent eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.





- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

2.5.3 Skin Hazard

⚠ WARNING

Skin Hazards During LightWELD Device Operation

Risk of permanent skin damage from invisible reflected and scattered Class 4 laser radiation. Also risk of skin damage as a result of exposure to UV light, heat and sparks produced during material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

⚠ WARNING

Welding Process - High Temperature

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

⇨ PPE must be worn during welding.

⇨ Required PPE includes: (1) welding helmet over specified laser safety glasses, (2) laser and heat resistant gloves, (3) laser and heat resistant clothing, and (4) laser and heat resistant apron. Sleeves and collars should be buttoned.

⇨ Avoid touching the welded part or the weld head nozzle tip and/or tube, with unprotected skin, immediately and shortly after laser emission.

Exposure to UV light may cause skin burns that are similar sunburns and will increase a welder's risk of skin cancer and accelerated signs of skin aging.

Depending on the intensity of the IR light, skin injuries may include thermal burns or excessive dry skin.

Welding sparks may also cause burns.

Laser material processing can transfer a significant amount of energy into a part. Parts may be extremely hot even after the welding (or cleaning) process is complete. Parts of the weld head can become hot during use. Ensure that the proper PPE is used to protect against potential burns.

Take precautions to prevent skin damage by wearing protective clothing such as laser-resistant and heat-resistant gloves, caps, leather apron and other laser-resistant and heat-resistant clothing. Protective clothing must be sufficiently resistant to UV radiation. Sleeves and collars should be buttoned.

2.5.4 Fire Hazard

⚠ DANGER

Laser can ignite solvents, gases, combustible materials

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

⇨ Exposure to solvents and other flammable materials and gases must be avoided and considered when installing and using this device.

⇨ Do not weld combustible and flammable materials (e.g. magnesium).

⇨ Combustible and flammable materials should be completely removed from the laser area whenever possible.

⚠ DANGER

LightWELD device operation can generate a fire or explosion!

The heat and sparks produced during system operation are capable of starting a fire or causing an explosion.

⇨ Laser welding should only be performed if the area is free of combustible materials.

⇨ Never weld on containers that have flammable or combustible material.

⇨ If the container contents are unknown, you should assume they are flammable or combustible.

⇨ Fire extinguishers should be nearby and accessible and personnel should be trained in their usage.

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

1. **ABC Dry Chemical** fire extinguisher is a good general purpose fire extinguisher to have available. This type of fire extinguisher is suitable for:
   - Fires involving solid materials, usually of an organic nature whose combustion results in the formation of embers, such as wood, paper and textiles.
   - Fires due to flammable liquids.
   - Electrical Fires
2. **Class D Dry Powder** fire extinguisher must also be available. This type of fire extinguisher is suitable for combustible metal fires.

⚠ DANGER

Using Incorrect Fire Extinguisher Can Accelerate Metal Fire

A water or CO2 extinguisher WILL NOT extinguish a metal fire. Choosing the right extinguisher can lessen or prevent property damage and save lives.

- ⇨ Class D (Dry Powder) fire extinguisher must be used for combustible metal fires.
- ⇨ The most common types of Class D fires occur in environments where fine metal powders, flakes, shavings, chips or similarly sized products are generated (such as aluminum powder and iron shavings).
- ⇨ Ensure the Laser Controlled Area is kept tidy.
- ⇨ To determine which extinguishing medium is most appropriate to use, a specialist should be consulted. Specific studies are required for Class D type fires and extinguishing medium.
- ⇨ Refer to regulations such as EN 2, EN3, and EN 1866.

2.5.5 Reflected Beam Hazard During Operation

⚠ WARNING

- ⇨ Exercise caution to avoid / minimize specular reflections. This primary laser in this product emits invisible laser radiation, corresponding to laser Class 4, at or around a wavelength of 1070nm (infrared).
- ⇨ In addition, the guide laser in this product emits visible laser radiation, corresponding to laser Class 2M, at or around a wavelength of 600-700 nm (red).

Often there can be numerous secondary laser beams produced at various angles near the laser output aperture. These beams are called “Specular Reflections” and are produced when the laser light reflects off a surface where the primary beam is incident.

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

⚠ WARNING

- ⇨ Highly reflective metals such as aluminum may cause some portion of the beam energy to be reflected from the target weld site and require additional precautions.
- ⇨ Specular reflections may also present a hazard to the operator if any portion of the beam is reflected from multiple surfaces.
- ⇨ Take precautions to understand the expected cone of specular reflection 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. See Weld Head Angle, Reflections and Viewing Position [▶ 57].
- ⇨ Operators must also be aware of reflections at all times. More reflections are likely to occur if laser parameters are not set correctly to achieve melting of the target part.

The following guidelines apply to all models. To achieve Safe Operating Conditions:

1. Proper Mode Selection Based on Material and Thickness.
2. Proper Nozzle Selection Based on Joint Geometry – See Nozzle Tip Selection Chart [▶ 56].

NOTICE

For safety reasons, LightWELD device operators must use only IPG nozzle tips. Refer to Accessories [▶ 71] for the part number of the IPG Nozzle Tip Kit. Replacement nozzle tips are available for purchase.

3. Proper nozzle installation – Refer to Installing Nozzle Tip for Welding [▶ 126] and Changing Nozzle and Adjusting Rotation [▶ 126].
4. Proper positioning of the LightWELD gun (Weld Head) – See Weld Head Angle, Reflections and Viewing Position [▶ 57].

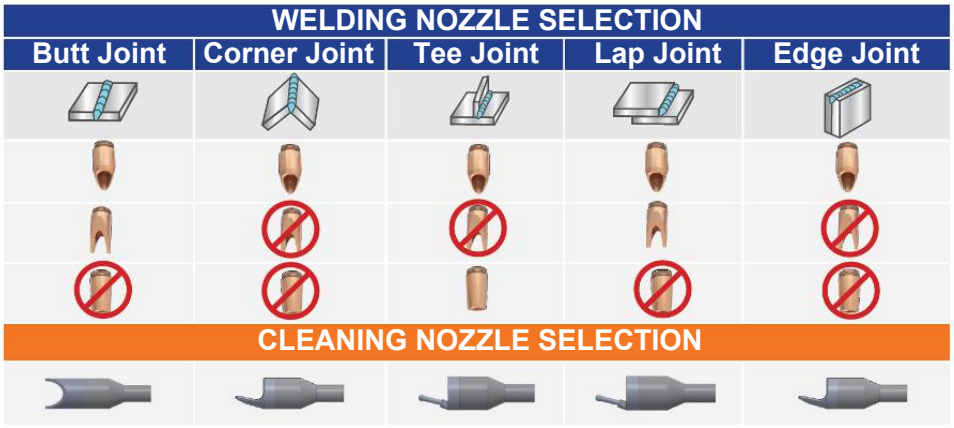


Figure 5: Nozzle Tip Selection Chart

For LightWELD XC models running in CLEAN laser mode, there are 3 additional nozzles available. Refer to Cleaning Nozzle Part Numbers - LightWELD XC Models [▸ 56].

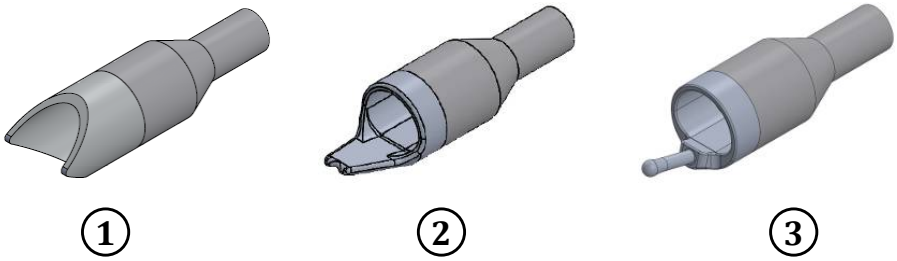


Figure 6: Cleaning Nozzle Part Numbers - LightWELD XC Models

1	2-Prong Cleaning Nozzle (CEU00003909XXXXU)	2	Outer Corner Nozzle (CEU00003803XXXXU)
3	1-Prong Cleaning Nozzle (CEU00003708XXXXU)	4	

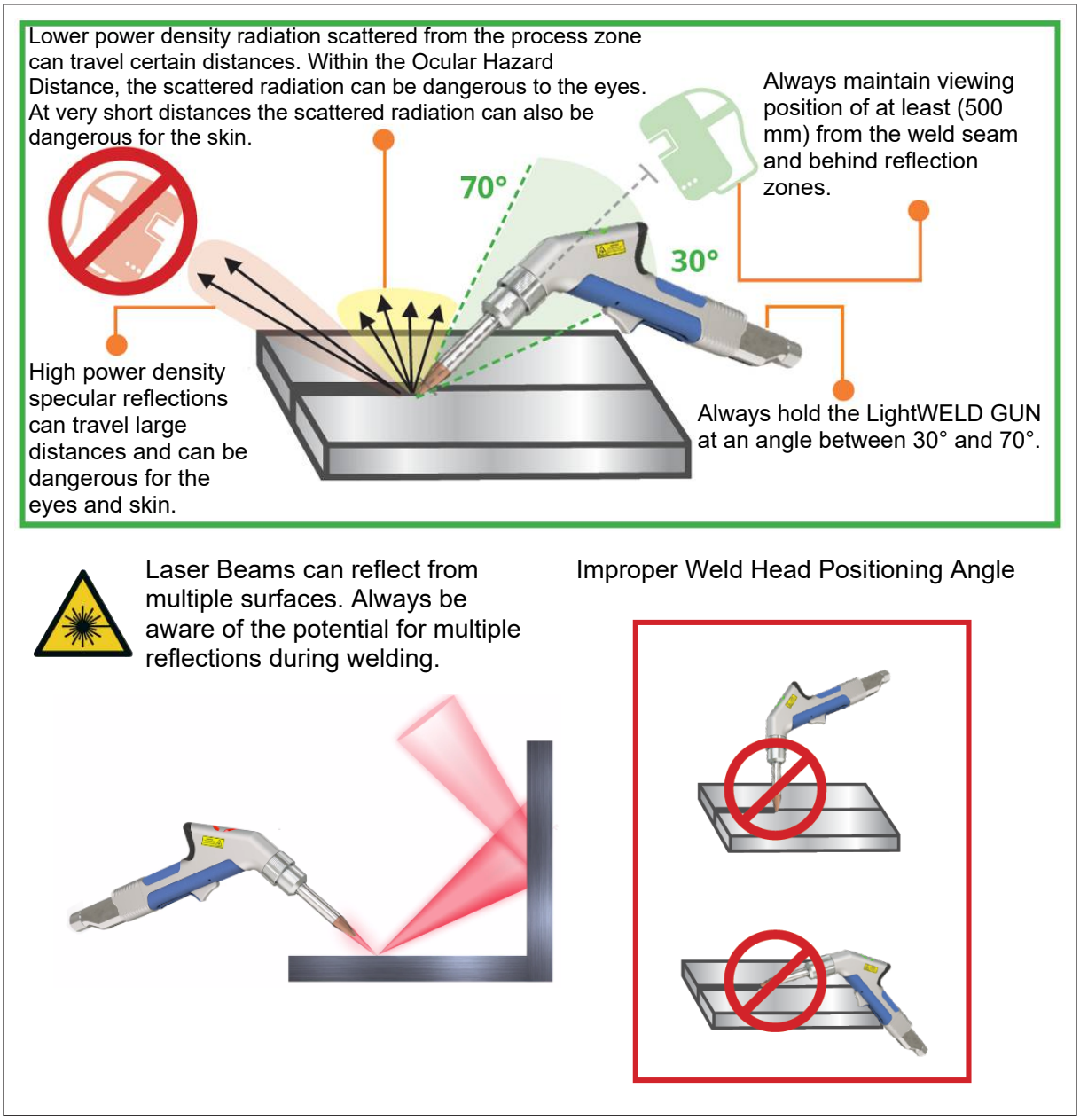


Table 12: Weld Head Angle, Reflections and Viewing Position

2.5.6 Process By-Products and Fume Hazards

When a laser beam reacts with any material, it can generate vapors, fumes, sparks and particulate debris. By-products from the laser process are often toxic and can pose additional safety hazards.

⚠ WARNING

Welding Process - Fumes and Particles

Damage to body tissues or organs from exposure to fumes and other by-products produced by the welding process.

- ⇨ Measures must be taken by the user depending on the material of the workpiece.
- ⇨ During welding keep your head away from the fumes.
- ⇨ Always weld in an area with adequate ventilation.
- ⇨ Hazardous and toxic fumes, vapors and particles need to be captured and exhausted from the work area by means of an extraction system.
- ⇨ Ensure that the work surface is properly vented. The opening of the capturing unit has to be placed as close as possible to the process zone.
- ⇨ PPE (respiratory protection) must be worn if released hazardous substances cannot be extracted close to the process.

- Welding “smoke” can be comprised of very fine particles and gases. Welding fumes and gases come from a combination of the material being welded or any filler material used, shielding gases used, paints, coatings, chemical reactions, and air contaminants.
- **Welding smoke can adversely affect the lungs, heart, kidneys and central nervous system. Primarily, the released hazardous substances are absorbed via the respiratory organs (i.e. inhaled).**
- When the laser interacts with target materials such as plastics, metals, composites, the target material may start to vaporize. **Often the fumes and mists cannot be seen, but are very toxic and pose a serious health hazard.**
- UV emissions given off during the welding process can react with the oxygen and nitrogen in the air to form ozone and nitrogen oxides which at high concentrations can be deadly.

⚠ WARNING

Risk of Asphyxiation in Poorly Ventilated Confined Spaces

Shielding gases used during welding can displace the air. Dangerous concentrations of toxic fumes and gases can build up very quickly causing unconsciousness and death from suffocation.

- ⇨ Conduct routine air monitoring to determine the levels of hazardous fumes in the laser area.
- ⇨ In confined spaces and other circumstances, the use of a respirator may also be required.

NOTICE

Risk Assessment for Welding Fumes, Particles, and Dust

It is the responsibility of the system owner to ensure proper disposal of waste debris and other by-products. Any extraction system must comply with local health and safety regulations. System owner minimum requirement before starting the laser process is to:

- ⇨ be familiar with the material to be processed, know what by-products may result, assess their risk to health and determine what precautions are necessary;
- ⇨ read and obey the safety data sheets and warning labels for all welding materials used;
- ⇨ employ appropriate measures to prevent or control the risk, such measures will normally require positive exhaust of fumes from the process zone and adequate purification before exhaust gases are returned to the atmosphere away from personnel;
- ⇨ inform, instruct and train operators about the risks, and the precautions to be taken;
- ⇨ where necessary, monitor the exposure of operators and carry out an appropriate form of surveillance of their health in compliance with local regulations;
- ⇨ consult a pertinent authority to find out what national, state and/or local regulations must be satisfied before exhaust gases are returned to the atmosphere.
- ⇨ **In Germany**: please observe and refer to the requirements in the following regulations:
- ⇨ Technical Rules for Hazardous Substances TRGS 560 “Air recirculation for activities involving carcinogenic, mutagenic and fertility-endangering dust”.
- ⇨ Technical Rules for Hazardous Substances (TRGS), in particular TRGS 402, TRGS 900 and TRGS 910, as well as TRGS 528 for welding work (all freely available on the Internet from the Federal Institute for Occupational Safety and Health - BAuA).
- ⇨ Ordinance on Hazardous Substances (GefStoffV).
- ⇨ Ordinance on Preventative Occupational Health Care (ArbMedVV).
- ⇨ **For other EU countries**: please follow the local regulations.

NOTICE

Fume Extraction Recommendations

IPG Photonics recommends Minimum Efficiency Reporting Value (MERV) of 15 or higher according to the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). That translates to filtration efficiency of the following by particle size:

- ⇨ 0.30-1.0 µm: less than or equal to 85%
- ⇨ 1.0-3.0 µm: less than or equal to 90%
- ⇨ 3.0-10.0 µm: less than or equal to 95%
- ⇨ MERV 15 corresponds to EN 779-2012 rating of F8
- ⇨ 90% ≤ Em < 95% M.E.: 55%
- ⇨ IPG Photonics recommends a welding fume extractor with a W3 Certificate which has a Minimum Filter Efficiency of 99% against welding fumes such as Kemper Startfil Extraction filter series: https://www.kempe.eu

2.5.7 Gas Cylinder Safety

⚠ WARNING

Placement and Securing of Gas Cylinders

Gas cylinders may explode if damaged or placed nearby to the welding area causing injury and property damage. Injury is also possible if cylinder tips over.

- ⇨ Gas cylinders should be shielded and located in areas where they cannot be struck or damaged.
- ⇨ Place them away from sources of heat, sparks or flame, as well as deflection from laser beam.
- ⇨ Cylinder must be stored upright and secured to a fixed support.

Need to have working regulators that are suitable for the gas and pressure required. All hoses and fittings should also be suitable for the application and maintained in good working condition.

2.6 General Safety Instructions

NOTICE

If laser device is used in a manner not specified in this document

The protection provided by the device may be impaired and the warranty will be voided.

NOTICE

⇨ Safety Card with important safety information is provided with the LightWELD system.

⇨ The Safety Card must always be in the Operator's field of vision.

⚠ WARNING

Do not Use Weld Heads from Other Suppliers

Connecting fiber or electrical connector to weld head from other suppliers will cause safety functions to not work as intended. This may also damage the equipment and increase the risk of injuries due to laser irradiation.

⇨ Only connect the fiber to an IPG approved and supplied weld head.

⇨ Do not plug in other devices to the laser welder head connections on the rear panel other than the cable and head provided.

2.6.1 Establish a Laser Controlled Area

⚠ WARNING

Laser Controlled Area Required for Class 4 Laser Product Operation

For more information on setting up a laser controlled area, the site Laser Safety Officer or safety officer should refer to the most recent revision of:

⇨ EN 60825-4 Safety of Laser Products - Part 4: Laser Guards

The operation of the product requires establishing of appropriate laser controlled area by the employer.

Personnel Qualifications: Laser Safety Officer and Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

- The employer is responsible and must ensure that a comprehensive work place and work process related hazard and risk assessment is carried out. Depending on the results of this hazard and risk assessment further protective means or further PPE must be applied or the working place or working process must be revised for safe operations of your application.
- In many jurisdictions, laser safety regulations require the appointment of a site Laser Safety Officer (LSO). The employer is primarily responsible for conformance and enforcement of laser safety regulations but can delegate the responsibilities or tasks. Key points for setting up the Laser Controlled Area is the deter-

mination of the foreseeable maximum irradiation personnel may be exposed to, then design of the PPE and shielding of the laser area.

- The primary laser in this product is Class 4. Therefore, the appointment of a site LSO is mandatory:
  - In Germany: According to OStrV, the appointment of a registered site LSO is mandatory when workers use or are exposed to Class 3R, 3B and 4 laser products.
  - For other EU countries: please follow the local regulations.
- Work with your site LSO to establish a laser controlled area (LCA) to protect personnel working in the area from being directly or indirectly exposed to the laser beam.
- Ensure that all personal protective equipment (PPE) is suitable for your application. Ensure that all required personal protective equipment are available and being used by personnel.
- Use the LightWELD system **only** in a laser controlled area with access controlled by door interlocks. Refer to Laser Controlled Area Door Interlock Example [▶ 95] for an example of how to configure door interlocks to the laser controlled area.
- Provide suitable protection, that can withstand direct and diffusely scattered beams to secure a laser safe work area and to prevent the beam from escaping the area.
- Restrict access in the LCA to only those individuals who are trained and authorized in laser safety while operating the handheld laser device. Post a sign with the names of all persons authorized to work within the laser work area.
- The Operator is the only person that is allowed to be in the LCA while the device is in operation. All others must remain outside. Ideally, the Operator can be observed and monitored from outside the laser area room using camera technology.
- For more information, please refer to EN 60825-1, EN 60825-4 and EN ISO 11553-2.

2.6.2 Optical Safety

NOTICE

Protective Window Inside Weld Head

The laser output is delivered through a protective window. Any dust on the end of the head assembly can burn the window and damage the laser.

⇨ Make sure that the window is clean and of good quality. Refer to Protective Window Replacement [▶ 178].

⚠ DANGER

Class 4 Laser Radiation from Aperture

Risk of permanent eye damage and vision impairment from invisible direct Class 4 laser beam.

- ⇨ Never look directly into a laser aperture (such as the output fiber, or weld head) while the unit is powered.
- ⇨ Avoid positioning the laser and all optical components at eye level.
- ⇨ Avoid using the laser in a darkened environment.
- ⇨ Always turn the key to the OFF position and disconnect the AC power when working with the output (i.e. mounting the laser head into a fixture, etc.). As an added precaution, remove the key from the keyswitch during such work.
- ⇨ For more information, please refer to:
  - ⇨ Laser Safety Eyewear and Welding Helmet [▶ 36], Secondary Radiation Hazard [▶ 49], Protective Eyewear for Laser Welding and Cleaning [▶ 49] and Skin Hazard [▶ 51].

⚠ CAUTION

Do not install or terminate the laser head when laser is active.

- ⇨ Always ensure the key is in the “OFF” position and unit is disconnected from AC power when performing these tasks.

2.6.3 Equipment

Laser light is strong enough to burn clothing and paint. The laser can cut and weld metal.

Light-sensitive elements in equipment, such as video or still cameras can also be damaged from exposure to the laser light.

2.7 Wearing Safety Components in System

NOTICE

Replacement of Weld Head Trigger Switches

The triggers are a wearing safety components and are subject to the standard EN ISO 13849-1. For more information about the exchange of wearing safety components, refer to Wearing Safety-Related Components [▶ 180].

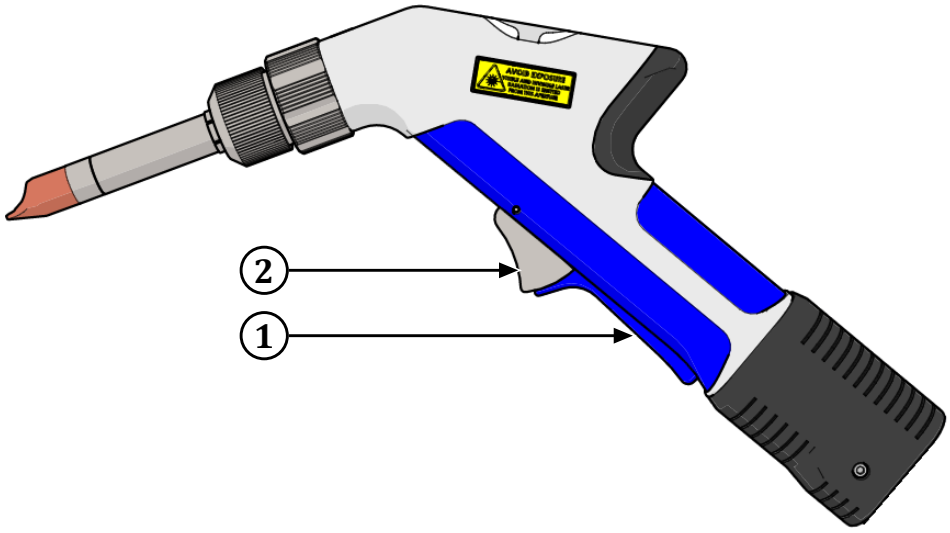


Figure 7: Weld Head Trigger Controls

1	Trigger 1	2	Trigger 2

2.8 Electrical Safety

⚠ WARNING

Electrical Voltage!

Lethal danger from direct or indirect contact with live parts.

⇨ There are no operator serviceable parts inside. Refer all servicing to IPG Service.

⇨ To prevent electrical shock, do not remove covers.

⇨ Any tampering with the product voids the warranty.

⚠ WARNING

The input voltage to the laser weld unit is potentially lethal.

⇨ All electrical cables and connections should be treated as if they were at a harmful level.

⇨ All electrical and weld gas connections must be connected prior to applying power to the unit.

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

⚠ WARNING

Improper Grounding and AC Voltage

To Ensure Electrical Safety:

- ⇨ Make sure the device is properly grounded through the protective conductor of the AC power cable. Any interruption of the protective grounding conductor from the protective earth terminal can result in personal injury.
- ⇨ Before supplying the power to the device, ensure that the correct voltage of the AC power source is used. Failure to use the correct voltage can cause damage to the device. Refer to the markings on your specific model for proper electrical supply connection.
- ⇨ Connections to external circuits except for Mains connections: the external connections between this product and other external devices are PELV (Protected Extra-Low Voltage) as defined by EN 61140. Non-Mains outputs of other devices connected to this product should also be PELV or SELV (Safety Extra-Low Voltage).

2.9 Environmental Safety

The equipment is designed for:

1. Indoor Use (non-residential)
2. Operation at less than 2000 meter altitude
3. Over Voltage Category II
4. Pollution Degree 2 Environment
5. Dry Locations – Do not operate in the rain/water
6. Ambient Air Temperature of 5 - 40°C (system will operate at 100% duty cycle up to 35°C. For temperatures between 35-40°C it will operate at a reduced duty cycle).
7. Relative Humidity of 10 – 90%
8. Refer to product specifications for additional information.

Keep away from sources of shock or vibration.

NOTICE

- ⇨ Inattentive, careless actions and operation can damage this laser equipment. Use caution while operating this equipment.
- ⇨ Follow all safety, operating and maintenance instructions in this manual.

2.9.1 Emitted Noise Level During Use

The product has the value of **84 db(A)**. The real sound pressure level in the application should be measured under actual conditions of use. The use of earplugs and/or other sound attenuation measures, such as barriers or other mitigations may be required. Follow local requirements, rules and regulations.

For product installation within the European Union, please reference standard EN ISO 11553-3.

2.9.2 Humidity

Do not expose the device to a high-moisture environment (>90% humidity).

2.9.3 Cooling and Temperature

The laser device is air-cooled. Operation at higher temperatures will accelerate aging, increase threshold current and lower slope efficiency. If the device is overheated, do not use it and call IPG for assistance. The device will turn emission off automatically and generate an alarm when the temperature of the laser exceeds 55°C.

2.9.4 Recycling and Disposal

NOTICE

WEEE Directive for Environmentally Safe Disposal

Incorrect disposal leads to environmental contamination and pollution.

⇨ Electronic devices have to be disposed according to the 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 life, this product must be sent to separate collections facilities for recovery and recycling.

⇨ Contact IPG Service (refer to IPG Service [▶ 192]) for further information concerning the decommissioning of this product.

By properly recycling electrical and electronic equipment, users can ensure environmentally sound treatment and disposal of waste equipment to reduce the potential for any environmental or health risks that can occur as a result of incorrect disposal.

2.10 Safety, Training, and Standards Resources

2.10.1 LightWELD Device Operation Training Resources

For information on using the LightWELD device, users can access training videos on the IPG Secure Support Page:

http://gettingstarted.handheldlaserwelder.com/

Content can be accessed by (1) selecting your language from the drop down menu; (2) entering the system serial number where prompted; and (3) Click the Get Started button (refer to Accessing support page for the first time [▶ 67]).

This will automatically take you to the main site landing page. On the main landing page, in the upper right corner, you may change at any time the language translation for the page. Just select your language from the drop down menu listing (refer to Changing Language on Main Landing Page [▶ 68]).

For specific questions concerning LightWELD device operation, contact IPG Service at:

For EU: IPGL-LSS-Support@ipgphotonics.com

For US: Lightweld@ipgphotonics.com

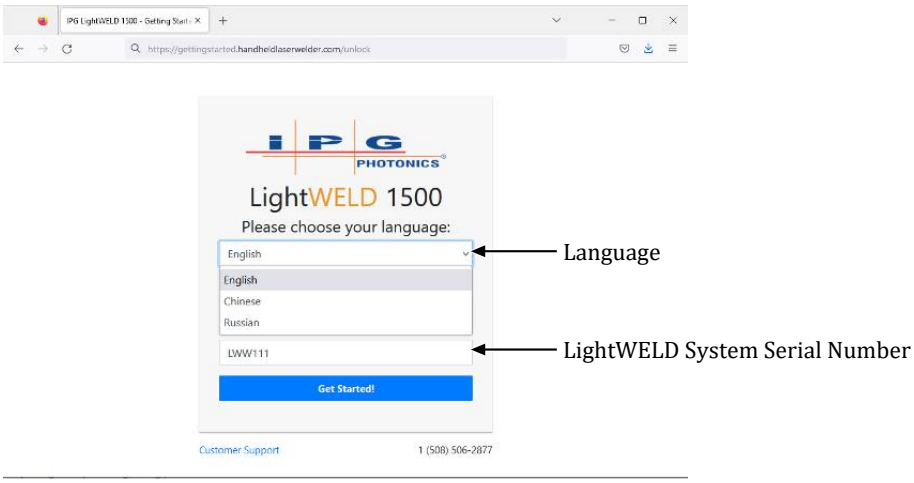


Figure 8: Accessing support page for the first time

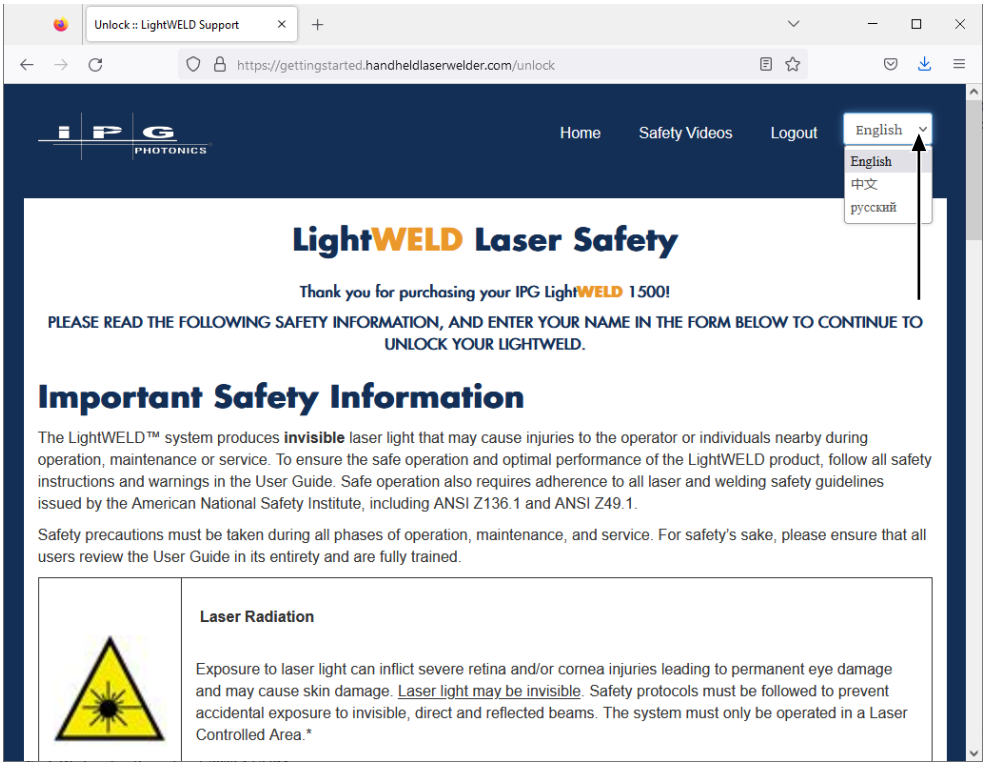


Figure 9: Changing Language on Main Landing Page

2.11 Additional Product Specific Safety Features

Additional handheld laser device safety features are discussed in this operating manual. Refer to Important Safety Functions [▶ 116]. Ensure you review and understand these important product features listed here.

- **Fiber Interlock** – refer to Fiber Interlock [▶ 116]
- **External Interlocks** – refer to External Interlocks [▶ 116]
- **Head Nozzle and Workpiece Clamp Interlock** – refer to Head Nozzle and Workpiece Clamp Interlock [▶ 117]
- **Weld Head Two Level Trigger** – refer to Weld Head Two Level Trigger [▶ 118]
- **Overheating Control** – refer to Overheating Control [▶ 119]
- **Plasma Detection** – refer to Plasma Detection [▶ 121]
- **Gas Pressure Monitoring** – refer to Gas Pressure Monitoring [▶ 121]
- **Emergency Stop Button (E-Stop)** – refer to Emergency Stop Button (E-Stop) [▶ 122]

- **Warning and Status Lights** – refer to Warning and Status Lights [▶ 123]

2.12 Unlock Code Required at First Power Up

NOTICE

When the LightWELD device is turned ON for the very first time:

The system will boot-up into a “locked” state. The unit front panel will be set to “9990”, “999”, and “99”. If the unit is connected to a computer, the web page interface also displays “Unit Locked”. When locked the front panel will not allow changes from the two lower knobs. Laser emission CANNOT be turned on while unit is locked regardless of interlock or alarm state (see Unit Locked on First Power Up [▶ 70]).

To receive the 4-digit unlock code:

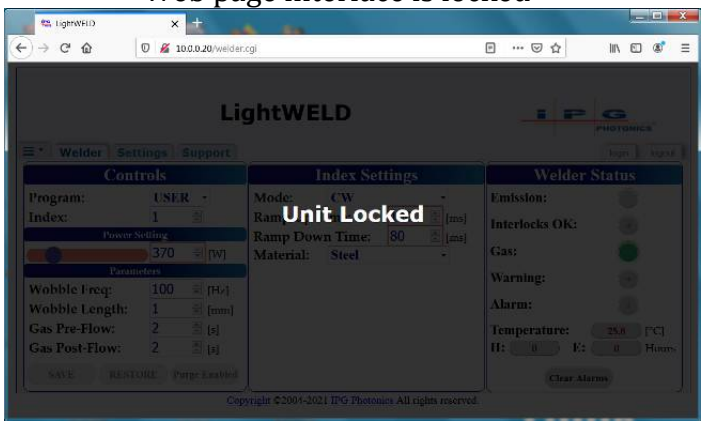
Users must first complete the IPG Customer Support Safety Training webinar. Unlock code is provided upon successful completion of training webinar.

To unlock the LightWELD device complete the safety training webinar and obtain the unlock code.

1) Use the `Laser Power` rotary control knob to set the unlock code (turn knob counter clockwise).
2) Press and hold both `Mode` buttons until the `Mode` display starts flashing quickly and then release the buttons (takes ~5 seconds).
3) If the inputted code was correct, the displays will update to show the current mode index settings. If code was incorrect the power display will reset back to 9990.

Unit is Locked

Web page interface is locked



1. Turn Laser Power knob to set unlock code.

2. Press and hold both mode buttons until mode display starts flashing then release.

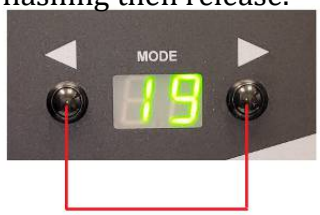


Figure 10: Unit Locked on First Power Up

3 Device Description

3.1 Accessories

The following accessories are included with your Laser Welder Device (see List of Available Accessories [▶ 71]).

Items	Part Number	Qty	Note
STANDARD ACCESSORIES			
Hand Laser Welding System Operating Manual	DOCCHUGMPSXX0018	1	This document
Power ON/OFF Security Keys	CEMCACCXXX0016XX	2	For switching ON/OFF the electrical power
Laminated Mode Chart	DOCCHRDMPSXX0025	1	Chart Listing Available Presets
Getting Started Product Flyer	DOCCHRDMPSXX0030	1	
LightWELD Operating Safety Card	DOCCHRDMPSXX0033	1	
Fiber Output Protective Cap Fiber Output Storage Sleeve	COPWHEXXH8XX008G P45-012609	1	Protective Cap is used to protect the quartz block. Storage sleeve used to protect the protective cap window and electrical contacts on the fiber bayonet when fiber cable is disconnected from weld head
Workpiece Clamp Cable (Choice of Cable Length)	CEU00002914XXXXU CEU00002583XXXXU	1	5 meter (5.47 yard) cable length or, 10 meter (10.94 yard) cable length
Laser Safety Glasses[a, b] (Choice of Size for Best Fit)	CMMIXXX0002677PX CMMIXXX0002678PX CMMIXXX0002679PX	1	Wraparound Frame Small Frame Large Frame
Safety Welding Helmet with Shield	CEU00005245XXXXU	1	To be worn over laser safety glasses
CONNECTOR, 32A 2P3W IP44 6H[a]	CECOXXX0000305PX	1	Mating Connector for AC line cord
CONN PLUG, 12PIN, 5.08 mm, SPG[a, c]	P41-007595	1	Mating Connector for 12-pin Interface

Items	Part Number	Qty	Note
Welding Nozzle Tip Kit[a]	CDSBME000089XXXU	1	4 types of nozzle tips
Cleaning Nozzle 2-Prong Cleaning Nozzle Outer Corner Cleaning Nozzle 1-Prong	CEU00003909XXXXU CEU00003803XXXXU CEU00003708XXXXU	1 1 1	Only for LightWELD XC models Only for LightWELD XC models Only for LightWELD XC models
Protective Window Replacement Kit[a]	CDSBOM00023703XU	1	5 Pack comes standard with unit
Ethernet CAT 6 - 10 ft (3.04 m) Cablea	CEMIXXX0000688PX	1	Connect between PC and Weld Unit for web page access and remote troubleshooting
Nitrile Gloves (10 pack)[a]	CMMIXXX0002659PX	1	Worn for maintenance related tasks
ADDITIONAL ACCESSORIES AVAILABLE FOR PURCHASE			
Wire Feeder Kit [c]	CEU00003358XXXXU	1	3rd Party unit with cable and weld head attachment included
Wire Feeder Integration Kit	CEU00003659XXXXU	1	Cable and Weld Head attachment for integration of 3rd party Wire Feeders
EWM Wire Feeder Kit	CEU00004221XXXXU	1	Cable and Weld Head attachment for integration of EWM tigSpeed 45 Wire Feeder
AB Wire Feeder Kit	CEU00004334XXXXU	1	Cable and Weld Head attachment for integration of ABICOR BINZEL ABIDRIVE V2 Wire Feeder
Heavy Duty Welding Cart with Wheels[c]	CEU00003073XXXXU	1	Cart (assembly required) used to hold weld unit, wire feeder and gas tank
Protective Window Replacement Kit	CDSBOM00023702XU	1	20 Pack

Table 13: List of Available Accessories

[a] Quantity 1 is included with welding unit. Additional quantities of these accessories may also be purchased separately if needed, in addition to the additional accessories available for purchase.

[b] These pairs specified here are for regions other than the EU. For users in the EU: (1) refer to Laser Safety Eyewear and Welding Helmet [▶ 36] for laser eyewear criteria; and (2) refer to Laser Safety Equipment Suppliers [▶ 39] for listing of laser safety eyewear suppliers in the EU.

[c] This product is not available for sale in the EU.

3.2 Weld Unit Front View

Figure 11: Front View

Item	Feature	Description	
1	Status Indicator Lights	Five LED light indicators are used to show the status of the welder unit. Indicators top to bottom include:	
			EMISSION - Lit yellow during welding process while laser emission in turned ON. Trigger 2 control on the weld head was pressed and all safety interlock loops were satisfied
			INTERLOCK - Lit green when all safety interlock loops are satisfied. Once this indicator is lit it means that laser emission can be turned ON by pressing the Trigger 2 control on the weld head, provided there are no alarms and gas delay time is met.

Item	Feature	Description	
			GAS - Lit green when there is sufficient gas pressure coming into the device from gas supply.
			WARNING - Lit yellow if there is no gas, temperature of the laser is approaching upper limit or guide laser is not functioning.
			ERROR - Lit red when alarm occurs. Alarms will stop the welding process by shutting down the laser emission.
2	Emergency Stop Button (E-Stop Button)	• Suspends power to the weld unit. When pressed, the main DC power supply will be disabled. • Once pressed, the E-Stop button can be reset by turning the red knob clockwise.	
3	Power Key Switch	• Turn key clockwise to 1 (ON) position to power the unit. • Turn key counter-clockwise to 0 (OFF) position to shutdown unit. • Key cannot be removed while in the 1 (ON) position.	
4	Laser Power Display with Control Knob	• Manually adjust Laser Output Power by turning the rotary control knob. • Clockwise will increase power. Counter-clockwise will decrease. • Four digit display.	
5	Program Disply with Mode Selection Buttons	• Use front panel buttons to increment up or down through the programmed recipes. • Programs are identified by two alphanumeric characters (e.g. 10, A1, etc.). • There are 20 user programmable recipes (00 to 19). • There are currently 26 preset modes with an additional 28 preset reserved for future upgrade. Preset program recipes will have a letter followed by a number 0 to 9.	

Item	Feature	Description
6	Wobble Frequency Display with Control Knob (Hz)	Manually adjust the Wobble Frequency (frequency of sinusoid) by turning the rotary control knob. Knob may control other functions for some laser modes. Refer to Figure 8-1
7	Wobble Length Display with Control Knob (mm)	Manually adjust the Wobble Length (line length) by turning the rotary control knob. Affects the magnitude of deflection of the laser beam via the galvanometer. Knob may control other functions for some laser modes. Refer to Figure 8-1

Table 14: LHW-Series Front Panel Features

3.3 Weld Unit Rear View

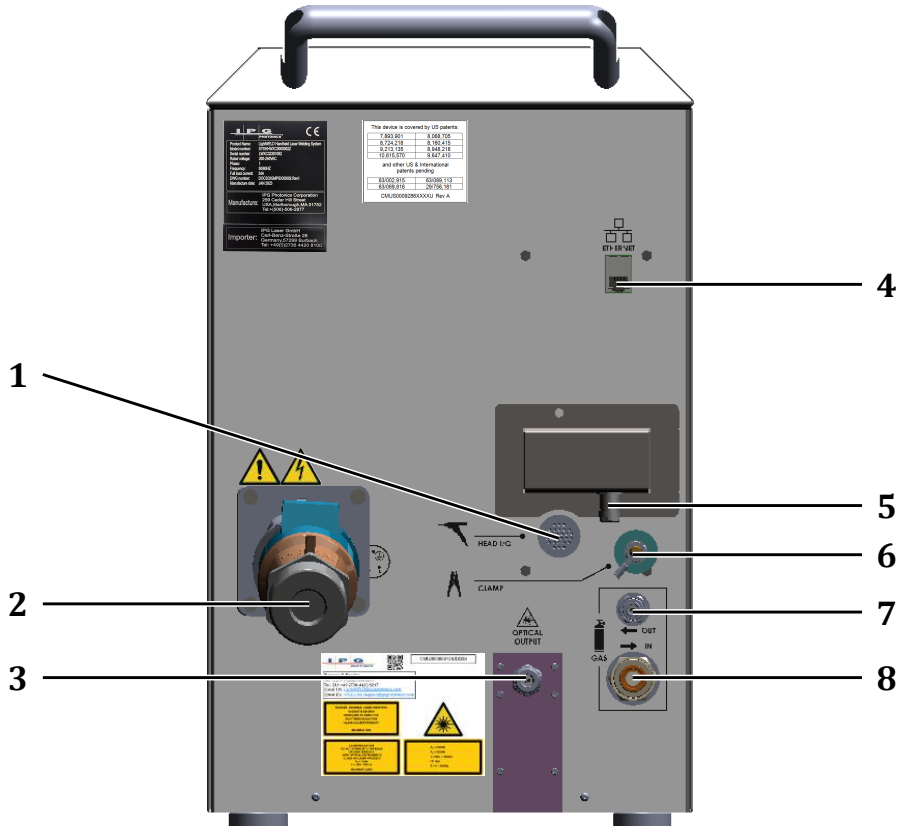


Figure 12: Rear View

Item	Feature	Description	
1	Weld Head Interface Connection	Cable connection to the weld head (power, I/O, etc.). Cable is routed through the umbilical.	
2	AC Line Input		AC input receptacle: 200-240 VAC, 50/60 Hz, 24A, EN 60309-1, -2

Item	Feature	Description
3	Laser Output Fiber Cable	 The output of the laser (fiber cable) is delivered through this location and attaches to the weld head (QBH output termination). Length is either 5 m (16.4 ft) or 10 m (32.8 ft). Infrared radiation is delivered to the weld head through this fiber. Fiber cable is routed through the umbilical.
4	Ethernet Port	Standard 10/100 Ethernet Communication Port. Ethernet connection to customer host computer. RJ-45 Connector. Use shielded Ethernet Cable. Access web page interface for welder status troubleshooting, recipe creation/management, and IP configuration. Firmware is also updated through this connection.
5	12-pin Interface Connection	I/O connector for wiring external interlocks, laser active interface and wire feeder integration.
6	M8 Shank for Workpiece Clamp Cable	Workpiece clamp cable attaches to this threaded M8 shank. This closes the safety interlock loop between the welder nozzle tip and this shank. It ensures the weld head is connected to the work piece before emission can safely be turned ON.
7	Gas Output to Weld Head	This tubing is routed through the umbilical.
8	Gas Input	Connect 12 mm OD flexible tubing from gas supply to rear panel input port.

Table 15: LHW-Series Rear Panel Features

3.4 Weld Head

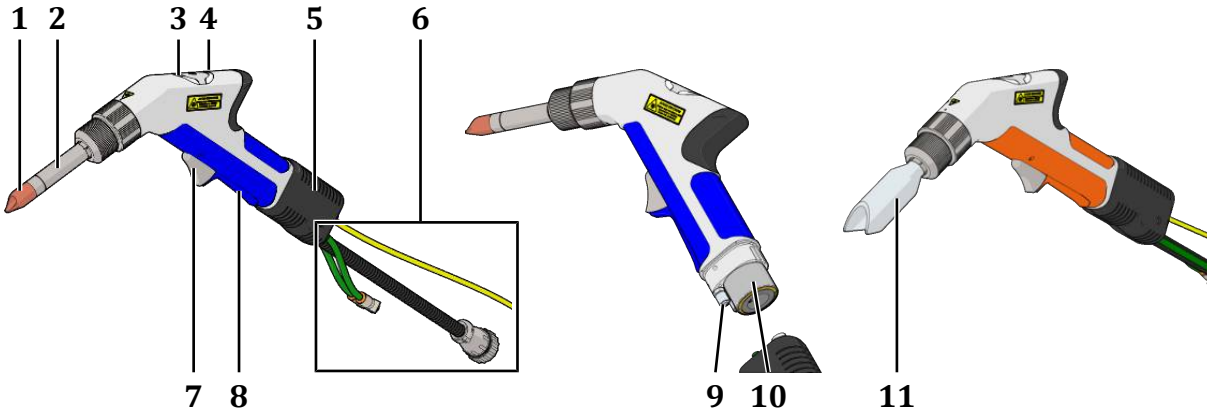


Figure 13: Weld Head

Item	Feature	Description
1	Nozzle Tip	Four nozzle tips come standard with the system.
2	Extension Tube	Nozzle tips are threaded onto this tube.
3	Red Emission ON Status Indicator	This will be lit red while laser emission is turned ON.
4	Green Status Indicator Light	Solid Green - while Trigger 1 is pressed and no errors are present. Blinking Green - once all the interlocks are fully satisfied. This indicates that the system is ready to fire. Operator can now press Trigger 2 control to start the laser emission.
5	Boot	Boot is replaceable and will conceal the fiber cable, gas tubing and weld head electrical and I/O cable.
6	Cabling Routed Through Umbilical	Picture is showing: (1) gas tubing, (2) yellow laser fiber cable and (3) weld head I/O cable. These are routed through the umbilical and are not normally visible during normal operation.
7	Trigger 2 - Start Laser Emission	This switch acts as a start button for the laser. When this is pressed, the laser will fire provided the safety conditions are satisfied and shield gas has been detected for at least 1.5 second prior.
8	Trigger 1 - Start Gas Flow	Press and hold Trigger 1 to begin shielding gas flow. This must remain pressed throughout the welding process. Trigger 1 should only be released once Trigger 2 is no longer being pressed.
9	Gas Line Connection	Shield gas tubing is routed through the weld head boot.
10	QBH Fiber Cable Connection	The unit will arrive with the fiber cable already inserted and connected to weld head.
11	Cleaning Nozzle (XC Models)	This attachment is only available on XC Models. It is intended to be used while operating the device in laser cleaning mode which enables a beam wobble length adjustment up to 15 mm.

Table 16: Weld Head Feature Descriptions

3.5 Layout and Dimensions

Welder unit dimensions are indicated in the drawing below.

Units are in mm [in]

Figure 14: Device Layout and Dimensions

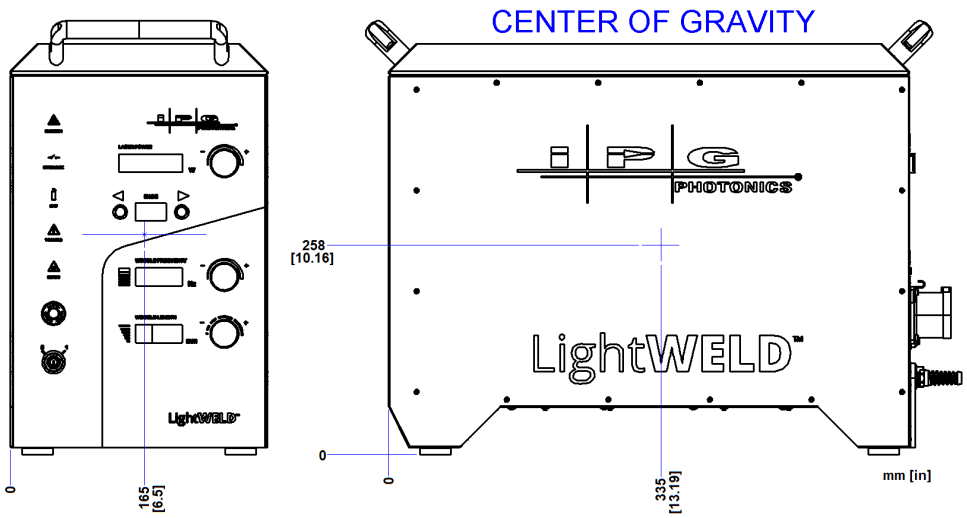


Figure 15: Center of Gravity

Weld Head dimensions are indicated in the drawing below.

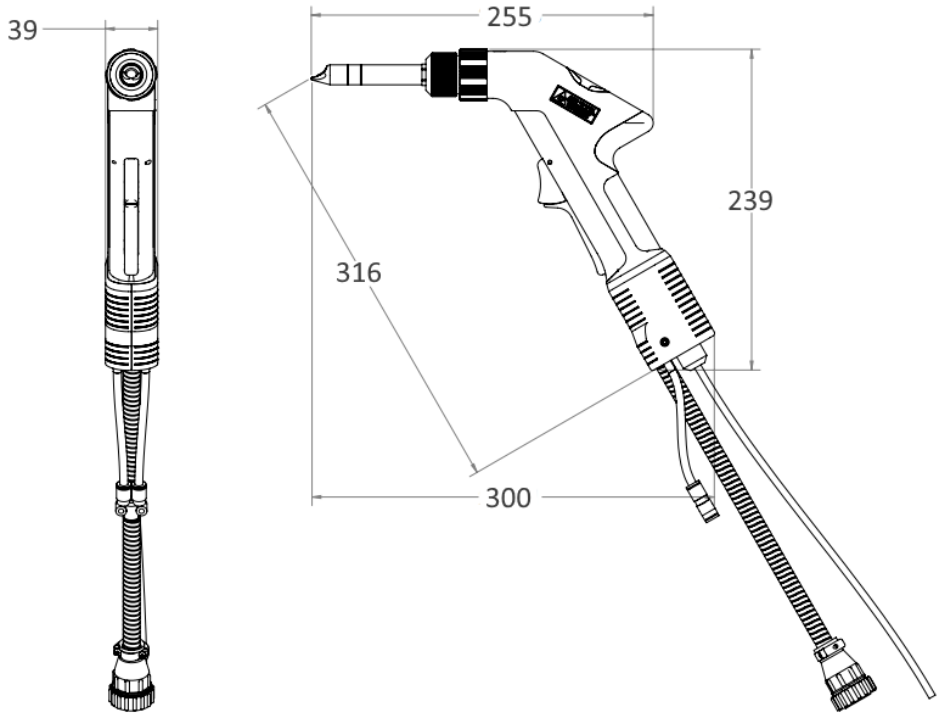


Figure 16: Weld Head Layout and Dimensions

3.6 Fiber Cable Output Connection

Refer to Maintenance Appendix

The LHW-series welder system will arrive with the fiber cable already inserted and connected to the weld head. Should it become necessary to disconnect and reconnect the fiber (e.g. need to replace weld head), refer to Connect/Disconnect Fiber Output [▶ 182].

The end connector of the fiber uses a protective cap that covers and protects the optical surface of the quartz block and a storage sleeve that protects the protective cap window and electrical contacts when not in use. Remove the storage sleeve from the connector immediately before optical cleaning and connecting to weld head.

NOTICE

Fiber Termination Inspection

It is imperative that a fiber termination is checked for dust, dirt, or damage every time the fiber cable is disconnected from the weld head.

⇨ For more detailed information on proper cleaning procedures for the output termination, refer to Output Termination Cleaning Procedures [▶ 187].

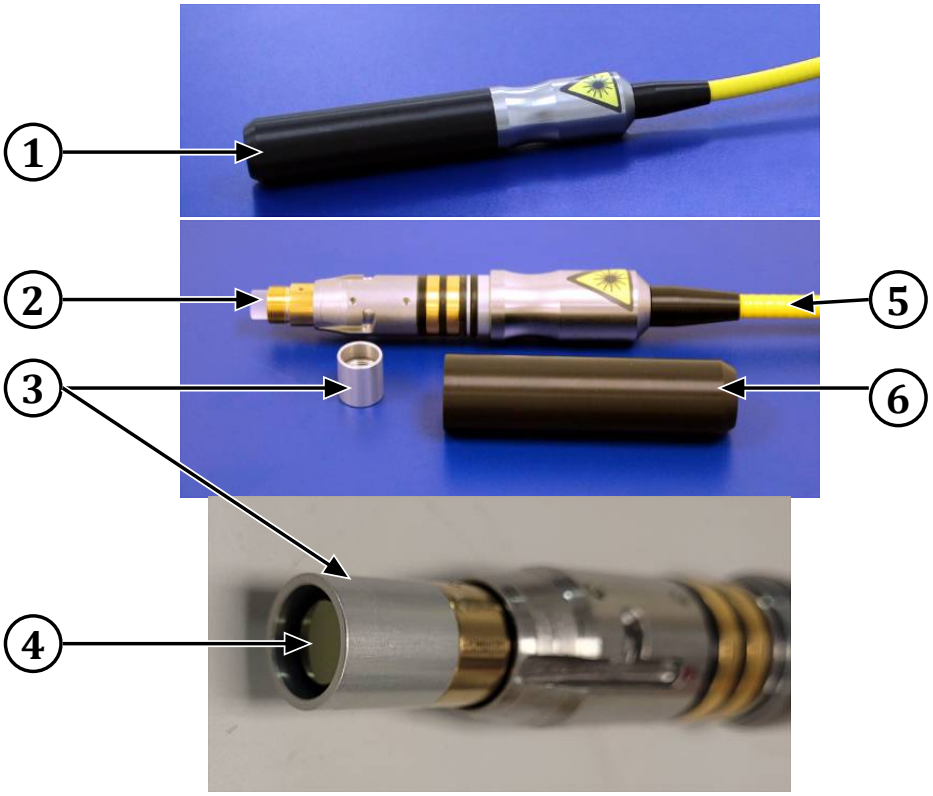


Figure 17: Optical FIber End Connector (Model LC-8)

1	Fiber End Connector with Cap and Sleeve	2	Quartz Block
3	Protective Cap	4	Protective Cap Window
5	Fiber	6	Storage Sleeve

4 Delivery and Transport

This chapter provides information regarding the delivery, transport and unpacking of the handheld laser welding system.

4.1 Delivery

The welding system is shipped in either:

- Domestic shipment - A foam insulated collapsible crate with foam shock absorbers and impact indicators to help secure and ensure safe handling during shipping. Or,
- International shipment - A foam insulated wooden crate with foam shock absorbers and impact indicators to help secure and ensure safe handling during shipping.

Special care is recommended when unpacking. To minimize the risk of damage to the unit, IPG Photonics recommends that you unpack the unit as instructed in this operating manual. Refer to Unpacking from Shipping Container [▶ 83].

Check for Damages Upon Delivery

⇨ If the packaging shows any signs of external damage, check unit for damages and notify the shipping company and IPG Photonics immediately.

⇨ Particular care must be taken when you remove the unit from the packing case to ensure that the fiber optic cable is not broken or damaged.

4.1.1 Inspection Upon Delivery

The shipping package is labeled with information for both the carrier and receiver; however, these markings may not always ensure proper handling. Inspect the crate exterior for any apparent damage that may have occurred during transit.

- Identification - A packing label is affixed on the top panel of the shipping package to: (1) identify the manufacturer's name, address and phone number; (2) provide general product information such as model number, model code, serial number; and (3) specify the shipping date (MM/DD/YEAR).
- Impact Indicators - The following labels and indicators are affixed on the side panels or ends of the wooden crate to help provide guidance for proper handling and what to do if mishandling is apparent (refer to Shipping Container Impact Indicators and Labeling [▶ 82]).

NORMAL SHIPPING CONDITION	CRATE WAS MISHANDLED
	 • Red indicates shock and rough handling. • Blue beads in arrow tip indicates container was mishandled or tipped.
DELICATE / HANDLE WITH CARE	**MONITORED SHIPMENT**
 • Particular care must be taken when removing the unit from the crate to ensure that the fiber optic cable is not broken or damaged. • Do not lift or position the unit by any of the attached fibers or cables.	

Table 17: Shipping Container Impact Indicators and Labeling

Shipping Container Indicators

Red and blue arrow indicators are a sign of possible damage (container mishandled).

- ⇨ Immediately after delivery check the crate and laser device for damage.
- ⇨ In the event of damage: (1) take pictures showing condition of crate, indicators, and unit; (2) inform both IPG and the shipping company in writing.
- ⇨ Always specify the serial number of the shock and/or tip and tell monitoring device.

4.2 Unpacking from Shipping Container

Unpacking the unit

IPG recommends the following:

- ⇨ Only work with suitable tools and aids.
- ⇨ Follow all steps to ensure safe unpacking of the products.
- ⇨ Always wear protective clothing.

For an illustration of this procedure, see Domestic Shipments - Collapsible Crate [▶ 84] and International Shipment - Wooden Crate [▶ 85].

1) Use pallet jack to move crate to unpacking location. Crate must be placed on a stable surface. Remove the outer plastic wrap.
2) For wooden crate: IPG recommends using a powered screwdriver to remove all of the top screws securing the top lid.
3) Remove the top lid and top foam insert.
4) The fiber umbilical will be looped and tie wrapped. The weld head will also be wrapped. Using a cutting tool remove the tie wraps securing the fiber to the second insert.

NOTICE

Laser Fiber Cable Handling

Severe laser damage will occur if optical fiber cable, routed through the umbilical, is mishandled (extreme bending, pulling or impact).

- ⇨ Do not bend the yellow optical fiber cable to a radius less than 50 mm minimum bending radius.
- ⇨ Do not apply excessive load or impact to the fiber cable.
- ⇨ NEVER move or lift the unit by pulling or dragging on the umbilical cabling.

5) Carefully place the umbilical and weld head on top of the unit.

6) Remove the crate side panels. To remove unit from crate, pick it up using the two handles at the top of the unit. IPG strongly recommends for two people to lift the unit at all times. Be careful when handling the umbilical and weld head.

⚠ CAUTION

Avoid Injury Due to Heavy Weight – 50 kg (110 lb)

Physical injuries are possible when attempting to carry the unit alone.

- ⇨ Always handle the welding unit with 2 persons.
- ⇨ Manual handling only for limited time/distance.
- ⇨ No manual handling by persons with impaired physical performance.
- ⇨ Use material handling gear for long distance transport.

7) A comprehensive packing list is included with the system documentation. Check all items in the crate against this list.

- ⇨ Contact IPG Service immediately if any of the items are missing or if any damage to the unit is evident. If any damage to the unit is evident or suspected, do not attempt to install or operate the laser device in any case.

8) Retain all packaging for future transportation or storage needs.

Figure 18: Domestic Shipments - Collapsible Crate

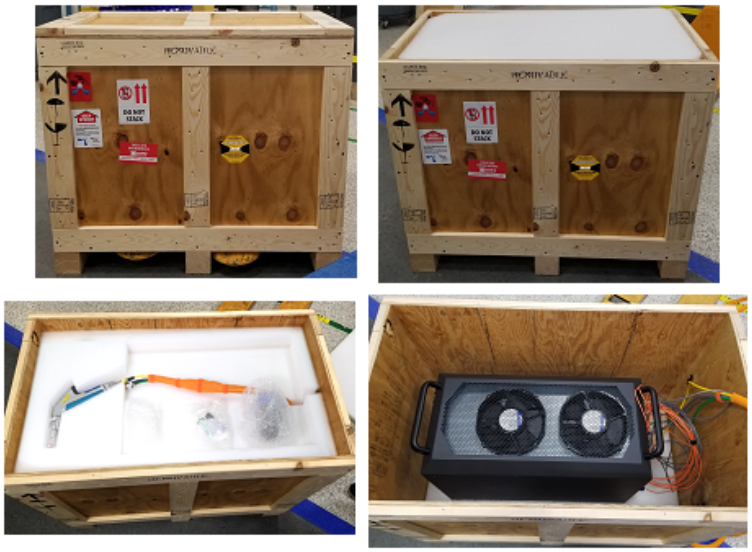


Figure 19: International Shipment - Wooden Crate

4.3 Transport to Installation Location

NOTICE

Laser Fiber Cable Handling

Severe laser damage will occur if optical fiber cable, routed through the umbilical, is mishandled (extreme bending, pulling or impact).

- ⇨ Do not bend the yellow optical fiber cable to a radius less than 50 mm minimum bending radius.
- ⇨ Do not apply excessive load or impact to the fiber cable.
- ⇨ NEVER move or lift the unit by pulling or dragging on the umbilical cabling.

NOTICE

Avoid Damage During Transport

Always transport the laser welder in the upright position.

1) If the installation site is a long distance away, carefully place the umbilical on top of the laser welder.
2) Using 2 people, pick up the device and load it onto a wheeled cart that is able to support the weight of the device and accessories.
3) Transport the laser welder to the installation site.

⚠ CAUTION

Avoid Injury Due to Heavy Weight – 50 kg (110 lb)

Physical injuries are possible when attempting to carry the unit alone.

- ⇨ Always handle the welding unit with 2 persons.
- ⇨ Manual handling only for limited time/distance.
- ⇨ No manual handling by persons with impaired physical performance.
- ⇨ Use material handling gear for long distance transport.

5 Installing Welding Device

5.1 Precautions

Personnel Qualifications: Maintenance Personnel and Electrician (refer to Personnel Qualifications [▷ 22]).

NOTICE

Damage to Welder System - Incorrect Voltage

Ensure the voltage and wiring is correct prior to turning ON the power.

⇨ Refer to the specification for proper electrical power requirements.

⇨ Ensure that the incoming voltage is equal to the level noted in the specification.

Operate only in an environment with sufficient airflow capacity that allows for the specified heat load developed during operation.

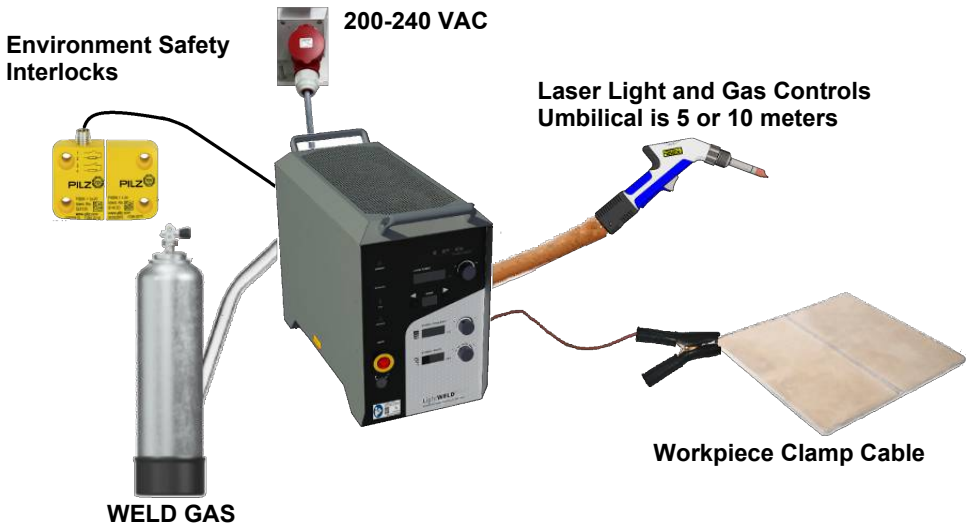


Figure 20: Connecting the Equipment

5.2 Air Flow and Installation Clearances

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

The laser welder unit is air cooled. In choosing the location to install the unit, make sure to leave approximately a 10 cm (3.94 in) clearance above and to the left and right of the unit. Never place any objects on top of the unit that may block the air exhaust. The direction of the air-flow is illustrated in the figure below.

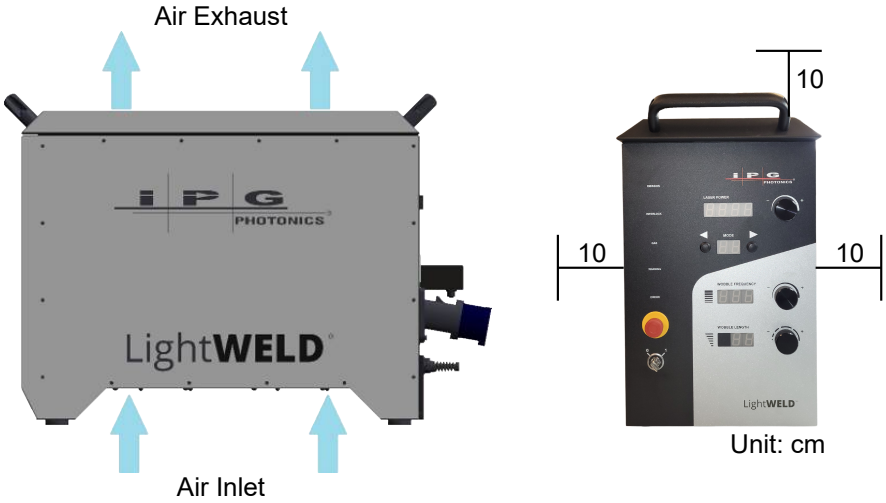


Figure 21: Unit Air Flow and Installation Clearances

5.3 Connect Workpiece Clamp Cable

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

A threaded M8 shank exits the back panel. The clamp cable must be attached to this shank and either the workpiece or the electrically conductive welding table on which the workpiece is placed is clamped before the laser can be turned ON. This closes a safety interlock loop between the welder nozzle tip and this shank.

Figure 22: Connect Workpiece Clamp Cable to Shank

5.4 Connect Welding Gas

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

Welding Gas specifications and connection to the back of the unit are specified in table Shield Gas Specifications [▶ 89]. Once connection is made, turn on the gas supply.

⚠ WARNING

Placement and Securing of Gas Cylinders

Gas cylinders may explode if damaged or placed nearby to the welding area causing injury and property damage. Injury is also possible if cylinder tips over.

- ⇨ Gas cylinders should be shielded and located in areas where they cannot be struck or damaged.
- ⇨ Place them away from sources of heat, sparks or flame, as well as deflection from laser beam.
- ⇨ Cylinder must be stored upright and secured to a fixed support.

Characteristic	Specification
Standard Welding Gas	• Argon • Nitrogen • Argon + CO_2 mix
Gas Pressure to Weld Unit Input	• **For LHW-1500-05**: 10-20 psi (69-138 kPa) • **For LHW-1500-10**: 15-30 psi (103-207 kPA)
Welding Gas Connections on Rear Panel	• **Facility Gas Line**: Connect customer supplied 12 mm flexible tubing from gas supply tank to rear panel gas input. • **Gas Line from Unit to Weld Head**: The ¼ inch gas line from unit to weld head will already be installed and connected at the factory. This poly tubing is routed through the umbilical.

Table 18: Shield Gas Specifications

5.5 Connect Weld Head Cable

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

Connect Weld Head I/O cable on the rear panel as indicated in Connect Weld Head I/O Cable [▶ 90]. This cable is routed through the umbilical. It will already be connected to the weld head upon arrival.

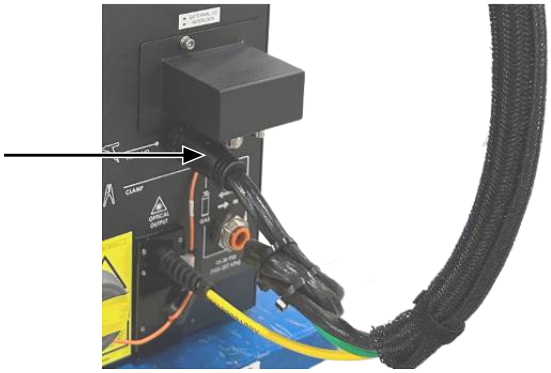


Figure 23: Connect Weld Head I/O Cable

5.6 Customer Interface Connections

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

The section describes the ports used to interface with the laser welder. The 12-pin connector provides a hardware interface to the unit that enables user to integrate external safety interlocks, power supply active warning indicators, integration of pedal and wire feeder.

The Ethernet connection is used to access the web page interface.

5.6.1 12-pin Interface Connector and Pinout

The 12-pin I/O connector is located on the rear panel of the device (as shown). For pinout information, see 12-pin Interface Connection and Pinout Table [▶ 91].

Figure 24: 12-pin M12 Female Interlock External I/O Connector, A Orientation

Figure 25: 12-pin M12 Male Connector Cable, A Orientation

Pin	Signal Name	Type	Notes
1	[2]External Interlock A+	Contact Closure[1]	External Safety Interlock Loop A. Laser cannot be started without the required safety interlocks being in place and satisfied.
2	[2]External Interlock A-		
3	[2]External Interlock B+	Contact Closure[1]	External Safety Interlock Loop B. Laser cannot be started without the required safety interlocks being in place and satisfied.
4	[2]External Interlock B-		
5	[4]Power Supply Enabled+	Contact Closure[3]	Output is normally open. The 5-6 contacts close when the power supply on the laser driver is enabled or told to be enabled. Note that this only means laser power supply is on, not the main unit power supply. Refer to both figure 12-pin Interface Output Pin Pairs (5-6, 7-8 and 9-10) [▷ 92] and note “3”.
6	[4]Power Supply Enabled-		
7	[4]Switch Enabled+	Contact Closure[3]	Output is normally open. The 7-8 contacts close when the switch enable on the laser driver is enabled or told to be enabled. Refer to both figure 12-pin Interface Output Pin Pairs (5-6, 7-8 and 9-10) [▷ 92] and note “3”.
8	[4]Switch Enabled-		
9	GPO+	Contact Closure[3]	General Purpose Output for optional wire feeder. Normally open. Closed if the output is active. The 9-10 contacts close when trigger 2 is pressed and enables the wire feeder start. Refer to both figure 12-pin Interface Output Pin Pairs (5-6, 7-8 and 9-10) [▷ 92] and note “3”.
10	GPO-		
11	GPI+	Contact Closure[1]	General Purpose Input. Connect together to activate input. Open for inactive. Optional Feature: Pins 11-12 are not used at this time.
12	GPI-		

Table 19: 12-pin Interface Connection and Pinout Table

[1] Contact Closure: Connection of potential free contacts only. Do not connect an external voltage.

[2] External Interlock Loops A and B should both be wired to same safety function according to EN ISO 13849-1. They should be redundant on same door, for example. These are NOT intended to be two independent safety interlocks.

[3] Output is an opto-isolated solid state relay output. **Current output must be limited to <60 mA** (fused by an 80 mA PTC). Contact closure could be used to drive PLC digital input or use with relay to drive larger currents. 24 V compliant if current limited to <60mA. **Switched voltage must be 40 Volts or less**.

[4] Pins 5-6 and 7-8 are redundant outputs for safety to indicate that laser emission is ON or could be ON. These outputs may be used to turn on a external emission warning device according to EN 60825-1.

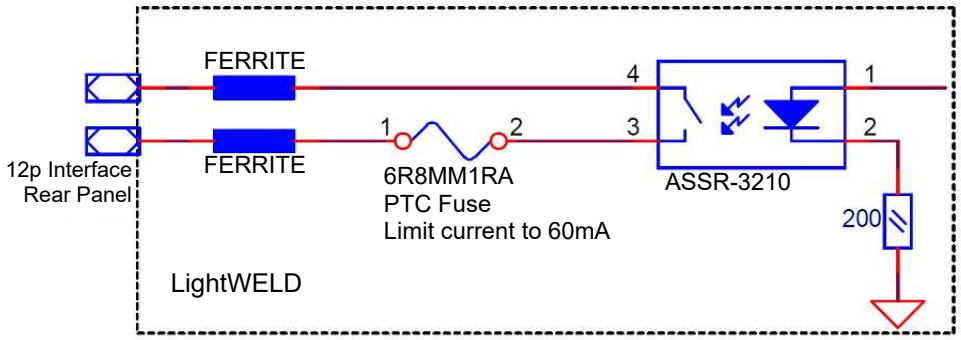


Figure 26: 12-pin Interface Output Pin Pairs (5-6, 7-8 and 9-10)

5.7 Connect Electrical Power

Personnel Qualifications: Electrician (refer to Personnel Qualifications [▶ 22]).

⚠ DANGER

Invisible class 4 laser radiation when the LightWELD device is energized

Risk of permanent skin or eye damage and vision impairment from invisible direct, reflected, and scattered Class 4 laser radiation.

⇨ Open all the safety circuits to make sure that no laser emission is possible.

⇨ Take appropriate measures to ensure that the safety circuits cannot be closed.

Please refer to the laser welder's product specification for power requirements. A CECOXXX0000305PX AC input mating power connector for device end (see List of Available Accessories [▶ 71]) is provided as part of the startup kit that ships with every unit. A strain relief is included as part of this AC inlet mating connector. An AC line cord and AC plug (for wall end) is not provided with your laser welder.

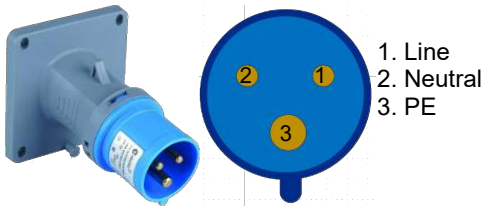
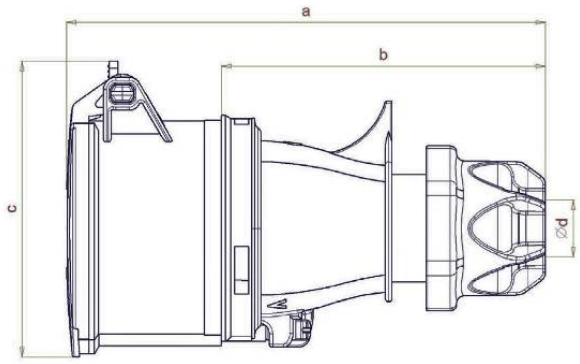
Characteristic	Specification
Input AC Voltage	200-240 V, single phase
Full Load Current	24 A
Input AC Frequency	50/60 Hz
Maximum Rated Power	4600 VA
AC Inlet Plug	Connector according to EN 60309-1, -2 
Mating Connector for AC Line Cord	• tp electric P/N: 3124-304-0901 • IPG Accessory P/N: CECOXXX0000305PX • Blue connector rated: – 250 VAC, 32 A – compliant with EN 60309-1, -2 should be used. 
Wire Specification	Use copper stranded wire size of 10 AWG (6 mm^2). Maximum AC power cable diameter is 20 mm (0.79 in). **NOTE**: IPG recommends the use of heavy-duty flexible cable. In Europe, use H07RN-F cable for this connection (and not H05RN-F).

Table 20: Wiring AC Line Input



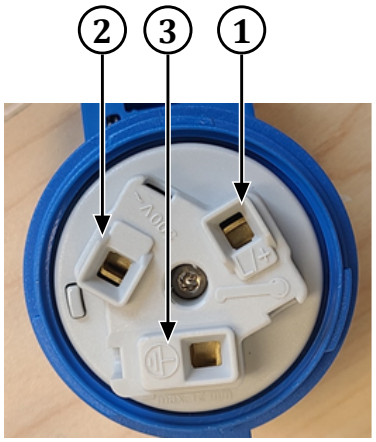
a = 156 mm
b = 100 mm
c = 91 mm
d cable Ø = 11-20.5 mm

Figure 27: Mating Connector Drawing

Personnel Qualifications: Electrician (refer to Personnel Qualifications [▶ 22]).

To connect electrical power, follow these steps.

1) Wire the power input to the voltage, phase and frequency indicated.
   - ⇨ Connect Brown Wire Line L to terminal marked L/+.
   - ⇨ Connect Blue Wire Neutral N to unmarked terminal.
   - ⇨ Connect Green/Yellow Wire PE (Protective Earth) to terminal with ⏚ symbol.
2) The electrical connection to the unit must be connected to dedicated AC mains with a circuit breaker that does not exceed 32 Amps. This must be in close proximity to the unit and within easy reach of the operator and marked as the disconnecting device for the unit.
3) The wiring is to be in accordance with all national and local code requirements. Electrical connections shall be made by personnel knowledgeable in electrical safety practices.



Mating connector cover is used to latch the connector as shown here to prevent accidental disconnection. Lift cap when unplugging.

Figure 28: AC Mating Connector

1	Line	2	Neutral
3	PE		

5.7.1 Connections to External Circuits

Except for Mains connection, the external connections between this product and other external devices are PELV (Protected Extra Low Voltage) as defined by EN 61140. Non-Mains outputs of other devices connected to this product should also be PELV or SELV (Safety Extra Low Voltage).

5.8 Laser Controlled Area Door Interlock Example

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

A 4-wire door switch is shown as an example (refer to Door Interlock Example [▶ 95]).

⚠ DANGER

Class 4 Invisible Laser Radiation

⇨ The LightWELD device is a Class 4 laser device and safety standards (EN 60825-1) call for it to be operated within a Laser Controlled Area that is equipped with safety controls which are activated upon entry of personnel into the Laser Controlled Area.

⇨ The LightWELD device utilizes a dual channel interlock safety system which shuts off the laser power supply when the user integrated entry sensors detect an opening into the Laser Controlled Area. This prevents access to laser radiation above applicable exposure levels.

5.8.1 Door Interlock Example

Many types of door switches are available, and their operation, in most cases, is similar to floor mats or optical sensors used for the same purpose.

In the example shown below, the door switch is comprised of two components: A switch unit with cable attached, typically fixed to the door frame; and the magnetic actuator usually mounted to the door in a position where it will activate the switch. The switch contains two contacts that close when proximate to the actuator (e.g., door is closed) and otherwise are open.

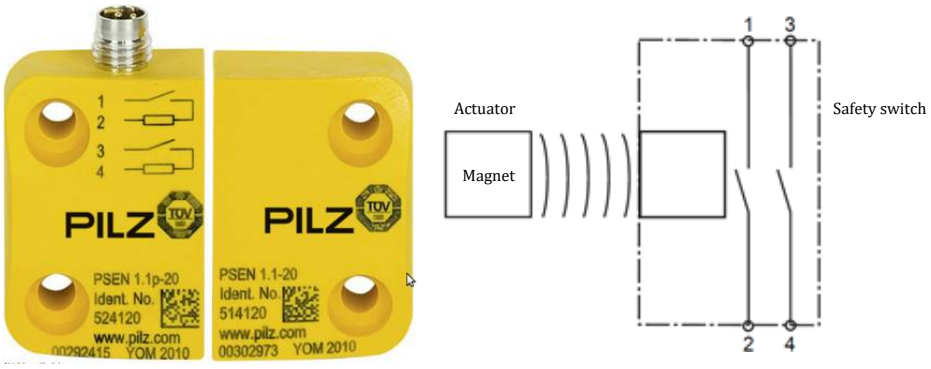
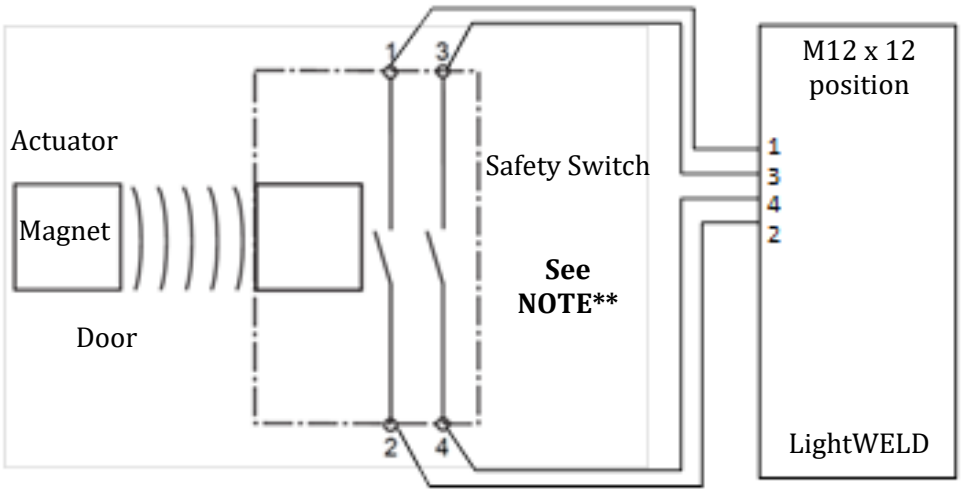


Figure 29: Pilz switch unit and magnetic actuator for door interlock

The documentation supplied with the switch will identify the different conductors in the cable or connector. Attention must be paid to wiring correctly and the protection of wiring from damage to avoid cross circuit short.



NOTE:** Safety switch incorporating 2 separate circuits and 4 contacts.

Figure 30: Interconnection example for the door interlock integration in the LightWELD safety logic.

The LightWELD device has redundant interlock circuits. The LightWELD device requires these interlock circuits be closed for the laser to operate (contact pairs 1-2 and 3-4, see 12-pin Interface Connection and Pinout Table [▷ 91]). The block diagram above shows a wiring diagram as an example for the integration of door interlocks in the safety circuit of the LightWELD device.

To integrate additional safety features (e.g. external e-stop) all safety related signals shall be connected to the safety logic of the laser controlled area (LCA). These signals form together the enable signal for the LightWELD device. This enable signal of the safety logic has to be connected to the I/O connector on the rear panel of the LightWELD device.

The user may wire to a M12 x 12 position A Code cable (such as Phoenix Contact #1554791) or directly to a M12 x 12 A Code male solder cup connector (such as Phoenix Contact #1404419).

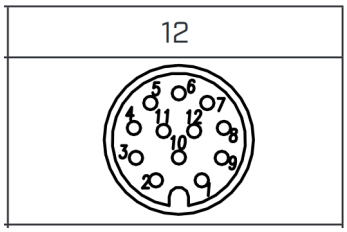
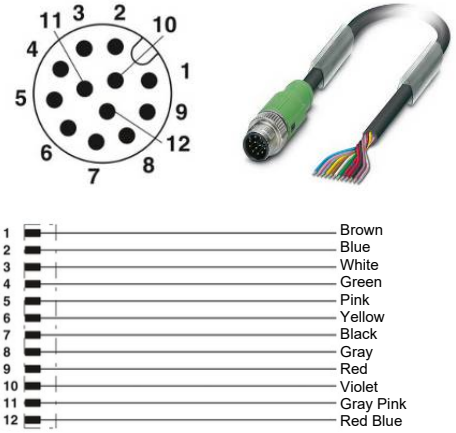
Female 12-pin customer interface connector on LightWELD device	Male connector (mate) male pin side view and wiring for example Phoenix Contact #1554791
	

Table 21: Wiring information for the recommended male connector Phoenix Contact #1554791

5.8.2 Testing Door Interlock

- ⇨ The cumulative interlock status may be viewed by either: (1) light indicator on front panel; or (2) the web page interface if the unit is connected to a computer (refer to Computer Connection to Device [▶ 146]).
- ⇨ Information on the state of each type of interlock is available through the webpage interface.
- ⇨ The signals External Interlock A and B are not satisfied, if the door interlock is open. The indicators External A and B OK in the webpage Welder Status are not lit.

- ⇨ The front panel indicator shows the cumulative interlock status for all interlocks (all interlocks must be satisfied for this indicator to be lit green).
- ⇨ Once the Interlock Indicator on the front panel is lit green it means laser emission can be turned ON.

⚠ DANGER

Class 4 Invisible Laser Radiation - Eye and Skin Hazards

Personnel may be exposed to class 4 invisible reflected or scattered laser radiation if Trigger 2 switch on the weld head is accidentally pressed during this procedure. Permanent and severe eye damage, vision impairment and/or skin burns can occur. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

1) Power up the LightWELD device. Refer to System Startup [▶ 101] and then come back to this section once the unit is turned ON.

⚠ WARNING

Eye and Skin Hazards during door interlock testing

- ⇨ Make sure Trigger 2 is not pressed during the door interlock test.
- ⇨ Never position the weld head towards the door under test.
- ⇨ Provide additional safety measures to protect the person involved in the door interlock test.
- ⇨ Provide additional safety measures to protect personnel outside of the LCA during the door interlock test.
- ⇨ Refer to Establish a Laser Controlled Area [▷ 61] and follow the instructions.

2) Confirm that the Interlock LED indicator is lit green (Door Interlock Closed - Safety Interlock is Satisfied [▷ 100]) when: (a) the interlocked door is closed; (b) the workpiece clamp is connected; (c) the Weld Head Trigger 1 gas control is pressed; and (d) the nozzle tip is touching the part.

3) Confirm that the Interlock LED indicator is OFF (Door Interlock Closed - Safety Interlock is Satisfied [▷ 100]) when: (a) the door interlock is open; (b) the workpiece clamp is connected; (c) the Weld Head Trigger 1 gas control is pressed; and (d) the nozzle tip is touching the part.

- ⇨ To test interlocks and view External A and B interlock state or to perform weld head diagnostics, users may: (1) use Front Panel Setup Mode (see Y0 Setup State Program Mode [▷ 111], item Interlock Groups) or (2) webpage Welder Status pane.

Interlock LED Indicator is lit green when: (1) External Safety Interlocks Closed (e.g. Door to Laser Controlled Area is closed); (2) Workpiece clamp is connected; (3) Weld Head Trigger 1 Control is Pressed; and (4) Nozzle is touching part

Figure 31: Door Interlock Closed - Safety Interlock is Satisfied

4) Have someone from authorized maintenance personnel to assist you in the door interlock test. This person opens the door interlock, while the operator is pressing Trigger 1 and touching the nozzle to the part. If the door switches were installed correctly, the external safety interlocks will open. Confirm that the Interlock LED indicator on the front panel turned OFF. Release the trigger 1 control and lift nozzle from part. Close the door again.

   ⇨ In case of the failed test, the use of the LightWELD device is prohibited. Integrate the door interlocks correctly and repeat the whole door interlock test procedure.

   ⇨ Please Note: The external safety interlocks have two redundant loops. If there is ever a mismatch (one loop opens while the other remains closed), the Error LED Indicator will illuminate and the error code Er13 will display. To clear this error both interlocks loops must first be opened and then closed again to continue.

5) Closing the door resets the interlocks. The LightWELD device is ready to operate.

⚠ DANGER

Operating Welder if Door Interlocks are not Functional

Personnel entering the Laser Controlled Area without PPE may be exposed to invisible Class 4 laser radiation from reflected or scattered laser light. Permanent and severe eye damage, vision impairment and/or skin burns can occur.

⇨ If defective, repair and/or replace interlock switches or wiring.

⇨ Redo the test procedure above to confirm the interlocks are functional.

5.9 System Startup

⚠ DANGER

Class 4 Invisible Laser Radiation - Eye and Skin Hazards

Personnel may be exposed to class 4 invisible reflected or scattered laser radiation if Trigger 2 switch on the weld head is accidentally pressed during this procedure. Permanent and severe eye damage, vision impairment and/or skin burns can occur. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

Personnel Qualifications: Operating and Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

⚠ WARNING

⇨ All electrical connections must be connected prior to applying power to the unit.

⇨ Where applicable, all connections must be secured with screws to ensure proper functionality.

⚠ WARNING

⇨ Make sure all power is removed from the laser when handling the delivery fiber cable. Minimum allowed bending radius is 50mm.

1) Ensure all connections required for successful installation have been completed.
   - ⇨ Electrical Connection – refer to Connect Electrical Power [▸ 92].
   - ⇨ Connect Workpiece Clamp Cable – refer to Connect Workpiece Clamp Cable [▸ 88].
   - ⇨ Gas Supply Connections and Supply Turned ON – refer to Connect Welding Gas [▸ 89].
   - ⇨ Weld Head Connections – refer to Connect Weld Head Cable [▸ 90].
2) Close external interlocks (12-pin connector: pins 1, 2 and 3, 4). If interlock is connected to door switches this means the door to the laser enclosure must be closed. Refer to 12-pin Interface Connector and Pinout [▸ 90] (pinout information) and Laser Controlled Area Door Interlock Example [▸ 95] (setup and testing of door interlocks).
3) Ensure the red E-Stop button, that is located on the front panel of the device, is released. If it is not, turn the button clockwise to release. Refer to Emergency Stop Button (E-Stop) [▸ 122].

⇨ When starting the laser device from an OFF state, even if you turn the key in the keyswitch to the (1) ON position, the laser device will not turn on if the E-Stop button is triggered (pressed). The E-Stop must first be released.

4) Turn the keyswitch clockwise to the 1 (ON) position.
5) All LED indicators and Displays will light ON for 3 seconds. Please wait for the device controller CPU to fully boot up (takes approximately 7 seconds).

6) When the LightWELD device is turned ON for the very first time, the system boots up into a “locked” state. A 4-digit unlock code is required to unlock the unit for use. Refer to Unlock Code Required at First Power Up [▷ 69] for instructions on how to proceed. If unit was previously unlocked skip to next step.

⇨ The IP address of the device is only shown when the unit first turns ON after the AC line cord is plugged into an outlet. The IP address of the device will show sequentially in the Wobble Frequency 3 digit display (e.g. 10 0 0 20 for factory default IP Address 10.0.0.20). See IP Address shown at first power up after AC line cord is plugged into an outlet [▷ 103].

⇨ **TIP:** If the IP address was changed and the user does not remember what it changed to, an easy way to recover it is to turn unit OFF (key to OFF position) and unplug the unit from AC power. The next time unit is plugged in and turned ON it will flash the IP address again.

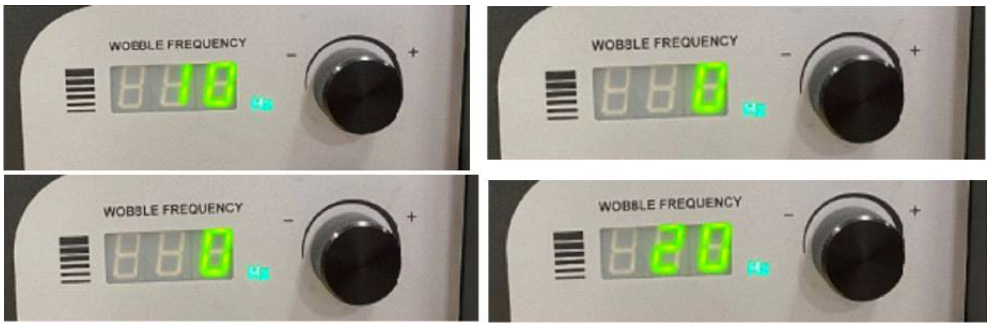


Figure 32: IP Address shown at first power up after AC line cord is plugged into an outlet

7) Once the unit is powered ON and unlocked:

Program Number Display: shows the last, previously used program number that was used prior to shutting down the unit.

Laser Power Display: will show the power (in W) according to the setting for the selected program number.

Wobble Frequency Display: shows the number according to the setting for the selected program number.

Wobble Length Display: shows the number according to the setting for the selected program number.

Guide Beam: Please note that the red guide beam will be OFF until the external interlocks are satisfied.

The laser welder is now ready for operation. Now the unit is powered ON.

⇨ If the hand welding system is not going to be used and will be idle for some time, it is recommended to shutdown the weld unit (refer to System Shutdown [▶ 104]).

5.10 System Shutdown

Personnel Qualifications: Operating and Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

To turn off the laser welder, the user must first disable emission after welding is completed:

1) Release Trigger 2 weld head control switch.

   This will stop emission.

2) Release Trigger 1 weld head control switch.

   This will stop the gas flow. The gas will continue to flow for an additional 1 second (default).

⇨ The pre and post gas flow time setting is settable via the web page interface. These settings are configurable up to a maximum of 10 seconds.

3) Turn the keyswitch to 0 (OFF) position.
4) Remove the key from the switch and secure the key to prevent unauthorized use!
5) Shut off the gas supply.

⇨ Turning keyswitch to 0 (OFF) position puts the weld unit into reset mode. The front panel displays and indicators are turned off. The laser cannot be turned on without the key inserted and turned to 1 (ON).

⇨ However, if the AC power cord remains plugged in, even with keyswitch set to OFF, the weld head is still powered and you will see the green status indicator on the weld head lit up.

6 Operating Front Panel Controls

Personnel Qualifications: Operating Personnel (see section Personnel Qualifications [▶ 22]).

DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

6.1 Rotary Control Knobs

Personnel Qualifications: Advanced Operating Personnel (refer to Personnel Qualifications [▶ 22]).

There are 3 rotary control knobs on the front panel.

- **Laser Power** – refer to Laser Power Rotary Control Knob [▶ 106].
- **Wobble Frequency** – refer to Wobble Frequency Rotary Control Knob [▶ 107].
- **Wobble Length** – refer to Wobble Length Rotary Control Knob [▶ 107].

6.1.1 Laser Power Rotary Control Knob

This control knob allows operators to increase (clockwise) or decrease (counter-clockwise) the laser power that will be used for welding up to the maximum allowable power as specified in the *PRODUCT SPECIFICATION* document for the device.

- The knob speed allows to increase/decrease the value faster or slower.
- Fast rotation of the knob increments power by 100W intervals. Slow rotation of the knob increments the power by 10W increments.
- If the program display starts to blink it indicates that one or more parameters have changed compared to the saved settings for that program. You are no longer using the preset settings (or settings from user created program).
- If the power required for the application is less than 10% of the total laser power consider using pulsed mode – refer to MODULATION Mode Parameters - Thin Joints and Foils [▶ 139] or HPP Mode Parameters - Reflective Materials [▶ 139].

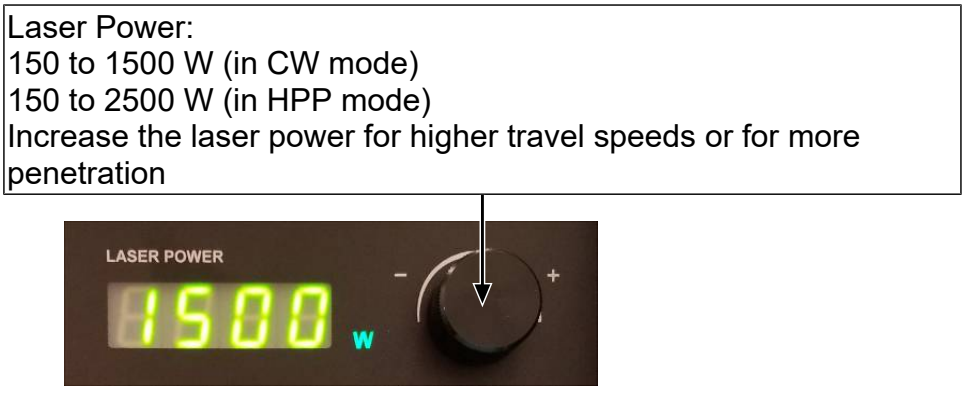


Figure 33: Laser Power Rotary Control Knob

6.1.2 Wobble Frequency Rotary Control Knob

This control knob allows operators to increase (clockwise) or decrease (counter-clockwise) the Wobble Frequency that will be used for welding up to the allowable limit of the current mode.

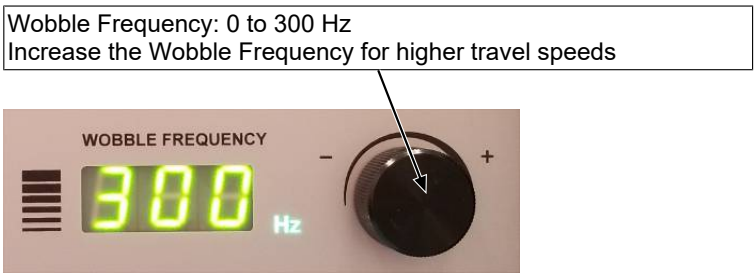


Figure 34: Wobble Frequency Rotary Control Knob

The knob speed allows to increase/decrease the value faster or slower.

Fast rotation of the knob increments the frequency by 10 Hz increments. Slow rotation of the knob increments the frequency by 1 Hz increments. The frequency setting can range anywhere from 0 up to 300 Hz.

If the program display starts to blink it indicates that one or more parameters have changed compared to the saved settings for that program. You are no longer using the preset settings (or settings from user created program).

If setting is at the low limit of 0 Hz this will turn the Beam Wobble OFF on the hand weld head.

6.1.3 Wobble Length Rotary Control Knob

This control knob allows operators to increase (clockwise) or decrease (counter-clockwise) the Wobble Length that will be used for welding up to the maximum allowable by current mode.

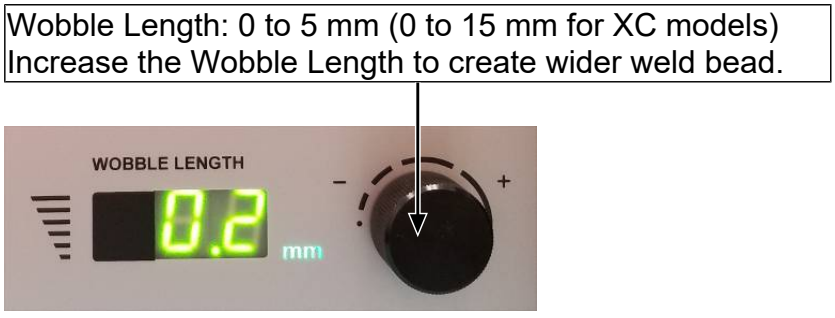


Figure 35: Wobble Length Rotary Control Knob

- The knob speed allows to increase/decrease the value faster or slower.

- Fast rotation of the knob increments the frequency by 10 mm increments. Slow rotation of the knob increments the frequency by 0.1 mm increments. The length setting can range anywhere from 0 up to 5.0 mm (or 0 - 15 mm for XC models operating in laser cleaning mode).
- If the program display starts to blink it indicates that one or more parameters have changed compared to the saved settings for that program. You are no longer using the preset settings (or settings from user created program).
- If the setting is at the low limit of 0 mm. This will turn the Beam Wobble OFF on the hand weld head.

6.2 Program Mode Recipe Selection Buttons

Personnel Qualifications: Advanced Operating Personnel (refer to Personnel Qualifications [▶ 22]).

Figure 36: Program Mode Recipe Selection

Pushing the program mode selection buttons will increase or decrease the number in the Program display by increment 1. As each new recipe is selected, the Laser Power, Wobble Frequency, and Wobble Length displays will change to whatever setting value is programmed for that selected recipe.

- There are two Program Mode Types: User and Preset.
- Users are allowed to create up to 20 User Mode recipes that are numbered 0 through 19. These recipes can be created either from the front panel control knobs or through the web interface. The user sets the Laser Power, Wobble Frequency and Length manually by using the rotary knobs on the front panel. When optimum settings are found, the recipe parameters are then saved under the selected program number. Refer to Program Mode Button Functions [▶ 109].
- Preset Programs are pre-programmed recipes from the factory. The program identification number will be a letter followed by a number. (e.g. A0, A1, A2, C0, C1, C2, etc).
- The Preset Program letter options can be: A, C, E, F, H, J, L, P, U, and Y.

Mode Button Functions	Description
Select Program Recipe	⇨ Pushing the Program Mode Up Button (right arrow) will increase the Program Number by 1. Once it reaches 19 it will start back at 0, 1, 2, etc. ⇨ Pushing the Program Mode Down Button (left arrow) will decrease the program Number by 1. Once it reaches 0 then it will go back to 19, 18, 17, etc. ⇨ To jump between program modes (User 0 to Preset A, C, E etc), press and hold the Up Button for ***2 seconds*** (or Down Button if decreasing). ⇨ Once in the Preset Mode, push the Up or Down button once to increment through the recipes for that Preset mode (e.g. A0, A1, A2, etc).
Save Program Recipe	For the selected program number, it will overwrite the values according to the present values displayed for Laser Power, Wobble Frequency and Wobble Length.To save recipe that was created: ⇨ Press and hold both the Mode Up and Down buttons simultaneously for ***3 seconds*** . Once the display stops blinking it is confirmation for the user that the program was saved
Reset Single Existing Recipe	This will reset the selected program back to the factory default. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for ***6 seconds*** . Once the display starts blinking faster it is reset.
Reset All Program Recipes	This will restore all program recipes back to the factory default. This function can also be done from the web page interface. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for greater than ***15 seconds*** . Once the display starts blinking extremely fast it is factory reset.

Table 22: Program Mode Button Functions

6.3 Device Front Panel Setup Mode

Personnel Qualifications: Advanced Operating Personnel (refer to Personnel Qualifications [▶ 22]).

Setting the program mode to Y0 (refer to Process Mode Chart that came with the device) puts the welder device into “Front Panel Setup Mode”.

This allows a user to set six global device parameters using the front panel control knobs instead of the welder webpage and therefore does not require a PC connected to the welder device.

It allows a user to view welder status information, such as warnings and interlock states, on the front panel display instead of the welder webpage. This is especially useful when testing interlocks or performing other troubleshooting tasks.

The Wobble Length rotary knob is used to select specific code numbers. The Wobble Frequency rotary knob is used to set parameter values (only for settable code numbers 0 to 5).

Please note that if the code selected is read-only, the Wobble Frequency rotary knob and Laser Power rotary knob will be disabled. For settable parameters only the Laser Power rotary knob is disabled.

Refer to Y0 Setup State Program Mode [▶ 111] for information on each setup state code number.

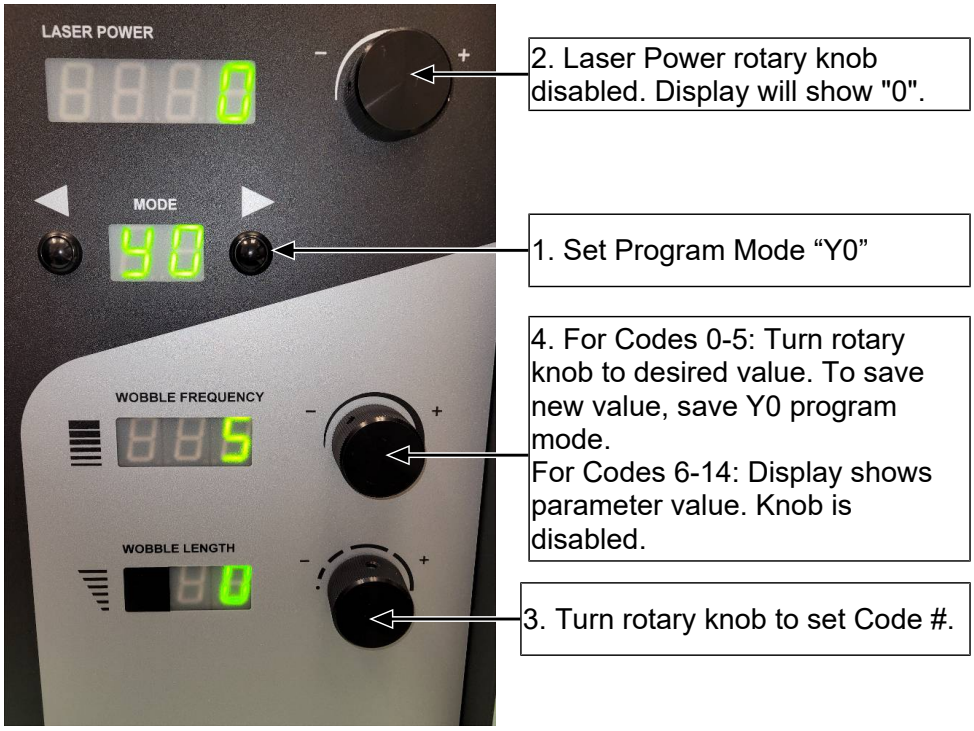
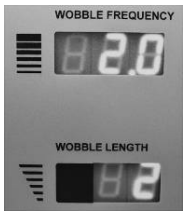
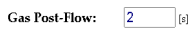
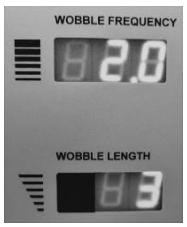
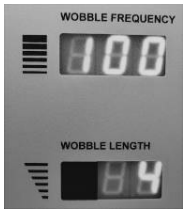
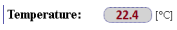
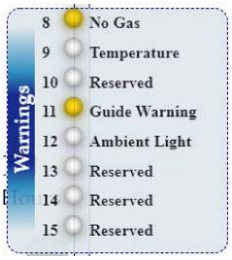
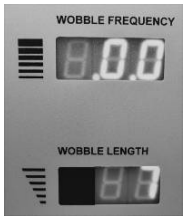
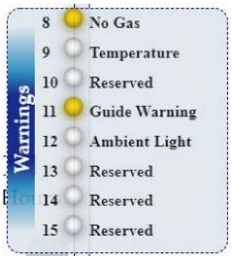
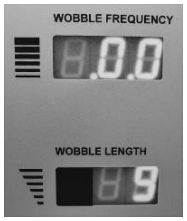
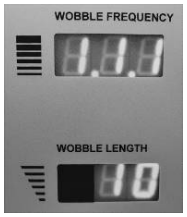
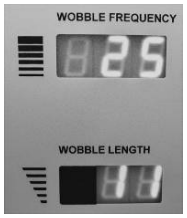
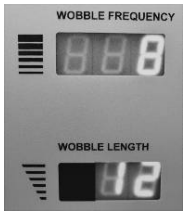
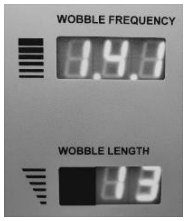


Figure 37: Front Panel Setup Mode Control

Code #	Parameter	Front Panel Displays	Explanation User must first set program mode to Y0
0	Wobble Offset  Refer to Configure Misc. Settings - Advanced Settings [▸ 167].		Sets wobble offset (to center output beam when using wire feeder). ⇨ Turn Wobble Length knob to Code 0. ⇨ Turn Wobble Frequency knob to set offset +/- 1mm. The value displayed is the offset multiplied by 10. Setting 5 is 0.5 mm offset. Setting 10 is equivalent to 1.0 mm offset. Setting -5 is equivalent to -0.5 mm. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.
1	Purge  Refer to Laser Welder Page [▸ 153].		Sets gas purge enabled/disabled. ⇨ Turn Wobble Length knob to Code 1. ⇨ Turn Wobble Frequency knob to enable/disable. 0= Purge Disabled and 1= Purge Enabled ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.
2	Pre-Flow Gas Time  Refer to Laser Welder Page [▸ 153].		Sets pre-flow gas time (in s). ⇨ Turn Wobble Length knob to Code 2. ⇨ Turn Wobble Frequency knob to set time 0.1 - 10 s. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.
3	Post Flow Gas Time  Refer to Laser Welder Page [▸ 153].		Sets gas post-flow time (in s). ⇨ Turn Wobble Length knob to Code 3. ⇨ Turn Wobble Frequency knob to set time 0.1 - 10 s. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.

Code #	Parameter	Front Panel Displays	Explanation User must first set program mode to Y0
4	Ramp Up Scale  Refer to Configure Misc. Settings - Advanced Settings [▸ 167].		Sets the ramp up scale. ⇨ Turn Wobble Length knob to Code 4. ⇨ Turn Wobble Frequency knob to set scale 10 - 200%. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.
5	Ramp Down Scale  Refer to Configure Misc. Settings - Advanced Settings [▸ 167].		Sets the ramp down scale. ⇨ Turn Wobble Length knob to Code 5. ⇨ Turn Wobble Frequency knob to set scale 10 - 200%. ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.
6	Laser Temperature 		Displays the laser temperature reading (in °C). ⇨ Turn Wobble Length knob to Code 6. Wobble Frequency display shows the laser temperature reading. In this example it is 22.4 °C.
7	Warning Group 1  See Welder Status Pane Features [▸ 155].	 [1]**See NOTE**	Displays first group of 3 Warning states. ⇨ Turn Wobble Length knob to Code 7. Wobble Frequency display shows warning state. In this example, ".0.0" or "0.0.0" (depending on display revision) indicates that there are no warnings. **0= NO WARNING and 1= WARNING** Result format, left to right, is specified below. 3rd Digit . 2nd Digit . 1st Digit **(Guide Warning).(Temperature).(No Gas)**

Code #	Parameter	Front Panel Displays	Explanation User must first set program mode to Y0
8	Warning Group 2  See Welder Status Pane Features [▶ 155].	 [1]**See NOTE**	Displays second group of 3 Warning states. ⇨ Turn Wobble Length knob to Code 8. Wobble Frequency display shows warning state. In this example, ".0.0" or "0.0.0" (depending on display revision) indicates that there are no warnings. **0= NO WARNING and 1= WARNING** Result format, left to right, is specified below. 3rd Digit . 2nd Digit . 1st Digit **(Reserved).(Reserved).(Ambient Light)**
9	Interlock Group 1  See Welder Status Pane Features [▶ 155].	 [1]**See NOTE**	Displays first group of 3 Interlock states. This is primarily used to test or troubleshoot the weld head. ⇨ Turn Wobble Length knob to Code 9. Wobble Frequency display shows interlock state. In this example, ".0.0" or "0.0.0" (depending on display revision) means that all 3 are NOT ACTIVE. **0= NOT ACTIVE and 1= ACTIVE** Result format, left to right, is specified below. 3rd Digit . 2nd Digit . 1st Digit **(Trigger 2 OK).(Trigger 1 OK).(Nozzle OK)** Weld Head Diagnostic Examples: When operator presses Trigger 1 (or 2) switch on weld head - it turns to 1. When operator releases Trigger 1 (or 2) switch - it turns to 0. Touch nozzle to workpiece - it turns to 1. Lift nozzle from workpiece - it turns to 0.

Code #	Parameter	Front Panel Displays	Explanation User must first set program mode to Y0
10	Interlock Group 2  See Welder Status Pane Features [▶ 155].	 [1]**See NOTE**	Displays second group of 3 Interlock states. ⇨ Turn Wobble Length knob to Code 10. Wobble Frequency display shows interlock state. In this example, 1.1.1 means that all 3 interlocks are OK. **0= NOT OK and 1= OK (interlock satisfied)** Result format, left to right, is specified below. 3rd Digit . 2nd Digit . 1st Digit **(Fiber Interlocks OK).(External A OK).(External B OK)** Interlock Examples: 1 - Fiber cable is properly connected to weld head. 1 - Door to laser controlled area is closed. External A/B interlocks are for door interlocks to laser controlled area, as an example.
11	Hours On  See Welder Status Pane Features [▶ 155].		Displays the device total ON hours (1 count for every 10 hours). ⇨ Turn Wobble Length knob to Code 11. Wobble Frequency display shows the total number of hours device was ON. In this example it's 25 counts or 250 hours.
12	Emission ON Hours  See Welder Status Pane Features [▶ 155].		Displays the device total Emission ON hours. ⇨ Turn Wobble Length knob to Code 12. Wobble Frequency display shows number of hours laser emission was ON. In this example it's 8 Emission ON hours.
13	Firmware Revision Refer to Product Support Page [▶ 161].		Displays the firmware revision number. ⇨ Turn Wobble Length knob to Code 13. Wobble Frequency display shows device revision number. In this example, the revision is 1.4.1.

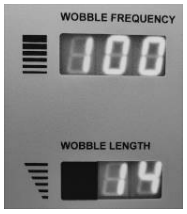
Code #	Parameter	Front Panel Displays	Explanation User must first set program mode to Y0
14	Purge Time Purge Time: 60 [s] Refer to Configure Misc. Settings - Advanced Settings [▶ 167].		Sets the Purge Time (seconds). ⇨ Turn Wobble Length knob to Code 14. ⇨ Turn Wobble Frequency knob to set time 0 to 998 s (default is 60 s). Setting the purge time to 999 will keep purge gas on indefinitely (replicating legacy operation). ⇨ Press and hold both the Mode Up and Down buttons simultaneously for 3 seconds to save setting.

Table 23: Y0 Setup State Program Mode

[1] **NOTE**: Digit on left may be blank on some models, depends on revision of display. In this case, Blank=0.

7 Operating Laser Welder

7.1 Important Safety Functions

7.1.1 Fiber Interlock

The optical interlock is connected to the optical fiber connector (LC-8) and provides a method to interlock the fiber connector to external optical components (such as the hand weld head). The laser welder monitors this signal and shuts down or prevents emission start if the optical connector is not properly terminated at the weld head.

The weld unit provides an interlock signal output based on the state of the interlock wires included in the fiber cable between the laser device and the hand weld head. If the fiber cable connection to the weld head is unplugged or broken, the two interlock relays will open.

⚠ WARNING

Do not use Weld Heads From Other Suppliers

Connecting fiber or electrical connector to weld head from other suppliers will cause safety functions to not work as intended. This may also damage the device.

⇨ Only connect the fiber to an IPG approved and supplied weld head.

⇨ Do not plug in other devices to the laser weld head connections on the rear panel other than the cable and head provided.

7.1.2 External Interlocks

The device includes an Interlock Safety Circuit that uses a dual-channel system with monitored output and manual reset. When you open the Interlock, the safety circuit opens and the power to the laser diodes is removed.

Close the dual-channel interlock (on 12-pin connector: pin-1 is connected with pin-2 and pin-3 is connected with pin-4). Otherwise, the internal main power supply is switched off and laser emission cannot be turned on.

Clearing Interlock Error:

Once any one of the pairs of the contacts mentioned above is opened, you cannot switch the laser's power supply on until the second pair is opened and then both pairs are closed.

These interlocks should be wired to the operator's external safety measures. Opening either channel will result in the clearing of the safety latches. The status of external interlock A and B are monitored for consistency by the device.

The external interlock pins are intended to satisfy the Remote Interlock Connector requirement as defined by EN 60825-1 (6.4). If the connections between pins 1,2 and 3,4 are breached by a door interlock or other means, laser emission will be prevented. Safety characteristics according to EN ISO 13849-1; Performance Level PL d, category 3.

7.1.3 Head Nozzle and Workpiece Clamp Interlock

This safety loop ensures the laser only fires when the head nozzle is electrically connected (touching) to the work piece. The operator must clamp the workpiece to the jack stud terminal on the rear panel of the unit. Whenever the nozzle of the head touches the work piece the nozzle interlock loop will be closed and satisfied. If the operator lifts the nozzle from the work piece during welding, this interlock loop opens and the laser will shut off automatically.

7.1.4 Weld Head Two Level Trigger

⚠ DANGER

Class 4 Invisible Laser Radiation - Eye and Skin Hazards

Personnel may be exposed to class 4 invisible reflected or scattered laser radiation if Trigger 2 switch on the weld head is accidentally pressed during this procedure. Permanent and severe eye damage, vision impairment and/or skin burns can occur. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

Built into the head is a trigger switch with two discrete channels. Trigger 1 is an interlock loop that closes when pressed. Trigger 2 is a start button and an additional interlock loop that will close when pressed.

Trigger 1 Switch

Pressing Trigger 1 on the weld head will turn on the shield gas. Whenever Trigger 1 is released the shield gas will stay on for an additional 1 second (post-flow gas time is configurable up to a maximum of 10 seconds) before turning off the gas flow.

To turn on the laser emission using the Trigger 2 switch, the operator must continue to hold the Trigger 1 switch closed during welding. Releasing Trigger 1 while Trigger 2 is pressed will cause an error that stops the laser emission.

Trigger 2 Switch

Pressing Trigger 2 on the weld head acts as a start button for the laser. The laser will fire provided all safety conditions are satisfied and the shield gas has been detected for at least 1 second prior (pre-flow gas time is configurable up to maximum of 10 seconds). To weld, the operator must continue to hold Trigger 2 switch closed for laser emission to stay on. Releasing Trigger 2 will stop laser emission. Trigger 2 can be released without releasing Trigger 1.

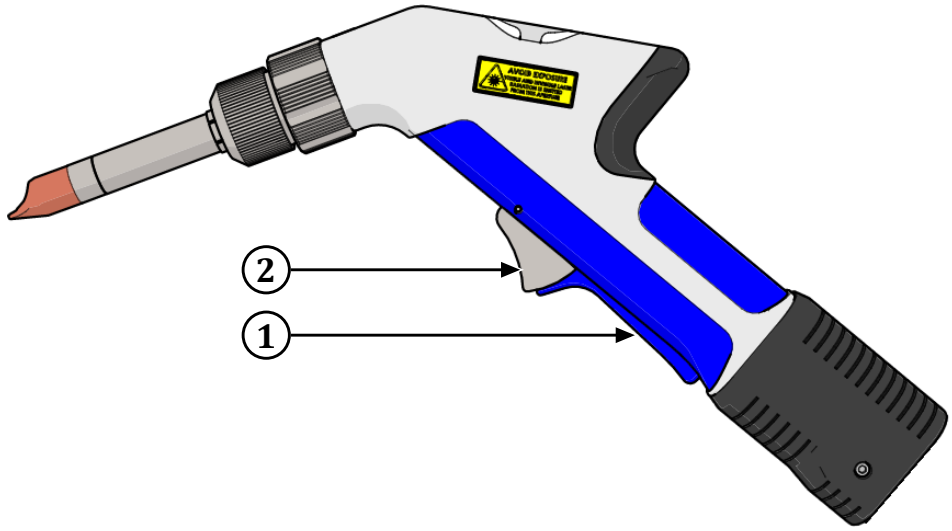


Figure 38: Weld Head Trigger Controls

1	Trigger 1 – Press & Hold to Start Gas Flow	2	Trigger 2 – Press & Hold to Start Laser Emission

7.1.5 Overheating Control

A thermal fuse is included in the weld head that will shut off the laser through the fiber interlock circuit if the weld head exceeds temperature limit from any cause including damaged optics.

A thermal sensor monitors the air-cooled laser heat sink temperature. If the temperature exceeds limits, the laser will not operate.

The location of the thermal fuse is indicated in the figure below (item 1).

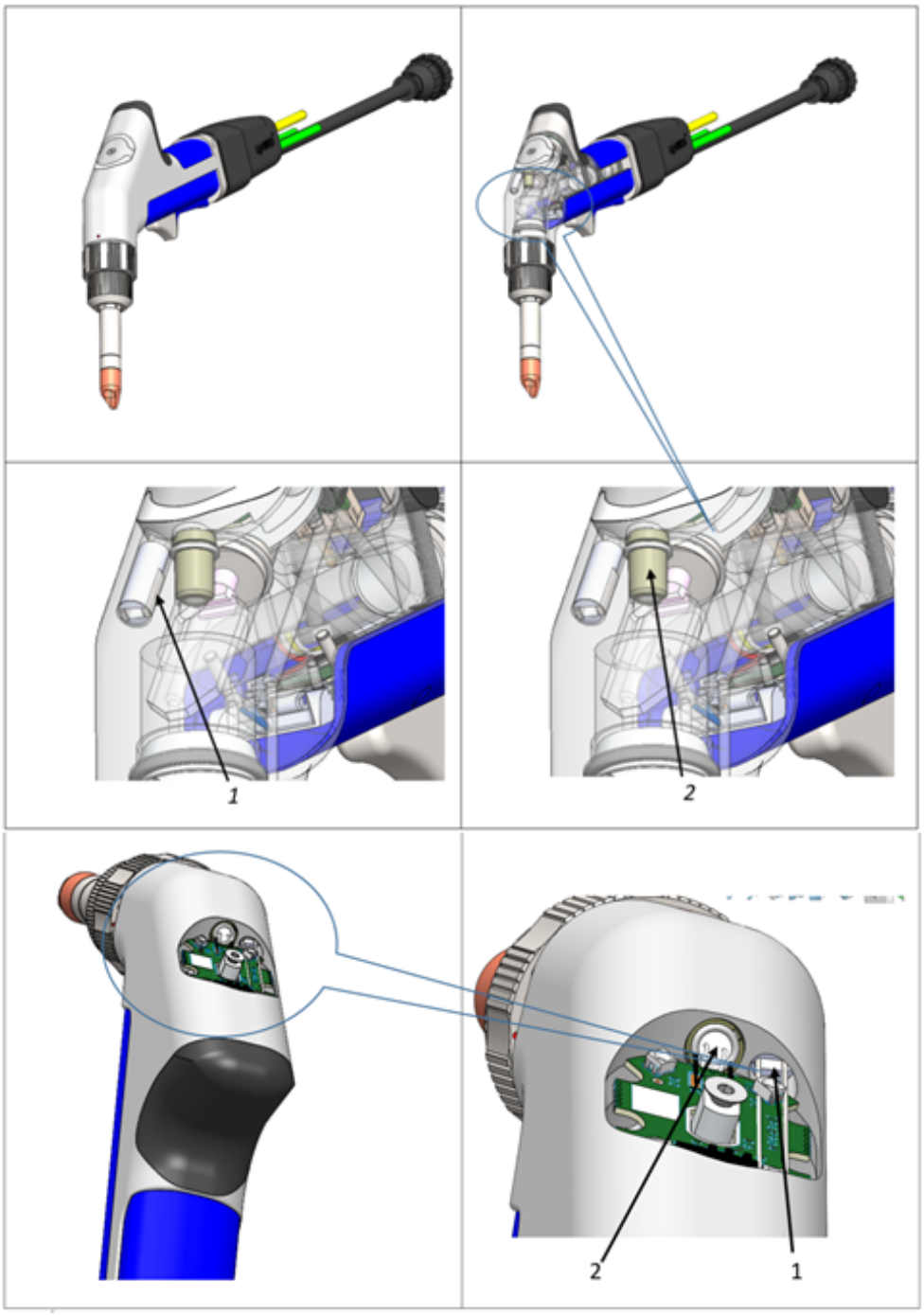


Figure 39: Weld head thermal fuse plasma sensor

Pos	Description
1	Thermal fuse
2	Plasma sensor

7.1.6 Plasma Detection

The handheld weld head includes a photo sensor to monitor plasma (the bright visible light created during welding). If there is not sufficient plasma light created after the start of a weld, the laser will automatically turn emission off. For the location of the Plasma Sensor, see figure Weld head thermal fuse plasma sensor [▷ 120] (item 2).

7.1.7 Gas Pressure Monitoring

The availability of shield gas is monitored by requiring a minimum gas pressure that activates a sensor. When there is less than approximately 10 psi (0.7 bar) pressure present, the laser will not turn on. The green gas LED indicator on the front panel will not be lit when there is insufficient pressure. If gas pressure exceeds maximum pressure, a relief valve opens to prevent damage to the gas valves. The pressure present sensor is located inside the base of the device. Refer to block diagram drawing in the figure below.

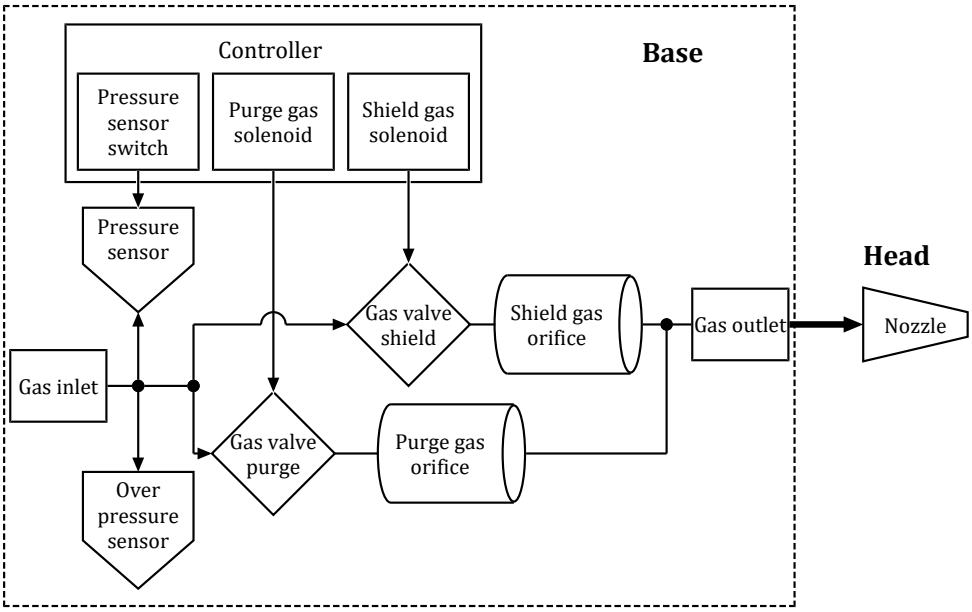


Figure 40: Gas Pressure Monitoring Block Diagram

7.1.8 Emergency Stop Button (E-Stop)

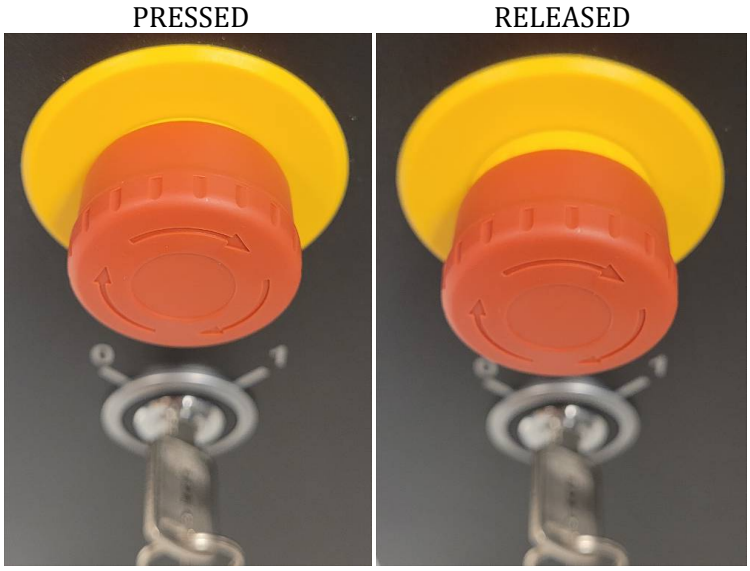


Figure 41: Emergency Stop Button (E-Stop)

In case of an emergency, press the red E-Stop button on the front panel.

- The E-Stop function opens an interlock in the safety circuitry of the device.
- The laser will turn off (laser emission will stop if it was on).
- The device controller CPU is held in reset.
- The pins 5-6, 7-8 on the 12-pin I/O connector are set OFF (refer to 12-pin Interface Connection and Pinout Table [▶ 91]).
- The wire feeder will stop, if one was connected and being used.
- Front panel: All indicator lights and LED displays will be off. All control knobs and buttons are disabled.
- Ethernet is disabled (communication between the laser device and connected PC is lost.) Will not be able to access the webpage interface.

To release the E-Stop:

Turn the red E-Stop button clockwise in the direction indicated by the arrows on the front of the red button, as shown in figure above.

During System Startup:

When starting the system from an OFF state users should first check if the E-Stop button is pressed and release it. Even if you turn the key in the keyswitch to the (1) ON position, the laser device will not turn ON while the E-Stop button is triggered (pressed).

During Laser Operation:

If the E-Stop button is pressed while laser emission is ON (i.e. during welding), the laser radiation will turn OFF (stop). Laser emission cannot be turned on again until the button is released.

7.1.9 Warning and Status Lights

On top of the weld head there are two status LED indicators:

- Emission Status Indicator is lit:
  - **Red** - When laser emission is ON.
- Interlock Status Indicator is lit:
  - **Solid Green** - When Trigger 1 control is pressed and no errors are present.
  - **Blinking Green** - Once all the interlocks are satisfied, the system is ready to fire. Operator can initiate laser emission by pressing Trigger 2 Control on the weld head.

The device front panel has five LED status indicators:

- **Emission** - Status indicator is lit yellow when laser emission is ON.
- **Interlock** - Status indicator is lit green when all safety interlock loops are satisfied. Once this indicator is lit it means that laser emission can be turned ON by pressing the Trigger 2 control on the weld head, provided there are no alarms and gas delay time is met.
- **Gas** - Status indicator is lit green when there is sufficient gas pressure coming into the device from gas supply.
- **Warning** - Status indicator is lit yellow if there is (1) no gas, (2) temperature of the laser is approaching upper limit, or (3) red guide laser is not functioning.
- **Error** - Status indicator is lit red when alarm occurs. Alarms will stop the welding process by shutting down laser emission.

7.2 Integrated Beam Wobble Function

The LightWELD device's "beam wobble" functionality creates a wider weld seam which improves the quality and aesthetics of the weld joint. The integrated wobble device optics deflect the laser beam and sweep it linearly back and forth along the cross-axis relative to the on-axis welding direction motion. The Wobble Frequency and Wobble Length can be adjusted via the rotary control knobs on the front panel of the weld unit.

Since the IR laser beam is invisible, users may use the visible red guide laser beam to fine tune the frequency and length parameters for the wobble device. In the images below, adjusting the wobble length (up to 5 mm possible), will increase the width of the weld seam as shown in figure Beam Wobble Function [▶ 124].

The wobble length can be adjusted up to 15 mm when the selected program is configured to use the CLEAN laser mode. This is only applicable for the cleaning models listed here:

- LightWELD XC

To use the 15 mm wobble length (for cleaning) the user must first install the optimum cleaning nozzle on the weld head. When using a different laser mode, other than cleaning mode, the wobble length will only be adjustable up to 5 mm.

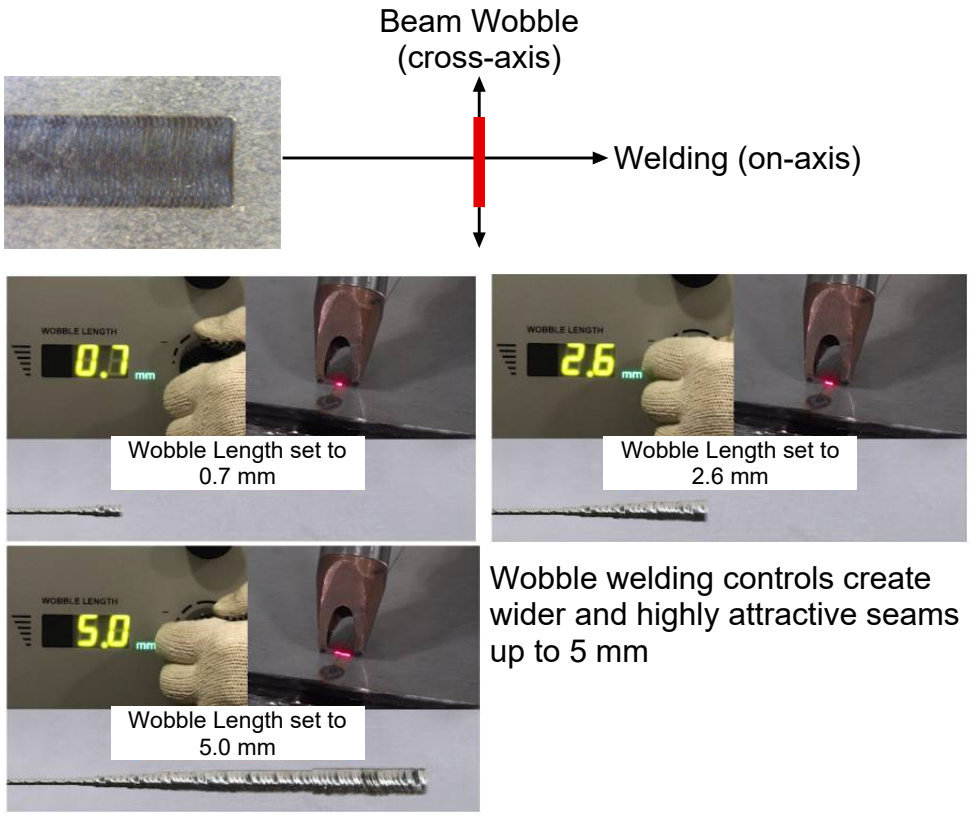


Figure 42: Beam Wobble Function

7.3 Weld Head Nozzle Tip and Tube

Personnel Qualifications: Advanced Operating Personnel (refer to Personnel Qualifications [▶ 22]).

7.3.1 Nozzle Tip Types

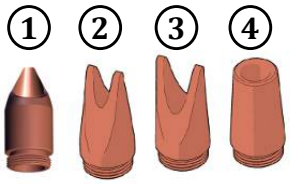
There are four types of nozzle tips available for welding (Nozzle Tip Selection Chart [▷ 125]). Proper selection of the nozzle tip is required for safety and to also achieve the optimum welding results. Use chart below to select the nozzle tip based on the type of weld joint (butt, corner, tee, lap or edge joints).

The chart only shows three of the four tips. The information in the 2 point nozzle tip row is applicable for both 6 mm and 9 mm types.

⚠ WARNING

Improper Nozzle Tip Selection

Improper nozzle tip selection increases the likelihood of unwanted and dangerous reflections, improper welding and the risk of injury. Refer to Nozzle Tip Selection Chart [▷ 125].



Nozzle Tip Kit (CDSBME000089XXXU):
1. 1-point (General Purpose)
2. 2-point, 6 mm
3. 2-point, 9 mm
4. Circle

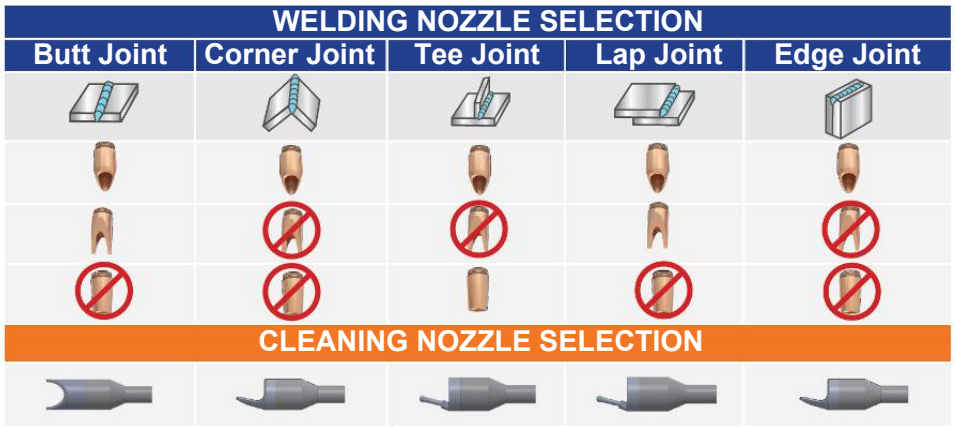


Figure 43: Nozzle Tip Selection Chart

For LightWELD XC models running in CLEAN laser mode, there are 3 additional nozzles available. Refer to Cleaning Nozzle Part Numbers - LightWELD XC Models [▷ 126].

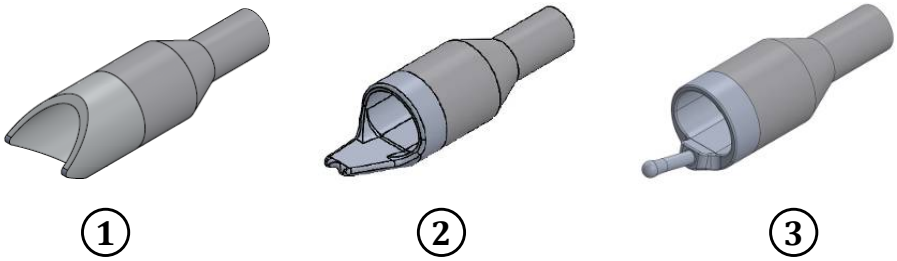


Figure 44: Cleaning Nozzle Part Numbers - LightWELD XC Models

1	2-Prong Cleaning Nozzle (CEU00003909XXXXU)	2	Outer Corner Nozzle (CEU00003803XXXXU)
3	1-Prong Cleaning Nozzle (CEU00003708XXXXU)	4	

7.3.2 Installing Nozzle Tip for Welding

⇨ Prior to changing the nozzle tip, shutdown the unit using the keyswitch (refer to System Shutdown [▶ 104]).

The following applies for all models. The nozzle tip will thread onto the weld head's extension tube. It is important to adjust the nozzle orientation (see next section) so that the tip is not rotated. Do not operate the device with the nozzle rotated.

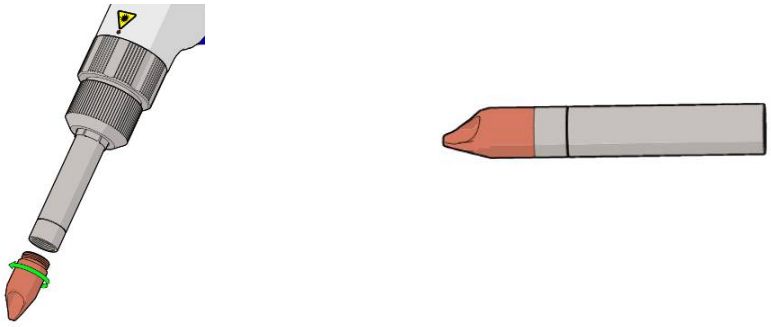


Figure 45: Nozzle Tip Installation

7.3.3 Changing Nozzle and Adjusting Rotation

Prior to adjusting or replacing the nozzle, please shutdown the unit using the keyswitch (refer to System Shutdown [▶ 104]).

1) First loosen the nut. See first row pictures in Changing and/or adjusting the weld head nozzle [▶ 128].

2) When switching between welding and cleaning nozzles, remove the nozzle from the weld head and replace with the nozzle type you want to use. Make sure you insert the nozzle as far as it will go into the weld head. See second row pictures in table Changing and/or adjusting the weld head nozzle [▶ 128].

NOTICE

Uncontrolled reflection of laser class 4 radiation in case of wrong nozzle tip orientation

Operating the device with the nozzle rotated, may cause the beam to reflect onto a part of the nozzle tip instead, possibly damaging the tip or causing a undesired and uncontrolled reflection or scattering of the laser light.

⇨ After the operator changes welding tips, he/she needs to check that the nozzle tip is not rotated.

⇨ For example pictures that show correct orientation of the welding nozzle tips and cleaning nozzles, refer to Examples of correct nozzle placement and orientation [▶ 129].

3) Check the orientation of the nozzle and correct the rotation. See third row pictures in Changing and/or adjusting the weld head nozzle [▶ 128]. For example pictures that show correct orientation of the welding nozzle tips and cleaning nozzles, refer to Examples of correct nozzle placement and orientation [▶ 129].

4) Once the nozzle orientation is corrected, tighten the nut to lock the nozzle position. Please only hand tighten. See fourth row pictures in Changing and/or adjusting the weld head nozzle [▶ 128].

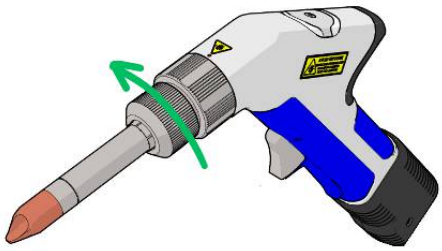
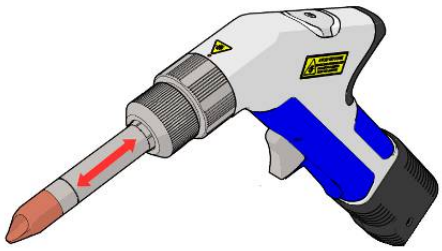
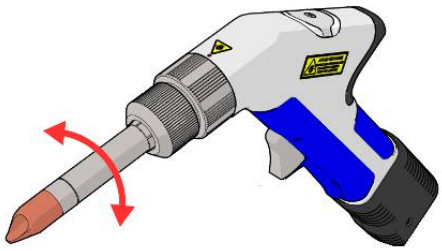
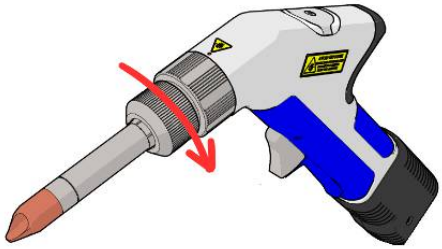
All Models	LightWELD XC Model - Cleaning Nozzle
1. Loosen nut to unlock nozzle. 	1. Loosen nut to unlock nozzle. 
2. Pull out the nozzle and insert the new nozzle. 	2. Pull out the nozzle and insert the new nozzle. 
3. Correct the nozzle rotation so tip is not rotated. 	3. Correct the nozzle rotation so tip is not rotated. 
4. Tighten nut to lock nozzle position. 	4. Tighten nut to lock nozzle position. 

Table 24: Changing and/or adjusting the weld head nozzle

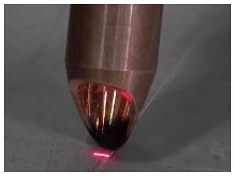
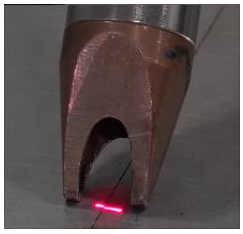
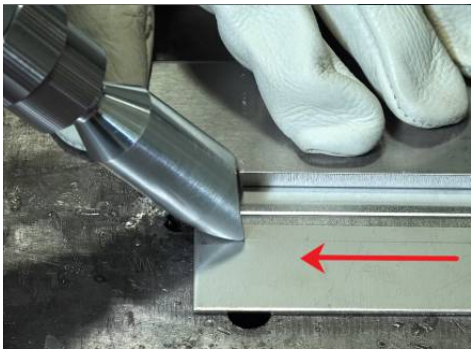
ALL MODELS - Welding Nozzle Tips	LightWELD XC Model - Cleaning Nozzles
1-point welding nozzle tip positioned over the seam is shown here. 	1-point cleaning nozzle is shown here. Red arrow indicates cleaning direction on-axis. 
2-point welding nozzle tip positioned across the seam is shown here. 	2-point cleaning nozzle is shown here. Red arrow indicates cleaning direction on-axis. 

Table 25: Examples of correct nozzle placement and orientation

7.4 Quick Start Welding Using Preset Programs

This section is applicable for all models.

Personnel Qualifications: Operating Personnel (refer to Personnel Qualifications [▷ 22]).

⚠ DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

1) Verify the door safety interlock circuit is working and lights the error indicator on the front panel of the device when the door is opened (external interlocks A or B open). Closing the door will clear the alarm. Refer to Testing Door Interlock [▷ 97].

2) Select nozzle tip. Install tip on weld head extension tube (refer to Weld Head Nozzle Tip and Tube [▷ 124]).

3) Select program recipe from Quick Start Table (refer to Quick Start Parameters Set [▶ 137]). For this example, we will choose preset program A2 for 2mm thickness stainless steel to be processed in CW laser mode.

4) Select the program (e.g. A2) using the unit's front panel buttons (see Program Mode Recipe Selection Buttons [▶ 108]).

5) Secure parts to be welded. In laser welding it is desirable to secure the parts with minimum gap and closely touching wherever possible.

6) Ensure the workpiece clamp is connected to either the parts, or the electrically conductive welding table on which the parts are placed.

Figure 46: Workpiece clamp connected to electrically conductive welding table

7) Press Trigger 1 on the weld head to turn on the shielding gas. Wait for a few seconds to clear the gas line.

8) Touch the nozzle tip to the part being welded. This closes the safety circuit and the laser is now ready to fire. Since the IR laser beam is invisible, use the red guide beam to position the nozzle correctly onto the part. The picture below shows the proper angle to hold the weld head when positioning the nozzle onto the part being welded.

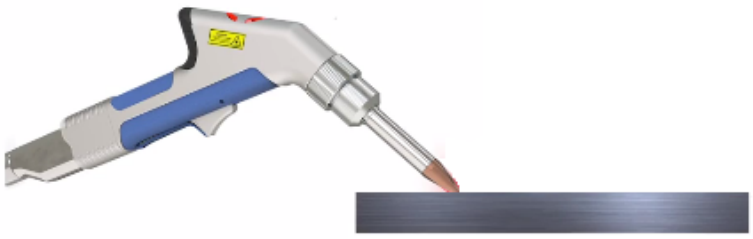


Figure 47: Proper angle to hold the weld head when positioning nozzle onto part

For Seam Welding:

⇨ Laser welding is done with a pulling motion at constant as possible travel speed to provide an even weld depth. By adjusting the speed or power you can change the depth of the weld.

⇨ Practice the motion before pressing Trigger 2. Do not break contact with the part. If the nozzle tip is lifted up off the part at any time, while Trigger 2 is pressed, the laser will automatically turn OFF.

9) Press Trigger 2 on the weld head to start laser emission and initiate welding.

For Tack Welding:

⇨ Press and hold Trigger 2 for 1 to 2 seconds. Release Trigger 2, move to next location and repeat steps 8 and 9.

⇨ To further improve the process, operators may adjust some of the process settings by either increasing or decreasing the laser power, wobble frequency or length using the three rotary control knobs on the front panel.

⇨ When operators make changes to the default recipe settings, the parameter values on the front panel display will flash. The flashing indicates that the current setting does not match the programmed recipe setting.

7.5 Quick Start Cleaning Using Preset Programs

This section is only applicable for models operating in laser cleaning mode. Cleaning models include:

- LightWELD XC

Personnel Qualifications: Operating Personnel (refer to Personnel Qualifications [▷ 22]).

⚠ DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

1) Verify the door safety interlock circuit is working and lights the error indicator on the front panel of the device when the door is opened (external interlocks A or B open). Closing the door will clear the alarm. Refer to Testing Door Interlock [▸ 97].

2) Select cleaning nozzle. Install nozzle on weld head (refer to Weld Head Nozzle Tip and Tube [▸ 124]).

⇨ When operating the device in laser cleaning mode an adjustment up to a 15 mm beam wobble length is allowed.

⇨ Please note that it is possible to clean a part using the same nozzle tip that was used during welding. However, for this case the beam wobble length should always be set to a value of 5 mm or less.

NOTICE

Using Incorrect Nozzle Results in Weld Head Damage!

Damage to weld head if beam wobble length is set to value greater than 5 mm while using a welding nozzle tip.

⇨ For cleaning width 5 to 15 mm, one of the cleaning nozzles MUST be installed on the weld head.

3) Select cleaning program recipe from the Process Mode Chart that came with the system (refer to Quick Start Parameters Set [▶ 137]). For this example, we will choose preset program P1.

⇨ There are preset cleaning programs for stainless steel, steel, galvanized steel and aluminum. For each material specified there will be a choice between a less aggressive or more aggressive cleaning program option.

4) Select the program (e.g. P1) using the unit's front panel buttons (refer to Program Mode Recipe Selection Buttons [▶ 108]).

5) Secure parts to be cleaned.

6) Ensure the workpiece clamp is connected to either the parts, or the electrically conductive welding table on which the parts are placed.

Figure 48: Workpiece clamp connected to electrically conductive welding table

7) Press Trigger 1 on the weld head to turn on the shielding gas. Wait for a few seconds to clear the gas line.

8) Touch the nozzle tip to the part being cleaned. This closes the safety circuit and the laser is now ready to fire. Since the IR laser beam is invisible, use the red guide beam to position the nozzle

correctly onto the part. The picture below shows the proper angle to hold the weld head when positioning the nozzle onto the part being cleaned.

Figure 49: LightWELD Operator Performing Laser Cleaning

For Cleaning:

- ⇨ Laser cleaning is done with a pulling motion at constant as possible travel speed.
- ⇨ Practice the motion before pressing Trigger 2. Do not break contact with the part. If the nozzle tip is lifted up off the part at any time, while Trigger 2 is pressed, the laser will automatically turn OFF.

9) Press Trigger 2 on the weld head to start laser emission and initiate cleaning.

- ⇨ To further improve the process, operators may adjust some of the process settings by either increasing or decreasing the laser power, wobble frequency or length using the three rotary control knobs on the front panel.
- ⇨ When operators make changes to the default recipe settings, the parameter values on the front panel display will flash. The flashing indicates that the current setting does not match the programmed recipe setting.

8 Program Recipes and Parameters

Personnel Qualifications: Advanced Operating Personnel (refer to Personnel Qualifications [▶ 22]).

⚠ DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

8.1 Quick Start Parameters Set

Select Preset program from IPG's Process Mode Chart to suit the welding application. For example, if welding 2 mm thickness stainless steel in CW mode, set program mode `A2` using the welder unit's front panel control buttons. To further optimize the welding process, the operator may use the three rotary control knobs to adjust those settings even further.

Laminated Mode Chart:

A laminated copy of the mode chart for your device is provided with the unit. If that sheet is lost, a copy of the mode chart may also be downloaded from the LightWELD Product Support webpage (refer to section Service and Support [▶ 192])

8.2 Welding Mode Descriptions

There are seven types of laser welding modes.

- **CW** - Used for seam welding (refer to CW Mode Parameters - Seam Welding [▶ 138])
- **TACK** - Used for tack welding (refer to TACK Mode Parameters - Tack Welding [▶ 138])
- **MODULATION** - Used for thin joints and foils (refer to MODULATION Mode Parameters - Thin Joints and Foils [▶ 139])
- **HPP** - Used for welding of reflective materials (refer to HPP Mode Parameters - Reflective Materials [▶ 139])
- **STITCH** - Used for stitch welding (refer to STITCH Mode Parameters - Stitch Welding [▶ 140])
- **CLEAN** - Cleaning is only available on XC models (refer to CLEAN Mode Parameters [▶ 140])
- **ADV. STITCH** - Used for stitch welding. This mode allows users to select pulse wave shapes that were previously set up. (refer to ADV STITCH Mode Parameters [▶ 141])

IMPORTANT: “W” on the Process Mode Chart

On the Process Mode Chart there is a mode “W” for Wire Welding. Wire welding is used when filler material is required to help bridge gaps or produce fillet weld.

To use a wire welding preset, it is required that the Wire Feeder Kit optional hardware be installed. The “W” mode is not a laser mode. It is a selection of preset programs that is configured to use one of the seven types of laser welding modes, listed above, during wire welding. The sections that follow only describe the laser welding modes

8.2.1 CW Mode Parameters - Seam Welding

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4	Ramp Up Time	ms	0	2000
5	Ramp Down Time	ms	0	2000
6	Material Selection	Choose either Steel or Aluminum		

Above parameter settings need to be configured to operate in “CW” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▷ 144].

8.2.2 TACK Mode Parameters - Tack Welding

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4	Ramp Up Time	ms	0	2000
5	Tack Time	ms	0	4500
6	Ramp Down Time	ms	0	2000
7	Material Selection	Choose either Steel or Aluminum		

Above parameter settings need to be configured to operate in “TACK” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▶ 144].

8.2.3 MODULATION Mode Parameters - Thin Joints and Foils

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4	Pulse Frequency	Hz	2	1500
5	Pulse Duty Cycle	%	0	100
6 [a]	Waveform Program N	1	0	20
7	Material Selection	Choose either Steel or Aluminum		

[a] Pulse waveform shapes 1-10 are created by the user and 11-20 are preset by IPG Photonics.

Above parameter settings need to be configured to operate in “MODULATION” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▶ 144].

8.2.4 HPP Mode Parameters - Reflective Materials

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	2500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4	Pulse Frequency	Hz	40	1500
5	Pulse Duty Cycle	%	0	20
6 [a]	Waveform Program N	1	0	20
7	Material Selection	Choose either Steel or Aluminum		

[a] Pulse waveform shapes 1-10 are created by the user and 11-20 are preset by IPG Photonics.

Above parameters settings need to be configured to operate in “HPP” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▷ 144].

8.2.5 STITCH Mode Parameters - Stitch Welding

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4	Ramp Up Time	ms	0	2000
5 [a]	Laser On Time	ms	0	35000
6 [a]	Ramp Down Time	ms	0	2000
7 [b]	Laser Off Time	ms	0	35000
8	Stitch Count	1	0	5000
9	Material Selection	Choose either Steel or Aluminum		

[a] When using the front panel knob, Laser On Time is controlled in units of seconds, with 0.1 s resolution. On the webpage it is controlled in ms (finer resolution).

[b] When using the front panel knob, Laser Off Time is controlled in units of seconds. The displayed value will be an integer value between 0 and 35 s. On the webpage it is controlled in ms (finer resolution).

Above parameters settings need to be configured to operate in “STITCH” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▷ 144].

8.2.6 CLEAN Mode Parameters

This section is applicable only for the following cleaning models listed here:

- LightWELD XC

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	15.0
4	Pulse Frequency	kHz	10	60
5	Pulse Duty Cycle	%	0	100

Above parameters settings need to be configured to operate in “CLEAN” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▷ 144].

8.2.7 ADV STITCH Mode Parameters

#	Parameter	Dimension	Min	Max
1	Laser Power	W	0	1500
2	Wobble Frequency	Hz	0	300
3	Wobble Length	mm	0	5.0
4 [a]	Laser On Time	ms	0	35000
5 [b]	Laser Off Time	ms	0	35000
6 [a]	Stitch Count	1	0	5000
7 [c]	Waveform Program N	1	0	20
8	Material Selection	Choose either Steel or Aluminum		

[a] When using the front panel knob, Laser On Time is controlled in units of seconds, with 0.1 s resolution. On the webpage it is controlled in ms (finer resolution).

[b] When using the front panel knob, Laser Off Time is controlled in units of seconds. The displayed value will be an integer value between 0 and 35 s. On the webpage it is controlled in ms (finer resolution).

[c] Pulse waveform shapes 1-10 are created by the user and 11-20 are preset by IPG Photonics.

Above parameters settings need to be configured to operate in “ADV STITCH” mode.

The min and max allowable settings are specified. Parameter definitions are specified in the glossary of terms. Refer to Glossary of Program Parameter Terms [▷ 144].

8.3 Front Panel Knob Adjustments

Front Panel Rotary Knob Adjustment Parameters:

As different User or Preset Program Modes are selected, the front panel rotary knob adjustment parameters will change. The Laser Power control knob will remain the same for all program recipes. However, the Wobble Frequency and Wobble Length knob adjustments will have different meanings.

For example, if a preset program is running in Stitch Mode, the two knobs will adjust Laser On Time and Laser Off Time instead. When the adjustment is no longer Hz and mm (because it is running in a different mode), the Hz and mm units of the front panel display will not light up.

PARAMETERS ADJUSTED BY FRONT PANEL KNOBS FOR WOBBLE FREQUENCY AND WOBBLE LENGTH
PRESET MODE VERSUS USER MODE

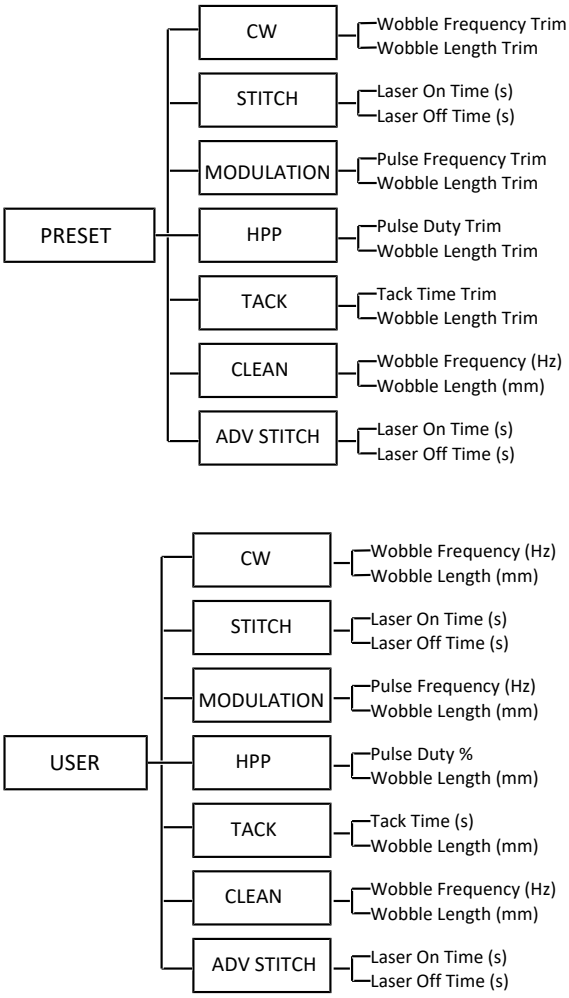


Figure 50: Program Display Control Knob Adjustments

Please note that CLEAN laser mode is only available on XC models.

Front Panel allowed knob adjustment of the parameters for each laser welding mode of operation are shown in Front Panel Knob Adjustments [▷ 143].

#	Laser Mode	Parameter Adjusted By Knob Wobble Frequency 	Parameter Adjusted by Knob Wobble Length 
Preset Mode:			
1	CW	Wobble Frequency Adjustment Range: +/- 50	Wobble Length Adjustment Range: +/- 5
2	Stitch	Laser On Time Adjustment Range: 0 - 35 s	Laser Off Time Adjustment Range: 0 - 35 s
3	Modulation	Pulse Frequency Adjustment Range: +/- 50	Wobble Length Adjustment Range: +/- 5
4	HPP	Pulse Duty Adjustment Range: +/- 50	Wobble Length Adjustment Range: +/- 5
5	Tack	Tack Time Adjustment Range: +/- 50	Wobble Length Adjustment Range: +/- 5
6	Clean * XC	Wobble Frequency Adjustment Range: NONE Required frequency automatically calculated based on set wobble length. This knob is disabled. Display will show “0” for this control.	Wobble Length Adjustment Range: 0 - 15 mm
7	Adv Stitch	Laser On Time Adjustment Range: 0 - 35 s	Laser Off Time Adjustment Range: 0 - 35 s
User Mode:			
1	CW	Wobble Frequency Adjustment Range: 0 to 300 Hz	Wobble Length Adjustment Range: 0 to 5 mm

2	Stitch	Laser On Time Adjustment Range: 0 - 35 s	Laser Off Time Adjustment Range: 0 - 35 s
3	Modulation	Pulse Frequency Adjustment Range: 0 to 500 Hz	Wobble Length Adjustment Range: 0 to 5 mm
4	HPP	Pulse Duty Adjustment Range: 0 to 20%	Wobble Length Adjustment Range: 0 to 5 mm
5	Tack	Tack Time Adjustment Range: 0 to 3.5 s	Wobble Length Adjustment Range: 0 to 5 mm
6	Clean * XC	Wobble Frequency Adjustment Range: 0 - 300 Hz	Wobble Length Adjustment Range: 0 - 15 mm
7	Adv Stitch	Laser On Time Adjustment Range: 0 - 35 s	Laser Off Time Adjustment Range: 0 - 35 s

Table 26: Front Panel Knob Adjustment Range vs Recipe Setting

8.4 Glossary of Program Parameter Terms

#	Name of Parameter	Unit	Definition of Term
1	Mode		The main operating configuration of the welder unit via the operator. There are 2 modes of operation: User and Preset modes.
2	Program Number		**User** mode: Program number consists of two numerical digits (e.g. 01). **Preset** mode: Program number has one letter and one numerical digit (e.g. A1).
3	Program Group		**User** mode: Only one program group. **Preset** mode: There are ten program groups (A, C, E, F, H, J, L, P, U, and Y).
4	Laser Mode		Laser mode may be set to either: (1) CW, (2) Tack, (3) Modulation, (4) HPP, (5) Stitch, (6) Clean - For XC models, or (7) Adv Stitch. Dictates which parameters the device will use for generating the laser output.
5	Laser Power	W	Sets the laser output power (or peak power in HPP mode).
6	Wobble Frequency	Hz	Sets the desired wobble device sinusoid frequency. The actual frequency is a function of the wobble length, and as such can be a smaller value if the requested frequency is outside of the range allowed by the wobble length.

7	Wobble Length	mm	Sets the desired wobble length (line length). This affects the magnitude of deflection of the laser beam via the galvanometer.
8	Ramp Up Time	ms	Rising rate of laser power.
9	Ramp Down Time	ms	Falling rate of laser power.
10	Laser ON Time	ms	For non-pulsed modes, determines time for laser to stay ON after emission trigger. Only applicable for “Stitch Mode”. **NOTE**: Front panel knob unit is seconds. Webpage unit is ms.
11	Laser OFF Time	ms	For non-pulsed modes, determines time for laser to stay OFF after ON time. Only applicable for “Stitch Mode”. **NOTE**: Front panel knob unit is seconds. Webpage unit is ms.
12	Pulse Frequency	Hz	For pulsed modes, determines repetition rate. **FOR XC MODELS**: The unit is kHz (not Hz) when using CLEAN laser mode.
13	Pulse Duty Cycle	%	For pulsed modes, determines ON period of laser power.
14	Wave Number		For pulsed modes, selects the pulse shape waveform to use for the pulse. Wave number 1-10 is allocated for user to create. Wave number 11-20 is IPG Preset.
15	Stitch Count		For “Stitch Mode”, determines the number of pulses to generate before turning emission OFF.
16	Tack Time	ms	For “Tack Mode”, determines the time to keep laser on before emission turns OFF on its own.
17	Material		Select the type of material being welded (e.g. steel, aluminum)

9 Computer Connection to Device

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

To access the welder unit's web page interface, users must first connect their PC to the welder's Ethernet port with the supplied Ethernet cable.

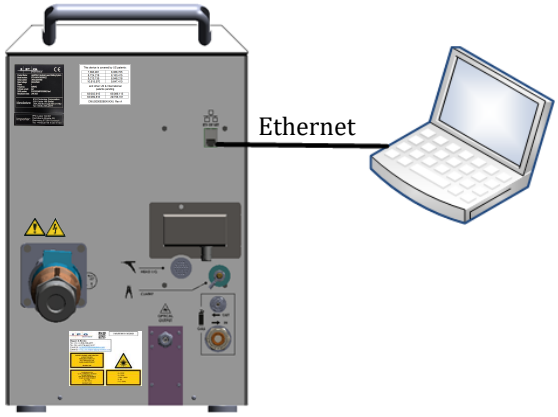


Figure 51: Connect Ethernet Cable from Laser Device to Host PC

9.1 Ethernet Connection

The laser welder device uses a fixed static IP address. In order to communicate with the laser welder, the host computer should be configured to have a static address and to be on the same subnet with the laser. See Default IP Configuration for Laser Device and Host Computer [▶ 146], which indicates the default IP configuration for the laser welder and the IP settings to use when configuring the user's PC to communicate with the welder.

	Welder Device Factory Default Settings	**Configure User's Host PC To Communicate with Welder**
IP Address	10.0.0.20	10.0.0.1
Subnet Mask	255.255.255.0	255.255.255.0
Default Gateway	10.0.0.1	Leave Blank

Table 27: Default IP Configuration for Laser Device and Host Computer

To configure the local area connection on the host computer refer to:

- Refer to PC Ethernet Configuration - WINDOWS 7 OS [▶ 147] - Computer running WINDOWS 7 OS
- Refer to PC Ethernet Configuration - WINDOWS 10 OS [▶ 148] - Computer running WINDOWS 10 OS

9.1.1 PC Ethernet Configuration - WINDOWS 7 OS

1) Open the `Windows Control Panel`:

⇨ Select `Network and Internet`.

⇨ Select `Network and Sharing Center`.

⇨ In the active networks list, click on the Local Area Connection corresponding to your network interface or USB-Ethernet adapter (it might be labeled as “Unidentified network”). See Control Panel-Network & Internet-Network & Sharing Center [▶ 147].

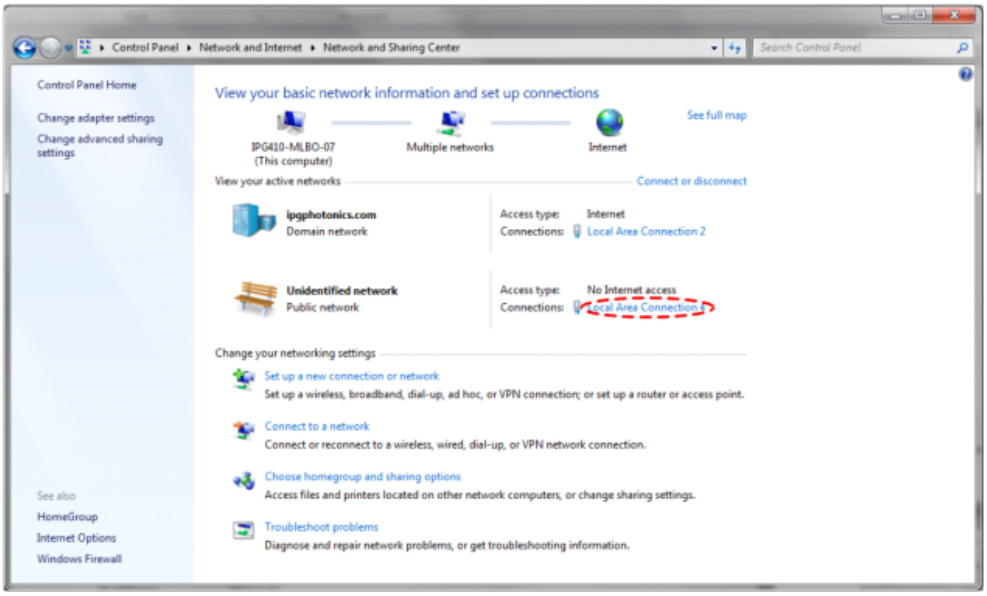


Figure 52: Control Panel-Network & Internet-Network & Sharing Center

2) On the `Local Area Connection Status` window, click on Properties.

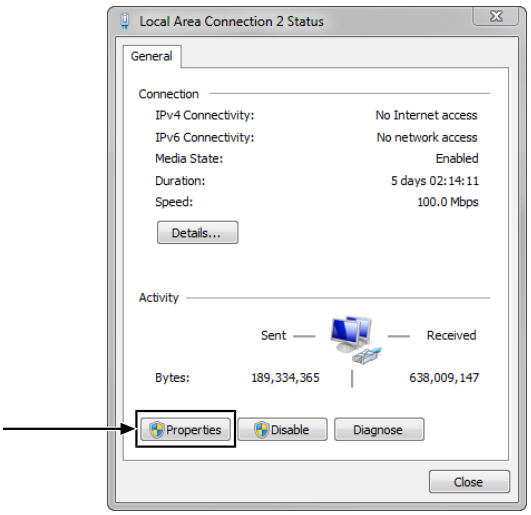


Figure 53: Local Area Connection Status Window

3) On the `Local Area Connection Properties` window:

⇨ Select `Internet Protocol Version 4 (TCP/IPv4)`.

⇨ Click the Properties button

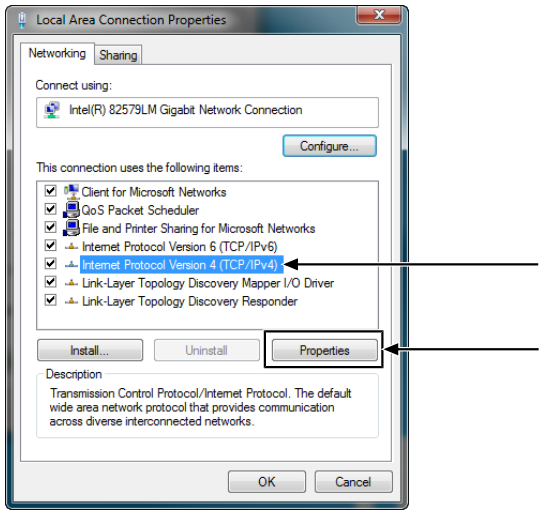


Figure 54: Local Area Connection Properties Window

4) Select `Use the following IP address`. Fill out entries and click OK.

⇨ IP address - 10.0.0.1 (for example)

⇨ Subnet Mask - 255.255.255.0

⇨ Default Gateway - Leave it blank

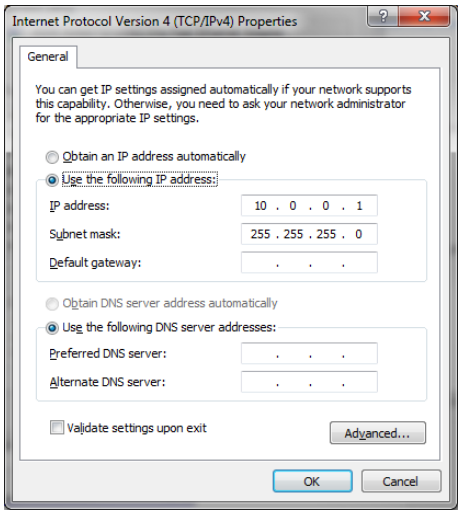


Figure 55: Internet Protocol Version 4 Properties Window

9.1.2 PC Ethernet Configuration - WINDOWS 10 OS

1) Open Windows `Start Menu`.

⇨ Scroll down and expand the folder `Windows System`.

⇨ Select `Control Panel`.

⇨ The `Control Panel` window opens.

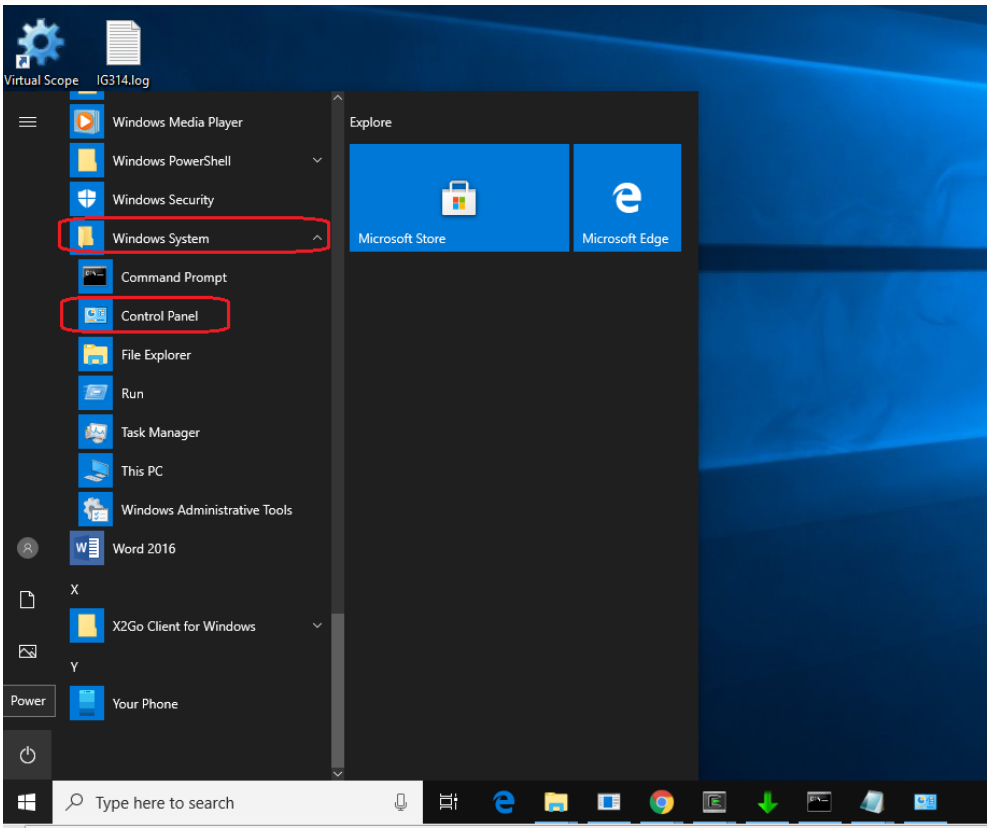


Figure 56: Windows Start Menu

2) Select `Network and Sharing Center` from the list.

⇨ The `Network and Sharing Center` window opens

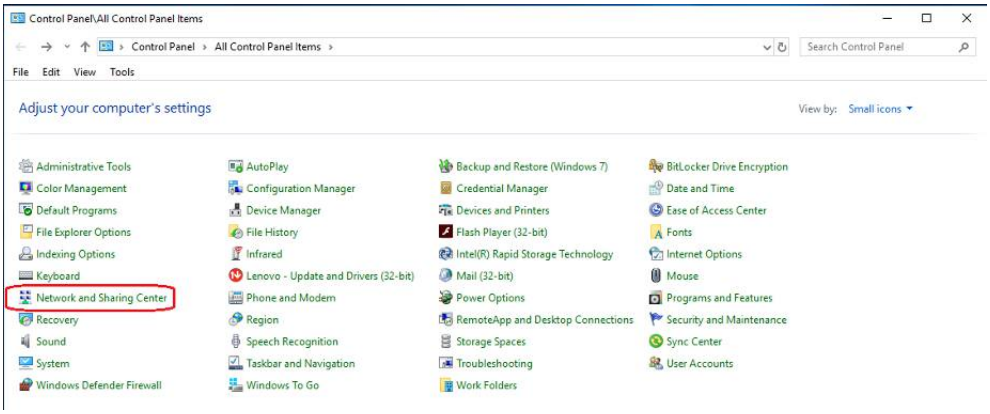


Figure 57: Windows Control Panel

3) In the active networks list, click on the Local Area Connection corresponding to your network interface or USB-Ethernet adapter (it might be labeled as “Unidentified network”). In this example it is Ethernet 2.

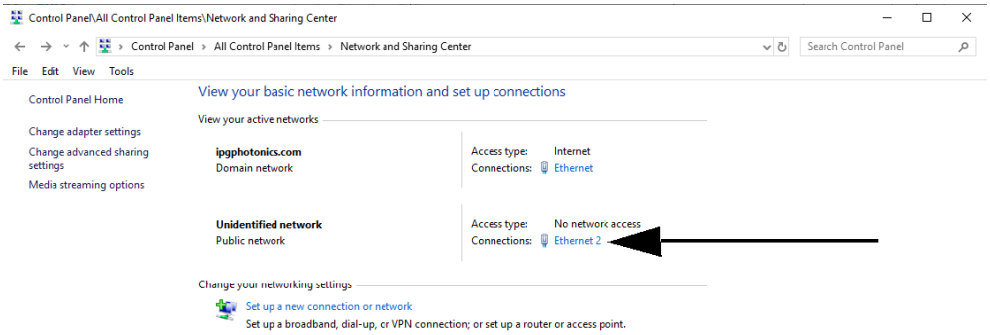


Figure 58: Network & Sharing Center Window

4) On the `Local Area Connection Status` window click on the Properties button.

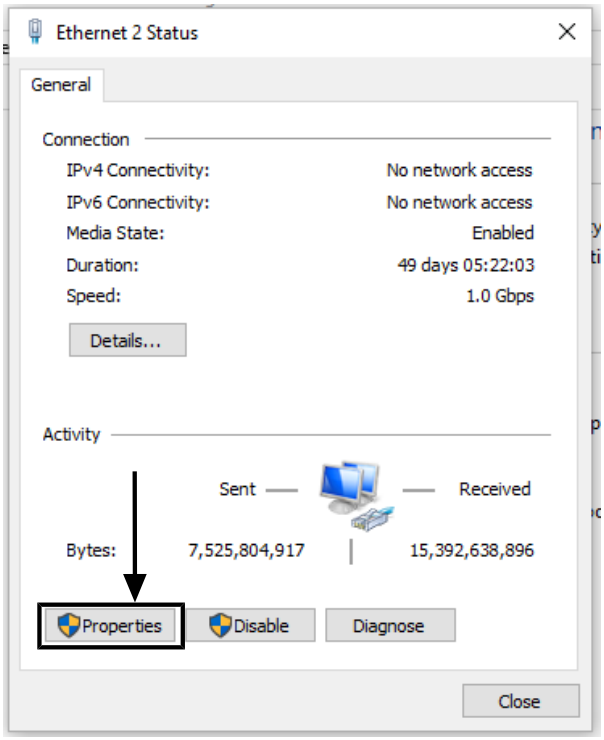


Figure 59: Local Area Connection Status Window

5) On the `Local Area Connection Properties` window:

⇨ Select `Internet Protocol Version 4 (TCP/IPv4).`

⇨ Click the Properties button

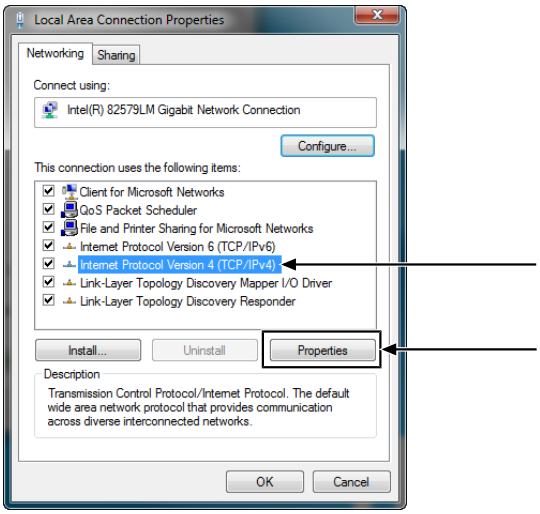


Figure 60: Local Area Connection Properties Window

6) Select `Use the following IP address`. Fill out entries and click OK.

⇨ IP address - 10.0.0.1 (for example)

⇨ Subnet Mask - 255.255.255.0

⇨ Default Gateway - Leave it blank

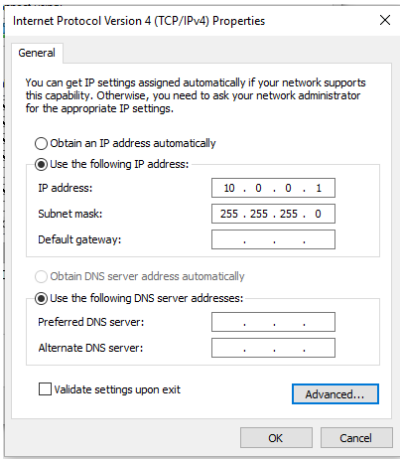


Figure 61: Internet Protocol Version 4 Properties Window

9.2 Web Page Interface

The web page interface enables you to view, create or modify program recipes. You can also use it to monitor the device status, view warning and alarm bits, as well as to view firmware revision information.

If you are experiencing technical support issues, use the diagnostic information available through the web page interface and provide it to IPG Service (refer to IPG Service [▶ 192]).

Depending on the firmware revision installed, some of the screens and features may not look exactly the same as what is shown here.

9.3 Accessing Device Web Pages

To access the device web page interface, it is recommended to use an updated version of Google Chrome or Firefox web browser. If you haven't already done so, setup your computer connection as instructed previously (refer to Ethernet Connection [▶ 146]).

1) Open your web browser.

2) In the address search bar, type the IP address for the device (default is 10.0.0.20) and press the Enter key.

Figure 62: Type device default IP address here

3) If successful, you will be directed to the Welder Page. The web page will display the model name at the top.

Figure 63: Tabs to switch between device web pages

4) Select from three available tabs to navigate between device web pages:

   ⇨ `Welder` - Opens the main Welder page (refer to Laser Welder Page [▶ 153]). Program recipe creation is performed here. Welder status and error information is found here.

   ⇨ `Settings` - Opens the Network Settings page (refer to Network Settings Page [▶ 160]). The network IP address configuration for the device is performed here.

   ⇨ `Support` - Opens the Product Support page. Software and firmware revision information is located here (refer to Product Support Page [▶ 161]).

   ⇨ `Login/Logout` - This login is for IPG personnel to access factory device settings.

9.4 Laser Welder Page

To access the Laser `Welder` page, click on the `Welder` tab.

The Welder page enables the user to perform similar and/or equivalent functions as what is done via the device front panel controls. Refer to Laser Welder Page – User Program Recipe [▶ 154] and Laser Welder Page – Preset Program Recipe [▶ 154].

The `Welder` page is broken down into two sections. On the left-hand side of the page will be the Program Recipe Setup. On the right-hand side of the page is the Welder Device Status Indicators.

When the `Welder` Page first opens it will automatically show the recipe currently set on the welder unit. In the section called `Controls` it will specify the type of program, either USER or Preset Program Letter (e.g. A).

The index will specify the number of the program. For example, user program number 1 or Preset group A index number 1 for program A1. To change between User and Preset, in the `Controls` section, click to display the “Program:” drop down menu and make selection. Then type the Index number and press the enter key. The recipe parameters and settings will change accordingly.

If changes are made to a program via the unit’s front panel control knobs and buttons, those changes will automatically be updated and shown on the `Welder` Page. Alternatively, any changes made on the `Welder` Page will automatically be updated to the unit.

Clicking on the Save button to save changes made to the current recipe. Clicking on the Restore button will revert the currently displayed recipe to the factory default settings.

The `Gas Pre-Flow` and `Gas Post-Flow` times are global settings that apply to all program modes. Users can set a time between 0.1 to 10 seconds. These values can also be set using the Front Panel Setup mode (refer to Y0 Setup State Program Mode [▶ 111]).

Click on Purge Enabled / Purge Disabled button to turn on/off the purge gas function. This is a global setting. The wording on this button will toggle between Enabled or Disabled depending on the what the current setting is set to. This feature can also be enabled/disabled using the Front Panel Setup mode (refer to Y0 Setup State Program Mode [▶ 111]).

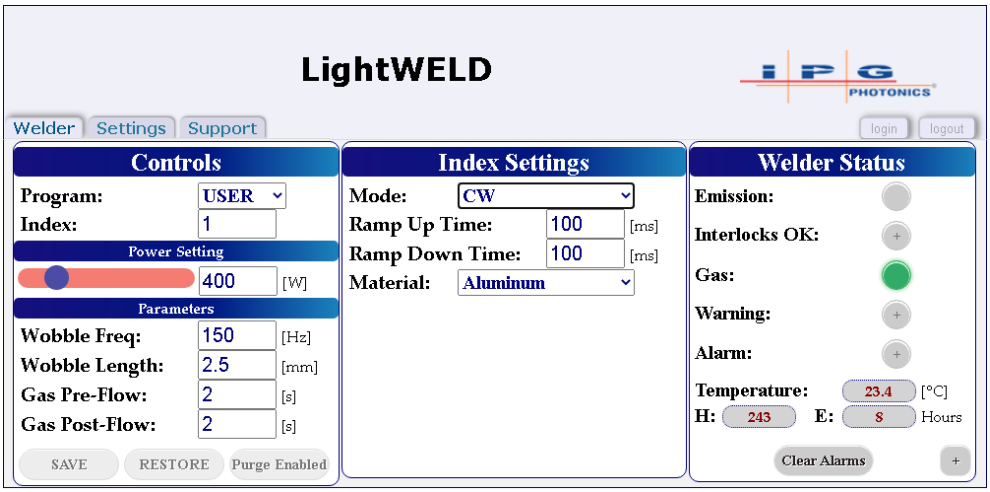


Figure 64: Laser Welder Page – User Program Recipe

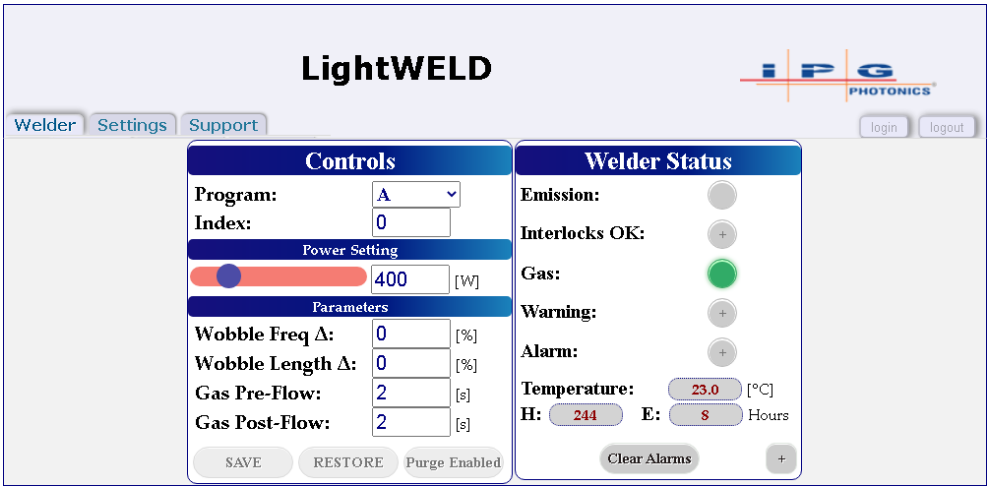


Figure 65: Laser Welder Page – Preset Program Recipe

9.4.1 Welder Status Indicator Pane

The `Welder Status` pane is a graphical representation of the unit's front panel indicators and will enable users to troubleshoot which particular status or alarm bits are causing the error or warning.

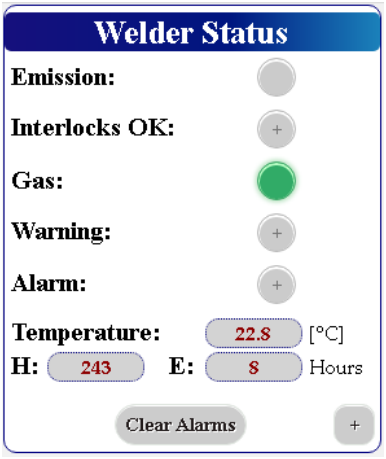
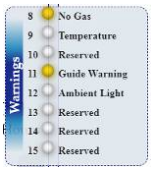


Figure 66: Welder Status Indicator Pane

Item	Feature	Description
1	Emission	• Lit yellow when emission is enabled
2	Interlocks OK [1] 	• When all interlocks are satisfied, the main indicator in the Welder Status pane will be lit green. • Clicking on the circle with the "+" sign will expand to show the list of 8 interlocks that must all be satisfied before welding can begin. • If the 9 interlock indicators are lit green it means interlock status is OK • To close (collapse) the interlock menu, click on the circle with the "-" sign again.
3	Gas	• The main indicator on the Welder Status pane will be lit green if there is sufficient gas pressure coming into the device from gas supply.

Item	Feature	Description
4	Warning [1] 	• The main Warning indicator will be lit yellow when there is a warning. If there are no warnings, it will not be lit (gray). • Clicking on the circle with the "+" sign will expand to show the list of warnings. • Currently there are warnings for: No Gas, Temperature, the Guide Laser not working, and Ambient Light. • Temperature and Guide Laser Warnings do not prevent emission from being turned on and will not turn off emission. • Ambient Light Warning - Indicates that the lighting in the work environment may cause the plasma alarm to not operate effectively. This is typically caused when the surrounding light is periodically pulsing/modulating at high enough lux that it can be confused for plasma by the detector. Conditions for generating this warning is observed right after all interlocks are satisfied (Trigger 1 pressed, nozzle touching part, ready to weld). • The ambient light warning can be cleared by releasing and pressing again Trigger 1 switch on the weld head. • If the ambient light warning is present when the user enables emission, a plasma alarm will instantly be generated. • If the user sees Er04 on the front panel, and the ambient light warning is also activated, then the plasma alarm was caused by the ambient light. If the ambient light warning is not lit, then the plasma alarm is due to a lack of plasma signal. • To close (collapse) the warning menu, click on the circle with the "-" sign again.

Item	Feature	Description
5	Alarm	• Main Alarm indicator will be lit red when the unit is in an error state. • Clicking on the circle with the "+" sign will expand to show the full list of error bits. • If there is an error that particular alarm bit will be lit red. • For more information about these error bits refer to Troubleshooting [▶ 170]. • When there is an error, the front panel display for power will specify the error code which will correspond to the alarm bit number shown here in the web interface (e.g. Er02 for Under Temp error). • Unlike warnings, if an error occurs during welding it will turn off laser emission. • To close (collapse) the alarm menu, click on the circle with the "-" sign again. 
6	Temperature (in °C) [1]	• Displays the laser's temperature reading.
7	H (in hours) [1]	• `Total ON` hours is a cumulative timer over the lifespan of the unit.
8	E (in hours) [1]	• `Emission ON` hours is a cumulative timer over the lifespan of the unit but only while emission was on.
9	Clear Alarms Button 	• Click button to clear alarms. This will perform a similar function as clearing the alarm using the Trigger 1 control on the weld head as long as the condition that caused the error in the first place was resolved.

Item	Feature	Description
10	Expand Advanced Settings 	• On the lower right corner of the Welder Status Pane is a button with the plus sign (+). Selecting this button expands the window and will display the Advanced Settings Options. • To close (collapse) the Advanced Settings, click on the button with the minus sign (-) again.

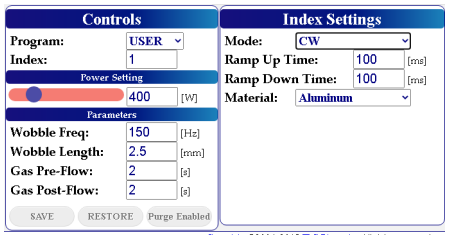
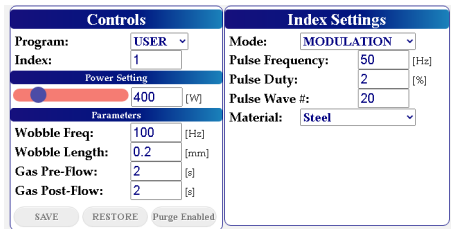
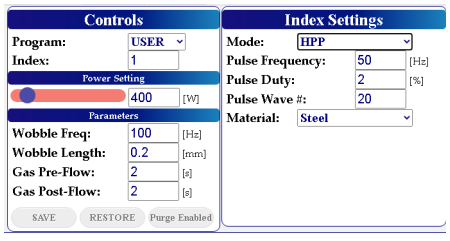
Table 28: Welder Status Pane Features

[1] Also viewable using Front Panel Setup Mode (see Y0 Setup State Program Mode [▶ 111]).

9.4.2 User Mode Program Recipe Setup

Depending on which Mode is selected, the recipe settings that must be configured will change as indicated (see User Mode Recipe Configuration per Laser Mode [▶ 158]). For more information on a particular parameter refer to Program Recipes and Parameters [▶ 136].

** There is a material selection option (e.g. Steel, Aluminum, etc.) shown in the “Index Settings” pane. This will automatically set appropriate thresholds for the plasma detection feature that depend on the material type selected.

Laser Mode	User Mode Recipe Configuration
CW Mode	
MODULATION Mode	
HPP Mode	

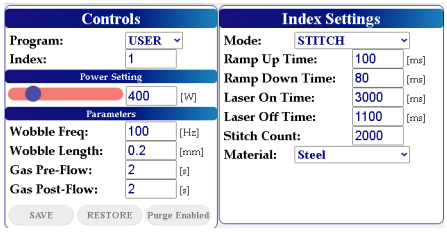
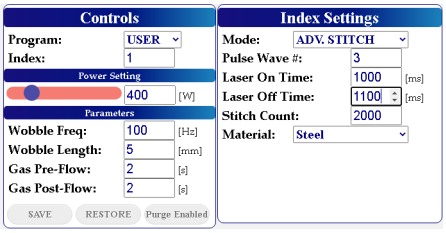
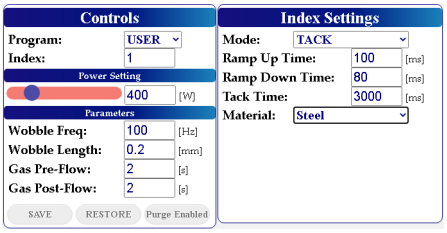
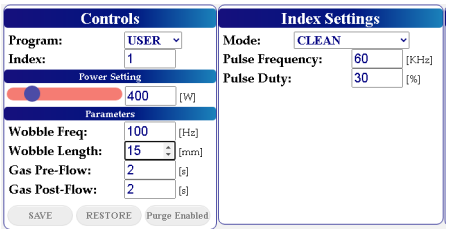
Laser Mode	User Mode Recipe Configuration
STITCH Mode	
ADV STITCH Mode	
TACK Mode	
CLEAN Mode XC Models Only	

Table 29: User Mode Recipe Configuration per Laser Mode

9.4.3 Preset Mode Program Recipe Setup

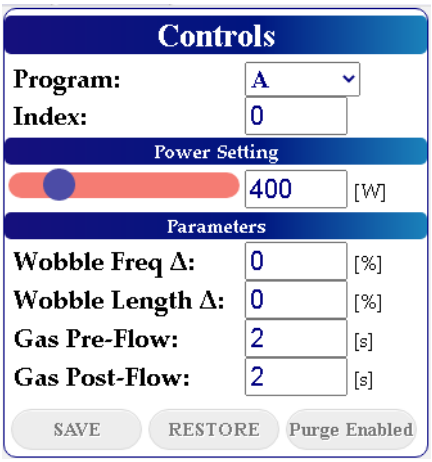


Figure 67: Preset Mode Recipe Configuration per Laser Mode

9.5 Network Settings Page

To access the Network Settings web page, click on the `Settings` tab. The Network Settings page enables the user to view or change the TCP/IP settings for the device. Refer to Network Settings Page [▶ 160].

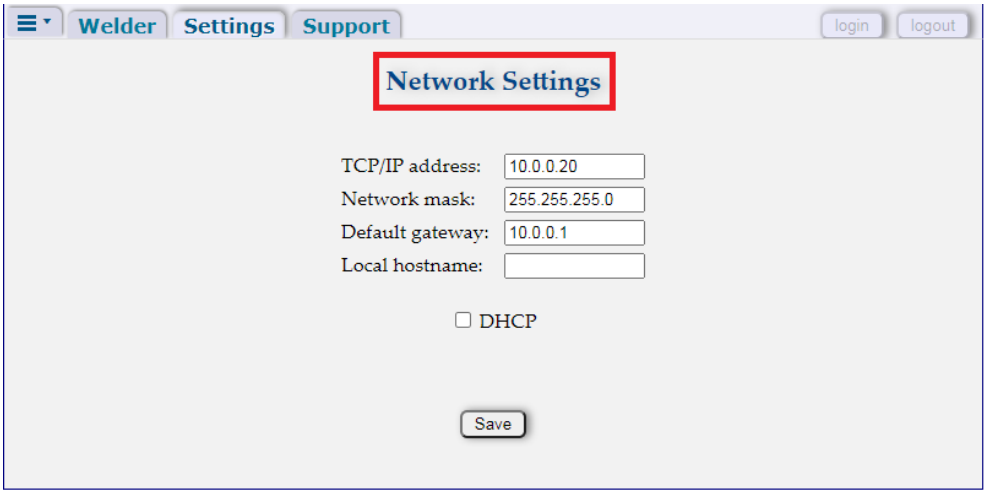


Figure 68: Network Settings Page

- Displays current Network Settings, except if DHCP is enabled.
- For DHCP Enabled, these fields will display default network settings that will be used only in the case where the device was unable to connect to the DHCP assigned IP Address at startup.
- User may change these settings by inputting the new network setting in the field (press `Enter` key).
- Click Save button to confirm changes.
- Must reboot device for changes to take effect.

Do not change the "Local hostname"!

9.6 Product Support Page

To access the Product Support web page, click on the `Support` tab.

The Product Support page displays:

- Software and Firmware revision information.
- Device serial number, model name and part number.
- Device MAC Address

Click on the Download button to download the unit configuration settings. A binary file will be saved into the `Downloads` folder. The name of the downloaded file will be: `dict_values_download_serial-number.bin`.

Should you experience technical issues with your device, please provide your IPG Service: (1) a screen shot of this page, (2) the downloaded binary file.

This information will assist in troubleshooting the issue (see Product Support Page [▶ 161]).

Figure 69: Product Support Page

9.7 Buzzer Setup - Advanced Settings

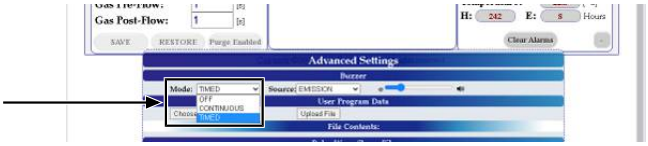
1) Click on the + button on the bottom right of the page to expand the Advanced Settings section of the webpage.

2) In the Buzzer section under Advanced Settings, select a mode from the Mode dropdown list.

   ⇨ OFF - Buzzer is not configured and will not activate.

   ⇨ CONTINUOUS - This turns the buzzer on continuously for as long as the condition specified in the Source dropdown list remains satisfied.

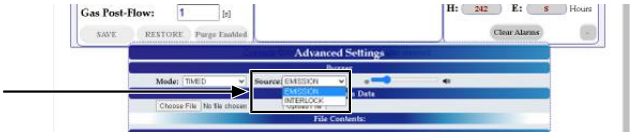
   ⇨ TIMED - As soon as the condition specified in the Source dropdown list is satisfied the buzzer will turn on for 2 seconds and then turn off.



3) Select the source from the Source dropdown list.

   ⇨ EMISSION - Buzzer will activate when laser emission turns on. All the interlocks are satisfied, the nozzle tip is touching the part and the weld head Trigger 2 switch was pressed. The Emission ON indicator on the front panel of the device is lit and the weld head indicator is lit red.

   ⇨ INTERLOCK - Buzzer will activate once all the interlocks are satisfied and the nozzle tip is touching the part. Emission is not activated yet (Trigger 2 was not pressed). The interlock indicator on the front panel of the device is lit green and the weld head indicator is blinking green.



4) Set the buzzer volume using the slider on the right.

9.8 User Program Data - Advanced Settings

9.8.1 Creating User Program Data File

The user is allowed to upload their own program data to the device. User must first create their program table using a standard CSV (comma-separated values) file.

The file must have the following format:

```
PROGRAM, INDEX, LASER MODE, WAVE #, POWER, W FREQ,
W LENGTH, RAMP UP, RAMP DN, LASER ON, LASER OFF,
STITCH #, TACK, FREQ, DUTY, CTRL,
```

The CSV file should contain the first row shown above, as a heading, so that the CPU is aware that the following data is a program data file. The units for each parameter is the same as what is shown in the web page interface. Refer to Glossary of Program Parameter Terms [▶ 144] for listing of parameters and their description.

The CSV file does not have to define every program index number. It may contain just one or multiple programs, up to 20, with a program index from 0 to 19.

Below is an example of CSV formatted data that would correspond to a program data file.

PROGRAM,	INDEX,	LASER MODE,	WAVE #,	POWER,	W FREQ,	W LENGTH,	RAMP UP,	RAMP DN,	LASER ON,	LASER OFF,	STITCH #,	TACK,	FREQ,	DUTY,	CTRL,
x,	0,	0,	1,	2000,	100,	1,	100,	100,	0,	0,	0,	0,	0,	0,	0,
x,	1,	0,	1,	500,	100,	1,	100,	100,	0,	0,	0,	0,	0,	0,	0,
x,	2,	0,	1,	800,	80,	3,	500,	200,	0,	0,	0,	0,	0,	0,	0,

9.8.2 Upload User Program Data File

Refer to figure Advanced Settings – Upload User Programs [▶ 164] which illustrates the steps required to upload user program file. User program files can be uploaded to the welder unit via the user webpage.

For instructions on accessing the device webpage, refer to Accessing Device Web Pages [▶ 152].

1) Click on the + button on the bottom right of the page to expand the `Advanced Settings` section of the webpage.

2) In the `User Program Data` section under `Advanced Settings`, click the Choose File button to upload your created CSV file. Follow the on-screen prompts and dialogs to select your file.

   ⇨ Once the file is selected, a preview visualization will be presented on the screen. You can use this preview to determine if your program settings look as intended. If the program settings do not look as intended, the user must modify the CSV file then follow step 2 again to see another preview.

3) If satisfied with the program data preview, press the Upload File button to upload the new user programs to the CPU. Please wait for the on-screen prompt which indicates that the file was successfully uploaded, before exiting from the browser.

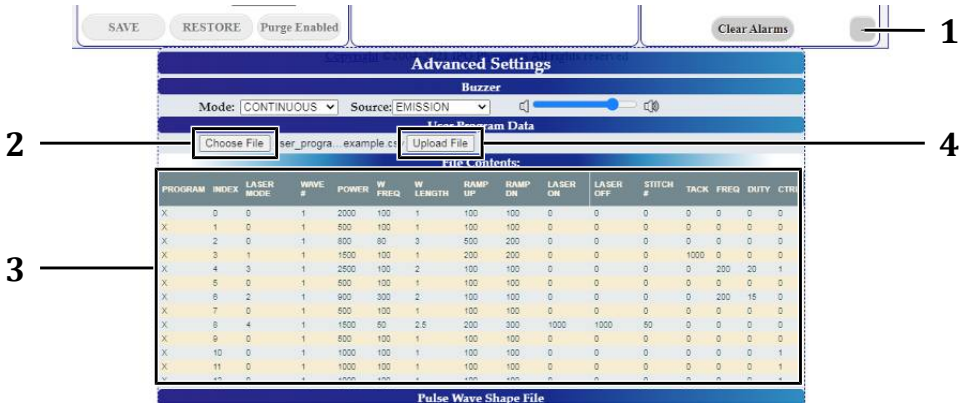


Figure 70: Advanced Settings – Upload User Programs

Item	Designation	Item	Designation
1	+ button (to expand Advanced Settings)	3	User program preview
2	Choose File button	4	Upload Wave File button

9.9 Pulse Shape Generation - Advanced Settings

Users can generate up to ten unique pulse shapes that can be selected by the pulse wave number (programs using MODULATION, HPP or ADV STITCH laser mode). Each pulse shape consists of six points - four unique points, plus the starting point, and the ending point. These points are defined in percentage units, with the x-axis being percentage of pulse on time (calculated from the set frequency and duty cycle for HPP and Modulation mode), and the y-axis being percentage of set laser power. The figure below provides an example pulse shape generated from six points.

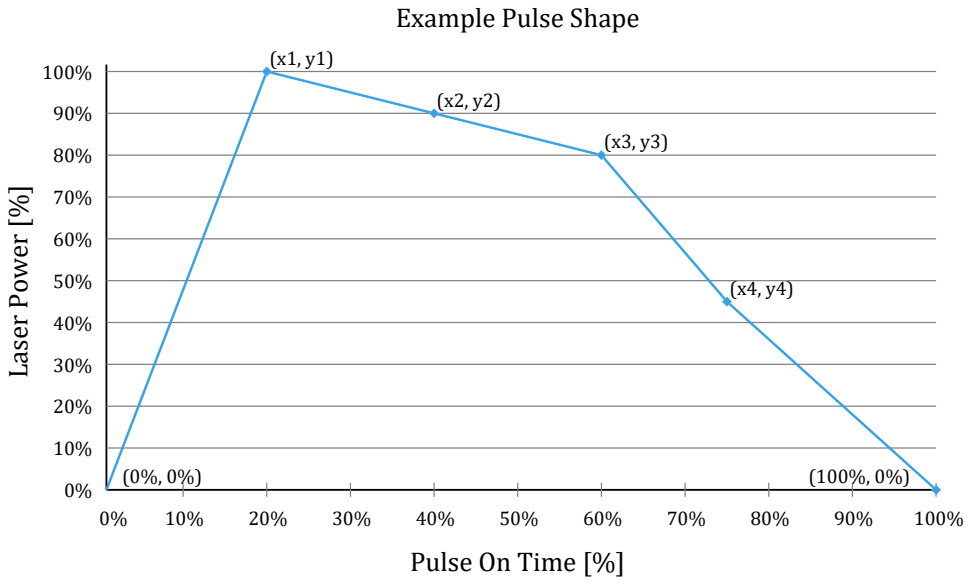


Figure 71: Example Pulse Shape

When a different pulse shape is requested, the CPU reads the points of the selected shape. It then converts the point units from percentages to proportional values of time period (x-axis) and laser power (y-axis). Once the points are converted, the rest of the pulse shape can be derived by interpolating between each point. The interpolation is provided by the equation below where:

- T = Current time
- T_{pt} = Time (x) of a given point
- P_{pt} = Power (y) of a given point

$$P_{shape} = P_{pt-1} + (T - T_{pt-1})\left[\frac{P_{pt} - P_{pt-1}}{T_{pt} - T_{pt-1}}\right]$$

Figure 72: Pulse shape equation

9.9.1 Pulse Shape Files

The pulse shapes can be created with standard CSV (comma-separated values) files. The file must have the following format:

```
Wave #, x1, y1, x2, y2, x3, y3, x4, y4,
```

The CSV file should contain the above row as a heading so that the CPU is aware that the following data is a pulse shape file. Wave # is an integer value from 1 – 10. It determines the pulse wave number for which the subsequent data in that row is used. The rest of the values in the row are numbers from 0 – 100% that determine the (x,y) point pairs. Note that the first and last points are omitted since they are always fixed at (0,0) and (0,100) respectively.

The wave CSV file does not have to define every wave number. It may contain just one, or multiple pulse shapes. Below is an example of a CSV formatted data that would correspond to a wave file.

Wave #,	x1,	y1,	x2,	y2,	x3,	y3,	x4,	y4,
1,	30,	30,	40,	100,	60,	100,	70,	30,
2,	50,	100,	100,	0,	100,	0,	100,	0,
3,	30,	100,	40,	100,	100,	0,	100,	0,
4,	60,	100,	70,	100,	100,	0,	100,	0,
5,	10,	50,	50,	50,	60,	100,	90,	100,
6,	20,	50,	50,	50,	80,	100,	90,	100,
7,	10,	100,	50,	100,	60,	100,	90,	100,
8,	30,	100,	60,	100,	60,	100,	70,	100,
9,	45,	100,	50,	100,	50,	100,	55,	100,
10,	15,	70,	40,	100,	60,	100,	85,	70,

Table 30: CSV-formatted pulse shape wave file

9.9.2 Uploading Pulse Shapes

Pulse shape files can be uploaded to the welder unit via the user webpage. Refer to figure Advanced Settings – Uploading user wave shape files [▷ 167] which illustrates these steps.

For instructions on accessing the device webpage, refer to Accessing Device Web Pages [▷ 152].

1) Click on the + button on the bottom right of the page to expand the `Advanced Settings` section of the webpage.

2) Go to `Pulse Shape File` section under `Advanced Settings`, press the Choose file button to upload your created shape file. Follow the on screen prompts and dialogs to select your pulse shape file.

3) Once the file is selected, a preview visualization will be presented on the screen of your created pulse shapes. You can use this preview to determine if your shapes look as intended. If a pulse shape is missing in the preview, it indicates that the particular shape row was malformed, and should be corrected (otherwise, the CPU will ignore it). If shapes are missing, or do not look as intended, the user must modify the CSV file then follow step 2 again to see another preview.

4) If satisfied with the pulse shapes preview, press the Upload Wave File button to upload the new shapes to the CPU. Please wait for the on-screen prompt which indicates that the pulse shapes were uploaded, before exiting from the browser.

5) To use one of these new uploaded pulse shapes, set the laser mode for your program to either MODULATION, HPP or ADV STITCH and then set the Pulse Wave # for your shape (valid numbers are 1 -10). Do not forget to save program.

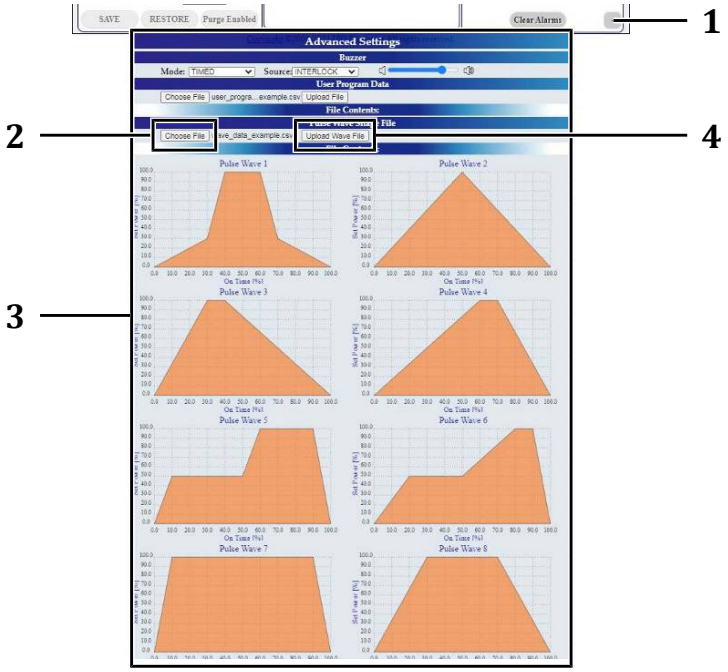


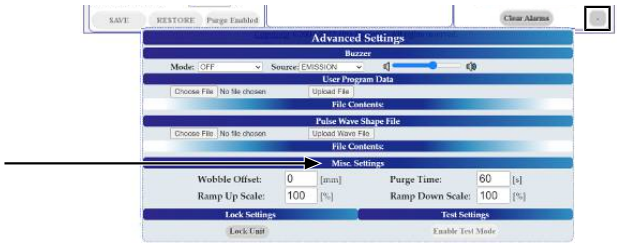
Figure 73: Advanced Settings – Uploading user wave shape files

Item	Designation	Item	Designation
1	+ button (to expand Advanced Settings)	3	Advanced Settings section
2	Choose File button	4	Upload Wave File button

9.10 Configure Misc. Settings - Advanced Settings

For instructions on accessing the device webpage, refer to Accessing Device Web Pages [▶ 152].

1) Click on the + button on the bottom right of the page to expand the Advanced Settings section of the webpage.



2) In the `Misc. Settings` section under `Advanced Settings`, set the `Wobble Offset`.

⇨ The wobble offset is along the same axis as the beam wobble and is used to center the beam when using the wire feeder.

⇨ Wobble offset must be a value within the limit of +/- 1 mm. Default value is 0 mm (no offset).

3) In the `Misc. Settings` section under `Advanced Settings`, set the values for `Ramp Up Scale` and `Ramp Down Scale`.

⇨ This sets global scale factors that will be applied to all user and preset program ramp up time and ramp down time settings. This only applies to programs that are configured to use either CW or STITCH laser mode.

⇨ Scale values must be within limit of 10-200%. Default value is 100%. For examples how the ramp scale will be applied, refer to Effects of Ramp Up Scale and Ramp Down Scale [▶ 168]

Program ramp time	Ramp Up Scale/ Ramp Down Scale	Scale factor applied to program ramp time	Actual ramp up time/ramp down time
1000 ms	10 %	0.1	100 ms
1000 ms	100 % (default)	1	1000 ms
1000 ms	200 %	2	2000 ms

Table 31: Effects of Ramp Up Scale and Ramp Down Scale

4) In the `Misc. Settings` section under `Advanced Settings`, set the `Purge Time`.

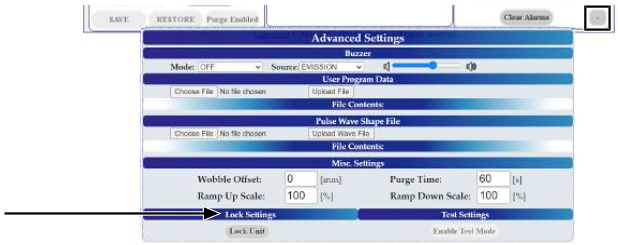
⇨ Purge gas will turn on after the user finishes welding, and only stay on for a set time (it will also turn on for the set time once after power up). In earlier firmware releases the purge gas was always on or always off. To prevent excess gas usage, this purge time setting was implemented.

⇨ The range of the purge time setting is 0 to 998 seconds, with a default value of 60 seconds. Setting the purge time to 999 will keep purge gas on infinitely (replicating legacy operation from older firmware).

9.11 Reseller Setting Lock Unit - Advanced Settings

For instructions on accessing the device webpage, refer to Accessing Device Web Pages [▶ 152].

1) Click on the + button on the bottom right of the page to expand the `Advanced Settings` section of the webpage.



2) In the `Lock Settings` section under `Advanced Settings`, click the Lock Unit button.

⇨ User will be asked to input the 4 digit unlock code and then click the Set Lock button to confirm the lock. This code was provided to user after successful completion of the IPG safety webinar. Once locked, the unit cannot be used and must be unlocked again. Refer to chapter Unlock Code Required at First Power Up [▶ 69].

10 Troubleshooting

⚠ DANGER

Eye and Skin Hazards During LightWELD Device Operation

Risk of permanent skin or eye damage and vision impairment from invisible reflected and scattered Class 4 laser radiation. Also risk of eye and skin damage as a result of exposure to UV light, welding bright light, heat and sparks produced during the material processing.

- ⇨ The person in the LCA must wear all appropriate personal protective equipment (PPE), including laser safety glasses, protective welding helmet, laser-resistant and heat resistant gloves, caps, suits, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned at all times.
- ⇨ Laser safety glasses alone do not provide sufficient eye and skin protection when LightWELD device is in use.
- ⇨ Operators must use the specified appropriate laser safety glasses only in combination with the specified appropriate welding helmet when the device is in operation.
- ⇨ In combination, the welding helmet and the laser safety glasses shall comply with the protection level at least D LB8 and I LB9 as defined in EN 207. Dependent on the results of hazard and risk assessment of the application further protective means and further PPE could be required.
- ⇨ IPG recommends to use appropriate laser safety glasses in combination with IPG LightWELD helmet.
- ⇨ ONLY one person is allowed to be in the LCA while the device is in operation. All other personnel must remain outside the LCA. Ideally the person in the LCA can be observed and monitored, by personnel outside the laser area, using camera technology.
- ⇨ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser device is operational.
- ⇨ If any PPE becomes damaged or compromised while using the LightWELD device, discontinue using the LightWELD device immediately and replace damaged PPE.

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

If an alarm occurs the Error status indicator on the front panel of the device will be lit red. There are 32 possible alarms. To determine which alarm bit(s) caused a particular error:

- Check the Laser Power display on the front panel. The error code will be shown on that display and will begin with the letters "Er" followed by a two-digit number (e.g. Er03 for alarm bit-3).
- Alternatively, users may view alarm status bits through the Welder web page interface. Refer to Laser Welder Page [▶ 153].

For a description of the alarms and methods for clearing them, see Welder Status Alarms Bit Table [▶ 171]. Many of the alarms can be cleared in one of three ways.

1. **Trigger 1 Control on Weld Head**: Release both Trigger 2 (if pressed) and Trigger 1 controls and re-press Trigger 1 again. Once Trigger 1 is pressed, the first thing it will do is to try to clear any alarms automatically. As long as the condition that caused it was resolved, the error should clear.
2. **Clear Alarms**: Users may also clear any errors through the Welder web page by clicking the Clear Alarms button. Refer to Welder Status Indicator Pane [▶ 155].
3. **Reboot Using Keyswitch**: A small subset of these alarms can only be cleared by rebooting the unit. If the condition that caused it was not resolved, the alarm is likely to occur again. If this is the case, contact IPG Service for assistance.

Error Alarms

⇨ For the front panel error display, the severity of the alarms increases with increasing error numbers. Er27 is more severe than Er01.

⇨ If more than one type of alarm has occurred, the alarm number with the higher severity will be displayed on the front panel. However if using the web page interface, the web page alarm indicator lights will show all the error alarms that occurred.

Code	Type of Alarm	Description	How to Clear Alarm?
Er00	----------	Reserved	----------
Er01	Galvo Position	Beam wobble control reported laser beam position error. Laser beam did not go to commanded position.	Trigger 1 Control or Clear Alarms button

Code	Type of Alarm	Description	How to Clear Alarm?
Er02	Under Temp	The laser module temperature is below the minimum temperature threshold for operation. To view the laser's temperature reading, go to the `Welder` web page and check `Welder Status Temperature` (refer to Laser Welder Page [▶ 153]).	Wait until case Temperature is greater than 8.5°C (47°F) then clear with either Trigger 1 Control or Clear Alarms button.
Er03	Over Temp	The laser module temperature has exceeded normal operating temperature (>55°C). If this occurs during welding, laser emission will turn OFF automatically. To view the laser's temperature reading, go to the `Welder` web page and check `Welder Status Temperature` (refer to Laser Welder Page [▶ 153]).	Wait until case Temperature has cooled down below warning threshold of 52°C (125°F) then clear by Trigger 1 Control or Clear Alarms button.
Er04	No Plasma	Plasma detection feature did not detect plasma during welding. There are 2 independent conditions that can cause this. Normal – No plasma detected during welding (light detected was below material threshold). Ambient – Ambient light surrounding the material is interfering with the plasma detector operation. This is always paired with the Ambient Light Warning. If Ambient Light Warning is active with Er04, then error was due to ambient. Refer to Laser Welder Page [▶ 153]).	Trigger 1 Control or Clear Alarms button
Er05	----------	Reserved	----------

Code	Type of Alarm	Description	How to Clear Alarm?
Er06	Fiber Fuse 1	First Internal fiber fuse photodiode reading exceeded the maximum allowable threshold (there is too much power in the external fiber). This is a critical error that must be addressed. Contact IPG Photonics for assistance.	Trigger 1 Control or Clear Alarms button
Er07	Fiber Fuse 2	Second Internal fiber fuse photodiode reading exceeded the maximum allowable threshold (there is too much power in the internal fiber). This is a critical error that must be addressed. Contact IPG Photonics for assistance.	Trigger 1 Control or Clear Alarms button
Er08	Back Reflection	Internal back reflection photodiode reading exceeded its threshold. Light is reflecting back into fiber.	Trigger 1 Control or Clear Alarms button
Er09	Under Power	Actual laser power is less than set point.	Trigger 1 Control or Clear Alarms button
Er10	Over Power	Actual laser power is greater than set point.	Trigger 1 Control or Clear Alarms button
Er11	Interlock Malfunction	Malfunctioning Interlock Safety Loop. Monitors key signals, remote start and “all safe” signals.	Power off and on the unit with the keyswitch, E-Stop or AC power cord.
Er12	Fiber Interlock	Malfunctioning fiber interlock safety loop. Check fiber cable connection to weld head. Disconnect and reconnect the fiber into the weld head.	If fiber interlock opens up then Trigger 1 Control or Clear Alarms button will clear error.
Er13	External Interlock	External A and External B (pins 1,2 and 3,4 on 12-pin connector) interlock state does not match. This indicates that one channel opened while the other one stayed closed.	Both Ext A and Ext B interlocks must both be open before Trigger 1 Control or Clear Alarms button will clear error.
Er14	PS Enable	On system startup, the laser power supply was in the enabled state.	Power off and on the unit with the keyswitch, E-Stop or AC power cord.

Code	Type of Alarm	Description	How to Clear Alarm?
Er15	Startup Diagnostic	One or more safety signals powered up into incorrect state. Monitors fiber interlock signals, remote start and "all safe" signals on startup.	Power off and on the unit with the keyswitch, E-Stop or AC power cord.
Er16	Power B Disable	Power supply was enabled before rising edge of emission on.	Power off and on the unit with the keyswitch, E-Stop or AC power cord.
Er17	Power A Disable	On rising edge of emission on signal, laser power supply enable was not on.	Power off and on the unit with the keyswitch, E-Stop or AC power cord.
Er18	External B Shutdown	While emission was ON, external interlock A (pins 3,4 on the 12-pin interface connector) opened unexpectedly so the laser was shutdown.	Trigger 1 Control or Clear Alarms button
Er19	External A Shutdown	While emission was ON, external interlock A (pins 1,2 on the 12-pin interface connector) opened unexpectedly so the laser was shutdown.	Trigger 1 Control or Clear Alarms button
Er20	Fiber Interlock Shutdown	While emission was ON, the fiber interlock opened which resulted in the laser being shutdown. Check fiber cable to weld head connection.	Trigger 1 Control or Clear Alarms button
Er21	Nozzle Shutdown	While emission was ON, the nozzle to workpiece clamp interlock opened which resulted in the laser being shutdown (e.g. During welding the operator lifted nozzle off part while still pressing Trigger 2).	Trigger 1 Control or Clear Alarms button
Er22	Trigger 1 Shutdown	While emission was ON, the Trigger 1 interlock opened which resulted in the laser being shutdown (e.g. During welding the operator released the Trigger 1 gas control on the weld head).	Trigger 1 Control or Clear Alarms button
Er23	PS Voltage	On the rising edge of emission ON, detected that the laser power supply was not regulating the voltage properly.	Trigger 1 Control or Clear Alarms button

Code	Type of Alarm	Description	How to Clear Alarm?
Er24	PS Current	While emission was ON detected that the laser power supply was not regulating current properly.	Trigger 1 Control or Clear Alarms button
Er25	Nozzle Startup	On system power up via keyswitch, E-Stop, or AC power the nozzle interlock was closed.	Open nozzle interlock (e.g. lift nozzle off part) then clear by Trigger 1 Control or Clear Alarms button.
Er26	Trigger 1 Startup	On system power up via keyswitch, E-Stop, or AC power the Trigger 1 interlock was closed.	Open Trigger 1 interlock (e.g. release Trigger 1 Control on Weld Head) then clear by Trigger 1 Control or Clear Alarms button.
Er27	Thermal Shutdown	The system's optical or electrical model determined the laser diodes were going to overheat.	Wait until the model(s) have cooled to a state operating temperature with emission OFF then use Trigger 1 Control or Clear Alarms button.
Er28	Nozzle Reset	Emission has occurred 25 times without the nozzle interlock opening up.	Open Nozzle interlock (e.g. lift the nozzle off the part) then clear by Trigger 1 Control or Clear Alarms button.
Er29	Trigger 1 Reset	Emission has occurred 25 times without the Trigger 1 interlock opening up.	Open Trigger 1 interlock (e.g. release Trigger 1 Control on Weld Head) then clear by Trigger 1 Control or Clear Alarms button.
Er30	Gas Shutdown	Gas pressure was not detected while emission was ON or the laser tried to fire before gas delay was met.	Trigger 1 Control or Clear Alarms button
Er31	Fan Alarm	Either fan was not detected spinning, checks continuously after 30 second startup delay.	Trigger 1 Control or Clear Alarms button once fans resume spinning

Table 32: Welder Status Alarms Bit Table

11 Decommissioning Welder Device

11.1 Disassembling Welder Device

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

To disassemble the laser welding device:

1) Turn OFF the gas supply to the welder device.
2) Turn the keyswitch to the OFF position. Remove the key and place it in a plastic bag. Then tape it to the front of the unit.
3) Disconnect the laser welder device from AC power.
4) Unplug the AC power cord from the AC inlet receptacle on the back of the device then loop it and tie wrap it.
5) Disconnect the 12-pin interface connector cable on the back of the welder device and unplug it.
6) Disconnect the orange workpiece clamp cable from the shank on the back of the welder device and then loop and tie wrap it.
7) On the back of the welder device, disconnect the flexible tubing from the GAS IN fitting. This is the facility gas line coming into to the system.
8) Carefully wrap the weld head with plastic and bubble wrap.
9) Carefully loop and tie wrap the umbilical and place the umbilical with weld head on top of the unit.

This completes the disassembly procedure.

11.2 Disposal

For disposal information please refer to Recycling and Disposal [▶ 66].

12 Maintenance

⚠ WARNING

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

All electrical cables and connections should be treated as if they were at a harmful level.

⚠ WARNING

Invisible class 4 laser radiation when the LightWELD device is energized

Risk of permanent skin or eye damage and vision impairment from invisible direct, reflected, and scattered Class 4 laser radiation during maintenance.

⇨ Shut off the LightWELD device (refer to System Shutdown [▷ 104]).

⇨ Remove the AC power connection.

⇨ Secure the device against being switched on again.

12.1 IPG Weld Head Maintenance

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

What Item	Interval	Type of Maintenance
Nozzle Tip	Daily	Regular inspection for contamination. Cleaning, if contaminated.
Protective Window	Daily	Regular inspection of the protective window for contamination and timely replacement, if contaminated. Refer to Protective Window Replacement [▷ 178] which describes the steps for disassembling and replacing this window if needed.
Fiber Cable	Daily	Daily visual inspection of yellow fiber cable for damage.
QBH Connection	Every 3 days	Regular inspection of QBH connector for looseness.
Trigger 1 & 2 Switches	3,2 years	The weld head trigger switches should be replaced every 3,2* years. *Refer to Wearing Safety-Related Components [▷ 180].

Table 33: Recommended Maintenance and Intervals

IPG Part Number	Quantity	Description
CDSBOM00023702XU (20 Pack)	1	Protective Window Replacement Kit (Only need one protective window for this procedure)
CDHOX041CQXXXXXU	1	Weld Head, LightWELD 2.0, 40/120, HLC8
CDHCX041CQXXXXXU	1	Weld Head, LightWELD XC, 40/120, HLC8

Table 34: List of Field Replaceable Parts

12.1.1 Protective Window Replacement

This procedure is applicable for all models. The protective window must always be clean and checked regularly.

NOTICE

Weld Head Maintenance Precaution

Weld Head can become damaged if maintenance is performed while AC power is ON.

⇨ Prior to performing any kind of maintenance on the hand weld head, maintenance personnel should (1) shut off the unit (refer to System Shutdown [▶ 104]) and (2) remove AC power connection.

NOTICE

Installing Protective Window from Other Suppliers

This may damage the weld head! This will also alter the specifications and performance of the device.

⇨ For safe and reliable operation only use an IPG supplied protective window. Only the IPG protective window will have the correct specifications and coating specifically designed to work with the laser inside the device.

NOTICE

Delicate Protective Window - Handle with Care!

Contamination or scratches on the protective window degrades the laser welding process. This may eventually crack the window and could damage the weld head.

⇨ Wear nitrile gloves. Avoid touching the flat surface of the protective window.

⇨ Do NOT use tweezers or other tools (may scratch the coating on the window).

⇨ Carefully pick up (or place) the protective window by its edge.

1) On the weld head, turn the silver nut counterclockwise to disengage window/nozzle assembly (Disengage Window/Nozzle Assembly [▶ 179]).

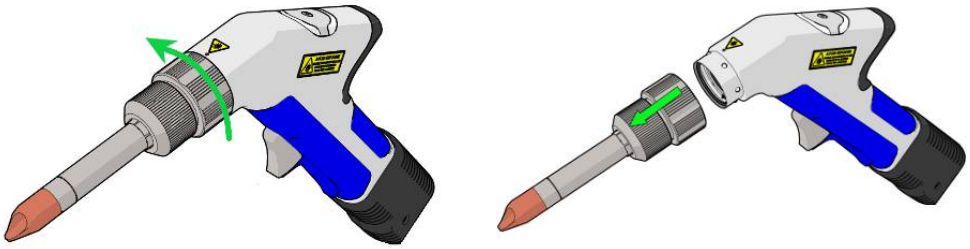


Figure 74: Disengage Window/Nozzle Assembly

2) Flip open the cap to access the protective window underneath. Users should inspect the new protective window for contamination prior to installing it. Use CDA to blow any dust or debris off the new protective window. Replace the protective window and securely close cap (Accessing Protective Window [▶ 179]).

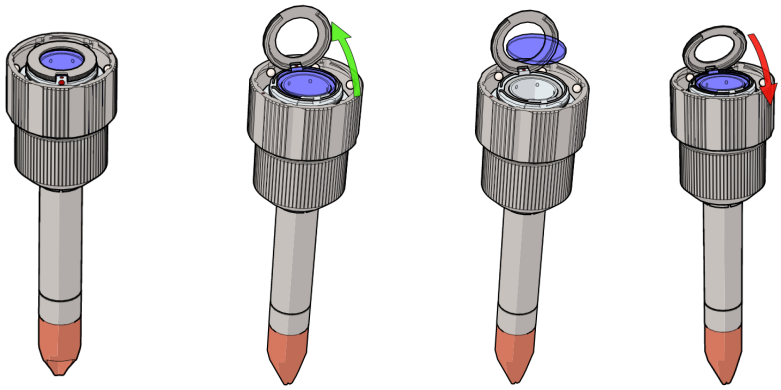


Figure 75: Accessing Protective Window

3) To reattach window/nozzle assembly (Steps to Reattach Window/Nozzle Assembly [▶ 179]):

   ⇨ Align the red marks (first figure below on left).

   ⇨ Align balls with circular cutouts (middle figure below).

   ⇨ Turn nut as shown to lock assembly in place (right figure below).

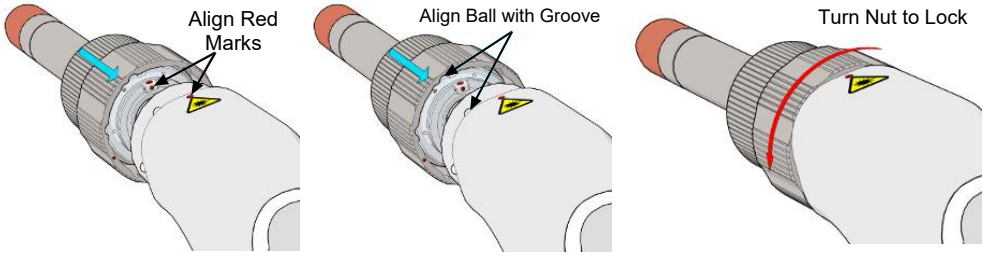


Figure 76: Steps to Reattach Window/Nozzle Assembly

End of Procedure

12.1.2 Wearing Safety-Related Components

NOTICE

Replacement of safety-related components

An n_{op} value is provided for wearing safety-related components (median value of annual component actuations as per EN ISO 13849-1). If the actual median value of annual component actuations exceeds this value, the time T_{10d} must be ascertained as per EN ISO 13849-1. Dependent on this, the safety-relevant component must be prematurely replaced.

Test Point	Trigger switches in weld head
Remedy	Replace the trigger switches
Time Interval	At n_{op} = 125000 cycles/year replace at 3,2 years. (B_{10d} = 4 x 10^5) or in the event of defects.
Item	Weld Head
Description	Contact local IPG Service to have weld head returned for switch replacement or exchanged (refer to IPG Service [▷ 192]).

Table 35: Weld Head Trigger Switch Replacement

The replacement of the weld head switches is only to be performed by IPG service personnel.

12.1.3 Replacing the Weld Head

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▷ 22]).

NOTICE

Weld Head Maintenance Precaution

Weld Head can become damaged if maintenance is performed while AC power is ON.

⇨ Prior to performing any kind of maintenance on the hand weld head, maintenance personnel should (1) shut off the unit (refer to System Shutdown [▷ 104]) and (2) remove AC power connection.

1) Unpack the new weld head and make sure to prepare it to receive the fiber bayonet. Place it on table nearby.
2) Remove the AC power cord from the system and turn off the gas supply.

3) From the bottom of the weld head, remove approximately 0.5 m (1.5 ft) of the netted sheathing from the umbilical cable to expose the cabling within.

4) Disconnect the electrical cable (see Disconnecting Weld Head [▷ 181], #1). Rotate the connector counter clockwise and pull to disconnect.

5) Disconnect the gas tubing (see Disconnecting Weld Head [▷ 181], #2). Press in fitting to remove tubing.

6) Remove the boot and disconnect the fiber output bayonet from the bottom of the weld head. Refer to Connect/Disconnect Fiber Output [▷ 182] for instructions on how to do this.

7) Once the bayonet is removed, and to maintain cleanliness, immediately connect the fiber output bayonet to the new head. For instructions on how to connect bayonet to the new weld head, refer to Connect/Disconnect Fiber Output [▷ 182].

8) Once the bayonet is connected, re-install the boot.

9) Reconnect the electrical cable. Check the orientation of the plug and plug into other connector. Rotate connector to lock in place.

10) Reconnect the gas tubing.

11) Re-install the netted sheathing that was removed from the umbilical cable in step 3.

12) Turn on gas supply. Power up the welding system.

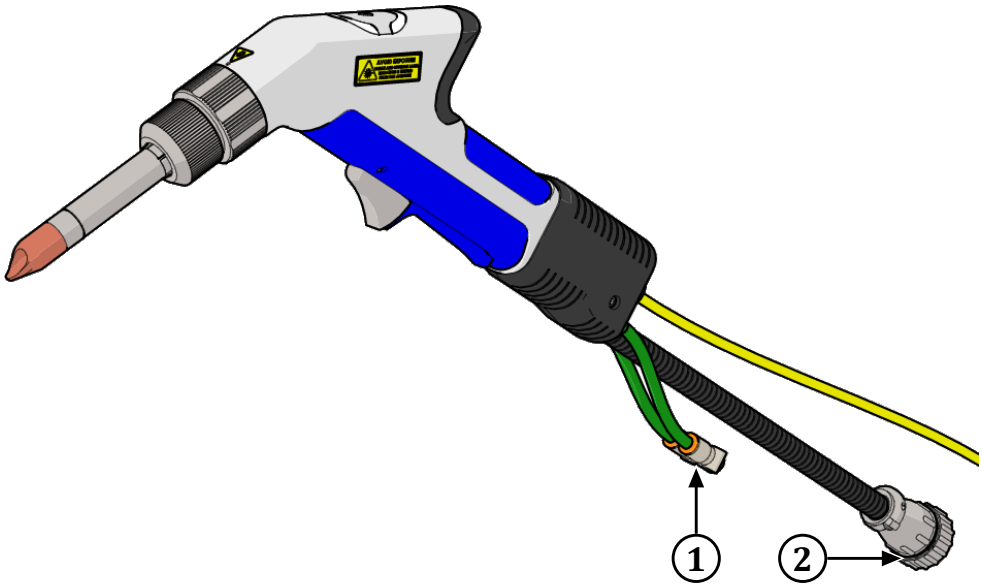


Figure 77: Disconnecting Weld Head

1	Gas Tubing Connection	2	Electrical Connection

12.2 Connect/Disconnect Fiber Output

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

The following procedures to disconnect and connect the fiber output to the weld head should only be necessary when replacing the output weld head. During normal operation, this does not need to be performed. Prior to reconnecting the fiber to the weld head, the cleaning procedure (refer to Output Termination Cleaning Procedures [▶ 187]) must also be performed.

These procedures are applicable for all models.

12.2.1 Precautions for Fiber Maintenance Procedures

NOTICE

Weld Head Maintenance Precaution

Weld Head can become damaged if maintenance is performed while AC power is ON.

⇨ Prior to performing any kind of maintenance on the hand weld head, maintenance personnel should (1) shut off the unit (refer to System Shutdown [▶ 104]) and (2) remove AC power connection.

NOTICE

Fiber Cable Terminator Contamination

The quartz block is very delicate and must stay perfectly clean. Any contamination will result in serious damage to the fiber cable. Refer to Fiber Cable Output Connection [▶ 79].

⇨ Always wear clean nitrile gloves when disconnecting fiber from weld head.

⇨ NEVER touch the quartz block at the end of the fiber connector.

⇨ Only remove fiber from weld head when necessary for replacement.

⇨ Always follow instructions in this section.

NOTICE

Laser Fiber Cable Handling

Severe laser damage will occur if optical fiber cable, routed through the umbilical, is mishandled (extreme bending, pulling or impact).

⇨ Do not bend the yellow optical fiber cable to a radius less than 50 mm minimum bending radius.

⇨ Do not apply excessive load or impact to the fiber cable.

⇨ NEVER move or lift the unit by pulling or dragging on the umbilical cabling.

12.2.2 Disconnect Fiber Output

⇨ Must read and follow precautions before beginning this procedure (refer to Precautions for Fiber Maintenance Procedures [▷ 182]).

The output fiber connection is within the boot section of the weld head.

1) Remove power from device.
2) To remove the boot, unscrew the 2 SHCS shown here and pull down the boot (see Removing Boot from weld head to expose fiber connector [▷ 183]).

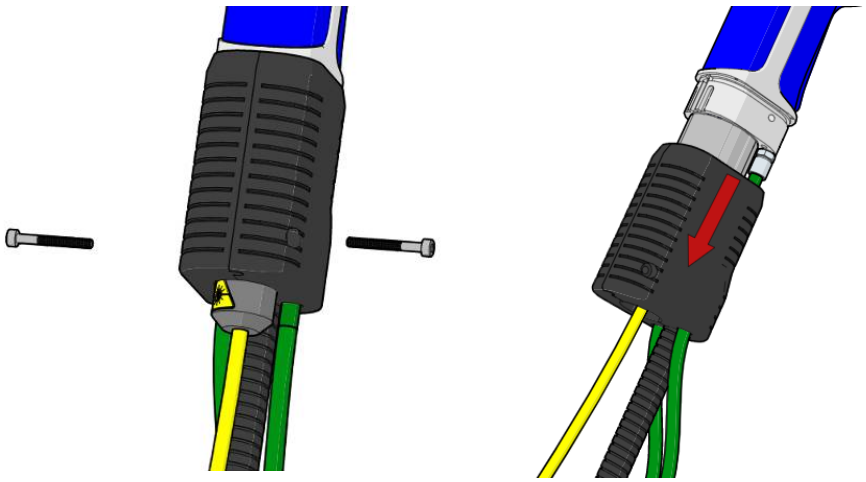


Figure 78: Removing Boot from weld head to expose fiber connector

3) Rotate receiver nut to align red dots as indicated in drawing below (see Rotate receiver nut to align red dots [▷ 184]).

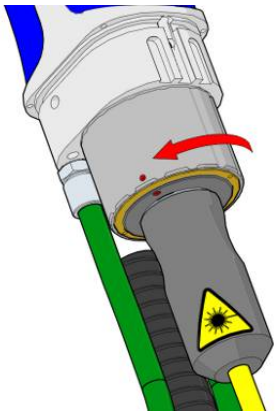


Figure 79: Rotate receiver nut to align red dots

4) Carefully pull out the fiber connector (see Pulling out fiber connector from weld head [▶ 184]).

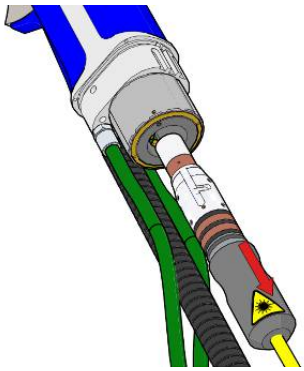


Figure 80: Pulling out fiber connector from weld head

5) Leave protective cap installed over quartz block. Install storage sleeve. Never touch the protective cap window or quartz block optical surfaces. These surfaces must remain clean.

6) Close the welding head with a protective cap.

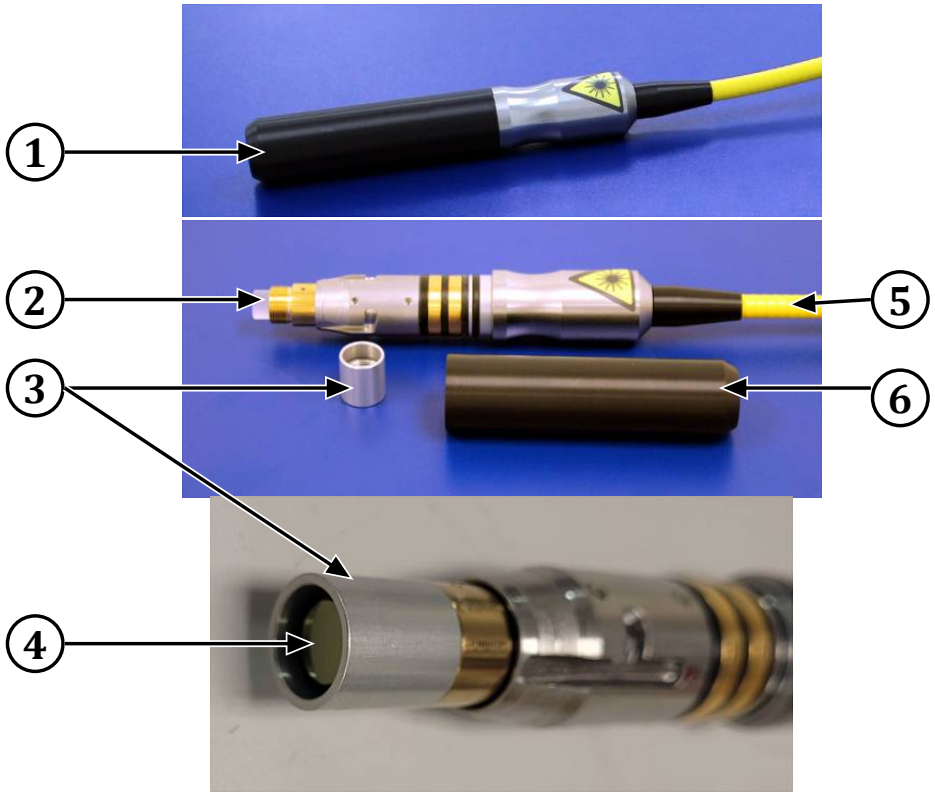


Figure 81: Fiber End Connector with Protective Cap and Sleeve

1	Fiber End Connector with Cap & Sleeve	2	Quartz Block
3	Protective Cap	4	Protective Cap Window
5	Fiber	6	Storage Sleeve

12.2.3 Connecting Fiber Cable to IPG Weld Head

⇨ Must read and follow precautions before beginning this procedure (refer to Precautions for Fiber Maintenance Procedures [▷ 182]).

1) Remove power from the device.
2) Before reconnecting the fiber to the weld head, the technician must first perform the cleaning procedure (refer to Output Termination Cleaning Procedures [▷ 187]) on the fiber output quartz block.
3) Remove storage sleeve from fiber bayonet. Leave protective cap on quartz block.

4) To reconnect the fiber output connector, please ensure the red dots on the receiver nut are aligned as shown.

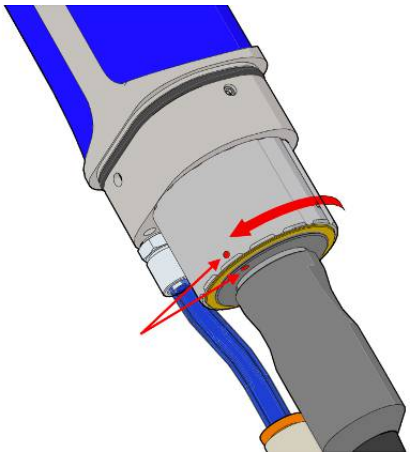


Figure 82: Align red dots on the receiver nut to reconnect fiber output connector

5) Insert the fiber by aligning the red dot on the fiber output connector with the red dots on the receiver as shown. Insert the fiber output connector as far as it will go but do not force it.

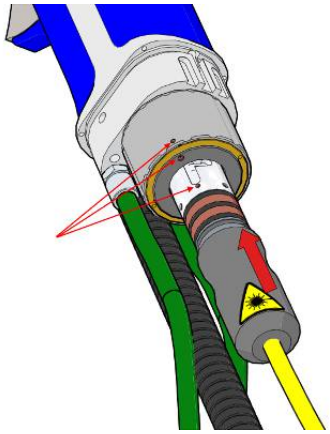


Figure 83: Insert fiber by aligning red dots on fiber output and receiver

6) Rotate receiver nut as shown to lock fiber connector in place.

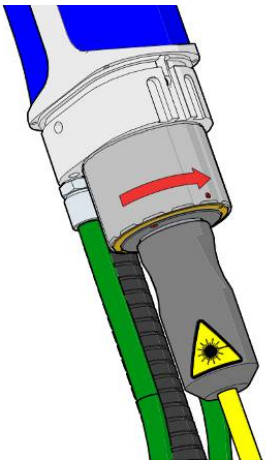


Figure 84: Rotate receiver nut to lock fiber connector

7) Reinstall and secure the weld head boot. Do not operate the weld head with the boot not secured in place. For pictures, please refer to Disconnect Fiber Output [▶ 183], step 2.

End of Procedure

12.3 Output Termination Cleaning Procedures

Personnel Qualifications: Maintenance Personnel (refer to Personnel Qualifications [▶ 22]).

It is imperative that a fiber termination is checked for dust, dirt or damage every time the fiber output connection to the weld head is disconnected.

NOTICE

Fiber Cable Terminator Contamination

The quartz block is very delicate and must stay perfectly clean. Any contamination will result in serious damage to the fiber cable. Refer to Fiber Cable Output Connection [▶ 79].

⇨ Always wear clean nitrile gloves when disconnecting fiber from weld head.

⇨ NEVER touch the quartz block at the end of the fiber connector.

⇨ Only remove fiber from weld head when necessary for replacement.

⇨ Always follow instructions in this section.

NOTICE

⇨ The use of a dirty or improperly cleaned output fiber termination can lead to serious damage to the unit. IPG Photonics is not responsible for any damages due to contaminated output fiber termination. Custom fiber terminations may require a different procedure.

12.3.1 Recommended Cleaning Supplies

NOTICE

Weld Head Maintenance Precaution

Weld Head can become damaged if maintenance is performed while AC power is ON.

⇨ Prior to performing any kind of maintenance on the hand weld head, maintenance personnel should (1) shut off the unit (refer to System Shutdown [▶ 104]) and (2) remove AC power connection.

The following items are recommended for cleaning the output termination:

- Powder free rubber gloves or finger cots
- Optical cleaning wipes and/or swabs
- Lens tissue
- Isopropanol (water free)
- Acetone (optical grade, water free)
- Compressed air (oil free, water free)
- Microscope (IPG model or equivalent)
- Light Source

Figure 85: Recommended Cleaning Supplies (not included)

IPG Photonics recommends the use of our fiber cable inspection microscope and cleaning kit, part number COLXXUX0000900XG. Contact IPG Service for details and ordering information.

12.3.2 Cleaning the Quartz Block (Generic Procedure)

⇨ It is imperative that you wear powder free rubber gloves during this cleaning procedure!

1) Perform the following procedure to clean the fiber output termination:
2) Turn off in the welder unit and remove power from the device (refer to System Shutdown [▶ 104]).
3) Spray the quartz block end face with Isopropyl Alcohol. Wipe it with a new sheet of lens tissue and blow the surface with clean compressed air.
4) Inspect the end face surface with the microscope.
5) Use light source to illuminate the end face of the fiber termination so that the light is reflected from the surface.

⇨ Always look at the surface at a slight angle to improve visibility.

6) Inspect the surface carefully. If contamination is visible on the quartz block, cleaning is necessary. Contamination will lead to dark spots on the surface.
7) Try to blow off the dust with compressed air from the side.

⇨ Never blow air directly at the surface because you might embed contaminants into the surface. Always blow across the surface being cleaned!

8) Place a new sheet of lens tissue on the surface of the quartz block as shown in the picture below. Put one drop of Isopropanol onto the lens tissue and wipe the wet spot laterally across the surface until it is dry.

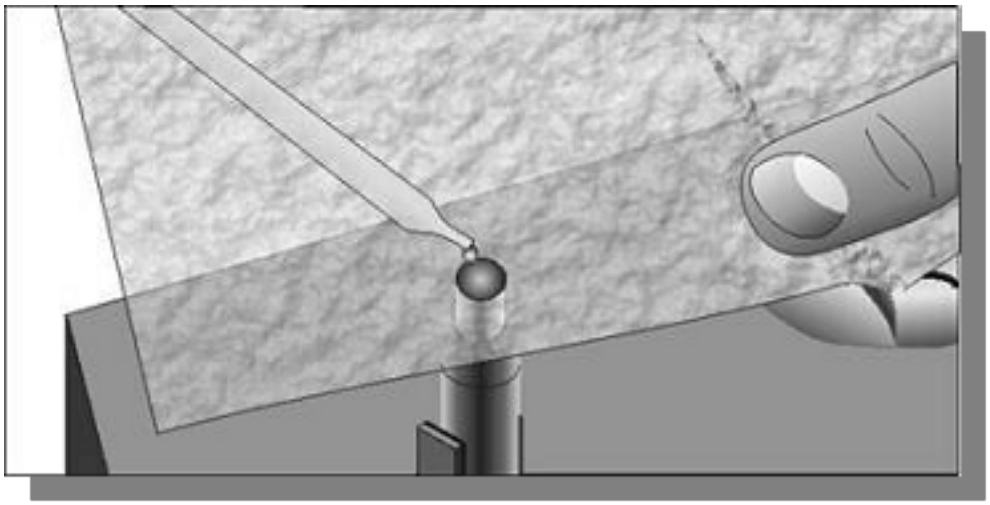


Figure 86: Isopropanol on lens tissue

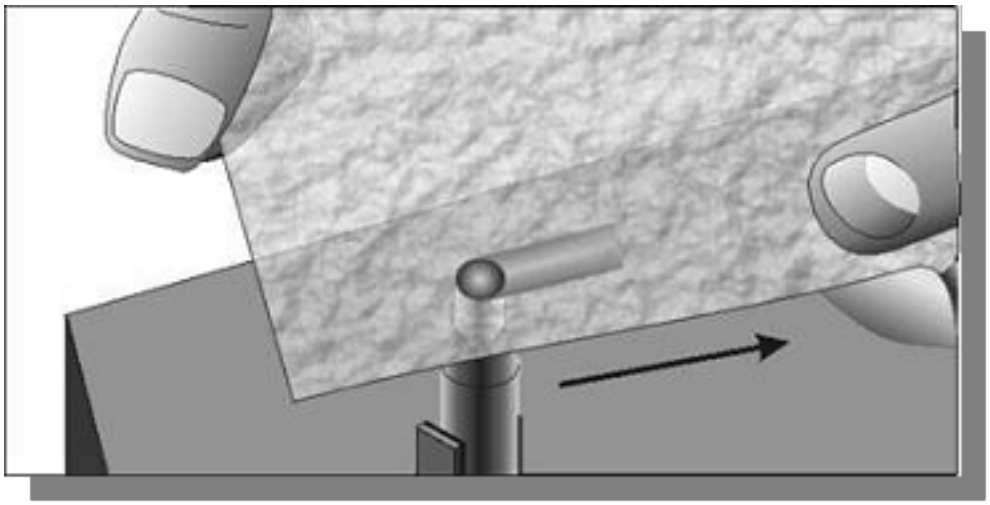


Figure 87: Lateral wipe across surface

⇨ Do not let the areas where your fingers have touched the tissue come into contact with the surface being cleaned.

9) Re-inspect the surface

10) Repeat step 7 with Acetone if it is still contaminated.

11) If necessary you should put a drop of acetone onto a cleaning swab and wipe away contamination in a circular motion, do not scratch the surface.

⇨ Do not touch the tip of the cleaning swab with your fingers.

⇨ To prevent contamination, only use each swab once.

12) Repeat above cleaning steps until all contamination is removed. This cleaning procedure can be stopped at any time if a good result has already been achieved.

⇨ It is hereby stated that damage to the fiber termination can occur due to mishandling; the use of incorrect cleaning procedures or chemicals for cleaning and is not covered by the warranty.

End of Procedure

13 Service and Support

There are no operator serviceable parts inside. Please refer all servicing to qualified IPG personnel.

13.1 IPG Service

Many issues and questions regarding the safety, set-up, operation and maintenance of the IPG products can be resolved by carefully reading this operating manual and/or by accessing the LightWELD Product Support webpage (refer to Accessing Product Support Webpages [▷ 193]).

For remote troubleshooting, refer to Remote Troubleshooting with Teamviewer [▷ 195].

If you have questions regarding the safety, set-up, operation or maintenance of your IPG product, contact IPG Service at:

United States:

IPG Photonics Corporation

259 Cedar Hill Street

Marlborough, MA 01752

USA

Telephone: +1 (508) - 506 - 2877

Email: Lightweld@ipgphotonics.com

European Union:

IPG Laser GmbH

Carl-Benz-Straße 28

57299 Burbach

Germany

Telephone: +49 2736 4420 8217

Email: IPGL-LSS-Support@ipgphotonics.com

If you cannot resolve the issues by using this operating manual or over the telephone with our technical support group, you might need to return the product to IPG. Refer to Product Returns [▷ 207] for more details.

13.1.1 Accessing Product Support Webpages

Scanning the QR code specified on the safety label located on the front of the unit will take you to the “LightWELD® Safety Information” webpage (refer to figure Scan QR Code on Safety Label [▶ 193]) at: https://safety.handheldlaserwelder.com

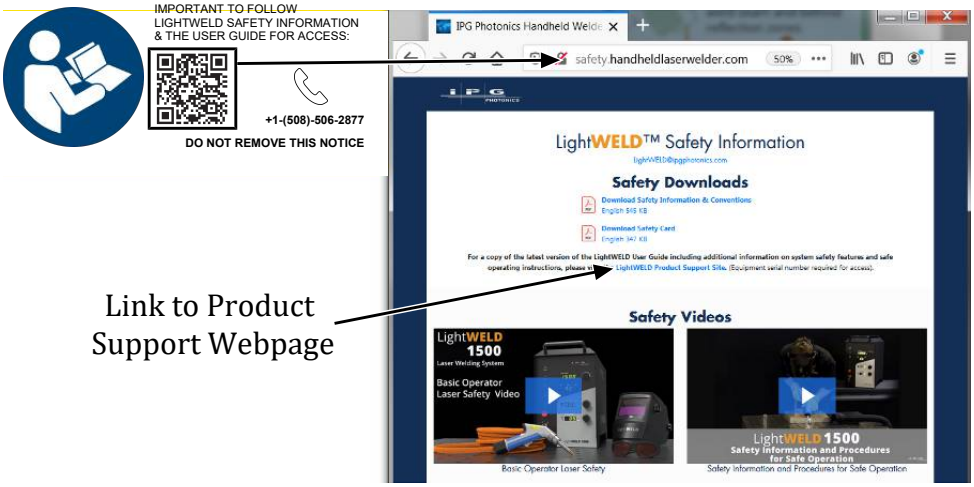


Figure 88: Scan QR Code on Safety Label

The Safety Information Page has important safety information and videos that must be reviewed by all the LightWELD device operators and all personnel that will be working within the welding laser control area. In the EU please contact +49 2736 4420 8217, or email IPGL-LSS-Support@ipgphotonics.com.

Clicking on the `LightWELD Product Support Site` link in the middle of the page takes you to the website: https://gettingstarted.handheldlaserwelder.com/

Input the serial number for your device and click the Get Started! button. The serial number is specified on the Identification label on the back of the unit.

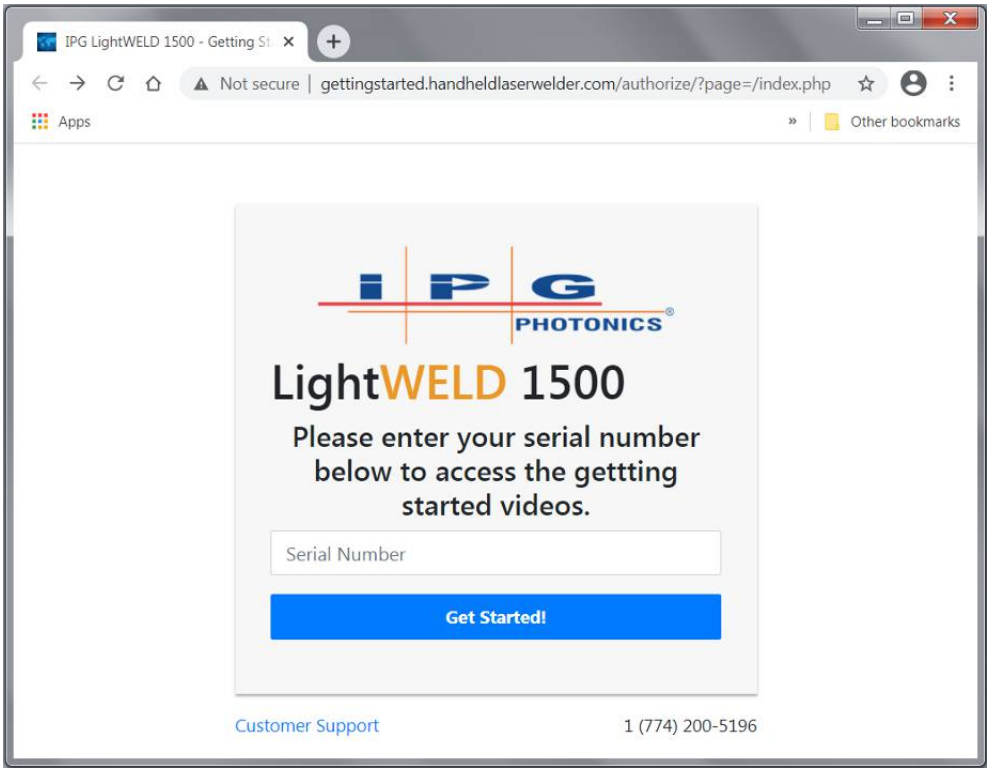


Figure 89: Input Serial Number to Access Support Page

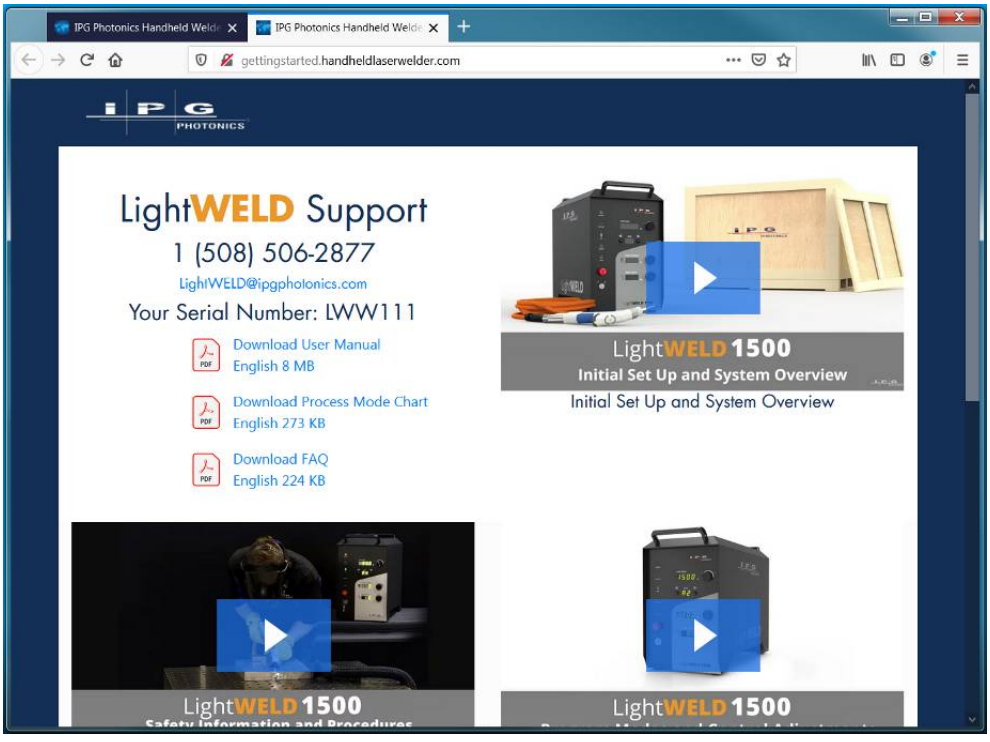


Figure 90: LightWELD Product Support Webpage

The LightWELD product support page will open. This page provides access to support videos that will assist users in setting up and operating the device. From this page users may also download the operating manual and Process Mode Chart.

Additional support information is also found on the IPG Photonics Laser Systems Support and Services webpage: https://lasersystems.ipgphotonics.com/support

13.1.2 Remote Troubleshooting with Teamviewer

Should remote troubleshooting with the IPG Service department be needed:

1. Connect a PC via Ethernet to the welder (refer to Computer Connection to Device [▶ 146]).
2. With an active internet connection, open web browser and type in the address: https://898.tv/lightweld
3. This will automatically download the TeamViewer executable file.

   Open Windows Explorer and navigate to the `Downloads` folder.

   Double-click on the file `TeamViewerQS.exe` to execute program.
4. You will be prompted by a security warning. Click the Run button to continue (see TeamViewer Executable Security Dialog [▶ 195]).

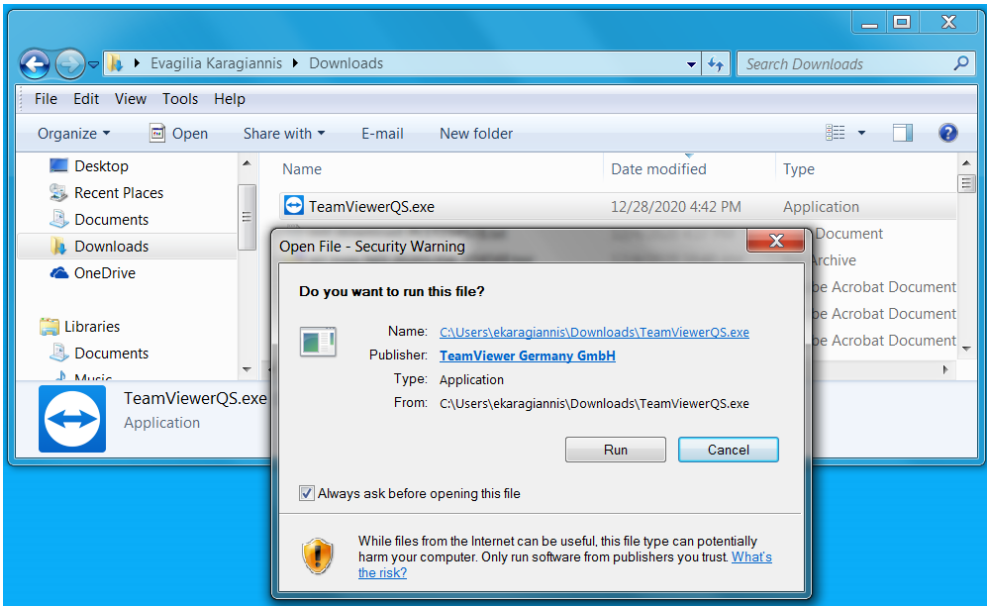


Figure 91: TeamViewer Executable Security Dialog

5. The Team Viewer License Agreement dialog will appear. Click the I Agree button to accept and continue (refer to figure TeamViewer License Agreement Dialog [▶ 196]).

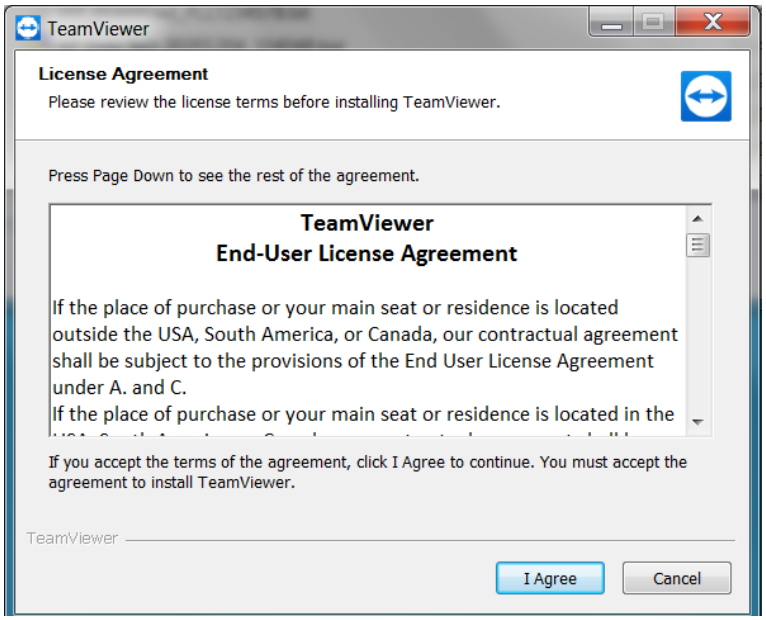


Figure 92: TeamViewer License Agreement Dialog

6. A pop-up window will appear. Supply the generated ID and Password to IPG Service (refer to figure TeamViewer Connection ID and Password [▶ 196]).

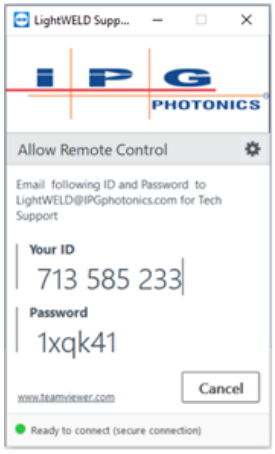


Figure 93: TeamViewer Connection ID and Password

14 Warranty

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21. Product Support. Product support for the SOFTWARE is not provided by MS, Microsoft Corporation, or their affiliates or subsidiaries. For product support, please refer to IPG support number provided in the documentation for the EQUIPMENT. Should you have any questions concerning this EULA, or if you desire to contact IPG for any other reason, please refer to the address provided in the documentation for the EQUIPMENT.

22. Termination. Without prejudice to any other rights, IPG may terminate this EULA if you fail to comply with the terms and conditions of this EULA. In such event, you must destroy all copies of the SOFTWARE and all of its component parts.

23. EXPORT RESTRICTIONS. You acknowledge that SOFTWARE is subject to U.S. and European Union export jurisdiction. You agree to comply with all applicable international and national laws that apply to the SOFTWARE, including the U.S. Export Administration Regulations, as well as end-user, end-use and destination restrictions issued by U.S. and other governments. For additional information see

http://www.microsoft.com/exporting.

15 Product Returns

Returns may be processed through the following offices, depending on your region:

- **Germany** - refer to Returns to Germany [▶ 207]
- **Italy** - refer to Returns to Italy [▶ 208]

15.1 Returns to Germany

Shipping address for returns to Germany:

IPG Laser GmbH

Daimler Str. 16

57299 Burbach

Germany

Tel: +49 2736 4420 8217

1. IPG Laser GmbH will only accept returns for which an approved Return Material Authorization (RMA) has been issued by IPG Laser GmbH. You should address to the customer support team at +49 2736 4420 8217 or IPGL-LSS-Support@ipgphotonics.com to discuss the return and request an RMA number. You must return defective products freight prepaid and insured to IPG Laser at the address shown herein. All products which have returned to IPG Laser but which are found to meet all previously applicable specifications for such products or which indicate damage to the fiber connectors not resulting from defect manufacturing, shall be subject to IPG Laser' standard examination charge in effect at the time and these costs shall be charged to the Buyer. All products returned to IPG Laser which are not accompanied by an itemized statement of defects, shall be returned to the Buyer at the Buyer's expense and IPG Laser shall not carry out any evaluation of such products. IPG Laser warrants to Buyer that its services, labor and replacement parts, assemblies and modules will be free of defects in material and workmanship for ninety (90) days from the date of shipment or performance of services.
2. Warranty Returns - Domestic & *International Buyers should pay for one-way freight costs to IPG Laser. IPG Laser will reimburse Buyers for applicable reasonable third-party freight costs and IPG Laser will pay for freight return cost back to the Buyer.
3. Non-Warranty Returns - Domestic & *International Buyers are responsible for two-way freight costs. If shipment consists of returns that are both warranty and non-warranty, the shipment will be considered as non-warranty. Any UNAUTHORIZED shipments

billed to IPG Laser without authorization will be re-invoiced to the Buyer. Confirming purchase orders are required for non-warranty returns.

4. *International Returns must include applicable DUTIES AND TAXES, and you must mark air bills with “RETURNED FOR REPAIR”. In any event, where IPG Laser accepts a shipment, IPG Laser will invoice to the Buyer for any charges as stated above.
5. Returns for credit will not be accepted unless authorized in advance, in writing by IPG Laser, in accordance with IPG Laser' Terms and Condition, including the warranty provisions. In most cases, restocking fees will apply.
6. All returns must be packaged adequately to avoid damage during shipment.
7. Complete packing list with product model and serial number will insure prompt repair, if the other terms of this form are followed.
8. See the IPG Terms and Conditions for the applicable warranty for the products before you request the return of the products.
9. RMA number will expire 31 days after the date of issue. Thereafter, units received in under the expired RMA number will result in a longer turnaround time. Include a copy of the completed RMA form with the return of your unit(s).

15.2 Returns to Italy

Shipping address for returns to Italy:

IPG Photonics (Italy) S.r.l.

Via XI Settembre, 11

20023 Cerro Maggiore (MI), Italy

Attention: Product Returns

Tel: +39.0331.1706.920

Email: IPGIT-MI-Systemsupport@ipgphotonics.com

1. IPG Photonics will only accept returns for which an approved Return Material Authorization (RMA) has been issued by IPG Photonics (Italy) S.r.l. You should address to the customer support team, at the above phone number or email address, to discuss the return and request an RMA number.
2. When returning the product, the RMA number you receive must be affixed to the outside of the packaging.
3. If, after sending and checking an offer, you choose to not carry out the repair, the inspection costs will be charged in the form of a service charges. (880€ + IVA + Shipping costs).

4. By sending the product to our service center, you authorize the product to be partially dismantled for inspection and fault analysis.
5. Dismantling the product can permanently damage parts. If the product then appears irreparable or you refuse the repair and request the return of the product, we cannot guarantee assembly in the original condition.
6. The returned product has to be free of any dangerous material or process remnants.
7. Please remove all adapters, connections, valves, attachments, etc. which are not internal components of the product. IPG Photonics assumes no responsibility for missing or damaged parts that are not internal components of the product.
8. Please return the damaged part within 30 days after receiving the RMA number.

16 Glossary

SI UNIT PREFIX USED (e.g. cm for centimeter)

T = tera (10^{12})	k = kilo (10^{3})	d = deci (10^{-1})	µ = micro (10^{-6})	f = femto (10^{-15})
G = giga (10^{9})	h = hecto (10^{2})	c = centi (10^{-2})	n = nano (10^{-9})	
M = mega (10^{6})	da = deca (10^{1})	m = milli (10^{-3})	p = pico (10^{-12})	

COMMONLY USED UNITS

s	second (time)
m	meter (length)
A or Amp	Amperes (electric current)
°C	Degrees centigrade or Celsius (temperature)
°F	Degrees Fahrenheit (temperature)
ft	foot (length)
Hz	Hertz or cycles per second (frequency)
J	Joule (energy)
g	grams (mass)
in	inches (length)
L or l	Liters (capacity)
lb	pound (mass)
N	Newton (force)
Ω	Ohm (resistance)
Pa	Pascal (pressure)
psi	pound per square inch (pressure)
rad	radian (plane angle)
V	Volt (electric potential)
W	Watt (power)
yd	Yard

ADDITIONAL SYMBOLS AND TERMS

λ	Lambda (wavelength symbol)

P_0	Max Average Output Power (in W)
P_p	Max Peak Output Power (in W)
t	Pulse Duration (in microseconds)
F	Pulse Repetition Rate (in kHz)
AC	Alternating Current
CDA	Compressed Dry Air
CDRH	Center for Devices and Radiological Health (U.S. Government)
CFR	Code of Federal Regulation (U.S. Government)
CPU	Central Processing Unit
CW	Continuous Wave (operating mode).
DC	Direct Current
EU	European Union is a political and economic union of 27 member states that are located primarily in Europe.
EN	European Norm
EN	International Electrotechnical Commission
HPP	High Peak Power (operating mode).
IP	Internet Protocol
IR	Infrared Radiation. Wavelengths range from 0.7-1000 microns.
LAN	Local Area Network
LCA	Laser Controlled Area
LD	Laser diode
OS	Operating System
PE	Protective earth conductor
PPE	Personal Protective Equipment
QBH	Quartz Block Head
QCW	Quasi-Continuous wave (operating mode)
rms	Root mean square or quadratic mean
TCP	Transmission control protocol
UV	Ultraviolet Radiation. Wavelengths range from 315-400 nm (UV-A), 280-315 nm (UV-B), and 100-280 nm (UV-C).

VAC	Voltage Alternating Current
VDC	Volts Direct Current
VIS	Visible Radiation. Wavelengths range from 400-700 nm.

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